

**Design and Development of Modules to Support Live
Microscopic Imaging on Ground-Based Microgravity
Simulators**

Audrey Lee

NASA John F. Kennedy Space Center

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Design and Development of Modules to Support Live Microscopic Imaging on Ground-Based Microgravity Simulators

Audrey Lee¹

*NASA John F. Kennedy Space Center, FL 32899
Columbia University, New York, NY 10027*

Abstract

In space, astronauts are exposed to environmental stressors that often result in physiological changes. One prominent stressor in spaceflight is microgravity, and research has shown that long term microgravity exposure causes muscle atrophy, bone loss, cardiovascular concerns, and vision impairment. It is critical to understand how altered gravity affects physiology on the cellular, molecular, and gene level in order to accurately assess health risks and to develop effective countermeasures. Ground-based microgravity simulators such as random positioning machines (RPMs) are used to produce some of the biological effects of altered gravity on different cell types and organisms. Real-time imaging during simulations are of particular interest as we can study how basic cell functions such as cell division, cell migration, and proliferation progress under microgravity conditions. However, design limitations of present microgravity simulators such as susceptibility to parasitic vibration and displacement of the sample from the center of rotation challenge the accuracy of experiment results and live images. We have developed a cell culture sample holder module suitable for live microscopic imaging on an RPM. CAD modeling and 3D printing technology were used to implement modifications to the sample holder and to install a digital microscope to perform live bright-field and fluorescent imaging. Vibration damping materials were also investigated to allow for stable imaging while the microgravity simulator was within a cell culture incubator. Novel methods and hardware modifications for improving live cell imaging on ground-based microgravity simulators were proposed and discussed.

¹ NIFS Intern, UB-A, NASA John F. Kennedy Space Center. Academic Institution: Columbia University.