July 23, 2012

Statement of

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before the

Committee on Commerce, Science and Transportation

United States Senate

Mr. Chairman and Members of the Committee, thank you for the honour and the opportunity to testify before you today and present the European Space Agency's role and capabilities on ISS, in particular with respect to its utilisation for scientific research, applications, technology development and education purposes. The successful utilisation of the ISS is of highest priority for the European Space Agency and for the European ISS partners.

The European Space Agency's role and capabilities on ISS

The International Space Station (ISS) is a unique scientific and technology platform in space, which continuously allows researchers from all over the world to put their talents to work on innovative experiments that could not be done here on Earth. Weightlessness, as well as other properties of the space environment, are influencing a huge variety of physical, chemical and biological processes. Low Earth orbit is therefore an ideal environment for research in a wide spectrum of disciplines, as well as an excellent area for preparing future human exploration of space. The domains for utilisation are many and diverse: from fundamental physics to human physiology, from new alloys to growth processes in plants, from astrophysics to demonstration of space technologies and services. It is in full recognition of the extraordinary utilisation

opportunities of the ISS that Europe decided to engage as a full and very active partner in this unique and unparalleled international cooperation undertaking together with the United States, Russia, Japan and Canada.

Europe, working through ESA, developed and operates two key elements of the Station: the European Columbus laboratory and the Automated Transfer Vehicle (ATV).

The European Columbus laboratory is one of the key ISS research capabilities, which ESA shares with NASA. Equipped with 10 interchangeable payload racks, Columbus is a multi-function laboratory with an advanced suite of research instruments, namely for fluid physics, materials science and biology and especially for human research. On its four external platforms with different orientations it also provides unique external exposure and observation accommodation capabilities for unpressurized payloads.

Europe's second biggest contribution is the Automated Transfer Vehicle (ATV), a vast versatile cargo supply vessel lifted into orbit by the Ariane-5 launcher with full autonomous rendez-vous and docking capabilities to ISS. The ATV carries up to 7 tonnes of cargo including provisions, scientific payloads and rocket propellant. Once docked, the craft can use its engines to boost the Station higher in its orbit, counteracting the drag from the Earth's atmosphere. After the first ATV, *Jules Verne* in 2008, *Johannes Kepler* was flown in 2011 and the third one, *Edoardo Amaldi* was launched to the ISS on 23 March 2012 and will still remain docked until the end of September. The fourth and fifth ATV’s are already in preparation for launch in 2013 and 2014.

Apart from Columbus and the ATV, Europe's scientists and engineers are also contributing other elements, equipment and design skills across many elements of the ISS.

Among these elements, the DMS-R data management system, which has been a key part of the Station's 'brain' since its July 2000 launch aboard the Russian Zvezda Service Module.

Europe built also two of the three nodes that link Station components, as well as the Cupola - a dome-like structure that is the crew's panoramic window on space and a control room for astronauts operating the Station Robotic Manipulator Systems and other equipment.

In fact, European technology plays an important part in many Station sections. Inside the United States Destiny research module, for instance, Europe has mounted, among other equipment, a specialized material science rack and freezer units. The Japanese Experiment Module also hosts one of the three MELFI freezers, which ESA has developed for NASA, as the cold stowage sample preservation reservoir on ISS, which is jointly used by the whole ISS partnership in conjunction with NASA’s smart cold transportation assets.

Europe also provides members of the ISS-crew. European astronauts have flown in space since 1983, and since 1998 the European Astronaut Centre in Cologne has concentrated on training men and women for future ISS missions. The first European to serve a tour of duty on the ISS, went on mission to the ISS in April 2001 on the Space Shuttle. Since then 18European astronauts have lived and worked on board the ISS as team members of fully integrated ISS crews.

The astronauts on the ISS will always be part of a much larger scientific team on Earth which is closely following the crew activities on ISS. The European user community is very active and therefore the corresponding ISS utilisation demand is very high. The current European research plan of selected flight experiments already lasts until 2017 and the next Announcements of Opportunity will be solicited in due time.

In fact the European mission control centres – the Columbus Control Centre (COL-CC) in Oberpfaffenhofen, Germany and the ATV Control Centre (ATV-CC) in Toulouse, France - direct onboard experiments and the European ATV missions, sharing Station command with the United States and Russia.

Nine European User Support and Operation Centres (USOCs) are based in national centres distributed throughout Europe. These centres are responsible for the use and implementation of European payloads on board the ISS and support the user community on the ground. The USOC activities also extend to investigations, which are done with European research equipment in ISS modules beyond Columbus.

Right now, Europe's participation in the ISS means that throughout ESA's Member States, thousands of Europe's best scientists and engineers at hundreds of universities and high-technology companies are working on the leading edge of 21st-Century science and engineering. And the European ISS team is fully embedded in the international ISS partnership, which allows to exploit many synergies and invaluable experiences.

Scientific and technological objectives and accomplishments to date

ESA – through its research programmes on board the ISS – has implemented a broad portfolio of research activities, in fundamental science, applied research as well as human exploration preparation and technology, addressing the following key research areas:

- Fundamental Physics
- Atmospheric and Environmental Research
- Materials Sciences
- Physics of Fluids and Combustion

- Astrobiology
- Cell, Developmental and Plant Biology
- Human Physiology and Performance
- Astrophysics
- Technology Testing

More than 200 experiments have been performed so far by ESA on board the ISS: short duration experiments before the assembly of the Columbus laboratory to the ISS, making use of Soyuz "Taxi-flights" under agreements with Russia, and since 2006 with NASA in the Destiny lab in the frame of the so-called "Early Utilisation Agreement" and also making use of Russian resources. Since the deployment of the Columbus laboratory in February 2008 increasingly long duration experiments – at an average of 30 to 40 per year – have also been implemented.

A very good example of the tangible benefits of the research on board ISS is the already successfully concluded IMPRESS project, a material sciences research project the results of which were actually instrumental to develop new light-weight alloys; these new light-weight alloys are now used for aircraft engines turbine blades, in an industry valued some 2 Billion Euro over the next 10 years. The space part of this research project has been performed with furnaces and electromagnetic levitation facilities on parabolic flights and short-duration Sounding Rocket missions. Now ESA's Material Science Laboratory (MSL), which is operated with NASA in the Destiny module under a bilateral cooperation agreement in the Materials Science Research Rack (MSRR-1), and soon also the unique Electro Magnetic Levitator (EML) in Columbus offer such capabilities for institutional and industrial users on board the Station. This will allow the optimum directional solidification of alloys in MSL and complementary container-less high-precision measurement of thermo-physical properties on a large variety of alloys which is essential for advanced casting processes and materials features.

Also the joint operation of the European developed ISS facilities Microgravity Science Glovebox (MSG), European Modular Cultivation System (EMCS), Pulmonary Function System (PFS) for a large suite of investigations with fluids, biology, human research and again the MELFI freezers for samples preservation are invaluable assets on ISS space for advanced experimentation by our increasingly demanding user communities.

Furthermore, many of the fundamental and applied research projects conducted within the European programme for Life and Physical Sciences in Space (ELIPS) create the growing knowledge basis for new products and improved processes, such as medical equipment, casting technologies, miniaturised sensors and devices.

In future an ensemble of high-precision atomic clocks (ACES) on ISS will demonstrate, in combination with the world best ground reference clocks, advancements in frequency and time measurements for navigation, improving navigational accuracy.

The ISS offers outstanding opportunities as test-bed for Human Exploration preparation beyond LEO. Apart from already on-going or planned scientific and technological investigations, ESA also fully supports the challenging ideas, which are under detailed elaboration by the International Expert Working Group (IEWG) teams under the leadership of NASA. The joint implementation of these activities by the whole ISS partnership will allow rapid progress and outstanding accomplishments on ISS for the preparation of future Human Exploration missions beyond LEO.

The European programme for Life and Physical Sciences in Space, ELIPS, involves some 1500 scientists in almost 150 projects included in the research pool of ISS experiments. ELIPS includes a large and diverse group of industrial users interested in application-oriented research and industrial R&D; industrial R&D is often implemented in combination with the objectives and expertise of institutional researchers from academia. Hence, the continued utilisation of ISS and Low Earth Orbit creates economic opportunities that stimulates both the academic and industrial sector and is providing for a variety of socio-economic benefits on Earth. ESA is making every effort, in full coordination with ISS international partners and through dedicated Announcements of Opportunities, to attract the best ISS utilisation proposals, including those from international research teams beyond the borders of Europe. Corresponding to the diversified user needs, ESA is following an approach that enables utilisation opportunities across the entire spectrum of utilisation fields.

Besides the significance of the ISS for science, applications and technology demonstrations, the ISS, its utilisation opportunities and the astronauts working on the Station are a strong inspiration for the young generations to consider a Science, Technology, Engineering and Mathematics (STEM) education. In this context, ESA carries out education activities on the ISS in close collaboration with NASA.

The continuous efforts of NASA for the global promotion of the ISS accomplishments with dedicated publications of the ISS Programme Science Forum and public events like the recent ISS Symposium in Berlin highlight the value of the International Space Station and the strength of its international partnership to the public.

Optimisation of ISS Utilisation and potential improvements

In order to optimize the science yield of ISS, the establishment of an internationally coordinated ISS research plan and joint science opportunities' solicitations are sought. The optimisation of the ISS utilisation can be accomplished making use of the well established international working groups in life and physical sciences (ISLSWG and IMSPG) and pooling research objectives and flight resources. ESA has currently identified more than 20 joint ISS experiments with NASA and in total more than 50 with all the ISS partners. The shared use of unique on-orbit research infrastructure is of high importance to allow optimum and efficient experimentation on ISS

according to terrestrial laboratories standards, despite the additional spaceflight challenges. In general most of the ISS research originates from earthbound problems. Hence a very solid anticipated terrestrial research programme is instrumental for defining and reaching challenging utilisation objectives on ISS, which are also of major impact in terms of Earth benefits. This close link even applies to a lot of the research and technology objectives for Human Exploration preparation on ISS. A thorough preparation of ISS experiments on ground or short-duration precursor flight opportunities (drop towers, parabolic flights, sounding rockets) is of great scientific and technical importance.

Conclusions

The successful and optimal utilisation of the ISS is important to ESA; ESA has already reaped considerable benefits from the scientific research, applications, technology demonstrations and education activities performed on the International Space Station, and more are expected to be realised in the continuation of the ISS utilisation in the years to come.

To conclude, I would like to take this opportunity to underline ahighly visible- and highly important dimension of the international partnership in the ISS programme: the excellent and highly valued cooperation between ESA-NASA. The forging of such an international partnership and getting experience in working together as partners is often referred to as one of the biggest achievements of the ISS programme. It is the international partnership that brought the ISS and its unique utilisation opportunities into existence and fruition. We will also need an international partnership, probably even a wider one than for the ISS, when aiming at the next steps of human space exploration.

Mr. Chairman, I would be happy to respond to any question you or the other Members of the Committee may have.

Thank you.