DUNE APA Prototyping

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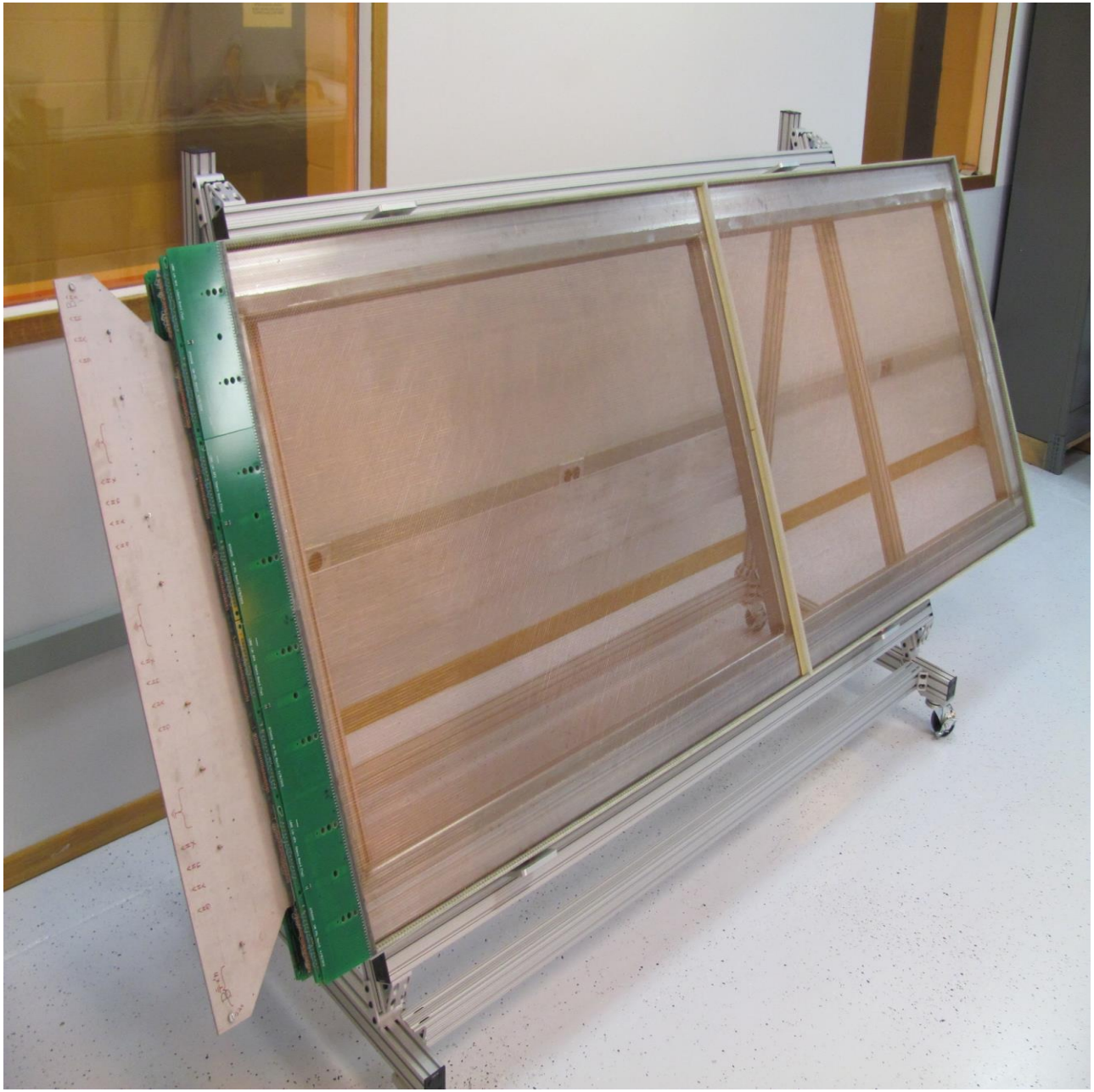
DUNE APA PDR

27 March 2019

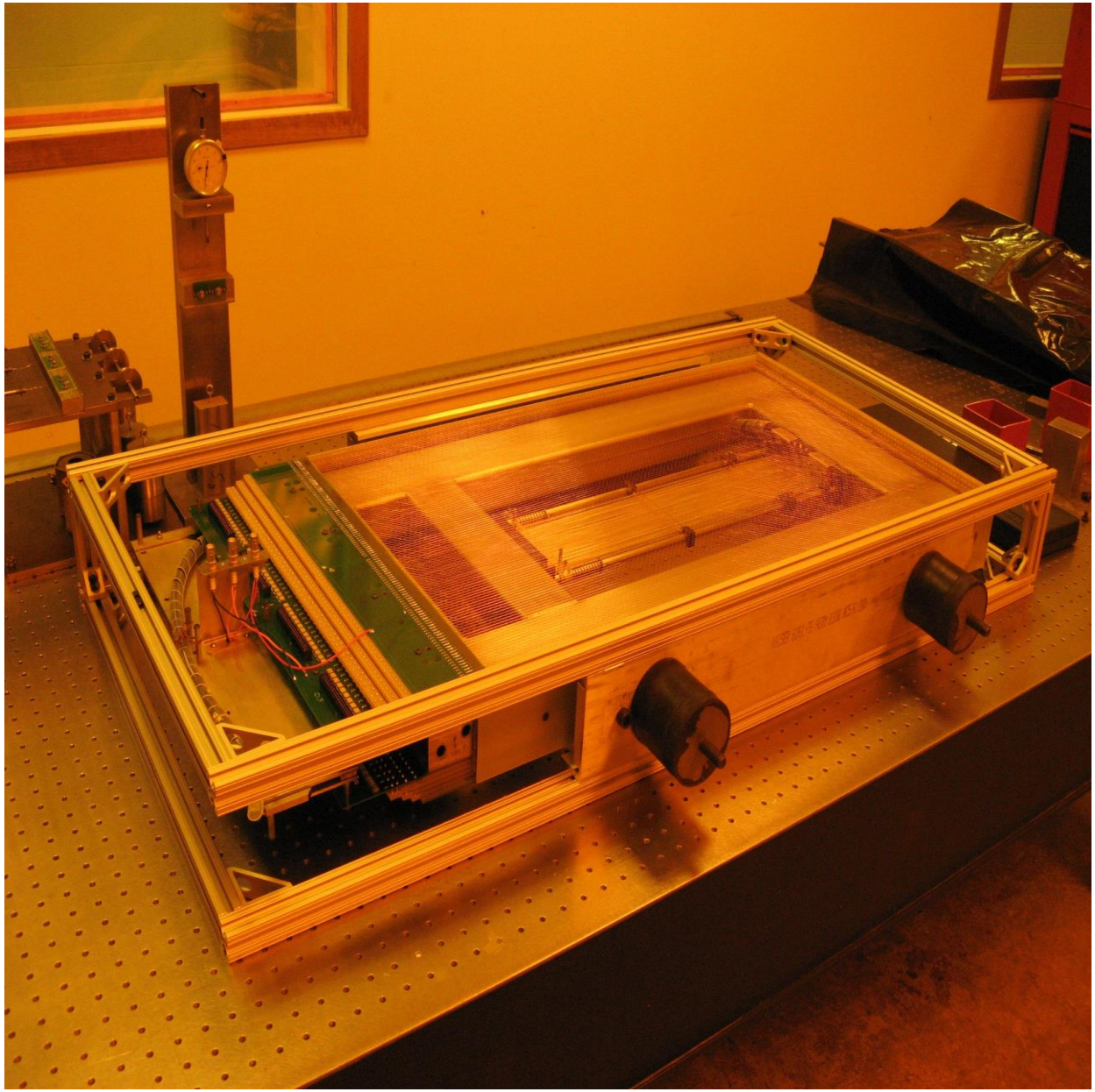
First, a little history

- There have been many prototyping efforts of APAs over the past seven years or so –
- 2012: a 40 percent scale APA was built based on the continuously wound concept of Bo Yu.
- 2013: first full scale frame was built, this frame was 7m x 2.5m and was a weldment
- 2015: four small APAs were built for use in the 35T cryostat at FNAL
- 2015/16: the first 6m x 2.3m frame was built in the “bolted joint” style
- 2017/18: six APAs were built in the US and UK for use in ProtoDUNE
- 2018: a small (~ 1m) APA was built for use in CE testing (ICEBERG)
- 2018/19: one additional ProtoDUNE style APA built in the UK



40 percent scale APA built at PSL. The concept originated with Bo Yu. It was a continuously wound concept – winding was done essentially by hand. The U and V plane wire angle was 45 degrees at that time.

A 7m x 2.5m frame was built in 2013. This frame was a monolithic weldment. It was time consuming to build and flatness was difficult to achieve. Note the fin at the head.



35T APA fully assembled and ready to ship.

Two 35T APAs during the TPC trial assembly at PSL.

Full scale ProtoDUNE APA in the winder. The fundamental difference between these APAs and those planned for the far detector is the thickness of the frame material and the addition of conduits for routing CE cables.

CE test APA (ICEBERG) built during summer of 2018. This APA is about 1.1 m on a side but otherwise shares many of the same characteristics as ProtoDUNE

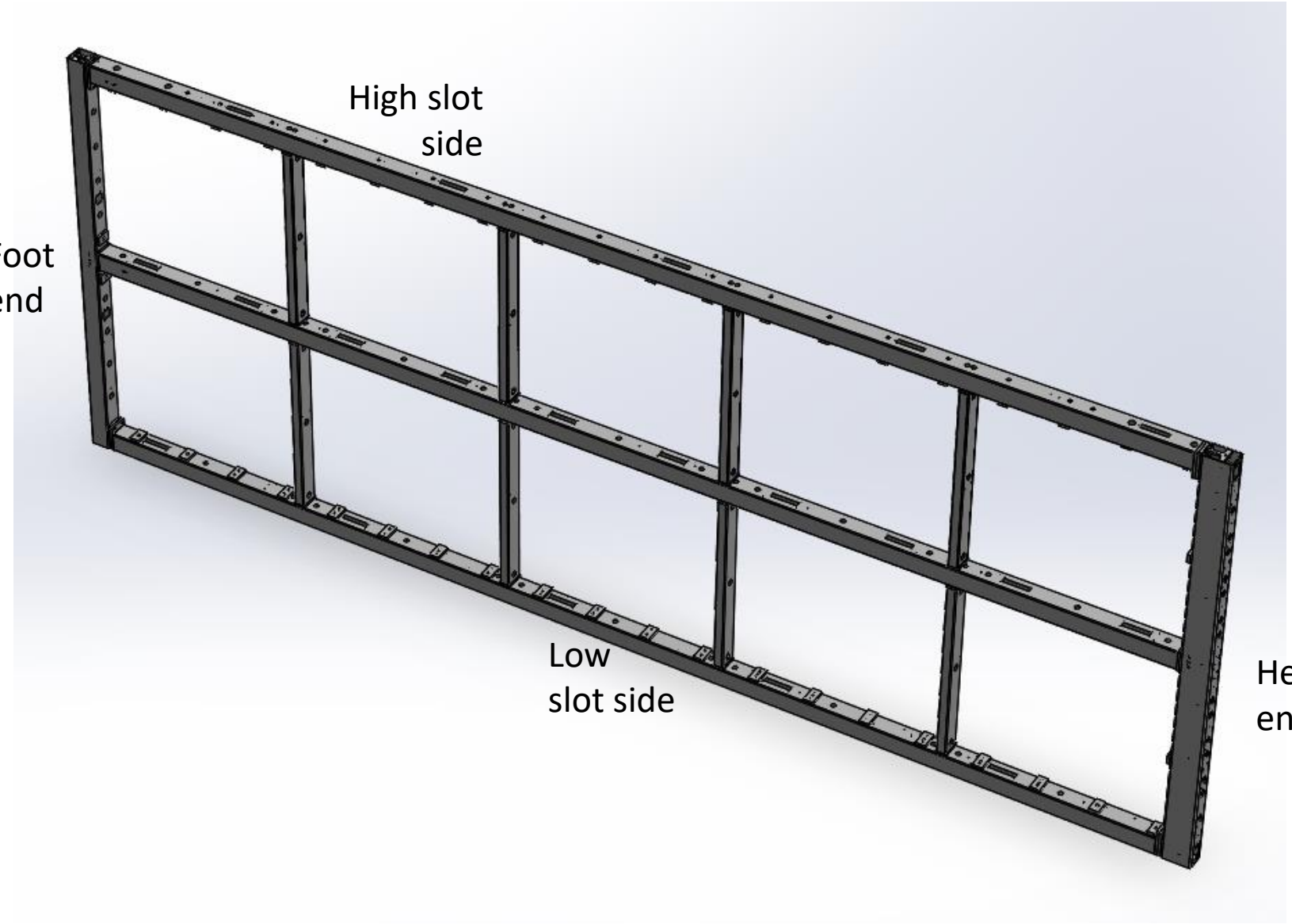
Next prototyping steps

- Frames for Ash River
- Pre-production board sets
- Pre-production prototypes in the US and the UK
- Additional tests at CERN in ProtoDUNE cryostat

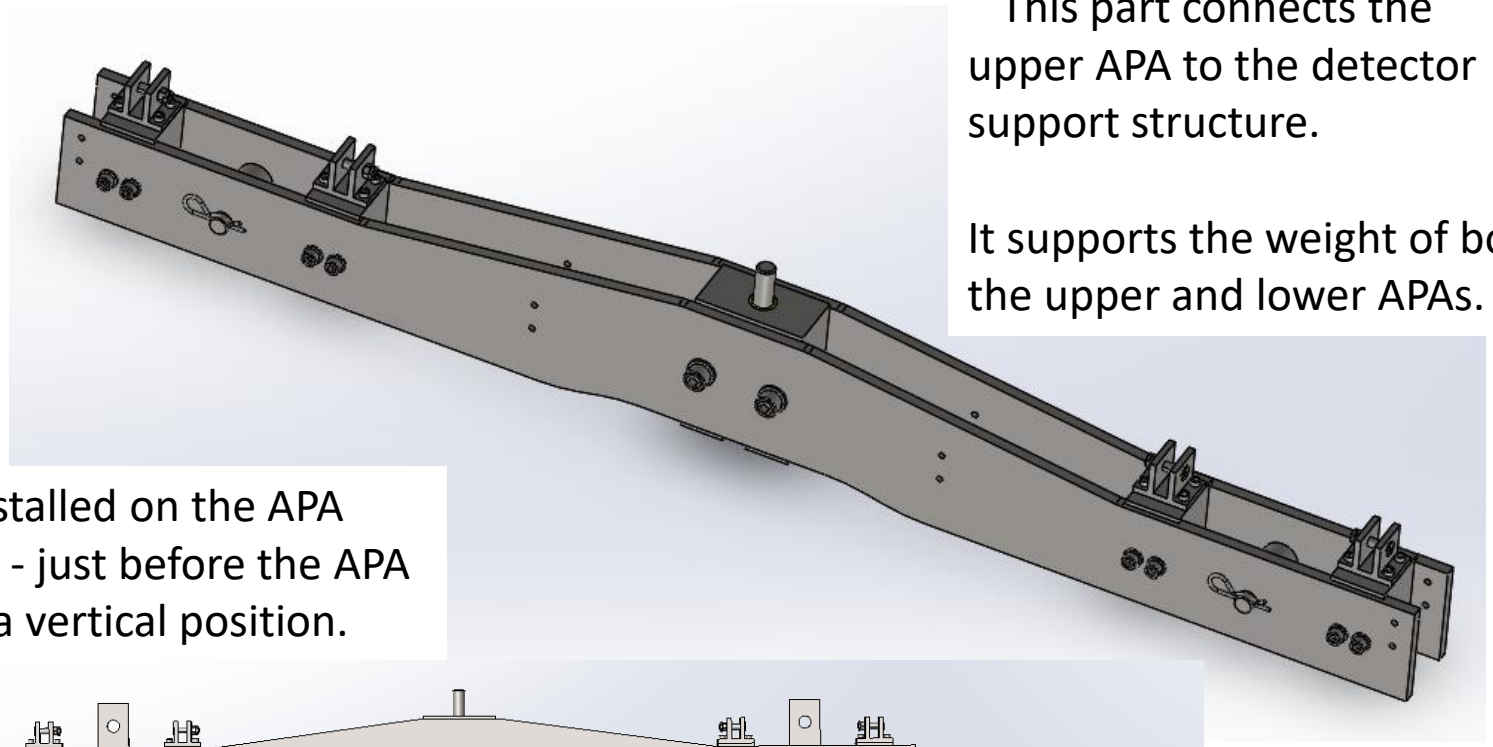
Frames for Ash River

- Building two frames at PSL (parts are in fabrication now)
- These frames are of the new 4 inch tube design
- Will include the new “conduit” feature for routing CE cables
- Will include a yoke and tees for supporting two APAs – this is a new design but similar to the ProtoDUNE
- Will include link hardware that connects the upper and lower APA

APA Stainless Steel Frame



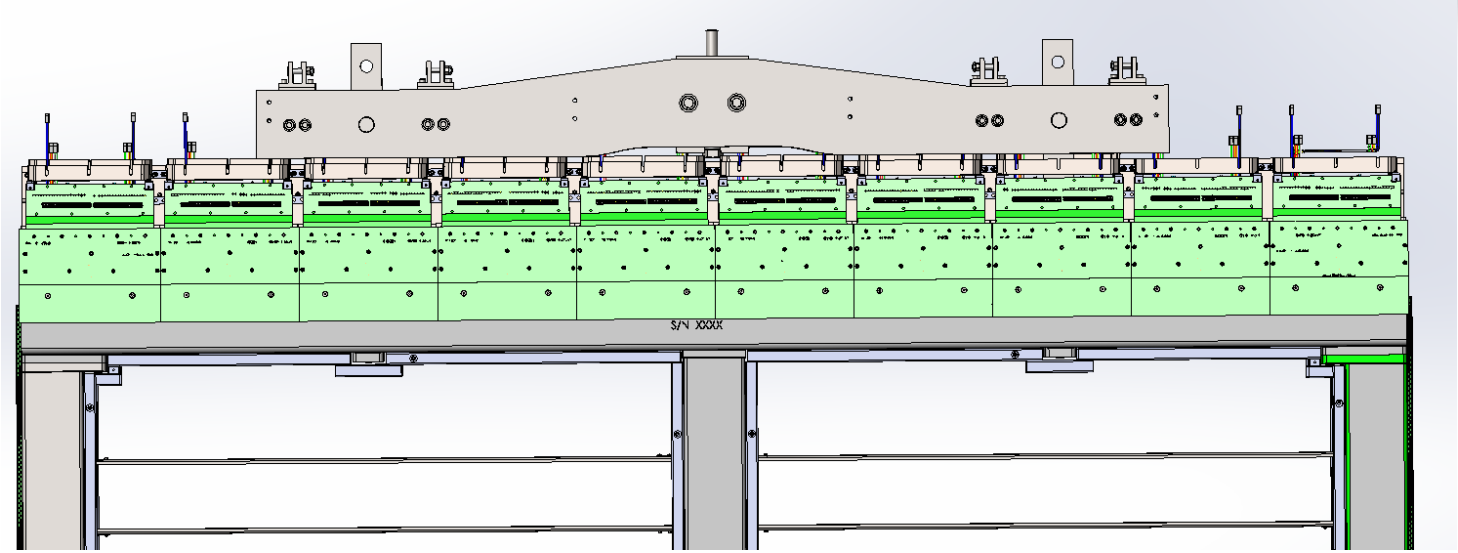
Upper Yoke



This part connects the upper APA to the detector support structure.

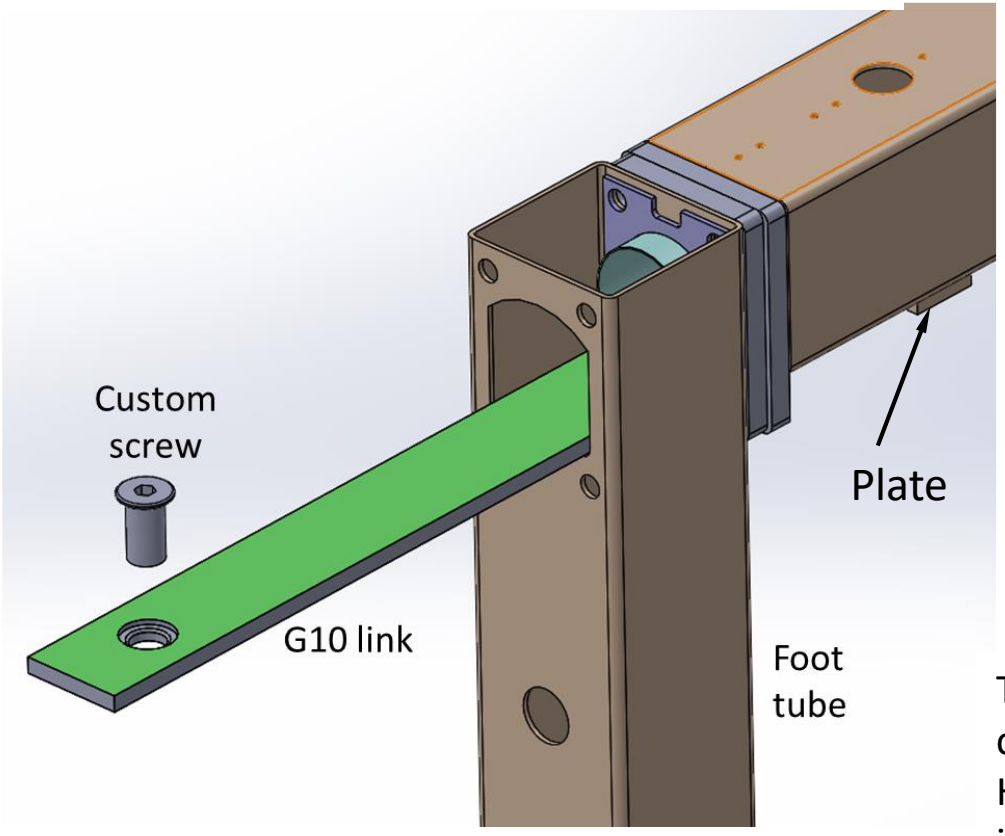
It supports the weight of both the upper and lower APAs.

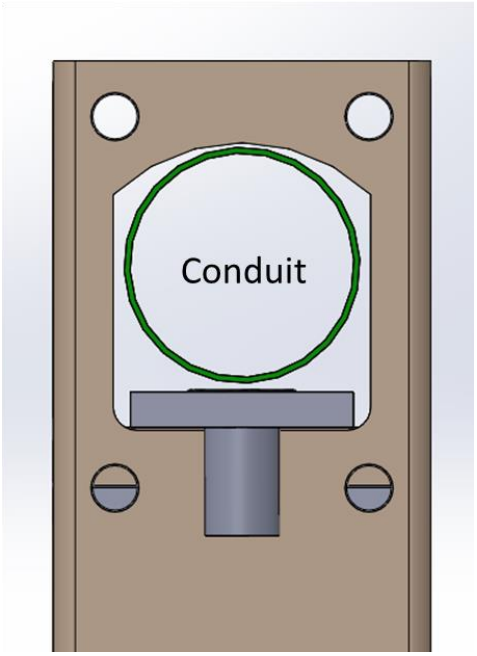
It will be installed on the APA underground - just before the APA is rotated to a vertical position.



Changes from ProtoDUNE to DUNE

The link is new to DUNE because there was no lower APA in ProtoDUNE. The link fits along the inner surface inside the side tube. The screws screw in to heavy plates welded to the outside of the side tube.

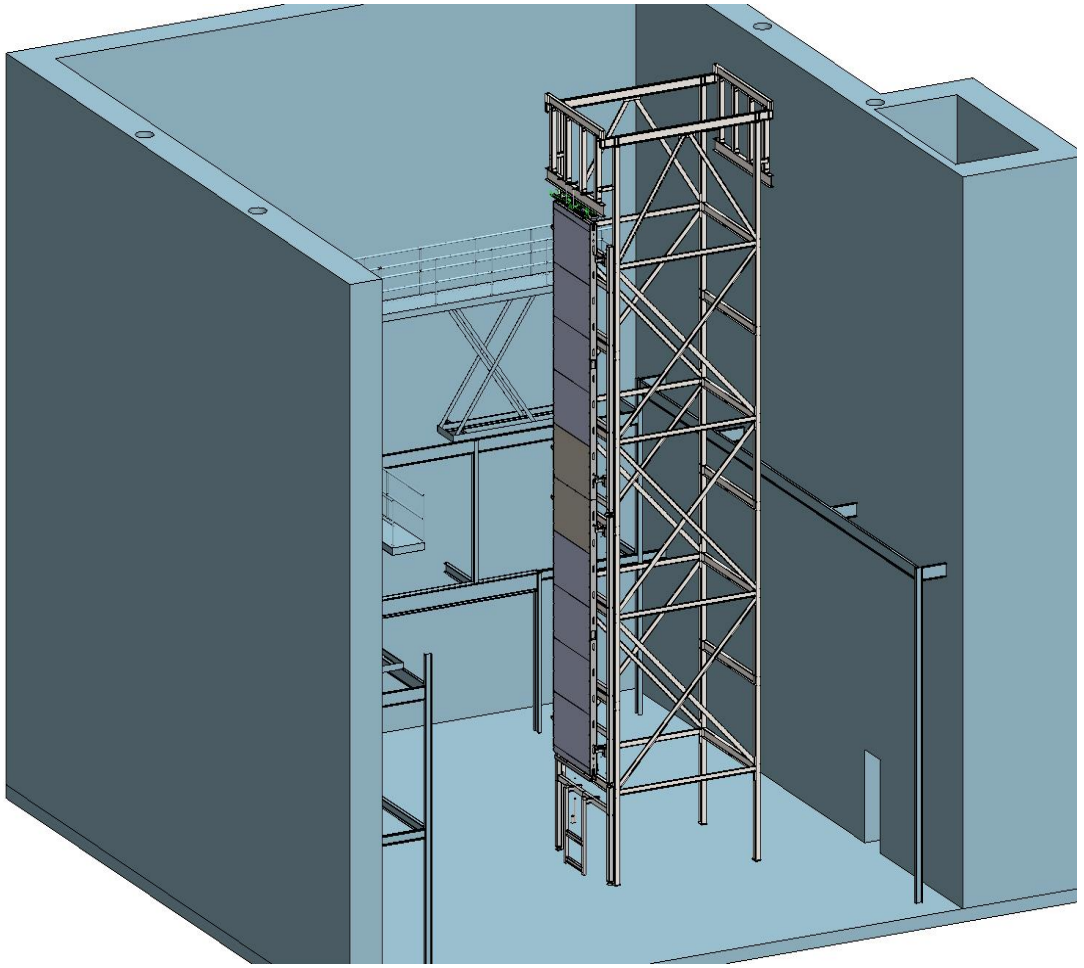




The link has been planned in G10 – and calculations show good safety margin. However, we are going to consider making it stainless steel for increased strength, with with G10 linings to insulate it from the frame.

Ash River test setup

- Two frames will be shipped to Ash River end of April for use in testing APA installation procedures underground



Board prototypes

- Building three sets of PC boards (board orders underway)
- As has already been described there is a complicated set of boards and features that are not traditional (thickness, milled edge, etc.)
- We will use this prototyping run to identify new vendors
  - This was a challenge during ProtoDUNE, only one vendor had both reasonable cost and delivery (Imagineering).
  - Finding even one additional vendor will be important for production work
- Two sets of these boards will be used in the fabrication of pre-production prototype APAs assuming they meet specifications
- The third set will be used for test purposes
- New custom pins and sockets will also be prototyped and evaluated

Pre-production prototype APAs

- In the US we plan to build two pre-production prototypes starting in fall 2019
  - This is an opportunity to exercise improvements to processes and design that have been planned since ProtoDUNE and to also bring new consortium members into the manufacturing process before full production occurs
  - These prototypes will be shipped to CERN for use in the next generation ProtoDUNE test (the exact nature of the configuration to be tested is under discussion)

UK Prototypes

- The plan is to build two (possibly four) APAs starting summer of 2020 that will then be shipped via the new custom shipping container to CERN
  - Once at CERN the quality steps worked out during the ProtoDUNE program will be executed (inspection, survey, wire tension tests)
  - Next, the APAs will have CE installed for testing in the CERN vertical cold box
- One or more of these APAs will stay for the next generation ProtoDUNE test
- Remaining APAs will be shipped to the US for use in the far detector

The two-APA shipping container.
(from Peter Sutcliffe – Liverpool)