Status of Beam Window for protoDUNE

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Constraints for placing the beam windows:

Beam line constraint:

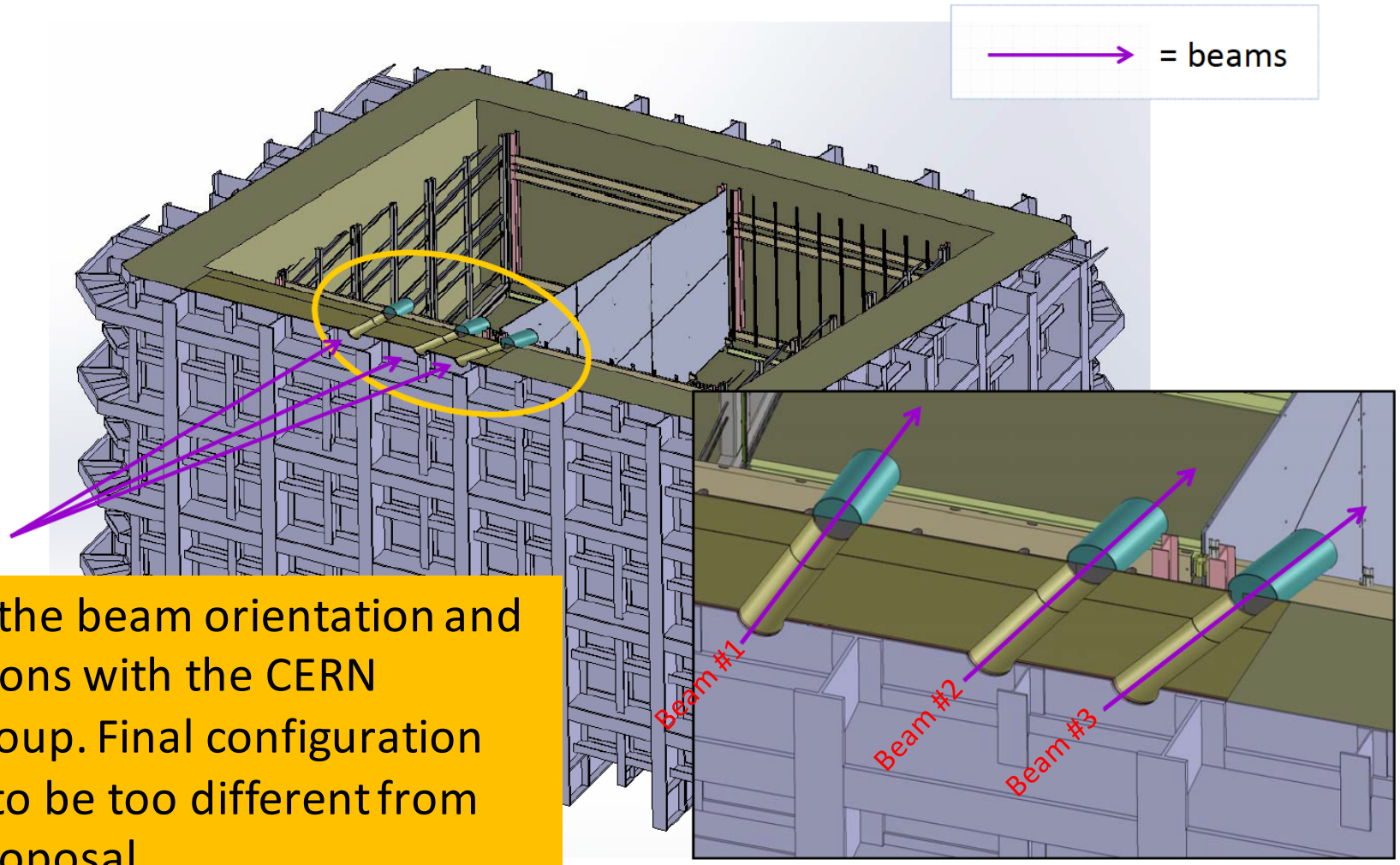
- Last dipole magnet is located about 8.5m from the front face of the cryostat
- Lateral offset of the magnet is ~1735mm (+y) from the center of the cryostat
- Vertical height of the magnet is ~8.6m from the floor of the pit
- Magnet bending: +/- 5˚ for 7 GeV/c; +/- 12˚ for 3 GeV/c

Requirements:

- Three beam windows (see Paola's slide):
  - Window 1 -> Mostly contain high energy shower in drift volume # 1, optimal for long (3.6m) drift
  - Window 2 -> Fully contain shower and CPA crosser
  - Window 3 -> Mostly Contain high energy shower in drift volume # 2, for long (3.6m) and short (2.2m) drift configurations
- Beam angle (horizontal x-y plane) > 3˚ w.r.t. x-axis
- Vertical beam dip angle ~10˚ (shower crosses near the center of TPC)

- Avoid interfering with the warm support structure I-beams

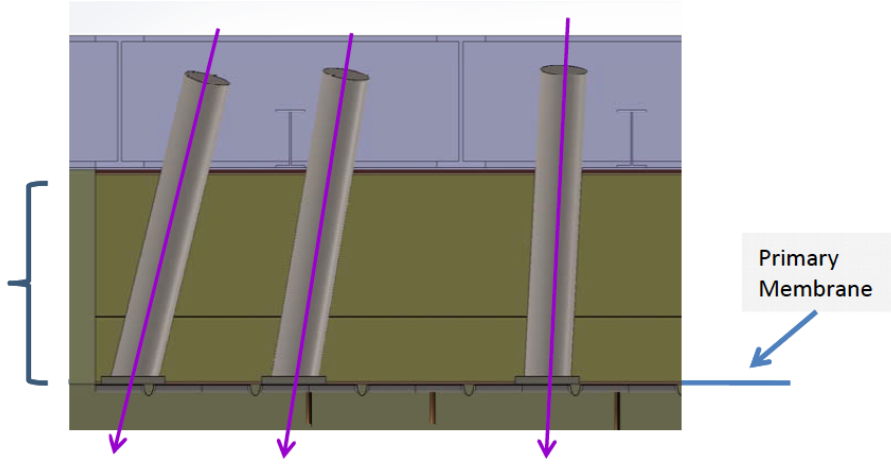
Beam Window Locations and Orientations



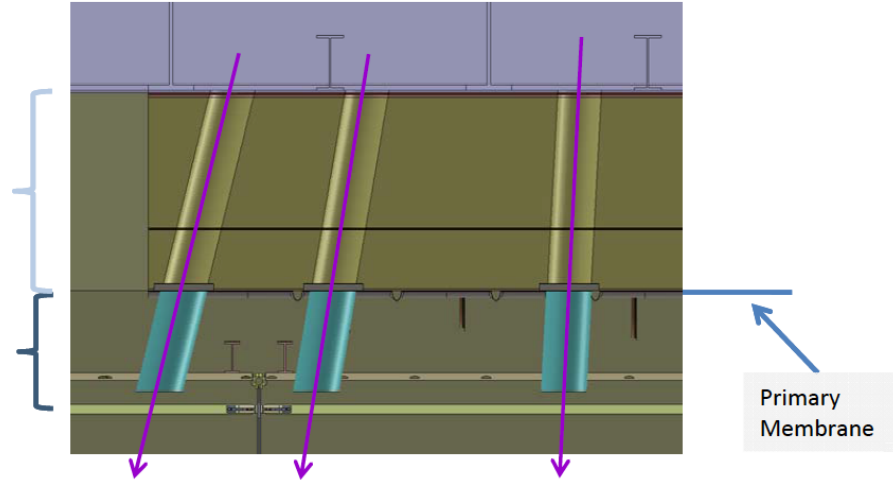
Still tweaking the beam orientation and window locations with the CERN accelerator group. Final configuration will likely not to be too different from the current proposal

Dual Beam Window Subsystems

System 1
Cryostat Wall Subsystem



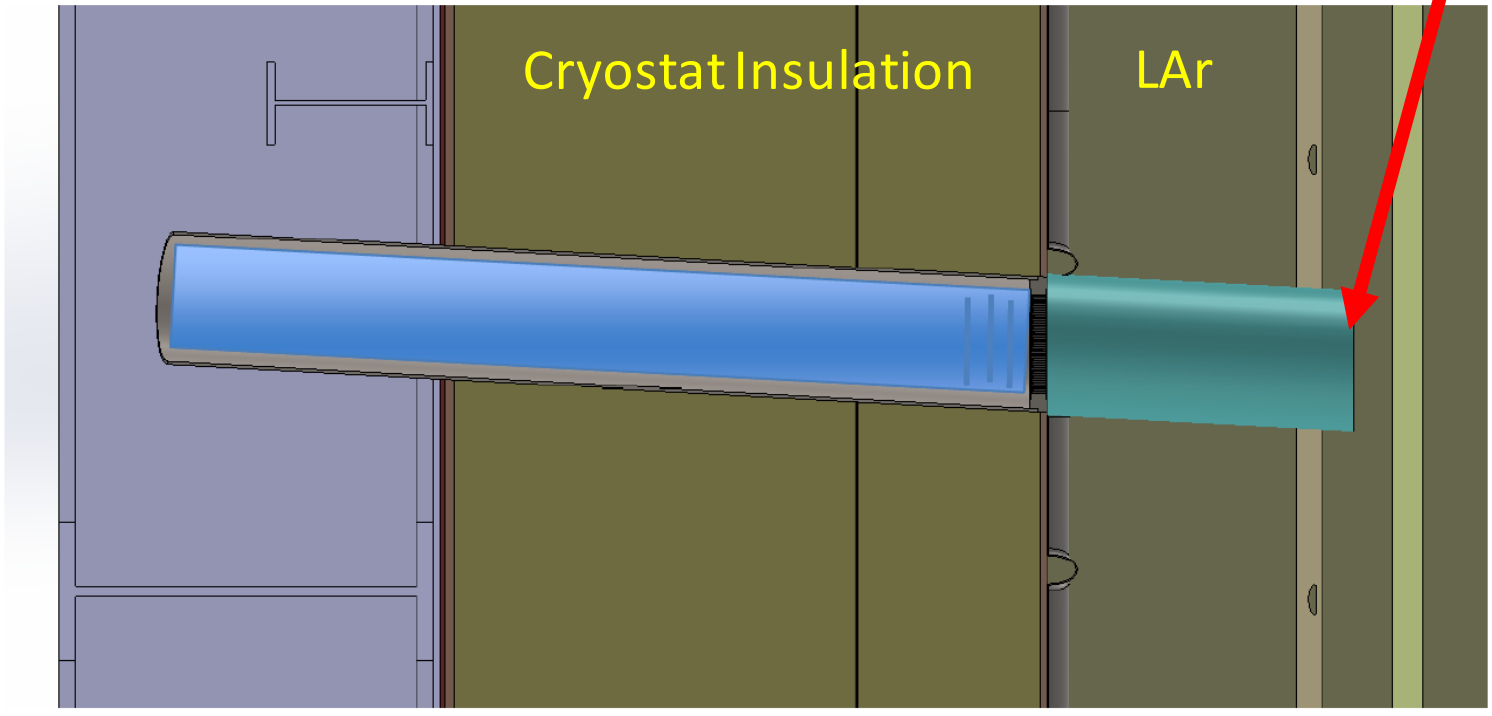
System 2
Cryostat Interior Subsystem



Beam Window Design: Dry Nitrogen System

Cryostat Wall | Cryostat Interior

Inner plug extends ~5cm beyond the field cage



Other beam window (system 1) options:

- Dual layer vacuum jacket vessel (think of a fancy thermal bottle with one end open. Expensive and not a viable option
- Extension of the vacuum beam pipe. Avoid ”breaks” at the end of the beam pipe and the start of our beam window:
    - Beam window would be under vacuum (share the same vacuum as the accelerator beam pipe)
    - More involved operation when moving beam pipe from one window position to another

Preference is to decouple the beam pipe with the beam window:

- Ease of operation when moving beam pipe
- Allow easy access to beam window area for installation of tracking detector inside the beam window

Issues for the Inner Plug

- In-Chamber: Membrane “anchor point” or “touch point” if allowable, per GTT
- Window location and corrugation locations are independently designed, but have an interface and potentially increase the length of LAr.