Central Detector Integration and Installation

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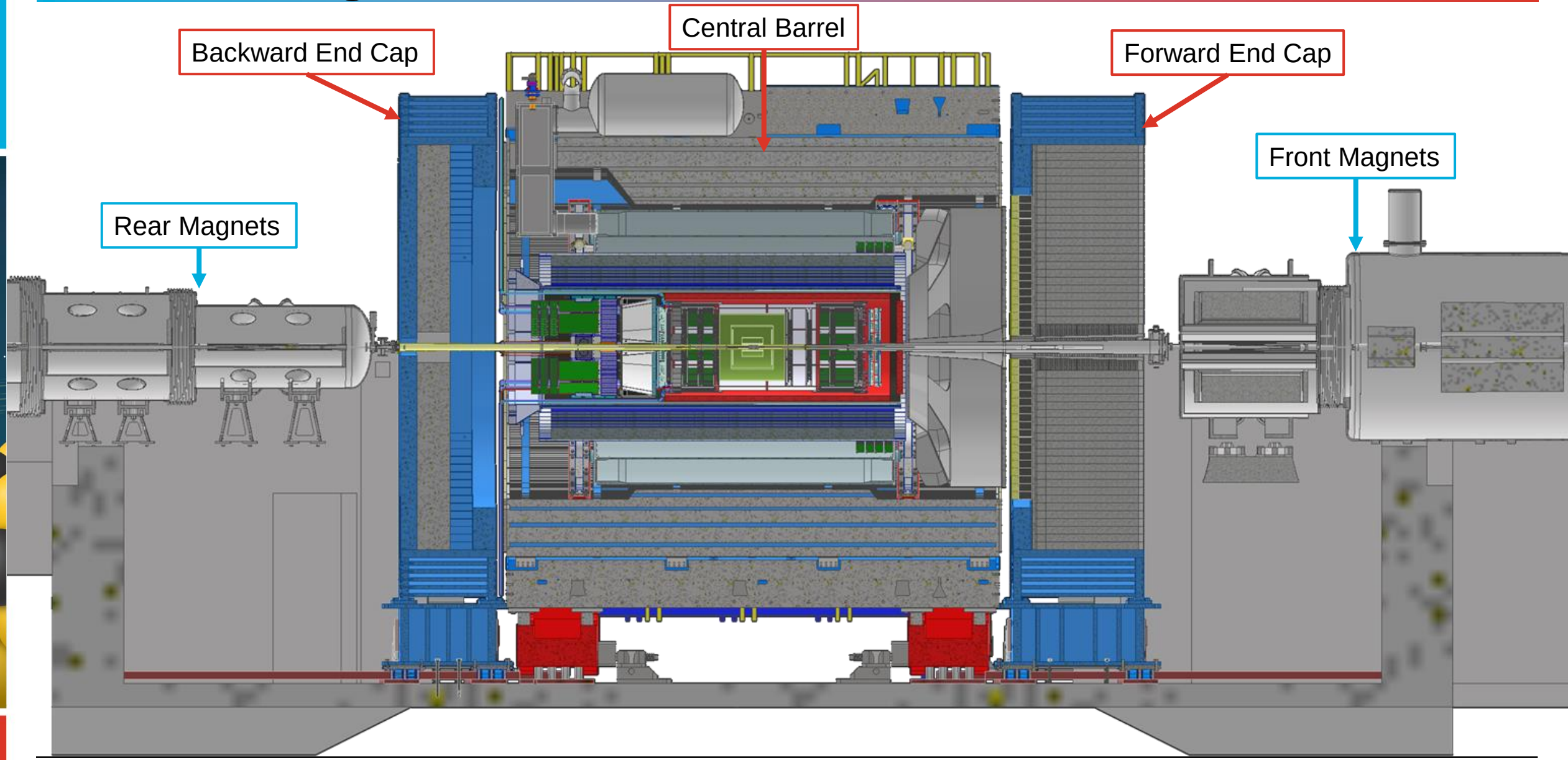
Contributions from Rahul Sharma & Roland Wimmer

ePIC Collaboration Meeting, Integration and Installation

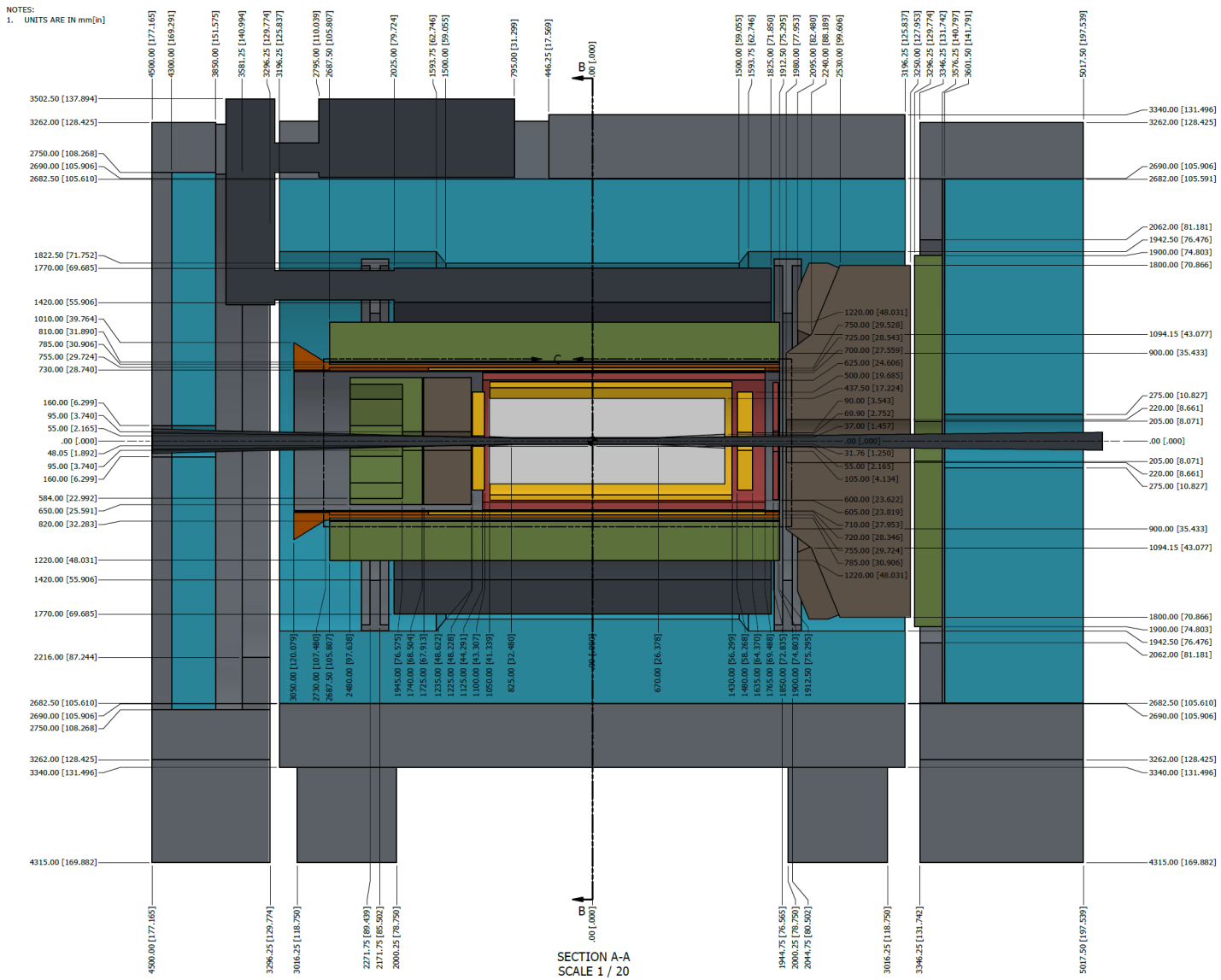
July 15th, 2024

Electron-Ion Collider

Overall Integration

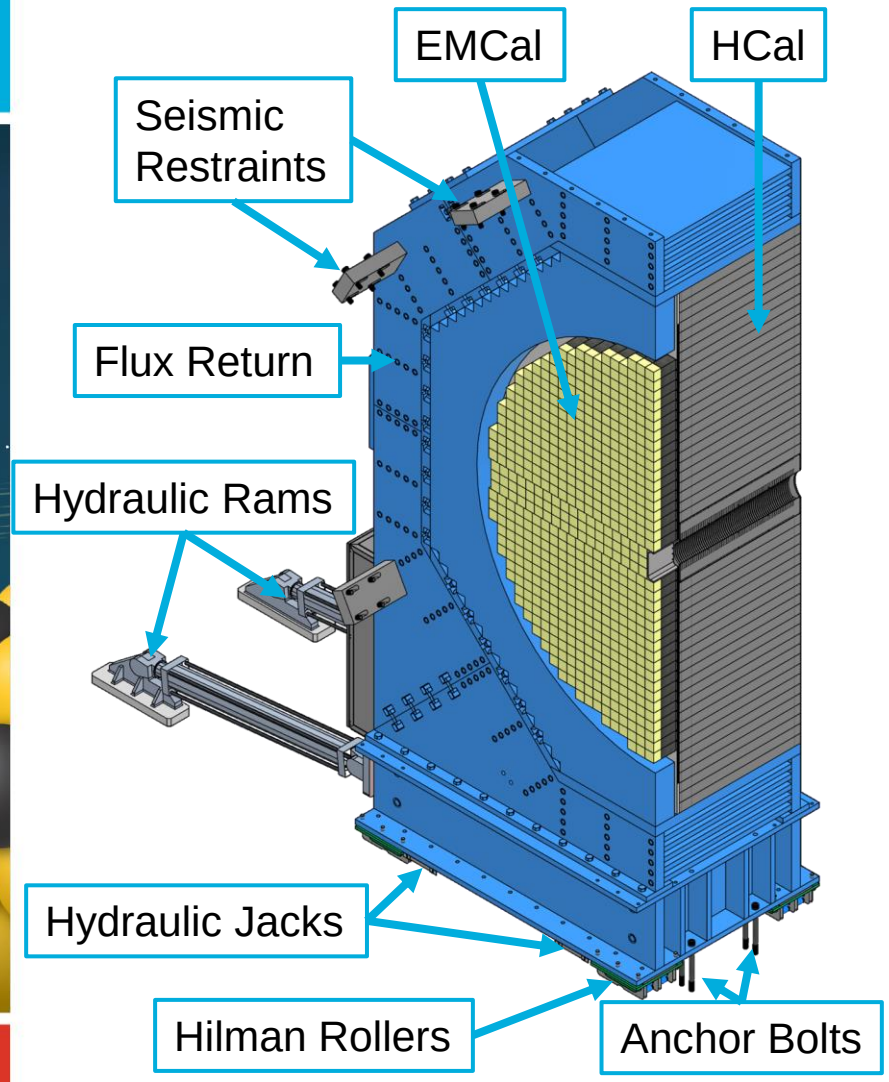


Envelope Drawing



Endcap Supports and Components

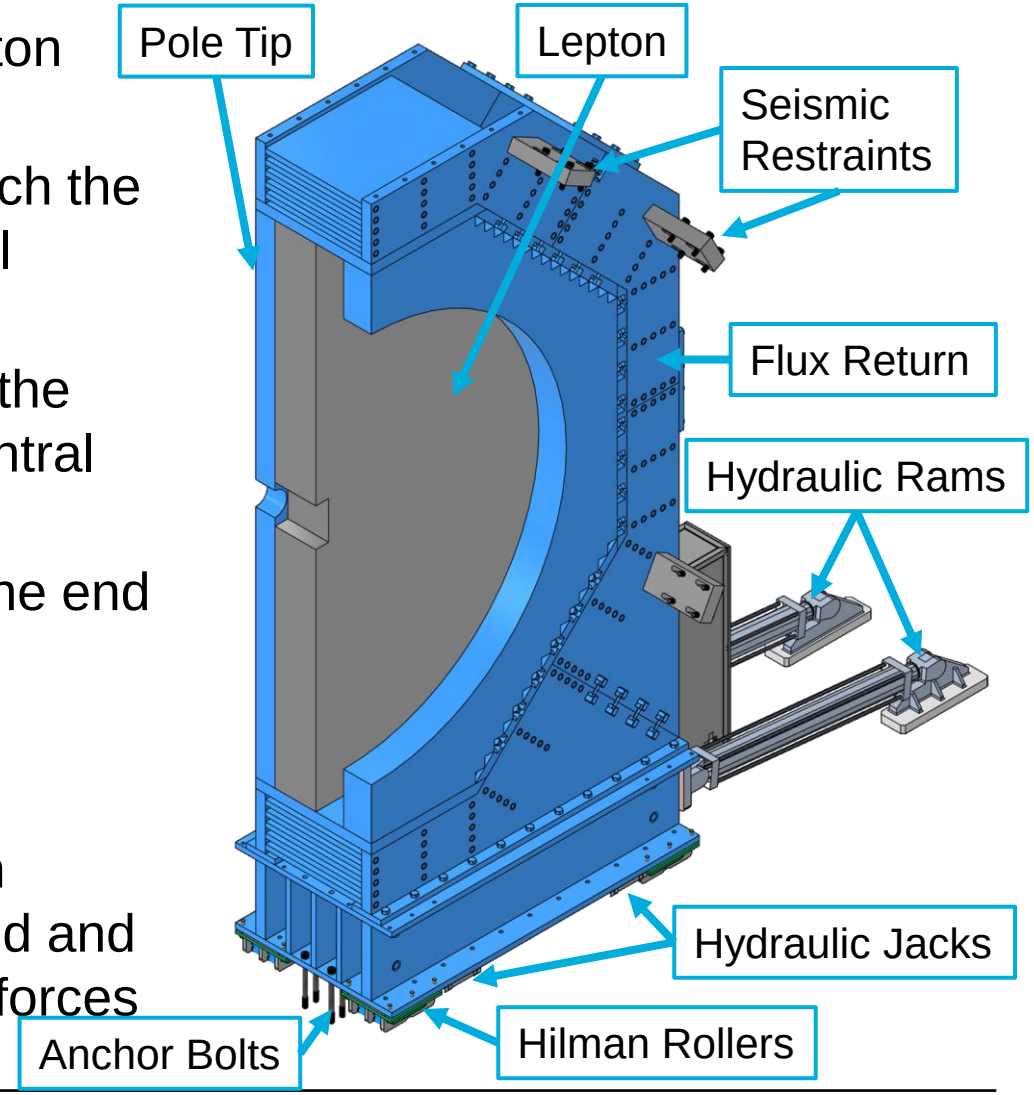
Forward Endcap (FE)
11’x7’x25’, 200ton



Description

- HCal, EMCal and Lepton are end cap detectors
- Seismic restraints attach the end caps to the central barrel
- Anchor bolts tie down the end caps when the central barrel isn’t available
- Hydraulic rams push the end caps on Hilman rollers
- Hydraulic jacks lift the detector for alignment
- Pole tip and flux return minimize the fringe field and balance the magnetic forces

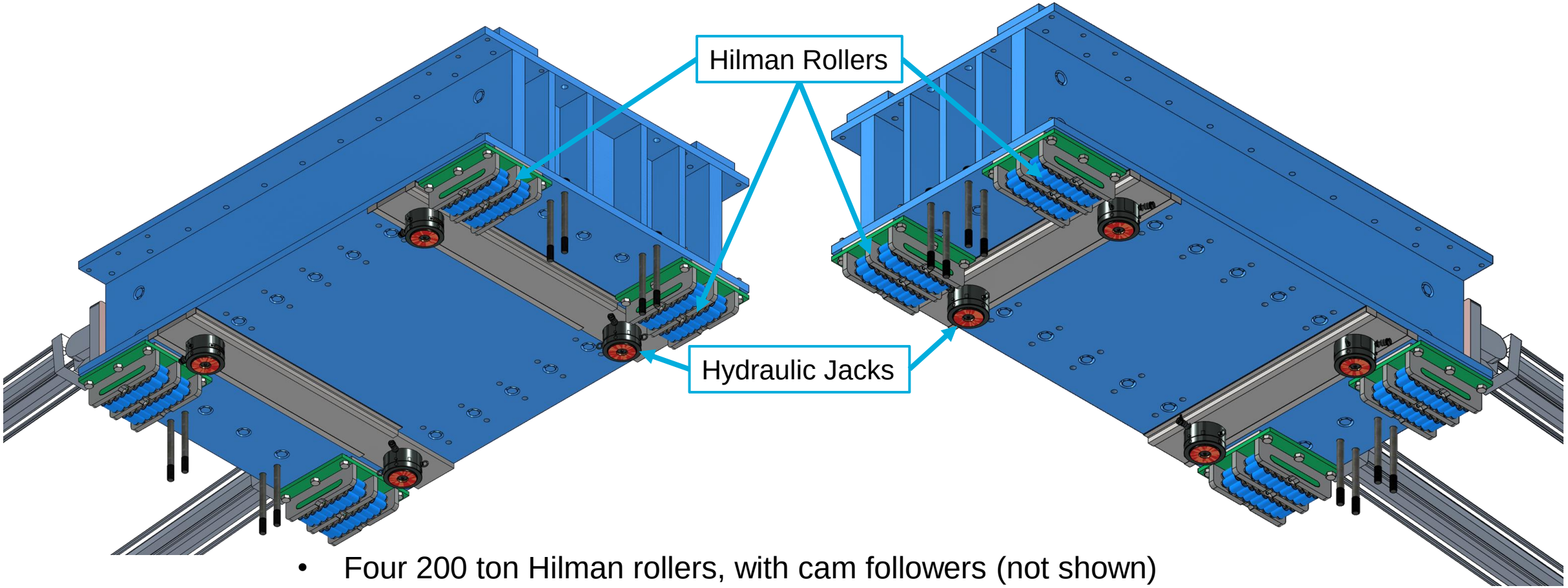
Backward Endcap (BE)
11’x5.5’x25’, 130ton



Endcap Supports and Components

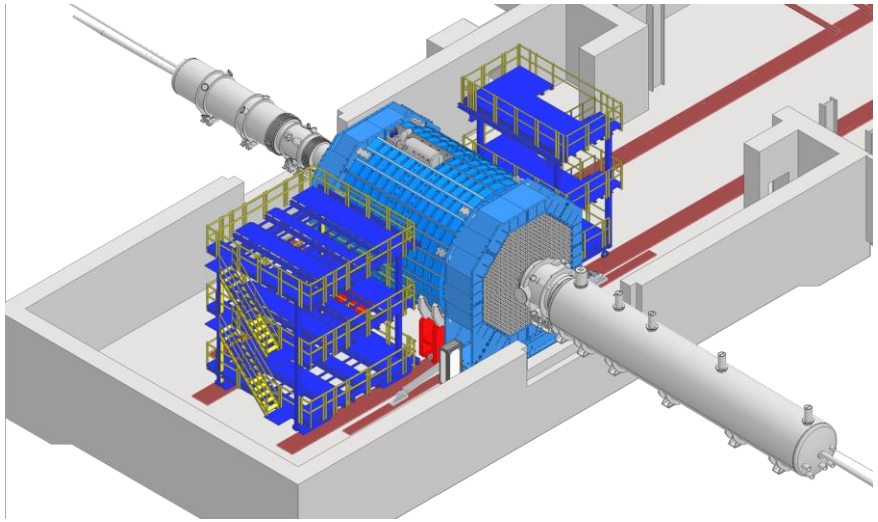
Forward Endcap (FE) – Base

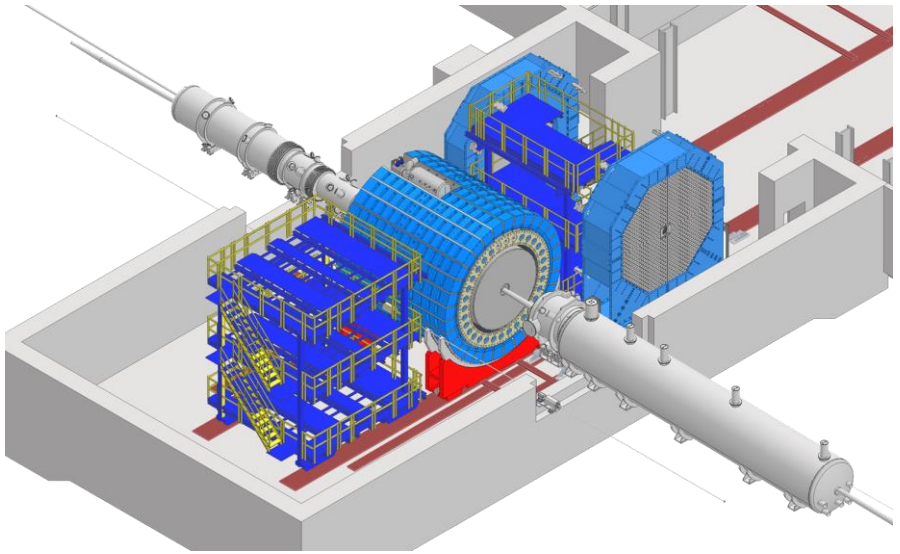
Backward Endcap (BE) – Base

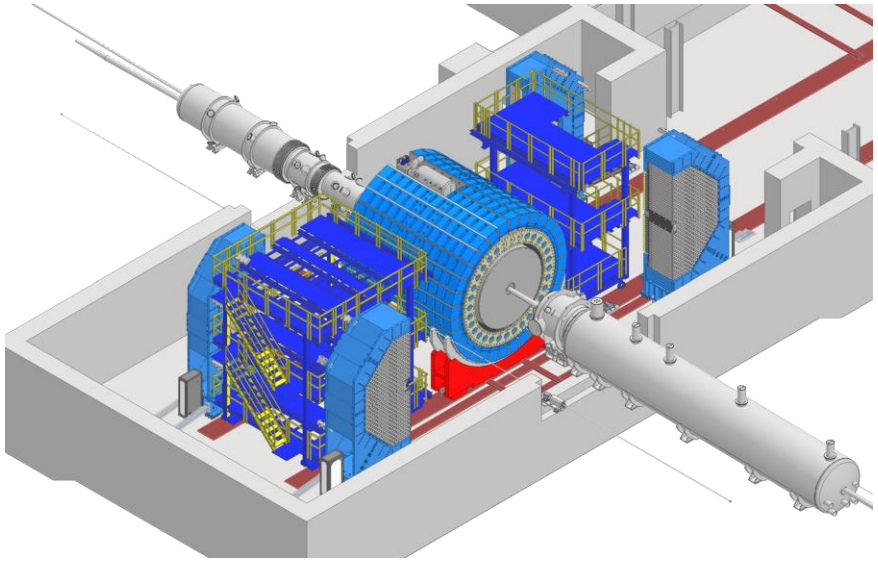


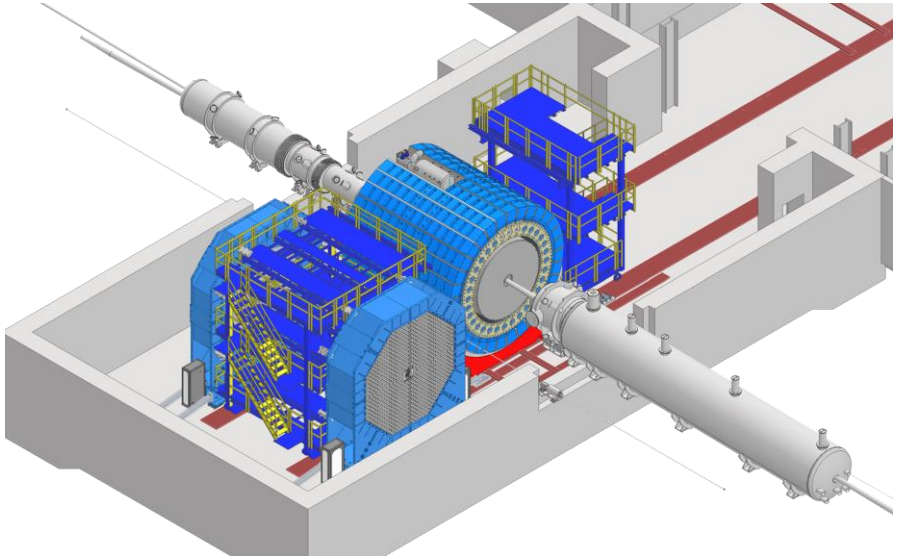
- Four 200 ton Hilman rollers, with cam followers (not shown)
- Four 250 ton 2” stroke Enerpac hydraulic locknut jacks
- Shim between the rollers and base, leaving the endcaps on the rollers
- Jacks could be removable and reused for all endcaps

Endcap installation and Choreography





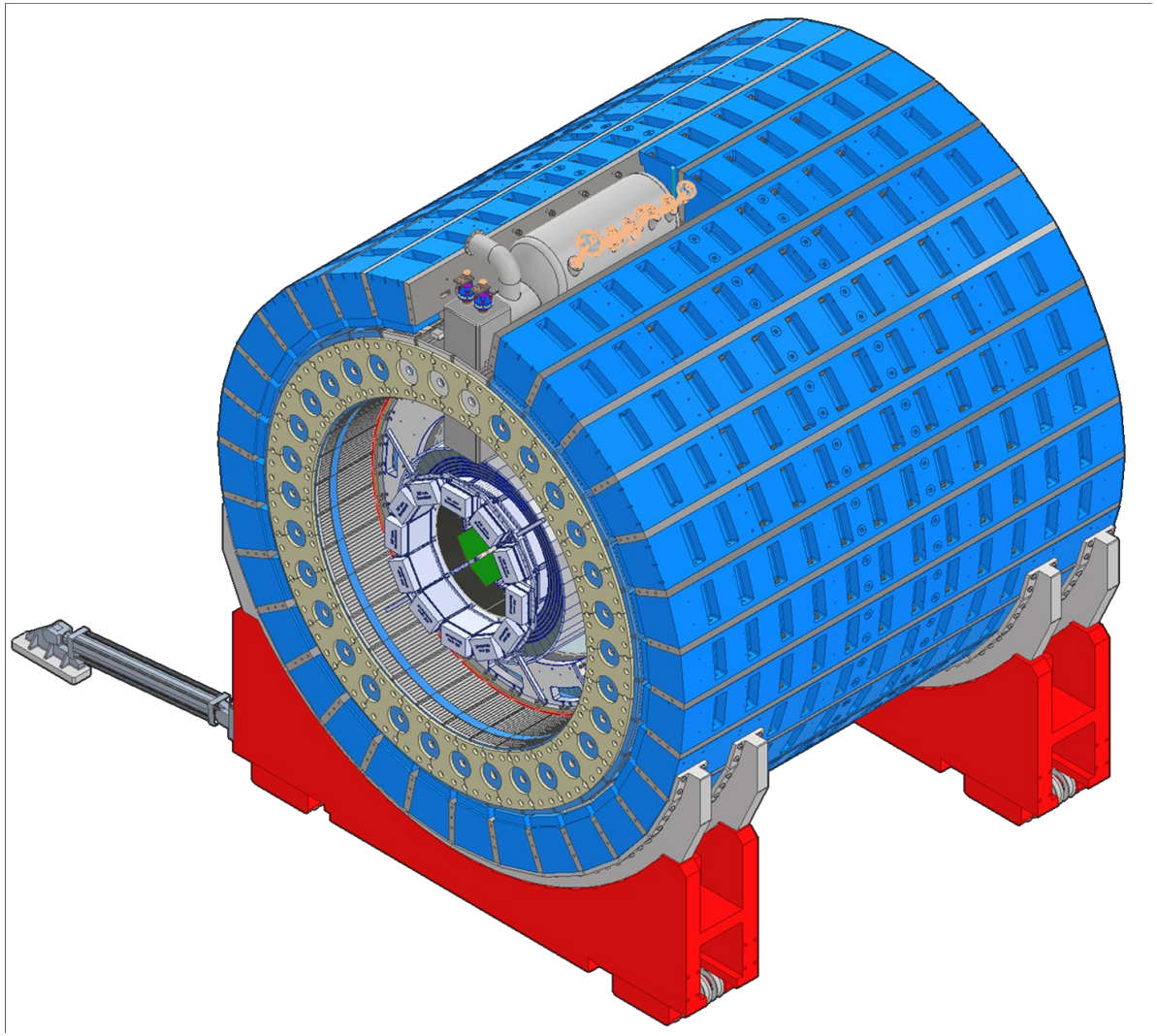




- The maximum extent of the positions needed for installation, integration and maintenance
- Making all options viable gives us significant flexibility
- Allows for beam pipe bake-out, inner detector removal and
- Platforms need to be trimmed to allow endcaps to move past them
- Need to work on services layout for endcap and central barrel detector to make sure they can pass each other smoothly without damage

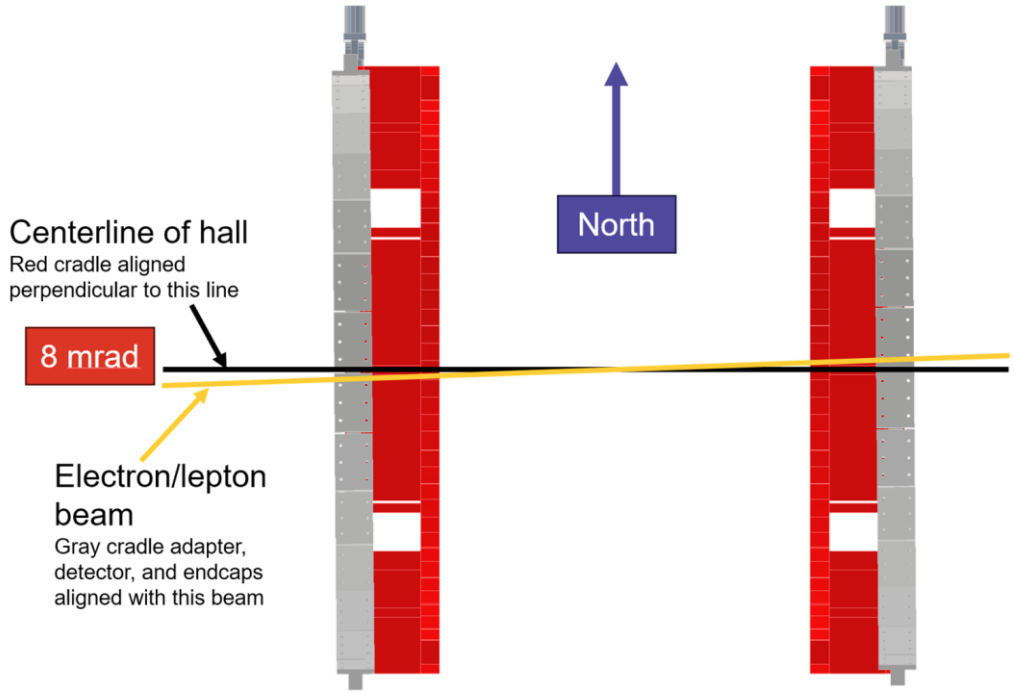
Cradle and flux return bar overview

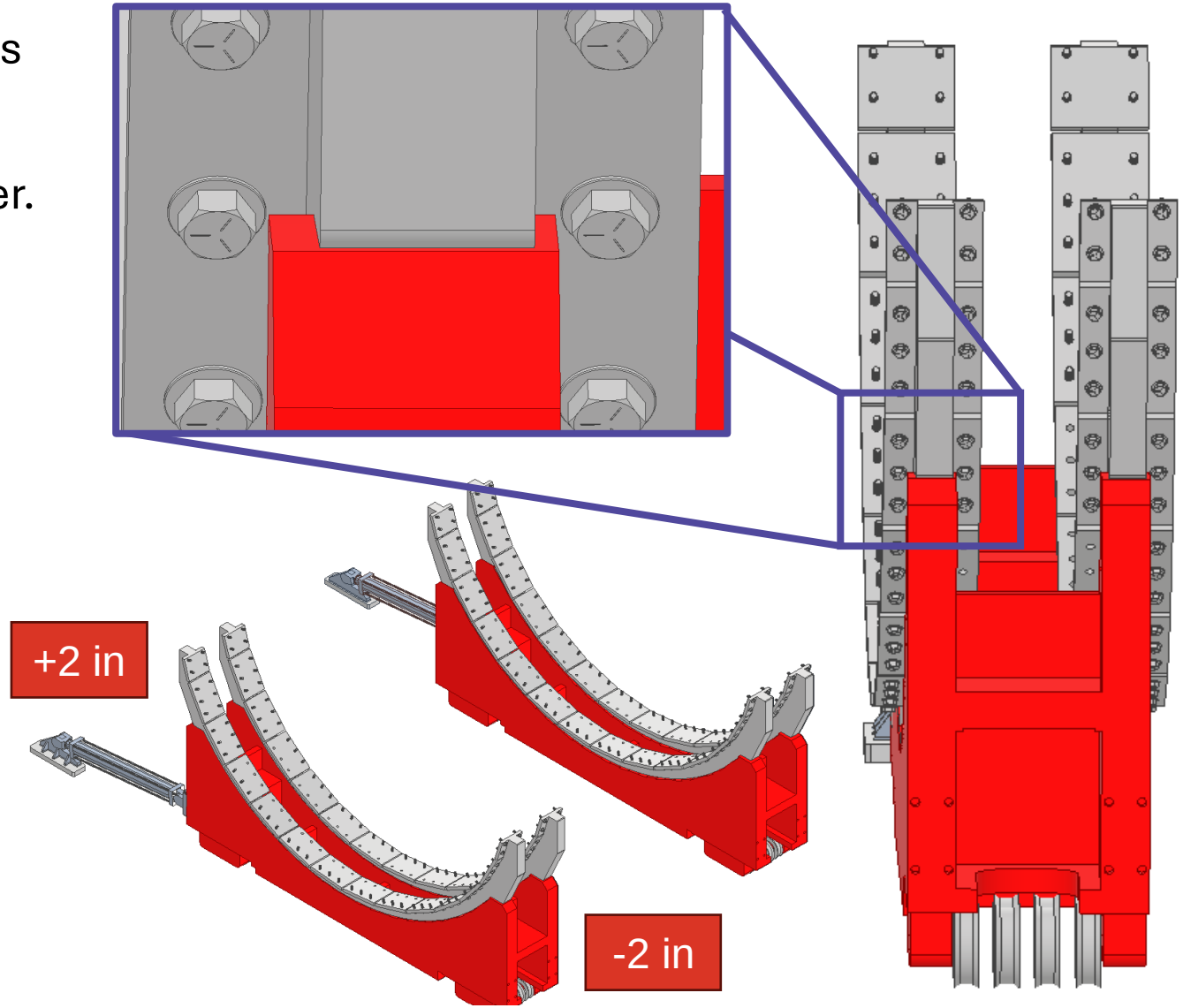
- We plan to reuse the cradle assembly and flux return bars from the STAR detector, located at BNL.
  - Cost and time savings by reusing steel.
- Will reuse all 30 STAR flux return bars and get two new half-length flux return bars fabricated.
- The EIC detector diameter is different than the STAR detector diameter. We want to maintain a continuous ring without air gaps, so we need to design and fabricate spacers to go between each flux return bar.
  - 31 full length spacer bars and one half-length spacer bar.
  - We plan to maintain the same material specs for the spacers as for the flux return bars unless cost or timing are prohibitive.
- The outer HCAL will be reused from sPHENIX and will attach to the flux return bars.
  - HCAL sectors will require a new mounting method – more on this later.
- Flux return bars, along with the entire detector, to be rotated 8 milliradians (0.458 degrees) to align with the lepton beam.
  - Will be taken up by cradle design - more on this later.



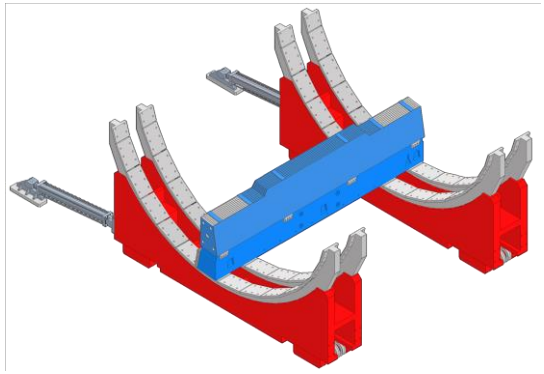
Flux Return and HCal Support, Cradle to Adapters Connection

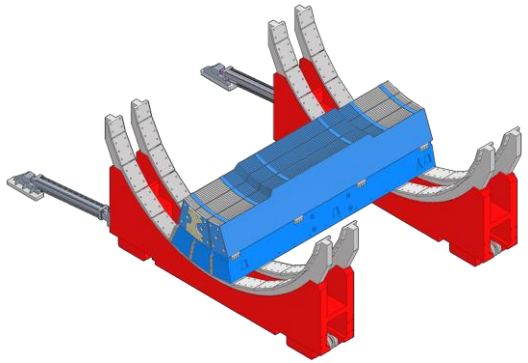
- Adapters will be welded to the cradles.
- 8 mrad rotation between bottom of adapters and cradle.
- The rotation causes an approximately ± 2 in shift from one end of the cradles to the other.
- Having the rotation built into the adapters allows for the bolt pattern on the flux return bars to be consistent from bar to bar.

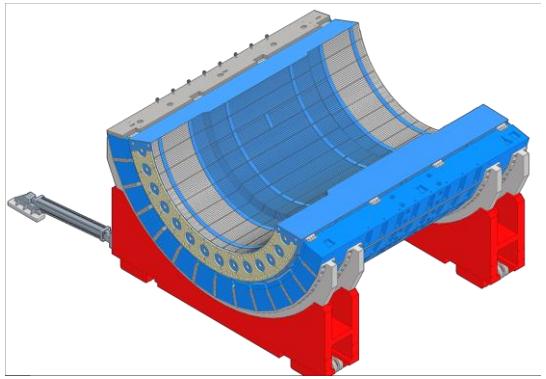




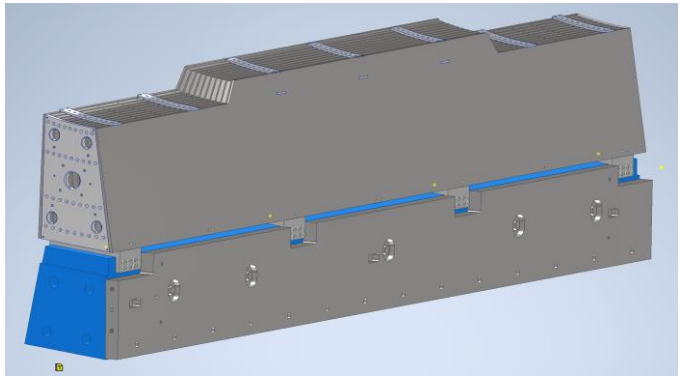
Flux Return and HCal Installation

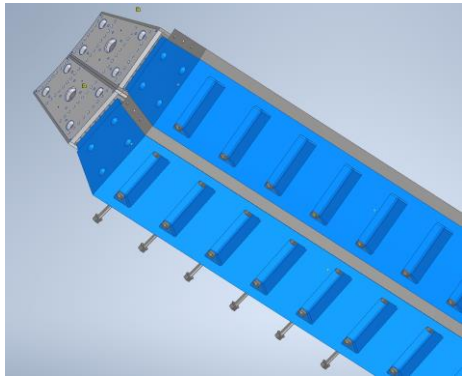


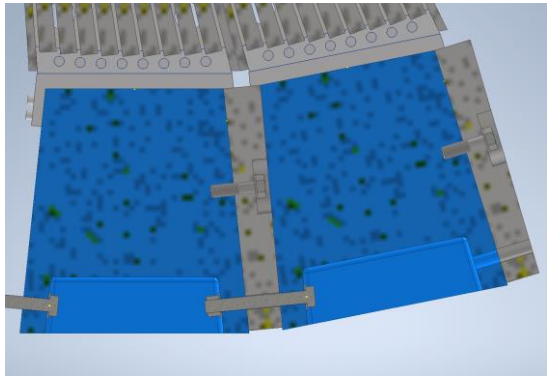




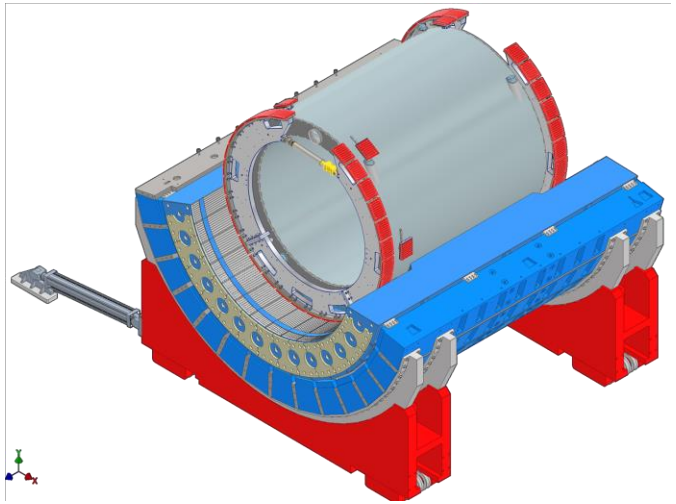
- We will build up one subassembly at a time consisting of a flux return bar, flux return bar spacer, and HCAL sector up to the 3 and 9 o'clock positions. After the 3 and 9 o'clock positions, the flux return bars + spacer subassemblies will be separate from the HCAL sectors.
- Each subassembly will then be added to the larger assembly.
- Possibly use SPHENIX HCAL Lift-Rotate plate design from sPHENIX to rotate each assembly during installation.
- Start from bottom center of the cradle, work upward, and shim as needed.
- Bolts between bars tightened with hydraulic tensioners. Bolts to cradle tightened with hydraulic torque wrenches.
- At top of HCAL ring and flux return bar ring, use a hydraulic spreader to allow final bar(s) to be installed.

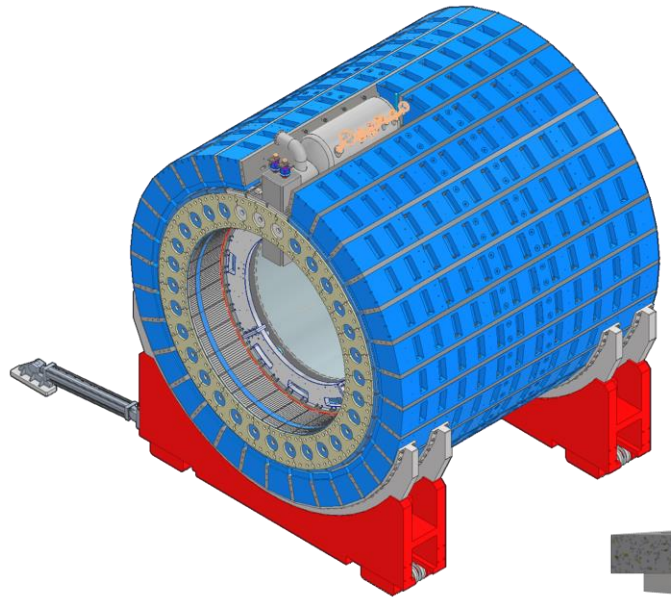


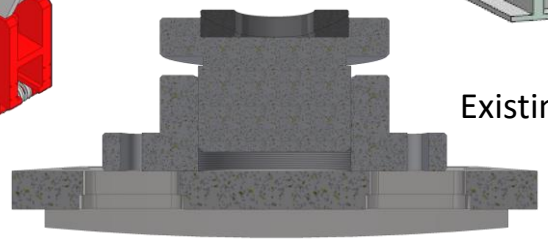




Magnet Support



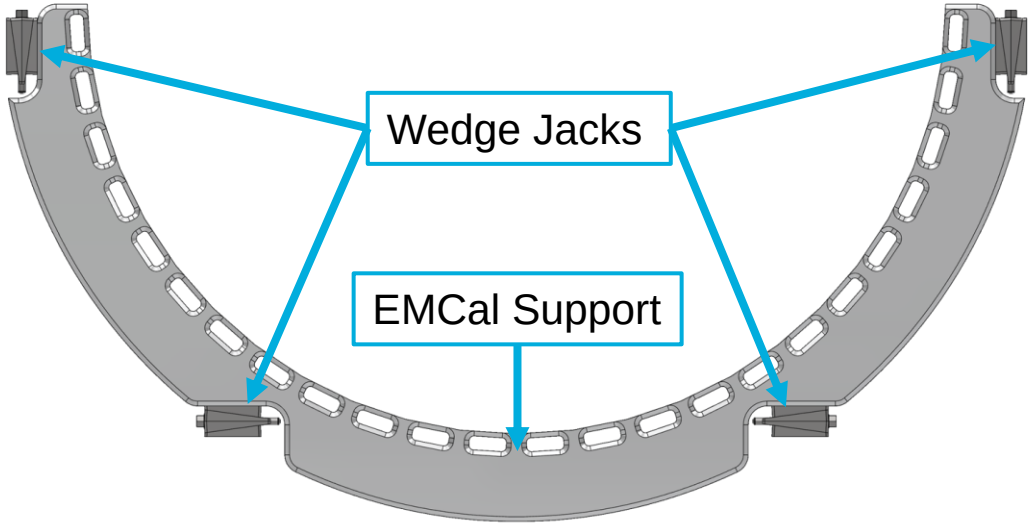


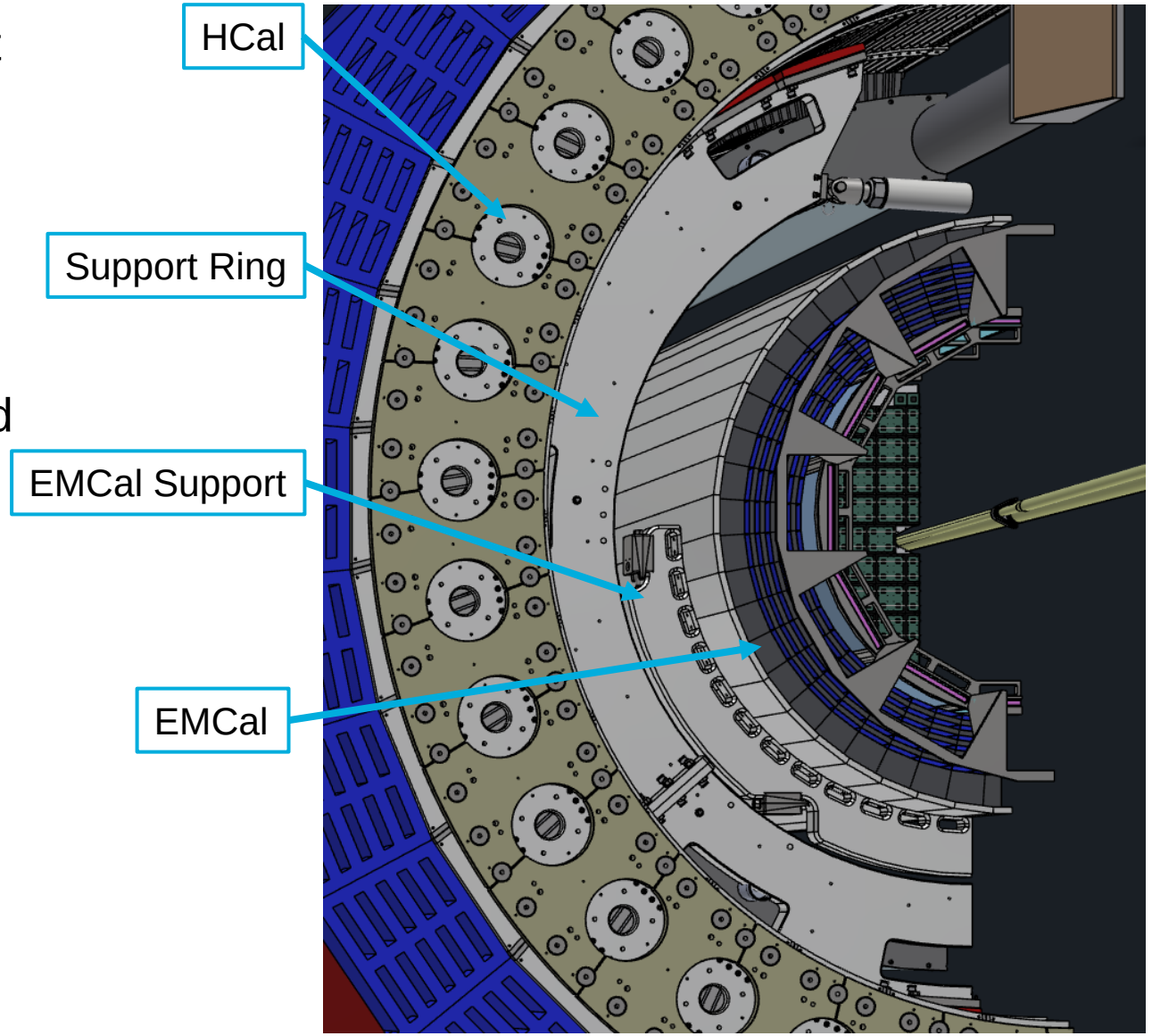


Magnet installation

Barrel EMCal Support

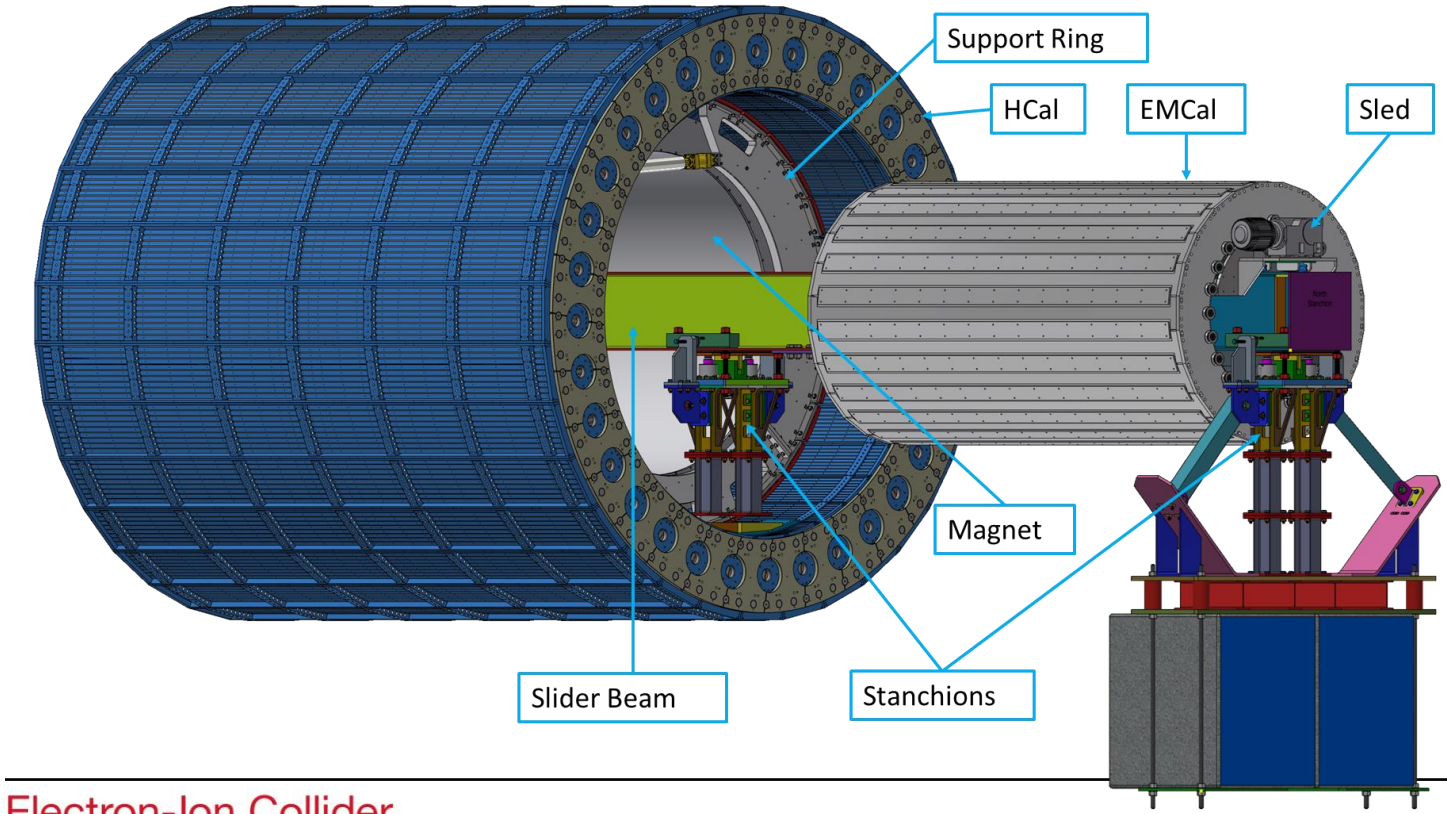
- EMCal supported off of existing HCal support rings
- Additional support added in between support rings and EMCal to take up radial gap
- Leveling wedge jacks and shimming used to adjust EMCal position
- Need to extend EMCal strongback on forward side to reach support rings





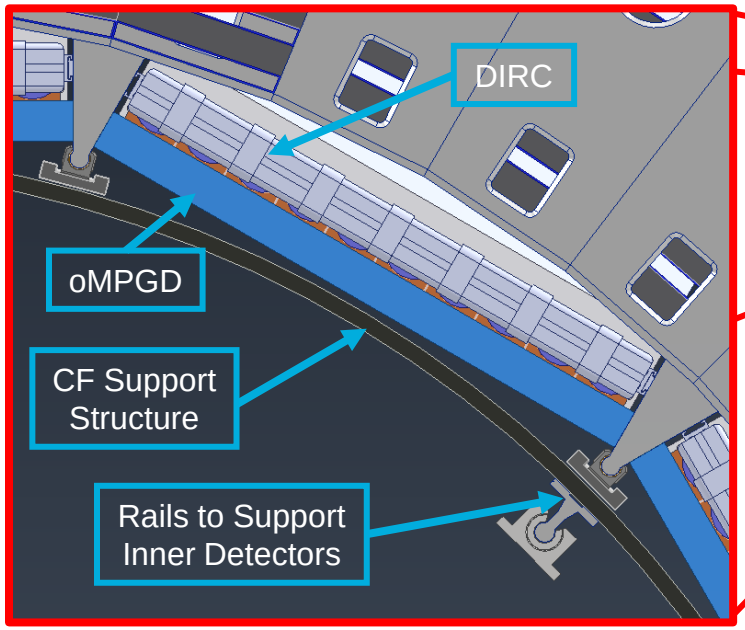
Barrel EMCal Installation

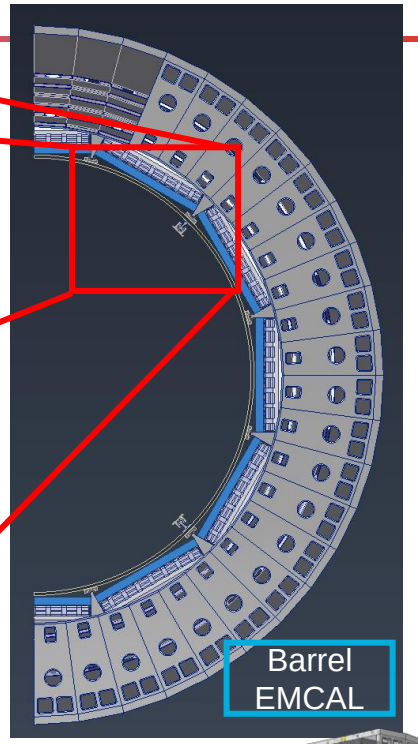
- Use existing installation tooling from sPHENIX that was used to install inner HCAL
- Assemble barrel EMCal on sled, A-frames and section of I-beam
- I-beam is inserted into the HCal and supported on stanchions
- Barrel EMCal is rolled in via the sled on the I-beam
- Barrel EMCal is attached to the support rings
- I-beam and stanchions are removed

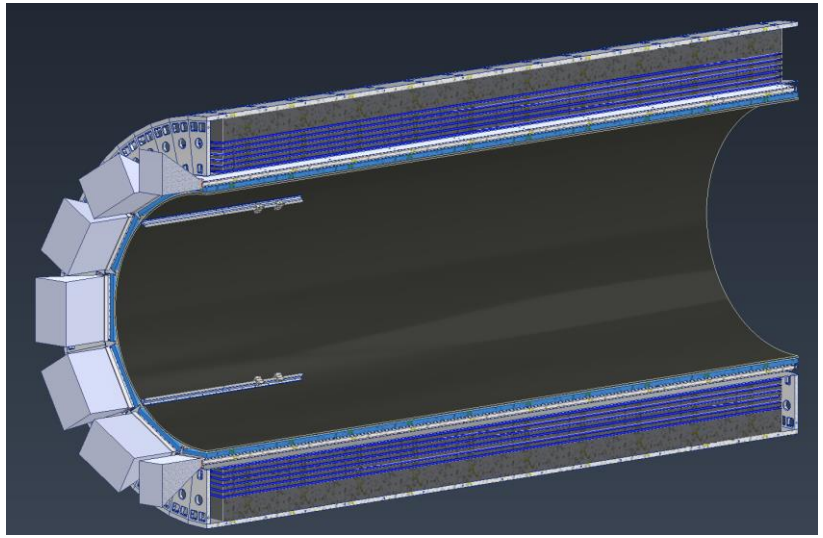


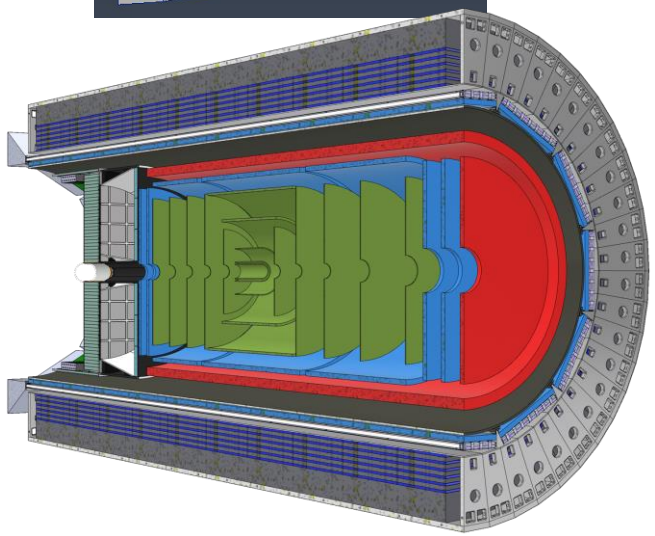
DIRC and oMPGD Support

- Use barrel EMCAL for support of inner detectors
- Outer MPGDs and DIRC will be nested in the area between rails.
- A carbon fiber support structure attached to the barrel EMCal will support all the inner detectors
- Separate Rails will be used for EEEMCal and pfRICH installation
- Gaps between the EEEMCal and the carbon fiber cylinder will allow for inner services to be brought out



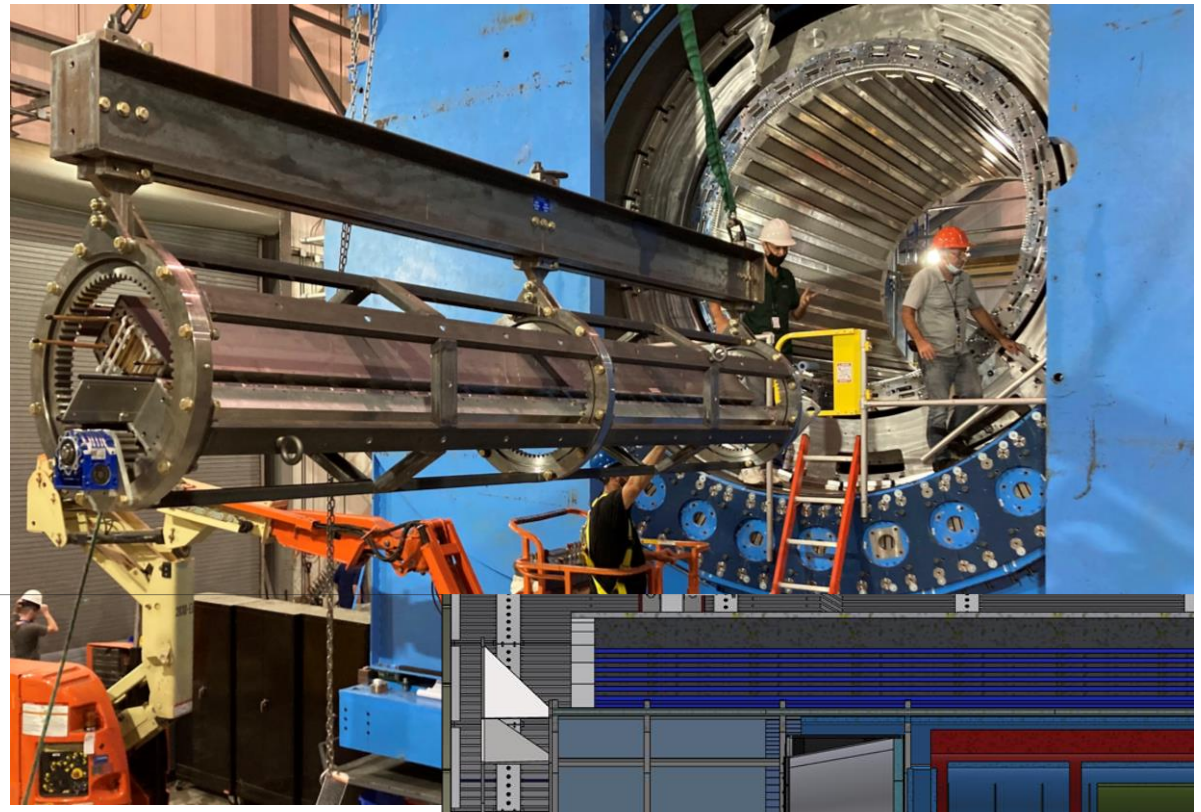


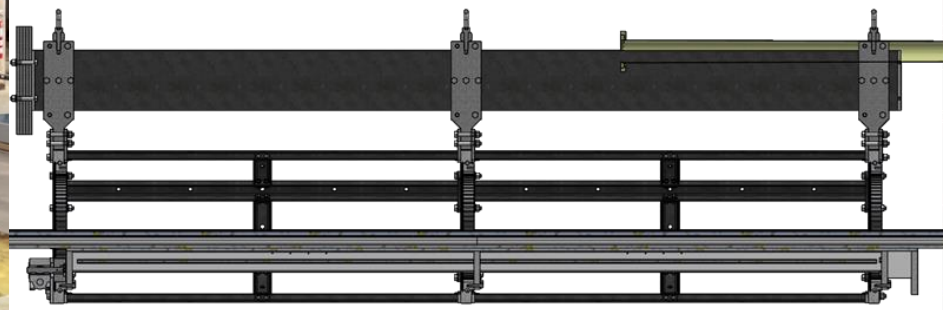


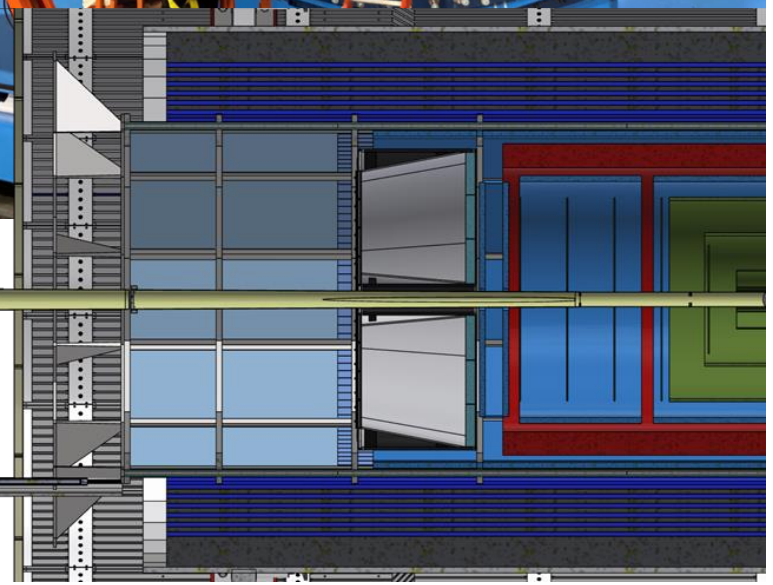


DIRC and oMPGD Installation

- Use existing installation tooling from sPHENIX that was used to install EMCal
- Tooling can rotate around axis parallel to Z
- Tooling has rails that allow for detectors to slide on and off of
- Detectors pulled in from far side

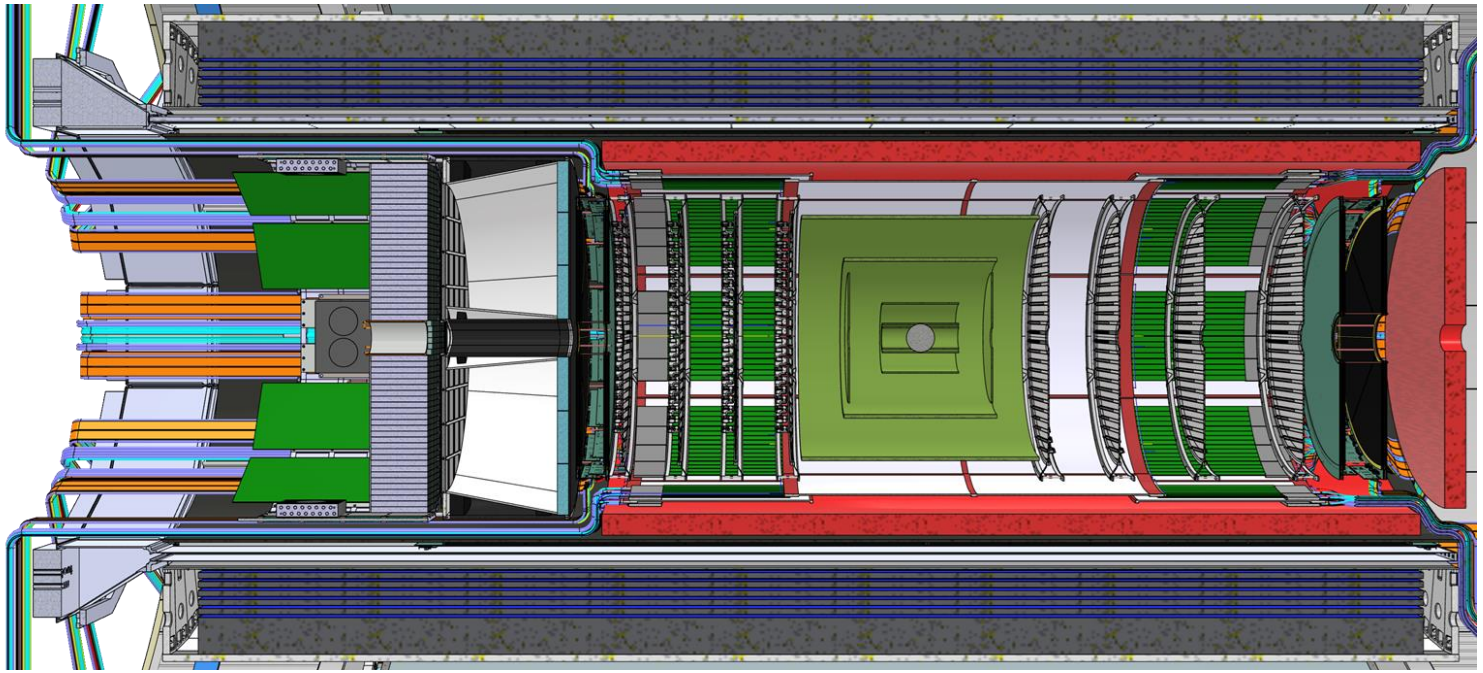


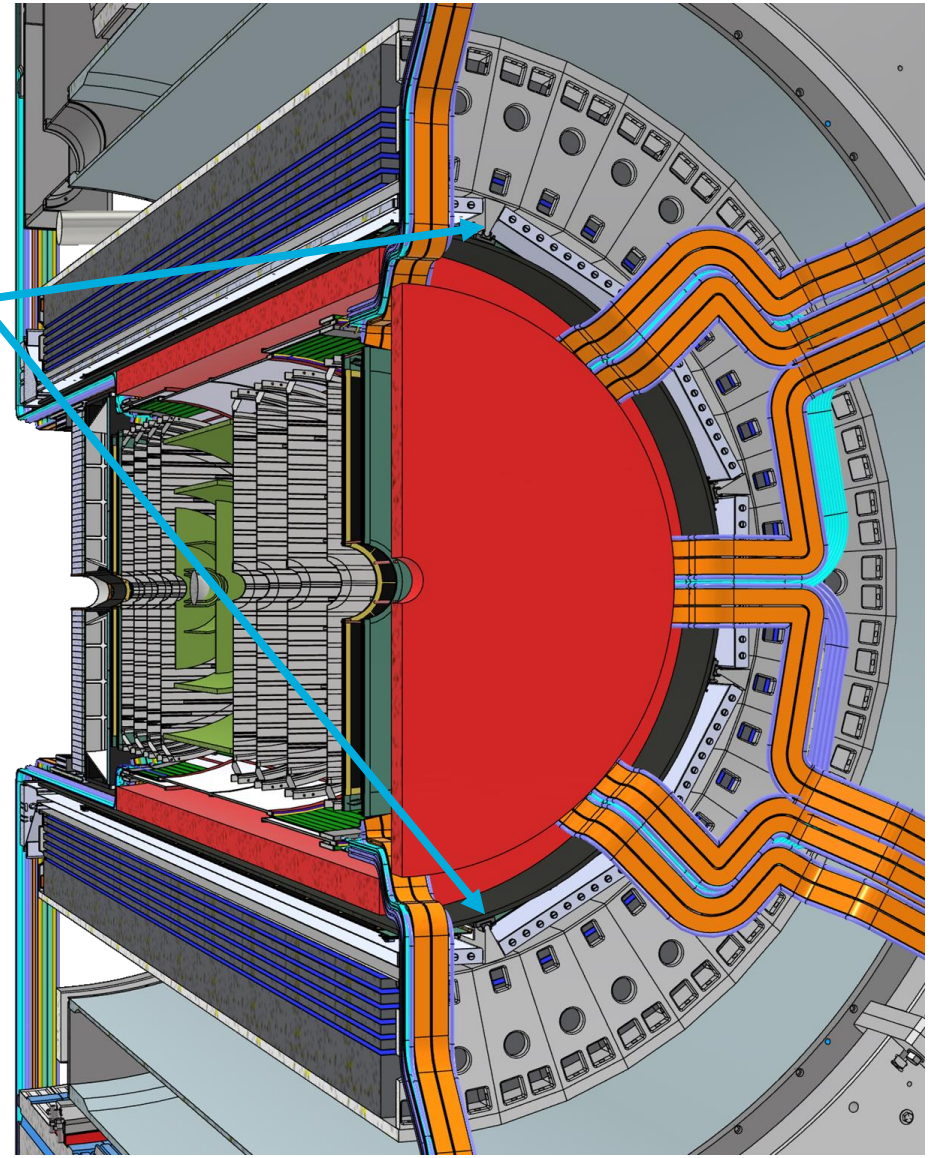




TOF, iMPGD and SVT Support – Conceptual

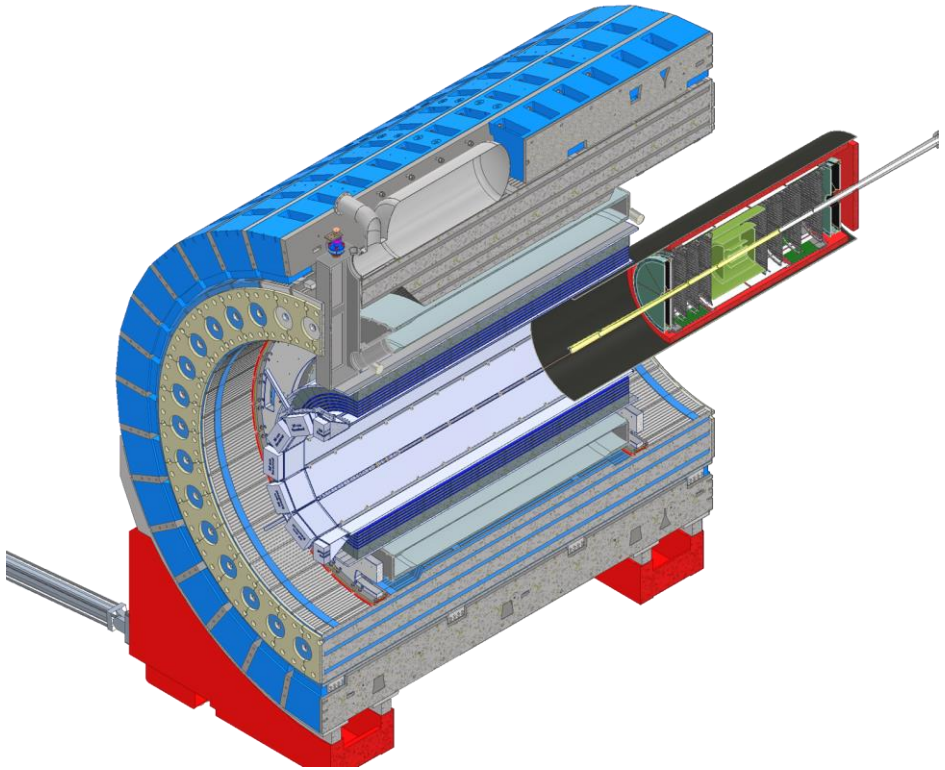
- Rails support the carbon fiber cylinder which holds the TOF, iMPGD, SVT and BP
- Load transferred to barrel EMCal
- Alignment mechanisms need to be designed and incorporated
- Is there sufficient clearance for adjustment/alignment?

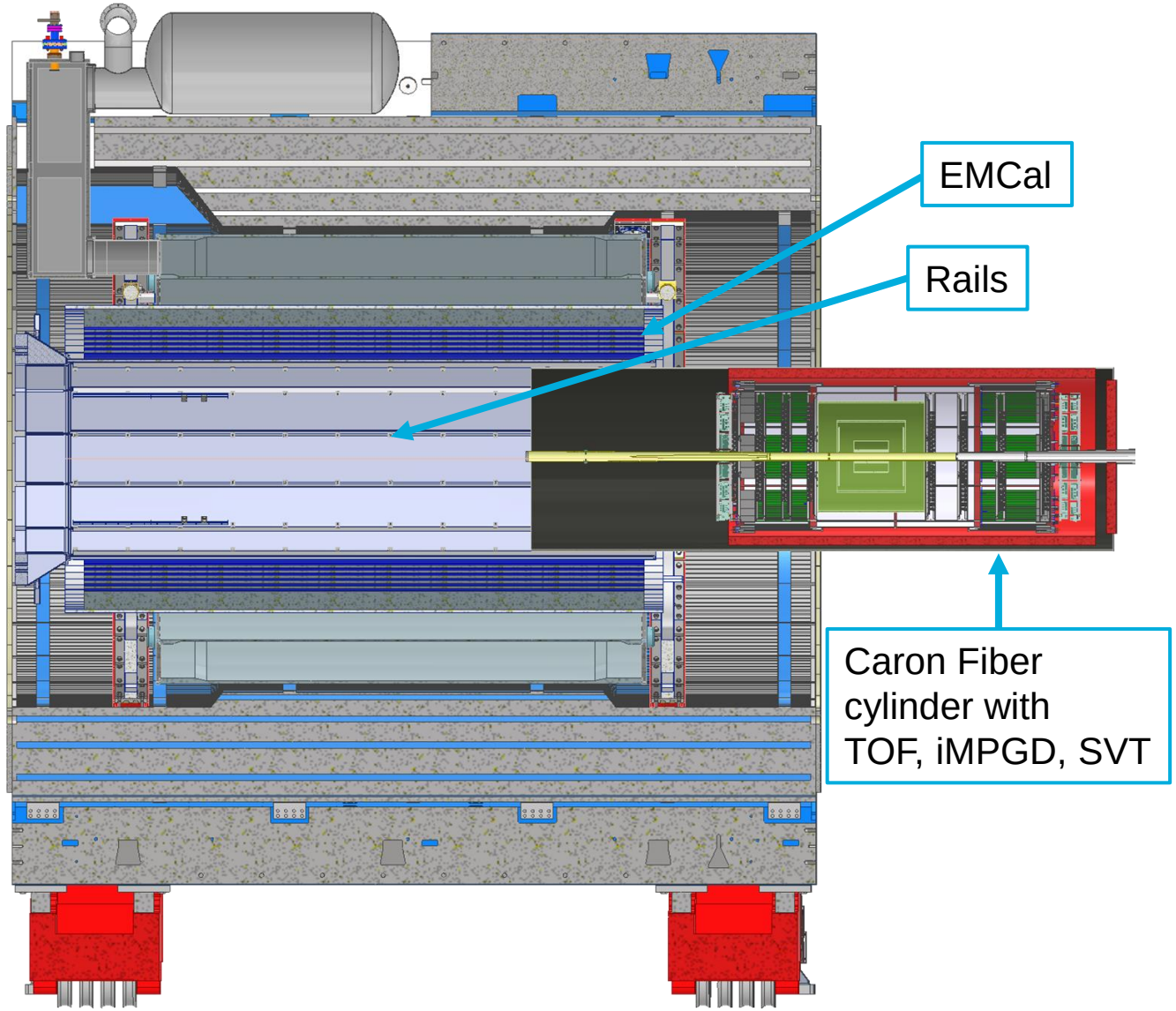




TOF, iMPGD and SVT Installation – Conceptual

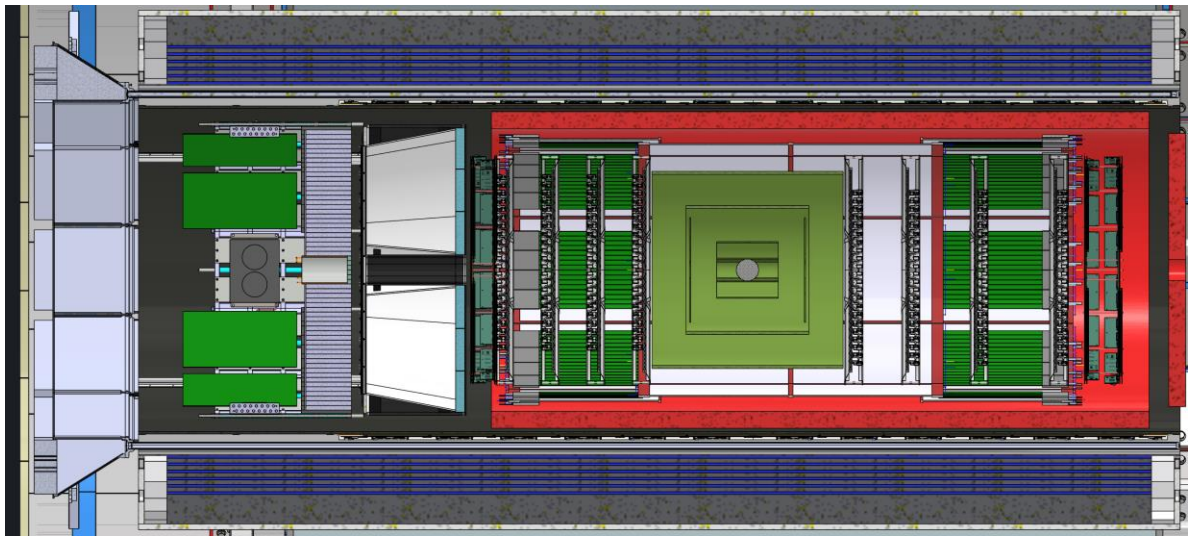
- The TOF, inner MPGD, SVT and BP will be assembled together prior to installation
- Will be installed as one unit on rails supported from the EMCal
- Lifting tooling needs to be designed

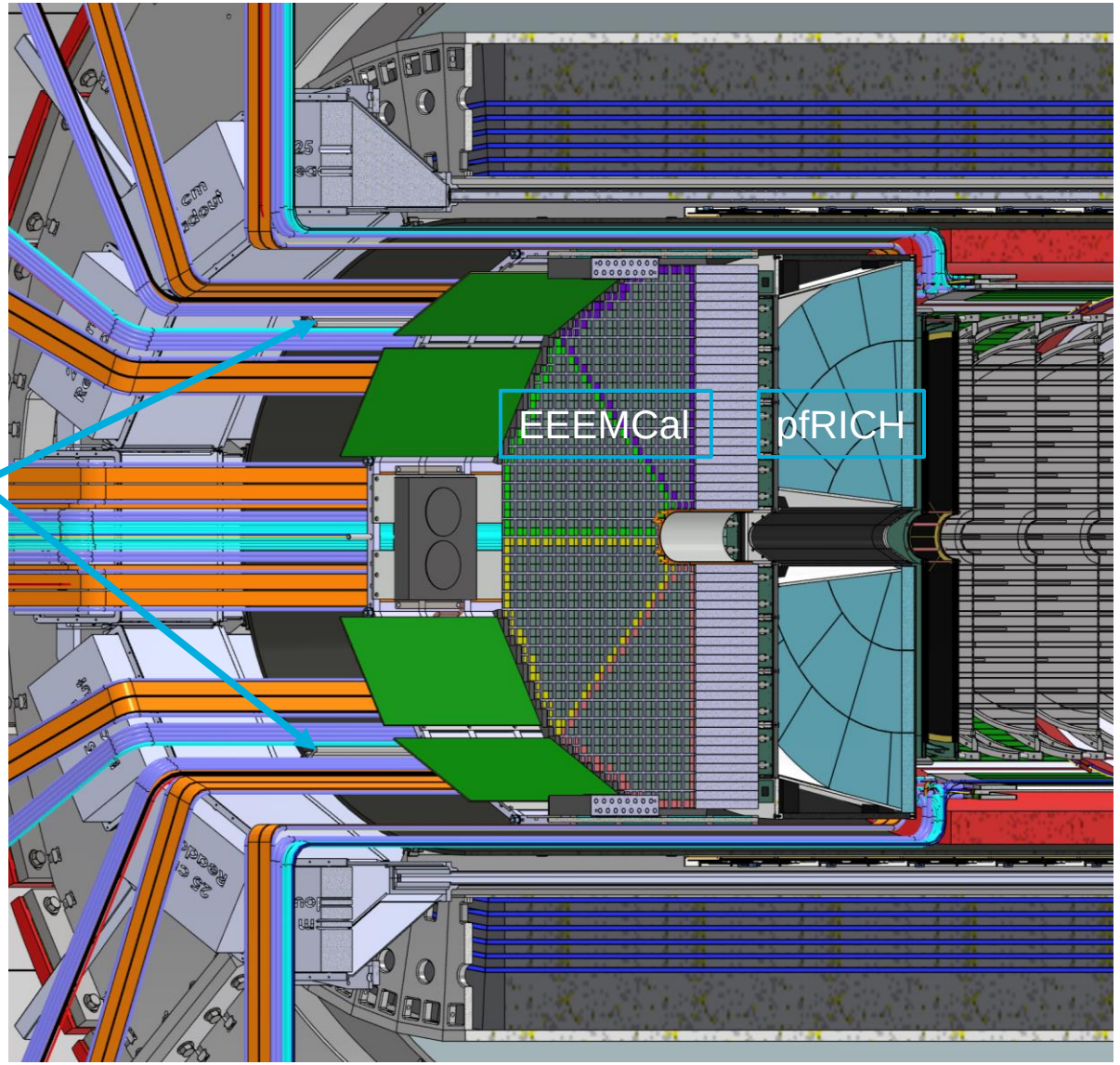




pfRICH and EEEMCal Support – Conceptual

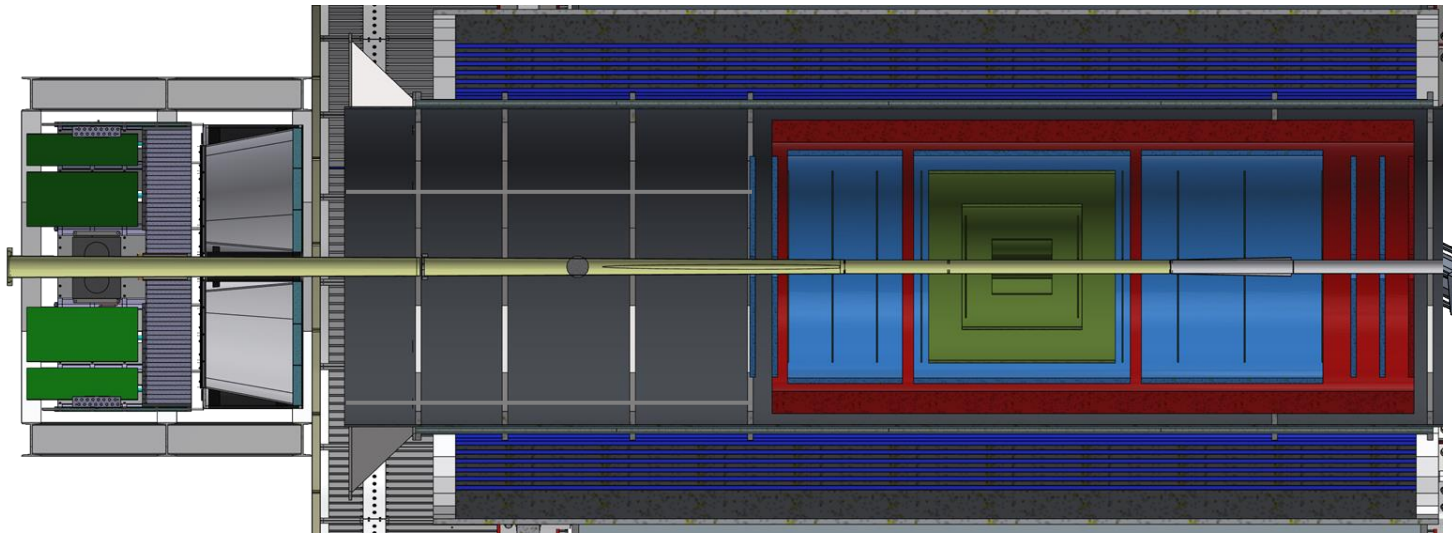
- Rails support the EEEMCal and pfRICH
- Potentially supported through the carbon fiber cylinder or cut outs will be made around them
- Load transferred to barrel EMCal
- Services need to be very well routed
- Alignment mechanisms need to be designed and incorporated

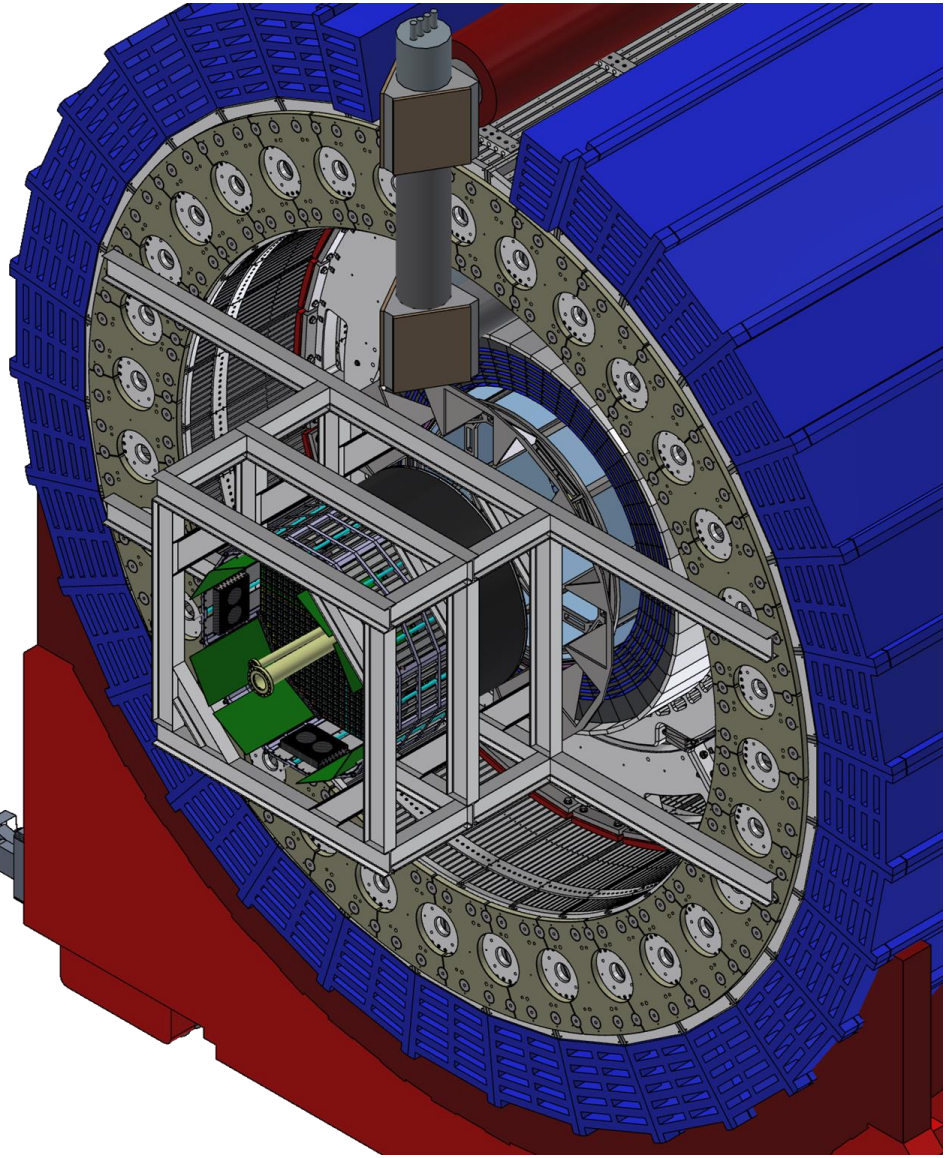




pfRICH and EEEMCal Installation – Conceptual

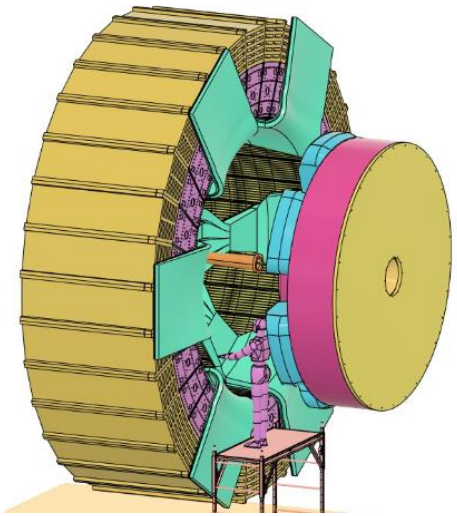
- Might be advantageous to use a box structure for EEEMCal and pfRICH shipping, handling and installation
- Attach box structure to beams bridging gap between HCal Sectors
- Need extension rails and a means of interfacing them for transition and installation
- Detectors could be installed together or separately

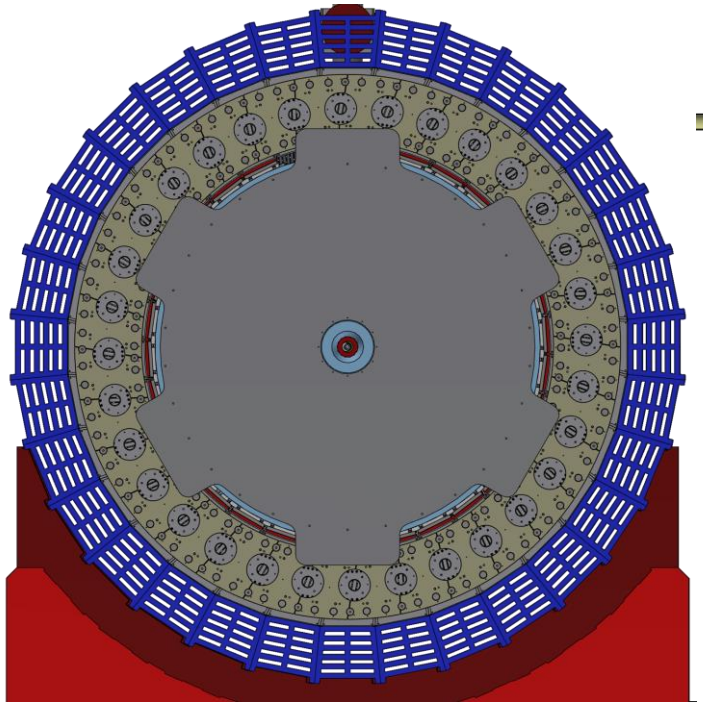


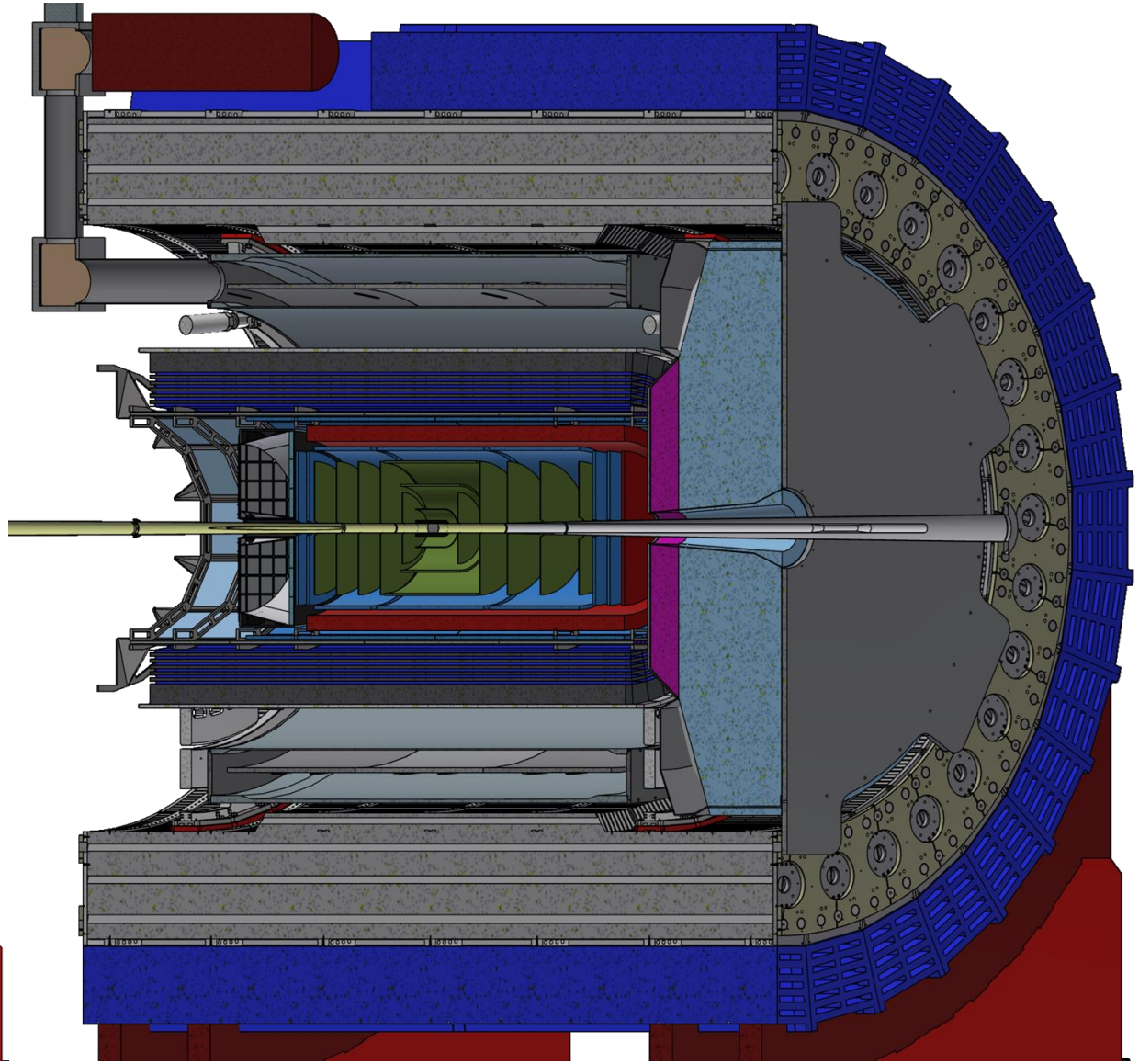


dRICH Support – Conceptual

- Assuming the back plate of the dRICH is bulk carbon fiber, can be extended
- Create tabs that can be attached to HCal, once attached, cantilevered off Hcal
- May need to add additional support in Z
- Minimizes space needed between dRICH OD and HCal ID.

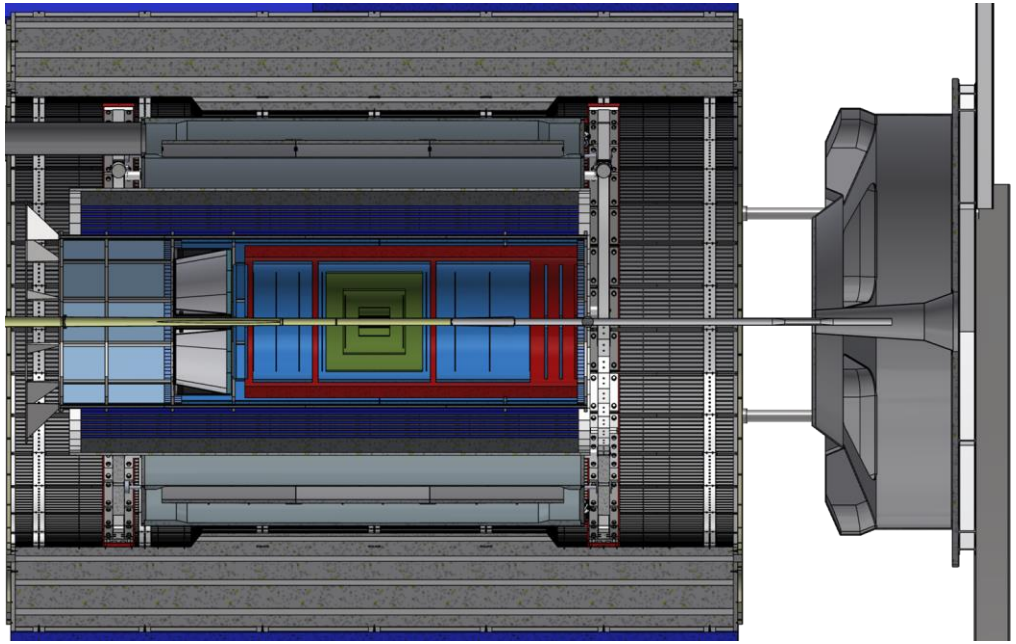


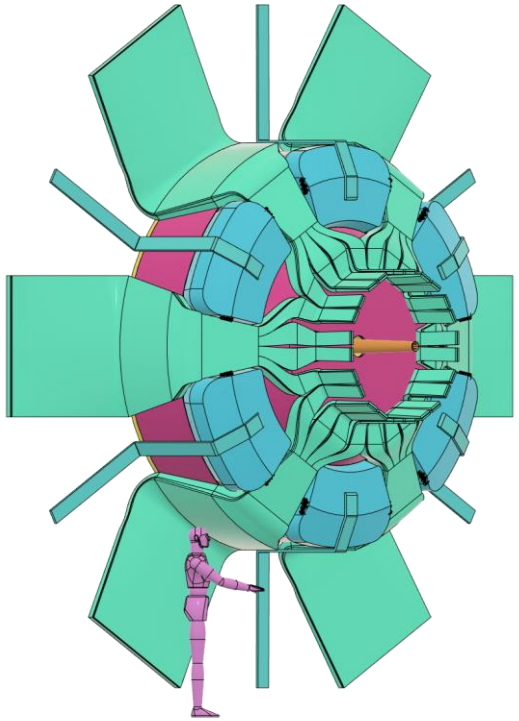


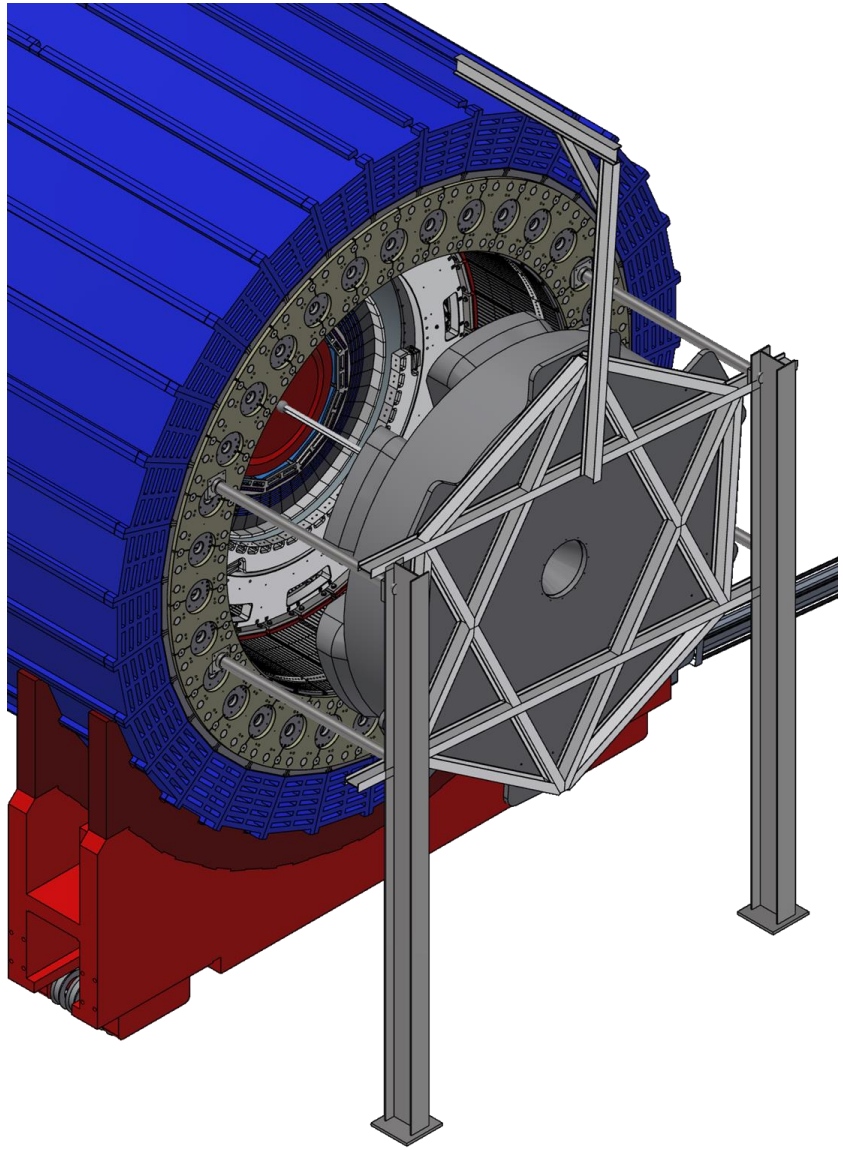


dRICH Installation – Conceptual

- Might be advantageous to use a temporary strongback for dRICH shipping, handling and installation
- External stanchions bolted to floor and rails mounted to stanchions and HCal
- C-fixture used to pick up and move dRICH over CG
- More complex if dRICH is split
- Services need to be very well routed








Questions?