Annual Report 2010

of the

International Space Exploration Coordination Group

INTERNATIONAL SPACE EXPLORATION COORDINATION GROUP

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1 Introduction

The fourth Annual Report of the International Space Exploration Coordination Group (ISECG) provides an overview of ISECG work in 2010. The annex to this report highlights the national exploration activities of some of the ISECG participating agencies during the past year.

This report is intended to record activities, products and accomplishments of the ISECG to inform stakeholders regarding the progress in implementing the Global Exploration Strategy (GES).

2 Executive Summary

In May 2007, fourteen space agencies[1] jointly released "The Global Exploration Strategy: The Framework for Coordination". It describes a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.

The Global Exploration Strategy (GES) articulates a compelling case for exploration to gain public support for a globally coordinated effort. It sets the stage for an evolving process towards a strategic and comprehensive approach to space exploration. It is not a proposal for a single global programme but recognizes that individual space exploration activities can achieve more through coordination and cooperation. The GES identifies a common set of exploration themes and benefits:

- New knowledge in science and technology
- A sustained presence – extending human frontiers
- Economic expansion
- A global partnership
- Inspiration and education

The GES called for a voluntary, non-binding coordination mechanism among interested space agencies. The **International Space Exploration Coordination Group ISECG** is the forum set up by the participating agencies to advance the GES through coordination of their mutual efforts in space exploration. The scope of ISECG is broad and strategic and activities are based on the following principles:

- Open and inclusive
- Flexible and evolutionary
- Effective
- Of mutual interest

The work is focused on products, findings and recommendations considered important to enabling individual agency decision-making.

[1] In alphabetical order: ASI (Italy), CNES (France), CNSA (China), CSA (Canada), CSIRO (Australia), DLR (Germany), ESA (European Space Agency), ISRO (India), JAXA (Japan), KARI (Republic of Korea), NASA (United States of America), NSAU (Ukraine), Roscosmos (Russia), UKSA (United Kingdom),. "Space Agencies" refers to government organizations responsible for space activities.

The year 2010 marked an important milestone in the process of implementing the GES due to the establishment of regular ISECG meetings at the Senior Agency Management (SAM) level. Those meetings allow senior agency managers to share common perspectives and increase understanding at the corporate level of ISECG strategic issues. Moreover, ISECG work progress is reviewed and guidance on the forward work is provided to the group.

Priorities as identified by the senior agency managers at the 1st SAM meeting in June:

1. Developing and maturing the Global Exploration Roadmap (GER)
2. Identifying near term collaboration opportunities
3. Interest in using ISS as a testbed for exploration preparatory work
4. Considering a high-level technology assessment roadmap to shape investments, priorities and identifying added value to agency decision-making (potential collaboration, high interest areas)
5. Increasing the visibility of ISECG and its products

In response to these priorities, ISECG continued to develop and shape its products in the past year. Guided by a set of common human lunar exploration goals, representing the shared interests of participating agencies, the "ISECG Reference Architecture for Human Lunar Exploration" was completed and published in 2010. This human space exploration conceptual architecture and concept of operations shall inform the lunar exploration planning and preparations of participating agencies. By comparatively assessing multiple lunar campaign options, the proposed architecture provides for a robust and flexible exploration strategy for the Moon. This reference architecture takes a phased approach to human lunar exploration, recognizing that lunar exploration provides opportunities to advance scientific knowledge, prepare for Mars exploration and capture the imagination of young people.

Development and maturation of the GER will contribute to enhanced coordination and cooperation for global space exploration activities and thereby enable the future implementation of gradually more challenging space exploration mission scenarios. The first version of the GER will be available by the fall of 2011 and will provide an overview of exploration plans of participating agencies as well as discuss recommendations for next steps for global exploration. These recommendations will include identification of near-term opportunities for coordination and cooperation, the role of the International Space Station (ISS) in advancing space exploration as well as an assessment of future global exploration mission scenarios.

In order to facilitate discussion between ISECG participating agencies, a web-based data repository is under development that shall provide a single reference source for ISECG members on the type and status of exploration-related missions, payloads, systems and technologies.

First important steps were taken to enhance communication of the status, products and value of the group. ISECG work was presented at the Global Lunar Conference in May in Beijing, China, the 38th Scientific Assembly of COSPAR in July in Bremen, Germany and the 61st International Astronautical Congress (IAC) in September in Prague, Czech Republic. The IAC plenary "Advancing the Global Exploration Strategy" together with the release of the ISECG brochure "Exploring together" at the IAC contributed successfully to the strategic communication effort of ISECG.

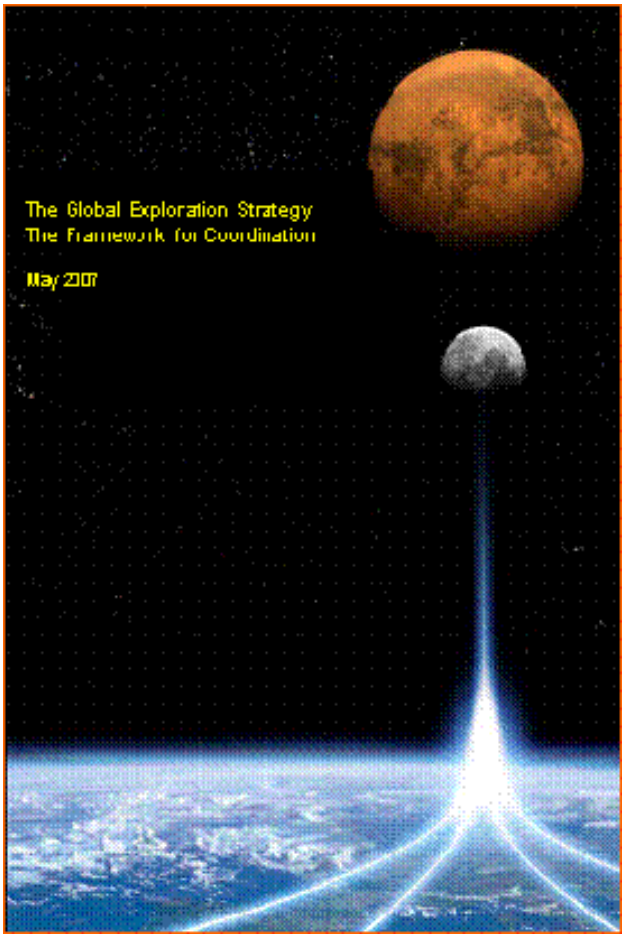
In summary, ISECG was able to advance the implementation of the GES in 2010 by serving as the international forum where interested agencies continued to share their objectives and plans for human and robotic space exploration. ISECG contributions included exploring concepts that reflect synergies and developing products that enable individual agencies to take concrete steps towards an internationally coordinated approach to space exploration.

The future work of ISECG will continue helping to maximize early international partnership opportunities, to increase robustness, safety and cost effectiveness of individual and collective exploration goals and to facilitate each agency's ability to effectively engage the public in space exploration activities.

3 ISECG Background

3.1 Global Exploration Strategy and Terms of Reference

The International Space Exploration Coordination Group (ISECG) was established in response to "The Global Exploration Strategy: The Framework for Coordination" developed by fourteen space agencies[1] and released in May 2007.



This GES Framework Document articulated a shared vision of coordinated human and robotic space exploration focused on solar system destinations where humans may one day live and work.
Among the many Framework Document findings was the need to establish a voluntary, non-binding international coordination mechanism through which individual agencies may exchange information regarding their interests, plans and activities in space exploration, and to work together on means of strengthening both individual exploration programmes as well as the collective effort.

The Terms of Reference (ToR) for the ISECG were formally adopted at the first meeting of the group in Berlin in November 2007. ISECG chairmanship rotates annually and effective as of June 23, 2010, NASA assumed chairmanship from ESA.

The purpose of ISECG is to work collectively towards the further development and implementation of the GES by providing a forum to discuss interests, objectives and plans in space exploration and by promoting interest and engagement in space exploration activities throughout society.

The scope of ISECG is broad and strategic and activities are based on the following principles:

- Open and inclusive
  - ISECG receives inputs from all interested agencies that invest in and perform space exploration activities
  - ISECG provides for consultations among all agencies with a vested interest in space exploration
- Flexible and evolutionary
  - Existing consultation and coordination mechanisms are taken into account
- Effective
  - ISECG encourages participating agencies to accept the role of the coordination process
  - ISECG encourages participating agencies to act upon the anticipated results of the coordination mechanism
- Of mutual interest
  - ISECG activities benefit all participants and respect national prerogatives
  - ISECG activities allow for optional participation based on the level of interest

ISECG participants focus on the development through consensus of non-binding products - findings, recommendations and other outputs as necessary - for use by the participating agencies.

3.2 Senior Agency Management Meeting

Since inception, ISECG has been successful in organizing and implementing its work plan.
However, the development of ISECG work has over time emphasized that discussions within the group include strategic level issues of corporate interest, such as key exploration destinations or a global exploration roadmap.
Given that the scope of ISECG is “broad and strategic” (ToR), an ISECG meeting at Senior Agency Management (SAM) level was thus considered to be crucial for the advancement of the global space exploration effort.
At the 4th ISECG Meeting in December 2009, Noordwijk (The Netherlands), it was agreed to arrange an ISECG meeting at SAM level in 2010. The purpose of the meeting was to allow senior agency managers to share common perspectives and increase understanding of ISECG strategic issues at the corporate level.
In June 2010, senior managers representing twelve ISECG member agencies met in National Harbor (Maryland, USA). to exchange views. They reviewed the progress of ISECG work and provided guidance for the future work priorities.

The senior agency managers identified five high interest items:

1. Developing and maturing the GER
2. Identifying near term collaboration opportunities
3. Interest in using ISS as a testbed for exploration preparatory work
4. Considering a high-level technology assessment roadmap to shape investments, priorities and identifying added value to agency decision-making

Potential collaboration, overlap and complementary efforts should be addressed as well as the timely coordination given the short formulation time windows. It should also be ensured that capabilities are responsive to the assessment of key destination questions such as why we go and when. Near-term discussions will also be needed to fully utilize ISS potential as a testbed for exploration.

5. Increasing the visibility of ISECG and its products

The status, products and value of ISECG should be better communicated both internally (agency to agency) and externally (to the public). This includes regular information exchange and media and publicity events. Senior agency managers will support these activities by keeping Heads of Agencies informed and leveraging key international forums and meetings.

Joint Statement
International Space Exploration Coordination Group
Senior Agency Management

June 23, 2010
National Harbor, Maryland

Senior managers representing space agencies in Canada (CSA), China (CNSA), Europe (ASI, CNES, DLR, ESA, UKSA), Japan (JAXA), Korea (KARI), Russia (Roscosmos), Ukraine (NSAU) and the United States (NASA) met at the National Harbor, Maryland, on June 23, 2010, to discuss their interests in globally coordinated human and robotic space exploration. Consensus was reached that significant progress has been made since their joint release of the Global Exploration Strategy (GES) in May 2007 and that steps can and should be taken to enhance their efforts to promote coordination and cooperation to enable a long term space exploration vision that is both sustainable and affordable.

The agency senior managers acknowledged the valuable work of the International Space Exploration Coordination Group (ISECG) -- the GES implementing body -- during the last three years, and welcomed the development of the first ISECG reference architecture, focused on human lunar exploration. They reached consensus on expanding their work to all key exploration destinations and the critical building blocks required to reach these destinations as part of a "global exploration roadmap" – a key part of an evolving international architecture effort. Senior managers discussed the importance of early dialog focused on near-term opportunities for cooperation, such as robotic precursor missions and utilization of ISS as an exploration test bed. The senior managers agreed on holding further strategic discussions at the senior management level and to review the progress of ISECG as products are developed and delivered.

It was also agreed to hold regular ISECG meetings at the SAM level and in accordance with this policy, an ISECG SAM teleconference was held in November 2010 to discuss the work progress and next steps.

SAM meetings will be continued in 2011 to ensure timely and effective alignment between ISECG activities and strategic considerations of ISECG member agencies.

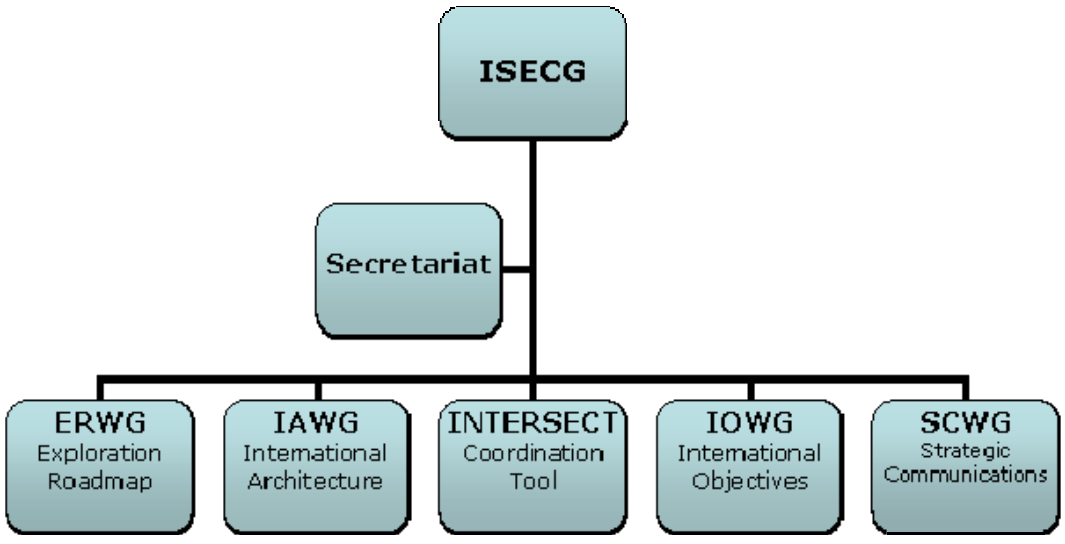
4 Working Group Activities

4.1 Overview

The bulk of the work leading to ISECG products is performed by ISECG working groups (WG) between meetings and is guided by monthly plenary ISECG teleconferences. The degree of participation in ISECG working groups varies by agency, and by product, but all products are shared with all ISECG participating agencies, throughout the development process. This "open and inclusive" approach – a key principle established in the GES - is endemic of all ISECG business.

ISECG and supporting working groups continue to receive outstanding support by a permanent secretariat, provided by ESA. In addition, the ISECG secretariat provides generic information about ISECG and its products, hosts and manages the ISECG website and supports space agencies that request ISECG membership.

ISECG member agencies that participate in the production of specific ISECG products (referred to as "participating agencies" of that product) demonstrate through their participation the flexible and evolutionary nature of ISECG to serve as a forum for interested agencies to progress a variety of initiatives of interest to their programmes and plans. Finally, the ISECG continues to focus on the development of products that are at once effective and of mutual interest to address the needs of the participating agencies. The ISECG performs its work through an evolving workplan which is updated periodically as required by the evolving needs of the participating agencies. This is also reflected in the current structure of ISECG, effective as of September 17, 2010:



4.2 Exploration Roadmap Working Group (ERWG)

4.2.1. Accomplishments

The Exploration Roadmap Working Group (ERWG) initiated in early 2010 work on the development of the Global Exploration Roadmap. The Global Exploration Roadmap is intended to be used by agencies as a reference tool which further elaborates the Global Exploration Strategy and is useful for each agency as it plans for and develops domestic support for exploration. Its development shall lead to enhanced coordination and cooperation for global space exploration activities and thereby enable the future implementation of gradually more challenging space exploration mission scenarios.
During the first half of 2010 a vision for the role and content of the Global Exploration Roadmap had been consolidated and subsequently endorsed at the 1st ISECG Meeting at Senior Agency Management level held on 23 June 2010. During the second half of 2010 work on the first version of the Global Exploration Roadmap had commenced which shall be finalised by the fall of 2011. The content, structure and development plan of the first version has been endorsed at the 2nd ISECG meeting at Senior Agency Management level held on 17 November 2010.
The Global Exploration Roadmap will provide an overview of agency exploration plans, as well as discuss recommendations for next steps for global exploration. These recommendations will include identification of near-term opportunities for coordination and cooperation, the role of ISS in advancing space exploration as well as an assessment of future global exploration mission scenarios. The overall vision and approach for the Global Exploration Roadmap had been presented at the IAC 2010.

4.2.2. Future Work

The Exploration Roadmap Working Group will develop by the fall of 2011 the first version of the Global Exploration Roadmap. Forward work will focus on developing an overview of agency's exploration plans encompassing human operations in Low Earth Orbit, robotic missions, development of key exploration systems, technology developments and terrestrial analogue activities as well as on identifying next steps for global exploration.
Consensus on next steps shall be developed through the joint definition, analysis and assessment of optional future global exploration mission scenarios. Particular attention will be paid to analysing the role of ISS in enabling future global exploration and identifying concrete near-term opportunities for coordination and cooperation

4.3. International Architecture Working Group (IAWG)

4.3.1. Accomplishments

The main accomplishment of the IAWG in 2010 was the completion of the ISECG Reference Architecture for Human Lunar Exploration. This architecture is the first human space exploration conceptual architecture and concept of operations to be developed by an international body. It represents a significant step forward for globally coordinating the human space exploration plans of participating agencies.

The reference architecture work was initiated to inform the lunar exploration planning and preparations of participating agencies. It serves to inform decision making by participating agencies in the areas of technology development, robotic precursor mission objectives, and potential partnerships. It also provided insights regarding the approach to interface standardization, which is considered essential for building a robust space exploration programme.
In response to the common goals established by the IOWG, the reference architecture takes a phased approach to human lunar exploration, recognizing that lunar exploration provides opportunities to advance scientific knowledge, prepare for Mars exploration and capture the imagination of our young people.
More information about the ISECG Reference Architecture for Human Lunar Exploration and the process followed by the IAWG can be found in the study report available for download on the ISECG homepage.

4.3.2. Future Work

The IAWG also began preparations to support the development of the Global Exploration Roadmap. It will organize to perform the conceptual architecture definition and analysis work required by the Exploration Roadmap Working Group.

4.4. International Space Exploration Coordination Tool (INTERSECT)

4.4.1. Accomplishments

The INTERSECT Working Group is focused on the development of a web-based, data repository which, when fully developed and maintained, is to provide a single reference source for ISECG members and working groups on the type and status of exploration-related missions, payloads, systems and technologies.
During 2010, the Working Group modified existing templates for data entry after iteration with ERWG to ensure the data collected will be compliant with the Global Exploration Roadmap development requirements. Similar discussion also started with IOWG.
The templates were finalised in December 2010, and distributed along with a comprehensively re-written User Manual (Version 2.2) to ISECG members and INTERSECT points of contact in each agency. Examples were also prepared based on ESA's existing missions, systems and technologies. Data collection can now begin in earnest to support the development of ISECG products.

4.4.2. Future Work

Future work for INTERSECT includes data management on the ISECG website, maintenance and implementation of further user requirements and identification of a process to support data provision from less active ISECG members.

4.5. International Objectives Working Group (IOWG)

4.5.1. Accomplishments

In 2010, the International Objectives Working Group (IOWG) used the set of previously developed common human lunar exploration goals, representing the shared interests of participating agencies, to guide development of the ISECG Reference Architecture for Human Lunar Exploration. The common goals, in concert with additional strategic considerations, were used by the IAWG and IOWG as the basis for comparatively assessing multiple lunar campaign options and provided assurance that the proposed reference architecture provides for a robust and flexible exploration strategy for the Moon. The IOWG's products were disseminated publicly via the Reference Architecture document and in papers published for the 61st International Astronautical Congress, all of which were made available on the ISECG website.

In response to direction from the multilateral assemblage of senior agency management, the IOWG supported initial development of a Global Exploration Roadmap by producing a plan to (1) collect the established objectives of agency exploration missions and facilitate identification of near-term opportunities for cooperation; (2) identify potential areas of agency interest for general and destination-specific human space exploration; and (3) develop a compelling articulation of the collective long-term strategic vision and rationale for space exploration.

4.5.2. Future Work

By mid 2011, the IOWG plans to deliver products that support development of the Global Exploration Roadmap, including (1) established objectives of agency exploration missions; (2) potential areas of agency interest for general and destination-specific human space exploration; and (3) a compelling articulation of the collective long-term strategic vision and rationale for space exploration.

4.6. Strategic Communications Working Group (SCWG)

4.6.1. Accomplishments

At the SAM meeting in June, one of the priorities identified for the forward work was to increase the visibility of ISECG and its products.
Internal discussions regarding the appropriate strategic approach resulted in a structural reorganisation of the working groups “Enhancement of Public Engagement” and “Relations with Existing Groups”. Effective as of September 17, 2010, those groups were merged into the “Strategic Communications Working Group” (SCWG).

In the past year, the SCWG worked on both internal and external communications in order to keep ISECG agencies informed and to enhance visibility and understanding of the status, products and value of ISECG. A strategic communications plan is under development. The SCWG supported working group activities and ISECG products development with regards to target group oriented communication.

Accordingly, ISECG made the first successful steps to increase its visibility within the space community. At the Global Lunar Conference in May in Beijing (China) and the 38th Scientific Assembly of COSPAR in July in Bremen (Germany), ISECG work was presented in the technical sessions and in a round table discussion. The 61st International Astronautical Congress (IAC) in September in Prague, Czech Republic, offered the most visible opportunity for the presentation of ISECG work in 2010. Eleven papers were presented in six different technical sessions (see fact sheet on page 15). The plenary "Advancing the Global Exploration Strategy" was one of the highlight events at the IAC. In response to the SAM request for an image brochure, the SCWG developed a publication illustrating the ISECG key message "Exploring together" for dissemination at the IAC and download on the ISECG website.

The brochure was supplemented by a fact sheet developed by the SCWG in order to draw attention to the eleven presentations of ISECG related work and the plenary "Advancing the Global Exploration Strategy".

INTERNATIONAL SPACE EXPLORATION COORDINATION GROUP AT THE IAC 2010

Mon, Sep 27, 2010 · HUMAN SPACE ENDEAVOURS SYMPOSIUM

B3.1 Overview Session (Present and Near-Term Human Space Flight Programmes) · 15:15 Meeting Hall V

IAC-10.B3.1.10 **An International Strategy for Exploration: Development Status of the ISECG Global Exploration Roadmap** *(Hufenbach, B.; Laurini. K.; Piedboeuf, J.C.; Schade, B.; Matsumoto, K.)*

IAC-10.B3.1.11 **Developing a Common Set of Human Lunar Exploration Goals and Objectives** *(Rhatigan, J.; Matsumoto, K.; Carey, W.; Hipkin, V.; Kim, H.D.)*

Tue, Sep 28, 2010 · SPACE EXPLORATION SYMPOSIUM

A3.1 Space Exploration Overview · 10:15 Panorama

IAC-10.A3.1.1 **Assessing Space Exploration Technology Requirements as a First Step towards Ensuring Technology Readiness for International Cooperation in Space Exploration** *(Laurini. K.; Hufenbach, B.; Satoh, N.; Piedboeuf, J.C.; Neumann, B.)*

Tue, Sep 28, 2010 · HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM

A5.1 Near Term Strategies for Lunar Surface Infrastructure · 10:15 Meeting Hall V

IAC-10.A5.1.1 **An Approach to Habitation for the Global Point of Departure (GPoD) Lunar Architecture** *(Toups, L.; Haese, M.; Kennedy, K.; Bagdigian, B.; Masato, S.; Griffin, B.; Rudisill, M.; Imamura, H.; Guirgis, P.; Mary, N.)*

IAC-10.A5.1.6 **A Power Architecture for the ISECG Reference Architecture for Human Lunar Exploration** *(Haese, M.; George, P.; Hoshino, T.; Mason, L.; Merrill, G.)*

IAC-10.A5.1.7 **Lunar In-Situ Resource Utilization in the ISECG Human Lunar Exploration Reference Architecture** *(Sanders, G.; Carey, W.; Piedboeuf, J.C.; Lorenzoni, A.)*

Wed, Sep 29, 2010 · SPACE EDUCATION AND OUTREACH SYMPOSIUM

E1.3 Calling Planet Earth - Space Outreach to the General Public · 15:15 Club D

IAC-10.E1.3.5 **Enhancement of Public Engagement: A Strategic Approach from the International Space Exploration Coordination Group ISECG** *(Boese, A.)*

Thu, Sep 30, 2010 · Plenary 6:

Advancing the Global Exploration Strategy
9:00-10:00 Plenary room

Thu, Sep 30, 2010 · HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM

A5.2 Long Term Scenarios for Human Lunar Presence · 10:15 Meeting Hall IV

IAC-10.A5.2.9 **An International Strategy for Human Exploration of the Moon: The International Space Exploration Coordination Group (ISECG) Reference Architecture for Human Lunar Exploration** *(Laurini. K.; Hufenbach, B.; Kawaguchi, J.; Piedboeuf, J.C.; Schade, B.; Lorenzoni, A.; Curtis, J.; Kim, H.D.)*

IAC-10.A5.2.10 **Human Lunar Exploration: International Campaign Development** *(Culbert, C.; Gonthier, Y.; Mongrard, O.; Sato, N.; Troutman, P.; Seaman, C.)*

IAC-10.A5.2.11 **Comparative Campaign Assessments In the ISECG Reference Architecture for Human Lunar Exploration** *(Carey, W.; Culbert, C.; Rhatigan, J.; Cirillo, W.; Goodliff, K.; Stromgren,C.)*

Thu, Sep 30, 2010 · HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM / HUMAN SPACE ENDEAVOURS SYMPOSIUM

A5.3-B3.6 Joint session on Human and Robotic Partnerships to Realize Space Exploration Goals · 15:15 Meeting Hall V

IAC-10.B3.6 - A5.3.10 **Robotic Pre-Cursor Missions: Enhancing Human Exploration** *(Suzuki, N.; Martin, E.; Mongrard, O.; Jefferies, S.; Seibert, M.)*

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4.6.2. Future Work

At the end of 2010, the SCWG started first discussions with the International Astronautical Federation (IAF) regarding a Global Exploration Conference in 2012. The initial concept comprises a Co-Chairmanship by the IAF and ISECG with organizational support from the American Institute for Aeronautics and Astronautics (AIAA).

ISECG visibility will be further enhanced by participation at events such as the IAC 2011 in Cape Town, South Africa.

The group will support and facilitate information exchange regarding ISECG background, its mandate and activities with relevant existing multilateral working groups, such as the International Space Life Sciences Working Group (ISLSWG).

Furthermore, the SCWG will support the development of the first version of the GER and ISECG activities to engage the public on the broader rationale and the benefits of space exploration.

5 Outlook

With the development of the first version of the GER by September 2011, ISECG will substantially contribute to the evolving process towards a global, strategic and coordinated approach to space exploration. With JAXA assuming chairmanship from NASA in mid 2011, ISECG will continue to work collectively focusing on products considered important to enabling both individual agency decision-making and the collective effort.

ANNEX:

Space Exploration Highlights of ISECG Member Agencies

(in alphabetical order)

1. Agenzia Spaziale Italiana (ASI), Italy –Italian Space Agency

Introduction

The year 2010 has been characterized, by the continuation of the programmes approved during the last ESA Ministerial Council, held in 2008, mainly the robotic mission ExoMars, for which Italy confirms its leadership, and the participation to the European Exploitation of the International Space Station, through the bilateral agreement between ESA and NASA and the MoU between NASA and ASI.

Past significant events and missions

Hereafter are reported the significant events related to exploration during the past year:

- *Human exploration*
  - In March, six payloads were approved by NASA in the frame of the STS-134/ULF6 mission. The relevant experiments represent the complement of science for the Shuttle mission of the Italian Astronaut Roberto Vittori.
  - On September 9th, the acceptance of the Permanent Multipurpose Module, derived by the MPLM FM1, Leonardo, and developed by the Italian Space Agency, through Thales Alenia Space Italia, for NASA, was successfully completed.
  - On December 15th, the ESA astronaut of Italian nationality Paolo Nespoli was launched from Baikonur on board of a Russian Soyuz starting his long duration ISS mission.
  - COSMIC (COmbustion Synthesis under MIcrogravity Conditions) experiment has been tested on parabolic flights in October using Mars and Moon regolith simulants.to verify the technologies for ISRU.
- *Robotics for exploration*
  - Together with European partners, the activities of ExoMars (Italian Prime Contractorship) have continued.
  - Continuation of the operations, data acquisition and analysis of Italian instruments on-board Mars Express (MARSIS and PFS) and NASA MRO mission (SHARAD).

Upcoming events

Italy foresees to follow both the human and robotic exploration. Attendance and active participation to the major events like IAF, COSPAR, etc. are confirmed. Involvement in ISECG activities will be mostly focused on the robotic support activities including scientific aspects and in situ resource utilization.

In this context Italy will focus its attention on the following programmes:

The 2010 will be characterized by a relevant involvement of Italy in the exploitation of the ISS, thus confirming its relevant role in this endeavour:

- The Shuttle mission STS-133/ULF5, foreseen in February 2011, will deliver the PMM to the ISS, providing a major contribution to enhancing the ISS stowage and logistic capabilities.
- The Italian astronaut, Roberto Vittori, will fly as crewmember of the STS134/ULF6. The mission will include a complement of Italian experiments.
- In the same mission, scheduled on April 2011, the Alpha Magnetic Spectrometer (AMS) experiment will be put on orbit to start the in-orbit operations. ASI is a major contributor to the programme.
- The Elite-S2 repeat will integrated through the 2011, to be ready for execution in the assigned Increment 31-32.
- A second facility for COSMIC programme dedicated to ISRU for Moon and Mars will be tested in a NASA parabolic flight.

Conclusion

Italy is strongly involved in Exploration, both astronauts and robotic. Currently our main objective is the Mars Robotic Exploration. At the same time, we are still aiming at enhancing our expertise in the following fields: robotics systems, pressurized modules and the relevant life support systems, ISRU systems, to acquire new technologies for space exploration.

2. Centre National D'Etudes Spatiales (CNES), France – French Space Agency

In October 2010 the French government and the CNES President signed the 'Contract between the state and CNES for the period 2011-2015'. In this document, it is stated that CNES shall 'make proposals to promote an international exploration programme of the Solar System in renewed governance'. In particular, an increased role for the European Union in exploration matters is foreseen. This is now feasible after the entry into force of the Lisbon Treaty in December 2009, which leads to a 3-pillar-based governance of space in Europe: the member states, the European Union and ESA. In that respect, CNES participated in 2010 to the 3 ESA-EU workshops on exploration and to the technical steering group which led to the second European high level conference on exploration in October 2010. During that event, the French minister in charge of Higher Education and Research proposed to create an international political forum on space exploration. This idea was welcome and 2011 should see the first concrete steps in that direction.

CNES and DLR have written in 2010 a joint document on exploration which is an essential input for building the French roadmap on exploration. The text underlines that 'missions to the moon, to Mars and to selected asteroids are valuated important from their scientific and programmatic relevance'. In terms of strategic steps, 3 periods are identified:

- 2010-2020: From ISS exploitation to space exploration

- 2020-2030: Reaching out beyond ISS to Moon and Mars

- > 2030: Beyond Moon and Mars

For France, significant exploration-related activities in the first period are:

- the participation to the development of ExoMars (in an ESA/NASA context) and the execution of the missions planned in 2016 and 2018:

    * Contribution to the payload for TGO and EDM (2016), Pasteur rover (2018)

    * Rover vision/navigation algorithms (2018)

    * CNES support on EDLS (2018)

- the exploitation and utilisation of the ISS:

    * ATV Control Center in Toulouse

    * French participation in the ESA ELIPS programme

    * CADMOS: French part of the ISS ground segment

* Physiology/space medicine: CARDIOLAB with DLR, CARDIOMED with ROSCOSMOS

* Fluid physics: DECLIC in cooperation with NASA

Other missions with a significant CNES involvement are worth being mentioned:

- Robotic missions to Mars: MSL (NASA, 2011), Phobos-Grunt (Roscosmos, 2011), Maven (NASA, 2013), studies on a Mars geophysical network and on an international Mars Sample Return mission.

- Robotic missions to other destinations: Rosetta (comet - ESA), Bepi-Colombo (Mercury - ESA), studies on Hayabusa 2 (asteroid - JAXA), on Selene 2 (Moon - JAXA) and on Eve (Venus - ESA)

- Human spaceflight: cooperation with China on cardiovascular monitoring (CARDIOSPACE)

3. Canadian Space Agency (CSA), Canada

Summary

Highlights for the year include: a re-organization of the CSA that creates a Space Exploration Branch that puts all exploration activities, including Astronomy, under one Director General; Canada's first ISS expedition crew mission that concluded in December 2009 and the announcement of Canada's next long-duration mission to the ISS when Canada's Chris Hatfield will also be the ISS Commander; full certification of Canada's robot Dextre on the ISS; delivery of the Alpha Particle X-ray Spectrometer for NASA's Mars Science Laboratory to be launched in 2011; agreements for contributions to future Mars missions; progress on Canada's contribution to the James Webb Space Telescope (the pointing system – Fine Guidance Sensor); significant progress, due to additional funds in Canada's Economic Action Plan (Stimulus budget) with our Exploration Core programme that is funding advanced development of signature exploration technologies; participation with in-situ resource utilization technologies and a rover in the 2010 Hawaii and Arizona Analog campaigns as well as our annual campaigns in the Arctic and British Columbia; and finally initiating the development of a new Canadian Space Exploration Strategic Plan that will have a twenty-five vision and ten-year plan.

CSA Re-Organization

On April 1st 2010 the previously announced re-organization of the CSA came into effect. The Agency is now organized under three mission Branches; Space Utilization that is responsible for space data, information and services; Space Exploration that includes International Space Station, robotic Planetary and Astronomy missions and technologies, and human missions and support (astronaut corps, space medicine etc); Space Science and Technology that is responsible for building capacity in Canadian industry, academia and research institutions.

International Space Station

Canadian astronaut Robert Thirsk became Canada's first astronaut to spend six-months on the International Space Station at the end of his mission in December 2009. Canadian astronaut Chris Hadfield has been assigned to the Expedition 34/35 crew that will launch in December 2012 and for part of his mission Chris will have the privilege of being the ISS Commander. At the end of 2010 Canada's dexterous robot Dextre on the ISS was declared operational with most tasks be controlled from the ground, thus adding to our expertise in telerobotics which will have many applications in future space exploration missions. Canada is also preparing for a formal decision to support continued operations of the ISS to at least 2020. During the summer of 2010 Guy Laliberté, founder and CEO of Cirque Du Soleil became Canada's first space tourist with a Soyuz mission to the ISS, which culminated in a live worldwide broadcast of events in major cities celebrating Guy's *Poetic Social Mission*.

Planetary Exploration

The CSA continues to provide instruments for Mars robotics missions and has the Alpha Particle X-ray Spectrometer, to measure the composition of Mars rocks and soil, on the NASA Mars Science Laboratory to be launched in 2011. We are making (modest) contributions to upcoming Mars missions namely ExoMars 2016, ExoMars 2018 with the goal to contribute to an eventual Mars Sample Return mission. We are also supporting Canadian proposals for NASA's New Frontiers programme that will result in a mission to the Moon, an Asteroid or Venus.

Astronomy

In astronomy work continues on our contribution to the James Webb Space Telescope, the telescope's pointing system called the Fine Guidance Sensor. Canadian technology that provides the essential reference signal for the Heterodyne Instrument for the Far Infrared (HIFI) was provided for ESA's Herschel space craft. Canada's "humble" telescope the Microvariability and Oscillation of STars (MOST) continues to make valuable contributions to the field of astronomy. In 2011 Canada's Near-Earth Object Surveillance Satellite will be launched. It is unique in that it has the capability (technology) to be able to look towards the Sun and thus detect for the first time objects directly between the Earth and the Sun. The Canadian astronomy community will formally release their Astronomy Long Range Plan early in 2011. It is a decadal plan similar, and aligned to, that released by the United States- Astro2010 and Europe's Cosmic Visions.

Exploration Signature Technology R&D

The CSA Exploration Core programme, created in 2007, funds advanced exploration technology development, and continues at an impressive pace, due to additional funding through Canada's Economic Action Plan (Stimulus budget). The goal is to ensure Canada's readiness to participate in future human and robotic exploration missions. Signature technologies include those for: robotics and on-orbit servicing, vision systems including Lidar/Lasers, spectrometer and far-infrared detectors, fine guidance sensors, planetary rovers and resource extraction, advanced crew medical systems and services, life support systems including autonomous food production/agriculture. In 2010, the Next Generation Canadarm project has progressed well. Under Exploration Surface Mobility contracts are now in place to develop lunar and Mars rovers in addition to a series of payloads.

Analog Activities

The CSA participated, in cooperation with NASA and Germany's DLR, in the In-Situ Resource Utilization demonstration in Hawaii in January-February 2010 and deployed an ExoMars breadboard Rover in Arizona in October. These were in addition to our annual analog missions in the Arctic and British Columbia, Canada.

Exploration Strategic Plan

The CSA has begun the development of a Canadian Space Exploration Strategic Plan that will update our 2007 Plan. The new Strategic Plan will have a twenty-five year vision and a ten-year plan. It will cover ISS Operations and Utilization, On-Orbit Robotic Servicing, Scientific Exploration of Mars, Human Exploration beyond Earth Orbit and Space Astronomy. Among the plan's guiding principles are to: focus and build on Canadian niches and space heritage, contribute to international missions, ensure a robust and sustainable programme, have contributions that will be visible and resonate with Canadians, have a plan that provides a balanced portfolio between destinations. We are planning to incorporate "public engagement/participatory exploration" in our plan. Also, the Plan will be in alignment with the Global Exploration Strategy with international cooperation being an essential element. Workshops have been held with the Canadian space communities within government, industry and academia. Our goal is to release the Exploration Strategic Plan during the summer of 2011.

4. Deutsches Zentrum für Luft- und Raumfahrt (DLR) – German Space Agency

Throughout 2010, there were several noticeable events related to manned Space Flight Activities and Space Exploration. Germany through DLR continues to play a major role within the European space sector, particularly in the European Space Agency (ESA).

Out of this world-Exhibition

'Out of this world', the Space Exhibition, attracted an unforeseen number of spectators. The exhibition in the 110 m tall and 60m wide Gasometer was opened on 2nd of April, 2009, to mark the International Year of Astronomy and will end 30th of December 2010. With roughly 430,000 visitors in 2009, and, continued as an official RUHR.2010 project, the exhibition received another 500,000 visitors in 2010 and turned out to be the RUHR.2010 project´s greatest success.

ILA 2010

Another big event was the biennial Internationale Luftfahrt-Ausstellung, ILA 2010, in Berlin. A main attraction was the Space Pavilion of the ILA. The visitors were very much interested in “Justine”, a humanoid robot which can be operated remotely, e.g. from ground while in orbit. Its 5-finger hand is human-like, very dexterous and sensitive enough to handle a raw egg . Justine demonstrated his skills and brew e.g. a cup of tea or coffee. ILA 2010 was a great success, 240.000 visitors saw the exhibition. Orders of nearly 16 Billion € have been contracted. In 2012, the next ILA will take place on the premises of the Berlin-Brandenburg International Airport (BBI), which is currently under construction.

COSPAR 2010

The largest conference on space science worldwide took place in the hanseatic city of Bremen, from 18th - 25th of July, 2010. Nearly 5000 participants from 64 nations joined the event. 4503 Abstracts were submitted, 2665 oral presentations were given.

Concerning exploration, COSPAR created a new panel (PEX) which prepared a comprehensive report on robotic and human exploration of Moon, Mars & near-Earth Asteroids. ISECG with its aims and activities was presented by Kathrin Laurini (NASA) and Bernhard Hufenbach (ESA).

German Astronaut of the ESA-Team

In 2010, Alexander Gerst, ESA-Astronaut of German nationality, completed his basic training together with his five colleagues in the ESA astronaut class 2009. Dr. Gerst is warmly welcomed and supported by the German Space Agency. A geophysicist by education, he reports openly on his education and professional career and about the hurdles he had to tackle to become an astronaut candidate of ESA, in competition with 8000 applicants. He regards his previous job as a geophysicist

in the field of volcanology as the 2nd best job in the world, traded in for what he believes to be the best job in the world: an ESA-Astronaut. DLR is looking forward to work intensively with Dr. Gerst and his colleagues on the future of human spaceflight.

German Space Strategy

The German Federal Government adopted a new Space Strategy at its cabinet meeting on 30 November 2010. The strategy paper was drafted jointly between the German Federal Ministry of Economics (BMWi) and the other federal ministries involved in space activities, and in consultation with scientific and business establishments such as the German Aerospace Center DLR. With the creation of a uniform legal framework and the drafting of a German space law, the plan needed for the next few years has been laid out. The document is available at: http://www.dlr.de/en/Portaldata/1/Resources/kommunikation/publikationen/raumfahrtstrategie_der_bundesreg_2010.pdf

NASA-DLR Framework Agreement & Lunar Science Institute Agreement

The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and NASA concluded a framework agreement for bilateral cooperation in Washington D.C. on 8 December 2010. The agreement was signed by NASA Administrator Charles F. Bolden and DLR Executive Board Chairman Johann-Dietrich Wörner. The partners have also agreed to cooperate on lunar research, enacted through the DLR-NASA Lunar Science Institute Agreement (NLSI) that was ratified on that occasion.

CNES-DLR, Report on Exploration

Through the course of 2010, the German Space Agency (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and the Centre National d'Etudes Spatiales (CNES) developed and formulated a joint Report on Exploration. The report was presented to the members of the ESA Council Meeting in Paris on December 15th, 2010. Both Agencies agree that a European Strategy should be proposed, where robotic- and human missions must be equally considered. The document describes three strategic steps for exploration within the next decades: the exploitation of ISS and robotic planetary exploration, options for European contributions to international human exploration, and preparations for human Mars missions through adequate elements and infrastructures. In that context, and with the technical, political and financial constraints in mind, all options for European contributions and potential stakeholders must be looked at and analyzed.

ISECG

Through the participation in the working groups and by leading the "Strategic Communications Working Group", DLR continued supporting the activities. The brochure "Exploring together" has been produced by DLR for ISECG.

5. European Space Agency (ESA)

Exploration Highlights

The Lisbon treaty which entered into force in December 2009 confers to the EU a shared competence in space, to "carry out activities, in particular to define and implement programmes". The exercise of this competence "shall not result in [EU] Member States being prevented from exercising theirs". Article 189 of the Treaty addresses space specifically, stating that the EU shall draw up a European space policy, and may coordinate the efforts needed for the exploration and exploitation of space. Measures to contribute to the achievement of these objectives may take the form of a European Space Programme. Furthermore, the Treaty specifies that the EU shall establish any appropriate relations with ESA.

European ministers, heads of space agencies, representatives from European member states and international delegations gathered for the 2nd International Conference on Space Exploration, co-organised by ESA, on 21 October in Brussels. The Conference concluded that action is needed now to ensure that Europe has a significant role in future space exploration. At the conference "A New Space Policy for Europe" on 26-27 October, the representative of the Presidency of the European Union confirmed the political importance of the Columbus Pilot Phase which consists in opening to all the EU members States the utilisation of the Columbus module. Ministers of the EU and ESA member States adopted on 25 November the resolution "Global challenges: taking full benefit of European space systems" with an entire section dedicated to Exploration (V – The European Vision on Space Exploration).

The International Space Station infrastructure continued to develop: Europe has now delivered all of its elements.. Space Shuttle *Endeavour* launched on 8 February, carrying the two European-built modules: Node-3 (Tranquillity) and Cupola. Node-3 was attached to the ISS on 12 February, and the shutters on the seven Cupola windows were opened on 17 February. The European Robotic Arm (ERA) Flight Spare elbow, was successfully attached to Russia's Mini Research Module 1 (MRM-1) after being launched on 14 May on Space Shuttle *Atlantis*. Automated Transfer Vehicle (ATV)-2 *Johannes Kepler* was shipped to Kourou on May 12 and is scheduled to be launched on 15 February 2011. ATV-3 *Edoardo Amaldi* is scheduled to launch no earlier than the end of February 2012. ATV-4 system integration is on schedule.

ISS utilisation has been extensive and is summarised in the following.

External payloads:

The SOLAR platform was in sun-pointing mode and acquiring data during the March, April and May windows. After two years of operations, it has been extended up to the Solar Maximum in 2013. On 10 March, the Expose-R payload with nine exobiology experiments reached one year on orbit outside

the ISS and will continue until the end of 2010, with the return of the sample trays to earth. The two different receivers for the Automatic Identification System (AIS) have been launched and installed in Columbus.

Human physiology and performance:

Extensions of human physiology experiments to February 2012 have been agreed, and existing experiments such as ThermoLab (Thermoregulation in Humans During Long-Term Spaceflight) and EKE (Assessment of Endurance Capacity by Gas Exchange and Heart Rate Kinetics During Physical Training) have been functioning well with the support of the Portable Pulmonary Function System in combination with NASA's VO2Max (Evaluation of Maximal Oxygen Uptake and Submaximal Estimates of VO_2max Before, During, and After Long Duration International Space Station Missions) experiment. The European Physiology Modules facility was activated on 7 January, supporting multiple experiments among which is PASSAGES (Scaling Body-Related Actions in the Absence of Gravity), a new neuroscience experiment testing how astronauts interpret visual information in weightlessness. Further utilisation relevant to exploration included the Muscle Atrophy Resistive Exercise System (MARES), launched on STS-131. The first and second runs of NASA's Tropi-2 (Analysis of a Novel Sensory Mechanism in Root Phototropism) experiment were completed in early March in the European Modular Cultivation System (EMCS) and the samples processed and placed in the European-built Minus Eighty Laboratory Freezer for ISS (MELFI). In Biolab, the second run of the WAICO (Waving and Coiling of Arabidopsis Roots at Different g-levels) experiment has been performed and the space plant was returned for detailed lab analysis on STS-132 in a thermally-conditioned state. The Matroshka radiation phantom has been equipped with a set of new dosimeters and is accommodated in JAXA's Kibo lab until early 2011 under an international cooperation agreement.

Materials and fluid physics research:

The CETSOL and MICAST (Activities for the Columnar-to-Equiaxed Transition in Solidification Processing and Microstructure Formation in Casting of Technical Alloys under Diffusive and Magnetically Controlled Convective Conditions) experiments were carried out in the Material Science Laboratory and 12 sample cartridges have been processed. CETSOL and MICAST are two complementary material science projects, which carry out research into the formation of microstructures during the solidification of metallic alloys. The Microgravity Science Glovebox was reactivated on 11 January with the remaining runs of the Selectable Optical Diagnostics Instrument (SODI) instrument's IVIDIL (Influence of Vibrations on Diffusion in Liquids) experiment, completed on 20 January. This has provided scientists with fascinating images of the behaviour of liquid mixtures under the influence of vibration.

Looking to the future use of the ISS to prepare for exploration beyond LEO, a 'Call for Ideas: ISS for Exploration' was released on 15 October, attracting 181 proposals from 19 countries and ESA staff

which covered a broad spectrum of areas of interest such as crew assistants, countermeasures for long-duration spaceflight, the monitoring of astronauts' health, robotics, maintenance, failure management and on-orbit repair, tele-operations as well as other topics.

ESA's 6 new astronauts graduated from basic training on 22 November. With 3 new flight opportunities to the ISS before 2015, the first will head into orbit in 2013. ESA astronaut Paolo Nespoli was launched on Soyuz TMA-120 from Baikonur on 15 December. During his mission, called *MagISStra*, he is carrying out an intensive programme of experiments, ranging from radiation monitoring to measurements that could improve oil recovery in petroleum reservoirs. ESA astronaut Roberto Vittori will fly next for ASI on the STS-134 mission scheduled for April 2011. This will install the Alpha Magnetic Spectrometer (AMS), which was delivered safely to the Kennedy Space Centre on 26 August. Andre Kuipers will follow for a 6-month flight as the European crewmember on Expeditions 30-31 in 2011-12.

As ESA astronauts continued to work on the ISS, on the ground, preparations for destinations beyond continue. The Mars500 long-duration isolation study began on 3 June in Moscow amidst great media interest, with an international crew of six comprising two Europeans, one Chinese and three Russians. ESA received 262 applications for participation, before selecting 4 candidates of which Romain Charles and Diego Urbina were chosen as the prime crew. On 15 September, the crew surpassed the 105 days in isolation achieved in the precursor study in 2009. The next major milestone will be a '"landing' on Mars" planned for 10 February 2011, with the 'return' back on Earth expected in early November 2011.

ESA's 52nd parabolic flight campaign was completed successfully in May with 12 experiments, including a fourth flight to enable the new ESA astronauts to train in microgravity conditions. The 53rd campaign was performed in November. Following the full certification of the Airbus A300 for partial gravity flights, an AO was issued to the European science community in June 2010 to submit their proposals for experiments to be performed under partial gravity. In 2011 ESA intends to organise a joint partial Moon and Mars gravity parabolic flight campaign together with CNES and DLR.

The winter-over isolation campaign in Concordia, Antarctica concluded in November and 2 bed rest studies were carried out at DLR and MEDES (Institut de Médecine et de Physiologie Spatiales), focusing on nutrition and centrifuge-generated artificial gravity respectively.

Maxus-8, the latest in the series of ESA-funded sounding rocket flights, was successfully launched on 26 March from Kiruna in northern Sweden.

Looking at preparatory activities for future human exploration, the Micro-Ecological Life Support System Alternative (MELiSSA) continued to progress as planned, with results received from the Phase 1 experiments. The industrial proposal for the Advanced Closed-Loop System (ACLS), which

focuses on air revitalisation, has been received and evaluation should be concluded early 2011. Further areas of study included In-Situ Resource Utilisation (ISRU), particularly oxygen extraction from lunar regolith, and fuel-cell technologies for large power density applications such as a lunar base.

The study and development of future exploration capabilities and precursor missions continued, including the Advanced Re-entry Vehicle (ARV), EXPErimental Re-entry Testbed (EXPERT), International Berthing/Docking Mechanism (IBDM) and Lunar Lander. The main ARV contract was signed on 17 March and the Phase A Preliminary Requirements Review took place successfully during the summer. The EXPERT vehicle integration is on schedule for a spring 2011 launch. The Lunar Lander continues to progress, with the Phase B1 contract signed on 16 September. The contract will culminate in a Preliminary System Requirements Review in 2012, which will provide the basis for the final design of the mission and lander. The International Docking Standard Working Group fifth Technical Interchange Meeting (TIM) was hosted by ESA at ESRIN from 14 to 18 June, and after development and testing, on 21 September, the release of an International Docking System Standard (IDSS) was approved. This contains the information necessary to describe the physical features and design loads of a standard docking interface, making docking operations more routine and eliminating critical obstacles to joint exploration undertakings. Taking into account these results, the activities on the International Berthing/Docking Mechanism (IBDM) are proceeding.

Looking at Mars exploration, the ESA's cooperative programme with NASA has made excellent progress on several fronts. The payload selection for the 2016 ExoMars orbiter mission has been completed, and the Announcement of Opportunity for the Entry, Descent and Landing Demonstrator Module (EDM) was released at the end of November. In parallel, the System Preliminary Design Review for both the 2016 ExoMars orbiter and the 2018 ExoMars rover was concluded in December. A number of candidate missions are being discussed for post-2018 launch opportunities to Mars.

ESA is supporting the activities of ISECG through its participation in all the working groups and continues to host the Secretariat.

An Inter-Directorate Exploration Scenarios Working Group, involving five ESA directorates was set up to analyse exploration scenarios and inform the ESA-EC political process which shall lead to the definition of a European vision for space exploration. Exploration Scenario Studies contracts were awarded during the summer to European industries to inform the development of a Strategic Plan for Human Spaceflight and Exploration by mid 2012.

6. Japan Aerospace Exploration Agency (JAXA) - Japan

General

On May 27, 2009, based on the "Basic Space Law" in 2008, the Cabinet Office for Space Strategy (SSHQ) released a "Basic Space Policy Plan" for the Government of Japan. This policy, which is broad in scope, proposes a five-year initiative for the development of a variety of capabilities. This policy are described with six basic pillars; (1)Ensure a rich, secure and safe life, (2)Contribute to enhancement of security, (3)Promote the utilization of space for Diplomacy, (4)Create an energetic future by promoting R&D of the forefront areas, (5)Foster strategic industries for the 21 st century, and (6)Consider the environment. And for these 6 basic pillars, 5 space systems for utilization and 4 R&D programmes are recommended for the government. The human space activity is declared as R&D programmes, and is composed with two major purpose, those are the utilization of ISS-Kibo and the moon exploration, with the importance of future lunar exploration for the utilization of Moon resources.

This policy ordered a more detailed one-year review of human space flight and lunar exploration. This review committee was started on August 4, 2009. The committee was tasked with 1) defining the meaning and goals of lunar exploration; 2) developing a concrete vision for robotic exploration by 2020; and 3) recommending a basic policy for future human exploration of the Moon, including international cooperation.

http://www.kantei.go.jp/jp/singi/utyuu/keikaku/pamph_en.pdf

On May 2010, the final report of this review committee was published. The summary of this report is introduced in next section.

JAXA's products for space exploration in 2010 are two major events, those are the world first success of solar sail satellite and also the world first sample return from asteroid, in the following sections. JAXA also experienced one regrettable event, that is the Akatsuki (Venus orbitor) failure and change of its mission profile to retry of Venus orbiting after a few years.

The report of Review Committee for Lunar Exploration

Japan has discussed the strategy for lunar exploration and has issued a final report named as "Lunar Exploration Strategy of Japan --World-Leading Robotic Lunar Exploration and Establishment of Technology Base towards Manned Space Activity --", in July 2010.

This report describes that the purpose of lunar exploration is to establish space technology towards solar system exploration autonomously, to enhance further the world's top class lunar science and to establish Japan's international presence.

In this report, it is also described the objectives Japan should seek for as follows. “To assemble an exploration base, for the first time in the world, in the South Pole region by robot in 2020 and to conduct internal structure exploration for more than one year by deploying observation instruments such as seismometer, exploration around the area by robot for several months, and collection and sample return of rocks that mankind has never obtained. With these activities, we will establish technologies to become an important step for future solar system exploration while trying to elucidate the Moon’s origin and evolution”.

As the 1st step of this strategy, it is proposed that Japan should perform soft landing and preliminary robotic lunar exploration in 2015. As for manned space activity, Japan concluded that steady establishment of technological base for the human space transportation to LEO is important as the first step regardless of exploration objectives.. This includes technologies for man rated launcher, safe return capability from the space, ECLSS, etc.

IKAROS: The world first solar sail satellite

A Solar Sail is a space yacht that gathers energy for propulsion from sunlight pressure by means of a membrane. A solar sail can move forward without consuming propellant as long as it can generate enough energy from sunlight.

A Solar Power Sail is a Japanese original concept that gets electricity from thin film solar cells on the membrane in addition to acceleration by solar radiation. A solar power sail craft can save the fuel using a solar sail and it can also gain the necessary electric power using a vast area of thin film solar cells on the membrane even when it is away from the sun. If ion-propulsion engines are driven by such solar cells, it can become a hybrid engine that is combined with photon acceleration to realize fuel-effective and flexible missions.

JAXA performs a mission to evaluate the performance of the solar power sails. The project name is IKAROS (Interplanetary Kite-craft Accelerated by Radiation Of the Sun). This craft was launched on May 21, 2010 together with the Venus Climate Orbiter, AKATSUKI. This is the world's first solar powered sail craft employing both photon propulsion and thin film solar power generation during its interplanetary cruise. IKAROS deployed successfully a square membrane whose tip-to-tip length is 20m, and generated solar power by means of thin film solar cells (minimum success level) within a few weeks. Two separation cameras took images of the deployed solar sail of IKAROS. Acceleration and navigation using the solar sail was demonstrated (full success level) within half a year for the first time in the world. IKAROS flied by Venus on December 8, 2010 and continues the first actual solar sail flying.

JAXA is studying the next solar power sail mission which will take place in the late 2010s. It involves a large sized solar power sail with a diameter of 50m, and is integrated ion-propulsion engines with high specific impulse. The destinations of the spacecraft are Jupiter and the Trojan asteroids. JAXA will lead future solar system exploration using solar power sails.

HAYABUSA return: The world first sample return from near earth asteroid

The Asteroid Explorer HAYABUSA, launched in May 2003, arrived at asteroid Itokawa in September 2005. HAYABUSA successfully landed on Itokawa that November, but then a series of problems developed, including a fuel leakage, engine malfunctions and the loss of communication. HAYABUSA's return to Earth was threatened many times, but the space probe managed to overcome these problems. It re-entered the atmosphere above the southern Australia sky on June 13, 2010, returning to Earth after traveling about 6 billion kilometers over seven years. The HAYABUA sample capsule landed in the Woomera Test Range in South Australia. And its all parts such as abrative heat-shields were retrieved successfully. It was the first time ever that a space probe landed on a celestial body other than the Moon and returned to Earth. The navigation for the return of the HAYABUSA was conducted with large cooperation of JPL/NASA. And the retrieval of the sample capsule was completed with large cooperation of Australian government and army.

http://www.jaxa.jp/article/special/index_e.html

http://jda.jaxa.jp/jda/v4_e.php?v_id=b4790e099df7ce575e5d2daf0a20cb5d&mode=search&genre=4&category=4064&mission=4069

JAXA has been engaged in collecting and categorizing particles in the sampler container that were brought back by the HAYABUSA.

As a result of the scanning electron microscope (SEM) observations and analyses of the samples, about 1,500 grains were identified as rocky particles, and most of them were judged to be of extraterrestrial origin, and definitely from Asteroid Itokawa, after further study of the analysis results and comparison of mineral compositions.

Their size is mostly less than 10 micrometers, and handling these grains requires very special skills and techniques.

JAXA and scientists started initial analyses for these ultra-minute particles.

http://www.jaxa.jp/projects/sat/muses_c/index_e.html

7. Korea Aerospace Research Institute (KARI) – Republic of Korea

Exploration Highlights

On June 2010, KARI made its second attempt to launch the KSLV-I (Korea Space Launch Vehicle I) from the Naro Space Center in Korea. KSLV-I was to launch a scientific small satellite, STSAT-2 (Science and Technology Satellite 2), into an elliptical orbit. STSAT-2 had a mass of 100kg and carried two main payloads, a microwave radiometer and a laser reflector. Unfortunately, STSAT-2 did not make it to orbit due to an unsuccessful launch.

Korea's first geostationary satellite, Communication, Ocean and Meteorological Satellite (COMS) was successfully launched in June using the Ariane-5 rocket from the Guiana Space Center in Kourou, French Guiana. COMS, also known as 'Chollian' in Korean, is a multipurpose geostationary satellite designed to monitor the atmosphere and ocean as well as provide communication services. KARI expects that COMS will enhance the accuracy of local weather forecasts providing weather and oceanographic data every 15 minutes.

In 2008, KARI and JAXA agreed to promote the utilization of the Japanese Experiment Module (JEM) in the International Space Station (ISS) through bilateral cooperation between the two parties. KARI is currently evaluating the feasibility of four candidate research items working closely with each PI as well as JAXA. KARI and JAXA prepared a joint intermediate report in the end of 2010 to demonstrate the successful progress of the feasibility study.

In order to prepare for future space exploration missions, KARI has begun preliminary research on mobile systems and science payload systems for planetary exploration. The research mainly deals with planetary science and the related basic technology necessary for space exploration such as to the Moon and Mars.

Since the beginning of the 1990s, KARI's space programme has mostly focused on Earth orbit missions, i.e., development of satellite systems, launch vehicle etc. However, recently the Korean government revised the 'Strategy Plan for Space Development' and attempted to broaden the scope of the national space programme. KARI's ambition to become a major player in space exploration is still in the on-going phase and Korea's space programme is expanding its area of interest into outer space.

8. National Aeronautics and Space Administration (NASA) - United States of America

Exploration Highlights

2010 was a year of both accomplishment and transition for NASA's exploration programmes. After proposing a new direction for NASA in February, President Obama visited the agency's Kennedy Space Center in Florida on April 15 to discuss details of his proposed plans for space exploration. In June, the President released a new National Space Policy which included the goal of expanding international cooperation on mutually beneficial space activities including human space flight and exploration. http://www.whitehouse.gov/the-press-office/fact-sheet-national-space-policy

In November, NASA and its international partners celebrated 10 years of permanent human presence on the **International Space Station**. More than 600 different research and technology development experiments have been conducted aboard the orbiting laboratory, many of which are producing advances in medicine, environmental systems and our understanding of the universe. NASA is also using the ISS to the maximum extent for research, technology demonstration and operations demonstrations in preparation for exploration beyond LEO. As the ISS transitions from its assembly phase to use as a unique scientific outpost, NASA is investing in the ISS's future by ensuring a wide pool of organizations outside the agency have access. The **NASA Authorization Act of 2010,** in addition to extending station operations until at least 2020, also directed NASA to select an independent, research organization to develop and manage a portion of the U.S. share of the station as a national laboratory.

With NASA's **Space Shuttle** fleet nearing retirement, three missions helped put finishing touches on the ISS this year. The STS-130 mission in February delivered a cupola with seven windows and a robotic control station. The STS-131 mission in April delivered science racks and new crew sleeping quarters. In May, the STS-132 crew delivered the Russian-built Mini Research Module-1 known as Rassvet to the orbiting laboratory. The module provides additional storage space and serves as a new docking port for Russian Soyuz and Progress spacecraft. http://www.nasa.gov/mission_pages/station/living/10years.html

NASA saw its efforts to stimulate commercial provision of space services advance in 2010. SpaceX, a **Commerical Orbital Transportation Services (COTS)** partner with NASA, became the first commercial company to launch and return a spacecraft from low Earth orbit. Orbital Sciences Corp., another partner in the COTS programmes, also experienced successful testing of its first-stage engine for its Taurus II rocket and opened the mission control center that will support the company's COTS programme missions. In October, NASA awarded contracts to six companies for the purchase of technical data resulting from industry efforts to develop vehicle capabilities and demonstrate end-to-end robotic lunar landing missions. The data from these "**Innovative Lunar Demonstrations Data**" contracts will inform the development of future human and robotic lander vehicles and exploration systems.

In mid 2010, NASA and the European Space Agency (ESA) selected five science instruments for the first mission of a joint programme to explore Mars in the coming decades. The **ExoMars Trace Gas Orbiter**, scheduled to launch in 2016, is the first in a series of planned joint robotic missions to the Red Planet. It will study the chemical makeup of the Martian atmosphere with a 1000-fold increase in sensitivity over previous Mars orbiters, and will also serve as an additional communications relay for Mars surface missions beginning in 2018.

Also in November, NASA's **EPOXI** spacecraft successfully flew past comet Hartley 2, providing unprecedented images and giving scientists new information about the comet's volume and material erupting from its surface. The information sheds new light on the nature of comets and their role in the formation of planets. EPOXI is an extended mission that used the Deep Impact spacecraft. http://www.nasa.gov/mission_pages/epoxi/epoxi20101104b.html

Scientists announced in 2010 new data about the moon uncovered by NASA's **Lunar CRater Observation and Sensing Satellite**, or LCROSS, and the **Lunar Reconnaissance Orbiter**, or LRO. Scientists determined the soil in the moon's shadowy craters is rich in useful materials, including water in the form of mostly pure ice crystals. Researchers also found the moon is chemically active and has a water cycle. By understanding the processes and environments that determine the delivery of water to the moon, where water ice is, and the active water cycle, future mission planners may be able to better determine which locations will have easily-accessible water. http://www.nasa.gov/mission_pages/LRO/news/lro-lcross-impact.html

Organizationally, NASA created a new Office of the Chief Technologist in February with the responsibility of targeting technologies that could be transformational in their ability to improve the agency's knowledge and capabilities, while reducing cost and expanding the reach of future aeronautics, science and exploration missions. In December, NASA provided the National Research Council (NRC) with 14 technology area roadmaps drafted by agency experts as NASA works toward a long-range technology-investment plan. An NRC panel will gather public comments on the draft technology plans and make recommendations back to NASA by January 2012. http://www.nasa.gov/oct

NASA expanded its online engagement of the public to continue its effort to be a leader in social media and web use. People now can find NASA, the agency's centers, programmes and projects on more than 200 locations across Twitter, Facebook, Flickr, YouTube and UStream. The agency's website, NASA.gov, won its second consecutive Webby award in 2010. The NASA App now is available for iPhone, iPad and iPod Touch. NASA also made the online engagement personal by inviting hundreds of participants to multiple Tweetup events that provided behind-the-scenes access across the agency. http://www.nasa.gov/connect

9. National Space Agency of Ukraine (NSAU)

Exploration Highlights

National Space Agency represents Ukraine in the International Space Exploration Coordination Group (ISECG). The year of 2010 was marked in our country with a number of significant space exploration projects, reported hereafter:

- "Radioastron" international space experiment on fundamental scientific research of the Universe structure by means of terrestrial-space interferometer with an extra-high angular resolution (to 8 mks of the bow), utilizing the unique on-ground facilities. Radio-interferometric exploration is one of Ukraine's major priorities due to availability of one of the world's biggest radio telescopes RT-70, which is upgraded with up-to-date radio-receiving and registering equipment.

- Modernization of RT-70 radio telescope and antenna control system testing. Conduction of space debris observation and radiolocation research sessions.

- Performance of 5 measurement sessions via "Interferometer" programme. RT-70 radio telescope was equipped with an extra-sensitive 18-26 GHz band receiver for its utilization within prospective "Spectr" and "Fobos-Grunt" international programmes' framework.

- Preparation for 5 joint space experiments in the framework of "Russian-Ukrainian cooperation programme in the field of exploration and utilization of outer space for 2007-2011". 9 experiments to be conducted on orbit were prepared in the framework of "Long-term programme of Russian-Ukrainian scientific research at the Russian ISS segment".

- Development of the unique STEP-F satellite telescope of electrons and protons as a constituent part of onboard scientific instrumentation. Designed for continuous measurement of the flows of electrons, protons and alfa-particles trapped in the internal and external radiation belt of Earth, it also enables a research of the solar space streams. In 2009, STEP-F was successfully put into orbit as a part of scientific equipment of Russian Koronas-Foton spacecraft. It is expected that low-energy electron flows discovered at the attitude of 600 km above Earth surface can become one of effective parameters for space weather monitoring (e.g. act as an earthquake forerunners).

- Preparation for "Potential" scientific experiment aimed at a space weather physics exploration. Being a part of "Ionosat" project, "Potential" was elaborated to practice methods of space weather monitoring and geophysical effects' retrieval in the ionosphere. Scientific programme was developed and a set of instruments designed and installed aboard "Sich-2" spacecraft.

Ukraine's path to space exploration goals' achievement lies in international cooperation, particularly in reinforcing its activities within ISECG framework.

10. UK Space Agency (UKSA) – United Kingdom

2010 saw the creation of the UK Space Agency, which replaced the British National Space Centre and becomes a fully functioning organisation from April 2011. This change brings most aspects of UK civil space policy and funding into a single organisation for the first time.

The UK Space Agency maintains the UK's commitment to robotic Mars exploration and in 2010 initiated full development of four instrument contributions for the 2018 rover. In early 2011 it will confirm scientific support for the 2016 Trace Gas Orbiter. The UK has been asked to co-chair the Joint Mars Architecture Review Team which will oversee the joint NASA/ESA Mars exploration programme.

The UK Space Agency is supporting a privately-financed development of technology for a proposed air-breathing, re-usable launcher, *Skylon*, which would form the basis of an infrastructure for both LEO operations and beyond LEO exploration. It also continues to examine options for commercially-driven lunar exploration.

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This publication has been produced by ISECG