

# **CubeSat Proximity Operations Demonstration (CPOD) Mission Update**

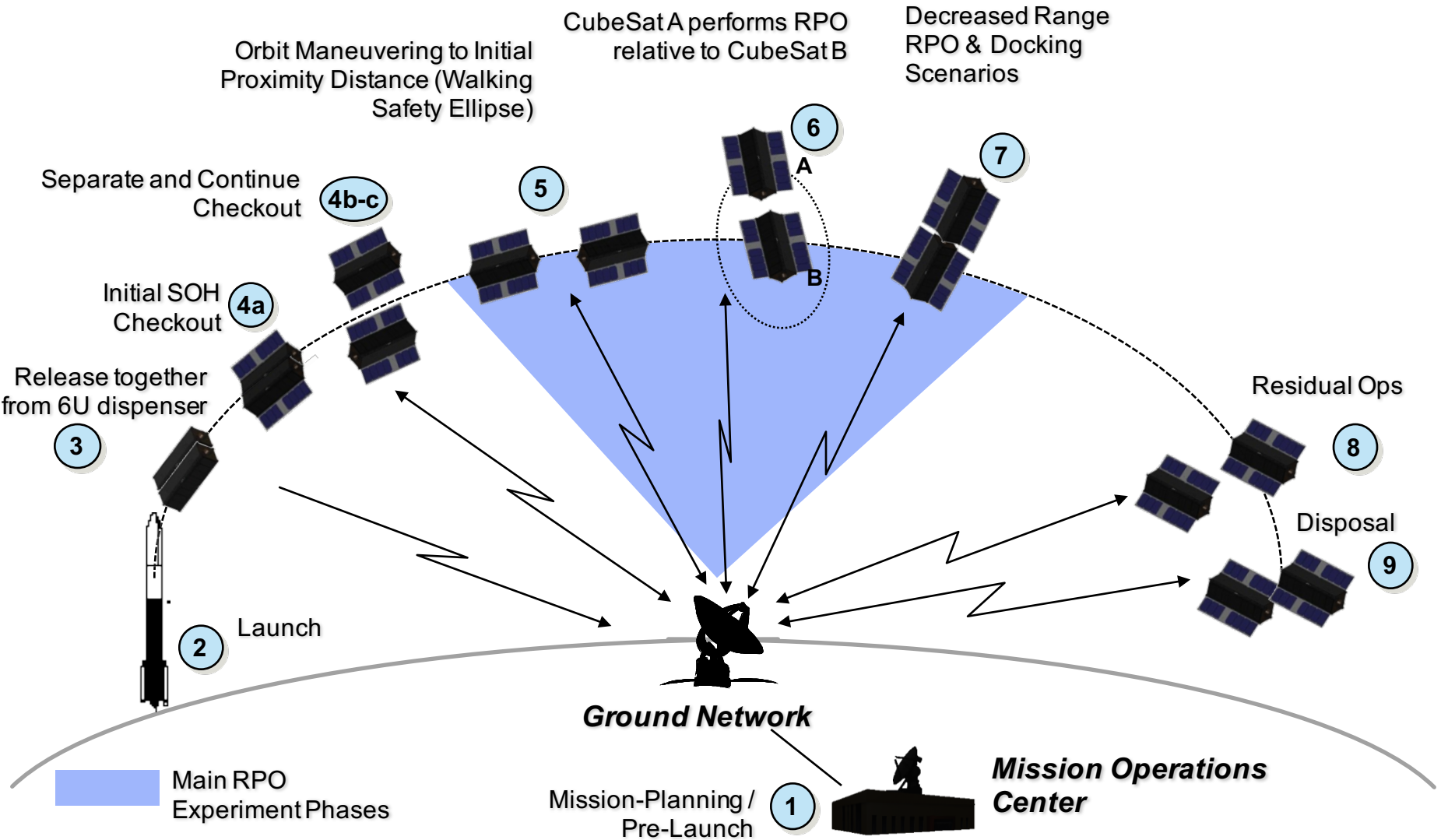
**Cal Poly CubeSat Workshop  
San Luis Obispo, CA  
04-22-2015**

**Austin Williams  
VP, Space Vehicles**

# ConOps Overview

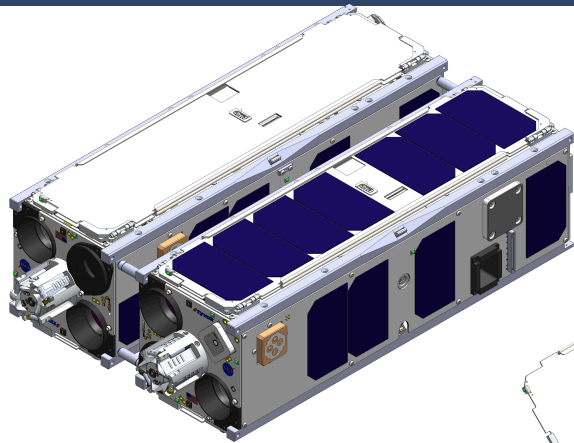
- Designed to Maximize Mission Success Probability

Tyvak Nano-Satellite Systems Inc.

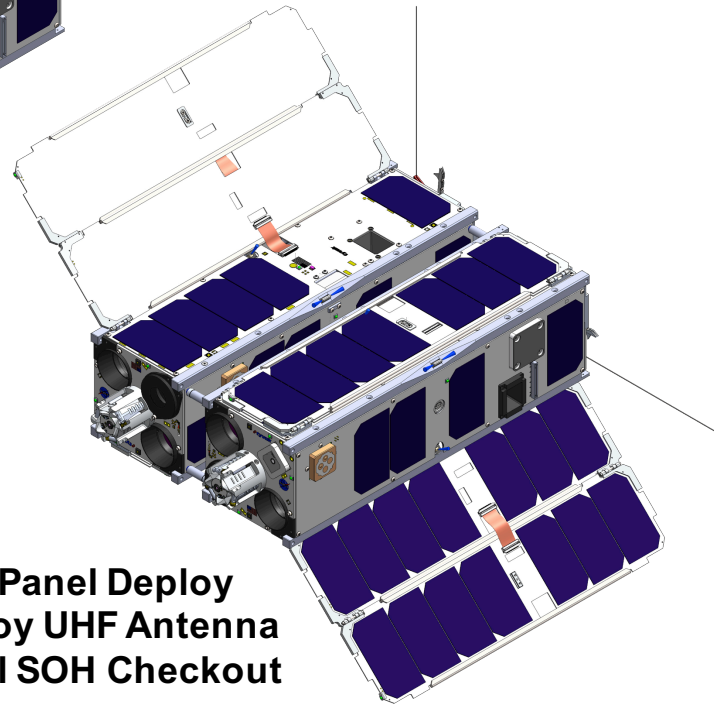


# Deployment Configurations and Vehicle Checkout

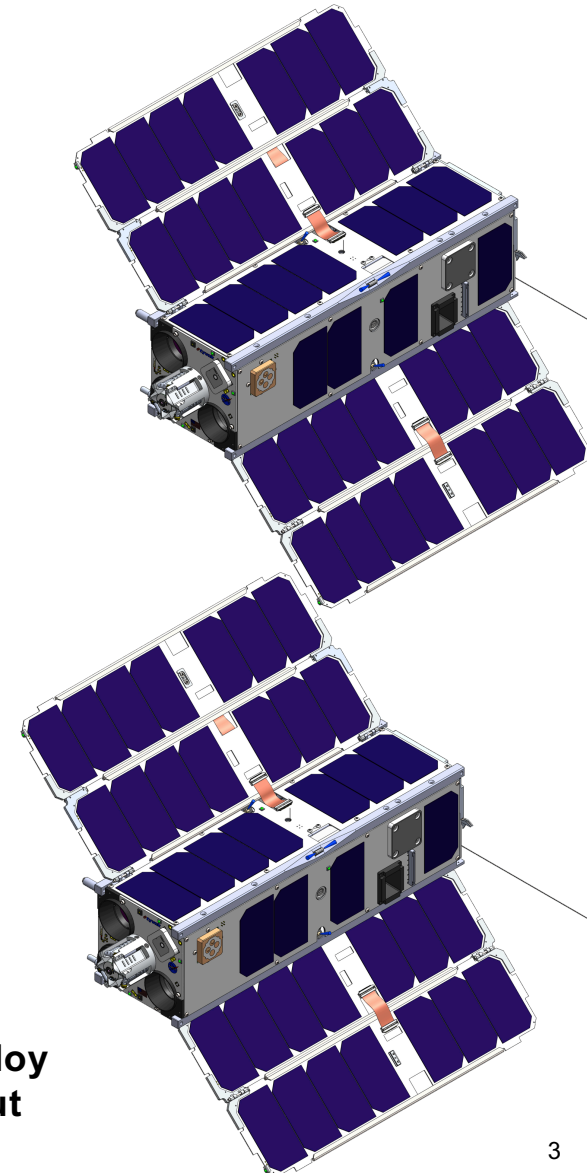
*Tyvak Nano-Satellite Systems Inc.*



**3** Connected "6U"  
Configuration



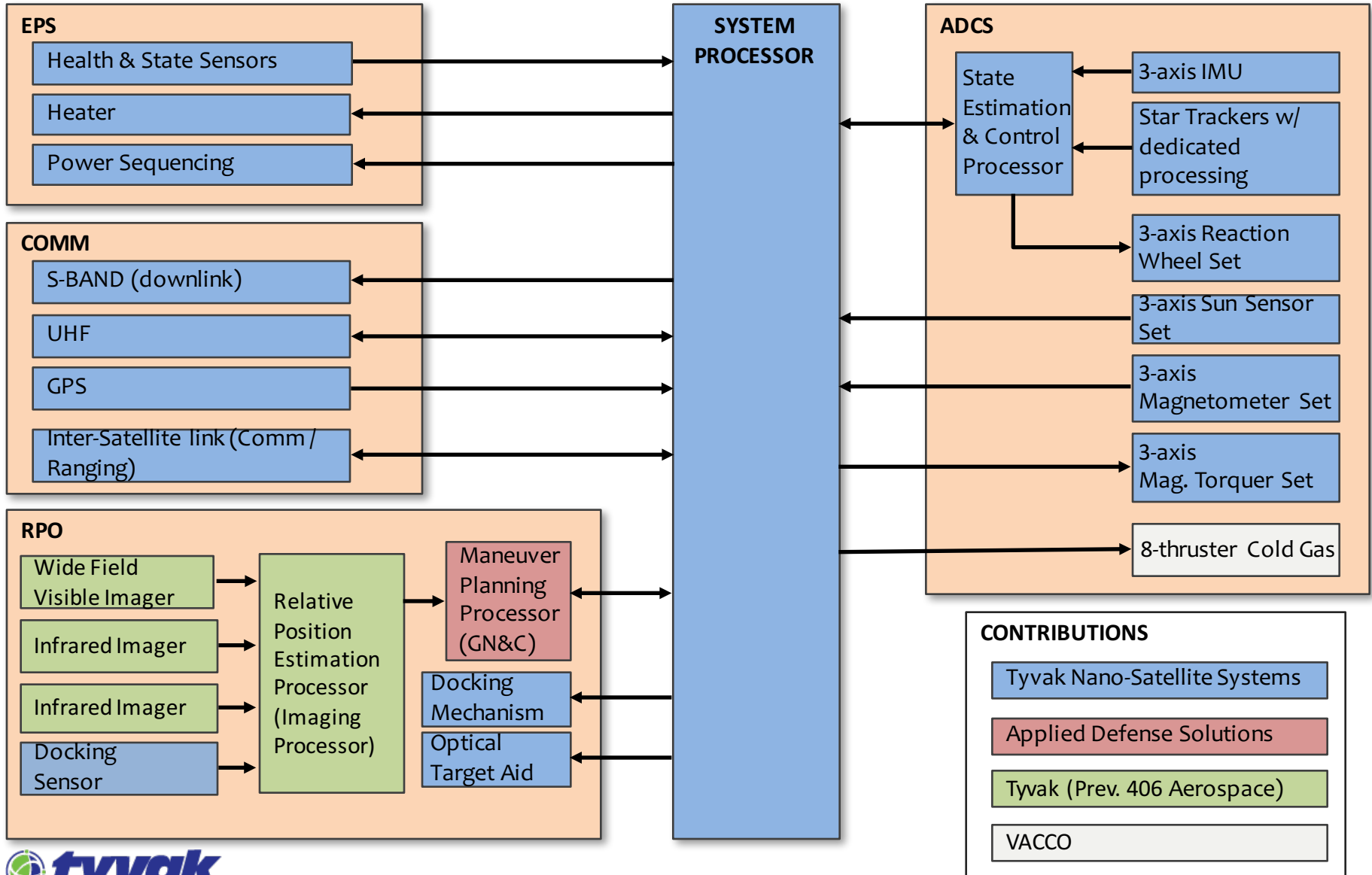
**4a** First Panel Deploy  
Deploy UHF Antenna  
Initial SOH Checkout



**4b-c** Vehicle Separation  
Second Panel Deploy  
Complete Checkout

# Space Vehicle Architecture

Tyvak Nano-Satellite Systems Inc.

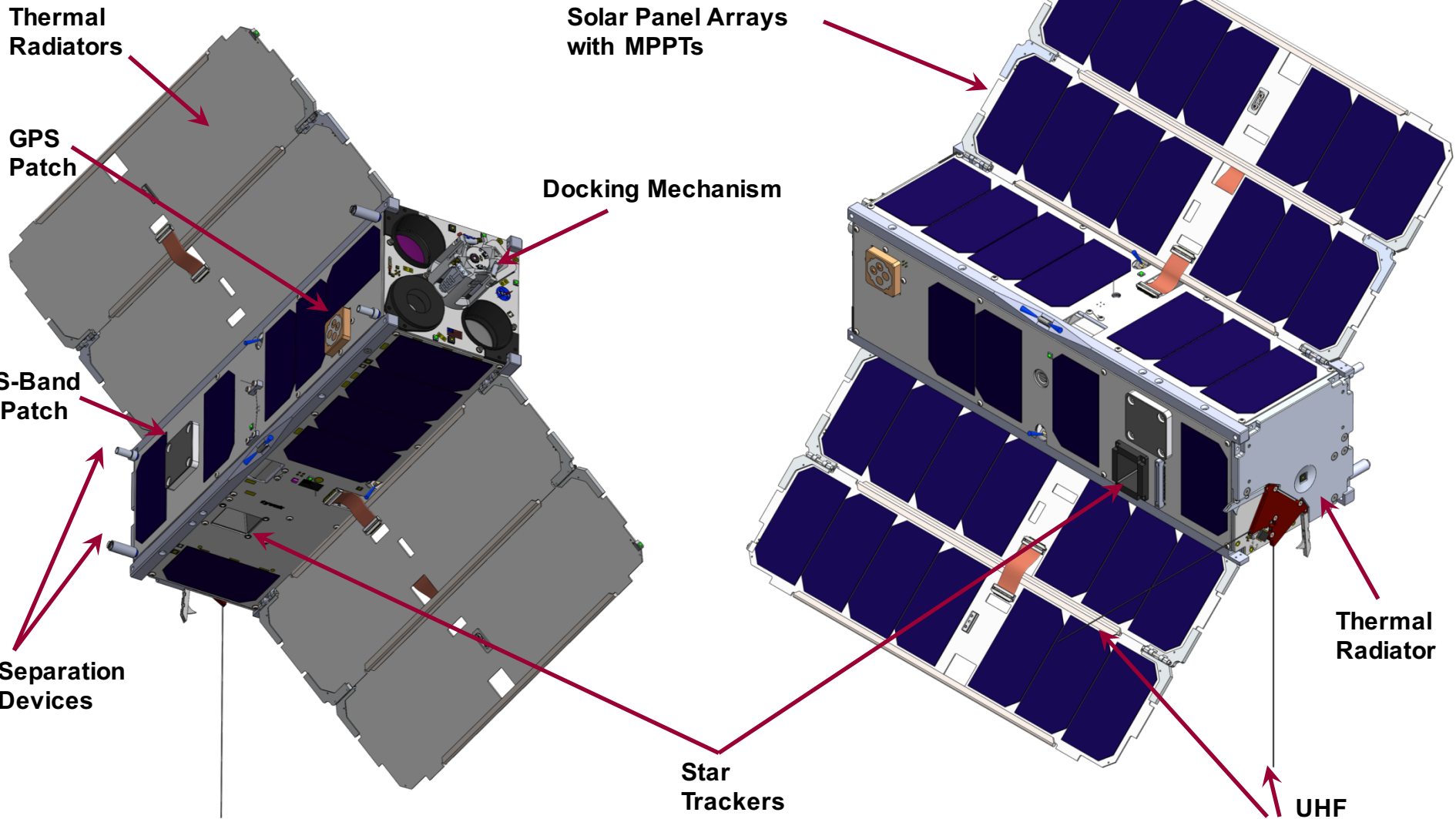




# Vehicle Configuration

## -External Isometric Views

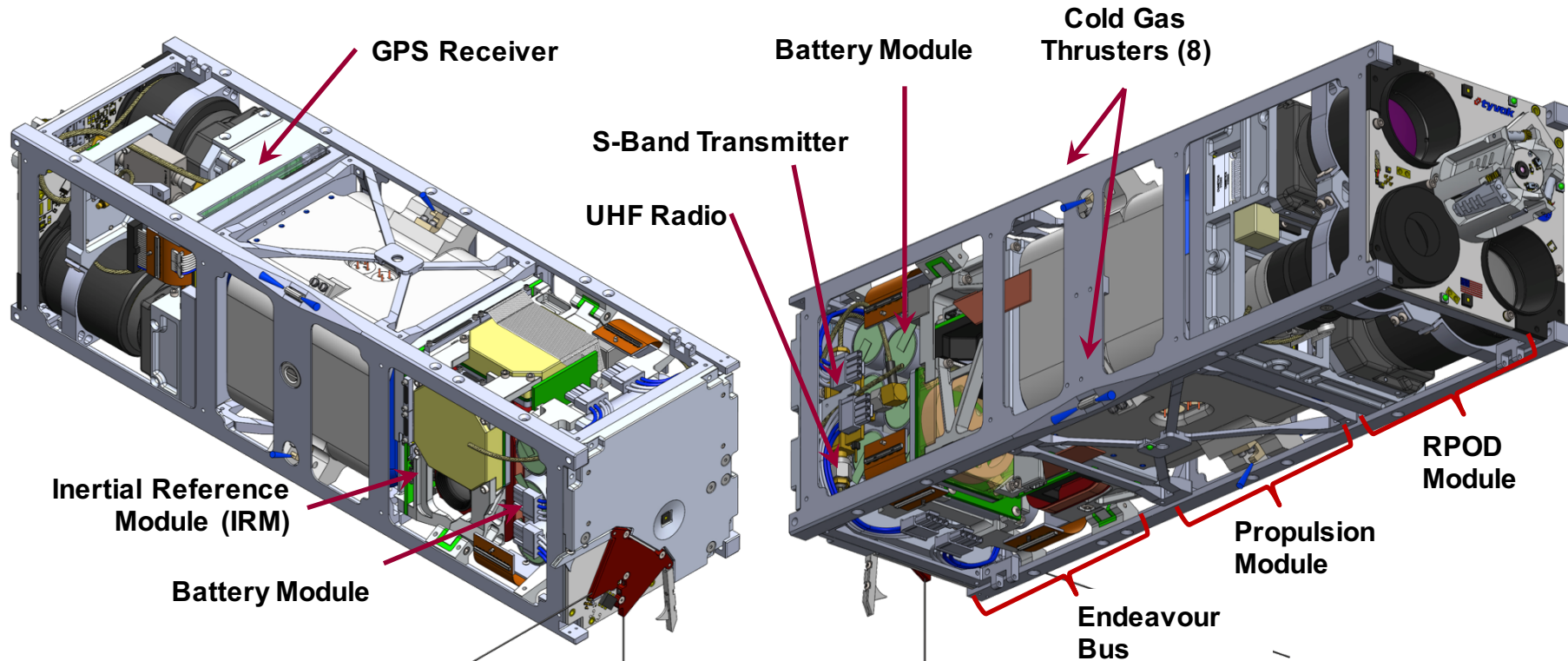
Tyvak Nano-Satellite Systems Inc.



# Vehicle Configuration

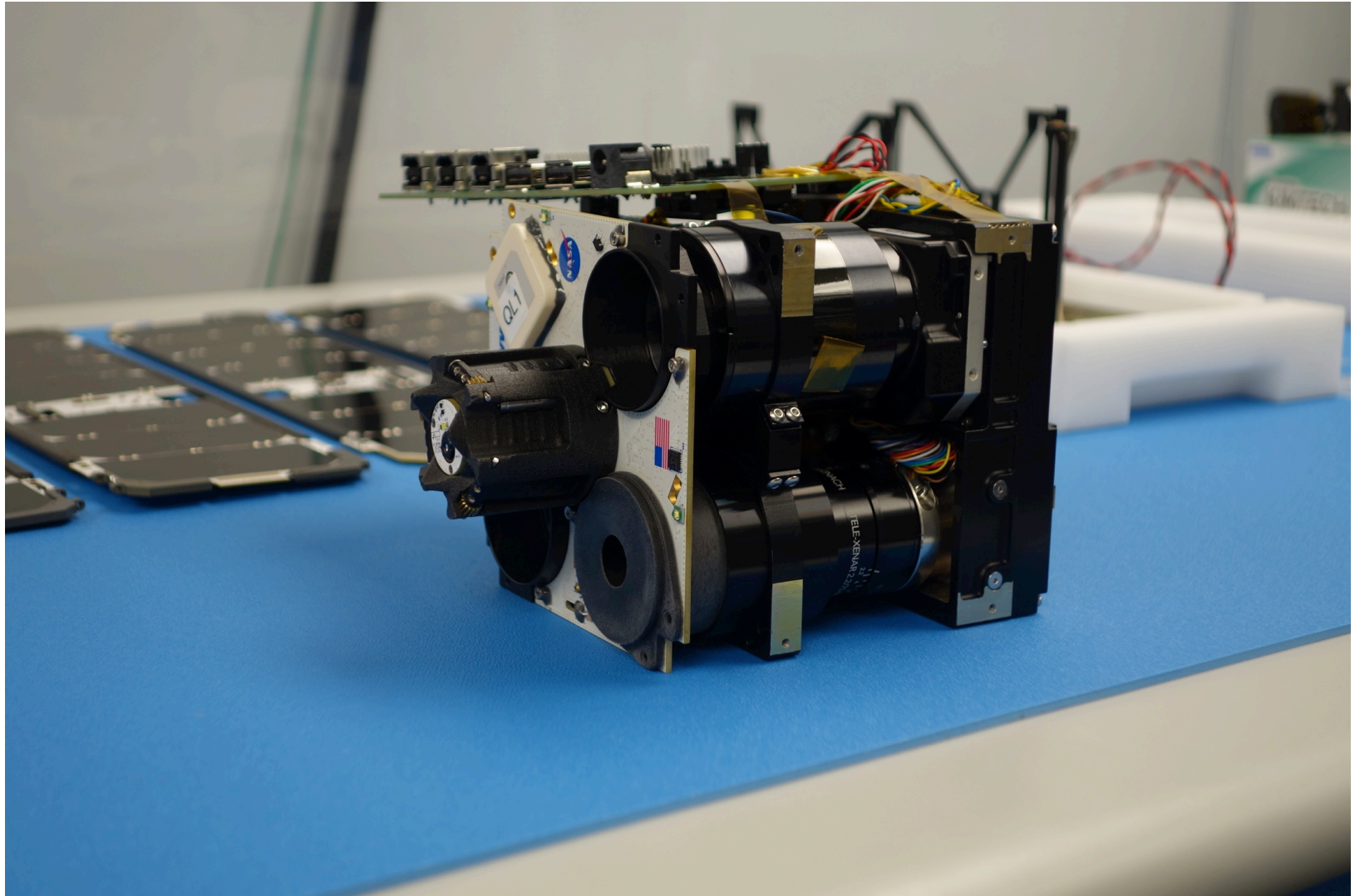
## -Internal Arrangement and Packaging

Tyvak Nano-Satellite Systems Inc.



# Payload – Tyvak's RPO Module

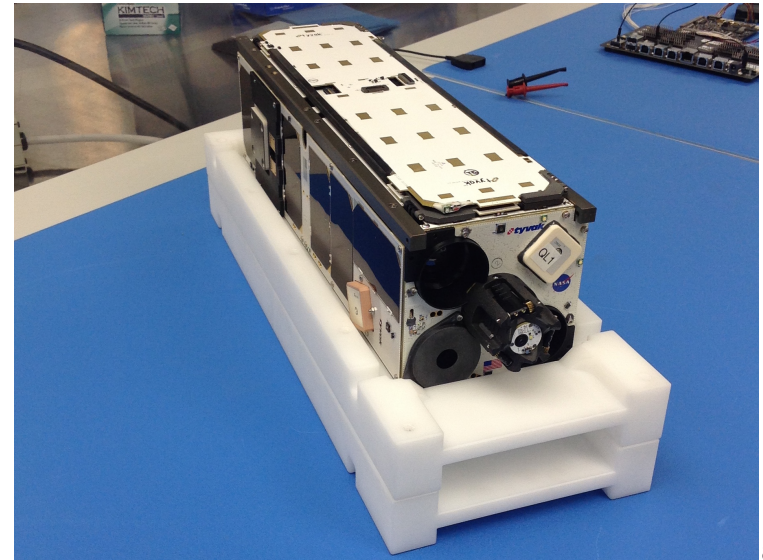
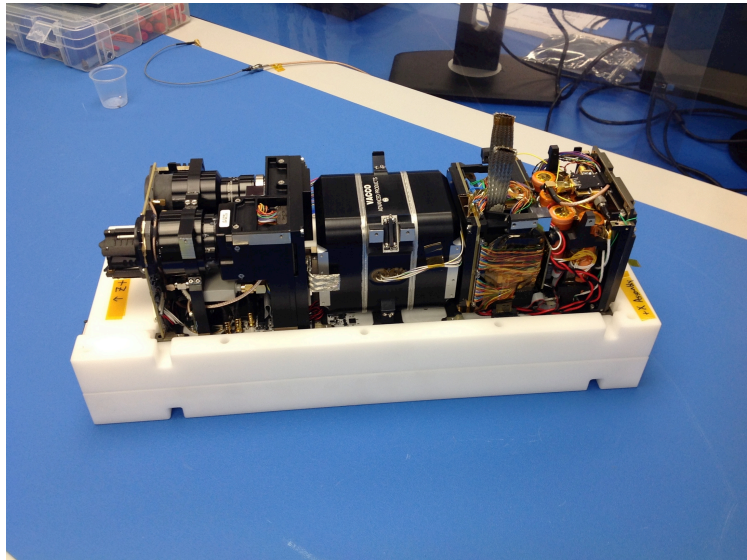
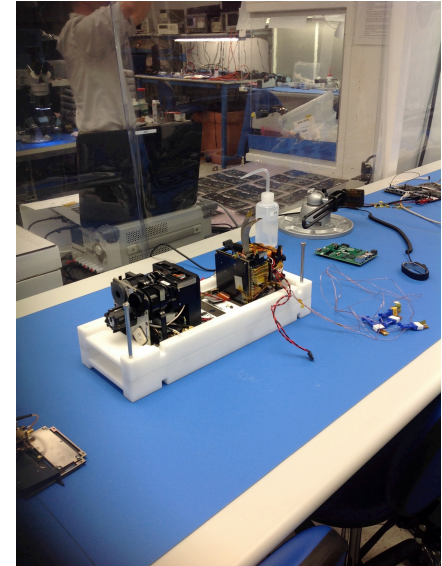
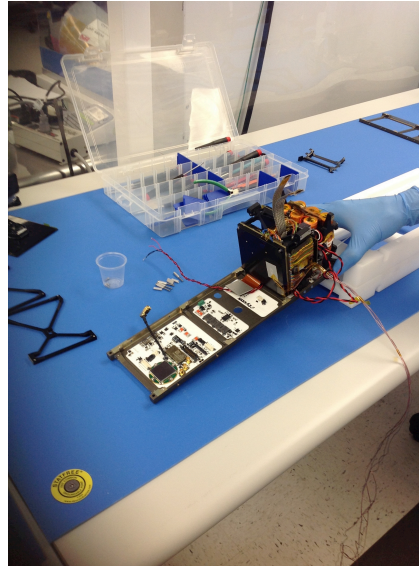
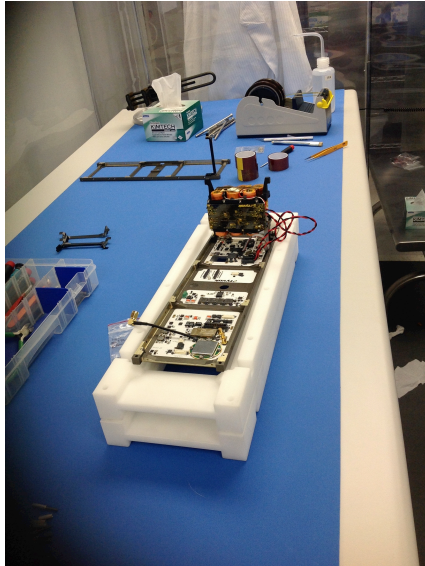
*Tyvak Nano-Satellite Systems Inc.*





# EDU Build-Up - System

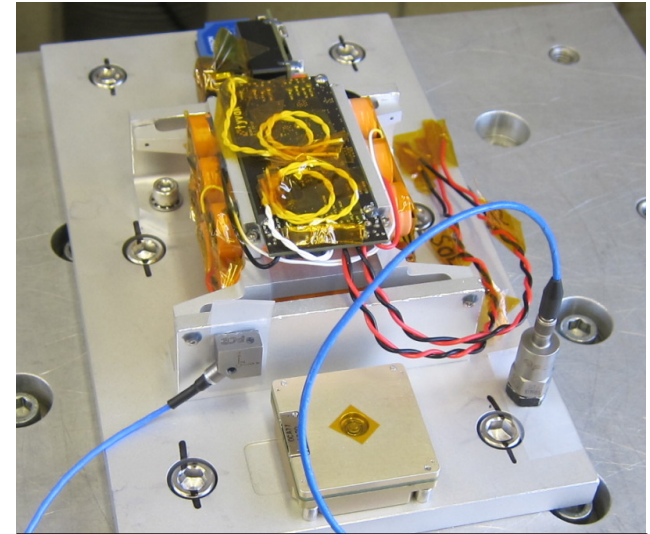
*Tyvak Nano-Satellite Systems Inc.*



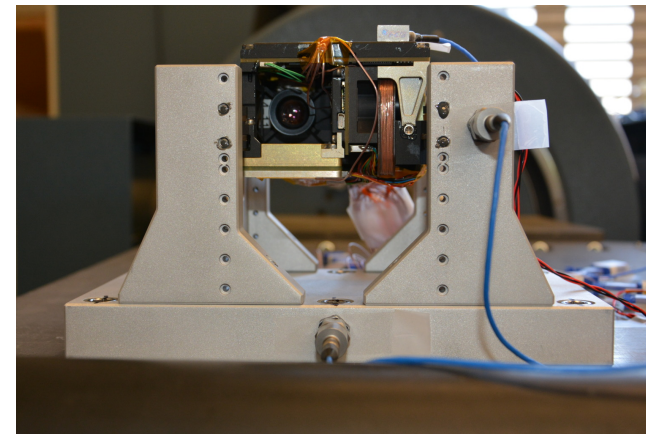
# Component and Subsystem Environmental Testing

*Tyvak Nano-Satellite Systems Inc.*

- **Early component and subsystem environmental testing used to reduce risk of issues at system level**
  - Risk reduction environmental testing completed on low TRL components (RWA, battery module, star camera, and IMU show on right)
  - Modules used to enable testing complex subsystems before full vehicle integration (IRM, RPOD, etc.)
- **Lessons Learned**
  - Thermal test before thermal vacuum testing
  - Design for repeated assembly and disassembly of complex modules
  - Feature rich test interfaces are invaluable when attempting to understand issues without deintegration



Component Vibration Testing



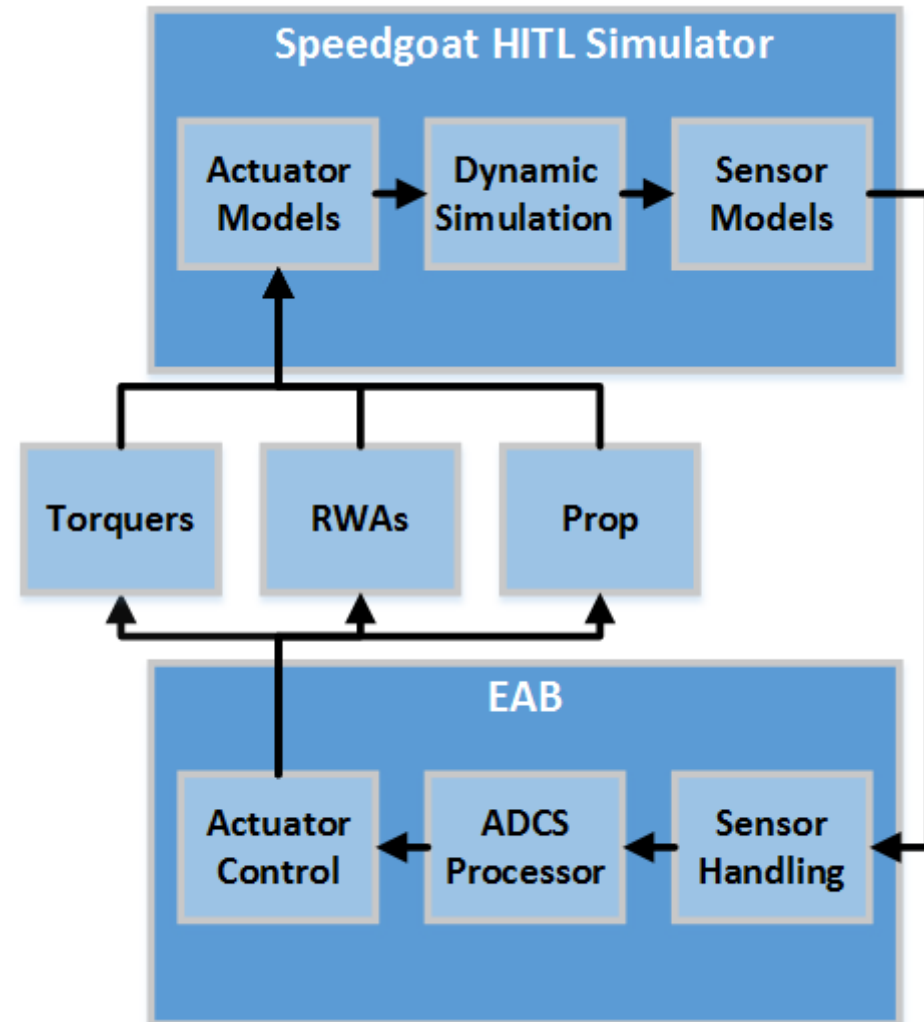
Subsystem Vibration Testing



# Hardware in the Loop (HITL) Testing

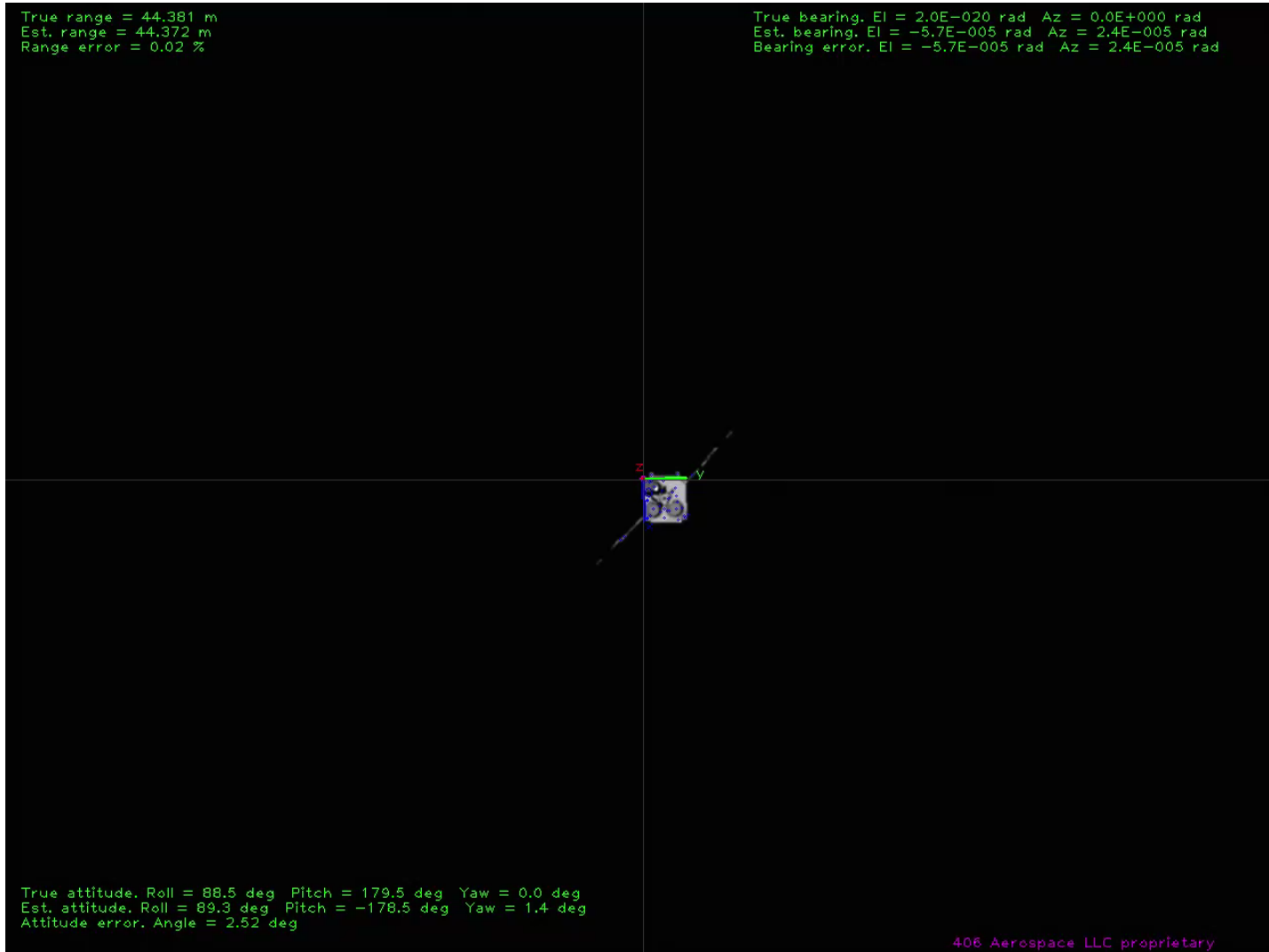
*Tyvak Nano-Satellite Systems Inc.*

- **Complex distributed ADCS/GNC system necessitated real time hardware in the loop testing**
  - Sensors and actuators simulated in real time with flight like dynamics
  - Autocoded truth and flight code enable rapid iteration and commonality between software only simulation and HITL testing
- **HITL platform operational and system is currently under test**
- **Lessons Learned**
  - HITL testing is possible for CubeSat class missions
  - HITL interfaces should be included in system and EGSE design from initial conception



# Range and Pose Determination Simulation

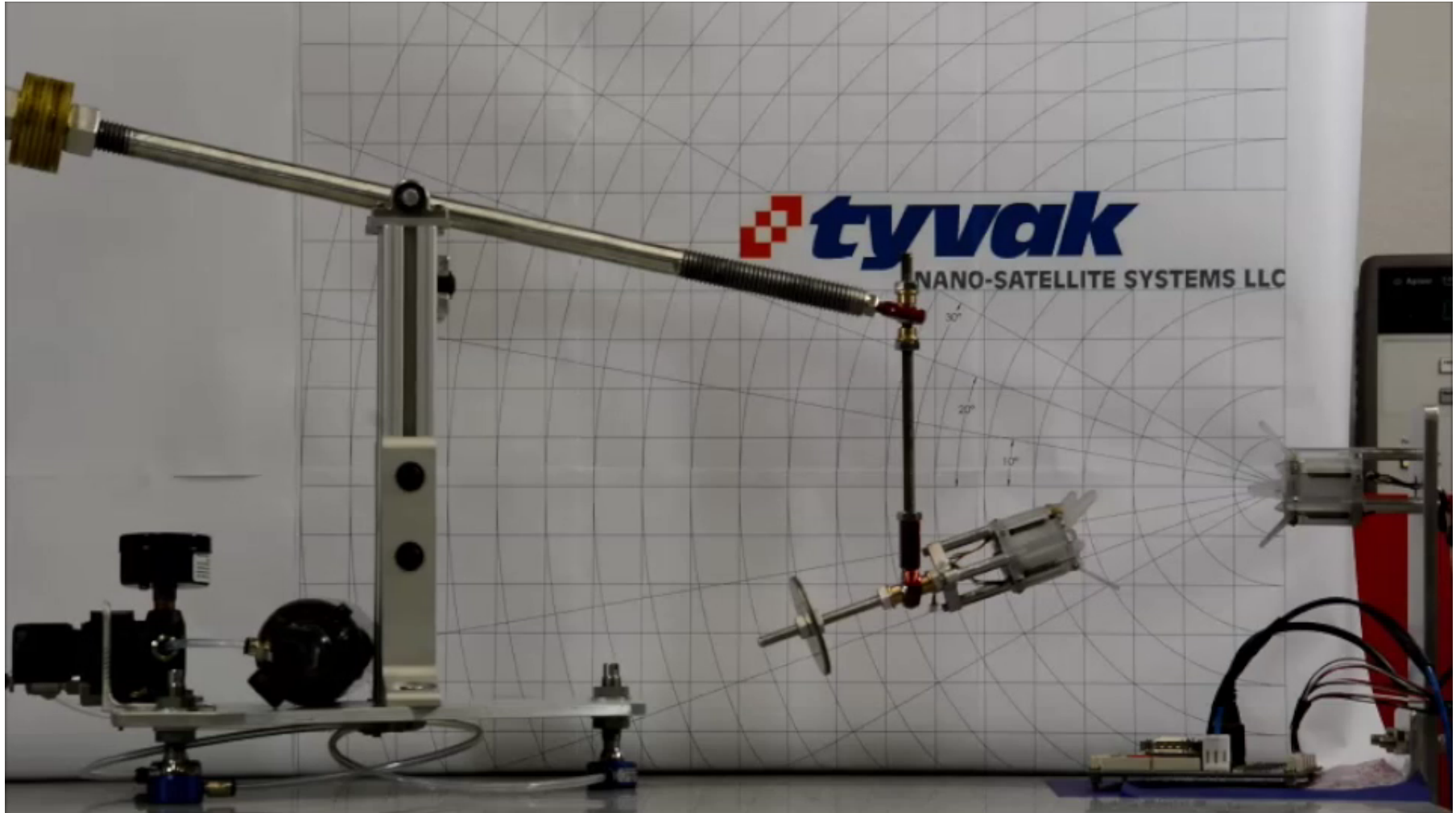
*Tyvak Nano-Satellite Systems Inc.*





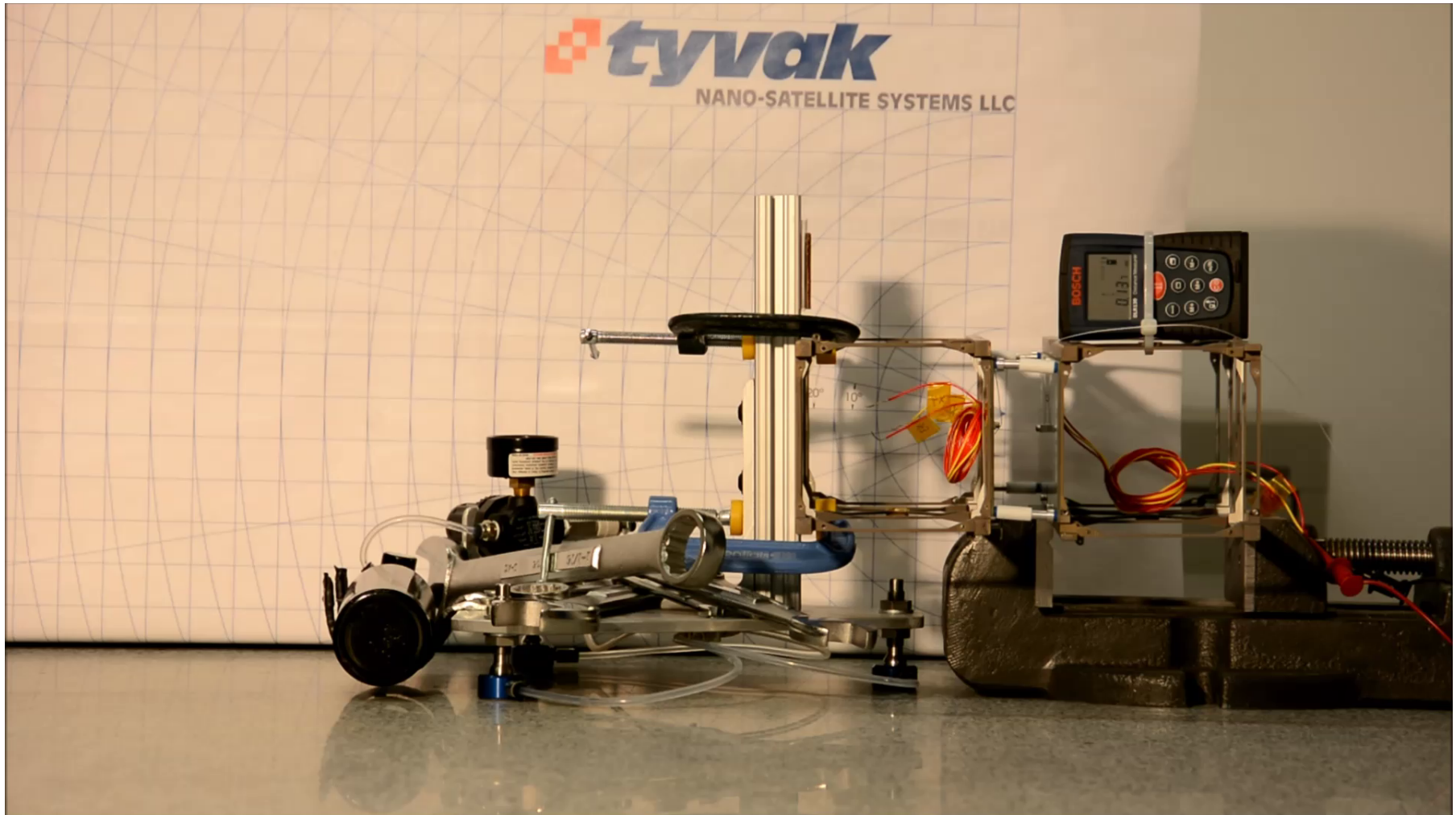
# Air Table Testing (Video) – Docking Mechanism Alignment

*Tyvak Nano-Satellite Systems Inc.*



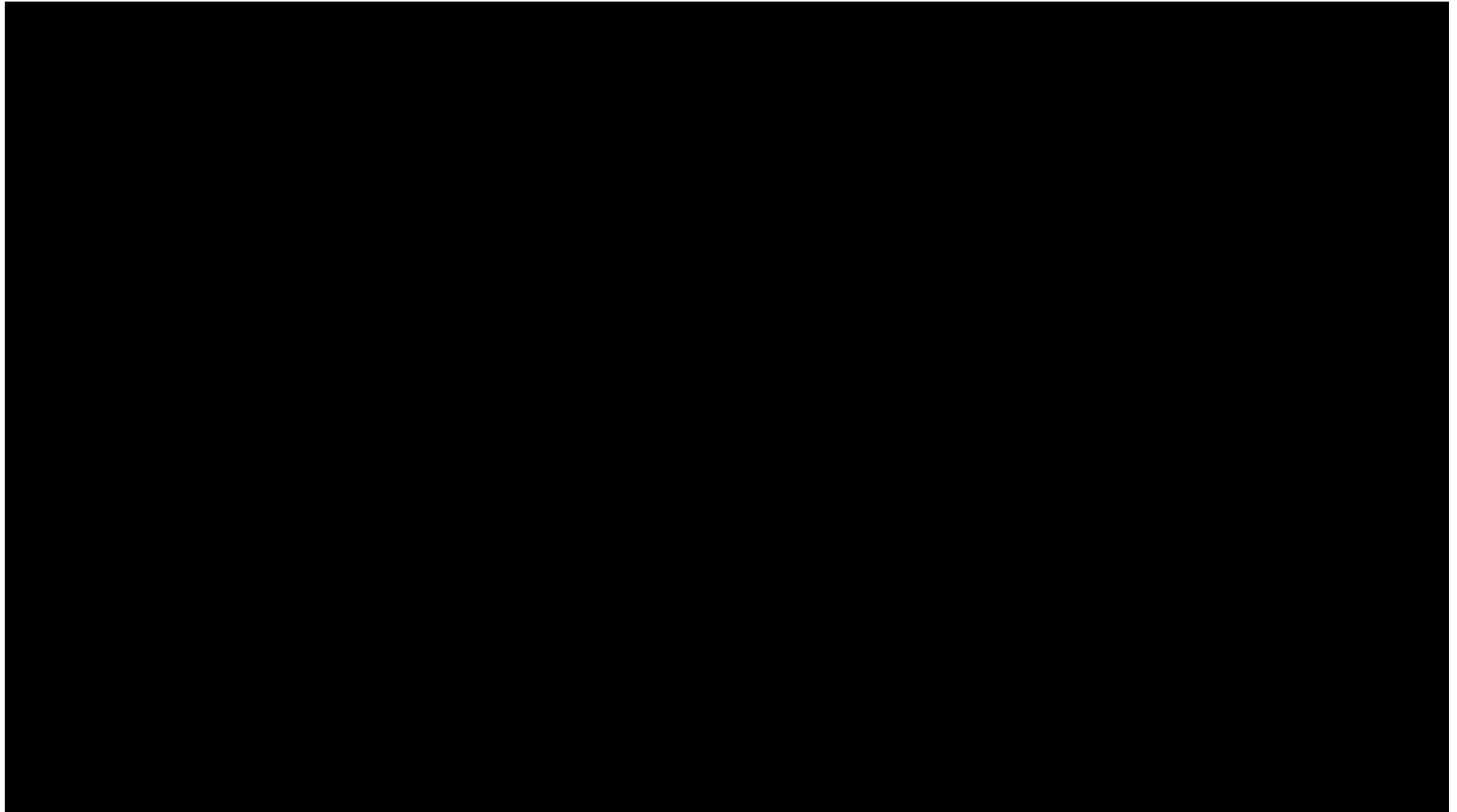
# Air Table Testing – Vehicle Separation

*Tyvak Nano-Satellite Systems Inc.*



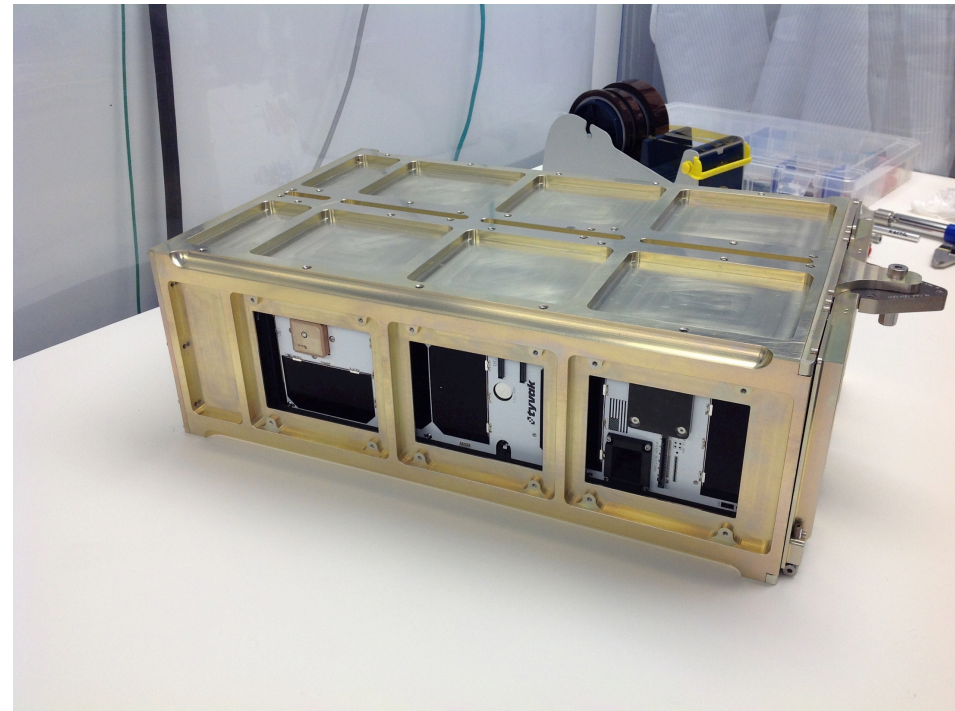
# EDU Deployable Test

*Tyvak Nano-Satellite Systems Inc.*



# Development Status

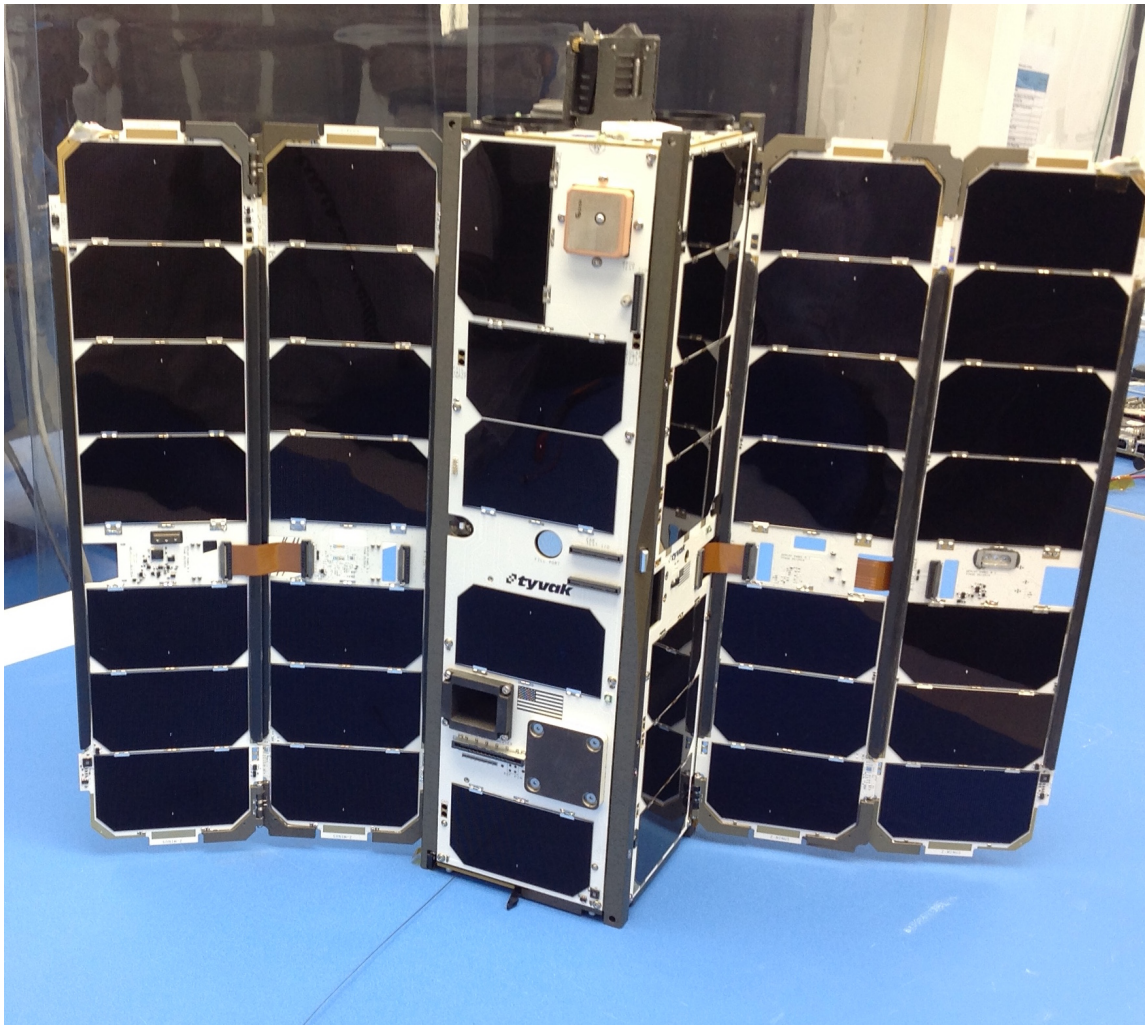
- **EDU vehicle assembled and undergoing final system functional tests**
  - **System level functional**
  - **EMI self compatibility**
  - **Vibration**
  - **Thermal vacuum**
- **Flight vehicles in assembly**
  - **Schedule margin to be used for additional mission assurance**
- **Considering multiple launch options Q1 2016**
- **Pursuing follow on missions to transition from technology demonstration to operational missions**





# CPOD Performance Summary

*Tyvak Nano-Satellite Systems Inc.*



Capability	Specification	Comments
<b>Average Power Generated</b>	~17W to 30W OAP	Polar Sun-Sync
<b>Average Load</b>	~15W	Fully Active
<b>Pointing Accuracy</b>	0.057 degrees (1 $\sigma$ )	Summation of Real World Error Sources
<b>Mission Data Downlink</b>	~60MB / day	UHF and S-Band
<b>Delta-V</b>	~30 m/s	Cold Gas
<b>Total Mass</b>	5.990kg	Wet Mass (13% Margin)

**Questions?**