Water from Moon Dust

LUWEX SUCCESSFULLY DEMONSTRATES TECHNOLOGIES FOR EXTRACTING WATER FROM LUNAR REGOLITH

7 January 2025

Image: LUWEX consortium

As part of the project LUWEX (Validation of Lunar Water Extraction and Purification Technologies for In-Situ Propellant and Consumables Production), an international team of researchers developed and successfully demonstrated technologies for extracting water from lunar regolith in laboratory conditions, showing how ice could be extracted from simulated lunar regolith. The extracted and purified water holds the potential for use as drinking water, oxygen production, or cryogenic rocket propellant in space—a critical step in supporting sustainable exploration of the solar system.

Led by the German Aerospace Center (DLR) in Bremen, the LUWEX research project developed and tested a water extraction process in large-scale experiments conducted at TU Braunschweig over several months. Each trial aimed to produce at least half a litre of water, a goal that was consistently achieved and even exceeded.

SIMULATING LUNAR CONDITIONS IN THE LAB

The LUWEX process was validated through experiments at TU Braunschweig's CoPhyLab (Comet Physics Laboratory), a unique facility designed to replicate lunar surface conditions. During the trials, nearly 65% of the water in the simulated regolith was successfully extracted and purified. Over the course of the experiments, more than three litres of potable water were produced.

The laboratory setup included a thermal vacuum chamber capable of simulating temperatures as low as -170°C under vacuum conditions. This facility, originally developed for comet research, enabled researchers to test extraction techniques at a realistic scale. Comprehensive monitoring was achieved using 14 integrated measurement systems, ensuring precise validation of the technology.

PRODUCING ICE-BEARING LUNAR REGOLITH IN THE LAB

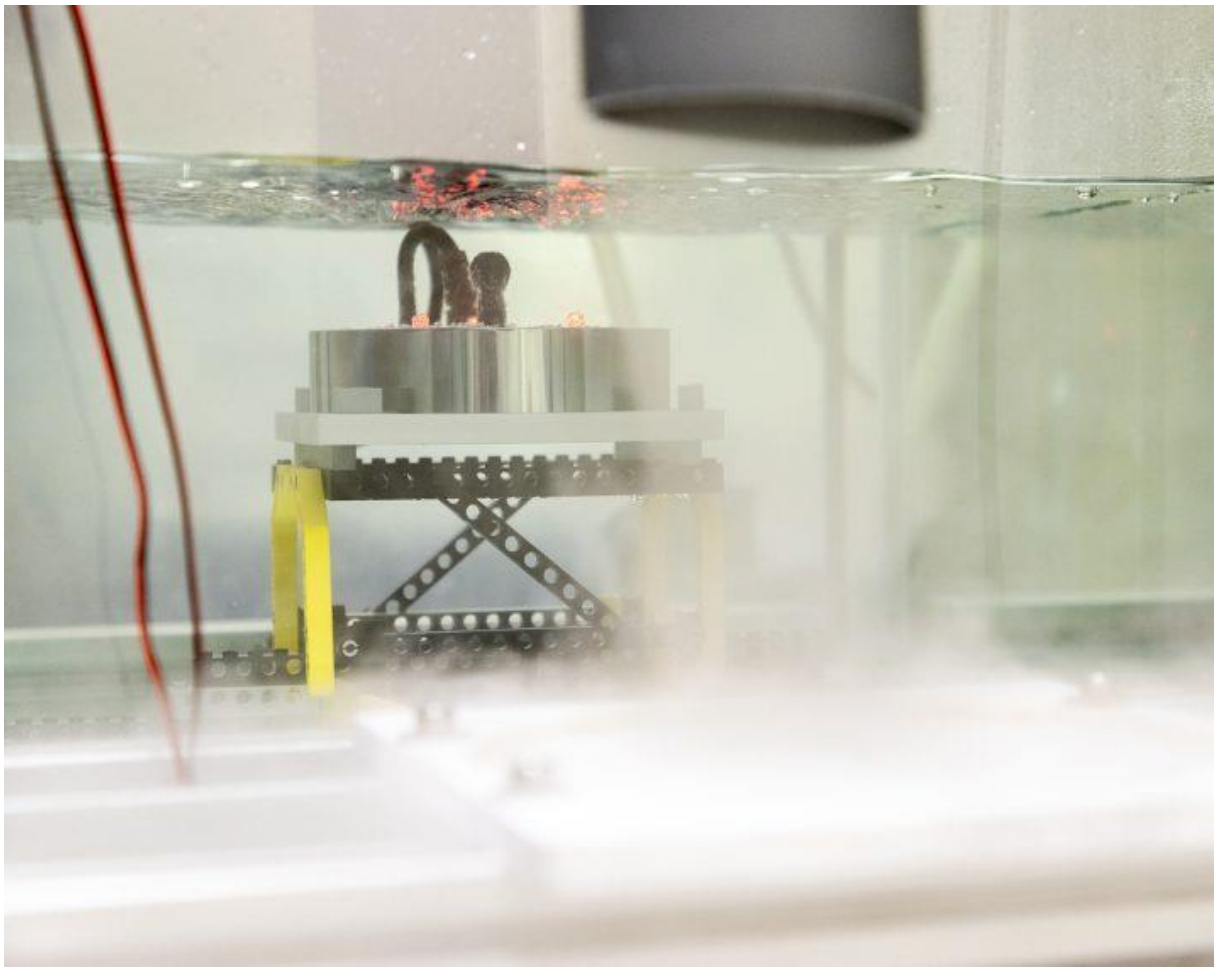
To simulate lunar regolith containing ice, scientists created a dust-ice mixture by combining synthetic lunar regolith with ice particles.

The ice was produced by flash-freezing fine water droplets in liquid nitrogen, creating spherical particles with an average radius of 2.4 micrometres—approximately one-twentieth the thickness of a human hair.

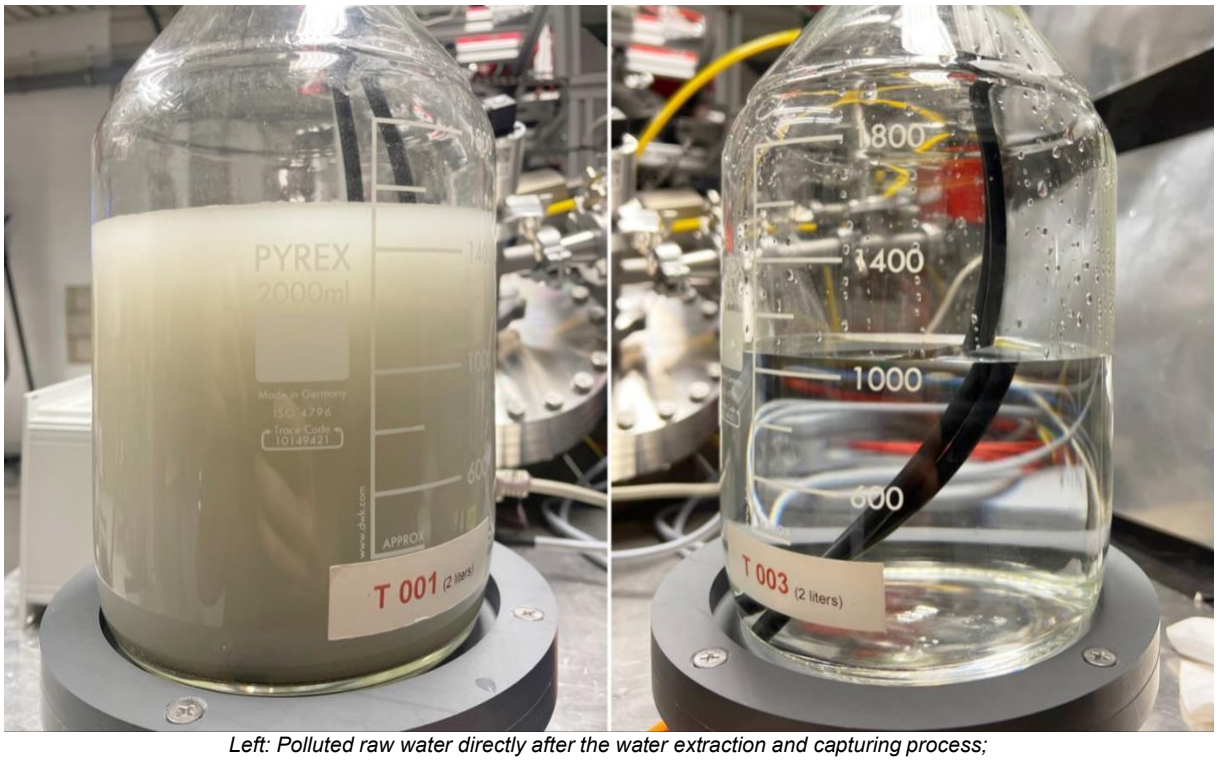
EXTRACTING AND PURIFYING WATER

The lunar ice simulant was placed in the water extraction system developed by DLR, located within the thermal vacuum chamber, allowing it to be tested under lunar-like conditions. Up to 15 kilograms of the simulant were placed in a pre-cooled container inside the vacuum chamber. The atmosphere was evacuated, and the simulant was heated and stirred to ensure even heat distribution. Under these conditions, the ice sublimated directly into water vapour, which was captured on copper tubes cooled to -150°C. The vapour re-condensed into ice, which was later liquefied for collection and purification.

Thales Alenia Space and Wroclaw University of Science and Technology were responsible for purifying the extracted water, ensuring its quality met stringent requirements for human use and rocket propellant production. Researchers optimised parameters such as temperature and stirring speed to maximise water yield while minimising energy consumption.



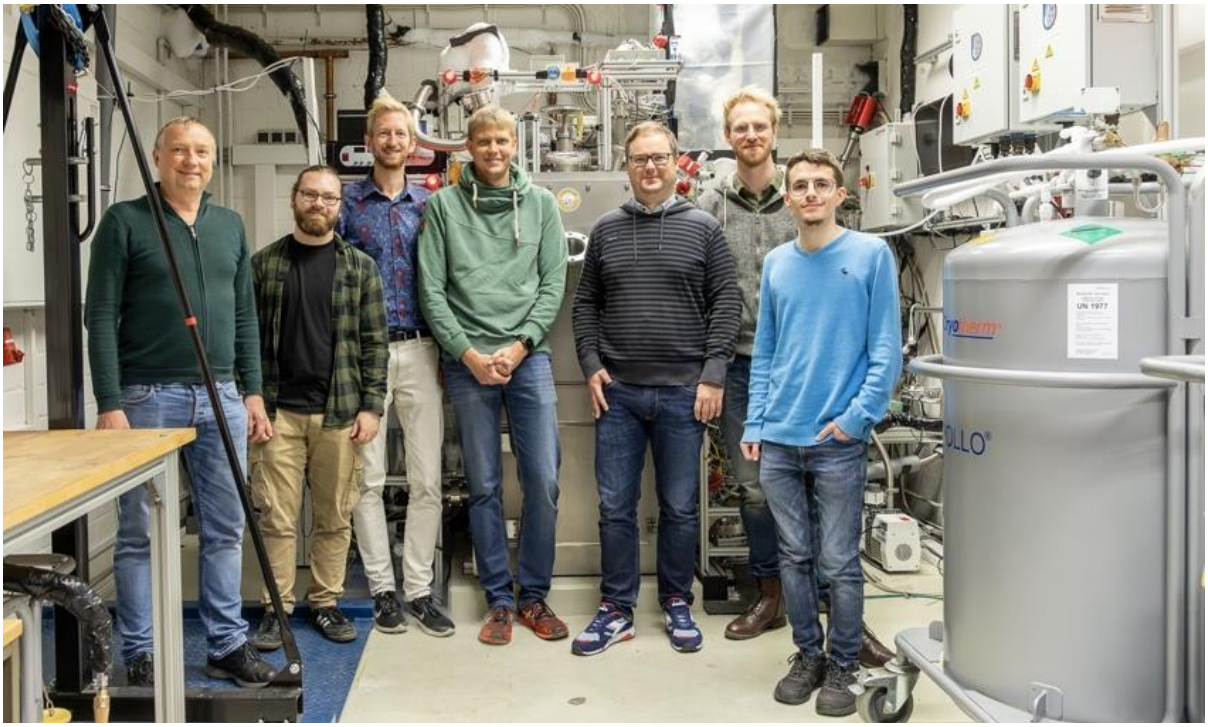
Ice machine for producing granular water ice. In the background, the piezo element is visible; in the foreground, water mist
Image: LUWEX consortium



Left: Polluted raw water directly after the water extraction and capturing process;
Right: Clean water as a result after purifying the raw water. Image: LUWEX consortium

COLLABORATIVE INTERNATIONAL EFFORT

The LUWEX project brought together an interdisciplinary team from Germany, Austria, Poland, and Italy. Key participants included TU Braunschweig, DLR, LIQUIFER Systems Group, Thales Alenia Space, Wroclaw University of Science and Technology, and SCANWAY SPACE. Each partner contributed critical subsystems or infrastructure, reflecting the project's collaborative nature.



Some of the LUWEX team members. Image: LUWEX consortium

SUMMARY

The LUWEX project, short for Validation of Lunar Water Extraction and Purification Technologies for In-Situ Propellant and Consumables Production, funded by the EU's Horizon Europe framework program, marks a significant milestone in lunar resource utilisation. By successfully developing and demonstrating technologies to extract and purify water from lunar regolith simulants, the project has laid the groundwork for sustainable space exploration and paved the way for future in-situ resource utilisation initiatives.

Grant agreement 101081937
Funded under Horizon 2022
Space Science and Exploration Technologies

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