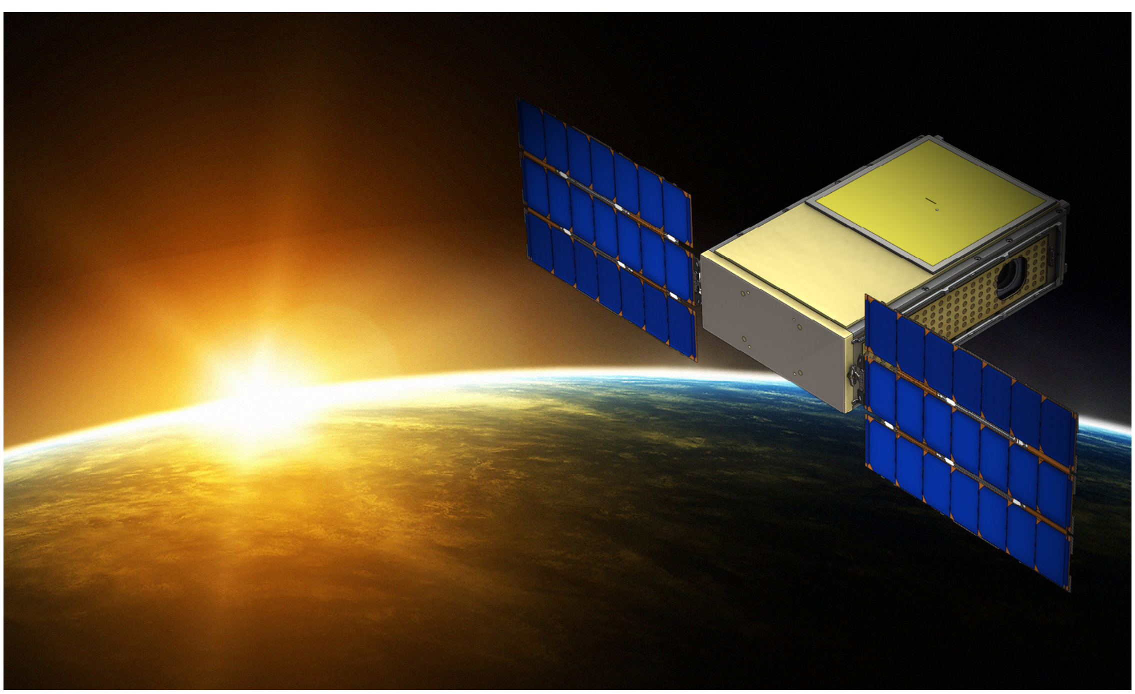
BioSentinel

The BioSentinel mission was selected in 2013 as one of three secondary payloads to fly on the Space Launch System's first Exploration Mission (EM-1) planned for launch in December 2017. The primary objective of BioSentinel is to demonstrate the use of simple model organisms as 'biosentinels' to detect, measure, and correlate the impact of space radiation to biological organisms including humans, a health risk over long durations beyond Low Earth Orbit (LEO). While progress identifying and characterizing biological radiation effects using Earth-based facilities has been significant, no terrestrial source duplicates the unique space radiation environment.

The payload instrument, a biosensor called BioSentinel, uses the yeast *S. cerevisiae* to measure double strand breaks (DSBs) that occur in response to ambient space radiation. DSBs are deleterious DNA lesions that are generated by highly energetic particles in the deep-space radiation spectrum and that are often repaired without errors. Specifically engineered nutrient selection strategies ensure that only DSB and repaired cells will grow in the BioSentinel reporter strains of yeast. Therefore measurements taken of culture growth and metabolic activity will be used to directly indicate a successful DSB-and-repair event.

BioSentinel is a 6-Unit (6U) spacecraft measuring approximately 14.4 inches long, 8.9 inches wide and 3.9 inches tall. It weighs about 30 pounds. At launch, BioSentinel resides within the second stage of the launch vehicle from which it is deployed to a lunar fly-by trajectory and into a heliocentric orbit where its distance to the sun is slightly closer than Earth's, varying between 0.98 to 0.92 AU. After completing the lunar fly-by and a two-week spacecraft check out, the science mission phase begins when the experiment start command is transmitted from the ground and initiates wetting of the first set of sample wells. Each set of wells is expected to be in its active biosentinel mode for 2 – 4 weeks following hydration; multiple such sets are included in three microfluidic cards. The sample wells of each microfluidic card contain three yeast strains: BioSentinel, wild type (occurring in nature) and *rad52* mutant,

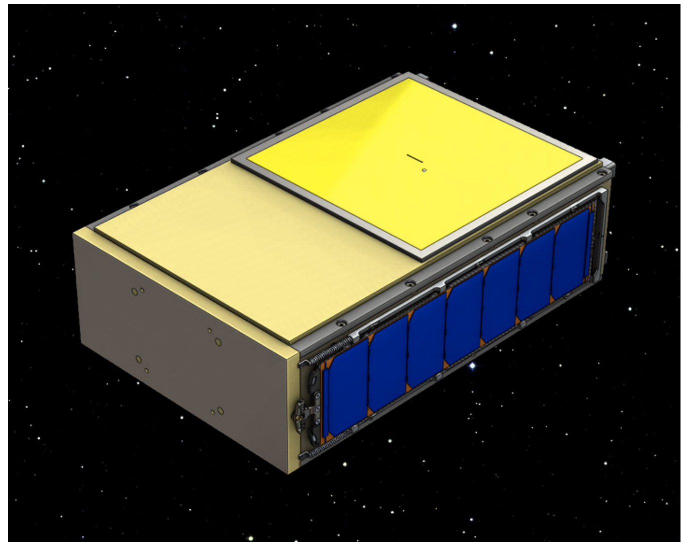


which are launched dry and are activated as described above by media addition at different time points over the 18-month mission. One reserve set of wells will be activated in the occurrence of a Solar Particle Event (SPE). Payload science data and spacecraft telemetry will be stored on board and then downloaded to the ground. This will continue over the duration of the mission.

Growth will be measured using a 3-color LED detection system and the metabolic indicator dye Alamar Blue. Biological measurements will be compared to data provided by onboard physical sensors and dosimeters and to Earth-based experiments using relevant energetic particle types, energies, and doses. Additionally, three additional identical BioSentinel payloads will be developed – one for the ISS where there is similar microgravity but a LEO-radiation environment, one for use as a delayed-synchronous ground control at a 1g and a low radiation environment, and one ground payload that will be used at Brookhaven National Laboratory in New York. Thus the BioSentinel payload will help calibrate the biological effect of radiation in deep space to analogous measurements conducted on Earth and on the ISS.

BioSentinel will conduct the first study of biological response to space radiation outside LEO in over 40 years. BioSentinel will address strategic knowledge gaps related to the biological effects of space radiation and will provide an adaptable platform to perform human-relevant measurements in multiple space environments. Yeast was selected for this mission as it is well-studied in space and its DNA repair mechanisms are common with human cells. BioSentinel's results will be critical for improving interpretation of the effects of space radiation exposure, and for reducing the risk associated with long-term human exploration.

The BioSentinel mission is funded by the Advanced Exploration Systems program within the Human Exploration and Operations Missions Directorate at NASA Headquarters. Partner organizations include NASA Ames Research Center, NASA Johnson Space Center, Loma Linda University Medical Center, and University of Saskatchewan.



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