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Politecnico di Torino

La QUALITÀ nell'AEROSPACE

Le sfide e i risultati

4-5 MAGGIO 2023
Politecnico di Torino

The International Habitat for Gateway Cislunar man-tended station TAS contribution: overview and safety approach

Abele Quaregna – Miriam Burrone

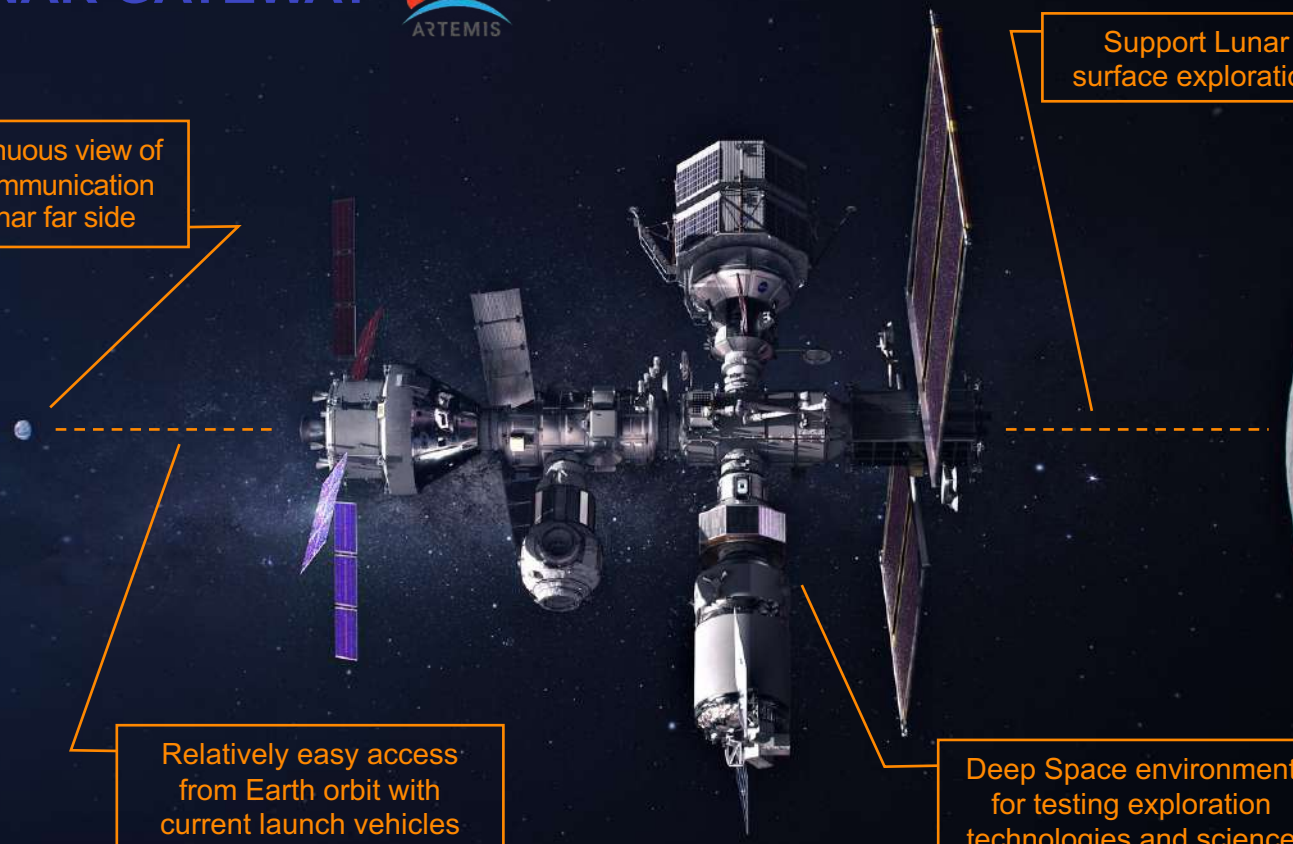
THALES ALENIA SPACE

CISLUNAR GATEWAY

ARTEMIS

Provide continuous view of Earth and communication relay for Lunar far side

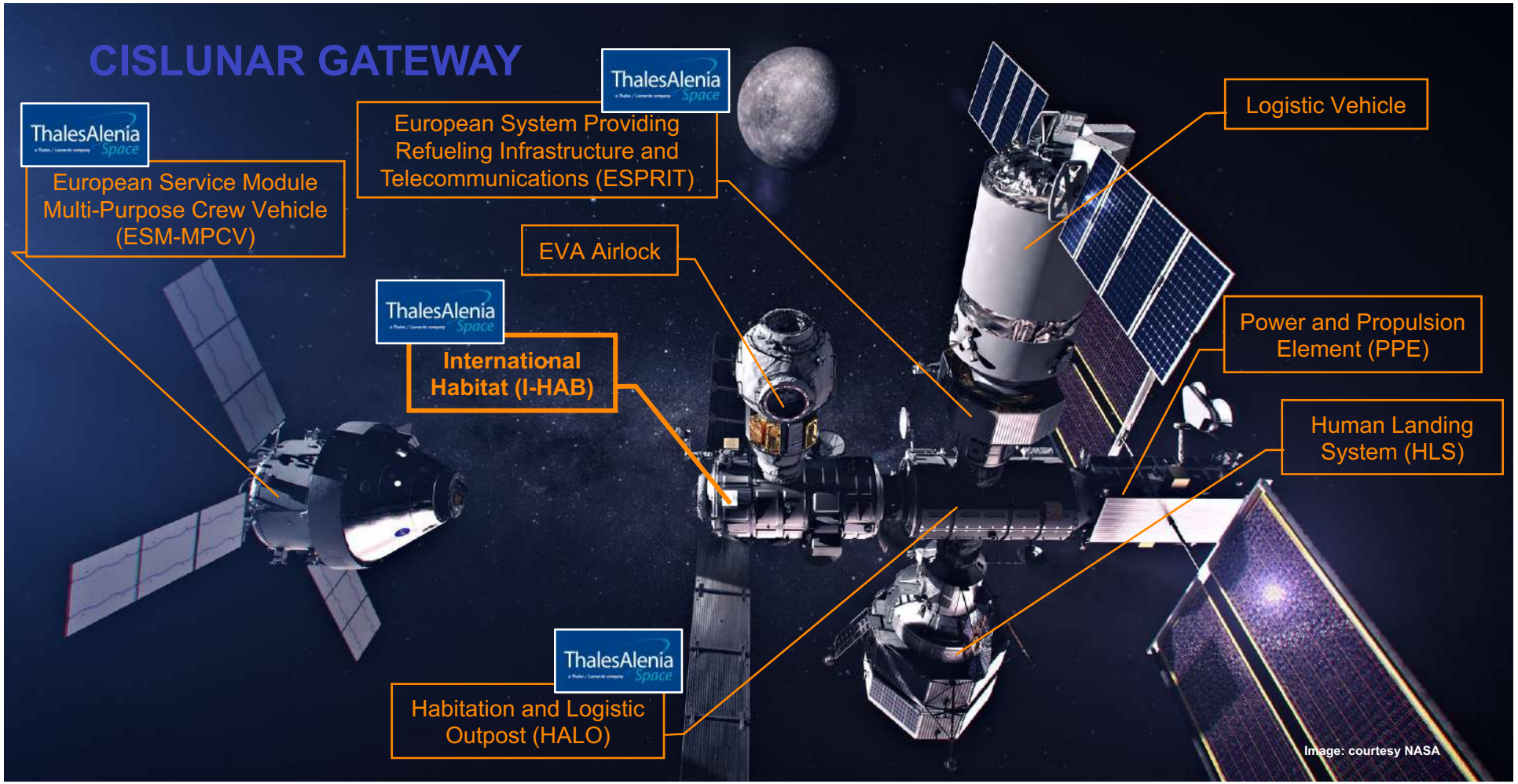
Support Lunar surface exploration



Relatively easy access from Earth orbit with current launch vehicles

Deep Space environment for testing exploration technologies and science

Image: courtesy NASA


CISLUNAR GATEWAY
ThalesAlenia Space
European Service Module Multi-Purpose Crew Vehicle (ESM-MPCV)
ThalesAlenia Space
European System Providing Refueling Infrastructure and Telecommunications (ESPRIT)
EVA Airlock
ThalesAlenia Space
International Habitat (I-HAB)
ThalesAlenia Space
Habitation and Logistic Outpost (HALO)
Logistic Vehicle
Power and Propulsion Element (PPE)
Human Landing System (HLS)
Image: courtesy NASA

La QUALITÀ nell'AEROSPACE

Le sfide e i risultati

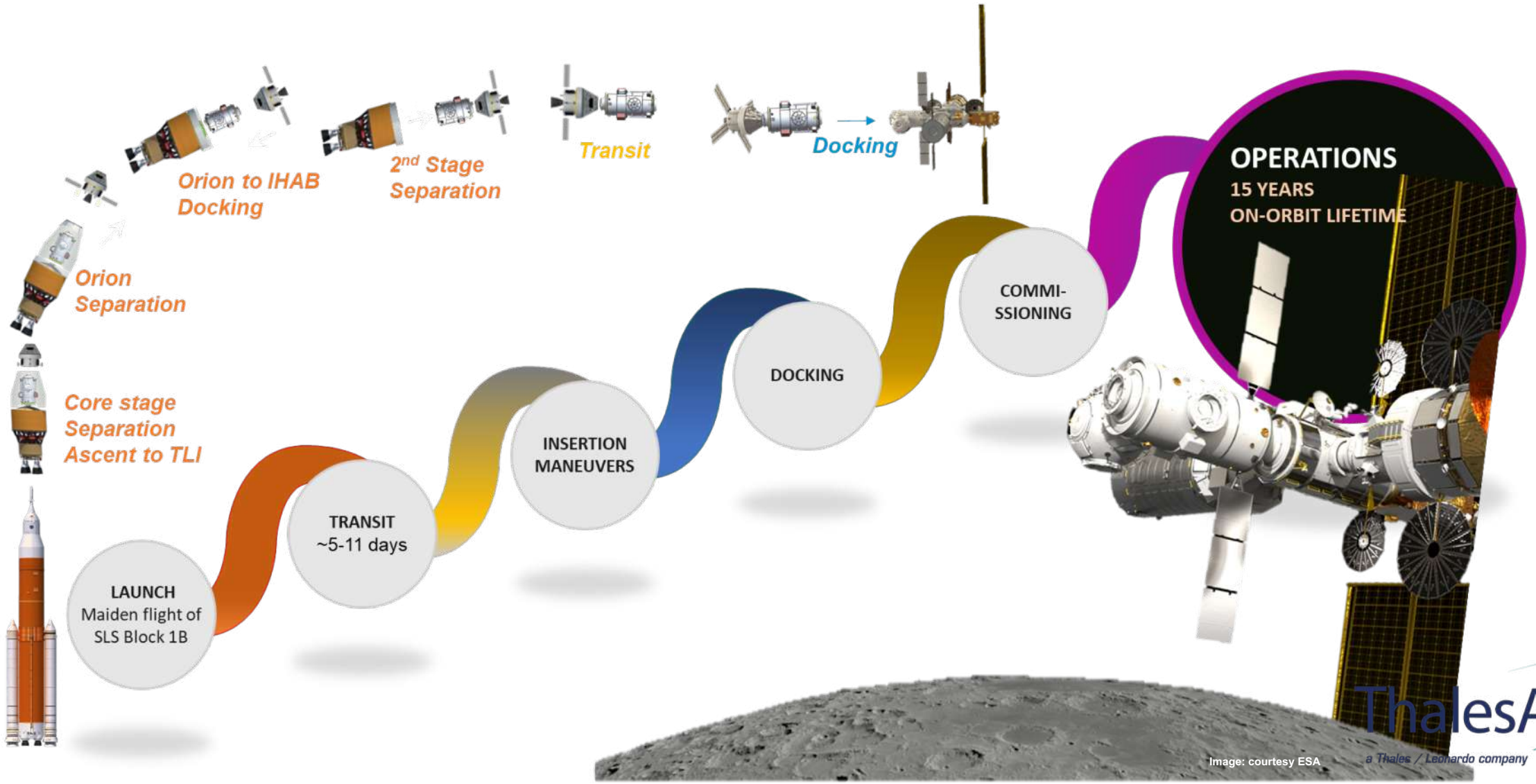


Image: courtesy ESA

La QUALITÀ nell'AEROSPACE

Le sfide e i risultati

Customer: European Space Agency

End User: NASA

Industrial consortium:

Core Team

ITALY

- TAS in Italy: **Prime Contractor**

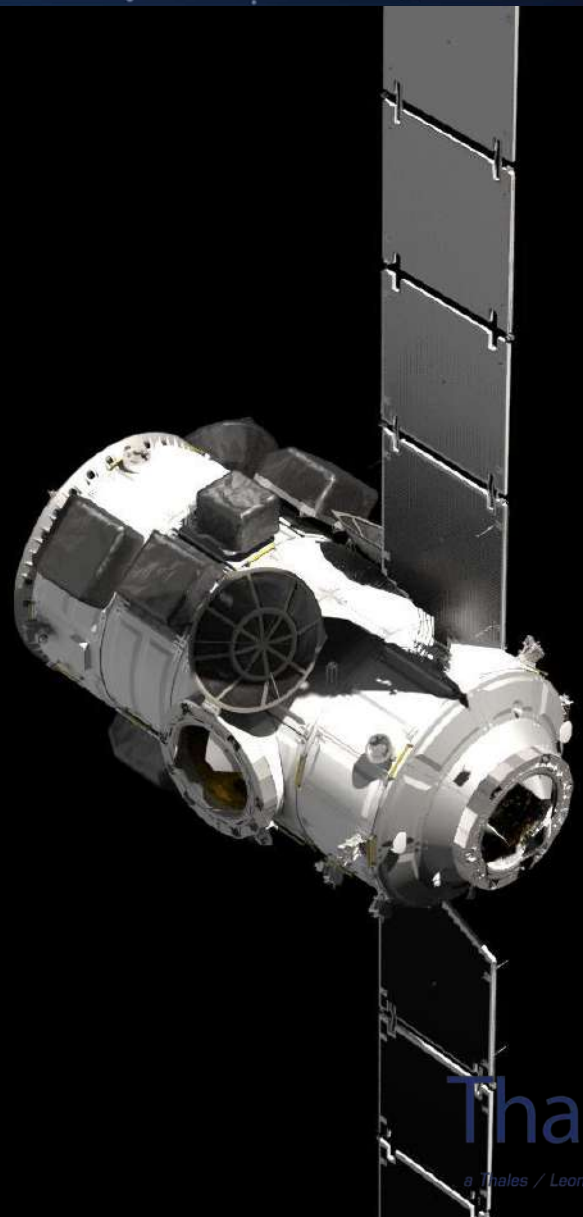
FRANCE

- TAS in France

AUSTRIA | **BELGIUM** | **CZECH REPUBLIC** | **GERMANY**

NETHERLANDS | **POLAND** | **ROMANIA** | **SPAIN**

SWITZERLAND | **UNITED KINDOM** | **ITALY** | **FRANCE**



Common Equipment

Ext. Robotics I/F

ECLSS Subsystem
Batteries
Cameras

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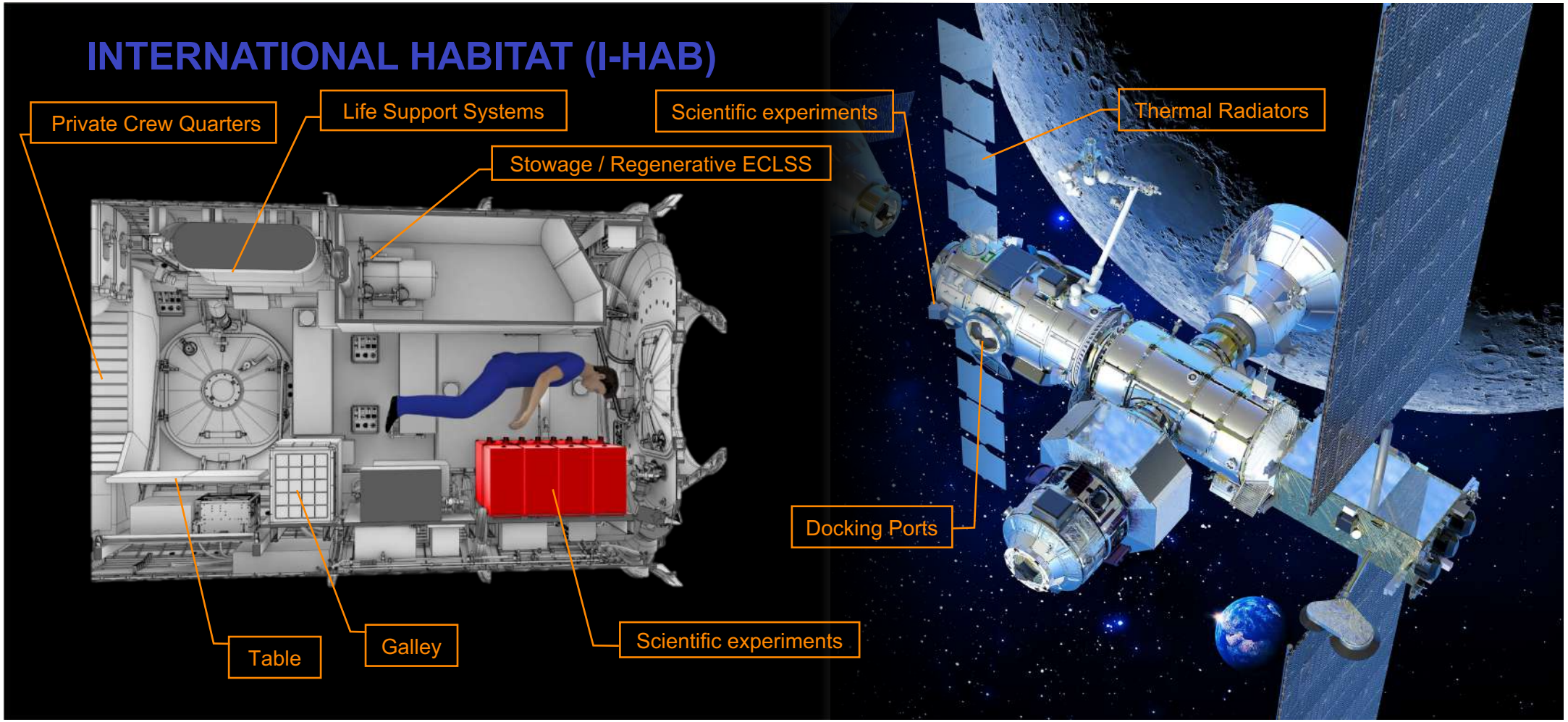
INTERNATIONAL HABITAT (I-HAB)



GATEWAY vs ISS Concept of Operations: safety and mission assurance impacts

GATEWAY	ISS
Mostly **uncrewed**	**Continually** crewed
Near Rectilinear Halo Orbit: 400K Km distance	**Low-Earth** Orbit: 400 Km distance
Pressurized volume: <**125 m³**	Pressurized volume: <**920 m³**
Deep Space Radiation environment	Earth's **magnetosphere shielding**
Lunar Dust Presence	**No Lunar Dust** presence

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GATEWAY Safety Approach: objective and philosophy

OVERALL OBJECTIVE

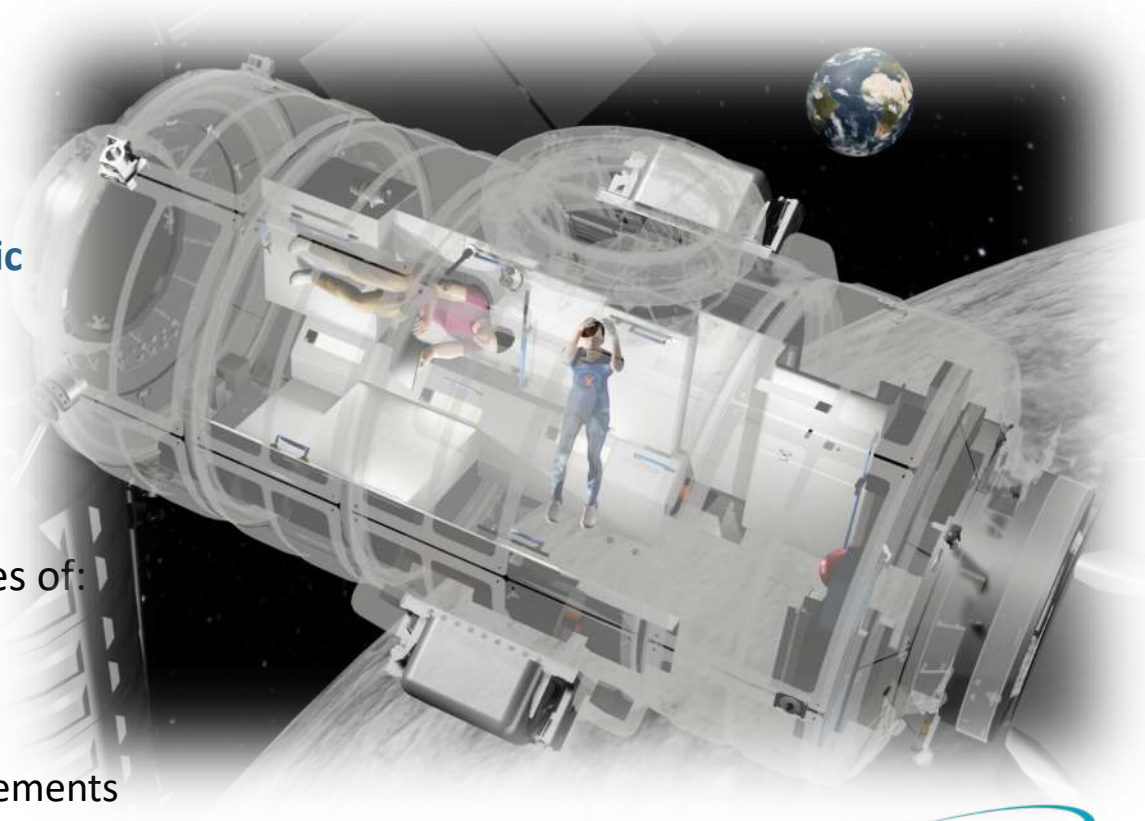
Safest practical design to accomplish the mission.

SAFETY PHILOSOPHY

Failure Tolerance as primary hazard control strategy against **catastrophic hazards**: loss of crew/loss of Gateway.

SAFETY REQUIREMENTS EVOLUTION

- ISS Program: tolerance to the "**combination of two failures**"
- Gateway Program: tolerance to "**at least a single failure**" on the bases of:
  - Improved confidence in hardware performance in space
  - Acquired knowledge on design robustness
  - Strict development and verification requirements (i.e., CBCS requirements for SW)



GP 10000 and GP10024 vs SSP 51721 Standard

GATEWAY Safety Approach

Safety analyses per **closed-loop approach** on design process:

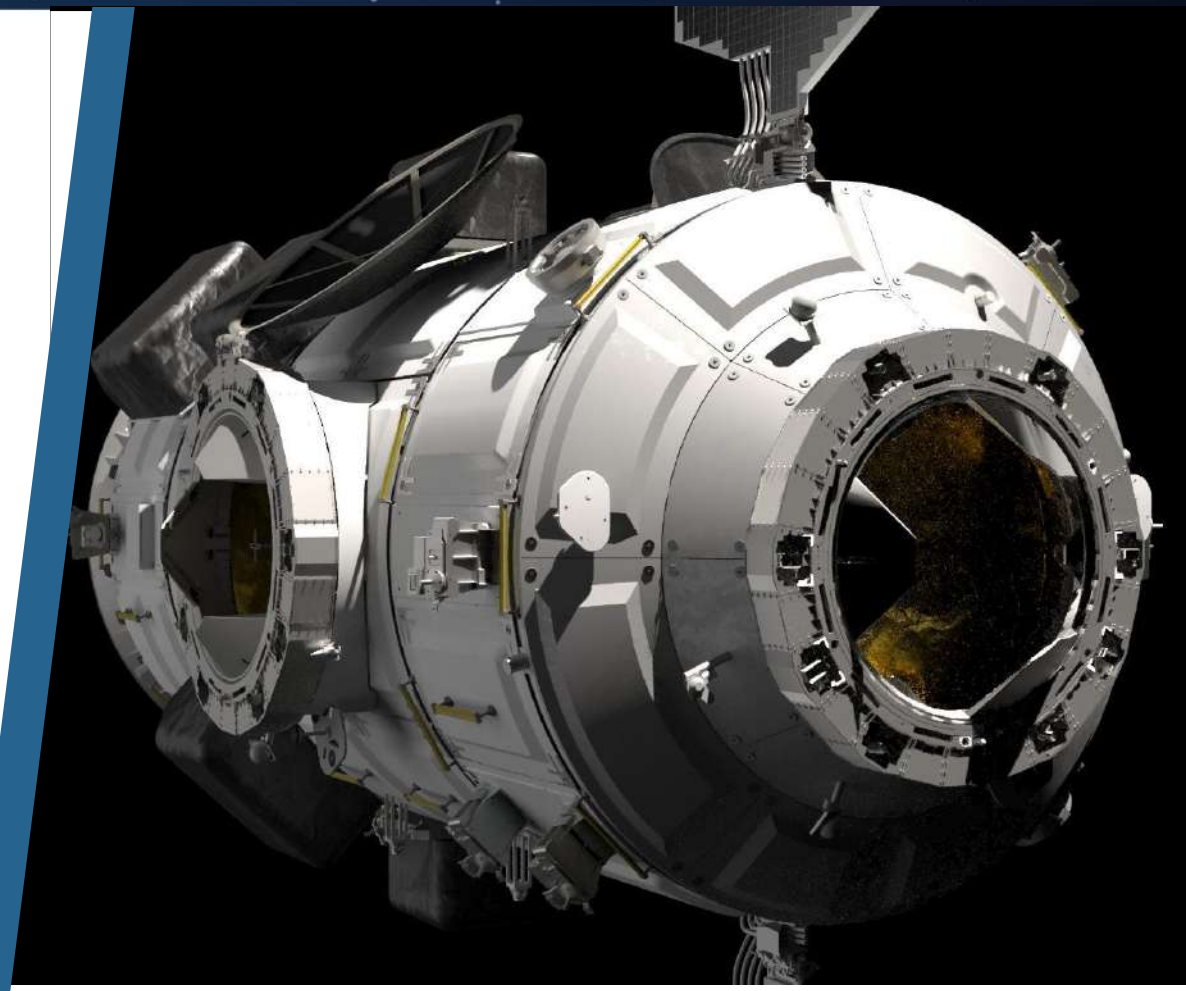
hazards controlled and residual acceptable risk.

Hazard Reports provide vital information on hazard control strategy, as risk acceptance documents.

Risk-informed approach:

structured technical rationale for acceptability of a design not failure tolerant is requested direct into the Hazard Reports.

Residual **risk** accurate
characterization
and **communication**



GATEWAY Safety Approach

The specific data required to justify a failure tolerance deviation, named "**Exemption**", will depend on the specific hazard cause for which the deviation is raised.

The information required as **technical merits for the acceptability** rationale shall address to more than 12 topics, as brief example:

a) Why is an exemption needed?

b) What is the duration of exposure to the hazard?

c) What is the time to effect?

d) […].

e) What information supports producibility of the design within acceptable risk?

f) Address any operational limitations or requirements for humans to control the hazard.

g) Address ability to repair within time to effect, with margin.

GATEWAY Safety Approach

Process for the approval of the safety analyses:

3-Phased Safety Review: Phase 0/I, Phase II and Phase III for both Flight and Ground Safety

Safety and Technical Autorithy: **Gateway ESA Safety Review Panel GESRP**

Co-Participation to the Safety Reviews of:

- **NASA** Gateway Integrated Safety Review Panel **GISRP.**
- Gateway **JAXA** Safety Review Panel **GJSRP**.
- Gateway **CSA** Safety Review Panel **GCSRP**.
- NASA **SLS/EGS** combined Payload Safety Review Panel **PSRP**.

I-HAB Safety Review Process and Activities

Phase 0/I Flight Safety Review:

done in 2021, 67 Hazard Reports submitted: ~340 Hazard Causes, 1020 Hazard Controls identified

Delta Phase 0/I Flight Safety Review:

to close Phase 0/1 Flight SR, ongoing in 2023

5 Safety Review Meetings planned, addressing 7-10 Hazard reports each

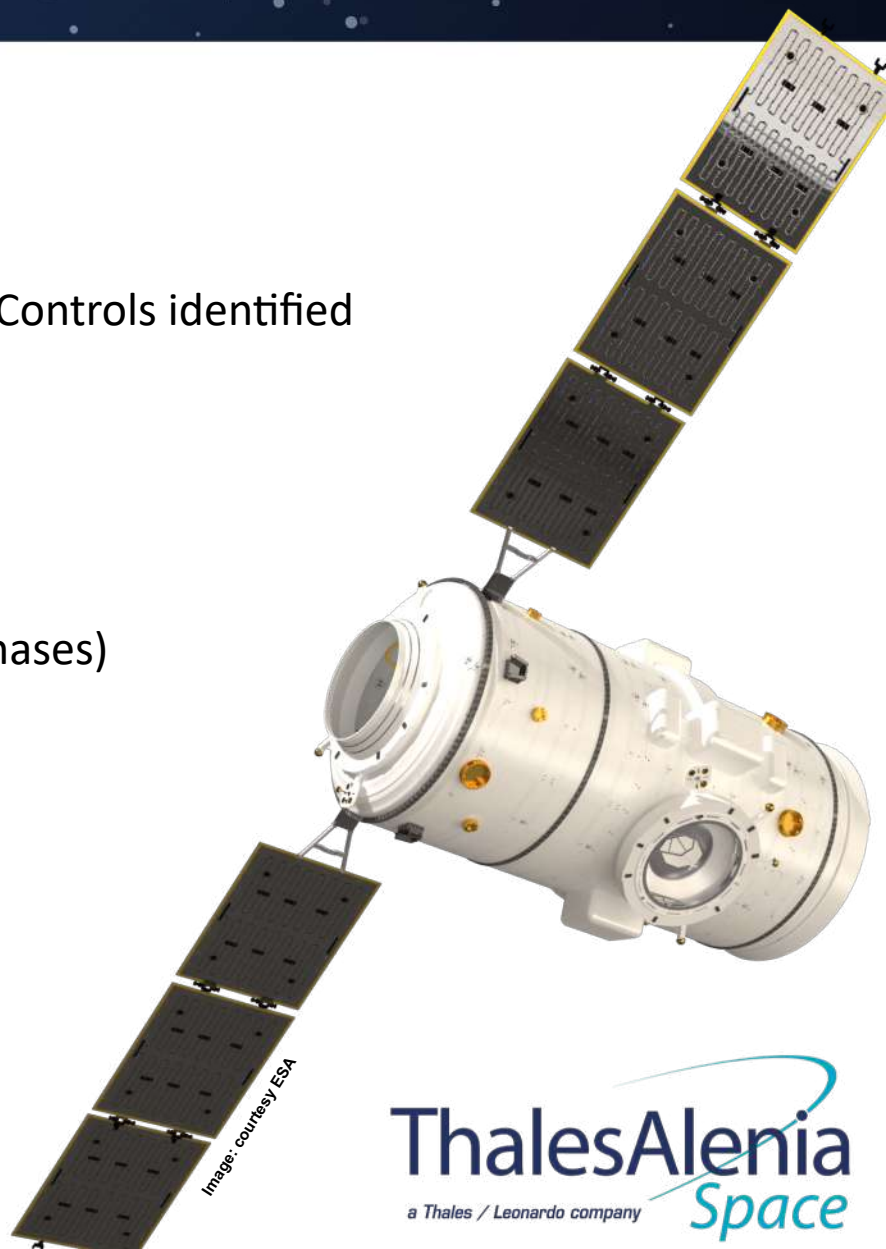
- **Hazard Reports** drafted: **43** (grouped version for Crewed and Uncrewed Phases)
- **Hazard Causes** Analyzed: ~ **270**
- **Hazard Controls** Identified: ~ **810**
- **Panel members**: **70-80** safety and subject matter **experts**

Phase 0/I Ground Safety Review:

planned in middle 2023, 28 Hazard Reports drafted:

~150 Hazard Causes, 375 Hazard Controls identified

All this activity to provide the safest design achievable for crewed missions.



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THANKS FOR YOUR ATTENTION