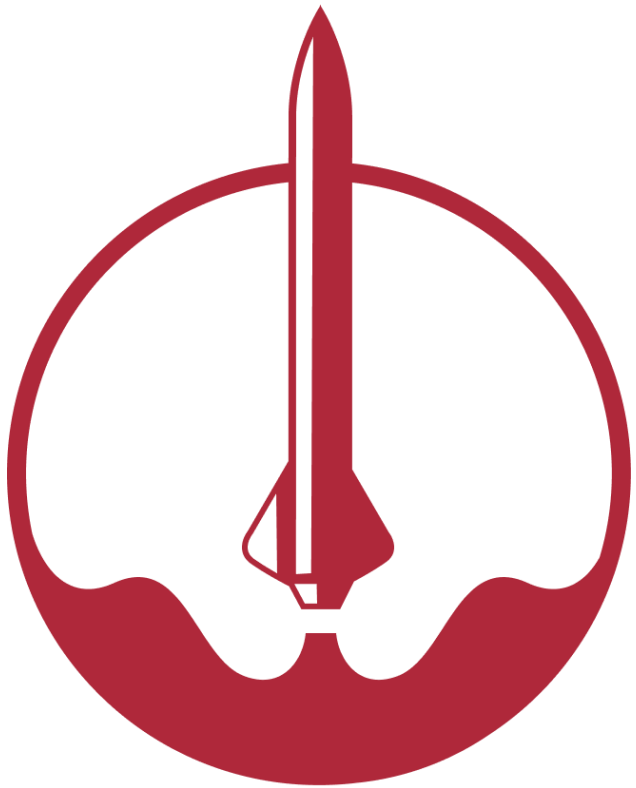
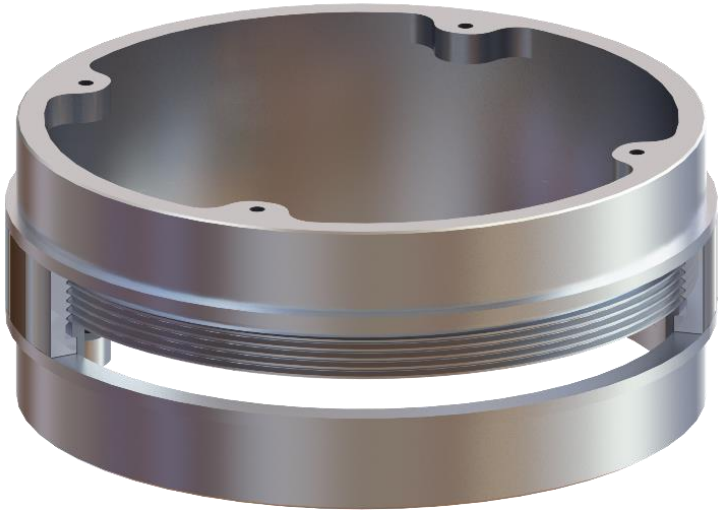
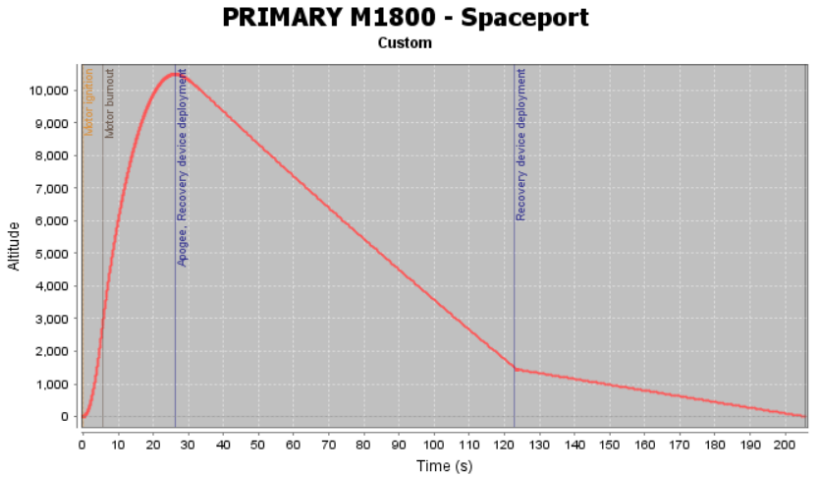
# Development and Verification of Threaded Airframe Joints

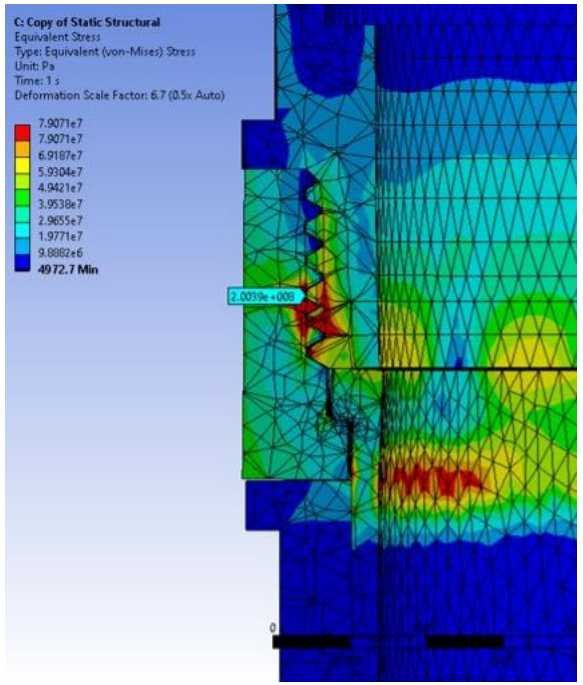
Worcester Polytechnic Institute
High Power Rocketry Club



# Presentation Breakdown






**Mechanical Design** → **Flight Conditions** → **Simulation and Testing**

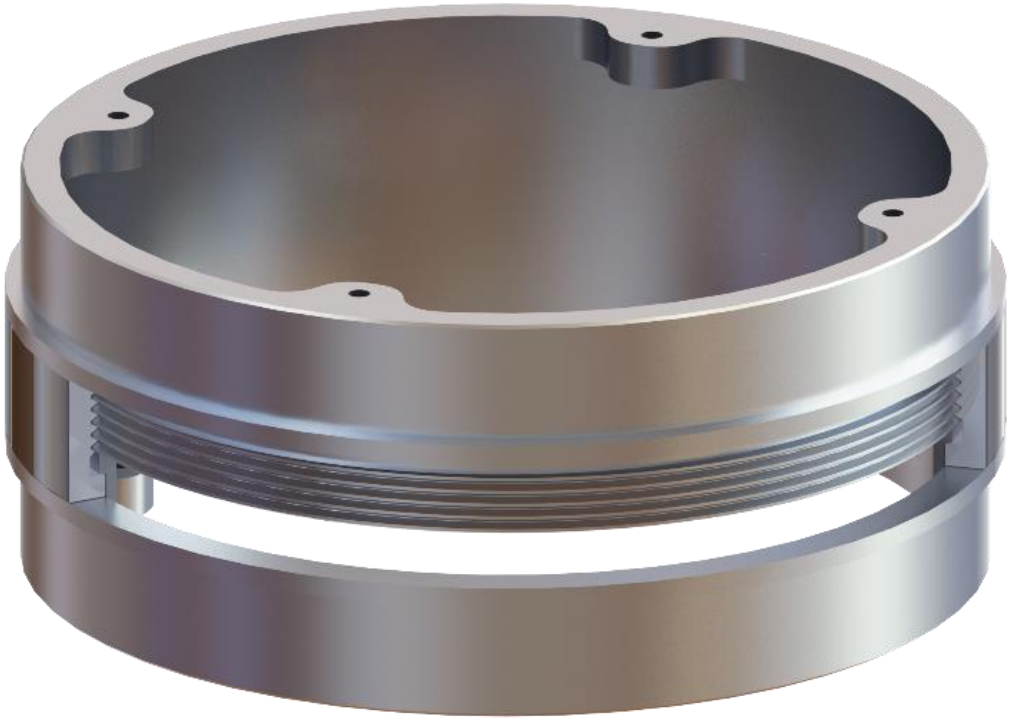
# Mechanical Design

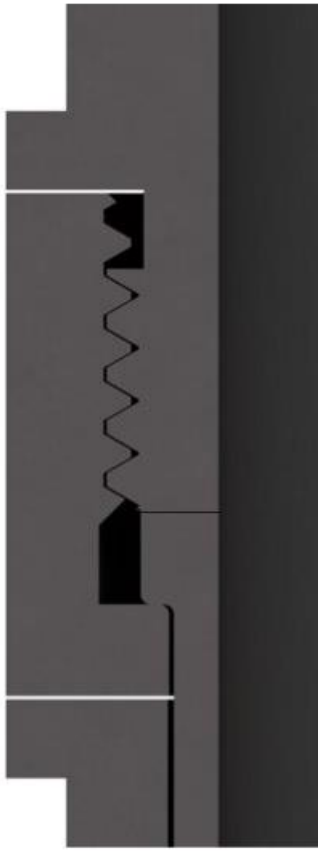
# Problem

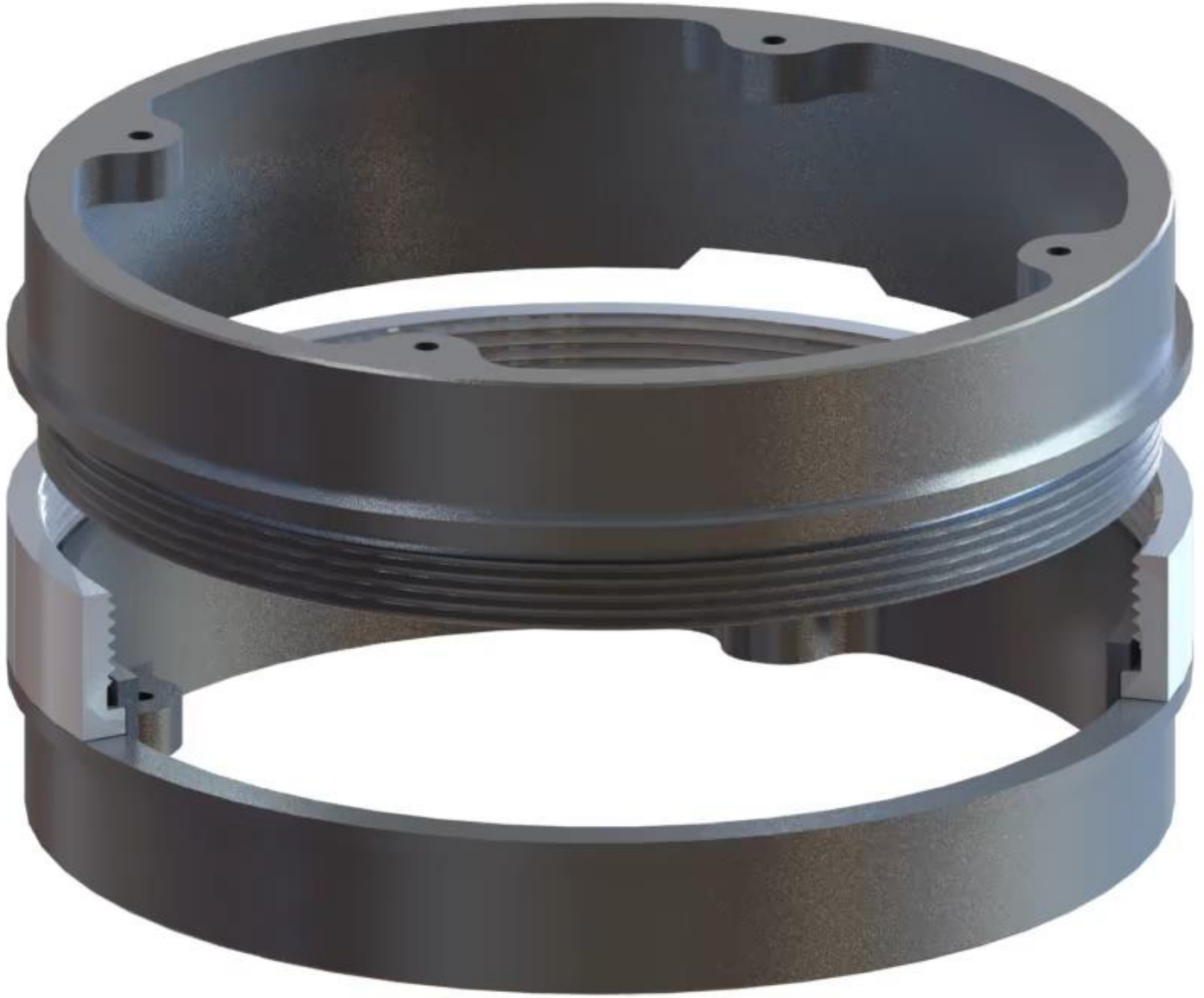
- Coupler tube joints are…
  - Difficult to assemble
  - Bendable
  - Heavy
- Develop an airframe joint that solves the downsides of coupler tube joints

# Coupling Mechanical Design

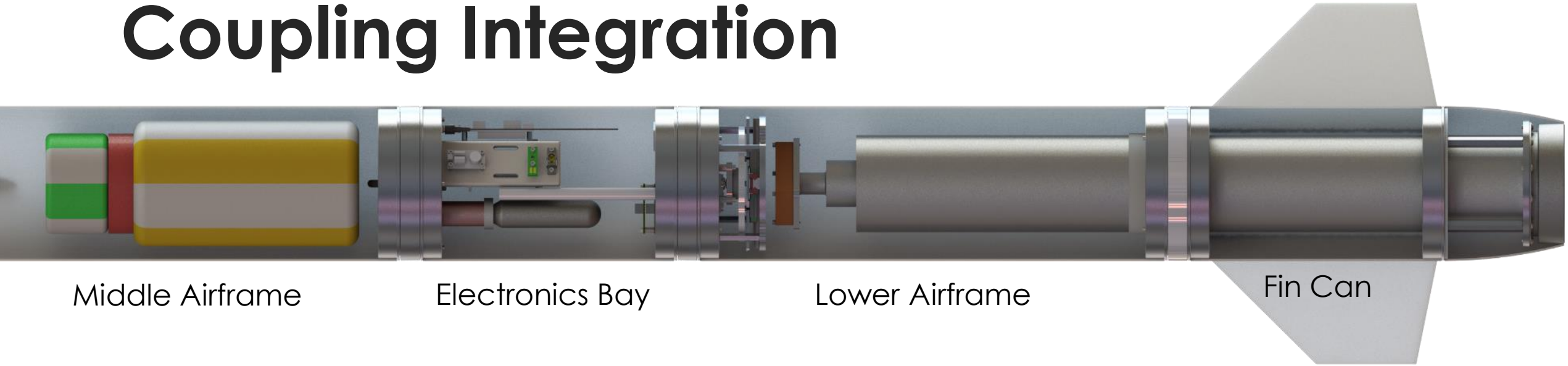
- Captive nut for threaded joints
- Low-profile and lightweight design
- 4-part aluminum joint
- Alignment tooth guarantees correct orientation







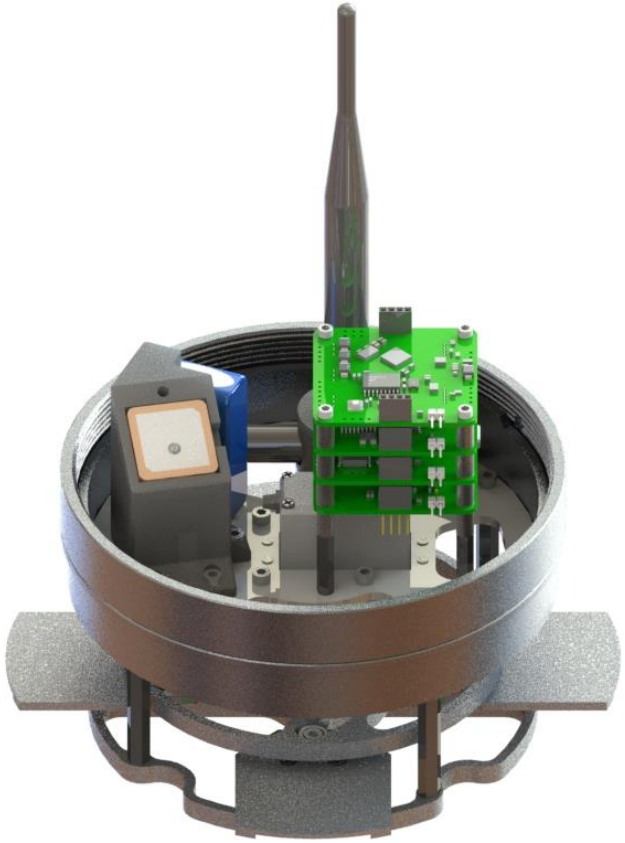
# Coupling Integration




- 3 Coupling Joints
- Connected to fiberglass body tubes via methyl-methacrylate structural adhesive

# Standardized Mounting

Electronics Bay

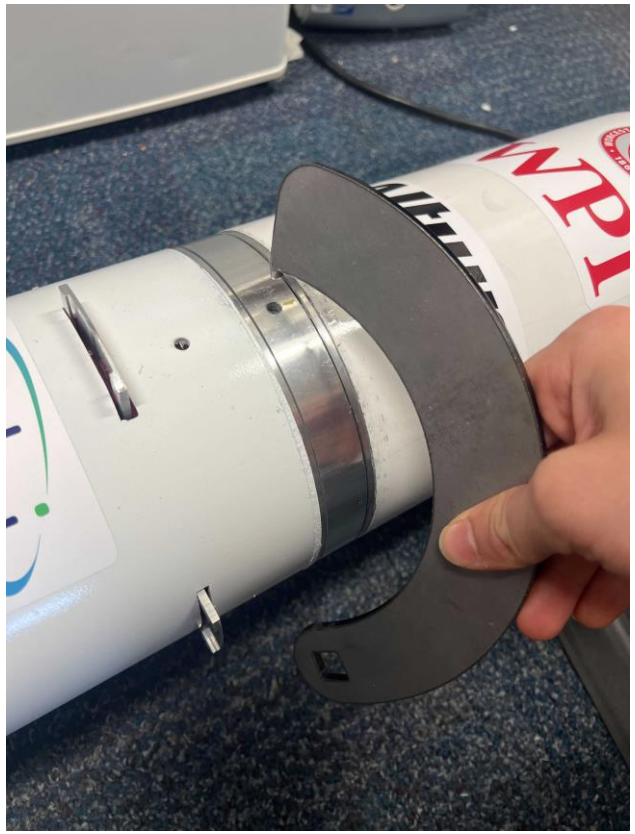


Airbrakes Module

- #8-32 bolt holes (x4)
- Modular

# Ease of Assembly

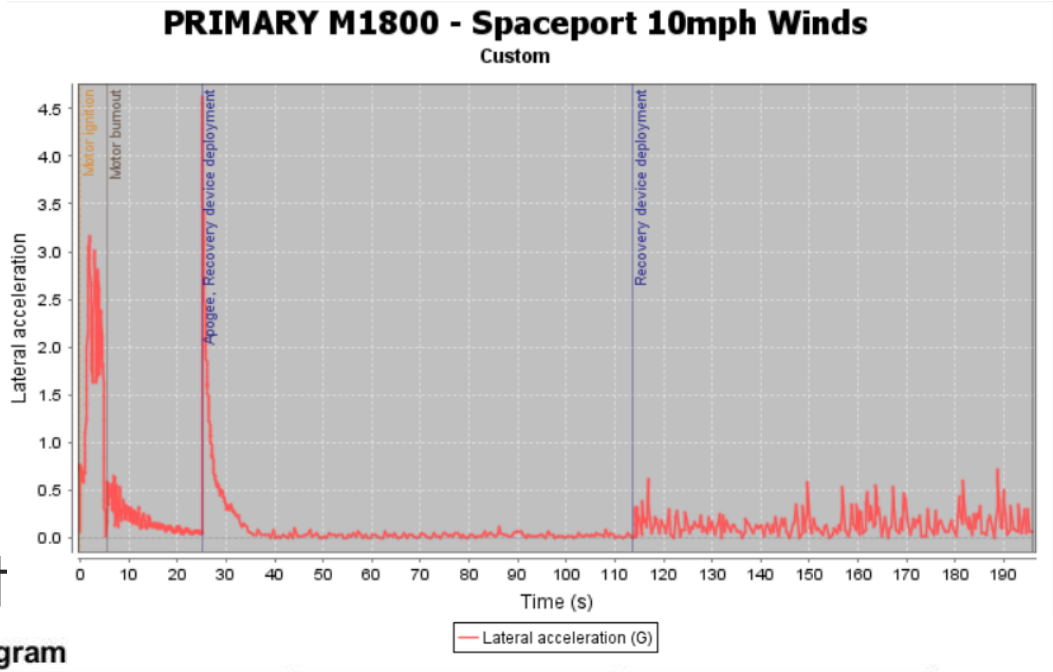
- Assembled with a torque wrench to guarantee consistent preload
- Allows for faster disassembly in adverse conditions

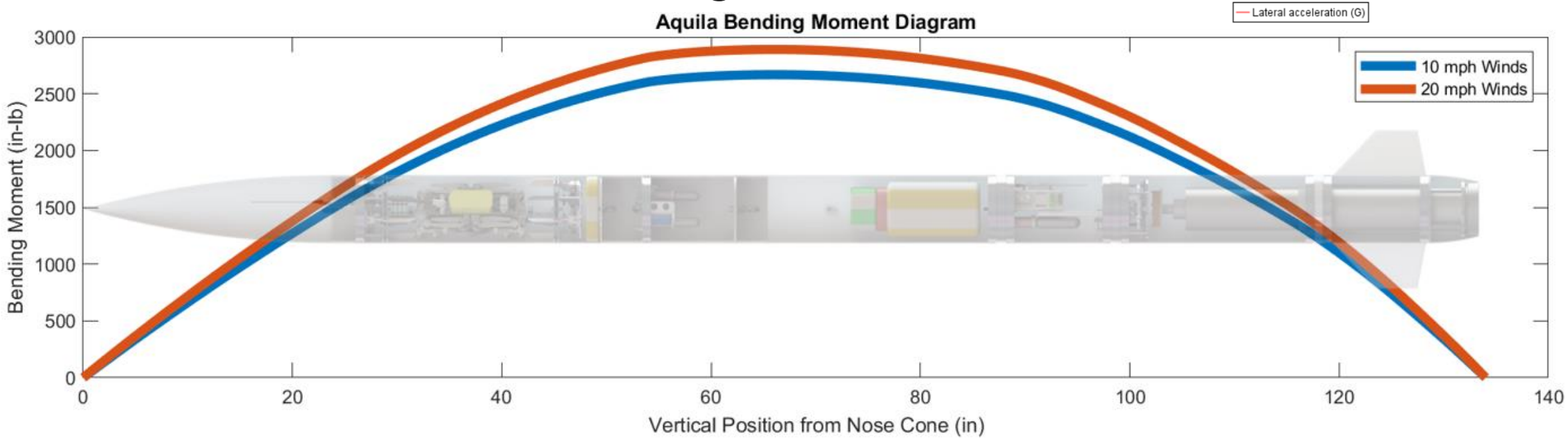


# Flight Conditions

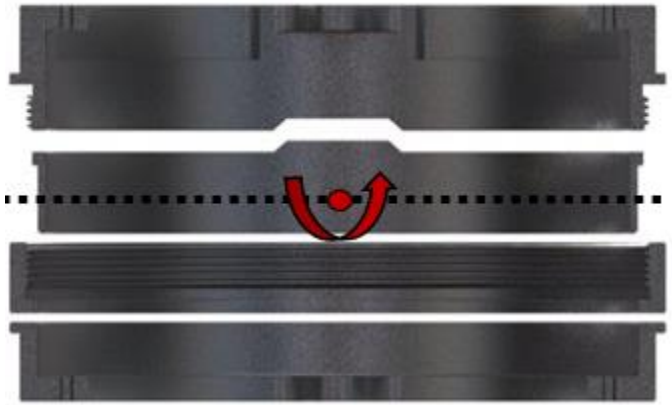
# Airframe Flight Loads

- Nominal flight: 10 mph winds
- 3Gs of Lateral Acceleration
- Maximum 2667 in-lb bending moment

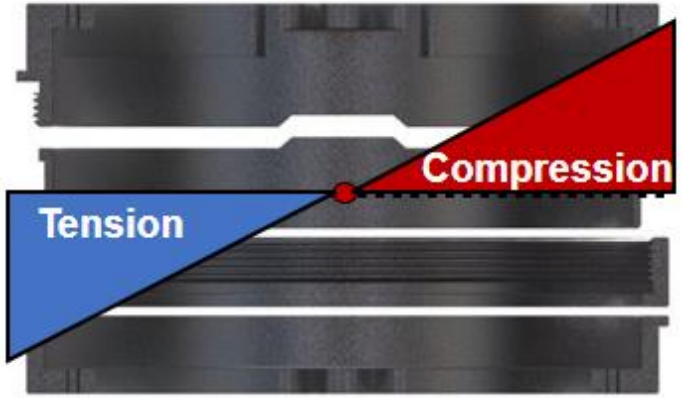


# Joint Rigidity: Preload

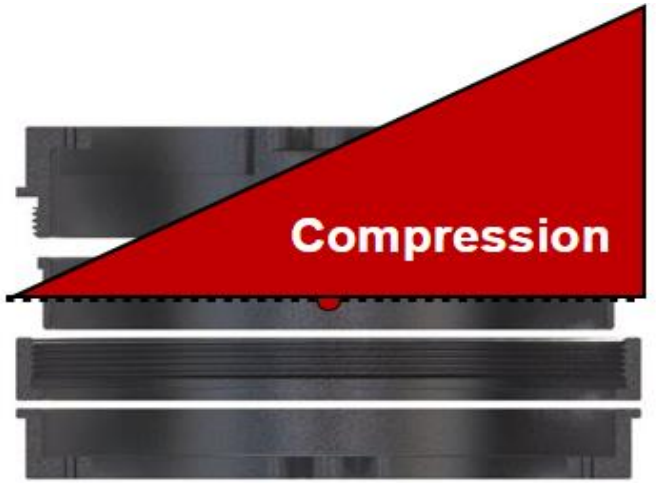


1)Bending Moment applied to joint




2)Bending Stress


3)Bolt Preload Compressive Stress

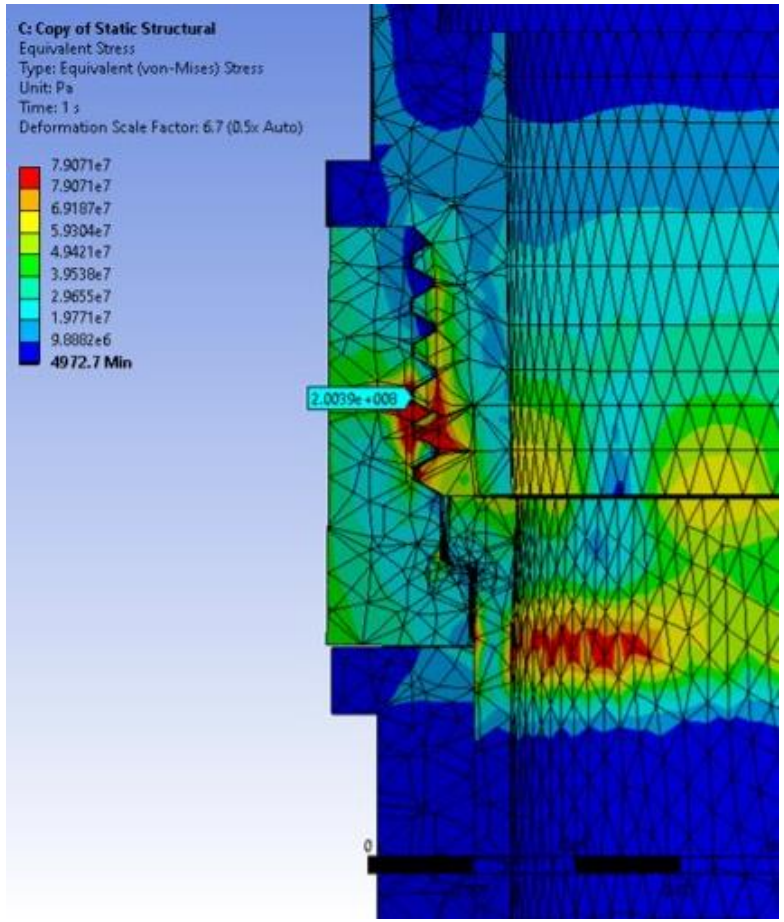



4)Resultant Preload + Bending Stress

# Simulation and Testing

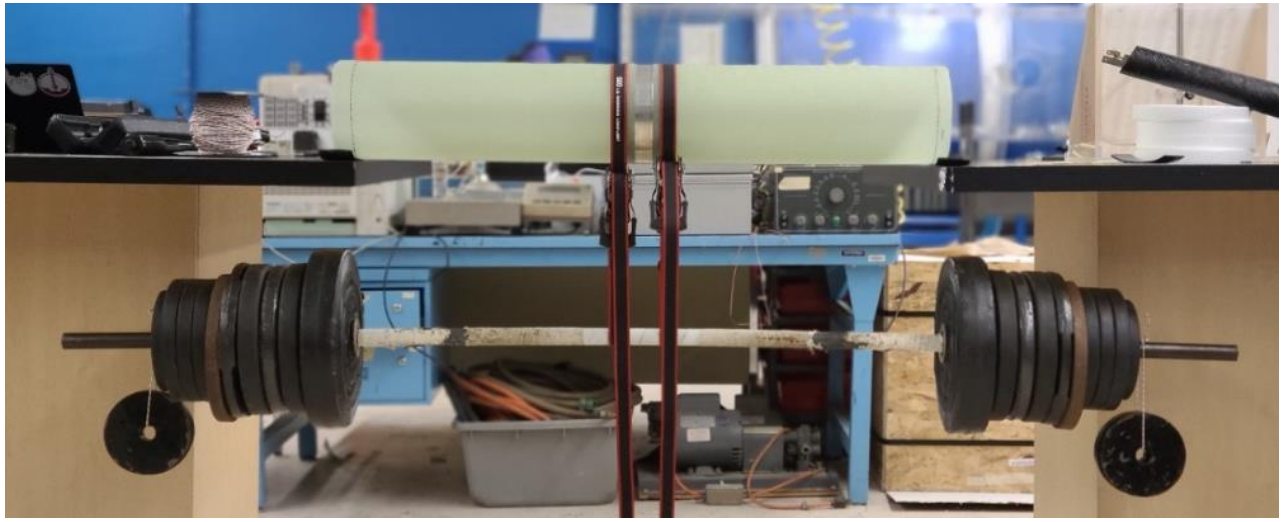
# Simulation and Verification

- Ansys Static Structural Simulation
- Simulated flight loads of 2667 in-lb with required bolt preload
- Safety Factor: 5.34
- Failure Mode: Bending of inner retaining ring flange



# Physical Testing

- 3-point flexural test
- Joint tested to nominal flight loads
- Load placed to emulate sim-accurate moment



# Final Assembly

| Quality | Standard Coupler Tube | Novel Couplings |
|---|---|---|
| Ease of Assembly | ~ 3 min | ~ 0.6 min |
| Joint Rigidity | None | Preloaded Joint |
| Ease of Manufacturability | COTS | 200 min cycle time |
| Weight | 2.52 lbs* | 1.75 lbs |
| Length | 12” | 2.555” |
| Cost of Materials | $85* | $120 |

* Previous Design

# Faster. Stronger. Better.

# Thank you