From ISS to Exploration

"Increasing Station Utilization Across All Research Areas"
NanoRacks Workshop, Leiden (NL), Dec. 2015

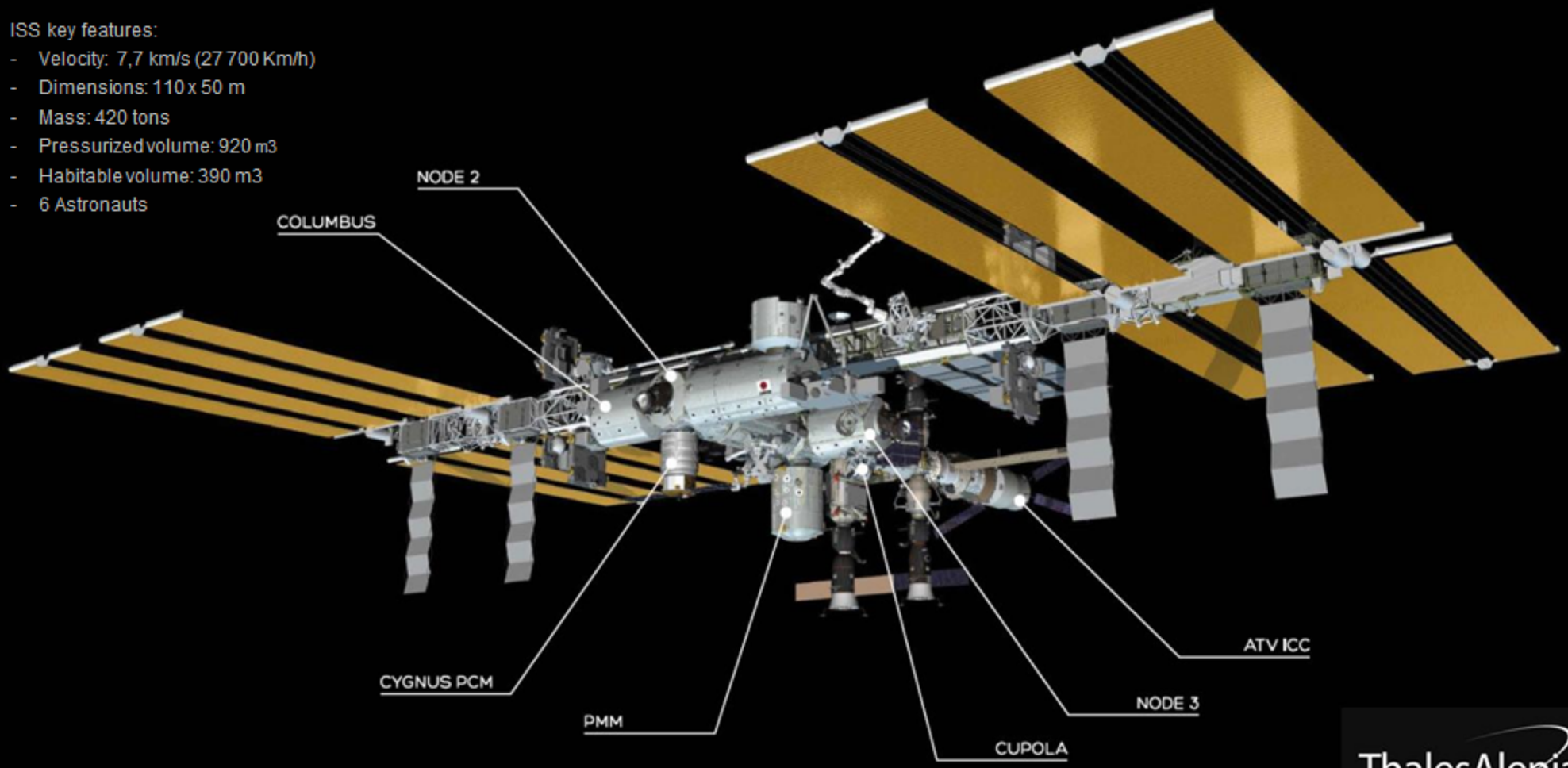
THALES ALENIA SPACE INTERNAL

ThalesAlenia Space
A Thales / Finmeccanica Company

International Space Station (ISS): what done

INTERNATIONAL SPACE STATION
elements built by Thales Alenia Space

ISS key features:
- Velocity: 7,7 km/s (27 700 Km/h)
- Dimensions: 110 x 50 m
- Mass: 420 tons
- Pressurized volume: 920 m3
- Habitable volume: 390 m3
- 6 Astronauts



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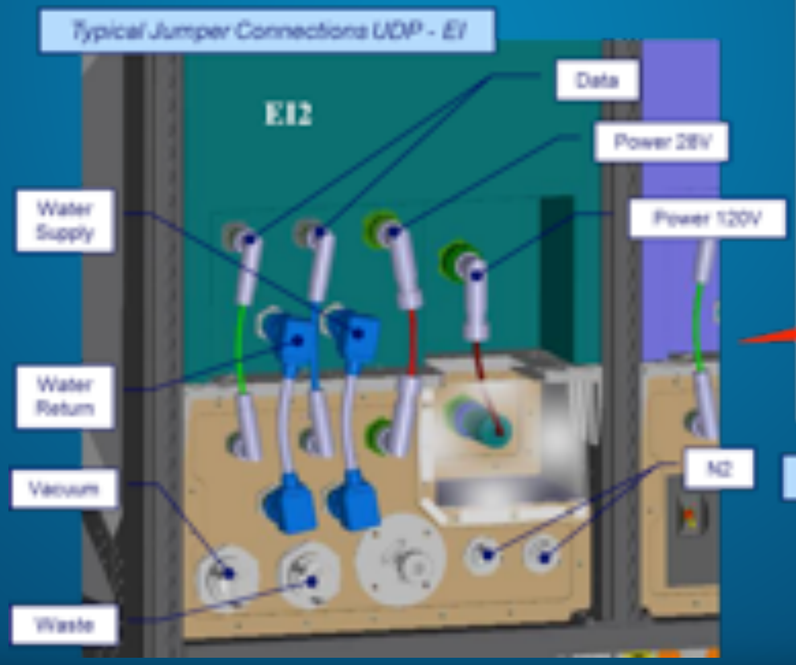
ISS: in work, ESA EDR2

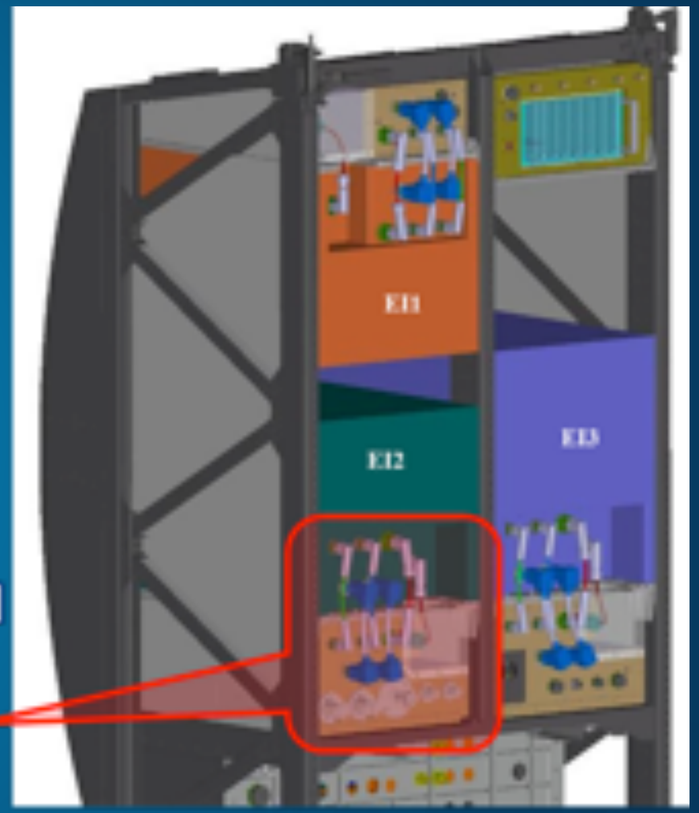
A Payload System Facility to enable flexible accommodation of short turnaround payloads (Experiment Inserts), by providing the necessary mechanical / functional interfaces and resources

Available Resources for EIs

- Cooling Water
- Nitrogen
- Waste & Vacuum I/F
- Power (120V and 28V)
- Data Link

Planned for launch on HTV8 in Autumn 2018

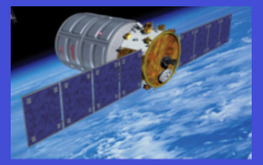




Typical Configuration on orbit with EIs installed

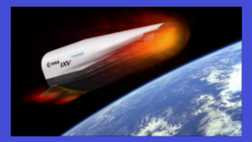
TAS-I Exploration Roadmap

Commercial Transportation Services



Inflatable modules

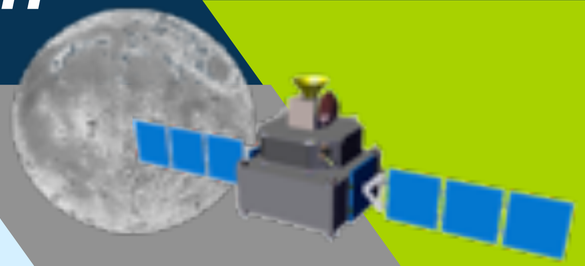
Technology Demonstrators



Robotics

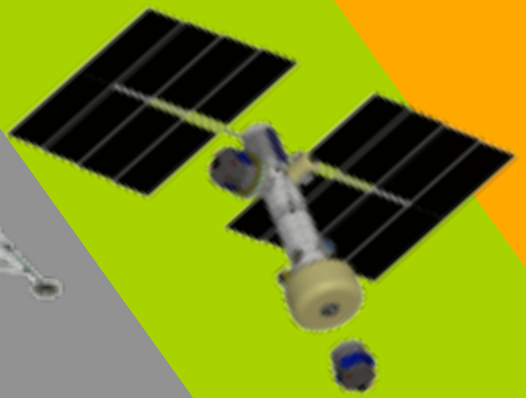
ISS Test Bed for Exploration

ISS



Orbiter Return Module (LPSR)

Orion ESM



Lunar Lander & Ascent vehicle

Press. Rover

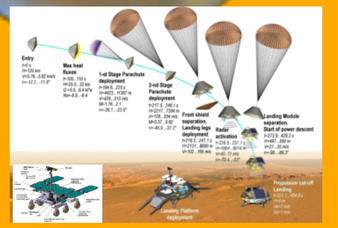
Habitat

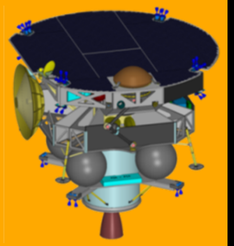
Beyond LEO (Cislunar)

Long Duration (Deep Space) Habitat

Moon

ExoMars





Post-EXM

Mars

Deep Space

Incremental, multi-step approach thru enabling technologies development, robotic missions and outposts set-up to support human missions

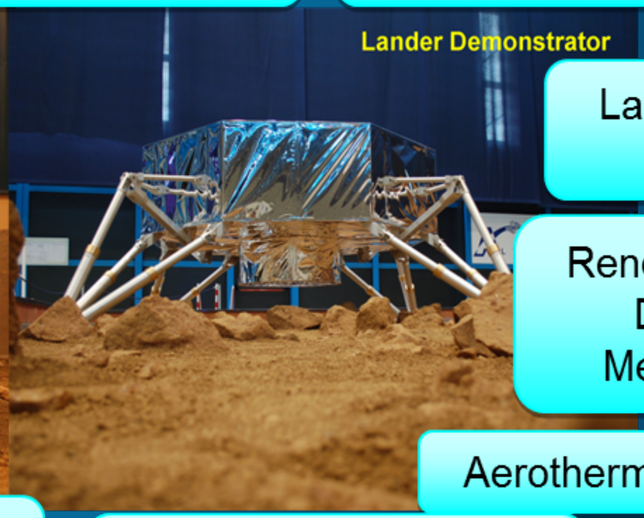
TAS-I Technologies & Products for Exploration

Environmental Control

Advanced Energy Storage

Ultra-light Structures

Human-machine Interface



Rigid & Inflatable Structures

Landing/Ascent System

Pressurised Structures

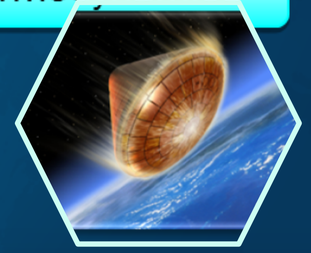
Rendez Vous & Docking Mechanism

Aerothermodynamics

Locomotion & Mechanisms

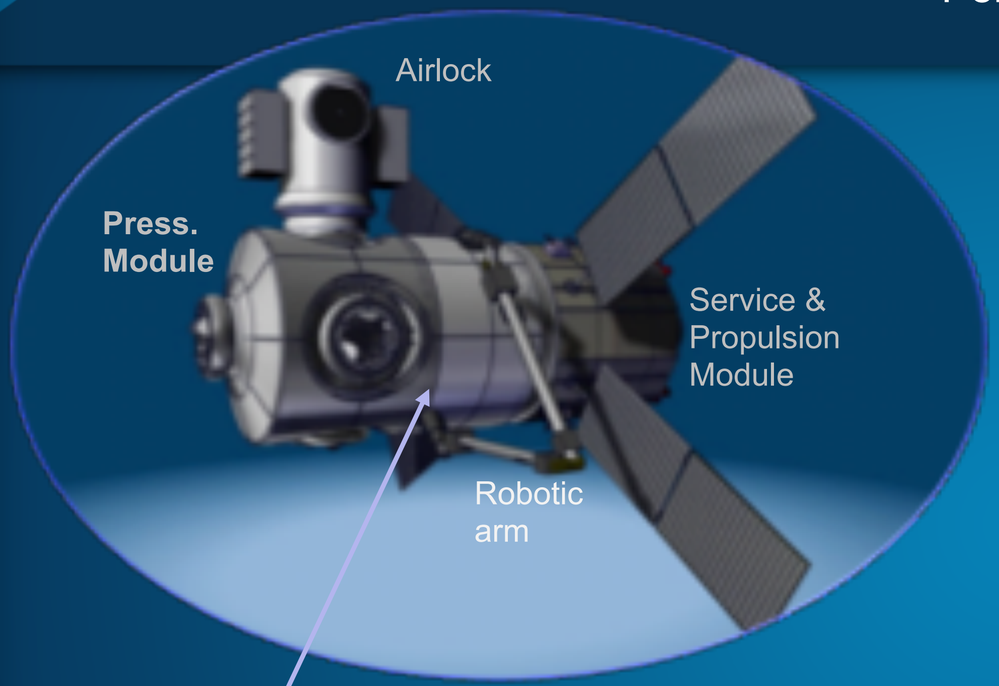
Navigation & Guidance

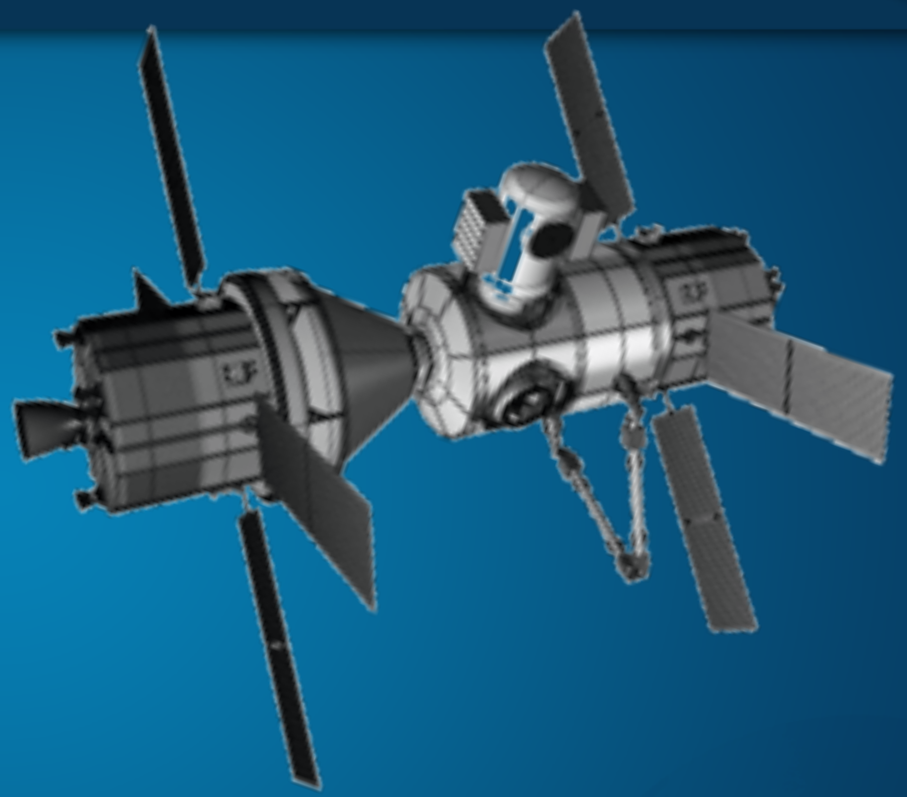
Health Management Systems



Cis-Lunar Habitat

Operated on a crew-tended base for short visit (30-45 days). Relying on Orion system when docked to it. Periodically resupplied by Cargo Carriers.





Node-like derived Habitation Modules
(dimensions and number of docking ports mission-dependent)

- Inspired by design heritage of ISS Pressurized Modules
- Simple yet robust by exploiting enhanced design features (lighter structures, MMOD protection integrated with thermal control,..)
- Evolvable, flexible, and modular, conceived as a platform to prove the technologies to take humans into deep space
- Supporting automation, tele-operations, robotics

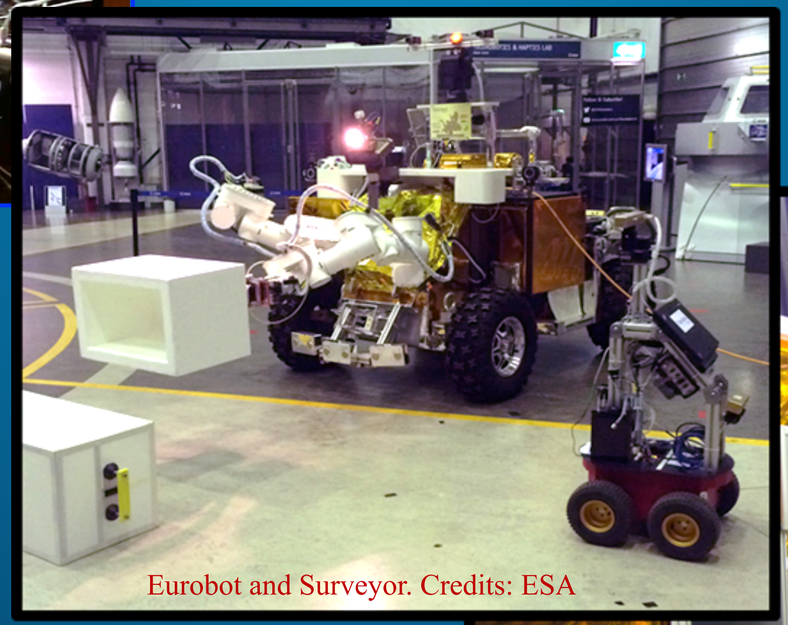
ISS, IOV for Exploration: Robotic Tele-Operation

Astronaut Andreas Mogensen operates Robots in space using ELIOS. (Eurobot fLIght cOntrol Station) MMI. Credits: Col-CC cam

ISS-based crew operation of multiple robots on Earth.

METERON “SUPVIS-E SDM (Short Duration Mission)” test successfully executed Sept. 2015 from ISS using TAS developed Flight MMI. Formal test planned early 2016.

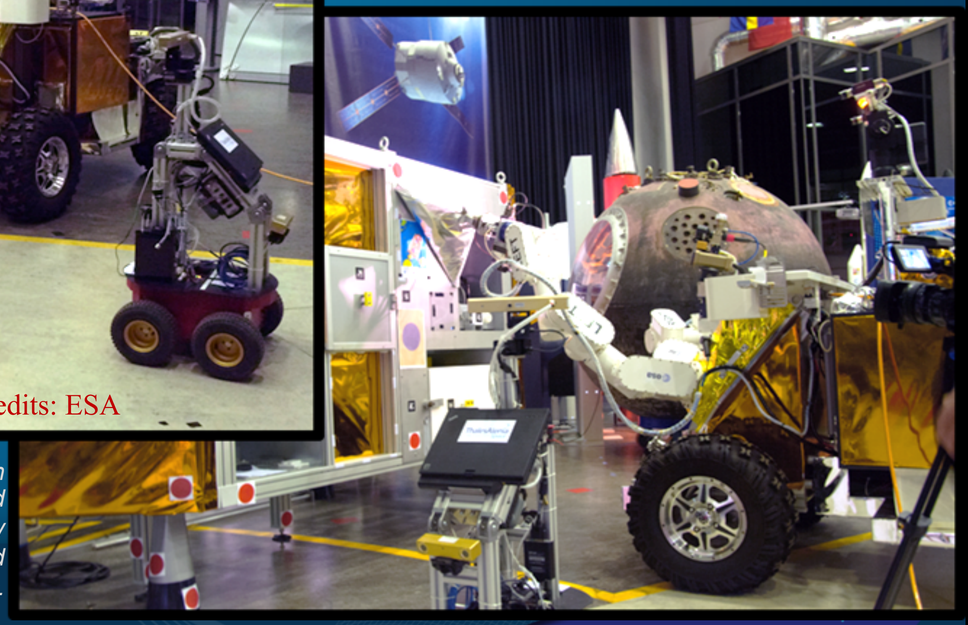
The test from ISS mimics and aims to proving capability to tele-operate robots / rovers on planets surface from space orbiting outposts, a key feature for future exploration missions



Eurobot and Surveyor. Credits: ESA

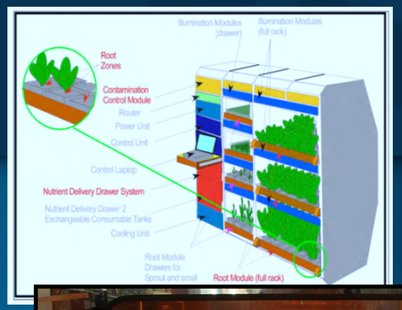
The scenario in place was the inspection and maintenance of an instrumented Lander Mock-up, and included proximity rover navigation, manipulation and computer vision technologies.

TAS EGP (ESA contract) and Surveyor Rover (STEPS2) at ESTEC premises during tele-operation from ISS



ISS, IOV for Exploration: Opportunities

Potential technologies for In-Orbit Validation @ ISS

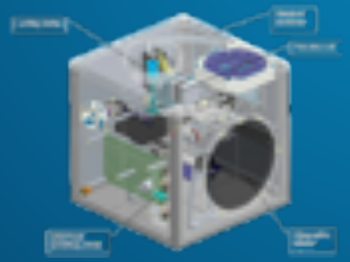


Greenhouse Demonstrator

In orbit demo of modular food complement unit technology (linked to ESA PFPU and H2020 EDEN ISS) with specific focus on the key gravity-sensitive Root Module for production of vegetable food.

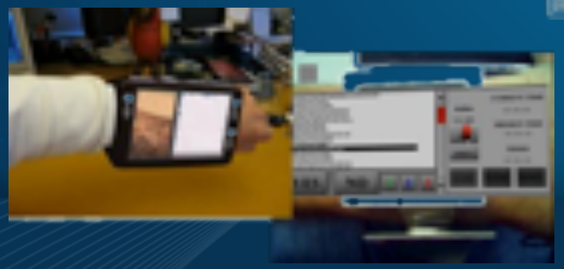
Regenerative Fuel Cell System (RFCS)

Validation of high density energy storage systems (~400 Wh/kg) for future space exploration applications (e.g. rovers, planetary base), by demonstrating critical functions in micro-g (phase separation, fluid dynamics inside cells)



Wire Feed Metal Deposition 3D Printing

To assess in orbit the process building parameters, and on ground the returned sample performances (metallurgical properties, defects, residual stresses,…), to enable capabilities for future in flight maintenance and repair



Augmented (and Virtual) Reality techniques

to facilitate on orbit operations