Arkansas Pico/Nano-Satellite Project
Micro Propulsion Systems

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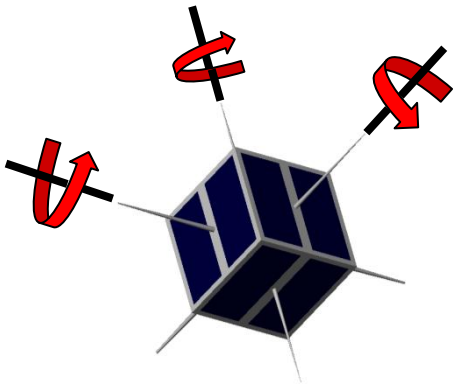
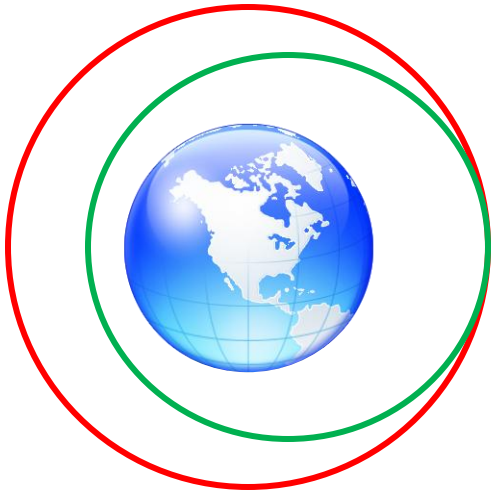
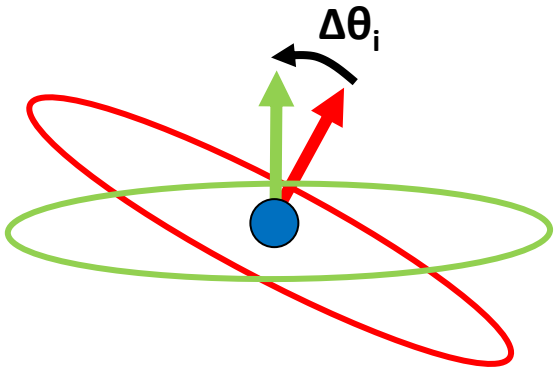
NASA

AIR FORCE RESEARCH LABORATORY

NanoSat Propulsion Requirements







Attitude Control

- 10s m/s total ΔV
- mN thrust levels
- μN impulse bits
- Need attitude determination
- Lateral thrusters for drag make-up

Orbital Maneuvers Thrusters (OMT)

In-Plane

- 100s m/s total ΔV
- 0.1-1N thrust levels
- Need ADACS
- Need knowledge of ephemeris

Out-of-Plane

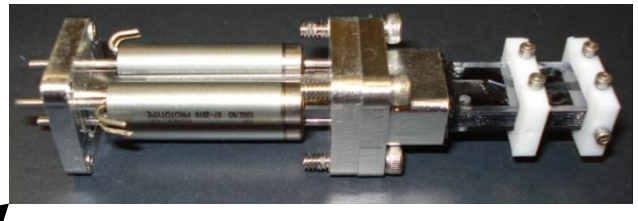
- Order of 1km total ΔV
- 0.1-1N thrust levels
- Need ADACS
- Need knowledge of ephemeris

Micro-propulsion Research TRLs at UA EMNSL

Sodium Azide Micro-wells
Attitude Control Gas Generator

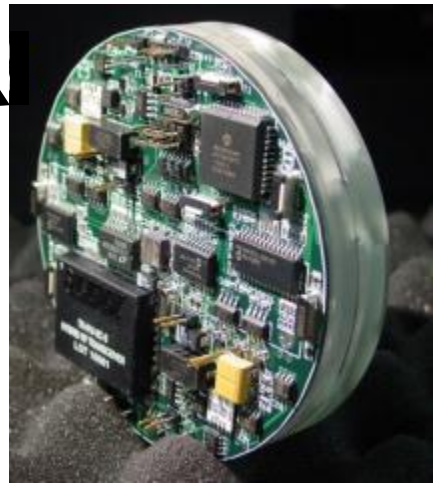
Micro-thruster RCT
(NASA Marshall)

Resistojet Thruster Core
0.5N Design

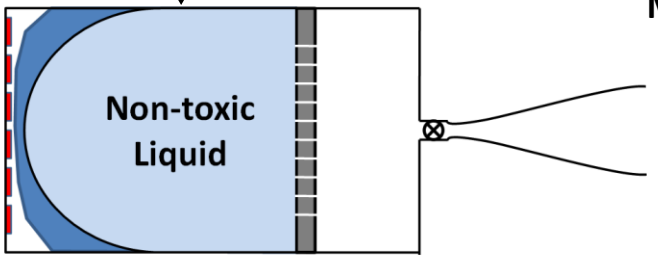


Basic Research | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Beyond University

Micro Pulsed Combustor
Developed at UCLA



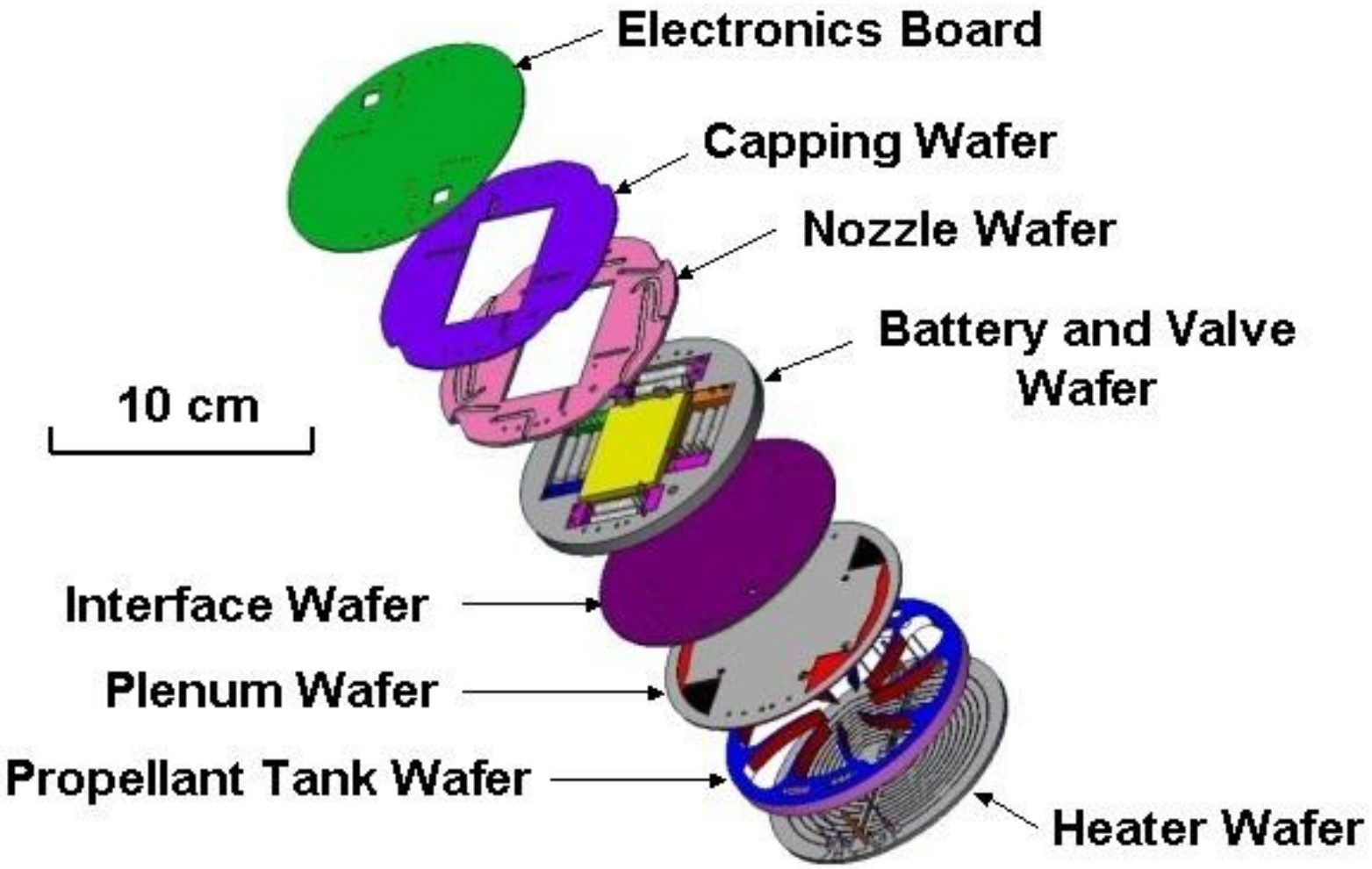
Cold Gas ADACS Module
Developed at The Aerospace Corporation
10cm diameter



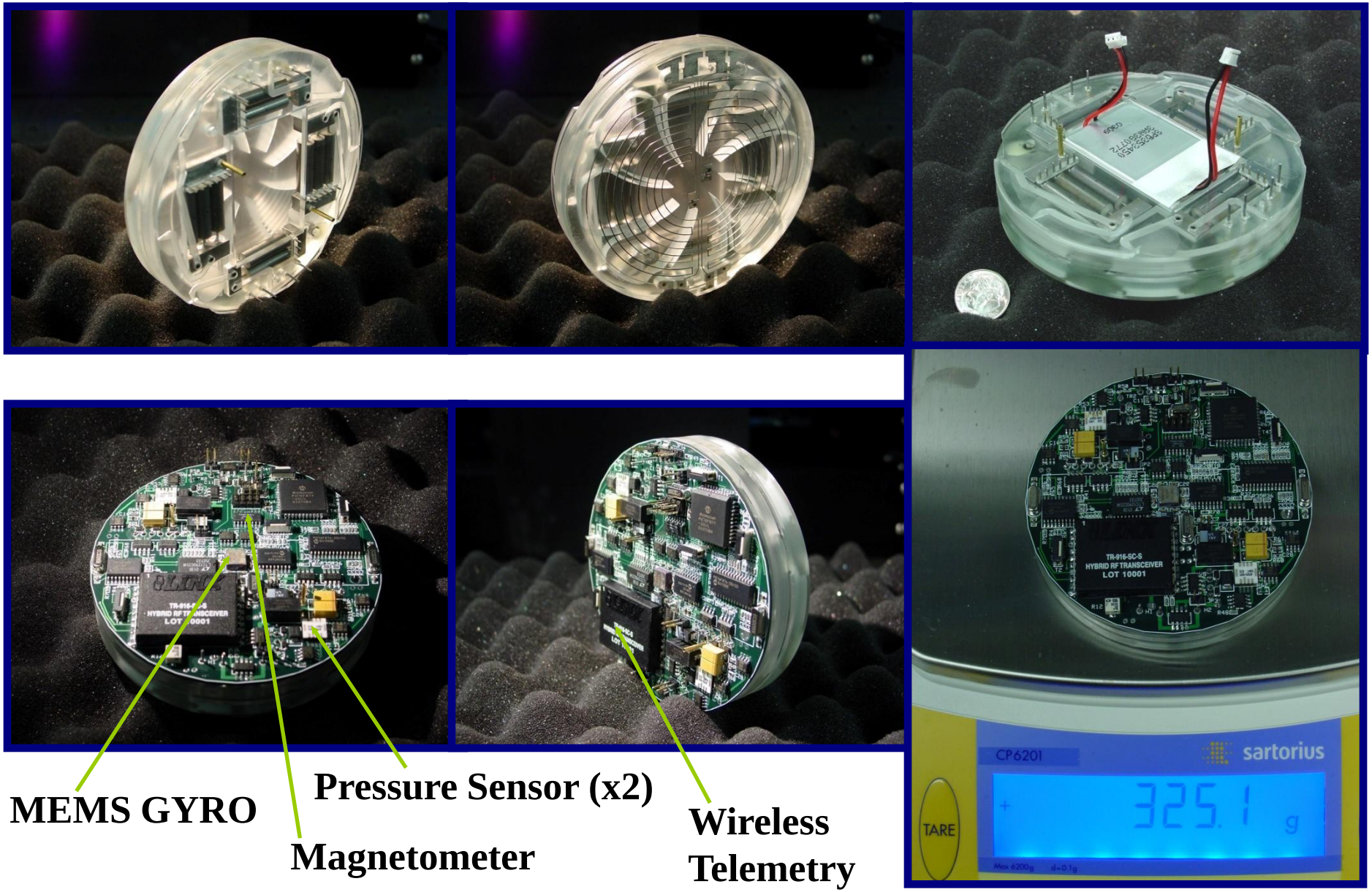
Green Liquid Propellant Cold Gas Thruster
Ambient Pressure Module

2012_09_15

Aerospace Corp. Nanosat Propulsion Module (COSA-PM)

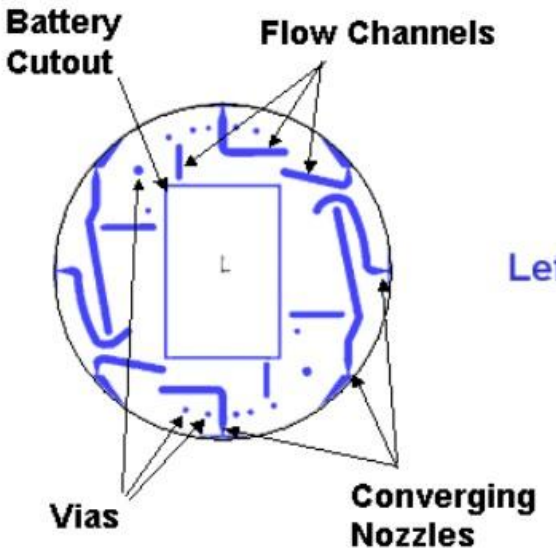


Fabricated COSA-PM Stacks

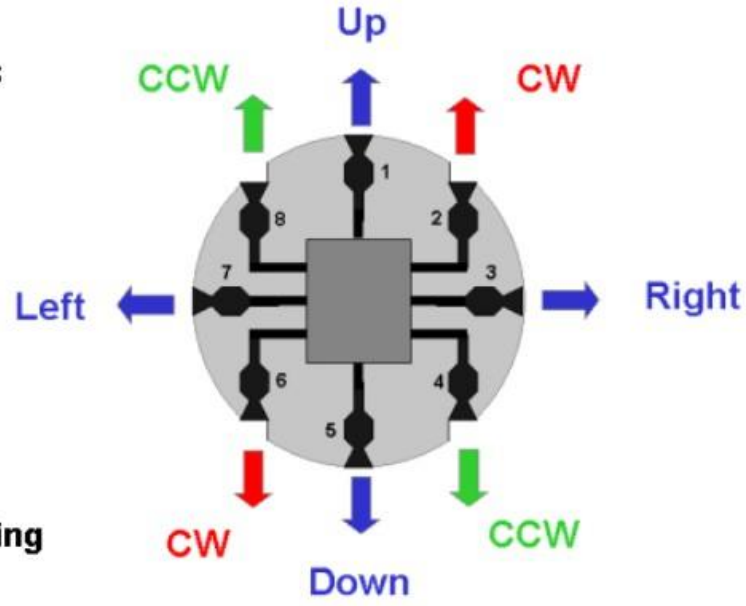


Thruster Nozzle Level

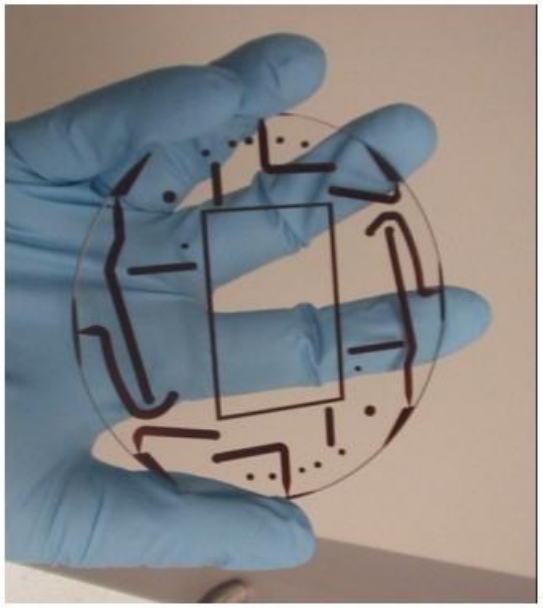
Wafer Layout



Thrust Directions



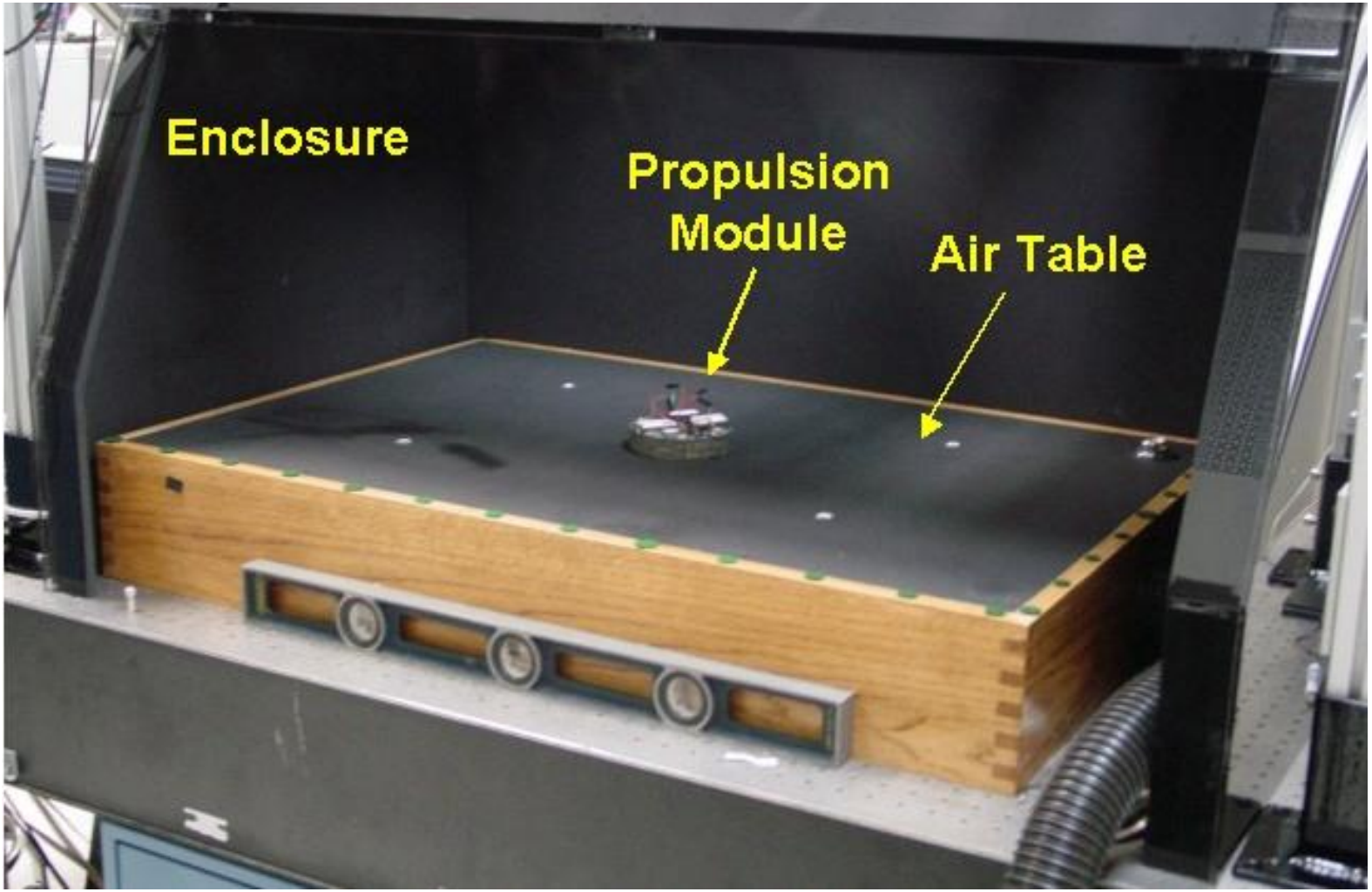
Patterned and Baked Wafer



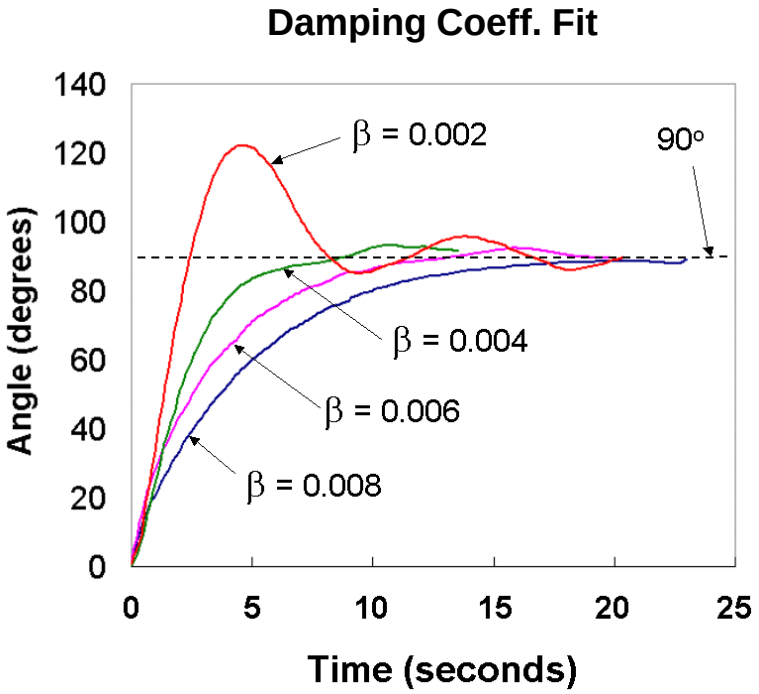
- 15m/s ΔV
- 20mN thrust level
- ~10μN impulse bits

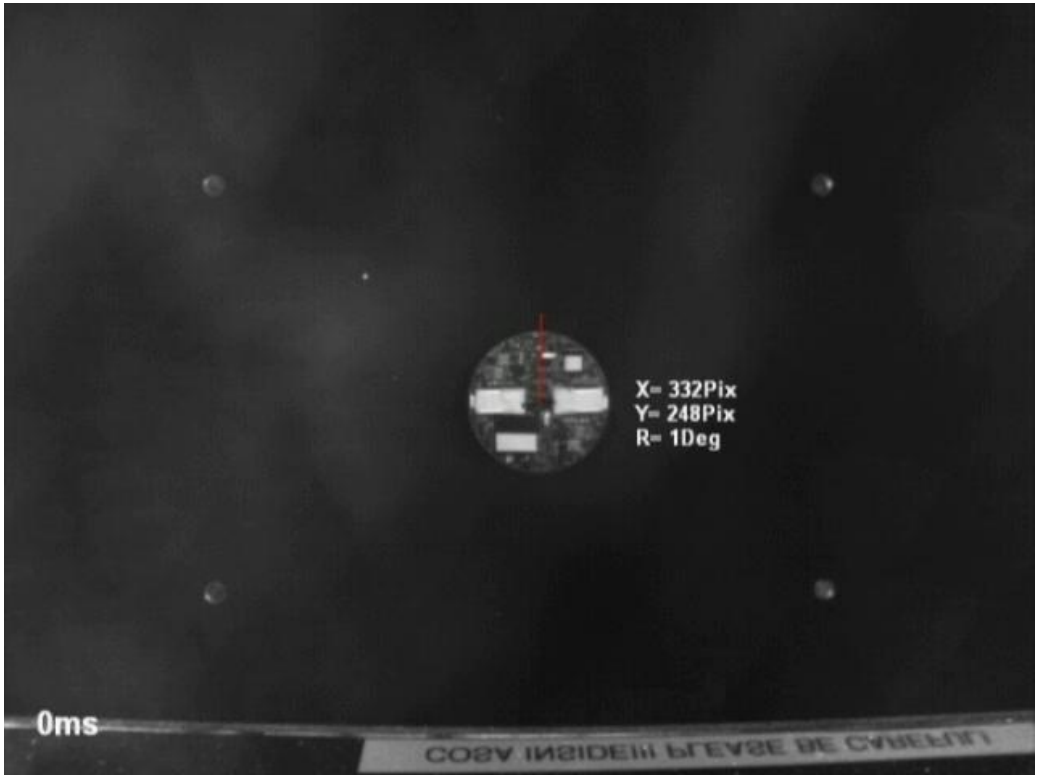
THE AEROSPACE CORPORATION

Air Table Experiment



Air Table Demonstration of Cold Gas System





Propellant-FE236fa

S. Janson, A. Huang, et. al., "Development of an Inspector Satellite Using Photostructurable Glass/Ceramic Materials," AIAA-2005-3650 (Space 2005).

Rapid-prototyped MEMS Propulsion and Radiation Test Satellite (RAMPART)

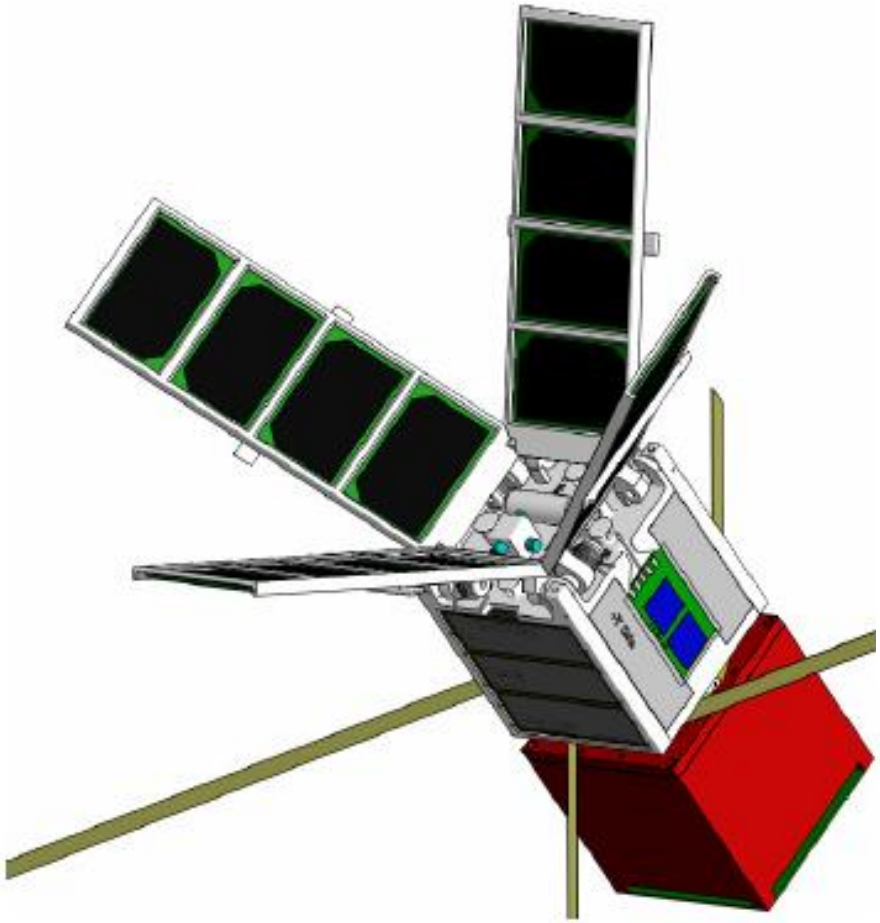
Mission Goal and Technology Demonstration

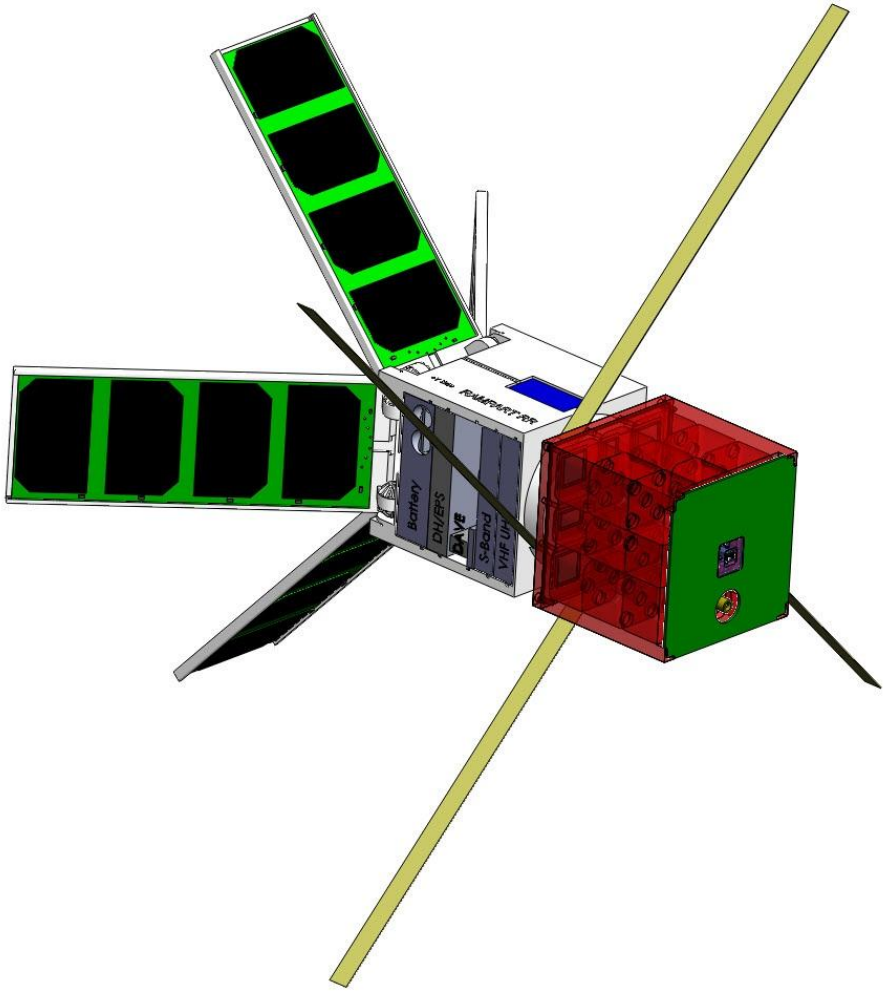
Goal: Demonstrate rapid prototyped nano-satellite technology in harsh space environment for Operationally Responsive Space

Technology Demonstration:

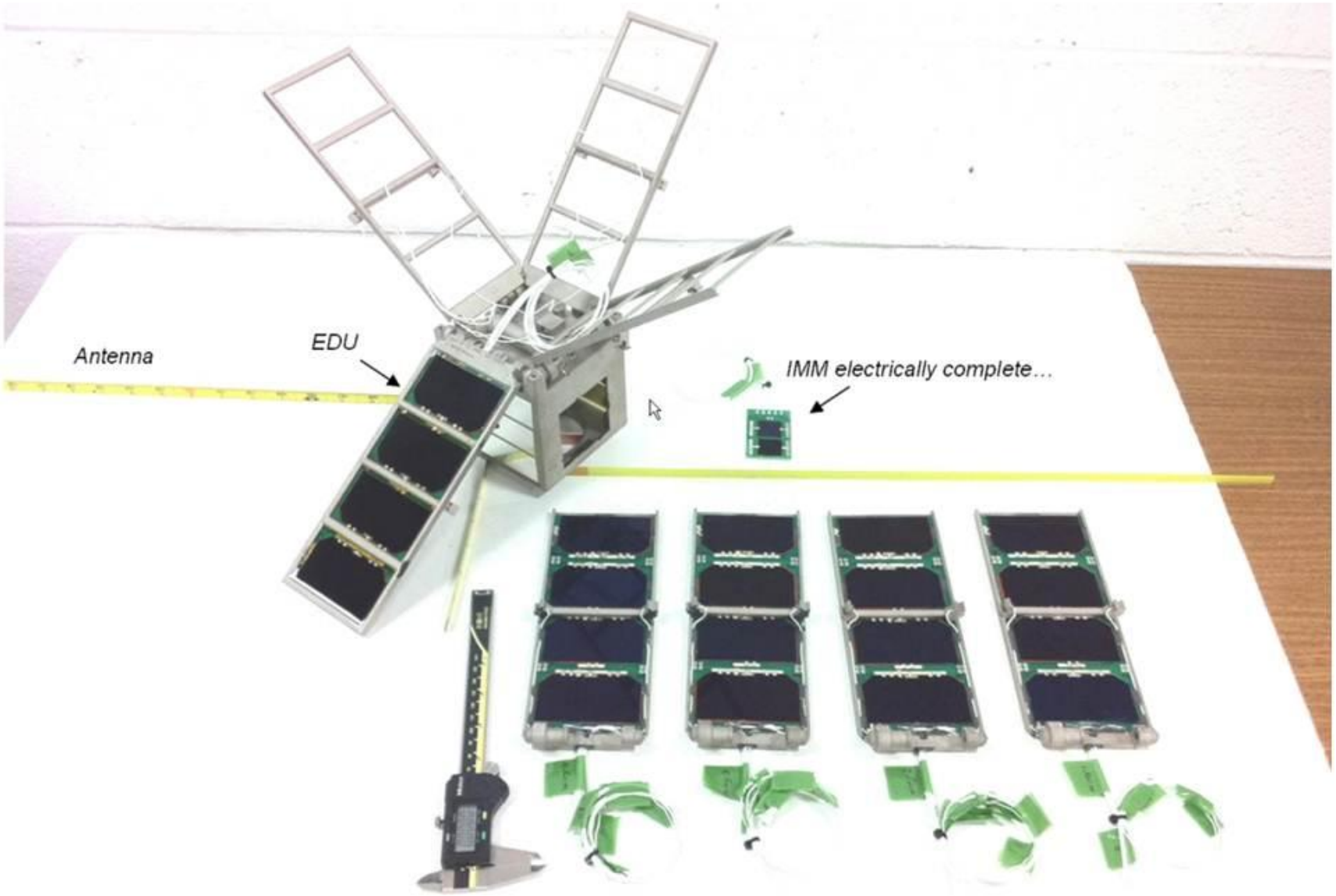
- CubeSat bus structure, solar panels and propulsion module fabricated via Rapid Prototype from metal-plated carbon-fiber filled Polyamide (Windform XT)
- Warm-gas safe-propellant Orbital Maneuvering Thruster system with MEMS-components [Arkansas]
- AFRL Cubeflow SPA-1 interface (plug-n-play)
- AFRL advanced solar cell technologies (>33% efficiency)
- Miniature Geiger Muller counter

RAMPART (a 2U CubeSat)



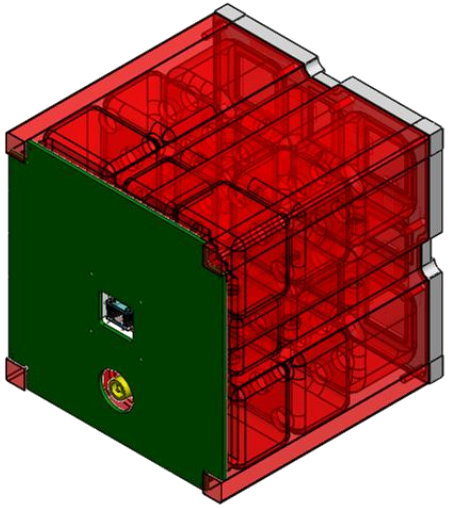


RAMPART Bus

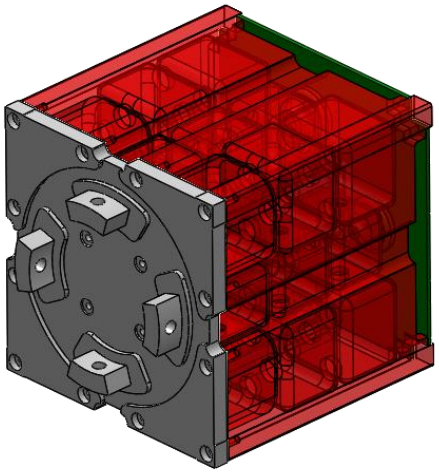


Courtesy of Walter Holemans (Planetary Systems Corporation)

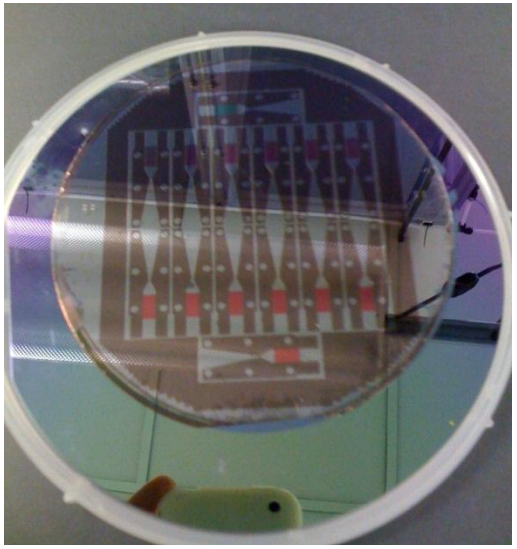
RAMPART Propulsion System Components



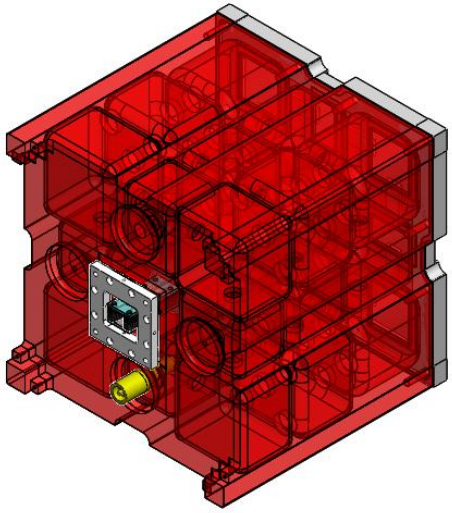
Propulsion Unit (Nozzle End)



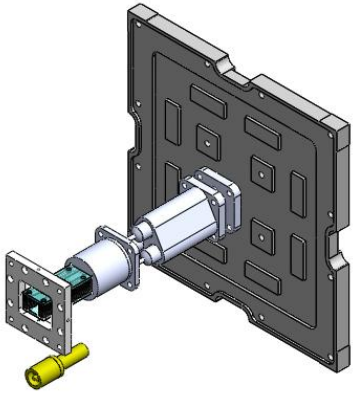
Interface Lug



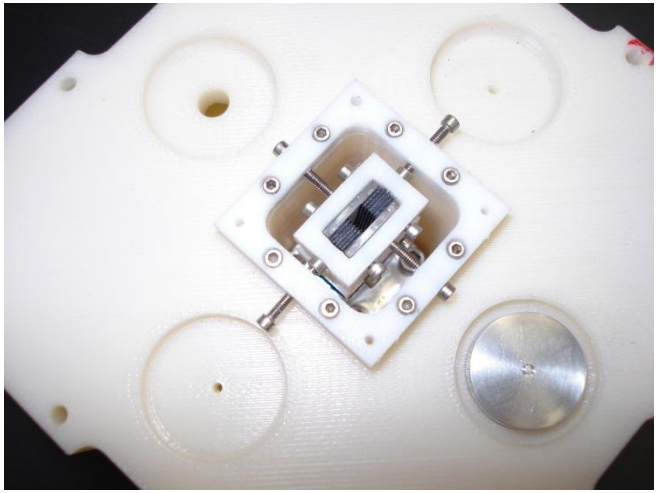
RAMPART thruster nozzles



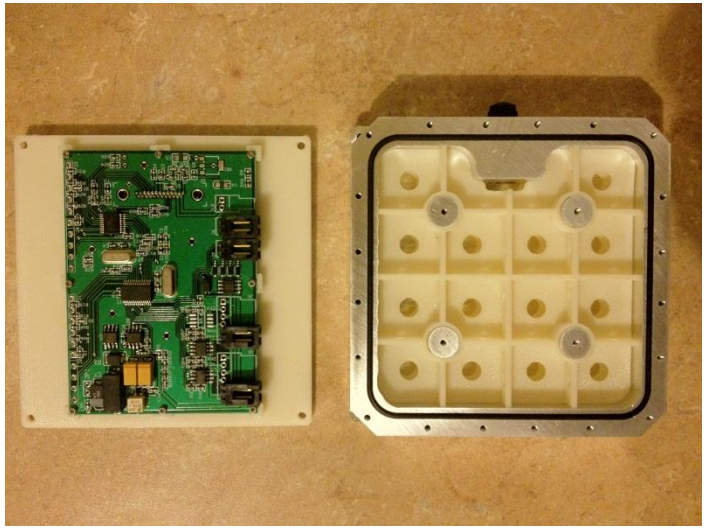
Windform XT (Red)

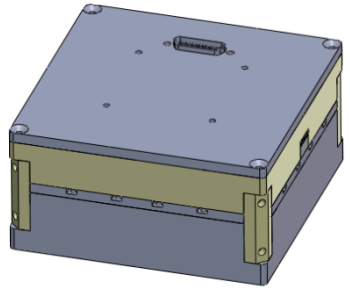


Thruster Core

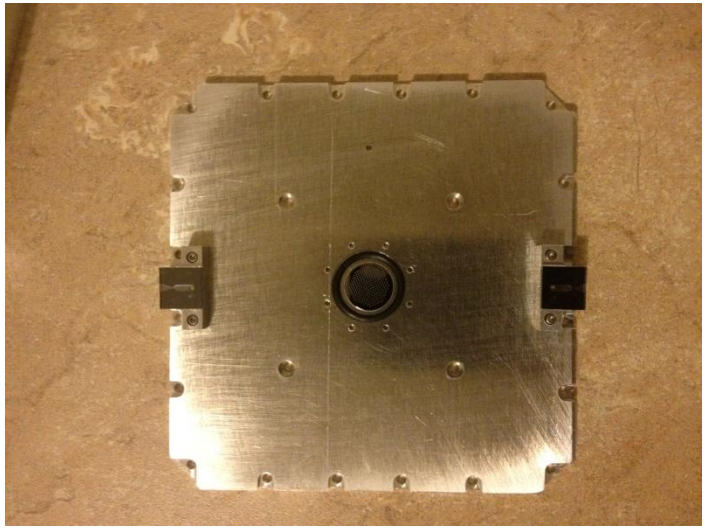


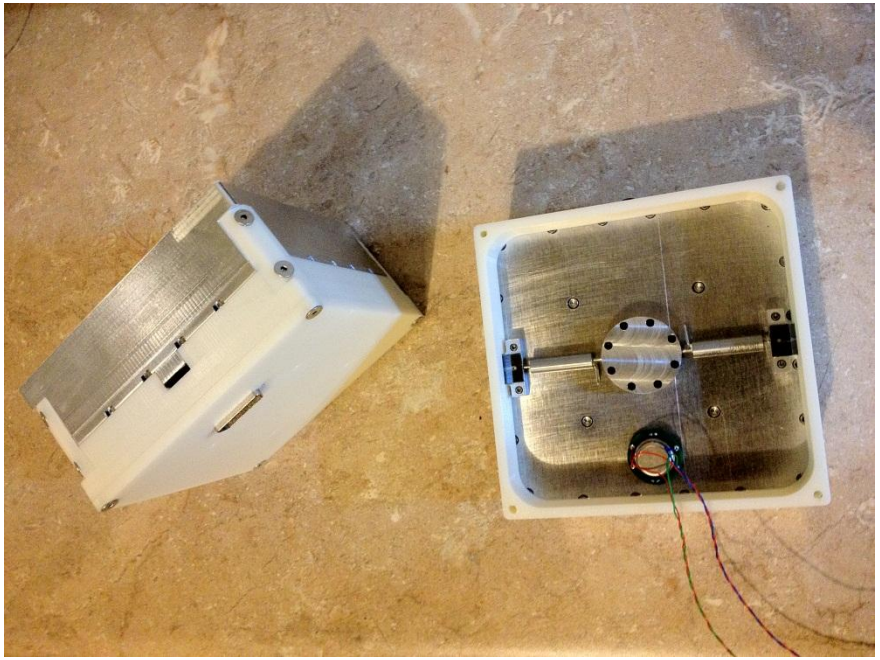
NASA Marshall Attitude Control Demonstrator





UA-PM





Conclusions

One of key critical future technology for NanoSatellites is to provide mobility. That capability is to be operationally demonstrated within the next 5 years, culminating in the high-difficulty formation flight missions.

Acknowledgments

- Aerospace Corporation
- Arkansas Space Grant Consortium
- AFRL sponsored flight for the Rapid-prototyped MEMS Propulsion and Radiation Test Satellite (RAMPART)
- NASA Marshall

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