

ITALY

Space Activities

Year 2009

Report available electronically from the website:

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Content

Introduction	03
Earth Observation	04
Observation of the Universe	06
Solar System Exploration	06
High Energy Astrophysics	07
Cosmology and Fundamental Physics	08
Space Debris	09
Space Habitability	09
Italian Astronauts	10
Space Transportation	10
Telecommunication and Navigation	11
Medicine and Biotechnologies	13
Operative Centres	14
Space Education	17
International Relations	18
Participated Companies	20
Annex I	
COSMO-SkyMed Mission	22
Annex II	
SORA Campaign	27

Introduction

Mr Enrico Saggese, Commissioner of the Italian Space Agency (ASI) for one year, on July 3rd 2009 has been appointed President of ASI by the Italian Government.

The year 2009 opened in style with the inauguration of the International Year of Astronomy, an event that sparked a myriad of meetings, events, magazines, and initiatives to bring people to the stars.

In particular, the exhibition " Stars and Particles" held in Rome, organized by the National Institute of Nuclear Physics (INFN), National Institute for Astrophysics (INAF) and the Italian Space Agency (ASI) resulted in a resounding success.

2009 was the "annus mirabilis" of high-energy astrophysics. New pulsars, cosmic phenomena of resurrection, evidence of dark matter, gamma bursts never seen before, flashes of light, super strong stellar explosions, black holes in action. These are some of the many surprises that have confirmed the excellence of Italy in this fascinating field. The protagonists were:

AGILE, a small Italian jewel launched in April 2007, and Fermi, a NASA mission with an Italian "heart" (the instrument LAT, Large Area Telescope, that has been made in our country). The significance of the results has earned the recognition of the National Academy of Sciences, the Henry Draper Medal to Neil Gehrels, chief scientist of the Swift satellite and astronomical telescope Fermi. According to the magazine Science, the new pulsar detected by Fermi is one of the ten most important scientific discoveries ever year.

A few hours after the earthquake of 6 April 2009 that struck Abruzzo and destroyed the City of L'Aquila, the satellites of Cosmo Sky-Med constellation, were pointing the area where the ground shook. The data available to the Civil Defence have allowed continuous monitoring over the area affected by the quake and offered valuable assistance to the machinery of relief, that promptly started to.

The last year was an important one in reaffirming the central role of Italy in the space field. Italy had the first opportunity to manage the Inter-ministerial conference of ESA with its Ministry of University and Research and obtained, thanks to the candidacy of the City of Naples, the assignment to Italy of the International Astronautical Conference (IAC) 2012.

Among the best activities of 2009, two missions named Herschel and Planck can be considered "the couple of the year" . After a scientific and technological development lasted over 10 years, on May 14, 2009 Herschel and Planck departed in tandem from Kourou on board an Ariane V rocket, two ESA missions with significant Italian contribution, among the most ambitious ever planned. Planck is a sort of time machine that will measure the birth of the Universe, by measuring the cosmic background radiation with a precision 10 times higher than the predecessors. Herschel is by now the largest telescope ever sent into orbit, observed in the band almost unexplored infra ancient galaxies and stars rising. A few months after their cosmic debut, both observers have demonstrated high performances: Planck produced the initial "scanning" of early universe and Herschel has obtained spectacular images.

In the year when the whole world celebrated the 40 years of Apollo 11 landing the Moon, it was the star of a dramatic discovery: there is water on the Moon, a fact that changes several scenarios for space exploration debate, still ongoing on whether to return to the moon or point to Mars. Together with its international partners, Italy is ready to face this new challenge.

Earth Observation

Italy devotes special attention to Earth observation programs. ASI is completing the deployment of sophisticated dual-use (civilian/military) Earth observation satellite constellation (four satellites), **COSMO-SkyMed**, dedicated to natural resources protection and disasters prevention and safety.

On October the 24th, 2008 the third COSMO-SkyMed satellite was successfully launched by the U.S. Vandenberg Base in California. The launch of the fourth satellite, originally planned for the beginning of 2010, has been delayed to the last quarter of 2010 due to industrial premises damages occurred during the huge L'Aquila-Abruzzo earthquake in April 2009.

COSMO-SkyMed system, developed by ASI in cooperation with the Italian Ministry of Defence, is a dual system that makes use of the most advanced remote sensing technology. It is composed by four X-band SAR (Synthetic Aperture Radar) satellites, providing high imaging resolutions - by day and night and by any weather - which are processed by a complex and geographically distributed Ground Segment infrastructure: Matera in Italy, Cordoba in Argentina, Kiruna in Sweden. The entire system is manufactured by Italian industries.

In May 2007 ASI released an Announcement of Opportunity to conduct scientific research and application development projects in Earth Observation using products from the COSMO-SkyMed mission. 200 proposals from 29 different countries have been evaluated. The selected proposals receive COSMO-SkyMed data at no cost.

The four satellites will provide 1.800 images per day. The first two COSMO-SkyMed satellites have already provided images of natural disasters like the shipwreck of the Russian tanker Volganefit in the Black Sea, the cyclone in Bangladesh, the landslide in Bolzan, the floods in Myanmar and Haiti,—the Earthquake in China and several other emergency events in 2009. Moreover, a first operational use of these satellites has been made by the National Civil Protection authority (the Department of Civil Protection) during events occurred in our country (the Etna eruption, the floods in Piemonte and Sardinia regions and the L'Aquila-Abruzzo earthquake).

For further information regarding the utilization of the COSMO-SkyMed satellites data, please see the annex and ASI website (<http://www.asi.it>).

COSMO-SkyMed programme is also the key element of the Italian Space Agency programme on Earth Observation applications. At the same time as the development of the COSMO-SkyMed System, the Italian Space Agency has started a program dedicated to understand and prove how space observation data could be used to face natural and man induced disasters.

The civil scope of the program (by now dedicated to hydro-geological risks, geophysical risks and risks related to fires, oil spills and pollution) is to integrate new functionalities, based on Earth Observation data, in the decision support systems of Institutional Users, like Civil Protection, Environmental Agencies, local Authorities.

These functionalities will be implemented and demonstrated through pilot projects, that deal with all the emergency phases (Knowledge and Prevention, Alert and Crisis, Post Crisis) and that answer the priorities and the needs of the Institutional Users.

All the test sites considered in the pilot projects are in Italy, but the methodology can be exported in different areas, so these projects could be seen as the national contribution to the GMES (Global Monitoring for Environment and Security) program and to Global Earth Observation System of System (GEOSS).

The program is being developed in close connection with the Italian Civil Protection in order to facilitate in the next future the transition of the existing monitoring and emergency response capabilities from pilot to operational services.

The COSMO-SkyMed system is part of the inter-governmental cooperation between Italy and France, based on the Agreement Concerning the Cooperation on Earth Observation signed in 2001, which established a dual system, **ORFEO**, composed by the Italian COSMO-SkyMed satellites and French Pleiades satellites.

An important cooperative effort devoted to the management of the natural disasters and emergencies is the bilateral cooperation between Italy and Argentina within the joint programme Italo-Argentine Satellite System for Emergency Management (**SIASGE**) based on

the ASI-CONAE agreement signed in 2005. The integrated system uses the Italian COSMO-SkyMed constellation and the Argentinean SAOCOM constellation composed by two L-band SAR satellites.

The combined use of C-Band, L-band and X-band SAR data will lead to improved performance in several specific applications.

In addition, Italy, through its contribution to the ESA GMES program, will also have the possibility of programming the GMES Sentinel 1 satellite and using the relevant C-band SAR data.

ASI has finalized the development of the **ROSA** instrument, a Radio Occultation Sounder for Atmosphere. It is dedicated to collect important information regarding temperature, pressure and humidity of atmosphere contributing to the study and monitoring of climate change. ROSA has been installed on board the Indian satellite, OCEANSAT-2 (launched in September 2009) and on board the Argentinean satellite, Aquarius/SAC-D, scheduled to launch in 2010.

Italy is developing hyperspectral technologies. Building on the positive experience of the project study HyPSEO, ASI is developing a new Earth observation system, **PRISMA**, a pre-operative program. It uses electro-optic instruments that integrate a hyperspectral sensor with a middle resolution panchromatic camera. This characteristic shell help the space observation to individuate also the chemical composition of the revealed objects.

In the frame of the ASI small missions program, **MIOSAT** is an Optical Mission based on a Microsatellite. It has both applicative and technological goals. The microsatellite, weighting 120 kg, will be based on a state of the art reusable and modular microsatellite platform. The payload, consisting of a high resolution panchromatic camera, an imaging interferometer, a Mach-Zehender micro-interferometer and a deployable telescope, will provide high resolution Earth observation data for environmental monitoring. Three technological experiments will be also embarked and tested in orbit.

ASI also supports EO data exploitation by means of a specific program devoted to disaster management. Several national emergencies have been identified, such as earthquakes, volcanoes, landslides, floods, air pollution, marine oil spills, forest fires, coastal risks. For each one, at least one Pilot Project has been set up and started, with the scope of developing a pre-operational demonstration system in collaboration with a "reference user" (usually the National Civil Protection). Activities are well under way.

At the European level Italy contributes to the Global Monitoring for Environment and Security (**GMES**) programme, an EU-led initiative, which will develop information services to be used for the definition and monitoring of EU policies in the field of environment and security.

With reference to the Italian contribution to the program, from one side, Italy, through its contribution to ESA, participates to the ESA optional program GMES Space Component Program (GSC) managed by the European Space Agency, on the other side, Italian entities (e.g. companies, researchers, public entities and the Italian Space Agency itself) are involved in projects, relevant to GMES services, funded by the European Commission within the R&D Framework Programs. Moreover, COSMO-SkyMed is one of the GMES contributing missions which will provide their data to the different services.

ASI participates in other Earth Observation Programs of the European Space Agency (ESA) like DATA USER Programme, ENVISAT 1, METEOSAT Second and Third Generation, EOEP Period 1, 2, and 3.

At the multilateral level Italy is member of the Group on Earth Observation (GEO), while ASI is member of the Committee on Earth Observation Satellites (CEOS). In the framework of the United Nations/COPUOS ASI participates in various international activities and projects.

Observation of the Universe

Solar System Exploration

Italy is one of the main contributors of the ESA optional programme, **Aurora**, with the purpose to give an important contribution to the "Worldwide Vision for Exploration", in the areas of main excellence of the Italian industries and science community: radar instruments, spectrometers, telecommunications, robotics and EDLS (Entry Descent and Landing Systems) subsystems. The long-term goal of the Aurora programme is the human exploration of Mars with Mars Sample Return as a main intermediate milestone whereas **ExoMars** will be the first European mission to have landed elements on the surface of the red planet. The Programme is composed by two missions the first one composed by an orbiter and a fixed lander is scheduled for launch in 2016. The second one consists of a rover deployed in 2018 by a NASA landing device (Skycrane). The rover will be equipped with a drill and a scientific package (to analyse the samples collected). Italy is interested among the other in the drill and the sample management system, the airbags and the parachutes, and will manage the Rover Operation Control Center during the operations at the Martian surface. Two Italian scientific experiments will be provided to the mission and a large number of Italian scientists are involved in several other instruments.

Italy is playing a significant role in the exploration of Saturn and its satellites with the NASA-ESA-ASI mission Cassini-Huygens and in Mars exploration through collaboration with NASA and ESA. In particular, ASI developed the radar instruments **MARSIS** (Mars Advanced Radar for Subsurface and Ionosphere Sounding), on board the **Mars Express** Mission, and **SHARAD** (SHallow RADar), embarked on the NASA mission **Mars Reconnaissance Orbiter**, both with the goal to search for liquid water and ice in Mars' subsurface.

During the year 2009 the two radars continued to send very significant information regarding this topic. In particular, radargrams provided by SHARAD allowed scientists to measure the stratification of the polar ice sheet. ASI also completed the development of a GIS (Geographical Information System) for Mars and other planetary surfaces called **PAGIS** (Planetary Geosciences Information System) that have produced a first high definition Martian Geological map of the ASI Planetary Map Series. ASI is also deploying an on field test facility in a Martian analogue environment located in the Moroccan desert where it will be possible to test instruments and landed elements or training operation teams in the main frame of the exploration programs.

The Italian spectrometer **PFS** (Planetary Fourier Spectrometer), on board Mars Express, is mapping the abundance of the water vapour and methane in the Martian atmosphere. Italy is also contributing to the ESA **Venus Express** mission currently orbiting around Venus. Venus Express has revealed detailed atmospheric dynamics and stunning details of the south polar vortex, while also discovering the hydroxyl radical in the Venusian atmosphere now the main topic of the research is to discover active volcanic activity. The main contribution to these results were achieved thanks to the data provided by the **VIRTIS** (Visible-IR Thermal Mapping Spectrometer) instrument co-led by an Italian and a French PI.

Italy is significantly present on the ESA mission to Mercury **BepiColombo** (scheduled for launch in 2014) with four PI instruments and an important contribution to other four experiments, all taking on the heritage of Italian excellence on the field.

Moreover, ASI-led instruments play a fundamental role in the study of primitive bodies such as comets and asteroids on missions which are currently cruising towards their targets. This year, the instruments on board ESA **Rosetta** spacecraft, on its way to comet 67P/Churyumov-Gerasimenko, has observed the asteroid Steins during its fly-by which occurred on September 5th. The OSIRIS Wide Angle Camera (**WAC**), realized in Italy, produced the first images of the asteroid. In the meantime, the NASA Discovery mission **Dawn** continues her fly towards Vesta and Ceres with on-board the Italian **VIR-MS** spectrometer (Visible-IR Mapping Spectrometer). Furthermore, a feasibility study has been carried out to check the possibility to use a VEGA launch vehicle for the JAXA Hayabusa-2 asteroid sample return mission.

ASI supports the International Lunar Network (**ILN**) initiative with the goal of building up a coordinated network of small geophysical stations to be deployed on the lunar surface to establish the nature of the Moon's core and its internal structure.

The Italian Space Agency is contributing to the NASA 2nd New Frontiers mission **Juno**. Scheduled for launch in 2011, Juno aims at carrying out a detailed study of the giant planet Jupiter: the spacecraft will investigate Jupiter's origins, its interior structure, its deep atmosphere (convection and wind dynamics) and its magnetosphere from an innovative, highly elliptical polar orbit with a suite of seven science instruments. ASI started to develop the infrared imaging spectrometer **JIRAM** (Jovian InfraRed Auroral Mapper) and the **Ka-Translator** for the radio-science experiment that will be provided to NASA. Furthermore, the utilization of the **Sardinia Radio Telescope** to provide the tracking service for the mission is currently under evaluation.

ASI is also supporting the Italian scientists involved in the proposals in competition within the ESA **Cosmic Vision** science programme. Among the pre-selected missions, those aiming at the exploration of the Solar System are: **Marco Polo**, a sample return mission from a primitive body to be developed in collaboration with JAXA; **Laplace**, a mission to Europa and the Jovian system, to be developed in conjunction with NASA and JAXA. The Italian contribution to those missions is focussed on low-frequency sounding radars, imaging spectrometers, atmospheric sensors, radio-science equipment and, in general, radiation hardened components. Italy is also interested in the **Cross-Scale** mission which goal is to study the interactions between the solar wind and Earth's magnetosphere.

Experimental campaigns performed with stratospheric balloons represent an important part of the Italian endeavour in space: tests and calibration of instruments to be employed in space are carried out through mid- and long-duration flights within Earth atmosphere. In late spring 2009 has been successfully launched by Svalbard base the **SORA** (Sounding Radar) mission with on board a radar similar to SHARAD to investigate well known polar and Antarctic areas in order to calibrate the radar data acquired on Mars and other 3 piggy-back experiments. The main experiment suffered a major problem the data of the other 3 are under analysis.

Finally, ASI plays a leading role in the study of the Sun and the **Space Weather**. In particular, the joint ASI-NASA instrument UVCS (Ultraviolet Coronagraph Spectrometer) on board of the ESA mission **SOHO** continues to provide outstanding data on the solar corona after more than 10 years in orbit. On the 15 of September on board an American sounding rocket has been launched the **Score** coronagraph that operated correctly, this is the precursor of the MAETIS experiment that will be embarked on the next ESA solar mission **Solar Orbiter**.

High Energy Astrophysics

After the success of the BeppoSAX mission, ASI was willing to carry out a new national mission for the study of the high-energy Universe: **AGILE**, (Astrorivelatore Gamma a Immagini Leggero). The launch took place in April 2007, with a two-year operational life. The core of the mission is a new generation gamma detector, a natural consequence of the evolution of detectors used for experiments of physics of elementary particles. In 2009 the mission has been extended for a period of two years.

Competences acquired so far have led ASI and the scientific community not only to the AGILE national mission, but also to collaborating in the realization of **SWIFT**, an American satellite for the study of gamma-ray bursts launched at the end of 2004, and to NASA mission, **GLAST**, now renamed **Fermi**, launched in June 2008. This mission, together with new extremely sensitive detectors within ground laboratories, will allow gamma-ray astronomy to take the decisive step from the explorative phase to full maturity.

AGILE is able to focus gamma-ray sources with an excellent resolution, as well as quickly analyse data in order to supply the results for their quick diffusion to the scientific community through the Asi Science Data Center- ASDC.

AGILE and SWIFT data are acquired at San Marco Space Base in Malindi (Kenya).

Italy participates in the international project for the development of the **AMS** (Alpha Magnetic Spectrometer), which represents a high energy particle physics experiment in space to be

installed on the International Space Station, in 2010, for at least three years of operation. It will be able to investigate the composition of cosmic rays and will provide the most sensitive search for the existence of anti matter nuclei and for the origin of dark matter. AMS will fly with the Italian astronaut Roberto Vittori on board the Shuttle on July 2010.

Since 2000 the **ASI Science Data Center (ASDC), located at ESA/ESRIN in Frascati (Italy)**, has been supporting all scientific missions of the Italian Space Agency in the management and preservation of scientific space data.

ASI is also supporting the Italian scientists involved in the proposals in competition within the ESA **Cosmic Vision** science programme. Among the pre-selected missions, those regarding High Energy Astrophysics are : **Euclid** devoted to the study of the phenomena associated to the dark energy and **IXO** dedicated to x and gamma rays.

Cosmology and Fundamental Physics

The Italian scientific community is participating in ESA Programmes **Herschel** and **Planck** launched in May 2009. Planck will examine cosmic microwave background radiations with an accuracy never achieved before to test theories of the early universe and the origin of cosmic structures; Herschel will study the evolutionary processes of the galaxies and the inner areas of star forming regions. ASI funds and manages the development of the Italian PI-ship instrument LFI and the Italian contribution to HFI for Planck and the Italian contribution to the instrument hardware and to the Instrument Control Centers for Herschel. The first results of the two missions are confirming excellent performances of the on board instruments.

Italy continues its contribution to the ESA mission **LISA Pathfinder** that will test the concept of detecting gravitational waves from space showing that it is possible to control and to measure the movement of two masses in a free fall condition. This technology is essential for future ESA-NASA programme, LISA (Laser Interferometer Space Antenna).

The national effort for the ESA mission **Gaia** is growing. ESA is directly realizing the spacecraft and the payload for this mission, whose aim is to obtain a three-dimensional map of our galaxy, revealing its composition, formation and evolution. To participate to the important scientific return of the mission, Italian scientists are deeply involved in the **DPAC** (Data Processing and Analysis Consortium), the consortium of European research institutes that will have the responsibility of the reduction and analysis of the enormous amount of data that will be produced by the mission.

In the field of cosmology, two experiments on stratospheric balloons are in preparation. **BOOMERanG** (Balloon Observations of Millimetric Extragalactic Radiation And Geophysics) is a microwave telescope that was first launched in 2000 and 2003 from Antarctic obtaining "images" of the first stages of Universe. The next flight, with on-board a new version of the instrument able to measure the properties of the polarization of cosmic radiation, is scheduled for 2011 from the Svalbard Islands.

Olimpo is a long-term mission on a stratospheric balloon to study the microwave cosmic background as well as the primordial galaxies. The first flight from the Svalbard Islands is scheduled to take place in 2010.

In the field of fundamental physics, ASI is managing the realization of the **LARES** satellite, to be launched in 2011 using the new European Space Agency launcher VEGA. The scientific aim of the mission is the accurate measurement of the Lense-Thirring effect, predicted by the general relativity theory.

ASI has also completed the phase A study for the Galileo Galilei mission, dedicated to the experimental test from space of the Equivalence Principle. The final evaluation for the continuation of the program is in progress.

Italy contributes to the progress of knowledge and expansion of the human knowledge frontiers by exploring the mysteries and the opportunities of the Universe, through data obtained from high technology space systems. Along with numerous contributions in international missions, Italy is also carrying out national projects: in 2009 the phase A studies have been completed for five small missions (**SAGACE** – Spectroscopic Active Galaxies And

Clusters Explorer, **POLARIX** – X-band polarimeter, **FLORAD** – microsattellites FLORal constellation for RADiometric observations, **MAGIA** – Missione Altimetrica Gravimetrica geochimica lunAre), **ADAHELI** – ADvanced Astronomy for HELIophysics). The selection for the B phase is progress to finally select the first one to be launched not earlier than 2012

Space Debris

Italy is constantly involved in the space debris issue with initiatives at national level and supporting international activities to mitigate and prevent damages caused by space debris. The Italian Space Agency is member of the Inter-Agency Space Debris Coordination Committee. It supports its work with a coordinated research activity on space debris monitoring, modelling, protection and mitigation.

At the European level, ASI cooperates with BNSC, CNES, DLR and ESA and applies at national level in each new spacecraft development, the prevention and mitigations clauses contained in the "European Code of Conduct for the Space Debris Mitigation".

The spacecraft operators of the Italian Cosmo/Skymed satellites constellation performed some collision avoidance maneuvers during the 2009 and following the Iridium 33 accident.

In 2009 the Italian delegation together with the German delegation made a request, that is included in a A/AC.105/2009/CRP.19, for the establishment, under the auspices of UN, of an international platform of data and information on objects in outer space. This data base - supplied on an exclusively voluntary basis and freely accessible to Member States - would be for the promotion of a safe and sustainable development of the peaceful uses of outer space. This initiative is in line and would support and complement the ongoing issue of "long term sustainability of space activities" proposed by the French delegation.

Consistent with the UNCOPUOS request made at its fifty-second session to Member States of the IADC, ASI, in October 2009, during one session of the IADC has informed the steering committee to prompt the STSC in February 2010.

Space Habitability

Italy plays a relevant role in the development and the utilization of the International Space Station (ISS), obtained through the bilateral agreement with NASA, signed in 1997, and the participation in the ESA program.

After the success of the Italian logistic modules **MPLM (Multi Purpose Logistic Modules)** Leonardo, Raffaello and Donatello, used to transport equipments, supplies and experiments, to the International Space Station and entered in the operational phases in 2001, Italy has been collaborating with ESA in various fundamental projects, such as **Columbus**, **ATV** (Automated Transfer Vehicle), **Node 2** and **Nodes 3** and **Cupola**, which are going to fly next February 7th, 2010.

Columbus Orbital Facility was successfully launched on board NASA's Space Shuttle Atlantis from the Kennedy Space Centre in Cape Canaveral, Florida on February 7, 2008.

The 11-ton European Laboratory has been delivered by the Space Shuttle to a berthing site on Node 2, adjacent to the U.S. Laboratory. This Facility is accommodating ten racks, five of them for European Space Agency utilization, the other five for NASA and possibly for the other partners of ISS. It will be used primarily for research and experimentation in microgravity conditions, mainly in the field of Life Sciences, Physical and Material Science. An Italian company has been the prime contractor for the primary Columbus structure and other critical elements.

On March the 9th 2008, **Jules Verne**, the European Automated Transfer Vehicle (ATV), was successfully launched by a special version of Ariane 5 launcher. Jules Verne, with a high Italian industrial participation, is an important space station supply spacecraft, delivering experiments, equipment and spare parts, as well as food, air and water for the permanent crew. Equipped with its own propulsion and navigation systems, the ATV is a multi-functional spacecraft,

combining the fully automatic capabilities of an unmanned vehicle with the safety requirements of a crewed vehicle.

Italian Astronauts

The Italian astronauts are members of the European Astronauts Corp. Presently two astronauts are active: Paolo Nespoli and Roberto Vittori (See ASI website for their biographies).

From 23 October to 7 November 2007, **Paolo Nespoli** flew as Mission Specialist on board Space Shuttle Discovery for the STS-120 flight to the International Space Station. This mission delivered and installed the Node 2, a major building block essential for further expansion of the ISS, including the addition of the European Columbus laboratory. Another important task of that mission was the relocation of one of the four solar arrays which provide power to the Station. Nespoli played a key role as the intravehicular activity astronaut for the mission's spacewalks, including the installation of Node 2. During the mission, named Esperia, Nespoli also performed a number of experiments for the European scientific community in the area of human physiology and biology. Nespoli also took part in educational activities.

In November 2008, Paolo Nespoli has been assigned to Expedition 26/27, a long duration mission to the International Space Station planned to take place from November 2010 to May 2011. He recently started his ISS training in Russia and in the US.

From 25th April to 5th May 2002 **Roberto Vittori** participated in a taxi-flight to the International Space Station, under an agreement between the Russian Space Agency Rosaviakosmos, the Italian Space Agency ASI and ESA. One main goal of this mission was the successful delivery of a new 'lifeboat' to the Station for use by the resident crew in the event of an emergency.

His second mission to the International Space Station, the Italian Soyuz mission 'Eneide' took place from 15th to 25th April 2005. As flight engineer on both ascent and return, Vittori had an active role in piloting and docking the spacecraft. On board the ISS, Vittori performed an intensive experimental programme.

In January 2009 Vittori started his training in Houston in preparation of a Shuttle mission to the international Space Station that will take place in July 2010.

Among the six new recruits of the European Astronaut Corps, that ESA presented on May 20, two are Italian: **Samantha Cristoforetti and Luca Parmitano**.

They were selected following a Europe-wide recruitment process that started 2008. Following thorough psychological, medical and professional screening that started with 8413 valid applications, they are the first new recruits to join the European Astronaut Corps since 1992. Samantha Cristoforetti is the first European astronaut lady.

Space Transportation

Italy supports the development and realization of transportation systems that contribute to the strategic independence of European access into space by means of several projects regarding current European launchers family and future (expendable and reusable) launchers. Activities are supported within the frame of contribution to ESA programs or of national development programs.

Most of the Italian activities dedicated to the actual European launchers family sector are included in the ESA Programmes, such as **ARIANE 5** (production and evolutions support), **VEGA** (development support) and **SOYUZ** at the Guyana Space Centre (development support).

Italian main contributions to **ARIANE 5** related programmes, such as evolutions and upgrades, infrastructures, support to production, surveillance, include solid boosters and the first stage turbo pump.

Italy is the main sponsor of VEGA with 65% of the total cost. VEGA is a small launch vehicle for satellites up to 1,5 tons in Low Earth Orbit. This program includes the development both of the

launcher and of the ground infrastructures at CGS (Guyana Space Centre), which are deemed as necessary for the integration and exploitation of the launch vector.

The year 2009 is marked with a final series of successful firing tests of solid rocket motors that confirm the performance capability of the VEGA launch system. In addition, the Italian satellite LARES, developed under ASI contract and selected by ESA as the first payload to be embarked on VEGA Qualification flight, is ongoing its design and realization phases. The main scientific objective of the LARES mission is the measurement of the dragging of inertial frame due to the Earth's angular momentum, or Lense-Thirring effect, and a high precision test of the Earth's gravitomagnetic field with accuracy of the order of a few percent. The LARES System will provide a significant contribution to accomplish the objectives of the VEGA Qualification Flight, whose first launch is now scheduled for the second semester 2010.

Italy supports the ESA program Soyuz that includes all necessary activities to launch the Russian vector Soyuz from the European base of CSG at Kourou.

With the aim of studying evolutions of the Vega launcher, ASI is supporting on national basis the **LYRA** project. In the framework of a Memorandum of Understanding on the Cooperation on Launcher and Space Propulsion, Italian and Russian industrial companies, under the provisions of national agencies, have started a cooperation concerning the development, manufacturing and testing of a new demonstrator engine operating with liquid methane as fuel. The propulsion activities are supported by launch vehicle system studies, aiming to provide possible architectures for the future evolution of the Vega Launch Vehicle, together with Guidance Navigation and Control (GNC) improvement activities.

On a national basis, ASI is supporting several other research and development projects, focused on the investigation and evaluation of key technologies for future space transport systems (expendable and/or reusable): among others, there are ASA project (innovative materials and structures for hot structures); CAST project (Aerothermodynamics and Aerodynamic for lift-off and re-entry). Further future initiatives are foreseen (Hybrid propulsion, Nanotechnologies, etc).

In the field of the future launchers, Italy is also involved in the ESA Future Launcher Preparatory Programme, with activities on System studies, Materials development, Propulsion, and mainly on Experimental re-entry Vehicle.

Telecommunication and Navigation

ASI participates in satellite navigation and telecommunication programmes in order to foster the research activities and demand of such services in the citizen life.

New satellites are being aimed at a number of different missions: mobile communications, multimedia services, and satellite navigation for accurate positioning of air, sea and ground transportation. Italian industry is now present in advanced sectors such as Ka band systems, L band systems, communication systems for civil protection, etc. ASI has now started to experiment and develop new services and technologies for the ground segment as well as for the space segment.

For multimedia and interactive communication (Tele-education, Telemedicine) ASI participates in **ARTEMIS**.

Italy develops telecommunication payloads and services able to increase the quality, quantity and variety of data offered to the end-users. The Italian scientific and technological community is committed in the development of new services and applications such as Tele-education, Institutional Telecommunication for Security and Emergencies, Telemedicine through prototype projects in collaboration with other public administrations.

ASI supports the development of high frequency communications capacity through research and innovation. In particular, ASI is carrying out three projects concerning experimental communication payload in W, Q/V and Optical bands. To this purpose three studies of feasibility of phase A has been carried out, which deduced that - by using current technologies - high frequency systems may be put into practice. Three A2 Phases are in progress.

Concerning the **Q/V band**, ASI is developing the first experimental telecommunication civil network in the world operating at **40/50 GHz**. It is composed by a space segment, that will be flown onboard the Alphasat ESA satellite, and a ground station network that includes earth stations in Italy and throughout Europe. Phase B studies on W and Optical bands will be started soon.

An important Italian project in cooperation with France is **ATHENA-FIDUS**. The project will develop a geostationary satellite for dual broad-band communications services dedicated to independent users and for Italian and French dual government use. The use of "bands" oriented towards providing broad-band telecommunications services in the entire hemisphere of the geostationary orbit is also foreseen to support military actions and Italian institutional and humanitarian missions abroad.

Athena-Fidus will realize a telecommunications infrastructure that can substitute/integrate ground networks in case they are not available or if they are damaged.

The system will provide the following services:

- Broad-band access to Internet for fixed or portable terminals located in areas with low levels (or degraded levels) of communications infrastructures (for the management of natural or harmful disasters in situations of general emergency)
- Broad-band telecommunications services for police force terminals (for example, access to remote multimedia databases)
- "Seamless" interconnections (LAN-to-LAN, Virtual Private Network) between sites that have local telecommunications infrastructures
- Telecommunications services to provide remote surveillance in critical areas (ports, airports, railway in both natural disaster and non-disaster areas, etc.)
- Telecommunications services for Armed Forces that complement existing or provided military solutions foreseen in the near future.

TELESAL is an Applicative Pilot Project in Telemedicine, managed and co-funded by ASI and the Italian Ministry of Health. TELESAL is an open system of applications and telecommunication systems that connect users with health care needs to centres providers of telemedicine. It provides a quality assistance also outside the hospital structures and in this way it helps to avoid their logistic congestion.

TELESAL technology will be onboard the Italian Costa Crociere fleet's flagship, and will provide cruisers and crew with a real virtual emergency room, working around the clock to support the resident medical staff.

In general, TELESAL aims at assuring the maximum propagation of medical education. It also intends to provides health assistance in developing countries.

Since long time Italy has recognised the potentiality of satellite navigation in fostering many applications and undertook initiatives to develop pre-operational projects to pave the way to an extensive use of it.

The Italian Space Agency funds **EGNOS** and **GALILEO** projects (one of the four Major founders), takes part in the GALILEO & EGNOS European Management Boards and Technical Control Bodies, promotes and develop National Application Projects aimed at fostering the use of satellite navigation, harmonizing them with European Projects.

The national satellite navigation projects answer to the specific public demand of increasing the Safety in the Transport Sectors and in general of improving territory safety and security. Satellite navigation helps to increase the safety but at the same time its use has to be suitably "protected".

The ASI plan of activities comprises a set of macro Projects in the transport sector, developed in strict coordination with the Ministry of Transport and Infrastructures: a **maritime Project** focussed on sea-highways and personal navigation, a **Dangerous Goods Transportation Project** aimed at supporting all the phases of this delicate transport activity, a **Civil Aviation Programme**, developed together with the National entity for Air Traffic Control ENAV, aimed at introducing EGNOS services and GALILEO services in the world of ATC/ATM.

Another project regards a specific project aimed at introducing the use of GALILEO Public regulated Service (**PRS**) with the governmental entities devoted to the safety and security of national territory.

Further, there is a project aimed at sustaining **Infomobility** and providing new services for traffic control, road tolling and billing. Then, a specific project has been set up to develop new services for urban mobility of **blind people** in order to provide them with detailed navigation both outdoor and indoor.

Two additional supporting projects are transversally sustaining these application projects: a project to foster the **Software Radio** technology within the satellite navigation terminals and a GALILEO geographic Test Bed, called GTR (**GALILEO Test Range**) aimed at developing a test area for signal analysis performance and terminals evaluation. It allows for a number of supports in Satellite Navigation programs: Emulation of Galileo signals generation, GNSS signals analysis and performance evaluation, support development of GNSS standards, validation of Terminals and sustain development of innovative applications and services of satellite navigation.

The Galileo Test Range, which will constitute an Excellence Centre for satellite navigation, has been developed in its First Stage by Regione Lazio and ASI that is going to bring this facility to its full development in the Second Stage of development.

There are also technological projects studies aimed at developing innovation in the field of satellite navigation **Signal Generation**. The projects study and carry out second-generation signal generators of navigation supplying, by exploiting frequency bands already assigned to the satellite radio-navigation system Galileo, best performances in terms of coding and modulation, so to guarantee to users the updating of their own data as well as their own position at a better rate than the one which is currently available, as well as more precise and accurate services. Furthermore, the possibility of application of signal optimization techniques with the aim of exploiting part of the available band as a communication channel between users has been studied.

Considering the reference clock on navigation satellites, ASI is supporting the development of two **atomic clocks** for Galileo 2nd generation (in substitution of the present clocks, in particular of the hydrogen maser PHM). Both projects, POP and ORA, respond to the above mission objective with some differences:

- POP (atomic clock using the Pulsed Optical Pumping technique), offers a stability close to that of the passive hydrogen maser (PHM) of Galileo constellation, but with less operational constraints and lower mass, size and power consumption;
- ORA (Optical Atomic Clock based on *neutral Strontium* (87Sr)) explores the possibility to develop a clock whose performances exceed the values foreseen for PHM, and characterized by very high long term stability.

ASI has strongly contributed to the UN-COPUOS Working Group on Satellite Navigation, as co-chairman with U.S., and favoured the establishment of the **International Committee on Satellite Navigation (ICG)**, which has started its works in 2005. Italy supports the objectives of the Committee, in particular, its function as coordinator among providers of the **Global Navigation System of Systems** and as focal point for international information exchange related to its activities and will chair and host the 2010 ICG Assembly in Turin in the week 18-22 October 2010.

Medicine and Biotechnologies

Italy is committed to enhance knowledge through space research and transfer it to diagnostic, therapeutic, preventive and biotechnological applications.

During the year 2009 the main activities were the followings:

1. **ALTEA**, Anomalous Long Term Effects in Astronauts is the third instrument developed by ASI for Life Sciences experiments on board the ISS. It was launched on board the Discovery Mission STS-121 in July 2006. The Mission ended in August 2007. In 2008 an agreement was signed with NASA to utilize this instrument as a detector for operational purposes. Thanks to this agreement Altea is today operative on board the ISS in DOSI mode.

2. **ELITE-S2**. The facility ELITE S2, forth ASI ISS payload for bio-medical experiments, has been launched on board Discovery in August 2007. The system is able to represent the movements of astronauts with extreme precision (less than one millimetre), and it is aimed at performing neuro and motor control studies in microG. The big amount of scientific data resulting from the experimental campaign conducted in 2008 are being evaluated by the scientists. The instrument is still on board the ISS waiting for other experimental sessions planned in 2010.

3. **MDS**. The MDS facility is an experiment with small rodents on ISS; the facility has been uploaded in the Station on August 2009, and is at the moment fully functional. The long durance experiments being conducted through the MDS facility aim to bring new light on the genetic mechanisms which drive the physiology and pathologies of the bone mass.

4. **BED-REST**. In the field of the national programs Osteoporosis and Muscle Atrophy (OSMA) and Disorders of Cardiorespiratory and Motor Control (DCMC), the second entirely Italian Bed-rest study has taken place in August 2008. The activity was set in collaboration with the University of Primorska (Capodistria, Slovenia).

5. Call for Ideas: **MARS 500** is an international project which regards a simulation of a human mission of long duration. Two Italian experiments were selected in 2008 and have been performed inside the Russian NEK facility, in Moscow, during the summer in 2009. The experiments are now concluded and the results are being evaluated by the scientific community.

6. Call for Ideas: **VUS**. In foresight of the flight of the Italian astronaut Roberto Vittori on the ISS, MED has originated a call for ideas; life sciences experiments are now being selected and will be performed in orbit during the permanence of Roberto in orbit in July 2010.

7. **DCMC**. After three intense years, the DCMC project has ended producing interesting results. "Disorders of Motor and Cardiorespiratory Control" is a national program aimed at developing scientific and clinical know-how in the field of gravitational physiology and at finding application of space fallouts to rehabilitative treatments of neuromotor and cardiorespiratory diseases.

8. **OSMA**. Osteoporosys and muscle atrophy are strictly connected pathologies, both related to ageing and to degenerative pathologies. ASI OSMA project aims at explaining the unresolved problems connected with these pathologies, that with incredible similitude are noticed both in old age and in astronauts. The OSMA program will conclude its studies at the end of 2009, with the study of first inflight results of the Italian payload MDS.

9. **MoMa**.

This programme aims to improve the level of scientific knowledge of the aging processes in Space and on Earth, and to develop countermeasures against the effects of severe and extreme environmental conditions. With this acquired knowledge, adequate preventive, diagnostic and therapeutic strategies will be elaborated. Innovative countermeasures for human health in Space, and the subsequent improvement in the quality of life of the elderly on Earth are the end targets of these activities. The program, coordinated by the University of Udine, involved 57 research institutes and in July 2009 successfully concluded its first phase.

Operative Centres

Centre for Space Geodesy "Giuseppe Colombo"

Located in the municipal district of Matera (southern Italy), the **Centre for Space Geodesy** (CGS) is dedicated to the late Professor Giuseppe ("Bepi") Colombo. Dedicated in 1983, the CGS is mainly devoted to Earth observation through advanced space techniques as space geodesy and remote sensing.

The presence of different observing methodologies (satellite and lunar laser ranging or SLR/LLR, very long baseline interferometry or VLBI, GNSS positioning, absolute gravimetry) makes CGS one of the few fundamental stations in the worldwide network, playing a crucial role for global geodynamics monitoring, from the long wavelength geopotential recovery to the materialization of the international Terrestrial Reference Frame.

CGS also hosts the civilian data user ground segment of the COSMO-SkyMed mission.

In line with ASI assignment to promote space technology for environmental managing and protection, ASI is implementing in Matera the **CNM** (National Multimission Centre) for acquisition, long term archiving, processing and dissemination of EO data and products.

During 2009, the CGS has carried out the whole spectrum of operational and data analysis activities in the fields of space geodesy and remote sensing and has continued to supply the international community with high accuracy results.

Stratospheric Balloon Base of Launch

The Stratospheric Balloon Base of Launch located in the region of Trapani-Milo (Sicily) was opened in 1975 and represents a world renowned structure able to carry out the design, the launch and the flight management of this specific technique, with a specialization in the systems of great mass and volume.

The launch base is located within an old airport 90 hectares large at the outskirts of Trapani, an ideal geographic location for trans-Mediterranean and transatlantic launches.

The Stratospheric Balloons Launch Facility is dedicated to the planning, development, launch, in-flight management and recovery of scientific and technological missions carried out using stratospheric balloons. The Base operates in collaboration with other agencies and national and international institutes (ARR, CNES, NASA, CNR, ENEA/PNRA, universities and international agencies)

Stratospheric balloons are in fact one way of access to space that Italy can manage autonomously and in which there is the expertise and rare specialization in the international space framework, combined with the special geographical position of the national site.

In order to achieve excellence ASI is promoting and encourages collaboration with scientific institutions as research centres and universities with consistent background, which provide competence on specific topics and are actively involved in projects and eventually used as on site support.

The "road map "of stratospheric ASI activities is the following:

1. Trans-Mediterranean missions: Consolidated activity carried out in the frame of ASI-INTA (Spain) MOU with stable uses in technological and scientific fields;
2. Long duration circumpolar missions: Activity with perspective of increase in the frame of ASI-ARR collaboration especially in the Arctic area for the development and operation of the Nobile/Amundsen Stratospheric Balloon Center – Svalbard (NASBC).
3. Circumequatorial LDB missions: Consolidated activity carried out by ASI:
 - Open the stratospheric flight activities in order to set-up a permanent launch facility in ASI and in Broglio Space Centre (Malindi- Kenya).
 - Up to 8 Pathfinder Flights (MA.BA.CA) (Malindi Balloon Campaign) will be performed from "Luigi Broglio Space Center" of Malindi (Kenya) in order to verify the feasibility and the typology of flights allowed; the activities have been started with the local and periodic launches of stratospheric radiosondes.
 - The activity will involve also the CNES team
4. Local missions: Activity consolidated with perspectives of increase for interplanetary and re-enter missions (USV, AURORA)
5. Educational missions: activity with increase perspectives but to verify also based on the costs; possibility of development in the student formation Flights foresee from all launch sites.

In the ANNEX II information about the recent SORA Campaign.

ASI Science Data Center

ASI's centre for the management and analysis of scientific data

The ASI Science Data Center (ASDC) is a multi-mission, multi-disciplinary, science operation center, data processing and data archiving facility. The ASDC has been built on the experience acquired within ASI with the management of the BeppoSAX Science Data Center in the late 1990s. It is located at the ESA site of ESRIN in Frascati, Italy where it has been in constant evolution since its establishment in November 2000. At the moment it has major responsibilities for three operational high-energy astronomy satellites, Swift, AGILE and Fermi, supports a number of Italian experiments aboard solar system exploration satellites (eg. SHARAD, MARSIS, etc.) and the archives for Herschel and GAIA (ESA) missions. Several new projects are foreseen for the future.

ASDC is fully funded by Italian Space Agency and it is part of the Observation of the Universe Unit. It operates in cooperation with ESA, NASA, INAF and INFN through specific agreements such as Memorandum of Understanding, Letters of Agreement and National Cooperation Agreements which define the responsibilities and the roles of ASI and ASDC in each program. Each year a detailed plan of activities is proposed by the ASDC Director to the ASDC Board, an external body which includes members of all National Institutes involved in the Center. The ASDC internal organisation is based on two main Boards, the Executive Board and the Scientific Board, which manage the supported projects and coordinate the scientific research. The national and international community provides feedback to ASDC through a User Committee. ASDC scientists belong to the active national scientific community.

In 2009 ASDC scientists have contributed to many important scientific activities leading to the publication of over 100 papers in international refereed journals. The most important results include the discovery of several Gamma-ray Bursts with Swift, of the most distant object in the Universe (at about 13 billions of light years), of many gamma-ray pulsars and blazars with Fermi and AGILE and of the Terrestrial Gamma-ray Flashes with AGILE.

Moreover, AGILE detected the Gamma-ray Emission from the Eta-Carinae Region, which is the first experimental confirmation of gamma-ray emission ($E > 100$ MeV) from the collision winds in a binary stellar system, and the Gamma-Ray Emission from the Vela Pulsar Wind Nebula, which is the first experimental confirmation of gamma-ray emission ($E > 100$ MeV) from a pulsar wind nebula. (<http://www.asdc.asi.it/>)

"Luigi Broglio" Space Centre in Malindi (Kenya)

Italy and Kenya are co-operating in space activities since 1964 through an inter-governmental agreement, the San Marco Project, renewed on 14th March 1995 for further 15 years and now in phase of re-negotiation.

In this framework the Space Centre "Luigi Broglio" was developed in Kenya. The Centre is located at 2° 56' South, 40° 12' East, on the Indian Ocean, near Malindi. The location is ideal to launch and support equatorial satellites and acquire Earth Observation (EO) images over the Central and Eastern Africa region.

The Broglio Space Centre (BSC) is subdivided into two main domains (segments):

- the **Sea Segment**, consisting of 5 offshore platforms equipped for the launch of satellites and sounding rockets and motorboats for personnel and material transportation between the mainland and the platforms;
- the **Land Segment**, known as Base Camp, covering an area of about 3.5 hectares. It contains a TT&C Complex, with two ground stations that provide real time acquisition, reception, recording, and transmission of satellite data, and a Remote Sensing Centre, dedicated to Earth Observation satellite data acquisition and processing, and includes a geophysical facility.

The space activity is concentrated in the two Ground Stations located at the San Marco Project base: MLD-01 and MLD-02.

MLD-01 is presently active in the acquisition of SWIFT and AGILE satellites.

MLD-02 is active in the acquisition of:

Tracking from and Hosting Support at Malindi for ESA:

- Hosting of ESA Equipment;
- TT&C of spacecraft during critical and routine phase (starting in June 2009);
- Tracking of Launchers (starting TBD);
- Tracking and payload data downloads of earth observation missions (starting TBD).

Tracking of Arianespace Launchers from Kourou CGS

- hosting of ESA/CNES equipments;
- tracking support to be provide to ESA/CNES launchers launched by the European Launch Base CGS in Kourou.

Support to Chinese human missions Shenzou.

The BSC is also hosting an experimental GALILEO sensor station to test the reception of the navigation message transmitted by the first two satellites of the constellation: Giove-A and Giove-B. The data collected are then relayed to the European Space Operation Centre (ESOC) in Darmstadt (Germany) for analysis.

The Remote Sensing Centre (RSC) is on stand-by in the acquisition of Earth observation satellites.

The Joint Steering Committee for the management of the bilateral agreement has appointed a joint Working Group with the task of producing a Feasibility Study for the realization of a Regional Centre for Earth Observation in Kenya. The study is complete and it foresees a distributed facility: acquisition, pre-processing, archiving and cataloguing would take place at the BSC in Malindi; processing, specific products generation and distribution to users would take place in Nairobi.

Since August 2008, ASI has started the activities to evaluate the possibility to launch stratospheric balloons from the San Marco Base.

The program foresees a Feasibility Study Phase to understand the wind's behaviour on ground and in the air column up to the stratospheric level, and will use simulation programs and ground and sounding surveys.

The campaign will last two years, and at the end it will be possible to verify possibilities and to set up a stratospheric balloon launch capability at the San Marco Base, and will prepare an implementation plan. In case of positive decision, the Kenyan research community will be encouraged to participate to this new activity.

Space Education

ASI promotes and funds scholarships for Masters and higher education courses to allow Italian students to have access to aerospace studies. In order to encourage the Italian participation also in international higher education courses, ASI promotes different initiatives such as the "Summer School at Alpbach" that is yearly organized by ESA and the Austrian Space and Research Agency.

An agreement among ASI and the University and Polytechnic of Bari regulates the cooperation on joined educational programs in the field of Earth Observation and its scientific applications. In Summer 2009 a 2 months course on SAR technology and applications was organized. The course was held at the ASI Space Geodesy Centre in Matera. Lessons, practice and case studies were conceived for newly graduates students and young researchers who wanted to growth in their knowledge of new technologies and applications in the field of Earth observation.

On the basis of an agreement with the Conference of the Italian University Rectors, ASI organize internships for university students and newly graduates, chosen among the most motivated. This is the main internship program, but ASI – to increase the number of participant students - has recently signed some more agreements with single universities and educational institutions. ASI usually awards internship holders a monthly scholarship, in relation to the evaluation of educational objectives achievement.

In addition, ASI supports the education and culture of the space technologies and applications also through several projects dedicated to teachers and students, and by promoting the use of high-tech and computer technology. In particular, ASI, in cooperation with the Italian Aerospace Research Centre, CIRA, is coordinating the activities concerning the programme "**Aerospace Educational Web Channel**". The main purpose of this program is to broadcast

via Internet educational modules regarding aerospace topics suitable for younger students. In support of this program is a web-site (www.spazioallescienze.it) that is a cultural bridge between schools and the institutions on favour of the spread of aerospace culture.

ASI has finalized the development of "Star4Physics", an original video-game via internet, named **edu-tainment**, (education-entertainment) that aims at teaching young people the fundamentals of physics.

Some students have prepared an experiment in biology that was launched on board Discovery last October 2007. During the mission, a two-way radio contact between students and the Italian astronaut Paolo Nespoli were realized with success.

In occasion of the Discovery mission, a comic was published and distributed through an Italian Magazine.

The Italian Space Agency is also deeply involved in developing new communication and promotion of activities oriented towards primary schools students. In particular, ASI produced three comics books on space topics (astronauts, EO and astrophysics) and completed a didactic and fascinating performance on astronomy, called "Minuetto Astronomico". At the moment, ASI is working on a new 3D didactic puzzle of COSMO-SkyMed satellite.

Every year ASI takes part in several educational events and fairs, such as "ABCD Italian Educational Fair" in Genoa and "Science Festival" in Rome. From October 2009 to February 2010 ASI will participate in a space exhibition called "Stars & Particles, the words of the Universe" at the Palazzo delle Esposizioni in Rome.

Italy is engaged in several educational space initiatives with international partners.

In the frame of ASI participation in "**Mario Gulich**" Institute (Cordoba, Argentina), annually, the Italian Government offers some fellowships to Argentinean students and researchers that offer them the possibility to study in Italian Universities and remote sensing research Centres.

The Mario Gulich Institute was originated in an agreement between the Argentine National Space Agency (CONAE) and the National University of Cordoba (UNC). From its creation the Italian Space Agency has had a significant participation in the Institute. A new Masters in Emergency Early Warning and Response Space Applications (AEARTE) has started and all the 13 students will spend six month in Italian Universities for a specialised stage.

In the frame of the Inter-governmental Agreement between Italy and Kenya regarding the **San Marco Project** in Malindi (Kenya), ASI supports the technical education and professional training of Kenyan students. Scholarships have been offered by the Italian Government to Kenyan researchers for PhDs in Italian Universities.

Moreover, the first step of a middle-term project that regards the participation of Kenya in a small space mission has started in 2008. A 18 months scholarship funded by ASI was awarded to three Kenyan young graduates. The three Kenyan engineers attended a six months Master in Satellites and orbital Platforms organized by the University of Rome "La Sapienza" and are now doing a twelve months training on job in the Italian space industry. The students is given the opportunity to develop both technical and managerial capabilities and skills.

International Relations

Bilateral and multilateral space cooperation is a fundamental pillar of the Italian space policy, which is promoted and managed by the Italian Space Agency.

The international space cooperation is articulated in two levels: the participation in the European Space Agency with the contribution to the European Space Policy and the bilateral relations and cooperation with European and non European Countries, besides the participation in International Organizations.

Currently, Space agreements with many space agencies or Countries are in force, among the others: ESA, CNES, DLR, Spain, Norway, NASA, ROSCOSMOS, CONAE, CNSA, CNES, ISRO, JAXA, BSA, ISA, Argentina, China, Russia, Kenya. However, intensive relations are in place with other countries in order to finalize new fields of collaboration.

At multilateral level, Italy is member of the UN/COPUOS and actively follows its activities through the Scientific and Technical Subcommittee and the Legal Subcommittee. In particular, Italy is interested in providing a relevant contribution to the global Sustainable Development through some COPUOS issues, such as the Space Debris, the Global Navigation Satellite Systems, the joint group COPUOS-IAEA (International Atomic Energy Agency), the implementation of the recommendations of UNISPACE III, the support to a disaster management space based system.

Italy participates in many international space organizations and *Committees fora*, such as GEO (Group of Earth Observation), CEOS (Committee on Earth Observation), ICG (International Committee on GNSS), the OECD-Global Forum on Space Economics (GFSE) and the Inter-Agency Space Debris Coordination Committee (IADC). ASI is also member of some other international Association and Institutes as IAF, ESPI, EURISY.

Participated Companies



The Company's corporate object consists in the development, manufacturing and marketing of products, services and applications for the Observation of the Earth. In particular the company is concerned with:

- design, implementation and marketing of applications, products and services for the Observation of the Earth;
- operation of land plants and services as well as of facilities conceived for the Observation of the Earth;
- management, application and technological advice;
- design and development of pilot applications and dedicated infrastructures;
- access to data and electronic marketing; - processing and transfer of technologies and skills to support industrial innovation;
- technological research and development of topics concerning the Observation of the Earth, with a special care for the development of market opportunities to be exploited directly or through third parties;
- promotion of innovative enterprises, including venture capital ones. <http://www.e-geos.it/>



Advanced Logistics Technology Engineering Center S.p.A.

Established in 2001, ALTEC is currently an SPA (public company) participated by ASI (29%), Alenia Spazio (51%) and ICARUSW (20%).

After the establishment of ALTEC S.p.A., ASI, as paracorporate agreements, entrusted Alenia Spazio first and then ALTEC some contracts for the supply of engineering and logistic support services to NASA and for the provision and maintenance of MPLM spare parts as well as for the support of their missions.

In particular ASI has requested the pursuing of sustainable development strategies for long-term programmes by also procuring private contracts and identifying any other funding opportunity from both government and private organizations.

Company's purposes include:

- the provision of engineering and logistic support services for the Space Station operation and activities as well as for the employment of other orbital infrastructures to ASI and ESA as well as to other Space Agencies and any Public Bodies, Scientific Communities, Italian and foreign Companies and other private organizations. Services are also included for storing, processing and distributing data concerning the abovementioned infrastructures;
- the promotion, marketing and selling of the Space Station opportunities and the relative provision of the engineering services required.



The Italian Centre for Aerospace Research

CIRA S.c.p.A. was founded in 1998. The Italian State controls it through the Italian Space Agency and the National Research Council. The Campania region and the main aerospace companies in Italy also have stakes. Employing over 300 staff, CIRA is entrusted with the implementation of Aerospace Research National Programme, as regulated by Ministerial Regulations n. 305 of 10/06/1998.

The Aerospace Research National Programme is a governmental measure, devised in compliance with the National Research Programme and with the National Space Plan which meets the requirements as expressed by Industry and Research.

The Aerospace Research National Programme takes into account the international prospects of aeronautical and space industry and consists in:

- the performance of scientific and technological research, education and training of aeronautical and space industry workers, to be pursued also through the involvement in European and International research programmes, in accordance with the scientific, technological and financial progress of the same industries and in compliance with the relative national and international schemes;
- the execution and management of works, facilities and infrastructures, capital goods and equipment required for the activities mentioned above, which are part of the Country's asset;
- By statutory law the annual grants-in-aid for CIRA overheads amounts to approx. Euros 20 million, while for the implementation of PRORA the State fund as fixed in 1989 amounts to about Euros 389 million, over 296 of which already invested (PRORA Monitoring Commission has fixed the deadline for the employment of the appropriations by the years 2007-08).

<http://www.cira.it/html/inglese/home/>



ELV SPA European Launch Vehicle

ELV is currently controlled 70% by Avio SpA, and 30% by ASI.

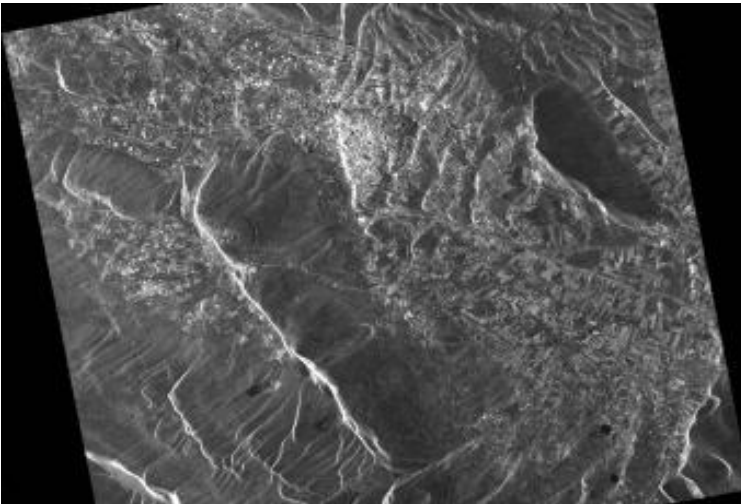
The company operates in the aerospace business in Italy and abroad and is in particular concerned with:

- 1) the management of Vega Programme as Prime Contractor;
- 2) the implementation, supervision, coordination and the direct and indirect monitoring of the design, production and manufacturing, and modification of the Vega launcher, its components and equipment. In particular it carries out:
 - o launcher system analysis;
 - o launcher integration and its management;
 - o launcher testing;
- 3) the assignment of Vega Programme implementation activities to sub-contractors selected in accordance with ESA (European Space Agency) principles;
- 4) the direction of programmes for the implementation, the supervision, the coordination and direct and indirect monitoring of tests and research programmes concerning the development of small-sized launchers and their components and equipment;
- 5) strategic marketing of small-sized launchers;
- 6) study, research and advice services.

ANNEX I

Italian COSMO-SkyMed satellites monitor the Abruzzi earthquake

The ASI satellite system for Earth Observation, COSMO-SkyMed acquired the first images of the area struck by an earthquake (magnitude 5.8 Richter) during the night between the 5th and the 6th of April 2009.



*Figure 6 – Flood evolution Map
[Credits to WFP]*

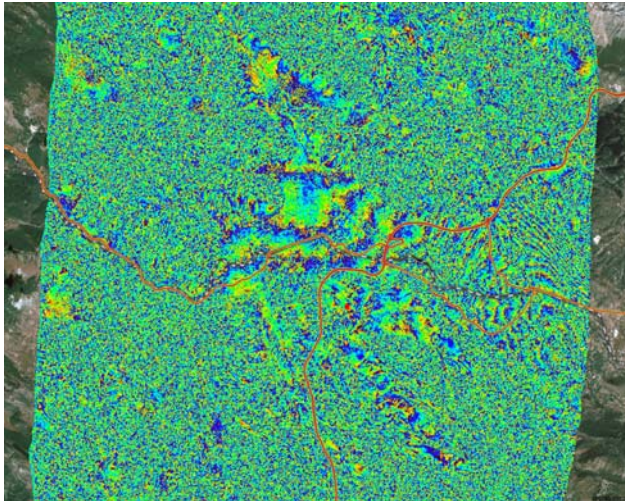


The image shown here next was obtained by comparing an earlier image, captured before the seismic event, and one taken on the 8th. The earlier image was artificially coloured in red, the later one in blue. The white areas correspond to those unchanged by the earthquake. The red spots are objects that appeared in the pre-seismic image but not in the post-seismic one, probably corresponding to collapsed buildings. Conversely, the blue/green areas reflected the radar signal in the second image but not in the first, so they may correspond to significant movements too.

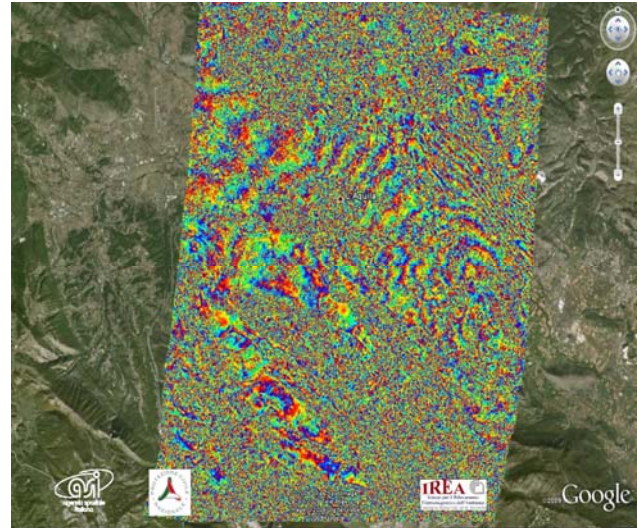
COSMO-SkyMed has kept providing images over the next days, allowing the Civil Protection Department to locate damages that were subsequently checked by helicopter.

The first interferograms

On April 11th the first interferogram of the area hit by the Abruzzo seismic event was obtained, in the framework of the collaboration between the Italian Space Agency and the Civil Protection Department, using data from the satellite system COSMO-SkyMed, processed by the IREA-CNR Institute.



The second one, also based on COSMO-SkyMed data, was processed by e-GEOS, a joint venture between ASI and Telespazio.

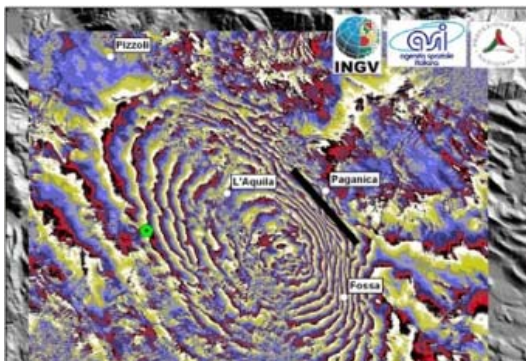


Both interferograms are based on images from the same geographical area taken with the same view angle, in different times, in order to measure geological changes using specific algorithms. These interferograms are based on two acquisitions taken by satellites on March 23 (before the earthquake) and April 8.

The interferogram (here shown over a Google Earth image) shows various coloured lines. Each complete colour cycle from yellow to blue corresponds to a movement of 15 mm in the terrain. In the most affected area, a movement of about 15 cm was detected.

The deep location of the earthquake fault

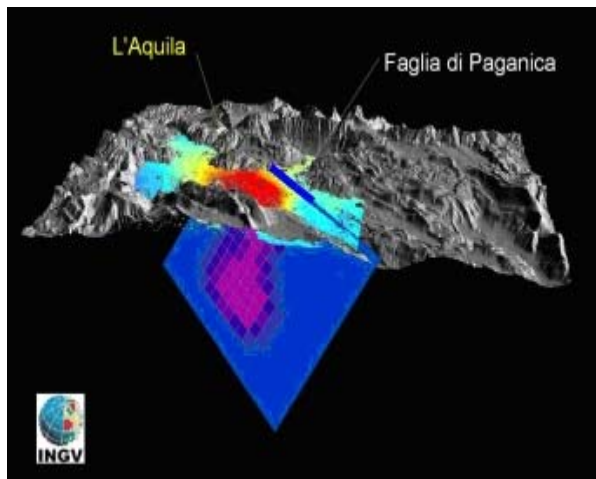
24 Apr 2009



Co-seismic ascending Cosmo-SkyMed interferogram covering the April 6, 2009

L'Aquila earthquake: pre-event image April 4, post-event image April 12. Each concentric colour band (fringe) indicates a ground subsidence (in the satellite Line of Sight) of 1.5 centimeters, for a total of about -25 cm between L'Aquila and the Fossa village.

This subsidence took place during the earthquake (co-seismic deformation) and is the surface response due to the dislocation at depth along the seismic fault plane. Using these and other observations, the Italian INGV (Istituto Nazionale di Geofisica e Vulcanologia) researchers have produced a numerical model of the seismic dislocation that allowed to identify to a good approximation the fault location, that is the fracture plane along which the dislocation of the Earth surface propagated. The black line in the figure above represents the partial outcrop of the fault plane itself.

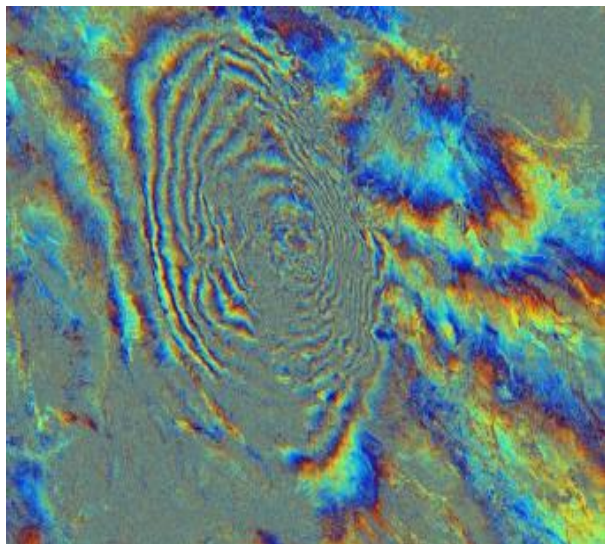


In this figure is shown the fault plane (in blue) obtained from the model computed by INGV starting from COSMO-SkyMed data. The fracture plane has a dip of about 50° towards the SW and passes under L'Aquila city.

During the earthquake, the Earth crust block located SW from the fault plane slid downside for a maximum slip of 90 cm at 4 km-depth, producing the ground subsidence pattern shown in the figure by red colour.

COSMO-SkyMed: the satellites continue to observe Abruzzi

03 Dec 2009



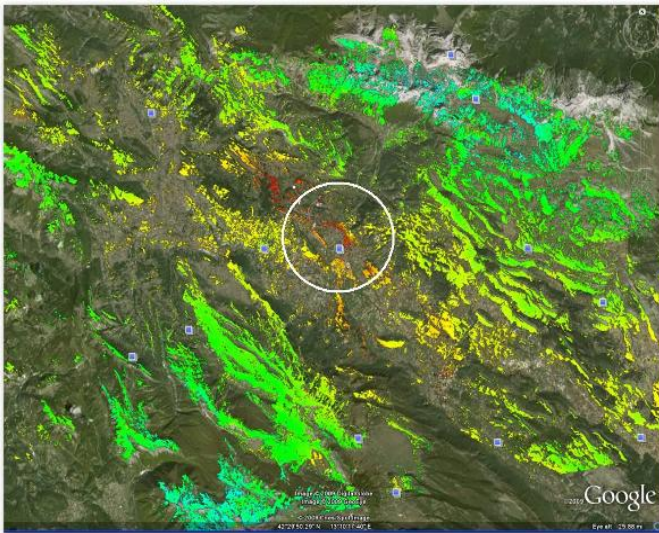
After the earthquake of 6 April, COSMO-SkyMed has continued to acquire images of Abruzzo for the Department of Civil Protection, for the purpose of surveying the earth movements in detail. The Department's objectives were particularly demanding due to the large size of the area concerned and the number of images that had to be acquired before they could have reliable measurements using interferometric techniques. Managing to reach the objectives in only a few months is a success story that was made possible by the unique operational capacity of COSMO.

The first results of this monitoring exercise have been made available by the MORFEO pilot project, one of the earth observation projects undertaken in collaboration with the Department of Civil Protection. MORFEO is an acronym which in Italian stands for "landslide monitoring and risk using earth observation data". It is a coordinated research and development initiative to create a prototypal system for supporting the Department of Civil Protection in evaluating and mitigating landslide risk. In order to monitor the deformations of the Earth's surface, it predominantly uses DInSAR technology, which offers a geographic and spatially distributed vision of the deformations to complement in situ measurements and GPS. Various

interferometric services are available in MORFEO, including maps of the areas to be monitored and low and high resolution maps of deformation, using SAR data in C, L and, of course, X bands.

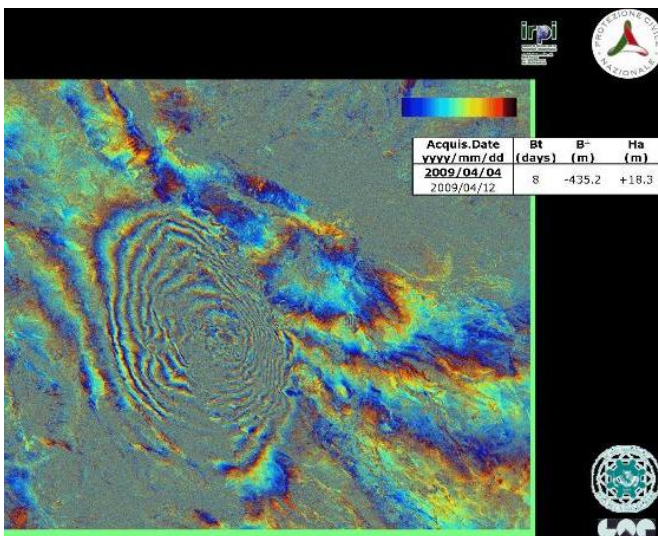
MORFEO is processing the COSMO Abruzzi data. Two scientific groups are involved in this interferometry work: IREA-CNR and the Physics Department of the Polytechnic of Bari, together with the GAP spin-off.

The results are truly significant and have already been presented at the FRINGE workshop at ESRIN in December 2009.



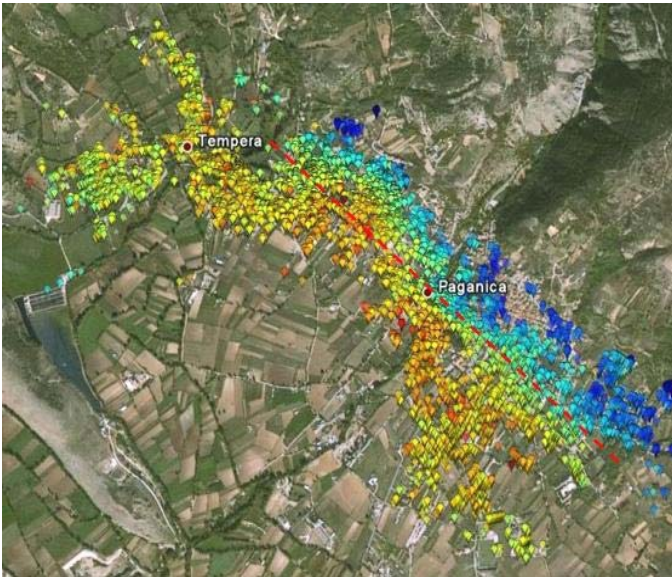
Post-seismic velocity

COSMO has continued to acquire data regularly after the shock of 6 April. This is the ground deformation velocity map obtained by the satellites. The low resolution, processed by CNR-IREA, allows us to assess the entire deformation pattern. The area of the fault is highlighted.



Co-seismic movements

The interferogram, obtained using a DEM with a resolution of 20 metres, combines two images taken by COSMO just before (4 April) and soon after (12 April) the earthquake, and shows the effects analysed soon after the event. Each fault is indicative of a 1.5 cm drop in ground level in the satellite's line of sight, inclined by about 36° with respect to the vertical.



Post-seismic movements

The high resolution, processed by the Physics Department and GAP, allows detailed mapping and also allows us to see the movement of single points close to the Paganica fault (the position of which is purely indicative in this image). In order to obtain these results 26 SAR images acquired by the COSMO-SkyMED constellation from 12 April to 20 September 2009 in stripmap image acquisition mode were processed. Analyses are still being made, also using ground data, to calibrate the satellite measurements.



L'Aquila

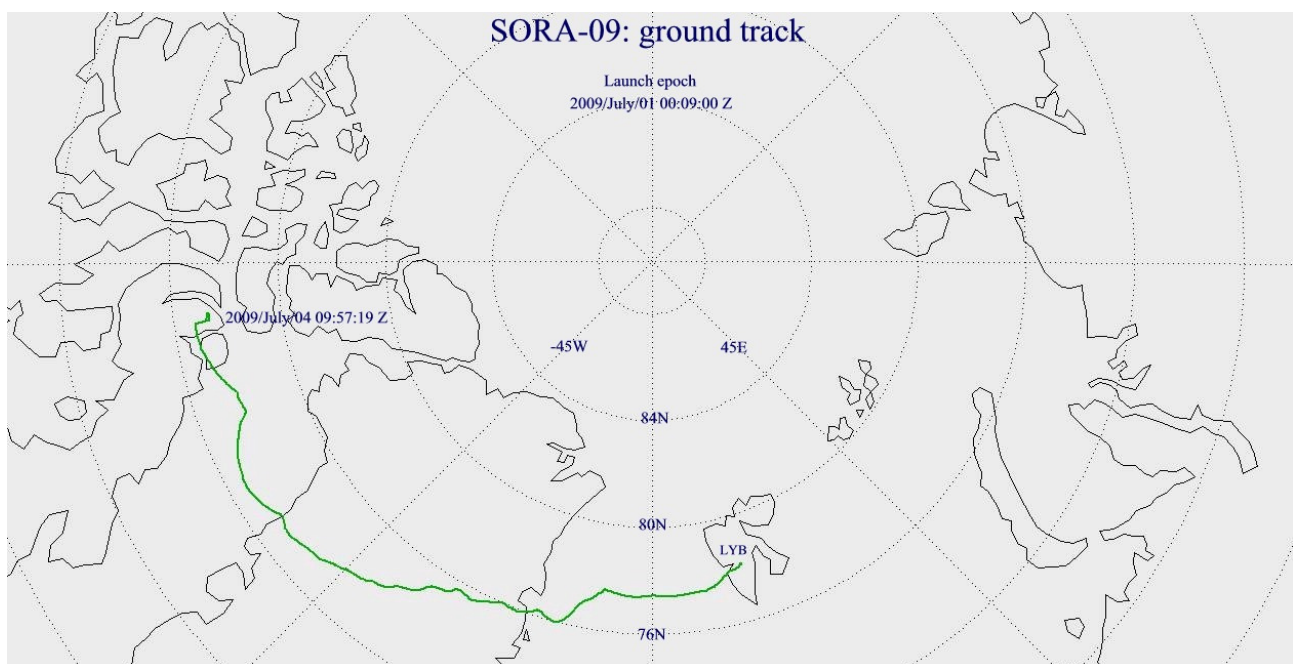
This is the detailed velocity map of L'Aquila (the castle can be clearly seen).

ANNEX II

SORA CAMPAIGN

May 24 – July 7, 2009

Early in the morning of July 1st, 2009 an 800,000 cubic meter balloon lifted off from the Longyearbyen airport at 00:08 UT with a 1.487 kg payload...destination - the stratosphere. The balloon climbed up to the floating altitude of 38 km until reaching eastern Greenland where the balloon was then "valved down" to 37km using remotely controlled valves in the balloon's apex fitting. This was the requested altitude by the Italian experimenters. After crossing the Greenland Ice Sheet the balloon continued on to Baffin Island where the flight was terminated after 4 days at float and the payload then impacted under parachute at 72° 42' 784 N 82°23' 400 W landing in an upright position only 40 km from an airfield. Recovery operations began immediately.



The SORA payload, although the 13th balloon launched by Nobile/Amundsen Scientific Balloon Center in Svalbard, is the largest balloon ever launched from Svalbard. It is the next step in the road to the development of the ASI/ARR N/A-SBC.

Science

SORA is part of a test program of the Agenzia Spaziale Italiana (ASI) in order to test the two penetrating radars that ASI has prepared for the Mars exploration. The first instrument is MARSIS on board of Mars Express ESA mission; the other is SHARAD for the Mars Reconnaissance Orbiter NASA mission. The SORA experiment will be dedicated to testing SEP-Aft Ops Brief SORA 2009 SHARAD. MARSIS has a strong penetration power (a few kilometers) and lower vertical resolution, whereas SHARAD will penetrate only several 100s meters but its data will have high resolution range. SORA will consist of a stratospheric balloon flying at about 35 km above sea level that will carry the experiment. The balloon will carry a model of SHARAD with the electronics scaled to the experiment parameters. The balloon will be launched from the Nobile/Amundsen-Scientific Balloon Center in Svalbard where the facility is a joint effort between Andoya Rocket Range and ASI. Simulations of the balloon trajectory show a trajectory crossing the Greenland Ice Sheet and then continuing on towards Baffin Island where the flight will be terminated and the payload brought to the surface under a parachute. During the flight the balloon will get data from northern Greenland the Eastern Canadian Archipelago. The experiment will be able to investigate thick ice sheets, permafrost areas, seasonally snow covered zones and sea ice. This experiment will support the analysis of the

SHARAD data and will provide some clues on the use of a similar instrument on the icy satellites.

Mounted as "Piggy-Back payloads" on the SORA gondola were 4 additional experiments:

- DUSTER: (University Parthope – Naples) (Dust in the Upper Stratosphere Tracking Experiment and Return) was first launched by ISTAR from Svalbard during the 2008 summer campaign. The objective of DUSTER is to collect stratospheric aerosol samples and return the instrument to the laboratory where abundance, size distribution, composition and mineralogy can be measured for each class of materials collected. A sampling of the stratosphere invariably includes particles from different sources. At any time the stratosphere contains extraterrestrial dust, dust from natural terrestrial sources (volcanic dust, wind-blown dust, biomass burning) and dust related to anthropogenic activities. Launch of DUSTER took place on 21 July 2008 from Longyearbyen airport.
- SIDERALE...technological development (National Institute of Astrophysics –Milan): The development of CdZnTe detector technology with advanced signal processing is a fundamental step for the exploitation of the hard X-ray to soft gamma-ray domain (0.05-2 MeV) in future missions. This type of semiconductor detectors have revealed excellent performances in space without the need for cryogenic devices: well known is their stability (over years), intrinsic good spectroscopic capability and high radiation tolerance (long lifetime in space). CZT sensors can be now formed by growth of highly uniform, cm²-sized crystals and assembled into relatively large detection planes due to their predictable and reliable electronic properties. Their use in space missions like INTEGRAL (in the slightly different "CdTe" version) and SWIFT have largely demonstrated such important features. Improving efficiency, broadband extension and energy resolution is important to serve as reliable devices for future generation of space instruments. In particular, it is now desirable to develop specific techniques or design solutions to extend energy range into the MeV region.
- ISA (National Institute of Astrophysics – Tor Vergata (Rome)): Measurements of the inertial and gravitational accelerations acting on the "gondola" during the balloon flight. The informations concerning the pendulum oscillation and rotation of the gondola will be of primary importance in order to determinate the most favorable condition for the release from stratospheric altitude of the GiZero capsule, that will be used to execute the GReAT (General Relativity Accuracy Test). GReAT is an ASI/NASA SEP-Aft Ops Brief SORA 2009 experiments that aims to test the weak equivalence principle, at the base of the Einstein's General Relativity, with a precision of some parts on 10⁻¹⁵.
- PIC-CR (University of Rome LS): PIC-CR is a small experiment to test the operation of PIC 16F887 in the stratosphere, in the presence of a strong background of cosmic rays. The experiment is able to reset itself in case a cosmic ray event hangs the operation of the program. And stores the number of resets in its internal memory. In this configuration the experiment needs to be recovered to read the final number of resets. However, if a RS232 downlink is available on the payload, the experiment can be connected to it through its serial interface, for continuous download of its data. The data rate is a few bytes every 10 seconds, transmitted with a serial protocol RS232 2400 N 8

CONTRIBUTING AGENCIES

ASI – Italian Space Agency: Funding, Telemetry, Electronics

ARR – Andoya Rocket Range: Facilities Management, Ground Support

University of Rome LS – Science Representative, Contract Management

ISTAR – International Science Technology And Research: Campaign Management, Launch Operations, Recovery Operations

LNS – Ground Support, Equipment Operators

Publisher: **ASI – Agenzia Spaziale Italiana**

Address: Viale di Villa Grazioli, 23
00198 - Rome – Italy

Editor: *Gabriella Arrigo, Simona Di Ciaccio*
National and International Relations Unit

Press date: Rome, January 2010