Flexing FLEX for Suborbital Studies: Biological Imaging & More

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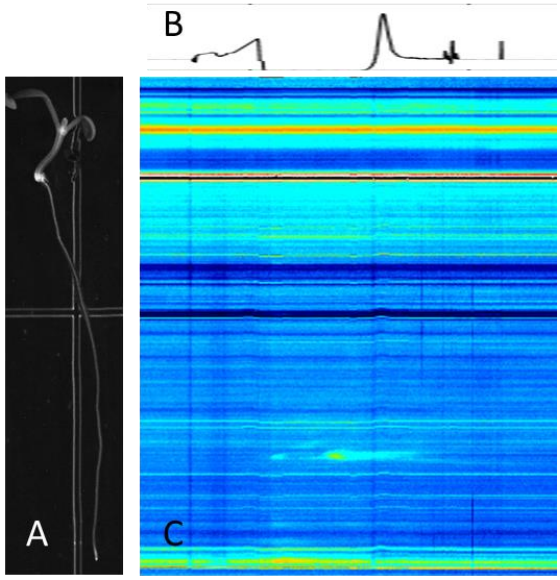
Abstract
Space launch and space travel's changes in gravitational profiles are unique and cannot currently be found or simulated in Earth-based environments. Suborbital flights, allow experiments to undergo the physical demands and gravitational changes that a rocket launch, transition to a weightless environment, and landing of a spacecraft encompasses. This express, but full simulation, of launch, microgravity, reentry and landing allow for the study of plants outside their evolutionary developed environment. This study addresses both hardware composition of a non-tended launch environment and the biological specimens utilized to study the response to the environment.

FLEX Imaging System

Hardware Development
Ongoing and continuous updates and adaptation to the FLEX hardware have been made in support of the P11 and P12 Blue Origin payload flights. Adaptions by way of removing a thermal imager and the addition of a second monochrome camera for GFP imaging. Both monochrome cameras are currently fitted with 520bp20 filters for optimal imaging. Additionally, a second LED pod for illumination was added for the secondary camera. A Surface 8 computer and MSR device are internal support hardware, both flown on previous flights.

Biological Specimen
Arabidopsis thaliana, modified with the GCaMP3 construct to express Green Fluorescent Protein (GFP) induced by calcium signaling, was used to demonstrate that rapid (~1 second resolution) biological signals occur during various phases of the flight. Calcium signaling has been shown to be responsive to light, gravity, and other biotic or abiotic stresses when applied to plants. The calcium signaling response, ubiquitous in plant tissues, allows to plants to respond to stimuli intercellularly, both at a tissue specific and whole plant level.

Conclusions
FLEX fluorescence imaging results indicate that plants are responsive to the suborbital spaceflight environment through changes in calcium signaling during the three distinct phases of the flight (launch, zero-g, and re-entry/landing). Launch hyper-g's show a decrease in overall GCaMP3 expression, followed by increases both generally and with tissue specific localization during the zero-g and re-entry portions of flight.



Data generated from FLEX on P11 flight for a single GCaMP WT plant during the flight. **A.** Cropped image of the representative plant. **B.** Gravitational data of the P11 flight. **C.** X – Average GFP expression intensity (by color) of the plant (correlated to the row average of plant expression intensity.) Y – Each column represents one second of flight (corresponding to G-data in B.)

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