ITALY

Space Activities

Year 2008

Report available electronically from the website:

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Content

Introduction *1988-2008: 20 years of ASI*

(http://www.asi.it/en/storia)

The history of the Italian space policy has its start in the end of the 1950s, while the Italian Space Agency (ASI) came into being in 1988, with the purpose to coordinate all of Italy's efforts and investments in scientific and industrial space sector.

Italy's conquest of space began in 1964 with the launch of the "San Marco" satellite, created for studying the lower atmosphere within the framework of collaboration between the Aerospace Research Centre of the University of Rome and NASA. The beginning of this series of satellites, which eventually find their natural launch base at the Italian centre of Malindi in Kenya, took place at the US Wallops Island Flight Facility base in Virginia. "San Marco" satellite was the first European satellite to be launched and made Italy the third country in the world, after the Soviet Union and the United States, to have launched its own satellite.

Within twenty years, ASI became one of the most significant players in the world in space science, satellite technologies and the development of mobile systems for exploring the Universe. Today, ASI has a key role at the European level where Italy is the third contributor country to the European Space Agency. The Italian scientific community as well the Italian space industry reached an unquestionable esteem and success in many fields as astrophysics, cosmology and solar exploration, the realization of sophisticated satellites and payloads.

On the 1st of August 2008 Enrico Saggese was appointed as ASI Commissioner. His Mandate prescribes to work out the next National Space Plan and a new nature and structure of the Italian Space Agency.

On November 26th 2008 ESA Ministerial Council in the Hague (The Nederland's). The Ministers in charge of space activities agreed to undertake new initiatives in several fields and endorsed the next phases of a set of ongoing programmes. Italy chaired the Ministerial Council and its mandate will continue for three years also for the Space Councils (joint and concomitant meeting of EU and ESA Councils) that will be convened during this period.
With regard to the programs, Italy confirmed its determinative ad leading position in the ExoMars program; continued to highly support the mandatory scientific programs and other important optional programs as GMES and International Space Station. Among the new programs, Italy supported the Air Traffic Management and also the Space Situational Awareness (SSA) and the Integrated Applications (IAP). Finally, Italy continued its support to the European Launcher Program with ARIANE-5 and VEGA, their relevant accompaniment programs (ARTA and VERTA) and the demonstration reentry vehicle IXV in the frame of the FLPP program..
Next ESA Ministerial Council will take place in Italy in 2011.

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 the third COSMO-SkyMed satellite has been successfully launched by the U.S. Vandenberg Base in California. The launch of the forth satellite is planed beginning of 2010.

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 leaded by Thales Alenia Space.

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 has been evaluated. The selected proposals receive COSMO-SkyMed data at no cost.

The four satellites will provide with 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 Volganeft in the Black See, the cyclone in Bangladesh, the landslide in Bolzan, the floods in Myanmar and Haiti and the Earthquake in China. 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).

For further information regarding the utilization of the first two COSMO-SkyMed satellites data, please see the annex and the 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.

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.

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.

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

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

Italy is developing hyperspectral technologies. Based 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 helps 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.

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

Operative Centres

Located in the municipal district of Matera (South of Italy), the **Centre for Space Geodesy** (CGS) is dedicated to Professor Giuseppe ("Bepi") Colombo. Opened 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 (geodetic satellite laser telemetry or SLR, radio-interferometer on a very long basis or VLBI, GPS positioning, PRARE orbital tracing) makes CGS one of the few main world network stations playing a crucial importance for the comprehension not only of the Mediterranean basin tectonics but also of many geophysics and geodynamics parameters, as well as for the materialization of the international Terrestrial Reference Frame.

At CGS is also located the civil data acquisition station of 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.

The **San Marco Space Base in Malindi (Kenya)** acquires Earth Observation satellite images both in L-band and in X-band. An average of 12 to 15 images per day are acquired from different sensors, processed and archived. A 6.2 m antenna in X-band is used to acquire MODIS/Terra and MODIS/Aqua. A L-band system is used to acquire NOAA/AVHRR and SeaStar/SeaWiFS. In the next months COSMO SkyMed data will be also acquired by Malindi Base and some of the application activities will be transferred from Space Geodesy Centre in Matera to Malindi. The first applications is the Hot-Spot Detection System (HSDS) based on MSG images, devoted to the early detection of wild fires in the Central and East Africa region.

Observation of the Universe

Solar System Exploration

Italy is one of the main contributor 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 land at the surface of the red planet. Scheduled for launch in 2016, it will deploy a rover equipped with a drill and a scientific package (Pasteur payload) to analyse the samples collected and a landed platform housing the geophysical and environmental package (Humboldt). 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. Four Italian scientific experiments will be provided to the mission and a large number of Italian scientists are involved in several other instruments.

Italy has played 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 in Mars' subsurface. During the year 2008 the two radars have sent very significant information regarding this topic. In particular, images provided by SHARAD allowed scientists to infer that the crust and the upper mantle of Mars are stiffer and colder than previously estimated. This implies that adequate environmental conditions for living organisms requiring liquid water could be found but at larger depths than previously thought. ASI has also initiated the development of a GIS (Geographical Information System) for Mars called **PAGIS** (Planetary Geosciences Information System) to elaborate and produce thematic maps.

The Italian spectrometer **PFS** (Planetary Fourier Spectrometer), on board Mars Express, has mapped the abundance of the water vapour and detected traces of methane in the Martian atmosphere. Italy is 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. 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 2013) 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, could observe 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** is flying 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.

During Summer 2008, representatives from ASI, BNSC, CNES, CSA, DLR, ISRO, JAXA, KARI following a NASA initiative to develop an International Lunar Network (**ILN**) gathered at NASA Ames and signed a "statement of intent" to declare their intention to explore together ways on how to establish such network. The goal is to build 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 provide 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; **TandEM** (Titan and Enceladus Mission), a mission to Saturn's moons Titan and Enceladus to be developed jointly with NASA; **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. The preparation of the **SoRa** (Sounding Radar) mission is about to be completed and will launch soon a radar similar to SHARAD to investigate well known polar and Antarctic areas in order to calibrate the radar data acquired on Mars.

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 then 10 years in orbit.

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.

Competence acquired so far has 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. AGILE's main feature is the combination of two image detectors simultaneously working within bands of gamma energy and hard X-rays, which merge into a single instrument with a great scientific potential.

Thirty scientific groups have participated in the first Announcement of Opportunity for the AGILE Mission presenting research projects based on the utilisation of AGILE gamma data. The approved proposals will have free access to the data for a year.

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.

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. ASDC provides up to date services to the scientific community in the field of scientific data management and archival research. ASDC is located at the European Space Agency's establishment of ESRIN, Frascati, Italy.

Cosmology and Fundamental Physics

The Italian scientific community is participating in ESA Programmes **Herschel** and **Planck** that will be launched in 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.

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 will realize directly 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 bythe 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 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 2010 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. Flights from the Svalbard Islands are scheduled to take place in 2009 and 2010.

In the field of fundamental physics, ASI is managing the realization of the LARES satellite, to be launched in November 2009 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 is also funding a phase A study for the Galileo Galilei mission, dedicated to the experimental test from space of the Equivalence Principle.

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: early in 2008 ASI awarded phase A studies for five small missions (**SAGACE** – Spectroscopic Active Galaxies And Clusters Explorer, **POLARIX** – X-band polarimeter, **FLORAD** – microsatellites FLOral constellation for RADiometric observations, **MAGIA** – Missione Altimetrica Gravimetrica geochImica lunAre), **ADAHELI** – ADvanced Astronomy for HELIophysics) through one-year contracts after which up to two missions could be selected to be launched not earlier than 2012

Space Debris

Italy is highly involved in space debris issue with initiatives at national level and supporting international activities in order to mitigate and prevent damages caused by space debris.
ASI 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 national level, every contract signed by ASI with the industries contains prevention and mitigations clauses.

At European level, ASI cooperates with BNSC, CNES, DLR and ESA and applies the "European Code of Conduct for the Space Debris Mitigation" which has been presented to the COSPAR congress of 2008 in Montreal (Canada), together with the UN-COPUOS Guidelines for the Space Debris Mitigation .

In May 2008 the Italian Space Agency has organised in Rome a national workshop with attendance from research centres, universities, industries, together with military and governmental representatives. A copy of the European Code of Conduct and of the UN-COPUOS Guidelines for the Space Debris Mitigation has been distributed and described in detail to all participants.

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 the **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.

Since long ago Italy 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 this 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: 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, 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.

There are projects studies aimed at developing innovation in the field of satellite navigation Signal Generator. 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.

Two additional technological support 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. The location of the main infrastructures is in South-East of Rome.

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 the 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.

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.

ASI 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.

Space Habitability

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

After the success of the Italian logistic modules **MPLM (Multi Purpose Logistic Modules)** Leonardo, Raffaello and Donatello used to transport to the International Space Station equipments, supplies and experiments through the U.S. spaceship -, Italy has been collaborating with ESA for different projects, such as **Columbus, ATV** (Automated Transfer Vehicle), **Node 2**, **Nodes 3** and **Cupola.**

Columbus Orbital Facility was successfully launched on board NASA's Space Shuttle Atlantis from the Kennedy Space Centre in Cape Canaveral, Florida on February 7th , 2008.
The 11-ton lab has been delivered by the Space Shuttle to a berthing site on Node 2, adjacent to the U.S. Laboratory and directly across from the Japanese Experiment Module. The Facility will accommodate ten racks, five of them for European Space Agency use, the other five for NASA. It will be used primarily for research and experimentation in microgravity conditions mainly in the field of Life Sciences, Physical and Material Science. Thales Alenia Spazio of Turin, Italy, was 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 launch vehicle. Jules Verne, with a high Italian industry 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 was the relocation of one of the four solar arrays that provide power to the Station. Nespoli played a key role as the intravehicular activity astronaut (or IVA) for the mission's spacewalks, including the installation of Node 2. During the mission, named Esperia, Nespoli also performed a number of European 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 will start his training in Houston in preparation of a Shuttle mission to the international space mission that will take place in 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 2008 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.

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 first experiments on the hardware were conducted in December 2007. The instrument is still on board the ISS waiting for other experimental sessions planned in 2009.

3. **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).

4. **Call for Ideas. MARS 500** is an international project which regards a simulation of a human mission of long duration and will be realized in Moscow. In 2008 two Italian experiments were selected and will be performed inside the Russian NEK facility in the 2008/2009 time frame.

Italy is a member of the International Space Life Sciences Working Group (ISLSWG). In this field, ASI coordinates the national scientific community, particularly in the areas of musculoskeletal system, neurophysiology and biotechnological applications, which are in compliance with the ISLSWG strategic planning.

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 Guiana Space Centre (development support).

Italian main contributions to ARIANE 5 development and 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 (Space Centre of Guyana), which are deemed as necessary for the integration of the launch vector.

The year 2008 is marked with a 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, has been selected by ESA as the first payload to be embarked on VEGA. 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 scheduled for November 2009.

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.

In the aim of studying evolutions of 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 agencies and industrial companies have started a cooperation concerning the development, manufacturing and certification of a new engine operating with liquid methane as fuel.
On national basis, ASI is supporting several 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, Nuclear propulsion, 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, Experimental re-entry vehicle.

Space Education

ASI promotes and funds PhD and Masters to allow Italian students to have access to aerospace studies. In order to promote the Italian participation 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 rules the cooperation on joined educational programs in the field of Earth Observation and its scientific applications. In July 2008 a 2 weeks summer course on SAR technology and applications was organized and the course was held at the ASI Space Geodesy Centre in Matera. Lessons, practice and case studies were conceived for an audience consisting in young professionals who already work in the EO field and need a refresher course in new technologies and applications.
ASI has recently renewed an agreement with the Conference of the Italian University Rectors in order to organize internships for university students and newly graduates that are chosen among the most motivated. ASI will award internship holders a monthly scholarship, related to educational objectives achievement evaluation.

ASI promotes the education and culture of the space technologies and applications through several programmes dedicated to teachers and students, and by promoting the use of high-tech and satellite technology. In particular, ASI, in collaboration with the Italian Aerospace Research Centre, CIRA, is coordinating the activities concerning the programme "**Aerospace Educational Web Channel**". The main purpose of this programme is to broadcast via satellite educational modules regarding aerospace topics suitable for younger students. Supporting this programme is a web-site (www.spazioallescuole.it), representing a cultural bridge between schools and the institutions, which promote the spread of aerospace culture.

ASI has finalized the development of an original video-game via internet, named ***edu-tainment***, (education-entertainment), which aims at educating young people to the basics 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 has been realized with success.
In occasion of the Discovery mission, a comic has been published and distributed through the 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 accomplished two comics books on space topics, a 3D puzzles of AGILE satellite and is about to carry out a didactic performance on astronomy and a new 3D puzzle of COSMO-SkyMed satellite.

Italy is engaged in several educational space initiatives with international partners like the Argentinean students in the framework of ASI participation in "**Mario Gulich" Institute**, in Cordoba (Argentina), that promotes high level Space Studies in Earth Observation. Annually, the Italian Government offers some fellowships to Argentinean students and researchers to study in Italian Universities and remote sensing research centres.

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 post-graduates and doctorates. The first step of a middle-term project that regards the participation of Kenya in an small space mission has just started. A 18 months scholarship funded by ASI was awarded to three Kenyan young graduates. The three Kenyan engineers have started a six months Master in Satellites and orbital Platforms organized by the University of Rome "La Sapienza". A twelve months training on job in the Italian space industry will complete their preparation. 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 relations and cooperation with non European Countries and 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, DLR, ISRO, JAXA, BSA, Argentina, China, Russia, Kenya. However, intensive relations are in place with many other countries in order to finalize new fields of collaboration. During 2007-8 relations have been established with Costa Rica, Chile, Korea, Egypt, Ukraine.

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 *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.

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COSMO-SkyMed MISSION: the first two satellites

The first satellite was launched on the 8th of June 2007 and the second one on the 9th December 2007 from Vandenberg Air Force Base in California (US). Both satellites have been successfully launched through BOEING DELTA II Rocket. The commissioning phase of the first two satellites begun after the Launch and Early Orbit Phase (LEOP). During the Commissioning Phase, both satellites and ground segment have shown the expected performances.
At the current time the system is in the operational phase and the civilian institutional and commercial users, as well as the defence users, are requiring acquisitions over a wide variety of interest areas. The third satellite was launched in October.

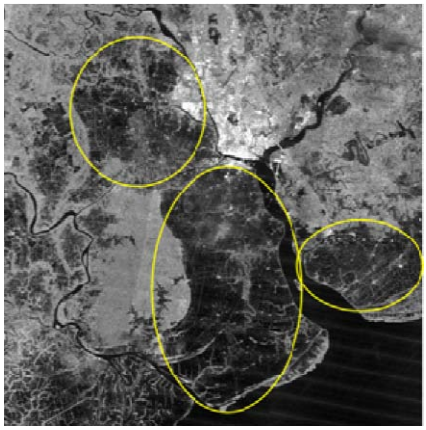
LEOP During this phase the launch completion and the correctness of the orbital parameters and the start-up of the satellite have been verified. Both satellites have been placed in a stable orbital configuration showing nominal parameters, in particular in terms of thermal and power stabilisation, telecommands and control and deployment of the satellite elements.

COMMISSIONING PHASE The Commissioning Phase has been performed at the same time for COSMO-SkyMed 1 and COSMO-SkyMed 2, at the end of this phase both satellites entered in the Operational Phase. During the Commissioning Phase the verification of the functionality, the performance and the operations of both satellites and of the overall System have been completed. All the payloads, subsystems and elements of the satellites have been verified in orbit through the utilisation of the overall Ground Segment. All the calibration activities have been completed testing and verifying the SAR antenna of each satellite. The verification and validation of the whole System (satellites, sites and support System) have been completed. The

OPERATIONAL PHASE The System entered in the operational phase on the 1st of August and currently is used by both civilian and defence users.

EXTRACT OF COSMO-SkyMed ACQUISITIONS During the Commissioning Phase the first two satellites have begun to acquire thousands of images all over the globe, showing the full potential of the System. In the following there are some examples of applications realised using the images of COSMO-SkyMed 1 and 2 during the Commissioning Phase, to give an idea of the capability of the System and also to highlight the activities already performed to help rescue actions in the emergency and natural disasters.

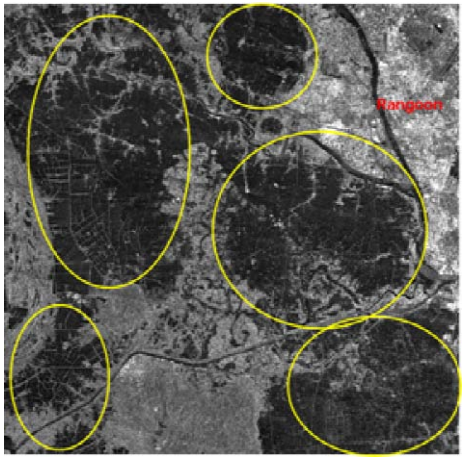
MYANMAR FLOOD (May 2008)



Devastating Cyclone Nargis hit the Yangon region (Myanmar) on May 3 2008.
On the 6th of May over Rangoon area COSMO-SkyMed 1 acquired an image (SCANSAR-Huge region) with a fast Response Time equal to 20 hours, allowing to know in a short time the situation of the area affected by the flood and to identify the main zones where the rescue actions had to take part.

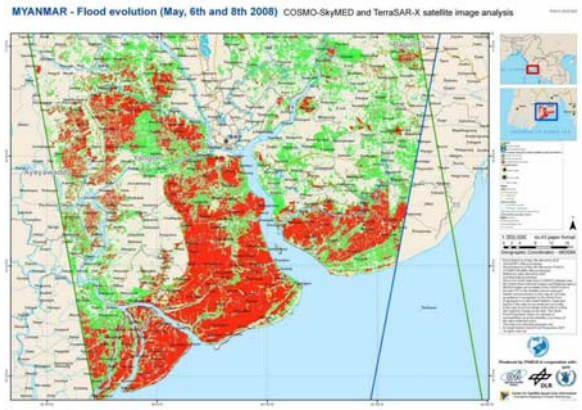
The COSMO-SkyMed acquisition (ScanSAR Huge Region collected the 6th of May) is reported on the left (*figure1*).

Figure 1 – ScanSAR Huge Region, 6May, Ragon Area, Myanmar



The flood areas are recognisable in the dark areas highlighted by the circles.

Figure 2 – Stripmap collected on the 8th of May over Rangoon Area, Myanmar.

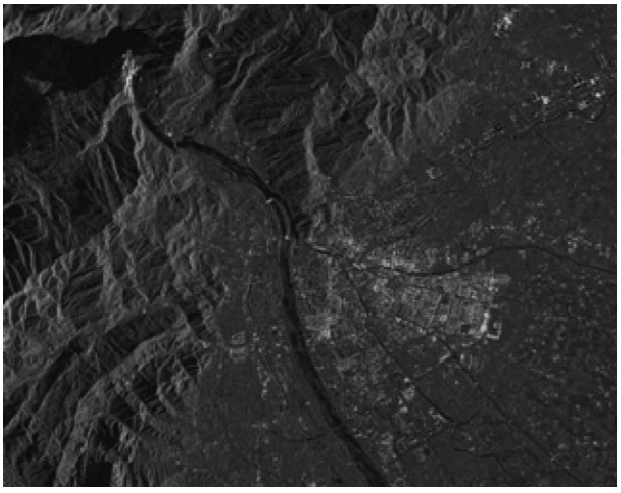


The World Food Programme (WFP) used COSMO-SkyMed images to create maps to be used for rescue actions.

The flood evolution (between 6th and 8th of May) has been represented in this picture elaborated by the WFP (red areas are affected by the flood).

Figure 3 – Flood evolution Map [Credits to WFP]

CHINA EARTHQUAKE (May 2008)



A powerful earthquake has killed at least 10,000 people in the province of Sichuan (China), out of which 5,000 in just one county. Many more have been killed and injured in other parts of China after the 7,8 magnitude quake struck on the 12th of May.

COSMO-SkyMed processed the first image with a Response Time of 16 hours from the alarm. In the following an image of the Guan-Xian area (in Sichuan province) is reported.

Figure 4 – Spotlight collected on the 13th of May 2008 over Guan-Xian city, China

The image was relevant for monitoring the damage and the general situation of Guan-Xian area and the potential damage of the dike (see top left of the image).

The images acquired by COSMO-SkyMed, in the days immediately after the earthquake, were of great importance tp help the rescue actions.

This event showed the relevant helpfulness of the COSMO-SkyMed space constellation in monitoring and observing natural disasters.

HAITI FLOODS (September 2008)

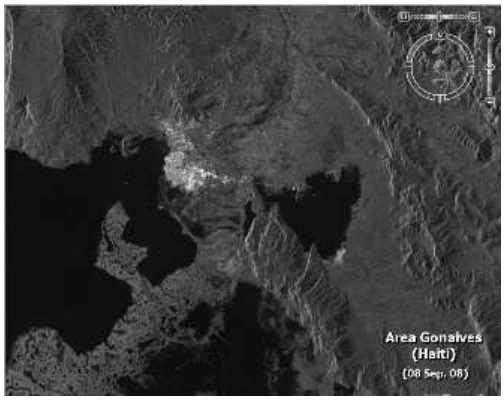


Figure 5 – Himage collected on the 6th of September 2008 over Gonaives Area (Haiti)

After the passages of Hanna and Ike urricanes, COSMO-SkyMed acquired on the 6th of September 2008 an image over the Gonaives Area and Artibonite Area capturing the situation after the disaster. The CSK images shows the flooded areas (black colour) on the area.

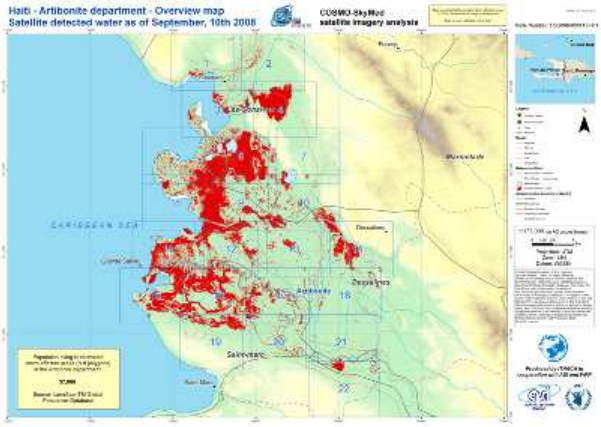


Figure 6 – Flood evolution Map [Credits to WFP]

The images acquired by the COSMO-SkyMed constellation have been used by the World Food Programme to elaborate 26 maps for damage assessment. A map is reproduced on the left, as an example.

Published: **ASI – Agenzia Spaziale Italiana**

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

Editor: *Gabriella Arrigo, Simona Di Ciaccio*

International Relations Office with non European Countries
Strategy, National and International Relations Unit

Press date: Rome, December 2008