

ESA: a Partner for Space Research

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Directorate of Human Spaceflight and Robotic Exploration

UK Space Conference, 30 May to 1 June, Manchester

Why Space Research



Exploiting the space environment (mg, radiation, viewing conditions)

Field of Research	Objective
Fundamental physics	Plasmas, Cold atoms and Quantum fluids
Physics of fluids & combustion	Structure and dynamics and Combustion
Material sciences	Thermo-physical properties and new materials
Biology	Cells and development of tissues
Astrobiology	Origin of life and life in the Universe
Human physiology	Integrated physiology and Neuroscience
Earth and Space science	Fundamental physics, Solar & Earth observations
Technology demonstration	Demonstration/ maturation of space technologies

Delivering new knowledge and numerous spin-offs for terrestrial applications



ISS, the Ultimate Laboratory in Space



Other Research Platforms

Sounding Rockets, Parabolic Flights, Ground-based



ESA Life and Physical Science Research and Applications Programme Element

- Aims to deliver socio-economic benefits and provide scientific contributions enabling future human exploration
- ~1500 scientists actively involved
- Uses ISS, sounding rockets, parabolic flights and ground based facilities

Specific Opportunities to participate in SciSpacE include:

- Continuously open AO for ground based facilities and parabolic flights
- Periodic AOs for dedicated ground based platforms (bedrest, isolation studies and radiation facilities) - opportunity for new scientists to join
- Possibility to collaborate with research groups/industries working on existing projects in the Microgravity Applications Programme (MAP)

Physical Sciences

Ultra-precise cold atom sensors, quantum information and high energy particles

*Boundaries of relativity and quantum physics.
Advanced navigation and communication.*

Soft or Complex matter

*Interactions and self-organisation in foams, emulsions, granular matter, atmospheric dust and colloids.
Food and (petro)chemical industry, physics of biological processes.*

Boiling, evaporation and heat transfer

*Multi-scale modelling of fluid physics including phase change.
Efficient cooling of micro-electronics, industrial boilers and power plants.*

Advanced material processing

*Microstructure formation and materials properties.
Casting, automotive and aerospace industry.*

Biology

Astrobiology

*Chemical and biological effects of exposure to space radiation and vacuum.
Origins, limits and signs of life in the Universe.*

Biology under non-Earth gravity conditions

*Understanding gravity-dependent processes in cells and organisms.
Biochemistry and health-related phenomena.*

Supporting life in hostile environments

*Understanding the effects of space factors on microorganisms and plants.
Integrated closed-loop life support systems for exploration.*

Human Research

The Human body under space conditions: adaptations and countermeasures

*Understanding human physiological processes.
Exploration –related health risks and their prevention.
Health and ageing issues on Earth.*

Psychological and neurosensory adaptations to reduced gravity, isolation and confinement

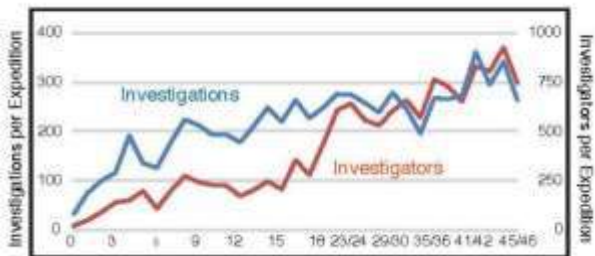
*Impact of spaceflight on psychological, sensorimotor and neuro-behavioural performance.
Selection, training and support methodologies for crew on long-duration missions.*

Cosmic radiation risks for Human Exploration of the Solar System

Self-standing and multidisciplinary research

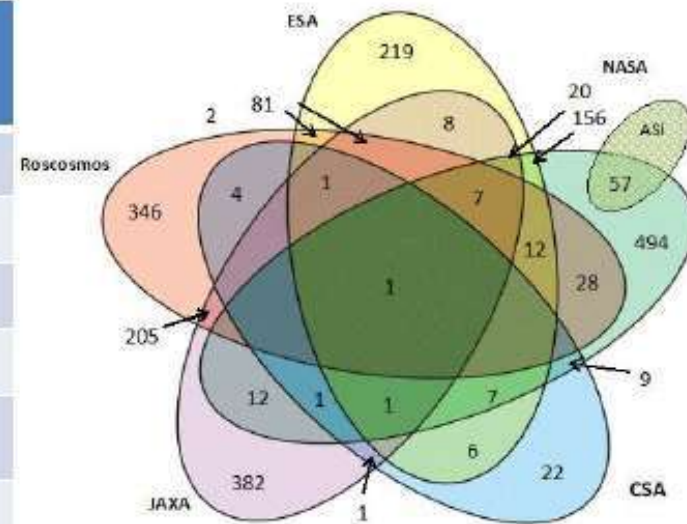
Energy storage, fire safety, cardiovascular fluid physics, hibernation and torpor

ISS Research Statistics

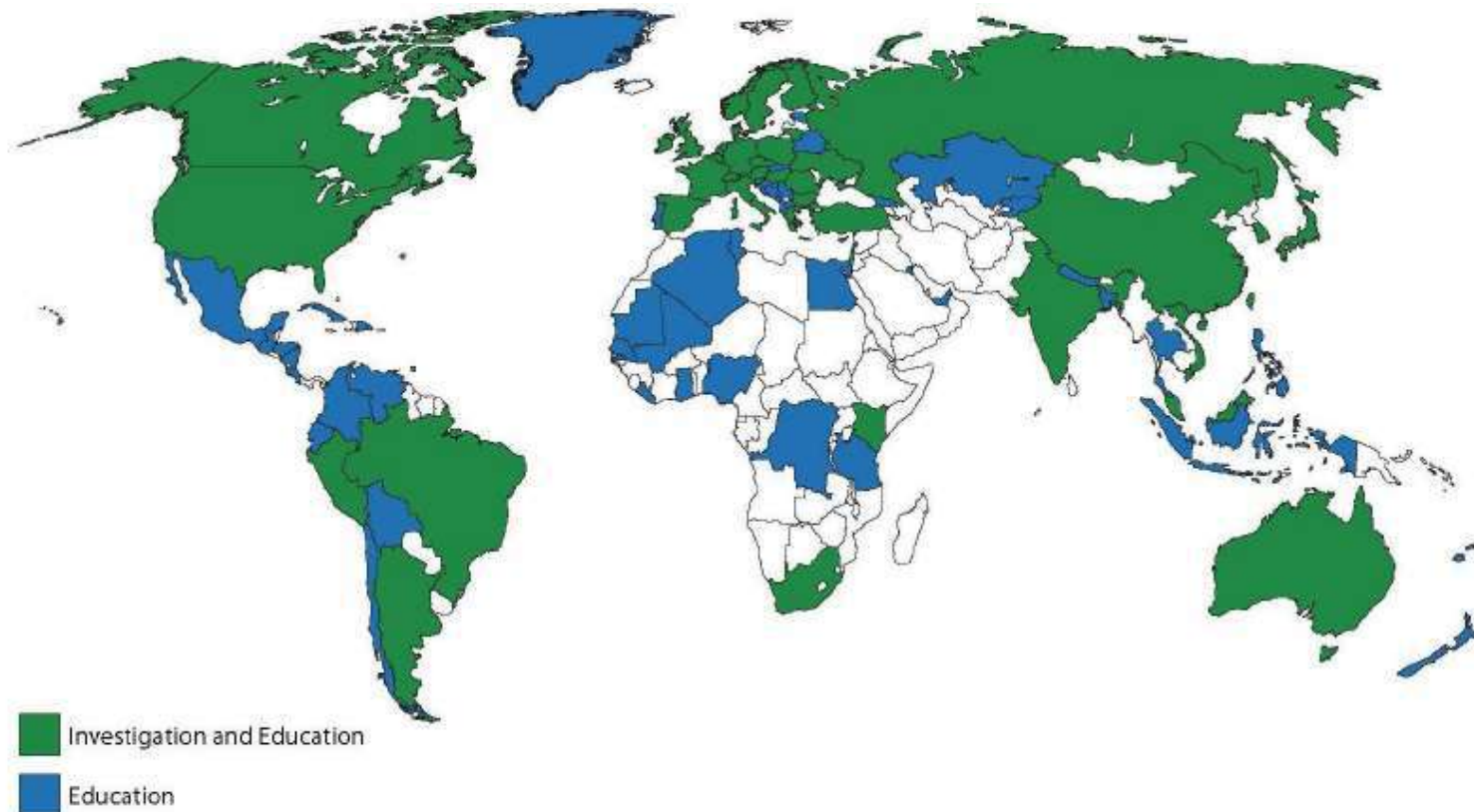


- Biology and Biotechnology
- Earth and Space Science
- Educational Activities and Outreach
- Human Research
- Physical Science
- Technology Development and Demonstration

	Agency Only	Collaboration (Hosting)	Investigations Implemented	Collaboration (Participating)	Total Agency Impact
CSA	22	9	31	24	55
ESA	219	72	291	230	521
JAXA	382	167	549	90	639
NASA*	551	165	716	89	805
Roscosmos	346	149	495	192	687
			2082		



ISS Research Statistics

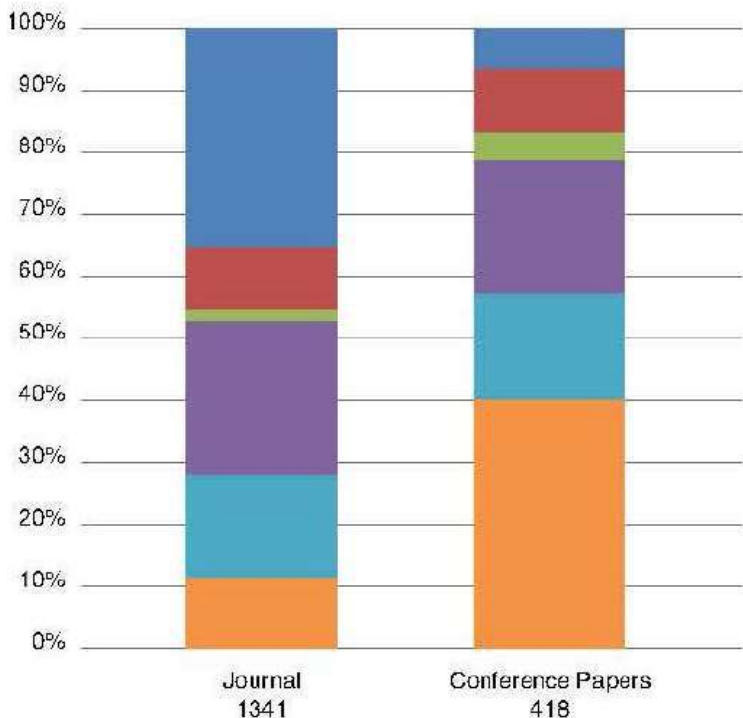


95 Countries/
Areas have
participated
in ISS
utilisation
through
March 2016



ISS Research Impact

ISS Results Publications through July 2016



- Biology and Biotechnology
- Earth and Space Science
- Educational Activities and Outreach
- Human Research
- Physical Science
- Technology Development and Demonstration

Not Shown: 130 publications from non-technical sources



Discovery



Benefits for Humanity



Exploration

Top 20 Journals with ISS Results* (Number of Publications)
PLOS ONE (36)
Nature (1)
Proceedings of the National Academy of Sciences of the United States of America (3)
Science (3)
Physical Review Letters (23)
Journal of Biological Chemistry (2)
Chemical Communications (1)
Journal of Neuroscience (1)
Advanced Materials (1)
Journal of Geophysical Research (5)
Optics Express (2)‡

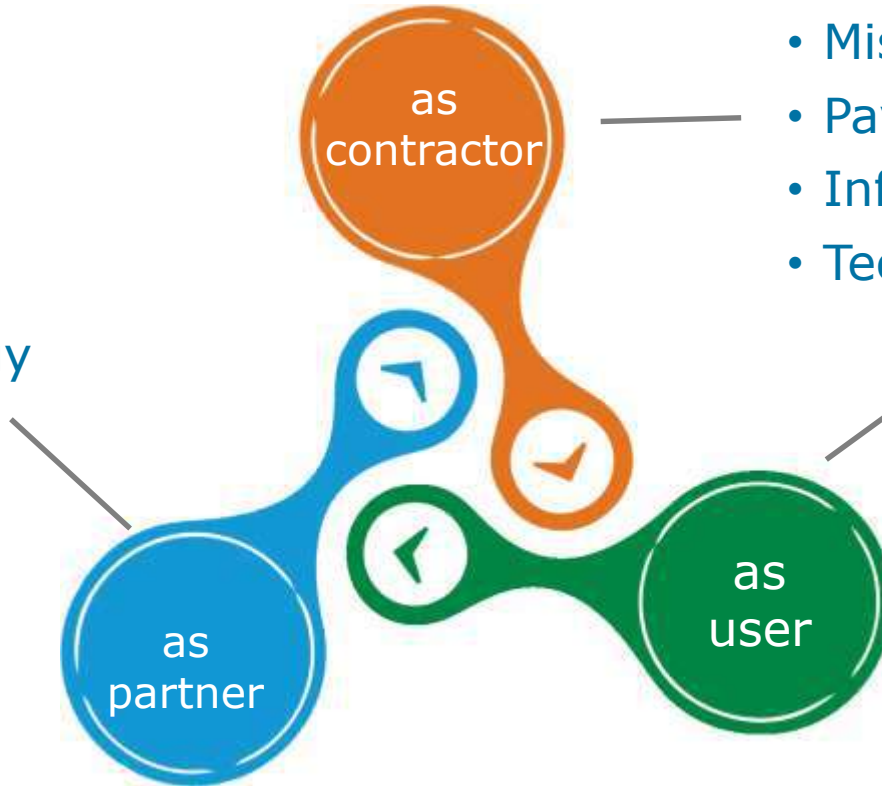
Scientific Reports (6)‡
Chemistry - A European Journal (1)
Geophysical Research Letters (1)
NeuroImage (1)
Journal of Chemical Physics (4)
Langmuir (2)
The Astrophysical Journal (1)
RSC Advances (1)‡
Journal of Physical Chemistry B (2)

*Journals are listed in Eigenfactor® order. Eigenfactor® is an estimate of the percentage of time users spend with a journal, with citations from influential journals ranked higher.

‡ Denotes a new Journal to the top 20 list since the Expedition 0-44 report.

How to Engage with ESA

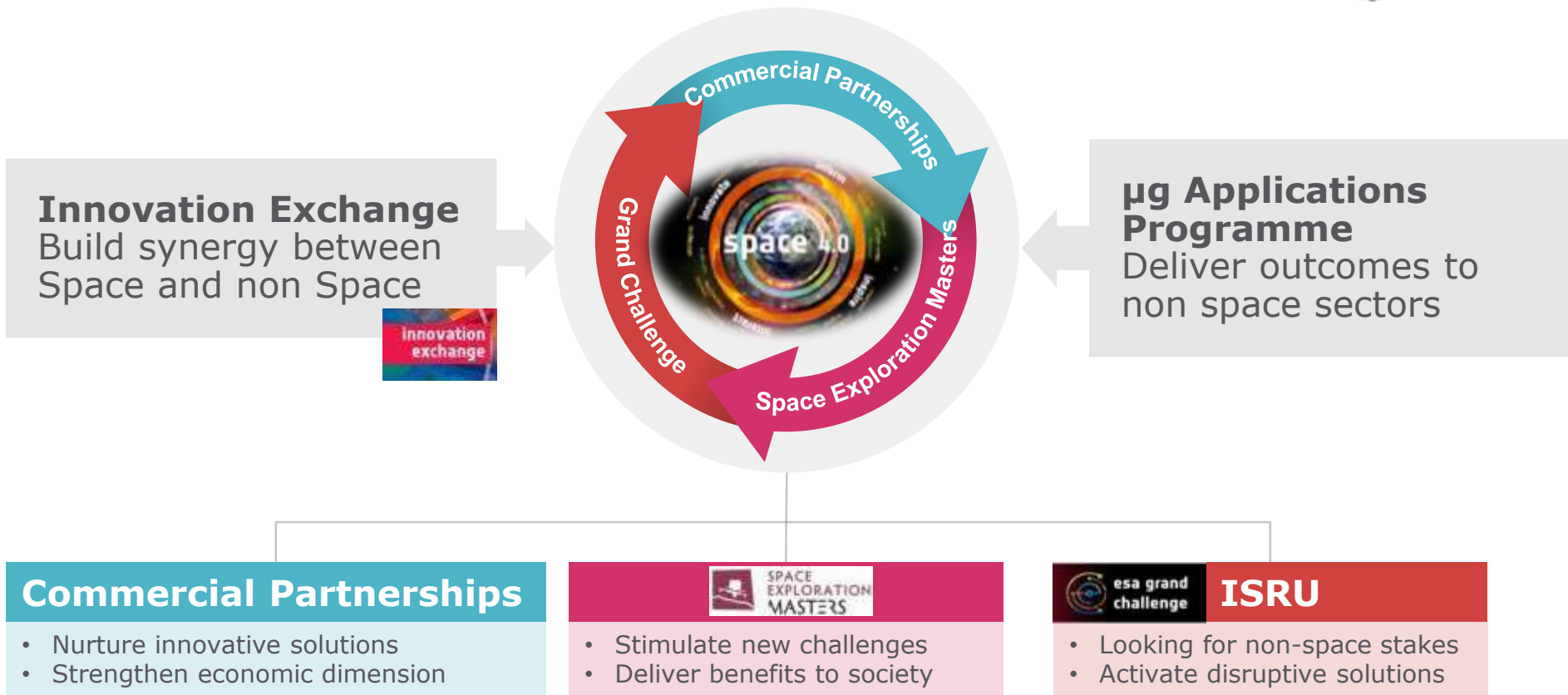
- Research partner
- Technology partner
- Business partner



- Missions
- Payloads
- Infrastructure
- Technology

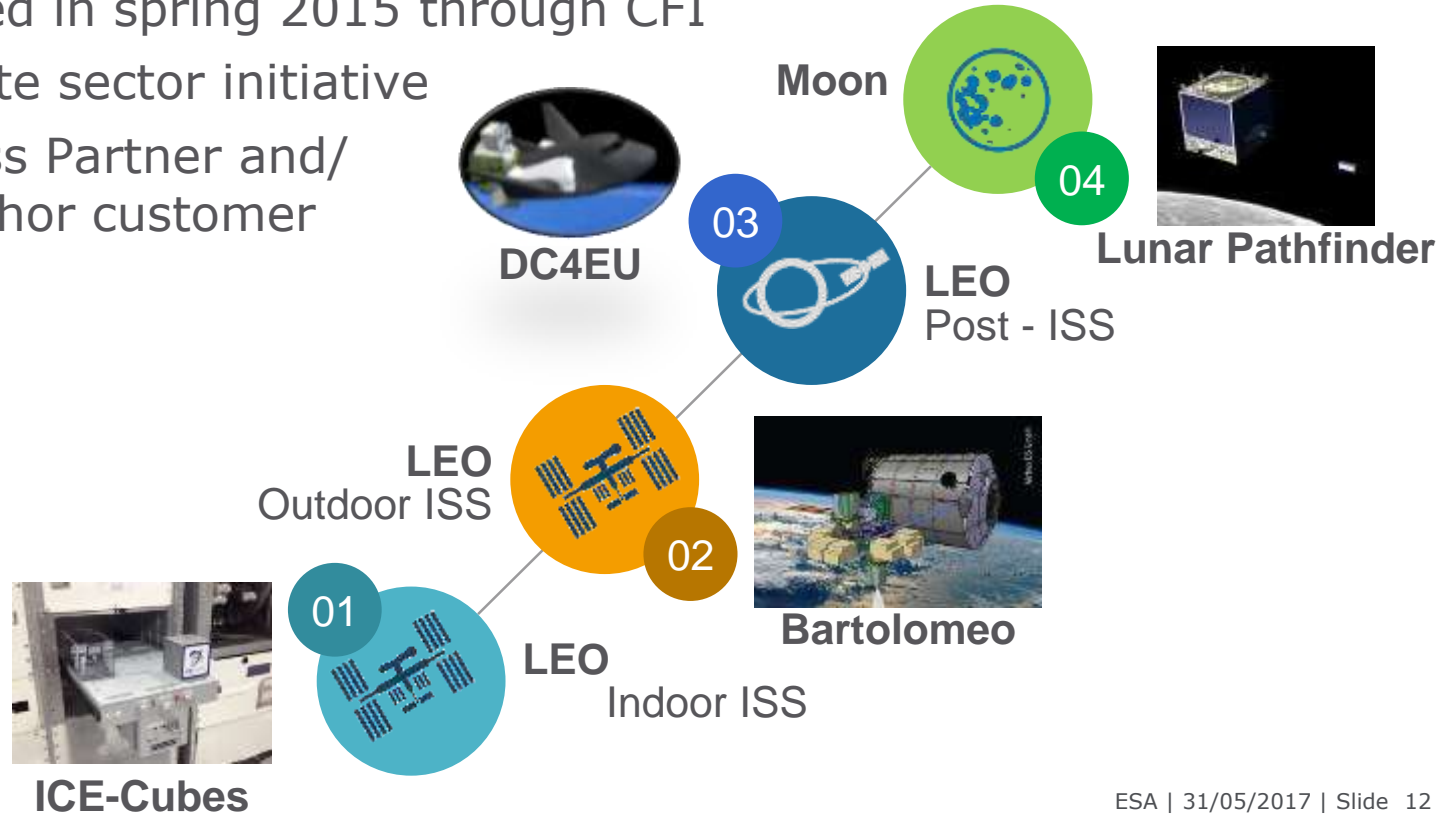
- Ground & Space-based infrastructure
- Data / knowledge / information
- Technology / patents

Three routes to access ISS as user: institutional, national or commercial





Commercial Partnerships

- Initiative started in spring 2015 through CFI
- Based on private sector initiative
- ESA as Business Partner and/or possibly anchor customer



International Commercial Experiment Cubes Services

 **Space Segment**
@ Columbus' EPM 



Real-time Communication

Planned start of service
aboard Columbus lab:
early 2018

10x10x10 cm
experiment cubes



User Segment

@ ICE-Cubes



 **Ground Segment**
@ Belgium site 



24h/7d

Book your trip now & fly 2018-2024

✓ Science, technology, business, education...

- ✓ Standard interfaces
- ✓ Launch and safety checks provided



- ✓ Easy access to data via IP



- ✓ Affordable, fast access to ISS

Points of Contact:

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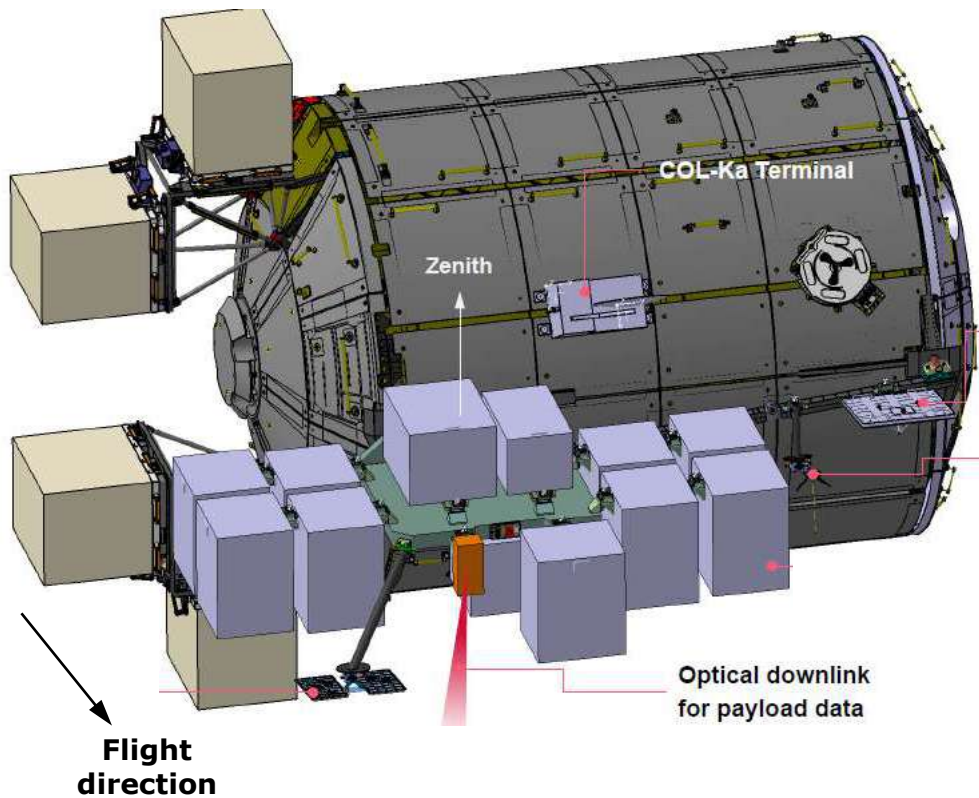
4-Month Cube [1U] Service

Education: 35 K€

Non Education: 50 K€

- ✓ $N \times N$ cubes possible
- ✓ Return possible at extra cost

Bartolomeo Platform and Service

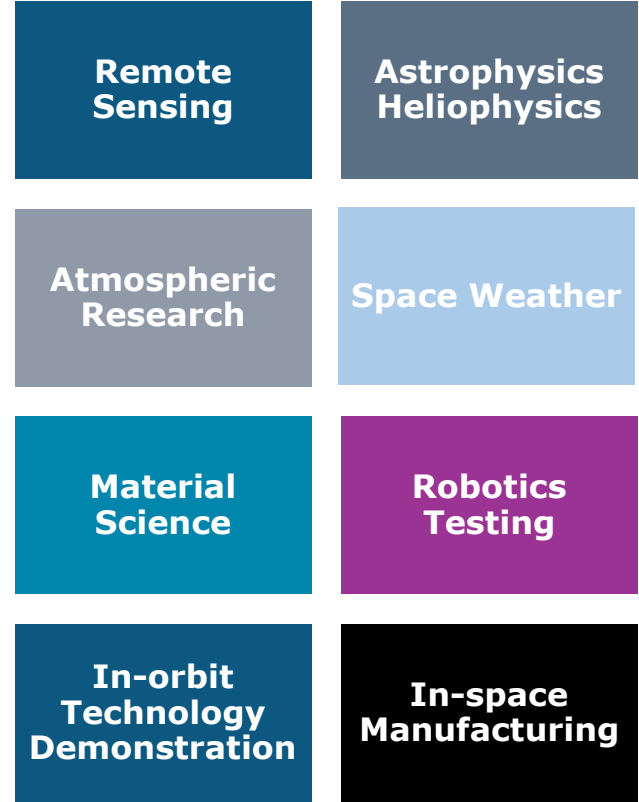


- 12 external payload slots (50-250 kg, various sizes)
- Optical data downlink capability for remote sensing payloads (2 Terabyte/day)
- Up to 800 W power provision
- Excellent Nadir / Zenith / Limb view, minor viewing obstructions
- Fully robotic installation of platform and payloads
- Airbus provided end-to-end mission service
- platform operations early 2019

Bartolomeo Value Proposition



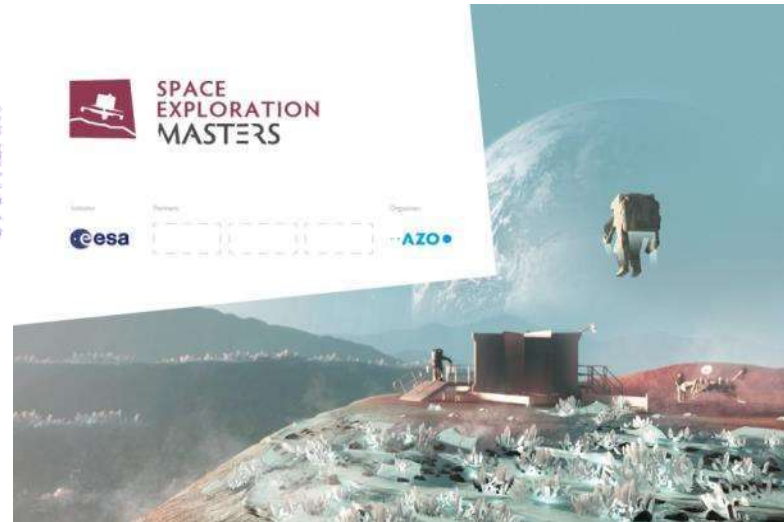
- New infrastructure : best ISS viewing positions, standardised payload accommodation and interfaces, various sizes, high rate data downlink capability
- Efficient use of ISS resources: no costly FRAM interfaces, no EVA/ crew time for payload installation and operation
- New ISS users: end-to-end mission integration and operation service, expertise in developing payloads, powerful marketing and sales network



Space Exploration Masters



- Aims to strengthen potential relevance of space exploration to society.
- Three prize categories: technology transfer, business innovation and scientific space exploration.



On-line application will be launched on 20 June 2017

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ESA Grand Challenge "In-situ Resource Utilisation"



Support cost effective R&D

Foster innovation

Encourage entrepreneurship



CM 2016

Foster cross-synergies between space and non space R&D

Add benefits to society



Since July 2016

Stimulate the ecosystem



Pool private investments and interests

Award new ideas



From 8 June 2017

Announcement



Staged approach: from ground-based proof to space

Prize > **1 M€** from sponsors



End 2017



Launch of the ESA **AO for post-ISS LEO Platforms** to explore options for partnerships with the private sector

Approach: permanently open to proposals for co-funded studies from potential partners

Timeline: announcement via EMITS news in May 2017

Fields of interest: business concepts for developing, deploying and operating cost-effective research platforms in LEO, including

- Innovation improving sustainability in operations and transportation
- Enabling technologies improving effectiveness
- International partnerships