

**Biological Validation of the Gene Expression Measurement Module (GEMM) for Microbial Gene Expression in Space.** Fathi Karouia<sup>1,2</sup>, Kia Peyvan<sup>3</sup>, Antonio Ricco<sup>1,4</sup>, and Andrew Pohorille<sup>1,2</sup>. <sup>1</sup>NASA Ames Research Center; <sup>2</sup>University of California San Francisco; <sup>3</sup>Peyvan Systems; and <sup>4</sup>Stanford University.

In order to facilitate astrobiological missions on the survival and adaptation of microorganisms and mixed microbial cultures in the space environment, we have developed a fully automated, miniaturized system for measuring gene expression on small spacecraft, Gene Expression Measurement Module (GEMM). This low-cost, low-power, multi-purpose instrument represents a major scientific and technological advancement by providing comprehensive data on cellular metabolism and regulation. The current system will support growth of microorganisms, extract and purify the RNA, hybridize it to the array, read the expression levels of a large number of genes by microarray analysis, and transmit the measurements to Earth.

The main goal of the current study was to evaluate if GEMM can provide accurate, sensitive and reproducible measurements of gene expression in biological systems. To this end, we carried out biological validation of the different subsystems and the end-to-end validation of accuracy, sensitivity and reproducibility, tested by way of measuring gene expression in samples from cell cultures using either standard laboratory procedures or the instrument. The cyanobacteria *Synechococcus elongatus* (*S. elongatus*) was used as the primary model organism. Furthermore, the sample preparation module was tested and validated by RT-PCR for other biological systems, *Escherichia coli* (*E. coli*) and *Saccharomyces cerevisiae* (*S. cerevisiae*). This study will potentially benefit the WetLab2 system that is currently being developed at NASA Ames. In all instances, the agreement between standard and instrument-based protocols was found to be satisfactory. This brings the system is a step closer towards the development of needed technology to sustain astrobiological missions on nanosatellite. Finally, technology and know-how derived from GEMM could be easily implemented to carry out high-throughput research onboard the ISS for life science programs in general, and astrobiology and space biology in particular.

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