

Exploration and Life Support Systems

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ESA Exploration Roadmap in the next years/decades



2020 > 2030

ESA in mutual inter-dependence



Trace Gas Orbiter



Entry, Descent, and Landing
Rosalind Franklin mission



Robotic arm & return orbiter
Mars Sample Return



2030 > 2040

European-led capabilities



Heavy cargo landing



Human transit habitation
Preparing to send humans to Mars



European Service Module
Deep space human transport



Gateway
Deep space habitation



Cargo logistics / mobility



Science/support activities
Living and working on the Moon



ISS Partner



Contribution
Commercial
stations

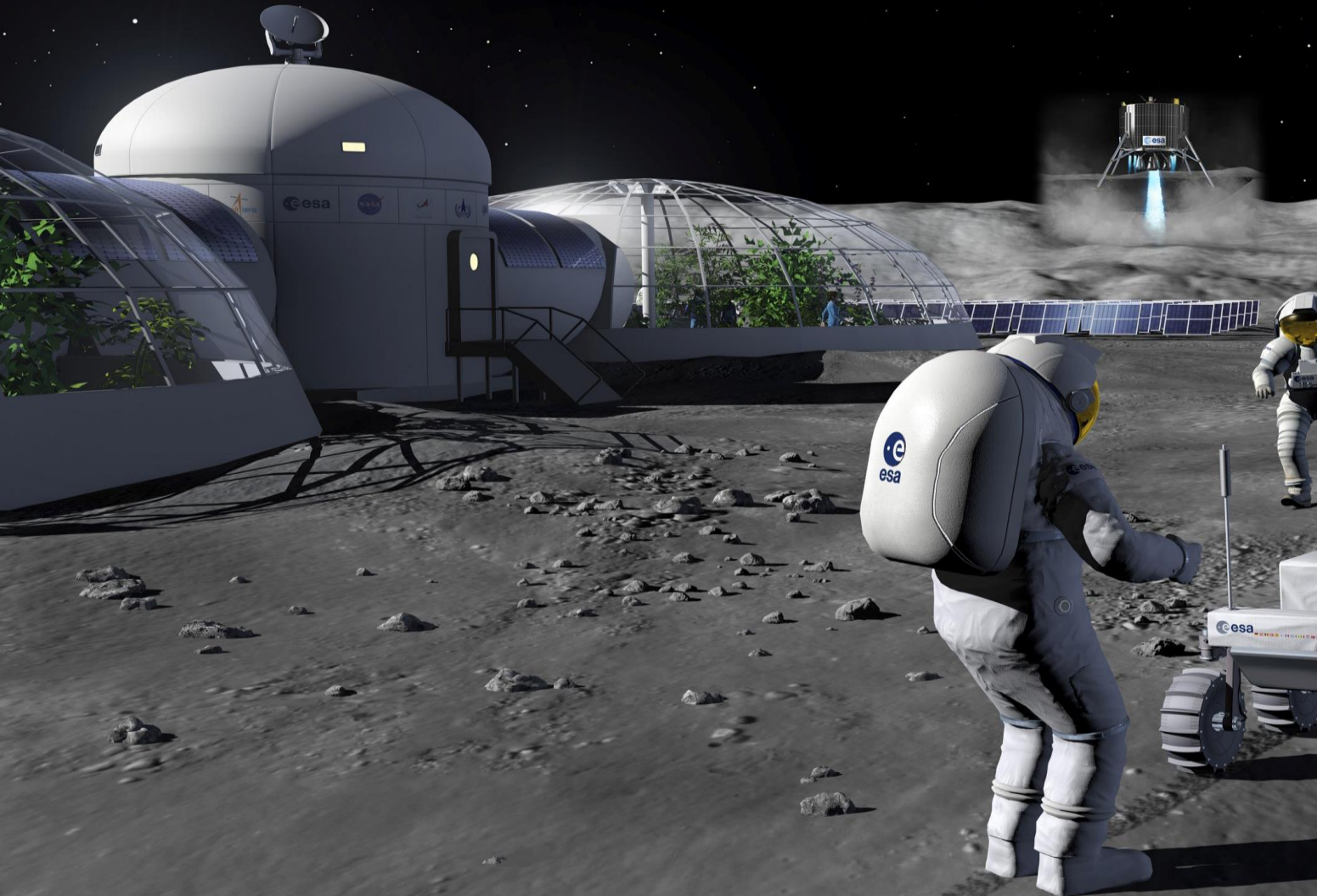


Cargo up/down



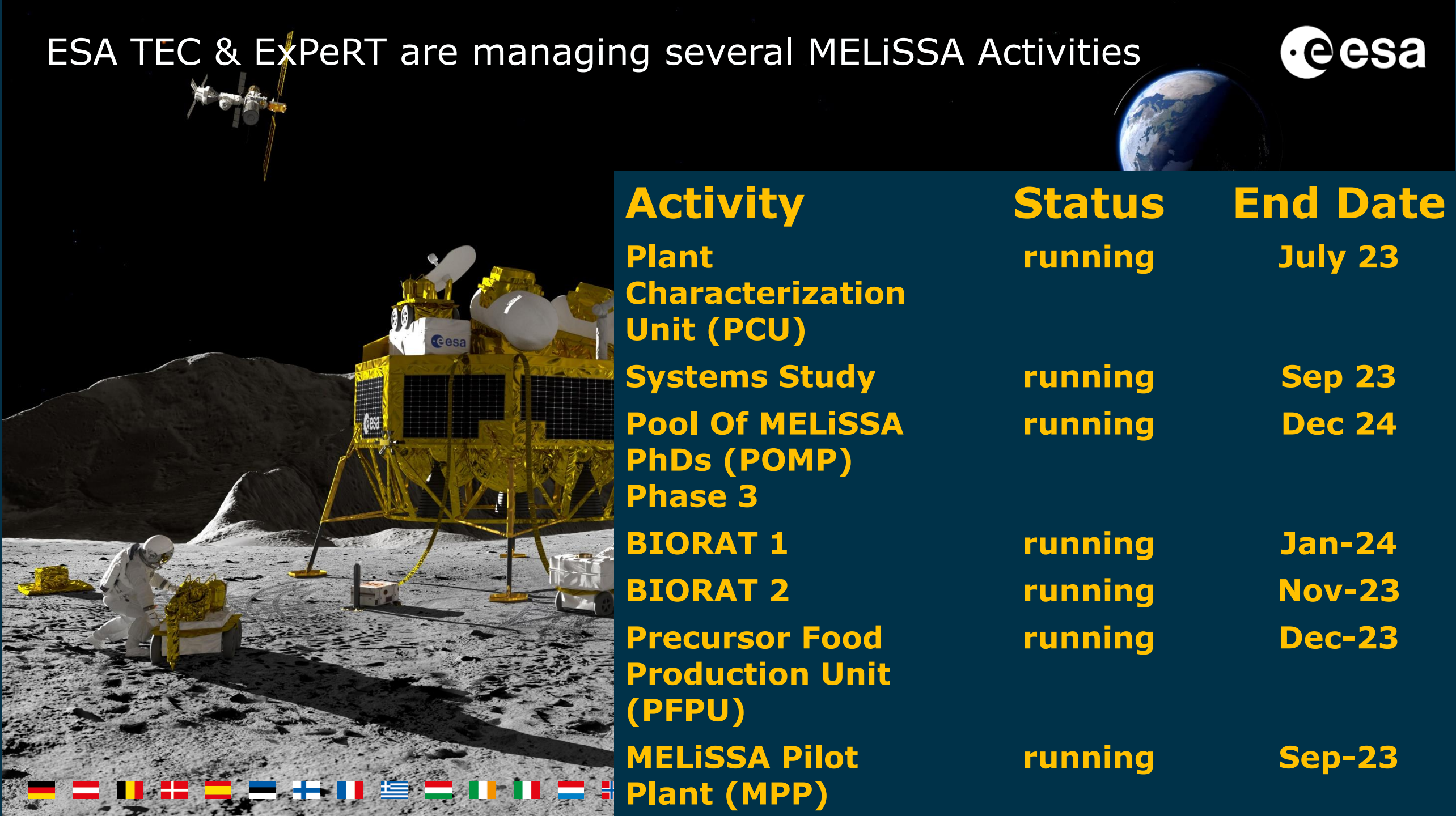
Human transportation
Enabling capabilities

SUSTAINABLE EXPLORATION: Life Support Systems functions



- Control environment, cabin air, atmosphere composition,
- Control concentration of contaminants,
- Provide water (Water collection, recovery, recycling, processing, distribution and quality control),
- Collect, inhibit and contain metabolic body wastes,
- Provide food (Food production, transformation and storage, quality control),
- Detect and suppress fire.

ESA TEC & ExPeRT are managing several MELiSSA Activities



Activity	Status	End Date
Plant Characterization Unit (PCU)	running	July 23
Systems Study	running	Sep 23
Pool Of MELiSSA PhDs (POMP) Phase 3	running	Dec 24
BIORAT 1	running	Jan-24
BIORAT 2	running	Nov-23
Precursor Food Production Unit (PFPU)	running	Dec-23
MELiSSA Pilot Plant (MPP)	running	Sep-23



EXPLORATION Studies

System studies related to the future Exploration missions are planned to define requirements and needs for technology development and technology demonstrators,

The proposed way ahead is to focus on a Human Mars transit habitation Module (HMM) as a core element of a round trip mission to Mars. This implies:

- defining requirements for the pressurised structure, internal environmental conditions and concept of operations,
- advancing the TRL levels of systems and sub-systems.

To achieve this goal several intermediate and sequential steps are needed:

- defining the requirements of a HMM ground based analogue test bed, integrating the many subsystems step by step in a realistic environment with humans in the loop with a focus on ECLSS;
- defining the requirements for an inflight validation of subsystems on the ISS (or other LEO platforms) when possible;
- Development of a precursor of the HMM
- a possible additional European contribution to the Gateway as a final deep space long-term testing of the HMM itself before assembly of the Mars mission convoy.



- Terrae Novae 2030+ strategy
 - ESA-PBHME(2021)19 rev1 (Feb. 2022)
- E3P Programme Proposal
 - ESA-PBHME(2021)23 rev1

- HRE-S for overall strategy and implementation coordination
- HRE-E (ExPeRT) for future missions and technologies definition
- HRE-R (SciSpace) for science strategy
- National experts, scientists and industry experts
- Workshops/Mtgs with MS, experts, scientists and industries

Future Mission Studies and Technologies in Exploration

HRE-E ExPeRT

- Phase 0/PrePhase A/Phase A/B1 for LEO, Moon and Mars
- Identification of Critical Technologies for Exploration Missions
- Definition of technology needs and requirements in coordination with D/TEC
- Technologies WorkPlan
- Technologies Maturation up to TRL5/6 in coordination with D/TEC
- Maturation of Technology P/Ls

HRE-R SciSpace

- Definition of Science Strategy for Exploration
- Definition of Science content for LEO, Moon, Mars missions
- Call/AO for experiments
- P/Ls development
- Support to Phase 0/pre-Phase A/Phase A/B1/ Phase B2/CD/E studies and missions
- Science P/L developments

HRE-O, HRE-L, HRE-M Destination leaders CS1-CS4

- Implementation Phase B2/C/D/E of LEO, Moon and Mars missions
- Maturation of technologies from TRL5/6 up to TRL8



Description



- Future human round trip Mars missions requires a highly optimised and reliable habitat as a core element.
- A ground based analogue Mars Transit Habitat(MTH) would provide an important testbed to develop, integrate and validate the required systems and technology with humans in the loop
- Prepares ESA for contributing critical elements to future human Mars exploration missions

Mars Transit Habitat Ground Based Demonstration Facility



Technology

- Advanced Life Support technologies
- Resource management, waste treatment and recycling
- Crew health medical support & countermeasures
- Habitat systems integration
- Autonomous operation & support to decision making



Science

- SciSpace strategy is in development.
- Possibility for human-subject and human-tended science
- Possibility for investigation and validation of countermeasures
- Possibility of observational research on human-related activities
- Physical sciences studies



Schedule

- **Past and ongoing activities**
Mars Transit Habitat CDF study completed in 2020
- **Potential future activities**
Feasibility and system definition studies
Implementation decision at CM25+

Thank You !

