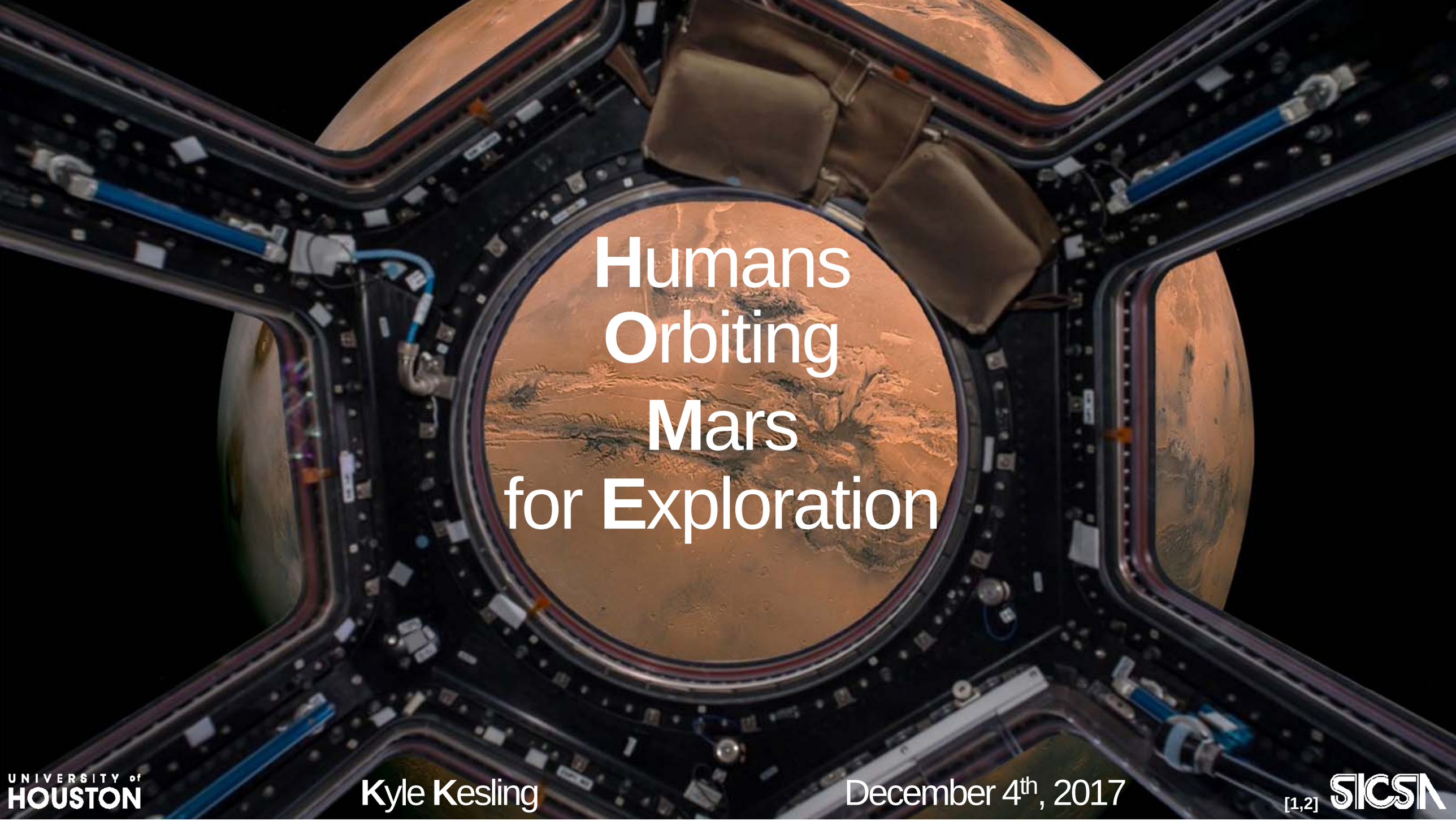


Humans **O**rbiting **M**ars for **E**xploration

UNIVERSITY of HOUSTON

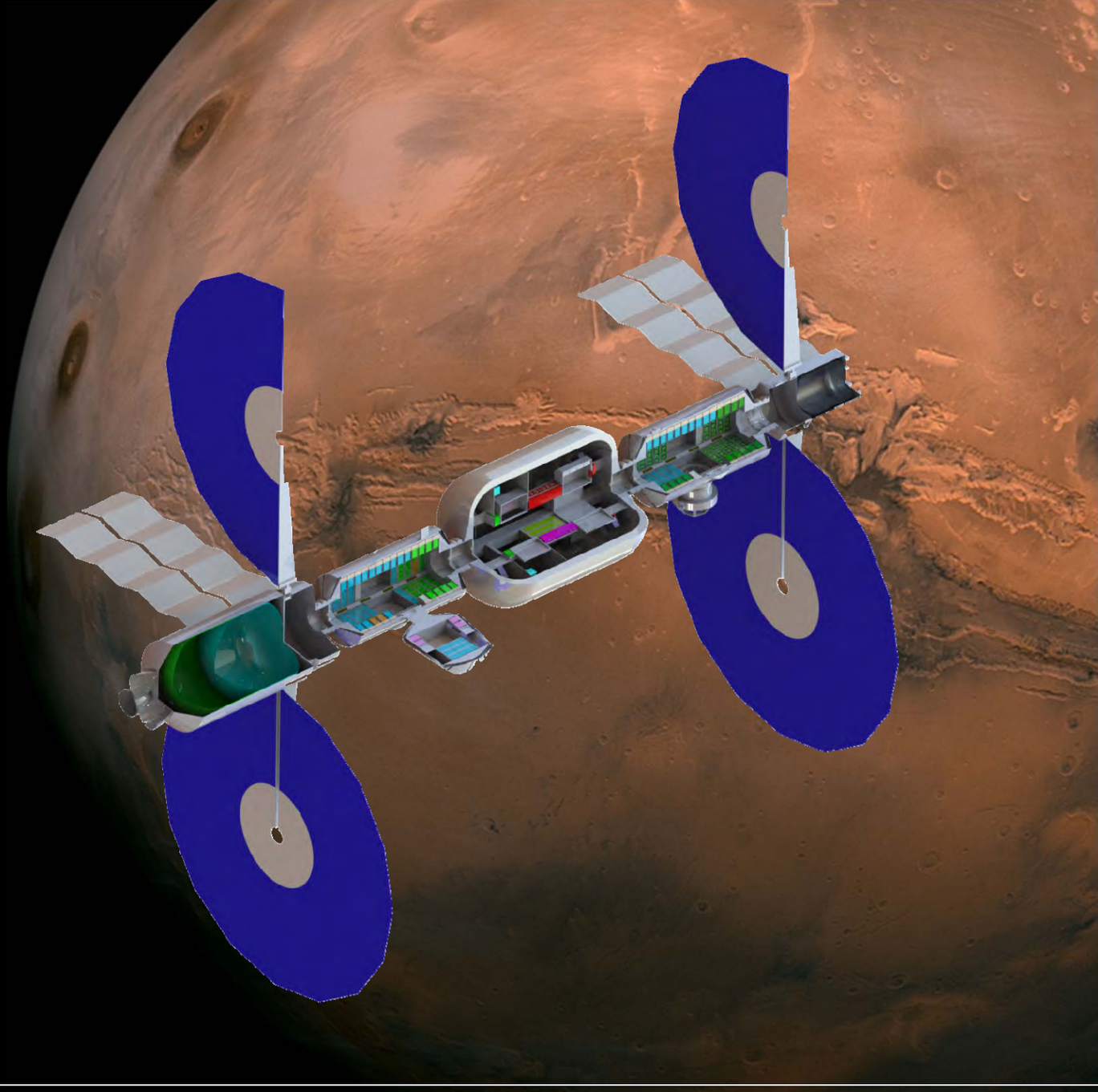
Kyle **K**esling [1,2]

SICSA

December 4th, 2017

Overview

- Why Orbit First?
- Mission Objectives
- Key Mission Assumptions
- Mission Overview
- Element Introductions and Module Layouts

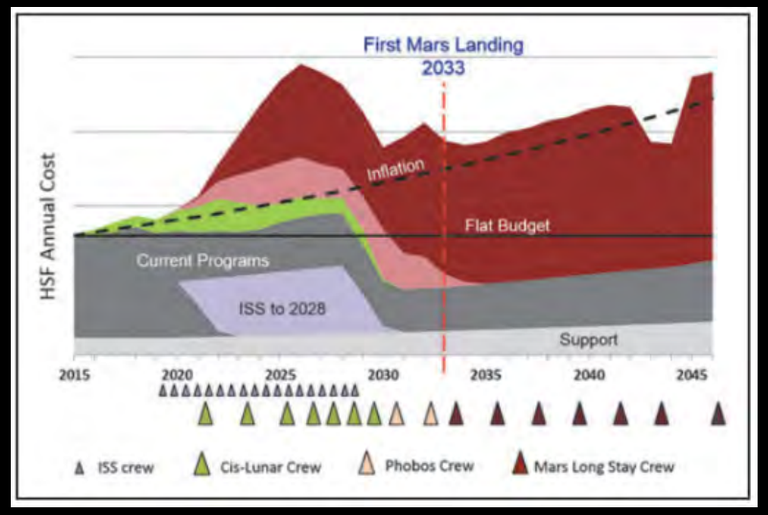


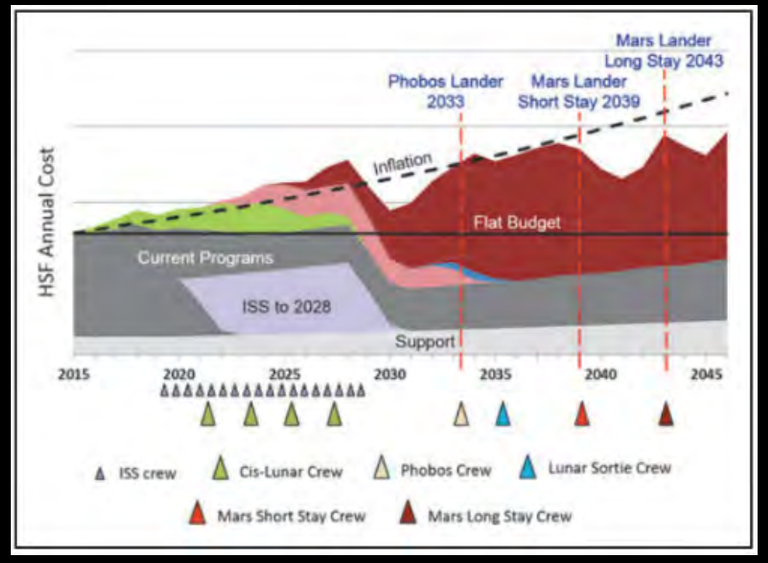
Why Orbit First?

Schedule driven

National Research Council & JPL cost profiles

Budget driven



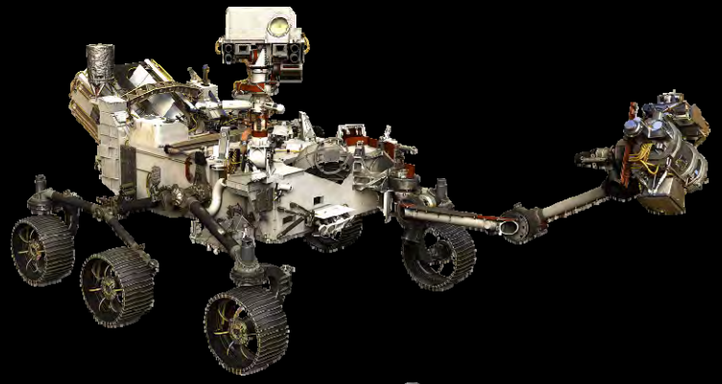


- Spreads out the cost; avoids surge in budget
- Allows time to develop the necessary surface elements
- Collect more samples sooner, rather than later

Mission Objectives

1. Retrieve and analyze samples from the Martian surface and Phobos

Mars 2020 rover



Japan's MMX

2. Validate the Entry, Descent, Landing, and Ascent (EDLA) vehicle

- Designed to land cargo and crew
  - Fetch rover (cargo)
  - Uncrewed for demo

- LOX / CH4

- Multiple options exist
  - NASA's Hercules Single-Stage Reusable Vehicle
  - SpaceX's BFR

Key Assumptions:

Conjunction-class Mission

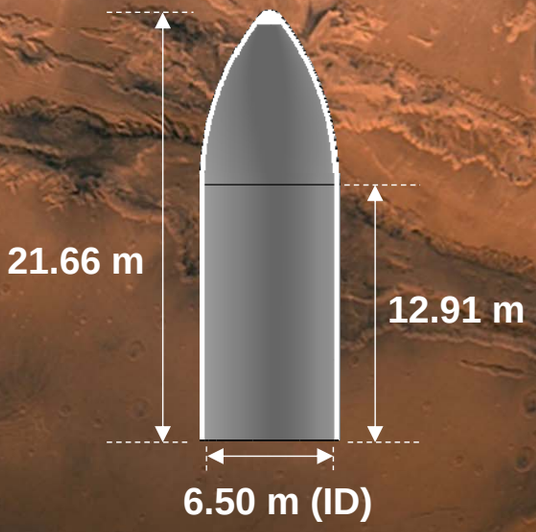
- Chemical propulsion for fast crew transit
- Lowers overall mission delta-v
- Follows future missions
- Sets the launch opportunities (~26 months)

Orbital mission | **Short-surface stay mission**

12/21/2028 **02/01/2031** 03/27/2033 **06/09/2035** 08/11/2037

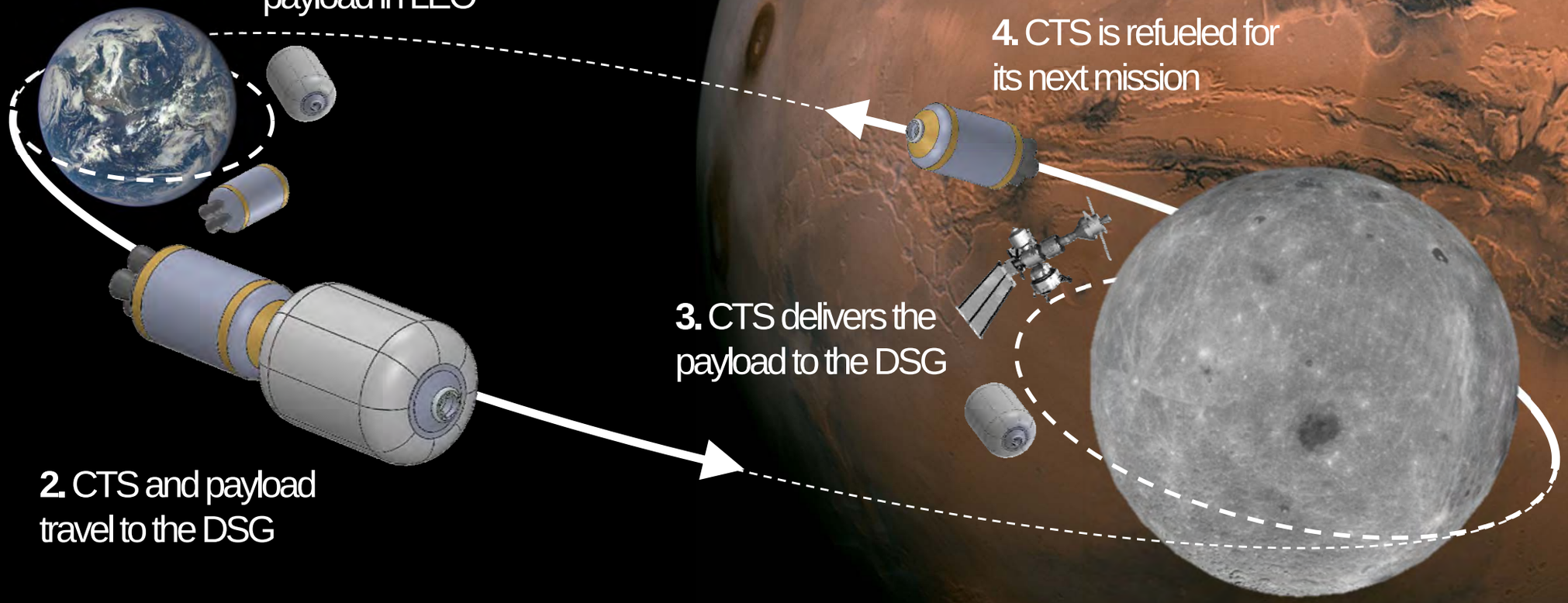
Reusable Launch Vehicles

- Lowers launch/ mission cost
- Increases launch cadence
- 45 metric tons to LEO
- 12.85 metric tons to cislunar space

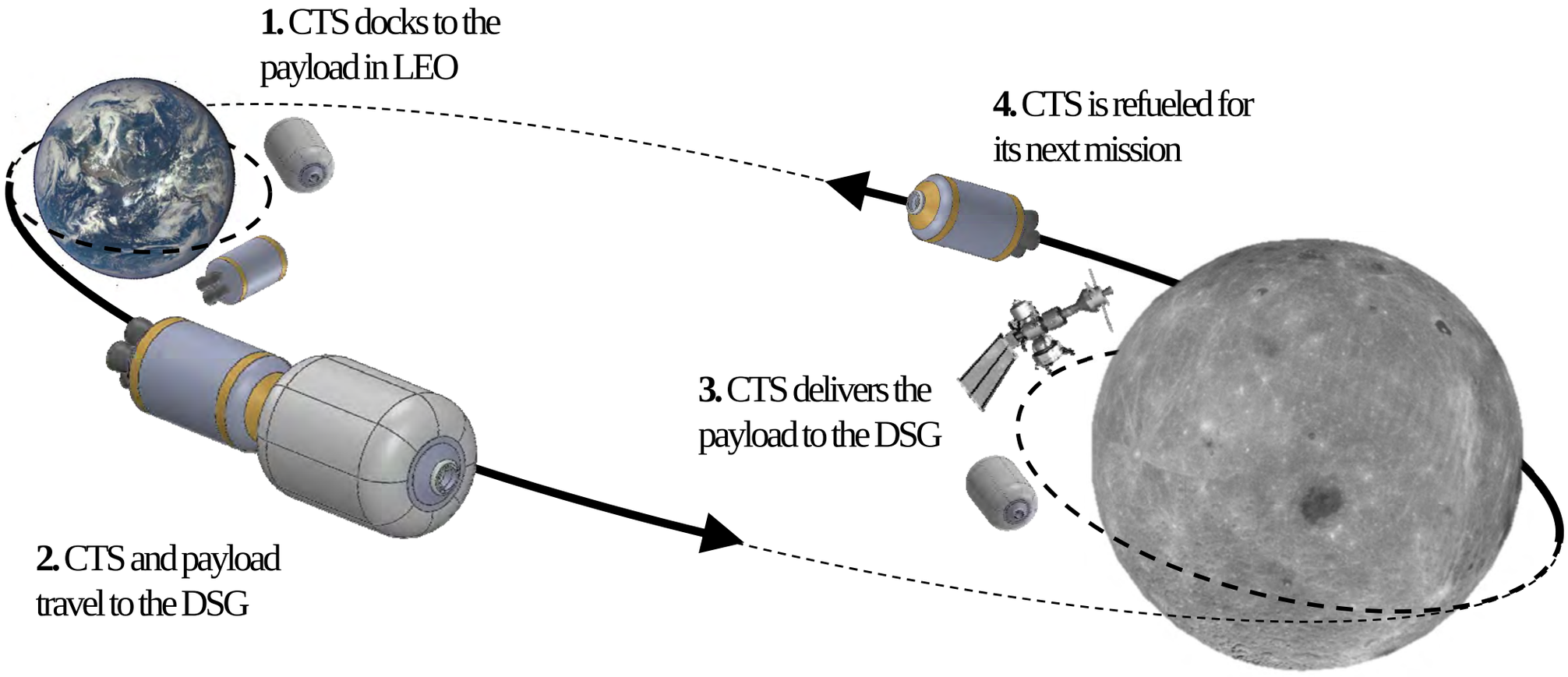


Blue Origin's 2 Stage New Glenn

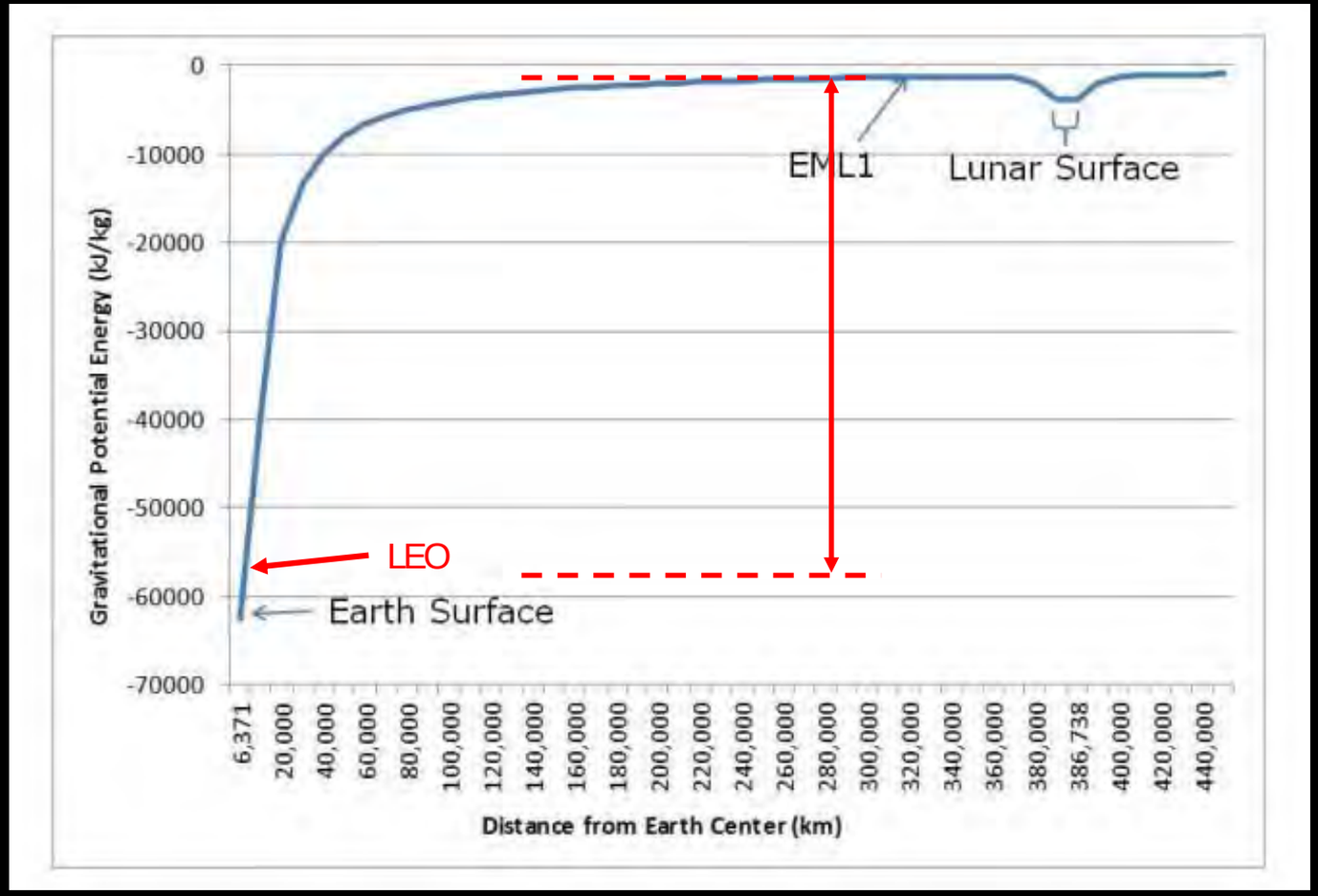
Key Assumptions: Cislunar Transport System



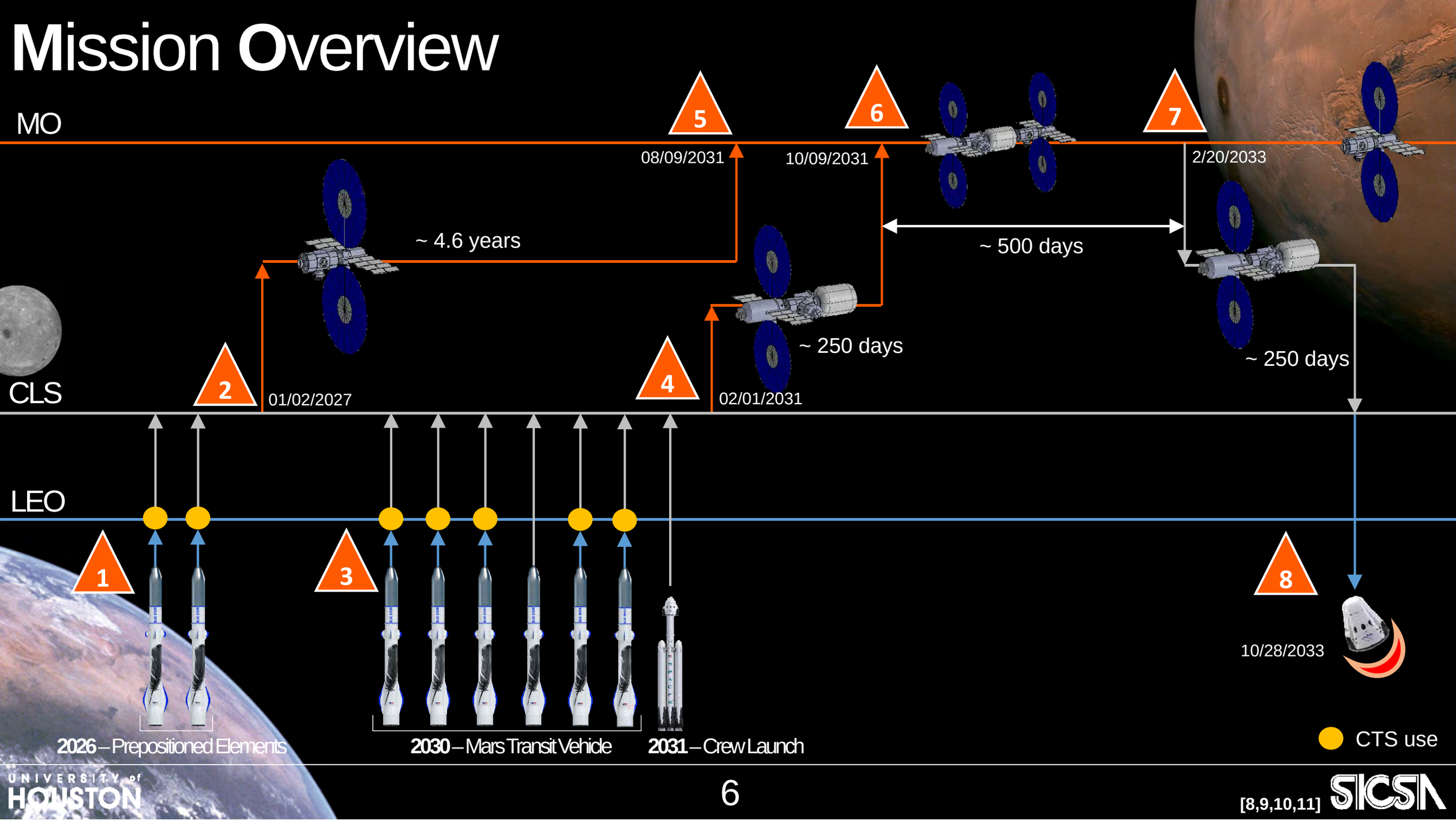
Key **A**ssumptions: **C**islunar **T**ransport **S**ystem



Key Assumptions: Cislunar Transport System



Mission Overview



Mission Overview

MO

CLS

LEO

A

B

C

D

E

F

G

H

01/02/2027

~ 4.6 years

08/09/2031

02/01/2031

~ 250 days

10/09/2031

~ 500 days

2/20/2033

~ 250 days

10/28/2033

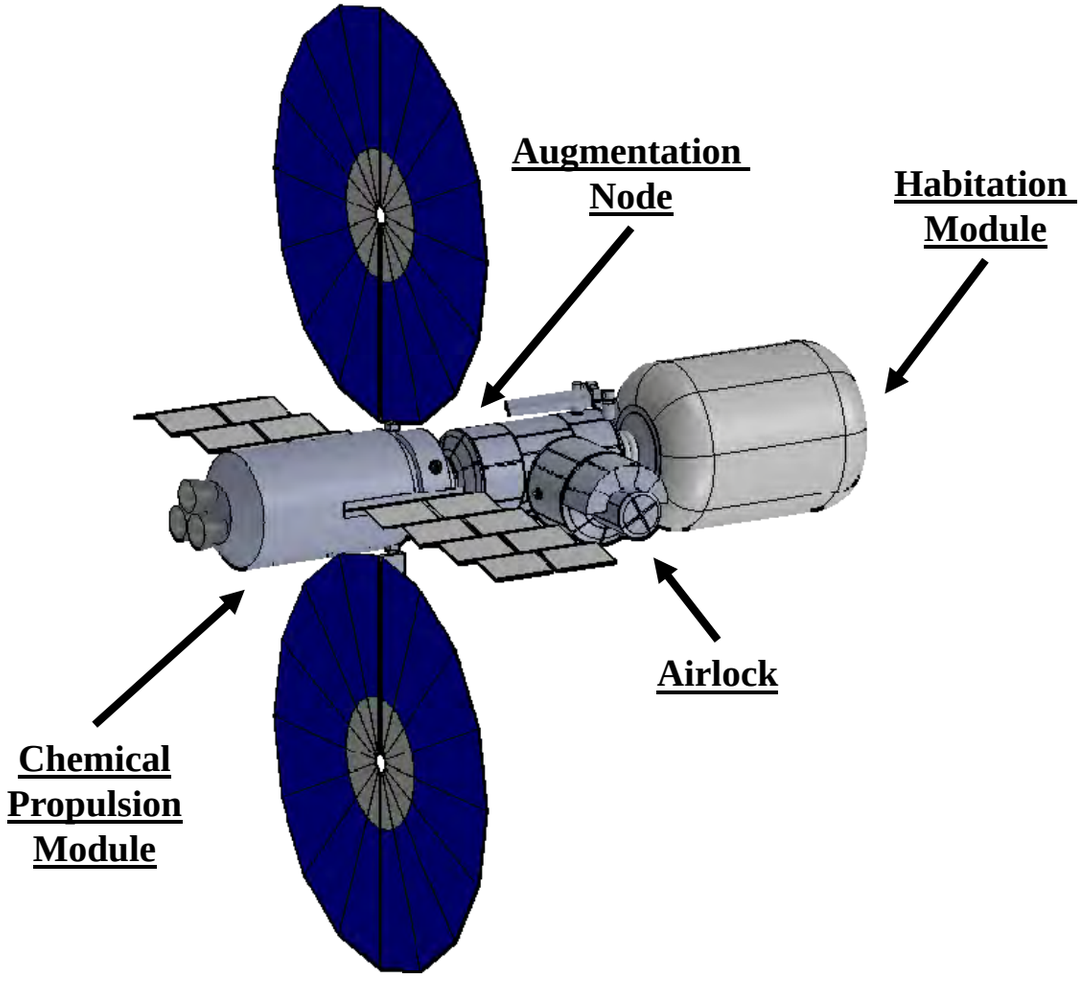
2026 – Prepositioned Elements

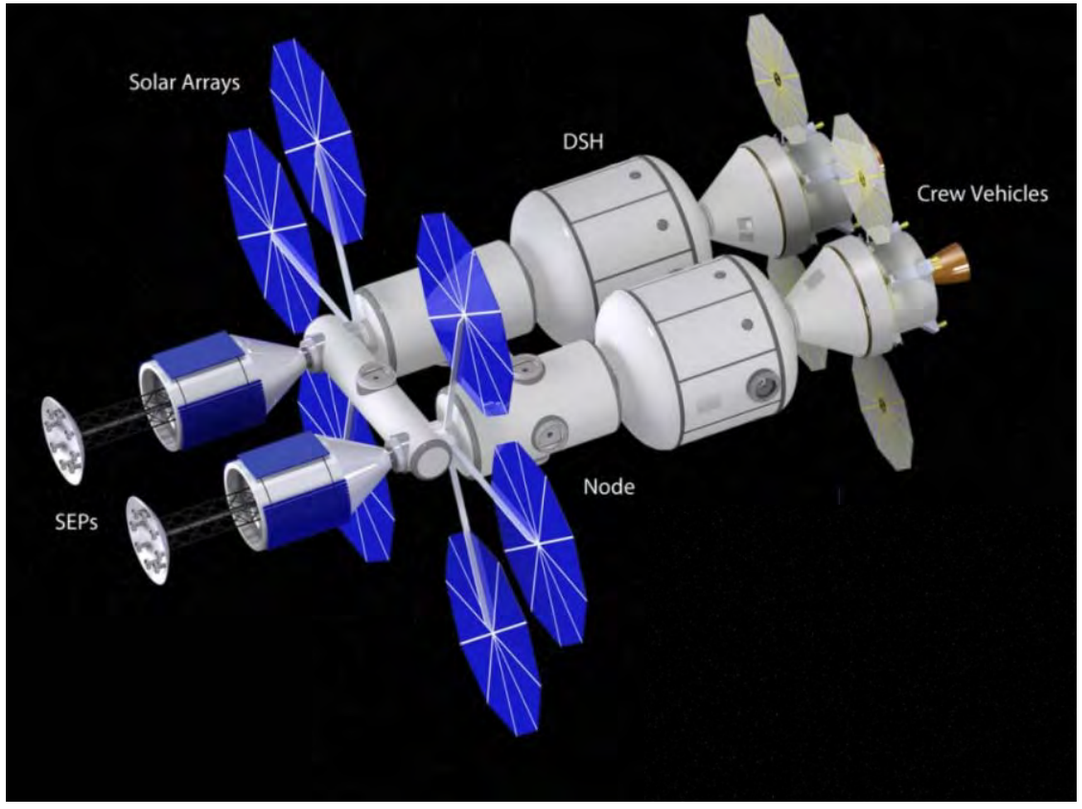
2030 – Mars Transit Vehicle

2031 – Crew Launch

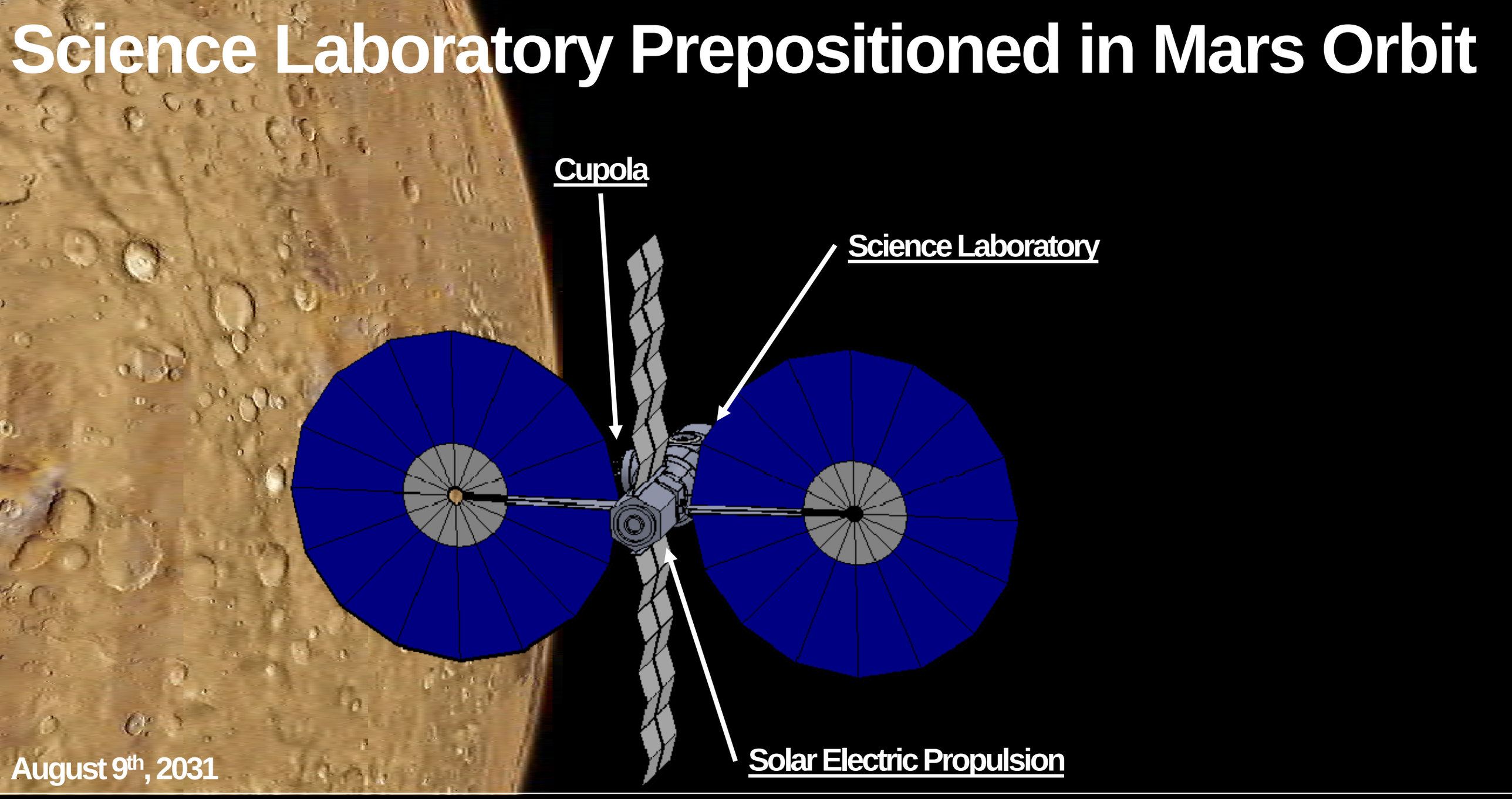
CTS use

[8,9,10,11]

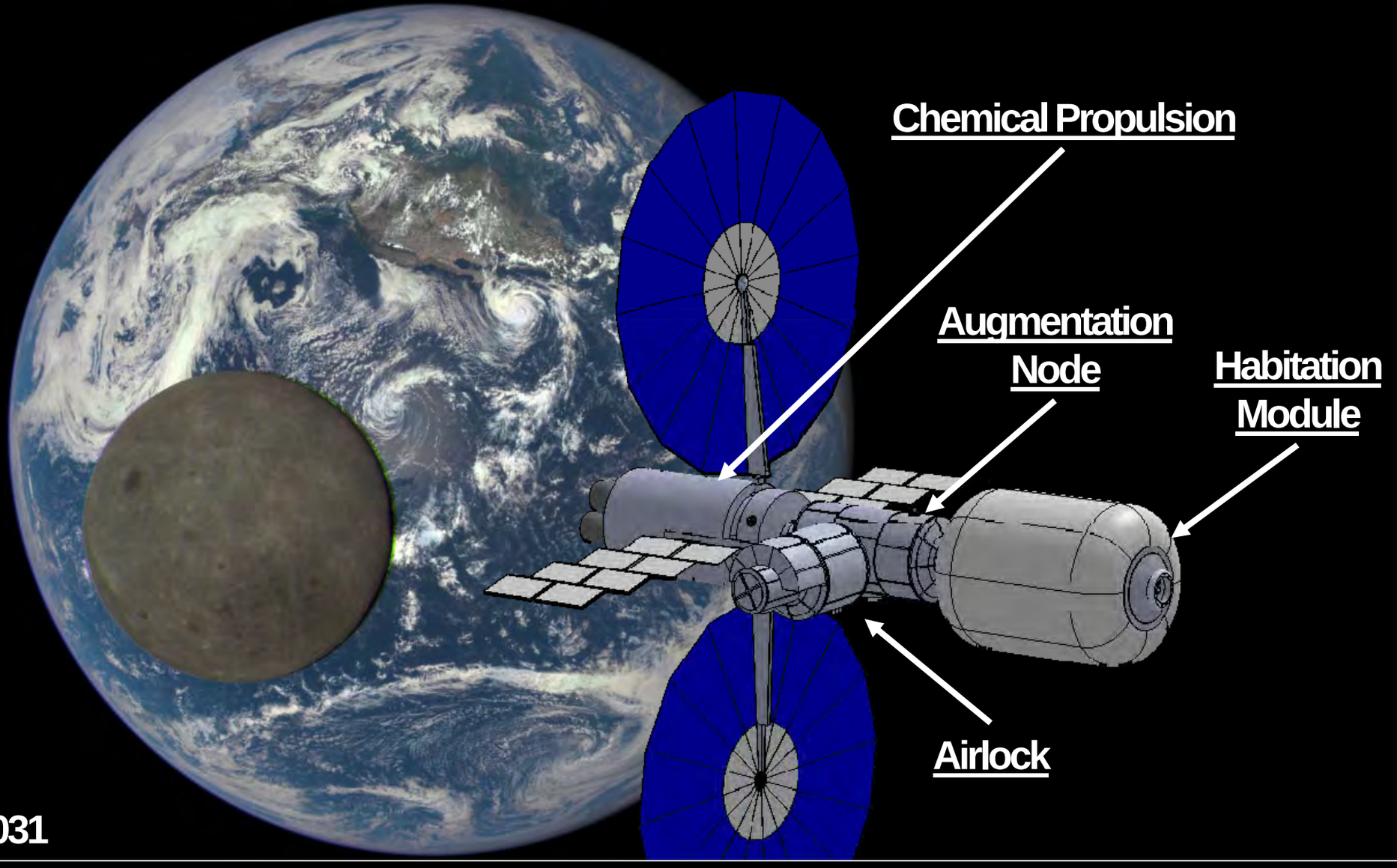

Augmentation Node
Habitation Module
Airlock
Chemical Propulsion Module


Solar Arrays
DSH
Crew Vehicles
Node
SEPs

Science Laboratory Prepositioned in Mars Orbit

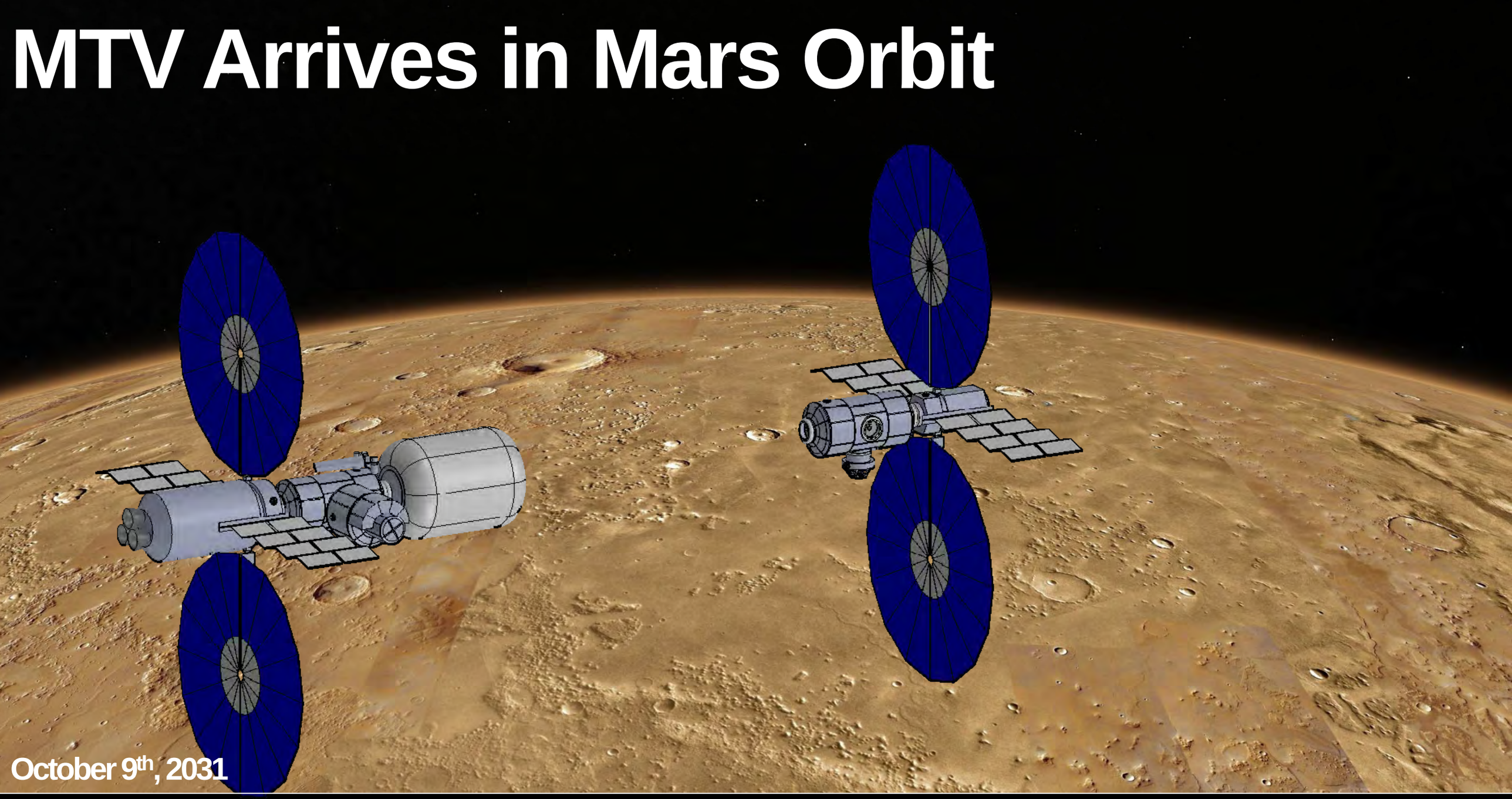


Mars Transit Vehicle Departs to Mars Orbit



February 1st, 2031

MTV Arrives in Mars Orbit

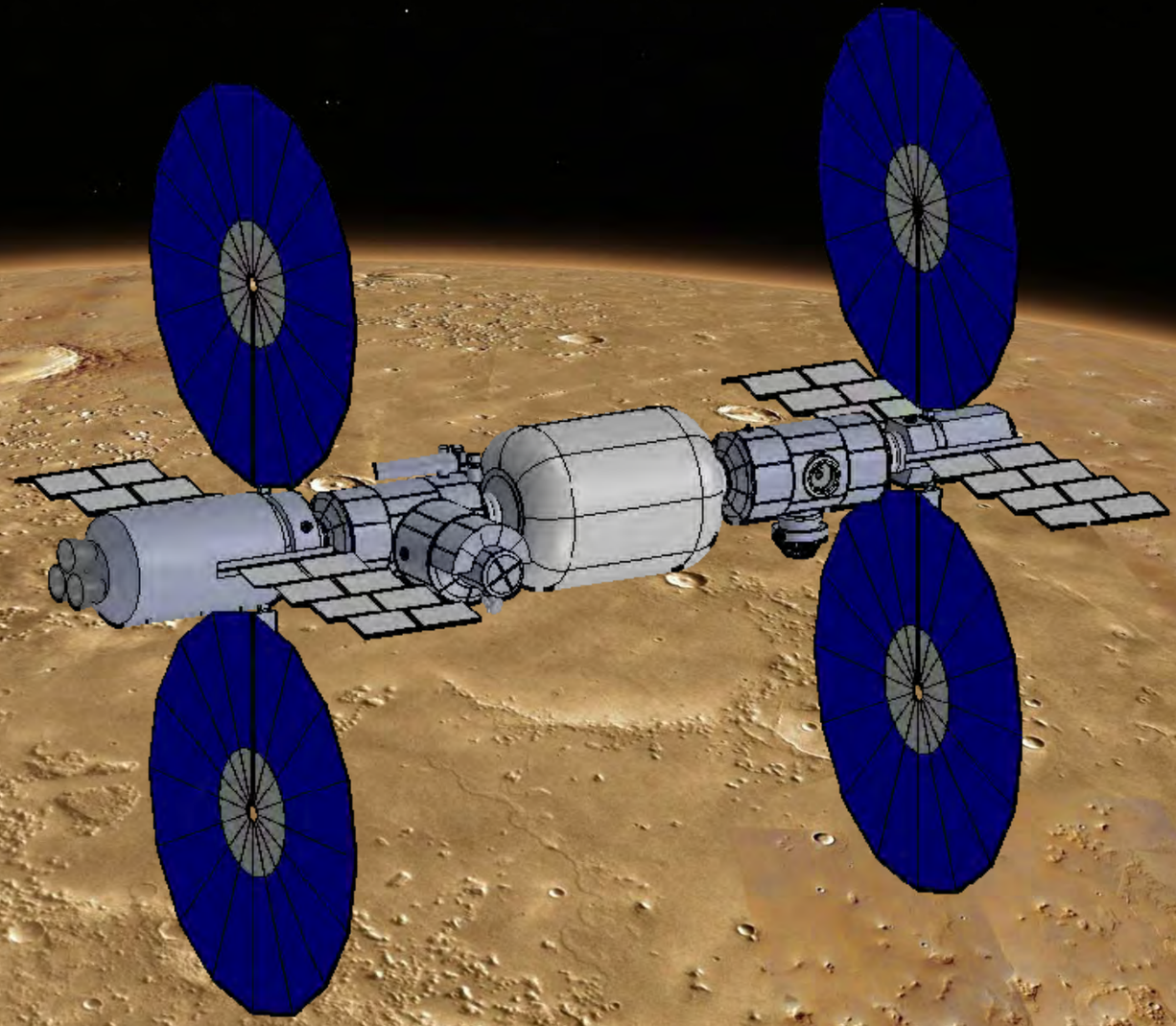


Mars Orbit Operations

- Telerobotic operations

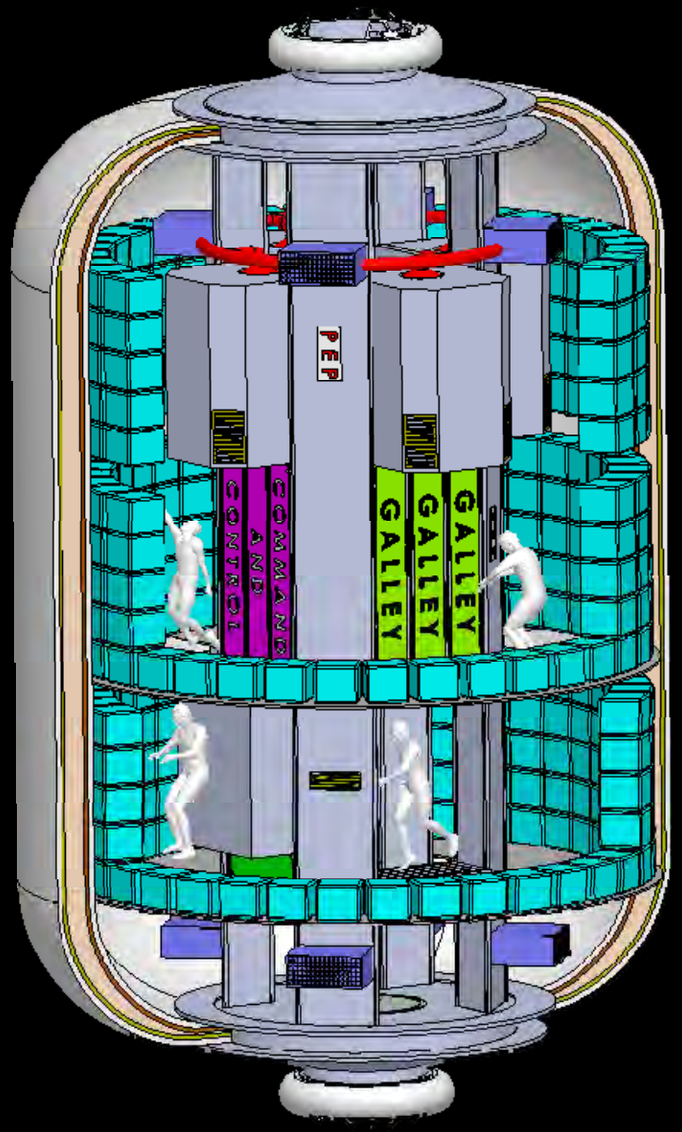
- Analyze returned samples

- Image future landing sites



October 9th, 2031 – February 20th, 2033

Habitation Module



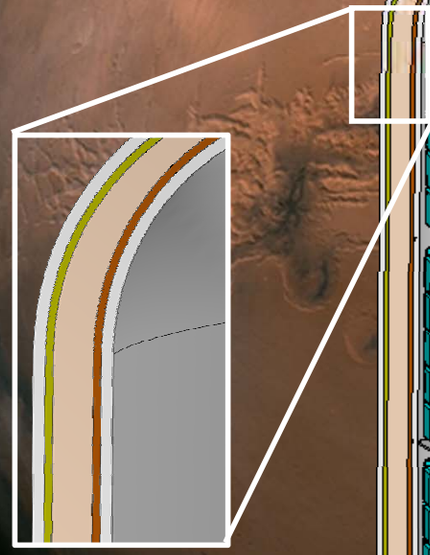
External Thermal Blanket

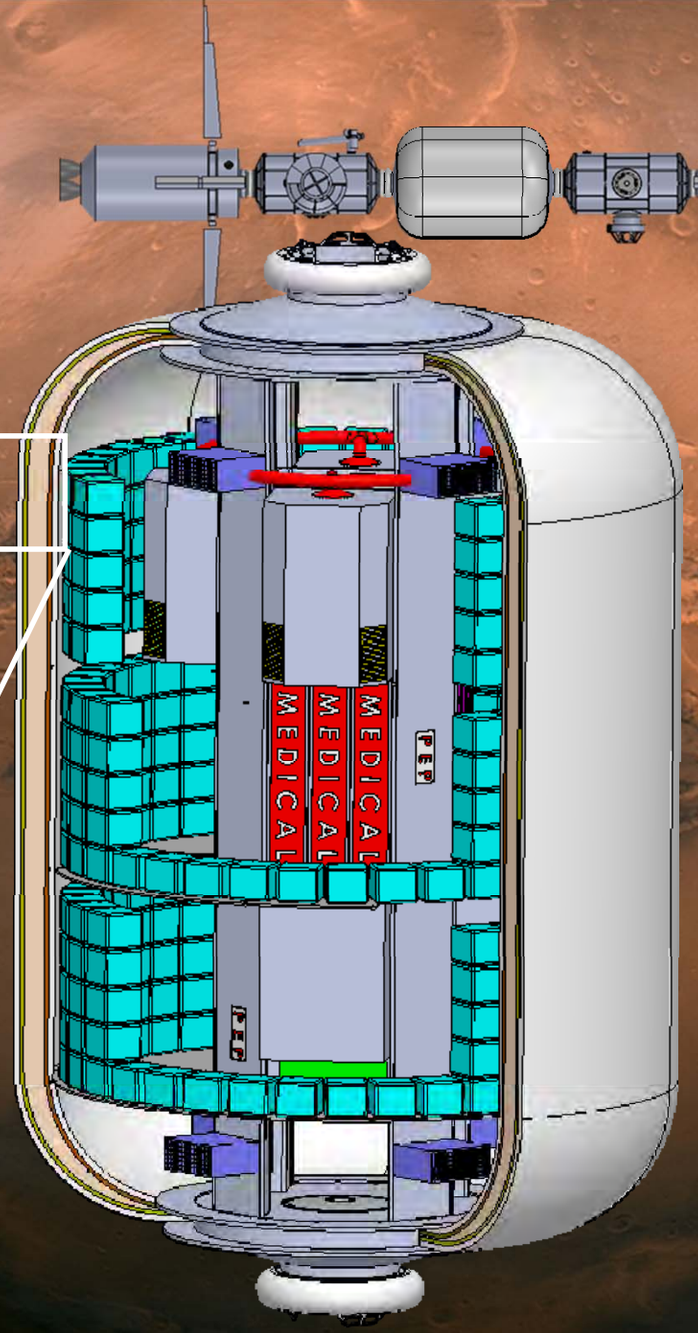
Micrometeoroid Protection

Radiation Protection

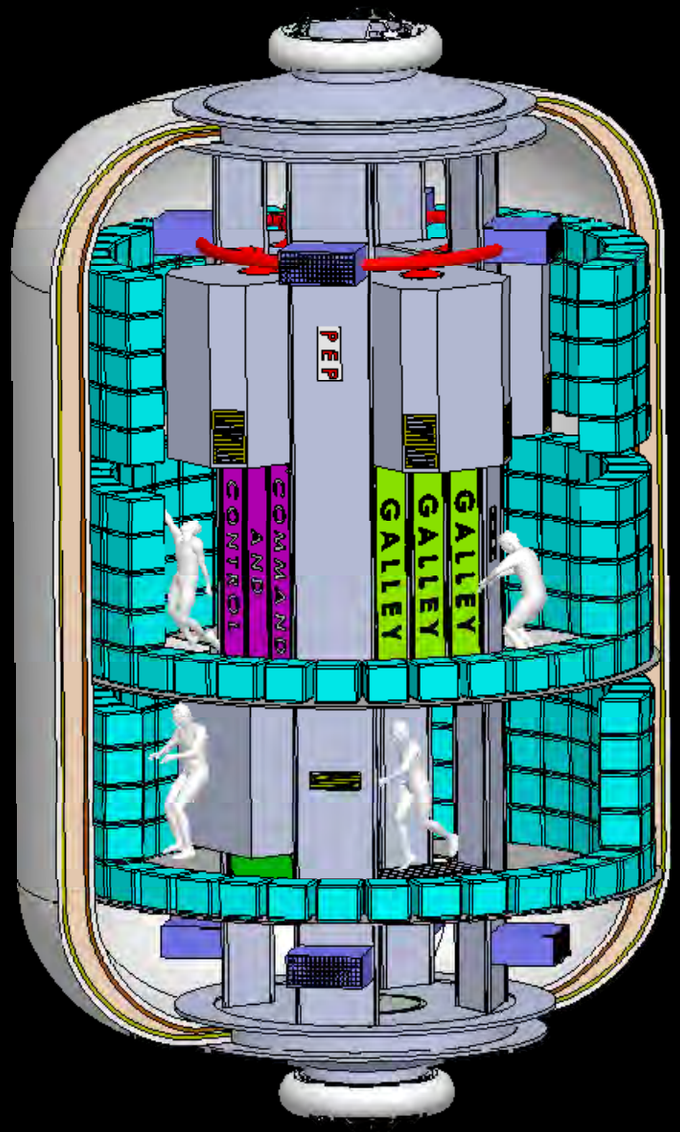
Restraint Layer

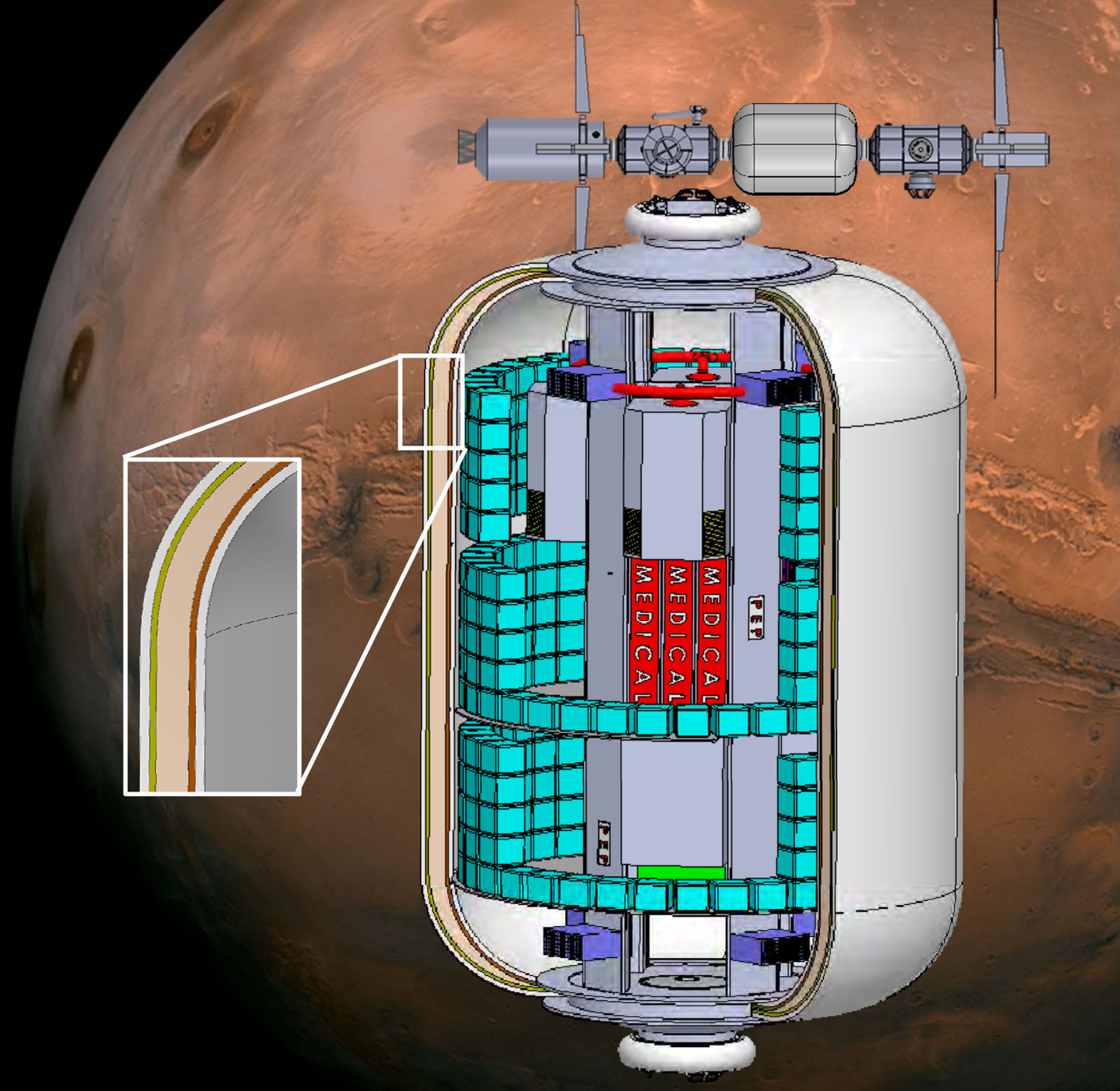
Integrated Redundant Pressure Bladders and Internal Scuff Barrier





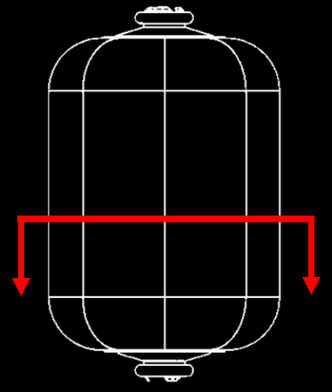
Habitation Module

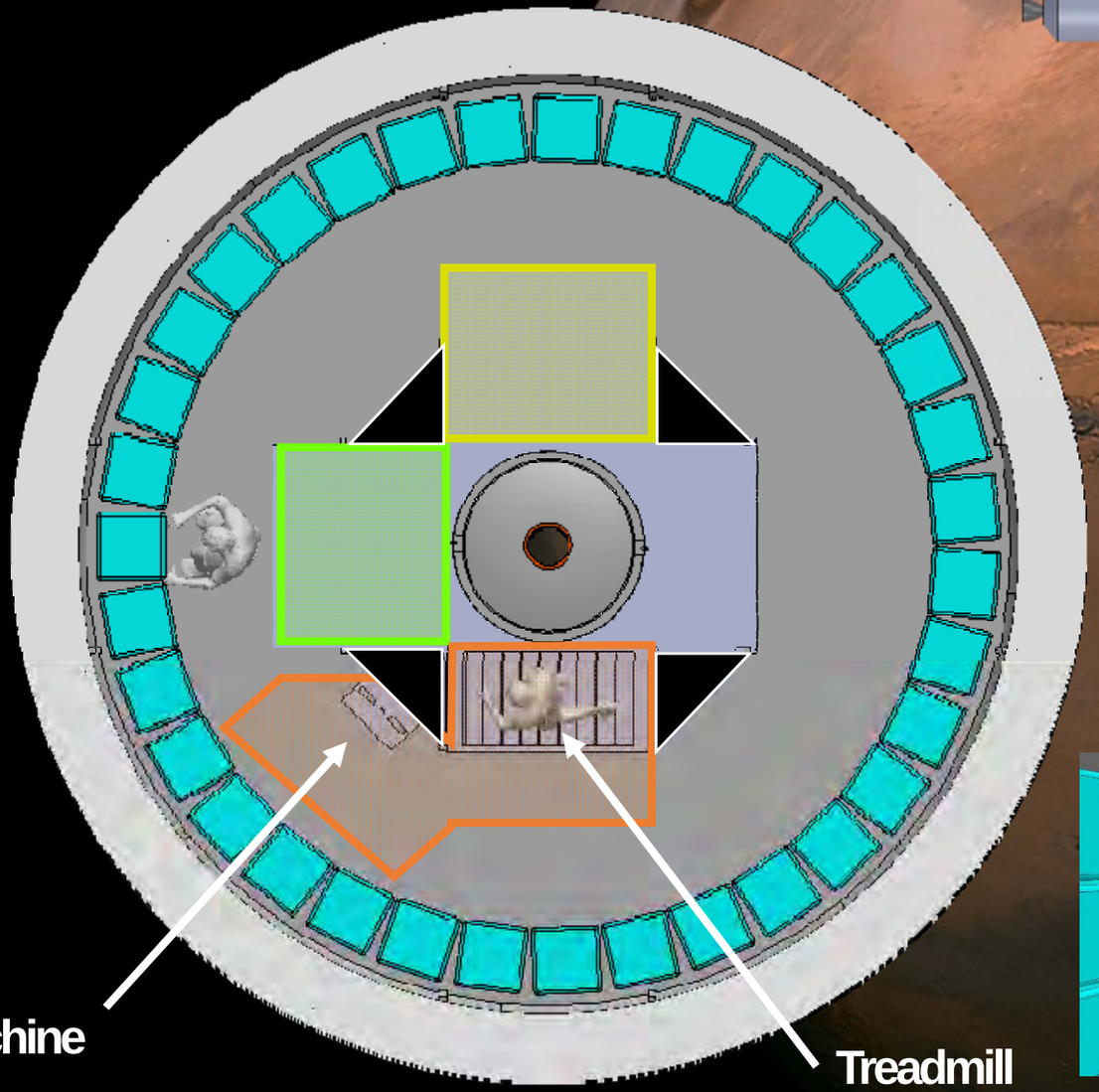


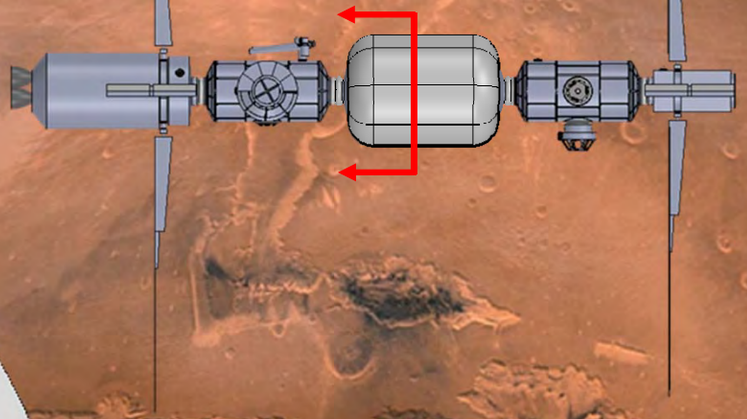


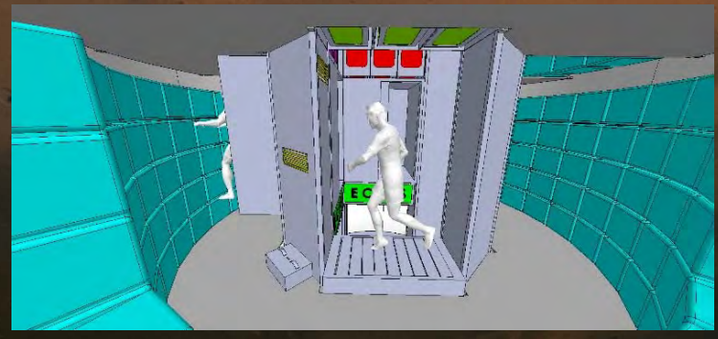
HAM – 1st Floor

- Exercise
- WCS (Toilet)
- Hygiene
- Stowage
- Utilities



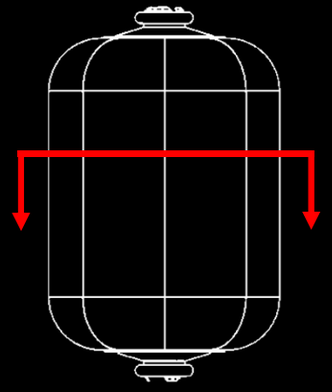


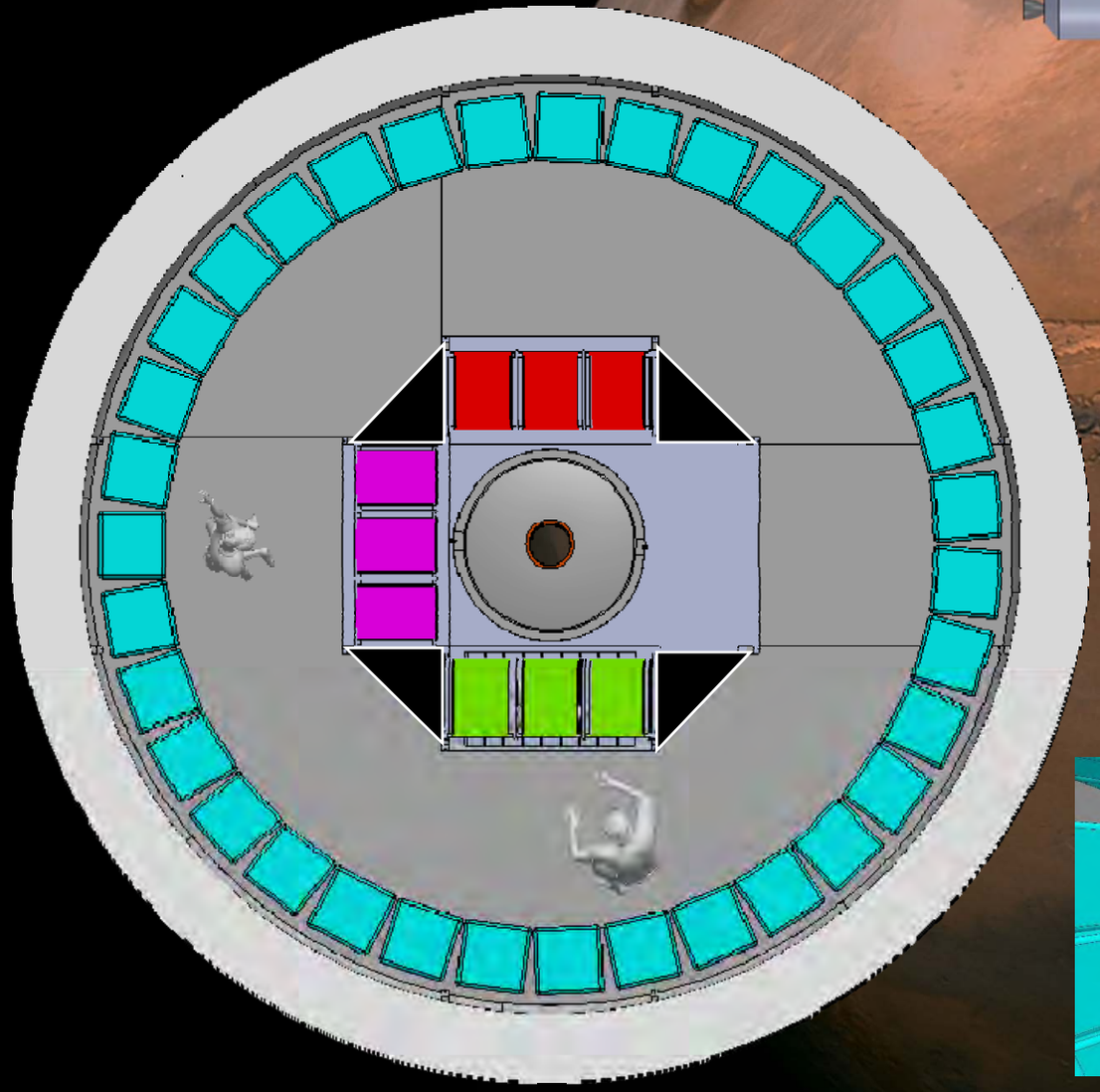


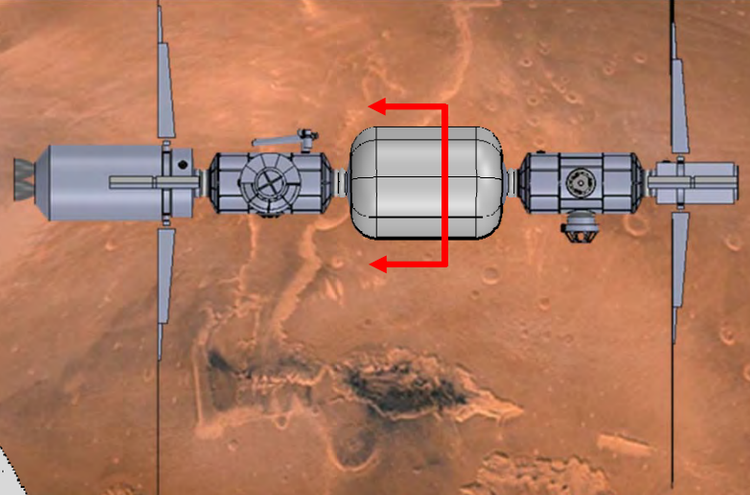


HAM – 2nd Floor

- Galley/ Wardroom
- Command and Control
- Medical
- Stowage
- Utilities







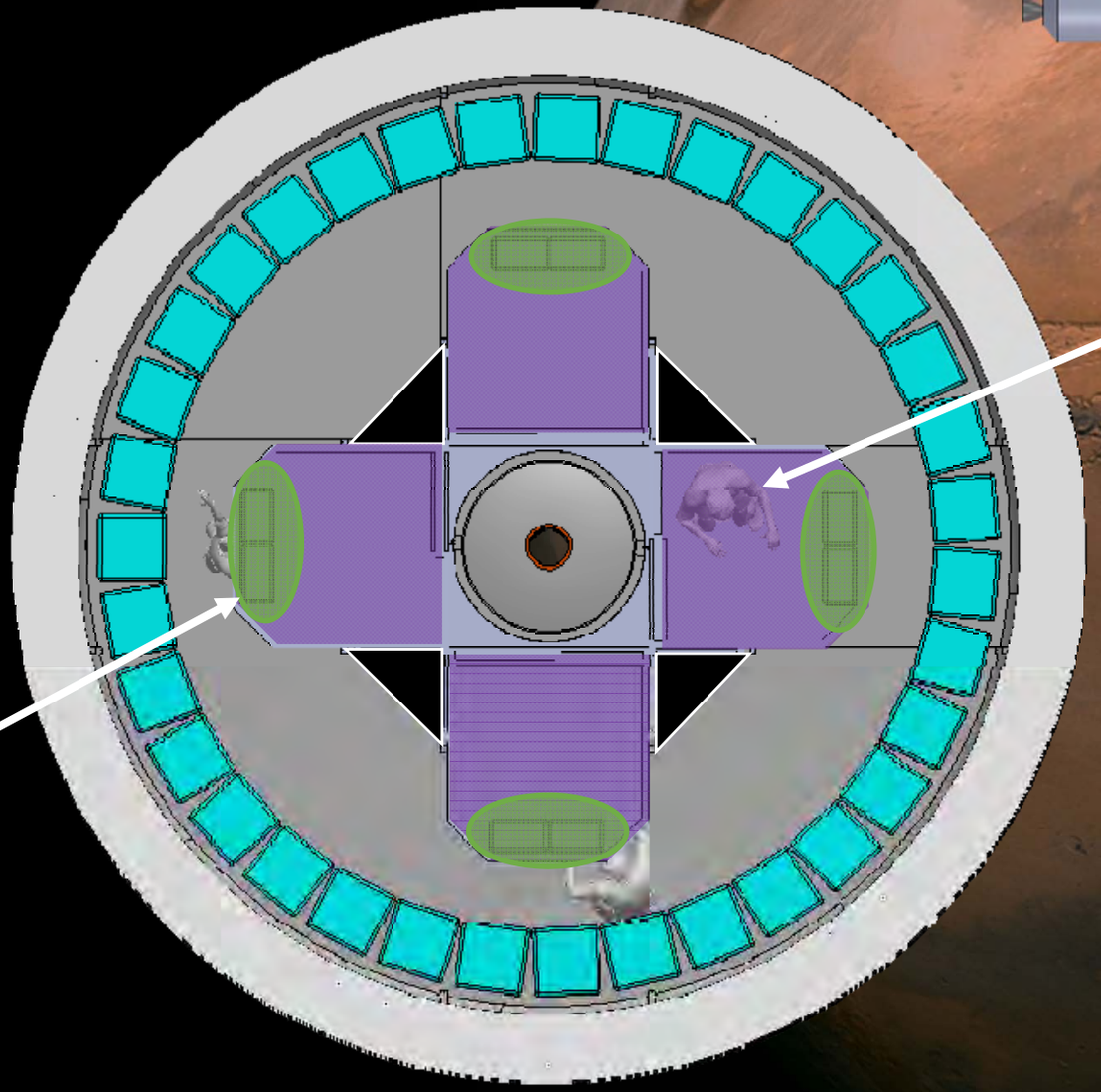
HAM – 3rd Floor

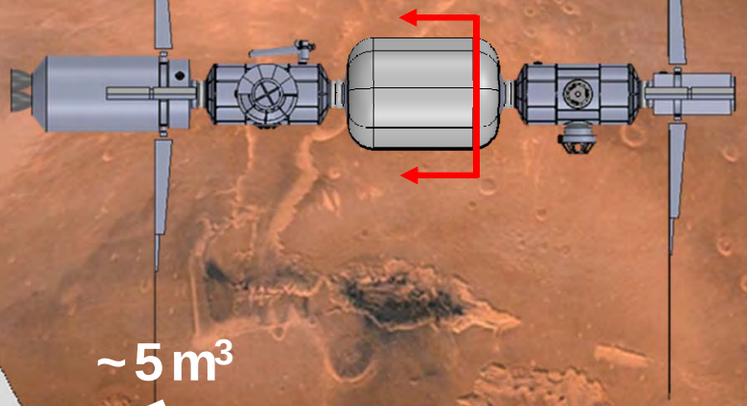
Crew Quarters

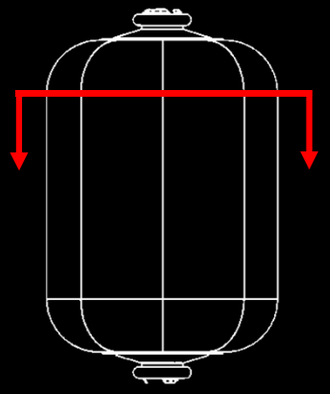
Personal Stowage

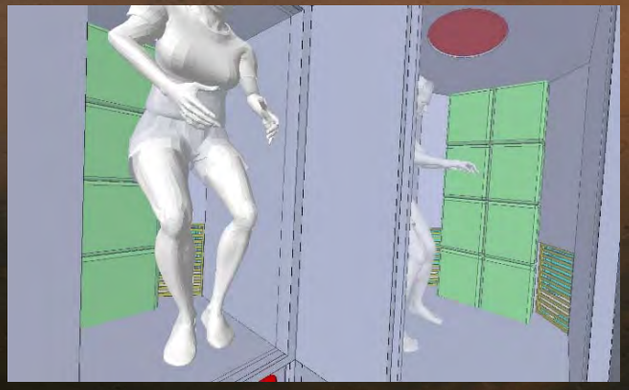
Other Stowage

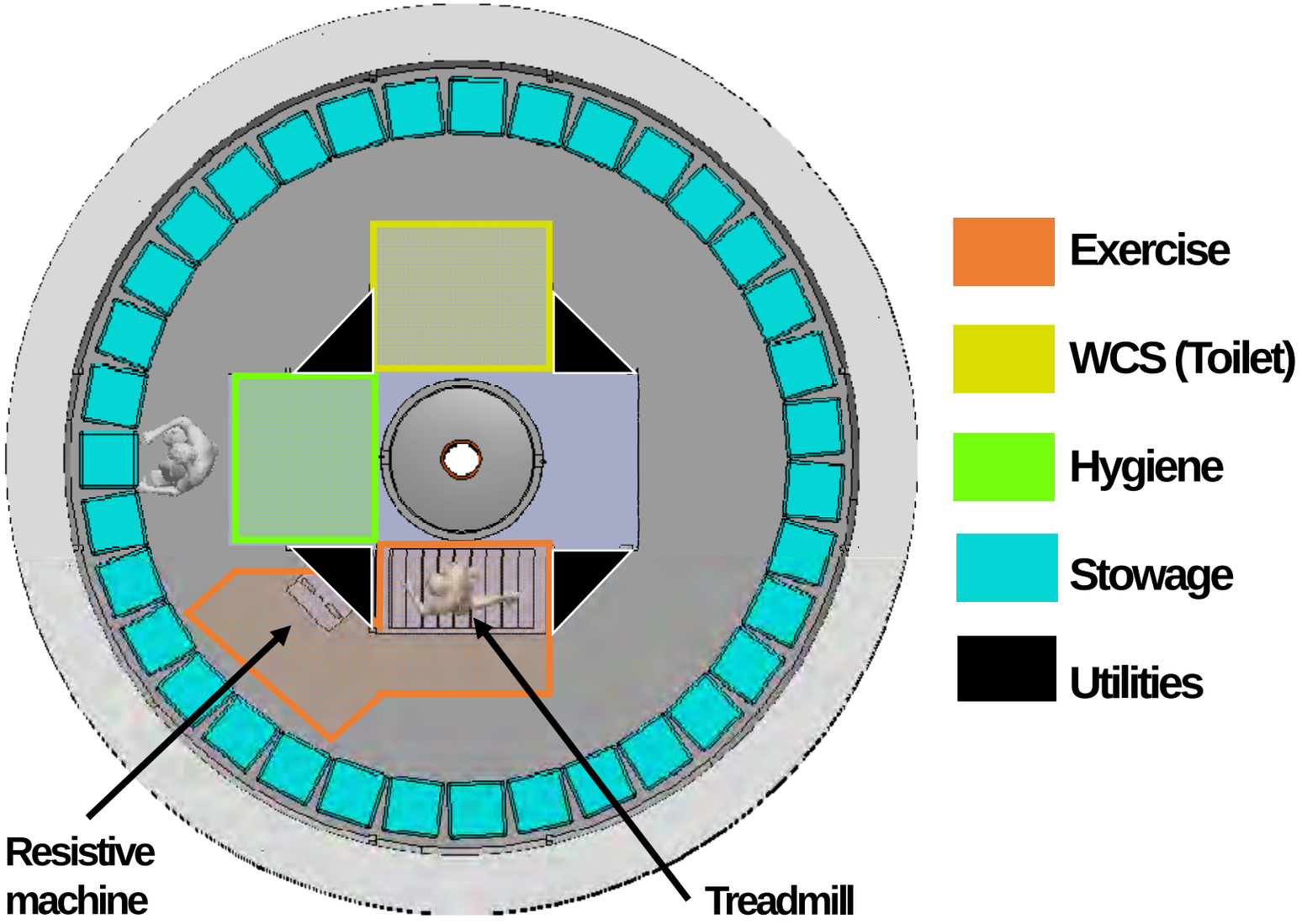
Utilities

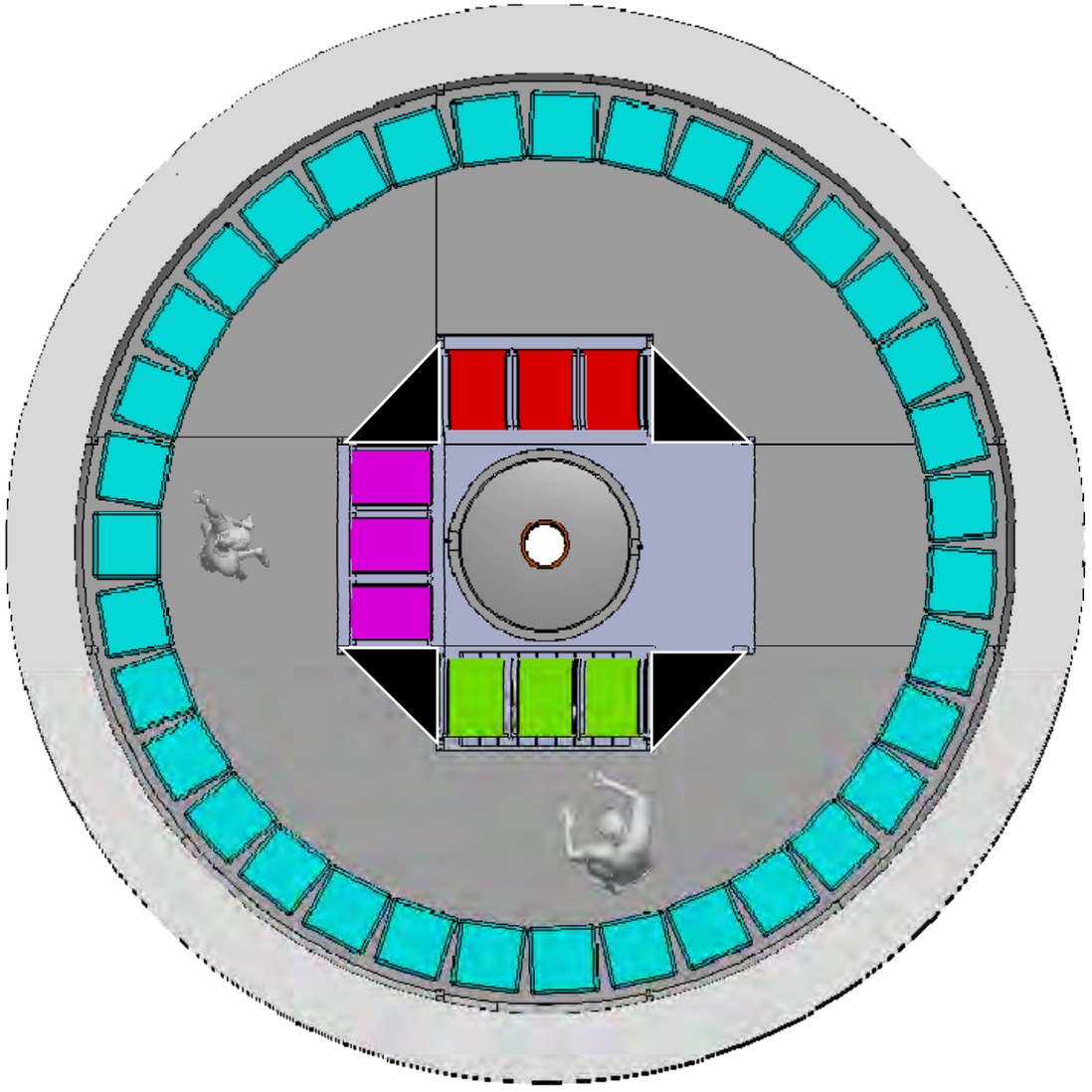









Exercise
WCS (Toilet)
Hygiene
Stowage
Utilities
Resistive machine
Treadmill



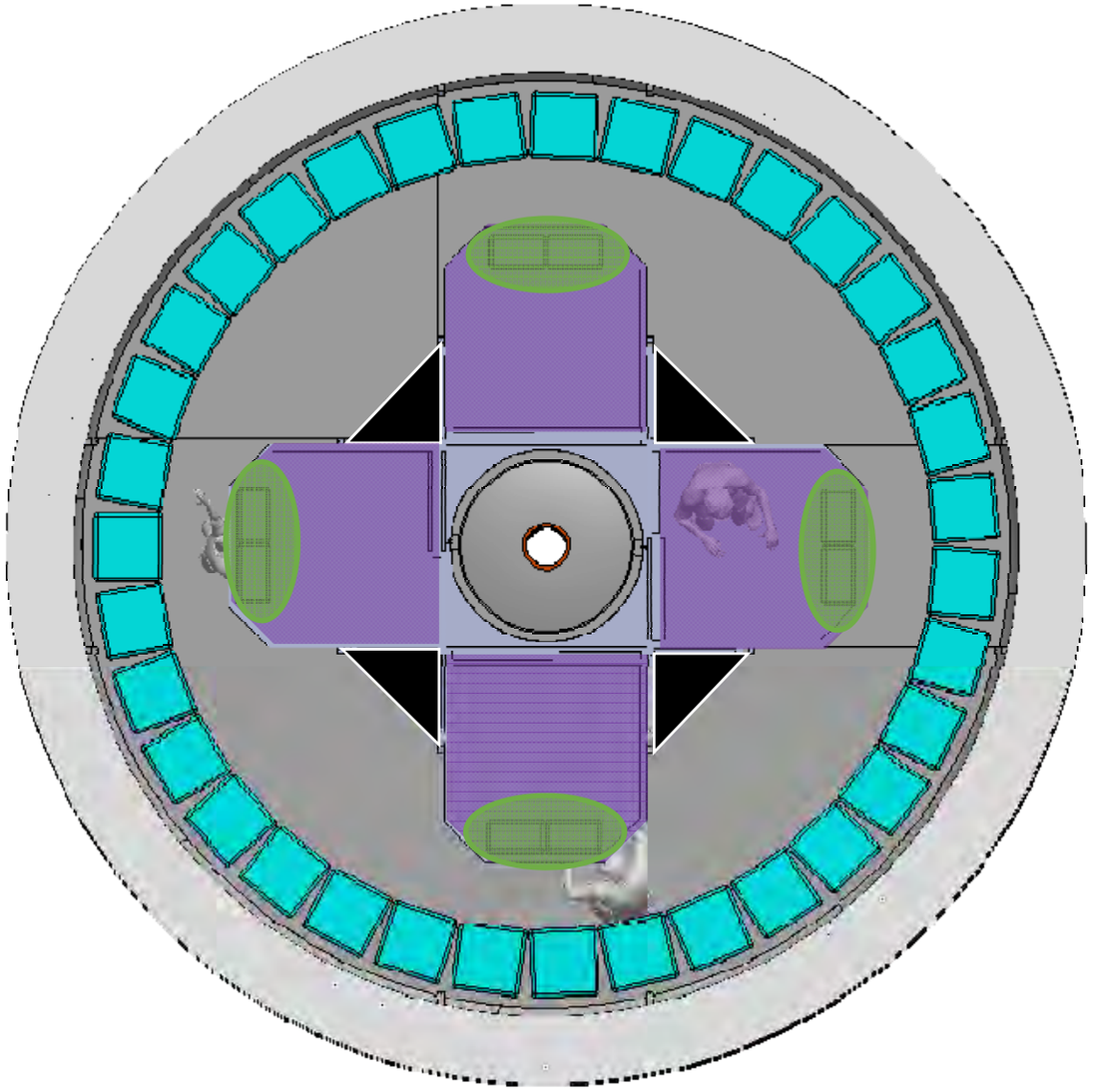
Galley/ Wardroom

Command and Control

Medical

Stowage

Utilities

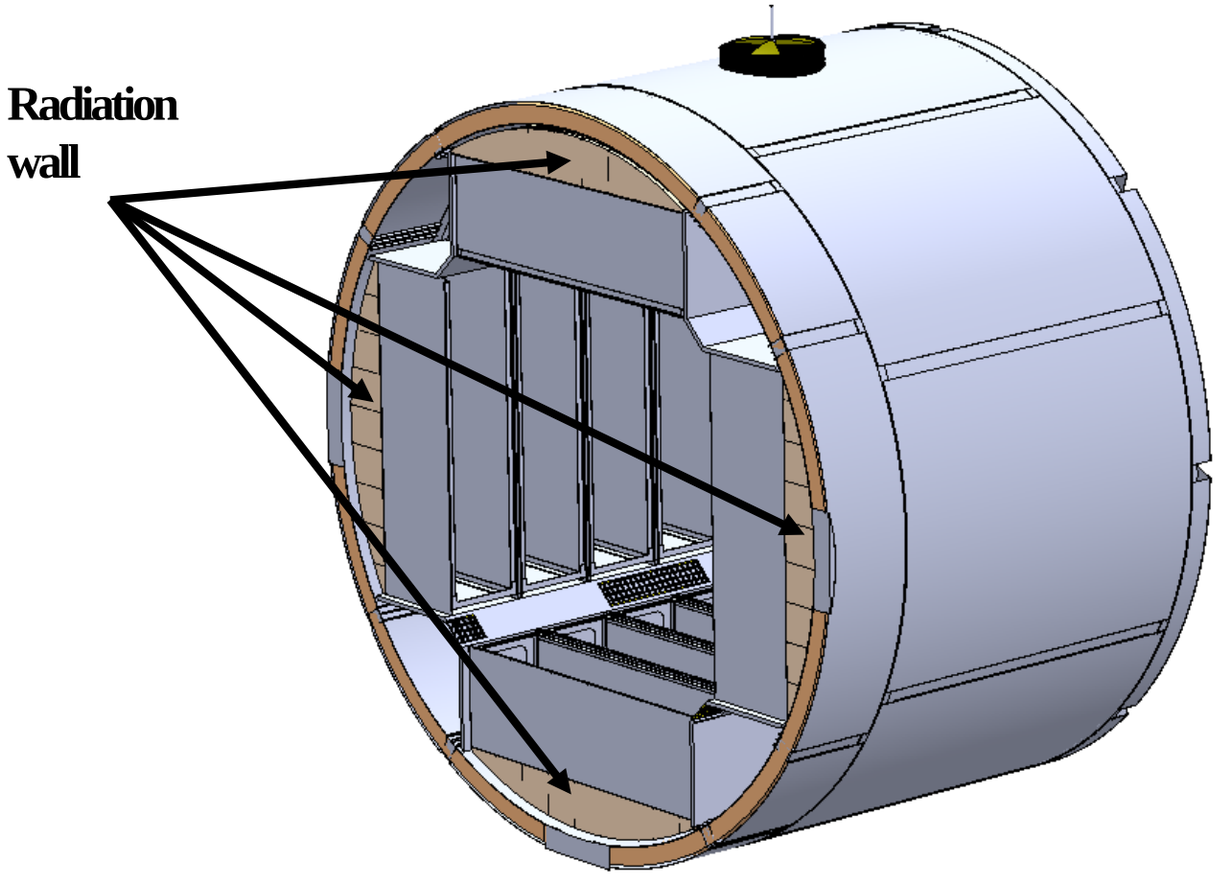


Crew Quarters

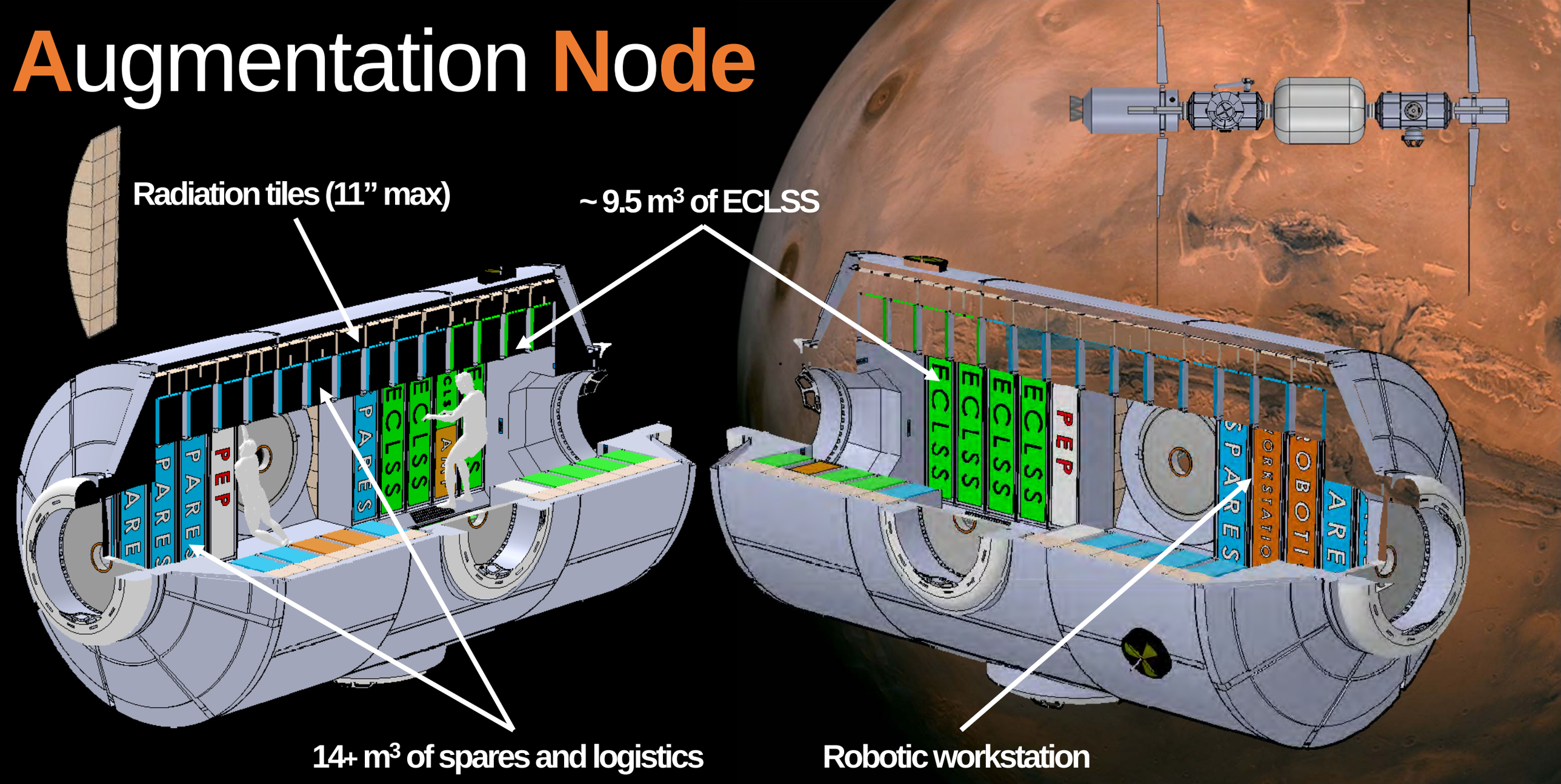
Personal Stowage

Other Stowage

Utilities

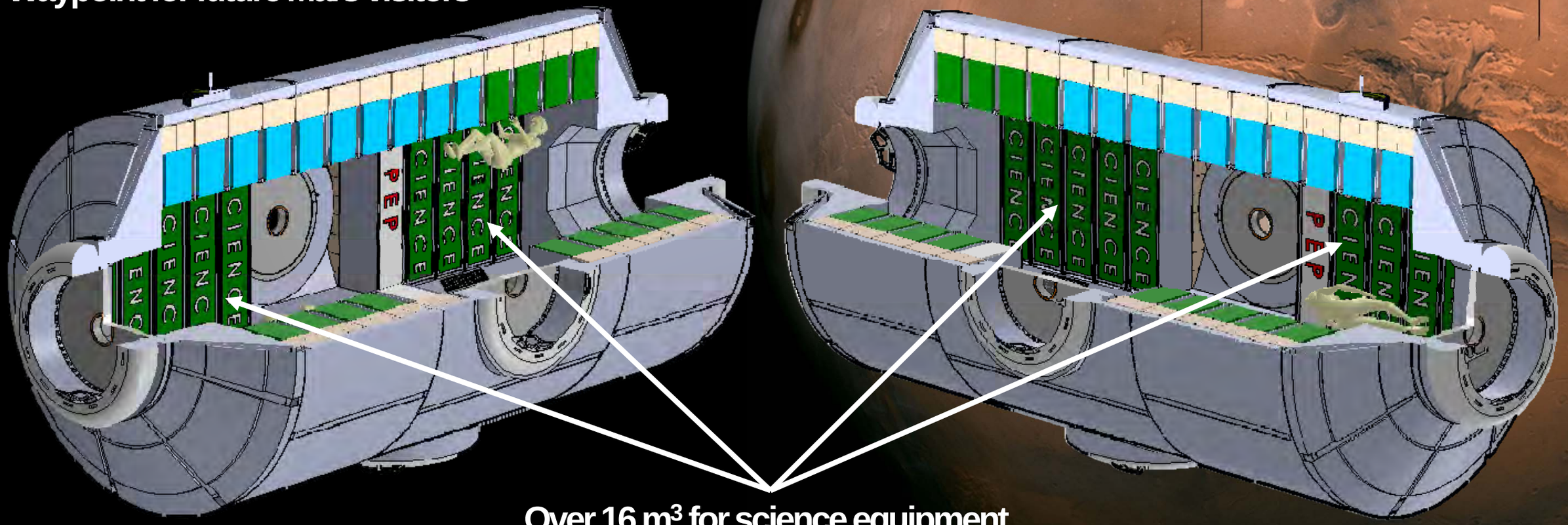

Radiation
wall

Augmentation Node



Science Laboratory

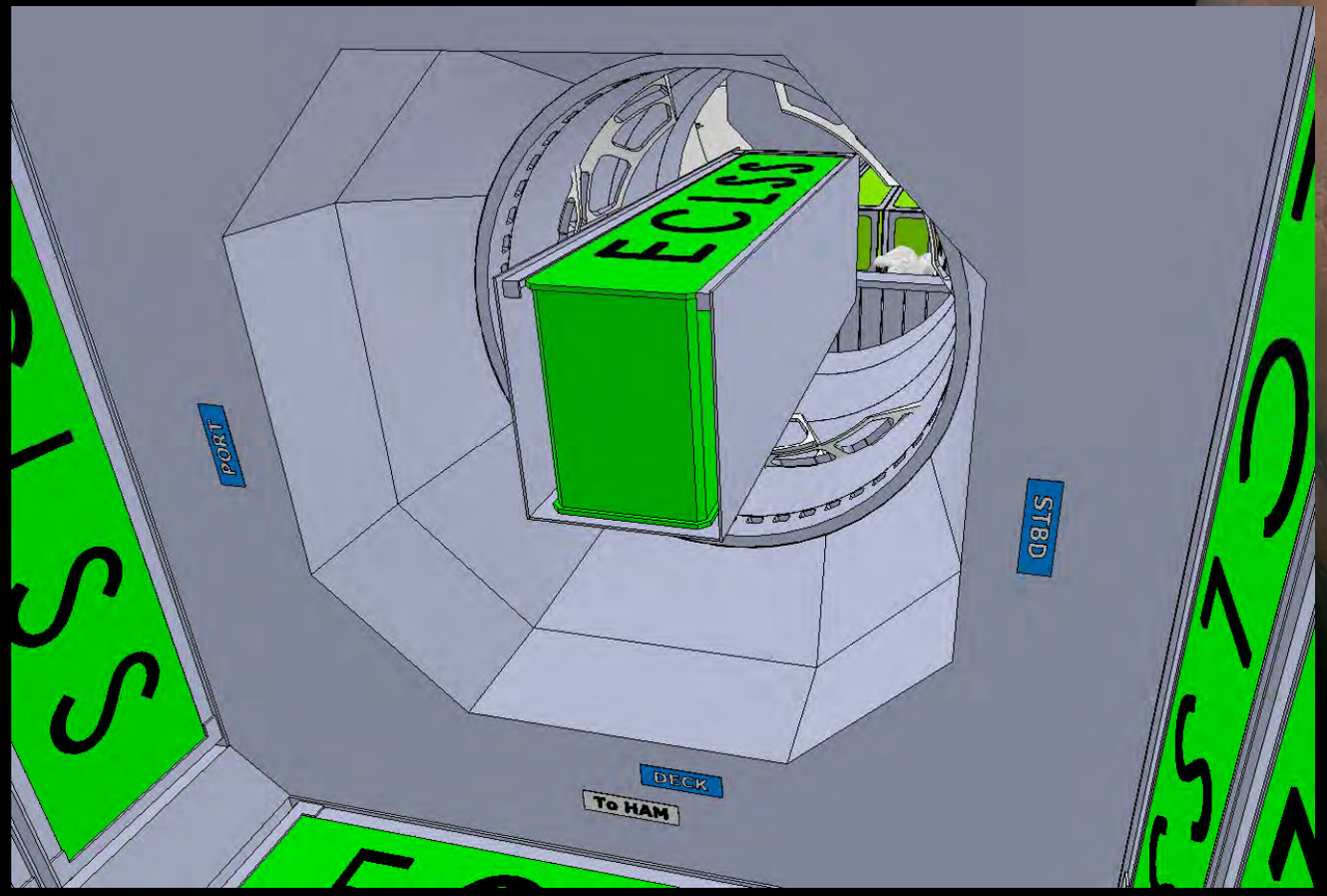
- On-orbit analysis of samples
- Waypoint for future Mars visitors



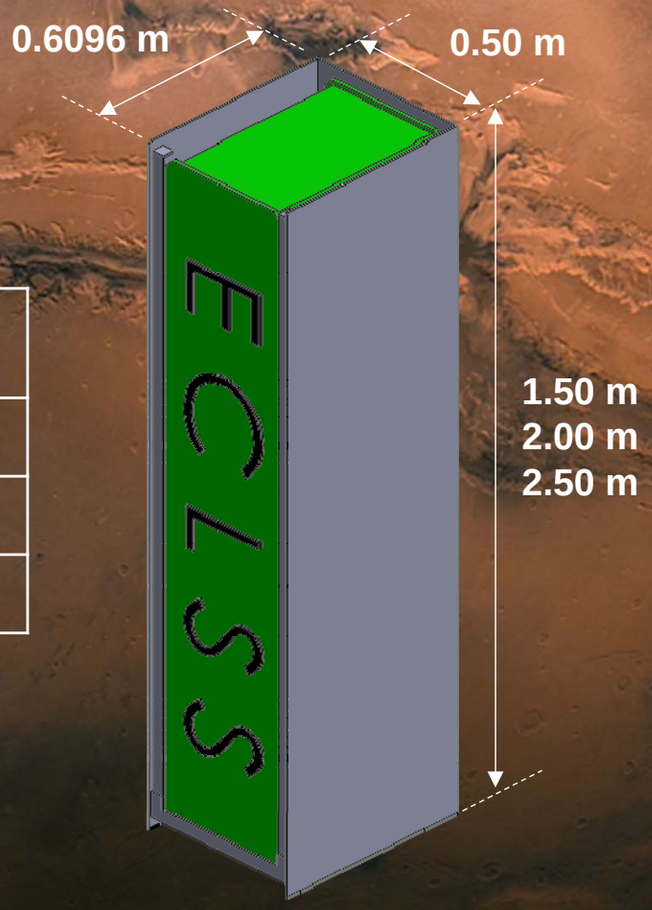
Over 16 m^3 for science equipment

The IDSS vs. The New Rack

Increased IDSS transfer passageway diameter from 0.8m to 1.1m
- Allows for new Rack Insertion Device (RID) to fit through the docking port



Rack Height (m)	Volume (m^3)
1.50	0.4572
2.00	0.6096
2.50	0.7620



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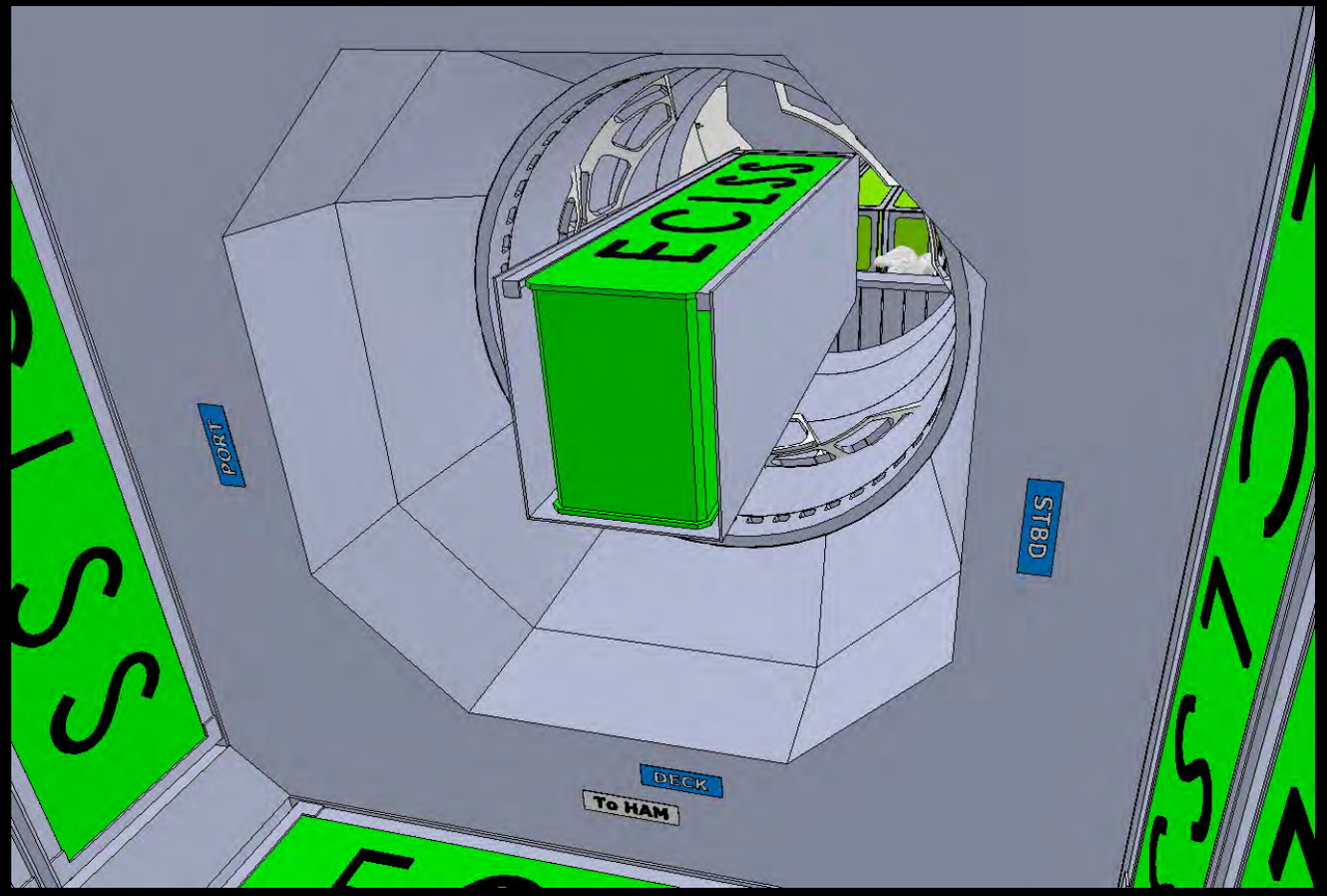

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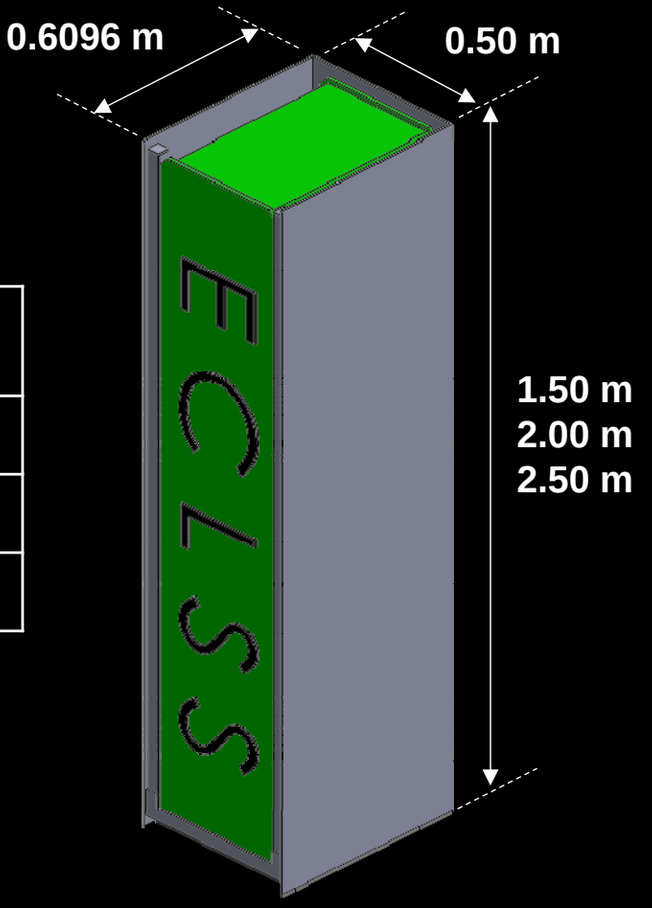
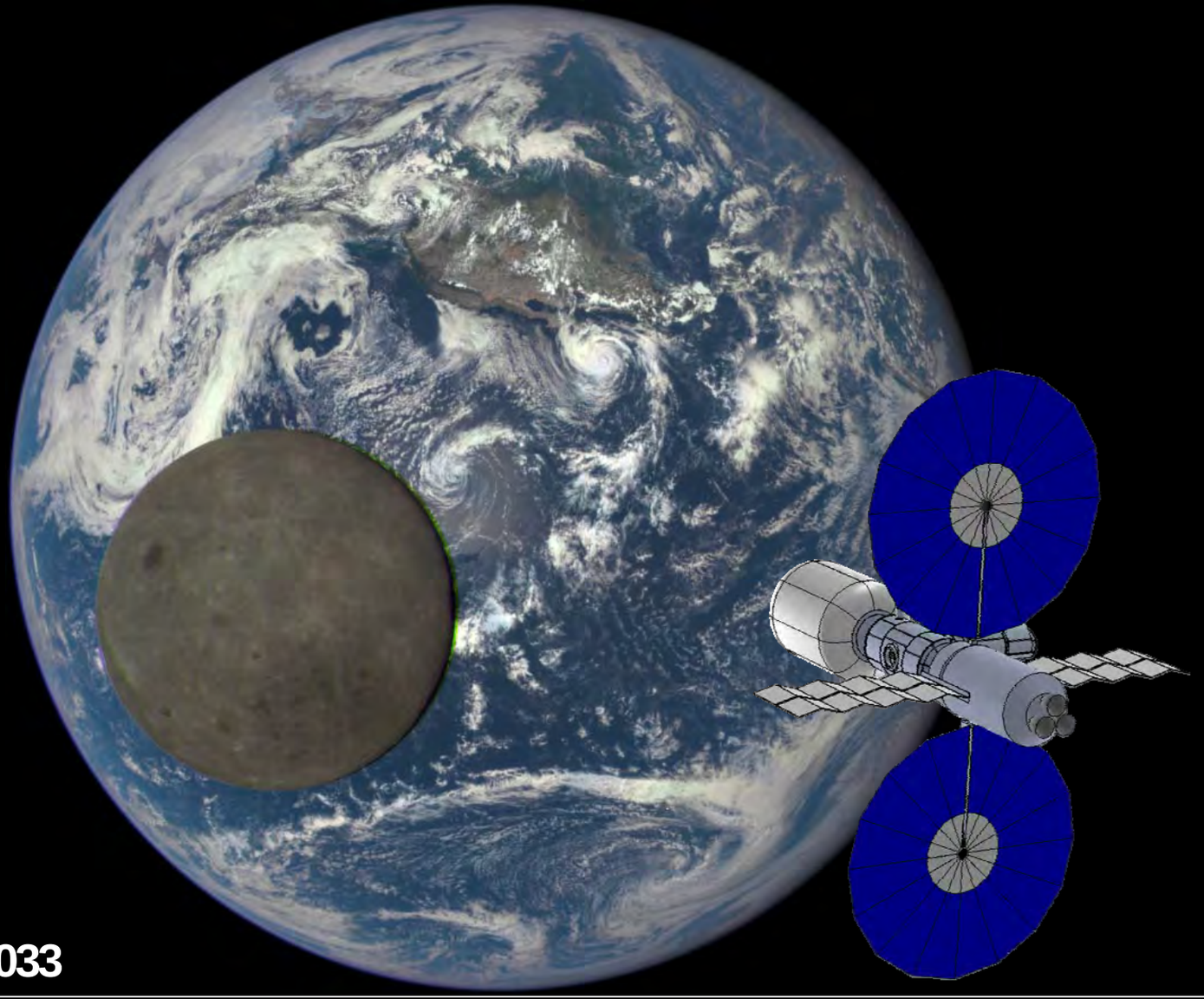


MTV Returns to the DSG



October 28th, 2033


Thank You!

References

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[3] *Price, Hoppy, et al. "A Minimal Architecture for Human Journeys to Mars." New Space, vol. 3, no. 2, 2015, pp. 73–81., doi:10.1089/space.2015.0018.*

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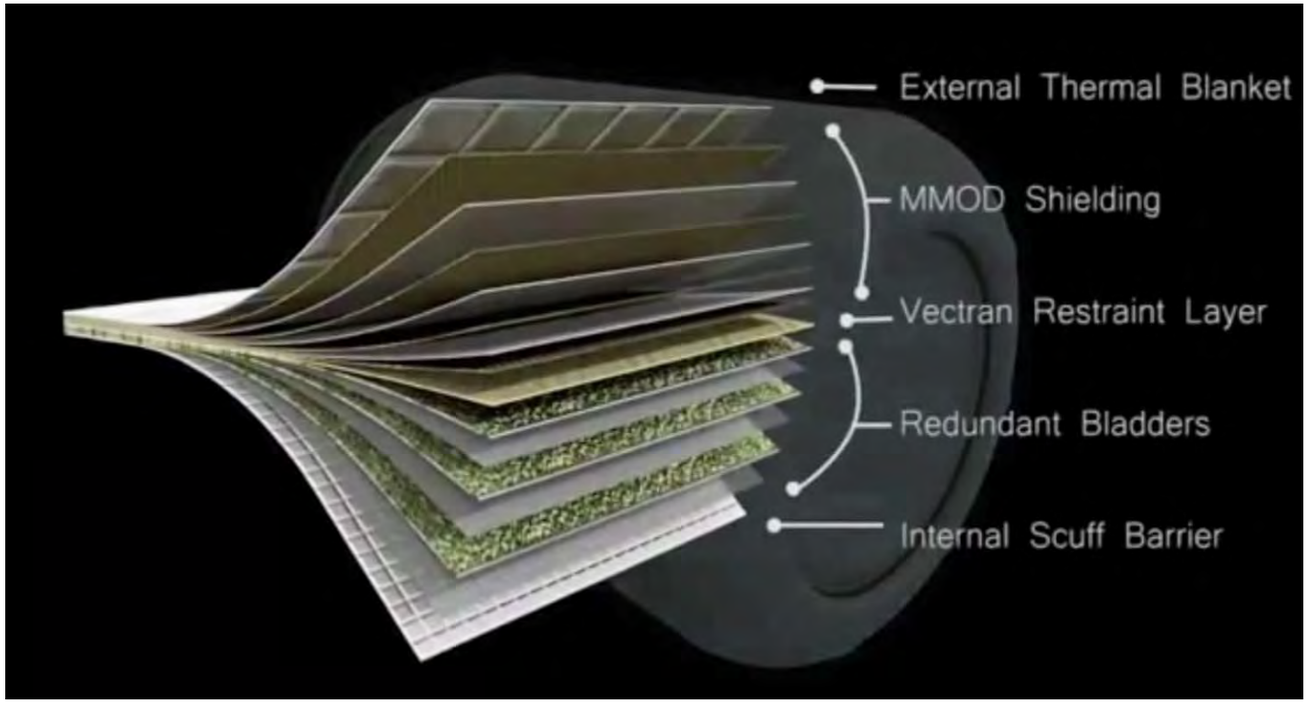
[14] *Lopez, Pedro, et al. "Logistics Needs for Potential Deep Space Mission Scenarios Post Asteroid Redirect Crewed Mission." 2015 IEEE Aerospace Conference, 2015, doi:10.1109/aero.2015.7119161.*



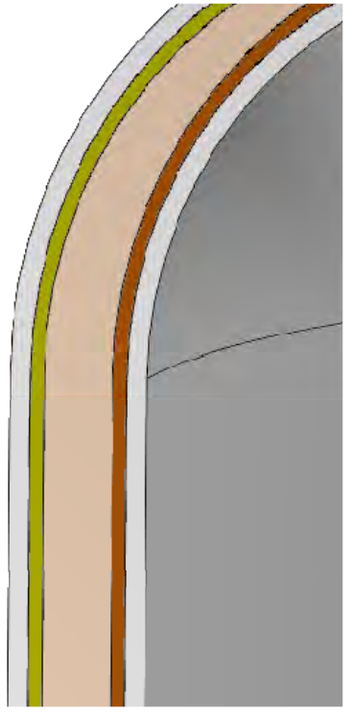
External Thermal Blanket

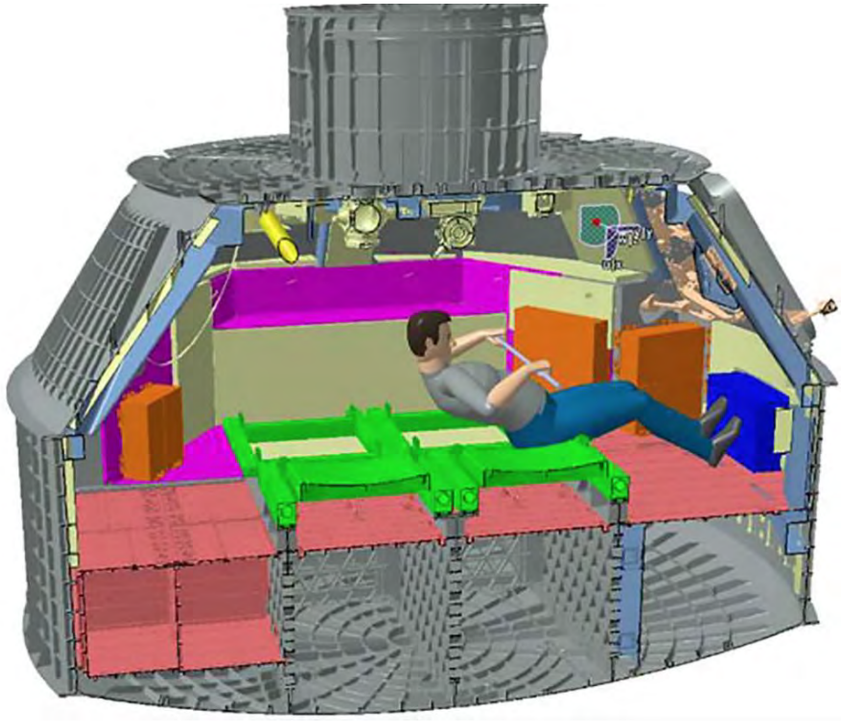
Micrometeoroid Protection

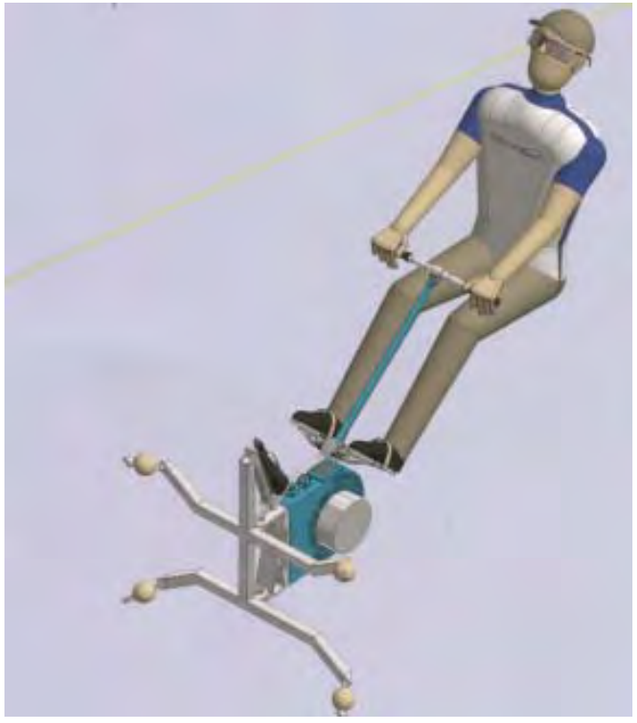
Radiation Protection

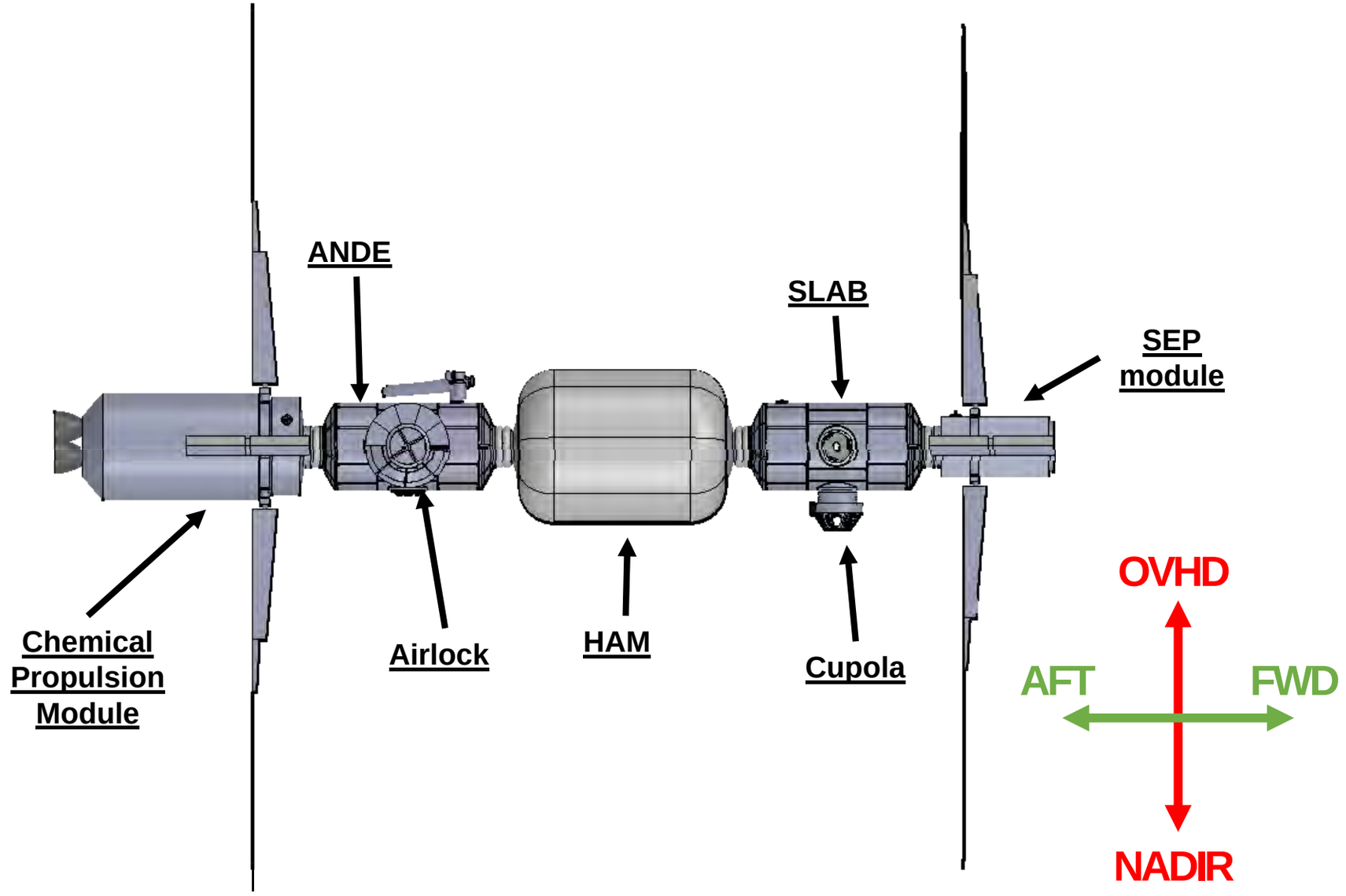
Restraint Layer

Integrated Redundant Pressure Bladders and Internal Scuff Barrier








ANDE
SLAB
SEP module
Chemical Propulsion Module
Airlock
HAM
Cupola
OVHD
AFT
FWD
NADIR

Logistics

Logistics from: *Logistics Needs for Potential Deep Space Mission Scenarios Post Asteroid Redirect Crewed Mission*

- 1000 day closed-loop
- 30 day open-loop contingency

# of Crew	4	5	6
Initial Estimates			
Total Mass (kg)	13,859.74	16,991.42	20,010.46
Total Volume (m^3)	52.91	64.51	75.43
Accounting for Spares			
Total Mass (kg)	15,527.30	19,036.11	22,418.67
Total Volume (m^3)	62.48	76.25	89.26