3 Month Progress Update

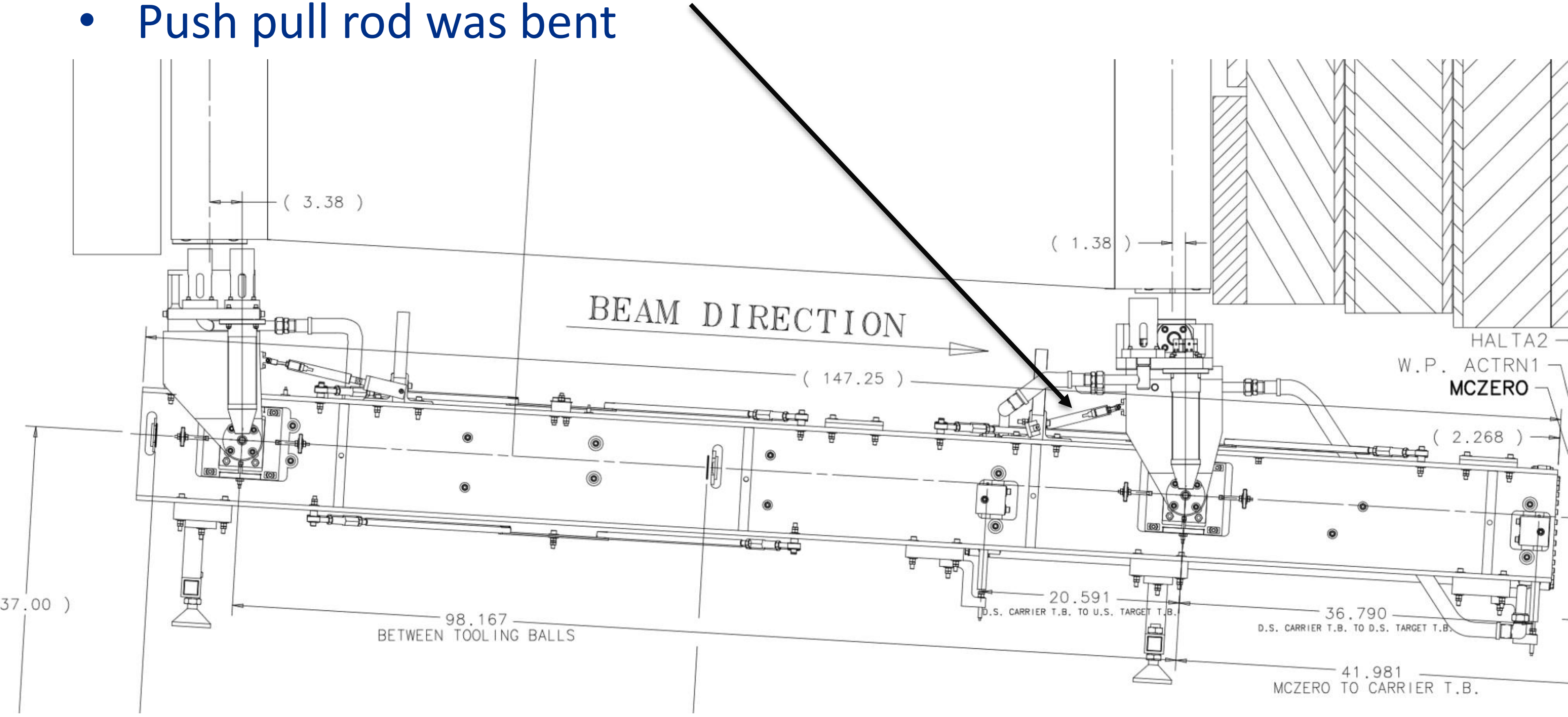
G. Lolov

TSD Meeting

13 December 2018

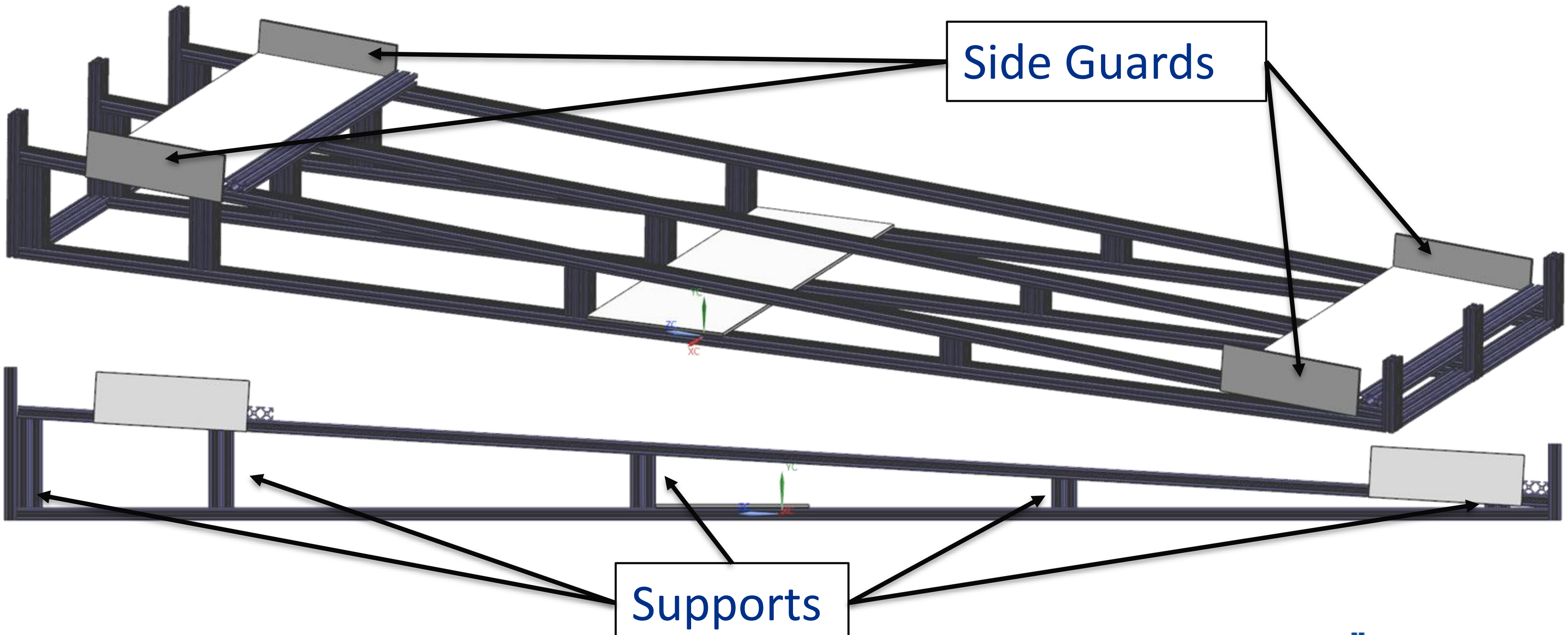
NOvA Installation Issues Recap

- Issue with push pull rod, plunger was hitting the stop
- Hanger couldn't align correctly with draw bar on module
- Push pull rod was bent



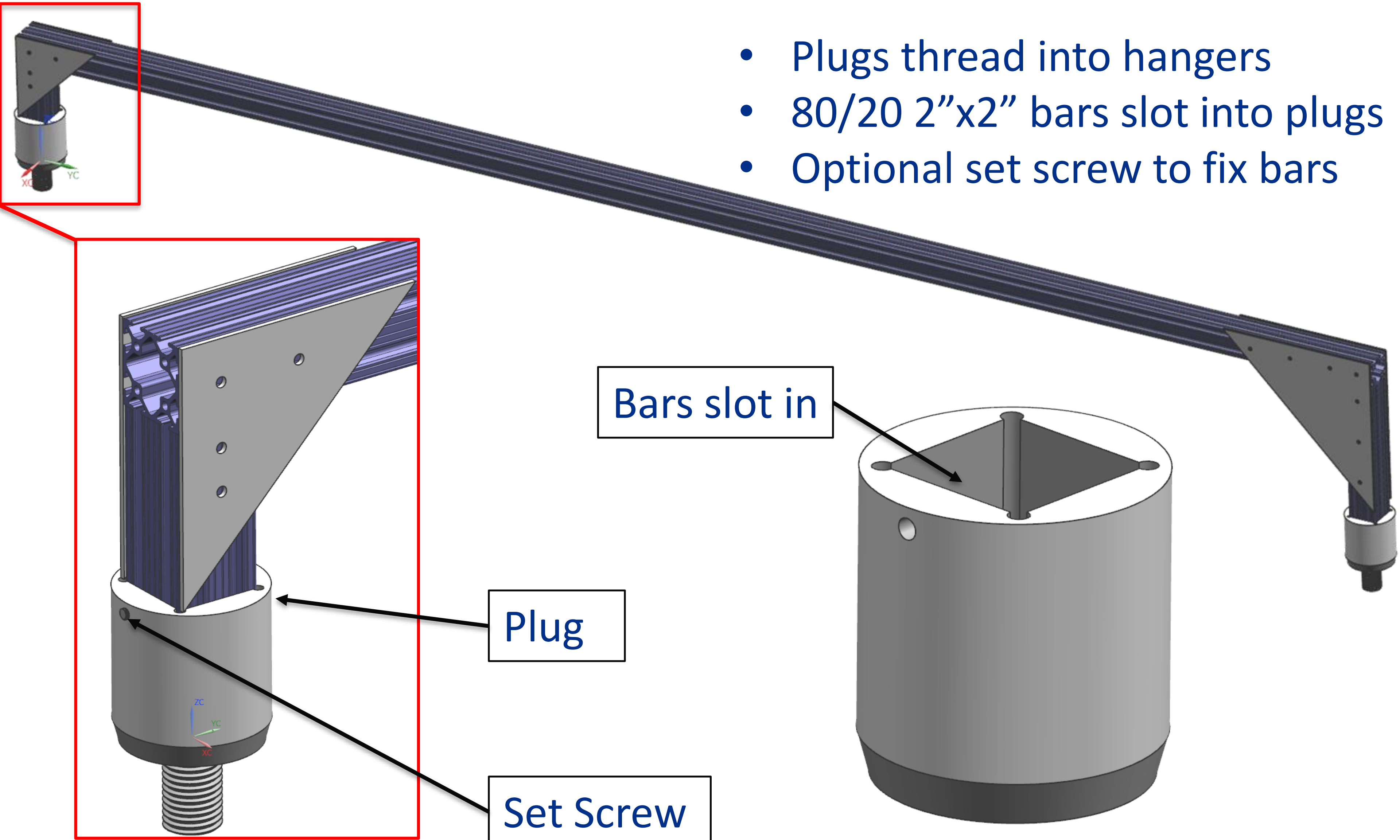
Target Carrier Ramp

- 2”x1” 80/20 for frame, 2”x2” 80/20 for supports
- Angled at 3.34349° like the target will be
- Side Guards for guidance
- 120 lbs estimated, can hang on wall



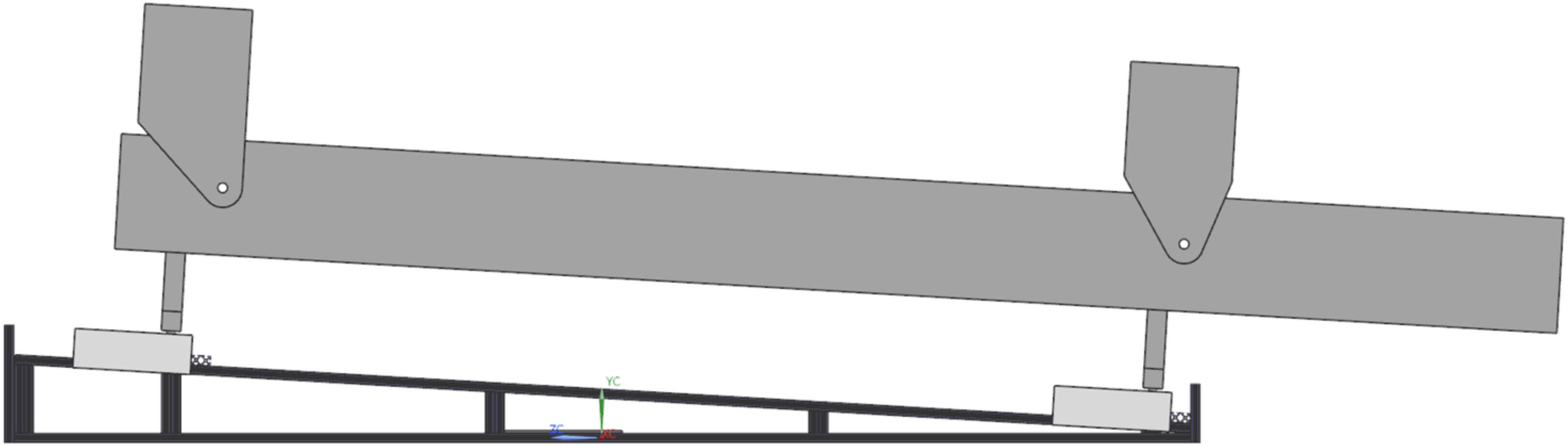
Hanger Positioner

- Plugs thread into hangers
- 80/20 2"x2" bars slot into plugs
- Optional set screw to fix bars



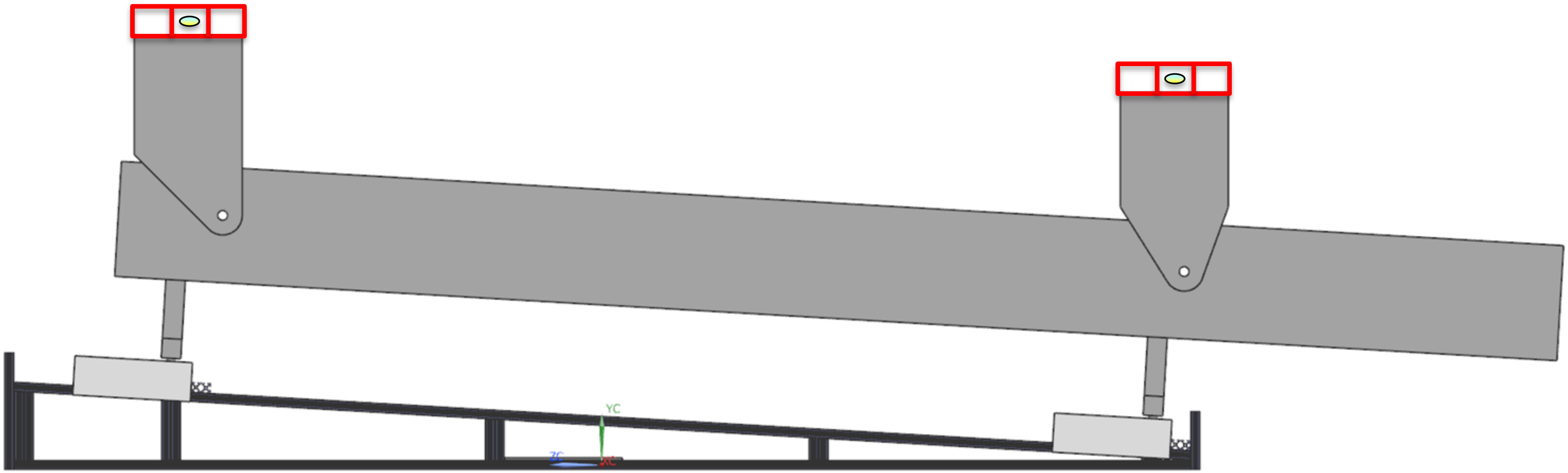
Installation Procedure

1) Place target carrier on ramp



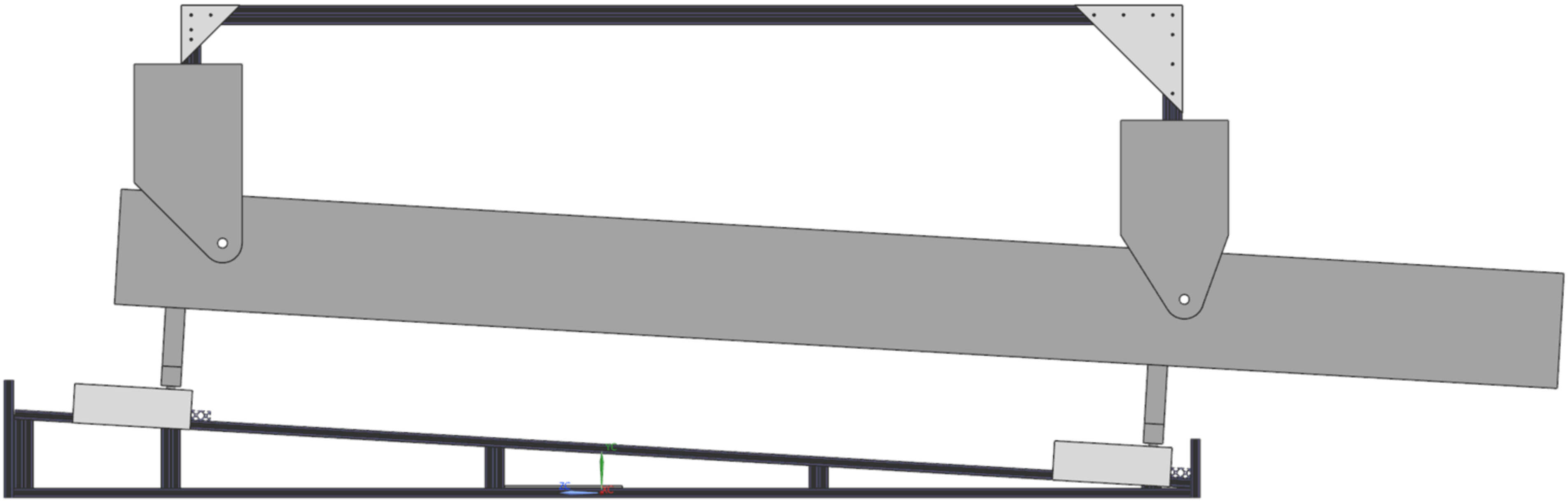
Installation Procedure

2) Adjust hangers using a level so that they are parallel to ground

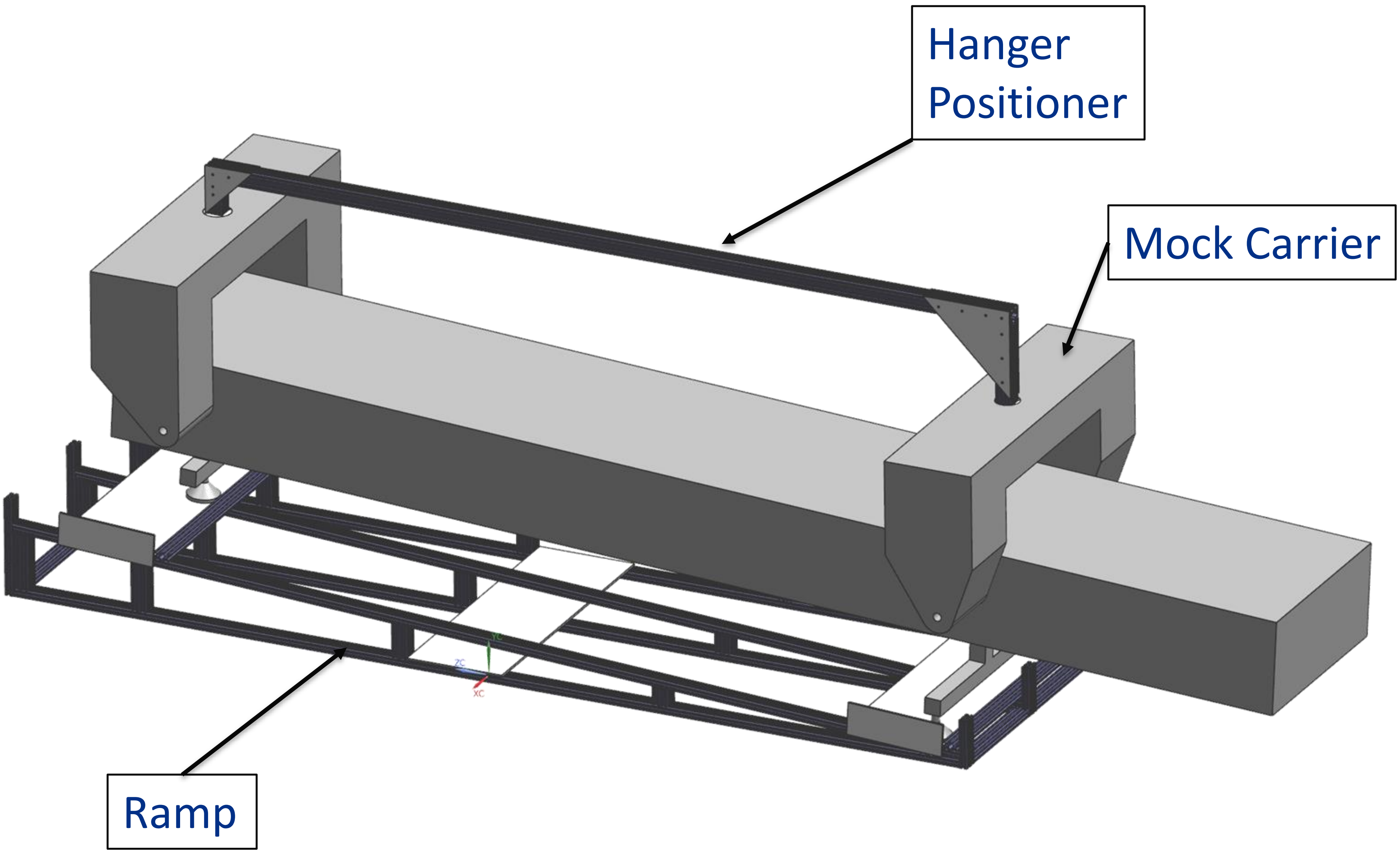


Installation Procedure

3) Grease plugs and thread in, then slot in the bar assembly to check if hanger adjustment is correct



Fully Assembled View



Pre-Installation Checklist

<u>MET Pre-Installation Checklist</u>

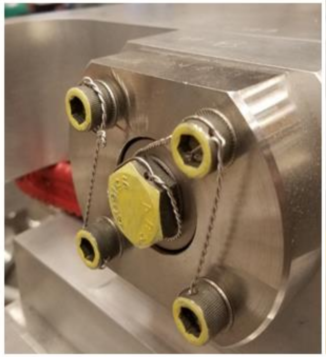
1) Thermocouple readout checks (MI-8 readout sheet for reference)

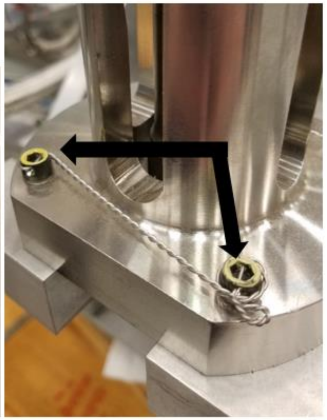
- Check all 11 thermocouples and make sure the readouts are reasonable

2) Make sure all thermocouples are potted by epoxy

3) Ensure all fasteners are secure

- Nuts/Jam Nuts must be tight
- Wire ties must be applied correctly





Stripline Shielding Blocks Fastener Failure

- Stud Bolts experienced fracture during preload
- Torsional failure due to galling

Stripline Shielding Blocks Fastener Failure

Axial Stress:

The steps to calculate axial stress include first calculating the amount of preload that can be expected from applying 40 ft-lbs of torque and then dividing the preload by the minor area of the bolt since it fractured at the threads. The preload force is given by equation 1.

$$F_{PL} = \frac{T}{K_T * d_{nom}} \qquad 1)$$

Where T is the torque applied, d_{nom} is the nominal bolt diameter, and K_T is the torque coefficient which is expanded in equation 2.

$$K_T = \left(\frac{r_t}{d_{nom}}\right)\left(\frac{tan\lambda + \mu_t seca}{1 - \mu_t tan\lambda seca}\right) + \frac{\mu_c r_c}{d_{nom}} \qquad 2)$$

Where r_t is the mean thread radius which is expanded in equation 3, r_c is the mean collar radius which is expanded in equation 4, λ is the lead angle which is expanded in equation 5, α is the thread half angle (30 degrees per ASME B1.1, 10.1b), μ_t is the friction coefficient between thread surfaces, and μ_c is the friction coefficient between the collar surfaces.

$$r_t = \frac{(d_{nom} + d_{minor})}{4} \qquad 3)$$

$$r_c = 0.625 * d_{nom} \qquad 4)$$

$$tan\lambda = \frac{1}{2\pi r_t (TPI)}; TPI = Threads\ Per\ Inch \qquad 5)$$

Note: In situations where the friction coefficient values are unknown, values of 0.15 are typically used (Shigley's Mechanical Engineering Design).
The value for minor diameter can either be looked up or calculated from equation 6.

$$d_{minor} = d_{nom} - \frac{1.299038}{TPI} \qquad 6)$$

Substituting all known values:

$$d_{minor} = 0.375 - \frac{1.299038}{16} = 0.294\ in$$

$$r_t = \frac{0.375 + 0.294}{4} = 0.167\ in$$

$$r_c = 0.625 * 0.375 = 0.234\ in$$

$$tan\lambda = \frac{1}{2\pi * 0.167 * 16} = 0.0595$$

$$\tau_{tor} = \frac{40ft - lb * \left(\frac{12in}{ft}\right) * \frac{0.294in}{2}}{\frac{\pi * (0.294)^4}{32}} = 96.2\ ksi$$

Therefore, it can be seen that if the full 40 ft-lbs of torque were applied when the nut locked up, a torsional shear stress of 96.2 ksi would result which is higher than the ultimate shear strength of the bolt which is 79.8 ksi. This would cause a torsional shear failure.
Backtracking to find the maximum torque that can be applied before torsional fracture leads to:

$$T = \frac{\tau_{tor} * J}{r_{min}} = \frac{(79{,}800) * \frac{\pi * (0.294)^4}{32}}{\frac{0.294}{2}} * \frac{ft}{12\ in} = 32.9\ ft - lb$$

Combined Stress:

While the cases that were just examined involved the full 40 ft-lb load being fully applied in either axial or torsional stress, a more likely scenario is that it was applied in a combination of the two. For a case such as this, the simplified von Mises equation shown in equation 10 is used to calculate the combined stress.

$$\sigma_{VM} = \sqrt{\sigma_{PL}^2 + 3\tau_{tor}^2} \qquad 10)$$

The Maximum Distortion Energy Theory states that the material will begin to yield when the von Mises stress reaches the material yield stress.

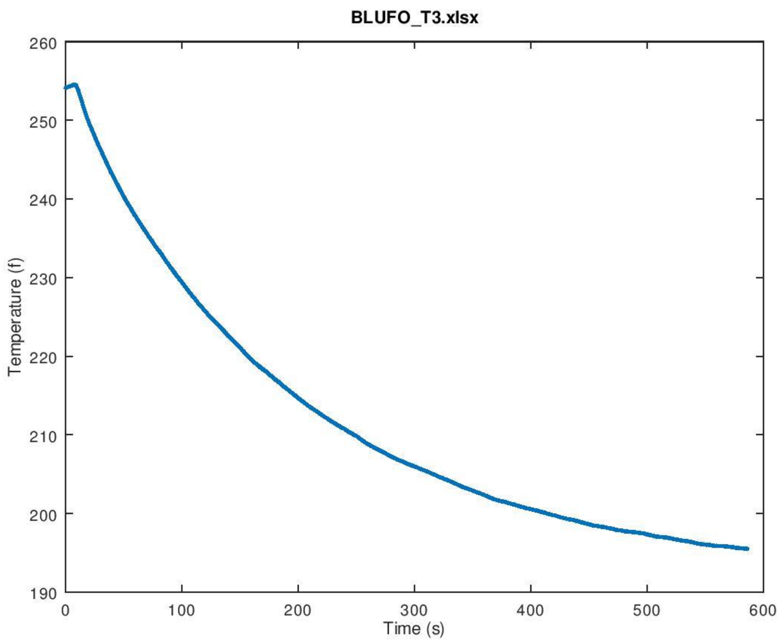
$$Yield\ Occurs\ When\quad \sigma_{VM} \geq \sigma_{yld}$$

Conclusion: Use ARP Fastener Lubricant to prevent galling

Stripline Airflow Testing

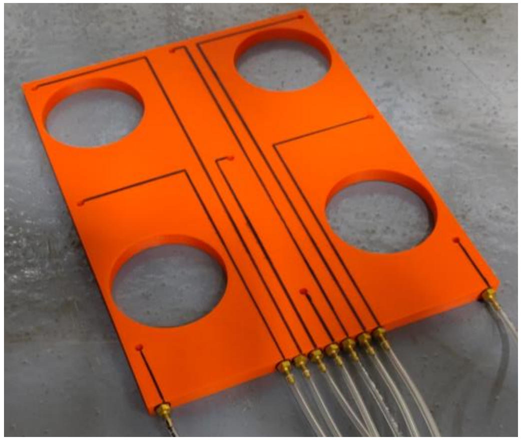
- Goal: Increase cooling on stripline to allow for move up to 1 MW

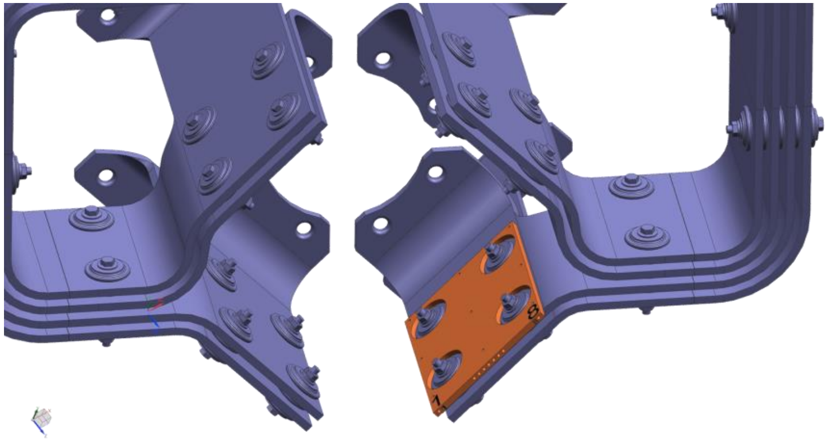
Cooling Curve Test



- Heated up coupon, turned on fans
- Derived convection coefficient

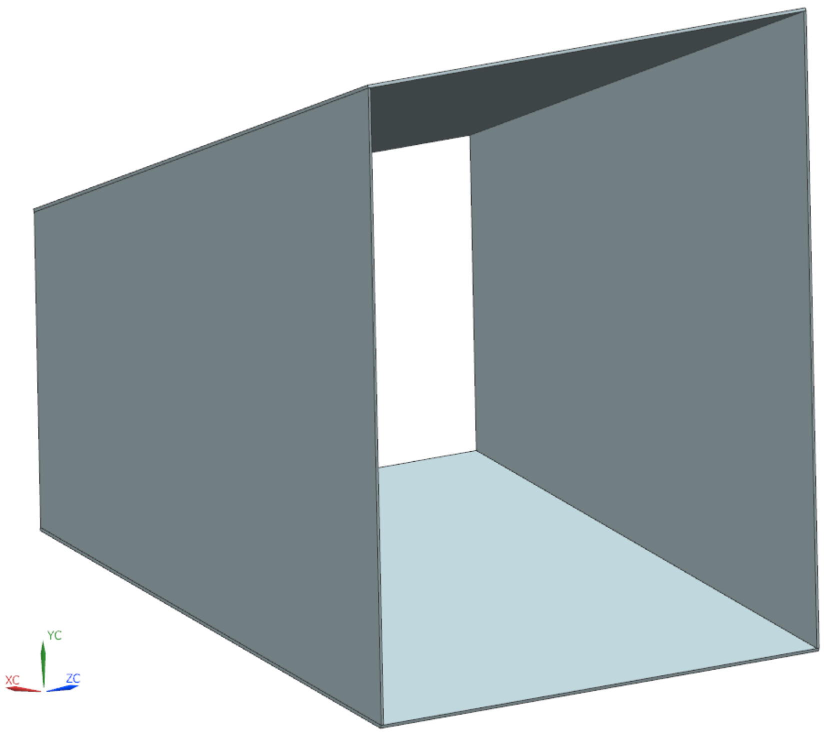
Pressure Test



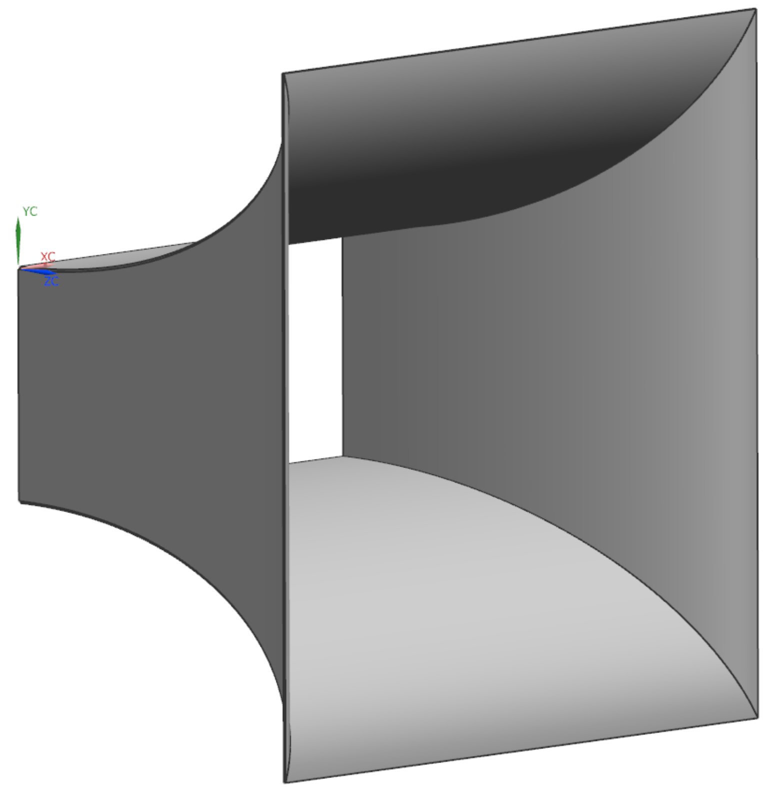


New Diverter Design: Inlet

- 4 sheet metal sheets curved into quarter-ellipses
- Inlet area doubled from previous design



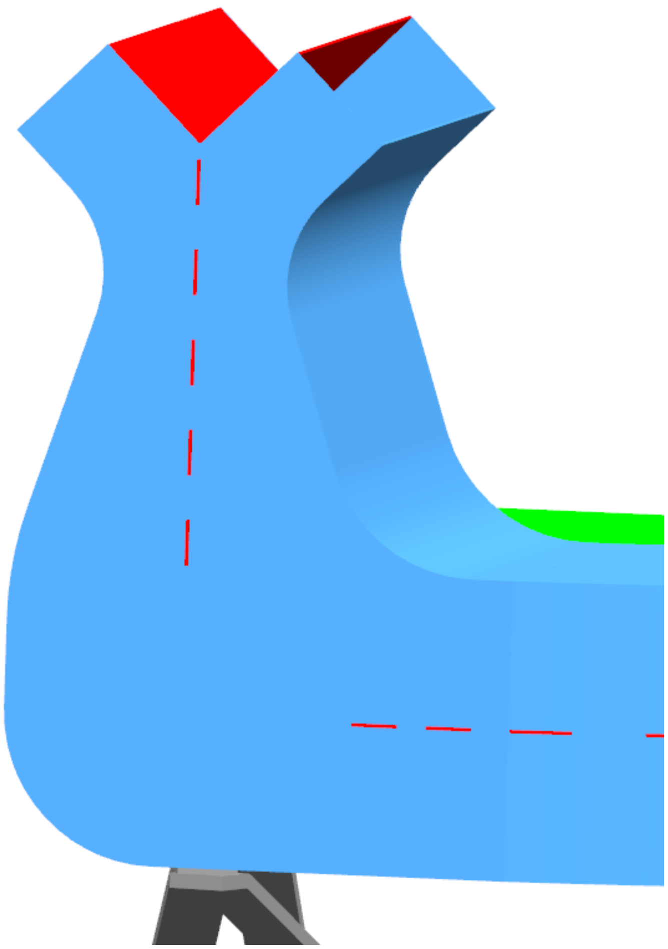
Old Design



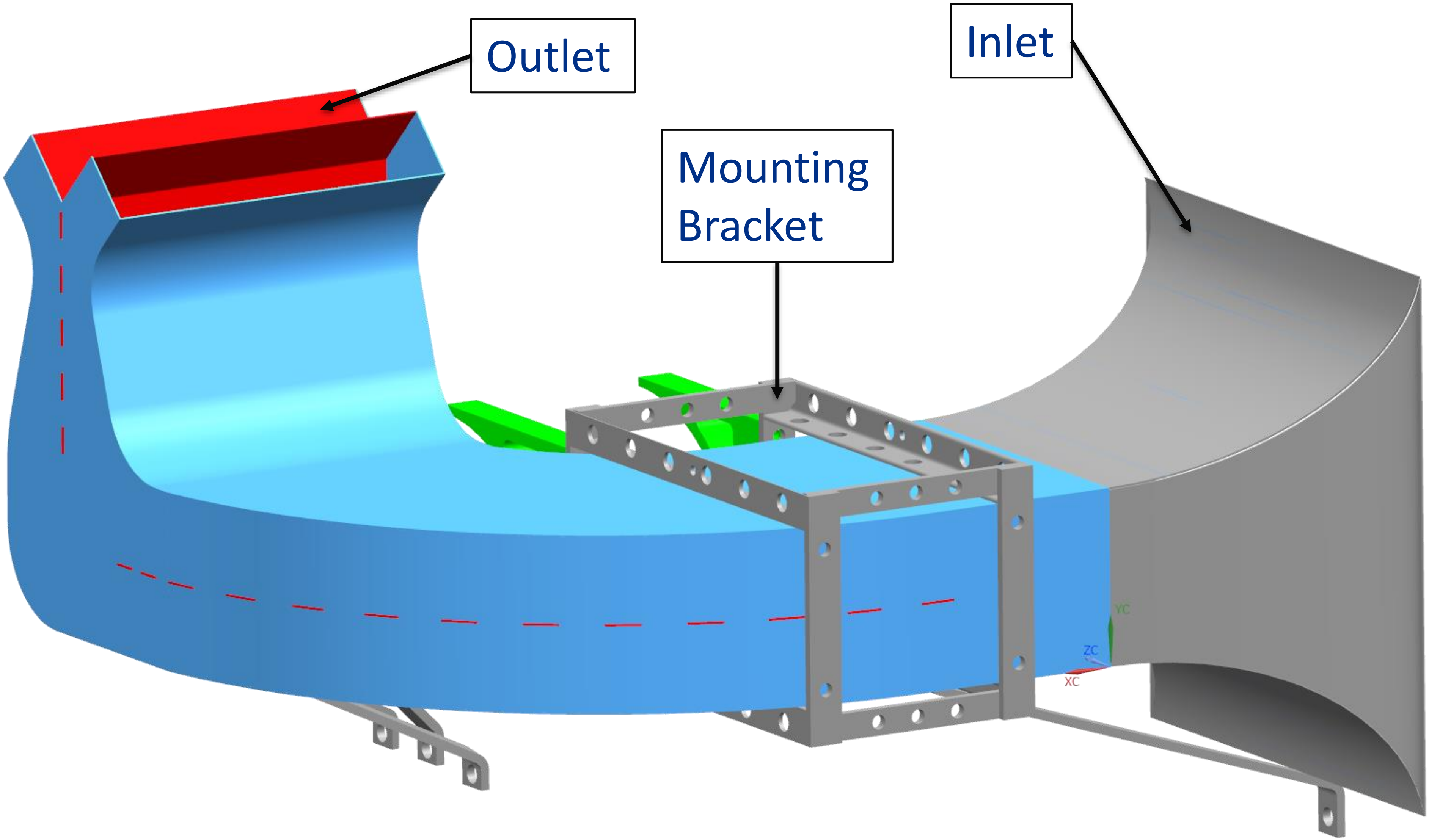
New Design

New Diverter Design: Outlet

- Made openings 2x as large since inlet area doubled
- Centered openings between stripline flags



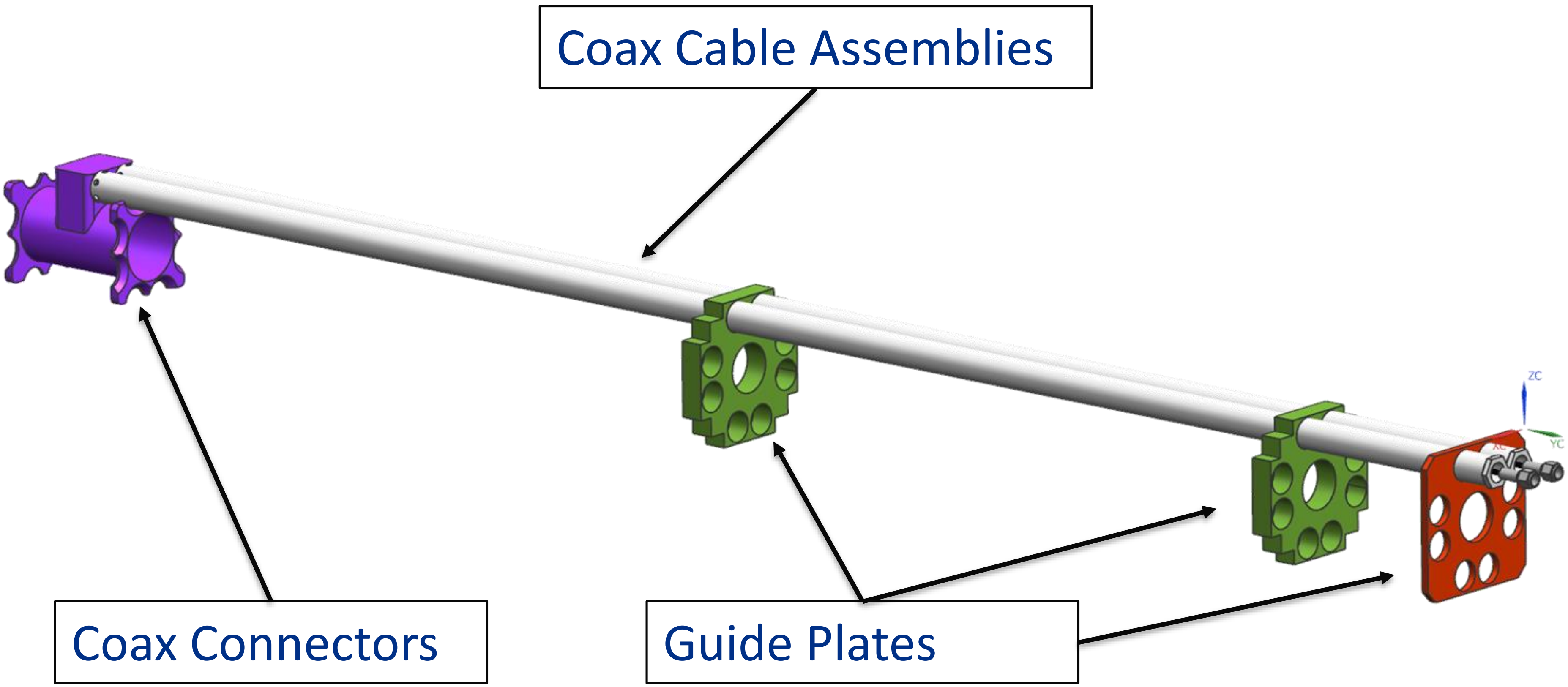
Full Diverter Assembly



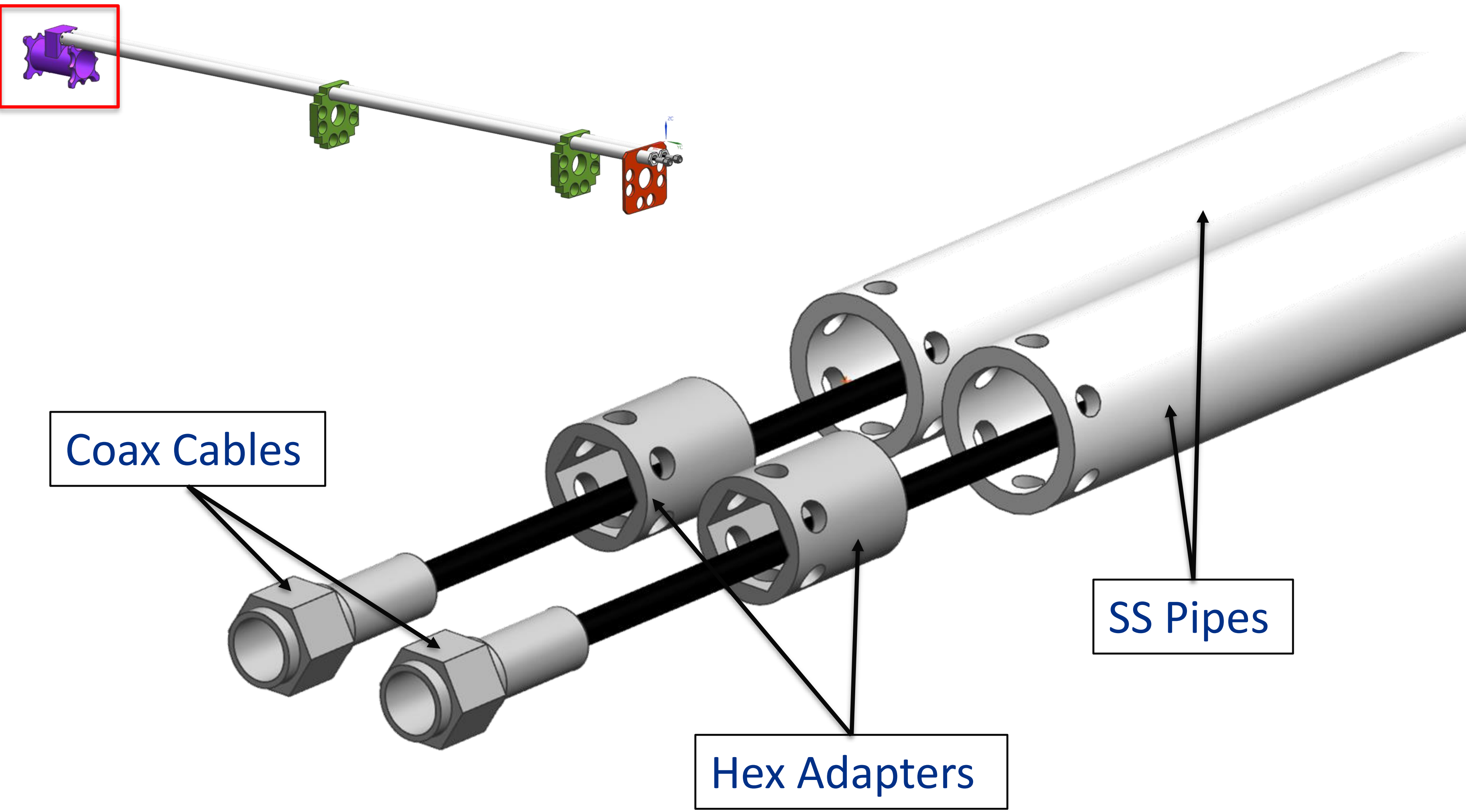
BnB Mechanical Model

- One of the coax cables for the BPMs failed
- Research more radiation resistant coax cables/connectors
  - Kapton
  - Ceramics
- Design a mechanical model to make replacing cables easier

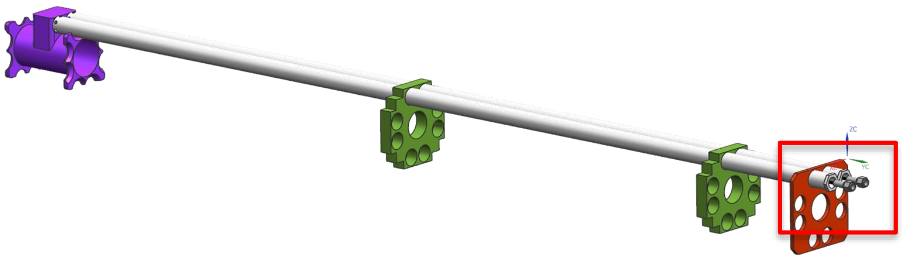
Coax Cable Assembly

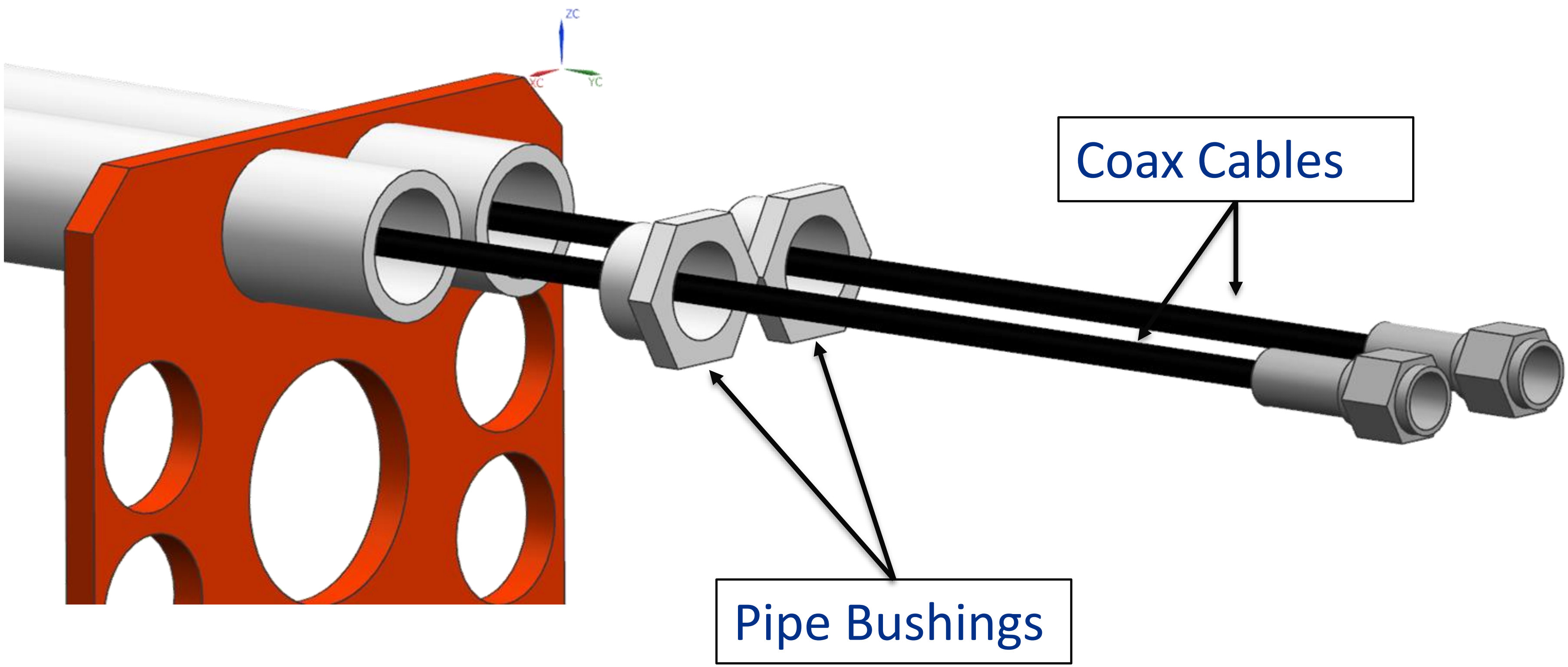


Coax Cable Assembly

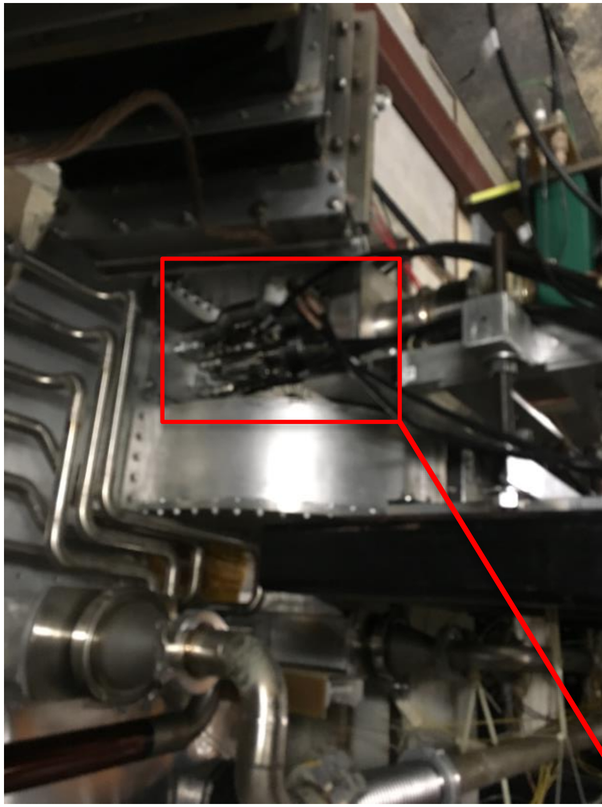


Coax Cable Assembly

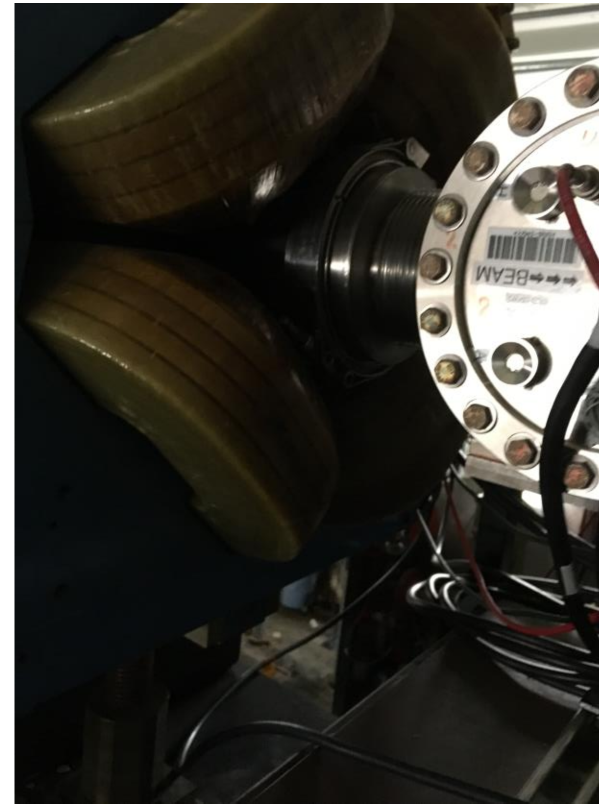


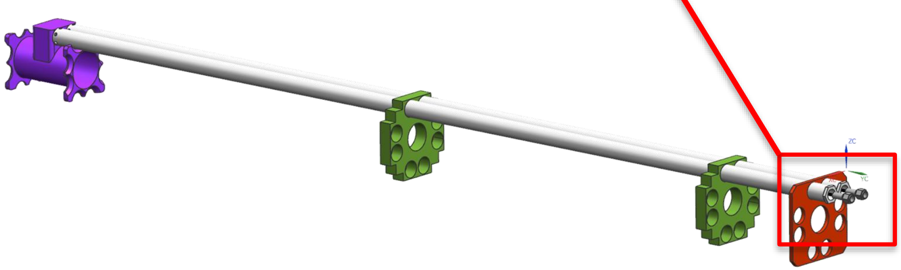


Possible Issues



- A lot of clutter
- Magnet will need to be moved back





Fermilab

Future Projects

- Mu2e Proposal for Emissivity/Creep Target Testing
- Electroless Nickel Coating Characterization on Horn
- Trained on CNC TiG Welding Machine
- USPAS on High Power Targets in January