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SIMULATING A SIMULATION: DEVELOPING LUNAR EXPLORATION OPERATIONS FOR THE LUNA FACILITY USING EUROPE'S PRIVATE ANALOGUE SITES

Abstract

Analogue missions serve as practical testbeds for space exploration, offering insights into the dynamics of crewed space operations. The LUNA facility, developed jointly by the German Aerospace Center (DLR) and the European Space Agency (ESA), stands as a prime example of high-fidelity analogue testing grounds designed to mimic lunar surface conditions accurately. This facility will play a pivotal role in advancing the understanding of long-term habitation challenges beyond Low Earth Orbit (LEO), addressing the unique demands of surface-based lunar operations. In anticipation of training real astronauts for lunar missions, it is possible to leverage observations from private analogue research facilities such as LunAres Research Station to streamline the development of operational concepts.

LunAres provides a comprehensive simulation environment consisting of a fully isolated habitat conjoined with an enclosed Extravehicular Activity (EVA) area, allowing for the detailed study of crew dynamics, tech demonstrations, and operations under simulated lunar conditions. As a part of NIKE-I, a 2023 mission taking place in this habitat, a team of six analogue astronauts undertook an operational test with intricate teamwork dynamics during one of the simulated EVAs. The operational setup coordinated the efforts of the habitat crew split between the EVA team and the habitat team ("HabComs"), as well as a ground support team comprising a Flight Director from DLR and system operators, with the results of the test intended to inform the development of operational concepts for the LUNA facility. This paper describes the preparatory activities of this test, the overall setup of the EVA, its scenario and the events encountered during its execution. The paper provides technical details of systems and equipment employed during the test, as well as the operational aspects such as individual positions and their responsibilities. The concluding section offers a discussion focused on lessons learned and the overall impressions from the operational test.

Keywords: analogue missions, operations, Lunar exploration, astronaut training