

LUWEX Lunar Water Extraction and Purification

Space resources at DLR Bremen





Synergetic Material Utilization - SMU

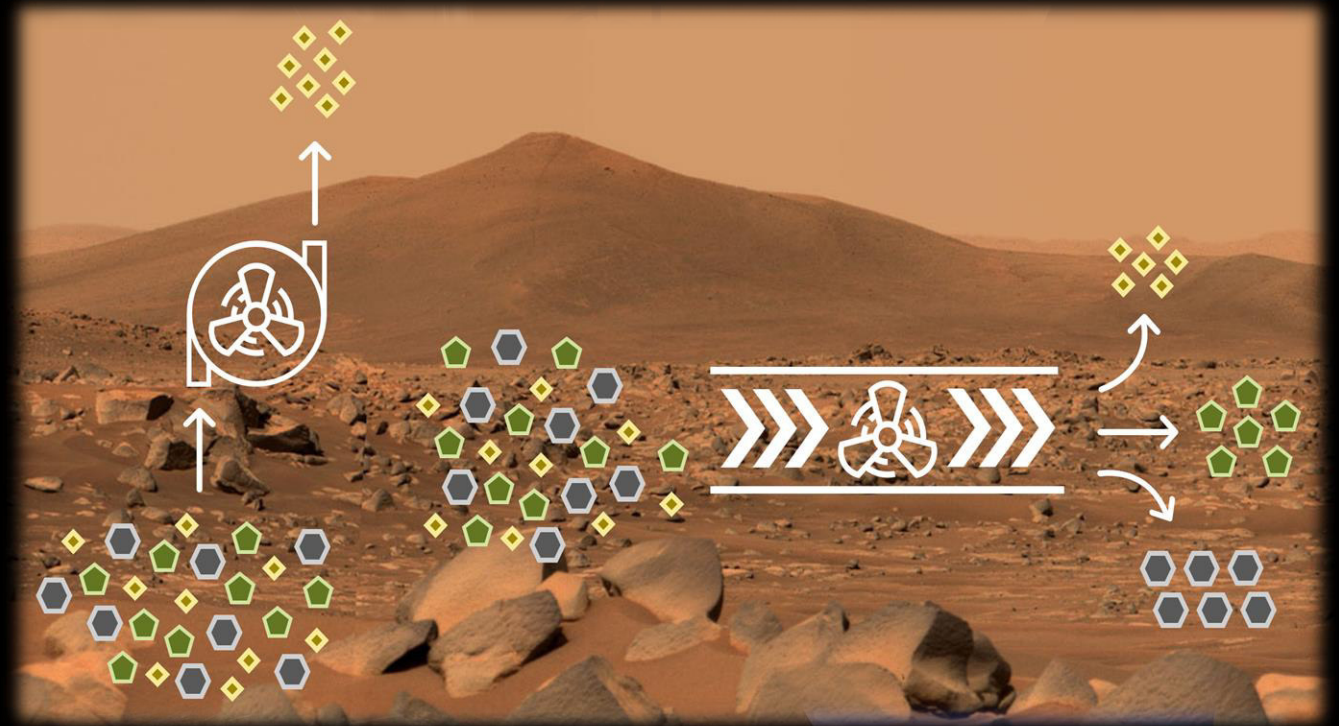


Combining Environmental Control and Life Support System (ECLSS) and In-situ Resource Utilization (ISRU) engineering, exploiting the synergies among both fields to enable sustainable exploration of the solar system.



SMU Research Topics Overview

Regolith Beneficiation and Utilization



SMU Research Topics Overview



Regolith Beneficiation and Utilization

**In-Situ Propellant and Consumables
Production**



© DLR - SMU



LUWEX

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



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



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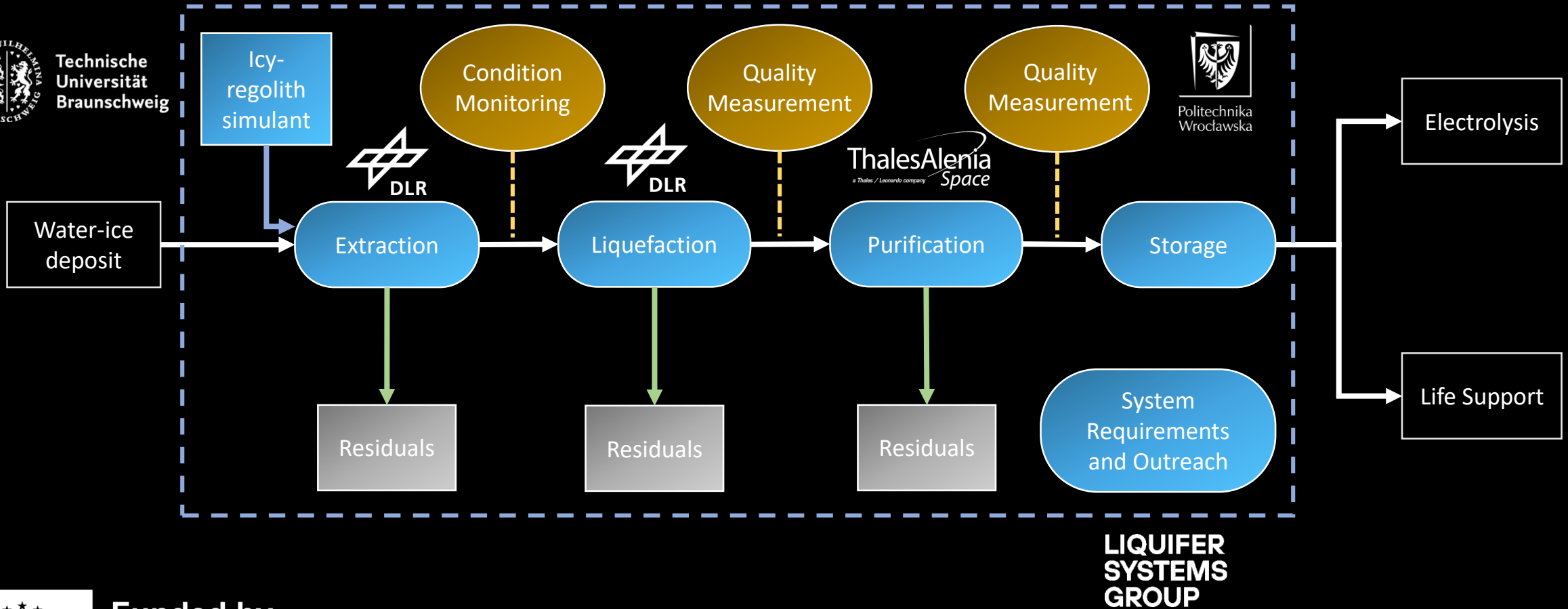


LUWEX

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



Technische
Universität
Braunschweig

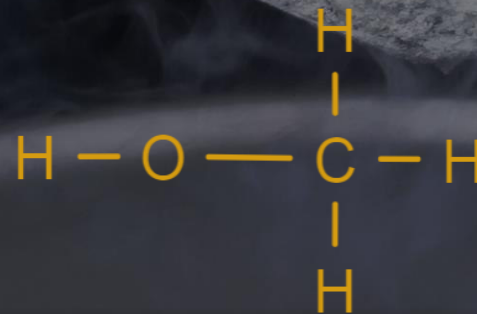
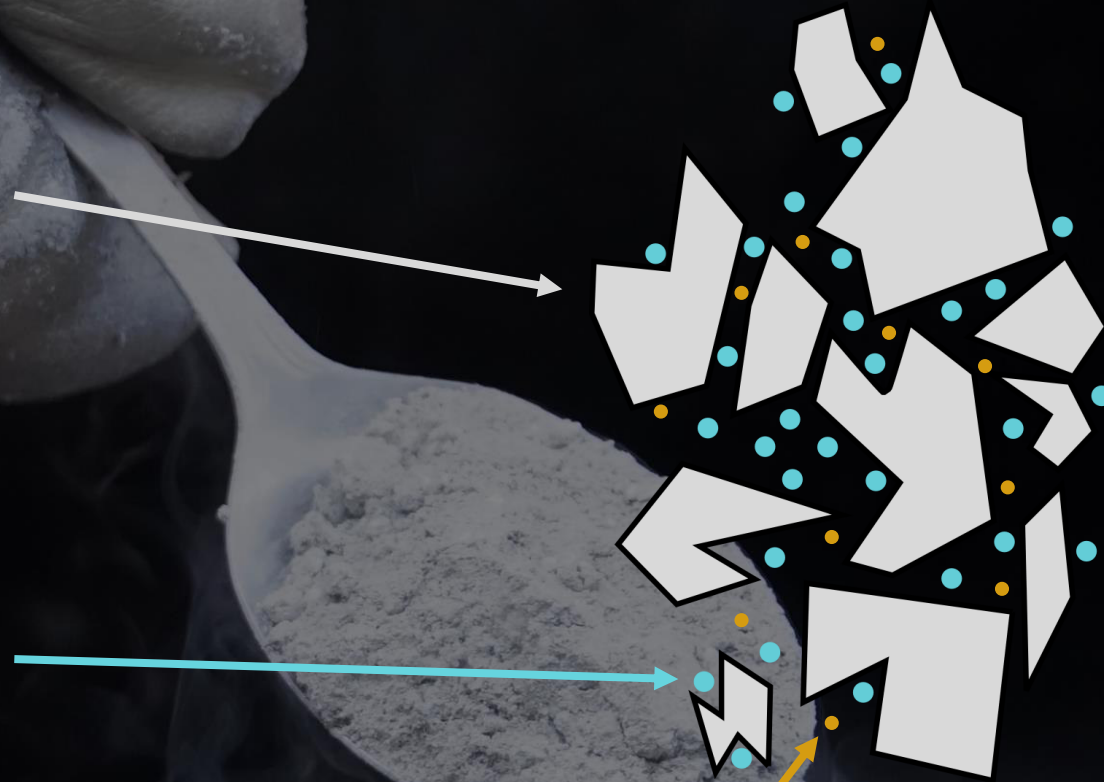
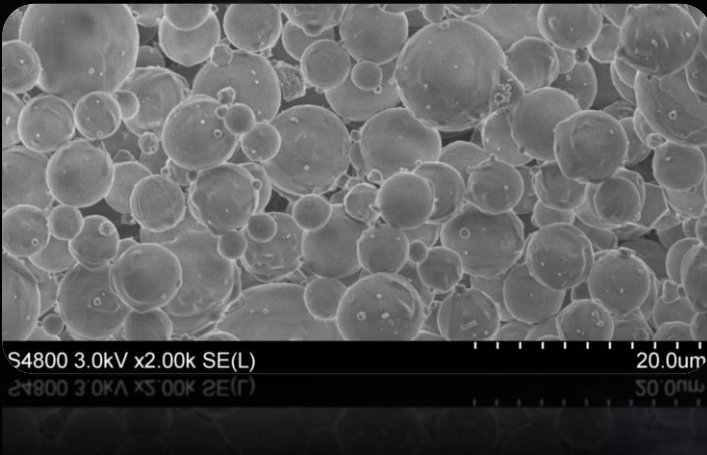


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LIQUIFER
SYSTEMS
GROUP

Icy-Regolith Simulant

© C. Kreuzig, et al. (2023)



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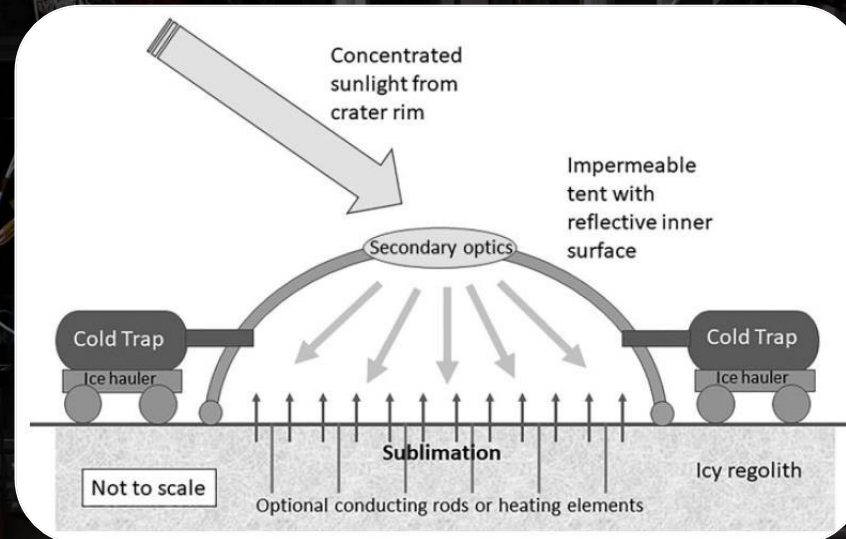


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Design choices for extraction

In-Situ Extraction
(Heated Dome)

Excavated Extraction



© Sowers & Dreyer et al. 2019



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Design choices for extraction

In-Situ Extraction
(Heated Dome)

Dynamic Stirring

Excavated Extraction

No Stirring



© Purrington et al. 2022



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Design choices for extraction

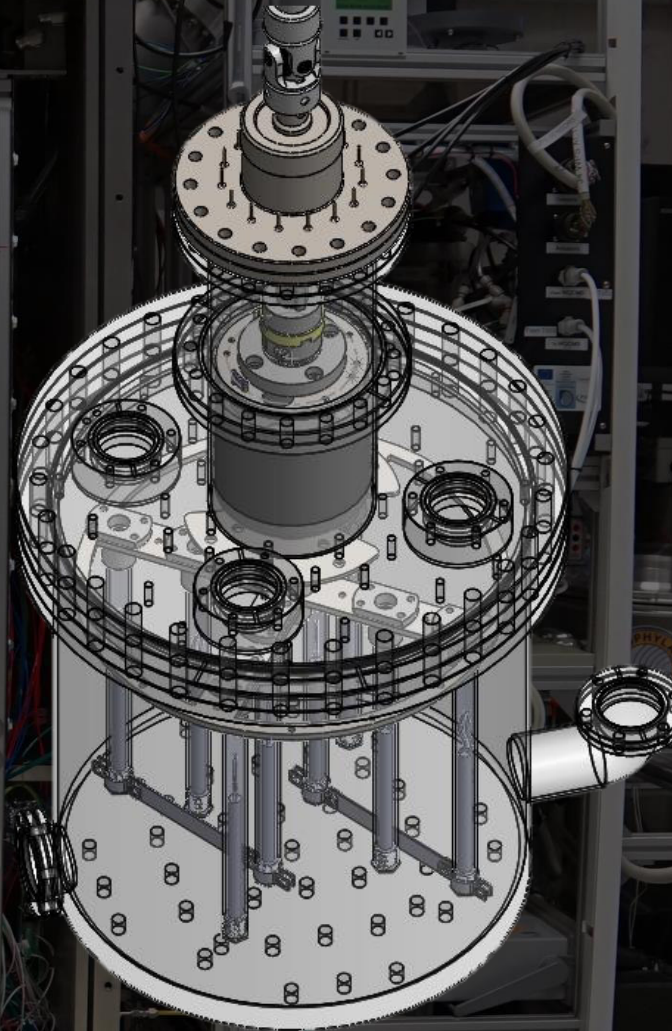
In-Situ Extraction
(Heated Dome)

Dynamic Stirring

Excavated Extraction

No Stirring

Sizing according to
purification
subsystem)



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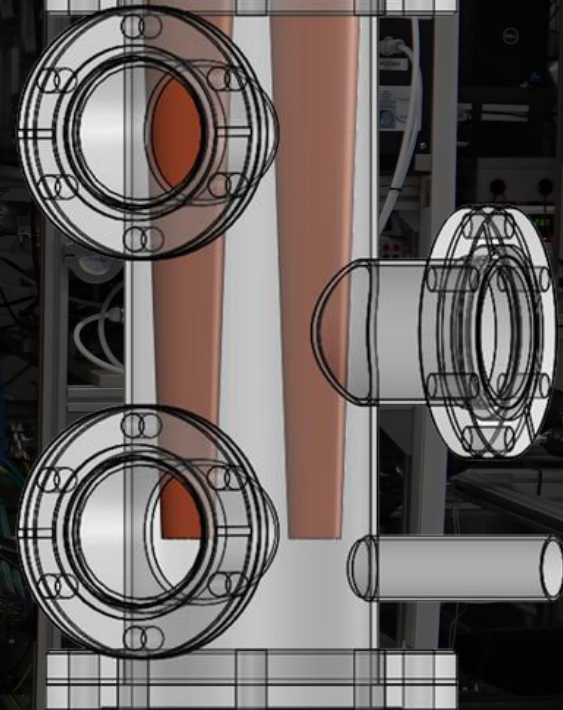
Design choices for extraction

Cold trap (deposition)

Based on work from
Holquist et al. 2021 &
Jurado 2021

Condenser

Secondary objective:
Methanol Purification



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LUWEX System



Water Extraction and
Capturing

Water
Purification

Water Quality

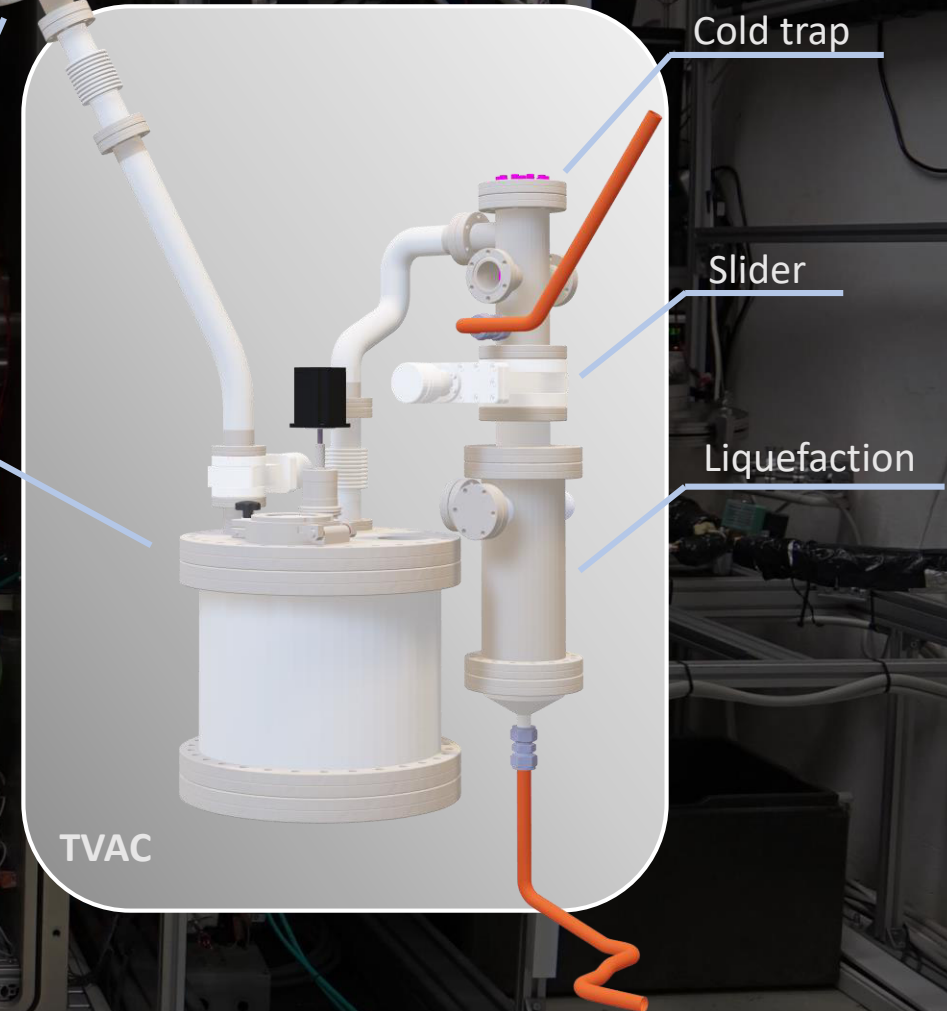
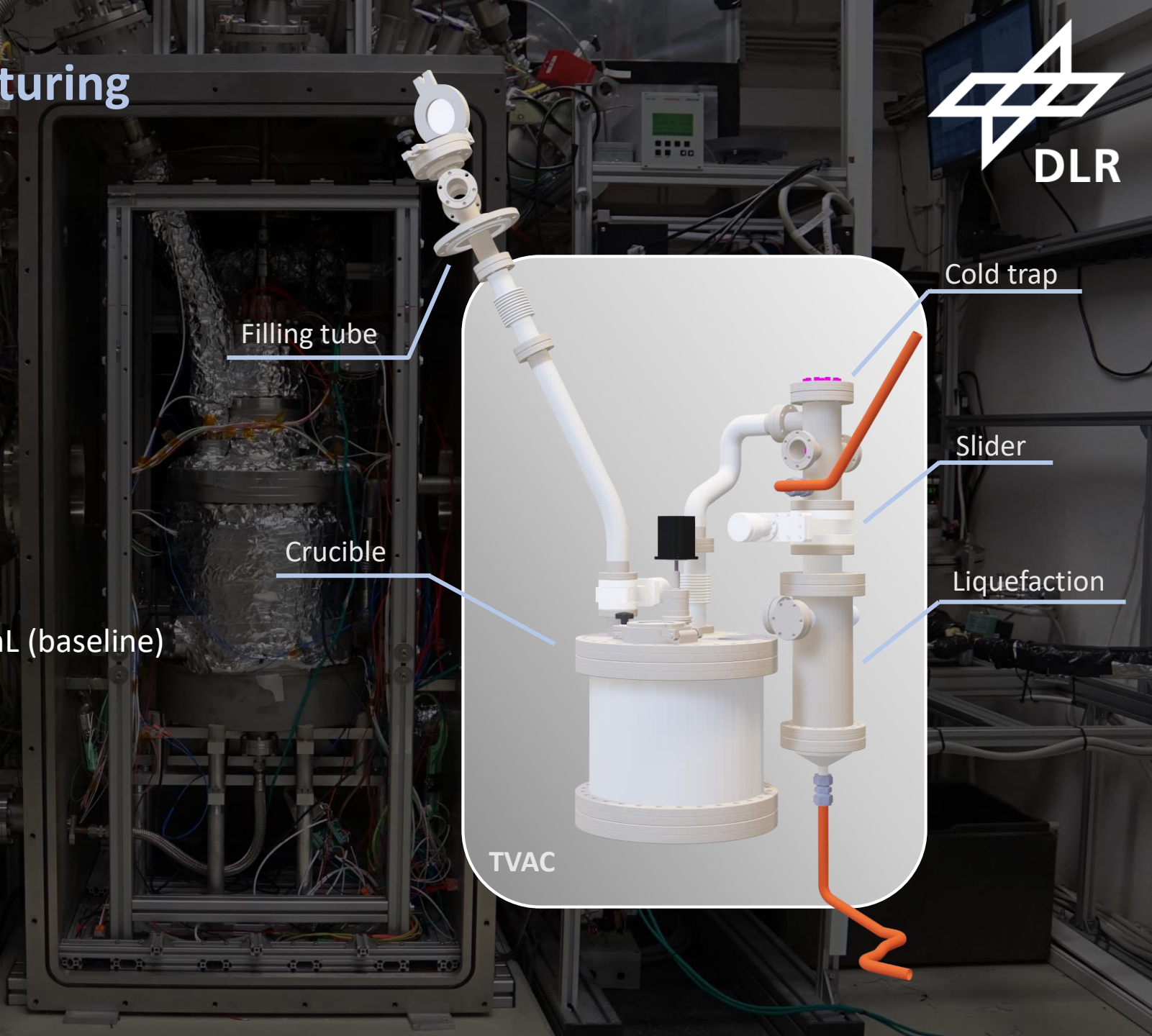
Thermal
Vacuum
Chamber
(TVAC)



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Water Extraction and Capturing

-  Dusty TVAC
-  Temperature $\approx 80 - 100$ K
-  Pressure $\approx 10e-6$ mbar
-  Icy regolith simulant mass up to 15 kg
-  Amount of water present 5 wt.%, 750 mL (baseline)
-  Presence of volatiles: CO_2 & Methanol



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Water Extraction and Capturing

-  (Re)filled crucible for 12 experiments
-  Successfully sublimated ice during 14 attempts
-  Regolith simulant or glass beads

Crucible



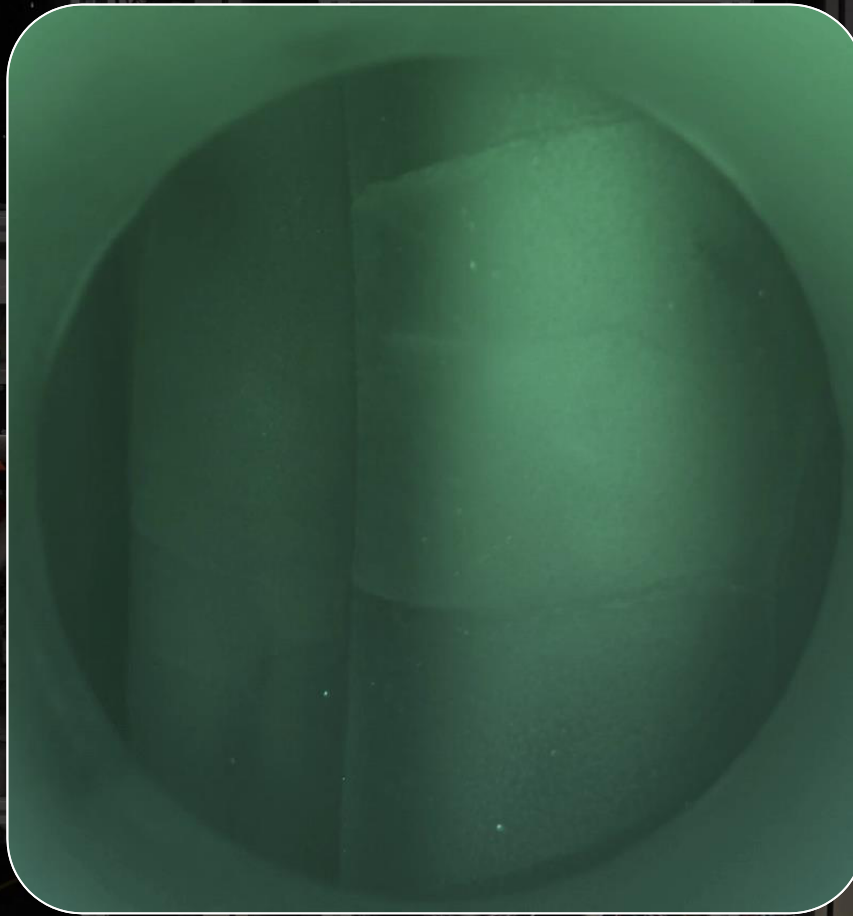
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Water Extraction and Capturing

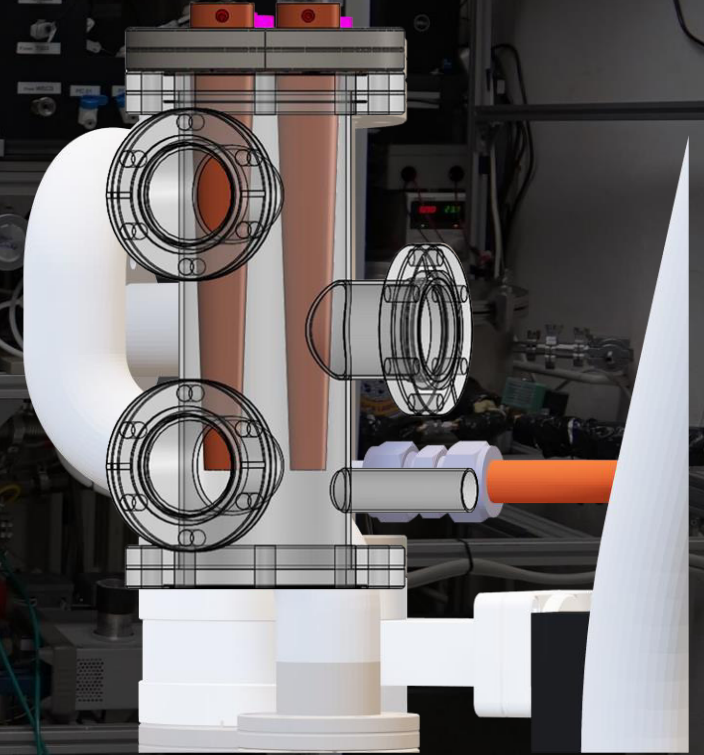
💧 Captured ice 14 times

💧 Capturing efficiency relatively high (around 90%)

💧 Methanol severely reduced efficiency

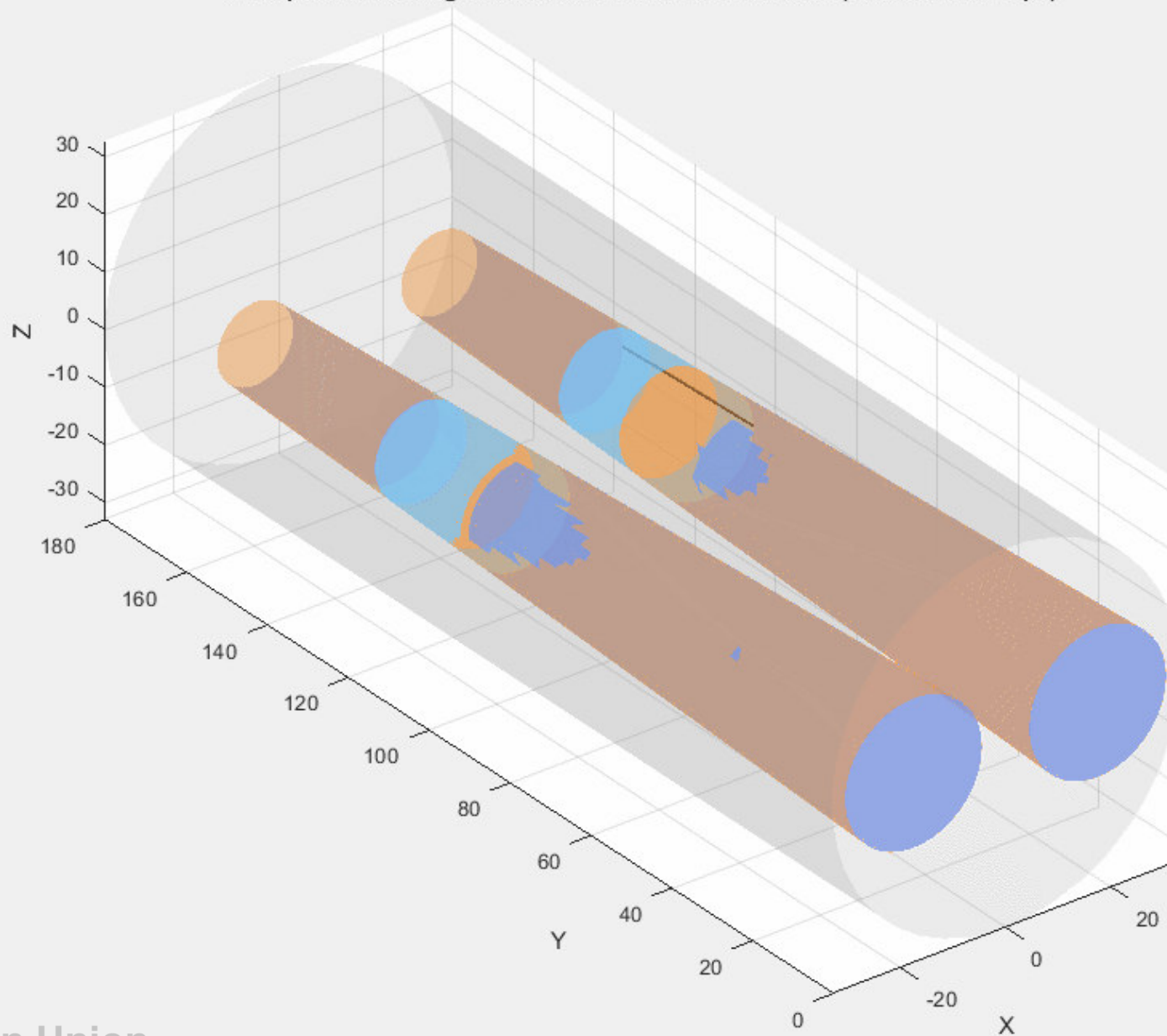


Cold trap



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Test203.2 - 2 Capturing (1/1) Phase
Row 1 | Time=14-Oct-2024 10:09:44 | T=0.000 mm | Vol=0.000e+00 mm^3
Extrapolated ice edge and revolved volume estimation (removed overlaps)



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Water Extraction and Capturing



60 kg of produced
simulants

20 - 50 g of water
per kWh

50 - 70% recovery
efficiency

3,7 kg of ice
sublimated

2,4 kg of water
recovered



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Full results yet to be published



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Water Purification - Requirements



Consuming less
than 1 g of
consumables per kg
of product water

Target
product water to
feed ratio $> 95\%$

Target product
water quality for
electrolysis and
potable water



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ThalesAlenia
a Thales / Leonardo company *Space*

Water Purification - Requirements



Target product water
quality for electrolysis
applications and
drinkable water

TOC < 0,5 ppm



Methanol < 0,5 ppm



EC < 1 $\mu\text{S}/\text{cm}$



pH < 7



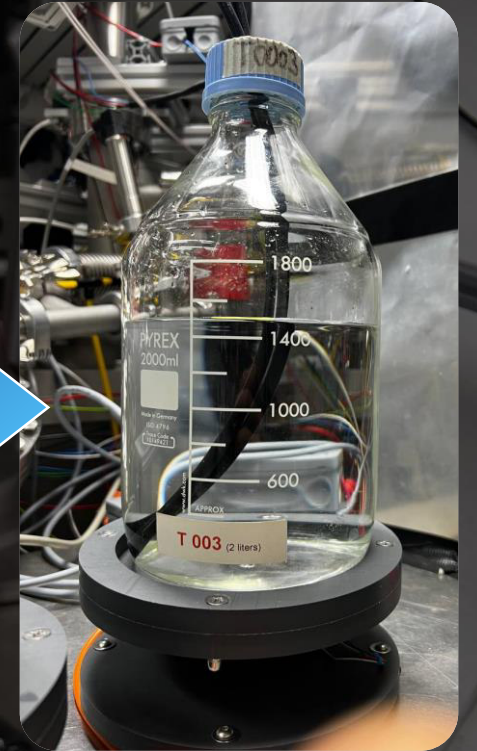
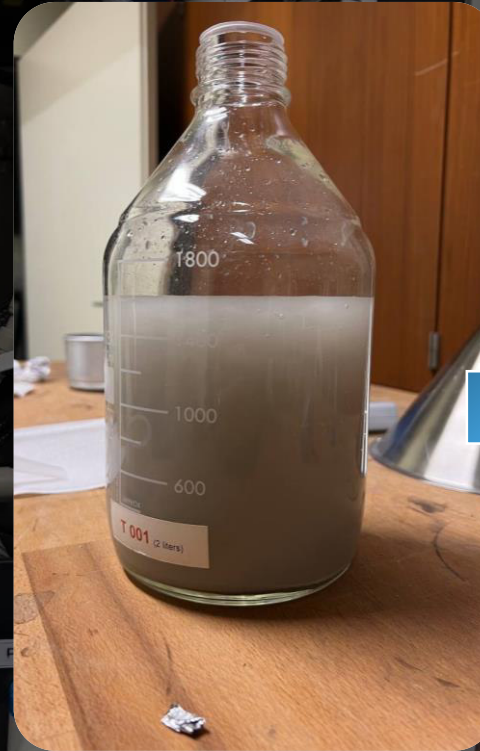
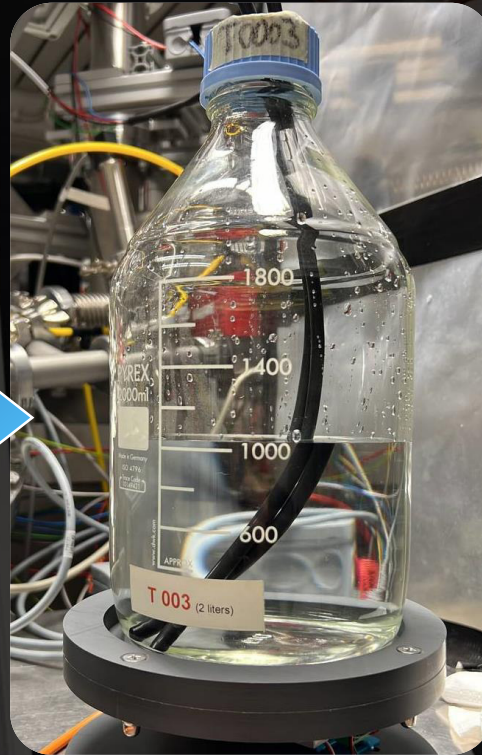
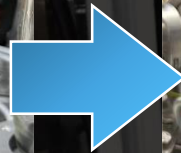
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ThalesAlenia
a Thales / Leonardo company Space

Water Purification Results

Glass beads and ice

Icy-regolith simulant





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The background of the slide is a dark, atmospheric image of an astronaut on the Moon. The astronaut is in the center, wearing a full spacesuit with a large oxygen tank on their back. They are crouching and holding a clear glass bottle that contains a glowing blue liquid. The Moon's surface is rocky and grey, with some shadows. In the background, the Earth is visible as a large, blue and white sphere against the black sky of space.

LUWEX is the first project to demonstrate large-scale water extraction and purification in a realistic lunar environment using a novel icy regolith simulant, setting a new benchmark in scale, completeness, and performance.



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Thank you!



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Brochure



Podcast

