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MOON EXPLORATION: THE ITALIAN INTEGRATED GROUND FACILITY TO SUPPORT TECHNOLOGIES TESTING AND LUNAR OPERATIONS PREPARATIONS, VALIDATION AND EXECUTION IN A REPRESENTATIVE LUNAR ENVIRONMENT

Abstract

After the conclusion of the Apollo era, the global interest about Moon exploration and colonization has reached a new peak, mainly led by the NASA "Artemis" project and the ESA "Terrae Novae" roadmap. Furthermore, with the signature of the "Artemis accords", many countries, including Italy with the Italian Space Agency, are providing contributions in term of infrastructures and services, with the goal to bring back humans and cutting-edge technologies in lunar orbit and on the surface of the Moon. The "back to the moon" tactic is considered a fundamental step of the Mars colonization strategy; humanity still needs to conquer knowledge and methodologies to safely send humans on the red planet: Moon is the place to gain what is still missing.

Within this roadmap, the Italian Space Agency decided to fund an integrated ground infrastructure to support development, testing, validation, training, and operation simulation of a wide spectrum of activities and equipment (e.g. robotic assets, surface infrastructures, ISRU technologies, scientific experiments), in view of their utilization on the Moon.

The facility design is under finalization at the time of writing this paper and its construction and testing is supposed to be completed by 2026. The facility will be built at the ALTEC headquarters in Turin, Italy, joining other similar facilities already available for supporting robotic surface operations on the Martian soil (i.e. Mars Terrain Simulator embedded into the Rover Operations Control Center supporting the operations of the ExoMars Rosalind Franklin Rover).

This paper provides the results of an up-to-date survey of similar facilities available all over the world, supporting lunar operations with indoors or outdoors equipment. On top of this, the paper describes the main characteristics and purposes of the Italian facility, with a focus on its distinguishing functionalities.

The Italian integrated ground facility is conceived around three main components: (1) Lunar Terrain Simulator (LTS): a lunar analogue indoor terrain covered by representative lunar regolith simulants; (2) Lunar Environment Simulator (LES): a controlled dirty thermo-vacuum chamber able to reproduce temperature, pressure and regolith contamination conditions characterizing the lunar surface; (3) Lunar Mission Control Center (LMCC): a center capable to interface with LTS and LES directly, in order to monitor the testing activities locally within the facility or from remote locations. Furthermore, the LMCC can be used for providing operations planning, monitoring control, and data analysis capabilities for real lunar missions.