Imaging During Suborbital Flights Suggest Gravity Transitions Generate Rapid Physiological Responses in Plants

Robert Ferl, Anna-Lisa Paul
University of Florida, ICBR, Horticultural Sciences, and PMCB, Gainesville, Florida, USA

Abstract

Recent flights with Blue Origin and Virgin Galactic have initiated and exploration of biological impacts of spaceflight that can and should be examined in the suborbital realm. The University of Florida FLEX biological imaging payload examined thermal and fluorescent imaging as experiment modalities for evaluation of physiological changes that accompany suborbital flight. This presentation contains operational information about the flight implementation as well as experiment data.

FLEX imager consisted of a thermal imaging camera (FLIR), fluorescent imaging camera, excitation lighting, filter wheel with four filters, data logger, battery and Microsoft Surface tablet. The primary focus of these flights was hardware readiness advancement, with the secondary emphasis on biological responses to spaceflight. Arabidopsis plants engineered with GFP signal transduction reporters served as the model organism for biological study. The system preformed successfully in flights with two different providers. Both experiments advanced the Technology Readiness Level (TRL) of the hardware, and also provided biological data that captured real-time transitions between gravity environments during flight.

Flight data demonstrate that there plants exhibit recognizable and quantifiable biological responses to various phases of suborbital flight, and suggest that initial transitions among gravities may engage gravity sensing other than those involved in orientation to the gravity vector on the surface of the Earth.

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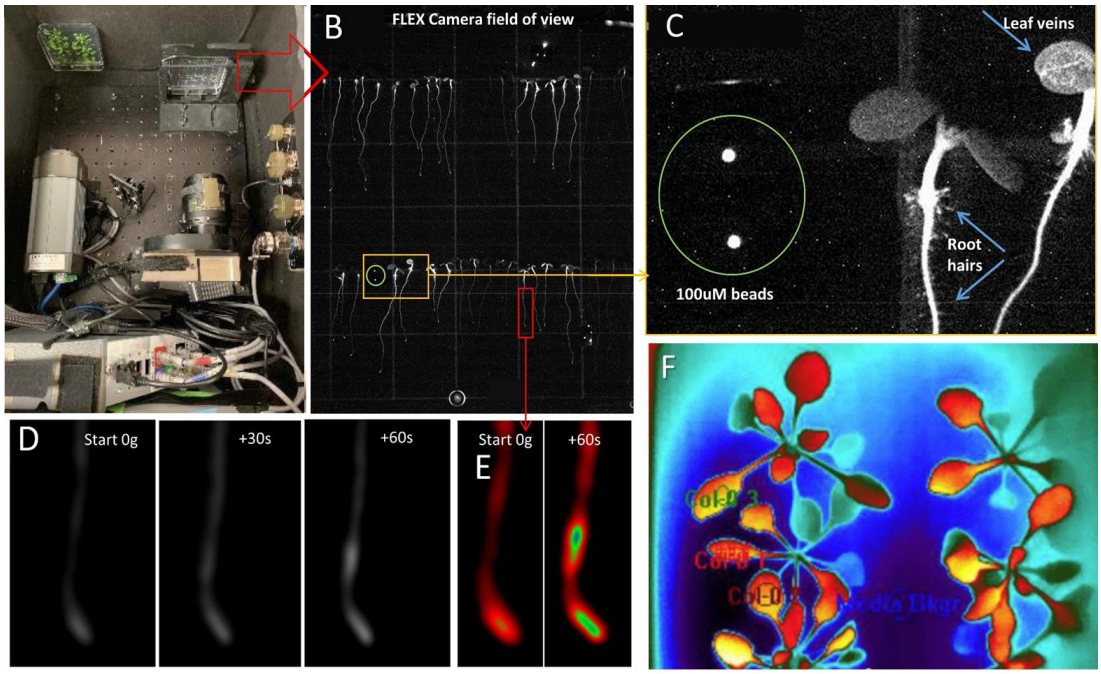

FLEX Imager state of the art – images from December 2018 flight with Virgin Galactic and the Blue Origin P7 flight in January 2019. A) Footprint of in the FLEX in the Blue Origin locker B) The field of view of the FLEX fluorescent imaging camera within a 10 cm square Petri plate. Green circle indicates the location of fluorescent calibration standards, boxes indicate the ROI shown in the cropped images in C and D. D) Microgravity induced changes in a Ca2+ biosensor, E) Image processing can enhance visualization. F) Virgin Galactic flight thermal mage from captured from FLIR thermal video recorder.