

# TPC Support and Constraint

## TPC Support

- Baseline support system (Assumes “gravity” constraint)
- Loading
- APA support detail
- CPA support detail
- End wall support concept
- Some comments on contraction

## TPC Constraint

- Effect of pressure on TPC position
- Alternative #1 – Springs
- Alternative #2 – Rails?
- Alternative #3a & 3b – Rigid support for center rail

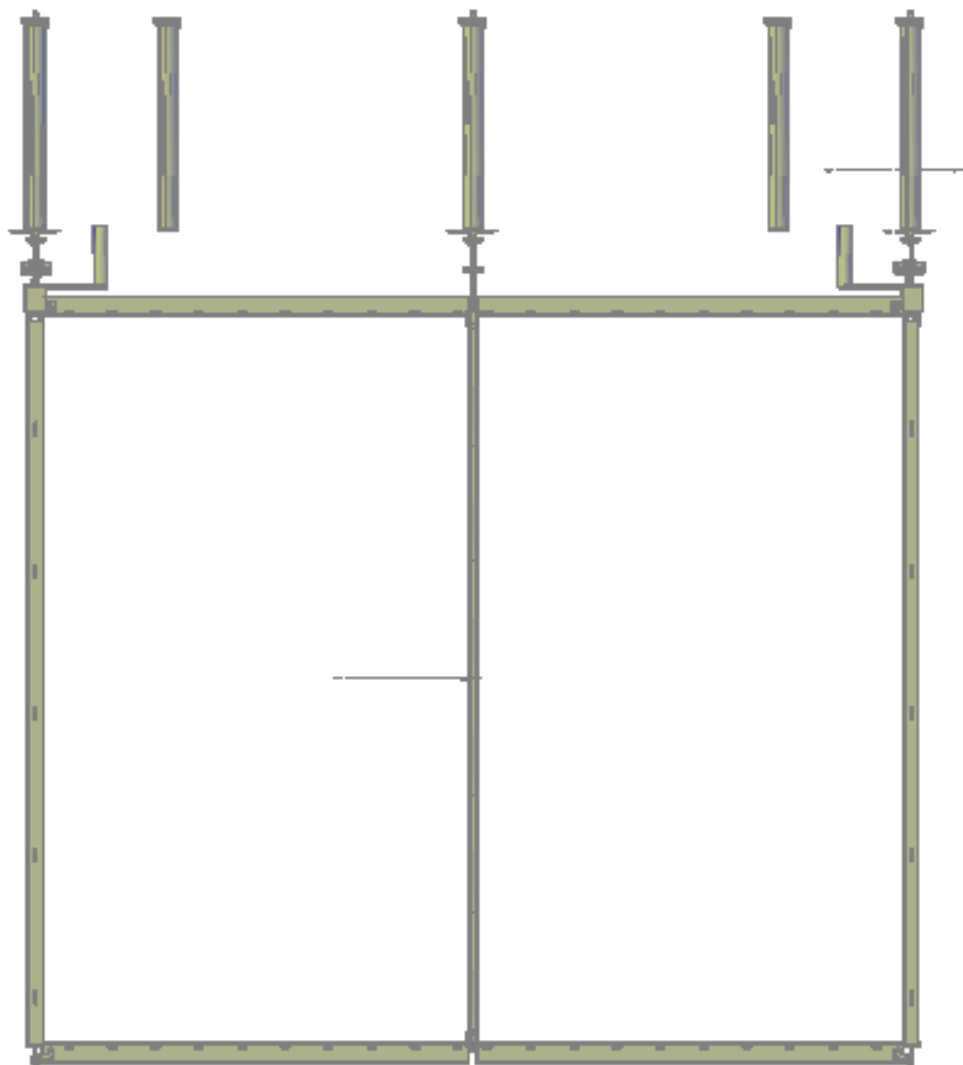
Installation

Questions

## Baseline support system (Assumes “gravity” constraint)

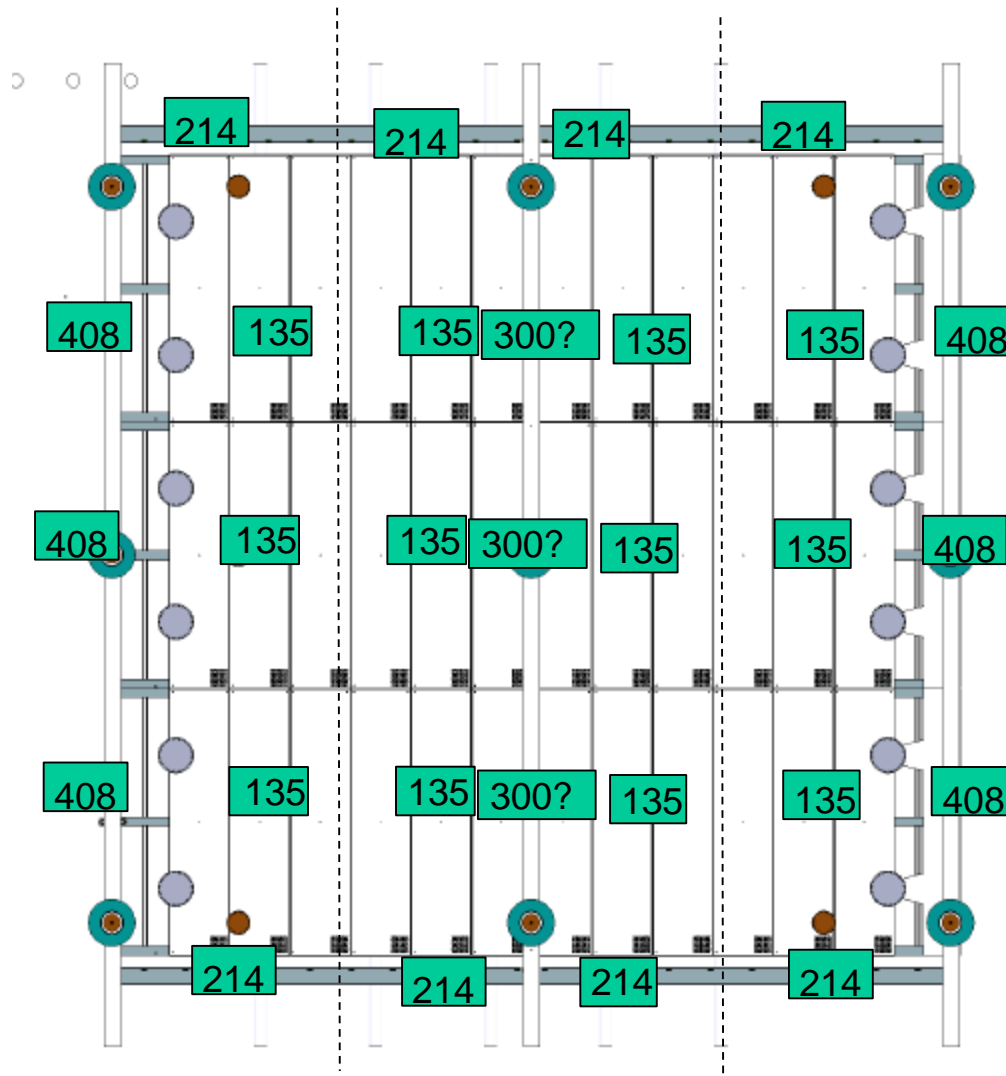
Minimum constraint –  
Safest for accommodating  
CTE

- If supporting cryo pipes, minimal horizontal loads can be transferred to structure
- Also strain in cables could affect TPC position if not careful



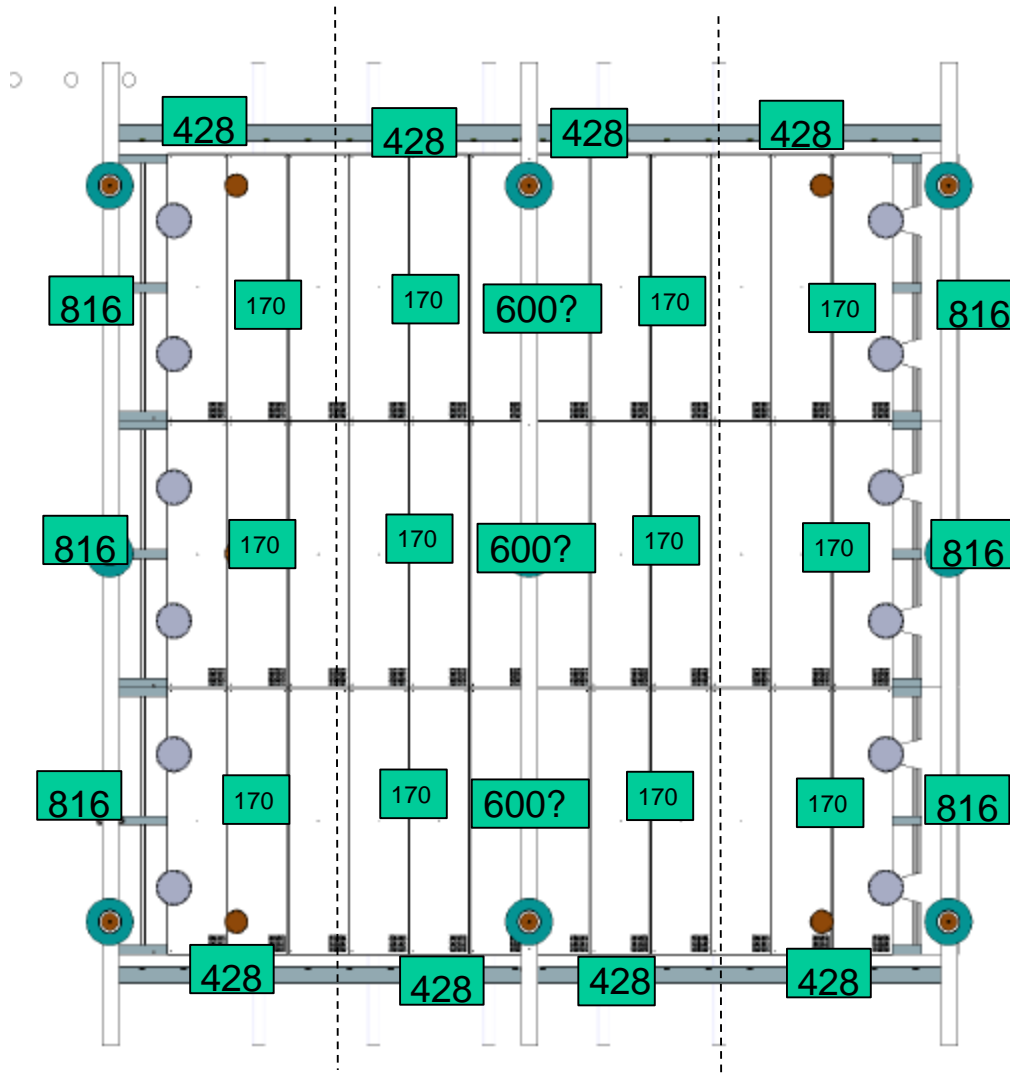
# Loading – protoDUNE (kg)

Assumes no ground plane on bottom

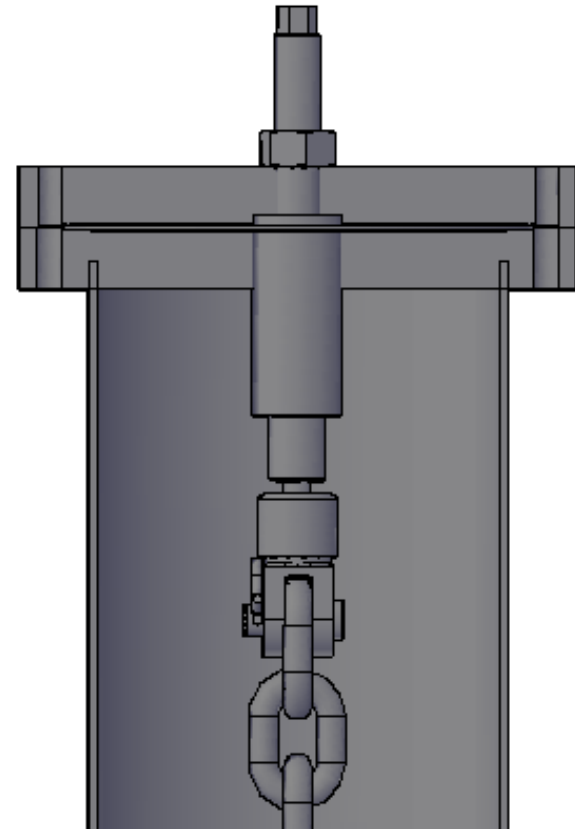
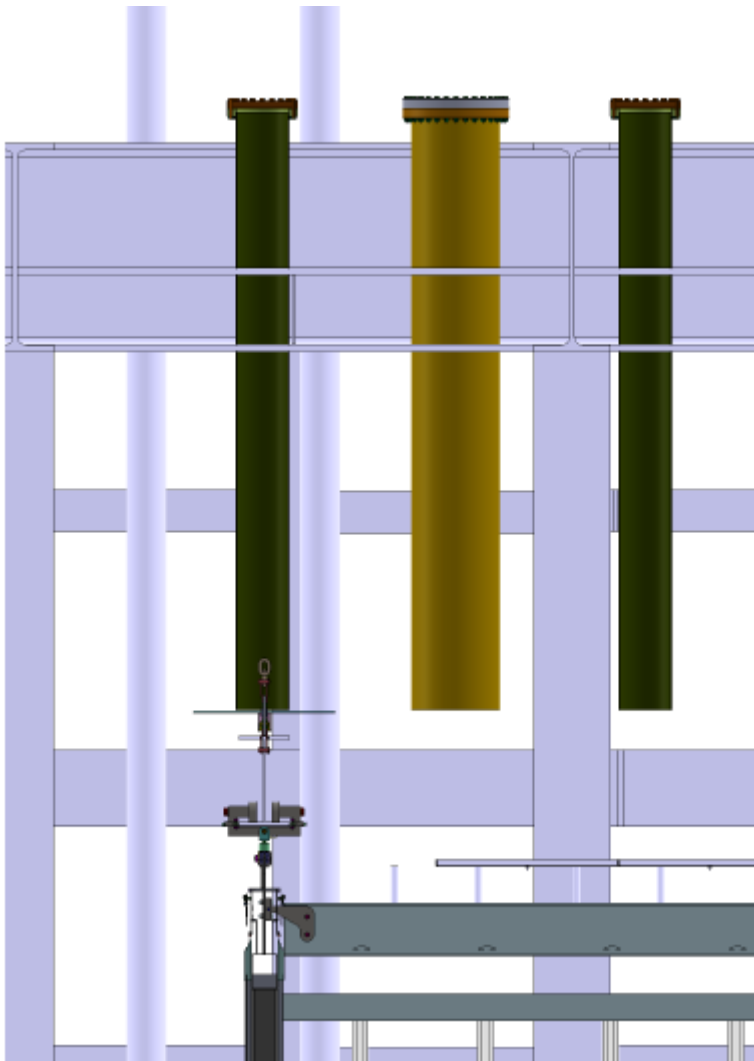


# Loading for DUNE shown on protoDUNE footprint (kg)

With ground plane at the bottom

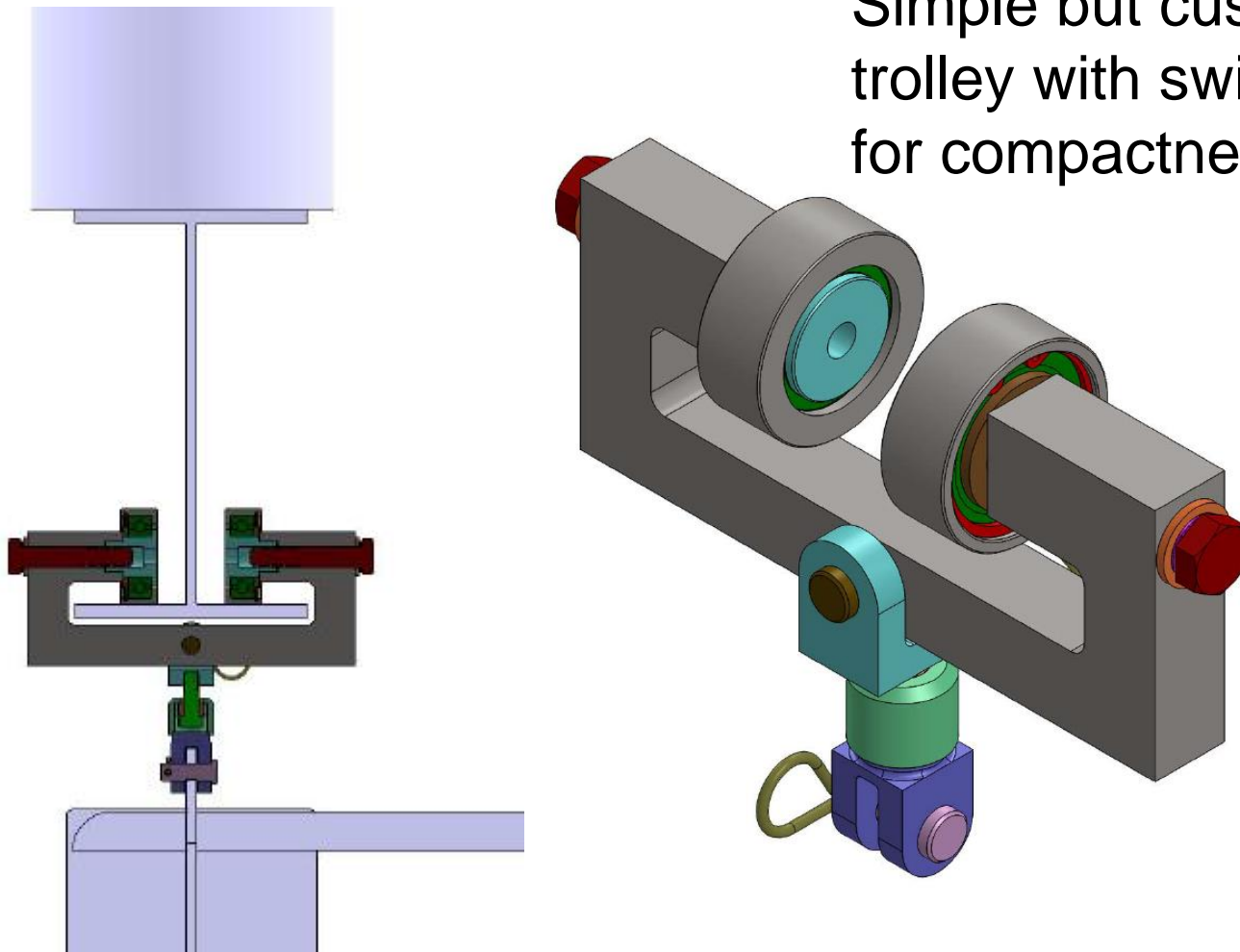


# APA Support Detail

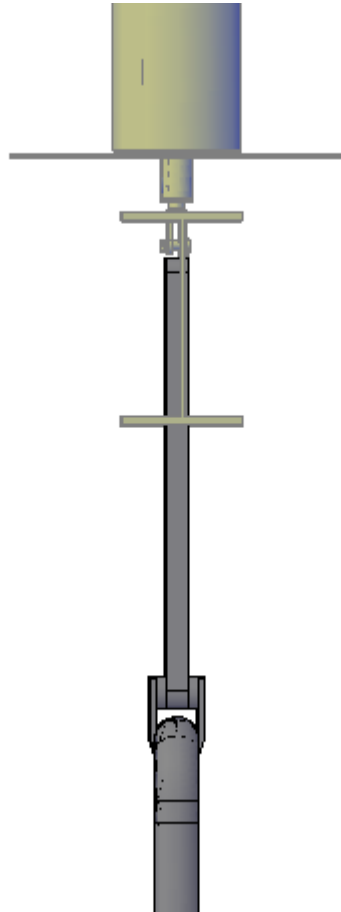


# APA support detail

Simple but custom  
trolley with swivel  
for compactness.

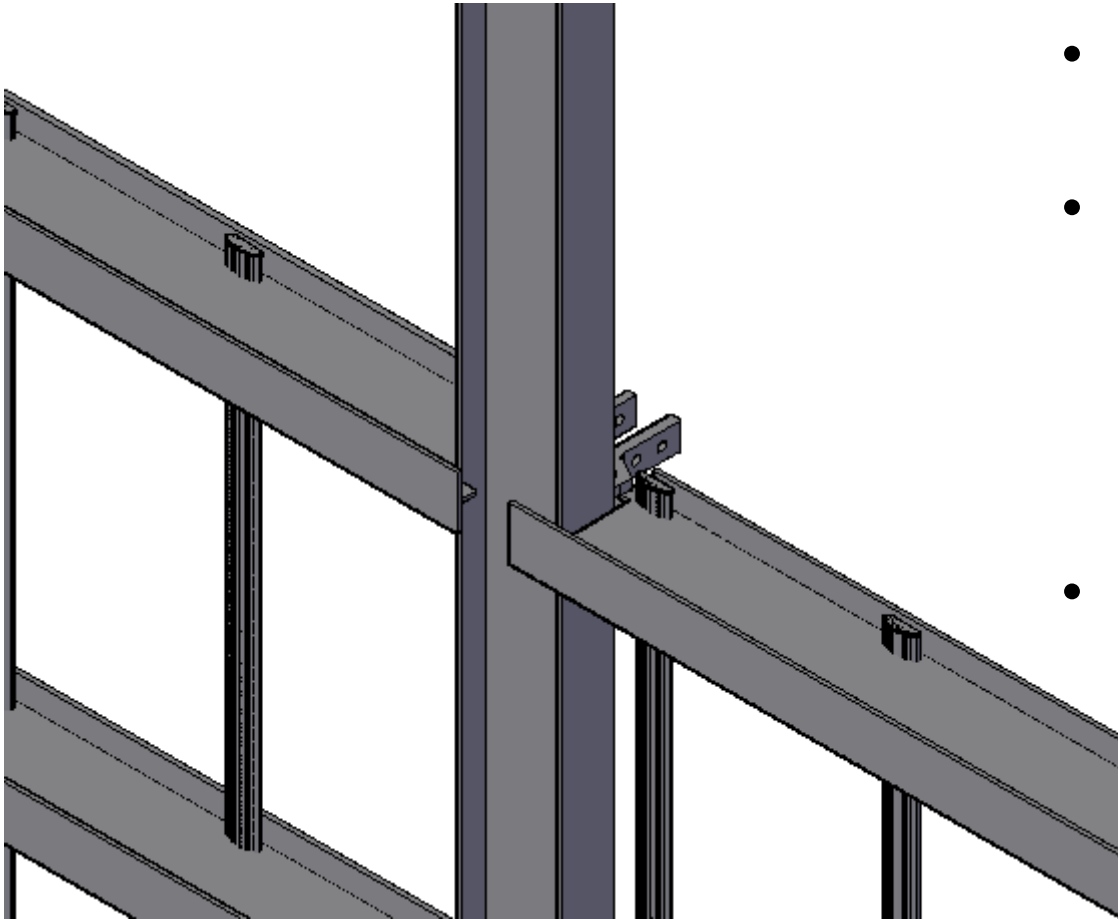


# CPA Support Detail



- CPA to beam needs definition.
- Need to finalize plane locations. (parameter drawing is needed.)
- Support to CPA as designed will accommodate differential CTE.
- Two point support may cause tipping in x-z plane.

# Endwall Support Concept

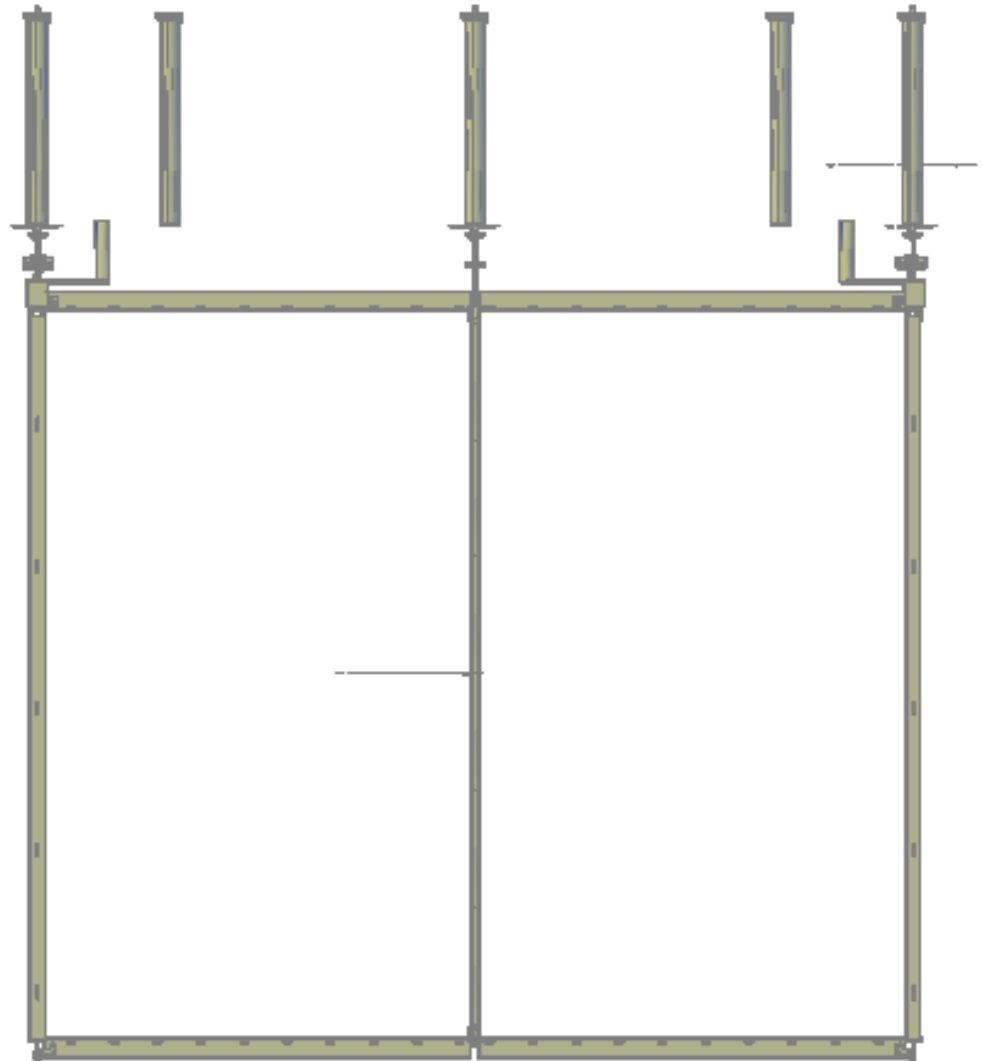


- Vertical beam takes load to rail
- Connection to CPA is slotted and probably travels with wall and is connected to CPA from inside
- FC to beam connection not shown



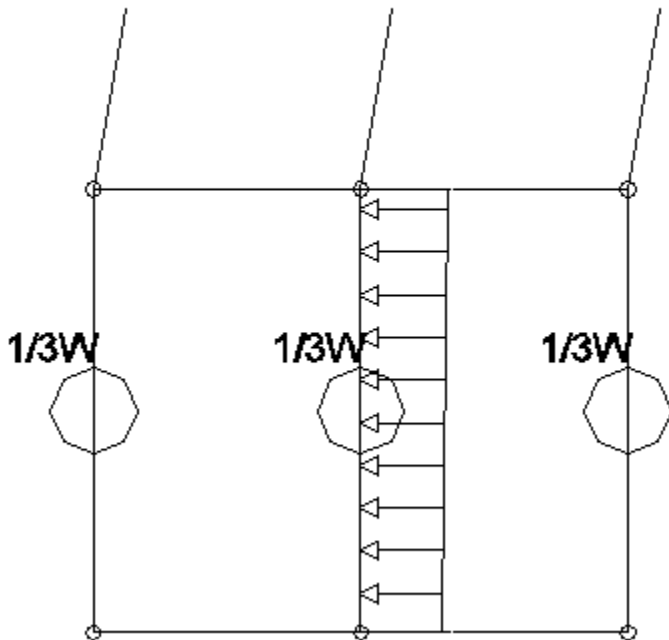
## Some comments on contraction

- APA plane contraction requires 150mm “nozzle” in FD. Maybe larger depending on true position.
- Anticipate CPA to beam differential CTE?
- Start with gap between CPAs?
- FC from slight trapezoid to rectangle?
- Must manage differential CTE of GP to FC.



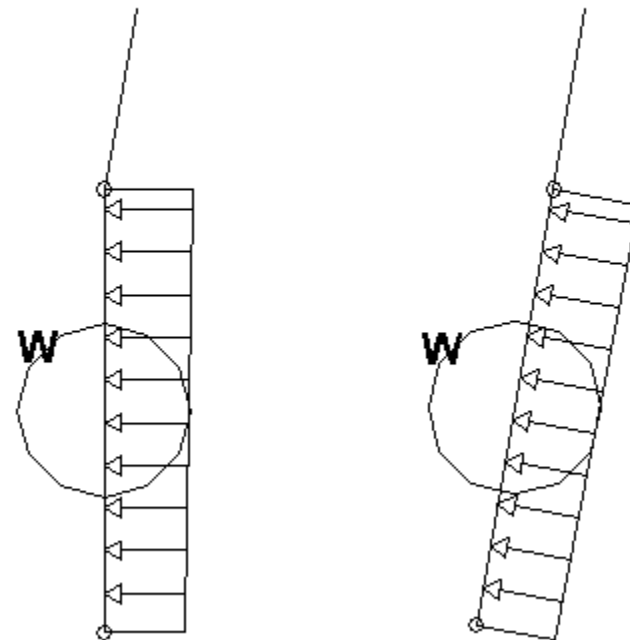
# Effect of pressure on position – Equivalent system with all mass at the TPC c.g.. Analysis based on one APA length of TPC

Top Stability



=

Bottom stability



Effect of pressure on position – Equivalent system with all mass at the TPC c.g.. Analysis based on one APA length of TPC. All values are based on 1Pa differential pressure on 1 CPA panel

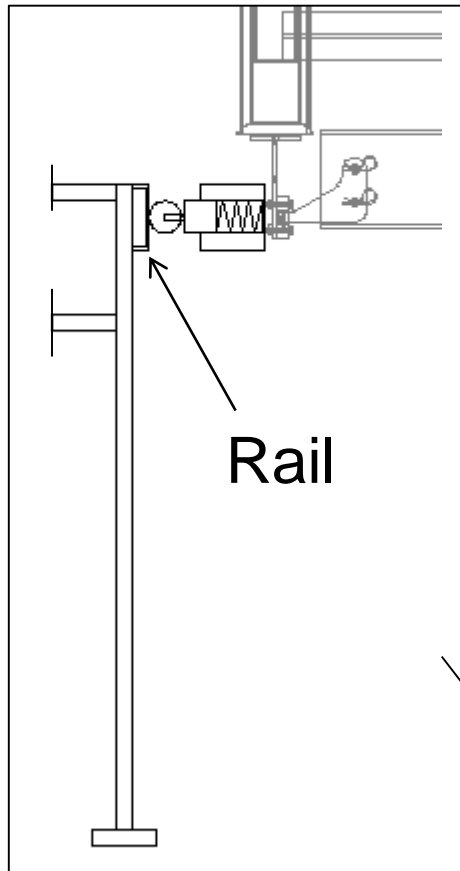
Top stability protoDUNE 2mm

Bottom stability protoDUNE 8mm

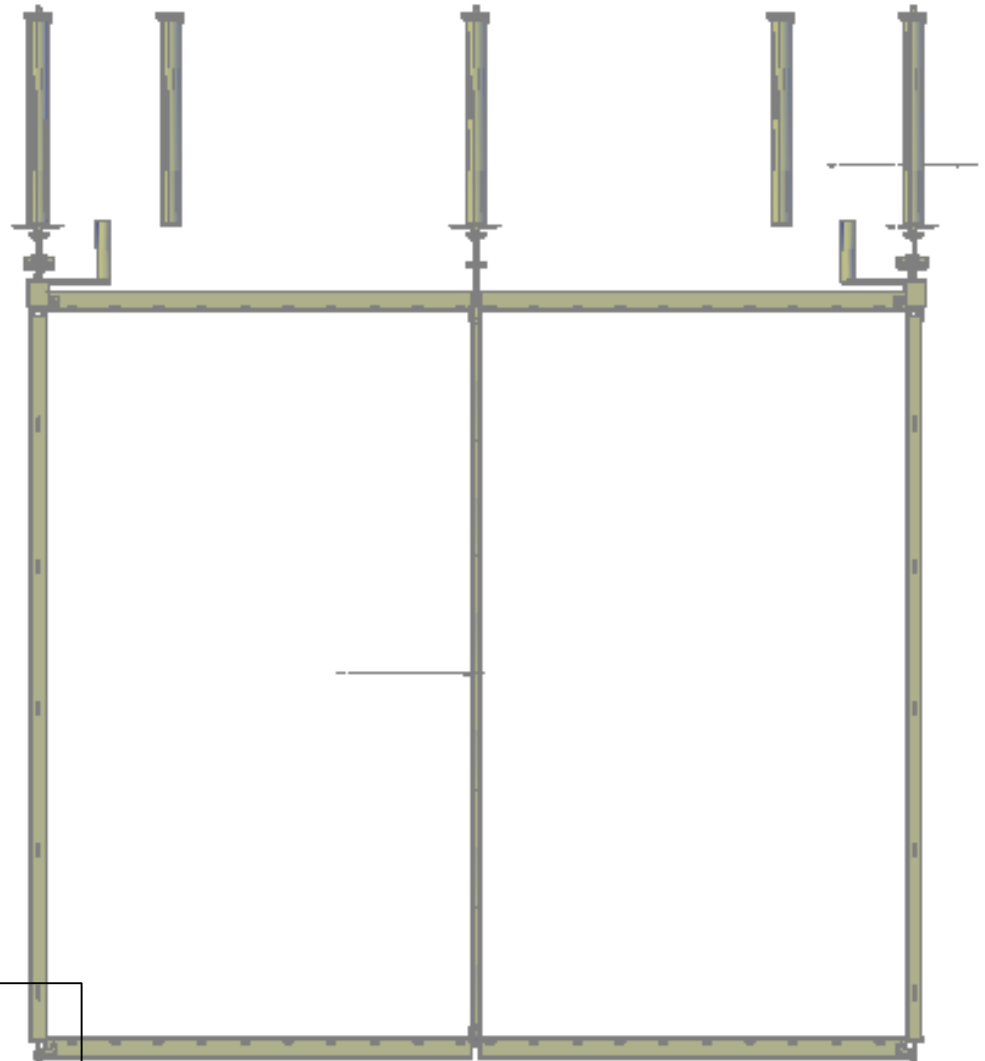
Top stability DUNE 1mm

Bottom stability DUNE 9mm

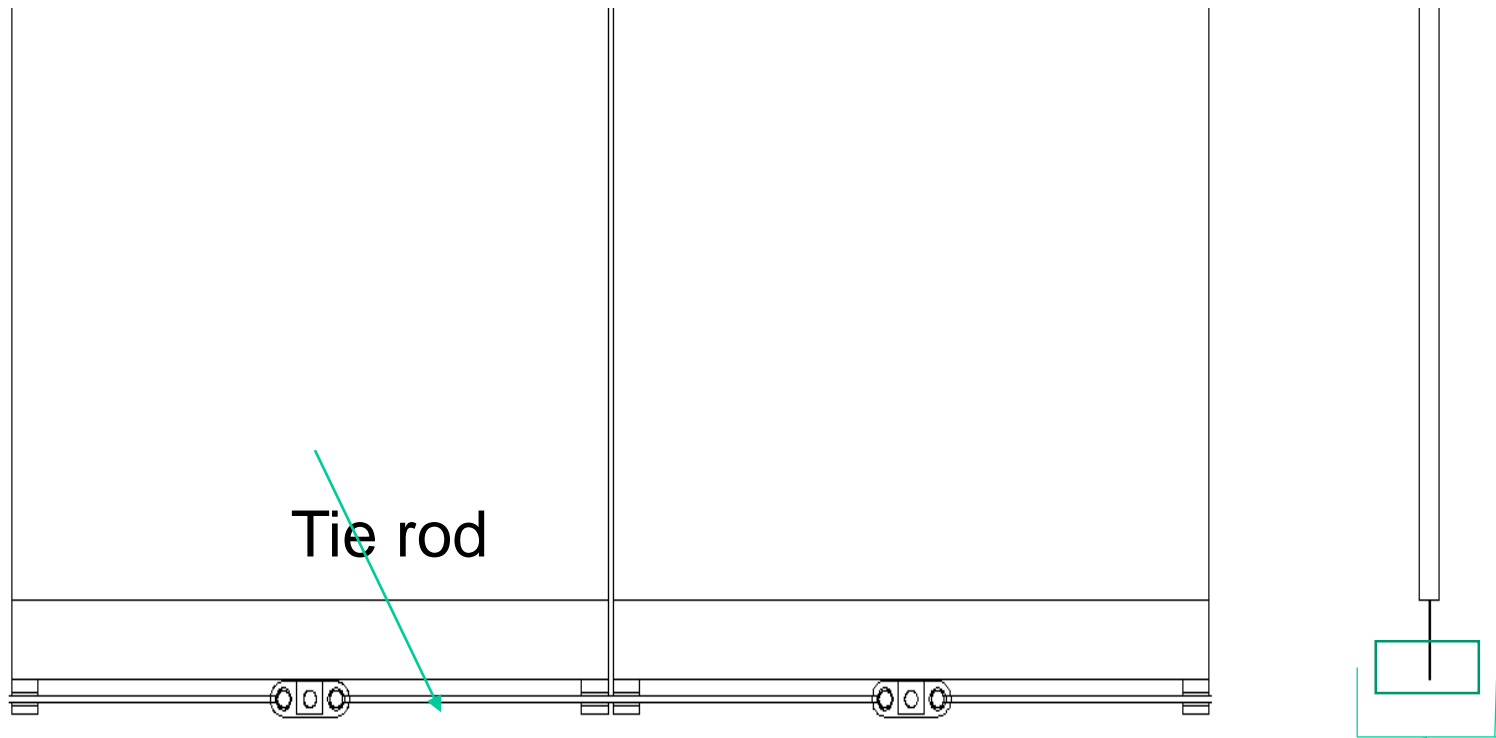
# Alternative #1 - springs



Very conceptual

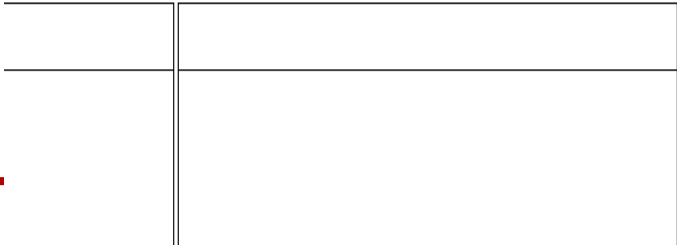
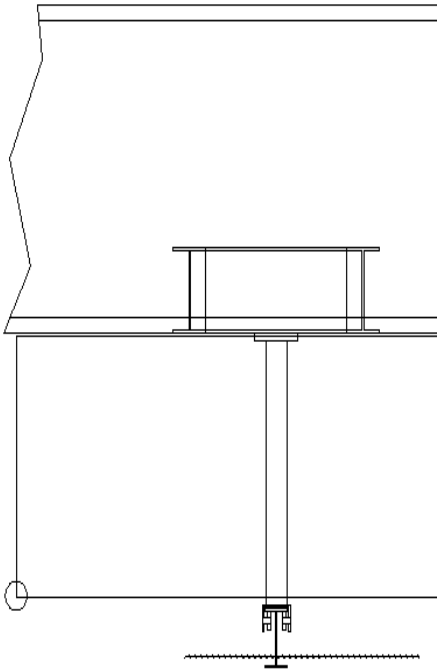
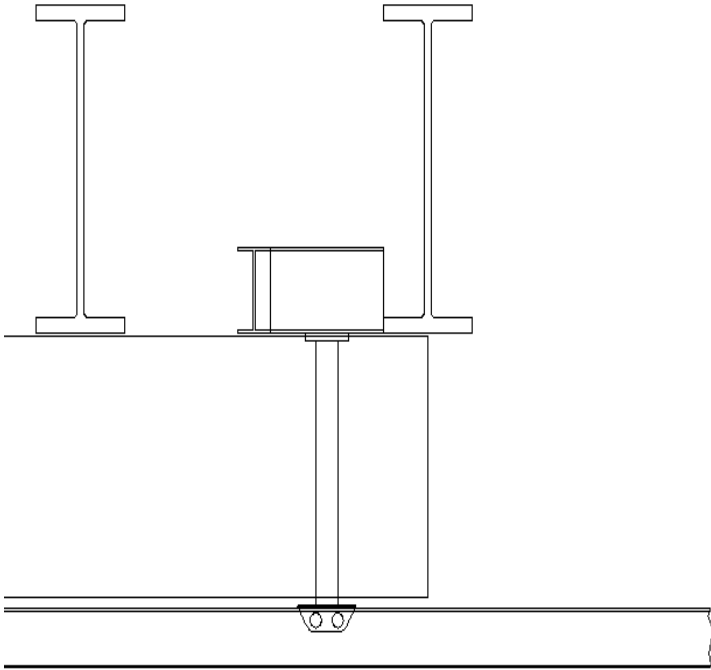


## Alternative #2 – Rails?



Plane could be constrained at the bottom in y with a rail.

# Alternative 3a and 3b rigid support to center rail



## Installation

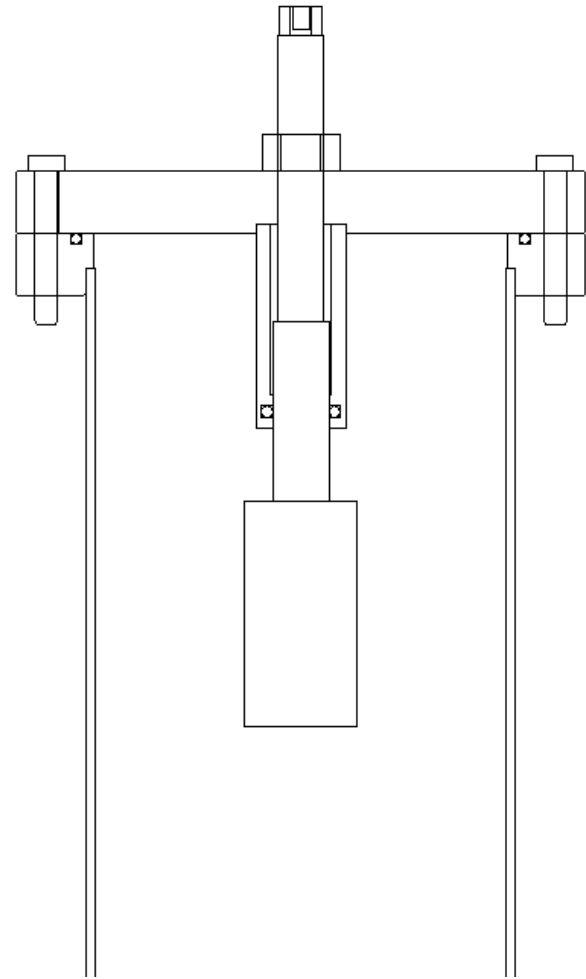
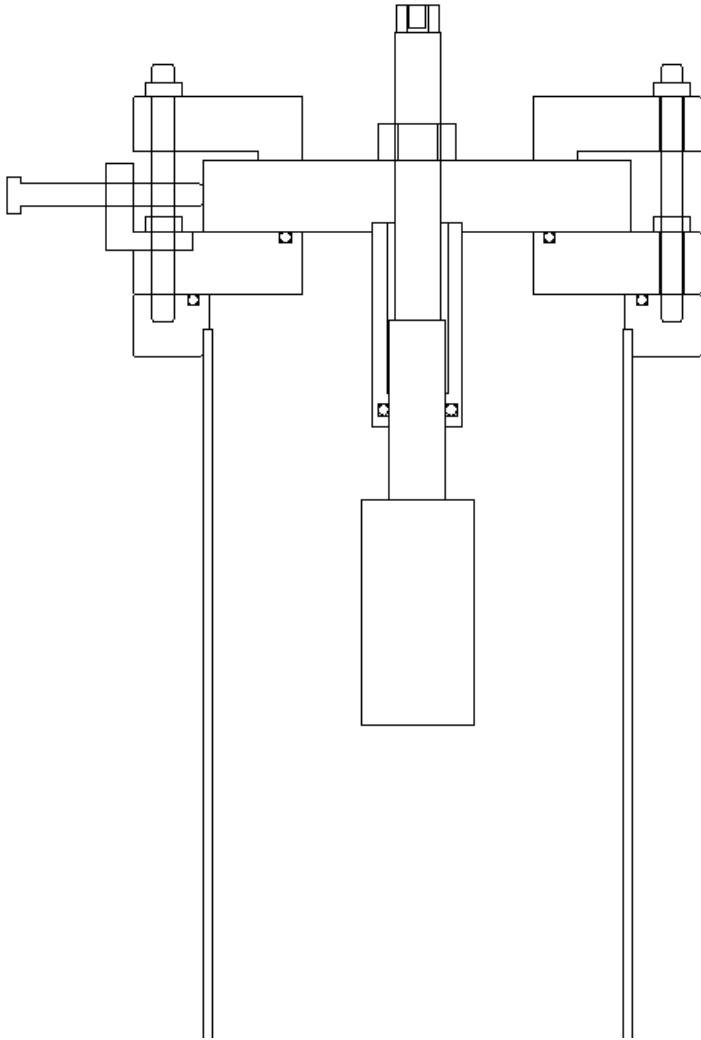
- Compatibility with Installation needs verification
- “Toaster” installation concept has advantages may change things

## Questions

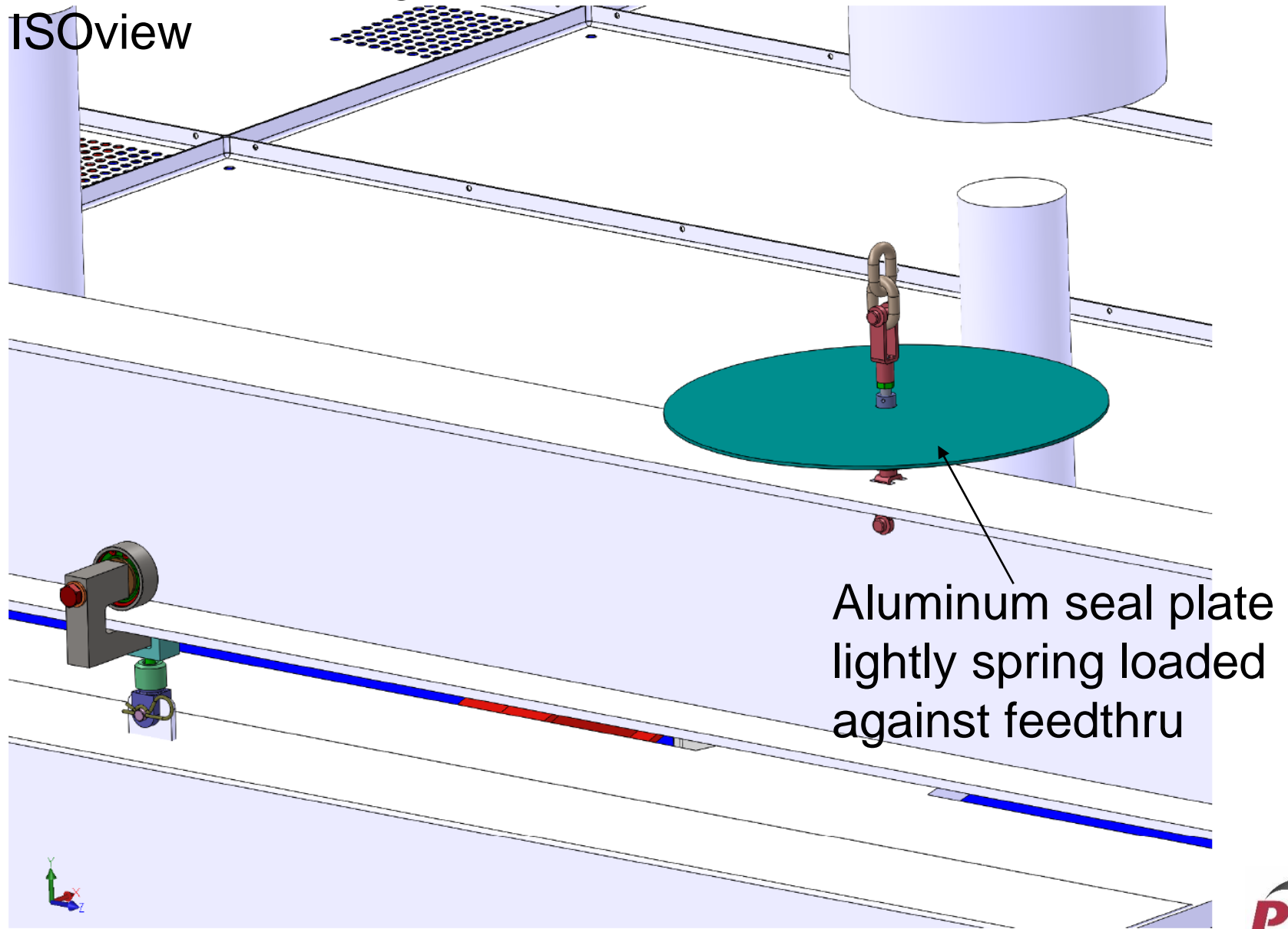
- What are practical positional tolerances for support feedthrough locations?
- Are there any issues with the beam pipe (or HV) if we shrink towards the center?
- Where are cryo pipes? How to support? Will they be vibrating?
- Corrugation pitch vs Roof belt pitch?
- Max cool down rate to design for?
- Max temperature gradient?
- Roof deflection for protoDUNE?
- Ullage temperature?
- Fabrication locational tolerance for feed-thrus?



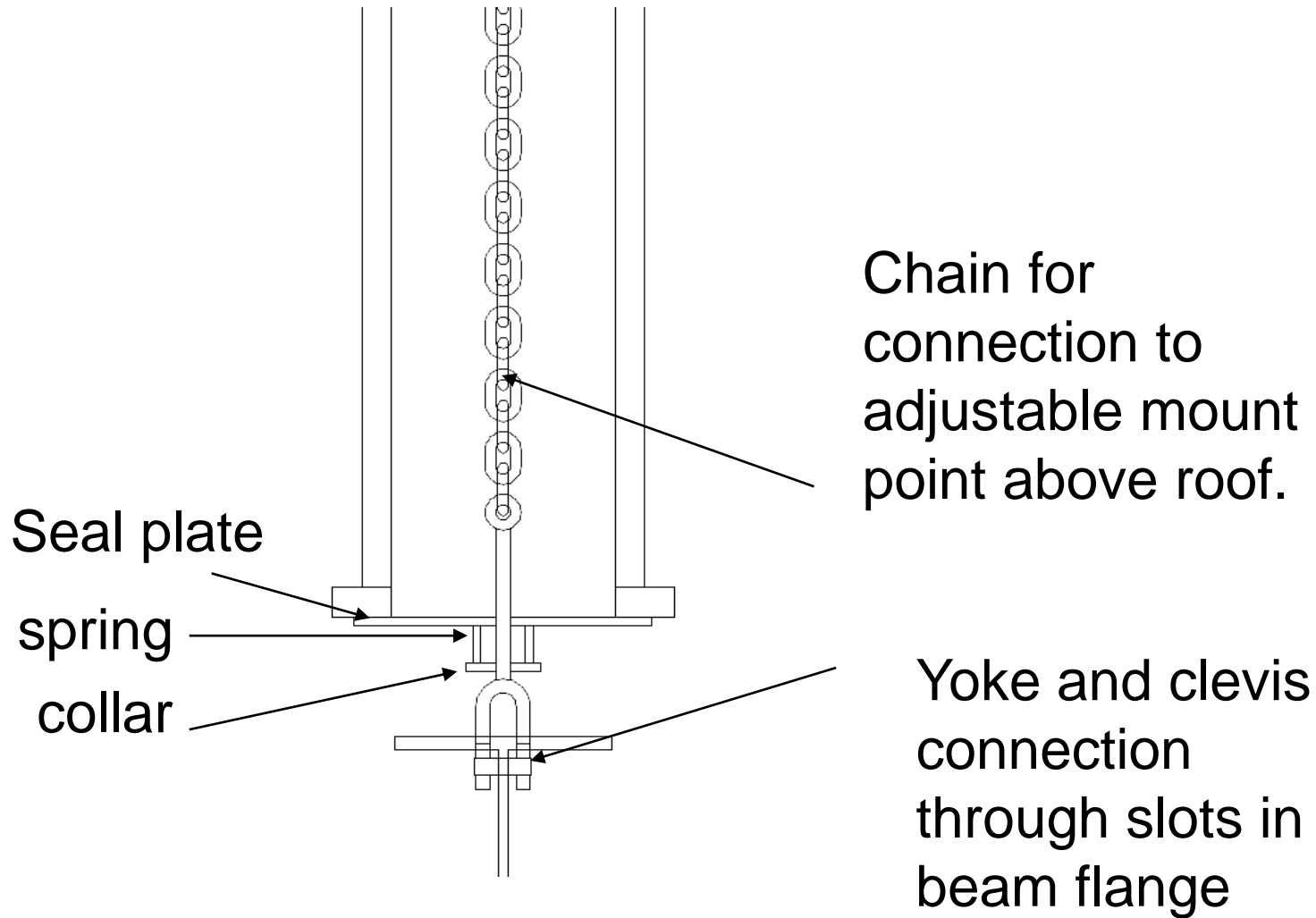
# Back up slides



# APA Rail mounting ISOview

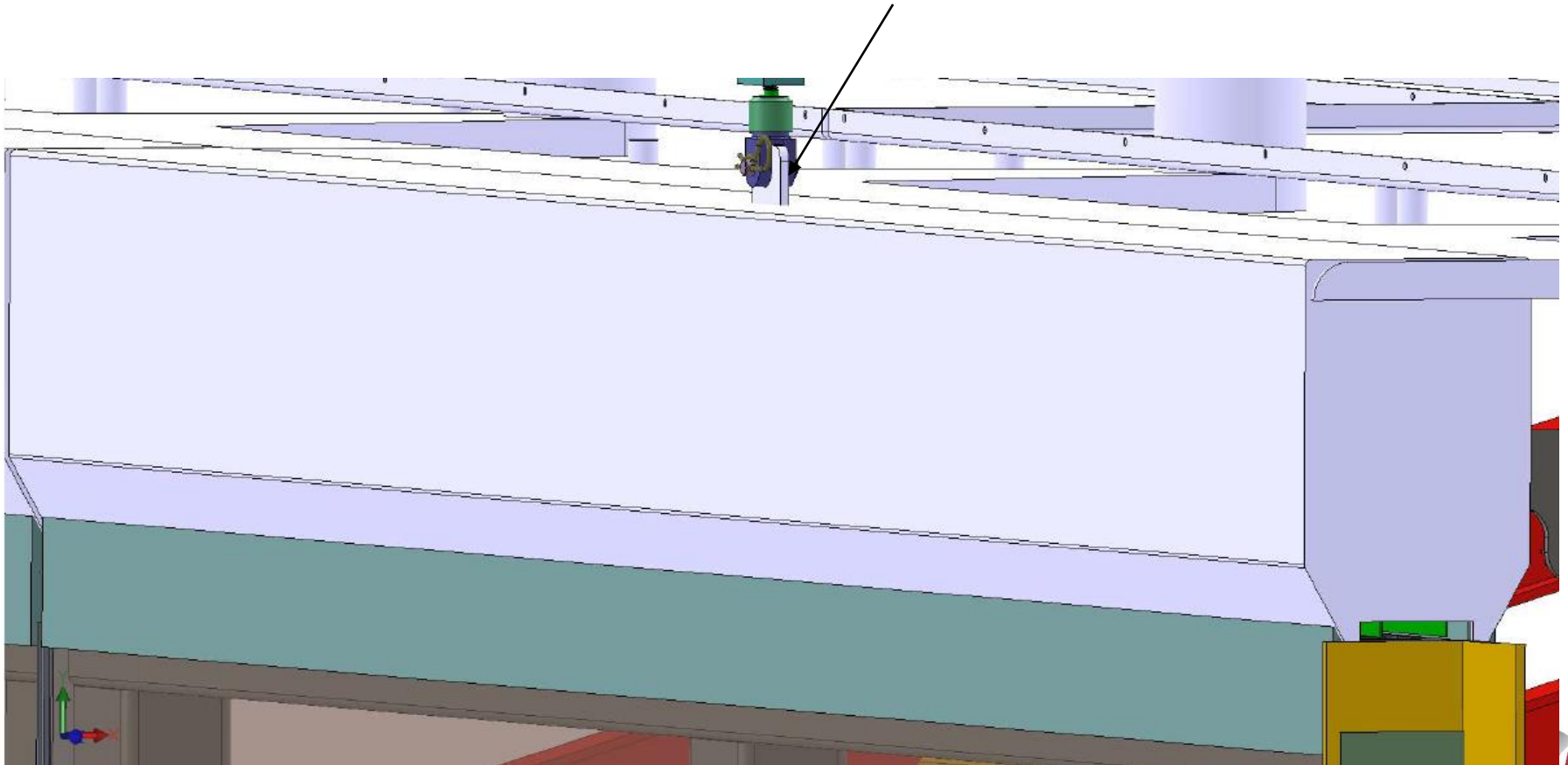


# Rail mounting



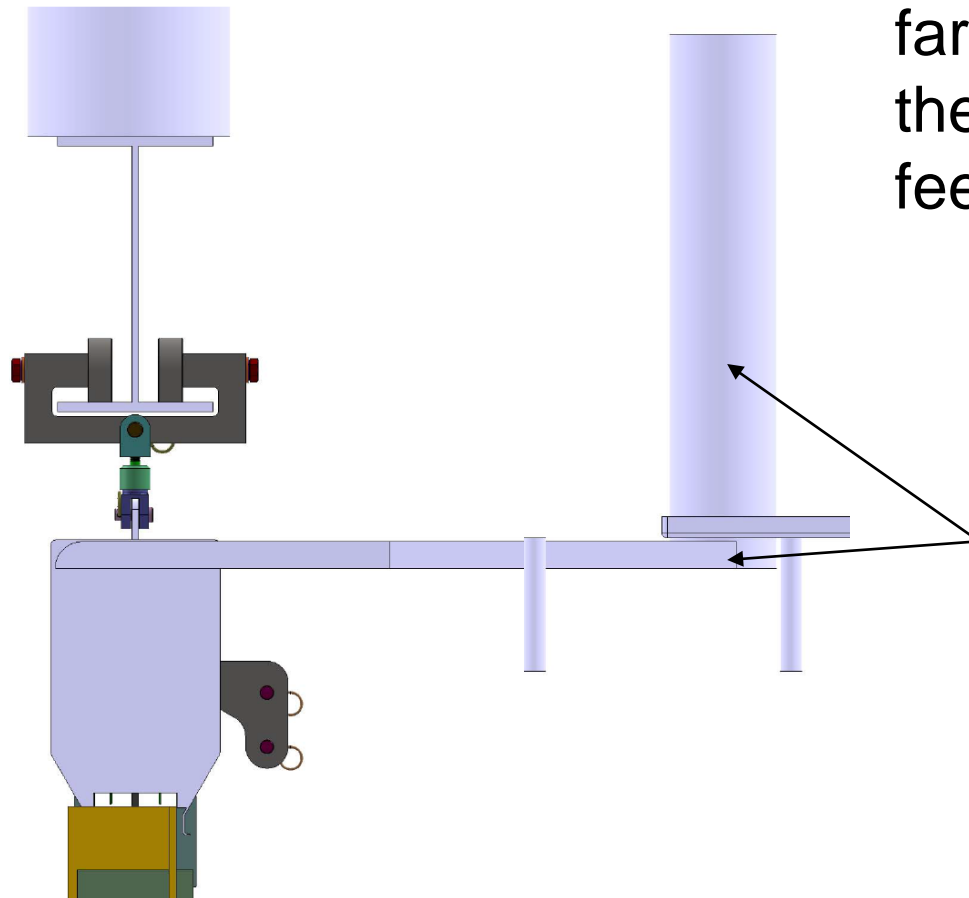
# Fin dimensions

Tab to be added to  
e-plate



# Cable Routing

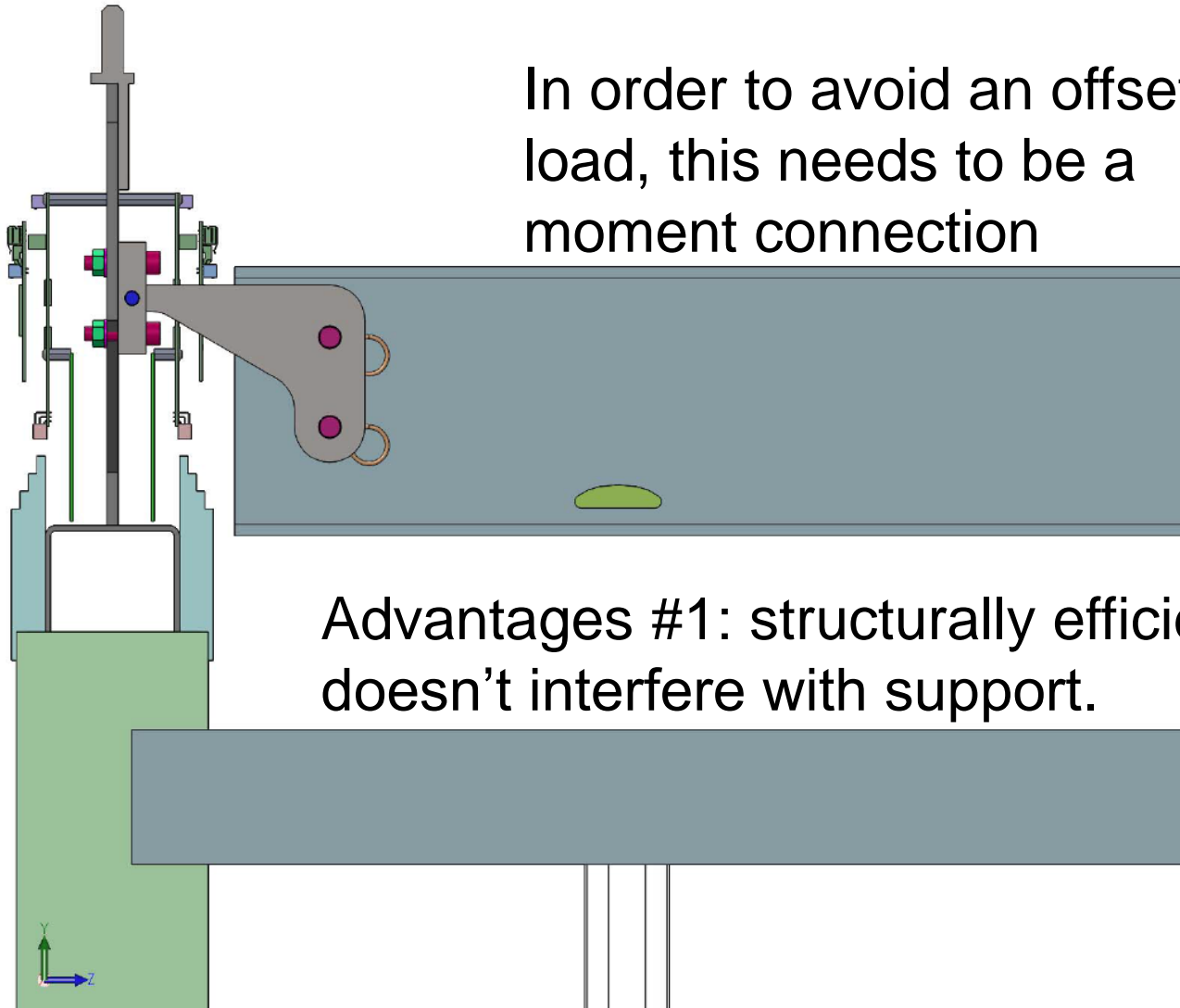
Cable route over top of e-plate and out the front of the faraday cage to the cable feedthrough.



Cable envelope  
(need to adjust  
to miss GP).

# APA to FC interface

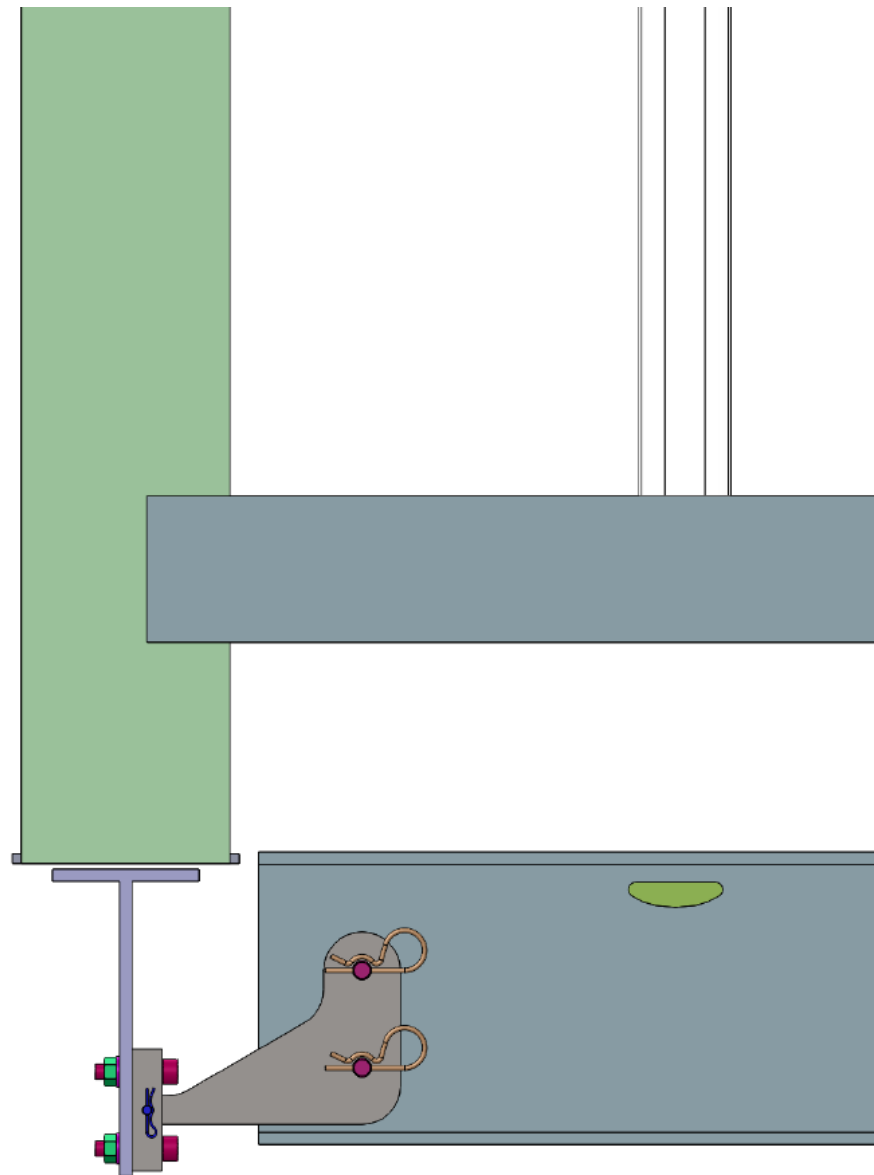
In order to avoid an offset load, this needs to be a moment connection



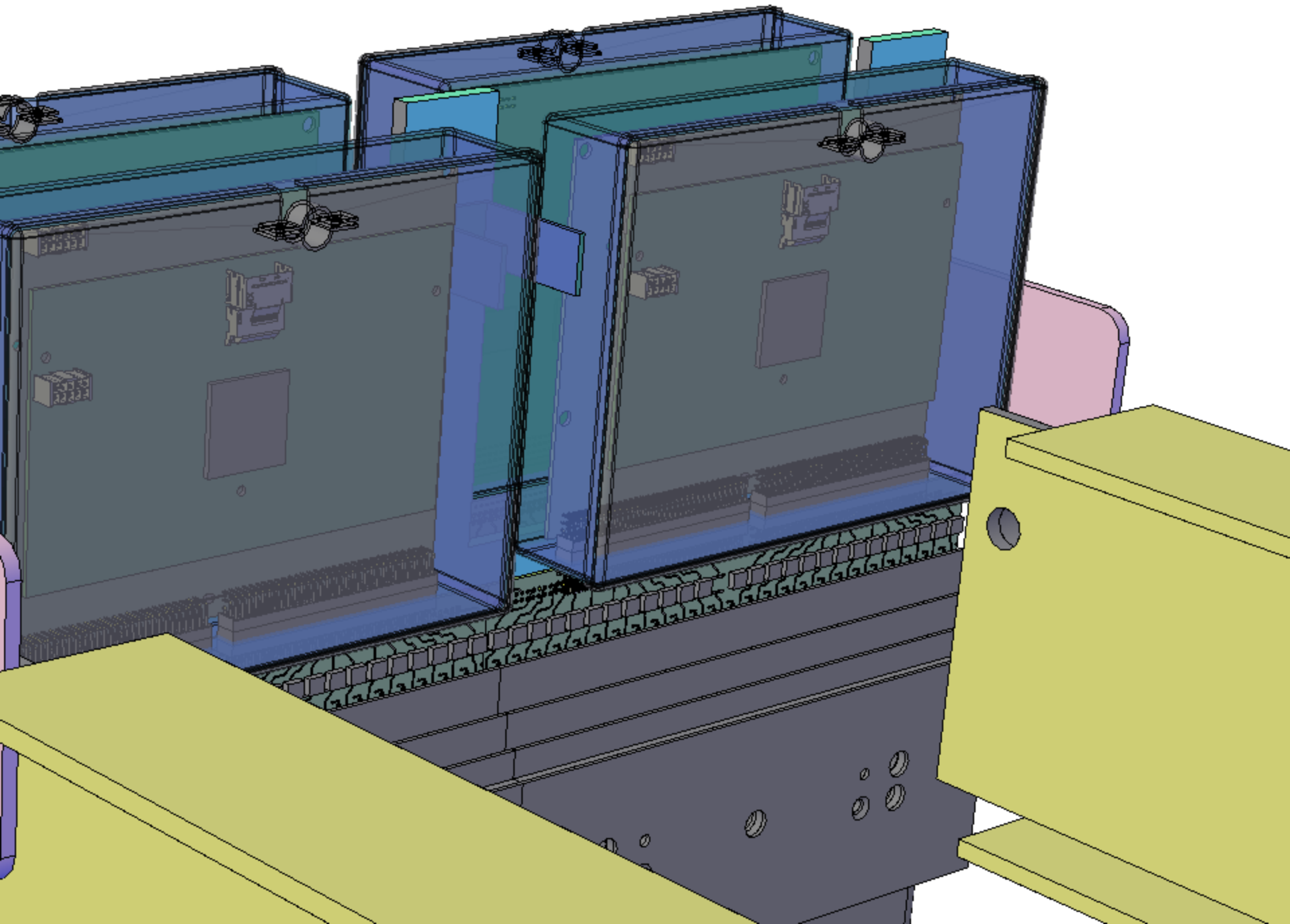
Advantages #1: structurally efficient, doesn't interfere with support.

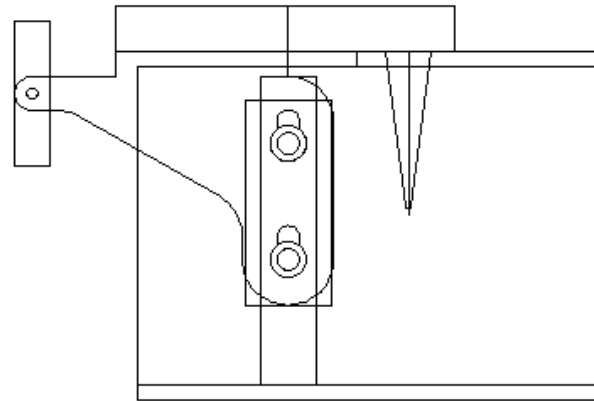
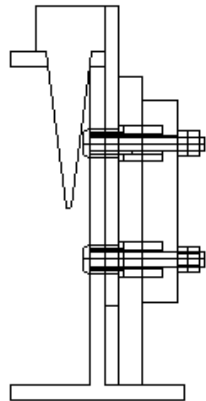
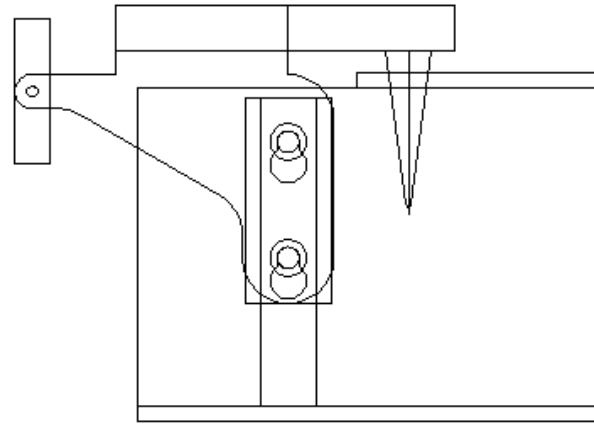
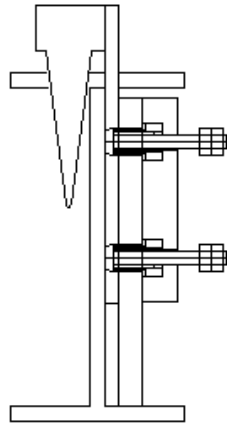
End view of  
bottom  
connection

Tee profile  
mounted to  
bottom of APA  
using spacers  
and frame  
rivnuts

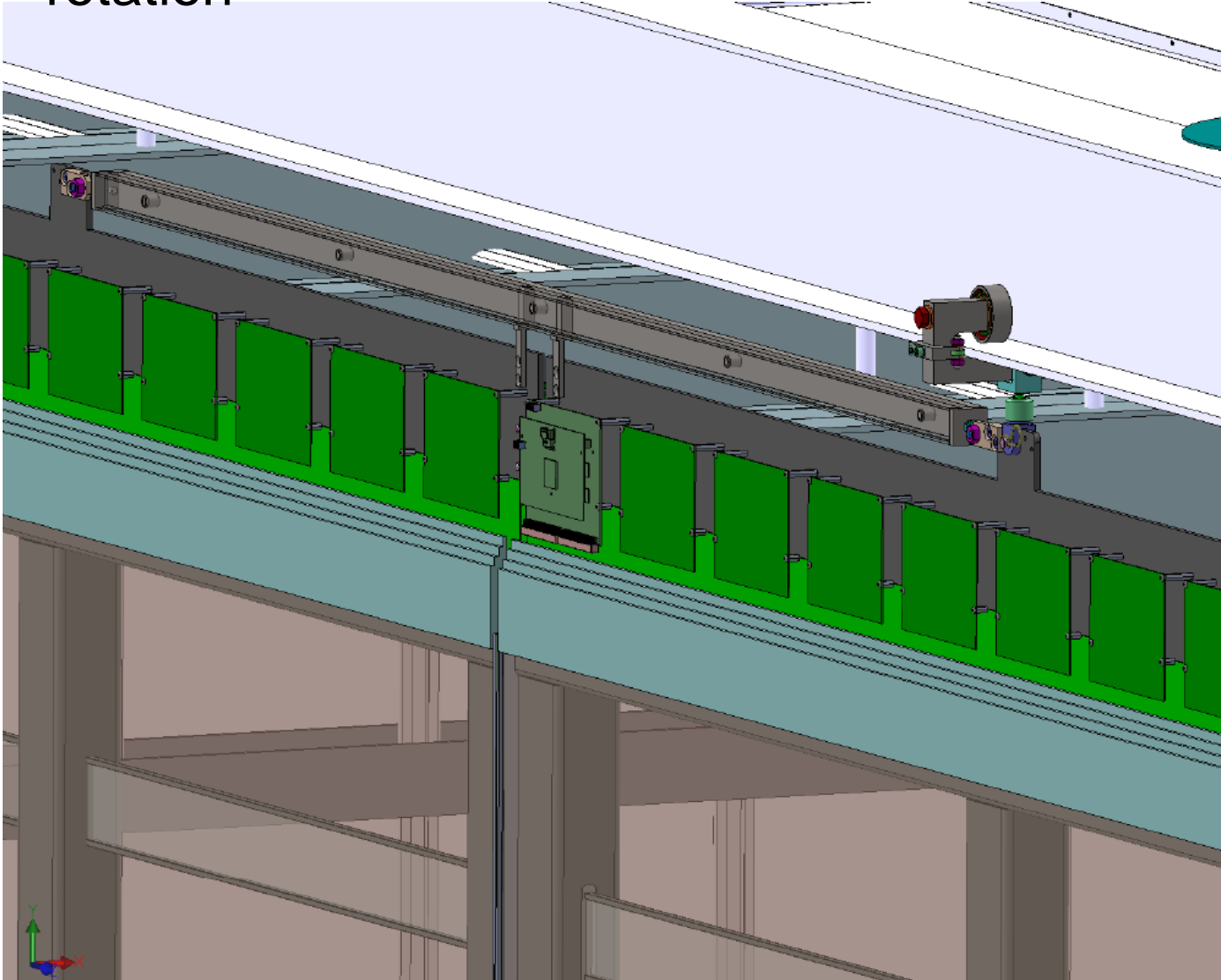




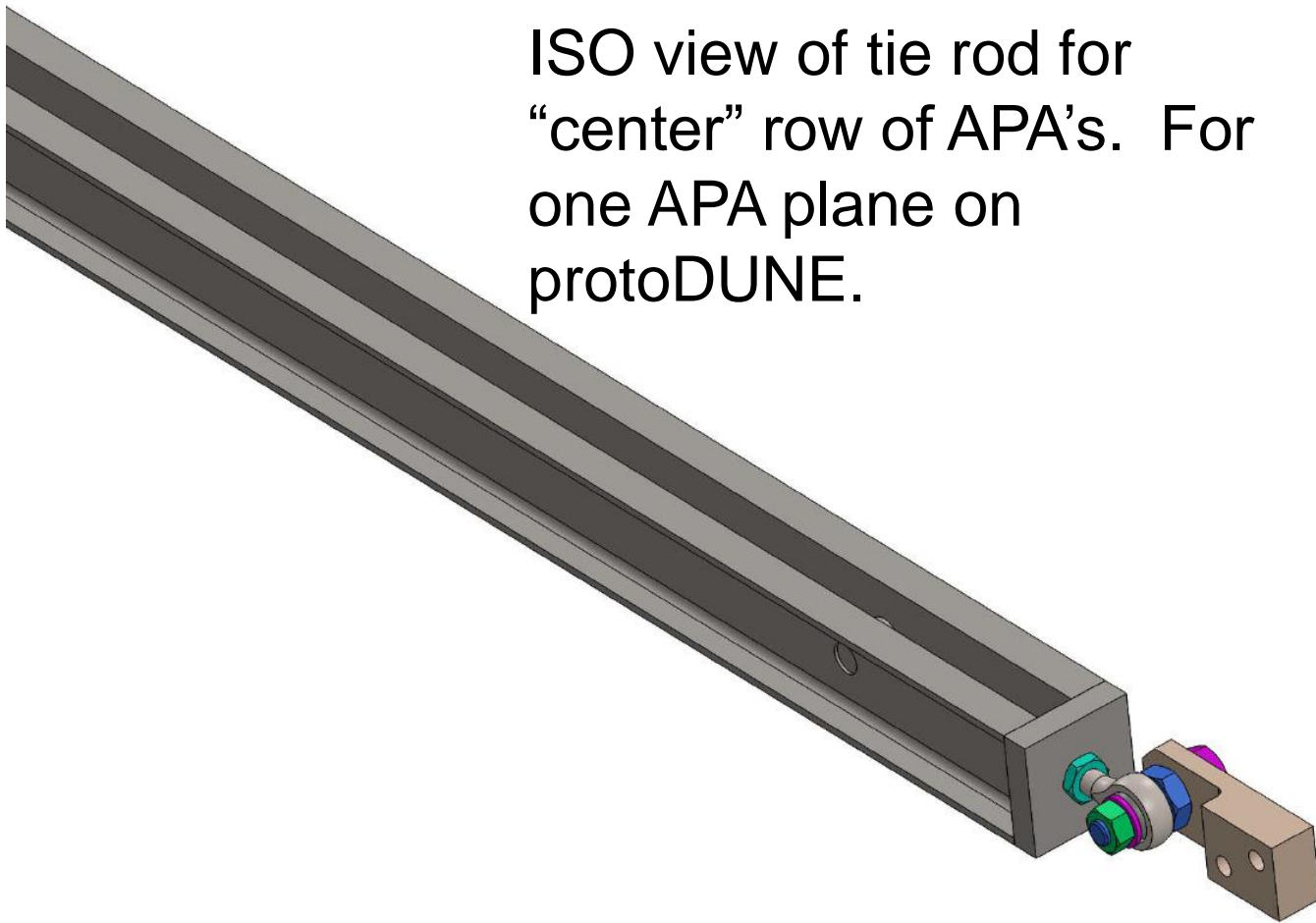




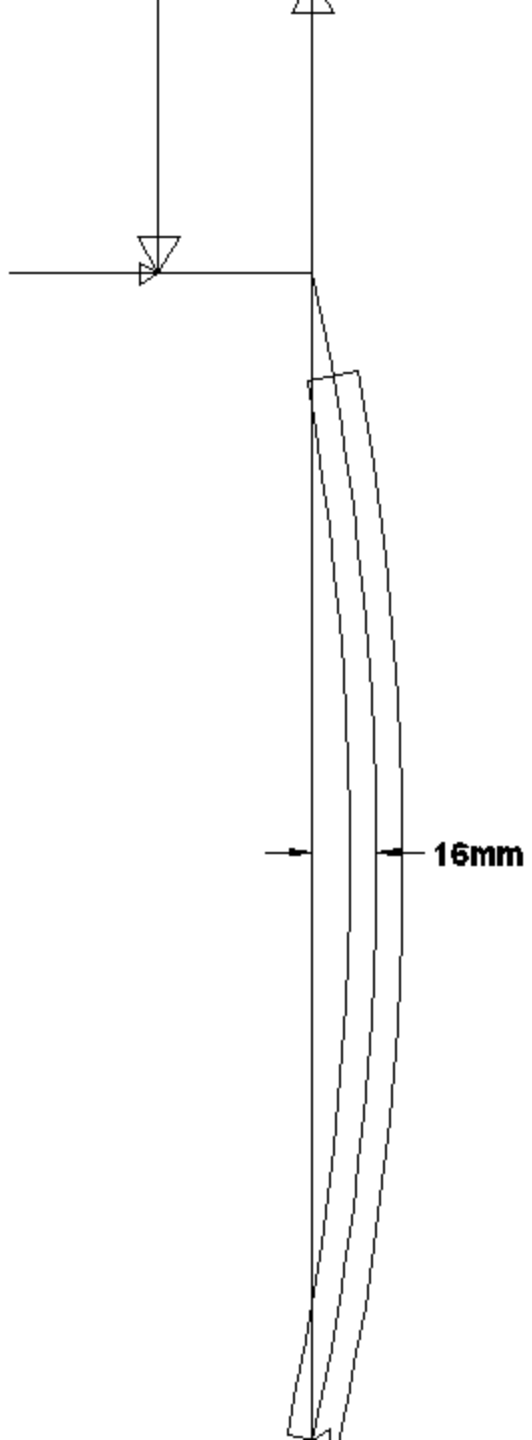
Tie rod between APA's to  
keep spacing and prevent  
rotation



ISO view of tie rod for  
“center” row of APA’s. For  
one APA plane on  
protoDUNE.



200kg/  
APA



200kg/  
APA



## CTE info

- 304 SS 2.8mm/m
- G-10 warp = 2.1mm/m
- Fiberglass axial = 1.65mm/m