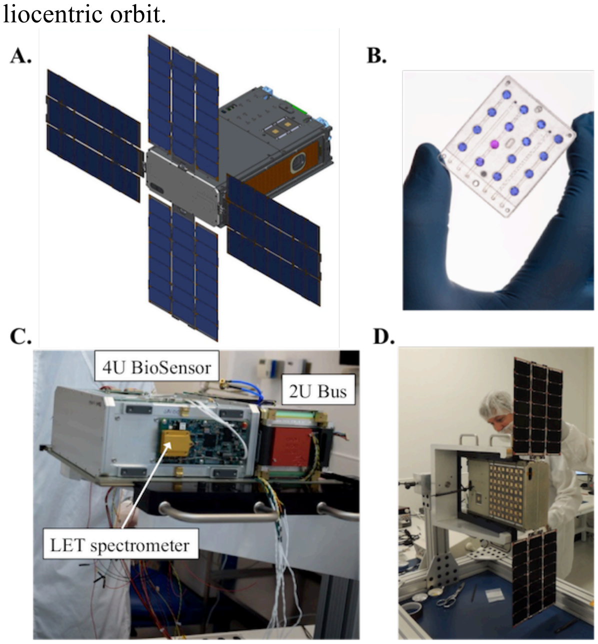
USING AUTONOMOUS BIO NANOSATELLITES FOR DEEP SPACE EXPLORATION. S.R. Santa Maria[1,2], L.C. Liddell[1,3], S.M. Tieze[1,4], A.J. Ricco[1], R. Hanel[1], and S. Bhattacharya[1], [1]NASA Ames Research Center, Moffett Field, CA 94035, [2]University of New Mexico, [3]Logyx LLC, [4]Blue Marble Space Institute of Science.

Introduction: NASA Ames Research Center has been the leader in developing autonomous bio nanosatellites to address strategic knowledge gaps about the effects of space travel on biological organisms, including GeneSat, PharmaSat, EcAMSat, and BioSentinel. BioSentinel will conduct the first study of biological response to space radiation outside Low Earth Orbit (LEO) in over 45 years. BioSentinel is an autonomous platform able to support biology and to investigate the effects of space radiation on a model organism in interplanetary deep space. It will fly onboard NASA's first Exploration Mission (EM-1), from which it will be deployed on a lunar fly-by trajectory and into a heliocentric orbit.



(A) Rendering of BioSentinel's 6U spacecraft. (B) Microfluidic card. (C) BioSensor & LET spectrometer fit check. (D) Solar panel deployment test.

BioSentinel will measure the DNA damage and response to ambient space radiation in a model biological organism, which will be compared to information provided by onboard physical radiation sensors and to data obtained in LEO (on the International Space Station, ISS) and on Earth. Even though the primary objective of the mission is to develop an autonomous spacecraft capable of conducting biological experiments in deep space, the BioSensor payload itself will be an adaptable instrument platform that can perform biological measurements with different microorganisms and in multiple space environments, including the ISS, free flyers, and other exploration platforms. Thus, nanosatellites like BioSentinel can be used to study the effects of both microgravity and space radiation, and can house different biological organisms to answer specific science questions. In addition to their flexibility, nanosatellites also provide a low-cost alternative to more complex and larger missions, and require minimal crew support, if any.

Instrumentation: BioSentinel is a 6U (11.6 x 23.9 x 36.6 cm; 13.6 kg) biosensor-based nanosatellite. The BioSensor payload currently under final development consists of a hermetic containment vessel of ~ 4U volume (10 x 20 x 20 cm) and 6 – 8 kg of mass. Our BioSensor advances multiple nanosatellite systems in order to perform autonomous biological measurements: (A) biology support in 18 independent microfluidic cards with 16 microwells each; (B) fluid delivery system consisting of pumps, valves, tubing, and media external to cards; (C) dedicated thermal control for each fluidic card capable of maintaining biological payload during stasis and growth phases; (D) dedicated 3-color optical detection system at each microwell for optical density and metabolic dye absorbance measurements; (E) biofluidics managing long-term (12 – 18 months) biological stasis and modular integrated samples instrumentation; (F) close integration of living biosensors with miniature physical radiation spectrometers (LET spectrometer), pressure and humidity sensors; (G) shielding-, hardening-, design-, and software-derived radiation tolerance for electronics; (H) communications from distances of ≥ 500,000 km.

BioSentinel is being developed at NASA Ames Research Center and funded by NASA's Advanced Exploration Systems (AES).