

ISRU ADVANCEMENTS: REGOLITH BENEFICIATION & PROPELLANT PRODUCTION OVERVIEW

DLR Institute of Space Systems, Bremen

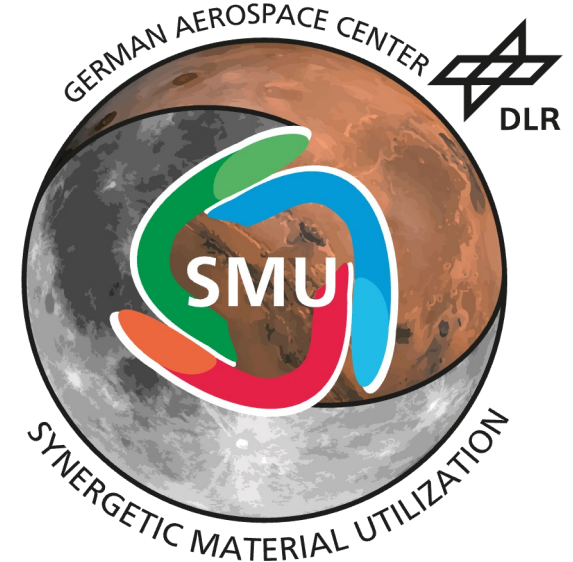
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Synergetic Material Utilization research group

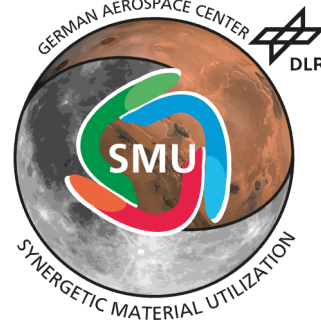


- Founded in June 2021 at the DLR Institute of Space Systems in Bremen.
- Focus on combining Life Support systems with In-Situ Resource Utilization (ISRU).
- Goal:
Build a small, young and innovative team to develop key technologies with a large impact in the research field.
- Combination of laboratory-scale experimental setups in relevant environment and simulations to raise the TRL to 5



Developing innovative in-situ resource utilization technologies to further advance German excellence in space exploration

Synergetic Material Utilization research group: Ongoing research



Regolith Beneficiation and Utilization

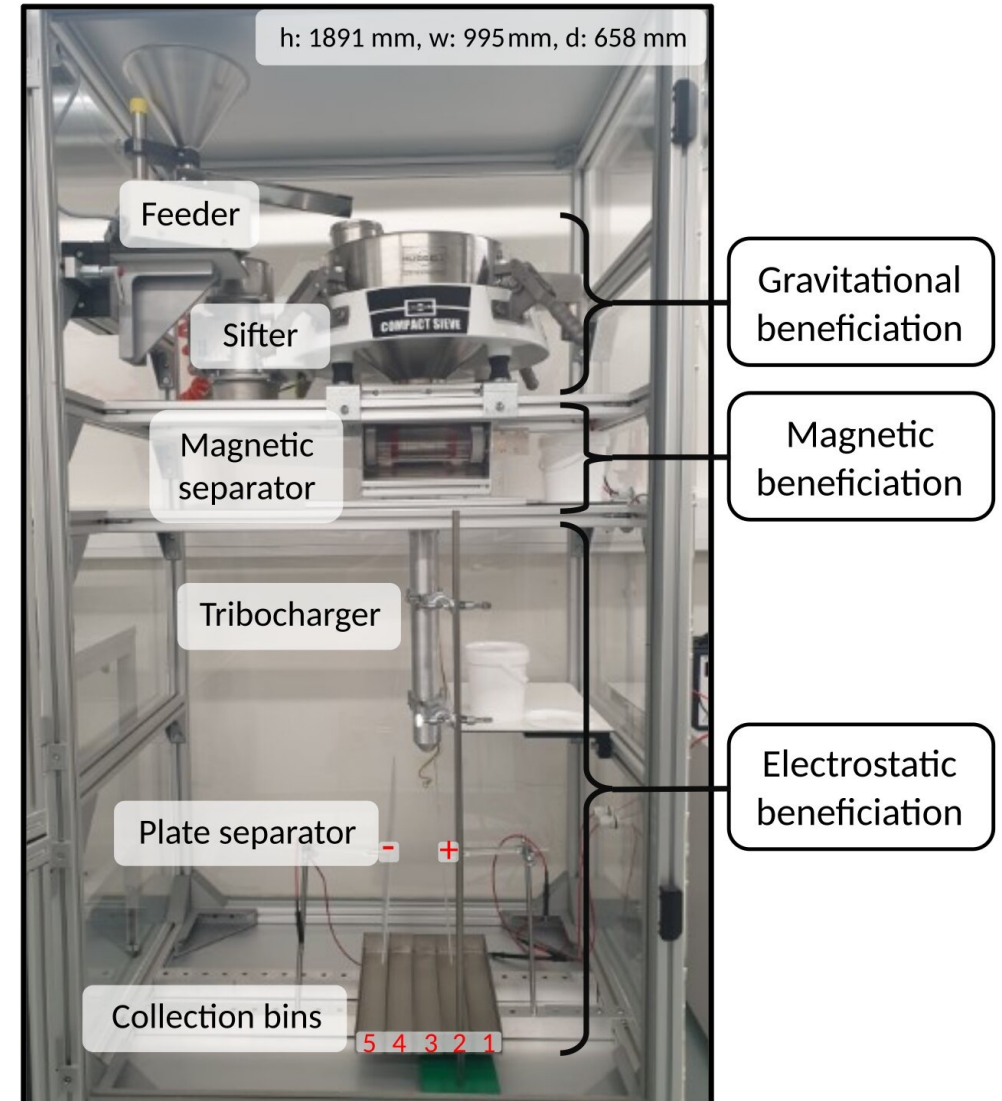


In-Situ Propellant and Consumables Production

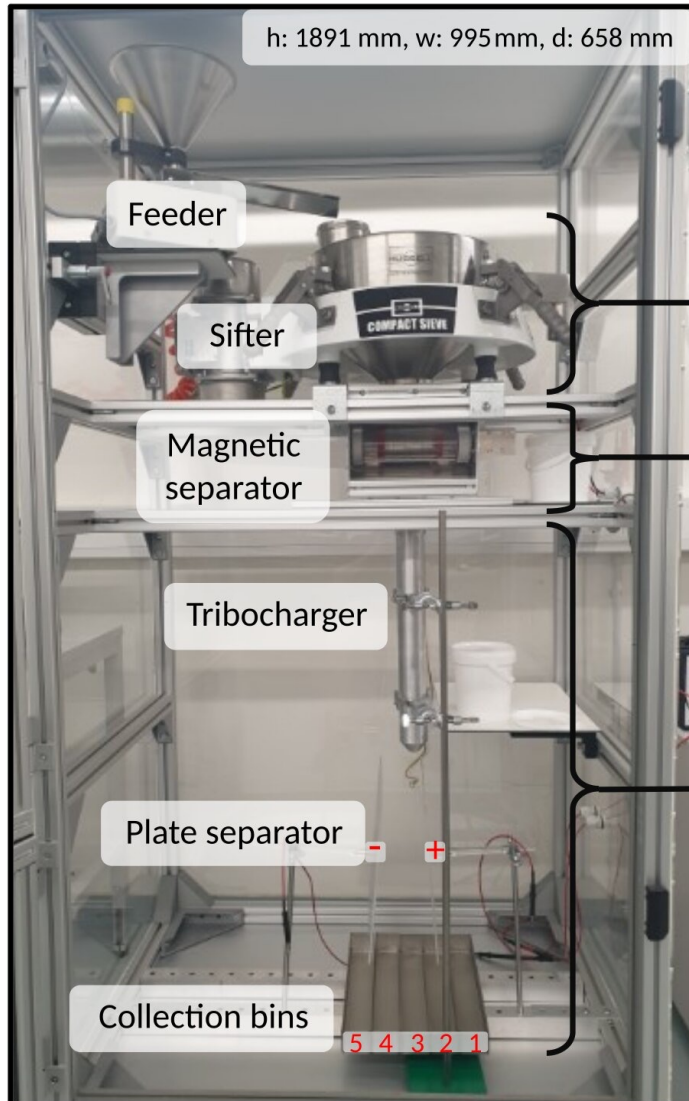


Regolith beneficiation and utilization: Current state of research

- **Gravitational beneficiation:** Remove all particles $> 200 \mu\text{m}$
 - a. Vibratory feeder
 - b. Horizontal vibratory sifter
- **Magnetic beneficiation:** Remove ferromagnetic agglutinates and metallic dust
 - a. Permanent magnet drum separator
- **Electrostatic beneficiation:** Separate Ilmenite from tailings
 - a. Tribocharger
 - b. Parallel plate separator



Regolith beneficiation and utilization: Experimental results



Gravitational
beneficiation

Magnetic
beneficiation

Electrostatic
beneficiation

Input sample

300 g

Gravitational
Beneficiation

$>200\ \mu\text{m}$

151 g

$<200\ \mu\text{m}$

Magnetic
Beneficiation

Magnetic

31.51 g

Non-magnetic

Electrostatic
Beneficiation

Output bins

5

4

3

2

1

0.73 wt.% Ilmenite

80 g

32 g

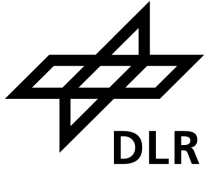
12 wt.% Ilmenite

For published literature:

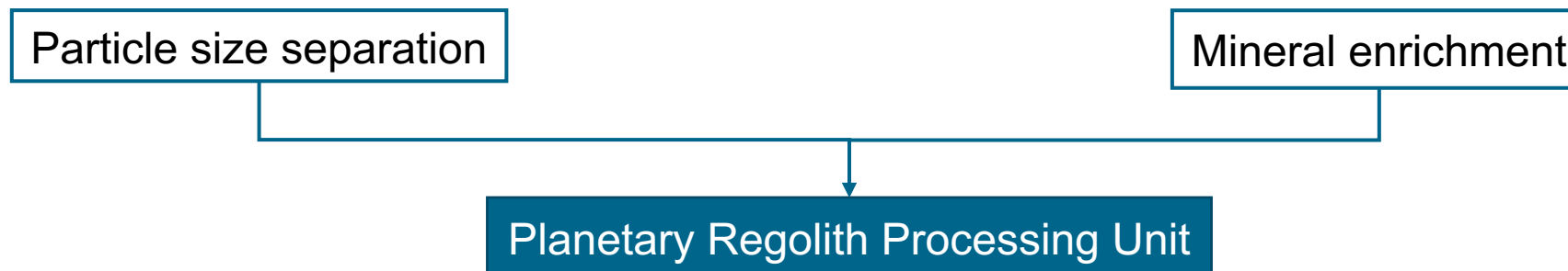


(Kulkarni, et.al. 2024)

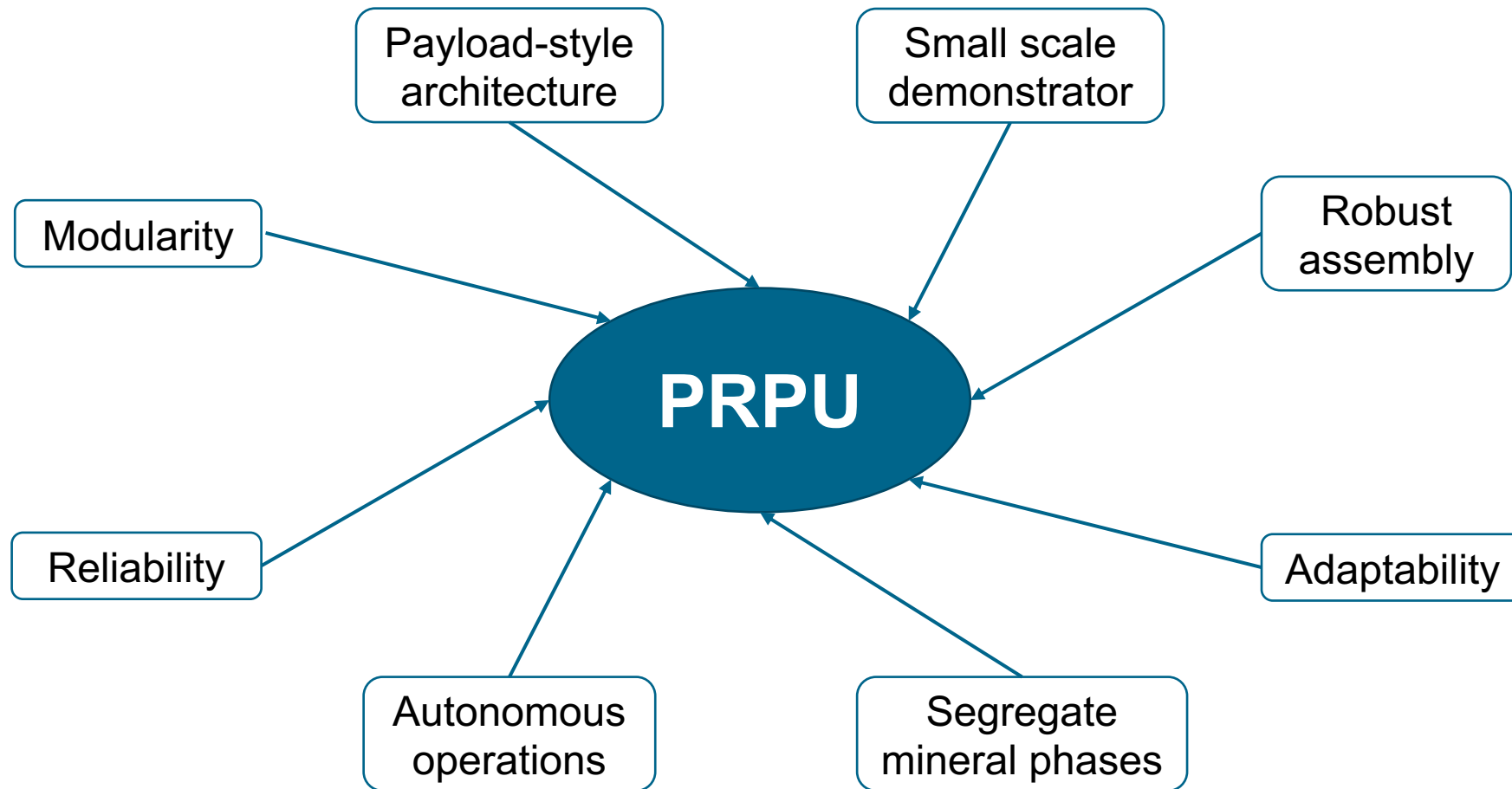
Regolith beneficiation and utilization: Planetary Regolith Processing Unit (PRPU)



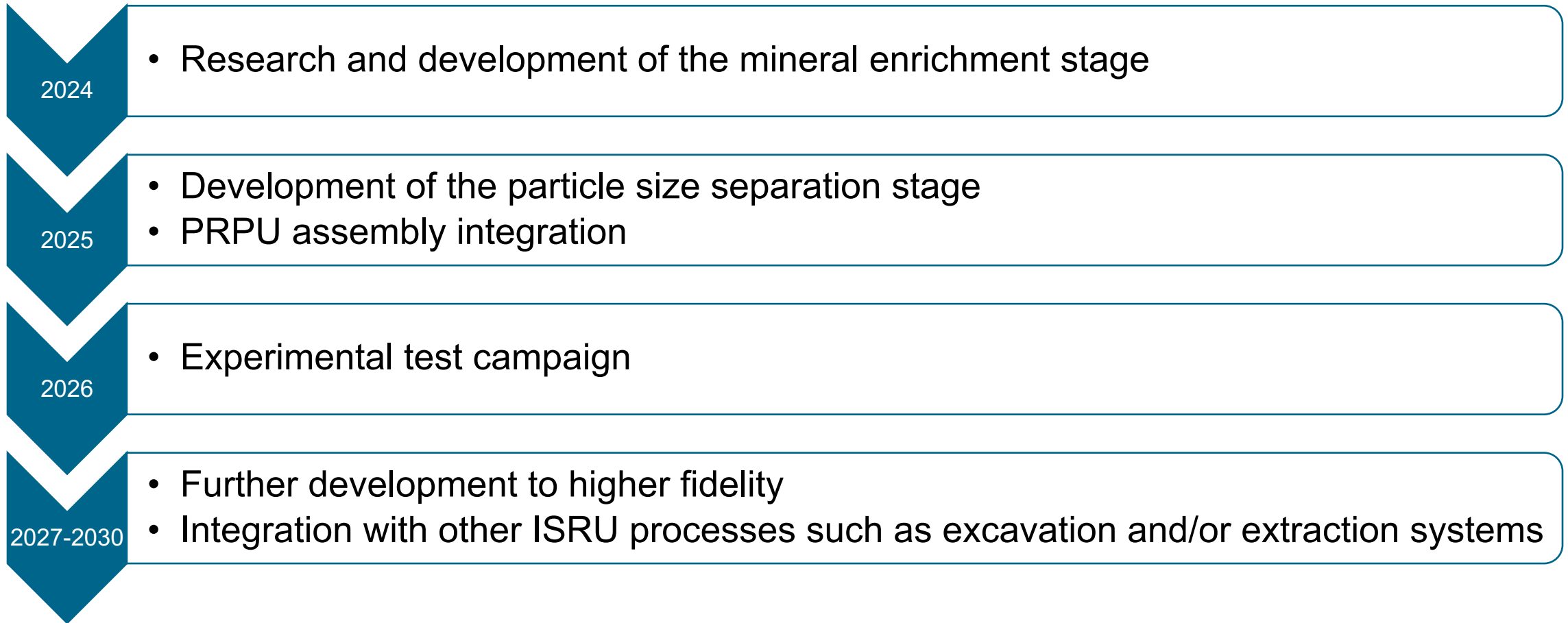
- The Planetary Regolith Processing Unit (PRPU) is a payload concept for a small scale in-situ demonstration mission
- It shall comprise of beneficiation technologies from the laboratory testbed with additional improvements as concluded from experimental trials
- The ultimate goal is to develop this payload up to a TRL 5/6 fidelity as a precursor for flight opportunities



Regolith beneficiation and utilization: Planetary Regolith Processing Unit (PRPU)



Development timeline



In-situ propellants and consumables production



LUWEX

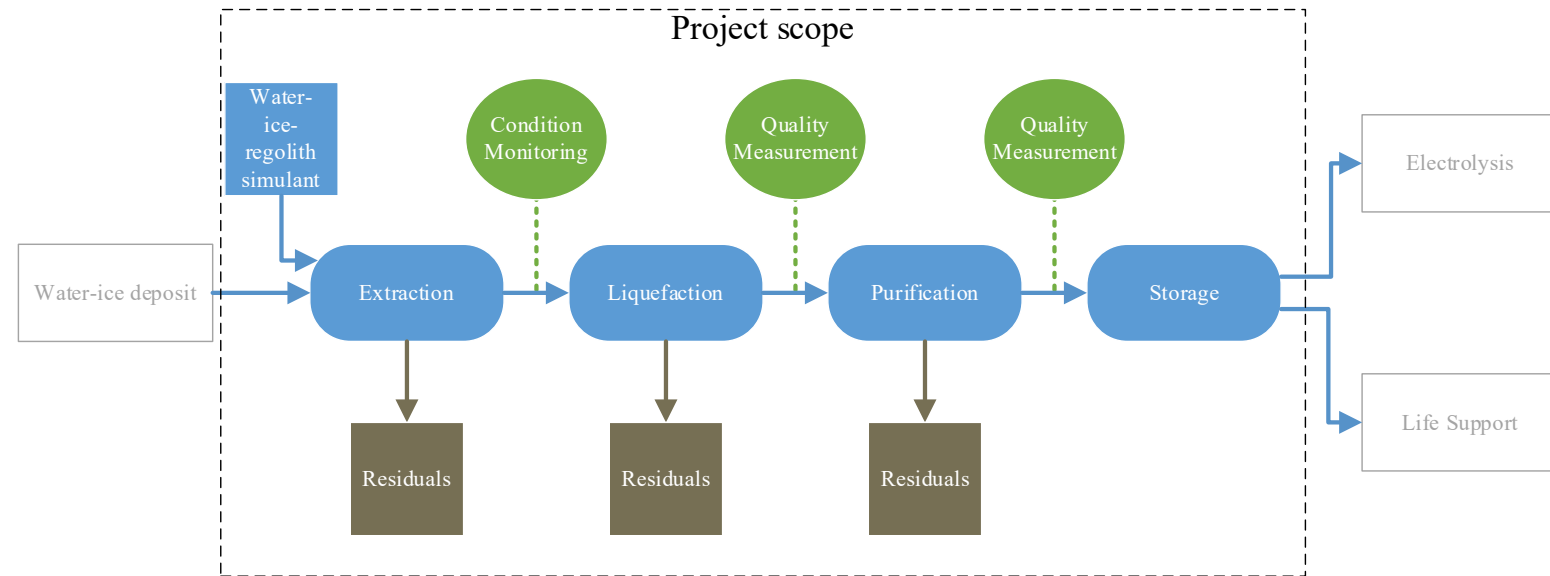
Validation of Lunar Water Extraction and Purification Technologies
for In-Situ Propellant and Consumables Production

Duration: Nov. 2022 – Oct. 2024.

EU-funded with 1.5 million €

Objective

The development, integration and validation of lunar water extraction and purification technologies for in-situ propellant and consumables production for future space exploration missions



Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center



Technische
Universität
Braunschweig



LIQUIFER
SYSTEMS
GROUP



ThalesAlenia
Space



Wrocław University
of Science and Technology

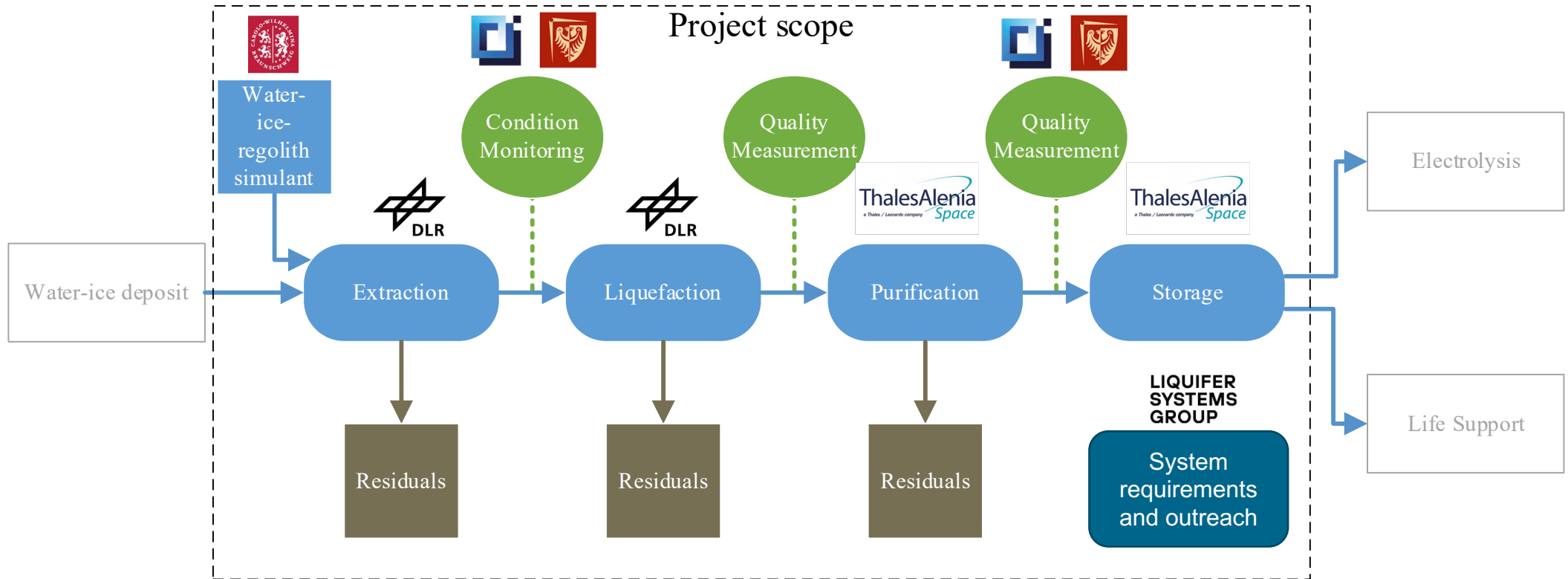


Scanway
imaging space



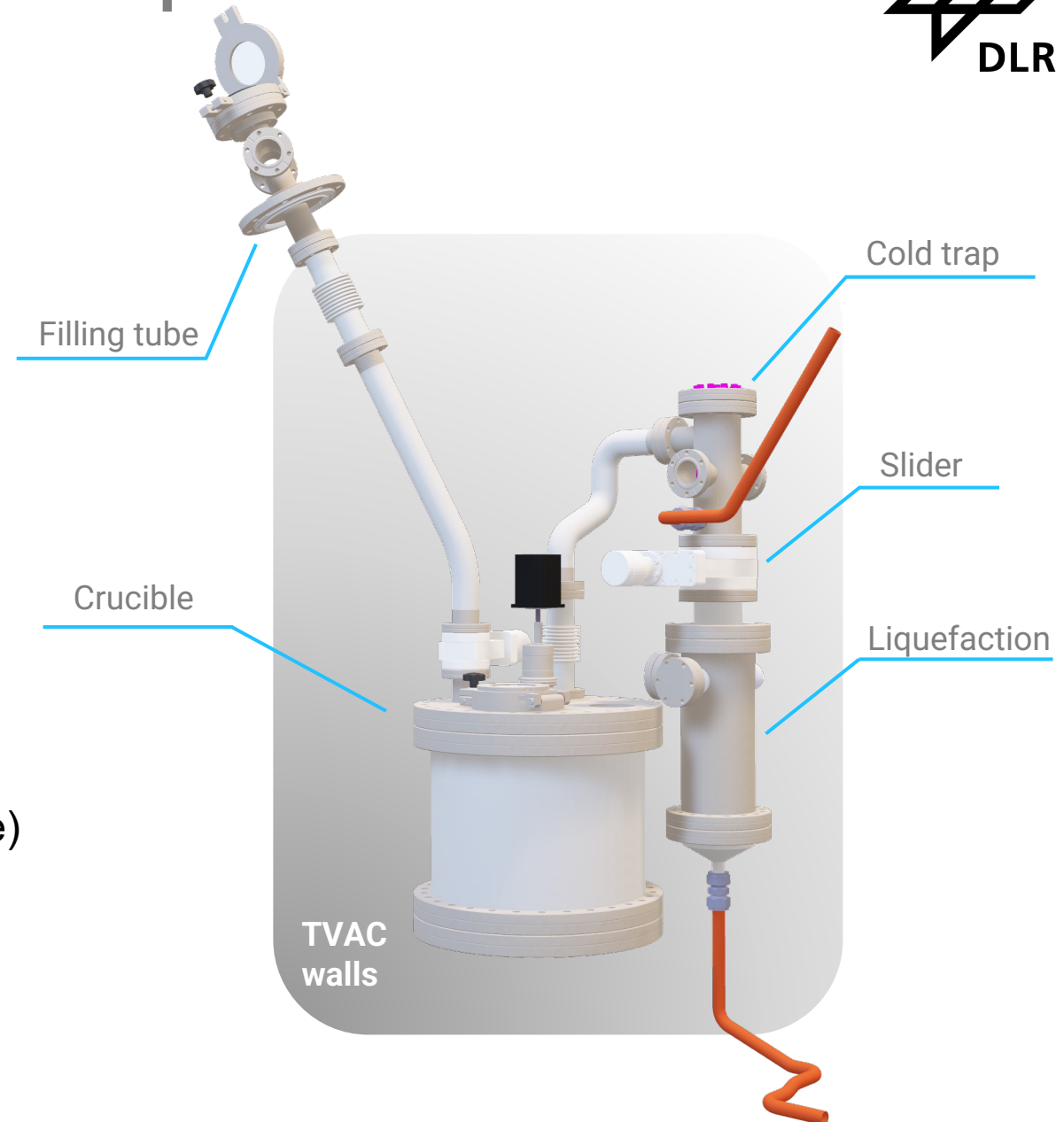
Funded by
the European Union

In-situ propellants and consumables production

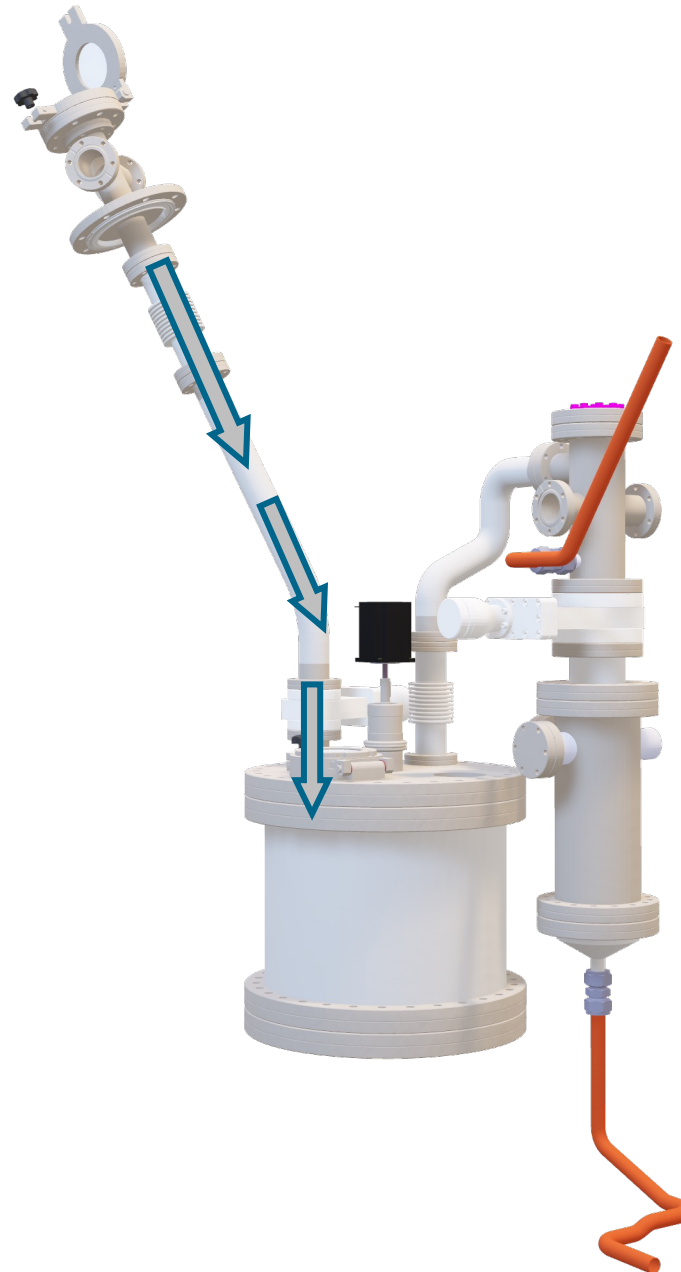
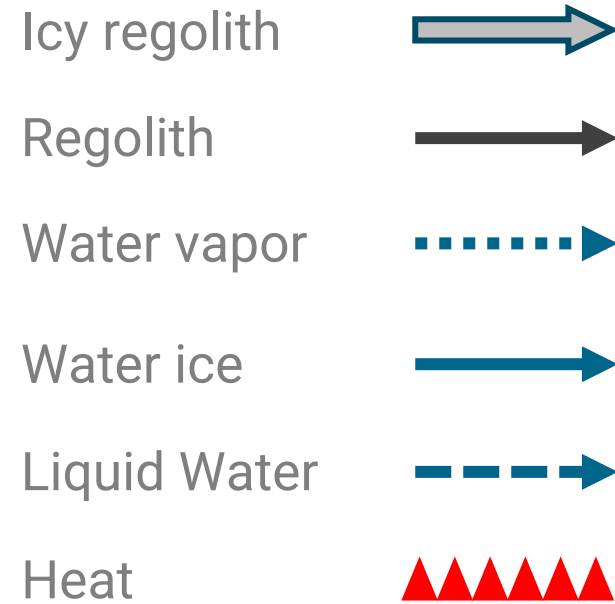


In-situ propellants and consumables production: Water extraction and capturing

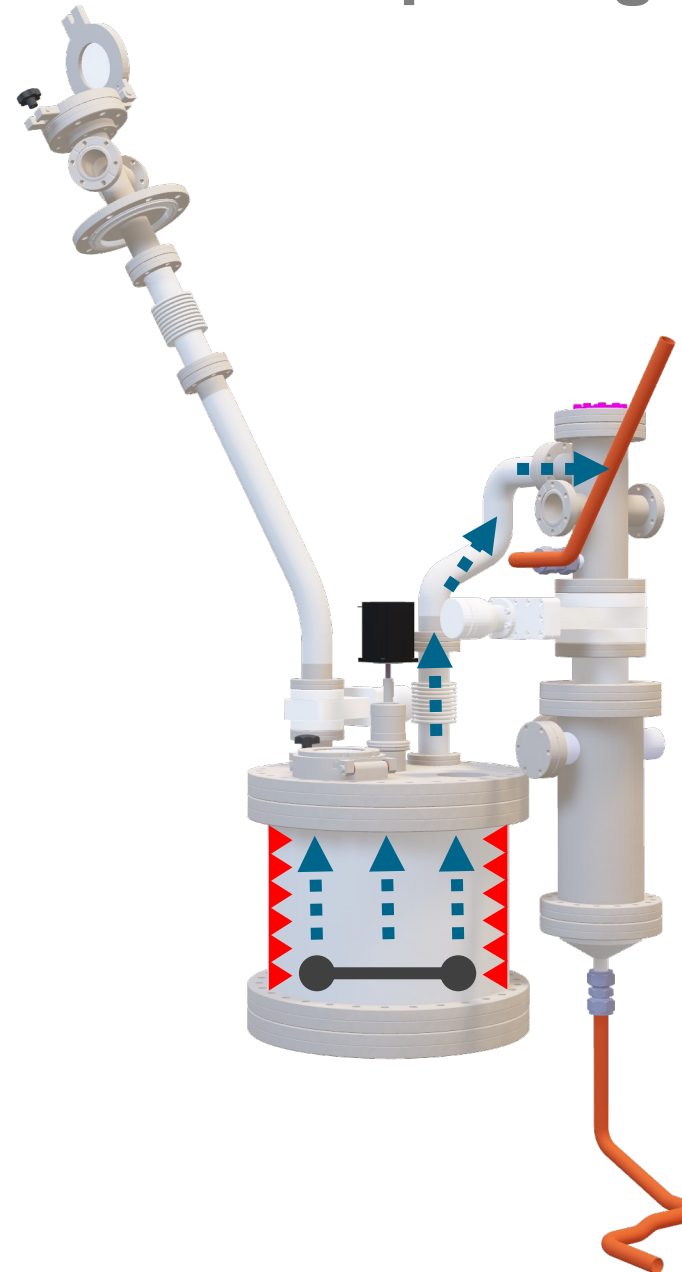
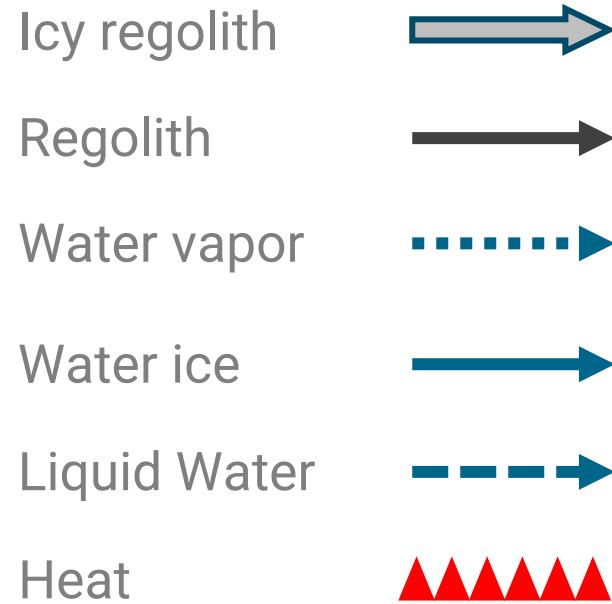
- Design for extraction and water capturing chosen using simulations and trade-offs.
- A water extraction crucible and a cold trap capturing device are placed in a “dusty” TVAC.
 - Temperature $\approx 80 - 100$ K.
 - Pressure $\approx 10\text{e-}6$ mbar.
 - Crucible size = $\varnothing 30$ cm x 30 cm.
 - Icy regolith simulant mass up to 15 kg.
 - Amount of water present 5 wt.%, 750 mL (baseline)
 - Presence of volatiles: CO_2 & Methanol



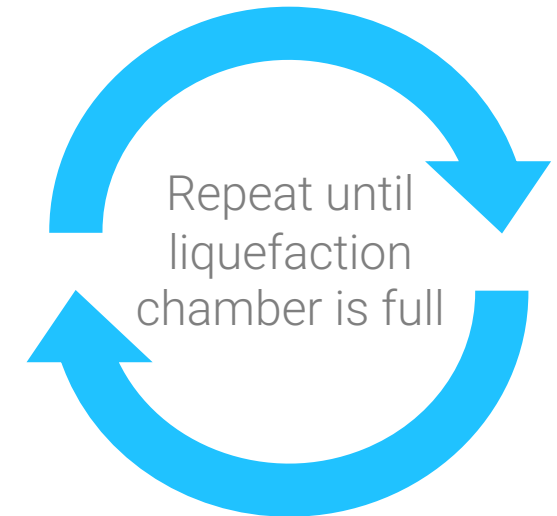
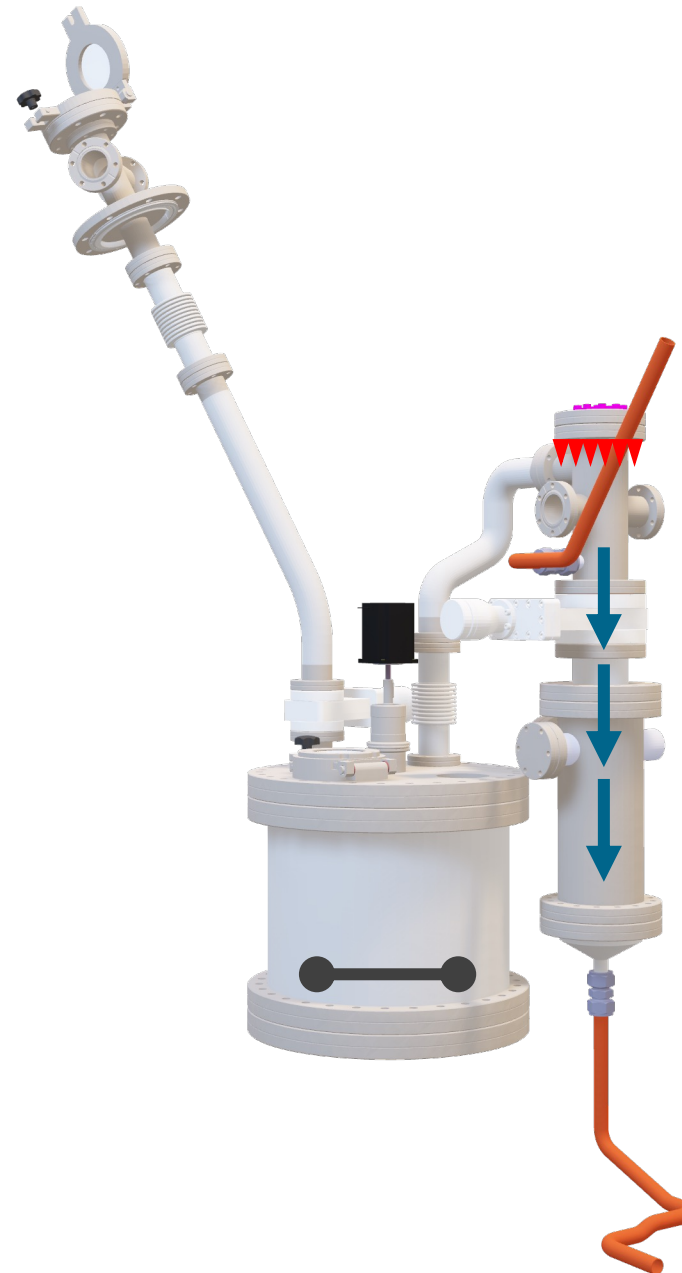
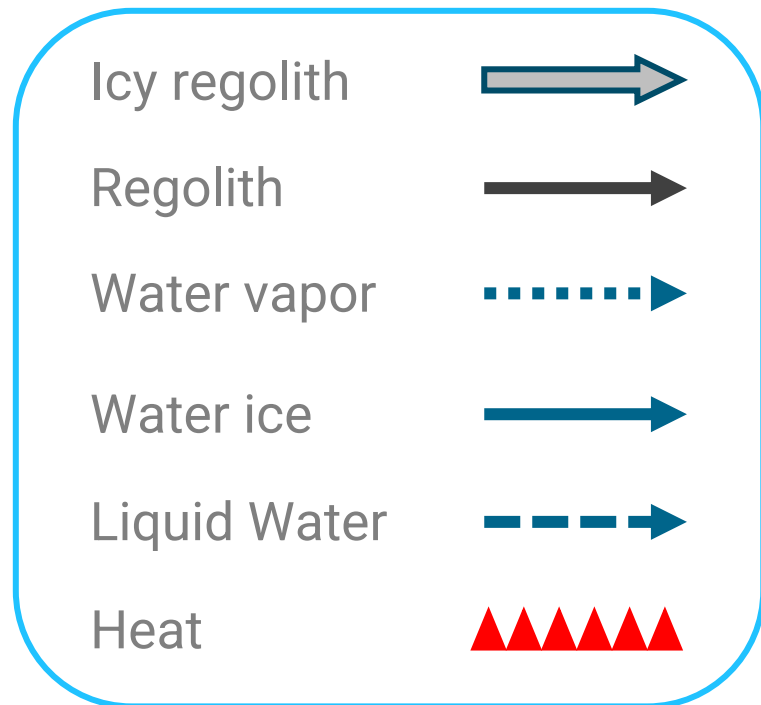
Systems operations: Filling



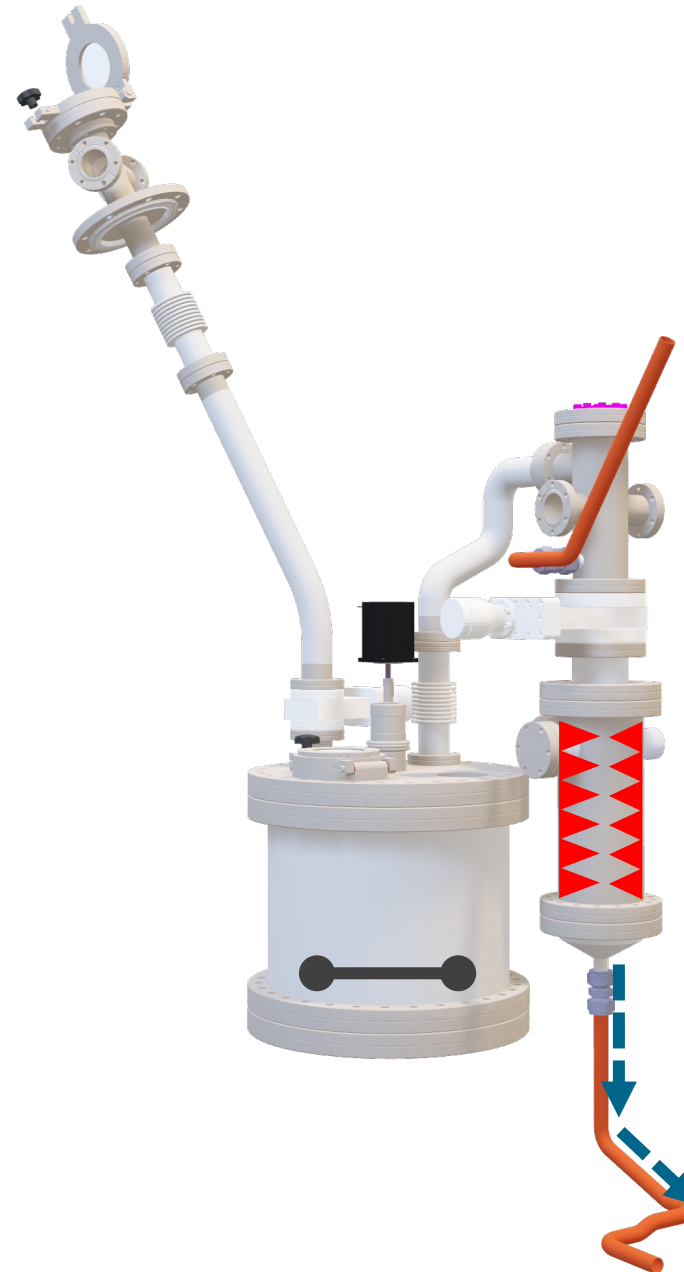
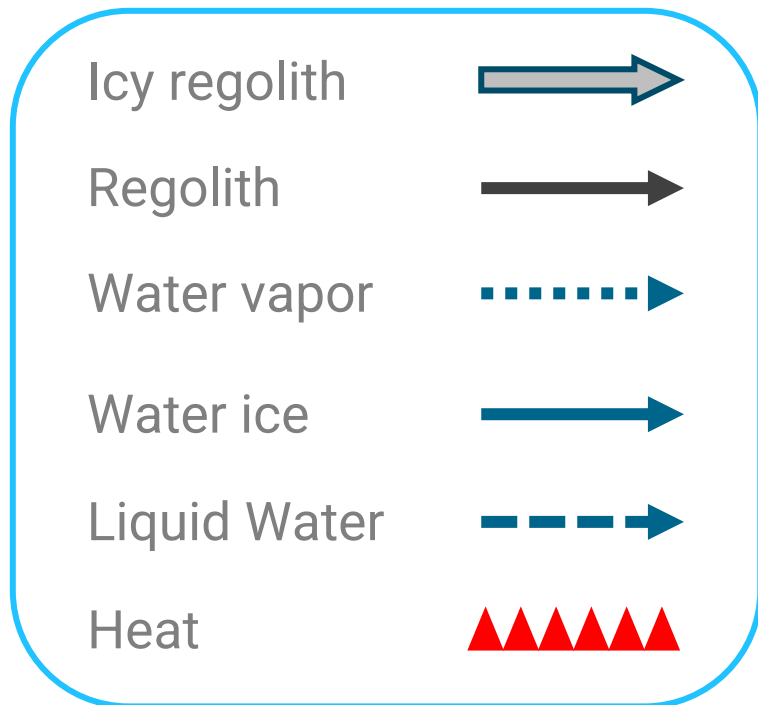
Systems operations: Extraction and capturing



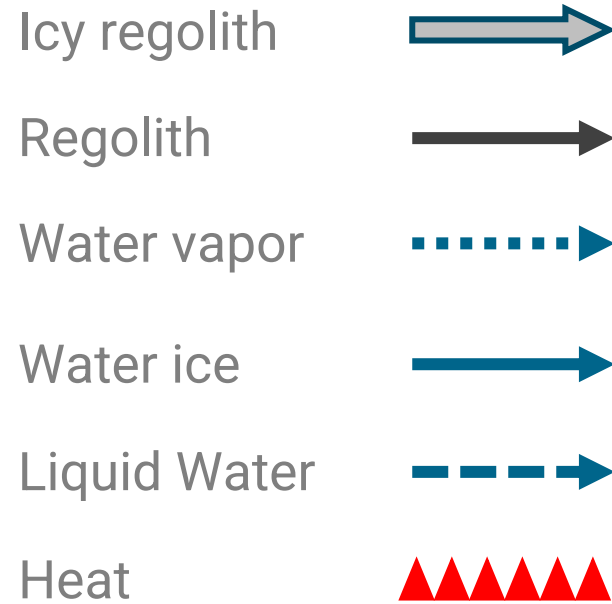
Systems operations: Delamination



Systems operations: Liquefaction



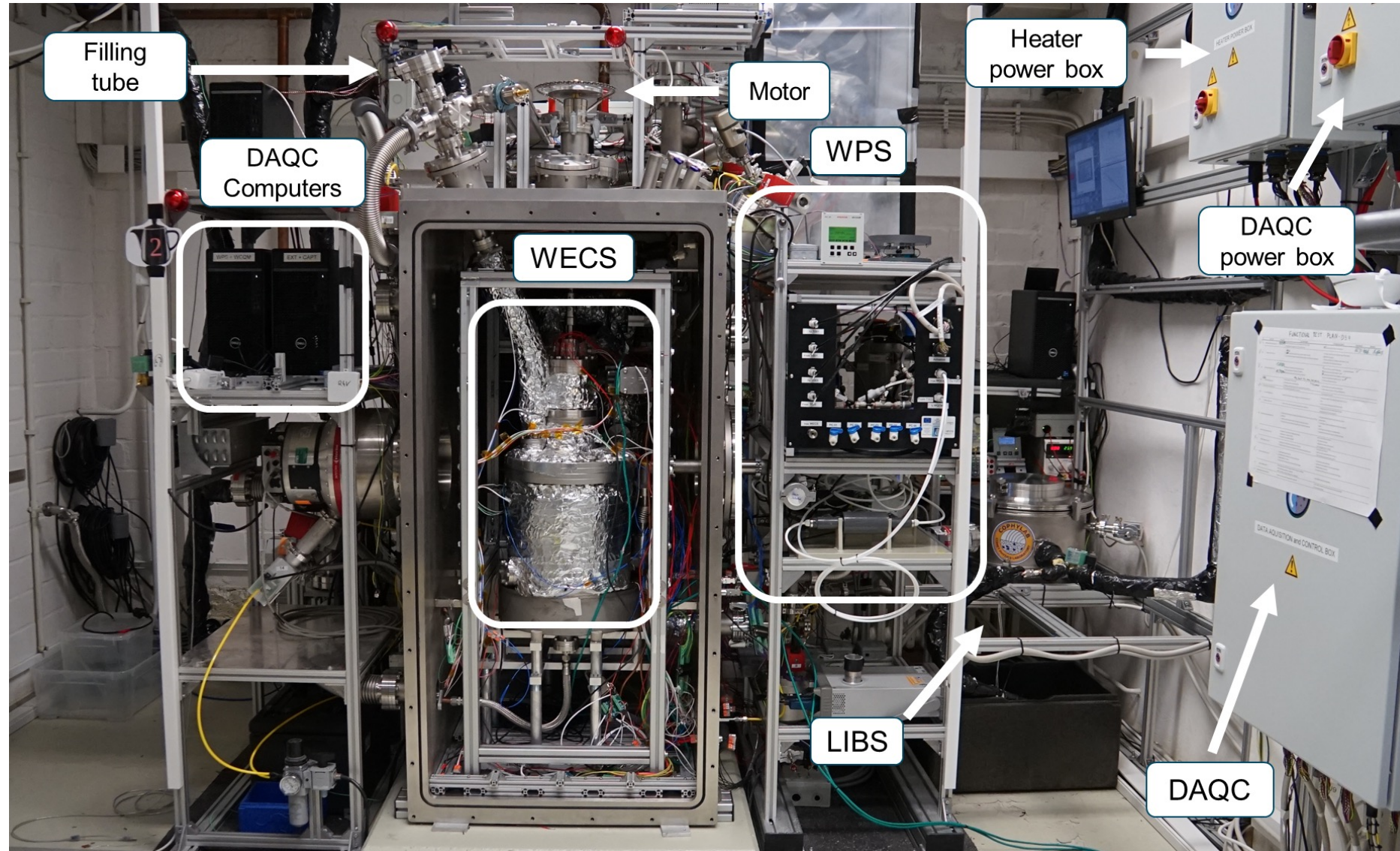
Systems operations: Emptying



For more project info:



In-situ propellants and consumables production: Current state of research (LUWEX)



In-situ propellants and consumables production: Project timeline



Oct 2024

- Reach TRL 4-5.
- Tech demo concrete design with mass, power and volume

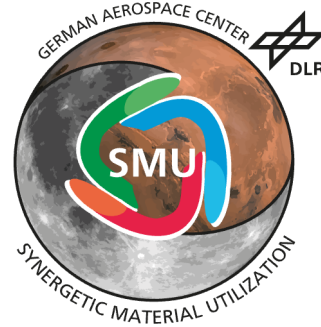
2025 -
2027

- Refined technology demonstrator design to TRL 6-7 and identifying potential flight opportunities.

2028 -
2030

- Payload delivery and launch

Research collaboration



Regolith Beneficiation and Utilization

- Oxygen and metals production
- In-situ construction
- Thermal and/or radiation protection shielding
- Excavation of regolith

In-Situ Propellant and Consumables Production

- Water extraction from icy regolith
- H₂-O₂ production through electrolysis
- Excavation of icy regolith

THANK YOU!

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