IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

Author: Dr. Andrea Emanuele Maria Casini
German Aerospace Center (DLR), Germany

Mrs. Petra Mittler
DLR (German Aerospace Center), Germany
Dr. Juergen Schlutz
European Space Agency (ESA), Germany
Dr. Thomas Uhlig
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Ms. Flavie Aditya Annick Suzanne Davida Tohotaua Rometsch
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Mr. Lionel Ferra
ESA, Germany
Dr. Aidan Cowley
ESA, Germany
Mrs. Beate Fischer
DLR, German Aerospace Center, Germany

LUNAR MISSIONS' SIMULATIONS IN ANALOGUE FACILITIES: THE OPERATIONAL CONCEPT AND THE FIRST COMMISSIONING OF THE ESA-DLR LUNA FACILITY

Abstract

Europe is actively preparing for human missions beyond Low Earth Orbit (LEO) towards Gateway and the lunar surface, contributing to and collaborating with partners such as the National Aeronautics and Space Administration (NASA) with the Artemis programme. In this framework, the European Space Agency (ESA) and the German Aerospace Centre (DLR) are currently developing a lunar analogue facility named LUNA in Cologne, Germany. This hall-type industrial structure has been designed for maximum immersion in simulated Moon surface exploration for analogue activities, operations development, astronaut training, technology maturation and scientific research. Its main feature is a 700 m2 testbed area filled with EAC-1, a lunar regolith simulant, complemented by a dedicated solar simulator that mimics the peculiar lunar light conditions. Reduced gravity operations will be simulated by using an offloading system, for both human and robotic use cases. Multi-day simulations in isolation are envisioned, where astronauts can use the crew quarters set up at the DLR :envihab facility as well as external modules such as the Future Lunar EXploration Habitat (FLEXHab) and the ground demonstrator for plant cultivation in extreme environments, EDEN-LUNA. An off-grid, regenerative energy system will supply electrical power to those external modules based on photovoltaics, batteries and fuel cell technology, much like a potential solution on the Moon could. In-Situ Resource Utilization (ISRU) experiments and dust mitigation strategies will be developed, eventually leading experience and recommendations for future human surface missions. Rover navigation and teleoperations will be part of the portfolio of activities to be carried out in LUNA, providing large area, reproducible, and well characterised analogue terrain. A modern control centre will leverage the experience of ESA and DLR of more than 20 years of continuous International Space Station (ISS) operations. Overall, robotic systems, lunar landers and astronauts will be able to interact in this closed artificial facility for end-to-end testing of mission operations in a

high-fidelity simulation environment. Innovative technologies such as eXtended Reality (XR) tools will be used to augment the immersion in lunar landscapes. The LUNA facility will complete those existing currently on the DLR campus Cologne, offering the possibility to fully replicate lunar surface operations, thus creating a worldwide unique centre of excellence for human spaceflight accessible to international partners, industries, research organisations and academic institutions. The present work describes the current status of the facility, the initial concept of operations and first commissioning activities foreseen for the utilization of LUNA from 2023.