Implementation Plan for the Research Activity of the Fondazione Bruno Kessler for the Year 2011

Trento, January 2011

Editoria n. 1 / 1-2011

Table of contents

Introduction

FBK has a tradition of excellence in various areas of research in information technologies, material sciences and the design and fabrication of microsystems. The year 2011 will correspond to a consistent growth in research activities and results, strengthening the presence of FBK research in an international panorama. The choice of objectives is aligned with European programmes and the national research plans, and concerns all areas of intervention that are traditional within FBK: from informatics to the science and technology of materials and of nanotechnologies, to microsensoristics and micromechanics.

The presence of FBK at an international level in the state of the art of research will be consolidated with: the realisation of advanced systems and prototypes, publications, invited presentations at congresses, presence in editorial boards of international specialised journals of notable diffusion and impact, presence in managerial boards of national and international scientific associations, and in European research networks.

At the same time, impact at a local level will be strengthened as well: FBK researchers will take part in commissions and committees, they'll organise schools, promote technological transfer and encourage innovation. The relationship established between FBK and the University of Trento deserves an explicit mention: the agreement between the institutions foresees strong involvement on behalf of FBK in advanced teaching, and in the research training for Ph.D. students. The cooperation concerns the information and communication technologies, mathematics, physics and engineering schools. Researchers from FBK will hold joint appointments for teaching courses at the University of Trento, both at the undergraduate and at the graduate levels, and will be present in the board of the Trento doctorate schools. Many doctor students will be hosted in the FBK labs, and prepare their theses while participating in FBK projects under the supervision of FBK advisors. There will be also students from the University of Trento that will spend some periods as interns at FBK, in particular for preparing their degree theses. This activity will be obviously in addition to collaborations between the two institutes for research projects of common interest.

FBK will also collaborate with the main national research bodies, and with agencies and qualified companies at a national and international level.

FBK is facing a period of growth and transformation. The challenge posed by such change (at local, national and international levels) in research strategies that concentrate more on projects and centres of excellence impose a change in ways of working, and the organisation of, and support to research in FBK. Hence the fundamental necessity currently facing FBK in order to attain its mission and expectations: competitive research on the international market with a strong impact also on the local market.

The goal for year 2011 is to strengthen the presence of FBK as a first rate research institute in the international scene, with a very strong presence in Europe, a strong national and local visibility, and impact. For this reason, the “Trento Research Innovation & Education System” (Trento-RISE) deserves a particular mention: Trento-RISE is an important FBK initiative, within the European Institute of Innovation and Technology (EIT). It represents a “new deal” for research and companies to work together, based on research that creates value and brings to innovation, going beyond academic education towards entrepreneurial education, and beyond technological innovation towards organizational, market, and social innovation. The objectives of Trento-RISE, a holistic approach to user-driven innovation, are the following: to contribute to the success of EIT, to be a first model of integration between research centers and university, to create a new model of collaboration between research and companies.

Furthermore, FBK has a long tradition in the humanistic disciplines which have historically conferred quality and distinction to the scientific research profile of the former Istituto Trentino di Cultura and the current Bruno Kessler Foundation and which have recently undergone an important riorganization process due to which the organizational transition as per the institutive law of the Foundation has been definitively completed. The distinctive characteristics of the new system layout, which the humanistic sector will have to implement as of 2011, can be summarized in the following chapters: valorization of the skills and scope heritage gathered over the years by the Centro per gli studi storici italo-germanici (ISIG) and by the Centro per le scienze religiose (ISR); focusing of research on strong horizontal scientific development lines, aiming to state of the art level; activation of vertical “application domains”, which will combine the specific expertise of each Center, benchmarking activity both locally and nationwide, also through the establishment of doctorate and post-doctorate programs; international alliances and collaborations. In particular, the large domains around which the critical mass and skills of both Centers for research and study will strengthen and expand have been identified in the subject areas of secularization, the public space and territoriality.

As specific research projects are concerned, the year 2011 will witness the start of the three-year project which ISIG will dedicate to “Transition” as a historiographical problem and big interpretative category of the steps which have reshaped modernity. As far as specific projects are concerned, the year 2011 will witness as well the focus of the activity of ISR on three distinct inquiry paths: fundamental religion as public religion; the body as a public space, and public and private in modern theory and practice. Regarding common research domains in which the two Centers will collaborate, some projects will benefit from the peculiar contribution of the Istituto per la ricerca valutativa sulle politiche pubbliche (IRVAPP), a research and study institution which, due to its significantly high performance at a national and international level, will count on a extended three-year local shareholder funding. IRVAPP together with Graphitech (Center for advanced computer graphics technologies), Celct (Center for the evaluation of languages and communication technologies) , Ahref, Create-Net (Center for research and communication) and CIRM (International center for mathematics research) represent important research and study entities which belong to a single network which, throughout 2011, will come even

closer by means of a strong efficiency-oriented effort of each transverse activity which will consolidate the central role of the Bruno Kessler Foundation in the context of non-academic research in our Province.

The Secretary General
ing. Andrea Simoni

SCIENCE AND TECHNOLOGY

CMM – Center for Materials and Microsystems

BIOMEMS – BIO MICROELECTRO-MECHANICAL SYSTEMS

Unit Name	BIOMEMS – Bio MicroElectro-Mechanical Systems	
Type	Research	
Head	Leandro Lorenzelli	
Staff	2010	2011
	7 Researchers	6 Researchers
	1 Technician	1 Technician
	2 PhD	1 Post Doc
		1 PhD (tbh)

Document Status: submitted 2010-11-30

1. Executive Summary

1.1. Objectives and main Activities

Starting from a background of expertises in microfabrication technology, microsystems and biotechnology, the mission of the BioMEMS research unit is the development of Microsystems and microsensors in three main areas: i.) biomedical diagnostics, ii.) biotechnology and iii.) environmental safety and security.

In the biomedical area, the main task is the development of technologies for “Lab on a Chip” (LOC) for the large-scale analysis of genes and proteins functionality and for the in-vitro analysis of cells in medical diagnostics.

In the biotechnological area, the activity is mainly focused on the development of microsystems for the detection of specific indicators of the quality of agro-food products especially in the wine sector.
In the environmental safety and security area, the main task is the development of technologies for MEMS-based sensors for water and gas monitoring.

From the technological point of view, starting from a consolidated approach based on fabrication technologies for solid state-based devices, the vision is to extend the knowledge to the development and the realization of a technological platform for mass producible flexible and conformable smart systems. The sensors will be based on flexible polymeric materials fully compatible with both MEMS and IC processes. The issues related to the improvement of sensor interconnectivity and 3D surface conformability will be considered as a primary task in this activity. New methods will be explored for stretchable interconnections between devices and conditioning electronics circuitry between different modules.

1.2. Personnel

In a multidisciplinary approach, the competences required by the group span from physics to biology and biotechnology, from electronic to material engineering. In this aim, from January 2011, the BioMEMS research personnel will be composed by 5 researchers (2 Electronic Eng, 2 Material Science Eng., 1 Physician), 1 tech-

nician, 1 Post Doc (EU-Marie Curie) 1 PhD Students (ICT – Electronics), and 1 researcher (Biotechnologist) with short term contract for R&D activities in the framework of an already approved project. The policy adopted during the past year 2010 allowed to have in charge at the BioMEMS group one more researcher in a permanent position and a post doc (EU- Marie Curie Actions).

1.3. Prominent collaborations

During 2011, the collaborations with the FBK Smart Optical Sensors and Interfaces (SOI) and Biofunctional Surfaces and Interfaces (BIOSINT) Research Units will be maintained and improved in order to expand the synergic and strongly interdisciplinary research activities for the study and development of new microsystems and microsensors in the biomedical fields.

External collaborations with research centers and universities will be focused to improve the technological issues inherent the main BIOMEMS scientific goals by introducing contributions in terms of complementary expertise and knowledge. A collaborative action on lab on chip for in vitro tests has been activated with the Centre for Integrative Biology (CIBIO) of the University of Trento (Prof. P. Macchi and Prof. O. Jousson). Moreover, specific strategic networking actions will be undertaken with the University of Milano as recognized reference points of research initiatives in the biomedical field and with Fondazione Filarete, an accelerator infrastructure, in order to evaluate a common strategy for a BIOMEMS possible spin-off initiative.

The research interests emerged during the 2010 on the field of the flexible electronics allowed to start research collaborations with some research centers operating in the same field (e.g. Technische Universität München - TUM))

2. Vision and Scientific Program

2.1. Vision and Goals

Innovative BioMEMS include the class of systems for diagnostics at cellular and molecular level, where the miniaturisation is generally considered the strategy to meet the requirements for efficient analysis and where further advances can be achieved by adopting a nano-microtechnological approach. In this aim, microsystems will provide essential interfaces between the macro world of human beings and the nano-world of molecules. The versatility offered by a multidisciplinary approach combining nano-microtechnology, nanomaterials and biology is the paradigm of a proposal for a BioMEMS research unit with high-tech content. The research on BioMEMS is aimed at the expansion of the synergic and strongly interdisciplinary research activities for the study and development of new microsystems and microsensors in the biomedical, biotechnological and environmental areas.

The fulfilment of this purpose is subordinated to the existence of collaborations with other Research Centers and University Departments with complementary expertises in fields such as materials science, nanotechnologies, biology and medical

diagnosis. With regard to knowledge transfer, we want to underline that the results of previous initiatives have already provided exploitation of results with SMEs and an increase of technological transfer activities is expected in the future.

In particular, the main research tasks are addressed to i.) biomedical, ii.) biotechnological, iii.) environmental safety and security, iv.) flexible sensors and systems areas. In details the main objectives will be:

– *Biomedical area main objectives*

  OB1: Development of innovative technologies for MEMS-based Lab-on-Chip (LOC) for gene and protein tests;

  OB2: Development of integrated systems for in-vitro cells assays.

  The BioMEMS research in the biomedical field is aimed at the study of microsystems devoted to four different classes of assays: MEMS-based microcantilever arrays for high throughput screens of gene (e.g. HLA - Human Leukocyte Antigens); arrays of integrated microPCR; protein assays using arrays of transparent microreactors coupled to an optical detection device; on-chip in-vitro tests of cells in medical diagnostics by means of electrically-actuated nanoporation approaches; on chip in-vitro drug screening tests using microfluidic mixers and gradient generators.

– *Biotechnological area main objectives*

  OB3: Development of a Multisensor Portable Monitoring System (MPMS) for agrofood applications.

  The overall objective of the biotechnological tasks is the realization of different scenario-tailored multiparametric systems for quality monitoring and decision support in the food production chains (e.g. wine). The target of this research activity will be the fabrication and experimental validation of Multiparametric Portable Monitoring Systems (MPMS) conceived for water and fermentation monitoring (i.e. wine yeast analysis). Concerning the last issue, an integrated platform for high-throughput screening (HTS) of wine yeast strains will be realized in order to improve the overall quality and productivity of wine making process.

– *Environmental safety and security area main objectives*

  OB4: Development of MEMS-based microsystems for environmental (indoor and outdoor) monitoring.

  In the safety and security area, the most appropriate technologies for the realisation low cost microsensors and microsystems will be investigated, aimed at gas monitoring (VOC-Volatile Organic Compounds, CH_4, CO, O_3, NO_x, H_2) in harsh environments (e.g. leakage monitoring of natural gas underwater pipeline) and for explosives (combined with pre-concentrators, solid state detectors, nano-guide) and fire detection (e.g. for forest arson monitoring by means of wireless networks). In the considered period, technologies and approaches for the realisation of integrated energy harvesting modules based on thermoelectric materials and polymeric MEMS substrates

will be investigated in order to guarantee the autonomous operation in distributed sensor networks.

– *Emerging technologies for flexible sensors and systems*

OB5: Tactile sensing arrays on flexible silicon

The goal is the development of tactile sensing modules and hence the skin for the humanoid robot, its integration with robot and subsequent use in the robot control loop for exploration and manipulation tasks. To this aim we will propose “smart” material films like piezoelectric polymers, as sensing element at the gate of a FET/TFT device for the implementation of touch sensors. A distribution of such devices over/into a flexible substrate will form the robot skin. Extensive experimental validation of the skin system and its suitability to various interaction, exploration and manipulation tasks will be performed on humanoid platforms.

2.2. Context and State of the Art

In this paragraph, some specific considerations concerning the technological aspects of the three considered application areas (biomedical, biotechnological, environmental) will be highlighted.

1.2.1. Microsystems for the biomedical area

a. Biomedical microsystems for *in vitro* analysis of cell cultures.

The development of new microsystems for *in vitro* cell culture analysis (Lab on a Cell, microelectrode arrays, micro-bioreactors) can provide real time information about the biochemical behaviour of a cell, when exposed to specific pharmacology treatments, and models to predict the toxicological effects at systemic level. New microsystems for cell analysis might be able to guarantee a real time control of the cell conditions not only in whole cell populations, but also for single cells. Moreover, in biomedical field there is a wide interest in the possibility to genetically handle single cells for gene therapy application. As a consequence, in the last years a strong interest has been focused on the fabrication of chips for electroporation and transfection, based on microelectrodes able to locally induce electric fields. Electroporation, compared to conventional transfection methods, has the advantage to be less invasive, since the induced cell membrane permeability is transitory and reversible. New microsystems have also been presented, using microfluidics to create trapping sites for cells and to guarantee a selective and local electroporation.

b. Biomedical microsystems for biomolecule detection through bioaffinity tests.

In the last years, many research activities have been dedicated to the study of chemical-biological sensors. Among different options, the most promising candidates for the future generation of sensors for bioaffinity tests are the systems based on microcantilevers (by means of surface stress or mass changes measurements) and using surface biofunctionalization technolo-

gies, able to perform high resolution and label-free measurements. Nowadays there is a big interest towards the fabrication of devices with thousands of integrated microcantilevers, as an alternative to the DNA microarrays and protein chip, since they can provide a high level of parallelism and real time, label-free detection of nucleotides hybridization, specific proteins and pathogenous elements. The strategy is to combine the high sensitivity of microcantilevers with respect to specific biomolecules with microfluidic structures to create sophisticated Lab on Chips (LOCs). Moreover, nanofabrication technologies can allow reaching sensitivity limit allowing the detection of single SNPs (Single nucleotide polymorphisms) in real time and the realisation of sophisticated and integrated systems for genomics and post genomics. The integration of the scientific areas cited above can be suitable for the design and fabrication of screening and diagnostic devices, which will have an impact on the health and welfare, and which are priority themes in the research guidelines of the European Community.

1.2.2. Microsystems for the biotechnological area

In the last years, the biotechnological field has expressed an increasing interest for methods and instrumentations suitable for a widespread quality control of the products during the production and the distribution, from the raw material to the end users. Traditionally, the quality control is performed off-line by specialized analysis laboratories; consequently, the development of on-line systems and sensors is an important added value for the effective monitoring of the most significant chemical-physical parameters. The synergy between nano- and micro-technologies has demonstrated a great potential for the development of microsystems based on miniaturised chemical-physical sensors, able to provide information useful for the quality control of the biotechnological processes. Advanced sensor techniques, as e-nose and e-tongue (electronic nose and tongue) using, for example, sensors coupled with biomolecular membranes, have strongly advanced in the last ten years. However, their success has been limited by issues such as a low lifetime and stability of bio-chemical components used as catalyst agents, the complexity of the chemical matrix in which the analytes must be detected and the presence of interfering substances. In order to reduce the interfering effects, MEMS technologies allow the miniaturisation and the integration of more sophisticated systems based on chemical separation (liquid-gas chromatography and electrophoretic methods) and on the sample pre-treatment. The combination of highly innovative technologies, devices and materials are fundamental for the development of multiparametric systems able to analyse liquid and gas mixtures and to discriminate the product quality. The dimension and cost reduction will allow a strong development of laboratory systems, in terms of performances and wide distribution. In perspective, these systems may substitute the expensive panel test and destructive laboratory analysis currently used.

1.2.3. Microsystems for the environmental security area

The main objective in the environmental security area is the development of knowledge and technologies needed to ensure the citizen security and to control

and prevent risks coming from different society areas. Control of life quality in terms of environmental security requires the development of sophisticated, reproducible and reliable analysis systems. Advanced microsystems technologies have the capability to answer adequately to new requirements in the environmental security field. In this sector, the state of the art presents various technological approaches and methodologies able to measure the parameters of interest with high accuracy. Many sophisticated laboratory techniques (Thin Layer Chromatography, Ion Mobility Spectrometry, Gas Chromatography (GC), Electron Capture Detector (ECD), Thermal Energy Analyzer (TEA), Mass Spectrometer (MS), High Performance Liquid Chromatography (HPLC)) allow the measurement of target parameters; however, the complexity of the used systems, long measurement times and the sample pre-treatment through expensive instrumentations often constitute a limit to the utilization of these techniques for the environmental control and security. The development of Microsystems in this field will allow a high integration level, fast response, low cost and widespread covering by means of both fixed stations wireless connected and portable systems with low power consumption. Microsystems based on miniaturised sensors can create new areas of application such as portable systems for on field measurement and for distributed monitoring architectures which have a high added value for environmental security with respect the already available technologies.

1.2.4. Emerging technologies for flexible sensors and systems

Electronic systems that can cover large areas on flexible substrates have received increasing attention in the last couple of decades. This type of electronics sometimes referred to as macroelectronics, uses TFTs distributed over large areas. Thin devices possesses properties like compliance, flexibility, conformability, elasticity, lightweight, etc. for a wide range of applications such as tactile sensors, flexible displays, electronic paper, electronic skin etc. Here, the overall size of the systems rather than the minimum feature size of an individual circuit component represents the primary scaling metric. A variety of semiconductor materials ranging from amorphous silicon, to small molecule organics and polymers, to polycrystalline silicon, and other inorganics, to carbon nanotubes, have been explored for large area flexible electronics. Thin film transistors (TFTs) represent, by far, the most successful systems for applications in large area electronics. Among organic semiconductor materials, two classes of materials, namely molecular compounds and polymers, have been used for flexible electronics. An emerging direction in research is to develop alternative materials and patterning techniques, with a goal of increasing performance, decreasing cost (per unit area), and enabling large area electronic systems to be formed on low cost, bendable substrates. Organic semiconductors are more studied for flexible electronic applications than some of the inorganic approaches (e.g. nanowires, nanocrystals). However, the modest performances demonstrated so far by organic semiconductors are limiting their range of applications. By contrast, many inorganic semiconductors exhibit high carrier mobilities and excellent stability. Concerning the BIOMEMS field, stretchable TFT circuits have also been reported for sensitive tactile sensors in smart skin applications. Recent advances in silicon based thin films

makes it is possible to fabricate high performance, flexible and foldable integrated circuits. While some of the high-performance real-time robotic applications require to read signals from touch sensors at high speed, in other cases the speed may not be the key issue. Different technologies have their respective advantages and disadvantages. Thus merging different technologies can enable new possibilities for the skin system.

2.3. Activities and Work Plan

In order to accomplish the scientific and technological main goals of the BioMEMS research unit, specific effort will be carried out through the considered activities. The first two activities are mainly focused on basic and applied research, while the third one, which is based on more consolidated technologies, is expected to provide also an effective technological transfer. These activities will run almost in-parallel, contributing to the overall goals of the scientific and technological research. Design, development, implementation and integration provide a logical sequence of keywords for the proposed research activities. At various phases of the tasks, validation procedures will be performed, ensuring that the implemented approach was successfully completed. As internal assessment approach, we will provide all the terms and methodologies to periodically validate and evaluate the individual steps, while experimental prototypes will be carried out at different stages of the objectives time-periods. The exploitation and dissemination of the results will constitute an additional activity for the whole duration of the research. All the activities concerning BIOMEMS research unit have been also included in the budget description and the percentage involvement of human resources has also been considered.

The description of the overall activity is analyzed according to the following work plan.

A1 Innovative technologies for MEMS-based Lab-on-Chip (LOC) for gene and proteins tests.

Starting from the state-of-the-art in the literature, a suitable configuration for the LOC will be studied, in order to provide the handling of DNA samples, PCR amplification and HLA typing with a label-free approach based on a microcantilever array of appropriate size functionalised with oligonucleotide probes. The label-free detector will be realised with a microcantilever array working in the bending mode (i.e. in the stress-detection mode), which is more suitable for operating in liquid phase. The technologies involved will deal with both ad hoc MEMS approaches for the realisation of thin suspended Silicon beams with tight thickness control, and the implementation of thin film cantilevers compatible with CMOS microelectronic processes. The possibility to perform similar test by using field effect transistors will be also evaluated during the 2011. For what concerns protein tests, a fluorescent based detection approach will be followed. The aim is to realize an integrated MEMS-based microreactors array consisting of a matrix of transparent plugged wells realized on an opaque silicon substrate. The array will provide a number of reaction sites in the same chip that can be independ-

ently functionalized and monitored allowing for a fast and all-on chip analysis.

A2 Integrated systems for in-vitro cells assays

The main goal of this task is the development of microsystems (Lab on Cell) for the study of the function of genes and proteins on in-vitro cell and more in general for monitoring the electrophysiological behaviour of a cell populations (e.g. neurons) after a bioelectronic or a biochemical stimulus. In the present approach, the microsystem will include MEMS-based single cell-poration techniques, specific modules for cell handling and separation, high density microelectrode array for cell stimulation and electrophysiological signal recording, and microfluidics for cell transfection of specific biomarkers for the recognition of pathogen mutations. An important aspect will concern the involvement of CIBIO (University of Trento) in these activities. These collaborations will encompass a basic research for the study of nanostructured materials with specific morphological and reactivity surface properties aimed to improve the microsystems biocompatibility and to promote the cell growth and the synthesis of biomarkers. During the 2010 the technological platform has been consolidated and in the 2011 the implementation plan for a spin off initiative will evaluated.

A second goal will be the realization of a microfluidic network for cell analysis in space laboratories for drug screening tests. With this aim, in the framework of a project financed by ASI (Italian Space Agency), different solutions for MEMS-based micro-bioreactors for in vitro tests will be integrated on chip in order to study the drug concentration effects on cell growth and differentiation.

A3 Multisensor Portable Monitoring System (MPMS) for agrofood applications

This activity will be devoted to the development of technologies for the realisation of an integrated system for the detection of indicators of biotechnological parameters. The main application of this system is the control of fermentation processes in the oenological field. In particular, components and portable systems with high integration level will be developed, using integrated multiparametric microsensors (ISFETs, conductivity and temperature sensors) to monitor cell growth assays especially focused on yeast quality assessment for wine applications. The research activity will also encompass the an evaluation study aimed to adopt microPCR modules for yeast analysis.

A4 Microsystems for environmental gas detection

In the safety and security systems field, the main objective is to develop innovative systems for gas detection suitable for distributed sensor-based architectures.

Starting from a consolidated technological platform for the realization of microheaters onto thin membranes (MEMS-based microhotplate), new technologies will be implemented to extend the potentialities of this class of sensors. In particular the improvement of these devices will be focused on the selectivity towards different gaseous species and on microsystems based on

integrated pre-concentrators for the detection of volatile substances and high vapour pressure gases in the part per billion (ppb) range. The application of this research activity will concern both indoor and outdoor fields where the miniaturization is an essential advantage. In indoor applications, the attention is focused on the development of integrated sensors for the detection of dangerous emissions like NO_x, CO, SO_x, hydrocarbons. In outdoor applications the interest will be focused on the development of systems for the detection of different gases, such as H_2, in fire detection applications inside the forest and for the detection of nitro-derived compounds released by explosives. In addition, in order to enable the implementation of autonomous sensors nodes, activities related to the development of thermoelectric energy harvesting will deal with the study of polymers modified with opportune fillers for the realisation of thermally conductive substrates (hot junction), and of suspended structures for thermal insulation of cold junctions.

A5 Tactile sensing arrays on flexible silicon

The activity will be focused on the study of a limited set of candidate transduction technologies for contact sensing; piezoelectric polymers, resistive, capacitive - being the most promising candidates for measuring geometric and mechanical quantities. The possibility of having transducers and conditioning electronics on same medium (or chip) will be explored as this will help to increase the signal to noise ratio and hence overall performance. Following this approach, each sensing device will have the transducer directly on a FET/TFT device, thereby reducing the length over which touch signal is transferred for further processing. Such a coupling of transducers (e.g. smart materials like piezoelectric polymers) with FET/TFT devices on rigid (e.g. silicon), or flexible (e.g. elastomeric) substrates, would result in improved performance and would possibly reduce the number of connections, which is a major issue in robotics.

2.4. Collaborations

1. Interdisciplinary Centre for Nanostructured Materials and Interfaces (CIMAINA), University of Milano, and Fondazione Filarete

   Reference Person: Prof. Paolo Milani

   The collaboration with both the University of Milano and Fondazione Filarete will be strategic for 2010 BioMEMS activity for the high scientific contents in the nanobiotechnological fields for the possibility of networking actions. During the 2010, the collaboration will concern the implementation of nanostructured materials on polymers as substrate for biomedical devices.

2. Laboratory of Biological Structure Mechanics – LaBS – Dept. of Structural Engineering Politecnico di Milano

   Reference Person: Prof. Gabriele Dubini and Prof. Pasquale Vena

   - Development of microfluidic modules for drug gradient generation and mixing fabricated using polymeric material. Micro-bioreactors will be integrated

in the chip in order to study the drug concentration effects on cell growth and differentiation.

- Mechanical characterisation of flexible microstructures.

3. Scuola Superiore Sant'Anna - Pisa

   Reference Person: Prof. A. Menciassi

   Modelling and development of microfluidic actuations modules (peristaltic micropumps and integrated valve for microfluidic handling) in lab on chip application.

4. Italian Institute of Technology (IIT) and Dept. of Biophysical and Electronic Engineering – University of Genova.

   Reference Person: Prof. G. Cannata, Prof. M. Valle, Prof. Sergio Martinoia

   - Development of innovative technologies for flexible tactile sensor array in robotic and haptic applications.

   - Development of 3D on chip scaffolds for in-vitro electrophysiological tests on neurons.

5. Technische Universität München (TUM)

   Reference Person: Prof. Paolo Lugli and Prof. Gordon Cheng

   Development of innovative technologies for flexible sensors.

6. Russian Research Center "Kurchatov Institute", Institute of applied chemical physics, Moscow

   Reference person: Prof. Alexey Vasiliv

   Deposition procedures of metal-oxides thik films on microhotplate-based gas microsensors for environmental applications and fire detection.

7. Universidade Federal de Santa Catarina, Bairro Trindade – Florianópolis - SC – Brasil

   Reference persons: Prof. Roberto Marchiori, prof. Andrè Pasa, Prof. A. Lago

   The collaboration with the University of Santa Caterina will mainly concern the following topics: a.) innovative technologies for carbon nanotubes deposition on microchip for both gas and biomedical applications; b.) Material study and development of technological approaches to magnetic-based microdevices; c.) Development of heath flow sensors based on miniaturized thermocouple integrated on silicon.

8. E&ECE Department, IIT Kharagpur India

   Reference persons: Prof. Tarun Kanti Bhattacharyya

   In the framework of ITPAR II a Trento-India research collaboration founded by Autonomous Province of Trento will be pursued a research activity related to the development of biomedical device for cell analysis based on chemical sensors. The collaboration will also encompass mobility of researchers (PhD and post doc).

2.5. Specific Needs and Points of Attention

Specific needs in terms of acquisition of special equipment foreseen during the 2011 are mainly related to the acquisition system for mechanical characterization of tactile sensors. From the personnel point of view main attention points will concern the assessment for a tenure track position or contract renewal (within the December 2011) on microfluidics.

3. Goals

All the 2010 goals were successfully achieved. The scheduling of the 2011 goals is reported in the following table.

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
G1 Microreactors for gene and protein tests.	R	E	Dec.	Goal 100%: development and testing of the final prototypes in experimental conditions	-
G2 MEMS and FET-based detectors for bioaffinity tests	R	E/I	Dec.	Goal 100%: development and testing of the MEMS silicon chip; Goal 50%: development and testing of the FET based silicon chip;	-
G3 Integrated systems for single cells in-vitro assays	R/I	E/I	Dec. Sept.	Goal 100%: development and testing of the proposed devices. Goal 100%: implementation plan for a spin off initiative	-
G4 Array of Multisensor Portable Monitoring System (MPMS) for yeast analysis	R	I	Sept.	Goal 100%: development and testing of the proposed devices and results dissemination.	-
G5 Development of MEMS-based microsystems for gas monitoring	I	E	Dec.	Goal 100%: development of a technological platform for microhotplate for fire detectors	-

				and indoor gas monitoring	
G6 FlexibleTactile sensing arrays	R	E	Dec.	Goal 50%: development and characterization of a set of flexible tactile sensors array for robotic applications	-
G7 Results dissemination	R	E	Sept.	Goal 100%: organization of conference session for results dissemination of FBK research initiatives on nano-micro.	-

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. September)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

From January 2011, the composition of the BioMEMS research personnel will be: 5 researchers (2 Electronic Eng, 2 Material Science Eng., 1 Physician), 1 technician, 1 PhD Students (ICT – Biotechnology) and 1 post doc (EU Marie Curie), 1 researcher with short term contract for R&D activities in the framework of an already approved project. During the 2011, the following actions will be proposed:

PhD and Post Doc positions: In order to broaden the knowledge on specific sectors of interests (i.e. technologies for flexible sensors, innovative materials for sensors and microsystems), during the 2011 a policy aimed at the involvement in the BIOMEMS research unit of PhD and post Doc researchers by means of specific national and EU research actions for researcher mobility (e.g. Marie Curie Actions) will be pursued.

Training and visiting researchers: During the same period the BioMEMS research unit will host foreign PhD students and graduate students for short term stages on microtechnolgy and flexible electronics.

Tenure track position: Main attention points will concern the assessment for a tenure track position aimed to guarantee and to consolidate the internal group expertise on microfluidics.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Risk 1: Specifically for the biomedical device sector (DNA sensors), lack in the sensors reliability (e.g. low sensitivity and reproducibility).	M	S	Depending on the cause of the risk (technological or physical-chemical) contingency actions will be the improvement of the fabrication of technological steps and of the surfaces functionalisation procedures.
Risk 2: Lack at the system integration level of the proposed microsystems	L	L	Evaluation and investigation of all the aspects related to the system integration **before** the development of the optimized versions.
Risk 3: Lack of expertise in particular key sectors could emerge in case of changes in the BIOMEMS research staff.	M	S	Transfer of individual expertise and knowledge to other researchers. An accurate analysis of risks and deadlines for any project.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

SOI – SMART OPTICAL SENSORS AND INTERFACES

Unit Name	SOI – Smart Optical Sensors and Interfaces	
Type	Applicative / Research	
Head	David Stoppa	
Staff	2010	2011
	8 Researchers	7 Researchers
	4 Technologists	2 Technologists
	2 Post Doc	1 Consultant
	2 PhD	3 PhD

Document Status: submitted 2010-12-02

1. Executive Summary

1.1. Objectives and main activities

The mission of Smart Optical Sensors and Interfaces - SOI - Research Unit is devoted to the integration on silicon, by means of state-of-the-art CMOS technologies, of smart optical sensors and full custom read-out interfaces.
Smart and highly integrated microsystems are developed by integrating, onto the same substrate, besides the detector elements, also electronic blocks, which fully or partially provide a local processing of the information generated by the detector itself.

The main objectives of the Unit are related to the design, fabrication, test and system integration of innovative and intelligent sensors with particular focus onto four main research topics:

i) single-photon, time resolved image sensors;

ii) IR/THz multispectral imagers;

iii) energy aware sensors;

iv) read-out interfaces for above-IC or hybrid sensors.

The work carried out during the life of the Unit (whose activity started in the 90ties), and especially that conducted in the last four years has been recognized by the international scientific community and has been the basis for a good number of funded projects both from the European FP6 and FP7 Programmes and from the local government (PAT).

The main expertise build up by the Unit's researchers is in the field of high sensitivity optical detector architectures which can be employed in different sensing device spanning from life science to ambient assisted living and from safety and security to cultural heritage preservation.

The skills in designing smart electronic interfaces, especially readout of arrays for multispectral sensors, have an important role in the research activity of SOI, as well as the competences developed in the field of low power imaging sensors for wireless sensor networks. Most of these activities are driven both from scientific chal-

lenges as those set by the international funding agencies like the EU as well as from roadmaps set by the leading industries in the fields of Microsystems. Moreover the research activities of SOI run along the lines dictated scientific strategic program of FBK for the period 2008-2013.

1.2. Personnel

The Unit is composed by a staff of 9 highly motivated persons, 7 of them carrying out research in the research fields mentioned above, while 2 are technologists supporting the research through activities of testing and prototyping. The consultant is mainly devoted to the development of the software, firmware and PCBs design required by the SOI sensors at an advanced stage of characterization. SOI has also three PhD students whose research activity is focused onto the first three main research topics of SOI.

Besides the professional skills in the design of integrated circuits, exhibited by SOI researchers, team working is one of the strengths of the group, which allows it to perform well also under demanding conditions.

1.3 Prominent Collaborations

Most of the sensors or interfaces, designed by SOI, connect the analog world to the digital domain of information technology, so that the Unit's activity lies within the overlap region between the two main research Centers of FBK: CMM and CIT. This allows the Unit to establish collaborations with Units of both Centers, as for example BIOMEMS, MEMS, ES and M2B2.

Within the external collaborations it is worth to mention those with national universities and institutes working in the field of detectors and machine vision such as Universities of Trento and Pavia, Politecnico of Milan, CNR-IMM and CNR-INOA where projects and ideas are elaborated and put forward. At international level, strong collaborations have been started with CEA-LETI (F), BOSCH GmBH (D) and THALES (F) for the activity on multispectral imaging, and with CSEM (CH), Technisce University of Delft (The Netherlands), STMicroelectronics (UK and France), Univ. of Edinburgh (UK), Univ. of Budapest, MEDISO (HU) for the activity on time resolved imaging.

The activity on energy-aware sensors is carried out together with Univ. of California, S. Cruz (US), Emza Visual Sense (IL) and Neuricam (I).

2. Vision and Scientific Program

Since ever the main activity of SOI has been focused on the integration of optical sensors on silicon, using standard CMOS micro-fabrication technologies. In 2007, when FBK took over ITC, the Unit's activity went straight into the new strategies of the Foundation contributing both to the *Nano and Micro Technologies – NMT* and to the *Embedded Intelligence and Systems - EIS* research programs, through the applicative domains on *Radiation Detector*, *Life science* and *Energy and Environment*. Within these contexts the focus of research has mainly been on advanced

optical/vision sensors, energy aware sensors, and smart integrated interfaces. All these activities have been carried out within funded projects and are the basis for the further and future development of the Unit's activities, which, as mentioned above fits with the FBK strategies but also with the directions of the Work Programmes set by the European Union within FP7 (2007-2013).

2.1. Context and State of the Art

The Strategic Research Agendas of the SOI international reference scientific communities, Photonics21 (www.photonics21.org) and EPOSS (www.smart-systemsintegration.org), set the roadmaps for the development of integrated sensors for the next 5 years. SOI keeps pursuing its activity taking specifications for developed sensors from the above mentioned SRAs and at the same time keeps track of the requests coming from the local industrial community in order to develop knowledge that might be useful or used for commercial exploitation, preferably by means of local SMEs.

In the domain of advanced optical/vision sensors, the activity is focused on *single-photon time resolved imaging sensors* and *multispectral imaging sensors*.

– *Time resolved imaging sensors* are detectors capable of measuring the impinging photon flux intensity and its time distribution onto a nano-second time scale. When compared with traditional passive digital camera, they offer great potential of improvement in many areas such as machine vision, virtual reality and ambient assisted-living, where they are used to extract the distance information of the objects in the scene or in life sciences where investigation tools such as fluorescence-lifetime imaging microscopy (FLIM) allow the mapping of many cell parameters and the detection of pathologies or DNA sequencing.

  The SOI unit is involved within two FP7 European projects where time-resolved imagers are developed. The SPADnet project targets the design of a totally new concept detector: a sensor network consisting of photonic modules, fabricated within deep-submicron CMOS imaging technology, capable of single-photon counting and picosecond time resolution specifically conceived for new generation Positron Emission Tomography (PET) machines. Each module can communicate with the other sensors in the network providing a sort of distributed intelligence. This feature will have a dramatic impact in the self-detection of coincident gamma-rays within the sensor network, thus reducing the amount of data stream out from the PET scanner, and enhancing the system resolution performance.

  On a different research topic it is the NETCARITY project, which aims at the development of a low-cost 3D camera sensor for tracking elderly people within their home and detect situations of danger like falls or collapses. Within this project SOI conceived a new photo-detector, which allows the realization of time-resolved pixel having a pixel pitch of 10um only, representing the smallest pixel ever developed, while a QVGA-format 3D camera –

one of the largest spatial resolution in the world - is under development to conclude the project.

– *Multispectral imaging sensors*. Detection and generation of THz electromagnetic frequencies (300GHz-30THz) has become one of the challenges of these years: the peculiar properties of the electromagnetic radiation in the terahertz region makes it interesting in the field of security and surveillance, industrial production control, materials science, environment and biomedical sensing. Currently no practical THz imager exists. Some —millimetre waves detectors have been developed in the region of 95GHz using heterodyne detection and antenna coupled bolometers. A sensor, although with a low sensitivity, has been demonstrated at 600GHz with only CMOS devices using oscillations of the electron plasma under the gate. Other devices suitable for imaging are built using quantum wells in expensive processes and materials and need cryogenic cooling. It is clear that there is a lack of a reliable and cost-effective THz detector suitable for imaging.

  SOI Unit is involved in the project MUTIVIS (FP7) where the main goal is the development of a medium resolution multispectral detector for visible, infrared and terahertz regions of the spectrum, capable also of spectroscopy capabilities. Within the project NAOMI, “Grande Progetto” of the Autonomous Province of Trento, SOI has an activity regarding the development of a single point THz detector for biological analysis. In these projects SOI is working together with big players like CEA-LETI (Grenoble, France), Thales (France), Bosch (Germany) who recognize the expertise and skills of SOI’s researchers in the integration on silicon of readout and processing electronics.

  There is finally an internal project running in collaboration with TUM-Munich (Prof. P. Lugli) and UNITN, aimed at implementing organic detectors on the top of a CMOS substrate in order to put the basis for the development of an organic, multispectral camera.

– *Energy aware sensors* are a big challenge in the implementation of the ICT program, above all for the topic regarding wireless sensor networks (WSN) and surveillance applications. Current visual sensors (for video surveillance, traffic monitoring etc.) are large, complex systems, often having separate cameras and video analysis servers. While wireless cameras are commonplace, a wireless visual sensor that needs no external power supply can today be rightfully considered as science fiction.

  The activity of SOI in this field started in 2008 and is mainly devoted on the development of ultra-low power sensing techniques and architectures for 2D vision sensors. Although several implementations have been proposed for low-power CMOS vision sensors, currently the FBK sensor is the one exhibiting the best performance with 100μW max at 3.3V and 50fps. This is the first step toward the demonstration that vision technology is mature for energy-autonomous wireless sensor networks applications. In 2009, SOI started a research project (Battery Operated Vision System for Wireless Applications – BOViS), funded by a bilateral agreement between Israel and It-

aly for further investigating this topic. After less that one year, FBK developed the first working prototype of vision sensor, in collaboration with Emza Visual Sense (IL), embedding a proprietary auto-adaptive algorithm for monitoring applications.

– *Smart integrated interfaces* are preferred over interfaces realized with standard off-the-shelf components whenever the integration and miniaturization of an electronic sensing systems has to be pushed to the limits of volume occupancy, reliability and customization. This is true in particular when the transducer, which is the front end of the sensor, is fabricated with a technology which does not allows the integration on the same substrate of both the sensing element and the reading and conditioning electronics, i.e. when CMOS compatibility is lacking. The smart integrated interfaces topic is particularly pushed in the SRA of the EPOSS technology platform where the paradigm *more-than-moore* pushes microsystem integration towards extreme miniaturization on one side and multifunctionality on the other.

  Although not being within the core activity of SOI, in the past three years works have been carried out with the support from funded projects such as MIDALCO, GOODFOOD and will be further supported in 2011 from the projects POCEMON (FP7) and NAOMI. It is important to stress that the activity is conducted in strong contact with other Research Units of CMM, i.e. M2B2, BIOMEMS and MEMSRAD, whose work on functionalized surfaces and transducers is complemented and completed by the design of an integrated readout and conditioning electronics. And, as more and more transducers will be produced with non-compatible CMOS processes, an increasing in the activity on this topic is expected. Even optical sensing could benefit from smart interfaces when the radiation to be sensed is outside the sensitivity interval of silicon.

References

- D. Stoppa, N. Massari, L. Pancheri, M. Malfatti, M. Perenzoni, L. Gonzo, “An 80×60 Range Image Sensor Based on 10μm 50MHz Lock-In Pixels in 0.18μm CMOS”, Proc. of IEEE International Conference on Solid-State Circuits ISSCC10, pp. 22.7, Feb. 2010.
- L. Pancheri, D. Stoppa, “A SPAD-based Pixel Linear Array for High-Speed Time-Gated Fluorescence Lifetime Imaging”, IEEE European Solid-State Circuits Conference (ESSCIRC`09), Athens, pp. 428-431, Sept. 2009.
- D. Stoppa, F. Borghetti, J. Richardson, R. Walker, L. Grant, R. Henderson, M. Gersbach, E. Charbon, “A 32x32-Pixel Array with In-Pixel Photon Counting and Arrival Time Measurement in the Analog Domain”, IEEE European Solid-State Circuits Conference (ESSCIRC`09),cpp. 204-207, Sept. 2009.
- O. Sgrott, D. Mosconi, M. Saiani, D. Stoppa, G. Pedretti, M. Perenzoni, L. Gonzo, “A 134-pixel CMOS Sensor for Combined Time-of-Flight and Optical Triangulation 3-D Imaging”, IEEE European Solid-State Circuits Conference (ESSCIRC`09), pp. 208-211, Sept. 2009.

- J. Richardson, R. Walker, L. Grant, D. Stoppa, F. Borghetti, E. Charbon, M. Gersbach, R. Henderson, “A 32x32 50ps Resolution 10 bit Time to Digital Converter Array in 130nm CMOS for Time Correlated Imaging”, IEEE Workshop on Advanced Image Sensors (IISW), 2009.
- N. Massari, M. De Nicola, N. Cottini, M. Gottardi,”A 64 x 64 pixels 30μW Vision Sensor with Binary Data Compression,” Proc. IEEE Sensors 2010, Waikoloa, HI, 1–4 Nov. 2010.
- N. Massari, M. De Nicola, M. Gottardi,”A 30μW 100dB Contrast Vision Sensor with Sync-Async Readout and Data Compression,” Proc. European Solid-State Circuits Conf., pp. 138-141, Seville, Spain, 14-16 Sept. 2010.
- N. Massari, M. De Nicola, G. Pedretti, M. Gottardi,”A New High Dynamic Range Oscillating Pixel for a bio-Inspired Sensor,” Proc. BIOCAS 2010, Paphos, Cyprus, 4-5 Nov. 2010.
- L. Gasparini, R. Manduchi, M. Gottardi,”An Ultra-Low-Power Contrast-Based Camera Node and its Application as a People Counter,” IEEE International Conference on Advanced Video and Signal-Based Surveillance, Boston, 29 Aug. – 1 Sept. 2010.

2.2. Vision and Goals

The roadmaps for contactless sensing set by scientific and industry panels and the increase of automation and remote monitoring applications let foresee an increase in the request of miniaturized, low power smart sensors, optical sensor are not an exception and will also follow the same trend.

The vision of SOI for the next three to five years is therefore that of consolidating its expertise and recognition level on integrated optical sensing, this approach is also in agreement with what proposed by the scientific strategic planning of FBK (known as Accordo di Programma 2008-2013, *AdP2008-2013*) and supported by the Autonomous Province of Trento.

Concerning *Time resolved imaging sensors*, the activity on the 3D imagers has produced excellent results and has contributed to advance the state of the art on these components. However, the NETCARITY project, which has partially funded the activity is planned to finish by March 2011 and, unless new projects are acquired, research on this topic will slow down. The technology developed so far could now enter a stage of market research for possible commercial exploitation; interests from companies like MESA Imaging, Siemens and OptoI have already been shown. IP protection/violation investigation is under way (Italian patent already submitted, EU extension requested) and, in parallel an activity of application driven system integration should be conducted.

The future challenges pursued by the scientific community in the field of time-resolved imagers are in the direction of increasing the number of pixels (megapixel sensor), solve the problem of background illumination and extend the dynamic range. SOI Unit will explore new SPAD device structures and advanced pixel topology to realize a very compact pixel with in-pixel photon counting capability, which could potentially lead to the development of large SPAD array camera. In this context the on going project NETCARITY, NAOMI and SPADnet will support

the activity for the next one to two years. Furthermore, new proposals will be submitted to upcoming calls to strengthen the research onto this topic.

On the front of *Multispectral imaging sensors*, the developments in the field of THz sensing will continue and follow different paths. One will be to continue the collaboration with our French partner CEA-LETI with the purpose of being recognized as reliable provider of readout circuits for their sensors with deep knowledge of the involved physical principles and technological constraints.

The other path will be to pursue a high-risk but high-pay off activity of investigation of alternative techniques which will enable FBK to take the lead in the development of THz sensors. This attempt will be made by exploiting solutions that will either foresee the use of the only CMOS technology for the sensing, and the exploitation of the FBK microfabrication capabilities.

At the same time, following also roadmaps given by the European technology platform Photonics21, developments will be aimed at achieving multispectral and multifeature imaging sensors implementing on the same substrate different sensing technologies and different functionalities. Previous and current experience will allow to pursue the combination of X-ray, IR, visible, THz imaging, in passive or active, time-resolved and high-dynamic range sensors. Preferred fields of application for such sensors are the security, scientific, and biomedical environments.

*Energy aware sensors***.** Custom CMOS low power sensors need to be exploited through proper initiatives both, at research level and at application level. The main goal of BOViS project is exactly in this direction. Moreover, EnerViS, FP7 STREP project proposal passed the evaluation step with 10.5, although is was too low to be funded. The project aimed at approaching the same topic, putting big emphasis on the power consumption of each component of the system.

Thanks to the preliminary results reached in the BOViS project, FBK and Emza Visual Sense started organizing an EU project toghether with other partners (Fraunhofer Institut (D), Univ. of Pavia, Univ, of Kent, JCP (F)), in order to strenghten the previous EnerViS project. This new initiative aimes at developing a complete energy-autonomous vision system based on groundbreaking interdisciplinary technologies (energy-aware algorithm, custom vision sensor, 3D CMOS technology, ultra-low power RF technology, Micropower energy harvesting).

*Smart integrated interfaces. A*lthough it may be a promising field, the effort of SOI in this activity will maintain a low profile or eventually merge in the multispectral imaging sensors field. Nevertheless, the activity will still support requests coming from other Units within CMM. The project POCEMON, which will require important efforts during 2011, will be the main funding source of the activity for the next two years.

2.3. Activities and Work Plan

During 2011 the activities of SOI will follow the planning set both from the ongoing projects and the AdP2008-2013. The internal activity will be focused more in the definition of a strategy which will allow to get the critical mass on topics in line with FBK strategic plan, while slowing down activities which might run out of scope. A lot of efforts will be devoted to scientific dissemination both through the conven-

tional channel of publications onto journals and conferences, and organizing important events such as international conference and workshops. The research activity according to ongoing projects will be the following:

– NETCARITY: the final 320x256-pixel 3D-TOF sensor will be tested and a prototype 3D camera will be assembled and extensively characterized. The prototype will be tested as a fall-detector for elderly people homes in cooperation with the image-processing algorithms developed by Univ. of Lecce.
– NAOMI: the two final devices will be designed, fabricated and tested for the time resolved VIS imaging and the THz detection respectively. New architectures will be investigated in order to increase sensitivity and time resolution of the sensors. Un-cooled THz pixel detector will be designed and fabricated with the internal process at FBK (MEMS RU); the readout electronics will be implemented and fabricated with a standard CMOS process.
– MUTIVIS: the final ROIC for the multispectral VIS-IR-THz detector will be electrically tested at a wafer level, and u-bolometers will be fabricated though post-processing fabrication by CEA-LETI. Successive testing of the devices will be carried out in collaboration with CEA-LETI and BOSH.
– POCEMON: the final CMOS ASIC will be designed aiming at the readout of the microcantilever-based detector array developed by the BIOMEMS Unit. The device will contain an array of ultra-low noise readout amplifiers (Sigma-Delta).

  Furthermore, an optical approach will be pursued as a contingency plan, developing a SPAD-based CMOS detector capable of monitoring the fluorescent radiation during the evolution of the PCR reaction.
– ACUBE: a new version with increased sensitivity of an event driven digital camera has been designed, fabricated and tested.
– BOViS: a new pixel architecture has been designed, embedding part of the Emza's proprietary algorithm for surveillance applications. A new prototype of 64x64 pixels vision sensor has been designed and fabricated, based on this pixel topology. Test is still in progress.
– SPADnet: a first chip prototype will be designed and submitted for fabrication on early 2011, while the first tape out within ST imaging technology is scheduled by the second half of the year. Those chips will be devoted to preliminary test the new pixel concept under developing within SPADnet project and specifically tailored for the PET application.

Financed by the AdP there will also be internal research activities, which constitute a fundamental part for the future of the Unit. In particular, new CMOS SPAD sensors will be investigated, exploring the feasibility of developing the first digital SPAD camera with in-pixel analog circuitry targeting pixel pitch below 30um with good fill-factor (>20%). A dedicated CMOS read-out ASIC will be fabricated aimed at realizing the first organic-on-CMOS image sensors (in collaboration with TUM-Munich). New CMOS technologies will be explored (0.15um from LFOUNDRY and 0.18um from AMS) as a basic research activity on new generation SPAD and all-CMOS THz detectors. Moreover, new applications for time-resolved SPAD detec-

tors will be investigated by means of collaborations with Università Tor Vergata (Prof. A. D'Amico) to explore the development of an innovative fluorescent-sensitive gas detector, and with CNR-Firenze and Art-Test (Dr. A. Pelagotti) to investigate on the use of FLIM techniques with SOI SPADs in the field of cultural heritage.

Two important dissemination events will be organized: on January 2011 SOI and 3DDOM Units will host an international workshop onto 3-D Time-of-Flight imaging and applications (RISA'11) and on July 2011 the international conference for PhD research in electronics (PRIME'11) will be arranged and chaired by SOI in collaboration with UNITN.

2.4. Collaborations

Internal Collaborations

Research Unit	*Reference Person*	*Description*
BIOMEMS	Leandro Lorenzelli	Within the project POCEMON, the SOI Unit will be in charge of the design fabrication and test of an array of readout channels for the Design of a readout chip. Within the project NAOMI, the two Units will coordinate to develop an integrated fluorescence based proteomic device.
MEMS	Benno Margesin	Within the project ESA MATRIX, SOI will contribute in integrating, at system level an electronic interface for readout and signal conditioning. Within the NAOMI project, the SOI unit will design the electronic interface for a the THz bolometer antenna.
ES	Alessandro Cimatti	Within the ACUBE project, the SOI Unit will realize a wireless monitoring camera for behavioural pattern detection.
M2B2	Cecilia Pederzolli	Testing of SOI SPAD detectors on FLIM experiments with proteins and DNA.
SRS	Claudio Piemonte	R&D activities onto the development of hybrid sensors with SOI CMOS readout and SRS SiPM detectors. New project will be submitted on this topic.

3DDOM	Fabio Remondino	Scientific dissemination activity in the field of 3D imaging (sensors and applications).

External Collaborations

Institution	*Reference Person*	*Description*
Technischen Universität München **-** TUM	Prof. P. Lugli	Investigate new materials (organic) for multispectral imaging onto CMOS substrate.
Università degli Studi di Trento	Prof. G.-F. Dalla Betta	New architectures for hybrid CMOS and organic photodetectors.
Università degli Studi di Trento	Prof. L. Pavesi	SOI will investigate the design of a detector for fluorescence detection in proteomcis. The reference project is NAOMI
University of Edinburgh (UK)	Prof. R. Henderson	Joint research activity on avalance photodiodes pixel in CMOS technologies and SPAD detectors for PET application. Reference project is SPADnet.
Delft University of Technology (The Netherlands)	Prof. E. Charbon	Sensor network with SPAD detectors for PET application. Reference project is SPADnet.
MRC Research Center Cambridge (UK)	Dr. A. Esposito	Research activity onto the validation of SOI SPAD systems onto multispectral FLIM microsopes.
CEA-LETI (France)	Dr. F. Simoens	Joint development of hybrid multispectral THz/IR detectors for security and surveillance. Reference project is MUTIVIS.
University of Hyderabad (India)	T. K. Bhattacharyya	Innovative materials and devices for THz and IR technology.
MESA Imaging (Switerlzand)	Dr. T. Oggier	Joint research on time-of-flight three-dimensional cameras.
MEDISO (Hungary)	Dr. G. Nemeth	Development of new CMOS SPAD sensors for next generation PET systems
Università degli Studi di Pavia	Prof. F. Maloberti	Research and development of low-noise Sigma-delta amplifiers and A/D converters.
Università Tor Vergata (Roma)	Prof. A. D'Amico	Explorative project onto the use of SOI SPAD detectors and porphyrines to develop new type of gas detectors.
University of California S. Cruz (UCSC)	Prof. R. Manduchi	Collaboration on system-embedded lightweight visual algoritms for people monitoring (US)

2.5. Specific Needs and Points of Attention

Concerning the research activity, the Unit relies on state of the art software packages for the design and simulation and, on commercial foundries for the fabrication of the integrated devices, therefore no major critical technical points exist. One issue is to have access to professional IC design tools (e.g. Cadence and Mentor Graphics) at the price of academic licensing, otherwise the cost would become prohibitive.

Furthermore, in 2009 the test labs, i.e. FUNLAB and LASERLAB have been renewed with larger space allocation and new equipments; this allow for precise and accurate test procedures. An external support to properly train people, which is supposed to have access to LASERLAB, is also recommended to enhance the security of the researchers.

Moreover, a specific need of the Unit is the built-up of competences on *system integration*; these skills and knowledge is more and more required for the collaborative projects and is something that must be an in-house (in FBK) activity as is of paramount importance a tight work operation between designers and system integrators.

Regarding the personnel, the Unit's strategy is that of having one or more key persons with permanent position for each step of the process of designing a sensor.
This process will still take a couple of years and is hindered by the fact that training of a good IC designer takes at least one and half year depending from the starting expertise. The latter is worsened from the lack of electronics specifics degrees at the local University.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Preconditions*
Development of the final QVGA 3D camera due for Netcarity Project.	R	E	March	Working Device	-
Assembly and test of the ROIC with post-processed u-bolometers for multispectral sensor due for MUTIVIS project.	R	E	June	Working Device	CEA-LETI successfully concludes the post-processing onto SOI CMOS wafers.
Development of a 64x64 pixels vision sensor prototype within BOViS project	R	E	September	Partially working device. Not fully tested yey.	-
Development of a system prototype of low power vision	R	E	August	Working device with no wireless comminucation	-

sensor based on contrast (BOViS project)					
Development of the explorative run of digital CMOS SiPM-like pixel in 0.35um.	R	I/E	June	Partially working device	-
Development of SPAD-based camera with analog in-pixel processing.	R	I	June	Working device	-
International Workshop on 3D imaging.	O	E	January	Good number of participants	-
International Conference PRIME 2011	O	E	July	Good number of participants and successful event	-
Design and test of the first sensor due within SPADnet fabricated within STMICRO 130nm.	R	E	October	Partially working structures.	-
Set up of new procedures for the testing flow and management of labs.	F	I	June	Improved testing workflow of SOI chips	-
Submission of 4-5 papers to international journals	R	E	December	At least three of them accepted.	-
Submission of three new projects in the field of time-resolved SPAD, THz detectors and energy-aware vision systems.	A	E	September	At least one of them accepted.	-
Submission of at least 8 papers to international conferences.	R	E	December	At least 4-5 papers accepted.	-
Enhance collaboration with M2B2 and SRS RU.	F	I	August	Common scientific projects and publications	-

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

As mentioned in section 2.5 the Unit's strategy is to have key persons in the design process with permanent position and make use of some term positions and PhD students to contribute in carrying out the research activity. At present the Unit is composed by 6 researchers, 3 technicians, 4 PhD students. Out of 6 researchers, 5 are from FBK and one from PAT; of them two are senior and 4 junior researchers, and 4 have a permanent position while 2 have a term position. Moreover there are 3 technicians, of which 1 with contract position, one with permanent position (FBK) and a consultant. A tenure track, starting by September 2010, has been proposed for one of the researcher who will go to fill the gap for the step of transducers physical simulation. The consultant, being a well-known expert in the field, will provide assistance in both technical aspects as well as in the testing and prototyping activity.

5. Risks and Mitigation Plans

The activity of SOI is, per se, a risk free activity because it doesn't relies on others contribution, except of course for the intrinsic risk of a research activity. However it has occurred in the past that, good trained researchers with term position having a key role in funded projects have left the Unit for a new job. This might have strong impact on the delivery of the project results especially for Units like SOI where the number of active projects is important.

Description	*Probability*	*Impact*	*Contingency*
Multispectral detector with CEA-LETI post-processing partially or not working properly	M	M/H	At this advance stage of the project quite difficult to compensate. If the issues are in the CMOS readout, workaround solutions to partially test the device will be implemented.
Vision sensor development with fully functionality (BOViS)	L	M	Pixel topology will be slightly improved. A new prototype of vision sensor will be fabricated.
Final version of the QVGA 3D camera partially or not working	M	L	The final prototype due for Netcarity will be based on the previous version of the sensor, already tested and working properly.
Skilled researcher is leaving the unit	M	M/H	New peopled will be hired and properly trained at the expense of some delay in delivery of projects milestones.

Notes:

Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High

Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

MEMS – MICRO-ELECTRO-MECHANICAL-SYSTEMS

Unit Name	MEMS – Micro-Electro-Mechanical-Systems	
Type	Research	
Head	Benno Margesin	
Staff	2010	2011
	9 Researchers	9 Researchers
	3 PhD	3 PhD

Document Status: submitted 2010-11-29

1. Executive Summary

In the next year a special attention will be paid to the reliability aspects of this technology and the 0-level packaging techniques for which the Unit will continue to develop its own concept. The Unit will also augment its presence in the field of RF MEMS devices with the development of micro-machined microwave filters based either on membrane supported oscillators or cavity oscillators depending on the frequency band (LS or Ka). Other objectives in this sector are the study of bolometers for cryogenic temperatures and room temperature, mainly for the detection of THz radiation.

More in general the group has the objective to enforce his competences in designing and realizing microsensors and microsystems. Therefore it will continue to cooperate tightly with the SOI Unit in order to increase the system integration capability and to be able to build complete systems with a dedicated electronic interface that will augment the appeal of these products for the industrial market. To achieve this the Unit will also try to increase its capabilities in the field of 0-level packaging for RF switches and capacitive microphones.

Among the strategic objectives of the unit is to become a local, national end European reference point for the RF MEM switch technology. In case of the switch technology the Unit will continue to offer this technology platform as an external service in strong cooperation with OPTO-I (packaging) and the University of Perugia (electromagnetic design).

The so far developed experience by the Unit places its activity in the field of Materials and Microsystems, specifically in The Research Unit MEMS has the mission to develop highly innovative sensors, actuators and electro-mechanic Microsystems (MEMS) for consumer and industrial applications and for basic research, using the in house processing capabilities.

In the field of the MEMS devices the main objective is focused on the development of a technological platform for the fabrication of RF MEM switch based components as there are SPST and SPDT switches, phase shifter, band-pass filters, power divider and reflect array's.

the field of Integrated Smart Systems and Sensors. Due to its expertise profile and scientific objectives the Research Unit has strong synergies with the research Units SOI.

Within CMM the MEMS Unit has the characteristic of a Research Unit whose activity is mainly devoted to applied research 65%) in the above mentioned fields, with some extensions in basic research (20%) and service for the industry (15%).

The actual staff of MEMS numbers to 9 researchers. In particular there are three permanent positions, one R1, one R1 and one PAT and six to term (RII, RIII, RIV). For two positions to term the extension of the contract is necessary as well as the consideration for a tenure track. The composition of the staff is already quite balanced and covers well the design, mechanical modelling, process development and control and the characterization. With the personnel acquisitions operated in 2010 also the RF competences could be improved.

The major collaborations of the Unit are with the Universities of Perugia and Padova respectively for RF MEM design and reliability assessment, with IMEC for the development of the 0-level packaging technology, TAS-I for the development of space components, TAS-F and TUD for the development of reflect array antennas and University La Sapienza for the development of MKID bolometers.

2. Vision and Scientific Program

Since the establishment of the former MEMSRaD Unit in 2007, part of which became the MEMS Unit in 2010, the MEMS activities have been focalized on the study and the development of a few selected device typologies that are at the same time of high interest to the industry or the basic research and challenging to make. The later aspect was and is considered important in order not only to exploit and extend the knowledge of the group, but also a basic requirement for fruitful scientific research. Last but not least for this activity the use of the in house fabrication technology is considered as a key strategic element that gives the activity an potential advantage with respect to competing institutions.

The activity of the last three years essentially confirm this approach even if in detail some changes and rebalancing of the activity of the group has been necessary.

2.1. Context and State of the Art

Currently the MEMS Unit has mainly three distinct research lines: RF MEMS, capacitive microphones and bolometers, both cryogenic and room temperature.
The activity on RF MEMS originates from the development of low loss passive RF components on dielectric membranes within an INCO COPERNICUS Project MEMSWAVE. Starting from 2001 a much more complex development of a technology platform for RF MEM switches was started, first within an ESA contract on MEM Switches as a subcontractor of Alcatel Alenia Space, now Thales Alenia Space, and then within the NoE AMICOM project. From the beginning the primary objective was the development of an versatile technology platform for the fabrication of passive components, wide band micro switches and microwave and

millimeter wave circuits for telecommunication, ground and satellite based and wireless applications. Within AMICOM the group developed successfully switches, tunable filters, phase shifters and reflect array antennas for 66 GHz and was able to provide the FBK technology plat for as a service for over 12 national and European research institutions. In addition in the last years the group has also worked on specific projects with distinguished institutions and industries mainly on the development of phase shifters.

In this field the group is currently involved in three ESA projects and two FP7 STREP projects. The first ESA project on 'Very Large Order Switch Matrices using MEMS Technology' aims at the realization of a 16x16 switching matrix for RF signals. In 2009 the group has realized the basic 2x2 switch matrixes that are now assembled by TAS-I in a final 16x16 matrix. In 2010 the project was put in standby due to problems with the fabrication of the packages. The second phase is scheduled for 2011. For this activity the SOI group is providing the control circuits for the switch matrixes. The purpose of the second ESA project on 'High Reliability MEMS Redundancy Switch', with FBK in the role of prime contractor, is the development of an reliable redundancy switch for satellite applications with an expected life time of 10+ years. The project has recently concluded successfully the first phase. For the reliability study 120+ device geometries have been designed. Two batches of 25 wafers each with 8 process variants have been evaluated and the main building blocks for the redundancy SPDT switch have been identified.

The third ESA project on the development of microwave micro-machined filters was started in 2010. Also in this project FBK is the technology provider, but in this case a completely new technology has to be developed that include not only the bulk micromachining but also wafer to wafer bonding and conductive through wafer via's. During 2010 the group has performed the preliminary technology assessments for this new technology and is now ready for the development of the first prototypes.

The first STREP project ARASCOM has the purpose to develop three demonstrators of reconfigurable reflect array antennas. This is one of the emerging fields for RF MEMS. These antennas are the low cost version of the much more complex phase array antennas, with potential applications in from ground and airborne telecommunication and obstacle detection. FBK is involved in the realization of an 77GHz reflect array and in the development of a hybrid technology combining MEMS switches with Liquid Crystal based switches. At the moment the first passive prototypes are ready for the assembly by the partners of the project.

The STREP project MEMSPACK is dedicated to the study of the packaging aspects of RF MEMS switches. This is one of the most critical issues for RF MEM switches. FBK is involved in providing the base technology on which different packaging concepts will be tested. In addition FBK contributes in the mechanical study of the packaged devices and the development of micro-sensors suitable to measure the parameters relevant to the quality of the package. In 2010 FBK has extensively tested the first series of sensors and started the second fabrication cycle.

All five projects will contribute in the next two years to enhance the FBK technology for RF MEM switches and components, one of very few available in Europe that

allow the monolithic integration of different types of switches with passive elements as well.

Together with the RF MEMS the silicon microphones are two of the three most fast growing markets of MEMS components. In the segment of the cellular phones they are quickly substituting the traditional microphones, due to their intrinsic robustness, degree of miniaturization and compatibility with automatic assembling techniques.

The activity at FBK on silicon microphones started within an commitment of STMicroelectronics. This allowed to develop a base process for microphones. With this process in the last two years a series of prototype microphones has been developed that have been included in different smart Microsystems. At the moment the activity in this field is marginal due to the lack of opportunities to participate in projects. Also for this type of devices the SOI group was involved in the development of specific interface electronic circuits.

The research and development on bolometers in FBK dates back in the early nineties The activity originates from the development of cryogenic type bolometers of the implanted silicon type. Within a few years it was possible to develop and optimize devices suitable for basic research, in particular for the measurement of the mass of the electron anti-neutrino. This, more than ten year effort is now dedicated to the realization of an large experiment (over 200 detectors). In recent years a new type of cryogenic bolometer has been also investigated. These kinetic inductance detectors, based on superconducting materials (niobium, aluminum) are potentially a good candidate for future large detector arrays, coupled to antennas for the detection of RF and THz radiation, that will be employed for the next generation satellites dedicated to CMB radiation polarization studies. At the moment four fabrication runs of these devices have been completed with success. It was possible to demonstrate the possibility to build these devices in aluminum on silicon and Safire substrates. In addition the first arrays have been realized and tested. At the moment new metals are investigated and specific design aspects as cross talk are addressed. In this context FBK has the opportunity to be among the few institution to be able to build these devices. This activity is pursued within the MEMS2 project with INFN.

In the last year also the development of un-cooled bolometers within the NA0MI project continued. During the year a first prototype run has been fabricated that allowed to evaluate the different process options and provided the first working samples for the assembly of the completed prototypes.

References

- A. Tazzoli, E. Autizi, M. Barbato, F. Solazzi, J. Iannacci, P. Farinelli, F. Giacomozzi, B. Margesin**,** R. Sorrentino, G. Meneghesso, *Impact of Continuous Actuation on the Reliability of Dielectric-Less Ohmic RF-MEMS Switches,* in Robert Plana (eds.), Microwave and Millimeter Wave MEMS, Bucharest, Editura Academiei Romane, 2010, pp. 233- 241.
- C. Palego, F. Solazzi, S. Halder, J. C. M. Hwang, P. Farinelli, R. Sorrentino, A. Faes, V. Mulloni, and B. Margesin**,** *Analysis of Power Capacity of RF MEMS Capacitive Shunt Switches Fabricated on Silicon or Quartz*

Substrates, 2010, (MEMSWAVE2010, Otranto -Lecce) da:06/28/2010 a 07/01/2010.

- V. Mulloni, F. Giacomozzi, B. Margesin, *Controlling stress and stress gradient during the release process in gold suspended micro-structures,* in «SENSORS AND ACTUATORS. A, PHYSICAL», vol. 162, n. 1, 2010, pp. 93-99.
- M. Calvo, C. Giordano, R. Battiston, P. de Bernardis, B. Margesin, S. Masi, A. Monfardini, *Development of Kinetic Inductance Detectors for Cosmic Microwave Background experiments,* in «EXPERIMENTAL ASTRONOMY», vol. online publication, 2010, pp. 1-10.

2.2. Vision and Goals

Within the next years the focus of the research activity will remain on the above mentioned research topics.

RF MEMS - The main goal for the next two years is still the stabilization of the technology. In addition two main aspects of the technology will be addressed: reliability and packaging. The first aspect regards the development of suitable process improvements but also design improvements that will allow to push the reliability of the devices at the level requested for space applications and other critical telecommunication applications. The development of reliable switching units within the ESA project REDUNDANCY will be a first goal for the next year. A second very important goal for this technology is the development of a suitable on wafer packaging technology, a prerequisite for the final industrialization of the technology and there introduction in demanding applications (space, airborne and ground telecommunication). One of the outcomes of the MEMSPACK project will be a better insight on the packaging approaches that will allow FBK to develop his one concept. For the next year first the concept developments both for thin film capping and wafer capping with vertical feed-through will continue.

Other medium term objectives are the construction of a 16x16 switching matrix and the fabrication of sub-arrays for a reflect-array for 77GHz.

In addition in this field the unit will foster the new activity on microwave filters, a key element for many RF systems. First goals in this area will be the demonstration of the wafer to wafer bonding and the fabrication of conductive wafer through via's, now in an intermediate development phase, both synergic with one of the packaging concepts mentioned above.

MICROPHONES – As stated above the development of the technology has been successful. Also this technology can benefit from the capping technology mentioned above. More in general in the next years the goal will be to see if the technology can be offered both to industry and for research purposes.

BOLOMETERS – In this area for the next years there are essentially two goals. One regards the complete development of the technology for MKID detectors. This will be performed within MEMS2 and in strong collaboration with basic research groups active in Cosmic Microwave Background experiments and neutrino mass experiments. An intermediate goal will be the realization of MIKDs and there integration with suitable antennas for the microwave and millimetre radiation.

The second goal in this area is the development of sensible un-cooled antenna coupled bolometers for THz detection. This goal is pursuit within the NAoMI project. A first result will be the realization and characterization of the prototype bolometers designed to test and develop the technology and in general the concept.

NEW TOPICS- compatible with the available resources the MEMS group is also looking into new topics in order to enlarge its action field. One of potentially interesting arguments are micro-trusters based on silicon micro-machined nozzles integrated with a micro-valve for the regulation of the thrust.

2.3. Activities and Work Plan

The activities and work planning of the group follows tightly the planning of the individual projects. In addition internal activities for further development of the technologies and test of new ideas/approaches are foreseen.

Within the ongoing contracts, we have fixed plans for 8 batches of wafers for the next year, all with custom design. In addition 4 extra batches are planned for internal developments.

The work flow is organized in three major areas: design and modelling, process development and control and characterization.

The specific activities planned for the different projects and internal developments for the next year are:

STREP ARASCOM: second prototype run for array elements and development of a integrated MEMS and LC switch technology.

STREP MEMSPACK: a first run of test-structures with resonating structures for the measurement of the atmosphere in the package and the stress/strain exerted on the packaged devices by the cap.

ESA MATRIX: second run of basic matrix elements.

ESA REDUNDANCY: start of the long term tests on the most promising switching units, fabrication of the redundancy unit.

ESA MIGNON: first prototypes of the filter elements.

FMIS: delivery of a batch of MEM switches developed for the switching of the antennas for the fire monitor sensor.

Thin film wafer capping: fabrication of the second technology test vehicles. Definition of the potentiality of this approach.

Wafer capping with vertical feed trough's: realization of the first wafer cap prototypes (in synergy with ESA MIGNON that needs the same technology capabilities)

NAoMI: realization of a second series of prototypes for the optimization of the concept. Test of the Photo Conductive antennas.

MEMS2: development of the MKID technology. Prototype arrays of microwave antennas integrated with MKID for the focal plane of an IR telescope.

2.4. Collaborations

Internal collaborations

Research Unit	*Reference Person*	*Description*
MT-Lab	PL. Bellutti	All the research activity performed by the Unit is done using the Microtechnology Lab either by using existing technologies or by developing new ones. In the next year this collaboration will extend to the wafer bonding activity and the advanced packaging facility.
SOI	M. Gottardi	The SOI Unit develops the electronic interfaces for some of the devices. In particular within ESA MATRICI they are developing the driving unit and software for the matrix
PAM	N. Bensaada	Compositional studies of the metal alloys employed in the switch process are studied with the help of the microanalysis facility of PAM

External collaborations

Research Unit	*Reference Person*	*Description*
Uni Perugia	Prof. R. Sorrentino	Uni PG is our partner in most of the projects on RF MEMS where they provide the electromagnetic design and the test capabilities.
SELEX SI	M. Dispenza	In ARASCOM we are developing the packaging of the reflect arrays
TAS-F	G. Caile	In ARASCOM we are developing together the reflect array
TUD	Prof. H. Jacobi	In ARASCOM we are developing the hybride technology for RF MEMS and LC MEMS
IMEC	H. Tilmans	In MEMSPACK we are cooperating on the 0-level packaging of RF MEMS
MEMSTC	S. Bouwstra	Within MEMSPACK we are cooperating on the mechanical modeling
IEMN	Prof. P. Roland	Within MEMSPACK we are working on the 0-level packaging
VTT	T. Heikilae	Within MEMSPACK we are developing the 1-level packaging with LTCC
ISIT	C. Hut	Within MEMSPACK we are working together on test structures for the characterization of packaged MEMS
TAS-I	G. Mannocchi	Within ESA MATRIX and ESA Redundancy we are developing the packaging with LTCC for space applications
CNR-IMM	R. Marcelli	Within ESA MATRIX and ESA Redundancy the CNR is characterizing our RF switches
TUM	Prof. L. Vietzorreck	Within ESA MATRIX and ESA Redundancy TUM is cooperating for the system design of the devices
TUM	Prof. G. Schrag	We are cooperating with TUM on the mechanical characterization of RF MEMS
Uni Padova	Prof. G. Meneghesso	Within ESA Redundancy a strong collaboration with Padova exists on the reliability aspects of the RF MEM technology

CONAE	Prof. A. Lamagna	RF MEM phase shifter
Lehigh Univ.	Prof. J. Hwang	On RF MEMS Reliability and performance characterization as a continuing activity initiated with the stage of a PhD student
OPTO-I	A. Maglione	Within ESA Redundancy we are developing a low cost package for RF MEMS and for FMIS we are providing the technology for the RF detector for forest fires
SELEX Comms	I. Pomona	6 bit phase shifters for phase array antennas
Uni Tn	Prof. L. Pavesi	We are cooperating with UniTn on the development of un-cooled Bolometers
Uni Bicocca	Prof. E. Fiorini	KID detectors and implanted silicon bolometers for the neutrino mass detection
CNRS-NEEL	A. Monfardini	KID detectors for use in astrophysics
La Sapienza	Prof. P. DeBernardis	KID detectors for CMB experiments
Uni Como	Prof. A. Giuliani	KID detectors and implanted silicon bolometers for the neutrino mass detection

2.5. Specific Needs and Points of Attention

For the activity of the next year the MEMS Unit has specific needs in two areas, personnel and technical support. For the activity of the Unit it is essential not only to maintain the actual level of employment simply in term of person-months but also to maintain the persons itself due to their specific knowledge not easily and quickly replaceable. In this regard attention has to be paid on two contracts that are expiring.

Regarding the technical aspects the Unit needs strong and constant support from the MT-Lab. Any temporary stop of the clean room or part of its machinery are deleterious for the timing of the projects of the Unit. Over more the new projects of the Unit require the use of the wafer bonding and the flipchip aligner and bonder. The availability of these two equipment as well as advice and manpower are as important conditions for the optimal start and continuation of the new activities.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Reliable SPDT switch	R	E	Oct.		
MW filter elements	R	E	July		Wafer bonder/flip-chip bonder
Wafer cap	R	E	Oct.		Wafer bonder
Thin film cap	R	E	June		
Optimized un-ocooled bolometer	R	E	Sep.		
KID detector array	R	E	Oct.		

Notes:

- Description: free text description of the goal.

- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other.
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal).
- Time frame: when you expect the result to be achieved (month granularity, e.g. september).
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The actual staff of the MEMS Unit numbers to 9 researchers. In particular there are three permanent positions: one R1, one R2 and one PAT and six to term (RII, RIII, RIV). For the actual activities of the Unit the staff is adequate.

The core team of the Unit consists in 3 expert researchers, two of which are senior. The team is complemented with researchers with a term contract on specific research projects. The composition is an interdisciplinary mix that covers essentially all needs of the Unit. The experience is generally high to very high. The team is particularly strong in all process and technology related aspects and the mechanical modelling. The small gap regarding the RF competences, covered in the past only by one person and an PhD student, has been nearly closed with the engagement of a new researcher and the funding of a PhD position at the University of Perugia.

To the activity of the Unit contribute also three PhD students, which help in exploring new topics of high scientific relevance while working at their thesis. One of them will discuss the thesis in spring. The other two are involved on the project MIGNON.

To keep the operating capability two positions to term will have to be extended. In two case the tenure track has to be considered due to the good performance of the person and also the needs of the Unit to keep the acquired knowledge.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Contract extensions	L	M	Acquisition and training of new persons
Equipment down time	L	H	Out sourcing, delay

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High.
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic.

MiNALab – Micro Nano Analytical Laboratory

Unit Name	MiNALab – Micro Nano Analytical Laboratory	
Type	Research	
Head	Massimo Bersani	
Staff	2010	2011
	11 Researchers	11 Researchers
	1 Technologist	1 Technologists
	1 Post Doc	1 Post Doc
	1 PhD	2 PhD (proposal submitted)

Document Status: submitted 2010-12-01

1. Executive Summary

Aim of the research unit is to develop and apply surface science analytical techniques and methodologies to fully characterize both inorganic and soft materials at micro and nano scale. A core activity is also the set up and promotion of a common analytical platform at Trentino level in copartecipation with the University of Trento, named TNLabs.

The unit pursues three mains objectives:

– realize and manage an analytical infrastructure being able to group equipment and competences present in FBK. In this way it will be possible to start a facility able to attract and link other resources and competences present on the local territory. Hence set up and organise a technological platform for material analysis integrating inter-institute facilities. On 29th November the networking TNLabs has been presented (www.tnlabs.eu); it will be tested during the first 6 months of 2011.

– Develop a research activity in some areas of surface science in order to improve the analytical methodologies and capabilities, set up networking –and external collaboration; support the research activity of the other internal research units; push the analytical equipment improvement

– Support industries needing material characterization or involved in analytical equipment production through consulting service or innovation actions.

The main research topics are in the fields of: Micro-nanoelectronics; materials for energy; food-chemistry.

The competences present in the unit are:

Analytical expertise. It comes from the historical mission and development of the group which has allowed to establish an important analytical infrastructure with a strong and diffuse expertise able to show the value and impact of research in surface science at a level of excellence.

The experience acquired in the development of methodologies and all the experimental work carried out with the available techniques allowed to obtain a relevant competence on instrumentation development. A strong link with the world of analytical equipment producers, a constant update on analytical needs and solutions, specific expertise on ultra high vacuum project-design and software development complete the scenario in this field.

Data mining. This competence based on statistic multivariate methods was acquired and increased in the last five years. It allows to integrate the analytical result and to obtain a more complete interpretation in particular on complex system. The effects are highlighted by a specific increase of publication quality and an extension of our analytical application fields.

Accreditation and quality management. This competence closely connected to analytical activity and industrial relationships allows to obtain the accreditation following the norm UNI/ISO 17025.

The activity of the unit is strongly linked with the analytical equipment and therefore upgrades and new acquisitions are of crucial importance to maintain the state of art in the highly competitive and fast developing field of surface science characterization; however the real asset of the unit is the personnel, which is the unique and irreplaceable source of competence described above. In 2010 some new equipments have been acquired; it is planned to install them in 2011.

These instruments are:

– Time of Flight Proton Transfer Mass Specrotmetry PTR-MS-ToF;
– new state of art XPS with spatial resolution;
– custom XRD/XRF instrument.

The internal analytical infrastructure is planned to be ascribed to a different and dedicated cost centre, but because of the required implementation efforts it will be included in the present strategic plan.

At this moment all the researchers involved in the unit have an experience of five years or longer. The number of researchers is dimensioned on the time needed to organize, manage and maintain the instrument infrastructure as well as to carry out research and technological activities.

Currently the Unit counts 11 researchers, 7 of them with a permanent position. For one of the remaining the temporary position is going to become permanent before the end of 2010. Among the remaining 3 researchers, 1 is planned to obtain a tenure track position before the end of 2013. Differently, the consequent lost of deep knowledge and specialized expertise will greatly penalize the Unit,.

The technical support to the Unit research activities is currently provided by a single technician, who takes charge of all the daily laboratory support activities and of the ordinary equipment maintenance.

The actions to be taken in the next year include:

– fix the permanent position related to Rossana Dell’Anna
– the implementation of a plan of career progression for researchers distinguishing themselves for their special commitment and working load.

It is necessary to acquire and form new instrument technicians. Those not yet present positions are necessary to ensure a suitable analytical service and to manage an analytical infrastructure in a configuration of open access to internal and external researchers.

Several collaborations characterize MiNALab research. Due to the nature itself devoted of analytical work the Unit activity relies very much on internal and external collaboration able to provide samples and complement MiNaLab expertise and capabilities. Collaborations are active in different fields: research, innovation and service activity. An extended list with a brief description is reported in paragraph 1.4.

1.1. Context and State of the Art

The activity on surface characterization allowed to gather and maintain in FBK a set of state of art analytical instruments run by highly qualified personnel with technical and scientific expertise. The instrumentation from 2011 is concentrate in the MiNALab infrastructure; it is listed in the following table.

Table 1. *Instruments constituents MiNALab infrastructures* (In Italic instruments previously mange by PAM units, in bold instrument planned to be acquired in 2011)

Acronym	*Definition/description*	*Model*	*Provider*
SIMS	Secondary Ion Mass Spectrometry	IMS WF/SC ULTRA	CAMECA
ToF-SIMS	Time of Flight Secondary Ion Mass Spectrometry	ToF-SIMS IV	Ion-Tof
XPS	X-Ray Photoelectron Spectroscopy	ESCA 200	SCIENTA
SEM/EDX	Scanning Electron Microscopy	JSM-7401F	Jeol
AFM	Atomic Force Microscopy	Solver Uni (P47)	Nt-mdt
AFM	Atomic Force Microscopy	Solver P47H	Nt-mdt
TXRF	Total Reflection X-Ray Fluorescence	TXRF 8010W	Atomika Instruments
Furnace	RTP Annealer	As-Micro	Annealsys
Profilmeter	Mechanical Profilmeter	P-6	KLA-Tencor
Auger	Multi-technique instrument for Electron Spectroscopy	PHI 590	PerkinElmer
Auger	Auger Electron Spectroscopy profiler	PHI 4200	PerkinElmer
XRD	X-Ray Diffraction	APD 2000	Italstructures
Tribology	Nano – Hardness and Scratch Tester		CSM
PTR-TOF-MS	**Ptoton Transfer Mass Spectroscopy**	**Custom**	**Kore Technology**
XPS	**X-Ray Photoelectron**		

	Spectroscopy High energy and spatial resolution		
XRD/XRF	**X-Ray Diffraction and Fluorescence**	**Custom**	

By means of these various techniques it is possible to investigate physic-chemical, topographical and morphological properties of surfaces and to correlate these with material properties.

The high level of analytical skills allowed to establish several international collaborations and receive funds for EU projects focused on characterization materials and analytical methodology development. In the table, the projects obtained in the last years are reported.

Table 2. *European project obtained in the last years*

Project	*Coordinator*	*Partners*	*Start/duration*	*FBK-Budget*
ILSIMS SEA; FP5	STM, Crolles	SIMENS, Lucent, Samsung, ITC-irst	1/9/2000; 18 months	36.440 €
IMPULSE IST; FP5	CNR-IMM	ESRF; ITC-irst; Univ. of Salford; AMD	1/12/2001; 36 months	132.887 €
ANNA I3; FP6	FBK-irst	12 partners	1/12/2006 48 months	1M €
ATHENIS; STREP; FP7	Austria Microsystems	Cavendish Kinetics; FBK; Univ. Wien; MASER; Valeo; Univ. Ferrara	1/1/2008; 36 months	100.000 €

From the analytical and methodological point of view, the previous described surface analytical instruments were used to study the following materials and related applicative/scientific issues:

- main activities topics are related to micro- and nanoelectronics; in particular, ultrashallow junctions, high-k and low-k films, nanocrystals, organic and inorganic contaminations, innovative substrates, and applications of new thermal processes have been the focus of different researches in this area
- at the same time, effort was devoted to explore new fields of material science, achieving evaluable results; organic materials for electronics and solar application, analyses related to environmental impact, food chemistry, thin film functional coating, nano-and biomaterials.

Currently, major publications and collaborations come from activities related to the microelectronics area. Nevertheless evaluable and very promising results were also obtained in the other previous listed fields.

In the last three years strategic actions were carried out to combine the consolidated research activities with new capabilities. The goal was to guarantee new impulse to the unit, also extending its field of competence. This expertise is focused on:

- development and application of machine learning techniques to exploit the multivariate nature of produced experimental data. Number and impact factor of related publications continuously increased in the considerate period.
- study, design and realization of new analytical instruments. The main result in this activity field has been obtained with a company start up devoted to X-ray diffraction instrument manufacturing.
- Maintain and improve measurements accreditation under the International norm UNI-ISO 17025.

1.2. Vision and Goals

The midterm strategy is structured in two main points:

Realization of a unique and common technological platform for the analytical facilities at Trentino level able to contribute effectively to the research in different fields of material science and to further develop the metrological and analytical skills. The expected impacts of this activity can be summarized as follows:

- Improvement of the local research on material science by a unique support on characterization
- Stronger interconnection and link between the different research groups
- Larger usability of the analytical instruments
- Improve quality of the service
- Define a common strategy on analytical infrastructure development to obtain a state of art facility
- Focus the investment in a more effective way
- Save management and maintenance costs
- Create a reference centre for metrological and analytical aspects

To obtain an analytical platform with characteristics of real excellence a 3-5 years strategic development plan has to be discussed, finalised and financially supported. Other key points are an appropriate human resource strategy and a quality management system of the facility.

The second point is related to the activity of the Unit devoted to develop analytical methodology and to tackle unsolved characterization problems. In this case the overall objective is to obtain in new application fields the same results and visibility obtained during the past years in the microelectronics area. To obtain these results all the researchers of the Unit will be involved to collaborate in synergic and multidisciplinary way, with their specific expertises. The main promising topics are related to biomaterials, food chemistry and material for energy. The multidisciplinary characteristics of these research fields also strongly required to collaborate with other FBK research Units and with external research groups. The

partner network will be therefore extended. To further pursue these research activities, the support of young scientists is strong recommended. Therefore, actions will be taken to offer PhD positions able to effective integrate the new scientific contributions into unit and its specific research activities, also to complete with different expertise the composite knowledge of the Unit.

1.3. Activities and Work Plan

The work will be organized following the hereinafter described activities:

1) Actions for ensuring the analytical technology platforms workability and management in FBK and its connection to a local analytical networking;

   This activity is focused to manage and run the first year of activity of an analytical infrastructure being able to group equipments and competences present in FBK. This internal infrastructure is planned to be part of a more general one called TNLabsTNLabs is a networking analytical infrastructure in common between UniTN and FBK that include more than 38 instruments

   This year is devoted to tackle and solve all problems and requirements emerging in:

   - planning and implementing an effective management of the analytical infrastructure. This task involves the test and implementation of a set of procedures, supported by an ad hoc designed software, defined for the whole infrastructure management, the instrumentation monitoring and maintenance, the instrumentation access, the tutoring of new users;
   - ensuring a rationale and effective organization of machine time distribution, in order to maximize the instrumental up-time and the number of users;
   - inferring from the access statistics of the year useful information for future upgrade strategies.
   - Setup TNLabs analytical infrastructure. The general goal is to obtain a new facility open to all research and production groups present in the Trentino territory. Specific objectives are: improve FBK/UniTN link; optimize the resources use; improve the operation; give a new support to local territory..
   - Provide an analytical support to other FBK units and UNITN research groups

   This activity will be run in collaboration with the active support of personal present in the units: PAM and CTP.

   It is considered mandatory taht the found realated to infrastructure management, maintenance and improvement will be not charge on the specific unit, These funds should be charged in a different and dedicate cost centre

2) Characterization of materials for nanoelectronic devices;

   The downscaling of electronic devices has brought the transition from microelectronics to nano-electronics. To tackle the related technological

challenges, the microelectronics industry faces the need for fast development of new processes and materials. Actual technological bottlenecks for next generation transistors.are the realisation of highly activated ultra shallow dopant distributions and new gate insulator materials (high-k materials). In the activities of the Unit, the ultra low energy SIMS (ULE-SIMS), other available surface analysis techniques and analytical instrumentation provided by established collaborations (such as synchrotron radiation laboratories) are combined to carry out accurate analysis and 'state-of-art' studies of the mechanisms lying behind the processes for solving such problems. Samples will be supplied by specific industrial demands or by important collaboration networks. Other case samples will be internally provided by FBK Units.

This is the most developed and advanced activity of the Unit, giving the main contribution to the overall obtained results. Current collaborations and active projects will allow to maintain an international state of the art research program in one of the most competitive and advanced fields of technology. Specific objectives for the year 2011 are:

- To maintain the same excellence level of the research of previous years
- To improve the international network analytical activity
- To extend the analytical methodological approach to close scientific area (optoeletronic; inorganic material for solar cell)
- To extend the research activity on new material aiming at substituting silicon devices
- To submit new projects and promote collaboration at international level

3) Effort increase for the characterization and data analysis in food chemistry, archeometry, and biomaterials fields;

The activity in the food chemistry field will be characterized by a collaboration with the CEFSA-CNR of Trento, University of Verona and University of Padova and will be focused on a complete methodological approach to find chemical fingerprints for sensory or quality characteristics of different foods. The approach will exploit the installation and use of a new PTR mass spectrometer, and the application of multivariate analysis techniques to maximize the information extraction from complex data obtained from this new instrument.

The collaboration on the archeometry activity with the faculty of Engineering of the University of Trento in the 2010 didn't develop as expected especially because the proposal submitted to PAT (Marie Curie Actions- COFUND) wasn't approved. Same activity was conducted in collaboration with the University of Orleans (some relevant publications are expected for 2011). The plan for this topic is to submit a project in the first part of 2011 in order to have new people that will be focused on this argument.

The biomaterial analysis and characterization are intended as part of multidisciplinary research investigations, requiring strong collaborations with biological and biomedical groups. Therefore they will benefit from

interactions with the Biosint Unit of FBK, as concerns inner activities, the University of Verona and Milano Bicocca University, as concerns external activities.

4) Focus on innovative analytical equipment design and implementation;

This point comprises two different activities:

- installation and set up of X-ray diffraction and fluorescence equipments in collaboration with TNX and in the frame of the NANOSTRATA project submitted to the call for proposal Made in Italy of National Ministry of Innovation and approved in 2010. A new drift solid state detector system for X-ray spectroscopy tested in collaboration with Ketek in 2010 will be installed on the instrument
- final evaluation of new ion source system partially developed in the 2007/2008

5) Support and involvement in industrial research initiatives, services;

In this framework, the acquired resources joined with the experience and knowledge gained from the project activities as above described are finalized in order to offer a high quality external analytical service. Particularly, the access to developed methodologies and micro-analytical experience as well as the use of the laboratories and the know-how relative to biomaterial investigations are offered. The main reasons for the service offering can be summarized as follows: 1) To benefit funding; 2) To help on a scientific and technological level Trentino, and the national economy and society; 3) To enrich researcher's expertise, to increase researcher's visibility and satisfaction.

This activity allowed in the 2010 to achieve 3 important financed projects (medium term time duration). The projects are at national (Made in Italy call) and local (legge 6) level. All the projects are focused on research development and innovation activities concerningof functional protective cover layers able to improve mechanical proprieties of different surface of metal products.

6) Organisation of the international conference SIMS XVIII

The biannual international conference on Secondary Ion Mass Spectrometry will be held In Riva del Garda during September 2011. The conference will be organised and managed on scientific and logistic point of view by FBK. The main personal involvement – and the budget of the eent – will be in charge of MiNALabs unit. More than 400 participants are expected, the scientific details of the conference are reported on the web-site www.simsXVIII.org.

7) Educational activities

To strengthen the link to local territory, MiNALab in collaboration with the Communication Area, will organise some activities devoted to the dissemination and scientific formation. A structured formation initiative for

high schools is planned as well as focused event to disseminate our activity on local territory.

1.4. Collaborations

For sake of simplicity the collaboration list can be divided in three typology:

Internal to fbk:

- Biosint, Cecilia Pederzolli, analytical characterization of functionalized surfaces in biomaterials investigations as support to activity research of Biosint Unit, in particular related to finalized project. The principal involved techniques are: XPS, SEM, AFM. Concerning the analytical technological platform, Biosint people could in prospective have direct access to instrumentation.
- Advanced Photonics and Photovoltaic (APP), Georg Pucker, a collaboration is planned on photovoltaic material and optoelectronic material. Both Unit take part to European and to other financed projects.
- Computational Physics (CTP) Maurizio Dapor, a collaboration has been proposed focused both on the simulation of electronic properties for material investigations, and on the support of CTP personal for analytical infrastructure management.
- PAM for the support on analytical infrastructure management. PAM is also involved in two financed MiNALab projects.
- 3D Optical Metrology - 3DOM involved in the X-Bridge project
- Analytical support and services will be also provided to any other internal Unit that will request analysis.

Research institutes

- University of Verona, Francesca Monti, FT-IR analysis for food chemistry and biomedicine. The Unit contribute is focused on the application of advanced statistical techniques to maximize the information extraction from FT-IR dataset. This experimental equipment can also provide complementary information in physical-chemical characterization carried out in the Unit.
- CEFSA-CNR of Trento, Andrea Boschetti, development of new analytical instrumentation and application of multivariate data analysis techniques for mass spectrometry analysis in food chemistry.
- CNR of Parma, Salvatore Iannotta, physical and chemical surface characterization of new material for solar energy cell production (funded by DAFNE CARITRO project);
- Collaborations linked to microelectronic research: PTB, synchrotron beam line, Berlin, Buckhard Beckhoff; CNR-IMM, Bologna, Roberto Balboni; Atom Institut, ATI, Wien, Cristina Streli; IMEL Institute, Athens, Androula Nassiopulo; Fraunhofer Institut, IISB, Erlangen, Andreas Nutsch and Peter Pichler; MFA Institute, Peter Petrik; University of Salford, Jaap van den Berg; University of Surrey, Karen Kirkby University of Patras, Spiros Ladas; Seton

Hall university, Mehmet Sahiner;Dublin City University DCU, Dublin, Patrick McNally; University of Newcastle, UK, Nick Cowern.

Several European projects and other financed collaboration on microelectronic topics support these collaborations.

- University of Trento, Stefano Gialannella, common platform development for archeometric research.
- Università di Roma “La Sapienza”, Antonio Polimeni, optoelectronics materials;
- Stanford Synchrotron Radiation Light Source,CA, USA, Joy Andrews Hayter, Yijin Liu, Piero Pianetta, XANES microscopy usinga full field transmission x-ray microscope (TXM) and application of EXFS analysis on nanomaterials
- CRISMAT, ENSICAEN, Daniel Chateigner, X-Ray Diffraction, Material Properties,
- University of Padova, Enrico Napolitani, collaboration in SIMS conference organisation
- University of Catania, Antonino Licciardello, collaboration in SIMS conference organisation
- University of Padova, Benedetto Ruperti, chemical understanding through spectrometry and spectroscopy multivariate data analysis of agricultural and food issues.
- University of Verona, Andrea Sbarbati, NMR multivariate data analysis for understanding the interactions between human nutrition and metabolism.
- University of Milan Bicocca, Gianfranco Cerofolini, analyses for biomedical applications
- University of Oviedo, Beatriz Fernàndez and Alberto Sanz-Medel, mass spectrometry methodology development

Companies and industrial partners:

- TNX, Povo Trento, Paolo Marconi, Start up in collaboration with FBK to manufacturing analytical equipment based on X-ray (diffraction and fluorescence)
- Lafer Piacenza, Claudio Carini,involved in Made in Italy project
- Zuani Rovereto Floriano Zambelli,involved in law 6 project
- 3D-oxide, Giacome Benvenuti, involved in submitted EU Project and internal collaboration on new oxides production for microelectronic application
- ENI Novara, Pasquale Ripiani, service activity to production support on solar devices
- MEMC Merano, Roberto Scala, service activity to production support on silicon wafers
- Applied Materials, AMAT, Santa Clara CA, Majeed Foad, research collaboration on innovative Annealing process for USJ formation
- Ketek, Munich, Sigfried Tehlke, company devoted to x-ray products, the collaboration is focused on test new detector system on our instrumentation

1.5. Specific Needs and Points of Attention

Infrastructure investment: in 2010 important investments have been realized. Three important installations will occur during 2011. Some minor upgrade are planned in the budget.

Strategic plan: a three years detailed strategic plan to set up and organize the analytical technology plan has to be discussed and shared with other Units, approved by FBK management and agreed upon as priority

Personnel: several appropriate figures for working in the MiNALab infrastructure are already present in FBK. It is however necessary to acquire and form new instrument technicians. These position are currently not present. Their are necessary to manage the instruments in the open access configuration, ensuring more in general an on-going support for any analytical services.

Budget: cost of maintenance, management, and running of infrastructure will be considered on a dedicated cost centre. In consideration of access improvements, instruments increase and new users the cost of infrastructure will increase with respect to the past year.

Support: Dedicated software for the infrastructure management is required as well as support of SIT. A software related to Quality Management will be provided within the framework of an external project.

2. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Internal analytical technology platform managment: first running year of a longer term realization plan	R,I	E,I	1 year	Define financial issues (20% of the goal) Testing of the organization management (20%) Management software realization (10%) Increase of the instrument use time (15%) Increase of the user number (15%) Procedures evaluation and necessary consequent adjustment (20%)	To achieve this goal a separate budget and a personal plans related to the directly involved units are required.
New analytical infrastructure in partnership with	R,I	E, I	1 year	First 6 months test (40%) Fix problems on	Consolidation of the collaboration with UniTN

UniTN, organization, management and test period				procedures and management (20%) Evaluation and official presentation (10%) Networking implementation (30)	
Characterization of materials for nanostructured surface;	R	E	1 year	Presentation of new projects at European level. Dedicated publications	
Analytical methodologies consolidation on new application fields	R	E	Octob er	Results in following fields: Food chemistry Acheometric applications	To consolidate and extend the collaborations
Submission of one new industrial research project (“legge 6”)	I, A	E	June	Project submission	Positive feedback by Industrial partners
International SIMS conference	O	E	Septe mber	School and Conference on SIMS performance	
Publication and presentation @ congress	R	E	Dece mber	Same rate of publications and communications obtained in the last 2 years	
Second year accreditation confirmation	F	I	May		No budget cuts
Installation of acquired equipments	R,I	I,E	Septe mber	PTR mass spectrometer (30%) New XPS equipment (30%) New custom XRD /XRF instrument (40%)	Completation of the infrastructure investment planned in 2010
Second patent in partnership with TNX on equipment development	I	I,E	April		
Self financing; incoming	O	I	Dece mber	At least 40 % of self financing is expected	It is essential not to consider the Infrastructure management cost in the Unit internal budget

Dissemination and education activities	I, O	E	1 year	Stages; formation initiative for high schools	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

3. Human Resources

Currently the Unit counts 11 researchers, 7 of them with a permanent position. One temporary position is going to become permanent within the end of 2010. Among the remaining 3 researchers, 1 is planned to obtain a tenure track position before the end of 2013.

The technical support to the Unit research activities is currently provided by a single technician, who takes charge of all the daily laboratory support activities and of the ordinary equipment maintenance.

The actions to be taken in the next year include:

- fix the permanent position (Rossana Dell'Anna)
- the implementation of a plan of career progression for researchers distinguishing themselves for their special commitment and working load.

The current personnel's experience of the Unit is as follows:

Four senior researchers (Unit Responsible included) with more than 15 years of experience. Four of them have experience in the field of analytical technique applications and development, and in metrology area, one has the PhD degree and is expert of data mining and simulation. Their employment contracts are: three permanent positions (1 FBK contract, 2 PAT contracts) and one tenure track position.

Five researchers with more than 8 years of experience, two of them have the PhD degree and obtained in the past a Post PhD position financed by PAT. Four of them have a permanent position, one is planned to obtain a tenure track position for 2013.

Two young researchers with less than 5 years of experience.

One technician with more than 15 years of experience in a permanent position. He is dedicated to infrastructure maintenance and support activities.

It is necessary to acquire and form new instrument technicians. These position are currently not present. Their are necessary to manage the instruments in the open access configuration, ensuring more in general an on-going support for any analytical services. PhD positions will be offered to increase the research productivity of the Unit.

4. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Complete the planned infrastructure investment and set up a medium term implementation plan. It is a fundamental step to set up a common technological platform for nano material characterization	Low	Severe	The main Unit goal will not be not reached. Delays in the implementation of the plan could have a strong impact on expected objectives. No effective alternative solutions have been identified.
Start to discuss a new personal plan, in order to fix fundamental capabilities and acquire new positions	Medium	Severe	If the analytical infrastructure is considered fundamentally strategic a long term plan on personal have to be discuss and fix. The aspect involves also other units
The expected self financing contribution is not achieved. Main cause could be related to SIMS conference	Low	Medium	The number of partecipants is fundamental
Maintenance cost exceeding due to analytical equipment ageing, and use improvement	Medium	Low	A non relevant difference in terms of total amount is expected with respect to the planned budget.
Publication level decrement	High	Medium	People focused on selffinancing and local impact

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

PAM-SE – PLASMA, ADVANCED MATERIALS AND SURFACE ENGINEERING

Unit Name	PAM-SE – Plasma, Advanced Materials and Surface Engineering	
Type	Research	
Head	Nadhira Bensaada Laidani	
Staff	2010	2011
	4 Researchers	4 Researchers
	2 Research fellowship	1 Technologist
	1 Technologist	2 Technicians
	2 Technicians	3 PhD
	4 PhD	1 Research fellowship for Caritro (ending May 2011)
		1 Research fellowship on the project Nanosmart (ending April 2011)
		1 Research fellowship on the project Nanosmart (tbh)

Document Status: submitted 2010-12-01

1. Executive Summary

1.1. Scientific research

The PAM-SE group competences, centred mainly on the synthesis and characterization of advanced materials (hard coatings, dielectrics, transparent materials, nano-composites and nano-laminates) have led to new prospects for a pluri-annual research activity based on the production of materials able to be used for alternative energy (photovoltaic) applications. The research activity in this field tend towards the synthesis of innovative materials such as transparent conductive oxides (TCO) as well as towards the exploration of new strategies for photovoltaic cells efficiency improvement. On the latter subject, the group is engaged in widening the range of solar radiation frequencies which can be exploited by photovoltaic systems, carrying on a research work which will fully take advantage of the PAM-SE's former experience in the study of nano-composites and nano-laminate materials.
Another sector of the Unit research activity regards surface engineering, through functionalization and manipulation of nanostructures like nanolaminates, metal nano-clusters, carbon nano-structures such as carbon nanotubes and similar. These structures can be integrated with macroscopic materials to achieve higher performances applicable in innovative photovoltaic cells and innovative biosensors. The PAM-SE unit is engaged in the investigation of the photo-luminescence of CNT and CNT-hybrid materials.

Industrial research

Scientific and technological support will be given to private local and national companies for new materials development and/or characterization, in the frame of industrial contracts either already existing (Project 'Made in Italy', in collaboration with MinaLab) or in course of negotiation (Zuani, Rovereto). Furthermore, facilities and expertises exist within the PAM-SE group in the field of material characterization and provide not only support to internal research projects, but also to local, national and international research institutions as well as private companies (like the Environment Park of Turin).

Education

PAM-SE Unit places a particular attention in education and formation of young researchers. 1 Ph.D candidate will continue her second year doctoral work, co-directed by PAM-SE Unit and Trento University (Physics Department), while 2 other students, from P. & M. Curie University (UPMC) of Paris, who joined the Unit for Ph.D theses co-directed by PAM-SE, will continue their second and third doctoral years. The Unit will also continue to entertain secondary school students (for example Centro Moda Canossa, Trento) for introduction to advanced textiles treatment processes.

Staff members

12 people in 2011: 4 researchers (1 FBK senior Res.II and head of the Unit, 1 PAT senior Res.II, 1 FBK Res. III, 1 junior researcher with "co.co.pro." contract, 2 researcher fellowship owner (ending), 1 Technologist, 1 research Technician (Db second level) and 1 maintenance Technician (Db), 3 Ph.D students. An annual fellowship on Nanosmart project will be available.

Most significant collaborations:

Internal:

(1) APP unit and MT-Lab, FBK: collaborations in the research filed of materials for photovoltaics, in the frame of common projects (PV and Oxi-Solar); (2) REET unit in FBK: collaborations in European project, support in Cer.Met materials production; (3) MinaLab unit, FBK: national project, support in mechanical characterizations; Mems unit, FBK: mechanical and structural characterizations;

External:

(1) University of Trento, Physics and Engineering department for Nanosmart PAT project; (2) CNR- section of Trento; (3) University P.&M. Curie of Paris, France, (4) Institut des Nanosciences of Paris (INSP), France, for PV and Oxi-Solar projects; (7) University Blaise Pascal, Clermont-Ferrand, France in the field of transparent oxides for energy applications.

2. Vision and Scientific Program

2.1. Vision and Goals

The research program of PAM-SE globally responds to well defined objectives toward the innovation in the photovolatic industry and started from the development of innovative materials. Subsequently the more important specific objectives of the research program for the photovoltaic sector:

- development of new conductive transparent oxides with processes at low temperature on flexible organic substrates and glasses.
- synthesis of new materials for the down-shifting of the UV-blue fraction of the solar spectrum.
- achievement of a meaningful increase of a c-Si solar efficiency by means of the use of photon converter materials.

The research on the materials will include:

(1) materials for the photon management with the purpose to exploit the more possible the available energy in the solar spectrum by widening the interval of the usable frequencies. We will use the principle of down-shifting of the radiation UV that is based on the use of materials with different structures and adequately doped to confer them a function of down-conversion (matrices of oxides doped with rare earths).

(2) materials used as transparent electrodes for the transport of photo-produced electric charges in thin films and organic solar cells. In existing photovoltaics, it is typically ITO that is used, the latter necessitates however deposition temperatures that are deleterious for the stability of the junctions or of the organic materials of the cell. The project foresees the synthesis of new oxides transparent conductors, more abundant and susceptible to be deposited at low temperature.

Activity with longer term than next year regards:

(1) the synthesis of TCO at low temperature with the technique of ALD to obtain films with high conductivity and coating conformality.

(2) optimization of the interface properties between silicon substrate and the TCOs and between organic substrate and TCOs produced with Rf sputtering and in future by ALD and ALD assisted by plasma.

(3) Integration of the TCOs produced with the different methods on the solar cells in silicon implemented with photon down-converter material and on organic cells.

The originality of the objectives of this program will allow a scientific progress and an added value of high technological importance touching some important sectors in the photovoltaic research. Results of excellence can also be reached and exploit internal collaborations with the laboratory of micro-fabrication MtLab that has a long experience in the realization of devices in silicon and with the unity APP that develops its research on cells with organic materials.

Other important sectors of our research are those related to surface engineering activities. The ability to synthesize and characterize materials of different natures is even more important for the development of appealing devices from the technological point of view. This trend in the latest years was integrated with the capability to synthesize and manipulate nanostructured materials. This opens important perspectives since nowadays nanotechnology is a common factor to all the research fields. Future trend will be the investigation of new C nanostructures and their integration with materials to obtain composite materials with advanced performances applicable for fabrication of sensors for environmental, health and biological purposes. Nanostructures are at the basis of the possibility to perform "nanoscopy" using non-invasive technologies that, if applied to bio-sector, preserve the physiological functions of living microorganisms.

2.2. Context and State of the Art

The power generation cost with prevailing silicon solar cells is currently much higher than that of household and industrial power price. These costs need to be reduced by an order of magnitude for PV cells to be competitive with other energy generation systems and to be manufactured on a large scale. This priority is also the main and the challenging goal of the worldwide research in the PV conversion of solar energy. This reflects several different requirements such as the availability of less expensive materials than crystalline silicon commonly used in the PV cells, the necessity of using less quantity of semi-conductor materials, or improving the conversion efficiency or increasing the solar radiation absorbance of the materials composing the PV cells. Although such material science topics have been greatly supported and encouraged by the European Commission, their development in Italy is dramatically limited, especially if compared to other European Countries like Germany or Spain.

Thin-film PV, based on amorphous silicon and chalcogenides thin films, are relatively low cost technology because of the reduced material and energy consumption and many manufacturing advantages. At the same time, the development of low cost and high quality transparent Transparent Conductive Oxides (TCO, in substitution of indium tin oxide, ITO) is considered an important research topic for this class of cells. TCO development becomes also crucial for the third generation cells, based on organic materials, where it is fundamental ensuring the device chemical stability by means of transparent materials which act as permeation barriers against the atmospheric gases. On this subject, it is worthy to note that transparent materials having electrical conductivity together with chemical stability in the atmospheric environment and mechanical stability, can only be obtained via complex architectures, using structured materials like nanocomposites or nanolaminates having fully characterized interfacial properties. Goal of PAM group will be the production of functional materials suitable for increasing the efficiency of the photovoltaic conversion system. In this way we intend to develop materials which can be potentially applicable in both the already existing second generation PV cells and in those which are still in the R&D domain (third generation cells).

The development of the TCOs is mostly tied to the developments of the transparent electronics. The use of transparent oxides in photovolatic cells based on thin

films, in substitution to the conventional ITO (indium tin oxide), is still to the level of concept. In parallel to this research directed to mainly develop processes and transparent conductors trying to resolve the difficulties in doping wide gap semiconductors as the oxides, new innovative approaches are being considered for the development of new materials. This "frontier" research is based on the manipulation of matter on nanometric scale and establishes some challenges as (1) to produce amorphous TCO with great mobility of charge carriers and (2) new discoveries among which the design of materials able to tune their dielectric answer according to the chemical surroundings.

2.3. Activities and Work Plan

The planned activity for 2011 will continue to focus on the study of the growth process and mechanism in low pressure plasma for TCO thin films synthesis, for photon down-converter films based on rare-earth doped oxides and for surface treatment and engineering. The search of high carrier mobility in films deposited at low temperature while maintaining high optical transparency of the materials will be pursued. In the case of TCO, the study will be applied to doped ZnO-based transparent conductive oxydes, along with an exploration of the conductive properties of new TiO_2/metal nanolayered films. Interface properties will be examined, from both a chemical and electronic point of view, in systems composed by the oxide-based film and crystalline silicon substrate, interface between films of oxide and amorphous Si or a-Si(H) interfaces in nano-layered systems. Dielectric and electrocaloric properties of multilayered systems will constitute a new sector activity of the Unit.

The activity planned for year 2011 in the frame of projects is summarized as follows:

- *Oxi-Solar project* (Caritro Foundation funding): Development of oxide-based materials for photon conversion for photovoltaics
  - Pursuing the activity of year 2010, synthesis of nanocomposite instead of monolithic thin films, based on TiO2 and doped with a rare earth for processes of down-shifting assisted by luminescence;
  - exploration of the rare earth-doped TiO2 films integration in a Si-solar cell;
  - Optical and structural characterization of the films synthesized for the down-shifting.

- *Nanosmart project* (PAT funding)
  - production of gold nanoparticles functionalized by PLCA
  - optimization of Raman spectroscopy (SERS) to follow drug delivery kinetics inside tumor cells;
  - study by means of electron spectroscopy of all aspects related to tasks of other partners of the project and requiring deep characterizations.

- *DiGesPo project- Distributed CHP generation from small size concentrated solar power (Eu project in collaboration with REET Unit)*

– composite oxide films (Cer.Met. materials) deposition on steel and aluminium, with low emissivity and high solar absorbance;
– multi-layered composite films synthesis;
– structural and chemical characterization.

- *Made in Italy project (National project in collaboration with MinaLab Unit)*

  Mechanical characterization of hard coatings: study of nanohardness and elasticity modulus, scratch tests for mechanical and adhesion stability.

2.4 Collaborations

The research collaborations which the Unit established so far and intends to care about in the future cover mainly:

– internal collaborations in funded projects: the skill to develop and characterize innovative materials is the main road leading to synergistic crossovers with the research of other FBK units. The PAM-SE unit will collaborate with APP group (Dr Georg Pucker), MTLab (Dr. Pierluiggi Belluti), MinaLab (Dr Massimo Bersani) and REET (Dr Alessandro Bozzoli).
– integrated characterizations
  - for film defect structures with Trento University, Positron Lab (Prof. Roberto S. Brusa), related to PV and Oxi-Solar projects. Positron Anihilation Spectroscopy will be very useful to investigate film defects and defect structure and chemistry.
  - for structural, optical and electronic properties with CNR section of Trento (Dr. Maurizio Ferrari).
– joint studies of synthesis technology of selected material classes like transparent oxyde-based films with
  - «Nanoscience Institute of Paris» and CNRS, France (Dr. Jacques Perrière)
  - Pierre & Marie Curie University, Plasma Process Engineering and Surface Treatments Lab, Paris, (Prof. Farzaneh Arefi)
  - Blaise Pascal University, Inorganic Materials Lab, Clermont-Ferrand , France (Dr. Eric Tomasella).

2.5. Specific Needs and Points of Attention

Research activity:

Need of a new film deposition technique

The project PV foresees the synthesis of new oxides transparent conductors, more abundant and susceptible to be deposited at low temperature. New methods of material synthesis are needed, as the Atomic Layer Deposition (ALD), able to produce film at low temperature on organic (polymers) substrates. In 2010, a market study concerning ALD technology has been made. In 2011, such a technology needs to be acquired and used, in agreement with what proposed by the scientific

strategic planning of FBK (Accordo di Programma 2008-2013, *AdP2008-2013*) and supported by the Autonomous Province of Trento.
Personnel:

With respect to 2010, in the first quarter of the next year, 1 researcher will end her fellowship and another one her contract. In the last case, the funding is covered by Nanosmart project, still running in 2011, which makes necessary hiring a new researcher with suited competences in nanoscience and thin film characterization.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
1- TCO synthesis: Mastering of plasma synthesis at low temperature for carrier mobility enhancement .	R, A	E	Dec. 2011	- Conductivity levels comparable to ITO -Consistent and valuable visibility through contributions and presentations at international conferences and prime novelty in international journals with impact factor or - patent	FBK facilities working properly
2- TCO treatment: Surface plasma treatment for surface electronic properties control	R, A	E	Dec. 2011	-consistent and valuable visibility through contributions and presentations at international conferences -accepted papers in International journals with impact factor or - patent	FBK facilities working properly
3- Project Oxi-Solar: Luminescence improvement in RE-doped TiO2 films for Si-solar cells	R, I, A	E	march 2011	-working system -consistent and valuable visibility through contributions and presentations at international conferences -accepted in International journals with impact factor or - patent	FBK facilities working properly
4- Project Oxi-Solar: Adequate down-shifting efficiency in RE-doped TiO2 films for Si-solar cells	R, I, A	E	July 2011	-working system -consistent and valuable visibility through contributions and presentations at international conferences -accepted papers in	FBK facilities working properly

				International journals with impact factor or - patent	
5- Project NanoSmart: production of PLCA functionalzed Au NPs;	I, R	E	During 2011	100% goal achieved if an efficient PLCA-PHA coating will be deposited on gold NPs	FBK facilities working properly
6- Project Nano-smart: optimization of Raman microscopy (SERS) to follow drug delivery	I, R	E	During 2011	100% goal achieved if using MicroRaman Au NPs we will be able to follow drug release inside tumor cells	Availability of proper sources to perform optimal Raman measurements
7- Fabrication of a DNA hybridization sensor based on a diamond FET	R, I, A	I	During 2011	100% goal achieved if the bio-sensor will be able to detect DNA hybridization	FBK facilities working properly
8- Investigation of C-based nanostructures (diamond nanopowder and graphene)	R, I, A	I	During 2011	100% goal achieved if we will able to set up collaborations with external Research institution to start this long term activity.	FBK facilities working properly

The research which the Unit intends to conduct enters an area that requires materials development and is asked to address industrial and societal needs in energy and environment. The design of new TCO materials (as an alternative to the conventional and costly indium-tin oxyde (ITO)) as well as the photon management based on nanostructured material science are relatively in their infancy, at a worldwide level, but they are characterised by a rapid growth and innovation.

The published literature affiliated to Italian research centres and dealing with materials for photovoltaics applications, one of the themes in which the Unit wishes to mature its experience, is poorly extended whatever be the research centre at local or national level. There is an important discrepancy between the Italian research and that of the world in this domain, which regards all of the synthesis processes, the characterization and the applications. So, the most important criterium the Unit will apply to its results evaluation will be the achievement of results able to cover one or more of the above aspects of the research in the field. That means publications on international scientific journals and contributions to international conferences, with original and prime results in at least one of the following areas: the synthesis processes and plasma treatments of the materials of interest, the introduction of new non-conventional metodologies for the characterisation of materials and plasma and the associated phenomenological modeling.

4. Human Resources

The Unit employes expert senior researchers as well as well-skilled young researchers and technologist, all forming a well-suited personnel to cover the planned activities. The competences of the Unit allow to ensure an adequate participation to each activity group, thanks to the scientific profile of the members. The plasma, thin films and surface treatments activity is guaranteed by 4 researchers and 2 of the PhD students, while the characterization task can be shared by 4 researchers, 1 technologist, 1 research technician and all PhD students.

The most of the staff is also available to industrial research support. A support to the internal group activity is given by a technician with skills in design and realisation of automatic systems for motion control, data acquisition and elaboration.

The composition of the PAM staff, which counts by the date 12 members, is as follows: 4 researchers (1 FBK senior Res.II and head of the Unit, 1 PAT senior Res.II, 1 FBK Res. III, 1 junior researcher with “co.co.pro.” contract, 1 researcher fellowship owner, 1 Technologist, 1 research technician (Db second level), 1 maintenance technician (Db) and 2 Ph.D students from UniTN. Two more Ph.D students from UPMC joined PAM-SE for co-directed theses. A Tecnologist of the staff, with a former contract valid till October 2010, has been stabilized in his position this year.

5. Risks and Mitigation Plans

The type of activity which the Unit continues to undertake, which falls into the basic research domain in material science field with well-defined application perspective, involves some not negligible risks. The solar cell technology matures so slowly on one hand and in the other hand, it needs much more public funding than other technologies. The issue is particularly severe for a photovoltaic technology based on materials which do not have additional applications outside the photovoltaic industry. For example, development of the 1st generation solar cells, based on crystalline Si, took advantage of crystalline Si production for the microelectronics industry. For the 2nd generation solar cells, based on thin films, technology based on a-Si, a material used in the microelectronics industry, is more developed with respect to technology based on other materials (CdTe, CIGSS), not used elsewhere, in spite of the better optical properties of the latter. Technology based on a-Si benefits in fact from knowledge and established technical infrastructures which can be transferred from the microelectronics to the photovoltaic industry. In other words, when developing a new semiconductor-based material for the photovoltaic industry, risks could be decreased by considering existent, well-established technologies from other fields, such as the “electronic” or “photonic” industry.

LISC – INTERDISCIPLINARY LABORATORY FOR COMPUTATIONAL SCIENCE

Unit Name	LISC – Interdisciplinary Laboratory for Computational Science	
Type	Research	
Head	Maurizio Dapor	
Staff	2010	2011
	6 Researchers 1 PhD	6 Researchers 1 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

1.1. Main Activities

Many-body problems in scattering theory; Reflection Electron Energy Loss Spectroscopy (REELS): surface effects; Electron-phonon interaction and polaronic effects; Path Integral Monte Carlo calculations of virial coefficients of light gases; Gas adsorption and dynamics in microporous materials; Dominant reaction pathways of thermally activated transitions; Computer simulations of DNA interacting with functionalised surfaces; Dissipative phenomena in precision mechanical measurements; Modeling and simulations of high efficiency silicon solar cells for concentrator systems.

1.2. Personnel

6 Researchers (Lucia Calliari, Maurizio Dapor, Giovanni Garberoglio, Giorgina Scarduelli, Enrico Serra, Simone Taioli), 1 PhD student (Anna Battisti).

1.3. Prominent collaborations

Internal collaborations:

M2B2 Unit (RNA strategic project)

PAM-SE Unit

MTLab

External collaborations:

National Institute for Standard and Technology (USA)

Russian Research Center (RRC) Kurchatov Institute, Moscow, Russia

Department of Physics, University of Vienna

Department of Physics, University College London

Institut für Festkörperphysik, Friedrich-Schiller - Universität Jena

ET (Einstein Telescope) WP2 (Suspension requirements characteristics)

Albert Einstein Institute Hannover: Max Planck Institute for Gravitational Physics

Institute of Physics, ASCR, v.v.i. Prague, Czech Republic

INFN, Laboratorio Nazionale di Legnaro

Dipartimento di fisica, Università di Camerino

Unità di Padova-Trento della collaborazione Virgo, CNRS-INFN

Dipartimento di chimica strutturale e stereochimica inorganica dell'Università di Milano

Dipartimento di ingegneria dei materiali e tecnologie industriali dell'Università degli Studi di Trento

Dipartimento di fisica dell'Università degli Studi di Trento

CNR-FBK Trento

IMEM-CNR Istituto Materiali per Elettronica e Magnetismo (Unità di Ricerca Nanoscienze - Trento)

Sistema integrato per la prevenzione degli incendi boschivi - FMIS

Trentino Building Efficiency and Sustainability Technologies - TBEST

2. Vision and Scientific Program

2.1. Context and State of the Art

– *Many-body problems in scattering theory*

Since the discovery of two-dimensional (2D) and meta-stable materials by Geim and Novoselov, very recently awarded with the Nobel prize in physics for their fundamental discoveries, a dramatic increase in the research dedicated to explore their physical properties took place. This holds especially for graphene. Its electronic properties allow one to address basic questions of quantum electrodynamics such as relativistic Dirac fermions, the Klein paradox or quantum Hall effect. Furthermore, the nanometer size, the scalability and room-temperature ballistic transport properties make graphene a promising candidate for future nanoelectronic devices with high charge carrier mobilities and an ideal material for spintronics. The research activity has been mainly focussed on the development and the application of a new theoretical method for calculating electron spectra in solids, such as X-Ray photoelectron and NEXAFS. Density functional theory (DFT) calculations of carbon-based nanostructures, notably graphene, have been performed using VASP and QUANTUM-ESPRESSO program suites. We have shown by angle-resolved photoemission spectroscopy (ARPES) and calculations that a tunable gap in quasi-free-standing monolayer graphene on Au can be induced by hydrogenation. The size of the gap can be controlled via hydrogen loading and reaches ~1.0 eV for a hydrogen coverage of 8%. The local rehybridization from sp^2 to sp^3 in the chemical bonding is observed by x-ray photoelectron spectroscopy and x-ray absorption and allows for a determination of the amount of chemisorbed hydrogen. The hydrogen induced gap formation is completely reversible by annealing without damaging graphene. Calculations of the

hydrogen loading-dependent core level binding energies and the spectral function of graphene are in excellent agreement with photoemission experiments. Hydrogenation of graphene gives access to tunable electronic and optical properties and thereby provides a model system to study hydrogen storage in carbon materials. Furthermore, we have shown that a new electronic state appears in quasi-free-standing hydrogenated graphene (H-graphene) upon electron doping. This state can act as an electron acceptor level for the π electrons of graphene. Its occupation can be controlled via the H/C ratio and allows for tuning gaphene's doping level. Our calculations of the electronic structure of H-graphene indicate that this state is largely composed from hydrogen 1s orbitals. Despite the randomness of H this state remains extended while electron localization sets in for the π states of graphene. Both the new theoretical method and its applications resulted in some pubblications in international journals and, to summarize methods and experimental techniques of use in electron spectroscopies of solids, an extensive review article on the state of art of electron spectroscopies in nanoclusters and solids has been accomplished. Finally, as a part of a productive collaboration with prof. Dario Alfe' (University College London) we are studying by a tight approach to DFT and molecular dynamics simulations the growth mechanisms of graphene and silicon carbide on inorganic substrates.

– *Reflection Electron Energy Loss Spectroscopy (REELS): surface effects*

Quantitative understanding of REELS in the plasmon region is nowadays the objective of a large amount of investigations. One of the most interesting topics deals with understanding how boundaries (surfaces and interfaces) modify electron energy loss spectra acquired at medium-low electron energy. Stated in other words, the task amounts to determine the Surface Excitation Probability (SEP) and the Inverse Inelastic Mean Free Path (IIMFP) which represent the probability that electrons travelling through solid materials lose their energy in surface and bulk excitations, respectively. The SEP and the IIMFP are crucial parameters for quantitative analysis by electron spectroscopy techniques (primarily Auger and photoemission). These parameters can be determined by Monte Carlo simulations of experimental spectra acquired under conditions where the importance of surface and bulk can be enhanced or diminished by changing, for example, the electron energy or the angle at which electrons cross the surface.

– *Electron-phonon interaction and polaronic effect*

When their energy becomes lower than 10-20 eV, very important energy loss mechanisms - and energy gain mechanisms as well - and angular deflection mechanisms for the electrons traveling in an insulating material are related to electron-phonon interaction. Concerning other energy loss mechanisms, the polaronic effect is also important for low energy electrons traveling in insulating materials. The polaron is a quasi-particle with a relevant effective mass. It corresponds to an induced polarization field that has a stabilizing effect on the moving electron. It consists of an electron, or of a hole created in the valence band, with its polarization cloud around it.

– *Path Integral Monte Carlo calculations of virial coefficients of light gases*

The coefficients appearing in the virial equation of state for Helium are used to correct for the slightly non-ideal behaviour of this gas in a wide range of applications, mostly related to metrology. In the past 30 years, the experimental measurement of these coefficients, the third one in particular, has been characterised by a negligible increase in the precision. On the other hand, state-of-the-art electronic-structure calculations on two- and three-body systems have been able to produce very accurate potential energy surfaces for interacting Helium atoms. These potential energy surfaces are the only ingredient needed for a fully ab-initio evaluation of the virial coefficients. However, a full implementation of the calculation of the third virial coefficient is not available. We already have been able to calculate the third virial coefficient of Helium-4, obtaining an uncertainty significantly smaller than the experimental one. However, our approach has been considering Boltzmann statistics only. In order to calculate the virial coefficients at low temperature, one has to consider the bosonic nature of the Helium atoms (fermionic in the case of the less-abundant He-3 isotope).

– *Gas adsorption and dynamics in microporous materials*

The recent discovery of Metal-Organic Frameworks has led to the synthesis of an impressive amount of novel microporous materials. The performance of these materials for gas adsorption, storage and separation is currently being assessed with experimental and theoretical methods in many research centres worldwide. In this respect, the development of reliable numerical methods is of paramount importance to understand the mechanisms of gas adsorption and diffusion in these materials, as well as pinpoint the materials more apt for a particular application, such as - for example - hydrogen storage, carbon dioxide removal or biogas purification. In particular, metal-organic frameworks with "open metal sites" are currently being considered as promising materials for hydrogen storage applications. In these materials there are metal-oxide moieties where the metal atoms are partially exposed to adsorbed gases. In this situation there might be a favourable attraction between the electronic clouds of the adsorbent and the adsorbate, therefore enhancing the adsorption properties. However, a precise characterisation of these phenomena is still lacking, and many experiments are being performed to investigate them in more detail. In particular, there have been measurements of hydrogen zero-point kinetic energy that point towards a very large interaction between hydrogen and the open metal site of a compound known as copper(II) benzene-1,3,5-tricarboxylate (Cu-BTC), and experiments on another compound known as MOF-74 are currently being planned.

– *Dominant reaction pathways of thermally activated transitions*

Many biomolecular processes occur on timescales which are many order of magnitude larger than the smallest timescale of the system, usually related to the stretching frequency of the chemical bonds. In particular, the folding process of a protein to its native structure takes place on the scale of milliseconds, to be compared with the scale of femtoseconds characteristic of the chemical bond oscillation. A direct computational approach to this phenomena is currently almost unfeasible, due to the extremely large resources that would be required. However, recent

theoretical developments have shown that if the starting and final configurations of a biomolecular transitions are known (and usually are, from X-ray scattering experiments), the complete dynamics of the transition can be efficiently reconstructed.

This theoretical framework is based on the very well established assumption of stochastic dynamics for the relevant (biomolecular) degrees of freedom, which can be expressed using a path integral formulation. In this way the problem of finding the most probable path along which a conformational transition takes place is reduced to a multidimensional minimization in a quite large (but manageable) path space of the system. This methodology has already been applied with success to the calculation of chemical reaction pathways and to the calculation of the folding pathways of small peptides using a completely ab-initio approach, in which the potential energy surface of interaction is calculated on-the-fly with quantum mechanical methods.

– *Computer simulations of DNA interacting with functionalised surfaces*

The growing importance of genomic characterisation of living organisms has led to the need of cheap yet precise methods for DNA sequencing. The first step towards this goal is the extraction of DNA form a biological fluid sample. Among the various techniques that have been proposed for this task, one of the most promising is based on the selective adsorption of DNA on positively charged surfaces, exploiting the fact that solvated DNA is negatively charged under common biological conditions. The DNA adsorbed on the surface can be released by changing the ionic content and the pH of the solution. Recent experiments proved the feasibility of such an approach, but do not give clear-cut indications on the optimal conditions under which this reversible adsorption takes place. We already set up a Molecular Dynamics model to simulate DNA interaction with amino-silane functionalised surfaces. We were able to measure a strong tendency of DNA to adsorb on the surfaces, but we could not yet investigate under which conditions desorption takes places.

– *Dissipative phenomena in precision mechanical measurements*

Development of low mechanical dissipation materials and systems is a key issue in many technological fields and plays an important role in precision measurements for fundamental research. In our research we address specifically the field of gravitational wave detectors, statistical mechanics and quantum opto-mechanics.

In fact the first generation of gravitational wave detectors has reached displacements sensitivity in the range 10^-21 m/√Hz, and further increments could be obtained only by a substantial improvement of the existing detectors, among the others the use of cryogenic temperatures and of silicon-based optical systems. Recent experiments have also shown that nanometric SiN membranes have unexpectedly low level of the mechanical dissipations. The reported value is well below the requirements on the mirrors coating mechanical losses for next generation of cryogenic interferometric gravitational wave detectors. Hence, the knowledge of the intrinsic dissipation mechanism of this material is currently becoming an important issue for developing new low dissipation resonators.

In this research we address the development of low dissipative silicon systems (optics, mechanical and opto-mechanical oscillators) and the study of their performances with Finite Element Modeling, phenomenological tunneling models, first principle approaches and experimental measurements.

– *Modeling and simulations of high efficiency silicon solar cells for concentrator systems*

Crystalline silicon solar cells are presently the predominant method of photovoltaic power generation globally. Silicon technology is still currently the best proven and most widely available technology for developing solar cells working with intermediate concentration levels. In order to cut production costs by reducing the usage of silicon, significant effort has focused on thinning the wafers or by reducing the area of silicon.

In our research we address specifically the field of small area single junction solar cells used in photovoltaic concentrator systems (CPV) with concentration levels in the range of 100X-130X. The availability of such cells, will be useful for the design of concentrator systems with a reasonable cost reduction with respect to conventional flat plate PV systems. Specifically, we focus our research on the development of the cell design and the study of their performances with Finite Element Modeling and experimental measurements.

2.2. Vision and Goals

– *Many-body problems in scattering theory*

The past 10 years have seen remarkable developments in two branches of condensed-matter physics. One is the study of strongly correlated systems, notably superconductors and low dimensionality carbon-based compounds, with the growing realisation that electronic states other than simple Fermi liquids occur in several materials families. This area has been fuelled by the potential applications of materials such as high-Tc superconductors and graphene, as well as by a fundamental desire to understand the ground states of interacting many-fermion systems. The other is the science of high intensity and high-brightness synchrotron radiation sources, which have allowed local measurement not only of structure with atomic resolution, but also electronic and vibrational spectroscopies. Advances in synchrotron radiation light sources have made it possible to perform accurate energy and angle-resolved core and valence electron spectroscopies, that allow unprecedented local access to the excitations of solids. Therefore, along with the application of theoretical and numerical techniques (code SURPRISES) to unravel electronic and optical properties in a variety of systems such as carbon and boron nitride based nanostructures by simulating electron spectra we aim to extend the available methodologies to include superconductivity phenomena.

We plan to use information from synchrotron and other benchtop experiments to address basic questions on the nature of the electronic states found in unconventional superconductors and carbon-based compounds and, more in general, to address how the electron-electron interaction reflects on the behavior of a many-particle quantum condensate. The fundamental theoretical question to be addressed is: what is the nature of the polaronic or correlated state in a quantum

many-body system? Of course, this is not a programme designed to solve all the problems in the context of the electronic structure of quantum condensates or superfluids, this has eluded the efforts of a whole community of theoretical physicists for more than twenty years. Rather, it is a focused attempt to attack theoretically some of the most important general questions in the field of many-body physics, through a particular set of well-controlled experimental data, focusing especially on electron spectroscopies of carbon-based compounds, ultracold atom-atom scattering and high-Tc superconductivity experiments.

– *Reflection Electron Energy Loss Spectroscopy (REELS): surface effects*

Contribution of LISC to this very active research field will be focused on materials whose spectra exhibit well-defined surface and bulk plasmon losses (primarily Al and Si). Monte Carlo simulation of spectra acquired at different electron energies will be the main approach to understand the role of surface and bulk. It is expected that these spectra and their evolution with electron energy could be simulated with good reproduction of all features (overall intensity, relative intensity of surface and bulk features, single and multiple losses).

– *Electron-phonon interaction and polaronic effect*

We'll deal with the Fröhlich theory concerning the electron-phonon interaction, subsequently developed by Llacer and Garwin. Fröhlich and, after him, LLacer and Garwin, considered the interaction of free conduction electrons with the longitudinal optical mode lattice vibrations. The interaction of slow electrons with the lattice corresponds to the creation (electrons loses energy) and to the annihilation (electrons gain energy) of phonons. The polaronic effect will be firstly treated with semi-empirical approaches: within 3-5 years we are planning to approach the problem by using theoretical approaches.

– *Path Integral Monte Carlo calculations of virial coefficients of light gases*

We plan to implement a full theoretical and numerical approach to calculate the values of the third and, possibly, fourth virial coefficient of Helium, using recently developed potential energy surfaces for the two- and three-body interactions. This approach will be based on a path integral description of the system, and will take into account both quantum diffraction and quantum statistical effects. The temperature derivatives of these coefficients, useful in the framework of acoustic thermometry, will also be evaluated.

– *Gas adsorption and dynamics in microporous materials*

Molecular simulations based on ab-initio methods, can be a useful tool to complement experimental investigations on the origin of the strong interaction between hydrogen and metal-organic frameworks. The two basic ingredients for a successful model are 1) a reliable potential energy surface and 2) a correct treatment of quantum diffraction effects, which can be appreciated also at room temperature. The first point above will be addressed by performing ab-initio simulations using state-of-the-art density functional calculations. Depending on the microscopic structure of the adsorbent, one can either simulate a full 3D crystalline structure or select a relevant moiety and compute the interaction of hydrogen with

this subsystem only. The second point will be addressed by two methods. In the zero-pressure limit (that is, for small loading of the adsorbent) one can solve the Schrödinger equation for the coupled hydrogen-MOF system and calculate all the relevant energy levels. At finite loading this direct approach is unfeasible, and Path Integral Monte Carlo methods will be used. Our main goals will be 1) reproduce the experimental results available on the interaction between hydrogen and metal-organic frameworks with open metal sites and 2) use the insights coming from the detailed molecular simulations to determine the effect of open metal sites on adsorption of hydrogen.

– *Dominant reaction pathways of thermally activated transitions*

We plan to extend the calculation of folding pathways to bigger molecules, including the largest for which a comparison with more standard and direct approaches is available.

The successful completion of this validation procedure will pave the way for more thorough investigations of the folding mechanism of larger systems, in particular small proteins characterised by the formation of alpha-helices and beta-sheets, which are the basic building blocks of the native structure of many proteins. At the same time, various extensions of the method will be considered. In particular it might be useful to include, at least at a semiclassical level, quantum diffraction effects on the dynamics of the lightest atoms (typically hydrogens).
Although the path integral formulation of the transition dynamics is in principle able to reconstruct not only the most probable path, but also the corresponding time information, it is not yet known how to extract experimentally important quantities - such as reaction rates - from this approach in a computationally efficient manner. Some effort will be dedicated also to develop the theory related to this task.

– *Computer simulations of DNA interacting with functionalised surfaces*

In order to define a precise protocol for DNA purification from a given biological sample, the assessment of various external conditions such as pH, ionic strength of the solution or types of the dissolved ions has to be evaluated.In this sense computer simulations can give useful insights as to the relevant mechanisms responsible for the reversible adsorption which has been experimental observed. The most important quantity measuring the tendency of DNA to attach or detach from a surface is the free energy of adsorption, and therefore our principal goal will be to compute it as a function of the concentration and type of counter- and co-ions in solution.

– *Dissipative phenomena in precision mechanical measurements*

Silicon is widely used as material for precision instrumentation, but its mechanical performances at the sensitivity level of 10-21 m/√Hz are not well known. The occurrence of disturbances from non-equilibrium effects must be thoroughly investigated, as well as the temperature behavior of intrinsic and thermoelastic losses. In a few years the unit will produce mechanical oscillators for measurements of dissipative phenomena and the modeling tools for understanding its physical behavior.

The know-how developed in this work will be used to develop low dissipation silicon-based optical components; a success in this task would represent a breakthrough in the field of precision measurements. Results from this research might be useful also for the development of micro and nano-mechanics membrane system in applications that include charge detectors, radio- frequency filters, magnetic resonance force microscopes, and torque magnetometers.

– *Modeling and simulations of high efficiency silicon solar cells for concentrator systems*

Photovoltaic concentrator systems (CPV) have been available for almost 30 years in laboratories and research fields to provide *green* electricity to the market.

A number of interesting CPV systems with very different approaches and degrees of success have been tested, but none of them has achieved the mass production level of flat plates PV systems. The current, main research effort into concentrator solar cells focuses on multijunction III–V-based solar cells (MJ cells) which have now achieved much greater efficiencies and higher con- centration levels with respect to the silicon solar cells.

However, high efficiency and high concentration concepts need very accurate systems, including their manufacture, installation and sun tracking which increase the total cost of the module. On the other hand, the research in the use of silicon solar cells for intermediate concentration level has not been sufficiently explored. The main problem is that the large development of low and intermediate concentration PV will occur when companies and research labs will match a good trade-off between a low-cost industrial process for high volumes with the costs needed for increasing the efficiency of a module.

Once this problem is solved, the global trend of concentrator installations could easily climb to tens of megawatts per year. In the following years the Unit will assist with a specific simulation and design work and MTLab in its challenge to produce silicon solar cells with efficiency above 21 % at one sun and 23 % in medium concentration context (100-150 x sun).

2.3. Activities and Work Plan

– *Many-body problems in scattering theory*

We will extend the Fano's multichannel scattering theory, in which the condensed matter group at LISC is familiar, in the context of many-body physics to study electronic properties in novel and technological relelvant materials, notably graphene, silicon carbide and hexagonal boron nitride (hBN). Furthermore, the discovery of tunability via Fano-Feshbach resonances has made it possible to control at will the strength and the sign of the effective interaction in quantum condensates, from BEC to superconductors. Particularly in many-particle systems, where the interaction has a small effective interaction radius, the information is enclosed in the scattering length, as in mean-field theories. To understand the role of electron-electron interaction on the molecular pairing, we will start from the ab-initio study of the scattering length in model experiments, such as ^{6}Li-^{6}Li, ^{40}K-^{40}K, D-D scattering at low temperatures. We will then move to more complex systems, such as

unconventional superconductors, to unravel the role of such an interaction to bring about quasi-particles pairing, which the key to understanding superconductivity. The connection between microscopic and macroscopic observables will be investigated using the Bogoliubov-De Gennes formalism, which is of paramount importance in many branches of physics, notably in ultra cold gases and high-Tc superconductivity, by calculating the microscopic density of states as a function of the energy. The fact that the density of states is continuum or presents a gap at some energies influences the conductivity of the medium for example. The solution of the Bogoliubov-De Gennes equations will allow us to refine the Hartree-Fock solutions, to treat more accurately the electron-electron Coulomb interaction, and to shed some light on how the electron-electron interaction, while repulsive in nature, can become attractive in some regions in space. In the latter investigation, we feel that a clear definition of the radius of the interaction potential is missing, while it is important to assess if such a radius is finite and comparable with the inter-particle distance or if the largely used contact potential approximation, as a limit of the previous case, is valid and can be safely used. Inclusion of an external magnetic field, as important in superfluidity or superconductivity context, will be considered.

– *Reflection Electron Energy Loss Spectroscopy (REELS): surface effects*

For the next year, the focus will be on understanding surface effects using REEL spectra from Si and Al as case studies.

– *Electron-phonon interaction and polaronic effect*

For the next year, we'll investigated the effect of the creation and annihilation of phonons on the shape of the electron inelastic mean free path of electrons in insulating materials (such as PMMA, SiO_2, Al_2O_3) when their energy in the solid is in the range 0-20 eV. The inclusion of the electron-phonon Fröhlich contribution into the previous calculations, performed within the dielectric theory scheme, is expected to introduce substantial changes in the shape of the electron inelastic mean free path in this very low energy range. Polaronic effect will be treated using semi-empirical laws able to evaluate the probability for a low-energy electron to be trapped in the ionic lattice.

– *Path Integral Monte Carlo calculations of virial coefficients of light gases*

We will extend the computer codes already written to calculate the third virial coefficient of light gases, Helium in particular, taking into account quantum statistical effects, using the path integral formalism will be used as the main computational tool. We will also consider the possibility to directly calculate the second temperature derivatives and the fourth virial coefficient.

– *Gas adsorption and dynamics in microporous materials*

We plan to perform a series of ab-initio calculations in order to calculate the potential energy surface of interaction of hydrogen molecules with the open metal sites of Cu-BTC and MOF-74. These potentials will be used as basic ingredients of quantum mechanical simulations aimed at calculating the zero-point energy of hydrogen molecules interacting with these materials, thus complementing neutron scattering results on these systems.

– *Dominant reaction pathways of thermally activated transitions*

We will implement and validate at least one of the mainstream classical force-fields used in the simulation of biomolecular systems, such as the AMBER force field. This force field will be used together with the generalised Born method to take into account solvation effects on the dynamics of the macromolecule. At the same time, we will consider the possibility of performing simulations of conformational transitions of large molecules using a completely ab-initio approach. The computational requirements for this aspect of the work will be thoroughly evaluated and the largest possible molecules will be simulated in this way.

– *Computer simulations of DNA interacting with functionalised surfaces*

We will use molecular simulations based on the umbrella sampling method to evaluate the free-energy profile of DNA oligomers as a function of the distance from a silica surface functionalised with amine groups. The free-energy profile will be calculated for various concentrations of co- and counter-ions in the solution, therefore analysing the effect of electrostatic screening on the adsorption energy. As a first step the solvation effects will be treated in an approximate way, using the generalised Born method. This method does not require the simulations of the ubiquitous water molecules and usually provides a very good first estimate of the relevant microscopic phenomena. These results will be used to estimate the computational effort needed for a full atomistic simulation (i.e. with explicit water molecules), which will be performed - if possible - to obtain a reliable estimate of the effect of the approximation of the method.

– *Dissipative phenomena in precision mechanical measurements*

The activities will be mainly devoted towards three main lines:

Modeling thermo-optic and intrinsic dissipation in crystalline and amorphous media: in collaboration with IFN-CNR Istituto di Fotonica e Nanotecnologie (Trento) we seek a new computational FEM-based tool for thermo-optic analysis of a multilayer coating over a silicon substrate. This tool will be useful to design macroscopic mechanical and opto-mechanics resonators, low-losses high reflectivity mirrors for the next generation gravitational wave detectors. This FEM-based tool is based on the combination of 2d 8-node multilayer elements used to model coatings and 3d 20-node elements for modeling substrates. The results will be compared whenever is possible with analytical formulas used to calculate the thermo-optic noise of mirrors in laser interferometer experiments. We will also use semi-classical, quantum tunneling and ab-initio approaches to model and analyze intrinsic loss mechanisms.

Design and fabrication and of membranes, MEMS and opto-mechanic (MOEMS) devices: in collaboration with IFN-CNR Istituto di Fotonica e Nanotecnologie (Trento), LENS, INFN Florence and MTLab-Fbk clean room facility we develop a new torsional low loss opto-mechanical oscillator that will be used as end mirror in a high finesse Fabry-Perot cavity for the realization of the ponderomotive squeezing. We also develop with IFN-CNR Istituto di Fotonica e Nanotecnologie (Trento) MEMS resonators with micro-mechanical techniques for studying non-equilibrium phenomenon.

Coating development: in collaboration with MTLab-Fbk we propose to develop an high reflectivity low loss multilayer SiN coating for the laser interferometric mirrors that can be also used for opto-mechanics resonators. Both the low and high refraction index materials will be obtained using SiN at different stoichiometry. Initially thin SiN membranes with different refraction index will be produced and both the mechanical and optical losses will be measured in the temperature range 4-300 K. Finally a complete multilayer mirror fulfilling all the interferometers requirements will be produced. The experimental cryogenic apparatus located at INFN Legnaro will be employed for characterization of the dissipative properties of those systems. The optical dissipation arising from the SiN membranes will be evaluated comparing the value of the finesse of a Fabry Perot cavity measured with or without the membrane inserted. The mechanical losses are estimated by measuring the membrane ring down time using as a displacement readout an optical lever coupled to a quadrant photodiode. Al the equipment is inserted in a cryostat with selectable temperature in the range 0.1-300 K.

Modeling and simulations of high efficiency silicon solar cells for concentrator systems

Modeling and simulations of high efficiency silicon solar cells for concentrator systems

In collaboration with MTLab-Fbk we seek to optimize the design of the solar cell starting from the results of a previous research project HCSC (High Concentration Solar Cells) where the major outcome was the development of a pre-industrialized process for silicon cells for intermediate sun concentration level.

The simulation and modeling activities will be mainly devoted towards:

- the improvements of the photogenerated current by enhancing the transmission coefficient of the anti-reflecting coating;
- the decreasing of the series resistance;
- the optimization of the junction for 100-150 Sun concentration working conditions.

We will study the solar cell behaviors by using both a Finite Element based process and a device simulator. We will use the process simulator to identify a correct com- bination of ion implantation parameters, oxidation times and temperatures suited to the definition of a shallow junction. Based on the doping profiles produced with the process simulation, a device simulator will be used for the evaluation of the I-V curves, the Energy Efficiency and its External/Internal Quantum Efficiency. Investigations on the generation and recombination phenomena will be carried out with this analysis.

Analytical formulas based on the Transmission Transfer Matrix and numerical ray tracing techniques will be also used to minimize the reflectance of the anti-reflecting coating made up of a combination of a texturing and a double layer PECVD dielectric film.

Another issue that will be addressed in collaboration with MTLab-Fbk is the development of an original (hopefully innovative) junctions shape for a possible enhancement of the separation capabilities of the whole junction. We will

investigate this idea by developing a specific mask layout according to the simulation results. Some critical parameters used in the simulations like the minority carrier lifetimes will be measured in the MTLab-Fbk facility in order to calibrate the simulation models.

2.4. Collaborations

National Institute for Standard and Technology of the United States of America
Dr. Allan H. Harvey
Path Integral Monte Carlo calculations of virial coefficients of light gases

Dipartimento di chimica strutturale e stereochimica inorganica dell'Università di Milano
Prof. Alberto Albinati and Dr. Peter Georgiev
Gas adsorption and dynamics in microporous materials

Dipartimento di fisica dell'Università degli Studi di Trento
Dr. Pietro Faccioli and Dr. Silvio a Beccara
Dominant reaction pathways of thermally activated transitions

Dipartimento di ingegneria dei materiali e tecnologie industriali dell'Università degli Studi di Trento
Prof. Stefano Gialanella
Electron-phonon interaction and polaronic effect

Russian Research Center (RRC) Kurchatov Institute, Moscow, Russia
Dr. Sergey Fanchenko, Dr Andrey Varfolomeev
Reflection Electron Energy Loss Spectroscopy (REELS): surface effects

Dipartimento di fisica, Università di Camerino
Dr. Stefano Simonucci
Many-body problems in scattering theory

Department of Physics, University of Vienna
Dr. Alex Gruneis
Many-body problems in scattering theory

Department of Physics, University College London
Prof. Dario Alfé
Many-body problems in scattering theory

Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena
Dr. Ronny Nawrodt

Albert Einstein Institute Hannover: Max Planck Institute for Gravitational Physics
Dr. Kazuhiro Yamamoto

CNR-FBK Trento
Dr. Roberto Verrucchi
Many-body problems in scattering theory

IMEM-CNR Istituto Materiali per Elettronica e Magnetismo (Unità di Ricerca Nanoscienze - Trento)
Dr. Michele Bonaldi

INFN, Laboratorio nazionale di Legnaro
Dr. J.P. Zendri

Unità di Padova-Trento della collaborazione Virgo, CNRS-INFN
Dr. Giovanni Prodi

Università di Firenze, Dipartimento di Fisica
Prof. Francesco Marin

Institute of Physics, ASCR, v.v.i. Prague, Czech Republic
Dr. Daniele Margarone

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Publishing on international recognized scientific journals	R	E	December	Relevance of the journal; number of citations.	
Fund raising	A	I/E	December	Amount acquired.	
Dissemination	R	I/E	December		Availability of funds.
Continuous learning	R	I	December	Attendance to schools, seminars, PhD award.	
LISC creation: merging of the unit CTP with the corresponding University group	I/R	I/E	June	Ability to find common objectives among the researchers.	Availability of funds; Organization issues.

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)

- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

6 Researchers (Lucia Calliari, Maurizio Dapor, Giovanni Garberoglio, Giorgina Scarduelli, Enrico Serra, Simone Taioli), 1 PhD student (Anna Battisti).

APP – ADVANCED PHOTONICS AND PHOTOVOLTAICS

Unit Name	APP – Advanced Photonics and Photovoltaics	
Type	Research	
Head	Georg Pucker	
Staff	2010	2011
	4 Researchers (1 tbh)	4 Researchers**
	1+1 Post Doc*	1 Post Doc***

Document Status: submitted 2010-12-01

* from UniTN another from EPFL, if financed by PAT.

** 3 from FBK + 1 visiting researcher from a company.

*** from UniTN.

1. Executive Summary

The research unit APP performs research in the field of photonics and photovoltaics. An important part of our research is based on our experience in the growth of silicon nanocrystals in dielectric matrices. These materials are applied in both silicon base light emitting devices and solar-cells. In both cases the devices are not mature for applications, but highly interesting from a scientific and technological point of view. In addition we develop optical waveguides and different kind of optical filters and micro-resonators. In the year 2009 we started to develop also organic solar cells. This research is performed within a project (Aurora II)funded by Radice Srl, from the Diatec group. Key projects for the year 2011 are: Aurora II (organic solar cells) the project Naomi (Photonics) and the project LIMA (nanocrystal based photovoltaics) supported by the European community. Within the project LIMA the research unit will participate in the improvement of the efficiency of back-contact silicon solar cells by the use of silicon-nanocrystals. Finally, within the project STRESS (*Studio della non linearita' di guide ottiche in silicio periodicamente stressato per nuove sorgenti laser nel medio infrarosso)* - funded by Fondazione Cariplo - we will work on the development of strained silicon waveguides for the generation of NIR-light based on stress induced non-linear optical properties in silicon.

APP will stay constant in the overall number of persons, unless we do not manage to add personal by external funding.

2. Vision and Scientific Program

2.1. Context and State of the Art

APP unit performs research and develops technologies in the field of silicon PHOTONICS and PHOTOVOLTAICS. Photonics generally spoken, include all aspects of light formation (e.g. light sources for lightning, displays, lasers), light

transport and management (e.g. mirrors, optics and waveguides), and all aspects of light detection. The centre of Microsystems and Materials performs research in several fields of Photonics (e.g. the unit SOI develops intelligent sensors, RAD is specialized in the development of sensors for high energy particles and silicon photo-multipliers, and MTLab among other devices produces both high energy particle sensors and photodiode based sensors). All these research in photonics is based on silicon, either using the in-house facility (MTLab) or by making use of an external foundry.

In silicon photonics research interest of APP is concentrated on (i) silicon-nanocrystals and their application in light emitting diodes and resonators, (ii) micro-resonators and coupled micro-resonators, (iii) optical waveguides and engineering of non-linear silicon waveguides.

(i) Within the last ten years MTLab in collaboration with the Department of Physics acquired considerable experience in the growth of silicon nano-crystals and their application. Silicon nano-crystals embedded in a dielectric matrix have physical properties, which differ significantly from bulk silicon (e.g. strong photo-luminescence due to carrier localization and quantum-confinement effects). Within a project funded by Intel, APP and UniTN used this knowledge to develop a light emitting diode, which switches on at a driving voltage of 1.7 V (APPLIED PHYSICS LETTERS 94, 221110 (2009)) and has a external power efficiency of 0.17%. The major achievement of this work is the excitation of the light emitting nano-crystals by both holes and electrons directly tunneling through the tiny oxide-layer separating the individual nano-crystals. This results in the low switch on voltage and increases significantly the lifetime of the device.

(ii) In addition APP recently started to investigate the properties of silicon nano-crystals in micro-resonators with quality factors larger than 5000. These research is motivated by the fact that in some cases silicon-nano-crystals can even show stimulated emission. By inclusion of the nano-crystals in a cavity (resonator) with extremely high quality factor, it might be possible to demonstrate on optical pumped laser. Together with the Physics Department of the University of Trento, we published, recently, a paper on the observation of the Purcell-effect in micro-resonators containg silicon nano-crystals [Phys. Review Letters 104, 2010, 103901]. The work is of some importance, since it proofs the observation of a quantum-electrodynamical effect for a so called bad-emitter even at room-temperatur. Silicon microfabrication technology driven by the miniaturization of the transistor allows nowadays to control the size or dimensions of devices and components with extremely high precisions down to some nanometers. Therefore it is often also the tool of choice for the realization of more complex optical structures such as coupled resonators. This devices can be used to study new and interesting optical phenomena such as optical Bloch oscillations, or forces between intense optical fields so called optical forces.

(iii) APP develops also optical waveguides for different spectral regions: Waveguides based on silicon nitride and oxynitrides for Lab on Chip applications, silicon and oxynitride waveguides for 1.5 micron and silicon based

waveguides for the NIR and MIR region for the guiding and generation of NIR and THz radiation. Silicon based waveguides are also studied for the generation of super-continuum light. SC-generation means that a laser pulse of a defined frequency broadens during propagation forming a wide continuous spectrum of light maintaining the coherence of the starting pulse. SC generation is optimized by appropriate design of the waveguides and of special interest in spectral regions where no tunable coherent light sources exist.

Silicon nano-crystals play also an important role in APP's second main research activity: PHOTOVOLTAICS. APP's research in photovoltaics is supported by the strategic project on photovoltaic's. In this field APP works on 2 projects: (i) nano-crystalline silicon based solar cells and (ii)organic solar cells.

(i) Research on solar cells based on silicon nano-crystals is part of a concept called 3rd generation photovoltaics developed and propagated by Prof. Martin Green of the University of New South Wales in Australia. 3rd generation solar cells should be significantly more efficient, cheaper and made from non toxic and abundant materials. Currently, a variety of ideas and concepts are investigated to increase significantly the efficiency of solar cells. One of the approaches envisions the combination of solar cells in a tandem configuration using a series of solar cells in which the properties of the single cell are tailored to a certain spectral area of the solar spectrum by controlling the size of the silicon-nano-crystals. Many technological and physical problems to overcome in this kind of solar cell are similar to the ones in nano-crystal based LEDs and it represents therefore a rather natural continuation of our research in silicon photonics. Starting from January 2010 APP is addressing this topic in the European project LIMA-*Improve photovoltaic efficiency by applying new concepts on the limit of light matter interaction*, FP7-248909.

(ii) In addition APP is continuing its research on organic solar cells (AuroraI and AuroraII) within a project for Radice SRL, of the Diatec group. Aim of the project is the development of an organic flexible solar cell with improved performance in the near-infrared region of the solar spectrum. Thanks to this project members of APP have also the chance to acquire a lot of experience on conductive polymers. This experience might be the seed for a stronger involvement of CMM in organic electronics in general.

2.2. Vision and Goals

Referring to the famous phrase of Feynman, one could predict that there is plenty of room in silicon photonics and photovoltaic's. APP is achieving currently a level of control in the growth process of silicon nano-crystals by PECVD, which will give us the possibility to explore potential and limitations of the growth method within the next 2 to 3 years. Our nano-crystalline LED's have currently a power efficiency of ~0.2% at low driving voltages and within the next 3 years (if funding is available), we should be able to verify if the technology can achieve 1-5% of efficiency. A stable LED based on silicon technology with an efficiency in the 1-5% range would find considerable commercial interest. The Lima project will give us the possibility to evaluate the potential of the technology for photovoltaics. The goals of the pro-

ject, improving by 10% the efficiency of a back contact silicon solar cell is very demanding and will request strong dedication of APP on the subject. However, the project gives FBK the possibility to collaborate with important players in the field of silicon photovoltaics - such as the University of New South Wales, Australia; Isofoton SA, (important producer of c-Si solar cells) ; the International Solar Energy Research Center in Konstanz, Germany; and the Technical University of Valencia, Spain – and in case of success, it will allow not only APP but the whole CMM to reinforce the position as important player in research in photovoltaics.

APP performs also significant research in the fields of microcavities, microresonators and non-linear optical waveguides, which led to a series of important publications and conference contributions. In addition this experience is applied in the development of different sensing systems either for research or bio-medical applications(see the projects: Naomi PAT, Nemo FP7). The activity of APP in this field will strongly benefit from the new lithographic system with increased optical resolution recently installed in MTLab and will clearly grow in importance within the next years. Recently, APP submitted a proposal to a call of the National French Space Agency (CNES) with the title: Photonic Molecule Bloch Oscillator. The proposal is under evaluation.

2.3. Activities and Work Plan

The year 2011 will see the members of APP mainly engaged in a series of projects: Lima, FP7-248909 ; Aurora II; Naomi FU-PAT, STRESS-Cariplo, and OXISOLAR (Fondazione Caritro).

Generally the work within APP is organized according the 2 main activities silicon photonics and photovoltaics and organic photovoltaics. 2 researchers work on the projects related to silicon photonics and photovoltaics and the other 2 on organic photovoltaics.

The work plan of the year 2011 is dictated mainly by the workplan of the most important projects:

The first months of 2011 will see intense activity on the project AURORA II, since the project should be finished within June 2011. In addition the project LIMA will enter the 2nd year and require a lot of effort and attention.

2.4. Collaborations

The Nanosciencelab of the Department of Physics of the University of Trento, led by L. Pavesi is the most important partner in the field of silicon photonics, while APP has the expertise in device characterization, Nanosciencelab is well equipped and experienced in device fabrication. APP and Nanosciencelab collaborate also in the field of nano-Si solar cells.

Other important collaborations in the field of silicon photonics are (1) the silicon photonics group of the Advanced Technology Institute of the University of Surrey, UK, managed by G. Mashanovich. The group has enormous experience in the design and fabrication of waveguides, grating couplers, filters and modulators, and (2) with the Electromagnetic Fields and Photonics Group of DEA, at the University of Brescia, Italy, led by Prof. Stefan Wabnitz, specialized in theory and simulation

of non-linear optics in nano-photonics and waveguides. Prof. Stefan Wabnitz is the co-ordinator of project STRESS.

Radice SRL, of the Diatec group, is currently the main industrial partner for the development of organic solar cells and co-ordinator of the Aurora-project.

Prof. Michele Maggini, Department of Organic Chemistry of the University of Padova, is an outstanding expert for the synthesis and properties of fullerene derivates. He collaborates worldwide with groups working on organic solar cells and is adviser of APP and Radice in the Aurora-project.

MTLab is the most important internal collaboration of APP. The collaboration includes the development of processes for silicon-photonics and photovoltaics and support in the testing of solar cells. MTLab is strongly involved in the projects Aurora and Lima.

M2B2 is our most important partner for structural analysis in both photonics and photovoltaics due to the experience of M2B2 in important analytical methods such as scanning electron microscopy, atomic force microscopy, x-ray photo-electron-spectroscopy and secondary ion mass spectrometry. APP and M2B2 collaborate in the projects ANNA, Aurora and Lima.

APP contributes also to the project OXISOLAR (Fondazione Caritro) led by the research unit PAM. APP and PAM collaborate also regarding the development and application of TCO's for organic solar cells.

2.5. Specific Needs and Points of Attention

APP is primarily an experimental group working lab-less, or in other words using the laboratories facilities of others either within FBK (e.g. MTLab, M2B2) or outside (e.g. Nanosciencelab UniTN). This situation is on hand convenient because APP being a small unit does not need to take care of maintenance on the other hand, it is often very complicated to stay within the scheduling of projects. In terms of optical measurements for silicon photonics FBK is very poorly equipped for the needs of APP and the unit relies mainly on external collaborations. This is especially a problem for collaborations with companies were a minimum of device characterization should be possible at FBK. For this purpose APP would need to establish a small laboratory housing 2 or 3 small optical benches and equipment for thin-film thickness and refractive index measurement (the laboratory might be part of a larger one, but should allow members of APP free excess to their equipment and instrumentation). Currently we plan to resolve the problem within a internal collaboration with the unit SOI, which has its own laboratory for optical measurements.

The performance (efficiency and stability) of organic solar cells suffers extremely, if the fabrication is performed in air. Although APP achieved an external power efficiency close to 2% fabricating the cells in air, the activity will have the need of acquisition of a glove box to perform cell fabrication in the future under inert gas atmosphere. The costs of the necessary investment can be estimated to be around 40 to 50 kEuro and can only be partially covered by the budget of the project Aurora II. The glove box should be installed either in the new MEMS laboratory of MTLab or in the general chemistry laboratory of FBK.

3. Goals

The 4 main goals for the year 2011 are closely related to the key projects of APP:

– LIMA: Proof that Si-quantum dots can result in an significant improvement in efficiency of back contact solar cells. Main risk for APP: APP might not succeed in controlling and improving the growth process.

– Naomi: During the year 2010 APP contributed to the project through the development of low loss oxy-nitride waveguides, 3D tapers and the integration of microresonators with waveguides. Within the 1st months of the year 2011 APP should finish the development of the optical platform for the microarray exited with waveguides.

– Silicon Photonics: Generation of light in the NIR and THz by strain in silicon waveguides. A series of strained and pooled waveguides are currently tested by the partners within the project STRESS. Main risk: In case of negative results from the measurements, it will be difficult to understand if the negative outcome is due to experimental problems are due to difficulties in device engineering.

Main risks of goals 1-2 are related to performance of instrumentation in MTLab (up-time of instrumentation and control). Problem will be kept under control by close collaboration with MTLab. Goal 3 will be achieved if the competences of the different partners can be successfully exploited.

– Aurora: Within the project Aurora, we plan to achieve an efficiency of 2-4 percent and to develop an process on flexible substrates. Currently, we achieved ~2% efficiency on rigid substrates. The main risk problem is still the same as in 2010: Devices are not stable enough in time, since we have to process under air. Best solution would be the acquirement of a glove box to work under inert atmosphere. Second best solution: Try to do some of the processing outside FBK (which was actually done under several occasions, but is complicated and difficult to organize).

4. Human Resources

During summer of 2010 the contracts of both Mher Ghulinyan and Yoann Jestin were renewed. Mher Ghulinyan has played a crucial role in the development of both competences and reputation of APP in photonics. Therefore, I would highly recommend to insert him in the tenure track of FBK. In addition, the contract of Yoann Jestin was renewed to guarantee continuity in our research on organic photovoltaics.

5. Risks and Mitigation Plans

Main risks of goals 1-2 (and goal 3 to some extent) are related to performance of instrumentation in MTLab (up-time of instrumentation and control) and process development. Problem will be kept under control by close collaboration with MTLab.

Routinely meetings will be organized to inform MTLab in time about the requirements for our projects and to organize the efficient use of the equipment. For very critical steps in some cases we might look for a back-up solution outside FBK.

A minor problem is the lack of equipment for optical measurements inside FBK due to the collaboration with the Physics Department of the University of Trento.

BIOSINT – BIOFUNCTIONAL SURFACES AND INTERFACES

Unit Name	BioSInt – Biofunctional Surfaces and Interfaces	
Type	Research	
Head	Cecilia Pederzolli	
Staff	2010	2011
	3 Researchers	4 Researchers
	2 Senior research assistants	2 Senior research assistants
	1 Post doc	2 PhD
	1 PhD	2 Undergraduate students
	1 Undergraduate student	

Document Status: submitted 2010-12-01

1. Executive Summary

1.1. Objectives and main activities

The research of the Biofunctional Surfaces and Interfaces (BioSInt) group is devoted to the development of soft biocompatible and biofunctional interfaces on solid surfaces through a) the study of the interactions between surfaces and molecules/biomolecules from a biological perspective and b) the development of processes enabling controlled attachment of functional biomolecules. The research group has multi-disciplinary competencies comprising members with biological, physical and chemical expertise. The main activity in the Unit covers three partially overlapping research fields: a) the study and development of surface functionalization processes aimed at the establishment of linkage strategies which allow biomolecule immobilization preserving conformation and optimizing surface density and orientation; b) the investigation of biointerfaces for the development of micro-devices for nucleic acid and protein analysis in diagnosis; c) the design and study of interfaces in the context of nanoparticles for molecular imaging and biophotonic applications.

In 2007, when FBK was established, biomedical studies and applications became one of the strategic areas of the Materials and Microsystems Center. In this context the Biosurfaces group received increased support within FBK. Since then it has been recognized by the local and national scientific communities for its activity in bionanotechnology. Now the research group is making an effort to obtain international recognition though scientific collaborations and projects funded by international agencies such as the EU community.

The BioSInt Unit focus on basic and applied research, also through joint activities and projects with start-up companies and industrial partners. In the coming year the research activities of the Unit will take place in the context of three projects: 1) A Nano-on-Micro approach to a multispectral analysis system for protein assays (Naomi), *PAT Grandi Progetti 2006*; 2) Point-Of-Care MONitoring and Diagnostics for Autoimmune Diseases (Pocemon) FP7-ICT-IP; 3) Biomedical systems for

nucleic acid analysis (RNA project) *Accordo di Programma 2009-2013*. Also the Unit is involved in the establishment of a new FBK-UniTN joint laboratory on genomics (Laboratory for Sequence and Structure Analysis for Health - LSSAH), which will get started its activity in the second part of 2011 (the details of this new initiative is reported separately).

The Unit comprises four senior researchers - 2 biologists, 2 physicists with a background in biophysics; two senior research assistants - 1 engineer, 1 chemist; and 2 PhD students from the International PhD in Biomolecular Sciences of CIBIO Centre (University of Trento). The four senior researchers form the core of Unit competencies; the tenure track period for one of these researchers is expected during next year. In addition, the Unit has the support of surface science researchers from MiNALab Unit for electron spectroscopy and scanning electron microscopy analysis. Finally, in 2011 the Unit will collaborate with the Faculty of Biotechnology also through the education of students from the Bachelor of Biomolecular Science and Technology which will be in the FBK Laboratories for their required experimental training.

1.2. Ethical Issues

The research activity involves the use of biological samples such as human or animal blood and human genetic materials: adult healthy volunteers, human genetic material and human biological samples.

1.3. Prominent collaborations

Internal:

Due to the complementary competencies we have ongoing collaborations with MiNALab Unit (material micro-analysis), Bio-MEMS Unit (development of micro-devices for diagnostic applications), SOI Unit (study of optical detection methods), CTP Unit (molecular simulation on surfaces) and IT-PMBE Unit (next-generation systems for nucleic acid analysis).

External:

CNR- Biophysics Institute (IBF) - Division of Trento (nanosystems for imaging and/or diagnostic applications); University of Ljubljana (Slovenia) (imaging of membrane proteins); Latemar Consortium (www.latemar.polito.it): Olivetti I-Jet, Polytechnic of Turin, University of Trieste, Biodiversity and University of Bologna (development of advanced devices for diagnostics and therapeutics); Laboratory of Translational Genomics, Centre for Integrative Biology (CIBIO), University of Trento (nanomaterials for DNA, RNA isolation and amplification; deep sequencing systems); Nanoscience Laboratory, Physics Department, University of Trento (biophotonics); Molecular Stamping (surface functionalization for DNA microarray); University of Ioannina, Greece (materials and microsystems for DNA sequences detection); University of Milano (materials and microsystems for DNA sequences detection).

2. Vision and Scientific Program

Since 2008, owing to the scientific reorganization of the MM Center, the research activity of the BioSInt team is part of a wider approach of the Center involving several research Units having as a final aim the use of micro and nanostructure technology for the development of improved medical devices (CMM-IRST *Programma Scientifico e Tecnologico 2009-2013, Nano–Micro Tecnologie per applicazioni biomedicali e BioNanoTecnologie/IT per le scienze della vita)*.

2.1. Context and State of the Art

The increasing demand for new technologies in health and personalized medicine requires the realization of low cost, flexible devices and new nanomaterials for diagnosis and therapy. A general requisite for the successful implementation of these tools is the development of suitable bio-functional materials and surfaces. The methods for the introduction of biological functionalities on inorganic/organic materials and tailoring their surface properties to improve their biocompatibility, constitute a core activity on which the successful development of these devices is based. In fact, extremely specific biorecognition elements have to be developed and linked to the device surface without compromising their bioactivity while addressing issues like the stability of the biocomponents.

The contact of these devices with complex biological samples, comprising many kinds of biomolecules (proteins, lipids and nucleic acids), poses strict requirements on their interfacial properties, especially considering the large surface over volume (s/v) ratio characterizing these devices. Thus biofouling, i.e. sticking of proteins to surfaces, becomes a bigger challenge. Non specific adsorption leads to an unpredictable concentration of assay components and influences the timing of delivery of analytes to the sensor area. On the other hand, some functions require the onset of strong non specific interactions between biomolecules and surfaces, a situation in which high s/v ratios permit the achievement of improved performances with respect to traditional devices. Therefore, both fundamental and applied research involving new materials and their biocompatibility have to be explored and represent a key step for the evolution of nanobiotechnology. In biomedical applications, traditional materials science and engineering face new challenges in synthesis and microstructure development since the requirements for general materials must be based on special biological needs. The most fascinating developments in nano-biomedicine are to be found in biomedical diagnosis and treatment, and involve the direct use of nanomaterials within a biological system.

With this aim in mind and building on the surface science competencies already present in the Institute, an interdisciplinary group was gradually developed with a twofold objective:

1) the study of the surface physico-chemical and morphological properties of material surfaces and the correlation with biological responses such as nucleic acids, proteins and cell adhesion (*Biological Surface Science*). High surface sensitive analytical techniques are utilized to examine the order and composition of the material surfaces allowing biomaterials and coatings analysis at the nanometer to micron scale using a range of complementary app-

roaches: X-ray photoelectron spectroscopy (XPS), time-of-flight-secondary ion mass spectrometry (Tof-SIMS) and scanning electron microscopy (SEM), atomic force microscopy (AFM), infrared spectroscopy (FTIR), optical spectroscopies and fluorescence microscopy (confocal and epi-fluorescence).

2) the study of *functionalisation processes* aimed to the development of biofunctional materials for biosensor and biochip applications. At the present the competences of the team are in the following fields: a) material surface chemical modifications for isolation of genomic DNA (silicon, glass and polymers) in research and/or diagnostics microdevices; b) carbon nanotubes functionalization with DNA oligonucleotide for biosensors; c) DNA oligonucleotide immobilization for microarray development; d) lipid-based coating for the realization of localized drug delivery systems; e) organic film deposition (i.e. PolyEhylenGlycols, chitosan, lipids, silanes) to create both non-fouling surfaces and functional surfaces.

2.2. Vision and Goals

Nanomedicine, the application of nanotechnology to healthcare, will be an essential tool to address many clinical needs in the future. It investigates the physical, chemical and biological properties of materials at the nanometer scale enabling the development of tools improving diagnosis, treatment and follow-up of disease. Although knowledge of metabolism processes at the cellular level continues to increase every year, we are still unable to diagnose diseases at a very early stage so as to treat and prevent them efficiently. Present medical practice relies on the appearance of typical symptoms for diagnosis and treatment of diseases. This is often too late for an effective cure because the disease has already spread all over the body, involving too many organs and compromising the body repair system. Nanotechnology is expected to have an enormous impact on the medical sector. New *"in vitro"* diagnostic tests will shift diagnosis to an earlier stage and allow preventive therapeutic measures. *"In vivo"* diagnosis will become more sensitive and precise due to new imaging techniques and nano-sized targeted agents. The efficacy of therapies will also be greatly improved by new systems that allow targeted delivery of therapeutic agents directly to the diseased site (Nanomedicine - Nanotechnology for Health, European Technology Platform, Strategic Research Agenda for Nanomedicine, November 2006).

In this very attractive and stimulating context the research activity of the BioSInt team will focus on the development of research and medical diagnostic (*"in vitro"*) tools over the next five years. This work will be carried out in close collaboration with technological partners (FBK-BioMEMS Unit, Olivetti I-Jet, Polytechnic of Turin, Molecular Stamping) and with biological groups, mainly the CIBIO Centre of Trento University, the IRCCS Burlo Garofolo-University of Trieste, University of Milano, University of Ioannina (Greece). *In vitro* diagnosis has traditionally been a laborious task. Blood and other body fluids or tissue samples are sent to a laboratory for analysis, which can take hours or days, and can be highly labor intensive. Progressively, miniaturization, parallelization and integration of different functions on a single device, based on techniques derived from the electronics industry,

have led to the development of a new generation of devices that are smaller, faster, cheaper and providing accurate readings. These analytical devices require much smaller samples and deliver more complete and more accurate biological data from a single measurement. Within the Latemar consortium we have been working for four years on the development of silicon and polymer-based lab-on-chips integrating the reactions of genomic DNA purification starting from blood, PCR (polymerase chain reaction) gene amplification and fluorescence detection of mutations related to inherited illnesses (2 patents pending). In agreement with the aims of the MM Center (RNA project, LSSAH laboratory) and considering the financed projects (Naomi, Pocemon) the research topics over the next five years are: 1) material surfaces for DNA purification in micro-conditions starting from untreated biological samples such as blood; 2) solid-phase systems for polysomal RNA isolation from cell culture and/or tissues; 3) nanostructured materials for sample preparation in deep sequencing systems (the details of this activity is reported separately); 4) optical and label-free (i.e. cantilevers, microresonators) detection methods aimed to higher sensitivity and specificity in micro conditions; 5) protein biomarkers identification and quantification using aptamer-based biosensor arrays.

Also, we intend to apply our competencies to a different field of nanomedicine with the study and development of nanoparticle coatings in collaboration with the local group of the CNR-IBF. The interaction of nanomaterials with cells and lipid bilayers is critical in many applications such as imaging and drug/gene delivery. These applications require the control of the nanoparticle-cell interactions, which are regulated mainly by nanoparticle surface properties. In this area the focus will concern the effect of different nanoparticle surface coatings on nanoparticle cell uptake also in collaboration with the Nanoscience Laboratory of University of Trento (silicon-based nanocrystals) and EPFL (synthesis and analysis of iron and gold nanoparticles). A further ongoing collaboration with the Trento Unit of CNR-IBF concerns the study of the protein interaction with supported lipid membranes. This effort brings together BioSInt molecular imaging competencies and the expertise of CNR-IBF in the determination of the function and structure of membrane binding proteins.

2.3. Activities and Work Plan

In order to accomplish the objectives of the BioSInt unit the following research activities are planned for the next year:

a) *Study of biomolecule-material interactions* (Naomi, Pocemon)

The investigation of the interactions between biomolecules (nucleic acids, proteins, lipids) and surfaces carrying different chemical, physical and morphological properties constitutes a fundamental aspect for the development of opportunely designed materials. The material surface properties determine its behavior when it comes in contact with biological fluids. A layer (or a multilayer) of biomolecules quickly covers the material surface causing in turn subsequent reactions with the complex mixture of molecules that are present in the surrounding. That means that it is a thin layer of few nanometers which takes control of the material reactions. Within the Naomi and

Pocemon projects will be crucial to perform the surface analysis of materials chosen for the chip realization (silicon and derivatives, polymers) to estimate the biocompatibility extent and perhaps the best passivation treatment for the specific application.

b) *Development of biofunctional surfaces for lab-on-chips in genomic analysis* (Latemar, Pocemon and RNA)

This task includes several activities with important objectives for the next year regarding DNA microdevices for molecular diagnosis: 1) the fully integration of the silicon-based device produced in Latemar (the project is officially concluded in September 2010 but some activities must be carried out to fully complete the work; point 1 and 2 of this task); 2) the prototype validation of the second Latemar lab-on-chip, made by using polymer-based technologies; 3) material surfaces for genomic DNA isolation (using crude biological samples such as blood) and gene amplification (PCR reaction) from adherent DNA aimed to the realization of a PDMS lab-on-chip for diagnosis of multi-factor diseases (Pocemon).

In addition, the RNA project will go on during 2011 following two directions: 1) the study of the interactions between polysomal cell fractions and surfaces with different chemistry and morphology; 2) development of a specific nanomaterial for the efficient isolation of mRNA under translation, suitable for integration in microdevices. The realization of functional surfaces able to specifically purify unmodified polysomes from cell lysates will constitute a fundamental step toward the realization of automated microdevices for polysome isolation. Surfaces with appropriate roughness and chemistry will be realized starting from evaporated gold on mica and depositing self-assembled monolayers of organic molecules carrying different functional groups. Surface properties using AFM, XPS, Tof-SIMS and fluorescence microscopy will be investigated. Part of the work will be also dedicated to a more advanced AFM use with the development of functional tips used to measure the strength of the interactions between ribosomes/polysomes and different chemical groups or biomolecules.

c) *Study of surface functionalization processes* (Naomi, Pocemon, Nanopur, Imbio)

In order to achieve the scientific objectives of the ongoing projects a strong effort will be applied to the study of surface modification methods:

- to optimize already realized processes: 1) microresonators coating with a silane activating film and subsequently with DNA-aptamers molecules acting as highly specific receptor for thrombin and/or epidermal growth factor (bioaffinity sensor); 2) lipid-based surface coating by nanoparticles for genomic DNA isolation; 3) glass and silicon surface coating with organic molecules (silanes, polymers) allowing the controlled immobilization of DNA in microarrays applications; 4) the optimization of the surface positive charge density using wet and plasma methods (biosurfaces for DNA isolation).

- to study and develop new processes: 1) surface passivation procedures for microfluidics in polymeric materials; 2) functionalization of microcantilevers made of silicon and gold for DNA hybridization detection; 3) silicon nanocrystal coating for molecular imaging applications.

d) *High resolution imaging using AFM* (RNA, PROSUM)

AFM imaging of molecular assemblies will be carried out: 1) the structural determination of polysomes, that are supramolecular assemblies where the genetic code carried by ribonucleic acids (mRNAs) is translated synthesizing proteins (RNA project); 2) the imaging of the molecular structures of membrane proteins in contact with lipid bilayers deposited on flat surfaces (PROSUM activity).

2.4. Collaborations

- CNR-IBF Trento, M. Dalla Serra - 1) high resolution imaging of protein toxins inserted into lipid model membranes using AFM; 2) lipid-based surface coatings of nanoparticles for DNA isolation (Nanopur) and for molecular imaging; 3) studies of nanoparticle-cell interactions.
- University of Trento: CIBIO Centre, prof. A. Quattrone - 1) RNA isolation from human cells, study of polysome structure (RNA), 2) FBK and CIBIO joint interdisciplinary Laboratory for Sequence and Structure Analysis for Health (LSSAH): nanomaterials for deep sequencing systems; Physics Department, prof. L. Pavesi – silicon biophotonics (Naomi).
- Polytechnic of Turin: Materials and Processes for Micro & Nano Technologies Labs, prof. F. Pirri - development of polymeric lab-on-chip for DNA isolation and amplification in point-of-care diagnostic applications (Latemar).
- University of Bologna: prof. L. Prodi - development and testing of a elettrochemiluminescent DNA sensor (Latemar).
- University of Trieste: IRRCS-Burlo-Garofalo, prof. P. Gasparini – validation of lab-on-chips for DNA isolation, gene amplification and fluorescence detection of mutations (Latemar).
- University of Padova: Department of Pharmaceutical Sciences, prof. B. Gatto - characterization and use of aptamers in bioaffinity sensors (Naomi).
- EPFL (Ecole Polytechnique Fédérale de Lausanne): Institute of Materials, prof. Klok - functional organic interfaces for controlled biomolecules immobilisation (Imbio); prof. F. Stellacci - synthesis and analysis of nanoparticles.
- CNR-IFN (Institute of Nanotechnology) Trento, S. Iannotta - functionalization and analysis of material activated by means of supersonic molecular beams (Naomi)
- CNR-IFAC (Istituto di Fisica Applicata "Nello Carrara") Firenze, S. Soria and G. Righini - functionalization and biological testing of resonant μspheres for label-free protein detection (Naomi)

- CIVEN (Coordinamento Interuniversitario Veneto per le Nanotecnologie), R. Pierobon and R. Bozio - functionalization processes and surface analysis, chip biological applications (Naomi)
- Olivetti I-Jet, L. Cognolato - development of silicon and polymeric lab-on-chip for DNA analyses (Latemar)
- Molecular Stamping Trento, G. De Ceglia – development of functional surfaces for microarrays (Imbio)
- Biotechnical Faculty, University of Ljubljana, Gregor Anderluh - imaging of membrane proteins (PROSUM)
- Dept of Science & Biomedical Technologies, School of Medicine, University of Milan, Fabio Macciardi - materials and microsystems for DNA sequences detection (Pocemon)
- Dept of Obstetrics and Gynaecology, Medical School of Ioannina University (Greece), Ioannis Georgiou - materials and microsystems for DNA sequences detection (Pocemon)

2.5. Specific Needs and Points of Attention

There are two points of attention that the Unit should address in the close future:

1) In 2011 the research activity within the Naomi and Pocemon projects will require a significant number of dedicated man/months. In addition, the collaboration with CIBIO Center will lead to the establishment of a common laboratory and the start of joint research activity (at least one person should be dedicated to this collaboration). All of these activities require considerable commitments in terms of time and personnel. Given these responsibilities, the concern is related to the difficulty to find time to research and develop new project proposals and to establish international collaborations as requested.
2) Laboratory costs: the Biomolecular Sciences and Interfaces laboratory incurs costs related, for instance, to the maintenance of the chemical and biological hoods, the system for water purification, the confocal microscope, the AFM as well as various solvents, reagents, etc. These facilities benefit not only BioSInt Unit but also the CNR-IBF, other CMM material science Units (MiNALab, PAM-SE, CTP), Molecular Stamping, CIBIO and E. Mach Foundation. At present these expenses are covered by the BioSint Unit, in the future a set amount should be allocated by the Institute to cover these costs.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Fluorescent microreactor arrays working with the epidermal growth factor	R, I	E	Decem ber		
PDMS lab-on-chip for	R, I	E	Dec.		

diagnosis of multi-factor diseases					
Defined material surface properties for polysomal RNA isolation	R	E	Oct.		
Starting of the deep sequencing activity (jointed LSSAH lab.)	R, I	I	Dec.		
Acquisition of a new pro-ject	R, I	E	Dec.		
Two publications of results in peer-rewied journals	R	E	Dec.		
Organization of workshop on optical detection sys-tems in biosensors	R	E	June		
Organization of the third edition of the Alp Nanobio International School ANIS-3	R	E	Dec.		

4. Human Resources

The Unit comprises 4 senior researchers - 2 biologists, 2 physicists with a back-ground in biophysics; two senior research assistants - 1 engineer, 1 chemist; and 2 PhD students from the International PhD in Biomolecular Sciences of CIBIO Centre (University of Trento). The Unit needs to consolidate its skill base by employing a permanent researcher with a solid background in biophysics, especially skilled in fluorescence techniques (such as confocal microscopy, two-photon microscopy), in spectroscopical methods especially suited for biological materials and in the syn-thesis of nanomaterial via wet-chemistry. One of the senior research assistants presently involved in the team has these competences as well as a demonstrated ability to work in a team-oriented environment and good organization and multi-tasking capabilities. For this collaborator the reallocation (from project-based coordinated ongoing collaboration contract to not permanent position of resear-cher, R3) is planned from January 2011 and the start of the tenure track period is expected within few months.

In addition, the Unit has the support of surface science researchers from MiNALab Unit for electron spectroscopy and scanning electron microscopy analysis.

The Unit needs to increase the number of personnel with competencies in biophysics and chemistry but this will require new incomes. However in the budget for the 2011 there is a request for the 6 months renewal of a collaboration contract for a research assistant in the framework of the collaboration with the CIBIO Center and for a new PhD position within the International PhD in Biomolecular Sciences.

SRS – SILICON RADIATION SENSORS

Unit Name	SrS – Silicon Radiation Sensors	
Type	Research	
Head	Claudio Piemonte	
Staff	2010	2011
	8 Researchers	8 Researchers
	1 PhD	1 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

1.1. Scientific context

Semiconductor detectors are used in a large variety of fields in science and technology, including nuclear physics, elementary particle physics, optical and x-ray astronomy, medicine, and materials testing – and the number of applications is growing continually. The success of semiconductor detectors is due to several unique properties that are not available with other types of detectors. FBK has been working in this field for more than ten years obtaining important results such as the mass production of silicon strip detectors for the AMS and ALICE experiments. In the last few years the activity has become even more important thanks to the development of new highly impacting technologies which led to the participation of the group to important EU projects.

1.2. Objectives and methods

The SrS research unit collects the FBK know-how in the field of Silicon Radiation Sensors. The goals are the development of sensors with high-tech content and the innovation transfer especially to the local territory.

The research content is focused in two areas:

- *Low-Light sensors*. The core activity is on Silicon Photomultipliers, which is one of the most interesting innovative technologies for low-light detection. FBK is developing its custom technology exploiting the MTlab as a produciotn foundry.
- *High-energy radiation sensors*. This field includes a variety of detector technologies which are manufactured in fully depleted high resistivity silicon. The main interest is on pixel, micro-strip and drift detectors. On the first two types FBK has a strong competence and the goal is to provide new customized solutions for the different applications. The third type is a completely new technology which attracts a lot of interest in precision spectroscopic measurements and astronomy.

Innovation transfer to the local territory is a key objective for the SRS research unit. In 2010, the group created a spin-off called “AdvanSiD” based on the successful

results on the SiPM research activity. An important objective for the next and following years is to establish a productive relationship with this new entity with an efficient transfer of the research results.

1.3. Personell

The group will be composed by the same number of researchers as in 2010: 8 researches employed by FBK and one PhD student. Among the 8 researchers, two are senior scientists (1 physicist, 1 electronic engineer) with a permanent position (FBK contract).

1.4. Collaborations

The main *internal collaboration* is with the MTLab in which most of the devices are manufactured. In 2010, we started collaborating also with SOI group and the plans are to reinforce it to develop complex systems based on our sensors.

The main *external collaborations* are with:

- National Institute for Nuclear Research (INFN), in both fields of SrS activity.
- Philips, in the field of low-light sensors. FBK is participating in two large EU projects.
- NexRay collaboration, for the development of Silicon Drift Detectors

2. Vision and Scientific Program

The SrS activity is focused on the development of radiation detectors using the silicon to convert the particle energy into an electrical signal. Silicon is probably the most interesting solid-state material in this field thanks both to the highly advanced process techniques available as well as the material availability compared to other semiconductors. These two advantages allow the production of high-quality, reliable sensors. Last but not least the cost is much lower compared to other semiconductors.

The SrS research interests cover two main topics: low-light sensors and high-energy radiation sensors.

2.1. Context and State of the Art

Low-light sensors

Within the scientific community developing machines based on the detection of very faint light (up to few thousands of photons per light pulse) there is a crescent need to work with a solid-state device able to replace the vacuum-based photomultiplier tube. The main advantages that can be achieved at the system level are: size reduction, ruggedness, cost.

A class of devices that have this potentiality are diodes working in a limited-Geiger regime. In this operation mode a diode can produce a very large (but finite) amount of charge per each photon converted, enabling, thus, the detection of single photons. Particularly appealing is a device, called silicon photomultiplier (SiPM), in

which several of such micro-diodes are connected in parallel to allow photon counting even in a short burst of light. Another extremely important feature of devices operated in Geiger-more is the extremely fast response.

The applications of a device, which is both sensitive to extremely weak light and fast, are numerous:

- Nuclear medicine: time-of-flight positron emission tomography
- Physics experiments: calorimetry, fiber tracking
- Astrophysics
- Biology: fluorescence measurements, cytometry
- Material analysis.

The SiPM development started at FBK in 2005 within the framework of the “PAT-INFN” agreement. Then, in 2008, FBK joined the EU project “HyperImage” coordinated by Philips for the development of SiPMs for a TOF-PET machine integrated with a magnetic resonance. This project will end in September 2011, but in the meantime, a second large European project started: SUBLIMA. Now, FBK has become one of the main actors in this field producing the largest devices in the world.

The technology developed by the goup is completely custom thanks to the presence of the MTlab clean room. This is a key advantage because the performance can be optimized acting on the fabrication process. It is worth noting that the SOI unit activity in this field is carried out with a different approach: it exploits standard CMOS technology. This allows a more efficient integration at the system level but imposes many restrictions on the optimization of the device performance. In 2010 we started a more intensive collaboration between the two groups to obtain competitive hybrid systems.

High-energy radiation sensors

High-energy radiation detection using silicon keeps continuing to be a very active field both in terms of R&D as well as market. The applications cover a wide range of fields:

- Physics experiments: trackers, ion detection
- Medical physics: X-ray detection, dosimetry
- Material characterization: spectroscopy;
- Homeland security
- Astrophysics

FBK has been working on high-energy silicon radiation detectors for more than 10 years obtaining important results such as the production of micro-strip sensors for the AMS and ALICE experiments in 2000-2004. This production activity is unique in Italy and one of the very few around the world. After those large productions, FBK had numerous requests (on average 6 per year) for small productions of customized micro-strip and pixel detectors for various experiments ranging from nuclear to medical physics. Flexibility in both the fabrication technology as well as the design has been FBK strong added value.

Besides pixel and micro-strip technologies, which are quite well established, FBK started completely new R&D activities on three-dimensional detectors (3D) and silicon drift detectors (SDD).

The development of 3D sensors, which represent the new frontier for large particle physics experiments, started in 2005 within the MEMS1 agreement between INFN and PAT. FBK has obtained extremely encouraging results being the second producer (after the inventor of the technology) whose devices have been characterized in a test beam. Still, a lot of work has still to be done to fulfil the requirements given by high-energy physics experiments.

The development of SDDs has started very recently: in 2009. The inputs that initiated such developments came both from industry as well as from INFN. This technology is extremely interesting both from the scientific as well as potential market point of view. In 2010 with obtained extremely good small size devices.

2.2. Vision and Goals

Low-light sensors

The SiPM is a rather a new sensor so significant improvements are expected in the coming years. There are common requirements coming from all applications such as the reduction of the dark noise and the improvement of the photo-detection efficiency. Then, each application has particular needs.

For a positron emission tomography system, which is so far the most interesting application, the photo-detection efficiency must be maximized in the blue region of the light spectrum. Then, special integrated packaging solutions have to be developed in order to allow the creation of large matrices with low dead area and without any obstacle on the sensitive side to allow the positioning of the scintillator crystal. Both aspects are quite delicate and require a consistent amount of work leading to a radical technological innovation (second generation SiPMs).

Thanks to the success of the SiPM activity, an important result was the creation of the spin-off AdvanSiD which is commercializing SiPM products developed by the SRS group. The key idea is to transfer continuously the R&D results to this company which in turn creates a link to the market.

High-energy radiation sensors

The SRS group intends to pursue three objectives in the coming years:

1. provide, with even more efficiency than in the past, customized pixel and micro-strip detectors for the scientific community and industry. This task requires a lot of effort in terms of layout, processing and testing and relation with the partner because it is usually segmented in many different contracts.
2. Finalize the development of 3D detectors in order to be ready for the upgrades of the large physics experiments at CERN. The primary goals are to develop a fully 3D sensor and an active edge detector.
3. Develop competitive SDDs to satisfy the requirements both for spectroscopic and tracking systems. This means we need to develop a technology with extremely low leakage current and thin radiation entrance window. Furthermore, we need to produce devices with an active area as large as 1cm2.

2.3. Activities and Work Plan

To start accomplishing the long-term objectives mentioned above, significant activity has to be carried out in design, simulation, process technology and testing.

Low-light sensors

In order to enhance the photo-detection efficiency in the blue region, in 2010 we modified the internal structure of the device starting the development of a p-on-n technology. In 2011 we will accurately test this new technology and implement adjustments to the fabrication process to improve the performance.

At the same time, we will continue the improvement of the standard n-on-p technology. In particular we will work on the noise reduction and uniformity of the device characteristics. These are crucial points that will enable the SiPM technology to be used in large systems.

In parallel the packaging issue will be tackled. The long-term plan is to develop a technology to bring the signals on the non-sensitive side of the device by means of conductive columns passing through the silicon bulk. The development requires a considerable effort on the technological side and this will be carried out in tight collaboration with the Micro Technology Laboratory. For the next year we plan to produce test structures and possibly SiPMs with front-to-rear side connections.

High-energy sensors

Three activities will proceed in parallel to fulfil the goals mentioned in the previous section. In particular:

Objective 1: We will respond to the request that have come/will come from INFN or other research institute for the development of customized detectors based on our standard platform technologies.

Objective 2: We will stabilize and optimize the process of the full 3D technology developed in 2010.

Objective 3: We will increase the size of the SDDs to produce devices of interest to the market.

The exploitation and dissemination of the results will constitute an additional activity to be carried out during the year.

2.4. Collaborations

The main collaborations foreseen for the next years are with:

- INFN. The MEMS2 agreement is the framework for this collaboration. Within this project, both topics covered by the research unit are covered.
- PHILIPS. The EU projects HyperImage and SUBLIMA are the framework for this collaboration. A large fraction of the low-level light topic is covered by this collaboration.
- Large Japanese company. The NexRay project is the framework for this collaboration. The activity in the High-energy radiation area.

Many other collaboration are ongoing with research institutes and companies which are not mentioned here.

2.5. Specific Needs and Points of Attention

In 2010 the SRS created a small electronic laboratory for electrical and functional characterization of the SiPMs with two testing lines. This laboratory is extremely useful due to the large amount of work coming from the EU projects and the MEMS2 agreement. Furthermore, the number of people is adequate to carry out the activity. For these reasons no particular needs are foreseen for the next year.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
SiPM – improvement of n-on-p technology	R	E	Dec.	Performance of produced devices	
SiPM – front-to-backside connection	R	E	Oct.	50%: test structures available	
Full 3D silicon detector: process stabilization	R	E	Nov.	Performance of produced devices	
Production of large area SDDs	R	E	June	Devices available	
Publication of research results	R	E	Dec.		
Enhanced collaboration with SOI research unit	F	I	Dec.	Common scientific projects/results/publication	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The SrS research team is composed by 8 researches employed by FBK and one PhD student.

Among the 8 researchers, two are senior scientists (1 physicist, 1 electronic engineer) with a permanent position (FBK contract). They have core competencies in simulation/layout and testing. The 6 young researchers (1 physicists, 5 electronic engineers) have competencies in simulation/layout, processing and testing respectively.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Equipment down time	L	S	
Researchers leave the unit with short warning time	M	S	

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

MTLAB – MICROTECHNOLOGIES LABORATORY

Unit Name	MTLab – Microtechnologies Laboratory	
Type	Laboratory	
Herad	Pierluigi Bellutti	
Staff	2010	2011
	10 Researchers	10 Researchers
	3 Technologists	3 Technologists
	1PhD	1PhD
	1 Co-pro	1 Co-pro (part time)
	1 Consultant	15 Technicians
	14 Technicians	
Document Status:	submitted 2010-12-01	

1. Executive Summary

MTLab effort is concentrated on growing as a reliable and a technologically updated facility where R&D activities in Radiation Detectors and MEMS areas, can be successfully carried out and where SME's, interested in this know how and capability, can find the opportunity to introduce innovation in their products, working together with us in a high quality- R&D and manufacturing environment.
MTLab will also play a leading role in the technological progress of the Country through collaboration in higher-education initiatives with universities and other research Partners at national and European level.

To meet these purposes, MTLab is structured as a Facility fully equipped to cover a wide range of fully characterized processes on 100 mm wafers (Silicon, quartz, glass…) offering also extensive functional testing.

MTLab is organised:

- to develop and carry out technological processes on behalf of the FBK Research Units.
- to offer technological know how on the available processes (research activity) developed both internally or jointly with other Research Units of FBK .
- to carry out engineering work to transfer technological innovation into marketable products .
- to support industrial production for medium quantity standard products (services).

MTlab is very flexible in mixing these types of activities whose relative weight changes over time depending on internal and external conditions.

MTLab is structured in four areas:

- Microfabrication (coord. L. Ferrario), carrying out manufacturing activities, including batch productions;

- Processes R&D (coord. M. Boscardin), developing new processes and providing technologies supervision
- Testing (coord. A. Collini), for process parametric control and functional testing of devices
- Integration (coord. P. Conci), developing solutions for advanced packaging and System engineering.

Each area has a qualified staff. Microfabrication, Testing and Integration have researchers that develop new specific activities and control advanced technologies, and technicians, for equipment operation and maintenance and standard activities. The research activities of Microfabrication is charged to Processes R&D one, an area involving researcher and technologists that are silicon process specialists and technologies supervisor.

The most relevant longterm collaborations of MTLab are with: INFN and CERN as a silicon processing facility and Optoi Microlectronics, for development and production of devices for industrial application. Many other could be listed, by they are mainly through other research Units of CMM.

2. Vision and Scientific Program

2.1. Context and State of the Art

It is important to emphasize that know how and equipments of MTLab belong to the “MEMS world”, quite different from Integrated Circuits (ICs) Silicon Technology. While ICs world is under pressure to follow the Moore’s law (the continuous shrinking down of the minimum feature of the technology accounts for the rapid equipment obsolescence and the astonishing increase of plant costs), MEMS had opened new fields of technological development, where the effort is more focussed on smart exploitation of relatively stabilized technological capability, an approached named “more than Moore”. In this way both equipments and basic processes blocks have much longer operating life with a beneficial impact on the related investments costs of (for instance, dismissed equipments from ICs are feeding a flourishing market of refurbished equipments for MEMS).

In comparing MEMS and ICs technologies one can recognise some common features, such as substrate material (i.e. silicon, although MEMS are also developed on quartz and glass) and the same suppliers of equipment, but also clear differences such as the use of gold which is widely used in MEMS and banned in ICs. A further feature of MEMS technology is the exploitation of the third dimension of silicon substrate, while ICs are a strictly planar technologies. It is important to notice that from a research point of view, ICs technology allows development of new devices in a fabless environment, because the customisation is at the design level and ICs silicon foundry offer standard technologies and packages. On the other hand, MEMS typically require customised technologies and this makes its access difficult for R&D institutions and SME. MTLab aims at making these resources more easily available to them. This is its core mission as well as its “raison d’etre”.

Based on the growing application range of MEMS devices and the need to grow a multidisciplinary scientific and technological Know-How, a sparkling research activity is going on, driving innovation in key markets such as automotive, ambient assisted living and bio-applications.

MTLab wants to expand its role in this field of growing interest as an open facility for MEMS at international level, offering similar services as those of an ICs foundry to selected Partners and with a broad but limited spectrum of technologies. Besides it offers the right environment for some Partners to develop their own technologies and processes getting advantage of the full equipment line available. MTLab is indeed well equipped for customised MEMS development and, more generally speaking, is a flexible structure suitable to develop "customised technologies". This is demonstrated by the undergoing activities with two major successes, both characterised by a high degree of a technological customisation: the production of large area detectors for space application and the growing production of customized optical devices for a local SME, with a worldwide market. During the last five years a remarkable financial effort was made to increase the capabilities of MTLab in terms of processing and testing equipment.

Microtechnologies activities at FBK are experiencing a period of indisputable visibility both at national and international level in well define application domains. MTLab is recognized as a unique Facility in Italy, and of comparable level to most of those present in Europe and elsewhere. To defend the actual position and to move to further developments itrequires a strategic plan to consolidate and expand the existing technological platforms. This plan may include the facility upgrading up to 6", a substrate dimension that our competitors have already adopted or are moving to.

2.2. Vision and Goals

MTLab activities are strongly connected with the scientific work of FBK research units of the Material & Microsystems area. The major objective of MTLab is to be a reliable and a technological updated facility where R&D activities in the area of MEMS, micro and nano technologies can be carried out and where enterprise, interested in these know-how and capabilities, can find the right partner to address innovation of their products,.

To fulfil this objective, MTLab have to share a common strategy with the Units.

Furthermore, MTLab will work to extend its capabilities to national level through an action of strategic marketing where actors such as large research institution, University and Industry/Economical Development Ministry should be involved. This action is absolutely necessary, because a well performing MTLab has a processing capability much higher than required by the local scientific and industrial demand. Some results have definitely demonstrated that this way is the right one. The consolidated relationship with INFN (National Institute of Nuclear Physics) is an example of tight collaboration with a large research institution; while the successful development of a gas sensors for an international company together with a recently acquired R&D international industrial project testifies that MTLab can meet the needs even of big industrial partners. Last, but non least, the success story with a

spin off (OptoI Microelectronics) is a proof of what technological transfer and innovation with local territory can produce.

What has just been said for the Country can be applied at European level, through strategic collaboration with outstanding partner such as CSEM, CEA-Leti and IMS-Fraunhofer. The seeds providing the starting point has already been thrown during 2009 and now MTLab is engaged in developing common projects, including those based on a “supply chain” model, to exploit the larger production capability available by these international partners. Within the international community, MTLab is qualified supplier for CERN experiment and is now involved setting up a “consortium” with some major detectors and integrated systems providers for the next generation experiments at LHC.

Beside this, MTLab has applied technological research activities focused on silicon based photovoltaic cells for solar concentrators. In this specific field MTLab would like to become a well recognised actor on the scene within the next 2-3 years, able to promote specific industrial exploitation of this promising technology. At present, in Italy, MTLab is the unique player covering development and production of silicon solar cell for concentration PV.

2.3. Activities and Work Plan

MTLab is are structured on Four Areas closely cooperating to meet on schedule and with the allocated resources the expected results. For the 2011, MTLab plans to carry out the following activities:

1. Processing as requested by the Research Units.
2. development of a silicon solar cell, for solar concentrators, having an efficiency of 21% in a concentration @ 60 suns
3. Stabilisation phototransitor technology for space application (devices for French space agency)
4. Carrying out the request acquired from INFN Groups (about 15 contracts).
5. Feasability study for a communication system between wafer tracking (Web-FabIS) and testing (OpenMeasure) software. Design and implementation of a test case for the extraction of online process control.
6. Support silicon microtechnology solutions for SME
7. Autonomous valorisation of R&D work by mean of specific publications
8. Implementation and test of the quality control procedures prepared along 2010. This is an internal project aimed at a future ISO certification of MTLab. Project leader is V. Zanini.

Specific activities for each labs are also planned including:

Microfabrication:

a. Acquisition new scrubber system for furnaces exhausts
b. Installation of new RCA wet bench and gold plater
c. Realization of the new gowning room

Process R&D

a. first attempt to integrate gettering module in SDD technology
b. further improvement on the 3D silicon radiation sensors technology

Testing:

c. Further progress in development of a demo system of PV panel on sun tracker (to be placed on the institute roof). This system is aimed at an “on field testing”.
d. Improvement of the solar cell test procedure for a better control of the temperature

Integration:

d. An optimisation of the silver fill Through Silicon Via in terms of homogeneity across the wafer.
e. Contract scouting for implementation of hermetic packaging under vacuum for radiation sensors within new projects

2.4. Collaborations

Collaboration already settled:

- FBK Research Units. MTLab will further strength and expand its collaboration with all the research units active on Silicon Microtechnology: MEMS, SRS, Bio-MEMS, and APP. Furthermore, joint activities with other units belonging to CMM are planned to have access to material and interfaces characterization (Minalab), for new materials suitable for PV application (PAM and APP), and support of electro-physical, thermo-electrical and mechanical simulation necessary for technologies developments (CTP).
- ENEA (Portici, Na), ARCES (Bologna): for Si photovoltaics technologies, the former for solar concentration systems, the latter for simulation.
- INFN: within the MEMS2 agreement, MTLab is playing the role of a “national facility” for INFN. for all INFN groups interested in silicon based microtechnologies.
- CERN: MTLab is within a consortium of European silicon detectors producers for future LHC upgrades
- External Silicon Foundries for technologies transfer: OlivettiJet (Arnad, Ao); Semefab (Scotland):
- Silicon Sensor (Gmbh, D) and Semefab (Scotland): R&D support for silicon device manufacturer
- OptoI Microelectronics: MTLab collaborate since long time with this spin off mainly in the fields of optical and MEMS devices. In the next year other development on sensors for building automation and PV systems are planned.
- Rigaku, Japanese company, MTLab provides production for high quality microstrip detectors used in analytical instrumentation.

Strategic European contacts:

- CSEM (Neuchatel, CH) and CEA-Leti (Grenoble, F) as partner on MEMS activity
- IMS Fraunhofer (Duisburg, D), for technology development, technology transfer and microsystems integration
- VTT (Helsinki, Fl), for detectors assembly
- CNM (Barcellona, E), under preparation

2.5. Specific Needs and Points of Attention

There is a need to replace the furnaces since they are old and under “risk” to face a possible catastrophic problems related to PC/software that are obsolete and without any possible solution. The possible plan to upgrade the microfabrication line up to 6”, at present limited by the furnace only, is suggesting the straightforward choice of changing the furnaces, acquiring system allowing both 4” and 6” processes. In this way the microfabrication facility will continue to operate at 4” and will be ready to be upgraded up to 6” without equipments replacement. It is worth noting that the upgrade cost up to 6” of the furnaces requires the change of the quartz boats only.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
silicon solar cell with 21% eff. @ 60 suns	I	E	Dec.		
SW for cross checking	F	I	Dec.		
Upgrade temperature control solar cell test procedure	F	I	Sept.		
Optimisation Through Silicon Via contacts with Ag filling	R	E	Dec.		
2 publications			Dec.		
Start up gold plater, RCA and scrbber	F	I	March-Dec.		
Phototransitors for space appl.	I	E	Dec.		
New gowning room	F	I	May-Aug		
Acquisition of a research contract including hermetic pkg	R	E	Dec.		
Training of TBH	F	I	Sep-Dec		
New evaluation model for technician staff	F	I	Jan-Jun		
MFLab-TLab data communication – feasibility and test case	F	I	Dec.		

Notes:
- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

- In 2011 three technicians are reaching the conclusion of the three years contracts. They should be confirmed for the next three years to exploit the formation investment MTlab has done, but the actual rules make this impossible. Therefore, their replacement is strictly necessary. Since one of these technicians have been deeply involved in maintenance training on several equipments to have him as optimum candidate to take the place of a senior which is going to be retired in 2012, his stabilization would be a strategic choice and it is strictly recommended.
- A part time collaborator is require to take the place of dr. Leleiva, that was in charge of the upgrade and maintenance of the SW for microfabrication, and recently left MTLab.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Equipment downtime	M	S	
Technician recruitment			
CR detector activity stop	sure	S	

Equipment downtime can be faced with the well trained and skilled maintenance team present in MTLab. However, severe situation can occur keeping equipment down for several weeks. In this case the only viable solution we have is to exploit external processing services with a dedicated budget item. The most reliable way would be to turn to maintenance contracts, but this is still too expensive in absence of mass production. In any case, an adequate maintenance budget is mandatory to mitigate this risk as well as the stabilization of the trained young technician to cover the one that will retire in 2012.

Notes:
- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

REET – RENEWABLE ENERGIES AND ENVIRONMENTAL TECHNOLOGIES

Unit Name	REET – Renewable Energies and Environmental Technologies	
Type	Research	
Head	Alessandro Bozzoli	
Staff	2010	2011
	7 Researchers	7 Researchers
	3 Technician	1 Technologist
	2 PhD	3 Technician
		2 PhD

Document Status submitted 2010-12-02

1. Executive Summary

REET unit is working on the sectors of *Renewable Energies*, *Environmental Technologies* and *Modelization processes*. Its activities in the specific fields go from *basic research* and *innovation* to *technology transfer* and *support to entrepreneurial sector* under the technological point of view.

The core attitude of REET unit is the support to local initiatives, networking the actions of the SME and the entrepreneurial sector, developing in parallel an international approach to its general vision, including cooperations, international projects, international partnerships and PhD students.

A brief description of the Main Activities include:

- *basic research*: starting activities on the sector of *Wireless energy and Rectennas technologies*, *Thermal Fluid research* applied to Solar and Geothermal technologies, *Energy Conversion processes* (biofuels, energy multigeneration) based on specific experience and skills of REET unit in the different sectors of Electromagnetic interactions, of Modeling, of Renewable energies.
- *innovation*: the innovation is the actual main application sector of REET unit. In the *Energy sector*, REET unit has launched a series of pilot projects in different areas including solar multi cogeneration technologies, energy conversion from waste biomasses, solar cooling and heating technologies; in the sector of *Environmental technologies* new technologies for the safety systems in industrial machineries and processes.
- *technology transfer and support to entrepreneurial sector*: REET unit is working on a series of projects, demonstrators and prototypes on the energy and environmental sectors. The specific projects have the intent to provide added values to the partner companies, to which the results and technologies will be transferred. Some innovations of REET unit will be transferred directly to Start Up activities.

REET unit is composed by 7 researchers (2 seniors), 1 technologist, 3 technicians and 2 PhD. The specific skills well represent all the different Main Activities of the unit, from the theoretical point of view to the more applied physic and engineering field. The objective on the skills development is to grow up a shared expertise on the Modeling sector and to specialize the unit personnel on the three main sectors of Energy, Modeling and Environmental Technologies, by three workgroups working on parallel projects and initiatives.

The unit is cooperating internally and at local and international level with a series of Institutes and Companies:

- *internally* main cooperations are with the *Center for Information Technology* on the EIT KIC ICT initiative (*Trentino Rise*), and with some units from the *Center for Materials and Microsystems* on the energy technologies.
- *at local level*, REET unit is cooperating with all research and public institutions and the main companies at large and Small - Medium level (amongs them are UniTn, FEM, PAT, APE, Habitech, ITEA, Dolomiti Energia, Enervals, ELMA, Vescovi Stufe, Eurostandard, Steinex, CRF, Ceii, and others).
- *at national and international level*, REET unit has a wide cooperation from all over Europe and at International level (amongs them are US DOE Pacific Nothwest National Laboratory, Uppsala University, TU Graz, TU Hamburg, University of Twente, Politecnico di Milano, Massachusetts Institute of Technology, Narva Lichtquellen, Consejo Superior de Investigaciones Científicas, Laboratório Nacional de Energia e Geologia, Acciona, Aermec SpA and others).

2. Vision and Scientific Program

2.1. Context and State of the Art

REET unit activities are build up on three main sectors, which include all projects and programs: *Renewable energies*, *Physical modeling* and *Bio-Electromagnetism*. Additional actions are guided within the ambit of *Dissemination and Exploitation*, including *Technology Transfer and support to Entrepreneurial world*. During the last year, REET unit has improved the following activities at local and international level:

- *Renewable energies sector*: REET unit has worked on a *full energy vision*, developing since two years a work plan divided into three phases. The plan is focused on innovations on the specific field of distributed cogeneration and retrofittable technologies applied to small-medium sized dimension.

The below picture describes the general VISION of REET activities in the field of Renewable Energies:

At the present time the PHASE 1 is completely in progress for the pilot projects in different application fields, all coordinated by REET unit.

SOLAR THERMAL/THERMODYNAMIC: *DiGeSPo*, a FP7 funded European project (best project of the CALL Energy-2009-1) to obtain a micro cogenerating technology for domestic applications based on Concentrated Solar Power of small size and applied to a Heat Engine (Stirling).

BIOMASSES: *BioTec*, a local funded project by Fondazione CaRiTRo on Energy conversion processes by waste agricultural and forestry biomasses.

BioDomUs, a funded project by the Province Energy Agency on a cogeneration of energy from small sized Stirling engine applied to a domestic pellet boiler.

Galef, a funded project by the Province of Trento – law6, on a small scale Organic Rankine Cycle applied to fluid bed gasification process.

SOLAR APPLIED TECHNOLOGIES: *SolTerm*, a funded project by the Province Energy Agency on a solar heating and cooling technology based on adsorption processes.

GEOTHERMAL (low entalpy): *GEOITEA*, a funded project by the Province Energy Agency based on technology developments on ground probes and heat pumps.

FUEL CELLS: EcoCell, a funded project by the Italian Ministry for Environment and Territory on optimization of Direct Methanol Fuel Cells, reducing the cross – over effect.

RESOURCE ASSESSMENT: BioPath, a funded project by the European Commission on the Central Europe program, on a Biomass and solid biofules certification and traceability control system.

- *Physical modeling*: the second sector of REET is active in mainly all the projects providing feedbacks and results for the optimal technology orientation and developments. Specific projects on Modelization has been run during this year (Hot Carpet project to optimize heat production for outdoor application like, markets, open space, ecc.).
- *Technology transfer and support to local companies*: the third sector of REET, is composed of a series of projects and initiatives actually running or in phase of development.

EUROSTANDARD project: about the development of a safety valve for natural gas infrastructures.

STEINEX project: about a safe technology for operators working on cutting-stone machines.

- *Dissemination and Exploitation actions*: activities on scientific publishing for International Congresses and Journals, activities to build up start up activities. In specific participation to the networks of the ISES (world and European congresses), of WREN (world congresses) and the the start up initiative of HT Solar in cooperation with AERMEC and TOSONI companies.
- *Education*: a series of educational activities have been performed, specifically the main are:
  - Course on Renewable Energies at the 2nd level Master Course promoted by FBK together with the University of Trento.
  - Lectures at the Styrian Academy Summer School on Sustainable Regional Systems.

Vision and Goals

The guiding Vision on Energy of REET unit starts from the consideration that no one technology or renewable energy system can support by itself the real and concrete realization of a energy-positive building. REET unit has worked on an ENERGY VISION for an integrated and hybrid system.

The realization of the plan should pass through a series of steps. The pilot projects on the specific themes and application areas, the technology transfer of consolidated technologies and the system integration and realization of hybrid technologies.

The whole plan is proceeding in the correct direction since two years and almost all the pilot projects has started or are starting at the present time. Some activities, as the solar cooling technology, are close to the second step, the technology transfer of results. Finally, all the pilot projects have been built looking forward to the third phase of hybrid technologies. In such way all the useful elements have been inserted within such projects. Some examples are the Technology Transfer Board for DiGeSPo project, where we have the intention to exploit, since now, the availability for a more complex hybrid system as an output of a pilot research oriented on the solar energy micro-cogeneration at distributed level.

The final objective is the realization of a FULL SYSTEM named the *+energy building*, able to produce in an integrated and feasible way thermal power for heating, cooling and hot sanitary water, electrical power and biofuels from domestic wastes and organic materials, to achieve at the best distributed scale of building, community or village.

2.3. Activities and Work Plan

During 2011, REET unit will be run 8 funded project, from energy to environmental sectors, on the described topics. All the actual resources, plus an additional employee and two PhD, will cover almost completely the related projects (see more details and summary on paragraph 2.1). The below table summarize the division of resources between the different projects and activities.

REET - Resources workplan, %				Start	Start	Start	Start	Start		
	In progress	In progress	In progress	01/01/2010	01/01/2010	01/01/2010	01/01/2010	01/01/2010		
2011	STEINEX	BIOTEC	DIGESPO	CONTEST	GALEF	CASA FUTURA	ECOCELL	GEOITEA	New Projects	TOTALI (%)
Alessandro Bozzoli		5	20	10	5	15	40	5		100
Luigi Crema		10	45	10	10	10	15			100
Marco Cozzini			70	20		5		5		100
Rolando Pontalti							75		25	100
Alessandro Vaccari	75				15	10				100
Guido Cicolini		10		15		5	70			100
Marco Frizzi	40						60			100
Alberto Zanetti				30	10	25	20	15		100
Fabrizio Alberti			100							100
Stefano Dalpez					15	35	50			100
TBH 1 - Ric. IV fascia			100							100
PhD-Sergej Barthashevic		50			50					100
PhD-Antonio Calà Lesina	100									100
Total efforts (%)	215	75	335	85	105	105	330	25	25	1300

Additional projects have been submitted or will be during next year on different themes:

– *ISLe project*: submitted project in the JTI FCH 2010 call, FBK is proposing as a coordinator of a international consortium (11 partners: PNNL, ACCIONA, POLIMI, CSIC, LNEG, UTWENTE and others) to realize an INTELLIGENT ENERGY STORAGE: THERMAL AND ELECTRICAL BACKUP FOR RENEWABLE ENERGY SYSTEMS AT DISTRIBUTED LEVEL, based on a regenerative cycle applied to Sodium Borohydride;

– *ReCap project*, proposed on the call FP7 – Environment 2010, on sustainable and resilient cities. FBK is participating as a partner of the project headed by TU Graz, in local partnership with Heliopolis company and the Municipality of Trento;

– *3Star project*, proposed in Sicily region together with local partners and a FBK local node, related to the development of a micro multi generation system based on Stirling Dish technology, able to deliver electrical and thermal power (for heating and cooling) and lighting for distributed level applications;

– *Contest project*, proposed to the Local Energy Agency to realize a demonstrator of a 10 kWel and 10 kWth Stirling Dish system;

– *Mistico project*, proposed to the Caritro Foundation – in partnership with other FBK units and external partners, related to the development of a micro CHP system based on concentrated PV and micro heat exchangers, developing new plasmonic coating for improve the overall electrical efficiency of the PV cell.

REET unit will participate to local projects on "Energy Sustainability of local Agro-Companies" and "Technological and sustainable alpine refuges".

2.4. Collaborations

The main REET foreseen cooperations will include:

– PACIFIC NORTHWEST NATIONAL LABORATORY, US DoE, lab fellow doc. Peter McGrail: subscription of a MoU between PNNL and FBK on mutual energy related activities, mainly on solar cooling, geothermal energy, fuel cells;

– UPPSALA UNIVERSITY (Sweden), prof. Ewa Wackelgard: development of new Cer.Met. materials as adsorbing layers for solar thermal applications at

medium temperatures. The development is an essential aspect within the DiGeSPo project;

- POLITECNICO di MILANO (Italy), prof. Giuseppe Silva and dr. Barbara Rivolta: development of new thermal fluids applied to solar thermal and thermodynamic technologies. The development is an essential aspect within the DiGeSPo project and for the application field of geothermal energy;
- SUSTAINABLE ENGINE SYSTEMS LTD. (UK), dr. Allan J. Organ and dr. Drummond Hislop: development of Stirling engine in both BioDomUs and DiGeSPo projects;
- MASSACHUSET INSTITUTE of TECHNOLOGY (USA), prof. Federico Casalegno: development of a sustainable building within the Manifattura Domani installation;
- NARVA LICHTQUELLEN (Germany), dr. Gerard Mientkewitz: development of new generation evacuated solar tubes. The development is an essential aspect within the DiGeSPo project;
- SUPSI - ISAAC – DACD - Centro Ticinese per la Geotermia - dr. Daniel PAHUD: research in geothermal domain to make better underground probes insulation; to improve thermal exchanges between working fluid and underground; to cooperate with solar thermal systems.
- UNIVERSITY of FERRARA, prof. Giuseppe Cruciani: investigations on a new porous material for adsorption cycles based on hydrophilic zeolite. The investigation is an essential aspect of SolTerm project on Solar Cooling Technology;
- ELECTRONIC MACHINING Srl, ing. Massimo Luminari: developments on reflection optics, on heat engines (Stirling), on solar tracking systems. The developments are essential aspects within the DiGeSPo and BioDomUs projects;
- FONDAZIONE EDMUND MACH, dr. Silvia Silvestri: development of a new combustion process to be applied to waste residues from agricultural and forestry sectors. The cooperation will be included in BioTec project.
- EURAC RESEARCH, dr. Wolfram Sparber, cooperation on international projects on +energy building.
- APE, ENERGY AGENCY OF THE PROVINCE OF TRENTO, dr. Roberto Bertoldi and arch. Giacomo Carlino: cooperation and support to the local energy plan of the Province of Trento; cooperation on local and international projects;
- ITEA, dr. Paolo Toniolli: cooperation on local and international projects related to +energy building and energy sustainability of domestic houses;
- DOLOMITI ENERGIA, dr. Stefano Quaglino: cooperation on local and international projects related to +energy building and energy sustainability of domestic houses;

Other foreseen cooperations on proposed projects include University "La Sapienza" (Rome), University of Trento, University of Padova, CRF (FIAT Research Centre), Vescovi Stufe, Technology University of Graz (Austria), University of Twente (Holland), E.ON research center from Aachen University (Germany),

Technological University of Harburg Hamburg (Germany), University of Santiago (Chile), and all international cooperation within eCANDO KIC Energy initiative (ESEIA).

2.5. Specific Needs and Points of Attention

REET unit will need to develop some structures for the next year to possibly realize in a efficient and proper way the various developments, prototypes and demonstrators, object of the actual projects:

- specific logistic to realize prototypes on the combustion process from biomasses, possibly in a place assisted by a chemical;
- chemical hood for preparation of proper thermal fluids with nanostructured materials;
- monitoring and testing systems;
- suitable infrastructures on north FBK building assisting the prototypes energy provision.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Place REET as a reference unit in the Energy Sector for distributed energy multigeneration	I, O	E	Dec.	Participation to international congresses, to the local energy plan, to international boards on energy (e.g. Solar Heating and Cooling Program of IEA), scientific paper publication.	Unit resources to be transferred to the dissemination of results.
Achieve the deliverables on DiGeSPo European project	R, O	E	June / Oct.	Project Committees properly outlined, Dissemination and Exploitation plan of the project, first targets and definitions on the innovation side.	Partners adhesion and participation, proper networking.
Increase the REET unit employees and expertise	F	I	June	Two people to be employed on the Energy sector mainly on ISLe project.	
Obtain good results on projects that will	R, I	E	June / Dec.	Continue Steinex project	Enough resources to be employed on

be closed or discussed during next year				in the proper way after the midterm meeting on June, close the BioDomUs project with good results by the middle of the year. Start of 3STAR project with cooperation between REET and CONFAPI Sicily.	the different initiatives.
Create a new START UP company on Solar technologies in Trento	O	E	June	Goal 70% achieved as for actual agreement on the proposal .	AERMEC (I) and TOSONI (I) adhesion to the initiative.
Write and submit at least two project proposals	A	I	March / Oct.	Proposal submission either with a coordinating role or as a partner.	Definition of different project Consortia.

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

REET team is actually composed by the following human resources:

2 Senior Researchers

5 Researchers

1 Technologist

3 Technicians

2 PhD

Tenure tracks prevision: the employment contract of two researchers will be converted from the actually “forward contract” to “long term contract”, one within the next year, the other within the next three year of forward contract.

The planned budget foresees an increasing in activities such as more companies cooperations and starting of new projects (both local and international) that requires the acquisition of new human resources.

Starting of new projects (proposals already sent) for the 2011 may require the acquisition of two additional researchers for the next year.

The request of innovation and research has taken two PhD students from the University of Trento in developing their doctorate program within REET unit itself.

Totally, the resources foreseen for the next year will be thirteen.

5. Risks and Mitigation Plans

From a general point of view, while exploring new and innovative technologies, the results and the success is not a goal without the presence of risks. The failure of a project and of a research is always takes into account since the beginning. Due to this fact, REET unit since the beginning of the actuation of its ENERGY VISION, which comprises several pilot projects, a lot of technology transfer actions to private entities and a certain number of innovations, covered by patents, but necessarily to be disseminated to all scientific community, has developed a series of mitigation plans running to prevent major failures. The below table summarize some of the main plans actuated.

Description	*Prob.*	*Impact*	*Contingency*
Failure on project results	M	S	Activate a network of international cooperation and select high level partners to work on specific themes. Train and prepare high skilled employees.
Project proposal failure	M	M	Develop project proposals on a networked program in which the single project is not left alone, but is integrated on a general vision, obtaining a higher overall impact.
Failure on technology transfer	H	S	The failure may have different origins, most of these come from the dialogue between research and entrepreneurial languages. To avoid discrepancy it is important to be related to companies in an emphatic attitude, fixing the proper monitoring points between parts.
Internal FBK Bureaucracy	M	M/S	Work in synergy with the different administration offices, trying to transfer the urgency of high impact actions to be run in cooperation with the research unit,

			try to develop a common language and a positive attitude.
Lack of resources, financial	L	M	The projects has a budget prevision. It should be planned with caution. In case of failure, it is important to monitor the problem and solve it with the required responsible level.
Lack of resources, human	L	M	In case of lack of planned resources on a project, direct possibly resources from other projects to cover the lack. In different case, plan the activities together with partners in a congruous time.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

3DOM – 3D OPTICAL METROLOGY

Unit Name	3DOM – 3D Optical Metrology	
Type	Research	
Head	Fabio Remondino	
Staff	2010	2011
	2 Researchers	3 Researchers
	2 Technologists	1 Technologist
	1 PhD	1 Post-Doc
		1 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Nowadays the surveying, monitoring and protection of our environment landscape, cities, man-made objects, etc.) and heritages (natural and cultural) need more interest and consideration. Geomatics, as a science for acquiring, processing, storing and delivery of geographic and spatially referenced (3D) information, is gathering more and more power as discipline for environment mapping and heritage documentation. Geomatics researchers can rely on photogrammetry and remote sensing as optical image-based techniques for the extraction of metric and semantic information from images or on active sensors, like laser scanners, radar or structured light systems, which have the advantage of providing directly 3D information. All these available platforms, sensors and technologies set the scene for totally new approaches, methodologies and perspectives for large sites recording, modeling, studying and protection. The 3DOM unit is inserted in these problematic and research issues, with a primarily mission to research and develop newly and advanced methodologies for 3D surveying and modeling in the fields of landscape and terrain monitoring, cultural heritage documentation, environmental changes, 3D repository development, deformation analyses, heat loos computation, cartography and mapping, geology, archaeology, architecture, virtual reality, etc.

2. Vision and Scientific Program

Since its origin within the SOI unit, the 3DOM group has based its researches and activities on the 3D modeling issue, for landscape surveying, 3D city reconstruction, cultural heritage documentation and digital conservation, industrial inspections, monitoring and change analyses, etc.

2.1. Context and state of the art

The 3D surveying and modeling topic is always a dynamic sector with new developments from the hardware and software sides. 3DOM rises from the expe-

rience acquired in the course of the past years in the SOI research unit in the 3D surveying and modeling field, using passive and active sensors, developing and characterize acquisition sensors and creating new 3D modeling methodology for many geo-referenced applications. At local level there are no other entities and group with such potentialities and background. At international level few research groups are the same level of the 3DOM unit from a surveying and 3D modeling point of few and the achievements in the publications and project results are significant.

Hardware, equipment and facilities available in the unit:

- Various PC with MS-WINDOWS and Linux OS
- Laser scanner triangulation-based Shape Grabber with head SG100 and SG1000
- Laser scanner TOF Leica Scanstation2
- Thermal videocamera FLIR P640 (7um-12um) with 640 x 480 pixel resolution
- Cooled video camera with interferential filters for chromatic reflectance measurements
- Digital camera Nikon D3X with 24 Mega Pixels
- Digital camera Kodak Professional DCS Pro SLR/n with 14 Mega Pixels
- Digital camera Canon EOS 350D with 8 Mega Pixels
- Digital camera Olympus E-20 with 5 Mega Pixels
- Objectives Nikkor AF autofocus (50mm f/1.4, 14-24mm f/2.8, 18-35mm f/3.5-4.5, 35-135mm f/3.5-4.5)
- Scanner Epson 1640 SU for small and medium format papers
- Total Station Topcon GPT-7000i
- Distanziometer Leica Geosystems Disto A6
- Polarize glasses for stereo vision and measurements
- E-log and Babuc systems for environmental data acquisition
- NEC projectors
- Testfield for geometric and thermal calibration of terrestrial digital cameras
- Ultraviolet Lamp 400W
- GPS MobileMapper CX with antenna
- Software:
- Polyworks (InnovMetric)
- Reconstructor (Joint Research Centre)
- PointCloud (Kubit GmbH)
- ShapeCapture (ShapeQuest Inc.)
- Photomodeler (Eos Systems Inc.)
- iWitness and Australis (Photometrix Pty Ltd)
- Rapidform (INUS Technology Inc)
- 3ds Max 2009 and 2010 (Autodesk)
- AutoCAD 2006 (Autodesk)
- Matlab R2006b (MathWorks)
- Photoshop CS2 (Adobe)
- ArcGIS 9.3 (ESRI)
- Mobile Mapper Office (Magellan)

- Cyclone (Leica)
- Leica Photogrammetry Suite (ERDAS)
- Clorama and Sat-PP (4DiXplorer)
- ThermaCAM Reporter (FLIR)
- TextCapture (ShapeQuest Inc.)
- Virtual theater (NRC)

References

- Remondino, F., 2010: Accurate and Detailed Image-Based 3D Documentation of Large Sites and Complex Objects. In "Digital Imaging for Cultural Heritage Preservation", F.Stanco, S.Battiato, G.Gallo (Eds). In press
- Benedetti, B., Gaiani, M., Remondino, F., 2010: Mesurés, dessinés et décrits avec la plus grande exactitude - Una metodologia per l'acquisizione e la restituzione di siti archeologici complessi ai fini della costruzione di sistemi informativi basati su modelli digitali 3D. Il caso dell'area archeologica di Pompei. SNS press, 359 pages.
- Barazzetti, L., Scaioni, M., Remondino, F., 2010: Orientation and 3D modeling from markerless terrestrial images: combining accuracy with automation. The Photogrammetric Record, 25(132), 1-26
- Remondino, F., Rizzi, A., Girardi, Petti, F., S. Avanzini, M., 2010: 3D Ichnology – Recovering digital 3D models of dinosaur footprints. The Photogrammetric Record, 25(131): 266–282
- Remondino, F., Rizzi, A., 2010: Reality-based 3D documentation of natural and cultural heritage sites – Techniques, problems and examples. Applied Geomatics, Vol.2(3): 85-100
- Remondino, F., 2010: Modellazione 3D di beni culturali - L'approccio multisensoriale e multi-risoluzione. Archeomatica, Vol. 1, March issue

2.2. Vision and Goal

The overall objective and goal of the 3DOM unit is to become the leader for all the issues related to geo-informatics research activities, including active and passive acquisition sensors, image and range data processing, 3D modeling and mapping. Being a reference point for all the geo-problems and geo-applications in Trentino will help to fill the existing gap in this sector. Although it is still a young and small figure in FBK, the group cohesion is good and we are seeking transversal and join activities with the other research units and international partners.

2.3. Activities and Work Plan

The activities of the 3DOM unit at international and local level will be dealing with the developments of new 3D recording methodologies, new data integration strategies and new 3D data visualization procedures. The activities will seek transversal and interdisciplinary researches and collaboration with the other FBK research units and external partners. Some already ongoing internal collaborations (TEV, MPBA) will be reinforced.

Following the actual topics of research running within the Geomatics community, the research issues of the unit will be dealing with:

- development of reliable, fast and cheap procedures for data acquisition from low-cost and low-altitude platforms, like small or unmanned autonomous vehicles (UAV), using sensors like SLR, consumer or thermal digital cameras or ranging devices (3M and Enerbuild project);
- exploit the potentialities of the latest very high-resolution satellites, like WorldView and GeoEye (3M project);
- Increasing the level of automation in the data processing, mostly for the image-based modeling pipeline which is still highly interactive in particular in terrestrial applications (where no automated commercial package is available);
- development of a powerful sensor integration strategy to combine range and image data to exploit the intrinsic potentials and advantages of each technique, compensate for the individual weaknesses of each method alone (e.g. texture or edges in scanning systems) and achieve more accurate and complete surveying, modeling, interpretation and digital conservation results (XBridge, Lavaredo, Dinosaur and APSAT project);
- realization of advance 3D repository systems and virtual platforms to collect and share information related to environment, landscape, archaeological sites, museums, etc. (Copan project)
- development of standards and protocols related to the 3D documentation, modeling and data conservation, as strongly requested by the international organization and committee like ASTM and VDI/VDE in the industrial and geomatics fields or UNESCO, ISPRS (International Society for Photogrammetry and Remote Sensing), ICOMOS (International Committee on Monuments and Sites), CIPA (International Committee for Architectural Photogrammetry), IAPR (International Association for Pattern Recognition) in the heritage field.

The services and applications where the unit could be involved are:

- low-cost (but accurate) environmental monitoring and mapping (at regional or national scale) using images or LiDAR data, for cadastral updating, urbanization controls, heating dispersion monitoring, geomorphology, disaster mapping, hazard prediction, studies on agricultural or mountainous terrains, 3D city modeling, landscape visualization, etc.;
- detailed and accurate heritage 3D documentation for digital preservation, conservation issues, digital restoration, tourism purposes, physical replicas, visualization and virtual reality applications, museum exhibitions, etc.;
- structural monitoring and recording using non-invasive methodologies;
- general 3D modeling and reverse engineering problems;
- support in decision planning for roads, railways, airports and urbanization based on maps and accurate large scale altimetric surveying;
- assistance of government, research, industry and private clients to collect, structure, manage and visualize geospatial information;

- estimation of parameters such as the percentage of the vegetation cover and biomass volume by comparing DTMs and DSMs;
- digital inventories and sharing for education, research, conservation, entertainment, walkthrough or tourism purposes;
- data and knowledge provider for a proper administration and management of the territory as well as realization of prevention and protection policies.

2.4. Collaborations

The unit has already established a strong network of contact and collaborations regarding data exchange, workshop/conference/tutorial/summerschool/exhibition organization, project partnership, etc.

- Art-Test, Firenze, Italy: multispectral analyses of paintings and Etruscan exhibition in Bruxelles
- ATS Enterprise, Siena, Italy: summerschool organization and Pava project
- Codevintec, Milano, Italy: Lavaredo project
- CNRS (Lab Map-Gamsau), France: workshop organization
- Dept. DAPT, University of Bologna, Italy – Prof. M.Gaiani: Pompeii project
- Dept. Archaeology, University of Trento, Italy – Prof. A.Pedrotti: APSAT project
- Dept. Geomatics, University of Newcastle upon Tyne, UK – Prof. J.Mills: tutorial organization and Heritage3D project
- Dept. Art and Art History, University of New Mexico, USA – Dr. J.von Schwerin: Copan project
- Dept. Earth Sciences, University of Pavia, Italy – Dr. F.Zucca: Lavaredo project
- Dept. Geosciences, University of Padua, Italy – Dr. N.Preto: Lavaredo project
- Dept. Geography, Durham University, UK – Prof. D.Donoghue: summerschool organization
- English Heritage, UK: Heritage3D project
- ENI, Italy: surveying works
- Gexcel, Brescia, Italy: Lavaredo project
- Geomatica, Trento, Italy: mapping project
- Graphitech, Trento, Italy: Etruscan exhibition in Bruxelles
- Helica, Amaro (UD), Italy: Lavaredo project
- Historia, Viterbo, Italy: Etruscan exhibition in Bruxelles
- Institute of Geodesy and Photogrammetry, ETH Zurich, Switzerland – Prof. A.Grun: Copan project
- ITABC, CNR Rome, Italy – Dr. S.Pescarin: summerschool organization
- Lapet Lab, University of Siena, Italy – Dr. S.Campana: summerschool organization and Pava project
- Leica Italy: summerschool organization
- Museo Tridentino di Scienze Naturali (MTSN), Trento, Italy: Dinosaur projects
- National Research Council Canada: 3D-ARCH project

- Politecnico of Milan, Italy (Dept. BEST, DIIAR, INDACO) – Prof. G.Guidi, Dr. M.Scaioni, Prof. L.Pinto: surveying and spherical photogrammetry project
- Protocube, Torino, Italy: Lavaredo project
- Scuola Normale Superiore (SNS), Pisa, Italy – Dr. B.Benedetti: Pompeii project
- Soprintendenza Archeologica della Provincia Autonoma di Trento, Italy: Gortyna project
- Soprintendenza Archeologica dell'Etruria Meridionale, Italy: Etruscan project
- TNX, Trento, Italy: XBridge project
- UNESCO, Paris, France
- University of California, Merced, USA – Prof. M.Forte: Copan project
- Zenit, Milano, Italy: UAV project

2.5. Specific need and points of attention

Some activities might need a replanning in the next months due to other possible incoming projects, new collaborations and opportunities in general. It might be also necessary to hire a new person (fully covered by existing projects) to overcome all the incoming requests of work and deliverables. But in general we don't foresee specific needs or points of attention pertaining the scientific activities of the 3DOM Unit.

3. Goals

- Investigate / Develop new active and passive surveying sensors
- Improve the existing 3D modeling methodologies employed in the geo-applications
- Provide reliable and effective solution for heat loos estimation, deformation analyses, monitoring, hazard mapping, precision farming, heritage documentation and conservation, city planning, etc.
- Realize new hardware and software to overcome the actual 3D recording and digital modeling lacks
- Provide a reference point for all the geomatics "problems"

4. Human Resources

At present the 3DOM unit is composed of 5 persons, 2 researchers, 2 technologists (1 from PAT) and one PhD and a PAT project. In the next year 2 new persons will join the unit (a researcher and a Post-Doc), one technologist will leave the unit and the other one will be upgraded to T3. The team is young and growing, a great synergy is present and the interesting works are bringing more unity and friendship in the group. The unit is very strong and good in 3D data processing and the recent awards and journal citations are encouraging. The increasing scientific visibility will also help in attracting new funding and projects as well as enforce its strength at local level.

5. Risk and Mitigation Plans

The activity of 3DOM is almost a risk free activity as it doesn't relies on others contributions. The research results rely only on the joint activities of the single components of the unit who are really motivated and young persons with many ideas and power. It will be a problem if a member of the unit will find another job due to the already limited number of personnel and the large amount of work. The young 3DOM unit is slowly growing and setting a good prospective for the future, with new incoming projects and activities which will raise the name of 3DOM and FBK in the surveying and modeling community at local and international level. The group cohesion is good and we are seeking also transversal and join activities with the other research units.

CIT – Center for Information Technology

ES – EMBEDDED SYSTEMS

Unit Name	ES – Embedded Systems	
Type	Research	
Head	Alessandro Cimatti	
Staff	2010	2011
	6 Researchers	5 Researchers
	7 Technologists	7 Technologists
	5 Post Doc	4 Post Doc
	5 PhD	8PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Embedded Systems are computer-based systems connected to some physical environment by means of sensors and actuators. They are pervasive in everyday life, in sectors including automotive, railways, space, industrial control, ambient assisted living, biomedical devices, and others. Embedded systems are often required to carry out complex and often critical tasks autonomously.

The Unit carries out activities in the field of Embedded Systems, along three main directions: advanced design methods, required to support the production of correct and reliable embedded systems; architectures for autonomous control, required to realize systems able to carry out complex tasks in de-structured environments without direct human intervention; protocols for distributed embedded systems, with particular reference to wireless sensor networks, to ease the task of programming and to maximize the available resources.

These activities all span from research to technology transfer, and rely on the development of software tools providing strong experimental support and competitive advantage. The unit carries out research with a strong emphasis on practical applications, and is currently participating in various projects. It has a strong interest in training students.

In terms of human resources, the unit is composed by approximately twenty people (including six researchers, seven technologists, five post docs, and five doctoral students).

The unit has several important collaborations. Among these, we point out the collaboration with the University of Trento on the development of the MathSAT solver, a verification engine delivered to Intel to support various phases of the development flow (including microcode verification, equivalence checking of sequential circuits, and optimized physical layout). We also point out the ongoing set-up of a joint laboratory with ALES, a consultancy company specializing in model-based design, with the aim of further penetrating the market of design automation for critical systems.

No specific ethical issues are present.

2. Vision and Scientific Program

2.1. Context and State of the Art

Embedded systems (ES) are computation systems connected to some physical system by means of sensors and actuators. Embedded Systems are pervasively present in our society. Over 98% of all computing chips are actually hidden or "embedded" in all sorts of things that do not even look like computers. Over 4 billion embedded processors were sold in 2006 and the global market is worth €60 billion with annual growth rates of 14%.

Application domains of ES are numerous. They include: the automotive domain (where ES are present in ABS, airbags, traction control, fuel injection), railways (where ES are used in control of the trackside devices such as switches and semaphores, onboard breaking control), avionics (where computers control most of the functions, ranging from power distribution, to diagnostic functions, to fly-by-wire procedures), space (where the use of software is continuously increasingly in satellite control and in autonomous rovers), energy (in industrial climatisation, building control and monitoring), bio-medical devices, healthcare and social assistance systems, and others.

A very important initiative denoting substantial interest in the field is the technological platform ARTEMIS (Advanced Research & Technology for Embedded Intelligence and Systems, http://www.artemis-ju.eu/) for the development of ES featuring some degree of intelligence and autonomy. The technology platform ARTEMIS has started in 2005 and has resulted in a Strategic Research Agenda in 2006. Based on this, the ARTEMIS members have created the European association ARTEMISIA, as a private component of the Joint Undertaking (JU) ARTEMIS. The JU, created in February 2008, involves the European Commission and many member states, and more than 180 members ranging from large enterprises, SME's, and research institutions.

2.2. Vision and Goals

An Embedded System is typically composed by one or more sensors providing inputs to an electronic data elaboration system, often based on microprocessors, and communicating results of the elaboration either to a final human user or to actuators that convert the results into actions in the environment, data-gathering portals, or to other embedded devices.

Fundamental features that must be guaranteed for the embedded systems – given their pervasiveness and their functionalities – are reliability, cost effectiveness, security, and performance (including power consumption). In some safety-critical applications, (automotive, railways, avionics, biomedical devices), it is necessary not only high reliability, but also the ability to detect and adapt to faults, in order for the system to be able to provide continuous service (even if in degraded operational conditions).

The functions carried out by ES are of ever increasing complexity, and often critical. For this reason, there is a strong need for design techniques able to guarantee a high degree of assurance. Another challenge is the ability to program embedded

systems so that complex functions can be obtained by combination of basic components within reliable composition schemas. It is also fundamentally important to be able to deal with aspects related to highly distributed ES, in particular the ones based on wireless communication.

The ES unit carries out activities in the setting of embedded systems, along the main directions outlined above. In particular, three main classes of challenges are considered: design methods, autonomous control, networked systems.

- *Design methods* are necessary because the functionalities are critical on one side, and very complex on the other. Traditional design methods may be unable to guarantee the required reliability measures within acceptable timing constraints. The approach investigated by the research line is based on expressive logical frameworks for the representation of different aspects of the design flow (such as requirements analysis, high level design, detailed design, implementation, safety assessment) as well as application areas (including continuous dynamics in physical domains, complex data structures for software). Ensuring the properties of the artifacts under analysis is reduced to logical inference in expressive fragments of First Order Logic. Such techniques, that extend traditional propositional reasoning, are a backbone for the analysis of dynamic systems. The main challenge is to develop methods and tools able to deal with extremely large systems with an automated and efficient way, providing effective usage to designers, in order to discover and pinpoint flaws in the designs under analysis, or to certify their absence.
- *Autonomous control* aims at the development of schemas for the realization of complex functions at the run-time, dealing with unexpected and unpredictable events, faults, and discovery of complex phenomena in the environment the embedded system interacts with. A prominent approach, referred to as model-based approach, relies on the logical formalisms used for design, to represent the functions and the environment dynamics, and to carry out important functions such as planning, intelligent execution and monitoring, runtime diagnosis, fault detection, identification and recovery, and replanning. The main objective is the identification of a comprehensive architecture, combining logical frameworks and probabilistic representations, and the definition of advanced algorithms for synthesizing the specified functionalities.
- *Networked systems.* Recent trends in distributed computing break the traditional assumptions of network stability, forcing applications to consider the dynamics within the network itself. A key objective is the development of new models and programming abstractions designed to ease application development for dynamic distributed scenarios, specifically wireless sensor networks (WSN). Although WSNs systems are composed of mostly immobile sensors, dynamicity arises from the insertion and removal of nodes, the use of mobile base stations, and inherent variabilities of wireless communication channels. The primary challenge is to develop models at the proper level of abstraction that simplifies the programming effort, but still provides enough programmer control to enable efficient applications. The outcome of our activities are novel models implemented as middleware and distributed algo-

rithms. Recent studies have confirmed that programmability of WSN nodes is one of the major barriers in their widespread adoption. Indeed, a wealth of research exists on operating system abstractions and macro programming techniques to ease the programming effort. The operating system abstractions are, by nature, too general and low level to significantly ease the programming task. On the other side of the spectrum, macro programming significantly reduces programming effort, but often sacrifices too much in terms of solution efficiency. In the WSN environment, such limitations are manifest as reduced system lifetime. The key idea is to propose an abstraction running atop of an existing operating system, and offering system-wide coordination through a single node programming model. Adoption of our proposed model is eased due to our instantiation of a parallel set of core WSN components such as MAC, routing, time synchronization, etc. One major open challenge is supporting WSN applications in which quality of service of data delivery must be guaranteed. Most existing systems fall short either due to their inherent complexity or to their inability to work in a cross-layer fashion to support high level goals at all levels of the communication stack.

The above research directions are intended to be more tightly combined in the longer term. On the one side, the integration will help to develop systems with Embedded Intelligence, where distributed processing based on WSN and high level reasoning are blended in a coherent and unique architecture for the monitoring and control of complex, possibly social environments. Particularly interesting are application areas related to Energy, Ambient Assisted Living, and Environmental Monitoring. On the other side, dedicated design methods will be provided for the formal analysis and deployment of WSN's.

2.3. Activities and Work Plan

The activities of the Unit revolve around a number of software tools. Their function is twofold. On one side, they provide a solid basis for experimental validation of basic research; on the other side, they provide the technological infrastructure used in technology transfer project.

The unit maintains and develops several tools based on formal reasoning: the MathSAT SMT engine; the NuSMV model checker, with the SA add-on for safety analysis; the EuRailCheck tool for requirements analysis; the COMPASS platform for functional correctness, safety assessment, diagnosability and performance evaluation. These functionalities are being integrated within the new release of the NuSMV system.

An important activity concerns the development of new efficient and effective formal methods techniques to support requirements analysis, verification and validation, decomposition and refinement, in order to maximize the expressiveness of the formal language without giving up the automation and scalability of the analyses. In the context of formal verification of requirements, we want to develop new and effective verification techniques to support the model checking of hardware and software, and to experiment them within the NuSMV and Kratos verification tools. Further activities include research in symbolic verification algorithms for the analy-

sis of systems with continuous dynamics (referred to as hybrid systems), and of concurrent software. To this end, the NuSMV model checker will be extended with functionalities provided by MathSAT, such as interpolation and unsatisfiable core extraction. Moreover, we will finalize the development of NuSMV plugins for the OCAS and MATLAB tools, an activity already undertaken within the MISSA project. Finally, we will further investigate the problem of installation optimization problem in the context of Particular Risk Analysis in avionics, i.e. the problem of finding an optimal installation of components, subject to functional, geometrical, and safety constraints.

In the field of intelligent control, the activity aims at tackling the problem of monitoring and diagnosability for hybrid systems. We will explore the use of expressive logics to model and reason about resource consumption, and the automated synthesis of monitors from high level descriptions of monitoring functionalities. We also plan to carry out an activity on autonomous planning and coordination for networks of agent, in presence of uncertainty and in partial observable environments, possibly communicating over a wireless sensor network. Finally, we will investigate symbolic methods for intelligent monitoring and machine learning techniques in the field of ambient assisted living.

In the line of WSN, we aim to support dependable wireless computing. We now have in our pocket a novel MAC-level protocol, upon which we can expand in many directions. We need to build and/or adapt higher level protocols. We need to integrate this with our TeenyLIME middleware, exploring the challenges of shifting from the standard CSMA to a TDMA-like approach. We also plan to continue in the development of a deployment methodology for WSNs and the supporting tools.

The activities outlined above are largely overlapping with and carried out within research projects involving the unit such as MISSA, IRONCAP ACUBE, ALES, VELOS, ROCKFALLDEFENSE, REQENG, and COMPASS. Several project proposals along the same lines have been submitted or planned.

2.4. Collaborations

- TEV Research Unit, Stefano Messelodi: investigating algorithms for installation design optimisation
- University of Trento, Roberto Sebastiani: joint development of the MathSAT solver
- University of Trento, Gian Pietro Picco: collaboration on TeenyLIME tasks and on wildlife monitoring
- University of Verona, Franco Fummi: integration of the constraint solving API into a commercial tool. Research to improve the use of SAT and SMT techniques within advanced ATPG algorithms
- Ales SRL., Alberto Ferrari: integration of an extended version of the NuSMV model checker into the Formal Spec Verifier, a plugin of MATLAB/Stateflow/Simulink for the verification of embedded designs
- University of Minnesota, Mats Heimdahl: collaboration on formal validation of model-based safety-critical embedded software

- University of York, Tim Kelly: to establish an international cooperation for a cross-domain review of risk assessment and safety analyses in the context of regulated public transport domains (avionics, automotive, and railways)
- FEM, Francesca Cagnacci: collaboration on wildlife monitoring
- Fondazione Don Gnocchi. Integration and test of Magic and Konnex BIOS in the context of the Casa Domotica FDG in Milan
- Cooperativa SAD. Deployment and high-level validation at the new Alzheimer daycare center at Vela - Trento

2.5. Specific Needs and Points of Attention

The following needs and points of attention are identified.

It is fundamental to increase the number of Ph.D. students; a substantial activity in advertisement and recruiting is envisaged to this end.

An intensive activity of project acquisition has been carried out. Depending on the number of accepted project proposals, a corresponding activity for recruiting of new personnel must be carried out. We expect that additional flexibility may be required to handle situations that require a sudden start.

The WSN work will exploit heavily the testbed deployed in 2010.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
New methods for scenario-based requirements validation, decomposition and refinement	R	E	Dec.	Goal 100%: development and one scientific publication	-
Strengthening the integration between the NuSMV model checker and the MathSAT solver for analysing infinite-state systems and (possibly non-linear) hybrid systems	R	I	Dec.	Goal 100%: development and testing on significant set of case studies	-
Participation to the 2011 hardware model checking competition and SMT competitions with the extended versions of the NuSMV model checker and the MathSAT solver	O	E	July	Goal 100%: participation and ranking within first three solvers	-

New algorithms for installation design optimization, that integrate numerical and symbolic reasoning. One patent under consideration, joint with Airbus UK and Queen Mary University	R	E	Dec.	Goal 100%: development and testing on significant set of case studies, application for patent	-
New algorithms for automated synthesis of FDIR, and completion of the work on synthesis of observability requirements.	R	E	Dec.	Goal 100%: development and testing on significant set of case studies, one scientific publication	-
Codification of our WSN deployment methodology, including code deployment and support tools for evaluating connectivity	R	E	December	Goal 100%: development and testing of the proposed devices	-
Work on REINS-MAC protocol: full description and initial testbed implementation results, Installation and evaluation in tower and tunnel, application to k-clustering, integration with a flexible routing protocol	R	E	Dec.	Goal 100%: development and evaluation on significant set of case studies, two scientific publications	-
Further work on platform for ambient assisted living, integration with the acube system, and evaluation and validation in SAD test bed environment	I	E	Dec.	Goal 100% Demonstration and evaluation in real-world scenario	-

4. Human Resources

The unit is composed of the following full time tenured researchers: Alessandro Cimatti, Marco Roveri, Marco Bozzano, Amy Murphy. It has a full time tenured senior technologist (Pietro Braghieri), and a full time tenured technologist, Roberto Cavada. Stefano Tonetta has joined the unit and in currently within a tenure track program.

The unit has several post-docs working on specific projects (Andrei Tchaltsev; Iman Narasamdya), and two Post-docs supported by grants of the PAT (Viktor Schuppan and Alberto Griggio).

Eliana Nardoni is an administrative person in staff to the Unit to provide administrative support on a large project.

The Unit has currently three Ph.D. Students enrolled at the University of Trento (Sergio Mover, Usman Raza, and Matteo Ceriotti), with an expected increase by

four units in 2011. Additional Ph.D. studentrs (Jeremy Ridgeway, Bas Shaafsma, Yusi Ramadian) are co-supervised by members of the Unit within collaborations with the University of Trento (prof. Sebastiani and prof. Palopoli).

The unit has several young programmers (Alessandro Mariotti, Marco Pensallorto, Andrea Micheli, Cristian Mattarei) working on various projects while studying at the University of Trento.

In 2009 and in 2010 there has been a substantial activity of training of young students from the University of Trento, with more than ten stages at the Unit. We intend to pursue this activity that has proved extremely satisfactory, and if possible increment the number of stages.

The research line in WSNs is carried out by one senior researcher (Murphy) and 2 PhD Students. One of those PhDs will graduate in April, and will likely stay at FBK through the end of the year to strengthen his publication record before putting himself on the market.

In general, the personnel was significantly reduced because of ending projects, and it is saturated on the projects that are stilla ctive. Depending on the outcome of the project acquisition campaing, there could be gaps to be filled with a junior research, postdoc-like, and/or programmers. The opening of a tenure track may also be considered.

5. Risks and Mitigation Plans

The unit is involved in several research and technology transfer projects. Each of them has obvious risks associated with it, and standard risk mitigation means are enforced.

There are no other specific risks that can be foreseen.

SE – SOFTWARE ENGINEERING

Unit Name	SE – Software Engineering	
Type	Research	
Head	Paolo Tonella	
Staff	2010	2011
	5 Researchers	5 Researchers
	2 Technologists	3 Technologists
	3 Post Doc	3 Post Doc**
	5 PhD	5 PhD***

Document Status: submitted 2010-11-26

* 2 finish in 2011.
** 1 finishes in 2011.
*** 3 finish in 2011; 3 new should start.

1. Executive Summary

Next generation software systems will be adaptive, dynamically changing, context aware and automatically configuring to the user's preferences and habits. They will take advantage of the functionalities offered by the so-called Future Internet. Engineering such systems is challenging, since their quality is hard to model and test. Our vision is that the two main tools to ensure high quality of next generation software are: (1) high quality requirements specification; and, (2) highly automated testing. The main activities planned for the upcoming years descend from this vision and include research on requirements modeling; testing of future internet applications; software evolution. Such activities are expected to have a strong technological impact, thanks to the projects ongoing within the SE unit: A-cube (Ambient Aware Assistance); FITTEST (Future Internet Testing); IBT (migration of legacy banking code); CERN (code analysis at CERN); IoS (Internet of Services).

The personnel, composed of 5 structured researchers, 3 technologists, 3 postdocs and 5 PhD students, is adequate for the unit's goals and activities. Collaborations with world class universities, such as University College London and University of Toronto are expected to be a main driver for high quality and high impact research results. The main point of attention is the high turn-over, associated with 3 PhD students giving their final exam in 2011 and one postdoc terminating his work in the A-cube project in October 2011.

2. Vision and Scientific Program

2.1. Context and State of the Art

Requirements:

Our research develops in the context of the studies on software engineering methods and techniques for next generation software systems, such as ambient

assistance systems and Internet of services. In order to understand the requirements for such systems two main aspects need to be to analyzed: first, the reconciliation of the individual user perspective with the social (organizational) perspective; second, the role of requirements engineering in enabling a software system to adapt seamlessly at run-time.

Addressing the first aspect, along the individual perspective, calls for making the individual users' preferences explicit. Eliciting and managing preferences of stakeholders have been studied in the last years to actively involve the users in prioritization processes, keeping their effort under an acceptable threshold ([Avesani et.al 2005], [Tonella et al. 2010]). Concerning the social perspective, a key issue is to deal with norms that regulate the involved organizations. Recently, we defined a Goal-Oriented methodology, namely Nomos, [Siena et al. 2009] and an argumentation theory, described in [Jureta et al. 2010], for the representation of laws and requirements to allow for the assessment of requirements compliancy.

With regard to requirements elicitation and analysis methods suitable for reconciling the individual and social perspectives, multi-paradigm approaches seem promising. Previous works considered the use of User Centered Design (UCD) techniques, such as Personas and Scenarios, with semiformal or formal approaches such as Goal-Oriented techniques (GORE) [Penserini et al. 2007, Darimont et al. 1997], UML, first order/descriptive/temporal logics. In [Haumer et al. 1998] the authors present a scenario based approach to the specification of goal models. In [Sutcliffe et al. 1998] a language based on first order logic is used to represents scenarios and artifacts used in the user interaction phases of requirements elicitation and representation. Finally, in [Aoyama 2007] Personas and Scenarios are used together with goal oriented techniques to elicit requirements and represent them in a semi-formal framework. Differently, in our recent work, we proposed to integrate UCD and GORE techniques both in the terms of the concepts and the requirements elicitation and analysis processes [Leonardi et al. 2010].

Along the second aspect mentioned above in relation to engineering self-adaptive systems, different research communities have recently proposed rich research agendas. Worth mentioning is the Software Engineering for Self-Adaptive Systems (SEAMS) community[1], which focuses on system architecture aspects [Cheng et al. 2008], and more recently the idea has emerged of making requirements as runtime artifacts to be exploited (reasoned on and refined) at run-time [Baresi et al. 2010, Qureshi et al. 2010, Sawyer et al 2010]. In our approach, we build upon state of the art research on foundation of requirements engineering, by making users' goals and preferences explicit in the definition of a requirement problem, by formulating the requirements problem as an optimization problem [Jureta et al. 2009, Jureta et al. 2010, Liaskos et al. 2010], and by involving direct the user in requirements elicitation [Seyff, et al. 2010].

To realize proof of concepts of the proposed methods and techniques we intend to exploit software agent and service-based technologies, while to validate their

[1] http://www.hpi.uni-potsdam.de/giese/public/selfadapt/front-page

effectiveness we intend to apply empirical study techniques [Wohlin 2000, Aranda et al. 2007].

Analysis and Testing:

The state of the art in search based test case generation [Harman 2007, Harman et al. 2001] is characterized by fitness functions that involve mainly coverage adequacy criteria. The distance from the coverage target is used as a fitness indicator. While these testing targets remain relevant for next generation complex and future Internet software systems as well, their adaptivity, dynamism and self-modifiability demand for novel fitness function definitions and search algorithms.

The vast, existing literature [Ricca et al. 2001, Elbaum et al. 2005, Sampath et al. 2007] on Web testing is focused on client server applications which implement a strictly serialized model of interaction, based on <form-submission, server-response> sequences. Testing of next generation (Ajax/rich client) Web applications has been considered only more recently [Mesbah et al. 2009, Marchetto et al. 2008]. For them, testing focused on semantic interactions, previously exploited to drive the generation of test cases for the code which implements the application's GUIs [Yuan et al. 2007], seems particularly promising.

Existing techniques to infer models useful for testing purposes [Lorenzoli et al. 2008, Dallmeier et al. 2006] rely either on algorithms for regular language learning or on predefined, hardcoded abstraction function. The former produce a state model which is hardly interpretable by humans. In fact, while event sequences are meaningful and can be used for test case generation, states do not necessarily correspond to an internal state of the application. Open issues in the area of model inference include: (1) optimizing the balance between over-approximation and under-approximation; and, (2) determining the feasibility of event sequences produced from the models. A competition (called Stamina, see: http://stamina.chefbe.net/) has been recently launched to help the research community compare different model inference algorithms and to guide researchers in improving their solutions.

Current research in the use of logs for testing focuses on observing errors from logs. We intend to extend this with the capability to infer oracles, likely oracles, and atypical executions from logs. State of the art tools for anomaly detection [Lorenzoli et al. 2008, Hangal et al. 2002] rely on invariant inference algorithms such as the one implemented in Daikon [Ernst et al. 2007]. However, richer temporal logics properties have been only partially investigated so far [Gabel et al. 2010].

Source code analysis in support to program comprehension has produced methods for ontology extraction from syntactic relations [Ratiu et al. 1008], for source code querying and concept location [Ratiu et al. 2008, Poshyvanyk et al. 2006] and for abbreviation analysis and meaning extraction [Lawrie et al. 2006-2007]. Integration of natural language processing techniques, such as natural language parsing, in such contexts remains a quite unexplored area that deserves further investigation.

References

- Mikio Aoyama: *Persona-Scenario-Goal Methodology for User-Centered Requirements Engineering*. RE 2007: 185-194
- J. Aranda, N. Ernst, J. Horkoff, and S. M. Easterbrook (2007) *A Framework for Empirical Evaluation of Model Comprehensibility*. International Workshop on Modeling in Software Engineering (MiSE-07), at the 29th International Conference on Software Engineering (ICSE'07), Minneapolis, USA, 19-20 May 2007.
- Paolo Avesani, Cinzia Bazzanella, Anna Perini, Angelo Susi: Facing Scalability Issues in Requirements Prioritization with Machine Learning Techniques. RE 2005, pp. 297-306.
- Baresi, L., Pasquale, L., Spoletini, P.: Fuzzy goals for requirements-driven adaptation. In: Proceedings of the 18th International Requirements Engineering Conference (RE'10). Sydney, Australia (2010)
- B. H. C. Cheng, H. Giese, P. Inverardi, J. Magee, and R. de Lemos. *Software engineering for self-adaptive systems: A research road map*. In volume 08031 of Dagstuhl Seminar Proceedings. Springer. LNCS 4802.
- Valentin Dallmeier, Christian Lindig, Andrzej Wasylkowski, Andreas Zeller: *Mining Object Behavior with ADABU*, WODA 2006: ICSE Workshop on Dynamic Analysis, May 2006.
- R. Darimont, E. Delor, P. Massonet & A. van Lamsweerde (1997): *GRAIL/KAOS: an environment for goal-driven requirements engineering*. In: ICSE'97. ACM, pp. 612–613.
- Sebastian G. Elbaum, Gregg Rothermel, Srikanth Karre, Marc Fisher II: *Leveraging User-Session Data to Support Web Application Testing*. IEEE Trans. Software Eng. 31(3): 187-202 (2005).
- Michael D. Ernst, Jeff H. Perkins, Philip J. Guo, Stephen McCamant, Carlos Pacheco, Matthew S. Tschantz, Chen Xiao: *The Daikon system for dynamic detection of likely invariants*. Sci. Comput. Program. 69(1-3): 35-45 (2007).
- Mark Gabel and Zhendong Su: *Online Inference and Enforcement of Temporal Properties.* In Proceedings of the International Conference on Software Engineering (ICSE), Cape Town, South Africa, pp. 15-24, 2010.
- S. Hangal and M. S. Lam. *Tracking down software bugs using automatic anomaly detection*. In proceedings of the International Conference on Software Engineering (ICSE). ACM Press, 2002.
- Mark Harman: *The Current State and Future of Search Based Software Engineering*. FOSE 2007: 342-357.
- Mark Harman, Bryan F. Jones: *Search-based software engineering*. Information & Software Technology 43(14): 833-839 (2001).
- Peter Haumer, Klaus Pohl, Klaus Weidenhaupt: *Requirements Elicitation and Validation with Real World Scenes*. IEEE Trans. Software Eng. 24(12): 1036-1054 (1998).

- Jureta, I., Mylopoulos, J., Faulkner, S.: A core ontology for requirements. Applied Ontology 4(3-4), 169–244 (2009)
- Jureta, I.J., Borgida, A., Ernst, N.A., Mylopoulos, J.: Techne: Towards a New Generation of Requirements Modeling Languages with Goals, Preferences, and Inconsistency Handling. In: International Conference on Requirements Engineering (RE). Sydney, Australia (Sep 2010)
- Ivan Jureta, Alberto Siena, John Mylopoulos, Anna Perini, Angelo Susi: Theory of Regulatory Compliance for Requirements Engineering CoRR abs/1002.3711: (2010)
- Dawn Lawrie, Henry Feild, David Binkley. *Extracting Meaning from Abbreviated Identifiers*. SCAM 2007: 213-222.
- Dawn Lawrie, Christopher Morrell, Henry Feild, David Binkley. *What's in a Name? A Study of Identifiers*. ICPC 2006: 3-12.
- Chiara Leonardi, Luca Sabatucci, Angelo Susi, Massimo Zancanaro: Ahab's Leg: Exploring the Issues of Communicating Semi-formal Requirements to the Final Users. CAiSE 2010, pp. 455-469, 2010
- Liaskos, S., McIlraith, S.A., Mylopoulos, J.: Integrating preferences into goal models for requirements engineering. In: Proceedings of the 18th International Requirements Engineering Conference (RE'10). Sydney, Australia (2010)
- Davide Lorenzoli, Leonardo Mariani, Mauro Pezzè: *Automatic generation of software behavioral models*. ICSE 2008: 501-510.
- Alessandro Marchetto, Paolo Tonella, Filippo Ricca: *State-Based Testing of Ajax Web Applications*. ICST 2008: 121-130.
- Ali Mesbah, Arie van Deursen: *Invariant-based automatic testing of AJAX user interfaces*. ICSE 2009: 210-220.
- Qureshi, N.A., Perini, A.: Requirements Engineering for Adaptive Service Based Applications. In: International Conference on Requirements Engineering (RE). pp. 108 – 111. Sydney, Australia (2010).
- Denys Poshyvanyk, Andrian Marcus, Václav Rajlich, Yann-Gaël Guéhéneuc, Giuliano Antoniol. *Combining Probabilistic Ranking and Latent Semantic Indexing for Feature Identification*. ICPC 2006: 137-148.
- Daniel Ratiu, Martin Feilkas, Jan Jürjens. *Extracting Domain Ontologies from Domain Specific APIs*. CSMR 2008: 203-212.
- Daniel Ratiu, Lars Heinemann. *Utilizing Web Search Engines for Program Analysis*. ICPC 2010: 94-103.
- Filippo Ricca, Paolo Tonella: *Analysis and Testing of Web Applications*. ICSE 2001:25-34.
- Sreedevi Sampath, Sara Sprenkle, Emily Gibson, Lori L. Pollock, Amie Souter Greenwald: *Applying Concept Analysis to User-Session-Based Testing of Web Applications*. IEEE Trans. Software Eng. 33(10): 643-658 (2007).

- Sawyer, P., Bencomo, N., Whittle, J., Letier, E., Finkelstein, A.: Requirements-aware systems a research agenda for re for self-adaptive systems. In: Proceedings of the 18th International Requirements Engineering Conference (RE'10). Sydney, Australia (2010)
- Seyff, N., Graf, F., Maiden, N.: Using Mobile RE Tools to Give End-Users Their Own Voice. In: International Conference on Requirements Engineering (RE), Sydney, Australia (2010), 37–46
- Alberto Siena, John Mylopoulos, Anna Perini, Angelo Susi: Designing Law-Compliant Software Requirements. ER 2009: 472-486
- Angelo Susi, Anna Perini, John Mylopoulos, Paolo Giorgini: *The Tropos Metamodel and its Use*. Informatica 29(4): 401-408 (2005).
- Alistair G. Sutcliffe, Neil A. M. Maiden, Shailey Minocha, Darrel Manuel: *Supporting Scenario-Based Requirements Engineering*. IEEE Trans. Software Eng. 24(12): 1072-1088 (1998).
- Paolo Tonella, Angelo Susi and Francis Palma. Using Interactive GA for Requirements Prioritization. in Proc. of SSBSE 2010, pp. .
- C. Wohlin, P. Runeson, M. Host, M. Ohlsson, B. Regnell, and A. Wesslen. *Experimentation in Software Engineering - An Introduction*. Kluwer Academic Publishers, 2000.
- Xun Yuan, Atif M. Memon: *Using GUI Run-Time State as Feedback to Generate Test Cases*. ICSE 2007: 396-405.

2.2. Vision and Goals

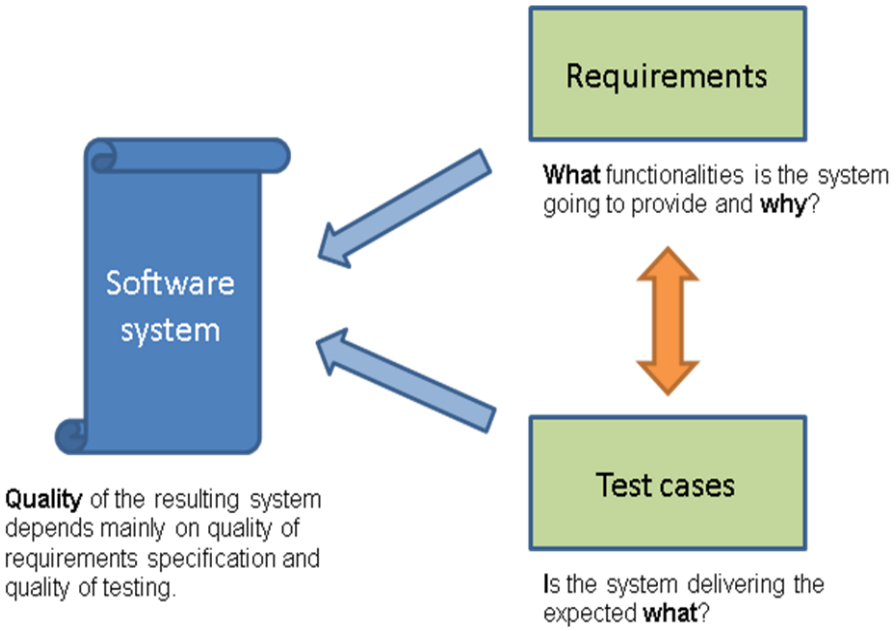

Figure 1: *Vision on quality of software system*

Next generation software systems, such as ambient assistance and future Internet systems, will operate in an open and dynamically changing environment and will

need to be able to cope with the heterogeneity of their users who can also dynamically change their preferences. Challenges for the engineering of such systems include:

1. *Self-modification and autonomic behavior*: specification and validation of the expected behavior is hard to achieve, since all changes possibly occurring dynamically must be taken into account.
2. *Low observability*: dynamic integration of 3rd party components makes it difficult to specify the composition's behavior upfront; testing becomes harder because of the possibility of dynamically discovered and integrated components, which can be observed only as black boxes.
3. *Distribution and asynchronous interactions*: new software systems live and interact with each other through the Internet, giving rise to an exponentially high number of possible interleaving executions, whose specification and testing is problematic.
4. *Ultra large scale*: next generation systems will be very large in scale, comprising systems of systems; requirements and test methods for them demand for novel approaches.

Our vision on the quality of such software systems, depicted in Figure 1, gives a central role to requirements specification and testing. Requirements specify *what* the system is supposed to do (functional requirements) and *how* it is supposed to do it (non functional requirements, such as performance, resource consumption, etc.). Moreover, requirements descend from a domain analysis which includes the *why* dimension that represents stakeholders goals. The quality of specification of the *why*, *what* and *how* determine very profoundly the quality of the realized system. We cannot expect the system to deliver more or better functionalities than those specified in the requirements. We also cannot expect ambiguous or contradictory requirements to lead to a satisfactory system.

Once the system is realized, the main method to assure that requirements are actually and accurately realized is testing. Having high quality requirements is not enough, since the implementation may deviate from them or may take shortcuts. It may just not meet them. Testing is a systematic way to exercise the realized system and check its behavior against the expected one, i.e., the one specified in the requirements. Hence high quality testing is always coupled with high quality requirements. Moreover, recent methodologies (e.g., agile methods) which stress the importance of *test driven development*, couple requirement gathering and test case definition from the very beginning of development. Testing represents a major cost for software companies, which involves substantial human effort in test case definition, execution and oracle specification. The testing phase can be highly improved by empowering software engineers with automated testing tools, which alleviate the manual effort required to define test sequences and test data, to run test cases and to verify the correctness of the output they produce. Hence, we intend to investigate novel methods for automated test case generation, execution and for the automated inference of oracles or for the automated detection of anomalous behaviors.

The strategic vision of our group is based on the crucial importance that requirements and testing have for the quality of software systems. Hence, we intend to investigate these two areas in isolation, as well as their interactions.

2.3. Activities and Work Plan

– *A1: Reverse engineering & re-engineering*

The activity on reverse and re-engineering is associated with two ongoing projects: (1) IBT, for the migration of a legacy banking system from the BAL (Business Application Language) programming language to Java; (2) CERN, for the analysis of the code developed for the Alice LHC experiment currently ongoing at CERN (see http://www.cern.ch).

Migration from BAL to Java is supported by a tool that is expected to reach maturity and to be applied in the field in 2011. The tool has been released to IBT at the end of 2010. The tool incorporates quite sophisticated static code analyses that are used to support the migration, such as: object layout identification and extraction; goto elimination; lock analysis. The main objectives for 2011 are: completing the functionalities implemented in the translator and supporting IBT in the migration process that will be carried out in 2011.

The static code analyses that are regularly conducted (with the night builds) on the CERN/Alice code aim at detecting violations of the coding conventions (style, coding and programming rules) that may lead to problems and failure. In 2011 we will also investigate the programmer's lexicon and how to improve it. We will use lexicon bad smell detection to determine lexicon problems and we will resort to LSI to formulate term improvement suggestions. We will also work on domain ontology extraction based on source code and textual information analysis (using NLP parsing techniques).

– *A2: Web testing*

The activity on Web testing is partially supported by external funds (the EU project FITTEST) and partially conducted as internal research, mainly in collaboration with PhD students.

The SE unit is responsible for the workpackage WP4 within FITTEST. This workpackage is about the automated extraction of models to be used for test case generation. During 2011, the main objective will be to define and assess empirically a number of model inference techniques. Specifically, we will use both state abstraction and event sequence abstraction, trying to balance automatically the degree of over vs. under-approximation. We will also investigate the problem of automatically determining the need for a model update, due to a change of behavior of the application under test (e.g., new release; new usage mode; etc.).

In order to improve the test case generation capabilities of Web testing tools that employ crawlers, we will study metrics of crawlability, to characterize the portions of a Web application that deserve a more focused testing effort because of a low crawlability. We will define and study adequacy testing

criteria for Web applications based on the alternative page generation behaviors that can be activated on the server side.

We will also work on security testing of Web applications. We will consider the possibility to use search based (e.g., genetic) algorithms to provide evidence for the presence of vulnerabilities in the code under analysis.

– *A3: Requirements engineering for socio-technical systems*

Socio technical systems are complex frameworks where the interaction/integration between humans and software systems is a crucial dimension. In this context we recognize the importance of three aspects related to the elicitation and management of requirements for those systems: the pervasive interaction of the system with the social domain, the management of the stakeholders' preferences, and the compliancy of requirements with laws regulating interactions between humans and between humans and systems.

The research in the area of requirements methodologies, aims at the specification of a framework for integrating two requirements methodologies, User-Centered Design (UCD) and Goal-Oriented, to improve the strength of Goal-Oriented techniques in modeling the domains by coupling the engineering perspective with a creative perspective typical of UCD approaches. The challenge here is that of integrating the approaches without compromising their very nature, assuring a synergy between methodologies via the definition of communication protocols between the practitioners of the two methodologies. This activity will be mainly financed by the ACube PAT project.

The role of requirements prioritization based on technical constraints and stakeholders' expectations and preferences is of extreme importance during the software development lifecycle. In our work we will focus on the specification and validation of algorithms based on Machine Learning and search based techniques for requirements prioritization that should be able to exploit available domain knowledge about possible priorities between requirements and, at the same time, to actively involve the stakeholders into the prioritization process.

The problem of compliance of socio technical systems to regulations is relevant when new systems have to be integrated into complex social settings. We will face at the problem of compliance as a modelling problem. Laws are expressed in terms of a set of legal concepts, such as those of "right", "obligation" and "privilege". Requirements, on the other hand, are expressed in terms of stakeholders' goals. The definition of law-compliant requirements is then a problem of transforming, through a systematic process, models of Laws, into models of Requirements. The objective of the research is that of defining a framework for law compliancy definition and assessment that builds on our recent research.

– *A4: Requirements engineering for adaptive systems*

Research on methods and techniques for engineering adaptive software tends to address design-time solutions to enable run-time adaptation, while suitable approaches for eliciting and specifying requirements for such software are still missing. In a recent work, we proposed the Continuous Adaptive Requirements Engineering (CARE) framework [Qureshi et al. 2010], in which we define design-time and run-time requirements engineering methods for engineering self-adaptive software. We plan to refine the CARE framework along the two following lines. First, we will revisit the core ontology and problem in requirements engineering for self-adaptive systems. Along this line we intend to investigate whether new core concepts will help defining the requirements problem for self-adaptive software, and what type of analysis needs to be performed to find feasible solutions at runtime. Second, we will investigate how to support "on-line" requirements acquisition by involving the end-user and the system itself. More specifically, along this line we intend to investigate how to support end-users in communicating needs & feedback, integrating ideas from the recent proposal about *iCompanion* [Seyff et al. 2010], and how to enable continuous on-line analysis of new needs and solution provisioning.

2.4. Collaborations

- *University College London, UK*, Mark Harman: joint research on search based software engineering (search based testing in particular).
- *Wayne State University, USA,* Andrian Marcus: joint research on evaluating and improving the quality of the programmer's lexicon.
- *Queen's University, Kingston, CA,* Thomas Dean*:* joint research on legacy systems re-engineering.
- *University of Genova,* Filippo Ricca: joint research on empirical studies on requirements engineering methods and techniques.
- *MIS, University of Haifa, Israel*, Iris Reinhartz-Berger, Irit Hadar, Tsvika Kuflik: joint research on empirical studies on requirements engineering methods and techniques
- *University of Namur (FNRS & Louvain School of Management), Belgium,* Ivan Jureta: joint research on foundations of methods for norm-compliant and self-adaptive software requirements engineering
- *University of Toronto, University of Trento,* John Mylopoulos: joint research on norm compliant requirements and organization of the Int. IEEE Conference on Requirements Engineering RE'11 in Trento.
- *University of Zurich*, Switzerland, Norbert Seyff: joint research on requirements acquisition at run-time, by involving the end-user.
- *University of Bolzano,* Alberto Siena*:* joint research on norm compliant requirements.

2.5. Specific Needs and Points of Attention

Activities and objectives might need re-planning during the next year, especially those more research oriented, depending on newly identified promising directions, new opportunities or collaborations, new projects, and new ideas in general. Periodic revision of the activities and detailed goals (see next section) contained in this document are essential to capture the highly dynamic and reactive nature of the research work.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
A1.1: Major release of BAL2Java translator, including all functionalities needed to support the IBT migration process.	I	E	June	Tool released	
A1.2: Experiment on lexicon analysis and improvement, and on domain ontology extraction.	R	E	Sep.r	Paper submitted	
A2.1: FITTEST deliverable D4.1: *Report on test model inference*.	R	E	April	Project deliverable	
A3.1: User-Centred and Goal-Oriented methodologies integration	R, A	E	Dec.	Paper submitted	
A3.2: Norm compliant requirements	R, A	E	Dec.	Paper submitted; Project proposal	
A3.3: Prioritization	R	E	Dec.	Paper submitted	
A4.1: Requirements Engineering for self-adaptive systems	R, A	E	Nov.	Paper submitted; Project proposal	
A5: IEEE Int. Conf. on Requirements Engineering in Trento, 2011	O	E	Sep.	Number of RE11 int. attendants	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The SE unit has a core team which consists of five researchers, two of which are senior. The core team works with some post-doc researchers having a term contract on specific research projects (e.g., FITTEST, A-cube, IoS). The unit employs also qualified human resources involved in the technology transfer activities (e.g., project IBT), with term contracts on project. Moreover, the exploration of topics having high scientific relevance for the group is carried out thanks to a substantial number of PhD students, who work toward their thesis within the SE group.

The professional growth of the researchers in the core team aims at an increased scientific visibility, the capability to attract funding and to have an impact in the local area. The development of the younger researchers toward seniority passes through scientific autonomy and recognisability. For them, a fundamental milestone will be coordinating and guiding PhD students and postdocs.

The team composition and size is adequate for the activities and projects planned for the next year. Younger researchers should be stimulated to try to target also top-ranked conferences and journals, planning ahead for such ambitious objectives. Since the group is dependent on the activity of the PhD students for most ongoing research, selection of outstanding PhD candidates is a priority for the group. The IBT project team is expected to decrease during 2011, since the BAL2Java translator is reaching maturity and is going to enter the ordinary maintenance phase, which requires lower resource allocation.

In 2011 three PhD students will give their final exam and finish their period within the group. One postdoc is also finishing, since the Acube project will terminate at the end of October 2011. As a consequence, the unit will experience a high turnover, which will involve the recruitment of three new PhD students.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
High turnover	H	M	Dedicate adequate time and resources to personnel selection and training.
Critical mass necessary for top-ranked, high impact research not achieved	H	M	Promote focusing of research activities around a few selected, and promising topics.
Insufficient self-funding	M	M	Apply for diversified types of grants.
Lack of group cohesion	M	M	Promote transversal activities across the areas of requirements modeling and testing.
Difficulty of integration of new team members	L	M	Promote joint research and activities within the group; promote internal discussion and presentation of ongoing work.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

SOA – SERVICE ORIENTED APPLICATIONS

Unit Name	SOA – Service Oriented Applications	
Type	Research	
Head	Marco Pistore	
Staff	2010	2011
	6 Researchers	6 Researchers
	6 Technologists	3 Technologists
	6 PhD	4 PhD

Document Status: submitted 2010-11-28

1. Executive Summary

The Service Oriented Application (SOA) Unit is concerned with the study and the development of advanced methodologies and techniques for the engineering of software applications based on the service-oriented paradigm. This paradigm defines a novel approach to software development that is gaining more and more impact in the ICT marketplace, namely the realization of new applications through the composition and customization of software "services". These services are self-contained, platform-agnostic computational elements that have been designed to be re-usable and to support rapid, low-cost and easy composition of loosely coupled distributed software applications. The service-oriented paradigm is recognized as one of the key enablers for companies to create new value from existing investments, reuse efforts across many projects and resources, and achieve new levels of agility through greater flexibility and lower cost structures. In the next years, the research unit will concentrate on key scientific challenges for service-oriented applications, including general and reliable mechanisms for composing applications out of existing services, novel approaches that allow end-users to be in charge of service composition, and novel approaches for to support "service level agreements" as the central concept for the realization of robust, adaptable service-oriented applications. The research is scenario-driven: we exploit scenarios in key application areas such as mobile value services and enterprise service integration, both for extracting requirements that drive the research activity, and for validating the research results.

To achieve its goals, the Unit has to perform activities that range from advanced research to technological scouting and, finally, to design, realization and exploitation of software tools and pilot studies. Research is carried out in a coordinated way by a core of researchers (6 in 2011), which coordinate further research efforts by a growing set of PhD students (4 in 2011). The realization of tools, prototypes and demonstrators and the transfer of the results to industry is supported by a team of technologists (3 in 2011). In 2009, the SOA Unit has launched a spin-off, sayService (http://www.sayservice.it), with the goal of bringing to the market some of the solutions developed by the Unit in the last years.

2010, the Unit has faced a serious turnover problem. Of the 18 staff members that were part of the SOA Unit at the beginning of 2010, only 10 (3 researchers, 3 technologists, 4 PhD) will still work in the Unit in 2011. Moreover, two more technologists are planning to leave SOA during 2011. This turnover is due to SOA personnel moving to sayService, due to problems related to the renewals of the contracts, and also due to job shifts. One of the goals of the Unit in 2011 is to consolidate the core group of people that will remain in the Unit and to start rebuilding the Unit with the enrollment of new researchers. During 2011, the activities of the Unit will also aim at streamlining the collaborations with sayService for what concerns projects with Industry, in order to reduce the need of internal technical staff.

Internal collaborations are fostered by the Joint Research Project on “Internet of Services” and involve in particular the “Software Engineering”, “Data & Knowledge Management”, and “Intelligent Interfaces & Interaction” units. External collaborations involve, in addition to sayService, large industrial partners at the European (in particular: SAP AG, DoCoMo Euro-Labs), national (in particular: Engineering SPA) as well as local companies in the ICT domain (in particular: GPI SPA). All these companies are partners of the Unit in research and/or industrial projects. External collaborations also involve, in addition to the University and to the research centers in Trentino, strong research groups at the leading edge of specific areas of Service Oriented Computing, such as the University of Stuttgart, or Politecnico di Milano, City University London. These collaborations aim at joint investigations based on a joint exploitation of the complementary competences and technologies of the partners.

2. Vision and Scientific Program

2.1. Context and State of the Art

The adoption of a service oriented business model is widely recognized as a necessary shift to change the European economy into a more dynamic and competitive knowledge-based society. This paradigm shift manifests itself by the evolution of business models from the sale of products to the provision of electronic services, where services are seen as utilities that can be used but that are not owned by users. In terms of IT technology, this shift translates into the evolution of implementations by software development into "solutions built by composition and configuration of software services".

Currently, in spite of established key principles for engineering service oriented applications (e.g. loose coupling, coarse grained service interfaces, dynamic service discovery and binding, self containment of services, service interoperability and protocol independence[1]) and of the existence of standards for service based applications (e.g. the ones from OASIS and W3C it is well recognized that "there is

[1] Erl, T.: Service-oriented Architecture. Prentice Hall, 2004.

[still] a need for [novel] ways of producing applications by configuration and composition of loosely coupled services"[2].

In this context, one of the key enabling techniques for service oriented engineering stands in the automated composition of distributed services into novel applications[3], an area where the group has built strong competences. The extension of these techniques to a comprehensive approach for the design of service oriented application is however still at a preliminary stage[4]. Adaptation techniques are also strongly needed, since adaptation is one of the key issues in service oriented engineering, both from the perspective of service providers and from the perspective of service consumers and composers. The results in the area of service adaptation and evolution are still very preliminary: they cover only limited aspects of the problem, such as monitoring the behavior of the service-oriented system to trigger adaptation when necessary[5]; or they focus on the infrastructural layer or on very specific aspects of the behavior of service compositions, such as addressing and binding.

Solving the two above problems is also crucial to enact mobile technology users to take full advantage of service provisioning. In particular, the very rapid evolution of mobile technologies has led to the mass-market adoption of mobile phones which increasingly integrate powerful connectivity capabilities, multimedia functionalities, as well as a variety of applications such as agendas, organizers, personal assistants, and address books. Such technology-rich mobile phones have the unique potential to act as portable gateways for their users, connecting them to a universe of "mobile services", ranging from personal management services, to internet services, and to services pervasively located in the environment. This paves the way to a huge marketplace of mobile services, whose enormous potential has been clearly recognized by the industry, as witnessed by the increasingly fast growth in the amount and diversity of services available to mobile phones. However, so far, the user is left alone with the task of combining available services in order to fully exploit their potential in an integrated way. This is an unbearable burden, to the point that paradoxically, the more services become available, the less they are likely to be effectively exploited by the user[6]. Specific techniques that support the user in composing services butting him/her at the center of the process need are severely lacking, and needed.

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2 NESSI Strategic Research Agenda. Vol. 1. Framing the future of the Service Oriented Economy. 2006.

3 Papazoglou, M.; Traverso, P.; Dustdar, S.; Leymann, F.: Service-Oriented Computing Research Roadmap. 2006.

4 Bertoli P., Pistore M., Traverso P.: Automated Composition of Web Services via Planning in Asynchronous Domains. Journal of Artificial Intelligence, 2010. To appear.

5 Marconi, A.; Pistore, M.; Traverso, P.: Automated Composition of Web Services: the ASTRO Approach. IEEE Data Eng. Bull. 31(3), 2008.

6 Bouwman, H., Carlsson, C., Walden, P., and Molina-Castillo, F.J.: Trends in Mobile Services in Finland 2004-2006: From Ringtones to Mobile Internet. *INFO* 10(2), 2008.

2.2. Vision and Goals

The goal of the Unit is the study and the development of advanced methodologies and techniques for the engineering of software applications based on a service-oriented paradigm. In particular, the unit will build on top of the state of the art just described and of the results achieved in the last years, targeting three specific research objectives.

- To consolidate and extend the methods and techniques for the composition of distributed business processed developed within the ASTRO research project.
- To develop novel approaches that allow end-users to be in charge of service composition, i.e., to provide usable, human-centric mechanisms for allowing the end-user to control the selection, configuration and composition of services according to their needs and requirements, without requiring them to understand the technical aspects of services and service composition.
- To support the adaptation and evolution of service oriented applications, in particular by promoting Service Level Agreements as the central concept for guiding their development.

These three objectives, which are complementary and strongly synergic, correspond, for year 2010, to the three activities detailed in the next subsections.

2.3. Activities and Work Plan

– *Distributed business processes*

This activity addresses the automated composition of distributed business processes and builds on top of the results achieved within the ASTRO project (http://www.astroproject.org). Within this activity, the effort in the next year will be focused in finding effective ways to add “semantic” annotations to distributed business processes, i.e., annotations that are oriented to make as unambiguous and as rigorous as needed the meaning of the data and of the procedures exploited in the business processes. Differently from current approaches, such as those based on OWL-S and WSMO, that, in spite of their expressive power, are hard to use in practice since they require comprehensive and usually large semantic descriptions of the domain, the approach that we intend to follow is based on a “minimalistic” usage of semantic annotations. That is, we will pursue approaches that reduce to the minimum the usage of semantic annotations – stopping as soon as the semantic annotations are good enough for the configuration and composition task at hand.

– *User-centric services*

The challenge addressed in this activity is to enable the mobile phone to take care of the burden of the combination of services, starting from simple user's constraints and requests. The goal is to make the mobile phone a simple yet extremely powerful tool that allows the user to keep control of the

combination and exploitation of the services, while relieving her from the technical burden of composing them in a coherent picture. This will be achieved by further investigating the novel approach to service composition devised in SOA, centered on the user, her activities and her goals. In this "user centric" service composition approach to the combination and harmonization of the services available to the mobile user, the services become part of the user's activities, constraints, and goals. Within this activity, we intend to investigate a set of specific scenarios devised in the YourWay! project, refining and extending our theories and techniques to support the design and execution of user-centric service compositions. In particular, the short-term goal is to provide solutions for the specific selected classes of mobile services in the YourWay! scenarios, providing the user with a unified interface to interact with them and to combine their functionalities.

– Support of adaptation and evolution via Service Level Agreements

  The objective of this activity is to investigate how adaptation and evolution can be supported for service-oriented applications, by making use of the key notion of Service Level Agreement. (SLA). SLAs define the exact conditions under which services are provided and consumed, and as such their run-time monitoring is the enabler that triggers an adaptation, since it signals the violation of a property on the quality of service required by the consumer: if there is no more agreement, then there is a need for change. This leads to two challenges: designing SLAs that allow the proper monitoring of properties related to adaptation, and designing SLAs that support as much as possible the autonomic adaptation and evolution of services.

  The objective of this activity is the realization of the "SLAs for monitoring" and of the "SLAs for adaptation" approaches just described. This includes the definition of an environment for the development and evolution of service oriented applications where the designer can defer to the run-time decisions on how to carry out a given process; conversely, the run-time environment can detect failures in performing the business process, for instance due to unforeseen changes in the business domain, and can trigger a redesign phase. During redesign, the overall model of the business application is updated, in order to reflect the changes in the domain (or in the strategic goals of a partner); decisions and procedures may now be fixed by the designer and, conversely, design decisions may be relaxed in order to give more flexibility to the run-time. In this framework, a redesign is not destructive with respect to the run-time: on the long term we envision a "continuous design" environment, where the human driven re-design and the supporting automated techniques concur to the achievement of the strategic goals in a service oriented world.

2.4. Collaborations

– *DoCoMo Euro-Labs*. Main reference person: Massimo Paolucci. Collaboration: bilateral YourWay! project between this Unit and DoCoMo Euro-Labs has finished in 2010. The project focused on the development of user-centric

methodology and support tool for service adoption on mobile phones. Follow-up projects are currently under discussion.

- *SAP AG*. Main reference person: Andreas Friesen. Collaboration in bilateral industrial project between this Unit and SAP AG. The project focuses on modeling and conformance analysis of service-oriented applications.
- *Engineering SPA*. Main reference persons: Piero Corte, Francesco Torelli. Collaboration: development of business process modeling methodology and support tool for service composition and adaptation (projects FRISBI and SLA@SOI). Exploitation of SLA-based techniques in the e-Government domain (SLA@SOI).
- *University of Stuttgart*. Main reference person: Frank Leymann. Collaboration: joint research on flow adaptation within the ALLOW project, and on techniques for cross-layer adaptation of service-based applications and service compositions in the scope of S-Cube EU project.
- *Politecnico di Milano*. Main reference persons: Luciano Baresi, Elisabetta di Nitto. Collaboration: joint research in the scope of S-Cube EU project. The goals are: (1) to study and develop integrated monitoring solutions for complex service-based applications; (2) to study the design principles, methodologies, and patterns for adaptable service-based applications.

2.5. Specific Needs and Points of Attention

Scientific program, objectives, projects and collaborations for year 2011 build on the work already undertaken by the Unit during the last years. Indeed, all the projects foreseen in 2011 are continuations of projects already started in previous years. For this reason, we do not foresee specific needs or points of attention pertaining the scientific work of the Unit.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Validated framework for human service composition	R	E	April	Scientific publications, project deliverables (FIRSBI), prototype tools, validation.	
Conformance analysis of service compositions mechanisms	R	E	April	Project deliverables (SAP project), prototype tools	
Conceptual and formal framework for fragment-based adaptation and evolution of service-oriented applications	R	E	July	Scientific publications, project deliverables (S-CUBE, SLA@SOI, ALLOW), prototype tools	

Framework for business process management in document-intensive domains	R	I	Oct.	Conceptual framework, prototype tools.	
Cross-layer service monitoring and adaptation framework	R	E	Dec.	Scientific publications, project deliverables (S-CUBE), advanced prototype tools	
Proactive service adaptation and evolution mechanisms	R	E	Dec.	Scientific publications, project deliverables (S-CUBE), advanced prototype tools	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

In 2009 the Unit had reached a dimension that was adequate to the objectives and undertaken activities. In 2010, the Unit has faced a serious, in part unexpected, turnover problem. Of the 18 staff members that were part of the SOA Unit at the beginning of 2010, only 10 (3 researchers, 3 technologists, 4 PhD) will still work in the Unit in 2011. This turnover is due to SOA personnel moving to sayService (2 researchers, 1 technologist), due to problems related to the renewals of the contracts (1 technologist) or admissions to continue the PhD career (2 Phd students), and also due to job shifts (1 researcher, 1 technologist). Moreover, two more technologists are planning to move from SOA to sayService during 2011.

One of the short term goals of the is to consolidate the core group of people that will remain in the Unit and to start rebuilding the Unit with the enrollment of new researchers. The objective is to reach by the end of 2012 a size similar to the one of 2009 for what concerns researchers and PhD students, with the addition of some post-docs; for what concerns the technologists, a reduced need is expected with respect to 2009, due to the possibility to exploit synergies with sayService for what concerns projects with Industry. In 2011, this consolidation process will start with the enrollment of two new researchers.

Moreover, in 2012 a tenure track is expected to start for one of the researchers of the Unit.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Unit cohesion. The strong turnover during 2010 and the heavy load of project activities has started harming the internal cohesion of the group. The risk is that the cohesion will start reducing in 2011 if correcting actions are not taken. This risk is accentuated by the very high project load for the personnel during the first half of the year (see next risk).	Medium	Severe	Consolidation of a new core group of people and the launch of new internal research activities. Teaming up activities such as retreat, working groups, and so on.
Mid-term sustainability. At the moment, the Unit has a high self-funding rate, due to a large number of ongoing projects. Most of these projects (4 out of 5) will end between April and July 2011. The self-funding can hence decrease substantially starting from the second half of 2011.	Medium	Low	Submission of project proposal is already ongoing and will continue during year 2011. More time for internal activities, while negative in terms of self-funding, will offer to the Unit the necessary time to consolidate and launch new research lines . Impact is considered Low in the short term, since a temporary reduced self-funding rate for the second half of 2011 and for the beginning of 2012 in anyhow seen as an acceptable follow up of the high self-funding of the last years.
New lead. During 2012, a turnover is planned in the head of Unit. In perspective, this can cause discontinuity in the governance and management of the Unit.	Medium	Severe	A new leadership will be built during 2011, as part of the foreseen group consolidation activities. This new leadership will start supporting the current head of Unit in order to smooth the turnover.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

6. Ethical Issues

Some of the evaluation activities undertaken by the SOA Unit may involve end users, whose location and activities are tracked in order to provide them contextual, personalized services. The Unit is aware of the ethical issues this involves. It will employ highest standard in dealing with these issues and have measures in place

to ensure conformance with legislation, and to adhere to the fair information principles (collection limitation, data quality, purpose specification, use limitation, security safeguards, openness, individual participation and accountability).

Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	Possibly
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	Possibly
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

DKM – DATA AND KNOWLEDGE MANAGEMENT

Unit Name	DKM – Data and Knowledge Management	
Type	Research	
Head	Luciano Serafini	
Staff	2010	2011
	4 Researchers*	4 Researchers
	2 Technologists	2 Technologist
	2 Post Docs	2 Post Doc
	3 PhD	3 PhD

Document Status: submitted 2010-11-06

* plus 1 Researcher on June 2011

1. Executive Summary

The Data & Knowledge Management research field comprises a range of practices used inside an organization (such as an enterprise, an interest group, or the entire web) to create, represent, share and make available knowledge and data, which are relevant for pursuing the organization's goals. It is an interdisciplinary research field on the border between computer science, sociology, economics, and mathematics. We contribute to the above research agenda by developing: methodologies and tools to support the elicitation of knowledge and its encoding in computer interpretable formats; logical formalisms for knowledge representation and reasoning; frameworks and tools for the integration of data and knowledge sources; and efficient and scalable services for the management of large, distributed, and modular knowledge bases.

Knowledge elicitation and modeling. This research area refers to the process of eliciting knowledge from data and people and its encoding in computer interpretable logical theories, called knowledge modules. Our current research is devoted to the development of a WEB 2.0 tool, called MoKi, the Modeling wiKi, able to support an effective collaboration between knowledge experts and knowledge engineers in the construction of integrated domain and process models, and of its evaluation and practical usage in a number of research projects and real use cases.

Knowledge representation. The work of the DKM research unit in this area concentrates on the development of logical formalisms for the representation of different forms of knowledge. Our current focus is on the representation of contextualized knowledge, semantically annotated business processes, and on the development of formalisms able to combine logical and statistical knowledge.

Knowledge integration In this area we investigate and develop logical formalisms and tool tailored to support the process of integrating heterogeneous and autonomous knowledge modules in a coherent distributed and modular knowledge base. Heterogeneity means that modules can use different schemata to represent the same knowledge; autonomy means that the management of knowledge modules is not centralized.

Knowledge services We work towards the implementation of efficient and scalable reasoning algorithms for distributed and modular knowledge bases. These services are applied to support automatic content extraction and integration, semantic web service composition, and analysis of medical procedures.

The unit is currently composed of 2 permanent positions (the coordinator and a senior researcher) 1 tenure, 3 post docs, a research assistant (to be stabilized by the end of 2010) 2. Phd. Students. For the next year(s) we plan to augment the number of Ph.D students

DKM unit collaborates on KR&R research themes with analogous research groups in University of Trento and Free university of Bozen. Furthermore DKM collaborates with the AI Lab of University of Siena in the field of integration of statistical and logical reasoning. Furthermore there we establish a formal joint research activity with the Know-Center in Graz. In order to apply KR&R method do domain specific problems, DKM collaborates internally and externally with many groups (see details in the appropriate section). These collaborations spam from the exploitation of knowledge for the management of large quantity of multimedia content, to the use of collaborative tools for modeling organizations, enterprises and public administrative processes.

2.1. Vision and Scientific Program

Knowledge is becoming an important asset in information technology for the following two main reasons: From the one hand, the web, and the semantic web, made available a *huge amount of content data*, under a multitude of forms spamming from completely unstructured (i.e., with no explicit semantics) information like natural language text, images, video, to well structured data (i.e., with explicit semantic) like, databases, linked data, RDF repositories and ontologies. On the other hand, the increased level of complexity, sophistication, and pervasiveness of the information technology in our everyday life, imposes to have flexible applications capable to smoothly adapt to many possible unpredicted situations. The consequence of this is that more and more applications require an *explicit, and as much complete as possible, representation of "the world"* in which they are suppose to operate. Such a representation should be machine understandable and will constitute the "store of meanings" to be attached to the object manipulated by the application.

The main vision of DKM research is shown in the following picture.

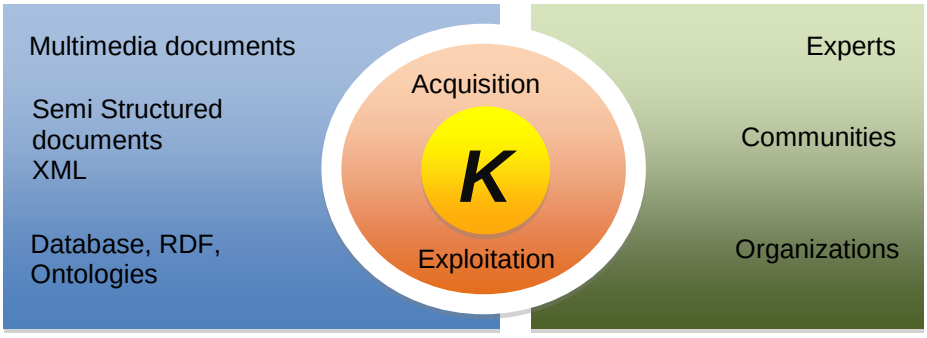


Figure 1. Knowledge acquisition, representation, integration and exploitation

The core research of the DKM unit is on knowledge representation, knowledge integration and reasoning, However, to apply the developed methodologies, we dedicate a substantial effort in developing techniques for the acquisition of knowledge about complex domains from electronic resources and from humans. Context and State of the Art (current)

In the last ten years, general approaches and tools for knowledge acquisition, representation, integration and services, have seen a tremendous improvement towards mature systems which can be applicable and integretable in real world complex applications. For knowledge acquisition, on the one side, we can find knowledge/ontology editors, like for instance Protégé, that support the manual editing of complex ontologies, on the other hand there is a number of tools for automatic content extraction, as for instance TextPro and Gate, that allow the automatic extraction of key concepts lists, basic facts, and other semi-structured material that represent an important pre-processed material for knowledge/ontology construction and population. However, using this tools and combining them for an effective knowledge acquisition process is far to be a pure standard application activity. The state of the art ontology editors are designed for knowledge engineers, which have a specific competence in logical modeling. Such tools do not provide sufficient support for assisting knowledge experts to input their knowledge about a certain domain in some informal (or semi formal) manner. On the other side, despite the state of the art tools for automatic knowledge mining from multimedia content are of great help in an early knowledge engineering phase, it's not easy to integrate them with other tools in order to create a full and integrated production chain for knowledge.

In the are of knowledge representation and reasoning, also the state of the art is quite advance, and provide off-the-shelf theories and tools for storing large knowledge base and doing complex reasoning. They spam from large RDF triple stores, like Sesame, Joseke, 3Store, etc. (see http://simile.mit.edu/reports/stores/ for a survey), to complex logical reasoners, such as Pellet, FACT++, OWLim, … (for Description Logics) and, Prover9/Mace4, SPASS, Vampire … (for full first order logic). In the middle we can find system like CYC which is at the same time, a huge knowledge repository and a reasoner. Despite being great tools, the application of

these tools has been limited to reason in well formalized environments (like program verification) but they are rarely applied to situation which are more open and not so well defined such as the processing of content of a multimedia document. Furthermore, all these approaches are well designed for crisp knowledge (mainly represented in some family of first order logic), while there is no much work done in integrating logical knowledge with statistical knowledge, which is now available by the huge quantity of data.

In the area of Knowledge integration, there are a number of theoretical and practical approaches, but the state of the art technology are far to be straightforward applicable to real situation in a plug and play manner. For instance semantic matching and ontology mapping are not ready to be deployable in real world applications.

Semantic services is an important research area because it justify all the effort done in knowledge acquisition, representation and integration. The goal of knowledge services is the one to make available knowledge in all the other application in a proper format. This span in semantic look up, semantic enrichment of content, verification, etc. This is a very wide area and it is impossible to give a precise state of the art, but in general we can see that there are a plethora of services each of which is designed for some specific application. General knowledge services are limited to standard reasoning services like satisfiability and logical consequence. However, in order to effectively exploit knowledge in application of content extraction or in application of knowledge management we need more sophisticated general services, like for instance semantic enrichment, abductive reasoning, explanation, etc.

2.2. Vision and Goals

The overall objective of the DKM research group is to apply and extend the stat-of-the-art methodologies and tools for knowledge acquisition, representation, integration, and exploitation, in order to support the development of knowledge intensive applications. This involves (i) the design of new theoretical frameworks and methodologies, (ii) the development/extension of tools, and (iii) the application of knowledge technologies to some specific domain.

The detailed plans in the four areas are described in the following subsections:

– *Knowledge Elicitation and Modeling (knowledge acquisition from human and content).* The development of high quality declarative models such as ontologies (or knowledge bases) and business process diagrams is a strategic area for practical applications of Knowledge Management. Building from our experience in several European and National projects, we have developed methodologies and tools that support modeling activity and to strengthen our position in technology transfer activities of knowledge elicitation and modeling. This effort is originated in three streams of research:

  1 The development of a flexible modeling tool, called MoKi: the Modeling wiKi (http://moki.fbk.eu) tailored to the collaborative development of integrated ontologies and process models.

2 The customization of MoKi to be applicable for modelling specific domains like for instance, the domain of public administrative procedures and documental flows, and the domain of medical processes, guidelines and layperson terminologies.

3 The investigation techniques, like design patterns, and modeling wizards, capable to guide domain experts, with scarce familiarity in conceptual modeling, to build good quality ontologies, and processes, and the embedding of such techniques in MoKi.

4 The development of large and complete ontology and process libraries describing typical domains, such as the work environment, governmental institutions, medical domains, environmental data, organic agriculture which could be exploited in practical applications.

– *Knowledge Representation.* In the last 20 years, the DKM unit has developed a solid background in the design of logical formalisms for the representation of different forms of knowledge. Our current focus and research directions are the following:

1. *Formalisms and tools for the representation and reasoning about contextualized knowledge:* In many situations knowledge consists of a set of statements, which are true only in a particular context. In AI there has been a lot of work in defining general formalisms for the representation and reasoning about contextualized knowledge (e.g., logic of contexts, and Multi Context Systems). The objective of this research is to specialize these formalisms in order to represent contextualized knowledge in the semantic web. The peculiarity of this research stands in the fact that languages for Knowledge Representation of the semantic web are limited in the expressivity but they provide many advantages on the computational level. During the last years we have developed a theoretical approach, called "contextualized knowledge repository" which has been implemented in an experimental reasoning tool on top of Sesame 2 RDF store. The main objective for the next years, is to develop efficient query answering and scalable reasoning mechanisms.
2. *Formalisms for the representation of semantically annotated business processes:* Enriching business process models with semantic annotations taken from an ontology has become a crucial necessity both in service provisioning, integration and composition, and in business processes management. In our work we represent semantically annotated business processes as part of an OWL knowledge base that formalizes the business process structure, the business domain, and a set of criteria describing correct semantic annotations. We also investigate how Semantic Web representation and reasoning techniques can be effectively applied to formalize, and automatically verify, sets of constraints on Business Process Diagrams that involve both knowledge about the domain and the process structure.
3. *Formalisms for the combined representation of logical and statistical knowledge:* Humans solve the problems of interpreting multimedia docu-

mentation by both exploiting structural regularities in the data, as well as making use of common sense and specialized knowledge that explicitly represents the meaning of data. In spite of this simple observation, current approaches to processing content over the Internet are based either on a statistical approach, which exploits the regularities of the content encoded in a statistical model, or, alternatively, by logical approaches, by exploiting logical knowledge encoded via logical theories (such as ontologies). In both cases this unilateral approach leads to a limitation in the performance or in the quality of the results. We believe that combining statistical knowledge with logical knowledge in a unique system would improve the efficiency and the effectiveness of content management applications. During the last two years, within the COPILOSK internal project we have realized a number of experiments in the area of natural language processing that showed the advantages of using background knowledge to improve tasks like co-reference resolution. In the next years we plan to generalize this use case by generalizing one of the most stable machine learning paradigms, like Regularization or Graphical Models, to include knowledge expressed in logical form.

– *Knowledge Exploitation and services:* This type of research is usually pursued within the specific application projects.

  1 *Knowledge management for environmental information integration.* Within the Pescado EU Project we will develop a mixed reasoning services for a decision support system in the area of environmental information. The reasoning service should provide advices to a user who wants to perform a specific activity, on the basis of the data collected from environmental services and the user profile. Given the uncertainty of the data and the fuzziness of the user profile, we has to support some form of uncertain reasoning.

  2 *Contextualized semantic enrichment of textual data:* In the last year of the LiveMemories project (ending in December 2011) we will concentrate in improving the “contextualized semantic enrichment service” which enriches all the mentions (i.e., portions of texts referring to persons, organizations and locations) of the local news articles with the information about the mentioned entity which are relevant for the context of the article, and are available in the contextualized knowledge repository. The task of semantic enrichment does not have a standard evaluation method. Therefore, one of the future objectives will be the definition of an evaluation strategy that allow us to evaluate the performance of the proposed semantic enrichment algorithm.

  3 *Knowledge management for medicine:* The aim of this activity is to use annotated business processes to represent and analyze processes in the medical domain. Processes can refer to medical guidelines as well as organizational aspects of the daily work in a medical ward. As a first case study we will focus on the modelling of the daily activities and practices of nurses in the oncology ward in BPMN. This modeling activities will have a twofold goal. First: to document the organizational practices of nurses;

and second: to analyze them and possibly find bottlenecks and critical paths. Modeling will be done using the collaborative MoKi.

4 *Knowledge management for Organic Agriculture*: Within the Organic Lingua EU Project we concentrate on the extension of the MoKi, platform for the representation of multi-lingual ontologies of organic agriculture.

5 *Knowledge management for administrative procedures*: Within the ProDe national project (Progetto Interregionale Dematerializzazione) we concentrate on the development of models for the formalization of the administrative procedures and the relative documental flows, in the public administration of the Provincia Autonoma di Trento. In doing this we will tailor MoKi to support such a modeling also for some of the other regions participating to the project.

2.3. Activities and Work Plan

See sections on goals

2.4. Collaborations

Data and knowledge management is an activity that, in most of the cases, has sense only in combination with other specific applications. Vice-versa, there are more and more applications that require the capability of dealing with semantically enriched data (i.e., data that are enriched with some form of explicit representation of knowledge. The consequence of this being that DKM in order to carry on high level impact research need to have a tight collaboration with other groups dealing in the specific application field. More in detail we collaborate with the following research groups:

Internal collaborations

– *HLT-FBK* content extraction from textual data (LiveMemories, Pescado, Jrp. Copilosk)
– *TEV-FBK* use of logical and statistical knowledge for object recognition in images (Jrp. Copilosk)
– *SE-FBK* semantic annotation of business processes
– *EHealth-FBK* collaborative specification of clinical guidelines (progetto e-onco) and construction of lay medical vocabulary (shared Ph.D. Elena Cardillo)

Local area collaborations

– *DKM-UniTN* Data and Knowledge management, and content processing

  Okkam S.R.L. integration of Contextualized Knowledge Repository and Okkam entity repository
– *Laboratory for Applied Ontology (ISTC-CNR)* Collaborative enterprise modeling in MoKi

External collaborations

– *Know Center Graz* Collaborative Enterprise Modelling (MoKi)

– *KRDB Research Centre for Knowledge and Data – University of Bolzano/Bozen* Logic base ontology integration
– *Laboratorio di Documentazione - Dipartimento di Linguistica, Università della Calabria* Knowledge management for management of documents in the public administration
– *Laboratory of Artificial Intelligence – University of Siena.* Extension of Regularization methods for dealing with logical constraints.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Collaborative modeling and MoKi	I/R/A	E	June-Sept.	a. Exploitation in ProDe National Project and Organic.Lingua EU project. b. Extending with further functionalities. E.g., Multilingua, name spaces, synchronization with an underlying reasoner. c. Scientific publishing d. evaluation	
Contextualized knowledge repository	I/R/A	E	June-Sept.	a. acquisition of a large dataset of background knowledge b. publication of the theoretical framework c. implementation of the basic query answering (for RDFS) d. tests and evaluations e. scientific pubblications.	
Logical and statistical knowledge integration	R/A	I	June-Sept.	a. Theoretical reference model for logic and statistical knowledge integration b. Prototype implementation of the reference model in a tool	

				(extending an existing tool) c. Use case on Natural language processing d. Use case on Image processing e. Paper publications f. Project Proposal submission	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The unit is currently composed of 2 permanent positions (the coordinator and a senior researcher) 1 junior researcher (3rd level) and 2 post doc a programmer and 3 Ph.D plus 1 Ph.D student shared with the e-health group who will finish her Ph.D at the beginning of 2011. At the beginning of 2011, we have to acquire a new post doc (to replace Dr. Andrei Tamilin who is leaving at the end of 2010) a new programmer for the ProDe, and at around mid 2011 we have to acquire a new post doc who will work on the OrganicLingua project.

5. Risks and Mitigation Plans

The application of Knowledge Management technologies to different areas, such as the ones listed above, requires on the one hand the acquisition of minimal competences in these areas and, on the other hand, the necessity of the customization of the tools and the methodology, reducing the possibility of their reuse. The main risk we run concerns this aspect, i.e., we will concentrate our energies in domain specific applications without developing new innovative technologies and providing significant scientific results.

6. Ethical Issues

Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	yes
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	yes
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

HLT – HUMAN LANGUAGE TECHNOLOGY

Unit Name	HLT – Human Language Technology	
Type	Research	
Head	Marcello Federico, Bernardo Magnini	
Staff	2010	2011
	14 Researchers	12 Researchers
	4 Technologists	4 Technologists
	2 Post Doc	1 Post Doc
	10 PhD	16 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Human Language Technology is a multi-disciplinary research unit that addresses the automatic processing of human language for a range of tasks. In particular, our research unit will focus on:

- Automatic speech recognition, that is the conversion of a speech signal into a readable text
- Machine Translation, that is the translation of speech or text from one language into another
- Content Processing, that includes the extraction, integration and retrieval of information from texts

HLT draws on several disciplines, such as Computational Linguistics or Natural Language Processing, Speech Processing, Information Retrieval, Machine Learning, Pattern Recognition, etc.

The HLT unit has been developing state-of-the-art technology in all the main research areas it operates in. The group has performed consistently well in several international evaluations, and is currently engaged in international projects for open source software development (e.g. the Moses platform for statistical machine translation). Research on speech recognition also meets the highest standards, and has reached the application market in several occasions. Moreover, people of the unit are key-players of many international initiatives around evaluation and benchmarking. The unit also provides technological support and high-level services in order to optimize the internal research activities, namely a shared and efficient computing environment, software tools, up to the creation and management of large scale linguistic resources.

During the year 2010 three termporary research contracts have expired and not renewed. One post-doc left the group. For the year 2011 such positions will not be substituted, although we plan to significantly increase the number of PhD students. The composition of the group includes 12 staff researchers, 4 technologists, 1 post-docs and 16 PhD students. According to our plans, future tenure-tracks will

be mainly in the machine translation and speech recognition areas, however no requests for activation are foreseen in 2011.

The unit has a remarkable track of funded projects already running thanks to strong and long lasting collaborations with key players in the field, such as U. Edinburgh UK, DFKI Germany, NiCT Japan, CMU USA, U. Karlsruhe Germany, U. Bar Ilan Israel, NIST USA, and U. Sheffield UK. Several proposals for new projects are currently under submission.

Finallly, the unit is leading a network of strategic collaborations for high level education programs involving local universities and industries:

- International Master School in Human Language Technologies and Interface with University of Trento
- European Master in Language Technologies and Communication with the Free University of Bolzano
- International Doctorate School in Information and Communication Technologies with University of Trento

2. Vision and Scientific Program

2.1. Context and State of the Art

Currently, most research fields in the area of human language technologies [1], like speech recognition (ASR) [2], machine translation (MT) [3] and information extraction (IE) [4], are dominated by statistical approaches, also generally referred to as data-driven or machine learning methods. Statistical methods and large scale experimental evaluations are nowadays at the forefront of HLT for two main reasons: the large amount of language resources that the digital era is steadily producing, and the rapid increase of computing power and memory that technology is achieving year after year. Progress in automatic speech recognition has recently enabled industrial applications. Similar innovation processes are as well expected for other technologies in the next years, such as machine translation and information access technologies. Future challenges, also solicited by international research programmes, are the integration of statistical approaches with linguistic and logical knowledge, in order to reduce the performance gap with humans, and the development of cognitive models in natural language processing [6].

The HLT unit has developed state-of-the-art technology in all main research fields it contributes in. The group working on text and speech MT [7] has performed consistently well in several international evaluations, and contributes to the most relevant open source project in the field. Research on ASR [8] also meets the highest standards, and is currently supporting an important start-up initiative deploying FBK's speech transcription technology. Research on content extraction [9] has a strong record of publications and evaluation results, namely on question answering and information extraction tasks. Finally, work on cognitive models will focus on so called affective computing, and the extraction of semantic information.

Moreover, people of the unit are key-players of many international initiatives around evaluation and benchmarking. Finally, work on resulted in publications at

top journals and conferences. Members of the HLT unit have a strong reputation in their scientific communities (Association for Computational Linguistics, Signal Processing Society, and Association for Computing Machinery).

References

1. C. Manning, H. Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press Cambridge, MA, 1999
2. M.J.F. Gales, D.Y. Kim , P.C. Woodland, D. Mrva, R. Sinha and S.E Tranter, “Progress in the CU-HTK Broadcast News Transcription System”, IEEE Trans. on Audio Speech and Language Processing, 2006.
3. H. Ney, “One Decade of Statistical Machine Translation: 1996–2005”, Proc. MT Summit X, pp. I 12- i-17, Phuket, Thailand, 2005
4. E. Appelt, “Introduction to information extraction”, AI Communications, 12:161-172, 1999.
5. T. Strzalkowski, S. Harabagiu, (Eds.), “Advances in Open Domain Question Answering”, Springer Series: Text, Speech and Language Technology , Vol. 32., 2006
6. J. Wiebe, T. Wilson, C. Cardie ,”Annotating expressions of opinions and emotions in language”, Language Resources and Evaluation, vol. 39, n. 2-3, pp. 165-210, 2005.
7. F.Casacuberta, M. *Federico*, H. *Ney*, E. Vidal. Recent Efforts in Spoken Language Translation, IEEE Signal Processing Magazine, 2008.
8. D. Giuliani, M. Gerosa, F. Brugnara,, “Improved Automatic Speech Recognition Through Speaker Normalization”, Computer Speech and Language. 20(1): pp. 107-123, 2006.
9. Gliozzo, Alfio, Carlo Strapparava, "Semantic Domains in Computational Linguistics", Computational Linguistics, 2009.

2.2. Vision and Goals

Our vision is to develop human language technologies that enable multilingual human-to-human communication and facilitate the access to large-scale spoken and written content, available through the Internet and other communication media.

Since its foundation in 2008, our short-medium term goals has been to become a world-class research group in the area of HLT, able to compete at the highest level in terms of scientific production, attraction of funding, recruitment of human resources, high-level education in collaboration with University of Trento, innovation and technological impact on the territory. Moreover, to reach maturity in the fields of information extraction and machine translation and to promote spin-offs, and to basically cover all aspects needed to the deployment of HLT: basic education, advanced research, R&D projects, software development standards, language resources, computing resources, and technology transfer.

2.3. Activities and Work Plan

Key technologies that will be investigated are automatic speech recognition, machine translation, information extraction, and content processing. Privileged application scenarios include speech analytics, multimedia data mining, and multilingual communication.

– *A1: Speech Recognition*

  Description. This activity addresses relevant scientific and technological challenges in the field of ASR. Proposed topics will permit to keep the edge on technology, to fuel running industrial initiatives, and to open new scenarios for future applications.

  T1.1 ASR core technology. R&D will address improvements on all major components, namely the search architecture, the acoustic, the language, and the pronunciation models. Research topics include: (i) data selection methods for language modeling and acoustic modeling; (ii) podcast transcription; (iii) multi channel and multi speaker audio streams.

  T1.2 Speech Analytic. This task focuses on technological advances related to the deployment of FBK's transcription engine: (i) fast speech decoding for automatic subtitling, (ii) fast on line adaptation; (iii) tools and documentation for acoustic model training; (iv) redundancy reduction in ASR output text; (v) prosodic-based meta-data extraction.

  T1.3 Multilingual ASR. This task focuses on: (i) multilingual audio stream processing (Arabic, German, French, Spanish, English, Portuguese, Russian, Turkish); (ii) cross-lingual language model adaptation; (iii) language detection, lightly supervised training from broadcast news streams.

– *A2: Machine Translation*

  Description. This activities cover research in the areas of text and speech statistical machine translation (SMT). Considered languages will be Arabic, French, Turkish, English, German, and Italian.

  T2.1 SMT core technology. Investigated issues will be: (i) new linguistically motivated re-ordering models; (ii) use of context in document translation to improve translation coherence; (iii) automatic acquisition of bilingual data from comparable corpora; (iv) pivot-language based machine translation; (v) self-tuning machine translation; (vi) user-adaptive machine translation (i.e learning from user corrections); (vii) integration of MT into CAT tools; (viii) integration of translation memories into MT.

  T2.2 Sign language translation. This topic aims at developing a system for translating Italian texts into the Italian Sign Language (LIS). FBK is involved in the first step of the translation process, i.e. the generation of a written form of the LIS, which will be animated through an virtual actor in the second step. we will investigate the following issues: (i) lexical and syntactic simplification of text; (ii) shrinking of a dictionary without loss of expressiveness by means of synonymy; (iii) automatic choice/creation of paraphrases and synonyms within the reduced dictionary.

T2.3 Cross-Lingual Textual Entailment (CLTE). CLTE represents a novel research direction, bridging the Machine Translation and Content Processing areas. The technology developed in the monolingual Textual Entailment scenario will be complemented by resources and techniques typically used in MT, to address the following tasks: i) the use of translation tables to support inference across languages, ii) the use of MT evaluation metrics as features for Textual Entailment, iii) the use of word alignment techniques to improve the performance of existing algorithms on cross-lingual data sets.

– *A3. Content processing*

This activity covers research in the areas of question answering, content acquisition and content integration from textual documents. The developed techniques will be applied in concrete use cases provided by the users involved in the various projects.

T3.1 Question Answering (QA) research will focus on: (i) the consolidation of the QALL-ME platform for entailment-based QA over structured data, and (ii) the scalability of the QALL-ME approach, to be tested over the Wikipedia "info-boxes". Part of this activity will be conducted in collaboration with the University of Bolzano.

T3.2 Textual Entailment (TE) will consolidate the EDITS open source platform. We will focus on the development of specialized entailment engines, particularly for managing contradictions, and on the automatic acquisition of textual entailment patterns for several applications, including the cross-language scenario of the Cosyne project.

T3.3 Knowledge Acquisition (KA) is useful in various knowledge management scenarios and has direct application in concrete use cases. While the HLT group has been developing KA technologies since several years, investigated issues for the next year include: large scale disambiguation over Wikipedia pages (the "Wiki Machine" project); the automatic extraction of temporal relations between events (to be exploited in the LiveMemories and Terence project); the extraction of terminology as support to ontology learning, and the extraction of relations based on Italian FrameNet, relevant for the Pescado project.

T3.4 Content Integration deals with the integration of knowledge extracted from different sources, mainly textual sources and background ontologies, in order to improve the quality of the knowledge extraction process. The activity in 2011 will focus on: (i) consolidating the cross document co-reference approach based on dynamic clustering with its integration within the LiveMemories scenario; (ii) the application of information extraction techniques to the medical domain (relevant for the E-Onco project); (iii) the integration of statistical and logical approaches to the task of event recognition, with specific focus on Markov Logics, in the context of the Copilosk project. (iv) developing the LiveMemories Knowledge Store, a large-scale repository of public knowledge for the Trentino province.

T3.5 Sentiment analysis (SA) focuses on automatic detection of emotions in written and spoken language, a research area, which is becoming increa-

singly important in computational linguistics. Relevant applications include text categorization according to affective relevance, opinion exploration for market analysis, affective computing and natural language interfaces for e-learning environments or educational/edutainment games. Specific research will becarried on fine-grained emotion annotation (for the Firb project) and opinion mining on large news archives (for the LiveMemories project).

T3.6 Language resources as support for language rehabilitation. This activity is carried out in collaboration with the CIMEC department at the Cognitive Science Faculty, and is focused on the extension and adaptation of existing linguistic resources that may be exploited in the context of therapies for people affected by linguistic deficits.

– *A4. Infrastrucure*

This activity provides technological support and high-level services in order to optimize the activities of the HLT Research Unit. Providing a shared and efficient environment, specific for the HLT issues, ranges from the management of special hardware equipments and software tools, up to the creation and management of linguistic resources.

T4.1 Technological infrastructure. This item covers all activities related to hardware and software issues. It includes the management of the cluster of high performance machines, the installation and management of specific (e.g. linguistic) software tools and packages, the storage and retrieval of huge data (e.g. acoustic data) as well as the definition of their format and documentation, the support for inter-process communication of research prototypes, as well as the infrastructure to support Web-based or interactive demonstration systems.

T4.2. Language Resources. Starting from the creation of an HLT repository of linguistic resources and a related website, the task addresses three main activities, namely (i) development and maintenance of written, spoken, and multilingual resources, (ii) systematic use of crowd-sourcing services (CrowdFlower) for internal data annotation and evaluation of language technologies, e.g. MT and TE, (iii) networking and dissemination. The first activity includes design and data collection, definition of annotation schemes, automatic annotation, creation of training data and gold standards, maintenance and management. Crowd-sourcing activities also include the design of evaluation tasks, filtering techniques for noisy responses, statistical analysis of results, cost-benefit analysis and optimization. The networking activity mainly focuses on maintaining relationships with other institutions, distributing resources, disseminating results, organising events and evaluation campaigns.

2.4. Collaborations

Major internal collaborations will be with the following FBK Units:

– DKM, for research on knowledge integration (LiveMemories project) and statistical logical models (Copilosk project).

- E-Health, for research on information extraction from text in the medical domain (E-Onco project).
- Web of Data, under the “call for idea” joint initiative on Linking unstructured sources (documents) with linked data on the Web.
- Translated Srl: collaboration on Machine Translation for CAT applications.

Major collaborations within the territory will be with:

- U. of Trento (M. Poesio, G. Riccardi), Master school in HLTI and ICT doctorate school;
- U. of Bolzano (R. Bernardi), Master in LCT;
- CIMEC (M. Poesio), joint research on language and cognition, and CIMEC PhD;
- CELCT, for the organization of evaluation campaigns;
- PerVoice (A. Tescari), technological transfer of HLT’s ASR technology;
- CLS (Giampaolo Mazzini), technological transfer in the area of multilingual digital libraries.

At the international level, the HLT foresees collaborations in 2011 with:

- NICT Japan and CMU USA for co-organizing the IWSLT workshop;
- U. Edinburgh, for the co-development of open source software;
- U. Bar Ilan, for joint research on textual entailment;
- NIST USA, for the organization of evaluations on text analysis.
- U. Sheffield, for information extraction.

2.5. Specific Needs and Points of Attention

The HLT research unit has recently relocate to its new office spaces inside the same building. Some extra financial effort is still expected in order to set up an appealing demonstration corner, made of two PCs equipped with large flat screens and two iPhones, and in general to refurbish offices and the common meeting room.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
ASR: Multilingual transcription	R	E	Dec.	More languages; improved performance on existing languages; language detection.	None
ASR: stream-based model adaptation	I	E	Dec.	Improved performance.	None
ASR: porting ASR to iPhone	I	E	Sept.	System test.	Availability of master student.

MT: Arabic-Italian translation	R	E	Sept.	Improved system exploiting results on pivot languages and comparable corpora.	None
MT: Italian sign language translation	R	E	Dec.	Improved translation relying on syntactic parsing.	Availability of data from partners. Availability of master student.
MT: re-ordering methods and context-based translation	R	E	Dec.	Improved translation performance and cohesion.	None.
MT: portable system	I	I	June	Translation of traveling expressions.	Availability of master student.
MT: Cross-lingual TE	R	E	March	Integration of a CLTE component into a distributed infrastructure for multi-lingual content synchronization.	None.
CP: Consolidation of the Wiki Machine	I	E	June	Feasibility study for market transfer and new services for linking linked data.	
CP: Knowledge Store	R	E	Nov.	Final version of the Knowledge Store with coverege on Trentino media.	
CP: Component-based TE	R	E	Sept.	Extension of EDITS core algorithms to manage phrase-based transformations.	
CP: Sentiment Analysis	R	I	Sept.	E-learning affective environment, opinion mining Live Memory data	
IS: HLT demonstration platform	I	I	Sept.	News Monitor and Live-Memories final demonstrator.	

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

According to our plans, future tenure-tracks will be mainly in the machine translation and speech recognition areas, however no requests for activation are foreseen in 2011. During 2010, five positions have been released: one temporary researcher, three postdocs, and one project assistant. The plan for replacement with two post-doc temporary positions (three years) has been partially accomplished: at the end of 2010 only one post-doc has been added. However, we foresee that additional post-docs will be activated in 2011 only against new external funding to be acquired.

The number of foreseen PhD students will significantly increase 2011 to balance and support R&D carried out by the permanent staff. We expect to open 7 new positions that compensate for the reduction in personnel and to fulfill the investment planned by FBK-CIT in this direction. For the new PhD students we plan some pre-phd internships to take advantage of the pre-enrollment facility offered by the University. As usual we plan to open positions for Summer internships that will reimburse travel, living, and lodging expenses of foreign students.

5. Risks and Mitigation Plans

During the lifetime of our research unit we have identified risks along the following dimensions:

- Research: i.e. the typical risks intrinsic of challenging activities, that may impact on foreseen research results, publications, and performance and utility of the developed technology.
- Resources: i.e. risks related to the availability and engagement of human resources, infrastructure resources, including computing and language resources.
- Funding: i.e. risks related to local and international competition for research funding

All the above risks may and should be mitigated through wise and well conducted management, by making senior members of the unit aware of such risks, by directing research towards worthy and exciting challenges, by favoring motivation through reward models of excellence and participation, by maintaining a pleasant working environment, by caring about established international relationships with top players in the research community also in terms of potential partnership in proposals.

MPBA – PREDICTIVE MODELS FOR BIOMEDICINE AND ENVIRONMENT

Unit Name	MPBA – Predictive Models for Biomedicine and Environment	
Type	Research	
Head	Cesare Furlanello	
Staff	2010	2011
	3 Researchers	3 Researchers
	16 Technologists*	8 Technologists**
	7 Post Doc	9 Post Doc
	4 PhD	5 PhD

Document Status: submitted 2010-11-30

* 4 data specialists

** 1 data specialist

1. Executive Summary

The scientific challenge of the MPBA research unit is creating computational tools to model the newest high-throughput data in human and environmental health together. The larger picture is the emerging need for predictive analysis on the unprecedented "data waves" that molecular biomedicine, epidemics and environmental data are offering to interdisciplinary research, separately and then in integration. Included in this challenge is the issue of scientific reproducibility on high-throughput data; although it is virtually easier to share data and methods between centers, assessing the sources of variability has then become increasingly harder. In summary, computational pipelines must be developed that upscale Statistical Machine Learning methods in Bioinformatics and Epidemic Models and deal with challenging data amount and reproducibility issues.

In 2011, MPBA aims at becoming an international reference centre for predictive methods on Next-Generation Sequencing (NGS) data in interdisciplinary collaboration with centers of excellence in Omics biomedicine. The effort will require the development of high performance scientific computing solutions that seek complex patterns within millions of variables or of cases and support reproducibility in all steps of analysis. The main technical investments will regard a new version of the open source machine learning library MLPY and an expansion of FBK cluster computing resources, essential with NGS data. Besides studying mathematical stability in reconstruction of biological networks, new algorithms for assessing variability of proteomics, microarray and NGS profiling will be investigated. Research will be developed within the new SEQC initiative, led by the US FDA as the MAQC-II study on variability in identifying clinical biomarkers, with critical implications in pharmaco-genomics. Furthermore, in 2011 MPBA will join as bioinformatics collaborator the FANTOM5 international consortium coordinated by the Japanese Omics RIKEN Center (Yokohama) and aimed to understand the control mechanisms dealing with functional variability of cells and difference of genetic

networks between human individuals. The participation to these two prestigious international projects will be supported by the creation of an interdisciplinary laboratory with CiBIO (UniTN) and the BioSint Unit of FBK-CMM, investing in two new PhD and a tenure track post-doc positions. MPBA will support as bioinformatics node the foundation of a national research network dedicated to applications to health of NGS platforms. Collaborative projects in clinical applications in oncogenomics and neurogenomics for 2011 will include the Hiperdart FP7 project for cancer biomarkers with ICO Barcelona, a study of miRNA signatures of depression with Fatebenefratelli Brescia, the TRADENT Caritro project on Neural tumors with CiBio, and a new collaboration with S. Raffaele on nucleosome structures. Explorative initiatives with UniTN will include metagenomics, phenotype models from genotype in Autism (Cognitive Science and Neuropathology Lab) and applications in NGS and metabolomics with the E. Mach Foundation.

The activity in Epidemic Models will consolidate collaboration with the Imperial College and UniTN, with a retrospective analysis of the A(H1N1) pandemic in Europe to clarify the role of school closure, demographic differences and human mobility in the spread of the epidemic (FP7 FLUMODCONT). Mathematical models for infectious diseases transmission will be carried out with Indiana University and ISI Foundation (FP7 EPIWORK project). MPBA models will be set for the national Health Institute (ISS) for prompt response to epidemic outbreaks, with real-time modeling of epidemics and the evaluation of possible control measures, within projects for the Italian centre for prevention and disease control (CCM) and the Ministry of Health. With UniPisa and Bocconi University, a project funded by the European Center for Disease Prevention and Control (ECDC) will study vaccination programs for childhood diseases, with focus on the Varicella Zoster virus. We also plan to study the long-term effects of demographic changes on the spread of infectious diseases. In collaboration with the University of Michigan Medical School individual-based models of tuberculosis will be developed to optimize health measures based on contact tracing. The effects of spontaneous behavioral changes on the spread of epidemics will be studied in collaboration with the Center for Nonlinear Studies at Los Alamos National Laboratory (LANL).

An open source geoinformatics platform (ENVIRO) will be completed for reproducible studies on the impact of climate change scenarios with crop epidemic and genomic in Trentino, for the “Major Project” ENVIROCHANGE with ETH Zurich and FEM. Further climate change studies will be developed with the UN agencies FAO and UNEP. Geoinformatics technologies will also be developed in projects with strong ethical impact of mapping indicators (traffic accidents, accessibility quantitative criminology, cancer) and in the Economic Territorial Interface (IET), a platform developed for providing socio-economic indicators.

Finally, the Unit will confirm a strong commitment in scientific dissemination to young people by organizing a scientific computing initiative in Bolzano and the 11th WebValley FBK summer school.

2. Vision and Scientific Program

2.1. Context and State of the Art

As shown by the results of the MAQC-II project (Li et al, Nat Bio 2010), the progress of science on biological high-throughput data is based on complex analysis paths. Such complexity implies a need for understanding and controlling all causes of variability that may affect one or more steps along the path. Guidelines and quality control algorithms establish the first element for a safe ground for comparing experiments, obtain same results from available digital versions of the data (repeatability) or apply the same methods to similar data with concordant results (replicability). It is now acknowledged, but still not firmly defined, that with NGS data science has hit a critical barrier due to the computational costs in terms of resources and expertise. The role of bioinformatics analysis, including access to HPC, is today as critical as producing the data and reproducibility is at risk of becoming a puzzle. According to Dudley and Butte (Nat Bio 2010), reproducibility of scientific findings in the era of cloud computing requires care to all aspects, including keeping total snapshots of computer systems so that one specific configuration of operating system, libraries and software modules is kept frozen for reviewers and users of scientific production. It is however inevitable that the promise of projects such as the International Cancer Genome Consortium (2010) is exactly integration of reproducible experiments on the best imaginable data. However, recent analysis of high-throughput molecular data, including NGS, has shown a pervasive presence of batch effects (Irizarry, Nat Rev Gen 2010), confirming the forensic bioinformatics concerns first expressed by Baggerly and Coombes (Annals Appl Stat 2009) and the *Scientists for Reproducibility* initiative.

The issue of reproducibility is indeed a pervasive issue in modern science: Climate Change research is experiencing an unjustified deficit of trust from citizens and decision makers just because concerns on methodology. The impact on Earth future of this lack of trust is not yet imaginable, and efforts are being made to repair the vulnus. Our own experience in the MAQC-II initiative and in the retrospective study on repeatability of microarrays studies in Nature Genetics (Ioannidis, Nat Gen 2009) has led us to the hypothesis that the same approach is needed in all scientific enterprises: in the ENVIRO tool each model of plant-pathogen systems is described as a workflow that can be easily rerun. Similarly, we are proposing to implement the same approach within the IET platform, so that analyses for landscape planning may be always be fully repeatable. Of course the choice of specific indicators, or of thresholds may orient a decision, but it is of paramount importance that anybody can be enabled to replicate.

This scenario gives an opportunity to FBK: the huge relative increase in throughput and decrease in costs offered in the last 4 months for the new –omics data produced with NGS platforms indicates that many platforms will be acquired, while still very few centers are actively integrating bioinformatics pipelines with machine learning (e.g. Raetsch Lab, MPI Tuebingen). Moreover, the integration of genomics and health data on a spatial scale is still underveloped, although environmental and socio-economic ‘sensors’ are potentially available as rich data flows from public databases.

The boundary between epidemiology and high-throughput genomics has also been breached for evaluating vaccination programs using genetic sequence data (Halloran and Holmes Am. J. Epidemiol. 2009). Mathematical and computational models are for themselves a relevant scientific and societal investment. They can be employed for simulating plausible scenarios of epidemic spread and for evaluating the effectiveness of containment and mitigation policies. They represent the scientific basis to give insight to public health policy makers to take their decisions on the intervention strategies that should be performed. Oversimplified model have however failed to correctly predict the outcome of the 2009 A(H1N1) pandemic in terms of both timing and impact; they could also behave poorly in predicting the long-term effects of endemic diseases as they do not incorporate relevant information on several sources of heterogeneity (e.g. different demographic structures, travel patterns, rational exemption to non-compulsory vaccination, spontaneous behavioral changes, host-genetic susceptibility) that can remarkably affect the spread of an epidemic. In this context, Individual-Based simulation Models (IBM) have become one of the most relevant approaches as they allow for a very detailed description of the population and they are particularly suitable to evaluate the effectiveness of (individually-targeted) public health control measures.

2.2. Vision and Goals

We aim to develop predictive models for an individualized health profile, based on highest resolution molecular data that can definitely reveal the individual variability and include the complex – and still unexplored – results of regulatory mechanisms. The models should also incorporate the environmental effects, and in the case of infectious disease they should progressively include the complexity of relationships between the disease mechanisms, the hosts and their variability. Replicability of all scientific analytic steps implementing this research program should be ensured.

The technical development of computational solutions that integrate and model together molecular data, epidemiological models and environmental factors is thus the critical medium term goal. Key steps to achieve this result will be (i) the integration of the information (both genomics and clinical) coming from different experiments and scales and (ii) the development of new algorithms for predictive modeling (classification or regression endowed with feature ranking and selection methods). These algorithms should aim at extracting ‘integrative patterns’ from different biological levels at the same time, possibly all at the whole-genome scale. The expected scenario is that machine learning algorithms shall be upscaled to deal with millions of static variables and millions of time series. The pivotal resource for the extraction of such integrative profiles is (iii) the development of state of art expertise in HPC. A further challenge will be (iv) the development of mathematical methods for networks, based on a combination of algebra and statistics. As stated in Sec 2.1, the previous steps will require (v) a direct action for replicability, such as the automated use of Data Analysis Plans (DAPs) up to adoption of system snapshots.

The rapid evolution of NGS technologies and their use on larger datasets of clinical interest (e.g. thousands of complete individual genomes available in 2010) will require analysis and modeling issues mirroring the early development of microarray technology and addressing new ones (e.g. processes allowing to sequence paraffine embed-

ded sample from biobanks). Certainly, data management and algorithmic issues will pose notable challenges, starting with Quality Control mechanisms. Applications will include transcriptome analysis (e.g. noncoding RNA, miRNA and polymorphisms detection, digital gene expression profiling), novel gene discovery (both for human and plant genomics). The gradual replacement of previous -omics platforms with NGS approaches is also expected. To guarantee utility of the data by capturing meta-data and ensuring replicability of the modeling process technologies will be adopted that will define and allow to share computational pipelines. Initiatives from the MGED society for NGS data (MINSEQE), the FDA SEQC consortium, and the NIST coordination will be certainly of great importance along this path.

In terms of complexity, it is still poorly known to what extent human behavior and its dynamics can affect the spread of an epidemic in a complex modern society as the one we live in today. We aim to give insight into this crucial question, by analyzing the effects of mobility patterns, population heterogeneity, individual behavior, demographic changes, immigration processes, vaccination choices on disease dynamics.

This research plan is highly ambitious in terms of data availability. Some simplification can be achieved by focusing first on plant-pathogen functional genomics. We will complete first, in interdisciplinary collaboration, a complete infrastructure for data integration, and definition of models that may depend on stable and varying environmental driving forces as well as on genomic and disease specific knowledge.

2.3. Activities and Work Plan

Activities for the 2011 will be structured in 4 main pillars (FGM, SciComp, EpiMod and Geo); the latter will also include innovation and dissemination actions.

a. *Bioinformatics for Functional Genomic Modeling (FGM)*

   This activity will be 75% overlapping to the activities on the new interdisciplinary Laboratory for Sequence and Structure Analysis LSSAH (FBK-CiBIO collaboration), see 2.5, item 1.

   - NGS-pipelines: consolidation of the NGS analysis framework (RNA-seq, Variant identification, Chip-SEQ, miRNA-SEQ, metagenomics) with implementation on the FBK-Kore cluster. Design and implementation of the bioinformatics services for the LSSAH. Studies on large scale test public data, replication of genome resequencing on public and original data (oncogenomics and neurogenomics). Activity in collaboration.
   - SEQC: Analysis of sources of variability: platform and tissue dependent biases, with focus on transcriptome, study designs and standards, potential pharmacogenomics aspects.
   - FANTOM5: Development of machine learning methods coupled to next-generation sequencing algorithms for the analysis of ultra-high throughput CAGE data, with focus on new algorithms for promoter identification and profiling methods for complex tissue time-dependent expression.
   - FP7 HIPERDART: biomarker identification of original colorectal microarrays from ICO, comparison to profiling on public datasets, analysis of signals from SunS process.

- TRADENT and other neurogenomics studies: translational deregulation in neural tumors, with CiBio; subclass identification of survival in neuroblastoma; molecular bases of Autism. miRNA profiling for neurogenomics and pharmacogenomics for individual treatment in major depression.

b. *Scientific Computing (SciComp): 25% on LSSAH*

- Software: MLPY platform (machine learning and preprocessing solutions, graphical user interfaces);
- Hardware: consolidation of the Linux cluster facility and experiments with HPC on graphical processors (GPGPU) and in mobility (ContextAware).

c. *Epidemic Model (EpiMod):*

- FP7 FLUMODCONT: retrospective analysis of the role of school closure, demographic differences and human mobility in the spread of A(H1N1) epidemic in Europe;
- FP7 EPIWORK: effects of mobility patterns and population heterogeneity on epidemic spread;
- RTMOD: setup and management of an emergency room situations and the setup of a network of information for the prompt response to epidemic outbreaks.
- CHICKISS: models of host-vector infectious diseases, with application to Chikungunya virus.
- CCM: real time models for the spread of influenza pandemic in Italy.
- VZV: analysis of childhood diseases and implications of specific vaccination programmes with specific focus on Varicella Zoster Virus.
- Exploratory actions: effects of demographic changes on the long-term dynamics of endemic diseases; individual-based models of tuberculosis to optimize health measures based on contact tracing; effects of spontaneous behavioral changes in response to lethal epidemics.

d. *Geoinformatics (Geo):*

- ENVIROCHANGE: Set up of the ENVIRO platform, with geographical web services and support to scientific reproducibility: for the study of vulnerability to climate change of the agricultural environment in Trentino. Development of automatic forest inventory and global habitat mapping subject to climate change scenarios. High throughput time series clustering for bioclimatic indexes.
- IET: interactive interfaces for on-line data analysis, interconnection of geographical and statistical data by web services;
- ENERBUILD: automatic methods for solar budget (PV estimates) on high resolution DTM, in combination with airborne stereo photogrammetry for 3D building structure extraction.
- RiskMapping: WebGIS infrastructures and statistical services for predictive risk modeling of traffic accidents (MITRIS), cancer epidemiology (CancerAtlas), victimization analysis (eSecurity).

- Dissemination: web services and interfaces for mobility (ContextAware); implementation of the mobile scientific computing project for high school students (with EURAC); Organization of the WebValley 2011 SummerCamp.

2.4. Collaborations

- Internal Collaborations: Security & Trust, A. Armando; Biofunctional Surfaces and Interfaces C, Pederzolli, 3DOM F. Remondino.
- University of Trento - A. Quattrone (CiBio): LSSAH laboratory. Projects: TRADENT Caritro project and Neuroblastoma research. O. Jousson: metagenomics. Y. Bozzi (CNR-CIBIO) & P. Venuti (Cognitive Science): molecular bases of autism.
- Fondazione Mach - (Genomics and Crop Biology) R. Velasco: coordinated action for NGS (RNA-seq and SNP identification) on grape, apple, and berry genomes. I. Pertot ENVIROCHANGE project. F. Mattivi (Quality and Nutrition): methods for mass-spectrometry in metabolomics, preprocessing, interfaces and DAPs for reproducible analysis.
- Centro San Giovanni di Dio – Fatebenefratelli Brescia, Genetic Unit, M. Gennarelli, L. Bocchio: “The regulation of neuroplasticity in the response to therapeutic drugs for mood disorders. The role of micro RNAs”, Brescia (Ministry of Health project).
- U.S. Food and Drug Administration (FDA), NCTR, L. Shi and Office of Translational Science, F. Goodsaid: MAQC-III / SEQC, The Sequencing Quality Control Project.
- Omics Science Center, RIKEN Yokohama Institute, P. Carninci and C. Daub: FANTOM5
- Catalan Institute of Oncology, ICO Barcelona, V. Moreno: HIPERDART FP7 project, identification of novel biomarkers of colorectal cancer.
- Microsoft Research – CosBI, A. Csikasz-Nagy: methods and bioinformatics tools for network analysis
- The Wistar Institute, Philadelphia, Genomics Core, L. Showe: bioinformatics pipelines for NGS.
- Computational Biology and Informatics Laboratory, UPenn and MGED Society, C. Stoeckert: development of international guidelines for data sharing in functional genomics and in NGS data in particular (special working group led by M. Salit, NIST).
- University of Trento, A. Pugliese, FP7 FLUMODCONT: retrospective analysis of the role of school closure, demographic differences and human mobility in the spread of A(H1N1) epidemic in Europe;
- Imperial College MRC Centre for Outbreak Analysis and Modelling, N. Ferguson, FP7 FLUMODCONT: retrospective analysis of the role of school closure, demographic differences and human mobility in the spread of A(H1N1) epidemic in Europe;

- ISI Foundation (Turin), V. Colizza, FP7 EPIWORK: Effects of mobility patterns and of population heterogeneity on the spread of an epidemic.
- Indiana University, A. Vespignani: modeling the spatiotemporal disease dynamics.
- University of Pisa, P. Manfredi, VZV: analysis of childhood diseases and implications of specific vaccination programmes with focus on *Varicella Zoster* virus. Effects of immigration processes and vaccination choices on the long-term dynamics of endemic diseases. Bocconi University (Milan), A. Melegaro: Effects of demographic changes on the long-term dynamics of endemic diseases
- Istituto Superiore di Sanità (ISS), C. Rizzo, CCM: real time models for the spread of influenza pandemic in Italy; CHIKISS: Chikungunya virus models; RTMOD: setup and management of an emergency room situations and the setup of a network of information for the prompt response to epidemic outbreaks.
- Center for Nonlinear Studies at Los Alamos National Laboratory, S. del Valle: effects of spontaneous behavioral changes on the spread of epidemics.
- University of Michigan Medical School, D. Kirshner: development of individual-based models of tuberculosis to optimize health measures based on contact tracing.

2.5. Specific Needs and Points of Attention

1. Development of strategic actions with UniTN and FEM are crucial to implement a partnership in research, lab resource sharing, and participation to projects as a unique Trento research node. The following three initiative are proposed:
   i. A joint lab ('LSSAH') with CiBio for Next Generation Sequencing studies and integrative bioinformatics, with a traslational focus on molecular oncology and neurogenomics, and applications in pharmacogenomics: MPBA will provide approximately 1.25 senior researcher py, 3 PhD students, 1 post-doc fellow, 2 technologists (scientific programmers), access to FBK-MPBA computing resources.
   ii. A structured initiative with FEM on high-throughput data analysis for plant genomics, metagenomics and metabolomics
   iii. A Joint Excellence Initiative ('EpiCore') with UniTN (Research Group in Population Equations) and FEM (EFB/EFP) for research on the mathematical, computational and biological bases of infectious diseases.
2. Limited institutional resources are available for international collaborations planned in 2011 (FDA initiatives, RIKEN FANTOM5 project) with respect to self-funded but focused projects. Need for explicit internal support actions.
3. Need for further investment program in HPC resources, which efficiently supported high impact factor papers in 2010: computing nodes with higher RAM availability are needed for the bioinformatics and epidemics models (128GB). Storage space for NGS data may need extension in 2011.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Retrospective analysis of A(H1N1) pandemic in Europe	R	E	March	Academic paper	
Methods for scientific replicability in high throughput omics	R	E	March	Open source released sw and Academic paper	Availability of validation data
NGS study on large scale test on public data, RNA-seq, Variant identification	R	E	April	SEQC result Academic paper	Availability of HPC storage and computing resources
WebValley 2011	I	E	June/July	Summer School	Funding
Machine Learning methods for network reconstruction	R	E	June	Open source released sw and Academic paper	Availability of GP-GPU resources
Behavioral changes during the A(H1N1) pandemic in Italy	R	E	Sep	Academic paper	
Individual based model of tuberculosis	R	E	Oct	Academic paper	Dataset availability
ENVIROCHANGE: workflow-based environment for reproducible analysis of climate change	I/R	E	Dec	ENVIRO Software beta version + Report or Academic Paper	Availability of climate change scenarios and of model database within the project

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

All current MPBA members are affiliated to FBK as employees, and only 3 senior Researchers (the coordinator R1 and two R2 researchers) have permanent positions. For 2011, the core research structure in the Unit will be based on 9 postdoc/R3 level fellows. Three of them joined from ETHZ and Dublin University College in 2009 and were enlisted within the 'rientro dei cervelli' national initiative; other four will be UniTN PhD graduates from biomathematics or from the ICT Bioinformatics track.

The technical personnel includes one part-time senior data coordinator, formerly a deputy of the Statistical Service; other 3 additional data specialists contributed to activities completed in 2010. Technical resources will be developed by 7 scientific programmers, but for a total of 4 py. Most of them have part-time contracts and were brilliant students at WebValley, now in the unit with a research internship, giving notable technical contribution. The ContextAware project (legge 6 PAT) has extended

its operation to June 2010 supporting part of the technical personnel. However, in case of acquisition of additional projects in geospatial technologies, available technical resources may result underestimated.

A strong contribute to research in 2011 will rely on 5 PhD fellows, all at Trento university. The number of PhD students is thus increased with two new fellowships awarded at the international CiBIO PhD program, one of which sponsored by the TRADENT project. For all the PhD students and several of the scientific programmers an external stage period is planned, possibly abroad, replicating the strongly positive training experience at the Wistar Institute and Kimmel Cancer centre in Philadelphia recently completed. The international collaboration with RIKEN is expected to provide further stage opportunities

Given the impact of externally funded projects, a strong synchronization of activities has been required in 2010: with most of postdoc fellows acting as deputy coordinator of a research project, with one senior researcher tutoring on management of resources and scientific progress. This approach will be replicated in 2011, with special coordination assigned for data related tasks, undergraduate student mentoring, and for the development of the bioinformatics and geoinformatics platforms.

In 2011, two tenure track slots will be assigned at postdoc level. Two additional tenure-track or permanent position for a postdoc or a technologist (scientific programmer) will be requested.

Finally, the unit will host students and foreign researchers with own funds.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
HiperDART: lack of discriminative probes on gene expression for colorectal cancer outcome in the new original ICO data	M/H	S	Consider also the methylation (epigenetic) arrays.
NGS-Pipeline for SEQC and FANTOM5 initiatives: a. inadequate HPC resources for implementation of workflows may introduce bias effects b. Saturation of storage space from the LSSAH facility (may block processing)	L	C	a. Obtain privileged access to memory/computing power within the FBK Kore cluster. (external computing facility is problematic due to huge dataset size) b. Anticipate event.
Collaboration on external of NGS or Deep Sequencing requiring extensive use of computational resources from FBK Kore cluster beyond the MPBA quota	M	C	Evaluate case by case impact of collaboration well in advance. In case of unavoidable collision, collaboration should provide additional computing resources
Time series analysis for ENVIROCHANGE: inability of completing experiments with existing GPGPU resource (still in experimental use)	L	M	Base computation on conventional resources in the FBK Kore cluster. Invest additional resources in GPGPU.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

6. Ethical Issues

The application research of the MPBA Unit is strongly focused on the processing of genomic and epidemiological data and of its association with environmental and socio-economic variables. We acknowledge that genomic data and phenotypic data will be needed that may include a potential issue for personal identification. However:

- The Unit will not directly collect and be responsible for data acquisition, but definite agreements with data providers will be produced (e.g. investigator requests for access to data). In all cases, the personal ID will be removed and only anonymous coding systems employed.
- In all cases deemed relevant for potential of personal identification, an IRB or an IRB exemption will be requested to a certified Ethical Committee. The confidentiality of the personally identifiable information will be maintained throughout the research and thereafter. The Ethical Committee of Trento University will be most likely involved for all research projects including other teams from UniTN as collaborating units.

TeV – Technologies of Vision

Unit Name	TeV – Technologies of Vision	
Type	Applicative, Research	
Head	Stefano Messelodi	
Staff	2010	2011
	6 Researchers	6 Researchers
	3 Technologists	3 Technologists
	2 Post Doc	1 Post Doc
	1 PhD	2 PhD

Document Status: submitted 2010-11-30

1. Executive Summary

The TeV research unit is conducting research in the field of computer vision and image analysis, with particular focus on the i) understanding of dynamic scenes populated by various kinds of moving entities (people/vehicles) and the ii) semantic annotation of images and videos aimed at the automated indexing of visual and multimedia material and subsequent integration of pieces of information coming from different sources. Specific emphasis is placed on an investment into methodological approaches that potentially abstract from the specific modality and tasks they operate on, such that acquired competences and research output may be shared with other units.

Based on the results of the research activities, the TeV unit aims to develop new technologies and prototypes that promote innovation in society by stimulating technology-transfer to existing companies and/or the creation of new ones.

Specific goals for 2011 are focused in three directions: i) focus research along the strategic lines devised by the Information Technologies Centre, i.e. the Joint Research Projects (JRPs) in the areas of Future Internet (FI) and Embedded Intelligence and Systems (EMIS); ii) strengthen the self- funding capability of the unit by applying for new grants (both EU and industrial projects); iii) contribute to the impact on the local territory by supporting the creation of a new start-up company with the main role of exploiting well consolidated results from our recent research.

Concerning TeV personnel in 2011, in order to strengthen the research potential of the group, two PhD students will join the group at the beginning of/or in the course of the year.

In the context of European projects, TeV is actively collaborating with ATOS Origin (Multi- national), the Athens Information Technology (Greece), the BBC (UK) and Queen Mary and Westfield College (UK); other external collaborations include the University of Modena, the University of Trento and the ST Microelectronics company. TeV is also actively collaborating internally with other FBK research units in

joint research projects and the ACUBE and APSAT projects. A further goal for 2011 is the activation of a close collaboration with Sebe's research group at DISI, University of Trento. This unit is involved in projects aimed at pushing technological progress for improving the quality of life for the elderly and disabled, with associated ethical issues (explicitly mentioned in the respective section of this document).

2. Vision and Scientific Program

2.1. Context and State of the Art

In recent years research activities have been focused in two main areas:

- Dynamic scene understanding (DSU): understanding of dynamic scenes populated by people/vehicles as a basic tool for the implementation of surveillance systems and human/machine interaction systems;
- Semantic image labelling (SIL): providing a semantic annotation of visual material focused on the development of systems for retrieval/browsing of large archives and for environmental monitoring.

Research in the former area has led to important scientific results in the past in the area of people tracking, and in which recent theoretical advancements have been published ([2], [3], [4], [5], [6]). Moreover, the underlying core technology is EU and US patent pending ([7], [8]) and, according to Examiner reports received recently, are permissible for protection. A live demonstrator of the tracking technology is constantly available and continuously updated through the integration of novel results produced by the research. Furthermore, the tracking technology has been tested in real environments, for example in booths at exhibits, real apartments and in the FBK foyer, providing important cues about critical issues that need to be addressed in the future.

Since 2008, we decided to investigate a novel approach to scene understanding, capable of supporting a perceptive adaptation to environmental conditions and to events taking place in the observed scene. This activity brought about PUMALAB, a Joint Research Project in the EMIS strategic line of the centre, coordinated by a researcher belonging to our unit.

Currently the research into dynamic scene understanding is carried out within the PUMALAB project and ACUBE, a project partially funded by PAT, where people tracking technologies are applied in a care-home environment.

The research activities in the second area have been partially carried out within local and European projects and have produced various scientific publications ([9], [10], [11], [12]), and the creation of a demonstrator showing our object recognition technology. Recently, we decided to focus our research on image annotation by exploiting contextual information coming from the image itself and/or from external sources like contextual and common sense knowledge. This choice motivated our active involvement in COPIOSK, a Joint Research Project in the FI strategic line of FBK.

In this research area we have launched an investigation in the context of the automatic annotation of panoramic images. This activity is naturally embedded inside

the FI strategic program and has led to the creation of the MARMOTA technology ([13], [14], [15]).

[1] A. Waibel, R. Stiefelhagen, R. Carlson, J. Casas, J. Kleindienst, L. Lamel, O. Lanz, D. Mostefa, M. Omologo, F. Pianesi, L. Polymenakos, G. Potamianos, J. Soldatos, G. Sutschet, J. Terken: “Computers in the Human Interaction Loop”. Chapter in Book, Handbook of Ambient Intelligence and Smart Environments, H. Nakashima, J. Augusto, and H. Aghajan Eds., Springer, 2010 ISBN: 978-0-387-93807-3

[2] E. Ricci, F. Tobia, G. Zen: “Learning Pedestrian Trajectories with Kernels”. International Conference on Pattern Recognition - ICPR 2010, Istanbul, Turkey, August 23-26, 2010

[3] G. Zen, O. Lanz, S. Messelodi, E. Ricci: “Tracking multiple people with illumination maps”. International Conference on Pattern Recognition - ICPR 2010, Istanbul, Turkey, August 23-26, 2010

[4] Brutti, O. Lanz: “A joint particle filter to track the position and head orientation of people using audio visual cues”. European Signal Processing Conference - EUSIPCO 2010, Aalborg, Denmark, August 23-27, 2010

[5] M. Poesio, M. Baroni, O. Lanz, A. Lenci, A. Potamianos, H. Schuetze, S. Schulte im Walde, L. Surian: “BabyExp: Constructing a huge multimodal resource to acquire commonsense knowledge like children do”. International Conference on Language Resources and Evaluation - LREC 2010, Valletta, Malta, May 17-23, 2010

[6] G. Zen, B. Lepri, E. Ricci, O. Lanz: “Space speaks – Towards socially and personality aware visual surveillance”. International Workshop on Multimodal Pervasive Video Analysis - MPVA 2010, Satellite workshop of ACMMM 2010, Firenze, Italy, October 29, 2010

[7] O. Lanz (EU 06116896.9 - pending; US 11/773483 - pending) - Method and apparatus for tracking a number of objects or object parts in image sequences [2006][2007]

[8] O. Lanz, S. Messelodi (EU 09425338.2 – pending; US n.a. – pending) - Method for efficient target detection in images robust to occlusion [2009][2010]

[9] A. Pnevmatikakis, N. Katsarakis, P. Chippendale, C. Andreatta, S. Messelodi, C.M. Modena, F. Tobia, “Tracking for context extraction in athletic events”, International Workshop on Social, Adaptive and Personalized Multimedia Interaction and Access - SAPMIA 2010, Satellite workshop of ACMMM 2010, Firenze, Italy, October 29, 2010

[10] M. Lecca, “An attention module for object detection in cluttered images”, Electronic Letters on Computer Vision and Image Analysis - ECLVIA , Vol. 8, No. 2, pp. 68-83, July 2009

[11] M. Lecca, S. Messelodi, “Computing von Kries illuminant changes by piecewise inversion of cumulative color histograms”, Electronic Letters on Computer Vision and Image Analysis - ECLVIA , Vol. 8, No. 2, pp. 1-17, July 2009

[12] M. Lecca, S. Messelodi, “Illuminant change estimation via minimization of color histogram divergence”, Computational Color Imaging Workshop - CCIW 2009, S. Etienne, France, March 26-27, 2009

[13] P. Chippendale, M. Zanin, C. Andreatta, “Mobile augmented photography”, 7th European Conference on Visual Media Production - CVMP 2010, London, UK, November 17-18, 2010

[14] P. Chippendale, M. Zanin, C. Andreatta, “Collective photography”, 6th European Conference on Visual Media Production - CVMP 2009, London, UK, November 12-13, 2009

[15] P. Chippendale, M. Zanin, C. Andreatta, “Re-photography and environment monitoring using a social sensor network”, 15th International Conference on Image Analysis and Processing – ICIAP 2009, Vietri sul Mare, Italy, September 8-11, 2009, pp. 34-42

2.2. Vision and Goals

In recent years, the unit has contributed to the advancement of the state-of-the-art, both in terms of research output and technology development, in the context of (i) the vision based monitoring of scenes involving people as the main actors of interest (within DSU), and (ii) the extraction of semantic and geo-referenced content from still images with the aid of context (within SIL). These two lines of activities have naturally emerged from the group members’ background, matured competences, and open aptitudes. While these activities have been conducted in parallel, mainly due to the amount of research/technology development effort put into play and financed by independent projects, the underlying technologies were considered orthogonal. Recently it became evident that, from a properly reshaped research perspective, these lines may reveal a significant overlap in terms of adopted methodology. Essential for these indications emerged have been discussions triggered by the unit’s involvement in the two Joint Research Projects PUMALAB and COPILOSK, and they are expected to continue to act as a catalyst in this regard in the near future. Although a significant shift of the unit’s research activities is not currently foreseen, we believe that a retargeting of the unit’s direction along a clear and unified vision may contribute to a more synergic integration, from which both sectors should benefit. This is a major goal for the unit in coming years.

Another need that has recently emerged, is that of stressing a more synergic loop between research output and technology development. TeV is involved in a number of projects targeting the real-world deployment of research prototypes developed over the years in an in-house setup. Given that progress on both research and technological aspects are in our mission, but by nature have often quite differentiated needs in terms of implementation and validation efforts (from proof-of-idea verification up to data collection and assessment in a live environment as an integrated component of a complex real time system), we intend to extend activities and allocate resources in a manner that is transparent whilst consistent with our mission and the competences, size, and attitudes of our group. An important initiative in this regard is the SmarTrack re-engineering project, an activity whose main objective is to support the transfer of [6][7] to a start-up company to be launched by

the unit and which, at the same time, will provide a redesigned implementation of a technology that has grown over the years as a research prototype rather than a product-oriented software. Indications about emerging critical issues for go-live application domains, where TeV technologies exhibit most of their potentials, as well as from projects with a more applicative orientation will reshape specific issues to be targeted by research as well as their priorities in compliance with the overall vision of the group. Whilst progress on research and methodology, including those obtained within the JPR's, but not limited to, once properly established, will be considered for integration in and the re-design of prototypes. This will create a closed, live and pro-active loop between research and technology advancement. This will also guarantee incremental and monitorable progress between them, and to keep up with the state-of-the-art that is essential to be an attractive partner for new funding opportunities.

Another aspect we consider important in the reshaping our long-term vision, is an investment into methodological approaches that can potentially abstract from a specific modality or task they operate on, such that acquired competences and research output may be shared with, or obtained through, a collaboration with other research units in FBK. In this regard, JRP's have proven to be an appropriate instrument for supporting activities that have been fruitful in the past (with SHINE and i3 units, [1]) and to establish new links (most notably with DKM and recently with ES). TeV's intention is to carry out core research from which in will be possible to bootstrap inter-disciplinary projects that are eligible for external funding, possibly within the EIT initiative. In this way, TeV aims to grow and best exploit the Centre's competences in the area of interaction and content and to increase self-funding. Recently, we established a new collaboration with Nicu Sebe's group at DISI, UniTN, which has led to the submission of a FP7 FET Young Explorer proposal with a significant overlap with PUMALAB. The unit is also coordinating a FP7 STREP proposal, namely VENTURI, which is looking at End-to-end Immersive and Interactive Media Technologies. In this venture, the i3 and WoD units have also been brought into the proposal, to both strengthen ties between our groups and also create a richer contribution from FBK as a whole to VENTURI. The unit is also participating in another FP7 STREP proposal, namely CREATURE, that aims at combining both the TV and internet worlds, in an integrated TV-Internet platform that will offer the end-user an enhanced experience, which will be adapted to his/her personal expectations and the viewing context, offering rich experience based on the best media distribution.

2.3. Activities and Work Plan

TeV activities for 2011 are organized into two categories: research and technology transfer.

The first category includes the research activities carried out within several projects and can be classified into two different types: internal strategic projects (PUMALAB and COPILOSK) and externally funded projects (My-e-Director 2012, ACUBE and APSAT). Additionally, unforeseen research activities may arise which inevitably require additional effort, for instance the preparation of proposals to apply for new grants, the revision of manuscripts in favour of journals editorial board or confer-

ence program committees, the tutoring of PhD or master thesis students, the presentation and demonstration of TeV's main results both at international and local level, and the participation in FBK internal initiatives.

In the area of Intelligent Perception, we intend to systematically address a number of issues that are faced in both open and non-collaborative environments. We will study and test theoretically grounded solutions to multi-modal tracking in scenes where the sensing undergoes an unknown distortion whose effect on the data varies in time and space (uneven and/or time-varying illumination in the video signal; reverberation and structured attenuation in the acoustic signal; ambient scattering in the electro-magnetic signature of environment). This encompasses: (i) the online estimation of a (non-)parametric model of the distortion function using people as passive sensors to sample relevant measurements, (ii) an adaptation to changes in the target model/signature by means of (iii) fusion with invariant features and orthogonal modalities (e.g. normalized image contrast, correlation of acoustic signals captured with a distributed microphone network, perturbations induced by people in the electromagnetic signature of an empty room). On top of this, we will look at the problem of resource constrained tracking in large and structured environments from a multi modal perspective by investigating (iv) the impact of focussed, active sensing and (v) the adaptive spatio-temporal fusion of multiple heterogeneous streams (captured by multiple cameras, but also by microphones and other sensors), (vi) to provide logs for a more robust interpretation of peoples' behaviour and (vii) to support cooperative and non-instantaneous target detection and signature acquisition (required to operate reliably in complex scenes with frequent obstructions, e.g. visual occlusions). From an applicative point of view, these activities are expected to have a direct and measurable impact on currently running projects (most notably ACUBE, and BVTECH), whilst at the same time they are expected to strengthen the technological backbone of the SmarTrack spin-off initiative, as they address those issues that have emerged to be critical for the range of application domains that may be covered. Nonetheless, related theoretical results will match the scientific objectives of PUMALAB, namely developing a state estimation framework supporting adaptation which is tailored to the sequential nature of multimodal perceptual input and to the physical world it refers to.

In line with COPILOSK objectives, our unit will, from a research perspective, focus its efforts on the design of a novel hybrid framework capable of accommodating, in a theoretically sound way, both statistical and symbolic reasoning to aid knowledge representation, inference and learning on problems where both dimensions are inherently present. In particular, TeV will play a central role in the implementation of the vision case study, whose main objective is the integration of contextual and common-sense knowledge into the image-based object recognition system and, in general, for the semantic annotation of images and videos. While this was identified early as a steering case study for COPILOSK, we believe that advances along these lines may impact on a broader range of activities in the SIL area. In particular, the VENTURI proposal concerns the realization of a contextually aware mixed-reality system that can not only create new hypermedia objects using smart mobile devices (i.e. next generation smart phones, with a multitude of on-board sensors), but more importantly enable the most natural delivery of information/content (in an

AR-type modality) to the user, according to many factors, such as: user context (running, on a train, working, at home, etc), network conditions (offline, 3G, sparse coverage, etc), local environment (noisy urban, peaceful countryside, etc.), type of data requested (images, text, video, hypermedia, etc), proximity of other users/smart objects, etc.. Although VENTURI has not directly been triggered by COPILOSK, but has rather emerged from independent activities related to MARMOTA technology and the FP7 My-e-Director project, the proposal will rely, among others, on methodologies for the aggregation and joint interpretation of hybrid data that may link, at least partially, to COPILOSK objectives. Furthermore, we will build upon competences and results that where achieved over the past two years along the internal activity related to MARMOTA to focus on (i) improving the outdoor image registration capabilities of MARMOTA in the presence of clutter (textured scenes) and unexpected occlusions (clouds), possibly exploiting results on automated calibration (ACUBE) and registration (APSAT), and, more generally, on (ii) the geo-location estimation of visual content, such as foreground/background, text detection and reading, global classification of man-made/natural scenarios. This technology could thus enhance the capabilities of search engines by understanding more about 3D and geo-referenced content in a scene through the automated extraction of a wealth of new and rich meta-data. New services could then be offered, e.g. to the tourist through the exploration of population dynamics and population interests from User Generated Content shared on sites like Flickr or Panoramio based on geo-reasoning and user rated aesthetic appeal.

The objective of our activities in the APSAT project (in collaboration with the 3DOM unit) is the development of a prototype to take a series of 2D photographs of a scene, using a standard camera, and have them converted into a 3D geometric model, with accompanying diffuse texture and normal map.

In the second category, we will focus on the exploitation of technologies realized by the unit over the years, so as to target FBK's mission to push the innovation of the local industrial network.

1. One such activity in this category is TeV's support in the creation of a company whose objective is the commercialization of new products based on our people tracking technology. TeV will provide a twofold contribution: (i) active participation in the process which aims to define an appropriate business plan for the NewCo, and (ii) support in terms of personnel, on a part-time basis, devoted to the porting of the tracking technology from a research prototype to a commercial product.
2. Analysis of the potential applications and market opportunities for the Augmented Reality system that is an implementation of the Marmota technology on an Android portable platform.
3. Design and implementation of a system for the automatic extraction of statistical data from traffic sequences to be used by the local government. The idea is to build upon TeV's competences in this field in order to set up a portable system for the estimation of an origin-destination map and to estimate the travel time of vehicles passing across two, or more, points of interest.

4. Activity to support the transfer of the SCOCA technology via an active contact with the Autometriks company in UK.
5. Investigation of the possible exploitation of our know-how in the field of character recognition and document analysis in the context of a collaboration with Informatica Trentina and PAT.

2.4. Collaborations

- A recent collaboration established with UniTN, DISI (Prof. Nicu Sebe) led to the submission of a FET Young Explorer proposal, covering aspects on learning for event-triggered sensing with the aid of an expert user included in the system through an advanced perceptual interface. Proposed activities are in line with PUMALAB objectives. Both parties aim to establish an even more systematic collaboration on various aspects of Intelligent Perception, preferably within the EIT initiative, and possibly by including FBK's expertise on behavioural analysis (i3 and AAL units with which we collaborate in PUMALAB).
- Other external collaborations are currently active within the EU-project *My-E-director 2012*. We have a close working relationship with the perceptual component providers in the project, namely AIT and BBC. In particular we are collaborating with AIT (Dr. Aristodemos Pnevmatikakis) with the aim of integrating, at low level, their face detector/recogniser with our text localization, tracking and reading module to improve the athlete identification performance of the system.
- We also have other active collaborations with Italian universities, such as Trento and Modena (Prof. Rita Cucchiara), and companies, such as ST Microelectronics (Ing. Massimo Mancuso), in addition to Fondazione Don Gnocchi and local research centres like CreateNet.
- Furthermore, we also have a good and successful working relationship with many FBK research units, which we intend to maintain and strengthen in the next year, in particular TeV is collaborating with SHINE, I3, DKM, ES and 3DOM.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre conditions*
Progress in the formalization of a theoretically grounded probabilistic framework to estimate a state space function using sparse observations, and its extension to tasks involving multimodal adaptation.	R	I/E	Sept	If implemented as an extension of SmarTrack it can be tested in the lab and on the live SmarTrack installation in the FBK foyer	
Online adaptive fusion of	R	I/E	Oct	The module can	

multiple cues and modalities in a spatio-temporal domain for tracking and posture detection, and its use to understand when the target model has to be updated.				be tested on data collected in the ACUBE demonstration sites, in our lab, and in live demos of the integrated ACUBE platform	
Automatic bootstrapping of parameters for the multi-modal tracking system: sensors calibration, 3D structure of the environment, distortion maps	R	I/E	June	The module can be tested in the ACUBE demonstration sites	
Progress on automated behaviour analysis, with particular emphasis on a tight integration between the tracking and the interpretation module, possibly in an audio-visual context	R	I/E	June	The module can be tested on sequences acquired in the lab	
Investigation on the possibility of (i) embedding symbolic constraints into a probabilistic state estimation framework via appropriate parameterization of the typical set, and, under the same principle, (ii) generating a new set of constraints for fast symbolic checking under the action of a probabilistic source	R	I/E	Dec.		
Obtain new grants from the European Community	A	E	Dec.		
Identification and analysis of a logical-probabilistic model for content processing and management	R	I	Dec.		
Design and implementation of the prototype for deriving 3D models from set of 2D images	I	I/E	Oct.	Realization of a demonstrative prototype	
Re-design and implementation of SmarTrack prototype to meet software engineering requirements for (i) increasing its flexibility and reducing implementation effort to integrate new research results, and (ii) supporting the start-up initiative in the product devel-	I	I/E	June		

opment on what concerns its core technology					
Creation of a new start-up company exploiting the SmarTrack technology	I	E	Sept.		Approval by the FBK CdA

4. Human Resources

At present, the TeV research unit is characterized by a well-established team, that has mature and relevant expertise and competences in the field of Computer Vision and Image Analysis. Moreover, the team has created, over time, a rich library of software tools and technical competencies to support research and to design and implement prototypes and demonstrative systems.
According to the mission of the unit, research activities have been conducted taking into account the general FBK aim to push innovation by creating collaborations with companies and institutions, especially those active in the Trentino territory.

In this regard, our recent collaborations with local companies and, most importantly, the decision to undertake during the current year, a process aimed at the creation of a new company with the purpose of exploiting the SmarTrack technology.

In order to achieve these goals, during 2010 we decided to strengthen the activities related to technology development by converting the research contracts of two researchers into technologist contracts. To mitigate the impact of this decision on the research activities, and the fact that a young researcher recently left the group, we are planning to increase the number of PhD students passing through TeV from one in 2010 to three by the end of 2011.

5. Risks and Mitigation Plans

Difficulties in finding sources of financial support could bias the group's activities towards applicative projects possibly leading to a diminished importance being paid to the scientific research activities.

The success of joint projects, where a good percentage of the TeV effort is devoted, depends not only on our disposition to collaborate and to create a good team, but also on factors which are external to the group's control.

A minor risk is the possibility of the unforeseen leaving of personnel with solid competences mainly because of the limited number of permanent positions the Foundation offers.

The potential impact of these risks can be reduced by continuously monitoring the activities and by detecting, as soon as possible, undesirable trends. Mitigation actions will include the reallocation of resources on the critical path and the focalisation of research and technological efforts on the core activities.

Description	*Prob.*	*Impact*	*Contingency*
Problems in joint projects	M	M	Discover them as soon as possible
Difficulties in obtaining grants	L	M	More resources on that activity, enforce our network of collaborations at European level
Leaving of personnel	L	H	New personnel, refocusing

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

6. Ethical Issues

Informed Consent	
Does the proposal involve children?	yes
Does the proposal involve patients or persons not able to give consent?	yes
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	yes
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	yes
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	

Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

I3 – INTELLIGENT INTERFACES AND INTERACTION

Unit Name	i3 – Intelligent interfaces and interaction	
Type	Research	
Head	Massimo Zancanaro	
Staff	2010	2011
	5 Researchers	5 Researchers*
	4 Technologists	2 Technologists
	3 Post Doc	1 Post Doc
	3 PhD	1 PhD**

Document Status: submitted 2010-11-26

* plus 2 new junior researchers.
** plus 2 new PhD.

1. Executive Summary

The i3 research unit focuses on designing interaction modalities for cutting-edge IT using a highly interdisciplinary approach borrowed from social sciences. The research objectives are at the same time technological—that is, developing innovative technologies—and social—that is, investigating how people use and benefit from these technologies.

The research activity is pursued along 4 challenges posed by new "intelligent" technologies to move beyond the "personal computer" paradigm: *implicit vs. explicit interaction*; *direct vs. indirect communication; shaping interaction for active learning by the system* and *interaction with stochastic systems.*

The workplan is divided in 3 areas targeted to research and innovation: *development of a framework for interaction design, design and development of active surfaces, automatic analysis of human behaviour*.

The group begins 2010 with 11 people. At present, we have 2 technicians (of which 1 tenured), 5 tenured researchers, 1 postdoc/junior researcher with an outgoing project at MIT. Two new positions are envisaged for junior researchers and 2 new PhD students.

Prominent collaborations already started and likely to continue in 2010 include University of Haifa, University of Nottingham and MIT.

2. Vision and Scientific Program

2.1. Context and State of the Art

The field of Human-Computer Interaction is a branch of Computer Science that since the late '70 studies how people use computers and how computers can be

better designed to fit people's needs. HCI was initially conceived as a branch of ergonomics but as computers became central to human life, it has become first a branch of design and latter a discipline in itself. A well established body of knowledge has been accumulating on the principles for designing usable graphical user interfaces for "traditional" computers as well as web sites. Traditionally, the whole debate has been focused around the notion of usability which denote the ease with which people can employ a particular tool or other human-made object in order to achieve a particular goal (ISO 9241): how to measure it and how to design for it.

The rapid progress of ICT in the last decade represents a challenge for Human-Computer Interaction because of the lack of well-established practices and guideline for the design. As computers are becoming available every time and embedded everywhere, usability in a strict sense is becoming a narrow concept. In fact, today research and open challenges on HCI consider a wider spectrum of aspects such as the possibility of interacting with a diversity of devices beyond traditional computers, the shift from single user-based interaction to collective interaction through users' communities and the need of defining new evaluation methodologies for such new interactive means.

Since its infancy, HCI recognized the importance of understanding the users in order to design better technologies and borrowed from the disciplines of Psychology and Sociology a large array of methodological frameworks and actual techniques. Today and tomorrow, it is of a paramount importance putting the human beings at the core of the design of technology: the pervasiveness of ICT in our world, its intrinsic role in shaping our society, makes the risk of digital divide a tragic possibility [Harper et al. 2008].

Shared co-located systems are an emerging class of devices and applications that allow a small group of users to share the same interface in the same place. They represent a radical shift from the paradigm of *one-user-one-computer*. As such, they are subject to different design constraints than standard Graphical User Interface (GUI) applications. Usually they are based on large interactive surfaces placed horizontally (in this configuration they are usually called tabletop devices) or vertically (often called wall displays) on which a specifically-designed interface is displayed or projected.

Automatic Behaviour Analysis represents the new frontier of research in multimodal systems. Multimodal analysis of behaviour is a relatively recent research area compared to the large body of studies focusing on multimodal input in human-computer interfaces, and aims at a deeper understanding of the context of interaction. Most of the present work on behaviour analysis (also known as activity recognition, but this term might be restrictive in some cases) is carried out by using devices such as sensors and motion detectors to collect data regarding the completion of activities in a properly equipped environment. A recent trend along this line is the study of automatic analysis of social signals which can represent an interesting approach for future interaction with systems.

References

– Harper, R., Rodden T., Rogers Y., Sellen A. (2008) Being Human. Human-Computer Interaction in the Year 2020. Microsoft.

– Vinciarelli A., Pantic M. and Bourlard H.(2009) Social Signal Processing: Survey of an Emerging Domain. Journal of Image and Vision Computing. Volume 27, Issue 12, November 2009, Pages 1743-1759.

2.2. Vision and Goals

The mission of the i^3 Research Unit is the study and the development of cutting-edge IT using a highly interdisciplinary approach borrowed from social sciences. The research objectives are at the same time technological (that is, developing innovative technologies) and social (that is, investigating how people use and benefit from these technologies). With the fast pace of technology advancement, the line between research and innovation is becoming blurred and instable. We aimed at advancing research by investigating basic issues of the relationships among IT and human beings while building a portfolio of skills that can be valued in the market. This portfolio will include a know-how on a set of techniques for design and rapid-prototyping of IT solutions as well as technical experience on a number of key IT domains to sustain the research and provide the basis for a regular spin-off of advanced technologies.

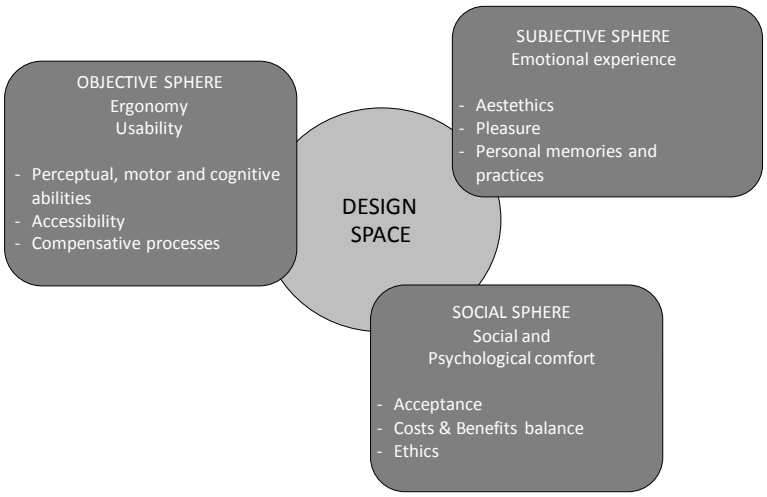


Figure 1. Beyond usability in the design of future IT

– *[what is design]* Design is the process that lays the basis for the making of an object or a system. Traditionally, there is a tension between the "engineering" perspective (getting the design right) and the "creative" perspective (getting the right design). The former requires accountable procedures and formal or semi-formal methods: from requirements analysis and ISO 830 documentation to UML (or TROPOS) approaches to system description. The latter encourages less formal practices aimed at catching sparking ideas by

inspirational techniques: from ethnographic fieldwork to get the gist of a domain to design storm to inspire “blue sky” concepts. Interaction design is a design discipline that focuses on making devices with which a user can interact, in particular computers.

– *[designing for the people by designing with the people]* Without informed design, any technology is more likely to be bad than good. Focusing with the people right from the beginning of the design (and development) process leads to more usable products. Adopting a user-centred approach implies: (i) early focus on users, tasks and environment; (ii) the active involvement of users; (iii) an appropriate allocation of function between user and system; (iv) the incorporation of user-derived feedback into system design; (v) iterative design whereby a prototype is designed, tested and modified. There is an international standard that is the basis for many UCD methodologies—ISO 13407: Human-centred design process (an improved version has been published as ISO TR 18529)—that defines a general process for including human-centred activities throughout a development life-cycle, though it does not specify exact methods.

  A step beyond user-centred design is focusing not only on functions and ergonomics by opening the design space subjective sphere of emotional experience and the social sphere of social and psychological comfort.

– *[i3 main objective: moving beyond the personal computer]* Although personal use of information technology has been the major trend in the last decades, new interesting trends are emerging for modalities of interaction that involve shared and ambient devices. These new technologies represents a challenge for Human-Computer Interaction because of the lack of well-established practices and guideline for the design. As computers is becoming embedded everywhere and available everytime, usability in a strict sense is becoming a narrow concept. When computers are no longer machine to work with sitting on the desk, new values emerge in the design process:
  - From single user to collaboration among a group
  - From the desktop to the environment
  - From products to services
  - From usability to user experience
  - From learnability to acceptability
  - From control to trust
  - From extrinsic to intrinsic motivation for interacting
  - Efficacy become more important than efficiency
  - “Intelligence” inside

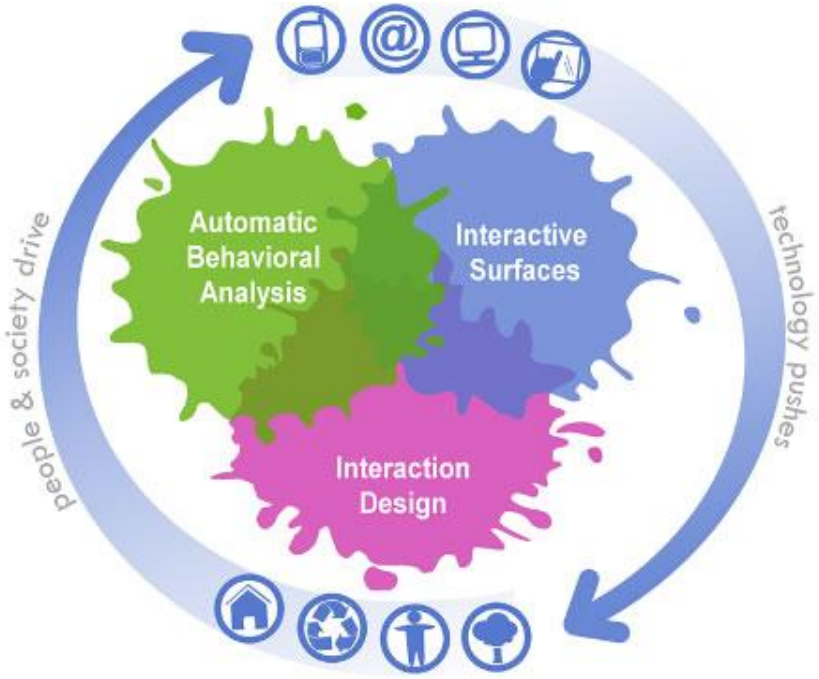


Figure 2. The 3 areas and the "cultural mediation"

– *[4 challenges to move beyond the personal computer]* In particular, four challenges may be recognized in designing interaction when the computer moves beyond the “personal” sphere:

  Challenge 1 - implicit vs. explicit interaction: multimodal components have the capability of enlarging the perceptual bandwidth of interactive systems and they provide the basis for extended input devices. For example, speech recognition may allow speech input, similarly automatic vision can be used to implement a gesture-based command interface. In these cases, the user directly and explicitly controls the system by using more natural or more effective way of communication. Furthermore, the same multimodal components may be used implicitly or indirectly by the system to understand the context of the interaction and respond autonomously to changes with little or no awareness by the users.

  Challenge 2 - direct vs. indirect communication: similarly, from the point of view of the output provided by the technology, computer systems have traditionally been thought as been on the focus of attention during the all the time required by the operator to perform a task. This is no longer the case with modern technologies, from mobile phones always on, emails for asynchronous communication or (inter)active digital signage, the way of communicating is often peripheral with respect to either the perceptual attention, the cognitive load or both. If the environment has to become (inter)active, it should stay in the peripheral most of time, to avoid flooding of information. How and when to move in the central focus of attention is something that has to be planned considering the characteristics and limitations of the hu-

man cognitive system but also the social conventions of the society in which is deployed.

Of course, indirect interaction, both for input and for output, offers more potential benefits but also more risks. In particular, if the user is not aware of the interaction the notions of usability and acceptability has to be completely rethought while the notion of trust may assume more importance than the traditional notion of control.

Challenge 3 - shaping interaction for active learning by the system: differently from traditional human-computer interaction, multimodal systems cannot be deployed once for all. Being based on learned models of human behaviour (from phonetic to social models) they have to tackle with the large variability of human beings. These models can be based on common models learned from data or derived from cognitive traits (or both) but they also have to be refined for each user and to evolve during the lifetime of the system. Active learning, a new class of machine learning algorithms and techniques, may represent a new foundation for multimodal systems but it raises new issues on how to design a system that is changing during and because of its use. This aspect can requires a new foundation for usability which takes into account co-evolution among users and systems in time.

Challenge 4 - interaction with stochastic systems: most multimodal systems are stochastic in nature. That is, the models of which they are based to interpret human behaviour encode probabilities and reasoning under uncertainty. Yet, in traditional human-computer interaction users are not accustomed with stochastic behaviour, all traditional GUI (Graphical User Interfaces) are deterministic. Even when stochastic algorithm are used, the interaction is considered deterministic: the simplest example is a spam filter that computes the conditional probability for an email with a given content to be a spam; at the level of the GUI, an email is redirected in the spam filter should the probability exceeds a threshold. A new range of possibilities may be considered to represent the complexity and the richness of a probabilistic framework in designing GUIs for multimodal system provided that the cognitive limitation of the users is taken in consideration.

– *[3 areas for research and innovation]* A well established experience in interaction design practices is our core asset and our ultimate goal is merging the “engineering approach” with the “creative” approach by using qualitative approaches to gathering the user needs while pushing technology advancement. We aim at acting as “cultural mediators” between the users and the developers by offering a set of services from understanding the users to blueprinting an IT solution.

  Two technological strands will be pursued to instantiate the research, share co-located systems and automatic behavior analysis. The former is currently one of the IT hypes since when Microsoft Surface has been released, the latter might represent an interesting development for the future of the field of Human-Computer Interaction.

Shared co-located systems are an emerging class of devices and applications that allow a small group of users to share the same interface in the same place. They represent a radical shift from the paradigm of one-user-one-computer. As such, they are subject to different design constraints than standard Graphical User Interface (GUI) applications. Usually they are based on large interactive surfaces placed horizontally (in this configuration they are usually called tabletop devices) or vertically (often called wall displays) on which a specifically-designed interface is displayed or projected.

Automatic behaviour analysis represents a new frontier of research in IT. Multimodal analysis of behaviour is a relatively recent research area compared to the large body of studies focusing on multimodal input in human-computer interfaces, and aims at a deeper understanding of the context of interaction. The automatic analysis of activities of daily living (such as eating, cooking, cleaning up, watching TV, …) are of great theoretical importance and an essential component of many services especially in a domestic environment for ambient assisted living and for assisted cognition. Similarly, an important role could be played by automatic assessment of properties and states inferable from the observation of human behavior such as personality, emotions, intentions, mood and so on.

[Applicative scenarios] Studying how people use technology invariably means to do research in applicative scenarios, though our research issues are more general in nature. The importance given on the approach of designing for the people by designing with the people and the exercise of design as mediation between technologist and people naturally brings us toward challenging domains where people are weaker, or the context is demanding or where the technology is a challenge. At present and in the next future, we are focusing in the following domains:

- Ambient Assisted Living where technology is meant to assist elderly people to live longer in their homes.
- E-Inclusion which encompasses the investigation and development of IT solution for improving the life or the therapy of disabled persons (in particular, autistic children, people with aphasia and mild cognitive disabilities and blind people).
- Education. In particular for what concern children and teenagers both in formal and informal learning situations (such as museums).

2.3. Activities and Work Plan

The activities for 2011 are organized along the 3 areas discussed above.

– *[Interaction Design]* Consolidation of an advanced framework for Interaction Design strongly based on user involvement; in particular,
  - Developing a framework for appropriation as started in the Netcarity project
  - merging formal methods of software requirements with “soft” methods pursued in ACUBE (also in collaboration with SE)

– *[Interactive Surfaces]* Advancement of the state of the art on surface-based interaction in particular for what concerns multi-user interaction and as quasi-peripheral displays;
  - investigating multi-user interaction in the context of autism therapy and educational contexts pursued in COSPATIAL project
  - studying indirect communication system aimed at inducing attitude or behavioral changes in a group of people; pursued in the ITCH project (European proposal submitted)
  - experimenting with new techniques for surface interaction
  - planning a technology transfer to the MobiTable device build in the Netcarity project (a proposal in a short list for AAL, and a plan for a Legge 6 with a local company)
– *[Human Behavior Analysis]* Focus the activity on human behavior analysis toward design services for indirect (input) interaction with particular emphasis on home-based, non-functional services.
  - Investigating the dimensions of the new interaction paradigm through actual prototypes and user studies: Mirror prototype for well-being in Netcarity; Café Table for ITCH ; and so on.
  - Refining internal skills of human behavior analysis pursued in ITCH.

We are also involved in the organization and conduction of a unique degree of study in Interfaces and Communication Technologies together with the Cognitive Science Department of the University of Trento in Rovereto. This degree is aimed at providing the students a truly interdisciplinary education including psychology, graphical design and computer science to train. Recently, the Department of Cognitive Science launched a new master degree with a track on the same topic.

2.4. Collaborations

University of Haifa

- Tamar Weiss (Department of Occupational Therapy) and Tsvi Kuflik (Department of Information Studies)
- The collaboration with the department of OT is mainly related to the project COSPATIAL where we are exploring new interaction possibilities offered by tabletop devices in the therapy for children with autism. The work with the department of IS is mainly conducted in the context of the ITCH project for what concerns innovative interfaces in the museum.

University of Bar-Ilan

- Nirit Bauminger (School of Education, Faculty of Social Sciences)
- The collaboration is mainly focused on the work on COSPATIAL. Dr. Bauminger is a reputed expert in Cognitive Behavioral Therapy which is used as the core of the new systems developed in the project.
- University of Nottingham
- Sue Cobb (Mixed Reality Lab)

- The collaboration is focused on the work on COSPATIAL in particular for what concern the relation between virtual reality and active surfaces as educational tools.

Eberhard Karls Universitaet Tuebingen

- Udo Weimer (Faculty of Chemistry)
- The collaboration is related to the work on NETCARITY and is based mainly on the development of the concept of sustainable design for Ambient Assisted Living.

IDIAP

- Alessandro Vinciarelli and Daniel Gatica-Perez
- The collaboration is based on common interests in the research fields of human-behavior analysis. Together with Dr. Vinciarelli, we are investigating the possibilities of automatic analysis of personality traits and with Dr. Perez we recently submitted an FP7 project proposal on indirect interfaces.

University of Trento, CIMEC and Department of Cognitive Science and DISI

- Gabriele Miceli (CIMEC/Cerin), Remo Job and Nicu Sebe (Department of Cognitive Science), Antonella De Angeli (DISI)
- The collaboration with Unitn is based on a number of small activities related to human-behavior analysis for Assisted Cognition, tabletop devices for cognitive therapy (Prof. Miceli) and foundational research on human-behavior analysis (Prof. Sebe) and HCI (Prof. De Angeli). Researchers of the i3 unit are also involved in the new undergraduate course on interface design (Interfacce e Tecnologie della Comunicazione) and the communication track for the Cognitive Science Master (Prof. Job).

2.5. Specific Needs and Points of Attention

The need of experimenting with non-traditional interfaces require the need of devoting a reasonable budget to hardware and consumables (such as projectors, sensors, special material). Because of the constraints on European funding, these costs should be covered with the AdP.

The need to refocus the activity of tabletops and to move toward new devices.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Mobile interface for Festival della Creatività	I	E	June	First working prototype to be evaluated with users	
Indirect interfaces: the Augmented Coffee Table	R	E	June	First working prototype to be evaluated with users	

Multi-touch collaborative interfaces	R	E	Dec.	Working prototypes of multi-touch surfaces	Some of the work is related to the objectives and deadlines of COSPATIAL, other projects are under negotiation

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The group is now composed by 11 people. At present, we have 2 technicians (of which 1 tenured), 5 tenured researchers, 1 postdoc/junior researcher with an outgoing project at MIT. Two new positions are envisaged for junior researchers and 2 new PhD students.

No tenure track are scheduled in 2011 for this research unit.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Reducing the amount of European funding due to the increase of competition at European level	M	S	Diversify the sources of funding by improving the skills on industrial projects
Excessive effort on industrial projects and reduction on impact on research	M	S	Focalize the industrial projects on either project for technology transfer or on very specific skills of the group (such as interaction design)

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

6. Ethical Issues

Informed Consent	
Does the proposal involve children?	yes
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	yes
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	yes
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	
Does the proposal involve tracking the location or observation of people?	yes
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

SHINE – SPEECH INTERACTION IN NOISY ENVIRONMENTS

Unit Name	SHINE – SpeecH Interaction in Noisy Environments	
Type	Research	
Head	Maurizio Omologo	
Staff	2010	2011
	5 Researchers	6 Researchers
	1 Technologist	1 Technologist
	1 Post Doc	1 Post Doc
	3 PhD	4 PhD

Document Status: submitted 2010-11-29

1. Executive Summary

The SHINE research unit deals with the study and the development of novel advanced techniques of audio signal processing and interpretation, mainly concerning speech signals acquired by multi-microphone systems in real applications.

The research aims to tackle and solve real problems with regard to *Voice Interaction* in noisy environments and more generally to *Acoustic Scene Analysis,* in general in indoor contexts. Moreover, research is planned in other very challenging fields as *Microphone array and loudspeaker array processing for Immersive Reality*, and *Musical Scene Analysis.* As for the strategic plan of the next five years, acoustic sensor networks for ambient intelligence and acoustic/speech interfaces for immersive digital environments probably represent the two main directions on which the Unit will be active with long-term research actions. Moreover, the foreseen activities include the investigation on a possible technology transfer action for some of the related application areas.

At present, the Unit comprises: one senior researcher, two expert researchers, two young researchers, one technician, one post-doc, four PhD students. The SHINE unit normally hosts master students and internships of students/researchers from abroad. Some of the members of the unit are active in education related activities, giving courses and supporting laboratories inside the Departments of Telecommunication, Information Engineering and Computer Science of University of Trento. It is planned that during the next three-five years two-three young researchers will be hired; moreover, new PhD positions will be opened, one-two per year as average. During the next three years, one or two present students will then be appointed to research positions, and a tenure-track will be established.

Important collaborations are maintained with research centers, universities, and industries in Italy and abroad, as FAU – University of Erlangen (Germany), Politecnico di Milano-Como (I), Imperial College of London (UK), Elektrobit (D), STMicroelectronics (I), Amuser (I), Fracarro Radioindustrie (I), and locally with SMEs. In

particular, the ongoing cooperation with Konnekta s.r.l. and DomoticArea s.r.l. concerns ongoing technology transfer to domotic applications of command-and-control voice interaction technologies. Some of the given collaborations are maintained inside European Project consortia as for instance SCENIC, a project which is under way. Inside FBK, an important activity of collaboration is ongoing with the TeV unit, thanks to the important opportunities of integration in a multi-modal fashion provided by audio and video processing technologies available in the two units. Finally, some members of the SHINE unit are contributing to the ACube consortium activities by providing state-of-the-art acoustic sensing technologies to deploy in an ambient assisted living context.

2. Vision and Scientific Program

2.1. Context and State of the Art

The SHINE unit conducts research and development activities related to both acoustic and speech signal processing, with a major emphasis on multi-microphone based solutions for acoustic scene analysis and distant-talking speech recognition tasks.

During the last decade, there has been a significant growth of interest in these fields, primarily due to:

– the demand coming from developers of technologies for more advanced and flexible acoustic/speech enabled human-computer interfaces, and, at the same time,

– the serious limitation in flexibility and robustness that still characterizes close-talking speech recognition technology when used in uncontrolled situations, not observed in a training phase.

The corresponding acoustic and speech related international communities are growing considerably, and specific conferences and workshops are yearly organized to present and discuss on progresses in the field, which confirms the important trend towards a confluence between traditionally independent research areas to a new inter-disciplinary context, which also characterizes the SHINE activity.

Numerous companies and research centers (e.g., IBM, Microsoft, etc.) are actively working on distant-talking speech processing, on microphone arrays for selective acquisition of speech, on immersive media capture and rendering, on localizing and tracking multiple acoustic sources in space, separating them from each other, cleaning them from reverberation and noise in order to enhance the resulting speech quality, etc. Industrial activities in the field witness a real need of progress with the aim of a more effective impact of these technologies in applications as command-and-control in domotics, automotive, video-conferencing, surveillance, etc.

However, there are many remaining challenges still very difficult to address, compared to voice interaction at less than one meter distance from microphones: some real environments exhibit a strongly reverberant and rather unpredictable behaviour, signals of interest are not narrowband, the allowed number of microphones

and the spatial extension of their distribution are quite limited and, usually, heavily constrained. Consequently, a poor performance is still obtained in the presence of a reverberation time above half a second, or in the case of multiple simultaneously active speakers. The ability of microphone array processing to extract dry sources in the latter cases is usually modest.

To tackle some of the above mentioned problems, distributing microphone arrays in space is another promising approach which was experimented under CHIL and DICIT (Distant-talking Interfaces for Control of Interactive TV) EC projects (http://chil.server.de, http://dicit.fbk.eu), as an example for the speaker localization and tracking task. In particular under DICIT, an EC project coordinated by FBK between 2006 and 2009, a multi-microphone front-end was realized that feeds a speech recognizer in a very effective way for voice control of TV and related devices. This technology can support any other human-machine dialogue interaction in a smart-home environment, even in a multi-speaker scenario. For this reason, the SHINE unit is currently active in possible technology transfer in this direction.

Again related to acoustic scene analysis, and in particular to the capability of separating and interpreting each contribution of a given set of sound sources diffused in an environment, another frontier is represented by blind source separation (BSS). During the last four years, the SHINE team has progressed significantly in this field, and a real-time prototype is now available for separation in a reverberant environment. A benchmarking that was conducted at international level showed the quality of the given solutions. The potential seems to be enormous, the most recent results suggests some possible application fields where this technology can be fruitfully exploited, among which speaker localization, acoustic echo cancellation (through so-called Semi-BSS techniques) and selective acquisition for videoconferencing and for any other of the previously mentioned application fields.

Finally, a field addressed more recently under SHINE regards musical signal processing. This topic is investigated due to the very high synergy with the other problems and technologies addressed by the Unit, and the very low effort that is actually needed for it. Several activities are being conducted worldwide by a growing research community that in general refers to MIREX, a framework under which algorithms proposed by different research teams are benchmarked in an objective and consistent way. As an example, MIREX includes tasks as audio melody extraction, audio beat tracking, and many problems related to the music information retrieval application field. In this context, during the last three years a research was conducted on the automatic chord recognition task, with very good performance achieved in the above-mentioned competition. Currently, the study includes beat tracking with the purpose of becoming competitive in fields as multimedia search for audio information retrieval, for which very interesting real application perspectives are envisaged at international level.

Overall, the competences of SHINE unit members encompass expertise that can also be exploited in other fields, related to acoustic/speech processing (e.g., speech analytics, human audio perception, social signal processing for behaviour analysis, etc.) but also to integration with sensing of different nature (e.g., video, electromagnetic, EEG and other bio, etc.).

2.2. Vision and Goals

Most of the activities being conducted under SHINE reflects a long-term vision defined four years ago. In general, this research will continue in the short-medium term with the aim of further progressing in each field. Moreover, a progressive extension in the scope of the research to other areas of investigation is felt necessary, as in the case of loudspeaker array based audio rendering, e.g. for immersive audio application purposes. Acoustic scene reconstruction requires the adoption of accurate sound propagation systems and of proper techniques of multi-channel sound generation in space. From a strategic point of view, the combination of acoustic scene analysis and corresponding reconstruction makes possible the realization of very promising novel applications in the areas of immersive virtual reality, for instance for entertainment (advanced immersive gaming, immersive content creation), immersive communications (telepresence), etc. The resulting more natural and personalized intelligent (3D) media for immersive experiences could connect people through remote presence, favour human-like socialization over the network, learning, training, rehabilitation, etc.. The SHINE team has already started to experiment the use of small loudspeaker arrays under the EC project SCENIC. It is however a direction that requires some investments, also in terms of professional hardware and devices to perform accurate and reliable experimental activities.

As far as acoustic scene analysis is concerned, another very challenging step regards loosely synchronized *microphone arrays*, which means that the microphones do not operate with same clocking and sampling frequency. With this regard, preliminary activities were started some years ago and have been reprised recently under A-Cube, but other significant efforts are needed to obtain advances due to the high complexity of the problem. It is worth noting that solving it would enable the development of real applications with no requirements of cabling and clocking the given devices (hence opened to wireless applications), which implies invasive approaches, very often not accepted by end-users.

Beside the above-mentioned topics, microphone array processing and acoustic scene analysis need further study on issues as: self-calibration of devices and geometry; automatic understanding of the acoustics of the environment; automatic classification of the background noise characteristics typically associated to diffuse sound fields propagating in the environment; increased ability of detecting, localizing, and classifying any kind of acoustic event occurring in the given scene; improved performance in terms of blind source separation of the distinct contributions that compose the given acoustic scene. Finally, a very important field to further investigate is sensor fusion, where a (complex) scene interpretation is derived from both audio and video information, and eventually from other sensing technologies.

As for research on distant-talking speech recognition, the lack of performance remains the main issue to address during the next five years, trying to increase the recognition rate on tasks of progressively higher complexity. Based on the achievements of DICIT, command-and-control in a domestic context (e.g., for instance for disabled individuals) still represents a good and complex enough example on which this research can be conducted during the next years, focusing on microphone array and related adaptive beamforming techniques, multi-channel

acoustic echo cancellation, speech activity detection and smart speech filtering, speaker identification, etc.. Moreover, research on acoustic modelling and novel acoustic features is necessary to improve the effectiveness of the distant-talking speech recognizer.

Finally, technology transfer and exploitation of the most promising SHINE technologies represents an important next step. Some of the given techniques represent the starting-point for applications in domotics, video-conferencing, anti-intrusion, surveillance, automotive, robotics, and so on. In all these fields, the joint use of microphone array processing and distant-talking ASR for simple command-and-control tasks can also enable the development of smart advanced human-machine interfaces, as in the case of support to disabled individuals. A more challenging but effective approach for a wider perspective in terms of market opportunities could consist in implementing some of the given techniques on DSP processors, or on other dedicated platforms (exploiting when possible opportunities of parallelizing and speeding up signal processing algorithm execution on dedicated chips, GPUs, etc., normally available in a given computing platform), and combine them with miniaturized devices as, for instance, MEMS digital microphone arrays. Thanks to the low-cost of MEMS microphones, their robustness (also for outdoor) and very small size, the foreseen ample diffusion of these devices in the consumer markets may enable a possible revolution in terms of novel acoustic sensing based applications for the forthcoming decade, which deserves to be monitored and followed.

2.3. Activities and Work Plan

The activities of SHINE during 2011 can be summarized in the following six main directions: 1) Acoustic Scene Analysis (ASA); 2) Distant-Talking ASR (DT-ASR); 3) Immersive audio; 4) Musical scene analysis 5) Integration with other sensing; 6) Technology transfer.

– *Acoustic scene analysis*

  Methods to obtain information about the acoustic scene from Global Coherence Field (GCF)-based acoustic maps are being investigated under the EC SCENIC project. Temporal and spatial properties of the sound wavefield can be obtained with high-spatial-resolution microphone arrays and geometric room models. During 2011, new methods to compute acoustic maps will be explored which integrate GCF with information about main reflections, depending on the room geometry and the source orientation/directivity. The analysis of reflected wavefronts will also be addressed in order obtain an environment-dependent model of sound propagation (e.g. detection of reflecting surfaces, characterization of the acoustic sources). Blind source separation will be explored in combination with the above-mentioned techniques to enrich the resulting representations and models as far as multiple-source contexts are concerned. From the given work, it is foreseen that new techniques for multi-speaker localization and tracking, head orientation and source directivity pattern estimation will be derived. Another related goal will concern the possible reduction of the number of sensors for an overall lower complexity.

Acoustic scene analysis involves also multichannel array processing for extracting a given source of interest. Blind and semi-blind source separation (BSS/SBSS) are the main fields in which this research will be conducted. To achieve the robustness needed in real-world applications, statistical models for the room acoustics and more precise models for the source spectra will be explicitly exploited.

Moreover, studies on speech/non speech classification under mismatch conditions, model adaptation for speaker identification in a distant-talking scenario, self-calibration of a microphone network, and loosely synchronized microphone array processing will continue.

A preliminary investigation is also planned to extract accurate information on pitch and formants, with the aim of realizing a more effective convergence between multi-path propagation modeling investigated for acoustic scene analysis and distant-talking speech recognition/speaker identification problems. A possible impact of this study may open to analysis of social interaction from a new perspective, mainly motivated by exploiting accurate acoustic/speech analysis when “observed” subjects are far from the microphones and are interacting one each other.

Finally, during 2011 a study may start which concerns localization cues associated to stereo acoustic stimuli which can eventually be correlated with experimental evidence that emerges from studies on human perception of sound at brain level.

– *Distant-talking ASR*

  Acoustic feature extraction and acoustic modeling tasks will be addressed: development of noise robust strategies, in particular auditory-based processing, variable frame rate analysis, feature normalization methods and improvement of speech intelligibility in noise (denoising, dereverberation). Moreover, adaptation techniques suitable for reverberant speech are addressed by a PhD thesis. Specific effort will be devoted to investigate issues related to domestic voice-based interaction, as use of natural language, robust rejection of out-of-domain sentences, combination with BSS and SBSS.

– *Immersive audio*

  Combined use of loudspeaker arrays and microphone arrays for active environment excitation is being explored. In conjunction with wavefield synthesis methods, loudspeaker arrays will be used with the purpose of producing structured emissions to probe an enclosure and observe the resulting response in terms of acoustic maps (GCF and Oriented-GCF).

– *Musical scene analysis*

  Beside the chord recognition task, during 2011 the activity will concern the development and integration of new signal processing methods for rhythm analysis, with the main purpose of eventually using the given techniques for song/cover detection. Participation to the MIREX competition is also planned.

– *Integration with other sensing*

  Ongoing activities under ACube and PumaLab projects will continue with the goal of integrating the most established acoustic sensing technologies in combination with sensors of different nature, in particular for audio-visual scene analysis.

– *Technology transfer*

  The most advanced and mature technologies of SHINE will be object of an exploratory activity oriented to a transfer to the market. To this purpose, a tight collaboration will continue with Konnekta s.r.l. and with DomoticArea s.r.l. for applications in the smart home context. In most of the cases, this requires to realize corresponding embedded solutions in general based on software implementations on DSP processors or on other dedicated platforms and miniaturized recording devices. To this purpose, a cooperation activity is planned with ST-MicroElectronics which will regard the use of MEMS microphone arrays.

2.4. Collaborations

– Erlangen University(Prof. W. Kellermann): collaboration on acoustic scene analysis under SCENIC.
– Konnekta(R.Giovannini): transfer technology/possible spin-off on voice-enabled domotic services
– Pol. Milano(Prof. Sarti): self-configuring environment-aware intelligent acoustic sensing under SCENIC.
– Imperial College of London(Prof. P. Naylor): under the SCENIC project we work on acoustic scene analysis.
– DomoticArea (I)(Ing. F. Giovanazzi): technology transfer for voice-enabled domotic services
– STMicroelectronics (I)(Ing. R. Sannino): collaboration on MEMS microphone array processing
– * Another possible collaboration is under discussion with CIMEC (Prof. A. Caramazza) as for localization cues in stereo audio acqisition and rendering.

2.5. Specific Needs and Points of Attention

If concrete actions will follow on the creation of a start-up/spin-off, some new activities, and costs not detailed here, are foreseen with regard to feasibility studies, intellectual property, etc.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Submission of a proposal for European project	A	E	Between Jan. and Sept. 2011		Time depends on the launch of next calls
Demonstration of a directivity estimation system and exploitation of main reflection estimates (related to SCENIC)	I	I	March 2011		
Journal paper submissions on achievements obtained under SCENIC	R	E	July 2011		
2 journal paper submissions on ASR robustness and 1 on BSS	R	E	Dec. 2011		
Software components for acoustic sensing and audio-video-other sens. fusion for Acube-PumaLab projects	I	E	September 2011		
Distributed microphone network for real-time multi-spaker tracking based on parallelism and CUDA libraries	I	I	Dec. 2011		
Home/entertainment ASR prototype: new functionalities	I	I	Dec. 2011		
KONNEKTA: demonstrator integrating acoustic-speech interfaces and WINA/Blind-Home tracking	I	E	June 2011		Collaboration could switch to a spin-off during the first half of 2011
Combination of Speech Separation and Speech recognition technologies	R	I	Sept. 2011	Possible participation to the CHIME challenge.	

4. Human Resources

At present, the Unit comprises: one senior researcher, two expert researchers, two young researchers, one technician, one post-doc, three PhD students. It is planned that during the next three-five years two-three young researchers will be hired; moreover, new PhD positions will be opened, one/two per year as average. During the next three years, one or two present students will then be appointed to research positions, and a tenure-track will be established.

During 2011, we plan to start one tenure track and to have two new PhD (starting from November 2011).

5. Risks and Mitigation Plans

Technology transfer actions, with a possible creation of a spin-off/start-up, is an important issue for 2011.

Proposals for next EC calls represent another crucial aspect: with this regard, several actions are planned in order to find fundings to better support future research activities of the project.

6. Ethical Issues

The Unit is sometimes involved in acoustic and speech data collection campaigns, during which the recruited subjects are asked to fill in related consent forms to allow the use of the resulting speech data for research purposes.

WED – WEB OF DATA UNIT

Unit Name	Wed – Web of Data Unit	
Type	Research	
Head	Giovanni Tummarello	
Staff	2010	2011
	1 Researcher (p.t.)	1 Researcher (p.t.)
	2 Technologists	2 Technologists
		1 Post Doc

Document Status: submitted 2010-12-01

1. Executive Summary

Established in 2010 (Technologists joined in Jan/Feb), the Web of Data (WeD) performs research on 2 main fronts:

a) Scalable infrastructures which can add value and exploit data which is published online in interoperable formats such as RDF, RDFa and Microformats. This is done by operating in constant joint operation/single team with the Data Intensive Infrastructure unit (DI2), also coordinated by Dr. Tummarello at the DERI institute, Galway (Ireland). The result is the advancement on the Sindice infrastructure which is now starting to exhibit realistic commercialization opportunities which will be investigated starting early 2011. Formal agreements have already been put in place during the year 2010 with FBK now inside the LION 2 research consortium.

b) Innovative technological platform for Open Data and their applications in local contexts – with direct tests and applicability on the local territory. To this end the WeD unit in 2010 started to build a network of local data producers who are also interested in reusing data by others. The Spazio Dati Trentino is a project started in late 2010 (November) that will demonstrate in 2011 the potential for open data publishing and reuse as well as the applied potential of notable projects such as LiveMemories.

For 2011 we expect the following outcomes from the current activities

a) Creation of a Spinff (Sindice Ltd) participated by FBK , DERI and possibly other partners of the ION2 research consortium.

b) Reaching of important technical milestones in terms of data acquisition cluster based data processing, ability to interact with diverse datasets (e.g. LiveMemories, and territory data) and ability to provide useful demonstrable benefits for local economy and public administration.

c) Execution of the SpazioDati project where we will demonstrate the use of WeD technology for the local territory by showing how local data can be processed and delivered back to provide tangible benefits and value for the participants but more importantly for the local community at large. The pro-

ject will have very early demonstration in late 2010 and will conclude with a economical feasibility study to pave the way to a specific SpazioData local spinoff.

d) Open Data activity. In 2010 the Wed Unit established together with others at the University of Trento a discussion group called “Trentino Open Data”. During 2011 several events are expecte and will be organized. One in particular (march 2011) will be hosted by the Wed Unit at FBK (Open Data Technology event)

e) Participation in the Wiki Linking project, led by Claudio Giuliano which will investigate commercialization opportunities for technology related to the Wikimachine in conjunction with web of data databases e.g. as taken from the Sindice infrastructure.

f) Hiring of a postdoc as per original plan. (2010 plan) plus a part time technologist specifically for the SpazioDati project

g) Continued cooperation activity with other FBK units also for project preparation. Currently working on 2 projects for the January 2011 FP7 call.

2. Vision and Scientific Program

2.1. Context and State of the Art

A very great number of web sites and applications produce and expose on the web data which can be of great value when integrated in other web sites or applications. It is a common characteristic of Web 2.0 sites to often provide ways for developers to reuse their internal data, e.g., via APIs. A considerable number of said data producing sites, and furthermore many more which do not offer APIs have however embraced a lightweight yet powerful way to expose internal data: semantic markup. Example of now count in the millions, fostered by the support given by Facebook (the “i like” it button is semantic markup) Google, Yahoo and more. To this, a movement known as “linked data” as well as others advocating open data on the web have made available considerable amounts of data potentially useful for reuse. This is also particularly true in the world of Public data where considerable movements are advocating for open data release by public bodies for the benefit of the general public. This vision, also sometime referred to as Web 3.0, is enabled through technologies such as Microformats and RDF. Examples of such information types are contacts, events, social networks, web polls and votes, reviews, and hundreds of other domain specific entities. The Wed Unit contributes to the state of the art in very large scale semantic data processing, specifically with respect to infrastructures which can collect this data openly from the web such as search engines [8].

At management of open data, the state of the art consists in initiatives like CKAN, or others which are similar in nature like www.dati.piemonte.it .These are definitely very important first steps but do not per se provide a platform upon which to directly build applications let alone directly address the end users/citizens. More advanced initiatives such as the recent [10] have started to put together important

dataset using tools typical of semantic web and demonstrated that mashups and other applications are possible in a particularly convenient way. Yet this initiative still requires a high degree of manual labor to create the mashups and its not generally targeted at end user/consumer scenarios.

Research Challanges

At high level, the challenges lie in how to turn these data into an enabler for future intelligent applications and finally how to benefit end users. In particular the following questions do not have a satisfying answer up to date:

- *How to find sources that describe topics and entities that I am actually interested in ?*
- *How to visualize, verify, process and integrate said data irrespectively of their format of origin and for specific, business valuable use cases?*
- *How to cleanse and transform said data to fit one's needs in a stream like way ?*
- *How to be compensated for data one produces and compensate others so to assure QoS in data provisioning?*

To reach these high level goals we will investigate in cloud scalable infrastructure for semantic data management and the use of lightweight web technology to allow easy delivery of high value contextual information also as an enhancement of existing web applications. Furthermore the challenge is to provide viable technological means for accounting the use of web datasets and to provide a fair model by which data producers receive feedback and some form of suitable compensation (be that even only acknowledgements) for their merits.

2.2. Vision and Goals

Over the next 3 to 5 years we intend to

a) Complete the research to reach a critical mass of functionalities and services to enable many valuable scenarios on the Web of Data, possibly well beyond our current specific examples. This will happen trough the following subgoals
   - Creation of effective tools for developers to locate useful and trusted web datasets and to explore them so to understand how to use them for their task at hand
   - Creation of cloud based "dataspace services". It should be possible to allocate dynamically resources to execute specific processes needed to solve a specific task. We will evolve models like those in [9] to operate on cluster techniques.
   - Creation of supporting tools to enable virtuous loops of data production/cleanup and fair utilization. This will come trough proper accounting methods, which will motivate and incentivize good quality data production.

b) Demonstrate that the above technology can have a disruptive impact also if not particularly when applied to local context, e.g. local business needs, local government needs and to deliver benefits in local interest citizen scenarios.

c) Demonstrate practically how the Web of Data provides a lever factor for a number of other IT based technologies that can express their full potential when used and offered as Web data related technologies. In particular investigate on valuable synergies and low hanging fruits in the interaction between web data and Human Language Technologies, Data & Knowledge Management, Intelligent Interfaces and Interactions, and more.

d) Contribute to the establishment of a culture of open data and establishing a strong role for FBK . This thanks to public initiatives and coordination with local and international academic and industrial partners.

2.3. Activities and Work Plan

Milestone 1 – M3

Sindice Spinoff company is out as an Irish entity, participated by FBK. Patenting options have been explored for technologies developed so far

Milestone 2 – M6

SpazioDati trentino project has been demonstrated and a report is available on commercial feasibility of a local Spaziodati spinoff

Milestone 3 - M12

Possibly a local startup company is generated based on the SpazioDati Trentino project. A number of FBK technologies have been investigated for inclusion in the Sindice project as services for the Web of data.

WeD will coordinate with the Unit for Data Intesive Infrastructures in DERI with respect to the general activities and by sharing goals but also on a day-to-day basis when needed. In particular it is expected that.

2.4. Specific Needs and Points of Attention

It is expected in the SpazioDati Trentino project to have multiple occasions to gather feedback and be able to steer the project toward providing highly relevant services for the participating partners. Multiple occasions are also expected to exchange the results e.g. with others in FBK but also with other scientific and technological as well as government bodies with interest in experimentation to enable an advanced information driven society and economy.

Care will have to be put in the correct handling of the relationships with said bodies so to maximize the overall interest and benefits from the activities that are being proposed by WeD and minimize possible drawbacks.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Impact of Research	R	E	9-12m	Roll out of new services based on Web Data	Satisfactory performance is obtained, Research and techno-logy issues are solved
	R	R	6-12m	Availability of a generic engine which can power the OKKAM appli-cation	
Projects	A	E	6-12m	Invited as partners in national or eu level proposal. Collaborating with other FBK units to share the availability of Sindice and its data as something of value in project proposal	Enough dis-semination for the new group is achieved
Team	F	I	3-6	Small yet high quality team in close contact with the DI2 team	Effective hiring attracts skilled pro-fessionals and postdoctoral researcher

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the “Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

Giovanni Tummarello, is hired part time, Michele Mostarda and Davide Palmisano have full time technologist level. During the very first months of 2011 a postdoc will be hired and a part time technologist for the SpazioDati project.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
It is possible to get a lot of data e.g. from local sources, however it is not trivial to connect this data well using simple techniques. Data might be too unstructured for effective querying	M	M	Increase cooperation with other research units in FBK to be able to use and import more advanced data analysis and enrichment techniques
Hard to hire good quality postdocs so difficult to get an extra person to support also funding acquisition	M	M	Increased visibility derived by the new achievements should help find better candidates, otherwise increase cooperation with other units in view of major funding calls.
Other initiatives to compete against sindice to provide similar services. Pace of progress to slow to keep up with Web 2.0 world which we offer services to	L	M	Increase the use of methodologies derived from the agile development world also to achieve research and technology objectives.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

References

1. R. Delbru, N. Toupikov, M. Catasta, and G. Tummarello."A Node Indexing Scheme for Web Entity Retrieval" Extended Semantic Web Technology Conference (ESWC) 2010
2. R. Delbru, N. Toupikov, M. Catasta, G. Tummarello, S. Decker "Hierarchical Link Analysis for Ranking Web Data" Extended Semantic Web Technology Conference (ESWC) 2010
3. G. Tummarello, R. Cyganiak, M. Catasta, S. Danielczyk, R. Delbru, S. Decker “Sig.ma: Live views on the Web of Data”, Demonstrations in proceedings of the WWW2010 conference
4. G. Tummarello, R. Cyganiak, M. Catasta, S. Danielczyk, R. Delbru, S. Decker, "Sig.ma: Live views on the Web of Data", Journal of Web Semantics: Science, Services and Agents on the World Wide Web - Volume 8, Issue 4, November 2010, Pages 355-364
5. G. Tummarello, S. Decker “Sig.ma: to see the Web of data, to foresee its future”, European Semantic technology conference, Vienna December 2009

6. G. Tummarello, R. Delbru “Publishing Data that Links Itself: a conjecture”, AAAI Spring Symposium "Linked Data Meets Artificial Intelligence", March 22-24 2010
7. M. Catasta, R. Delbru, N.Toupikov, and G. Tummarello “Managing Terabytes of Web Semantics Data” In “Semantic Web Information Management A Model-Based Perspective” De Virgilio, Roberto; Giunchiglia, Fausto; Tanca, Letizia (eds) 2009 - ISBN: 978-3-642-04328-4
8. P. Mika, G. Tummarello “Web Semantics in the Clouds”, IEEE Intelligent Systems, Volume 23 , Issue 5 (September 2008) ISSN:1541-1672
9. D. Le Phuoc, A. Polleres, C. Morbidoni, M. Hauswirth, G. Tummarello “Rapid Semantic Web Mashup Development through Semantic Web Pipes”, World Wide Web Conference 2009, Madrid
10. Williams, Jin Guang Zheng, Johanna Flores, Zhenning Shangguan, Gino Gervasio, Deborah L. McGuinness and Jim Hendler “TWC Linked Open Government Data” Semantic Web Challenge 2010, ISWC 2010.

SECURITY AND TRUST

Unit Name	Security and Trust	
Type	Research	
Head	Alessandro Armando	
Staff	2010	2011
	2 Researchers	3 Researchers 1 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Identity and Access Management Systems (IAMS for short) ensure that the right people access the right services by centralizing identities and rights management, thereby greatly simplifying the design and implementation of complex distributed applications. So, IAMS implement the most security critical aspects of applications and any vulnerability in a IAMS may result in severe security breaches that make identity theft and other attacks possible to the whole system.

The goal of the project is to develop automated security analysis techniques and tools for IAMS to be used in several phases of their development cycle, ranging from design to deployment, thereby contributing to improve the security of such systems and the applications based on them. The project will focus on the development of automated analysis techniques for the security-critical aspects of the IAMS: browser-based protocols for the Single Sign-On (SSO) and access control policies.

The design and analysis of these components is usually so complex that severe vulnerabilities are often present even after intensive use of traditional verification techniques, such as manual inspection or testing. This is witnessed, for example, by vulnerabilities found in various SSO protocols, such as SAML SSO, MS Passport/CardSpace and the SAML-based SSO for Google Apps, even years after their publication, implementation, and usage.

Achieving the goals of the project will significantly advance the state-of-the-art in the security analysis of the IAMS. Today, there are no specific tools supporting the automatic analysis of security-sensitive browser-based protocols and access control policies of practical relevance.

2. Vision and Scientific Program

2.1. Context and State of the Art

Although many research lines have implications with the project, in this section we focus on the work that is most directly relevant to ours, namely the formal

specification and automatic analysis of security protocols and access control policies.

Security protocols are usually modelled as state machines exchanging messages over one or more communication channels that are under the control of an attacker. The attacker is assumed to be able to observe, intercept, and insert messages over the channels and it is characterized by a set of deductive capabilities (e.g., the ability to compute the cleartext from the corresponding cyphertext once the encryption key is known). An attacker capable of all these activities is called a Dolev-Yao attacker. Most state-of-the-art protocol analysis techniques assume that communication channel are controlled by a Dolev-Yao attacker. However, there exist several situations of practical relevance (e.g., web-browser protocols assume that messages are exchanged over a SSL/TLS connection) where the Dolev-Yao model is unrealistic. This leads the available techniques to report spurious vulnerabilities (i.e. false positives) thereby making them almost unusable.

A lot of work has been devoted to the development of automated analysis techniques for security protocols . Many techniques have been put forward that are based on, e.g., Strand-Spaces, Constraint Solving, and Symbolic Model Checking. We have contributed to the field by developing a security analysis technique based on a combination of SAT developed in AI Planning with Bounded Model Checking for LTL. The technique has been implemented in a bounded model checker for security protocols, called SATMC. SATMC is one of the back-ends of the AVISPA Tool, one of the most successful tools systems for the automated analysis of security protocols (more than 500 registered users in the mailing lists and more than 1000 downloads) which has been used to tackle industrial size protocols. Furthermore, using SATMC, we have discovered two serious vulnerabilities in the SAML-based SSO protocol used by Google Apps. However SATMC does not directly support the modeling of browser-based protocols and the analyses mentioned above required some hardwiring of certain aspects of the model in the tool.

Declarative languages based on the Logic Programming paradigm are routinely used to model access control policies. They have two attractive features: expressiveness and unambiguous semantics. The former allows one to express a wide variety of key mechanisms for the decentralized management of access (such as delegation and trust) in a uniform framework. Delegation is a central concept of many languages such as SecPal and DKAL, which can be seen as extensions of Datalog. Furthermore, both SecPal and DKAL allow one to declaratively specify some additional features of policy management systems such as structured resources, role hierarchies, etc. Other declarative languages are tailored to specific aspects such as the handling of time constraints. Recent proposals extend these languages with a dynamic dimension so as to be able to express state updates as a result of the application of a policy rule. Mechanized analysis of logic-based languages is possible as they have unambiguous semantics. Several such techniques have been proposed in the literature. For example, certain analysis methods developed for ARBAC models permit to establish if a user can acquire a role that he is not supposed to get because of subtle interactions between the

administration policy rules and the role hierarchy. More recently, analysis techniques for dynamic policies have been developed for (dynamic) extensions of Datalog. The main limitation of many of these techniques is that the number of users in the system should be known and fixed during the analysis phase.

2.2. Vision and Goals

The main goal of the project is to develop automated security analysis techniques and tools for Identity and Access Management Systems (IAMS). To this end the project will focus on the development of techniques for the automated analysis of security critical components of the IAMS, namely:

- browser-based Single Sign-On protocols and
- access control policies.

SSO protocols are a special type of security protocols and as such they aim at guaranteeing certain security properties (e.g., confidentiality or authentication) by using cryptographic primitives. The design of security protocols in general (and hence also of SSO protocols) is notoriously difficult. Severe vulnerabilities have been discovered in many protocols even after years from their publication and implementation or even their intensive use. Furthermore, some vulnerabilities allow one to perform attacks that do not exploit the weaknesses of the cryptographic primitives but are based on unforeseen interleaving of the actions of the participants and the attacker. This makes such attacks very easy to realize and thus they often may have dramatic impacts. Given the huge number of interleaving of the actions of the protocol participants, these vulnerabilities are very difficult to spot by manual inspection of the protocol or by traditional techniques (such as testing).

In the case of IAMS, the situation is further complicated by the fact that these protocols are executed by standard web-browsers: browsers are not uniquely devoted to execute the protocol but concurrently perform many other activities, they adopt a very primitive security policy (i.e. same origin policy) and their cryptographic capabilities are limited to the use of the SSL/TLS protocol. Browser-based SSO protocols are no exception: most of them (namely SAML SSO, MS Passport/CardSpace, and the SAML-based SSO for Google Apps) have been found to be vulnerable to serious flaws.

The definition of access control policies comes with many difficulties too. On the one hand, the policies should guarantee that a minimal set of users showing adequate permissions can access certain resources or functionalities (principle of least privilege). On the other hand, the policies should be flexible enough to allow the application to work in a wide range of situations. For this reason, the traditional models for access control (such as RBAC) have been extended in several ways; e.g., with delegation of roles or permissions and with rules for policy administration (ARBAC). Furthermore, access control policies can be dynamic, i.e. they may contribute to modify the state of the application in some way. All these aspects, which are ubiquitous in more advanced IAMS, make the analysis of access control policies so complex to make manual inspection of the rules impossible.

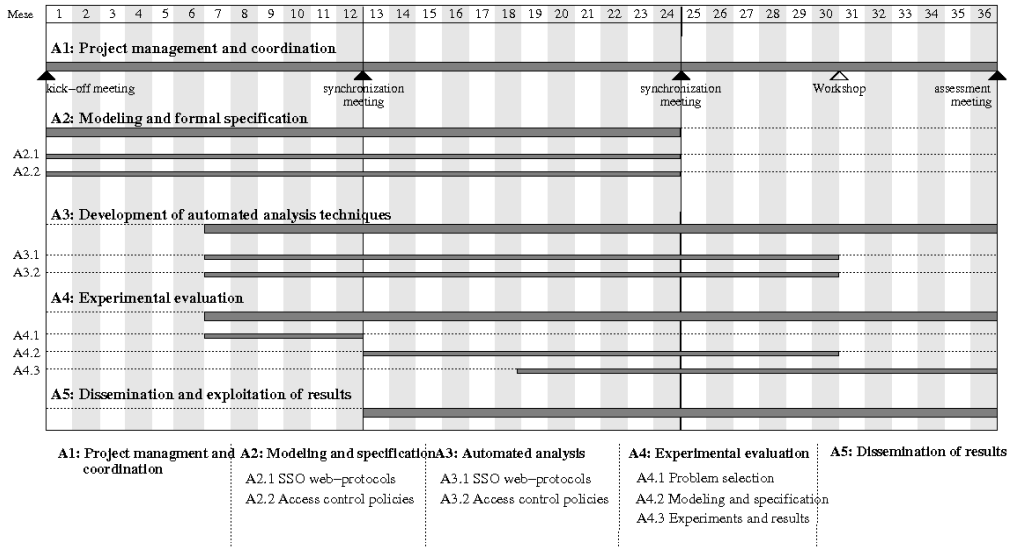
The project will focus on the following two scientific objectives:

O1. *Modeling and formal specification*: We will define formal languages for specifying security-critical components of IAMS and related security properties. The languages should be easily usable by both designers and security analysts and it should be easy to translate them to the input languages of automated analysis tools developed in the project. For SSO protocols, besides specifying the format of the exchanged messages, the language should allow one to describe the security of the communication channels (e.g., TLS/SSL), the inference capabilities of the attacker and a detailed model of the web-browser. For access control policies, the specification language should be able to express the attributes of user profiles and the mechanisms capable of identifying the attributes that are relevant for a certain application. The language should be able to express sophisticated features such as dynamic rules. Finally, the language must be able to express the key security properties of IAMS, such as safety, availability, and separation of duty.

O2. *Design of automated analysis techniques*. For SSO protocols, given a formal specification of an SSO browser-based protocol and the scenario where it is used (including the inference capabilities of the attacker) and a formula expressing the desired security properties, the analysis techniques should be able to establish whether the protocol satisfies the property in the given scenario. If it is not the case, the techniques should be able to produce a sequence of actions of the protocol leading to the violation of the property. Similarly, given a formal specification of an access control policy and the scenario where this is used and a formula expressing the desired security properties, the techniques should be able to establish whether the policy satisfies the property in the scenario. Furthermore, techniques capable of establishing some security properties for all possible scenarios will be developed. (These problems are un-decidable in the general case, but decidability results exist if additional hypotheses are assumed, e.g., only finitely many sessions are considered.)

2.3. Activities and Work Plan

The work plan of the research activity spans 3 years starting on April 1st, 2010 and it is organized in 5 activities (named A1, A2, A3, A4, and A5 below) as described in the following Gantt chart.



Activity A1 is devoted to project management and coordination. Activities A2 and A3 tackle the objectives O1 and O2 described in Section 2.2, respectively. Activity A4 starts at month 6 and it is devoted to assess the effectiveness of the techniques developed in A2 and A3. Activity A5 will be devoted to the dissemination and exploitation of the results.

During the first year of the project (next year) we will focus on the following activities:

A2. *Modeling and formal specification*: We will develop formal languages for specifying SSO protocols and access control policies. Syntactic analyzers and translators for such languages will be implemented in SATMC and their expressiveness will be experimentally evaluated against case studies selected in activity A4. For SSO protocols, the starting point will be the specification languages developed within the EU project AVANTSSAR. This language must be extended to support some mechanisms typical of web-browsers (e.g. the handling of cookies) and the specification of trust relationships. For access control policies, the starting point will be a declarative language such as SecPal or DKAL that allows one to express a vast variety of policy management mechanisms in a uniform way. The key extension will be to identify suitable constructs to express the dynamic effects of the application of policy rules.

A3. *Development of automated analysis techniques*: We will develop techniques for the automated analysis of security protocols for identity management and access control policies. Such techniques will be implemented in SATMC and their effectiveness will be evaluated against case studies selected in activity A4. For SSO protocols, the model checking techniques available in SATMC will be extended to support the specification constructs identified in A2. We believe that these techniques will permit the verification of industrial size protocols using secure communication channels (such as SSL/TLS). For access control policies, we will extend the model checking techniques available in SATMC for the debugging of dynamic policies that

are ubiquitous in IAMS. We will also develop parameterized techniques for the analysis of these policies regardless of the number of users in the system.

A4. *Experimental evaluation*: We will define a library of problems of industrial relevance that will be used to assess the adequacy of the specification languages defined in A2 and the effectiveness of the analysis techniques developed in A3. In the first year, we will devote our efforts to identify a selection of representative problems. In general, IAMS are designed to meet a variety of security properties such as authentication, secrecy, anonymity, etc. By a careful scrutiny of the protocols and access control policies used in state-of-the-art IAMS (e.g., SAML, SSO, OpenId, OAuth), we will identify a set of practically relevant security problems. The selected problems will be formalized by using the languages identified in activity A2. This will give important hints about the adequacy of the languages and will provide the starting point for the experimental evaluation of the techniques developed in activity A3. The library of problems will be made available to the whole scientific community on the web site of the research unit.

A5. *Dissemination and Exploitation of the results:* We will start disseminating the results of the project by presenting papers at international scientific conferences.

2.4. Collaborations

- Univ. degli Studi di Verona (Prof. Luca Viganò): formal modeling of security policies.SAP AG (Dr. Volkmar Lotz, Dr. Luca Compagna): formal modeling of browser-based protocols and security-sensitive business processes.
- Siemens AG (Dr. Jorge Cuellar): formal modeling of browser-based protocols.
- E-Health Unit (Dr. Stefano Forte): analysis of a SSO solution for E-Health (TreC Project).

We also plan to host visits of Prof. Alexander Pretchnert (Karlsruhe Institute of Technology) and other internationally renowned researchers in the area of Security & Trust.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Design and development of a specification language for SSO protocols and access control policies	R	I	Dec.	Revised description of the syntax and semantics. Modeling of some selected case studies.	

Selection and formal analysis of selected case studies	R	I	Dec.	List of selected cases studies.	Specification language for SSO protocols and access control policies
Techniques for automated analysis of SSO protocols and access control policies	R	I	Dec.	Description of the techniques. Prototype and preliminary evaluation on selected case studies.	Specification language for SSO protocols and access control policies

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

Prof. Alessandro Armando is the head of the research unit. Dr. Silvio Ranise (previously researched with tenure at INRIA-Lorraine in France, with international experience in state-of-the-art verification techniques) and Dr. Roberto Carbone (previously postdoc at the University of Genova, with solid experience in the automated verification of security protocols) joined the team on April 1st, 2010 and November 2nd, 2010 respectively. It is also foreseen that one PhD student will join the project.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Failure to deliver design of the specification language for SSO protocols and access control policies	VL	C	The probability is very low as we have a solid starting point in the specification language developed in the AVANTSSAR project.
Failure to identify case studies	L	M	The assessment of the analysis techniques will be difficult but not impossible (e.g., by using artificially

			creafted examples). A preliminary analysis of further profiles of the SAML SSO and of the Oauth protocol has already been conducted.
Failure to perform automatic analysis of the selected case studies	L	M	The techniques developed in the AVANTSSAR project will provide the starting point. However, they can be used as they are to perform some analysis of IAMS with some hacking.
Recruitment	L	S	Scouting of potential researchers and post-docs has already started.

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

CCL – COMPUTATIONAL COGNITION LABORATORY

Unit Name	CCL – Computational Cognition Laboratory	
Type	Research	
Head	Fabio Pianesi	
Staff	2010	2010
	1 Researcher	1 Researcher
	2 PhD students	6 PhD students

Document Status: submitted 2010-12-01

1. Executive Summary

The CCL exploratory project is a place where various competences and skills present in FBK and in UniTn-CIMEC interact to investigate new ideas and concepts in the field of Human Computing, feeding them into the Ambient Assisted Living (AAL) perspective on the design and development of advanced services for the elderly.

CCL structures its activities into three core areas: “Research Issues in Human Computing”, “Strategic Activities for AAL” and “Higher Education”.

Research Issues in Human Computing. A few selected research issues in Human Computing have been identified that can crucially improve the capabilities of computer system to deliver better services. In particular, the extraction of static features (personality traits and dispositions, preferences, life styles) and the analysis of dynamic aspects of human life (activities executed be the user, mood and social dynamics) conducted within a life-logging framework.

Strategic Activities for AAL. The work done during the last few years has created a critical mass in Trentino in terms of research capability, interest of the relevant stakeholders, involvement of companies, and demonstrated capacity to use technology for answering societal needs. These important results will be put on firmer basis and consolidated by: a) a stronger role of FBK in the promotion of national AAL activities, as members of the steering board of the Italian Association for Ambient Assisted Living (AItAAL) and organizers of its first national conference; b) a continued and increased participation in European initiatives and projects.

Higher Education. Human Computing and AAL require appropriate educational actions aimed to train the future levies of researchers and professionals. CCL will continue playing a major role in the new and quite successful ‘laurea’ curriculum on Interfaces and Communication Technologies at the Faculty of Cognitive Science in Rovereto, and in the new track on multimodal communication at the master in Cognitive Science.

2. Vision and Scientific Program

2.1. Context and State of the Art

Variously called Human Computing, Human-Centric Computing, etc., a new body of knowledge and practices is growing that crosscuts advanced ICT sectors (Embedded Systems, Ambient Intelligence, Ubiquitous and Pervasive Computing, Internet of Things, Internet of People, etc.) joining them in marriage with frontier disciplines such as Human-Computer Interaction and Interaction Designs, having as best men Social Psychology and Cognitive Sciences, and with the non occasional assistance of Sociology. This broad and extremely interesting domain is finding its way into many research programmes, often disguised under various vests. For instance, in 2009-2010 FP7 Workprogramme there is virtually no challenge where the human-machine confrontation is not considered: objective ICT-2009-1.4 talks of human behaviour; challenge 2 is entirely dedicated to cognitive systems, ambient intelligence and interfaces, objective ICT-2008-4 addresses human perception and attention, human cooperation and decision, etc.

Human Computing finds a straightforward application to Ambient Assisted Living (AAL), a new perspective on the design and development of services aimed to improving the quality of life of different categories of users, and in particular the elderly. By 2020, 25% of the EU's population will be over 65. Spending on pensions, health and long-term care is expected to increase by 4-8% of GDP in coming decades, with total expenditures tripling by 2050. At the same time, older Europeans are important consumers with a combined wealth of over €3000 billion: a potential that is almost completely overlooked by ICT, given that the majority of older people do not enjoy the benefits of the digital age—e.g., only 10% use the internet. A major obstacle to a wider adoption of technology by the elders is the fact that current technologies and services have not been designed for older people, a highly diversified population, with specific needs and requirements that are continuously re-shaped by changing physical, cognitive and social conditions. Human Computing, by integrating all the necessary skills (ICT, social and cognitive psychology, HCI, sociology, etc) has therefore much to contribute to AAL.

Many national and trans-national bodies have taken important steps towards AAL: the EU has developed specific actions, both within FP6 and FP7 (€400m planned in FP7); the AAL Joint Programme (some €600m) has been launched and is now up and running, featuring the participation of more than 23 member states (Switzerland will join soon); moreover, several European countries have adopted specific national actions. The result is that between 2008 and 2013, the EU, the Member States and the private sector are investing more than €1 billion in research and innovation for AAL.

In Trentino, PAT has been active in this area for years, framing its strategy within the e-Welfare political vision, adopted by the Provincial Council in 2007, and the more recent strategic initiative for family policies. PAT sensitivity to these issues is crucial: it is at the territorial level, in fact, that: a) societal requests and needs from older people become political issues; b) political issues are turned into actual services; c) services can be adapted to meet the demands and the requirements of the various stakeholders. Research institutions can and must accompany the proc-

ess by devising and then deploying their own strategic visions where technologies are studied and developed to serve individual and societal needs and enforce individual and societal values.

Besides its scientific and technical articulations, Human Computing and AAL require appropriate educational actions aimed to train the future levies of researchers and professionals. A successful high education in this area does not only require a re-design of curricula and courses, but it takes advantage of a truly cross-disciplinary environment where students can contribute to shape the new Human-Computing perspective.

This EP provides a framework for various competences and skills present in FBK and in UniTn-CIMEC to interact and contribute to Human Computing and Ambient Assisted Living. After the start-up during 2008, the EP has formed a mixed FBK-UniTn working group, structuring its activities into three core areas: “Research Issues in Human Computing”, “Strategic Activities for AAL” and “Higher Education”. We briefly mention some of the results obtained so far.

Research Issues in Human Computing

CCL coordinates FBK activities in Netcarity (FP6), one of the biggest IP in the area of AAL.

We have addressed the execution of simple daily activities by people with mild cognitive disorders (dressing and undressing; buttoning/unbuttoning, for which a patent is pending) and investigated the import of the understanding of human traits and human activities for computer systems in AAL scenarios.

We have been very active in the new emerging area of Social Computing, with several publications accepted, participations in conferences’ and workshops’ program committees, invited memberships in doctoral dissertations committees.

Strategic Activities for AAL

Thanks to the Netcarity project, an ample network of relevant stakeholders (PAT, associations of older people, social services and their territorial articulations, companies, etc.) has been built and nurtured. Among the outcomes of this extended partnership we mention:

- the acquisition and successful completion of the ‘Contact Centre’ project, an *in vivo* experimentation of advanced service providing tele-care and the management of various types of alarms (water, smoke and fire, gas, fall-detection);
- the finalization of a FBK-ITEA-PAT-UniTn agreement for the setting up and management of a smart home to be used both as a showcasing and as an experimental facility;
- the organization of two events. The first one was held in May and target a local audience. It was structured around a number of working groups that discussed and produced guide lines, suggestions and state of the art views. The results were delivered to PAT, which use them to produce its strategic vision on services for families and the citizen. The second event, held in October, was the second Italian Forum of Ambient Assisted Living.

- the participation in a joint PAT-FBK working group that, exploiting the results of the May event, produced the 'Strategic Plan for AAL in Trentino' submitted to the Provincial Council.
- a strong partnership with local companies (in particular, GPI), with a general agreement being currently discussed for a large scale experimentation of advanced AAL services in Trentino.
- the invited participation in a number of international committees that have led to: the formalization of a proposal for a Joint Programming Initiative on Aging and Well Being (approved by CREST, by the European Council of Research Ministers); a proposal for an AAL Region Network, submitted to the AAAL (Association for Ambient Assisted Living); a proposal, under development, for the future AAL strategies of the Innovation Union Flagship Initiative.

Higher education

CCL has played a major role in the establishment and management of the ITC (Interfaces and Communication Technologies) 'Laurea Triennale' curriculum in Rovereto. Freshmen registration has passed from 34 for the first academic year (2008-2009) to 54 in the second and more than 65 in the third (current) one. This highly innovative course is the first in Italy (and one of the few in Europe) to integrate cognitive science and computer science in a unique perspective.

2.2. Vision and Goals

In the next 3-5 years, we will continue articulating our activities along the three main directions discussed above.

2.2.1. Research in Human Computing

CCL has identified a few areas that are crucial for the development of Human Computing activities targeting the elders. They will be pursued through it internal partnership (I3, HLT, CeRiN and CLIC), the participation in national and European projects (e.g., Netcarity), the support and coordinating actions for new European initiatives (see above), a new strategic approach to the deployment of AAL services with a major role being played by companies. Most of these activities will converge with those of Trento RISE, paving the way to important collaborations between FBK and Trento RISE on AAL.

The activities will focus on: a) the identification and analysis of aspects of human life that can improve the capability of computer system to deploy useful services in an appropriate manner to older people: static features (personality traits and dispositions, preferences, life styles) and dynamic aspects (activities executed be the person, mood, social dynamics); b) the identification of new interaction modalities for older people, with an emphasis on the indirect interaction pursued by I3; c) the development of advanced supports for people with mild cognitive disorders that incorporate results from points (a) and (b); the launch of a new research activity (in cooperation with prof. Sandy Pentland of MIT) on life logging devoted to the automatic analysis of social aspects by means of simple, wearable devices (sociometric badges).

This EP will continue to manage the activities of the Advisory Board of ACM-ICMI (the ACM International Conference on Multimodal Interaction) for the next two years. It will also manage the activities of the ICMI Society, the scientific society of the multimodal interaction community that has recently been established in the USA.

2.2.2. Strategic Activities for AAL

Trentino has gained a leading position in AAL at the national and European level, also thanks to its stakeholders' demonstrated capability of using the territory as an extended laboratory where advanced solutions are tested and deployed. We will strengthen and consolidate Trentino's critical mass (in terms of research capability, interest of the relevant stakeholders, involvement of companies, and demonstrated capacity to use technology for answering societal needs) by promoting the uptake of the strategic plan for AAL in Trentino and Trentino's role in national AAL activities.

AAL Activities

Starting from the results of the PAT-FBK group, we will launch a number of initiatives within Trento RISE characterized by the strong participation of companies and the extensive experimentation of the proposed solution in the territory. Among the technical and scientific issues, the following topics are currently being discussed.

- The development of advanced services for older people, including environmental and personal safety, on-line shopping, teletransportation, telecompany, etc.
- Social networking for older people. By this we mean both the extension of existing social networking platform or modalities (FaceBook, Twiter, etc.) to older people, and the much more interesting issue of extending the elder's physical network (her children and grandchildren, friends, communities) to a physical-virtual continuum for mutual assistance and support (e-altruism), leisure and entertainment..

European level activities

Besides the participation in EU funded projects, we intend to continue to play an active role in the definition of EU strategies in AAL, thanks to our participation in international forums (JPI, Innovation Europe Initiative).

2.2.3. Higher Education

Our involvement will continue in the ICT 'corso di laurea' in Rovereto with the goal of making it into one of the most advanced places where higher education in Human Computing is pursued. To this end, we will contribute to strengthening areas such as the international programme (seminars and talks by relevant invited speakers; student exchanges; etc.) and the connection with companies, in particular local ones. An increasing involvement is expected in the new track of the master in Cognitive Science and in the COBRAS doctoral programme. In both cases we intend to strengthen the presence of topics relevant to Human Computing and Ambient Assisted Living.

2.3. Activities and Work Plan

Activity 1. Research in Human Computing.

- We will conclude the Netcarity project, by finalizing out work on innovative services for mood control.
- Investigation of the role that context plays in the expression of personality. Shift from personality as a static trait to personality states.
- New project on life logging, in cooperation with Sandy Pentland (MIT).
- Submission of a proposal for FERS together with a local company.
- Management of the activities of the Advisory Board of the ACM ICMI Conference and of the ICMI Society.

Activity 2. Strategic Activities for AAL.

- Participation in the steering board of AItAAL
- Participation in the committees for the JPI on Aging and Well Being and on the Innovation Union Initiative.

Activity 3. Higher education

- Establishment of links with companies (stages, student projects inspired to companies' needs).
- Tutoring of doctoral students (COBRAS and DISI)

2.4. Collaborations

- University of Haifa (Tamar Weiss and Tsvi Kuflik)
- Eberhard Karls Universität Tübingen - Udo Weimar
- CIMEC-CeRiN (Gabriele Miceli) and CIMEC-CLIC (Massimo Poesio)
- Facoltà di Scienze Cognitive (UniTn)
- IDIAP - Daniel Gatica-Perez, Alessandro Vinciarelli
- MIT – Sandy Pentland
- University of Trento, DISI - Nicu Sebe
- PAT - Luciano Malfer
- IMM-CNR - Pietro Siciliano
- DFKI - Hans Uszokoreit, Jan Alexandersson
- CreateNet - Oscar Mayora
- GPI - Paolo Girardi e Giampaolo Armellin
- AAAL - Gerhard Finking

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Project proposal on AAL submitted to Trento RISE	I/A	E	April	Submission to Trento RISE of a proposal on advanced AAL services in Trentino	
Life Logging – Pilot experiment	R	E	May	Results from the pilot experiment on life logging in Trento	
Exploitation of results from Netcarity	I	E	June	Submission of Legge 6 and/or AAL-JP proposals	
Finalization of Netcarity	R	E	Sept.	Final review meeting	

4. Human Resources

2010. The resources of this Exploratory Project consisted of the coordinator and two PhD students of the COBRAS (Cognitive and Brain Sciences) doctoral school of the University of Trento.

2011. Maintaining the typology of resources exploited so far, during 2011 this EP will make available three more scholarships, two for the COBRAS doctoral school and one for DISI, starting academic year 2011-2012.

5. Risks and Mitigation Plans

Some of our activities depend on external factors not 'fully' under our control. This is especially true of the strategic initiatives we are involved for AAL at the European level. The groups we are participating in have a consultant role and there is no guarantee that the commission (or any other relevant entity/agency) will then endorse the proposals and give them way.

6. Ethical Issues

Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	yes
Does the proposal involve adult healthy volunteers?	yes

Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	yes
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	yes
Does the proposal involve tracking the location or observation of people?	yes
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

ICT4G – INFORMATION AND COMMUNICATION TECHNOLOGIES

Unit Name	ICT4G – Information and Communication Technologies	
Type	Research	
Head	Adolfo Villafiorita	
Staff	2010	2011
	1 Researcher	1 Researcher
	1 Post Doc	1 Post Doc*
	2 Technologists	1 Technologist (tbh)
	1 Technologist (part-time)	1 Technologist (part-time)
	0 PhD (2 on nov 2010)	3 PhD**
	1 Pre-PhD Student	3 MSc Students
	4 MSc Students	

Document Status: submitted 2010-11-26

***** transitioning to tenure in 2011.
****** + 2 with the 27th call, nov 2011.

1. Executive Summary

The (longer term) goal of the ICT4G is looking at novel ways of using technology to preserve and improve people's life. More specifically, the unit focuses on how to use ICT for addressing critical problems of societies with low ICT penetration in a way that life is impacted for the better. Notice that by low ICT penetration, we not only refer to developing countries (where the penetration is remarkably low) but also to societies with significant and tangible gaps that could be effectively addressed by the usage of new technologies.

The unit started operating in 2010. In spite of his relatively short history, the unit has been actively working in the area, where its role is starting being recognized both by the scientific community and by international organizations.

An investment in a new thematic area is costly and presents risks, both for the people involved and for the organization supporting it; two main questions need to be answered: "why doing it?" and "why us?".

The answer to the first question is obvious: we can simply restate the unit's mission. More in general, the initiative finds a very fertile ground in Trentino, which has a long tradition in cooperation, as demonstrated by the various initiatives in the social on which PAT is involved. Cooperation and social impact is also very well aligned with the mission of the Center for Information Technology (CIT).

Regarding the second question (why us), we need to mention that ICT not only is having a tremendous impact in improving the condition of life in the developed world, but it is also a main driver of change and innovation in the developing world. We also need to mention that ICT has been successfully used to help and support marginalized communities and the people who works with them (e.g. homeless, foreign workers).

The unit has competences in living labs/(business) process modeling/management, legal informatics, interoperability and standards. These competences have been applied in ICT4G projects by the unit and we believe have they can have a tremendous impact in fostering innovation and development alike. These competences are enablers for the delivery of standardized and interoperable solutions (fostering data exchange and analysis, reduced costs in developing and managing IT infrastructures), they change the way in which Governments operate (making them more efficient and more transparent, thus fostering also private initiatives), and they enablers for practice-based innovation and, consequently, development.

These, however, are not all the competences the group needs to nurture. The Economist published in 2010 a special related to the Telcoms in emerging markets. Two striking figures of the report include:

0) the growth of mobile phones in developing countries: "[...] in 2000 the developing countries accounted for around one quarter of the world's 700m or so mobile phones. By the beginning of 2009 their share had grown to three-quarters of a total of which by then had risen to over 4 billion."

1) the impact of mobile phones in developing countries: "[...] a ten extra phones per 100 people in a typical developing country boosts growth in DFP per person by 0.8 percentage points. [...]"

If we stick to this vision, mobile technologies will soon become both the reference tool for the deployment of ICT solutions in developing countries and an important factor of growth.

We intend therefore to grow competences in two areas that are relevant for ICT4G. The first one is mobile and the second one is development of web application, with some emphasis on security of web applications.

The group has been growing various connections with all the actors typically involved ICT4D/G projects: we mention UTICT (the technical unit for the implementation of eGovernment in Mozambique) and EICTDA (the Ethiopian Agency for the implementation of eGovernment); some contacts and collaborations are in the making with NGOs (we mention GOV2U and JEMBI); some contacts and collaborations are in place with African Universities (we mention Rhodes University, Fort Hare University, Nelson Mandela Metropolitan University, Computer Science Department Addis Ababa).

2. Vision and Scientific Program

2.1. Context and State of the Art

There is growing research interest about the usage of ICT for development. We mention ICT4G at Georgia Tech, the D-Lab at MIT, FOKUS (Fraunhofer's Institute for Open Communication Institute for Open Communication Systems), and ICT for Development Centre, University of Cape Town, South Africa.

– *Georgia Tech's ICT4D.* Michael Best leads a group and teaches at Georgia Tech on topics related to the usage of ICT for developing countries. Initiatives seem to be focused on two main areas:

  2) analysis and policies, with topics such as. e.g. how ICT can be used to promote democracy and peace; the impact of Internet connectivity in developing countries; making ICT initiatives sustainable)

  3) human computer interaction, related to examining interaction design to address the needs, desires and aspirations of people in low-income areas. Quoting from the website: "Examining interaction design to address the needs, desires and aspirations of people in low-income areas. How do we design (or why) the personal out of personal computers, the desk out of the desktop and English from the QWERTY keyboard? Should we create a community computer based on agricultural or family metaphors, for instance? What is a user or community centered design for low-income countries?"

– *D-Lab, MIT.* Similar to ICT4D at Georgia Tech, D-Lab is a program at the Massachusetts Institute of Technology (MIT) that fosters the development of appropriate technologies and sustainable solutions within the framework of international development. D-Lab's mission is to improve the quality of life of low-income households through the creation and implementation of low cost technologies. D-Lab's portfolio of technologies also serves as an educational vehicle that allows students to gain an optimistic and practical understanding of their roles in alleviating poverty. (http://d-lab.mit.edu)

  There are currently nine different academic offerings that make up the suite of D-Lab classes, falling into the broad categories of Development, Design and Dissemination. All D-Lab courses are based on the same values and principles of providing experiential learning, using technology to address poverty, building the local creative capacity, promoting local innovation, valuing indigenous knowledge, fostering participatory development and co-creation, and building sustainable organizations and partnerships.

– *Fraunhofer FOKUS*. The institute, composed of seven different laboratories, research and develops communication and integration technologies in the fields of telecommunication, automotive, e-Government, and software development. Rather active in the developing countries, we mention the NET4DC project (really a program rather than a project), about providing universal access to global communication infrastructures. Among the initiatives we mention both programmatic actions (e.g. development of a –continuously updated– roadmap towards all-inclusion; R&D projects to install an initial wireless wide-area communication infrastructure for rural deployment) and concrete projects (e.g.technical solutions and use-cases for sustainable service deployment in developing countries; a field-trial in rural Africa to evaluate real-world deployment). (http://www.fokus.fraunhofer.de/en/fokus/ index.html)

– *ICT4D@UCT.* Created in 2008 the center is a multi-disciplinary group with emphasis in HCI and Ethnography. The group seems to bring together

people with strong expertise in system development and deployment and focuses on the deployment of actual solutions. Application areas cover mobile, e-health. They also run a course with a mix of case studies and methods. (http://www.ict4d.cs.uct.ac.za/?p=142)

2.2. Vision and Goals

In shaping the long term vision of the group we focus on the following items:

4) Mission and how we differentiate from similar initiatives
5) Competences relevant for ICT4G that we have in house and competences that we need to acquire

Mission and how we differentiate from similar initiatives

The (longer term) goal of the unit is looking at novel ways of using technology to preserve and improve people's life. More specifically, the unit focuses on how to use ICT for addressing critical problems of societies with low ICT penetration in a way that life is impacted for the better. Notice that by low ICT penetration, we not only refer to developing nations (where the penetration is remarkably low) but also to societies with significant and tangible gaps that could be effectively addressed by the usage of new technologies.

When compared with similar initiatives (see, e.g., related work) our initiatives has some weaknesses, some complementarities, and some strengths. Weaknesses are mainly related to training: we do not have courses at the University or exchange programs with other countries, such as Mozambique. The strategy here is joining forces and collaborate with the University of Trento. Complementarities refer to the technical know-how we have, which nicely complements that of other initiatives, such as ICT4D @ Georgia Tech. Also the strategy here is joining forces with existing initiatives. We mention (also in order of time and maturity) Georgia Tech, ICT4D@UCT, and FOKUS.

Competences

The group at the moment is competent and recognized in the scientific community for its contribution to business process modeling, interoperability, living labs, and security analysis of processes.

Mobile is playing an increasing role in development and we also expect tablet computing and, possibly, e-readers to become an important tool for development. We therefore expect to build competences in Android development.

Approach

We intend to focus on development and deployment of applications that could either be developed in response to a specific need of a stakeholder or as an internal initiative. In the second case, the solution needs to find some kind of eventual deployment on the field.

We also need to carry one some "residual" and historical activities, such as the collaboration with ESA and PhD in Web Application Security, with the opportunity of putting it under an ICT4G perspective.

2.3 Activities and Work Plan

In 2010 the unit started building a network of contacts in the scientific community, government agencies, and NGOs. The activities in 2011 will move along the line of 2010.

The goal for next year is building a more solid ground for the initiative. In particular the following areas will have to be developed:

6) Financing & projects: we want to get funding for initiatives.
7) Networking: we want to strengthen our network and collaborations.
8) Competences: we want to strengthen our competences in the area of mobile and Android wrt to tablets and e-readers.

The unit will be involved in the organization and operations of the Maputo Living Lab, the result of a long term collaboration with UTICT and local research centers.

Applications: we want to focus effort on the development of one/two key application that could be used to directly or indirectly contribute to a better development.

2.4 Collaborations

Structural collaborations (e.g. project):

9) MLL (Maputo Living Lab), Mozambique (UTICT, Mlwane University, Business Innovation Center - Maputo, UNITN, CREATE-NET).

Being built (contacts and preliminary plans; need formalization in a project):

10) Rhodes University
11) Fort Hare University

Planned (not in place, possible new collaborations)

12) Georgia Tech. GeorgiaTech has a group working on ICT for development. We intend to investigate the possibility of collaborations and work together towards the goals of ICT4G.
13) Nelson Mandela Metropolitan University

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
MLL (Maputo Living Lab)	IRA	E	2011-2013	MLL up and running from the administration and management point of view. Some initiatives in place.	

Program Committees and AFRICOMM	R	E		Consolidate our role in AFRI-COMM	
1-2 EU Project Proposal (submitted)	A	E	2011		
Strengthen our competences on mobile/Android	IR	I	2011-2013	Some apps developed, possibly with MSc students.	Human resource availability, which is not clear at the moment

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

5. Human Resources

Between 2010 and 2011 there has been a considerable shift towards younger resources, dedicated to research.

We need to mention tenuring of Komminist, which is going to take place in 2011.

Resource	*Number*	*Name*
Researcher	1	Adolfo Villafiorita
Tenure Track (R3)	1	Komminist Sisai Weldemariam
PhD	3 + 2	Aaron Ciaghi, Birhanu Mekuria Eshete, Ilse Grau (*) + 2 positions opening in Nov 2011
Pre-PhD Grant	0	
TBH (mar-dec)	1	
Part-time	1	Francesca Longo

(*) technically a Co.Pro., but enrolled in the PhD program.

Main criticalities

Lack of technologists is going to be a problem starting this year and possibly worsening as projects hopefully come.

Three years from now, when the PhD students graduate, I expect tenuring to become an important aspect to keep the unit in good health.

6. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Staff turnover due to external constraints (e.g. short-term contracts)	H	H	Risk highlighted and occurred in 2010. It still represents the main risk for the unit.
Difficulties in consolidating partnership with new countries	M	M	Favor networking through students, personal connection, conferences.
Group size	VH	M	The group is quite compact. This will make rather difficult to exploit opportunities, if they arise.
Lack of focus on “hard” competences (risk of becoming solution providers with “nothing” to say)	H	VH	Define a few strong research lines; find collaborations; have student pursue the lines

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

NILAB – NEURO INFORMATICS LABORATORY

Unit Name	NILab – Neuro Informatics Laboratory	
Type	Research	
Head	Paolo Avesani	
Staff	2010	2011
	3 Researchers	3 Researchers
	3 PhD	3 PhD

Document Status: submitted 2010-11-26

1. Executive Summary

NILab is a laboratory devoted to neuroinformatics raised as a joint initiative of Fondazione Bruno Kessler and University of Trento. The laboratory is located in Mattarello at the Center for Mind and Brain Sciences (CIMeC). Neuroinformatics is mainly concerned with the data interpretation and data management for neuroscience. Currently the activities of NILab are focussed on data interpretation.

The main effort of NILab is devoted to research. The goal is to advance the computational methods for brain data interpretation. More in detail the orientation is to investigate how machine learning approaches might provide competitive advantages in neuroscience investigations. The ambition is to cover the wide range of heterogeneous sources of brain data that are managed at CIMeC as fMRI, DW-MRI, MEG, EEG, TMS.

The research agenda includes three main challenges that are recognized as the most prominent by the scientific community: multivariate brain mapping, real-time brain decoding, functional and structural brain connectivity. The first challenge is concerned with the design of computational methods for whole brain multi-voxels pattern analysis; the second challenge aims to deliver a learning model to perform brain decoding in real-time, creating the premise for an adaptive protocol of stimuli; the third challenge is dealing with the issue of joint analysis of funtional and structural data that should become viable using a relational learning approach.

The open challenge is to devise an effective multidisciplinary collaboration with the researchers working at CIMeC on a broad scope of areas as cognitive neuroscience, social neuroscience, neuroeconomics. Special attention is devoted to the collaboration with CERIN, a research institute on health care devoted to cognitive rehabilitation. The ultimate goal is to deliver computational methods that might be beneficial for the diagnosis or the treatment of patients.

A second objective of NILab is related to technology. A support to brain data analysis and interpretation it is expected to take place by prototyping and engineering computational tools. The delivery of software component will represent the main strategy for sharing and spreading the results of research. The impact of our activity will be evaluated not only with respect to the original contribution but also the capability of promoting the best practice.

Part of the activities of NILab is devoted to support the education of COBRAS, the international PhD School on Mind and Brain Sciences of the University of Trento. More in general NILab is aiming to become a competence center for the best practice on multivariate pattern analysis at CIMeC.

The laboratory is conceived as a small research unit composed by six persons, half of them are researchers and the other half are PhD student at the international ICT PhD school of the University of Trento.

The research activities of the next year will involve collaborations with James Haxby, Darmouth, USA; Walter Schneider, LRDC, University of Pittsburgh, USA; Giorgio Coricelli, CNRS, Lyon, France; Gabriele Miceli, CERIN, Italy; Larry Manevitz, University of Haifa, Israel.

A critical point in the workplan for 2011 is concerned with an effective strategy for funding raising. Neuroinformatics is not properly covered by the 7 Framework Program of Europe. At the same time Italy, different from the other western countries doesn't support a national research program on neuroscience.

2. Vision and Scientific Program

Neuroinformatics is concerned with data interpretation and data management for neuroscientific investigations. In Trentino there are research institutions like Fondazione Bruno Kessler (FBK), the Department of Engineering and Information Science (DISI), the Center for Mind/Brain Sciences (CIMeC) that cover all these areas of competences. The Neuroinformatics Laboratory aims to become a reference point for the interdisciplinary research between computer science and neuroscience.

2.1. Context and State of the Art

The international community of neuroscience is experiencing a new emerging awarness of the role of computer science. The Organisation for Economic Cooperation and Development (OECD) Global Science Forum promoted few years ago the International Neuroinformatics Coordinating Facilities (INCF). INCF aims to acknowledge the scientific community working on neuroinformatics, a discipline that stands at the intersection of neuroscience and information science. This research field encompasses the data and knowledge management of neuroscientific data and the deveopment of computational models for improving the understanding of brain functions.

The research effort of NILab is focussed on the design of computational models and development of data analysis tools for neuroimaging interpretation. CIMeC represents a meaningful and demanding context for NILab: the laboratory on neuroimaging (LNIF) hosts many kinds of non-invasive instruments for brain activity recording and at the same time a large team of cognitive neuroscientists. The challenge is to address the wide range of heterogeneous data coming from different sources like fMRI, DW-MRI, MEG, EEG, TMS, all of them available at CIMeC. Additional complexity arises from the recent trend of multimodal imaging where different kinds of data are acquired simultaneously.

In fMRI data analysis the reference techniques are based on univariate model and haemodynamic filter. Only few years ago machine learning approaches have been introduced in the neuroscience community to enable multivariate pattern analysis of brain data. The main advantage is to address data analysis without the restrictive assumption of the knowledge on haemodynamic response. The usual processing of fMRI data to compute brain mapping has been extended to include also an additional task called brain decoding. Brain decoding allows to estimate the mental state of a subject looking at the recording of BOLD signal. There are still many open issues related to computational methods for brain decoding, we mention only few of them. To characterize from the statistical point of view the results of a classifier is an issue that usually is not considered in the community of machine learning but it is relevant for the testing of hypothesis in the neuroscience investigation. Shaping the computation of a brain map as a problem of classification has scalability issues that prevents the delivery of effective solutions. A further source of complexity rises from the meaningful variance that affects two subsequent brain recordings on the same subject or cross-subjects.

Further challenges for multivariate pattern analysis are related to the evolution of the neuroimaging techniques. The recent development of diffusion weighted imaging introduced the possibility to obtain the functional struture of the brain. While the reconstruction algorithms allow to rebuild the structure of fibers, the problem of segmenting the main anatomical tracts is still matter of research. The complexity of the problem rises from the difficulty of co-registering two brains since the meaningful cross-subject variance.

The new frontier of brain data analysis is the join interpretation of structural and functional data. Both functional and diffusion neuroimaging enables the synthesis of abstract representation of the brain in terms of graph, namely connectome. The acquisition of competences on managing both functional and structural data is a precondition to face with the most innovative challenge in brain data interpretation.

2.2. Vision and Goals

The evolution of the research in the field of neuroscience is requiring more advanced computational method to interpret brain data. The deep understanding of brain images has to be mediated by computer which is in charge to elaborate human readable results. The challenge of designing computational method for brain data interpretation is continuously evolving because new experimental protocols are proposed and because new imaging methods emerge.

The long term vision is to become a competence center for the elaboration of neuroscientific data as a natural complement of the neuroimaging laboratories at the Center for Brain and Mind Sciences. The ultimate goal of NILab is to advance the research on computational methods for brain data interpretation. The expectation is that more powerful methods for data analysis might provide competitive advantages to the cognitive neuroscience investigations taking place at CIMeC. Close relationships with neuroscientists should provide a better focus towards computational problems relevant for enhancing the understanding of brain functions.

Technology plays a key role in our vision. We argue that a meaningful impact on brain data interpretation requires not only the design of new computational methods but also the delivery of tools. Special attention will be devoted to design and to develop software solutions which should enforce the sharing of knowledge between computer scientists and neuroscientists. To ensure a sustainable strategy we devised to join an open source software project, namely pyMVPA, that already includes main reference actors of the international scientific community.

2.3. Activities and Work Plan

The next year the activities will be organized around five main lines.

– *Activity 1 - Brain Decoding*. Brain decoding is concerned with the prediction of mental state starting from the analysis of brain activity recording. The research aims to deal with the issues of deploying a classifier on data collected from a session different from the session whose data have been used for training. The ultimate goal is to design a computational method that enables the brain decoding in real time.

– *Activity 2 - Brain Mapping.* Brain mapping allows neuroscientists to recognize which brain areas are related to a specific activity. The goal of our research is to address a twofold challenge: to deploy a solution that at the same time will support multivariate analysis and will be computationally efficient. The expected benefit will be the opportunity to interpret brain data acquired using a wider range of design protocols.

– *Activity 3 - Brain Connectivity*. Brain connectivity aims to investigate brain function looking at the brain structure as a graph where voxels are nodes and tracts are arcs. The recent techniques of diffusion imaging allow to reconstruct the fiber tracts of the brain. The research goal is to recognize meaningful anatomical tracts using supervised machine learning approach. The challenge is to perform cross-subject tract segmentation without requiring brain coregistration.

– *Activity 4 - Software tool.* pyMVPA is an open source software tool based on python to support multivariate pattern analysis of brain data. The goal is twofold: on one hand it is to acquire the skills for an extensive use with data collected at CIMeC, on the other hand it is to contribute to the development of the tool implementing new computational methods.

– *Activity 5 - Education.* COBRAS is the international PhD school on mind and brain sciences of CIMeC. The objective is to partially support the education of PhD students organizing seminars, tutorial and readings on multivariate pattern recognition of brain data.

2.4. Collaborations

– James Haxby, Darmouth, USA. Haxby is leading the group that is developing pyMVPA, an open source software tool based on python for supporting multivariate pattern analysis of brain imaging; NILab joined this initiative and is part of the team that is currently extending the software project.

– Walter Schneider, LRDC, University of Pittsburgh, USA. Schneider is the leader of the Pittsburgh Brain Competitions that since 2006 aim to propose to the scientific community a well defined challenges in brain imaging interpretation to enable computer scientists to join neuroscience research; NILab is contributing in organizing the scientific aspects of competitions.
– Giorgio Coricelli, CNRS, Lyon, France. Coricelli is working in the field of neuroeconomics and social neuroscience; NILab is working at a joint research project where to combine an investigation on neural mechanism of reputation building with a machine learning approach that enables a real-time fMRI brain imaging interpretation.
– Gabriele Miceli, CERIN, Italy. Miceli is the director of CERIN, a medical center devoted to cognitive rehabilitation. NILab is studying a computational learning method that allows physicians to interpret fMRI brain images when two subsequent acquisitions are interleaved by an innovative experimental therapy.
– Larry Manevitz, University of Haifa, Israel. Manevitz is the head of Department of Computer Science; NILab is setting up a collaboration to investigate the use of liquid state machine as a computational method to interpret fMRI brain images.

2.5. Specific Needs and Points of Attention

Despite of the fact that neuroinformatics is in between neuroscience and computer science it is not true that the opportunity for funding is twice as a single discipline. Since neuroinformatics is mainly concerned with methodological aspects of brain interpretation, it is usually considered marginal in the neuroscience calls. At the same time the European Union doesn't include neuroscience among the main application domain for ICT. In Europe research on neuroscience is mainly funded by national agencies. Differently from other countries, like Germany or France, Italy doesn't provide a specific research funds program for neuroscience. To setup a funding strategy is not straightforward and additional effort is required to recognize alternative ways of proceeding.

Currently the research effort and the focus of activities is restricted to brain data interpretation. Nevertheless the challenge of brain data interpretation is strongly related to the challenge of brain data management. The scientific community of neuroinformatics covers both of them and also in Trento these competences are available at the University of Trento and Fondazione Kessler. NILab is working to aggregate competences and interests around this research field. A major effort would be required to acknowledge this opportunity by the local government.

An additional issue is concerned with the policy to distribute brain data. Sharing data is becoming more and more a winning factor to promote own research and to increase the visibility of the institution. Nevertheless the distribution of data requires to adopt a licence that preserves the ownership without affecting the dissemination. This issue should be managed at the higher level than the single research unit.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Brain decoding	R	E	Dec.	Submission Publication	Dataset
Brain mapping	R	E	June	Submission Publication	Dataset
Brain connectivity	R	E	June	Submission Publication	Dataset
Software Tool	I	E	Dec.	Delivery soft-ware	
Education	O	E	Dec.	Lectures Seminars	

4. Human Resources

Currently the team of NILab includes 6 persons, half of them are researchers and the other half are PhD students. The researchers are qualified as follows: a senior research heading the laboratory, a junior research with a permanent position and a post-doc researcher with a tenure track. The three PhD students are distributed along different cycles of the international ICT PhD School of the University of Trento, the 25th, 26th and 27th respectively.

E-HEALTH

Unit Name	e-Health	
Type	Applicative	
Head	Stefano Forti	
Staff	2010	2011
	4 Researchers	3 Researchers
	5 Technologists	6 Technologists
	1 Technician	1 Technician
	2 PhD	2 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Main Activities

The Pervasive eHealth Unit – PeH is a *multidisciplinary group* carrying out *innovation and applied research* in eHealth area within a conceptual framework that comprises four basic activities: formulation of models and concepts, developing innovative applications, validating these applications in laboratory and on-the-field (*living laboratory*), studying the effects of these applications in several healthcare settings (clinical proof-of-concepts). This framework is implemented by methods and techniques from interaction design, a user-centered approach to design that emphasizes the importance of involving final users throughout the whole process of design of the product or system within an iterative design-evaluation process.

The activities of PeH unit will be carried out in strong collaboration at local, national and international levels and will focus on two main themes:

- Study of pervasive eHealth applications and services supporting new models of care in which citizens and patients are actively involved in the process of care (Patient-centered eHealth-PCeH).
- Study of pervasive eHealth applications and systems for healthcare operators (Clinical eHealth-CLeH) supporting the quality of the care process.

An innovation laboratory on Pervasive eHealth (SEPLab) has been established within the unit as a “inter-institutional and multidisciplinary common space” in which FBK researchers and technologist, policy makers (eg. from Healthcare department of Province of Trento and/of Ministry of Health), healthcare operators and managers (eg. from local and national healthcare institutions) and citizens share common strategies and carry out projects in the healthcare domain.

The ultimate goal of the PeH, in particular of SEPLab, is the promotion of innovation at local and national level in the domain of health and healthcare, through scientific projects aimed to introduce in the daily life of citizens and in the clinical practice of healthcare professionals innovative ehealth services, involving public and private stakeholders of healthcare domain. In this context, the PeH unit represents

one of the means through which FBK may contribute to realize the challenges of its mission.

Prominent collaborations

- Dpt. of Health, Autonomous Province of Trento
- Dpt. of Innovation and Research, Autonomous Province of Trento
- Health Care Service Authority of Trento
- Dpt. of Sociology, University of Trento
- Dpt. of Law, University of Trento
- Faculty of Art & Design, University of Venice
- Dpt..of Information and Knowledge Engineering, Danube University Krems-Austria
- Local IT companies (GPI, AMS, MTT)
- Laboratory of Applied Ontology, Cognitive Science Institute, CNR, Roma
- Istituto Regionale Studi e Ricerca Sociale, Trento

2. Vision and Scientific Program

2.1. Context and State of the Art

Industrialized countries are called to face new challenges in the health care sector due to many different changes such as:

- the percentage growth of the elderly population
- the increase in chronic pathologies
- the growing request for high quality health care services and their increased costs
- citizens' demand to be more involved and play an active role in the their own care.

To face these problems health institutions of Western countries are starting to change their policies and their organizational structures implementing new forms of social and health services focusing more on primary and secondary prevention, experimenting new model of citizens-centred care that directly involve patients and their families, creating new forms of health care services for home-based management of chronic illness.

Information and communication technology (ICTs) can help in creating this "digital infrastructure" of innovative healthcare services (e-care), providing not only health-care professionals but also citizens with technological tools to help and support them in managing health on a daily basis, easily, through different devices (computer, smartphone, TV and so on), everywhere they are (home, work, holidays).

In this context pervasive eHealth is emerging as a new interdisciplinary research field that aims at using pervasive computing, ICTs (internet, mobile and so on) and the biomedical engineering technologies (e.g. sensors) to study and design new solutions to support western health institutions in facing the challenges and

changes described above. Even though if pervasive eHealth shares some research topics with other disciplines (e.g. biomedical engineering, medical informatics, pervasive and ubiquitous computing), it has its own objectives (e.g. supporting new care models) and approaches (clinical proof of concept) that pertain to medical domain, which give this discipline a specific and distinct connotation. Some of the most relevant sub-fields of interest of pervasive eHealth are monitoring and body sensor network, pervasive assistive technologies, pervasive computing for hospitals, preventive and persuasive technologies, self-treatment e self-management, decision support systems.

A key to face the new challenges of the healthcare sector will be to implement a research and innovation paradigm with a strong multidisciplinary connotation, allowing people with different backgrounds (research, healthcare sector, public-private sector) to cooperate with a common aim sharing methods, technologies, platforms and infrastructures developed by different disciplines to create new solutions for the healthcare sector.

Previous work of PeH group has been focused on the study of eHealth applications in Heart Failure and Oncology disciplines.

- eHeartFailure was a 44-month proof-of-concept study (started in May 2002, finished in December 2005) with the overall goal of assessing the feasibility of a computer-based co-operative work framework (e-HF system) for favouring a continuous and shared care delivery among the Health Care Professionals (HCPs) involved in the management of heart failure patients on the territory of the province of Trento (NE Italy).
- In June 1997 we started a 3-year project on Medical Informatics, founded by the Italian Ministry of Health. The objective of the project was a Teleconsultation system based on an web based Oncological Electronic Patient Record (OEPR) to share clinical data between the Oncological Unit of the S.Chiara hospital of Trento and the peripheral hospitals of our Province lacking an oncological service on site. Currently, all the patients accessing the Oncological Unit are managed through the OEPR. By the end of the year 2008, the OEPR contained data of more than 12,000 patients, and it was accessed a total of about 70,000 times.
- From March 2007 to December 2009 we carried out a project, partly funded by the Fondazione CaRiTRo of Trento, for the design and development of a guideline-based Decision Support System, for supporting the decision of oncologists during the beast cancer treatment process in the Medical Oncology Unit of the S.Chiara Hospital of Trento. The system was based on the encoding of internal treatment protocols in Asbru.
- In May 2010 a framework agreement was signed between FBK and the Health Care Service Trust of Trento for constituting the eOnco territorial laboratory in the Medical Oncology Unit of S.Chiara Hospital of Trento.. The eOnco laboratory is the environment in which to implement and test innovative ICT-based solutions to support healthcare professionals in delivering cancer care and to design models to improve the process.

2.2. Vision and Goals

The general aim of the applied research unit "Pervasive eHealth-PeH" is the study of methods and models for the design, implementation and evaluation of prototypic applications and ICT-based innovative services supporting the management of data, information and knowledge in healthcare domain. The activities of PeH unit will be carried out in strong collaboration with institutions at local, national and international levels and will focus on two main themes:

- Study of pervasive eHealth applications and services supporting new models of care in which citizens and patients are actively involved in the process (Patient-centered eHealth-PCeH).
- Study of pervasive eHealth applications and systems for healthcare professionals (Clinical eHealth-CLeH) supporting the quality of the care process.

From the *innovation perspective* (along the dimensions of services toward PA and of technology transfer for companies), the mission of PeH unit is to conduct research in collaboration with FBK research units (internal "interface") and promote innovation in the eHealth domain toward local and national PAs (Health Ministry, Health departments, hospitals, etc.) and companies active in the healthcare market.

In this context, an innovation laboratory on Pervasive eHealth (SEPLab) has been established as a "inter-institutional and multidisciplinary common space" in which FBK researchers and technologist, policy makers (e.g. from Healthcare department of Province of Trento and/of Ministry of Health), healthcare professionals and managers (e.g. from local and national healthcare institutions) and citizens share common strategies and carry out projects in the healthcare domain. SEPLab, composed by personnel, competencies, knowledge, methods and technologies, carries out innovation in eHealth area within a conceptual framework that comprises four basic activities: formulation of models and concepts, developing innovative applications, studying the effects of these applications in several healthcare settings (clinical proof-of-concepts), and validating these applications in laboratory and on-the-field (territorial laboratory). Territorial labs are real life settings in which end users actively involved in the development, testing and assessment of innovation processes. The active involvement of the people and institutions in the territorial lab is gained through the adoption of techniques that allow and encourage participation at each stage of the process. In more specific terms, this framework will be implemented by methods and techniques from interaction design, a user-centred approach to design that emphasizes the importance of involving final users throughout the whole process of design of the product or system within an iterative design-evaluation process.

The Pervasive eHealth Unit has two active Territorial Labs.

- *TreC* (Citizens Clinical Record): the project aims at deploying and testing a web based platform which will become a fully working service in the next years. The experimentation at the moment involves approx. 350 people living in the Province of Trento (this being the territorial lab).
- *eOnco*: this lab involves the Medical Oncology Unit of Trento and some local software companies. The common aim is to test new software/hardware so-

lutions to support and improve different aspects of the clinical work in the Medical Oncology Unit.

The activities of PeH unit are dealing with the domain of innovative services of public utility (i-Services) and with the research program Future Internet (see Accordo di Programma of FBK 2009-2013).

2.3. Activities and Work Plan

The innovation and research activities at the PeH Unit will be organized within patient-centred and clinical eHealth areas, as follows:

– *Patient-Centred eHealth – PCeH.* Patient-Centred eHealth (PCEH) and Consumer Health Informatics (CHI) have been rapidly emerging as important, distinct fields of scientific and practical endeavour. They can be considered as a form of e-Health, focusing on applications in which the patient (or caregiver) is an active, involved participant in the management of his/her health and care. PCEH and CHI are branches of medical informatics that analyse consumers' needs for information, study and implement methods for making information accessible to consumers, and model and integrate consumers' preferences into medical information systems. The social and policy context for this research area derives from the increasing attention devoted to personalized care and empowerment of citizens in the management of their care. Personal Health Record (PHR) is a specific application that falls within the domain of PCEH. There are many PHR-related research themes including consumer research, health services research, and technical research.

  In 2010 we deployed a prototype of "TreC: la Cartella Clinica del Cittadino" (project funded by the Department of Health and the Department of Research and Innovation of the Autonomous Province of Trento) which is now currently used by approx. 350 citizens in Trento region. In 2011 we will assess different dimensions of the platform: usability and performances; users' acceptance and patterns of use; socio-organizational impact. These research activities will build on the findings of the first evaluations carried out in the last months of 2010.

  The main activities pertaining innovation for 2011 will be conducted in SE-PLab and will regard: i) 3 clinical pilot studies carried out in collaboration with the local health authority on home monitoring with patient with chronic disease; ii) the design and implementation of multiplatform applications of the TreC system; iii) development of an ontology-based system for the creation of a consumer-oriented medical vocabulary for Italian (ICMV), reflecting the different ways consumers and patients express and think about health topics;

– *Clinical eHealth – CLeH.* Despite the considerable progress in cancer prevention and treatments, studies in the U.S. and the Netherlands indicate that in the United States the quality of care provided is still sub-optimal. Pervasive knowledge-based computerized services supporting different moments

of the everyday clinical activities (e.g., care-flow management tools, guideline-based Decision Support tools), available on a variety of devices and able to provide the right information and knowledge in the right place at the right time, can promote the practitioners' compliance with state-of-the-art evidence-based medicine and improve the care process outcomes. In light of this, the aim of this activity is to analyze and model the oncological care process and design, implement, and evaluate in a real clinical setting knowledge-based services to support oncologists in the task of delivering an evidence-based cost effective oncological care of high quality to cancer patients accessing the oncological unit of the S. Chiara hospital of Trento. This activity is collocated in the Knowledge Representation for Healthcare (KRH) research stream and spans several important research topics in Medical Informatics (MI): acquisition, modelling, integration and use of medical knowledge, design and evaluation of effective knowledge-based supporting tools, semantic interoperability between knowledge-based systems and data-based systems (EHR), visualization of clinical information and knowledge.

Also in 2011 these activities will be mainly carried on under the internally funded project “eOnco JRP: Pervasive knowledge and data management in cancer care”. The general aim of the project is to study and develop an ICT-based model for fully supporting the entire shared oncological care delivery process in an oncological department, trying to partly implement what can be called the “hospital of the future” paradigm. This model will support a multidisciplinary collaborative distributed process based on the best scientific evidence. Besides the collaboration with the Medical Oncology Unit, the project involves the FBK research lines HLT and DKM.

In 2010 we started the observational activity in the Medical Oncology Unit, focused on the analysis of the complex clinical activities of physicians and nurses and of the breast cancer multidisciplinary meetings held for cancer treatment decision. From the first observational results we started to model the clinical workflow using state-of-the-art software engineering techniques (BMPN enriched with semantic annotations).

In 2011 we will carry out the complete mapping of clinical workflow in the Unit and validate the model with healthcare professionals. The model will be used to devise and propose software (services) and hardware (pervasive devices) solutions to support and improve the care delivery process.

2.4. Collaborations

PA and Healthcare local Organizations

- Department of Health(Autonomous Province of Trento) (PCeH area, TreC project). The reference person is Diego Conforti. Department of Health has co-funded the project and co-participates in the management of the project.
- Department of Innovation and Research (Autonomous Province of Trento) (PCeH area, TreC project). Department of Innovation and Research Health has co-funded the project and co-participates in the management of the project.

- Health Care Service Authority of Trento (TreC project, eOnco project)
  - Information systems. The reference person is Leonardo Sartori. Several technologists of the information system service participate in the design and development phases of TreC project, mainly on the aspect related to interoperability of TreC system with health information systems.
  - Oncology Department, S. Chiara Hospital, Trento (ClEH area, eOnco project) The reference person is Enzo Galligioni (Head of the Medical Oncology Unit.). The Medical Oncology Unit represents the “territorial laboratory” in which to test and evaluate the solutions developed by clinical ehealth area. Moreover, oncologists of the Unit are the domain experts for modelling the care process and defining the user requirements and the functionalities of the systems.
  - Other Department of S. Chiara Hospital (PCeH area, treC project). Several health operators from departments of local Health Care Service Authority participate in the design, development and test phases of TreC project mainly on the realization of the specific modules of TreC systems

Research Institutions

- University of Trento (TreC project)
  - Dpt of Sociology. The reference person is Alberto Zanutto. Researchers of sociology department participate to the needs assessment, requirements definition and on-the-field tests of the treC system
  - Dpt of Law. The reference person is Umberto Izzo. Researchers of law department participate to the study of the legal aspects related to the use of TreC system.
- Istituto Regionale Studi e Ricerca Sociale (IRSRS), Trento (TreC project). The reference person is Francesca Gennai, PhD. The collaboration is specifically aimed at research & educational projects that involve elderly people.
- Dpt. of Information and Knowledge Engineering - Danube University Krems-Austria (ClEH area) the reference person is dr. Silvia Miksch (Head of the Dpt. of Information and Knowledge Engineering)
- who is head of the group that maintains the formal guideline representation language Asbru and the Asbru interpreter. We use the Asbru language in the Oncocure project and we intend to continue the collaboration in 2010 for the evaluation and the extension of the DSS developed in the course of this project.
- Laboratory of Applied Ontology, Cognitive Science Institute, CNR, Roma (ClEH area, eOnco). The reference person is Domenico Pisanelli. who is an expert of ontologies in medicine. The collaboration regards the design and development of ontologies in the cancer domain (e.g., an ontology of therapies) for favouring both the unambiguous communication between doctors and computer scientist and the semantic interoperability between different software systems (e.g., an Electronic Healthcare Record and a guideline-based DSS).
-

Local Companies

- MTT pro (SEPLab area , eOnco project). The reference person is Michele Galvagni. MTT pro is the company that owns and maintains the Electronic Healthcare Record used int ht eMedical Oncology Unit of the S. Chiara Hospital. Hence, the collaboration regards the integration, at data and user interface level, of the knowledge-based support tools designed by our line.
- Argentea (SEPLab area, Trec project). The reference person is Giampaolo Armellin. Argentea participates in the TreC project in the development and tuning phases of the TreC system.
- AMS Trento (SEPLab area, Trec project). The reference person is Andrea Gardumi. AMS participate to the TreC project in the study and integration of homecare solutions into the TreC system.

Patients Associations

ALIR Trentino -Associazione per la lotta all'insufficienza respiratoria; TBM Tribunale del malato; Associazione Alzheimer Trento; ATMAR - Associazione Trentina Malati Reumatici; Associazione Nuovi Orizzonti; ANMIL - Associazione Nazionale Mutilati e Invalidi del Lavoro; AMIC - Associazione Mediatori Interculturali; FAP - Federazione Nazionale Anziani e Pensionati ACLI; ADGT - Associazione Diabete giovanile Onlus; ATD - Associazione Trentina Diabetici; DCA - Distubi Comportamento Alimentare; SPI - Sindacato Pensionati Italiani- CGIL; Lega Pasi Battisti; ANMIC - Associazione Nazionale Mutilati ed Invalidi Civili; Coperativa Handicrea.

2.5. Specific needs and Points of Attention

The deployment of TreC requires a careful attention to some specific issues such as people's acceptance of the technology, privacy and accessibility problems, integration of the system in the existing healthcare infrastructures, organizational problems in managing patient-created information and their integration in the workflow. These dimensions will be explored through distinct research actions aimed at analyzing both the technical and socio-organizational effects of the deployment of the system.

As regards the eOnco activities, a particular attention must be posed when introducing new software/hardware tools in a clinical environment in which there exist established work procedures, since features of ICT intended to improve patient care can lead to rejection of ICT, or can produce unexpected negative consequences or unsafe workarounds if poorly aligned with the existing workflow'.

3. Goals

Goal 1 Assessment of TreC system (basic functions) in the Province of Trento

Description: The Base module of TreC (online clinical reports, generic health personal observations) will be assessed through the use of qualitative and quantitative methodologies. The evaluation will focus on both technical and social aspects of the sys-

	tem. From the technical standpoint, the objective is to increase the functionalities and the stability of the system while expanding the number of users (2000 before the end of 2011). From the social standpoint, we aim at understanding which changes it brings about in the ways medical data are collected, visualized and accessed.
Type:	Innovation (50%), Applied Research (50%)
Scope:	External
Time Frame:	December: overall evaluation of the trec system
Measurement plan:	Number of citizens using the basic module of TreC.

Goal 2 Technical and clinical proof-of-concept of disease-specific modules of TreC system

Description:	Specific modules of TreC regarding new models of care will be conducted al least in the areas of diabetes, heart failure and asthma. Homecare technologies (devices for the measurement of vital parameters) will be integrated in remote monitoring applications. Final users (chronic patients and healthcare operators)will be involved through user-centered design approach. Technical proof-of-concept will be conducted in a laboratory setting for testing usability. Clinical proof-of-concepts will be conducted to test new model of care based on TreC.
Type:	Innovation (60%), Applied Research (40%)
Scope:	Internal/External
Time Frame:	June: design and technical proof-of-concept of the modules for diabetes, heart failure and asthma December: clinical proof-of-concept of the modules for diabetes, heart failure and asthma
Measurement plan:	Number of specific modules designed, realized and tested.
Pre-conditions:	Implementation of specific modules is subject to the active participation of local healthcare organization (Azienda Provinciale per i Servizi Sanitari)

Goal 4 Definition of a complete nurse process model

Description:	In the course of 2011 the BPMN model of the nurse work processes will be completed with be completed and will cover the four activity fields identified in the Medical Unit: admission, patient management, diagnostic and laboratory test management, and pharmacological therapy administration. The model will be enriched with the semantic annotations

	that will allow automatic reasoning on the model. The process midel will be presented to the Unti staff to analyze and discuss its correctness.
Type:	Innovation (20%), Applied Research (80%)
Scope:	External
Time Frame:	May: complete model of the nurse oncological care process
Measurement plan:	The BPMN model of the process with semantic annotations.
Preconditions:	Analysis of the care process is subject to the active participation of the local Medical Oncology Unit

Goal 5 Definition and of devices and services .to support the nurse care process.

Description:	Once computer sciences and healthcare professionals have agreed on the model, it will serve to discuss which devices and services can be introduced in the process and the process activties that could beneficiate of such tools. ICT-based tools, infact, must be carefully introduced in a clinical work environment in order that they don't disrupt the workflow causing their rejection by the final users. Upon the identification of services, test deployments could be made.
Type:	Innovation (60%), Applied Research (40%)
Scope:	External
Time Frame:	September: identification of possible devices/services. December: test implementation of one/two services.
Measurement plan:	The list of device and the specification of services.
Preconditions:	Identification of process tasks that can be supported by ICT

4. Human Resources

Pervasive eHealth unit can be ideally thought as constituted by two subgroups working in close collaboration and focused on applied research and innovation with different perspectives. A group composed by three researchers and two PhD students would be mainly focused on research topics and would aim to publish research papers and participate to conferences and workshops. This subgroup represent the interface toward the FBK research units and the "external" interface of eHealth unit toward scientific communities focused on specific research fields and themes (e.g. knowledge management in healthcare). A second group composed by six technologists and one technician would be more focused on the design and development of eHealth systems and services in a perspective of innovation in eHealth arena. This subgroup represent the "external" interface of eHealth unit toward the local and national community of stakeholders involved in eHealth and

should be mainly focused on the study of innovative services in healthcare (e.g. personal health record).

5. Risks and Mitigation Plans

Major risks are related to the deployment of TreC system on the field. In particular:

Description	*Prob.*	*Impact*	*Contingency*
Limited use of TreC system by citizens	M	S	Not foreseeable
Scarce cooperation from Health Care Service Authority in the realization of disease-specific modules of Trec	M	S	Not foreseeable

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

SoNet – Social Networking

Unit Name	SoNet – Social Networking	
Type	Research	
Head	Paolo Massa	
Staff	2010	2011
	1 Researcher	1 Researcher
	1 Technologist	1 Technologist
	1 PhD	2 PhD
	2 Developers	2 Developers

Document Status: submtted 2010-11-26

1. Executive Summary

SoNet is currently an explorative project, started in 2008. This section summarizes activities and goals for 2011. SoNet is a relatively “young” group whose focus is on Social Networking and Collaboration Systems. The planned activities relate to two main areas: (1) research and (2) knowledge and technology transfer.

About research, we should mention that Social Networking is a young and rapidly and tumultuously growing research field. For this reason, we tried to identify a niche in which we could reasonably achieve success (i.e. publish papers). The idenfied niche is related to users activities and their sociality inside Wikipedia, also with an attention on how they create collective memories.

About knowledge and technology transfer, we have created and maintained a broad and fruitful set of relationships with local actors and in particular with the local public administration , which acknowledge us as the main local experts on social networking, open source ad related movement (like wikipedia and openstreetmap). We will keep and strengthen this relationship and put it at work with real projects and by increasing the dissemination of the open movement (source, content and data).

Wikipedia and open source can be as two examples of how people collaborate through the Web and our goal is to both study this important and disruptive phenomenon and to transfer knowldge and technology about it in order to exploit the opportunities it offers.

The topics of SoNet are of great relevance also for the newborn Fondazione AHREF (founded by FBK, PAT and Informatica Trentina). For this reason the goal of 2011 will be also the creation of synergies with this new player.

2. Vision and Scientific Program

2.1. Context and State of the Art

Social networking and Web2.0 are two of the most important trends in the current technology scenario, able to shake and completely redefine our societies and the daily activities of the world inhabitants. It is a change in how the Web is conceived as an enabler, a platform and its conceptualization of social interactions among humans.

Social networking sites (SNS), such as facebook.com, youtube.com, myspace.com, wikipedia.org, flickr.com, linkedin.com, twitter.com, etc, are currently referred as normal part of the daily activities by newspapers and general public discourse. The number of users of those SNSs counts in the hundreds of millions each and it is increasing daily, as new users start using them in order to share knowledge, collaborate and interact socially with already exiting friends and acquaintances and to meet new ones.

The fact users typically create contents, often through collaboration, in these systems is possibly even more impacting our world. Users are often referred as prosumer, a combination of the terms “producer” and “consumer” in order to underline their new active role. In this context, a niche subcategory is the creation of memories and how people collectively create and maintain their collective memories.

Research about these new forms of collaboration and interaction mediated by ICT tools have boomed recently since SNSs provide an incredible mean for studying social phenomena as they occur in the large. Research about SNSs and Collaboration Systems involves fields as diverse as sociology, economics, anthropology, political science and, of course, computer science as a basic tool enabling them and providing ways to analyze them.

We believe it is crucial not only to study this important topic but also to transfer knowledge on how to best use it and exploit its disruptive power.

In fact, from a technological point of view, it is more and more crucial to be able to “deploy” SNSs systems in different contexts, for example for improving collaboration among geographically spread people.

Open source is another disruptive phenomenon that can be considered an example of how people can create resources collaborating through the web. This form of creating software artifacts is becoming more and more important and acknowledged and it is crucial for the local actors (in particular the public administration) to understand and profit from this topic and the related ones such as open data and open content.

SNSs and collaboration systems are relevant also in the broader context of Social Media. With this regard, it is intention of SoNet members to continue and strengthen the collaboration with the newly born AHREF foundation.
Summaryzing, we believe Wikipedia and Open Source are two important examples of a trend which is changing our society and we believe it is crucial to have a group in FBK which study them and is able to transfer the related knowledge and technology.

2.2. Vision and Goals

SoNet is currently an explorative project, started in 2008. We envision SoNet to become a stable unit. Nevertheless, our time horizon for this document is just one year.

2.3. Activities and Work Plan

Activities are grouped into 2 categories: research, and knowledge/technology transfer.

Research:

The research activity is focused on sociality and collaboration among users in Wikipedia.Wikipedia is a huge and ongoing experiment of collective creation of knowledge. Millions of people are creating, without being paid, millions of pages of an encyclopedia in more than 260 languages; an encyclopedia whose quality is comparable with others built in more traditional ways.

Many questions about Wikipedia remained unexplored and open. While research has focused on content (pages, categories and their quality), less work has been done on studying people who create this content, about their characteristics, motivations and the social structures they create inside the socio-technological platform.

The specific lines are the following.

1. Sociality in Wikipedia: how Wikipedians collaborates? What do they talk and negotiate about? In which communication structures? Are these networks different from other known networks (facebook, but also the Web or road network)? We will also study sociality in a longitudinal manner: what are the differences between English Wikipedia when it had 100 users and now that they are more than 13 millions? Moreover, are there differences among the Wikipedia in the different languages, such as the French, Spanish and Vietnamite one, for instance?
2. Information extraction: dumps about every activity occured in Wikipedia are available. However the dimension of the dump for the English Wikipedia is of 5.6 Terabytes. Processing this huge amount of information is challenging from a content point of view (what can be extracted) and also from a technological point of view. The goal here is to provide a foundational research on social network extraction from Wikipedia, releasing as open source the different algorithms created and to write a paper explaining them along with the release of social network datasets. This paper might receive many citations and position SoNet as central at the international level about this topic.
3. Collective Memories formation in Wikipedia: the PhD activity of Michela Ferron (advisor Paolo Massa) focuses on this activity. The assumption is that pages about traumatic events such as September 11 or London and Madrid terrorist attacks can be analyzed in the framework of collective memories research from a quantitative point of view. The Wikipedia page

about the London attacks, for instance, has been created 28 minutes after the first explosion and has received 2000 changes just in the very first day of existance.

4. Gender in Wikipedia (in collaboration with the internal inter-centers project GOSH). The specific research questions are: is there a correlation between a Wikipedian characteristics (content focus, edit activity, …) and his/her gender? Is a female more likely to become Wikipedia admin in an election?
5. Personalized Wikipedia: is it possible to personalize pages of Wikipedia from the very subjective point of view of each user? What such a system would unveil about how people build and imagine knowledge, reality and objectivity?

   Summaryzing, the rational behind this line of research is that Wikipedia provides many enlightening social dynamics which are still largely unstudied. Our goal is to become one of the leading experts in worldwid research community.

Knowledge and technology transfer:

From the beginning of Sonet, there was a strong attention to the technological side of Social Networking and collaboration Systems. This is a rapidly evolving field and it is important to experiment with it in order to be aware of the recent trends and effectively transfer them.

The first activity carried on by SoNet waw the creation of an internal application of knowledge sharing among employees of FBK. The software, known as FBK "desktop.fbk.eu" and released as open source on the site http://taolin.fbk.eu, has allowed the group to study the technical issues and social inclusion tools web2 .0 in the company (Enterprise 2.0). The first months of 2011 will be dedicated to the transfer of know-how and technology to the offices of internal service in FBK.
In 2001, our empirical transfer of technology and knowledge will continue mainly focusing on two specific concrete projects with two local partners: the association Trentini nel Mondo and the company Tassullo. The goal is to create, launch and study two social networking and collaboration platforms. The first one is designed to create a collabortive place on the Web where Trentino people who are leaving outside of Italy can remain in contact and enrich Trentino with new social and economic opportunities. the second social platform will be designed to fulfill the goal of Tassullo company to create a single global marketplace for restorers worldwide in order to empower collaboration and make Tassullo a central player in the world market. We will also release as open source a Dynamic Carpooling prototype whose goal is to enable collaboration among seekers and suppliers of car rides.

We also believe the local public administrations would benefit from a greater understanding of the opportunities offered by Social Networking tools and Collaborative Systems.

In particular, the topics of open source, open content, open data is becoming more and more relevant for administrations. It is goal of SoNet to transfer knowledge about how the PAT can best exploit existing open source softwares and how to release the software it commits. As a matter of fact, most of the software created

by SoNet is already released as open source, see for example http://taolin.fbk.eu, https://github.com/morail/wiki-network/, http://nevede.com, http://dycapo.org

For instance, SoNet will be involved in a first project for the choosing an open source software license for the CSS project, which also includes dissemination and transfer of good practice for the management of open source projects. Most of these projects are also a source of fundraising whose projects have already been accepted.

Part of the activity of knowledge transfer will also be in the frame of the internal project "Research as a profession" through seminars and projects with schools of Trentino. Topics covered will include: open source, open content, open data, Wikipedia, OpenStreetMap, the use of open source GIS tools, the use of Web2.0 tools in school, etc. ....

2.4. Collaborations

– AHREF Foundation - synergies in research projects of research in social media

The E-gov unit of FBK about the problematics in open source software

Tassullo s.p.a about the creation of a social network platform for restorers

Trentini nel Mondo ONLUS about a collaborative platform where people from Trentino in the World and people from the local country can exchange ideas to create economic and cultural projects

The unit of Innovation FBK, especially for the project "Research as a profession"

Informatica Trentina – Giulio De Petra, Isabella Bressan, Marco Combetto for the projects in public participation

internal inter-centers project GOSH.fbk.eu

HLT in the context of project LiveMemories and the study of collective memories in Wikipedia

2.5. Specific Needs and Points of Attention

Collaboration with AHREF still needs to be better defined and depends a lot on which researchers and thinkers they will employ and when this will occur.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Papers about social networks and collaboration among users in Wikipedia as explained above	R	E	Dec.		
Papers about how communities build and	R	E	Sept.		

maintain their memories in Wikipedia (LiveMemories project)					
Trentini nel Mondo - collaboration platform	A	E	May		
Transfer of know-how and technology to the internal FBK group of l communication on the platform desktop.fbk.eu	I	I	March		
Support for the FBK project "Research as profession"	I	I	Dec.		Currently there are projects to be agreed with schools of Trentino
Open Source licensing and modality for the CSS project	I	E	August		The project was held in conjunction with the e-gov unit of FBK
Support for the social network platform made by Tassullo spa	O	E	Dec.		The project is the result of a grant from the European Social Fund won in 2010 by Tassullo spa.
Joint projects with AHREF about fact checking and social media and collabortive journalism	I	E	Dec.		Depending on when AHREF will hire researchers
Become a representative for the local public administration on the issues: open source, open data, open content, Web2.0, social networking, ICT tools that promote collaboration and content creation	I	E	Dec.		

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if c)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the gSpecific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

Paolo Massa, researcher

Maurizio Napolitano, technologist

Michela Ferron, PhD student at CIMEC unitn

Asta Zelenkauskaite, PhD student at Indiana University, USA (completing thesis).

Marco Frassoni, developer

To be hired developer, (to replace Davide Setti, who went to work for AHREF in November 2010).

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Collaboration with AHREF does not focus on concrete projects	L	M	It depends on which researchers AHREF will hire and when.
CoPro programmers going to work for other entities (AHREF, SayService, …) and our difficulty in replacing them with skilled programmers .	M	S	

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C – Catastrophic

6. Ethical Issues

Informed Consent	
Does the proposal involve children?	
Does the proposal involve patients or persons not able to give consent?	
Does the proposal involve adult healthy volunteers?	
Does the proposal involve Human Genetic Material?	
Does the proposal involve Human biological samples?	
Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
Does the proposal involve Human Embryos?	
Does the proposal involve Human Foetal Tissue / Cells?	
Does the proposal involve Human Embryonic Stem Cells?	
Privacy	

Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
Does the proposal involve tracking the location or observation of people?	yes
Research on Animals	
Does the proposal involve research on animals?	
Are those animals transgenic small laboratory animals?	
Are those animals transgenic farm animals?	
Are those animals cloned farm animals?	
Are those animals non-human primates?	
Research Involving Developing Countries	
Use of local resources (genetic, animal, plant etc)	
Impact on local community	
Dual Use	
Research having direct military application	
Research having the potential for terrorist abuse	
ICT Implants	
Does the proposal involve clinical trials of ICT implants?	

FREEIT – FREE INFORMATION TECHNOLOGY

Unit Name	FreeIT – Free Information Technology	
Type	Research	
Head	Bruno Caprile	
Staff	2010	2011
	2 Researchers	1 Researcher

Document Status: submitted 2010-12-01

1. Executive Summary

The FreeIT exploratory project aims at fostering the Free Culture in the Information Technology domain, with a special attention to the new generations and the public dimension of innovation. Broad in scope, but sharp in aims, the project targets the local (Trentino) society with focused, joint initiatives sharing a common inspiration: to apply the ideas and the devices characteristic of the Free Culture to the innovation of educational programs and the public administration and services. The project builds on the competence and experience gained in a series of initiatives carried out in the recent past, and leverages on a solid network of connections established with several territorial agents. Over the last two years, *OpenStreetMap*, the open initiative aimed at building a free world map, has represented a vehicle of promotion and a reference of sort for the FreeIT project. As a planetary-scale, successful application, OpenStreetMap provides in fact a paradigmatic, almost ideal example for introducing the Free Culture principles in a variety of education and innovation contexts. Entering its third year of life, however, FreeIT is mature to pursue new avenues and opportunities. In particular for 2011, we identify the problems arising from the free, participatory construction and reuse of data managed by public administrations, as a new, concrete challenge for the project.

In 2010, a joint initiative was started for the definition of guidelines and protocols enabling the public (commune) administrations in Trentino to release selected data for public reuse. The project, carried out with the partnership of the Consorzio dei Comuni Trentini has already brought interesting results. In particular, a study was carried out on the acquisition process and the deriving property rights for a class of digital data that the municipalities generally own and employ (e.g., toponomastic; cadastre). In 2011, we expect to define a first version of an open framework for the release of data for public reuse, thereby establishing a best practice to be followed, propagated and expanded. While mostly concentrated on this task, in 2011 FreeIT shall not reduce its continuing commitment with the world of education. In particular, two projects shall be carried out in collaboration with the high schools system in Trentino (for which FBK has signed protocols of agreement with several high schools), and with a non-profit organization active in the social/young generations domain. For what concerns the high schools, we will support teachers in the organization of hands-on labs and classes, aimed at the acquisition of the (legal)

notions and (technical) skills necessary to master the production and reuse of *free contents.* With a non-profit association based in Povo (Cooperativa sociale Kaleidoscopio), we will finally build a reference point (a lab, enriched with educational events) for the local community of young people, dedicated to the practice and dissemination of free software and other topics related to the Free Culture.

2. Vision and Scientific Program

As it is by now widely acknowledged, the onset and development of the Information Society is characterized by the emergence of new frameworks for the production, distribution, sharing and reuse of digital contents. Especially interesting among these, are the so-called "*Commons-based peer production*" models, aimed at inviting participation in the construction and use of knowledge. While, for example, mathematics has for centuries enjoyed an (almost) undisputed status of "common", very different has been the situation in other realms of knowledge, in the sciences, in the humanities, and in the arts in general. Dating back to the seventies of the past century, the free software movement has represented the first, and perhaps most lucid attempt to create a common of knowledge in technology, based on the elegant and uncompromising licensing device known under the name of General Public License (GPL). This is the license that has made the operating system GNU-Linux possible, beside serving as a standard reference for the generations of free licenses to come.

In this perspective, Creative Commons (CC) is perhaps the most systematic and promising initiative aimed at evolving the spirit and approach of the Free Software movement, widening the range of application to images, videos, texts, music, educational material, and virtually any kind of digital contents. Established in 2001 as a nonprofit organization, Creative Commons is devoted to building a system of copyright licenses allowing authors to effectively communicate which rights they elect to reserve, and which ones they waive for the benefit of recipients or other creators.

Simple as it may appear, the Creative Commons mechanism has been extremely successful and pervasive worldwide: most of wikipedia's contents, counting millions of articles, and estimated 350 million visitors per month, are released under CC licenses. OpenStreetMap, now migrating to a license more suited to highly structured data (the Open Database License), was born and has flourished under a CC umbrella. Today, the amount of digital contents circulating with a CC license is immense, and a series of search/indexing tools have been developed for seamlessly locating contents published in the Web with specific licensing rules. Based on the free licensing of educational material are also the Open *Learning* programs at several universities, and the Open Access paradigm for scholarly publishing.

The (free) license is therefore at the heart of free culture. It should be acknowledged, however, that the relationship between free licenses and the contents they made available may not be immediately perceived by the public (and policy makers alike), accustomed as they generally are with more traditional, proprietary frameworks. But much has been moving in the last few years. Starting

with the US, public administrators worldwide have progressively gained awareness of the benefits deriving from free licensing, especially when associated with enforcement of open formats. In Europe, the forerunner of the movement for what concerns the public administrations are the UK, with the *data.gov.uk* project and portal. In Italy, several public administrations have set up an infrastructure for the release of free data, with the Regione Piemonte as perhaps the most advanced example (see http://www.dati.piemonte.it/). At the national level, the European directives have started being enforced, after many years of uncertainty. In particular, the first version of an open license for data (the Italian Open Data License v1.0) was recently released.

2.1. Context and State of the Art

Quite a few people and research groups at our Foundation have been active on issues related to the dissemination of Free Culture in the last ten years. Let us recall here the early experiments of all free software labs at WebValley, since the first edition of the summer camp (2001), and the contributions given to the development of the GRASS Geographic Information System.

Starting in 2004, we have contributed to the E-Society Project promoted by the Provincia Autonoma di Trento, serving in two of the advisory groups of the project. The first task-force focused on Interoperability and Open Source Software, drafting recommendations for the local government; the second group worked on Education and Digital Literacy. As for interoperability, the advisory group issued a series of recommendations, later enforced by a local government decree. At the time of writing, a survey to assess the degree of awareness of the public administrations in Trentino towards free software and interoperability is being administered for the second time, following a first survey completed in 2007.

As for education and digital literacy, the task force recommended a series of actions aimed at improving the technological infrastructure and a more competent use of technology in the classroom. The task force also recommended that the student's skills in managing digital information contents be closely monitored, especially for what concerns (self)awareness in the use of technology and digital literacy in the social dimension. A project (SYLLABUS) was therefore carried out for the study and implementation of a methodology for the assessment of the digital competence of teen-age students.

As a contribution to the dissemination of the Free Culture models and opportunities, in the last two years we have carried out a variety of promotional activities, organizing discussion events (e.g., "Si può fare", in 2008), organizing (e.g., OSMIT 2009) and participating to national and international conferences (UMAP 2009). We have also been consistently committed to education, developing and offering introductory tracks for students (starting from the 2nd grade!) and teachers, in which the emphasis is set on the nature and management of information as opposed to the mere "apelike" usage of the PC. In 2010 we have organized a series of seminars on the principles and practices of open contents (software, data, and multimedia), dedicated to a wide public of scientists and administrative personnel.

2.2. Vision and Goals

The project is exploratory. As such, underlying vision has been outlined in the previous section. The foreseeable outcomes and goals are short term (2010), and are described in the coming section.

2.3. Activities and Work Plan

In 2011 the project shall concentrate on three activities already started in 2010, and shall pursue new opportunities for application.

The first project is developed with the collaboration of the Consorzio dei Comuni Trentini and the communes of Rovereto, Riva del Garda, Storo, Stenico and Mezzolombardo. The objective of the project is to define a model and a protocol for the free licensing of data owned by the municipalities. administrations, and especially communes, produce and use large amounts of digital data. It would be very interesting if at least some of these data could be recirculated in the community at large, favoring participation, and strengthening the bonds with the natural and anthropic environment. Appealing as it may seem, the goal is not straightforward to achieve: a) digital data of interest come to the disposition of the administrations through a variety of means and processes. Not always, in fact, the communes are the legal owner of the data they use; b) mostly for cultural reasons, public administrators are also generally unwilling to release data if commercial exploitation can be foreseen – an attitude inspired by a noble defense of the public interest, that turns in many instances counterproductive; c) data often contain private information, unsuited for public use. Privacy and security have to be properly addressed. A way to overcome these difficulties and disseminate viable solutions, is to make a joint effort to develop an “how-to” guide (a protocol) able to support the public administrations in the release of data, providing a set of best practices, as well as technical and legal guidance.

In the framework of the agreements that FBK has signed with several high schools in Trentino, the FreeIT project shall provide support for the education of the young generations to the construction of shared knowledge, and the acquisition of a more mature awareness in the comprehension and use of technology. Continuing with our long-lasting commitment, in 2011 we will collaborate with teachers in the construction of hands-on labs, delivering also a series of lectures centered on the use of free georeferenced data for enriching the discovery and acquisition of cultural heritage contents.

The third initiative that will be carried out in 2011 consists in supporting a group of teen-agers and students approaching the world of free software. The project (StayOpen) is developed in collaboration with the Cooperativa sociale Kaleidoscopio, and is partially funded by the municipality of Trento through a program dedicated to the young generations. The projects aims at creating a (physical) lab based on free software, inviting participation and open to the local community. More specifically, FreeIT will help a core group of participants in the learning and growth process. This will span the acquisition of the necessary technical skills, the management of the lab and the instruments, the connection with other developers and users, and the dissemination of the culture.

2.4. Collaborations

- Consorzio dei Comuni Trentini and several municipalities of the Trentino Province, as partners in the definition of a protocol for the release of public administration data.
- Liceo Rosmini, Rovereto, as part of the agreements established with the educational systems of Trentino.
- Cooperativa Sociale Kaleidoscopio, for the StayOpen project. The municipality of Strigno, for a joint project being proposed in the domain of territorial awareness for the young generations.

3. Goals

- To complete and experiment with a protocol for the release for public reuse, of data owned by Trentino's municipalities;
- To support the Consorzio dei Comuni Trentini in the joint initiatives for the innovation of the public administration.

4. Human Resources

One junior researcher.

5. Risks and Mitigation Plans

As all exploratory enterprises, the project brings with it also a fair amount of risk. However, the bigger challenge to the success of the project may not lie in its technical or intellectual difficulties, as much as in its capability of communicating the importance of the problems it tries to tackle, and the symmetric capability by public institutions to receive, with awareness and determination, what the project has to offer on the innovation game.

E-GOVERNMENT

Unit Name	e-Government	
Type	Research	
Head	Michele Trainotti	
Staff	2010	2011
	3 Technologists	3 Technologists

Document Status: submitted 2010-11-26

1. Executive Summary

Innovation in the key area of interoperability and e-Government is a process that, to be effective, requires a strong collaboration between public administrations, research institutes, private companies and users. This collaboration is also the key that allows the public administration to offer its citizens efficient services at reasonable prices.

Consistent efforts were made in the past in the Autonomous Province of Trento (PAT) to foster a collaboration between the different groups working in the domain of e-Government. However, despite these efforts, a common strategy that could identify the roles of the different actors in this area has yet to be defined. This is the main reason why the potential offered by research in this field has not yet been fully exploited.

The *e-Government unit* at FBK is a small and flexible group that has the goal of providing support for those activities and projects that aim at surpassing the current situation and developing a global strategy for Trentino in the area of interoperability and e-Government.

The e-Government unit is composed of three people: the unit coordinator and two project managers. The small number of personnel is a strength of the unit, allowing flexibility and ease of management. All the members are capable of working autonomously and have several years of experience in the areas of research and/or project management.

The e-Government unit aims at facilitating the creation of strategic collaborations, incubating project ideas, identifying market opportunities, proposing strategic solutions for Trentino.
The unit has active collaboration with several local companies (GPI, Dedagroup, Engeneering…), with local public administrations (Municipalities of Trento and Rovereto, Province of Trento), APSS (the local healthcare agency/center), Informatica Trentina and research groups in FBK (DKM, E-Health).

To accomplish its goal the e-Government unit will focus its effort in two areas:

- Defining and deploying of the system for “Cooperazione Applicativa” in Trentino.
- Managing and participating in innovation projects.

The expected result of the effort in these two areas it to empower the collaboration network with the public administration, research and companies, and to develop a cluster of e-government projects that will be managed by the unit.

2. Vision and Scientific Program

2.1. Context and State of the Art

Innovation in the key area of interoperability and e-Government is a process that, to be effective, needs a strong collaboration between public administrations, research institutes, industries and users. This collaboration is also the key that allows the public administration to offer its citizens efficient services at reasonable prices.

Consistent efforts were made in the past in the Autonomous Province of Trento (PAT) to activate a collaboration between the different actors working in the domain of e-Government. However, despite these efforts, a common strategy that could identify the roles of the different actors in this area has yet to be defined. This is the main reason why the potential offered by research in this field has not been fully exploited.

2.2. Vision and Goals

Innovation projects in the e-Government domain are one of the key driver to the development of a region. In particular, innovation projects:

- can drive the development of public administrations, because they allow it to give its citizens efficient services, contributing to improve productivity indices of the territory;
- can stimulate the research world, because they force researchers to tackle real problems, to define precise research directions, and allow them to easily measure the impact of their work;
- are an important resources for companies that, working in a close partnership with the public administration and the research groups, can acquire on one hand a field knowledge of the real problems of the PA, and on the other hand the skill to apply those novel technologies and methods that can assure a competitive advantage.

One of the condition to be able to activate the collaboration between PA, companies and research groups, is to identify the areas that will enable the definition of a common vocabulary between these subjects, so to minimize miscomprehensions and build a common strategy that will decline single individual strategies in a shared framework. The adoption of the service on demand paradigm for the management of the interaction between different agencies and offices in the public administration, and the eventual adoption of a SPCoop solution for the interoperability at the regional level, will represent the key factor to enable the virtuous collaboration described above.

The development of a technical and organizational solution for interoperability will allow:

- the public administration to decrease its costs by avoiding multiple processing of the same information, thus providing faster and more efficient services;
- research groups to face problems of process complexity management and service interaction requirements, such as semantic processing, monitoring, requirement study and so on;
- companies to measure themselves with complex challenges and suggest innovative solutions that will represent a competitive advantage of strategic importance when competing in the national and international market.

The e-Government unit plans to work proactively to support and facilitate the path of the local public administration towards a tangible and correct declination of the system for “cooperazione applicativa”. In addition to managing and participating in innovation project that will further this vision, the e-Government unit will carry on activities with the goal of coordinating the wide range of ongoing projects carried out by different actors in this domain.

2.3. Activities and Work Plan

A number of internal (in FBK) and external (PAT and Informatica Trentina) surveys allowed us to define precisely the activities in which the research unit will focus its efforts in 2011:

These activities can be divided in three groups:

- A1 – Activities in support of the information system for territory and environment (SIAT)
- A2 – Activities to deploy the system for “Cooperazione Applicativa” in Trentino.
- A3 – Activities to integrate projects in the areas of healthcare and social policies

A1 Activities in support of SIAT. This activity consists of managing the transition of the project IET (Interfaccia economico territoriale) from prototype to production. The IET project realized a software prototype that, combining territorial data with statistical data from social and economy domain, can provide a support for city planning and land management.

The support provided by the e-Government unit will aim at integrating the IET software in the information system for territory and environment.

A2 Activities to deploy the system for “Cooperazione Applicativa”. This activity consists of managing the deployment of the system for “Cooperazione applicativa” in Trentino, and is closely linked with the deployment of a system for managing the electronic record in the public administration, based on the PiTre protocol.

There are three ongoing project that operates in this area:

- PiTre (Protocollo informatico Trentino): has the goal of providing a system for the shared management of document flow and electronic protocols. The PiTre system is able to unambiguously indentify a document or a file through its life-cycle, and support the interoperability of public offices.

- ProDe (Progetto interregional dematerializzazione): aims at advancing the dematerialization process in public administrations, indentifying standards and guidelines and promoting a common vision to all the participating Regions.
- ICAR (Interoperabilità e cooperazione applicative tra enti): intend to realize the basic infrastructure for the interoperability among institutions and public administrations.

Creating a strong synergy and collaboration between these three projects is of critical importance to guarantee the success of this activity. During 2011 the e-Government unit will work towards the realization of a common framework to that will define the relations and roles of the three projects among themselves and with the local public administrations.

A3 Activities to integrate projects in the areas of healthcare and social policies. This activity consist of the deployment of the infrastructure for "Cooperazione applicativa" in the healthcare domain and, at the same time, managing the integration and deployment of project TreC and project ContactCenter in the above infrastructure

The effort in this area can be summarized in three projects

- CSS (Cartella Socio Sanitaria): has the goal of providing an electronic record containing patient health, social and clinical information. This projects aim at integrating the information provided by different structures by providing a virtual cooperation environment, and thus being able to summarize all the records of patient clinical encounters.
- TreC: the TreC project works on a medical record named "TreC" (an acronym for Cartella Clinica del Cittadino –Citizens' Clinical Record). The goal of the project is to allow people from all the territory of province of Trento to access, manage and share their health information (e.g. lab test) through a secure access web portal.
- ContactCenter: the goal of the project is the development of policies and activities that will contribute to life quality improvement and to improve the autonomy of disabled and elderly people.

The e-Government unit activities in this area for year 2011 aim at giving a common vision to these three projects, as well as creating a common framework in which these projects can benefit from each other.

2.4. Collaborations

The e-Government unit aims at facilitating the creation of strategic collaborations, incubating project ideas, identifying market opportunities, proposing strategic solutions for Trentino.

The unit has active collaboration with several companies:

- GPI
- Dedagroup
- Engeneering

- Informatica Trentina
- Studio Vega
- University of Trento
- Cisis
- Municipalities of Trento and Rovereto
- APSS (Local healthcare Angecy/Center)

In addition, the e-government units has ongoing collaborations with other research units at FBK (DKM, E-Health, SOA).

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
To bring research running initiatives, techniques and methodologies in the e-government production environment.	I	E	Dec. 2011	self-evident	
To coordinate from an organizational point of view a cluster of e-government projects in "cooperazione applicativa".	I	E	March 2011	self-evident	
To strengthen the collaboration network with the Public Sector, research, and industrial partners	I	E	Dec. 2011	self-evident	

Notes:

- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The e-Government unit is composed of three people: the unit coordinator and two project managers.

The unit human resources provide specific project management expertise. Other technical, domain specific and organization competences will be provided, when needed, from specific collaboration with the FBK research units, with Autonomous Province of Trento, with Informatica Trentina and other partners present in the territory.

5. Risks and Mitigation Plans

The e-Government unit should be considered as a value for the Trentino innovation system. The main risk is that unit strategies, actions and coordination activities could be considered in competition with strategies and actions from other actors. This risk can be minimize first by defining an institutional role for the unit and second by updating partners and other actors in the e-government community about the unit strategies and actions.

Description	*Prob.*	*Impact*	*Contingency*
Strategy and actions in competition with the partners strategies and actions	M	S	

Notes:

- Prob. is one of: VL - Very Low, L - Low, M - Medium, H - High, VH - Very High
- Impact is one of: N – Negligible, L - Low, M – Medium, S – Severe, C - Catastrophic

Other Research Areas

ECT* - EUROPEAN CENTRE FOR THEORETICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS

Name	ECT* - European Centre for Theoretical Studies in Nuclear Physics and Related Areas	
Type	Research	
Head	Achim Richter	
Staff	2010	2011
	9 Researchers	10 Researchers
	1 Technologist	1 Technologist

Document Status: submitted 2010-12-01

1. Executive Summary

The objectives of the European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) concern fundamental research. With nearly 700 visitors from all over the world, spending from a week to several months at the Centre, ECT* has achieved high visibility and a coordinating function in the European and international scientific community by holding

- Workshops and Collaboration Meetings on topical problems at the forefront of contemporary developments in nuclear physics and related areas like astrophysics, condensed matter physics and quantal physics of small systems,
- Doctoral Training Programs for talented young physicists,

and by fostering

- Research done by an in-house group of Postdoctoral Fellows and Senior Research Associates together with visitors and physicists elsewhere.

Furthermore, since 2009 ECT* administers scientifically a new research project named

- AURORA, which consists of interdisciplinary proposals that explore the architectural opportunities for high performance computing (HPC) systems optimized for a limited number of highly relevant scientific computing applications in physics, biology, genomics and radiation therapy. It is a joint PAT/INFN project involving several local and national institutions and is furthermore embedded into the European scene of HPC.

The prerequisite for reaching the ambitious goals of the research program and for guaranteeing and still improving the present high performance of ECT* requires:

- Fixed term competitive positions at the Research Associate and Postdoctoral level
- An administrative framework and a fully developed infrastructure for an optimal operation of the Centre, and
- A continuing financial support from the FBK, European research councils and EU programs.

All these points are treated in some detail in this document.

2. Vision and Scientific Program

2.1. Context and State of the Art

The European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*) grew from a concerted action of the European Nuclear Physics community. It started operating in 1993 and has since developed into a very successful research center for nuclear physics in a broad sense, promoting contact between theorists and experimentalists, providing support for ongoing or planned experimental programs, and playing an increasingly important role in the training of young researchers. With an average of nearly 700 visitors per year, spending from a week to several months at the centre, ECT* has achieved high visibility and a coordinating function in the European and international scientific community at large.

ECT* is unique and the only center of its kind in Europe. It is similar in scope and mission to the Institute for Nuclear Theory in Seattle, USA. It is an institutional member of NuPECC, the Associated Nuclear Physics Expert Committee of the European Science Foundation. It was recognized within the fifth and sixth EU programs as a « Major Research Infrastructure », and since 01/01/09 is recognized and supported as a Transnational Access Activity and from 01/09/10 on also as a member of a Joint Research Activity within the FP7 program of the EC. It has formerly been operating as a "Marie Curie Training Site" for several years. It has its own Statutes, which have been endorsed by the European Science Foundation and by the FBK. The Scientific Policy of ECT* is decided by an internationally assembled Scientific Board.

2.2. Vision and Goals

As stipulated in the Statutes the scientific goals of the ECT* are:

- to arrange in-depth research on topical problems at the forefront of contemporary developments in theoretical nuclear physics
- to foster interdisciplinary contacts between nuclear physics and neighbouring fields such as particle physics, astrophysics, condensed matter physics and the quantal physics of small systems
- to encourage talented young physicists by arranging for them to participate in the activities of the ECT*, by organizing training projects and establishing networks of active young researchers
- to strengthen the interaction between theoretical and experimental physicists.

These benchmarks are reached through the following scientific activities: international workshops and collaboration meetings, advanced doctoral training programs, and research carried out by postdoctoral fellows and research associates as well as long term visitors, interacting closely with the director of the centre. Research collaborations exist also with the Physics Department and the Center for Bose-Einstein Condensation (BEC) at the University of Trento. There are further agreements with other scientific institutions worldwide, in particular with the ICTP in Trieste which allows its visitors to spend time at ECT*.

The first phase of a new research project, named AURORA Science, has just been completed. It consists of interdisciplinary proposals that explore the architectural opportunities for high performance computing systems optimized for a limited number of highly relevant scientific computing applications, including: theoretical physics, biology, genomics, and radiation therapy. It involves several local and national institutions like: ECT*, Fondazione Edmondo Mach, IASMA, ATreP, Dipartimento di Fisica Università di Trento, Dipartimento di Fisica Università di Ferrara, Dipartimento di Fisica Università di Parma, INFN and its local sections (Trento, Ferrara, Parma, Milano), Dipartimento di Ingegneria dell'Informazione Università di Padova, Dipartimento di Fisica Universita` di Milano-Bicocca. A tremendous effort has been put into the project in 2010 with the result of having presently at the end of the year a 10 Teraflops prototype high performance computer operating. The AURORA machine is situated in the Laboratory for Interdisciplinary Computational Science (LISC) jointly run by the FBK and the UNITN. Besides benchmark calculations AURORA is already producing very interesting physics results in some of the fields listed above. Presently a report is written on the installation, operation and scientific output of the first phase of AURORA which will end July 31, 2011. This report is the basis for obtaining additional support from the PAT/FBK and from INFN in which the machine will be brought up to the scale of 100 Teraflops in 2011 and 2012.

On top of its technical and scientific results, the project is expected to have a significant impact on the local scientific community by training also junior researchers at the forefront of scientific and technological problems and to provide the basis to create and exploit a leading High Performance Computer (HPC) infrastructure. This will eventually put the Trento Province on the map of high performance computer centers in Europe. The project is scientifically administered by ECT*.

The ECT* is highly appreciated by the large community of its users and its Scientific Board has recently conducted a reflection on the future of the Centre. This is summarized in a short document ("ECT* in 2020 – A Vision") that was circulated among the ECT* associates for comments and input and is now available on the ECT* web site. This document will serve as a guideline for strategic planning over and above the present period of 2009 – 2013.

In fact the gradual emergence of a European Research Area (ERA) and growing international coordination ECT* faces new opportunities and challenges. Significant European and global investments are made presently in accelerator and other experimental facilities. Their efficient utilization requires good coordination and exchanges of ideas – experiments stimulating theory and *vice versa*. Interdisciplinary contacts between the various subfields covered by ECT* and with related areas of physics and science is beneficial to all parties.

The ECT* workshop program has developed very successfully and already serves many of these needs. The unifying Europe and global research scene motivate further strengthening and innovation:

- More proactive measures, whereby ECT* as an ideal meeting ground identifies the need for workshops on specific topics, and makes them happen.
- ECT* as a place of choice for collaboration meetings of experimental and theoretical research groups of various sizes.

- An active visitor program, including physicists who work in areas related to ongoing training activities at ECT*.
- Cross-disciplinary activities, such as the physics of cold atoms and of mesoscopic physics.
- Activities that bring science closer to the citizens. An example in 2010 has been a lecture by Dr. Catalina Curceanu from LNF who organized an ECT* workshop and has also spoken to students of the High School “Liceo Galilei” in Trento about Modern Physics.

The benefits for the ERA are therefore:

- ECT* furthers the mobility of frontline researchers within and to Europe.
- ECT* generates future leaders of research. Its fixed-term faculty forms a talent pool for universities and laboratories.

They require for the ECT* a continuity for the:

- Fixed term competitive positions at research associate and postdoctoral level
- An administrative framework for an optimal operation of the Centre
- A fully developed infrastructure
- A continuing financial support from the FBK, European research councils and EU programs.

Finally it should be stressed that Europe faces a shortage of skilled scientists. To improve the situation in the years to come ECT* will thus increasingly support the training of PhD students and Postdocs through lecture courses and visits.

- Extended training periods in topical areas. Students attend lectures, are guided by ECT* scientists and participate in workshops during their stay. They are provided with office space and encouraged to pursue also their own research work.
- Collaboration with Graduate Schools operating at a European level. ECT* hosts lecture weeks - an example from 2010 has been an AURORA School for High Performance Computing - and supports other training events.
- Promotion of joint research projects between its researchers and physicists elsewhere. In the context of such projects ECT* senior researchers may serve as co-supervisors of PhD students at European universities.

2.3. Activities and Work Plan

Objectives

The scientific activities of ECT* concern fundamental research. As recalled above, these accompany the developments of nuclear physics in a broad sense, and occasionally concern cross-disciplinary topics. The choices of the various workshops and training programs are made by the Scientific Board in accord with the scientific director of the Centre. Both also decide about the main orientations of the research done at ECT* by selecting the research personnel and taking initiative in opening positions in specific areas. In what follows the projects of 2011 are summarized.

Projects

1. International workshops and collaboration meetings

   In 2011 the following eighteen projects are already approved:

   Amplitude Analysis in Hadron Spectroscopy, (24–28 January, Organizers: A. Szczepaniak, C. Hanhart, M. Pennington, E. Santopinto, U. Wiedner); *Effective Theories and the Nuclear Many-body Problem,* (7-11 March, Organizers: T. Papenbrock, H.-W. Hammer, M. Hjorth-Jensen); *Fundamental Physics at the European Spallation Source,* (26-29 April, Organizers: J. Rathsman, J.J. Gaardhoje, G. Martinez-Pinedo); *Recent Developments in Transfer and Knockout Reactions*, (9-13 May, Organizers: E. Rehm, B. Back, J. Schiffer); *The Origin of the Elements: A Modern Perspective*, (16-20 May, Organizers: Y. Qian, G. Fuller, W. Haxton, G. Martinez-Pinedo, F.K. Thielemann); *Standard and Novel QCD Phenomena at Hadron Colliders*, (30 May-3 June, Organizers: D. Triantafyllopoulos, F. Gelis, E. Iancu, C. Marquet); *Nuclear Many-Body Open Quantum Systems: Continuum and Correlations in Light Nuclei*, (6-10 June, Organizers: C. Forssén, H. Fynbo, G. Hagen, L. Platter, H. Simon); *Clusters in Nuclei and Nuclear Matter: Nuclear Structure, Heavy Ion Collisions, and Astrophysics*, (13-17 June, Organizers: G. Roepke, T. Klahn, S. Typel, S. Shlomo); *New Trends in the Physics of the Quantum Vacuum: from Condensed Matter, to Gravitation and Cosmology* (27 June-1 July, Organizers: I. Carusotto, R. Balbinot, A. Fabbri); *Not so Few, but not too Many,* (4-8 July, Organizers: N. Barnea, M. Gattobigio, A. Kievsky); *Three-Nucleon Forces in Vacuum and in the Medium,* (11-15 July, Organizers: C. Barbieri, E. Epelbaum, T. Otsuka, K. Sekiguchi); *Speakable in Quantum Mechanics: Atomic, Nuclear and Subnuclear Physics Tests,* (29 August-2 September, Organizers: C. Curceanu, J. Marton, E. Milotti); *QCD Green's Functions, Confinement, and Phenomenology*, (12-16 September, Organizers: D. Binosi, A. C. Aquilar, John M. Cornwall, Joannis Papavassiliou); *Strange Hadronic Matter*, (26-30 September, Organizers: J. Pochodzalla, A. Feliciello, O. Hashimoto, H. Lenske, A. Ramos); *STRONGnet 2011*, (3-7 October, Organizers: F. Di Renzo, G. Bali); *Nuclear Structure Seen Through Ground-State Properties of Exotic Nuclei,* (17-21 October, Organizers: M. Kowalska, K. Blaum, P. van Isacker); *LC11: Understanding QCD at Linear Colliders in Searching for Old and New Physics,* (7-11 November, Organizers: L. Pancheri, S. De Curtis, S. Moretti, A. De Roeck, F. Richard); *Short Range Correlations in Nuclei and Hard QCD Phenomena,* (14-18 November, Organizers: C. Ciofi Degli Atti, M. Strikman).

The approval of the following two projects in 2011 is still pending:

   Beyond-Mean-Field Models and ab-initio Method for Correlated Nucleons, (Organizers: M. Grasso, T. Aumann, G. Colò, M. Hjorth-Jensen); *Chiral Dynamics with Wilson Fermions,* (Organizers: J. Verbaarschot, P.H. Damgaard, K. Splittorff).

   Since the deadline of applications was September 15, 2010 the total number of projects that will be run in 2011 is thus expected to be 18 + 2. This num-

ber is to be compared to the total number of workshop in 2010 which was 18, corresponding to 687 visitors of the ECT*, each one spending about 6 days at Trento. The national distribution of participants to these activities is stable over the years: about 41% come from France, Germany and Italy, 29% from the other European countries, 17% from the USA, and 13% from the rest of the world.

2. Advanced doctoral training program

The advanced training of young researchers represents an important part of ECT*'s activities. The by now traditional spring doctoral training program (DTP) has developed into a very successful format, with each year a group of about 20 full time students and about 5 part time students spending two/three months at ECT*. In 2010 (April 12 – June 11), the doctoral training program was focused on «Nuclear structure and nuclear astrophysics with radioactive ion beams». In 2011 the program will be centered about «Neutrinos in nuclear-, particle- and astrophysics». It is organized by Baha Balantekin (University of Wisconsin, Madison), Cristina Volpe (IPN, Orsay) and Christian Weinheimer (University of Műnster). The program is designed to train the young generation of theoretical and experimental physicists about the physics of neutrinos investigated at the present and on at the upcoming new experimental facilities in Europe, Japan and the United States of America. The lecturers of the DTP 2011 will be: A.B. Balantekin (University of Wisconsin, Madison), J. Bernabeu (Universitad de Valencia), A. Faessler (University of Tuebingen), E. Fiorini (Università di Milano Bicocca and INFN), G. Fuller (University of California, San Diego), C. Giunti (INFN Torino), S. Kraft-Bermuth (University of Giessen), T. Lasserre (CEA/Saclay), M. Lindner (MPI Kernphysik, Heidelberg), C. Pena-Garay (Universitad de Valencia), A. Poves (Universidad Autonoma, Madrid), P. Vogel (Caltech), C. Volpe (IPN, Orsay), C. Weinheimer (University of Műnster), Y. Wong (RWTH Aachen), K. Zuber (TU Dresden).

The topics to be covered will include an introduction to the basic properties of neutrinos, solar and supernova neutrinos, direct neutrino mass measurements and their interpretation, nuclear structure physics pertinent to weak-interaction processes, origin of the neutrino mass, cosmological neutrinos, connection between neutrinos and nucleosynthesis in various settings, double beta decay, neutrino oscillations and leptonic CP-violation.

As in previous years George Ripka (Saclay) will act in an important function as student coordinator and advisor within the 2011 DTP from April 11 to June 17.

2.4. Visiting Scientists, Research Personnel and Collaborations

The presence of visiting scientists is extremely important for the research carried out at the Centre. Usually typical times visitors spend ant interact with the research personnel range from a week to a few months. In 2010, 41 scientists visited the ECT*: Austria (1), Australia (3), Belgium (4), Brazil (3), Croatia (1), France (3), Germany (6), Hungary (1), Israel (1), Italy (6), Japan (2), Netherlands (1), Spain (4), Sweden (1), UK (1), USA (3).

For the year 2011 (and each year to come afterwards) the number of visiting scientists is expected to be about the same as in 2010 and the years before.

The research personnel at ECT* in 2010 consisted of the following members:

- Massimiliano Alvioli (Junior Postdoc for HP2/WP3)
- Daniele Binosi (Senior Postdoc)
- Marco Cristoforetti (Junior Postdoc for Aurora)
- Cesar Fernandez Ramirez (Junior Postdoc)
- Lorenzo Fortunato (Junior Postdoc)
- Bingwei Long (Junior Postdoc)
- Laura Munoz (Junior Postdoc as successor of Bingwei Long)
- Stefano Melis (Junior Postdoc for HP2/WP3)
- Luigi Scorzato (Senior Postdoc for Aurora)
- Dionysis Triantafyllopoulos (Senior Research Associate)

The research personnel at ECT* in 2011 will increase by one new Senior Research Associate position. Furthermore, since the two year contracts of Cesar Fernandez Ramirez and Lorenzo Fortunato, respectively, end in 2011, two new Postdocs will substitute them. The calls for applications are already closed.

This research personnel will allow the scientific director of ECT* to continue and develop further a core of research at ECT* covering a wide spectrum of activities in nuclear physics, and also facilitate cross fertilization between its various subfields.

Scientific collaborations between the in-house researchers will continue and start new, respectively, with each new researcher joining ECT*. Furthermore, strong collaborations with physicists outside the Centre are particularly important for its scientific standing, and for these the last ECT* Annual Report from 2009 (www.ect.it), Chapter 4, p. 83-106, may serve as an example.

Strong scientific relations exist not only with Bose-Einstein-Condensation center but also with the internationally well known theoretical group in nuclear and atomic many-body physics at the Physics Department of the University of Trento. Furthermore a PhD student is supported by ECT*; a joint colloquium between ECT*, BEC and the Physics Department is organized regularly and - as noted above – a joint workshop will again be organized in 2011.

Incidentally, the last joint interdisciplinary workshops on “New Frontiers in Graphene Physics” held 12-14 April, 2010 at the ECT* has been overwhelmingly successful indeed. Later on in the year one of the invited key speakers, Konstantin Sergeevich Novaselov from the University of Manchester, has been awarded the 2010 Nobel Prize in Physics.

Also the presence at ECT* of researchers belonging to the "Quantum Information Processing Group" should be recorded. Particularly noteworthy is the important responsibility taken by Daniele Binosi (in close cooperation with Tommaso Calarco, now professor at University of Ulm, Germany) in the coordination of a large European consortium on quantum computing (QUITE).

Finally, a prerequisite for the success in 2010 of the high performance computing project AURORA described in Sect. 2.2 above has been and will also be in 2011 a strong and efficient collaboration of all partners involved.

2.5. Specific Needs and Points of Attention

After the number of researchers at the ECT* has decreased continuously from 14 in 2006 to 6 in the first part of 2009, it has fortunately increased again to 9 researchers in 2010. This is totally in line with an increase in the number of projects and the size of the scientific activities of the Centre. In order to execute the ambitious research program in 2011 and the years thereafter the two Junior Postdoc positions (presently held by Cesar Fernandez Ramirez and Lorenzo Fortunato, respectly, who will both leave ECT* in 2011) must be filled again with Junior Postdocs. These two positions are listed in Sect. 2.4 above together with a new Senior Research Associate position which is absolutely essential for hiring someone in the field of nuclear many-body physics as strongly suggested by the International Committee who reviewed the ECT* in 2008. Furthermore, special attention should be paid to the fact that the funding of two researchers within the AURORA project (Junior Postdoc Marco Cristoforetti and Senior Postdoc Luigi Scorzato) runs out at the end of the first phase of the project, i.e. on July 31, 2011. Therefore every effort should and will be made to continue AURORA into its foreseen second phase and secure the funding of these positions.

3. Goals

- Here the various goals of ECT* for 2011 described in some detail in Sect. 2 are again summarized as follows:
- Research at the forefront of theoretical nuclear physics
- Foster interdisciplinary contacts between nuclear physics and neighboring research fields
- Strengthen the interaction between theoretical and experimental physicists
- Doctoral training programs for talented young researchers
- Workshops and collaboration meetings on topics at the forefront of physics
- Operate and expand the high performance computer AURORA and its infrastructure further in an effective collaboration between FBK/ECT*, UNITN, INFN and other institutions

4. Human Resources

In order to operate the ECT* with its large and ambitious scientific program described in Sect. 2 above a dedicated and efficient administrative and technical staff is necessary.

Therefore, the most recent decision by the FBK to change the temporary contracts of Serena degli Avancini and Susan Driessen upon the request by the Director of

ECT* into permanent contracts as of December 01, 2010 has been a very important step for stabilizing the functioning of ECT* for the years to come. Both of them are key figures amongst ECT*'s administrative staff.

For many years the ECT* workshops have been administered by Ines Campo and Cristina Costa. The latter will retire by the end of 2010 so that from 2011 on Ines Campo will solely be responsible for all workshops. Since she has, however, requested to work part time only, the workshop program needs an additional person to support her. The FBK has already agreed to open a call for an appropriate part-time position.

Since the Co.co.pro part-time contract of Gian Maria Ziglio will run out the end of 2010 – he has managed the ECT* database and website and has responsible for preparation of the ECT* Annual Report – a redistribution of activities and responsibilities amongst the remaining administrative staff members is underway.

With the loss of Costa's and Ziglio's positions by the end of 2010 and the creation of the above mentioned "new" part-time position for the workshop program, ECT* will have from 2011 on one administrative staff position less than in 2010, i.e. 6 vs. 7. Given the fact, that out of the 6 positions 4 (Ines Campo, Susan Driessen, Tiziana Ingrassia, tbh) will only be filled by persons with part-time contracts, the administrative personnel of ECT* can not be reduced anymore in the future.

Finally, upon the request of the ECT* Director the procedure "stabilizzazione" for Senior Postdoc Daniele Binosi has also be initiated by the FBK management. He is a first rate researcher and vital for the stability and further development of ECT*'s future research program.

CREATE-NET – CENTER FOR RESEARCH AND TELECOMMUNICATION EXPERIMENTATION FOR NETWORKED COMMUNITIES

Name	CREATE-NET – Center for REsearch And Telecommunication Experimentation for NETworked Communities	
Type	Research	
Head	Imrich Chlamtac	
Staff	2010	2011
	52 Researchers	56 Researchers
	22 Management and Support Personnel	25 Management and Support Personnel
	20 Innovation (EAI)	35 Innovation (EAI)

Document Status submitted 2010-12-09

1. Executive Summary

CREATE-NET was founded by some of the most prestigious universities and research centers in Europe in April 2003. We have now established a network of over 300 research partners throughout Europe, including top research institutions and companies. We also have funded collaborations with leading institutions in the US (MIT and Georgia Tech), China (Tsinghua and BUPT), South Africa (SAP) and Israel (Technion).

CREATE-NET has been very successful in attracting European and local funding. In the last three calls of Europe's FP6 program and first three calls of FP7, we were awarded 19 projects, including the coordination of an Integrated Project called BIONETS, applying biologically-inspired approaches to networks and services, especially in the emerging pervasive world where billions or trillions of devices will need to be connected.

CREATE-NET established a state-of-the-art testbed for the testing and experimentation of new technologies. The test-bed includes an optical and wireless network, plus the Living Space home-of-the-future, ambient intelligence lab. The Testbed concept recently been extended to the overall Trentino research system in ICT and CREATE-NET in now strongly involved in implementing a province-wide experimental infrastructure which supports applied research of all the local institutions, together with the public administration and the SMEs.

By creating synergies between leading academic institutions, companies and research centers in Europe and around the world, CREATE-NET's objective is to sponsor the highest quality research and innovation, and help convert talent and human capital into Intellectual Property and start-ups for promoting European high-tech competitiveness, with the aim of building a global platform of scientific

collaboration and experimentation in communications-driven technologies and applications.

Through research and development of these technologies CREATE-NET seeks to positively impact the global society, by contributing to improving the quality of life of its citizens, while ensuring a sustainable future.

Being an international association, on one hand, CREATE-NET acts as a promoter of "globalization of knowledge and research" facilitating the cooperation and interaction of researchers from around the world to became the focal point in Europe for "engineering of research and innovation" in ICT (Information & Communication Technologies).

On the other hand, CREATE-NET's objective is to provide significant benefits to the Autonomous Province of Trento by attracting research and innovation talent on the territory, enhancing the prestige of the province internationally and making an important contribution to the local economy.

Over the coming years, the research endeavours in CREATE-NET will contribute to the realization of the Future Internet, both in terms of enabling technologies and the corresponding applications and services.

2. Vision and Mission Statement

CREATE-NET's vision is to build a multi-disciplinary and internationally recognized center for research and innovation centered around the Future Internet theme, focussing on research excellence in telecommuncations and ICT-driven innovation.

CREATE-NET's overal mission may be summarized as: '*ICT for quality of life and a sustainable future*'. Correspondingly, CREATE-NET's mission statement consists of four main pillars:

1. Research excellence in ICT (Information & Communication Technologies) with focus on telecommunications
2. Promote technology transfer through engineering of technologies and experimentation of solutions on the territory
3. Foster ICT-driven innovation in 'vertical' market sectors with demonstrated societal impact
4. Promote innovation at a European level, in order to contribute to Europe's competitivness in the high-tech sector

The development of CREATE-NET mission statement provides a clear path of the lifecycle the centre develops for its activities, that starting from research ideas follow a path through engineering of technologies and solutions to innovation, with the objective of achieving economic and societal impact.

2.1. Research Directions and Strategy

During the course of 2010 CREATE-NET has reviewed internally its research activities and organization with the objective of identifying the current strenghts and

weaknesses, in order to define a strategy also in view of the changing market trends and opportunities.

The result has been a refocussing of the research activities and the identification of new market sectors, seen as application areas, where ICT and in particular communication technologies can act as a driver for innovation, thus making existing systems 'smarter'.

Addressing specific application areas is also instrumental for CREATE-NET in terms of elaborating an exploitation plan towards the industry, which will include, in addition to the ICT sector, also the most prominent sectors to which ICT technologies can be applied.

2.2. Scientific Approach and Positioning

Drawing on a multidisciplinary approach, CREATE-NET builds a bridge between researchers, users' communities and industry with the overall aim of identifying and proposing solutions in order to respond effectively to the new technological and societal challenges. Correspondingly, CREATE-NET envisions a future scenario involving a co-evolution of technology and society, whereby the network becomes pervasive, delivering and processing user-centered information in a distributed and secure manner. In this scenario, CREATE-NET research will focus on a set of Future Internet enabling technologies, including:

- Reconfigurable optical networks
- Cognitive networks
- Generic Service Delivery Platforms (SDPs)
- Dynamic resource management
- Data management
- Models/algorithm for large scale networks
- Autonomic bio-inspired systems
- Trusted systems
- Identity & access management
- Long-term security
- Context intelligence and adaptation
- Audio-visual media
- HCI (human-computer interaction)

As for the areas of technology research, the figure below shows the positioning of CREATE-NET in the Future Internet arena:

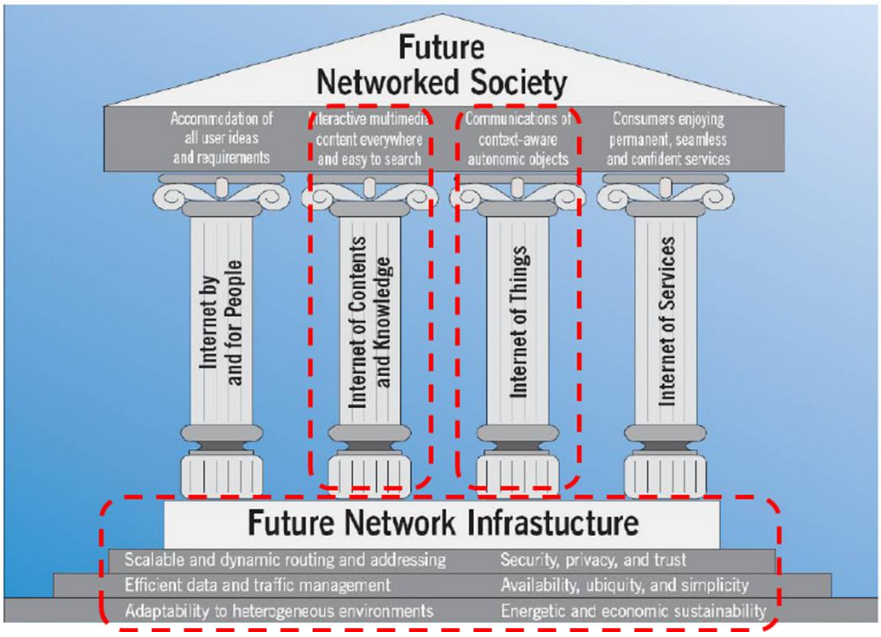


Figure 1. *CREATE-NET's main areas of interest in the Future Internet*

On the other hand, CREATE-NET is investing in the application of ICT to other sectors, addressing the need to make public service infrastructures and business processes significantly smarter (i.e. more intelligent, more efficient and more sustainable), through tighter integration with the Future Internet networking and computing capabilities. In particular, CREATE-NET is focussing on the following sectors:

- Energy
- Environment
- Transportantion and sustainable mobility
- Social networking

Such focus is the result of a decisional process based on the analysis of the telecom market, in Italy in particular, where there exists a negative trend in terms of R&D investments, especially regarding medium-long term research. An opposite trend is observed in other sectors, such as Energy, with the presence of solid actors at a national level, with a strong push towards innovation both in the native technologies of the sector (e.g. renewable energy sources) and in the ancillary enabling technologies, among which is included ICT.

2.2.1. CREATE-NET's Organizational Structure

The organisational structure of CREATE-NET has been designed to implement its mission, and comprises a *Research and Engineering Department* plus an *Innovation Department*.

The Research and Engineering Department is structured according to three Research areas that with a synergic approach cover different scientific and

technological fields in the ICT world, plus an Engineering area dedicated to technology transfer and innovation projects.

The Research and Engineering Department is coordinated by the Research Director who is in charge, among the other tasks, of monitoring the research developments at European and global level as well as the ICT market evolution, in order to define the strategic research directions of the centre.

The Innovation Department was promoting and is now supporting the establishment and growth of the European Alliance for Innovation (EAI). Through the EAI, CREATE-NET and the other local institutions can leverage on a large paneuropean organization where the local stakeholder have a strong opportunity for connecting with the mayor players and for marketing and promoting the results of the research activities.

CREATE-NET's structure is dynamic and capable to respond, with appropriate organizational changes, to external stimuli and opportunities. The current structure is therefore aligned to research themes that are considered relevant in terms of innovation capabilities and market opportunities.

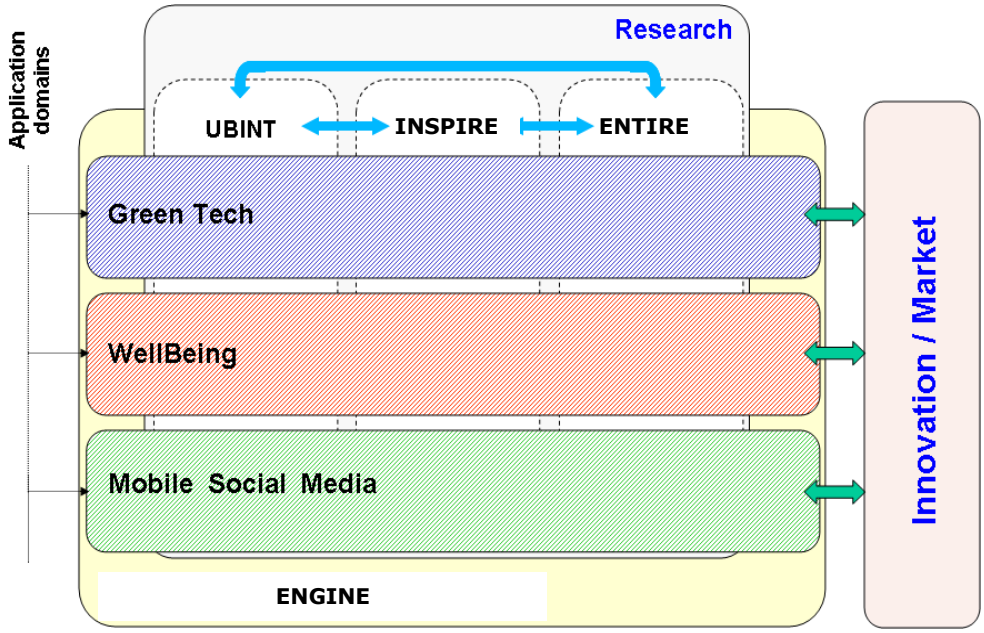


Figure 2. *CREATE-NET's organizational structure*

2.2.2. Research & Engineering Areas

This section provides a general overview of the Research and Application areas within CREATE-NET. Currently, only Research areas are fully staffed, while the activities of the Application areas are in the process of being formalized, starting from the formation of thematic Working Groups. In this respect, the model adopted by CREATE-NET regarding the Application areas foresees a driving role (i.e. a 'market pull' action) with respect to the research efforts, with the objectives of develop-

ing integrated innovative solutions for the relevant sector. Furthermore, the Application areas provide requirements and as such constitute an important input for stimulating the research activities. For each Application area, it is envisioned to have a reference person and a team with the responsibility of developing a market vision, identify relevant actors and industrial partners with the objective of developing joint projects in which the vision can be implemented and fully realized.

2.3. Research and Engineering Areas

As described below, CREATE-NET's core research focuses on three areas – eNTIRE, iNSPIRE, and UBiNT – working complementarily and in synergy.

With an approach that embraces network technologies, algorithms and user aspects, eNTIRE's focus is on the dynamic control and management of core and access network resources. iNSPIRE focuses on technologies, algorithms and methods for the design and the management of emerging and unconventional wireless networks. With a user-centric perspective, UBiNT's research field is on interaction design and innovative methodologies and technologies enabling smart interaction.

ENGINE, with the responsibility of engineering and prototyping provides support to the research areas, transferring their results into solutions for real-life applications.

- *eNTIRE - Network and service technologies and infrastructure*. The broad research scope of the eNTIRE area consists of the dynamic control and management of resources at various levels, spanning from optical transport and cognitive wireless resources to communication and computing ones.

  Such dynamic control and optimized usage of resources is pursued leveraging on extensive knowledge on network and service technologies, namely in the fields of the optical transport control plane and routing, cognitive radio, access networks coexistence and interoperability, cooperative networking, broadband wireless, data management, modeling and energy-aware use of computing resources. This research finds applications in both the IT industry (energy-efficient data-center management, Enterprise 2.0) and the telecommunication industry where it contributes to the evolution of traditional operator business models.

  - Amongst the key competences of the eNTIRE area:
  - Optical networks control plane and routing
  - GMPLS/MPLS networks
  - Cognitive radio
  - Spectrum sensing and dynamic allocation
  - Broadband wireless access
  - Energy-efficient use of access technologies and computing resources
  - Cooperative networking
  - Data and data-center management

- *iNSPIRE- Networking & security Solutions for pervasive Computing system*s.The iNSPIRE research team pursues a multidisciplinary approach to

devise innovative networking and security solutions for pervasive computing systems. The group's activities are inspired by a hybrid approach, whereby research is deeply intertwined with experimentations, leading to solutions that are able to turn novel scientific paradigms into working prototypes.

The group works in tight collaboration with the ENGINE Team for the realization of prototypes and proof-of-concept implementation of innovative solutions. Key aspects of the group research agenda include: the focus on data as the basic brick of pervasive communication systems, the introduction of security considerations as constituent properties of the system, the design of distributed, autonomic and "green" algorithms/protocols, the development of methods for evaluating performance and the focus on robustness and resilience as key performance indicators for pervasive systems.

The iNSPIRE team pursues research on pervasive computing and communications environments. Key competences of the group include:

- Scalable networking solutions for large-scale computing/communications environments
- Platforms for opportunistic networking
- Autonomic network management
- Energy-efficient protocols
- Design and experimentation of multi-hop wireless networks
- Data confidentiality solutions for large-scale systems
- Policy-based access control for distributed right management

- *UBiNT- Ubiquitous interaction*. The UBiNT's research activity focuses on the design, development, evaluation and understanding of user-centered, interactive ubiquitous computing environments. The nature of the technologies investigated in UBiNT drives the research activity through three main phases: acquisition of users' contextual information; analysis of this information to understand users' contextual situation; and the development of novel interaction modalities in response to the acquired understanding. Realization of these phases employs state-of-the-art methodologies used in the design and evaluation of interactive ubiquitous environments.

  The approach of the UBiNT group promotes the use of non-obtrusive technologies, interwoven to a high degree with users' surroundings. Using this approach, acquisition and understanding of users' context becomes minimally intrusive, providing a natural and intuitive interaction environment.

  Key competences of the UBiNT group include:

  - Context sensing and adaptation for user support in ubiquitous systems
  - Human activity recognition techniques
  - Interaction design
  - Users studies
  - Multimodal interaction

- *ENGINE - Engineering and fast prototyping*. ENGINE contributes to the realization of the global CREATE-NET vision by engineering novel technologies to translate research results into solutions for real-life applications for users and communities. This mission is implemented through a tight collaboration with the research areas in the development of proofs of concepts and prototypes for possible long-term commercial exploitation.

  Turning research ideas into experimental pilots whose objective is to prove the feasibility and potential impact of innovative concepts is of tremendous importance while performing applied research today. Nevertheless, this "hands-on" approach provides real-world feedback to researchers, helping them to refine their ideas and to identify new challenges, ultimately triggering new research directions.

  Furthermore, ENGINE is the area within the Center leading all the trusted advisory services toward the local government (PAT – Autonomous Province of Trento) and its affiliated companies with respect to main initiatives such as the core/access high-speed network and the e-Society/e-Welfare plans.

  ENGINE contributes to the shared vision of the Future Internet by means of advanced experimentation in the following areas:

  - Network control and management (optical core networks and multi-hop wireless networks)
  - Virtualization of network infrastructures
  - Integration between wireless distribution and sensor networks
  - Mobile-based applications based on opportunistic networking concepts
  - Convergence between IP/Telco networks

2.4. Application Areas

Three Application areas, covering Green Tech (namely smart energy systems and sustainable mobility), Well Being and Mobile Social Media, cut across the Research areas resulting in an overall matrix structure as illustrated in the following:

- *Green Tech* – This Application area relates to the confirmed international trends linking climate change to green-house gas (GHG) emissions and a more efficient energy resources usage. In this context, CREATE-NET plans to leverage on the points of strength of the research groups to promote the use of ICT technologies for reducing the environmental impact associated with our behaviour in daily activities, including the usage of ICT technologies themselves. The relevance of this Application area within CREATE-NET's strategy is supported by the involvement in projects focused on the delivery of concrete results in the area of 'green' technologies. The leading projects in this area are MOTUS (a cooperative project led by Telecom Italia under the Industria 2015 Programme) on sustainable environmental-friendly mobility and TRITON on energy savings in road tunnels. Other ongoing projects within the EU framework are: ComplexEnergy (a Coordinated Action to bridge the ICT, Energy and Complex Systems research communities for a multidisciplinary approach to efficient energy management), C2POWER

(access technologies to minimise energy consumption in portable devices) and FIT4GREEN (reduction of energy consumption in data centres and federated data centres through an "energy-aware" process allocation and management).

- *Well Being* – The rapid evolution of ICTs during the recent year brings a huge opportunity to apply such technologies to achieve a positive impact on people's well being across the different dimensions of their everyday life. In CREATE-NET such opportunity is being exploited to apply the various ICT competences of the Research areas to the development of services and solutions able to improve quality of life and people's well being through ICT. The focus of this Application area is on the development and application of ubiquitous computing technologies for managing and monitoring personal health, providing assistance in daily activities and, more in general, supporting through continuous monitoring and care the personal wellness of people. Active projects in this area are: ACUBE, MONARCA and Interstress. All three projects focus on non-invasive monitoring of patients affected by different pathologies and in different contexts, namely: ACUBE deals with Alzheimer patients in day-care centres; MONARCA is about a multi-parametric monitoring of patients affected by bipolar disorders; Interstress studies the use of virtual reality techniques for developing appropriate therapies for people affected by stress disorders.
- *Mobile Social Media* – Social Media emerges as the new way for mass media communication. Leveraging people's needs for social interaction, the culture of participation is developed by means of modern Web 2.0 technologies, defining as a matter of fact Web 2.0 as a synonym for users participation. Mobile Social Media moves an additional step forward, combining the powerful concept of Social Media with the immediacy enabled by mobile technologies. Mobile Social Media allows the development of novel application scenarios where individuals have the possibility of capturing moments of their lives, instantly share them with other and making available information and contents to other member of the group. In the context of this Application area CREATE-NET is acquiring competences and developing a significant critical mass. In particular, among the various initiatives is a platform for mobile advertising, called u-Hopper, which has resulted in the acquisition of seed money investments and the creation of a spin-off company.

2.5. Innovation and EAI

CREATE-NET's Innovation activity complements the research and engineering expertise towards the fulfillment of the overall mission of the Center, focusing on four key application domains: Green Tech, Well-Being, Mobile Social Media and Future Internet Technologies.

Innovation, in cooperation with the research and engineering areas, promotes research exploitation and uptake in the industry and in the market, leveraging the expertise of the engineering team to develop advanced prototypes, translated in innovative services and spin-offs.

True to its spirit that innovation cannot be achieved in isolation, the Innovation Department is also involved in the launch and the promotion of the *European Alliance for Innovation (EAI)* – an open federated ecosystem where individuals and organizations collaborate to drive innovation in market sectors and technology areas where Europe has the highest potential to be competitive.

- Through its role in the EAI, the Innovation team promotes a distinctive approach to developing a unified innovation landscape, by:
- Building the critical mass to achieve innovation promoting a grassroots approach through the EAI
- Bringing technology-driven applications to society-driven services
- Advancing ICT-based innovative solutions, leveraging on know-how and competences developed through cooperative and applied research
- Transferring results into society and business through field testing and experimentation, and developing start-ups and spin-off activities

Since 2009 CREATE-NET's Innovation team is promoting the EAI as a pan-European movement for building a unique Innovation Society composed of professionals at all levels of the Innovation Cycle, involving major European players including ETSI, ICST, EIT, COST, CEPIS, Informatics Europe, EUREKA, EATCS, EICTA, Engineering, NESSI, Living Labs, Fraunhofer Fokus, EVCA, EIFN, PBN, CREATECH, CSEM, Gesellschaft für Informatik, ITIF, Joint Institute for Innovation Policy, PSCE and REEEP.

EAI brings together individuals and organizations to further their respective core missions to drive innovation in market sectors where Europe has the highest potential to be competitive. It envisions innovation as a complete cycle. Starting from education to research to business to policy, leading to development of a marketable product or technology. The overall cycle will ultimately generate positive outcomes, from job creation to improved living standards

The EAI started as a follow-up of a European Commission sponsored meeting which took place in Lyon (ICT2008), in which the idea of forming a European Alliance for Innovation was put forward, consisting of a partnership of ICT key actors. The principal objective is to address the issue of the fragmentation of R&D efforts, and to represent the European ICT sector as one.

CREATE-NET has been instrumental in creating the European Alliance for Innovation. The main steps that have already taken place in creating this society have been:

- March 2008. During a meeting with Fabio Colasanti, Director-General, Information Society and Media (INFSO) Directorate of the European Commission, in Trento, CREATE-NET presented the idea of creating a grassroots research society to improve innovation in Europe. It was proposed that this would be based on The Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering (ICST), a non-profit research society that CREATE-NET has been instrumental in founding and supporting.
- November 2008. As a follow up, a European Commission sponsored consultation workshop was held in Lyon to discuss the formation of a European re-

search society. A key result of this meeting was the creation of the European Alliance for Innovation consisting of key European players.

- February 2009. The first meeting of the European Alliance for Innovation was held resulting in the interest of the above 23 key European players with a concrete set of action items and initiatives based on an agreed framework document.
- November 2009. The 4th European Alliance for innovation Preparatory Meeting took place in Budapest to present the EAI initiative to key players and experts of the ICT sector, involved in all aspects of the Innovation Cycle. It was agreed to share recommendations with key players in Europe including the European Commission, Organizations and Institutions expressing interest and other key actors in Europe.
- July 2010. CREATE-NET, EAI and the Autonomous Province of Trento, organized the European Forum for Innovation – EFI 2010. The Forum agenda included a day dedicated to speeches from European Union officials, major industry representatives and EAI partners, Science for Innovation and Business and Technology (SIB) Councils workshops, and other workshops that addressed the current European status quo in technology and the innovation cycle. Part of this international event included the 5th EAI meeting which brought together European key leaders, international institutions, private sector companies, universities and individuals to promote the launch of the EAI.
- September 2010. EAI was formally presented at the European Parliament in Brussels on the 29th of September. The event was hosted by the Italian Member of the European Parliament Hon. Dorfman, who introduced EAI as the innovation community answer to the current problem of fragmentation in Europe – a problem identified by Innovation Commissioner Maire Geoghegan-Quinn. A representative of the Commissioner Maire Geoghegan-Quinn Cabinet, Mr. Waldmer Kutt, intervened to present the European Commission position on the EC initatives related to Innovation. The 6th EAI meeting took place at the same time. The EAI Secretariat presented to the members the upates on the SIB Programme and Summits developments, introducing the first Beta of the Community Portal.

As a federated platform to connect the strategic long-term view of member organizations with a community of individuals, organized in a grassroots movement, the EAI is composed of two independent and collaborating constituencies:

- A Strategic Forum made up of leading organizations, responsible for the Strategic Innovation Agenda, identification and proposition of innovation policies, advocacy of policy and regulation and definition of priorities to benefit innovation.
- An EAI Community constituted by individuals, actively and directly participating in innovation building activities, organized according to thematic interest groups, the Science, Innovation and Business Technology Councils (SIBs), which form the “working platforms” of EAI.

The organizational structure of the EAI offers:

- Openness for participation and transparency of information flow;
- Federation of different services and components facilitating innovation development;
- Effective leadership of operational platforms for community activities;
- Efficient management of the activities and the decision making process.

Figure 3. *EAI Innovation Cycle and Instruments*

The three key strategic objectives for EAI to achieve its mission are:

1. *Cultivate a convergence of the european innovation community*

   The unified framework proposed by EAI, driven by a grassroots' approach, will lead to a more efficient and consistent way of tackling the current slow-moving innovation cycle in Europe. The EAI intends gathering, under one umbrella, all stakeholders in ICT enabled innovation and business to create a sustainable community able to streamline and enhance Europe's innovation cycle.

2. *Become the collective point of access for european innovation*

   With the primary goal of advancing European competitiveness, societal progress and market-place opportunities, the EAI shall be the collaborative 'platform' for all organizations and individuals who are engaged in the multiple disciplines operating within the European innovation cycle.

3. *Become the incubator for systemic european innovation process, practice and policy leadership*

   To achieve its mission, EAI will serve as 'incubator' for the development and coordination of technological advancement, systemic efficiency and best practices in the collaborative innovation process. The result will be a more cohesive and productive methodology for European innovation process and practice.

2.6. Activities and Work Plan

An overview of 2011 Work Plan is provided for each of the areas within Research and Engineering and for EAI.

eNTIRE - Network and service Technologies and InfrastructuREs. The workplan for 2011 will see the eNTIRE area involved in a number of different collaborative projects listed hereafter in summary. eNTIRE researchers will contribute mainly to 4 EU FP7 existing collaborative projects. These consist of the Integrated Project EUWB (IP ending in July) where we lead the work-package on Cognitive UWB Radio and Coexistence, and of the STREPs CHRON, C2POWER and FIT4GREEN. Within CHRON we are involved mainly in control plane management and cognitive path selection activities. In C2POWER we contribute to the work on cooperative short range communications for power saving. Finally in FIT4GREEN our involvement is in the domain of optimization algorithms aimed at minimizing the power consumption of datacentres.

Apart from project related tasks, some of the 2011 activities will seek further funding opportunities to strengthen focus and achieve further momentum necessary to sustain a common future vision for the above mentioned project activities.

In this respect eNTIRE area will further explore the enablers for dynamic control, management and integration of communication resources at various levels, from access technologies to spectrum to optical network to computing resources. With regards to the higher layers the focus of our research will be on data management for sustainable mobility and on modelling and energy-aware use of computing resources.

To sustain such a vision eNTIRE people will be involved in the preparation of at least 3 proposals for Call 7 (these relate to Internet of Things, transportation and future media delivery topics). Conferences CrownCom for radio spectrum and PSATS for satellite communication and a C2POWER workshop at VTC2011, where eNTIRE people are directly involved, will also provide good opportunities for dissemination in these directions.

iNSPIRE - Networking and Security Solutions for Pervasive Computing Systems. The workplan for 2011 for the iNSPIRE area includes a number of different collaborative projects. The iNSPIRE team will contribute to 5 EU collaborative projects FP7 CONSEQUENCE (STREP), FP7 SMART-Net (STREP), FP7 EPIWORK (IP), FP7 ComplexEnergy (SSA) and FP7 ENDORSE (STREP), one industrial project with a local company (TI-SENTO) and an industrial project with a major French industry (OBELIX-2).

Apart from project related tasks, iNSPIRE will seek further funding opportunities to strengthen focus and achieve further momentum: such fund raising activity will be approached accounting for the common future vision for the area and for CREATE-NET as a whole as well.

In this respect the iNSPIRE group will explore (i) opportunities arising from the widespread diffusion of smart-phone devices able to embed short-range communication interfaces and a carrying onboard a number of sensors (audio, video, GPS,

accelerometers) (ii) issues related to the development and deployment of self-management strategies for green networking in light infrastructure networks (WMNs, LTE, HAPs) (iii) research avenues related to the design and development of novel security solutions for pervasive computing environments. To this aim, one important objective is the strengthening of existing links with major players in the ICT arena, as well as the establishment of new strategic partnerships with key stakeholders in the field.

UBiNT- Ubiquitous Interaction Group. UBInt will be active overall in nine projects during 2011. Two of them are EU STREPs funded in the topic of ICT for Health that started in February and March 2010 respectively (MONARCA and INTER-STRESS). Activities will include a third EU Project (NEXTMEDIA) that is supposed to end in October 2011. Other activities will include 1 PAT-Legge 6 project (iTheater), 1 PAT-FESR (Geomedia), 1 PAT-"Grandi Progetti" (ACube) and a local project (Crisalide-Roncegno). Additionally one National project funded under the framework "Made in Italy" (DesigNet) is likely to start in 2011.UBiNT will pursue new funding opportunities in 2011 in the framework of FP7 Call 8 and other National and Local instruments in a collaborative way with other CN areas. The research activity overall will focus on three main aspects:

- Development of innovative interactive means (e.g. based on tangible interfaces, persuasive interfaces, physical computing, beyond audio/visual interaction);
- Analysis and understanding of users contextual situation for providing timely and relevant information (e.g. through human activity recognition, context sensitive systems and participatory sensing);
- Investigation on innovative methodologies for design and evaluation of interactive ubiquitous environments. As part of this focus of activities, UBiNT will collaborate with other areas of CREATE-NET for improving their prototypes design through user-centered methodologies rendering them more engaging.

ENGINE - Engineering and Fast Prototyping. During 2011 Engineering will be involved in several projects, 9 in total, most under ENGINE direct coordination. Indeed, being strongly focused on experimental research activity, ENGINE is strongly tied with research performed by all Research Areas in CREATE-NET, and contributes to many of the projects they are involved with.

The ENGINE group is involved in cooperation activities with several industrial partners such as one of the leading networking equipment manufacturer (DAIGO-2 and MATRIGO-4 projects), Win.net Srl (SEROFON project) and Futur3 (ACKA project, led by iNSPIRE group). In term of collaboration with other areas, ENGINE people are going to be involved in two European FP7 projects: CHRON project (led by eNTIRE group) and INTERSTRESS project (led by UBiNT group), as well as in a local project (ACUBE) funded by PAT and led by UBiNT group. ENGINE will also keep on maintaining its local Cisco Academy which is offering advanced courses on networking since 2008. Another key activity in 2011 will be the operational set

up of the new Trentino Testbed which should become the common platform for distributed experimentation within the recent framework of Trento RISE.

During 2011, more efforts will be devoted to consolidating relationships with industry and building new collaborations, including local SMEs in the Trento province. A few examples of industry targets nationally/internationally: Alcatel Lucent Italia and Ericsson; and locally: Algorab, Far System R&D. Of course the collaboration with PAT "Servizio Reti" and with Trentino Network are expected to follow up with the continuation of the network planning consultancy activity on the WiNET wireless network, as well as with the provisioning of tools and guidelines to improve the integration and efficiency of Trentino Network's Network Management processes and systems. We are also expecting to be involved on the already planned FTTH deployment which will start soon with the purpose of providing 100% coverage in the Province. Few funding opportunities at EU level will also be pursued in collaboration with all CREATE-NET Research Areas with the purpose of bringing research results toward prototypical outcomes, by possibly testing them on top of Trentino Testbed experimental facility.

EAI - European Alliance for Innovation. CREATE-NET plan for supporting the EAI growth, particularly in terms of the local impact, is put Trentino economic and research ecosystem in the center of this European innovation network and provide the following benefits locally:

- establish the province's reputation as a catalyst for innovation in Europe;
- bring companies to Trentino (e.g. for testing);
- promote Trentino research and education;
- create new interactions with the European Commission and key EU players;
- bring top people to the province for events with global exposure;
- give global visibility to the research, projects and achievements from the province;
- act as a clearing house and due-diligence coming from the network;
- create other new businesses in Trentino.

Up to now, more than 68 international organizations have joined the Alliance, including multinational companies as IBM and Huawei, networks of research centers as CNRS in France, academic institutions as Universidad de Deustro in Spain, private investors as in IBAN Italy, public funders as COST, organizations of companies as AICA. In addition, are members of EAI organizations representing about a thousand European SMEs, such as the International Network for Small and Medium Enterprises - INSME, Innova, Mazowieckie Klaster and Sharp. Overall, through its members EAI reaches a community of innovation of more than 4 million people and can become a formidable instrument for the internationalization of the Trentino's economy and research.

In order to achieve these objectives in 2011 CREATE-NET is establishing a coordinating and operational entity that serve as a coordination point for the European Innovation Alliance. In particular, it develops and manages a series of portals, which serves as the online meeting place of what is today a collection of uncoordinated, fragmented organizations in the scientific community in Europe, and it sup-

ports the dissemination and marketing activities of the Alliance both in terms of magazines and journals and of event organizations.

The following table provides an overview of the projects that will see CREATE-NET involvement in 2011. The table includes approved projects only. In addition to the listed projects, a number of additional projects or cooperation proposals have been submitted that will be confirmed during the course of 2011.

Project	*Description*	*Key Partners*
CONSE-QUENCE	Data-centric information protection framework based on data-sharing agreements.	CNR Pisa, ICL
EUWB	Advanced methods of wireless technology such as cognitive signalling, intelligent multiple antenna and multiband/multimode UWB system concepts to enable the introduction of advanced services and competitive applications using flexible spectrum allocation.	EADS Airbus, Philips, Telefonica, Bosch, Thales
FIT4GREEN	FIT4Green aims at contributing to ICT energy reducing efforts by creating an energy-aware layer of plug-ins for data centre automation frameworks.	HP, ENI
C2POWER	Cognitive and cooperative strategies to decrease the overall energy consumption and radiated power of mobile devices while still enabling the required performance in terms of QoS.	EADS, Infineon Tech
SMART-Net	Scalability, resilience, security, system capacities, coverage, connectivity and cost reduction of the telecommunication infrastructure in broadband wireless access (BWA) scenarios	France Telecom, Thales
EPIWORK	Multidisciplinary research and development for the design of epidemic forecast infrastructures to be used in by epidemiologists and public health scientists.	ISI Torino
ComplexEnergy	Support action to bridge the ICT, Energy and Complex Systems research communities in order to formulate innovative approaches to energy system modeling, design and governance.	INNAXIS
MONARCA	Develop and validate solutions for multiparametric, long term monitoring of behavioural and physiological information relevant to bipolar disorder.	Univ. Passau, ETHZ, IT Univ. of Copenhagen, TILAK
INTER-STRESS	Design, develop and test an advanced ICT based solution for the objective and quantitative assessment of symptoms using biosensors and behavioural analysis for the treatment of psychological stress.	Istituto Auxologico, FIMI Philips
NextMedia	Coordination of the efforts in Europe towards producing a clear situation of the Future Media Internet, create common pillars (e.g. the Future Media Internet reference architecture for Europe) and support the results of the developments of the European projects by means of the following actions.	UPM, CERTH, ATOS
CHRON	Heterogeneous Reconfigurable Optical Network	Centro para el

	project. CREATE-NET is leading a work package on control/management and test-bed development. The plan is to test the deployed CP solution on the Testbed under development in Trentino.	Desarrollo de las Telecomunicaciones de Castilla y León – CEDETEL, Huawei, Telekomunikacja Polska
ENDORSE	The project brings together a consortium of data protection legal experts, academic computer science partners, software implementors and interested industry players. The project will produce a privacy rule definition language which will be used to express the appropriate European directives together with national legislative implementations.	Waterford Institute of Technology (TSSG), University of Zaragosa, Tilburg University
AUTOCLUSTER	The Project brings together Universities, R&D institutions, SME support facilities from EU-15, NMS as well as IPA to prepare and create the first automotive network in South East Europe. The second level clustering activities proposed by the project are improving the innovation capacities in the region and technology and know-how transfer - improving the innovation circle.	Automobilový klaster - západné Slovensko, Automotive Cluster Vienna Region
MOTUS	Industry (Funding Source MAP) research project lead by Telecom Italia to develop a complete solution for sustainable mobility including tracing and monitoring vehicles and giving suggestions for mobility solutions to reduce air pollution and to encourage citizens consciousness.	Telecom Italia, CRF
ACUBE	PAT Grandi Progetti. Advanced integrated infrastructure for intelligent monitoring in nursing homes.	FBK, UNITN, Don Gnocchi
iTheater	PAT/Legge 6. Development of an interactive integrated system for story-creation and storytelling based on tangible interfaces and animation editing dedicated to children in pre-scholar age.	Computer Learning, FBK
Compass	PAT FESR Call / Legge 6. Aplication platform and personal communications services to support individuals and communities of people interaction to each other and with a centralized organizations during events (e.g. scientific summits, B2B, trade shows, sport events, etc.)	Intelinks
TI SENTO	PAT FESR Call / Legge 6. eParticipation platform supporting the people-centric sensing in urban environment and the sharing of information and multimedia content produced by people in mobility.	Cogito
GeoMedia	PAT FESR Call / Legge 6. Software and telecommunications technologies to produce geolocated interactive video content, delivered to the end users via mobile terminal, to be used for tourism and events.	Interplay
SEROFON	PAT FESR Call / Legge 6. The project is about advanced developments of the OpenFlow (OF) framework to deploy network virtualization mechanisms into an operational network. The ob-	Win.Net

	jective is to facilitate the separation between Network Infrastructure Providers (NIP) and Service Providers (SP) through the introduction of a new stakeholder, the Virtual Network Provider who could provide a Virtual Network to an ISP potentially spanning different NIP's networks.	
ACKA	PAT Legge 5. Adaptive optimization of wireless mesh networks in outdoor environments using a methodology for dynamic management of network resources based on the quality of the links between access point and user terminals.	FUTURE3
MATRIGO IV and DAIGO	A research and an R&D industry fully funded cooperation on impact of impairments on the dynamic establishment of light-paths in translucent optical networks.	CISCO

3. Goals

Goals in CREATE-NET identified for the different areas according to the following four categories:

- Funding
- Research Excellence
- Business Development, Industry and IPR
- People Development.

These general goal categories are mapped and scoped to the different areas, according to their role and activity plan.

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*
Funding	A	E	Dec.	Number of successful projects and funding level
Research Excellence	R	E	Dec.	Number and type of publications
Business Development, Industry and IPR	I	E	Dec.	Number of processed industry contacts, industry funding, number of invention reports
People Development	CN	I	Dec.	Performance Evaluation

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

To manage the increased number of activities in the research projects CREATE-NET is involved, we need to hire selected resources in certain areas. The overall hiring plan is as follows:

Research and Engineering HR plan	2010	2011
Research and Engineering	52	56
Management and Support personnel	22	25
Total	74	81

For the Alliance for Innovation activities we plan the following Human Resources:

Alliance for Innovation HR Plan	2010	2011
Total	20	35

CIRM – CENTRO INTERNAZIONALE PER LA RICERCA MATEMATICA

Unit Name	CIRM – Centro Internazionale per la Ricerca Matematica	
Type	Research	
Head	Fabrizio Catanese	
Staff	2010	2011
	2 Post Doc	2 Post Doc
	1 Administrative Assistant	1 Administrative Assistant

Document Status: submitted 2010-12-01

1. Executive Summary

In 1978 the CIRM was founded by ITC in collaboration with the Italian National Research Council (C.N.R.), with targeted main activity the organization of week long workshops and Conferences on current topics of mathematical research.

The Centre began working on a provisional basis in Spring 1979; in 1982 it was formally established within the ITC.

Next to the traditional activity, which has seen the CIRM organize 236 international mathematical Meetings and Conferences, and next to the related editorial activity, which has seen the publication of 58 research books and journal volumes, present in the libraries of most Universities in the world, in 2008 the Comitato Direttivo set up a new range of activities, focused on the aim to have research done at the CIRM, along with scientific training.

Especially a new program was set up, encompassing four types of visiting positions, with the intention of stimulating the interaction between the mathematical research community of the Trento area and the European and international mathematical community.

The new range of activities includes:

- 2 Post Doc positions per year;
- Visiting Professor and Visiting Scholars positions;
- Research in Pairs.

In 2011 CIRM will organize eight scientific events in the fields of Algebraic Geometry, Calculus of Variations, Quantum Probability, Hysteresis, Nonlinear Numerical Methods, Complex Analysis and Geometry, Mathematical Physics and Numerical Approximation. For the specific program please see points 2 and 2.3.

Outstanding scientists such as Michael Vaughan-Lee (Oxford) and top level postdoctoral fellows such as Dariush Ehsani (Berlin) will visit CIRM to do joint research with scientists active in the Trento area. Specifically Vaughan-Lee, a major expert on the classification of p-groups and finite Lie rings, will start a collaboration with Andrea Caranti and Willem de Graaf (Trento). One of the goals of this project is to

develop a corresponding set of algorithms and programmes for finite nilpotent rings, with the applications to Abelian Galois Hopf extensions in mind. Dariush Ehsani will work together with Alessandro Perotti (Trento) on: "The ∂-Neumann problem on singular complex spaces", a central problem in the theory of several complex variables, with applications to forms and domains which are of fundamental importance in the theory.

The Research in Pairs project about "Exceptional singularities and Fano varieties" by Ivan Cheltsov (Edinburgh), Constantin Shramov (Steklov Moscow), Jihun Park (Pohang Institute of Science and Techn., Korea) has been already approved by the Comitato Direttivo and it will be carried out next June. The research area of this proposal is a lively branch of Algebraic Geometry, situated at the crossroads between classification theory of algebraic varieties and singularity theory. This is a constantly developing branch of mathematics with numerous applications in other areas of mathematics and physics, including Mathematical Physics, Differential Geometry, Topology and many others.

The Comitato Direttivo is discussing other submitted research projects for next year and other proposals are expected to be submitted (according to the rules set, applications can be submitted at any time and are evaluated by the Comitato Direttivo and referees in a short time, always less than three months).

The personnel of the CIRM consists of the Director, the Administrative Assistant and two Post-Docs. The current Director is Fabrizio Catanese, professor at Bayreuth University (Germany), who was re-appointed for the period 2008-2011. The Administrative Assistant is Augusto Micheletti, who is in charge of organizing the logistic aspects of the several scientific activities and to create and maintain an excellent work environment allowing the researchers to have a fruitful scientific activity during their visit, without troubles deriving from having to bother about logistic and other problems.

Starting from the year 2008 CIRM offers two annual Postdoc Fellowships for researches in the field of Mathematics. After a very close examination of the scientific merits of the candidates, the CIRM's Comitato Direttivo (with the help of referees) agreed that, among the applications for the year 2011, the best candidate is Sonia Mazzucchi.

Sonia Mazzucchi has an excellent research record, which amply qualifies her for a professor position: she has already had more than one postdoc positions, so that in her case one will have not just a Postdoctoral scholar who does training, but a mature scientists carrying out successfully her research. On May 1, 2011 she will start her research at CIRM on the theme of "Functional integration with applications to quantum dynamical systems", in collaboration with Luciano Tubaro and the group of stochastic processes in the Department of Mathematics of the University of Trento. The aim of her project is the development and the study of new techniques in the field of functional integration, with the purpose of finding further applications to the study of quantum dynamical systems.

The second of the applicants in the ranking, Francescopaolo Montefalcone, has already begun his research at CIRM on December 1, 2010. He is working under the scientific supervision of Francesco Serra Cassano (University of Trento) about

the research project “Questions about regularity of minimizers of the H-perimeter in Carnot’s groups”.

CIRM’s Comitato Direttivo decided to offer a six months postdoc position to the third of the applicants in the ranking, Silvia Barbina (currently working for Cambridge University Press, from which she will take a leave of absence), who works in the interesting field of Model Theory and will work in Trento under the scientific supervision of Stefano Baratella (University of Trento)

Special mention should be made of the collaborations signed by the Director of CIRM, which will bring external income by the Mathematics Department of the University of Trento for the next three years of Euro 15000 per year and by the INdAM (Istituto Nazionale di Alta Matematica), which will financially support the planned common activities.

Other income to the budget of CIRM will come from the Municipality of Levico and APT Valsugana.

2. Vision and Scientific Program

The Scientific Program of CIRM for the year 2011 includes the following Conferences and Schools:

– “XXI Convegno Nazionale di Calcolo delle Variazioni”.

  Scientific Organizers: Luigi Ambrosio (SNS Pisa), Gianni Dal Maso (SISSA Trieste), Paolo Marcellini (Firenze), Raul Serapioni (Trento), Francesco Serra Cassano (Trento). Period: February 6-11, 2011.

– “European Workshop on High Order Nonlinear Numerical Methods for Evolutionary PDEs: Theory and Applications (HONOM 2011)”.

  Scientific Organizers: Eleuterio Toro (Trento), Michael Dumbser (Trento), Claus Dieter Munz (Stuttgart) and Remi Abgrall (Bordeaux). Period: April 26-29, 2011.

– “The 32nd International Conference on Quantum Probability and Related Topics”.

  Scientific Organizers: Luigi Accardi (Roma II), Viacheslav Belavkin (Nottingham), Marek Bozejko (Wroclaw), Franco Fagnola (Pol. Milano), Takeyuki Hida (Meijo), Robin L. Hudson (Loughborough), Hui-Hsiung Kuo (Louisiana), Masanori Ohya (Tokyo), K.R. Parthasarathy (New Dehli), Denes Petz (Budapest), Rolando Rebolledo (Santiago), K.B. Sinha (Kolkata), Michael Schurmann (Greifswald), Oleg Smolyanov (Moscow), Igor Volovich (Moscow). Period: one week in Spring 2011.

– “8th International Symposium on Hysteresis and Micromagnetics Modeling”.

  Scientific Organizers: Giorgio Bertotti (INRIM Torino), Claudio Serpico (Napoli), Augusto Visintin (Trento), Ciro Visone (Sannio). Period: May 8-12, 2011.

– “Complex Analysis and Geometry - XX”.

Scientific Organizers: Vincenzo Ancona (Firenze), Claudio Arezzo (Parma), Filippo Bracci (Roma II) and Alessandro Silva (Roma I). Period: June 13-17, 2011.

– "Seventh School on Analysis and Geometry in Metric Spaces".

  Scientific Organizers: Luigi Ambrosio (SNS Pisa), Bruno Franchi (Bologna), Raul Serapioni (Trento) and Francesco Serra Cassano (Trento). Period: June 19-24, 2011.

– "Partial Differential Equations in Mathematical Physics and their Numerical Approximation"

  Scientific Organizers: Hugo Beirao da Veiga (Pisa) and Alberto Valli (Trento). Period: September 4-9, 2011.

– "School (and Workshop) on Tropical and Toric Geometry".

  Scientific Organizers: Giancarlo Casnati (Pol. Torino), Claudio Fontanari (Trento), Federica Galluzzi (Torino), Roberto Notari (Pol. Milano), Francesco Vaccarino (Pol. Torino). Period: September 11-17, 2011.

  Concerning the Visiting Professors, Visiting Scholars and the RIP's programs the projects will continue in 2011.

  Visiting Scholars will perform mathematical research in cooperation with scientists and researchers of Trento University or, more generally, of the Trento area, holding also research seminars. A list of accepted CIRM's Visitors for 2011 includes: Dariush Ehsani (Berlin), Michael Vaughan-Lee (Oxford), and the RIP's Ivan Cheltsov (Edinburgh), Constantin Shramov (Steklov Moscow), Jihun Park (Pohang Institute of Science and Techn.). Other research proposals are in progress .

  The three Postdocs, Sonia Mazzucchi, Francescopaolo Montefalcone and Silvia Barbina, will work in the respective areas of specialization: Quantum Dynamical Systems, Geometric Measure Theory and Model Theory (Mathematical Logic).

2.1. Context and State of the Art

Mathematical research nowadays is no longer the fruit of powerful minds working in isolation and quiet.

On the one hand all the unprecedented scientific and technological development of society cries our for large investments, and for an increased mathematization of all the applied sciences.

Nowadays mathematics plays a double challenge.

The future of mankind, especially in view of the future shortage of resources, and the need to find new sources and a less wasteful use of the existing ones are relying on a vast scale growth of rationality and programming (this includes of course giving up to war as a way of solving problems and disputes), and a spreading of scientific knowledge. Mathematics is then the primary discipline, since centuries source of rational thinking , the primary science which deals with solving new problems by logic deduction and not by random trial and error experiments.

On the other hand even the progress of theoretical (pure) mathematics has become more of a social enterprise than an accomplishment of isolated individuals. A typical example was the solution of the Fermat problem in 1994, where more than a hundred researchers from different nationalities were involved on a long term research project, encompassing more than 80 years, each giving essential inputs in the directions which were envisaged in several scientific Conferences, especially those which took place in the 50's and 60's in USA and Japan.

Mathematics is now officially recognized as being an international enterprise, and each environment must be immediately open to the new directions and innovations which make their way through.

For this reason it is recognized to be of primary importance the existence of research structures, many of which (like in Luminy, France, or in Barcelona, Spain, Trento, Italia) are called CIRM = International Centre for Mathematics Research.
There are many of these research Institutions, usually one or two in many nations, like the Mathematisches Forschungsinstitut in Oberwolfach (Germany), the Max Planck Institut fuer Mathematik (Bonn, Germany), the Centre Emil Borel de l'Institute Henri Poincare' , Paris, the IHES= Institut des Hautes Etudes Scientifiques (Bur sur Yvette, France), the Banach Centre in Warsaw and in Bedlewo,the Isaac Newton Centre for Mathematical Sciences in Cambridge (GB), the IAS= Institute for Advanced Study, Princeton (USA), the Clay Mathematics Institute (Cambridge USA),the KIAS= Korean Institute for Advanced Study (Seoul), the Research Institute for Mathematical Sciences (Kyoto, Japan), and many others.

There is also the deeply felt need that these research Institutions, especially the European ones, should keep in close contact and collaboration which each other. For this reason was also founded the ERCOM , with the intention of coordinating the activities , and fostering exchanges.

The CIRM has set up its role recently in this context as an Institution which is not only active in the organization of scientific exchanges through international workshops, schools and Conferences, but also is a permanent institution which hosts mathematical research, stimulating the scientific growth of the mathematical community in the Trento area.

This is witnessed by the extremely high scientific stature of the Members of the Comitato Direttivo:

- Fabrizio Catanese, Universität Bayreuth,
- Luigi Ambrosio, Scuola Normale Superiore Pisa,
- Marco Andreatta, Università degli Studi di Trento,
- Alberto Valli, Università degli Studi di Trento,
- Don Zagier, Max Planck Institut für Mathematik Bonn e College de France Paris.

The loss of Fritz Grunewald was very saddening and the Comitato Direttivo looked for some replacement, in order to keep up with the internalization of CIRM. The proposed two new members are Boris Dubrovin (SISSA Trieste) and Simon Salamon (Politecnico Torino). This should allow the Comitato Direttivo to cover a very wide spectrum, including Differential Geometry and Mathematical Physics.

2.2. Vision and Goals

The CIRM has a long term established reputation for the invaluable service to the mathematical community rendered through the organization of Conferences, schools and workshops.

Our long term goal is to establish also a reputation as a place where high quality mathematical research is produced, through the new research activities which have been set up in the last 3 years.

These are the new programs:

1. Visiting professors and visiting scholars
2. Research in Pairs.
3. Post doc Fellowships.

Activity 1. is focused around the target to stimulate cooperation with scientists who are active in the Trento area, be it for joint research projects, or for delivering series of lectures, or Ph.D.

courses, to disseminate new knowledge, methodologies and techniques.

Activity 2. is the most original and innovative: it brings together foreign scientists who work together, in a fully free environment, on a well defined research project, with the intention of bringing it to end through the intense and direct cooperation.

This project is very interesting , and also not very expensive, since the visiting scientists receive essentially from the CIRM only an expense reimbursement.

Activity 3. is instead crucial for the future: the training of future researchers, especially in this critical situation, plays a primary role concerning the general aims sketched in section 2.1.

In all of these activities it is planned to intensify the existing cooperations with other research Institutions, both the formalized ones, with the Istituto Nazionale di Matematica " Francesco Severi", and with the Dipartimento di Matematica della Universita' di Trento. But also, and more important, the non formalized or occasional ones, as with the Max Planck Institute in Bonn, the Hausdorff Zentrum in Bonn, the Forschergruppe 790 of the Deutsche Forschungsgemeinschaft, the Scuola Normale Superiore di Pisa and many others.

For this reason the new programs of the CIRM have been advertized on the Notices of the major Mathematical Societies (Italian, American, ..).

2.3. Activities and Work Plan

1. "*XXI Convegno Nazionale di Calcolo delle Variazioni".* This is the twenty-first edition of a series of meetings started in 1990 focused on the scientific personality of Ennio De Giorgi, one of the most famous Italian mathematicians, dead on October 25, 1996. The purpose of this conference is to give an overview of the current researches and to define a few open problems in the field. The Organizing Committee has been componed by the national responsibles of three National Projects of research. More than 100 participants attended the last editions of this conference and the exchanges of ideas and the fruitful interactions have produced a lot

of scientific collaborations and papers. We expect the same number of participants in the next edition.

2. *"European Workshop on High Order Nonlinear Numerical Methods for Evolutionary PDEs: Theory and Applications (HONOM 2011)".* A very wide variety of processes in science, engineering and biology involve evolutionary PDE. Numerical simulations and predictions, particularly for scientific purposes, demand the use of accurate numerical methods for solving systems of time dependent partial differential equations. This is most evident in acoustics, when attempting to evolve weak signals for long distances and for long times or in the simulation of turbulent flow when attempting to capture small structures on relatively coarse grids. In addition to the classical requirement of conservation, of fundamental importance is high accuracy in both space and time for all processes involved (e.g. advection, reaction, diffusion, dispersion). However, as is well-known from Godunov's theorem, accuracy of linear schemes greater than one brings in the Gibbs phenomenon, producing solutions with spurious oscillations. The real challenge is then to construct non-linear (non-oscillatory) schemes of high accuracy, even for solving linear problems.

Significant advances have been made in the last two decades on the construction of conservative, non-linear schemes of high order of accuracy in both space and time. These advances were pioneered by the family of TVD (Total Variation Diminishing) methods, by now a well-established approach that produces relatively simple and practical second-order schemes. To go beyond second-order, a high degree of sophistication is required. There are at present several approaches that, at least partially, fulfil some of the basic requirements. Examples include the ENO method and its variant the WENO method, the DG Finite Element methods and the ADER approach.

Themes of the conference are: Algorithm design, Analysis and applications of non-linear schemes of accuracy greater than two, Following the finite difference, Finite volume or finite element approaches.

The invited plenary speakers are: Dinshaw Balsara (Notre Dame), Francesco Bassi (Bergamo), Juan Cheng (Beijing), Bernardo Cockburn (Minnesota), David Darmofal (MIT), Bruno Després (Paris VI), Giacomo Dimarco (Toulouse), David Schuster (NASA Langley Research Center), Spencer Sherwin (Imperial College), Vladimir Titarev (Cranfield).

Ample space will be left in the scientific programme for contributed talks.

3. "The 32nd International Conference on Quantum Probability and Related Topics". This conference is intended to be the continuation of those with the same title held in Bengaluru (India) in 2010, in Guanajato (Mexico) in 2009, in Tunis in 2008 and in Levico Terme under CIRM sponsorship in 2005.

The main topics of the conference will be: Stochastic independences and independent increment processes, Free probability and random matrices, Quantum Markov semigroups and processes, White noise and higher powers of white noise, Quantum stochastic calculus, Stochastic analysis, Hilbert modules, Product sys-

tems, isometries, Quantum Information, Physics and biology, Quantum measurement, filtering, control and statistics.

The aim of this sequence of conferences is to select the most important results of the last years, to improve the interdisciplinary collaborations, especially among the youngest researchers, to foster exchange of ideas and interaction between the various fields of mathematics involved in PQ researches.

The tentative list of speakers includes: M. Schuermann, U. Franz, N. Muraki, M. Bozejko, R. Speicher, K. Dykema, A. Arnold, F. Fagnola, R. Carbone, F. Cipriani, F. Fidaleo, L. Accardi, N. Asai, W. Ayed, A. Barhoumi, A. Boukas, A.M. Chebotarev, A. Belton, D. Goswami, R.L. Hudson, J.M. Lindsay, G. Da Prato, Yu.G. Kondratiev, M. Roeckner, Z.-M. Ma, B.V. Bhat, M. Skeide, R. Floricel, M. Ohya, I. Ojima, D. Petz, F. Hiai, N. Watanabe, A. Barchielli, M. Gregoratti, V. Belavkin, F. Bagarello, J. Gough, R. Gill.

4. *"8th International Symposium on Hysteresis and Micromagnetics Modeling"***.** The 8th International Symposium on Hysteresis and Micromagnetics Modeling (HMM-2011) is intended to be a forum for presentation and discussion of the most recent advancements in the fields of hysteresis modeling and computational micromagnetics. Continuing with the tradition of the previous HMM symposia, HMM-2011 has a strong interdisciplinar vocation. The aim is, in fact, to bring together scientists with a wide range of backgrounds (physicists, mathematicians, material scientists, engineers, etc) to exchange ideas, methods and results. Although special emphasis will be made on magnetic hysteresis, there will be sessions in the program focused on universal aspects of hysteresis, independently of its origin. The scientific program of this 3-day symposium will consist of invited and contributed talks and posters, organized in different thematic sessions. The topics covered include the following:

- General hysteresis and coupled problems: mathematics of hysteresis, statistical aspects, etc..
- Scalar and Vector hysteresis: modeling, experiments and measurements
- Hysteresis in continuum mechanics
- Barkhausen noise, disorder
- Classical spin models: random-field models, domain wall models, etc...
- Thermal relaxation, aftereffects
- Micromagnetics: theory
- Micromagnetics: numerical techniques, field calculations, standard problems
- Micromagnetics, applications: hysteresis properties of nanoparticles, spin dynamics of coherent structures, etc...

The Department of Mathematics of the University of Trento, the Istituto Nazionale di Ricerca Metrologica of Torino and the Universities of Sannio and of Napoli will support the conference financially.

5. *"Complex Analysis and Geometry - XX".* In 1981 two of the scientific organizers of this conference thought that perhaps other complex analysts and complex ge-

ometers deserved the opportunity of having a regular forum in which a presentation of the main results of the year would be given regardless of specialties (from algebraic geometry to P.D.E. and microanalysis). The first meeting was held in 1982 and in 2011 we will reach the twentieth edition. We foresee for 2011 edition the participation of 80-100 researchers, many of them post-doc students and young researchers. During the years, three volumes of proceedings of this series of meetings were published by Plenum Press (1993), Marcel Dekker (1996), Longman (1997).

6. *"Seventh School on Analysis and Geometry in Metric Spaces".* The six previous schools took place in Trento in May 1999, June 2001, May 2003, May 2005 and in Levico Terme in June 2007 and June 2009, always under the sponsorship of the CIRM.

The aim of the schools is to offer a glimpse on selected research topics in Calculus of Variations and Geometric Measure Theory on Carnot-Carathéodory spaces - and possibly on even more general metric spaces - and to focus on their applications.

Analysis and Geometry on these structures has been object of extensive research in the last few years, with applications ranging from classic ones - degenerate elliptic equations, optimal control theory, differential geometry, harmonic analysis - to very new ones as the functional structure of the visual cortex.

As in the previous meetings it is the intention of the organizers to put together young and well-known researchers active in the field and to encourage informal discussion on current trends and developments in the area.

Traditionally, the core of each school are four or five short courses (4/5 hours each) together with a number of single talks.

In the previous six editions, short courses have been given by the following speakers (in alphabetical order) : A. Agrachev (SISSA, Trieste), L. Ambrosio (Scuola Nornale Superiore of Pisa), Z. Balogh (University of Bern), M. Bonk (University of Michigan, Ann Arbor), T. Coulhon (University of Cergy- Pontoise), M. Cowling (University of New South Wales, Sydney), G. David (University of Paris XI), J. Heinonen (University of Michigan, Ann Arbor), B. Kleiner (University of Michigan, Ann Arbor), P. Koskela (University of Jyvaskyla), E. Lanconelli (University of Bologna), J. Manfredi (University of Pittsburgh), P. Mattila (University of Helsinki), P. Pansu (University of Paris XI), H.M. Reimann (University of Bern), F. Ricci (Scuola Normale Superiore), M. Ritoré (University of Granada), S. Semmes (Rice University), K.T. Sturm (University of Bonn), H. Sussmann (Rutgers University), T. Toro (University of Washington, Seattle), M. Troyanov (Polytechnic of Lausanne), R. Wheeden (Rutgers University).

Lecture notes of the courses given at the first school were collected in the book, published by the Scuola Normale Superiore of Pisa, "*Lecture Notes on Analysis in Metric Spaces*", edited by L. Ambrosio and F. Serra Cassano. A second issue containing lecture notes of the second and third school is in preparation, edited by L. Ambrosio, B. Franchi, R. Serapioni and F. Serra Cassano.

In the Seventh School, there will be the following four speakers: Nicola Garofalo (Università di Padova and Purdue University), T. Iwaniec (Syracuse University), J. Maly (University of Prague) and U. Boscain (CMAP, Ecole Polytechnique, Paris).
The participants attending each of the previous schools have been about 50. Most of them were PhD students and post-docs; among them about one third were coming from abroad. We expect to have in 2011 a comparable number of participants and possibly a larger number from abroad.

7. "School (and Workshop) on Tropical and Toric Geometry" . This meeting is articulated in a School and in a Workshop. The School will give the students and young researchers the opportunity of learning the subject from experts in the area. Main speakers of the school will be S. Di Rocco (KTH Stockholm) and G. Mikhalkin (Genève), who will deliver 5 or 6 lectures each and participate in individual consultations with the participants.

Moreover a common assistant to deliver some exercise classes in coordination with S. Di Rocco and G. Mikhalkin, will be contacted.

This meeting follows the previous ten, organized since 2001 by some members of the research group "Algebraic, Computational and Differential Geometry" of the Dipartimento di Matematica – Politecnico di Torino. From 2001 to 2005 such meetings were held in Torino but, since 2006, they have been held at CIRM – FBK in Povo (Trento).

As for the previous ones, the 2011 meeting is primarily aimed at both graduate and Ph.D. students, and to both young and senior researchers.

The program includes:

S. Di Rocco. *Toric Geometry.*

Toric varieties have provided a remarkably fertile testing ground for general theories in Algebraic Geometry.

The action of the algebraic torus gives a reach combinatorial structure which not only serves as a useful computational tool but equally importantly as a bridge to neighboring areas such as Combinatorics, Statistics, Biology and more. The emphasis of this series of lectures is on the study of the geometry of projective toric varieties and its relation to convex geometry. Lectures 2-5 will each introduce research areas in toric geometry where problems are still open, typically in the singular case.

– Introduction to normal projective toric varieties and the correspondence with lattice convex polytopes. Basic notions and basic examples will be presented.
– Projective invariants in toric geometry: Osculating spaces and projective duality. The two problems have a particularly nice solution in smooth toric geometry which gives interesting formulas when applied to the corresponding convex/combinatorial setting.
– Polyhedral adjunction theory. The Nef-cone and Effective-cone of a toric variety, and their interior, are rational cones. This property is fundamental to work with certain invariants associated to adjoint linear systems such as the nef value and the normalized spectral value. Again toric geometry

leads to particularly nice results which turned out to be fundamental to solve certain combinatorial conjectures.

– Positivity of equivariant vector bundles. The positivity of line bundles (i.e. the nef and ample-cone) of a non-singular toric variety is well understood. There are nice geometrical and combinatorial criteria measuring how positive a given line bundle is. Equivariant vector bundles have a combinatorial description but it is still unclear how to read off properties like global generation and very ampleness. The problem will be explained and recent results will be discussed.
– Projective normality of toric variety. The problem of projective normality is of particular interest for toric varieties because of its analog in convex geometry. The property of satisfying N_p and its connection to the positivity of the embedding will be discussed.

G. Mikhalkin. *Tropical Geometry*.

The lectures will cover basic notions of tropical geometry with a focus on their topological treatment. The tentative schedule is listed below, however the actual lectures might be modified depending on the feedback from the audience.

– Real 1-parametric families of complex manifolds and their tropical limits. Examples.
– Matroids, integer affine structure, formal definition of tropical variety. Projective spaces. Hypersurfaces and complete intersections.
– Chow group vs. homological cycles in tropical varieties. Intersection theory. Tropical waves and detecting algebraic cycles.
– Moduli spaces of curves in tropical manifolds. Enumerative problems. Reality questions.
– Connection to Mirror Symmetry and further topics.

The Workshop on the state of the art will give the opportunity to senior researchers to address common problems. Most of the conferences will be delivered by invited speakers, some others by participants to the school. Accordingly to our budget the invited speakers will be selected from a list of experts in the subject, such as L. Caporaso, C. Casagrande, J. Draisma, I. Itemberg, D. Maclagan, L. Migliorini, R.M. Mirò-Roig, S. Payne.

8. *"Partial Differential Equations in Mathematical Physics and their Numerical Approximation".* Aim of the conference is to present the state-of-the-art of research in Partial Differential Equations of Continuum Mechanics, especially non-linear theories, with a particular regard to the Mathematical Theory and Numerical Aspects in Fluid Mechanics. Clearly we have to limit the analysis to some specifics areas, important from the theoretical point of view or for real life applications (Oceanography, blood flow, etc.).

From the theoretical point of view we are interested in classical open problems like existence, uniqueness, regularity, stability, and asymptotic behaviour for Navier-Stokes and Euler equations. We also want to consider singular limit problems (for instance, in-viscid limits and incompressible limits) and classical open problems

like Leray's problem for stationary Navier-Stokes equations in domains with non-homogeneous Dirichlet boundary conditions.

Main concern will be the consideration of non-Newtonian fluids. Let us comment on this point:

It is well established by experimental evidence that the viscosity of several fluids depends on symmetric part of the velocity gradient ("sjear-dependent viscosity"). The simplest dependence is, for example, as a power of the deformation tensor. In these models viscosity may monotonically increase or decrease with increasing shear rate. We speak of "shear thickening" and "shear thinning" fluids, respectively. Equations describing shear thickening effects are employed in numerical simulations of gases and fluids, starting from the celebrated works of J. von Neumann and R..D. Richtmyer (J. Appl. Phys. 1950) and of J. Smagorinsky (Mon. Weather Rev. 1963), who introduced the famous turbulence model bearing now his name. As a peculiar example of fluid exhibiting shear thinning we have the human blood. Other examples are suspensions of particles and carrier oil. In the last decades, the onset of "smart" materials, biological fluids, and real-life applications to the study of turbulent flows put the class of power-law fluids as a paradigm for the mathematical investigation. Fine analytical properties of the solutions are requested, since they are needed for the numerical convergence error estimates. With different motivations O.A. Ladyzhenskaya, at the International Mathematics Congress in 1966 proposed a general class of equations with viscosity depending on the velocity through its symmetric gradient ("shear dependent viscosity"). See the English 1959 edition of the famous book of the same author: "The Mathematical Theory of Viscous Incompressible Flow". This model showed a big relevance in several theoretical and applied problems. In the mathematical theory of fluid mechanics, after the famous conference of O.A. Ladyzhenskaya (followed also by several research papers by the same author), the interest for these systems of partial differential equations grew up. Big influence has also been given by an entire chapter of the well known 1969 book "Quelques Méthodes de Résolution des Problèmes aux Limites Non Linéaires", by J.-L. Lions, in which a similar, simplified, model is introduced. The interior regularity for these problems has been studied by several authors. On the contrary, the problem of the regularity up to the boundary has been addressed only by few authors. The presence of the boundary poses several new problems. Existence of solutions for some fundamental problems are still open like, for instance, Electro-rheological fluids or temperature dependent material coefficients.

We are also particular interested in the theoretical and numerical study of boundary conditions important in applications, like slip boundary conditions of Navier type.

Finally, the interaction between researchers coming from different but related areas should be one of the most important products of the conference.

2.4. Collaborations

An agreement between the Department of Mathematics of the University of Trento and the CIRM was signed, by Fabrizio Catanese, Director of CIRM, and Raul Serapioni, Director of the Department. The Department will contribute each year,

for the three following years, Euro 15000 directly to the CIRM. A joint Committee, formed by Andreatta, Catanese and Valli is nominated, which will decide the ways in which the cooperation will take place.

On May 8, 2008 another agreement between the INdAM (Istituto Nazionale di Alta Matematica) and the CIRM was signed by Fabrizio Catanese and Vincenzo Ancona, Director of the INdAM. CIRM and INdAM will collaborate in the organization of scientific activities and will support them financially. A joint Committee formed by Andreatta, Catanese, Ancona and Capuzzo Dolcetta is nominated.

FONDAZIONE GRAPHITECH - CENTER FOR ADVANCED COMPUTER GRAPHICS TECHNOLOGIES

Name	Fondazione GraphiTech - Center for Advanced Computer Graphics Technologies	
Type	Research	
Head	Raffaele de Amicis	
Staff	2010	2011
	4 Researchers	5Researchers
	3 Technologists	3Technologists
	4 Early stages researchers	5 Early stages researchers
	2 PhD	2 PhD

Document Status: submitted 2010-12-7

1. Executive Summary

In the current and future scientific and technological worldwide panorama, Information and Communication Technologies (ICT) play a critical role for the development of new services and products that bring innovation into companies and ultimately improve the quality of life of the society. An important subset of ICT deals with Computer Graphics technologies, including Multimodal-Multimedia and Interactive Digital Media technologies, and their applications with special focus on visualization, interaction and communication of visual and multimodal information in the broadest sense.

In this context, GraphiTech, Centre for Advanced Computer Graphics Technologies, has been established to enhance the competitiveness of Trentino's industries through research and development activities in the broad technology area of advanced computer graphics, mixed reality, information and communication systems.

The mission of the Foundation is to contribute towards the transfer of knowledge between the research sector and the industry through the promotion of research activities. GraphiTech, through its activities, stimulates collaboration and friendship in the field of information technology, between the Trentino province, Italy and Germany and it performs world-class research and development in advanced computer graphics technologies. Its international nature is strengthened by its membership to the GraphicsMedia.Net one of the widest research network in computer graphics worldwide.

Currently, GraphiTech is involved in several projects both at the Global, European, and National level. Projects are being carried out as R&D activities, through financing by the EU, NATO or by local framework programmes, as well as through applied research projects, commissioned by industries or local authorities.

In order to be excellent, best-in-kind at the local level, but at the same time be a relevant player at international level, GraphiTech has developed so far a key global profile, reached a critical mass, implemented a number of robust collaborations, and achieved a strong international presence. Thus, GraphiTech is able to shape and define its own future being a proactive actor at international level in terms of applied research and technology transfer.

Along with John Hagel's idea of innovation as "*the ability to create and capture economic value from invention*", GraphiTech is delivering "*tangible innovation*" through its scientific and industrial research and development activities.

2. Vision and Scientific Program

In this years of Research and Development activities at local, national, EU and global level, GraphiTech has participated and contributed to the scientific community in the following understanding of Computer Graphics as: "*the technology with which pictures, in the broadest sense of the word (synthetic graphics as well as grayscale and color images), are captured or generated, presented, manipulated, digitally processed in the appropriate form for the respective application and merged with other, non-graphical application data. This also includes the computer-supported integration and manipulation of these pictures and 3D models with other kinds of data, such as audio, speech and video (to create multimedia systems) as well as corresponding advanced dialog and interactive technologies. Concepts which characterize the important topics of computer graphics are, to name a few, Visualizing Information, Visual Data Mining, Visual Computing, Virtual Reality (VR), Augmented Reality (AR), Interactive Internet Services and Secure Image Transmission and Communication*."

In this context, GraphiTech has carried out research in different, yet related, areas grounded upon three different application domains:

1. *Virtual Engineering*. *This is defined as "the discipline which integrates geometric models and related engineering tools for analysis, simulation, optimization, and decision making tools within a computer-generated environment that facilitates multidisciplinary collaborative product development*". Computer Aided Design and Manufacturing (CAD/CAM) technologies, which originated about 45 years ago, have become a key part of the product development and production processes. Virtual Engineering has been shaped by the combination of achievements spun from several disciplines, such as Classical and Computational Geometry, Approximation Theory (in particular the theory of spline functions), Numerical Analysis, and Computer Graphics. Mathematics and Computer Graphics are the alphabet and the language needed when developing CAD/CAM software. The great progress accomplished in algebraic and differential geometry during the last century has a potential to significantly improve CAD/CAM.

GraphiTech is focusing on fundamental problems related to constraints within CAD systems, and how to efficiently use the remaining degrees of freedom in order to tackle several challenges including:

- How to sketch 2D-profiles, including issues dealing with constraints related to topology, angle, distances, etc.
- How to model kinematics and dynamics of 3D rigid bodies, dealing with constraints related to contact, joints, etc.
- How to create surfaces effectively managing constraints on points, curves, curvature, minimization of some tension, avoid oscillations, etc.

The major challenges in terms of 3D visualization that we are considering to address are:

- How to visualize huge CAD models -in real-time- with high frame rate and good quality on standard PCs.
- How to visualize CAD models together with other 3D graphics data, e.g. terrains, seabed, reservoir data, weather conditions and more.
- How to take advantage of new algorithms and 3D graphics hardware for real-time CAD visualization.
- How to scale systems in order to best use existing hardware on high-end systems, and at the same time ensure:
  - Acceptable visual quality and rendering speed on standard systems.
  - Deployment on mobile platform.

Besides classical research issues related to Geometric Modelling and 3D Visualization, another research activity, which has started this year, has focused on image-based modelling, with the goal of extracting geometric features from images. The possibility to extract metric information from images is ensured through the adoption of photogrammetric techniques. Photogrammetry allows reconstructing three-dimensional metric models from photographic images.

The main issues related to this topic are:

- Ensuring geometric modelling of the cameras - including the lens calibration and accuracy assessment-.
- Developing effective feature extraction techniques - including edge detection, region growing, image correlation etc.-.
- Perform precise feature reconstruction - including automatic and semi-automatic techniques-.

2. Virtual Content Creation and Interactive Applications for a Culturally Interconnected Cyber World. Intuitive access to information is becoming a central concern for those developing consumer technologies dealing with various types of media-rich information. Within the cultural heritage domain, the driving vision is to connect different cultures through new technologies as well as to develop instruments for re-qualification of archaeological, architectural and monumental heritage.

Within this application domain, GraphiTech is developing technologies to create virtual showcases, with the ambition of making them standard equipment for museums and other public exhibitions as well as education, engineering, advertisement and entertainment institutions.

Museum set-ups, art galleries, archaeological sites or ancient monuments in fact are typically perceived by non-specialists as fragmented, partial and difficult to in-

terpret and comprehend thus causing a frustrating and limited experience for most visitors. Typically curators of those events try to compensate for this by providing visitors with textual information, additional illustrations or physical models. However this “one-fits-all” approach cannot benefit from the different cultural backgrounds of those visiting the site. Recent advances in computer and graphics systems, projection and tracking technologies, input devices, and networking infrastructures form the basis for realising this vision.

Additionally people need interactive and mobile tools to be able access media-rich environment on demand. This requires developing new approaches to interact with digital content, capable to leverage real-time information collected from the web and new interaction devices based on both touch screens and the variety of sensors fitted today within mobile devices.

An additional interesting research item has been brought by the recent success of Digital Educational (video) Games (DEGs), often referred to as “serious games”, which have been applied to simulate situations where there is a clear need for direct, first-hand experience, e.g. within didactical programmes to be used at school or to train workers. Their use has proved to be beneficial whenever direct experience is not available either because it refers to rare events, e.g. reconstruction of human models subject to rare pathologies or simulation of driving under psychoactive substances, or because it requires unsustainable time and/or costs, e.g. in case of military training.

The main characteristics that make DEGs particularly suited to be used within a didactical context are:

- Their educational context is channelled through a “learn-by-doing” methodology. It has been proved that information learned in this way is acquired more easily and is more persistent if compared to traditional frontal training.
- Learning-by-doing promotes a more compelling and spontaneous interaction, both with the system and with other trainees, if compared to traditional frontal training.
- Being able to act within a safe environment increases user’s trust in their abilities.
- DEGs promote rapid, continuous yet effective feedback.

One of the grand challenges by tackled by GraphiTech is the unobtrusive integration of information technologies in order to enhance a proper learning experience and to facilitate and improve the knowledge transfer.

3. *GeoVisual Analytics (GVA).* GVA aims at maximising the potential wide use of geographic information to describe, assess and visually depict physical features and geographically referenced activities on the Earth. In fact nowadays, it is widely acknowledged that geospatial information can be used with great benefits across a vast spectrum of human endeavours. The goal of GVA is to maximize the benefit of the extremely large information flow available today as well as to prevent a dangerous “information overload”.

This requires research on methods and techniques to provide intelligent complexity reduction across geospatial information of environmental relevance. For this reason it is necessary to develop analytical tools capable to represent, within a single

interactive environment, information coming from different geospatial data repositories as well as from environmental sensors. The development has to bring to the adoption of a graphical language capable to ensure abstraction over physical characteristics of the environment and the phenomena of interest occurring within it.

In particular research has to develop tools capable to ensure interactive visualization, in a completely transparent manner, of databases managed within multidisciplinary, heterogeneous operational contexts, used for applications ranging from environmental planning and monitoring, to risk management.

The two main RTD issues can be coarsely grouped under two grand challenges:

- **GeoSpatial Visual Modeling**: this represents the sequence of steps that spatial information takes to evolve from a storage state to its visual representation. Usually it is a process aimed at the construction of a well-suited and optimized data structure to arrange and render large amount of data. An example of this could be a tessellator based on Voronoi Diagram used to render Triangulated Irregular Networks (TINs) from a Digital Elevation Model (DEM).
- **GeoSpatial Visual Processing**: this is the act of taking spatial data as input (e.g. as OGC® GML standard format), and to build a chain of processes capable to elaborate it (e.g. as chaining of OGC® WPS - Web Processing Services) and eventually produce an output that is going to be rendered on a visually-rich environment (e.g. based on World Wind).

3. *Goals*

GraphiTech is engaged in the following scientific challenges which have been classified, for the sake of consistence with the previous section, according within three aforementioned application domains.

1. *Virtual Engineering*. Within this area future activities will be framed in the context of project SAGA (ShApes Geometry Algebra –www.saga-network.eu-) whose goal is to investigate the possibility of defining different forms of constraint-based design.

Within this context we refer to designed features as “constraints”, defined by the design purpose, which should be properly integrated with the final CAD model. The integration involves studying the types of representations typical of constraints and CAD models, analyse their geometry and topology, identify the points at which a constraint can fit the designed object. The study requires also studying how the object should evolve to satisfy the constraints, areas of possible interpolation of the constraints and the model.

The considered industrial scenario focuses on timber structures and aims at implementing non-destructive diagnosis techniques essential to optimize production processes and to ensure optimal maintenance and restoration of existing structures. The objective is to develop more effective automatic visual grading criteria to correlate and detect mechanical properties of lumber with visual features, such as

growth characteristics, surface decay and geometrical defects that can affect these properties.

Several image-based modelling techniques are applied in order to extract the characteristic features of the timber structures. Various image analysis processing techniques are investigated in order to automatically generate those features, using the photogrammetry model. The resulting information will not only have to be qualitative but also quantitative. More specifically the goals being pursued within this research activity are:

- The development of a novel methodology to evaluate timber, taking into account the material variability within each member.
- The identification of novel techniques and approaches for detection and modelling of gross anatomical features of wood.
- The definition of a complementary approach to visual grading for mechanical assessment of timber elements.

2. *Virtual Content Creation and Interactive Applications for a Culturally Interconnected Cyber World.* The objectives of the research activity will be to overcome, or at least minimize, the perceptual gap between cultural heritage and their virtual reconstruction through the adoption of immersive and pervasive Virtual Reality (VR) technologies. The goal is to create 3D reconstructions of buildings and other forms of heritage, whose traces are still visible today within archaeological sites, and to visualize and interact with them through technologies borrowed from the domain of Virtual Reality, such as Head Mounted Displays (HMDs), tiled displays and multitouch screens as those found within tablets or PDAs.

A further objective of the research activity is to create a semantically-enriched 3D model, which can benefit from the re-organization of the additional multimedia information available according to the final use of the application. If compared to constrained learning paths, imposed by other traditional learning tools such as books, documentaries, which are organized according to structured sequences of events, this on-going research activity has the ambitious goal of explore “transversal paths”, intersecting traditional learning paths and open to possible contaminations from other disciplines in order to amplify diversity and variety, rather than specialization and virtualisation.

As a consequence, the data available, whose access requires contributions from different disciplines and competences, is selected and re-organized according to the new media and new technologies available including, but not limited to, smartphones (e.g. iPhones) or tablets (iPads). From this point of view, we could state that the hypertext can be considered as a typical example of presentation of information that occurs neither in conventional nor mono-directional terms, while the Internet of Future is the means to navigate within the information available through personalized routes.

One of the challenges is to couple the web-based content with other “worlds” of knowledge and learning, which can possibly be more intuitive, including 3D and augmented environments, and adapt them to a variety of different users. Knowledge, meant as a 3D matrix which can be integrated with personal and original

user choices, rather than along pre-set directions and sequential chapters, is only one of the subjects and goals of our research activity.

In a nutshell, the three main objectives of this application domain are:

To develop hardware and software technologies for virtual showcases which are:

- Affordable to everybody, through cost-effective off-the-shelf hardware.
- Human-centred, through use of wireless and intuitive interaction technologies without head-worn devices - e.g. through natural speech-based interaction.
- Internet2.0-enabled, download content on demand from decentralized global web-bases services.
- Real-time and interactive access to multimedia information through 2D/3D graphics, animations, stereo/3D sound, images, text, synthesized speech, haptic information and tactile information, etc.
    - To develop the knowledge and technology to design and implement virtual showcases allowing:
        - Effective content management.
        - User-friendly authoring.
    - To evaluate virtual showcase setups in real-world environments for:
        - Public exhibitions, e.g. in museums, schools and other information-transferring institutions.
        - Private use, e.g. to consumer applications designed to provide ubiquitous and more efficient access to digital resources through mobile devices.

This requires user-studies and acceptance evaluations whose results will have to feed-back into the development process to ensure an iterative and incremental improvement process, until complete maturity is finally reached.

One of the main objectives of this application domain is the enhancement of user-friendliness of information society technologies with an emphasis on accessibility and quality of public services. Museums, for examples, are an important and well-established public services attracting a large and very general audience. Consumer applications to provide intelligent (e.g. location based) ubiquitous access (e.g. through iPads) to web-based digital resources, is another key example.

For this reason the Foundation has been engaged into the development of interactive applications for mobile platforms including, but not limited to, iPads and iPhones. This has been motivated by the widespread diffusion of these devices and their recent commercial success. This has allowed evolving those previous technologies, initially developed to ensure better fruition of cultural heritage, to new more effective platforms capable to ensure much wider access to the public.

Particularly the rapid success enjoyed by iPhones, iPods and iPads has completely changed the business model as well as the way to approach final users, meant also as potential customers. Such a disruptive approach to delivering consumer software solutions has been one of the main drivers, which has brought GraphiTech to focus on interactive solutions for mobile users. As a results research activi-

ties have brought to the development of a number of apps, a fraction of which are also available from iTunes. Current plans include release of further development as "apps" with the precise goal of maximizing the impact and scope of RTD activities.

3. *GeoVisual Analytics.* The research activity within this application domain has focused on how to reduce complexity, coupling this with studies on the methodologies necessary to ensure, at different levels of abstraction, the management of the information available.

The challenge is to generate information starting from data available, which is often characterized by complex internal cross-references and relationships to different factors. Research has to focus on development of a number of automatic or semi-automatic processes capable to identify and qualify a given data, and consequently encode it the most appropriate form. For this reason the specific focus of our research activity has been to promote the convergence of interactive visualization with intelligent complexity reduction, including investigating methodologies and developing IT platforms to support discovery of unexpected patterns with respect to prior knowledge. Through understanding of their surrounding environment, it becomes possible to assign a semantic meaning to a given data item. The user can then acquire further awareness on the information available, through higher level GVA tools.

This approach can potentially support complex cognitive processes based on automatic models capable to identify patterns typical of specific events, through the identification of condition arising from variation of spatial configurations, from monitoring of spatial data across time or from deviation of numerical data associate to a given geographical features to name but a few. This requires, more specifically, the development of techniques and tools capable to identify data of interest or information patterns within a vast data flow made of multidimensional geographical data coming from databases, environmental sensors, traffic sensors, pollution sensors etc.

Within this area, research activities will be framed in the context of FP7 i-Tour (STREP). This project will bring to the development of a user-friendly reliable travel information system for optimal multi-modal passenger trips based on novel data collection techniques capable to promote and award sustainable travel choices. i-Tour predicates an approach whereby citizens can benefit from a wide range of Location Based Services (LBS). These are based on the widespread availability low-cost portable localisation technologies, including GPS and forthcoming GALILEO services, as well as on the ubiquitous availability of wireless network connections (e.g. UMTS, Wi-Fi or WiMax) at the urban and rural level. This vision is in line within the priorities set by the EU ICT for Mobility Strategic Research Agenda which advocates the use of info-mobility service, including pre-trip, on-trip and post-trip information.

The i-Tour client will be designed to promote use of public transport by encouraging sustainable behavioural patterns and by defining rewarding mechanisms for citizens opting for travel choices with positive impact on climate change (e.g. based on public transport use as well as on cycling/walking). For instance citizens opting for public transport options, in place of travelling by car, will be informed of the Kg of CO_2 or the amount of PM emission saved. This information will be used to create

reward schemas where collected CO_2/PM emissions can be redeemed, for instance, for free public transport tickets or free MP3 tunes download. These rewarding strategies will be borne out of extensive user requirement analysis and they will take into account different needs from various travellers' profiles e.g. young users vs. elderly travellers, residents vs. tourists etc.

A further project in this domain is the eContentPlus NatureSDIPlus (BPN) which will conclude its activities with the successful deployment of the 3D geo-portal. The latter is mainly a data catalogue, intended to provide a comprehensive listing of GIS data sets and map services relevant to biodiversity conservation. The geoportal will be the entry point to access data and related services either directly by data providers or through existing best practice Regional/National (R/N) geoportal.

Another key project is the ICT PSP BRISEIDE (Pilot B) which aims at delivering (1) time-aware extension of data models developed in the context of previous/on-going EU INSPIRE related projects (e.g. in the context of GMES, eContentPlus), (2) application (e.g. Civil Protection) based on the integration of existing, user operational information and (3) value added services for spatio-temporal data management, authoring, processing, analysis and interactive visualisation.

In particular the goal of our research activity is to focus on issues related to environmental security through the development of novel technologies capable to support environmental decision making, by developing better tools to support control, monitoring and planning of a territory. BRISEIDE will be applied, tested and validated within a Civil Protection application context, using the INSPIRE relevant themes, via a chain of stakeholders, data providers, technology partners, and downstream users. The Pilot operational phase will last 12 months and will consider real life events, with extensions in additional domains, being considered and assessed.

Additionally this application domain lists a further ICT PSP Smart-Island (Pilot B), whose goal is to simultaneously deliver eight "multiple" smart web-services linked to the needs of the Mediterranean Islands, within a dynamic 3D user interface which can ensure interactive visualization and data management. The eight smart web-services, integrated within one geo-platform, address the following themes: (i) 3D-yachting (Transport), (ii) 3D-aerodrome (Transport), (iii) 3D-Leisure (Citizens), (iv) Real-Estate (Business), (v) Statistics for Planning (Infrastructure), (vi) 3D-Forest Fire Fighting (Environment), (vii) Smart Retailing (Commercial), (viii) 3D-Weather (Citizens, Government).

Last, but not least, the A22 project (industrial project) aims at introducing key improvements within the enterprise IT infrastructure to be used by the A22 Italian motorway operator. This will be essential to manage its infrastructure and services, by using a technology based on geospatial information. To do so the project will require developing an innovative 3D geobrowser to be used within enterprise contexts, by the engineering division of the motorway company, in order to deliver the highest possible quality of service, to improve preparedness in case of unforeseen event and to facilitate access of information during daily business, yielding higher efficiency and lower costs.

2.1. Activities and Work Plan

An overview of the 2011 Work Plan is provided below. This has been outlined, for the sake of consistency with the previous sections, according to the three aforementioned application domains.

1. *Virtual Engineering.* With specific regard to the SAGA project, research will encompass the following activities:

- Survey of the state-of-art of algorithms for change of representation, and modelling techniques for curves and surfaces.
- Study of algebraic curves and surfaces.
- Study of multi-grid/multiresolution techniques with special consideration for network usage and GPU processing. It is expected to reach high performance to deliver surfaces representations and an efficient data structure for collaborative modelling.
- Study of measures, shape properties, as well as high-level information such as symmetry. The main goal is focused on discovering properties, which can protect features and improve the direct manipulation experience.
- Study of modelling/interaction techniques that can explore and expose the aforementioned items.
- Study of collaborative modelling techniques. With these techniques it will be possible to speed up efficiently the modelling of complex shapes.Deployment of an algorithm for the computation of Almost Vanishing Polynomials on thin clients including the support for multiple tolerance variables and compound Almost Vanishing Polynomials.
- Full system integration and conclusions.

From an industrial scenario standpoint throughout 2011, the use of Non Distructive Techniques (NDTs) will be investigated, with the aim of evaluating their effectiveness to extract geometric information of the structural organization of wood at the macro-scale.

Due to the fact that wood has a heterogeneous structure that can be observed hierarchically over a spectrum of length scales, the analysis of anatomic characteristics of wood at the macro-scale (annual rings, knots, checks, etc.) is the basis of visual strength grading. Moreover the parameters of computational models can be drawn from the structural features of wood, through so called “morphology-based models”, in order to depict the variability of material properties. In the morphological approach, rather than treating the material as a statistically homogenized continuum, this is represented as a collection of discrete elements representing structural features, observed at the different scales.

According to the scope of the analysis, two-dimensional or three-dimensional geometric domains can be defined, with different levels of detail. For the definition of realistic geometries, a description of the investigated structures is necessary, which can be obtained from images of external, visible features, or from non-destructive imaging of internal, non-visible features. Within these activities the

three-dimensional anatomical macroscopic organization of the wood material is detected, in spruce elements, through of different NDT techniques.

In particular, results of imaging techniques, such as x-ray and ultrasonic tomography, as well as of local mechanical testing, such as those from drill-resistance profiles, will be analyzed. The edge-detection method developed so far has proved to be effective to detect intra-ring boundaries on both the transversal and the longitudinal faces of the samples. Problems can occur, however, in case of a great variability of ring thickness. In this case a partitioning technique that permits to separately analyses regions of different density needs to be implemented.

The automatic detection of texture features is also sensitive to the characteristics of the wood surfaces (residual element roughness) and the species. The curve and surface modeling method is effective in case of clear and diagonal grained wood elements. However, in the latter case, parametric surfaces, with more than four boundary curves, are present and characterized by a lesser smoothness. The presence of knots and the consequent local distortion of the growth layers layout is the cause of a significant spread in the results. Therefore knots and relevant distortions of the material layering should be taken into account in order to achieve a more predictable model for timber elements in structural dimension.

Furthermore, in order to extend the method to full-size members, a simplification of the domain geometry must be produced. For this purpose, the modelled parametric surfaces should be used to map the variation of the material directions within the element.

Another topic which will be subject of our research is the image-based modelling analysis of timber structures to retrieve geometric features. For complete surface measurements, methods of digital closed range photogrammetry are usually better qualified because they allow automatic measurements of two and three-dimensional displacement fields, deformations and defects. The essential measurement of parameters (precision, measuring range, surface of measuring objects, etc.) pose challenges to the design of efficient photogrammetric measurement procedures.

Planning and efficiently performing photogrammetric measurements in a wide range of material testing tasks, requires a systematic approach to the technique and the definition of task-oriented measurement concepts.

2. *Virtual Content Creation and Interactive Applications for a Culturally Interconnected Cyber World.* Within year 2011 a number of deployments will be considered to enhance fruition of content through a wide range of hardware and software solutions. In terms of content creation we will deliver a virtual interactive reconstruction of the Ancient City of Trento during the historical periods 1200 AD, 1500 AD, 1700 AD and 1900 AD. This will also require creation of animations showing the evolution of the city during the four historical periods within a virtual world. The activity will also have to consider reconstruction of human models with animations to be used to populate the virtual world.

The system, including 3D scene and imaging, will have to be optimised to be able to deploy a lightweight interactive virtual world usable on mobile devices like iPads, iPhones and Android smartphones.

The virtual scene will have to embed forms of content access capable of delivering multimedia content on mobile devices. The challenge in fact is to deliver "transparent" forms of content delivery based also on geo-localization, ensuring that a user could walk along a street and see how the city looked in previous time.

Additionally we will explore, on the one hand, development of more effective interaction metaphors based on use of commodity hardware including, but not limited to, devices such as the Wii™ Balance Board or Microsoft Kinect™. On the other hand, the use of more advanced visualisation technologies will be explored. This will include support for hi-resolution large-scale stereoscopic display, such as the set-up in place at the S.A.S.S. theatre (to be used as test bed), or tessellated screens composed of arrays of seamlessly blending video projectors.

Last but not least activities will also focus on development of further mobile applications on iOS and Android for educational purposes or life-long learning (e-Learning), to improve personal mobility or to improve social cooperation (e-Inclusion).

3. *GeoVisual Analytics.* With regard to the project BRISEIDE, year 2011 will see a number of different activities which will require the involvement of the final users that will have to take place through a series of organized workshops.

The planned activities include first definition of use cases. All the use cases will have to be covered in order for the system to be tested successfully during later stages of development. The overall potential for use cases to be included in the system is significant in order to provide a flexible and practically usable system. This will encompass all normal everyday operating scenarios that will be later used to validate the compliancy of the solution to the initial requirements. All of these scenarios will have to be tackled before a final solution is finalised and implemented.

Additionally it will be necessary to define user requirements. This activity is concerned with the identification of all type of users inside the involved PSI and the definition and analysis of their needs/requirements. A methodological framework will be developed for the analysis of the user requirements, taking into account the following issues: 1) to involve various user groups with specific requirements according to their profile; 2) to include the deployment of value added services; 3) to tackle various safety, security and data privacy issues.

The objective of the proposed methodology is to identify the major categories of services and functionalities of the system that best comply with the needs of the users and their perceived requirements with regard to their daily activities. A key issue in achieving this goal relates to collecting the views of the users on the potential system functionalities and performance. Interviews and well-designed surveys will be employed in order to perform this task.

The activities will proceed with the definition of service requirements in terms of added value services, their relation to existing OWS already in place by data providers or by eContentPlus projects. This includes also definition of requirements in terms of orchestration of WPS.

Further work will be necessary for the definition of metadata requirements relevant to the use case selected as well as from other EU projects from which data will be

made available. It should be noted that the latter would be gathered from existing available deliverables already produced by the relevant projects. In fact, although most of the EU projects the project will build on, are in progress and therefore not complete, all of them have already completed the definition of metadata as this has been one of the early activities of all projects.

It will also be necessary to perform a survey of existing GI and services. This requires identification of all existing data and services available through partners, public repositories and other eContentPlus projects. Additionally a survey will explore availability of processing services within the open source community.

The existing base-maps and thematic datasets, relevant to BRISEIDE Database Model, as well as available services identified throughout previous activities will be analysed with the purposes of defying any adaptation or processing required delivering a harmonised and seamless infrastructures.

Additionally we will produce a software architecture that will form the basis of all developments: the reference architecture will be the Reference Model for the ORCHESTRA Architecture (http://www.eu-orchestra.org). It will have to adhere to the requirements produced and to specify the architectures for all system components and sub-components, ranging from the infrastructure servers that gather and process the available GI to the client application. Once a semi-final version of the architecture has been finalized, it will have to undergo a series of reviews and testing cycles by all technical partners in order to verify that all use-case scenarios are handled successfully and efficiently.

The architecture will be then enhanced in order to allow for future modifications and extensibility, thus allowing it a much longer useable lifecycle.

The architecture of BRISEIDE will take into account and provide connections/integration to existing solutions e.g. available through other EU projects by providing connectors to existing services (e.g. WMS, CSW etc.).

With regard to the project i-Tour, which will involve GraphiTech as technical coordinator, activities for year 2011 will have the objective to develop the i-Tour portal and services including the development of the two i-Tour applications (desktop and mobile clients).

For this reason our work will focus on the development of specific user-friendly interfaces required by the desktop and mobile client mobility applications. Development will maximize system's ease of use, learning curve and effectiveness.

More specifically the planned activities will first include design of the interface structure. Then the activities will proceed with the development of innovative user friendly metaphors for mobility systems. This will bring to the definition and development of patterns of interaction between different types of users and the travel information system. The activities will identify and develop the interaction patterns in order to avoid critical bottlenecks and to improve system efficiency. According to the defined patterns, we will develop a user interface which can support the user in accomplishing travel decisions in a natural user-centred way by using combined interaction such as sketches, gestures, etc.

A further goal is to design the interface module, which will motivate a user to use public transport by developing serious-game-based strategies built on top of the

reduced amount of emitted CO_2/PM caused by sustainable travel choices. The serious-game approach will be implemented in order to develop supportive, positive and undemanding interactions. Our work will bring to development of several representations of rewarding schemes, according to different user profiles, e.g. discounts for public transport, free download of music tunes etc.

Further work will be necessary to design the wizard, which will reveal user's preferences about travel and adaptation/rescheduling options. The interface module will be identifying user's travel preferences through analysis of user decisions in a series of choice situations with different travel options.

The interface module will have to ensure adaptation preferences where in a series of hypothetical situations the existing schedule and unforeseen events are varied and the user can indicate preferences for adaptation alternatives. The adaptation experiments and the interface module will be responsible for updating user preferences each time the user makes a choice regarding travel options or schedule adaptations.

The i-Tour mobility system considers users themselves as data providers by giving the opportunity to share timely on-site geo-reference data. The goal is therefore to design an intuitive interface aimed at supporting travellers while uploading/updating and validating the information about the urban environment such as information on traffic, offices/shops moving to new premises, change of museums' opening hours etc.

The interface will take care of constraints defined by different user groups (young users, elderly users), different activities and different mobile devices (e.g. Smartphones or PDAs).

A further goal is to develop the interface module, which will be invoked every time a travel solution should be made/updated. The work will focus on designing of two main interface components whose goals are: 1) To inform the traveller about unforeseen events which have happened and about the need to reschedule the route or agenda; 2) To recommend new travel solutions according to user's agenda, travel and adaptation preferences.

It should be noted that within i-Tour the online traffic data available at the test sites will be retrieved from available sources like traffic management centres. Sensor information, where accessed directly, will be exposed through the relevant OGC® standards such as Sensor Observation Service (SOS) or Sensor Alert Service (SAS).

Wherever relevant, development will be carried on exploiting existing open source projects in the field of Sensor Web and/or contributing to their implementation and adoption as standard technology. This will be performed by dedicated services (online modules) that interface the traffic management centre with the database used for i-Tour user services. The data base will contain these raw online traffic data (e.g. traffic volumes) and algorithms for data integration and network traffic situation generation will use these data to add to the network such information needed for the user services (e.g. travel times per links). In a first step, a traffic model containing base data like digital road network will be integrated into the database.

Then higher level services will be developed using and combining information coming from low-level services to produce complex services required for functions such as routing, trust management, recommendations etc. For this reason we will create software interfaces capable to make all components interoperable within the entire infrastructure where any processing functionality will be exposed using the relevant OGC® standard Web Processing Service (WPS).

The research work will provide the services that will ensure proper communication between i-Tour clients and the service infrastructure. This will include deployment of a number of OGC® compliant services including WMS (Web Map Services), WFS-T (Web Feature Services, WCS (Web Coverage Services) to name but a few. Specifically real-time information will be exposed through OGC® OpenLS (OpenGIS® Location Services), also known as the GeoMobility Server (GMS), the reference standard platform for location-based application services.

Finally integration will be performed so that all components and interfaces will be integrated within an i-Tour toolbox ready to be deployed by administrations and public transport providers. The final demonstrator will be tested with all the partners; the results of the first validation will be used to produce a final version of the demonstrator, which, in turn, will undergo the final validation.

With regard to the project NatureSDIPlus the planned activities will include the definition of a metadata profile for evaluation and use and a common data model for nature conservation data, starting from the use of the provided datasets. Guidelines and manuals for target users and INSPIRE Drafting Teams (DTs), including procedures on how to adapt existing databases and datasets to the common data model and metadata profile, will be provided. Multicultural aspects, also including multilingual aspects, are covered as added value to the concept of interoperability.

A comprehensive contribution to the guidelines and recommendations for a draft metadata profile will be developed, aimed at describing the data themes addressed by INSPIRE enriched by semantics to allow for the searching and discovery of objects by using terms understandable by different target users. A semantic model of metadata (e.g. thesaurus on ontology based) related to the core data will be provided.

The guidelines and recommendations will be prepared assuming a user' s perspective and will consider both evaluation (i.e. the fitness to a specific use) and use (i.e. the easy use of data itself). The starting point is represented by the already existing INSPIRE profile for discovery and the ISO 19115/119 standards.

Based upon the INSPIRE metadata profile and the results from the state-of-the-art analysis and target user-needs, the activities will then deal with the proposal for a common data model for the data on nature conservation as addressed by the INSPIRE Directive. The existing data models from the partners and reference material on data models related to the themes involved, will be analysed as a starting point. A common model will be defined and proposed to the thematic community.

The project will then proceed with development of the procedures for retrieval of the existing spatial datasets, their transformation, validation and the setup of a set of services (including the NATURE-SDIPlus geoportal and the common multilingual

thesaurus services) to access and exploit these datasets by a network of Service Providers.

The work will proceed with the implementation of the NATURE-SDIPlus database model and all the specified information access/processing/transfer work-flows and procedures on OGC-compliant technological infrastructures, established by service providers. For this it will be necessary to ensure processing of the existing base-maps and relevant thematic datasets according to the OGC- and INSPIRE-compliant specifications, quality control of the processed datasets, cross-lingual attribute data and metadata harmonization.

The collected national base-maps and thematic datasets (relevant to NATURE-SDIPlus database model) will be processed into new harmonised and seamless datasets, following NATURE-SDIPlus technical specifications on GIS data, attribute records and metadata descriptors. This will be the most critical phase of the project, actually producing the NATURE-SDIPlus data and metadata. Tight cooperation and communication between service providers will be crucial for the overall success of this important phase of the project.

Based on the common data model developed, each identified data set will be re-mapped on the new data structure. The possibility to remap on-the-fly the available datasets through a specific service will be evaluated for each specific dataset and, eventually, the built services will be available on the NATURE-SDIPlus geoportal.

Finally it will be necessary to verify if the processed datasets are compliant with current standards and directives, and especially with OGC and ISO standards, upon which INSPIRE is based, as well as the INSPIRE Implementing Rules. Moreover tests on data searching and accessibility to access functionality, including multilingual and multicultural aspects, will be carried out.

A plan to evaluate the quality of the data will be mainly based on checking the following aspects: correctness - a set of test to check the correctness of the accessed data (source data vs. delivered data); availability - the published data are available through the geoportal; understanding - the presented data are understandable and useful for the target user. An evaluation of the feedback from target users will be performed to test the data usability.

Starting from the common data model defined, a set of guidelines will be produced to generalize the datasets from the local to more general levels. These guidelines will be applied and tested in a test area that will be selected during the project.

2.2. Collaborations currently in place

- University of Oslo, CMA/Department of Mathematics, Norway, Ragni Piene: collaboration within the SAGA Project.
- Johannes Kepler Universität Linz, Institute of Applied Geometry, Austria, Bert Jüttler: collaboration within the SAGA Project.
- Universidad de Cantabria, Departamento de Matemáticas, Estadística y Computación, Laureano Gonzalez-Vega: collaboration within the SAGA Project.

- Vilniaus Universitetas, Computer Science Department, Lithuania, Rimvydas Krasauskas: collaboration within the SAGA Project.
- National and Kapodistrian University of Athens, Lab of Geometric and Algebraic algorithms, Greece, Ioannis Emiris: collaboration within the SAGA Project.
- SINTEF ICT-institute, Department of Applied Mathematics, Norway, Tor Dokken: collaboration within the SAGA Project.
- INRIA, Galaad group, France, Bernard Mourrain: collaboration within the SAGA Project.
- Missler Software, France, Dominique Laffret: collaboration within the SAGA Project.
- University College London, UK, Licia Capra: Collaboration to deliver interactive application for trust management.
- C3L, UK, Scott Cadzow: Collaboration to deliver secure communication web-services.
- Technical University Eindhoven, The Netherlands, Theo Arentze: Collaboration to develop multi-modal routing systems necessary to i-Tour.
- PTV Planung Transport Verkehr AG, Germany, Thomas Benz: Collaboration within the i-tour Project.
- Ula srl, Italy, Davide Calì: Collaboration to deliver effective interfaces based on natural language processing.
- Elasis S.c.p.a., Italy, Anita Fiorentino: Collaboration within the i-tour Project.
- SinerGIS Srl, Italy, Piergiorgio Cipriano, Stefano Pezzi: Collaboration within the BRISEIDE Project.
- Epsilon International, Greece, Marc Bonazountas: Collaboration within the BRISEIDE Project.
- CCSS - Czech Centre for Science and Society, Czech Republic, Karel Charvat: Collaboration within the BRISEIDE Project.
- University of West Bohemia, Czech Republic, Karel Janecka: Collaboration within the BRISEIDE Project.
- Geofoto, Croatia, Dragan Divjak: Collaboration within the BRISEIDE Project.
- 52North, Germany, Bastian Shaffer: Collaboration within the BRISEIDE Project.
- ISPRA – Istituto Per la Protezione e la Rocerca Ambientale, Italy, Luca Guerrieri: Collaboration within the BRISEIDE Project.
- Reggiani, Italy, Luca Maroni: Collaboration within the BRISEIDE Project.
- Instituto GeograficoPortugues, Portugal, Maria Vale: Collaboration within the BRISEIDE Project.
- Università La Sapienza, Italy, Mauro Salvemini: Collaboration within the BRISEIDE Project.
- Gobierno de Navarra, Spain, Andreas Valentin: Collaboration within the BRISEIDE Project.

- Tracasa, Spain, Maria Cabello: Collaboration within the BRISEIDE Project.
- TDF - Technology Development Foundation, Latvia, Kaspars Skalbergs: Collaboration within the BRISEIDE Project.
- Intergraph, Italy, Carmelo Attardo: Collaboration within the BRISEIDE Project
- University of Trento, Italy, Maurizio Piazza: collaboration with the Laboratory on Testing Material in the field of geometric modelling the timber structures.
- University of Trento, Italy, Paolo Bouquet: collaboration with the aim to join the semantic web approach with the Geospatial Information into the Geo-Semantic web.
- University of Trento, Italy, Claudio Fontanari: collaboration within the SAGA Project.
- FBK, Italy, Fabio Remondino: collaboration with the aim to provide archaeological and cultural heritage survey data in a more useful way into the 3D GeoBrowser.

4. Human Resources

Personal success and business strategies layer over time and must be carefully fuelled. The corporate world is well aware of how knowledge management affects performances in terms of innovation, productivity and quality.

Quite often (within Trentino research system), it is not well known how to best exploit this "intangible capital". There are several well acknowledged and effective solutions to deal with knowledge-related issues with regards to products and services. However the problem arises when the subject of the observation and assessment is the human resource within its knowledge dimension.

Yet assessment of employees' performances is a skill that research centres need to improve since it is essential to provide important feedbacks and it produces information on the type of work carried out by the staff and on their achievements. Additionally it is essential to watch the overall system's health and it helps understand how the institution is achieving the strategic objectives of the surrounding territory. Evaluating researchers is therefore essential to control and therefore improve operational and strategic results of the "research enterprise".

However how can we better learn from history, behaviours, requirements and performances of each individual? This is an important body of knowledge that can be used to develop strategies to drive future changes in relation to everything that affects the business of the research centre. It is essential to know very well the staff for a correct definition of communication and cooperation mechanisms but also to set up detailed assessments schemas, to establish rewards or to take appropriate decisions related to organizational improvements or required training actions.

Researchers and employees evaluation process at GraphiTech Foundation is based on a simple methodology to improve efficiency and organization. GraphiTech Foundation has deployed a continuous skills assessment program which aims at

increasing the overall productivity of the centre. We could list, as example: weekly meetings, internal peer review, proposal editing process, per-project functional structure, and timesheets.

Thanks to these assessment tools, the management can retrieve unbiased high-quality information necessary for the definition and management of development programs, in line with internal requirements, promoting staff growth and efficiency through a global knowledge of their competences and needs. Staff members then are more motivated, being aware of the criteria used to assess their results and requirements, which are accounted for. It is obvious that knowledge management is also an internal competitive factor.

When looking at these issues with a certain detachment, one may wonder how to manage (from an insider perspective, i.e. from the standpoint of a person familiar with the research system) the staff assessment policy, how to deploy and how to best use the acquired knowledge to improve the organizational aspects, how to award those performing best, how to react in case of training gaps.

The “intoxication” we have suffered with regard to competence assessment policies, typical of the research world, has often created confusion and, in many cases, it has not brought to the desired results. In fact we were looking for a more tangible approach beyond the more or less widespread practices of certification and description of roles. The rapid pace at which organizational changes occur, together with the dynamic nature of the contracts signed and high-level strategy in place (we could mention as example the vagueness of early business model of Graphitech), which have always characterized the market being targeted by Graphitech, have always highlighted the need for equally flexible assessment methods that can better fit with the local context, with short reaction times as close as possible to those of the market we are addressing.

What we certainly do not need, as it often happens, unfortunately, is an extensive analysis that lasts for so long that, by the end of the preparatory stage, the organization has already changed. Any working environment, and even more the research world, is already unstable enough. The organization, professional skills, competences requested, as well as market requirements change continuously. Therefore a scientific approach (refer to scientific management) is perhaps not always applicable to describe the value chain.

Then how to deal with the issue of rewarding competences? The resulting answer is the simplest yet the most rigorous. It is essential to implement a procedure (see the aforementioned actions) that allows a job & performance evaluation, to identify organizational roles and to understand any match between skills required by the local context and professionalism of individuals, taking into account implications of compensation policies to deploy an “internally fair” organizational framework.

Unfortunately we have discovered that is not quite the case in the real life as we have noticed a typical mistake, which, is to deploy solutions that eventually do not allow setting input parameters and comparison/evaluation factors.

Three main elements will contribute to determine how GraphiTech watches the human capital:

- The organization that is represented by competences and know-how for businesses.
- Processes that yield standardized activities in terms of product development.
- Projects which are extraordinary activities in a well-defined timeframe for specific productions aimed to improve and innovate.

Being aware of the human capital strengthens all those three items, it is therefore essential to nail down a few initial steps, by moving the information retrieval process back into the core business.

In practical terms this means allocating “weights” to job positions that will have to be mapped to different tasks to be carried out. The main indicators to be observed are: number of signed contracts, savings on consumables, delivering projects on schedule, results of dissemination activity, capacity to produce innovation. The indicators thus become drivers for the job evaluation process, i.e. to map and weight different positions (based on the needs of the institution, of the running projects and active processes). They also become performance appraisal and evaluation tools, as well as indicators of the level of performance the system is able to react with.

This simple assessment system unfortunately has clashed with

- the overall system stiffness, indifferent – in practice – to performance assessment;
- inflexibility of contracts, meant – within the research world – as a permanent form of insecurity (the “co.co.pro” contract for instance does not allow implementing Management By Objectives, MBOs).

Nevertheless by knowing its human asset, it has been possible to strengthened Foundation GraphiTech within its organizational, competence and knowledge dimensions. To do so it has been essential to bring back the process of collection of information into the company activities.

However, what should we assess and, above all, what do we really assess? Certainly personal competences, actions and behaviours as well as results achieved when compared against the goal set. Based on this information it has been possible to start – in Graphitech – policies to improve quality, productivity and innovation. The key role plaid by management, essential both to define objectives, should not be forgotten neither should the “rewarding” factor.

The required information is collected to define promotions and salary policies as well as to ensure the very own assessment of the centre. One of the most successful strategies to deploy a performance evaluation system is to have it driven by economic incentives. The economic leverage allows enforcing the importance of messages related to the assessment process, practically favouring best performers, fostering enforcement of good practices.

Unfortunately the introduction of different salary levels, based on performance evaluation, is regarded as worrying due to possible tensions related to the assessment process itself. In fact other institutions often deploy different salary and compensation policies on the basis of unclear or independent processes, without benefiting from the availability of excellent managing and HR systems, of complex organizational structures, of their strong institutional acknowledgment.

This model is clearly wrong and it does not provide precise metrics to assess achievement of objectives and it does not ensure continuity to personal and group-wise assessment and, above all, system-wise valuation.

Additionally we should not forget the importance of a fair assessment of performance, a just compensation and contractual policy. Compensations linked to assessment improve, without any doubt, the acceptance level among staff members as well as their satisfaction with regard to the whole system, thus improving its competitiveness within the widest research world.

Business Development

Fondazione GraphiTech started also to plan specific actions in order to better exploit and disseminate the internal research and know-how and EU project funded activities.

Those activities are an integral part of the strategic plan of Fondazione GraphiTech and are not managed as mere commercial actions but to build up long-term relationships with major counterparts as potential industrial partners or to establish networked initiative at a pan European framework with other institutions.

As matter of fact, Fondazione GraphiTech has started to contribute proactively to create a kind of club of excellence with other EU national champions in the computer graphics scenario. This initiative will bring opportunities to interrelate research and studies among various computer graphics competence centres from Portugal (CCG) and Spain (Vicomtech) with Italy (Fondazione Graphitech) and Germany (DFKI and HPI), aiming also to exchange knowledge and build a common approach to technological trends.

Fondazione GraphiTech business development plans are represented by the following mainstreams:

- Dissemination and exploitation activities from current EU projects.
- Research outreach with local administration (part of them are also in the EU Projects workload).
- Building new relations with national companies in order to give easier and immediate opportunities to exploit the internal competences and applied scientific results.
- In the image below a graphical representation of Fondazione GraphiTech approach to the innovation market.

Additionally Fondazione GraphiTech will be engaged in a number of "horizontal" non-scientific activities, yet essential for the success of the project, including the development of IPR & licensing policy, to ensure the most efficient dissemination of its projects' results.

This will be accomplished by mechanisms like open source and also by publication of relevant documents. This approach will bring a further advantage to the RTD activities, which will leverage –whenever applicable- on the Open Source (OS) community in order to exploit the enormous potential of the OS world in terms of actual software component development and further dissemination. The OS community channel will amplify the potential adoption of the technology to a broader audience.

A further aim is to delineate a common strategy towards exploitation of the tangible and intangible results being delivered by the running projects. We will develop a detailed exploitation strategy and this will contain a plan on how they intend to exploit the knowledge from this project. This will produce a blueprint that will provide the foundation of any exploitation initiative, thus benefiting from common knowledge and experience.

A business model will be then defined where the corresponding market segments will be estimated according to the best practice models of market forecast. This model will be the basis for a continuously updated 5-year business including the required investments and the estimated Return on Investment (ROI).

In essence the methodology will produce a number of business plans that will also include a strategy, financial analysis with meticulous risk analysis. The continuous risk analysis will be performed to detect any potential weakness and identify adequate solutions.

All projects' developments will be accompanied by a continuous technology and market watch by all the technological and industrial partners in order to identify the exploitation potential at the very early stage of the technology development.

Additionally we will also investigate how the use of a standardised open approach allows also the definition of Service Level Agreement (SLA), identifying metrics (e.g. Average Speed to Answer – ASA, Time Service Factor – TSF, Turn Around

Time – TAT, precision, accuracy etc.) required to define indicators such as availability, performance, serviceability and, in more general terms, for guaranteeing Quality of Service (QoS) to all services we will be developing.

5. Risks and Mitigation Plans

Graphitech's internal procedures, applied to all running projects, include a risk management procedure which is set in place to ensure proper control over the activities and their compliancy with the various work plans under the coordination of a Quality - Risk Manager (QM).

The main risks associated to the projects are grouped under three categories:

- Technological risks.
- Problems caused by a staff providing unsatisfactory results or leaving the GraphiTech altogether.
- Problem caused by unsatisfactory involvement of other (external to GraphiTech) partners / users / stakeholders.

With regard to technological risks, which are those most critical and most likely to occur, should any of these arise the management will explore the possibility to adopt alternative technological solutions either based on existing RTD or commercial solutions. As general strategy we try to adopt modular infrastructures to intrinsically reduce the effect of technological failures, as effects would be limited to single components with no propagation to the entire project.

Risks caused by staff delivering unsatisfactory results or leaving GraphiTech have been carefully examined and the associated contingency plan has been defined on a per-project basis.

CELCT – CENTER FOR THE EVALUATION OF LANGUAGE AND COMMUNICATION TECHNOLOGIES

Unit Name	CELCT - Center for the Evaluation of Language and Communication Technologies	
Type	Applicative	
Head	Emanuele Pianta	
Staff	2010	2011
	6 Researchers	6 Researchers
	3 Technologists	2 Technologists

Document Status: submitted 2010-11-02

1. Executive Summary

CELCT is an independent center founded in 2003 under the initiative of ITC-irst (now FBK) and DFKI (Deutches Forschungszentrum für Künstliche Intelligenz), with the mission of becoming a competence unit for the evaluation of multimodal language and communication technologies. Evaluation activities in this area were already performed within the two institutions that are the charter members of the center. However FBK and DFKI thought that it was convenient for them to move those activities to an independent specialized organization, which could offer its services to a larger research and industry community, and could also guarantee the high level of competence and independence which is expected from an international evaluation center. In the last five years the center has interpreted its mission by promoting and participating in a number of evaluation-related activities. The activity of CELCT should be put in a international context where evaluation activities for language and communication technologies are becoming more and more widespread especially in the research community. Evaluation activities imply at least four aspects: definition of a task to evaluate, production of reference datasets (benchmarks); development of evaluation paradigms and methodologies; organization of evaluation campaigns. CELCT can play an important role in this international context. The main rationale for CELCT activity is the need to concentrate and factorize competences which are now scattered in different organizations and that suffer a lack of coordination and long term view, as well as shortage of funding. The role of a small center as CELCT cannot be that of substituting those activities, but should be facilitating and promoting them, acting as reference point and multiplier. In the first phase of its activities CELCT has mainly struggled to gather competences and to gain visibility and credibility in the evaluation community. It is now in the process of increasing the level of linking and interaction with all the important players in the arena. We have contacted a number of international institutions sharing common strategic views about the relevance of evaluation activities for research and industry, about the role of CELCT to foster such activities, and about the best ways of promoting and sustaining them in a European context.

In the long run the goal of this networking activity is involving those institution at various level (from the Advisory Board to the Members Assembly), and starting new projects that will improve the level of self-financing of the center.

2. Vision and Scientific Program

2.1. Context and State of the Art

CELCT is an independent center founded in 2003 under the initiative of ITC-irst (now FBK) and DFKI (Deutches Forschungszentrum für Künstliche Intelligenz). The activities of the center actually began at the end of 2004 and have been funded up to 2008 by a grant of the Province of Trento (PAT). The grant has been extended for one year in 2009. Since 2010 CELCT has been included in the FBK Accordo di programma.

The center was funded with the mission of becoming a competence unit for the evaluation of multimodal language and communication technologies. Evaluation activities in this area were already performed within the two institutions that are the charter members of the center. However FBK and DFKI thought that it was convenient for them to move those activities to an independent specialized organization, which could offer its services to a larger research and industry community, and could also guarantee the high level of competence and independence which is expected from an international evaluation center.

In the last five years the center has interpreted its mission by promoting and participating in a number of evaluation-related activities. More specifically CELCT has contributed to the organization of national and international evaluation campaigns, such as CLEF (Cross Language Information Access - with specific focus on Cross Language Question Answering), DUC (Document Understanding Conference, automatic summarization), IWSLT (International Workshop on Spoken Language Translation, speech-to-speech automatic translation), Evalita (Evaluation of tools for Italian language processing), RTE-PASCAL (Recognizing Textual Entailment). The center contributed to the evaluation activities of three European Projects (EuroMatrix, PatExpert, Cosyne) and to a number of national research projects such as ontoPrivacy (creation of domain ontology from the Italian Data Protection Code) and LiveMemories (annotation of a corpus of Italian news according to the TimeMl standard). CELCT has also been involved the SmsCollector industry project (collection and annotation of a corpus of 2 million words of Sms messages), and participates currently in the PROMISE European project (evaluation of cross-language information access).

The activity of CELCT should be put in a international context where evaluation activities for language and communication technologies are becoming more and more widespread especially in the research community. Evaluation activities imply at least four aspects: definition of a task to evaluate, production of reference datasets (benchmarks); development of evaluation paradigms and methodologies; organization of evaluation campaigns.

The *selection of a target task* to evaluate is a crucial aspect of any evaluation activity. The choice can be done on the basis of theoretical motivations or as an

answer to the (real or supposed) needs of technology users; it can follow research community interests and practices, or can be urged by funding agencies (possibly inspired to political motivations). For instance, evaluation activities on information extraction and machine translation have been promoted in the United States by public government agencies, in specific domains such as terrorist attacks, and for specific languages such as Arabic or Farsi, which show a clear connection with the priorities of the foreign policy of the United States government. On the other side, evaluation activities on the task of word sense disambiguation have been promoted by researchers groups in Europe mostly in accordance with the theoretical interests of the research community. Finally, evaluation in the area of information retrieval may constitute an example of technology-driven evaluation activities, given the high impact of search engine development for the Internet industry. It should be noted that whereas in the United States the institutions responsible for research funding have since long time understood that evaluation can be used as a means to orient and foster research according to specific strategic directions, in Europe evaluation activities have been basically left to the research community, with little or no public support. This has both advantages and disadvantages, as we will see below.

Once a task has been chosen, it is very important that it is clearly defined in a way that allows for actually measuring and comparing the performance of concrete systems. For instance, whereas the natural language processing research community has since longtime recognized the importance of inference for text understanding, only recently with the definition of the task of textual entailment it has become possible to evaluate the ability of systems to deal with inference on a shared and measurable ground.

The second activity crucial to evaluation is producing *reference benchmarks*. This requires first of all a *selection* of relevant data (e.g. text documents, user clicks, video-recordings, etc), so that they constitute a significant sampling of the data on which systems are expected to operate in a real life situation; for instance, if the task consists in extracting relevant texts from HTML pages (by skipping menus, advertisement, copyright warnings, etc.), then we need to collect a set of HTML pages which reflects the variability of structures and layouts that can be found in current websites. Reference datasets are usually split in two parts, the *development* and the *test dataset*. The development dataset can be inspected by system developers and used to train or tune their systems, whereas the test dataset should be used blindly to evaluate the final performance of a system. The splitting between development and test dataset should be performed so that they are reasonably homogeneous in terms of sampling of significant phenomena. In most, but not all, cases a manual annotation of the selected dataset is performed, which is then used as gold standard (or ground truth) for measuring the performance of automatic systems, that is as the optimal output that systems should try to obtain. Note that if the manual effort to annotate data is too intensive, the benchmark may be produced only for test purposes (no development set is made available). *Manual annotation* of data requires very specialized skills: design of the annotation scheme; production of clear annotation guidelines; development or adaptation of specific graphical user interfaces for annotation; selection, instruction, training and

coordination of annotators; assessment of the agreement between them; release of the annotations in standard-compliant exchange formats.

In the area of manual annotation, two innovative approaches have been recently introduced with the aim of getting more annotated data at lower costs. They are both based on Internet and on-line communities. The first approach exploits on-line games. The idea here is set up on-line games that are entertaining for internet users, and allow, as a side effect, for the collection of data which can be used in the same way as manual annotations (see the ESP game, which allows for collecting word-annotated images). Another innovation in this area comes from the recent introduction of the so called Mechanical Turk, which is a web-based service made available by Amazon America. The service can be seen as a sort of on-line work market, where people can propose simple tasks to be executed through an on-line interface, and other people from all over the world accept to execute the task. The proposed tasks must be very simple and their cost are usually relatively low. A number of people have proposed the following strategy to exploit the Mechanical Turk for data annotation: take a possibly complex annotation task and try to decompose it in a number of elementary steps; propose each of them as an elementary task through the Mechanical Turk; propose each elementary task to at least 5 or more annotators, and keep only those annotations which show a good level of agreement between annotators. The total number of annotators required by this strategy is much higher than in the traditional approach, but, given their lower cost, the total cost of the annotation may be consistently lower as well.

It should also be noted that not all tasks allow for adopting the gold standard approach to evaluation, that is deciding in advance what is the optimal output of a system. In some cases, as for instance in information retrieval, where systems are expected to select a ranked list of documents relevant for a topic, the nature of the task makes the gold standard approach unfeasible. For this tasks it is necessary to use post-hoc evaluation, that is we first take the output of the system and then assess its goodness.

Whether the evaluation is based on a priori gold standard, or post-doc evaluation, a crucial issue is what *metrics* can be used to measure the performance of a system in comparison with other systems. A good metrics should be clearly defined; it should be meaningful, that is it should be easy for humans to understand what aspect of the task it measures; ideally it should also be possible to calculate the metrics in a automatic way, without the need of human judgment/intervention, but maintaining a good correlation with human judgments. The field of information retrieval has produced some of the most widely used metrics that are *precision*, *recall*, and a combination of them called *F-measure*. The rationale behind these metrics is measuring on one side how accurate the output of the system is (precision) and on the other side how much of the expected output is actually produced (recall). Other metrics have been proposed for different tasks. For instance the so called Blue Score proposed for the evaluation of machine translation, turned out to be crucial for a substantial advancement of the field. Note that the machine translation task can exploit the gold standard approach, as human-made translations can be used to this purpose. However the research in this field did not develop all its potentialities until a metrics was developed which could be calculated automatically

by comparing the output of the machine translation systems with a pool of reference human translations, and which proved to correlate in a significant way with human judgment about the quality of a translation. Generally speaking the availability of a gold standard combined with a metrics which can be calculated independently of human intervention is crucial for the development of any task, as it allows system developers to tune and measure in any moment the performance of their systems.

The so called *evaluation campaigns* are the most successful modality for promoting the assessment of the state of the art of a field on a specific task, although they are and should not be considered as the only option (see below). A typical evaluation campaign is based on the following steps: definition of the task which is object of the campaign; publication of a call for participation; preparation of a possibly annotated dataset to be distributed to participants; distribution of the training data to be used by participants to train or tune their systems; distribution of the test set to the participants, who in a limited time slot (e.g. one or two weeks) are expected to run their systems on the test data and to send the results to the organizers; evaluation of the results of the systems on the basis of well established and shared evaluation metrics; analysis of the results of the campaign; organization of a workshop or conference, where the results of the campaign are made public and are analyzed by all participants in order to assess the degree of advancement of the field on the specific task and the perspectives for further developments; publication of the papers presented at the workshop/conference. The datasets used for the campaign use usually made available through a portal and can be used by other system developers to compare the performance of their systems against the results of state of the art systems.

This approach to evaluation can be labeled as *in-vitro*. As all in-vitro research, it has a huge number of advantages, but also some shortcomings. The main problem with the in-vitro evaluation of technology is that it does not take into account the role of the user of the technology. This may explain perhaps why the research on language and communication technologies has had so far relatively little impact on the industry. To obviate to this lack of impact, evaluation of language and communication technologies should be more and more concerned with the role, the needs, and the reaction of users of such technologies. This is not an easy task, however. Involving the user can be highly challenging from an organization and methodology point of view, and will require much higher investments than in-vitro evaluation.

2.2. Vision and Goals

CELCT can play an important role in the international context sketched in the previous section. The main rationale for CELCT activity is the need to concentrate and factorize competences which are now scattered in different organizations and that suffer a lack of coordination and long term view, as well as shortage of funding. The role of as small center as CELCT cannot be that of substituting those activities, but should consist in facilitating and promoting them, acting as reference point and multiplier. In the first phase of its activities CELCT has mainly struggled to gather competences and to gain visibility and credibility in the evaluation commu-

nity. It is now in the process of increasing the level of linking and interaction with all the important players in the arena. For this reason, we have contacted a number of international institutions sharing the following strategic views:

- *Evaluation* is crucial to the development of HL-MCT research; this is clearly shown by the growing number and relevance of evaluation campaigns in the research practice of the field; evaluation campaigns provide the ground for a fair and methodologically sound comparison of results obtained by competing scientific approaches; they also provide benchmarks and annotated data that foster research beyond the campaign itself.
- Organizing an *evaluation campaign* is a complex, specialized and costly task, which requires scientific strategic vision, managing skills, specialized methodological competence, computational infrastructures, trained human resources to annotate data and/or evaluate them.
- Although the HL-MCT community already deems evaluation-related issues as fundamental, there is much space for improvement. For instance, it still happens too often that the results described in a published paper can hardly be reproduced by other researchers. What we would like to see is something like the following: if a researcher runs an experiment and publishes its results, then the set up, the data sets, even the software used for the run, are made available from a stable and public repository so that other researchers can reproduce the same results, understand how they where obtained, test the same software on a different dataset. At least, it should be possible to make a difference between researcher that follow this practice and those who do not.
- Whereas in the United States, there exist an *official institution* (National Institute of Standards and Technology - NIST), funded by the central government, which promotes and co-ordinates evaluation activities, in Europe evaluation activities are self-organized and promoted by individual researchers on a voluntary basis; one of the few evaluation initiatives receiving partial funds from the EU (Treble-CLEF) has been recently discontinued. This bottom-up approach to evaluation has in immense value and should not be neglected. However it also has its weaknesses, such as the lack of coordination and long-term view, the potential lack of continuity due to its volunteering basis, the difficulty in finding synergies and exploit scale factors; the inability to trigger fund raising.
- Another crucial aspect sets Europe apart from the Unites States, as far as the evaluation of language related research is concerned. Europe is strongly *multilingual*. The evaluation effort must be multiplied by the number of languages that are spoken in the European Union. The lack of evaluation benchmarks and organized evaluation activities can seriously hinder the development of HLT research on minority languages. A super-national institution could take the role of facilitating the development of language-specific evaluation activities by factorizing effort and porting methodological and managing expertise from resource-rich to resource-poor languages.
- It is time for the European research community to support an institution that takes over the task of promoting and coordinating evaluation activities in a

stable and *organized* way, complementing and integrating the bottom-up, volunteering approach.

– Although the European Commission seems not to be ready at the moment to directly create/fund an evaluation center, *European research institutions* can promote and support the development of such a center, with the final aim of getting recognized (and partly funded) by the EU. The supporting research institutions share the view that the evaluation center should be distinct from each of the supporting institutions, but also recognize their interest in influencing and promoting its evaluation policy.

A number of accompanying conditions make CELCT a good candidate to become a European reference point for the evaluation of HL-MCT research and development. Based in Trento, near the cross-point of the boarder between South and Nord Europe, and the border between West and East Europe, CELCT takes advantage of the financial and strategic support of a local government that strongly believes on the necessity to foster research and innovation, as a means to win the challenges of economical and social development. Also, CELCT is based in a geographical area hosting a pool of research institutions and companies which form a sort of education, research, and development district focused on HL-MCT topics: FBK, University of Trento (DISI, CIMEC, HLTI Master), University of Bolzano (European Master in Language and Communication Technologies), Expert System spa, PerVoice spa. Some of the research institutions in this group are participating, along with CELCT, to the creation of TrentoRise, an association that with a big number of other research institutions in Europe participates to the ICT Labs Knowledge and Innovation Community (KIC) funded by the European Institute of Innovation and Technology (EIT). We expect that thanks to all the relationships that CELCT has created, it will possible to start new projects which will improve the level of external funding of the center.

Although the European research community is the first addressee of the CELCT activity, we think that the interaction with the industry world and with the local organizations working on language technologies is also an essential part of our mission. To improve on these aspects, on one side we contacted a number of local, national and international industry players in the HL-MCT field and asked them to participate in the Advisory Board of the Center. This organism gives CELCT advice about the needs and the perspectives of the HL-MCT industry with a focus on evaluation-related activities. On the other side we recently contributed to the creation of two new local organizations: the LinMiTech Association, that gathers the local institutions dealing with minority languages, and the SemanticValley consortium, which has the aim of promoting the creation of a district in Trentino for all activities related to knowledge and language technologies.

2.3. Activities and Work Plan

Here follows a list of activities that CELCT can carry out to realize its mission:

– Define, organize and run *evaluation campaigns*.

– Provide *managing support* to research individual/groups willing to organize an evaluation campaign.

- Develop evaluation-oriented *benchmarks*.
- Promote the evaluation/comparison of specific *HL-MCT engines* distributed for research purposes and or under open/free software license.
- Promote the development of a *Web Service infrastructure* facilitating the comparison of HL-MCT software installed in different places but accessible trough the Internet.
- Support *companies* developing HL-MCT applications in the (public or private) assessment of the software they produce.
- Design and support a rich and *interactive portal*, collecting all information about evaluation related issues.
- Certify that a commercial HL-MCT application is compliant with a recognized *standard* (should such a standard be defined).
- Certify that a publicly funded research project has followed *safe evaluation methodologies*.

The evaluation related activities of CELCT span on a broad range of HL-MCT tasks. For some of them CELCT has already internal scientific competences: morphological analysis, PoS tagging, chunking, sentence splitting, word and sentence alignment, multi-word extraction, key-phrase extraction, entity recognition, relation extraction, event recognition, local and cross-document co-reference, shallow and deep parsing, question answering, lexical acquisition, wordnet and framenet development, cross-language semantic projection, ontology learning, corpora annotation, textual entailment.

For other tasks the center can rely on the scientific co-operation with its two supporters, FBK and DFKI, and the increasing integration between FBK, CELCT and University of Trento, in the HL-MCT area: anaphora resolution, semantic role labelling, opinion mining, dialogue processing, word sense disambiguation, text classification, information extraction, machine translation, speech recognition, human computer interaction, computational humour, assisted cognition.

We expect that the broadening of the pool of research institution that cooperate with CELCT can widen also the range of scientific topics for which CELCT has the expertise or scientific consultancy to carry out evaluation activities: see for instance automatic generation, summarization, ontology development.

As for the coming year (2011) CELCT has already planned a number of specific activities which are described in the following list:

- *CLEF2011*: CELCT will be the organizer of CLEF2011 (Conference on Multilingual and Multimodal Information Access Evaluation). More specifically it will be responsible for maintaining the site of the conference and the related evaluation campaign, and will also be responsible for the publications. This activity is part of the PROMISE European Project.
- *RTE-7*: CELCT will participate in the organization of the seventh edition of the Pascal Challenge called Recognizing Textual Entailment.
- *LiveMemories*: CELCT will continue an activity started in 2009 aiming at the annotation of a corpus of local newspaper documents according to the

TimeML standard. TimeML allows for annotating information about temporal expressions, events, and temporal relations between events. Temporal processing is becoming a very important task for language processing, and CELCT aims at becoming a reference point at international level for the evaluation of this task.

- *Evaluation Portal*: CELCT will continue an activity aiming at building a portal where evaluation related information and resources will be collected and made available to the public. In building this infrastructure we will experiment with innovative ways of offering evaluation services through the Web.
- *Publications*: acquiring credibility in the scientific community is crucial for a center which aims at being considered a reference point for evaluation activities. For this reason it is important that CELCT gets published the results of its work in relevant scientific conferences and journals.

2.4. Collaborations

CELCT collaborates with Italian and international institutions.

- FBK is the main partner of CELCT; we collaborate in a number of projects such as the annotation of the ICAB corpus with temporal information (in the context of the LiveMemories activities), the COSYINE European project, and other minor annotation activities.
- CELCT cooperates with the University of Padova in the framework of the PROMISE Network of Excellence.
- CELCT cooperates with the National Institute of Standards and Technology (NIST, USA), and with the Bar Ilan University (Tel Aviv, Israel) in the organization of the annual RTE (Textual Entailment) challenge.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Improve scientific visibility	R	E	Dec. 2011	Number of publications, Involvement in scientific committees	
Acquire at least one new European Project	A	E	Dec. 2011	Approval of the project by the EU	

4. Human Resources

The CELCT staff is currently composed of 11 people; 2 of them are FBK employees. Distribution of works is as follow:

1 director (part-time)

1 secretary (full-time)

2 senior researchers (one part-time and one full-time)

3 researchers (full time)

2 junior researcher (full and part-time)

2 computer technicians (part-time)

In 2010 we hired a full-time computer technician based in Trento (in substitution of the two part-time resources based in Pisa). Given the high complexity of the skills required by the work, permanent education will be pursued mainly thanks to the cooperation with FBK, DFKI and the University of Trento. Salary levels are relatively low. Although the financial situation for 2011 does not allow for much improvement on this area, it should be kept as important action for the following years.

5. Risks and Mitigation Plans

Description	Prob.	Impact	Contingency
No new project is acquired	M	M/H	The balance can be kept by reducing the center activities.

CNR-FBK. BIOMOLECULES AND BIOLOGICAL MEMBRANES (IBF-CMM)

Unit Name	CNR-FBK. Biomolecules and Biological Membranes (IBF-CMM)	
Type	Research	
Head	Mauro Dalla Serra	
Staff	2010	2011
	FBK	*FBK*
	1 post doc (ended 15/10/2010)	1 researcher (permanent position)
	0.4 secretary	1 post doc (Co.pro)
	2 associate researchers (starting 01/12/2010)	0.5 secretary
		2 associate researchers
	CNR-IBF	*CNR-IBF*
	2 senior researchers	2 senior researchers
	1 researcher npp[1]	1 researcher[6]
	1 researcher npp (outgoing)[2]	1 researcher npp
	1 post-doc (“assegno di ricerca”)	1 researcher npp (out-going)[2]
	1 PhD student	3 PhD student
	1 secretary[3]	1 secretary
	0.3 secretary	0.3 secretary
	1 Co.pro	2 Co.pro
	1 fellowship [4]	1 fellowship[4]
	1 researcher (in the process TBH[5])	1 researcher[5])
	1 technician (in the process TBH[5])	1 technician
	1 associate professor	1 associate professor
	1 associate post-doc	1 associate post-doc

Document Status: submitted 2010-11-26

[1] npp = non permanent position;

[2] started on 2010/16/10 on a PAT grant;

[3] new permanent position starting by 01/12/2010;

[4] on an external grant;

[5] TBH = to be hired;

[6] trasferred in my unit from other CNR Institute (starting on 01/06/2011)

1. Executive Summary

This document describes the two research activities of the Biomolecules and Biological Membranes (BioMBio) Unit, i.e. *(i) Pore-Forming Toxins and AntiMicrobial Peptides* and *(ii) Molecular Imaging.* Collectively, the BioMBio Unit main activities will be focused on basic research on the understanding the mechanism of action of macro biomolecules with high relevance for human health and environmental impact.

(i) *Pore-Forming Toxins and AntiMicrobial Peptides*.The group has developed an original, inter- and multidisciplinary biophysical and biochemical approach to investigate structural and functional aspects of the interaction between proteins and biological membrane. Particular efforts have been devoted to study the mechanism of action of membrane-damaging toxins using model and biological membranes. These toxins, known as Pore-Forming Toxins (PFTs) and AntiMicrobial Peptides (AMPs), are mainly bacterial toxins relevant for human health, but they are also produced by plants and animals and constitute their arsenal weapons for attack or defence. They reach the target cell causing destabilization of the plasma membrane and final cell death. A biophysical characterization of PFTs is important since they are excellent archetypal model systems for understanding key aspects of protein-protein and protein lipid interactions and protein conformational transitions. Recently, new evidences show a concentration dependence of PFTs action. Therefore particular attention will be focused towards the understanding of the secondary cellular effects induced by sublitic amounts of PFTs. In addition these toxins may have also many interesting biotechnological applications. For example as (i) component of antitumoral and antifungal drugs, (ii) biosensors in aqueous phase and (iii) component in drug delivery systems; some of which have been investigated from BioMBio Unit.

(ii) *Molecular Imaging*. We aim at the establishment of a new stream of research in the new multidisciplinary field of molecular imaging, which enables noninvasive in vivo investigation of cellular functions and molecular processes involved in physiological and pathological conditions. For instance, HIV biology has been extensively studied by experimental approaches based on molecular biology and biochemistry bulk analysis, and yet the Achilles' hill of HIV virus has to be identified. Thanks to a strong collaboration between physicists and biologists we developed a system to efficiently visualize HIV in the nucleus. Our experimental set up has been proven valid to track single viral particles at the nuclear level. We will further prove the power of this experimental approach to analyze the interaction of HIV with cellular factors and with nuclear membrane complexes involved in nuclear import. It is worth noting that the cellular cofactors exploited by the virus for its replication are the emerging pharmacological targets for new therapies. In fact, the fast mutation rate of HIV genome has been its secret to survive to new drugs against viral proteins. So, the targeting of the interaction between the virus and the host cell "changeless" cofactors is the new emerging strategy. Our second specific interest is in chloride imaging by molecular sensors. Monitoring of chloride by non-invasive means is of primary importance in many biomedical and biological fields. Chloride ion plays a special role in nervous system functioning because the main inhibitory (GABA and glycine) and excitatory (glutamate) neurotransmitters act via Cl-selective channels and Cl-transporters, respectively; thus, local chloride gradients determine the balance between excitatory and inhibitory neurosynaptic transmission. Since the concentration of intracellular chloride ([Cl-]i) and its permeance are

highly regulated by various Cl-selective channels and Cl-transporters, dysfunction of these proteins, and consequently alterations of intracellular chloride homeostasis, occurs in hereditary and acquired human diseases as cystic fibrosis, epilepsy and Bartter syndrome.

The research activity involves the use of biological samples such as human or animal blood.

2. Vision and Scientific Program

2.1. Context and State of the Art

(i) *Pore-Forming Toxins and AntiMicrobial Peptides.* Pore forming protein toxins (PFTs) and antimicrobial peptides (AMPs) are one of Nature's most potent biological factors of attack and/or defence. They are widespread throughout all the biological kingdoms. They constitute the arsenal of sophisticated and efficient weapons produced during the ancient evolutionary race between host and pathogens. Not surprisingly, both classes of weapons interact and impair the integrity of the plasma membrane, which represents the first line of cell defence and is crucial for cell identity, function and vitality. PFTs and AMPs often kill cells simply by punching an aqueous pore through their membranes. Despite different in amino acid sequence and structure, the major steps leading to pore formation are similar. Collectively, these molecules can be considered excellent candidates for studying and understanding structure-function relationships of protein-protein and protein-membrane interactions. In addition, they offer a number of biotechnological applications as component of antitumoral and antifungal drugs, as biosensors in aqueous phase and as component in drug delivery systems.

(ii) *Molecular Imaging*. Molecular imaging is a new integrative discipline that enables noninvasive in vivo investigation of cellular functions and molecular processes involved in physiological and pathological conditions. The laboratory is focused on the development of new biosensor capable to image particular functions, pathways and targets playing relevant roles in translational research, and in various microscopy and nanoscopy techniques including live imaging, total internal reflection microscopy fluorescence (TIRF)-microscopy, photo-activated localization microscopy (PALM).

Auto evaluation

Dalla Serra h-index=20; total articles with citation=58; average citation per article=19.71

Arosio h-index=14; total articles with citation=29; average citation per article=11.59

Reference list (2009-2010)

1. Arosio,D., F.Ricci, L.Marchetti, R.Gualdani, L.Albertazzi, and F.Beltram. 2010. *Nat Methods* 7:516-518.
2. Guella,G., I.Mancini, G.Mariotto, B.Rossi, and G.Viliani. 2009. *Phys. Chem. Chem. Phys.* 11:2420-2427.
3. Guella,G., D.Skropeta, G.Di Giuseppe, and F.Dini. 2010. *Mar. Drugs* 8:2080-2116.
4. Guella,G., R.Frassanito, I.Mancini, T.Sandron, L.Modeo, F.Verni, F.Dini, and G.Petroni. 2010. *Eur. J. Org. Chem.* 3:427-434.
5. Kristan,K., G.Viero, M.Dalla Serra, P.Macek, and G.Anderluh. 2009. *Toxicon* 54:1125-1134.
6. Marchetti,L., L.Comelli, B.D'Innocenzo, L.Puzzi, S.Luin, D.Arosio, M.Calvello, R.Mendoza-Maldonado, F.Peverali, F.Trovato, S.Riva, G.Biamonti, G.Abdurashidova, F.Beltram, and A.Falaschi. 2010. *Nucleic Acids Res.*
7. Potrich,C., H.Bastiani, D.A.Colin, S.Huck, G.Prévost, and M.Dalla Serra. 2009. *J. Membr. Biol.* 227:13-24.
8. Praper,T., A.F.P.Sonnen, G.Viero, A.Kladnik, C.J.Froelich, G.Anderluh, M.Dalla Serra, and R.J.Gilbert. 2010. *J Biol Chem* In press.
9. Ramoino,P., F.Dini, P.Bianchini, A.Diaspro, G.Guella, and C.Usai. 2009. *J. Compar. Physiol. A*.
10. Rebolj,K., B.Bakrac, M.Garvas, K.Ota, M.Sentjurc, C.Potrich, M.Coraiola, R.Tomazzolli, M.Dalla Serra, P.Macek, and K.Sepcic. 2010. *BBA - Biomembranes* 1798:891-902.
11. Tejuca,M., G.Anderluh, and M.Dalla Serra. 2009. *Toxicon* 54:1206-1214.

2.2. Vision and Goals

The results achieved will be evaluated in terms of publications in peer reviewed journals, invited oral presentations at international congresses, establishment of new prototypes and protocols, patents.

(i) *Pore-Forming Toxins and AntiMicrobial Peptides.* Depending upon the success of the submitted proposals, we will focus our attention on:

a) The interaction of PFTs and AMPs with cell membranes; PFTs and AMPs could be good sensor for investigating lipid composition and organization of cell membranes. *In collaboration with Uni.Ljubljana (Anderluh), FEM (Moser) and Uni.Lublin (Gagos).*

b) Characterization of α-synuclein interaction with membranes and its organization. *In collaboration with UniPD (Bubacco), Uni Cambridge (Klenerman), UniTN (Ricci) and CiBio (Macchi, Guella).*

c) Identification and characterization of PFTs that permits the design and development of anticancer devices. These proteins can be the toxic component present in immunotoxin or that can be loaded on magnetic nanoparticles. *In*

collaboration with FBK (Pederzolli, Speranza), UniHabana (Tejuca) and U-niTN (Migliaresi).

d) The understanding of the cellular effects induced by sublytic PFT concentrations. *In collaboration with CiBio (Viero), FEM (Moser) and Uni.Strasbourg (Prévost).*

(ii) *Molecular Imaging*. Two are our current aims:

a) Chloride imaging. By mutagenesis of the green fluorescent protein (GFP), we recently identified a mutation (T203Y) sufficient to create a highly specific anion-binding site that, when occupied leads to the complete loss of fluorescence via static quenching. We have exploited this GFP property within a ratiometric-design concept for the development of a combined pH and chloride concentration sensor. Specific goals are now to extend this imaging in living animals though 2-photon excitation microscopy and establish a high-throughput chloride flux assay.

b) Visualization of HIV-1 and single particle tracking of intranuclear dynamics in collaboration with the Molecular Virology laboratory. Nuclear import and subsequent integration of viral genome are emerging as tightly regulated aspects of the HIV-1 lifecycle. We are interested in defining the dynamics, energy-dependent motion and molecular interactions exploited by the virus to target specific integration sites. Specifically, we investigate the nuclear translocation and the nuclear trafficking of the HIV genome

2.3 Activities and Work Plan

(i) *Pore-Forming Toxins and AntiMicrobial Peptides.* Activities and work plan for the next year will be mainly focused on the already funded research projects which are in the drugs delivery and neuroscience fields.

The unit will be partially involved into basic research activities for improving our knowledge on protein-protein and protein-lipid interactions.

In more details the research activities of the next year will be focused on:

1. Studies on the mechanism of action of some cholesterol dependent cytolysins and perforin. Both protein families are able to form huge yet uncharacterized pores that may be used also for facilitating nanoparticles and/or drug delivery into the cell. Electrophysiological data so far collected will be finalized to be published in two separate papers and will be described into two PhD theses in collaboration with the Slovenian group.
2. Further investigations on the permeabilizing ability of α-synuclein (wt, mutants, dimers and truncated forms) are necessary for supporting our data and model. Electrophysiology, single molecule fluorescence and infra-red spectroscopy techniques will be involved. Lipid requirement will be investigated by MS and NMR spectrometry (in Guella's lab).

(ii) *Molecular Imaging.* The research activities will be focused on:

a) Recruitment of 2-3 postdocs and junior students/researchers (50% non-Italian)

b) Establishment of new experimental setups: (i)Live imaging high-resolution microscopy with physiological shear-stress flow and microfluidic chips (ii) High-throughput spectroscopy for rapid screening of novel molecular sensors (iii)High Content microscopy Analysis for drug screening (e.g. HIV drugs blocking cytoplasm-nucleus translocation).

2.4 Collaborations

- FBK *C. Pederzolli*: anticancer drug design and construction, drug delivery, design and construction lipid coated biomimetic nanosystems; *G. Speranza*, stability and cell localization of functionalized nanoparticles possibly involved in cancer diagnosis and therapy
- CiBio *G. Viero*, regulatory effects of sublytic α-hemolysin doses; *P. Macchi*, *in vitro* studies of the cellular effects of proteins involved in neurodegenerative diseases; *A. Provenzani*: Chloride sensor development and compound screening by high-content microscopy analysis; *A. Cereseto*: Single HIV particle tracking and development of high content microscopy screening of novel HIV drugs
- BIOtech *C. Migliaresi*: characterization, *in vitro* cell interaction and localization of functionalized magnetic nanoparticles possibly involved in cancer diagnosis and therapy
- Uni. Padova Dept. Biology, *L. Bubacco*: expression, biochemical and biophysical characterization of α-synuclein involved in Parkinson's disease
- Uni. Cambridge (UK) Dept. Chemistry, *David Klenerman*: single molecule visualization of α-synuclein
- Uni. Ljubljana, Slovenia Dept.Biology, Gregor Anderluh: pore-forming toxins as useful tools in biotechnology, molecular mechanisms of action, Surface Plasmon Resonance studies
- Ist. NanoScienze, CNR, Pisa, G.M. Ratto, M. Cecchini, Nano-fluidic systems and two-photon imaging
- Northwestern Univ., Chicago IL, USA, T. Hope, Single HIV particle tracking in vivo
- European Brain Research Institute, Roma, A. Bacci: Chloride imaging in epilepsy
- Ist. Neuroscienze, CNR: *M. Caleo*, Chloride imaging in the evaluation of intracerebral injection of botulinum neurotoxin A (BoNT/A) for the treatment of pharmacoresistant epilepsy; *G. Carmignoto*: Cl imaging in slice models for the study of the inhibitory-excitatory balance in neuronal activities.
- IIT, Genova *L. Cancedda, T. Fellin*: Chloride imaging in animals.
- ETH Zurich *A. Ferrari*,: development of high resolution microscopy for single particle analysis in living cells under shear stress conditions
- NCI, Bethesda, USA *G. Franchini*: Study of HTLV virus cell infection under physiological shear-stress conditions

- Karolinska Inst., Stockholm *P. Sekyrova*: Cl transport in embryonic stem cells in early development.
- Mediterranean Institute of Neurobiology, Marseille, France *P. Bregestovski*: Visualizing activity of chloride selective receptor-operated channels.

2.5 Specific Needs and Points of Attention

In line with the development plan for the CNR-IBF Unit in Trento new research activities are going to be established and new people to be recruited. New office and laboratory spaces are crucial to support this effort. A concrete care from FBK will be appreciated.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Smart nanoparticles for imaging, detection and therapy of cancers (NanoSmart) (PAT)	R	E	Dec.	publication/ dissemination	
Electrophysiological characterization of alpha-synuclein, a protein involved into the neurodegeneration of Parkinson's Disease (SynPark) (caritro)	R	E	June	publication/ dissemination	
Single molecule fluorescence approach to study protein oligomer formation (SINGLESYN) (PAT)	R	E	Dec.r	publication/ dissemination	
Translational tuning in neuroblastoma by bacterial toxins (caritro)	R	E	April	publication/ dissemination	
Structural and dynamical aspects of the pheromone-receptor interaction in the "model" ciliate Euplotes (PRIN)	R	E	June	publication/ dissemination	
Epilepsy: mechanisms of circuit hyper-excitability and novel therapeutic strategies (Salute 2009)	R	E	Dec.	publication/ dissemination	
Targeting HIV integration Co-factors, targeting cellular proteins during nuclear import or integration of HIV (EU Acronym: THINC). (FP 7 Health 2007)	R	E	Dec.	publication/ dissemination	
Biosensor-based assay for high-throughput quantitative screening of chloride transport. (Salute 2009)	R	E	Dec.	publication/ dissemination	

Inter-neuronal dysfunction in genetic epilepsies: insights from a mouse model of severe myoclonic epilepsy of infancy (SMEI) (Telethon)	R	E	Dec.	publication/ dissemination	
Imaging molecolare della concentrazione intracellulare di cloruro in modelli animali dell'epilessia: sviluppo di sensori, studio delle cause molecolari dell'epilessia e screening "high-throughput" di nuovi farmaci.	R	E	Dec.	publication/ dissemination	If approved FIRB (fir) 2010
Progettazione razionale di Nano-Biosensori per misure intracellulari di Cl- e pH per microscopia in-vivo.	R	E	Dec.		If approved PRIN 2009
Molecular mechanism of action of cholesterol dependent cytolysins and possible biotechnological applications (CDC_action)	R	E			If approved (PAT post doc 2009)
Pore-forming toxins as useful tools in biotechnology: molecular mechanisms of action	R	E			If approved (MAE Italian-Slovenian bilateral project renewal 2010)
Construction and characterisation of a proteic transport machine that mimics nuclear pore complex (NanoArtPore)	R				If approved (PAT post doc 2010)
Title to be decided (deadline 16/12/2010)	R				If approved FIRB (fir) 2010

- Notes:
- Description: free text description of the goal.
- Type: use I for Innovation, R for Research, A if related to improve financing (e.g. project proposals), F if related to achieving internal goals (F = FBK; e.g. deploying a system in FBK to improve internal communication), O for Other
- Scope: use I for Internal (the goal does not have impact, for the year, outside the unit/FBK), E for External (the goal has visibility and or involves actors other than FBK, e.g. a European Project is External; developing a tool we do not intend to distribute is internal)
- Time frame: when you expect the result to be achieved (month granularity, e.g. september)
- Measurement mean: if not self-evident, provide a mean to measure the achievement of the goal. If the goal can be partially achieved, please provide means to measure partial achievement (e.g. goal 50% achieved if …)
- Pre-conditions: if there are some significant pre-conditions. REMARK: if the pre-condition has already been mentioned in the "Specific Needs and Attention points, make a reference to the text there – no need to repeat.

4. Human Resources

The research team of BioMBio RU consists of two senior researchers at CNR staff and a newly hired secretary, plus many post-docs (none of them with a permanent position) and students with expertises and competences in biophysics, biochemistry, cell biology, cell biophysics, molecular biology, and physics.

In the very recent past CNR is putting big efforts to stabilize the most critical situation of the RU which is its low staff mass. In fact CNR-IBF opened a 3 years PhD student position (starting 1st Nov 2009), and it has opened a public competition for a researcher and it is going to open a competition for a technician. Herewith a permanent position as FBK researcher has been proposed. Actually this is not to be interpreted as a new position, rather than a necessary replacement of the FBK permanent position of Mauro Dalla Serra, that has recently been hired by CNR-IBF.

A tenure track position to a post-doc with at least two postdoctoral years documented experience in biophysical/biochemical scientific research is here proposed. This carrier progression will positively stimulate the interest of other motivated collaborators that will see the opportunity to be hired by a local institute.

5. Risks and Mitigation Plans

This session highlights the main criticalities of our project and provides the alternatives to manage, mitigate, and control risks in order to successfully achieve goals under the restraint of a fixed budget and schedule. In any case, it is clear that it's difficult to identify all the risks in advance. It is the intent of the RU coordinator to provide the means to handle identified hypothetical risks, as they appear.

Acquisition Alternatives. Some key subjects of our investigations are PFTs and AMPs. We obtain these macromolecules at high purified degree through an already well established collaborative network, having both support and leadership roles. Protein and mutant production require deep expertise in molecular biology and in protein purification, and it is expensive and time consuming. Therefore its delocalization may represent an advantage, but it could become a critical point when the local needs do not fit a general network interest. Experts in protein expression and purification methods have been acquired by the BioMBio RU to circumvent this eventuality. Alternatively, some of the molecules of our interest can be available off-the-shelf or under custom design, but at variable prices.

Fund rising. The planned and future activities are strongly based on the acquired expertise and international visibility of the Unit members. Many of them hold non-permanent positions, therefore their salaries are charged directly on the projects. A very critical point is to guarantee a vital financial support for the staff members involved. This is mainly based on the success of the applications that in last analysis reside on the excellence of the personnel involved. People have to be highly motivated, well determined in reaching the planned tasks, with a strong scientific com-

petence and high sense of responsibility, and prone to publish all the results. A crucial point is therefore a very accurate selection of the people to be hired.

Risk monitor and communication. A continuous monitoring of the risk as they arise will be crucial. For this it could be helpful a proactive and open discussion with lab members at weekly lab meetings on the identification and analysis of the risks and on the mitigation actions to be needed to address the identified risks.

Administration and management. All the administrative workload is carried on only by one secretary. This can be good since a single person has the entire view of all the aspects of our unit. But at the same time this role could become too heavy. CNR is going to hire a new position in support of and to be coordinated by the actual unit secretary.

One of the project goals is not achieved. If one of the projects isn't actuated on time it will not stop our activity since, even if we are not a big group, our *modus operandi* is trying to work at the same time on more than one project instead of working only on a big one.

If a person is leaving. There is also the possibility that one member of the group leaves. We will overcome its absence thanks to the support of our external strong collaborations. In fact most of the projects are accomplished with well-establish open and trusted collaborators.

6. Ethical Issues

Informed Consent	
• Does the proposal involve children?	
• Does the proposal involve patients or persons not able to give consent?	
• Does the proposal involve adult healthy volunteers?	
• Does the proposal involve Human Genetic Material?	yes
• Does the proposal involve Human biological samples?	yes
• Does the proposal involve Human data collection?	
Research on Human embryo/foetus	
• Does the proposal involve Human Embryos?	
• Does the proposal involve Human Foetal Tissue / Cells?	
• Does the proposal involve Human Embryonic Stem Cells?	
Privacy	
• Does the proposal involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	

• Does the proposal involve tracking the location or observation of people?	
Research on Animals	
• Does the proposal involve research on animals?	
• Are those animals transgenic small laboratory animals?	
• Are those animals transgenic farm animals?	
• Are those animals cloned farm animals?	
• Are those animals non-human primates?	
Research Involving Developing Countries	
• Use of local resources (genetic, animal, plant etc)	yes
• Impact on local community	
Dual Use	
• Research having direct military application	
• Research having the potential for terrorist abuse	
ICT Implants	
• Does the proposal involve clinical trials of ICT implants?	

CNR-FBK. PHOTONICS: MATERIALS, STRUCTURES AND DIAGNOSTIC - CNR-IFN

Unit Name	CNR-FBK. Photonics: Materials, Structures and Diagnostic - CNR-IFN	
Type	Research	
Head	Maurizio Ferrari	
Staff	2010	2011
	CNR 3 Researchers 3 Technician 1 Post Doc 2 PhD	CNR 3 Researchers 1 Researcher[1] 3 Technician 2 Post Doc 2.25 PhD 0.8 graduate students 1 Administration[2] 1 Researcher[3]
	FBK 3 Researchers 1 Technician 0.5 Administration	FBK 3 Researchers 1 Technician 0.5 Administration

Document Status: submitted 2010-12-01

[1] non permanent position

[2] new permanent position

[3] TBH = to be hired

1. Executive Summary

The document presents three significant activities characterized by a common scientific background that, thanks synergistic exploitation of the different competences and transversal technological and scientific interests, contribute to the strategic motivations of the unit “Photonics: Materials, Structures and Diagnostic”. The research unit is constituted by researchers which belong to FBK and CNR-IFN, with FBK people working as IFN-CNR full time associated. Moreover the unit is involved in high level formation with a appropriate number of Post-Doc, PhD and graduate students The researches of the unit cover several topics well identified in the CNR-FBK general agreement signed on 8th June 2009 and fully fit with the themes of the Materials and Devices CNR Department where the Photonics unit and the CNR-IFN institute are active.

The main activities concern research, innovation, as well as education through the study of advanced devices, systems and structures for photonics and nanotechnology. The research unit promotes the development and the application, both from

the scientific and technological point of view, in several fields such as Photonics, Nanotechnologies and Microfabrication, Microelectronic, Lasers and Incoherent Sources, Synchrotron light and X rays, quantum mechatronics. The scientific and technological skills, as well as the diagnostic techniques, which constitute an important patrimony of the photonics unit cover the full range from the study of physical mechanisms crucial for synthesis, development and characterization of innovative photonic materials to architecture and fabrication of devices suitable for application in strategic interest areas such as sensing, information technology, and light sources. The research activities managed by the unit have an important innovative lift because the proposed subjects favor cross-disciplinarily among physics, material science, and technologies crucial for fabrication of materials, structures, and photonic devices as well as for the assessment of their physical and chemical properties. The tackled subjects enhance the growing of technological and scientific competences in area of photonics potentially transferable to innovative commercial deliverables. The social impact of the activity concerns professional training of high-qualified researchers in the area of photonics and in the technological-scientific innovation of synthesis of materials, fabrication and characterization techniques, devices architecture, and understanding of physical mechanisms. The synergy with local research centers and university are optimal. The collaborations activated at national and international level reflect the ability of the research unit in promoting projects of local, national, and international strategic interest including European projects.

The unit has a staff consisting of one time contract CNR researcher and of ten permanent positions, six researchers (3 CNR/ 3 FBK) and four technicians (3 CNR/1 FBK) distributed on the three main research topics above presented. The researchers have excellent skill and competences in the specific topics and the human resources are based on motivated Post-Doc, PhD and graduate students

The prominent collaborations are:

at internal level with

- FBK - Materials and Microsystems
- CNR – IFN Milano and Roma units

at local level with

- Department of Physics
- Department of Materials Engineering and Industrial Technologies
- Department of Mechanical and Structural Engineering

at national level with

- Dept. of Physics, Univ. Roma 3
- Dept. of Physics, Univ. Messina
- Università di Roma “La Sapienza”
- University of Padova
- INFN Section of Padua, Section of Perugina, and Laboratori Nazionali di Legnaro
- IFAC-CNR
- Polytechnic of Bari
- Polytechnic of Torino
- Polytecnic of Milano

at international level with

- INFN-CNR OGG and GILDA-CRG at ESRF
- ISSP – Riga Latvia
- Coe College – Cedar Rapids, USA
- CNRS and Université Marseille
- CNES – Centre national d'études spatiales France
- Département Chimie, IUT and Lab. des Fluorures CNRS Le Mans,
- Ecole Nationale Supérieure des Sciences Appliquées et de Technologies, Lannion
- Hyderabad University
- University of Nottingham

2. Vision and Scientific Program

New materials, nanomaterials, metamaterials, optical fibers, microsystems, micro/nanotechnologies, microresonators, luminescent structures, plasmonic structures, and complex systems are the scientific and technological fields covered by photonics. In general photonics materials and innovative structures based on photonics should assist in enhancing performance and applications envelope of photonics. This is generally concerned with enhancing *functionality* and *reducing cost*. In many applications one also has to address *footprint* and, of increasing importance, *power dissipation* so that the so called green photonics has to be considered. The photonics research units focus its activity to develop significant contribution in this area characterized by a high degree of cross-linked topics and interdisciplinary activities which involve the *physics of solid state materials*, *glass photonics*, *X-ray photonics* and *quantum mechatronics*. Long-term research in photonics of strategic importance concerns study, design, fabrication, assessment, development of components, systems, materials and structures where transversal technologies and synergistic use of different competences present in the research unit are the substantial add value and the main requests/goals are high functionality, innovation, viability, low power consumption, efficiency, and knowledge development.

2.1. Context and State of the Art

Glass photonics activity, responsible M. Ferrari, refers to the strategic areas identified by European Union in the Photonics21 technological platform and the corresponding Italian platform PhoRIt (Photonics Research in Italy). Motivation of glass photonics research is related to the historical fact that breakthroughs in technology – and hence new applications that create wealth and improve the quality of life and of the environment – come from blue sky frontier research, and in photonics several examples demonstrate that the time lag from research to the market is relatively small. Research addressing this challenge will develop emerging materials such as metamaterials, nanostructured and nanocomposites systems, plasmonic based structures, as well as confined geometries. The issues are connected to optics and physics of the materials joint to the accompanying technological development. Examples are photonic crystals,

quantum dots of different complexities, such as composite colloidal quantum dots, and different kind of waveguides, integrated optics systems, solar energy conversion photonic structures, microresonators and micro-nano cavities. Materials for UV, mid-IR devices, THz diagnostics are also considered crucial. Materials, new structures, innovative systems, and new phenomena offer endless possibilities for the creation of novel devices with application in *green photonics* covering the field of ICT, sensing including biological systems and structural engineering, environment monitoring, photovoltaic. The main objective of the unit is then to provide a high-level scientific and technological research on these fields playing a significant role on the long term photonic strategies of the national and European landscape, but also to be a reliable scientific resource for specific solution to the local industrial requirement.

X-ray photonics activity, responsible F. Rocca, mainly refers to the development and application of instrumentation and methodologies for X-Ray investigations in Material Physics. The current development of nanotechnologies is the direct consequence of the large knowledge in Physics and Chemistry obtained in previous years through a myriad of spectroscopic and structural studies. They produced the necessary background and knowledge for the development of methods of production and techniques of investigation focused on the manipulation and interaction with objects of sub-micrometer dimensions, typical of the Nanosciences. The use of Synchrotron Light and Neutron Sources at the Large Scale International and National Facilities is fundamental in this field, with the value added to be intrinsically an internationally open and networked scientific environment. The current state and the new perspectives of the Upgrade process at ESRF (European Synchrotron Radiation Facility) promise for the next years the possibility of new structural investigations and spectroscopies with coherent beams having nano dimensions and peculiar temporal structure. These aspects, together with the possibility to have different complementary information on different scales (from interatomic distances, to short and medium range ordering, to large scale aggregations of matter) justify the choice to be present in the field with sufficient critical mass in frontier experiments. The project “STRUMEX” is active since many years within these perspectives and is originally deep-rooted on the Research Activities on Solid State Physics developed in collaboration with the Dept. of Physics, University of Trento. On the other side, the participation to RD activities at Synchrotron Radiation Facilities is one of the peculiar characteristics of the Group, that since 1980 is directly cooperating to the development of Beamlines and related Instrumentations in national and European Synchrotron Radiation Facilities. The Activities of the Group are centered on the study of structural and dynamical properties from a local point of view on systems having different degree of disorder (glasses, amorphous systems, gels, crystals, dopants, films,…). We develop techniques and methodologies to investigate, at the local level, the origin of applicative properties. The main aim is to gain an ab initio interpretation of physical and physico-chemical phenomena that determine the useful properties, through an integration of experimental techniques.

Quantum mechatronics activity, responsible P. Falferi, is mostly dedicated to the development of ultra-low noise sensors applied to detectors of gravitational waves. The direct detection of gravitational waves (GW) is one of the great challenges of contempo-

rary experimental physics. Its aim is to open up a new window on the Universe, in astrophysics as well as in cosmology and in fundamental physics. Gravitational waves are a potentially unique probe, which can carry fundamental information, inaccessible by electromagnetic or other means. Their first detection is pursued by means of planned space-borne detectors (low frequency band, 0.1-100 mHz) and routinely operating and improving Earth-based detectors (high frequency band, 10-10000 Hz). As unexpected by-product, the ultrasensitive displacement measurement techniques developed for the latter may offer a way to experimentally test quantum effects in macroscopic objects (analogous to the superposition of states in Schrodinger's cat), a goal that has stimulated worldwide intense experimental efforts in the last years.

Currently two resonant bar GW detectors are routinely operating: AURIGA, the most sensitive, and NAUTILUS, both with a good duty cycle and a bandwidth of several tens of Hz in the 1 kHz range. Recently, three large GW interferometers (the two LIGO in the US and VIRGO in Italy) have been completed and are now in operation with a sensitivity exceeding that of resonant bars and having a larger bandwidth. The preparation of a space-based interferometric detector (LISA) is underway, with an earliest launch date scheduled for 2020.

Constrains on the density of primordial gravitational waves can be obtained from the polarization of the Cosmic Microwave Background. After the success of the space missions COBE and BOOMERANG other experiments devoted to study the details of the Cosmic Microwave Background are planned. A promising key element of these detectors is the Microwave Kinetic Inductance Detector (MKID), a superconducting microwave LC resonator operated at very low temperatures.

2.2. Vision and Goals

Glass photonics activity will exploit its competences to succeed in the achievement of the scheduled deliverables related to several specific projects already funded or still in evaluation. In the following we briefly report on general topics where the goals allow to understand the different specific objectives. Fabrication of photonic crystals based structures for the development of photonic devices is a project allowing to exploit the competence of the unit in sol-gel photonics, plasmonic structures, and sensing. The main goal is the realization and the characterization of new class of nano-microstructured systems, for the development of specific different functionalities involving a large area of photonic technologies and application-specific photonic components and subsystems. The following systems will be fabricated and experimentally explored for their possible applications: a) Photonic crystal structures in inverse opal configuration made of a dielectric network codoped with rare earth ions, in order to obtain laser action exploiting the random laser effect in the integrated circuits; b) Nanostructures in direct opal configuration infiltrated with elastic polymeric materials to be used as a strain sensor; c) Semispherical metallic voids to obtain an enhancement in the Raman signal of organic molecules; d) Core-shell nano-microsphere both passive and activated by luminescent species having in mind different kind of geometries, including self-assembled structures. Moreover, the research unit is focused on the development of techniques that enable in-situ controlling properties of the designed metamaterials and demonstrate their applications in novel devices to light control. Fabrication

of oxide-based structures for downconverter application is a project where the competences of the unit in the fabrication of active waveguides, also by rf sputtering technique, will be exploited with the aim to increase the efficiency of the silicon-based solar cells. Advanced materials for coherent emission at new wavelengths activity aims at establishing a forefront of research in the field of novel optical coherent sources working at new wavelengths, i.e. in the visible and in the mid infrared wavelength region. The novelty is on the investigation of new materials, up to now only envisaged, which could act efficiently as coherent sources for emitting photons at wavelengths by direct emission in the visible and in the mid-IR, at wavelengths higher than 2 micron and up to 10 micron. The advanced materials investigated will then be processed into different configurations including optical fibres and planar waveguides. Micro-nano structures exploit the competences in 1D microcavities, spherical microresonators to develop a new generation of micro-laser and optical sensors.

X-ray photonics activity is based on 4 Lines, parallel and complementary:

(i) Basic Studies of Physics of Condensed Matter, with particular focus on Local Structure and Dynamics in amorphous and crystalline solids investigated by X-ray Absorption and Diffraction;

(ii) Development of new Equipment and Methodologies for Synchrotron Radiation experiments;

(iii) Application of expertise to specific problems of interest;

(iv) Production and first characterization of glassy systems (via melt quenching or sol-gel), crystals, nanoclusters, and films.

The main research topics that will be developed in the next years can be summarized as follows:

a) Study of the static and dynamic properties of matter in crystalline and amorphous state: in particular EXAFS will be used in comparison with diffraction measurements, in order to describe the local dynamics around some selected atoms of the materials under investigation. An example of application of these studies is the description of the local mechanism of negative thermal expansion.

b) Study of local structure and dynamics in confined systems and nanostructures. This is the natural extension of previous works on bulk crystalline materials, Si nanoclusters, glass ceramics and, from a more technical point of view, of our cooperation in developing tools for near field microscopy using X-ray at Synchrotron Radiation Facilities.

c) Study of the correlation between local structure and conduction properties in amorphous systems. We have a long history in studying fast ion conducing glasses and the effects of dopants in amorphous semiconductors. We plan to study new glassy systems and the effect of dopant on crystallization of amorphous semiconductors.

d) Study of the local environment of rare-earths ions and basic components in relation with the optical properties in glasses and crystals for photonics applications. This is one of the main topics of common interest of IFN-CNR: new

possibilities are now open by the micro focused beamlines and tools for investigations at the nanoscale. As usual, we are working also on the development of dedicated instrumentation necessary for the study of new materials.

e) Modelization and experimental characterization of disorder in solid state materials by X-ray Spectroscopies: the knowledge and description of short and medium-range structures is the general goal of a long term programme that span from careful experimental studies to development of appropriate methodologies and theoretical approaches dedicated to the study of "disorder" of the matter.

Concerning specific experimental resources:

a) recently, we have upgraded the gas-sensors of our big Glove-Box for sample preparation in controlled atmosphere: this apparatus may be still improved with special equipment inside.
b) A cryostat-oven (77-750 K) of IFN-CNR is available for XRD in situ measurements. The XRD activity is open to requests coming from local groups and cooperators of University, IFN-CNR and FBK. Informal cooperations are active in the fields of Energetics, Environment, Cultural Heritage, Sensors, NanoSciences,
c) The complex instrumentation for detection of X-ray excited Optical luminescence (XEOL) is currently working, and can be upgraded in the future for time-resolved measurements;
d) for the use of the XEOL apparatus using SNOM probes, we should continue the International Cooperation with partners of X-TIP, or invest money to build an independent apparatus. For future applications at Synchrotron Radiation, a dedicated effort and manpower resources should be programmed. Possibilities for new activity in X-ray Microscopy should be evaluated in the future.;
e) our cooperation with the GILDA Beamline at ESRF (F) should be renewed, in correspondence with the future Upgrade Programme of the Beamline, at present under discussion with CNR and MIUR.

The *quantum mechatronics* group is involved in a good fraction of the worldwide activities in the field of gravitational waves, being an active partner in AURIGA (INFN resonant detector), LISA (ESA/NASA space interferometer) VIRGO (ground based interferometer) and ET (Einstein Telescope, a third generation cryogenic interferometer) projects. The group has developed a variety of original experimental techniques. These include for instance high sensitivity, almost quantum limited, SQUID amplifiers, to be used as the final stage of ultra sensitive motion detectors in gravitational wave antennas and similar systems. They also include femto-Newton sensitivity torsion-pendulums to test parasitic forces on test-masses to be used as geodetic tracers in space-borne gravitational experiment. These technologies are and will be employed for the development of the mirror control system of ET, the feedback cooling of ultracryogenic mechanical resonators and for testing on ground of LISA sensor performances. The main goals for the next 5 years are the following.

- The launch of the ESA LISA Pathfinder mission is foreseen for the beginning of 2013. This mission aims to demonstrate the near-perfect free-fall of geodesic reference test masses inside a satellite, to within 3 fm/s2/Hz1/2. In addition to demonstrating the key technology for the LISA gravitational wave observatory – which aims at a launch in roughly 10 years – LISA Pathfinder represents the test-bench for all future missions requiring high precision free-fall.
- Third generation cryogenic GW detectors, like the proposed underground ET, aim at a sensitivity curve 100 times better than that of current LIGO and Virgo detectors; to this end the development of new techniques for the control system used to keep the interferometer on resonance is required and the noise introduced by the actuators on the mirrors must be kept below their mechanical thermal noise at 4.2K
- In the field of the experimental tests on quantum effects in macroscopic objects the remarkable result obtained in 2008 (Phys. Rev. Lett. 101, 033601 (2008); article included by the American Institute of Physics in the top ten results of the year 2008 in Physics (Physics News Update, AIP Bulletin 879, 2008)) can be improved with a dedicated experiment in which an ultracryogenic macroscopic mechanical resonator is feedback cooled towards its quantum ground state.

As regards the experiments for the detailed measurement of the Cosmic Microwave Background that can provide information on the density of primordial gravitational waves, the expertise of the group on cryogenics at very low temperatures and noise measurements will be devoted to the characterization of the MKIDs produced in FBK. The goal is the realization of a mosaic detector to be installed at Millimetre and Infrared Testa Grigia Observatory (MITO) (Cervinia) in collaboration with De Bernardis group.

2.3. Activities and Work Plan

Glass photonics activity is scheduled as follows:

- Fabrication and characterization of sol-gel derived photonics crystals and rf-sputtering prepared microcavities. This activity concerns opal fabrication with direct and inverse structure, infiltration with elastomers and active materials, colloidal structures fabrication, plasmonic system fabrication, metamaterials, 1 D microcavities fabrication, morphologic, structural and spectroscopic assessment of the fabricated systems.
- Fabrication and assessment of nanostructured glass-ceramic waveguides and spherical microresonators. This activity will consider: - definition of the fabrication protocol of SiO_2-SnO_2, SiO_2-HfO_2, SiO_2-GeO_2 glass ceramic waveguides, - spherical microresonators fabrication, coating, and development of the experimental setup for optical assessment.
- design of appropriate structures for THz transmission; This activity will consider: - design of polymer based structures for THz transmission, - evaluation of suitable configurations, protocol for rib-geometry fabrication; spectroscopic and structural assessment

- fabrication and assessment of downconverters systems based on combined action of nanocrystals (nanoparticles) and luminescent ions. This activity will consider: - fabrication HfO_2 based film activated by rare earth ions, - evaluation of the energy transfer mechanism – developing of specific diagnostic techniques for efficiency estimation – design of waveguiding configuration.

X-ray photonics will perform the following axis of activity.

Ordinary Research Activity: Previous Research Programs on fast ion conducting glasses, semiconductors, glass ceramics, optical waveguides, negative thermal expansion, X-ray Instrumentation will be continued, within our network of relationships. Results will be presented at some important Conferences (7th International Conference on Borate Glasses, Crystals, and Melts (Halifax, Canada); E-MRS (Nice, F); Int. Conf. "Functional Materials and Nanotechnologies "FN&MT – 2011(Riga, April 5 – 8, 2011), …). Original Papers will be submitted for publication on well selected Journals.

EXAFS new proposals: We plan to continue in 2011 some of the Projects started recently. In particular on the role of Cr and Ni in a-Si for metal-induced crystallization; on the influence of Cu on the ferromagnetism in Cu-doped ZnO films (and in general diluted magnetic semiconductors (DMS)); on the micro-structural modifications induced by Laser annealing in Lead-Vanadate Glasses; on the local structure of mobile cations in fast-ion conducting systems.

Samples and new materials: depending on grants and manpower, we will prepare new Cu-based borate glasses, ZnO films, a-Si doped with metals (Cr, Ni,), optical waveguides doped with Er. Some of the new samples will be, of course, done in cooperation with other local and International participants (from USA, from India through ITPAR) to our Projects.

Exploiting new perspectives: an effort will be done to reinforce our network of cooperation, in order to have access to EU or International Grants. We are currently waiting for the evaluation of the FIMAX project, presented at EU-FP7 on Nov. 2010. Possible further fields for future EU projects will be: glasses for photonics, Nano-scale chemical mapping, X-ray Spectroscopies and Applications. Large Scale Facilities.

The group working in *quantum mechatronics* schedules his activity for the next year on the following tasks:

- the role of the control system of an interferometric gravitational wave detector is to maintain the correct resonant condition of fields (lengths and alignments) inside the interferometer within a series of maximum residual RMS fluctuations of all the degrees of freedom around the operating point. The use of the actuation system currently employed in the room temperature interferometers (coil-magnet) in the cryogenic interferometers (ET) could not only compromise the control at very low frequencies but also represent an extra noise source in the detection bandwidth. To check this hypothesis we will continue SQUID measurements of the magnetic noise produced by permanent magnets at 4.2K.

- As regards the activity on quantum effects in macroscopic objects we will start measurements of quality factor of mechanical resonators and tests of the noise performance of a two-stage SQUID amplifier and the working principle of the feedback cooling technique on a macroscopic electrical resonator with the goal to obtain an average occupation number of 30.
- For the LISA Pathfinder mission, the immediate objectives are the in-laboratory testing of the hardware relevant to the purity of free-fall. Specifically, the group will perform, using a torsion pendulum with sub-fN sensitivity, the final tests of the force noise that arises in the interaction between the test mass and the surrounding capacitive sensor that is used to control the flight of the satellite around the free-falling test mass.
- Several tests on dilution refrigerator will be necessary to evaluate and then adjust the superconducting transition temperature of the MKIDs produced in FBK by changing its fabrication process.

2.4. Collaborations

FBK

– FBK Materials and Microsystems (N. Laidhani, G. Speranza, G. Pucker) Photovoltaic, Emerging materials, Integrated optics, sensing
– FBK-MEMS (Benno Margesin) – Microwave Kinetic Inductance Detectors (MKIDs) within MEMS-2
– FBK-MTLab Trento (Pierluigi Bellutti) – Microwave Kinetic Inductance Detectors (MKIDs) within MEMS-2
– FBK-CNR IMEM (Michele Bonaldi) – Design, production and testing of mechanical resonators for feedback cooling experiments

Trento University

– Department of Physics: (Giovanni Andrea Prodi and Stefano Vitale) - Ultracryogenic tests of mechanical resonators, torsion pendulum tests for LISA Pathfinder and Microwave Kinetic Inductance Detectors (MKIDs); *X-ray Group* (Giuseppe Dalba): Local Stucture and Dynamics in Solids studied by X-ray Absorption and Diffraction; *Optical Spectroscopy Group* (P. Verrocchio) Materials for Photonics and basic science; *Lab. IDEA* (A. Miotello): X-ray Diffraction Studies of materials of interest, rf-sputtering fabricated structures; *Lab. Nanoscienze* (L. Pavesi) Photonics structures, nanophotonics.
– Department of Materials Engineering and Industrial Technologies: Material Science, Nanoscience, XRD
– Department of Mechanical and Structural Engineering (D. Zonta, R. Zandonini) Sensing

CNR-IFN

– IFN Milano (R. Ramponi) Laser writing and micromachining
– IFN Roma (V. Foglietti) Waveguide patterning

Other Institutions

- INFN-CNR OGG and GILDA-CRG at ESRF (Grenoble – F) (F. D'Acapito,. C. Maurizio) Synchrotron Radiation.
- Dept. of Physics, Univ. Roma 3 (S. Mobilio, C. Meneghini) Local Stucture and Dynamics in Solids.
- Dept. of Physics, Univ. Messina (M. Cutroni, A. Mandanici) and Dept. of Chemical-Physics, Univ. Pavia (P. Mustarelli). Fast Ion conducting Glasses:
- University of Padova: (A. Martucci) sol-gel photonics,
- INFN Section of Padua and Laboratori Nazionali di Legnaro (Jean-Pierre Zendri and Luca Taffarello) – Low temperature measurements of quality factor of mechanical resonators, (Massimo Cerdonio) – AURIGA data taking; Section of Perugia (Roberto Battiston) - Microwave Kinetic Inductance Detectors (MKIDs
- Università di Roma "La Sapienza" (Paolo De Bernardis) – Microwave Kinetic Inductance Detectors (MKIDs)
- IFAC-CNR Firenze MDF Lab (G.C. Righini) Glass Photonics – Materials and devices fabrication
- ISSP – Riga Latvia (J.Purans, A. Kuzmins) XANES and EXAFS Studies on glasses and crystals
- IBM-Zurich (N. Afify) Rare-earth doped systems for photonics
- Coe College – Cedar Rapids, USA (M. Affatigato) Structural and spectroscopical studied on Glasses
- CNRS and Université Marseille (D. Pailarey and D. Tonneau) X-ray Microscopies
- Departamento de Engenharia de Materiais, Instituto Superior Técnico, Lisboa, Portugal, Almeida Rui (Sol-gel waveguides, rare earth and metallic nanoparticles codoped systems, non-conventional glasses).
- Département Chimie, IUT and Lab. des Fluorures CNRS Le Mans, (C Duverger, B. Boulard) Education, Training and Qualifying technologies, Non-conventional glasses and glass ceramics)
- Ecole Nationale Supérieure des Sciences Appliquées et de Technologies, Lannion France, (Feron Patrice) Integrated optics microlasers.
- Hyderabad University, School of Physics, (D. Narayana Rao) Nonlinear optics, Ultrafast phenomena and Spectroscopy, material science, nanocomposite materials
- Institut für Physik, Universität Greifswald, Germany, (A. Quandt) Theory of Low Dimensional Composite Nanomaterials, Metamaterials, Plasmonics.
- ITIMS International Training Institute for Material Science, Hanoi University of Technology, Vietnam, (Pham Than Huy) Synthesis and Processing of nano-materials for sensing, optoelectronics and photonic applications.
- University of Nottingham Novel Photonic Glasses School of Mechanical Materials, Manufacturing Engineering and Management, (A.B. Seddon) Glass Ceramics in non oxide glasses.

- Rudjer Boskovic Institute, Zagreb, Croatia, (Mile Ivanda) Nanocomposite-based complex structures fabrication by LPCVD, Stimulated Raman,Scattering.
- CNES – Centre national d'études spatiales France. Glass micro-minispheres for the development of hyper-frequency sources with high spectral purity
- Polytechnic of Bari (Francesco Prudenzano) Modeling of photonic systems – metastructures – photonic crystals – nano—microspheres – laser sources
- Polytechnic of Torino (Daniel Milanese) Low phonon performs and fibers for Vis-Nir-Mir laser action.

Experiments

- AURIGA: the INFN Sections of Padua, LNL, Trento and Ferrara and the Universities of Padua, Trento and Ferrara involved
- VIRGO: more than 20 institutions in Europe are involved in Virgo
- LISA and LISA Pathfinder: more than 100 institutions involved worldwide
- Experimental Activity at Synchrotron Radiation: development and utilization (Europe- Japan)

European Projects

- ET (Einstein Telescope) is a Design Study project concerning the conceptual design of a cryogenic GW interferometer of third generation. Eight research institutions involved.
- COST Action MP0702 2008-2011: Towards Functional Sub-Wavelength Photonic Structures (26 counties involved)

2.5. Specific Needs and Points of Attention

The specific needs for the research unit concern the increase of the human resources. During 2010 one time contract CNR researcher was acquired and another one is expected in 2011. It is important the interest of FBK on this aspect so that new researcher position would be strongly beneficial for the increase of the competitively of the unit.

Point of attentions are:

- The quantum mechatronics research unit, with two FBK researchers with permanent position, ask for permanent staff growth also considering the novel activities performed in collaboration with other FBK units.
- b) In order to develop own projects X-ray photonics group believes that the possibility to hire new PhD Students or Young Researchers using CNR or FBK resources should be considered and planned.
- Glass photonics unit has acquired a CO_2 laser for laser material processing. A full cooperation with FBK for the development of this activity deserves a certain attention. Moreover a strong effort on upgrading and maintenance of the instrumentation is a priority for the unit as well as the acquisition of a research position.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Development of TiN MKIDs with transition temperature down to 100 mK	R	E			
Evaluation of the noise from magnet-coil actuator for ET	R	E	-	-	-
Feedback cooling applied to a macroscopic electrical resonator to obtain an average occupation number of 30	R	E	-	-	See specific needs and points of attention
Torsion pendulum testing of the force noise with flight model capacitive position sensor (LISA Pathfinder)	R	E	-	-	-
Novel silicon based materials for optoelectronics	R	E	-	Quality factor	
Fabbricazione di nanostrutture metalliche a cristallo fotonico per biosensori SERS	R	E	-	SERS	
1D microcavities for luminescence enhancement	R	E	August	Enhancement and quality factor	-
Sources hyperfréquences à très haute pureté spectrale à base de mini-résonateurs optique	A	E	-	-	Approval
Glass ceramic spherical microresonators	R	E	March	Quality factor	Clean room availability
Ruđer Bošković Institute Centre of Excelence for Nanostructural Research and Analysis / RUBICON FP7-REGPOT-2011-1 project	A	E			Approval
Fabrication of nanostructured systems in opal configuration for the development of photonic devices	R	E	April, Nov.	Reflectance; PL and Raman enhancement	
Futuro in Ricerca 2010 Sorgenti laser nel visibile e nel medio infrarosso basate su nuovi materiali attivi	A	E	-	-	Approval
Futuro in Ricerca 2010 Cyclodextrin nanosponges:	A	E	-	-	Approval

a new class of polymers for drug delivery					
Studio con spettroscopia positronica del ruolo dei difetti di tipo vacanza nella cinetica di assorbimento di idrogeno in Mg drogato Nb e nei processi di crescita di guide di luce per la fotonica.	A	E	-	-	Approval
Laser a 2.1 micron con elevata qualità di fascio in fibra multicore drogata con olmio (PRIN 2009)	A	E			Approval
Studio delle proprietà strutturali e dinamiche di liquidi ionici	A	E			Approval
FIMAX: Shear Force Microscopy and Chemical MApping by X-ray Spectroscopy	A	E			Approval
Interplay between structural and electronic properties in nanostructures : X-ray Absorption studies and Theoretical modelling	R	E			
Experiments at SR	R	I/E	2011	Numbers of Accepted and realized experiments	Acceptance from International Committees
Papers	R	E	2011	Numbers/quality	-
Conferences	R	E	2011	Numbers of Accepted Contributions/ Invitations	-
Applications to local, national, EU research projects	I/R	E			

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

The unit has a staff consisting of one time contract CNR researcher and of ten permanent positions, six researchers (3 CNR/ 3 FBK) and four technicians (3 CNR/1 FBK) distributed on the three main research topics above presented. The researchers have excellent skill and competences in the specific topics and the human resources are based on motivated Post-Doc, PhD and graduate students However, the research unit is clearly understaffed in respect to the scheduled ac-

tivities. Moreover there are some young and active researchers, which have the competences and the scientific skill to be the perfect candidates for a permanent position as researcher in the unit Photonics: Materials, Structures and Diagnostic. For these reasons the unit asks for al least two CNR/FBK research position

The *quantum mechatronics* research unit, with two FBK researchers with permanent position, needs permanent staff growth. In particular, Andrea Vinante, for a long time co-worker of the unit and key person for the project on the quantum effects in macroscopic objects and for the characterization of the Kinetic Inductance Detectors at ultracryogenic temperatures, works now in a competing lab in Leiden (the Netherlands). Given his ten-year experience in research (Ph.D. Degree in Physics in February 2002, h-index 12, 31 publications on peer-reviewed journals) a permanent position is indicated.

The *Glass Photonics* unit considers as priority a research position requiring specific competences in the field of fabrication by sol-gel route of photonic crystals, planar waveguides, microresonators and microcavities and in the structural and spectroscopic diagnostic techniques. Actually, this activity is performed by dr. Andrea Chiappini as time contract CNR research grant until August 2011.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Loss of coherence among the main activities	M	S	Periodical meetings among the persons in charge in order to strength the common point of the different research and collaborate to the solution of specific problems.
Understaffed units	H	C	Continuous synergistic use of the important collaboration network in order to provide human resources devoted to the understaffed research tasks.
Spread out of competences due to the large amount of different tasks inside each main activity	M	S	Assure the full contact among the researcher, technicians and students involved in the research in order to share competences and reduce time consuming.

Notes*:*

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

CNR-FBK. NANOSCIENCE: MATERIALS, FUNCTIONALIZATION AND PROTOTYPE DEVICES (CNR-IMEM)

Unit Name	CNR-FBK. Nanoscience: materials, functionalization and prototype devices (CNR-IMEM)	
Type	Research	
Head	Salvatore Iannotta	
Staff	2010	2011
	CNR 7 Researchers 3 Technician 7 Post Doc 2 PhD 0.3 Administration	CNR 3 Researchers 2 Researchers* 2 Technician 1 Technician* 3 Post Doc 2 PhD 1 Administration
	FBK 2 Researchers 1 Technician 0.3 Administration	FBK 2 Researchers 1 Technician 2 Grant 0.1 Administration

Document Status submitted 2010-12-02

* non permanent position.

1. Executive Summary

The approach and horizon of the activities developed by the research group "Nanoscience: materials, functionalization and prototype devices" span from basic studies and methods up to prototype development to validate and enable potential applications and technology developments. Our interdisciplinary vision and research practice complements refined growth synthesis and characterization methods with device prototyping aiming at exploring and demonstrating functional properties, applications and technological perspectives. This is carried out via the fruitful interchange among the very active principal investigators of the team and the strong interactions at the international and national levels as well as within the provincial research network, FBK to start with.

The team, after a rearrangement within CNR institutions, changed the referring Institute, from IFN to IMEM, Institute of Materials for Magnetism and Electronics, having its main site in Parma. IMEM has now opened an official research site in Trento with the idea of increasing the impact and activities in collaboration with FBK and the whole Trentino research network. The team includes researchers of FBK and CNR-IMEM, working on projects focused on state of the art themes that

well fit the CNR-FBK general agreement signed on 8th June 2009 and at the core of the major trends defined by the strategic plans of the Materials and Devices CNR Department. The group is also involved in major research projects involving the Department Systems of Production dealing with applied and industrial research as well as basic technology developments mainly focused on materials and processes for Energy and Sensing.

From the point of view of the basic studies and method developments our original efforts are aimed at the synthesis/growth of (multi-) functional materials based on inorganic (metal-oxides and wide band-gap semi-conductors in particular), organic (pi-conjugated and bio-molecules) and hybrids, aiming at controlling chemical-physical, structural and morphological properties at the different length-scales, while we are engaged in fundamental studies concerning the understanding of noise fluctuations. Development of Instrumentation is a key strength of the group that is approached with the aim both of extending the ability to explore the materials preparation and properties as well as of paving the way to application and technology potential developments. We finalize our studies to two major areas of application, innovation and technological interests: sensing (passive and active devices mainly for VOC and bio) and energy (in particular dye sensitized and bulk heterojunction photovoltaic). Along these tacks we develop materials, processes, structures, systems and prototype devices.

The expertise developed by the team has strong elements of originality since the team has devoted during the years strong efforts in developing methods and instrumentation as well as original processes cross-linking the original expertise in physics, chemistry and material sciences that form the background of the researchers involved. Such an hard core experimental approach makes even more direct and natural the applicative and technological projection. From this point of view the team is very complementary to the research activities carried out in CMM – FBK and the University departments of Physics and Engineering with which an increasingly effective collaboration is being developed on several subjects as the numerous co-participated projects demonstrate. The final destination of our research work is on subjects of strong social impact such as materials, processes and devices for renewable energy, for sensing and instrumentation applied to agro-food, environment and bio-medical applications. On these topics we also develop a strong effective work in preparing young scientists that come from different university and very often are being formed in virtuous exchanges with foreign leading labs. In fact the very tight collaboration with national and international leading labs is the outcome of the propensity and ability of this research team to promote projects of local, national, and international strategic interest including European projects.

The unit has a staff consisting 8 permanent positions, six researchers (3 CNR/ 2 FBK) and three technicians (2 CNR/1 FBK) distributed. At present the staff includes also 3 CNR researchers and 1 technician with yearly renewable contracts. The activities, lead by full time staff the researchers can count on strongly motivated PhD students and PostDoc positions.

Pominent collaborations:

at internal level with - FBK - Materials and Microsystems - CNR – IFN – Photonics Trento; IMEM – Institute of Materials for Electronics and Magnetism -CNR – IBF – Institute of Biophysics

at local level with -IVALSA-CNR; -Fondazione E. Mach - Department of Physics - Department of Materials engineering and Industrial Technologies - Department of Environmental Engineering - -CIBIO – Università di Trento

at national level with CNR Institutes: IMM-Catania; INOA-Firenze, ISOF- Bologna; ISMN-Bologna, ISM -Roma. INFN – Padova laboratori di Legnaro. -Dipartments of Physics, Chemikstry and Environmental Agronomy and Crop Science University of Padova; IIT- Genova and NNL- CNR – Lecce; - Politecnico di Torino; -University of Cagliari; Dipartiments of Physics and Chemistry -University of Parma - ELETTRA synchrotron radiation faility, S. Nannarone (BEAR beamline).

at international level with

University of Groningen (NL); University of Innsbruck (A); University of Leiden (Olanda)- University of Berlin; Imperial College – London; University of Cornell Ithaca NY- USA – University of Montreal (CAN) – Institute of ThermoPhysics – Russsian Academy of Sciences, IMM - University of Nijmegen, Max Planck and University of Stuttgart (D).

2. Vision and Scientific Program

Within the exploding field of nanoscience and nanotechnology the development of materials at the different length-scales, their hierarchical organization and their ability to give multi-parameter, multifunctional responses when assembled, organized or used in systems and devices are some of the major issues that make the world “nano” so interesting scientifically and so appealing and promising for the technological perspectives.

The ability to synthesize/tailor, functionalize/sensitize and assemble the material to make systems and devices requires an intrinsic multidisciplinary approach with complementary expertise. The major promise of nanoscience is the ability to produce materials, systems and devices with tailorable innovative properties that could transversally produce strong impact on many, if not all, technologically relevant fields ranging from (nano) electronics, mechanics, bio-medicine. It’s a field where the distance between long-term research and application is supposed to be strongly reduced so that the impact could be very strong and effective. We approach this challenging field by developing novel strategies to the growth/synthesis of inorganic, molecular-organic and of hybrid nanostructures, by studying fundamental properties at the different length-scales and by developing instrumentation specific and complementary instrumentation. On this basis we are able to cover the whole chain going from the material, the study an understanding of its properties up to the preparation of prototype devices where the (multi-) functional properties are demonstrated and validated.

2.1. Context and State of the Art

– *Functional/multifunctional inorganic, organic and hybrid materials (Activity coordinated by S. Iannotta, responsible R. Verucchi).* It's an activity that addresses the key issue of tailoring materials and properties at the different length-scales. The approach and ideas developed are based on the basic idea of overcoming the limits of (wet) chemistry using kinetically activated processes by controlling the precursors in gas phase. Such an approach could potentially combine very different advantages: extending the number and quality of viable processes to prepare the nanostructures, controlling the assembling and positioning of the nanoaggregates, forming and controlling properties at the interfaces, defining novel structures and systems; combining materials that could be hardly be combined by standard chemical processes where the number of viable "linkers" are often very limited. Particularly very interesting is the case of nano-organic-inorganic hybrids where the way the organic molecule is being reacted with the inorganic counterpart can be usually carried out by a few functional groups such as carboxylic, amino etc. The final properties of the nano-hybrid will of course depend on such groups with limitation that could not easily be overcome by standard chemical routes. The extension to novel nanostructures that can be prepared/synthesized by such non-equilibrium processes are of great interest because they can be tailored producing novel and extended properties and/or increasing control on the way they interact. These are issues of interest by themselves from the point of view of basic understanding and studies but they are also very promising in applications such as (bio)sensing, sensitized photovoltaic conversion as we have already demonstrated in the last few years. Sensitization, organic/inorganic nano-interface control and growth of the organic layers by the kinetic approach, developed by the proposers, based on supersonic seeded beams, is uniquely suitable to promote controlled reactivity and has been successfully applied to hybrids synthesis and surface functionalization paving the way to new classes of devices.

– *Spontaneous fluctuations and dissipation (responsible M. Bonaldi)*. The study of the spontaneous fluctuations (thermal noise) and dissipation in mechanical systems probes fundamental aspects of statistical mechanics. In fact fluctuations and dissipation originate by the same physical phenomenon, namely the interaction with the thermal bath, which is also responsible for the irreversible entropy production. For this reason fluctuations give an insight into the behavior of systems kept out of equilibrium, where the standard thermodynamic rules are no more applicable. This is the case of small systems like drifting Brownian particles, where short-time violations of the II law of thermodynamic were recently observed [Wang, PRL 89, 050601 (2002)], or molecular machines, which are thought to harness thermal fluctuations and rectify them using energy from chemical sources [Bustamante, Physics Today, July 2005, p 43-46]. On the other hand nonequilibrium effects are ubiquitous, and can be observed, at the energy scales typical of thermal fluctuations, both in nanosystems or in ton-sized resonators [Bo-

naldi, PRL 103, 010601 (2009)], Therefore experiments on thermal noise connects usually separated fields of research: nonequilibrium statistical mechanics and precision position measurement.

– *Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Monitoring (responsible A. Boschetti).* At present many chemical-physics processes, due to human activities, are subject to more and more accurate and sensitive controls for environmental quality, process quality or safety reason. Many of these processes can be monitored by non invasive detection of gaseous systems produced (atmospheric pollution, combustion, food preservation, agro-biological processes, breath analysis etc.). Detailed understanding of such processes is more and more demanding in real time and high sensitivity detection of many molecular systems at the same time. Real time multicomponent trace gas detection is quickly growing in interest: monitoring and diagnosis of complex processes need the knowledge ,possibly in non destructive way, of the most possible molecular species emitted. Important application fields are quality air control, combustion processes, modified atmospheres in food preservation, ripening and senescence processes in agronomic products, plant physiology studies and medical diagnosis by breath analysis. Our team combines the development of solid state devices with instrumentation development and applications so that complementary approaches can be used to cross-calibrate the methods and, most important of all to address applications and technology developments. High sensitivity trace gas detection of interest for biological, agro-industrial processes, energetics and environmental quality control by means of CO2 and/or diode lasers based resonant photoacoustic spectroscopy and proton transfer reaction mass spectrometry techniques *will further developed to extend selectivity and sensitivity.*

2.2. Vision and Goals

– *Functional/multifunctional inorganic, organic and hybrid materials.* The nanoscience road seems to be the best way to achieve materials desired final properties, with a control of physical/chemical processes at several length scales enabling an unprecedented success in realizing specifically designed multifunctionalities. In this framework, our group has developed an original approach to synthesis of organic, inorganic and hybrid materials based on growth of thin films in vacuum by means of supersonic seeded beams (SuMBD). Based on the achieved results the capability of SuMBD to control and tailor the chemical, physical and structural properties of films by tuning the kinetics of the particles in the beam, namely their kinetic energy, will be further studied and extended to different classes of molecules and cluster of atoms aiming at tailoring electron, optical and functional properties. Potential hierarchical organization of the structures by the deposition itself will be explored. The recent change of the Nanoscience team Insitute, from IFN to IMEM, actually pave the way for a series of new and more fruitful actions in the field of material structural characterization, synthesis of inorganic

material at the nano- and meso-scale and their functionalization, creation of devices for sensing and energy production, study on the magnetic properties of organic/inorganic materials. The results achieved on pentacene, where the control of the growth process has achieved unprecedented results on SiO2, as well as TiO phthalocyanine on quartz and mica have demonstrated that SuMBD is a well-suited method for controlling deposition over a wide range of length-scales. The ability to control the assembling of molecules will be combine with the unique possibility to synthesize refractory nano-micro-crystalline materials. We have already shown that polycrystalline SiC can be synthesized by using C60 supersonic beams on a Si(111) substrate at low temperature (down to room), suggesting the possibility to induce formation of bonds at the surface by kinetic activation of chemical reactions. The unprecedented perspective that we are pursuing is functionalization by direct co-deposition of inorganic materials, (e.g. metal oxides, SiC, etc.) by organic molecules like phthalocyanines, porphyrins and bio-relevant molecules. This opens a fully new perspective where the realization of devices engineered at the nanoscale and based on the use of new organic, inorganic and hybrid materials becomes feasible and applicable to the fields of health care, energetic, electronics. The group will further develop the ability to produce prototype devices having as active element materials synthesized by means of the SuMBD approach. The aforementioned codeposition system will be further developed and equipped in order to realize devices like sensors, organic FET, photovoltaic cells. The major developments will be in active sensing devices based on OFET's Electrochemical sensors, new generation of Photovoltaic cells. Organic FET based on highly ordered pentacene thin film have been produced, as well as photovoltaic cells based on organic and hybrid materials. Together with the ability to realize devices, specific instrumentation for sensors, FET and PV cells characterization have been developed. The sensing devices will be specifically tailored to work in gas-phase for VOC and trace gases sensing as well as in liquid and micro-fluidic environment. We envisage the development of systems combining the different devices developed in microfluidic integrated systems where simultaneously will be monitored head space and liquid parameter.

We envisage novel architectures for all-solid-state solar cells that promise: vast, tailorable contact area between hybrid materials which is beneficial to separate electric charges, best contact between the nanohybrids and the TCO (transparent conductive oxides), a viable innovative approach for matching solar spectrum using "simple" molecules via kinetically activated reactivity, forming the equivalent of a multiple molecular junction with potentially higher PV conversion efficiency, favorable conduction properties and high charge mobility synthesizing ordered materials and structures. A main advantage of our approach is the ability to study and optimize, quasi-independently, several of the different processes contributing to PV.

Characterization by means of in-situ surface electron spectroscopies and ellipsometry will made possible the interpretation and correct analysis of the chemical, physical and structural properties of the synthesized materials. A

UHV system, fully devoted to growth of thin films in a codeposition approach and their analysis in-situ has been developed in our lab. Nevertheless, ex-situ SEM analysis with EDX analysis and the several collaborations of this group has made achievable a complete characterization of morphological and structural properties of thin films, also exploiting the potentialities of synchrotron radiation light experiments.

The group is involved in several medium term projects (1-2 years), having main goals the synthesis of thin film organic/inorganic hybrid materials, to be used as active elements in sensing and PV cells solid state devices, and the growth of organic based electronics and optoelectronics. From the point of view of future development (up to 5 years), also exploiting the several collaborations with national and international leading groups, we will explore the use of multifunctional materials as SiC and graphene, their functionalization by means of organic molecules in order to exploit the intrinsic biocompatibility and good transport properties, respectively. A particular attention will be pointed to the interaction of molecules with nanoscale structured inorganic material such as quantum dots. The possibility to use also multilayered structure for organic-based eterojunctions will be explored. The approach will be always based on the use of supersonic seeded beams from the point of view of the synthesis. The creation of new PV cells based on the use of functionalized nanoaggregates, also exploiting quantum effects will be addressed. An important issue will be to study the functionalization of organic/inorganic surfaces to make them compatible for interaction with other specific organic molecules, also achieving a significant biocompatibility.

In the next future (1-2 years), and according to the currently active projects, main goals are related to the realization of PV solid state solar cells, based on organic thin films synthesized by SuMBD approach, also in a multilayer structure exploiting the formation of eterojunctions , and functionalizing metal oxides structures. The need to manage all step involved in the realization of a PV device, in particular control of the interfaces, material purity, thin film chemical and physical structure requires a tough work, mainly realized exploiting the skills of our group but also thanks to the several collaborations in the field. The long term evolution of this work will be the production of devices showing high efficiency in specific light absorption ranges, fully controlling the energy production processes in all aspects.

The development of gas sensors has long been one of the main task of our activity. The idea is to increase gas selectivity of inorganic based sensors due to specific surface functionalization. The activity will be addressed to sensing of VOC or gas strongly related to health care. Moreover, the achievement of a high biocompatibility will make possible the realization of devices suitable also for in vivo applications. From a technical point of view, the possibility to create sensors based also on active responses will be explored, being them transistors or optical emitting materials. Finally, electrochemical sensors for bio-fields will be explored: it is envisaged the use of these devices based on organic FET to study cell culture and propagation in liquid environment.

– *Spontaneous fluctuations and dissipation.* The current theoretical approaches to nonequilibrium fluctuations (“Fluctuation Theorems”) address time reversal properties of the fluctuations, but do not de-scribe the amplitude of the thermal noise produced in practical experimental de-vices. As we have developed a state of the art technology for precision measure-ments in resonating mechanical systems (displacement sensitivity of some 10-19 m/√Hz and intrinsic loss as low as 10-8), we can investigate in full detail the Prob-ability Density Function (PDF) of fluctuations in mechanical systems maintained in nonequilibrium steady state. As a first step we shall address steady states obtained by a thermal gradient, and we expect that new theoretical results will be reachable from the outcome of these experiments. We also note that, as this experimental configuration is common in precision measurements, our results will be useful in the design of the next generation of interferometric gravitational wave detector.

  As a second step we plan to use the devices developed during step one for studying feedback cooled systems, where the thermal noise is reduced due to a properly chosen feedback. These are nonequilibrium systems where the detection of quantum effects in the mechanical coupling between light and a micromechanical resonator is actively searched for by many research groups around the world. The production of a movable mirror with high mechanical susceptibility (so to have a detectable motion when pushed by radiation pressure) and low mechanical dissipation (to increase coherence time and to reduce the thermal noise outside the mechanical resonator bandwidth) will be pursued by using the most advanced expertise available to reduce mechanical losses and the most recent developments in the field of nanotechnologies and micro-oscillators.

– *Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Moniotring.* Major developments will concern further development of the instrumentation with the goal of extending the monitoring capabilities of multi-gas and VOC (Volatile Organic Compounds) detection both on the side of Laser Spectroscopy and Mass-spectrometric methods. Both of them, in parallel to the developments of the devices based on nanostructures will be used as referring standards for the calibration of the sensitivity, selectivity and reliability under different environment. From this point of view, several research activities are performed together with the Nanoscience team part involved in preparation of biosensors, with the intention to calibrate and better define response of these devices. Also of interest will be the development of interfaces for microfluidic environment where to measure head-space developments in conjunction with bio-relevant processes and eventually bio-medical. For the laser based systems the instrumentation developments will deal with the extension of the methods to solid state lasers while for the mass spectrometric methods the PTR-MS will be implemented with a TOF mass spectrometer that will enhance the ability to attribute to specific chemicals and processes the monitoring of the masses that will be detected. Strategies based on modern statistical methods will be also developed to this end in collaboration with CMM-FBK. From the application point of view, besides,

processes relevant for bio-medical applications we will further focus on agro-industrial, agro-food, energy production and environmental studies.

2.3. Activities and Work Plan

– *Functional/multifunctional inorganic, organic and hybrid materials.* The research activity of the Nanoscience group is mainly developed on the basis of the several ongoing project, even if a number of studies are performed according to collaborations and as a proof of concept in view of possible fields of action. In the last year, they have been studied the properties and type of growth of naftalene dicarboxilic acid by supersonic beams on Si3N4 and SiO2, a system being the functionalized surface for the creation of an optical sensing device for proteomic. To this end, analysis performed using electron spectroscopies from synchrotron radiation source will give useful information (during the next year) on the chemical/physical properties of the interface. In the same project, a specific work will be devoted to the realization of highly passivated polymer surfaces, mainly used for the realization of microfluidic circuits. In the field of surface functionalization, experiments have been performed also regarding the interaction of organic with metal oxides, such as TiO2, ZnO, also in form of nanoshaped materials. In the future, the use of these nanostructured systems will be implemented, also in case of other semiconducting materials such as III-V. An extensive characterization activity will be devoted to the study and comprehension of the chemical/physical processes occurring at the film interface: in situ surface electron spectroscopies and ellipsometry, as well as ex situ microscopies and use of synchrotron radiation light will be also exploited.

  The synthesis of SiC on Si surface by means of fullerene supersonic beams has received an important drive with the collaboration with the CTP-FBK group, in the mainframe of a project devoted to the study and comprehension of the physical/chemical processes leading to the formation of the carbide with the SuMBD approach. This collaboration will produce important results and high level publications are envisaged.

  A relevant part of the work will deal with the development of active sensing devices both OFET and EC-FET specifically designed to detect the evolution of bio-systems and their interaction with nanoparticles. The devices will be based on pi-conjugated molecules, on hybrid materials, functionalized oxides and polymers, engineered in the preparation itself of the active materials.

  New generation of sensitized solar cells will be developed based on ZnO and TiO2 nanostructures sensitized with phthalocyanines, porphyrines and other organic molecules. Particularly challenging is the development of PV cells base on ZnO tetrapods and ordered nanorods the functionalization of which will follow innovative schemes where simultaneous sensitization of each nanostructure will be carried out with up to three molecules with complementary properties so to much at the best the sola spectrum. The preliminary studies performed in the last year will pave the way for the effective realization of PV devices.

– *Spontaneous fluctuations and dissipation.* We are working to produce a silicon oscillator for fundamental physics experiments on high Q oscillators. Starting from the well known Double Paddle design, we applied corner compensation technique and a jigsaw mask to obtain a device with the needed properties in terms of resonant frequencies and mechanical dissipation. After the realization of the device, gold electrodes were evaporated to allow the electrostatic excitation an detection of the DPO's vibrational modes by capacitive coupling with an external electrode assembly. We developed the electronic set-up to drive the oscillation of the oscillator and to detect its displacement with a sensitivity better that 1E-12 m/√Hz.

  The behavior of the oscillator has been fully characterized in terms of mechanical transfer function and quality factor of its resonant modes. We identified the reso-nant modes and their quality factor, in good agreement with the FEM simulation and the theory of thermoelastic dissipation. The effects of the seismic isolation system were found relevant only for modes at low frequency, where the attachment losses overwhelms the thermoelastic dissipation. The torsional antisymmetric modes shows a quality factor above 1E5 at room temperature and 1E7 at liquid helium temperature, at the state-of-the-art for this kind of devices.

  Starting from the design of the Double Paddle Oscillator produced and characte-rized during 2010, we will produce a silicon oscillators properly modified to allow the application of a thermal gradient. The oscillator will be designed with the aid of Finite Element Modeling in a full thermoelastic framework, in order to set up a nod-al support and to account for thermoelastic dissipative phenomena. The prototype will be then characterized in terms of dissipation and modal spectrum. We will also develop a suspension system to reduce the technical vibrational noise on the oscillator and to possibly observe the thermal noise of the torsional modes.

  We will develop a mechanical oscillators equipped with a micro-mirror, suitable to be used as end mirrors for high finesse optical cavities. The design of the MEM oscillator will be accomplished by many cycles of Finite Element optimization to reach the best balance among any conflicting features. In particular, we will spe-cialize the functionality of different parts of the oscillator (mirror, elastic element, support) so to reduce the strain energy stored in the more dissipative materials (optical coatings). In addition, the elastic elements will be designed so to act mostly as torsional springs, in order to reduce the contribution of thermoelastic losses. On each proposed design, we will simulate both the resulting mechanical susceptibility, which sets the response to radiation pressure in the optical cavity, and the losses, which determine the overall mechanical quality factor. The unit will work side by side with the production facility at FBK to mutually adapt the design and the production techniques.

– *Laser Spectroscopy and Mass Spectrometry Methods for Sensing and Monitoring.* The ongoing studies on the relationship between VOC emissions and physiological aspects in plants and products of interest for the local territory

have been developed, in collaboration with relevant partner in the Trento area. Main interest area are and will be the understanding and applying preservation and agronomical procedures that best optimize quality and time-duration in products such as apple, berry-fruits, olives and olive oil etc.. Cross-correlated studies using the sensing devices developed using the materials and methods developed in the other activities of the group will be also developed aiming at qualifying the properties and performance of devices and processes. A focus of interest will be the study and monitoring of environmental processes also correlated to energy production. integration of the different instrumentation and devices will also be investigated and developed.

2.4. Collaborations

- FBK Materials and Microsystems. FBK, C. Pederzolli (M2B2): functionalization and characterization of SiO2 surface, L. Lorenzelli (BioMEMS): realization of biosensore based on TiO" deposited by SuMBD, M. Dapor (CTP): theoretical simulations of photoemission and functionalization processes, – study of dissipative phenomena in mechanical oscillators and thin films. Development of models to evaluate thermoelastic noise of silicon devices. M. Bersani (M2B2) development and characterization of hybrid materials for PV and devlopmkent of instrumentation base on mass spectrometry and innovative ionization methods. Benno Margesin – MemSRAad -Development of silicon mechanical resonators, with low losses properly designed to measure non-equilibrium effects in spontaneous oscillation (thermal noise). RET – A. Bozzoli – On line monitoring of the environmental impact of Energy production prototype plants by detection of VOC and Gas emissions
- Trento University. - Department of Physics: *Low Temperature Laboratory* (Giovanni Andrea Prodi) measurements of quality factor of mechanical resonators - *Lab. Nanoscienze* (L. Pavesi) Molecular materials for Photonics and Sensing; M. Scotoni – Molecular Aligned supersonic beams and developments of laser base for VOC and trace gas detection. - Department of Materials Engineering and Industrial Technologies: Material Science, Bio-Nanoscience, Bio-medical applications (C.Migliaresi and A.Motta) - Department of Civil and Environmental Engineering *Prof. Paolo Baggio*-monitoring fumes in processes of thermo-chemical conversion of bio-masses.
- CNR-IMEM, G. Salviati: AFM, CL, TEM characterization of inorganic and functionalized surfaces; - A. Zappettini nanostructure of Oxides for PV and Sensing; F. Albertini – magnetic nanoparticles for bio-medical applications; R. Mosca – Development of EC-FET for application in microfluidic environments
- CNR-IFN.Trento - Commessa Photonics (Falferi) – Design, production and testing of mechanical resonators for feedback cooling experiments

- CNR-IVALSA – (M. Negri) VOCs monitoring to assess bio-mass evolution and woods provenance quality, including health impact in confined environments
- University of Padova: Departments of Physic (M. Cerdonio) – AURIGA data taking, Chemistry (M. Casarin) theoretical simulations of photoemission and XAS experiments from organic molecules; Department of Environmental Agronomy and Crop Science University (A. Ramina) plant Physiology and Genetics -- Nanophase materials.
- Politecnico di Torino – Lamberto Rondoni – Development of theoretical models for system kept out of equilibrium, molecular dynamics simulation of the system; F. Pirri, SiC based devices and electronics.
- INFN Section of Padovaa and Laboratori Nazionali di Legnaro (J.P Zendri and L. Taffarello) – Low temperature measurements of quality factor of mechanical resonators; (L.Conti) measurements on nonequilibrium systems
- CNR-ISM (A. Amore Buonapasta) theoretical simulations of organic-inorganic interactions
- University of Florence – (Francesco Marin) Design and characterization of MEMS micromirror,
- University of Groningen (NL) – (F. Hernike materials research center) (P. Rudolf) studies of elementary processe in the growth of molecular materials on solid surfaces
- University of Leiden (NL) – (A. Vinante) Feedback cooling on resonant Microsystems.
- University of Berlin (D)(department of Physics) (Prof N. Koch) molecular transistors)
- University of Cornell (USA) (Nanoscience Facility) (Prof. G. Malliaras) new generation, polymer based EC-FET)
- University of Nijmegen – Life Science Trace gas Facility – F. Harren
- University of Montreal (CAN)- (F. Rosei) sensitized nanotube based devices
- Institute of ThermoPhysics – Russian Academy of Sciences (Prof. A. Rebrov) Novel Supersonic Beam Sources
- Max Planck and University of Stuttgart (D) (F. Schrieber) molecular systems, growth and self-assembling on solid surfaces.

Experiments

- AURIGA: the INFN Sections of Padua, LNL, Trento and Ferrara and the Universities of Padua, Trento and Ferrara involved
- ELETTRA synchrotron, S. Nannarone (BEAR beamline): PES, XAS analysis of organic/inorganic materials

Ongoing European Projects

- TOPOS - Tailoring Growth and Opto-Electronic Properties for Organic Nanoscale Semiconductor Devices (MOIF –CT 2006 – 040864

- RARENOISE Low-probability, large fluctuations of the noise in detectors of gravitational waves ERC –(202280)

2.5. Specific Needs and Points of Attention

The research team needs further expansion in personnel and projects to support the wide spectrum of expertise and know how that is being developed. On the CNR side, one possible position of researcher could be hired in 2011.

Point of attentions are: the increasing synergy with research activities in CMM could be further developed by the financial support of young scientist both for a PhD program and coming from abroad. Such a program should be developed by joint applications.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Development of EC-O-FET based on modified Oligohiophenes Nano-smart Project	R	E	Oct.	Electrical characteristics	-
Control of the growth of organic/inorganic structures on surfaces in the submonolayer regime	R	E	-	Chemical-Physical, structural an mophological characterization	-
Development of sen-sors based on functionalized surfaces by SuMBD (NAOMI project)	R	E	Sept.	Surface characterization and paper on functionalized surfaces	
Functionalization of quantum dots PRIN2009 project (MURST)	R	E	-	Paper on organic inorganic inter-action at the nanoscale	Approval
3C-SiC growth on SiGe surfaces (FIRB2010)	R-A	E	June	First attempt of functionalization	Approval
Energy production from photovoltaic and piezoelectric approa-ches (FIRB2010)	R-A	E	-	PV cells	Approval
Test of PV cells based on Nanohybrids (pro-ject DAFNE)	R	E	April	Paper on nanohybrids synthesis and Prototype devi-ces	-
Design of a low loss silicon micromirror	R-A	E	Oct.	Decay measurements of mechanical	-

				and optical resonances	
Monitoring and control of wood biomasses and their combustion	I-A	E	Nov.	VOC spectra and report	-
Virgin Olive oil traced by harvest time of the olives	R	E	Oct.	VOC spectra and reports	-
Papers	R	E	2011	7 Paper on leading international journals	-
Conferences	R	E	2011	Numbers of Accepted Contributions/ Invitations	-

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

The unit has a staff consisting 8 permanent positions, six researchers (3 CNR/ 2 FBK) and three technicians (2 CNR/1 FBK). At present the staff includes also 3 CNR researchers and one technician with yearly renewable contracts. The activities, lead by the full time researchers can count on strongly motivated PhD students. However the research would requires a significant recruiting to best cope with the scheduled activities. Moreover there are some young and active researchers, which have the competences and the scientific skill to be the perfect candidates for a permanent position as researcher in the unit Nanoscience: materials, functionalization and prototype devices (CNR- IMEM). For these reasons the unit proposes to hire a FBK research position.

5. Risks and Mitigation Plans

Description	*Prob.*	*Impact*	*Contingency*
Loss of overall coherence in the specific planning of the main activities	L	M	Organization through module of activities with periodical meetings. Planning as a project with specific Gannt
Under-critical Size of the groups involved in the different tasks and financed projects	H	S	Strong coordination with all the partners involved in the different projects. Coordination beyond the single financed projects.

Notes*:*

Prob. VL = Very Low; L = Low; M = Medium; H = High, VH = Very High

Impact. N = Negligible, L = Low, M = Medium, S = Severe, C = Catastrophic

HAIFA

Name	Haifa	
Type	Research	
Head	Oliviero Stock	
Staff	2010	2011
	1 Researcher	1 Researcher

Document Status: submitted 2010-12-01

1. Executive Summary

The present project, called Intelligent Technologies for Cultural Visits and Mobile Education – a.k.a. ITCH (Intelligent Technologies for Cultural Heritage) – is funded by the Italian Ministry for Universities and Research under a "FIRB" framework of Israeli-Italian projects and by a special initiative of the Provincia Autonoma di Trento.

Thirty-one projects were retained for funding out of over 160 applicants, and ITCH received the largest funding. Partners are FBK-IRST and University of Trento in Italy, and University of Haifa and Bar Ilan University in Israel.

Formally, ITCH began in October 2006. However, the official start was earlier than expected and on most fronts we were operational by spring 2007. In some cases we were obliged to start open operations later, due to the difficulty of finding suitable postdocs or PhD students in Israel while the economy was flourishing. These aspects were taken into account for the time extension, of the project until June 30, 2011 (with no additional funding).

This project is devoted to the development of intelligent technology for cultural heritage and mobile learning.

Cultural heritage is an important applied area, and an extremely rich setting for studying novel user interfaces and language processing systems. The area is particularly relevant also for the prospects of new investments in musea in Trentino (in particular the new MUSE) and will be an important applicative theme within Trento RISE. Besides its specific focus, it must be noted that several technologies developed may be useful also in other applied domains.

The relevant units at FBK-irst are essential components of this project. Partners in this distributed activity are: University of Haifa, Bar Ilan University and University of Trento.

The theme of the project focuses on an area for which there was substantial work done at IRST through the years (see in particular the PEACH project) and then was also initiated in the last phase of the previous collaboration project with University of Haifa. The collaboration with University of Haifa, and with Bar Ilan University has already benefitted activity within FBK-irst, at these levels: a) technical quality of collaboration (e.g. the direct impact of scientific developments in the lan-

guage processing area); b) possibility of exploiting multidisciplinary aspects not present at FBK (e.g. involvement of conflict resolution experts, or drama experts in relation to novel interfaces for the museum); c) instrumenting a museum within the university permits to carry on experimentations difficult to realize in a different setting; d) as a side effect, being a catalyzing element for industrial relations (e.g. the recent visit by an Israeli industrial delegation and the discussion about establishing an incubator in Trento) and for the promotion of the Trentino system (e.g. project reputation contributed to the standing of Trento as a partner in the EIT, appreciation expressed publicly in many forms by the Italian Ambassador in Tel Aviv, visit by President Dellai to Israel President Shimon Peres based on scientific collaboration).

2. Vision and Scientific Program

2.1. Context and State of the Art

This project takes place in the context of the ongoing collaboration with Israel and focuses on technology for providing better guides and interfaces for museum visits. State of the art is provided in several papers of ours. For example the PEACH book (O. Stock, M. Zancanaro [eds.] PEACH: Intelligent Interfaces for Museum Visits Cognitive Technologies Series, Springer, Berlin- Heidelberg, ISBN: 978-3-540-68754-2, 2007). It should be added that up to now the project has produced over one hundred international publications.

2.2. Vision and Goals

The project includes a practical side: a guide prototype resulting from our research has been engineered and in the coming months is going to be used by the public. Code has been rewritten, and a positioning system based on proximity has been integrated. This part, that now requires the final verifications, has involved a company of Trento, Tretec. Contents have been substantially expanded (300 presentations) to cover most of the Hecht Museum and to include presentations in English, Hebrew and Arabic. In order to cope with expenses such as equipment, maintenance etc., we are relying on additional funds (about $ 150.000) provided by the Hecht Foundation. The system now realized with web-based technology will be used with Ipods-Touch working with WiFI, the platform chosen as museum equipment to be offered to visitors, but it will be possible also to use the system with any personal smartphone.

The installation at the Hecht Museum will be free for the public. It will also integrate new prototypical components and it will consent to perform extended testing with real users, both on the realized system and on results of novel research.

As for the specific research themes in the project, they are centered around the concept of small group of visitors. The adoption of intelligent technologies has mainly been focused on the idea of yielding personalized material to the individual visitor. But mostly, visitors come to museums in small groups-- a family or friends, and the idea of the project has been to see how intelligent technologies can be designed to exploit this particular social dimension to provide a better museum expe-

rience. Therefore, in this project we have included themes such as group modeling, and detection of social behaviors so to automatically adapt system actions to the situation. One specific focus is for mobile presentations for individuals in a group, inspired by the wealth of experience in theatre and drama; the concept is to engage a group of visitors with a dram that is based on techniques that should have the effect of inducing them to entertain a conversation about the experience, something etnographers consider a key aspect in a successful visit.

Another aspect is technology for the museum café (a social setting *par excellence*), where activity is based on a sensor equipped table that observes the behavior of people sitting around it, and aims at orienting the conversation to the recent museum experience.

Other themes in the project deal with language processing for information extraction and access, in the archeological domain of the museum. Yet another theme, concerned with the production of creative language, explores automatic techniques for getting the attention of readers by using humor or changing the affective valence of a small text, by means of manipulation of its words. One different theme focuses on integration of ontologies and techniques for semantic matching, and, with a more theory-oriented approach, temporal and spatial reasoning based on graphs. We found appropriate space in the project also for extended experiments with the Narrative Negotiation and Reconciliation Table, that we have developed earlier together with University of Haifa, as it can constitute a tool that can be eventually positioned in a museum for fostering coexistence.

2.3. Activities and Work Plan

To use the terminology present in the description of themes in the FIRB document (in Italian) the points of development are listed here below with the main partners working on the subject.

- 1.1. Museum Visitors Guide for the whole Hecht museum - historic/archeological part (University of Haifa)
- 1.2. User modeling techniques for small groups (University of Haifa)
- 2.1. Methodology for dealing with presentations on personal spaces and on large displays (University of Haifa and FBK-IRST, Trento)
- 2.2. Techniques for advertisement of exhibits and persuasion (FBK-IRST, Trento)
- 3.1. Reasoning about graphs with application to temporal and spatial reasoning (University of Haifa)
- 3.2. Semantic matching and ontological graphs (Università di Trento)
- 4. Planner for dynamic presentations for members of a small group (University of Haifa)
- 5. Table for joint narration (University of Haifa, FBK-IRST, Trento)
- 6. Natural language processing and information extraction (Bar Ilan University, IRST Trento)

- 7. Tabletop interface for a group at Museum Café (FBK-IRST Trento)
- 8. Evaluation of interfaces

Note that for most aspects of the project the coming final semester will deal with evaluation.

2.4. Collaborations

- On this project FBK-irst has as partners Università di Trento, University of Haifa and Bar Ilan University.
- Co-coordinator of the project is Professor Martin Golumbic from University of Haifa. The project enjoys the advice of a very prestigious scientific board, composed of Professor Barbara Grosz (chair), Harvard University, Professor Wolfgang Wahlster (DFKI) and Professor Andrew Ortony, NorthWestern University.

2.5. Specific Needs and Points of Attention

As said, due to slow start in resource acquisition, the project was extended to June 30, 2011(relying on the remaining funds already granted for the project).

3. Goals

Description Type Scope Time frame Measurement mean Preconditions

- Hecht Museum guide operational I and R E Junesubstantial Evaluation with humans and publications
- Drama inspired group presentations R E June. Prototype with complete drama. Evaluation with humans. Publications
- Cafè table R E June Evaluation with humans. Publications
- Access to linguistic info about archeology RE June Prototype and Publications
- Language variations RE June Prototype and Publications
- NNR table RE Data Analysis and Publications

4. Human Resources

Coordinator

Two units involved: I3P and HLT

Human resources at University of Haifa and Bar Ilan University

MIT-FBK ALLIANCE – MOBILE EXPERIENCE LAB ALLIANCE

Name	MIT-FBK Alliance – Mobile Experience Lab Alliance	
Type	Applicative	
Head	Federico Casalegno	
Staff	2010	2011
	4 Researchers	2 Researchers
	2 Post Doc	2 Post Doc
	3 PhD	3 PhD

Document Status: submitted 2010-12-01

1. Executive Summary

Our research focus on “Connected Sustainable Home”:

Our vision aims to design a home where architecture and urbanism are truly sustainable, not only by virtue of the materials they use but also by what buildings can do and the better lives they enable their inhabitants to live.

The Connected Sustainable Home is built on four main design principles that pose four fundamental questions:

- Sustainable Architecture
- Green Energy
- Information and Communication Technologies
- Social Sustainability

In order to answer these design principles and to realize our vision, we started the first phase of the MEL-FBK Alliance activities with initial studies on:

- Background Research on Green Building
- Advances on Solar Energy and Climate
- Digital Fabrication and Dynamic Window
- Impact of ICT on Sustainable Behavior

We aim to achieve our vision with the construction of a prototype. We are collaborating internally with REET. External collaboration are established with Distretto Tecnologico Trentino, with Manifattura Domani, with Museo Tridentino di Scienze Naturali, with CNR-IVALSA.

2. Vision and Scientific Program

2.1. Vision and Goals

Our vision includes the construction of a prototype of connected sustainable home. Within this prototype we would like to pursue different research areas:

- SUSTAINABLE ARCHITECTURE: implementation of a vivid and specialized architecture that embodies particular sustainable principles, integrated into the landscape in an efficient and elegant way.
- SMART ENERGY SYSTEM: use of natural sources of energy for the energy supply of the home such as solar panels, rainwater retention, biomass and windmills.
- INFORMATION AND COMMUNICATION TECHNOLOGIES: integration of information and communication technologies to create a responsive system be- tween users, architecture and energy systems.
- SOCIAL SUSTAINABILITY: integration of the individual home with the community with a focus on the social aspects of sustainable living and the local economy.

2.2. Context and State of the Art

What are the current systems implemented around the world that rate green buildings?

There are many labs and researchers actively involved in constructing green buildings. Successful green architecture uses resources like energy and water efficiently, while reducing waste generated during the construction process. Yet, there is currently no standardized set of indicators for measuring and monitoring sustainable development worldwide.

We looked at a selection of case studies and built designs of both architectural and energy systems that illustrate the emergent notion of critical radical sustainability.

Taking into account local conditions, the alliance applied procedures to design home configurations that take advantage of both local environmental conditions and new materials.

Finally, by linking previous explorations on material distribution and form factors the alliance created a landscape design strategy to optimize location, form factor, orientation, materials, and fabrication processes. The following projects tallies features commonly found in the some of the most innovative green buildings.

2.3. Activities and Work Plan

Our prototype is a modular research platform to experiment pioneering architectural and electronics solutions in order to design spaces to promote sustainable living. Designed as living environment, it will evolve according to emerging research areas.

Initially we have been working to design and implement a located prototype. After several trials to find a suitable location, we are now restarting to work on a transportable prototype design.

2.4. Collaborations

We have an FBK researcher in residence researching home technologies. We work with the CSAIL Artificial Intelligence Lab at MIT in order to design the optimization system for the dynamic window for energy management.

Finally, we also aim to enlarge our collaboration with the territory, and to strength our work with local companies which can help and benefit with the prototype. We are looking forward to have technical collaboration with local companies in particular regarding the Dynamic windows and its main component, such as the glass, the films, the frame, for the wooden structure and for the thermal mass component. We also work with local institutions like Manifattura Domani, Habitech, IVALSA, Trentino Sviluppo and the Provincia of Trento.

2.5. Specific Needs and Points of Attention

Building a prototype is extremely complex for several reasons. We are dealing with internal and external legal issues, working to have the appropriate construction permits and authorization from local government, hiring and interviewing the right personnel, ensuring we are following the protocols, and finalizing agreements between various parties in order to proceed with the building of the prototype.

We have been offered several locations (10) in the last 18 month by Manifattura Domani and by FBK. None of them were actually available. For this reason, after a conference call between Prof. Zanotti, Prof. Simoni and Prof. Casalegno held on the 19th of November we decided to redesign from scratch the prototype adding another features to the prototype: it has to be transportable and modular. This means that the work done so far will be adapted to the new design that is ongoing. Up to today, we still don't have an offer for a suitable and available location in Trentino. After initial studies, we are confident that a transportable prototype can be realized, and we are waiting the final results of the feasibility study in order to proceed with the transportable prototype.

3. Goals

The goal is really to experiment our research through the construction of our prototype and keep experimenting new research areas and subjects while focusing on the topic of sustainability.

MEMS-2

The MEMS 2 project is a continuation of the one developed within the frame of the first PAT-INFN agreement. MEMS2 is a direct agreement between INFN and FBK, supported and co-funded by PAT.

There are three strategic lines in the project. The first one is the continuation of the R&D activities on two projects inherited from MEMS1, that are Silicon Photomultiplier (SiPM) and the Kinetic Inductance Detectors (KID). The second line concerns the engineering work of the first SiPM technology version in order to address its industrial exploitation. The engineering work will also include the second technology generation, in case of success of the dedicated R&D activity. The latter line is focused to assure an access to all INFN Groups to FBK-MTLab capabilities, including the expertise of the MEMS and SRS Research Units, to support their research activities in new detectors. This last strategic line, named “Facility”, allows also the prosecution of the project activities that were present in the previous MEMS1 and not officially included in MEMS2. In this way, the FBK capabilities will be available for all the INFN Groups, independently on the specific project.

The foreseen programmed activities and related results for 2011 are the following:

- Silicon Photomultiplier. The main activity foreseen for the year 2011 is the continuation of the development of the realization of device having a “through silicon vias” solution for the device/package electrical connection. Furthermore, the use of the stepper as lithographic equipment to improve the device fill factor is also planned.
- Kinetic Inductance Detectors. This work is strongly linked to the activity of prof. de Bernardis research team in Rome, “La Sapienza” University. During 2010 a cryostat able to work at 300 mK, specifically designed and realized for this project task, has been installed within the Physics Department of UniTN. For 2011 a testing activity using this equipment is foreseen as well as the development of MKID realization on thin silicon membrane to reduce the noise.
- Facility. During 2010 a lot of work has been submitted, part of it is completed. The incoming year is already full of planned activities spun on several targets including new radiation sensors, mechanical and optical devices. The numbers of requested activities are stating the importance of a Facility actions within the FBK/INFN strategic relationship.

In the MEMS2 project there are not real critical issues, with the exception of the equipment up time, typical for the Facility action and already commented in MTLab budget.

AURORA

AuroraScience is a project managed by ECT* and has been already outlined in the ECT* section of this document. Here we provide more details. AuroraScience is a research project at the crossroad of Computational Sciences and Computer Architecture. It builds on the combined know-how collectively available to the members of the collaboration on:

- design, development and operation of application-driven high-performance computer system (e.g., the series of APE machines, developed by INFN).
- algorithm development and physics analysis in computational areas of physics (Lattice Gauge Theory, Computational Fluid-Dynamics, Molecular Dynamics), Quantitative Biology (Protein Folding), Bioinformatics (Gene Sequencing) and Medical Physics.

AuroraScience is a scientific project enabled by leading-edge computational systems and by specific competences in the useful operation of these systems. The project started formally on July 31, 2009. The project is now in its first phase, which will end on July 31st, 2011, and we are applying for the second phase. The milestones of the project in 2011 are here explained in reference with the accomplishment of 2010:

- *Development of the Aurora computing system*. A prototype AURORA system has been installed, which implements the special communication network developed by the AuroraScience collaboration. Currently, the system has a peak performance of 10TFlops and is producing results for the AuroraScience collaboration. On the basis of these results we are now applying for the second phase of the project. If this is approved, we will be able to install a much larger machine (of the order of 100 TFlops).
- *Lattice QCD.* Three codes of LQCD have been ported and optimized for the AURORA architecture. New algorithms have been developed and tested. Production of LQCD data has started. The goal for 2011 is to produce the first scientific results based on the AURORA prototype available now and continue the development and tuning of optimized algorithms.
- *Nuclear Physics.* The adaptation to the AURORA system of existing algorithms and codes both for Auxiliary Field Diffusion Monte Carlo and for few-body computations has been completed. The goal for 2011 is to produce the first scientific results based on the AURORA prototype available now and test new algorithms that have been developed to exploit the 3D network developed by AuroraScience.
- *Protein Folding.* The Dominant Folding Pathway (DFP) method is now running on the AURORA system. The goal for 2011 is to produce the first scientific results based on the AURORA prototype and develop a new algorithm that exploits the 3D network developed by AuroraScience.
- *Bioinformatics.* A new algorithm for Gene Sequencing, suitable for the data produced by the new generation sequencing machine, has been designed,

developed and is being tested. The goal for 2011 is to complete such tests and start the analysis of real genomic data.

– *Radiotherapy.* The basic libraries relevant for MC simulations of radiotherapy have been tested on the AURORA system. Unfortunately, the position that should support further activities is being filled only now, because of administrative delays. The goal for 2011 is the numerical simulation in AURORA of radiation with a complexity analogous to the one necessary in a typical radiotherapy treatment plan.
– *High Level Training.* The first school for doctoral students organized by AuroraScience at ECT* in the fall 2010 has been very successful and a second edition is planned for 2011.

These milestones justify the financial requests for the AuroraScience project in 2011. In fact, 400kE is the contribution of FBK for the AURORA prototype which is planned for the second phase of the project. The machine of the second phase will be much more powerful than the first phase one, thanks to both technological progresses and to a more substantial contribution from INFN. The items [2-6] above involve different scientific competences which are met in the different institutions that contribute to the project, but require the work of persons with full time research positions completely dedicated to those tasks. This justifies the request in 2011 of 325kE for FBK research positions (some of them working under the supervision of INFN staff) and 487kE for collaborations with the other partner institutions. In particular the Fondazione E.Mach will coordinate the developments in item [5], ATreP the activities in [6], the University of Trento those in items [3,4], FBK-ECT* those in item [2]. The group of computer scientists at DEI (University of Padova) are assisting the other groups in the developments of novel algorithms. The organization of the school in item [7] will cost about 35kE. The remaining 34kE of the budget for High Level Training will be used either to invite a senior visiting professor or to co-fund a PhD position. The remaining items in the budget refer to expenses for equipments, software, servers, storage..., that are motivated in the full AuroraScience proposal.

SPIN-OFFS AND HOLDINGS

Among Fondazione Bruno Kessler's main objectives, already specifically acknowledged in its Bylaws, is the transfer of research results and the support of new entrepreneurships.

This objective can be achieved in various ways, including that of creating and/or participating in consortia, companies and other public or private juridical subjects, in compliance with the foundation's purposes.

This plan is also precisely stated in the Framework Agreement stipulated with the Autonomous Province of Trento for the XIV that states that Fondazione Bruno Kessler has to support the already created enterprises and has to create two new enterprises by 2013.

Assuming that this scenario also represents the context of Fondazione Bruno Kessler's strategic objectives, as from 2009 work has been done to precisely actuate the support for the launching of several initiatives, by defining not only the rules and procedures for governing the spin-off phenomenon but also, in 2010, by creating a specific unit (with a specific budget) that is dedicated, among other activities, to the creation and support of entrepreneurial activities.

Solely for information purposes, here under are the activities that have to be carried out with the objective of supporting and creating spin-offs:

- Support the activities of the spin-offs created in 2010, namely AdvanSid S.r.l., Practix S.r.l., Okkam Trustee, CLS S.r.l.
- Support the activities of the previously created spin-offs (12 companies) and help them to consolidate their presence on the market
- Enforce the links between the organisations belongings to FBK group (6 bodies), harmonizing their activities and monitoring their results
- Improve the collaboration with Trentino Sviluppo, with the aim of stimulating the growth of new companies and increasing the entrepreneurial culture inside the Fondazione Bruno Kessler.

HUMANITIES

Isig – Centro per gli studi storici italo-germanici

Name	Isig – Centro per gli studi storici italo-germanici	
Type	Research	
Head	Paolo Pombeni	
Staff	2010	2011
	3 Researchers	1 Senior Advisor
	14 Researchers co.pro	14 Researchers
	2 PhD	1 Researcher co.pro
		2 PhD

Document Status: submitted 2010-12-01

1. Introduction

The research plan for the year 2011 has its roots into what was asked to our Institute after the former director, prof. Gian Enrico Rusconi, resigned in February 2010. As it is well known, FBK's governing board charged a special group composed by professors Marco Bellabarba, Lutz Klinkhammer and Paolo Pombeni to elaborate a project for the future of ISIG-Cssig. This was done and submitted to the governing board at the beginnings of July. It was aimed to restyle our research centre along 3 main lines: i) reinforcing the profile of the Centre not only as a "research community", but as an "institute of research", what does not simply mean that the researchers were more or less friendly oriented toward each other and vaguely working around a common too comprehensive subject, but that the Centre was working as a unit engaged in a clear-cut common project expected to produce a final result of relevance to the international community; ii) taking into due account that we are part of a scientific network established in Trento, what means that we have to develop a "visibility" as well as a "responsibility" in order to concur to the general development of this area; iii) knowing that we have also duties of serving the local community, sharing with it what the scientific research is discovering and developing.

In the frame of these lines we will start to implement what is in the project approved by the governing board in July. We wrote there that humanistic studies are still active, at least in the university environment, in terms of research of an «individual» type. An individual researcher chooses his or her topic, requests financial support from a research body and attempts to bring the proposed investigation to a conclusion. The possibility of it being research which involves more than one person does not contradict this configuration. The classic form is the «school» (historiographic, theological, ideological, etc.), where homogeneity is given to the most vaguely defined aspects of the research environment or to the application of certain methodologies. In all of these cases, however, the work produced by each individual researcher remained a work per se with a life of its own and which then entered into the general circuit of a specialist field.

The environment for this type of research is the university: each scholar accumulates, in substance, personal «results» to be able to utilise them in academic competitions which could lead to them being offered positions in that particular field. With this in mind, the choice of research areas is only relatively speaking significant (apart from the tendency to «follow the fashion» of the moment) and the possible inclusion in a «school» depends on the personal inclinations or current circumstances.

Obviously the context in which scientific and technological research is carried out is normally extremely different. The dominant context here is the «laboratory» and research is not developed on the basis of the personal inclination of the researcher, but on the objectives which the laboratory sets itself and which are then structured in a specific manner to reach those set objectives. The laboratory is constructed around a research option and its director expresses and guarantees a correspondence between the project which has given rise to the laboratory and the product which will result from its use. An individual researcher is always part of a team because the nature of experiments (and today also of international connections) in the research environment leaves practically no space for individual, isolated creativity.

The question arising is whether it makes sense to propose something similar in humanities. The question is urgent for us in a moment when we are faced with a centre for research which is not a university centre. In a university, whether desirable or not, the aim governing the institution is the «transfer of learning», whether in the form of teaching (from courses in the faculty to conferring doctorates) or in the form of perpetuation of discipline codes. In a «non-university» centre for research, does it still make sense to reproduce this world?

It would even be possible to answer in the positive, but in this case, it would mean sliding either towards a form of private elitist university, or towards a body whose aim is simply the financial support of people preparing to enter into the university world (in other words, a supply source for «study bursaries»).

We think, however, that the meaning of a non-university research centre is to produce not the «transfer of learning», but «progress in knowledge»: this means that its aim is to identify problems which cause a certain socio-cultural system to reach a crisis (which is where research finances derive from) and to attempt to resolve such problems by means of targeted, scientific investigations. As in medical science, a certain well-known disease becomes the object of study because familiarisation with the disease is the route to learning how to cure it. Thus also in humanistic and social sciences, a certain problem is identified and efforts are made to describe and understand it, in the conviction that this knowledge initiates «progress» in a way in which society may confront such problems without remaining a victim of it or, even less so, being negatively conditioned by it.

Obviously, this presupposes a small revolution in respect of the manner in which the choice of the subject was traditionally made in the academic scene, and therefore the field of history to be studied (we limit ourselves to this comment, as it is the subject of our work): our starting point is neither the elaboration of the «sources» with which we are for various reasons faced, nor what historical research already in progress suggests to scholars for their own implementation. On the contrary, we

base our work on the identification of subjects with which our referral society deems to have difficulty in terms of its development and growth. These topics are not per se «historiographic» in an exclusive sense and can also be studied from the viewpoint of other disciplines, but we maintain that a study of a historiographic nature can cast light on its important aspects, which would not be discovered by other means, and can enable the referral society to find an «authentication» modality which is of a deeper understanding of the present and consequently affects the choices it makes to confront its problems (because every political and social community is in the first instance «a history» and understands itself better by means of a little awareness of the history from which it originates).

Two main things were needed to transform this general reflections into a plan of research. On one side the determination of a proper topic; on the other the building of a research team selected in view of and in dependence on this specific process.

2. Research

The choosen topics was “the historical question of transition”. You could ask what sense it makes to set the term or concept of «transition» as the key topic for a large research project. On the one hand, you could observe that transition has been much discussed, not only in historiography, but also in common reflections on the developments and succession of events of what are synthetically called «historical epochs». It was often the case, and this will be demonstrated in various contributions in the second part, that it is maintained that in fact everything is «in transition», since to a certain extent, everything is in evolution. In this way, the concept has been widened to denote all phases of transformation from a certain situation to a partially or completely different one. In this context, for example, it has become common to talk about transition in respect of a political regime, both in a radical sense (for example, from a dictatorship to a democracy) as well as in the event of less dramatic changes (for example, from restricted suffrage to universal). Similar can also be said for changes which take place in the fields of literature, art and music, when one thinks of a passage from the domination of a certain «school» to a «school» with a different inspiration.

Naturally, this method of setting our theme is not wrong, but it is more simplistically «specific»: in other words, in these cases we look at the changes in some limited paradigms within a restricted area of human life. Moreover: sometimes these changes can also be relative, but still appear radical because they are thus presented by means of a reading which is more or less biased, and which witnesses or protagonists of such a period would support.

In our research we would, however, like to study the roots of the subject of «transition», that means asking ourselves whether it is because there are historical periods when a certain paradigm limited to one more or less circumscribed part of social life doesn’t change, but in fact, the perception of humans changes and the relationships which they establish with their surroundings changes. The subject is not obviously new and is at the basis of history itself with its ability to distinguish between «ancient» and «modern», perhaps forcing us to choose a «middle age»;

then, when tri-partition does not any longer satisfy needs, a «post-modern age» is introduced, the meaning of which is not really clear, because it is similar more than anything else to the advertising slogan «whiter than white».

In reality it is exactly when we begin not to understand that the moment to investigate the problem of transition arrives, which in a technical sense means those phases when the paradigms of understanding dissolve, in which culture in an anthropological sense (meaning the transmission of shared instruments of interpretation and the meaning given to things and events with which we come into contact) enters into crisis. We cannot and we should not have a simplistic vision of these phases, meaning imagining that what happens according to the ruling paradigms as well as deriving from the «crisis» is the origin of normal human memory: a traumatic break between a «before» and an «after», a clear passage from darkness to light. Rather, the passage happens in a complex and gradual manner, not coincidentally often when simultaneously contemplating the exaltation and perfection of the world at sunset, and the progressive perception of the loss of sense and meaning. This is the phenomenon which Huizinga already described in 1919 in his famous book The Waning of the Middle Ages.

But transition can also have a more radical meaning, by paying more attention to the moment of the event and not to the present, although the most famous theories on the subject have taken fairly wide periods into consideration, even very long ones. If we look at, for example, the classic proposal made by Karl Jaspers in 1949 in his book *The Origin and Goal of History* where he introduces the term of «axial age», we see that the philosopher speaks of a period of as long as 600 years, from 800 to 200 B.C. during which time, as he says, in China, India and the East (which some people now call Eurasia) an almost parallel revolution developed which affected both religion and philosophy and, with the birth of the so-called «clerics», the transcendental vision of history was originated. Thus we have a «pivotal era» which covers six centuries. For our project, as we will see in the following paragraph, there is a prior stimulus.

If we also look at a more recent contribution, from the renowned Reinhart Koselleck with his identification of a «saddle period», we see that the period in question is substantially a century, from 1750 to 1850 (or 1870). In this case, and the semantic difference is not insignificant, Koselleck does not talk of a «cardinal era», but of a «watershed era», (an imported neologism because of its similarity with other terminology).

In both cases, however, what is of more interest to the historian is, as was mentioned above, the dissolving and reforming of paradigms. But what, if confronting what we reported above, makes us say that the study of transition in this specific way is different from common observations, since we all live in a constant state of transition? The answer is very simple. Transition which is experienced every day, always present in our lives, is not really a «watershed» nor really «pivotal», to repeat these two metaphors. It is an adaptation, a small redevelopment of cultural paradigms as they are understood in anthropology. When we identify the existence of an axial age, we are however witnessing a watershed, or a change of paradigms which will connote all of the epoch: during which certain of these paradigms will be the subject of mutation, of discussion,

development, but they will never be completely revolutionised to move on to others.

The important thing to be underlined is that whilst the metaphors of pivot or watershed delineate so to say a fixed point in space, the age of transition delineates a movement, a trajectory stretching through time. It is this which renders the historical term transition equivocal. We are not in fact searching for a temporal point, to use a traditional term «periodisating date», but, as in the case presented by Jaspers, we are looking at a period during which, with successive evolutions, new thoughts and small transitions are formed, such paradigms as we identify after the event, with a cultural process, as determining for the formation of a paradigm which on the one hand confers sense and meaning to the entire period and on the other hand gives the following epochs a platform for senses and meanings which permeate them as dialectic reference terms in spite of the radical alterations and the dissolution they create in respect of those paradigms.

Certainly, these «pivotal eras» are not the subject of history, but of historiography, empirical interpretations which are possible only in the light of a different understanding which humans have of themselves.

Does it make sense to return to these subjects today? We obviously think it does, starting with the invitation which is extended by the Bruno Kessler Foundation to reflect on the «dominants», such as the subjects of public space and secularisation.

If we consider these subjects in the real sense of the words, we see that public space is confined by the understanding which a society has of itself and by «education», which in relationship with this transmits to its own components, both individual and institutional. From this point of view, fixed public spaces do not exist, but public spaces created virtually by the dominant cultures: they may be the local square or communities on the Internet, the city or cohabitation based on ideological bonds, the state or nation, or various «small homelands». All of these are the products of a development and, as such, all of them are subject to that which connects them with the overall problem, which in the past would have been called «historical evolution».

The same may be said with regard to «secularisation». What does it mean, if not the fact that humans are constrained to modify their relationship with «meanings», the specific field of religious learning, by means of the relationship that it must have with the «sense» to attribute to that which happens in the contingent historical space (which for the sake of convenience we define as «the century»)?

As has already been mentioned, this phenomenon was interpreted, according to a well-known formulation introduced by Max Weber, as the «demagification» of the world, meaning a shift in the search for explanations from the super-natural world to the world of reason, to the point of using, if we can use a play on words here, the similarly well-known formulation by Hegel whereby all that is real is rational and all that is rational real. To what extent this movement characterised an epoch and to what extent at the same time there was a transition and consolidation of the two phases will remain the crux of our research.

Certainly for many people, these phenomena are constantly at work and form the routine web of human relationships. Nevertheless, it seems difficult to deny that phases of «emergency» exist. Let us stop a little to reflect on this term, which encapsulates the meaning of the exceptional event in which the normal rules of reaction in terms of our surroundings are seen, as much as the meaning, in the literal sense of «surfacing», of the coming to light of something which we had not noticed before, or only partially and incompletely.

It is in this context that our decision to focus our attention on the reconsideration of the phenomenon of «transition» gains weight, as a pillar of historical change. Naturally, in saying this, we do not want to deny that history is a continuation of change nor to attach the phenomenon onto any evolutional period which could be taken into consideration.

Once again, it is the words which are important. «Transition» means passage, and therefore a change of panorama, of context, of paradigms: it means, if we wanted to reproduce the biblical archetype which basically still conditions our way of thinking, leaving Egypt behind us, whose onions have become intolerable, to reach, by crossing a desert, the Promised Land which the Israelites had already been excitedly imagining before reaching it. And, still using this metaphor, the desert is not only hostile and inhospitable, but it is the place where the conflict between the strength of nostalgia for the past and yearnings for the future are put to the test.

Does it make sense today to pose a question of this kind as «pillar» of historical research? We obviously believe so, inasmuch as we happen to live in a period which from many points of view appears as a desert crossing, which makes us at times regret the onions of a culture which we have declared «finished», «overtaken», and which in any case, no longer offers us acceptable explanations, but at the same time challenges us to imagine whether on the other side of the desert there may really be the «promised land» where we may find the equilibrium we have lost.

And so we return to the choice of retracing and investigating some key moments in the history of Europe, inevitably read, particularly in the FBK and Trentine region, as was conditioned on the level of departure by the relationship with the Italo-Germanic context, to understand how a «community of destiny» defends itself in the face of the challenges posed by the exhaustion of a «cultural» system and the question of its reformulation, if not its re-foundation. Obviously here, as a cultural system, we do not simply mean the complex of ideas and intellectual developments of which one immediately thinks when reading the words, but we want to refer to the whole context which contributes to human development of the capability of relating and reacting with and to the world in which we live. In this sense the institutions and the material living conditions, the regulation of economic relationships and the management of daily needs, interpersonal relationships, as well as relationships between «powers», all these are essential components of the cultural universe, because it is by means of participation in this web that humans learn and understand their role both in the community of which they are part, and in the relationship system to which they are subjected.

What we think could characterise the research on transition which will begin in 2011 is that all idea of «progress» has been abandoned. We do not mean here that transition is a passage from an inferior state to a superior one, meaning that a certain culture is abandoned because it is in reality «overtaken» in favour of a new one which would be «more valid». On the contrary, it is thought that change is functional not so much in terms of a progress of knowledge, but towards its fulfilment of the task of providing answers to the challenges which from a certain point of view remain fundamentally stable, being in relation with the profoundest part of the human spirit, whilst from another point of view, these challenges need to be redefined to remain in equilibrium with respect to the mutation of the contextual conditions. To use another metaphor, they have made the cultural lens «opaque» which we use to look at our surrounding reality.

In the second instance, we must clarify that our concentration on European analyses, in fact, a very limited area of Europe which has direct experience of cultural interaction (the Italo-Germanic and its relationships with the British and French zones) is another thing which in the past went under the title of «Eurocentrism», even if it is no longer derived from a concept of «superiority» and «centrality» of this area, but rather taking the starting point of its consciousness of being relative and peculiar, which, however, at the same time is the consciousness of the impossibility of substituting Eurocentrism as a universal history with a sort of «universal globalised history» which would need pluricultural competence not at our disposal and which would make a prospective series of comparisons more arduous.

The problem with which we are faced today is with regard to regaining an eye for the long term when thinking of the study of history. The specialisation of knowledge, most of all following the explosion in teaching methods in the university system and the consequent widening of the student cohort and their communication instruments (editorials, magazines, conferences), has led to a weakening of the perspective of that which, drawing on the lesson of the Annales, was once called «the long duration». It may be of curiosity to note that this was introduced as a polemical counterbalance to «political» history, without foundation thought to be a history of events, giving details of kings and battles. In reality, as the structures for what is usually called the material society can be read with a view to the long term, so can and must the same be said for the structures which animate the sphere of politics, which is somewhat more complex than the simple dimension which we would call the history of the exercise of power, inasmuch as long-term reading must be carried out including cultural and religious history, which also have their own structural dimensions which must be reconstructed.

The public or political sphere is the result of a complex of interactions which can without doubt be broken down into a series of specialist investigations of the individual components, but which only find their meaning when considered within their entirety. It is exactly this complexity which we want to look at, bearing in mind that it is the key to understanding the historical process and could assist our orientation in the understanding of the transition which we are experiencing.

This is therefore why we thought of identifying some specific historical periods in which we would then attempt to verify the plausibility and the heuristic capacity of a

historical category such as that of «transition». Within a long period which, as will be explained later, practically goes from the definitive affirmation of humanism and its entry onto the world stage and that which is usually called «globalisation» (i.e., from the middle of the 15th century to the second half of the 20th century), we have identified three phases to be examined: the period from the Italian Wars to the end of the Council of Trent (1494-1563); the passage from the age of enlightenment to that of the restorative-modernising stabilisation (1770-1848); the «stabilising dissolution» of the period 1945-1973.

These are probably, but this will be verified during the research, all different types of transition from each other. Nonetheless it seems that all of them can pose the question of transition in one way or another. We mention some of these now only as examples, whilst our work group will take forward other activities.

Let us start with the problem of the definition of public space: from the «res publica christiana», to the nation states with their «sense of concert», to the «Atlantic community», we are witness to alterations of cultural/institutional horizons which then fall to the redefinition of the real spaces in which we live, in material terms (the square, the town, the homeland, the ideological institutional universe), or in intellectual terms (constitutions, value systems, religious beliefs), the «communities of destiny» to which these horizons relate.

We continue to use the Weberian term «communities of destiny», because we maintain that it is important to underline how the historian must pay particular attention to the community context which defines experiences, and be aware that it is necessary to know that the community context is a «plural» dimension, which means that in people's experience and in institutions there is a cohabitation and web of community belonging (with all the interactions and conflicts which arise from the sense of belonging to different communities).

Let us not forget that transition has always a feeling of ambivalence, because it is not so much a work of elimination or substitution of materials, as much as reordering of the spatial collation of these materials with respect to the hypothetical centre of the system of equilibrium: we borrow this image from political ideologies by Michael Freeden, who noted that in all political ideologies the same concepts exist, whilst what differs is their collation, their distance from the centre.

In the organisation of public space, to continue with this example, in the various epochs mechanisms are proposed which are different with respect to the circulation of ideas, with respect to the problem of the categories charged with constructing or managing the consensus, of the mechanisms of legitimisation of the relationship between command and obedience, etc. What is common to all periods of transition is the work of constructing the political-social equilibrium: it is here that it differs from the normal historical change which is a work of adjustment of an equilibrium which is substantially accepted more than a real work of construction (or reconstruction) of an equilibrium which has the aim of presenting itself as new.

From this standpoint we could draw attention to the three pillars we find, although in different forms, in the transition phases during the «era» we have defined as our research era.

– *Construction processes in the «sense» in eras of transition*. This deals with examining how in an era of «passage» on the cultural front (secular and religious, cultural and popular) as on the «social costume» front the changes which were in course have been exorcised or there have been attempts to rationalise them. The form of the investigation will be pivotal both in terms of its comparative aspect (different nations and different cultures, different epochs, with the same problems) and, within the limits of the possible, in terms of «micro-history», i.e., on circumscribed individual studies, but which consider themselves to be meaningful in the verification of assumptions identified in the course of more general research.
– *Construction processes of the political consensus in eras of transition*. This deals with the investigation of what the «political institutions» have contemplated to construct and maintain the consensus around themselves in terms of «government» objectives they set: from legislative interventions to rhetorical instruments, from the invention of new «containers» to the consecration of those already existing, from the control of fear to the management of hope. Particular attention could be paid to the problem of the construction of «identities» and to leadership (for many people these two topics are connected, as leaders of also constructors of identities): what are the characteristics of leaders in different epochs and different contexts, how are they legitimised, how are they considered or not considered to be an «expression» of a certain society?
– *The role of the «sciences» as governmental and disciplinary instruments in the «age of anxiety»*. Science has always been presented as a means of rationalising fear by demonstrating that problems can be solved using reason, and that that which seemed «mysterious» was in reality «rational» (here there is a tendential conflict with religions which deny the possibility of dominating life and the environment using only human strength, being by definition «finished»). We can speak of «sciences» both in the traditional sense (medicine, physics, chemistry, etc.), as well as in the current sense of «social sciences» (law, history, sociology, economics, etc.) Investigation how scientific paradigms (or even sometimes pseudo-scientific) have measured up in operations to «govern anxiety» and in responding to their epistemological requisites to exercise in this way forms of power, can nowadays be an explanation of many of our difficulties, such as how to reconstruct the «anti-scientific» reactions which have appeared towards the challenges of science.

It has been in moving away from these reflections that we have arrived at, (also by means of the perusal of literature carried out in teams by the researchers of the FBK-Isig who accepted a collaboration in the phase of the project, and who will find themselves listed in the second part of this document), the definition of the «long term» as the subject of our research which attempts to unify the concept of transition also in the plural.

Two famous scholars, Samuel Eisenstadt, who already in 1982 had discussed our topic in a much-discussed article[1], and Wolfgang Schluchter, who had considered the subject in this fundamental studies of Max Weber[2], published a text book in 1998 which relaunched the subject of the «axial age» to be able to understand the forming of the age of «modernity»[3].

In this work, the two authors drew attention to the fact that this epoch included in institutional terms the nation state and the rational capitalistic economy; in cultural terms the construction of new collective identities connected to the construction of the nation states, but encompassed in a complete cultural programme which articulated itself in differentiated modes in terms of the structuralisation of the principle social arenas. According to the authors, therefore, not only «modernity» in the singular was witnessed, but also in the plural, within the framework of which there was an «original» European code: this contemplates a modification of the way to consider an active role for human beings in the universe, a relationship between the two Weberian notions of Wertrationalität and Zweckrationalität, the cosmological concept of time in its relationship to the historical concept of time, the belief in progress, the relationship between history and progress, the relationship between the individual and the collective, and that between reason and emotion.

Here we are not interested in repeating in detail the thinking of the two authors on the subject of the age of «modernity» in Europe, which they traditionally have begin from the 16th century until after the World War II, without however stopping to consider whether and when this period should finish. Rather, we are interested in recalling the objective which they see fit to propose, namely research which understands how to take seriously the problem of the «pivotal eras»: the study of the system of inter-relationships between the systems of government and discipline in the political-social order, the various types of public spheres which exist (which they believe date back to the study of Habermas, but which could be even earlier) and finally the different types of collective identities.

And therefore we propose the reconsideration of the problem of transition as being typical of the «modern age», overtaking the traditional approach of the «transition to modernity», more or less corresponding to the modern age, and as has been written to a certain degree ingenuously, to the «end of history», inasmuch as progress would reach its culmination beyond which it would not be possible to go, if not towards a dissolution.

How do we consider the chronological space which embraces this modernity? Of course, this can be done from many different viewpoints, but we maintain that it is appropriate for us to act taking the cultural context into consideration in which we find ourselves at present. For this reason, we have identified the first period as stretching from the Italian Wars to the end of the Council of Trent (1494-1563). These two historical events are symbolic as watersheds: the Italian Wars because

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1 S. Eisenstadt, *The Axial Age: the Emergence of Transcendental Visions and the Rise of Clerics*, «European Journal of Sociology», 23, 1982, pp. 294-314.

2 Citiamo per tutti, W. Schluchter, *Religion und Lebensführung*, 2 voll., Frankfurt a. M., Suhrkamp, 1991

3 S.N. Eisenstadt, W. Schluchter, *Paths to Early Modernities – A Comparative View*, «Daedalus». 127, 1998, pp. 1-18.

they determine the fall of the, in a manner of speaking, «reduced» dimension of the geopolitical space to demonstrate increasingly how the future is not in the hands of nation states, because defining the powers which disputed the territories of Italy in this way does not seem appropriate to us, but of political spheres which have in their «dimension» and their control of these resources the origins of their own capability to expand; the Council of Trent because it signalled not only the splitting of the «res publica christianorum», but also the necessity for survival on the part of the church and religion to give itself either a centralised «paradigm» (the church is Roman Catholic) or to accept being a component of the nascent weighty political-territorial identities in opposition to each other (religious imperium and political imperium must coincide, not in a general abstract way, but in the actual relationship of the population with the ruling powers). In this framework, as we will see in detail in the research proposed in the third part of this document, the dominium of the «public space» as with the relationship between the religious, public and private spheres, assume characters which are different from those in the «antique» world.

For many, the paradigms which were embryonically formed during this phase will survive longest, but not without mutations. Certainly, these are from a certain viewpoint of a continuous nature, but from another viewpoint, they demonstrate a movement towards confrontation with the «watersheds», which become «pivotal» for the subsequent phases.

In this way, we have identified two moments which seem of interest for the verification of the coordinates which we have tried to delineate.

– The first moment coincides almost fully with the Saddle Period which was defined by Koselleck: the German historian in fact had it coincide with the hundred years between 1750 and 1850. It seems to us that this period represents what we hypothetically define as a restorative-modernising stabilisation. After the revolution of enlightenment, which however demonstrates the re-emergence of the process of rationalisation starting with the period of the two reforms (the Protestant and Roman Catholic reforms), we witness a global reorganisation of governance systems in the public sphere, on the level of both political and civic society. This reorganisation moves on two planes, apparently in contradiction with one another: on the one hand, the acceptance of «modernity» and its ability to rationalise and organise public spheres, on the other hand the will to «restore order» with a characteristic lack of faith in the legitimisation of the only rational force if this seems capable of challenging the social stratifications of existing powers.
– Finally, we must give some consideration to the choice of the period 1945-1973 as the last period of our study, because this could seem perplexing as a period of «transition». However, to us it seems a period of particular interest because in this case the transition takes the form of what could be defined as a «stabilising dissolution». Indeed, for some people, this period would seem to be the definitive systemisation of paradigms which mutated between the middle of the 1800s and the end of World War II (liberal-democratic constitutionalisation, «classless» societies, human rights developments, rule of public opinion, etc.), whilst however, that «maturity»

ends by being a maturity which exactly with its conceptualisation (typical example are social sciences) allows a crisis of consensus to arise towards those values which are pressed into the discussion of form, because when used in the discussion of substance, they lose their strength.

So in the end, such stabilisation will be revealed as a mise en crise which is handed down to us, so that it is exactly the «secularisation» of these horizons, that is to say their reduction to shape (and here we should mention the notion of Verfassungspatriotismus with which Habermas will always delude himself to have overcome the problem of the traditional constitutional legitimisation) which renders them increasingly difficult to put forward.

For some people, the emblematic Second Vatican Council, which implicitly suggested dissolving, not so much the Tridentine paradigm in itself, but its sclerotisation and reduction practically to a magic formula, will end by being the key which opens a religious Pandora's Box which relaunches rather than resolves the problem of the relationship which religions have with modernity.

From this point of view, the choice of 1973 as an emblematic year of a new historical «watershed» seems to us to be confirmed by recent studies which have identified the 1970s as the beginning of a turning point[4]. A series of dates are recorded by Niall Ferguson to support his thesis on turning points and are connected to technological evolutions: 1970, invention of the barcode; 1971 invention of the microprocessor, of the floppy disk, of the CAT; 1972 invention of e-mails; 1974 invention of the pocket calculator; 1975, invention of the first home-computer (Altair); 1976 invention of VHS recorders; 1977, invention of MRI technology; 1978, in vitro fertilisation and ultrasound. Of course, it is possible to debate the importance of this technological revolution, but at least at a symbolic level, it seems clear to us that it represents the beginning of a «new world».

We have already mentioned that the definition of this new epoch which opened up after the 1970s as being «post-modern» seems to us almost a capitulation: it constitutes the end of the preceding period, without however giving a name to the new one, we fear because it in reality has not fully «revealed» itself, remaining in the balance between the dissatisfaction with a post-war stabilisation in which nobody longer believes, and the fear of abandoning those certainties which we believed to have achieved because we have no idea how to replace them with anything convincing.

This however is not an argument for historical research. We will be satisfied if we succeed in reaching our object of re-reading the concept of transition within the modern age, connecting it to the internal transitions which it has undertaken.

As mentioned above, the aim of the research is to join the international historiographic debate with a contribution which is convincing. From this point of

[4] Cfr. N. Ferguson, *Crisis, What Crisis? The 1970s and the Shock of the Global*, in N. Ferguson - Ch.S. Maier - E. Manela - D.J. Sargent (edd), *The Shock of the Global. The 1970s in perspective*, Cambridge 2010, pp. 1-21; Ch.S. Maier, *«Malaise». The crisis of capitalism in the 1970s*, *ibidem*, pp. 25- 48.

view, the ambitious aim we have is to reconfirm and relaunch the nature of the FBK-Isig as a centre of excellence.

For this reason, the starting point of the research is an international academic competition to recruit the research workers who will be necessary to carry it out. The selecting process among the 174 applications (37 from outside Italy) is presently in progress: final stage is planned December 9-11, 2010. When we will know who are the 10 research-fellows in charge for the project and how each member of this team (with the addition of other 2 permanent fellows of the Isig) will develop a specific topic in the frame established by the research project, we could start to really implement the steps to realise our project.

What we expect after the term of three years' work will be the publication of a study in three volumes, one for each of the periods chosen, with a far-reaching introduction which will pull together the threads of the results arrived at by the different contributions making up the research. The publication shall be realised not only in Italian, but also in English, as this is nowadays the standard required for the international circulation of research.

The introductory text will be intended to pull together all the threads of the work carried out and a complete interpretation of transition in this age of «modernity» is proposed, an age which has formed European public space between the end of the 15th and the second half of the 20th centuries.

The first year of research (2011) will be devoted to the real foundation of the research group with its 3 sub-units. This is more difficult than could be supposed. We have to deal with a group of researcher totally new for an half (because 6 of the 12 will be researchers already acquainted with the Cssig- 2 alreardy permanent fellows, 4 becoming from the former not tenured members, in accordance with the agreement signed by FBK with the Unions representatives), but for all, intellectually speaking, the project is a new adventure. In response to this challenge we will devote the first part of the year to a cooperative work in order to fix the methodological and logical parameters of our research, to explore and discuss the literature and the sources available, to establish the final lines of the division of work among the researchers.

From this moment on each researcher will start working on his own specific topic of the project, but with a weekly moment of confront in which to check the progresses and to adjust them in the frame of the general plan. We expect that every 3 months each researcher will submit to the direction (prof. Paolo Pombeni and prof. Marco Bellabarba) a written report of his work. As a final result of this first year each researcher is expected to produce a contribution for publication, may be relevant reviews of some important books, articles in learned journals on partial topics of his/her research, essays.

3. Publishing

For the circulation of our research we are in train of revising our presence in the international scientific market with our "Annali". Discussing this matter, we enter also in what we propose to do under point ii), that is our service and presence

inside the “science-pole” of Trento. At present the “Annali” has some problems because its formula seems to be not entirely fitted for the new situation under... the realm of internet. We have decided to transform it into a semestral journal, one number published in Italian, one number published in German. The aim is to become a real bridge between two worlds, without supposing that the contacts could happen without any linguistic problem. Unfortunately even among the historians the number of persons able to read German in Italy and Italian in Germany is restricting more and more, while on the contrary there is a growing number of scholars interested in knowing what is produced on the other side. For this reason we will facilitate best German products of current historical research to circulate in Italy thanks to translation, and the same in the reverse form for what concerns Italian historiography. As an additional contribute the new series of the “Annali” will have a large section of books review in both issues: in Italian the one paying attention to the German historiographic production, and the reverse in the German one.

The editors of the “Annali” will be the Director *pro tempore* of the Isig and a distinguished German Historian (at present: prof. Louise Schorn-Schütte). The editorial work will be done by the researchers of the Cssig as part of their duties. We believe that this is a way of improving the research abilities of the group and of introducing it into an international scientific circuit.

We plan to call the scientific community in Trento to become part of this enterprise, asking to the historians of the University to elect 2 of them to join the editorial board. As an opening to the national community we will ask for a representative the Association of Scholars in Early Modern History and that of Scholars in Modern and Contemporary History.

Our attention will be also turned to the publishing section. This is a well directed branch of FBK, with a remarkable tradition and audience in the scientific national and international environment. Nevertheless we assume that something could be done to improve our performance. We wish to revise our activity in the field of sources’ publication, a very specialised field where the high costs of printing in the traditional form are no longer sustainable. So we plan to reduce the printing of the books collecting and editing sources from the Archives to a limited numbers of copies produced with the low cost technologies, and to print on the web a free copy in a specialised site. In general we hope to improve the production of books in our traditional collections taking more into account the capacity of the different researches and of the proceedings of our conferences to meet the expectations of a wide public. This means to limit the space for hyper-learned research, and try to gain opportunities to promote works dealing with key-point of the historical debate and with topics assumed to be crucial for the today intellectual debate.

4. University Partnerships

We plan also to interact with an important partner as the University of Trento so as with the University system in Italy and in the German speaking countries. We have promised to our colleague historians at the University of Trento to inform them

about the profiles of our researchers so that they could call them to some form of cooperation in the university teaching, of course if they need it and find it appropriate. The rule will be that they have to apply not to single individuals in a form of private relationship, but at the Direction of the Isig in a formal way which means that FBK will be formally involved and could present in its social budget this service freely offered to the local University.

Of course we will continue with our tradition of having a big conference a year (traditionally in September – the so called "Settimane di Studio"). In 2011 the chosen topic will be "Minorities inside the Empires. Multi-national Empires and minority question in time of Nationalism 1880-1918". The conference will be lead by prof. Brigitte Mazohl (Innsbruck) and prof. Paolo Pombeni (Isig and Bologna) and will see the participation of a selected group of scholars of the Habsburgian, Russian, British, German empires.

Another service offered to the university world will be a Summer School for Doctoral Students. This is intended for young PhD students at their first year of course and aims to make available for them a selective introduction to the today problems of historical sciences in the interdisciplinary framework. The plan is to have 10-15 students staying for a week here in Trento and attending lectures and seminars read mainly by members of our research team with the addition of one of two distinguished scholars. In this way we socialize what our Centre is doing and at the same time we offer an opportunity to our researcher to check their capacity to confront with the insides of historiography as well as we give a chance to PhD students to meet what means a real centre for advanced research.

5. Activities Directed at a Wider Audience

In conclusion few words about our activity directed to a wider local audience. We find our duty to be at service of a community in which we are enrooted. It goes without saying that every initiative we assume is open to everybody interested, but of course in many occasions the nature of a scientific and specialised discussion will prevent an attendance extended to the general public.

To overcome this we have planned to move in two directions. First of all we have contacted nearly all the groups and institutions, from secondary schools to various associations, interested in questions related to the historical research. We offered them to cooperate in all the ways they thought interesting for them and possible for us. Secondly we continue to plan occasions of public meetings around historical topics or around the public figure of distinguished historians, meetings arranged in a way that makes them enjoyable for a general audience. In this framework we will underline some initiatives already planned.

From December 2010 until May 2011 we well have the series of public lectures "Historians to the fore" with Emilio Gentile, Benedetta Craveri, Adriano Prosperi, Carlo Ginzburg, each interviewed by two of our researchers. In January we will present the book of late professor Bernam, *Law and Revolution*, edited by prof. Diego Quaglioni. Next February it will be the time of an important seminar about the recent book of prof. Paolo Prodi, *Il paradigma tridentino,* where the author will

discuss it with prof. Alain Talon (Sorbonne University) and the researchers of Cssig. Of course other initiatives of this type will be realized during next year, but we refrain from planning everything in advance in order to be flexible toward what happens in the field of historical research.

6. Fund Raising

Some final reflections must be done about the problem of fund raising. We are perfectly aware that in times of financial crisis a research institution cannot depend entirely on what was its ordinary budget, subject as it is to cuts and rethinking. So it is our intention to explore every possible way to apply for extra funds coming from the opportunities offered to the research by private foundation, European Union, etc. We have already applied to the “Fondazione Caritro” with a joint project on “The weight of the past in rebuilding political systems after 1945: the cases of Italy, Germany, Austria and France”. This is a joint venture between Cssig, Department of History and Politics of Bologna University, Department of Politics of Innsbruck University (requested 100.000 euros). The answer to this application is expected for the beginnings of 2011. We are also exploring the possibility to join to a group led by the University of Potsdam to compete for the big project launched in the frame of the 7° programme of the EU “Evolving concept of borders”. The competition is extremely hard, because there will be only one project admitted, by the sum expected is extremely relevant (from 6 to 10 million euros). Of course we are ready to catch all the opportunities which will open in 2011 in order to increase our budget. As usual we ask our partners in organizing conference, seminars, etc. to have part into financing these events.

ISR – Centro per le scienze religiose

Name	Isr – Centro per le scienze religiose	
Type	Research	
Head	Antonio Autiero	
Staff	2010	2011
	3 Researchers	3 Researchers
	5 Researchers co.pro	3 Researchers co.pro

Document Status: submitted 2010-12-01

1. Introduction

The 2011 programme of official activities of the Centre for Religious Studies puts into practice what was decided on by the FBK's Board when it met on 2 July 2010 as part of the process of restructuring the humanities area of the Foundation.

The document drawn up during the restructuring process and approved by the Board at that meeting laid down strategic decisions on subject areas that would place the research centre in a better position to respond to demands emerging within current theological and religious debate. During the various phases leading up to these decisions, there was a multi-stranded and thorough-going discussion with the governing bodies of the FBK (the President and the Scientific Council), and with the dedicated working group set up (the 'Building Team'). The outcome of this process was the document finalised on 18 June 2010 and then approved by the Board on 2 July.

Given that the decisions made were prospective and medium- and long-term, the 2011 Implementation Plan needs to be seen within the framework of the three-year period 2011-2013. This implies that decisions reached for the year 2011 are just the first step in a longer and forward-looking strategy that, at least in this phase, has been set out over three years, in part to bring this current programming into step with the five-year Programme Agreement for 2009-2014 drawn up with the Autonomous Province of Trento.

2. Aims

a) *Coherence with strategic decisions*

The actual Implementation Plan will be subject to close supervision in order to ensure continuity of initiatives and to avoid fragmentation of interests. This need is even more important if we take into account the very wide range of possible forms that given subject areas can take in religious studies and theological disciplines. The coherency referred to here will also affect decisions on publications for the year and for the three-year period.

b) *Mixed involvement in governance of the Centre*

There will be focussed change in the make-up of the Board of Management, which suffered during the last round of restructuring discussions. This should lead to greater involvement in the management of the Centre of both internal project heads and external members, whose contribution might well lead to new forms of inter-institutional cooperation.

c) *Institutional interaction*

This mainly involves different types of synergy between the various research centres in the FBK, first and foremost the Centre for Italian-German Historical Studies. In this relation, the executive of the FBK (the President and Secretary General) should intensify such contacts through the appropriate bodies (here the Boards of Management).

Given its geographical location, the FBK-ISR will continue and strengthen its links with the University of Trento, especially as the university seeks to reposition itself within the Trentino research system as a whole. Cooperation with the university in recent years (to date with the Faculties of Arts & Humanities, Law, Engineering, Cognitive Sciences and the Gender Studies Centre) will likewise continue and intensify as dictated by the content of the ISR's projects.

d) *Recruitment of research personnel*

Given the transitional nature of the past year and the decisions adopted at Board level for 2011 and the three-year period of which it is part, there will be targeted recruitment to the various projects. The first phase - the 2011 year - can also be seen as a first step during which utilisation of funds will be limited (with recruitment of new personnel late in the year). This of course implies higher levels of funding in subsequent years.

e) *Moving the CSSR*

The Corso Superiore di Scienze Religiose (CSSR - School of Religious Studies) will be moved from its premises in Via III Novembre to an area inside the FBK itself in Via S. Croce. This must be seen not just as a logistical move but also a measure to make the CSSR part of the overall research centre. This will mean greater involvement of teaching staff and students in research activities and will lay the foundation for the development of a doctoral programme in religious studies which should be launched in the last year of the three-year period.

f) *Reorganisation of support services*

The new needs arising from the general review of the Centre and the changes in research staff structures in turn require revision of technical and organisational support services. This will involve review of utilisation of both space and secretarial staff, whose areas of responsibility will need to be redefined; one post might go altogether while the contract for another position might be upgraded from temporary to permanent.

3. Overall direction

The strategic decisions outlined here take account of the real current situation of theological research and religious studies in Italy, which do not have a regular presence in public academic institutions. The decisions also draw on the experience of the Centre for Religious Studies as part of the ITC and later the FBK, stretching back decades.

On this twin basis, the future nature and strategy of research undertaken at the Centre will clearly be 'theological'. More specifically this will involve analysis of the contexts and styles of a new theological discourse that would be capable of situating itself within the *public space*.

This would in turn be connected to the '*emancipatory*' impact of theology, going beyond any pretensions of 'neutrality', as best expressed in reflections on *embodiment* and its meanings, both in terms of an anthropology of subjectivity and the *public/private tension* pervading political philosophy in the modern age.

Such a choice of subject area can be justified for theoretical reasons but also because of the history of Trento (the Council of Trent, Reformation and Counter-Reformation), which saw the city emerge as central to a process of confinement of theology inside ecclesiastical institutions at the beginning of modern era. And it is in and from Trento that such confinement might be overcome through the development of an institution devoted to investigation and research on '*Public Theology*', an emphasis also carried over into the teaching activity of the FBK-ISR (the CSSR).

4. Projects

1. *Fundamental theology as 'Public Theology'*

a) *Description of research subject area*

Premise: Theology capable of showing itself sensitive to respect for a space for shared thinking, on a par with other human sciences, must acknowledge the 'equivocal' character of religion, which resides in the fact that religion does not express the process that might explain it. Religious content hides the conditions of its own generation of meanings since these conditions are subject to the experience of faith, which in a context that has become secularised is no longer a shared experience (not even within the community of those declaring to be believers). Theology with a public vocation may no longer base itself on a premise that determines and organises its entire discourse, while the assumption that the opacity of language can be transcended in order to render present and evident substantial truths is no longer acceptable. Shedding these cumbersome privileges does however open very encouraging vistas allowing better understanding of the tangible manifestation of the religious phenomenon. And if such understanding is not reductive it needs the skills of theologians.

– A plausible point of departure for research might be the acknowledgement of the implicitly fundamental-theological nature of investigation of

the various ways of believing (diachronically but more especially synchronically) and the theological enhancement of the category of doubt. This must then be a non-'dogmatic' but rather 'stylistic' approach to religious identity and faith as a lifestyle within a plurality of manners of inhabiting the world. Which is also the background for the theoretical and pragmatic articulation of the theme of the dialogue between religions. The desired public resonance of theology requires that it is reasonably possible to reach mutual understanding, within the public space and discourse, on the constituent dynamics of religious faith, dynamics involving trust in and anticipation of meaning that are common to all individual experience.

– The question of the faith of the theologian seems typical even in its superficiality. If none but the believer can engage in theology, it will be difficult for theology to gain acceptance among publically organised sciences; but if faith has no bearing for the purposes of research, theology can contribute nothing that a philosophy of religion would not already be in a position to offer. The question cannot be settled on the basis of a binary dialectic of faith/non-belief, and this absence of decidability tells us something about theology itself. If it aims to be something like a 'science of faith', it must begin to admit a necessary critical distance from what is lived as faith, and thus it must also be capable of articulating accurately the complex relationship between public and private in the religious sphere.
– Fundamental theology and the hermeneutics of the text: 'narrative vulnerability' as an opportunity for theological reason and as a guarantee of a space for freedom. Bible scripture has a double role: it constitutes the groundwork for theological reflection and it is the product of a culture that has profoundly influenced the genesis of modern thought. Insofar as exegetical study indentifies in biblical scripture the origin of the categories and manners of thinking that have contributed to the formation of modernity, such study can set up a dialogue with sciences that have embraced, or which were formed through, its concepts and language. The narrative nature of the text has profound repercussions on the practice of theology (in what sense can the text be seen as 'founding'?), and on all the various spheres of exegesis that bear witness to the public role of religion.

b) Research personnel

- The current staff structure of two researchers (one of whom on a permanent contract), will be supplemented in the first/second quarter of 2011 by two further researchers in order to create better interaction between different types of theological expertise (systematic/biblical theology and sociology of religion)
- In successive years of the three-year period, these four posts will be further supplemented by a doctoral student, whose position is to be funded jointly by external institutions and the FBK.

- A limited period Visiting Fellowship will also be used to include another theologian on the project (Candidate: Professor Maureen Junker-Kenny – University of Dublin).

c) Actions for 2011

- Convention on Bible and culture, in partnership with the Associazione Laica di Cultura Biblica 'Biblia' ('Biblia' Lay Association of Bible Culture) – 28 April-1 May 2011.
- Seminar on sociology of religion in association with the University of Münster (Spring 2011).
- 'Internal' research workshop with results to be published in monographic form in the journal 'Sociologia' of the Istituto Luigi Sturzo.

d) Partnerships

- Center of Theological Inquiry – University of Princeton (William Storrar).
- Center for Catholic Thought and Culture - University of San Diego (Gerard Mannion),
- Department of Theology & Religious Studies - University of Glasgow (Julie Clague).

2. *The body as a public place*

a) Description of research subject area

- Our belonging to the public space is substantially determined and marked by our condition as women and men who are and have a body and manifest themselves through it. Both the individual and social dimensions of the human being are expressed in the body: as an embodied being the individual belongs to a social body, and is a 'member' of it, and as such is both subject and object of regulatory discourses regarding the ideal body, regarding its duty within society, and regarding bodily discipline and opportunities for enhancement benefitting both the individual and society. The body thus represents the site at which the human being's individual and social dimensions intersect, together with the discourses of various disciplines (biology, sociology, religion, medicine, politics, etc.). Through our body seen as a 'genderised' body (not just due to its biological nature, but also as it is interpreted and lived as a social and cultural entity) we form our identity, interact with society, and become 'social beings'. The realisation of the existence of the body almost never comes about in a vacuum and in a completely independent manner, but rather always through concrete conditions (of the historical, social, cultural or biological type) that influence one other reciprocally.
- One of these conditions has always been and remains religion, which has had a strong influence on images of the human body and thus on the human being as male/female. To this must be added another condition –

essential in the present day – that of the mass media that transmit and construct normative images of the body. Furthermore the 'technological-scientific world' is closely linked with the mass media; its relentless development poses a strong challenge to traditional views on the body. What is the boundary between the body and technology? How can scientific discoveries contribute to altering ways of looking at the body? Is the body the property of the individual? And if so, to what extent? Is it possible to consider the body as a common denominator between all human beings, and to find through it a point of conciliation between cultural, sexual and ethical diversities, *inter alia*? Combinations of these questions might usefully contribute to research on embodiment that could also benefit from the perspective provided by gender studies that have always underlined the plural and volatile aspect of the body despite its apparent stability and tangibility. The subject area also requires considerable attention to anthropology (and theological anthropology), leading to the definition of some aspects that would contribute to a reflection on the role of theology and its contribution in the public space.

– The task of theology in the public space must include analysis of the ways in which theology with its images of the ideal female or male body has contributed to the formation and imposition of tangible bodies, the embodied human beings who are agents within the public space. Subsequently it will be necessary to discover how theology, however, also offers the means for overcoming such conditions, resisting predominating ideologies of a normative nature regarding the 'perfect body'. The regulatory and also emancipatory power of religion will thus be revealed. At the same time, a theological anthropology focused on the bodily aspect and on the social dimensions of the human/embodied being allows for serious and open dialogue with society, taking embodied existence itself, something that is part of the common experience of all women and men, as its point of departure.

b) Research personnel

– The current project staff structure of two researchers (both on temporary contracts) will also be supplemented in the first/second quarter of 2011 by a call for applications for two further researcher posts. Their qualifications will have to match exact profiles of theological-anthropological specialisation.
– In successive years of the three-year period (and in accordance with the union agreements of August 2010), a decision regarding a permanent project leader will be taken and the team will be further supplemented by a doctoral student, whose position is to be funded jointly by external institutions and the FBK.
– A limited period Visiting Fellowship will also be used to include another academic on the project (Candidate: Susan Ross - Loyola University Chicago).

c) Actions for 2011

- Gender Seminar in partnership with the 'Commun(icat)ing Bodies' project (Graz/Zurich/FBK): The body as a public place: Interactions between *religio* and *polis* (December 2011).
- Internal workshop in partnership with the GOSH-FBK project .

d) Partnerships

- Institut für die Wissenschaft vom Menschen, Vienna (Cornelia Klinger, Susanne Lettow).
- 'Commun(icat)ing Bodies' research project, with Universities of Graz and Zurich (2009–2012).
- Wirtschafts- und Sozialwissenschaftliche Fakultät/Lehrstuhl Geschlechtersoziologie, Universität Potsdam (Prof. Theresa Wobbe).

3. *Public and private in modern theory and practice*

a) Description of research subject area

Premise. When we speak of 'public' theology or the 'public' importance of faith we are taking for granted the existence of two well-defined spheres of our experience: one private, interior, intimate and one, as said, public, external, shared (or sharable). The apparent obviousness of this distinction in fact hides a complex scheme of concepts that in turn rests on an implicit background of social practices, images and meanings, the substance, origin and consistency of which are still difficult for us to decipher; and all the more so today when many of the modern 'myths' (progress, access to education, civilisation) are increasingly betraying their transitory and historically/culturally contingent nature. If we accept this verdict on the present, any investigation into the distinction between the public and private must by necessity refer to the three poles around which the experience of the modern subject is structured: interiority, reason and secularity.

- The first segment of research thus sets as its preliminary task systematic analysis of the key dichotomy in culture and in modern anthropologies of subjectivity: the distinction in other words between what is seen as 'own' (intimate, akin, affectively or axiologically charged), because it is internal, and what is not 'own', because it is placed on the outside and is extraneous, mute. The definition of the limits separating the two spheres - and therefore of their inclusiveness - has been the centre of an ongoing argument between the various voices of modern culture, from which different conceptions of human beings and their relationship to the world have emerged that continue to struggle for predominance. The problem is obviously not simply epistemological or psychological, but also involves understanding of the political community, its purposes, and its very legitimacy: in a word, its identity.

– From the very beginning, the modern age has had to deal with often bitter conflicts between the opinions and beliefs (primarily of a religious nature) of individuals and groups. And from the beginning, reason, in its various incarnations (instrumental, natural, communicative, emancipatory), has appeared as an essential resource for mediating between the subjective sphere of convictions and desires and the objective sphere of law (natural or artificial) and force (natural or artificial). It is therefore essential to analyse the evolution of the concept of public reason from Descartes through to Habermas and Rawls. And Kant obviously plays a central part in this story.
– As Charles Taylor recently sustained in his great work *A Secular Age*, modernity can also be understood as a historical age in which 'secularity' took on a new image (and practice). More specifically, the birth of what he refers to as the 'immanent frame' had as its first, partial and provisional result the simultaneous interiorisation, privatisation and feminisation of belief and religious practice. Currently this specific historical-cultural constellation is subject to strong pressure both from within and without. Above all the many variations of modernity developing outside of Europe and the North Atlantic present an interesting cultural workshop that is attracting increasing attention from academics. This is another area of research deserving investment.

b) Research personnel

– The current project staff structure is two researchers, one of whom temporary and the other scheduled to conclude their research within the year, inside the framework of the 'Future of Human Nature' project, also drawing to a close. The subject area covered by this new project requires that the outgoing researcher be replaced with a new appointment. The project will also require, during the course of the year, the recruitment of a further researcher, bringing staff to three by the end of 2011. The new appointees must have a background in philosophy and an evident interest in dealing with questions of theological-political nature.
– In successive years of the three-year period the team will be further supplemented by a doctoral student, whose position is to be funded jointly by external institutions and the FBK.
– A limited period *Visiting Fellowship* will also be used to include another academic on the project (Candidate: Prof. Ludwig Siep – Philosophisches Seminar – University of Münster).

c) Actions for 2011

– International and interdisciplinary convention on the question of Determinism and its different forms (February 2011), at the end of the 'Future of Human Nature' project.
– Cycle of seminars analysing the relationship between some of the most important contemporary or 20th century philosophers (Rawls, Habermas, Taylor, Rorty, Nussbaum, etc.) and religious faith.

d) Partnerships

- Centre for Transcultural Studies - Northwestern University Evanston, IL (Charles Taylor).
- University of Erfurt – Max Weber Kolleg (Hans Joas).
- Università degli Studi di Milano-Bicocca, PRIN 2010 project: 'Passion and politics in the global age: Political imagination and the limits of the 'Other'. Longings for belonging and feelings of extraneousness'.

5. CSSR – Corso Superiore di Scienze religiose

Normal teaching activities will continue throughout 2011 (as part of academic years 2010-2011 and 2011-2012).

In the Spring of 2011 the Board of Management of the CSSR, in accordance with the statues and regulations, will plan courses to be run in the following academic year.

6. Library and Publishing

The Library will receive an adequate level of investment in order to ensure ongoing acquisition of books and journals and to provide bibliographical support for research activities within the three current project areas of the Centre.

The Centre's journal and book publications schedule – as well as the publication of the «Annali di studi religiose» – will proceed as planned jointly with the publications area of the FBK.

Other Research Areas

IRVAPP – ISTITUTO PER LA RICERCA VALUTATIVA SULLE POLITICHE PUBBLICHE

Name	Irvapp– Istituto per la ricerca valutativa sulle politiche pubbliche	
Type	Research	
Head	Antonio Schizzerotto	
Staff	2010	2011
	16 Researchers 1 Administrative Staff	18 Researchers 1 Administrative Staff

Document Status: submitted 2010-12-02

1. Executive Summary

For the year 2011 Irvapp will undertake fifteen research projects. Five of them are about the impact evaluations of policies commissioned by the Autonomous Province of Trento. Three of them are about the impact evaluations of policies implemented by the Region Tuscany and the Region Basilicata, respectively. One of them is the impact evaluation of an important Development Project in Nigeria, for which Irvapp has recently signed a research contract with the World Bank group. The remaining six projects are about the impact evaluations of national reforms on education and labour market (for more detailed information, see this document: point 2.3).

With respect to external training activities, in February 2011 Irvapp will organize an advanced course for PhD students and junior researchers on “Fundamentals and methods of policy impact evaluation” to be held in Venice in cooperation with the Istituto Veneto di Scienze, Lettere ed Arti. The course will present the fundamental principles of impact evaluation analysis with a specific focus on the counterfactual theory of causal inference as well as on the statistical methods and techniques for counterfactual analysis.

In 2011 the most prominent collaboration for Irvapp will be with the Development Impact Evaluation (DIME) Initiative group of the WORLD BANK. In October 2010 Irvapp renewed a research contract with the World Bank group to collaborate on the impact evaluation of an important Development Project in Nigeria: the Commercial Agriculture Development Project (CADP). The impact evaluation will assess the efficacy of various project components to boost agriculture production in five pilot states of the country. Another prominent collaboration in 2011 will be the continuation of that with the Italian Ministry of Education and Fondazione Giovanni Agnelli to evaluate the impact of the introduction of new learning technologies (Interactive Whiteboards) in the lower secondary school.

Finally, it is worth to stress that a new international cooperation with FAO could start in 2011, as clarified in section 2.5.

In 2011 the Irvapp research staff will be composed of an interdisciplinary team of 15 researchers in Economics, Sociology and Statistics, 1 Deputy Director, carrying out managerial and communication tasks, and 1 staff employee with administrative and secretarial duties (see points 2.5 and 4). It is quite likely that during 2011 Irvapp will further widen its researchers team by hiring young scholars in the fields of educational, welfare and industrial policies evaluations.

Probably, Irvapp's current institutional network (Istituto Regionale di Studi e Ricerca, Consiglio per le Scienze Sociali, Fondazione Istituto Carlo Cattaneo, Dipartimento di Economia dell'Università di Torino) will not wide in 2011, as the position of Irvapp within the Fondazione Bruno Kessler (FBK) is under discussion.

The most salient ethical issue concerning Irvapp research activities is related to privacy and data protection. As a research institution, Irvapp is subject to the "Code of conduct and professional practice applying to processing of personal data for statistical and scientific purposes" - *Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi statistici e scientifici* (Provvedimento del Garante n. 2 del 16 giugno 2004, Gazzetta Ufficiale 14 agosto 2004, n. 190). Therefore, Irvapp is allowed to disseminate statistical results, also by publishing them, only in aggregated format, or else in a manner preventing data subjects from being identified.

2. Vision and Scientific Program

2.1. Context and State of the Art

Irvapp was established in March 2008 by FBK and started its activity on April 1st, 2008. Irvapp aims at providing evaluations of *policy impact* to international, national and local agencies engaged in public policy in order to contribute to establishing an informed and *evidence-based* policy making. The methodological paradigm underlying Irvapp's empirical work is the counterfactual model of causality. That is, the effects of public policies are measured as a difference between the observed/measured outcomes after the intervention and what would have occurred in the absence of the intervention.

In 2010 Irvapp has completed 4 short-term research projects and accomplished some important steps of other long-term projects. All of them are listed here below:

- The effects of temporary job experiences on short-term labour market outcomes in Italy.
- The effects of remedial exams on student achievement in the higher secondary school system in Italy.
- Evaluation of the 2001 reform of higher education in Italy.
- Merit-based financial aid to students from low-income families and its effects on university enrollment.
- Reconciling paid work and family responsibilities: The role of 'service vouchers' in the Province of Trento.

– Incentives to firms: Do they affect the output of the innovation process?

The working papers regarding the above projects (except that regarding the Evaluation of the 2001 reform of higher education in Italy, which has yet to be completed) are available on the Irvapp website: http://Irvapp.fbk.eu/pubblications/progress%20reports.

All the scientific publications of Irvapp members, appeared in 2010, are listed in the appendix 1 to this document,

2.2. Vision and Goals

Irvapp is a policy-relevant research organization. It aims at carrying out policy evaluation research to quantify the effects of policy interventions. The scientific mission for the next five years includes the evaluation of social policies, the dissemination of findings from this research, the promotion of a culture of impact evaluation in Italy, the training of policy evaluators, and the setting-up of a policy-relevant data archive.

Although some progress has been made in recent years, in Italy the lack of a culture of impact evaluation and the difficulty in accessing both administrative and survey data remain major problems in policy evaluation. Therefore, promoting a culture of impact evaluation through training activities, research dissemination, and the establishment of policy-relevant data archive will be key activities for the Institute.

Irvapp intends to fulfil its mission also through the promotion and implementation of policy pilots. The use of pilots has been widespread in the USA and Canada, as well as in the UK. Irvapp wants to open up new opportunities, at both national and international level, for the utilization of policy pilots. The aim is to provide policy makers with an *ex-ante* test of the policy on a small-scale, that will help shaping and - if necessary - redesigning the final policy before being rolled out on a large-scale.

2.3. Activities and Work Plan

Research projects

– *Evaluating the impact of a Minimum Income Guarantee programme in the Province of Trento*

  The project evaluates the impact of a Minimum Income Guarantee programme, introduced in the Province of Trento in October 2009, on several outcomes: poverty, labour market participation and consumption behaviour. The Minimum Income Guarantee program is means-tested and aims at lifting out of poverty families living below the ICEF poverty line of 6,500 € per year, by topping their equivalent disposable income up to the above mentioned level. The outcomes of this policy are evaluated on the basis of data collected through a panel survey of participants and observationally equivalent non participants. During 2010, the first wave of data collection was completed, and preliminary descriptive evidence was produced. During 2011 the second wave of data collection will be carried out and, based on data from both waves, a timely *ex-post* impact evaluation will be performed. Beside, a

short questionnaire will be administered to the universe of programme beneficiaries to monitor their perception of the programme and its impact on material wellbeing.

– *Reconciling paid work and family responsibilities: The role of 'service vouchers' in the Province of Trento*

  The project aims at evaluating the impact of a program recently introduced by the Province of Trento and designed to help women to reconcile work and family responsibilities by alleviating the costs of childcare through voucher to subsidise the relevant services. Over the last year Irvapp has produced two reports using administrative data of recipients of the vouchers, to be discussed with the policy-makers of the Province of Trento. The follow-up for the year 2011 seeks to implement the policy recommendations provided by Irvapp and monitor their likely impact on the behavior of vouchers beneficiaries.

– *Merit-based financial aid to students from low-income families and its effects on university enrollment*

  The project is aimed at measuring the effectiveness of a means-tested intervention of the Province of Trento designed to reduce education inequality by increasing the transition rates from higher secondary school to university through financial aid, aimed at compensating indirect costs of university enrollment of good students from lower class families. In 2010 data on transitions from higher secondary school to university were collected, exploiting CATI and CAWI procedures. A working paper reporting the main results of the survey was produced together with an executive summary containing some practical suggestion that will be adopted (in 2011) by the Province of Trento in order to adjust and make more effective the intervention. In 2011 the process of data collection, regarding both the university enrollment of students who achieved a higher secondary school diploma in 2010 and the performances of university students enrolled in 2009, will continue. Hence, a longitudinal data archive will be produced. These longitudinal data will allow us to evaluate the effects of the measure on the transition rate to university, as well as its impact on the drop-out rates and the academic achievements of university students from lower class families who benefit from it.

– *Monitoring costs and evaluating effects of training vocational courses for employed and unemployed peoples in the Province of Trento*

  The goal of this project is twofold. On one side, it will compare the costs of training vocational courses supplied by the Province of Trento under the FSE rules and intended to act as an active labour policy to the costs of courses with similar purposes and characteristics but directly funded by the Province. On the other side, the project will consist of an analysis of the impact of these courses on both the career trajectories of the employed and the chances of finding a job of the unemployed.

– *Impact evaluation study of the new arrangements of labour policies in the Province of Trento*

  It is quite likely that during 2011 the Province of Trento, through *Agenzia del Lavoro*, will implement innovative passive and active measures of labour policy. Irvapp has been invited to evaluate the effects of these possible policies on some crucial outcomes such as: i) level of living of persons receiving either unemployment benefits or a wage supplementation fund (CIG); ii) duration of unemployment episodes of those getting passive labour measures; iii) employment chances of persons receiving active labour policy measures; iv) effectiveness of eligibility rules to active and passive labour policies in avoiding opportunistic behaviour; v) effects of labour policies on firms' size and behaviour.

– *Evaluating the impact of an anti-poverty measure in the Region Basilicata*

  In 2011 the Region Basilicata will implement an anti-poverty measure intended to guarantee that families with an annual disposable equivalent income below the threshold of 4,800 euro (according to ISEE rules) receive a money transfer. Irvapp has been invited by the Region Basilicata to assess the effects of this subsidy on the level of living of persons and families receiving it.

– *Evaluating the impact of a program of local development in the Region Basilicata*

  The Region Basilicata is promoting the development of the Pollino Lucano – the Basilicata side of the Pollino mountain – by enhancing its touristic attractiveness. We have available information on tourist flows at the municipality level for the whole area, from some years before the implementation of the programme to the years immediately after it. The identification strategy is a diff-in-diff's according to which the before-after variation of the outcome – the size of the tourist flow - in the municipalities where the manufacts have been laid down is compared to the before-after variation in the other municipalities.

– *Methodological proposal for the evaluation of incentives aimed at promoting strategic alliances among firms in the Region Tuscany*

  The project, assigned to Irvapp through IRPET (the economic research institute of the region Tuscany), is aimed at developing an articulated proposal about how to evaluate the effectiveness of public subsidies intended to promote strategic alliances and value-chain cooperation agreements among firms in the Region Tuscany. The evaluation methodology is designed on the ground of the specific industrial policies implemented by the Region Tuscany.

– *The project Cl@ssi 2.0.*

  The Cl@ssi 2.0 project is carried out in cooperation with the Italian Ministry of Education, the Fondazione "Giovanni Agnelli" (Turin) and the "Fondazione per la Scuola" (Turin). It seeks to evaluate the impact of ICT enhanced teaching on students achievement through the systematic comparison of a

paired treatment-control classrooms across a representative sample of schools in Italy. In the year 2010 the first wave of data designed to measure the initial educational achievements of pupils has been finalized, before the treatment group has been subject to the program. Irvapp has produced the first report based on this data showing that the treatment and control groups within each school have indeed a very similar level of educational achievement once some relevant individual and family characteristics of the students are controlled for. In 2011 the project will continue with the second wave of the data which shall allow us to measure the impact of the ICT technologies on the educational achievement of the students.

– *Evaluation of the "Maestro unico" reform*

  Starting from the school year 2009/10, the number of teachers employed in primary schools in Italy was sizably reduced by the roll out of the so called "Maestro unico" (One-Teacher) reform. In its bare essentials, the pupils to teacher ratio across schools was exogenously increased by switching from a regime of three teachers per class to a regime of just one teacher per class. We plan to carry out a feasibility study to look into the effects on the reform on cognitive development of pupils, thus linking up this reform to the international literature that quantifies the returns of cognitive and non-cognitive skills on outcomes determined at later ages in life. The feasibility study will consider the availability of existing (administrative or survey) data, as well as the possibility to collect additional information through new surveys suitably designed by Irvapp.

– *The Italian programme 'Liste di Mobilità': An analysis of the impact of its 'passive' component*

  The project aims at evaluating the impact of the passive component of "Liste di mobilità", an Italian labour market programme introduced to handle redundancies in the labour market. During 2010 we have linked data from the INPS (National Social Security Agency) administrative archives to the register of all workers entering the programme over the years 1995-1998 for the Veneto Region. Moreover we have prepared a useful dataset with the labour market history of all these workers over a time window from six years before the enrolment in the programme to three years after. In 2011 we aim at carrying out the analysis to identify and estimate the causal effect of the passive component of the programme.

– *Changes in the Italian unemployment insurance scheme and estimation of their effects on unemployment duration and transition to a new job*

  After exploratory analyses on a small sample, this project started recently using the new WHIP (Work Histories Italian Panel), which consists of a fairly large sample (1:15 sample/population ratio) of workers in the private sector and is updated to 2005 (made available by a research agreement with the Department of Economics, University of Turin). The project will exploit discontinuities of the Italian unemployment insurance (UI) scheme over time and across age groups - in maximum allotted duration and/or in the replacement rate -, in order to estimate their impact on the length of

unemployment spells and probabilities of re-employment. Preliminary, attention will be given to the role of eligibility conditions, which stayed unchanged, on restricting the number of eligible workers as the consequence of the diffusion of temporary jobs.

– *Whip4Policies*

  According to a research agreement with the Department of Economics, University of Turin, the project aims to develop a new database - Whip4Policies - specifically suitable for the evaluation of policies on public pensions and unemployment benefits. The reconstruction of the evolution of the regulatory framework over time, together with the conceptual design of a database, will end up with the generation of suitable algorithms, to be merged with the original WHIP dataset in order to assess the effects of policy changes.

– *Impact evaluation of the Nigeria Commercial Agriculture Development Project*

  The Commercial Agriculture Development Project (CADP) aims at strengthening agricultural production systems and supporting the dissemination and adoption of new technologies, for targeted value chains among small and medium scale commercial farmers in five participating states in the country. The impact evaluation will quantify the effects of the roll out of various project components in five pilot stats of the country. The data collection process, which is due to start in early December, will soon call for the development of the sampling scheme across pilot areas, and – later in 2011 – for the analysis of key economic and demographic indicators at baseline (i.e. before the programme roll out). During 2011 Irvapp will be involved in the development of the follow up survey, which will allow the research team to draw causal inference on the effects of the CADP during 2012.

– *Power calculations for the Minimum Detectable Effect*

  The aim of the project is to review the existing literature on the optimal design of social experiments considering statistical problems of longstanding concern in agricultural, biological, educational and social policy research, and to look into the possibility of addressing the same problem for non-experimental designs.

Training activities

2011 edition of Irvapp School

In February 2011 Irvapp organizes, in cooperation with the Istituto Veneto di Scienze, Lettere ed Arti, an advanced training course on “Fundamentals and Methods for the Evaluation of Public Policies” for Ph.D students and academic researchers. The course will take place on the premises of the Istituto Veneto, in Venice, The medium-term plan is to carry out the advanced course – or a similar initiative – once per year, in Trento and in Venice alternatively.

Seminars for the year 2011

In 2011 Irvapp will organise a series of seven seminars held by internationally outstanding scholars and regarding substantive and methodological topics related to impact evaluation of public policies. The seminars are addressed to Italian researchers in the field of public policies evaluation.

2.4. Collaborations

– Institution: THE WORLD BANK

Irvapp reference persons: Antonio Schizzerotto and Erich Battistin

Word Bank's reference person: Arianna Legovini, Head, Development Impact Evaluation Initiative.

The aim of this partnership is to collaborate on the impact evaluation of an important Development Project in Nigeria. The Commercial Agriculture Development Project (CADP) aims at strengthening agricultural production systems and supporting the dissemination and adoption of new technologies, for targeted value chains among small and medium scale commercial farmers in five participating states in the country.

Institution: DEPARTMENT OF ECONOMICS OF THE UNIVERSITY OF TURIN

Irvapp reference persons: Antonio Schizzerotto and Ugo Trivellato

University of Turin's reference person: Roberto Leombruni, researcher at the Department of Economics.Irvapp, jointly with Department of Economics of the University of Turin is going to develop a new database - Whip4Policies – derived from administrative information by the National Social Security Institute (INPS) suitable for the evaluation of policies regarding public pensions and unemployment benefits.

– Institution: MIUR/FONDAZIONE GIOVANNI AGNELLI

Irvapp reference persons: Antonio Schizzerotto and Enrico Rettore

Fondazione Giovanni Agnelli's reference person: Andrea Gavosto, President of Fondazione.

The aim of such collaboration is to assess the impact of the introduction of new learning technologies in the Italian lower secondary school system.

– Institution: IRPET

Irvapp reference person: Antonio Schizzerotto

IRPET reference person: Stefano Casini Benvenuti, head of IRPET

The purpose of this collaboration is to find some methodologically sound analytical procedures in order to assess the impact of the Region Tuscany industrial policy aimed at the promotion of strategic alliances and cooperation agreements among firms.

2.5. Specific Needs and Points of Attention

Due to the increasing number of projects and researchers involved in them, for the next year Irvapp is in need of office space. At the moment, we have reached full capacity.

Precisely because of the wide number of research projects to be carried out, and the variety of their topics, during 2011, Irvapp, as mentioned in section 2.1, is in need of launching 4-5 calls for junior researcher positions and 1 call for a senior researcher position. Irvapp is also in need of a Deputy Director to deal with general management problems, development (drafting, negotiating, reviewing) of applications and relative costing in order to establish international contracts for national and international research grants, and communication strategies .

Obviously, it is quite likely that during 2011, beside those listed above, Irvapp will be invited to carry out some other new research projects, besides those listed in the former section. A very important opportunity of new research activity could come from FAO. Indeed, Erich Battistin has been invited to chair the methodological session on program evaluation at the FAO workshop: "*Measuring the Impacts of Food Security Related Programming: Addressing Methodological Issues, Gaps, and Lessons-Learned scheduled*", to be held in Rome on the 6th and 7th of December, 2010. It will look into the possibility of providing FAO with technical assistance in the analysis of two national nutrition surveys, in Colombia (ongoing) and Mexico (upcoming), where the Latin American Household Food Security Scale will be included. In particular, it will be discussed whether Irvapp could be involved in the external validation of this scale, thus establishing tight partnerships with policy relevant research institutes in Latin America. Participation at the workshop will represent a unique opportunity for a feasibility study on the potential of starting new projects in developing economies.

3. Goals

Description	*Type*	*Scope*	*Time frame*	*Measurement mean*	*Pre-conditions*
Research activity	R	E	Dec.	15 research projects	
Research dissemination	R	E	Dec.	2 conferences, 6 seminars, 8 publications	
Promoting culture of impact evaluation	O	E	April	1 training courses	

Notes:

Type. I = Innovation; R = Research, A = related to improve financing; F = related to achieving internal goals; O = Other

Scope. I = Internal, E = External

4. Human Resources

Currently (i.e. end of November 2010) the Irvapp research staff is composed of an interdisciplinary team of 11 researchers in Economics, Sociology and Statistics, and 1 administrative secretary.

Antonio Schizzerotto, professor in Sociology at the University of Trento, is Director of Irvapp. Senior researchers are Erich Battistin (associate professor of Economic Statistics, University of Padova), Enrico Rettore (professor of Economic Statistics, University of Padova) and Ugo Trivellato (Director of Research and professor of Economic Statistics, University of Padova). Junior Researchers of Irvapp are: Carlo Gianelle, Silvia Girardi, Gianluca Mazzarella, Alvaro Martinez Perez, Loris Vergolini, and Nadir Zanini. Anna Stenghel is Irvapp's administrative secretary. As implicitly stated above in section 1, new junior researchers with welfare policies competencies and a new Deputy Director will be hired during 2011.

These new hiring are justified by the increasing amount of research projects the Institute will be carrying out during the year 2011. For the same reason, as already stated in sections 1 and 2, Irvapp is planning to further wide its junior research team.

Besides internal members, Irvapp can rely on the temporary cooperation of some external researchers. Obviously their contributions to the Institute is strictly related to specific research projects. They are Carlo Barone (researcher in Sociology, University of Trento), Adriano Paggiaro (researcher in Economic Statistics, University of Padova) and Roberto Leombruni (researcher in Economics, University of Turin). However, it has to be stressed that Irvapp is planning a progressive reduction of external collaborations.

AHREF FOUNDATION

1. Executive Summary

The aim of Ahref Foundation is to develop the means for studying the quality of information emerging from the social network ushered into existence by the internet and the digital media, with the aim of conceiving, designing, implementing, experimenting with and testing ways of incentivising improved quality of such information.

This in turn involves a whole range of topics requiring research and further study: the definition of "quality" and "information", familiarity with the social and technological dynamics of the networks of individuals going online and expressing themselves on the internet, the relationship between these digital networks and the wider social network developed in the region, understanding of the non-linear logic that can be perceived in the complexity of the information ecosystem, the creation of hypotheses regarding what could be termed an incentivising mechanism in this context, the roles and capacities of the various actors within the ecosystem itself.

The Fondazione Ahref was set up in 2010 and commenced operations only in the autumn of that year. To date its activities have centred on the necessary bureaucratic procedures, the process of refashioning its founding principles as a work plan, and the appointment of full- and part-time staff.

2. Vision and scientific/operational programm

2.1. Context, state of the art and vision

From the advent of the internet and the social media, the information ecosystem has seen accelerated innovation in all areas. Basically, the single most significant phenomenon has been the disappearance of technological and economic barriers to publication, resulting in a large increase in the number of those actively involved in the production of public knowledge. This has resulted in a shift in the strategic system of information filters from before to after publication. Which in turn has resulted in a new model for the information ecosystem.

The concept of information quality is one of the notions most affected by transformation. In the earlier model, quality was the implicit result of editorial filters, traditional authorities, and powers who were in a position to allow or disallow publication. These factors continue to exert their influence. But they are now forced to play catch-up with a situation in which everything may be published and is in fact published without a significant degree of preliminary online filtering; only subsequently can published work be located, assessed and interpreted using technologies and procedures that have been completely overhauled and are in constant evolution. The quality that was previously defined by filters prior to publication must today be evaluated *ex post*, on the basis of criteria and mechanisms that are only now in the process of being defined. The fundamental dynamic that has come about in this

new context is the activation of social filters, based on the action of the individuals expressing themselves, interconnecting, and recognising one another on the web, perhaps reconstructing elements of social capital that had been partially lost in the preceding age (or at least creating the conditions in which this might come about).

The quality of information in the age of social media is thus a research topic of prime importance, in part because it is fundamental to the construction of the common agenda of, and coordination among, the inhabitants of a region. Understanding the dynamics of information quality in the social media requires the ability to propose hypotheses on the feasibility of constructing platforms capable of incentivising quality, with programmatic refusal of any project involving "top-down" definitions that would not only be doomed to failure given the logic of the net but would also betray its historical task of rebalancing the social capital that had been lost due to the excessive influence of hierarchical media in the earlier model. Indeed, in the very attempt to understand how a body of practices might emerge that could influence the quality of information on the net using "bottom up" logic, it should be possible to renew the conception of information quality, improving the dynamics for creating a common agenda.

But such hypotheses, all of which require further study, have little chance of actually crystallising if pilot projects are not set up to test their viability. This activity of planning and of making actual proposals on the basis of hypotheses generated in research will be put into practice independently by Ahref or in association with other already existing facilities.

Structurally, the context of this research is multidisciplinary. The basic points of reference can be found in media literacy studies, but theoreticians of digital evolution, academic scholars of social capital, designers of the human-technology interface, critics dealing with new forms of narration and analysts of the media economy must all be counted as additional and valuable sources of knowledge. Furthermore, research must also draw on observations made by users, designers and businesspeople involved in the platforms that are tangibly changing the information ecosystem.

2.2. Main branches of research identified to date

– Definition of information quality. Development of quality standards for information research. Development of notions of quality for design, narration and the technological efficiency of platforms on which information is developed in the social networks.
– Analysis of notions of credibility, reputation and attention on the net in regard to the relationship trends emerging in social networks and their interrelation with dynamics of information. Factual control practices in social platforms
– Analysis of the quality of platforms devoted to recounting everyday life and of the social functions of the information exchanged there. Participants in social networks exchange news, photos, videos, and log on and greet one another first and foremost to talk about their own lives. Indeed, recounting one's own life is a fundamental aspect of the construction of social networks

and word of mouth. This aspect is in fact a way of creating information on everyday life and community life in a given region, but it also becomes a medium, made up of interconnected individuals. Moreover, this argument is also linked to the much-studied dynamic of hyper-local information, considered as one of the most promising dimensions for the future of the media.

– Applications of social networks for developing specific knowledge in the area of technology and science, understood as fundamental dimensions of regional development. This sector is particularly relevant and indeed crucial for questions linked to the quality and verification of information. Further study in this area could also have important knock-on effects on other sectors requiring particular attention to quality.
– Decoding and education of techniques of narration used and usable in the social media. Open data development opportunities linked to the transparency of quantitative information generated by public institutions. The language of video and media literacy. Rights and duties of citizens providing information.

2.3. Work plan

Every branch of research is organised by a work group, structured into a series of workshops, and analysed with a view to achieving verifiable work hypotheses. The technical solutions to be proposed are then readied and subsequently tested in the field.

Works terms and schedules are currently being drawn up.

2.4. Cooperation

Ahref Foundation will develop national and international cooperation on each branch of research and each verification activity.

The Foundation is open to contributions from new partners and supporters, taking the form of well-defined projects in line with its stated aims.

Its profoundly international scientific committee and the network of global contacts it has cultivated since its very inception certainly indicate that international cooperation will be effectively developed.

2.5. Particular needs and points requiring attention

Ahref research requires practical innovation and an evident openness to the logic of the web, fast-moving and profound at the same time. The main risks affecting Ahref's structure stem from the problems posed by bureaucracy rightly designed to manage resource flows in a transparent and standardised manner, thus potentially obstructing the speed required in the operations of a structure that must by necessity work to the rhythms of the web.

3. Ethical problems

Ahref Foundation is a not-for-profit, non-aligned organisation oriented towards co-operation. Everything is arrayed around the central aim of constructing a platform at the service of the media ecosystem, feeding and incentivising mechanisms that might bring about the emergence of practices or indeed companies – particularly of young people – in a position to take advantage of the opportunities offered by the social media in the information ecosystem. It is difficult to take a non-aligned approach in Italy. But serving the working public and its capacity to influence the common agenda necessarily involves firm resistance to any overlap between Ahref's research work and existing systems of partisan interest.

RESEARCH SUPPORT, ADMINISTRATION, AND FUNCTIONING

In support of research, administration, and functioning

The strategic horizon defined in the “Research activities Plan for the Program Agreement of the Bruno Kessler Foundation for the 2009-2013 period”, regarding the administrative support activities ensured by the Services system designed according to the organizational directives passed in July 2009, are confirmed for 2011. Please refer to the above mentioned “Plan” for a more organic representation of the reference context, long term goals and structural actions relating to the latter.

The projects and activities described in the “Partial Plan 2010” are included in the 2009-2013 planning as well, projects and activities which for continuity’s sake have been largely confermed for the year 2011 although with “higher expectations” after the the conclusion of the institutional and organizational transition stage and the stabilization of a more intelligible and organized system layout, within wider Province research and higher education sectors.

The “higher expectations” with regards to the nature and functions of the Research Support Services are explicitly sanctioned in the “Program Agreement 2011-2013” which, filling a gap in the Province programming, identifies – at least over the medium term – goals and results to be pursued and criteria and standards that should inspire the operational dimension of the foundation. Furthermore, they will, as far as the system support activities of the Foundation are concerned, take dispositions for the annual and long-term budgeting of the Autonomous Province of Trento included in the 2011 Province budget law aiming at control and rationalization of expenses and at streamlining of organizational structures. Consequently, in order to facilitate a more precise cost and overhead analytical evaluation, the accounting partition of the administrative activities among “support”, “administration” and “operation” remain unchanged. This allows to strengthen the process, not only from the accounting standpoint, through which it becomes possible to better highlight the specific nature of costs generated by the overall activity of the foundation and at the same time to guarantee the formal conditions necessary to qualify the expenses in a more incisive way. In more detail, in 2011 – once the new regulations system and operational guidelines are in place – the system of service procedures and paperwork, linked to the measurement system ensured by the Evaluation Core started in 2009, will be implemented. This operational approach is ensuring and will ensure in the future, without larger resources, a significant increase in productivity and performances offered by Support services both internally and to the multiple entities bound to the Foundation by the Program Agreement.

Furthermore, the operational start of the actions needed to the gradual introduction of the new information system will strengthen the streamlining effort undertaken through the transition of the Foundation. Such process, thanks to article 12 of the Program Agreement 2011-2013, is now enhanced by a new system awareness

without whom even the Foundation design risked to prove inevitably limited. Once the verification process of the suitability of the information model in use and its performance has been finalized, the year 2011 will be dedicated to the configuration and testing of a first “package” of information solutions in adherence to the operational model which has in the meantime established itself in the space in which the Foundation acts as a junction in an articulated system of functions and players.

At this point we have to underline that the turnover of the personnel involved in all administration, support and operations services, already under planning, has deliberately been linked to the rate of implementation of the new information system and adequately integrated.

With reference to the structural actions destined to remain unchanged from the administration models which had characterized the organizational and administrative dimension previous to the reform plan, the year 2011 will see the full operation of the evaluation system of executive officers and managers, the extension of such system to line leaders and, after the pilot on inside customers, the start up of an analysis of the customer-provider environment. At the same time the year 2011 will see the consolidation of premium systems bound to administrative procedures increasingly based on merit, transparency and traceability principles and criteria.

Regarding personnel policies, during 2011 – together with the consolidation of the administrative system of the multiple and diverse contract platforms present in the Foundation and the end of a group of important pilot projects designed to enhance the intrinsic potential of the complex structure according to the new system in the foundation on one hand, and the new research contract on the other hand, we will see the full operation of an organic plant of policies and actions specifically targeted on the cycle of professional life and on the individual trajectory of research employees. Please refer to the “FBK Professional System Project”, already under testing, for further details.

The reorganization of the entire administrative area was guided by the new accounting drivers presented by the passage to a private accounting and by the parallel running of financial practices still in use as far as the reference shareholder is concerned. Such reorganization, following also system decisions inspired to the achievement of a new corporate culture, approaches the year 2011 strengthened by the European certification regarding the valorization of personnel costs. All actions needed to qualify the most important non-Agreement financial procedures of the Foundation will be conducted in accordance with the operational model validated by such certification. With reference to the Program Agreement, in view of its definitive implementation, the year 2011 will represent the stable configuration of the procedural model, both regulatory and operational, of the financial relationship with the reference shareholder.

With regards to the Support services for the humanistic pole, during 2011 – with the benefit of the completed scientific reorganization of its Study and research centers – those operational procedures and organizational decisions which cannot be postponed any further, will be fully enforced. The implementation of open access policies, which in the future will be applied to the results of scientific research as well, will enter a stage of increased tangibility and so will the administration of the

editorial and library dimensions; the latter – started during 2010 in adherence to the pursuit of a wider system vision – will be greatly enhanced thanks to a radical revision of the current alliances and partnerships.

During 2011 the internal and external communications and marketing units, having consolidated the significant improvement achieved during the past three years of activity, will focus their effort mainly on the areas of the visibility of the distinct characteristics of the Foundation in the international scenario and on the social network. In accordance with the budget dtrectives, the year 2011 will represent an important time of strategic reassessment of the communication pattern and experimentation of new operational solutions. As far as infostructures and IT services are concerned, the year 2011 will conferm the strong innovation drive of the whole system controlled by Technology Innovation through the development of the architectures needed to support the strong convergence in the field of electronic services offered by subjects of the research and higher education systems and the creation of out-and-out platforms for the management of shared services. The introduction of both a new information system and a communication system able to benefit, also budgetwise, from the significant potential represented by the digital technology will entail an additional and extraordinary effort.

The action undertaken on the operations field, considering the extraordinary actions required after years of general neglect, has already been suitably made up in the investments area; please refer to the relating “program plans” for a better understanding of actions anticipated for 2011. It is however worth reminding that, as throughout 2010, efforts will be multiplied in the areas of reorganization and renovation of indoor spaces, the implementation of the plan for high energy efficiency works, the sustainability project, and the contracts of the most important service currently being outsourced.

STRATEGIC INVESTMENTS

Labs and instrumentation

During 2011 some specific action must be implemented to support the technological capabilities of CMM Laboratories. This mainly means specific investment in MTLab and MiNALab to upgrade the existing equipment as well as the covering of technical vacancies.

Referring to MTLab, in 2011, while the systems bought in 2010 (a wet bench for 6" wafers and a scrubber) will be installed, investment will mainly be finalized to upgrade the furnaces, at present the major block to proceed towards the 6" wafers upgrade of the Microfabrication line, since they are not upgradable. The chosen strategy foresees the acquisition of a group of furnaces supporting both 4" and 6" wafers, thus enabling the operation with 4" wafers till the final decision of the general upgrade will be taken. The substitution is a strategic choice that must be done in any case. The software controlling the furnaces is so old that there are not alternative solution on the market. In case of crash the entire line would be stopped for many months, thus realizing an extremely critical situation with respect to the several commitment already in place.

During 2010 MiNALab performed some relevant investments:

An innovative PTR-MS system (Proton Transfer Reaction Mass Spectrometry) to realize an analytical platform able to detect ions produced by different sources has been acquired and a state of art XPS has been purchased, in order to improve the analytical capability in the electronic field improving in particular the lateral resolution characterization. An SEM/EDS upgrade related to spectroscopy detector and instrument software was also done, while a new XRD/XRF custom based on internal project has been ordered

All the listed instrumentation will be installed during 2011. They represent an important improvement of the analytical labs and a new set of facilities available for the surface materials community.

During the 2011 are also planned two new investments. The former is an upgrade of the X-rays diffraction APD 2000 (italstructures), the latter is a plasma cleaner and critical point dryer for improving the sample preparation methodology for microscopy and spectroscopy techniques.

Building Plan

FBK has submitted to the Autonomous Province of Trento, within the framework of the Programme Agreement, a building plan that includes the works envisaged in the 2009-2013 period plan. It includes works intended to improve institutional activities (laboratories, offices, communal spaces) and for services aimed at improving the quality of life on site and encompassing also subjects external to the Foundation, such as the scientific hub of the University and its resident population. Such works would include, among others: a new service centre with cafeteria and snack bar, a reading room, a fitness room, a kindergarten and a welcoming structure for other age groups (space 0_100), as well as the expansion of the space available for the University library and a conference centre. The LEED NC (new construction) rating system will be applied to the new buildings, in compliance with the choices made by the Province for its work projects.

Among the restructuring works on the existing structures, of particular significance is the energy efficiency enhancement project designed for both the technological systems and the outer walls of the buildings, for which forms of Provincial and State aids are being sought.

For 2011 we anticipate special works of three kinds:

- Reorganization and redevelopment works of research and administrative activities (core activities) spaces
- works aiming at improving security conditions of the buildings and the technical systems
- environmental sustainability and energy saving works

The internal renovation of 1.100 square meters of offices, laboratories and meeting rooms for a total 125 work stations destined to the FBK research units and to the first phase of the new Trento-RISE installation are included as part of the first typology.

Works aiming at security improvement of the buildings will include the replacement of the obsolete climatization systems and the retrofitting of the outer linings. Works of reclamation of the construction components, doors and windows, and sewage system will be performed. Additionally, outside works will be carried out in order to increase security levels of the areas sorrounding the buildings which house systems or research equipment.

Sustainability works will include the extention of the LEED EB&OM certification process to the Povo buildings and energy efficiency works for the East Building in Povo, partially financed by the Province of Trento, upon qualification as an environmental protection project.

The foundation is verifying also the possibility of obtaining sponsorship for the new bar-cafeteria structure, whose project has already been approved by executives, and which should provide high quality service to personnel of the foundation, their partners' and to university staff of the neighbouring School of Science.

Information Systems

Fondazione Bruno Kessler will undertake a major structural investment in the information systems area, supporting two major programs aimed to support the reach of FBK's strategic objectives. The first program was launched to redefine FBK's organizational and operational model, while the second program is more related to increase efficiency, effectiveness and quality by replacing current systems with a more centralized and robust corporate information system.

The organization and operation model redefinition is underway, and many results have already been achieved. There are anyhow still some areas that have not been addressed yet, and implemented changes that require minor reviews to fine tune them based on the experience gained after change implementation. The proper definition and adoption of a new information system is essential not only to support the new model implementation, but also to acquire feedback on the new organization model itself.

Regarding the second program mentioned, we need to address inefficiencies and duplications due to the use of multiple systems, and streamline corporate processes and information flows. Major side effect of current multiple systems complexity are data quality issues, and inefficiency driven by the complexity of the handling of not uncommon errors or exceptions.

The overall new information system adoption plan, that should last at least three years, shall initially focus on Human Resources, subsequently extending to the administration and accounting areas and to resource management. Overall change management processes need to be defined in order to make it easier to handle interactions with the current systems complexity.

Various activities are envisioned for the year 2011:

- Gather and update requirements, by adopting a requirements and feedback review model;
- Introduce solution change management governance and guidelines (FBK wide);
- Detailed program definition (including project charters, communication plans and key roles);
- Initial team setup, identifying and engaging decision makers, stakeholders and key users;
- Selection of ERP software suite and modules, of suppliers and of project partners;
- Implementation Team setup, identifying and engaging programmers, trainers, testers;
- Development, deployment and adoption of an ERP for Human Resources solution;
- Requirements gathering, solution proposal and solution validation for the administration and accounting areas.

Financial planning 2011

	2011		
Polo scientifico e tecnologico	**Costi**	**Ricavi**	**AdP**
CMM	9.805.523	4.770.750	5.034.772
CIT	11.680.836	5.611.927	6.068.909
Pool di Segreteria	169.602	0	169.602
ECT	1.859.477	1.347.296	512.181
Cefsa	650.176	22.830	627.346
Create-Net	2.950.000	0	2.950.000
Cirm	237.000	40.000	197.000
Graphitech	400.000	0	400.000
CELCT	270.000	0	270.000
AHREF	1.000.000	0	1.000.000
Progetto HAIFA	161.269	68.382	92.888
Progetto MITLAB	643.940	0	643.940
Progetto MEMS2	911.854	911.854	0
Progetto AURORA	664.552	664.552	0
Spin-off	400.000	0	400.000
Polo umanistico			
ISIG	1.158.871	34.614	1.124.258
ISR	802.934	22.000	780.934
IRVAPP	760.000	0	760.000
Valutazione	322.694	0	322.694
Grant Office e Trasferimento Tecnologico	1.008.879	19.039	989.839
Supporto al polo umanistico	854.474	51.000	803.474
People Innovation	808.415	0	808.415
Technology Innovation	587.113	0	587.113
Legale	169.822	0	169.822
Sicurezza	285.713	0	285.713
PS FBK	622.556	32.019	590.538
Organi Istituzionali	954.752	0	954.752
Amministrazione contabile	2.264.505	0	2.264.505
Amministrazione del personale	620.976	0	620.976
Acquisti e Appalti	681.952	0	681.952
Servizio Tecnico	315.050	0	315.050
Plessi	2.599.940	0	2.599.940
Costi comuni	3.156.612	870.000	2.286.612
Investimenti strategici	1.439.000	0	1.439.000
Piano edilizio	1.220.000	0	1.220.000
Nuovo Sistema Informativo	74.389	0	74.389
RICERCA CORE	29.146.035	13.494.205	15.651.830
RICERCA PARTECIPATE	5.380.000	0	5.380.000
SUPPORTO ALLA RICERCA	4.659.665	102.058	4.557.607
AMMINISTRAZIONE	4.522.184	0	4.522.184
FUNZIONAMENTO	6.071.602	870.000	5.201.602
PIANO DEGLI INVESTIMENTI	2.733.389	0	2.733.389
TOTALI	**52.512.875**	**14.466.263**	**38.046.612**

Copertura dei costi a carico ADP	2011
Fondi ordinari AdP	32.900.000
Fondi SIEP	1.000.000
Utilizzo risorse andate in economie sul piano edilizio fase 1	905.116
Economie	579.496
Traslazioni da anni precedenti	2.662.000
TOTALE	**38.046.612**