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EXPERIMENT VERIFICATION TEST OF THE ARTEMIS I 'DEEP SPACE RADIATION GENOMICS' EXPERIMENT

Abstract

During the upcoming Artemis missions, NASA's Orion spacecraft (and crew as of the Artemis II mission) will be exposed to the deep space radiation environment beyond the protection of Earth's magnetosphere. Hence, it is essential to characterize the effects of space radiation, microgravity, and the combination thereof on cells and organisms, i.e., to quantify the correlation between the deep space radiation environment and genetic changes in cells. To address this, the Artemis I mission will include the Peristaltic Laboratory for Automated Science with Multigenerations (PLASM) hardware containing the Deep Space Radiation Genomics (DSRG) experiment. The scientific aims of DSRG are (*i*) to identify the metabolic and genomic pathways in yeast affected by microgravity, space radiation, and their combination, and (*ii*) to differentiate between gravity and radiation exposure on single-gene deletion/overexpressing strains' ability to thrive in the spaceflight environment. Yeast is used as a model

system because 70% of its essential genes have a human homolog, and over half of these homologs can functionally replace their human counterpart. As part of the experiment preparation towards spaceflight, an Experiment Verification Test (EVT) was performed at the Kennedy Space Center to verify that the experiment design, hardware, and approach to automated operations will enable achieving the scientific aims. For this, fluidic systems were assembled, sterilized, loaded, and acceptance-tested, and subsequently integrated with the engineering parts to produce a flight-like PLASM unit. Each fluidic system consisted of (*i*) a Media Bag, (*ii*) four Culture Bags loaded with *Saccharomyces cerevisiae* (two with deletion series and the remaining two with overexpression series), and (*iii*) tubing and check valves. The EVT PLASM unit was put under a temperature profile replicating the different phases of flight, including handover to launch, spaceflight, and splashdown to handover back to the science team, for a 58-day period. At EVT end, the rate of activation, cellular growth, RNA integrity, and sample contamination were interrogated. All of the experiment's success criteria were satisfied, encouraging our efforts to perform this investigation on Artemis I. This manuscript thus describes the process of spaceflight experiment design maturation with a focus on the EVT, its results, DSRG's preparation for its planned launch on Artemis I in 2022, and how the PLASM hardware can enable other scientific goals on future Artemis missions and/or the Lunar Orbital Platform – Gateway.

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