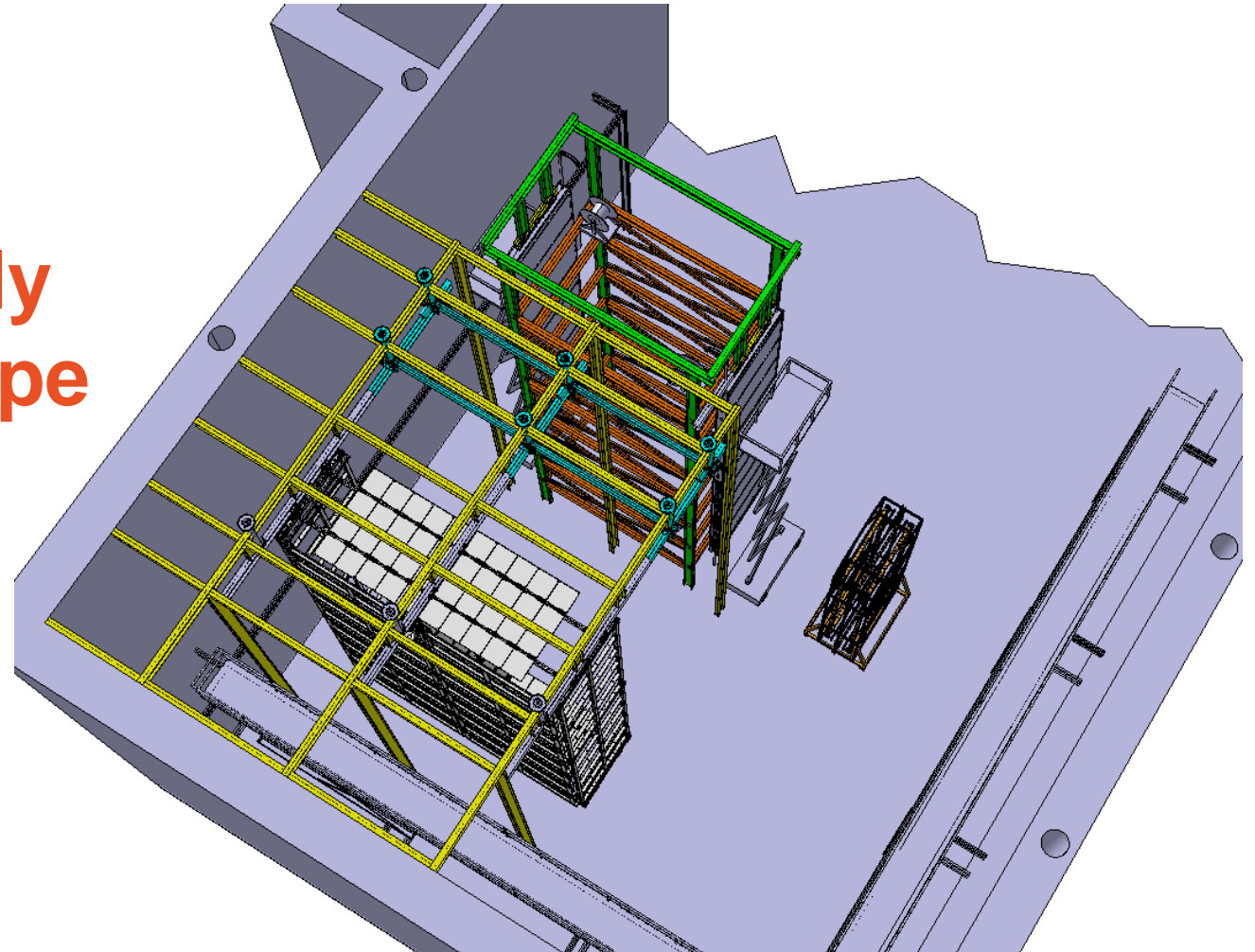


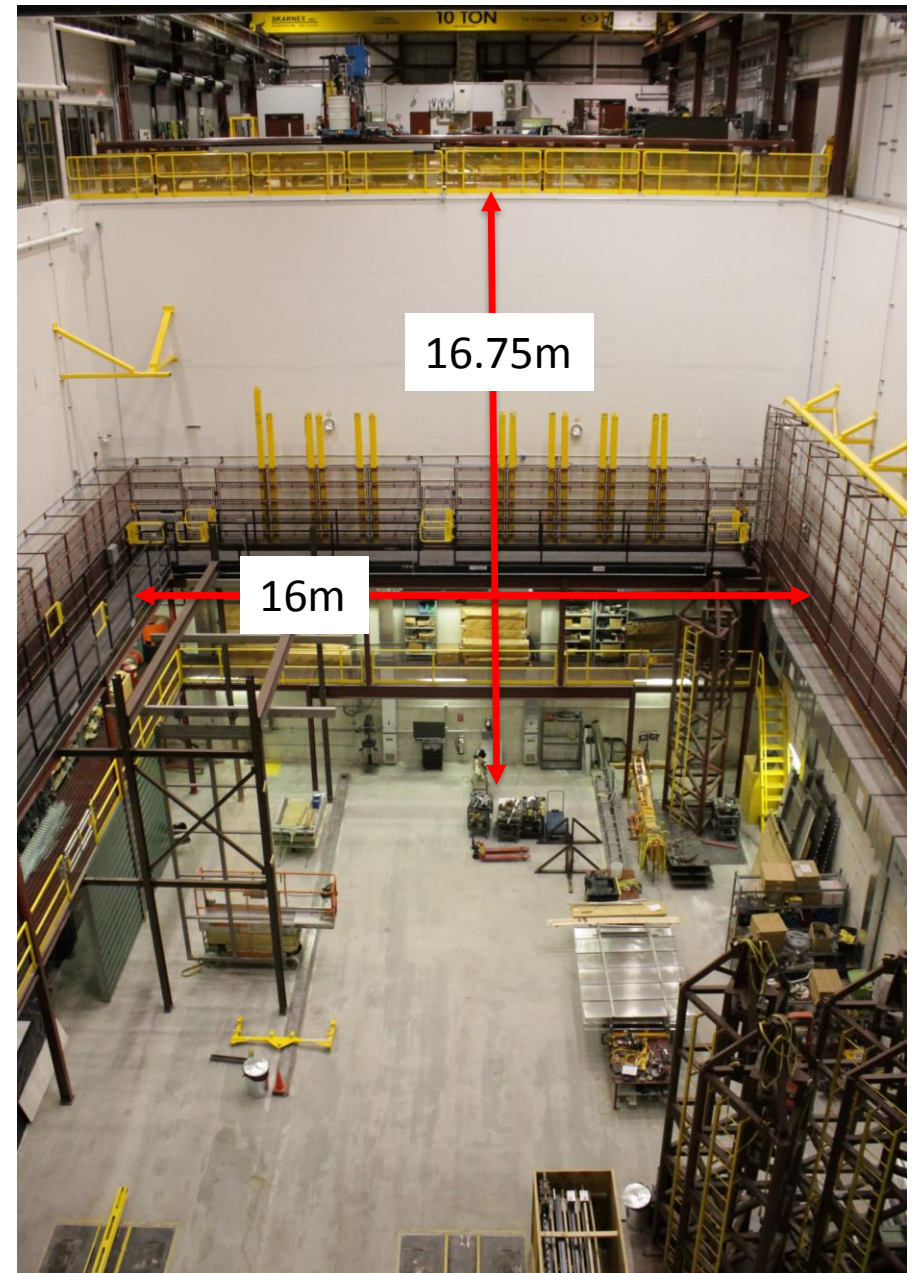
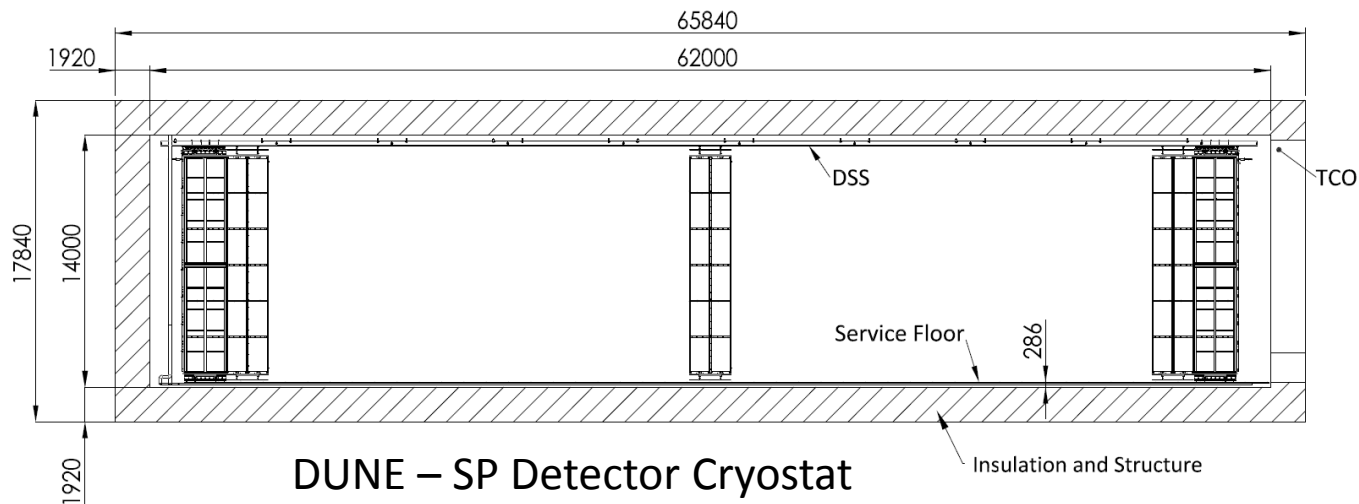
# DUNE FD-Trial Assembly Update at Ash River Scope

William Miller  
25 January, 2019  
Version 1



# DUNE-Trial Assembly at Ash River




The NOvA Far Detector Assembly hall is the right size for setting up the DUNE-Trial Assembly. With a loading dock area and two 10-ton overhead cranes, fork lifts, scissor lifts, work shop and experienced technicians we have the ability to adjust the Scope of work as needed



# Goals of DUNE-Trial Assembly at Ash River

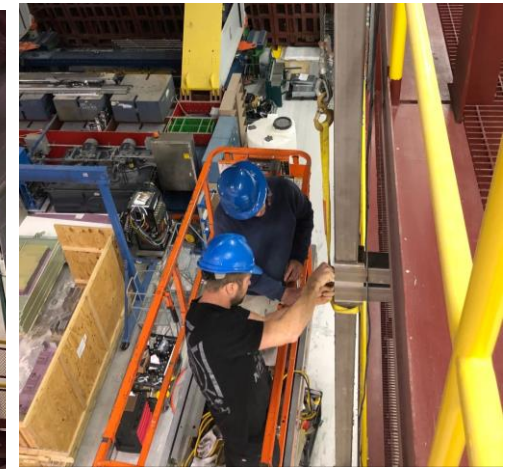
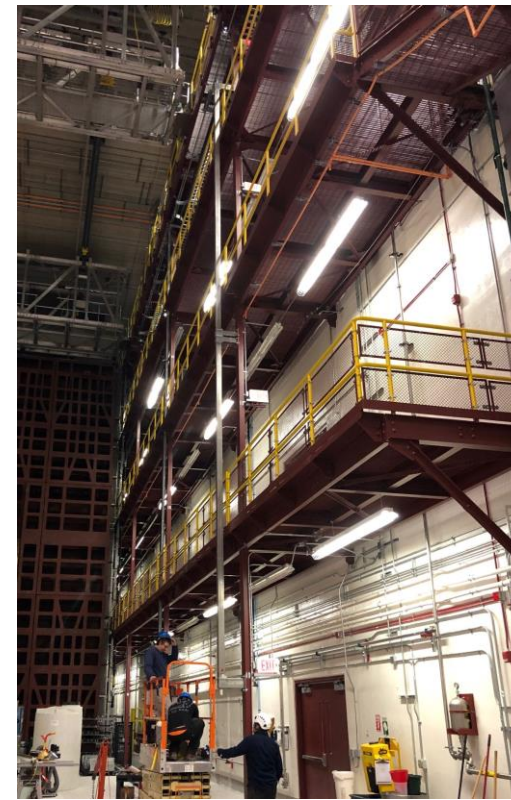
- Test all full scale TPC (Time Projection Chamber) components and installation equipment during assembly stages and inside the cryostat including
  - APA Assembly including manipulation of APA shipping frames, joining an APA pair together, testing of PD (Photon Detector) components, CE (Cold Electronics) cabling, APA protection, movement on shuttle beam, cryostat cabling and final deployment in cryostat.
  - DSS (Detector Support Structure) and shuttle beam system including final detector configuration
  - Assembly of HV system including construction of an End Wall, CPA pairs, movement on shuttle beam and final deployment in cryostat
  - Future Assembly of Dual Phase detector components
- Write full set of Hazard analyses and assembly procedure documents including gathering all component documentation
- Test access equipment (scaffold, scissor lifts, work platforms) and lifting fixtures
- Assembly time and motion studies including labor estimates
- Future-Training site for lead workers as DUNE begins setup, testing mechanical modifications

# Summary-Trial Assembly Scope at Ash River

- Phase 0-Pre TDR  **FY19**
  - HV Field Cage prototypes for ground plane support- Completed first phase
  - Check vertical cable installation with two APA side tubes- **In place now**
    - First set of tests week of December 17<sup>th</sup>
  - Build APA Cabling Tower to test 2 APAs both connection and cabling & CPA assembly- **March**
  - Use ProtoDUNE Trial Assembly frame to test DUNE FC deployment and top ground plane support- **January-March**
- Phase 1  **FY20**
  - Build DSS shuttle, 3 sections of DSS beam
  - Test movement of CPA and APA from cleanroom to final destination, including cabling of APA along cryostat side wall
  - Test APA, CPA, Endwall and FC deployment in one drift section
  - Test assembly sequence of final section of TPC including removal of DSS shuttle beam runway rails, moving TPC components so TCO can be closed up
  - Test APA Shipping frame
- Phase 2  **FY21**
  - Include the top of the cryostat (no warm structure) with feed-thru's as needed to test complete installation system
  - Test DSS installation
  - Design feed-thru's to support Dual Phase installation test

# DUNE Cable Tests-Now

- APA side tubes are mounted and in position
  - Several tests with conduit and mesh completed
  - Dec 17-18 we did a series of tests with different configurations of the cable bundle as well as some strain relief trials
  - Some additional tests in January/February

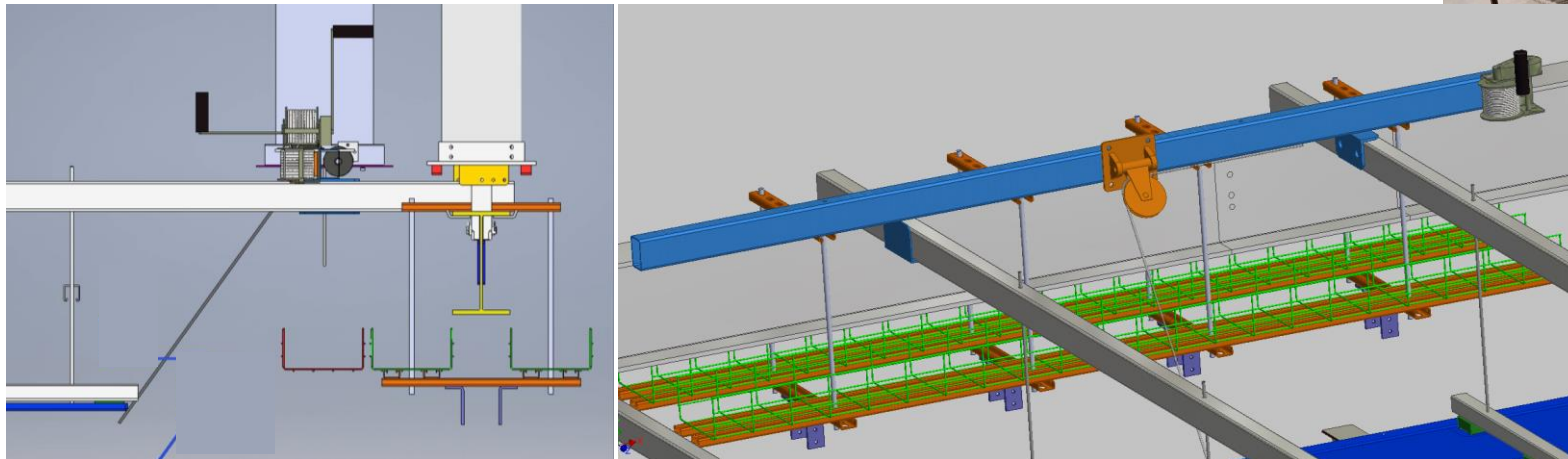


# DUNE-HV Field Cage and Ground Plane

- HV FC Ground plane
  - Completed first test with increasing the distance of the ground plane from the extrusions using a 4" FR4 beam
  - Completed second test (picture to the right) using an 2" Al square tube
- January-Using existing ProtoDUNE trial assembly structure
  - Test deployment of DUNE Field Cage Deployment
  - Test possible Ground plane support
- Late February remove ProtoDUNE structure



Ground Plane support Modifications

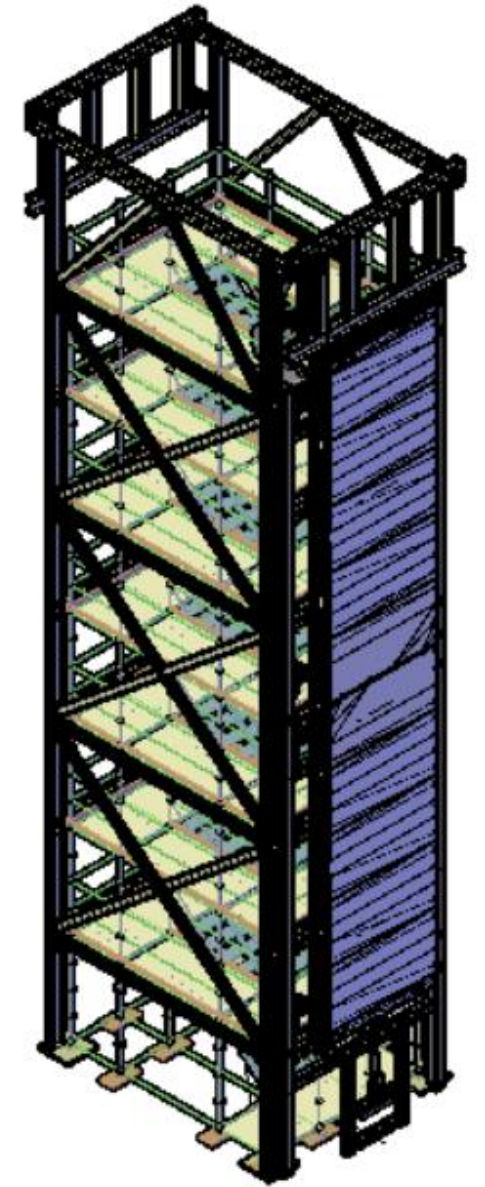


DUNE Field Cage Deployment concept



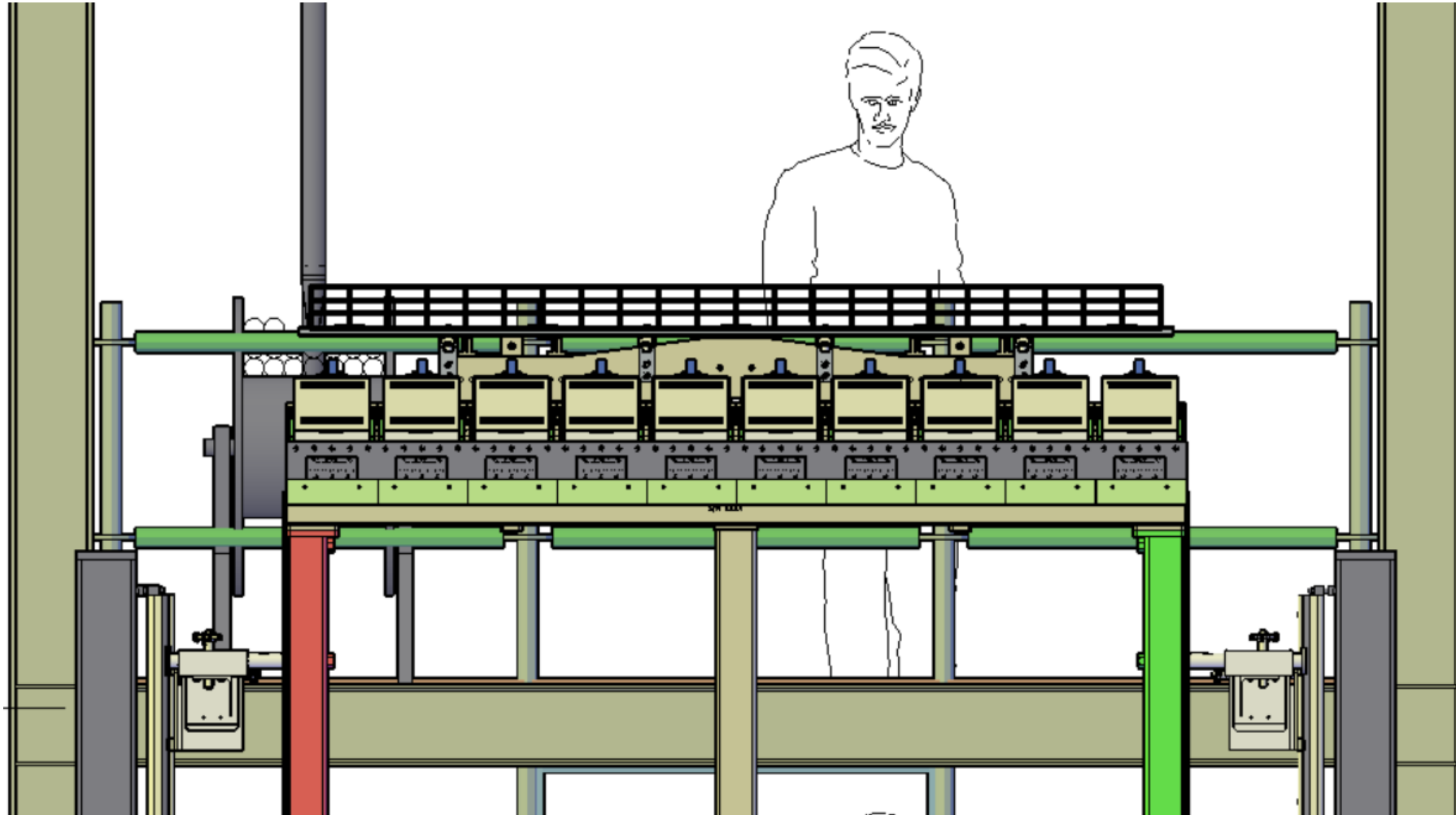
# Phase 0 FY19 Trial Assembly APA Tower

- Purchase/rent Scaffold for APA cabling tower-This information is needed to align the scaffold levels to the horizontal beams on the tower. Bid has been awarded to API (They built the NOvA Building)
- Design of tower would allow us to do both the connection of the APA Pairs, cabling and protection tests. A CPA assembly station will be added as the design matures. The APA tower bid will go out as a design/build so we have properly stamped assembly drawings- **Expect bids to go out in early February**
- The elevation on the work platform is the same as the cleanroom at DUNE based on the elevation of the Detector Support Structure.
- NOvA crew will get all building permits required as well as write HA and procedure documents for approval by UMN ESH. Training and documentation will be developed as needed



**APA Cabling Tower**

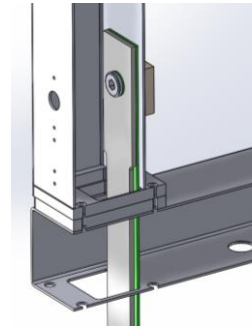
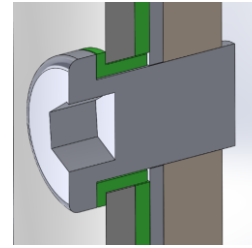
# Access for the top of the APA Cabling Tower



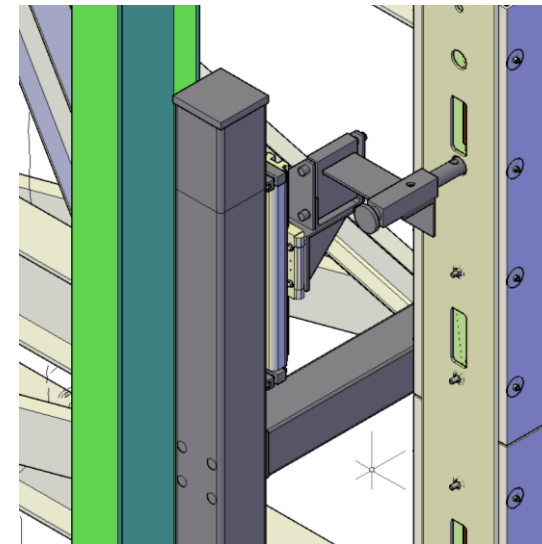


# APA Cabling Tower Features

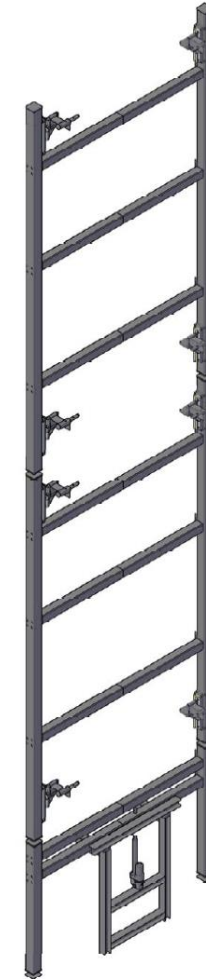
- The steel tower is self supporting and give horizontal stability to the scaffolding stair tower.
- The spacing on the horizontal beams on the ends maximizes access to allow removal of the protection panels after cabling is completed
- The pair of APA frames will be supplied by PSL. They will have all the features of a real APA but no wires and include APA connection bars. We would have the ability to add APA protection. There would be several sets of rails for installing Photon Detectors
- The APA Mounting Frame, stabilizing hardware and jack system will be designed and supplied by PSL and bolted to the APA Tower by the NOvA crew. They would include assembly drawings



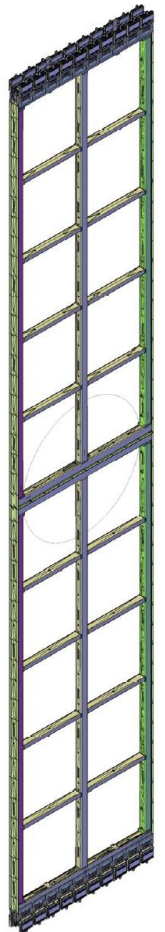
**APA connection hardware**



**Iso-view of the  
APA stabilizing  
hardware**



**APA  
Mounting  
frame**



**Pair  
APA  
Frames**

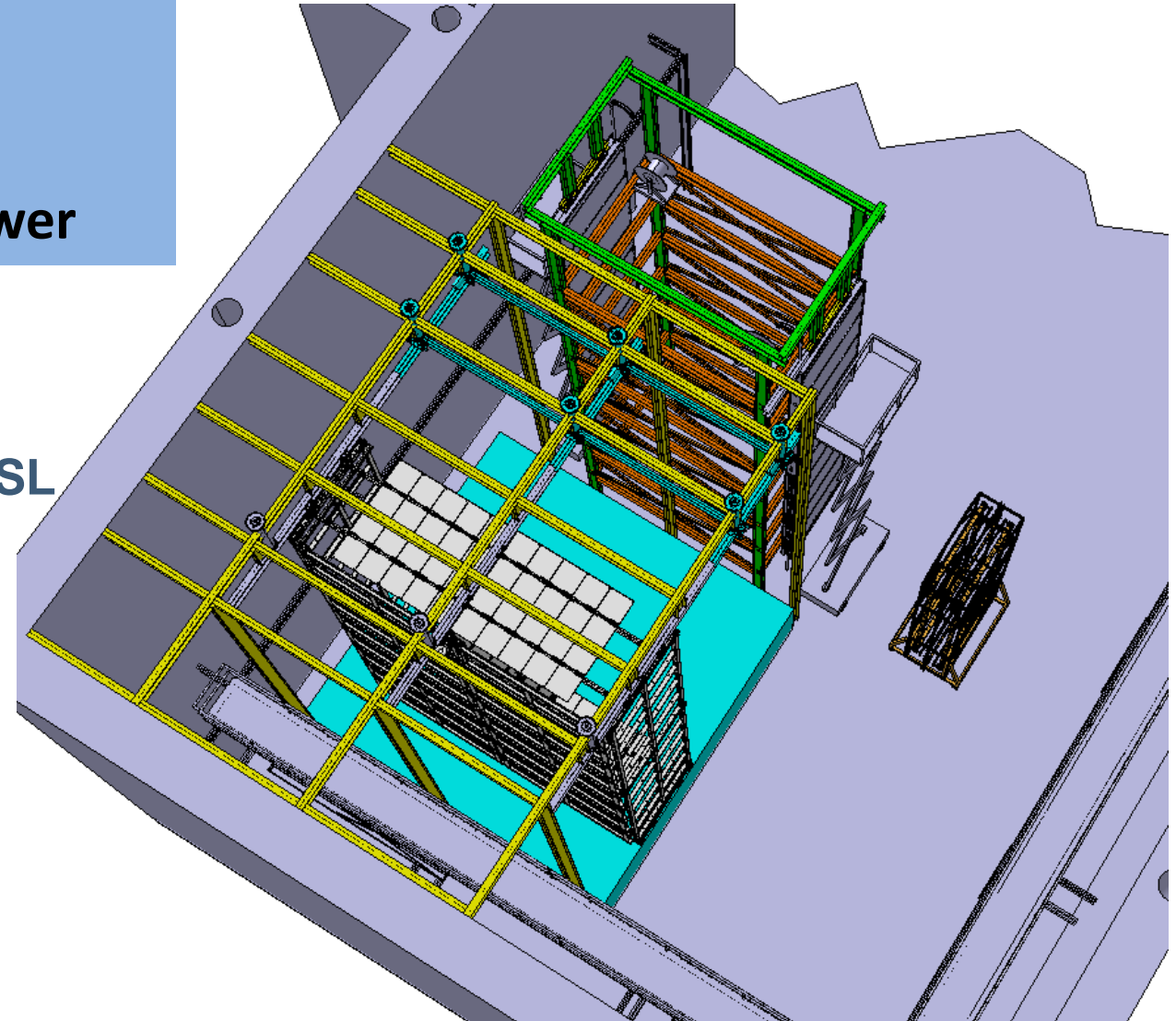
# Phase 0-APA Cable Tower March 2019-Schedule

Design APA Cabling Tower and location so:

- Phase 1 DSS shuttle runway beam
- Phase 2 top of cryostat work

Can be added without modifications to tower

- Ability to test access issues on back side of tower (same layout as DUNE cleanroom)
- We expect the APA frames with yokes from **PSL** to arrive at Ash River in early March
- We expect APA mounting frame and APA stabilizers in mid-March- **PSL**
- Need to order 2-4 sets of cables, connectors, cable mesh and cable strain relief- **BNL**
- PD cable with connectors and several sets of PD rails- **Colorado State**

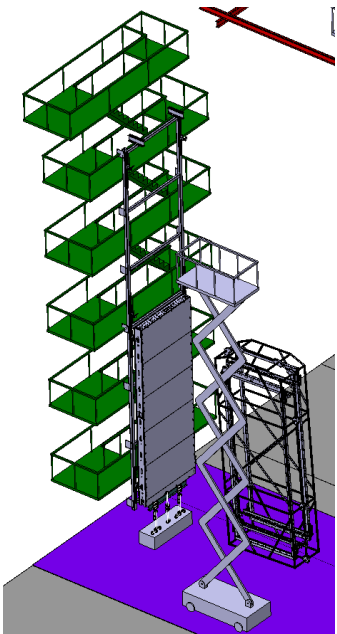


# Additional Equipment needed-Phase 0

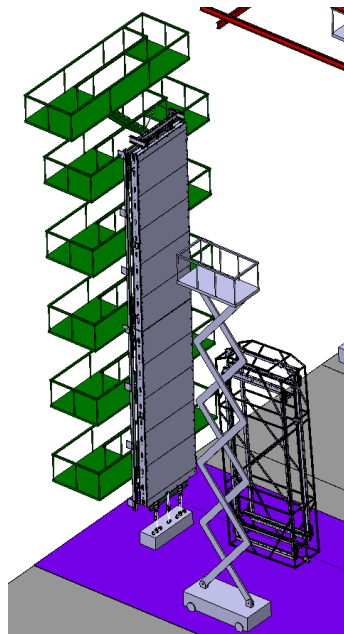
- Use all access equipment proposed for DUNE to confirm that it works:
  - Mobile Scissor Lift-Only 40' available in US, needed for center APA connection and for phase 1 work- **Quotes in progress**
  - Static scissor lift capable of reaching ~50'. We are getting quotes from 2 different vendors.
- Lifting fixture for both top and bottom APA- **Design PSL purchase ?? Needed later in FY19**
- APA shipping frame- **APA consortia Needed later in FY19**
- We have ordered sheave wheel, a motorized cable puller and cable spool to do additional tests on the APA side tube tester. These will be used on the APA cabling tower - **UMN**
- Order cable trays and brackets for full cable tests- **BNL and UMN**
- Additional slings and lifting equipment- **UMN**

# APA Assembly Procedures

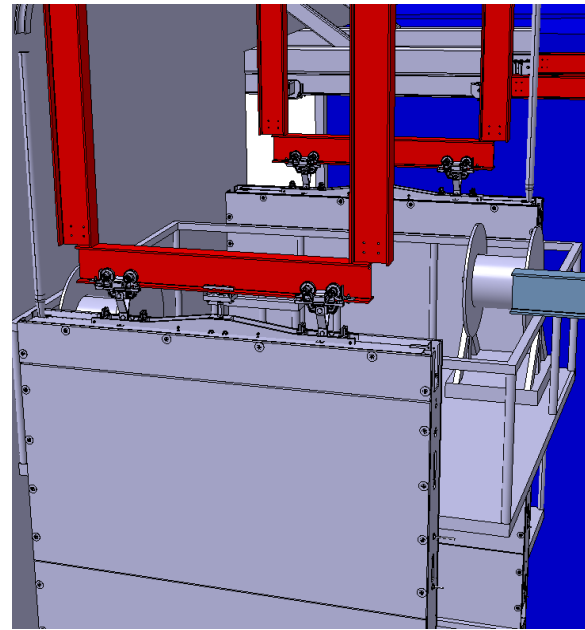
We will not have the APA shipping frame or the final lifting fixtures for our first tests. Frames will be rigged using slings



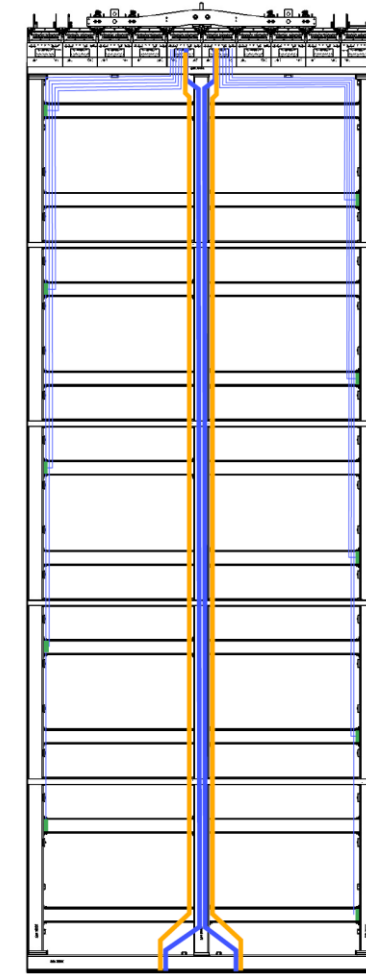
Lower APA will be placed on APA mounting frame. The load is supported by the bottom jacks



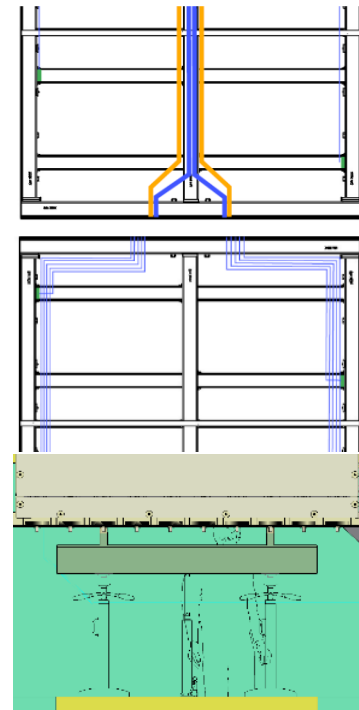
Top APA will be placed on APA mounting frame. The load is supported by APA Trolleys



Trolleys are mounted on 10" stainless steel I-Beam same as DSS. Access needed to both vertical APA side tubes



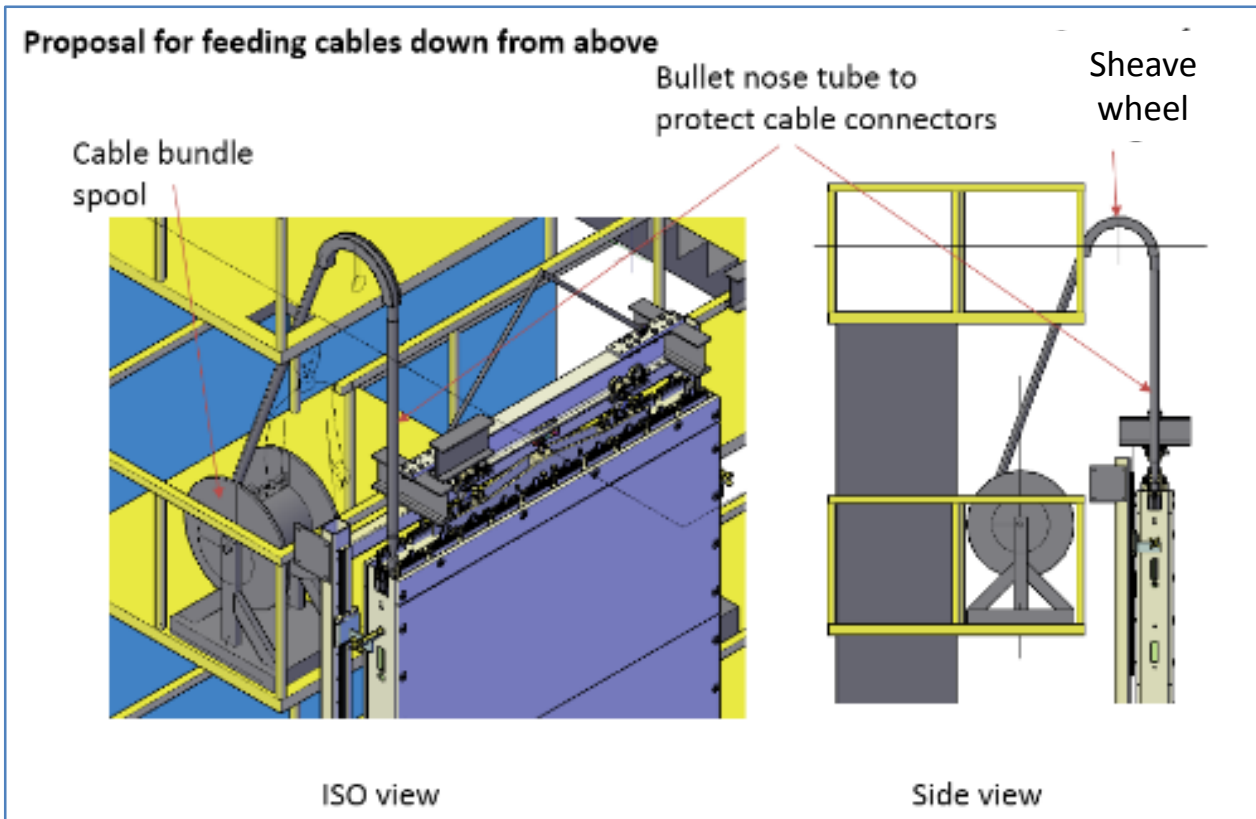
PD cables run inside the APA frames and must be connected in the middle



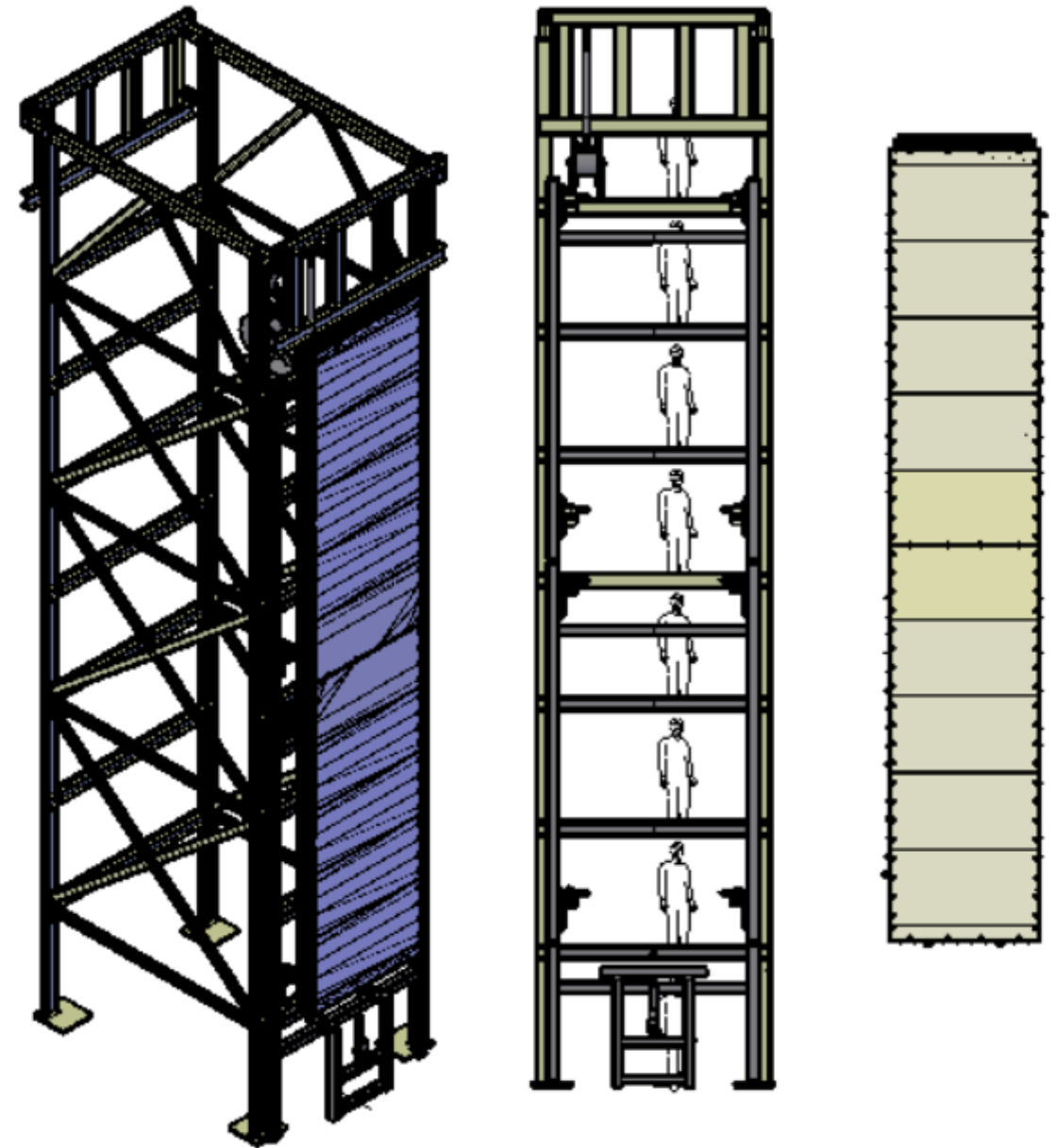
Hydraulic jacks raise bottom APA up and connection is made

# Phase 0-Testing Procedure

We are now ready to Install CE cables



Img. from Dan Wenman



# Documentation for Phase 0

All documentation will be located in folders in EDMS at CERN. This will be a prototype for documentation for DUNE

- Similar to what we did for CERN on ProtoDUNE but following Fermilab documentation guidelines
- Hazard Analysis for each task including all PPE and Training requirements
- Detailed step by step procedures
- All lifting fixtures, trolleys will have completed documentation including calculations and load tests

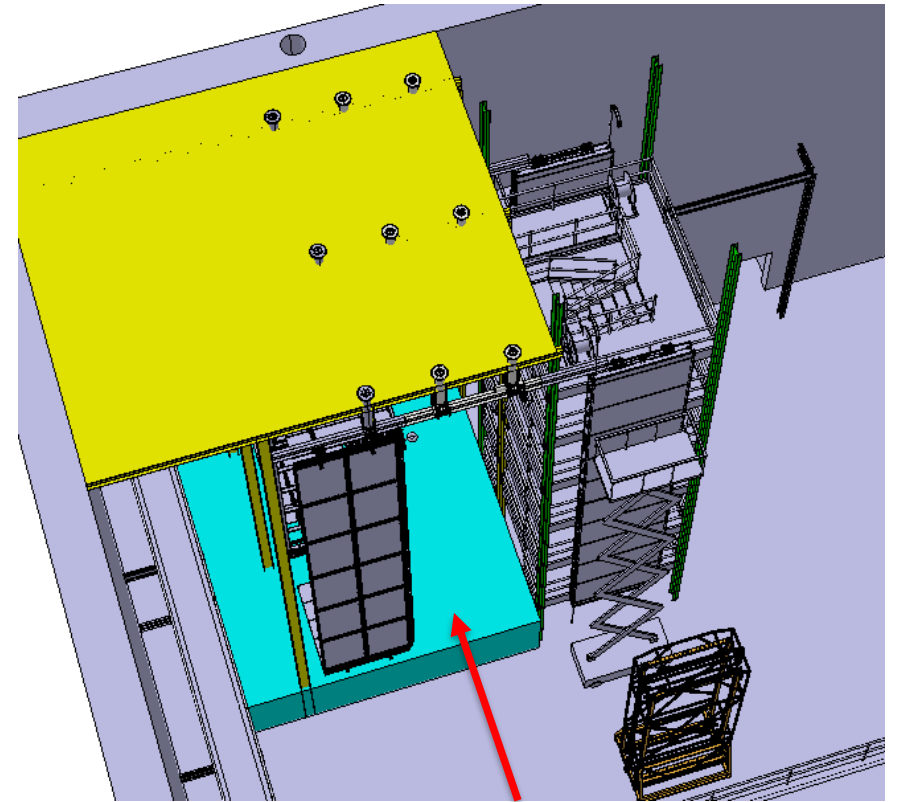
- List of documents-End Wall

Document	EDMS #	Status
End Wall analysis warm	1816841	Released
Transport Beam	1853726	Released
APA Trolley	1834246	Released
Spreader Bar, Swivel, 5/8" pin	1876417	Released
TCO Intermediate Beam	1871905	Released
Procedure for building End Wall-Cleanroom	Draft	Draft
Procedure mounting End Wall-Cryostat	Draft	Draft

**All Ash River documentation will be reviewed UMD Safety Officer- Jean Cranston and Fermilab ESH**

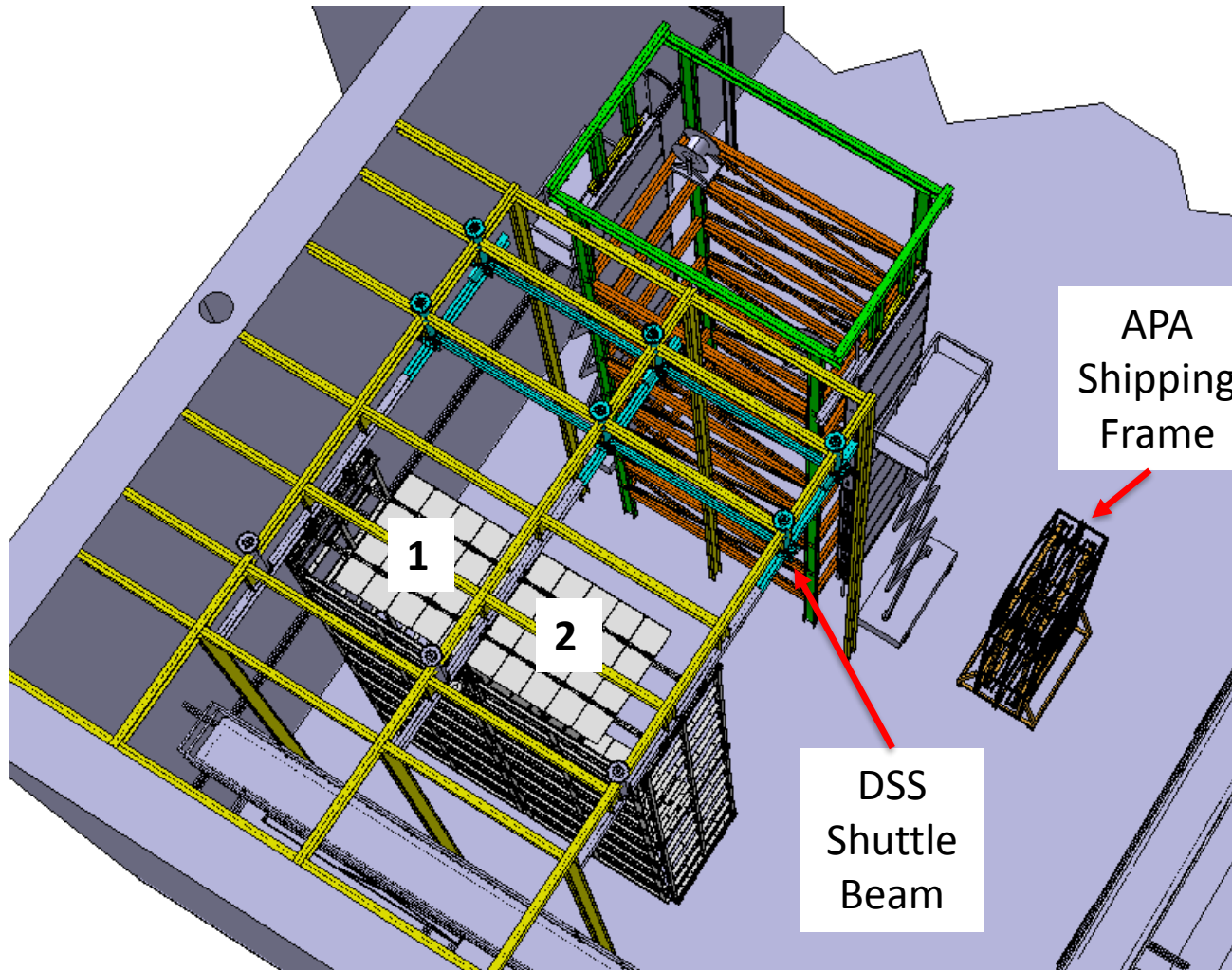
# Phase 1 FY20-Cryostat Structure

- Design/Build bid for mockup of the Cryostat Structure including the ability to add feed-thru tubes for grated decking if funding is available
- Order DSS components and assembly DSS shuttle beam and 3 DSS rails consistent with the TCO opening and the first row of TPC components- **Design by Vic Guarino at ANL**
- **Decision needs to be made if full test of DSS Feed-Thru hanger should be done. This would change the layout of the beam support structure**
- Design should allow top of cryostat to line up with existing loading dock floor if possible

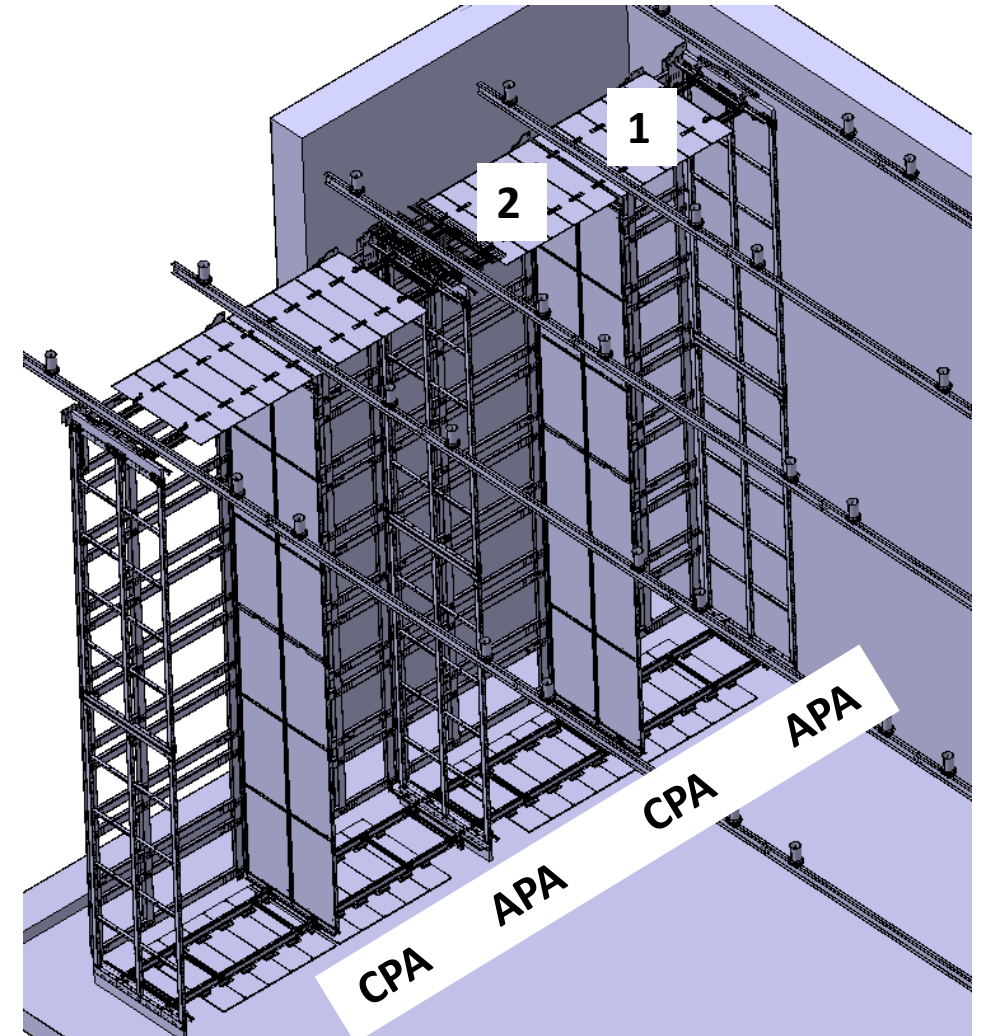


**Elevation of the DSS and cryostat floor needs to be determined. Cost savings by making NOvA Assembly area floor cryostat floor**

# Two Completed TPC drift volumes with DSS Shuttle



DUNE - Ash River Trial Assembly

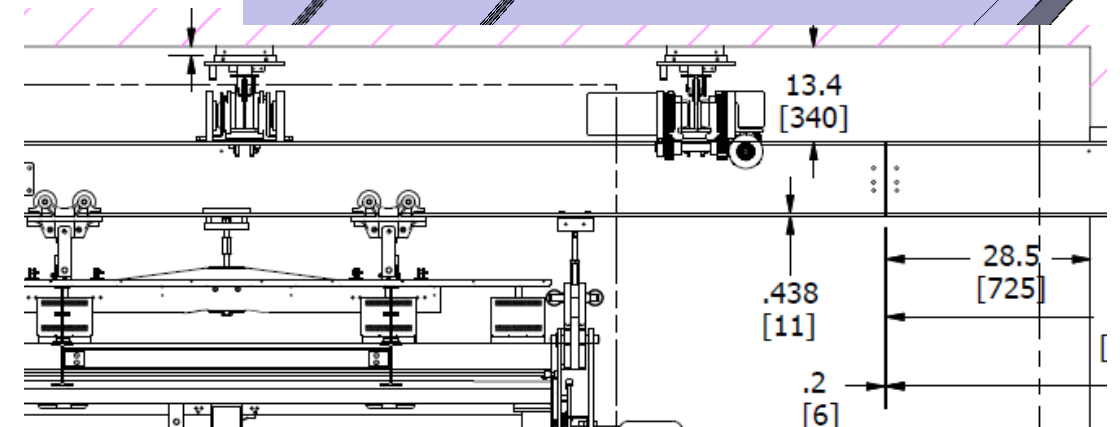
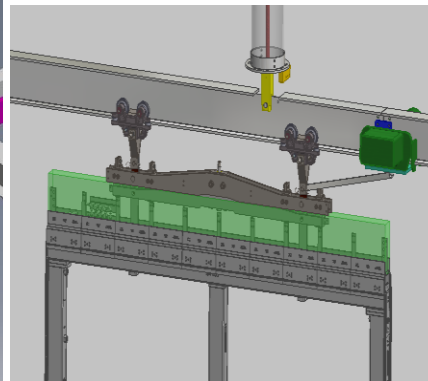
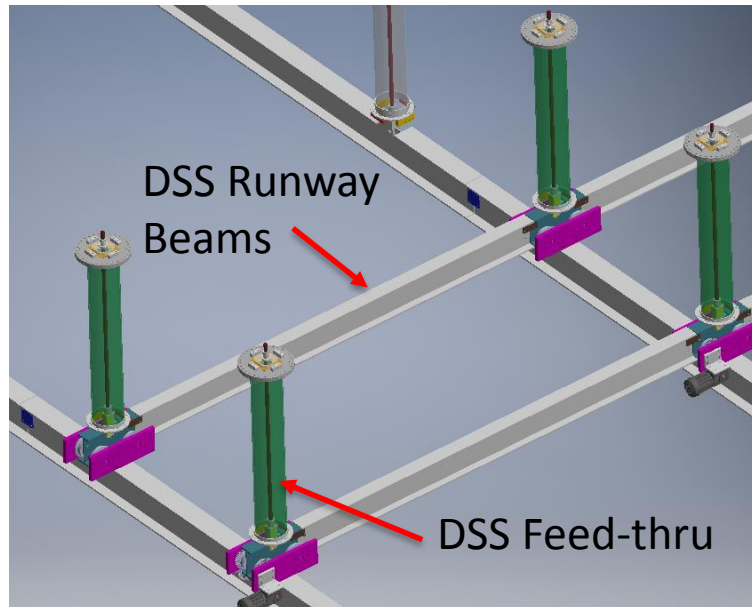
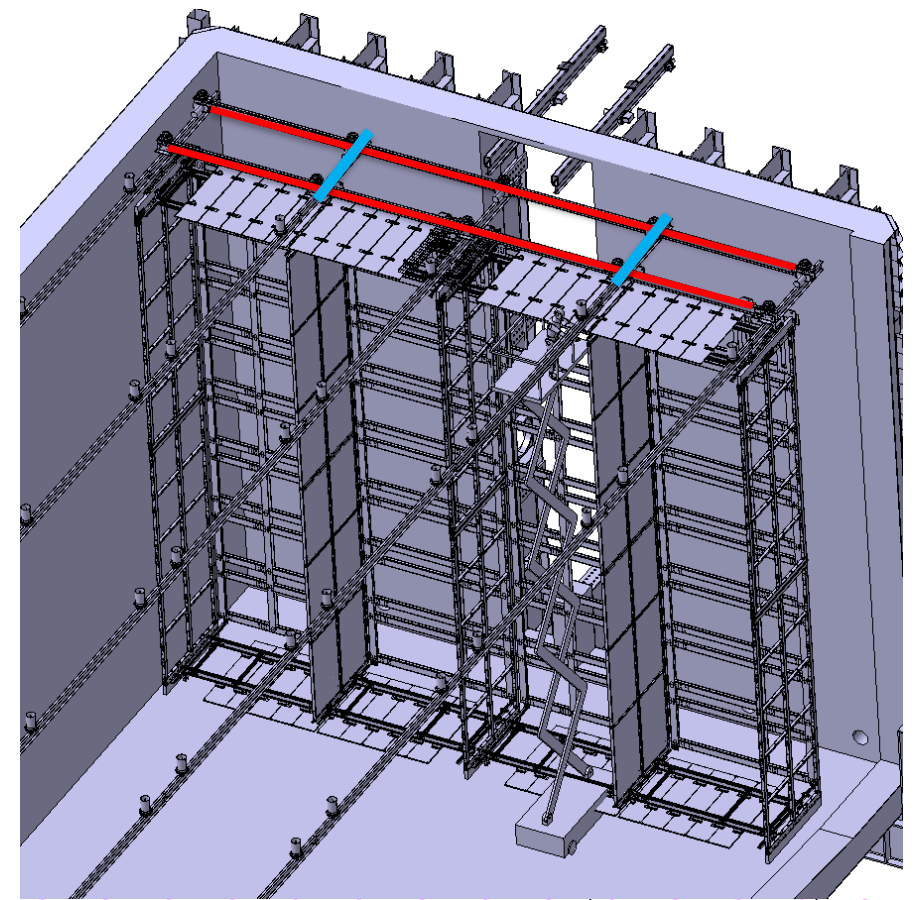


DUNE – Single Phase Detector



# Phase 1-FY20 DSS Shuttle

- Build DSS shuttle and DSS beams
  - Test how it is powered for movement
  - Test beam connections and access to them
  - **Do we want to test DSS installation procedures?**
- Test how APA pair and CPA components move

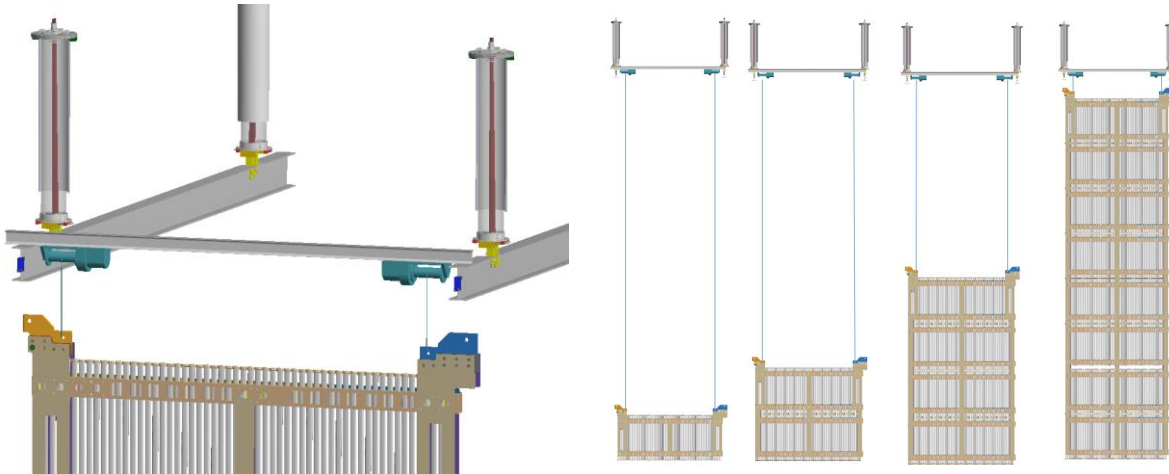
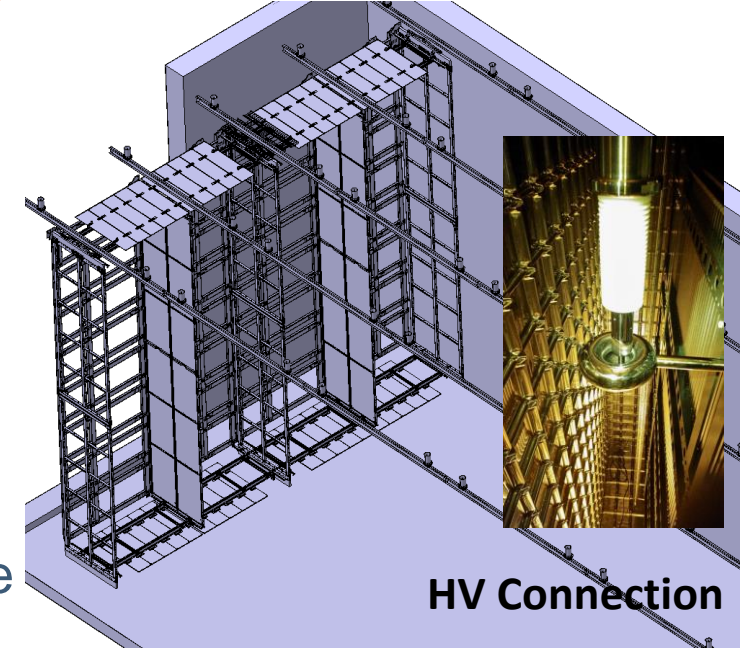


# Phase 1 – FY20 TPC Assembly Procedures

- Once the DSS has been installed and the subfloor is in place we are ready to start

## No access equipment can reach once End Walls are in place

- First the any instrumentation (purity monitors, temperature sensors, cameras) that are installed at the end of the cryostat must be installed first
- HV connection is made to CPA
- Then the 4 end wall sections are build just like in protoDUNE with the pieces connected at floor level and raised up



Purity Monitor



Temp Sensors



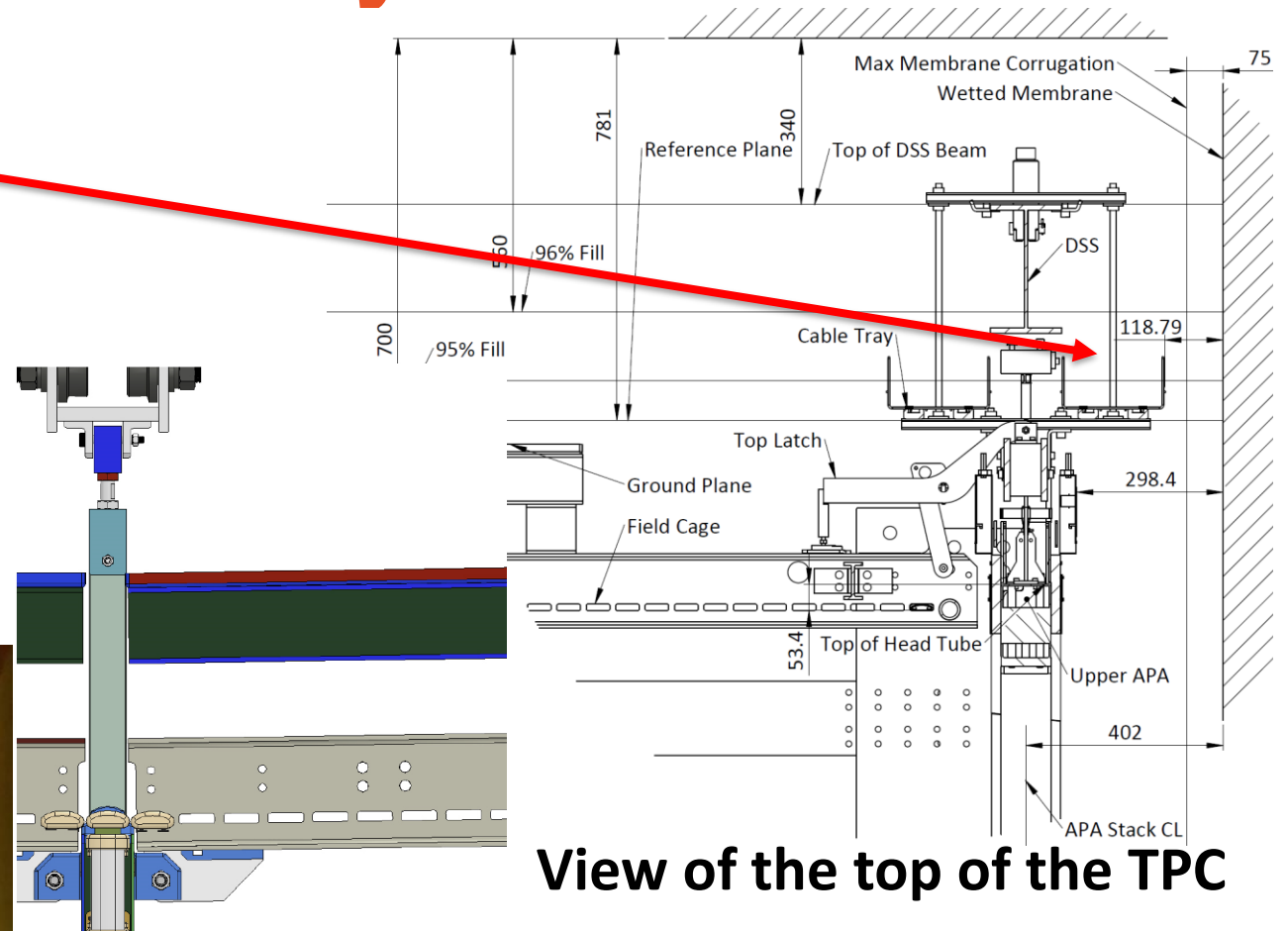
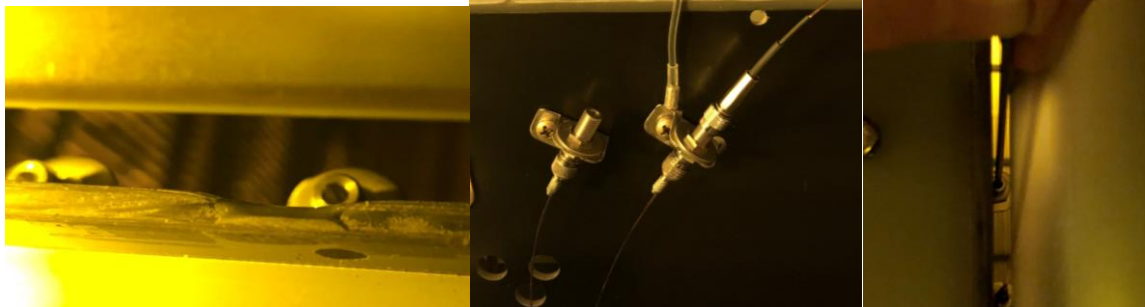
Gradient Temp Sen

# Phase 1-FY20 TPC Assembly Procedures

Lot's of questions to answer:

- Can we physically we access the cables on the back side of the APA?
- Can we remove the APA trolley (not shown) ?
- We do not have the light flasher/defuser system in the drawing, difficult to install on the CPA even more difficult to run the glass fibers up to the feed-thru.

Had to remove the profile and feed down thru crack on the back side



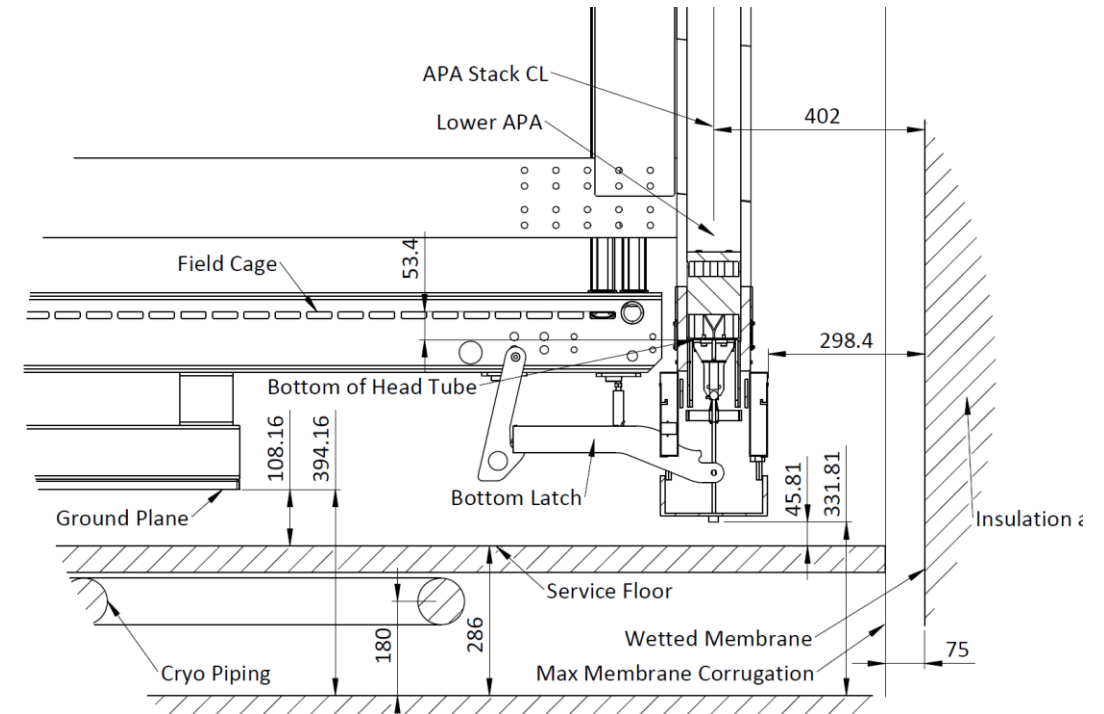
**View of the top of the TPC**

**CPA, FC and Ground Plane**

# Phase 1-FY20 TPC Assembly Procedures

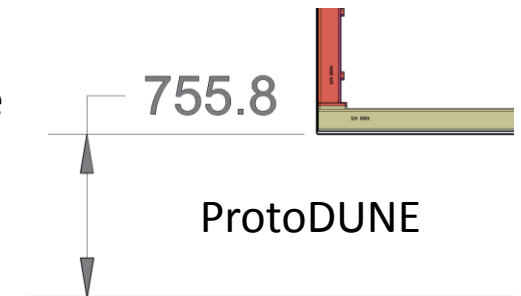
- Write procedures for move APA and CPA components into the cryostat in into
- Test clearances cabling and assembly of APA against wall top and bottom
  - Adding cable tray support
  - Removing trolleys
  - Attaching APA and CPA hanging hardware
  - Moving cables into feed-thru cable tray
- Mock up position of cryostat walls
- Deploy top and bottom field cage, access to latches, etc. –**Very worried**

**It is even worse on the top**



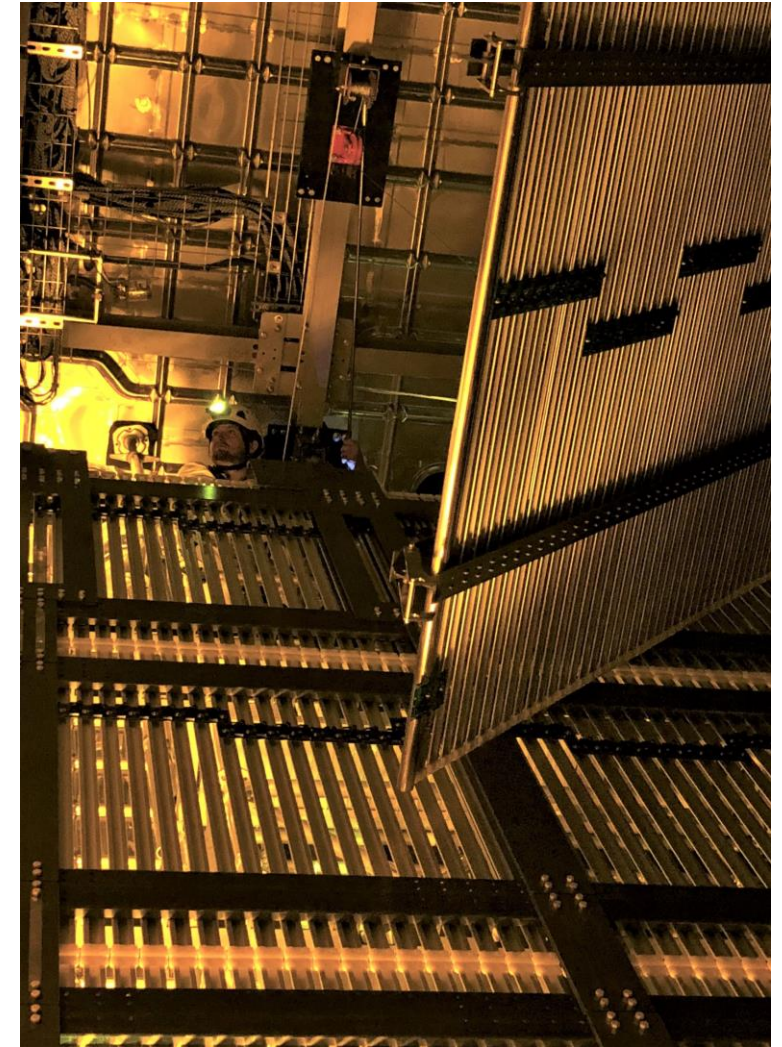
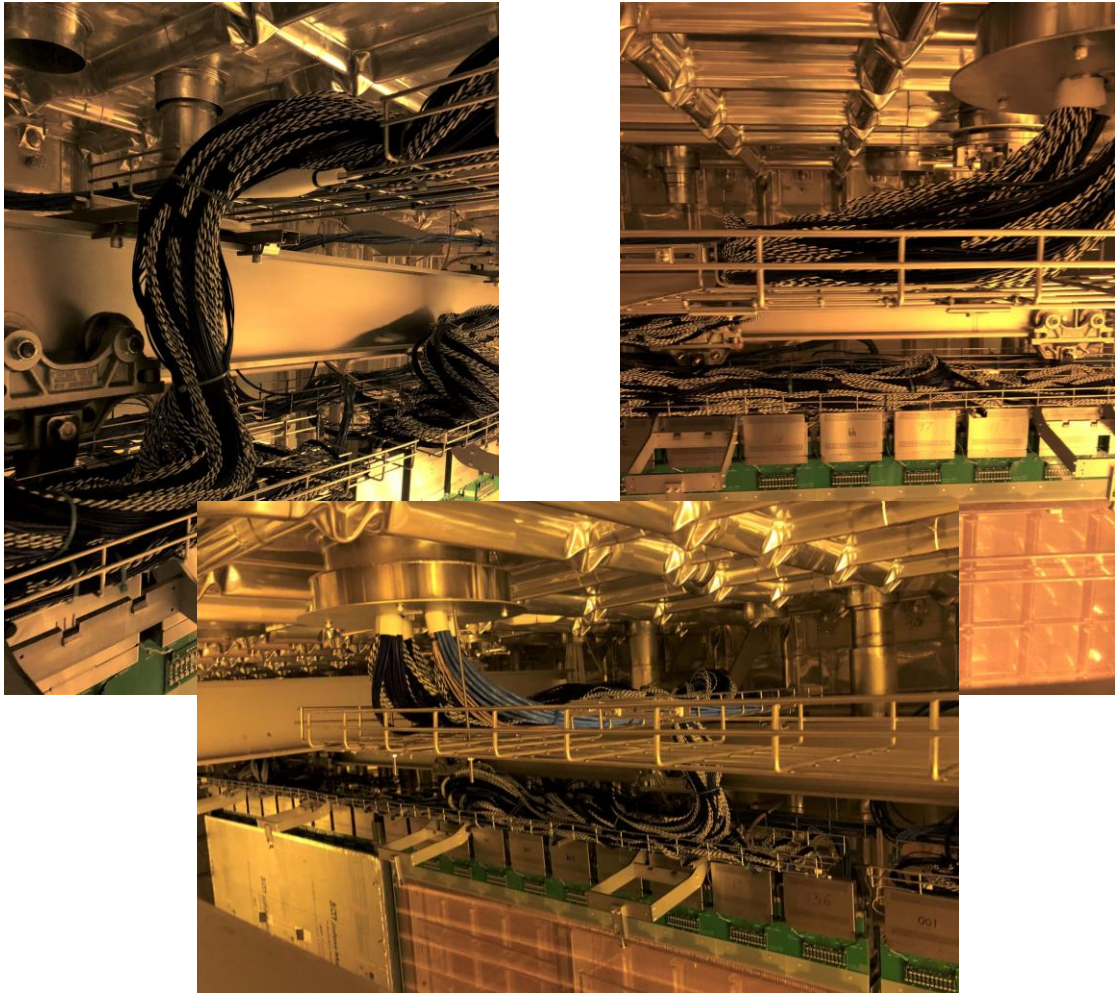
Dune has only 331mm clearance from the bottom of the APA to the face of the cryostat  
ProtoDUNE had 756mm

**17 inches less!**



# Phase 1-FY20 TPC Assembly Procedures

Now that APA pair panels are in place CE cables are run in the feed thru and tested



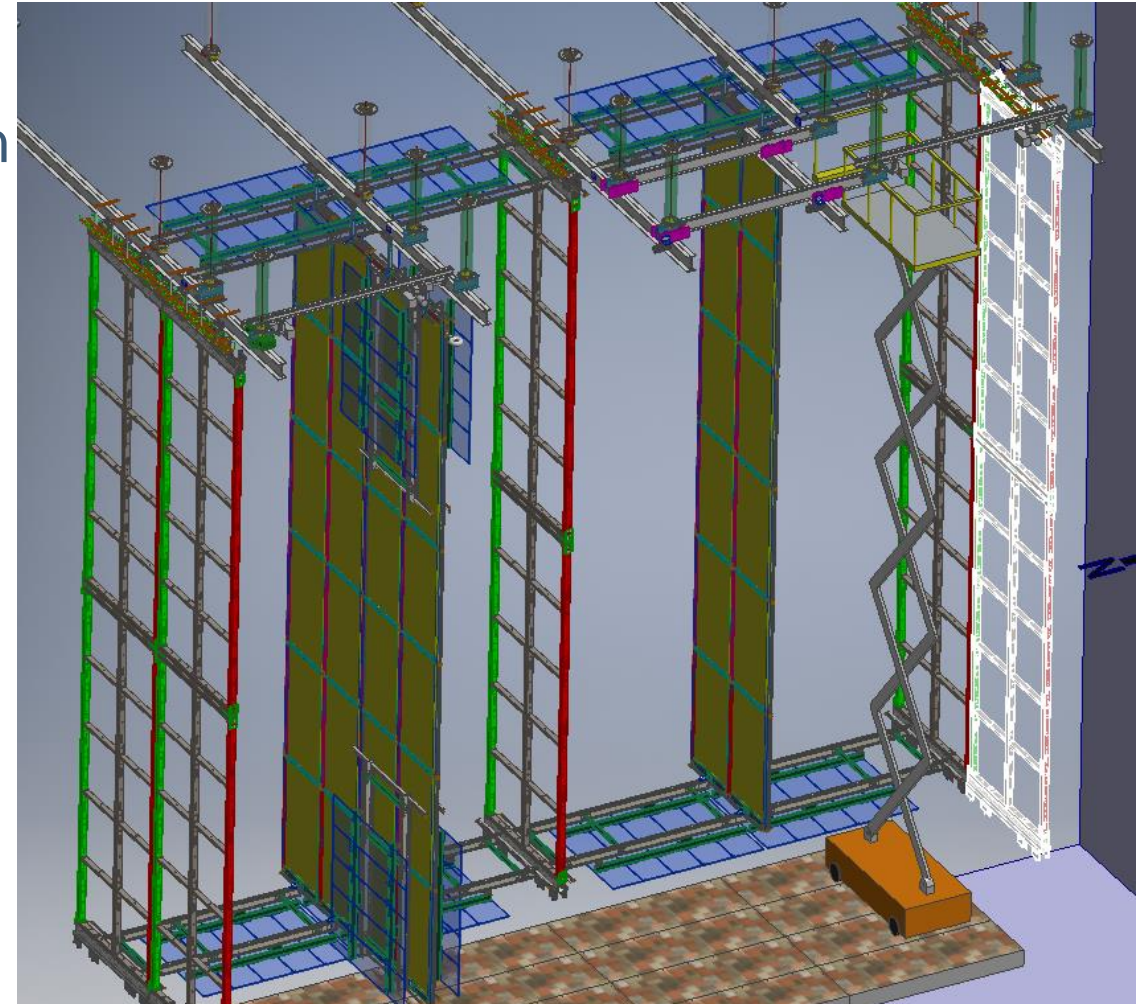
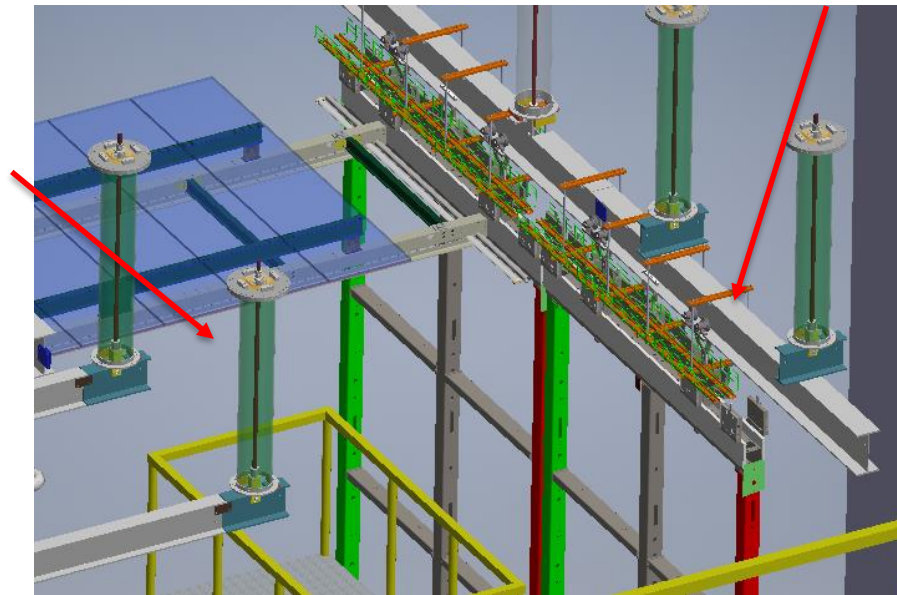
Then the Field Cages are deployed

# Phase 1-FY20 closing up the TCO

Placing the 25<sup>th</sup> row of TPC components and removing the runway beams while leaving enough room for closing the TCO (Temporary Construction Opening) will be difficult and needs to be tested

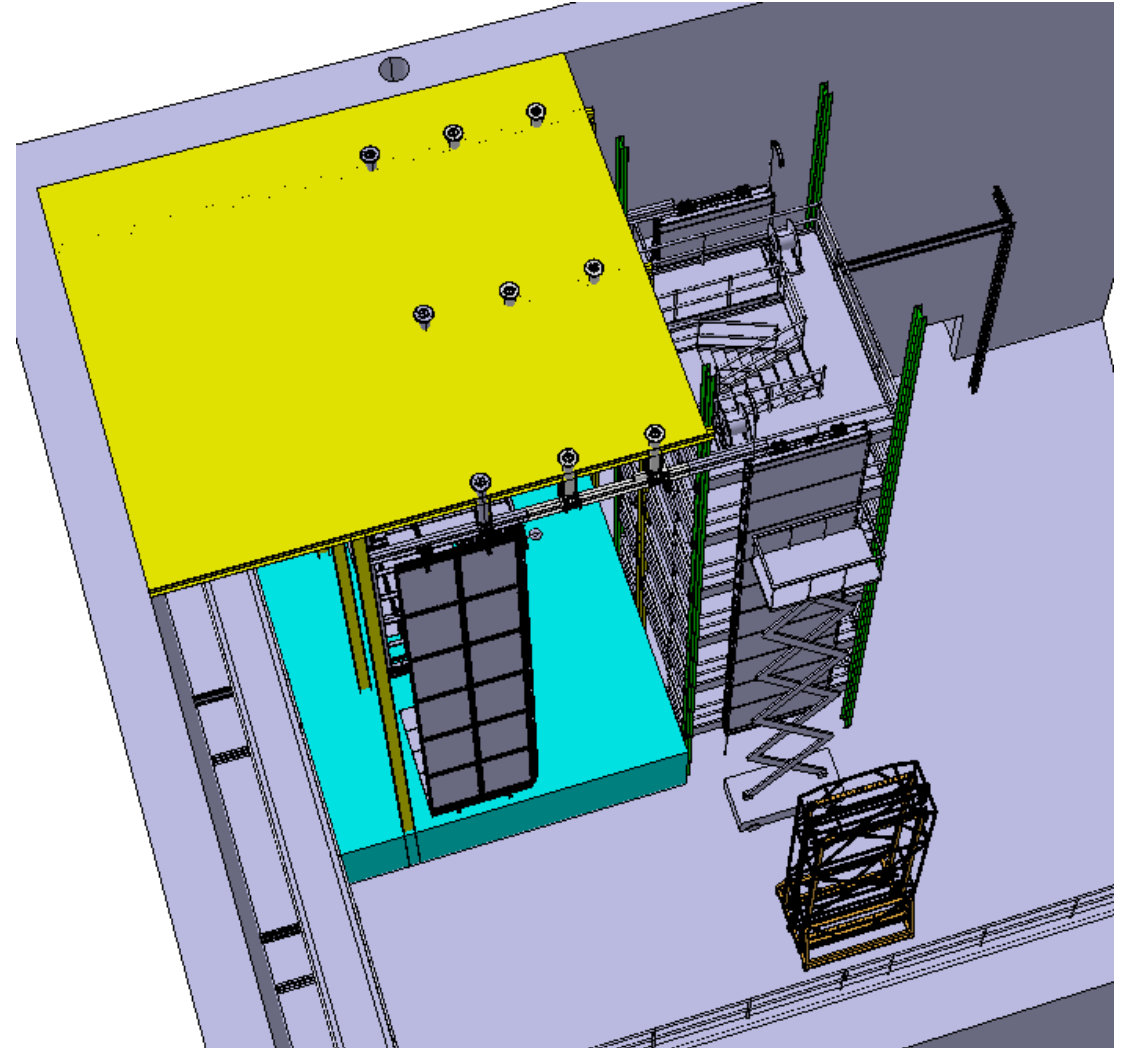
Shuttle Beam is then Permanently Mounted

Runway Beams are Removed



# Phase 2- FY21 Cryostat Deck Summary

- Support beams for Cryostat Deck roof should be flush with loading dock floor, decking should be open grating to eliminate a need for changes to the sprinkler system
- Mock up feed-thru for both, DSS installation, APA cabling and DP trial assembly
- Gives additional flexibility to do a full test of TPC assembly now possible including time and motion studies.

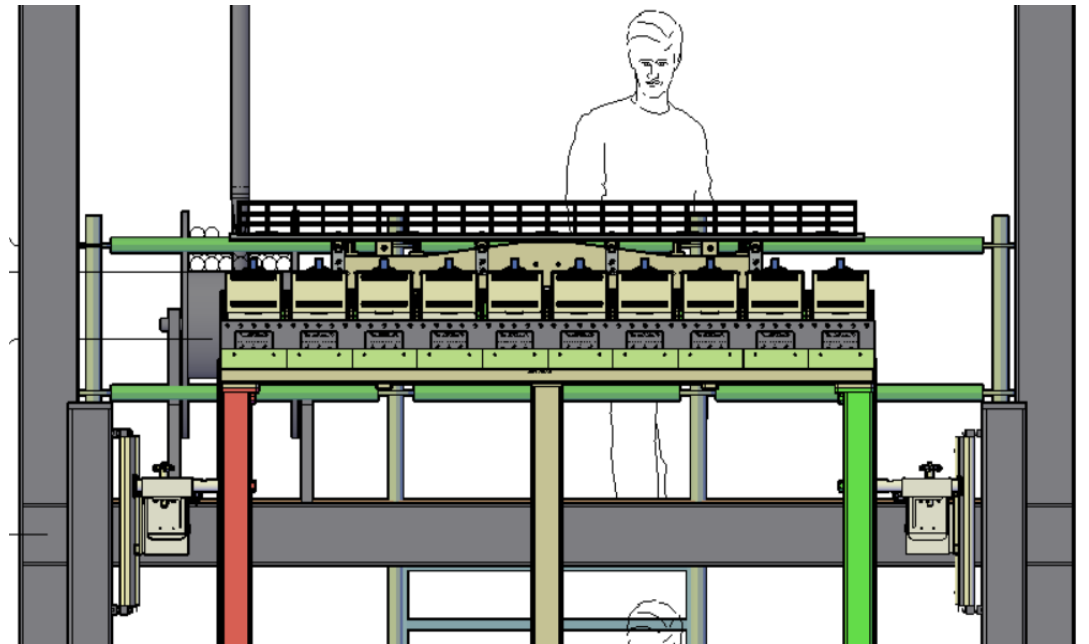


# Remaining Trial Assembly Issues-Phase 0

Phase 0: Likely will not start tower construction until late March

- Finish the tower design so it can go out for Design Build Bid: (~2 months behind)
- Once we have Design/assembly drawings submit to code officials to get building permit approved (~1 month)
- Write documentation for procedures for first steps of phase 0, get approved by Jean Cranston (University Safety) and FNAL Safety (Mike Andrews) this includes all components APA design and structural documentation

- Need design for CPA assembly to add attachments to tower design- Can we design CPA so we have access to most of the back of the CPA pairs? Horizontal beams for attachment.
- Getting elevations of the APA horizontal beams correct





# Trial Assembly Issues-Phase1-2

Other open to be questions-Phase 1 & 2:

- Do we mock up cryostat floor and sub-floor? (may need this to really try scissor lift and test access)
- Do we want/need a floor (phase 2) with feed thrus so we can fully test APA cabling?
- Trying to design this so we can be flexible over the next year as designs mature.
- Need design for APA lifting fixtures
- Need design for CPA tower