LUNA Analog Facility

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Simulation and Testing in a Moon Analog Environment

The German Aerospace Center (DLR) and the European Space Agency (ESA) jointly operate the LUNA Analog Facility in Cologne, Germany. The LUNA Analog Facility is a cutting-edge research and testing environment, uniquely designed to support a wide range of lunar exploration technologies. Whether for academic, industrial, or institutional research, the facility provides a variety of specialized areas for simulating lunar surface conditions and conducting advanced experiments.

At the heart of the facility is the Regolith Test Field, a 700 square meters area filled with the EAC-1A lunar regolith simulant (mare-type), which can be customized to simulate a variety of lunar terrain features, including craters, hills, and smooth surfaces. Equipped with seismic sensors and geological rock samples, this test field offers a wide-ranging platform for campaigns. The area's dimensions – 33 meters by 20 meters – can accommodate experimental equipment up to 4 meters by 5.25 meters. Please note that all users and personnel must wear protective equipment to avoid contamination of the simulant.

The LUNA Analog Facility in Cologne during the inauguration event in September 2024.

Point of Contact

German Aerospace Center (DLR)
Space Operations and Astronaut Training
Dr. Andrea E. M. Casini
Linder Hoehe, D-51147 Cologne

E-Mail: luna@luna-analog-facility.de

DLR.de/RB
LUNA-Analog-Facility.de

The Deep Floor Area, part of the regolith test field, extends to a depth of three meters. This zone includes an artificial lava tunnel and buried targets, designed to simulate lunar subsurface structures. It enables testing of lunar exploration tools and techniques and supports activities such as sampling, excavation, and drilling, which are vital for in-situ resource utilization (ISRU) and astronaut safety. Additionally a dust lab filled with highland-type regolith is available for campaign use.

Furthermore, to support seamless operations, the facility's Ground Segment provides robust infrastructure for local and remote control of experiments. This includes four fixed cameras with low-light and infrared capabilities, Wi-Fi connectivity, and VPN access for remote device integration. The Voice Communications System (VoCS) enables real-time communication between the control room and personnel in the test field, even while wearing full protective gear. Additionally, the Monitoring and Control System (MCS-L) will ensure smooth integration of user experiments into the LUNA network, offering centralized management of experiments, real-time data exchange, and remote control from ESA, MUSC or GSOC control centres. All in all, MCS-L utilizes CCSDS space packets and LUNA's Disruption Tolerant Networking (DTN) to exchange data, with results available in raw or decoded formats for the user after the campaign's completion.

Moreover, the LUNA Analog Facility offers two commercial rovers, each of which conforms to a 3U cubesat standard, with additional space of 2U cubesat standard for self-contained payloads. These rovers can be controlled remotely via a web browser and include video streaming capabilities, allowing for enhanced user engagement, especially for science, technology, engineering, and mathematics (STEM) applications. Another larger rover is under development for even more advanced testing. Additionally, the facility provides two customized EXCON analog EVA exploration suits, ideal for astronaut simulation campaigns, offering a realistic lunar analog environment.

Further enriching the testing environment is the ESA EL3 Argonaut Lander Mock-up, which enables users to study astronaut ergonomics, mission planning, and automation procedures. The Sun Simulation system, based on high-performance adjustable lamps, currently simulates lunar sunlight conditions in polar regions, with a more advanced permanent installation expected by 2025. A crane with a 3.2-ton load capacity further supports large-scale experimental setups, offering flexibility for positioning campaign equipment across the test field.

In addition to these established elements, the LUNA Analog Facility is still developing new elements. Planned future developments include the Candelabra Sun Simulator (Q4/2025), the Moon Zeppelin Ramp (Q1/2026), the Puppeteer Gravity Offload System (Q3/2026), a Workshop Area (Q1/2025), Extended Reality Motion Capture (Q4/2025), and more. These upgrades will greatly enhance the facility's ability to support a broad range of scientific and technological campaigns. For a full list of elements, please visit LUNAs website where you will find more detailed descriptions of the elements implemented and still under development.

If you are planning a campaign, interested parties must contact the LUNA team and submit a campaign request form. The LUNA Utilization Control Board, comprising experts from ESA and DLR, will review proposals and collaborate with approved applicants to finalize details. The minimum lead time for experiments is two months, with more complex campaigns requiring additional preparation time. For further information and to initiate a campaign, please reach out to campaigns@luna-analog-facility.de.
For more details on upcoming developments and to submit an experiment proposal, visit our website or contact the team via:

- General Inquiries: luna@luna-analog-facility.de
- Campaign Inquiries: campaigns@luna-analog-facility.de
- Press Inquiries: media@luna-analog-facility.de

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THE MOON ON EARTH

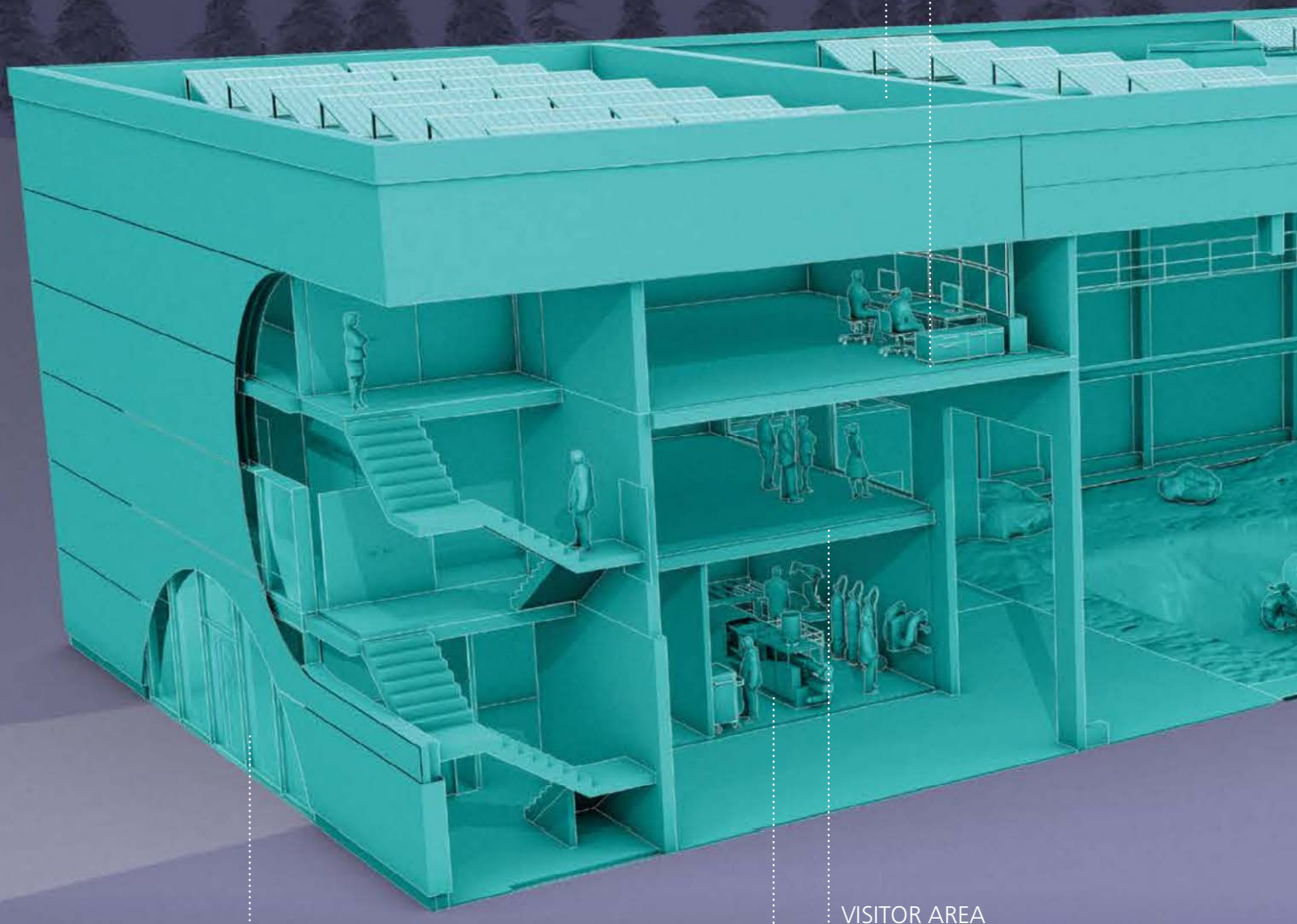
The LUNA Moon analog facility in Cologne

SOLAR CELLS

Photovoltaic systems are installed on the roof of the building to reduce the facility's carbon footprint.

XR LABORATORY

eXtended Reality technologies are playing an increasingly important role in simulations, preparatory activities and training for space missions. An XR development and digital production studio is planned for this purpose.



MAIN ENTRANCE

PREPARATION ROOMS

A workshop, experiment preparation rooms, a gas laboratory and a lunar dust laboratory are also part of the facility.

VISITOR AREA

LUNA is designed to inspire. Here, visitors have a direct view of the lunar surface and can admire a real Moon rock.

A VIEW INSIDE THE EDEN LUNA LABORATORY

An almost closed life-support system in which vertical plant growth is being tested.

More information:
luna-analog-facility.de/en/

ROBOTIC ARM

The robotic arm is controlled using artificial intelligence. It assists with tasks that have to be performed during the cultivation process.

LUNAR SURFACE

The regolith surface is the centrepiece of LUNA. The basaltic simulant EAC-1A obtained from a nearby location simulates the lunar dust.

SUSPENSION SYSTEM

Astronauts in spacesuits are supported in such a way that they can move around as if they were actually on the lunar surface with lunar gravity.

PLANTS

Plants suitable for spaceflight are grown here. These include cabbages, herbs and peppers. For the first time, strawberries are also going to be cultivated.

HABITAT

Prototype for a Moon base.

DEEP FLOOR AREA

The regolith here is three metres deep and there are different slopes for taking samples, drilling, processing the lunar soil or for crater simulation.

ROVER

The hall will be used for more than just astronautical activities. Robotic tests and validation activities will also be conducted here.

LANDER

Handling and interactions on the Moon can be tested using a replica of the future ESA Argonaut lander.

SUN SIMULATOR

The very special lighting conditions on the Moon can be recreated here.

EDEN LUNA

This greenhouse is a further development of EDEN ISS.

It has been more than 50 years since the last human set foot on the Moon. The return to Earth's natural satellite is a stated goal of international space exploration. The LUNA analog facility is designed to prepare astronauts for such a mission. Here, they can train for their tasks on the lunar surface together with the relevant teams in the control centres. Robots can also be tested under realistic conditions. LUNA is also available to university researchers as well as members of industry, start-ups and small and medium-sized enterprises. The 700-square-metre, nine-metre-high hall is located on the DLR site in Cologne-Porz. LUNA is a joint project of DLR and the European Space Agency (ESA). The facility is operated by the Microgravity User Support Center (MUSC), the European Astronaut Centre (EAC) and the German Space Operations Center (GSOC) in Oberpfaffenhofen.