AUTONOMOUS NANOSATELLITE BIOIMAGING IN LOW EARTH ORBIT

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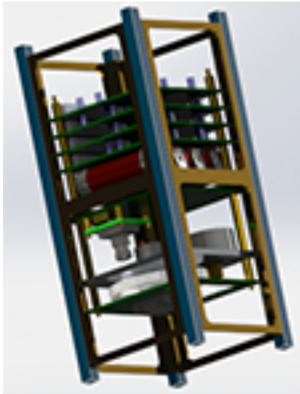
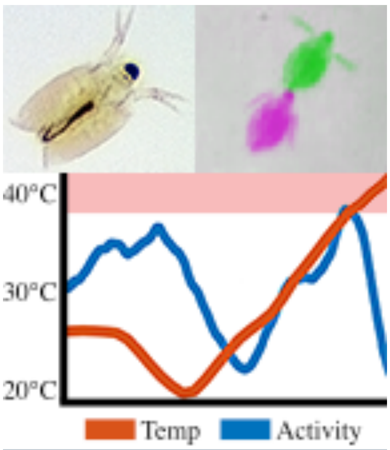
Introduction: Understanding how biological systems react to the stresses of Low Earth Orbit (LEO) informs safety features of future manned space missions. LEO environments are subject to radiative, thermal, and gravitational stresses that can alter the natural state of living organisms. Assessing how these influence life has remained expensive, and is dependent on enormous ancillary mission support. Recent interest in standardized nanosatellite platforms, known as "CubeSats," has ushered in a new era of low-cost, easily deployable LEO research tools. Here, we introduce a first-of-its-kind CubeSat design capable of autonomous regulation and imaging of a biological specimen, and show preliminary ground-based data from a potential model organism, the *Cyclops* copepod.



Proposed CubeSat Design

Methods: Our CubeSat is based on a standard "2U" specification (100 x 100 x 270 mm). One half is dedicated to power electronics, sensors, and the flight computer. The other half consists of a novel biocarousel capable of housing and imaging nine individual wells. A Peltier module attached to the biocarousel (used for thermal regulation) was exploited here to modify the thermal properties of a *Cyclops* microenvironment in a ground-based simulation. Images were synced with temperature data and bioactivity quantified in MATLAB.



Cyclops Motion and Thermal Results

Results and Discussion: Our results reveal temperature-dependent activity of, and a lethal thermal threshold for, the *Cyclops*. Furthermore, we prove that precise bio-environment control and bio-well imaging is possible in the form factor of a 2U CubeSat. As imaging becomes more broadly applied to biological investigations (e.g. fluorescent calcium indicators), our CubeSat represents the first step towards a future direction of space research. One of the many challenges faced before orbiting is developing biocarousel wells for cells or organisms that can withstand prelaunch transport and storage.

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