Far Detector
CERN integration meeting

DUNE Engineering Meeting

- from Monday, 9 November 2015 at 02:00 to Thursday, 12 November 2015 at 13:00 (US/Eastern)
- CERN (3179-1-D06)
- 385 Route de Meyrin, Point 1 (Atlas site)

- https://indico.cern.ch/event/459004/other-view?view=standard

Talks are posted and the web page is public.

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Description Google map link for directions from CERN reception to Ideasquare (Building 3179) available here: https://goo.gl/WNSa6P

Go to day

Monday, 9 November 2015

02:30 - 02:40 **Organization and Goals** *10'* (Open Area)
Speaker: James Allen Stewart (Brookhaven National Laboratory (US))
welcome-nov2015...

Join

02:40 - 03:00 **Cathode Plane design status, installation and issues** *20'*
Speakers: Rahul Sharma (BNL), Rahul Sharma (Brookhaven National Laboratory (US))
CPA Micarta Based... CPA Micarta Based...

03:00 - 03:20 **Field Cage design Status Installation and Issues** *20'*
Speakers: Rahul Sharma (BNL), Rahul Sharma (Brookhaven National Laboratory (US))
Field Cage Design.... Field Cage Design....

03:20 - 03:40 TPC support and constraints 20'

CERN Engineering Week Goals

- 1) Decision on the CPA materials 1/2 day review
- 2) Decide on placement of Laser alignment and beam window 1/2 day
- 3) Signal flange interface to the cryostat - Need remote attendance of electronics people.
- 4) Work on Cathode/rail/cryostat interface
- 5) Work on APA/rail/cryostat interface
- 6) Work on cabling and interfaces
- 7) Work on Field cage/ground plan interfaces to APA and CPA
- 8) Work on beam window/TPC/Cryostat interfaces
- 9) Installation planning
  - TCO Definition.
- 10) Cryostat loads
- 11) Plan mockup studies of critical
- 12) Debug the edms data interface and go over document structure.
- 13) Plan documents for the review in December
- 14) Plan the Detector reviews
- 15) Internal Cryo-Piping
- 16)Grounding and power

Made substantial progress on most goals

Cathode Material Discussion

- Reasons for resistive cathode:
  - Stored energy in DUNE is sufficient to potentially damage the cryostat membrane
    - A ground plane could potentially mitigates this.
  - The voltage swing of the cathode during discharge produces a voltage pulse on the preamps. Simple simulation showed the current in the protection diode is a factor of two less than the diode rating. The resistive cathode reduced this current by orders of magnitude.
- Conclusion: Surface resistivity in the 1 to 100 MOhm/square is required.
- Planarity within 1 cm.

Investigated materials

- Micarta ("bakelite")
  - Intrinsic bulk resistivity in the required range (few MOhm/cm)
  - Density comparable to LAr
- G10 vetronite coated with resistive layers:
  - ~ Mohm/square ink print with specific patterns
  - Glued bulk resistive kapton foil (25 μm, 6-9 MOhm/cm)
  - Graphite loaded (outer layers) G10

Radiological measurements

- sample: NORPLEX, Micarta, NP 315, phenolic laminate with graphite, black
- weight: 23.0 g
- live time: 328991 s
- detector: GePaolo
- radionuclide concentrations:
- Th-232:
- Ra-228: (15.2 +- 0.5) Bq/kg <==> (3.74 +- 0.13) E-6 g/g
- Th-228 (15.8 +- 0.5) Bq/kg <==> (3.88 +- 0.13) E-6 g/g
- U-238:
- Ra-226 (9.1 +- 0.3) Bq/kg <==> (7.4 +- 0.2) E-7 g/g
- Pa-234m (6 +- 3) Bq/kg <==> (5 +- 2) E-7 g/g
- U-235 < 0.24 Bq/kg <==> < 4.2 E-7 g/g
- K-40: (7.6 +- 0.6) Bq/kg <==> (2.5 +- 0.2) E-4 g/g
- Cs-137 < 50 mBq/kg
- upper limits with k=1.645,
- uncertainties are given with k=1 (approx. 68% CL);
- Ra-228 from Ac-228;
- Th-228 from Pb-212 & Bi-212 & Tl-208;
- Ra-226 from Pb-214 & Bi-214;
- U-235 from U-235 & Ra-226/Pb-214/Bi-214

sample: Current Inc., C770 ESD (Electro-Static Dissipative material), G10/FR4 (glass/epoxy)
weight: 89.0 g
live time: 830876 s
detector: GePaolo

radionuclide concentrations:

Th-232:
Ra-228: (54 +- 8) mBq/kg <==> (13 +- 2) E-8 g/g
Th-228 (49 +- 6) mBq/kg <==> (12 +- 2) E-8 g/g

U-238:
Ra-226 (47 +- 5) mBq/kg <==> (3.8 +- 0.4) E-9 g/g
Pa-234m < 0.52 Bq/kg <==> < 4.2 E-8 g/g

U-235 < 6.9 mBq/kg <==> < 1.2 E-8 g/g

K-40: (4.9 +- 0.3) Bq/kg <==> (1.6 +- 0.1) E-4 g/g

Cs-137 < 3.7 mBq/kg

upper limits with k=1.645,
uncertainties are given with k=1 (approx. 68% CL);

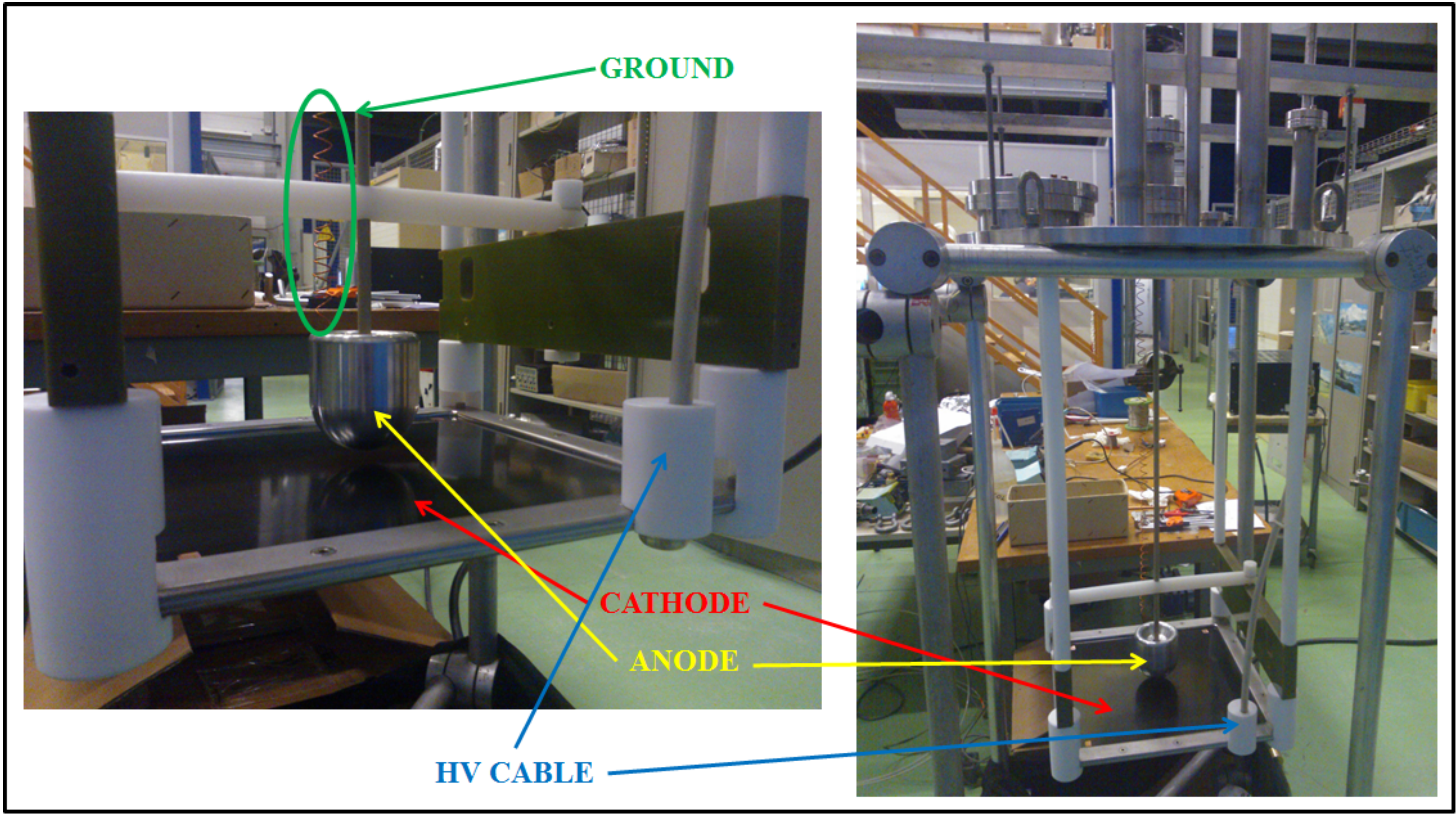
Ra-228 from Ac-228;
Th-228 from Pb-212 & Bi-212 & Tl-208;
Ra-226 from Pb-214 & Bi-214;
U-235 from U-235 & Ra-226/Pb-214/Bi-214

Measurements taken at Gran Sasso
Micarta is worse than G10 for Uranium/Thorium/Potassium… chains

Material choice for structural frame

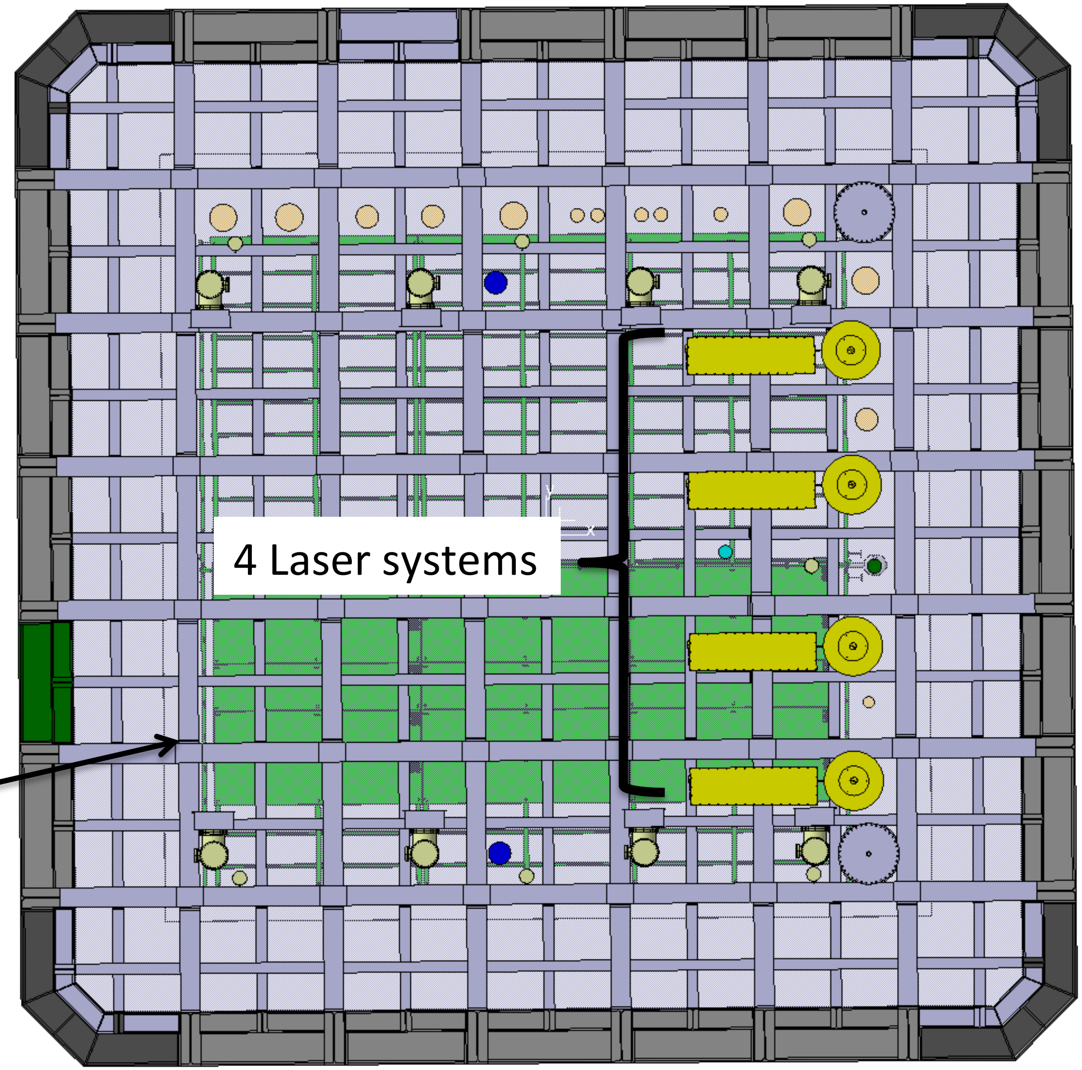
- G-10 preferred over Micarta for structural elements.
- Advantages:
  - Lower radiological
  - Denser than LAr (CPA will not float)
  - Stronger than Micarta
  - Cheap
  - Cathode inner frame does not need to be resistive.
- Sandwich of thin G10 foils with resistive coating mounted on G10 bar frame:
  - Total thickness ~1 cm seems feasible.
  - Coating choice can be defined
  - Density larger that LAr eases suspension and planarity

HV Test setup at CERN



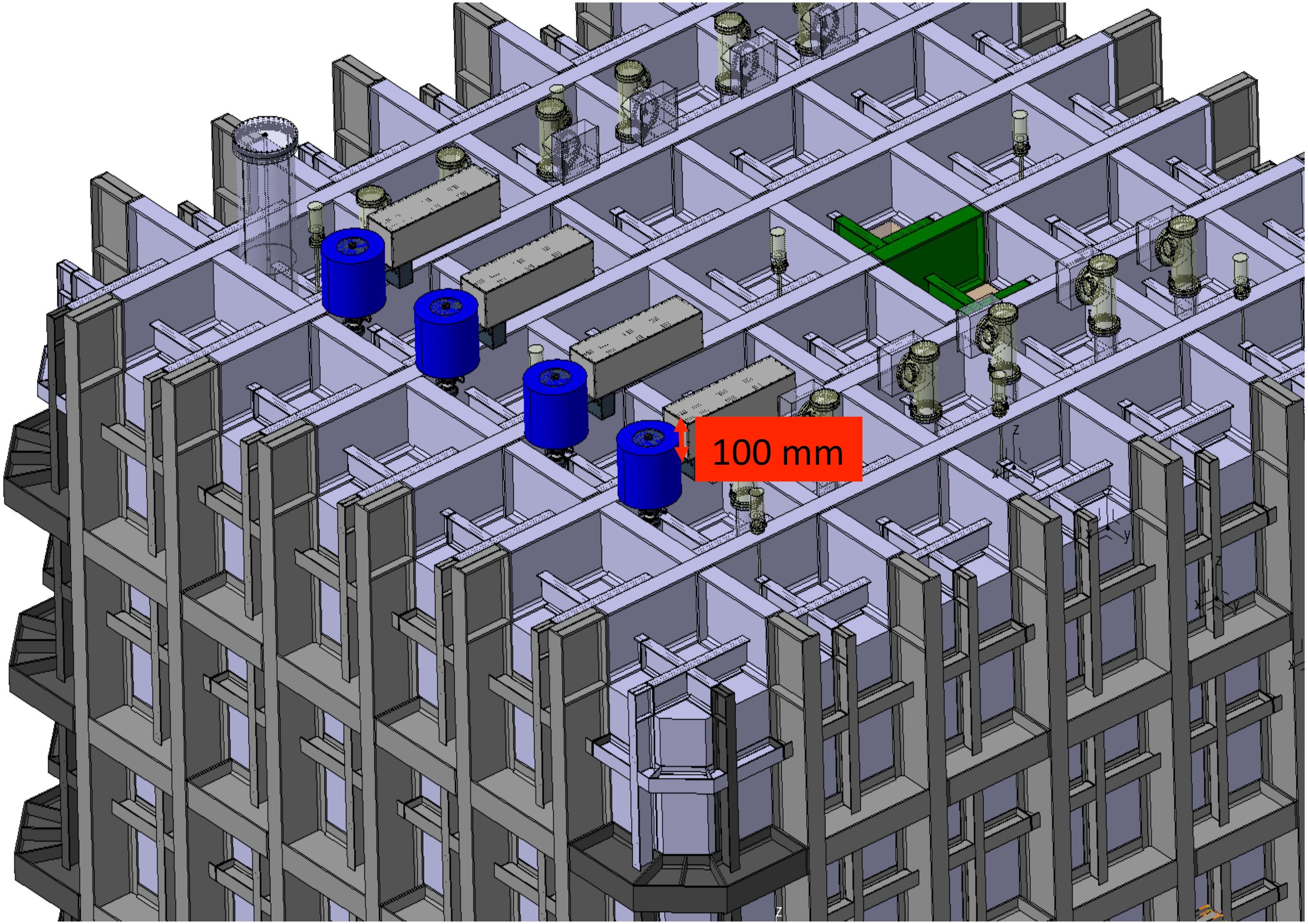
Resistive material is kept in position by SS frame. Connection with a small amount of silver paste. Sustaining structure for cathode plate and anode is in plastics (vetronite, teflon, PEEK).

Laser Calibration System

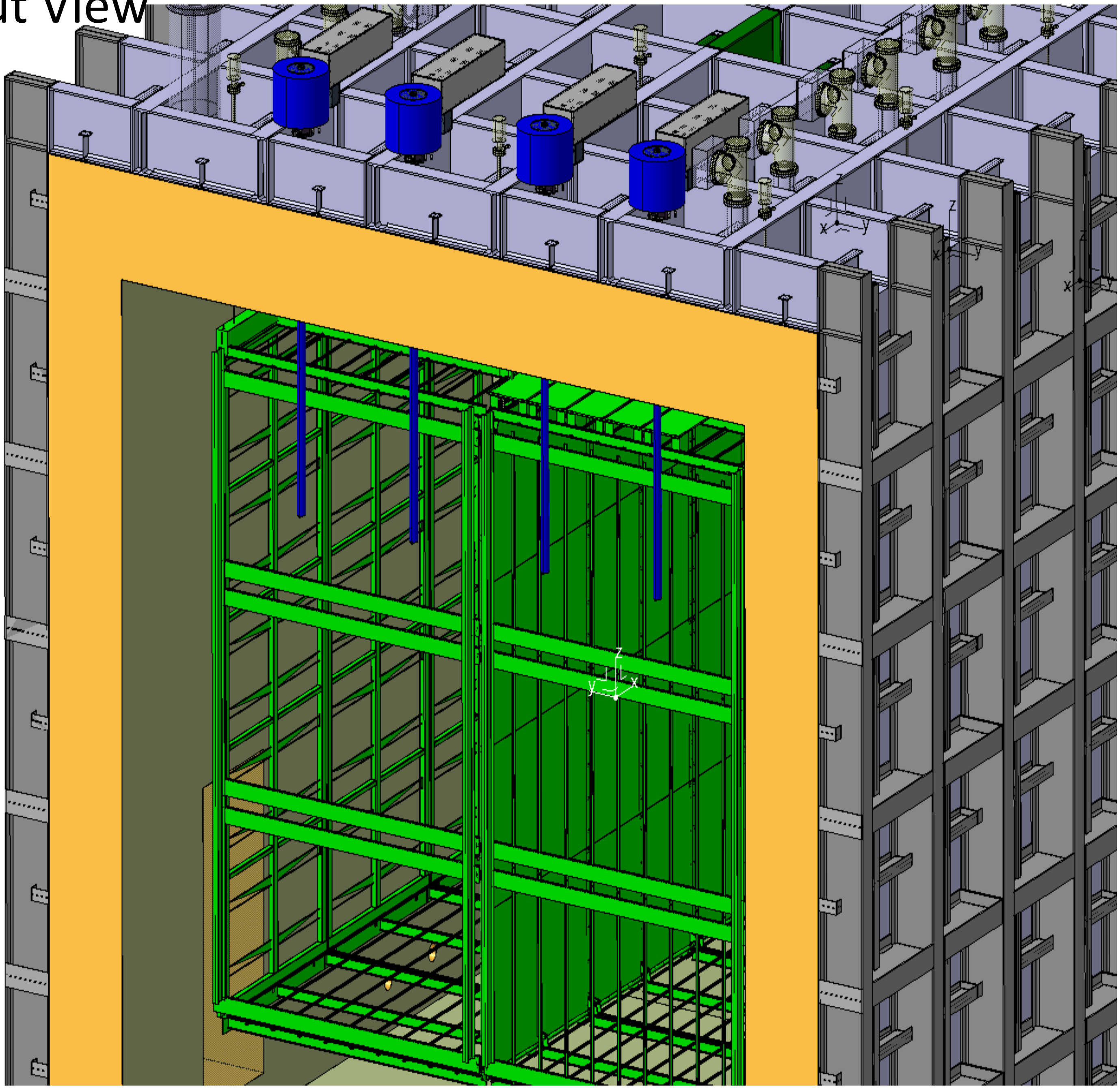


- Placed Laser Calibration using SBND 3D model with modifications from Igor.
- Located the cryostat penetrations required.

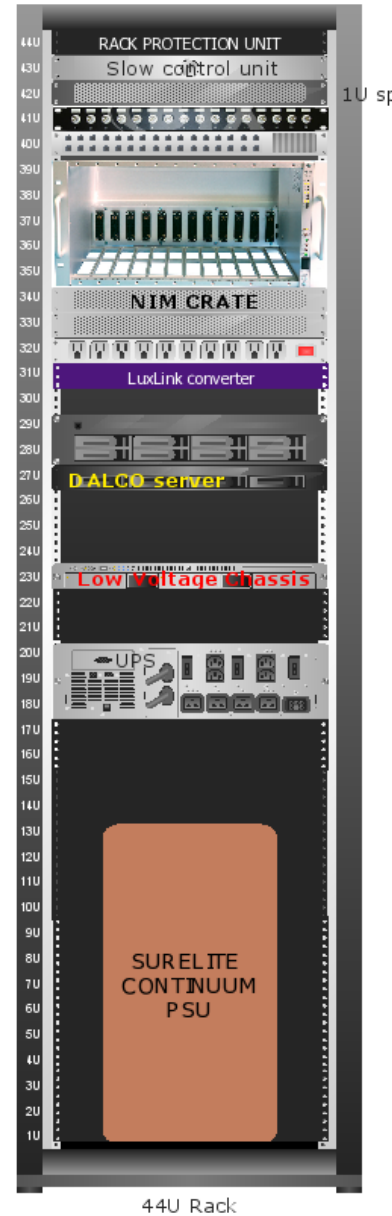
Isometric View



Cut View



LASER Rack

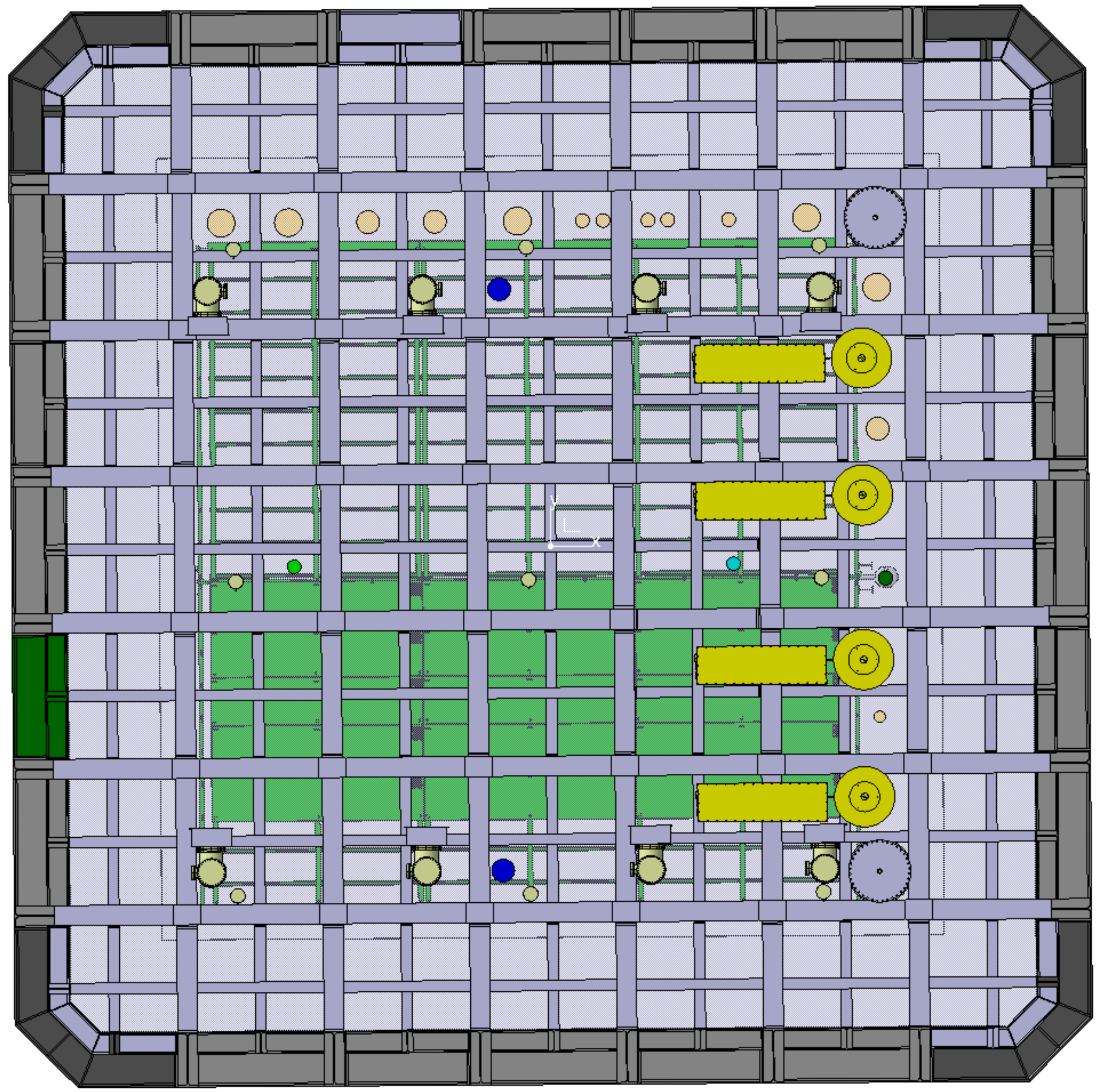


Penetration summary

- Penetrations detector:
- West TPC translation suspension: N. 3, crossing tube diameter 200 mm
- Center TPC translation suspension: N. 3, crossing tube diameter 150 mm
- *East TPC translation suspension: N. 3, crossing tube diameter 150 mm*
- Signal cable chimney FTs: N. 8, crossing tube diameter 250 mm
- Spare on Signal cable row FTs: N. 2, crossing tube diameter 250 mm
- Laser FTs: N. 4, crossing tube diameter 100 mm
- Calibration Fiber CPA FT: N. 1, crossing tube diameter 150 mm
- Spare on CPA line FTs: N. 2?, crossing tube diameter 150 mm
- *HV FT: N. 1, crossing tube diameter 156 mm*
- Manhole: N. 2, crossing tube diameter 609 mm

- *Angled beam windows – west side N. 3, crossing tube diameter 300 mm*

- *2 Spare over beam window NEED TO CHECK!*



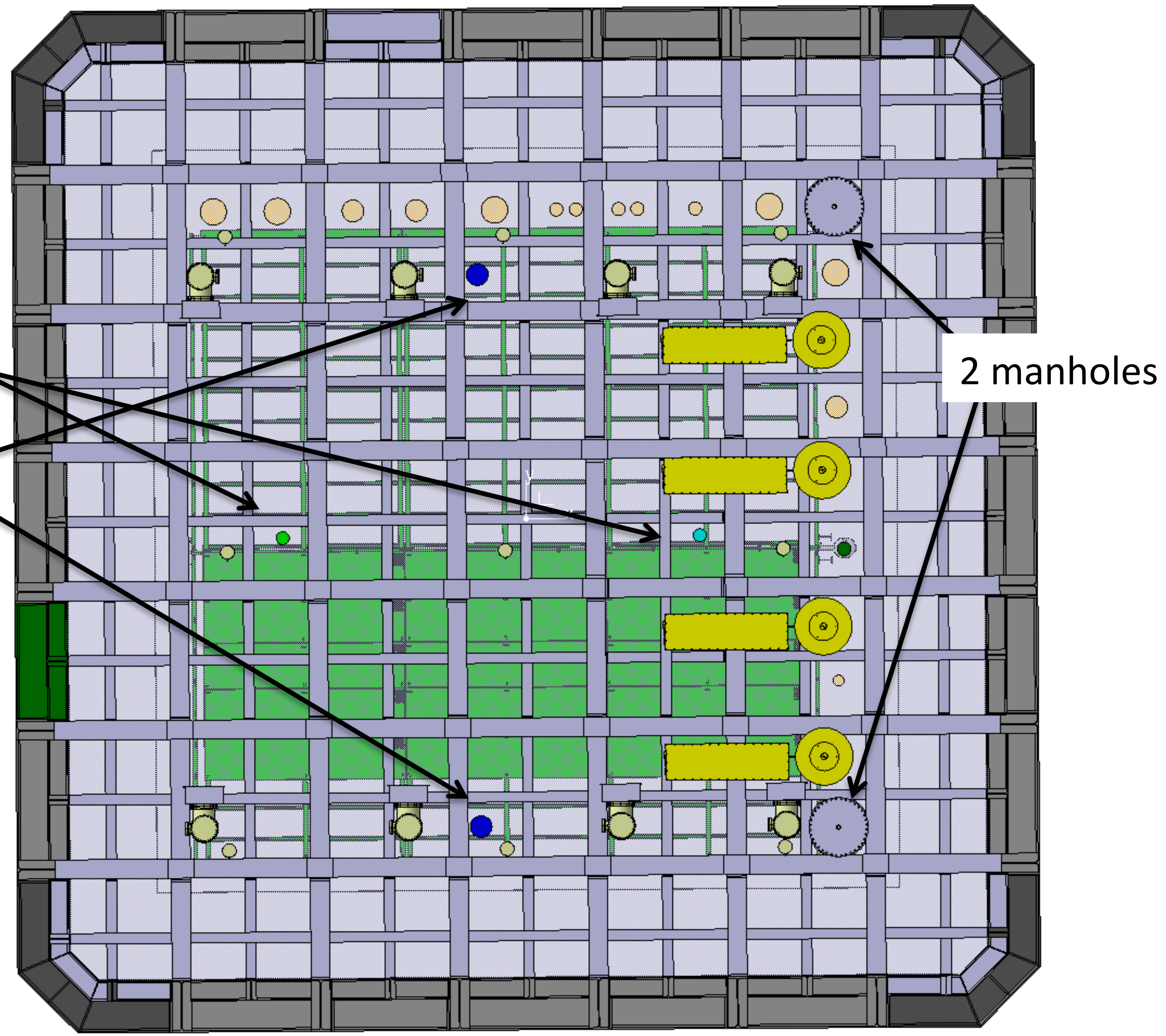
TCO

TPC mounting beams

Penetrations:
West TPC translation suspension: N. 3, crossing tube diameter 200 mm
Center TPC translation suspension: N. 3, crossing tube diameter 150 mm
East TPC translation suspension: N. 3, crossing tube diameter 150 mm

Spare Penetrations:

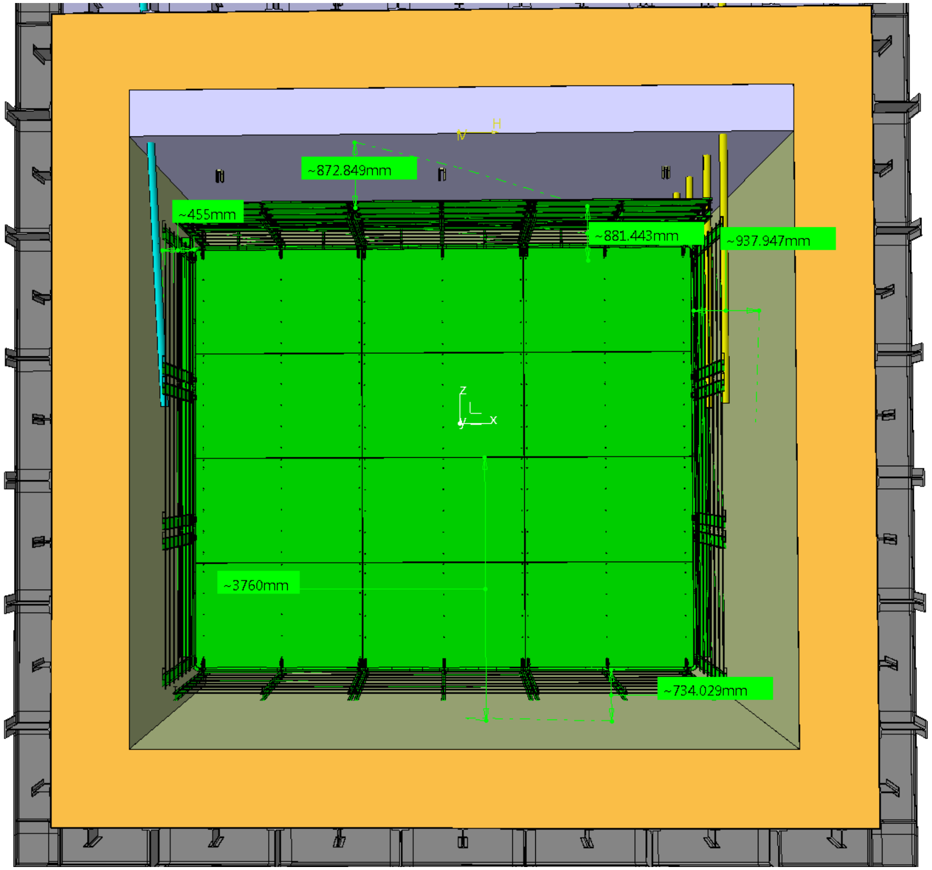
- Two along the cathode plane (fibers plus?)
- One on each APA feedthru row
- Two over the beam windows (not shown)



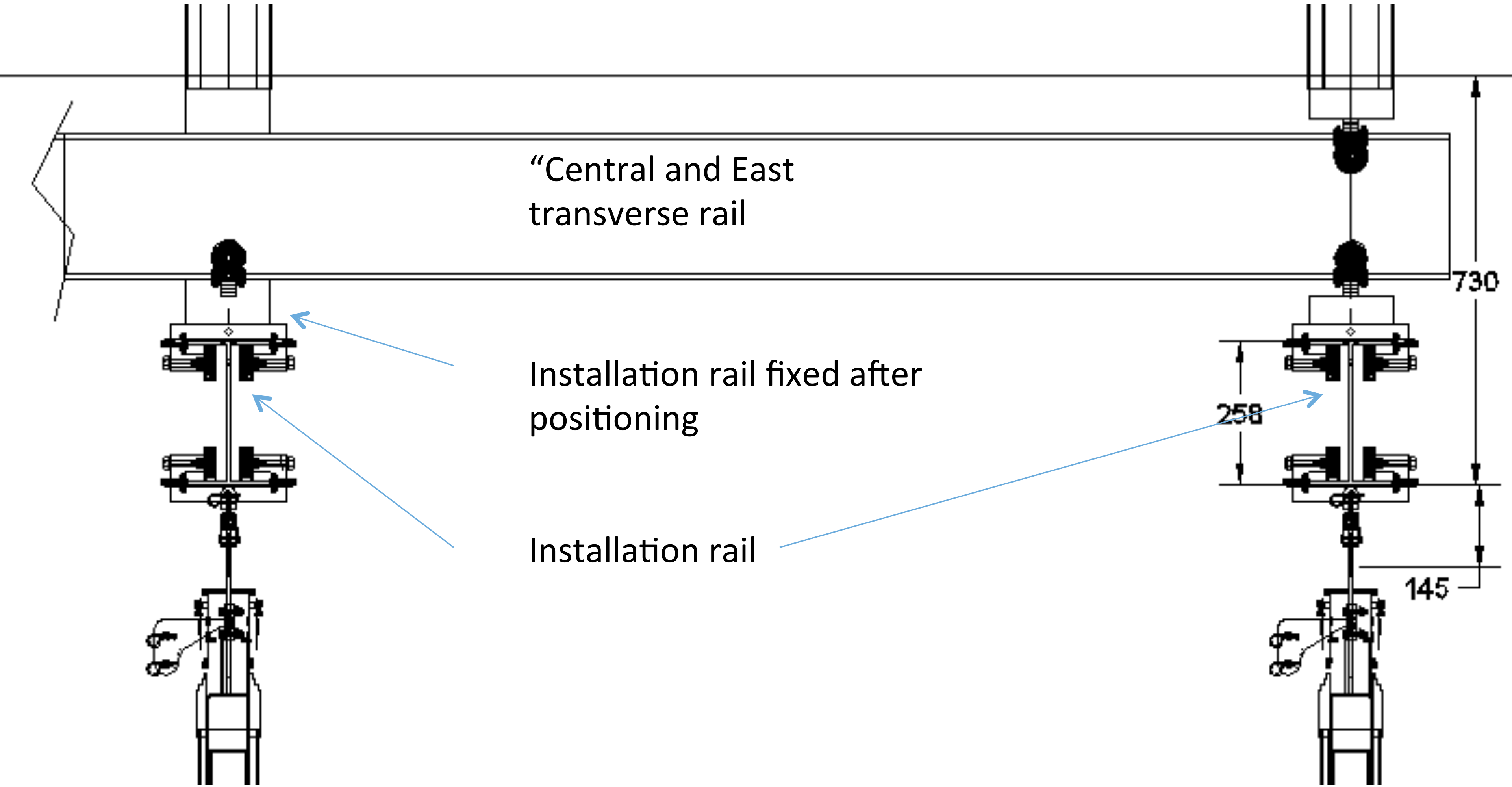
If needed then one could try to integrate other functionality into the feedthru flanges perhaps using a cross rather than a tee to increase spares effectively

Detector position

- The detector was positioned in the cryostat according to the far detector parameters.
- The cryostat was shortened by 600mm.
  - Moves the detector away from muon background
  - Reduced the needed LAr
  - Reduces stress in the iron increasing safety factor
  - Agreed with WA105
- Cross rails are foreseen which will allow changing from 3.6 m to 2.5 m if needed.

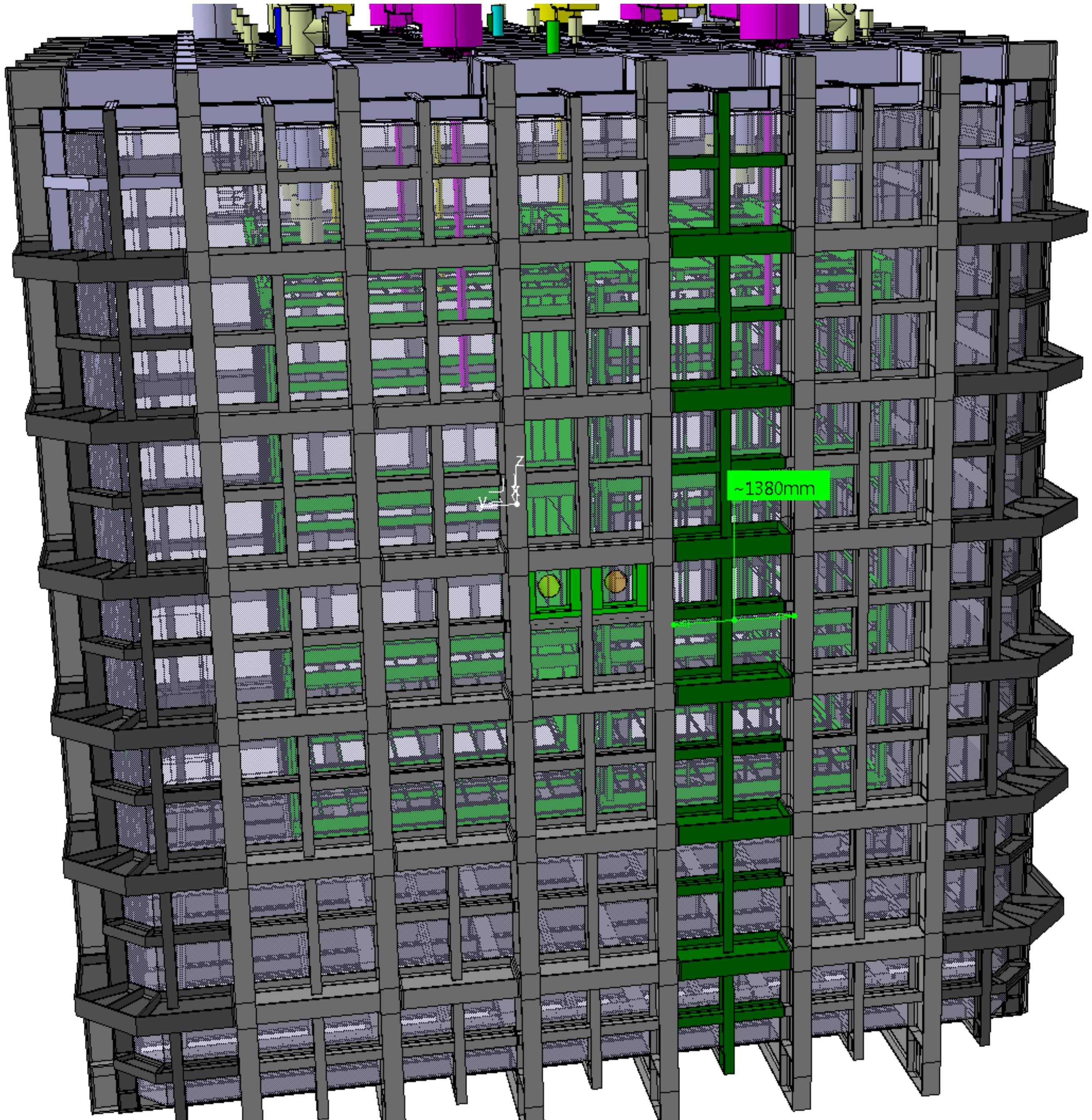


TPC support structure



Afternoon session found no show stoppers to installing through a TCO

Temporary Construction Opening



Cryostat Interfaces & Beam Window

– Keep primary membrane intact as-is. Low density foam and active pumping.
– Connect the beam line pipe to window.
– Continue to investigate moving into past Field Cage region.
– Can’t move the beam line. Provide target point to him by end of week.
– Explore simulating events in the TPC region
– Wants the detector to be lowered in z-direction due to muons from upstream target.

Update from CERN

- EHN1 extension making good progress. Expect completion in August 2016.
- Outfitting and beam planning are well advanced
- CERN hiring experiments interface to the facilities (January)
- Some desire within CERN management to merge ProtoDUNE and WA105 under DUNE
- Initial planning for a meeting at CERN for European contribution to ProtoDUNE/DUNE in ~Feb.
- Schedule development for ProtoDUNE ongoing (2nd ProtoDUNE run?)
  - Cryostat Review Dec 17-18
  - detector design reviews in spring-summer
- Need plan for ProtoDUNE presence at CERN (offices near EHN1)

Summary

- The TPC placement in the cryostat was fixed.
- Cathode plane materials were identified.
- The proposed cryostat penetrations were defined.
- Use of a TCO for installation was confirmed
- Potential placement of a laser system was found.
- Identified areas for further work on the beam window.
  - Placement still needs fixed

- A great deal of progress was made.
- Next meeting ~Feb-Mar 2016