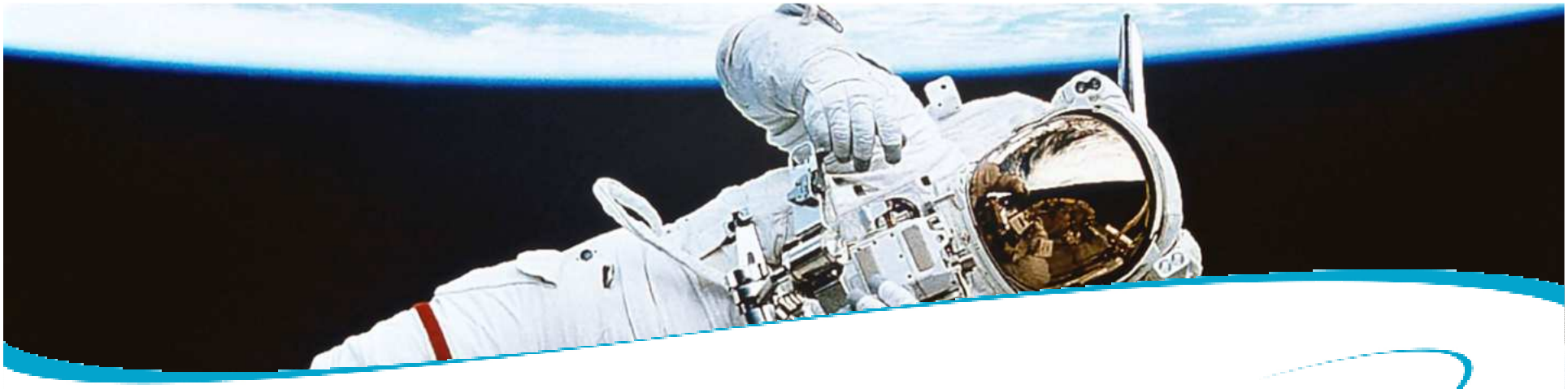

ThalesAlenia Space
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From ISS to Human Space Exploration: TAS-I Contribution and Perspectives

Piero Messidoro

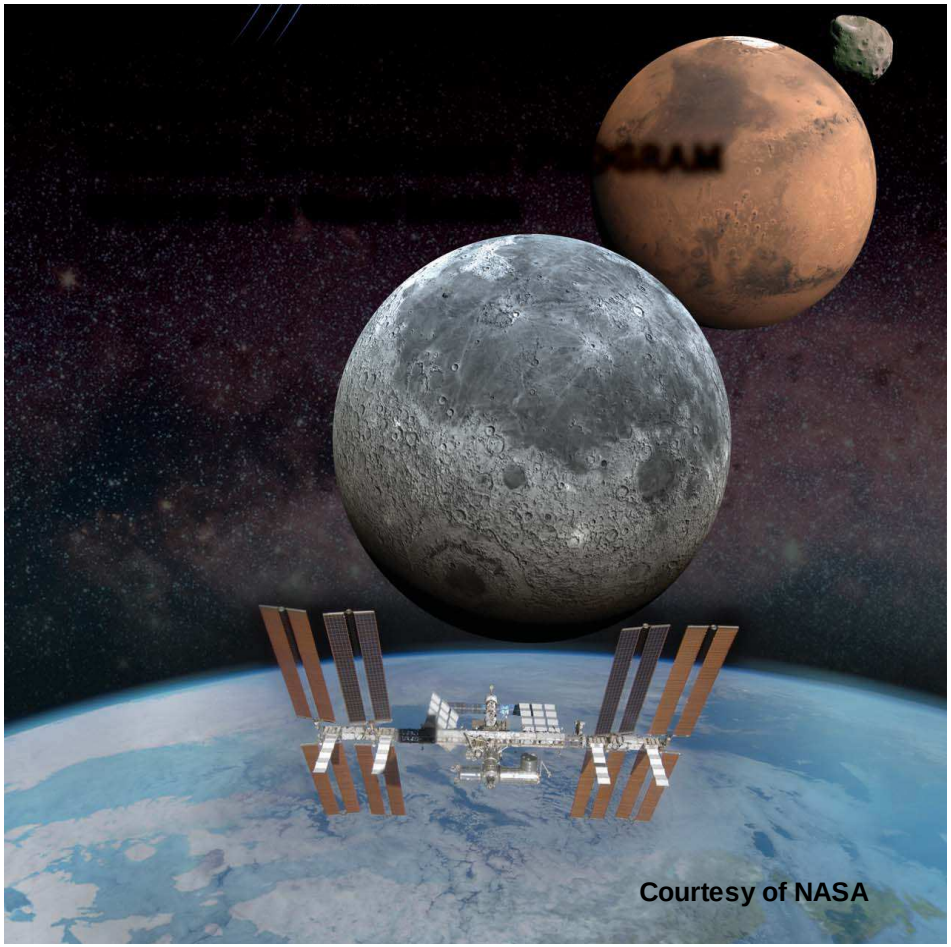
THALES

BSSIT

October 2010

Schiaparelli – BNU Torino

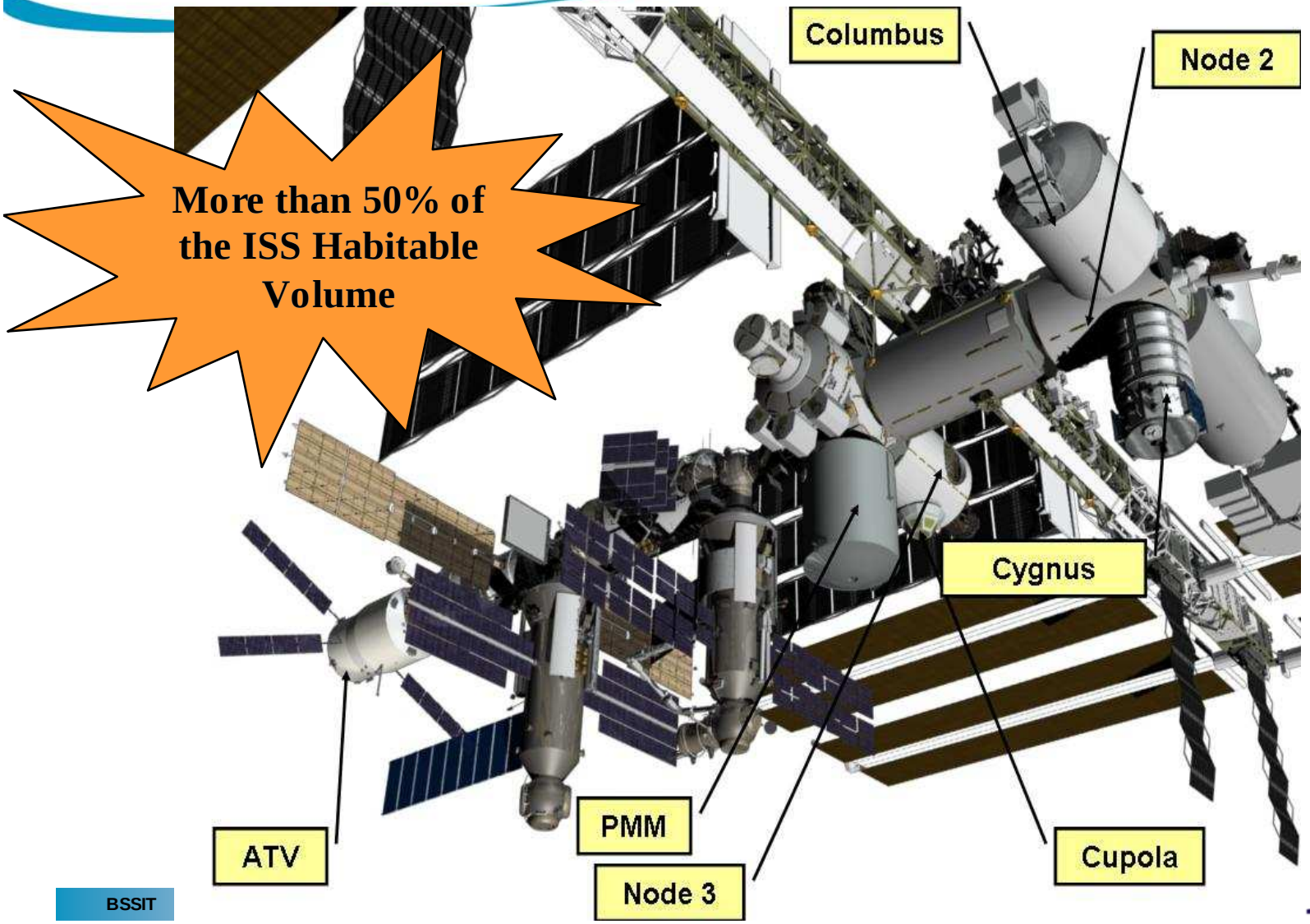
Human Space Exploration



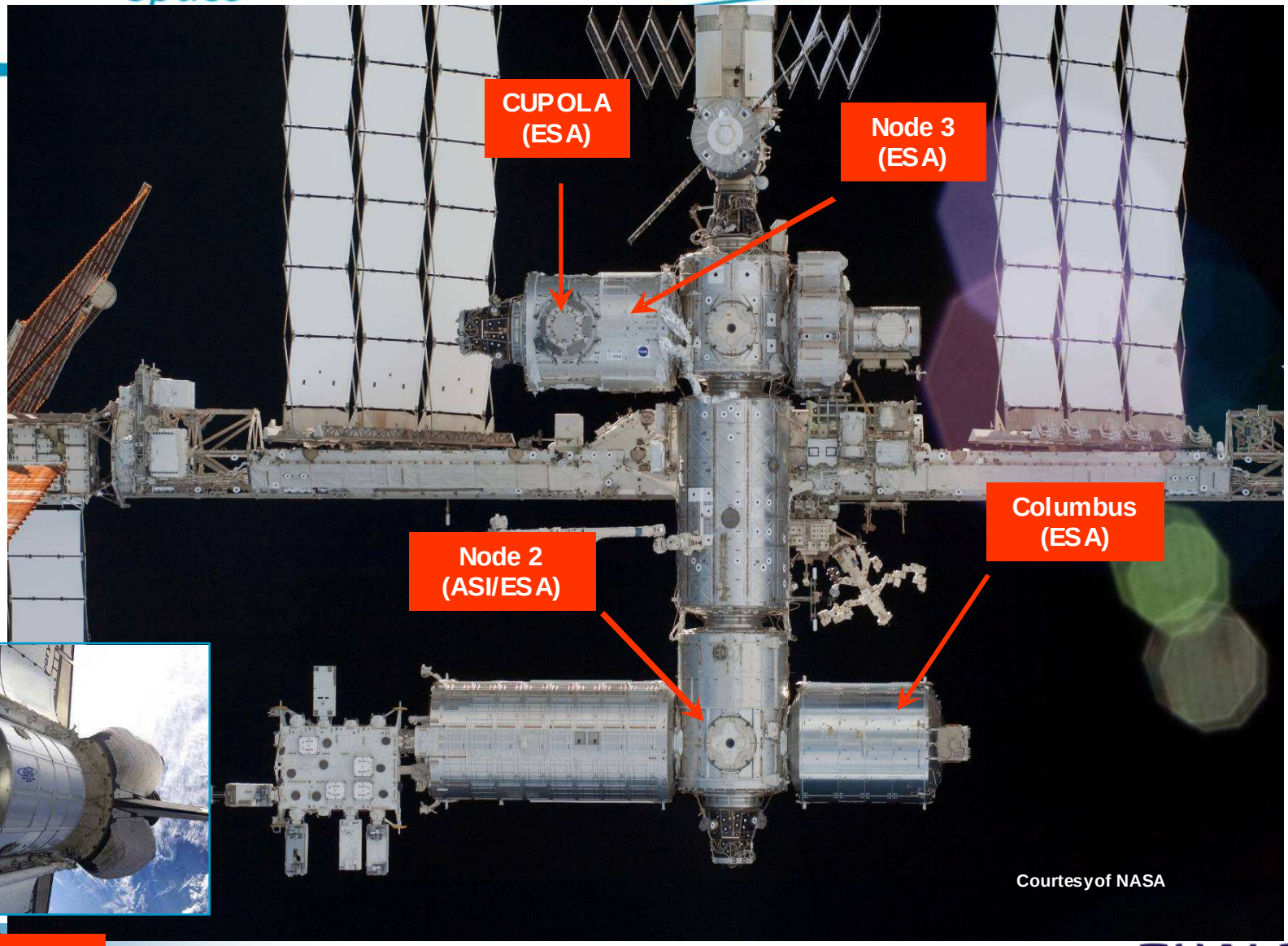
Opportunity for the Humankind to pass the boundaries of the Hearth, colonizing new worlds where it will be possible to live and operate

Thales Alenia Space contributes to the International Space Station program

Thales Alenia Space elements for International Space Station

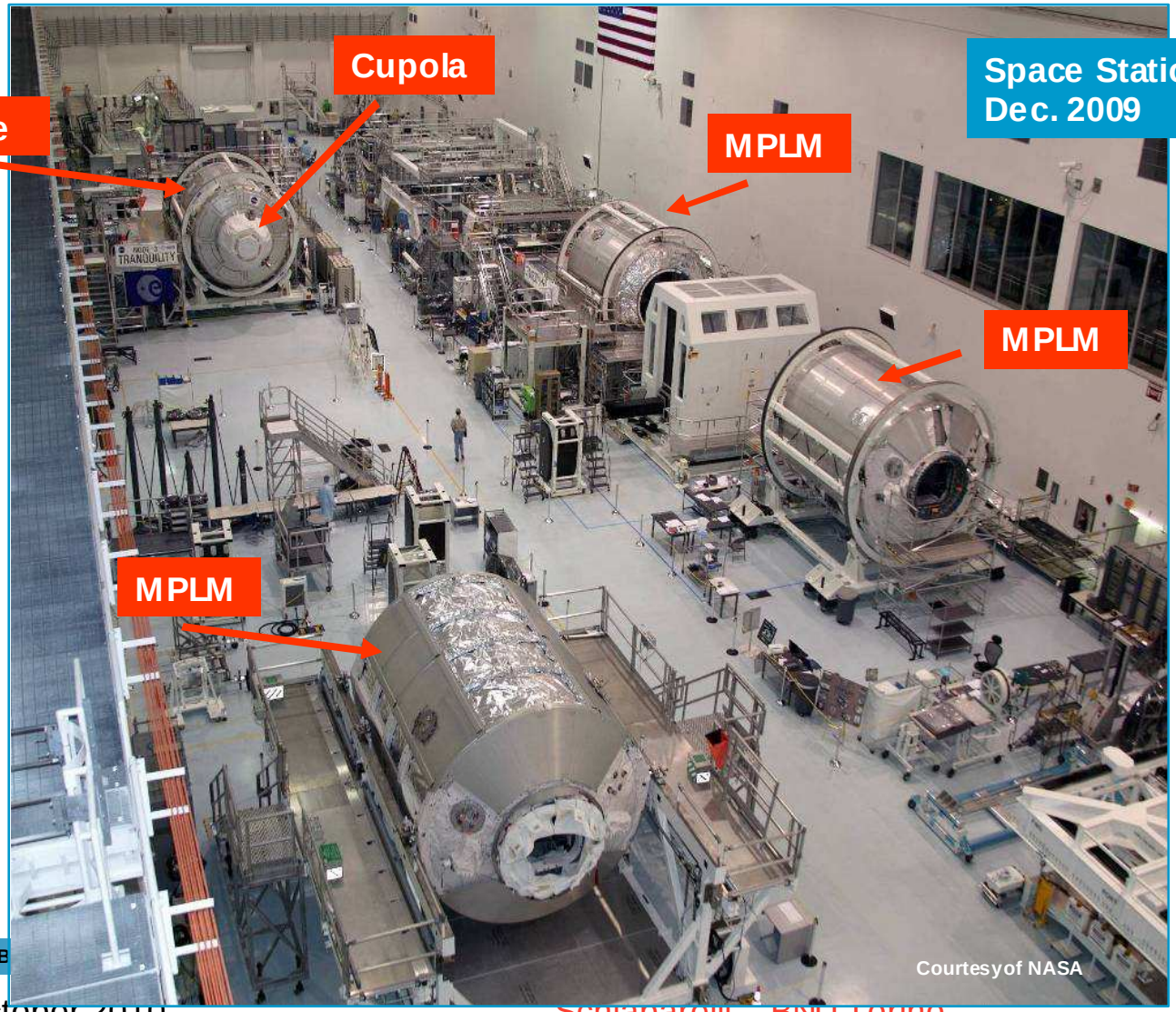


Thales Alenia Space elements for International Space Station



MPLM (ASI)

Thales Alenia Space elements for International Space Station



Space Station Processing Facility – Dec. 2009

MPLM
Multi Purpose Logistics Module

Functions:

- Logistic functions (cargo re-supply) and up-down trasportation (equipment, materials) as support to the Station operations (modules preparation, utilization, mantenance)

3 Flight Units: Leonardo/Raffaello/ Donatello

Features:

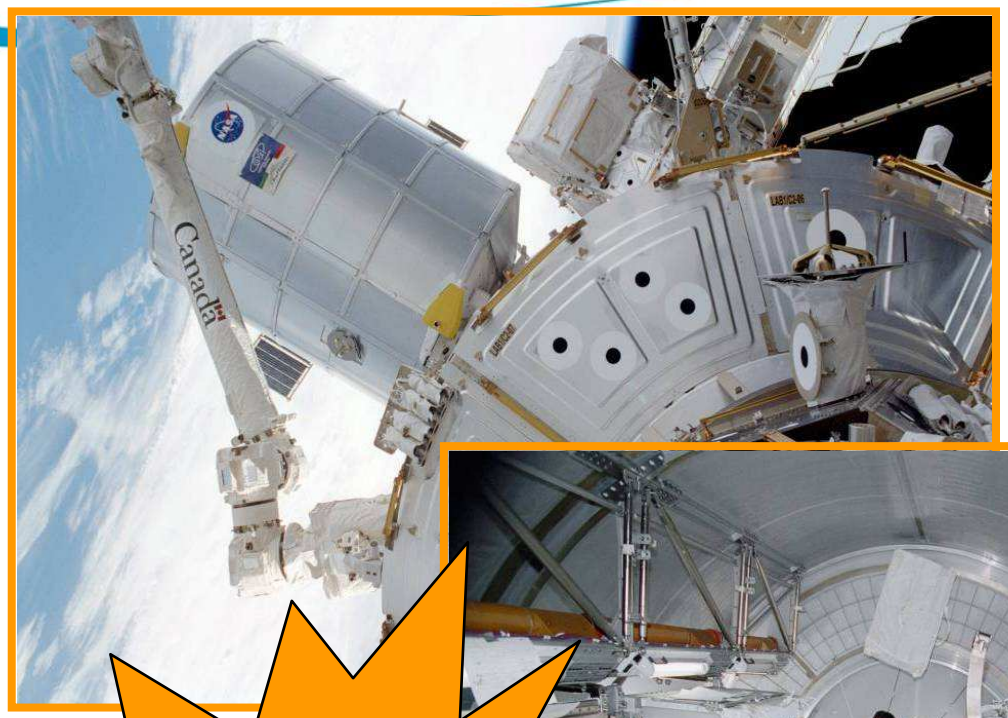
- Lenght: 6.6 m
- Diameter: 4.2 m
- Weight (empty): 4470 kg
- Cargo capability: 9000 kg

MPLM
Multi Purpose Logistics Module

- Aluminum pressurized welded structure
- Meteoroid & Debris protection system
- Active (coolant fluid loop) and passive (MLI blankets and heaters) thermal control
- Environmental control
- Electrical power distribution (up to 3 kW)
- Data Management and Processing

10 Shuttle Missions Executed

MPLM
Multi Purpose Logistics Module



1 additional Mission +PMM Planned up to 2011

- The Module can be visited and inhabited by the Crew during the entire mission duration (typically 12 days + margins)
- Can accommodate up to 16 racks ISPR-like
- 5 of these racks can be supported by active interfaces (electrical power, data, thermal cooling)

COLUMBUS

The laboratory is a pressurized volume of about 8 meters, with a diameter of 4.5 m, and with a controlled atmosphere

Shuttle Launch
7th of February 2008

COLUMBUS

Internal volume corresponding to a 16-racks cargo capability:

- only 3 accommodate equipment of subsystems
- other 3 are conceived as generic containment volume for the Space Station
- 10 are reserved for the operative payloads

Columbus has the standard characteristics for the payload-racks interchangeability:

- Nitrogen supply
- waste gases removal
- availability of a pneumatic vacuum source
- cooling capability

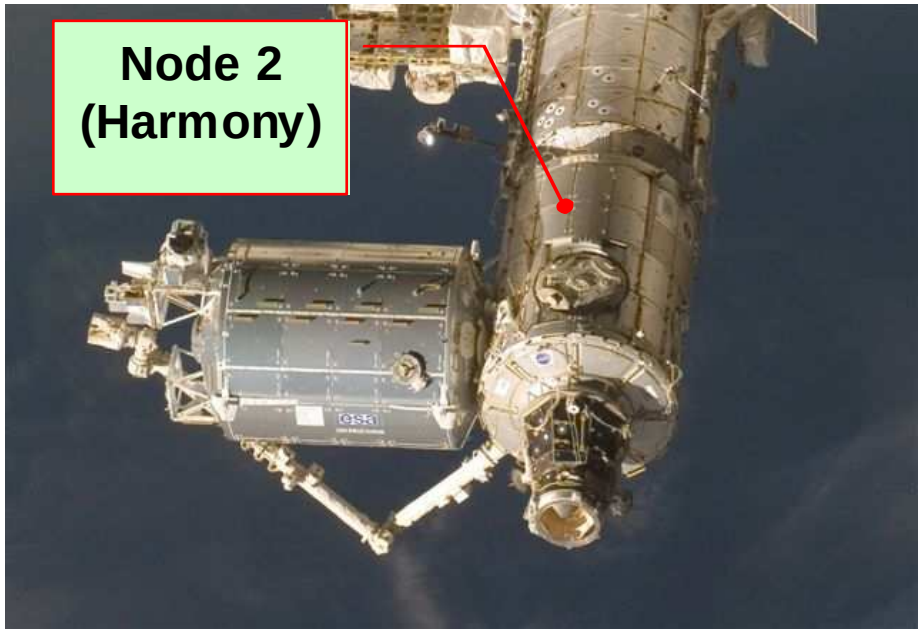
and provides a micro-gravity environment essential for the execution of the research in specific fields

In-Orbit Experimentation up to 2020

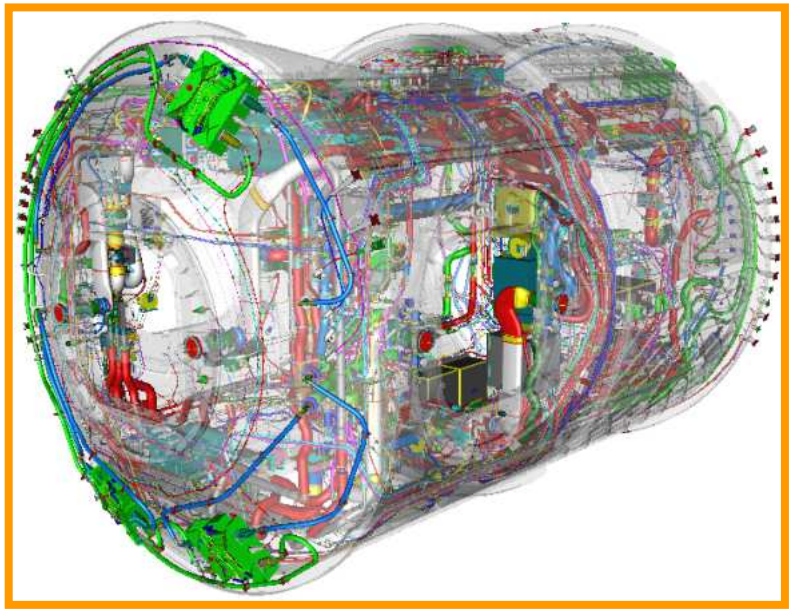
NODE 2

Functions:

- pressurized passage-way for the Crew
- trasfers commands and data, audio and video communications
- distributes resources of different type, such as oxygen, nitrogen, water (wasted, for the fuel cells and for the cooling) and electrical power



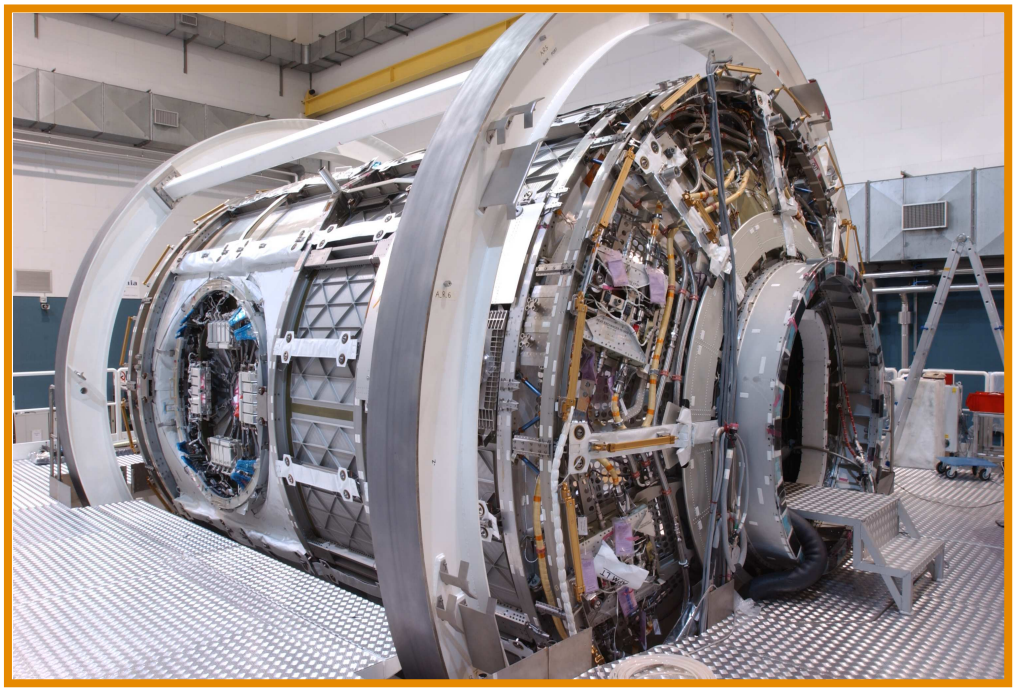
NODE 2



Features:

- **Length: 7.14 m**
- **Diameter: 4.48 m**
- **Launch Mass: 13500 kg**

Includes 6 Common Berthing Mechanisms for the connection with other modules (5 active and 1 passive)



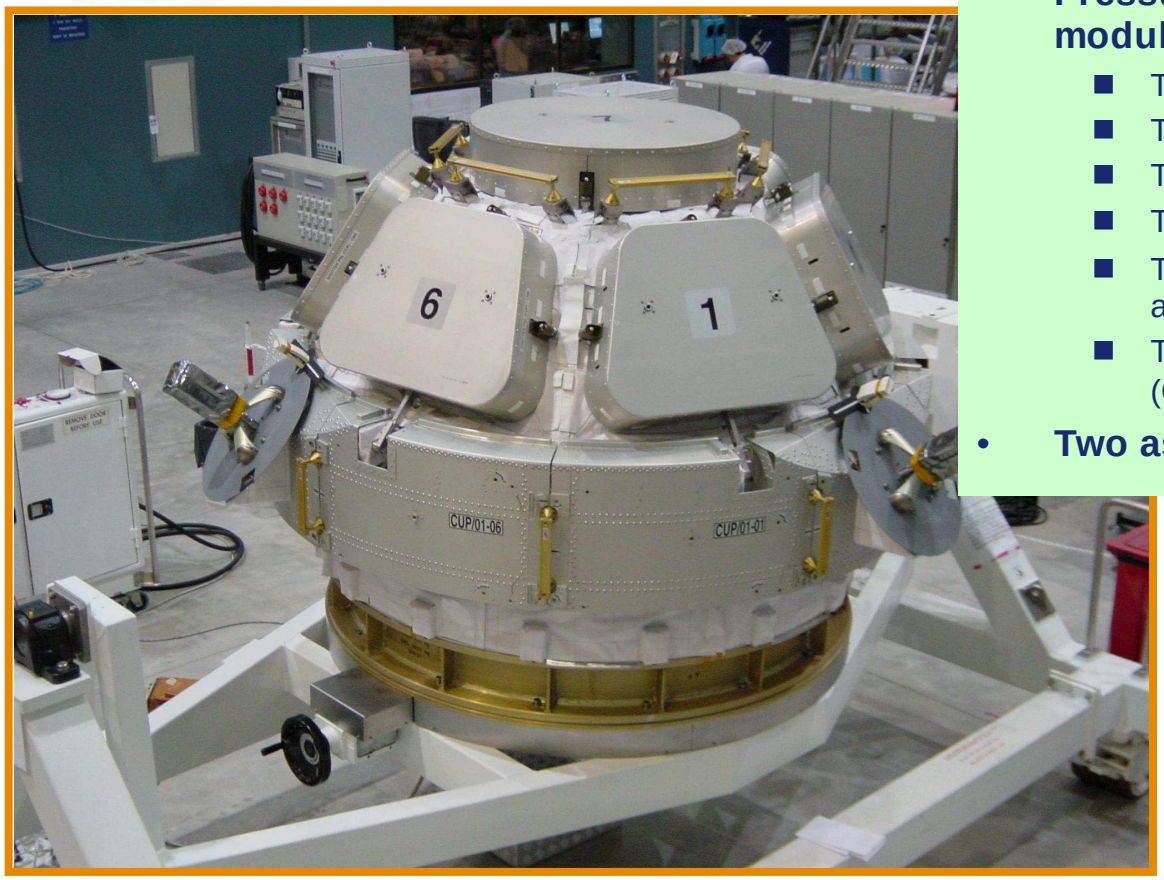
- Thales/Alenia Space – Italia played the role of Industrial Prime, with responsibilities in the design, integration and verification at Element level

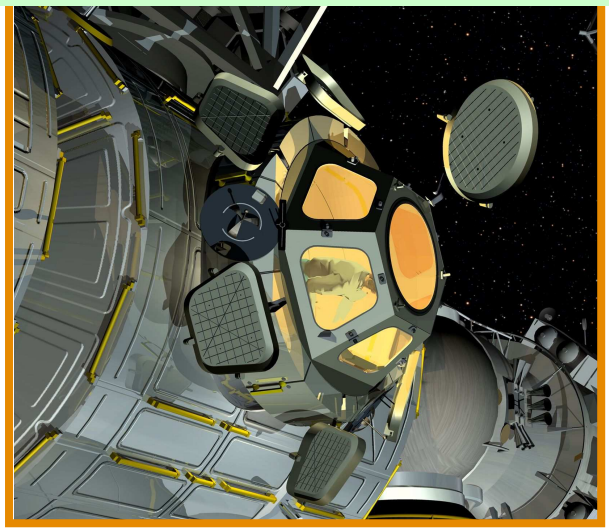
NODE 2

Shuttle Launch
Node 2
“Harmony”
23rd October
2007

CUPOLA

- **Pressurized element used as observation module for the Crew towards:**
  - The Earth,
  - The Celestial objects,
  - The Station external sufaces,
  - The Shuttle's berthing operations,
  - The extra-vehicular operations of the Crew and the Robotic systems,
  - The movements of the manipulators (Orbiter's and Station's)
- **Two astronauts can work in cooperation**



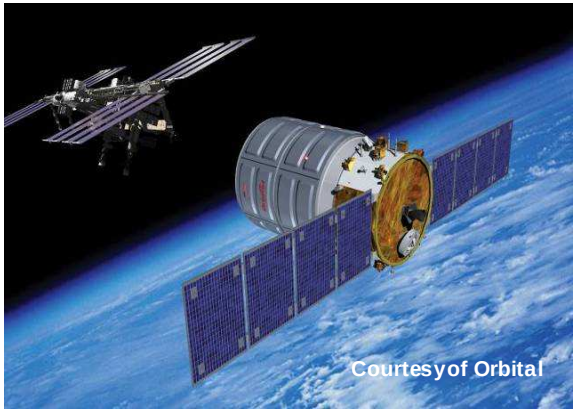


NODE 3

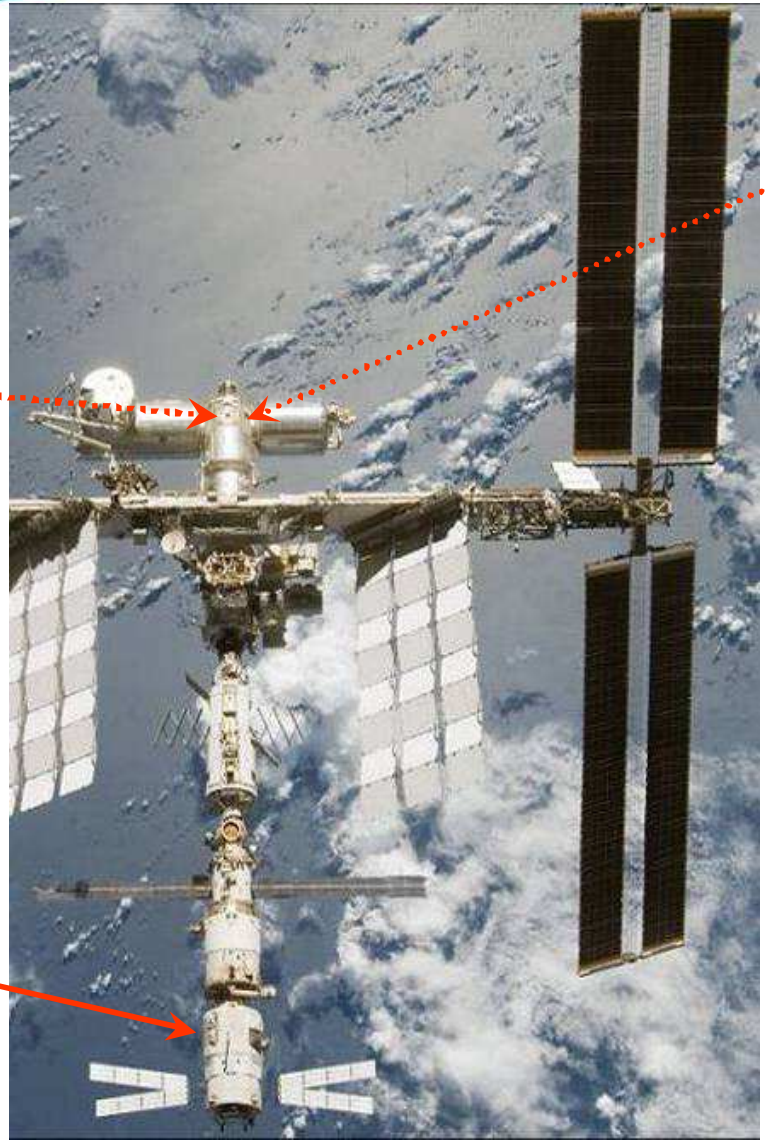
- **Functions:**
  - Resources distribution to the adjacent modules (as Node 2)
  - Accommodate and support:
    - Air revitalization racks (NASA): Atmosphere Revitalization System, Oxygen generation System)
    - Water processing racks (NASA)
    - Waste & Hygiene Compartment
    - Treadmill

Shuttle Launch
Node 3 "Tranquillity"
with Cupola
February 2010

Thales Alenia Space elements for International Space Station operation



NASA Commerical Orbital Transportation Services / Commercial Resupply Services – Cygnus Pressurized Cargo Modules



MPLM / PMM (ASI)

ALTEC Mission Support Complex

(MPLM Operations Support for ASI, ESA Operations Support)

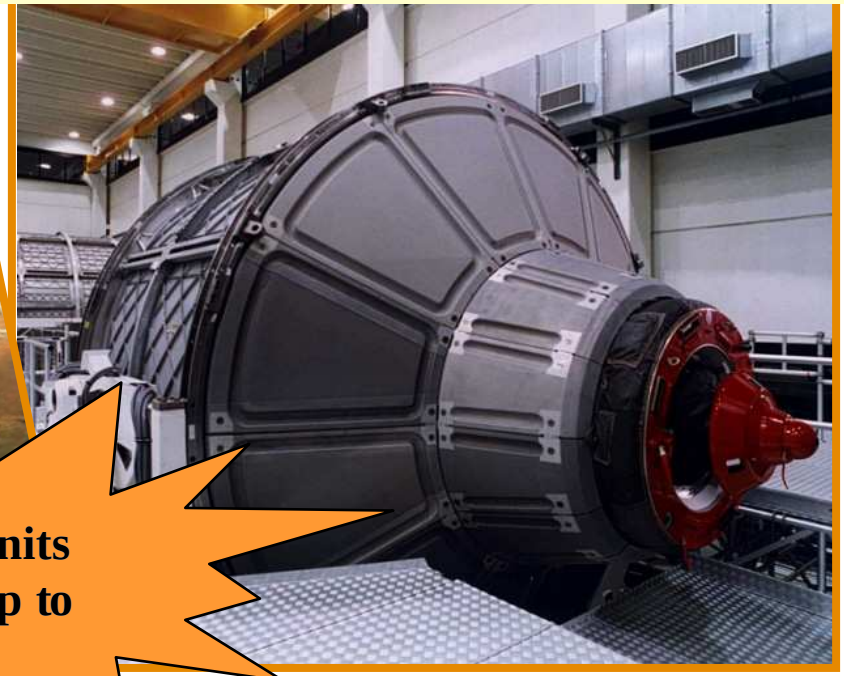
ATV Cargo Carrier (ESA)

October 2010

Schiaparelli – BNU Torino

ATV
Automated Transfer Vehicle

- **Launched by Ariane 5, provides support services to the ISS, along a period of six months docked to the Zvezda russian module**
  - Propulsion to ISS in order to increase orbit altitude (re-boost) and to help in the attitude control
  - Provision of cargo, resource replenishment (water, air, oxygen, nitrogen) and removal of waste products
  - Propellant re-supply
  - The typical cargo mission foresees a combination of resources and propellant, whose total net mass can achieve 7.2 ton



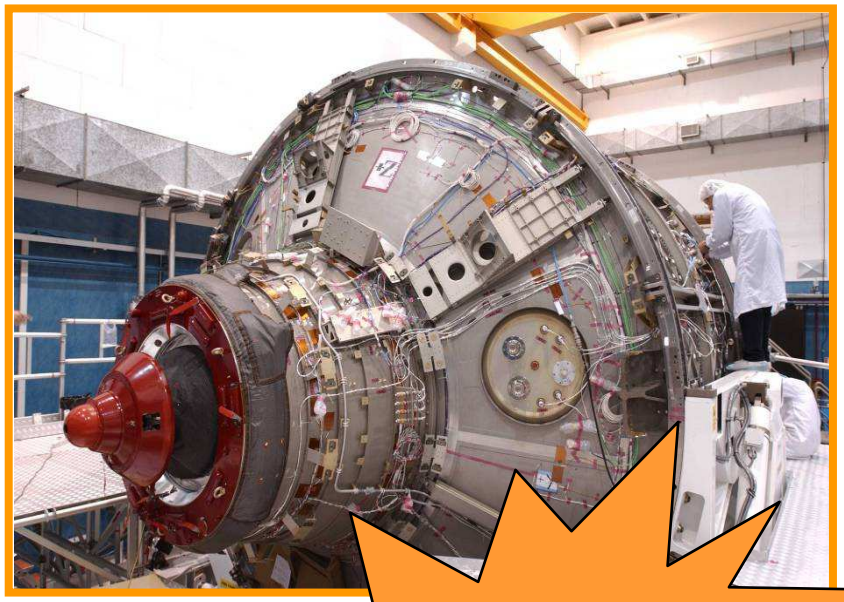
5 Flight Units Planned up to 2013

- **ESA Program**
- **Thales Alenia Space Italia is responsible for the system design and production of the Integrated Cargo Carrier for the Prime Astrium TS**

ATV
Automated Transfer Vehicle

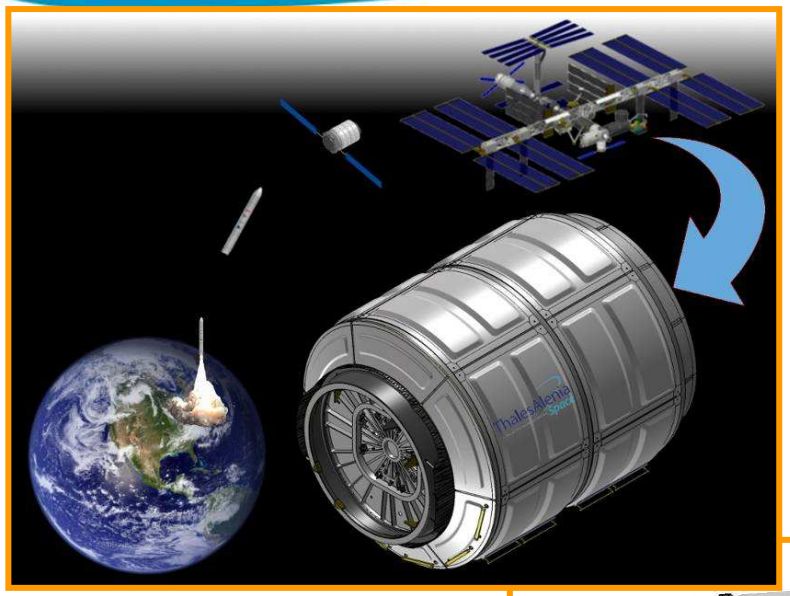
- Equipped with the Russian Docking System which allows to approach the Russian door, self-engage into the mechanism and connect autonomously to the Station

- ATV can allow disposal of Space Station wastes through a destructive atmospheric reentry (up to 5500 kg of solid wastes in the pressurized volume and up to 840 kg of liquid wastes in the water tanks)

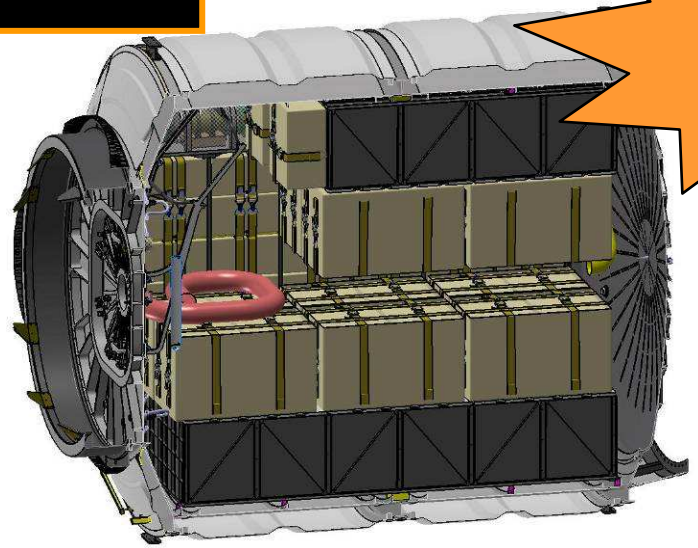


"J.Verne"
First Launch
8th of March
2008

COTS - CRS
ISS Cargo Resupply Services- Pressurized System



9 Flight Units
First Mission
in 2011



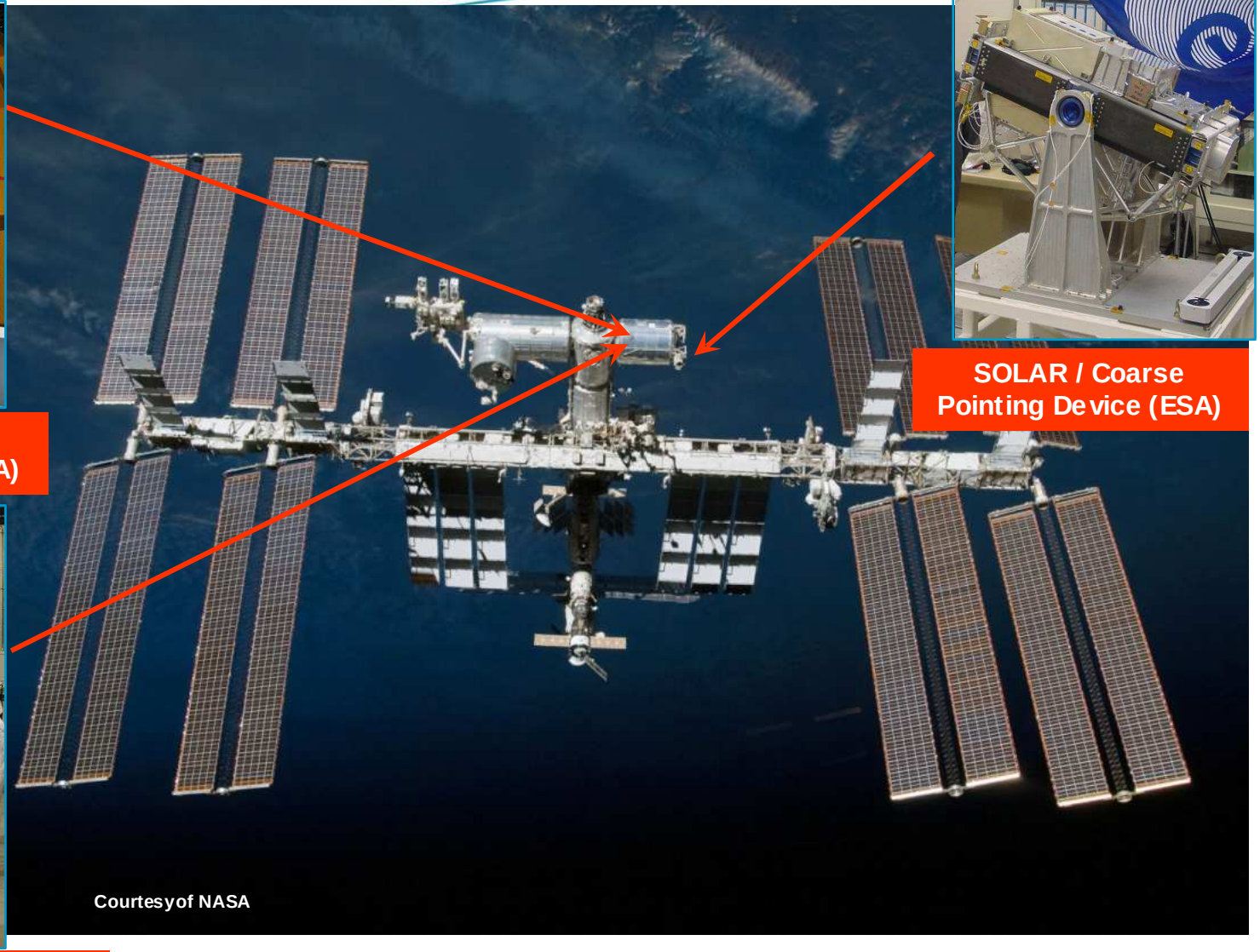
- Cargo module launched by Taurus II and transported by a Cygnus propulsion module to the ISS

- Can accommodate up to 2.7 tons of cargo active or passive (cargo module total mass around 4.5 tons)

Thales Alenia Space elements for International Space Station utilization

Fluid Science Laboratory (FSL, ESA)

European Drawer Rack (EDR, ESA)

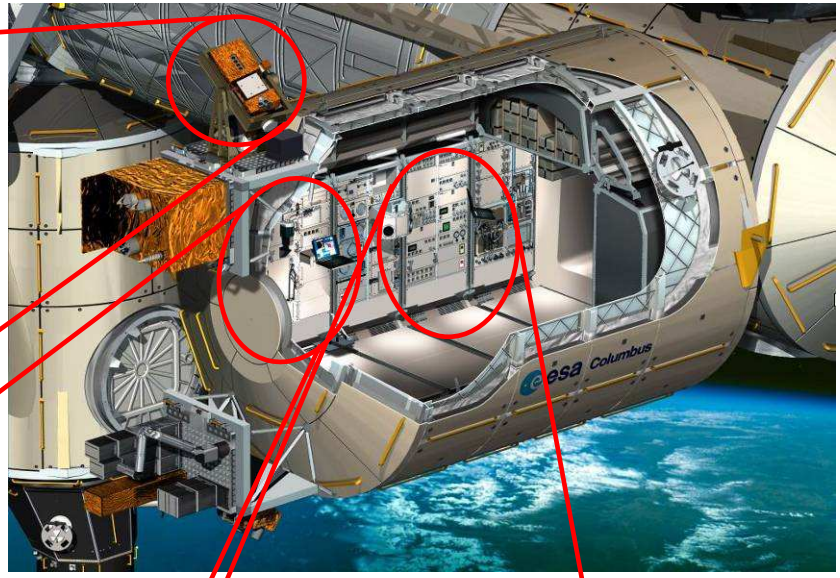


Courtesy of NASA

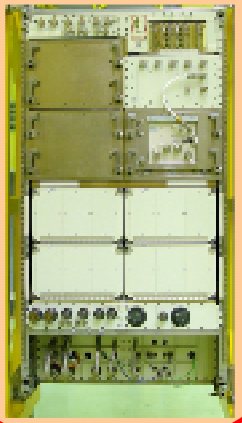
SOLAR / Coarse Pointing Device (ESA)

COLUMBUS PAYLOADS

SOLAR
is an External Payload for assembly on the Columbus External Payload Adapter (CEPA), with the scientific objective of solar radiation measurement for a duration of 18 to 36 months



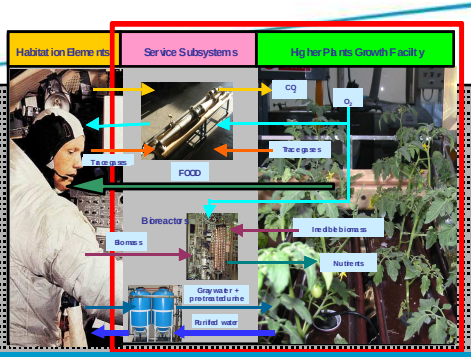
FSL
a flexible and highly modular facility, supports scientific micro-gravity research in fluid physics



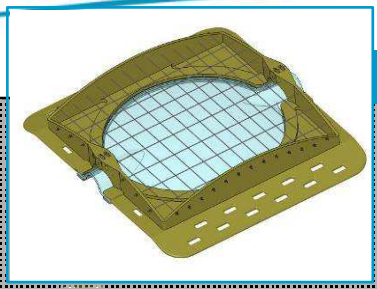
EDR
provides an infrastructure for direct integration of small payloads, and optimizes the distribution of utilities and resources to them

Preparation for exploration

Flexibe Commercial Structure (FLECS, ASI)

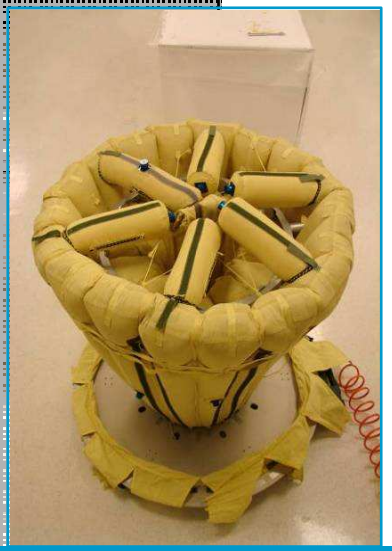


Controllo Ambientale Biorigenerativo (CAB, ASI)



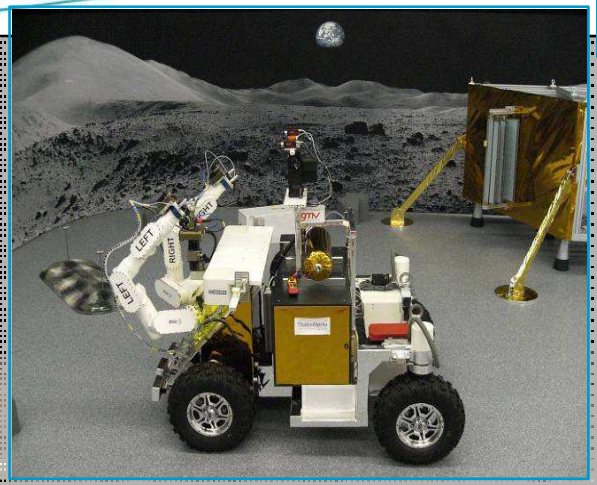
Flexible Windows (ESA)

Inflatable Module (IMOD, ESA)



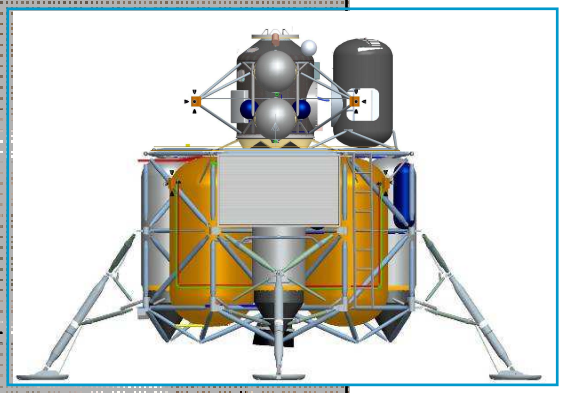
Inflatable Capture Mechanism (ICM, ESA)

Preparation for exploration

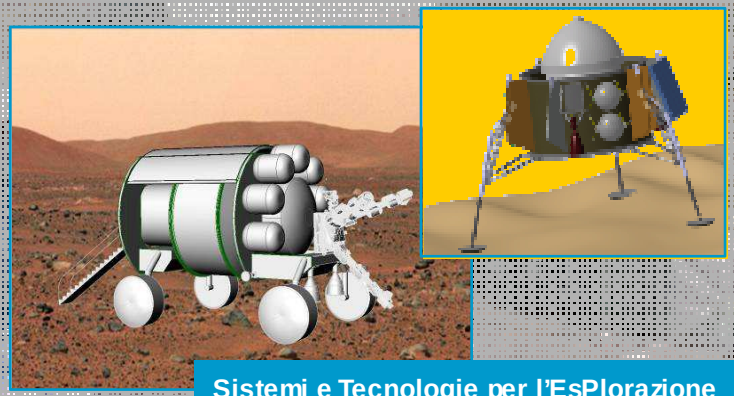


Eurobot Ground Prototype for Exploration (ESA)

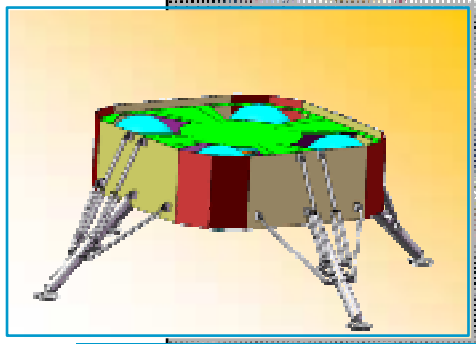
Pressurized Lunar Rover (ESA)



NASA Altair Conceptual Design Phase (Boeing)



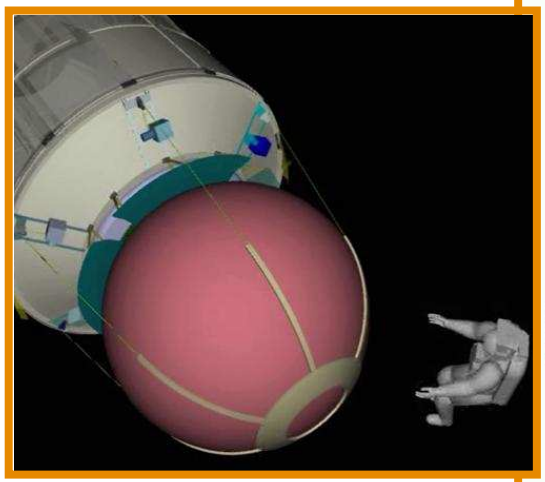
Sistemi e Tecnologie per l'EsPlorazione Spaziale (STEPS, Regione Piemonte)

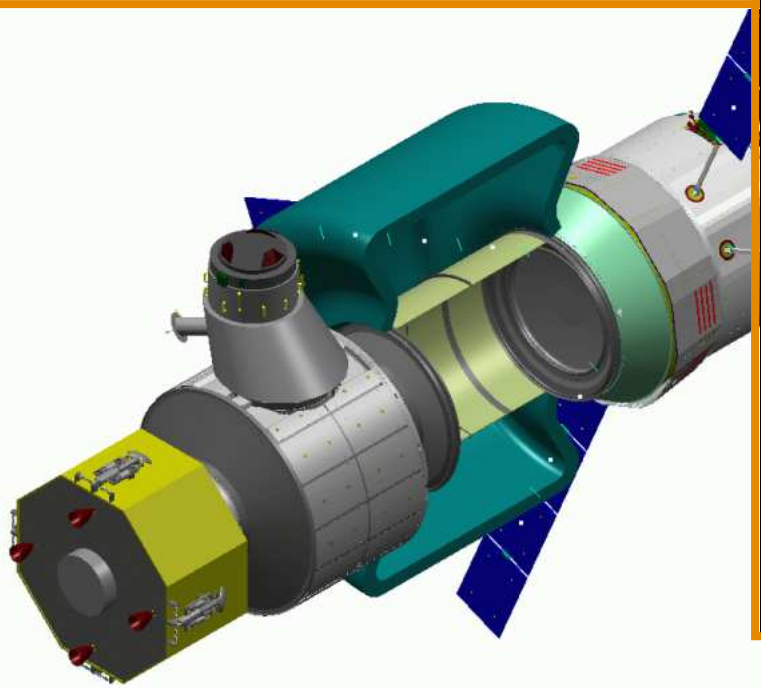


Landing System Development (ESA)

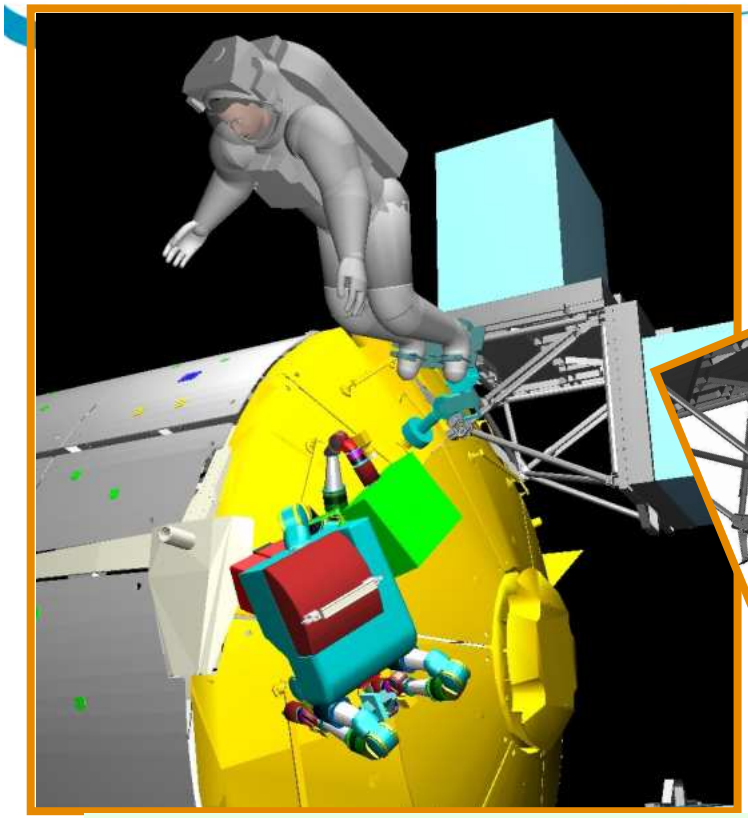
Habitation Modules with Inflatable Structure

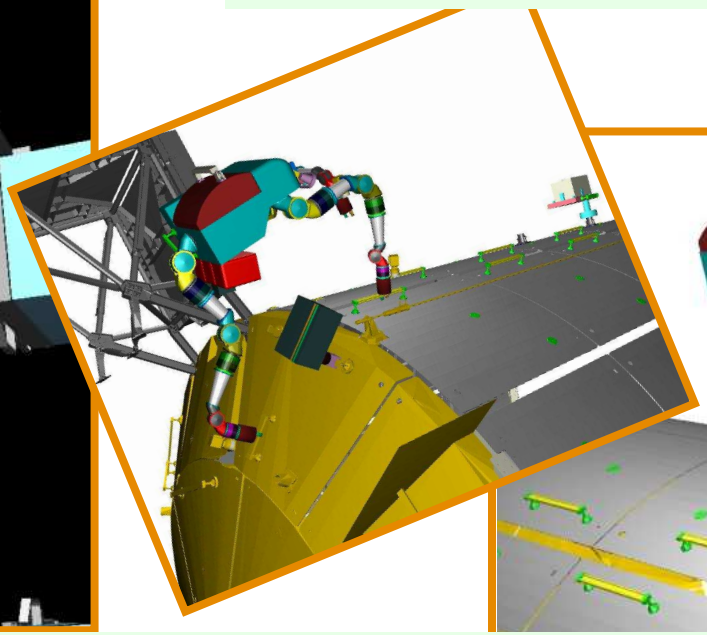
Utilization of inflatable structures, capable to deploy large habitable volumes in orbit (or on the lunar surface) suitable for long, continuous permanence of humans, although minimizing the needed launch volumes

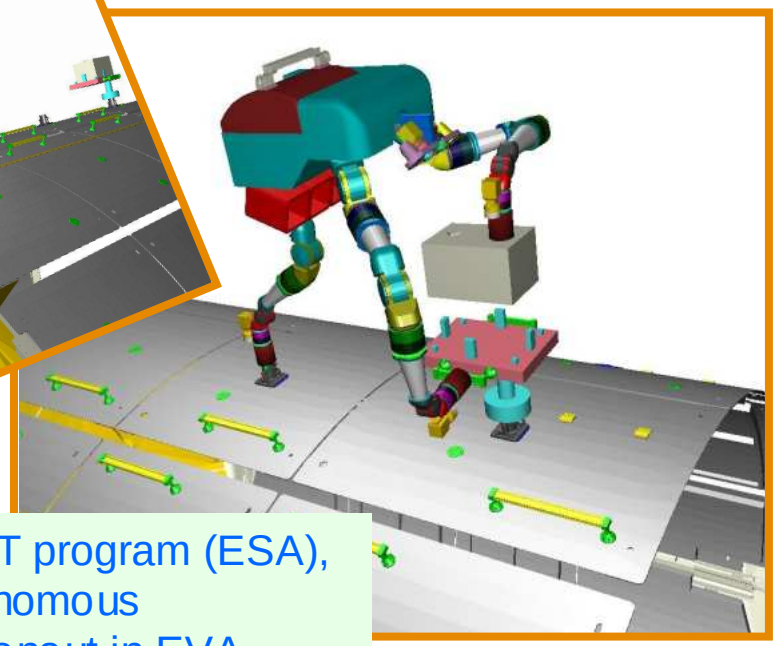




Collaborative Robotics: EUROBOT



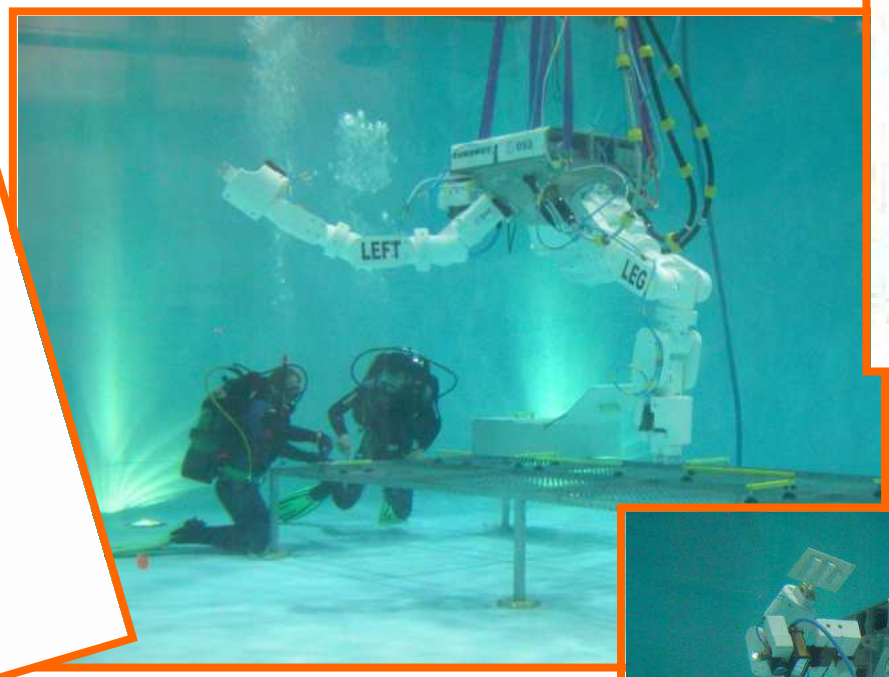


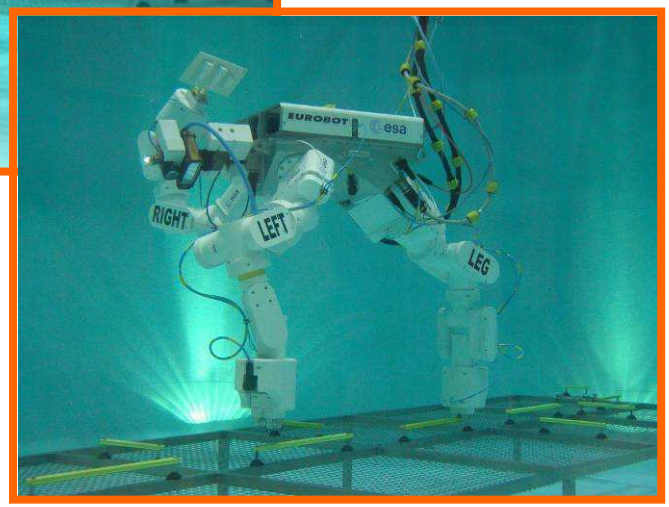


- Specific studies on collaborative robotics applications, including assistant robots for the astronauts' activity

- Particular importance is deserved by the EUROBOT program (ESA), oriented to the definition of a robot capable of autonomous operations or available for cooperation with an astronaut in EVA, moving on the external surface of the Station modules, and utilizing the same mobility aids designed for the astronauts

Collaborative Robotics: EUROBOT





Wet Model Test in ALTEC NBF - 2007

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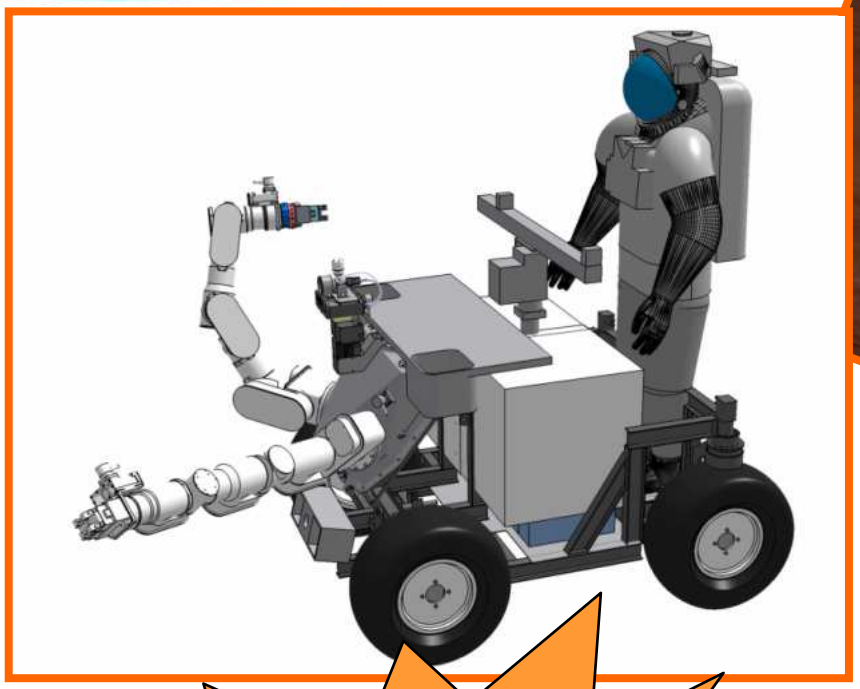
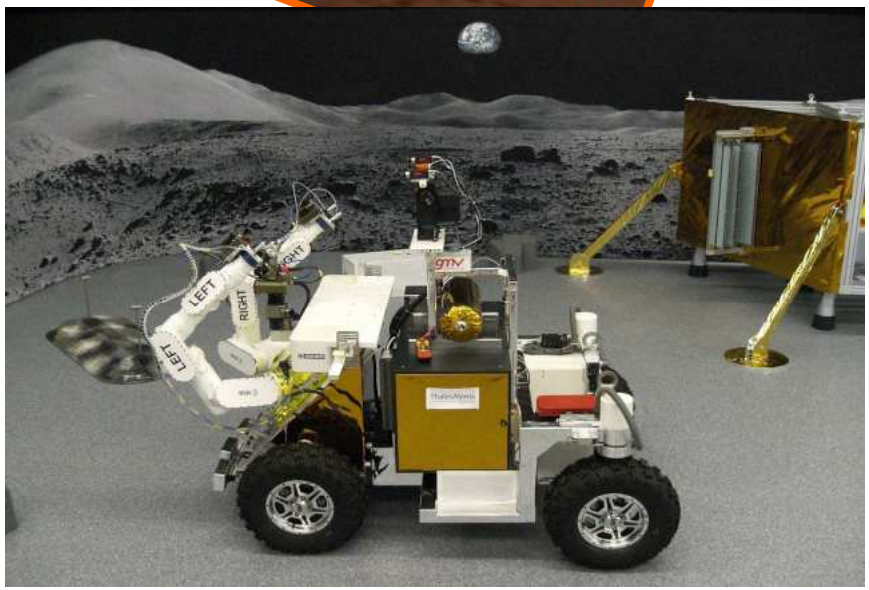
EUROBOT





Ground Prototype for Exploration Study - 2009

BSSIT

October 2010

Schiaparelli – BNU Torino

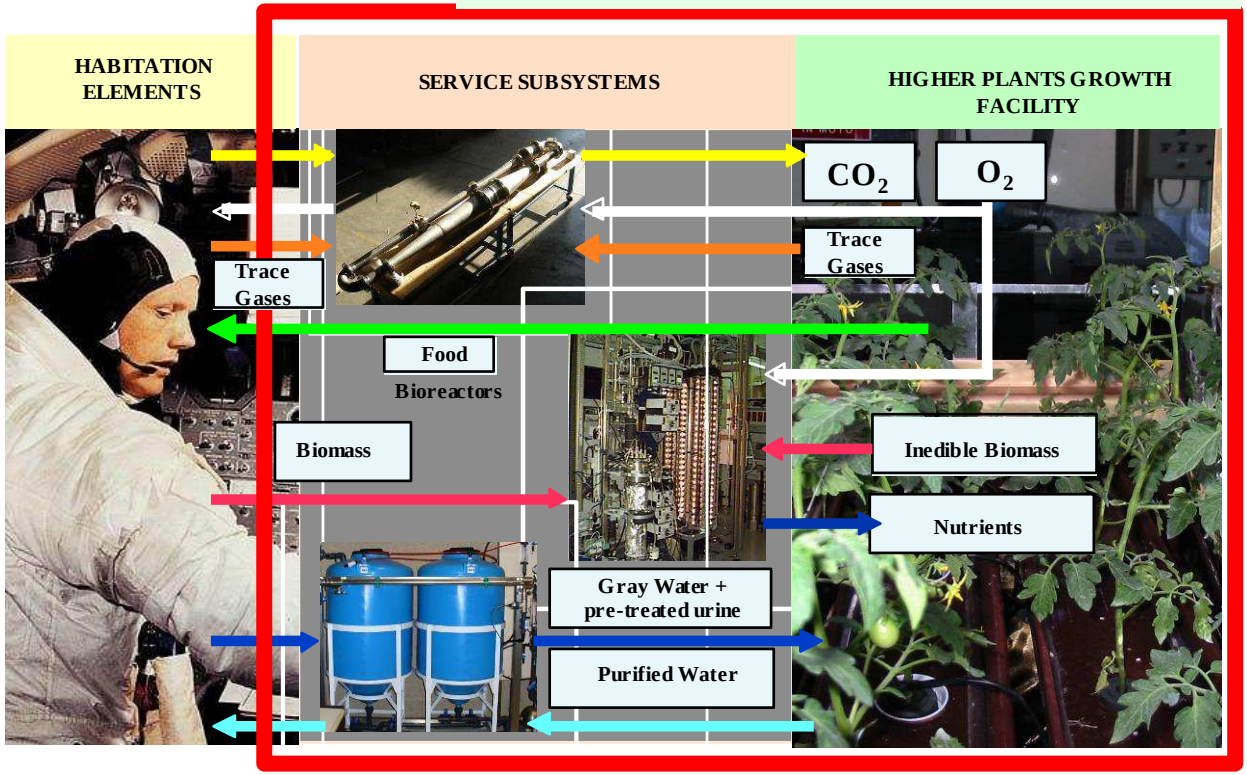
THALES

ThalesAlenia Space
A Thales / Finmeccanica Company

agenzia spaziale italiana

- Development of a controlled biological system, for the regeneration of resources and the production of food for life support in long duration missions
- The greenhouse module is the key infrastructure to be developed

- Higher plants as basic elements for food and oxygen production, CO2 regeneration and water purification via the photosynthetic and leaf transpiration processes, associated cultivation technologies (e.g. lighting, nutrient delivery)
- Biological & physico-chemical systems for environmental monitoring & control, waste management, power & data distribution, etc.

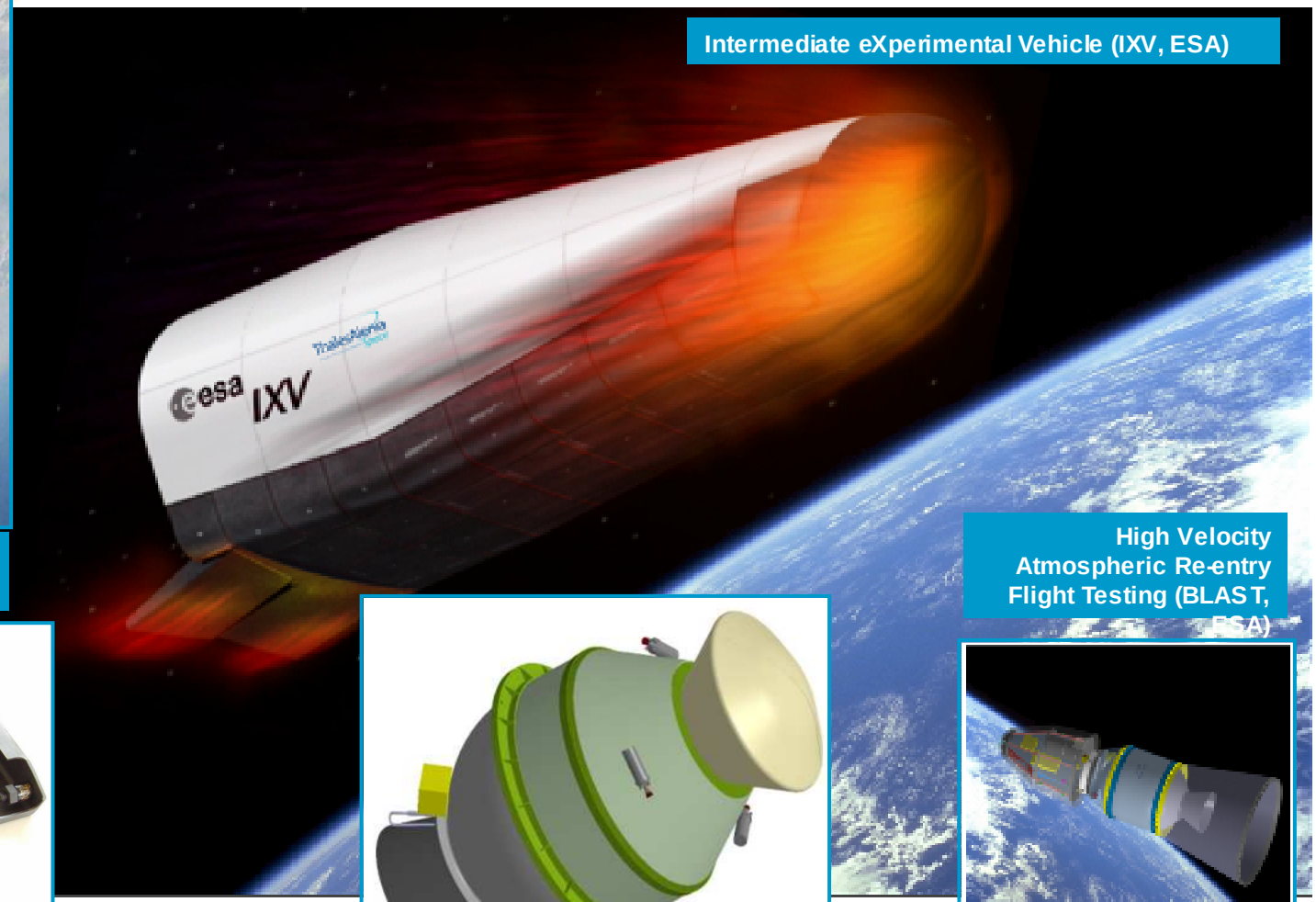


BSSIT

THALES

Reentry systems and demonstrators

Experimental Re-entry Test-Bed (EXPERT, ESA)



Intermediate eXperimental Vehicle (IXV, ESA)

Reusable Metallic Structures (ESA)

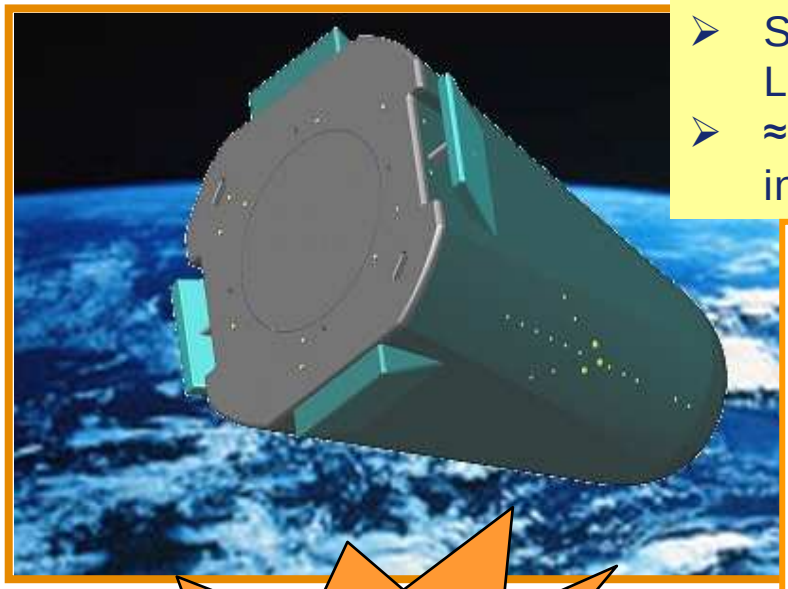
in flight research on radiation (RadFlight, ESA)

High Velocity Atmospheric Re-entry Flight Testing (BLAST, ESA)

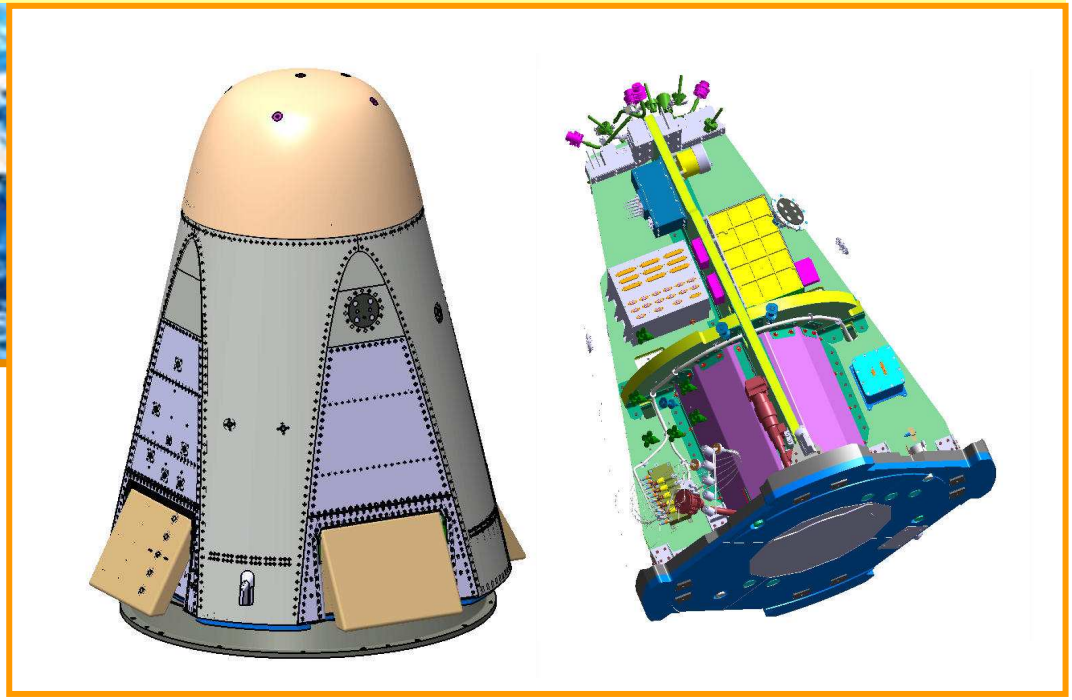
BSSIT

EXPERT

- Flying test bed performing a ballistic sub-orbital flight for demonstration of re-entry technologies and acquisition of in-flight measurements about critical AD/ATD phenomena
- Submarine-launched from Pacific Ocean by Russian Launcher Volna
- ≈120 km apogee trajectory, 5 km/s velocity at entry interface (100 km)

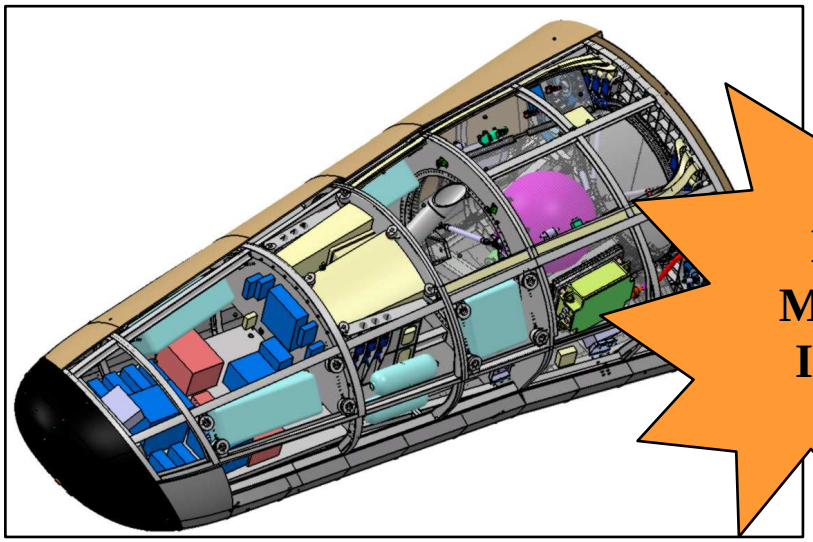


VOLNA MISSION 2011



IXV

- Platform for the experimentation of advanced thermal protections and hot structures as well as GNC and flight control functions in a representative LEO re-entry environment.
- To validate tools and methodologies related to aerothermodynamics phenomena



IXV DEMO MISSION IN 2013

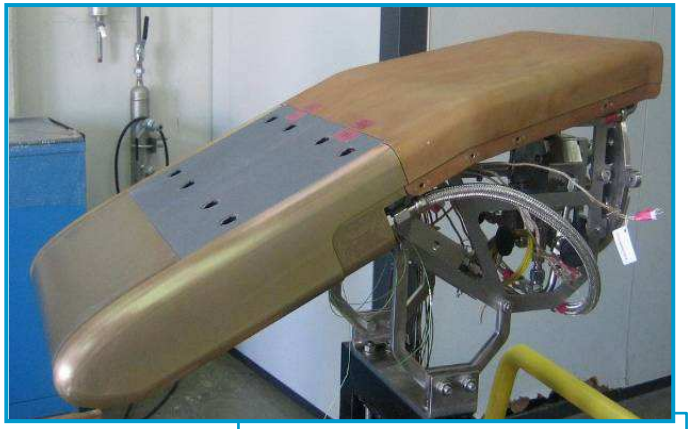
- Entry Speed 7.7 km/s at 120 km
- Suborbital trajectory (5°) Max altittude 480 km
- Launched with VEGA from Kourou
- Splashdown in the Pacific Ocean

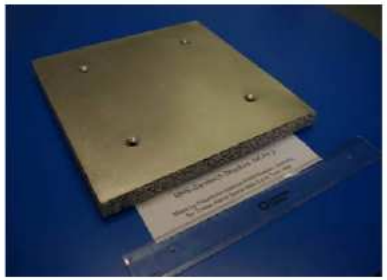
Re-entry technologies

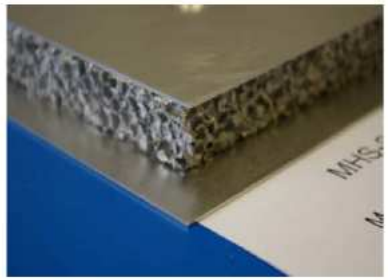
FLPP Materials & Structures – Thermal Protection System (ESA)

CSTS Breadboarding – Ablative TPS (ESA)

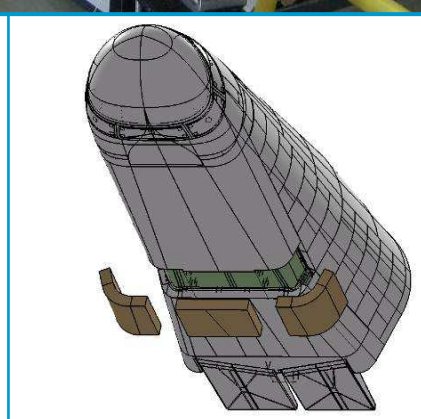
Advanced Structural Assembly (ASA, ASI)





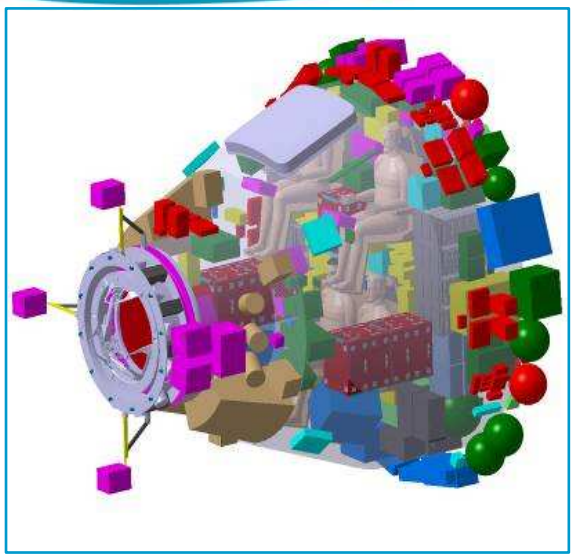


FLPP Materials & Structures - Hollow Sphere Material (ESA)



ASA2 (ASI)

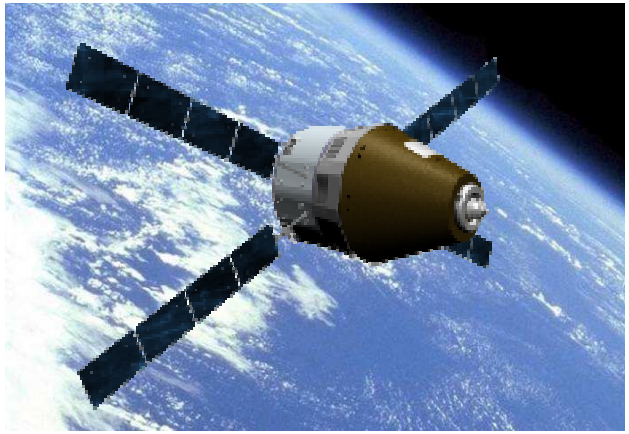
Human transportation systems



Advanced Re-entry Vehicle Phase 0 (ARV, ESA)

Crew Exploration Vehicle – Orion Phase B (CEV, NASA)

Crew Transfer Vehicle Preparatory Phase (CTV, ESA)



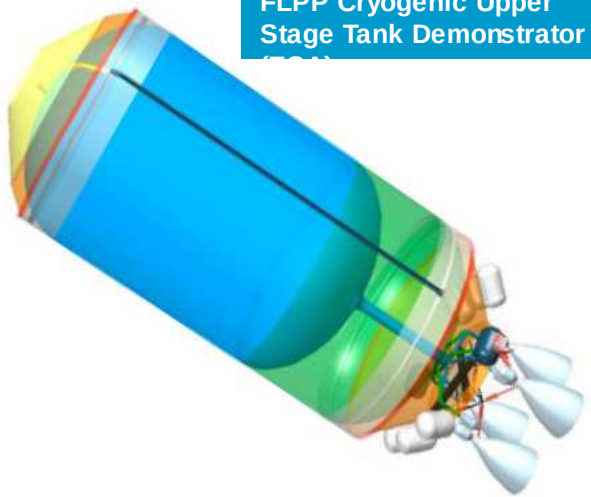
Crew Space Transportation System (CSTS, ESA)

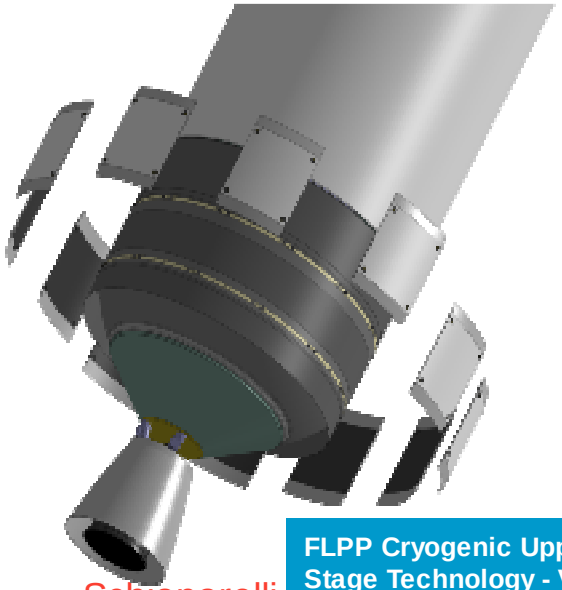
X-38 (ESA / NASA)

Future launchers technologies

FAST2 (ASI) &
Cryogenic Insulation (ESA)

FLPP Cryogenic Upper
Stage Tank Demonstrator





Schiaparelli

FLPP Cryogenic Upper
Stage Technology - Versatile
Thermal Insulation (ESA)

Hybrid Propulsion (ESA)

BSSIT

October 2010

Conclusions

Thales Alenia Space in Torino :

- Is developing as the company Centre of Excellence for Space Exploration
- Is preparing for the technical challenges :
  - Supporting the International Master SEEDS with Politecnico di Torino
  - Through internal research activities and studies for ASI/ESA/EC
  - Developing a suitable networking in the Piedmont Aerospace District with SME, Academies e Research centers (STEPS project)