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NASA'S BIOSENTINEL DEEP SPACE CUBESAT MISSION: SUCCESSES AND LESSONS LEARNED

Abstract

BioSentinel is one of ten secondary payloads (all 6U CubeSats) deployed from NASA's Artemis I rocket on November 16, 2022. The main goals of BioSentinel were to develop an instrument capable of supporting biological organisms and to characterize the radiation environment in interplanetary deep space.

In addition to the spacecraft bus, BioSentinel contained two scientific payloads, a microfluidic-based instrument with thermal control capabilities to detect and measure cell growth and metabolic activity in microbes (called BioSensor), and a charged particle detector or LET spectrometer to measure ionizing radiation dose and to provide particle spectra based on their linear energy transfer. After launch and a short lunar fly-by, BioSentinel reached a stable heliocentric orbit a few days later to initiate the science phase of the mission. Even though all hardware subsystems were validated in deep space, the BioSensor microfluidic subsystem experienced anomalies throughout the initial 6-month mission. On the other hand, the LET spectrometer continues to work nominally. Interestingly, multiple solar particle events (SPEs) have been observed during the past year as we approach solar maximum. An identical BioSensor unit was flown to the International Space Station (ISS) in late-2021, where all the technologies were first demonstrated (prior to Artemis I) in addition to completing all science objectives.

The main goals of this presentation are (1) to present flight data from the deep space payload, including biology, fluidics, electronics, and mission operations, and (2) to discuss the lessons learned – what worked and what did not – from this unique complex mission, and how these lessons have aided in the development of the Lunar Explorer Instrument for space biology Applications (LEIA) mission, launching to the lunar surface on a commercial lander no earlier than 2026.

The satellite is currently at 50 million kms from the Earth (as of October 2024), communicating to Earth via the Deep Space Network (DSN) once per week. BioSentinel is supported by NASA's Exploration Systems Development Mission Directorate (ESDMD).