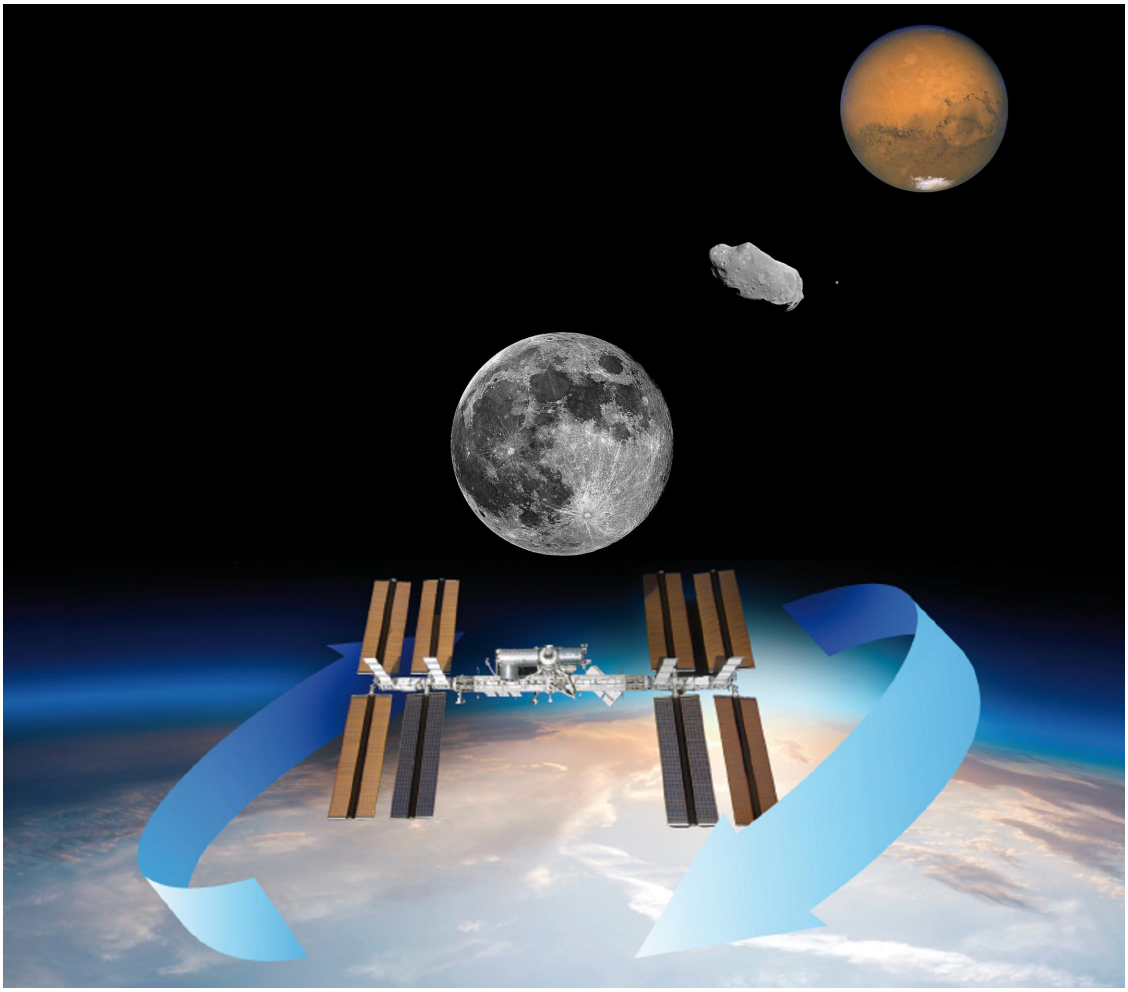
1st European Seminar on "Technologies from Space Exploration"

Torino (I), 2011 October 18th-19th

EXECUTIVE REPORT



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Checked by: Piero MESSIDORO – WG Chair
Richard AMBROSI – WG Co-Chair

January, 2012

"Sooner or later for good or ill, a united mankind, equipped with science and power, will probably turn its attention to the other planets, not only for economic exploitation, but also as possible homes for man... The goal for the solar system would seem to be that it should become an interplanetary community of very diverse worlds ... each contributing to the common experience its characteristic view of the universe. Through the pooling of this wealth of experience, through this "commonwealth of worlds", new levels of mental and spiritual development should become possible, levels at present quite inconceivable to man."

Olaf Stapledon, address to the British Interplanetary Society, 1948

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1. Executive Summary

The Seminar was attended by around one hundred and eighty participants, from more than thirty organizations, belonging to ten European Regions. Hosted by NEREUS-Associate member ALTEC SpA on its premises in Piedmont, it was organized by Piedmont Region, which leads the NEREUS WG on "Technologies from Space Exploration" and NEREUS in collaboration with Thales Alenia Space.

Its aim was awareness rising of the benefits for European citizens through Space Exploration programs and involved technologies. The Seminar also wanted to bring its contribution in view of the third International Conference on Space Exploration to be held in Lucca in November 2011, highlighting the fact that the challenges associated with Space Exploration and Research promote economic growth by stimulating innovation, technology developments, education and training of highly skilled engineers and scientists, fully meeting a number of Europe 2020 priorities.

The Seminar was organized in two sessions, a political and a technical one. In the *welcome addresses* of the political session local, Italian and European Institutions confirmed their support to Space Exploration programs and related initiatives.
It was underlined that Space Exploration is a crucial strategic topic which embodies the desire for all of humankind to discover new horizons and landing on other planets: Space Exploration means, above all and ultimately, direct human presence, supported and preceded as appropriate by robotic missions.
There are four main enablers for Europe to proceed with Space Exploration: international cooperation, since it is a global endeavour; political vision and long-term commitments; technology; and the International Space Station (ISS), which is an extraordinary test bed for Exploration and the starting point of the global Exploration roadmap.
European efforts could be focussed on some key enabler technology pillars, such as:

- Entry, Descent and Landing capabilities
- Regenerative life support systems
- Ultra light and inflatable structures
- Energy sources, generation and storage
- Novel advanced propulsion systems
- Robotics, automation, remote control, and enhancement in human-robot interaction
- Advanced propulsion
- High temperature protective materials
- Applied nanotechnologies
- Rendezvous and Docking / Capture

Added value can be generated in areas such as the protection of the environment, energy, health and industrial processes; synergies can be exploited with non-space sectors (such as energy or environment), that could lead to spin-in or technology transfer opportunities with mutual benefit.

By conferring the EU a competence on space, the Lisbon Treaty puts in fact EU space policy at the service of the Union ultimate goal of ensuring the well-being of its people. From the Commission standpoint, it is important to encourage not only close links between Space Exploration and social and economic challenges but also to demonstrate its impact on innovation dynamics in different sectors.

Most expenditure on Space Exploration is used for contracting out innovative technology development activities. Numerous and well documented spin-off effects illustrate the result of using these innovative technologies, which give rise to valuable benefits for citizen's and economy. Targeted expenditure in Space Exploration can trigger major innovations in sectors such as health, secure access to energy and renewable energy, access to clean water, robotics and automation, as it was shown in the Seminar technical session.

In the round table, which followed the welcome addresses, the main discussion was about how to proceed with Exploration programs, taking into account both the current economic crisis and the uncertainties in exploration plans in the world (including in the US). It was underlined that any time is the right one to start the dialogue, aiming at defining international cooperation in line with individual plans, and that Europeans should take advantage of this economic situation to prepare the future space activities, first of all in terms of technology developments.

Mankind on Mars is indeed not an issue of *if*, but only of *when and/or how*. The next years shall be devoted to set-up the international long term vision in Space Exploration, sharing objectives – which means intermediate destinations, type of missions and scientific goals – and investments in a way commensurate to individual capacities, technical and financial.
This will be in particular a political challenge for Europe in its capacity to federate a global political, scientific and technology initiative.

The technical session of the second day was dedicated to the regional user needs with respect to space exploration, and the direct and indirect outcomes from those enabling technologies. From the regional user need perspective, the direct outcomes imply industrial developments in terms of technological innovation and high value-adding activities; the indirect ones produce knowledge spill-over in terms of supply chain qualification and empowerment, Research and qualified employment; while the enabling outcomes make service advances possible, in fields such as remote sensing, info-mobility, telemedicine, and others.

Several examples of already realized spin-offs from exploration technologies were presented, applied to different sectors, such as environment, health, civil protection, renewable energy, that illustrate how innovations and technologies developed in the frame of Space Exploration can be commercially exploited.
These technology and knowledge transfers show the obvious benefits to maximize the return of investment in European space research; to provide cross-disciplinary opportunities; to provide economic potential and motivation for both technology donors and receivers.

It has to be recalled that a recent EC publication on Space Exploration and Innovation reports that 183 spin-offs, generating from ESA activities in the period 1997-2008, were identified, of which 37 (20%) originating from Space Exploration. This number represents a *lower bound estimate* as, in a number of cases, the origin of space spin-offs is not readily identifiable. These 37 spin-offs equate to three spin-offs a year from a (current) space exploration annual budget of €0.6 billion per year.

The last part of the Seminar was dedicated to introduce existing European facilities, whose core mission is to promote space exploration among the broad public, whose possible evolution is proposed to be a European network of "Exploratoria", to offer a more effective and complementary product (promotion set up/promotion approach) to the public, to be definitely conscious of the fascinating scientific and technological world, and stimulating young active participation in its evolution.

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2. Introduction

This report summarizes the results of the Torino Seminar, with a focus on the outcome from the technical sessions, which addressed the regional user needs with respect to space exploration, the direct and indirect (spin-offs) products from space exploration, and the Exploratoria project.

The already realized spin-offs and the Exploratoria facilities already in place in some NEREUS Regions are widely described in the NEREUS brochure published and released at the Torino Seminar. The brochure is available online on the NEREUS publications webpage.

Several other examples of potential spin-offs were also presented during the Seminar in the poster session: the abstract of them are reported here, showing the relevance of these developments which could turn into commercial products in the short term.

The shown spin-offs want to demonstrate the interest of European Regions in using applications and products from technologies developed for space science and exploration, and that investments in space science and exploration create unexpected benefits for the European citizens and stimulate economic growth in Europe.

Conclusions and perspectives are drawn at the end of the report, linked with the activity planning for 2012 of the NEREUS Working Group of "Technologies from Space Exploration".

2.1 Agenda of the Seminar

18 October 2011, 14:00 h

Political Session

I. *Welcome addresses*
Introductory remarks by ALTEC **C. Romanelli**, Italian Presidency of the Council of Ministers **A. Giordani,** host Piedmont Region **M. Giordano,** NEREUS **A. Cavalli**, Turin Municipality **T. Dealessandri**, Committee of the Regions (CoR) **M. Bresso**, European Chamber of Commerce **A. Barberis**, European Commission (EC) **A. Gonzalez**, ESA - European Space Agency **G. Morsillo**, ASI - Italian Space Agency **M. Ricottilli**

15:15 – 15:45h *Coffee Break (sponsored by Nereus)*

II. *Round table on Vision and Strategies for Space Exploration in Europe* ***(moderated by S. Rosa Brusin)***
Views of the European Commission (EC) **A. Gonzalez**, European Space Agency (ESA) **I. Duvaux-Bechon,** National Space Agencies: ASI **A. Lorenzoni**, CNES **F. Spiero**, UKSA **M. Chahal** and Industry representatives: Eurospace **J.J. Tortora**

18:15 h Adjourn

Social event in ALTEC, with a speech given by P. Nespoli - European Astronaut

19 October 2011, 08:30 h

Technical Session
Introduced by NEREUS ***R. Ayazi***

I. *Regional user needs with respect to space exploration*
Interests and expectations of NEREUS Regions, aerospace districts and local clusters: Piedmont Aerospace District **D. Moncalvo,** Midlands Aerospace Alliance **T. Maskell**, Lombardy Aerospace Cluster **A. Vallerani,**

II. *Direct outcomes from exploration technologies*
Experiences and perspectives of Industry, Research Centers and Academia: Thales Alenia Space **L. Gatti,** Politecnico di Milano **A. Ercoli-Finzi,** CISAS Università di Padova **P. Benvenuti,** Leicester University SRC **G. Fraser**

10:30 – 11:00 h *Coffee Break (sponsored by Thales Alenia Space)*

Introduced by ESA ***G. Boerci***

III. *Indirect results and technology spin-offs from space exploration*
Experiences and perspectives of Industry, including SMEs: Innovative Optical Materials for the developments of Diffractive and Holographic Devices by Antares Scarl **- E. Pusone,** MARISSA Project by SP.A.I.C. srl **– S. Chiesa,** Mini Gamma Ray Camera by Leicester University **– J. Lees,** HIT09 srl project **– R. Da Forno,** RiskNat by Thales Alenia Space **– V. Basso**

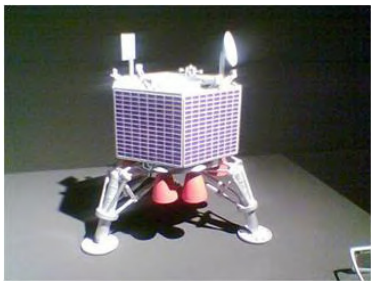
IV. *Attracting potential end-user and young generation (Exploratoria)*
Presentations from already existing space exploration centers and their plans for the future: Infini-TO and others by CIFS on behalf of Piedmont Region **A. Ferrari,** National Space Centre (East Midlans) **G. Fraser,** Citè de l'espace (Midi-Pyrènèes) **J.B. Desbois**, Volandia and others by CGS on behalf of Lombardy Region **F. Mailland**

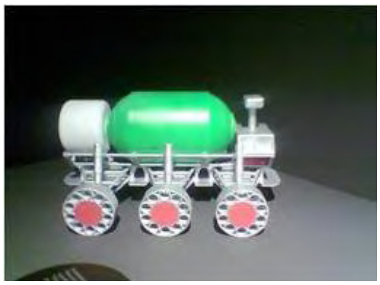
13:00h Conclusions and perspectives by the WG Chair P. Messidoro
13:30h *End of Seminar*

3. User needs with respect to space exploration and already realized spin-offs in the NEREUS Regions

Interests and expectations of some NEREUS Regions, aerospace districts and local clusters, i.e. Piedmont Aerospace District, Midlands Aerospace Alliance, and Lombardy Aerospace Cluster, were presented.

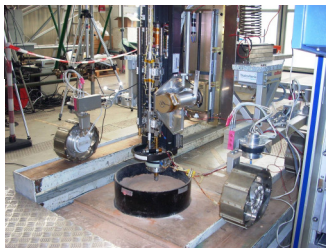
Piedmont has a long lasting tradition as Aerospace Cluster (since 1909), which puts together seven leading firms, one of them being Thales Alenia Space, over 230 SMEs, a strong Research system (Universities and Research Centres), being all of them organized together and duly supported by the regional institutions. The regional government supports three Technology Platforms: one of them is called STEPS (*Sistemi e Tecnologie per l'EsPlorazione Spaziale*) and deals with the development of technologies for Moon and Mars landing and rovering by virtual and physical demonstrators. Some developments have already found different applications from space, e.g. in support to services for the local civil protection.





The Midlands Aerospace Alliance was established in 2003 and has 250 members. It has a three-fold strategy: 1) share knowledge and information, to improve market and business opportunities; 2) deliver support programmes to members, to improve performance; 3) coordinate shared strategy, to develop an overall aerospace cluster strategy through pro-active partnering.
Space Ideas Hub is a £2m, 3 year project, focusing upon technology transfer to businesses in the East Midlands: being financed by EU and the University of Leicester/Space Research Centre (SRC), it has a dedicated team to help businesses exploit from space-related technologies, especially at the benefit of local SMEs. The project has the goals to create new businesses engaging SMEs, leverage investments, favor the collaboration between SMEs and Universities, and boost patents/licensing.

The Lombardy Aerospace Cluster is made by 185 Companies with a 4 Beuro turnover. The cluster main goal is to promote the autonomous growth of SMEs by: encouraging the growth of supply chain through the support to innovation and the creation of best practices; supporting internationalization and marketing; seizing opportunities for collaboration; developing education and training; catching finance opportunities. Specific competencies are present in this cluster, ranging from mission analysis to system design, from technology development capabilities to test facility design, implementation and use.



The support to space activities at regional level in the NEREUS Regions aims to reinforce the capabilities already in place, acquired through ESA, National and EU funds from Industry, Research Centers and Academia of the territories. Thus, the second part of the technical session of the Seminar was devoted to show the direct outcomes from exploration technologies, in terms of experiences and perspectives of the different players, i.e. Industry, Research Centers and Academia.

In general terms, the direct outcomes from Space Exploration may be summarized as below:

- Economic Impact
- Regional Focus
- Growth via SMEs
- Disruptive Technologies
- Inspiration
- Interdisciplinary Research
- Policy Influence (e.g. Climate Change)
- International Collaboration
- Technology Transfer

More in details, it was shown how European space actors are fully engaged in those developments that enable robotic and human exploration of the solar system, such as:

- Entry Descent and Landing (EDL), as identification of safe landing site on planet surface and guided soft and precise landing. These technologies need vision-based image processing algorithms as input to dedicated GNC algorithms.

- Landing legs, required to perform the soft landing, by an active system for impact absorption based on adjustability after landing, to cope with terrain roughness nad slopes.

- Robotics and autonomy for surface exploration, in particular for the environment description, path identification and hazard risk minimization. Enhanced navigation performances are achieved through innovative sensors for visual odometry and for rover motion path generation.

- Cooperative rover formation, and rover reconfigurability / reuse for mission cost reduction and flexibility.

- Inflatable structures, which will play a fundamental role in the future of LEO infrastructures, and in Moon and Mars outposts. Their high compaction at launch offers the possibility for on-orbit deployment of huge volumes and surface extension, unreachable with current rigid metallic structures.

- Regenerative life support technologies and subsystems, which maximize efficiency in terms of % of recovery and reduced consumables for space infrastructures and human exploration.

- ISRU: In Situ Resource Utilization, for using resources available on the explored planet itself.

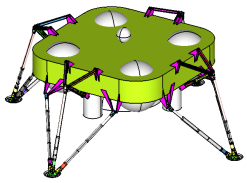
- Aerothermodynamics and TPS for atmospheric entry or re-entry phase, which are crucial phases where space vehicle undergoes a relevant overheating due to the friction with the planet atmosphere which can damage or completely destroy the spacecraft.

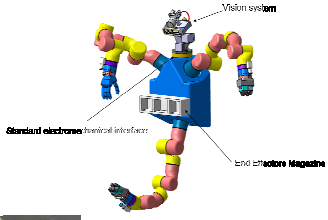
- Crew collaborative robotics, i.e. robots or other automatic/semi-automatic devices which shall properly collaborate in the same planetary environment with the humans for maintenance, servicing operations

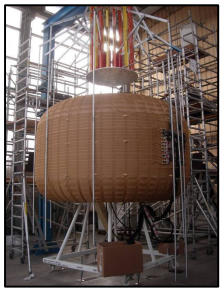
- Regenerative fuel cells, since future planetary exploration will require advanced energy storage technologies in order to provide higher power and higher storage densities than secondary chemical batteries.

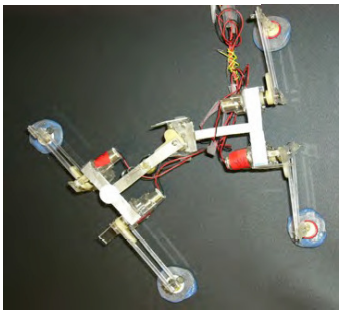
- Health management systems, which allow to acquire system data about the integrity status of a space vehicle and to process them into information to support operational decisions, spanning both flight and ground phases. This results in improved vehicle safety and reliability, minimized maintenance actions, improved readiness and availability, and vehicle life extension.

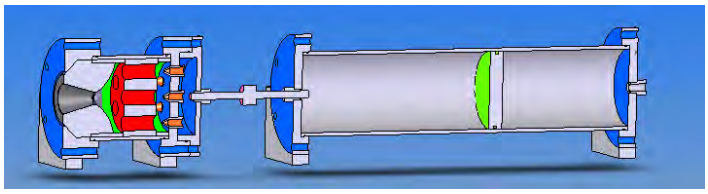
- Rendezvous and Docking / Capture, which are mandatory capabilities to support exploration missions characterized by complex systems architectures and operations, such as: sample collecting from the planet surface to be brought to Earth, and spacecraft assembly both in orbit and on planet surface.



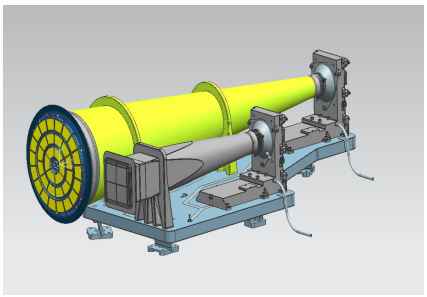


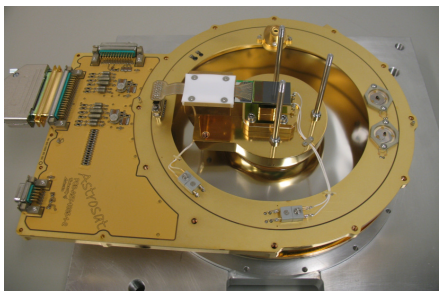


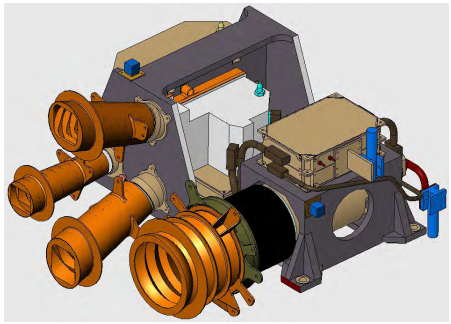




Concerning space science, several valuable examples of instrumentation and systems developed for science missions were presented at the Seminar, such as the BepiColombo Mercury Imaging X-ray Spectrometer (MIXS) and the SIMBIO-SYS System , the James Webb MIRI, the *Astrosat* Soft X-ray Telescope CCD focal plane camera, the METIS solar coronograph for Solar Orbiter.





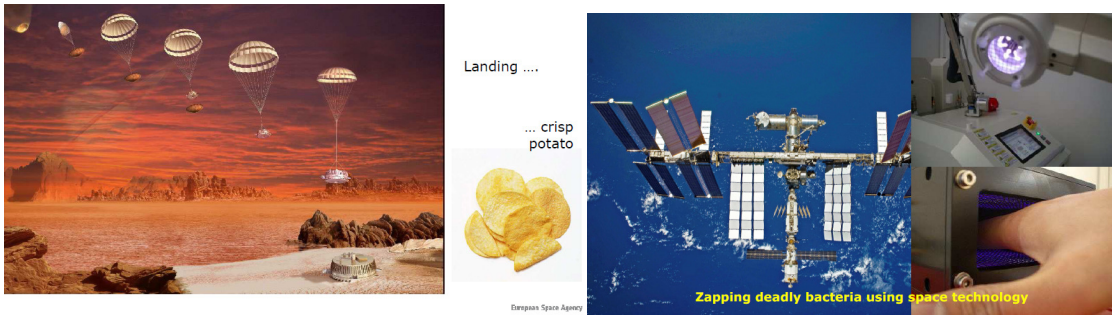


The third part of the Seminar technical session addressed the technology spin-offs – those already realized – from space exploration technologies in the NEREUS regions. This session was introduced by ESA/TTP (Technology Transfer Program).

ESA underlined the importance of technology transfer which leads to knowledge transfer, in the sense that technology developed for a space application may be applied, with modifications, in a different sector. For example, space sensors a re used in medicine and space-derived materials can be found in cars.

We must think "outside the box" and be proactive: technology transfer brings economic benefits by increasing revenues for both technology donors and receivers.
Technology transfer brings several, sometimes non obvious, benefits:

- ease the burden imposed on public resources
- maximise the return on investment in ESA's space research
- minimise the duplication
- provide cross-disciplinary opportunities
- provide economic potential and motivation for both technology donors and technology receivers

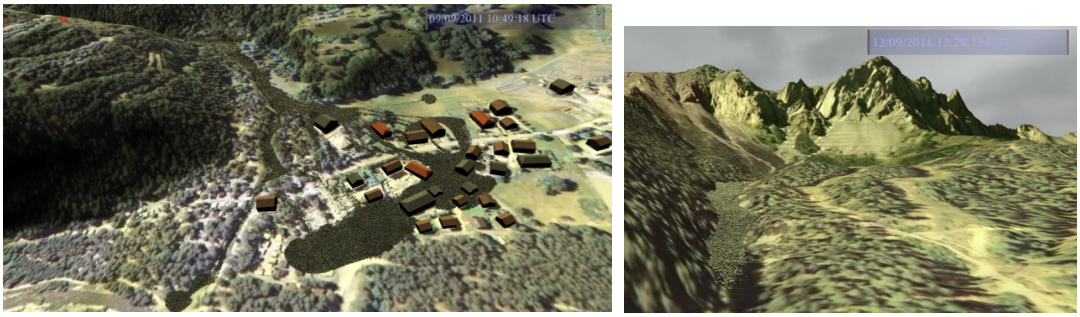


Experiences on spin-offs and perspectives of Industry, including SMEs, were then presented and are **described in detail in the published NEREUS brochure.**

Several NEREUS regions highlighted their realized spin-offs and applications in fields such as environment and geology, arts and culture, renewable energy, transport, medicine and health care.

Just to name them, the presented developments are:

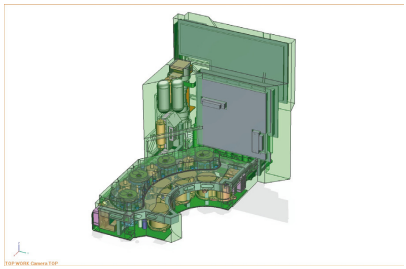
RiskNat, by Piedmont Region: three dimensional passive stereo visualizations of geological data are nowadays featured in several applications, but true real-time interactive simulations (4D: space+time) of geological events aren't very common. RiskNat uses this type of simulations derived from Space Exploration technology to represent geological phenomena as risks public education and planning support.



Beaulard (Piedmont, I) conoid: real-time simulation of flood

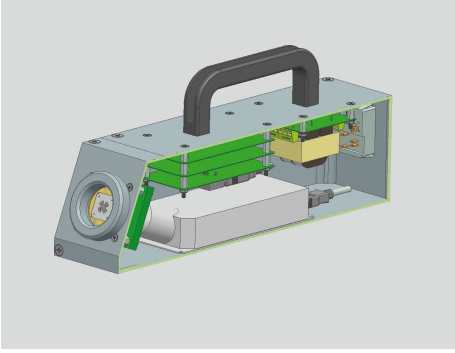
MARISSA, by Piedmont Region: MARISSA (an English translation of the Acronyms could be: "Mobility and Innovation for Small Mobile Robotic Vehicles for Senior People Monitoring and Care") is a concept of a Robotic System capable of assist Old People, that are alone in their house. The System allows a remote User (Familiar or Social Operator) to visual monitoring the Person under care at any time and allows him to communicate easily whenever he/she wants (with view of a "well known face"). The System will also be capable of performing simple tasks, like, for instance, "agenda", "clock" and administering medicines at the right time, with check of the effective consumption.

Life Marker Chip, by East Midlands: it is a novel instrument that seeks to extract organics from crushed Mars samples to detect and measure various organic compounds at the level of ppb to ppm and search for possible evidence of extinct and extant Life. The technologies and techniques involved in the instrument have many possible applications from petro-chemical processing through to sample processing.

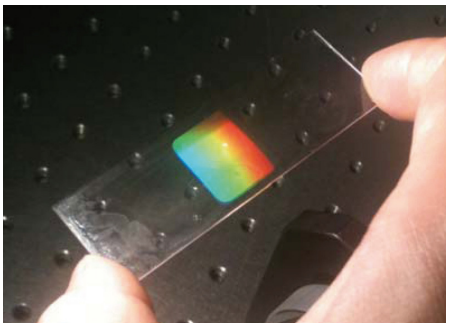


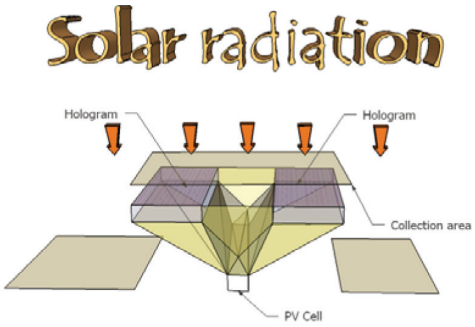
Mini Gamma Ray Camera, by East Midlands: current nuclear imaging instruments are large fixed devices located in imaging departments. This does not allow imaging procedures at the bedside, in operating theatres, clinics or intensive care units. The Mini Gamma Ray Camera will offer healthcare benefits by providing patients and medical teams with versatile, point-of-care technology particularly suited to surgical procedures.

Hand-Held Mineral Analyzer, by East Midlands: analysis of rocks, minerals and other samples in the field is important in a range of disciplines, including geological surveys/ prospecting, soil analysis, mining, cement, archaeology, and environmental surveys. While hand-held x-ray fluorescence (XRF) analyzers have been available for many years, these give only the elemental composition of a sample. The *mineralogical* composition is of greater interest in many applications, and can be derived through x-ray diffraction (XRD) analysis. Compact, lightweight XRD technology developed for space missions is being used to develop a terrestrial hand-held XRD analyzer. The crucial aspect of the technology is the ability to analyze unprepared whole rock specimens, in contrast to conventional XRD methods which require preparation of samples.

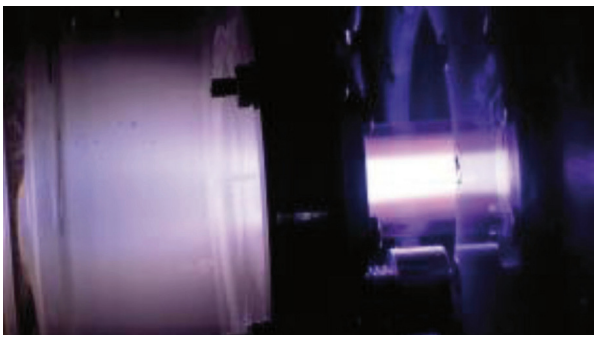


Innovative Optical Materials for the developments of Diffractive and Holographic Devices, by Lombardy Region: The space technologies applied in the development of scientific payload, as used in the analysis of the atmosphere composition for Planetary observation applications, have been used to realize highly efficient diffractive devices for integration in low cost and compact instrumentation, for terrestrial application in the fields of renewable energy and civil protection.

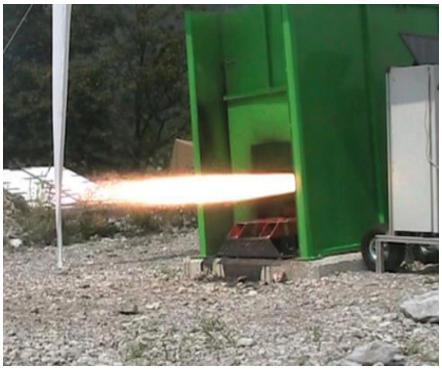




HIT09, by Veneto Region: HIT09 is a spin-off whose objective is to transfer the knowledge acquired at Padua University within plasma-propulsion, rocket propulsion and aeronautic propulsion to the market, in order to develop advanced propulsion system, and in order to provide a very highly specialized support to aerospace company. Key feature of HIT09 is the capability of developing advanced fluid and plasmas simulation codes, designing dedicated experiments and developing customized propulsion systems. These capabilities may be transferred to several fields different from Space, such as renewable energy, transport, civil protection, nano manufacturing processes.



Plume of an hybrid rocket during laboratory tests



Helicon plasma thruster during test

4. Potential spin-offs from space exploration technologies in the NEREUS Regions

As stated by ESA (*), "Innovation is not always the invention of a brand-new or revolutionary technology. The most efficient innovations actually stem from using existing technologies for purposes unrelated to their original applications. This principle is referred to as 'technology transfer'…. Space not only spawns the world's most innovative and most intricate technologies, but also the most thoroughly tested and thus the safest. Many of those technologies have found their way back to Earth – space technology touches virtually every aspect of our everyday life. From intelligent textiles to car safety, from medical innovations to novel engineering solutions, from gaming technology to high-tech environmental-control systems, we are surrounded by technology that originated in the space sector and is now generating profits for businesses in a multitude of other markets."

Several examples of potential spin-offs from space science and exploration technologies were presented in the poster session of the Torino Seminar. Their abstracts are reported here below.

It has to be underlined that these developments in progress have a relevant potential to become products in the market place. Thus their transfer from Space to terrestrial products and services should be encouraged and supported by ESA, through the Technology Transfer Initiative, and by the Union, through FPVII and the new HORIZON 2020 Program.

Concerning space technology developments, Europe is currently one of the three leading space powers, but compared to the level of investment in space R&D in US (e.g. about 20% of the total NASA budget), the European level of investment in future space technologies is insufficient (less than 10% of total expenditure in space) and needs to be strengthened along the entire chain, i.e. from basic technology research up to demonstration.
At the beginning of the chain, the fundamental technological research is of utmost importance and heavily relies on key enabling technologies, which have a high potential of generating breakthrough technologies with terrestrial applications; at the end, the demonstration and validation of new technologies and concepts in the space and terrestrial analogue environments enable concrete advances.

Thus, the future European program HORIZON 2020, as for Space, should be based on these pillars, which enable European competitiveness, non-dependence and foster space-based innovation. It should have a significant percentage of funding devoted to Space Science and Exploration, including technology transfer aspects, common Space/non Space R&D, and terrestrial analogues.

(*) *from ESA publication: "Down to Earth"- how space technology improves our lives. Technology Transfer Programme*

COSE Centre/VR-LAB
PIEDMONT Region

1. **Spin-off domain identification**

PLANETARIUMS/MUSEUMS/SCIENTIFIC COMMUNICATION/DIDACTICS

2. **Objective and level of innovation of the spin-off**

TAS-I/COSE Centre contains a VR-LAB which is powered by a TRO (Technology Research Office). The VR-LAB objective is TAS-I products Engineering support. The VR-LAB is an infrastructure equipped with modern HW, SW and interaction devices that create a 4D (space plus time) environment able to allow immersive rendering of the product behaviors in the target environment. The TRO is the brain of the VR-LAB in which SW experts coming from Academia developed VERITAS (Virtual Environment Research in TAS).
The VR-LAB born thanks to EU/F#5 "*VIEW (Virtual Environment and Workplace) of the future*" project and is connected in developments to EU R&T projects (e.g. FP#7/MANUVAR).

The VR-LAB contains today and will contain in the future a catalog of Products (bigger than that one flown) and Environments related to space exploration and science, which are not available on ground. This kind of virtual products can be demonstrated (updated frequently) in Space Virtual Museums or Planetariums. The interconnection between these facilities and the Centre could be matter of extension project. The technology itself as demonstrated by the collaboration performed with other domains can be exploited in areas in which there is the need to manage big amount of data in multidisciplinary context or where the product is so big and complex that is not easy to explain it to public (e.g. Energy, Medicine). The VR-LAB has been built in collaboration between TAS-I and Local Universities (POLITO, UNITO and UNPMN) SW departments.

3. **Status**

VR-LAB is in use by all the TAS-I projects mainly for the product design reviews.
The developed technology has been exploited to other domains e.g. Astrophysics (collaboration with CIFS – Consorzio Interuniversitario di Fisica Spaziale and UNITO for a Regional project called ASTRO-VR, collaboration with Civil Protection for a Project called RiskNat).
The VR-LAB since 6 years has been included in the public visits organized by the TAS-I external communication office. Some of the simulations produced in the VR-LAB have been shown in many external events e.g. Le Bourget airshow THALES boot in 2009 and 2011, Torino Planetarium in 2008, the year of astronomy Torino-Biblioteca Nazionale in 2009, Le Mysterè de l'Universe in Paris-Trocaderò in 2010, 150th anniversary of Italian Republic – TORINO-Officine Grandi Riparazioni in 2011, VOLANDIA space pavilion at the Aeronautics museum in MALPENSA-Italy in 2011.

4. **Rational for European Citizen interest/application**

Utilization of such a multimedia technology could allow public as well as scientific and industrial communities to assess space or other domains product or technology history, current and future projects in an easy attractive an comprehensible way using real data coming from the different stakeholders (e.g. scientific, industrial) allowing users to obtain an immersive digital scenarios experience in interactive way.

Scenarios could be easily modified in accordance to the objectives of the demos and new scenarios could be maintained up-to-date by the stakeholders to represent a new source of interest for the visitors.

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Resource management, logistics and transport optimization
PIEDMONT Region

1. **Spin-off domain identification**

Good Warehousing/Distribution And Resource/Transportation Management

2. **Objective and level of innovation of the spin-off**

Since the very beginnings, the International Space Station (ISS) program has faced more and more challenging logistics, resource and transportation management demands, due to the ever increasing support requirements in terms of flight crew size, infrastructure and utilisation.
The advanced optimization methodologies, which Thales Alenia Space Italia has been successfully adopting since two decades to deal with the ISS demanding traffic issues, as well as complex cargo accommodation and on-board stowage, carry along a substantial potential to effectively support logistics, resource management and transportation on the ground too.
The aim of the spin-off we are to put forward is that of treasuring the specialist experience gained in such a complex operational scenarios as the one of the ISS, in order to increase efficiency, while reducing costs, in the framework of the tertiary sector, eventually improving our daily life as well.

3. **Status**

Thales Alenia Space Italia avails advanced in-house optimization assets, aimed at carrying out the logistic support of the ISS utilization at different levels. A remarkable example dates back to the recent past, when, on ESA funding, the company carried out an ad hoc traffic model, to look into the challenging issue of the ISS on-orbit resources re-supply, with the task of optimizing both the upload and download plans, by taking into account complex features such as the orbit altitude maintenance by re-boosting or the removal of the trash produced on-board.
Moreover, even more detailed analysis is needed when dealing with the deriving cargo accommodation and on-board stowage problems, characterized by the demanding need of exploiting the available volume, as much as possible, in compliance with tight geometrical and balancing constraints.
For this reason, Thales Alenia Space Italia initiated the CAST project (Cargo Accommodation Support Tool), specifically designed to optimize the analytical cargo accommodation of all ATV missions. Funded by ESA, the project gave rise to a first version of the CAST tool, profitably used for the first two ATV missions - Jules Verne and Johan Kepler - successfully accomplished in 2008 and 2011 respectively. An updated version of the tool, at present under further development, is going to be utilized for all the foreseen future ATV missions.
A specific CAST extension, already in use, has been tailored to the on-board stowage problem concerning the ISS attached Columbus Laboratory. Its purpose is that of minimizing the crew effort necessary to rearrange the current on-board cargo, depending on the upload and download flux.

4. **Rational for European Citizen interest/application**

Perspective spin-off applications are up to covering a very wide area, ranging from logistics support to arctic exploration and to every-day transportation systems. Remarkable technological fallout is expected for the civil aeronautics, naval, railway and automotive sectors, logistics, transportation and manufacturing petroleum industry. Specific application includes high-speed train loading, ship cargo balancing and naval architecture, volume exploitation, resource optimization, activity planning/scheduling, depot/warehouse handling, lot sizing and material planning, robotic-based warehousing, oil-rigs management.

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Naval architecture and ship cargo optimization

Logistic support, volume exploitation and resource/activity planning/scheduling

High-speed train loading optimization

Petroleum industry and oil-rigs management

Aviation logistics optimization

Laue Project
EMILIA ROMAGNA Region

1. **Spin-off domain identification**

new photon diffraction imaging technique for nuclear diagnostic medicine and radiotherapy

2. **Objective /Performance and level of innovation**

γ–ray lens with Laue geometry shall open a new prospective in the nuclear diagnostic medicine and radiotherapy. For diagnostic, it will allow an increase of resolution and reduction of radiation dose. For radiotherapy, it will allow to radiate only the cancer region

3. **Status**

Laue project is a continuation of HAXTEL project (funded by ASI) for the study and development of a diffractive lens with a suitable geometry (Laue or transmission geometry) to be adopted in a new generation of γ–ray telescopes for astronomy. Laue lens shall be a fundamental breakthrough in astronomy because shall allow the focalization of a large band of radiation energy over 100 keV.

With the state-of-art of more advanced technologies (reflection from multilayer coating) it is impossible to efficiently focus gamma-rays a beyond 100 keV. This new generation of γ–ray telescopes based on Laue lens shall allow to image celestial objects emitting γ–ray radiation, with further benefit in terms of sensitivity improvement.

4. **Rationale for European Citizen interest/ application:**

The Laue lens for astronomy has inspired an application for new photon diffraction imaging technique for nuclear diagnostic medicine and radiotherapy.

The availability of a technology able to make imaging in the γ–ray field can allow:

- development of new diagnostic system operating in the energy range 100-300 keV with improved radiation concentration (obtained by simply adjusting of the source-to-lens and lens-to-detector distances).
- Because of the properties of photon diffraction, only one gamma-ray energy can be imaged at a time which can significantly reduce the background contribution from scattered gamma rays.
- No additional radioactivity would be needed on a patient who has already undergone a scan since the new system should be sensitive enough to detect the remaining radioactivity.

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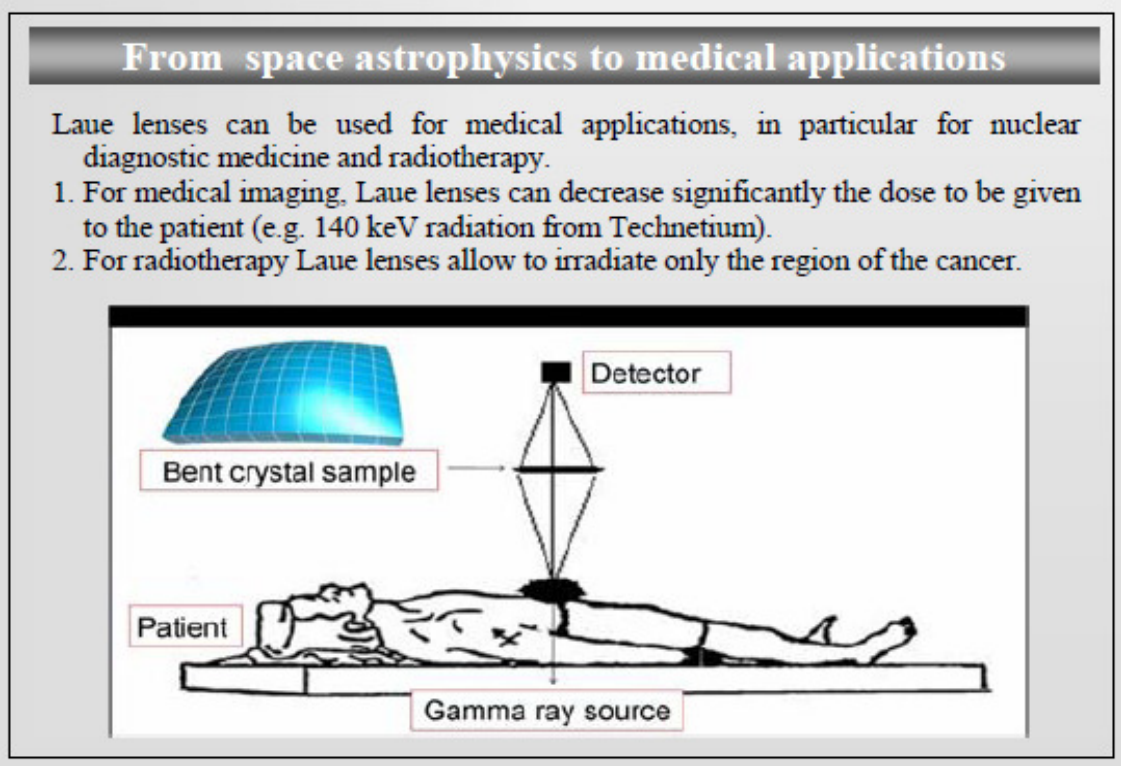

Penta Dynamic Solutions
PIEDMONT Region

1. **Spin-off domain identification**

Home automation: security, custom user interfaces, and energy management

2. **Objective and level of innovation of the spin-off:**

Penta Dynamic Solutions is a spinoff of the University of Piemonte Orientale, which enters in the area of home automation taking an approach strongly different from the one of most companies active in this area:

- Platform based on standard mini/micro pc, Linux and open source software.
- Smart software easy to customize to the user needs and to the environment.
- Emphasis on custom solutions to support aged or handicapped persons.
- Heavy use of image analysis and interpretation in order to build smart sensors, as an alternative to more invasive traditional sensors, which require the user to carry specific devices.

3. **Status**

Penta Dynamic Solutions is already active since one year and is now marketing the first release of a product "Horus", which is, in large parte, a spinoff technology of STEPS project. Horus exploits sophisticated algorithms of image analysis, developed for space applications, to detect intruders and hazards in a domestic environment.

4. **Rational for European Citizen interest / application**

Penta Dynamic Solutions represents a good example of how the research effort in order to develop solutions for space applications can lead to concrete results a citizen can benefit in the every day life.

5. **Participants and Authors**

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Horus is a spinoff technology originated from the experience of the Department of Computer Science of the University of "Piemonte Oreintale" in STEPS project. Designed for Home security and automation it is provided with powerful algorithms of computer visions, capable of detecting intruders or hazard situations dangerous for the inhabitants. This technology is directly inherited from the vision based techniques developed for Mars landing and for hazard detection in space missions.

Moreover, tools developed in order to support astronauts during space missions are now proposed by Horus as utilities for managing and maintaining the domestic appliances. A Technical Assistant based on low cost computer vision techniques can help an astronaut to repair a space rover, as well as a housewife to change the dishwasher filter.

Finally, Horus is provided with a powerful sensorial system deriving from the experience gained with sensors used in navigation robots.

Born from an academic experience, Horus is now the leading technological product of Penta Dynamic Solutions S.r.L, a recently born spinoff of the University of "Piemonte Orientale".

AMV - Automatic Mice Vivarium
LOMBARDY Region

1. **Spin-off domain identification:**

Healthcare, Civil Protection and surveillance.

2. **Objective and level of innovation of the spin-off**

The AMV (Automatic Mice Vivarium) SPIN OFF concept has been identified starting from the experience gained by Thales Alenia Space Milan (previous Laben) in the framework of the MDS (Mice Drawer System), an ASI (Italian Space Agency) funded program.

From 1947, animals were flown to investigate various biological processes and the effects of the space flight might have on them, keeping in mind the human space flight risks and costs. In this context MDS has the objective to extend the human presence safely beyond low Earth orbit.

MDS provided, during August - November 2009, a general-purpose International Space Station (ISS) facility; it was used on board the ISS by a large number of researchers and scientists for different experiment types, establishing a space flight permanence record for a mice group, with a limited requirement of the astronaut time.

During 2009 flight this experiments facility used a validated mouse model to investigate the genetic mechanisms underlying bone mass loss in microgravity. Other 20 Experiments conducted with the MDS, running in parallel during the first flight, are an analogue to a more intrusive, complex and challenging human research experiment.

3. **Status**

MDS is a current ISS Operational Facilities of the Italian Space Agency –ASI.
With respect to other ISS Facilities, the use of living specimen (in this case mice) introduces an additional and very important aspect: the animal well being (and the related public awareness concerning their well-being), this aspect needs to be carefully considered taking also into proper account the influence of environmental and biologic factors on the experimental scientific results

MDS was accommodated inside an External Container that fits inside a Double Payload Carrier (DPC). DPC permits installation of MDS inside the former US Shuttle Middeck *or ISS Express Rack.

4. **Rational for European Citizen interest / application**

In the frame of hazard area, where a carefully biological / medical investigation is requested without jeopardize human life, AMV derived from the MDS heritage, could provide safe and reliable solutions.

As matter of facts, in order ***to guarantee a high degree of the facility autonomy,*** and therefore *the minimisation of external human servicing*, the Control Unit of the AMV, is in charge to provide the data management and environment control tasks as well as continuous monitoring of the facility status.

AMV configuration could permit the execution of experiments in which, for example, by modular blocks up to 6 individually housed mice or 8 grouped-housed mice (4 couples); moreover several different accommodation configuration can be provided.

5. **Participants and Authors**

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MDS establishing a 90 days space flight permanence record for a mice group on ISS

Spinoff from Space Regenerative Fuel Cells Technology
LOMBARDY Region

1. **Spin-off domain identification:**

Renewable Energy (Generation and Storage)

2. **Objective/performance and level of innovation of the "SPIN OFF":**

The Regenerative Fuel Cell Technology developed for Space Exploration has a broad innovation potential for terrestrial applications. Innovative concepts developed for satisfying the Space Exploration very demanding requirements can lead to higher performances and lighter systems that could be very attractive for non-space applications.

3. **Status**

The CGS project described in the present paper is related to the development of regenerative fuel cell technologies for Exploration applications, based on Proton Exchange Membrane (PEM). The output of the project, whose completion is expected before the end of 2011, is to reach a Technology Readiness Level between 4 and 5 (Component and/or breadboard validation in Laboratory / Relevant Environment). A Technology Demonstrator has been developed and the relevant Test Campaign has already been started.

4. **Rational for European Citizen interest/application**

Main terrestrial application areas benefitting from Fuel Cell Space Technology developments include Stationary Power Plants for land, water and air vehicles, and mobile electronic products. Moreover, developments in Fuel Cell Technologies from non-space sectors could be very beneficial for advancing the Technology Readiness Level of Space Applications, giving room to very promising "Spin-in" initiatives and maximising cross-developments benefits between space and non-space sector.

5. **Participants** and Authors

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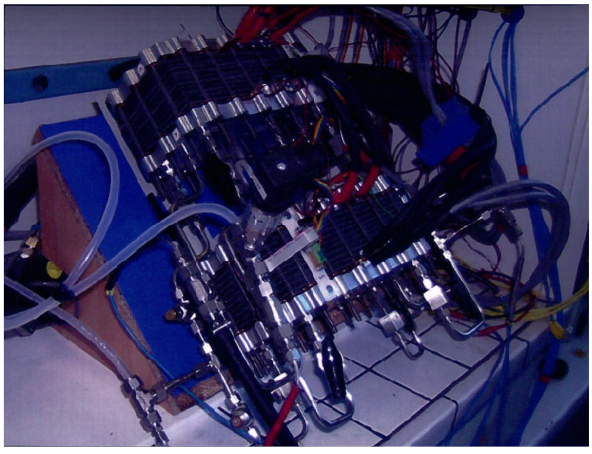

OptiShape

LOMBARDY Region

1. **Spin-off domain identification:**

Technology- Optics

2. **Objective and level of innovation of the spin-off**

OptiShape will be a INAF-OAB spin-off constituted to transfer the opportunity offered bt the in-house developed Ion Beam Figuring plants to the industries related with high precision optics.

The Ion Beam Figuring (IBF) is the most accurate process of optical finishing. The IBF process can be applied to many materials and is capable to figure both regular and free-form optics.

Possible applications for the IBF technology are identified in every field requiring high quality optics, such as astronomical and remote sensing satellites, semiconductors lithography, metrology. With the general increasing of the required optics quality (to miniaturize optical systems, to enhance the resolution, etc) the IBF performances became suitable to match with the industries interests.

3. **Status**

Two Ion Beam Figuring plants were developed at the INAF-OAB Labs. Dr. Mauro Ghigo has carried out the scientific research required to realize these IBF plans in the last 10 years. These plants are currently working and allow figuring optical components at the higher today available accuracy (few nm shape error).

4. **Rational for European Citizen interest / application**

The Ion Beam Figuring technique figuring capability gives the real opportunity to enhance the performances of optics Instead of the classical optics manufacturing methods, it is deterministic and applicable to a wide range of materials (SiC, Zerodur, glasses, metals, etc.) and to free-form geometries.

5. **Participants and Authors**

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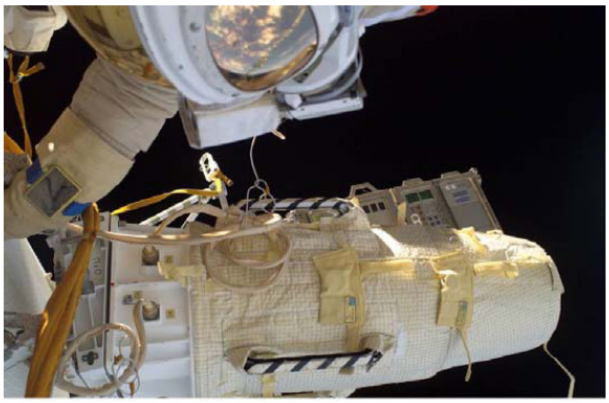
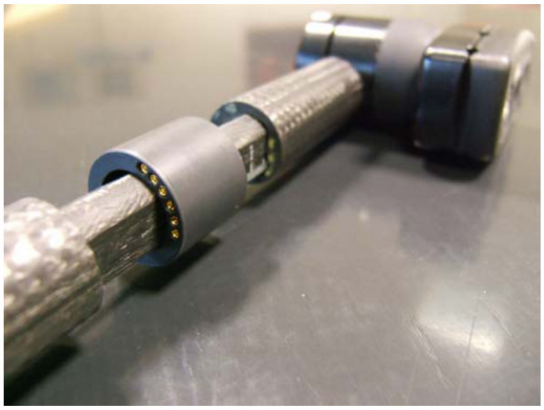
DTM external fixator, with embedded telemetry system
EMILIA ROMAGNA Region



From Space experience……to orthopaedics patients, for their better and quicker recovery



Thanks to telemetry, the surgeon can monitor the progress of the bone healing with patient is free to move.
This is true also at a very large distance from the Hospital.
During convalescence, the patient can travel safe, sure to be controlled in real time.

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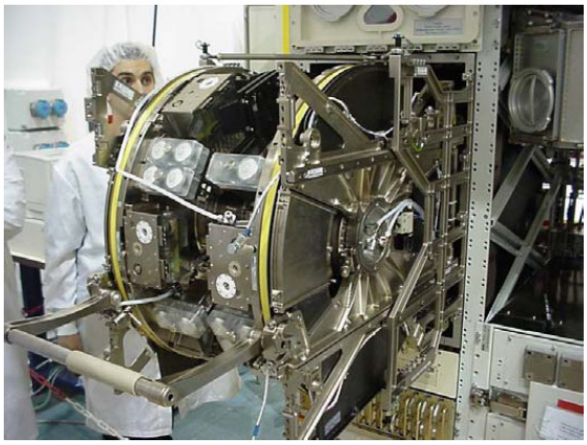
SENTINEL – Helicopter Safety System
EMILIA ROMAGNA Region



From the International Space Station new safety system for helicopters and light airplanes

"Sentinel" is an innovative device able to improve the safety of helicopters and light airplanes, by monitoring the structure health. It performs continuously and automatically. The crew is informed in real time about the conditions of his aircraft: in case an incipient defect occurs, "Sentinel" tells the pilot where this defect is taking place, and also informs about the approx. remaining flying time available

Safe flight *Warning! Light defect is present onboard*

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Terrestrial applications of an ultra-miniaturised XRD/XRF instrument developed for planetary studies

ABRUZZO Region

1. **Spin-off domain identification**

Monitoring and Access to resources, Materials

2. **Objective and level of innovation of the spin-off**

X-ray diffraction (XRD) and fluorescence (XRF) are key techniques for the analysis of mineralogical composition and chemistry of materials. Particularly, it'd be very useful the development of a portable instrument which combines these two techniques for the in situ, non-destructive analysis of art manufactures or polluted soils.

The need of high level miniaturisation required for space applications, provided the know-how for producing light and compact components which are well suitable for portable instrument. This type of instrument does not exist yet.

3. **Status**

The first step is the development of a demonstrator of the portable equipment for terrestrial application. In the frame of Exomars 2018 Mars mission, the team, led by L. Marinangeli, developed a Structural,

Thermal and Mechanical Model (STM) and critical parts of the flight-like Electrical Model.

The Italian Space Agency (ASI) is the leading funding agency with an important contribution of the UK Space Agency for the detection system

4. **Rational for European Citizen interest / application**

The attractive and limited engineering budget requested from this tailored XRD/XRF instrument allows a wide field of applications.

This development will be an European technological harmonisation process where the professional capabilities and knowledge of different European labs, industries and universities are joined together.

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Airbag technology from Space to Earth

LAZIO Region

1. **Spin-off domain identification**

Aeronautical (Helicopters) Application

2. **Objective and level of innovation of the spin-off**

Transfer the airbag technology developed for Martian landing to guarantee safe impact to helicopters in case of crash

3. **Status**

Analytical approach completed; development in progress

4. **Rational for European Citizen interest / application**

Increase safety for the Helicopters

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Agrospace technologies for terrestrial applications

LAZIO Region

1. **Spin-off domain identification**

Agricoltural applications

2. **Objective and level of innovation of the spin-off**

Utilize agrospace technologies (in particular Hydroponics) for extreme environment terrestrial applications, such as South Pole, or in other peculiar environment, such as Balcony greenhouses.

3. **Status**

Demonstrators and prototypes have been developed

4. **Rational for European Citizen interest / application**

Support with fresh vegetables people in extreme cenvironmental conditions; self-production of vegetables also in urban environment

5. **Participants and Authors**

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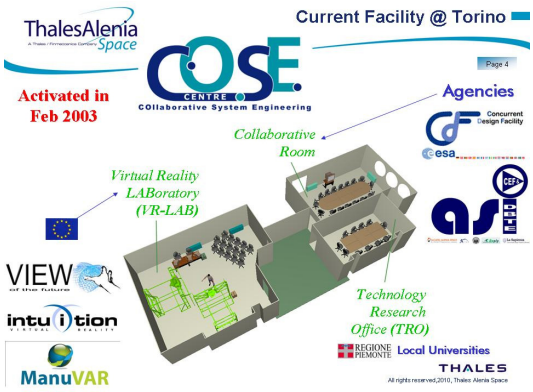
5. About the Exploratoria project and its facilities

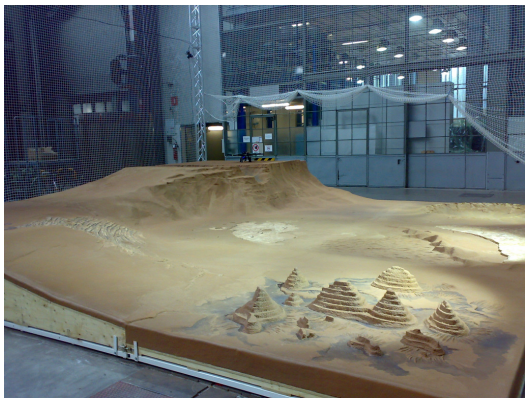
Centers that stimulate interest in space exploration adventure and spark enthusiasm for space already exist, spread in some European Countries and NEREUS Regions.

The astronomical park Infini.To was inaugurated in 2007 next to the Torino Astronomical Observatory in Pino Torinese, on the hills 15 km from Torino, with the aim to offer students, teachers and the general public updated information and exhibits on the progress of astronomy and space science. Today it is deeply rooted in Piedmont and it has strong contacts with leading Italian and international museums. In addition it also collaborates with universities, research institutions and companies. It has been visited by 200.000 people in the first 4 years of operation.

Not so far from this astronomical park two other facilities exist, located at Thales Alenia Space in Torino. One of them is the COllaborative System Engineering (COSE) Centre, containing a virtual reality lab (VR-Lab), which is an infrastructure equipped with modern HW, SW and interaction devices that create a 4D (space plus time) environment able to allow immersive rendering of the product behaviors in the target environment. The VR-LAB makes possible, for instance, to visit the Solar System and to make a trip back in the visible universe from today to the Big-bang navigating in 4D the known stars and galaxies of the Hipparcos Satellite and Sloan Digital Sky Survey catalogs.

The other facility located in Thales Alenia Space in Torino is the Planetary Landing Validation Facility (PLVF), which is an infrastructure equipped with modern HW, SW and interaction devices that re-create a planetary surface environment allowing an automated aerial platform flying over it with an high precision control. PLVF is easily adaptable to perform didactic experiments, allowing public to trial how to land or fly on Mars and Moon, taking into account on-board resources and environmental conditions.

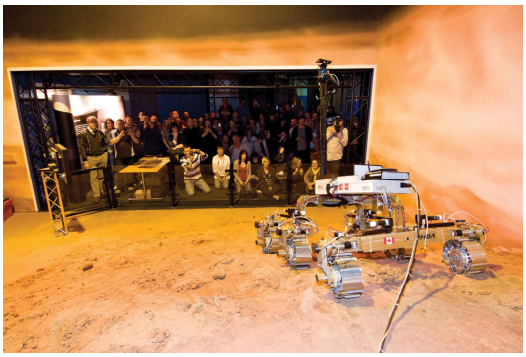




Close to Thales Alenia Space in Torino another facility is located, ALTEC, which is the Italian center of excellence operating in an international context for the provision of hi-tech engineering services relevant to operations and utilization of the International Space Station (ISS), other space infrastructure, and in support of future robotic and manned planetary exploration. ALTEC offers the following capabilities:

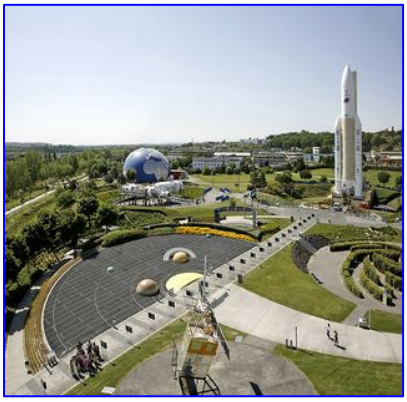
- Mars and Moon Terrain Demonstrator to test the development of exploration technologies;
- Neutral Buoyancy Test Facility (NBTF) to allow the simulation of activities typical of a reduced gravity environment;
- technical areas with controlled temperature, humidity, air and environment cleanliness;
- classrooms and spaces for training and dissemination of scientific and technological space activities and dedicates areas for the preparation of exhibitions and workshops (eg. auditorium, exhibition hall).

Another facility is located in East Midlands at the University of Leicester: it is the National Space Centre (NSC). The National Space Centre is an established science centre with a mission to enhance the public understanding of space and its relevance to everyday life, and encourage young people to become the scientists and engineers of the future. An education charity with international links in the space community and additional business activities that provide content for science centres, the National Space Centre is an obvious Exploratorium that can help develop the scope and content of other exploratoria in the network.
The National Space Academy supports 14-19 year olds and their teachers in their physics, chemistry, biology, mathematics and geography studies using space and climate change as learning contexts. Its programmes are delivered by a network of outstanding teachers and scientists.
NSC Creative is a team of computer animators that creates films for planetaria and for flat screen applications. It is well-placed to create content that can be shared by the network of exploratoria. In the UK, it has created a film called *We Are Astronomers* for a network of seven planetaria. The film has been seen by one million people.

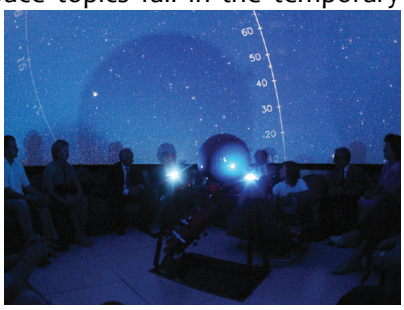


In the Midi Pyrenees Region Cité de l'espace is located. It is an Edutainment Theme Park on Space and the conquest of Space. Inaugurated in June 1997 and located on the eastern outskirts of Toulouse, France, it has already received over 4 million visitors. Cité de l'espace offers a chance to explore fascinating attractions on over 5 hectares. The Park has the twofold aim of contributing to teaching about Space and astronomy in a fun comprehensive way and being a showcase for all Space-related activities, notably in Toulouse, Europe's Space capital.
It has permanent interactive exhibitions: four floors to discover the main principles of the Universe and the telescopes and probes sent to the edge of Space to reveal the secrets of the planets and the Cosmos. A window on the world with the most stunning interactive views of Earth taken by observation satellites, the control room to monitor the Ariane rocket in its missions and a weather forecasters' room to meet a weatherman and discover the instruments to help professionals predict the weather.
Cité de l'espace plays a dynamic part in the scientific culture in the Toulouse region, organizing many events, conferences and meetings to put Space news and innovations in the spotlight.

The Lombardy Region is one of the core elements of the Italian Aerospace Industry. It has many key players involved in the divulgation and popularization of space related items and technologies. Among them Volandia Park, Brera Astronomical Observatory, the Museo Nazionale della Scienza e della Tecnologia, and the Milano Planetarium represent a strong core on which to start enhancing the space activities promotion and divulgation in line with the NEREUS Exploratioria network concept.



The Volandia 11 pavilions are dedicated to the exposition of aeronautics and astronautics stuffs. The space dedicated exposition includes spacecraft mock-ups of different space missions, representative for the fundamental steps of the human kind in space.
In the space pavilion visitors walk among mockup of former and current space missions and have the possibilities to experience the ISS in 3D room.
The Planetario di Milano offers a 20meters diameter hemisphere which virtually represents the sky in any kind of conditions to support the speaker, depending on the given lecture.
The Museo Nazionale della Scienza e della Tecnologia has a 23000 sqm dedicated to science and technology permanent and temporary exhibitions. Space topics fall in the temporary exhibitions, mainly related to relevant events in the field.



The Osservatorio Astronomico di Brera was one of the first Italian Research institutes to supply with specialized and professional people in order to communicate the scientific knowledge. It has a dedicated structure for communication of scientific knowledge, featuring a multimedia room for public lectures. It has didactic laboratories and two professional telescopes which are used for night-time observations open to the public and to the schools.

5.1 Network of Exploratoria in Europe: a NEREUS proposal

Definition of Exploratorium

Supplying a simple definition for an Exploratorium is a very difficult task. Indeed, an Exploratorium is many things. For instance, it is typically perceived as a science museum. Deeper inside, it is a site where the discovery of the world can be experienced by both new practices and well-advanced technologies; a place in which science means massive interaction with the audience; a centre for high quality scientific dissemination; an original way of learning with fun; and a network of both academic / scientific and industry cooperating partners. Fundamentally, it is a laboratory whose main purpose is to spread scientific culture worldwide – the popularization of science should combine scientific rigours and suitable teaching methodologies.
Space Exploration is based on both human and robotic missions.

Why and how a network of Exploratoria in Europe

Why: because the EU citizens are drivers to spread around the usefulness of technologies from space exploration, and are drivers of cross-fertilized ideas.

How: setting-up a main Exploratorium site per interested Country, networked with other Exploratoria in Europe, plus some "travelling" sites for exhibits, shows, …to bring the Exploratorium experience in all the interested regions in Europe.

Benefits of such an initiative for the EU citizens may be recognized in terms of: 1. advance in new technologies with expected R.O.I.; 2. advance in scientific knowledge; 3. economical growth; 4. new highly specialized jobs.

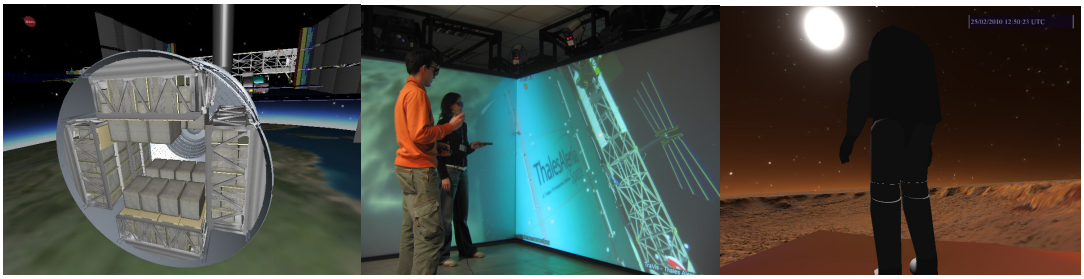
The project

Broadly speaking, an Exploratorium aims to actively involve the audience into the organization of a space exploration mission step by step. In particular, the interest should be addressed on either how to use the state-of-the-art technologies or identify the needed but not yet at our disposal ones; to evaluate risks arising from inter-planetary journeys; and to consider how a manned crew can survive and work in extra-terrestrial environments.

For that end, an Exploratorium will be equipped with a number of workspaces in order to show the simulation of the main steps of a space exploration mission. Suitable consoles, stereo monitors, and 3D immersive devices will be supplied as well in order to allow active interactions with the simulated scenarios.

The Exploratorium will be organized into several main themes, such as:

- The history of the Human Space Exploration (in order to show the current state-of-the-art and fix the very next goals);
- The organization of a space mission towards the Moon and/or Mars with a manned crew. The focus here is to experiment interactively with the main phases of the technical preparations for such a mission. The audience will be asked to manage spacecraft cargoes, supplies and the housing environments. According to those choices, a simulated scenario will show the possible effects upon the mission;
- The human and robotic space exploration. The focus here is to show the interest of robotic missions and how robots could serve manned crew;
- The space journey, with a particular emphasis on dangers a manned crew could meet along it (e.g., radiations, and meteorites / asteroids impacts). The journey will end up with a simulation of the landing phase;
- Virtual replication in a very immersive environment of some of the most exciting space phenomena in the Solar system;
- A deeper insight into the landing phase (with a particular reference to the simulation of the physical environment reactions to it) and the setting up of the housing units hosting the crew on that planetary surface. This main theme should focus also on environmental risks on alien planets (e.g., radiations, atmospheric phenomena, lack of water and oxygen, ...)
- How planetary surface technologies and collaborative robotics can support planetary exploration
- How to organize a long term space exploration journey: travelling to extrasolar planets is at present a dream only, but many research projects on stellar spaceships based on novel propulsion systems are already under way
- A dream in 3D: mankind on a Earth-like planet, but travelling to deep space by means of space observatories that receive data from the beginning of the Universe.



The proposal

Following to a feasibility study it is proposed to build, under EC/ESA funds, the European network of Exploratoria, based as much as possible on already existing facilities and locations (e.g. planetarium in Torino, la cite de l'espace in Toulouse, SRC in Leicester, etc.).

This network shall include:

- One main site per Country, taking benefit of all the complementarities in terms of facilities and expertise present in that Country
- Secondary sites: everywhere an existing museum / laboratory / science center / hall / ... can / wants to house in a particular facility / equipment / attraction in a permanent / temporary way
- Temporary travelling sites with "lighter", reduced versions of the original attractions in stable sites: for exhibits / shows / conferences / kermes / galas / …

This initiative shall be built in strict cooperation among the different Space actors, such as the involved European regions, local Universities and Research Centers and industry – both large companies and SMEs.

The network of European Exploratoria will "democratize" Space Exploration and make it literally accessible to everyone.

6. Conclusions and perspectives

The 2011 Torino Seminar aimed to awareness rising of the benefits for the European citizens through Space Exploration programs and involved technologies.

It was held some weeks before the Third International Conference on Exploration / First meeting of the High-level International Space Exploration Platform in Lucca (I), where Government representatives from around the world highlighted the importance of future space exploration and its direct benefit to humankind.

In addition to advancing the state of the art in science, technology and engineering, these leaders affirmed that there are unprecedented opportunities to deliver benefits to humanity on Earth while paving the way for future space exploration activities. These benefits include fuelling future discoveries; addressing global challenges in space and on Earth through the use of innovative technology; creating global partnerships by sharing challenging and peaceful goals; inspiring society and especially the younger generations through collective and individual efforts; and enabling economic expansion and new business opportunities. The international high-level policy dialogue initiated in Lucca contributes to delivering these benefits. Furthermore, the Government representatives in Lucca committed to begin the open structured high-level policy dialogue on space exploration at the government-level for the benefit of humankind: next dialogue will be held in 2013 in USA.

The NEREUS Seminar wanted to bring to the attention of the Union and National Governments the results already achieved – thanks to the support of space National Agencies and ESA – in transferring space exploration technologies at the benefit of the European citizens, and the potential of many other technologies to be adapted to terrestrial use in the next future. Furthermore, the Seminar wanted to present the Exploratoria project which fits perfectly with the Lucca declaration on inspiring young generations to embrace scientific and technical carriers in the Space domain.

The NEREUS Working Group on "Technologies from Space Exploration" will continue in its efforts in 2012, having as ultimate goal to boost technology innovation and spin-offs from space exploration technologies down to Earth applications.

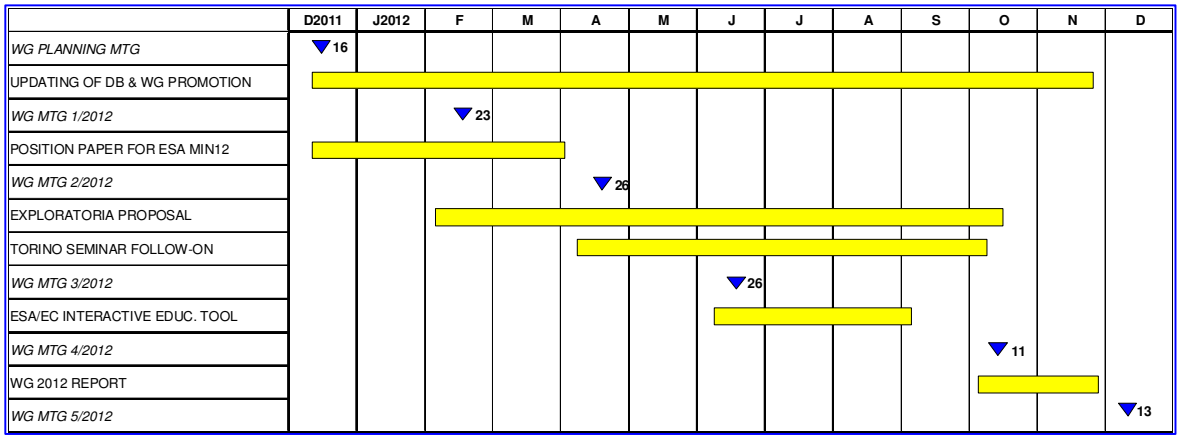
In view of the next ESA Council Meeting at Ministerial level the NEREUS WG expresses the need to have a strong program to support the spin-offs, and especially a dedicated budget for the proof of concepts / prototyping of the technology to be transferred from Space into terrestrial application.

In the short term, the WG aims at preparing the **2nd European Seminar on "Technologies from Space Exploration"**, which will be held in 2013, hosted by the Space Research Centre at the University of Leicester, before the 2nd meeting of the High-level International Space Exploration Platform in USA. This is done in order to convey to the Platform the NEREUS contribution to the dialogue.

The WG activities in 2012 are summarized as follows:

- Updating of the DB of the space exploration capabilities in the NEREUS Regions.
- Promotion and awareness rising to attract other European Regions in the WG.
- Position papers preparation and dissemination for the next ESA Ministerial Council and for the budget & programmatic set-up of the Horizon 2020 program: main themes are techno transfers from space exploration, common R&D space exploration -non space, EXPLORATORIA, and simulation facility networking.
- Revision of the EXPLORATORIA proposal taking into account the inclusion of Observatories in the network.
- Preparation and submission of the EXPLORATORIA project proposal to the 6th space call in the frame of FPVII.
- Preparation of follow-on of the Torino seminar, to be done on a regular basis in Europe.
- Propose to ESA/EC innovative interactive tools for education and communication in space exploration, e.g. live video web-links, so that the public becomes a real-time actor.

The 2012 activity schedule is the following:



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The authors of this report would like to thank NEREUS Regions, ESA, the Union and Committee of Regions representatives, Italian Government, Piedmont Region and local Institutions, the astronaut Paolo Nespoli, Industry and Academia, the press, and all the Torino Seminar participants for their valuable support and contribution to this first European initiative, whose aim was awareness rising of the benefits for European citizens through Space Exploration programs and involved technologies.