

DLR-ESA LUNA Greenhouse – from Antarctica to Europe’s Lunar Analogue Facility

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Abstract – long

Long-term human exploration missions to the Lunar or Mars surface as planned as part of the e.g. ARTEMIS program, or any terrestrial habitated areas suffering from environmental changes, require food supply and reliable life support systems. International and sustainable long-term human exploration missions require new concepts and thorough preparatory tests. One element for such an undertaking is the DLR greenhouse system EDEN LUNA which will test key technologies which might be necessary for the exploration and possible economic use of the Moon. With the ESA/DLR LUNA analogue facility, co-funded by ESA, DLR and the county of North Rhine Westphalia in Germany, DLR and ESA are building a Moon-Analogue Simulation facility at DLR Cologne. EDEN LUNA will extend the simulation environment and add a space-analogue greenhouse to the facility. New ideas and technologies shall be tested, validated, and applied with exploration and space experts. Together with different partners the entire LUNA environment shall push innovation and mature prototypes towards becoming space worthy equipment. LUNA is a complex project contributing to various aspects of human lunar surface missions through feasibility tests, training and concepts of operations development in an analogue environment.

The German Aerospace Center (DLR) founded the Planetary Infrastructures research group working on bio-regenerative life support systems (BLSS) more than 10 years ago. Together with international partners various Greenhouse Systems have been designed, built and operated – one of them is EDEN (Evolution Design of Environmentally-closed Nutrition-Sources) ISS. EDEN ISS was deployed in Antarctica at the German Neumayer Station III for almost five years and generated more than 1 ton of biomass. The Neumayer station is operated year-round with a summer crew of 50-60 people and a winter crew of 9 people. All supplies (e.g. food, spare parts, tools) can only be delivered during the few summer months with great logistical effort. This remote location makes the Neumayer Station III an excellent test area for human space exploration test missions. Now the EDEN Mobile Test Facility enters its second life as EDEN LUNA. Next to updating the CEA technologies, the automation and remote-control is enhanced by AI. Data gathered from operations in the Antarctic as well as from ISS indicated that a significant amount of crew time was required to carry out nominal and off-nominal tasks. The Robotic Arm System EVE (EDEN Versatile End-Effector) is intended to demonstrate the capability to reduce the required crew time demand. At the same time the C.R.O.P.® biofilter (Combined Regenerative Organic food Production) will be introduced to the CEA system to transform (synthetic) urine into a usable nutrient solution base for the Greenhouse.

This presentation will give an overview of the EDEN research projects, summarize main findings and show new elements to the greenhouse for space with the EDEN Versatile End Effector (EVE) and C.R.O.P.® biofilter.

Keywords — Human Spaceflight; ISS; EDEN ISS, Antarctica, EDEN LUNA, Bio-Regenerative Life Support System, BLSS, LUNA, ESA, DLR, C.R.O.P.®



Figure 1 EDEN ISS becomes EDEN LUNA, here: the precursor mission in Antarctica, NM Station III



Figure 2 LUNA hall located in Cologne, Germany; Artists impression, ESA-DLR

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