Paper ID: 87125
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Maurizio Deffacis
Altec S.p.A., Italy

Mr. Diego Bussi
Altec S.p.A., Italy
Mrs. Chiara Picco
Altec S.p.A., Italy
Mrs. Rosa Sapone
Altec S.p.A., Italy
Mr. Marco Barrera
Altec S.p.A., Italy
Dr. Marco Cicala
ASI - Italian Space Agency, Italy
Dr. Francesco Latini
Italian Space Agency (ASI), Italy

INDOOR ANALOGUE FACILITIES, FROM MARS TO THE MOON: NEW CHALLENGES AND INNOVATIVE SOLUTIONS TO REPRODUCE WITH HIGH FIDELITY THE LUNAR ENVIRONMENT EXPLOITING CAPABILITIES AND SKILLS ACQUIRED FROM THE MARS TERRAIN SIMULATOR DESIGN EXPERIENCES

Abstract

Italy is paving the way for the exploration and resources utilization at the Lunar South Pole in the frame of the Artemis and Gateway programmes. In December 2023 ALTEC started the development of the Lunar Space Operations Center in Turin (Italy), under Italian Space Agency contract: leveraging on the initiatives in the Human Space Flight and in the Space Exploration, ALTEC aims at supporting future activities on the Moon, in order to realise a permanent human presence on Earth's satellite, as well as a sustainable access and exploitation to its resources.

The Lunar Space Operations Center will include a Lunar Terrain Simulator (LTS), an indoor analogue facility designed to reproduce with high fidelity, from a morphological and mineralogical point of view, the terrain characteristics at the landing site in the Lunar South Pole region and to support the daily ground operations through rehearsal and troubleshooting on representative hardware and instrumentation.

The LTS arena concept is based on the Mars Terrain Simulator (MTS), presented at IAC 2018. The MTS is part of a wider ground control facility known as the Rover Operations Control Center, implemented at ALTEC premises for the ESA ExoMars Rosalind Franklin Program (EXM-RFM), specially tailored to perform the Rover Ground Test Model functional testing and to give the adequate support to the Rover surface mission in case of contingency.

Several strategies will be put in place to design the LTS and simulate the lunar surface operations, using the acquired skills from the MTS. The LTS arena will be adapted to create the main Lunar topographic features with the approaches already validated in the MTS facility, while the reconfiguration in terms of slopes, crevasses, rock distribution will be executed by means of dedicated support equipment and mechanical tools. Arena Systems consisting of a set of digital cameras will be used to track the motion of specific items inside the terrain, to generate the 3D Digital Elevation Map of the arena, to acquire images

and to record videos.

This paper presents the initial phases and the current status of the LTS development, focusing both on the exploitation of MTS experiences and on the new challenges to face with the Lunar environment, e.g. the identification of the lunar regolith simulants, the management of the fine dust particles, the implementation of a smart gravity reduction device, the replica of the correct lunar lighting conditions.