Paper ID: 85697
oral

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IPB)

Author: Dr. Valentina Sumini
Politecnico di Milano, Italy, valentina.sumini@polimi.it

Dr. Lorenzo Isolan
Alma Mater Studiorum - University of Bologna, Italy, lorenzo.isolan2@unibo.it
Prof. Marco Sumini
Alma Mater Studiorum - University of Bologna, Italy, marco.sumini@unibo.it

RADIATION PROTECTION BY DESIGN STRATEGY FOR LUNAR HABITATS

Abstract

The vision of the NASA Artemis program, as well as other international exploration programs, to establish a near permanent human presence on the Moon highlights the critical importance of radiation protection for astronaut safety and habitat sustainability. To cope with the radiation hazards coming from various sources, from Galactic Cosmic Rays (GCR) to solar flares to materials' activation, the classical approach is based on an 'add-on' philosophy, where protection systems are added or inserted in an effort to not introduce relevant perturbation to the standard habitat setup. A completely different approach could involve incorporating radiation protection constraints among the basic criteria from the very beginning of the design process. These constraints would be placed at the same level of importance as mass or resilience with respect to micrometeoroid protection and In-Situ Resources Utilization (ISRU), to mention just a few of the strategic aspects. When this approach comes fully into play, it turns out that reference solutions can stem out from biological structures like sea-urchin or starfish, where a synthesis from structural and functional solutions has been fully reached as result of the evolutionary path. Topology optimization plays a crucial role in this context, enabling the efficient and innovative design of lunar habitats that emulate the evolutionary adaptability of natural structures. The integration of radiation protection into the design process implies that computational tools like Monte Carlo transport codes, e.g. MCNP6.2, become part of the design phase. They share a common computational basis, like unstructured mesh domains, with structural and related topology or energy transfer analysis. Some preliminary results about bio-inspired lunar habitats, where the radiation protection by design approach and extensive use of ISRU have been implemented, will be presented and discussed. This approach advances the exploration of bio-inspired structures that seamlessly conform to the challenging extraterrestrial environment.