APA Design Changes and Integration

Dan Wenman

FS Integration/Installation Planning Meeting

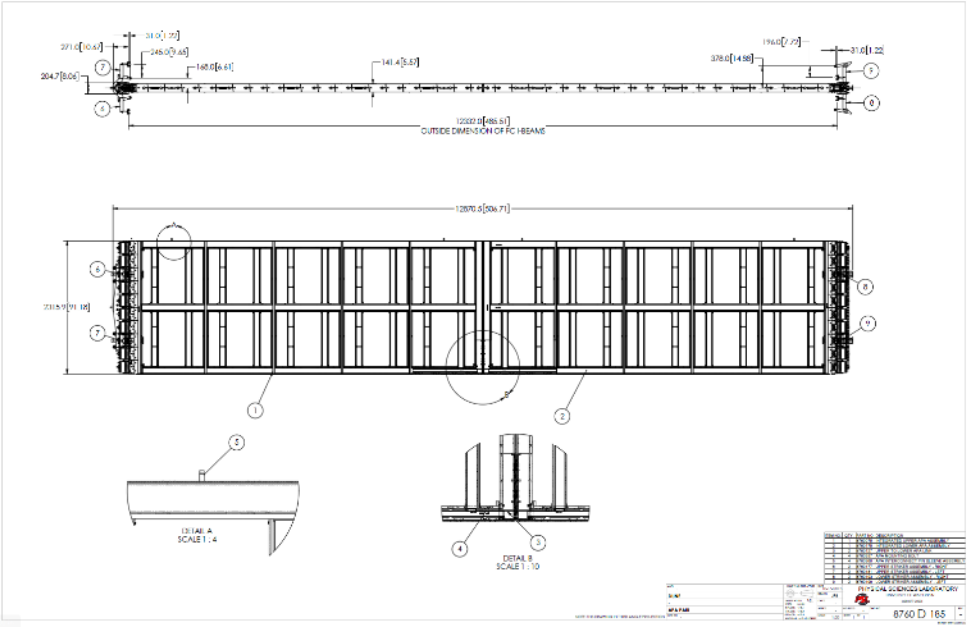
February 3, 2020

Outline

- APA pair design
- Integration
  - SP TPC
  - HV
  - PDS
  - DSS
  - CAL/CI
- APA fixtures
  - Lifting fixtures
  - APA assembly fixture
- Schedule

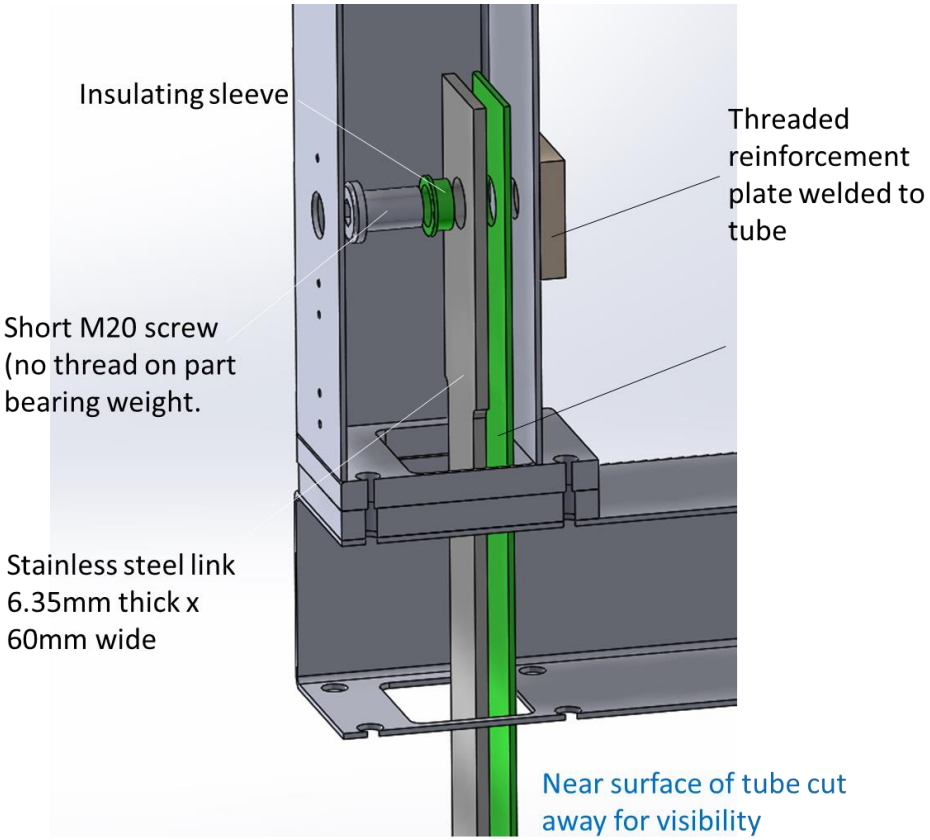
APA pair design

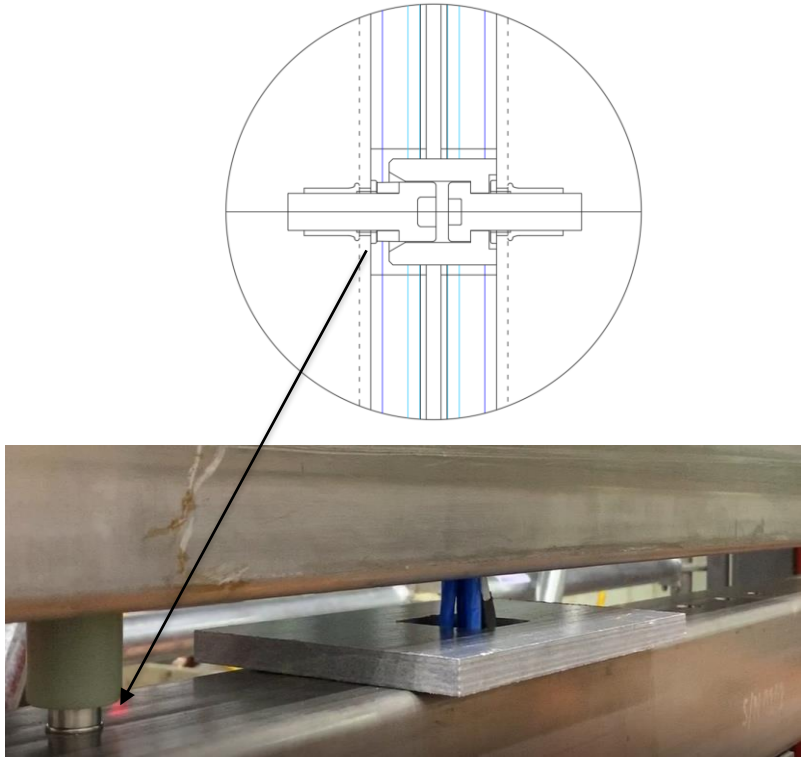
- An assembly of and Upper and Lower APA
- Work in Process drawings and models can be found in EDMS project CERN-0000193827
- The APA pair mass <1200kg. Will be posted to EDMS soon.



Connection between upper and lower APA

- APA to APA links support the Lower APA.
- Alignment pins control the alignment between the top and bottom APA

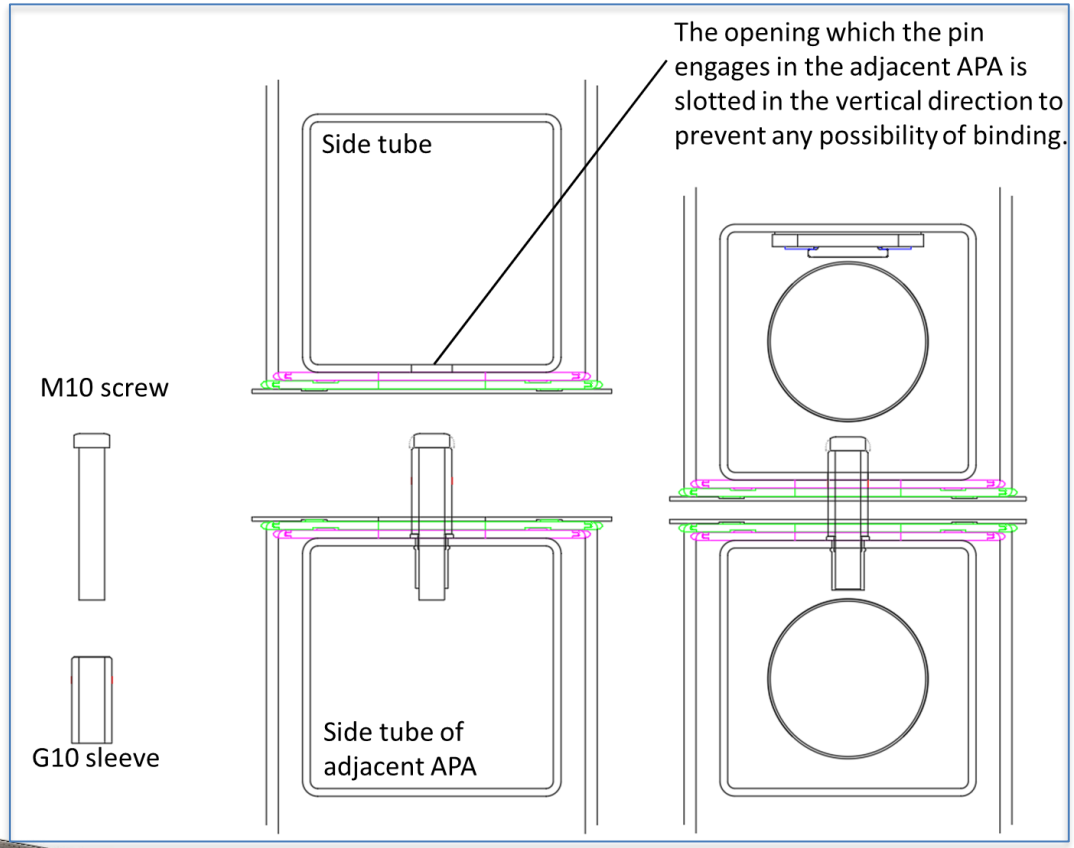


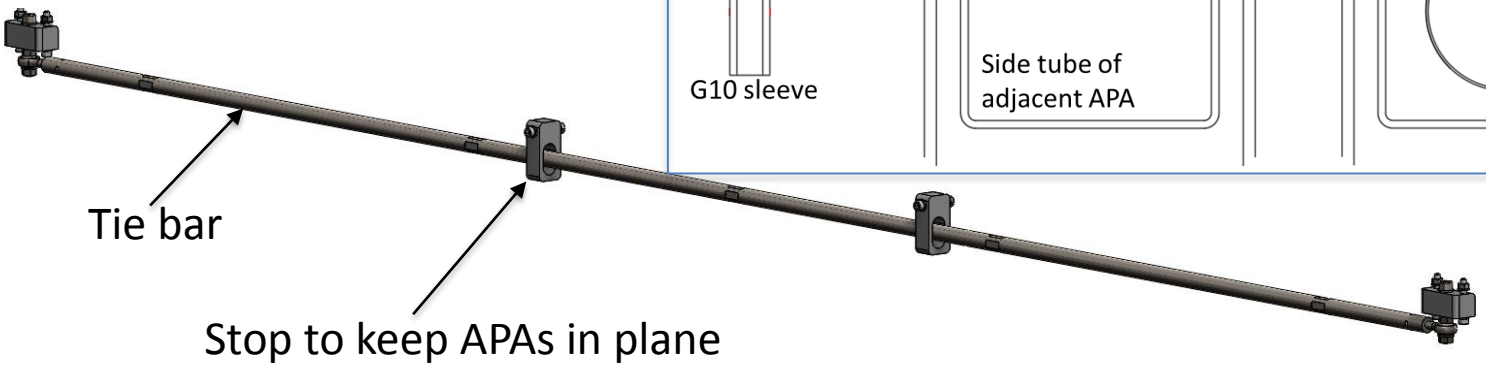


1 Pin-to-hole and 1 pin-to-slot engage and control alignment

Connections between APA pairs

- Alignment pins and slots to align edges of an APA to its neighbor
  - “Telescoping” pin for gaps that “open up” during cooldown to be designed
- Tie bars to maintain spacing and to keep the APA plane flat
  - Connect APA pairs mounted on a single DSS beam

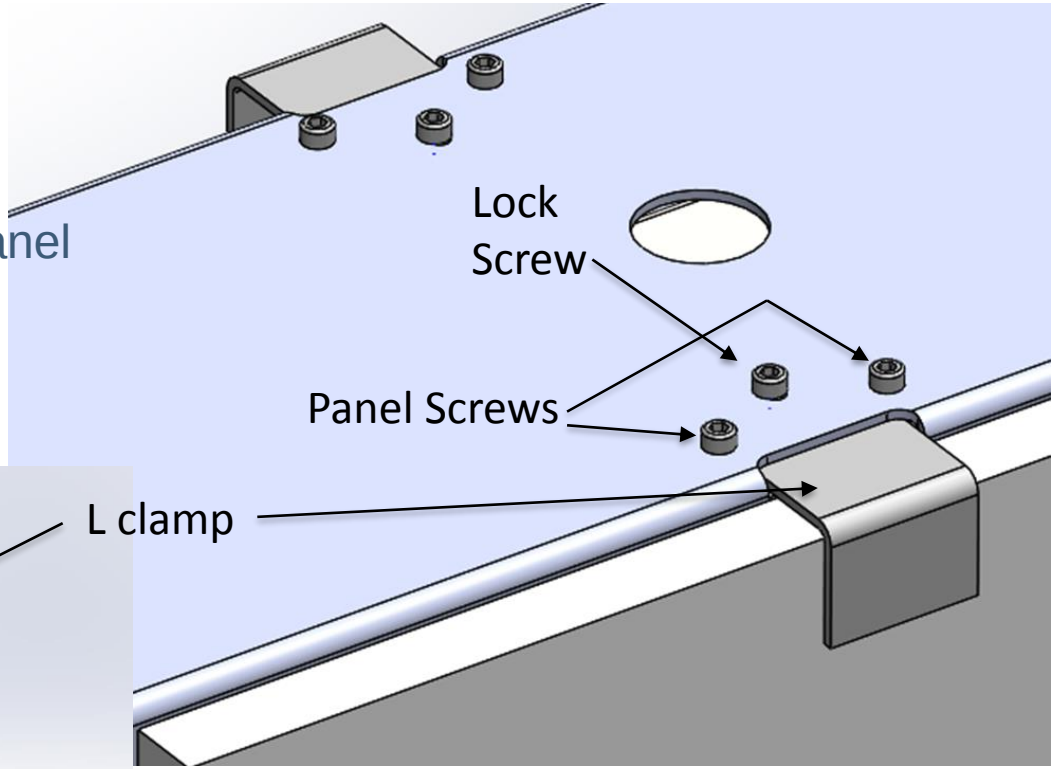




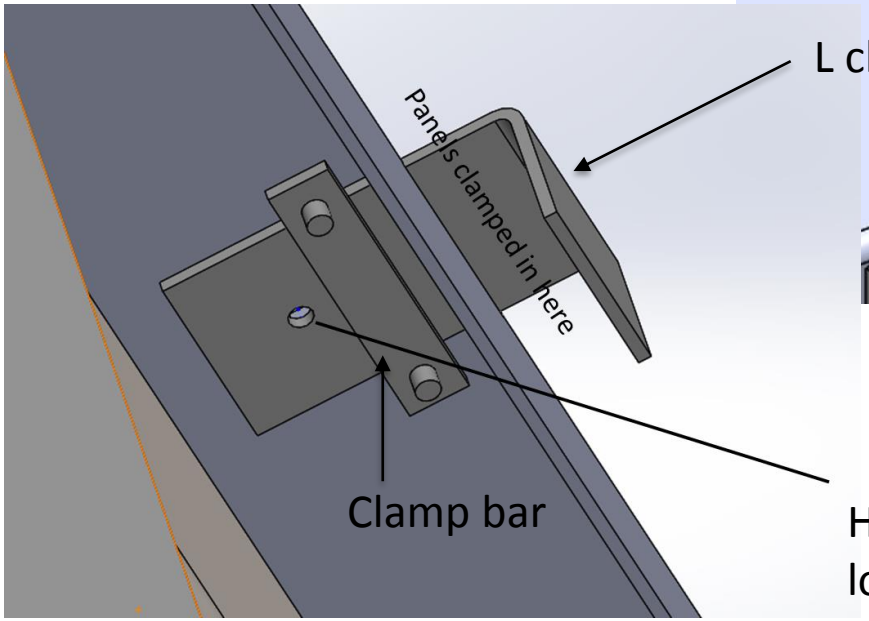
APA Protection

Proposal for securing panels

1. All Clamp bars are loose
2. Panel is positioned
3. L clamp slides in against the panel
4. Panels screws tightened
5. Lock screw is tightened



View of installed panel

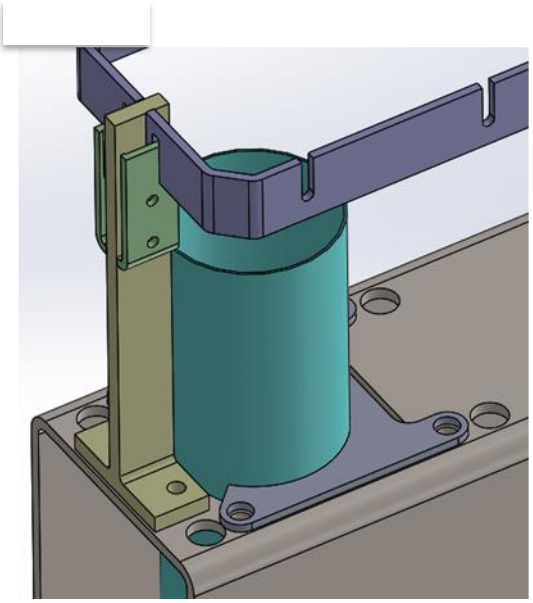


View from underneath channel

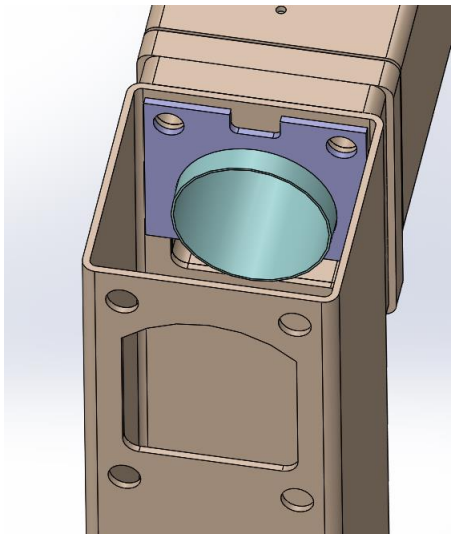
Images from Lee Greenler

APA to SP TPC – cable conduits

- Cable conduits have been added to the APA side tubes to allow for pulling CE cables through the side tubes.



Conduit is supported on head end

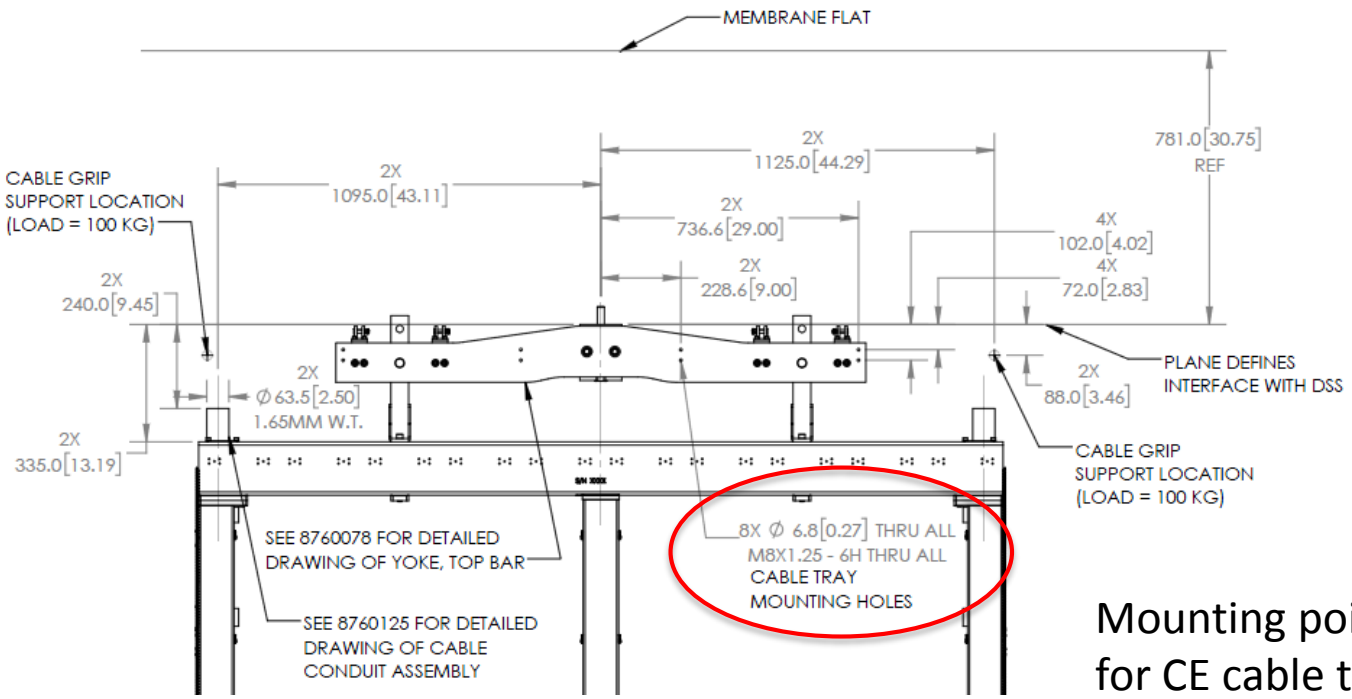


Conduit is constrained at foot end, but does not carry load

Cable support mounts to APA head tube – to be designed

APA to SP TPC - CE cable tray

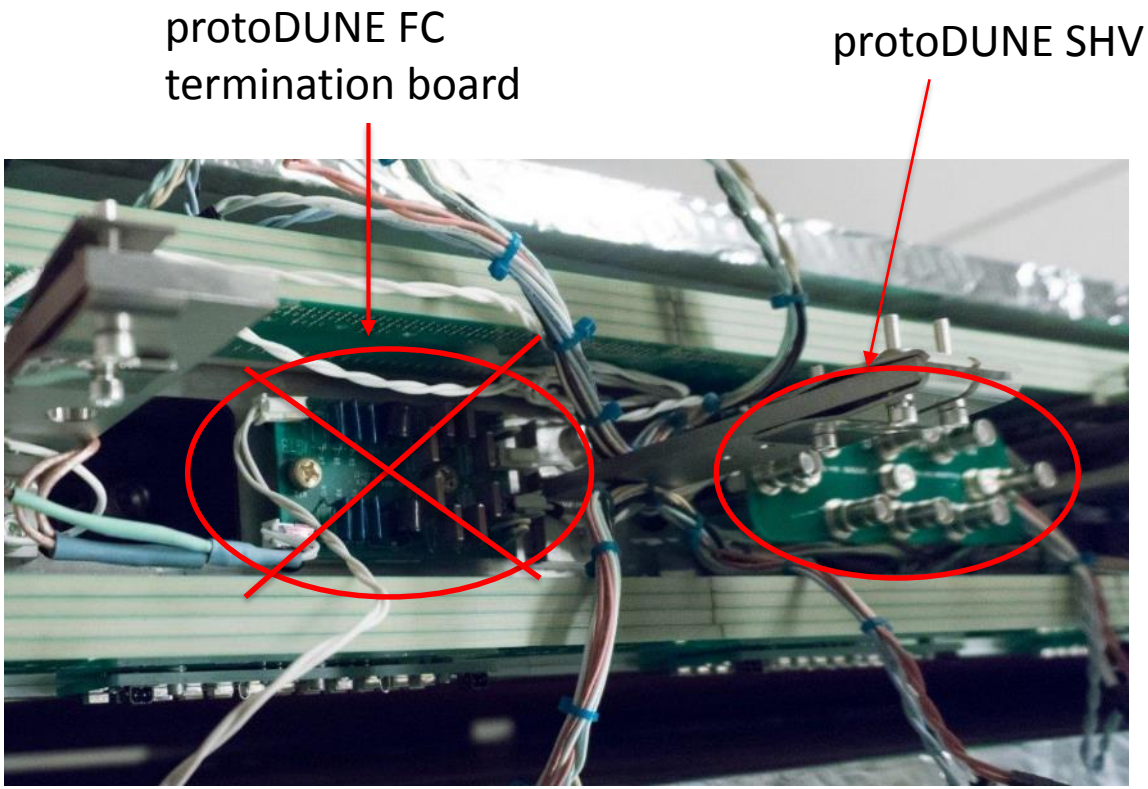
- CE cable tray is mounted on the APA yoke during installation
- Tray is transferred to the DSS.
- Effects of off balance load needs to be evaluated and addressed.



Mounting points for CE cable tray

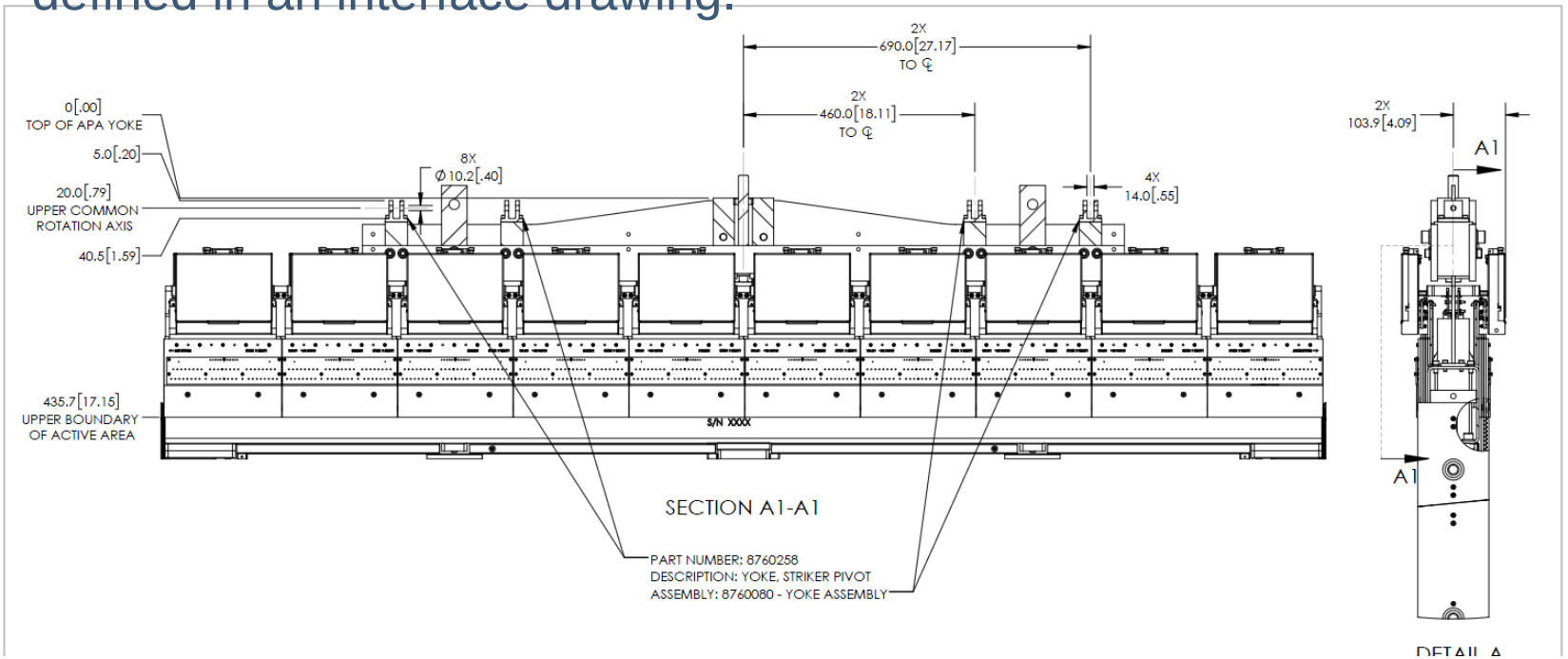
APA to SP TPC – SHV board

- The SHV board mounts to the head tube. The number connectors needed has been reduced and the SHV board design will be modified accordingly.



APA to HV - Latches

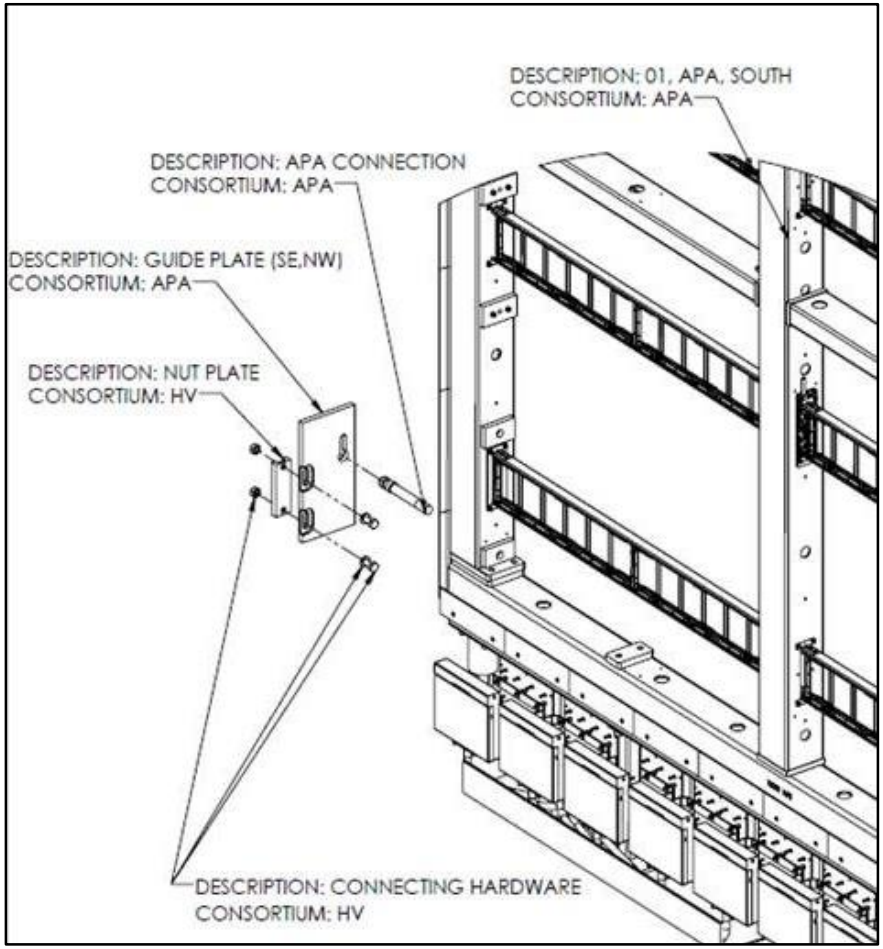
- Latches are HV responsibility.
- The latch mounting/pivot points are the interface and these feature are defined in an interface drawing.



FC latch mount points

APA to HV – EW Connection

- The lower APA is connected to provide some stability and control the relative positions.
- 6 locations near the head tube of the lower APA
- Responsibilities for hardware are defined.
- The protoDUNE design needs to be modified for DUNE

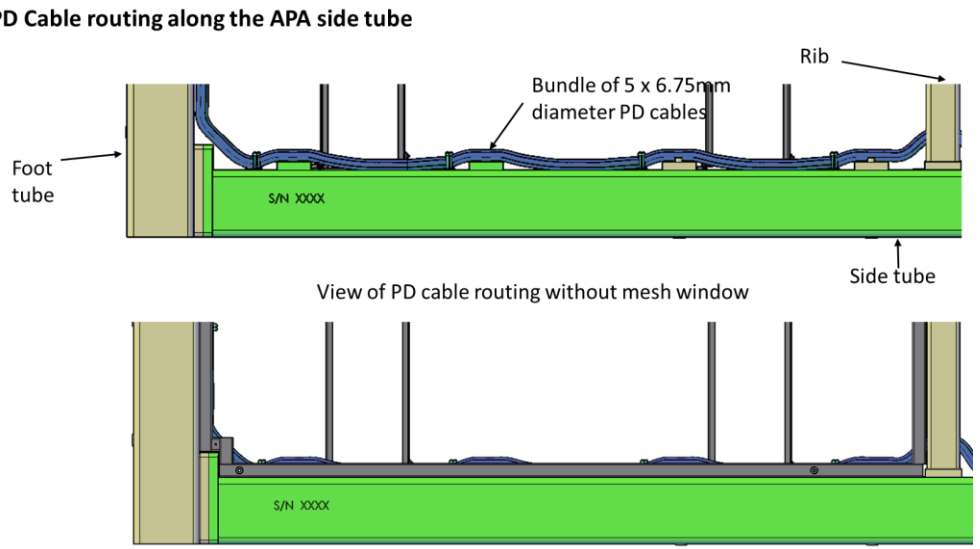


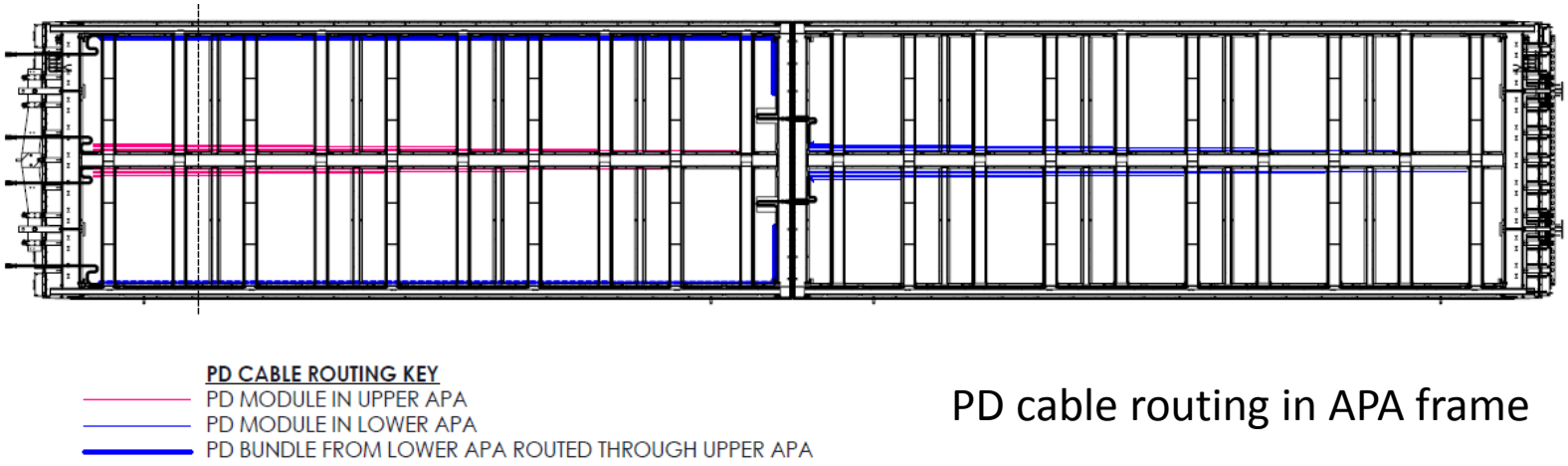
Hardware shown is from protoDUNE

here is the NP04 implementation of the design. FD specific design is expected to be similar, with one plate at the bottom of the TPC and one at mid-height.

APA to PD – Rails and Cables

- PD rails are preinstalled in the APA frame
- PD (and temperature sensors) cables are pre-routed to the APA frame before wire wrapping
- APA provides cable tie anchors on frame and cable ties.
- Cable slack will be controlled.
- The behavior of the cable harnesses (and new APA mesh panels) will be tested in the PSL cold box in March.

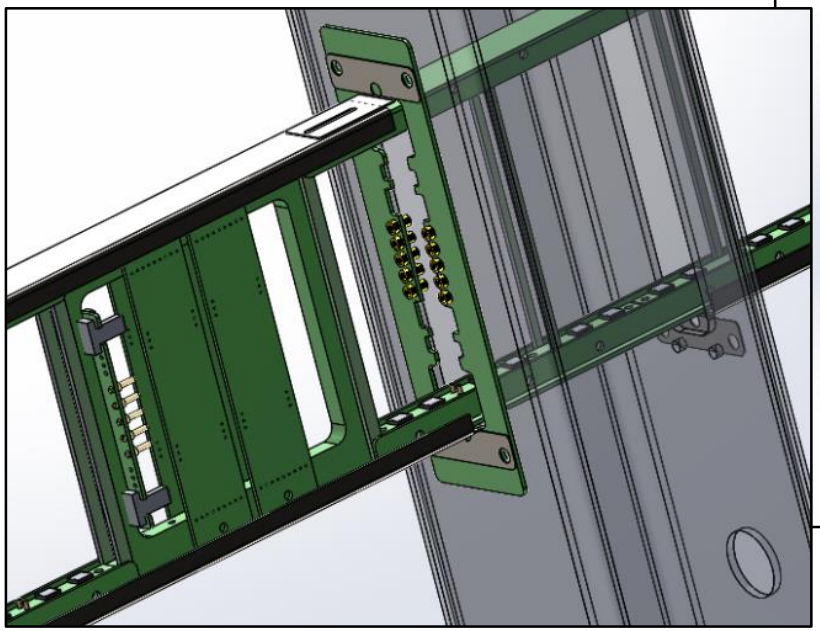




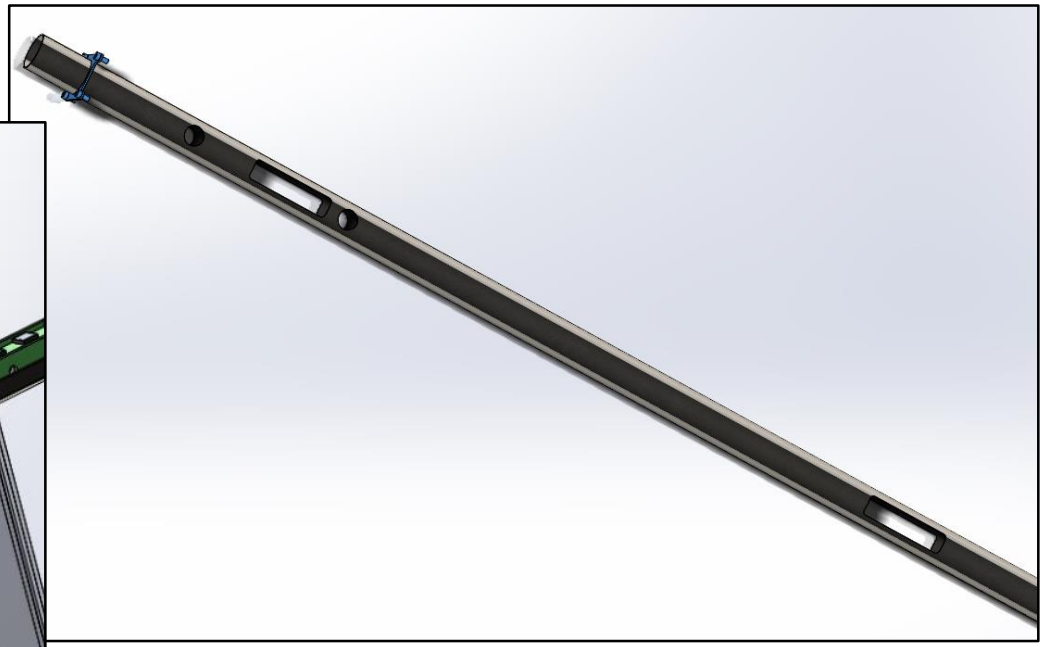
PD cable routing in APA frame

APA to PD - PDs

- Slots have been added to the CE conduit to allow PDs to be inserted with conduits pre-installed.
- The dimensional interface has been captured in interface drawings.



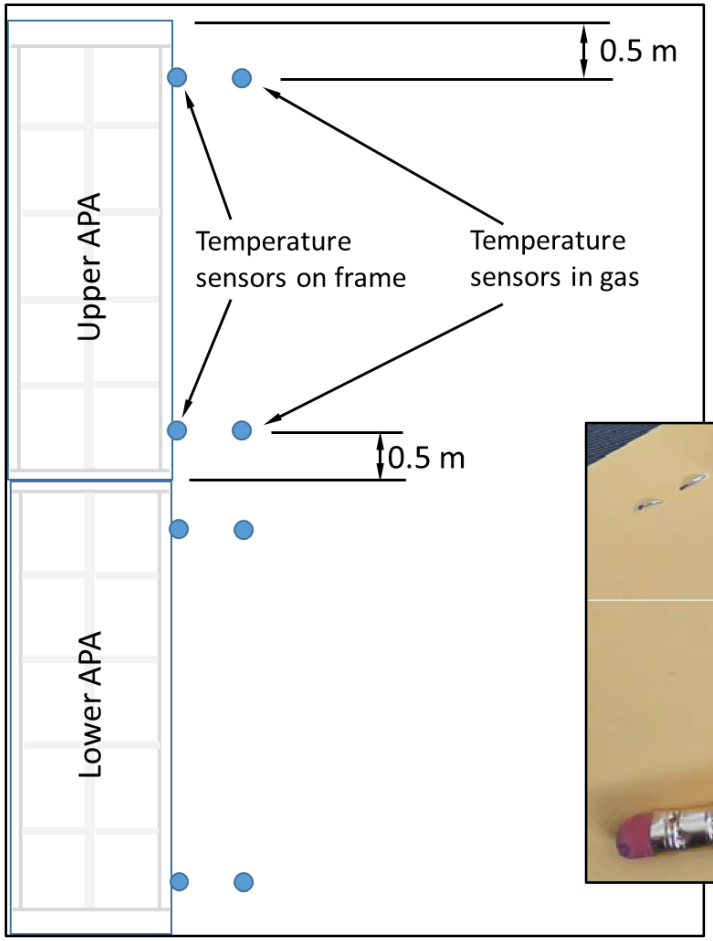
PD mount



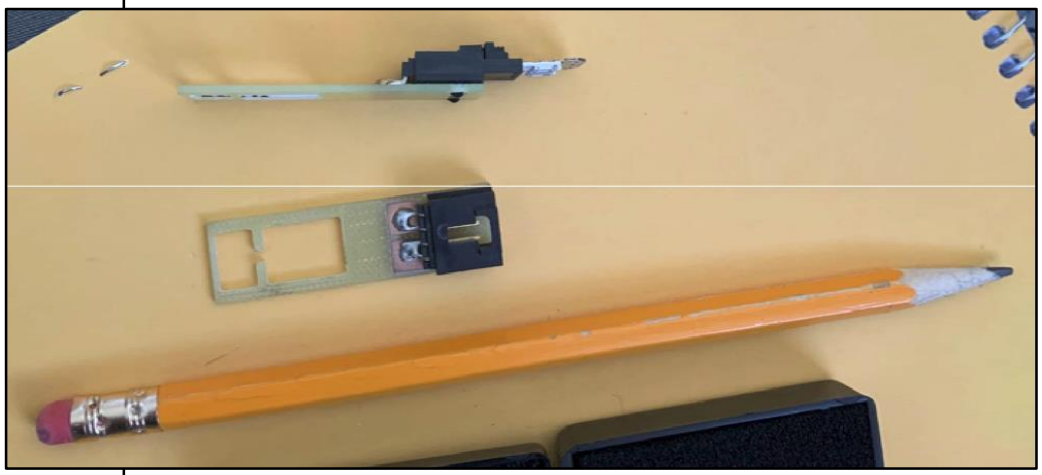
Conduit with slots

APA to CAL/CI Temperature Sensors

- Proposal for temperature sensor mounting locations.
- Provides thermal gradient in height and delta t between argon and frame and between two foot tubes.
- APA is working with CAL/CI and PDs to determine mounting and cable routing



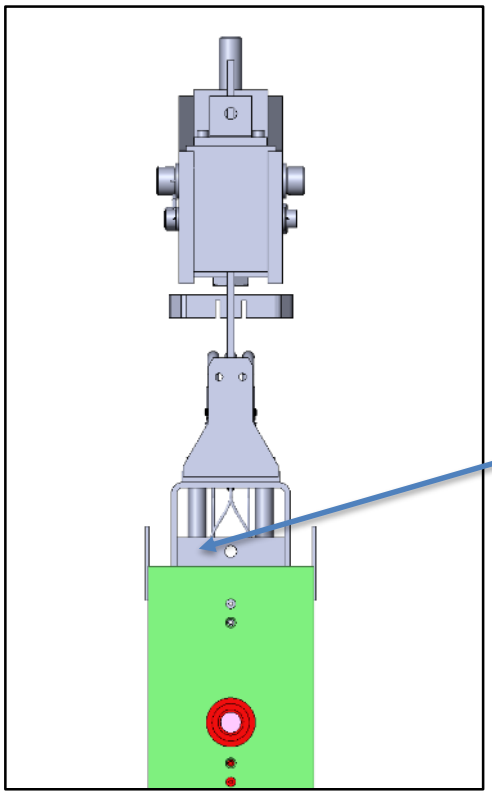
Sensor Locations



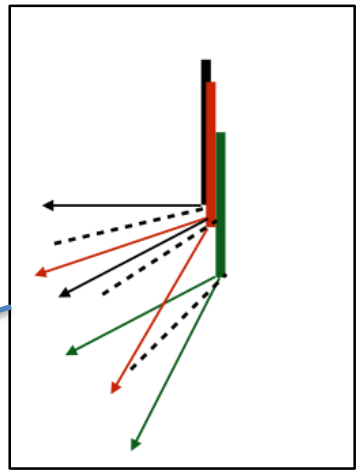
Sample sensor - Top view shows sensor with both male and female connectors

APA to CAL/CI - Lasers

- Laser diffusers – provisional tapped holes will be provided in the APA



Head end of Upper APA

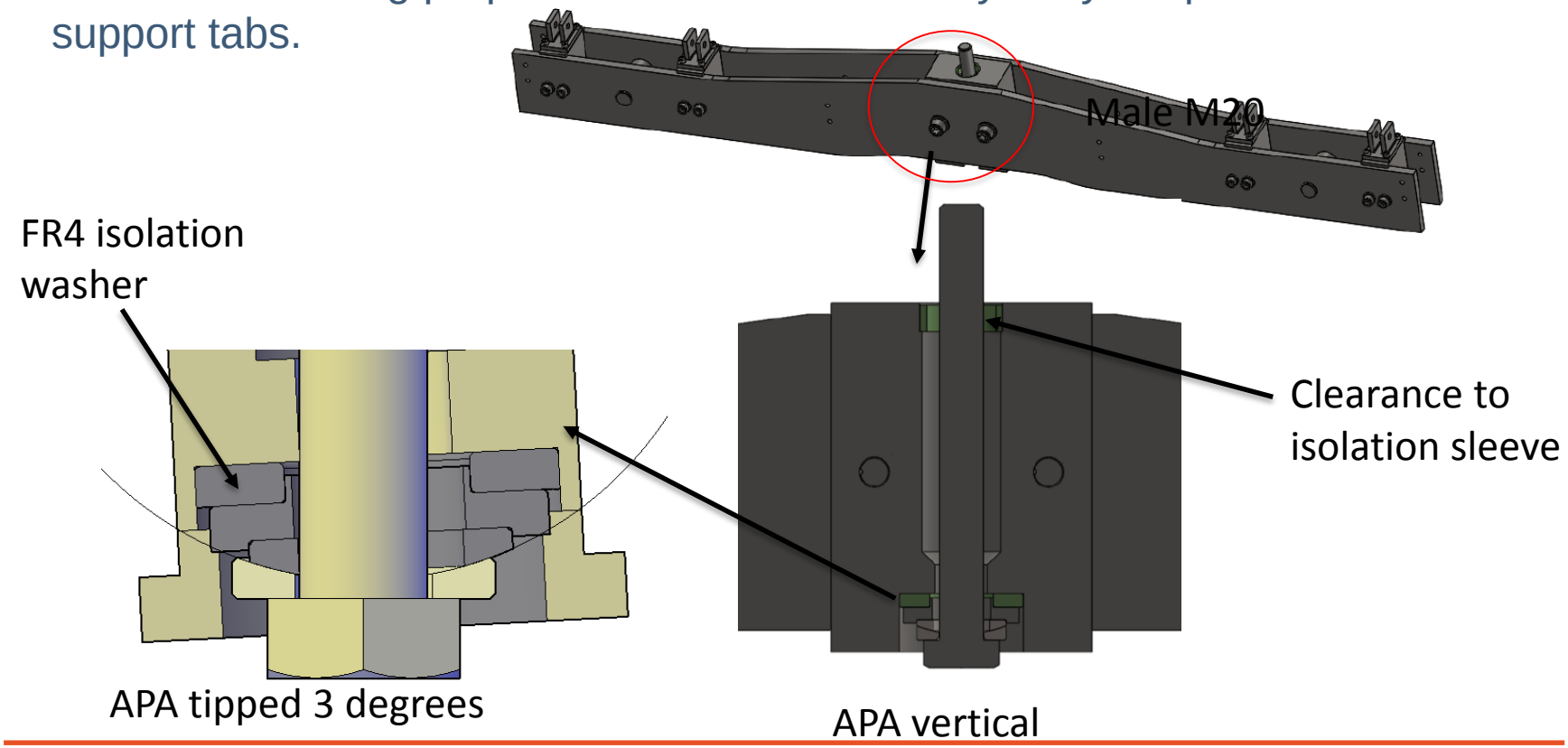


Staggered diffuser with differing distal tips

https://indico.fnal.gov/event/21445/session/12/contribution/107/material/slides/0.pdf

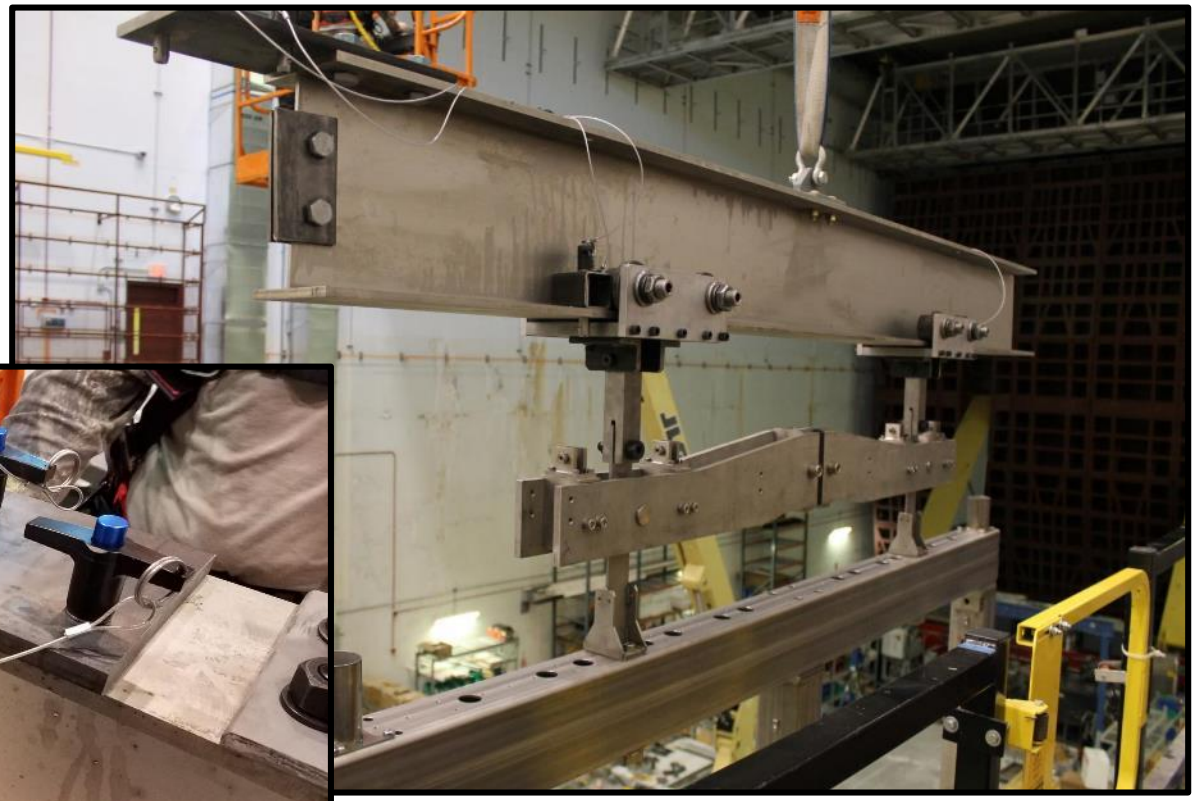
APA to DSS - Yoke

- A Male M20 bolt is used to mount the APA pair to the DSS
- Support point has compliance to avoid bending stress, allows APA to hang straight when installed and provides electrical isolation
- APA is considering proposal to mount DSS trolleys to yoke plates instead of support tabs.

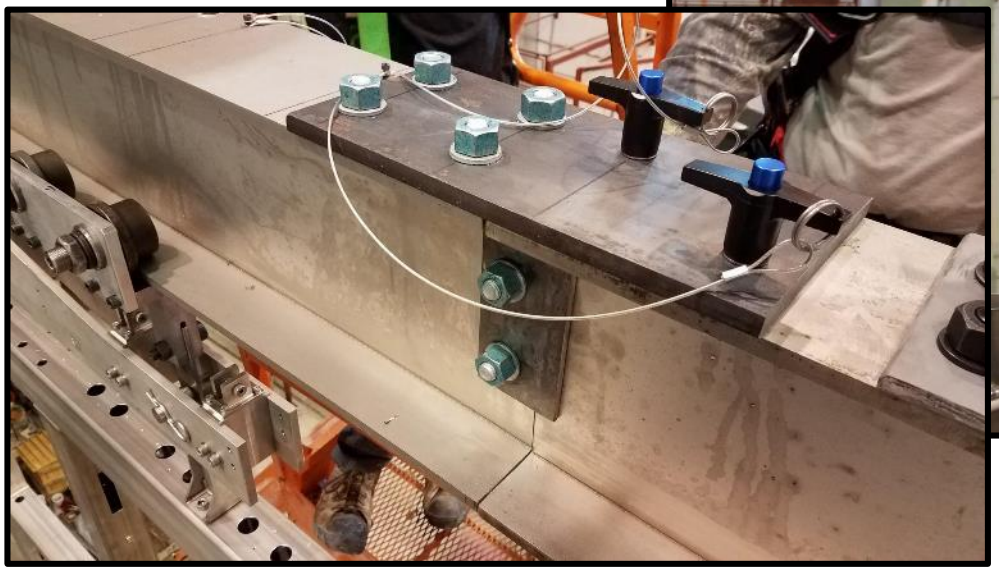


Upper APA lifting

- Upper APA lifting fixture has been successfully tested in Ash River



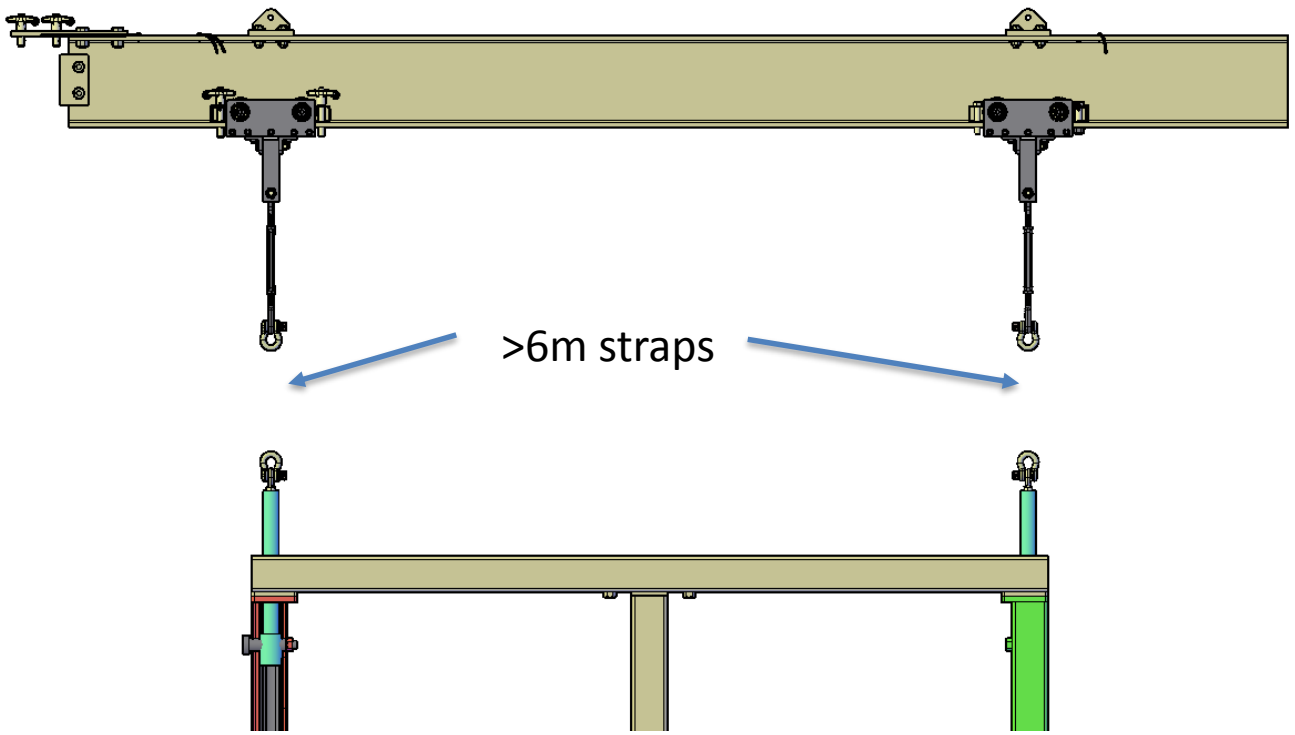
Upper APA supported on lifting beam



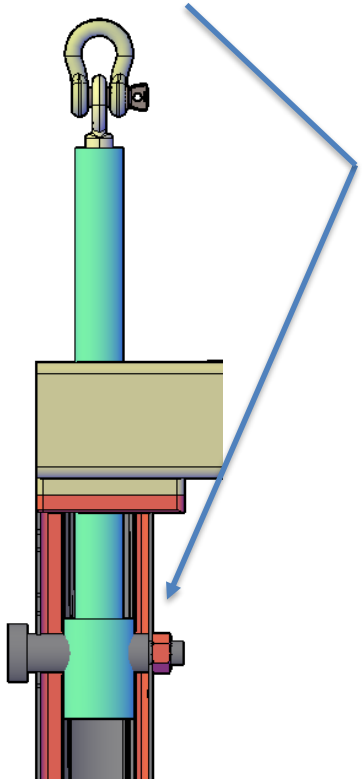
Lifting beam connected for transfer to assembly fixture

Lower APA lifting - Proposal

- Lower APA assembly fixture design is being developed
- Similar to top APA but with long straps.
- Connects to APA using 1 M20 hole per side



Lifting link inserts into conduit and is secured by 20mm bolt/pin



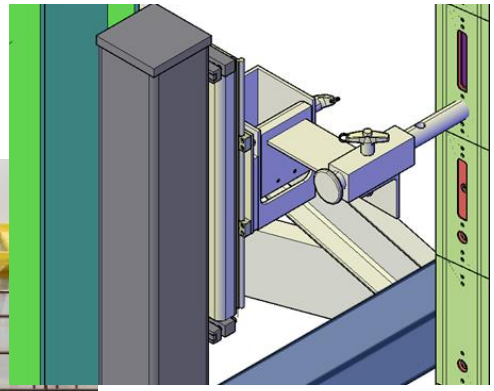
APA assembly fixture

- Bottom APA is delivered to the actuator stand and stabilized.
- Top APA is delivered to beam above and stabilized
- Bottom APA is lifted and connected to the top APA

APA assembly fixture

- Stabilizers do not support any load but position and guide the APAs
- The actuator stand lifts the lower APA to make connections to the upper APA
- Stabilizers pivot out of the way to allow the assembled pair to pass by
- Successfully tested at Ash River

Stabilizer being deployed



Stabilizer

Actuator stand

Pre-production APA

- We always thought necessary to build a pre-production APA to test all interfaces with other Consortia, in particular CE and PDS
- The pre-production APA would be tested in the cold box at CERN in advance of the APA Final Design review and would serve as input for the APA Final Design Review
- If no additional modifications are needed, the pre-production APA would be installed in ProtoDUNE-II

APA Schedule

- 60% APA electrical review (18-19 Nov. 2019, PSL) concluded with fair number of recommendations
- Task Force to advise on mechanical and electrical specifications: T. Shaw (chair), A. Laundrie (design engineer), M. Sodeberg, M. Eads, J. Evans, G. Miller, T. Jones, A. Ezeribe
- Transport box 60% design review late April
- Make transport box prototype (USA), test at Ash River & SURF
- Construction of pre-production APA starting this Spring
- Final APA Design Review this Summer
- Initiate production of ProtoDUNE-II APAs

APA Production

- Production of APAs
  - 6 winders in US (2 UChicago, 2 Yale, 2 PSL)
  - 4 winders in UK

APA Production/year

Production Site	2020	2021	2022	2023
Daresbury	4 to 6	24	24	24
Yale		2	9	13
Chicago		2	9	13
PSL		6	10	12
TOT	**4 to 6**	**34**	**52**	**62**

- End of APA Production - detector module #1 September 2023
- End of APA Production - detector module #2 April 2026