HVS Planning for FD Integration/Installation

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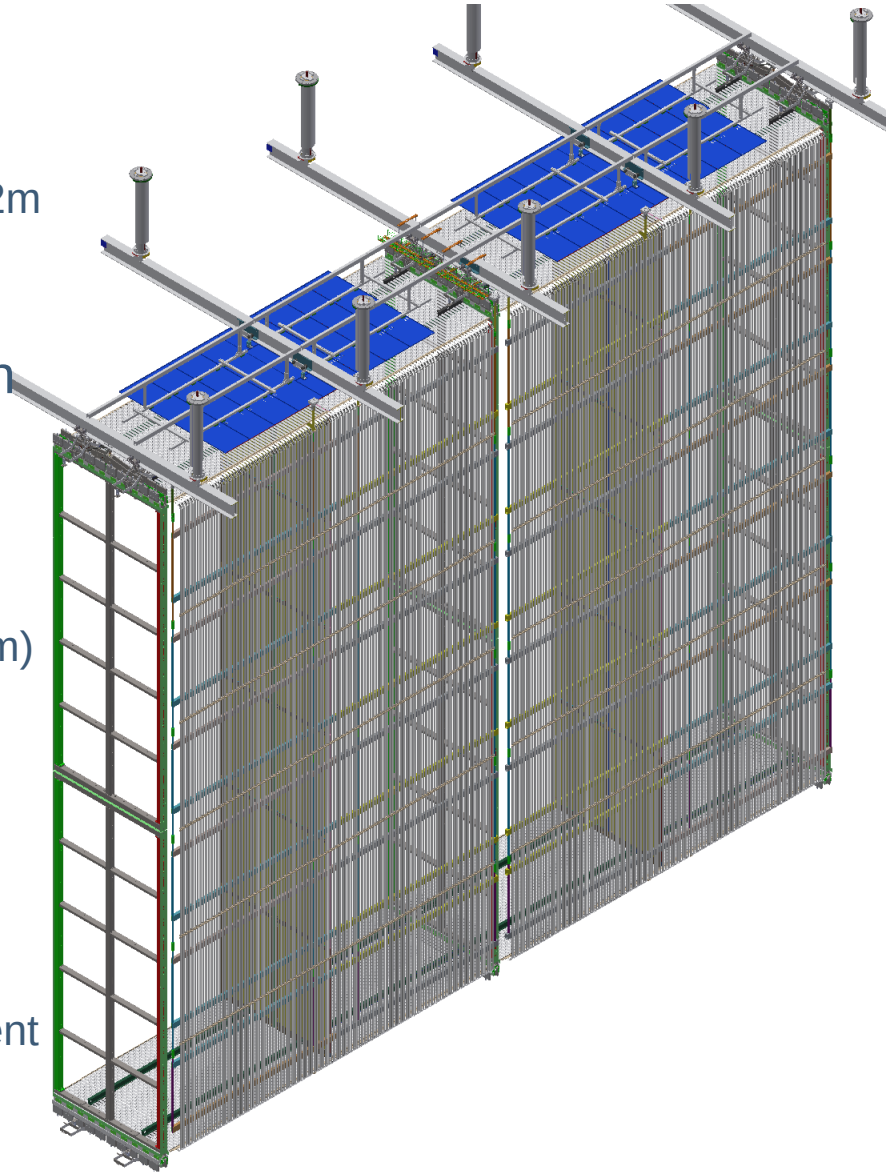
Outline

- Status of Design
  - 3D models
  - Installation sequence
  - Analysis
- Status of prototyping
  - AR, EWFC, CPA assembly frame, FC assembly table
- ProtoDUNE II design
- Action items from last workshop
- Interface documents
- Recent scope change

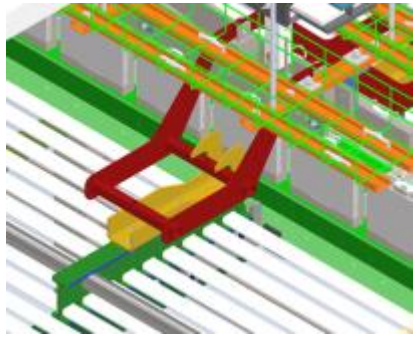
The New HVS design

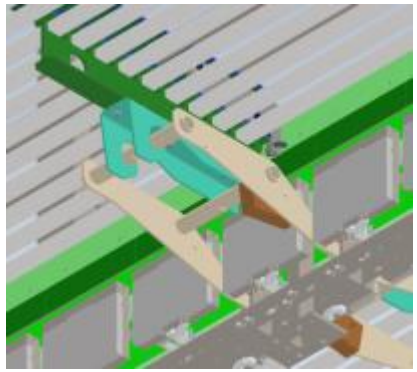
- 2 End Wall FC's each made of:
  - 4 columns of 6 high 24 EW identical modules (2m x 3.5m), with top/bottom modules hosting bent aluminum profiles
- 25 ~ identical CPA/TBFC/GP rows, each made of:
  - 2 CPA's: 6 basic unit (1.15m x 4 m)
  - 8 Top/Bottom FC module (3.5m x 2.3m)
  - 4 Top Ground Planes (4 units each: 2.3m x 0.5m) hanged independently to the DSS beams
- Assembly & Installation of FC modules:
  - Performed fully underground (NP02 experience on FC)
  - about 1 month for EW
  - 1 week for each CPA/TBFC/GP slice: deployment of FC at the end of installation.



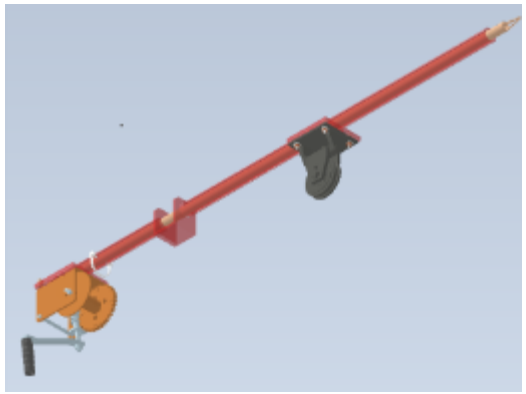
Recent Updates to the 3D Model

- Released a set of 3D models to EDMS at end of last year → v5
- New FC-APA latches
  - Aluminum construction, fewer parts, lower profile, no risk to APA wires during FC deployment
  - Proper FC to latch attachment
- New bottom FC deployment winch bar



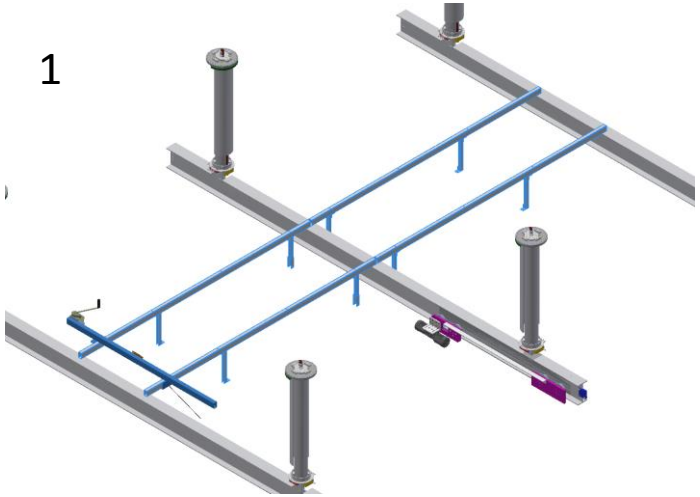


- Known Issues / to do list
  - EWFC interference with APA: →move each EWFC outwards by ~ 15mm
  - PD diffuser on CPA: mounting features known. Waiting for placement pattern from PDS
  - Missing EWFC to CPA/APA attachment features
  - Missing FC openings for ionization lasers



GP Installation Steps

1



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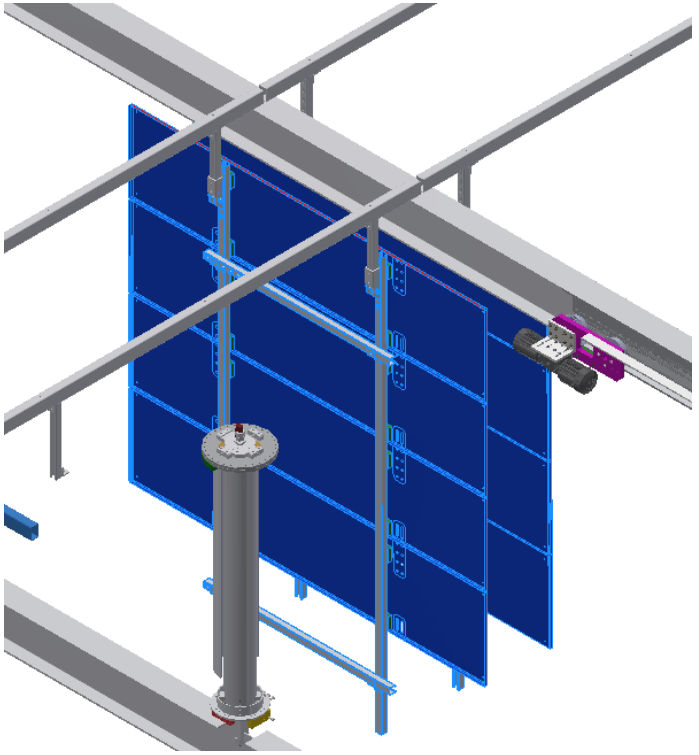

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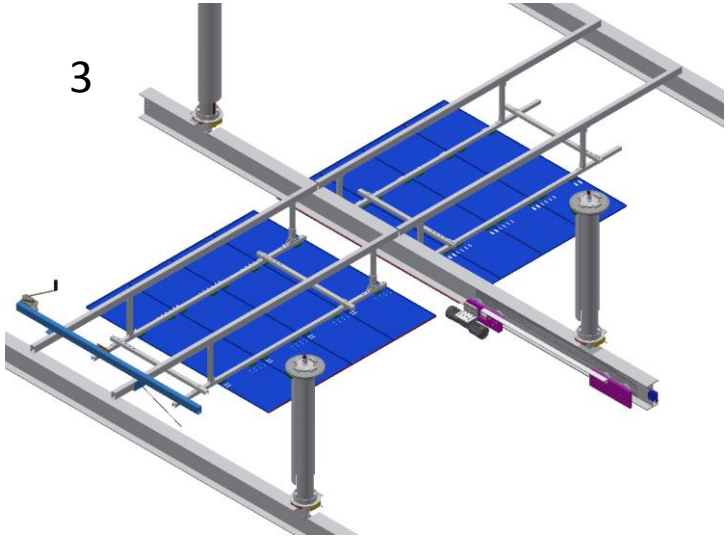
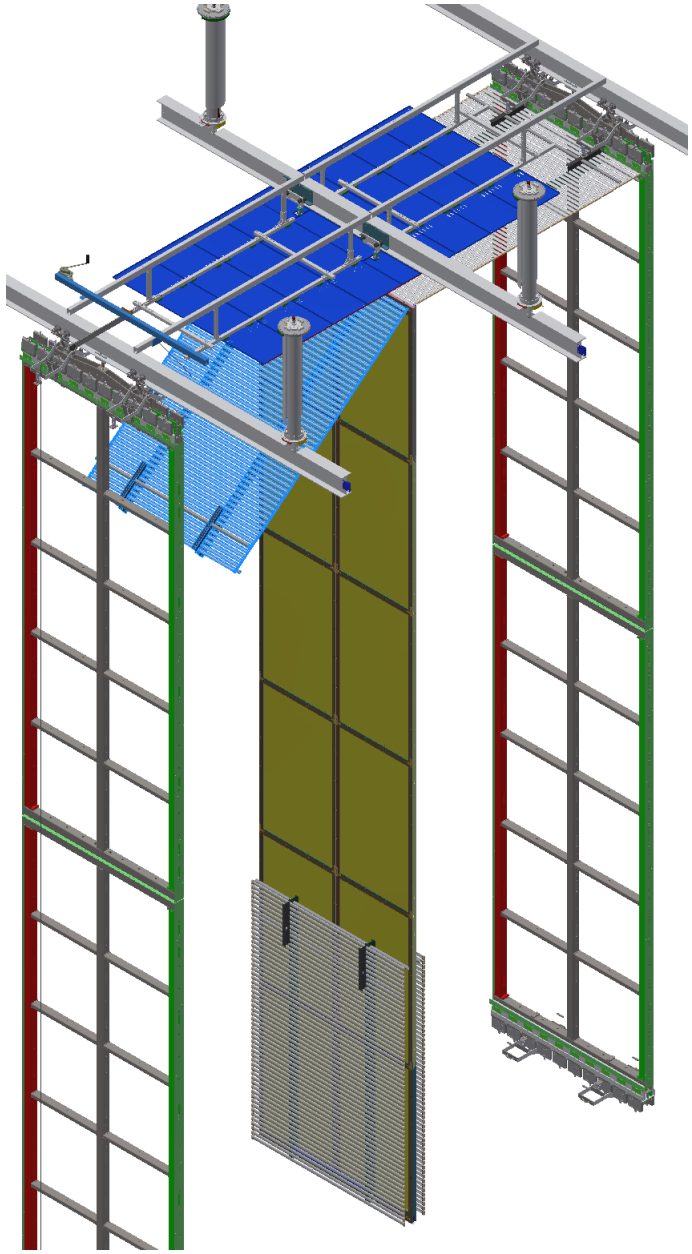


1. Install the ground plane support beams over the DSS beams.
2. After installation of CPA/FC super module, and connecting PD flasher fibers, install the ground plane modules.
3. Raise the GP modules after the CE cable installation.
4. (not shown) install the GP filler pieces over the middle GP gap, connect the GP readout cables

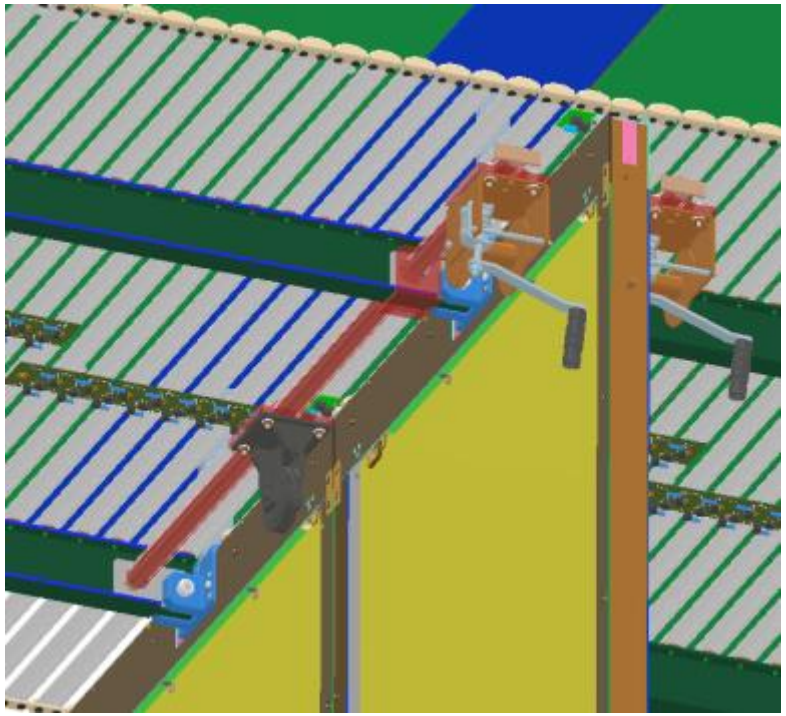
Top FC Deployment

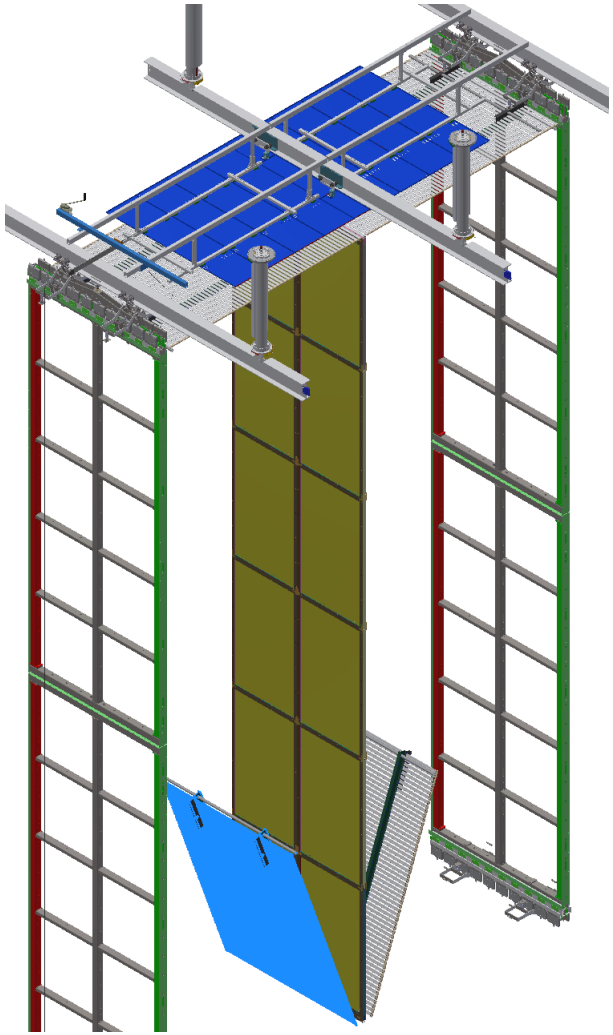
- Deploy the top FC modules using winch bars on the GP support beams.
- Connect top FC termination wires
- This action (and the following ones) can be performed during the insertion of the row in the cryostat or when the full CPA/TBFC rows are inserted.
- In the latter case insertion rate could decoupling from that of the APA



Bottom FC Deployment

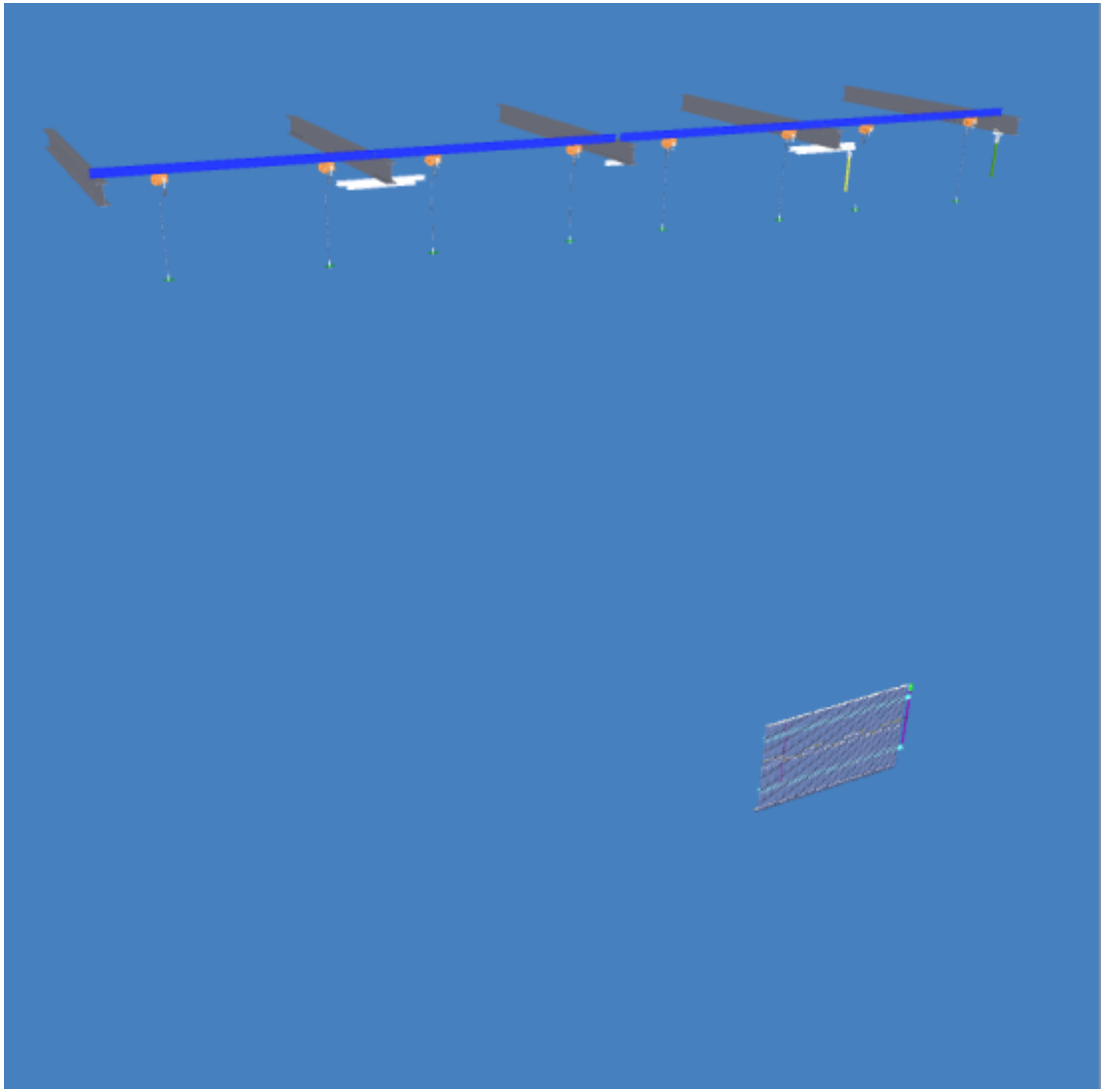
- Deploy the 2 bottom FC modules, preferably symmetrically to minimize the lateral swing of the CPA.
- The bottom FCs are lowered through a temporary winch bar attached to the CPA side of the top FC I-beams





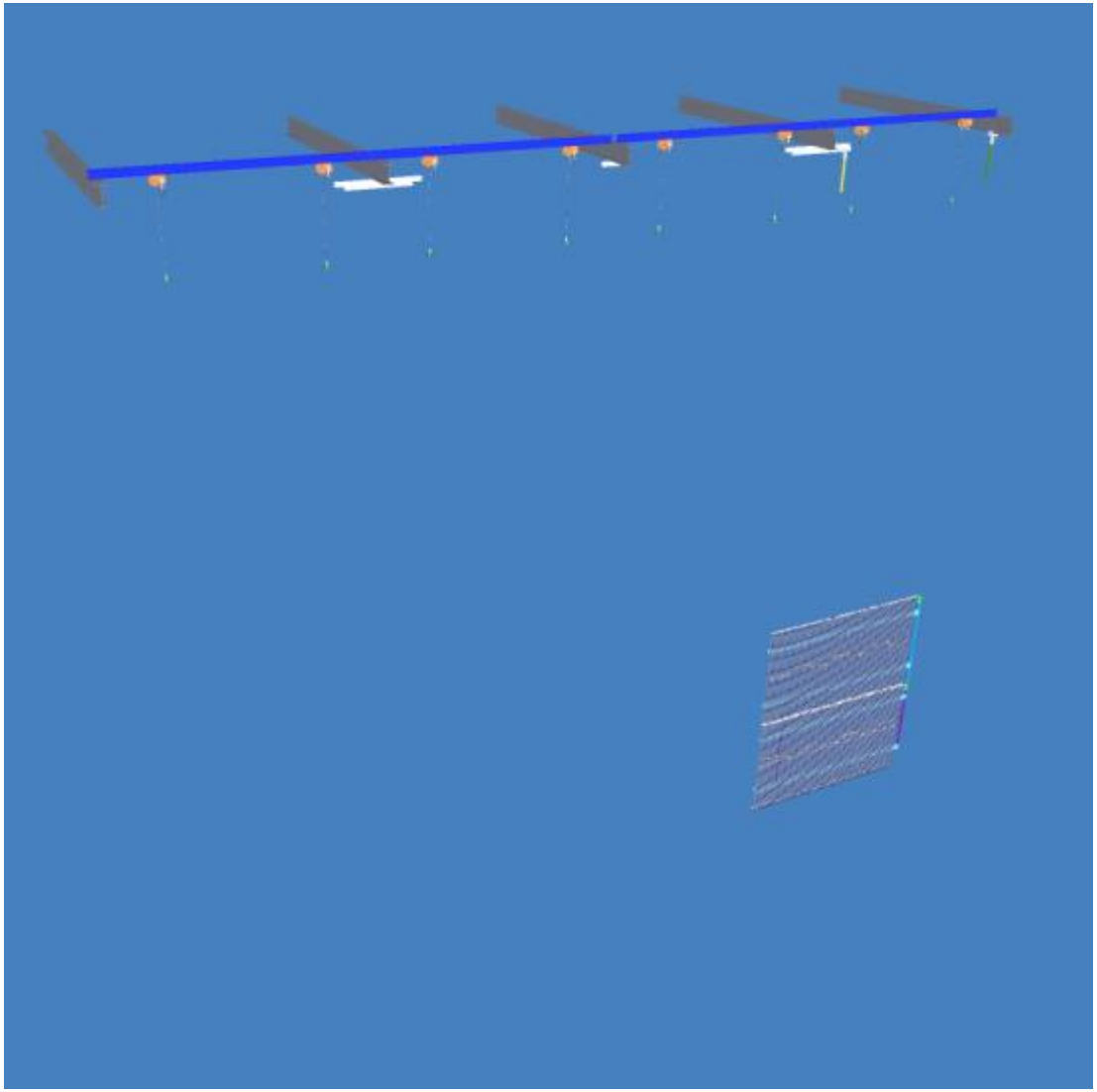
East Endwall Installation

- Install temporary endwall support beams with winches over the 5 DSS beams
- Attach column 1, row 1 (top) EWFC module to the winches of support beam
- Raise the module by 2m



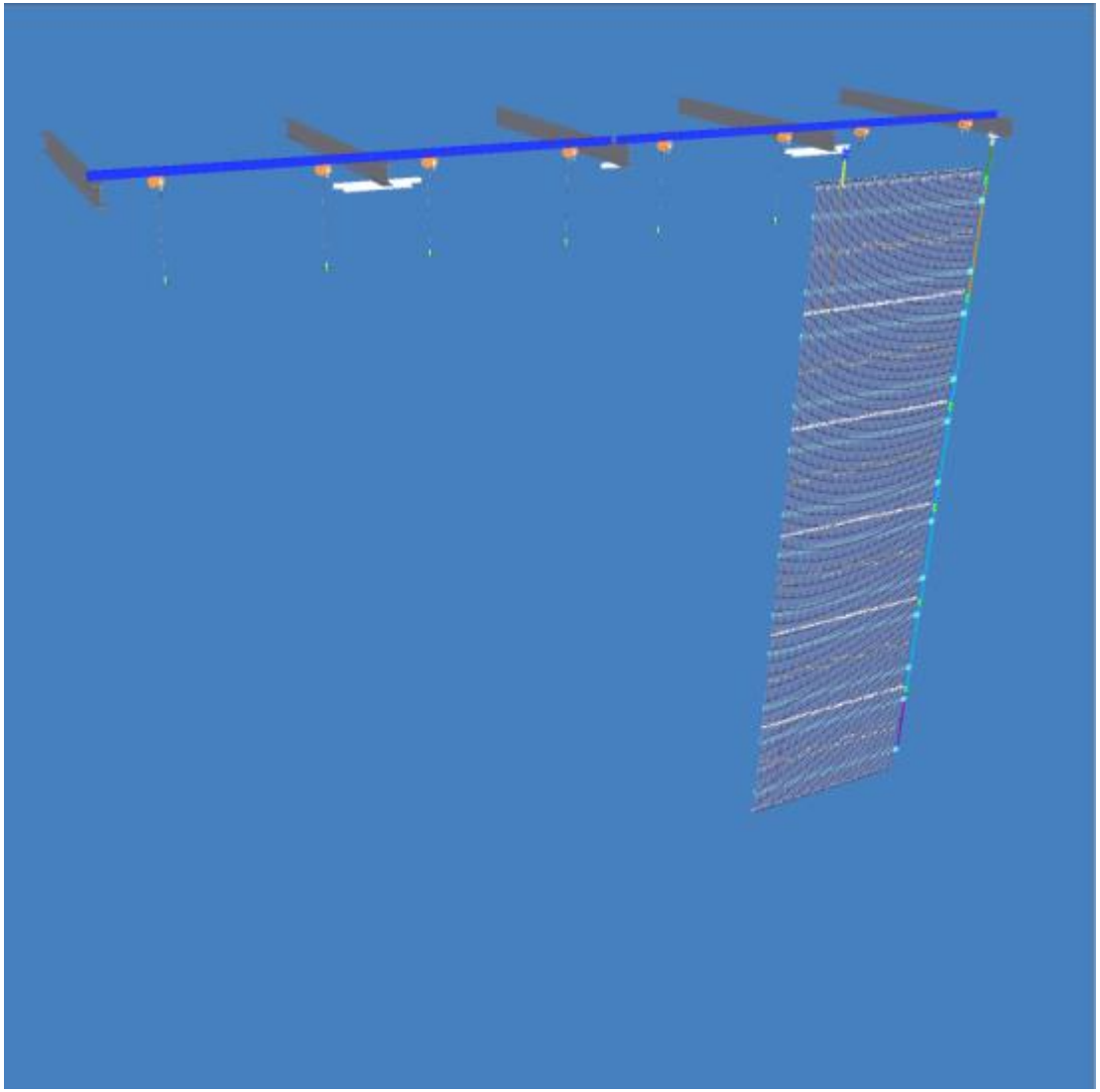
East Endwall Installation

- Attach the second EWFC module under the first one by installing and tightening 4 bolts on the two aluminum bars on the EWFC modules
- Raise the column by 2m



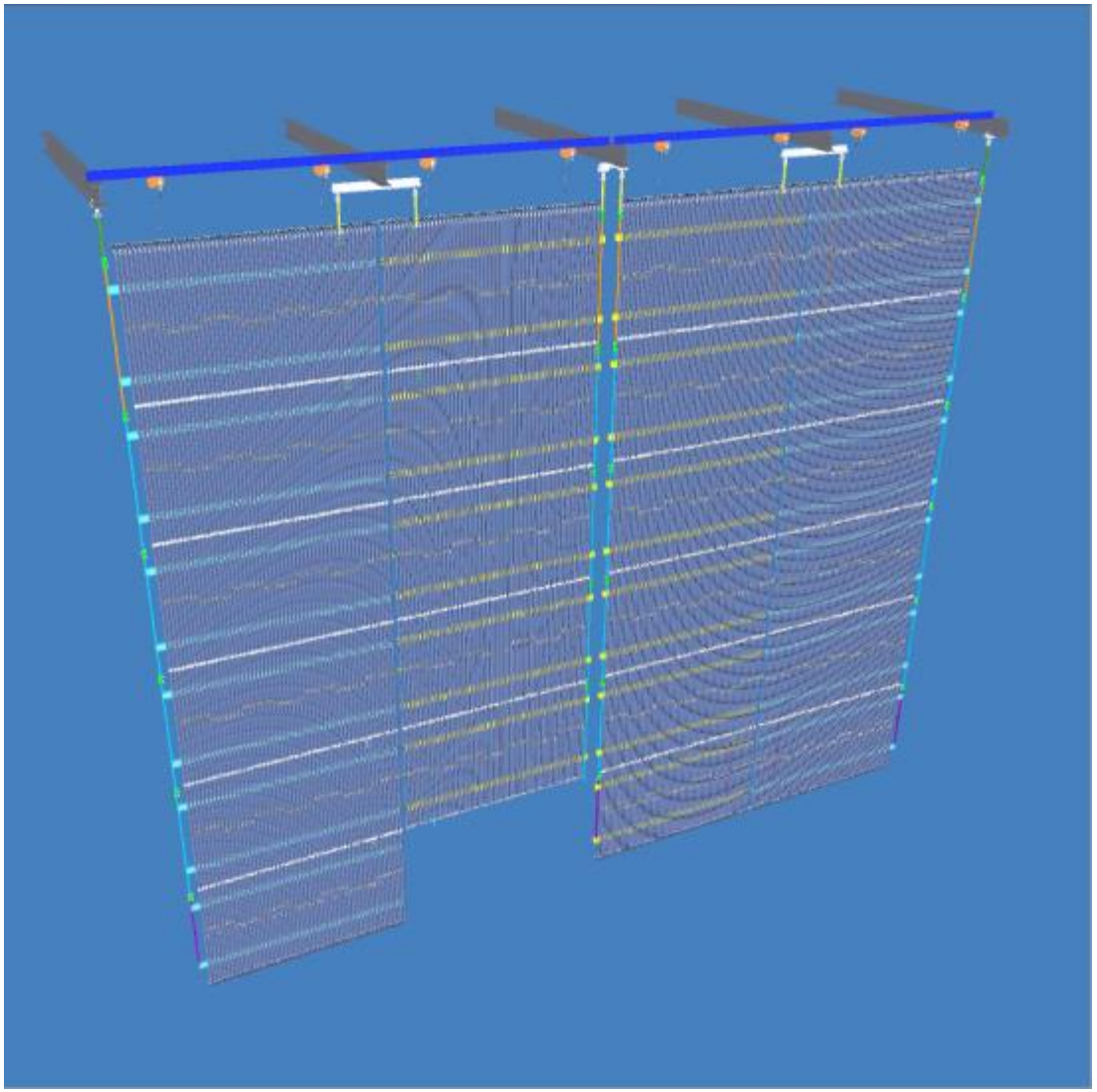
East Endwall Installation

- Repeat the process until all 6 modules in this column are connected and at the designed height.



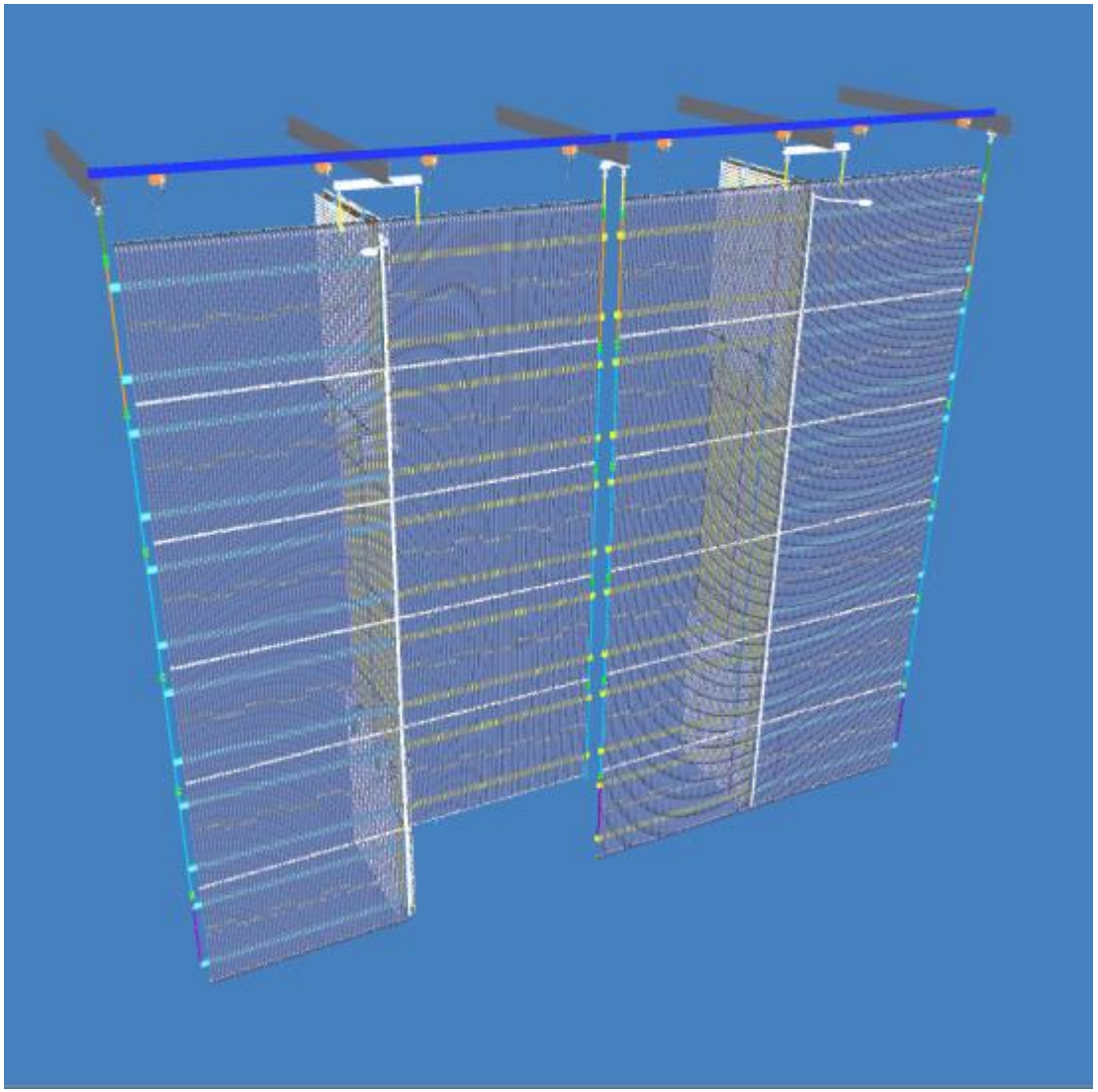
East Endwall Installation

- Repeat the same process for the other 3 drift volumes until all four columns are raised. Leave the bottom module on one of the columns out for now so the scissor lift can pass under (with the hand rails folded)



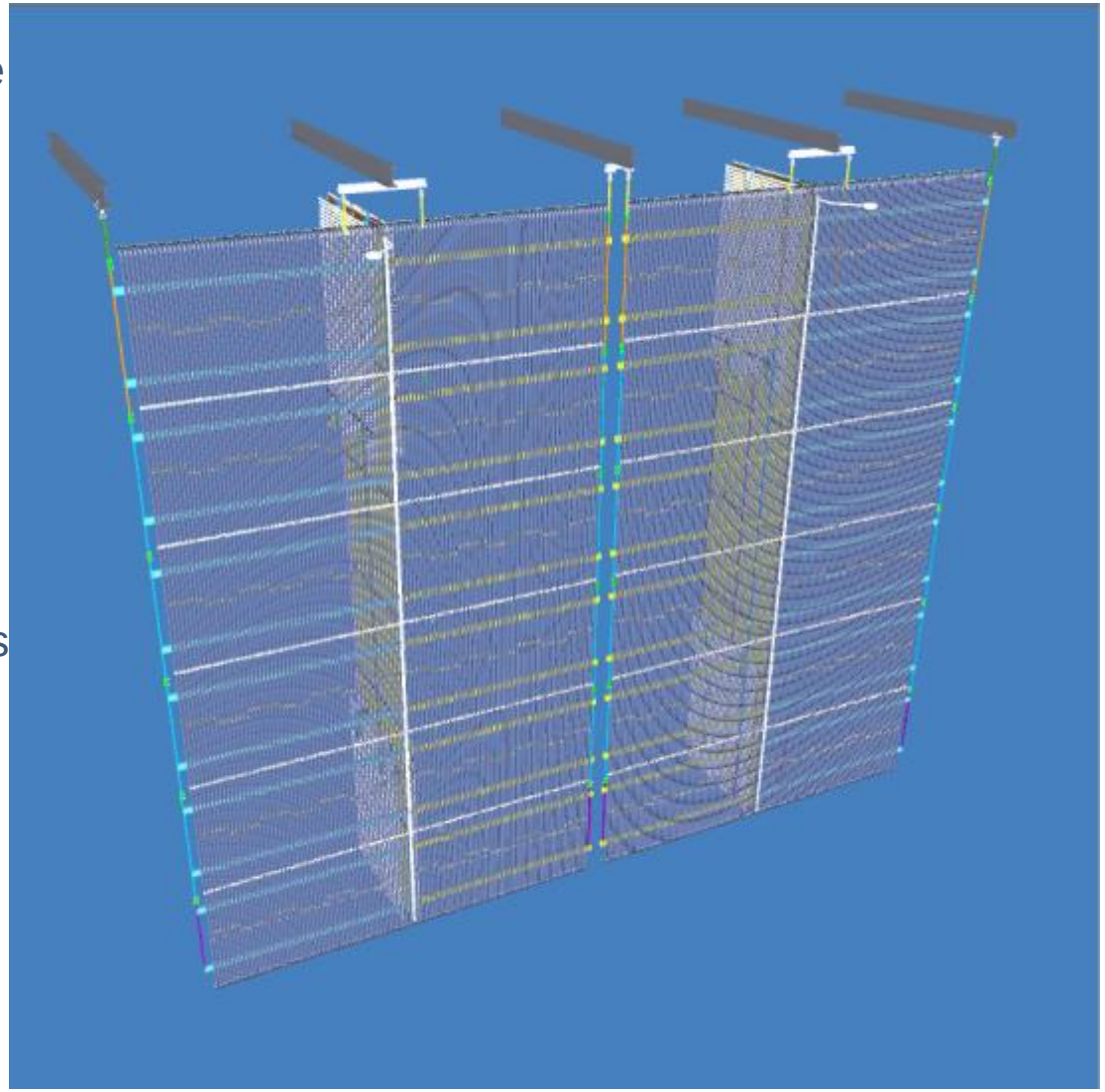
East Endwall Installation

- Move the CPA/FC assemblies for Row 1 into position, lock the CPAs to the EWFC guiding blocks.
- Connect EWFC RDBs to the CPAs
- Install the two HVFT cups onto the CPAs, check continuity.
- Install the two HVFTs on the cryostat top, verify contact to the HVFT cups



East Endwall Installation

- Move the scissor lift inside the TPC, install the missing EWFC module from inside to complete the EW assembly
- Transfer the load of each EW column from the temporary support beam to the final EW support points. This needs to be done on each side of the cathode together.
- Remove the temporary beams
- Now we are ready for the APAs.



West Endwall Installation

Starting point: Row 1-24 FCs have been fully deployed and QCed. Row 25 CPA/FC in position and folded. Deployment lift bars on the T/B FCs installed. Row 25 ground plane deployed. Floor is in place under Row 25.

West EW installation steps:

- Installed temporary EW installation beams over DSS beams at their outward most position
- Build the top 5 modules of all 4 EW columns under the temporary EW installation beams
- Lift the 5 module stacks up to the top of the TPC to their final position
- Drive scissor lift under the EW stacks into each drift to make EW-CPA connections at different heights, QC electrical connections, tie all the lifting ropes to the T/B FC lift bars.
- Loosen the rope used to keep the pair of bottom FCs against the CPA such they open up to ~ 15° w.r.t. the CPA.
- Drive the scissor lift out of the TPC, install the 6th (bottom) EWFC module (2m tall) to each of the EWFC stack, make electrical connections and QC.
- Remove the floor under row 25, pass the floor boards under EWFC.
- Lower the EWFC by ~ 30cm.
- Raise the top FC modules using winch bars mounted on the GP support beams as usual. Make electric connections to the FC termination cable,
- Thread the rope connecting to the bottom FC lift bars to the winch bar pulley and winch. Install the bottom FC deployment winch bars to the underside of the top FCs over the gap above the lowered EW.
- Lower the bottom FC modules in pairs symmetrically on both sides of a CPA until latches engage. Make electrical connections from under the bottom FC to their termination cables.
- Remove the winch bars under the top FC modules. Lower the ropes to the bottom FC.
- Raise the EW columns up above their final position until the lift bars on the top of the bottom FC modules are accessible.
- Remove the lift bars and ropes from the bottom FC.
- Lower the EW columns back to their design height, push the EW toward the TPC, transfer EW load to final lift bars. Connect the EW-CPA, EW-APA attachment features
- Remove the temporary EW installation beams.
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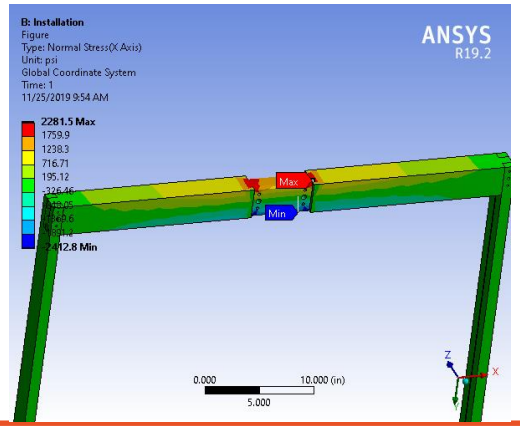
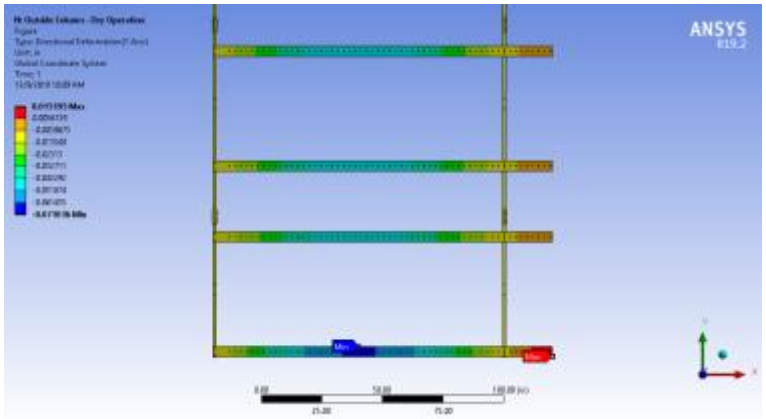
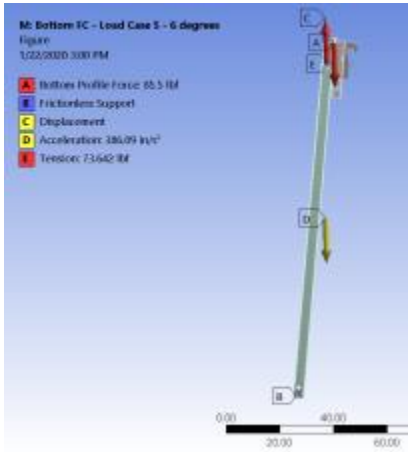
Structural Analysis

- Structural analysis for the CPAs, Endwall field cage modules, and the top/bottom field cage modules have been posted to EDMS and submitted to the Compliance Office base on the original agreed upon analysis plan.
- We met Giuseppe and Olga last week to discuss the documents and seek feedback.
- We are expecting a formal memorandum from CO soon and we will update the documents accordingly.





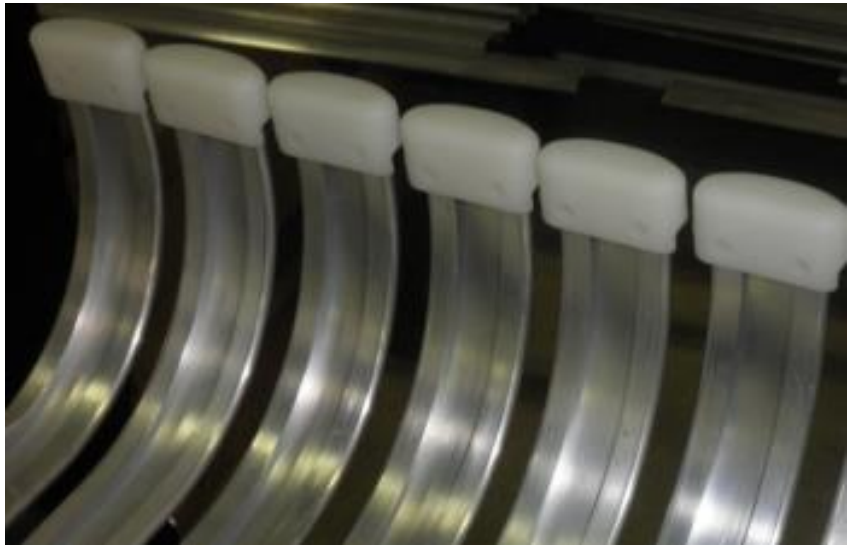


Prototyping Activities: Ash River

- Ash River: validation of the new ground plane and field cage concept, CPA assembly frame.

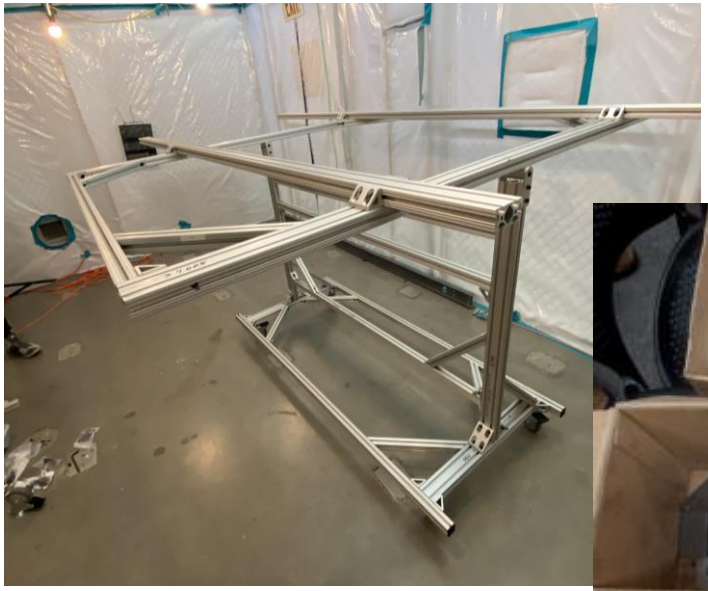
Prototyping Activities: LSU

- First full size endwall FC module completed last month
- Iterations of the profile bending tool resulted in quick and consistent 90° bent profiles.
- Working on the EW assembly fixture.



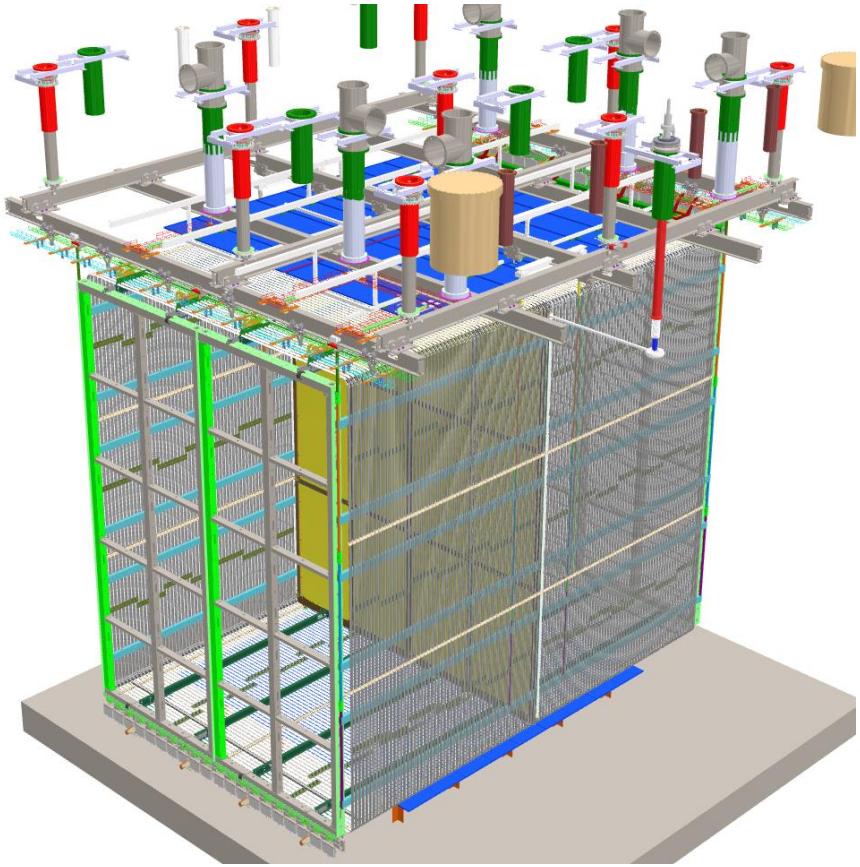
Prototyping Activities: SBU & UTA

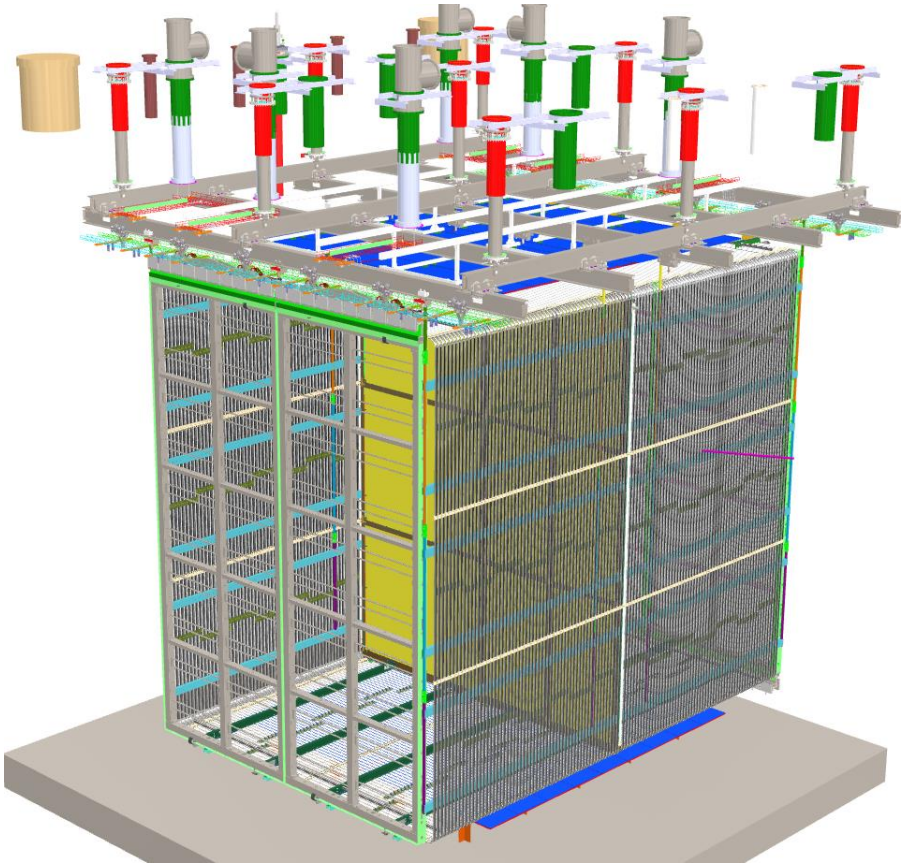
- Received FRP parts, and profiles
- Constructed an FC assembly table, second on the way
- All parts for AR modules are available
- We are on track to deliver the FC parts to AR in end or March / early April.



ProtoDUNE II

Unofficial TPC model for initial studies
https://edms.cern.ch/document/2261583/1



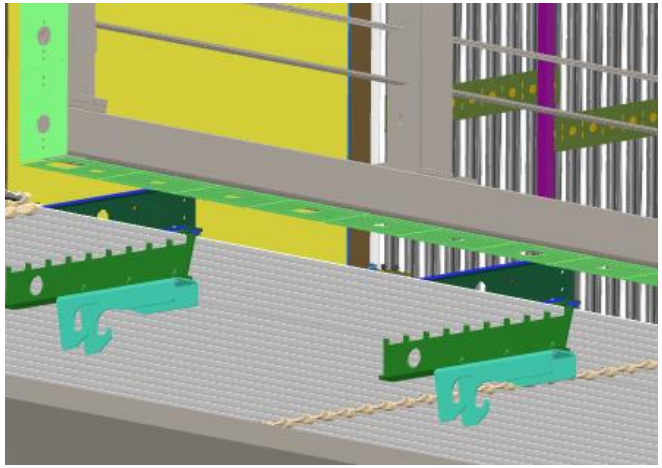


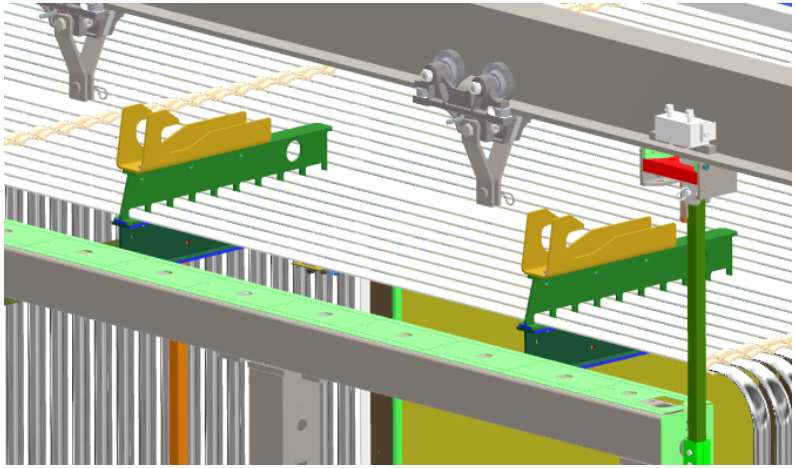
Key Differences

	NP04	FD	NP04 R2	Issues
APA thickness	76.2mm	101.6mm	101.6mm	
APA-CPA Plane Pitch	3637mm	3574mm	3574mm	
APA yoke height	110mm	160mm	BL: 160mm BR:?	APA-DSS support, APA-top FC latches
APA-APA pitch	2320mm	2328mm	2328mm?	Do we want to simulate the larger (+19mm) gap between APAs cross FD DSS beams?
APA orientation	Upright	Both	BL: Upright BR: Inverted	Inverted APA support, APA-FC latches on bottom of upright, top of inverted APAs.
FC-GP clearance	20cm	30cm	30cm	CPA hanger length, trolley design
Upper GP	On top FC	To DSS	To DSS	B & D bridge beams have restricted travel range
Lower GP	On BFC	None	On floor	Design new bottom GP support structure
Beam plug	Yes	No	Yes, much longer	Design new BP

APA Interface Issues

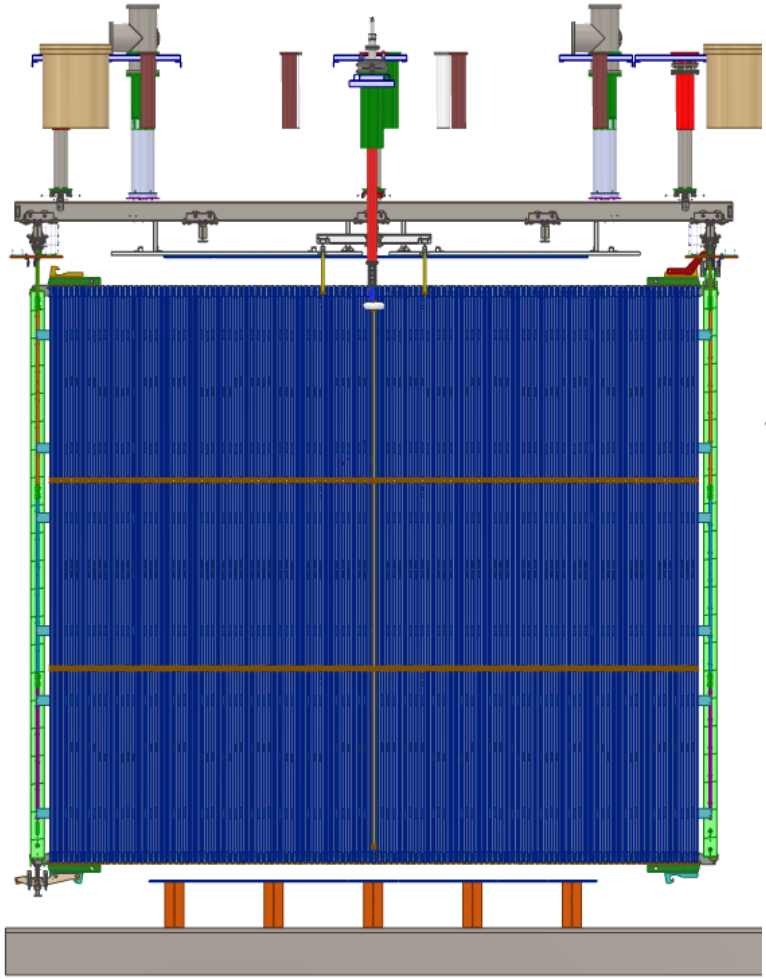
- Need special support structure to tie the bottom of the upright APA to bottom FC and top of the inverted APA to the top FC.
- Propose to set the heights of the APA/HVS modules in this way:
  - Use the upright FD APA yoke to set the height of the upright APA
  - Use the new FD APA-FC top latch to set the height of the top FC modules
  - Use the Run1 CPA top and bottom hinges to set the lower FD FC height
  - Design a new bottom FC latch anchor for the upright APA
  - Use FD bottom FC-APA latches to set the position of the inverted APA
  - Design a new inverted APA lifting yoke for this APA height, and design a new FC latch anchor on this yoke

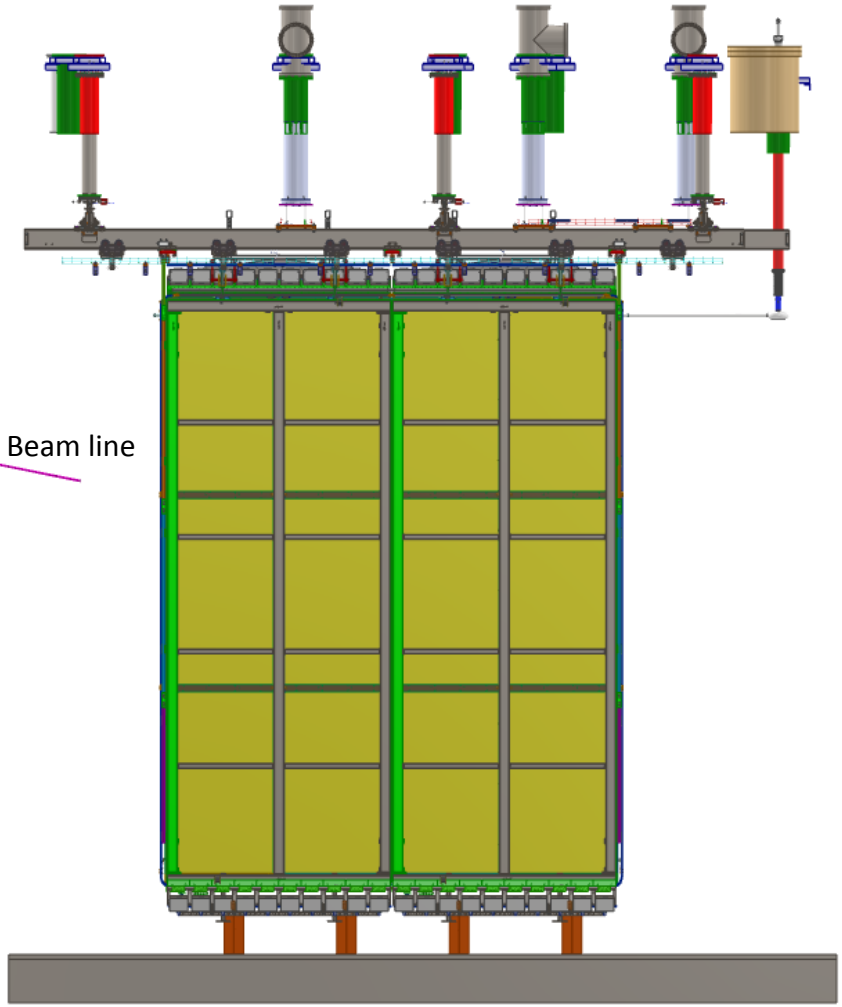




More Views of the TPC

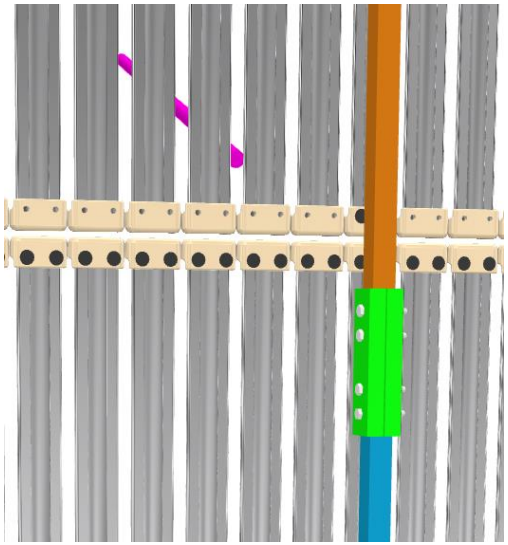
The TPC maintains the same center point as NP04 v1 (endwalls moved in ½ APA width). To center the TPC inside the cryostat, it needs to move DS by another 320mm.

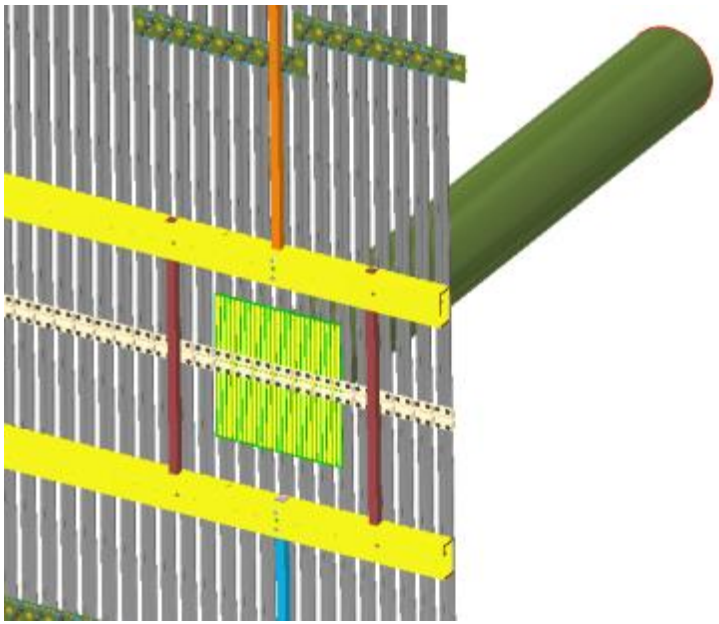




Beam Plug for the Smaller TPC

- The smaller TPC requires a longer beam plug: 1.8m long if the TPC is centered inside the cryostat.
- We have the option of building a beam plug using a similar construction as the current plug, or a simpler pipe with internal and external resistive coating.
- The beam intersect the EWFC near a module gap and close to the lift bar of the FD EWFC module. We have to make some change to the standard modules.





Action Items from Last Meeting

- ID 81939: Define endwall installation procedures
  - East end wall sequence defined, and it is included in I&I's installation document.
  - West end wall sequence is not finalized due to the limited access to the HVS modules. Several options are currently being explored.
  - Will finalize the steps after the Row 25 installation trial at AR this summer/fall.
- ID 81967: Determine the locations of the HV power supplies
  - Requirement sent to TC: allocate one rack and the adjacent space of a rack within 20m of the locations of each of the 4 possible HVFTs. The spaces on the east end will be initial occupied by HVPS and filter/excess cables, while the spaces on the west end are reserved for a possible failure scenario when we have to relocate a HVPS to the other end of the cathode.

Interface Updates

- APA
  - Interface to APA has been simplified to be mechanical only (APA-FC latches and EW attachment). Electrical interface has been eliminated.
- CE
  - FC termination board ground reference changed to the cable shield instead of the APA frame. Failsafe termination will be connected directly to the DSS beam (new interface) . Bottom FC failsafe goes through a new cable in the CE cable bundle to DSS.
- PDS
  - Number of diffusers are still to be defined.
  - Reflector foil mounting option removed.
- CALCI
  - Move photoelectric laser and radioactive source related interfaces to "To Do List"
- DAQ/SC
  - No major changes are identified.

Recent Scope Changes

- Last week we were informed that the ground plane modules and their support structures to the DSS beams have been moved to the I&I scope.
- We are still trying to understand the details on the responsibilities between the consortium and the I&I for both FD and ProtoDUNE II as a result of this change.
- We have passed along the current design and wish lists to Dimitar. Some of these features have been incorporated in the latest DSS design.
- This change alters HVS interfaces not only to DSS, but also CE, PDS, CALCI.
- We'll have to further update these interface documents.

Summary

- The HVS for the FD is nearly feature complete and modeled in 3D.
- Structural analysis of the HVS components posted on EDMS and submitted to CO for feedback.
- Prototyping of the FD modules are underway. Most of the key components' cost is now known.
- First round of installation trial at Ash River using the first FD modules at the ProtoDUNE setup is planned for end of April.
- Conceptual configuration of ProtoDUNE II TPC with 4 APAs is posted for initial discussions. Working on finding a solution for a longer beam plug.
- Had 3 way discussions with other consortia/TC in the last few days. Will update existing ICDs to reflect the changes we are planning for the FD.
- Still need to understand the details on the ownership change of the ground plane.