BAMMsat-on-BEXUS: A technology and operation demonstration of a bioCubeSat platform on a stratospheric balloon flight educational program

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I. Background

BAMMsat stands for **B**ioscience, **A**strobiology, **M**aterials and **M**edicine science on CubeSat. BEXUS is a European-wide program for university students to fly experiments on a large stratospheric balloon. BAMMsat-on-BEXUS (BoB) is an experiment due to launch in October 2020.

Fig. 1: Representation of BAMMsat-on-BEXUS flight

II. Aim and objectives

Aim: To perform technology and operation demonstration of a BAMMsat payload using, *C. elegans*, on the BEXUS stratospheric balloon flight in anticipation for future spaceflight.

Objectives:

1. Develop and demonstrate the ability to handle, integrate, and operate biological specimens (*C. elegans*) in BAMMsat bioCubeSat payload in a spaceflight representative context.

2. Demonstrate the key BAMMsat bioCubeSat payload ability to provide controlled environments relevant to maintaining viable biological samples in extreme operational environments. (specifically thermal and fluidic control together with appropriate housekeeping sensing).

III. Why *C. elegans*?

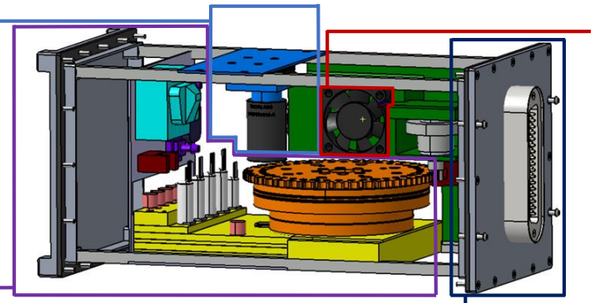
- Multicellular organisms, including *C. elegans*, have never flown on bioCubeSat.
- High-throughput drug experiment on nematode has not been conducted in spaceflight to date.
- Well accepted model of human/astronaut biological research on Earth and in spaceflight.
- Flight heritage on the Space Shuttle, ISS, Shijian-8 and Shenzhou-8

Fig. 2: *C.* elegans grown in BAMMsat microfluidics disc

IV. Experiment setup

Imaging system
Raspberry Pi V2 camera will capture video and static images for assessing sample health and activity.

Fluidics system
Fluidically perturb individual sample chambers at regular intervals and administers growth, drugs, and preservative compounds.



Thermal system
Maintains a regulated temperature to ensure samples viability at +12 °C ±2 °C during pre-flight and +20 °C ±2 °C during flight.

Pressure Vessel
Maintains a controlled pressurised and thermal environment and holds an atmosphere for samples use (image shown without vessel wall).

Fig. 3 CAD design of BoB payload

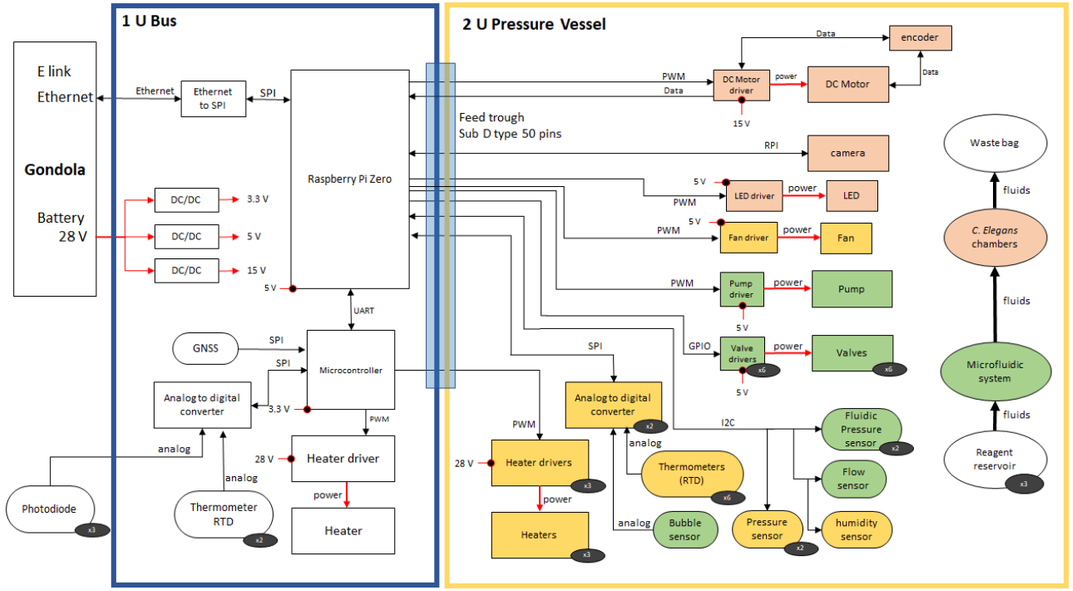
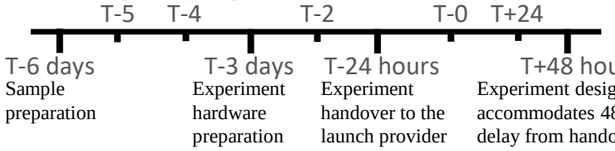


Fig. 4: Preliminary BoB systems overview and electronics design interface

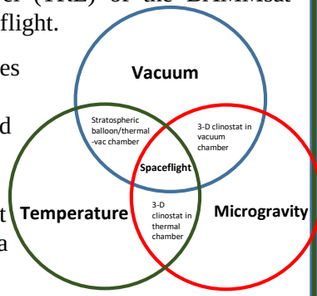
V. Pre-flight operations

- Biological spaceflight research has pre-imposed additional requirements during pre-flight operation to ensure sample viability.
- BoB's pre-flight operation have been designed to accommodate future orbital flight opportunities.
- Current pre-flight operations:



VI. Summary

- We anticipate that the BoB experiment will lead to an increase in the technology readiness level (TRL) of the BAMMsat payload in preparation for orbital flight.
- Stratospheric balloon flight provides an appropriate environment to simulate the harsh environment and operation in spaceflight with near vacuum (~11 mbar) and reduced temperature (-50°C), albeit without the vibration and microgravity on a sounding rocket.



- Having *C. elegans* as another biological sample on-board a compact, automated bioCubeSat could contribute significantly to the science community by opening doors to a range of experiments

VII. Acknowledgement

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