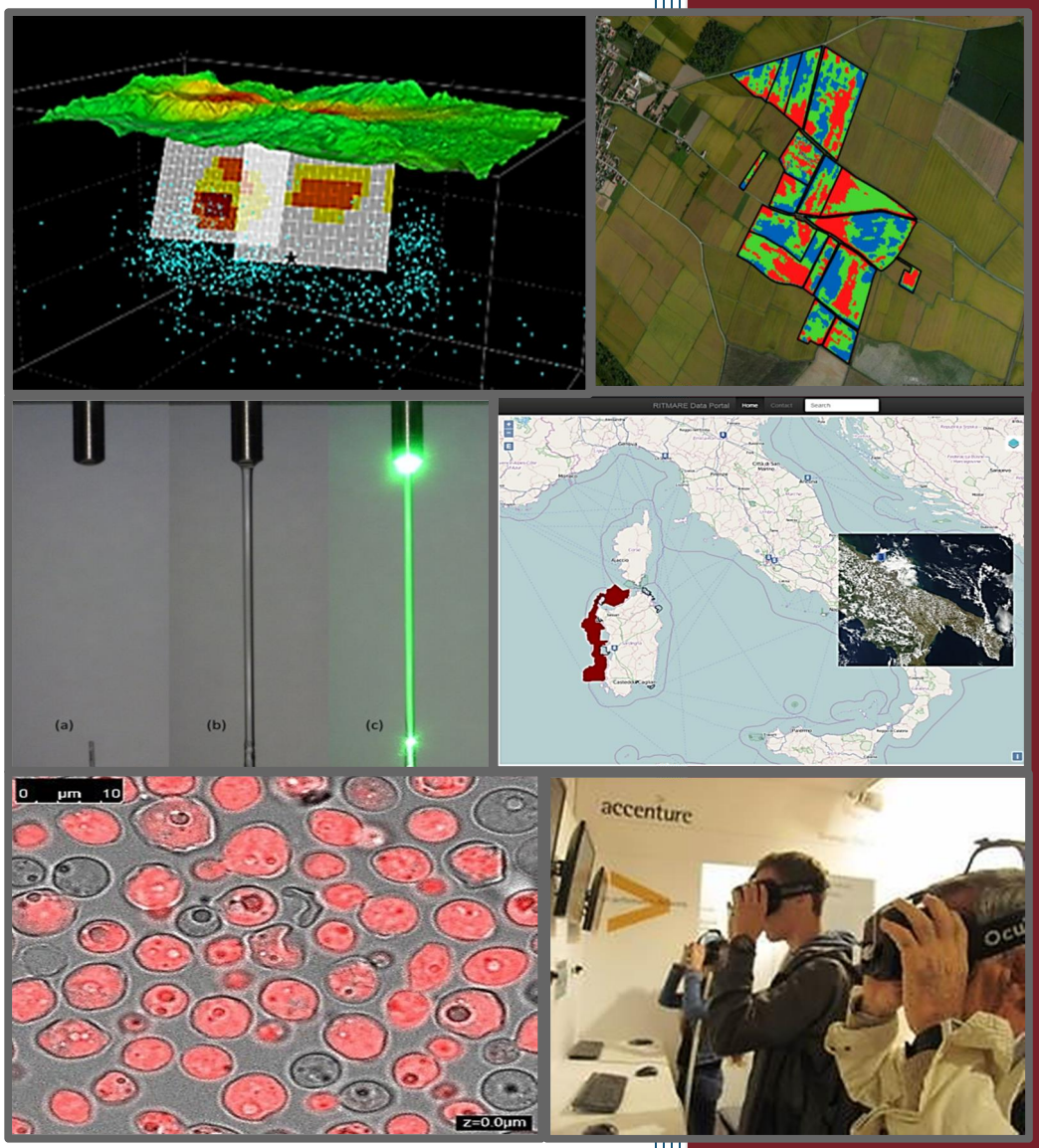
National Research Council of Italy

Institute for Electromagnetic Sensing of the Environment (IREA)

Report of activities 2013-2016



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Edited by Maria Consiglia Rasulo

On the cover

1. Modeling of Amatrice's earthquake source of August 24th from data detected through satellite radar interferometry techniques.
2. Precision farming applications: classification of rice fields in areas with low (red), normal (green) and high (blue) vegetative vigor. The maps, derived in this case by the RapidEye image analysis, can be used to implement Variable Rate Fertilization (VRT) agro-practices.
3. Optofluidic jet waveguides for liquid monitoring.
4. Rhythm Data Portal (RDP), unique data and metadata access point shared by institutes or research groups (nodes) involved in the Spatial Data Infrastructure (SDI). RDP allows both to explore the data and metadata delivered by the autonomous and distributed nodes of the SDI, and to simultaneously display different types of information relevant to one or more geographic areas, making it accessible not only to researchers from different disciplines but also to any user who has access to the network.
5. Oleaginous yeasts exposed to pulsed electric fields and stained with propidium iodide
6. Some participants in Food Futuring Tours (FFT), a cycle of workshops on the future of food organized by IREA in collaboration with EC JRC under Expo2015 in Milan. FFT is a public engagement initiative where, through participatory methodologies, a hundred Expo visitors reflected on the impact of science and technology on the food system and produced some scenarios on the future of food.

Preface

I am proud to present the fourth volume devoted to the activities carried out at the Institute for Electromagnetic Sensing of the Environment (IREA) over the last four years. Our reports are now important means of information and communication outward from an Institute that, thanks to the existing expertise, its multidisciplinary and scientific vitality, has grown a lot (not only numerically!) in the 16 years since its foundation. Indeed, in these years IREA has become a reference point within the research areas in which it operates and one of the excellence Institutes of CNR, as confirmed by the assessment of the CNR Institutes concluded in 2015 and the outcome of the Quality Evaluation of Research (VQR) carried out by the National Agency for Evaluation of the University and Research System (ANVUR), which ended in December 2016.

The purpose of the volume is to promote and disseminate the acquired scientific knowledge also outside the scientific context, in order to intrigue and motivate non-experts towards concepts that are often considered difficult to understand, if not out of everyday reality.

By reading the following pages one can capture the high social impact, as well as the scientific one, of the research activities carried out at IREA, which help to give answers to very important issues in relation to major challenges in areas ranging from the monitoring of environment and territory, safety, protection of strategic infrastructure, development of technologies for the sustainable management and protection of cultural heritage, till to agribusiness, healthcare and health.

Leafing through this volume the reader can find a brief description of the main research lines carried out, the list of the scientific production in the four years and the short profiles of researchers and technical and administrative staff, as well as the list of contracted staff, associated and in training. They all contribute daily to the research activities and to the Institute functioning. Then, the projects in which the Institute participated, even with a coordinating role, are briefly presented.

The volume ends with the main news published on the IREA website in the past four years, through which some important scientific results or events that involved the Institute have been highlighted.

A special thank for the precious work done goes to Maria Consiglia Rasulo who took care the design, drafting, and graphics, and to all the IREA staff that contributed to the realization of this volume.

Riccardo Lanari
Direttore IREA

Indice

Introduction

The Institute for Electromagnetic Sensing of the Environment (IREA) carries out research activities related to the development of methodologies and technologies for acquisition, processing, fusion and interpretation of images and data obtained by electromagnetic sensors operating on satellites, aircrafts and in situ, aimed at monitoring the environment and territory, non-invasive diagnostics and electromagnetic risk assessment. In addition, methodologies and technologies for the realization of geospatial data infrastructures and biomedical applications of electromagnetic fields are developed. Attention is also devoted to activities of investigation, research, and experimentation on the public communication of science as well as to activities on science education.

IREA is part of the largest public research institution in Italy, the National Research Council (CNR). It is committed to the "Engineering – ICT and technology for Energy and Transports" Department and participates in the activities of the "Earth System Science and Technologies for the Environment" Department. In addition, the Institute is involved in research projects in collaboration with the Department of "Social and Human Sciences - Cultural Heritage".

Similarly to the findings from the evaluation process of the CNR Institutes concluded in 2010, the latest CNR assessment, completed in 2015, and the one carried out by the National Agency for Evaluation of the University and Research System (ANVUR), which ended in December 2016, confirmed the positioning of IREA in the band of excellence of the CNR Institutes and, more generally, of the national research system.

IREA is a highly multi-disciplinary reality, having internally consolidated skills in the fields of microwave and optical remote sensing, electromagnetic diagnostics, computer science for the management and treatment of geo-spatial data, geophysics for the study of geological processes starting from remote sensing data, bioelectromagnetics for assessing the risk of exposure to electromagnetic fields and their possible applications in medicine, as well.

The research activities carried out meet the important needs of scientific and technological development of the Country. They have numerous application outcomes in areas of strategic importance such as environment, security, safety, and health.

The monitoring of the environment and territory is achieved through the development of advanced methodologies for airborne and satellite image processing, in situ measurement acquisition and elaboration, as well as geographical information treatment. The activities are very well framed in the European program for Earth Observation "Copernicus", whose purpose is to provide accurate and timely information on the territory and the environment that surrounds us. Many techniques of Earth Observation have been developed at IREA over the years with important implications in various application areas.

Particular attention is devoted to the agricultural sector that must face important challenges due to the continuous pressure of global demand for food, particularly in

developing countries. The analysis of satellite images of the Earth's surface allows crop mapping and monitoring of their status as well as tracking their vegetative development and maximizing yields. In this framework, IREA was engaged during the last three years as the coordinator of a European project (ERMES - An Earth obseRvation Model-based RicE information Service) for the development of services based on satellite data to support the system of rice production in Italy and Europe, with the long-term goal of exporting these technologies to African and Asian countries. Another important application based on high-resolution images (satellite, aircraft, drone), called 'Precision Farming', allows analysis of variability inside the field and its relationships with germination problems, nutritional or water deficiencies, and the translation of remote sensing data into information directly employable for business management.

IREA also has considerable expertise in the use of Earth Observation Technologies for the monitoring of inland aquatic ecosystems (lakes and lagoons) and coastal areas, in particular for the detection of algal blooms, the growth and areal evolution of the submerged vegetation and the control of discharges. Among water resources, natural and artificial lakes are the main reservoir of fresh water. The health of these ecosystems depends on the presence of substances of different origin such as nutrient concentration, suspended solid particles resulting from soil erosion, the presence of heavy metals and pesticides introduced by humans. Improper use of these substances can seriously alter the hydrological equilibria of water bodies; therefore, the control and management of the water resource is strategic and imperative. In this field, satellite technologies, which allow you to monitor large parts of the territory with frequent and continuous observations over time, are a valuable tool for analysis. The Institute involvement in various national and international projects has enabled the consolidation of its image analysis ability, implementation algorithms and codes used to generate different types of products needed for water monitoring.

The issue of security is central to IREA research activities. Increasing the level of safety and security of European citizens is another important challenge of Copernicus as well as of Horizon 2020, the principal program of the European Union for funding research and innovation, which aims to contribute to the achievement of the goals specific to the Europe 2020 Strategy. One of the objectives is to increase the society resilience with respect to natural disasters or human-caused accidents, through the development of innovative solutions in the field of crisis management and the protection of critical infrastructures. In this framework, IREA activities on Differential SAR Interferometry are included, thanks to which it is possible to detect even small deformations of the Earth's surface by satellite. In this context, IREA researchers developed an innovative methodology widely used internationally, called SBAS (Small BAseline Subset), which allows the study of the temporal evolution of ground deformation phenomena. Measuring these deformations is of utmost importance for risk prevention and support for decisions in times of crisis. Indeed, in volcanic areas deformations are often precursor signals of eruptions or anyhow index of an increase in volcanic activity. The detection of deformations is also of great importance for earthquakes and landslides study. In this context, IREA, which is a Competence Center for the Civil Protection Department, provided useful information on deformation caused by the seismic events that hit Central Italy from August 2016. In addition, IREA participates in the monitoring activities of Campi Flegrei Caldera. These activities have strongly benefited from the data provided by the SAR constellation Sentinel-1 of the Copernicus Program. The carried out studies have not been limited to the national territory but have produced important results for or the understanding of seismic events, such as that occurred in Nepal in April 2015 and in Chile in September 2015, and volcanic phenomena such as those relating to the Yellowstone Caldera and the Wolf Volcano in The Galápagos Islands. Starting from satellite information and from in situ measurements, IREA researchers have then realized various models of the sources responsible for the observed deformations. The developed inversion methods have allowed us to describe their shapes and locations. In addition, IREA has contributed to the development of advanced techniques for the processing of high-resolution SAR data acquired by airborne sensors. They have important applications for the generation of digital terrain and ground deformation maps, with potentially significant benefits in Civil Protection scenarios. Thanks to the satellite SAR tomography techniques developed at IREA and awarded by the IEEE Society, it is now possible to perform 3D reconstructions with high detail and monitor the deformation

of singular buildings and infrastructures. In this case, as well, the possible applications are very relevant.

The integration of optical and SAR remote sensing data is a recent study topic at IREA, but it has already demonstrated the complementarity of the two systems for fire and crop monitoring. Optical data allows observing and monitor the various vegetation characteristics such as biomass, chlorophyll content, photosynthetic pigments and water content, but they are limited due to signal saturation under high biomass conditions. SAR data, instead, allows penetrating the upper layers of vegetation. A multi-source approach, therefore, allows exploiting the specificities and overcome the limits of each acquisition technique. The synergistic use of these data is certainly a promising approach for the future, especially in view of the full operation of the Sentinel-1 and 2 satellite missions of the Copernicus program, which make available optical and SAR data with significant resolutions (geometry and radiometry) and in a completely free way.

In the field of environmental monitoring technologies, optical sensors for in situ investigations play a particularly important role as they provide high sensitivity, fast response times and high selectivity. In particular, at the IREA optoelectronics laboratories fiber-optic sensors based on Brillouin's stimulated scattering have been developed. They allow monitoring deformations and temperatures over distances up to tens of kilometers. This enables to realize extensive monitoring networks, demonstrating in recent years huge potentialities in monitoring the structural integrity of buildings and large transport infrastructures, such as bridges, viaducts and dams, a crucial aspect for the prevention of natural disasters and to guarantee the security of people and things. These sensors were also successfully used in determining the temperature profile in exploration wells in areas of volcanic interest, in wells designed to assess the geothermal potential of the subsoil, and, more recently, in high-resolution (cm) structural monitoring of aeronautical structures made of composite materials. The results of this research led to the filing of two patents, the first of which is currently under extension to the United States and Europe. Another interesting technology developed at IREA in the field of in situ environmental monitoring is related to the development of optofluidic sensors, miniaturized optical sensors for monitoring liquids where the sample liquid is an integral part of the photon structure. This approach enables the creation of fully innovative devices, the so-called miniaturized laboratories, a new and promising technology that is intended to reproduce the analyses traditionally carried out in the laboratory on a micrometric scale. Thanks to the optofluidic sensors, it was possible to determine the presence of nitrates in water and quantify the presence of pollutants with high mutagenic and cancerous power.

The methodologies of processing data from geo-radar and imaging beyond the obstacle, developed at IREA as part of electromagnetic diagnostics in situ, are issues of great relevance for safety too. They allow obtaining detailed information on the state of conservation of the good or of the monitored structures and detecting possible risk factors through a non-invasive monitoring. Very significant are also the most recent developments related to technologies for the enhancement of cultural heritage, with particular regard to aspects of its conservation and safeguarding. These activities have led to the realization and development of sensors and electromagnetic detection methods that have generated considerable interest. To confirm this, IREA actively collaborates with the Special Superintendency for Archaeological Heritage of Pompeii, Herculaneum, and Stabia of the Ministry of Cultural Heritage and Tourism. In this context, IREA contributed to the organization of the "Geophysics and Remote Sensing for Archeology" School, which was held in Pompeii in May 2016.

Another central theme in the Europe 2020 strategy, highlighted by the recent "Digital Agenda" of the European Commission, is the interoperability between information systems, including those related to spatial information. For years, IREA has been studying techniques for the integration of multisource geographic information and has been dealing with the development of e-infrastructures to share on the web the geographic data that the Institute itself largely produces. The activity makes direct reference to the European Directive INSPIRE (Infrastructure for Spatial Information in Europe), which aims to make spatial information of the various European countries compatible and usable in a cross-border context. To confirm the value of the activities carried out in the field of

e-infrastructure development, IREA was responsible for the implementation of data infrastructures of the flagship project RITMARE, the main national research project on the sea of the five-year period 2012-2016. In this framework, IREA developed the open source software suite "GET-IT (Geoinformation Enabling Toolkit) starter kit" whose brand was registered in November 2015. It allows publishing on the web, through standardized OGC (Open Geospatial Consortium) services, not only maps but also observations acquired by sensors and it can be used by a broad spectrum of users to make the INSPIRE directive more operational and ,therefore, more effective. The software includes the EDI editor that guides and assists in metadata creation and publication according to the INSPIRE standards, thereby addressing the challenges of quality and coherence of geographic information. In 2016, this software was reported as a new tool for all Public Administrations committed to enhancing their territorial data assets by the National Directory of Territorial Data.

More recently, IREA researchers have focused on the study, development, and implementation of distributed systems for satellite data processing, with particular reference to cloud platforms, capable of hosting large archives of satellite data and providing considerable computing resources. In addition, IREA contributes to the implementation of an IT platform for the massive and automatic exploitation of Earth Observation satellite data within the ESA project GEP (Geohazard Exploitation Platform) and participates in the project for the implementation of the European infrastructure EPOS (European Plate Observing System) that aims at a better understanding of physical and chemical processes that cause Earthquakes, volcanic eruptions, tsunamis, ground instabilities, and processes that control the tectonics and dynamics of the Earth's surface. In this context, IREA is responsible for the entire work-package on the use of satellite data.

Regarding the research activities related to healthcare and health, they can be grouped in two main research streams. The first one is devoted to the study of non-thermal biological effects of low and high-frequency electromagnetic fields, with the goal of providing useful information to the development of safety standards for population exposure. In this field, IREA participates in the World Health Organization working group and other groups of experts at the international level (European Commission, Swedish Radiation Safety Authority, IEEE) for the review of the scientific literature on biological effects of non-ionizing electromagnetic fields, in order to release informational scientific reports. More recently, another activity has been complemented to this "historical" one of IREA, with the purpose of exploring the possibility of using electromagnetic fields for new clinical and diagnostic applications. In this framework, IREA researchers are engaged in the development of innovative technologies for diagnostics and therapy based on the use of electromagnetic fields at microwave frequencies. In particular, they are involved in the development of a novel technique for the early diagnosis of breast cancer and of innovative protocols to broaden the application spectrum of electro-chemotherapy, a technique used for cancer therapy that is based on the use of pulsed electric fields in combination with cytotoxic molecules. Moreover, interactions between electromagnetic fields at microwave frequencies and nanoparticles are studied. The latter, by selectively binding to tumor cells, on the one hand increase their identification on the other facilitate the localization of the therapeutic treatment.

Many others are the themes on which IREA researchers work, such as the study of the properties of materials and artefacts using TeraHertz frequency sensors, the analysis of territorial planning and the effects of soil sealing due to the territory cementation, the development of remote sensing techniques to estimate the characteristics of marine ice, currents and wind fields on the sea surface, also thanks to the development of innovative radar systems for sea state monitoring.

Offices

IREA has its headquarters in Napoli and a secondary location in Milano.

The headquarters of Napoli (as at 31/12/2016) houses 35 nits of structured staff, 14 research fellows and many young people in education with PhDs, scholarships, internships and thesis. There are four major research infrastructures: a cluster for remote sensing data processing, a laboratory of electromagnetic diagnostics, an optical and optoelectronic sensing laboratory and a bioelectromagnetics laboratory.

At the secondary location of Milano, there are 25 24 units of staff and 12 research fellows.

It is equipped with a laboratory of optical-electronic for activities of calibration/validation of remote sensing data.

In Sirmione del Garda (Brescia) there is another site, the Experimental Station "Eugenio Zilioli". In its spaces, several scientific activities are carried out, in particular, those related to the study of the lake water quality, and the activities of dissemination and environmental education. In addition, the Experimental Station houses the Centre for Environmental Detection of the Municipality of Sirmione with whom it collaborates on several topics related to the study and control of the Lake Garda area.

Napoli
Headquarters

Milano
Secondary Location

Experimental Station "Eugenio Zilioli" Sirmione del Garda (Brescia)

The new IREA headquarters inside the CNR Technology Hub in Napoli

On February 4, 2016, the new headquarters of the CNR Technology Hub in Napoli was inaugurated. It will house the Institute for Electromagnetic Sensing of the Environment (IREA) and the Combustion Research Institute (IRC), thus becoming a multidisciplinary research area in the fields of the electromagnetic monitoring of environment and territory, the control and reduction of pollutants produced by burning fossil, biomass, biofuels, and waste.

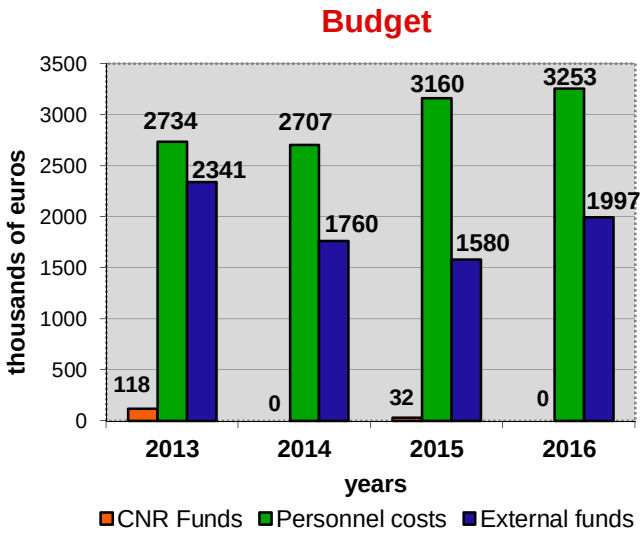
The complex, of about 10,000 square meters, is distributed on three floors and is located in Via Marconi. It will host more than 120 researchers, technicians, and administrative staff and will allow having more functional environments and equipment for the research activities.

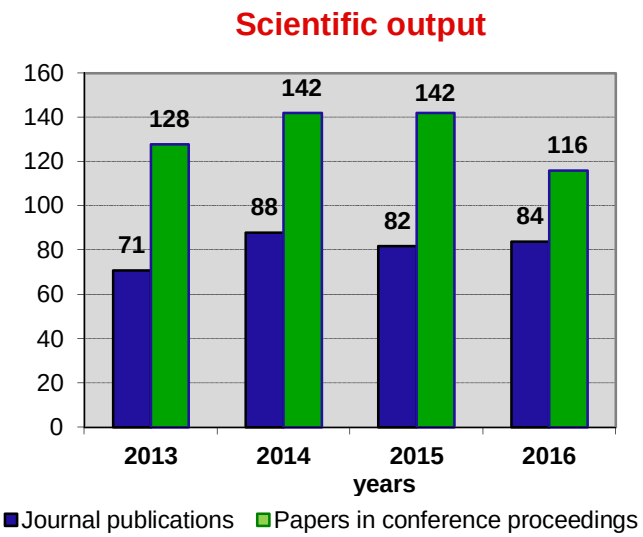
For its building both the application of the latest methods of construction in seismic areas and advanced methodologies for energy efficiency have been used.

Budget and Performance

IREA can be considered an institute in "health", with a remarkable capacity for self-financing and scientific production.

The analysis of data relating to IREA funding and to the scientific output in the period 2013-2016 shows both a remarkable ability to find external financial resources, resulting from participation in national and European research projects and from cooperation with industries, and a high scientific output, characterized by publications in the most prestigious journals in the reference sectors.





Collaborations and relationships with the socio-economic reality

IREA is fully integrated into the national and international research context. The Institute has strong collaborations with many Universities and Research Centers, both national and international, as well as with companies and local Institutions, above all in the Campania and Lombardia Regions.

Large and prestigious is the set of funding bodies of the research and development activities carried out by the Institute. Among them, there are the European Commission, the European Space Agency, the Italian Space Agency, the Civil Protection Department, Regions and Local Authorities, various domestic and foreign companies. IREA is a Center of Competence of the Civil Protection Department (DPC) for the satellite monitoring of ground deformation, participates in the National Interuniversity Consortium for Telecommunications (CNIT) and in the Interuniversity Center on Interaction between Electromagnetic Fields and Biosystems (ICEmB). The Institute is part of the SPIN-IT platform, the National Technological Platform dedicated to Space, and the National Technological Platform on Security SERIT (Security Research in ITaly). Finally, The Institute has actively contributed to the activities of to the Italian Cluster for Aerospace Technology (CTNA).

IREA is also very well rooted in the territory. It participates in two centers of competence of the Campania Region, respectively on "ICT" (CeRICT) and on the "Analysis and monitoring of environmental risk" (AMRA), and in the High Technology Consortium for Cultural Heritage (Databenc). In the Lombardia Region, IREA participates in the activities of the Aerospace District and of the cluster on “Technologies for Smart Communities”. Moreover, IREA provides technical and scientific support to the Lombardia Region in the framework of NEREUS (Network of European Regions Using Space Technologies), the European network that supports the regional strategies on the space issues.

Laboratories and Equipment

At the headquarters in Napoli there are four main infrastructures: a cluster for satellite radar data processing, an electromagnetic diagnostics laboratory, an optical and optoelectronic sensing laboratory, and a bioelectromagnetics laboratory.

Cluster for remote sensing data processing

The **cluster dedicated to satellite radar data processing** was funded by MIUR under the project PON I-AMICA. It was designed and implemented at IREA with the aim of optimizing the performance according to the particular application type. As a matter of fact, radar data processing requires the use a significant disk space and a high number of data access operations. The system has a high degree of scalability and redundancy and is, therefore, inherently resistant to faults, that is, to the partial breaking of its components.

The architecture is composed of two front-end nodes in heartbeat and 22 processing nodes at 64-bit based on eight core dual-processor Intel Xeon, for a total of 352 hyperthreading processing units (core) and 8448 GB of RAM. Each processing node, on which the 64-bit version of the operating system Linux is installed, is equipped with a drive in Direct Attached Storage (DAS) mode and RAID 5 configuration.

An external 160 TB storage unit connected to the system by means of 4 high-performance Fibre Channel completes the architecture. The total disk space available, also through the use of a parallel file system, is about 1.2 PB.

Contact person

Simone Guarino

In the **electromagnetic diagnostics laboratory**, research and development activity is carried out within the framework of active microwave and terahertz diagnostics aimed at the detection, localization, and characterization of static and moving objects, hidden or buried in complex scenarios, as well as the remote detection and characterization of vital signs. To pursue these aims, measuring devices, data processing technologies, and dedicated software are available. Among the instrumentations available, partly acquired through the PON project I-AMICA, there are:

- a K2Ris georadar system suitable to survey sub-soils and vertical structures; the system is equipped with a dual frequency single fold antenna working at 200 MHz and 600 MHz nominal central frequencies and a single frequency antenna working at 2GHz;

- a holographic radar, named RASCAN4/4000, suitable to obtain bi-dimensional images of the subsurface layers of the structure under test in real time; the penetration depth reaches about 10cm;

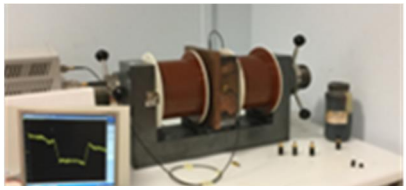
Georadar K2RIS system

THz Zomega FICO system

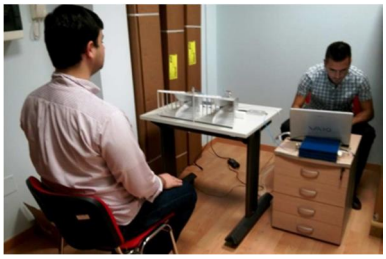
- a last generation system operating at THz frequencies, THz-Zomega Fico (fiber-coupled terahertz time domain system) for high-resolution (millimeter) spectroscopy and imaging, working both in transmission and reflection modes, with the following features:

a) spectral range from 60GHz to 3THz;
b) 3GHz spectral resolution;
c) 500 Hz acquisition frequency;

- a prototype exposure system for imaging in the presence of magnetic nanoparticles (MNP);
- an X-band radar system for the characterization of the sea state;
- a bio-radar prototype for the detection of vital signs;



Sistema per l'imaging mediante MNP



bio-radar system

- 2 workstation con 8 Processori di cui una con 144 GigaByte di RAM e l'altra con 48 GigaByte di RAM;
- 3 Dual Processor con 8 GigaByte di RAM, 2 Intel Core I-5 Processor con 8 GigaByte di RAM, 1 Workstation con 8 Processori Xeon e 256 GigaByte di RAM.

As far the software is concerned, at IREA electromagnetic diagnostics laboratory methodologies have been developed that, starting from data measured by ground penetrating radar systems operating in situ and/or airborne platforms, allows obtaining high-resolution and reduced ambiguity images of the investigated scene. The developed methodologies benefit from the study of the electromagnetic scattering phenomenon and, as a function of the adopted physical/mathematical model describing the signal-target interaction, can be grouped in strategies for the localization of unknown objects and their geometric characterizations (size, shape) and approaches capable of providing an accurate quantitative characterization of the electromagnetic properties (dielectric permittivity, electric conductivity and magnetic permeability) of the objects under test. The software was completely developed in-house. It represents a significant added value in all those applications in which it is of interest to exploit the ability of microwaves to penetrate opaque materials and interact with them in order to perform a non-destructive and non-invasive diagnostics.

Contact person

Ilaria Catapano

Direct laser writing lithographic system

The **optical and optoelectronic sensing laboratory** is equipped with instruments for the development, manufacture, and characterization of planar optofluidic and optoelectronic integrated sensors and fiber optic sensors.

As for the integrated optical and optofluidic sensors, the laboratory is furnished with a clean room, equipped with 3µm resolution direct laser writing lithographic system and a spin-coater to apply uniform polymeric thin films, which allows the manufacture of polymer optical guides and devices. Technological facilities available also include a computer numerical control (CNC) micromilling with a 5µm resolution, an optical profilometer, an oxygen plasma system, and a thermal press for the manufacture of microfluidic devices. There are also four benches for the characterization of integrated optical sensors for the development, analysis and characterization of optical and optofluidic sensors, with particular reference to sensors for chemical and biological applications. Benches are equipped with: wide spectrum sources UV-Vis-NIR (190nm-2100nm) coupled with optic fiber; tuneable sources at around λ=780nm and λ=780nm; femtosecond laser source at λ=780nm; pulsed laser source at λ=1064nm, 532nm, 266nm; optical microscopes, spectrophotometers, and high-resolution monocromators.

As far as fiber optic sensors are concerned, the laboratory is furnished with most of the instruments aimed at developing and optically characterizing distributed optical fiber sensors based on Brillouin and Raleigh scattering. In particular, there is a prototype of fiber optic distributed sensor for strain/temperature monitoring, a conventional and photon counting OTDR system, an OFDR system, fiber optic fusion splicer, lapping and a polishing machine.

The laboratory is also equipped with 2 workstations with 8 processors (144 Gigabytes and 48 Gigabytes of RAM, respectively) dedicated to the design and simulation of optical and optofluidic devices.

Contact person

Romeo Bernini

Introduction

The activity carried out at the **Bioelectromagnetics laboratory** mainly deals with the evaluation of effects induced in vitro in biological systems by exposures to high frequency (from 900 MHz to about 10 GHz) and low frequency (50 Hz) electromagnetic fields, and to pulsed electric fields with variable duration (μs to ns) and intensity (kV/m – MV/m). Monitoring and control of population exposure to electromagnetic fields in the urban and working environment are also carried out. .

To this aim, the laboratory is fully equipped with facilities for the design and realization of electromagnetic field exposure systems, and for numerical and experimental dosimetry employed to characterize electromagnetic parameters and to control environmental and electromagnetics parameters during cell culture exposures. In particular, the main facilities are: continuous and modulated wave signal generators (250 kHz – 3 GHz), function generators (0.2 Hz – 2 MHz), low and high frequency amplifiers, network analyzer, spectrum analyzer, gaussmeter, oscilloscopes, waveguide and coaxial cable components, power sensors, Helmholtz coils, termo-couple and multichannel fiber optic thermometers, software based on the FDTD and FEM techniques (Semcad X, Speag) for the electromagnetic characterization of microwave devices and for numerical dosimetry.

High frequency exposure system

System for the generation of ultrashort high voltage electric pulses

The laboratory is also equipped with facilities for the generation and control of high voltage electric pulses: high voltage generators and solid state switches, low voltage pulse generator for remote control of the switches, coaxial cable and microstrip transmission lines, fiber optic coupling systems, high voltage probes, digital multi-meters and signal generators.

The main facilities of the cell biology laboratory are: sterile cell culture room with laminar flow, biohazard hoods, CO2 incubators, centrifuges, cryo-preservation systems, optical microscopes, fluorescence microscope with CCD camera, confocal microscope, Leica TCS SP5 (recently upgraded with a 460-670 nm white laser excitation system, a 405 nm CW laser and a resonant scanning system, acquired in the framework of a POR-FESR 2007/2013 Campania Region funding), flow-cytometer, fluorimeter and spectrophotometer.

Confocal microscope

For indoor and outdoor electromagnetic field measurements, IREA is equipped with wideband meters and probes for low frequency (5 Hz – 32 kHz) electric and magnetic fields and RF electromagnetic field (100 kHz – 3 GHz) measurements, a Hall gaussmeter for static magnetic field measurements, and a spectrum analyzer for narrow band electromagnetic field measurements (100 kHz – 3 GHz).

Contact person
Olga Zeni

The secondary location of Milano has an **optical-electronic laboratory** equipped with spectroradiometric instrumentation for the acquisition of indoor and outdoor spectral signatures.

Portable spectroradiometer for field measurements (350-2500 nm spectral range)

An optic bench is also available, which is used to calibrate spectro-radiometric instruments and scientific instrumentation for field activities in terrestrial and lacustrine/marine environments.

Principal equipments are:
FieldSpec ASD spectroradiometer (350-2500 nm) provided with underwater and surface optical fibers; WISP-3 Water Insight spectroradiometer (400-900 nm); Raytek PM40 thermoradiometer (8-14 micron); EKO MS-120 sun photometer (368 nm, 500 nm, 675 nm, 778 nm); PAR Licor sensor for the measurement of light along the water column (400-700 nm); AccuPAR LP80 ceptometer – Decagon Devices; fluorimeter for algal pigments; FATA – Fluorescence And Turbidity Analyzer: device for the continuous measurement along horizontal transects of water quality parameters; Goniometer - MultiANgular Device for Radiometric Observations over Natural Surfaces (MANDRONS): goniometer for angular measures of reflected radiance and for the sampling of BRDF; hemispheric camera with fisheye lens; topographic GPS.

Contact person
Mauro Musanti

The Experimental Station "Eugenio Zilioli", located at Sirmione (Garda Lake, Italy), has an educational laboratory for the analysis of waters and one boat for periodic measures carried out in the lake. The laboratory is equipped with two electronic microscopes and two water filtration apparatus.

Recently, a solar photometer has been installed close to the station, which contributes to the Aeronet network.

From 2011 the center is one of the LTER sampling stations (The Long Term Ecological Research Network), which in turn makes part of the International Net ILTER from 2006, bringing together 39 Countries in all the five continents for what concerns ecological studies.

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(manager for the activities on the territory)
Alba L'Astorina
(communication manager)

Research topics

In line with the Institute's mission, Irea research activities focus on 5 main topics, which correspond to as many research groups :

- Microwave Remote Sensing
- Optical Remote Sensing
- Electromagnetic Diagnostics
- Geographic Information Systems
- Bioelectromagnetics

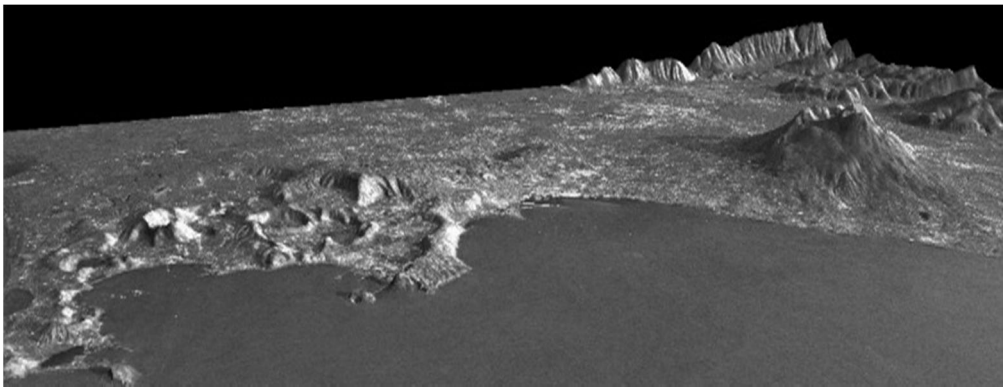
Investigation, research and experimentation activities on public communication of science and and science education activities are also conducted

The reserach staff distribution - at 31 December 2016 - with respect to the research topics is schematized below:

Microwave Remote Sensing 1 Director of Research* 2 Senior Researchers 14 Researchers (5 of these are temporary staff)	**Optical Remote Sensing** 1 Director of Research 1 Senior Researcher 10 Researchers (4 of these are temporary staff)	**Electromagnetic Diagnostics** 3 Senior Researchers 3 Researchers (2 of these are temporary staff)
Geographic Information Systems 2 Senior Researchers 2 Researchers	**Bioelettromagnetics** 1 Senior Researcher 2 Researchers (1 of these is temporary staff)	**Public communication of science** 1 Technologist

* on leave since he holds the positions of the Institute direction

Microwave remote sensing



Remote Sensing is a set of multidisciplinary techniques and methodologies that aim at obtaining information about the environment through "remote" measurements.

In particular, microwave remote sensing uses electromagnetic radiation with a wavelength between 1 cm and 1 m (commonly referred to as microwaves) as a measurement tool. Due to the greater wavelength compared to visible and infrared radiation, microwaves exhibit the important property of penetrating clouds, fog, and possible ash or powder coverages (for example, in the case of an erupting volcano or a collapsed building). This important property makes this technique virtually suitable to work in any weather condition or environment.

Microwave remote sensing systems are classified into two groups: passive and active. Passive systems collect the radiation that is naturally emitted by the observed surface. In fact, objects emit energy at the microwave frequencies, although sometimes in an extremely small amount. These systems are generally characterized by relatively low spatial resolutions.

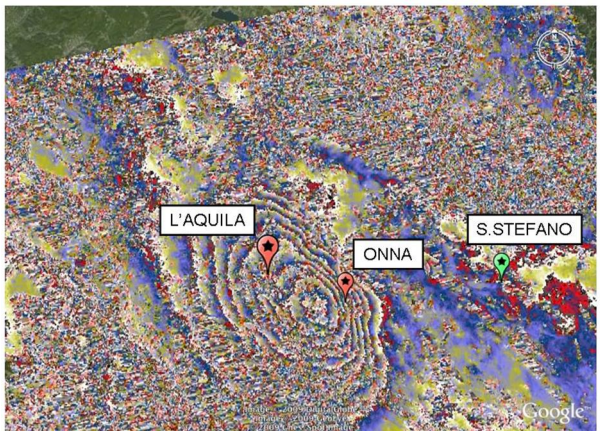
Differently, active systems are characterized by the presence of their own source (transmitter) that "lights up" the observed scene and, therefore, can be used night and day, independently of the presence of the sun. The sensor transmits a signal in the microwave bandwidth and records the part that is backscattered by the target towards the sensor itself. The power of the backscattered signal allows discriminating between different targets within the scene, while the time between the sent and the received signal is used to measure the distance of the target. A system that operates in this way is called RADAR (the name stands for RAdio Detection And Ranging), and may allow obtaining a "microwave image" of the observed scene.

The most commonly used microwave imaging sensor is the Synthetic Aperture Radar (SAR) that is a radar system capable of providing high-resolution microwave images. They have distinctive characteristics compared to the images acquired in the visible or infrared bands; for this reason, radar and optical data can be complementary, as they carry on a different informative contribution.

It is important to highlight that the radar images can be obtained and made available to all the community, especially to those responsible for land management (Ministries and government agencies such as the Civil Protection authorities, public and local authorities, etc.), only after a significant (in terms of time and computer resources) processing operation. The main activities of the IREA researchers working in the Microwave Remote Sensing area are focused on studying innovative methods and techniques for the processing and interpretation of these remotely sensed data.

Interferometria Differenziale Radar ad Apertura Sintetica

The measurements of the ground small variations related to earthquakes, landslides, volcanic activity (or, more in general, deformation phenomena affecting the Earth's surface), in any weather condition and at any time of night or day by using sensors mounted on board satellites orbiting at several hundred kilometres away from the Earth, is possible to be performed using a method called Differential Interferometry that is based on the use of Synthetic Aperture Radar (SAR) images.



Envisat interferogram related to the earthquake in L'Aquila in 2009

The interferometric techniques compare (make "interfere") two SAR images acquired from the same location but at different times. If something has changed in between the two acquisitions, that can occur when there is a terrain deformation between two successive passages of the sensor, such a movement is displayed as a continuous sequence of coloured stripes, the so-called interference fringes (or interferogram). To obtain a quantitative measurement of the deformation, the interferogram must be interpreted: each colour cycle represents an amount of deformation equal to half the wavelength of the radar radiation. Since wavelengths in the microwave range are typically between 10 cm and 1 cm, we easily understand how this technique can provide displacement measurements with centimeter precision.

In addition to measuring a single deformation episode, the temporal deformation evolution can be also followed by properly combining a set of images acquired over time. In fact, satellites carrying SAR sensors are not in geostationary orbits as those used for telecommunications, but they revisit the same area on a regular basis. In recent years, we have moved from the 35 days repeat-cycle of the European Space Agency (ESA) ERS 1/2 and ENVISAT satellites (active from 1992 to 2012) to the new generation sensors, such as those on board the Italian COSMO-SkyMed constellation capable of 4 acquisitions in 16 days, up to the new Sentinel satellite constellation of the European Copernicus Programme, characterized by a revisit time of 6 days.

Among the techniques that can generate deformation time series, there is SBAS (the acronym for Small Baseline Subset) which has been fully developed at IREA and has reached a very widespread popularity. The use of this technique allows generating ground deformation maps at medium and high spatial resolutions, with a much denser spatial coverage than traditional geodetic methods (levelling campaigns or GPS stations) and with temporal frequencies that are continuously increasing.

The use of these technologies has important implications in environmental monitoring applications, in the understanding of geophysical phenomena and in controlling the stability of buildings and large infrastructures.

Applications

Measurement of volcanic deformation
Study of earthquakes
Monitoring of landslides
Monitoring of urban areas and infrastructure

Personnel involved

Eugenio Sansosti
Riccardo Lanari
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Paolo Berardino
Francesco Casu
Mariarosaria Manzo
Michele Manunta
Antonio Pepe
Giuseppe Solaro
Pietro Tizzani
Giovanni Zeni
Diego Reale
Simone Guarino
Manuela Bonano
Susi Pepe
Fabiana Calò
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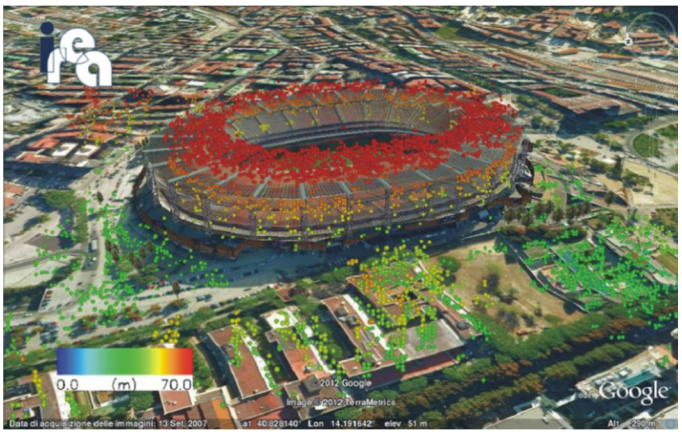
Adele Fusco
Pasquale Imperatore
Chandrakanta Ojha
Ivana Zinno
Claudio De Luca
Sabatino Buonanno
Stefano Perna
Salvatore Stramondo
Vincenzo Cuomo

Spaceborne SAR tomography for reconstruction and monitoring of buildings and infrastructure



3D reconstruction of the San Paolo Stadium in the city of Napoli (South Italy) achieved by a tomographic processing of COSMO-SkyMed data (Courtesy of ASI), overlaid on an optical image taken from Google Earth

Multidimensional SAR focusing, 3D (space) and 4D (space-time), more commonly known as SAR Tomography, is an innovative technique for the analysis of multipass SAR data which extends the classical SAR interferometry concepts. IREA is a leading group in this technology, as evidenced by numerous international scientific awards. SAR Tomography allows generating veritable 3D reconstructions of sensed structures with a high spatial level of detail.

This technology operates as a real "radar scanner", which allows to "inspect" (3D Imaging) very accurately the details of the observed scene from space. It allows also to solve the geometric distortion problems, which are intrinsic to the SAR system, in areas characterized by a high density of vertical structures, such as urban areas, where the overlap of radar echoes belonging to different parts of the single structure under observation is experienced.

By extending the tomographic model in the time domain (Differential SAR Tomography or 4D Imaging), it is possible to accurately monitor over the time possible target deformations. The availability of high spatial resolution data, provided by the new generation of satellite sensors (such as the German TerraSAR-X and the Italian COSMO-SkyMed), enables to estimate millimetric deformations of single built structures, such as those due to thermal dilation phenomena (5D Imaging).

Recent activities in the SAR Tomography framework have concerned the development of the CAESAR (Component extrAction and sElection SAR) technique, granted with an Italian patent currently under evaluation for European extension. CAESAR operates a noise filtering of the data by properly balancing the spatial resolution loss and the improvements in terms of density of output measurement points for which deformation time series are provided.

Together with the technological progress of SAR sensors, SAR tomographic based techniques began providing 3D and 4D reconstruction of single structures over wide areas with a very high level of details. Results are in fact comparable to those obtained from optical sensors commonly used for 3D reconstruction of buildings as ground-based and airborne LIDAR systems, but with the further advantage of the synoptic view and of the temporal monitoring.

Currently, SAR Tomography represents the most effective SAR technology for the monitoring of complex areas, such as, for example, urban environments and infrastructures. The possibility to access detailed 3D models of individual structures on ground (for example buildings and infrastructures) and to monitor them in terms of temporal deformation at high-resolution represents an important advantage in the urban monitoring context and also for the environmental monitoring and security and the management of risk situations.

Personnel involved

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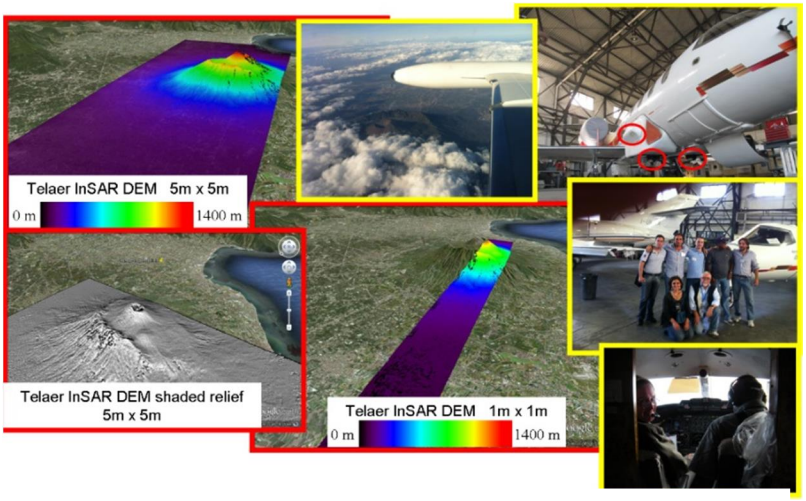
Francesco Paolo Sica

Applications

3D reconstruction
Monitoring of infrastructure and urban areas

Airborne SAR Interferometry techniques



TELAER system and the results
of the first topographic experiments related to Vesuvius

In the last decade, the Differential SAR Interferometry (DInSAR) technique was used to generate time series of ground deformation with millimeter accuracy by exploiting data acquired by satellite. However, in some circumstances DInSAR by satellite cannot be fully adequate. Indeed, the orbits described by the satellites used for remote sensing applications do not allow measurements of ground deformation along the North-South direction. In addition, the time interval between two consecutive acquisitions of the same illuminated area on the ground ("revisiting time") is fixed and does not allow monitoring deformation phenomena occurring on a daily scale, as required in emergency scenarios. Instead, airborne SAR platforms provide higher operational flexibility and allow us the overcoming of some limitations of satellite acquisitions. Unfortunately, the extension of the DInSAR technique to airborne data is not trivial, due to the so-called residual motion errors that typically characterize the airborne SAR datasets.

At IREA, several techniques have been developed to compensate residual motion errors in airborne SAR images. Such techniques have been applied to data acquired by the OrbiSar airborne sensor (operating at X-band) over the Perugia area during an experimental campaign organized in 2004 in collaboration with the Institute of Research for the Hydrogeological Protection (IRPI) of the National Research Council (CNR), the Vesuvius Observatory and the OrbiSat Remote Sensing company. This has allowed us the generation of X-band airborne SAR differential interferograms characterized by accuracies of the order of millimeters.

More recently, in order to successfully apply the aforementioned techniques also to Italian sensors, IREA has been involved in the upgrading of the AeS4 TELAER airborne SAR system operating at the X-band (10 GHz) and owned by the Agency for Agriculture Subsidy Payments (AGEA). In particular, CNR funded (on its own MIUR funding) the upgrading of the TELAER SAR system in the frame of cooperation with AGEA. Moreover, CNR entrusted IREA for managing all the activities related to such a system upgrading, included the flight-tests. The aim of this upgrading was twofold. First, the system, which was originally equipped with a single TX/RX antenna, has been upgraded to a single-pass interferometric configuration that allows carrying out single-pass across-track as well as along-track applications. Second, a modern inertial navigation system has been acquired for DInSAR applications.

Personnel involved

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Carmen Esposito
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Virginia Zamparelli
Giuseppe Jackson

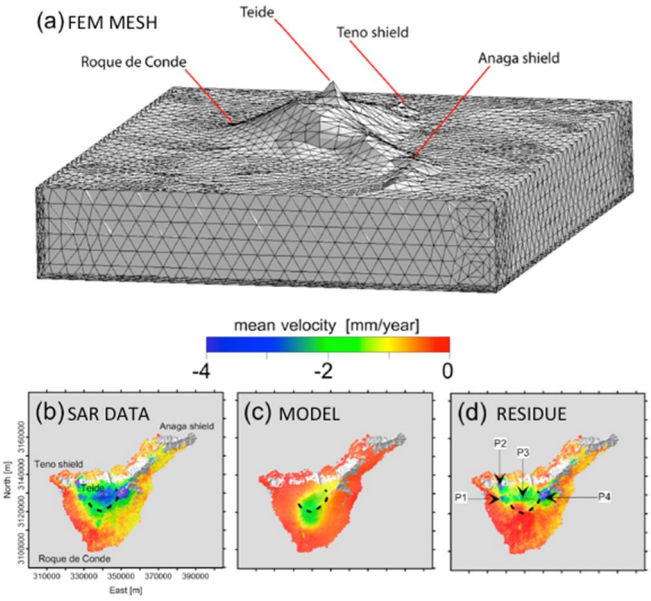
The system upgrading was completed in January 2013. Subsequently, a flight-test campaign was carried out over the Somma-Vesuvius volcanic complex, the Campi Flegrei caldera and the Ischia island, Italy, covering an area of about 4000 km2 . The InSAR data processing of the acquired data was carried out at IREA and allowed the generation of Digital Elevation Models (DEMs) characterized by accuracies and resolutions on the order of the meter.

Applications

Monitoring of ground deformations of daily scale
Landslide monitoring
High resolution Digital Elevation Model generation

Geophysical modeling of remote sensing data and geodetic measurements

The geophysical processes that take place in several kilometers below the earth's surface, such as the movement of a seismogenic fault, the accumulation of magma, the variation of pressure in the reservoirs magmatic, in many cases cause deformation of the earth's surface that can be measured with geodetic methods and remote sensing techniques such as SAR interferometry (InSAR). The results of these measurements and the subsequent geophysical modeling of the sources, due to the deformation, can provide crucial information for the assessment of volcanic and seismic risk and the proper planning of human activities.



Modeling of deformation effects on Tenerife island from interferometric SAR data

It is possible to model the deforming sources through analytical and numerical approaches. In analytical modeling, the most common models can reproduce the observed deformation in a sufficiently realistic way by using simple functions characterized by a limited number of parameters. Although in these simplified approaches several aspects (the properties of magma inside the source, including its compressibility, the asperities along the fault plane, the crustal heterogeneity) are neglected, the analytical models are still a valuable tool for a preliminary evaluation on the localization and the geometric characteristics of the sources that have generated the observed deformation, information obtained through the inversion of surface deformation data (InSAR, GPS, EDM, tiltmetric, etc ...).

Numerical modeling is a powerful tool that can allow realistic simulations of geophysical processes, using heterogeneous information and efficient mathematical methods. There are various numerical modeling techniques; the most used in the Earth Sciences is the FEM (Finite Element Method) technique. The exponential increase in knowledge of geophysical systems and technological development of numerical modeling tools have enabled the implementation of more and more complex modeling approaches, able to represent the spatio-temporal variability of the physical parameters that influence the development of a natural system. In this context, the finite element modeling multi-physics is a new frontier for the understanding the spatial and temporal evolution of different geodynamic settings such as volcanic and seismic areas and those with a hydrogeological instability.

IREA is committed to the development of research activities on the geophysical modeling of remote sensing data; these activities have already provided important results in the study of the major earthquakes that have hit our country in recent years. Relevant are also the results of the analysis of the main Italian volcanoes and various other volcanic sites of great scientific interest.

Applications

Study and analysis of volcanic areas
Study and analysis of seismogenic areas
Study and analysis of areas subject to hydrogeological instability

Personnel involved

Pietro Tizzani
Giuseppe Solaro
Giovanni Zeni
Susi Pepe
Raffaele Castaldo
Riccardo Lanari
Eugenio Sansosti
Vincenzo De Novellis
Luca DÕAuria

GRID and Cloud platforms exploitation for the interferometric processing of SAR data

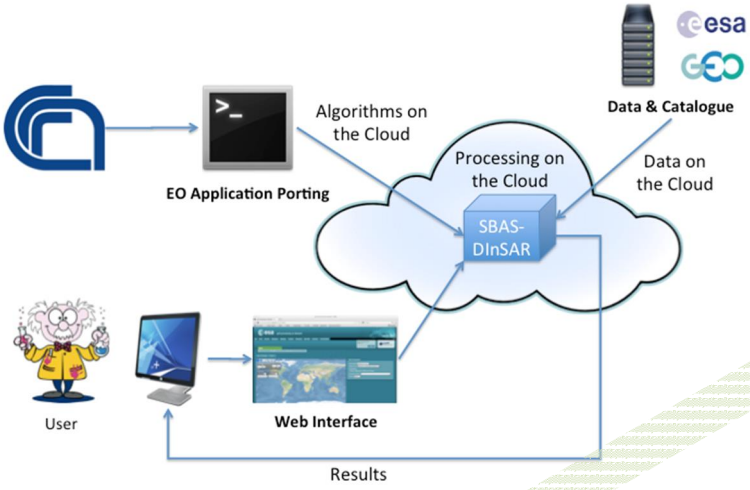
The Differential SAR Interferometry (DInSAR) is a well-established microwave remote sensing technique that allows us to estimate the ground deformations with centimeter to millimeter accuracy. In the last decades, thanks to both the ever increasing SAR data availability as well as the development of advanced algorithms, such as the Small BAseline Subset (SBAS) technique, differential interferometry has shown to be a very effective tool not only to better comprehend geophysical phenomena at local and regional scales, but also to support natural and anthropogenic hazard mitigation and management.

The current DInSAR scenario is characterized by the huge availability of SAR data acquired firstly by the ESA ERS and ENVISAT sensors, then by the RADARSAT-1/2 Canadian missions and finally by the COSMO-SkyMed (ASI) and TerraSAR-X (DLR) constellations. For some years, the SAR sensors aboard the European constellation Sentinel-1 have made it possible to take a further step forward in the availability of data acquired, thanks to the revisit time which may fall up to 6 days (with Sentinel-1A and 1B) and the adopted global coverage acquisition policy.

In order to fully benefit from such a huge SAR data amount to analyze and monitor Earth's surface deformation, both high performance computing (HPC) resources as well as proper DInSAR algorithms, which are able to effectively and efficiently exploit these computing facilities, are needed.

In this context, the IREA research activity is focused on studying, developing and implementing novel DInSAR algorithmic solutions for the exploitation of high performance computing platforms. Particular attention is given to the use of multi-nodes and multi-cores distributed computing architectures, such as GRID and Cloud, in the perspective of both maximizing the size of employed data-sets and minimizing the processing elapsed times.

Consequently, the main research activity objective is the development of advanced DInSAR methodologies allowing us to handle and process the increasing available SAR data amount within reasonable time frames. Furthermore, the implementation of innovative algorithmic tools for the generation of Earth's surface displacement maps at a continental scale, which can be used for a global analysis and therefore a comprehensive understanding of ground deformation phenomena, is under investigation. The achievement of such targets, besides the considerable inherent scientific implications, has important consequences in the Civil Protection framework for natural and anthropogenic hazards management, prevention and mitigation, both in pre-alert and emergency phases.



Schematic sketch of interferometric SAR processing in a cloud environment

Finally, the opportunity given by Cloud computing platforms to store data archives, computing resources and processing algorithms, together with the capability to simply share data and results within the research community, open new challenging scenarios for a global scientific knowledge fruition and spread (open science), so placing satellite technologies on the road traced by the European Science Open Cloud Initiative.

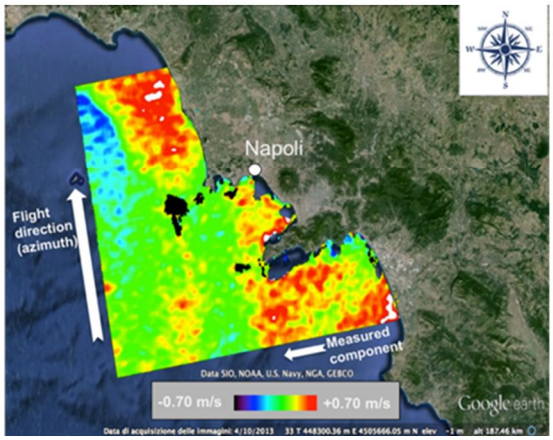
Applications

Measurement of volcanic deformation
Study of earthquakes
Monitoring of landslides

Personnel involved

Francesco Casu
Michele Manunta
Riccardo Lanari
Claudio De Luca
Pasquale Imperatore
Ivana Zinno
Sabatino Buonanno

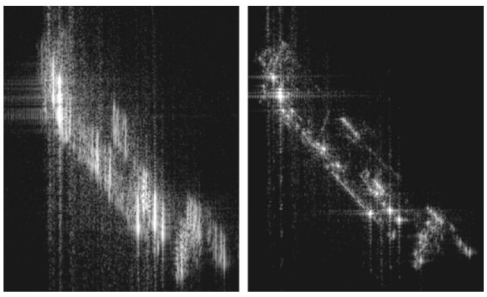
SAR technologies for marine environement monitoring



Map of the line-of-sight component of the sea surface velocity estimated on an ENVISAT SAR image of September 22, 2010. The map is displayed in the Google Earth environment

In the context of ocean dynamics, SAR techniques can be considered as a very useful tool to understand marine phenomena. In particular, SAR sensors allow monitoring some key parameters that characterize the sea state, such as sea currents, sea waves and the influence of the wind on the sea surface. In this context, IREA has recently focused on the estimation of sea currents, carried out by exploiting the Doppler shift induced on a single SAR image. This method is based on the phenomenon by which the presence of a relative motion between the observed scene and the sensor, f.i. the sea currents motion, determines a shift of the Doppler power spectrum from the zero-Doppler to a mean Doppler frequency (Doppler Centroid) which is proportional to the radial component of the relative motion. Research activities are mainly focused on the compensation of spurious signals, mainly originated by Earth rotation and platform attitude. An example of the estimation of the sea surface radial velocity on the coastal area of the Campania region is provided in the upper image.

A further application, in the context of maritime remote sensing, is the microwave radar imaging of moving ships acquired by airborne or satellite SAR sensor, or by a fixed radar system (known as Inverse SAR). In this framework, the Doppler effect has been considered again to generate 2D high-resolution radar images of moving targets. The main applications of this technique are typically related to the maritime traffic control and the harbour security awareness. An example of the focusing of a moving vessel on data acquired by the Cosmo-SkyMed satellite operating in the spotlight mode is provided in the right Figure.



Refocusing of raw Cosmo-Skymed data of a moving ship (data copyright of the Italian Space Agency)

Finally, as part of the upgrading of the Italian InSAeS4 X-band SAR airborne system, research activities related to the availability of three antennas have been developed. The three antenna architecture resembles a hybrid across-/along-track (XT/AT-InSAR) interferometric SAR configuration which allows retrieving information related to both the topography and the sea surface velocity with much more details and higher resolution than those obtained by the Doppler frequency spectrum analysis.

Applications

Sea state monitoring
Maritime traffic control
Harbour security

Personale coinvolto

Gianfranco Fornaro
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Giuseppe Jackson
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Stefano Perna
Diego Reale
Virginia Zamparelli
Francesco Paolo Sica

Optical Remote Sensing

The development of aerospace technologies offers the opportunity to observe the Earth's surface from a completely new point of view. Thanks to the optical-electronic sensors installed on board aircraft or satellites, remote sensing techniques allow to extract information concerning the environment where we live on the basis of measurements of the electromagnetic radiation. It is thus possible to study physical characteristics of the surfaces and objects and, under certain boundary conditions, also related to subsurface situations, thanks to measurements performed without being in contact with the targets.

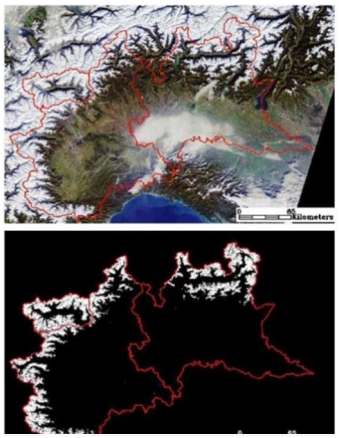
In order to derive these information, Optical Remote Sensing exploits the portion of the electromagnetic radiation ranging from Visible (0.4 micrometer) up to Near-InfraRed (NIR) and Thermal Infrared (TIR, 15 micrometers). In this region of the electromagnetic spectrum, the primary source of energy is the solar radiation that is reflected or absorbed by the surfaces or the radiation naturally emitted from the surface as a function of their thermal state.

The ability to capture images of large areas of the entire Earth's surface, even in places difficult to access such as polar or tropical forests, at wavelengths "invisible" allows you to highlight phenomena not otherwise be observed and detected. Melting glaciers, water pollution, wildland fires, deforestation and climate change, but also land use/land cover change and natural resources as agricultural crops can be observed in a systematic and consistent way, and their temporal dynamics can be monitored even with daily and hourly frequencies.

Thanks to these features, Remote Sensing plays an important and unique role contributing to the studies of the environment and natural resources, and to the activities for the prevention, assessment and management of risks related to natural disasters such as floods, landslides, fires , earthquakes, volcanic eruptions.

IREA researchers are engaged in research activities for the continuous development of methodologies suited to derive from the spectral measurements acquired from aircraft and satellites useful information for the sustainable management of land and water environments.

Thematic Mapping



The Alps at the border among Valle d'Aosta, Piemonte and Lombardia regions (red outlines) and snow cover maps as obtained from the MERIS sensor onboard the ENVISAT/ESA satellite

Thematic mapping, generally understood as the extraction of value-added information from raw or pre-processed data, is one of the most common and relevant application fields in remote sensing. It can be divided into sub-categories, such as pattern recognition, feature extraction, and thematic classification. Thematic and land cover maps derived from remotely sensed imagery can support land and environment monitoring, as well as management and planning activities.

Proper response actions to environmental and climate emergencies - floods and landslides, earthquakes and fires, food and water security - are based on updated spatial-temporal thematic knowledge, especially if accessible in a digital cartographic format. This knowledge is useful to the deployment of preliminary actions, the quantification of damage extension and the planning of recovery and prevention measures. The availability of thematic maps is relevant not only in disaster management, but is also a crucial information source for land and environmental management: for example in forestry, mapping is important for both global monitoring of fires and their implications on climate and environment. In some policy sectors, such as agriculture in the European Union, thematic maps derived from satellite imagery are used to rule the distribution of support funding and for the confirmation of beneficiaries' declarations, with a significant economic impact (Common Agricultural Policy counts for 45 up to 50 % of the EU annual budget).

Further examples of the relevance of remote thematic mapping in other application fields, include: urban and land planning, recognition of dangerous materials as asbestos or oil spills, soil sealing, water availability as connected to ice and snow melt, and complex ecosystems monitoring.

Starting from 1972 - the year NASA launched the first Earth Observation satellite (ERTS/Landsat 1) - to the next generations of satellites and satellite constellations, specifically designed to provide continuous data for a global monitoring at a daily or weekly cycle (i.e. the Sentinel satellite series managed by ESA under the umbrella of the Copernicus-GMES programme, and NASA Landsat 8), remotely sensed data and imagery have grown a lot and will continue to grow and diversify in the future, from the spectral and spatial resolution point of view, thus requiring the development of novel analysis and information extraction methodologies for the provision of more refined and accurate value-added information.

Personnel involved

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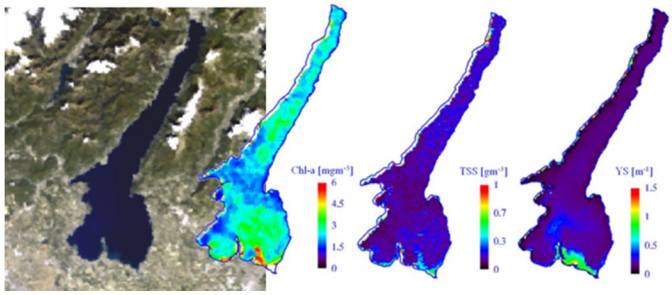
Giacomo Fontanelli
Erica Matta
Peter Wadhams

Applications

Land cover and land use mapping
Burned areas mapping
Early crop mapping
Geolithological mapping of outcrops
Study of spatio-temporal dynamics of carbon stocks in urban areas
Damage assessment after flood and tsunami events
Identification of hydrocarbon / hazardous materials spills
Laboratory spectral characterisation of materials

Evaluation of bio-geophysical parameters using physically based models



Maps of concentrations of chlorophyll-a, yellow substances and suspended solids in Lake Garda from MERIS data

Some bio-geophysical parameters, such as qualitative or quantitative indicators of the condition of natural surfaces, can be estimated from remote sensed data. Images acquired from both optical and microwave spectrum range can be used as source of data, and different kind of physically based models can be implemented in order to estimate the parameters of interest. These models describe both the interaction between the electro-magnetic radiation and natural surfaces (e.g. radiative transfer models) and processes concerning surface properties (e.g. wave phenomena). When optical remote sensing techniques are used, data acquired in the visible-infrared wavelengths are analyzed taking in account absorption and scattering phenomena acting both in the atmospheric medium and at surface level. Thanks to radiative transfer equations, optical parameters, which in turn describe some bio-geophysical properties of natural surfaces, are estimated with good accuracy. On the other hand, microwave radiation properties make the Synthetic Aperture Radar (SAR) sensors particularly suitable to estimate geometric features of natural surfaces.

Nowadays, activities aimed to the determination of bio-geophysical parameters are many, with applications interesting different environments. At the basis of the estimation techniques, the signal recorded by satellite sensors is converted in physical quantities at surface level (e.g. spectral reflectance, radar cross section), which in turn can be related to different parameters. Among them: water quality parameter concentrations (e.g. chlorophyll-a, suspended solids); bottom depth and substrate characteristics in coastal zones; biomass estimation of both aquatic and terrestrial vegetation; evaluation of structural indicators of vegetation (e.g. Leaf Area Index); determination of snow cover properties (albedo, grain-size); estimation of wind field and directional properties of waves on the water surface; estimation of marine ice thickness at the interface with the open ocean.

Physically based models for the estimation of bio-geophysical parameters, if well calibrated and validated, allow the elaboration of remote images independently from instrumental and sensor characteristics, making this methodology especially suitable for retrospective and multi-temporal analysis using multi-sensor data.

Personnel involved

Claudia Giardino
Pietro Alessandro Brivio
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Monica Pepe
Giacomo De Carolis
Mario Gomarasca
Mariano Bresciani
Daniela Stroppiana
Francesco Nutini
Erica Matta
Vittorio Brando
Gabriele Candiani
Lucia Laurenza
Monica Pinardi

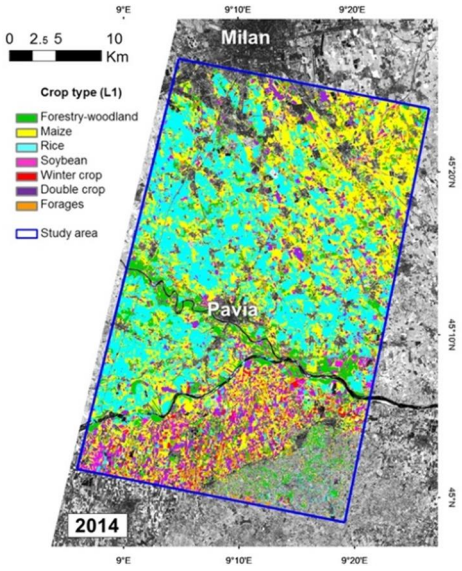
Applications

Water quality and coastal vegetation
Nutritional status of crops
Monitoring of wetland ecosystems
Seasonal variation of alpine vegetation
Snow water content

Environmental and natural resources monitoring

The term 'monitoring' identifies the set of activities aiming at observing a phenomenon, or a variable which characterizes the phenomenon, to follow its regular development and/or to highlight the occurrence of critical or alarming conditions. Environmental monitoring, in particular, is directly linked to the management of natural resources which is carried out on the basis of information derived from the observation and/or data on the conditions of the Earth surface and of the atmosphere.

In this framework, data acquired by sensors onboard satellite platforms offer a unique opportunity of systematically observing natural vegetation, agro-ecosystems and water resources with a synoptic view and over large areas. Several satellite sensors are currently available for environmental monitoring, and the choice of the most suitable source of data in terms of revisiting time (frequency of observation) and geometric and radiometric resolutions depends on the type of application.



Crop map over the agricultural region between Milan and Pavia, Italy, for the year 2014 and derived from optical and SAR satellite data

The use of time series of satellite data is of key importance for monitoring natural resources and the environment. The availability of long time series, which today can be as long as 30 years, allows the identification of geographic regions where present conditions are significantly different from the long time trends and thus need further and detailed analysis. In addition, near-real time (or quasi near-real time) satellite image acquisitions during a period of interest is crucial for a prompt intervention aimed at protecting the vegetation and/or limiting the damages as well as for the implementation of farming practices driven by the actual crop conditions.

Personnel involved

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In this framework, satellite images can be exploited to estimate parameters which are descriptors of the status of the environment; these parameters, together with in situ measurements and/or observations collected by traditional field campaigns and/or sensor networks, can be assimilated into mathematical models of the natural processes or used as source of information in operative monitoring systems.

For what concerns the land compartment, some of the parameters which can be estimated from satellite images are the biophysical properties of the vegetation (e.g. Biomass, Leaf Area Index – LAI, water content), the forest cover characteristics and status (forest cover classes, species composition, forest productivity, burned areas and fire occurrence), and the crops phenology and conditions (productivity and yield, phenological stages, water stress conditions, health status). For what concerns the water compartment of the ecosystems, some of the parameters which can be estimated from satellite images are related to the characteristics of the snow cover (e.g. snow cover extent, snow cover water equivalent) and the parameters which describe surface water quality as, for example, surface temperature, transparency, chlorophyll concentration.

Applications

Monitoring crop status and phenology
Seasonal trends of land surface temperature for the identification of thermal anomalies
Snow cover and glacier seasonal trends in the Alpine mountains
Analysis of the relationship between the quality of inland waters and the deposition of atmospheric aerosols
Spatio-temporal analysis of the aquatic vegetation
Analysis of soil consumption and urban evolution

Proximal sensing and Cal/Val activities

Field measures are key activities of Earth Observation (EO) sciences. The generation of remote sensing products often depends on calculations based on in-situ measurements. As an example, it can be mentioned the use of analytical models for the estimation of bio-geophysical parameters, which usually takes advantage from physical relations calibrated with in-situ measures about the bio-optical properties of natural surfaces.

Field activities are also performed in order to collect measures comparable with satellite derived data; in this way the accuracy of algorithms implemented for the generation of thematic maps can be evaluated. Furthermore, the collection and analysis of field data by means of scientific instrumentation used both in-situ and in laboratory, is a good way to have a large database for the understanding and/or modelling of interaction processes between electromagnetic energy and natural surfaces.

In general, in-situ measures allow a database for both the interpretation of remote sensed data and for the elaboration of the electromagnetic signal to be generated, with positive impacts on EO techniques in the scientific field and for the satisfaction of different stakeholders' requirements (end-users). Within this context IREA has a long experience carried on thanks to important investments on state-of-the-art instrumentation (e.g. spectroradiometers, thermal camera, solar photometers) and the development of prototypes (e.g. multi-angular goniometer, sampling technique for water fluxes using flow-through method), purposely designed to satisfy the needs of the research activity.

Measuring soil reflectance over agricultural land with a field spectroradiometer

Personnel involved

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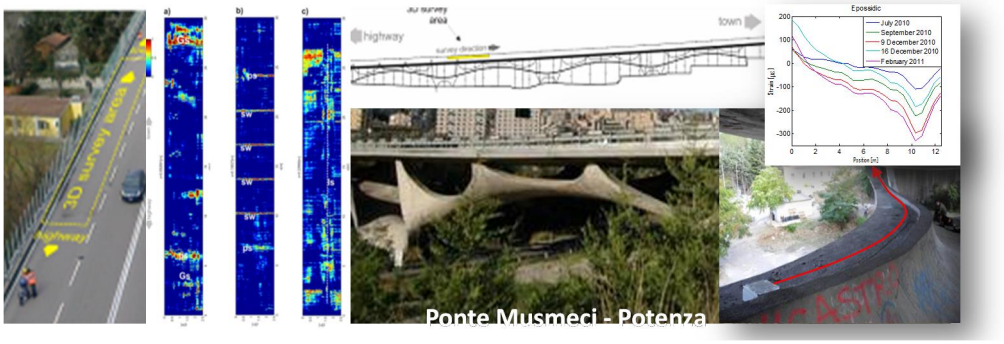
Applications

Calibration of physically based models for the estimation of bio-geophysical parameters from optical data
Validation of products/maps obtained from the elaboration of Earth observation data
Hyperspectral analysis of reflectance signal for the characterization of different material typologies

Electromagnetic diagnostics



The electromagnetic diagnostics involves a wide range of technologies in which sensors and data processing methods are developed in order to pursue monitoring and diagnostic goals, such as the monitoring of civil structures, critical infrastructures and the state of the sea, the medical and cultural heritage diagnostics, the detection of pollutants, the issues related to physical security, such as the localization of explosive devices, the detection of hidden objects on people and the remote detection of vital signs.

Based on the use of non-ionizing radiation at frequencies ranging from microwave to terahertz until reaching the optical ones, the electromagnetic diagnostics exploits the ability of electromagnetic waves to penetrate materials and interact with them in order to detect, locate and characterize objects and risk factors in a non-destructive and non-invasive way. This is possible thanks to technologies capable of operating at different frequencies and of providing information on different spatial and temporal scales.

The focus of the research activities is the development of methodologies of measurement and data processing able to overcome the limitations of those currently in use, which are affected by the extreme simplification of the physical / mathematical models used to describe the interaction between electromagnetic radiation and the objects under test. In this frame, the main goals concern both the design of active electromagnetic sensors, such as fiber optic and microwave sensors, and the study of the physical electromagnetic scattering phenomena.

The main research activities carried out by IREA researchers are referred to:

- the development of microwave tomography approaches and methods for radar data processing in order to obtain high-resolution and reduced ambiguity images of static or moving objects, hidden or buried in complex scenarios;

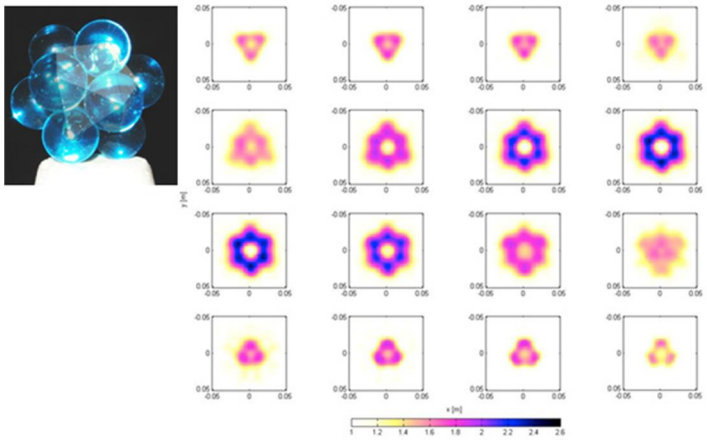
- the design, characterization, and use of electromagnetic sensors including: fiber optic distributed sensors to measure temperature and / or deformation of the structure investigated on distances up to tens of kilometers, microwave and the terahertz sensors for material characterization;

- the creation of micro-laboratories for integrated environmental, chemical and biological analysis;

- the development of specific data processing algorithms, in order to elaborate data collected by means of possibly not canonical measurement configurations, and devices designed for specific diagnostic applications such as, for instance, the high-resolution monitoring of critical infrastructures, the mapping of the water content in the subsoil, the through walls imaging, the motion tracking, the detection of physiological signals (breathing and heartbeat), the monitoring of sea conditions and the diagnostics for biomedical and teranostic purposes.

Electromagnetic diagnostics

Radar Tomography



Dielectric permittivity profile of a cluster of plastic spheres reconstructed from measurements of the electric field by means of a nonlinear imaging approach developed at IREA

The capacity of electromagnetic waves to penetrate material bodies and interact with them constitutes the physical principle underlying the electromagnetic diagnostic techniques. These imaging methodologies allow non-contact and non-invasive characterization of morphology and electromagnetic parameters of unknown objects placed in opaque media or hidden by obstacles.

To this end, the development of appropriate methodologies for the processing of radar data, gathered by means of possibly non-canonical measurement configurations, is needed. These methodologies rely on physical / mathematical models able to describe accurately the wave / target interaction in complex scenarios, and appropriate mathematical tools for the reliable solution of the non-linear and ill-posed inverse problem, which underlines the imaging. Based on these requirements, the methodologies developed at IREA aim at providing images from which it is possible to determine the characteristic parameters of the scenario under test in a not ambiguous way.

IREA researchers have a long experience in this field, which has allowed the development of different approaches tested in different applicative contexts.

From a conceptual point of view, the developed methodologies can be classified into two groups:
1) strategies for the localization of unknown objects and their geometric (size, shape) characterization;
2) approaches able to provide an accurate (quantitative) characterization of the electromagnetic properties of the objects under test.

These data processing approaches are an useful diagnostic tool in a vast number of applications in which the radar imaging is of interest, including civil structures and critical infrastructure monitoring, diagnostics of cultural heritage, underground utilities mapping in urban environments, applications related to physical security, such as land mines and unexploded ordnance detection, through wall imaging, tunnel detection, detection of hidden objects on people, remote sensing of vital signs (such as breathing and heart rate).

A technological environment in which the use of these methodologies is extremely relevant is that of the ground penetrating radar (GPR), a radar system specifically designed for the imaging of buried or hidden structures. In this context, the methodologies developed at IREA, particularly those aimed at the localization and morphological characterization of unknown objects, have been successfully applied in many investigation campaigns through GPR. These were performed in the various national and international research projects which involved the exploration of archaeological sites (home of the Centaur in Pompeii, ancient Stabiae and Pontecagnano in Campania, Viggiano Lucania and many others), the monitoring of civil structures and infrastructure (eg Musmeci bridge in Potenza and different Swiss motorway courses), and the diagnostics of cultural heritage (GPR survey in the Hall of 500 in Firenze in search of hidden states of the Vasari's painting).

Personnel involved

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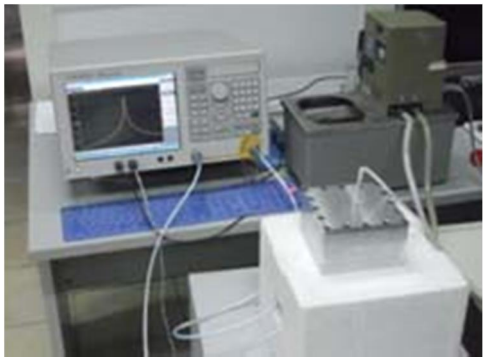
Applications

Sub-surface diagnostics
Monitoring of large civil infrastructure
Through and Intra wall imaging
Conservation of cultural heritage
Pipeline monitoring
Detection of vital signs

Mircowave and terahertz sensors

The measurements of the dielectric properties of materials are subject of numerous studies due to their implications in various application fields. The ability to monitor non-destructively and in real-time the response of materials to electromagnetic fields at microwave and terahertz frequencies provides useful information about various physical and chemical parameters of the material under test. For a specific orientation of the electric field and a fixed working frequency, the electromagnetic properties of a substance can be related to physical parameters such as temperature, concentration, pressure, humidity, mechanical stress, molecular structure, and so on. Therefore, such sensors are of interest in many application contexts, including:



Microwave sensor for water pollutant detection developed at IREA

- Food industry and agriculture: estimation of heating rates when the materials are exposed to high intensity fields, determination of moisture content, food storage, verification of product quality, etc.;
- Medical and pharmaceutical industry: tissue characterization, testing and production of drugs, characterization of solvents, chemical reactions, etc.;
- Electronics industry: characterization of substrates, printed circuit boards, etc.;
- Aerospace/defense industry: radar absorbent materials, radomes, etc.

Personnel involved

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In this framework, the activities carried out by researchers of IREA are devoted to the design and characterization of microwave sensors (e.g. sensors for the characterization of liquid solutions and bioradar sensors), and to investigations at THz frequencies. These latter are designed to perform a non-invasive characterization of materials using their unique spectral response in the band 0.3 - 3 THz or to provide high-resolution images of their internal structure.

Applications

Water pollution monitoring
Evaluation of water stress of vegetation
Conservation of cultural heritage
Detection of vital signs

Distributed fiber optic sensors

Prototype of a distributed sensors based on stimulated Brillouin scattering entirely developed at IREA

Nowadays, fiber optic sensor technologies are used in various application fields since offer solutions significantly advantageous compared to the conventional sensor technologies. Compared to conventional techniques, there are several advantages in the use of fiber optic sensors as, for instance: high sensitivity, immunity to electromagnetic interference, small size, safety in potentially explosive environments and reduced wiring.

These sensors are ideal for building very large monitoring networks. In addition, they are mechanically and chemically compatible with the majority of construction materials. However, the commonly used fiber sensors allow an accurate measurement of the parameters of interest at a single point, but this represents a difficulty when a high resolution over long distances is required, and interrogation of several point sensors becomes an unpractical solution.

Electromagnetic diagnostics

Personnel involved

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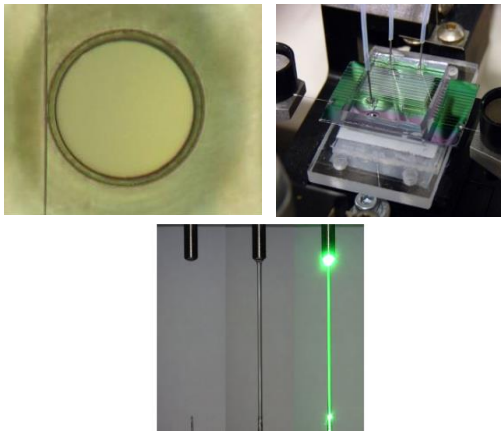
The use of distributed sensors overcomes these limitations. For this purpose, the research carried out by researchers at IREA has enabled to develop new configurations of distributed sensors based on stimulated Brillouin scattering, which allows to measure temperature and / or deformations of large structures with high resolution. In this context, IREA researchers hold a position of national leadership and excellence at European level. The results of the research activities led to the filing of two patents, one of which also extended to the United States of America.

Applications

Monitoring of large civil infrastructure
Monitoring of pipes
Monitoring of geothermal and volcanic areas

Integrated optical and optofluidic sensors



Optofluidic sensors developed at IREA

The optofluidic sensors are a recent innovation in sensoristics. They combine the unique characteristics of liquids to those of microfluidics leading to innovative devices. In this field, for instance, there are sensors based on liquid jet waveguides, recently developed by IREA researchers. Moreover, optofluidic sensors provide easy integration to electronic devices.

Integrated optical sensors, which integrate on the same platform optoelectronic elements for the signal processing, offer great advantages in terms of costs, weight and size. These devices, in fact, can be fabricated with reduced costs as respect to the conventional counterparts. Moreover, due to reduced dimensions, they require a very small amount of sample thus reducing sample consuming and allowing field deployability.

The research activity of IREA in the field of integrated micro-sized devices is focused on the realization of optofluidic devices, which makes use of fluid to tune the optical property of the device itself. Optofluidic devices allow the full integration of the microfluidic and optic elements, leading to very compact devices. In this framework, IREA researchers have a long experience in the design, modeling, fabrication and characterization of a new class of optofluidic waveguides called Antiresonant Reflecting Optical Waveguides (ARROW), which are capable of confining light to core with a refractive index lower than either of the surrounding cladding layers.

Optofluidic devices have been fabricated with silicon,polymers and by developing hybrid approaches that make use of both silicon and polymer. Polymer-based devices have been fabricated with PDMS, PMMA and SU-8 by using soft lithography technique, milling machine, or by direct UV-laser writing system, respectively. In particular, all-polymer optical ring resonators have been fabricated and applied as refractive-index- based sensor and biosensors.

Moreover, by developing an innovative hybrid approach, the scientists of IREA have recently demonstrated a hybrid optofluidic waveguide, named h-ARROW, which has been obtained by substituting the top antiresonant cladding layers with a PDMS layer.

These new waveguides have been fabricated and characterized and successfully applied for the realization of an integrated optofluidic platform for sensing application. The ARROW waveguides, on the basis of the design principle, can be directly used as refractive index sensor or they can be exploited as flow cell in order to increase the light interaction with the sample to be tested (liquids or gases).

These waveguides have also been applied as a basic element in the realization of more complex photonic devices like:

- Refractometers
- Optofluidic multimode interference coupler
- Tunable optofluidic filter
- Optofluidic integrated Mach-Zehnder interferometer
- Integrated optofluidic ring resonator
- Hybrid silicon-PDMS optofluidic platform

Personnel involved

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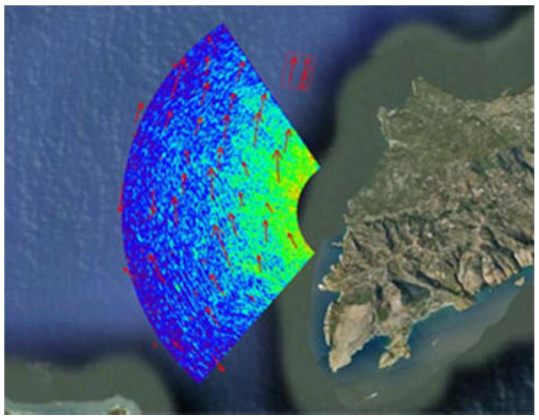
Gianluca Persichetti
Angelica Grimaldi
Giovanni Onorato

Applications

Water pollutants monitoring
Biochemical and biomedica sensors

Sea state monitoring through X-band marine radars



Map of sea surface currents obtained by processing X-band radar images

According to a study carried out by the European Space Agency (ESA) in the last twenty years, more than 200 supertankers and container ships have sunk as a result of extreme sea conditions and anomalous waves, leading to loss of human lives and environmental disasters. By taking into account this problem, the scientific research and the technological innovation are opening new horizons about the possibility to monitor sea state through X-band marine radar systems, which are commonly installed on large vessels and at the port authority sites.

This opportunity arises from the characteristics of the signals measured by a common navigation radar, which do not depend only on the reflection of the electromagnetic waves generated by the targets (obstacles, ships) present in the surveillance area, but also on the waves reflected by the sea surface. Therefore, through the smart processing of the signal that is commonly regarded as a disturbance component (clutter) in navigation applications, it is possible to obtain information on the spatial and temporal behaviour of the wave motion. This offers an appealing alternative to the currently adopted methods for the detection of the sea state, such as the ondametric buoys and the HF radars, with the advantage of being extremely easy to install, operate, maintain, and, not least, requiring comparatively low installation and management costs.

The idea of exploiting the information hidden in the electromagnetic waves reflected from the sea surface made the IREA researchers capable of developing an innovative methodology for an accurate estimation of sea surface currents and bathymetry, which can be applied in both the terrestrial contexts (coastal monitoring, meteorology, operations support to search and rescue) and in the offshore scenarios (aid to navigation, safety of offshore platforms).

In the frame of this research activity, a technology transfer initiative has been carried out, and this action has led to the birth of the company Remocean SpA, a spin-off of the CNR.

Personnel involved

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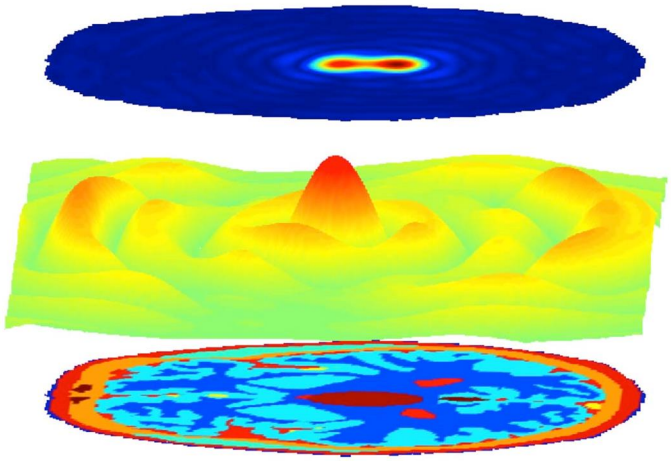
Applications

Coastal monitoring
Monitoring by ship
Wind estimation
Identification and tracking of targets

Electromagnetic diagnostics

Electromagnetic fields in diagnostics and therapy



Conceptual diagram of the simulation and data processing tools developed at IREA for diagnosis of cerebral stroke by means of microwave tomography

The study of the interaction between electromagnetic fields and biological systems, such as the human body, has been for a long time one of the most active sectors in basic and applied research involving the technologies of electromagnetism.

If historically these activities were focused on the study of the possible harmful effects of the interaction between fields and biological systems as well as dosimetric evaluation, an innovative paradigm has recently emerged, which looks to the remarkable possibilities offered by the use of such interaction to produce a specific effect.

Evidently, this new paradigm is of significant interest in the medical field, where the nature of the non-ionizing electromagnetic fields, their ability to penetrate matter, and the specificity of the electromagnetic properties of the different human tissues (also according to their pathological condition) has given the impetus to the study and development of new diagnostic and therapeutic methodologies, which may cooperate with those currently in use in order to improve the quality (and the precocity) of the diagnosis, or contribute to more effective treatment of certain diseases.

A possible example of a therapeutic application of this new paradigm is microwave hyperthermia, wherein the selective heating of cancerous tissues, by focusing the energy of the microwave field in the region of interest, is exploited to induce apoptosis (ablation) of diseased cells or to locally increase the effectiveness of chemotherapy and radiotherapy. In diagnostics, one example is the morphological and functional screening for the early diagnosis of breast cancer, which exploits the different microwave response of healthy tissues compared to the diseased ones, in order to obtain diagnostic information from the measure of the fields scattered by the anatomic region under examination.

In this frame, the research activity carried out at IREA for some years deals with the development of innovative diagnostic, monitoring and therapeutic strategies based on the use of electromagnetic fields at microwave frequencies.

In particular, it aims at the definition of the exposure conditions needed to induce the desired effect, so optimizing the interaction between electromagnetic fields and human tissues, the design of the synthesis and tuning of the radiant systems, as well as the development of methods for the processing of data aimed at the extrapolation of diagnostic information and of the imaging approaches for the electromagnetic properties characterization of biological structures. Besides this methodological contribution, more recently an experimental activity, which exploits prototypal instrumentation developed in the Diagnostics Laboratory of IREA, is also carried out.

About diagnosis, the focus is on two issues. The first is the development of a novel technique for the early diagnosis of breast cancer, which uses nanomagnetic contrast agents able to selectively concentrate in cancerous tissues. Thanks to the non-magnetic nature of the human body, the use of such a contrast agent, already approved for other biomedical applications, allows reducing the incidence of false positive and negative, with an obvious benefit in terms of reliability and quality of diagnosis.

As far as monitoring is concerned, there are two main topics of research. The first one concerns the study of the use of differential microwave imaging techniques to monitor the evolution of the disease in its course during a therapy. In particular, the focus is on the monitoring of physiological changes of

brain tissue caused by alterations of normal blood flow (ischemia, hemorrhage) or traumatic events (hematoma). In both cases, the research activities aim at the design of devices able to optimize the interaction between electromagnetic fields and human tissue, and at the development of imaging approaches capable of characterizing, from the point of view of the electromagnetic properties, complex biological environments. The second topic of research is about the contactless monitoring (possibly in the presence of obstacles) of vital signs such as breath rate and heartbeat, through radar technologies (bioradar).

With regard to the therapeutic aspects, the research addresses the development of new methods for the microwave hyperthermia, and in particular the design and implementation of applicators capable of focusing the electromagnetic energy in the diseased tissue, while minimizing the heating of the surrounding tissues so to avoid side effects. The use of appropriate optimization techniques for the synthesis of the field and the accurate numerical modeling of the electromagnetic signal propagation and its interaction with exposed biological structures are crucial for the activity, which also provides the tools necessary to a suitable planning of specific therapeutic treatments.

Finally, it is also a topic of research the possibility of using the set of methods and tools designed for the development of “theranostic” systems, in which the dual nature (diagnostic / therapeutic) of microwaves is used in a synergistic way. In particular, the goal is the design of a system that integrates a device for the thermal therapy with a diagnostic device, able to obtain the necessary information for the planning of the specific therapeutic treatment and verify in progress its evolution and effectiveness.

With regard to the therapeutic aspects, the research addresses the development of new methods for the microwave hyperthermia, and in particular the design and implementation of applicators capable of focusing the electromagnetic energy in the diseased tissue, while minimizing the heating of the surrounding tissues so to avoid side effects. The use of appropriate optimization techniques for the synthesis of the field and the accurate numerical modeling of the propagation of the electromagnetic signal and its interaction with biological structures exposed are crucial for the activity, which also provides the tools necessary to a suitable planning of specific therapeutic treatments.

Finally, it is also topic of research the possibility of using the set of methods and tools developed for the development of “theranostic” systems, in which the dual nature (diagnostic / therapeutic) of microwaves is used in a synergistic way. In particular, the goal is the design of a system, which integrates a device for thermal therapy with a diagnostic device, able to obtain the information required for the planning of the specific therapeutic treatment and verify work in progress and the evolution's effectiveness.

Personnel involved

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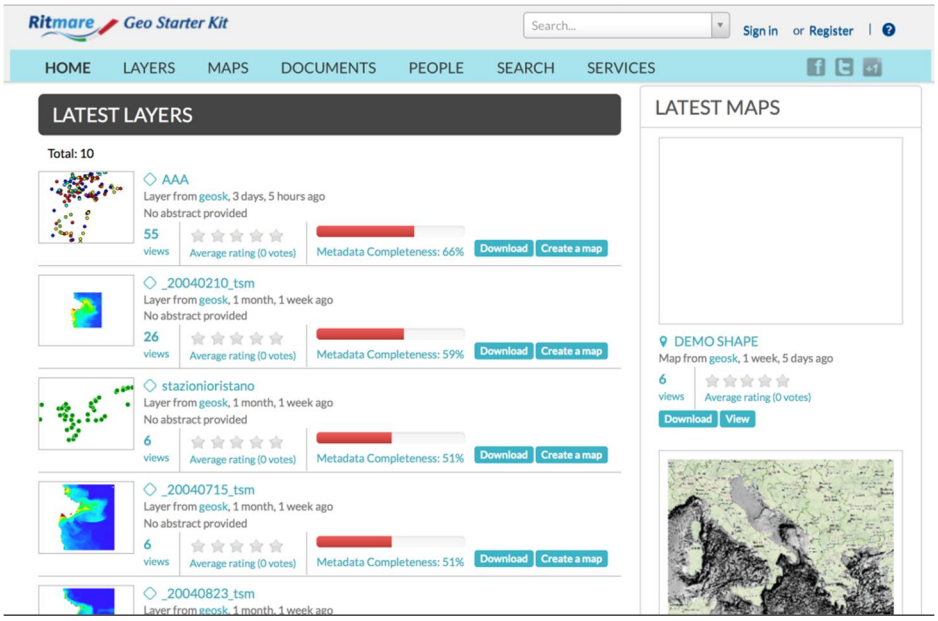
Applications

Microwave diagnostics of breast cancer, possibly enhanced by contrat agents
Monitoring of post-acute crebral stroke
Non invasive monitoring ofablation and hypertermia treatment
Contactless and remote monitoring of vital signs
Planning of patient specific therapeutic treatments

Geographic Information Systems



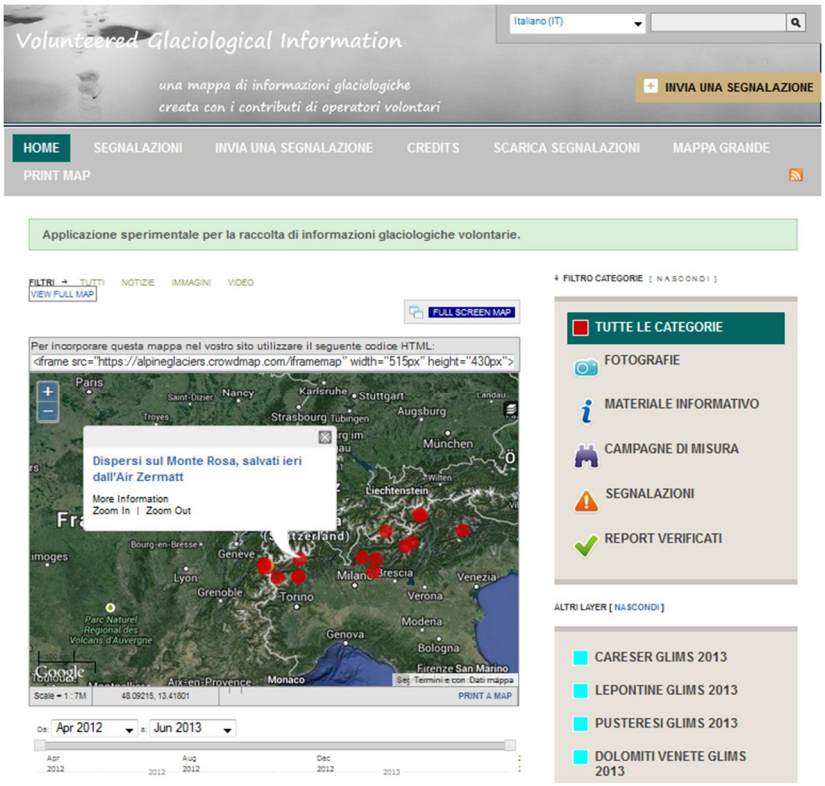
Geographic information is living a phase of lively and rapid transformation with respect to data collection, diffusion, and analysis models.

Geographic Information Systems (GIS) were born in the Sixties of the last Century in order to facilitate the analysis of great geographic areas and their resources under the pressure of growing populations.

Over the decades, these systems have been refining the technologies adopted and they are now able to quickly store and retrieve great amount of observations on the territory, process them in a reasonable time, accurately collect digital geographic remarks, like in the case of the popular GPS, for determining the position on the globe, aerophotogrammetry, remote sensing. In the era of the Internet, developments in this sector are no longer counted: from spatial data infrastructures, virtual globes (like Google Earth) to voluntary data collection through cell phones and mobile devices.

At IREA the research in this area is carried out through two activities.

Big Data and geographic information on the web from smart and social sources



VGI (Volunteer Geographic Information) application storing and visualizing information on glaciers collected through smart tools

Traditionally Big Data means heterogeneous, multi-source, non-structured information on the Web characterized by huge volumes, great velocity of updating and high semantic variability.

The interest of research on the links between Big Data and geography is highly increasing. The capacity of detecting, interpreting and analyzing Big Data, created by smart, mobile applications to signal, comment or document with photos, videos, etc. critical environmental events witnessed by the providers, can fruitfully help in different situations: to prevent catastrophic accidents, to monitor the territory evolution, to plan mitigation activities and resource distribution during both ordinary management and emergencies, and to improve population security.

Big Data often includes either explicit geographic contents, with GPS coordinates, or implicit contents, expressed by names of geographic locations in the texts, which is created and shared on the Web by social tools such as Twitter, FaceBook or specific applications for geographic information such as Foursquare, Ushahidi, etc.

Managing Big Data involves multiple techniques related to various disciplines such as Information Retrieval of textual documents for searching, lexical analysis, and representation of the contents of interest; techniques of interoperable managing and sharing of geo-information for mapping spatial references; spatio-temporal data mining for contextual content analysis; and at last techniques of validation of the quality of heterogeneous, multi-media information.

Usually, such information is affected by uncertainty and imprecision: hence its management requires appropriate methods such as statistics and soft computing.

Personnel involved

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Applications

Snow-cover monitoring
Alpine glaciers monitoring
Monitoring of slope instability
Gathering in-situ observations on crop status in agriculture for calibration of remote sensing image classifiers
Volunteers Geographic Information acquisition and management at municipality level to plan local mitigation interventions
Geo-temporal analysis of periodic and aperiodic events reported in social media (Project Simulator)
Improving the quality of life of elderly people at home by the provision of information on geo-located services (Project CARE-G)

Interoperable infrastructures for geodata

The field of studies of interoperable infrastructures for geodata is highly topical so much that even some texts of contemporary literature borrow their acronyms and glossaries to enrich their own pages, make them current and curious.

The activity carried out at IREA in this field arises from the need to use the Internet to spread and process geospatial products of its own research, whether it is digital maps that derive from satellite Earth Observation or observations collected by field sensors.

In fact, also the world of Geographic Information Systems (GIS) has not been able to escape the process of 'webbing' that by now invests many areas. The Internet has set itself as a new development platform also for geospatial data, dictating the rules of their use.

The web is not suitable for monolithic applications controlled by a single vendor: its approach is that of a system without owners, based on precise sets of reference standards. Moreover, the Internet requires an operability not bound to systems owned by each user. This feature takes the name of interoperability and is the basis of complex systems called Inter-operable Geodata Infrastructures (SDI, Spatial Data Infrastructure).

IREA researchers engaged in this field work closely with their expert domain colleagues, such as geologists, ecologists, and limnologists, in their attempt to combine as much as possible modern IT technologies and tools with the requirements and practices of those who create and use data and information in specific areas of research, such as satellite remote sensing, ecology, biology, geology, etc.

At this moment, IREA deals with the development of spatial data infrastructures, especially in the fields of ecology and biology, in marine, lacustrine, and terrestrial research.

This research activity combines with several international initiatives. Among them, we mention the European Directive INSPIRE, the European Commission's Copernicus / GMES Program, GEO-GEOSS and the Open Geospatial Consortium (OGC).

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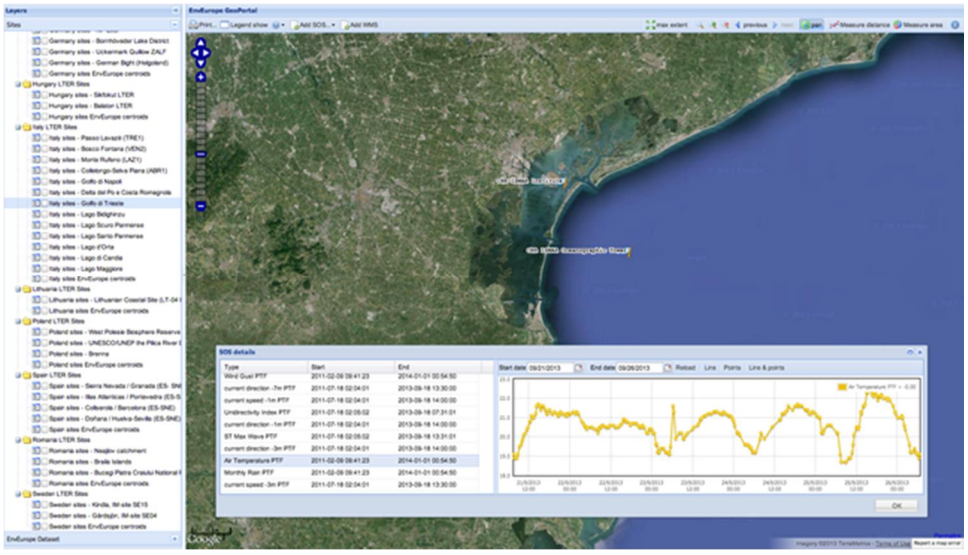
Luigi Ranghetti
Maria Antonia Brovelli

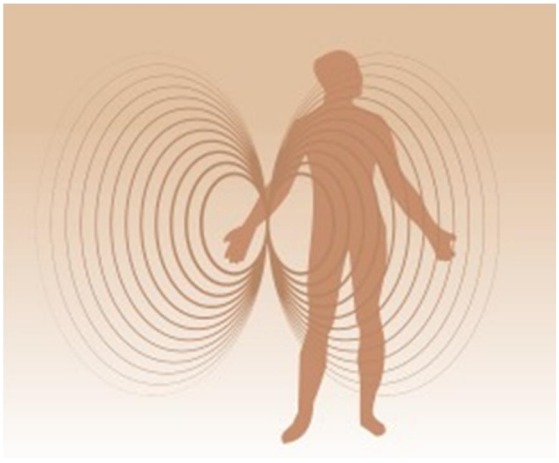


GeoViewer, developed by IREA, enables the interoperable sharing of observations from heterogeneous distributed sensors

Applications

Agriculture
Water
Ecology
Biodiversity
Fires

Bioelectromagnetics



The debate about the influence of electromagnetic fields (EMF) on human health is still active and controversial and gives rise to a great concern in the general public for the possible cancer risk in the proximity of power lines, radio-TV stations, radio base stations and mobile phones. On the other hand, the interaction between electromagnetic fields and biological systems are being exploited in clinical and biomedical applications.

So, what is the impact of electromagnetic fields on human health? Moreover, can they be useful for new clinical applications under safety conditions? For many years, researchers at IREA have been trying to answer some of these questions by means of experimental activities.

The attention is focused on non ionizing radiations whose health effects and clinical applications are still of great scientific interest. In particular, IREA activities aim to cover the following aspects of the bioelectromagnetic research:

• evaluation of the interaction between electric, magnetic and electromagnetic fields and biosystems by means of in vitro experiments on mammalian cell cultures by applying cell biology and molecular techniques. Exposure systems are designed and realized by means of numerical and experimental dosimetric techniques that allow the strict control of environmental (temperature, humidity) and electromagnetic (dose absorbed by the sample) conditions during the exposure;

• use of pulsed electric fields and RF-EMF for biomedical applications. In vitro investigations on cell lines from healthy and cancer tissues are carried out either for the optimization and the extension of the technologies already in use in clinics (electrochemotherapy) or to lay the foundation for the development of new therapeutic applications in oncology;

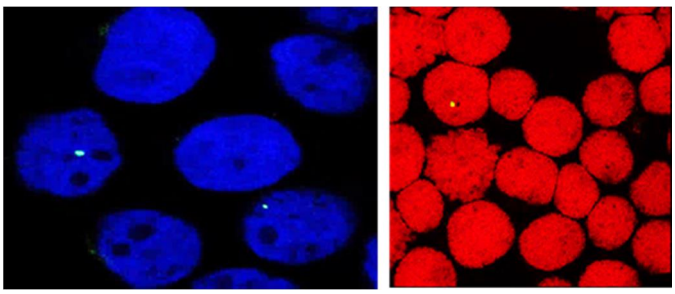
• monitoring activity of electric, magnetic and electromagnetic fields levels in urban and working environment. In situ measurements for the exposure assessment of general public, with particular attention to sensitive sites such as school and hospitals, and workers in MRI environment, are carried out. In the latter case, instruments and methodologies, useful for personnel involved in the health risk evaluation, are also developed;

• health risk evaluation deriving from electromagnetic fields exposure. The activity carried out in the framework of international working groups, consists in the critical revision of scientific literature in order to release monographs and technical reports to be used by competent authorities for the revision of EMF exposure limits and for the communication to the general public.

Interaction between electric, magnetic and lectromagnetic fields and biological systems

In 2002, extremely low frequency (0-300 Hz; ELF) electromagnetic fields (EMF), associated with the power generation and delivery network, and in 2011 Radiofrequency (30 kHz-300 GHz, RF) EMF, have been classified by the International Agency for Research on Cancer (IARC) in class 2B as "possible carcinogen" for humans, mainly on the base of epidemiological evidences. Gaps in knowledge still exist on the biological effects and their relevance with respect to the possible health risk.

The attention of IREA researchers is focused on the effects of ELF (50 Hz) and RF EMF, with particular attention to the frequencies in use for mobile phones (800-2000 MHz). The in vitro biological research carried out at IREA aims to find possible biological mechanisms explaining interactions between EMF and living organisms to give plausibility to the hypothesis of carcinogenicity of these fields. Taking advantage of the multidisciplinary expertise of IREA researchers, the exposure systems, in agreement with the quality standards of the World Health Organization (WHO), are designed and realized in order to perform "in vitro" experiments under well-defined and strictly controlled conditions, in terms of electromagnetic and environmental parameters. Exposure systems, PC controlled, are hosted in standard cell culture incubators in order to assure the proper conditions of temperature, CO2 and humidity inside the biological samples during the exposure. Identical exposure systems, but not fed, are employed to host control samples (sham samples) in order to exclude that possible biological effects could arise from environmental conditions inside exposure systems and not from EMF exposure. After exposures, cell samples are handled for the evaluation of those biological endpoints for which effects have been reported and evidence of replication does exist in the literature. Among the biological effects, the effects on DNA are particularly relevant since DNA damage is always present in the first stages of carcinogenesis.

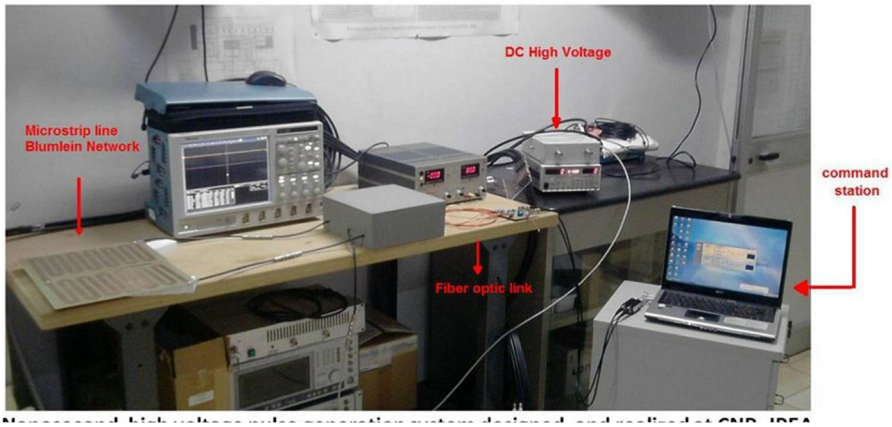


Nuclei of human neuroblastoma (SHSY5Y, blue) and promyelocytic (HL-60, red) cells marked with fluorescent dye to visualize DNA damage(green spot) by means of confocal microscopy

In the framework of these activities, the effects of combined exposures in the presence of chemical and physical agents are also investigated, aimed to study the effect of co-promotion of the carcinogenic event in which, as widely recognized, more than one agent is involved.

A more recently introduced activity at IREA is the study of cellular effects of pulsed electric fields of high intensity and duration in the range of nanosecond (ns Pulsed Electric Fields, ns PEF). It has been demonstrated that exposure of mammalian cells to nsPEFs is able to increase the plasma membrane permeability to normal impermeable substances (electroporation), interact with intracellular structures and induce different cell death pathways in cancer cells. Several interaction mechanisms to highlight the nsPEF- induced effects have been hypothesized by means of modeling and experimental approach, but the understanding of such mechanisms is still lacking to obtain the definition of a new, non-thermal and drug free technology for cancer therapy.

In this framework, the activity at IREA is devoted to the characterization of the effects of nsPEF exposure in mammalian cell cultures, with particular attention to the study of the role of exposure parameters (electric field intensity, repetition frequency, exposure modality). This is approached by modeling tools and experimental investigations. Moreover, innovative systems for the generation of nsPEFs and their application to cell samples are also designed and developed.



Nanosecond, high voltage pulse generation system designed and realized at IREA

Recently, researchers at IREA are also studying the interaction mechanisms of electroporation by using the THz spectroscopy, that is a non-invasive well-recognized methodology to study different biological structures (proteins, DNA, RNA) at a molecular level. As a matter of fact, THz radiation interacts with dynamic processes taking place on a subpicosecond time scale. This activity, possible at IREA thanks to a time domain THz spectroscopy system recently acquired, aims to study the dynamic processes at the level of membrane structures, in PEF and ns-PEF-exposed cells.

Personnel involved

Maria Rosaria Scarfì
Olga Zeni
Anna Sannino
Stefania Romeo
Rita Massa

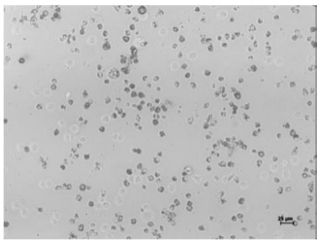
Applications

Understanding the interaction mechanisms between electromagnetic fields and biological systems
Contribution to the formulation of safety standards for exposures to electromagnetic fields
Understanding the mechanisms of interaction between nsPEF and biological systems
Use of THz spectroscopy for the study of biological processes at molecular level

Biomedical applications of electric, magnetic and electromagnetic fields

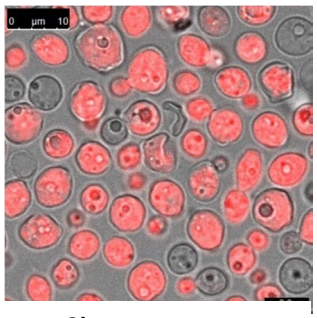
The study of interaction mechanisms between electric, magnetic and electromagnetic fields and biological systems, performed at IREA, aims to the development and/or optimization of the biomedical applications of electromagnetic fields (EMF). In particular, in the framework of the study of cooperative effects of EMF and chemical and/or physical agents, IREA researchers have demonstrated that pre-exposure of mammalian cells to RF – EMF can offer protection from DNA damage induced by subsequent treatment with chemical or physical agents (Adaptive Response). These results are of particular interest since they demonstrate, for the first time, that non-ionizing non-genotoxic radiations are able to induce an adaptive response and offer interesting perspectives in the framework of radioprotection and therapeutic applications. As a matter of fact, finding exposure conditions able to induce an adaptive response in healthy cells and not in cancer cells could be useful in optimizing the balance between the damage induced in healthy and cancer tissues in chemo- and radiotherapy treatments. Two of the scientific publications on RF-induced adaptive response have been selected for the publication in two different editions of the Highlights of the National Research Council.

The phenomenon of electroporation induced by Pulsed Electric Fields (PEFS) with amplitude in the range of KV/m and durations from milliseconds (ms) to microseconds (μs) are currently employed in the clinic to enhance the efficacy of chemotherapeutic drugs (electro-chemotherapy, ECT), in the treatment of cutaneous and subcutaneous solid tumors. Currently, a unique standard electric protocol (ESOPE) that is used on human subjects exists in the clinics. Such a protocol promotes the massive entrance of chemotherapeutic drugs with high cytotoxicity into cancer cells improving their efficacy. At the same time, the drug concentration administered to patients is reduced with a consequent decrease of the side effects to healthy tissues surrounding the tumor.



Human promyelocytic cells (HL-60) exposed to PEFs in the presence of calcium

In this framework, IREA activities consist in the development of new procedures for ECT to extend its applications in the treatment of solid tumors. In particular, new electroporation protocols are under investigation to be employed when the standard protocol results less efficient due to the great differences in electric impedance of large tumor tissues (equivalent electroporation protocols).



Oleaginous yeasts exposed to PEF and propidium iodide stained

More recently, investigations on electroporation in the presence of calcium have been launched. The massive entrance of calcium in cancer cells, by electroporation, induces cell death in the absence of side effects typical of chemotherapeutic drugs. The use of "calcium electroporation" represents an innovative, very promising cancer therapy, due to the weak cytotoxicity of calcium treatments and the low costs of the treatment. These activities are in the collaboration network of the Cost Action TD 1104 "European network for the development of electroporation-based technologies and treatments". Beside the biomedical field, the IREA activities in this framework are also devoted to industrial applications. Both PEF and EMF in the frequency range of microwaves can be used for lipids extraction from oleaginous yeasts, to be employed for the synthesis of second generation biodiesel.

Moreover, IREA researchers are involved in the electromagnetic characterization of liquid and solid materials at radiofrequency and microwave for the development of biological tissues mimicking materials and phantoms to be employed in MRI investigations.

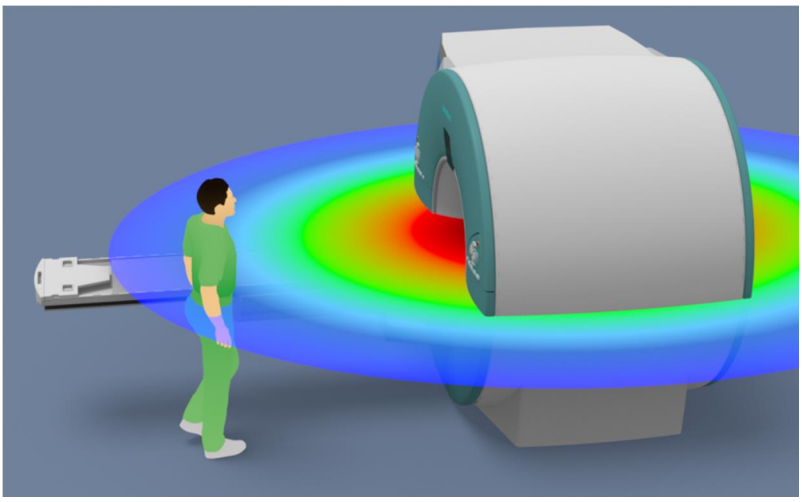
Personnel involved

Maria Rosaria Scarfì
Olga Zeni
Anna Sannino
Stefania Romeo
Luigi Zeni
Rita Massa

Applications

Development and/or optimization of the applications of electromagnetic fields and pulsed electric fields in biomedical and industrial research

Electromagnetic field levels monitoring and health risk evaluation in urban and working environment



The widespread, nationwide diffusion of sources of low (high voltage power lines and delivery network) and high frequency (radio base stations, radio-TV implants...) sources of electromagnetic fields raises the question of the evaluation of background levels of electromagnetic fields in the environment, in order to characterize the exposure conditions of the general public, and to verify the compliance with exposure limits defined by national and international regulations. This assessment is particularly important in sensitive areas (schools, hospitals) where the prolonged permanence of sensitive subjects like children and elders is foreseen. Moreover, the employment of technologies based on non-ionizing electromagnetic fields in industrial and sanitary frameworks, and, more in general, in working environments, raises the issue of the evaluation of occupational risk associated with this type of exposure.

IREA researchers are involved in the characterization and health risk evaluation due to exposure to EMF employed in the Magnetic Resonance Imaging (MRI) Systems. In MRI environment, besides the patients, different professional categories (technicians, medical doctors, healthcare assistants, personnel involved in maintenance or cleaning) can be exposed to intense static magnetic fields, low frequency EMF (gradient fields) and radio frequency fields. The exposure conditions depend on both the technological features of MRI device and the activities carried out in the MRI suite. The activities of IREA are focused on: a) laboratory investigations aimed at evaluating the biological effects in mammalian cell cultures exposed to static magnetic fields, and in buccal mucosa cells deriving from MRI workers and control subjects (ex vivo analysis); b) monitoring of workers exposure, direct observation of working activities and preliminary procedures, and discussion with workers. Moreover, instruments for the personnel involved in the health risk evaluations are developed: 1) application tools for the simple and fast simulation of movements of workers around MRI scanner for a qualitative estimation of the exposure conditions associated with such movements; 2) risk evaluation forms for the collection of information about the magnet type and the activities carried out in the magnet room by the different professional categories; 3) educational material (video, documents) for the dissemination of such activities.

Such instruments are distributed in public and private healthcare structures of Campania Region, with the final goal of contributing, at least with regard to the electromagnetic field associated risks, to the establishment and diffusion of a more conscious knowledge of the safety in working environment.

Applications

Characterization of exposure scenarios to EMF in urban and working environment

Diffusion of knowledge of the safety in working activities involving exposures to non ionizing EMF and formation of workers and personnel devoted to health risk evaluation

Personnel involved

Maria Rosaria Scarfì
Olga Zeni
Anna Sannino
Stefania Romeo
Rita Massa

Health risk evaluation deriving from EMF exposure

The widespread use of technologies based on non-ionizing electromagnetic fields (from a static field to radiofrequency), has generated a big concern in the general public for the potential adverse effects on human health. During the last sixty years, researchers have employed different parameters to evaluate the effects of in vitro and in vivo (laboratory animals and volunteers) exposures. Nevertheless, data reported in the peer-reviewed scientific literature are mainly inconsistent with the indication of effects in certain cases, and absence of effects in others.

At an international level, there are organizations devoted to the analysis of literature data, including the observations reported in epidemiological studies. The aim is to define guidelines or standards with respect to the exposure of general public and workers and provide policy makers with the scientific information needed to develop and disseminate official information to the general public on the effects of such exposures on human health.

The activity of IREA researchers in this area consists in evaluating the in vitro literature in the framework of international expert groups (World Health Organizations, European Commission, Swedish Radiation Safety Authority, IEEE) and contributing to the delivery of monographs or technical reports to be used for the health risk evaluation and the identification of research priorities in this specific area.

Personnel involved

Maria Rosaria Scarfì

Olga Zeni

Applicazioni

Contribution to the formulation of safety standards for exposure to non- ionizing EMF

Contribution to the identification of ñgaps in knowledgeò with the final goals to drive the future research in Bioelectromagnetics

Public Communication of Science

The Public communication of science is nowadays an essential activity for every research institution and one of the new key elements of what has been defined as the era of "post-academic" science.

In recent decades, many transformations have occurred in the production of knowledge. The many links between Science and Society make researchers have more frequent relations with the world "outside" the scientific community, which implies the use of channels, language, goals, methods and levels of involvement differentiated according to the individuals with whom researchers relate to. These include public officials, politicians, entrepreneurs, industry professionals, journalists, but also ordinary citizens, opinion groups, civil society representatives, students, teachers.

In this context, it is clear the reason why more and more research institutions and individual researchers are personally involved in communication activities. However, it is often given little attention to the skills of the communicator and to the role, values and ideas of science and society in his/her activities. Even less of it is given to understanding the expectations of the various publics or to evaluating the impact that research can have on the society. Yet the understanding of these issues is important in order to communicate in a competent, efficient and transparent way.

The theoretical and empirical research on public communication of science and its relationship with society today is an interdisciplinary field recognized at international level, although still much to be explored in Italy. The methodological approaches are typical of the social sciences, but the issues affect all areas of the scientific knowledge, from those related to the impact of techno-science in social life, to the opportunity to gain access to research data and to share knowledge also with non-experts. This poses challenges for those, in a scientific institution such as IREA, who perform research on topics such as the safety of the environment and society, and want to communicate it.

In this context are to be considered the activities that the institute dedicates to the public communication of science. The issue is being exploited both in the sense of promoting the corporate communication, and as a field of research. In the first case, the communication is developed through the IREA website, press releases, and newspaper articles, as well as within the dissemination of research projects. In the second case, the public communication is itself a research topic that, making use of the typical tools of social studies, investigates the role played by the scientific community in the interaction between knowledge, environment and society. This dual approach allows both to experiment models of public communication more aware of the changes taking place in the relationship between science and society, and to cover greater involvement and participation of the various stakeholders in the process.

Institutional communication and scientific dissemination

IREA performs institutional communication activities in order to valorize the results of the activities carried out, make known their competences and potentiality, increase the possibilities of collaboration, enhance the potential social and economic impacts of research, bring young people closer to science and to scientific carreer, and raise public awareness about the importance of research by fostering widespread and deeper knowledge on issues of considerable public and social interest.

Institutional communication activities are also addressed internally, to employees and collaborators, in order to promote a broad circulation of information on the activities and the staff involvement in them, to create motivation, participation and sharing with the institutional mission.

The main tools of communication are the institutional website, editorial products (reports, brochures), multimedia products (presentations, videos), press releases and news, dissemination articles.

Personnel involved

Maria Consiglia Rasulo
Alba Lô Astorina
Riccardo Lanari
Pietro Alessandro Brivio
Paola Carrara

Other important moments of IREA public communication are represented by the participation in events and manifestations of the dissemination of science, such as "Futuro Remoto", which is held at Città della Scienza in Naples, and the Festival of Science in Genoa, to which IREA has taken part for several years. Attention is also given to the organization of guided tours of students and teachers at the Institute laboratories.

Applications

Enhancement of IREA research activities

Dissemination of project results and users' involvement

The Dissemination of project results refers to that portion of communication activities that nowadays all projects need to implement in order to raise awareness of the research carried out within the several funding programs. Some recent publications emphasize the importance of these activities: they need personnel experienced in communication strategies and recommend not to limit their role to the simple project-design but also to provide reporting procedures for evaluation of the results.

In this context, the involvement of stakeholders or user in research projects won, over time, a well-defined role in both national and international research contexts. Horizon 2020, the new EU Framework Programme for Innovation and Community financing system (2014-2020), moves clearly in this direction.

The scientific community now recognizes the importance of a less traditional and more involved approach, which exceed the mere purpose of disseminating the results of research and aims, rather, to the active involvement of stakeholders and their consultation.

We can get, in some cases, to the project co-design, planning the inclusion of a pool of stakeholders or users in the project itself. IREA research projects, both national and international ones, have extensive experience in this kind of activity that, in some cases, requires the involvement of users and the analysis of their expectations, making use of technological applications and interactive web spaces.

IREA is engaged in this activities at two levels. On one side, the Institute activates a series of stakeholder involvement events, within qualitative and quantitative surveys of its institutional research projects (national and international). On the other hand, it recognizes to projects' stakeholders the role of co-researchers, making them active participants of training, retraining and dissemination initiatives. Among the methods of stakeholder's participation and empowerment most implemented and adopted in research, IREA has experience in qualitative interviews, focus groups, the Metaplan, the World Café and the DELPHI method.

Personnel involved

Alba LÔAstorina
Irene Tomasoni
Maria Consiglia Rasulo

Applications

Projectsôneeds analysis about communication and exploitation of results
Strategies for better involving users and stakeholders
Planning, implementation and evaluation of communication activites in national and international projects

Investigation and testing of models of public communication of science

Survey activities – making use of both quantitative and qualitative research methods - are part of an international context where the importance of understanding the scope and the meaning of the communication commitment of the scientific community is widely recognized. Analyzing the way in which research institutions and individual researchers communicate, aims at better understanding the role, the tools, and the critical issues that those involved in institutional scientific communication have to face.

Besides these investigation activities, IREA experiences patterns of communication addressed to the schools where giving emphasis to the cultural and social dimensions of Science is the strategy to make it more accessible. Some significant proposals implemented with the students were: the introduction of the scientific debate and discussion with experts around the issues of "science complexity", "science uncertainty", and "science in progress" through the use of participatory methodologies; the sharing of research contents and processes through the introduction, to some classes, of selected IREA research projects.

Special attention is given, arranging these educational proposals, to the use of remote sensing as a methodological perspective to obtain a different study and observation of the planet in all its components. Remote sensing is also considered a useful tool to understand and represent the natural phenomena and the transformations related to the human activity at local and global scales; as a support to a better understanding of concepts such as sustainable development and environmental awareness; as a technical and scientific issue that can raise awareness about the importance of science and technology in everyday life; finally as an opportunity to approach the educational world to the research one.

Public Communication of Science

Another science communication sector adopted the use of Web 2.0 tools and channels, characterized by a high level of interaction between the user and the web applications, to collect and disseminate information with a participatory approach. This IREA activity especially highlights its researchers' skills in the field of the Geospatial Web and the Citizen Science and represent an example of the connection between the institutional research issues and the public communication of science.

At last, an important activity among Public Communication ones, is the organization of the CNR Research Conference called "Research and Communication: theory and models in research institutions" which aims at bringing the debate on the public communication of science outside the circle of insiders encouraging researchers themselves to rethink their role as experts and their relationship with the society and helping to reduce the distance between those who "produce" science and those who "reflect" on it.

Personnel involved

Alba La Astorina
Laura Criscuolo
Mariano Bresciani
Irene Tomasoni

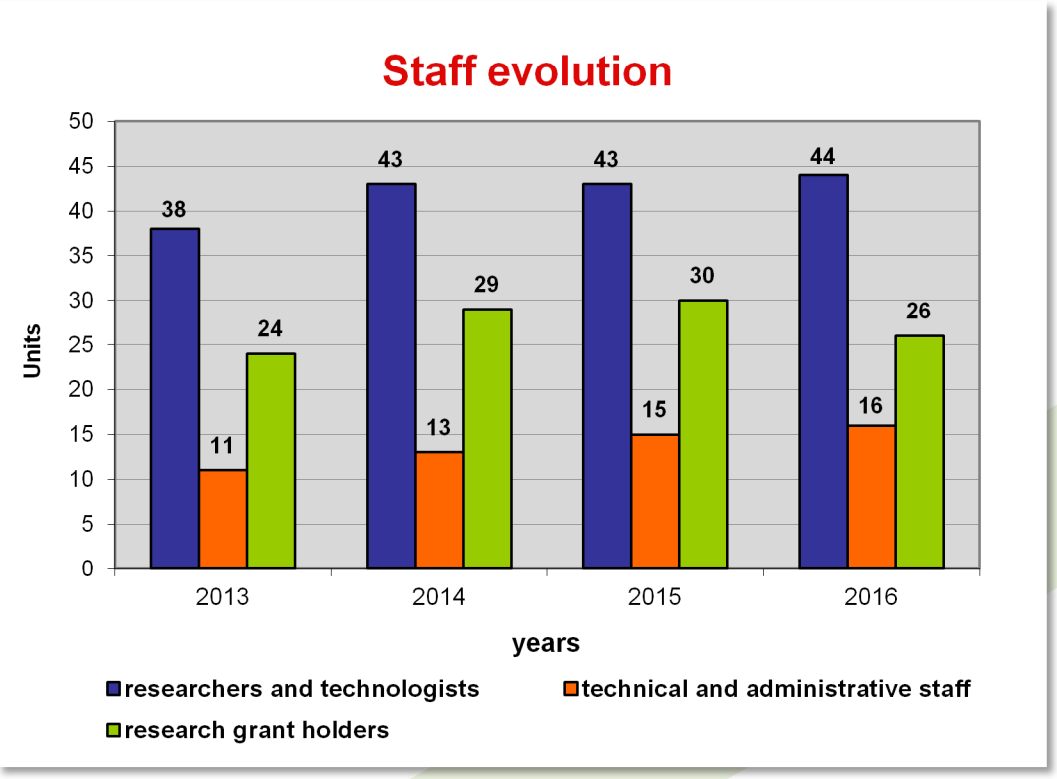
Applications

Understanding the dynamics of science communication in public research institutions
Formulation of standard approaches and techniques on public communication of science and education models
Creation of networks between research institutions and citizenship
Using the Geospatial Web and the Volunteered Geographic Information (VGI) to produce knowledge

IREA is a growing reality. The analysis of the last four years data related to the research staff, the technical and administrative staff and the temporary staff, in fact, shows an increasing trend.

The IREA staff - at 31 December 2016 - has about 90 units, distributed between the headquarters in Napoli and the Support Unit in Milano, including 44 structured researchers and technologists (12 are temporary researchers), 16 technical and administrative assistants (6 are temporary staff) and 26 unstructured researchers.

Furthermore, 9 associate researchers and many young people in training through scholarships, PhDs, traineeships, and students who carry out their thesis at the Institute, contribute to the research activities.



Staff

Director

Riccardo LANARI
lanari.r@irea.cnr.it

Graduated in 1989, summa cum laude, in Electronic Engineering at the University of Napoli "Federico II", in the same year he joined IRECE-CNR and after IREA, where he currently occupies the position of Senior Researcher. His main research interests are in the Synthetic Aperture Radar (SAR) data processing field as well as in SAR interferometry techniques; on these topics he holds two patents, has authored about 100 international journal papers and, in 1999, the book entitled "Synthetic Aperture Radar Processing", written in collaboration with prof. Giorgio Franceschetti and edited by CRC-PRESS. Riccardo Lanari has been a visiting scientist at different foreign research institutes, including the Institute of Space and Astronautical Science (ISAS), Japan (1993), the German Aerospace Research Establishment (DLR), Germany (1991 and 1994), and the Jet Propulsion Laboratory (JPL), USA (1997, 2004 and 2008), where he received a NASA award and a recognition for the technical developments related to the SRTM mission. He has been adjunct professor of Electrical Communication at the University of Sannio (Benevento) and lecturer of the SAR module course of the International Master in Airborne Photo-grammetry and Remote Sensing offered by the Institute of Geomatics in Barcelona (Spain). In 2013, he qualified as a Full Professor both in the area of Telecommunications and of Geophysics. He has served as a chairman and a technical program committee member at several international conferences. He is also Distinguished Speaker of the IEEE Geoscience and Remote Sensing Society (IEEE-GRSS) and, since 2013, Fellow of the IEEE Society. In October 2015 he won the "Guido Dorso" award in the section "Research". In November 2016 he was nominated by the European Geosciences Union (EGU) winner of the Christiaan Huygens Medal 2017, one of the prizes awarded annually by the EGU to eminent scientists for their extraordinary research contribution in the field of Earth, planetary and space sciences. Since December 2010 he has been director of IREA.

Director of Research

Pietro Alessandro BRIVIO
brivio.pa@irea.cnr.it

Graduated with honors in Physics at the State University of Milan, since January 2010 is Director of Research at the National Research Council (CNR) where he is working since 1977 before with a Fellowship and in 1982 as Researcher. From December 2004 to December 2015 he has been Head of CNR-IREA UOS in Milan. Active in the Optical Remote Sensing from airborne and satellite platforms for monitoring natural resources and state of the environment, his expertise ranges from the analysis of radiometric signals to the automatic interpretation of digital images for applications at local and continental scales. He is responsible of research projects at national (Min-Environment, ASI, companies) and international (EU, ESA, NASA) level, including GEOLAND (EU FP6, 2004-2006) and Geoland2 (EU FP7, 2008-2012) NARMA-Natural Resource Monitoring in Africa. Author of numerous publications in ISI journals and international conferences. Editor of Special Issues: Pattern Recognition Letters, 1996, Int. Journal of Remote Sensing, 2003. Visiting Scientist (1996-1997) at the Institute for Remote Sensing Applications, EU-JRC (Ispra) and for the Summer 2014 at the College of Natural Resources, University of Idaho (Moscow-ID, USA). Professor of Remote Sensing (1997-2005) at the Politecnico di Milano, Environmental Engineering and Land Management, Como Campus. Senior Member IEEE Geoscience and Remote Sensing Society and member of GOFCGOLD Fire Implementation Team. In 2013, he qualified as a Full Professor in the area 08 / A4-Geomatics..

Senior Researchers

Romeo BERNINI
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Romeo Bernini received the Laurea degree (summa cum laude) in Electronic Engineering at the University of Napoli Federico II in 1995 and took his Ph.D in Electronic Engineering from the Second University of Napoli, Italy. In 1999, he worked at DIMES (Delft Institute of Microelectronics and Submicrontechnology) of Technical University of DELFT (The Netherlands) as a Visiting Scientist. In 2000, he was a Research Fellow at the Second University of Napoli. Since 2001 he has been a Researcher at CNR-IREA. His main fields of interest include integrated optical sensors, microfluidic and optofluidic devices and fiber sensors. He is the author of more than 120 papers on international journals and conference proceedings and six invited talk at international conferences. He acts as a reviewer for a number of international journals. He was unit leader and WP leader in several national and international projects. In 2001, he received the best Doctoral Thesis Award in Optoelectronics of the IEEE-LEOS Italian Chapter.

Gloria BORDOGNA
bordogna.g@irea.cnr.it

Gloria Bordogna has been Senior Researcher at IREA in Milano since 1-12-2015. She received the Laurea degree in Physics from the University of Milano in 1984 and she has been working at CNR since 1986. From 2003 to 2010 she was a adjunct professor of the course "Information Systems III" the University of Bergamo. In 2013 she qualified as a Full Professor. In October 2012 and 2013 she was visiting researcher at IRSTEA-TETIS in Montpellier. Since 2008, she has been organizing the special track entitled "Information Access and Retrieval" at the "ACM Symposium on Applied Computing". She is a member of the editorial board of the journals "Newsletter of SIGAPP, ACR, Applied Computing Review", "Intelligent Decision Technologies" and "Global Journal of Technology and Optimization". She has worked as a reviewer for numerous journals and research agencies (ANR, France, FWO, Belgium, ERCEA, ERC Starting Grants), and participates in the program committee of many international conferences. The core of its research activities is the modeling of the uncertainty and imprecision of information in information retrieval systems, databases and geographic information systems with soft computing methods. In this context she has dealt with methods for the presentation of textual contents, flexible questioning languages, textual and geographic information analysis methods on the Web and in social networks. She edited four volumes and a special edition of JASIST journal and published more than 200 articles on journals and international conference papers.

Lorenzo CROCCO
crocco.l@irea.cnr.it

Since 2001, he is a research scientist at IREA-Napoli, focusing his activities on the development of new methodologies for non invasive electromagnetic diagnostics, ground penetrating radar, microwave biomedical imaging, as well as therapeutic applications of electromagnetic fields. He has been principal investigator of several research projects, author of many publications on international scientific journals, guest editor of special issues and chairman of international conferences. Since 2013, he has been a Member of the Management Committee at COST Action TD1301 “MiMed”, devoted to medical applications of microwave imaging. He was an adjunct professor at the Mediterranea University of Reggio Calabria, where he is currently a member of the Board of Ph.D. Advisors in ICT and electrical engineering. Since 2013, he has been a lecturer in Ph.D. courses organized by European School of Antennas (ESoA). In 2014, he achieved the National Scientific Qualification as University Professor of Electromagnetic Fields. Lorenzo Crocco is an IEEE senior member and a Fellow of The Electromagnetics Academy (TEA). He was the recipient of the “Barzilai” Award for Young Scientists from the Italian Electromagnetic Society (2004). In 2009, he was awarded as one of the top 100 under 40 scientists of CNR.

Senior Researchers

Gianfranco FORNARO
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Gianfranco Fornaro received the M.S. degree (summa cum laude) in electronic engineering and the Ph.D. degree from the University of Napoli "Federico II" in 1992 and 1997, respectively. Since 1993 he has been with the Institute for Electromagnetic Sensing of the Environment (IREA), Napoli, where he is currently a Senior Researcher working in the area of airborne and spaceborne Synthetic Aperture Radar (SAR) focusing, SAR interferometry and SAR tomography. He has been Adjunct Professor in the area of communications in several Universities, currently at the University of Napoli "Parthenope". In 2013, he achieved the Full Professor habilitation in the Telecommunication area. Dr. Fornaro was visiting scientist at the Politecnico of Milano and at the German Aerospace Establishment (DLR). He was a United Nation consultant at the Istituto Tecnologico de Aeronautica (ITA) in Sao José dos Campos (Brazil) and at RESTEC (Tokyo). He has been a lecturer at the International radar/SAR Summer School of the Fraunhofer Institute since 2010 and in the NATO Lecture Series since 2013. He was also a Convener, tutorial Lecturer and Chairman of sessions dedicated to SAR in several international conferences. Dr. Fornaro has authored more than a hundred of papers. He received the Mountbatten Premium by the Institution of Electrical Engineers (IEE) in 1997, the Best Paper Award of the journal *Geoscience and Remote Sensing Letters* in 2011 and the Mention for Best 2011 Reviewer of the *IEEE Transactions on Geoscience and Remote Sensing Journal*. In December 2016, he was elevated to Fellow by IEEE for his for contributions to SAR processing in differential interferometry and tomography.

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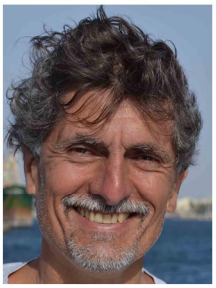

Mario A. Gomarasca conducts applied research using remote sensing techniques in the field of Geomatics at IREA, Milano. He graduated in Agricultural Science from the State University of Milano, followed specialized courses at the International Institute for Geo-Information Science and Earth Observation (ITC), Enschede, The Netherlands, and worked as a Visiting Scientist at the Laboratory for Applications in Remote Sensing (LARS), Purdue University, West Lafayette, iN, USA, with Arizona State University, Tucson, USA, and the National Wetlands Research Center (NWRC-USGS), Lafayette, Louisiana, USA. President of ASITA (Federation of Scientific Associations for Territorial and Environmental Information) since its foundation in 1998 until 2003; Italian deputy in the European Association of Remote Sensing Laboratories (EARSeL) since 1999; Expert for the European Commission Directorates General Society Technology Innovation, Research and Enterprise for the evaluation of proposals and the review of projects since 1998. Expert in GMES and INSPIRE directives of the European Commission. Author of over 170 publications; coordinator of research projects and applications. Teacher training courses and Master nationally and internationally. Author of books: *Elements of Geomatics*, 2004 Ed. AIT; *Basic of Geomatics*, Springer, 2009.

Anna RAMPINI
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Researcher at the National Research Council since 1984, firstly at the Institute of Cosmic Physics and Related Technologies, later at the Institute for Information Technologies Multimedia, and since 2001 Senior Researcher at IREA. The main field of her scientific activity was the development of methods for processing, analysis and interpretation of images with particular attention to the study and implementation of techniques for multi-source data integration for land monitoring and planning, and prevention of environmental risks. From 2005 to 2010 she was the responsible for the "Techniques for interpretation of remotely sensed multi-dimensional data" research line. She participated in numerous national and international projects. She was the coordinator of the "Italian Glacier Monitoring from Space" national project (2001-2003), funded by the Italian Space Agency. She also coordinated the European projects "FIREMEN: a knowledge-based decision support system for FIre Risk Evaluation Mediterranean Environment" (1994-1996), funded by the European Community under the program Environment 90-94, and "AWARE: a tool for monitoring and forecasting Available WAter Resource in Mountain environment" (2005-2008), Specific Targeted Research Project (STREP) within the FP6-AERO SPACE GMES 2003.

Eugenio SANSOSTI
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Graduated summa cum laude in 1995 in Telecommunication Engineering at the University of Napoli "Federico II", Italy, he joined CNR in 1997, where he holds now a Senior Researcher position. He was an Adjunct Professor of Signal Theory at the University of Reggio Calabria and of Signal Theory and Telecommunication at the University of Cassino, both in Italy. He has collaborated with the German Aerospace Establishment (DLR), with Jet Propulsion Laboratory, Pasadena, California (U.S.A.), and he was an Image Processing Adviser at Istituto Tecnologico de Aeronautica (ITA), Sao José dos Campos, SP, Brazil, under contract with the United Nation Organization (UNO). He was in the Italian scientific team for the NASA Shuttle Radar Topography Mission (SRTM) in 2000. He organized and was a general chairman of 2 international workshops on the use of Remote Sensing Techniques for Monitoring Volcanoes and Seismogenic Areas (USEReST 2005 e 2008); on the same topic, he was a chairman for two invited sessions at the IGARSS'09 symposium in Cape Town, South Africa. Since 2002, he has been a Senior Member of IEEE. His main research interest are in SAR signal processing techniques and their application to geophysics.

Maria Rosaria SCARFI'
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Graduated in Biological Sciences (cum laude) at the University of Napoli, she has been researcher since 1984 and Senior Researcher since 2001 at CNR-IREA in Napoli, where she works on the interaction between electromagnetic fields and biological systems and she is head of the Bioelectromagnetics laboratory. She was a member of the Directive Council of the European Bioelectromagnetics Association (2001-2009) and the Bioelectromagnetics Society (2009-2012). In 2005, she was a co-director of the course on "Genotoxic effects of electromagnetic fields" at the International School of Bioelectro-magnetics in Erice, Sicily. From 2006 to 2012 she was an expert member of the International Commission on Non-Ionizing Radiation Protection (ICNIRP). She is a a member of the Academic Board of the Ph.D. course in Electronic Engineering at the Second University of Napoli, member of the Management Committee of the COST TD1104 (European Network for the Development of Electroporation based technologies and treatments), of the group of experts for drafting the monograph "Environmental Health Criteria Monograph of Radiofrequency Electromagnetic Fields" (WHO), and of the external experts group for drafting the opinion on "Potential health effects of exposure to EMF" (EU-SCENHIR). She is an academic editor for the peer-reviewed journal *PlosOne*.

Francesco SOLDOVIERI
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Graduated in Electronics Engineering in 1992 from the University of Salerno, he obtained his Ph.D. in Electronic Engineering from the University of Naples Federico II. He has been a researcher at IREA since 2001 and a senior researcher since 2006. He has been a member of Scientific Committees and Technical Review Panels of several editions of the International Conference on Ground Penetrating Radar, the International Workshop on Advanced Penetrating Radar and IGARSS. He was a session organizer/ convener at PIERS and EGU General Assembly. He was the General Editor of the International Workshop on Advanced Ground Penetrating Radar, Naples, Italy, General Co-Chair of the International Conference on Ground Penetrating Radar in Lecce, Italy, and Guest Editor for several Special Issues on international journals. He is a member of the Editorial Board of several journals and a reviewer for many international journals. He was an adjunct professor at the University "Mediterranea" of Reggio Calabria and the Second University of Naples, holding courses in Electromagnetic Fields, Antennas, Microwave, Electromagnetic Diagnostics. He received the 1999 Prize "Honorable Mention for the H.A. Wheeler Applications Prize Paper Award of the IEEE Antennas and Propagation Society" for the best application work. Its main research interests include electromagnetic diagnostics, inverse scattering, GPR applications, antenna diagnostics and characterization; sea state monitoring through X-band radar images. He is a co-author of more than 180 papers in national and international journals and about 200 proceedings at International Conferences.

Staff

Massimo ANTONINETTI
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Geologist and researcher at CNR since 1989, he carries out his activities at IREA, Milano. He is interested in processing and interpretation of satellite images for the study of geological structures and glacio-nival coverage evolution, for the evaluation of the geothermal potential in low and high enthalpy areas, and for the forecast of agricultural production. He was the Project Coordinator T.O.W.E.R. (Top Of the World Elevation Remeasurement): Matterhorn 1999, Monte Rosa 2000 Cerro Aconcagua 2001. He participated to several on-field geological research activities in Himalaya and Karakorum in the framework of EV-K2-CNR Project. He is the IREA deputy at NEREUS, Network of European Regions Using Space Technologies, Brussels, and at the Lombardia Aerospace Cluster.

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Graduated in 1998 in Nautical Sciences at the Naval Institute University Napoli Italy, he joined IREA (formerly IRECE) in 1999, where he is a Researcher. He is interested in the development of algorithms geocoding of SAR images and studies of surface deformation by using differential SAR interferometry (DIFSAR). He has collaborated in the development of a new approach for the analysis of the temporal evolution of the Earth's surface deformations based on the combination of differential interferograms (SBAS technique). Over the years, he has participated actively in the upgrading of technical SBAS (high resolution, geometric registration, data integration ERS/Envisat, GIS integration). He has participated in several studies of volcanic areas, seismogenic, landslide areas and urban areas using the technique SBAS and collaborated with different national and international scientific institutions. He is working on the acquisition and processing of SAR data plane with particular attention to aspects of motion compensation errors and realization of interferometric products (Digital Surface Map).

Mirco BOSCHETTI
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Mirco Boschetti received the Laurea Degree (summa cum laude) in Scienze Ambientali (19998) from the University of Milano Bicocca and he got the Ph.D. from the State University of Milano (Agronomy faculty). He has been with the National Research Council (CNR) of Italy since 1999, and he is a researcher at IREA since 2010. His research activity regards the use of remote sensing for vegetation and agro-ecosystem monitoring and the definition of environmental indicator through geographic multisource data integration. He has worked on automatic interpretation methods of multispectral and hyperspectral images acquired by airplane or satellite platform for the retrieval of bio-physical parameters and land cover mapping. In the last few years he is working on vegetation phenological parameters estimation, crop mapping and agro-practises monitoring from time series of low resolution images. Presently he is the coordinator of the FP7 SPACE project ERMES "An Earth obseRvation Model based RicE information Service". He is a member of the Italian Association of Remote Sensing (AIT) and belongs to the Scientific Board of ASITA.

Paola CARRARA
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Researcher at CNR since 1986, her scientific activity is related to the design and development of information systems, in particular architectures, techniques and standards for geographic information on the Web. In this framework she was involved in numerous projects, among which IDE-Univers that created the first spatial data infrastructure for research data in Europe, and she is now the coordinator of SubProject 7 in RITMARE, the Italian flagship Project on marine research, in charge of activating the interoperable data infrastructure of the Project. She is also active in researches on the integration and sharing of (Volunteer) spatial information, with particular reference to the European network LTER (Long Term Ecological Research). She supported the European spatial Programme GMES/Copernicus and has been the coordinator of the FP7 Project DORIS_Net (2011-13), building the European platform of Copernicus Regional Contact Offices. She is an author in many publications on international journals and guest editor of special issues. Since December 2015, she has been Head of the IREA secondary office in Milano.

Francesco CASU
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Francesco Casu received the Laurea degree (summa cum laude) and the Ph.D. in Electronic Engineering and Computer Science from the University of Cagliari, Italy, in 2003 and 2009, respectively. Since 2003, he has been with the IREA (Napoli). He was a Visiting Scientist at the University of Texas at Austin, the Jet Propulsion Laboratory, Pasadena, and the Department of Geophysics at the Stanford University. His main research interests are in the DInSAR field, in the multi-pass interferometry (particularly concerning the improvement of the SBAS-DInSAR algorithm) and in the SBAS-DInSAR measurement assessment. He is currently developing advanced InSAR techniques for the exploitation of high-performance computing resources (GRID and Cloud Computing) in order to reduce SBAS chain execution times and handle large amounts of SAR data. He is responsible for the scientific Convention between IREA and the Civil Protection Department.

Ilaria CATAPANO
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Graduated in Telecommunications Engineering at the University of Naples "Federico II", she received the Ph.D. in Electric and Information Engineering from the University of Cassino (Italy). Since 2003 she has been a researcher at IREA in Naples. From October 2006 to March 2007 she was a Postdoctoral Researcher at the Fresnel Institute in Marseille, France. In 2010 she was an adjunct Professor at the Mediterranea University of Reggio Calabria (Italy), and an invited lecturer at São Paulo University (Brazil) during the 15th Summer School in Geophysics in 2013. Her research activities relate to electromagnetic diagnostics and are mainly aimed at the development and experimental validation of microwave imaging approaches for morphological reconstruction and quantitative estimation of electromagnetic parameters of diffusers in complex scenarios, the use of radar systems for sub-surface surveys, the THz spectroscopy and imaging. Ilaria Catapano is an IEEE Member. She received the G. Barzilai Award by the Italian Electromagnetic Society (SIEM) in 2004 and the Young Scientist Award at the XXIX URSI General Assembly in Chicago, Illinois, in 2008.

Giacomo DE CAROLIS
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Graduated with honors in Physics from the University of Bari in 1987, from 1992 to 2004 he joined as a researcher the Institute of Spatial technologies (CNR-ITIS) at the Geodesy Spatial Center, Italian Space Agency, based in Matera, Italy. From 2004 to 2010 he joined CNR-ISSIA and since 2010 he has been with CNR-IREA in Milano. His research is devoted to the development of techniques and methods for the retrieval of geo–physical parameters detected by SAR and optical imaging instruments. It also includes the integration of information gathered by multi-source sensors. His research is part of the Earth's observation and physical description methodologies. His scientific interest is focused on the development of methods for inversion of SAR and optical data for the estimation of bio/geophysical parameters of the Earth's surface, with particular reference to the marine surface and polar regions. Author of numerous publications, since 2012 he has been an adjunct Professor in charge of Remote Sensing at the Politecnico di Milano, Environmental Engineering, Como Campus.

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Claudia Giardino has a background in remote sensing with a degree in Environmental Engineering from the Polytechnic of Milano. From the same university, she also received the Ph.D. title in Geodetic and Topographic Sciences. Her thesis Ph.D. “Anisotropy of the reflected radiation field over natural surface” has received the "Prize for young scholars in the field of Earth Observation”. Since December 2001, she has been a researcher at IREA in Milano, where she is the responsible of the research line optical remote sensing for the estimation of bio-geo-physical parameters and calibration/validation activities. Since 2005, she has been the responsible for the Experimental Station “Eugenio Zilioli” in Sirmione del Garda. She coordinates several research projects, both national and international. Since 2005, she has been PI for ESA ENVISAT-1 data. She is a member of the working group “Remote Sensing of near-coastal areas and inland waters” of the International Group of Earth Observation (GEO). She is part of the Editorial Board of the European Journal of Remote Sensing. In 2002 and 2006, she was a Visiting Scientist in the Remote Sensing Group of the CSIRO-Land and Water in Canberra, Australia.

Staff

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Degree in foreign languages and literature with a thesis on sociology of culture; as a journalist, at CNR she Degree in foreign languages and literature; as a journalist, at CNR she has always been involved in public communication of science, working for the Press Office and organizing outreach and education activities. Currently she's working at IREA in Milano as a responsible for the Dissemination of the results within national and international projects. She also carries out studies on the use of remote sensing for environmental education in collaboration with the Experimental Station "E. Zilioli" in Sirmione. Since 2007, she has collaborated with the CNR Group "Communication of science and education Studies", which performs research on science education and communication aiming. In particular, she coordinates the research line on "Models of public communication of science", whose aim is to investigate models of communication by researchers and to promote opportunities for public debate on the change in communication within research institutions and the perspective this change can give to the relationship between science and society.

Michele MANUNTA
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Graduated in electronic engineering from the University of Cagliari in December 2001, he received the Ph.D. title in Electronic Engineering and Computer Science in 2009. Since 2002, he has been a Researcher at IREA in Napoli. His interests are mainly in the field of signal processing of SAR/DInSAR signals at high spatial resolution. In particular, he works in the development of DInSAR algorithms and techniques for the study of Earth's surface deformations related to natural (landslides, volcanoes, earthquakes and subsidence) and anthropogenic (excavations in urban areas, monitoring of infrastructure, control of archaeological sites) phenomena. More recently, his interests have broadened to the use of large-scale computing infrastructures, such as GRID and Cloud, for SAR interferometry applications. He was a visiting scientist at Institut Cartografic de Catalunya (Spain) and Rosenstiel School of Marine and Atmospheric Science of the University of Miami (USA). He was involved with leadership roles in various Italian and European initiatives for the use of Earth Observation technologies for environmental risk management. He is the responsible for the work package on the use of satellite data in the project for the European infrastructure implementation EPOS (European Plate Observing System).

Mariarosaria MANZO
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Mariarosaria Manzo received the Laurea degree (summa cum laude) in mathematics from the University of Napoli "Federico II" and the Ph.D. degree from the University of Basilicata, Potenza, Italy. She joined IREA in 2002. She was a Visiting Researcher at the German Aerospace Centre - DLR (Oberpfaffenhofen, Germany) and at the Geodesy Laboratory, University of Miami (Florida, USA). Her research activities concern Differential Synthetic Aperture Radar Interferometry (DInSAR); in particular, her interests involve DInSAR algorithm development for the generation of velocity maps and corresponding time series starting from SAR data acquired by the first and second generation satellite sensors, and the application of such algorithms for the monitoring of surface displacements, such as those produced by subsidence, volcano activity, earthquakes and landslides. She has been and is currently involved, also as a scientific responsible, in several national and international Research Projects such as Convenzione MiSE-IREA, FP7 MARsite, PON I-AMICA and Atlante Geotermico projects. More recently, her research interests also concern the development of optimization/ inversion algorithms for the analytical modeling of seismic and volcanic sources by using DInSAR and geodetic data.

Alessandro OGGIONI
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Graduated in Natural Sciences (2000), he he obtained his Ph.D. (2005) in Ecology from the University of Parma. Researcher at the CNR since 2005, he worked at the Institute of Ecosystem Study Pallanza (ISE) in the field of the temporal evolution and spatial distribution of phytoplankton of the lake and of ecology of aquatic plants (macrophytes), even as the national contact point for the Water Framework Directive (WFD - 2000/60/EC). In 2008, with the participation of the CNR Interdepartmental Project GIIDA he began to carry out activities on the management of environmental data through the use of geospatial services (OGC). Since 2011 researcher at IREA, he is actively involved in in the action of data management within the Project Life + EnvEurope and the European LTER network (Long Term Ecological Research) with implications regarding the implementation of instruments Information for the collection, research (through MetaData) and the sharing of ecological data; the use of these through the use of geographic services organized for the web (OGC); the creation of workflows and processes (Web Processing Service - WPS). Since 2012, he has been the responsible for the implementation of the action of Spatial Data Infrastructure for the project Flag of the National Research Programme RITMARE within the Subproject 7.

Antonio PAUCIULLO
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Graduated with honors from the University of Napoli "Federico II", he received the Ph.D. degree in Information Engineering from the same University. After a short working experience as Network Manager and Designer in he INTELTEC S.p.A. of Napoli, since 2001 he has been with IREA in Napoli, where he carries out his research activity in the field of microwave remote sensing through SAR technology, with particular attention to interferometric and tomographic multi-acquisition techniques. From 2002 to 2012 he was an Adjunct Professor of Electrical Communications, Signal Theory, Digital Signal Processing, Telecommunications and Remote Sensing Systems at the University of Cassino (Italy).

Antonio PEPE
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Antonio Pepe received the Laurea degree in Electronic Engineering and the Ph.D. degree from the University of Napoli, Federico II, in 2000 and 2007, respectively. He carries out his research activities at IREA, Napoli, where he has been a researcher since 2009. His main research interests include the development of innovative differential SAR interferometry algorithms for the monitoring of the Earth's surface displacement (mostly due to seismo-tectonic, volcanic, hydro-geological causes). More recently, his interests have included the integration of radar and optical data for the monitoring of forestland subject to fires. Within these frameworks, he has acted as a scientific supervisor of several scientific projects, and he authored numerous papers on peer-reviewed journals. Since 2003, he has been a member of the Editorial Board of the "Advances in Geology" journal and "Asian Journal of Geosciences". Also, he was a Visiting Scientist at the University of Texas at Austin, in 2005, at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, in 2009 and, more recently (in 2014), at East China Normal University (ECNU), Shanghai. Since 2012, he has been also an adjunct professor of Signal Theory at the "Università della Basilicata", Potenza, Italy.

Staff

Monica PEPE
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Monica Pepe received a degree in Geology and the Ph.D. in Physical Geography, and has been with the CNR since 1994. She carries out research in optical remote sensing, and focuses on automatic mapping of the Earth's surface (hydrosphere, cryosphere, biosphere, geosphere). She investigates pattern recognition approaches, also considering approximate reasoning and domain knowledge representation techniques. Currently, her activity is mainly dedicated to hyperspectral imagery, sensed from either aerial and satellite platforms, and on the proximal sensing of materials finalized to their spectral characterization. Additionally to remote sensing, she is involved in digital Earth research, particularly geoservices in the framework of the INSPIRE Directive. In these research domains she has joined several projects co-funded by the Italian and European space agencies, by the European Commission (FIREMEN, SALMON, AWARE), national flagship projects (RITMARE, La Fabbrica del Futuro) and private ones (ENI).

Francesco SERAFINO
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Graduated in Electronic Engineering at the University of Reggio Calabria (Italy), he received an international Ph.D. in Information and Communication Technologies at the University "Federico II" of Napoli in collaboration with the 'Delft Institute for Earth-Space Oriental Research' (DEOS), Netherlands where he was a Visiting Scientist for over six months. He spent more than ten years on Synthetic Aperture Radar (SAR) data processing, Differential SAR Interferometry and Multipass 3D and Differential SAR Tomography. At the moment he is a researcher at IREA in a temporary assignment at the Institute of Biometeorology (CNR-IBIMET) in Livorno. His main scientific interest is focused on the extraction of hydrodynamic parameters from marine radar images sequences, with particular interest on the surface current and bathymetry map generation and space-time wave height reconstruction. He is the author of more than 50 papers and inventor of two European patents. In September 2010, he founded the company, spin-off of the CNR, REMOCEAN S.P.A., to commercialize a system for sea surface monitoring through analysis of radar data. The company was judged in 2013 and 2014 among the top 10 Italian startups.

Giuseppe SOLARO
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Dr. Giuseppe Solaro, geophysicist, is a Researcher at IREA from 2010. He received the Ph.D. degree in Earth Science in 2005 at University Federico II of Napoli. He was a visiting student at the Blaise Pascal University of Clermont-Ferrand in France in 2003 and got a research fellowship at INGV from 2005 to 2010. Since 2010 he has been with IREA in Napoli. His main scientific interests include the development of algorithms for the generation of maps and deformation time series through Synthetic Aperture Radar interferometry techniques to analyze and model displacement in volcanic and seismic areas.

Pietro TIZZANI
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Degree in Geology from the University of Napoli "Federico II", in 2002 he received the Ph.D. in Geophysics and Volcanology from the same University. Since 2010 he has been a researcher at IREA in Napoli. His research fields are focused on the quantitative analysis of the geodynamic processes that affect long and short term evolution of volcanic and seismogenic area. In particular, the studies have been directed both on seismotectonic and rheology of the lithosphere, and the use of advanced differential interferometry (InSAR) techniques and their integration with GPS data, EDM, leveling and gravimetry, to analyze the ground deformation pattern in volcanic and seismogenic areas. In this context a quantitative approach, based on numerical multiphysical optimization procedures, was developed to investigate the stress source responsible of ground deformation in the several geodynamic scenarios.

Paolo VILLA
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Paolo Villa got his degree in Environmental Engineering in 2004 and his Ph.D. in Geodesy and Geomatics in 2008 from the Polytechnic of Milano. After a collaboration with Hydraulics, Infrastructures, Environment and Surveying Engineering (DIIAR) Department of Polytechnic of Milano, since 2006 he has worked at the National Research Council (CNR), first as a research fellow of the Institute for Electromagnetic Sensing of the Environment (IREA) in Milano, and then as a researcher of the Institute of Information Science and Technologies (ISTI) in Pisa, and finally back again at IREA, Milano. In 2013, he was a visiting scientist at the Nanjing Institute of Geography and Limnology (NIGLAS), Chinese Academy of Sciences , on the topic "Integrated Landscape-Water Quality Monitoring through Remote Sensing". His research themes range from environmental applications of image processing and remote sensing techniques (for geology, urban mapping, natural hazards, wetland vegetation and crops monitoring), with specific reference to testing and advancing integration of optical and SAR data for thematic applications, to Spatial Data Infrastructures and geodata harmonization.

Giovanni ZENI
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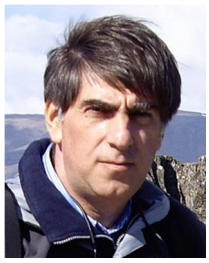

Graduated in Geology at the Science Department of the University of Napoli "Federico II", he received the Ph.D. degree in Environmental Engineering from the University of Basilicata (Potenza) in 2009. In 2001, he began his research at IREA in Napoli, where he currently holds the position of researcher. In 2008, he was a Visiting Scientist at the Research Institute GFZ - Geo-Forschungs-Zentrum–Potsdam, Germany. Since 2001, he has actively participated in research activities related to national and international projects. His main research interests are in the Differential Interferometric Synthetic Aperture Radar (DInSAR), in particular dealing with the development and application of algorithms for the generation of deformation maps and time series through DInSAR data and integration in geographic information systems (GIS). Currently he is also interested in the development/optimization of inversion algorithms for the Geophysical modeling of deformation in seismic and volcanic areas and those affected by subsidence and hydrogeological instability from DInSAR and geodetic data.

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Graduated in Biological Sciences at the University of Napoli, she received the Ph.D. from the University of Bologna in 1996. Since 2001, she has been a researcher at IREA in Napoli where, in the framework of Bioelectromagnetics, she is involved in the study of the interactions between electromagnetic fields or pulsed electric fields with mammalian cells. She also works on nanoparticles biocompatibility studies. Since 2012, she has been working on drafting the World Health Organization monograph “Environmental Health Criteria Monograph of Radiofrequency Electromagnetic Fields”, and has been an external expert for the “Scientific Committee for the Emerging and Newly Identified Health Risks” (EU-SCENHIR). Since 2012, she has been a member of the working group 1 (Basic mechanism of electroporation and modeling) in the COST TD1104 “European Network for the Development of Electroporation based Technologies and Treatments”. She is a member of the Editorial Board of the “Scientific World Journal – Biophysics” and “Conference Paper in Sciences – Biophysics”. She serves as a reviewer for several international peer-reviewed journals in the framework of bioelectromagnetics and is co-authors of a large number of papers published on international peer-reviewed journals.

Temporary Researchers

Manuela BONANO
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Manuela Bonano received the Master degree (summa cum laude) in Environmental Engineering from the University of Cagliari, Italy, and the Ph.D. degree from the University of Roma "La Sapienza", Italy, in 2004 and 2012, respectively. Since 2007, she has started her research activity at IREA, where she currently holds a temporary Research position. In 2011, she was a Visiting Scientist at the Earth and Planetary Science (EPS) Department of the University of California at Berkeley (UCB), USA. Her main research interests are in the DInSAR field concerning the development of advanced multi-pass interferometry algorithms, particularly focused on full resolution DInSAR analysis for investigating local deformation affecting single buildings and man-made structures. Currently, she works on the development and application of advanced DInSAR techniques for processing SAR data acquired by novel generation satellites, such as X-band COSMO-SkyMed and TerraSAR-X, as well as C-band Sentinel-1.

Mariano BRESCIANI
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Mariano Bresciani received the degree in Natural Science aand the Ph.D. degree from Parma University, Italy. Since 2013 he has been a temporary researcher at IREA in Milano. His research activity is focused on ecological characterization of inland waters (cyanobacteria and phytoplankton types) by remote sensing. He is specialized in the study of aquatic vegetation environments with traditional methodologies and remote sensing techniques. He has a long experience in field campaigns for chemical, biological, and radiometric data acquisition. He is also collaborating with local authorities for supporting management actions and monitoring of inland water bodies. He is the responsible for managing areas of reed bed of Lake Garda and is the coordinator of the LTER network for the Experimental Station Eugenio Zilioli of Sirmione. Since 2003, he has collaborated with the CRA Sirmione where he is the responsible for monitoring and environmental disclosure. He is a member of the Italian Association of Remote Sensing and member of the editorial board of the Journal of LImnology.

Lorenzo BUSETTO
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Lorenzo Busetto graduated in Environmental Sciences at the University of Milano-Bicocca in 2001, and after graduation, he continued specializing in remote sensing for the classification of high-resolution remote sensing data. From 2003 to 2011 he was a Research Fellow at the Institute of Atmospheric Pollution Research (CNR-IIA) and at the Environmental Dynamics Remote Sensing Laboratory of the University of Milano-Bicocca, where he obtained a PhD in Environmental Science in 2007. His work focused on the development of techniques for the estimation of biochemical vegetation and structural parameters useful for carbon balance modeling, and in the analysis of MODIS time series for forest monitoring and for studying the relationships between phenological and climatic interannual variability in Alpine areas. He worked at the Forest Resources and Climate Unit of the JRC (Ispra) from October 2011 to March 2014, where his main research concerned the analysis of post-fire vegetation regeneration from MODIS satellite data, and on the estimation of Above Ground Biomass increment from Remote Sensing data. In March 2014, he joined CNR-IREA as a temporary researcher, where he works on different projects regarding Remote Sensing applications for agriculture monitoring.

Gabriele CANDIANI
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Gabriele Candiani received the M.S. degree in environmental engineering in 2002 from the Politecnico di Milano and the Ph.D. degree in information engineering in 2010 from Univeristà degli studi di Brescia. From 2002 to 2007 he worked for the CNR where his main research topic involved the assessment of water quality parameters from remotely sensed images. From 2007 to 2010, during his Ph.D. degree at Università degli Studi di Brescia, he worked on data assimilation techniques to merge data from both ground stations and satellite sensors into air quality models. From 2010 to 2012 he worked at Politecnico di Milano where he was involved in anomaly detection studies related to hydrocarbon exploration. Since 2012 he has been working for the CNR focusing on different research topics: data fusion of satellite images with different spatio-temporal resolutions (SPOT4Take5), analysis of remotely sensed data, mainly hyperspectral, for the interpretation and classification of different land covers (ENI Geosat) as well as the characterization of particles derived from Waste of Electrical and Electronic Equipment (FIDEAS, WEEEReflex). Since 2014, he has been with the Institute for Electromagnetic Sensing of the Environment (IREA), Milano.

Raffele CASTALDO
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Graduated in geophysics and applied geophysics in 2007 at the University of Naples "FEDERICO II", he received the Ph.D. degree in Analysis of Environmental Systems from the same university in 2011 for the analysis of the spatial and temporal variation of the gravimetric field used to monitor a gas storage site. From 2011 to 2016 he was a research fellow at IREA-CNR in Naples, and acquired expertise in analyzing and interpreting the Differential Interferometry SAR (DInSAR) measurements for the study of ground deformation occurred in Volcanic, seismogenic and in landslide areas. From August 2016 he is a temporary researcher at the same institute of CNR, dealing with the generation of physically-based models for the simulation of the natural processes that control the evolution of surface deformation patterns. The main scientific role is related to the analysis of DInSAR measurements and the development of numerical models for the interpretation of geological processes. He is the author of several publications on international journals.

Angelica GRIMALDI

Angelica Grimaldi graduated in Physics in 2007 at the University of Napoli Federico II. She received her PhD degree in Novel Technology for Materials, Sensors and Imaging from the same University, carrying out the research activity at the ENEA Research Center of Portici. From April 2013 to September 2016 she was a Researcher at IREA in Napoli. Her research activity concerned the realization and characterization of polymeric optical and optofluidic devices for the development of environmental and biomedical sensors.

Giovanni ONORATO

Giovanni Onorato took a degree “cum laude” in Physics in 2006 at the University of Napoli “Federico II” and a Ph.D. at the same University with a thesis on particle physics for the analysis and measurement of the rate of a rare decay of the B meson. From 2010 to 2012 he worked at Fermilab in Chicago for the Mu2e experiment, which had the purpose of demonstrating the existence of the direct decay of a muon into an electron. From September 2012 to September 2013 he collaborated with the INFN in Lecce for the construction of a gas chamber detector for the MEG experiment of the PSI laboratory in Zurich, based on the idea of the detector proposed by the Lecce laboratory at the Mu2e experiment at Fermilab. In 2013, he won the national selection for the qualification to associate professor. From June 2014 to June 2016 he worked for IREA as a researcher. His activity involved the design, realization and testing of a fuel level sensor for aircrafts based on an optical fiber system made in plastic and glass to avoid metal components to be present in the airplane tank. In parallel, he worked on the application of the multivariate analysis statistical techniques for Raman spectroscopy and fluorescence studies.

Staff

Susi PEPE
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Graduated in Geological Science at the University of Napoli Federico II, Susi Pepe obtained the Ph.D. in 2007 with a dissertation relevant to enhancement and management of Agro-Forestry Resources. From 2004 to 2007 she was with the University of Basilicata and University of Bari, where she worked for the soil study in landslide and gullies areas. Since 2007, she has been working at IREA in Napoli where she is now a temporary researcher. Her research activity is focused on data processing techniques, differential interferometry (InSAR) for the study of surface displacements in volcanic areas and in landslide areas. In this context, she is involved in the development of analytical and numerical models for the interpretation and characterization of the structures that control the evolution of deformational patterns present in the above mentioned areas.

Gianluca PERSICHETTI
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Gianluca Persichetti is a physicist. He received his master degree from the University of Napoli "Federico II". Then, he was a research specialist at a private company for activities related to Quantum Cryptography. After (2007-2010) he joined the INFN experiment VIRGO dealing with sensing and actuation systems. In 2010, he received a Ph.D. in "Novel Technologies for Materials Sensors and Imaging" at the University of Napoli "Federico II". From 2011 to 2012 he was a Research Fellow at IREA for activities related to the research program VIGOR (Evaluation of the geothermal potential of Convergence Regions) dealing with the development and application of distributed optical fiber sensors for geothermal applications. Since 2012 he has been a temporary Researcher at IREA. His research activities include the development of fiber optic sensors and integrated optofluid sensors. He is a reviser for international journals in the field of sensors and optics.

Stefania ROMEO
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Stefania Romeo received the Laurea degree (summa cum laude) in Biomedical Engineering from the University of Naples Federico II, and the PhD in Electronic Engineering from the Second University of Naples in 2008 and 2012, respectively. Since June 2012, she has been with IREA-CNR (Napoli) as Research Fellow, while since March 2016 she is with the same institute as Researcher. She was a visiting student at the University of Southern California, Department of Electrical Engineering and Electrophysics, from September 2010 to March 2011. She was a visiting scientist at the Department of Oncology of the University of Copenhagen in May 2014, in the framework of a short-term scientific mission funded by the COST Action TD1104 (European Network for the Development of Electroporation-based technologies and Treatments). In 2015 she won the Young Investigators Competition (second prize) in the framework of the "1st World Congress on Electroporation and Pulsed Electric Fields". Her research activity is in the framework of Bioelectromagnetics, and concerns 1) the design, realization and characterization of in vitro exposure systems to electromagnetic fields at extremely low frequencies and radiofrequency, and of high voltage, nanosecond pulse generators; 2) the study of the interactions between pulsed electric fields and bio-systems, by both experimental activity and numerical modelling, finalized to the development of biomedical and industrial applications; 3) evaluation of occupational exposure to electromagnetic fields.

Diego REALE
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Diego Reale received the M.D. degree in telecommunication engineering from the University of Cassino, Italy, in 2007 and the Ph.D. in information engineering from the University of Napoli "Parthenope" in 2011. In 2007, he joined IREA where he currently holds the position of Researcher. His main research interests are framed in the interferometric processing of SAR data, with particular reference to SAR tomography and to the application of these techniques to data acquired by the new generation of SAR sensors with very high spatial resolution, such as COSMO-SkyMed and TerraSAR-X. In October 2010, he was a Visiting Scientist at the Remote Sensing Technology Institute (IMF) of the German Aerospace Center (DLR). In 2011 he was awarded at the Student Competition at the Joint Urban Remote Sensing Event in Munich, Germany. In 2012, his paper "Tomographic Imaging and Monitoring of Buildings with Very High Resolution Data", coauthored by Gianfranco Fornaro and Antonio Pauciullo from IREA and Xiaoxiang Zhu and Richard Bamler from the German Space Agency (DLR), was awarded as the 2011 IEEE Geoscience and Remote Sensing Letter Best Paper.

Daniela STROPPIANA
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Daniela Stroppiana received her degree in Environmental Engineering in 1998 from the Politecnico of Milano, and her PhD from the Technical University of Lisbon in 2005. She has more than 15 years of experience in processing and interpreting Earth Observation data for Natural Resources monitoring. Between 1998 and 2002, she worked at the Joint Research Centre of the European Commission, for the development of algorithms for mapping active fires and burned area at the global and continental scales with satellite imageries. From 2002 to 2004 she worked at the Istituto Agronomico per l'Oltremare, Ministero Affari Esteri, Firenze, involved in a project for training foreign students in the use of satellite imagery and soil balance models the monitoring of natural and agricultural resources. Since 2004 she has been at IREA, working on national and international projects on the assessment of natural vegetation, vegetation disturbances and agricultural monitoring. At the same time, she carries out research activities in the field of fire monitoring and in particular on the integration of remote sensing radar and optical data.

Genni TESTA
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Genni Testa graduated in Physics (Solid State) with 110/110 cum Laude at the University of Napoli Federico II, Italy, in 2005, and received the Ph.D. degree in Electronic Engineering, at the Second University of Napoli, in 2009. In 2007 she was a visiting scientist at the Delft Institute of Microelectronics and Nanoelectronics (DIMES) of the Technological University of Delft (Netherlands), carrying out a research activity focused on realization of silicon integrated optical devices. During this period, she attended a basic course on the MST/MEMS technology. From November 2008 to June 2010 she worked at IREA with a post-doctoral position. Since June 2010, she has worked at IREA as a temporary research-scientist. Since 2012, she has been the scientific responsible of the IREA research unit for a FIRB project entitled “Ultra-Sensitive Flow-Through Optofluidic MicroResonators for Biosensing Applications”. She acts as a reviewer for a number of international journals. Her research activities deal with integrated silicon based and polymer-based optofluidic devices for biosensing application and environmental monitoring and distributed fiber sensor based on Brillouin scattering for temperature and strain measurements.

Ivana ZINNO
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Ivana Zinno received the degree (summa cum laude) in Telecommunication Engineering and the Ph.D. in Electronic and Telecommunication Engineering, both from the University of Naples Federico II, in 2008 and 2011, respectively. In 2011 she received a grant from the University of Naples to be spent at the Department of Electronic and Telecommunication Engineering for research in the field of remote sensing. Since January 2012, she has been with the IREA-CNR, Naples, where she currently holds a Researcher position. Her main research interests are in the field of microwave remote sensing and SAR image processing and regard value added information retrieval from SAR data. In particular, her activities concern differential SAR interferometry for monitoring the surface displacements, with particular emphasis on data of novel generation satellite constellations such as COSMO-SkyMed and Sentinel-1. Her work is currently focused on the development of advanced Differential SAR Interferometry (DInSAR) techniques and processing chains for large-scale surface deformation time series generation, which are able to exploit HPC distributed computing architectures (GRID and Cloud Computing). In this framework, she works both with computing platforms of the European Space Agency (ESA), for the development of interferometric web services and tools, and with the Elastic Compute Cloud (EC2) of Amazon Web Services (AWS).

Technical and administrative staff

Antonella BENTLEY
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CNR employee since 1993 as a V-Level Administrative Collaborator, she has previously served in the decentralized Accounting Department of Lombardy; then, since 2003, at the Institute for Construction Technologies (ITC) and, since 12 May 2016 at IREA in Milan where she is responsible for administrative issues. Her activities concern the administrative / accounting management of the secondary location of Irea.

Alberto CREMA
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Technician at IREA in Milano, he performs the analysis and processing of satellite optical data concerning time series analysis of images with different spatial resolutions. The main issues are monitoring and mapping of the natural environment and especially agriculture. After graduating in Agro-Environmental Sciences at the Faculty of Agriculture of Milano with a thesis carried out at the KU Leuven (Belgium) on issues related to remote sensing (2010), he provided consulting for the study of the spectral characteristics of a desert area contaminated by hydrocarbons with optical/radar data-fusion techniques (2010-2011). From November 2011 to February 2013 he was a fellow for the development of tools for automatic mapping of agricultural crops (rice) using time series of images of the MODIS sensor. He has experience in analysis of very high resolution aerial thermography for the evaluation of the dispersion energy efficiency of buildings. He is currently working in Ermes and Space4Agri projects for monitoring and extracting information phenology and water stress by extensive crops such as rice and maize.

Francesca DI MATTEO
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Graduated in Economics at the University of Roma "La Sapienza", she has worked at IREA in Napoli since 2001. She manages contracting and reporting activities for European research projects. Within projects where CNR is involved as Coordinator, she liaises with the Research Executive Agency of the European Commission and coordinates the financial reporting of the whole partnership. In some international meetings of the projects, she had oral presentations on financial topics concerning the 7th Framework Programme of the EC. She is also involved in the Institute procedures for the personnel selection and the adjudication of professional collaboration assignments, in the management of national and international contracts and agreements with public and private Bodies. Since 2003 she has been the Bursar of the Institute.

Cristiano FUGAZZA
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Degree in Computer Science at the Department of Computer Science, University of Milano, he received his Ph.D. from the same university, dealing with Knowledge Management and Semantic Web. He is a technical collaborator at IREA in Milan, where he deals with semantic interoperability. He worked at the Spatial Data Infrastructure Unit (SDIU) JRC-IES (Institute for Environment and Sustainability, Joint Research Centre, European Commission) dealing with the creation, harmonization and use of Multilingual thesauri in SKOS format for annotation and search of geospatial resources. He contributed to the development of the Global Earth Observation System (GEOSS) and the European geospatial data infrastructure established by the INSPIRE directive, by managing a harmonized reference thesauri repository and thematic thesauruses. He has published in international journals and conferences in the domains of infrastructure for geospatial data, supply chain management, business modeling, digital rights management, privacy of personal data and persistent identifiers.

Simone GUARINO
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Hired at CNR in 1988, he has worked at IREA, headquarters in Napoli, since the date of its foundation in 2001. His activity deals with the systemistic management of network services, System Administration problems and management of the cluster for remote sensing data processing, whose architecture was designed by himself. He participates in research projects on SAR interferometry techniques and analysis of methodologies for integrating Synthetic Aperture Radar (SAR) data in a geographic information system (GIS)

Mauro MUSANTI
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Mauro Musanti is a surveyor. He has worked at CNR since 1984, first at the secretariat of the CNR President (1984-1993), then at IRRS (abolished in 1999) and now at IREA in Milano. He is the responsible for the logistics and planning of activities outdoor and technical manager for the logistics activities on the Experimental Station "Eugenio Zilioli" in Sirmione (Garda lake, Italy). He participates in various field campaigns on land, lake and coastal sea for the acquisition of radiometric measurements to validate models and products of remotely sensed data, finding the necessary technical solutions to improve the acquisition of point measurements. Scientific Secretary of the I (Milano), II (Roma), III (Milano) and IV (Milano) meeting on field spectroradiometry ASD.

Luciana ONORATO
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CNR employee since 1988, since May 2016 she has worked at IREA's Secondary location in Milan, where she holds the role of Level VI technical operator. She deals with secretarial service, staff presence management, and she provides support in goods and services acquisition procedures.

Ferdinando PARISI
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Employed at the IREA headquarters in Napoli since 2010 as Level VI Technical Collaborator, he held various forward contracts at the same Institute since 2004. His activity concerns the implementation of software interfaces for managing problems related to the computing systems operating under Linux and Windows, as well as for the management and maintenance of the "cluster" architecture for SAR data processing by means of satellite interferometric techniques. He is also responsible for the informatic accessibility and contact person for the technical problems of the IREA website

Maria Consiglia RASULO
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Graduated in foreign languages and literature at the Istituto Universitario Orientale in Napoli, since 1991 she has worked at the National Research Council where she currently has a position as a IV level Technical Collaborator. Her activity concerns the institutional communication, the design and implementation of editorial and multimedia products about the Institute activities, such as videos, brochures, and presentations, in order to encourage the knowledge and dissemination of the results of the Institute research activities and to promote its image. She is the responsible for the activities of publication in the IREA website, in particular news, press releases, as well as the general information on the Institute. She is the contact person for the CNR press office. She is also in charge of the library management of the headquarters in Napoli. She also takes care of the IREA participation in events and exhibitions for science popularization, and the organization of visits to the Institute laboratories for students and teachers. Currently, she carries out communication activity within the European project EPOS.

Staff

Generoso SOLE
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Administrative Secretary of IREA, he has worked at CNR since 1984. His responsibilities involve the administrative management of the Institute and concern, among other things, preparation of tenders, registrations of commitments, issuing of payment orders, budget and final balance arrangements. He is the administrative responsible of several national (PON, FIRB, etc.) and regional (POR, Law 5, etc.) projects for which he edits the periodic reports. He is the person in charge for the electronic protocol registration system.

Enrica VISCARDI

Enrica Viscardi was employed at IREA, Unit of Milano, from 2011 to April 2016. She was in charge of the Unit administrative and financial activities. She dealt with the management of contracts for the supply and purchase of goods and services, financial agreements, contracts, financial commitments, payments and procedures for reimbursement of travel costs to IREA employees.

Temporary technical and administrative staff

Anna BASONI
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Anna Basoni is a technical collaborator at IREA in Milan where she supports financial and technical reporting activities for European, National and Regional projects. She is an environmental engineer with a background in environmental economics. She holds a Masters in Environmental Management from Bocconi University (Milan) where she worked for five years as a consultant on water management and application of the EU Water Framework Directive. From 2010 to 2015 she received a research grant from IREA for the valorisation of research results in the field of Earth Observation (EO) downstream services of the Copernicus European Programme. She was the co-founder and coordinator of the regional contact office in Lombardy in the DORIS_Net Project, a coordination and support action funded by EU FP7 aimed at fostering partnerships between providers and users, promoting EO downstream services among regional stakeholders and engaging new potential users of EO products.

Simone LELLA
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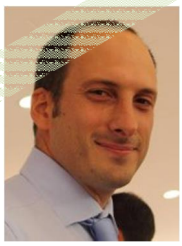

Graduated in Information and Communication Technology, he started his collaboration with the Institute for Electromagnetic Sensing of the Environment in Milano in 2010 receiving a research grant for the deployment of geoportal and services INSPIRE and OGC compliant. In this framework, he developed experience on administration and security of computer systems and networks, supporting the management of the IREA computer systems. Since 2014, he has worked as a Technical Collaborator supporting the information system of CARE-G project. He also supports some administrative issues.

Lucia Simona LOMBARDO
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Graduated in Banking, Finance and Insurance Sciences at the Università Cattolica del Sacro Cuore in Milan, since February 2015 she has been an administrative collaborator at IREA in Milan. In particular, she focuses her activities in the purchase process in and outside the electronic market for PA (MePa), management of tenders following the contract code, registrations of commitments, issuing of payment orders, and preparation of financial balance arrangements. Her activity also includes secretariat, electronic management of documents in the digital register, coordination of preparation phases and competitions for new staff recruitment. She has also the role of Secretary in competitions for temporary personnel. She is the Bursar of IREA secondary location in Milan.

Elena PALMA
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Elena Palma has been working at IREA in Napoli as a temporary administrative collaborator since 2010. She is primarily involved in secretary services, staff presence management and electronic protocol registration system. She also manages the personnel travels, she provides support in the Institute goods and services acquisition and in procedures for the assignment of research grants and scholarships. She also has the role of Secretary in competitions for the recruitment of temporary personnel, fellowships, and research grants.

Elena RECCHIA

Graduated in Political Sciences at Bologna University, Elena Recchia was a temporary administrative and financial officer at IREA, Unit of Milano, from October 2013 to December 2014. She dealt with the management of contracts for the supply and purchase of goods and services, financial agreements and cash desk expenditures. She supported the management of procedures for new staff selection and recruitment, and the financial management of European, National and Regional funded projects that involved IREA as coordinator or partner. In particular, she was the coordinator of the Administrative and Financial Team of VII FP ERMES project.

Nadia RUSSO
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Graduated in Economic Science at the University of Napoli Federico II, she has been working at IREA in Napoli since October 2013 as a temporary administrative collaborator. She is involved in supporting the administrative, accounting and fiscal activities related to the national and European research projects. She provides support to the electronic protocol registration system, secretary activities and the financial reporting of research projects funded by the European Commission or the Italian Ministry of Research.

Anna SANNINO
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Anna Sannino received the degree in Biology from the University of Napoli Federico II, and the PhD from the University of Salerno in 2002 and 2013, respectively. Since 2014 she has been with IREA Napoli, as a temporary technical staff. From 2002 to 2014 she was with IREA as a research grant holders. Her research activity is in the framework of Bioelectromagnetics, dealing with the evaluation of biological effects of low and high-frequency electromagnetic fields, alone or in combination with environmental pollutants. These activities are carried out by means of cytogenetic (micronucleus with cytokinesis block and comet assay) and cytotoxicity assays (cell viability, oxidative stress, apoptosis). Moreover, Dr. Sannino took part in the study about the evaluation of the cytotoxicity induced by multiwalled carbon-nanotubes (buckypaper) and magnetic nanoparticles in mammalian cell cultures and is currently involved in the evaluation of the cellular and sub-cellular effects induced by high voltage, nanosecond electric pulses in mammalian cells by applying cytofluorimetry techniques and confocal microscopy.

Associate Researchers

Ovidio Mario BUCCI
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Full Professor of electromagnetic fields at the Engineering Faculty, University of Napoli "Federico II", he was Head of the Department of Electronics Engineering and Vice Rector of the University of Napoli. From 2001 to 2011 he was the Director of IREA. He held scientific and administrative positions in numerous national and international organizations, in particular European Actions COST. He is also a member of the Management Committee of the European School of Antennas. Since 1993, he has been an IEEE Fellow and a Member of the Accademia Pontaniana. He won several awards and honors, including the Gold Medal for Science and Culture from the Ministry of Scientific Research. His scientific activity concerns the scattering by loaded surfaces and reflectors and their use to control the radiation pattern of reflector antennas, the analysis and synthesis of antennas, the study of the analytical properties of the electromagnetic fields and the development of field representations by means of non-redundant sampling, NF-FF measurement techniques, inverse problems and non-destructive electromagnetic diagnostics, and applications of electromagnetic fields to control biological processes.

Sabatino BUONANNO
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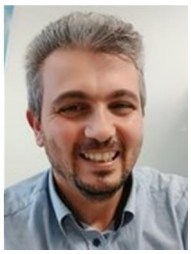

Degree in computer engineering from the University of Sannio in 2003 he was the Head of Information Systems at the satellite data receiving station MARSec (Mediterranean Agency for Remote Sensing and Environmental Control) of the Benevento province from 2004 to 2012. He participated in several national and international projects, such as the "EMSA framework for a satellite monitoring service for marine oil spill detection and surveillance of European waters" in collaboration with Telespazio, and a variety of projects on environmental monitoring using satellite data for the Campania Region. He participated in the coordination of certification activities of MARSec for the receiving of the Canadian satellite RADARSAT-1 and the Israeli satellite EROS-A. He was a teacher in computer science. Currently he is pursuing the Ph.D. degree at the University "La Sapienza" of Rome and is associated as a Ph.D. student at IREA, where he is dealing with code efficiency, data management, visualization and integration with other information sources OGC compliant for better handling information of surface deformation phenomena obtained with the DInSAR technique.

Gennaro BELLIZZI
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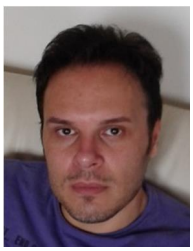
gennaro.bellizzi@unina.it



Gennaro Bellizzi received the "Laurea" degree (summa cum laude) in telecommunication engineering and the Ph.D. degree in electronic and telecommunication engineering from the Università di Napoli Federico II, Naples, Italy, in 2004 and 2008, respectively. Since January 2008, he has been a researcher at the Department of Electronics and Telecommunication Engineering, University of Napoli Federico II. His research interests include the analysis and modeling of the interactions mechanisms between electromagnetic fields and nanomachines, the electromagnetic characterization of magnetic nanoparticles and magnetic fluids, the definition of optimum criteria in magnetic fluid hyperthermia, the microwave imaging, and inverse scattering techniques. Dr. Bellizzi received the Sannino Award for young scientists at the XVIII Riunione Nazionale di Elettromagnetismo, in September 2010. Since July 2015, he has been an associate researcher at IREA in Napoli where he collaborates in the activities of the Electromagnetic Diagnostic group in the field of diagnostic and therapeutic applications of electromagnetic fields.

Maria Antonia BROVELLI
Polytechnic of Milan
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Degree with honors in Physics, Ph.D. in Geodesy. Full Professor of Geographic Information Systems (GIS) at the Polytechnic of Milan. From 2006 to 2011 she taught a GIS course at the ETH – Zurich. From 2001 to 2011 she was the scientific responsible of the Geomatics Laboratory of the Polytechnic of Milan and since 2011 she has been Vice-Rector for the Como Campus of the Polytechnic of Milan. She is co-chair of ISPRS WG IV/5 "Distributed and Web-Based Geoinformation Services and Applications"; Member of the Advisory Board of the Open Source Geospatial Lab at the Center for geospatial science, University of Nottingham; Member of the Scientific Committee of the Italian Photogrammetric and Topography Society (SIFET). In 2015 she organized the conference FOSS4G Europe and was awarded the Sol Katz Award OSGeo. Since September 2015 she has been associated at IREA in Milan. The cooperative activities relate to the Institute's participation in GeoForAll and collaboration in initiatives and projects related to the geographical crowdsourcing and Volunteer Geographic Information (VGI).

Luca DôAURIA
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Luca D'Auria is a researcher at the National Institute of Geophysics and Volcanology (INGV), Section of Naples, Vesuvius Observatory. He deals with seismology and volcanoes geophysics, with particular reference to the monitoring of active volcanoes. Between 2006 and 2014 he was the person in charge of the Seismology Laboratory and since 2014 the head of the INGV-OV monitoring room. Since July 2015, he has been associated at IREA where he collaborates in the activities of the group of Geophysics for the development of inversion models of satellite data, devoted to the study of seismogenic and volcanic areas.

Tommaso ISERNIA
Mediterranea University of Reggio Calabria
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Full professor of Electromagnetic Fields at the Mediterranea University of Reggio Calabria, he teaches several courses concerning foundations of electromagnetic fields, antennas, wave propagation in complex environments and techniques and applications of electromagnetic fields. He is the coordinator of the didactic program in ICT and Electrical Engineering. Since 2004, he is organizer and lecturer in Ph.D. courses of European School of Antennas (ESoA). He is a member of the Board of Administrators of the National Consortium on Telecommunications (CNIT) and delegate for Mediterranea University in the management board of Calabria Region Science and Technology Park (CalPark). Since April 2013, he is an associate researcher at IREA-Napoli, where he collaborates with the Electromagnetic Diagnostics group, mainly on activities concerned with inversion and synthesis techniques applied to biomedical diagnostics, subsurface prospections, and focusing of electromagnetic field in complex, partially unknown, environments.

Giuseppe JACKSON
University of Naples "Parthenope"
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Giuseppe Jackson graduated in Telecommunications Engineering at the University of Cassino and Southern Lazio in 2013, and received a PhD in "Information Engineering" from the University of Naples "Parthenope" in 2016. Since 2015, he has been associated as a PhD student at IREA-CNR for conducting research activities on airborne radar (microwave) remote sensing, in the context of the flagship project RITMARE.

Staff

Rita MASSA
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Associate Professor of Electromagnetic Fields in the Faculty of Engineering of the University Federico II of Napoli, she is with the Department of Physics of the same University and is Director of the course in "Electromagnetic Fields: Risks and Security" of the Faculty of Engineering and Medicine. Since 2010 she is an associate researcher at IREA, where she collaborates with the Bioelectromagnetics group in the study of the biological effects of electromagnetic fields at high frequency, in the presence and absence of environmental pollutants and / or model molecules, and within the monitoring of exposure to electric, magnetic and electromagnetic fields in urban and working environment.

Stefano PERNA
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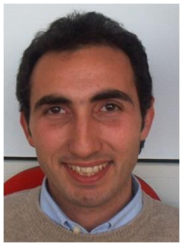

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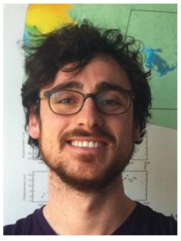

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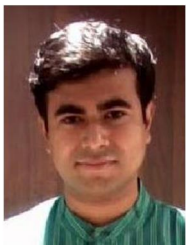

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Patents and Trademarks

2015

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IREA has been present in 24 international projects (3 of these with a coordinating role); 14 were funded by the European Union under the Seventh Framework Programme and Horizon 2020.

At a national level, IREA has coordinated research activities of 12 projects and participated in several projects funded by the Italian Ministry of Education, University and Research (MIUR), by the Ministry of Economic Development (MISE), by the Italian Space Agency (ASI), by Regione Campania and Regione Lombardia. It should be remembered, also, the provision of highly qualified institutional services as that carried out for the Italian Department of Civil Protection of which IREA is Centre of Competence for the satellite monitoring of ground deformations.

The Institute has been also involved in industrial research projects funded or carried out in collaboration with companies of national relevance. IREA has conducted a project financed by e-Geos, one funded by Società Cattolica di Assicurazioni Soc. Coop . and Fata Assicurazioni.

Projects in progress

International Projects

BRIDAS - Brillouin Distributed sensor for Aeronautical Structures

The project is addressed to the development of a prototype for distributed strain measurements in optical fibers for industrial aeronautical contexts: composite manufacturing plants, structural test platforms and airborne conditions. The prototype will be based on stimulated Brillouin scattering (SBS), and will be aimed to the structural health monitoring of composite parts employed in the aeronautical industry. The developed prototype will have performance significantly superior to those offered by commercial SBS-based interrogation units The prototype will be employed in the evaluation of quality and structural health of composite parts for the aeronautical industry, such as complete fuselage, wings, vertical or horizontal tail plane of passenger commercial aircrafts.

Funding body: European Union ï H2020
Prime contractor: Università degli Studi della Campania "Luigi Vanvitelli"
Period of activity: 2016 - 2018
IREA project manager Romeo Bernini
Funds to IREA: ú 135.156

Projects

CHARMING - Constraining Seismic Hazard Models with InSAR and GPS

The objective of the project is the implementation of research activities based on the use of data generated by the ESA's Envisat and ERS satellite missions and the Global Positioning System (GPS). The project concerns the probabilistic assessment of seismic hazard (PSHA). End users of PSHA indicators represent a broad community, including subjects that deal with land use planning, the seismic safety of the building (for the design of buildings and critical facilities, lifelines, etc.), the preparation to disasters and recovery, emergency response and mitigation of seismic risk. The main objective of the project is to see if the Earth's surface deformation measurements, derived from synthetic aperture radar (SAR) data and GPS, can be incorporated successfully in PSHA models to improve their quality. The project takes advantage of several synergies in terms of scientific expertise and data sources from different SAR and GPS sensors, seismic data, modeling and geological data in situ.

Funding body: ESA (European Space Agency)
***Prime contractor*:** National Institute of Geophysics and Volcanology (INGV)
Period of activity: 2014 - 2016
IREA project manager: Gianfranco Fornaro
Funds to IREA: ú 24.392

eLTER - European Long-Term Ecosystem and socio-ecological Research Infrastructure

The general objective of the eLTER project is to make sites and socio-ecological platforms belonging to the long-term European Research Network (LTER Europe) advance, providing high-quality services to multiple purposes. It will enable the survey on a European scale of key ecosystems and socio-ecological systems, supporting decision-making based on knowledge at various levels. IREA has been involved for many years in the activity of the Italian and European Long-Term Ecological Research Network (LTER), and has actively worked on the implementation of the prototype of the LTER Europe Spatial Data Infrastructure (SDI). As part of the eLTER project, IREA will take care of the implementation of a software suite for data management of the different nodes that will make up the infrastructure with an emphasis on 1. Integration of existing structures and 2. Use of standard for distribution and storage of data (eg. Open Geospatial Consortium - OGC).

***Prime contractor*:** CNR - Institute of Agro-environmental and Forest Biology (IBAF)
Period of activity: 2015 - 2019
IREA project manager: Alessandro Oggioni
***Funds to IREA*:** ú 90.000

EOMORES - Earth Observation based services for Monitoring and Reporting of Ecological Status

EOMORES aims to develop new highly efficient commercial services for operational inland and coastal ecological water quality monitoring. Inland and coastal water bodies constitute essential components of ecology and biodiversity, they buffer climate change and influence many aspects of the economy (recreation, fisheries) and human welfare (e.g. drinking water supply). EOMORES will develop fully-automated commercial, reliable and sustainable services based on the integration of Earth observation (Sentinel 1, 2 and 3), in situ monitoring using optical in-situ sensors with integrated GNSS positioning, and ecological modeling. The validated data from these components will be flexibly combined into higher-level products to fit the users' information needs. Three service concepts are envisaged: 1) operational water quality monitoring and forecasting for operational water management, 2) implementation of validated EO-based water quality indicators for WFD and other reporting and 3) historic compilation of data for specific ecological analysis. IREA's activities will address the implementation of the satellite data processing system, particularly for Italian study cases (Lake Trasimeno and the subalpine lakes of Lombardy).
Three main types of services are provided: 1) continuous water quality monitoring and quality status forecast for water resource management; 2) implementation of water quality indicators based on EO data for the

Water Framework Directive implementation, 3) creation of historical archives both from EO data (eg MERIS) and ecological models for long-term ecological analysis.

Funding body: European Union ï H2020
Prime contractor: Water Insight
Period of activity: 2016 - 2019
IREA project manager: Claudia Giardino
Funds to IREA: ú 240.125

EPOS - European Plate Observing System

EPOS aims at creating a pan-European infrastructure for solid Earth science to support a safe and sustainable society. To this purpose, EPOS will combine national Earth science facilities, the associated data and models together with the scientific expertise into one integrated delivery system for a better understanding of the Earth's physical and chemical processes that control earthquakes, volcanic eruptions, ground instability and tsunami as well as the processes driving tectonics and Earth's surface dynamics. Moreover, EPOS will enable innovative multidisciplinary research able to make a step change in developing new concepts and tools for key answers to scientific and socio-economic questions concerning geo-hazards and geo-resources. EPOS is currently in the implementation phase (EPOS-IP), within which IREA is responsible for the WP12 "Satellite Data" for the development of the satellite component of EPOS. In particular, the main objective is to contribute with services (interferograms, ground deformation maps and time series, integrated use of SAR and optical satellite data) that have already proven their effectiveness in investigating the physical processes controlling earthquakes, volcanic eruptions, and unrest episodes.

Funding body: European Union ï H2020
Prime contractor: National Institute of Geophysics and Volcanology (INGV)
Period of activity: 2015 - 2019
IREA project manager: Michele Manunta
Funds to IREA: ú 292.500

ERMES - An Earth obseRvation Model based RicE information Service

ERMES aims to develop a prototype of downstream service dedicated to rice sector based on the assimilation of EO and in situ data within crop yield modelling. The objective of this service, targeted to European needs, is to a) contribute to the regional authorities in the implementation of agro-environmental policies; b) support farming activities for sustainable management practices; c) provide independent reliable information to the agro-business sector. The long-term goal is to extend and adapt the service to Asian and African markets, in order to boost European competitiveness and contribute to a sustainable development.

Funding body: European Union - 7° Programma Quadro SPACE
Prime contractor: **IREA**
Period of activity: 2014 - 2016
IREA project manager: Mirco Boschetti
Funds to IREA: ú 444.484

GEP - Geohazards Exploitation Platform

The GEP project aims to implement an IT platform for the massive and automatic exploitation of satellite data for Earth observation, with particular reference to past ESA missions (eg. ERS, ENVISAT) and missions of the Copernicus program (Sentinel). In particular, the platform will provide data access, availability of "tools" and resources to process them remotely, sharing of results among the platform users. The IREA activity consists in the implementation of a system for the systematic and massive processing of SAR data acquired by the Sentinel-1 satellite in order to generate, automatically

and in an unsupervised way, maps and ground displacement time series through the SBAS-DInSAR. IREA also plays the role, in close cooperation with ESA, of the Scientific Communicator of the platform, with the main task to select, analyze and publicize the activities and the results obtained through the GEP platform.

Funding body: ESA (European Space Agency)
***Prime contractor*:** Terradue UK Ltd
Period of activity: 2015 - 2019
IREA project manager: Francesco Casu
***Funds to IREA*:** ú 80.300

GLaSS - Global Lakes Sentinel Services

The project plans a research activity committed to the development of a system able to manage, process, and produce data from Sentinel 2 and Sentinel 3 sensors for studying water quality in lakes. In this project, field and simulation activities are planned for the calibration and the validation of remote sensing data and algorithms generation through bio-optical modeling and identification and measurement of optically active parameters, required for lacustrine ecosystem quality characterization. In particular, the areas of interest for CNR-IREA are lakes Garda and Maggiore.

Funding body: European Union, Seventh Framework Programme
***Prime contractor*:** Water Insight (NL)
Period of activity: 2013 - 2016
IREA project managers: Claudia Giardino, Mariano Bresciani
Funds to IREA: ú 224.902

HEMOSPEC - Advanced spectroscopic hemogram for personalized care against live threatening infections using an integrated chip assisted bio-photonic system

Life threatening infectious diseases and sepsis are worldwide problems due to their high mortality rates. In order to select optimal treatments for the highly heterogeneous group of patients and to reduce costs, there is an urgent need for novel multiplexed tools that better characterize the patient and its specific immune response. Within the EU-supported research project HemoSpec, a multidisciplinary team of researchers, clinicians and engineers from six European countries has joined forces to develop an innovative device for early, fast and reliable medical diagnosis of infectious diseases and sepsis using only minimal amounts of patient's blood. The HemoSpec device will enable that the patient receives the therapy ideally suited to his needs at the right time. The IREA contribution to the project concerns the development and optimization of an optical-microfluidic platform for the detection of some sepsis markers.

Funding body: European Union, Seventh Framework Programme
***Prime contractor*:** Institut Fuer Photonische Technologien E.V.
Period of activity: 2013 - 2017
IREA project manager: Romeo Bernini
Funds to IREA : ú 204.000

HERACLES - Heritage Resilience Against CLimate Events on Site

HERACLES main objective is to design, validate and promote responsive systems/solutions for effective resilience of CH (cultural heritage) against climate change effects, considering as a mandatory premise an holistic, multidisciplinary approach through the involvement of different expertise (end-users, industry/ SMEs, scientists, conservators/restorators and social experts, decision, and policy makers). This will be operationally pursued with the development of a system exploiting an ICT platform able to collect and integrate multisource information in order to effectively provide complete and updated situational awareness and support decision for innovative measurements improving CH resilience, including new solutions for

maintenance and conservation. The HERACLES effectiveness will be ensured by the design and validation of manageable methodologies also for the definition of operational procedures and guidelines for risk mitigation and management. It will be validated in two challenging test beds, key study cases for the climate change impact on European CH assets. The IREA involvement in the project concernes the use of satellite and in-situ radar systems for the diagnostics and monitoring of cultural assets. With reference to microwave sensing, IREA-CNR will apply its expertise on tomographic approaches to high resolution investigations, up to the diagnosis of single structural element, thanks also to the use of radar data from satellite platforms such as Sentinel 1 and COSMO -SKYMED. Regarding electromagnetic diagnostics, IREA will perform structural diagnostic activities using georadar and holographic radar. In this field, IREA has a recognized international visibility role in data processing.

Funding body: Unione Europea, Horizon 2020
Prime contractor**:** CNR ï Istituto per lo Studio dei Materiali Nanostrutturati) ISMN
Period of activity: 2016 - 2019
IREA project manager: Francesco Soldovieri
Funds to IREA: ú 294.861

Hyperspectral Imaging Mission Concepts

The main purpose of the project is to define future hyperspectral missions and to evaluate all the technical requirements for future operational hyperspectral imaging systems. The project involves evaluating options for creating a spatial and terrestrial infrastructure that can meet the observation needs and identify any necessary technological developments. In particular, IREA will analyze the technical requirements and maturity of algorithms for future hyperspectral missions for the study of aquatic ecosystems (lakes, lagoons, rivers and coastal areas).

Funding body: ESA (European Space Agency)
Prime contractor**:** e-geos
Period of activity: 2016 - 2017
IREA project manager: Claudia Giardino
Funds to IREA: ú 29.000

ICE-ARC- Ice, Climate, and Economics - Arctic Research on Change

The ICE-ARC project aims to understand and quantify the multiple stresses involved in the change in the Arctic marine environment. Particular focus is on the rapid retreat and collapse of the Arctic sea ice cover and to assess the climatic (ice, ocean, atmosphere and ecosystem), economic and social impacts of these stresses on regional and global scales. It is not possible to look at one aspect of this system in isolation; a coupled atmosphere/ cryosphere/ocean/ecosystem approach is needed. Our observations will focus on reducing the uncertainty in understanding of Arctic physical processes which are vital in climate and ecosystem change and which may not be adequately represented in present models. Results of the observational programme, which includes satellite synthetic aperture radar (SAR) systems for remote sensing observations, will be fed into an ice-ocean-atmosphere model which, after validation, will make projections - with reduced uncertainties - of the rate and nature of future changes in the ice cover, ocean structure and atmospheric temperature and circulation. In parallel with this, an ecosystems model will perform the same role for marine living resources. IREA contribution to ICE-ARC will be in the analysis of SAR imagery of the marginal ice zone where frazil and pancake sea ice will form in order to retrieve and map the ice thickness distribution.

Funding body: European Union, Seventh Framework Programme
Prime contractor**:** NERC - Natural Environment Research Council
Period of activity: 2014 - 2017
IREA project manager: Giacomo De Carolis
Funds to IREA: ú 190.673

Projects

INFORM - Improved monitoring and forecasting of ecological status of European INland waters by combining Future earth ObseRvation data and Models

INFORM aims to explore how the capabilities of upcoming sensors (EnMap, PRISMA, S2, S3), combined with innovative analysis and the coupling with biogeochemical models, can be exploited to deliver improved products for inland water quality addressing better the end-user demands.

Funding body: European Union, Seventh Framework Programme SPACE
***Prime contractor*:** VITO (Belgium)
Period of activity: 2014 - 2017
IREA project managers: Claudia Giardino; Mariano Bresciani
Funds to IREA: ú 260.577

Integration of the interferometric SBAS tool into ESA Geohazards Exploitation Platform

Differential SAR Interferometry tools within the processing on-demand platforms of the European Space Agency (ESA). In particular, the SBAS-DInSAR tool, developed by IREA and able to generate ground displacement maps and time series from a stack of either ERS-ENVISAT or Sentinel-1 data, has been integrated within the G-POD (Grid Processing On Demand) end GEP (Geohazards Exploitation Platform) platforms of ESA. This activity allowed us to set up an on-demand operational service, freely available via web to the platform users for scientific purposes.

Funding body: ESA (European Space Agency)
***Prime contractor*:** **IREA**
Period of activity: 2015 - 2016
IREA project manager: Francesco Casu
***Funds to IREA*:** ú 85.000

MacroSense: Monitoring macrophyte physiology using proximal and remote sensing

The goal of Macrosense project is to study the physiological response of macrophytes to environmental factors through the use of spectroradiometric (in proximity and remote) data integrated to limnologic and eco-physiological data in a multidisciplinary approach.

Funding body: CNR/HAS (Hungarian academy of Sciences)
***Prime contractor*:** IREA, Balaton Limnological Institute
Period of activity: 2016 - 2018
IREA project manager: Paolo Villa
Funds to IREA: ú 12.000

MEDSUV - MEDiterranean SUpersite Volcanoes

The main goal of the project has been the realization of a multidisciplinary investigation of the volcanic risk relevant to the volcanic districts of South Italy, including Mt. Vesuvius/Campi Flegrei Caldera (Napoli Bay area) and Mt. Etna volcano (Sicily). This project has been carried out by an international consortium made by research institutions active in the remote sensing field. IREA has been involved, in particular, in the generation of deformation maps of the investigated areas, as well as displacement time-series, through the use of synthetic aperture radar (SAR) images gathered at X-band by the COSMO-Skymed sensor's constellation operated by Italian Space Agency (ASI).

Funding body: European Union, Seventh Framework Programme
***Prime contractor*:** National Institute of Geophysics and Volcanology (INGV)
Period of activity: 2013 - 2016
IREA project manager: Antonio Pepe
Funds to IREA: ú 180.000

NANODEM - NANOphotonic DEvice for Multiple therapeutic drug monitoring

The project concerns the development of a point-of-care therapeutic monitoring of immunosuppressants and related metabolites in transplant patients. In particular, it has been developed an optic/microfluidic chip and a suitable readout system that will allow the continuous monitoring of immunosuppressants and related metabolites for 48H in transplant patients.

Funding body: European Union, Seventh Framework Programme
Prime contractor: CNR - Istituto di Fisica Applicata ñNello Carraraò(IFAC)
Period of activity: 2012 - 2016
IREA project manager: Romeo Bernini
Funds to IREA: ú 220.000

ODIP 2 - Extending the Ocean Data Interoperability Platform

The project aims to continue and extend the success activities of the Ocean Data Interoperability platform (ODIP) that was initiated under FP7 ODIP project in October 2012. The ODIP 2 objectives are: 1. provide a coordination platform to facilitate interoperability and the integrated management of marine data among the EU, US and Australian infrastructures to obtain a global portal; 2. develop common approaches to the marine data management components such as vocabularies, formats, Quality Assurance (QA), Quality Control (QC), Sensor Web Enablement (SWE), and services for the discovery data, access, authentication, mapping, visualization, ingestion; 3. extend the field of application of the current activities to include additional ODIP domains, such as marine biology and bathymetry, and new emerging technological challenges. IREA is involved specifically in the prototype 3 ODIP whose main goal is the creation of a Sensor Observation Service (SOS) prototype that can be used as a common approach to the access, visualization and data ingestion.

Funding body: European Union, H2020
Prime contractor: Natural Environment Research Council (NERC-UK)
Period of activity: 2015 - 2018
IREA project managers: Alessandro Oggioni
Funds to IREA: ú 220.000

ScenaRICE - Scenario integrated assessment for sustainable rice production systems

The strategic objective of ScenaRICE is to make a significant contribution in identifying and analyzing innovative and more sustainable Systems of Rice Production (SPR). The project aims to 1) propose a framework of methodological and technological tools such as models for the simulation of the growth, development, and production of rice; GIS and remote sensing methods for spatial representation and monitoring of crops; models for multi-agents and bio-economic analysis of the socio-economic interactions; methodologies for life cycle assessment for the evaluation of the SPR interaction with the environment; 2) test the approach by developing applications in some significant case studies of different nature and location. The research working group intends to operate in Europe (Lomellina and Vercelli in Italy, Camargue in France) and in Africa (Madagascar, Sierra Leone, with the participation of AfricaRice).

Funding body: Agropolis (Fr) / Fond Cariplo
Prime contractor: INRA (Fr)/UniMi
Period of activity: 2013 - 2016
IREA project managers: Mirco Boschetti, Pietro Alessandro Brivio
Funds to IREA: ú 74.880

Sen2Coral

Coral reefs are in decline worldwide and monitoring activities are important for assessing the impact of disturbance on reefs and tracking subsequent recovery or decline. Sentinel-2 data may be capable of a fundamentally superior level of habitat mapping. The Sen2Coral aims is to provide a set of modules implemented as open source software that can provide a validated processing chain for coral reef remote sensing. The final project output should be two data processors, one for mapping (habitat, bathymetry, and water quality) and one for detection change, to be embedded in a software package easily used by volunteers for coral reefs monitoring around the world (crowdsourcing). Study areas are: Heron Island and Lizard Island (Australia), Lampi Island (Myanmar), Primeiras and Segundas (Mozambique), Lighthouse and Ngedrak Reef (Palau) and Nuku Hiva, Marquesas Islands (French Polynesia). The activity of IREA is related to the implementation of bio-optical modeling dedicated to shallow waters of coral reefs.

Funding body: ESA (European Space Agency) - SEOM
Prime contractor: ARGANS
Period of activity: 2016 - 2018
IREA project manager: Claudia Giardino
Funds to IREA: ú 29.998

SPACE-O - Space Assisted Water Quality Forecasting Platform for Optimized Decision Making in Water Supply Services

SPACE-O integrates state-of-the-art Earth Observations products and in-situ monitoring with advanced water quality hydrological models and ICT tools, into a powerful decision support system. The objective is to generate real-time, short- to medium-term forecasting of water flows and quality data in reservoirs for drinking and irrigation use. IREA's activities will involve collaboration with EoMAP for the generation of quality water products and the generation of value-added products, such as surface cyanobacterial flowering maps. All the results obtained in the project will be used to optimize water treatment operations and establish a service line in the water sector.

Funding body: European Union, H2020
Prime contractor: EMVIS (GR)
Period of activity: 2016 - 2018
IREA project manager: Claudia Giardino
Funds to IREA: ú 182.250

TEP-Quick Win

The aim of the project has been to develop a platform to develop a collaborative research platform based on distributed architectures (Cloud Computing) for the sharing of data, algorithms and processing resources in the field of Earth Observation, and in particular within the Geohazard field. More specifically, the TEP Quick Win is the continuer of the SSEP project (SuperSite Exploitation Platform) of ESA and a precursor of the Geohazard Thematic Exploitation Platform (G-TEP), again of ESA. The activity of IREA within the project has been to supply value-added interferometric contents to be shared on the platform developed by TEP-QW. Moreover, IREA supports the definition of a web interface to manage and operate an Interferometric processing service through the SBAS algorithm (developed by IREA) in a Cloud Computing environment, as well as participates in testing and validation activities of project results.

Funding body: European Space Agency
Prime contractor: CGI IT UK Limited
Period of activity: 2014 - 2016
IREA project manager: Francesco Casu
Funds to IREA: ú 43.120

TERVAGRI - Territorial variability of agricultural performances under climate change

The aim of the project is to explore future agricultural landscapes, modeling their performance in the context of climate change to reconcile food production and resource use. The research focuses on two Mediterranean study cases characterized by cultivation systems, one based on rice and the other on lavender. In order to characterize the variability in the time and space of agricultural conditions in terms of climate, cultivation systems and their performance (production, economy, environment), it will carry out an analysis of satellite data such as MODIS / Landsat (NASA) at different spatial resolution and time frequency. The project also includes a "visiting" period at IREA of a Post-Doc and an INRA (Fr) researcher.

Funding body: INRA (Fr) e CIRAD (Fr)
Prime contractor: **IREA**
Period of activity: 2016
IREA project managers: Mirco Boschetti, Pietro Alessandro Brivio
Funds to IREA: ú 11.000

National Projects

Automatic classifiers for LCCS

Within this project, IREA offers its highly qualified scientific expertise for the automatic classification of satellite data time series for the identification of classes provided by the Land Cover Classification System (LCCS) of FAO. The proposal is coordinated by Exelis Visual Information Solutions Italia s.r.l. in response to the request by e-Geos S.p.A. under the framework agreement "Copernicus Hot Spot Mapping (C-GL-HSM)" between e-Geos S.p.A. and the JRC of the European Commission for mapping soil cover and changes. The project aims to develop a set of routines / functions for the automatic classification of satellite data to support photo-interpretation of classification maps. The functions will be developed in ENVI / IDL, which is the most suitable development environment because it allows you to use ENVI libraries, optimizing development times and delivering more reliable software. In addition, ENVI provides a framework to facilitate the insertion of new functions. Developed routines / functions can be included in a workflow to support land cover classification activities. Specifically, the developed functions will allow the calculation of spectral indices, synthetic features from time series, supervised classification through training areas, rule classification, and semantic fusion of thematic maps obtained from classifiers.

Funding body: EXELIS Visual Information Solutions srl
Prime contractor: **IREA**
Period of activity: 2016
IREA project manager: Daniela Stroppiana
Funds to IREA: ú 31.400

BLASCO - Blending LAboratory and Satellite techniques for detecting CyanObacteria

The main purpose of the BLASCO project is to develop a technique to identify potentially toxic cyanobacteria, which grow in lacustrine environments, by means of remote sensing techniques. To achieve this goal, an intense laboratory activity was initially conducted to study the optical properties of cyanobacteria. On the basis of the collected observations, algorithms for processing satellite data will be then developed and calibrated. The results of this project could help to effectively monitor the impact of cyanobacteria blooms on the lake water quality.

Funding body: Fondazione Cariplo
Prime contractor: CNR ï Institute of Ecosystem Study (ISE)
Period of activity: 2015 - 2017
IREA project manager: Mariano Bresciani, Claudia Giardino
Funds to IREA: ú 120.000

Projects

DIPOLO

The aim of the project was to design and develop a portable device for monitoring and storing occupational exposure levels at high frequency electromagnetic fields for operators / installers operating next to frequency spreading systems of Mobile Telephony (BTS) and radio links. In particular, two isotropic electric field sensors have been designed, one operating at typical mobile telephones frequencies (925-2160 MHz) and the other at radio link frequencies (7-28 GHz). Hardware components and prototype materials were also identified.

Funding body: The second University of Naples (SUN), Industrial and Information Engineering Department
***Prime contractor*:** **IREA**
Period of activity: 2015 - 2016
IREA project manager: Eugenio Sansosti
Funds to IREA: ú 20.000

Evaluation of occupational exposure to electromagnetic fields and bio-monitoring of magnetic resonance workers

The aim of the project is to provide health authorities with tools and operating methods for risk assessment of workers exposed to electromagnetic fields in use for Magnetic Resonance imaging systems, with particular reference to gradient fields that are generated during execution diagnostic tests, and electric fields and currents induced in human tissues by movement through a spatially inhomogeneous static magnetic field. This is of particular importance given the recent development of high-field magnetic resonance used for experimentation on volunteers. In addition, bio-monitoring of workers will be carried out by evaluating the DNA damage in exfoliated buccal mucosa cells taken from workers identified among the employees/collaborators of public and private partners.

Funding body: Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro (INAIL)
***Prime contractor*:** **IREA**
Period of activity: 2016 - 2017
IREA project manager: Maria Rosaria Scarfì
Funds to IREA: ú 60.000

Generation of pre-operational products aimed at the evaluation of surface deformation by the use of advanced methodologies for the processing of remote sensing synthetic aperture radar data

The activities are conducted within the framework of the Agreement between the Department of Civil Protection (DPC) and IREA, which acts as a competence center for DPC on DInSAR data. In particular, IREA monitors the Campi Flegrei caldera through the SAR COSMO-SkyMed data and must generate the displacement field induced by the major seismic events nationwide. In addition, IREA develops advanced algorithms to process SAR data acquired from the recently launched satellite Sentinel-1. Finally, IREA uses 3D tomographic SAR techniques to improve the definition of models of buildings and infrastructure in areas prone to seismic risk.

Funding body: Department of Civil Protection (DPC)
***Prime contractor*:** **IREA**
Period of activity: 2015-2016
IREA project manager: Francesco Casu
Funds to IREA: ú 163.940

HOT SPOT MAPPING

Copernicus Global Land Service - High Resolution Hot Spot Mapping is part of Land Cover and Land Cover Change (LC / LCC) initiatives. The main objective is the implementation of a transformation chain for land cover mapping and land cover changes for some areas of interest (hot spots) located mainly

in the African continent. The maps produced will be based on the FAO-LCCS approach. The processing chain provides some basic steps to produce maps such as: the selection of input data (satellite data) whose characteristics vary depending on the areas of interest, scale / product and class of interest; pre-processing of data that must be automatic, robust, and flexible to adapt to different types of Earth Observation Data (OT); automatic classification for the most general level of soil cover classes (dichotomic classification LCCS); visual inspection and interpretation of photos of the final products to obtain maximum geometric and thematic accuracy; internal control of the production chain quality and final products to verify geometric and thematic accuracy. The consortium is led by e-Geos with Ithaca nd Iberian Telespazio as partners. CNR-IREA, Exelis, ISPRA and an LCCS expert are sub-contracting. IREA works on the drafting of the internal quality control protocol for production and supervision of the automatic classification of LCCS classes.

Funding body: e-Geos
***Prime contractor*: IREA**
Period of activity: 2016
IREA project manager: Mirco Boschetti
Funds to IREA: ú 48.346

ISEO: Improving the lake Status from Eutrophy towards Oligotrophy

ISEO Project

The main objective of the ISEO project is to identify and evaluate the synergic effects on water quality of local pressures and global warming in order to identify innovative and effective management strategies based on the results of monitoring and modeling activities. IREA involment in the project concerns the lake's synoptic monitoring in order to detect pollution events (eg river plumes and algal blooms) from satellite images. In addition, in the project the submerged macrophytic areas and the maps integrated with biochemical data collected in situ will be mapped through the analysis of high resolution spatial images in order to evaluate the contamination by nutrients and their capacity to retain and counteract the loads of phosphorus in the waters.

Funding body: Fondazione Cariplo
Prime contractor: Università degli Studi di Brescia - Department of Civil, Environmental, Architectural Engineering and Mathematics
Period of activity: 2016 - 2019
IREA project managers: Claudia Giardino, Mariano Bresciani
Funds to IREA: ú 30.900

PANACEA - The role of frazil and PANcake ice in the mass and energy budgets of the AntarctiC sEA ice cover

The project aims to study the role of the frazil and pancake (FP) ice in the climatology of the Ross Sea through the use of satellite images acquired by synthetic aperture radar (SAR), in combination with a physical model of formation and evolution of the FP ice in turbulent waters, able to calculate the energetic exchanges that take place between ocean and atmosphere and the resulting degree of salinity in the water column. Satellite observations and theoretical predictions of the properties of FP ice are being validated with in situ measurements conducted in the Ross Sea on the research vessel "Italica" during the XXIX and XXXI Antarctic Expedition of PNRA. The ultimate goal of the research is to evaluate, on a regional scale, the mass balance of the FP ice and the energy exchange between ocean and atmosphere, as well as the salt budget in the water column at a time of rapid climatic changes in the cryosphere of our planet.

Funding body: Ministry of Education, University and Research (MIUR) - PNRA
***Prime contractor:* IREA**
Period of activity: 2014 - 2016
IREA project manager: Giacomo De Carolis
Funds to IREA: ú 88.000

Projects

RITMARE ï The Italian Research for the Sea

RITMARE is a Flagship Project of the National Research Programs funded by the Italian Ministry of Education, University, and Research. RITMARE is the leading national marine research project for the period 2012-2016; it is coordinated by the National Research Council and brings together the Italian scientific community working on marine and maritime issues in an integrated effort, as well as some major industrial groups. Objectives of the project are strengthening Italy's ability to meet the challenges of globalization and competitiveness, climate change, degradation of the marine environment, maritime safety and security and sustainability of energy supplies. RITMARE is divided into seven sub-projects: 1. Maritime Technologies; 2. Technologies for Sustainable Fishing; 3. Planning of the Maritime Space in Coastal Waters; 4. Planning of the Deep Marine Environment and the Open Sea; 5. Observation System for the Marine Mediterranean Environment; 6. Research, Training, and Dissemination Structures; 7. Interoperable Infrastructure for the Observation Network and Marine Data. IREA contribution is in sub-project 1 with optical fiber sensor activity; sub-project 3 with hyperspectral and SAR remote sensing activities applied to coastal areas; sub-project 5 with SAR remote sensing for sea study with reference to the COSMO-SkyMed ASI program and X-band coastal radar; sub-project 7 with the design and implementation of an infrastructure for sharing data, information and processes generated by the other RITMARE sub-projects. IREA coordinates sub-project 7.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** National Research Council of Italy
Period of activity: 2012 - 2016
IREA project managers: Paola Carrara, Claudia Giardino, Giacomo De Carolis, Romeo Bernini, Paolo Berardino, Gianfranco Fornaro, Michele Manunta, Francesco Serafino
Funds to IREA: ú 2.900.000

SAPERE- Space Advanced project Excellence in Research and Enterprise

SAPERE is a project within the larger initiative of the Italian Aerospace Cluster (CTNA) that aims at coordinating the Italian space sector, developing its industrial, scientific and academic components. The project aims at continuing the development of Earth Observation and emergency management (crisis management) fields. The project focuses on the need for short revisit time in observation systems, the ability to use sensors of different nature (e.g. radar, optical) and finally on the use of these instruments more flexible and fast. This will help to manage more effectively the Pre-disaster, Disaster Response, Post-Disaster phases. CNR's involvement includes personnel from 9 of its Institutes, among them IREA that coordinates the activities of the whole CNR.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** Thales Alenia Space Italia
Period of activity: 2014 - 2017
IREA project manager: Eugenio Sansosti
Funds to IREA: ú 249.600

SATFARMING - Applications of remote sensing techniques to support crop monitoring

IREA has been experimenting and developing for years methodologies and prototypes for applying Earth observation techniques (whether by plane, drone or satellite) to monitor the state of the crops and to provide specific information about the time-space dynamics during the season as a support to modern farming practices. In this context, the company Bonifiche Terreni Ferraresi S.p.A expressed interest in experimenting the use of satellite remote sensing techniques to monitor the growth of the crop in its seasonal dynamics within its own company. Experimentation can be framed within the European Copernicus Program, with respect to the development of downstream services. In particular,

it is intended to experiment the potential of the European Space Agency Sentinel-2 satellite for the production of useful information in the field of agricultural monitoring during the 2016 season in the context of precision farming activities to support the sustainable management of crops present in the company.

Funding body: Società Bonifiche Terreni Ferraresi S.p.A
***Prime contractor*:** **IREA**
Period of activity: 2016
IREA project manager: Mirco Boschetti
Funds to IREA: ú 50.000

SM@RTINFRA-SSHCH - Infrastrutture integrate intelligenti per lôecosistema dei dati delle scienze sociali, umane e del patrimonio culturale

SM@RTINFRA-SSHCH has the general objective the promotion and development of a coordinated system of national nodes of European research infrastructures in the sector SSHCH. The structure SM@RTINFRA-SSHCH will rationalize resources effectively and efficiently; create bridges to overcome the gap between experts of different disciplines, equipment resources and digital methods of data analysis, and users; facilitate the attraction of external financing with a focus on European research programs; strengthen the role of Italy as a European leader in this sector.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** National Research Council of Italy
Period of activity: 2014-2017
IREA project manager: Francesco Soldovieri
Funds to IREA: ú 6.000

Study of surface deformations by means of satellite analysis and geophysical modeling of seismogenic sources for the control of underground activities

The Operational Agreement that IREA has signed with the Ministry of Economic Development (MISE) - General Directorate for the Safety and Environmental Protection of Mining and Energy Activities - has the aim to monitor surface deformations of the areas of interest for the MiSE, with particular reference to the pilot sites on which the Guidelines for Monitoring the Underground Activities will be tested for the first time. This monitoring is carried out by 1) the use of satellite radar data, acquired by first and second generation sensors, elaborated with the advanced technique of Differential Interferometry known as SBAS to obtain information on the spatial distribution of surface deformations and their time evolution; 2) the development of a multi-parameter and multi-physical analysis methodology that, using heterogeneous data, enables a modeling of the geophysical / geological processes that characterize the areas covered by the study activities.

Funding body: Ministry of Economic Development (MISE)
***Prime contractor*:** **IREA**
Period of activity: 2015 - 2017
IREA project managers: Riccardo Lanari, Mariarosaria Manzo, Giuseppe Solaro
Funds to IREA: ú 580.000

Technological evolution and experimentation, via aerial platform, of a radar sensor in VHF and UHF bands (frequencies below 1 GHz)

The Italian Space Agency (ASI) has a P-band multifrequency Radar operating in "Sounder" mode at 150 MHz frequency, and a "SAR-Imager" at UHF-Low - 450 MHz - e UHF-High - 900 MHz operating frequencies. The project aims to consolidate knowledge and technologies related to this instrument by ensuring the evolution of the radar realized and experimented within the ASI project "P-Band Radar", in order to rise its performance and broaden its operational range by implementing the full polarization, the increase of

frequency bands, and transmitted power. The project involves carrying out experimental campaigns for data acquisition and analysis aimed at calibrating, characterizing and understanding the actual capabilities of the instrument. IREA participates in the project by performing data-processing activities for experimental campaigns both for the Sounder mode and SAR-Imager mode.

Funding body: Italian Space Agency
Prime contractor: CO.RI.S.T.A. (Consortium of Research on Advanced Remote Sensing Systems)
Period of activity: 2015 - 2018
IREA project manager: Gianfranco Fornaro
Funds to IREA: ú 30.000

TELEMOD - Integrated application of satellite-based remote sensing techniques to support peritals and agriconsulting activities

The project context is the integrated application of remote sensing and modeling techniques to support insurance activities for agricultural risks. The assumption is that a technician called to estimate the damages caused by a negative event on herbaceous crops can get a better result if supported by the modern non-destructive analysis / monitoring / simulation tools of the crops themselves. These tools mainly include satellite modeling and remote sensing techniques to provide useful site-specific information relating to individual parcels or portions of these, mainly related to the development and cultivation vigor.

Funding body: Società Cattolica di Assicurazioni Soc. Coop. And Fata Assicurazioni Danni S.p.A.
Prime contractor: University of Milano
Period of activity: 2015 - 2016
IREA project manager: Monica Pepe
Funds to IREA: ú 16.000

TELEMOD-2 - Integrated application of satellite-based remote sensing techniques to support peritals and agriconsulting activities

The project context is the integrated application of remote sensing and modeling techniques to support insurance activities for agricultural risks. The project activities are aimed at producing and evaluating maps of vegetation indices from which different statistics and metrics can be derived. These maps provide objective indications on the vegetative vigor of culture and on its variability in intracampo. On the one hand, such data can be used both to monitor crop development and to derive nutrition-related information in order to better manage agricultural practices. On the other hand, the same maps can provide information before and after an adverse event, in order to identify potentially damaged areas. The project also includes exploratory phases for the use of new generation satellites, both in the Copernicus applications and in the micro and nano-satellite applications.

Committente: Società Cattolica di Assicurazioni Soc. Coop. and Fata Assicurazioni Danni S.p.A.
Prime contractor: **IREA**
Periodo di attività: 2016 - 2017
Responsabile IREA: Monica Pepe
Finanziamento IREA: ú 82.200

Regional project

ACTIVITI - Cultural Attractors and Information Technologies for the Interactive Valorization and the Innovative Tourism

The project aims to develop technological solutions for the preservation and the valorization of cultural heritage. In particular, IREA is involved in the use of spaceborne monitoring techniques for the conservation of cultural heritage.

Funding body: Regione Campania, Call CAMPUS to Projects for Industrial Research and Experimental Development
Prime contractor: PIERRECI cooperative society
Period of activity: 2013 - 2016
IREA project manager: Gianfranco Fornaro
Funds to IREA: ú 54.000

Monitoring the village of Avigliano (PZ) and Gorgoglione (MT)

The project concerns the monitoring of surface deformation related to phenomena of subsidence or hydrogeological instability affecting the villages of Avigliano (Potenza) and Gorgoglione (Matera), Basilicata region. In particular, it is planned the integration of advanced technologies of satellite radar remote sensing and geophysical techniques for the definition of the geological-structural planning of the study areas and the geometric reconstruction of any possible landslide bodies. In addition, it is expected both to characterize the main parameters related to structures / facilities located in high-risk areas, and to detect and study the movements localized to the scale of individual buildings occurred in the last 15 years in the areas under consideration. Specifically, IREA activity concerns the analysis, carried out with space-borne SAR Interferometry techniques, of images acquired by ENVISAT and COSMO-SkyMed sensors, in order to obtain deformation time series and displacement velocity maps relevant to the two investigated areas, useful to define the evolution dynamic of the studied phenomena.

Funding body: Regione Basilicata
Prime contractor: CNR - Institute of Methodologies for Environmental Analysis (IMAA)
Period of activity: 2015 - 2016
IREA project manager: Francesco Casu
Funds to IREA: ú 50.000

Realization and characterization of an innovative exposure system to ultra-short high voltage electric pulses for biological analysis by confocal microscopy

The project aims to realize an experimental set-up for the generation of high voltage electric pulses in the range of nanoseconds (nsPEF), with variable polarity and duration, for exposures of cellular samples. The system has been designed in such a way to be interfaced with a confocal microscope in order to allow nsPEF exposure and the “real-time” measurement of intracellular effects. Experimental evidence exists of the effectiveness of high voltage electric pulses in selective modulating the cellular functions. In particular, nsPEF exposure is capable of inducing selective permeabilization of cell membranes, with the induced effects depending on cell type and on the duration and intensity of the pulses. In any case, the action mechanisms of such pulses need adequate in-depth analyses. The confocal laser microscopy, combined with the use of fluorescent probes, allows to simultaneously measure different intracellular parameters at the single cell level, and on a cluster of cells, with high spatiotemporal resolution. The use of this technology offers great potentialities for the study of the non-thermal biological effects of nsPEF, for which have been assumed transient disturbances, that are capable of triggering cellular processes of various nature.

Funding body: Regione Campania
Prime contractor: **IREA**
Period of activity: 2015 - 2016
IREA project manager: Maria Rosaria Scarfì
Funds to IREA: ú 12.500

SIMULATOR-ADS - Integrated modular system for risk management and prevention - enriched with satellite data

SIMULATOR-ADS is a project of the specialization area of the "Smart Cities and Communities" cluster of the Lombardy region, extending the results of the previous SIMULATOR project that developed a decision support prototype system for local authorities in line with the Features of Civil Protection 2.0. The ultimate goal of the project is to protect the security of the citizen and the community through the development of innovative ICT and aerospace applications and their integration into a modular multi-source territorial information system for quasi-real-time monitoring of the territory and infrastructures, the prevention and reduction of reduction of natural and anthropic origin risks, the management of risks and emergencies in accordance with the existing regional legislation. The task of IREA is to develop methods for the creation of down streaming services based on the use of satellite data from ESA Sentinel and NASA missions in order to calculate indicators of the state of the territory, at municipal / sub-municipal level, with optimum weekly frequency, considering multi-source satellite acquisitions.

Funding body: Regione Lombardia
***Period of activity*:** CEFRIEL , S.C.R.L.
Periodo di attività: 2016 - 2018
IREA project manager: Gloria Bordogna
***Funds to IREA*:** ú 80.000

Concluded projects

International projects

AMISS - Active and Passive Microwaves for Security and Subsurface imaging

The AMISS project was devoted to establishing a network of partnerships with the aim of providing theoretical and applicative advances in the field of active and passive microwave systems. The main objectives of the project were: 1) Development and characterization of new active and passive sensors and systems for microwave imaging; 2) analysis and validation of new approaches for the treatment of GPR data for the imaging of critical infrastructure and subsoil; 3) integration of the state of the art and new hardware for imaging and characterization of approaches to deal with realistic security situations in applications of subsoil surveys; 4) development and feasibility study of bio-radar technology (system and data processing) for the detection of vital signs and the identification / characterization of human in complex scenarios. The project involved three European partners (Italy, The Netherlands, Turkey) and 4 partners from third countries (Russia, Ukraine, Brazil), whose skills are complementary in terms of the achievement of scientific objectives and the knowledge transfer.

Funding body: European Union, Seventh Framework Programme
Prime contractor: National Research Council of Italy
Period of activity: 2011 - 2014
IREA project manager: Francesco Soldovieri
Funds to IREA: ú 117.800

CANALETTO - Investigation on the biological effects of low doses of I-131 and comparison with subjects occupationally exposed in the framework of nuclear medicine

The project dealt with the evaluation of individual sensitivity, at molecular and chromosomal level, to low and high doses of ionizing and non-ionizing radiations, with the aim of investigating the impact of occupational exposures on the DNA repair efficiency. The project envisaged a) molecular and cellular studies in cultures of lymphocytes from subjects exposed for occupational (MRI, X-rays, scintigraphy) or for diagnostic (low doses of I-131) purposes, and b) laboratory studies to evaluate whether low doses of ionizing or non-ionizing radiations, in the considered working environments, are able to modify the DNA repair capabilities and can be involved in protective (adaptive response) or pathologic processes.

Funding body: Italian Ministry of Foreign Affairs
Prime contractor: **IREA** and Institute of Nuclear Physics Henryk Niewodniczanski, Dept. of Environmental and Radiation Biology, Cracow, Poland
Period of activity: 2013 - 2015
IREA project manager: Maria Rosaria Scarfì

cyan-IS-was - cyanobacteria assessment in Italian and Swedish waters from space

cyan-IS-was is a cooperation project whose goal was the understanding of the appearance, bloom, persistence and decline dynamics of cyanobacteria communities in lakes and marine coastal waters through remote sensing techniques.

Funding body: Ministry of Education, University and Research (MIUR) ï MAE
Prime contractor: **IREA**
Period of activity: 2010 - 2013
IREA project manager: Claudia Giardino
Funds to IREA: ú 170.276

DORIS - Ground Deformations risk scenarios: an advanced assessment service

DORIS was an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, including landslides and ground subsidence, at different temporal and spatial scales and in various physiographic and environmental settings. DORIS integrated traditional and innovative Earth Observation (EO) and ground based (non-EO) data and technologies to improve our understanding of the complex phenomena that result in ground deformations, and to foster the ability of Environmental and Civil Protection authorities to manage the risks posed by ground deformations. Within the project, IREA contributed to the development of innovative products for DInSAR monitoring of surface deformation.

Funding body: European Union, Seventh Framework Programme ï European Downstream Service
Prime contractor: National Research Council of Italy
Period of activity: 2010 - 2013
IREA project manager: Michele Manunta
Funds to IREA: ú 232.875

DORIS Net - Downstream Observatory organised by Regions active In Space - Network

The main goal of the Project was the creation of the platform of Copernicus Regional Contact Offices (RCO) able to provide to different local actors (private companies, research bodies, local and regional authorities, end users) information on: the offer of regional products and services in Copernicus (past GMES), the EU spatial Programme; development opportunities of new regional products from remote sensing; participation to events organized by Copernicus and RCOs in the involved regions. To this aim a web platform was

created, i.e. the "European Copernicus Downstream Service Platform", in order to reach an effective coordination of research and application activities involving European regions and Copernicus bodies.

Funding body: European Union, Seventh Framework Programme
Prime contractor: **IREA**
Period of activity: 2011 - 2013
IREA project manager: Paola Carrara
Funds to IREA: ú 154.617

E-CEO - E-Collaboration for Earth Observation

E-CEO was a project whose aim was to create a collaboration platform based on a cloud computing environment that, through the definition and implementation of some "contests" (exercises), would allow the development and adoption of new methodologies for the development and exploitation of Earth Observation data. In particular, IREA activities concerned the definition of the contest relative to SAR interferometry.

Funding body: European Space Agency
Prime contractor: Terradue UK Ltd
Period of activity: 2013 - 2015
IREA project manager: Francesco Casu
Funds to IREA: ú 20.000

EnvEurope - Environmental quality and pressures assessment across Europe

This Project originated from the LTER-Europe network, represented by more than 400 research sites in Europe. It contributed to the integration and coordination of long-term research on ecosystems and the monitoring initiatives in Europe. EnvEurope was focused on the understanding of the current status of ecosystems and their evolution; it was characterized by a trans-eco domain approach at large scale, involving terrestrial, marine and freshwater domains in the whole continent. More than 65 LTER sites from 11 countries participated in the Project, which delivered ecological dataset and information on the status and long-term trends of ecosystems at European scale, on the basis of data collected in the field. EnvEurope wished to contribute in filling the gap between science and policy, improving scientific support to environmental policy and European sustainability plans.

Funding body: European Union
Prime contractor: CNR - Institute of Marine Sciences (ISMAR)
Period of activity: 2011 - 2014
IREA project manager: Paola Carrara
Funds to IREA: ú 103.500

EULAKES - European Lakes Under Environmental Stressors

EULAKES was a research project which involved 9 partners among environmental agencies, research centers, and universities, among which 4 Italians, 2 Hungarian, 2 Austrian and 1 Polish. The study objects were some large European lakes: Lake Garda in Italy, Lake Balaton in Hungaria, Lake Neusiedl in Austria and Lake Charzykowskie in Poland. EULAKES allocated about 3 million euros to improve monitoring systems, integrating in situ measurements and remote sensing observations, to realize climate changes simulations in order to evaluate waters vulnerability and define a common management action strategy.

Funding body: European Union
Prime contractor: Lake Garda Community
Period of activity: 2010 - 2013
IREA project manager: Claudia Giardino
Funds to IREA: ú 73.125

Helix Nebula - The Science Cloud

Helix Nebula was an FP7 project, coordinated by CERN, whose aim was establishing a Cloud Computing European platform dedicated to Science. The Helix Nebula structure was defined and developed on three Pilot-Projects proposed by CERN, EMBL, and ESA. IREA was active on the ESA's Pilot project, namely SSEP - SuperSites Exploitation Platform, as an early-adopter of the Helix-Nebula infrastructure for the migration, in a Cloud environment, of the SBAS algorithm. IREA also had a role within the User Requirements and Governance definitions.

Funding body: European Union, Seventh Framework Programme
***Prime contractor*:** CERN
Period of activity: 2012 - 2014
IREA project manager: Francesco Casu
Funds to IREA: ú 48.499

INFOaaS ï Information as a Service

Earth Observation satellites have been providing a huge volume of data on our planet for more than 20 years. The future global monitoring from space, combined with the heritage data (coming from ERS and Envisat program for instance) make up a unique and incredible amount of valuable information. In order to initiate a Data Analytics platform based on EO satellite data, the project focused on a use case related to the Oil & Gas market dealing with land movement monitoring. As a first step, INFOaaS set up an operational pilot service hosted on Helix Nebula in order to address this use case. The main objectives of this platform were to provide: a simple access to flexible and powerful external cloud capacity to analyze data without any bulk data download; an easy access to off-the-shelf analysis and visualization tools; an access point for downstream services (refined data products for a particular spatiotemporal region of interest).

Funding body: European Space Agency
***Prime contractor*:** ATOS
Period of activity: 2014 - 2015
IREA project manager: Michele Manunta
Funds to IREA: ú 12.600

LAMPRE - LAndslide Modelling and tools for vulnerability assessment Preparedness and REcovery management

The FP7 LAMPRE project proposed to execute innovative research and technological developments to increase GMES limited operational capacity to cope with triggered landslide events and their consequences, in Europe and elsewhere. LAMPRE will enhance landslide risk mitigation/preparedness efforts and post-event-landslide recovery and reconstruction activities, in highly vulnerable geographic and geologic regions. The project improved the ability to detect/map landslides, assess/forecast the impact of triggered landslide events on vulnerable elements, and model landscape changes caused by slope failures.

Funding body: European Union, Seventh Framework Programme
***Prime contractor*:** National Research Council of Italy
Period of activity: 2013 - 2015
IREA project manager: Pietro Tizzani
Funds to IREA: ú 120.000

MARsite - New directions in seismic hazard assessment through focused Earth Observation in the Marmara Supersite

The project aimed to collect, share and integrate multidisciplinary data (seismologic, geochemical, surveying, satellite, etc.) in order to carry out assessment, mitigation, and management of seismic risk in the Region of the Sea of Marmara. IREA activity within the project concerned the analysis and monitoring of deformations

of the Earth's surface in selected areas in the Region of the Sea of Marmara, through the use of the Differential Interferometry technique called SBAS (Small BAseline Subset) applied to Synthetic Aperture Radar (SAR) data in X-band acquired by the constellation of SAR sensors COSMO-SkyMed.

Funding body: European Union, Seventh Framework Programme
Prime contractor: KOERI (Kandilli Observatory and Earthquake Research Institute), Turchia
Period of activity: 2012 - 2015
IREA project managers: Mariarosaria Manzo, Giuseppe Solaro
Funds to IREA: ú 99.450

SABER - Satellite Broadband for European Regions

The project, which involved 26 partners, aimed to explore how satellite systems can help to reduce the digital divide in Europe, to get to define the guidelines for best using and disseminating the broadband and related technologies required. The activities were divided into three phases: after a first analysis of the experiences of European regions that had already used a satellite system, it would share information about technological opportunities and the regulatory requirements of the European Digital Agenda 2013.

Funding body: European Union, Seventh Framework Programme
Prime contractor: CSI-Piemonte
Period of activity: 2012 - 2014
IREA project manager: Mario Angelo Gomarasca
Funds to IREA: ú 16.000

SAFUEL - The SAfer FUEL system

The project concerned the development of an innovative system for the management and control of fuel in airplanes. In particular, innovative acoustic and optical sensors were developed to eliminate the risk of explosion associated with conventional electrical sensors.

Funding body: European Union, Seventh Framework Programme
Prime contractor: CNR - Institute of Applied Physics ñNello Carraraò
Period of activity: 2012 - 2015
IREA project manager: Romeo Bernini
Funds to IREA: ú 293.325

TERRAFIRMA

The project aim was to provide support to Civil protection Agencies and bodies for the management of natural hazards in the evaluation and mitigation of risk, by using the most advanced satellite SAR technologies to measure ground deformation. Thanks to the use of these data, the project provided information about the risk associated with movements of the ground throughout the 27 European Union countries.

Funding body: European Space Agency
Prime contractor: Altamira Information (Spain)
Period of activity: 2011 - 2013
IREA project managers: Michele Manunta, Eugenio Sansosti
Funds to IREA: ú 20.000

National projects

Acquasense - Development of control systems, application of materials and processes for the improvement of drinking water quality

The project concerned the development of an innovative system for real-time monitoring of water distribution plants and the generation of timely alarm signals on the quality of drinking water in the occurrence of abnormal events.

Funding body: Ministry of Economic Development
***Prime contractor*:** West Systems S.r.l.
Period of activity: 2011 - 2014
IREA project manager: Romeo Bernini
Funds to IREA: ú 193.061

CLAM-PHYM - Coasts and Lake Assessment and Monitoring by PRISMA HYperspectral Mission

CLAM-PHYM was a research project whose goal was the evaluation of PRISMA (Hyperspectral Precursor of the Application Mission) capabilities in water quality applications. The project dealt with coastal and internal waters complexity and variability and related issues through physics-based approaches. CLAM-PHYM included an important field activity as data source for data and products calibration and validation.

Funding body: Italian Space Agency
***Prime contractor*:** CNR - Institute of Marine Sciences
Period of activity: 2011 - 2015
IREA project manager: Claudia Giardino
Funds to IREA: ú 130.000

Data-LTER-Mountain - Harmonisation and standards for existing and newly collected Data and MetaData on LTER sites in Italian Mountain ecosystems

In the framework of the NextData Project - a national system for the retrieval, storage, access and diffusion of environmental and climate data from mountain and marine areas - the project Data-LTER-Mountain developed a distributed system of archives and access services to data and metadata collected in Long Term Ecological Research (LTER) sites located in mountain ecosystems in Italy. IREA worked to define standards to suitably describe and harmonize bio-ecological data and metadata; develope the system of mountain LTER sites' archives and access services to the results of research in mountainous ecosystems, in connection with the archives of NextData.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** CNR - Institute of Agro-environmental and Forest Biology (IBAF)
Period of activity: 2014 - 2015
IREA project manager: Paola Carrara
Funds to IREA: ú 108.325
Funding body: European Union ï H2020

Development and testing of a distributed fiber optic sensor based on the phenomenon of Brillouin scattering for temperature monitoring

The project concerned the development of a distributed fiber optic sensors based on Brillouin scattering for temperature monitoring of rails. In particular, temperature monitoring was demonstrated over a rails distance of 5 Km and with a spatial resolution of 5m.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** University of Sannio
Period of activity: 2013
IREA project manager: Romeo Bernini
Funds to IREA: ú 20.000

Projects

e-SHS - ICT for Health and Social Solidarity

The main goal of the e-SHS project was to build an integrated platform for personal and personalized healthcare services, based on the use of innovative and non-invasive ICT technologies. Such an aim is perfectly aligned with the scope of the Health&Well-being societal challenge posed by the H2020 program. The core of the developed platform will be the patient/end-user, who will take advantage of the proposed services (remote monitoring, assisted-living, remote support by clinicians) to overcome her/his social exclusion and /or clinical risk. This will allow improving the subject's quality of life and independence in both a domestic or outdoor environment, with also a positive impact on costs for the social healthcare system. The proposed services include remote non-invasive monitoring of subjects, support for in-house rehabilitation and development of social network for patients support.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** National Research Council of Italy
Period of activity: 2014 - 2015
IREA project manager: Lorenzo Crocco
***Funds to IREA**: **ú** 6.000*

Evaluation of the occupational risk from exposures to electromagnetic fields employed in MRI systems

The project dealt with the evaluation of several aspects concerning the exposure of workers to magnetic fields employed for MRI, with particular attention to static magnetic fields. The experimental activity concerned both the evaluation of biological effects induced by in vitro exposures and the monitoring of magnetic induction levels in working places. In particular, for the in vitro experiments, human fibroblasts were used as a cell model, and different exposure duration and conditions were investigated for the evaluation of the effects in terms of several parameters critical for cell function and carcinogenesis process. Moreover, a measurement campaign was carried out for monitoring the levels of magnetic induction in several hospitals of the Campania Region.

Funding body: Italian Workers Compensation Authority (INAIL)
***Prime contractor*:** **IREA**
Period of activity: 2012 - 2015
IREA project manager: Maria Rosaria Scarfì
Funds to IREA: ú 150.000

Generation of pre-operational products aimed at evaluating Earth's surface deformation via the use of advanced synthetic aperture radar processing methodologies

The activities were conducted within the agreement between the Department of Civil Protection (DPC) and IREA, which acted as a Center of Competence for DPC on DInSAR data. In particular, IREA operatively monitored via DInSAR data the Campi Flegrei Caldera through COSMO-SkyMed SAR data and generated in defined time the displacement field induced by main seismic events at national level. Moreover, IREA develop d advanced algorithms to process SAR data acquired by the recently launched Sentinel-1 satellite. Finally, IREA used 3D tomographic SAR techniques to improve the definition of building and infrastructure models in areas subject to seismic hazard.

Funding body: Civil Protection Department (DCP)
***Prime contractor*:** **IREA**
Period of activity: 2014
IREA project manager: Francesco Casu
Funds to IREA: ú 170.000

GEOSAT - Geological Application of Satellite Technologies

GEOSAT was a research project aimed at the definition of main technical features for designing a satellite sensor, optimal for oil exploration. In this context, IREA was in charge to investigate aerial and satellite hyperspectral-sensing techniques for the retrieval of geo-lithotypes and their mapping. The project involved also the collection and archiving of in situ data together with the development of specific image classification algorithms. Main research topics were the creation of a spectral database of geo-lithotypes from in situ spectral measurements; a geo-lithological mapping of optical hyperspectral imagery, either airborne and spaceborne; the evaluation of technological and theoretical constraints for the feasibility of lithotypes remote mapping, considering also the fusion with active remote sensing techniques (radar and lidar).

Funding body: ENI S.p.A.
Prime contractor: **IREA**
Period of activity: 2010 - 2013
IREA project manager: Monica Pepe
Funds to IREA: € 267.157

Geothermal Atlas - Characterization, classification, and mapping of geothermal conventional and non-conventional resources

The Geothermal Atlas aimd to verify, locate and generate an updated atlas of geothermal resources usable for the production of geothermal energy in the Southern Italian Regions through the use of methodologies already available and under development. The project was one of the six projects for innovation and development of Southern Italy coordinated by the National Research Council and funded by the Law of stability 2010. IREA activity concerned the generation of deformation time series from SAR data sequences in the coastal areas of geothermal interest and the generation of maps on a regional and local scale of the surface thermal state variability, due to the geothermal potential, derived from optical satellite remote sensing data with particular reference to thermal IR bands.

Funding body: Ministry of Education, University and Research (MIUR)
Prime contractor: National Research Council of Italy
Period of activity: 2011 - 2014
IREA project managers: Mariarosaria Manzo, Pietro Tizzani
Funds to IREA: € 77.000

HABITAT - HArBour trafflc opTimizAtion sysTem

The aim of the project was the research, development, prototyping, testing and validation of an integrated system of "all vessels, all weather, all day" type, mainly concerning the port, for the control and support of maritime navigation in the last nautical mile. This system is able to: provide a real-time and accurate traffic situation in the last nautical mile for all types of ships and boats ("all vessel"), including also those not equipped with sensors/cooperating systems for all weather conditions ("all weather"), 24/24 hours ("all day"), not only with simple plot, but with advanced graphics in dynamic viewing of the plan of the ships/boats themselves; provide to all the ships and boats sailing in the last nautical mile a real-time navigation supporting system, which can improve the precision, speed and safety of rigging and docking; interoperate with existing systems (existing and/or developing) of the public administration; provide an advanced simulation system for the exercise and training of pilots and all operators involved in the port traffic control.

Funding body: Ministry of Education, University and Research (MIUR), PON industrial research projects
Prime contractor: VITROCISET S.p.A.
Period of activity: 2011 - 2014
IREA project managers: Francesco Soldovieri, Gianfranco Fornaro
Funds to IREA: € 444.605

Projects

I-AMICA - High Technological Infrastructure for Climate and Environment Monitoring

The project aimed to perform interventions for the adaptation and strengthening of infrastructures in the regions of Southern Italy in order to promote and develop facilities and equipment, such as integrated platforms, sensors, instrumentation, mobile stations for environmental detection, etc., useful for the monitoring of climate and environment in the Mediterranean region and in other sensitive areas of Earth. IREA activities within the project were related to 1) the strengthening of the processing and storage system of remotely sensed data to perform advanced analysis in various scenarios of environmental interest (monitoring of bio-geophysical parameters, mapping of deformation phenomena in coastal areas , study of marine currents), and 2) the strengthening of optical, optoelectronics and electromagnetic sensors for monitoring climatic and environmental parameters (temperature and albedo of surfaces, deformations, water content in the subsoil and in vegetation, determination of the stratigraphy and characterization of subsurface, characterization of particles suspended and dissolved in water).

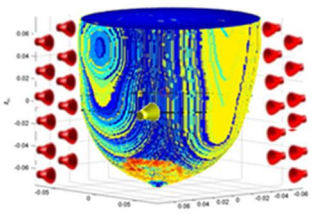
Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** National Research Council of Italy
Period of activity: 2012 - 2015
IREA project manager: Mariarosaria Manzo
Funds to IREA: ú 1.191.000

MathTech - Mathematics for better society and technological innovation

The project was based on the exploitation of mathematical methods in some of the main lines of action of the Horizon2020 program, which are also relevant for applied research at Italian level. The key element was the transversal nature of mathematical and quantitative approaches, which allowed them to be applied in several different fields. In particular, the attention was devoted to four topics: health&well-being, smart transportations, climate and factories of the future. For all these sectors, mathematical techniques and methodologies had a crucial and unifying role as the basic tool to introduce (product and process) innovations as well as for the optimization of activities. In addition, the project allowed a closer cooperation between CNR researchers and University researchers associated with INDAM, thus creating a high-level trans-institutional network.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** CNR- Institute for applied mathematics "Mauro Picone" (IAC), CNR - Istituto Nazionale di Alta Matematica (INdAM)
Period of activity: 2014 - 2015
IREA project manager: Lorenzo Crocco
Funds to IREA: ú 6.386

MERIT - MEdical Research in ITaly



In the frame of MERIT program, IREA was involved in the task "Development of methods for the extraction and integration of diagnostic information aimed at defining personalized therapeutic clinical pathways in diseases with high social impact". Within this project, the specific task of the IREA research unit, which had professor Ovidio Mario Bucci as the scientific coordinator, was to investigate the feasibility of an innovative technique for the diagnosis of breast cancer, complementary to those currently in use, which could provide a non-invasive reliable (reduction of false positive/negative) and efficient (time reduction of examination and processing) diagnosis. This technique is based on microwave imaging enhanced by magnetic nanoparticles as a contrast agent.

Funding body: Ministry of Education, University and Research (MIUR)
***Prime contractor*:** CNR - Institute of Biostructure and Bioimaging (IBB)
Period of activity: 2011 - 2014
IREA project managers: Ovidio Mario Bucci, Lorenzo Crocco
Funds to IREA: ú 138.600

Multidisciplinary study on the preparatory phases of an earthquake

The project goal was the study of a series of countermeasures, to be put to use in a case of emergency due to a big earthquake, through the preliminary study of physical mechanisms that are active during its preparatory phase. To achieve this task the most advanced technologies available for the monitoring of geophysical signals were adopted also by potentially developing alternative and innovative solutions. In this context, IREA group was involved in an activity concerning the generation of surface displacement maps and time-series of deformation at C- and X-band, as well as the subsequent modeling of involved stress sources, by profitably taking into account information coming from a GPS network and a series of Corner Reflectors located in the near proximity of the Alta Tiberina Fault (ATF), Umbria region, Italy.

Funding body: Ministry of Education, University and Research (MIUR)
Prime contractor: National Institute of Geophysics and Volcanology (INGV)
Period of activity: 2013 - 2015
IREA project manager: Antonio Pepe
Funds to IREA: ú 150.000

SAR data processing of Alpine regions

The project focused on ground deformations monitoring through the use of satellite RADAR data. It intended to foster the use of advanced services based on remote sensing and, in particular, on the most advanced SAR systems, such as the Italian constellation Cosmo-SkyMed. The activities aimed at designing and developing a monitoring methodology shared between institutional and private end users, and at increasing in Alto Adige region the know-how and the expertise relevant to the remote sensing monitoring techniques. The activities were defined to foster the systematic monitoring of areas affected by landslides phenomena, in order to investigate and understand the current hazard conditions and establish an effective planning of the territory suitable to mitigate and prevent the risk conditions.

Funding body: EURAC
Prime contractor: **IREA**
Period of activity: 2014 - 2015
IREA project manager: Michele Manunta
Funds to IREA: ú 12.200

SAR4Volcanoes - Use of interferometric techniques for studying ground deformation in volcanic areas

The project, funded by the Italian Space Agency (ASI) in the framework of a cooperation with the Japanese Space Agency (JAXA), concerned the joint use of X-band and L-band Synthetic Aperture Radar (SAR) data for measuring ground deformation in volcanic areas, also in support of the geophysical modeling of the magmatic sources.

Funding body: Italian Space Agency (ASI)
Prime contractor: **IREA**
Period of activity: 2011 - 2013
IREA project manager: Eugenio Sansosti
Funds to IREA: ú 108.087

S1 - Improving the knowledge of Seismic potential of Padana Plain

This project aimed at improving the ability to estimate the tectonic deformation in the Padana Plain in Italy by integrated the use of GPS and InSAR techniques. In particular, the spatial coverage characteristics of InSAR measurements allowed separating areas affected by natural or anthropic subsidence. By using an appropriate modeling of the horizontal component associated with the subsidence, the horizontal tectonic deformation field was corrected for the high-frequency components. This allowed us to improve our knowledge on the strain accumulation in the Padana Plain, thus improving its seismogenic potential estimation ability.

Funding body: Italian Civil Protection Department (DCP)
Prime contractor: National Institute of Geophysics and Volcanology- INGV, Roma
Period of activity: 2012 - 2013
IREA project manager: Paolo Berardino
Funds to IREA: ú 12.500

Projects

Ultra-Sensitive Flow-Through Optofluidic MicroResonators for Biosensing Applications

The objective of this project was the development of three ultra-sensitive "flow-through" optofluidic microresonators, namely optofluidic photonic crystal microresonator, optofluidic microbubble resonator, and optofluidic ring resonator, based on different operation principles and on different fabrication technologies. The assessment of the microresonators was evaluated by the optical the detection of specific sepsis biomarkers, such as procalcitonin and neopterin, with high sensitivity and low limit of detection, thus breaking a new ground in the biosensors and Lab-on-Chip fields and, in turn, healthcare and point-of-care applications. The main objective of the IREA research unit in the framework of this project was the design, simulation, fabrication and characterization of the optofluidic ring resonator (ORR). The flow-through ORR consists of an optofluidic ring resonator based on a hybrid-silicon polymer liquid core Antiresonant Reflecting Optical Waveguides (H-ARROW). The H-ARROW is composed of two integrated part: a silicon integrated part that comprises the waveguideiquid core for delivering the liquid sample, and a polymer-based part for the realization of the fluidic inlet and outlet. The liquid core waveguides allowed the same channel to be used both for guiding light and, at the same time, for delivering the sample under analysis, which resulted in a strong liquid-light interaction suitable for high sensitivity sensing application.

Funding body: Ministry of Education, University and Research (MIUR)
Prime contractor: University of Pisa
Period of activity: 2013 - 2015
IREA project manager: Genni Testa
Funds to IREA: ú 206.322

VIGOR - Evaluation of the geothermal potential of Convergence Regions

VIGOR project had the aim to improve the application of geothermal wells as the energy resource, comprising the use of high temperature as a source of electricity and of low/medium temperature for heat generation. One of the purposes of the project was to collect specific scientific information about geothermal sites of interest in order to promote low-temperature applications of this energy source, without compromising environmental health and safety. In the framework of this project, the researchers of IREA had the objective to support the study of geothermal sites by means of remote sensing techniques. In particular, a distributed fiber optic sensor was supplied by IREA to experience temperature monitoring of geothermal wells.

Funding body: Ministry of Economic Development
Prime contractor: National Research Council of Italy
Period of activity: 2010 -2014
IREA project manager: Romeo Bernini
Funds to IREA: ú 234.000

WEEE Reflex: Highly Evolvable E-waste Recycling Technologies and Systems

The project was part of the Flagship Project “Factory of the Future”, a research program coordinated by the Italian National Research Council, that aimed at creating a long-lasting national community characterized by scientific excellence of research and able to outline the future directions of innovation within the Italian manufacturing sector. Waste from Electric and Electronic Equipment (WEEE) is the fastest growing waste stream in EU, with 5% increase per year. The WEEE flows are in continuous evolution as new products and materials are entering the WEEE streams, making the disposal particular difficult. The WEEE ReFlex project developed the technological solutions to address the system co-evolution problem at recycling system level. In particular, the project integrated and demonstrated in-line WEEE characterization hyperspectral technologies and new reconfigurable particles’ routing modules supported by integrated process and system models for profitably driving the recycling system evolution.

Funding body: Ministry of Education, University and Research (MIUR) - Flagship Project ñFactory of the Futureò
Prime contractor: CNR ï Institute of Industrial Technologies and Automation
Period of activity: 2014
IREA project manager: Monica Pepe
Funds to IREA: ú 31.320

Regional projects

CARE-G: A Service platform for health and life quality care of senior citizens

The objective of the CARE-G project was creating a platform of services for the care of both the health and the quality of life of elderly people. This platform was conceived as a Web-based infrastructure for accessing both spatial data of interest, such as locations of hospitals, pharmacies, recreative sites to ease the life of elderly people, and programs information relating to a lifestyle appropriate for the elderly people, such as information on specific diets and neurophysiology tests. The platform was designed to satisfy the following constrains: a) to be low cost, b) a wide dissemination and transferability, c) a quality assessment for its utility in helping the senior citizen and their caregivers to adopt proactive behaviors with respect to their health and social practices. This last constraint was also the main social objective of the project whose ambition was to promote and encourage attitudes and lifestyles such as to limit the need of interventions by public or private health and social operators. Through the platform it is also possible to collect and manage socio-environmental and health information about the individual elderly citizens, possibly by means of their monitoring through personal wearable detectors devoted to collect clinical and physical parameters, digital health records for neurocognitive parameters, behavioural responses to physical exercises, systems of analysis of personalized clinical risks, which include management systems of care plans and clinical programs of lifestyle. These data were integrated, interpreted and geolocalized on the Lombardy territory in order to map the socio-sanitary and environmental community of elderly citizens; in this way it was provided to administrators the basic knowledge to address the choices towards the planning of architectural structures best suited to the socio-sanitary and urban community of elderly citizens.

Funding body: Regione Lombardia - CNR
Prime contractor: CNR - Institute of Molecular Bioimaging and Physiology
Period of activity: 2013 - 2015
IREA project manager: Anna Rampini
Funds to IREA: ú 62.538

FIDEAS - Intelligent Factory for Advanced and Sustainable De-manufacturing

Mechatronics and electronics products End-Of-Life currently constitutes a very complex process which is responsible for serious environmental impacts. Furthermore, as it is currently configured, it does not allow to benefit from the economic opportunities related to the residual value of components and materials that are disposed of. This project aimed at conceiving and building enabling technologies and business models for demanufacturing factories, that should be considered as a constitutive element of the manufacturing system in the frame of a new integrated manufacturing-demanufacturing paradigm. Demanufacturing factories will intelligently and automatically implement optimal End-Of-Life strategies (products remanufacturing, components re-use and materials recycling under a “zero waste” approach), based on the products to be treated and on their conditions.

Funding body: Regione Lombardia ï CNR
Prime contractor: **IREA**
Period of activity: 2013 - 2015
IREA project manager: Monica Pepe
Funds to IREA: ú 78.750

Mapping and Biometric monitoring pre and post intervention of rushes of Brescia and Verona on Lake Garda

The project planned existing rushes mapping in a sub-coast of Lake Garda (Province of Brescia, Italy) through the use of remote sensing and/or airborne images. The final aim was to compile a complete rushes census, with a gathering of health condition estimates through field radiometric and biometric

measurements. Field measurements interpretation allowed to give guidelines for the area management and to assess management intervention quality.

Funding body: Provincia di Brescia
Prime contractor: **IREA**
Period of activity: 2012 - 2014
IREA project manager: Mariano Bresciani
Funds to IREA: ú 18.300

Se@ME - Sustainable e-marittime @ssistance for Maritime Employees, Passengers and Yachtsmen

The project was motivated by the need/opportunity to design and develop a research, development and industrialization plan of the knowledge technologies suitable for the sea, by promoting the cooperation between the national maritime industry and the research system.

Funding body: Regione Campania, CAMPUS annuncement for Industrial Research and Experimental Development Projects
Prime contractor: Industria Armamento Meridionale SPA (INARME)
Period of activity: 2012 - 2015
IREA project manager: Francesco Soldovieri
Funds to IREA: ú 311.237

SINOPIAE - System-prototype for multi-source Integrative Observation techniques of multispectral satellite, aircraft and ground data for multi-scale monitoring of the variations of environmental indicators related to Atmospheric constituents and Energy dispersion

The project goal was the realization of a prototype system for Lombardy department for the multi-scale monitoring of environmental parameters, as atmospheric constituents concentration at the surface (gas and aerosol) in urban and not urban areas, natural and anthropogenic aerosol components, thermal dispersion in urban areas, direct climatic effects of natural and anthropogenic (direct forcing) aerosols. The system will help to understand meteo-climatic processes at a regional scale forced by anthropogenic activities. This purpose will be reached through the realization of modules responsible for the assessment of the effects of air pollution (gas and aerosol) on regional scale and on barely populated regions such as lakes and glaciers; for the evaluation of thermal dispersion on urban scale, of direct effects of aerosol on radiation equilibrium of the surface-atmosphere system at the regional scale and the interaction of emission scenarios of air and energy pollutants in the urban environment; through the integration of multi-source observations from sensors at the ground, on aircraft and satellite and through the use of models that consider the meteorology, the transport, the dispersion and the chemistry of pollutants and their interaction with the radiation aspects.

Funding body: Regione Lombardia
Prime contractor: CGS Compagnia Generale per lo Spazio
Period of activity: 2013 - 2014
IREA project manager: Anna Rampini
Funds to IREA: ú 140.087

Targets, probes and signals in therapy and diagnosis

The project, developed in strict collaboration with IGEA S.p.A. (Carpi, MO), dealt with the set up of electroporation protocols, equivalent to those used for electrochemotherapy (ECT), for the intracellular delivery of molecules. Moreover, the impact of electroporation and anti-tumor drugs on drug-resistant cancer cell lines was also evaluated. The project aimed also to investigate the association

of electroporation with recently developed chemotherapy drugs since the actual knowledge on the use of chemotherapy drugs is referred to very old studies (1992).

Funding body: Regione Campania
***Prime contractor*:** National Research Council of Italy
Period of activity: 2013 - 2015
IREA project manager: Maria Rosaria Scarfì

SPACE4AGRI: remote sensing technologies and web 2.0 for the agricultural sector in Lombardy

Crop monitoring is one of the major activities of IREA where researchers have been studying the agricultural sector for years with also a strong interest in agricultural monitoring in developing countries. Research focuses on the assessment of crop status and health, on crop yield estimation and forecast and on the detection of critical and anomalous crop conditions with the aim of supporting agricultural management. The topic is of great interest worldwide and in Europe, in particular, where resources are also allocated relying on aerospace technologies for Earth Observation (EO). Agriculture is a topic of interest also at the national and regional levels since Lombardy is the primarily agricultural region in Italy and ranks amongst the first in Europe. In this context, IREA was the coordinator of a research project named "Space4Agri- satellite technologies and web 2.0 for supporting the agricultural sector in Lombardy" funded by Regione Lombardia within the Framework Agreement between Regione Lombardia and CNR. The purpose of Space4Agri was to take advantage of Earth Observation technologies (space, aero and in situ) to improve agricultural monitoring, planning, and management by the public and private sectors. The major objective was to integrate in an innovative way the advancements in three sectors: earth observation mainly with satellite sensors, the frontier technologies of aeronautic such as Unmanned Airmobile Vehicles (UAV), and the availability of sensor observations and smart technologies for in situ data collection, in order to meet the demand of consistent and updated information from the agricultural sector in Lombardy. The methodologies proposed in the Space4Agri project were tested on a study area which is naturally identified as the river Po plain region in Lombardy. In this area are located 54.333 farms which represent about 3.3% of the national total but cover an area of about 986 853 hectares (Used Agricultural Surface, SAU-Superficie Agricola Utilizzata), about 7.7% of the land surface devoted to agriculture in Italy.

Funding body: Regione Lombardia ï CNR
Prime contractor: **IREA**
Period of activity: 2013 - 2015
IREA project manager: Pietro Alessandro Brivio
***Funds to IREA*:** ú 351.000

TEMASAV - Technologies and Environmental Monitoring for Sustainability of Large Areas

The project involved the development and transfer of new technologies to companies in the field of environmental and territorial protection and for the sustainability of cities and territories. The project operated at two different scales: in wide areas for the sustainability of human intervention and for the protection, and conservation of resources and at urban scale with reference to the built structures.

Funding body: Regione Campania
Prime contractor: University di Napoli "Federico II"
Period of activity: 2011 - 2015
IREA project manager: Gianfranco Fornaro
Funds to IREA: ú 53.550

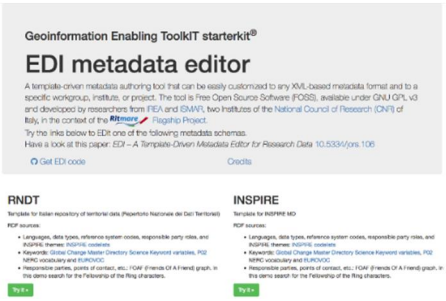
VGI4EO - Volunteer Geographic Information (VGI) to support Earth Observation (EO)

In recent years, with the spread of Internet and mobile devices connected to it, it has been established a new practice in the conduct of research projects known as "Citizen Science" (CS), which appeals to the active participation of citizens or specific communities for the creation of information contents, many of them with geographic content (Volunteer Geographic Information or VGI). The Earth Observation via Remote Sensing techniques can derive particular benefit from VGI as an immense and distributed source of 'truth' on the ground, which allows improving the accuracy of the monitoring through a more effective data calibration and the development of more efficient algorithms. This project was related to the use of VGI to support Remote Sensing applications for land monitoring. In particular, the following issues were developed and discussed: identification of communities that could help provide voluntary information in support of the data from RS; issues related to the quality, access and processing of the voluntary data; identification of pilot applications for the integration and testing of VGI and data from RS to improve the monitoring of the territory and the environment. Particular attention was paid to the existing Citizens' Observatories and to crowdsourcing practices to support research in the field of remote sensing and the development of related downstream services - Copernicus.

Funding body: Regione Lombardia ï POR
Prime contractor: **IREA**
Period of activity: 2015
IREA project manager: Alba L'Astorina
Funds to IREA: ú 12.500

15 December 2016

EDI Metadata Editor: a software for the management of spatial data



The National Directory of Territorial Data has reported EDI software as a new tool for all Public Administrations committed to enhancing their territorial data heritage. EDI, developed by IREA-CNR under the RITMARE project, responds in particular to the challenges of quality and coherence of geographic information by giving a variety of modules that guide users to creating metadata in a simple and effective way. EDI editor is currently available online and allows a standard compilation according to Italian law (RNDT), but also complying with European and international specifications (INSPIRE and SensorML), thus meeting the needs of different users. Groups, projects or research institutes, but also technicians working in Public Administrations, can take advantage from the product by benefiting from some features that make data management less burdensome. The software, licensed under Free Open Source (FOSS) GNU GPL v3, is fully customizable. Aspects that were recognized by EDI in the RNDT portal, today a public register of national territorial information certified and available precisely thanks to its metadata.

14 December 2016

Gianfranco Fornaro elevated to IEEE Fellow

Gianfranco Fornaro, Senior Researcher at IREA, has been elevated to Fellow by IEEE for his for contributions to SAR processing in differential interferometry and tomography. The Fellow grade will be effective by 1 January 2017. IEEE, “the Institute of Electrical and Electronics Engineers”, is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. IEEE has more than 420,000 members in over 160 countries and publishes a third of the world’s technical literature in electrical engineering, computer science, and electronics. The prestigious elevation to the highest grade of membership in the IEEE is reserved, following a rigorous evaluation procedure, to IEEE members that have contributed through extraordinary accomplishments to the advancement or application of engineering, science, and technology, bringing the realization of significant value to society.

Read 814 times

21 November 2016

A European Geosciences Union Medal to Riccardo Lanari

Riccardo Lanari, director of IREA, has been announced as the recipient of the 2017 Christiaan Huygens Medal, one of the prizes that the European Geosciences Union (EGU) awards each year to eminent scientists for their outstanding research contribution to the Earth, planetary and space sciences. In particular, the Christiaan Huygens Medal rewards innovations, discoveries, or relevant contributions that have led to significant progress in the area of "Geosciences Instrumentation and Data Systems".

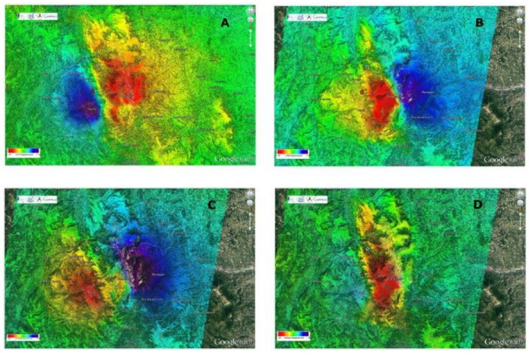
Read 744 times

The number of readings was assessed at 06/10/2017

News

2 November 2016

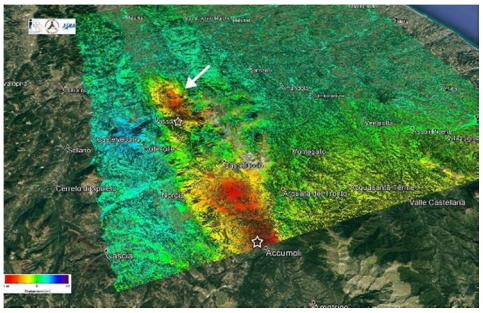
New results on the 30 October 2016 earthquake retrieved from the Sentinel-1 satellite radar data



The study of ground deformation and seismic sources, now focused on the 30 October 2016 earthquake, is enriched with new important results obtained from the processing of radar images collected from the Sentinel-1 constellation along ascending and descending orbits. Thanks to the new radar images, acquired on 1 November 2016 from ascending and descending orbits by the (C-band) sensors of the Sentinel-1 constellation of the Copernicus European Programme, the processing performed by CNR-IREA by using the differential radar interferometry technique has now revealed the surface deformation related to the earthquake, in all its extension (about 1100 square kilometers) and complexity. In particular, by combining the deformation maps obtained by the Sentinel-1 ascending and descending acquisitions (Figure 1A and Figure 1B, respectively) it is possible to estimate both the vertical and east-west displacement components. Two large horizontal deformation lobes are clearly visible (see Figure 1C): the first is centered approximately in the Montegallo zone and exhibits an eastward movement (with a maximum deformation of about 40 cm), the latter is centered in the area of Norcia with westward deformation (with a maximum displacement of about 30 cm). It is also evident a significant vertical deformation (Figure 1D) with a strong subsidence pattern of mote than 60 cm in the area of Castelluccio (already retrieved from previous analysis of Sentinel-1 data), and an uplift of about 12 cm in correspondence to the area of Norcia. It is worth noting that the deformation pattern related to the area of Norcia was already partially retrieved through the analysis carried out by jointly using the first Sentinel-1 data and those provided by the COSMO-SkyMed constellation (X-band) developed by the Italian Space Agency in cooperation with the Italian Ministry of Defense. Finally, it is pointed out that, due to the considerable amount of the occurred deformation, it is reasonable to assume that the detected displacements are underestimated up to 30%. However, these effects will be corrected thanks to the exploitation of new already planned images that will be acquired in the next coming days, especially those collected by the radar sensor (L-band) onboard the Japanese satellite ALOS 2.

29 October 2016

The earthquake of October 26 from satellite acquisitions

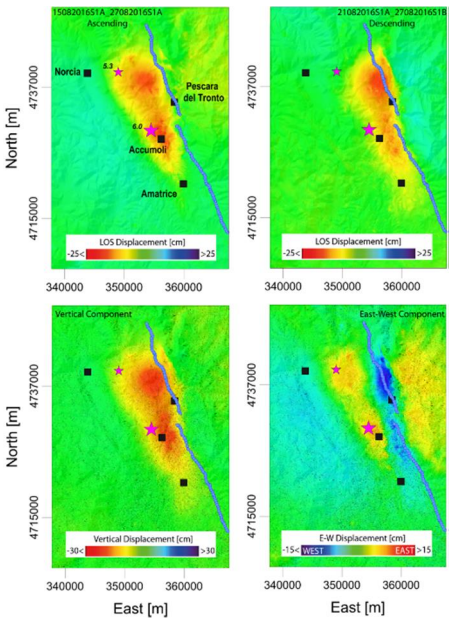


The study of the Earth's deformations and seismic sources continues, focusing on the events of October 26. The activity is coordinated by the Department of Civil Protection (DPC) and is carried out by a team of researchers from the Institute for Electromagnetic Sensing of the Environment of the National Research Council (CNR-IREA of Naples) and the National Institute of Geophysics and Vulcanology (INGV), centers of competence in satellite radar data processing and seismology, respectively, with the support of the Italian Space Agency (ASI). "Using the data from the Japanese satellite ALOS 2, the team of CNR-IREA and INGV researchers measured also on this occasion and with high precision, the permanent ground movements originated during the earthquake by using differential interferometry," explains the director of CNR-IREA, Riccardo Lanari. "In this case, the bandwidth used (L band) from the radar operating on board the ALOS 2 satellite allowed us to detect the ground deformations despite the affected area was particularly covered by vegetation. These deformations occur about 8 kilometers further north than those caused by Amatrice's earthquake on August 24, and characterize an area that extends about 20 km northward and have a maximum subsidence of about 18 cm (corresponding to 22 centimeters away, compared to the radar line of sight) at the Vallestretta area". "Ground movements, along with other geological and seismological data, are undergoing analysis to elaborate physical-mathematical models through which it will be possible to identify the fault responsible for the earthquake and to characterize its profound activity. The first results

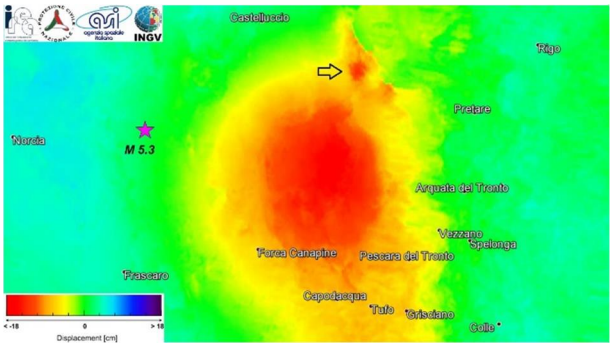
seem to indicate that the fault activated on October 26 is part of the same geological structure that caused the previous earthquake of Amatrice. The fault plane, therefore, is inclined to the west about 50 °, lies between 10 and 3 kilometers in depth and does not reach the surface," explains Stefano Salvi of INGV. "Starting from the Colfiorito sequence in 1997, radar satellite data have been used many times in Italy to detect seismic and volcanic sources, thanks also to the techniques developed by CNR-IREA researchers who are now at the international forefront." The purpose of the Civil Protection Department, during a seismic emergency, is to quickly obtain a picture of the ground deformations and displacements caused by the earthquake in the epicenter area. The CNR-IREA and INGV Competence Centers, thanks to their specific skills, support the Department in the use of satellite data and information and their integration with in situ data. This collaboration enables the development of products, methods, and procedures that improve the national emergency response system and are available to the entire National Civil Protection Service.

30 August 2016

New results on the Amatrice earthquake of August 24, 2016, obtained from Sentinel-1 and COSMO-SKyMed satellites radars



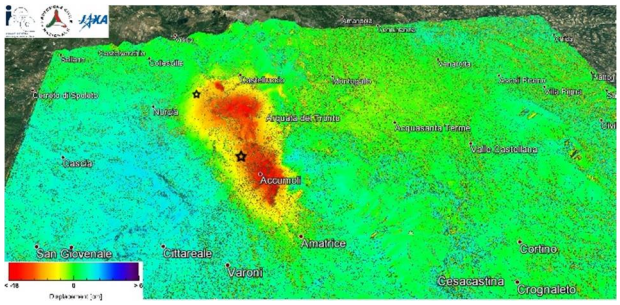
The study of the ground deformations and seismic sources related to the events of 24 August 2016 is going on. After the first products obtained by using the radar data of the Japanese satellite ALOS 2, the analysis has also been enriched by the results of radar image processing obtained most recently by sensors (operating in C-band) of the Sentinel-1 constellation of the European Copernicus program and those (operating in X-band) of the Italian constellation COSMO-SkyMed developed by the Italian Space Agency in co-operation with the Ministry of Defense. In particular, applying the Differential SAR Interferometry technique to the joint use of Sentinel-1A and Sentinel-1B images acquired by ascending (South-North) and descending (North-South) orbits, it was possible to estimate the ground displacements along the two lines of sight of the radars, and from these, to extract the vertical and east-west components of deformations (Figure 1). The obtained results confirm the ground subsidence with the characteristic shape of a "spoon" that extends for about 20 km northwards, already observed from the analysis of ALOS 2 data, with a deformation of about 20 cm located at the area of Accumoli. Note also that the East-West component concerns an area larger than the vertical one (about 20 x 25 km^2) and is characterized by the presence of four alternating displacement areas (blue towards the west and red toward the east, as shown in Figure 1), with maximum deformation values of about 16 cm westward. In addition to Sentinel-1 data, CNR and INGV researchers benefited from the radar acquisitions of the Italian constellation COSMO-SkyMed X-band sensors. It is emphasized that, thanks to the high spatial resolutions of this system, it is possible to obtain information on the ground deformation pattern with a great spatial detail. In this regard, Figure 2 shows the map of co-seismic deformation, generated from radar data acquired on descending orbits on 20/08/2016 (pre-event) and 28/08/2016 (post-event), relating to the zone stretching from Tufo and Pescara del Tronto to the area of Castelluccio. Note that the best spatial resolution also allows identifying localized deformation effects (landslides, reactivated faults) such as, for example, the ground displacement (identified by the arrow in Figure 2) relating to an area extending approximately 800 x 600 m on the side of Mount Vettore, probably linked to a slope instability. The information obtained is particularly relevant for the analysis of geological and geophysical processes underway and for the study of the fault behaviour through the development of advanced physical-mathematical models.



News

26 August 2016

Satellite sensing helps to identify the faults of the Amatrice earthquake of 24/08/2016



By exploiting the data of the Japanese satellite ALOS 2, obtained through scientific projects, a team of CNR and INGV researchers (coordinated by Riccardo Lanari, director of CNR-IREA, and by Stefano Salvi, technologist manager of INGV), measured with high precision the permanent ground displacements occurred during the earthquake, using the Differential Interferometry technique. This technique allows detecting deformations of the ground surface with centimeter accuracy by comparing radar images acquired before the event with those after the earthquake. In particular, a ground subsidence with the shape of a "spoon" has been pointed out, which extends for about 20 km northwards and has a maximum value of about 20 centimeters at the Accumoli area. The ground displacement map was then used to develop the physical-mathematical models of the fault that originated the earthquake. Faults can be visualized as fracture planes along which two blocks of the Earth's crust are sliding: when the movement is very rapid an earthquake is generated. The fault that originated the Amatrice earthquake lies a few miles deep in the area between Amatrice and Norcia, under Accumuli. It is a 25 km long fracture plan that drifts southwest (towards Rieti) with a tilt of 50 °. This plan corresponds to a fault already known by surface geological studies. A detailed knowledge of the location and characteristics of seismic sources is a key element for emergency management and is also important for the development of more reliable seismic hazard maps.

4 July 2016

The "LTER Terramare walk" halts at the Experimental Station Eugenio Zilioli

On 1 July 2016, the CNR Experimental Station Eugenio Zilioli hosted the LTER Terramare Walk. Through six stages traveled mostly by bike, "Terramare - The story of the change in forests, lakes and sea" will cross three regions of northern Italy (Lombardy, Trentino Alto Adige and Veneto), within rivers, lakes, forests, meadows, hills, wetlands to arrive in Venice, where land and sea are perpetually seeking harmony. The journey, departed from the LTER site of Bosco Fontana on July 1, ended in Venice on July 6, winding through the northern ecosystems of Lake Garda and Tovel Lake, crossing the Valsugana and then reaching the lagoon of Venice and the North Adriatic. During the stage of July 1st, Mariano Bresciani, Ilaria Cazzaniga, and Claudia Giardino of CNR-IREA, accompanied the participants in the visit of the Experimental Station Eugenio Zilioli, which has been part of the LTER network since 2011.

5 May 2016

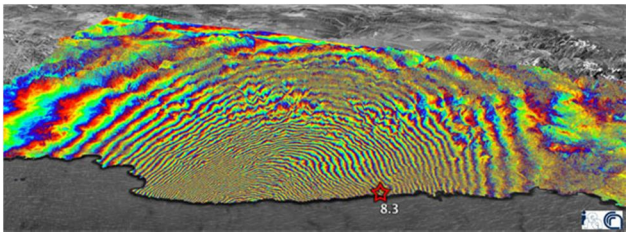
In the archaeological site of Pompeii the school "Geophysics and Remote Sensing for Archaeology"

In the fascinating setting of Pompeii archaeological area, the school "Geophysics and Remote Sensing for Archaeology" will be held from 9 to 13 May 2016. The course is organised by two Institutes of the National Research Council (CNR) of Italy, i.e. CNR-IBAM and CNR-IREA, and the *Soprintendenza Speciale Beni Archeologici Pompei, Ercolano e Stabia*. The School aims at giving the opportunity to scholars, Ph.D. students, researchers and specialists in Geophysics, Remote Sensing and Archaeology, to deepen their knowledge and expertise with geophysical and remote sensing techniques for archaeology and cultural heritage documentation and management. The school consists of lectures and on-field practical work.

Read 3109 times

3 May 2016

An innovative system for the automatic processing of SAR data



The European satellite Sentinel-1, which operates under the European Copernicus Environmental Monitoring Program, is a powerful system for measuring the deformation of the Earth's surface through the Synthetic Aperture Radar Interferometry technique (InSAR) thanks, in particular, to its acquisition capabilities at global scale as well as the open and free data access policy. However, raw data acquired by the satellite requires specific processing algorithms to be transformed into information products directly accessible to an user, and this may discourage those who are unfamiliar with InSAR techniques. In this regard, IREA has developed a tool that, through a user-friendly web interface, allows users to generate interferograms automatically. Thanks to this service, users can select SAR images from the Sentinel-1 data store, set up some processing parameters, and automatically process the images to get the corresponding interferogram. This will enable a wider use of Sentinel-1 SAR data, extend research on interferometric techniques and make it easier to generate accurate InSAR measurements. IREA developed this web tool under the Geohazards TEP (Geohazards Thematic Exploitation Platform) project of the European Space Agency (ESA), which aims to implement a computing platform for the massive and automatic exploitation of Earth Observation Satellite Data. The web tool is available since April 2016 for scientific users belonging to the community that revolves around the Geo-hazard, as the first prototype within ESA's G-POD (Grid Processing On Demand) processing infrastructure. The prototype will become a pre-operational service by the beginning of 2017. The news has been also reported on the European Space Agency website.

29 Aprile 2016

Satisfaction for the results of the Space Apps Challenge 2016 in Naples

Great success and great enthusiasm for the second Neapolitan edition of the Space Apps Challenge, the big event promoted by NASA and organized in Naples by CNR-IREA, the Industrial Engineering Department of the University of Naples Federico II and the US Consulate General to Southern Italy, with the coordination of Chandrakanta Ojha, the young Indian researcher who studies and works at IREA and was the winner of the Space Apps 2013 edition in Rome. About 90, this year, were the competitors, 17 teams of students and science and technology enthusiasts who have been committing for 36 hours looking for innovative solutions to the challenges launched by NASA to meet global needs. First prize, selected by the local jury, was attributed to the team with the evocative name "A sfogliatella on Mars". The 5 boys proposed a solution to improve Martian exploration, designing a spider-like vehicle to speed up the movements on the Red Planet surface, taking into account its roughness, and to collect specimens in the event of a future colonization of Mars. The second place went to the "Space Kangaroos" with the "Martian Kangaroo" project, again a device conceived to help mobility on Mars. In addition to winning cash prizes, made available this year by the Consulate of the United States for South Italy, these two projects will compete for global competition. The People's Choice Award, voted by all the participants in the event, went to "Team Eight". Some components of this group had already participated in the previous Neapolitan edition of Space Apps, winning it. During the press conference for the official presentation of the event, held at the University Federico II premises in Via Nuova Agnano on Thursday 21 April, the US Consul General for South Italy, Colombia Barrosse, had defined the event "A great opportunity for young Neapolitan scholars". "The beauties of Naples - added the Consul Barrosse - are many and are all very famous, but they are not only those we see in the postcards. The young people of Naples and the South are among the excellence of Italy and Europe and we are certain that they will be able to demonstrate it also on this occasion. This initiative represents a road to prosperity and stability in the world. Science can act as a bridge between different countries".

News

7 Aprile 2016

NASA Space Apps Challenge 2016 in Napoli

Naples is once again among the 158 cities of the world in which the fifth International Space Apps Challenge, the big event promoted by NASA, which will take place on April 23 and 24 at the Faculty of Engineering in Via Nuova Agnano 11. Thanks to the organization supported by CNR-IREA, the Department of Industrial Engineering, University of Naples Federico II, and the US Consulate General for Southern Italy, many young people will have an opportunity to participate in an exciting global event and to propose their projects to one of the most prestigious institutions in the world such as NASA. The International Space Apps Challenge is an event in which teams of students, technologists, scientists, designers, entrepreneurs, or simply enthusiasts of science and technology, work together and collaborate for 48 hours in various cities in the world to design innovative solutions to global challenges on Earth and in space. The first Space Apps Challenge took place in 2012 among 25 cities around the world. Over the years, the event has involved a growing number of cities and participants. In 2015 it counted 13,918 participants in 133 cities globally, with 949 projects, and became the biggest hackathon ever made. For the first time, Napoli became part of this great event in 2015 and continues its active participation also for the current year. Registration has already been started and it is absolutely free and open to everyone. At the end of the event, on Sunday afternoon, April 24, two teams will be selected as local winners. In addition, one People's Choice will be announced on the Space Apps Event. Among all the local winners, NASA will select the global winners in each of the five finalist categories: Best Use of Data, Best Use of Hardware, Best Mission Concept, Galactic Impact and Most Inspirational.

Read 2000 volte

5 February 2016

Inaugurated in Naples the headquarters of the CNR Technology Center

Less than 4 years (compared to the expected 16 months) after the laying of the first stone, today the new headquarters of the National Technology Research Council of Naples has been inaugurated. The location will shortly host the Institute for Electromagnetic Sensing of the Environment (IREA) and the Combustion Research Institute (IRC), thus becoming a multidisciplinary research area on the issues of electromagnetic monitoring of the environment and the territory, and the reduction, control and abatement of pollutants produced by fossil fuels, biomass, biofuels and waste. The complex of about 10,000 sqm., distributed over three floors, is located in via Marconi. It will welcome more than 120 researchers, technicians and administrative staff, and will enable them to have more functional environments and equipment for research. "This site will be a reference point for the entire CNR," said President Luigi Nicolais. "Its realization is the result of a teamwork with the Interregional Authority for Public Works and the Municipality of Naples, thanks to which it was possible to tighten the times, usually long, tied to bureaucracy. This place - he added - is not only destined for research but it is itself the result of research and technological innovation." In fact, state-of-the-art systems were used for the construction of the structure, starting with the one for the construction of the floor slab that has reduced the construction time of 70% and a saving of material compared to traditional systems. In addition, with due regard to the environment and energy efficiency, heating systems have been installed that "alert" the presence of people. In fact, the internal temperature increases or decreases depending on whether the researchers enter or exit the rooms rooms. The Superintendent to Public Works, Vittorio Rapisarda Federico, emphasized in his speech the quality of the work realized, not only from an architectural and aesthetic point of view but also a technological one. "In addition to the application of the latest construction methods in the seismic area",

the Superintendent pointed out, "particular attention has been paid to efficiency and energy savings. The structure has ventilated facades, high tech thermal standing finish, and solar roof panels. The Technological Pole completion" - added the Superintendent - concludes a route that began in 2006, when the Convention between the CNR and the Authority for Public Works was signed". The complexity of the regulatory framework in the field of urban planning has taken six years for the laying of the first stone in July 2012.

22 January 2016

Mirco Boschetti presents ERMES's activities at the Museum of Science and Technology in Milan

The space is a privileged place to study vegetation, sea currents, water quality, natural resources, atmospheric pollutants, and greenhouse gases on a grand scale. Thanks to the integration of data sent from satellites to those locally collected on the ground, it is possible to improve the cultivation of agricultural land by optimizing the use of water and fertilizers, foresee crop size and to address development policies towards sustainable forestry practices.

Letto 4915 volte

30 December 2015

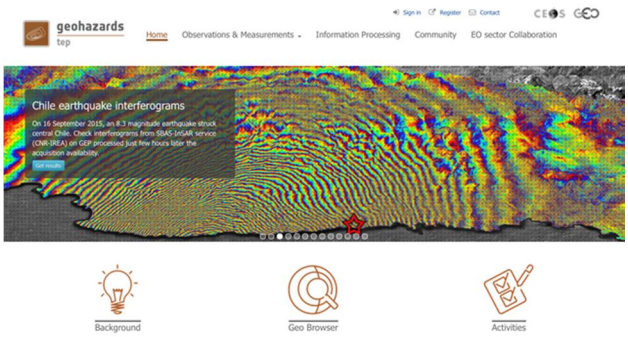
Continental scale mapping capabilities of Sentinel-1 sensor: the 12-days InSAR coherence over Europe

Sentinel-1 is the first satellite of the Copernicus program and is equipped with a Synthetic Aperture Radar (SAR) sensor that is able to provide day-night acquisitions nearly over the whole World. The Sentinel-1 operational mode on land is the so-called Interferometric Wide Swath (IWS). It guarantees the Earth's global coverage with a revisit time of 12 days, thus making Sentinel-1 as a powerful system for surface displacement monitoring at a global scale through the Interferometric SAR (InSAR) technique. In this context, scientists of IREA-CNR processed 380 Sentinel-1 imagery, acquired over Europe during the June-July 2015 period and coupled in 190 12-days interferometric pairs with 2 looks in azimuth and 10 in range, with the final aim to analyse the InSAR characteristics of the European Continent. Such a study permits to assess the Sentinel-1 InSAR performances as well as to have an idea of the expected InSAR measurements quality over the Europe. As a result, in Figure 1 the 12-days Interferometric Coherence map of almost the entire Europe is shown; note that white and black areas correspond to high (close to 1) and low (close to 0) coherence values, respectively. "This work demonstrates the high capabilities of the Sentinel-1 system for surface displacement detection at global scale", states Francesco Casu, a researcher at IREA-CNR, "and represents the first step towards the generation of continental scale Earth's surface deformation maps and time series".

Read 2158 times

11 December 2015

Training course on the SBAS-DInSAR web tool for Earth surface deformation analysis



In the frame of the next AGU 2015 Fall meeting, IREA-CNR organized a training event on "Training on the SBAS-DInSAR web tool for Earth surface deformation analysis through the ESA Geohazard Exploitation Platform". The event originates in the context of space-borne geodetic techniques, and will focus on Differential Synthetic Aperture Radar Interferometry (DInSAR), which has already demonstrated its capability to measure surface displacements in different conditions and scenarios.

In particular, the advanced DInSAR time series processing methods, as for instance the Small BAseline Subset (SBAS) that allows studying both the spatial and temporal variability of the surface displacements, have proven to be particularly suitable in different contexts, as for natural hazards (volcanoes, earthquakes and landslides) and human-induced deformation (subsidence due to aquifer exploitation, mining operations, and building of large infrastructures). Recently, the IREA-CNR implementation of the SBAS algorithm has been fully integrated (http://goo.gl/KE9Qna) within the ESA's Grid Processing on Demand (G-POD) environment, which is part of the Geohazards Thematic Exploitation Platform (GEP) of ESA. The GEP is an R&D activity on the ESA EO ground segment to demonstrate the benefit of new techniques for large-scale processing of EO data. This encompasses user-driven on-demand processing as well as systematic processing, to address common information needs of the geohazards community as a whole. Accordingly, the GEP is sourced with data, computing resources and processing tools, including SBAS-DInSAR, relevant to the geohazard theme. The integration of the SBAS-DInSAR algorithm within GEP resulted in a web-based tool freely available to the scientific community. This tool allows users to process, from their own laptops, the European SAR data archives (ERS, ENVISAT, and Sentinel-1) for obtaining surface displacement maps and time series in a completely unsupervised way, without caring about data download and processing facility procurements.

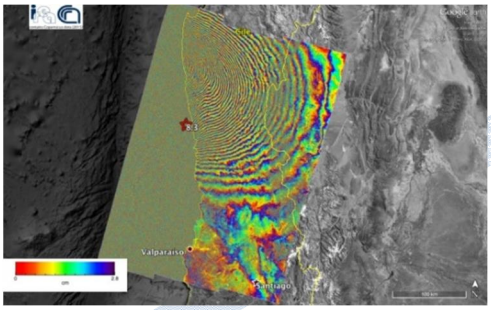
25 September 2015

New developments for the treatment of cancer with pulsed electric fields: awarded a young IREA researcher

During the "1st World Congress on Electroporation and Pulsed Electric Fields in Biology, Medicine and Food & Environmental Technologies", which was held in in Portoroz (Slovenia) from 5 to 10 September 2015, Dr. Stefania Romeo, a research fellow at IREA in Naples, received the second prize in the category Medicine and Biology of the Young Investigator Competition reserved to young researchers under 35. The work presented, entitled "Electroporation of a bladder cancer cell line in presence of calcium: efficacy dependence on electric field strength and calcium concentration" (authors: Stefania Romeo, Emilie L. Hansen, Stine K. Frandsen, Julie Gehl), deals with the use of intense pulsed electric fields to facilitate the massive entry of calcium into the tumor cells so as to induce death. This technique is very promising in the field of cancer therapy, being the calcium non-toxic and cheaper than the commonly used drugs for electrochemotherapy. The methodology was used for the first time by the group of Dr. Julie Gehl from the Department of Oncology at the University of Copenhagen, with whom Dr. Romeo worked in May 2014 in the framework of a short term scientific mission funded by COST TD1104 (European Network for the development of Electroporation-based Technologies and Treatments). During the period of co-operation, an experimental work with subsequent analysis of data was done, to optimize some parameters of the technique (electric field intensity and concentration of calcium) in order to increase the efficiency of the treatment. The results of this work have been published in the journal PLoS ONE.

24 September 2015

Earthquake in Chile: the ground deformation measured by processing the data of European satellite Sentinel-1A

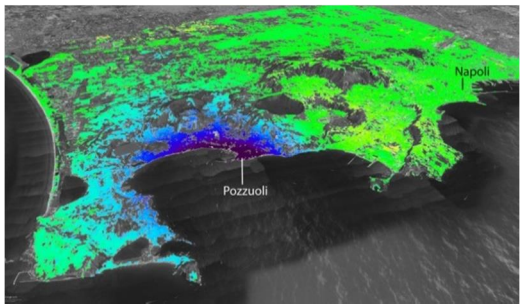


An earthquake of magnitude 8.3 struck the central region of Chile, 46 km west of the city of Illapel, at 22:54:33 (UTC) on September 16, 2015. The area is considered one of the regions at highest seismic risk in the world. The seismic activity in the region is caused by the convergence of the Nazca and South America plates with a relative movement between the two plates of about 74 mm/year (source: USGS). The earthquake is the result of a movement along a reverse fault dipping eastward, having a length of approximately 250 km and a width of about

100 km. Via differential radar interferometry, researchers at the Institute for Electromagnetic Sensing of the Environment have studied the field of surface deformation caused by the quake. In particular, they used the data acquired on July 31 and September 17, 2015 (immediately after the event) by the European satellite Sentinel-1A, that have made it possible to generate the displacement map (interferogram) shown in the figure. Each color band (fringe) indicates a ground shift of approximately 2.8 centimeters, with a maximum deformation of about 140 centimeters. The activity has been conducted as part of the agreement between IREA-CNR and the Italian Department of Civil Protection (DCP), the TEP-QuickWin project of the European Space Agency (ESA) and the project "High Technological Infrastructure for Integrated Monitoring of Climate and Environment" (I-AMICA) funded by the Italian Ministry of Education, University and Research as part of the National Operational Programme (PON). The presented results contain Copernicus data 2015.

9 September 2015

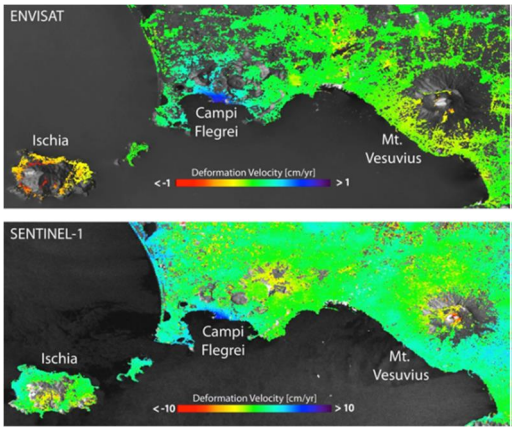
Satellites and GPS to study the flow of magma beneath the Campi Flegrei



A new technique can calculate, through Satellites and GPS data, how the deep magma goes up inside the ground of Campi Flegrei, creating even millimeter deformations of the Earth's surface. A mechanism probably common to other calderas (Yellowstone in the US and Rabaul in Papua New Guinea). The study, published in Scientific Reports, provides new monitoring systems useful to deal with possible future volcanic crises. The data acquired from satellites and GPS receivers of the network of sensors placed in the Campi Flegrei area are used to monitor the Earth's surface deformations and to know, in real time, the trend of the ground uplift in the caldera. This is the new monitoring technique developed by a team of researchers from the Institute for Electromagnetic Sensing of the Environment of the National Research Council (CNR-IREA) and the Vesuvius Observatory of the National Institute of Geophysics at Volcanology (INGV- OV), in order to better understand the uplift phenomena occurred in recent years at Campi Flegrei. The study, which is part of the monitoring activities promoted by the Italian Department of Civil Protection (DPC) and those undertaken under the European project MED-SUV (MEDiterraneanSUpersite Volcanoes), was published in Scientific Reports. The results of the study are of great importance for the interpretation of the data acquired by the new generations of satellites (like those of the constellation Sentinel of the European Program Copernicus, carried out by the European Space) and the innovative technologies of geophysical monitoring at Campi Flegrei. "These new monitoring systems, integrated with the new methods of analysis, may provide a useful tool to address possible, future volcanic crises at Campi Flegrei" says Susi Pepe at CNR.

10 June 2015

A new frontier for land monitoring with the European satellite Sentinel-1A

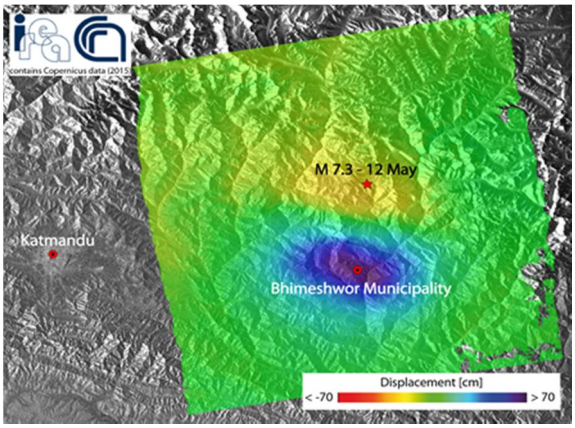


Researchers at the Institute for Electromagnetic Sensing of the Environment (IREA) have obtained a drastic improvement in mapping surface deformations thanks to data acquired by the year-old European satellite Sentinel-1A. The result, which opens new perspectives for earthquake and volcano monitoring, has been recently reported on the European Space Agency website. "Our study - said Riccardo Lanari, Director of IREA - clearly demonstrates that we can dramatically increase the spatial coverage of deformation maps, in terms of pixel density, in comparison to the results obtained with previous generations of SAR systems such as ERS and Envisat." This is evident when comparing the mean deformation velocity maps generated from Sentinel-1A and Envisat data over Napoli Bay (Italy), where

three main volcanic complexes – Mount Vesuvius, Campi Flegrei Caldera, and Ischia island – are located. In particular, the Sentinel-1A maps clearly show the volcano's 'spreading effect' at the summit of Mount Vesuvius, which was only partially visible with previous products from ERS and Envisat. Also evident is the improvement of the measurement density achieved over the Campi Flegrei Caldera, characterized by an ongoing uplift. The result has been achieved thanks to the SBAS (Small BAseline Subset) technique developed by IREA researchers, which permits the generation of spatially dense and highly accurate mean deformation velocity maps. Already worldwide used, this technique is getting a growing interest. This is evidenced, for instance, by the large use of a version of the SBAS technique implemented in the Grid Processing On Demand (GPOD) portal of the ESA Geohazards Exploitation Platform (GEP), which allows users to perform automatic and user-friendly advanced analysis of the Earth's surface deformations by using ERS and Envisat data, and, in a near future, also Sentinel-1 data. "The possibility to access Sentinel-1 SAR data, with the large coverage and a free and open access data policy, opens new perspectives in civil protection scenarios," noted Michele Manunta, a researcher of IREA. "For instance, we may already generate, in an operational context, interferograms of nearly the entire Italian territory." Surface deformation mapping will be further improved with the upcoming launch of Sentinel-1A's sister satellite – Sentinel-1B – that will shorten the revisit time from 12 to six days.

16 May 2015

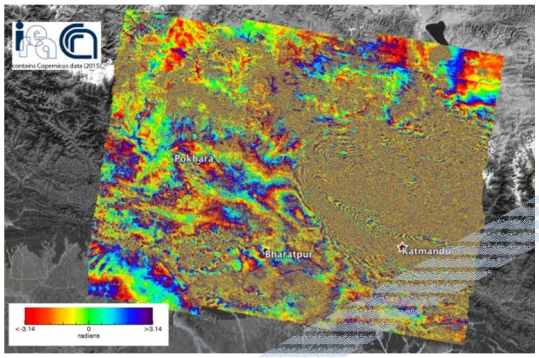
Nepal: the Earth shakes again



A new earthquake of magnitude 7.3 struck the Nepal area on 12 May 2015 and it is the one that, among all the aftershocks, released the biggest energy after the main event of the last April 25th. Researchers at the Institute for the Electromagnetic Sensing of the Environment of the Italian National Research Council generated a map of the ground displacement induced by this new earthquake through the Differential SAR interferometry technique, by exploiting data acquired by the Sentinel-1A satellite of the European program Copernicus. The deformed area extends for about 40 x 60 km2 Eastward of Katmandu. The detected displacement is about 70 cm toward the satellite in the maximum deforming area (blue zone in the figure). The measured displacement field has been very likely induced by the same structures involved in the main shock of the last April 25th, and it is compatible with the migration towards East of the aftershocks. The activity has been conducted as part of the agreement between IREA-CNR and the Civil Protection Department (DPC), and in the framework of the Geohazards Exploitation Platform (GEP) project (ESA) and I-AMICA (High Technological Infrastructure for Integrated Monitoring of Climate and Environment) project, which is funded by MIUR under the National Operative Programme (PON).

28 April 2015

Nepal earthquake: the ground deformation measured from space



The radar acquisitions of the new generation satellite Sentinel-1A of the European Program Copernicus allowed us to analyze the ongoing seismic phenomena and the permanent effects of the ground movements caused by the violent earthquake of magnitude 7.8 that struck Nepal on April 25, 2015. The study has been conducted by a team of researchers at the Institute for Electromagnetic Sensing of the Environment of the National Research Council of Naples (IREA-CNR) using differential radar interferometry, the technique which allows measuring ground deformations even in the order of a few centimeters on very large areas from space. The figure shows

the obtained interferogram, i.e. the map of the surface deformation induced by the earthquake, which is in a time interval ranging from April 17 to April 29, 2015. Each color band (fringe) indicates a ground shift of approximately 3 cm, with a maximum deformation of about 1 m. The displacement occurred as a result of the earthquake and subsequent shocks. It is the surface response to the fault plane displacement in depth.

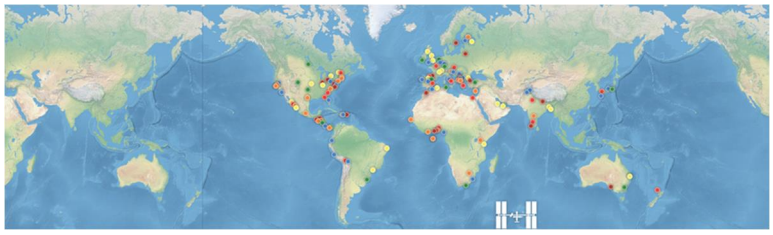
16 March 2015

Published the SCENIHR final opinion on the potential health effects of exposure to electromagnetic fields

As a part of the activities that the European Commission plays in monitoring the potential effects of electromagnetic fields on health, IREA participates in the activities of SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks). The researchers Maria Rosaria Scarfì and Olga Zeni, named "external experts" by the Commission, have contributed to the drafting of the "Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF)", published March 6, 2015. The primary purpose of the "Opinion" is to update the previous report of 2009 through the review of the scientific literature on the effects of non-ionizing electromagnetic fields published in the period 2009-2014. In addition, the new publication covers areas for which, in the past, major "gaps in knowledge" had been identified, and discusses the possible mechanisms of interaction between electromagnetic fields and biological systems and the potential role of co-exposures to environmental stressors.

11 March 2015

IREA among the local organizers of the International Space Apps Challenge



The fourth International Space Apps Challenge will take place all around the world on April 11 and 12, 2015. This is the largest worldwide Hackathon with thousands of participants in all continents who collaborate and work together over 48-hours to design innovative solutions for the most thrilling challenges that world is facing today. NASA is leading this global collaboration along with a number of government collaborators and over 100 local organizing teams across the globe. IREA is one of the local organizers of this mega event, along with the Department of Industrial Engineering, University of Naples Federico II, in collaboration with the U.S. Consulate Southern Italy. Dr. Chandrakanta Ojha, a Research Fellow at IREA, along with other scientists of IREA have taken the initiative for organizing the Space Apps Challenge 2015 in Napoli.

News

21 November 2014

Online the website of the project "ERMES: an Earth obseRvation Model based RicE information Service"

The website of ERMES, the project coordinated by the Institute for Electromagnetic Sensing of the Environment and funded under the Seventh Framework Programme of the European Union, is from today active at http://www.ermes-fp7space.eu. The agricultural sector needs a sustainable approach both economically and environmentally. ERMES intends to give its instrumental and research contribution in this direction. In particular, the project - lasting three years (2014-2017) - aims to build a prototype of services dedicated to the agricultural sector of rice-growing productions. ERMES will integrate different areas of research: from the innovative techniques of remote sensing and Earth Observation (EO), which use data from satellite sensors (optical and radar), to modeling solutions of crop growth, in order to produce geo-referenced data dedicated to the sector of rice production. The produced information will be supplied to end users through advanced Web services (Geoportal) and smart applications. In this context, the project aims to provide innovative solutions useful to various stakeholders: authorities, agro-environmental policymakers, farms that must meet the criteria of sustainability of production in terms of economic and environmental impact and, not least, the agro-business sector, interested in the monitoring of production and the state of the crops. "The ERMES website has been thought so that whoever, in addition to the researchers involved and the experts, can follow the progress of the research and the obtained results, and can also retrieve data, documents, maps, models and applications produced" explains Mirco Boschetti (IREA), Project Coordinator of ERMES. "The platform, set up in a multilingual version and with the possibility of sharing on the most important social networks, will be the main tool for the project communication and dissemination".

21 November 2014

A new sun photometer on Lake Garda

A photometer of the 'AERONET' network, positioned at the Archaeological site of Grotte di Catullo in Sirmione on Lake Garda, was inaugurated last October 22. The sun photometer Cimel is a tool that helps to measure the values of the optical thickness of the atmosphere and, therefore, it can be an interesting device to evaluate some c characteristics of the suspended particles in the atmosphere, such as their quantity and origin, namely if they are desert dust, sea spray, combustion products, etc. The measurements are repeated every 15 minutes during the day, in eight different wavelengths. The collected data are automatically sent to the network AERONET, the international network founded by NASA and PHOTONS, that collects data from similar sensors placed around the world (currently over 400 are active). "The Sirmione photometer was positioned at a strategic point on the northern tip of the Sirmione peninsula," says Claudia Giardino, IREA researcher and Principal Investigator of the network site. "This will allow us to collect data from a visual horizon wide enough. Its contribution to the monitoring of the atmosphere will add to that valuable of other similar photometers positioned in the Po Valley, Venice, Modena, and Ispra long ago." The measurements on the ground of the Cimel photometer can also be very useful for the treatment of data derived from satellite measurements of the area, allowing us 'to correct' the satellite images, 'disturbed' by the atmosphere and the powders present in it. In short, the photometer will allow us 'to read' and better interpret the satellite images of the Gardesana areas with a better assessment of the ecological parameters of these environments. The instrumentation purchase and placement have been possible thanks to the funding from the Lombardia Region within the SINOPIAE Project and the collaboration with the Superintendence for Archaeological Heritage of Lombardia that granted its installation on the roof of the Sirmione Museum located in this archaeological area.

17 November 2014

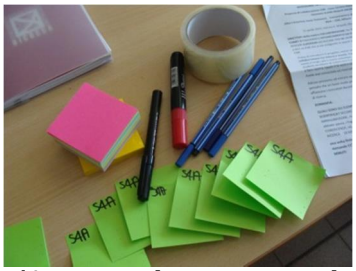
SPIE Best Student Paper Awards to a young IREA scholarship holder

Francescopaolo Sica, a scholarship holder at IREA, was awarded the Best Student Paper Award of SPIE Remote Sensing Conference (Amsterdam, 22-25 Sept. 2014) in the area "SAR Image Analysis, Modeling, and Techniques". The paper "Benefits of blind speckle decorrelation for InSAR processing", by F. Sica, L. Alparone, F. Argenti, G. Fornaro, A. Lapini, D. Reale, is the result of the collaboration between IREA and the Department of Information Engineering of the University of Firenze. The work deals with the problem of limiting the effects of noise from highly reflective targets, typical of the signals acquired from high-resolution sensors in X-band as those of the COSMO-SkyMed constellation, for the generation of accurate products of SAR interferometry. The latter is a technique that has important implications for the generation of digital elevation maps at a global scale and in the monitoring of deformations associated with natural hazards and security of buildings and infrastructures.

Read 2390 times

6 November 2014

Series of meetings between IREA researchers and students on classic themes of a research project



The first public meeting of "The research goes to school" will be held at the CNR Research Area in Milano on November 12. It is a training path addressed to the world of education focused on the issues of a scientific research project conducted by the National Research Council, Space4Agri (S4A). "A project is the place par excellence where the cycle of knowledge production is expressed. To follow it, through workshops and meetings, can allow students and teachers to better understand how research issues and procedures are today faced by the scientific community", says Alba L'Astorina, the person in charge of Space4Agri WP7 "Dissemination and Capacity Building Actions". But the role of CNR is also to reflect and make people think about new ways of teaching and communicating science that involve actively and collaboratively all participants, giving particular emphasis to the knowledge exchange. The activities that S4A leads with the school employ the participatory methodologies tested within the researches that Irea dedicates to public communication of science, as a member of the CNR research unit "Science Communication and Education" (COMeSE). In Milano, the activities benefit from the collaboration with the network of schools "Science Association under 18". The Day is one of the CNR approach events to Expo 2015.

Read 1644 times

16 October 2014

"Futuro Remoto" 2014

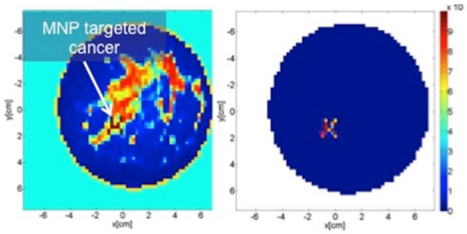
Again this year IREA participates in "Futuro Remoto", one of the most important and well-established European events for the dissemination of the scientific and technological culture. The theme of this XXVIII edition, which includes as usual events, conferences, meetings with scientists, visits to scientific laboratories and museums, is "The Sea". IREA contributes to this great event of science and culture with a meeting with students on "Radar technology for monitoring the environment and the sea", to be held on November 7 at 10:00 am at the headquarters of the Institute in via Diocleziano 328, Napoli. During the visit the students will learn about the operating principle of some unconventional radar systems, that is different from those commonly used for the management of air and sea traffic. In particular, they will be explained how to use a radar system to obtain information on the state of the sea, the surface currents, and the seabed bathymetry. Moreover, they will be shown how the ground penetrating radar works, a radar system designed to locate objects in different mediums such as sand, cement, ground. In addition, students will be able to check how it is possible to obtain high-resolution images of the geometric characteristics of not directly visible objects using by themselves a holographic radar.

Read 1694 times

News

14 October 2014

Prestigious award to a young IREA researcher



During the XX Italian Meeting on Electromagnetics held in Padova from September 15 to 18, Rosa Scapaticci, a research fellow at IREA, together with Martina Bevacqua Ph.D., student at the University Mediterranea of Reggio Calabria, was honored with the Barzilai Prize, a prestigious award assigned by SIEm (Italian Society of Electro-magnetics) to the best contribution proposed at the Meeting by authors under the age of 35 years. The award was assigned to the work 'Exploiting compressive sensing in Magnetic Nano Particle enhanced MWI for breast cancer imaging' in which the young scholars have proposed a processing methodology able to improve the performance of a new technique for microwave diagnostics of breast cancer, developed at IREA within the MERIT project. This diagnostic technique uses electromagnetic fields at microwave frequencies as a non-invasive and non-harmful survey instrument, jointly with magnetic nanoparticles as a contrast agent. These latters, "functionalized" through appropriate biochemical procedures, are indeed able to concentrate only in tumor tissues and to induce a selective variation of the magnetic properties. Given the non-magnetic nature of human tissues, this "marking" allows obtaining a highly reliable diagnostic technique. The methodology proposed by the authors, who analyzed its potentiality through a broad campaign of numerical simulations and found improved performances compared to the standard techniques used so far, can provide significant advantages such as the ability to identify small lesions, a crucial factor in the early diagnosis, or to appreciate the morphology of the lesion, useful information for clinicians in order to identify its typology.

Read 5410 times

21 July 2014

Online the Proceedings of the Third National Conference "Interaction between Electromagnetic Fields and Biosystems"

The Proceedings of the III National Conference "Interactions between Electromagnetic Fields and Biosystems", which was held in Napoli from 2 to 4 July 2014, are available on the website of ICEmB, the Interuniversity Center on Interaction between Electromagnetic Fields and Biosystems of which IREA is one of the Research Units. The aim of the conference was to stimulate the dialogue between researchers from different disciplines (engineering, physics, biology and medicine) working in the field of bioelectromagnetics, provide a photograph of the state of the art of the research in this field in Italy, and provide a basis for the orientation toward future developments. Chair of the conference was Professor Rita Massa, University of Napoli "Federico II and associate researcher at IREA. Dr. Maria Rosaria Scarfì, IREA Senior Researcher, was part of the Scientific Committee and Dr. Olga Zeni, IREA Researcher, was a member of the Scientific Committee and the Scientific Secretariat.

Read 1512 times

1 July 2014

IREA protagonist of a Special Issue of the Journal IEEE "Signal Processing Magazine"

The prestigious IEEE Journal "Signal Processing Magazine" reserved a special issue on "Recent Advances in Synthetic Aperture Radar Imaging" in July 2014. The special issue is dedicated to the most significant recent developments in the fields of SAR data processing techniques and applications. Gianfranco Fornaro, IREA Senior Researcher, is one of the guest editors of this special issue together with three other prominent international experts in the field. The special issue articles provide a review of remote sensing methods for microwave SAR sensors, describe the application scenario, and include suggestions for future development lines. IREA is specifically involved in the issue of SAR tomography, in collaboration with the University of Pisa, for applications in complex scenarios such as the urban ones and infrastructures, and in collaboration with the Second University of Napoli, for SAR technics in unconventional scenarios,

including subsurface and through-wall-imaging. The special issue cover is dedicated to the results obtained by IREA, in collaboration with the German Space Agency (DLR), in the reconstruction of individual buildings through SAR tomography. The relevance of the technology proposed and developed at IREA is widely recognized by the scientific community and witnessed by several international awards.

Read 1620 times

30 June 2014

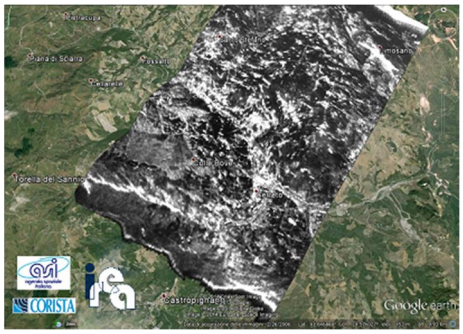
Journal of Geophysics and Engineering Best Paper Award to an IREA researcher

Francesco Soldovieri, Senior Researcher at IREA, together with John Leucci and Raffaele Persico of IBAM-CNR, received the Journal of Geophysics and Engineering Best Paper Award last June 16. It is a prize for one of the eleven articles selected in the first decade of the journal for their scientific relevance and impact in terms of citations. The paper, entitled 'Detection of fractures from GPR data: the case history of the Cathedral of Otranto', deals with the theme of non-invasive diagnostics for the study of the conservation status of the 'core' columns inside the Crypt of the Cathedral of Otranto. The innovative character of the paper relates to the use of an advanced procedure of data processing based on microwave tomography, capable of obtaining images of the column internal state easily interpretable by users. Published in 2007, the article is very quoted by the scientific community of geophysics applied to monuments.

Read 1494 times

9 April 2014

Completed the experimentation activity of a P-band radar system



It has been completed the research and development activity aimed at the implementation and testing of a multi-frequency radar system operating in the P-band (frequencies below 1 GHz), in particular in the VHF and UHF. The system is owned by the Italian Space Agency (ASI), made by the Consortium for Research on Advanced Remote Sensing Systems (CORISTA), and experimented with the participation of the Institute for Electromagnetic Sensing of the Environment of CNR, the Polytechnic of Milano and the University of Trento. It allows obtaining information on the sub-surface layer of the investigated area through the use of frequencies lower than those of the "classic" L, C and X-bands. The capability of the P-band radar to penetrate surfaces has relevant applications to safety, monitoring of forests, biomass and soil moisture estimation, as well as for the analysis of glaciers, for archeology, geology, and planetary exploration. The interest of the Defense towards the exploration of the potentialities offered by the military use of the P-band allowed us to carry out the radar testing through two flight campaigns with aircraft provided by the Aeronautica Militare. As part of the experiment, IREA led the data processing necessary to provide to the P-band radar the ability to discriminate the objects to the ground, with detail comparable to that of the human eye. The generation of P-band images requires a complex signal processing that, in the specific case of installation on a helicopter, concerned mainly the accurate compensation of the platform motion errors.

Read 1712 times

7 March 2014

NEREUS International Conference SPACE4YOU

NEREUS (Network of European Regions Using Space Technologies) and its member region Apulia organized the international conference “Space, a driver for competitiveness and growth” (27-28 February 2014 - Bari, Italy), aimed at presenting how space uses and applications respond to a number of societal and economic challenges of the everyday life. Bringing together the demand and supply side of space services, the idea is to better understand regional needs and potential benefits

of an increased uptake. The event, mainly addressed to European regions, local authorities and their stakeholders, featured interventions by representatives of the European Commission, Space Agencies as well as representatives from the academic, research and industrial sectors to share knowledge, experiences, and expertise. Thematic and best practice sessions, as well as roundtable debates, animated the 2-day event. IREA actively participates in NEREUS. IREA is an associated member of NEREUS and led its flagship FP7 project DORIS_Net to set up the European network of Copernicus-GMES Regional Contact Offices (RCOs) to raise awareness and strengthen regional involvement in Copernicus-GMES, Europe's flagship program for Global Monitoring of the Environment and Security.

Read 3490 times

12 December 2013

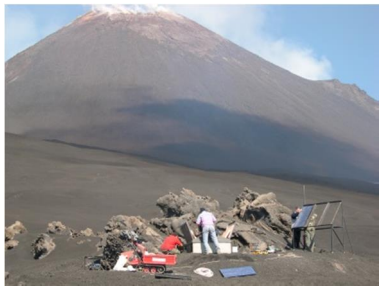
The sustainable city: scientific and technological innovation for efficient, safe and healthy cities

As part of the events to celebrate the 90th anniversary of the National Research Council of Italy, the Department of Engineering, ICT and Technology for Energy and Transport (DIITET) organized a conference entitled "The Sustainable City: scientific and technological innovation for efficient, healthy and safe cities" that was held in Roma on December 10, 2013. The purpose of the initiative was to present projects, methodologies, tools, developed by the Institutes related to DIITET, which aimed at creating smart cities to improve life quality. During the day, the journalist Daniele Cerrato - TV host of TGR Leonardo - interviewed some CNR experts. Among them Gianfranco Fornaro, Senior Researcher at IREA, who dealt with the theme of Global security for the city: technologies for satellite monitoring of urban areas and infrastructures.

Read 2090 times

29 November 2013

Spatial data and terrestrial measurements to better understand volcanoes

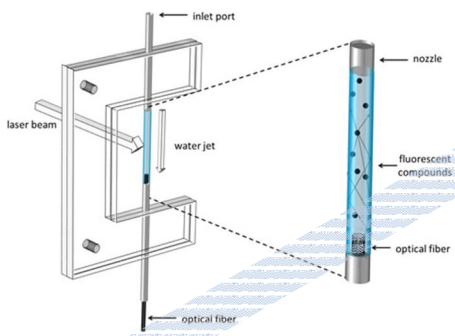


For the first time, satellite data and ground measurements were used in order to detect the possible magma rising that 'announces' the eruptive activity of Etna. The study, that resulted from the collaboration between the National Research Council of Italy (CNR), the National Institute of Geophysics and Volcanology (INGV), and the Italian Space Agency (ASI), was published in Scientific Reports of Nature. Understanding the internal structure of a volcano and its functioning is one of the main targets of volcanological studies. In order to do this, scientists can only rely on information gathered from the volcano surface and the analysis of released products (lava, gases, ash, ...). For the first time, the study utilizes synergically the measurements of ground deflection, calculated by using data collected by satellite radars as Ers / Envisat and COSMO-SkyMed, and information on the small variations in the gravitational field measured near the volcano surface.

Read 2019 times

31 October 2013

Detection of pollutants in drinkable waters through jet waveguides



A naked jet of water that doubles as both the sample and the collection equipment, providing a simple, cheap, and portable new tool to analyze liquids. The device was designed and realized by a group of IREA researchers, composed of Gianluca Persichetti and Genni Testa and led by Romeo Bernini. They have developed an optofluidic sensor that forgoes the channels in favor of a narrow stream of water unconfined by tubes or pipes. It allows overcoming one of the major limitations of microfluidic detectors for testing water, which make use of the fluorescent property of pollutants. As a matter of fact, in such

devices laser light that illuminates bacteria and chemicals in the water also shines on the channel walls, where it scatters and obscures the distinction between the fluorescing contaminants and their background. The device was tested with varying amounts of some of the main pollutants of ground water that are hazardous and carcinogenic, proving extremely sensitive. It can detect pollutant levels even lower than those allowed by the Environmental Protection Agency (EPA). The instrument could also sense Bacillus subtillus, a harmless bacterium similar to the one that causes anthrax. The device was developed in the framework of the research project ACQUASENSE. It does not require any pretreatment of the sample to be analyzed and can be easily plugged in normal water pipes. The extreme cheapness and compactness of the device make it suitable for its use in early warning systems for water quality monitoring.

26 July 2013

Prize of the International Space Apps Challenge for Chandrakanta Ojha, Research Fellow at IREA

On November 18, 2013 Mr. Chandrakanta Ojha, a Research Fellow at IREA and a doctoral student at the University of Roma 'La Sapienza', will be at NASA's John F. Kennedy Space Center in Florida (USA) to attend the launch of MAVEN, the spacecraft directed to Mars to explore the Martian upper atmosphere. The remarkable opportunity was offered by NASA as a prize for achieving the 2nd place at a competition launched from the Kennedy Space Centre (KSC) as a part of the International Space Apps Challenge. The challenge, organized by NASA with the aim of producing solutions to the global needs relevant to life both on Earth and in space, was held on 20 and 21 of April 2013 and involved about 9,000 people in 83 cities around the world. At the University of Roma 'La Sapienza' a team made up of international young people including Mr. Chandrakanta Ojha, participated in the KSC challenge under 'Deployable Greenhouse' with a project entitled 'Green on the Red Planet'. The project concerns the development of a modular greenhouse with rigid and inflatable elements for a future self-sustainable human base on Mars. It would be capable of providing quality and quantity of food for four astronauts during their stay on Mars and would be well equipped with automatic operating systems by exploiting energy system based on solar, wind and nuclear power to autonomous harvesting using robot farmers.

28 June 2013

Third annual day of SERIT

The next July 8, with the organizational and logistical support of IREA, it will be held the third annual day of SERIT, the national technology platform promoted by CNR and Finmeccanica which includes companies and institutions in Italy dealing with research in the field of security. The event will be an opportunity to present the third Volume of the SERIT Platform which includes national priorities to support in "Horizon 2020". The day will begin with the greeting of the President of the National Research Council of Italy, the Mayor of Napoli and the President of the Campania Region. Then, in the Round Table chaired by a representative of the European Commission, funding opportunities for the themes "Security in H2020", with particular reference to the role of research and industry in Southern Italy, will be discussed. In the afternoon there will be a brief presentation of IREA which, with the laboratory Radar for security applications and monitoring of the territory, won the Serit Award 2012, the recognition to the public and / or private Italian laboratory which stood out for the research and innovation in the field of Security.

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