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SCIENCE VERIFICATION TEST OF THE ARTEMIS 1 'DEEP SPACE RADIATION GENOMICS' EXPERIMENT

Abstract

During the upcoming Artemis missions, NASA's Orion spacecraft (and their crew as of the Artemis 2 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 make a correlation between the deep space radiation environment and changes at the genetic level in cells. To address this, the Artemis 1 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 a combination of both, and (*ii*) to differentiate between gravity and radiation exposure on single-gene deletion and single-gene overexpressing strains' ability to thrive in the spaceflight environment. Yeast is used 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 design maturation, a Science Verification Test (SVT) was performed using PLASM components. The goal of the SVT was to demonstrate that the experiment design will enable the team to achieve the scientific aims. For this, a PLASM fluidic system was assembled, sterilized, loaded, and acceptance-tested, as we plan to do for the spaceflight units. This fluidic system consisted of (*i*) a Media Bag loaded with YPD supplemented with Geneticin G418, (*ii*) four Culture Bags loaded with *Saccharomyces cerevisiae* by4743 (parent strain of the deletion and overexpression series), (iii) a peristaltic pump, and (iv) a fluidic system connecting the Media and Culture Bags through check valves. The loaded hardware was put under a temperature profile replicating the different phases of flight, including PLASM handover to launch, spaceflight, and splashdown to PLASM handover back to the science team, for a 69-day period. At SVT end, the rate of activation, cellular growth, RNA integrity, and sample contamination were interrogated. This manuscript thus describes the process of spaceflight experiment design maturation with a focus on the SVT, DSRG's preparation for its planned launch on Artemis 1 on 2021, 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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