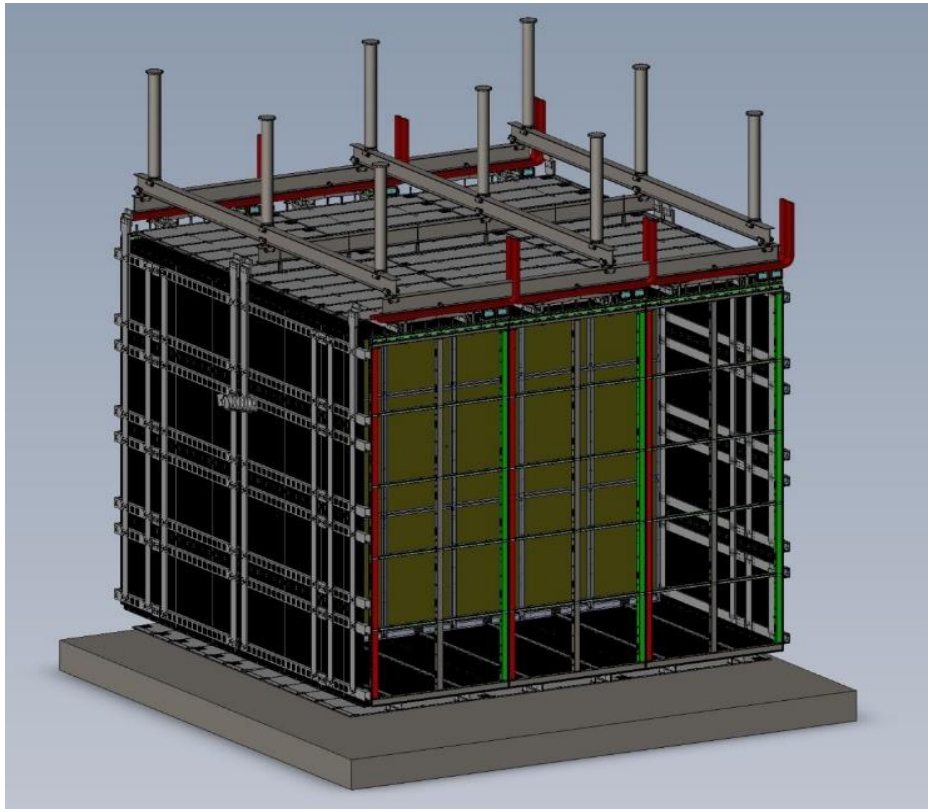
ProtoDUNE Assembly Sequence and Access Issues



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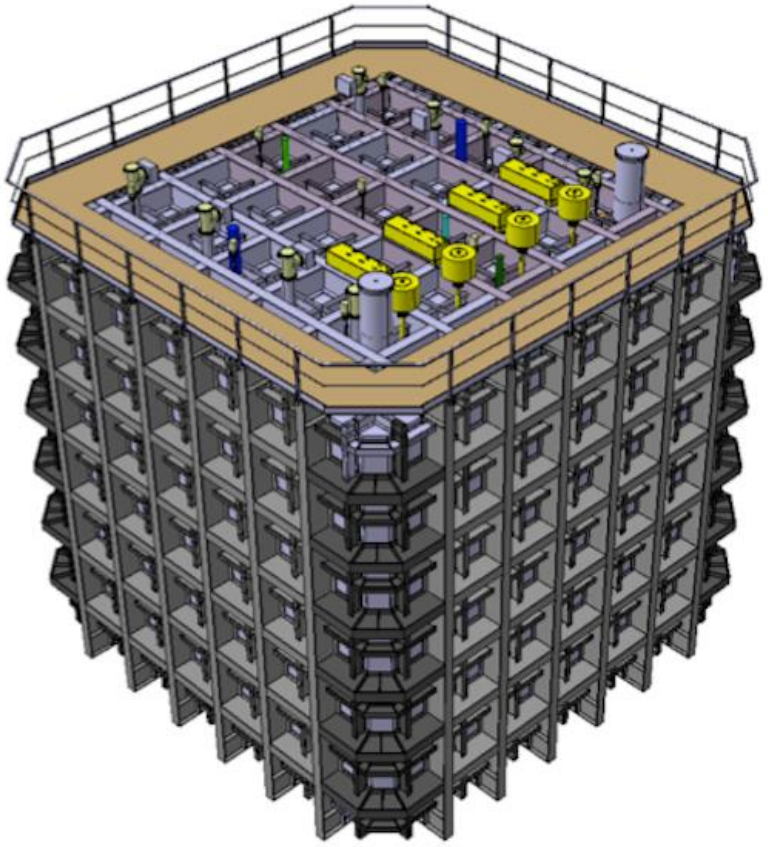
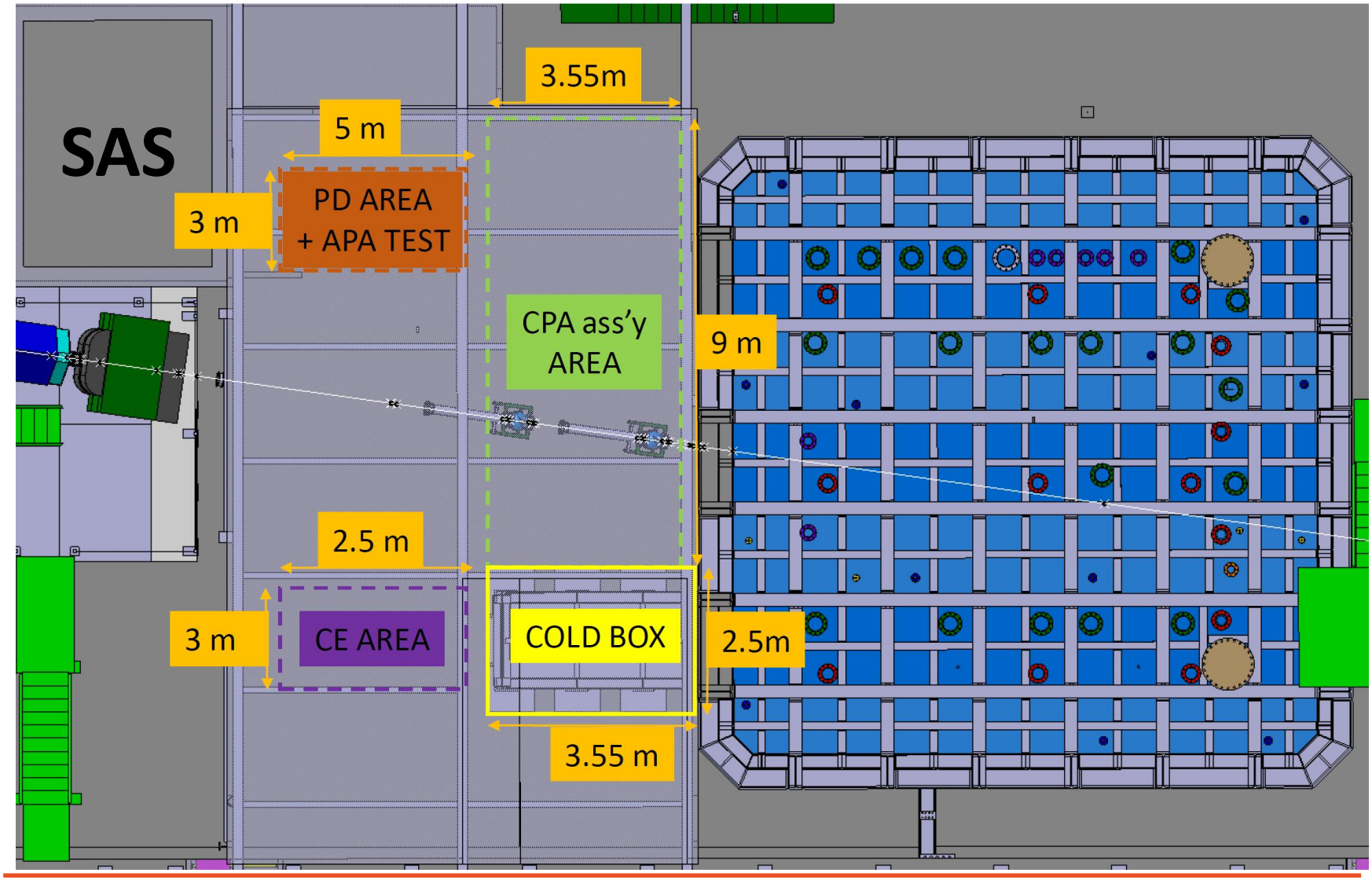
Access needed for ProtoDUNE

- Access is required both inside the cryostat and outside in the cleanroom during pre-assembly
- Goal is to maximize work in the cleanroom area where access is simplified
- We are constrained by a TCO (Temporary Construction Opening) that is 1.2m wide and ~7m tall for ¾ of the installation
- During the final phase of installation of the TPC all remaining access devices must be removed by a 710 (29”) manhole, scaffolding must be tubular/clamp design



ProtoDUNE
NP04 (single phase)
Warm Structure

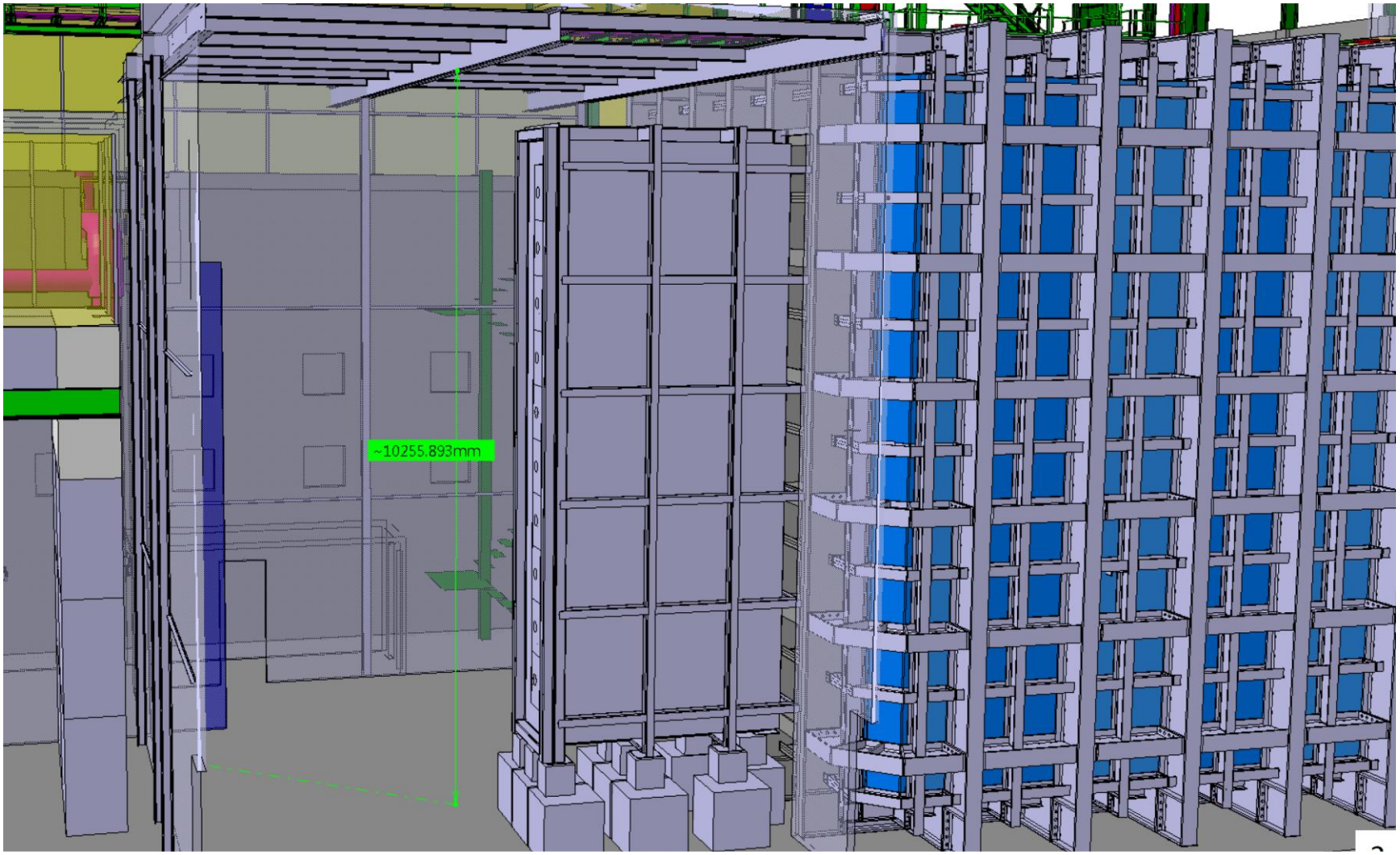
Access in the Cleanroom Area



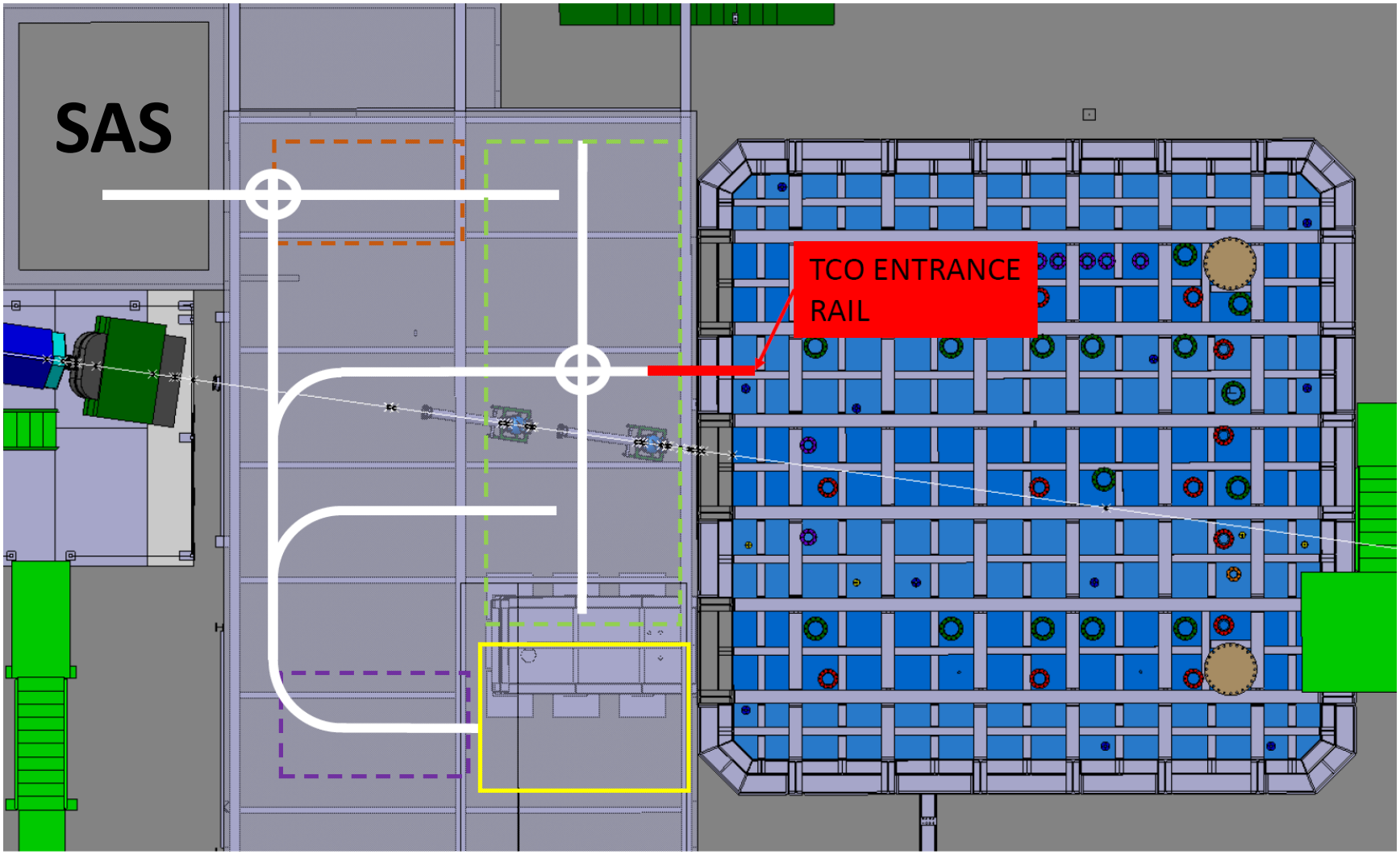
Access in the Cleanroom Area

- TPC materials will be lowered via crane through the roof of the SAS shown in the plan view on slide 3. Materials will be lowered via crane for access in the 8m x 13m clean room. A scissor lift can be used to transfer the load from the crane to the dedicated rail system shown on slide 5. Other items can be placed on a cart and wheeled in the double doors.
- Scissor lifts can used through out the clean room for the majority of the work. The highest required working platform elevation for access needed for installing the cold electronics, transferring load to rail system, etc. is ~8m (26 feet) and they should be large enough to hold 2 people plus some equipment (200kg?)
- We will need a minimum of 2 scissor lifts ~ plus some lower height rolling 1-2m tall work platforms
- We will need several sized rolling carts, smaller ones for tools and parts, at least one large one for the field cages 4m x 2.5m rated for 1000kg

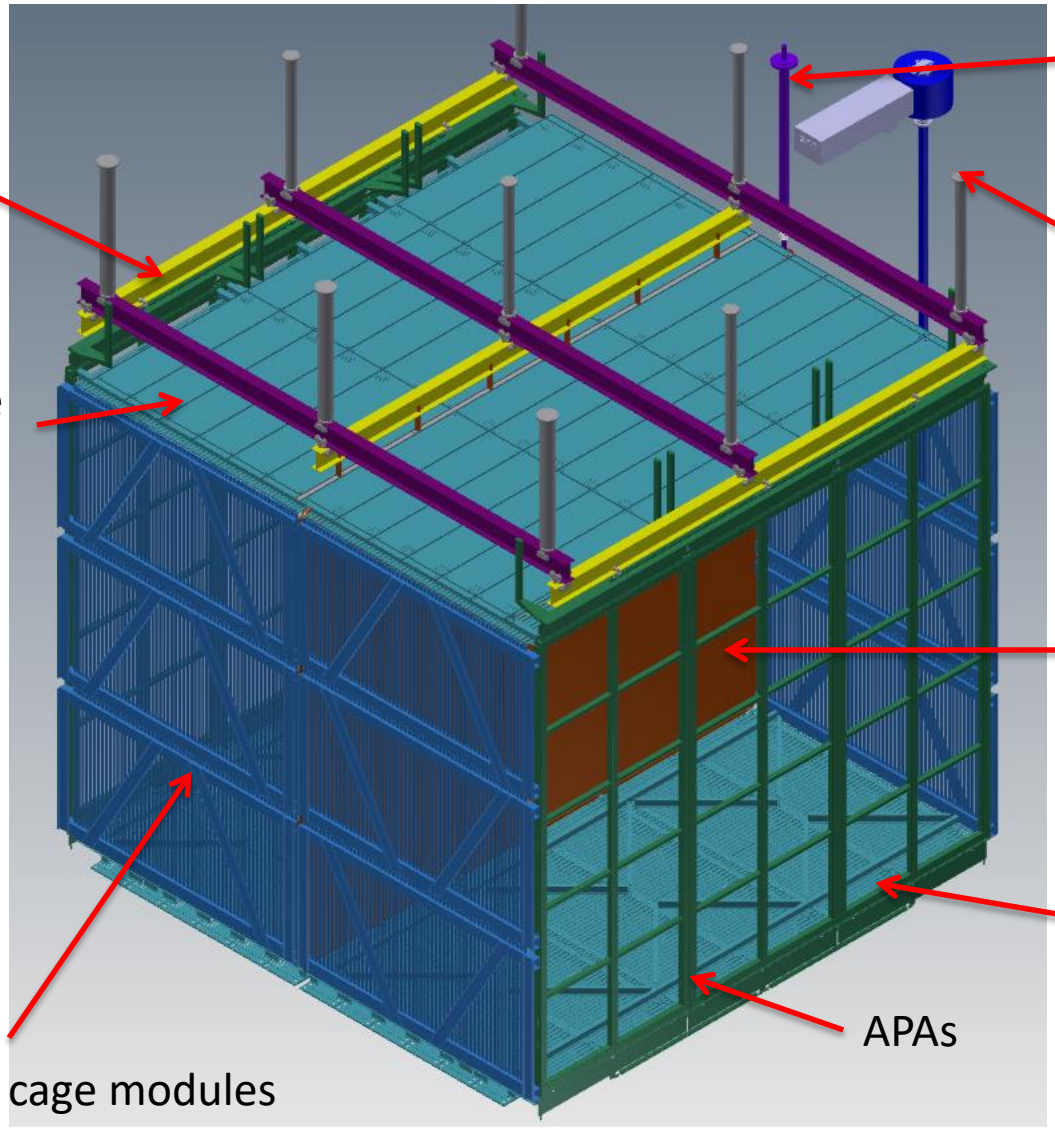
Access in the Cleanroom Area



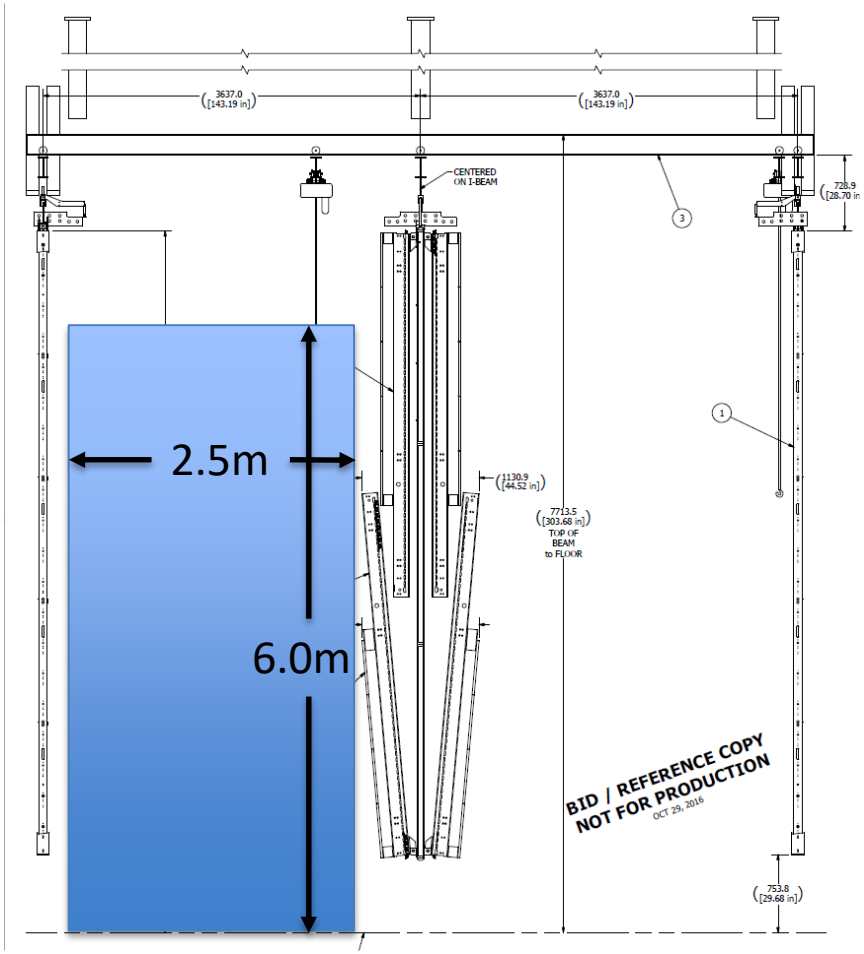
Cleanroom rail transport system

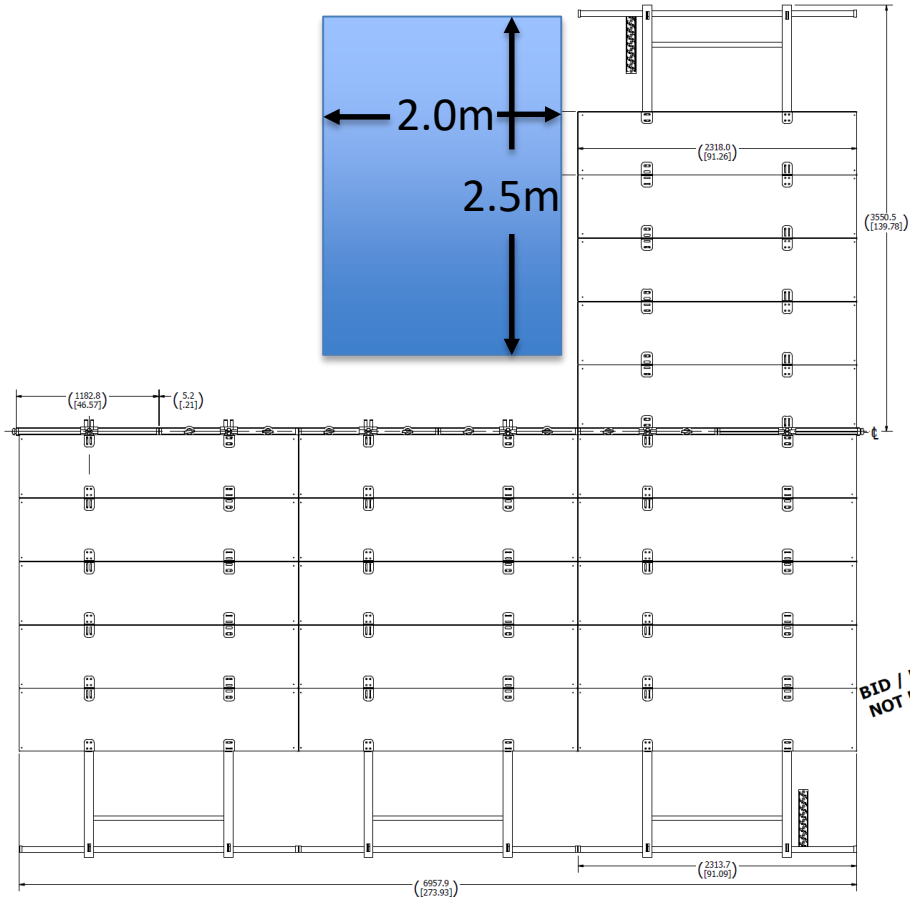


The TPC Model-6m Tall x 7.2m x 7.2m



Scaffolding Maximum Size Limit



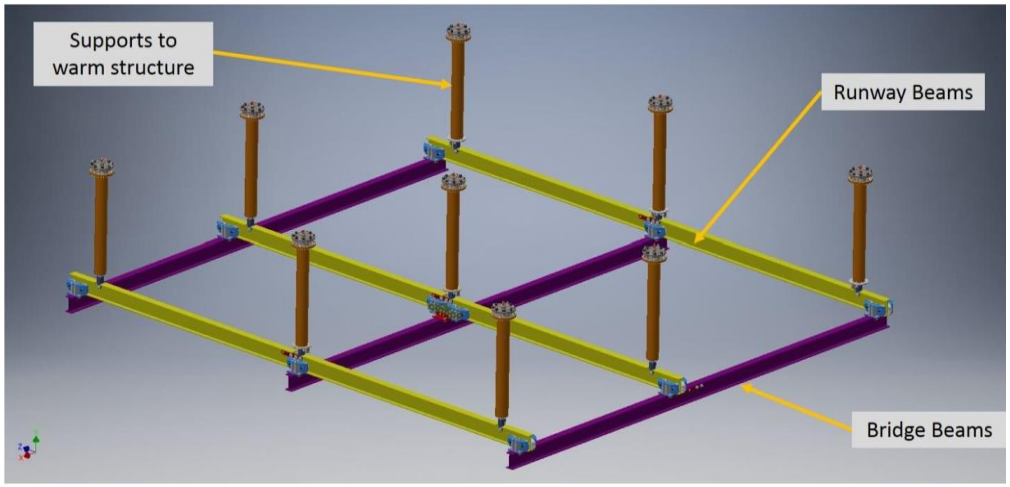


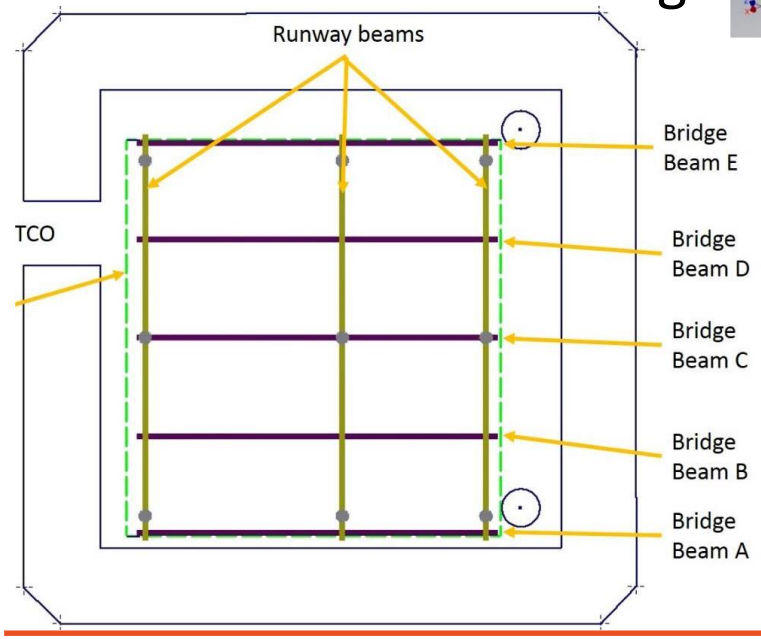
Side view-length 2.5m clearance 485mm
Height 6m, must be able to adjust height

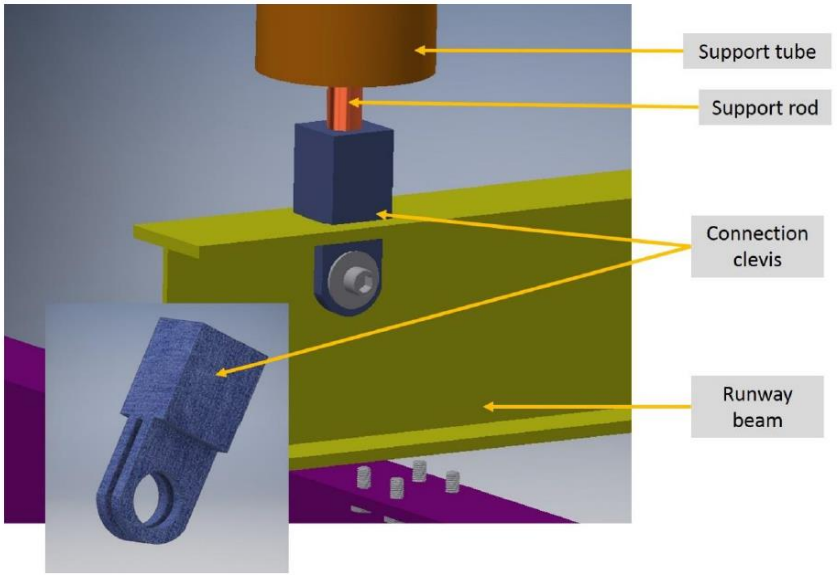
Plan View-width 2.0m clearance 313mm
Length 2.5m clearance 485mm

DSS-Detector Support System

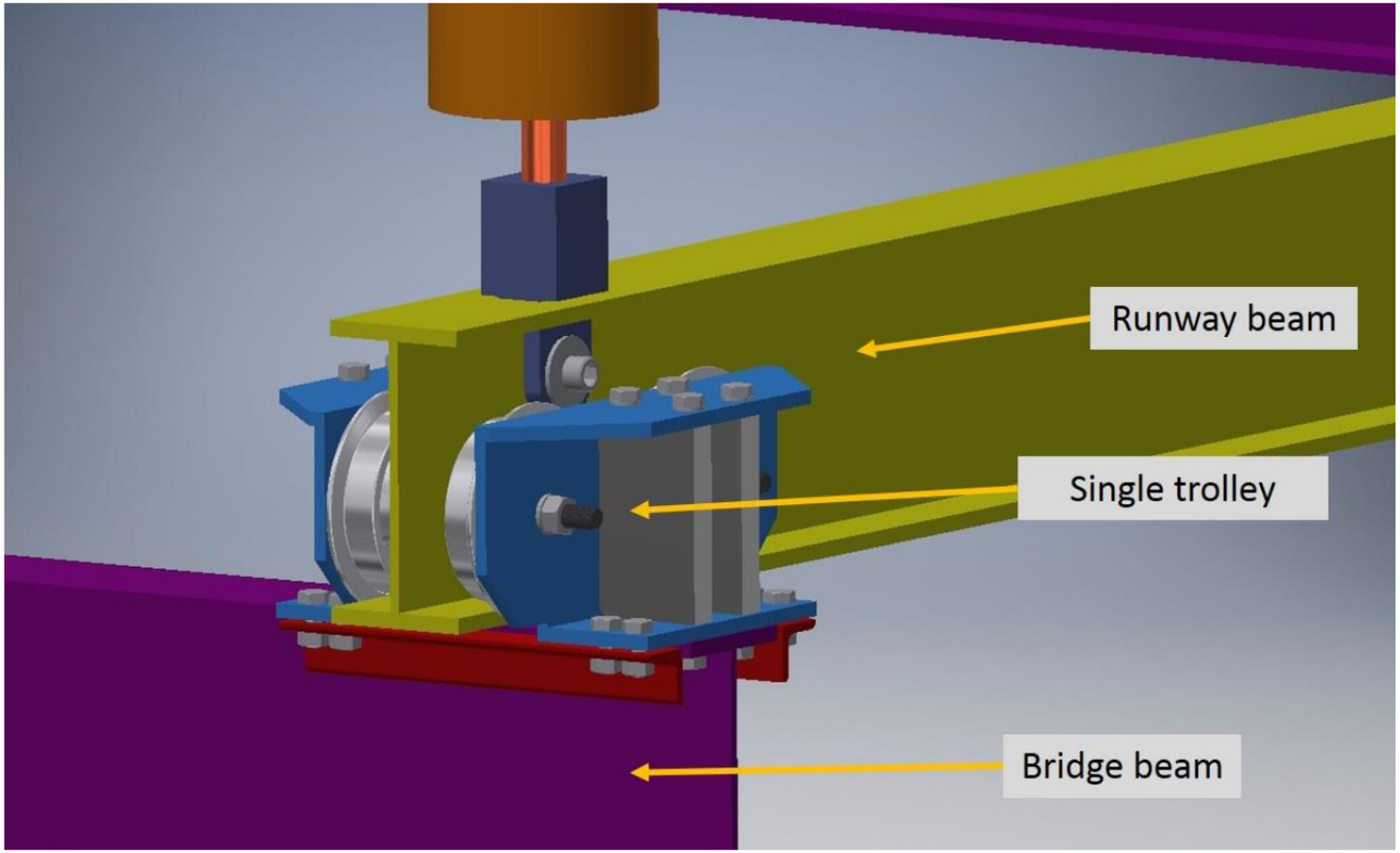
The 3 two piece Runway Beams are installed first in the cryostat and attached to the support rod with a connection clevis. Access via 2m x 2.5m x 6m scaffolding





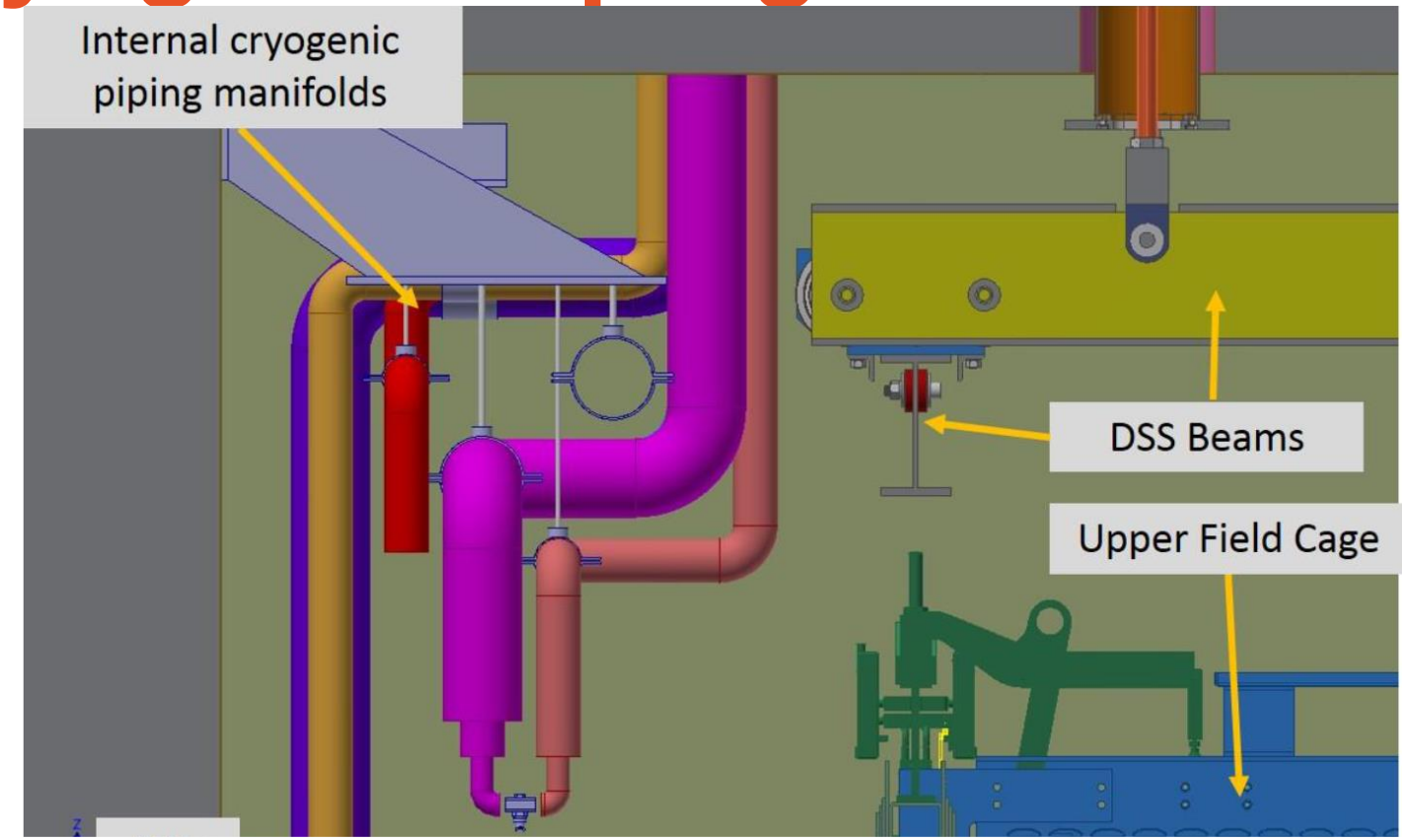


DSS-Trolley and Bridge Beam



Using a small electric hoist, the 5 bridge beams are lifted into position and connected to the single trolley system. These are stainless with non-lubricated bushings. 2m x 2.5m x 6m scaffolding will be needed for reach each of these 15 connections.

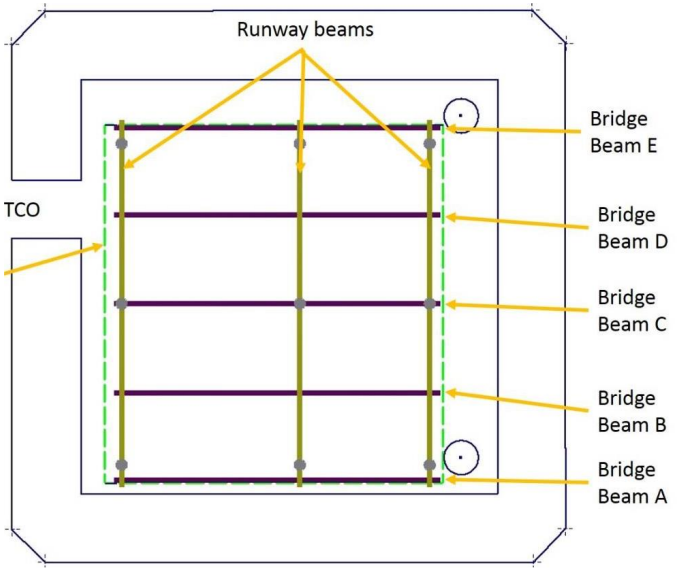
Cryogenic Piping Manifolds

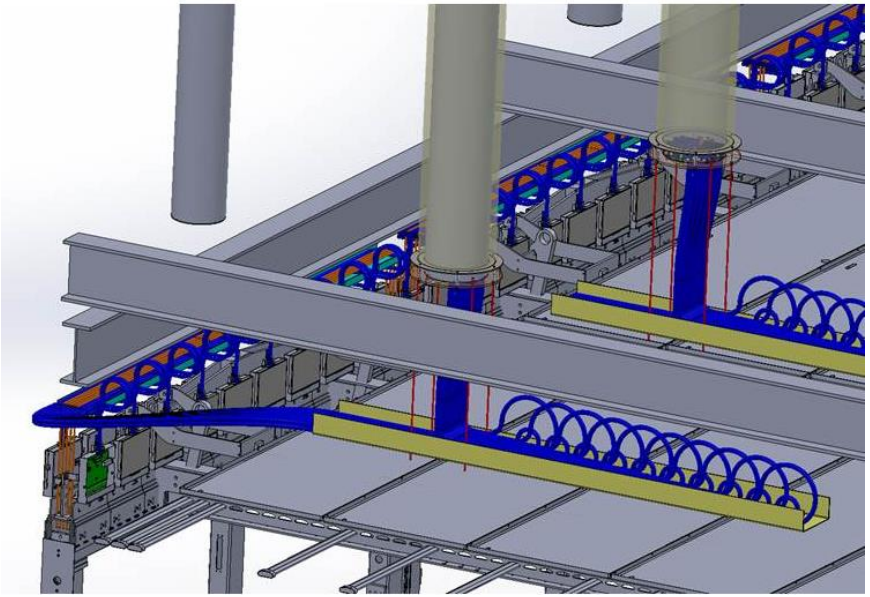


Once the Detector Support Structure is completed the Cryogenic Piping is installed. Some of the manifolds are heavy, we may be able to use the DSS to help lift in place, otherwise the will be lifted via tripod/hoist from the top of the warm structure. Scaffolding access will be needed to connect manifolds to the hanger brackets

APA Sequence

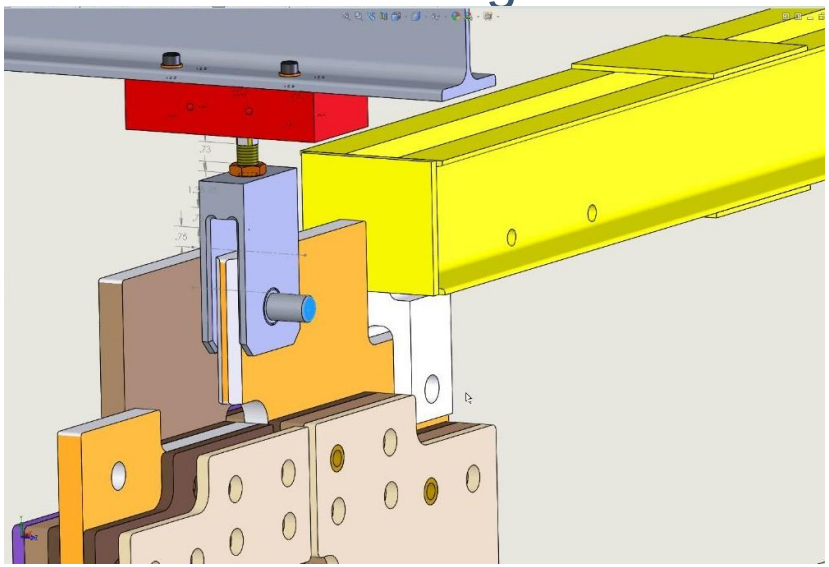
- Each APA requires access via scissor lift to install and test the Photon Detectors and cabling
- It then is moved to a different location on front of the Cold Box where it's cold electronics are installed and is then tested in the Cold Box
- Once all 3 APAs have completed their testing they are joined together in front of the TCO and rolled into the Cryostat on Beam A
- Once the APAs are in their final position scaffolding is set up by APA 1 to route the cables to the feed-thru then continue with APA 2 and 3. The scaffolding will have to be moved at least once to reach all 3 feed-thru's

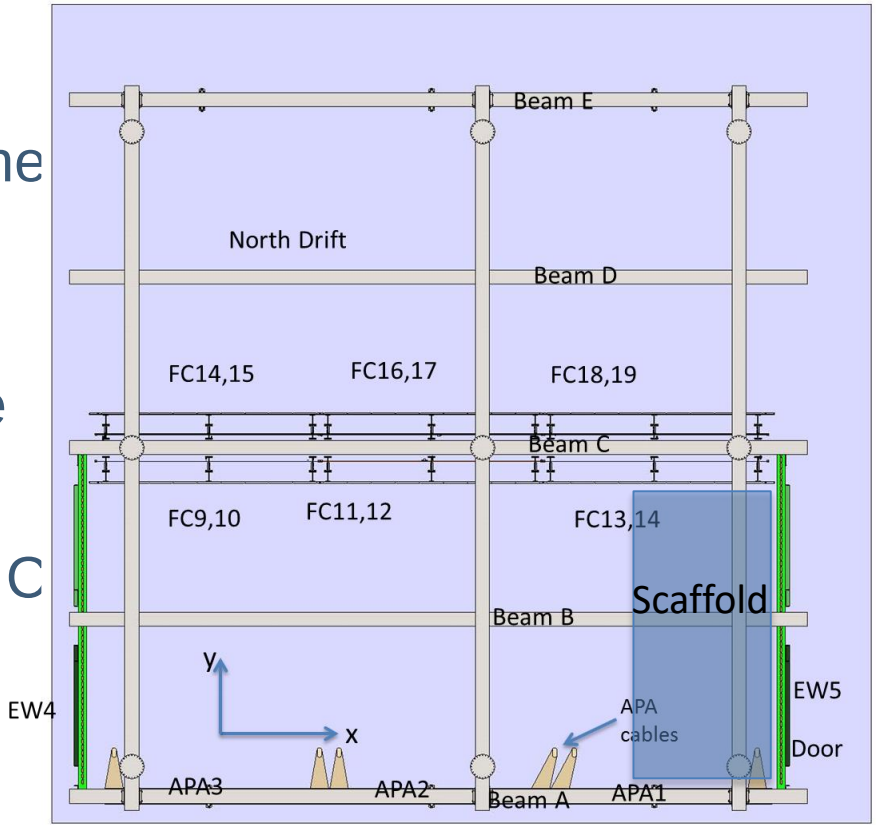




End Wall

- Beam B with End Wall 4 & 5 on it can be moved into position using the spreader bar, swivel and trolley.
- The end walls can not be mounted until installation of Beam C with the complete set of CPA/FC
- EW4 and 5 are hung on Beam A & C

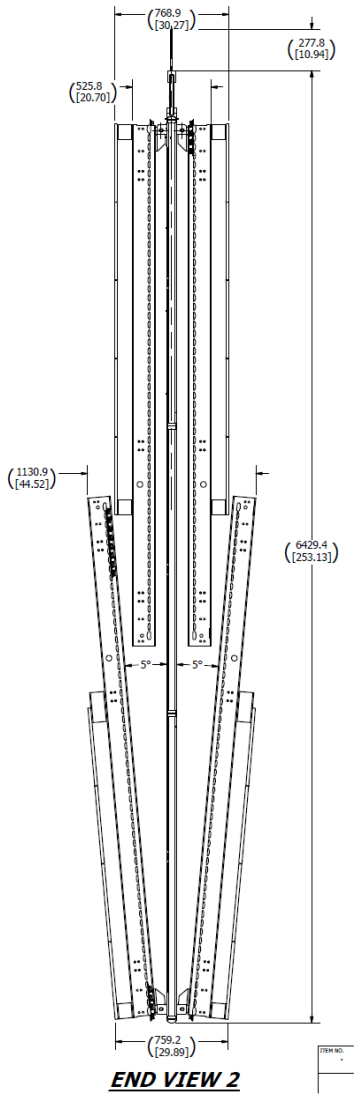




Access via 2m x 2.5m x6m scaffolding will need to be moved for each End Wall, difficult reach to center mount

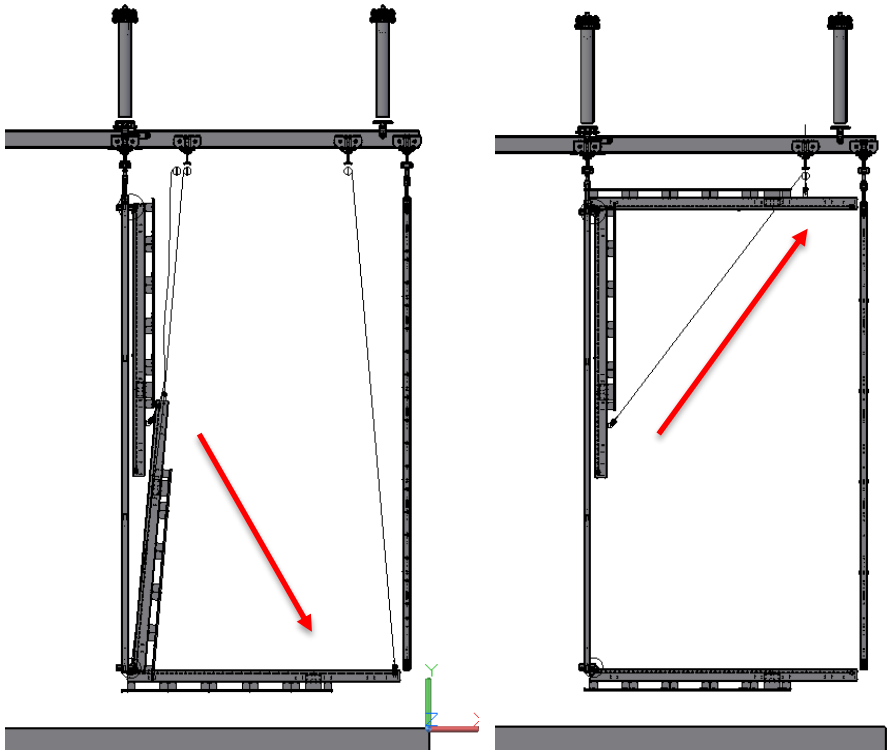
FC mounting to CPA-Clean Room

- First in the cleanroom in the CPA assembly area shown on page 3 after a “pair” of CPAs are joined via threaded rod and spacer, the field shaping strips are mounted and all electrical connections are completed.
- QC is then completed on the CPA
- The two top field cages are mounted first to the two hinges located at the top of the CPA “Pair”.
- The two bottom field cages are added using a off center lifting attachment to give the correct angle.
- The bottom FC is attached to the top FC on each side then this pair is completed
- Access is via scissor lift.

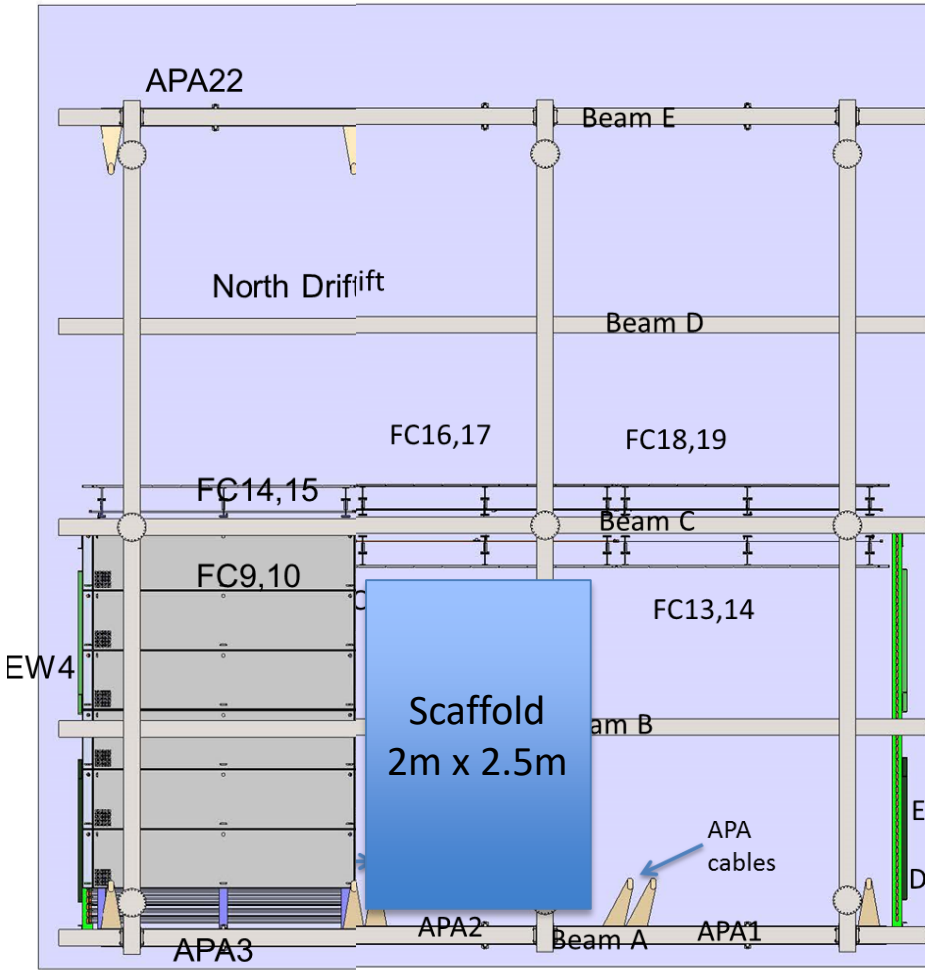


Field Cage Deployment:FC9-FC10

Scaffolding is set up in the TPC to deploy the first set of Field cages

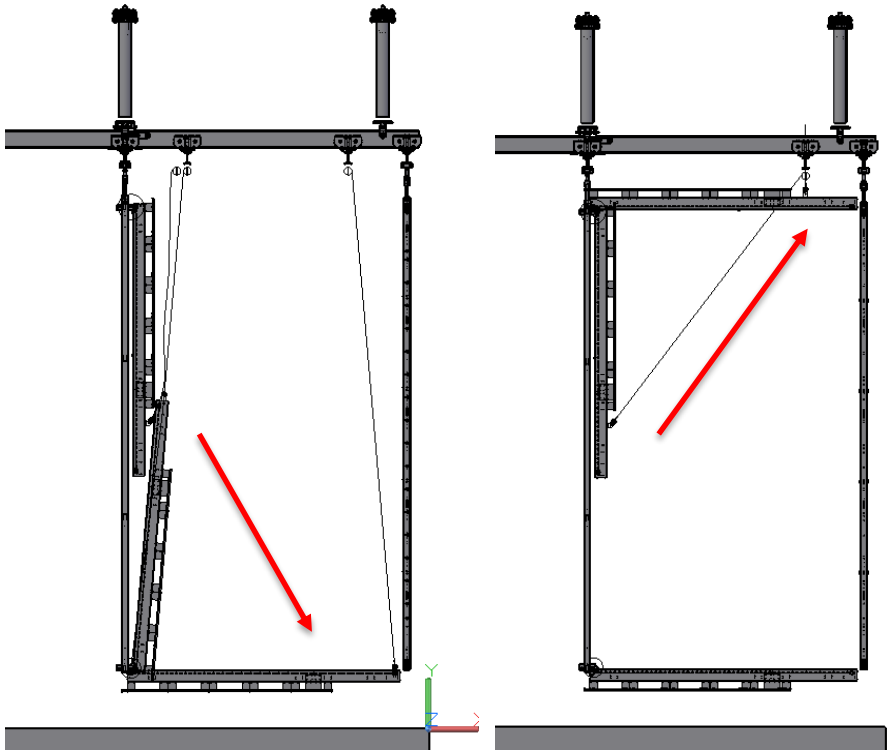


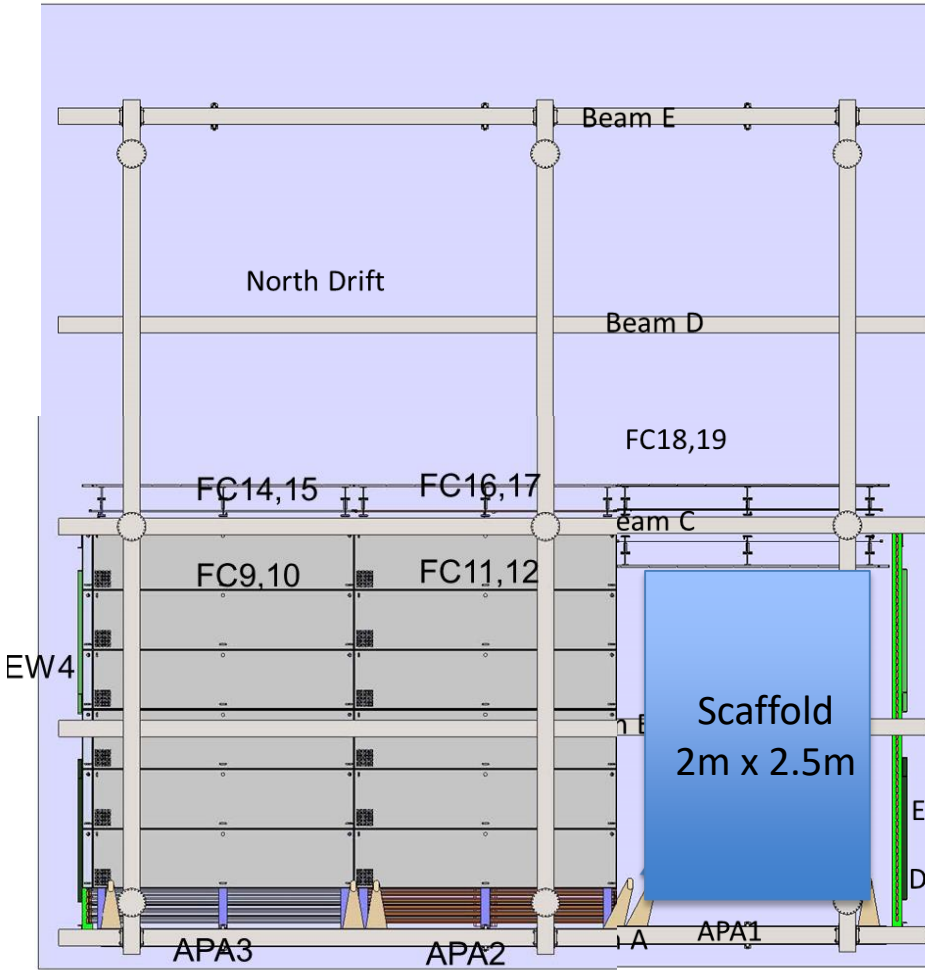
FC9 is lowered and FC10 is raised using pulley/hoist mounted on Beam B



Field Cage Deployment:FC11-FC12

Scaffolding is set up in the TPC to deploy the first set of Field cages

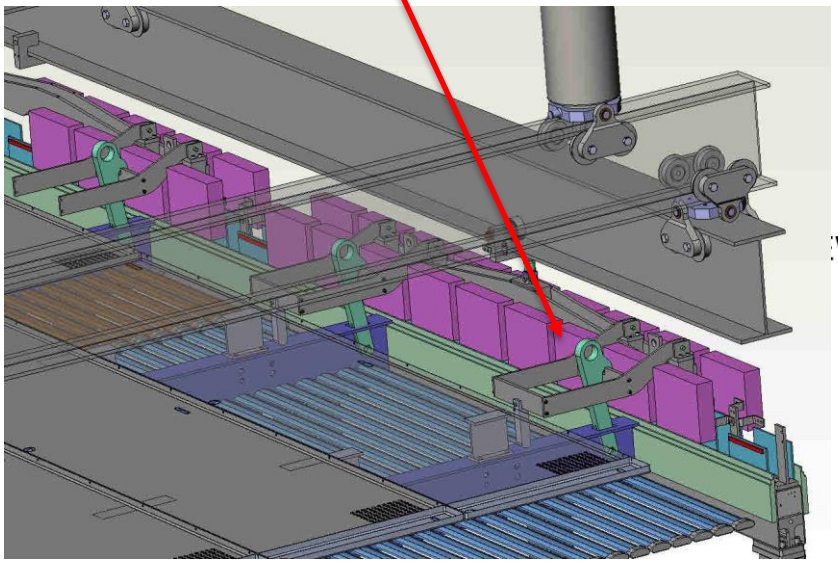


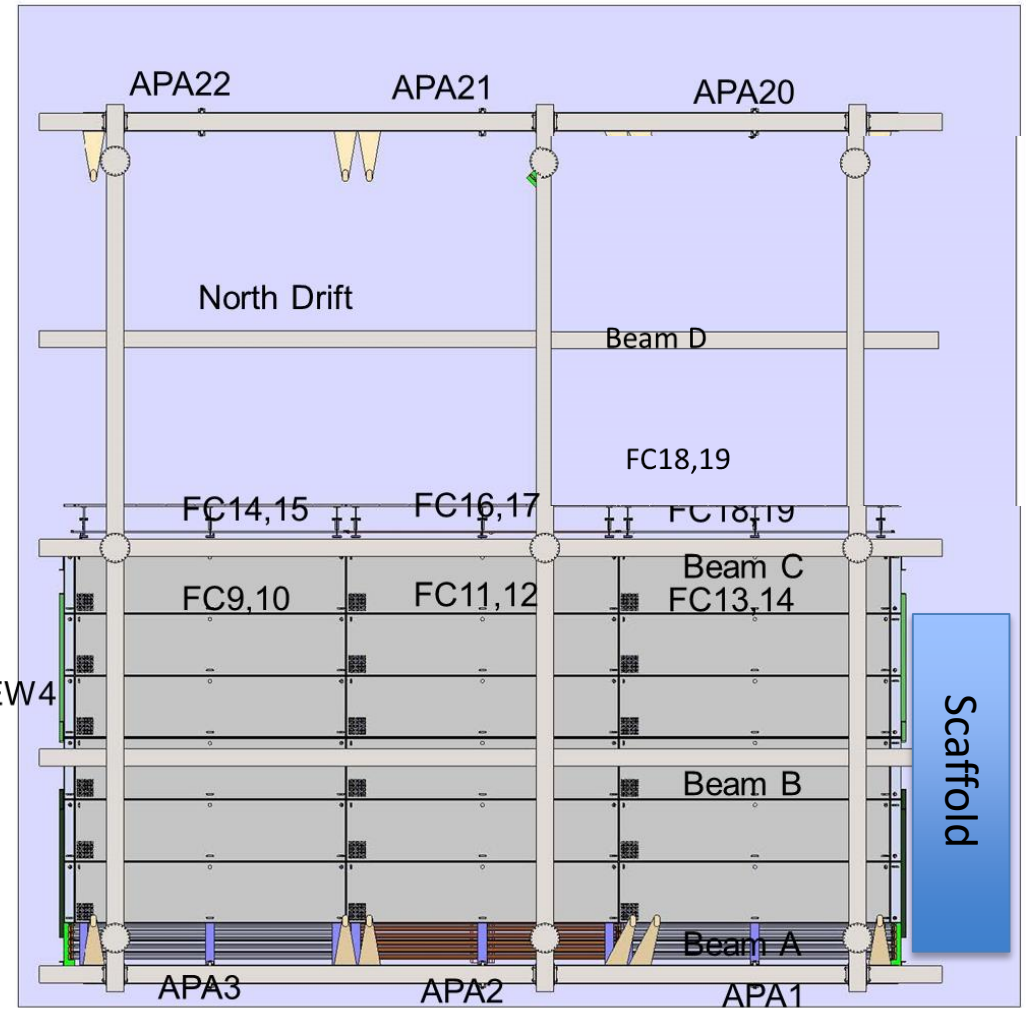


FC11 is lowered and FC12 is raised using pulley/hoist mounted on Beam B

Field Cage Deployment:FC13-FC14

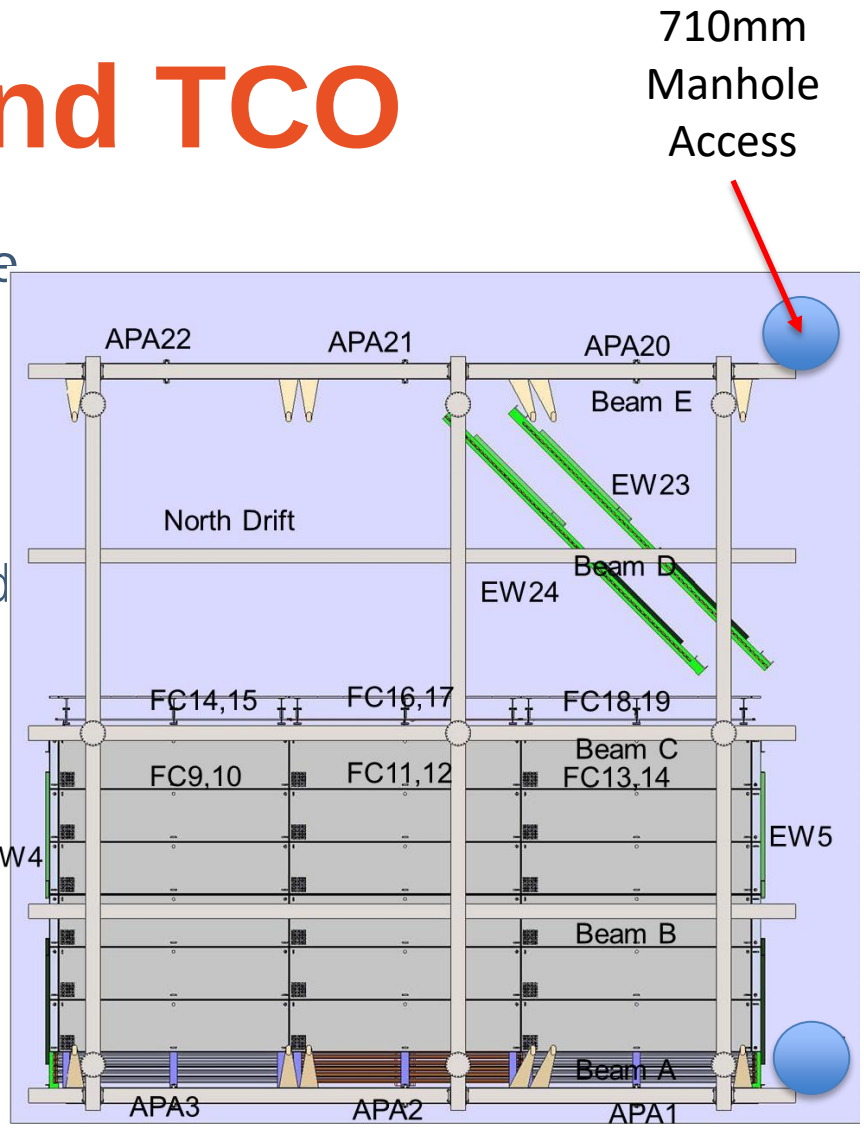
- Deployment of FC 13/14 are the most difficult and this step is repeated again on FC18/19
- The scaffolding can only be 750 wide for access needed to engage latches and make final electrical connections





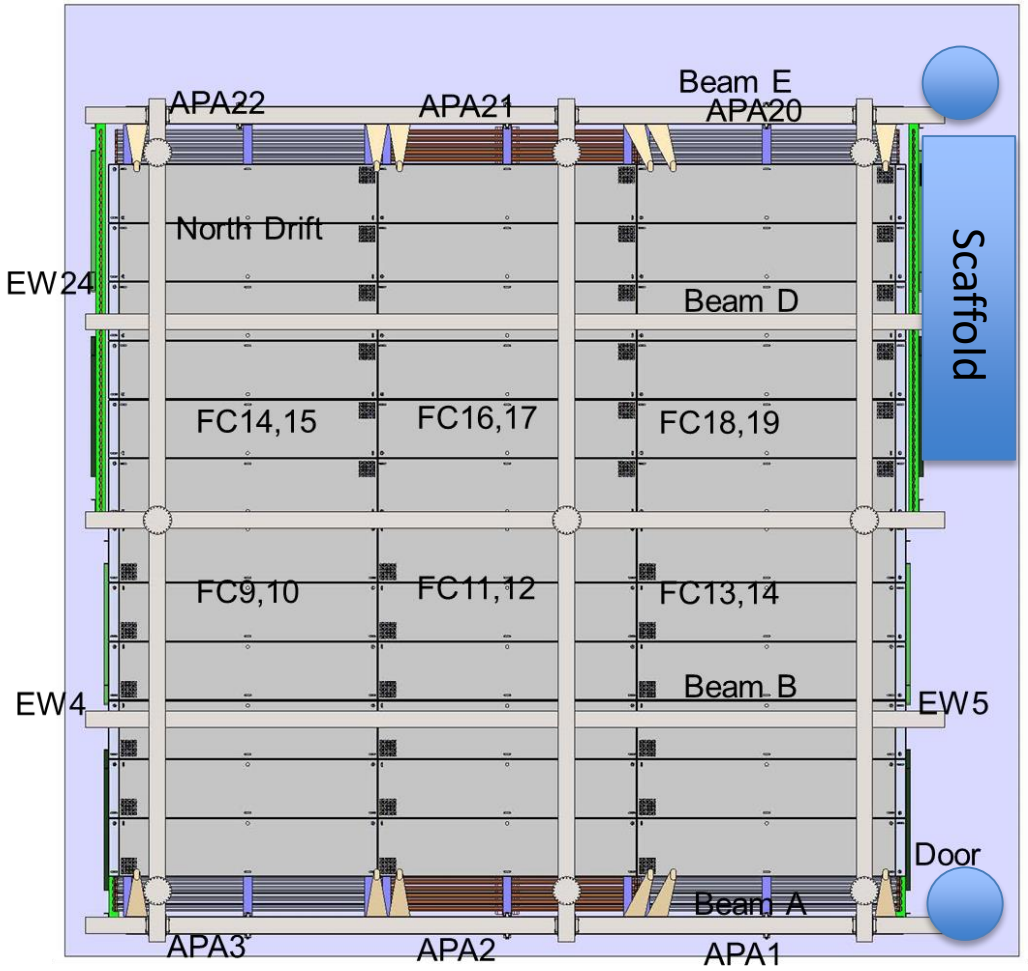
North Drift EW and TCO

- Before deployment of the North Drift Endwalls and FC the TCO needs to be welded shut
- This will require all insulation blocks and needed welding equipment to be stored in North Drift Area. It is likely we can move Beam B to the north and use the End Walls to help protect the APAs and allow better access to the manholes
- Once TCO is closed End Wall and FC deployment can be done in the same sequence as the South Drift
- **All final installation steps are performed in a confined space environment with access via tripod with man-lift for manhole**



Final Steps to closing Cryostat

- Once FC19 is deployed and final connections are made, access door openings in End Wall 5 and 23 are closed up
- All scaffolding, tools and personnel are then lifted up thru manhole



Access Equipment Summary

- Clean Room
  - Two 8m (26') scissor lifts similar to Ash River JLG-2630ES
  - Several miscellaneous height rolling step work platforms 1-3m
  - One large rolling cart-4mx2.5m 1000kg
- Cryostat
  - ~2m W x 2.5m L x 6m H scaffold system. It needs to be of a tubular design so it can fit out manhole
  - ~.75m W x 2.5m L x 6m H for use outside the TCO
  - Tripod with man-lift capability above manhole to lower/raise personnel once TCO is closed