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DEVELOPING SPACELAB – A MINIATURISED AUTOMATED LABORATORY – FOR 2D AND 3D
CELL CULTURES**Abstract**

This paper describes the efforts made by Frontier developing technology to enable life science experiments investigating the effects of microgravity on biological systems. The developments are working to evolve the successful BAMMsat-on-BEXUS mission, which maintained and monitored *C. elegans* organisms in stratospheric conditions, to both 2D and 3D cell culture platforms suitable for RD in microgravity.

In 2021, the 2nd generation bioCubeSat, BAMMsat (Bioscience, Astrobiology, Medical, Material science on CubeSats), was flown onboard the BEXUS30 stratospheric balloon. The flight successfully demonstrated the system's ability to maintain and monitor biological samples (*C. elegans*) in extreme stratospheric conditions. BAMMsat had a 3U CubeSat format, housing multiple biological samples in a liquid environment controlled by microfluidics with chemical sensors and visible microscopy available for in-situ monitoring. The system design has since evolved, and a new SpaceLab system is being developed.

2D cell culture is an extremely common and versatile technique used in in vitro investigations. Frontier is developing technology to enable analogous experiments to be conducted in space with common characterisation methods that you find in a terrestrial biological lab - namely, fluorescence and traditional brightfield microscopy. The aim of this hardware is to minimise the jump for terrestrial users to adopt space experimentation.

Frontier aims to evolve the 2D cell culture system towards organ-on-a-chip (OOC) technology. OOC however has shown high promise and fidelity in in vitro investigations as human cells can be co-cultured with other cell types to give an environment that more closely mimics the native environment compared to 2D cell culture platforms. The FDA Modernisation Act 2.0 in 2022 dictated that OOC data can be included in regulatory approval cases, which will dramatically increase the use of this technology.

Frontier are working to iterate SpaceLab to incorporate both 2D cell culture and OOC technology suitable for spaceflight. SpaceLab is compatible with a wide variety of platforms (including ISS facilities and upcoming commercial stations), maximising the number of flight opportunities for future customers. The current status of developments and range of applications are described herein.