MICROGRAVITY PROPELLANT GAUGING USING MODAL ANALYSIS: PHASE II

(Proposal Number will be assigned by FOP)

Technology Need

Propellant mass gauging is currently only feasible for settled propellant.

Gauging uncertainties increase toward mission end-of-life, increasing costs associated with mission design and decreasing effective mission life.

Gauging uncertainties typically account for a significant fraction of mission cost.

The proposed MPG method demonstrates gauging unsettled propellant with accuracy that exceeds existing methods by an appreciable measure.

Technology Concept

Fluid *Mass Loading* refers to the change in structural properties of a material immersed in a fluid. In MPG, we exploit the shift in acoustic resonance modes of a propellant tank resulting from liquid propellant adhered to the tank walls in zero-g.

The MPG technology is currently at TRL 4-5.

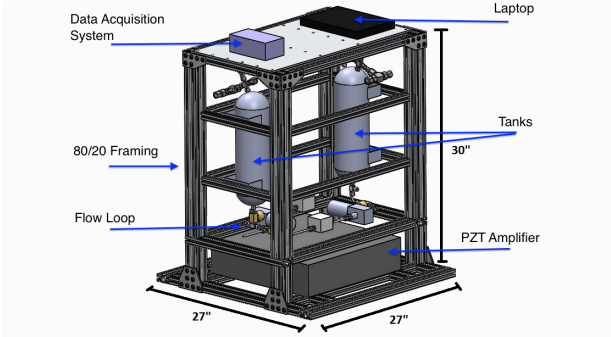
Technology Development Team

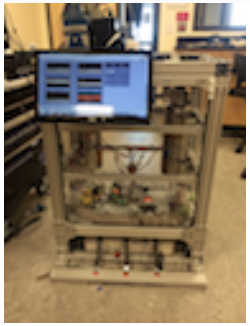
Project PI: Dr. Kevin Crosby, Professor of Physics and Dean of Natural and Social Sciences, Carthage College

Test Apparatus

The MPG Flight Rig consists of two 7-liter propellant tanks, a flow loop that moves propellant simulant (water) between the tanks, and a data acquisition system.

The experimental rig occupies a volume (LxWxH) of 27-in x 27-in x 36-in. and has a total weight of 180 lb.





Flight Requirements/Objectives

Test Plan: Acquire 30 data points at 1% fill-fraction intervals at 5 data points per fill level.
Objective 1: Demonstrate unsettled zero-g gauging accuracies of 1.5-2.0% of tank volume with comparable measurement uncertainties in a COPV tank.
Objective 2: Demonstrate efficacy of MPG approach at 2 different tank pressure states.
Objective 3: Characterize the gauging method during zero-g continuous transfer operations.

Technology Advancement

The parabolic test program will demonstrate real-time gauging of zero-g unsettled propellant with markedly higher resolution and lower uncertainties than existing methods. Results will be demonstrated in a COPV in the low-fill (end-of-life) regime. The test program will advance the MPG tech. to TRL 5-6.

Technology End Users

MPG End-users include commercial and military satellite providers, NASA human spaceflight program, and launch services providers. Commercial and NASA programs developing on-orbit fuel depots are also considered as potential end users.

Technology Area: TA-02.4 *In-Space Propellant Gauging*