"EcAMSat and BioSentinel: Autonomous Bio Nanosatellites Addressing Strategic Knowledge Gaps for Manned Spaceflight Beyond LEO"

Mike Padgen, Ph.D.
NASA Ames Research Center

Abstract:

Manned missions beyond low Earth orbit (LEO) require that several strategic knowledge gaps about the effects of space travel on the human body be addressed. NASA Ames Research Center has been the leader in developing autonomous bio nanosatellites, including past successful missions for GeneSat, PharmaSat, and O/OREOS, that tackled some of these issues. These nanosatellites provide in situ measurements, which deliver insight into the dynamic changes in cell behavior in microgravity. In this talk, two upcoming bio nanosatellites developed at Ames, the E. coli Antimicrobial Satellite (EcAMSat) and BioSentinel, will be discussed. Both satellites contain microfluidic systems that precisely deliver nutrients to the microorganisms stored within wells of fluidic cards. Each well, in turn, has its own 3-color LED and detector system which is used to monitor changes in metabolic activity with alamarBlue, a redox indicator, and the optical density of the cells.

EcAMSat investigates the effects of microgravity on bacterial resistance to antimicrobial drugs, vital knowledge for understanding how to maintain the health of astronauts in long-term and beyond LEO spaceflight. The behavior of wild type and mutant uropathic E. coli will be compared in microgravity and with ground data to help understand the molecular mechanisms behind antibiotic resistance and how these phenotypes might change in space. BioSentinel seeks to directly measure the effects of space radiation on budding yeast S. cerevisiae, particularly double strand breaks (DSB). While hitching a ride on the SLS EM-1 mission (Orion's first unmanned mission to the moon) in 2018, BioSentinel will be kicked off and enter into a heliocentric orbit, becoming the first study of the effects of radiation on living organisms outside LEO since the Apollo program. The yeast are stored in eighteen independent 16-well microfluidic cards, which will be individually activated over the 12 month mission duration. In addition to the wild type and radiation-sensitive mutant strains, a BioSentinel strain of yeast has been developed, which requires a DSB to reactivate growth, thereby allowing for a direct measurement of DSBs caused by radiation. These two missions demonstrate the utility of using autonomous nanosatellites to address strategic knowledge gaps in the push to once again extend manned spaceflight beyond LEO.

Bio:

As a fluidic engineer at NASA Ames Research Center, current responsibilities include assembly, testing, and developing quality control processes for the fluidic payloads of bio nanosatellites. In particular, for both the EcAMSat and BioSentinel payloads, improved assembly approaches and fill performance of the fluidic cards that house the biology. Developed tests for individual components and assemblies to mitigate risk of fluidic failure during flight. Primary decision maker for the hardware configuration and assembly of the payload for the EcAMSat flight. Past research experience focused on the development of micro- and nanotechnology solutions that address biomedical needs, with six years of experience with the design, fabrication, modeling, testing, and characterization of microdevices, sensors, and polymeric scaffolds. Additional research experience includes molecular and cell biomedical applications involving 2-D and 3-D cell culture, protein assays, immunocytochemistry, and microdevice integration for *in vivo* experimentation.