Get Away Special Passive Attitude Control Satellite -GASPACS-

UTAH STATE UNIVERSITY-UNDERGRADUATE RESEARCH

CUBESAT WORKSHOP

2 AUGUST 2014

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Heritage


MICROGRAVITY RESEARCH
A
GET AWAY SPECIAL
UTAH STATE UNIVERSITY


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Mission of GASPACS

- Primary Objective:
  - Deploy and rigidize a 1 meter long inflatable UV cured boom from a 1U CubeSat platform in low Earth orbit
- Secondary Objective:
  - Measure attitude behavior of GASPACS to observe the effectiveness of the deployed boom assisting in a passive attitude control system

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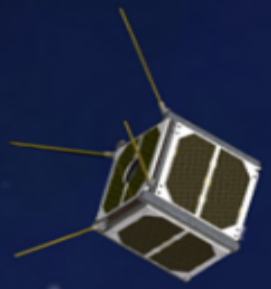
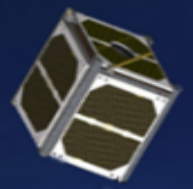
Phase 1

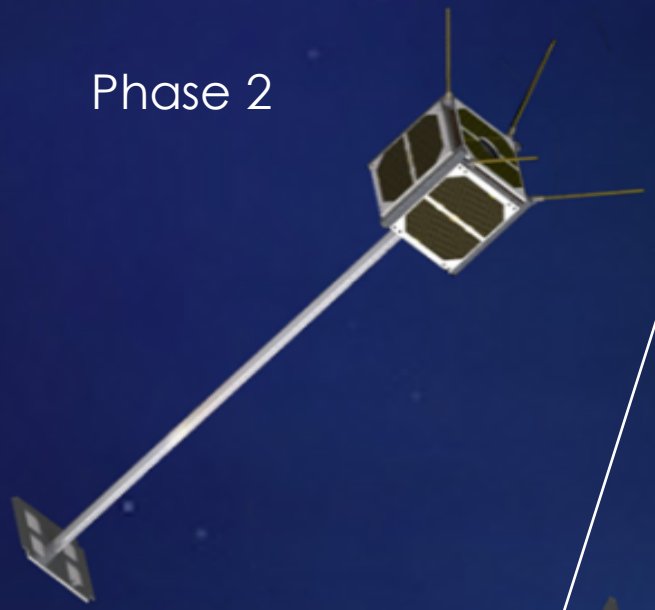


Antenna Deployment



P-Pod Deployment

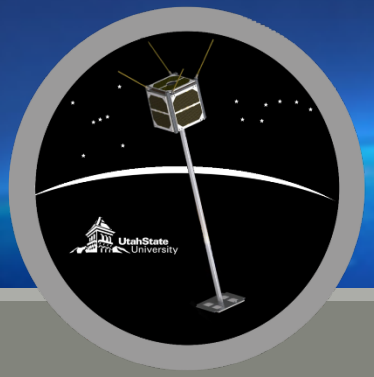
Phase 2



Aero Boom Deployment

Phase 3

Aero Stabilization



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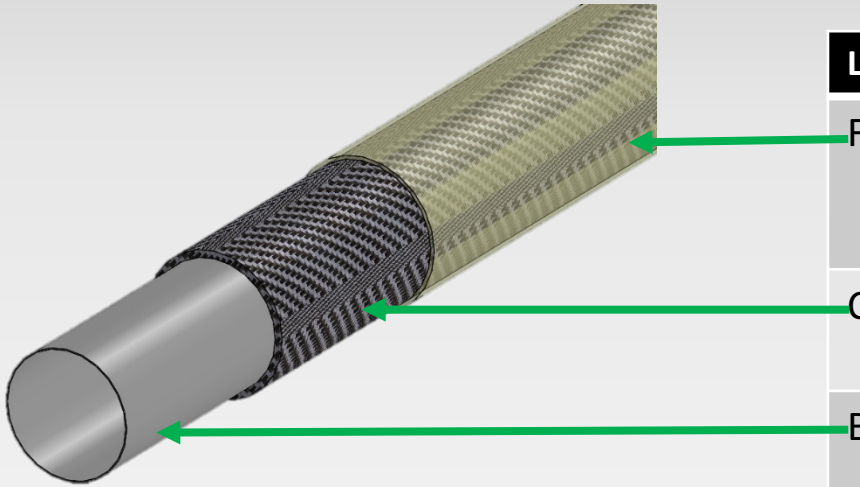
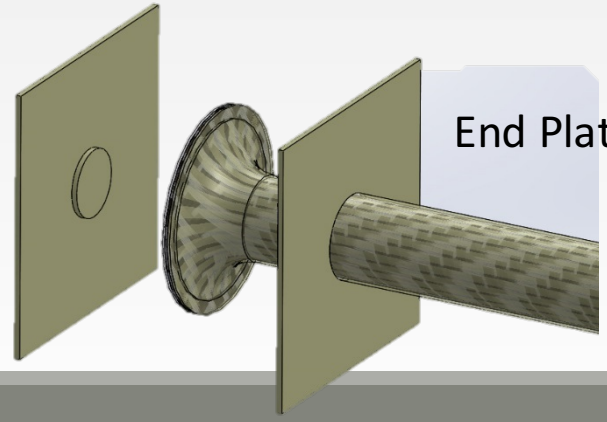
Boom Design



Layer	Material	Function
Film Layer	Mylar	1. Protects uncured composite overwrap when packed 2. Contains uncured resin from outgassing 3. Transmits UV radiation from sun for resin cure
Carrier	S-Glass	1. Contain pressure forces on bladder. 2. Carries impregnated UV curing resin
Bladder	Mylar	1. Gas impermeable layer for containing air 2. Reflects UV radiation back into the fiber glass



End Plate Interface

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ROC™-E37X1

- UV Curing Acrylate Resin, *Rigidization on Command*
- Rapid cure under solar radiation
- Good durability, low shrinkage, low outgassing, low toxicity
- Good dielectric and mechanical properties with temperature resistance

Adherent Technologies, Inc.

AT Inc.

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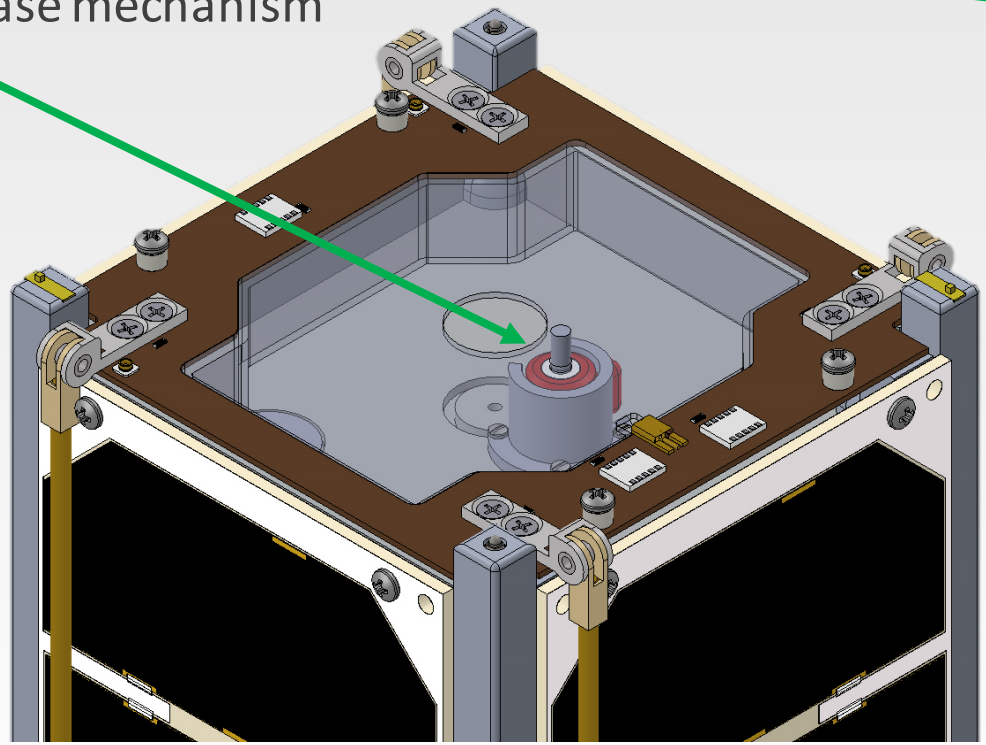
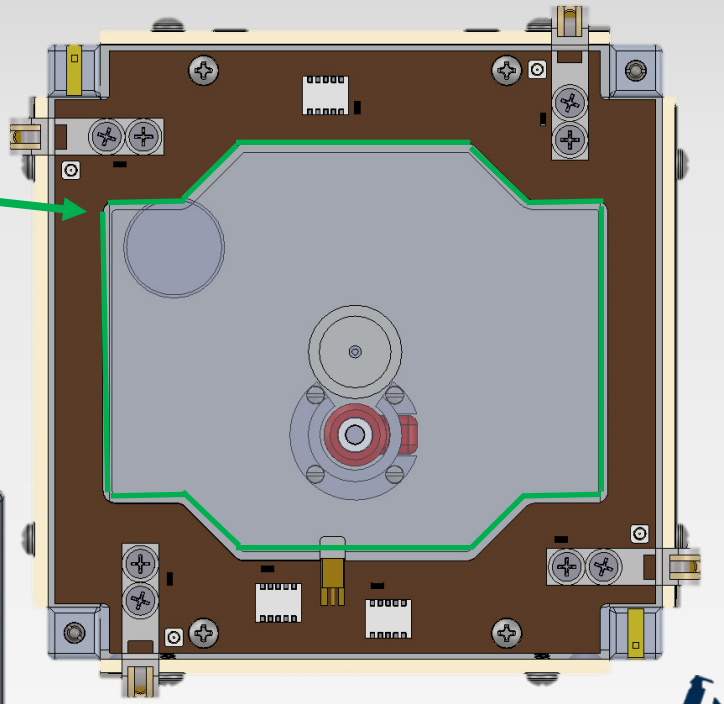
Boom Design

- Boom Packing and Deployment
  - Chamber for Boom Packing
- Frangibolt release mechanism





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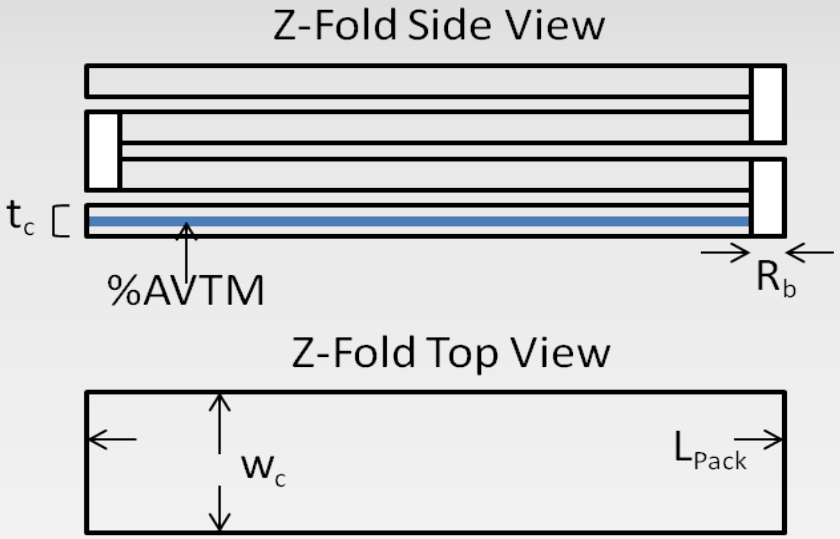
Testing: Internal Pressure

Vacuum testing for internal pressure analysis of packed volume modeling in MatLab to validate concept of boom inflation through a relative pressure change introduced from launch into orbit

Through test results, we are validating a numerical model that predicts final inflated pressure based on the air volume to boom thickness ratio of the packed boom (AVBT)



$$V_{Pack} = [w_c - (2 * t_m)](VATM * t_c)(L_{Pack} - 2R_b) * NL$$

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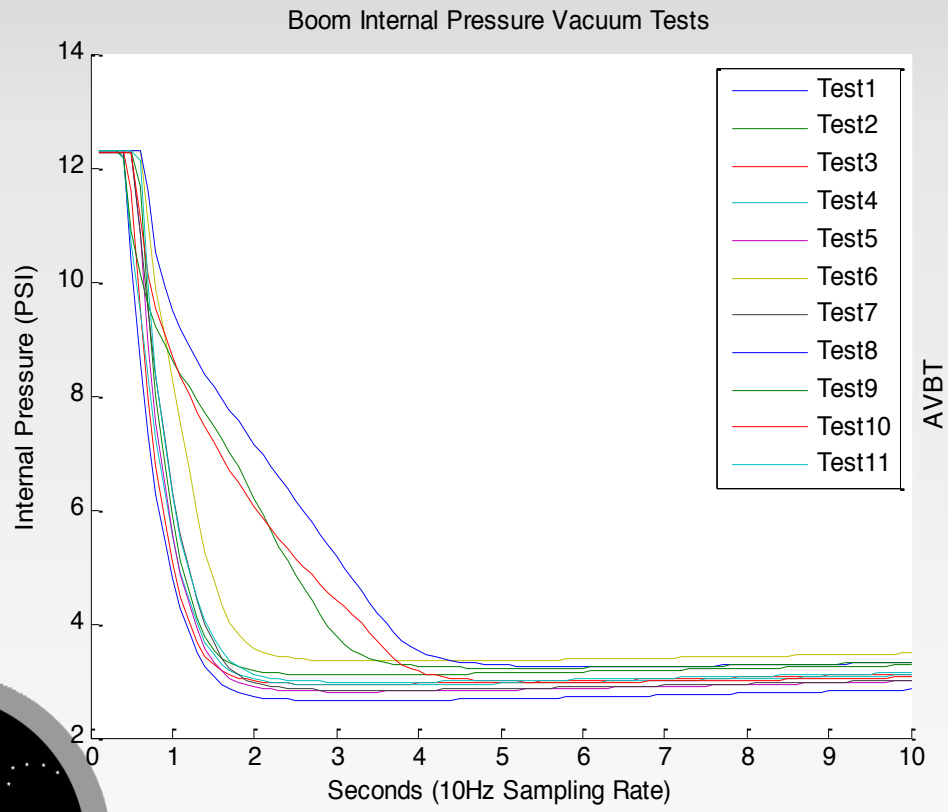
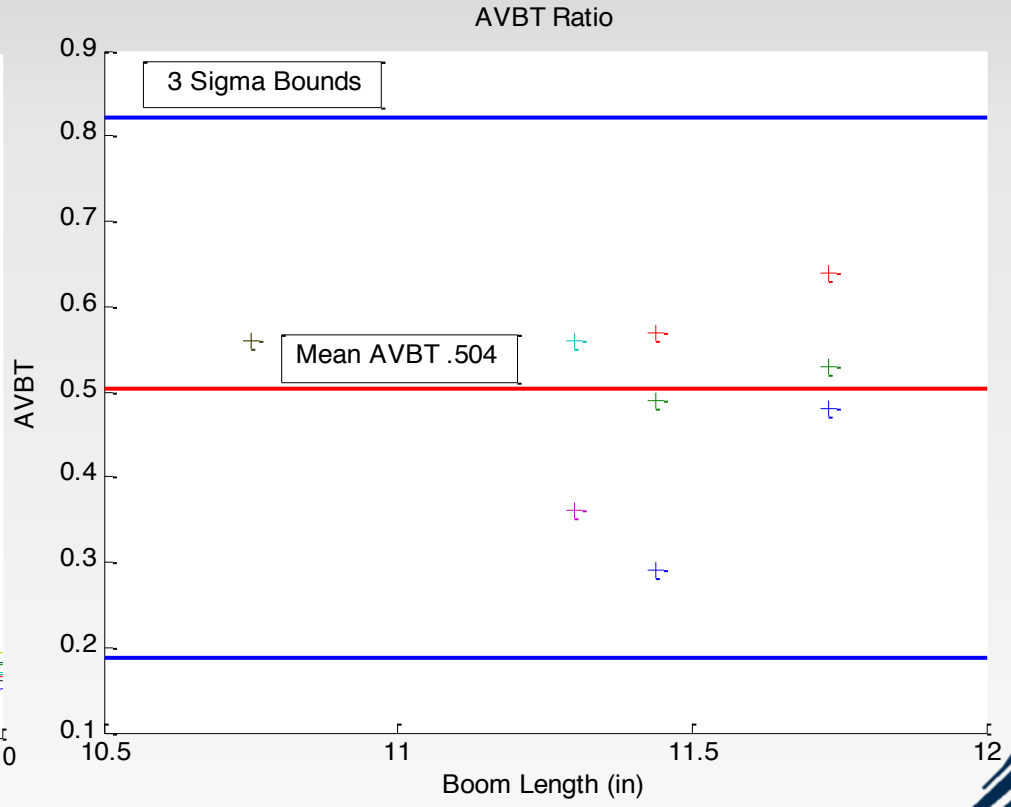
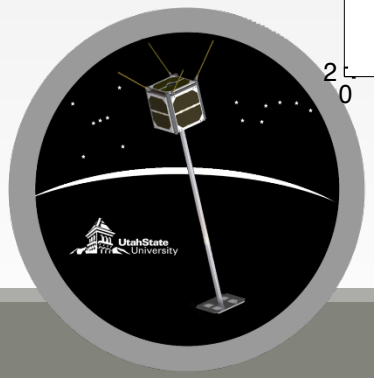
Testing: Internal Pressure







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Major Environmental Disturbance Torques

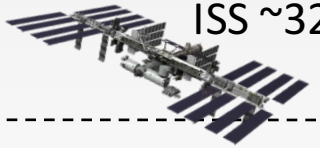
~400,000 km

Geosynchronous
~35,000 km

Lunar Region

Medium Earth Orbit
~2,000 km-GEO

GASPACS ~325 km



ISS ~325 km

Low Earth Orbit

Solar Radiation Pressure

Atmospheric Drag

Gravity Gradient

Magnetic Field

Passive Attitude Control Methods

- Using environmental torques for attitude stabilization
- Reduces computational and power demands for satellite missions

Control Type	Pointing Options	Satellite Heritage
Gravity Gradient	Earth local vertical	IceCube 1, 2 (Lost in launch)
Passive Magnetic	North/South only	Ky-Sat 1, QuakeSat, Delfi-C3
Atmospheric Drag	Velocity Vector	PAMS

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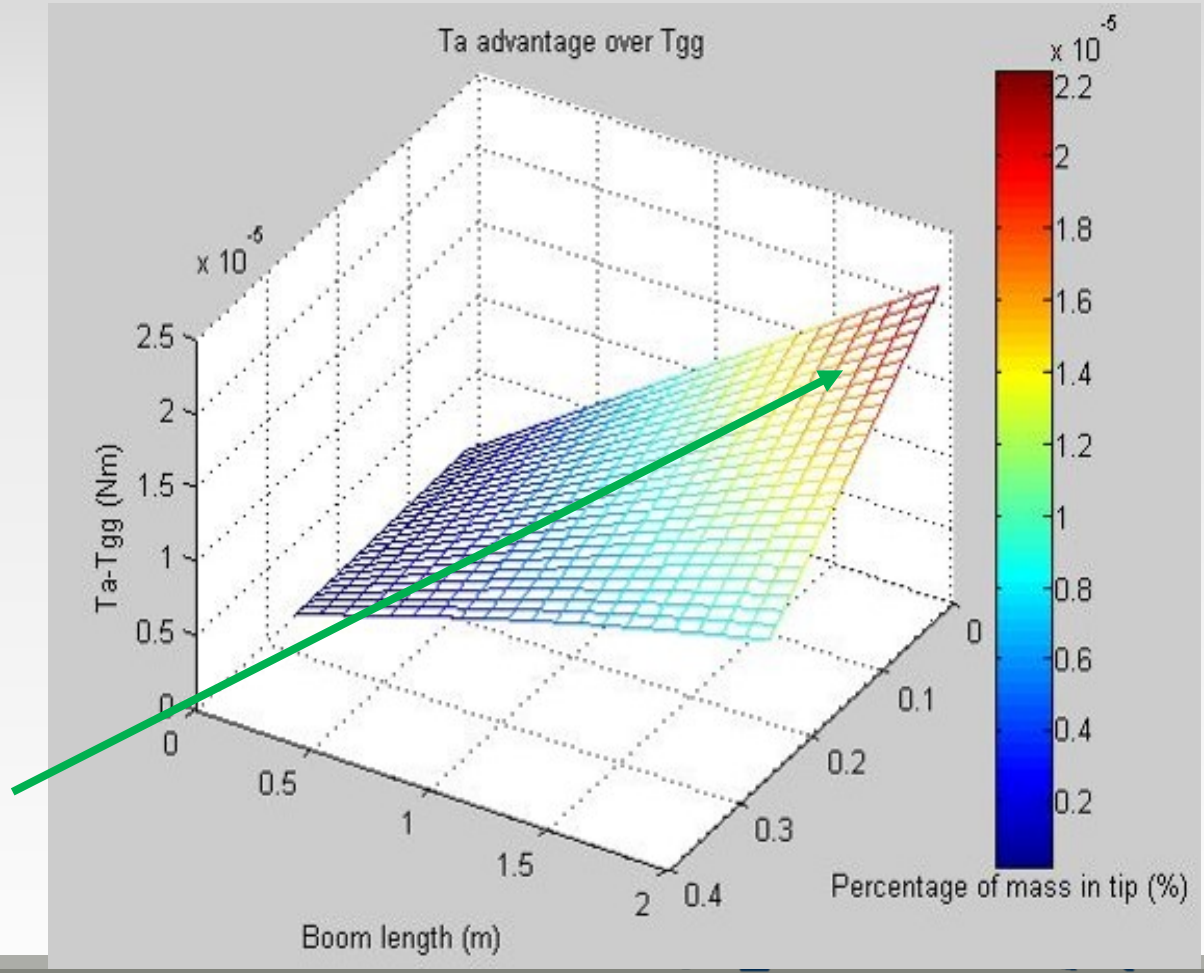
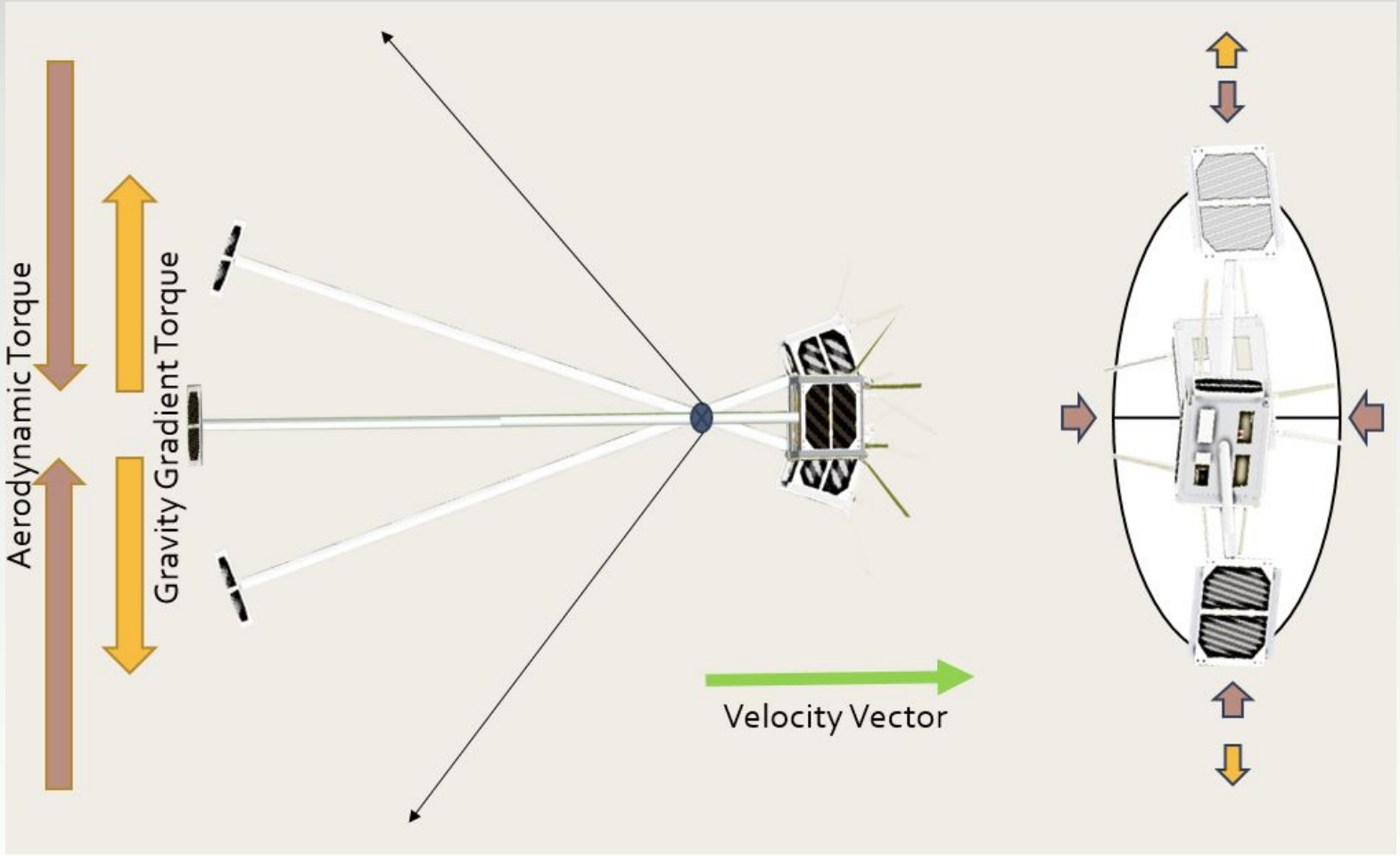
Atmospheric Drag vs. Gravity Gradient

- Original Gravity-Gradient Design in higher altitude LEO orbit with deployable boom
- ISS altitude orbit dominated by atmospheric drag
- GASPACS has been designed to optimize atmospheric drag torques for passive control stabilized along the velocity vector in orbit.

Controlling Torque optimized with boom length and reduced tip mass



Passive Attitude Control Concept



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Key Partners & Acknowledgments

Special thanks to Jim Elwell, John Elwell, Jan Sojka, Chad Fish, and Charles Swenson

Questions?

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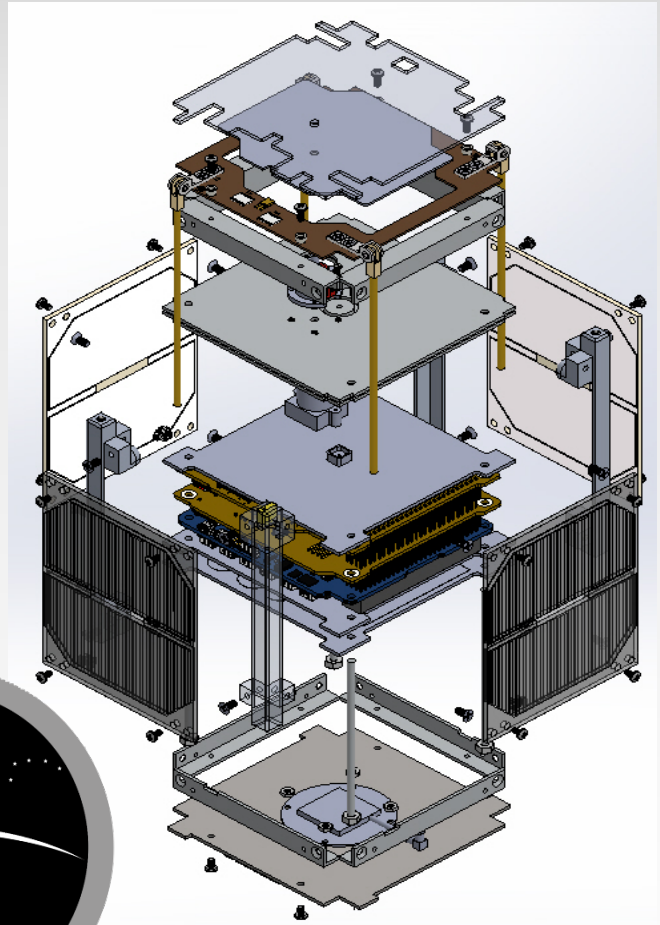
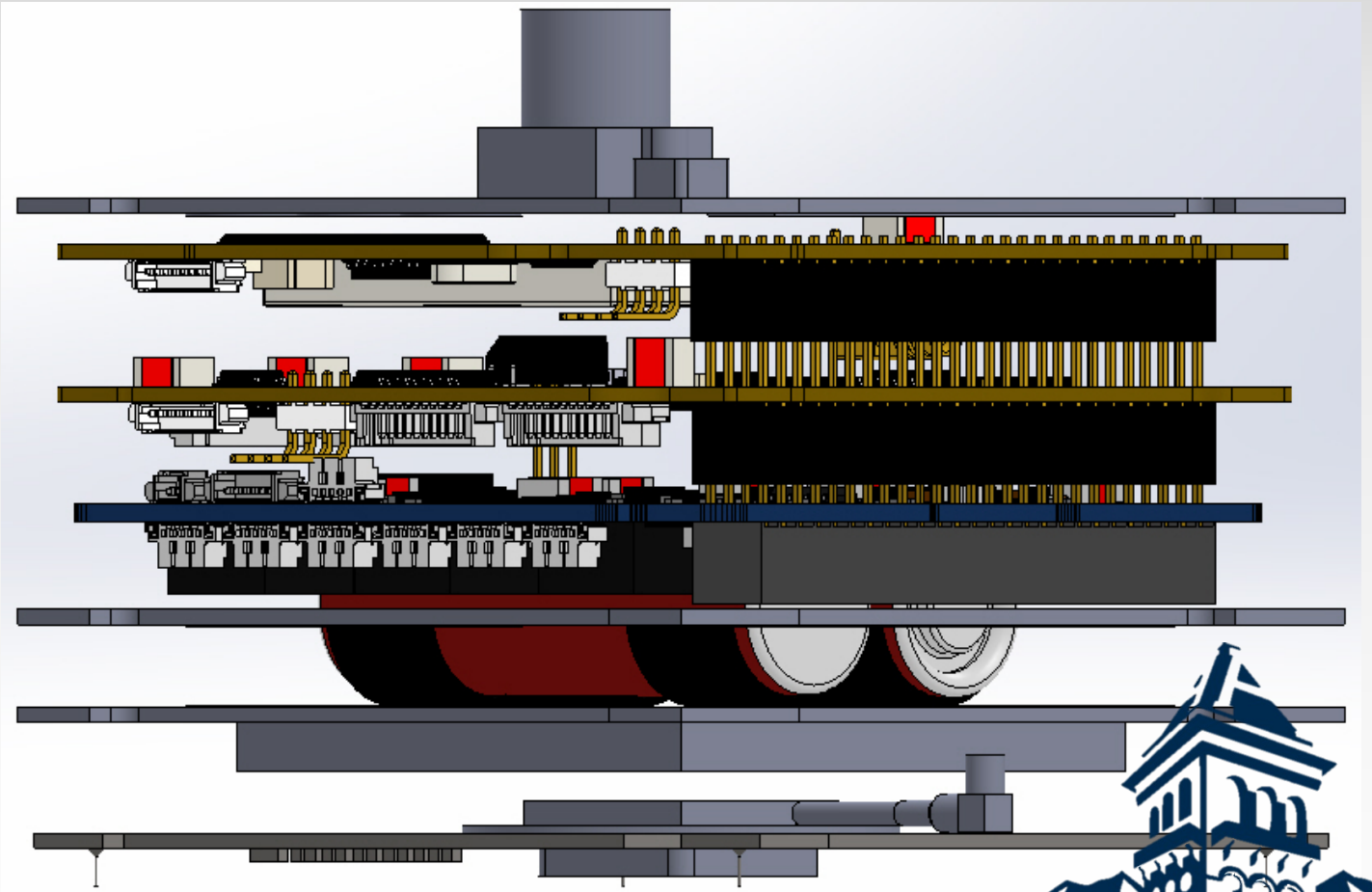
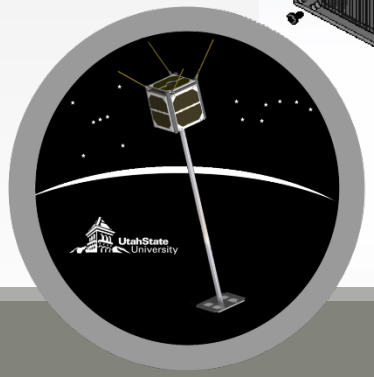
Design







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