ProtoDUNE SP configuration and interface overview

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DSS review

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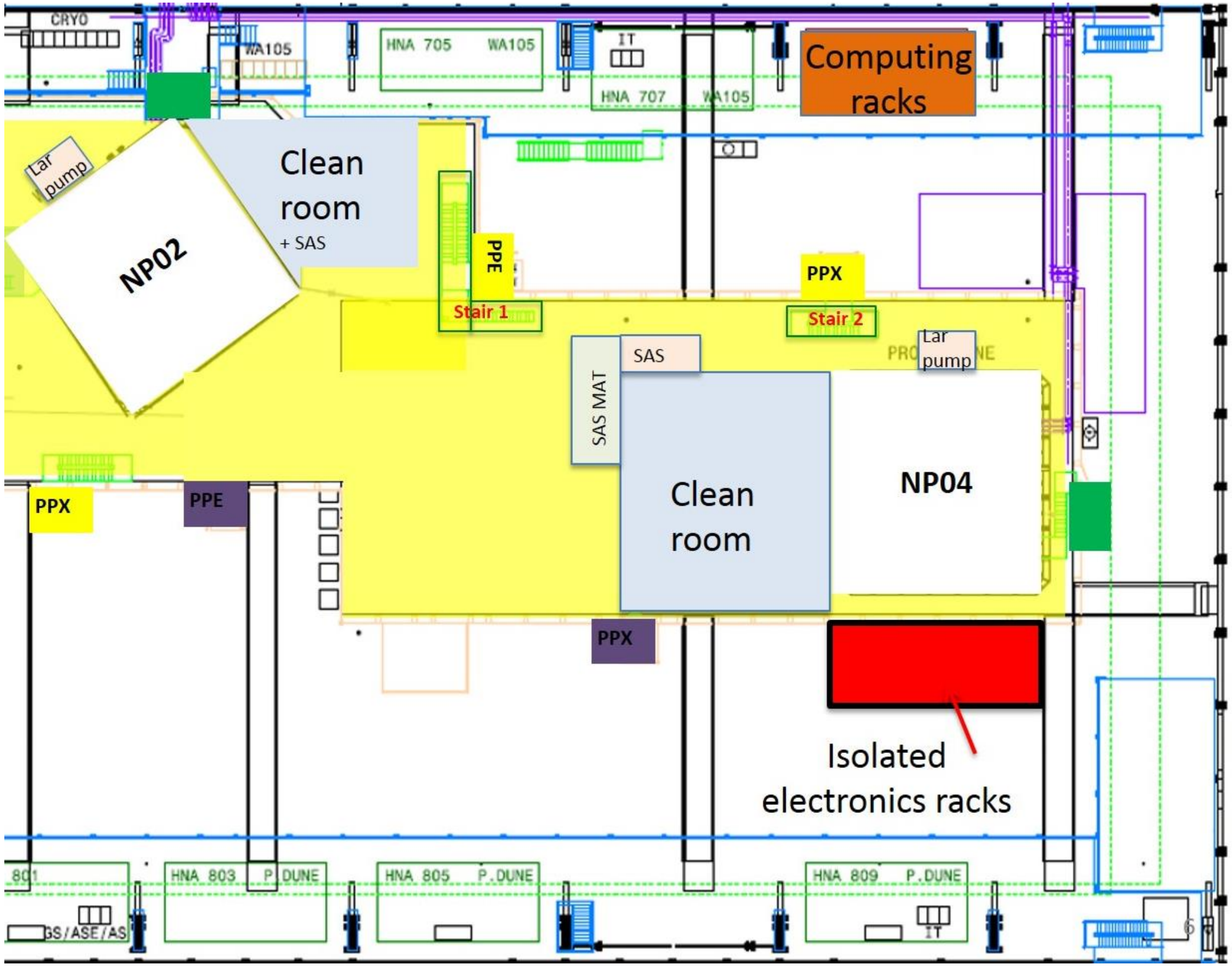
Outline

- Facility integration and 3D models
- DSS Interfaces
- Summary

Layout in EHN1

Jura or North

Beam entrance or West



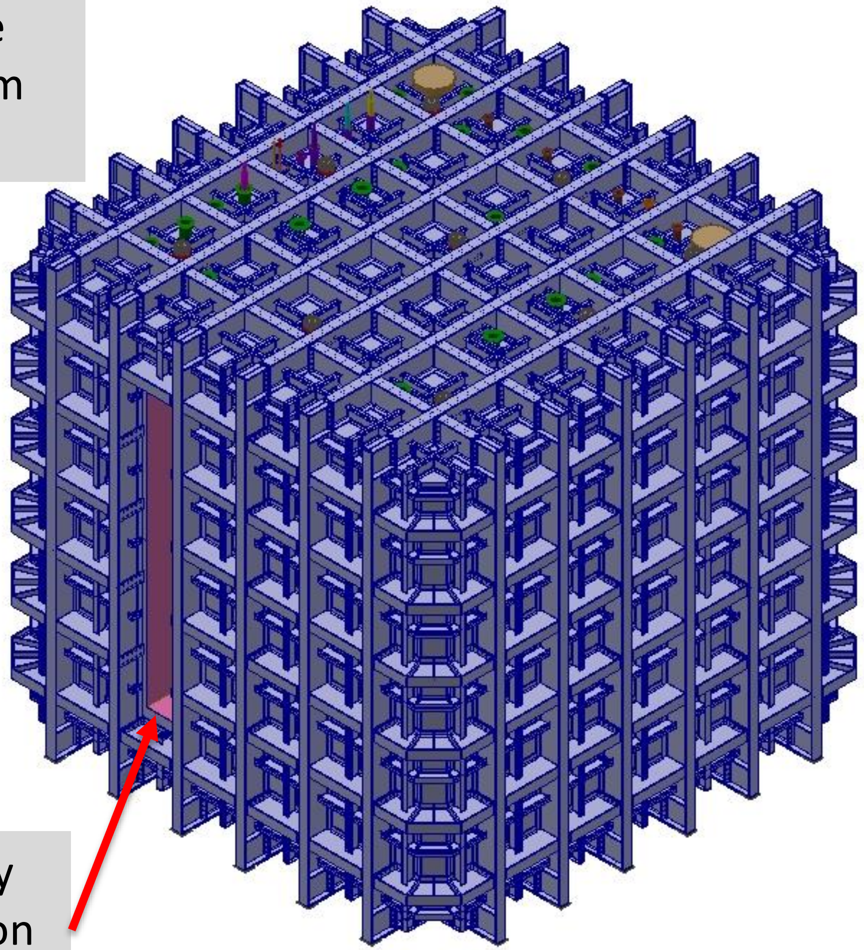
Downstream or East

From M Nessi

Saleve or South

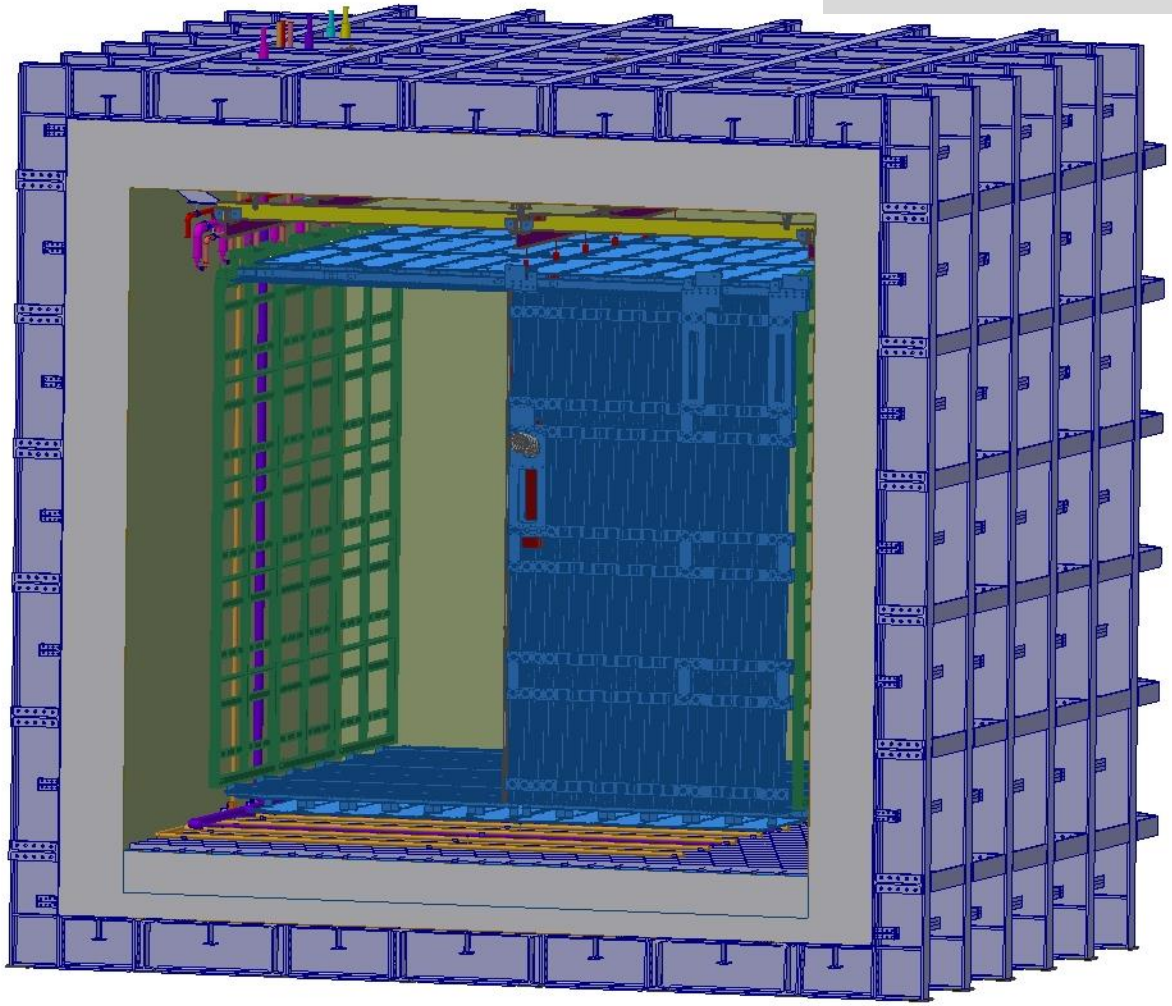
ProtoDUNE SP cryostat and TPC

Current cryostat 3D solid model showing the cryostat warm structure



Temporary construction opening

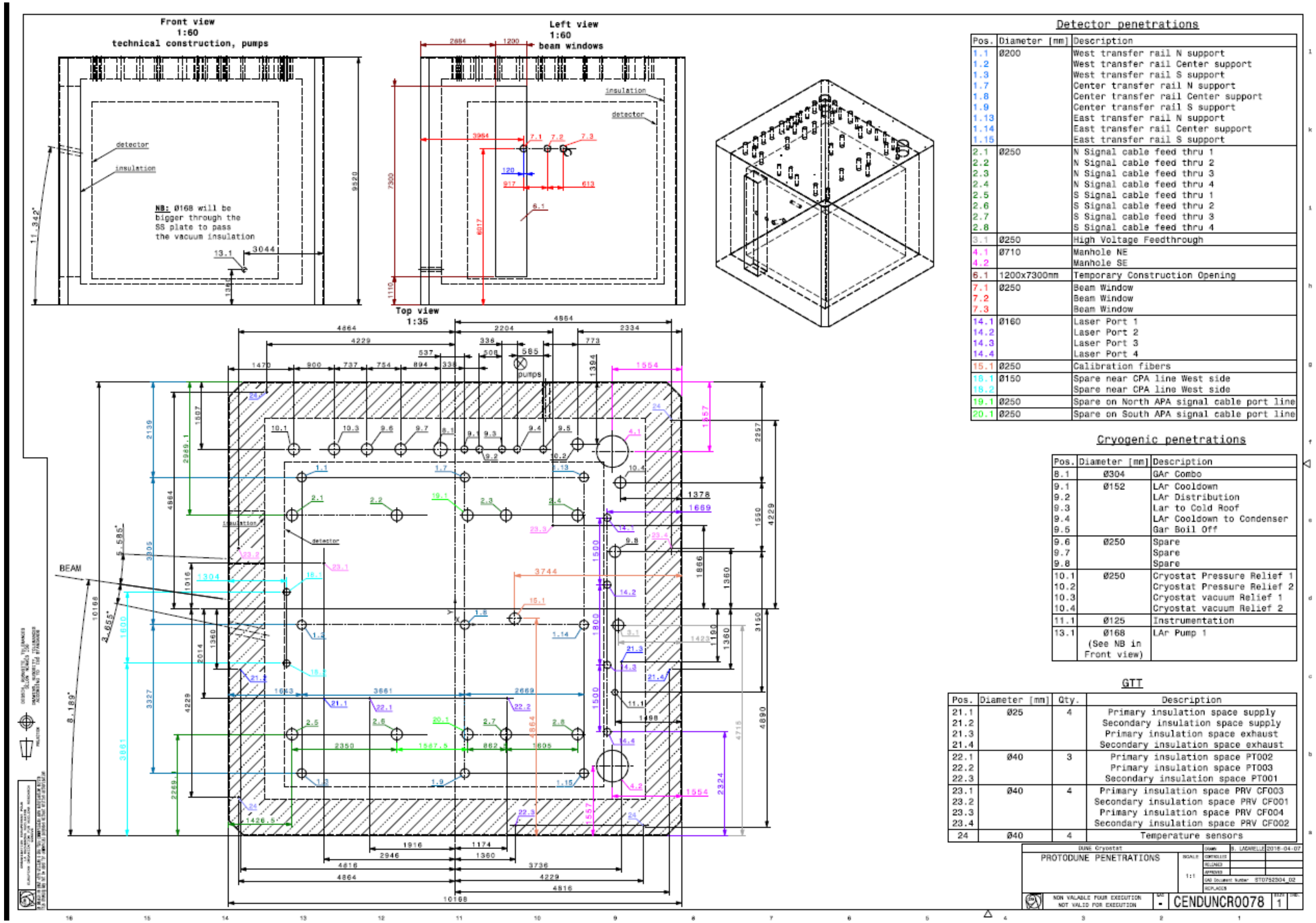
Model sectioned to show integrated TPC and cryogenic piping



Charge question #4

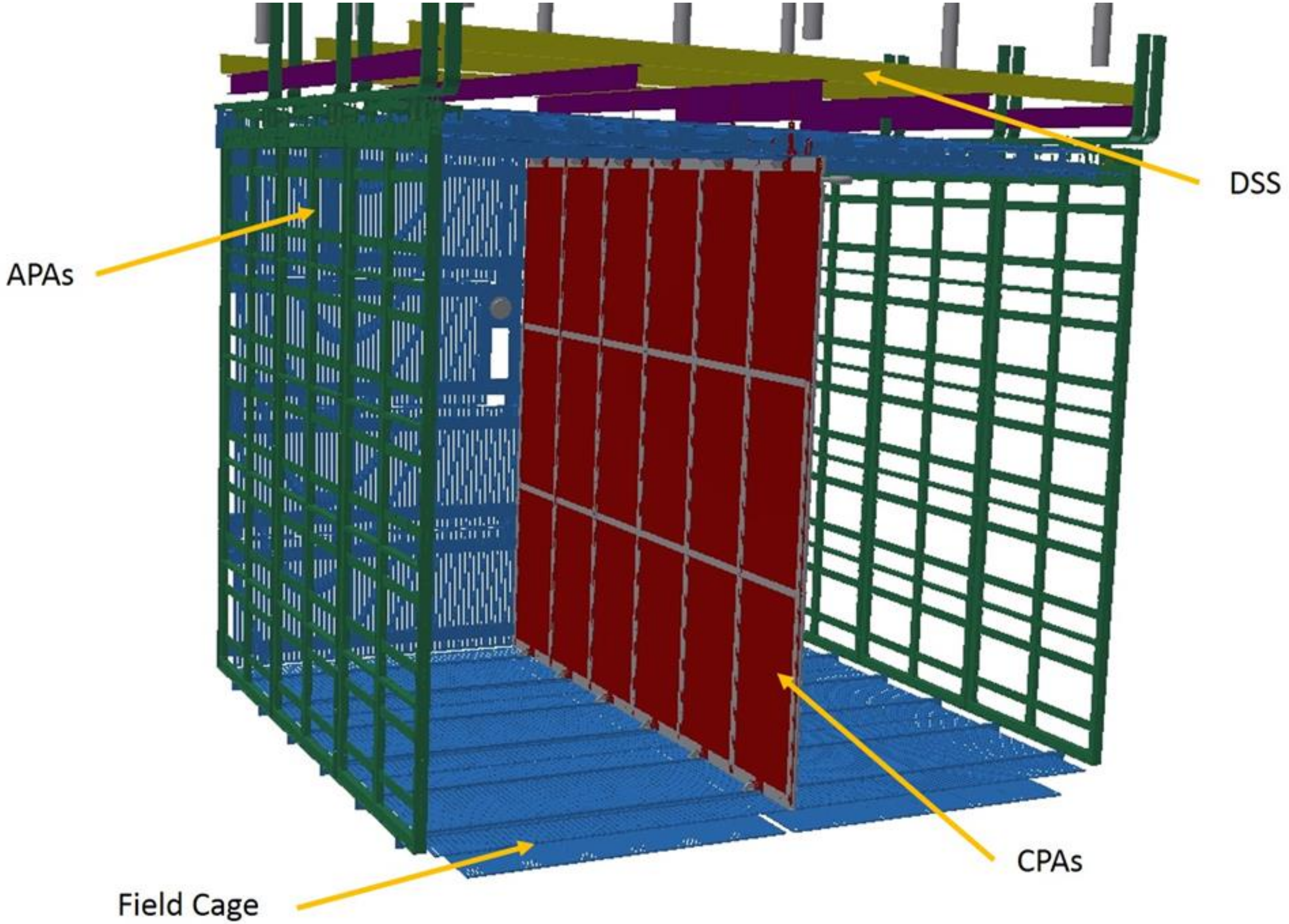
Cryostat penetration drawing

https://edms.cern.ch/document/1543241/3

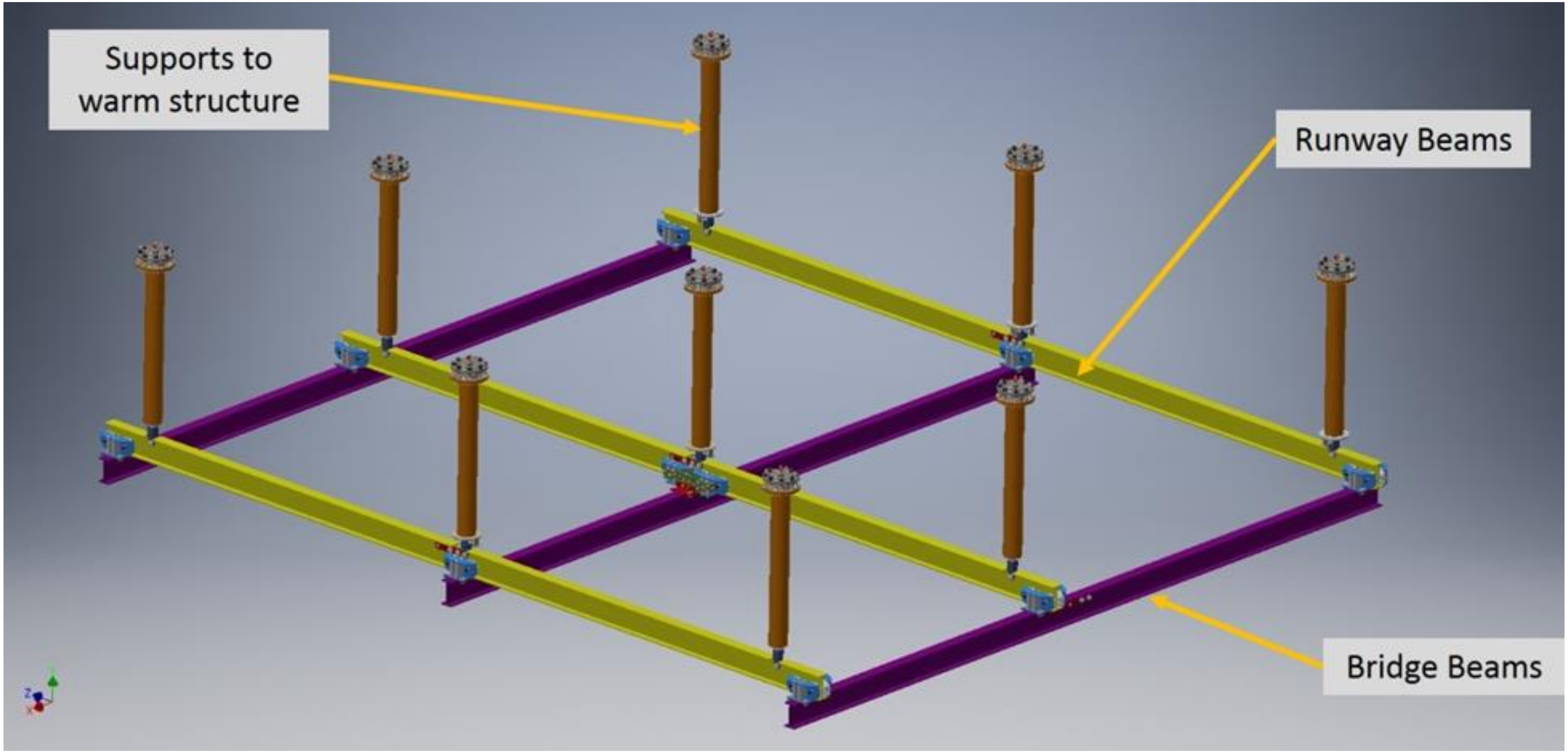


ProtoDUNE SP TPC

- The ProtoDUNE SP TPC consists of
  - Two rows of Anode Plane Assemblies (APAs) that are located near the walls of the cryostat.
  - One Cathode Plane Assembly (CPAs) that is located between the two rows of APAs.
  - The Field Cage Assemblies (FC) enclose the APA/CPA volume on the open ends, top and bottom.
  - The Detector Support Structure (DSS) is located at the top and supports the TPC through penetrations in the warm structure and inner membrane of the cryostat.



DSS



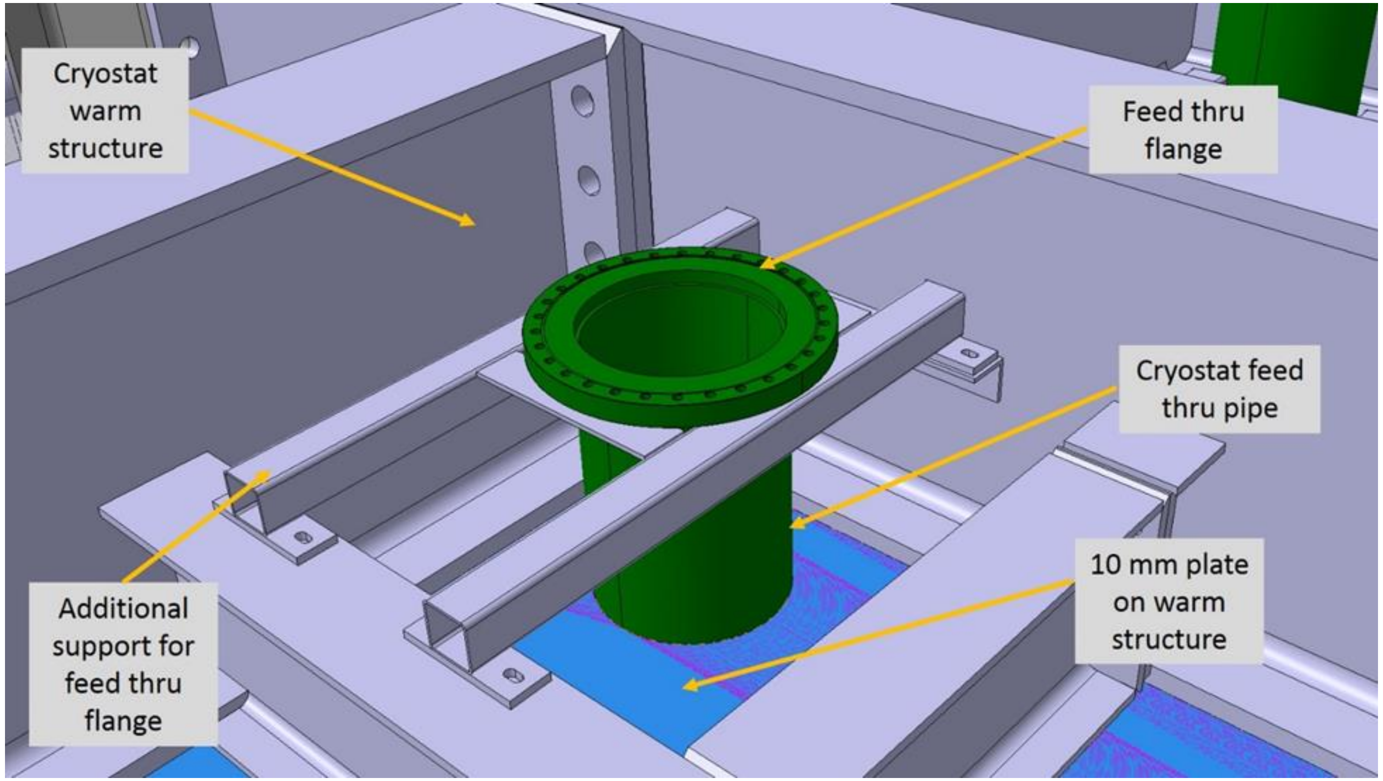
Only three bridge beams are shown. Five will be used for installation.

DSS Interfaces (internal and external)

- Warm structure to DSS hanger assembly.
- DSS hanger assembly to runway beams.
- Runway beam connection to bridge beam.
- Bridge beam to TPC components.
- Internal cryogenic piping

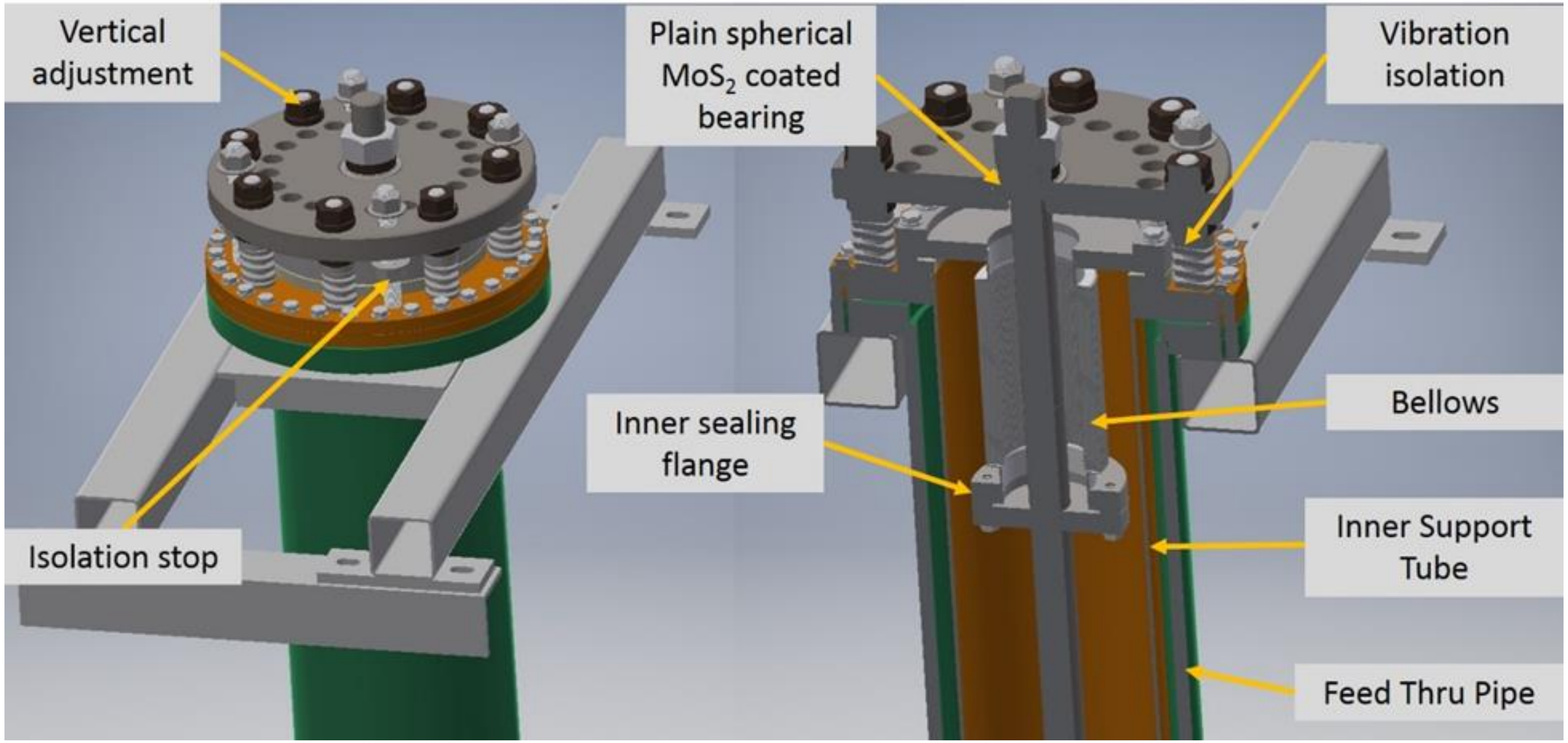
Charge question #3

Preparations on the warm structure
(provided with warm structure)



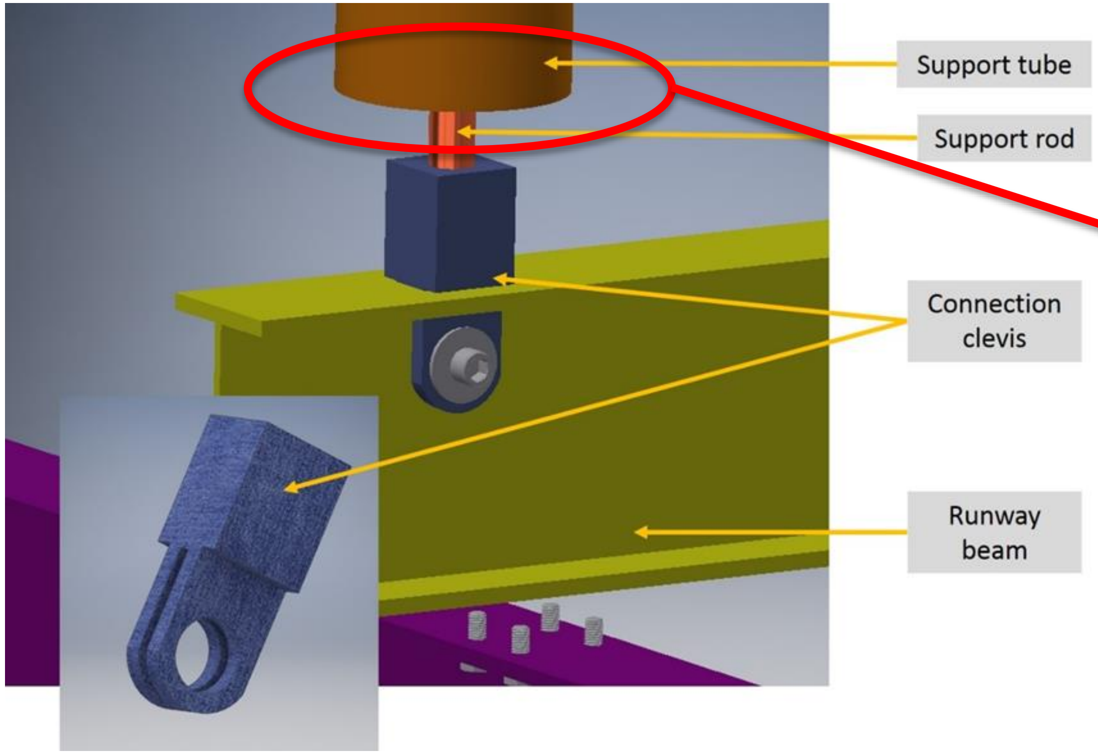
- The flanges and feed thru pipes are reinforced at each of the 9 positions on the warm structure.
- The loads at each point will be supplied to CERN for design and confirmation of the additional support structure required.
- The support pipe is 200 mm OD and 180 mm ID.
- Oversized flanges (DN250 CF) will be used to provide a larger surface area to react the loading.

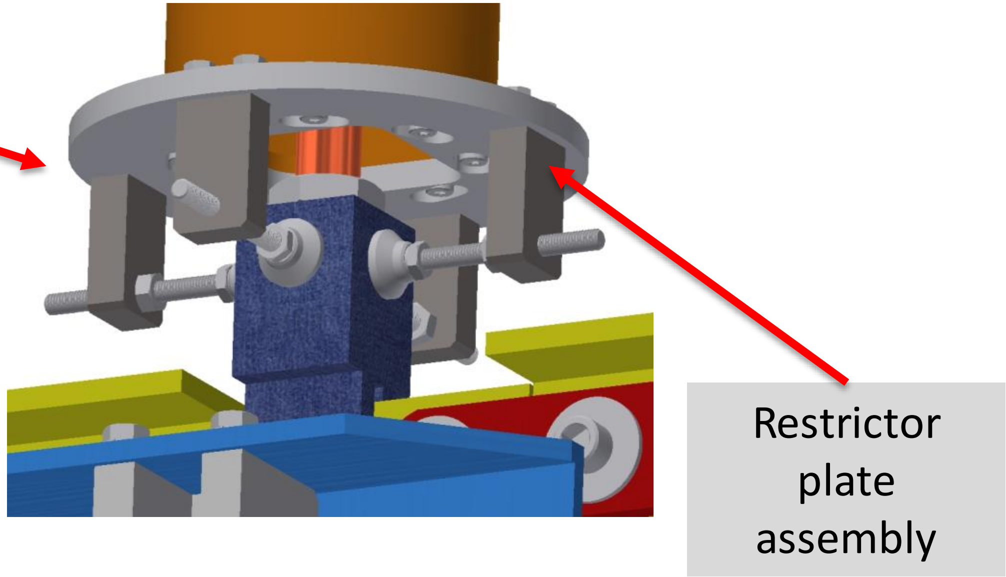
DSS hanger assembly



- Main support interface with the warm structure.
- Accommodates motion of the DSS and TPC.
- Can provide vibration dampening and adjustment between warm structure and DSS.
- Must provide gas seal for cryostat.

Support rod to runway beam connection

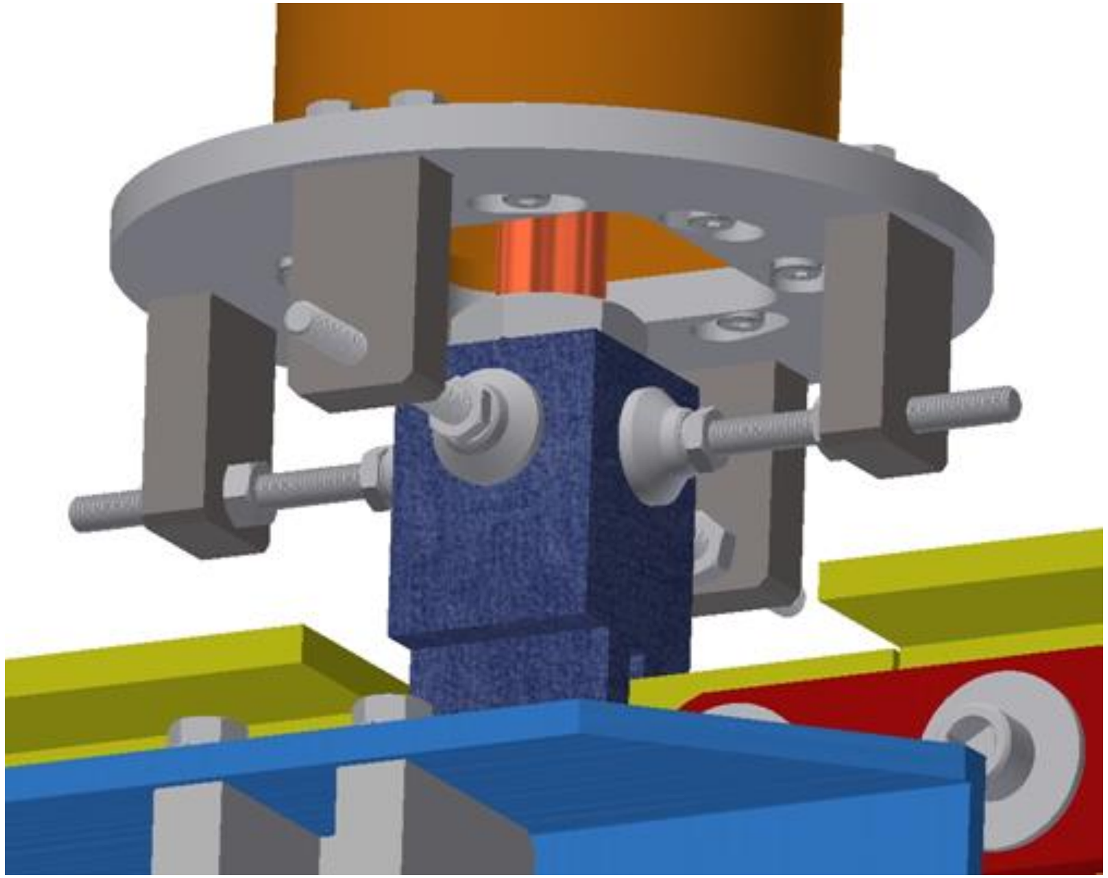




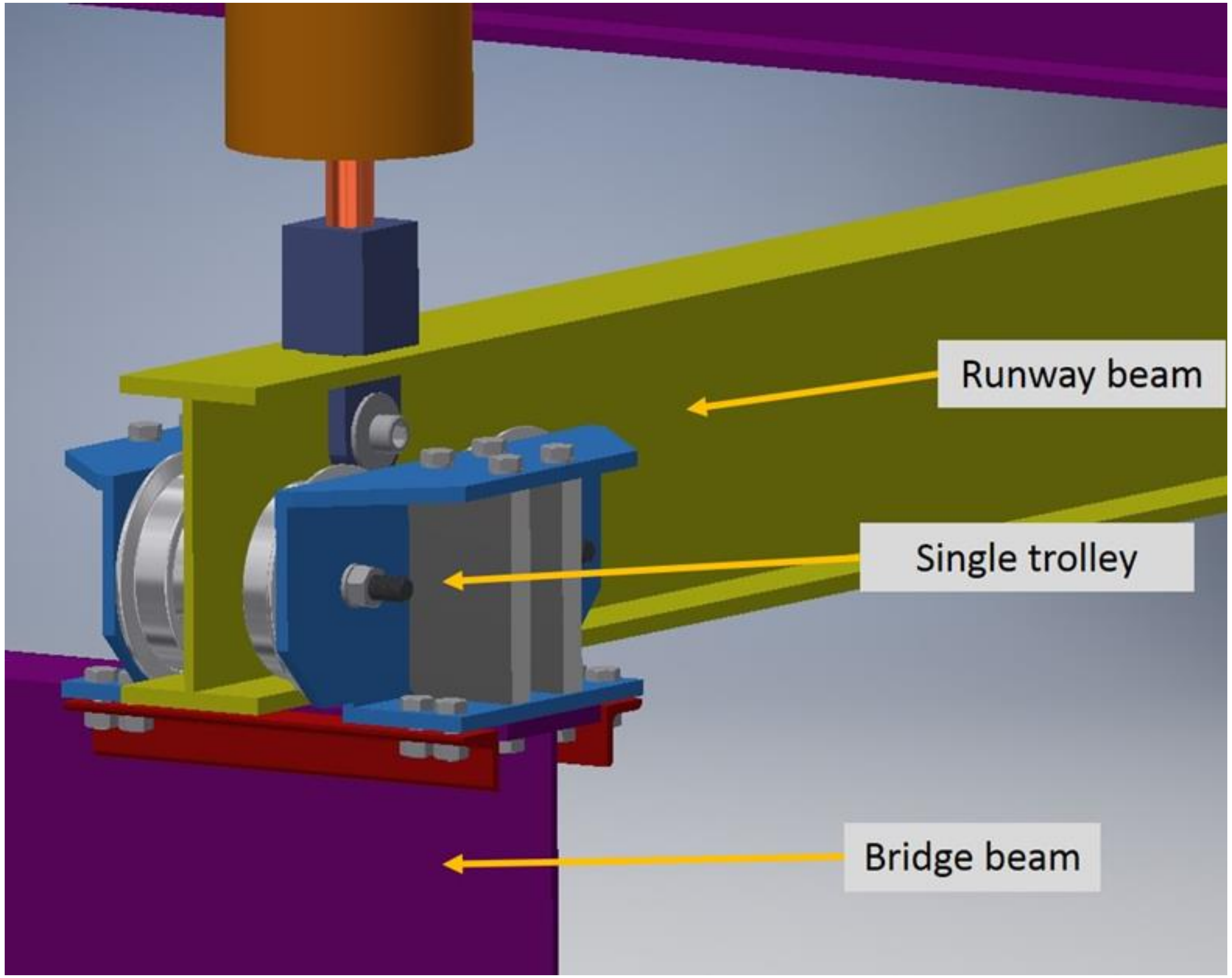
- Main support interface between DSS hanger assembly and DSS beams.
- The clevis pivots in Y direction to react the contraction of the runway beam and transfers the TPC load through the web of the runway beam.
- The restrictor plate assembly is attached to the end of the support tube.

Restrictor plate assembly

- The restrictor plate assembly is attached to the end of the support tube that extends down from the DSS hanger assembly.
- The restrictor plate can be configured to constrain motion of the clevis in either X, Y or both directions.
- This is necessary to control the location of the TPC with respect to the cryostat membrane.
- Any horizontal loads created by the runway beams can be transferred to the support tube through the restrictor plate assembly.

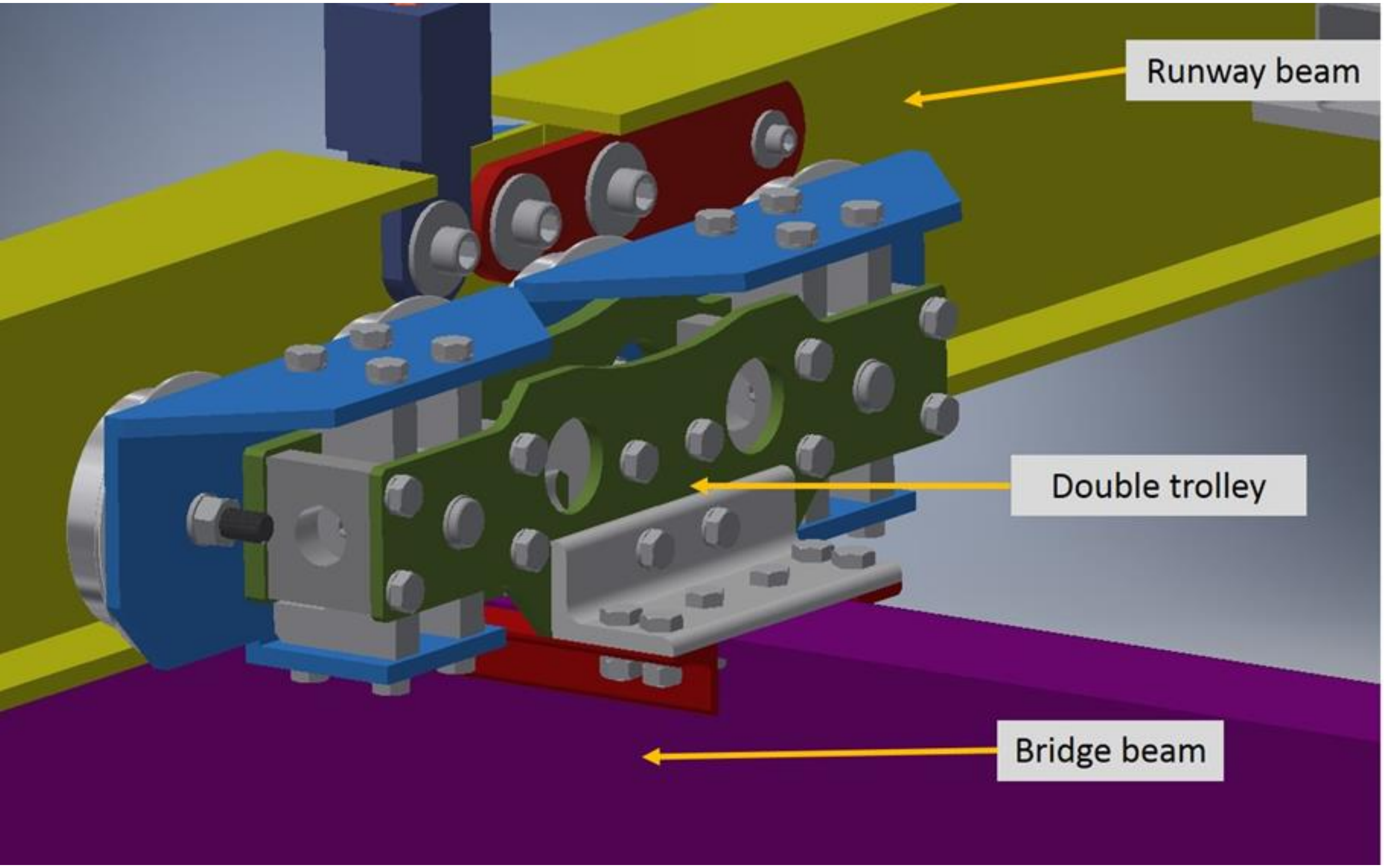


Beam to beam connections



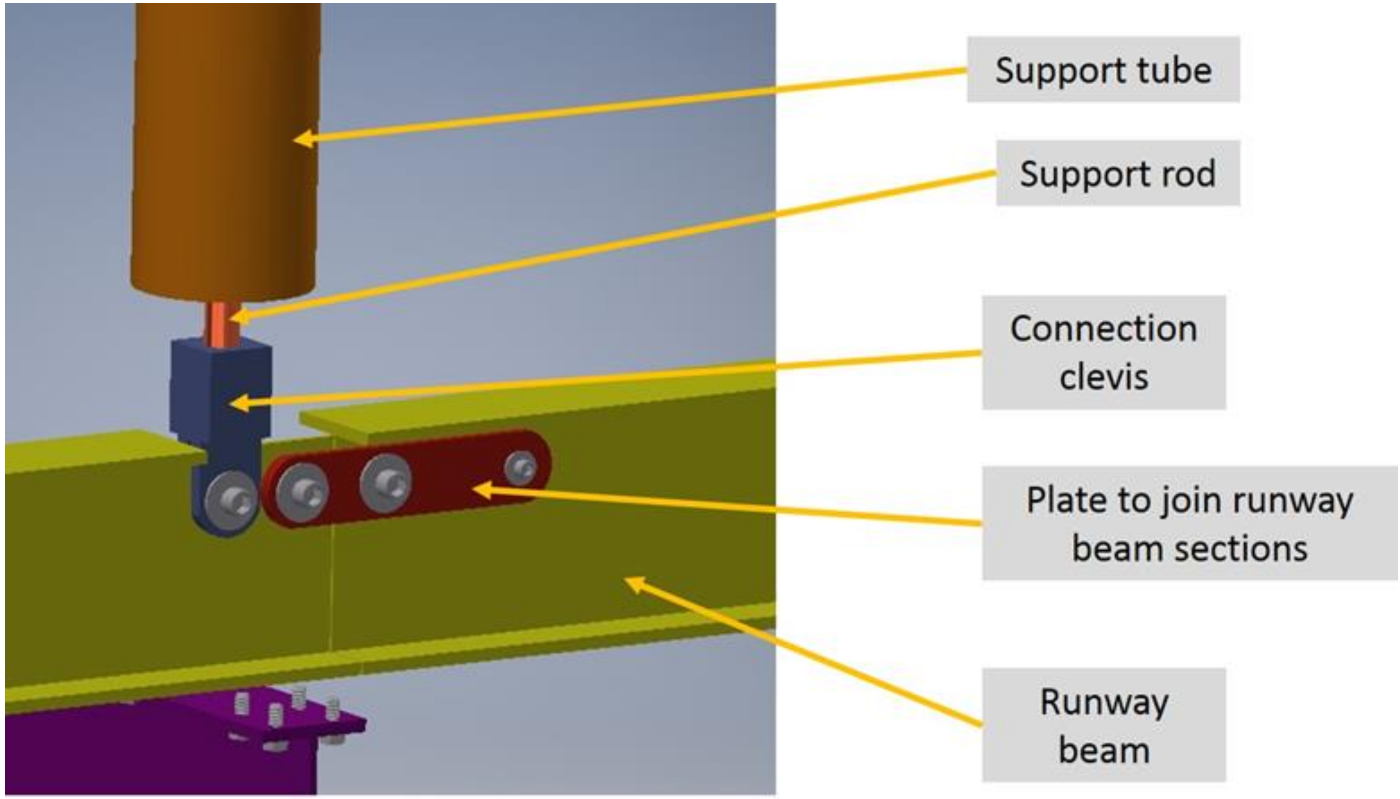
- The connection between the runway and bridge beams will be accomplished with a series of trolleys.
- These trolleys are similar to commercially available versions, but customized for use at cryogenic temperatures.
- The trolleys are fixed to the top flange of the bridge beam.
- The rollers will be guided on the lower flange of the runway beams.
- These rollers allow for the translation of the bridge beams in Y inside the cryostat to position the TPC elements and to accommodate motion during cooldown.

Beam to beam connections



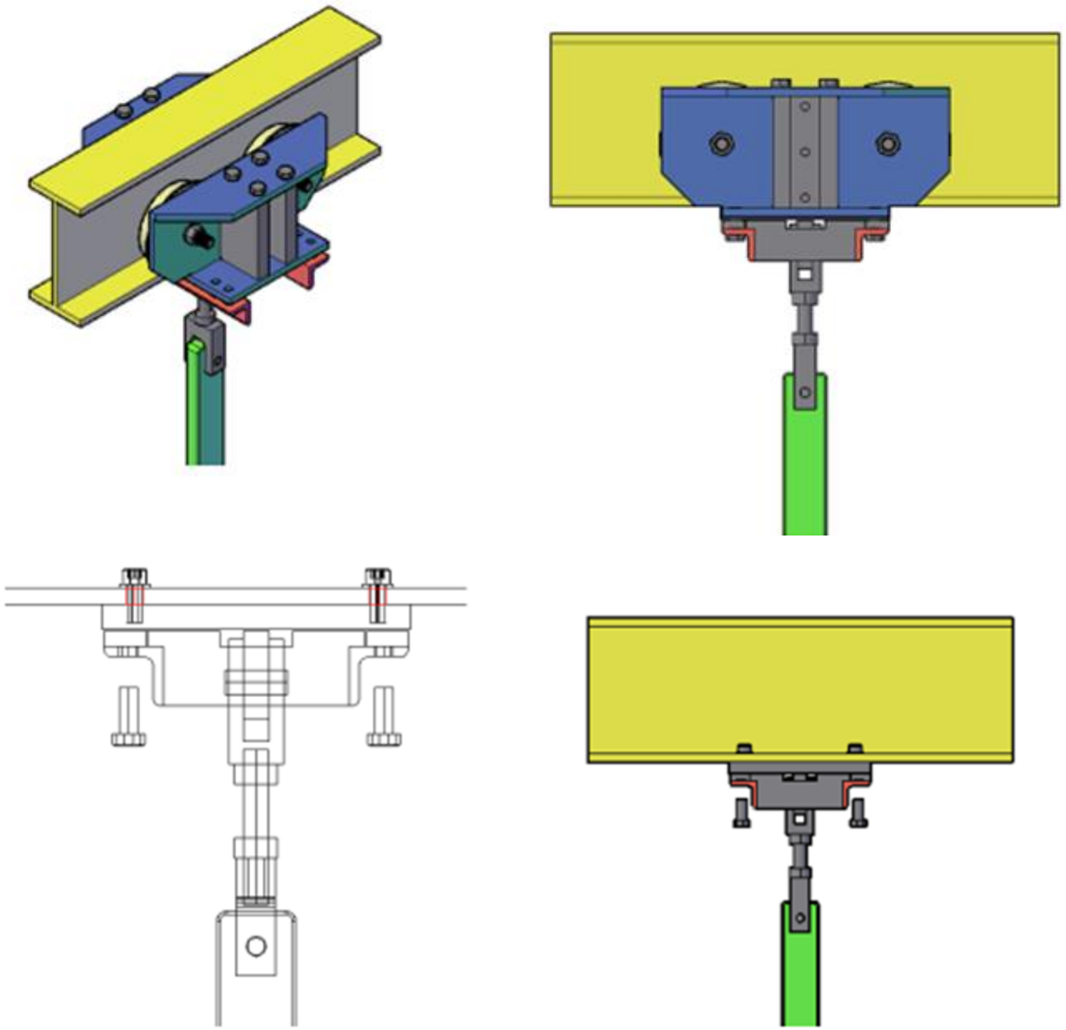
- At the center support point for the DSS, a double trolley will be used.
- The double trolley is required due to the increased loads at the central point.
- It will be constructed using the same materials and methods as the single trolley.
- The double trolley will also be fixed to the bridge beam and guided on the runway beam.
- Since the double trolley spans across the intersection of the two beam segments, it will articulate to mimic the motion of the individual segments.

Articulating beam joint



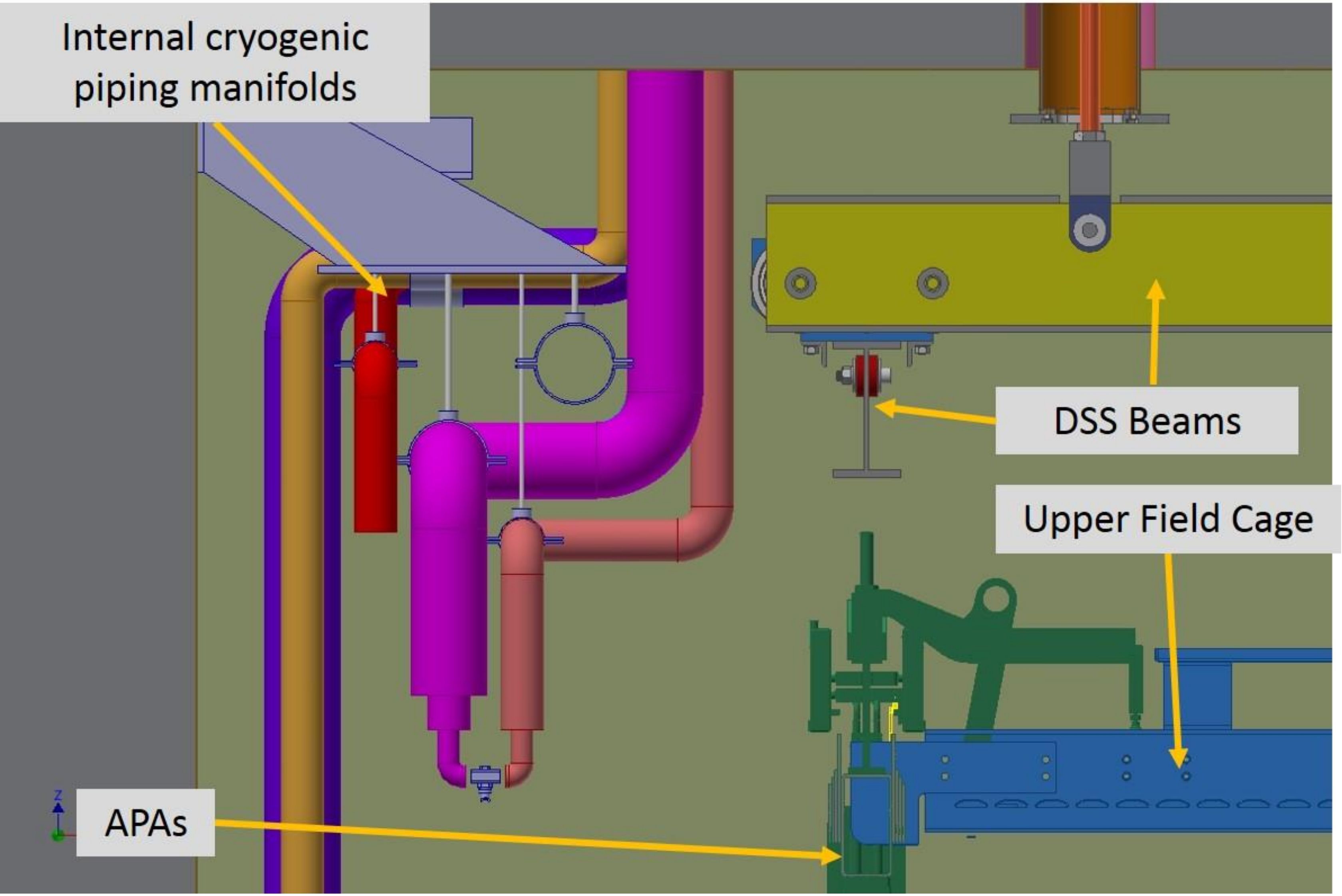
- Both the runway and bridge beams will have an articulating joint at their approximate mid point.
- These joints allows the beams to pivot in Z or the vertical direction.
- This motion is required to accommodate the various deflections in the roof of the cryostat warm structure.
- Without these joints, the beams would not follow the movement of the cryostat roof, causing the support rods to become over loaded.

TPC supports and hangers



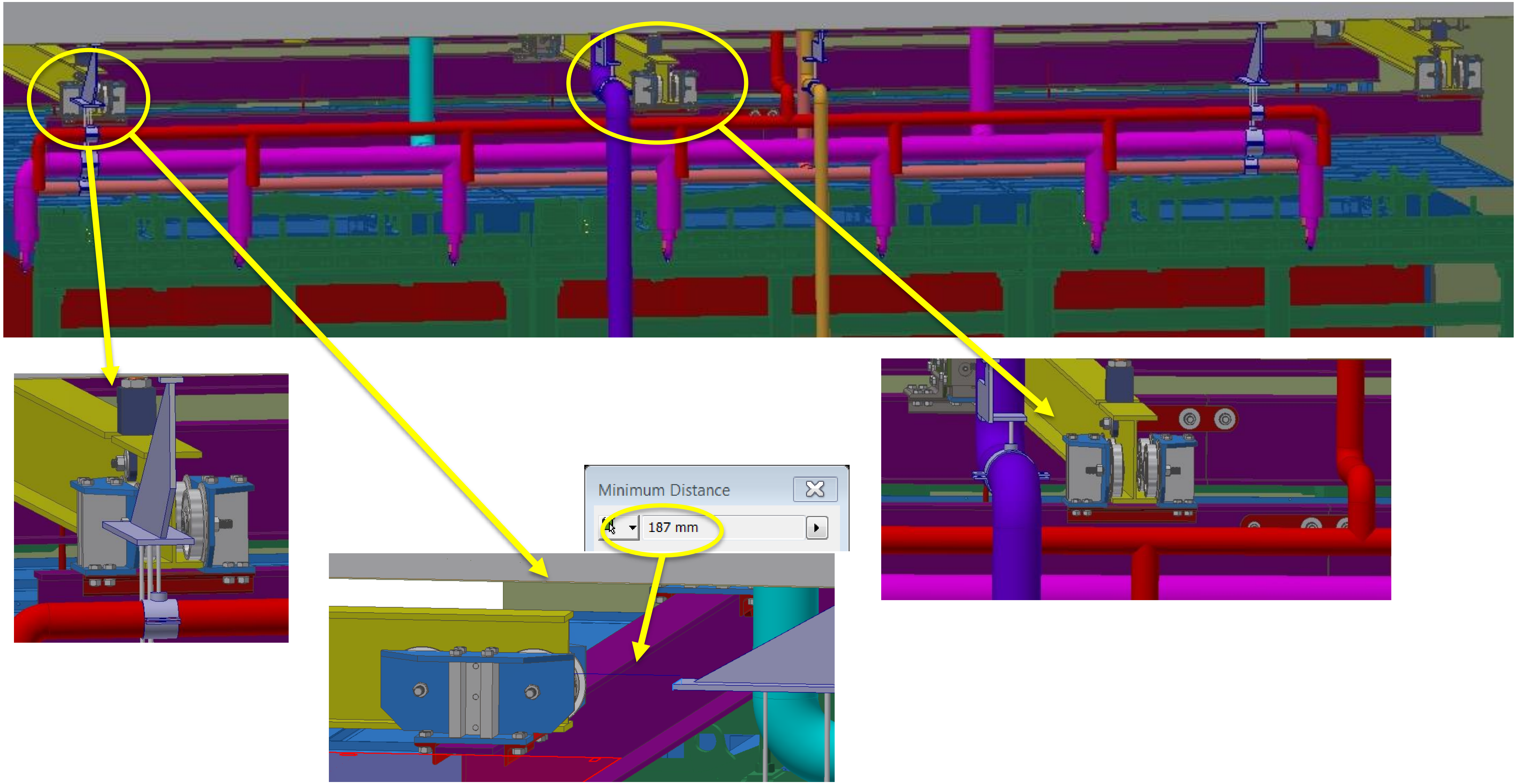
- The TPC elements will be moved into the cryostat using commercial trolleys. Views of the CPA supported from the commercial trolleys are shown in the two upper figures.
- When the elements reach their correct position on the bridge beam, their loads will be transferred to stationary support points. Views of the stationary support are shown in the lower two figures.
- The APAs will also be transferred to stationary points (not shown).

Internal cryogenic piping



- The internal cryogenic piping enters the cryostat through a series of feed thrus in the roof along the Jura side.
- The figure shows an end view of the upper corner in the X direction.
- This view shows the proximity of the piping and supports to the DSS and cryostat.

DSS to cryogenic piping proximity



Summary

- The overall integration of ProtoDUNE SP, the cryostat, TPC and the DSS is well advanced.
- 3D solid models are being integrated from multiple sources.
- The interfaces with the DSS, both external and internal, are well understood.
- The design of each of these interfaces is being finalized and the appropriate analysis and documentation is being produced.

Back up slides