LUNAR AGRICULTURE MODULE GROUND TEST DEMONSTRATOR

An International Effort to Develop a Full-Scale Testbed for Bioregenerative Life Support

Michel F. Franke, German Aerospace Center (DLR), 08/10/2025

INTRODUCTION

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Research Group

Planetary Infrastructures

Bioregenerative Life Support Systems (BLSS)

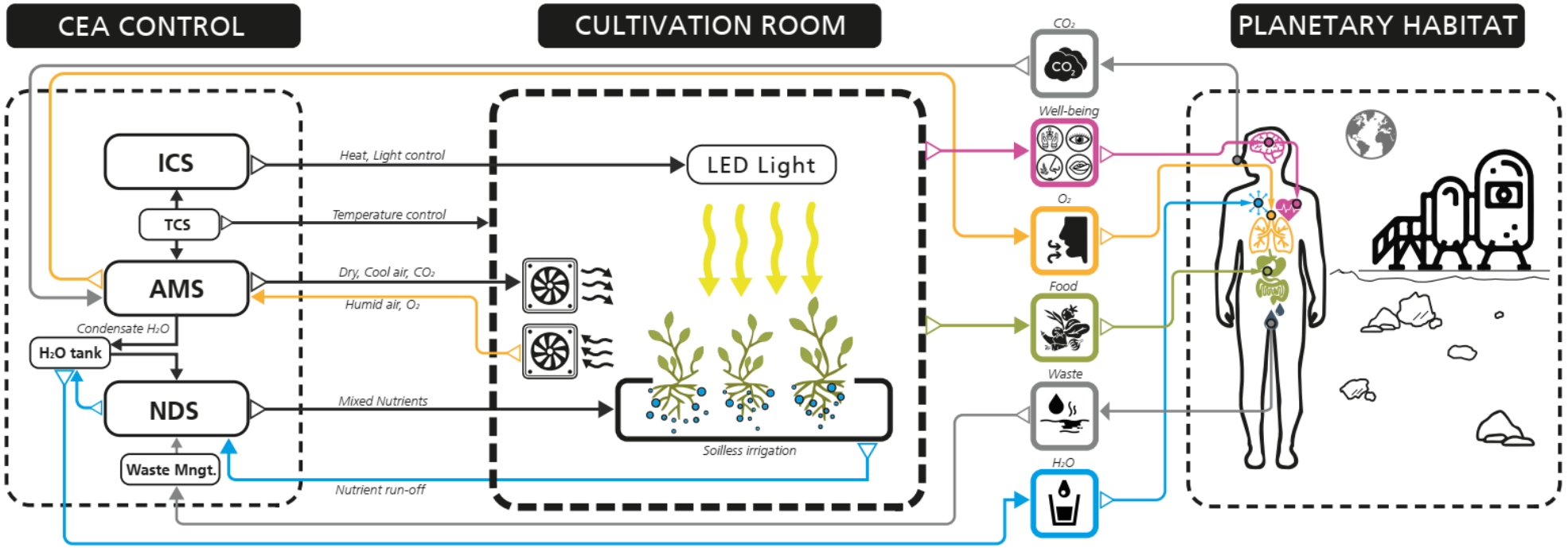
In-Situ Resource Utilization (ISRU)

Deep Space Habitat Development

- System analysis & concurrent engineering studies
- Hardware development, design & procurement
- Assembly, integration & (analogue field) testing
- Operation & technology transfer (e.g. vertical farming)

Research Topic

Bio-regenerative Life Support

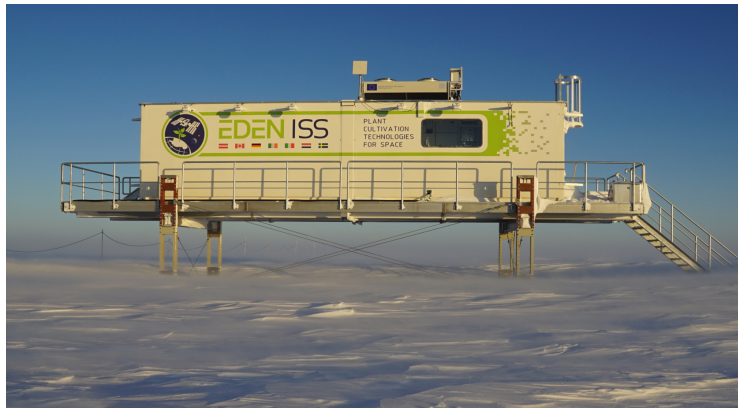


- **Goal:** Creating an artificial symbiosis between plants and humans
- **Input:** CO2-rich air (respiration), water (recycled grey water), nutrients, light
- **Output:** O2-rich air, water (dissolved in air as RH), nutritious biomass, mental well-being

Research Projects

Space Demonstrators and Analogues

EDEN ISS

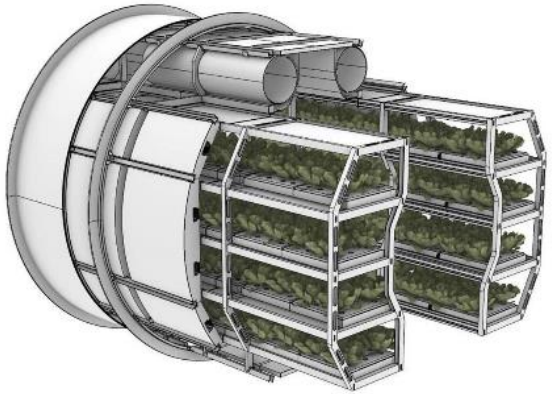


Container-sized plant cultivation test facility in Antarctica.
Built to demonstrate and validate key technologies and procedures necessary for safe food production in harsh environment.

EDEN LUNA

Life extension of the EDEN ISS system with fully redesigned subsystems and a refurbished structure. Attached to the LUNA analog facility in Cologne, operated by DLR/ESA employees & astronauts

LAM-GTD

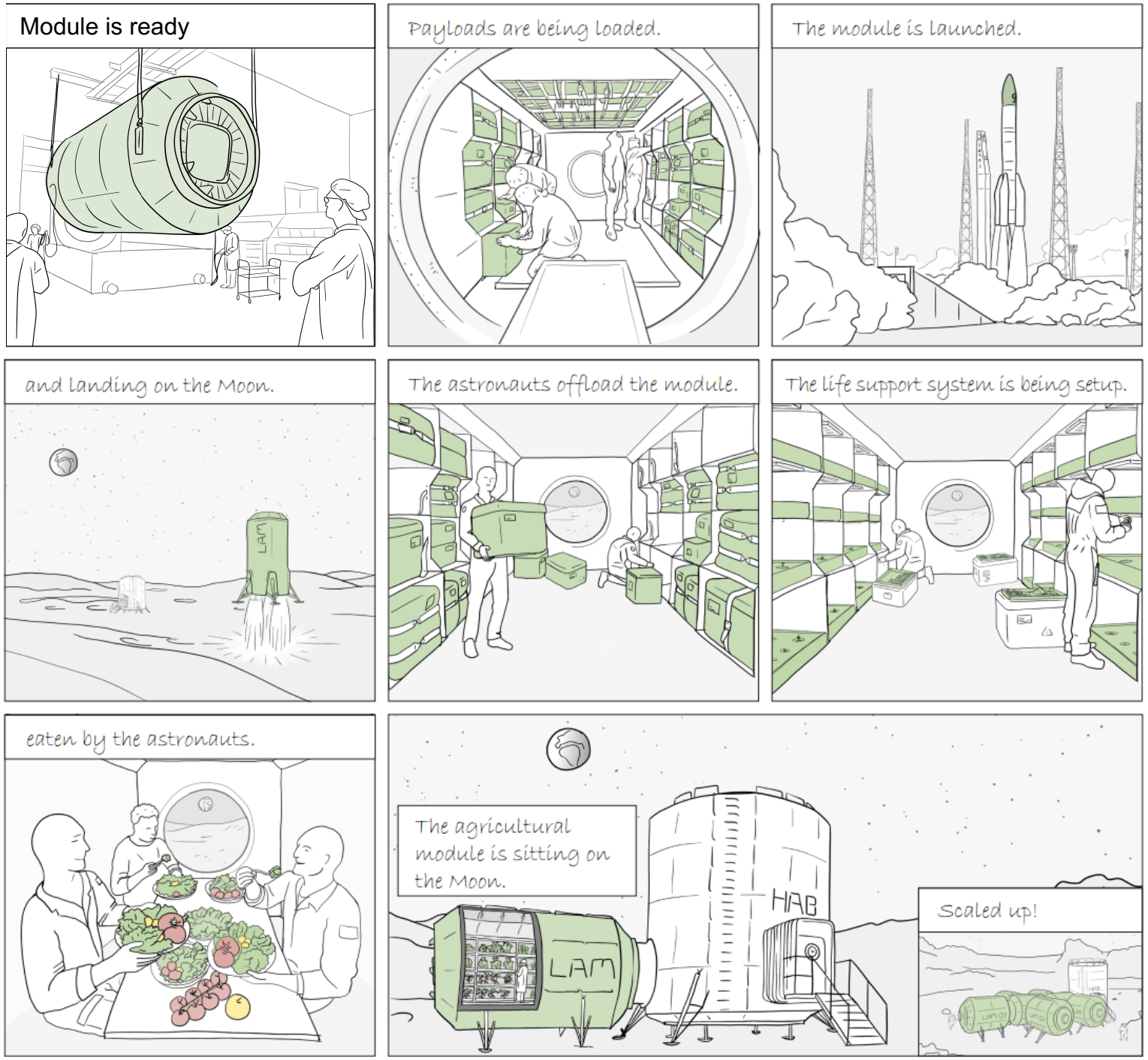


Attempt to take BLSS one step closer to space. It is a cargo module which turns into a lunar greenhouse once it reaches the Moon. The GTD is developed with space in mind, but operated on Earth

Research Goal

L2L

Logistic to Life Support System



DLR

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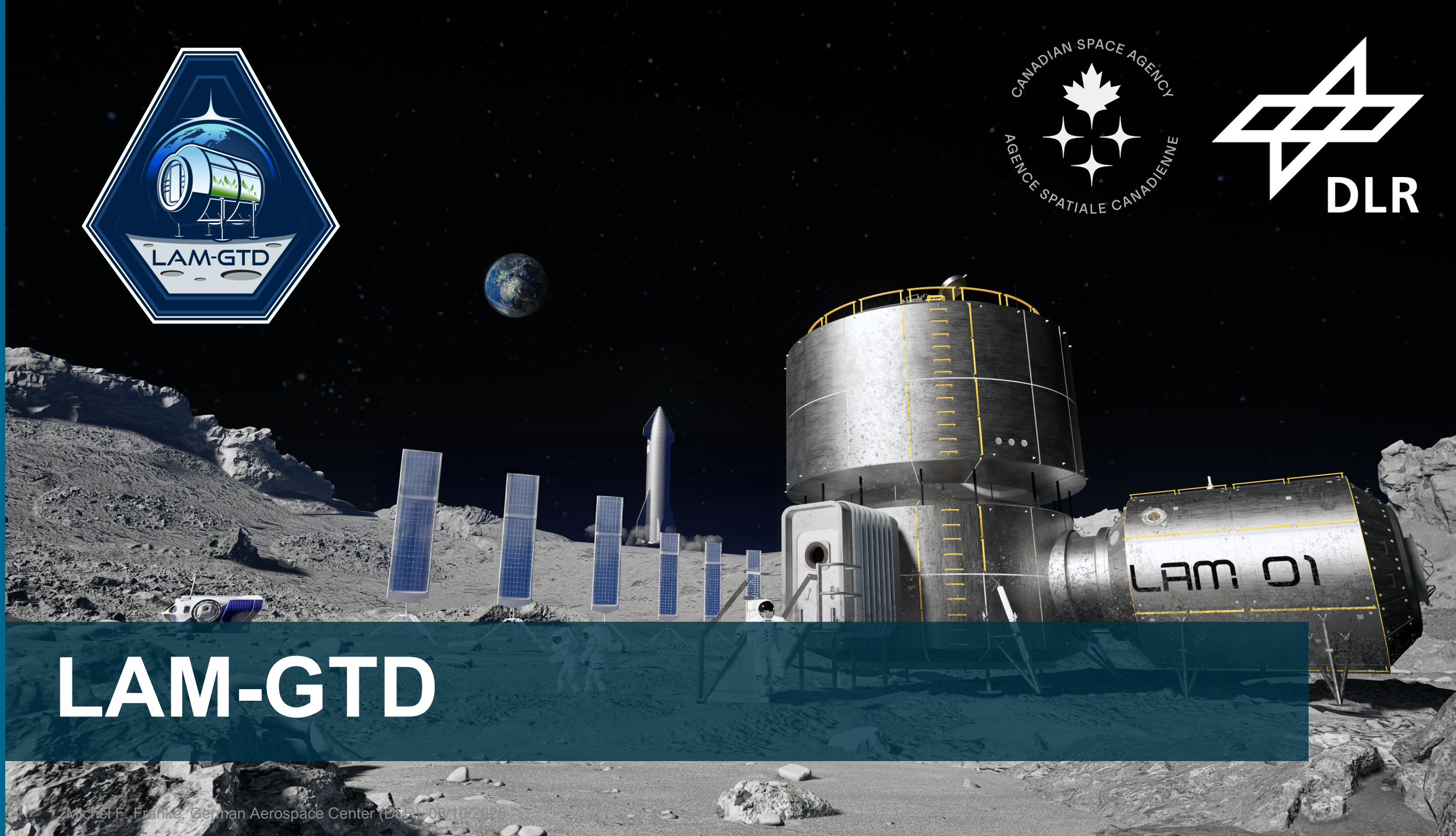

LAM-GTD
CANADIAN SPACE AGENCY
AGENCE SPATIALE CANADIENNE
DLR
LAM 01

LAM-GTD

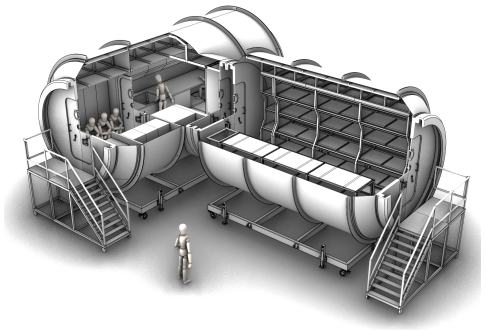
VISION

Laboratory Testing

- CEA breadboard
- Laboratory environment

Analogue Testing

- Integrated system
- Extreme environment



LAM-GTD

- Space-ready system
- Space-like conditions

LAM

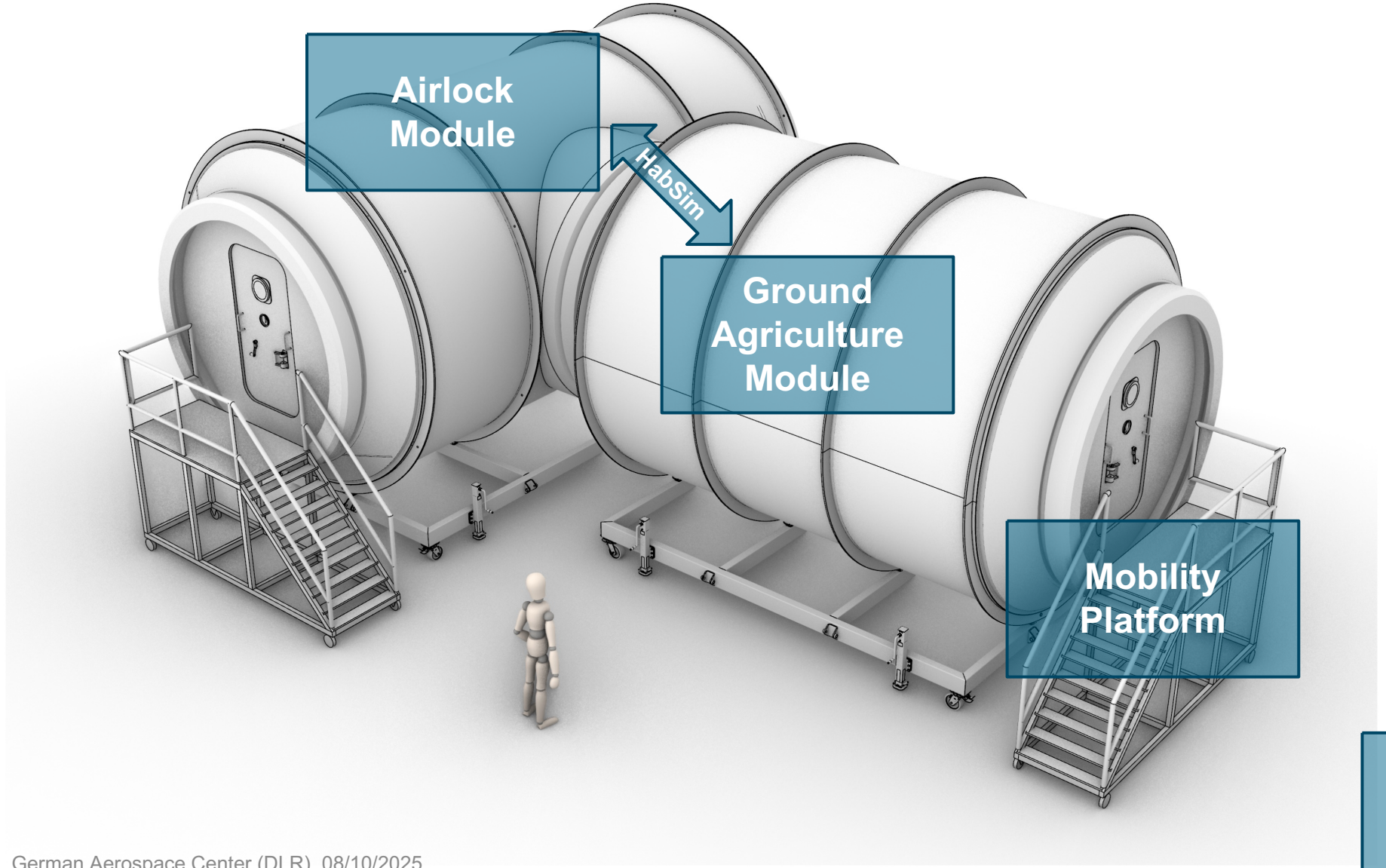
- Full space system
- Lunar environment

- **LAM-GTD:** *Full-size mockup of the LAM with adaptions to terrestrial conditions*
- **LAM:** *Space-grade BLSS to cultivate plants for lunar surface exploration missions*

MISSION

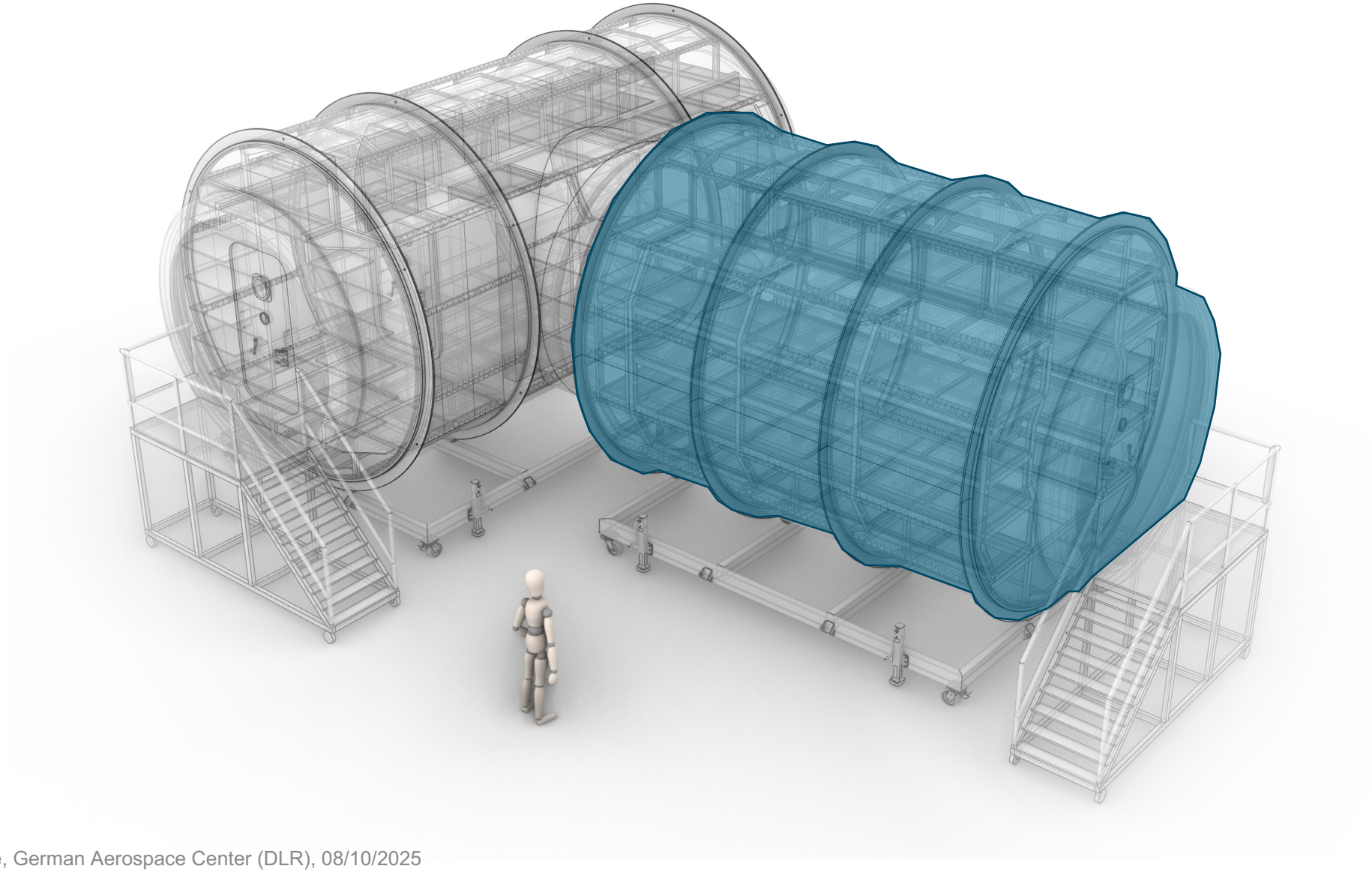
- Ground-based verification of semi-closed loop BLSS for crewed lunar missions
- Provide sufficient growth area to enable research in space food production
- Provide high level of autonomy to reduce crew time during operations
- Contribute to global exploration roadmaps and involve international partners
- Inform related applications on Earth (e.g., in harsh environments)

LAM-GTD

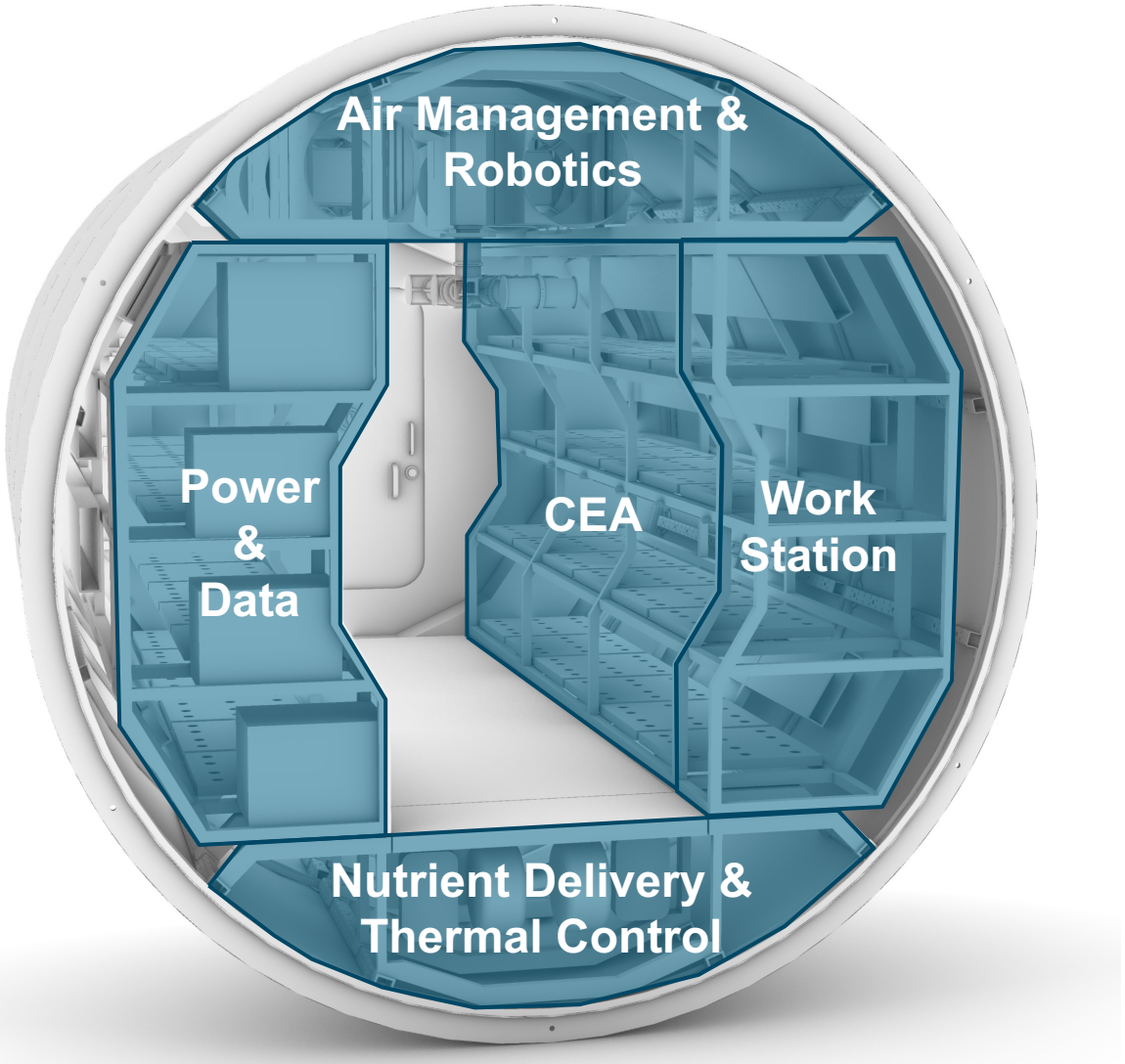


Mission Control Center

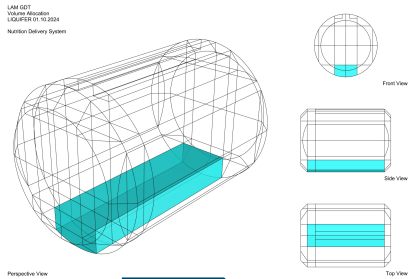
LAM-GTD



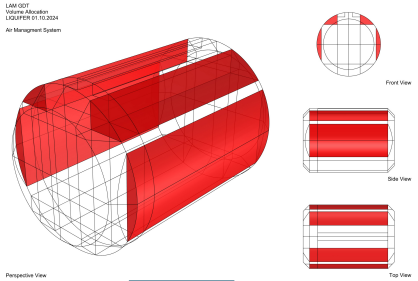
GROUND AGRICULTURE MODULE



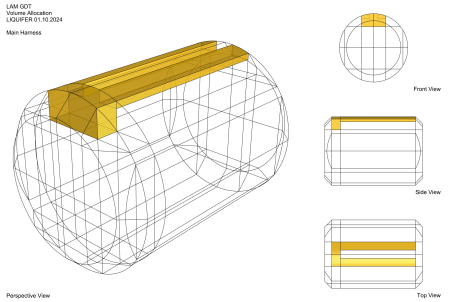
SUBSYSTEMS



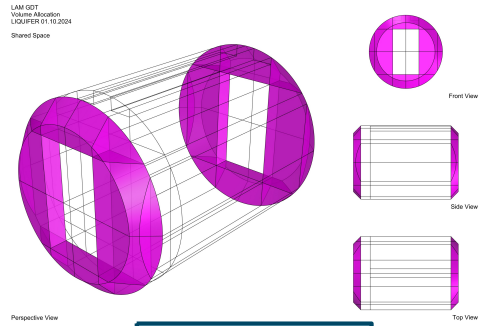
NDS



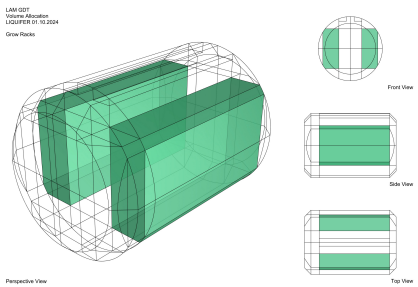
AMS



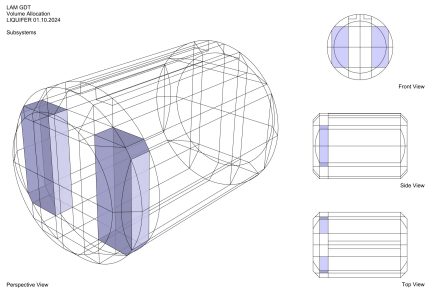
Main Harness



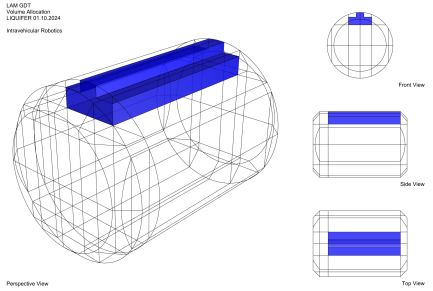
Interfaces



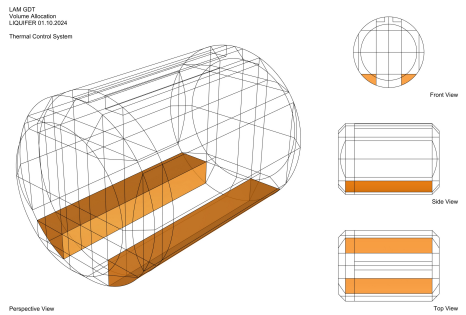
Grow Racks & LCS



EPS, DHCS, Work Station

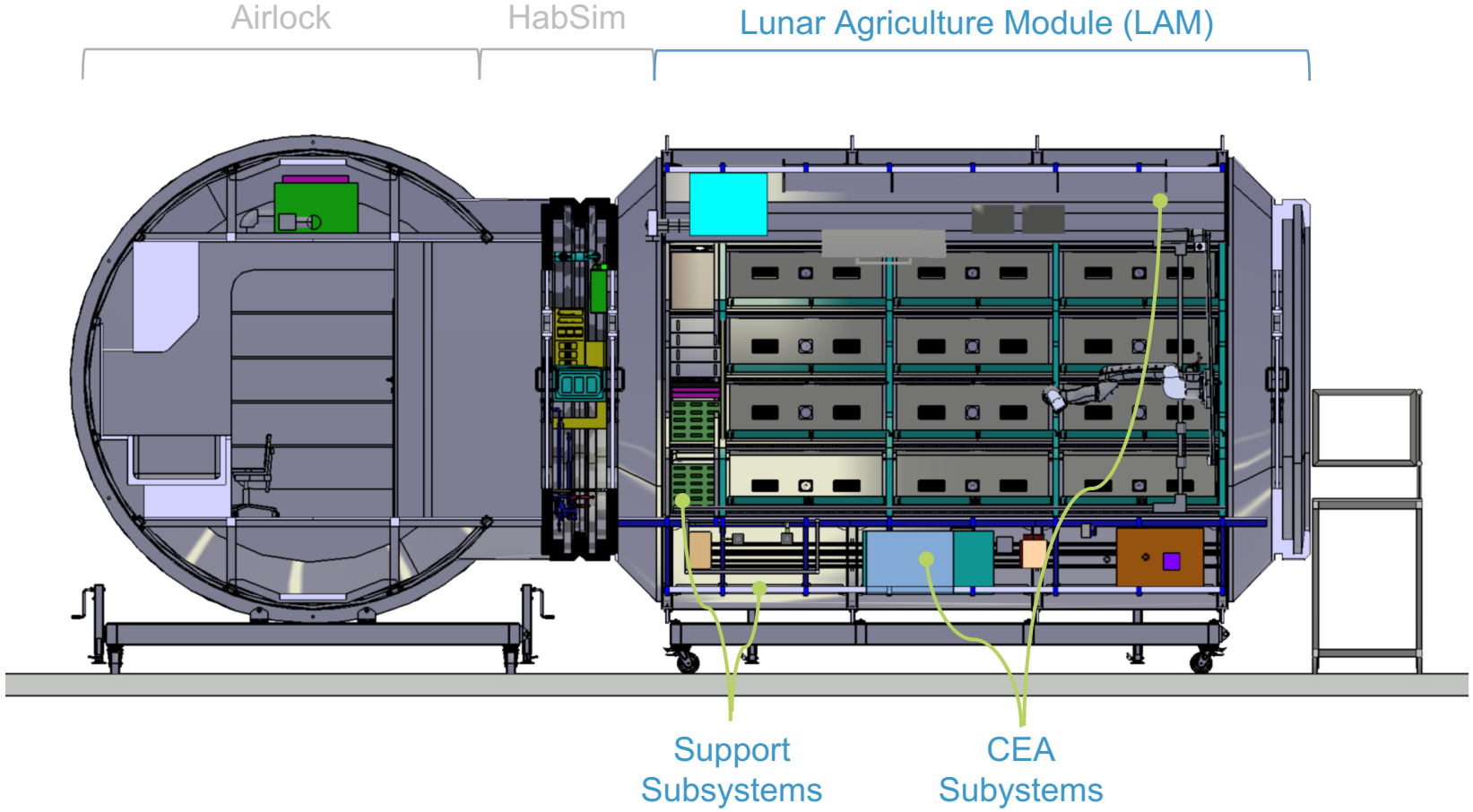


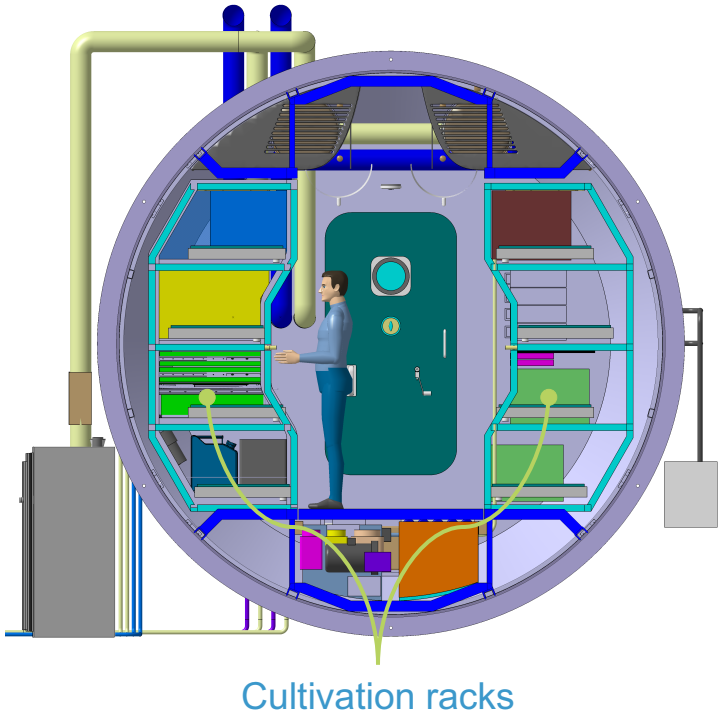
Robotics



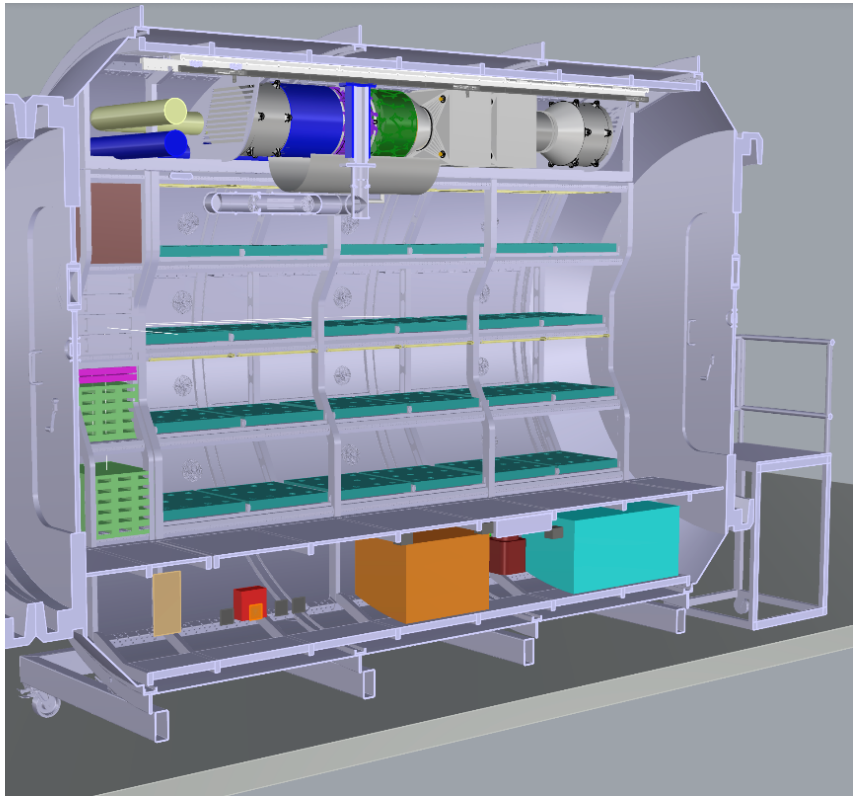
Thermal

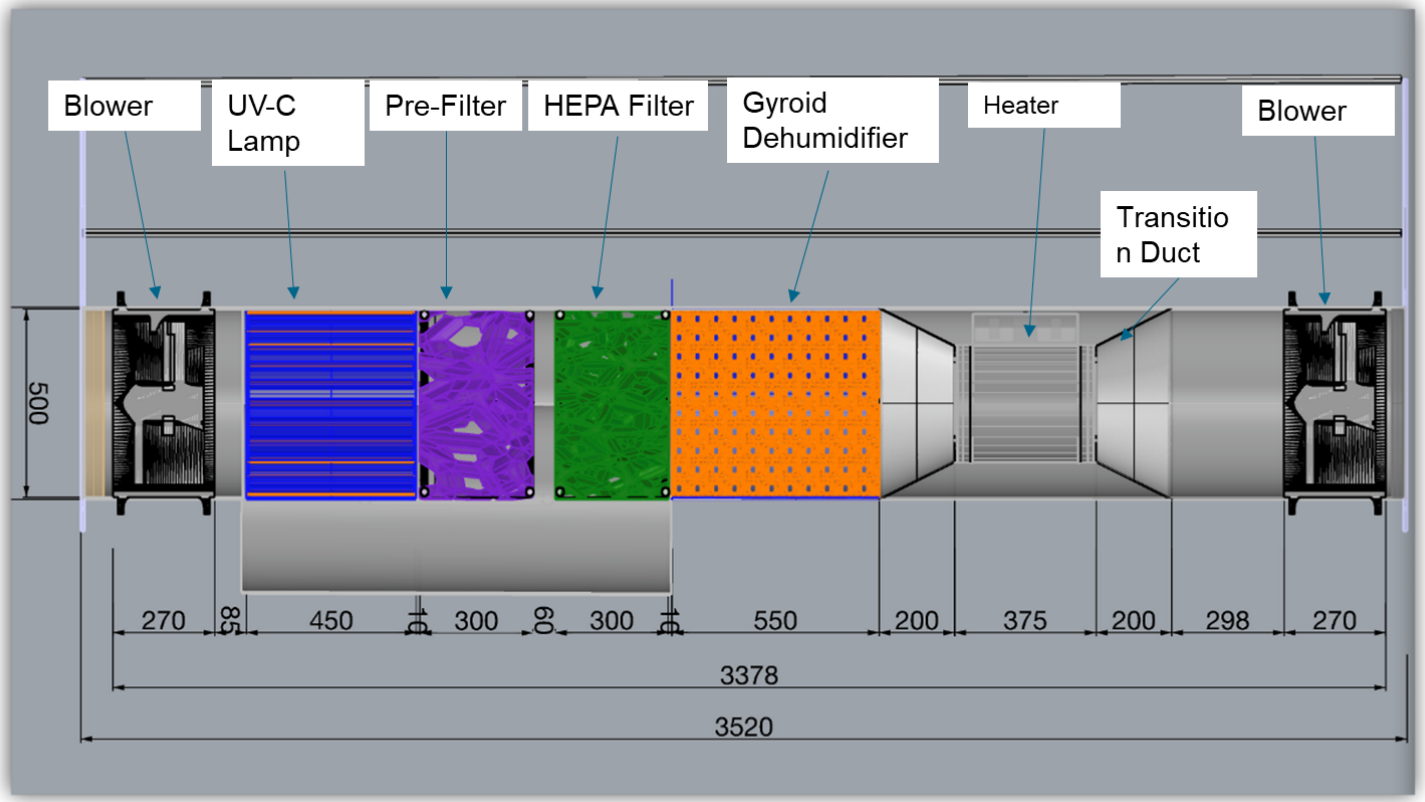
STRUCTURE & CONFIGURATION





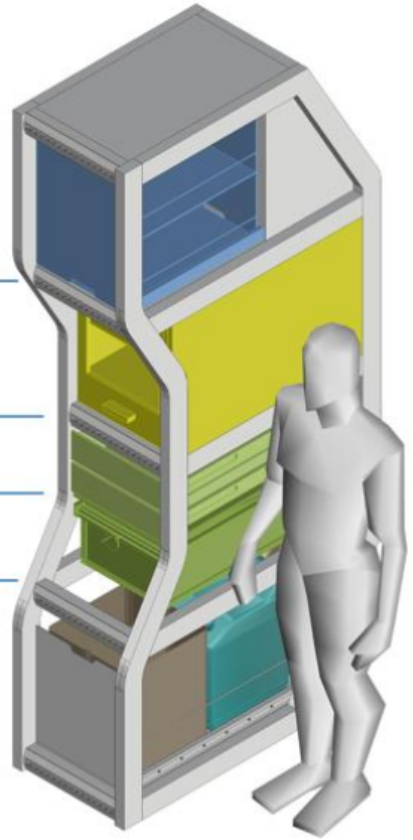
AIR MANAGEMENT SYSTEM

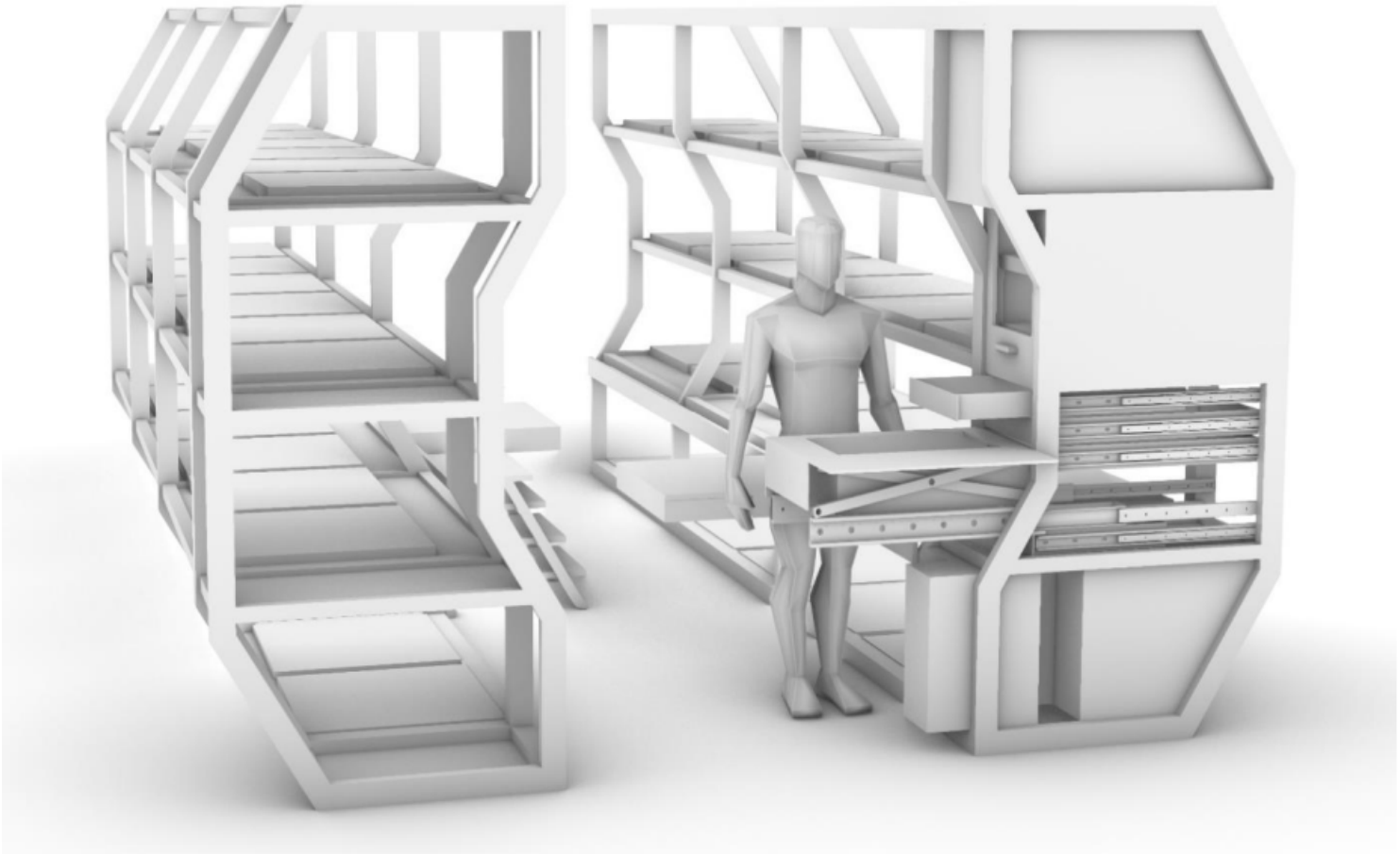




- **Air Pressure:** 57 kPa (34% O2), 70 kPa (26% O2), 101 kPa (21% O2)
- **Temperature:** 16 °C … 27 °C
- **Humidity:** 45 % … 85 %

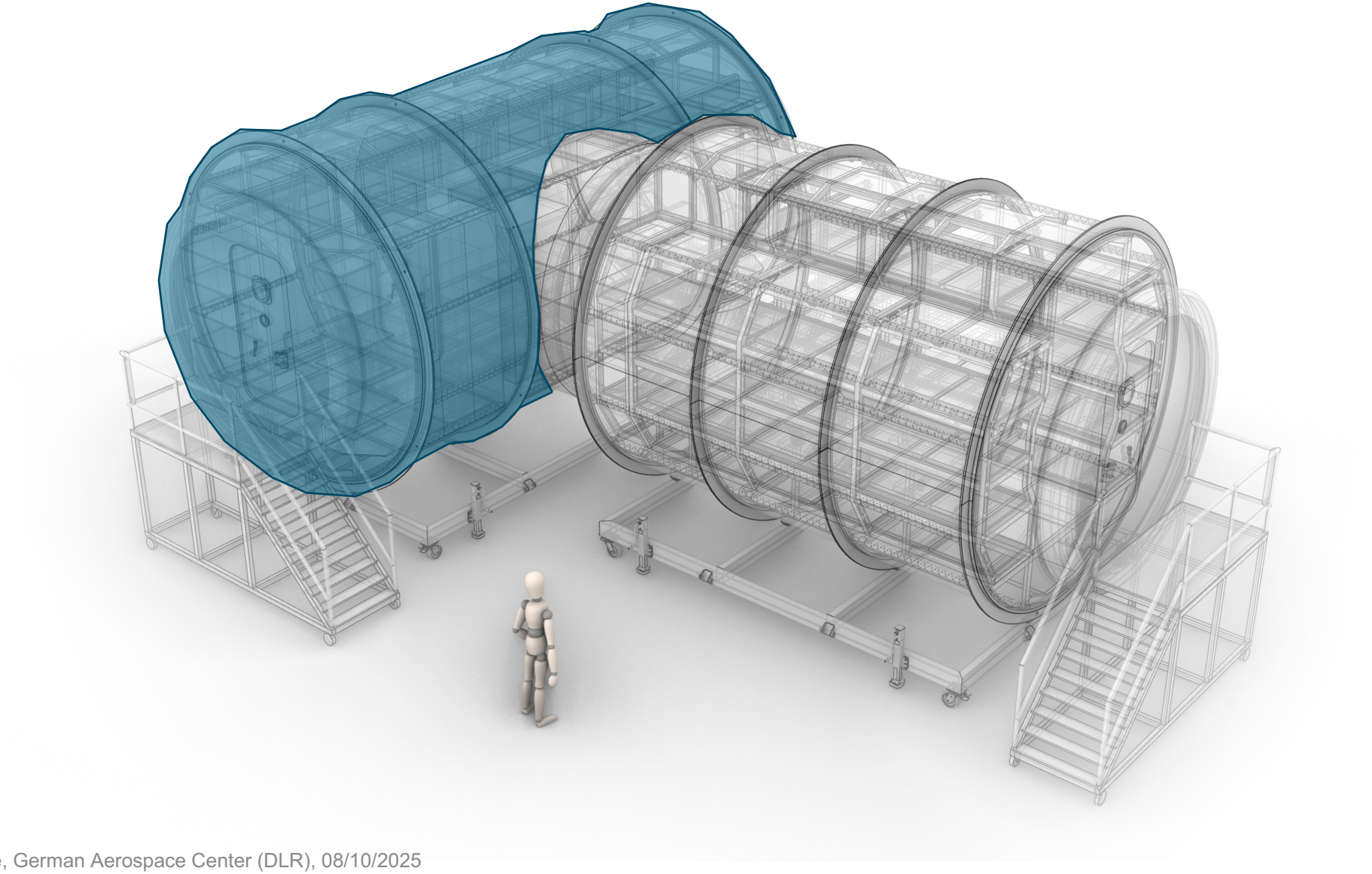
WORK STATION



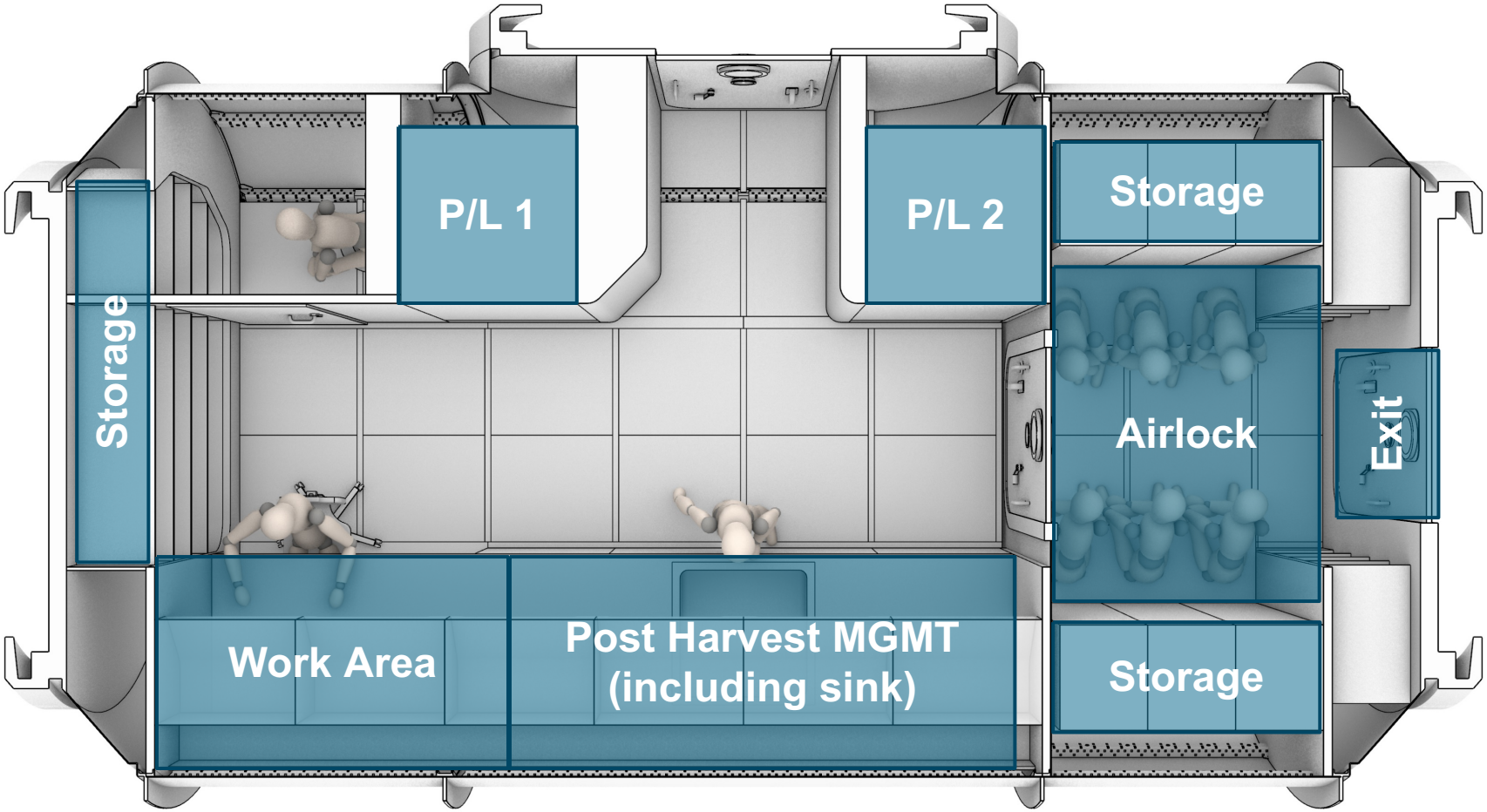


- Developed a human-centered workstation within a single rack to support activities in the GAM
- Focus on human factors, design process followed NASA Human Integration Design

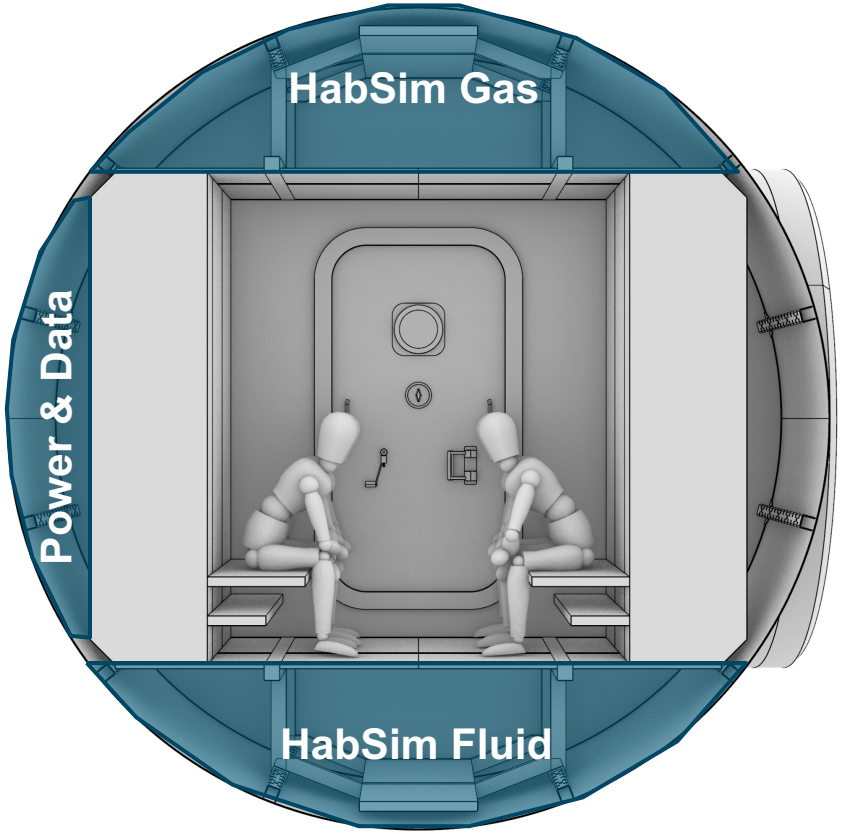
LAM-GTD

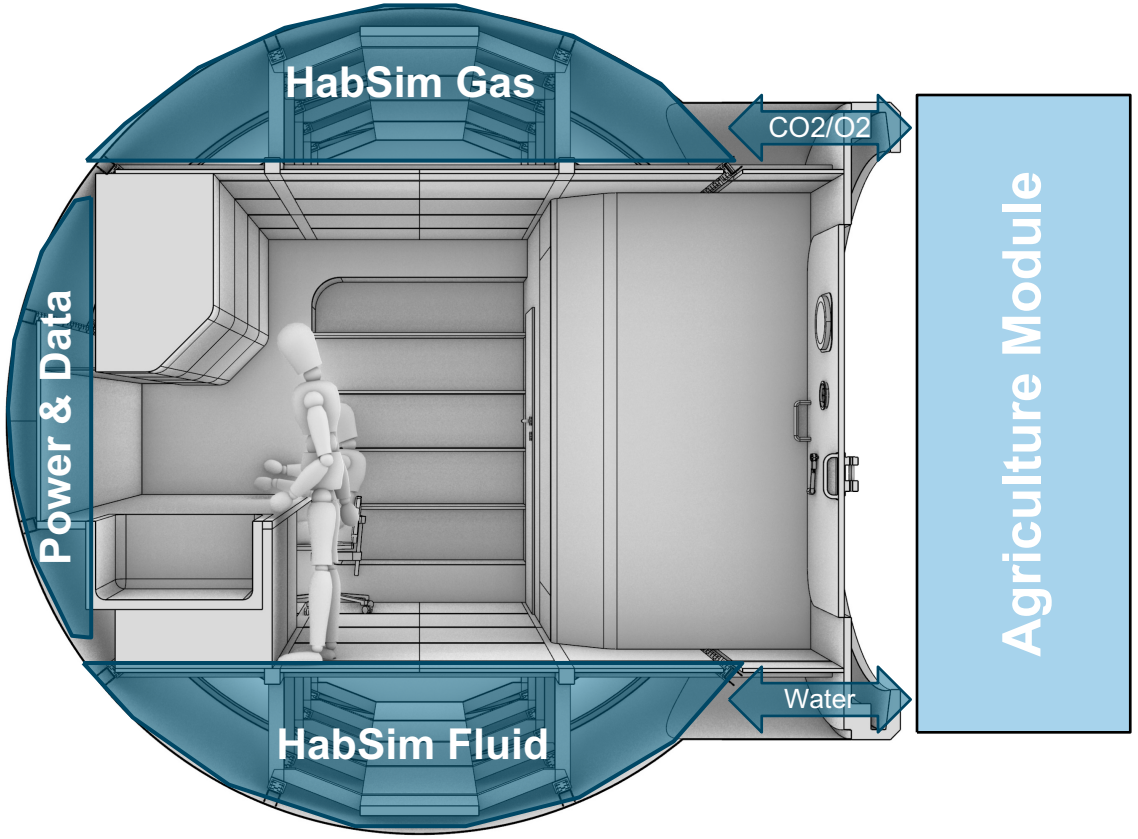


AIRLOCK MODULE

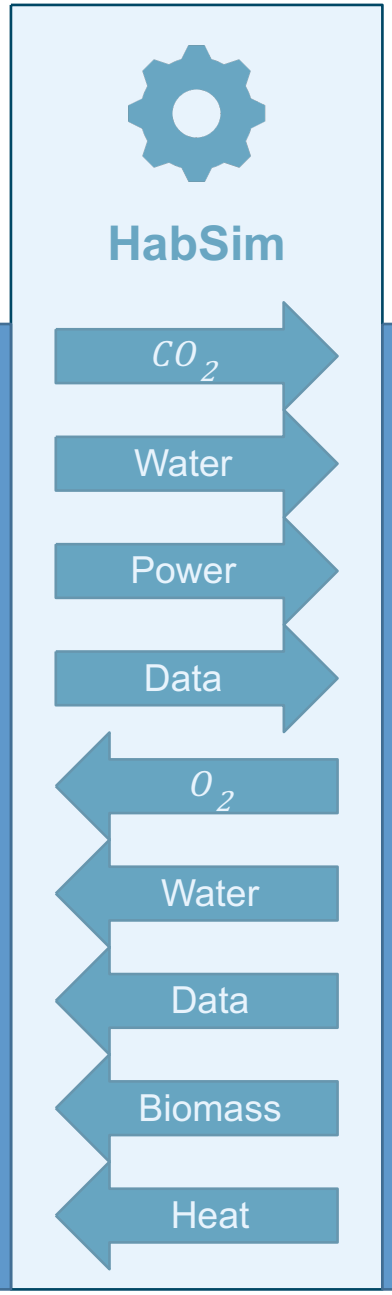


AIRLOCK MODULE





HABITAT SIMULATOR



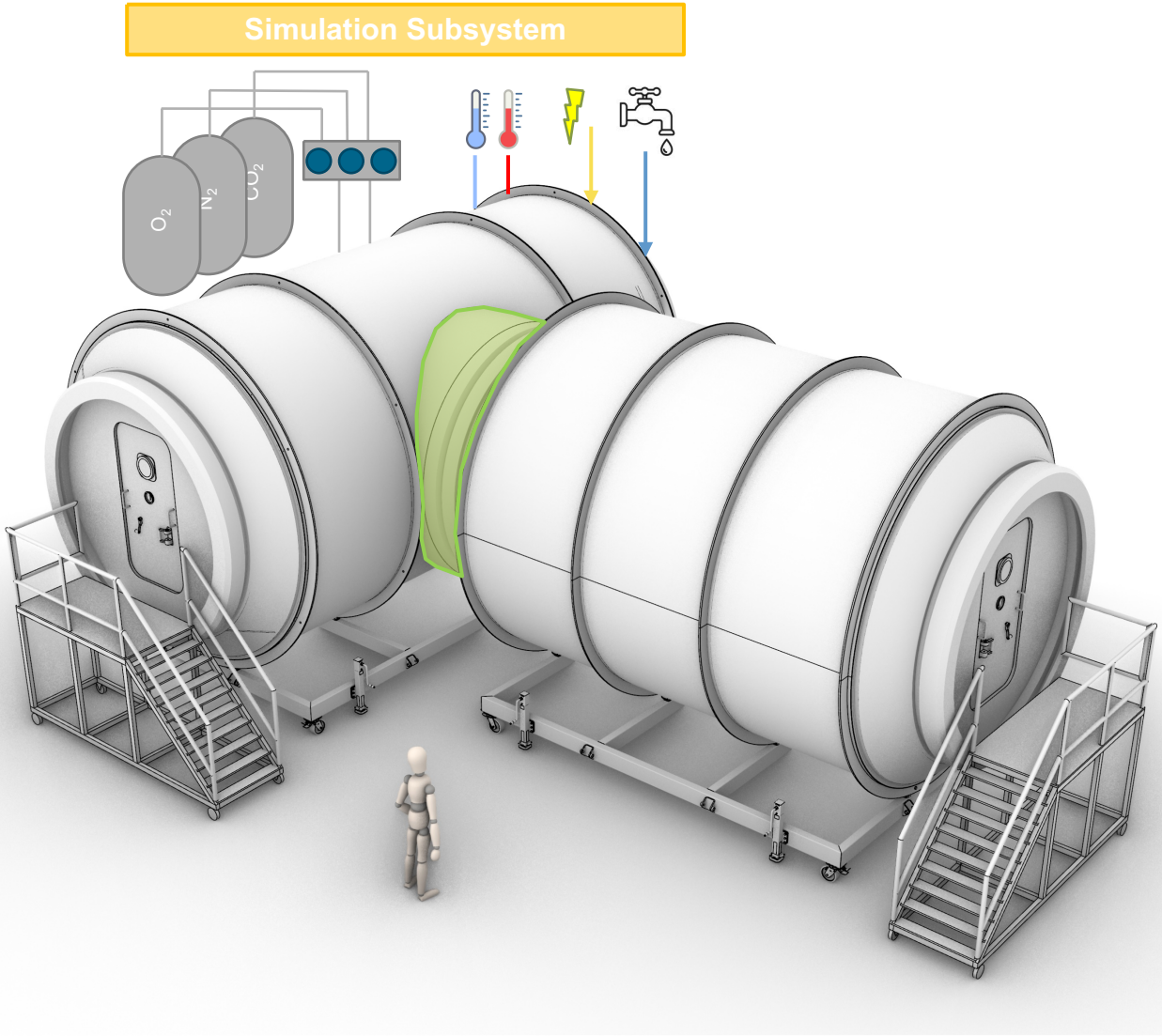
Air Lock Module (ALM)

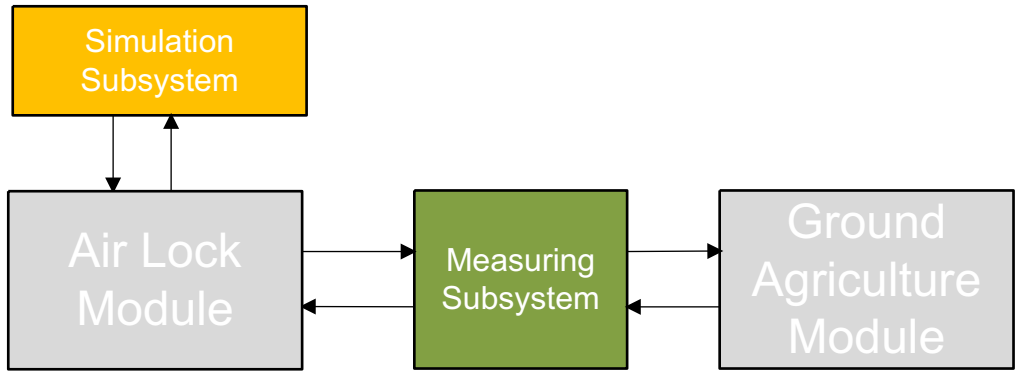
- Fictive crew of 3
- Power supply (400 V 3ph)
- Heat rejection (e.g. radiators)
- Communication (e.g. antenna)
- Food processing & storage
- Payloads

Ground Agriculture Module (GAM)

- Plant growth area
- Power consumers (28 V DC)
- CEA subsystems (AMS, NDS, LCS)
- Support subsystems (DHCS, EPS, TCS)
- Work area (nursery, storage, waste etc.)

HABITAT SIMULATOR





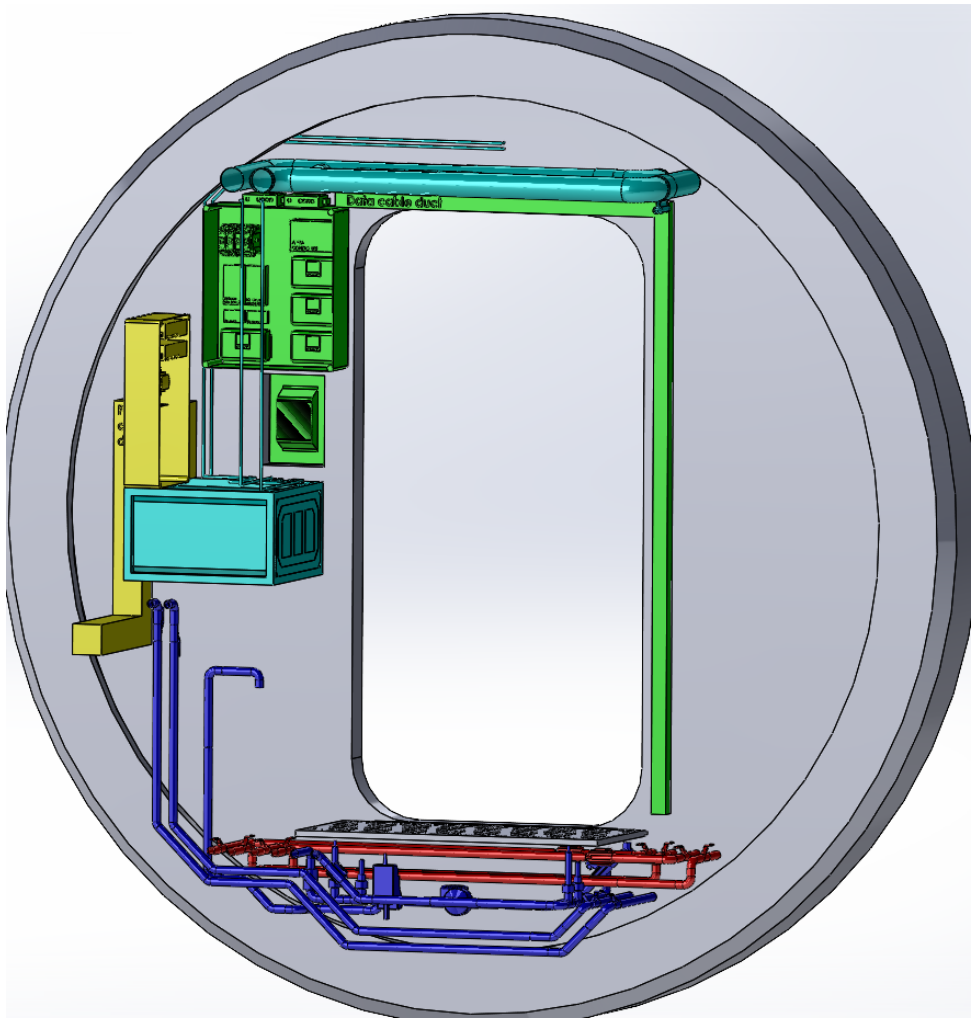
Simulation Subsystem

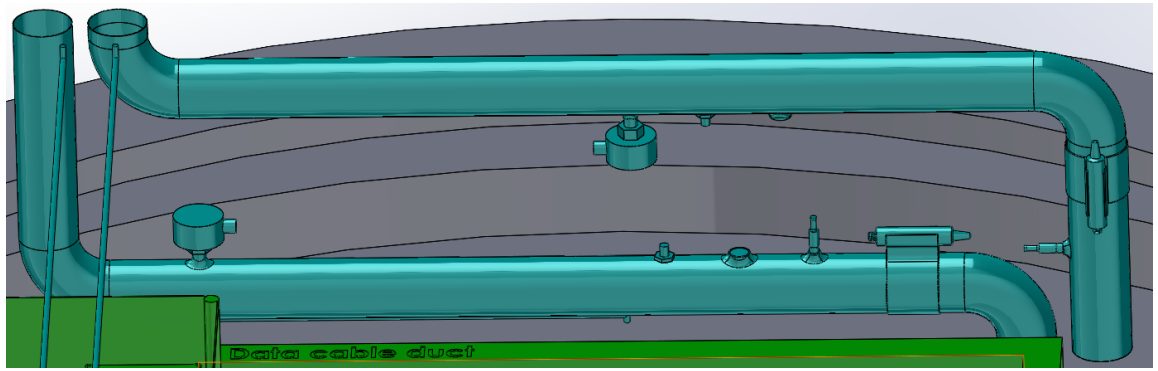
Simulates fluxes between LAM-GTD and an imaginary space habitat (like moon base or lunar gateway)

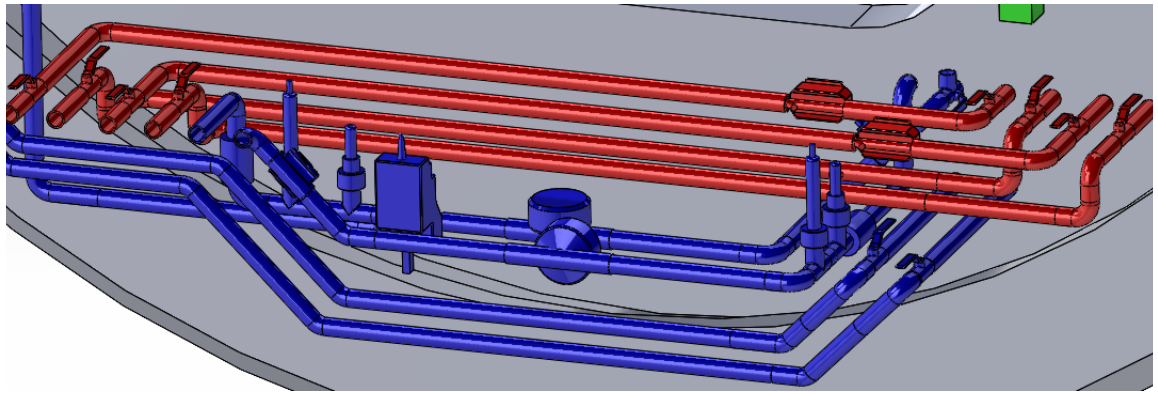
Measuring Subsystem

Measures fluxes between the modules ALM and GAM of the LAM-GTD

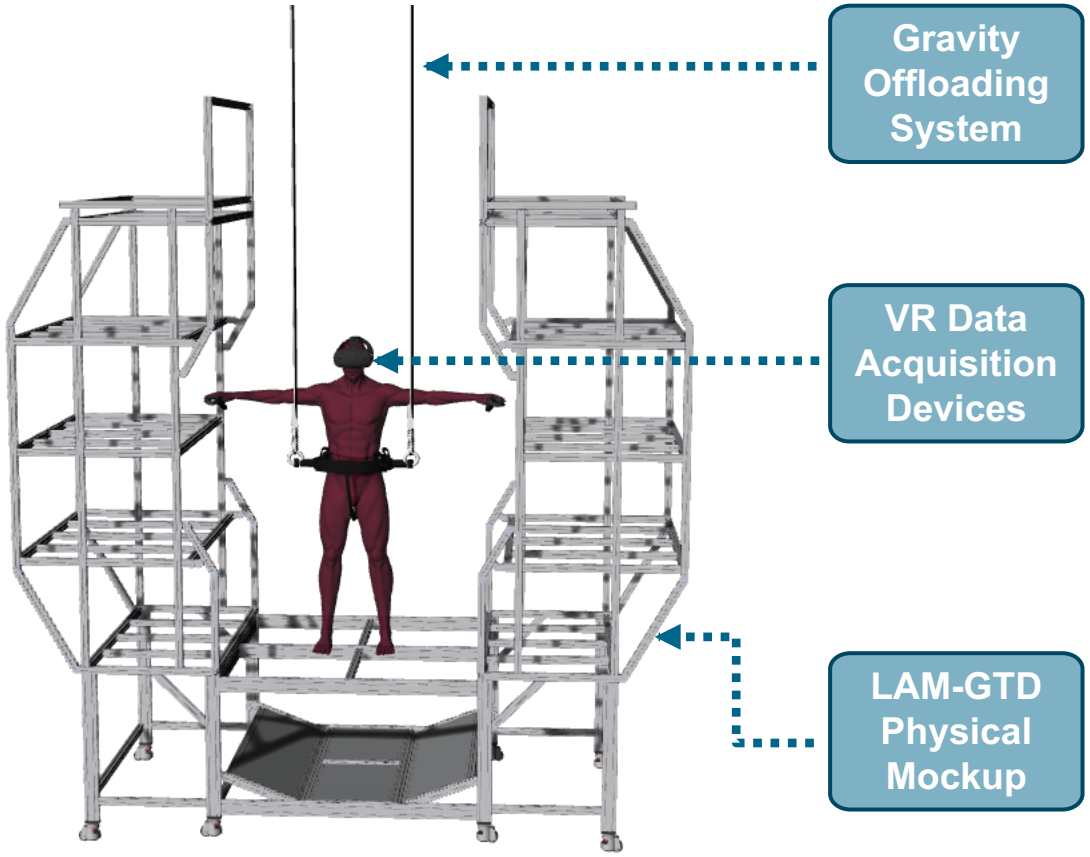
HABITAT SIMULATOR







LAM REDUCED GRAVITY SIMULATOR



- Investigating the impact of lunar gravity on Human Factors and Behavioral Performance during intravehicular activities within the GAM, under a simulated hypo-gravity environment

Now over to you, Jared!

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Date: 2025-10-08

Author: Michel Fabien Franke et al.

Institute: German Aerospace Center, Institute of Space Systems

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