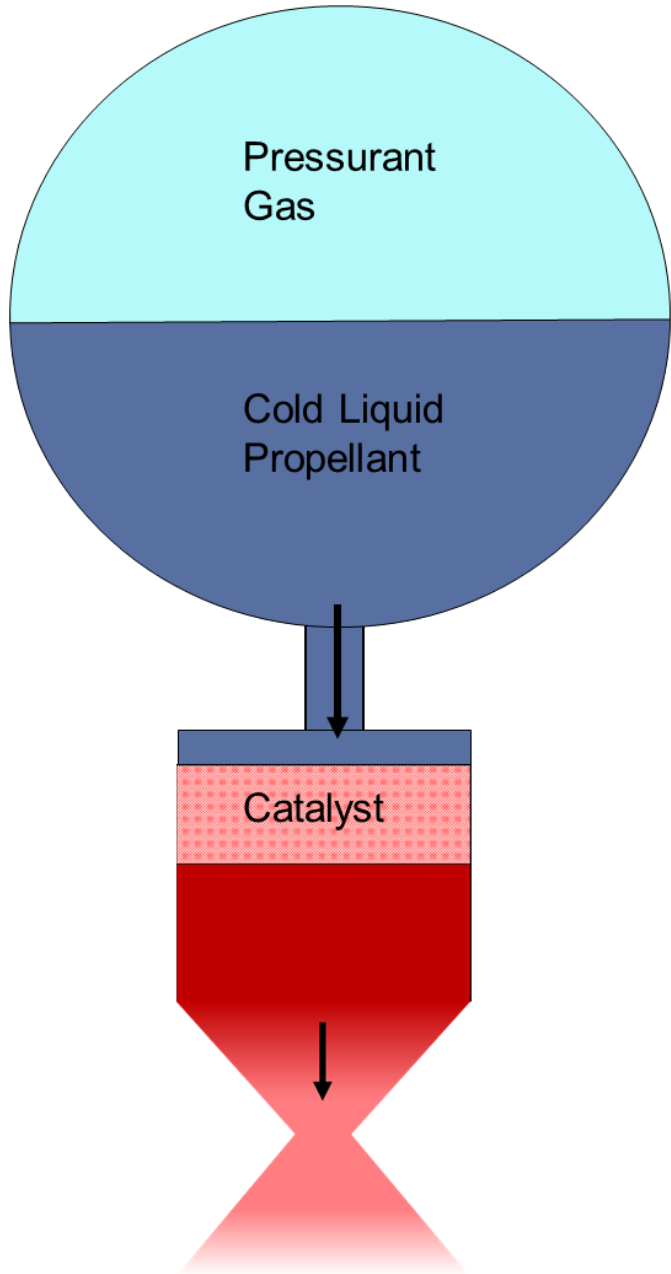# HyPer- a Green Monopropellant for Small Satellite Propulsion

Brandie L. Rhodes, Madison Piechowski, David Hinkley, Evan R. Ulrich
The Aerospace Corporation
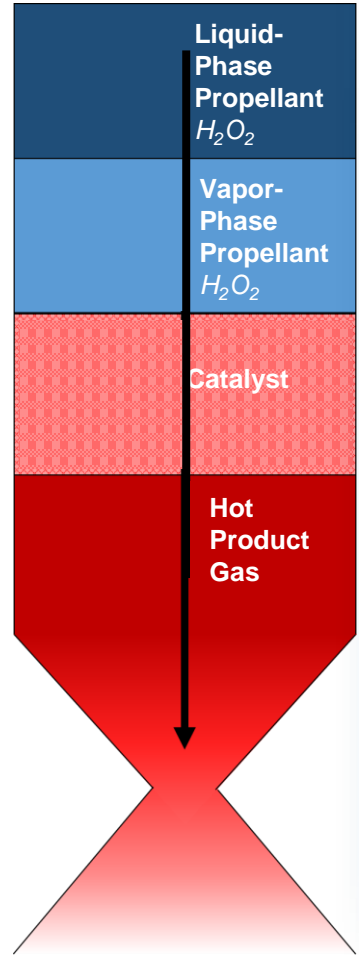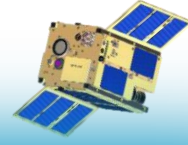
August 10, 2021

Hydrogen Peroxide Vapor Thruster

For Small Satellites

Liquid-Phase Propellant H_2O_2

Vapor-Phase Propellant H_2O_2

Catalyst

Hot Product Gas

Controllable low thrust

Green propellant

Low pressure

Low power

Continuous thrust and pulse options

Small overall package

Pressurant Gas

Cold Liquid Propellant

Catalyst

HyPer on Slingshot

- Experimental payload
- Placed in the approximate C.G. of spacecraft (12U Blue Canyon bus)
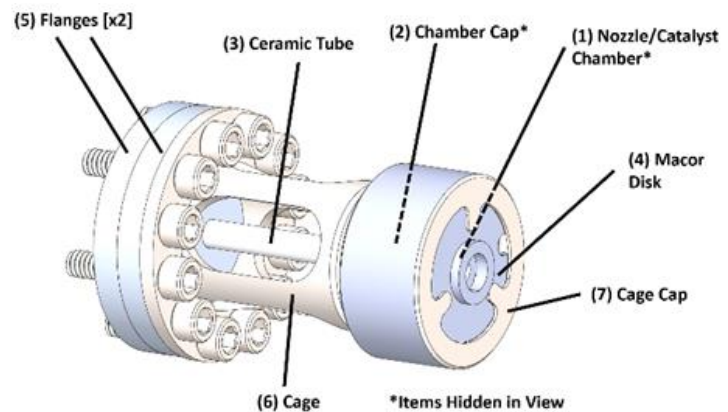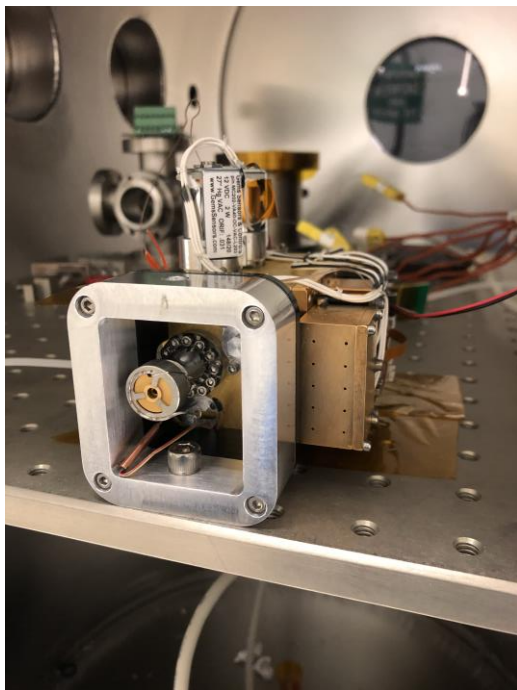
- 0.75 U, 0.4 kg
- 15 - 20 W consumption during operation

- 20 ml high test peroxide
- Single fault tolerant
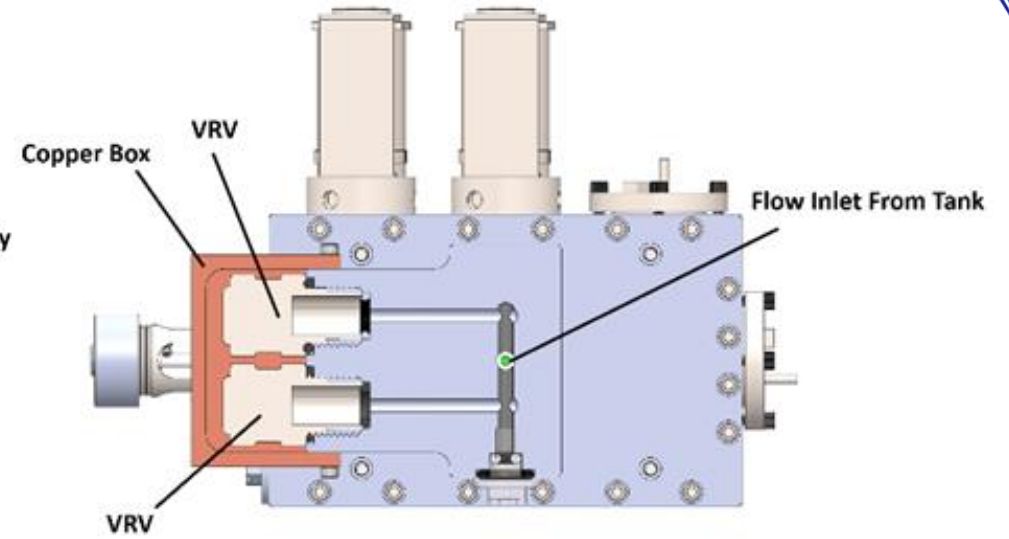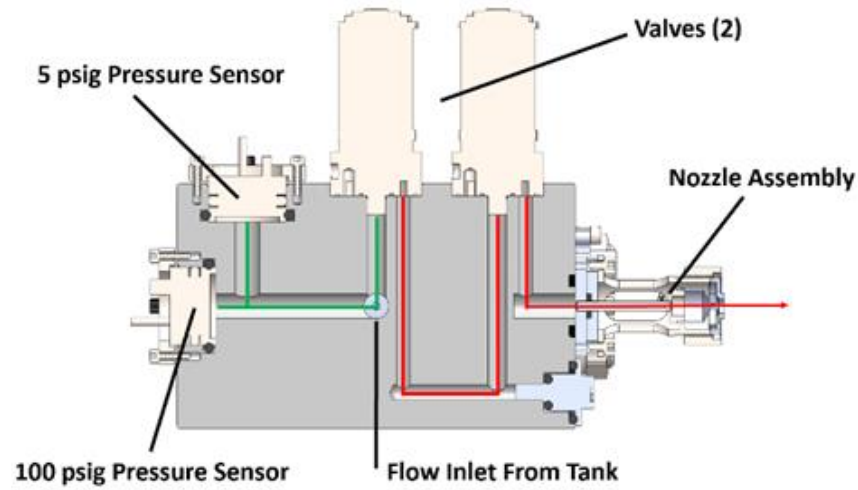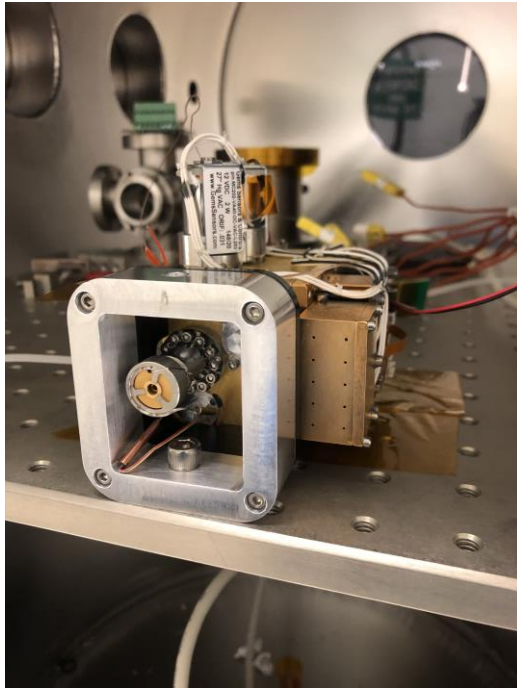- Overpressurization protection

- Thrust: 0.1- 10 mN, I_{sp}: 80 – 200 s
  - *Controllable on-orbit via propellant temperature control*
- Pulse and continuous operation
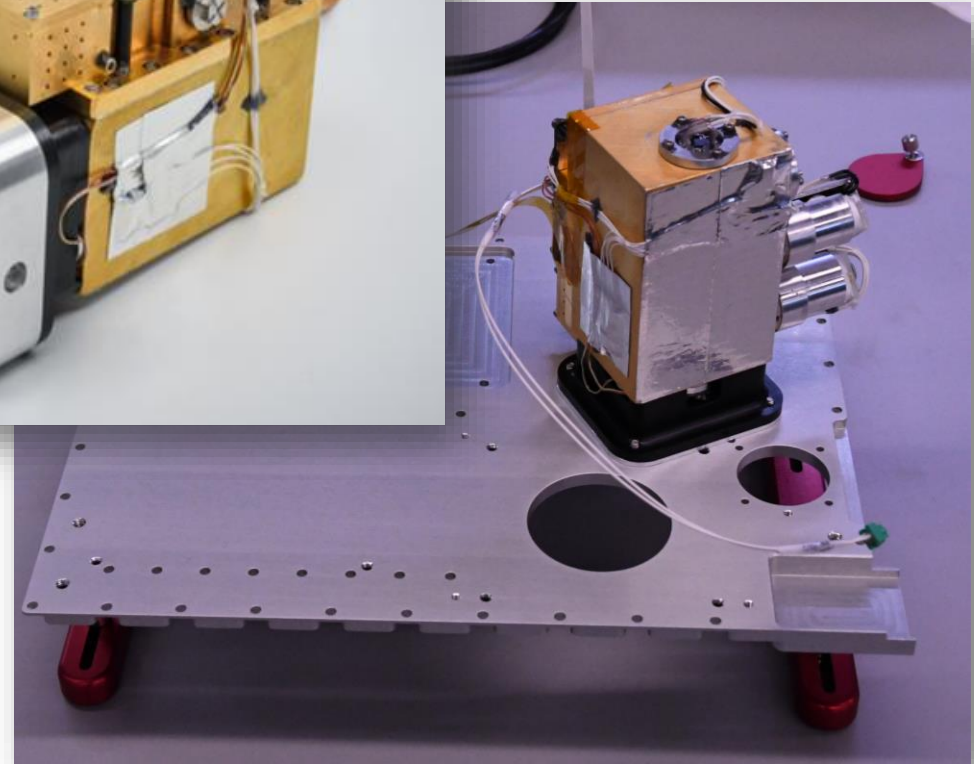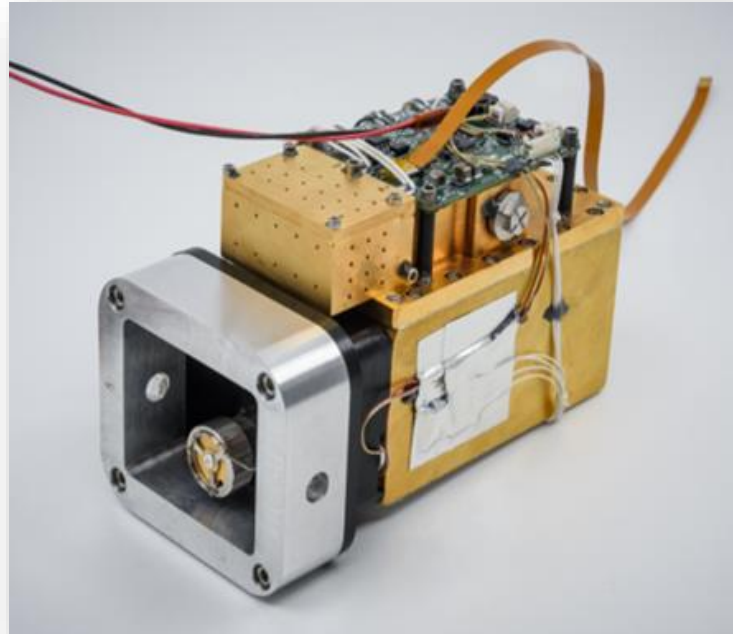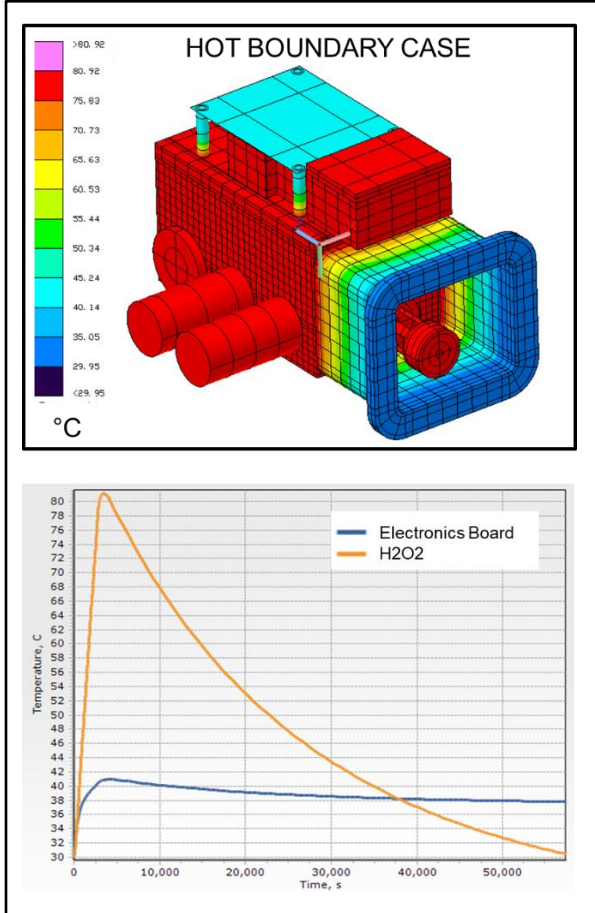
Design and Construction
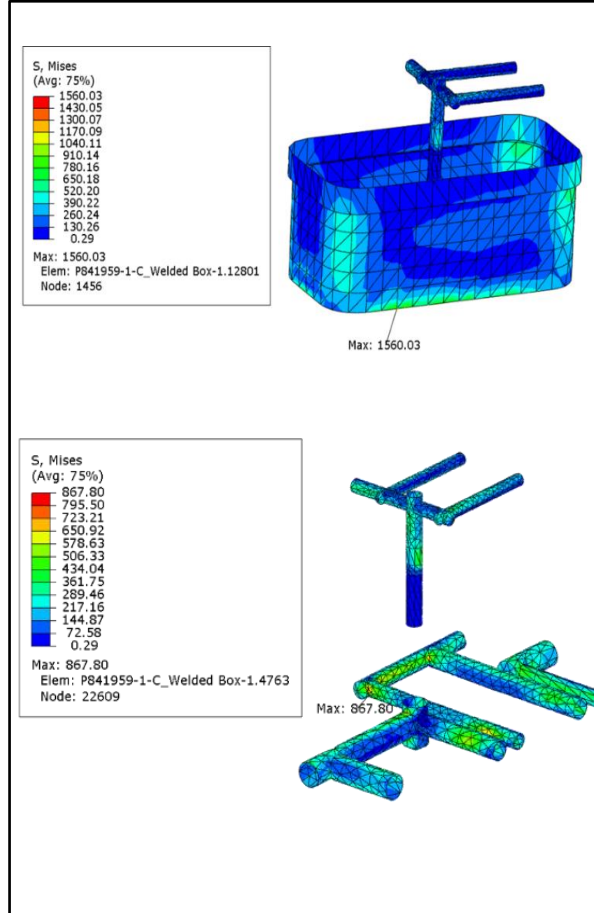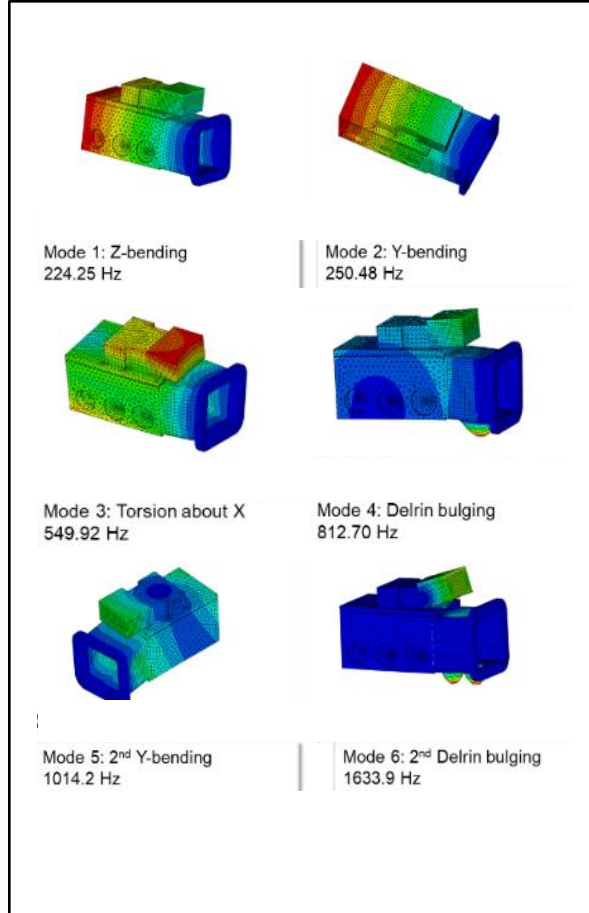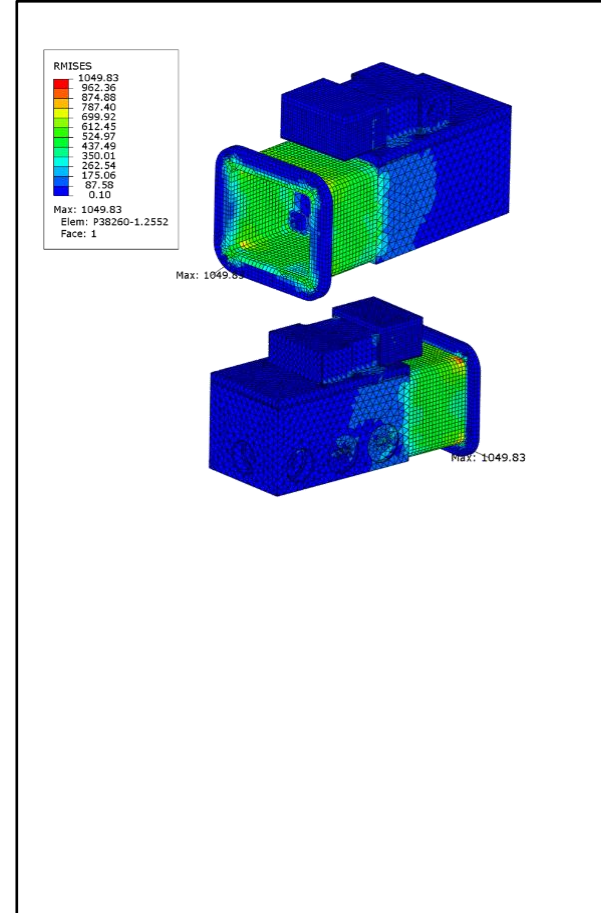
Design and Construction

Analysis
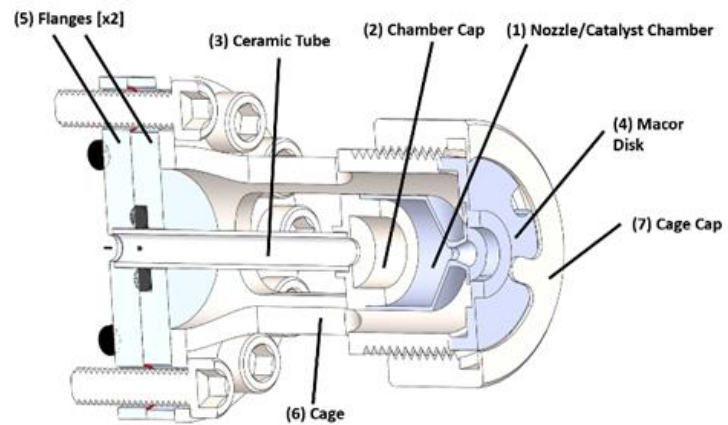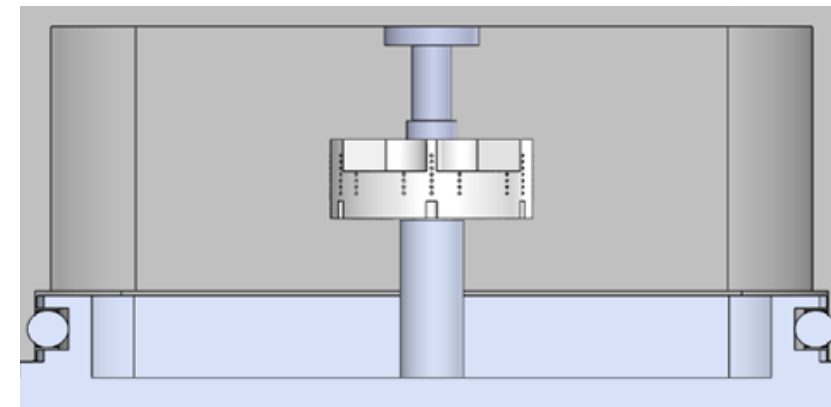
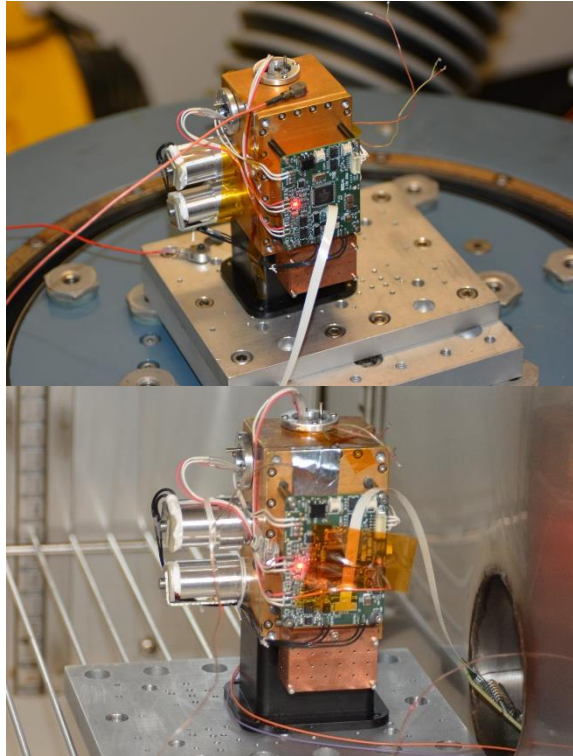## Thermal

Internal Pressure
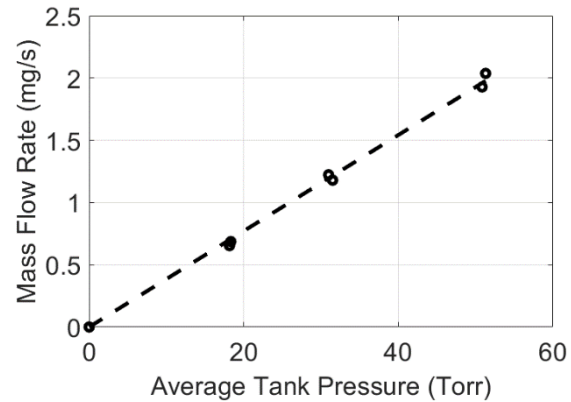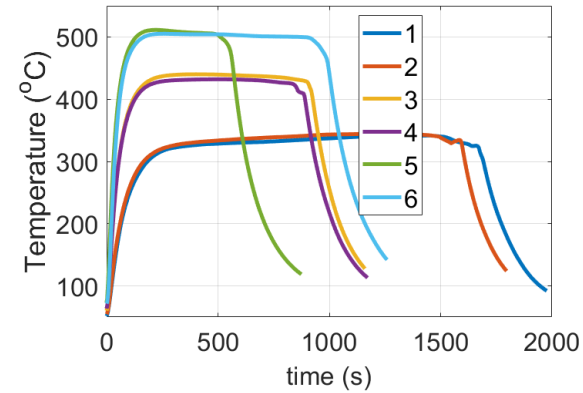

Modal

Random Response
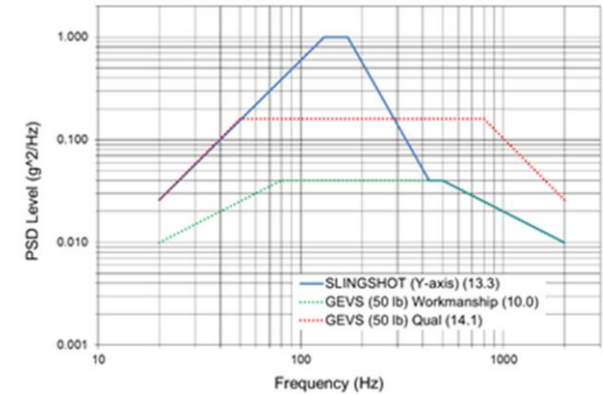
Ground Test Campaign

- Hydrostatic
- Leak checks
- Long term pressure rise
- Vibration
- Ambient thermal cycle
- Vacuum thermal cycle
- Hot fire

Hyper with propellant on vibration table (top) and in thermal cycle chamber (bottom)
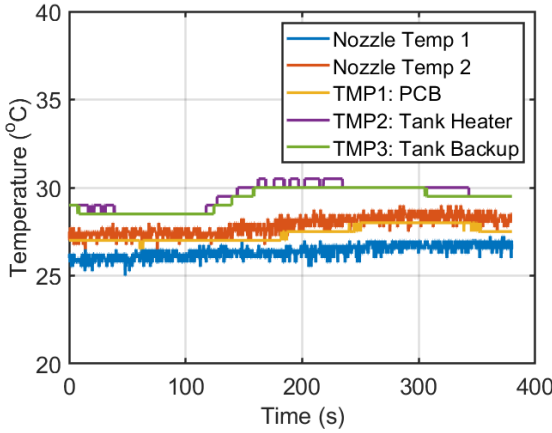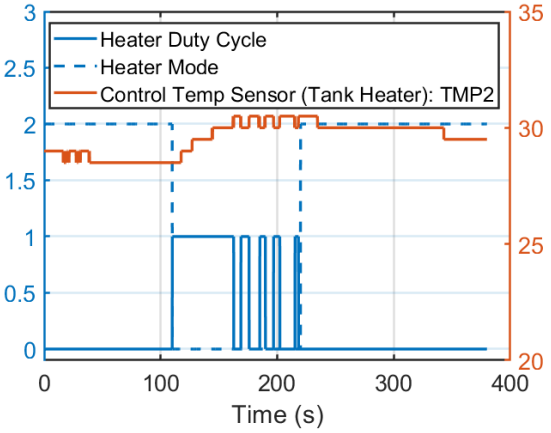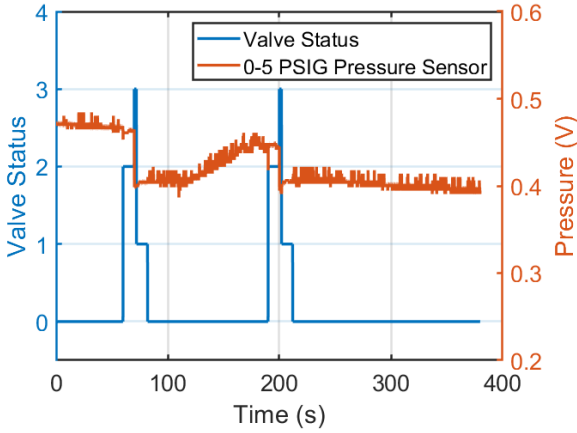

Nozzle temperatures and system mass flow rates
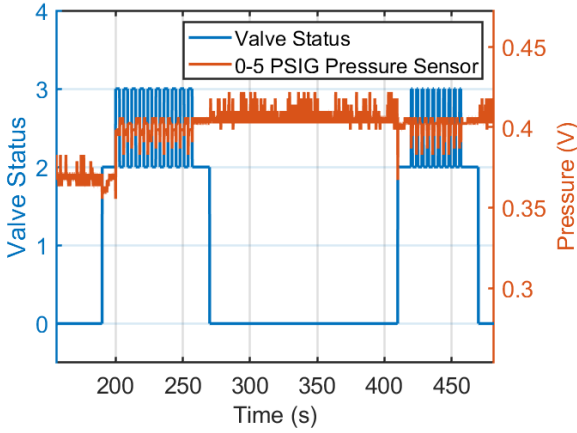

Slingshot and NASA GEVS Profiles
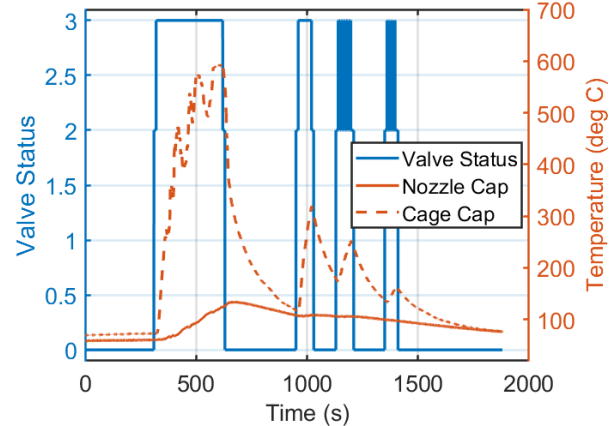
Flight Software Checkout

- Functional test

- Pulse test

- Hot fire

- Liveness test

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Next Steps

- HyPer passed all unit level and panel level testing and is proceeding to full spacecraft integration.
- After spacecraft integration and launch site delivery, propellant will be loaded.
- Liveness testing will be performed at each stage of integration.
- Post-propellant loading, data will be unavailable until on-orbit checkout.
- Launch planned for 2022 Q1.

Ongoing Work

- Thrust and specific impulse characterization
- Operational software development
- HyPer 2.0