Abstract

The architecture of the BoB BioCubeSat can be summarised in five major subsystems:

1. The 1U Bus containing the Command and Data Handling system and electrical interfaces to the BEXUS gondola.
2. The Multi-Chamber Sample Disk system which contains the motor to provide rotation to the sample disk and rotary valve, enabling discrete sample chamber access.
3. The Imaging System which can take pictures of the biological specimen by means of a CSI-2 interfaced Raspberry Pi camera and a miniaturized optical lens system.
4. The Microfluidic System which comprises a fluidic valve manifold, a pump, and a suite of fluidic pressure, flow rate, and bubble sensors.
5. The Thermal Control System utilizing three-wire resistance temperature detectors and coil and film heaters in the 2U pressure vessel, maintaining environmental control for the biological samples.

System Architecture

BioCubeSat Heritage

The concept of biological experiments on CubeSats has been established in LEO by NASA and a private company, SpacePharma. To date, seven bioCubeSats have successfully launched into orbit. While the volume and mass restrictions in CubeSats are challenging, the success of these systems is proven and de-risks the basic concept of bioCubeSats.

Timeline

1. GeneSat 2009, NASA
2. PharmaSat 2009, NASA
3. OOREOS 2010, NASA
4. SporeSat 2014, NASA
5. Dido-2 2017, SpacePharma
6. EcAMSat 2017, NASA
7. Dido-3 2020, SpacePharma

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Computing

The design for BoB required a mixture of robust simplicity and a capability to enable prototyping of complex autonomous operations with a limited development timeline and budget. The payload contains two off-the-shelf flight computers, integrated with bespoke PCBs and running a combination of open-source and custom software in Python and C++.

Operations

For the initial BoB test flight, a fully autonomous experiment sequence is planned, with the aim to validate the biological operations. A combination of open-source and bespoke software is used for mission control. Ultimately, the BAMMsat system should be used by the scientific community to perform a wide range of experiments.

Capabilities include:

• Hosting up to 32 discrete samples.
• Microscopy of individual samples.
• Individual sample perturbation with multiple fluids.
• Sample temperature regulation (± 1°C).
• Monitoring of parameters including pressure, oxygen concentration, chamber pH, etc.

Future BAMMsat payloads in orbit can readily be adapted to perform autonomous experiments tailored to the specific needs of the scientific community.

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