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BAMMSAT RECENT DEVELOPMENT: A BIOCUBESAT HARDWARE PLATFORM TO ENABLE BIOLOGICAL STUDIES IN SPACE.

Abstract

As humanity aspires to go beyond LEO for the first time since the Apollo era with planned long-duration spaceflight to the Moon and Mars, our knowledge on how deep space environments affect Earth's biology including humans is still inadequate. A crewed mission could take months and years which translates to a combination of long-duration radiation exposure to high energy particles and microgravity beyond LEO. There is a significant knowledge gap on the effect of space environment on biological materials especially for beyond ISS and above. These biological studies require frequent access and large numbers of discrete samples. CubeSat platforms offer opportunities to improve access with reduced development time, more frequent flight opportunities and reduced mission costs. The interception of biological experiment and CubeSat has been established in LEO by NASA and a private entity, SpacePharma, with their bioCubeSats: GeneSat, PharmaSat, O/OREOS, SporeSat, EcAMSat, and Dido-2 respectively. There is another crucial bioCubeSat scheduled to launch in the near future. This is BioSentinel, the first bioCubeSat and most likely the first biological experiment to be performed beyond LEO in four decades since the Apollo era.

BAMMsat concept (Bioscience, Astrobiology, Medicine and Material science on CubeSats) is a bioCubeSat hardware platform being developed at Cranfield University for application in LEO and beyond LEO. The platform utilised the readily available, low-cost miniaturised sensors, actuators and fluidics components to enable bioscience experiment by reproducing the features in a traditional laboratory into a miniaturised "laboratory" while being compatible with the mass, volume, and power budget of CubeSat payloads. The hardware is designed to be flexible for a broad range of applications and biological systems utilising core features which are the abilities to (i) house multiple samples, (ii) maintain samples in an appropriate local environment, (iii) perturb sample fluidically, and (iv) monitor samples. Presently, an end-to-end BAMMsat payload breadboard has been developed with the ability to house forty discrete samples and observe these with a miniaturised fluorescence microscope. This paper reports on the design and on-going development of the integrated BAMMsat payload breadboard with results from the fluidics, sensors and actuators testing. *C. elegans*, a nematode worm, commonly used as a model organism has been used as an example to demonstrate biocompatibility with the platform.