Life Support Systems validation: from space to ground, and back

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Expert Life Support & Habitability

Domain Exploration & Science Italy

OUR JOB, OUR MISSION

A challenging environment for humans & systems

Cosmic Rays

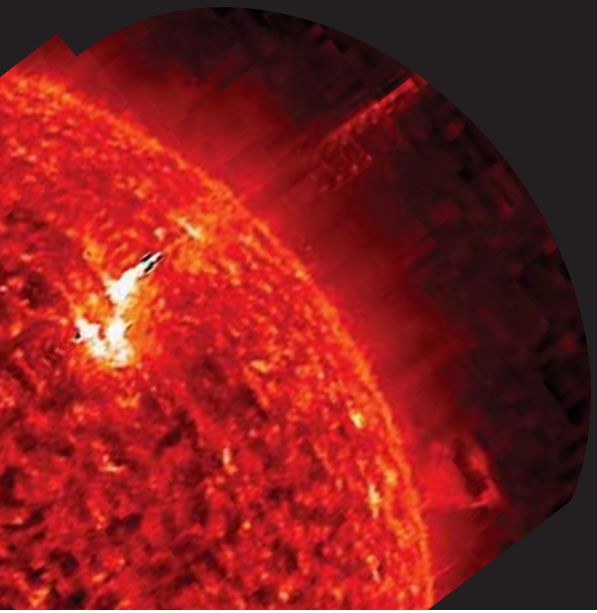
Meteoroids

Altered g

Atmospheres

Dust

Vacuum

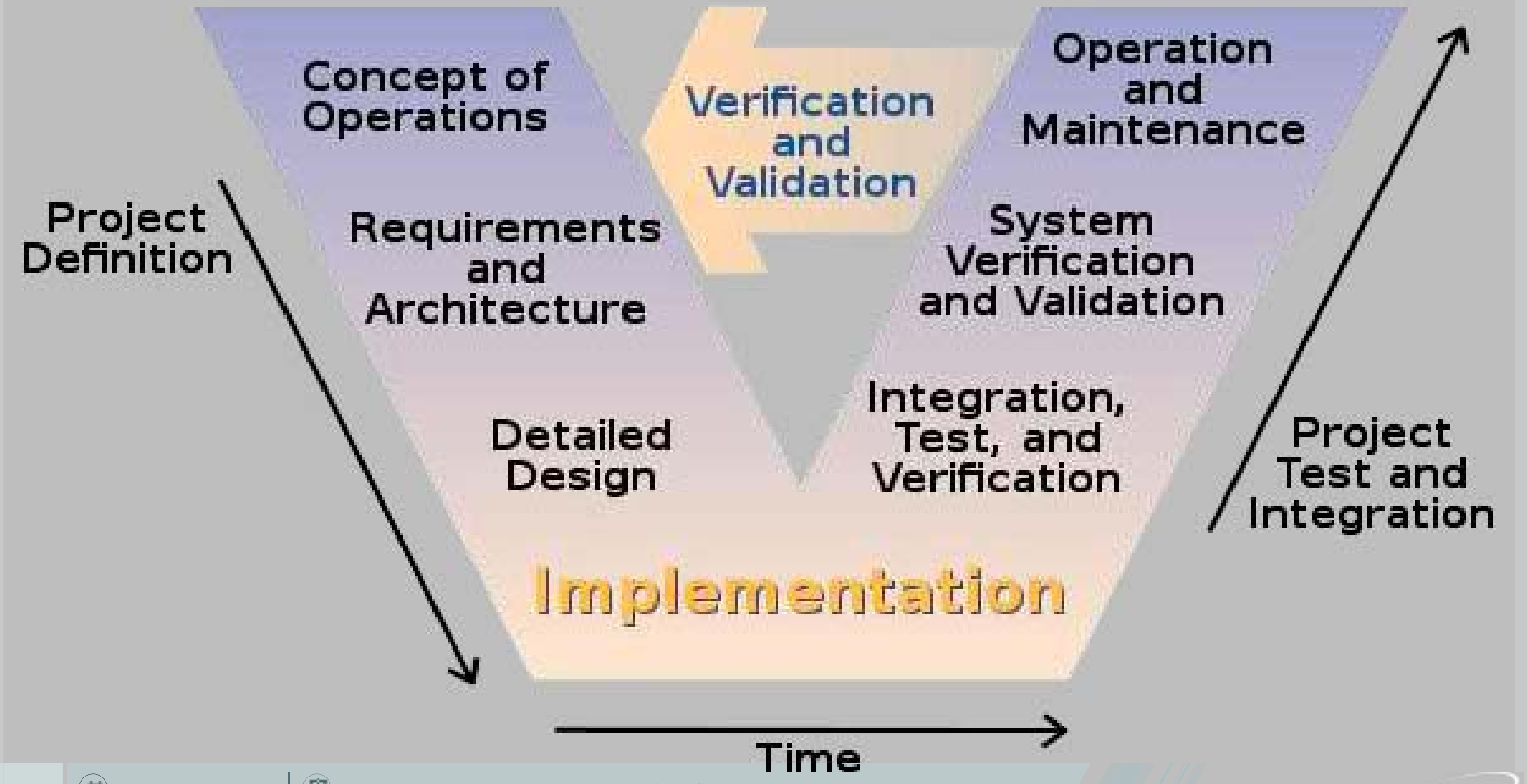


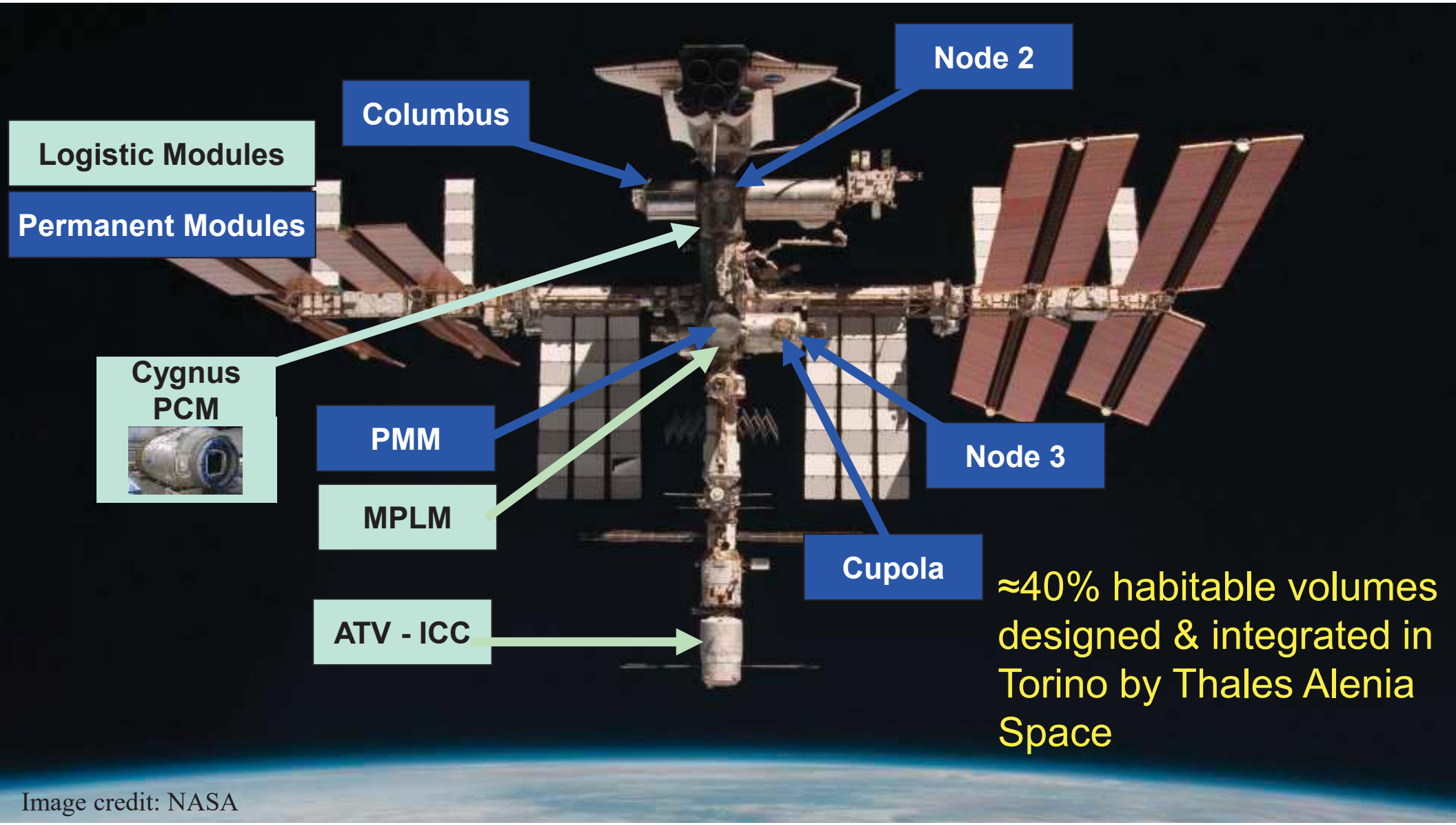
Plasma

Solar Particles

Extensive VERIFICATION

Verification with a capital V




Node 2
Columbus
Logistic Modules
Permanent Modules
Cygnus PCM
PMM
MPLM
Node 3
Cupola
ATV - ICC
≈40% habitable volumes designed & integrated in Torino by Thales Alenia Space
Image credit: NASA

The Nodes: the most complex ISS modules

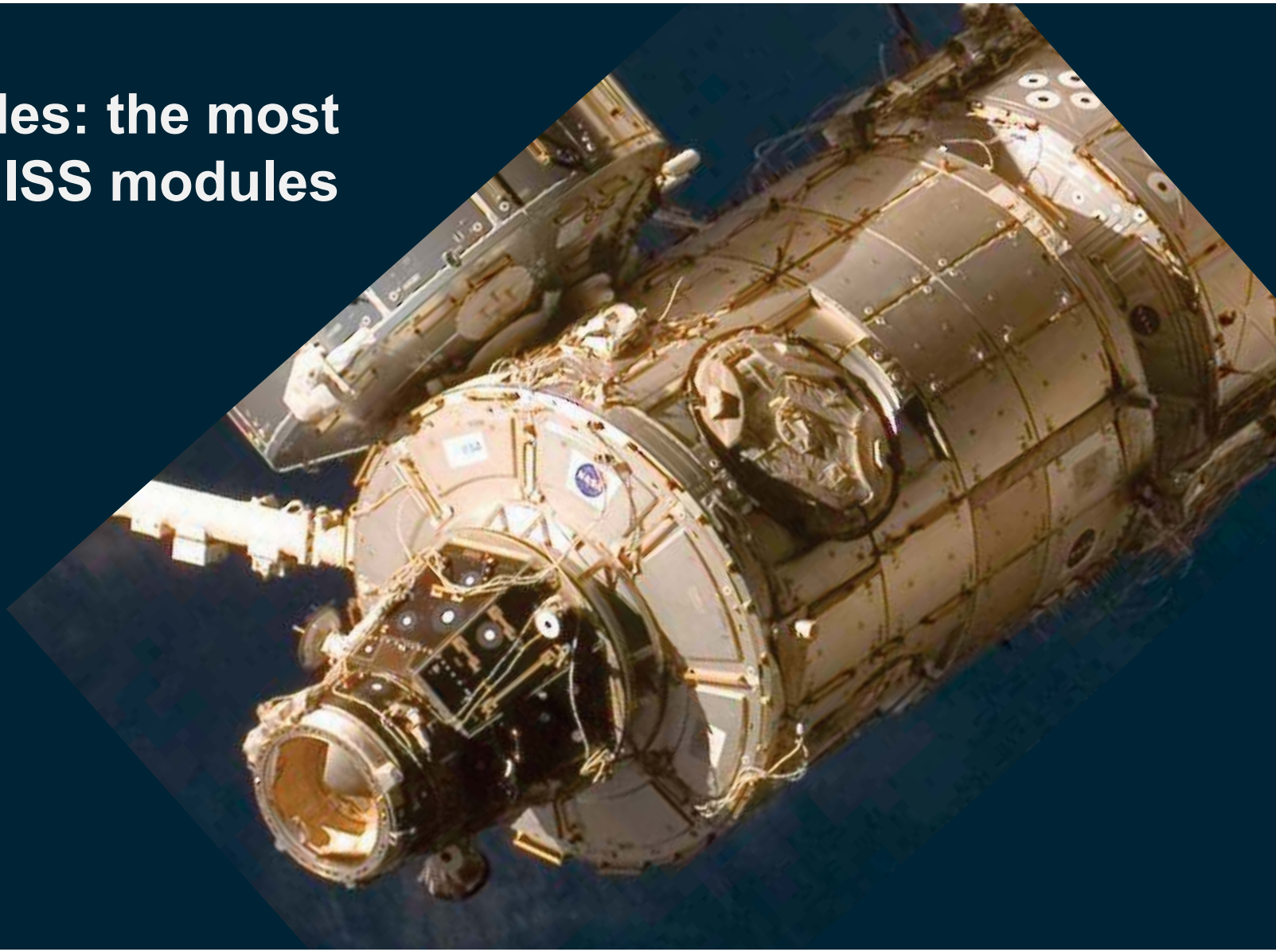


Image credit: NASA

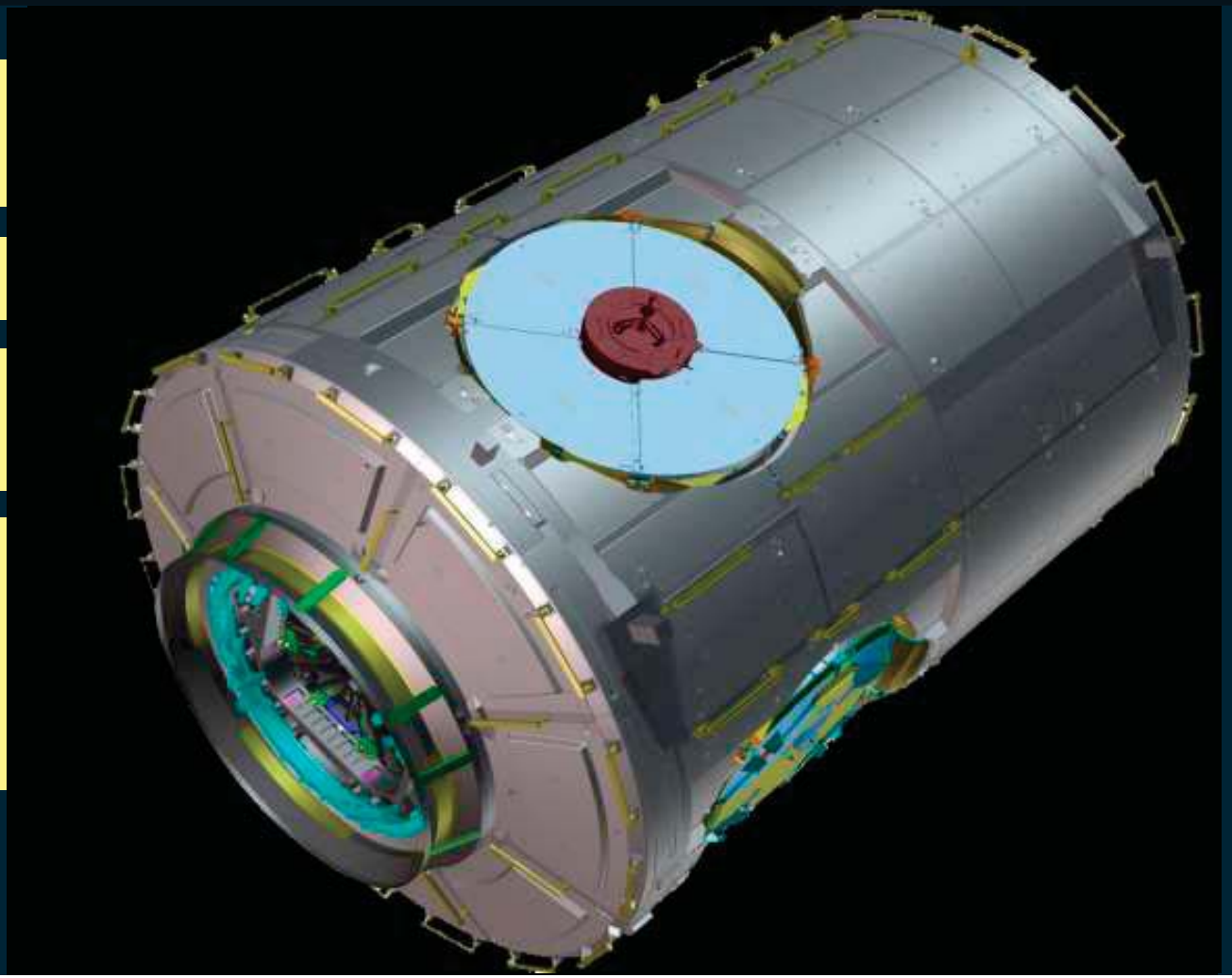
Pressurized Module – structures, passive thermal elements

Micro-meteoroid & Orbital Debris Shielding

Passive Thermal Insulation

Primary Structure Pressurized w/ Hatches

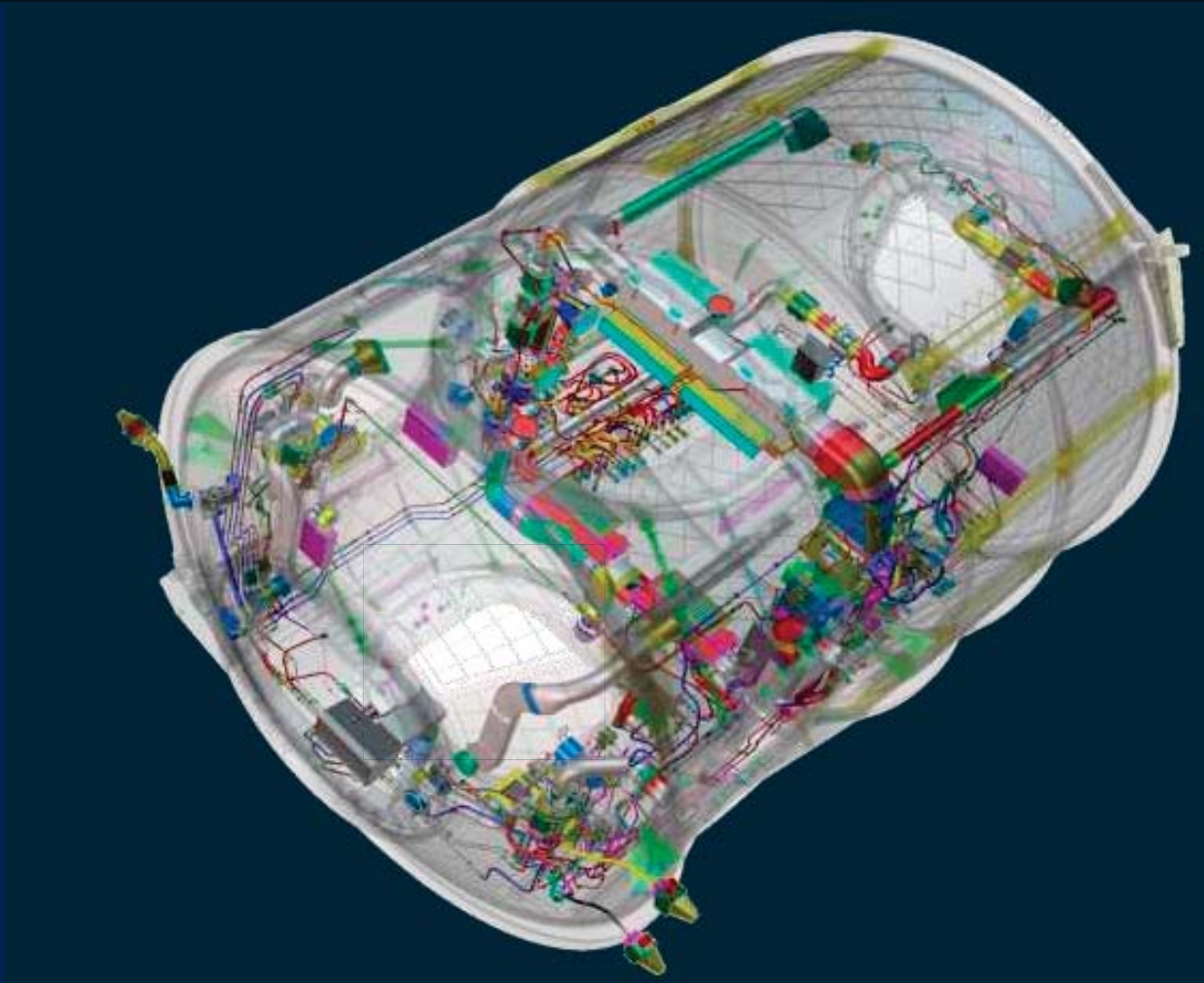
Secondary structures and racks
To accommodate equipment and experiments



Pressurized Module – internal active systems

Environmental Control & Life Support System

- **Cabin Pressurization**
- **Temperature & Humidity Control**
- **Atmosphere purification**
- **Water Management**
- **Fire Detection & Suppression**
- *Integration of NASA Regenerative LS Racks (Node 3)*

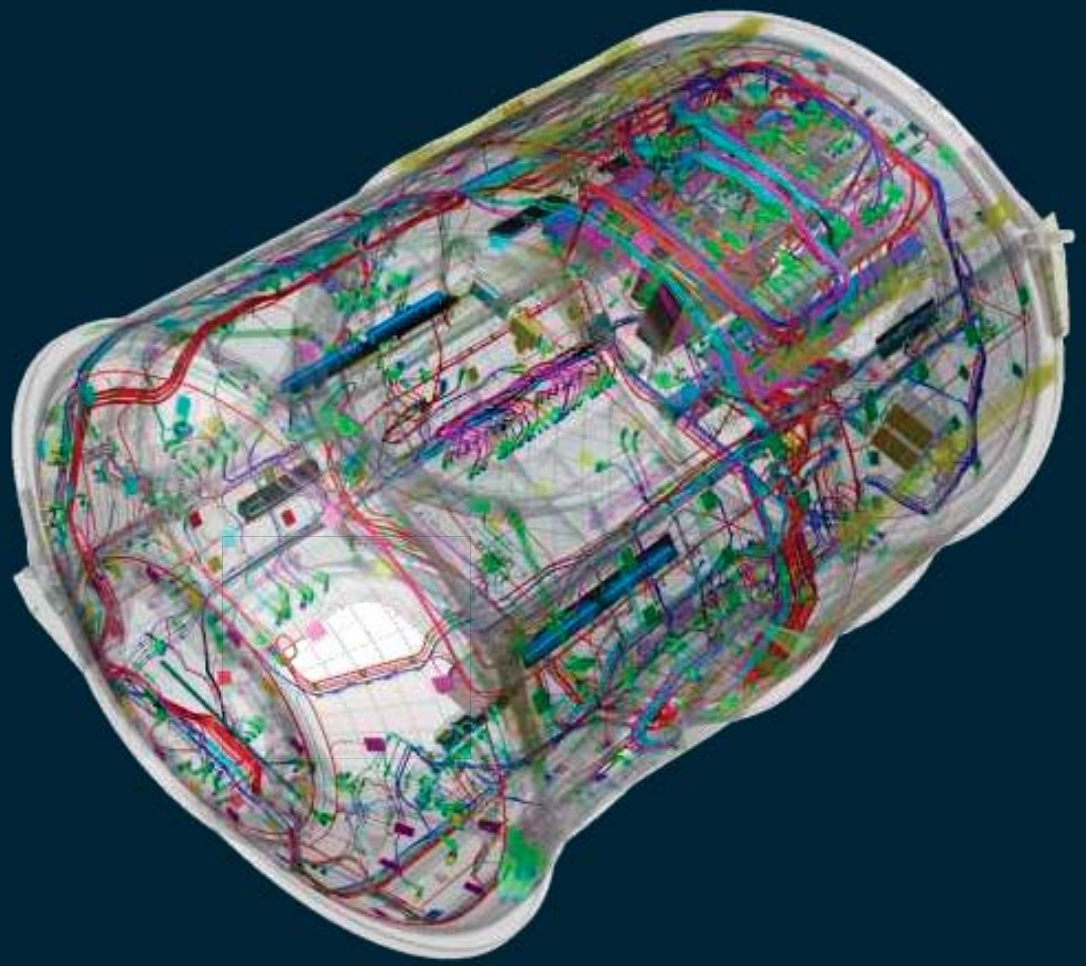


Pressurized Module – internal active systems

Active Thermal Control

Avionics

- Computers
- Audio & video
- Power distribution
- Harness



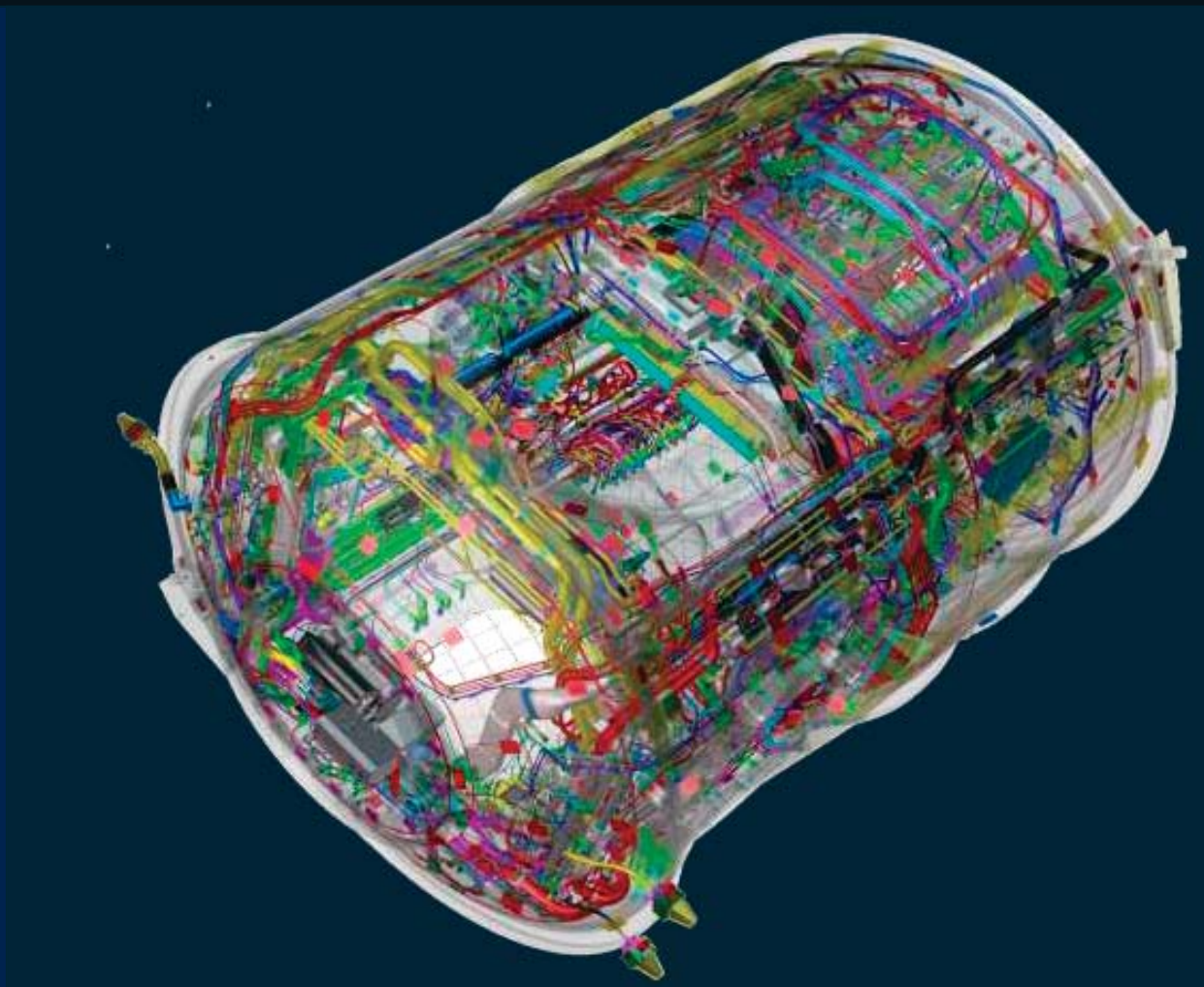
Pressurized Module – internal active systems

Integrated Design

Digital mock-up
virtual reality

Verification:
From component to element levels (on ground)

Validation:
by users (crew) on orbit



NODE 2 HARMONY, 23 october 2007… > 10 years on orbit!

Image credit:
NASA


On orbit human habitats
The Cupola
Controlled p, T, RH, O_2, N_2, CO_2, contaminants
Image credit: NASA

All perfect and ready then?

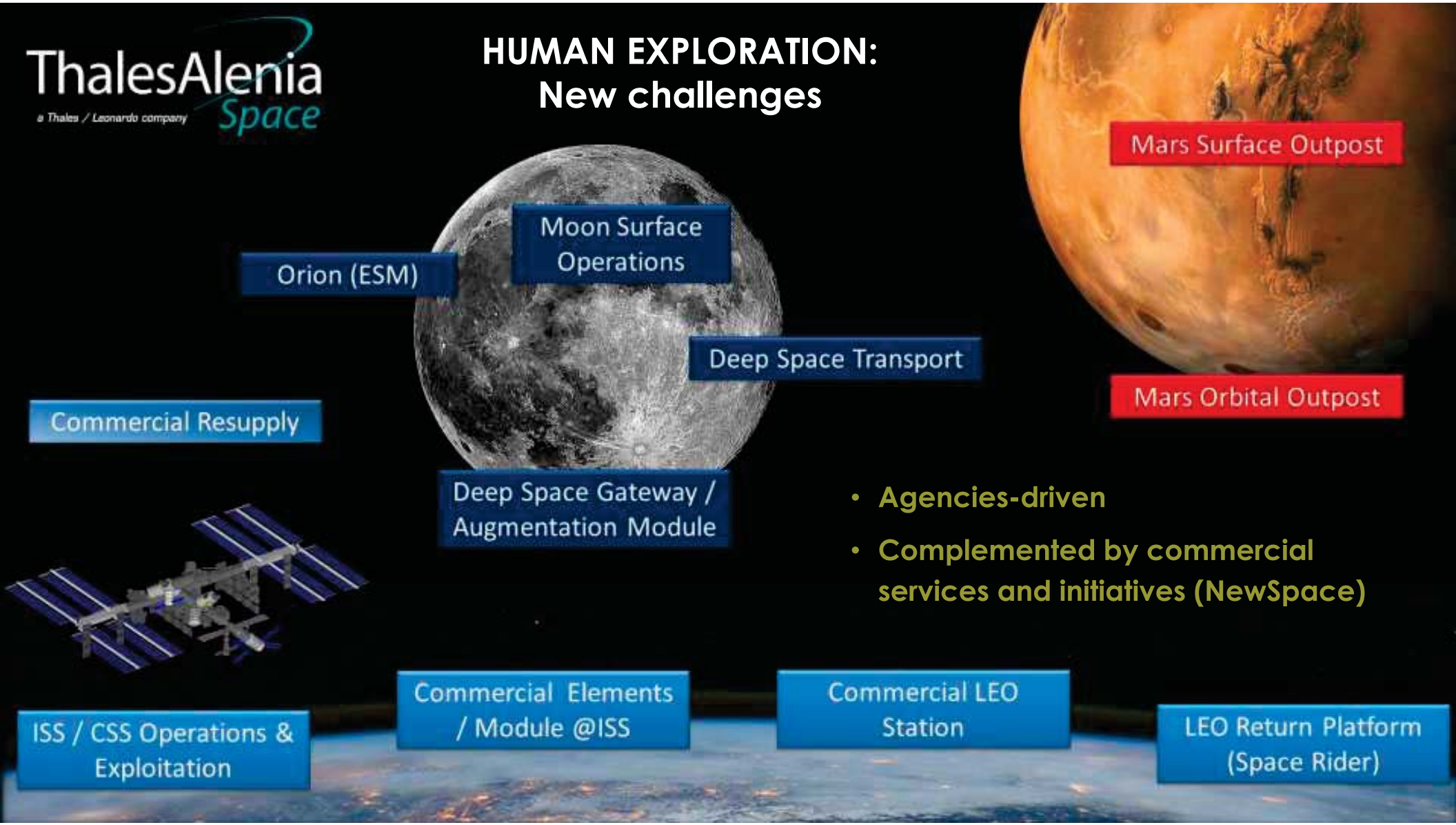
Well…

OPEN

ThalesAlenia Space
A Thales / Finmeccanica Company

ThalesAlenia Space
a Thales / Leonardo company

HUMAN EXPLORATION: New challenges



- **Agencies-driven**
- **Complemented by commercial services and initiatives (NewSpace)**

Humans in deep space / planets:

many technical challenges!

- **radiation**
- **vital resources**
- **distance**
- **habitat volume**

New approaches needed:

Project → Product
Program → Product Line

→ Service

Silo mode → Agile, Lean

Build – Measure – Learn

More demo in-space and analogues

Product / Service: Commercial Resupply Service

NASA

Orbital

NASA COMMERCIAL CREW & CARGO

Cygnus PCM

ThalesAlenia Space

Cygnus at ISS

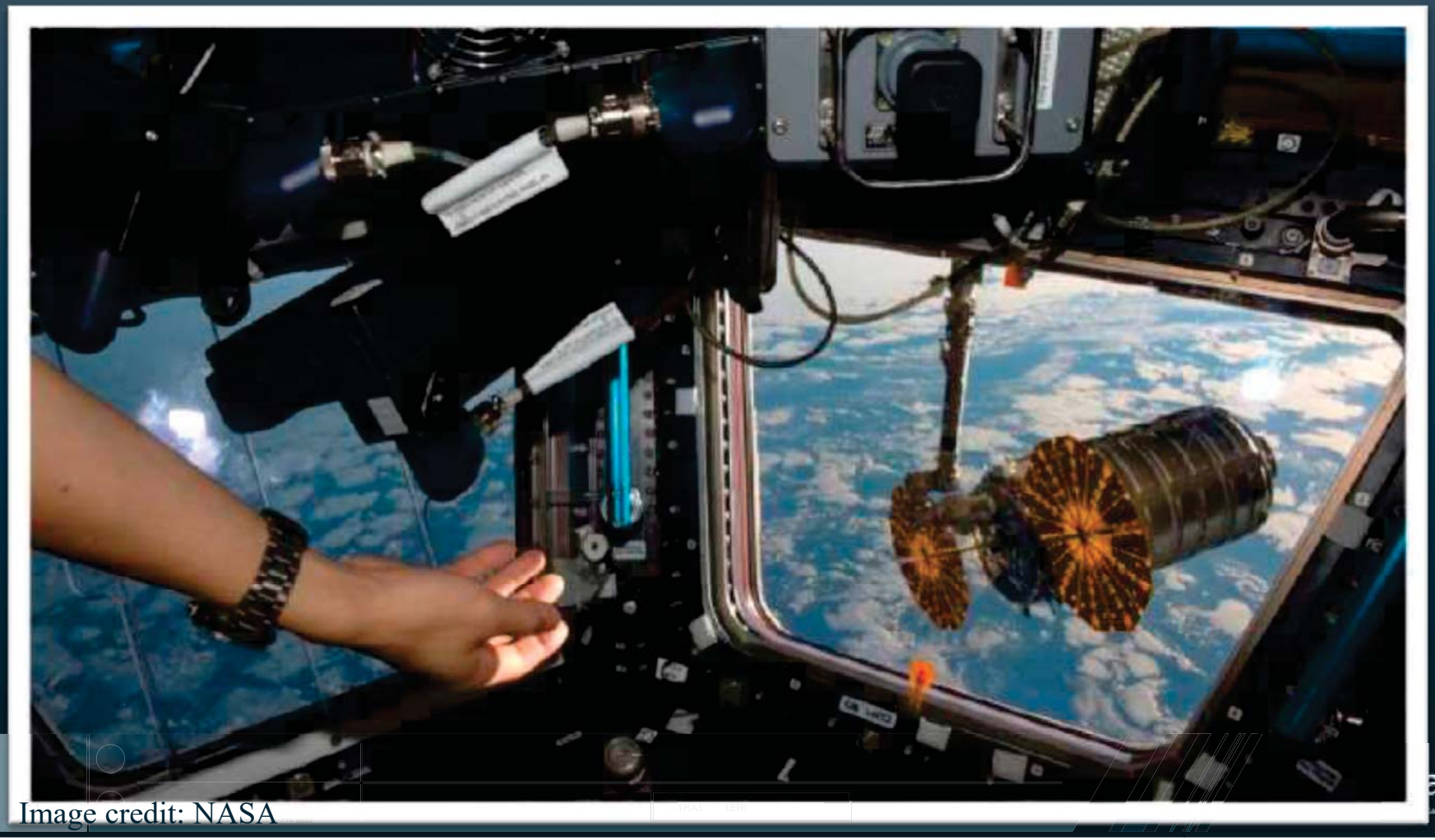


Image credit: NASA

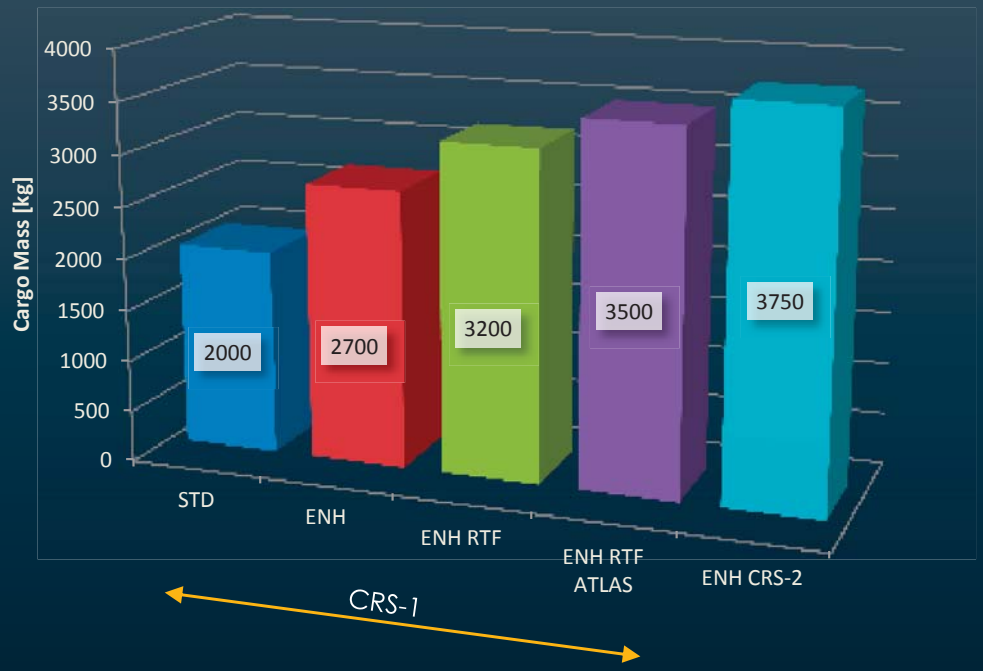
alesAlenia
Space

Cygnus for Cargo Resupply – many flight tests!

COTS-1
- 1 Flight unit
- Flown Sept. 2013

CRS-1
- 11 Flight units
- 9 units completed & delivered
- 1st mission in Jan. 2014 / Last flown in Nov. 2017
- Next planned in Mar. 2018

CRS-2
- 6 Flight units
- Primary structure welding in progress



Constant Cargo Capability Improvement

We are good at making “space silo” but… BEWARE!

SRR

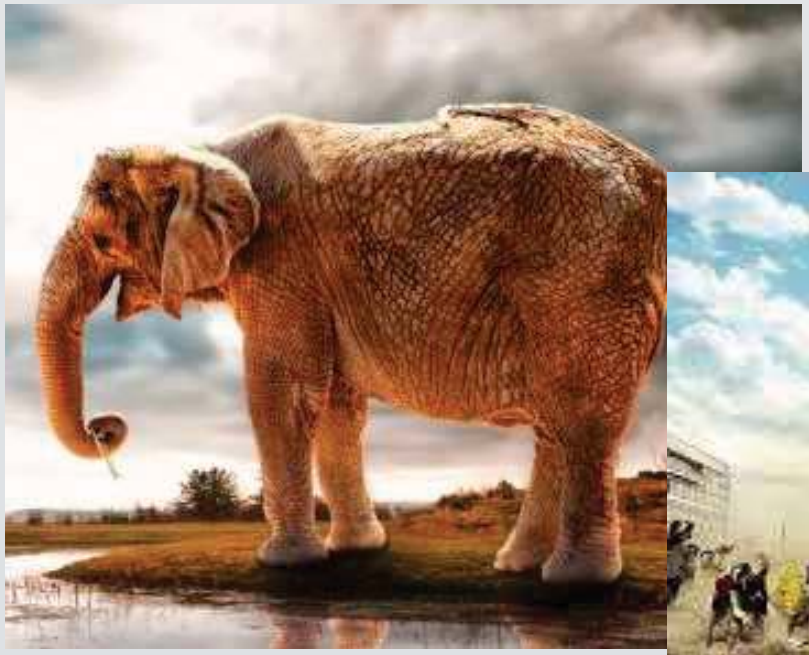
PDR

CDR

QR/FAR

time

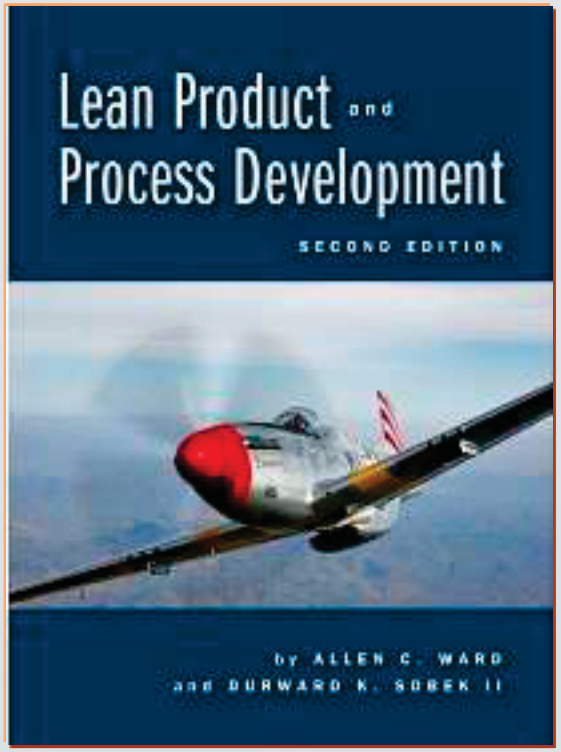
Need to get agile, LEAN

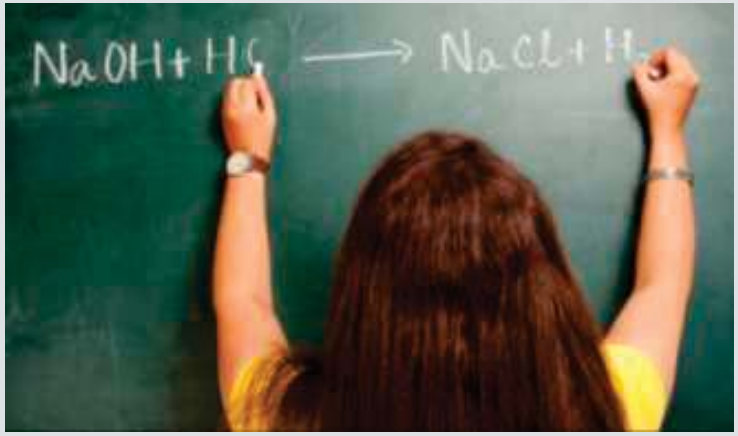


Innovation

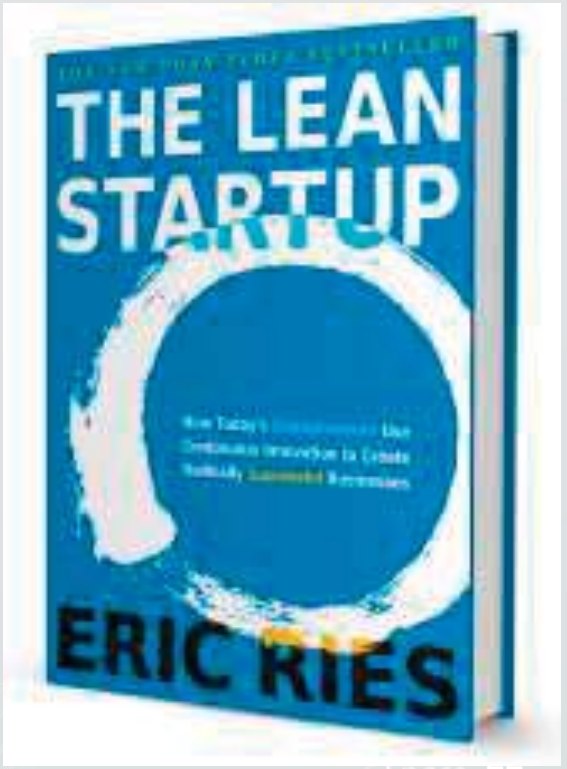
Execution

Need to get agile, LEAN, ambidextrous





Innovation



Execution

Lean Start-up – Minimum Viable Product

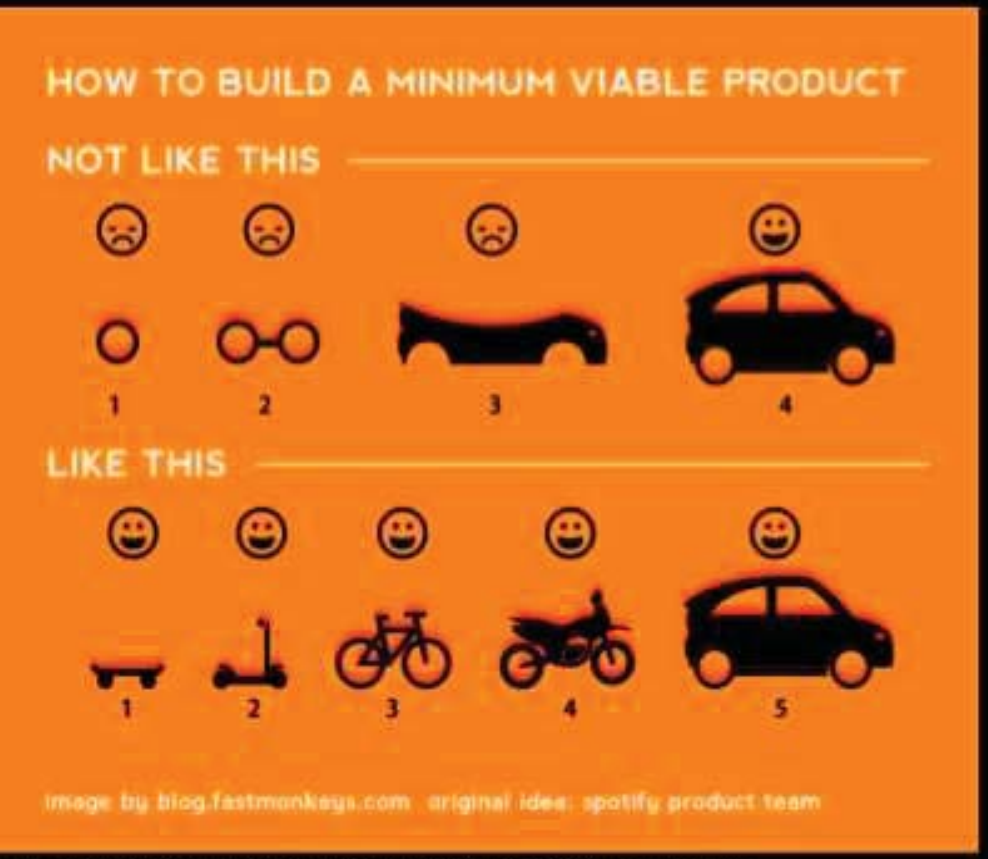
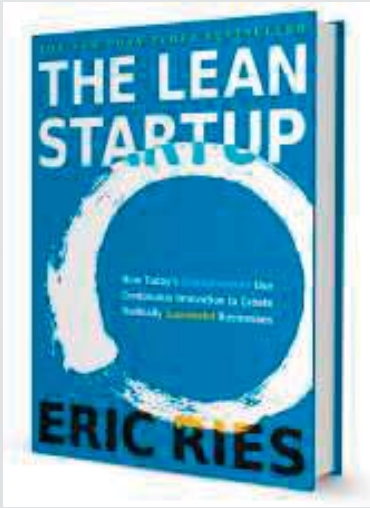
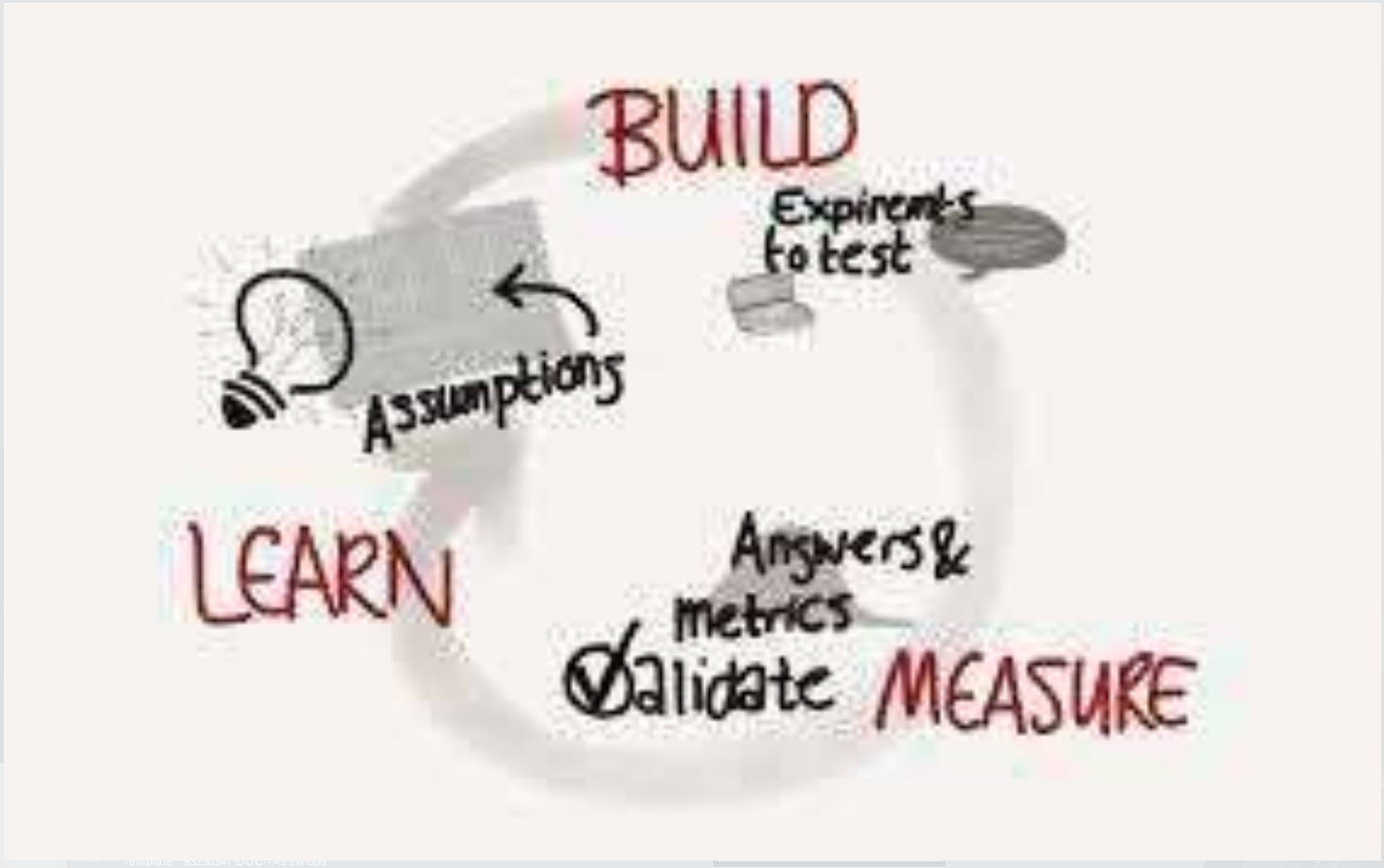


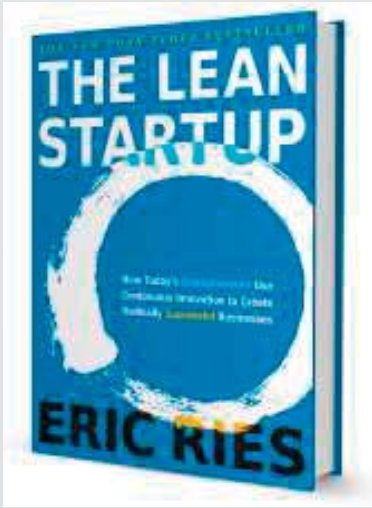
Image (modified) http://blog.fastmonkeys.com/2014/06/18/minimum-viable-product-your-ultimate-guide-to-mvp-great-examples/

Figure out the smallest element of functionality that delivers value to your users, then build and test that. Refine and iterate.



Lean Start-up: Build – Measure – Learn





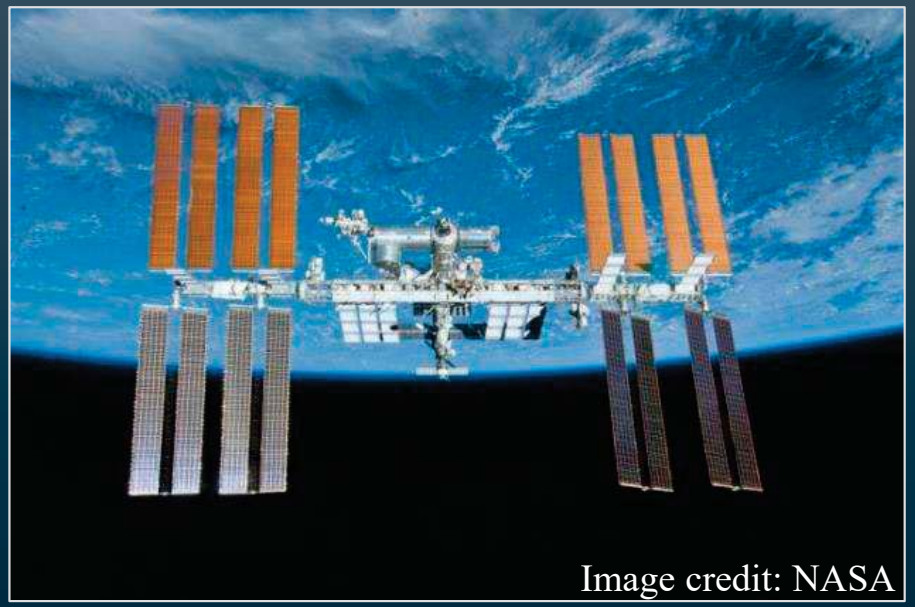
Lean Start-up for overcoming the “TRL Death Valley”

TRL 6/7

More affordable demonstration in space and analogue environments

Credit: Karen Portin, on Flickr

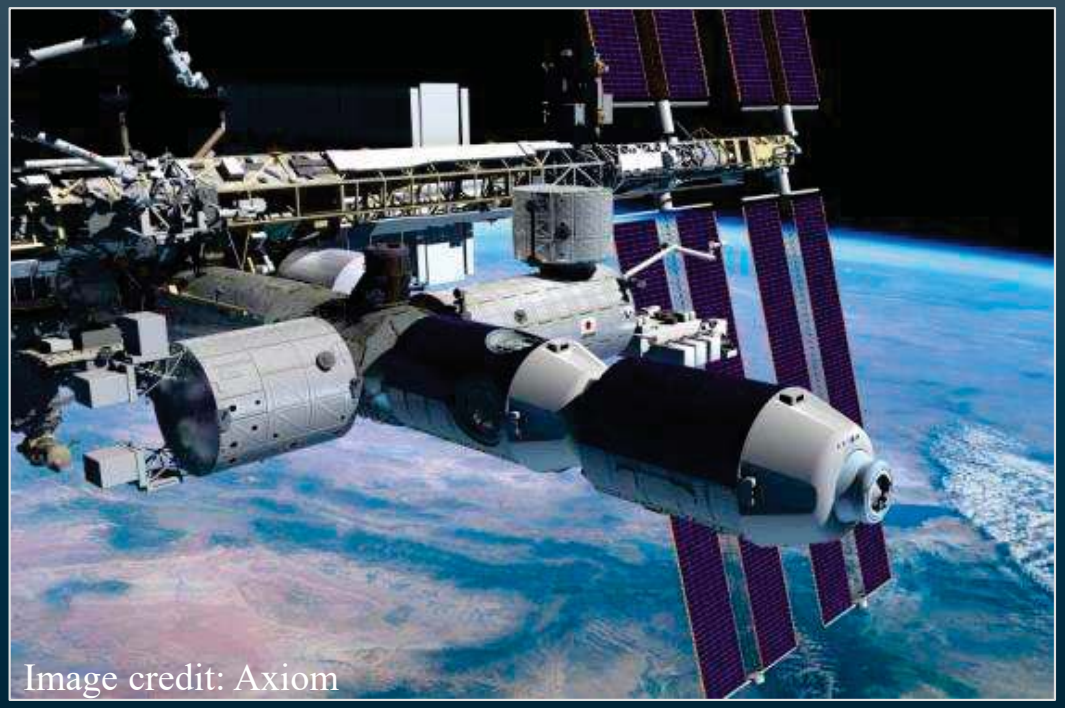
Platforms for On-orbit R&D, Demonstration, Verification



Exploration Technology Validation @ ISS

(ESA, ASI)

Demonstrations in preparation of deep space exploration (PERSEO for crew radiation protection, advanced closed loop environmental control, food production,…)



Commercial LEO Station (Axiom)

Pressurized elements under design by Thales Alenia Space

PERSEO - Personal Radiation Shielding for intErplanetary missiOns

Paolo Nespoli on ISS, November 7th 2017: mission accomplished!

Credit: NASA

Space Station

Image credit: NASA

Veggie

April 13, 2018

Space Station Science Highlights: Week of April 9, 2018

Future: PFPU

Destiny, the U.S. Laboratory aboard the space station.
APThe pink glow from the Veggie plant growth facility in Columbus can be seen ahead in Node 2.

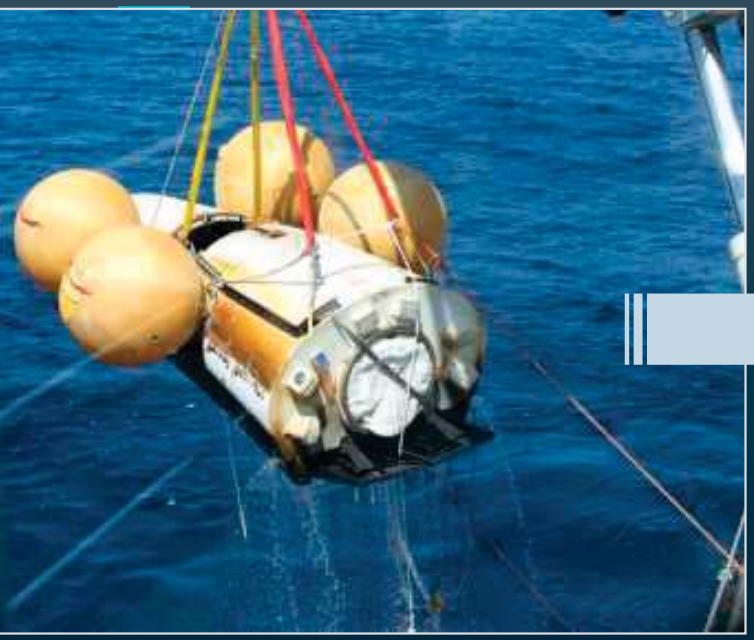
Credits: NASA

05/07/2018

Ref.:

OPEN

Future platforms for On-orbit R&D, Demonstration, Verification



IXV successful demo (Feb 2015)

SpaceRider (ESA)
Orbital and re-entry platform, under development by Thales Alenia Space and AVIO

Exploration of moon and Mars surface

Resupply mass / cost / distance

Stock resources

Regenerate air and water via phys/chem tech

Produce food Bioregenerative

Exploit analogue environments

The PIUME product line

Thanks for your attention!