EDEN ISS: Plant Production Facility Ground Testing

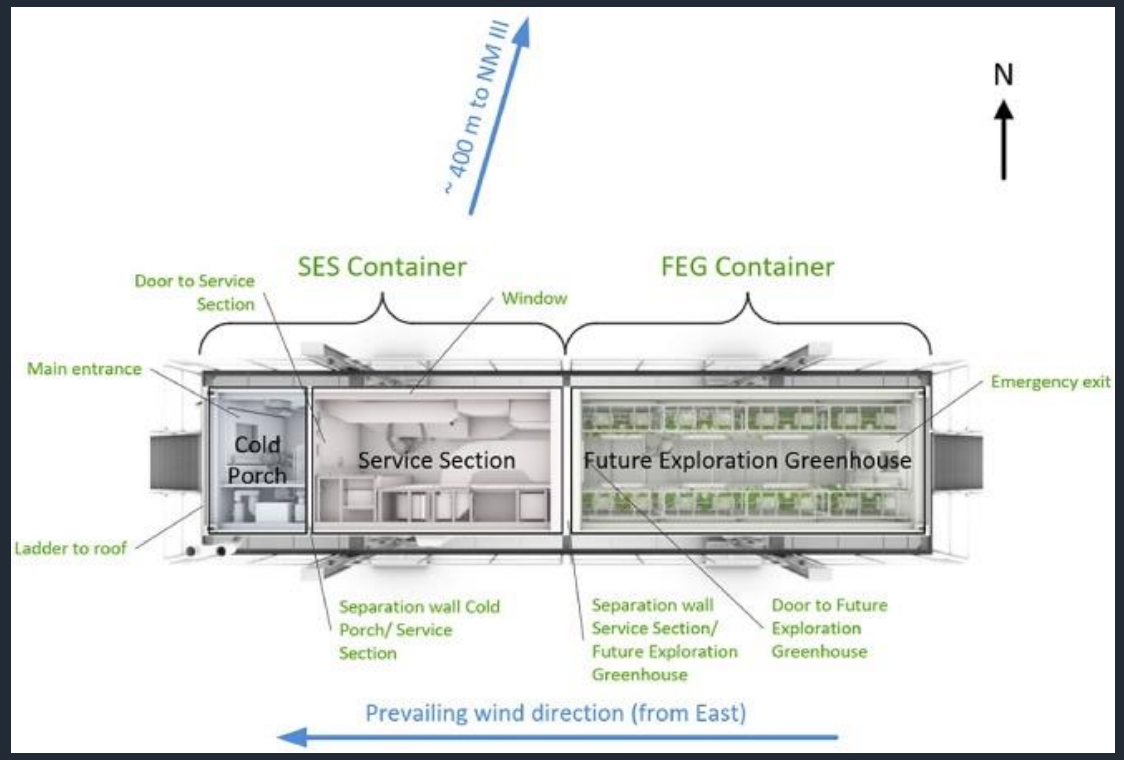
Presented by **Jess M. Bunchek** to the

National Academies of Sciences, Engineering, and Medicine – Committee on Biological and Physical Sciences in Space (CBPSS)

March 20, 2024 | Contact: jess.bunchek@dlr.de

Photo: J. Bunchek

EDEN ISS – Overview



- Neumayer Station III, Antarctica (70°S 8°W)
- 12.5 m^2 crop cultivation space with aeroponics
- >1 metric ton total fresh vegetables, fruit, and herbs

Graphic & Photo: DLR; Video: J. Bunchek

EDEN ISS – Overview

- Neumayer Station III, Antarctica (70°S 8°W)
- 12.5 m^2 crop cultivation space with aeroponics
- >1 metric ton total fresh vegetables, fruit, and herbs

Graphic & Photo: DLR; Video: J. Bunchek

EDEN ISS – Overview

Overwintering: 14-15 months
Isolation phase: 9-11 months

2018 2019 2020 2021

Volunteer Operators (overwintering crew of 9)

Dedicated Operator (overwintering crew of 10)

Photos: DLR, E. Horvath, AWI, L. Ort

EDEN ISS – Data Collection & Research Areas

Systems Configuration & Analysis
- Power requirement
- Supplemental CO_2 requirement
- Data handling & transfer

Consumables
- Freshwater & nutrient consumption
- Wastewater production

Hardware
- Remote monitoring & data capturing capabilities
- Remote daily photographs
- Plant health monitoring cameras
- Supplies & spare parts
- NASA passive system prototype

Horticulture
- Testing new crops
- Data taken at plant level
- Fresh edible and inedible biomass
- Nutrition subsamples
- Crop stress & multispectral imaging (University of Florida)

Micro/Molecular Biology
- Surface swab, nutrient solution, and plant tissue sampling

Crew Time
- Collected in greater detail
- NASA Task Load Index workload assessment

Crew Metrics
- Expanded from ISS Veggie crew surveys (U Penn/Charité)
- Gut microbiome (Ludwig Maximilian University - Munich)

RESEARCH CAMPAIGN: BLiSS

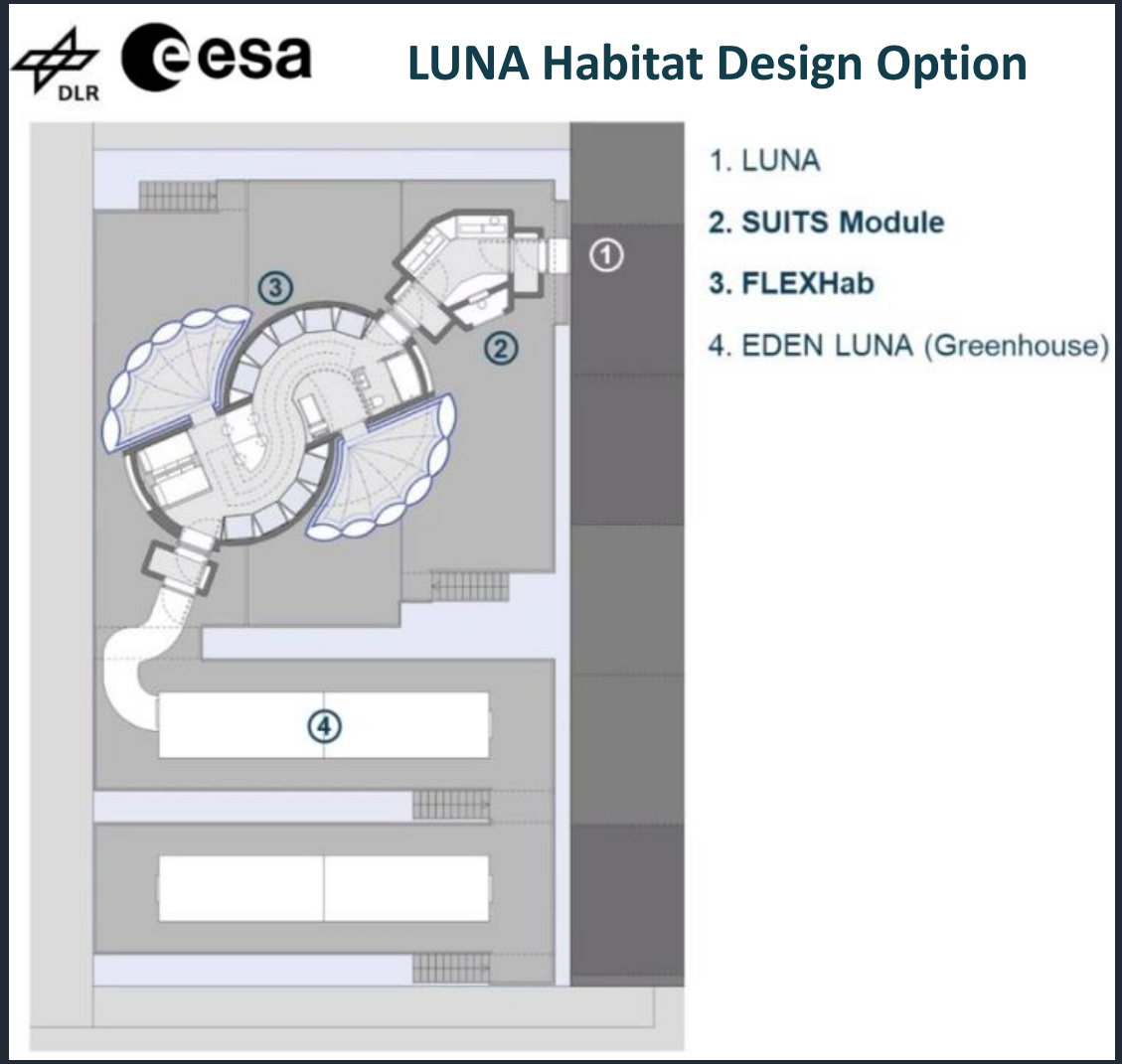
- Develop self-sustainable biological life-support systems that produce food, clean water, renew air, process waste, and create critical materials to meet the challenges of long-duration space missions.
- Harness beneficial properties of plants and microbes that will enable humans to live in space, independent of resupply from Earth.
- Create a highly functioning, robust, and resilient ecosystem and space environment that is self-sustainable under extraterrestrial radiation and gravity conditions.
- Enable long-duration (>3 years) exploration of deep space by providing a fully or partially closed–loop biological life-support systems.

Items in red represent BLiSS research goals not included EDEN ISS.

Next Steps – EDEN LUNA

- Use refurbished/reoutfitted EDEN ISS infrastructure
- New controlled environment agriculture (CEA) technologies, using lessons learned from EDEN ISS & recognized research goals
- Expand test campaigns of a nearly closed BLiSS
  - Robotic support
  - C.R.O.P. – Nutrient filter for producing plant nutrients from urine
  - Astronaut-in-the-loop (EAC)
  - AI risk analyses
- EDEN integration in Cologne: Q1/2026
- Initial operation for 2026, designed for use through 2029

LUNA analog facility



Graphics: DLR/ESA

Next Steps – LAM-GTD

Lunar Agricultural Module Ground Test Demonstrator (LAM-GTD)

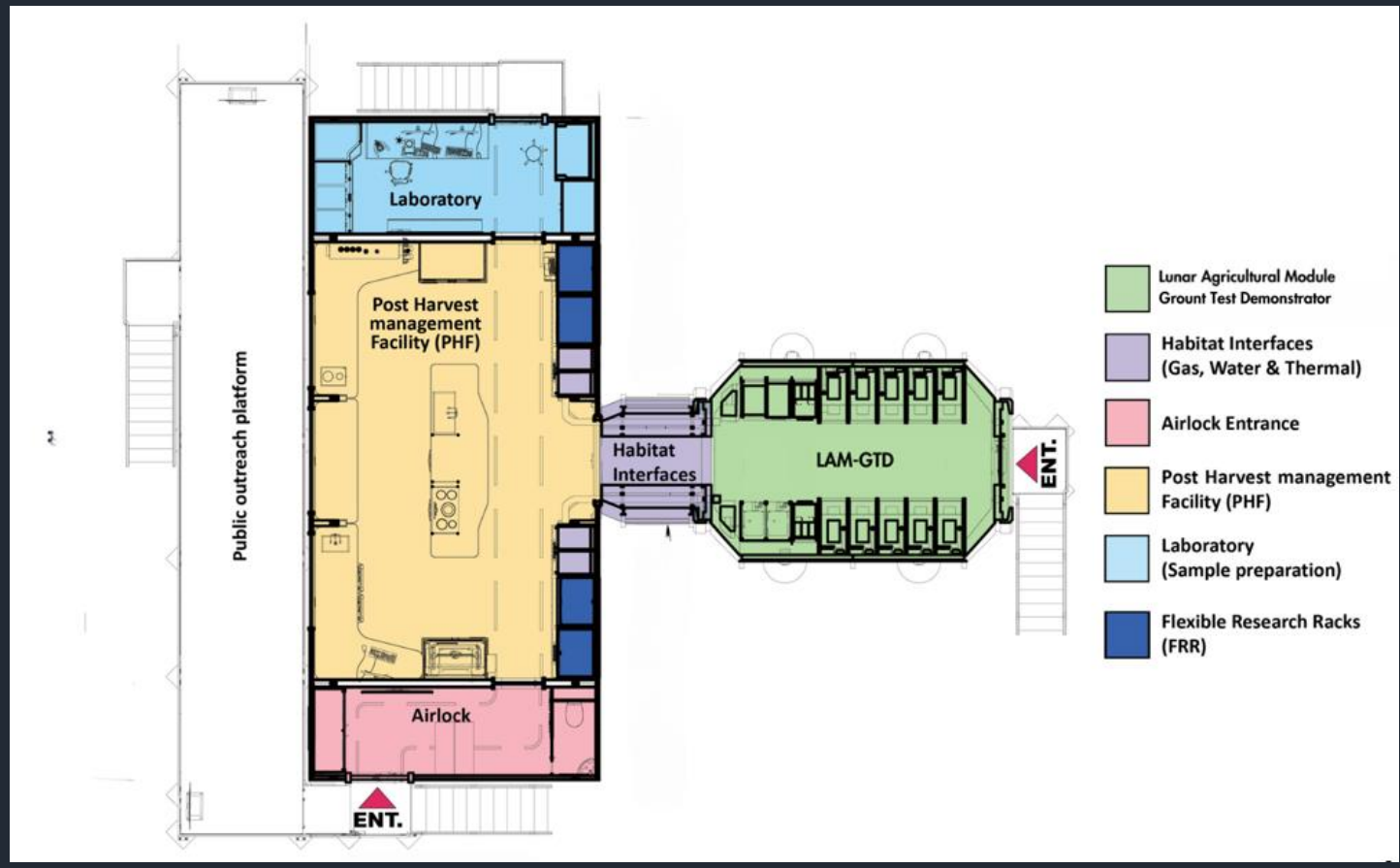
- Operate at “exploration atmosphere” (56.3 kPa, 34% O_2)

- HabSim facility
  - Exchange of fluids, power, and data between the habitat and GTD-LAM
  - Ground testing: CO_2, O_2 exchange

- VESTA – Post-Harvest Management Facility

- Nearly closed BLiSS – missing waste processing and reintegration

- Multi-agency collaboration



Graphic: T. Blomqvist/DLR; Logo: DLR

Food Processing

Food Storage

Space compatible kitchen equipment

Inedible Biomass Utilization

Synergies and cohesion

Food Production

Graphic: T. Blomqvist/DLR

Thank you!

Photo: M. Trautmann