HVS Consortium

Single Phase Far Detector: ITF & installation requirements

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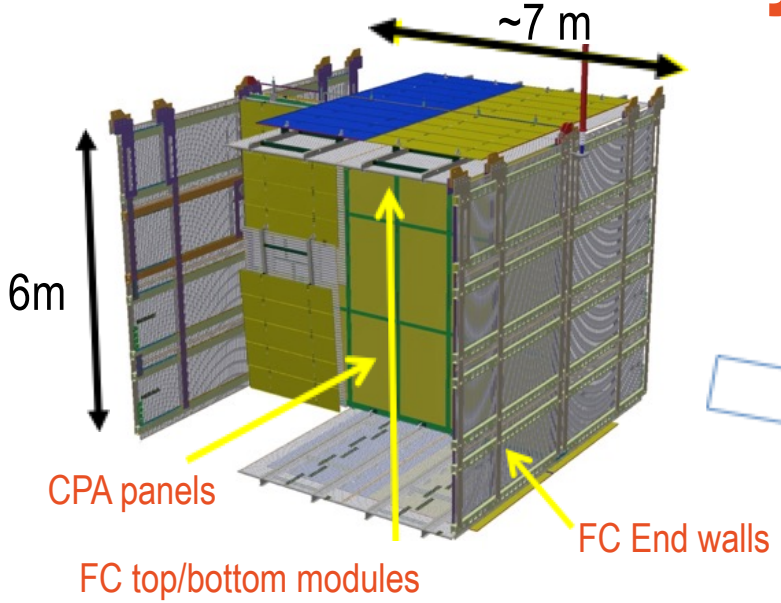
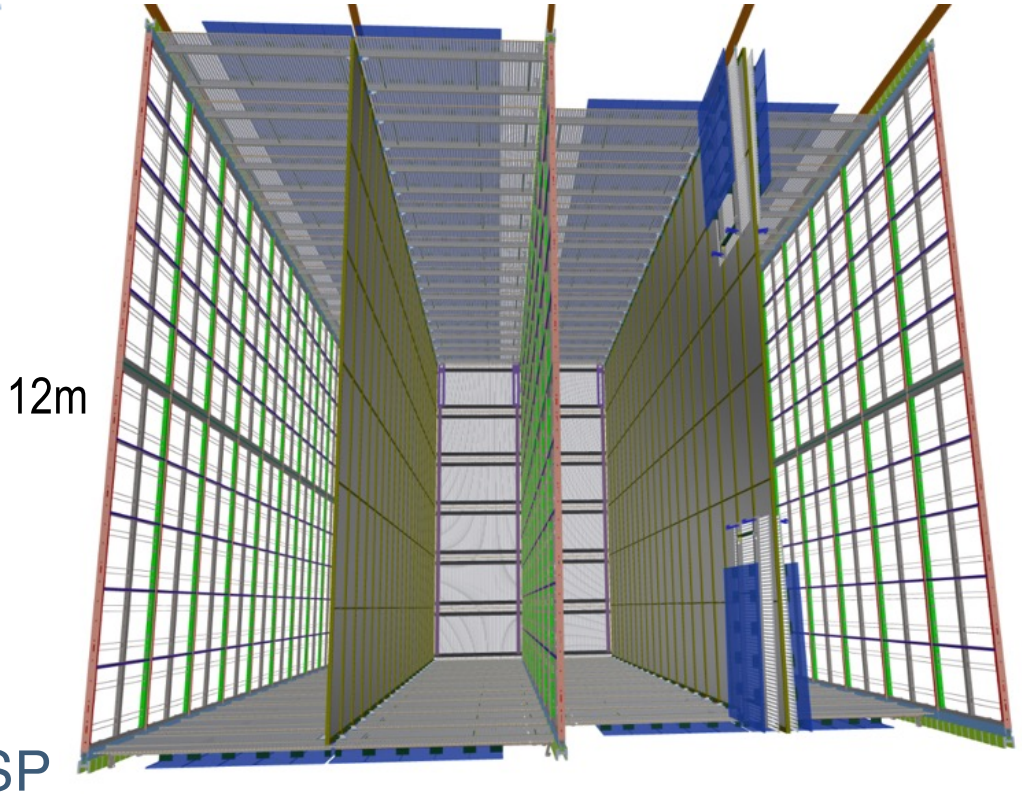
DUNE SP HV System



From ProtoDUNE to DUNE Far detector



- 100 CPA modules, 12m high
  - 600 1.15x2m^2 resistive panels
- 200 top/bottom FC modules
  - equipped with Ground Planes
- 64 End-wall FC modules
  - Each 1.5m tall
- Same modularity as ProtoDUNE SP

HV design changes from ProtoDune

(*Docdb 6260*)

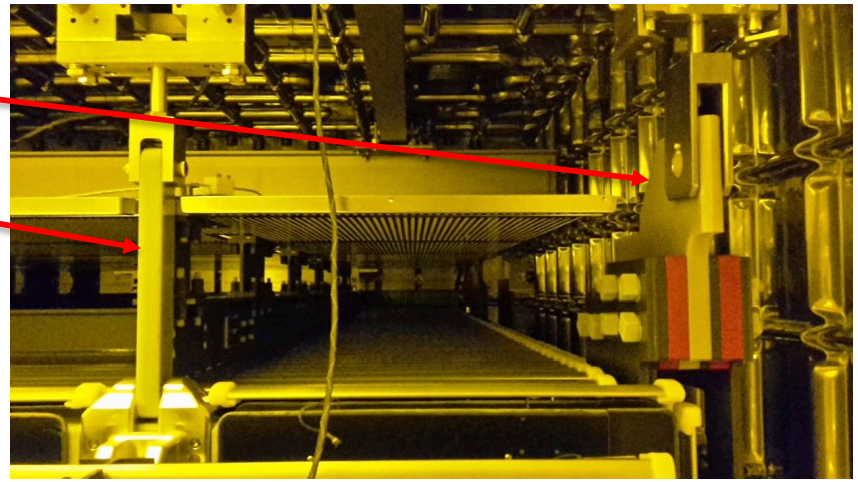
- Top/Bottom FC modules basically unchanged
- CPA basically unchanged except now is 12m tall
- End Wall Modules basically unchanged.
- *Lessons learned from installation* (*Docdb 8246*)
  - SS on SS thread galling – silver plate?
  - Quality of slip nuts
  - FC Hinge hole tolerance
  - FC diagonal brace?
  - Connection between GPs – need to notch spacer
  - GP isolation between FCs
  - Move EW lifting point to coincide with CG (allowing also for a possible use of bent profiles)

Lessons from initial NP04 operation

- Early operation revealed PS / HV filters induced instabilities:
  - New PS replaced
  - New HV filter design/construction started
- With new PS, operation at the nominal voltage at 180 kV randomly affected by two kind of instabilities.
  - Fast discharges:
    - Tens per day recorded of the DCS fast acquisition
    - ALL of THEM report a current signal on at least one GP
    - Total charge from PS correspond to total charge on GP's
  - Excess sustained current streams:
    - Few per day
    - Current signal ALWAYS on ONE GP (UP-US-BL) & Beam Plug Termination
    - Only a fraction of the PS current visible on UP-US-BL & BPT

Lessons from initial NP04 operation

- NO excess noise recorded on APA electronics with any HV instability
- Some excess activity recorded on Photon Detectors close to affected GP only in coincidence with streamers
- NO evidence of direct relation with LAr purity (maybe stream quenching)
- Very likely NO instability current from EW to GD
- Investigation of origin of streamer still on-going
  - CPA to ground path through the FRP surface
    - End Wall supports?
    - CPA hangers?
    - HV Feed-through?
- Mitigation in HVS design
  - Increase GP distance from FC
  - Reduce number of GP-FC FRP spacers



GP-FC design upgrade

- Presently under study and test:
  - Reduce the number of spacers connecting the FRP I-beam to the GP I-beam
  - Place the spacers as far as possible from the high field region
  - Stability calculation and mockup tests underway
  - Same concept for top and bottom FC
- Also under study:
  - Move the I-beam above the GP
  - use metal instead of FRP for the GP I-beam (reduce plastic in high field region)
  - Alternative concepts to decouple GP's

ITF Requirements

- Store ~1 month of Components.
- CPA
  - Crates ~ 4.3m x 1.5m x 1m (800 lbs) – 1 Pair of CPAs per crate
  - Storage for up to ~16 crates
  - 2 crates per week need to be delivered to SURF
  - 50 crates in total
  - Crates delivered to ITF in 20ft Containers
- Top/bottom FC
  - Ground Planes will be removed during shipping
  - Crates ~ 3.9m x 2.5m x 1.2m (1100 lbs)
  - 4 FC modules per crate
  - 8 GP modules per crate
  - storage of up to ~16+8 crates – total 50+25 crates
  - 2+1 crates per week delivered to Surf
  - Crates delivered to ITF in 20ft containers
- End Wall FC
  - Crates ~ 3.9m x 2.5m x 1m - 4 FC modules per crate
  - 8 crates at the beginning of installation + 8 crates at the end

ITF Requirements

- Minimal activities at ITF
  - Visual Sample Inspection
  - With the above shipping scheme, no repackaging into underground crates foreseen
- Space Requirements
  - ~500m^2 needed for storage
  - clean room (~100 m2) to host FC modules for visual/electrical inspection
- Facility Requirements
  - Loading dock
  - Forklift
  - 1 ton crane
  - Work benches/Testing stations
  - Desks/network access
- Personal
  - 2-3 ITF personnel
  - HV people shared with underground activities

HV Installation
What is needed from facilities/TC?

- Personnel to deploy CPA/FC inside the cryostat (?)
- 1 ton bridge crane for assembling CPA and mounting top FC
- 2 scissor lifts -- power available for charging their batteries
- Storage space in drifts for 2 CPA crates and 2 FC crates
- Storage space in cleanroom for a tool box, a cabinet for supplies, lifting fixtures.
- Supports off of the north wall for CPA assembly fixture
- Platform in front of west TCO that is level with the cryostat floor and can accommodate a scissors lift

HVS consortium will provide…

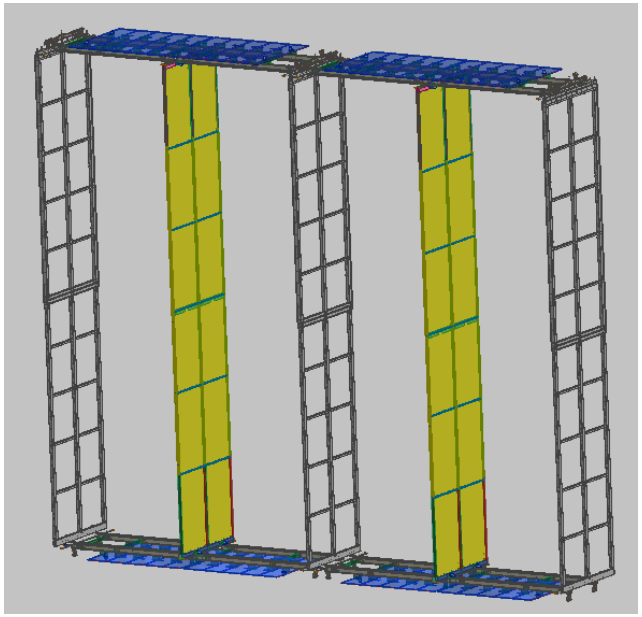
- Personnel for assembling CPA/FC modules in cleanroom
  - expect 4-5 people in the shift team
  - 8 shifts/week: (3 for assembly+1 for deployment) x 2
- CPA assembly fixture
- Lifting fixtures for CPA and FC
- Equipment for testing CPA/FC before insertion into cryostat
- Portable cranes to deploy bottom FC modules

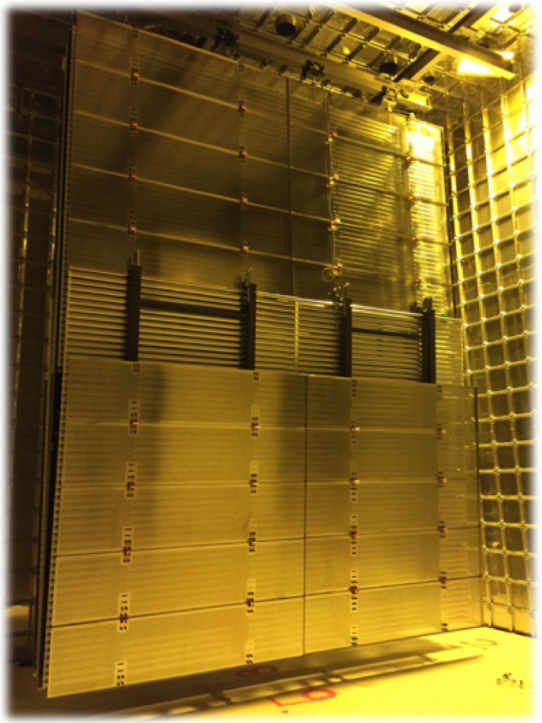
Detector Assembly and Installation

- HVS consortium will provide the assembly personnel
- Two CPA/FC assemblies will be constructed per week
- Three shifts are expected to be needed for each CPA/FC assembly
- CPA crates will hold six 4m long modules – 1 crate needed for each CPA/FC assembly
- FC crates will hold 4 FC modules – 1 crate needed for each CPA/FC assembly + ½ crate of GP
- GP attachment to FC performed in clean room
- Three CPA modules, each 4m long, are connected using a fixture.
- FC modules attached to CPA pair on TCO beam

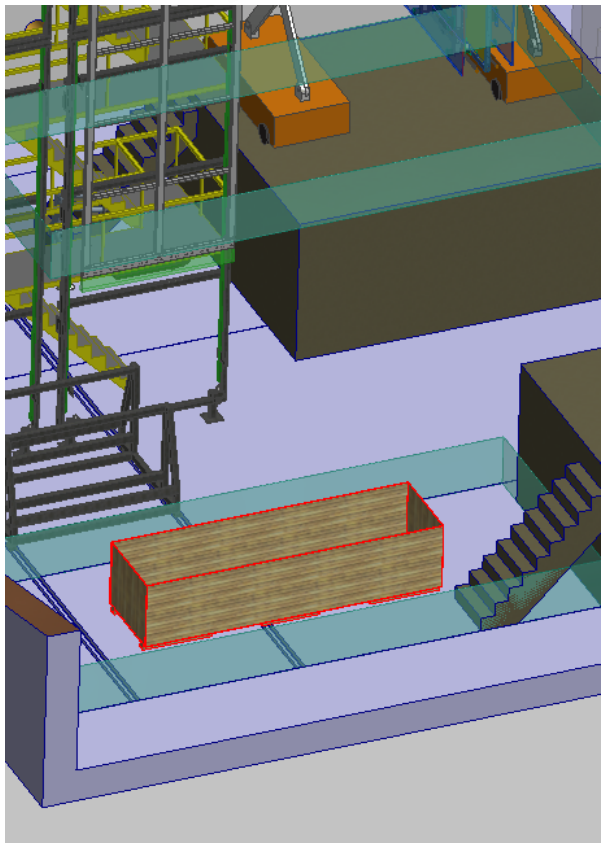
Installation Sequence

- Current Plan is to install one row of detectors at a time, deploy the top and bottom FC
  - CPA installation can occur much faster than APA installation
  - FC deployment blocks further access to APAs and cables
  - Serial installation does limit exposure of APAs
- Proposed installation is to install complete rows of APA/CPA and deploy FC's at the end
  - Floor is kept in place until bottom FCs deployed
  - Extensive access to APA and cables
  - Similar to ProtoDune installation sequence
  - More efficient use of manpower?
  - Less interference with APA



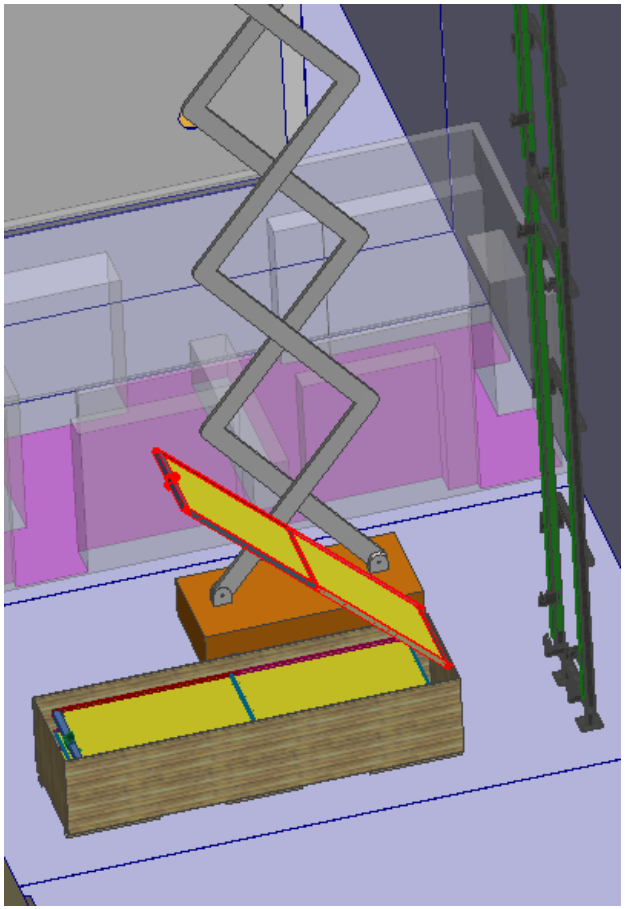


CPA Unpacking & Assembly

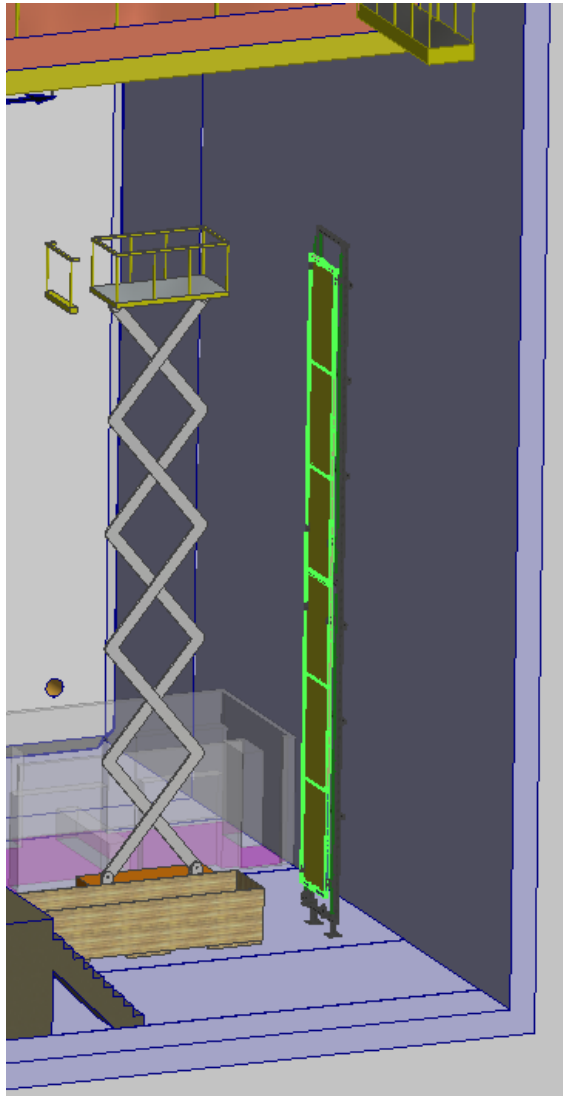


Boxed CPA lowered into SAS and moved to Assy Fixture in CR

Boxed CPA in position. 1/3 panel being raised from crate

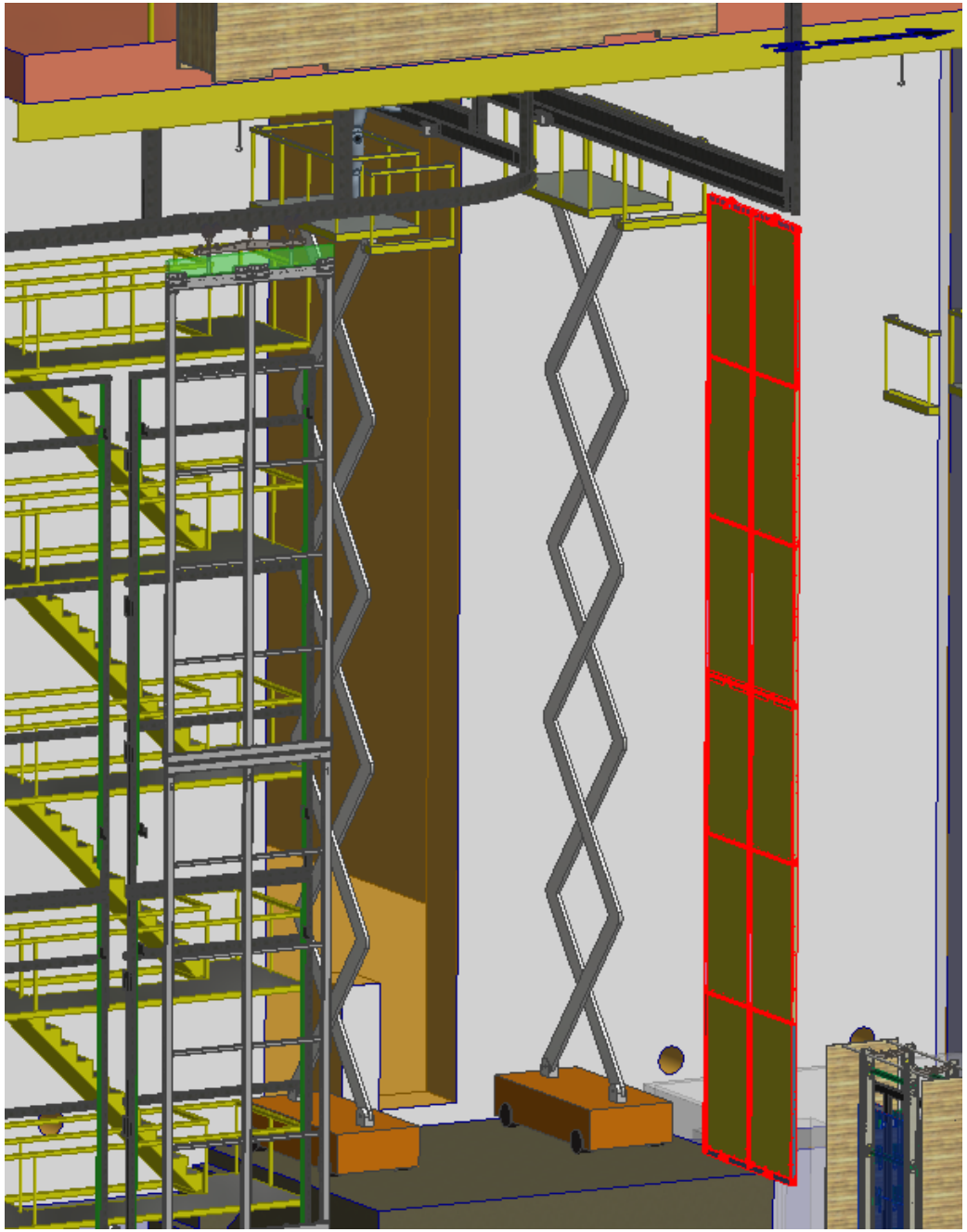


CPA panels placed into fixture



CPA Unpacking & Assembly

Assembled CPA panel placed onto TCO Beam

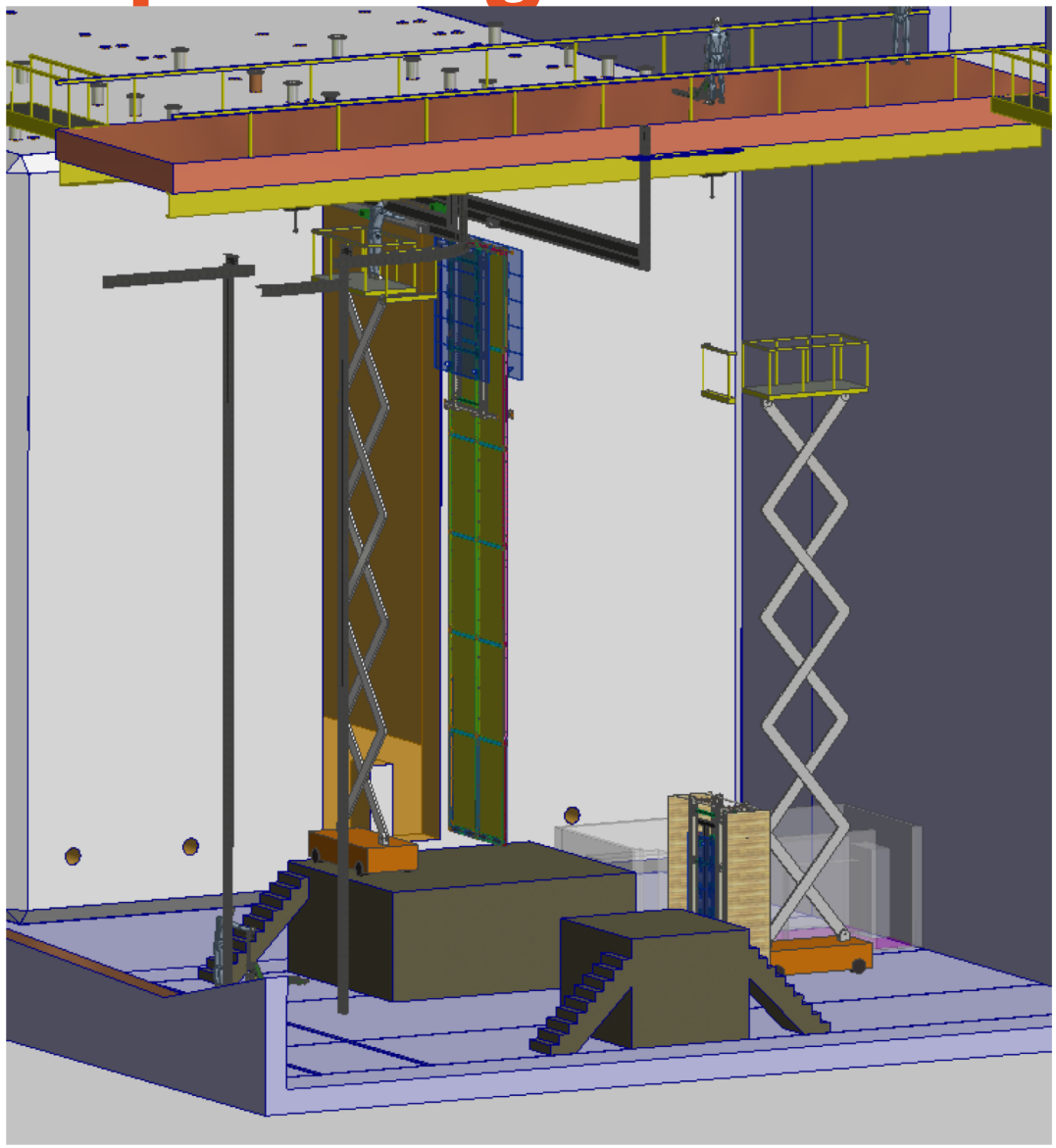


Top/bottom FC Unpacking & Assembly

Crated FC Panels and GP assembly lowered into SAS and moved into Clean Room

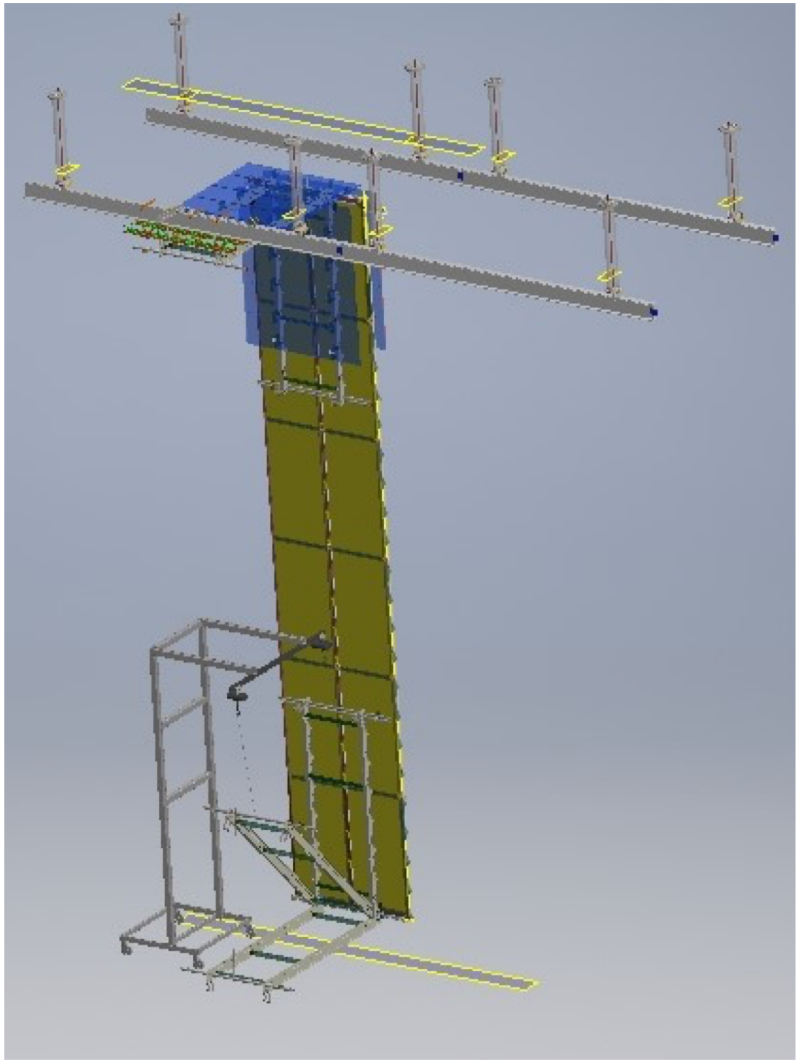
GP assembly remounted on FC panels

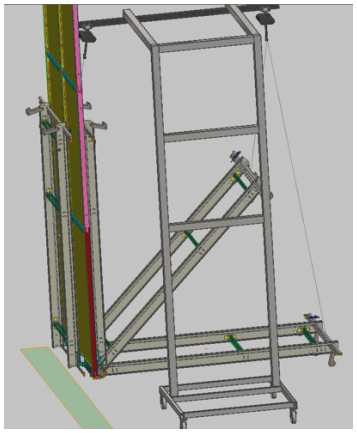
Top FC Panels installed as the CP array hangs under the TCO beam

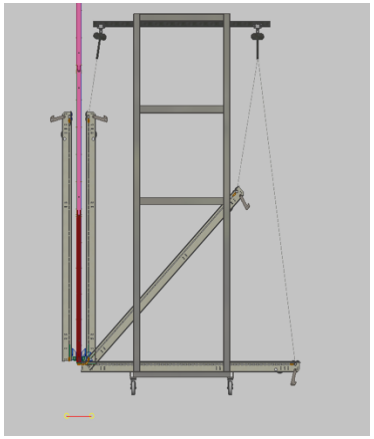


Bottom FC Deployment

- Brought in the cryostat on a cart or hanging from the TCO beam
- Mounted to CPA's when the latter is in its final place using a fixture
- Deployed immediately using fixture in the same manner as ProtoDune SP
- Left and right FC's on same CPA could be deployed simultaneously

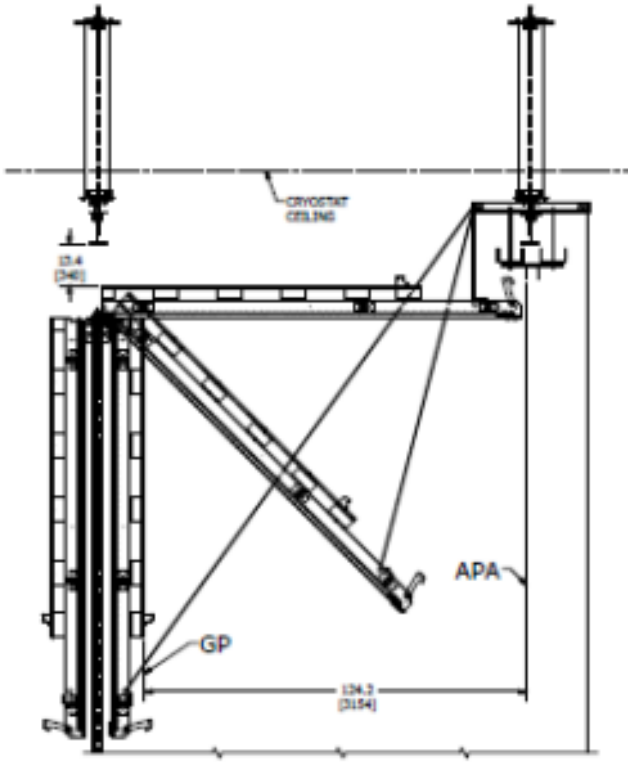


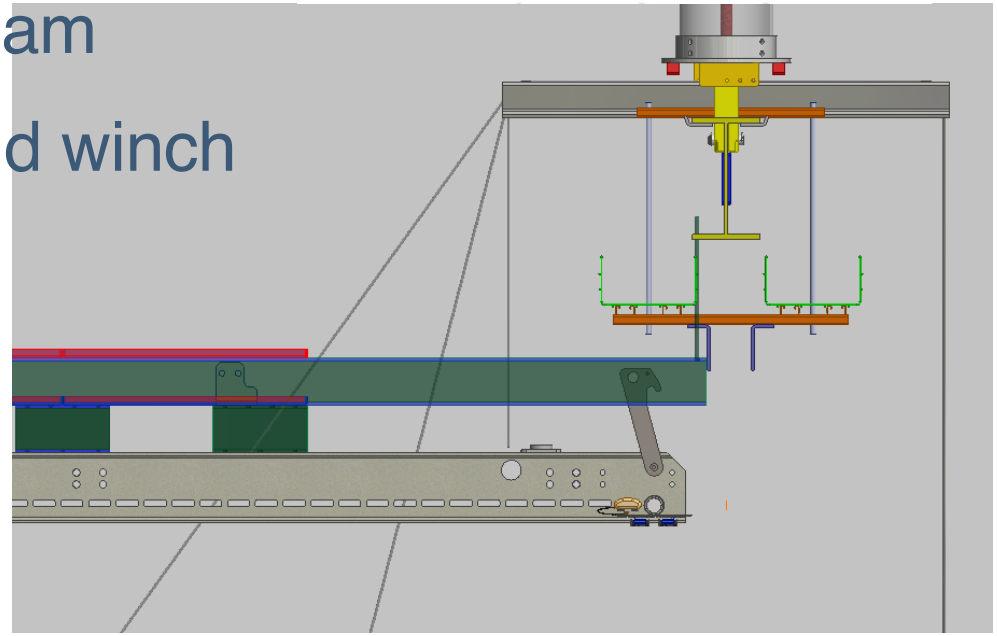


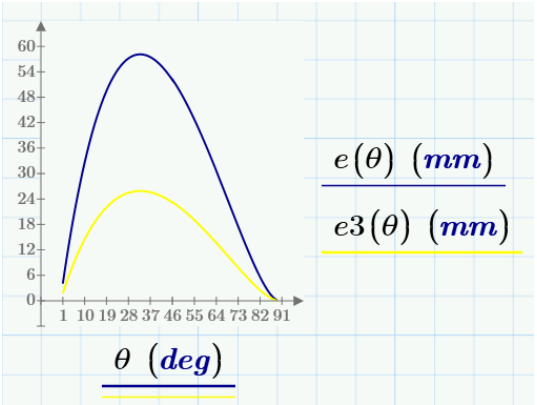


Top FC Deployment

- Top FC hung from CPAs outside cryostat similar to PDune
- Fixture mounted to top of APA DSS beam for raising FC similar to PDune
- Lift point is offset from DSS beam so that lift rope/cable avoids cable trays which cause torque on DSS beam
- Torque offset by APA weight and winch on ground

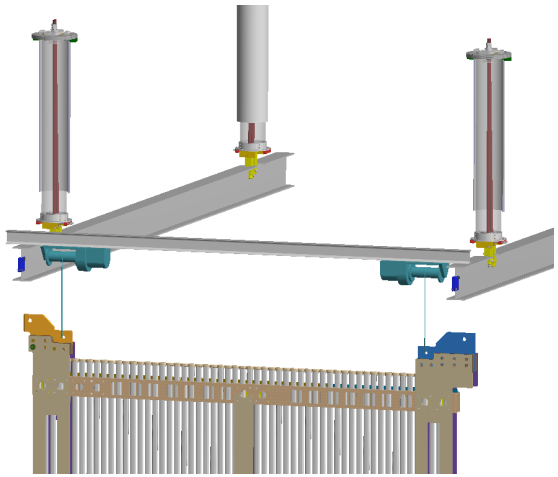


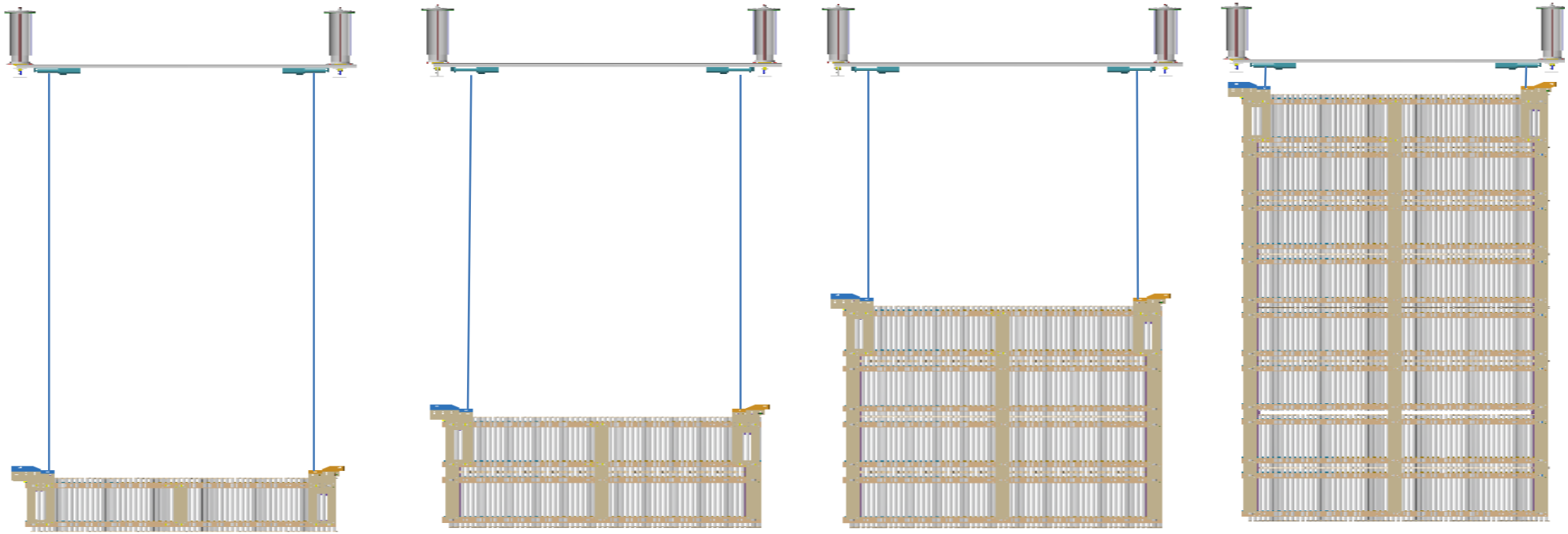




EndWalls installation

- 4” aluminum beam (35 lbs) placed across DSS beams to support winches
- EW modules packaged in a “toaster” crate
- EWs raised in place, winches and beam removed





Summary

- HV system is very similar to that of ProtoDune.
- GP distance may increase from 20 to 30/40 cm
- Little work to be performed at ITF other than storage and visual inspection
- In the scheme where one row of detectors is assembled at a time and the top and bottom FC are deployed, 2 CPA and 2 x 4 FC modules a week need to go underground
- Downstream End-Wall fully installed before CPA/APA installation, upstream after full top/bottom deployment