Airbrake Integration

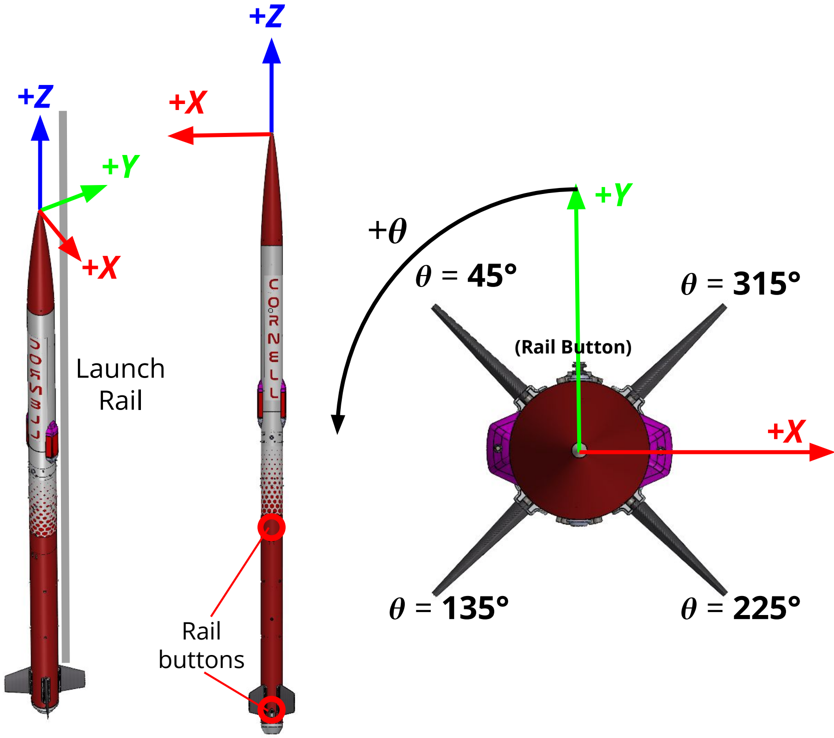
Final Design Review
Saturday, November 15, 2025
Langston Johnson

Address Action Items from IDR

- Action Items from IDR
  - Bulkhead Mass Reductions
    - Ansys to Verify
  - Electrical Pass Through
    - Using Notches Instead of Amphenol Pass Throughs
    - Bottom Bulkhead No Longer Sealed
  - Mechanism Integration
    - New Motor Retaining Ring
    - Lintech Rail Integration
    - Mechanical Clearances

CRT Launch Vehicle Frame

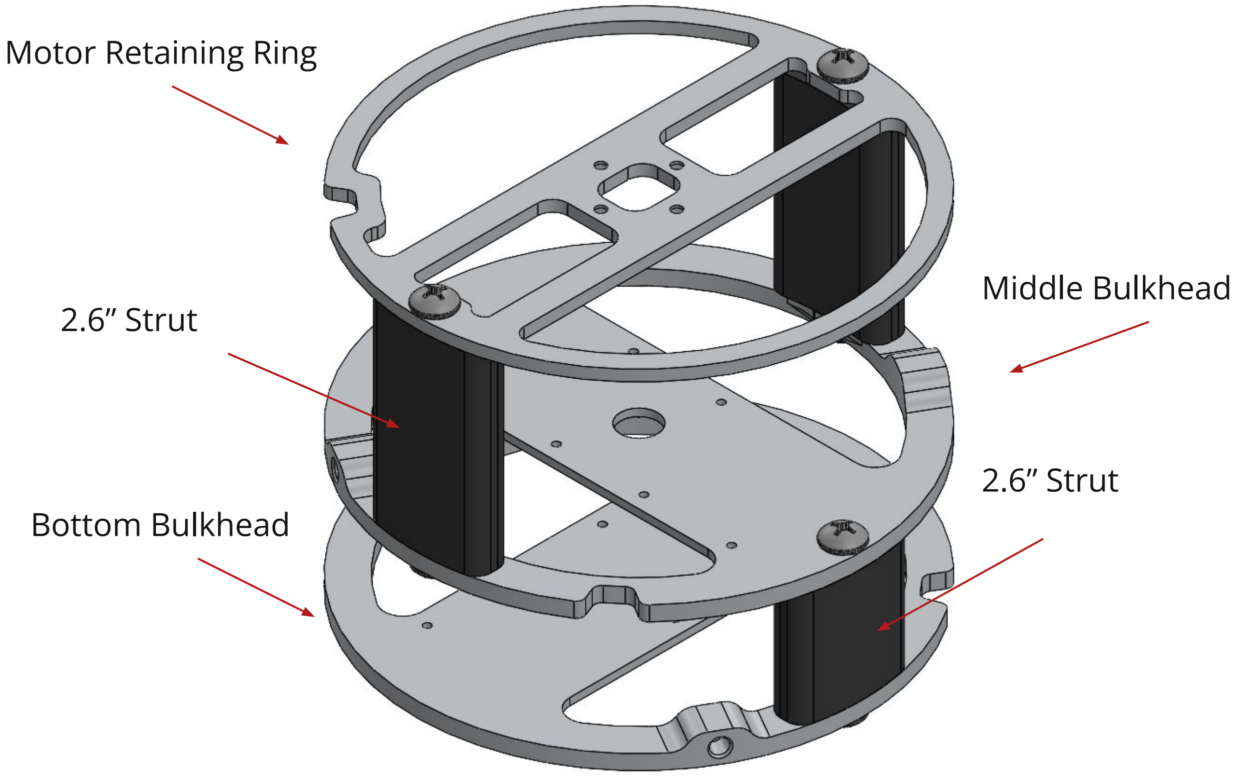
- The CRT LV frame is a right handed Cartesian coordinate system located at the theoretical nose termination (TNT), or tip of the nose cone.
- The orientation of this coordinate system is based on the position of the launch rail prior to lift off, with rail buttons located in line with ***+Y*.**
- The ***+Z*** axis points forward out of the nose of the vehicle.
- The ***+Y*** axis points outward in the direction of the rail buttons and launch rail.
- The ***+X*** axis is rotated 270° in the ***+Z*** direction from ***+Y***, completing a right handed coordinate system.
- The angle θ is defined as the angle counterclockwise from the ***+Y*** axis when viewed from the ***+Z*** direction.
- To aid with LV integration, subsystem CAD assemblies should be oriented to fit this coordinate system in Solidworks.



System Overview

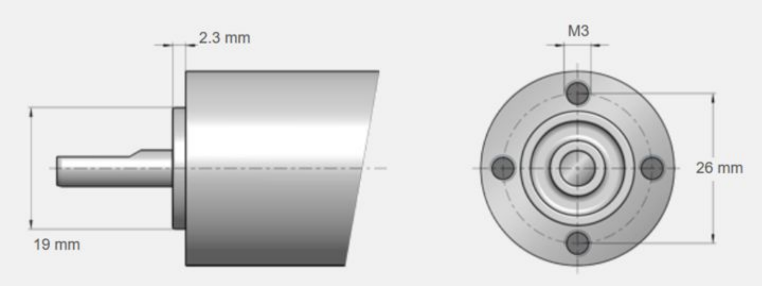
- Parents: Launch Vehicle (LV)
- Airbrake Mechanism
- Function: Transfer Aerodynamic Load from Airbrakes to LV

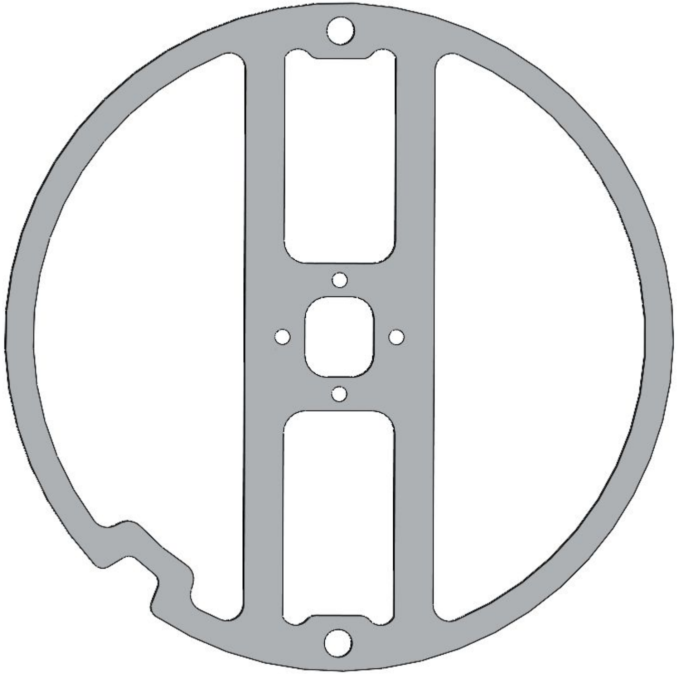
System Overview



Motor Retaining Ring

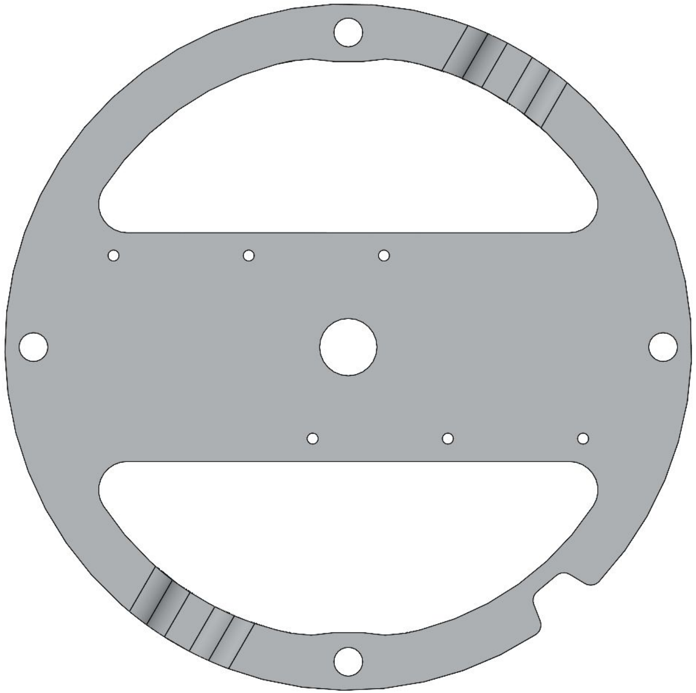
Updated Holes - ECX Flat 32S
Notch 140° CCW from y+
Mass: .145 lbs





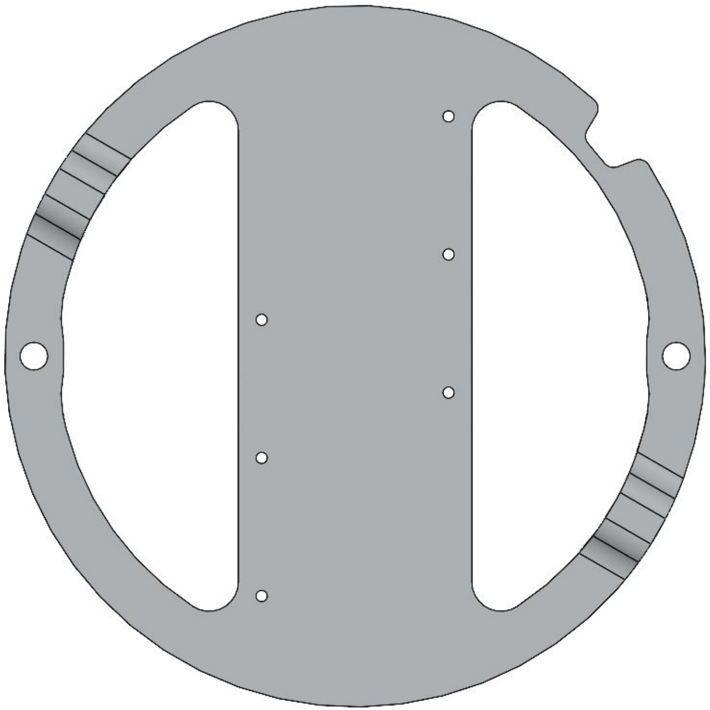
Middle Bulkhead

Lintech Rail 14.mm spacing
Axel Pass Through
Notch 220° CCW from y+
Mass: .267 lbs
Outer thickness: 0.2”
Base Thickness: 0.1”



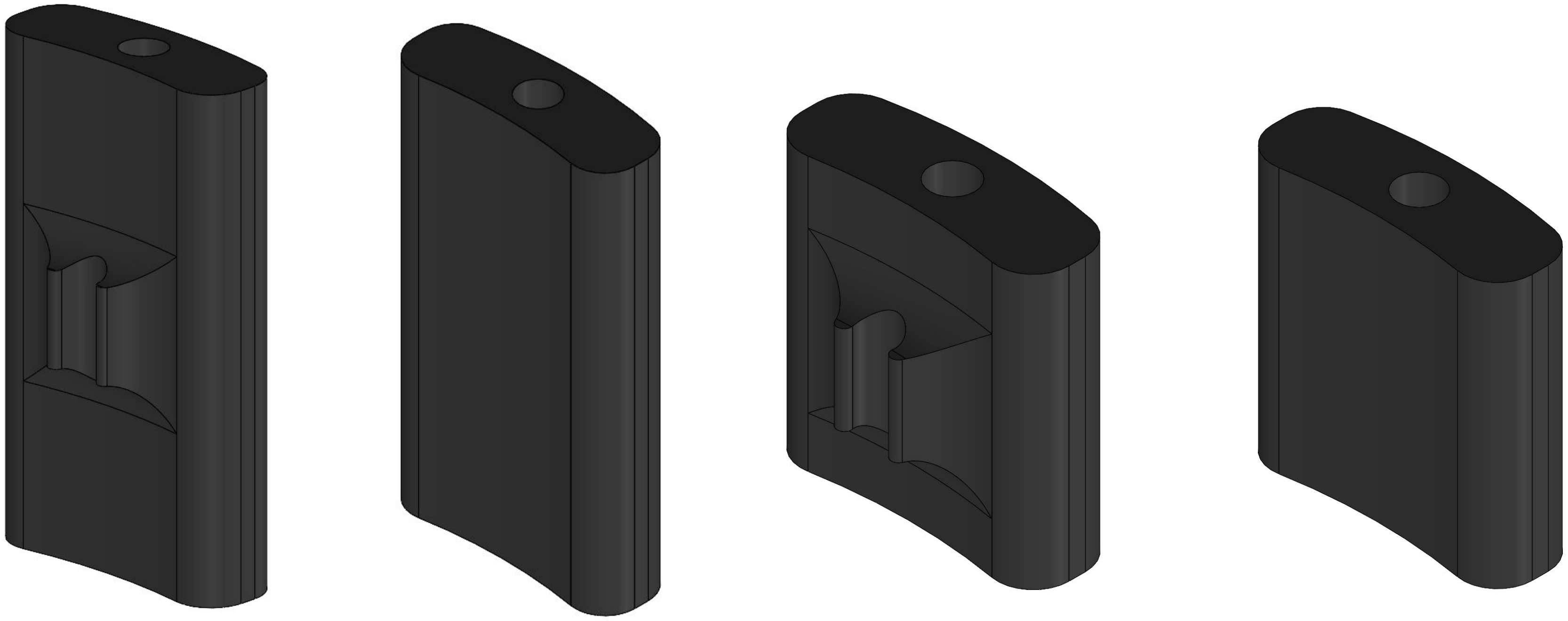
Middle Bulkhead

Lintech Rail [14.mm](14.mm) spacing
Not Sealed
Notch 220° CCW from y+
Mass: .27 lbs
Outer thickness: 0.2”
Base Thickness: 0.1”



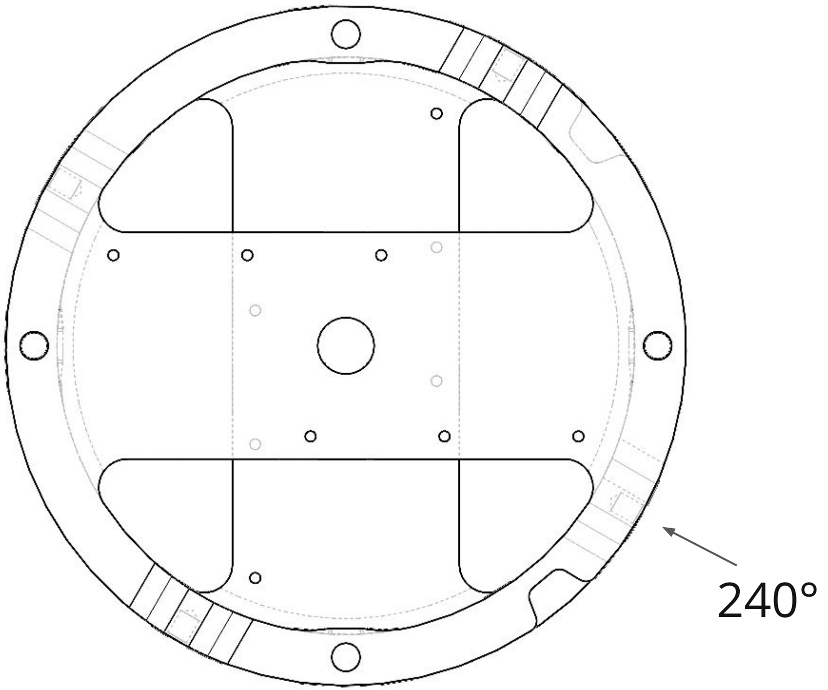
PETG Struts

1.6” and 2.6”



Clocking

- Bottom Right Hole 240° CCW from y+
- Holes are clocked 90° relative to one another
- Clocked to maximize the distance from the fastener hole and the airbrake apertures, without interfering with struts and electrical pass through.



Bill of Materials

Airbrake Integration Bill of Materials								
Product	**Link**	**Vendor**	**System(s)**	**Package Quantity**	**Quantity per Package**	**Package Price**	**Total Price**	**In Stock ?**
Brass Tapered Heat-Set Inserts	Link	McMaster	Struts	1	25	$15.76	$15.76	Y
Black-Oxide 18-8 Hex Pan Head Phillips Screws	Link	McMaster	Struts	1	50	$16.61	$16.61	Y
¼-20 Key Inserts		Mc Master	Bulkheads	1	4	$3.51	$14.04	Y
PETG Filament					On Hand			Y
6” Round Stock								

Requirements + Verification Plan

- See System Requirements Review document here
- The LV and the Payload have functional requirements for successful flight and mission. The linked document lists requirements mandated by the competition.
- FULLY review all LV and Payload competition and determine which requirements apply to you.
- Provide a table of the requirements and verification plans that apply to your system in the FDR presentation. Make sure to include the tests you intend to conduct.

Requirements + Verification Plan

Launch Vehicle Requirements		
Requirement	**Verification Plan**	**Verified? (T/F)**
SYS 1 All components on the LV that interface with the airframe shall have at least .005" clearance with the ID of the airframe	Design. Integration	T
SYS 4 Structural components shall be designed to a minimum MoS of 0.5. (Designed to Mos of 1.5)	Design, Ansys	T
STRUC 2 Launch vehicles shall be constructed to withstand the operating stresses and retain structural integrity under the conditions encountered during handling as well as rocket flight.	Design, Ansys. Stand on it.	T

Failure Mode Effect Analysis

Failure Mode Effects Analysis (FMEA)						
Hazard	**Causes**	**Effects**	**Mitigation Plan**	**Verification Plan**	**Risk Level**	**Verified? (T/F)**
Bolt Shear/ Deform during flight	Excess aerodynamic load Manufacturing defects	Mechanism fails to deploy Possible airframe structural failure	-Hand Calcs -Structural Analysis	Manual Testing. Applying Axial Loads	Low	T
Electrical Passthrough Difficulty	Overly stiff wiring / strain Incorrect bend radius	Damage during integration Higher assembly time	CAD routing refinement Add strain relief	Routing Test	Medium	F
Mechanism Integration Difficulty	Misaligned mounting holes Inaccessible screws	Excessive integration time Incorrect assembly	CAD Tolerancing	Integration	Low	F

Safety Hazards

It’s completely safe :D

Fill in this chart for your system.

Safety Hazards

Safety Hazards						
Hazard	**Causes**	**Effects**	**Mitigation Plan**	**Verification Plan**	**Risk Level**	**Verified? (T/F)**
Sharp Edges During Assembly	Improper deburring of CNC / 3D printed parts	Physical Harm	Deburr & chamfer all edges	Visual inspection	Low	F
Heat Insert Installation	Hot	Burn	Lock tf in	<=	Low	F

Fastener Calcs

Fastener: Black Oxide: ¼” 20.
Maximum Aerodynamic Load +System Mass: 142.6 lbf

1x Screw can support the maximum loading experienced by the system with a FoS of 34.7.

x4 Fasteners

Black Oxide Alloy Steel

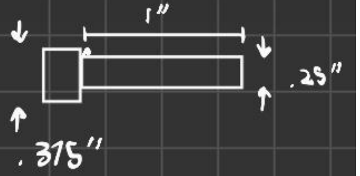
$\sigma_u = 170$ ksi

$\tau_u = (.6)\sigma_u = 102$ ksi

$A = \pi\left(\frac{.25}{2}\right)^2 = \frac{\pi}{64} \approx 0.05\ in^2$

$V_{max} = \tau_u A$

$V_{max} = \underline{5007\ lbf}$



Integrated Load Bearing Structural Analysis

- Estimated max load is around 620 (aerodynamic drag at MAV close), testing with FOS = 2.5, so loading with 1550 N ramped with 7075-T6 bulkheads

AL 7075-T6 [FIXED]

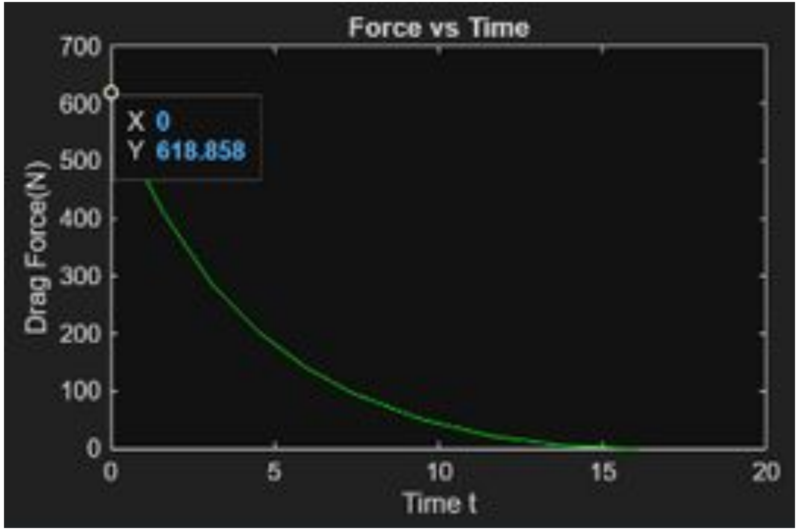
"Equation of State and Strength Properties of Selected Materials". Steinberg D.J. LLNL. Feb 1991

Density	2804 kg/m³
Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	7.17e+10 Pa
Poisson's Ratio	0.33
Bulk Modulus	7.0294e+10 Pa
Shear Modulus	2.6955e+10 Pa

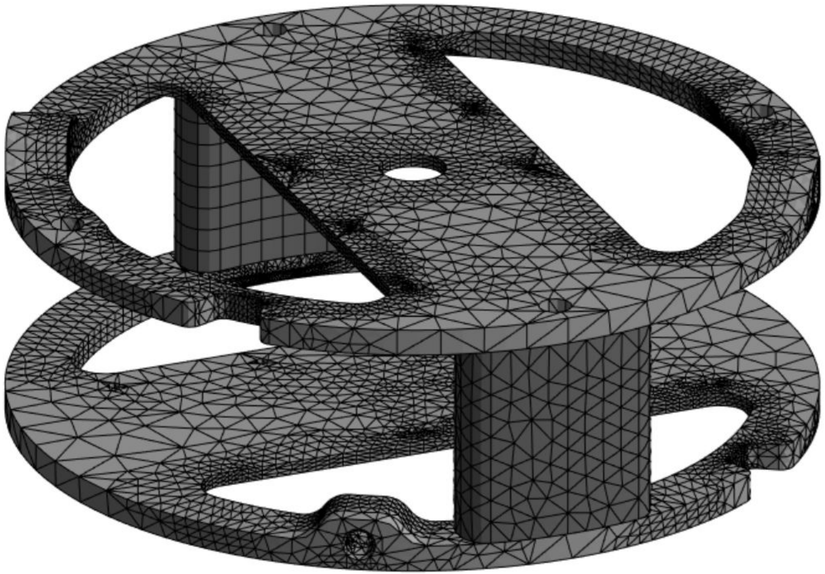
PETG

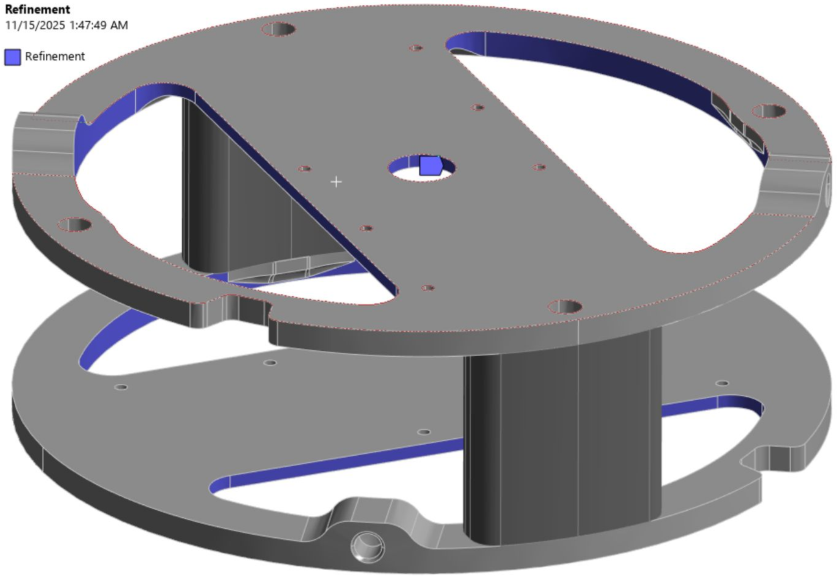
Rough Approximation of PETG

Density	1270 kg/m³
Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	2.4e+09 Pa
Poisson's Ratio	0.4
Bulk Modulus	4e+09 Pa
Shear Modulus	8.5714e+08 Pa

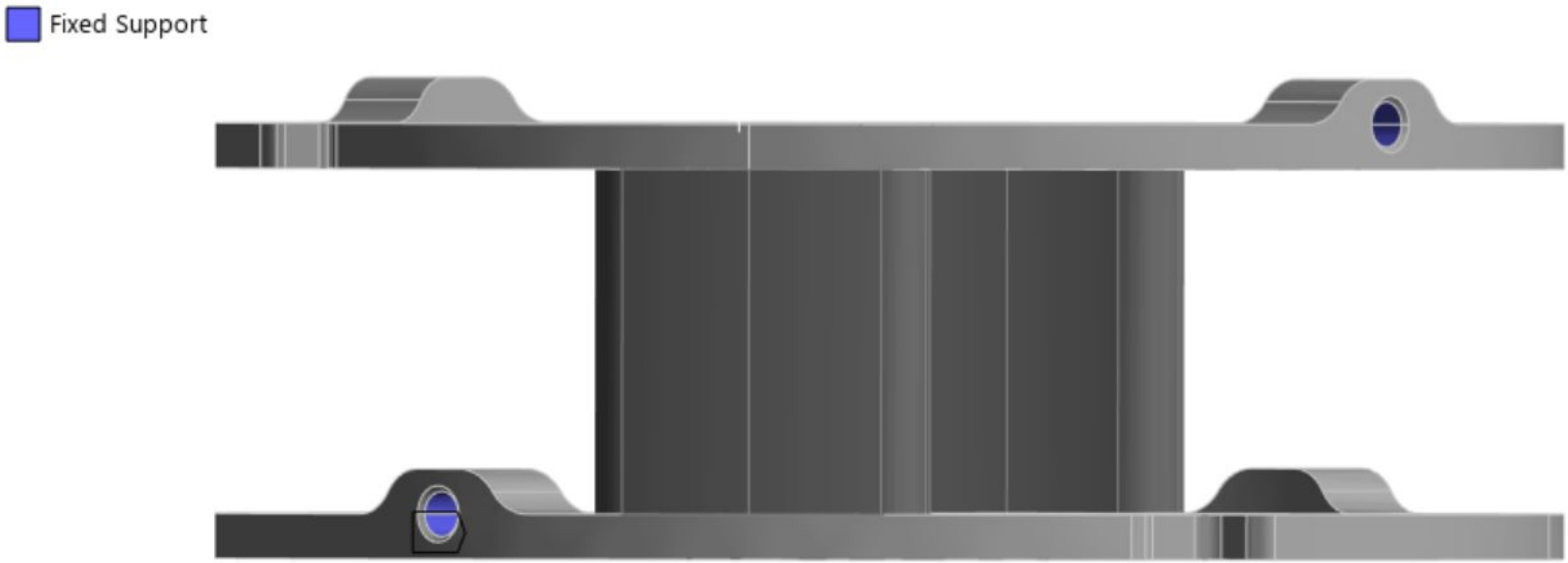


Integrated Load Bearing Structural Analysis

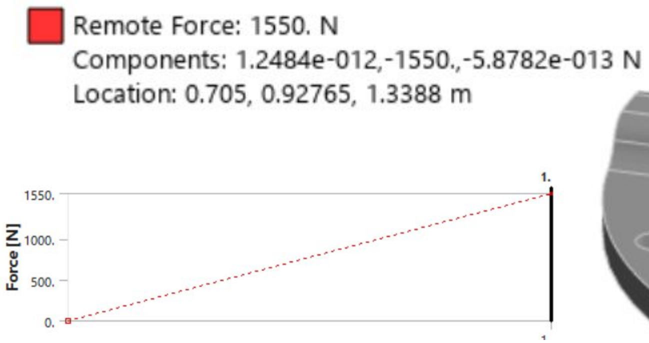


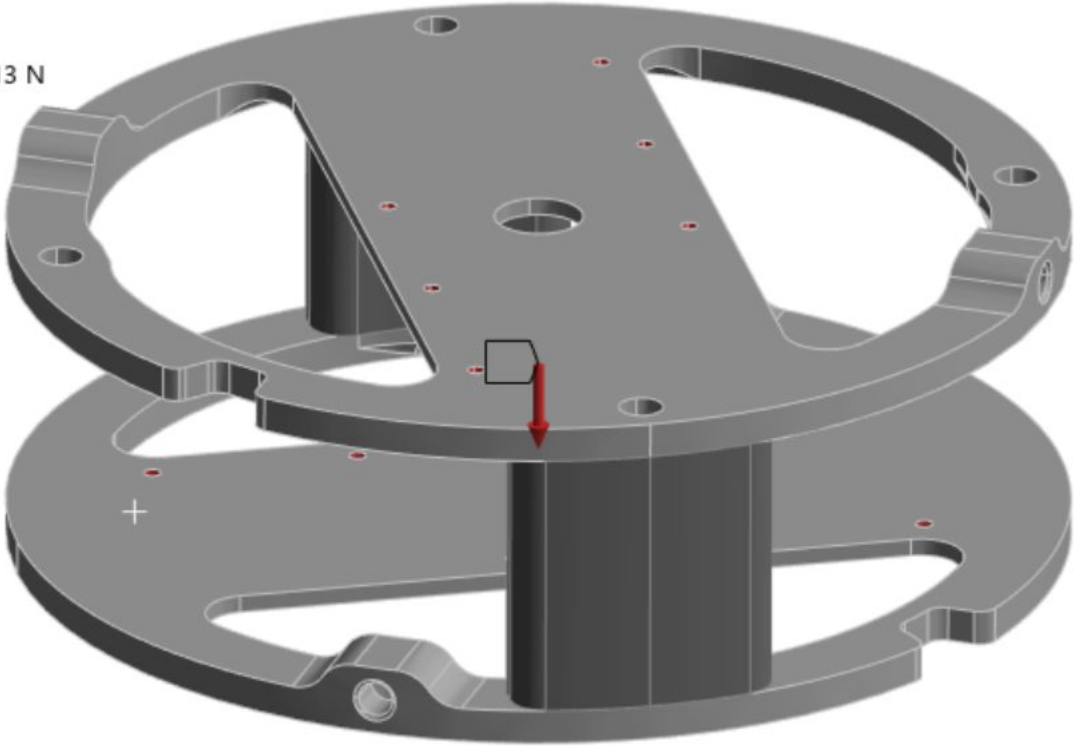


Integrated Load Bearing Structural Analysis



Integrated Load Bearing Structural Analysis



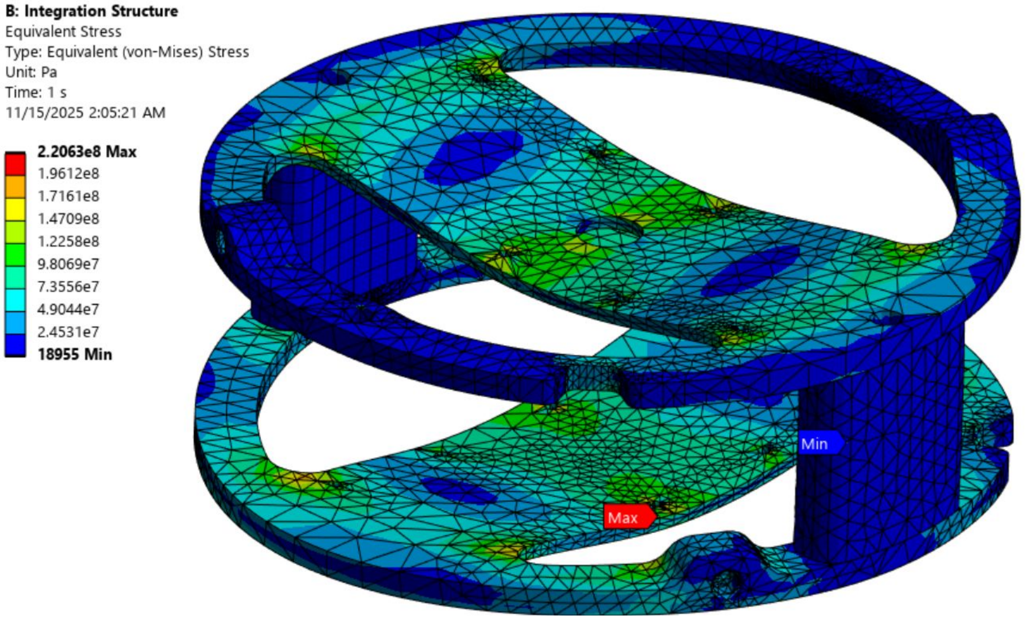


Adding Force where rails transmits load to bulkheads

Integrated Load Bearing Structural Analysis

Maximum Eq Stress(7075): 2.2MPa MoS: 227 (σ_y= 503 MPa)

With FoS 2.5 Loading



Manufacturing Plan (Machining)

Composites						
Part Description	**Quantity**	**Prereqs**	**Machine**	**Time (hours)**	**Status**	**Responsible Engineer**
Motor Retaining Ring	1	CAM	Haas	6	Incomplete	Johan K
Middle Bulkhead	1	CAM	Haas 4th axis?	7	Incomplete	Johan K
Bottom Bulkhead	1	CAM	Haas 4th axis?	6.7	Incomplete	Johan K

Testing Plan

- Airbrakes Mechanism Integration is primary test
- Then electrical pass through
- For Strength testing axial compression of the loading bearing sub-assembly

Next Steps

- Finalize remaining integration hurdles with mechanism
- Confirm wire bend radius is feasible
- Integration Meetings during the next few airbrake standing meets