Design Status of Recent Changes

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Triple I group

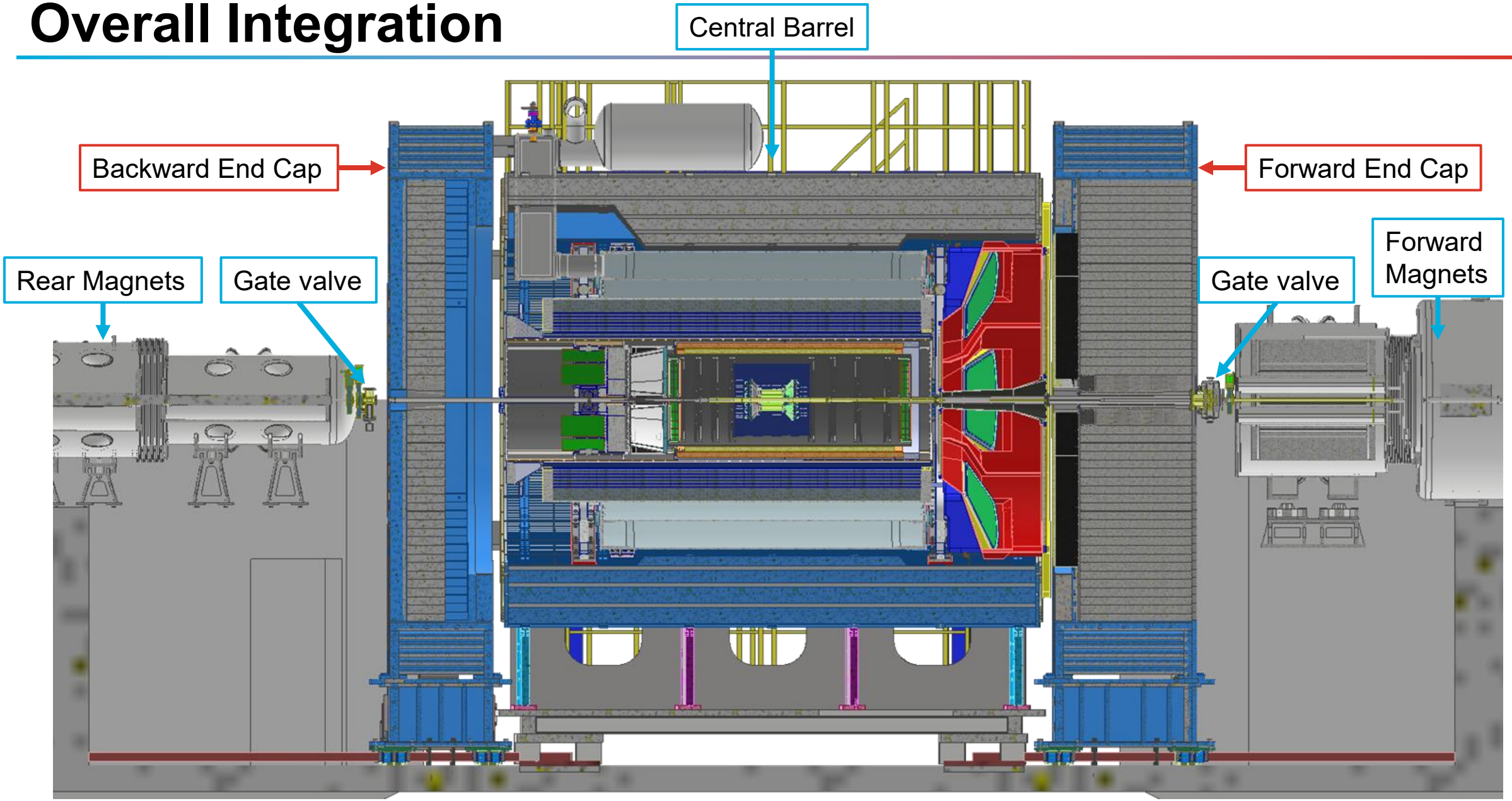
ePIC Collaboration Meeting
July 14th – 18th, 2025

Electron-Ion Collider

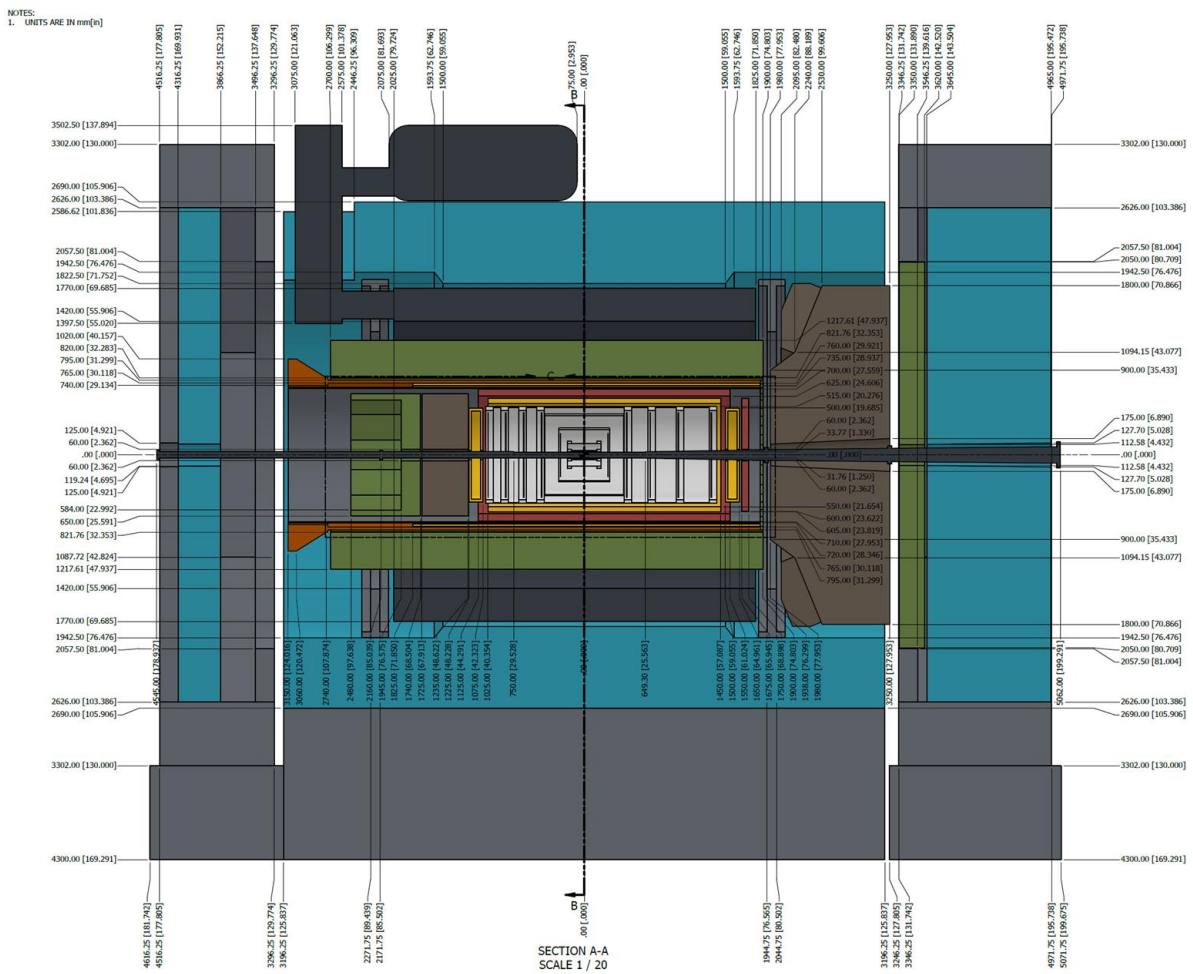
Outline

- EPIC Full Model Overview
- Envelopes
- Installation Sequence
  - Cradle
  - Barrel EMCal support
  - GST & PST
  - Cymbal
  - Platforms
- Services Layout
- Maintenance
- Summary/Next Steps

Overall Integration



Updates: Envelope



To be implemented soon

- Cymbal shifted 1 cm out in radius
- MPGD and TOF disks reduced in radius

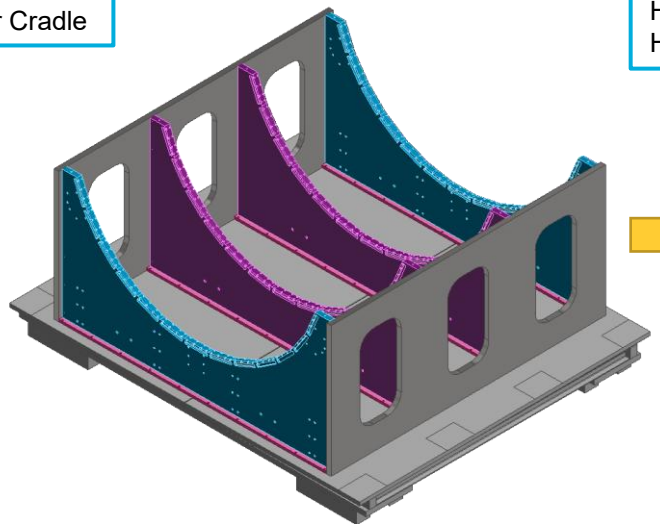
Older updates

- Most Disks ID increased a few mm for beam pipe
- DIRC shorted light pipe
- ToF shortened to align ToF and Cymbal centers and for services
- SVT Backward Disks moved closer to IP
- dRICH ID increased and shifted

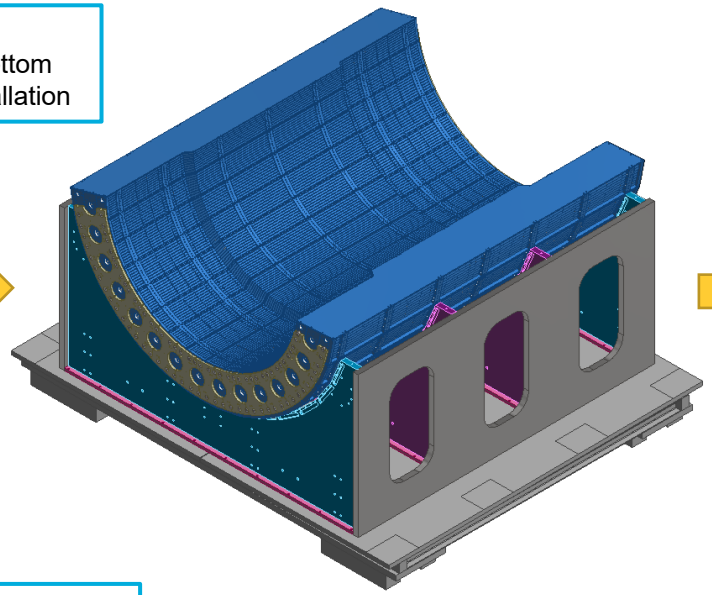
		Date	2/20/2025	5/27/2025	2/20/2025	5/27/2025
	Disk		Radius (mm)		X Offset (mm)	
Forward	SVT	1	36.75	36.75	0	0
		2	40.5	42.25	1	3.25
		3	47.5	49	8.5	10
		4	55.5	57	16.5	17.75
	MPGD	-	65	68.5	25	24.5
	TOF	-	65	70.75	25	26.5
Backward	SVT	1	36.75	36.75	0	0
		2	36.75	40	0	0
		3	38	41	-1	-1
		4	42.5	43.25	-3.25	-3.25
	MPGD	-	50	50.75	0	5.75
	TOF	-	-	-	-	-

Assembly: ePIC Barrel

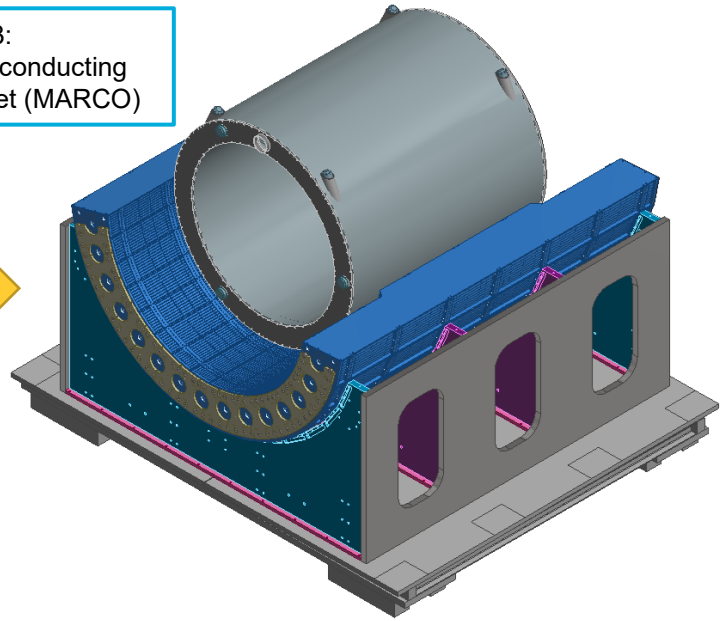
Step 1:
Detector Cradle



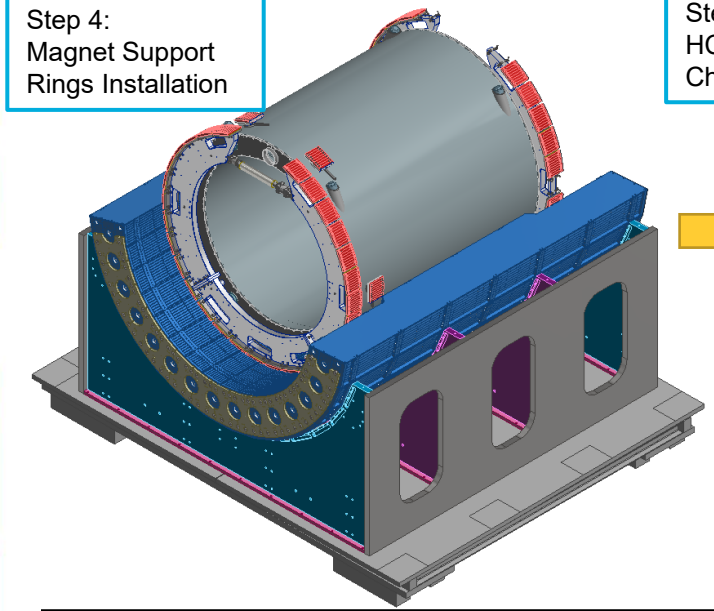
Step 2:
HCAL Bottom
Half Installation



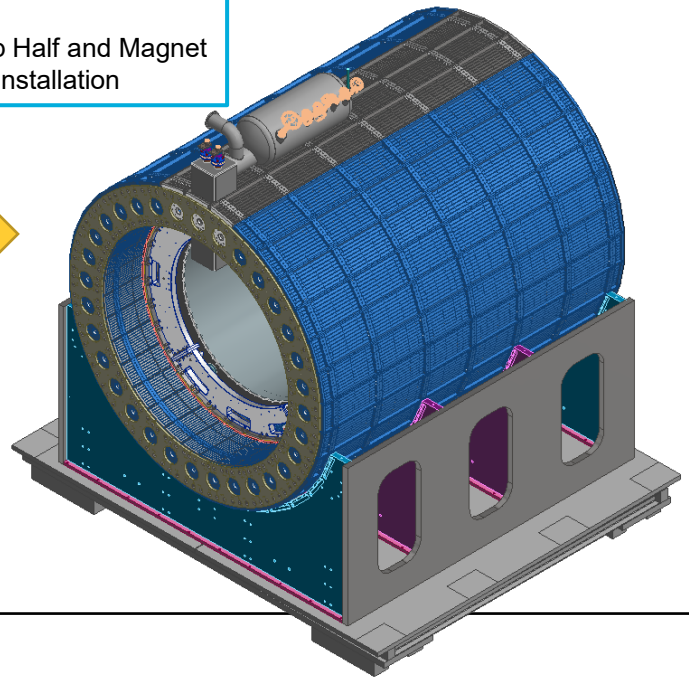
Step 3:
Superconducting
Magnet (MARCO)



Step 4:
Magnet Support
Rings Installation



Step 5:
HCAL Top Half and Magnet
Chimney Installation



Photos of Magnet Installation from sPHENIX Experiment

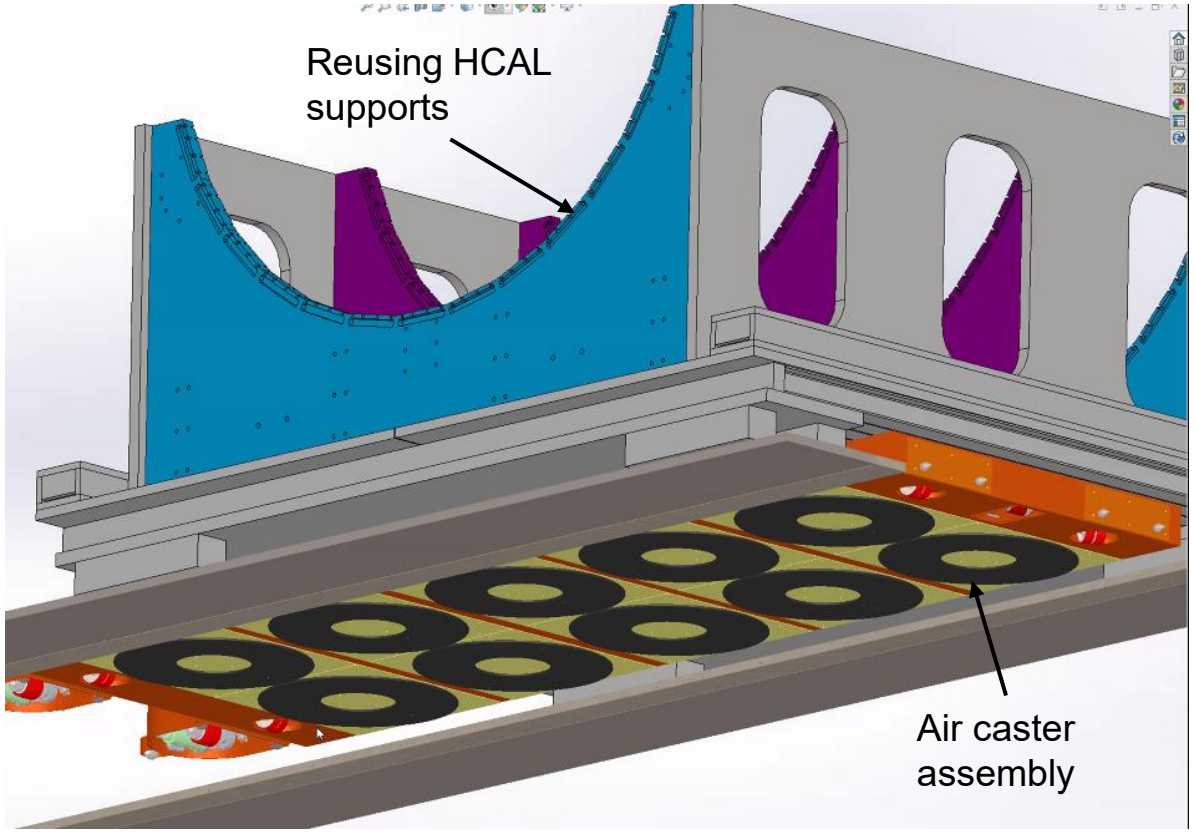
Updates: Cradle and Moving Mechanism

Cradle

- We plan to re-use the barrel HCAL supports from sPHENIX along with the outer barrel HCAL.
- We plan to make a new lower section of the cradle that will fit with the STAR hall tracks and interface with air casters, which will be used to move the cradle.

Air casters

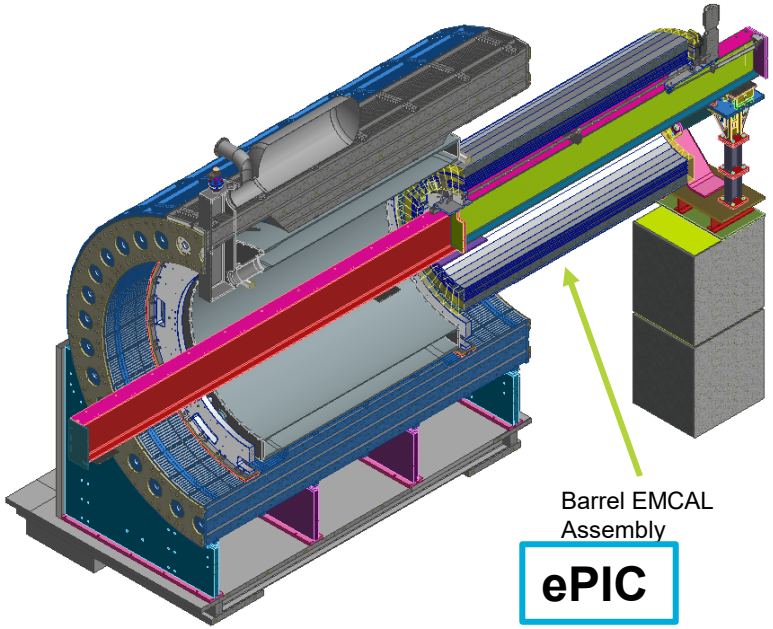
- We researched and ranked different moving options for the cradle, and air casters were the top choice.
- Use air casters to lift the cradle, move it with STAR hydraulic pistons.
- Use fixed stops anchored to the floor and additional hydraulic pistons for precision positioning.
- Use track followers (rollers) to constrain the cradle to one of the two tracks in the floor.
- Our detector is estimated to weigh less than 900 tons. The company Aerogo has proposed an assembly of ten 90 ton casters, operating at 75 psi.
- The assembly will be rolled into place under the detector, and then the air casters can be inflated to raise the detector.



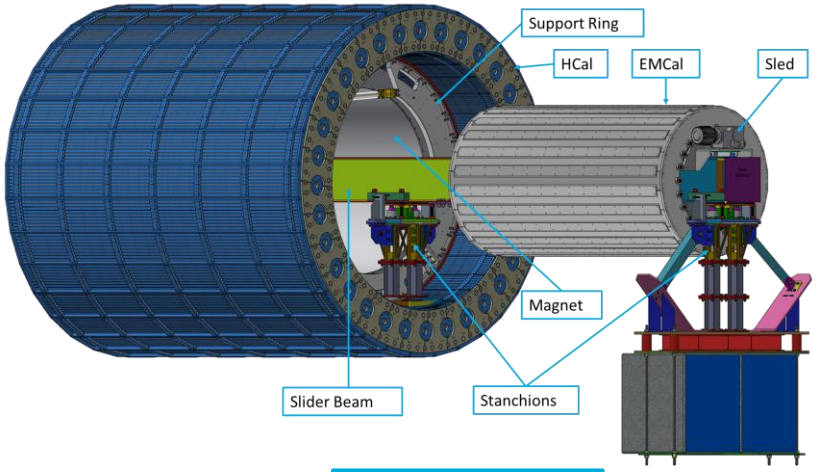
Example applications

[Move Up to 5000 Tons - Heavy Load Moving Solutions | AeroGo]

Assembly: ePIC Barrel



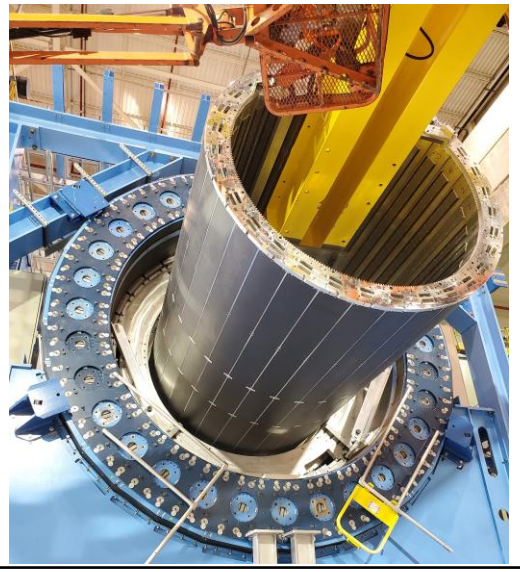
ePIC



sPHENIX

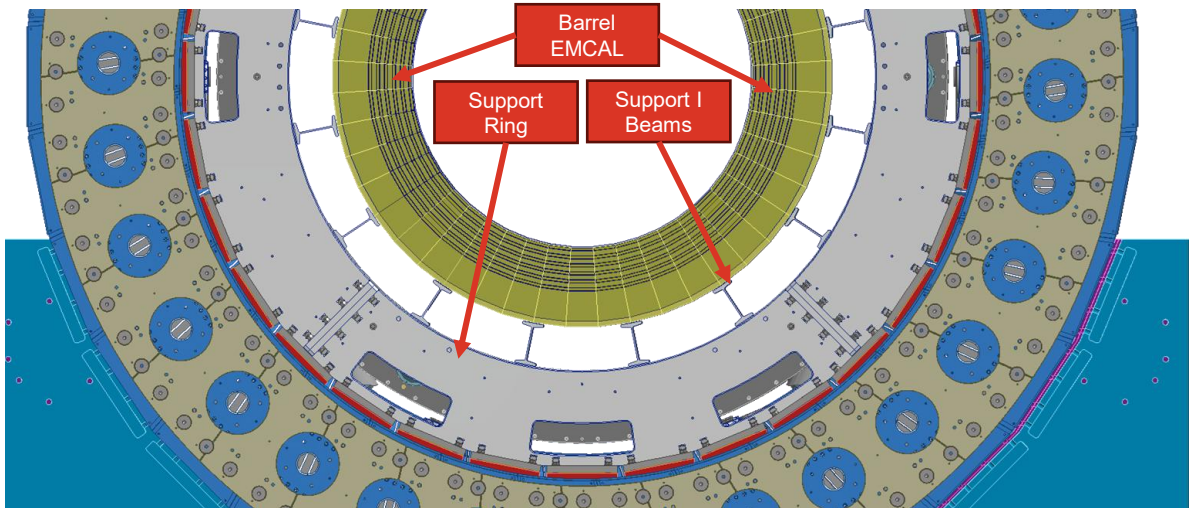
Step 6: Barrel EMCAL Installation:

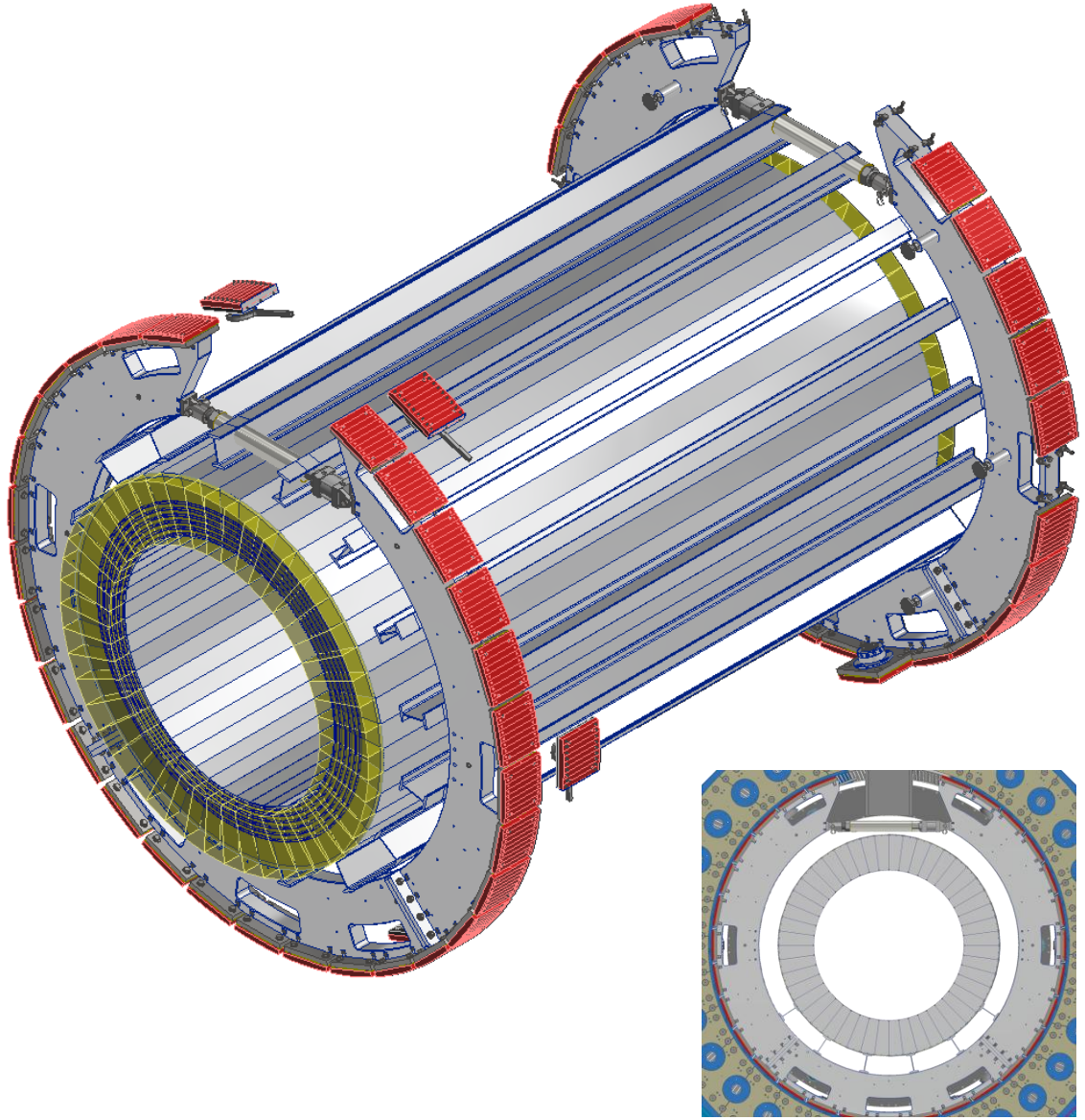
- We plan to use existing installation tooling from sPHENIX that was used to install Inner HCAL as shown in photos
- The I-beam is inserted into the HCal and supported on stanchions.
- Barrel EMCal will be assembled in front of ePIC Barrel
- The Barrel EMCal is rolled in via the sled on the I-beam.
- The Barrel EMCal is attached to the support rings.
- The I-beam and stanchions are removed.
- Barrel EMCal will be supported via the sPHENIX inner support rings
- At both inner support rings there will be aluminum I-Beams for support
- Support Hierarchy:
  - Cradle → HCal → Inner Support Rings → EMCal Support → Barrel EMCal → Carbon Fiber Support Tube → Inner Detectors



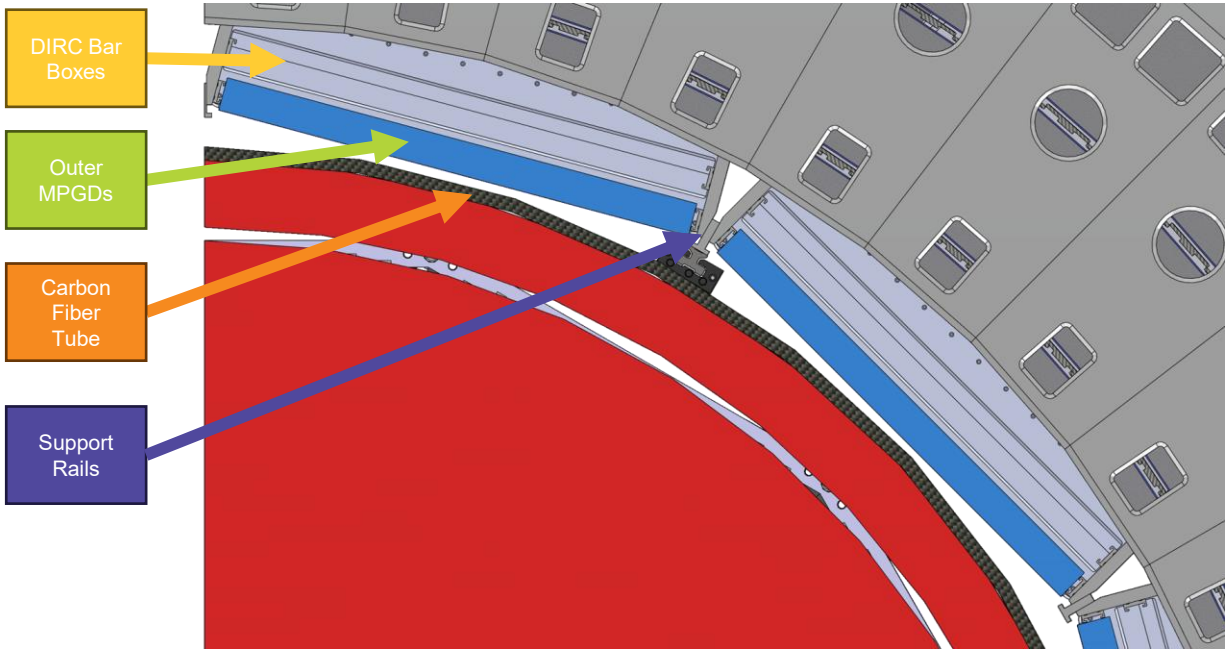
Update: Barrel ECal Support

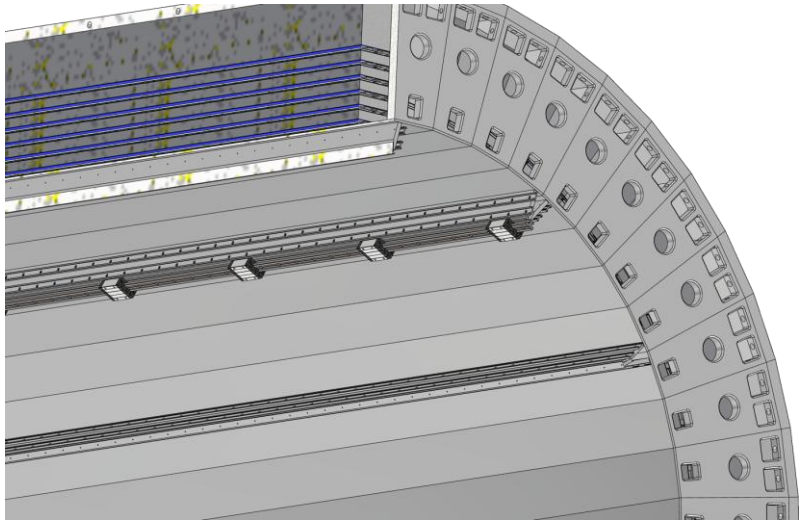
- The concept is to support the barrel EMCal from a series of I-beams that bridges the gap between the support rings.
- These beam mitigate the cantilevered loads on the forward direction.
- The lower 6 or so I beams are required, all other beams need to looked at in more detail.



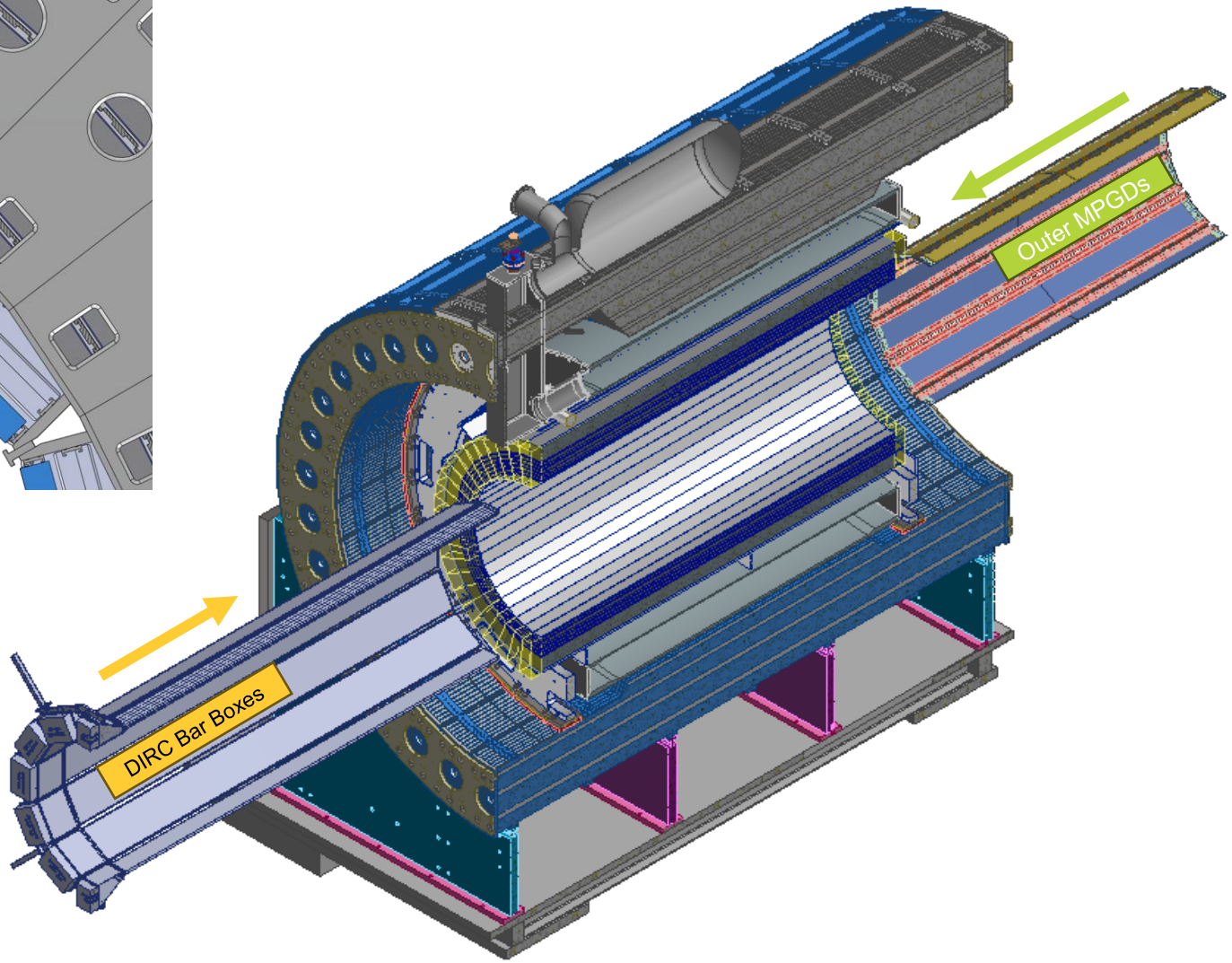


Assembly: ePIC Barrel



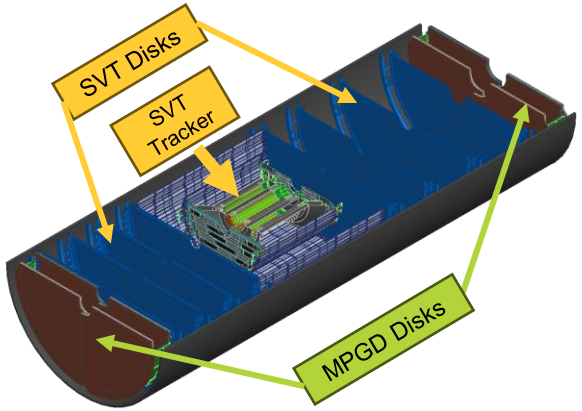


Step 7: DIRC Bars and Outer MPGDs Installation

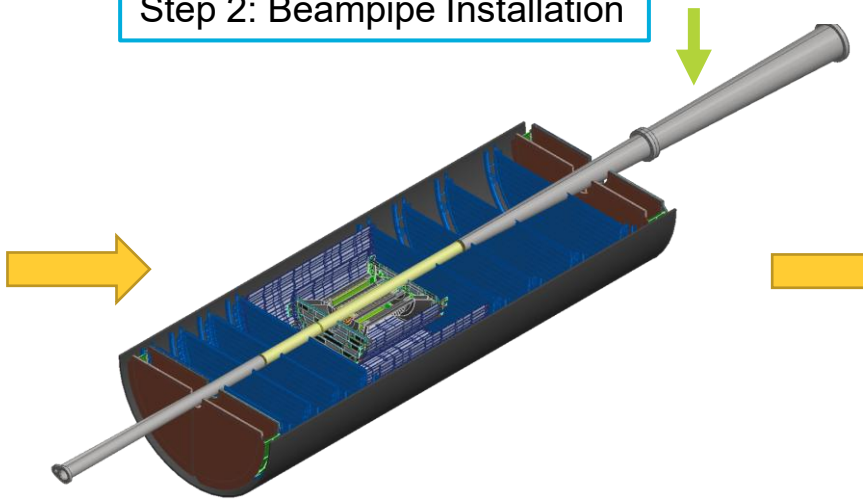


Assembly: Global Support Tube (GST)

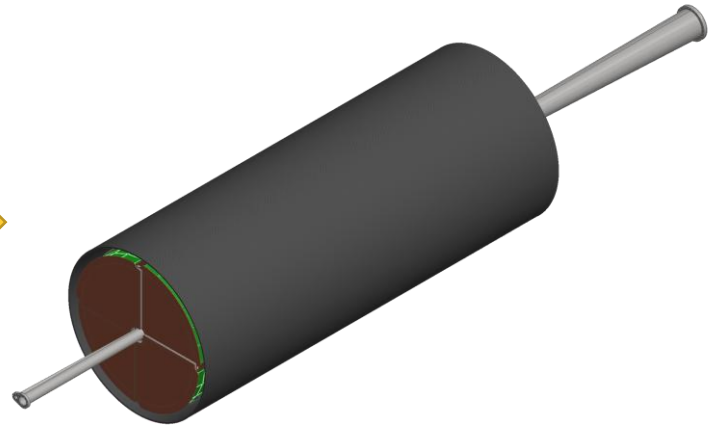
Step 1: PST Bottom half assembly



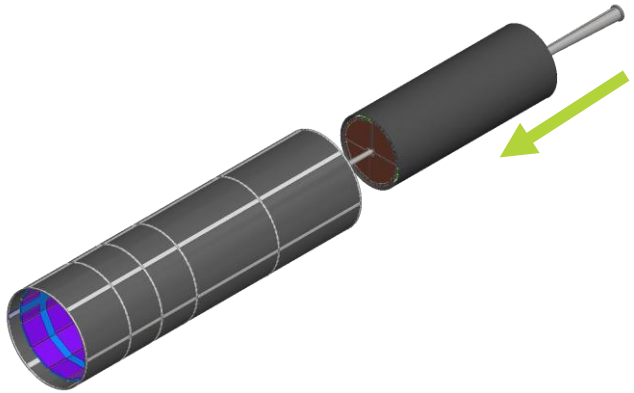
Step 2: Beampipe Installation



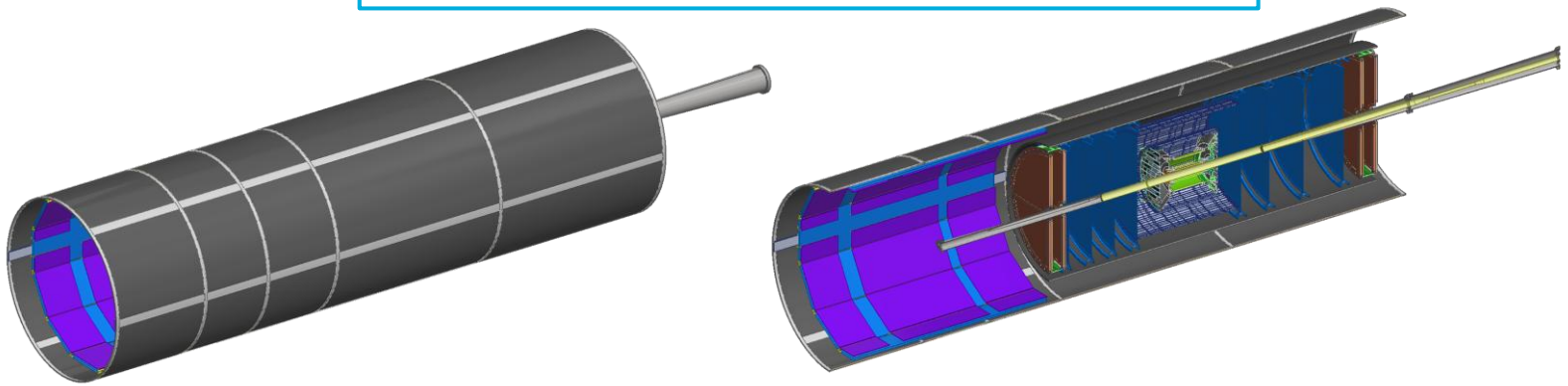
Step 3: PST Top half Installation



Step 4: PST Installation into GST



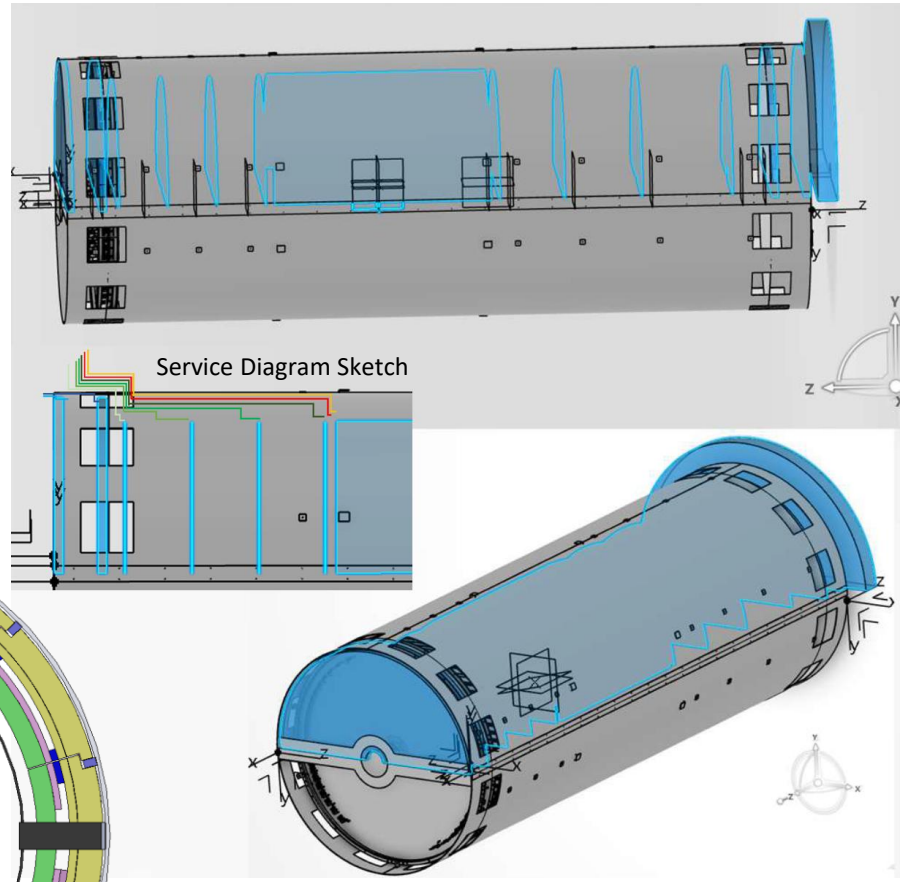
Step 5: GST ready for installation into Central Barrel

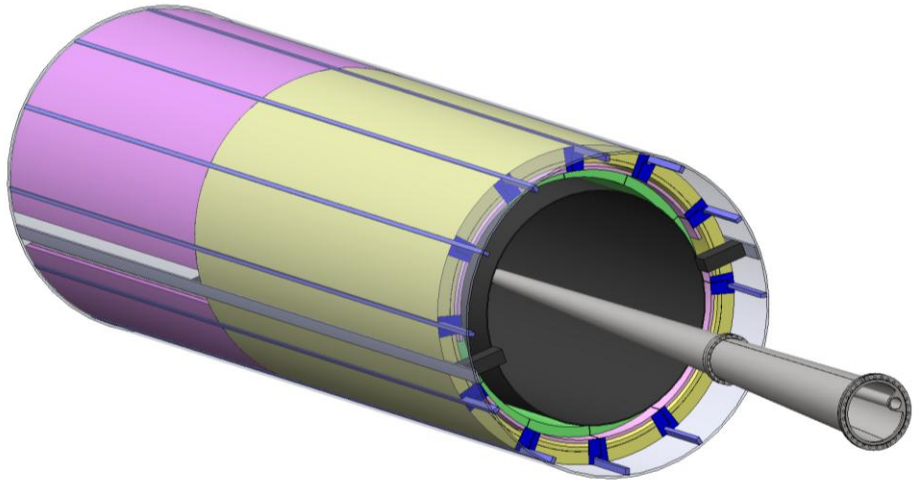


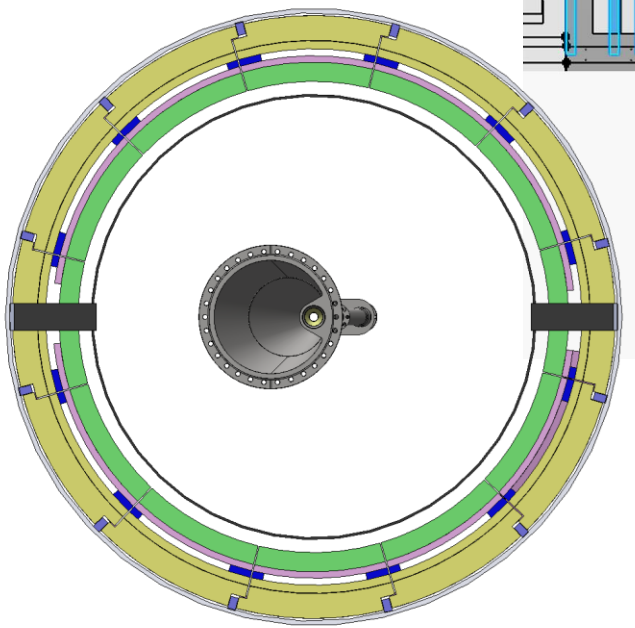
- Global Support Tube (GST) is the Carbon fiber support structure for inner detectors. GST assembly will take place in the Assembly hall on a set of carts
- Cymbal (Inner MPGD) and Barrel TOF detector trays will be installed after GST is installed in Barrel during initial installation.
- Cymbal and Barrel TOF detectors can be removed for maintenance in the experimental hall without removing GST assembly from Barrel.

Updates: GST/PST

- SVT just had a workshop, more details of the GST and PST updates here: https://indico.bnl.gov/event/28216/
- GST has 12 sets of rails for ToF and Cymbal installation
- GST also supports PST at “4 corners”
- PST supports SVT and MPGD disks
- Services from SVT come out of “windows” in PST, then are routed along GST (work in progress)
- Air cooling being evaluated

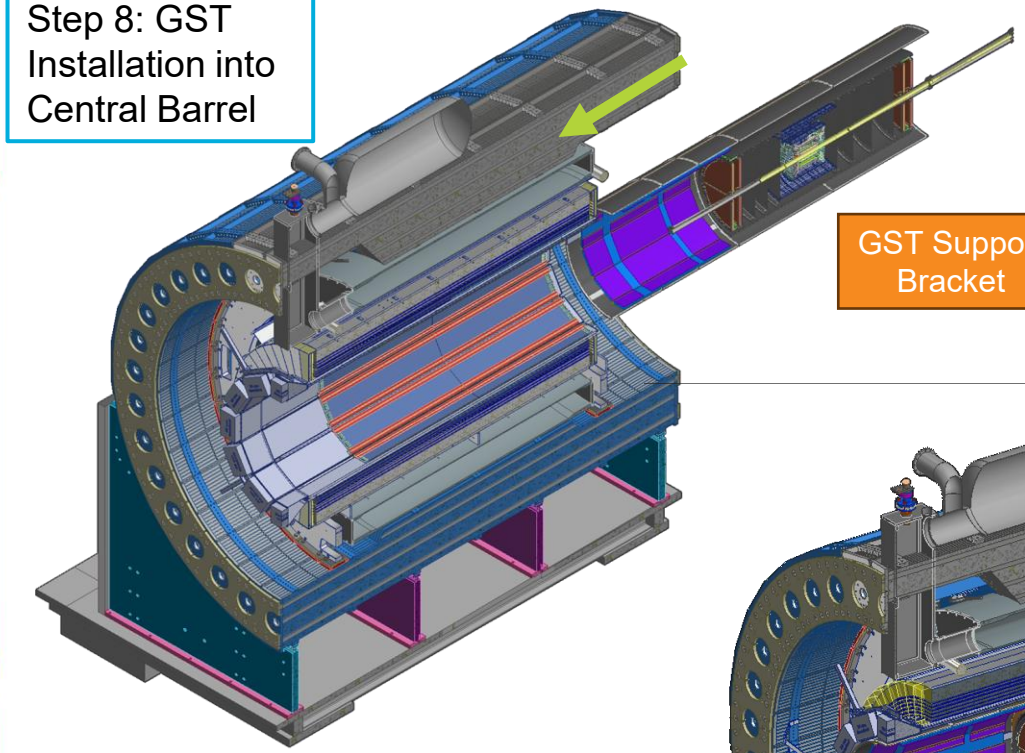




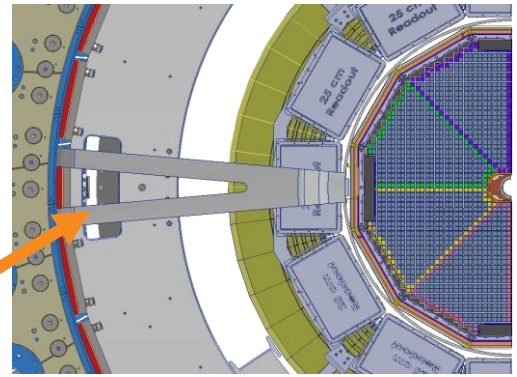


Assembly: ePIC Barrel

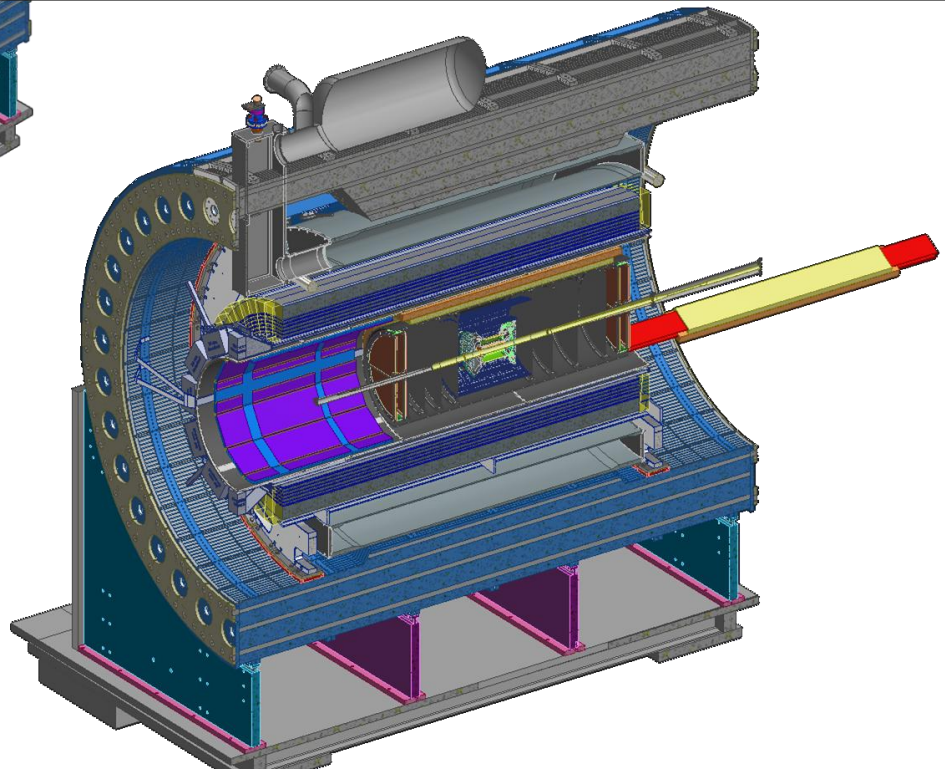
Step 8: GST Installation into Central Barrel



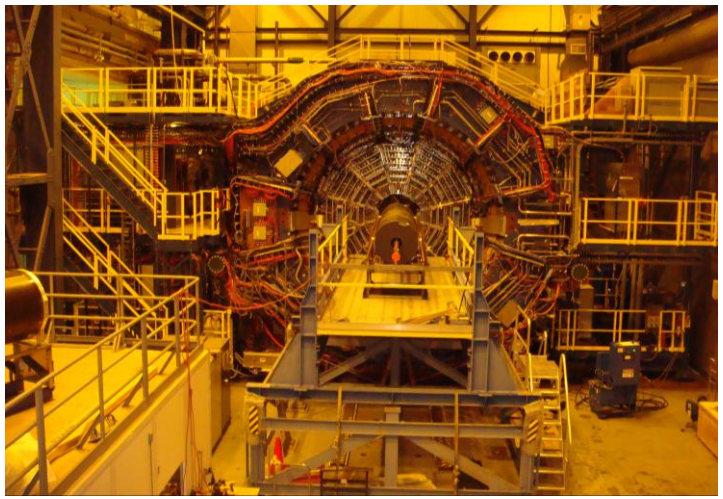
GST Support Bracket



Step 9: ToF & CYMBAL Installation into GST



Planning on reusing STAR IDS Platform for GST Installation

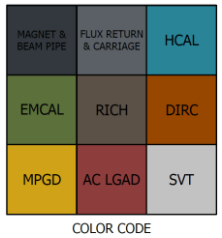


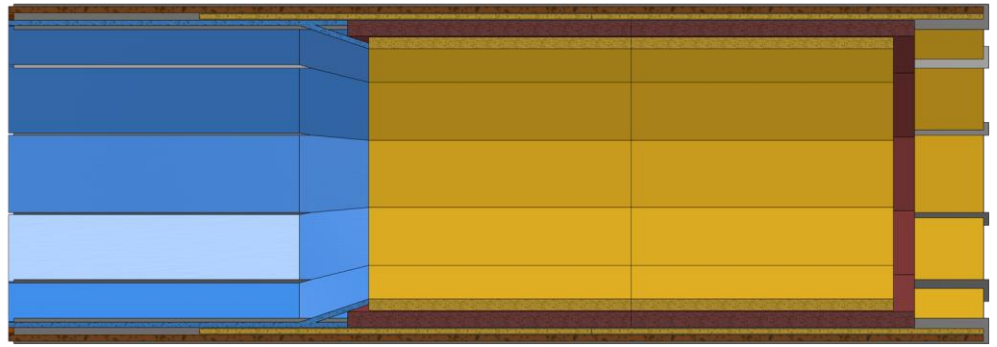
STAR Carbon Fiber detector Support Structure Installation

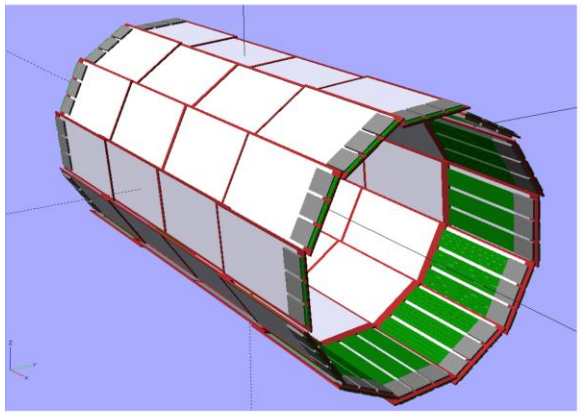
Updates: Cymbal

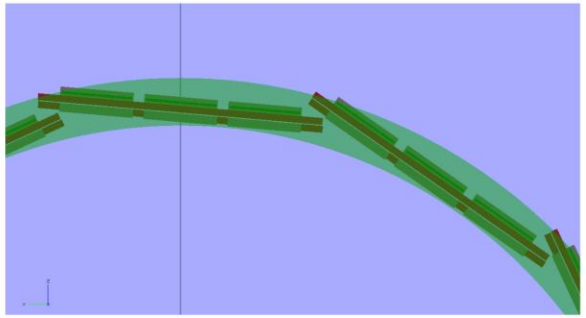
- CyMBaL is now moving from a configuration of 8 to 12 independent sectors
  - Supported on from the ToF
  - Done to make it more serviceable
- From **32 to 48** modules of ~33 cm width
  - FEB: 128 → 144, SALSA: 512 → 576, (+12,5%)
- Cylindrical Vs flat tiles

Slides 19, 20, 21 show the maintenance constraints

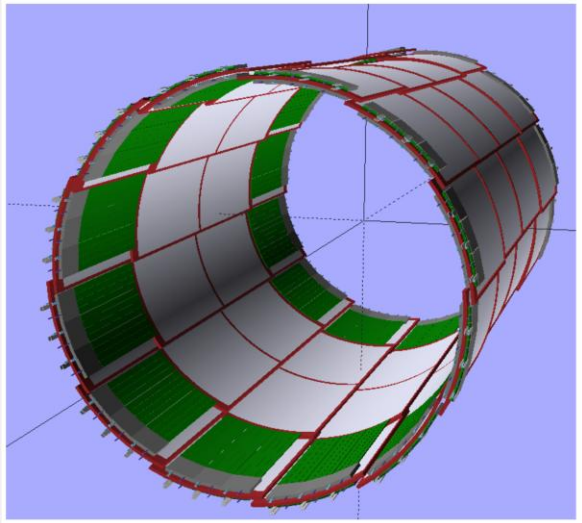


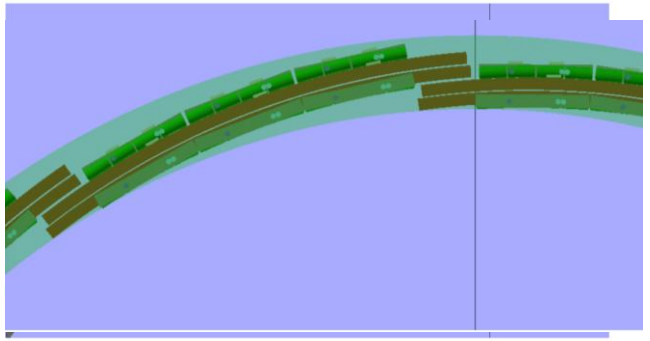






Keeping zone: [560,615] mm
Flat modules (slats)
Slat thickness: 8 mm
Delta radius in-out modules: 9 mm
Tiles tilt angle = 5 degrees
Tile dimensions= 330x670 mm^2

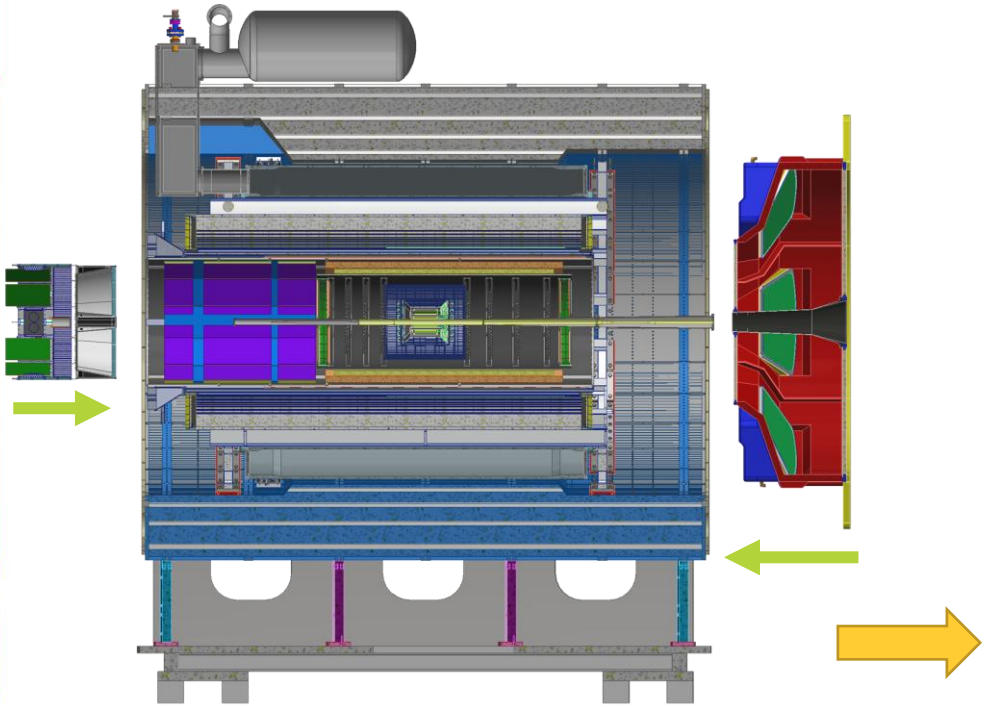




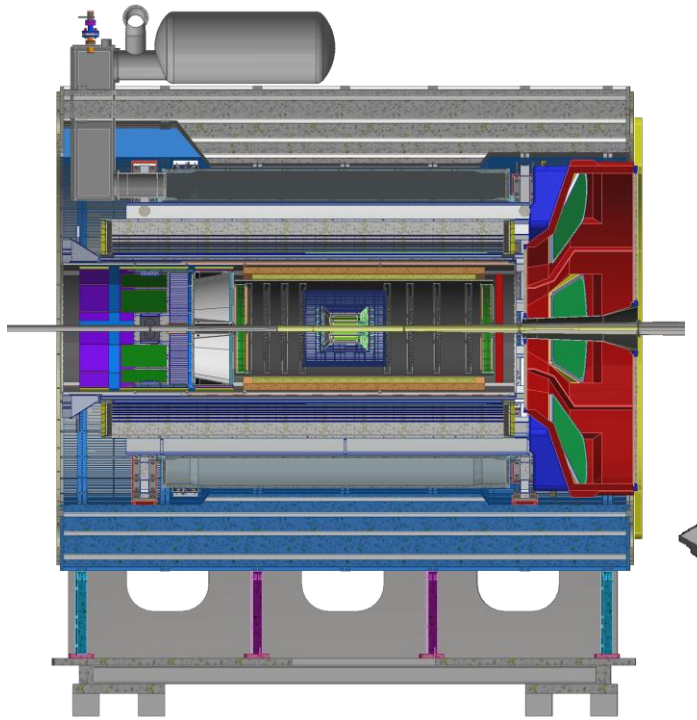
Keeping zone: [560,615] mm
Tile curvature radius: 572 mm
Tile thickness: 9 mm
Delta radius in-out modules: 10 mm
Tiles tilt angle = 4 degrees
Tile dimensions= 340x670 mm^2

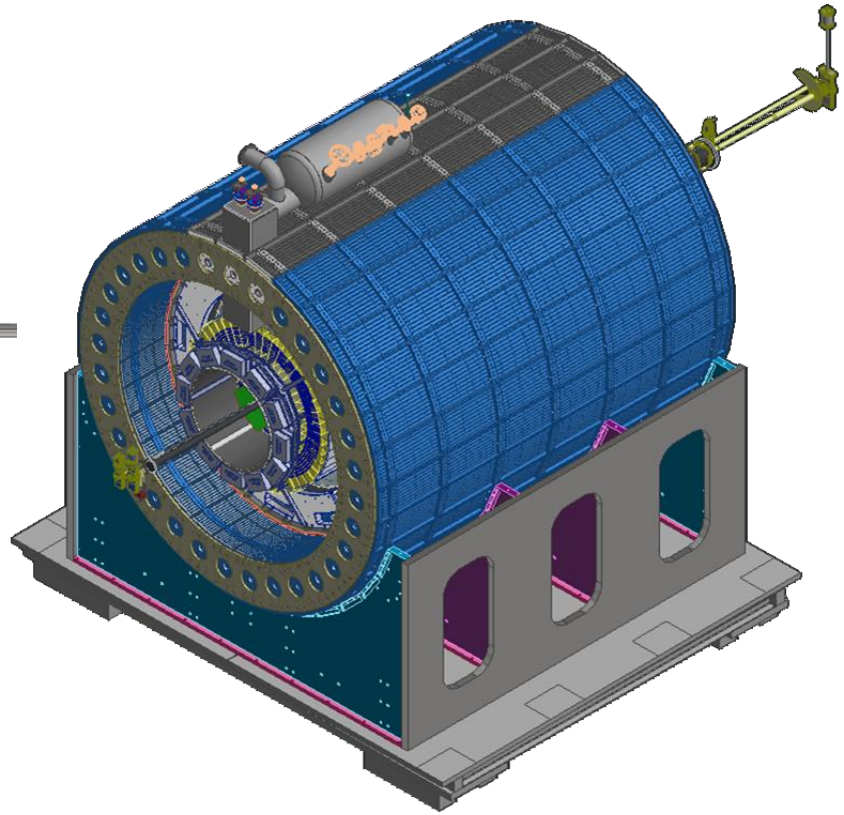
Assembly: ePIC Barrel

Step 10: EEEMCAL, pfRICH, & dRICH Installation



Step 11: Assembly Complete

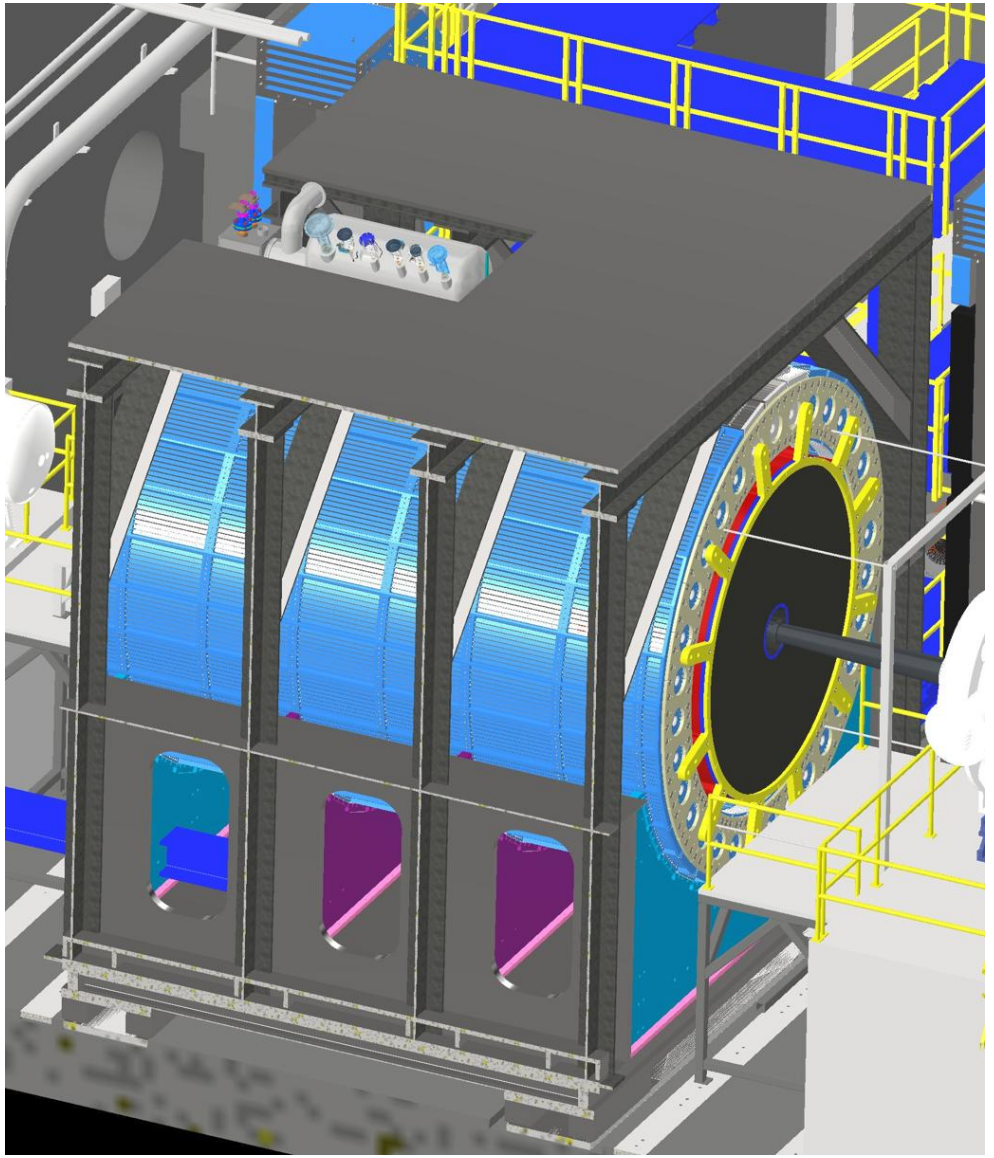




- pfRICH and dRICH detectors are installed from backward side and dRICH detector is installed from forward side.
- After Final Assembly, detector is ready to be rolled in to the experimental hall.

Updates: Detector Platform

- We will likely re-use components from the sPHENIX platform, and the overall design will likely be similar but with a smaller platform size.
- The detector platform will need to support additional flux return steel to balance out the load on the magnet.
- Need to evaluate structural integrity since two main support beams have been cut to fit the magnet phase separator
- We do not plan to have equipment permanently installed on the platform since it will not clear the entryway between the experimental and assembly hall.
- We need to remove the safety rails (not shown) when moving between the experimental and assembly hall.



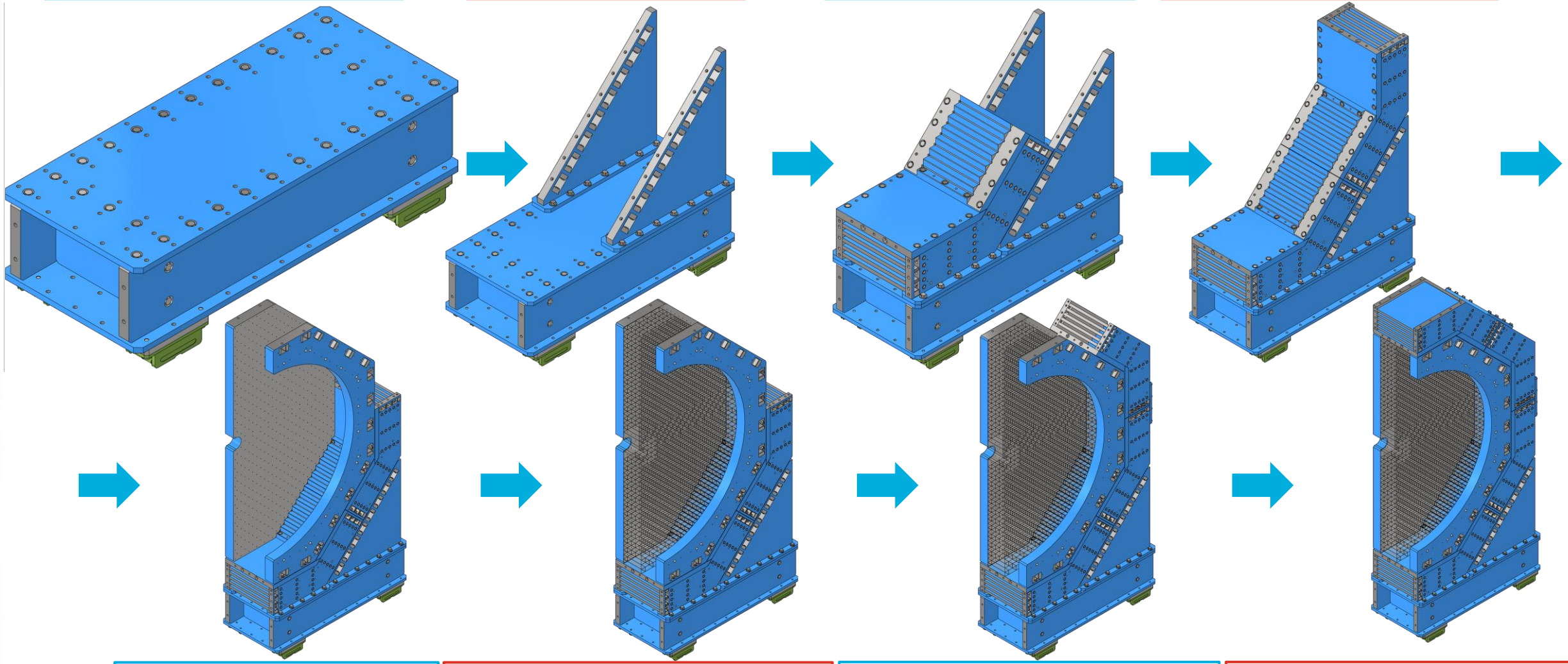
Assembly: Endcap Assembly Steps

1. Base shimmed to height and anchored
   FE: 11.25ton BE: 9.5ton

2. Flux return support attached
   FE: 15ton BE: 13.25ton

3. First flux return module attached
   FE: 28.25ton BE: 23.5ton

4. Second flux return module attached
   FE: 41.5ton BE: 33.75ton



5. Pole tip and half annulus attached
   FE: 51.5ton BE: 60.5ton

6. Detector installed
   FE: 51.5ton (+100ton) BE: 60.5ton (+30ton)

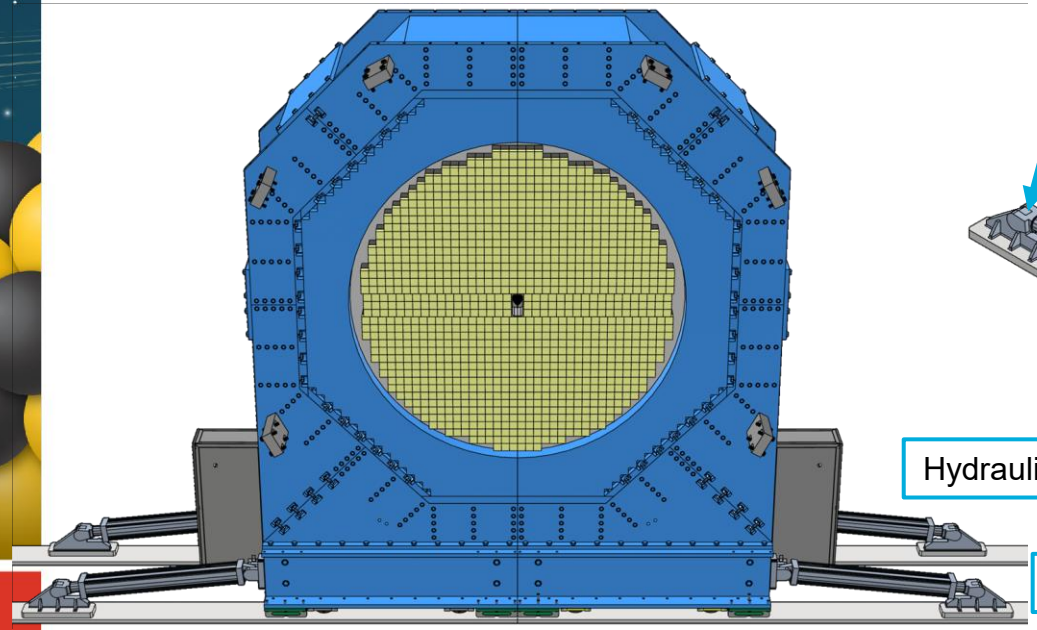
7. Third flux return module attached
   FE: 65.5ton (+100ton) BE: 71.25ton (+30ton)

8. Forth flux return module attached
   FE: 79.5ton (+100ton) BE: 82ton (+30ton)

Updates: EndCaps

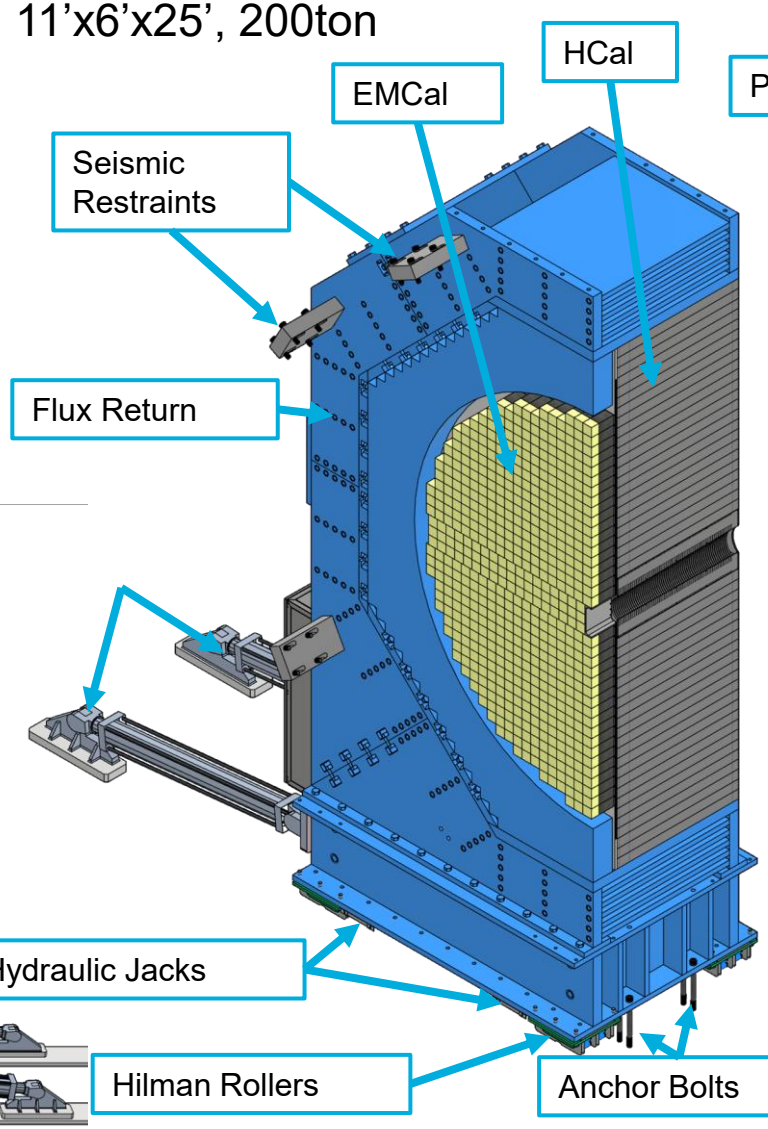
Status:

- FDR completed
- Design and analysis completed
- Drawings completed and being reviewed
- Vendor Quotes available
- Possibility of reduction of flux return steel if magnet simulations can show it works. Potential for some cost savings.
- PRR planned for Summer 2025 (now)



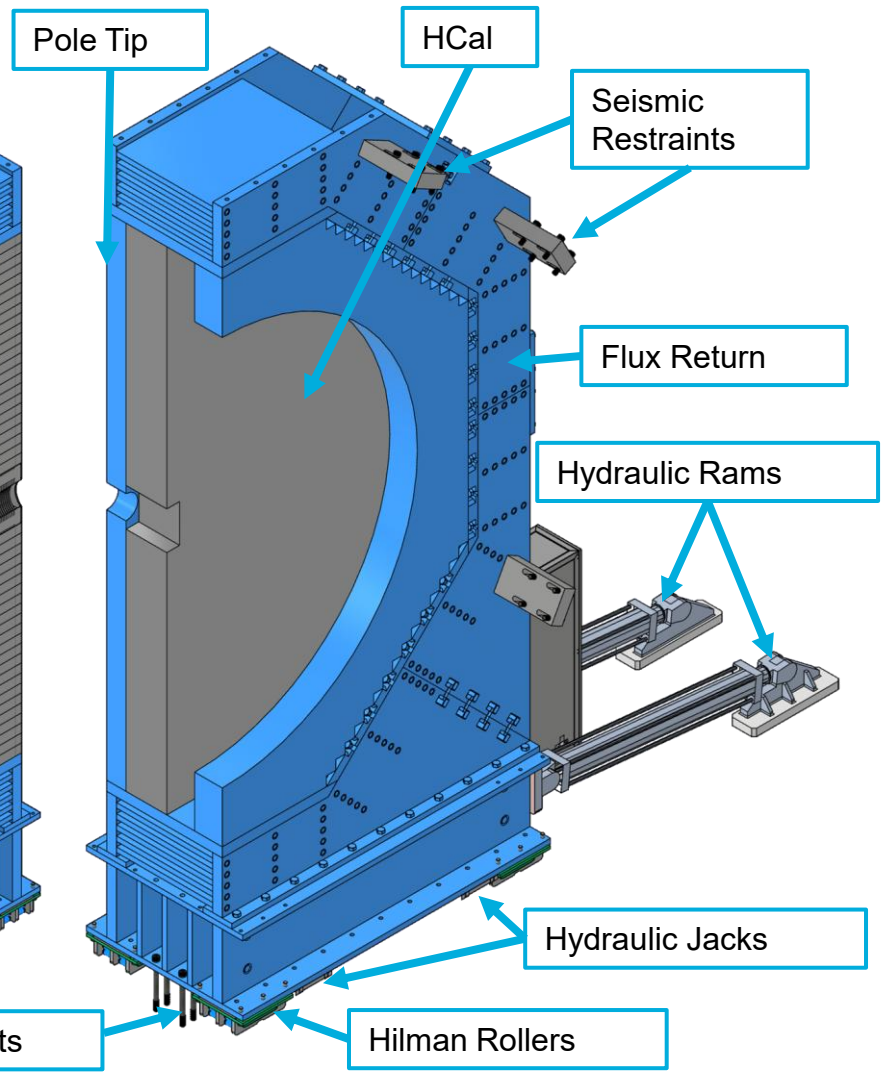
Forward Endcap (FE)

11’x6’x25’, 200ton

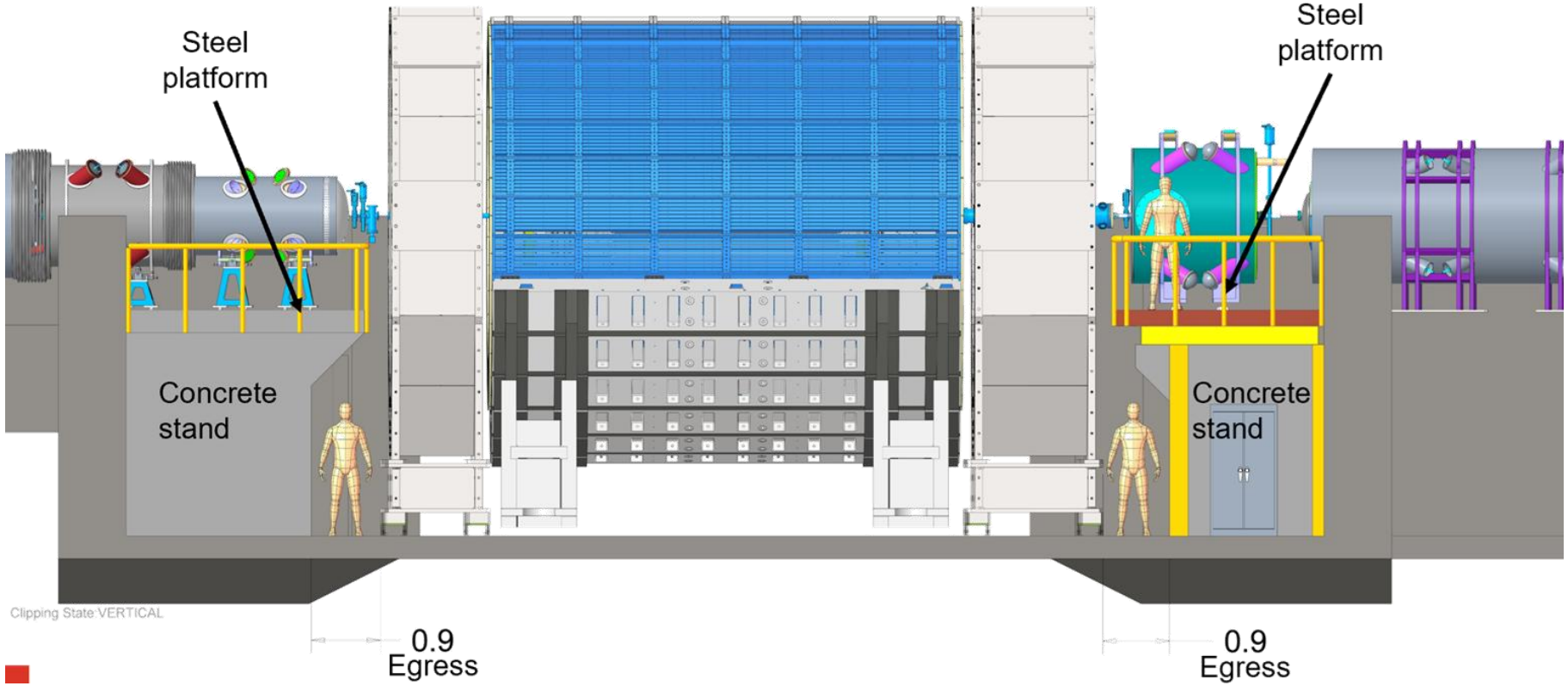


Backward Endcap (BE)

11’x4’x25’, 130ton



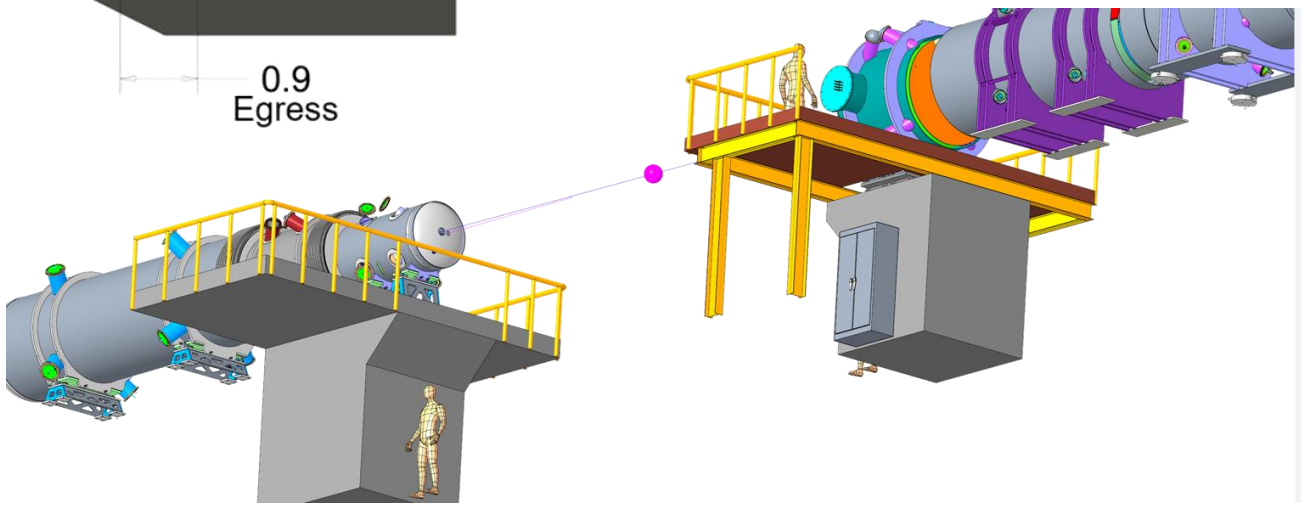
Update: Forward and Backward Magnet Platforms



Platforms are under discussion

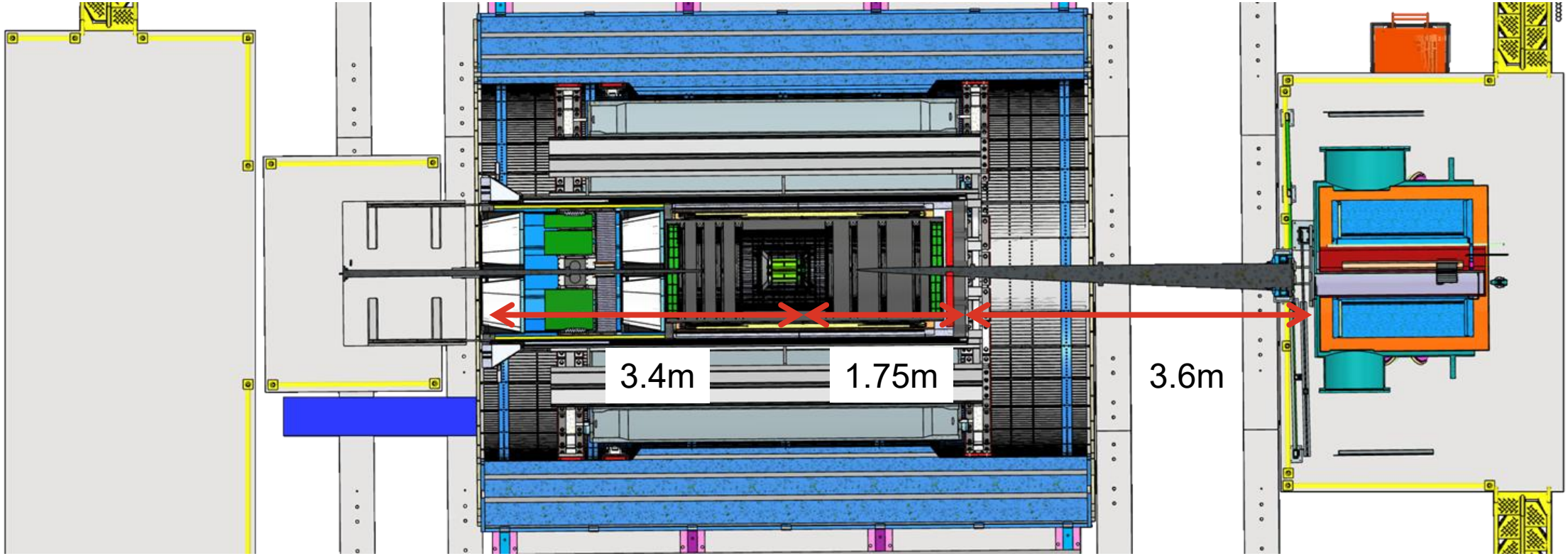
Two considerations:

- Magnets need to be supported by concrete blocks
  - Needed to minimize vibration
- We need two means of egress
  - 36” width minimum



Serviceability Considerations

- oMPGD, TOF and Cymbal uninstalled from forward side as pfRICH and EEEMCal block the radial space needed to uninstall from the backward side.
- B0 to GST is ~3.6m, forward half of barrel oMPGD, TOF and Cymbal are ~1.75m and backward half of barrel TOF and Cymbal are ~3.4m.



EPIC Maintenance Schedule

1		Summer Shutdown 2030 Start	0 days	Mon 7/1/30	Mon 7/1/30		
2		**Shutdown Prepration**	**4.5 days**	**Mon 7/1/30**	**Tue 7/9/30**		
2.1		Remove Ground Straps	0.5 days	Mon 7/1/30	Mon 7/1/30	1	M Techs
2.2		Remove Seismic Anchors and Retract Links for Endcaps	2 days	Mon 7/1/30	Wed 7/3/30	3	M Techs
2.3		Open Hadron and Lepton Endcaps	2 days	Wed 7/3/30	Tue 7/9/30	4	M Techs
2.4		Open Shield Wall Plug	1 day	Wed 7/3/30	Mon 7/8/30	4	Riggers
2.5		Removal of Vacuum pipes	1 day	Mon 7/1/30	Mon 7/1/30	1	Vac Grp
3		Remove Shield Wall	3 days	Tue 7/9/30	Fri 7/12/30	1,5,6	Riggers
4		**ePIC Roll Out Prepration**	**15 days**	**Fri 7/12/30**	**Fri 8/2/30**		
4.1		Removal of EEEMCAL and pfRICH	5 days	Fri 7/12/30	Fri 7/19/30	8	M Techs
4.2		Remove gas lines from NW Corner	1 day	Fri 7/19/30	Mon 7/22/30	10	
4.3		Move PASS umbilical	1 day	Mon 7/22/30	Tue 7/23/30	11	PASS
4.4		Remove Magnet Cryo Jumpers	2 days	Tue 7/23/30	Thu 7/25/30	12	M Techs
4.5		Disconnect and Remove Power Bridge	2 days	Thu 7/25/30	Mon 7/29/30	13	M Techs,Elects
4.6		Remove MCW Pipes	1 day	Mon 7/29/30	Tue 7/30/30	14	M Techs
4.7		Dscnt btry fire panel 4 roll	0.5 days	Tue 7/30/30	Tue 7/30/30	15	M Techs
4.8		Prepare Hydraulic unit and hoses	0.5 days	Wed 7/31/30	Wed 7/31/30	16	M Techs
4.9		Crane/Fiber Prep	1 day	Wed 7/31/30	Thu 8/1/30	17	M Techs
4.10		Remove Seismic Anchors	1 day	Thu 8/1/30	Fri 8/2/30	18	M Techs
5		**Roll ePIC Out**	**2 days**	**Fri 8/2/30**	**Tue 8/6/30**	**19**	**M Techs**
6		**ePIC Post Roll Out Prepration**	**3 days**	**Tue 8/6/30**	**Fri 8/9/30**		
6.1		Install Cryo Connections in the Assembly Hall	1 day	Tue 8/6/30	Wed 8/7/30	20	Riggers,Carps
6.2		Hook Up MCW	1 day	Wed 8/7/30	Thu 8/8/30	22	M Techs
6.3		Install Stairs	1 day	Thu 8/8/30	Fri 8/9/30	23	Carps,Riggers
7		**GST**	**56 days**	**Fri 8/9/30**	**Wed 10/30/30**		
7.1		Remove dRICH Detector	3 days	Fri 8/9/30	Wed 8/14/30	24	M Techs
7.2		Install GST Platform East and Align to Barrel	3 days	Wed 8/14/30	Mon 8/19/30	26	Riggers,M Techs,Carps
7.3		Hookup and position GST Platform on West for Eifel Tower Structure	2 days	Mon 8/19/30	Wed 8/21/30	27	M Techs,Carps
7.4		Disconnect all the cables/Fibers and dressing	3 days	Wed 8/21/30	Mon 8/26/30	28	E Techs
7.5		Remove GST	1 day	Mon 8/26/30	Tue 8/27/30	29	M Techs
7.6		Diassemble GST	5 days	Tue 8/27/30	Wed 9/4/30	30	M Techs
7.7		Replacement of Parts/Maintenance and Testing	20 days	Wed 9/4/30	Wed 10/2/30	31	
7.8		Reassemble GST	5 days	Wed 10/2/30	Thu 10/10/30	32	M Techs
7.9		Install GST	1 day	Thu 10/10/30	Fri 10/11/30	33	M Techs
7.10		Reconnect all the cables/Fibers and dressing and Testing	5 days	Fri 10/11/30	Fri 10/18/30	34	M Techs
7.11		Remove GST platform East and West	3 days	Fri 10/18/30	Wed 10/23/30	35	M Techs
7.12		Install and Test dRICH detector	5 days	Wed 10/23/30	Wed 10/30/30	36	M Techs
8		**ePIC Roll In Prepration**	**1 day**	**Wed 10/30/30**	**Thu 10/31/30**		
8.1		Remove MCW and Temporary Staircases and Seismic Anchors	1 day	Wed 10/30/30	Thu 10/31/30	37	M Techs
9		**Roll In ePIC**	**2 days**	**Thu 10/31/30**	**Mon 11/4/30**	**39**	**M Techs,STSG**
10		**ePIC IR Hookup**	**4 days**	**Mon 11/4/30**	**Fri 11/8/30**		
10.1		Install Power Bridge and Restore AC Power	1 day	Mon 11/4/30	Tue 11/5/30	40	M Techs
10.2		Install MCW/TPC Water Pipes and Turn on Water	1 day	Tue 11/5/30	Wed 11/6/30	42	M Techs
10.3		Install Stairs and Seismic Anchors	1 day	Wed 11/6/30	Thu 11/7/30	43	Carps,Riggers
10.4		Restor DC Power for Magnet	1 day	Thu 11/7/30	Fri 11/8/30	44	M Techs
11		**Final Tasks**	**27 days**	**Mon 11/4/30**	**Wed 12/18/30**		
11.1		Close Up Beam Pipe	2 days	Mon 11/4/30	Wed 11/6/30	40	Vac Grp
11.2		Bake Out Beam Pipe	10 days	Wed 11/6/30	Wed 11/20/30	47	Vac Grp
11.3		Shield Wall Installation	3 days	Wed 11/6/30	Mon 11/11/30	47	Riggers
11.4		Global Interlock Testing	5 days	Mon 11/11/30	Mon 11/18/30	49	M Techs
11.5		Install EEEMCAL and pfRICH Detectors	5 days	Mon 11/11/30	Mon 11/18/30	49	Carps
11.6		Cabling and Testing	3 days	Mon 11/18/30	Thu 11/21/30	51	M Techs

- EPIC shutdown is 6 months (26 weeks) long
- The schedule shown is optimistic, and assumes:
  - Everything goes as expected
  - Support from BNL groups/collaboration exactly when needed
  - 1 week for holidays and 2 weeks for cosmics
  - Working one shift on weekdays
- To service inner most detectors we need to break vacuum and roll into the AH. After accounting for this process and its reversal, we only get 20 days for maintenance of all the inner detectors
- Time saved by eliminating need to perform task:
  - Bakeout the beam pipe: ~3 weeks
  - Roll in and out of the AH: ~5 weeks
  - Remove and install GST: ~6 weeks

EPIC Maintenance Goals

- There are 4 scenarios we consider for maintaining detectors:
  - **Scenario 1 -** Detectors are maintainable in IR, without breaking vacuum
    - **~ 90 days (18 weeks) for maintenance**
    - This is the ideal scenario, however in most cases only minimal inner detector maintenance can be done.
    - Endcap detectors, dRICH, BIC, and DIRC are included in this scenario..
  - **Scenario 2 -** Detectors are maintainable in IR, with breaking vacuum
    - **~ 75 days (15 weeks) for maintenance**
    - This is a middling scenario, allowing for more access to inner detectors, though not complete.
    - EEEMCal, pfRICH, oMPGD, ToF, and Cymbal are included in this scenario.
  - **Scenario 3 -** Detectors are maintainable in AH, without uninstalling GST
    - **~ 50 days (10 weeks) for maintenance**
    - This is a middling scenario, allowing for more space in Z for detector removal.
    - No detectors are included in this scenario unless the barrel is already in the AH.
  - **Scenario 4 -** Detectors are maintainable in AH, with uninstalling GST
    - **~ 20 days (4 weeks) for maintenance**
    - The is the least desirable scenario, however we will have access to all aspects of the detector.
    - Required for SVT and all Disks.

Gas Systems for ePIC

1. pfRICH, hpDIRC, BIC, ToF

- Uses dry Nitrogen
- Design requirements are understood and easy to implement.

2. MPGD

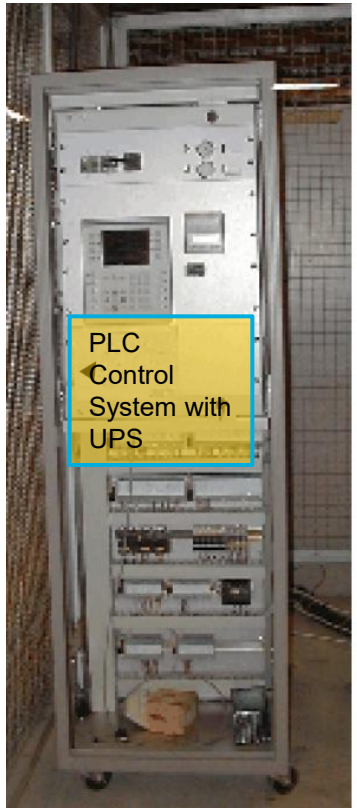
- Uses a mixture of **Argon, CO_2, and isobutane**
- **Gas mixture ratios** still need to be finalized
- A **dedicated safety system** is required due to the flammability of isobutane
- Design is **relatively straightforward** and can be implemented with standard practices

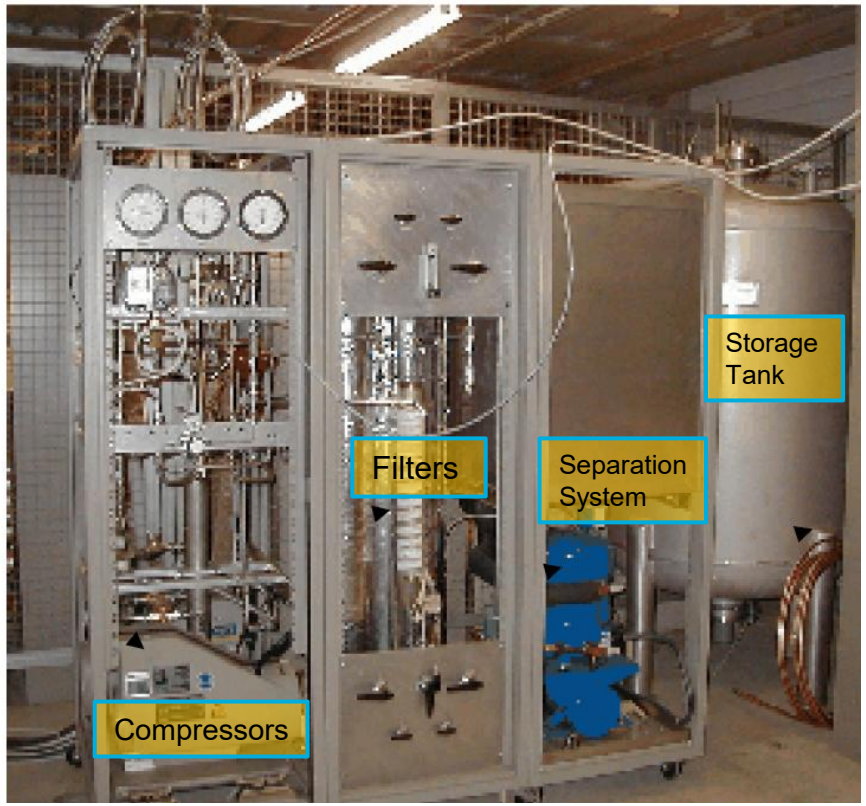
3. dRICH

- Uses **Hexafluoroethane (C_2F_6)** as the radiator gas
- Due to C_2F_6 being a **greenhouse gas**, a **recirculation/recovery system** is necessary
- System is **more complex** than the others
- Leveraging designs from **existing experiments** will help accelerate development
- Combination of gas filtering and phase separators will be used for the recovery system.
- **STAR TPC gas system plumbing** from gas pad to experimental hall is a potential candidate for reuse

4. SVT Air Cooling

- Uses compressed dry air
- Design requirements are to be determined



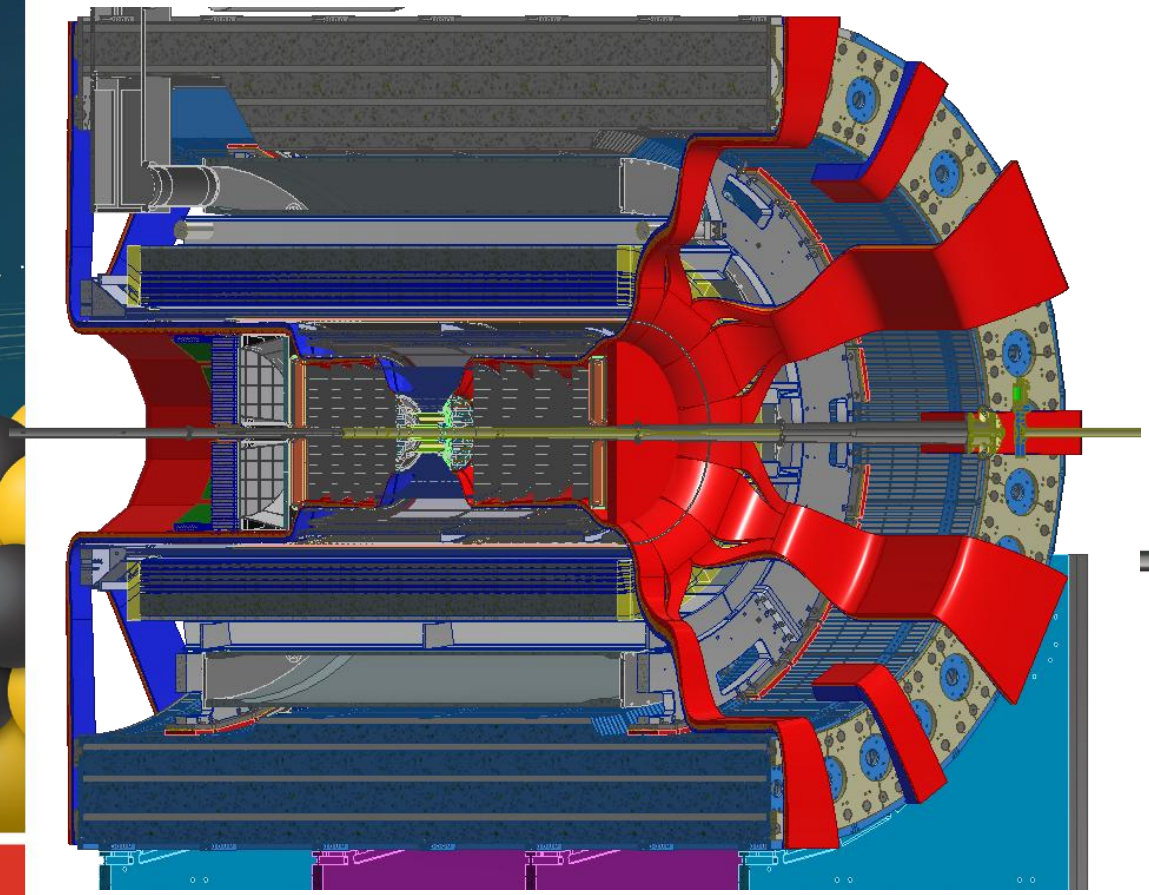


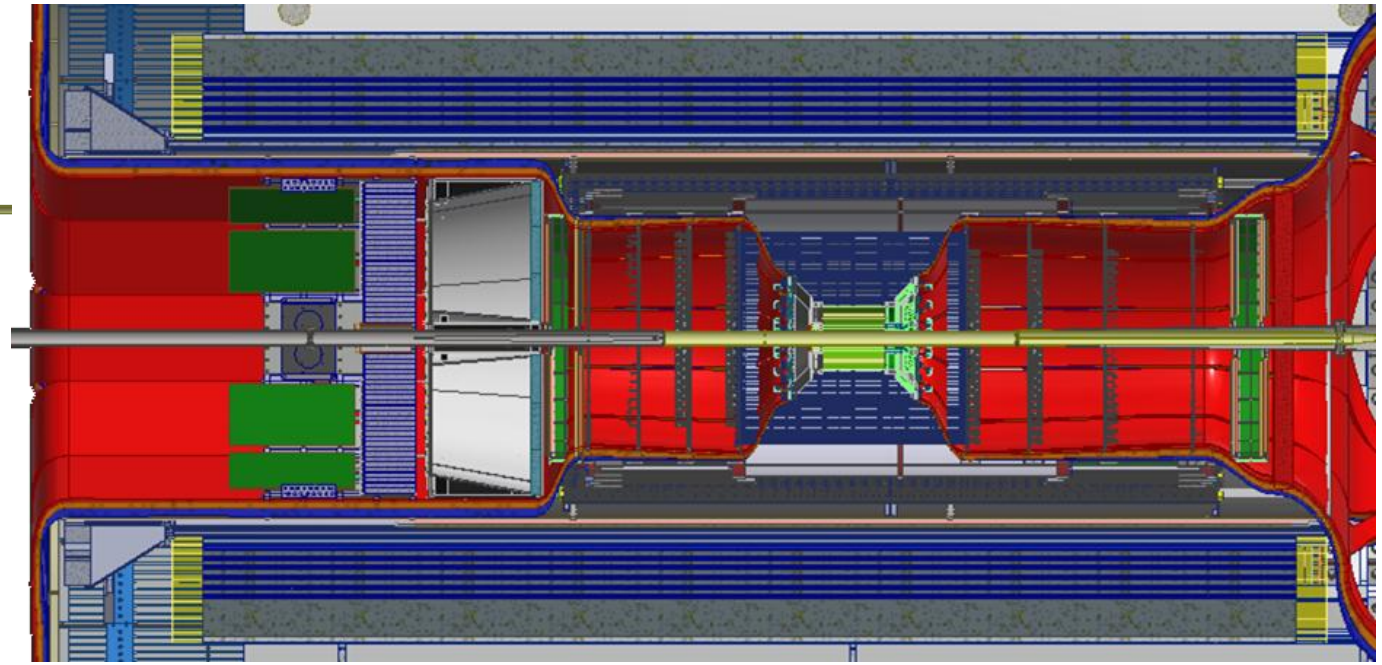
COMPASS RICH Gas system serves as a baseline to dRICH Gas System

Services Layout

- Services (Cables and Cooling Lines etc.) must pass through the gap between Endcaps and detector barrel
- Services Estimates were collected from various subgroups.
- Layout is shown in snapshots below.

Subsytem	Quantity	Cross Area (cm^2)	+50% Packing for Bundles	+50% for MISC spacing needs	Available Space		
Red Path IP to pfRICH Inner face							
Total	5503	754.98	1132.48	1698.71	1800.00	Used space:	94.37%
Red Path From pfRICH to EEEMCAL Inner face							
Total	6584	915.41	1373.12	2130.17	2251.00	Used space:	94.63%
Red Path From EEEMCAL to Flux Return Bars							
Total	19502	2487.80	3731.70	4906.26	9650.97	Used space:	50.84%
Orange Path From IP to AC-LGAD Disk							
Total	5503	754.98	1132.48	1698.71	1998.05	Used space:	56.68%
Orange Path From AC-LGAD disk to Aerogel							
Total	7739	1554.25	2331.38	3497.07	3568.85	Used space:	97.99%
Orange Path From dRICH Aerogel to Dogbones							
Total	8363	1720.87	2581.30	3968.25	4964.00	Used space:	79.94%
Orange Path From 4 to 5							
Total	12841	2281.32	3421.97	5229.26	12189.38	Used space:	42.90%





Detector Reviews planned for 2025

Preliminary Design Reviews (60% design maturity equivalent, called PDR, PDR2 or PDR3, pending the subsystem)

- PDR: MPGD Tracking Detectors (6.10.03.02) – Summer/Fall 2025 – Note: FDR only after completion of first engineering test articles
- PDR2: Silicon Tracking Detectors (6.10.03.01) – Fall 2025 – TBD, pending early results of ITS3 ER2
- ✓ PDR2: Cherenkov-based Particle Identification Detectors (6.10.04; pfRICH, hpDIRC, dRICH) – April 1-2, 2025
- PDR2: AC-LGAD-based Particle Identification Detectors (6.10.04; BTOF, FTOF, common systems) – November 2025
- PDR3: Barrel EM Cal (6.10.05.02) – August 28-29 (?) 2025 → **Confirmed for September 17-18 to accommodate reviewers**
- PDR2: Backward HCAL (6.10.06.01) – ~September 2025
- PDR: Magnet Cryogenics and infrastructure (6.10.07) – September/October 2025
- PDR3: Electronics/DAQ-computing (6.10.08. 6.10.09.01) – **Confirmed for September 3-4 2025** – this does not include slow controls
- PDR: DAQ-Slow Controls (6.10.09.02) – November/December 2025 – Later to ensure integration DAQ in the collider common platform
- PDR: Integration, Infrastructure and Installation (6.10.10) – September/October – everything outside GST, includes cradle, HCAL, etc.
- PDR: Integration, Infrastructure and Installation (6.10.10) – November/December 2025 – everything inside GST
- PDR3: IR Integration and Auxiliary Detectors (6.10.11) – November/December 2025 – includes 6.10.14 lumi detector
- PDR2: Polarimetry (6.10.14) – September/October 2025 – January/February 2026

Final Design Reviews (FDR):

- ✓ FDR**:** Final Design Review of the BABAR DIRC Bar Refurbishment for the High Performance DIRC Particle Identification Detector – April 1, 2025
- FDR: Forward EM Calorimetry (6.10.05.03) – **aim for last week July (July 31?) → reconsidered and will do PDR this Fall**
- FDR: Backward EM Calorimetry – → **February 2026?**. Barrel & Forward HCAL (6.10.05.01; 6.10.06.02; 6.10.06.03) → **will do PDR this Fall**

Project Reviews:

- ✓ DOE OPA CD-3B Review – January 7-9, 2025
- ✓ "Red Team" Review (acts as Director's Review for DOE OPA Focused Status Review) – May 20-21, 2025
- DOE OPA Focused Status Review – August 5-7, 2025

Other Meetings:

- ✓ EIC International Computing Organization (EICO) – April 2–4, 2025 @BNL
- ✓ Detector R&D Day hosted by ePIC and EIC Project – April 16-17, 2025
- ✓ Technical interchange meeting with EIC Computing and Software Advisory Committee (ECSAC) – May 12, 2025
- ✓ 5th RRB Meeting**:** June 5-6, 2025 – Prague, Czech
- ✓ 10th DAC Meeting – Comprehensive look to design status and readiness for CD-2**.** June 11-13, 2025.
- 6th RRB Meeting: November 4-5, 2025 - BNL

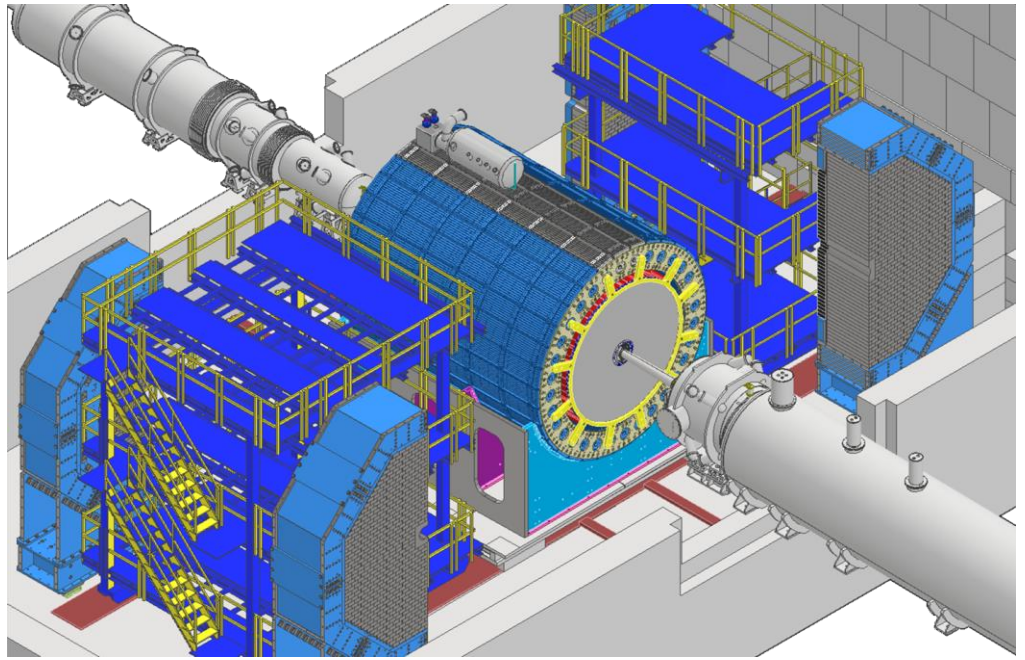
Summary

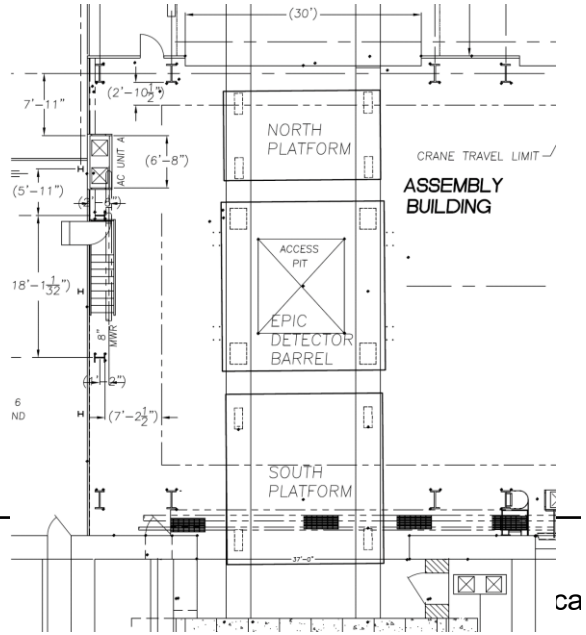
- Minor updates to various detector envelopes
- Changed from Hilman rollers to air bearings to allow for easier and more precise positioning of the central detector
- Updated designs for the barrel EMCal support, DIRC and oMPGD support, and GST/PST
- Cymbal changing from 8 segments to 12 for serviceability
  - See Audrey's talk on Friday
- Cabling plan and RDO placements needs to be further refined with cable trays etc.
  - See Roland's talk
- Cooling and power requirements for various detectors and electronics are being refined
  - See Girish's talk
- PDRs for support structures, integration and installation to be held from Oct to Dec 2025.
- PDRs for subsystems will be held throughout the remainder of this year

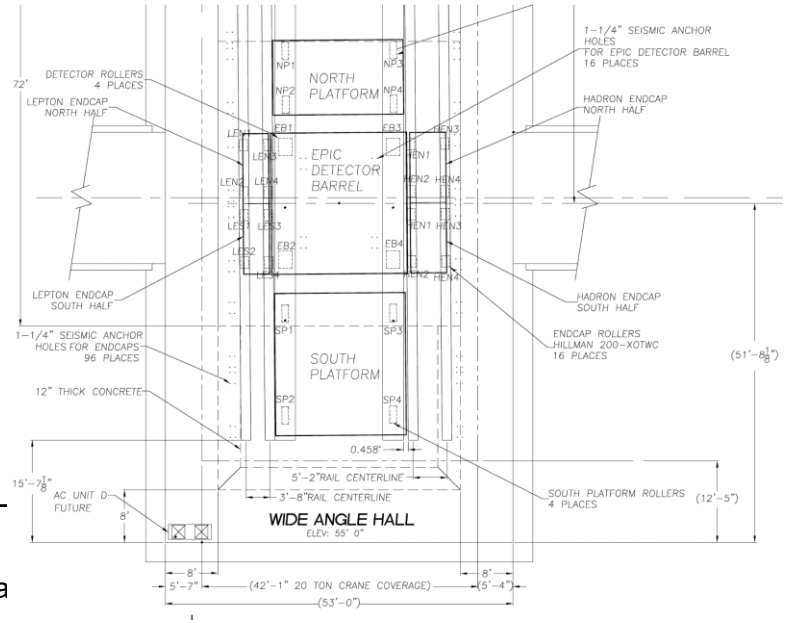

BACK UP

Infrastructure and Utilities

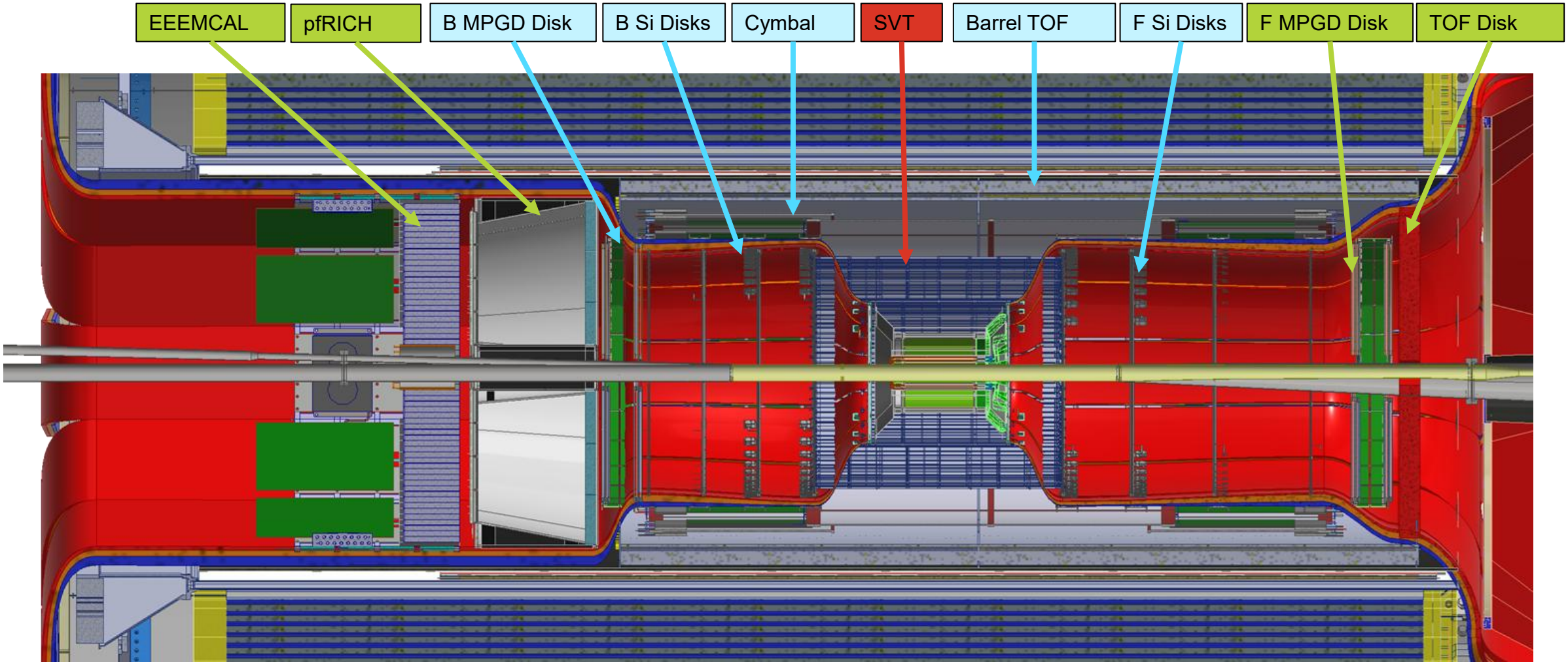
- ePIC detector weight including Endcaps is more than existing STAR detector.
- Analysis required to find out if any modifications are needed to the current concrete floor.
- New rails will be needed for the Endcaps
- Detailed explanation of following details were put together in the document “EPIC Floor Loads and Placement” and have been provided to EIC Infrastructure Group.
  - Hillman Rollers and their placement,
  - Location of new rails,
  - Weights of EPIC Barrel, Hadron & Lepton Endcaps
  - Other relevant details with detailed drawings and model snapshots.
- SOW with Requisition in BNL Procurement System.
- External consulting firm to analyze loads on concrete floor.
- Detailed explanation of utilities and upgrades needed were also put together in the document “EPIC Utilities” and have been provided to EIC Infrastructure Group.





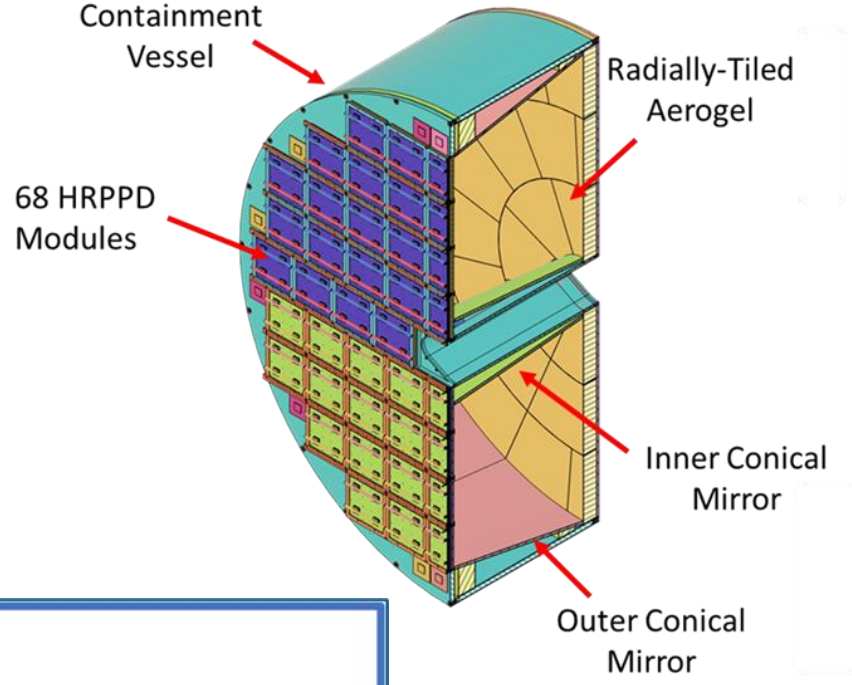


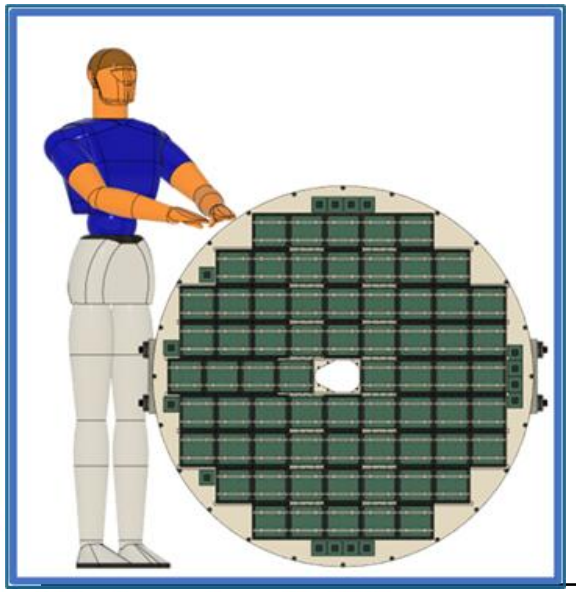
GST Model with Detectors



- Current Inner Detector Models inside GST.
- Working on design modifications to make Barrel TOF and Cymbal detectors serviceable in the experimental hall.

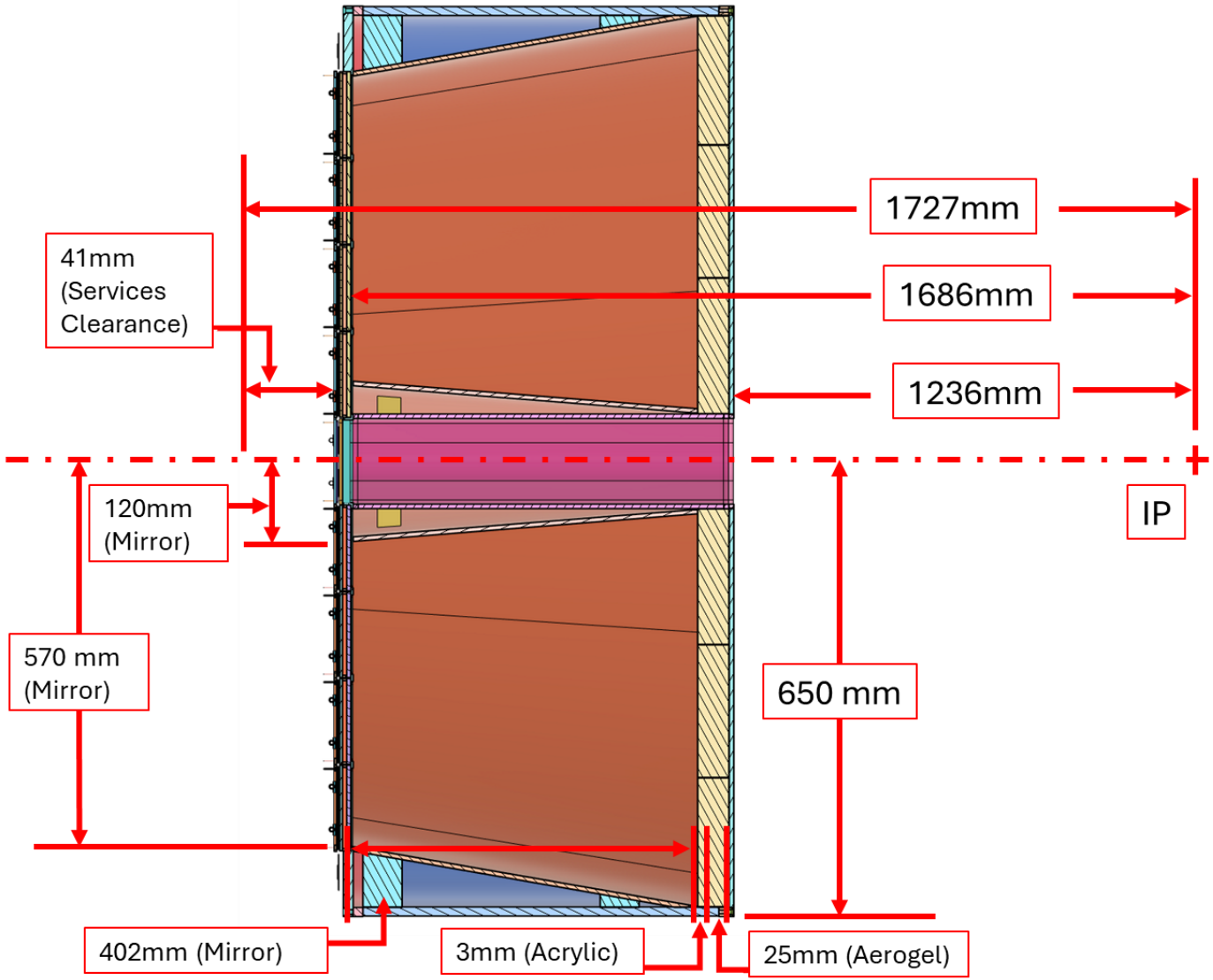
pfRICH





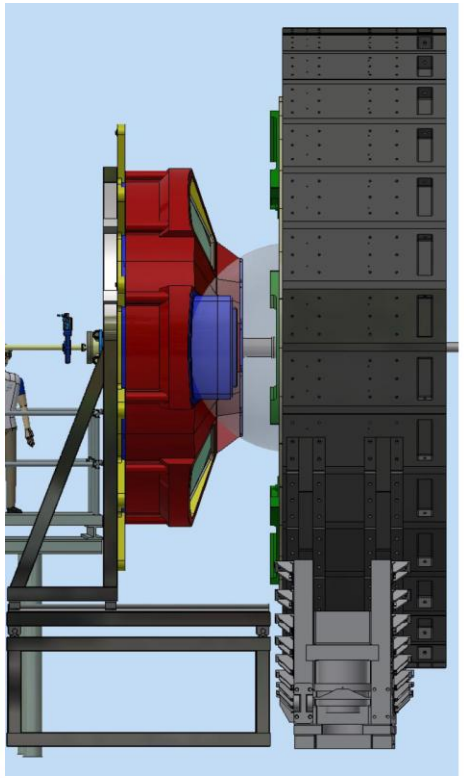
Major Components:

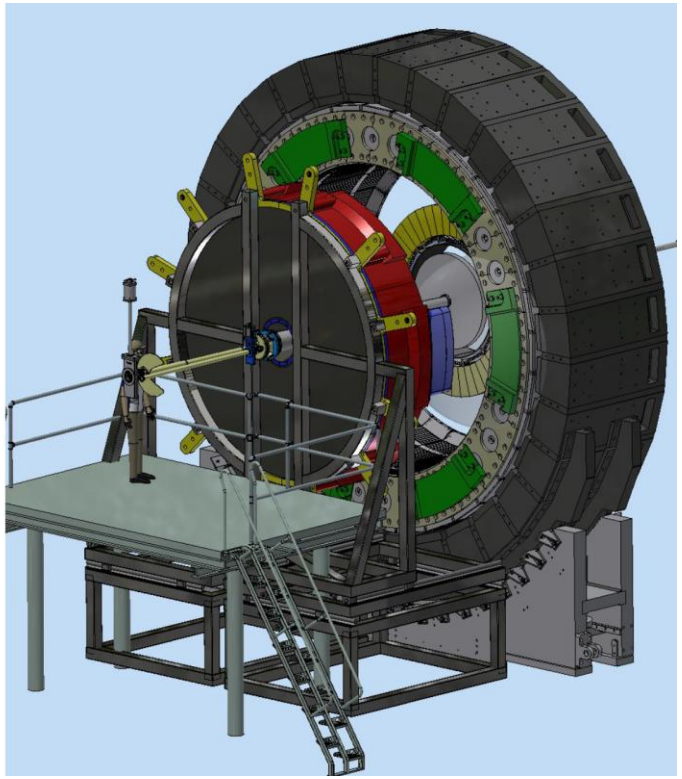
- Vessel
- Sensor Plane
- Mirrors
- Aerogel Wall

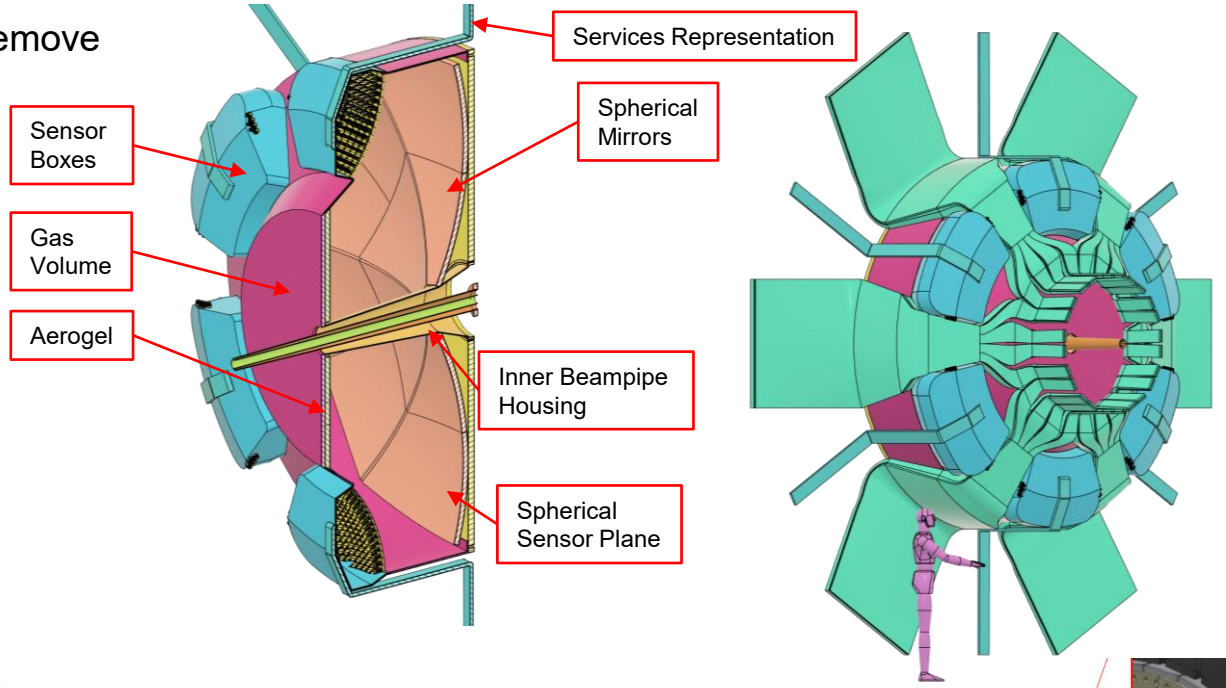


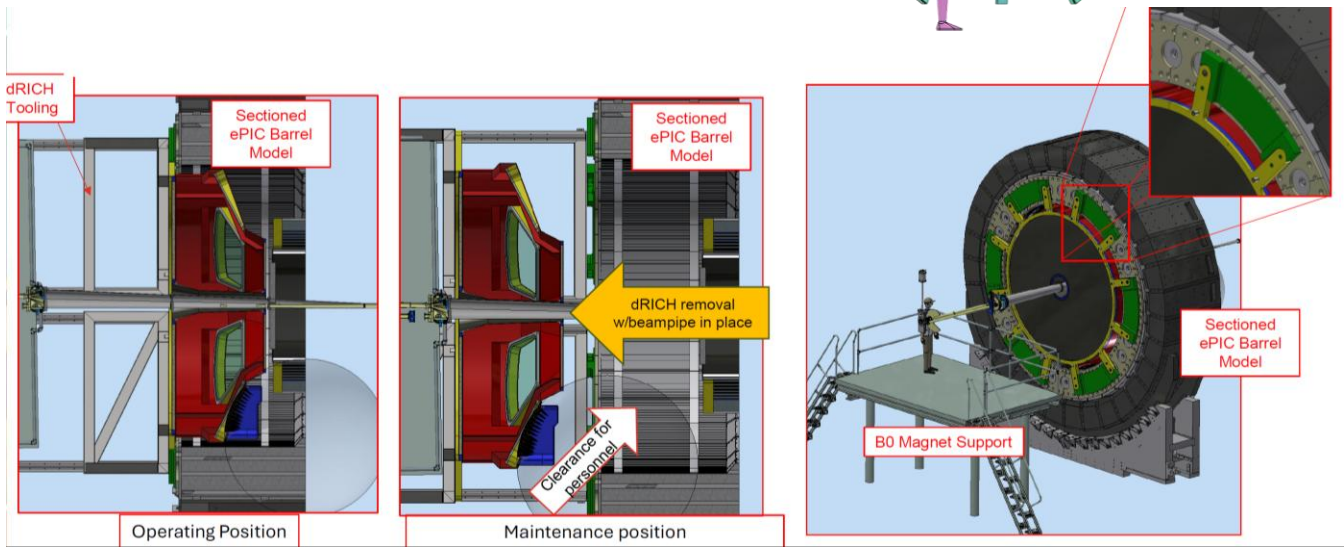
dRICH

- Due to the anticipated need for maintenance in the hall, options to remove the dRICH were investigated.
- dRICH is kept whole and slid as far back as possible.



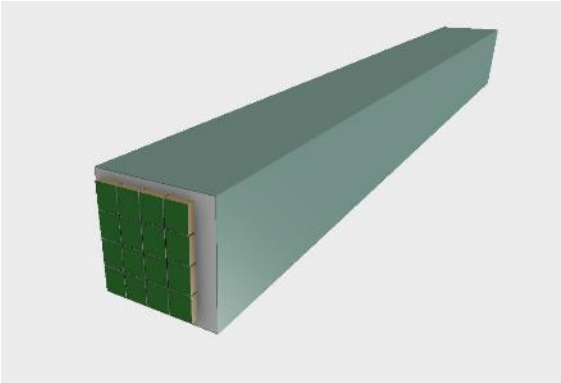




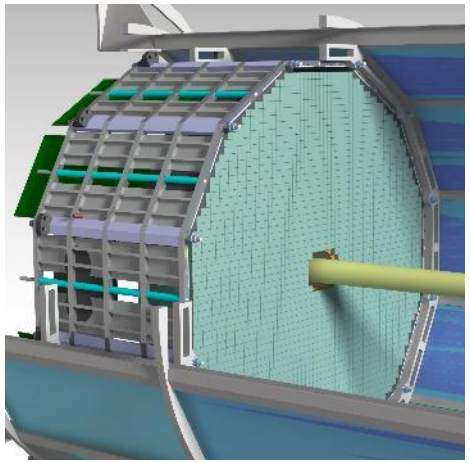


EEEMCal

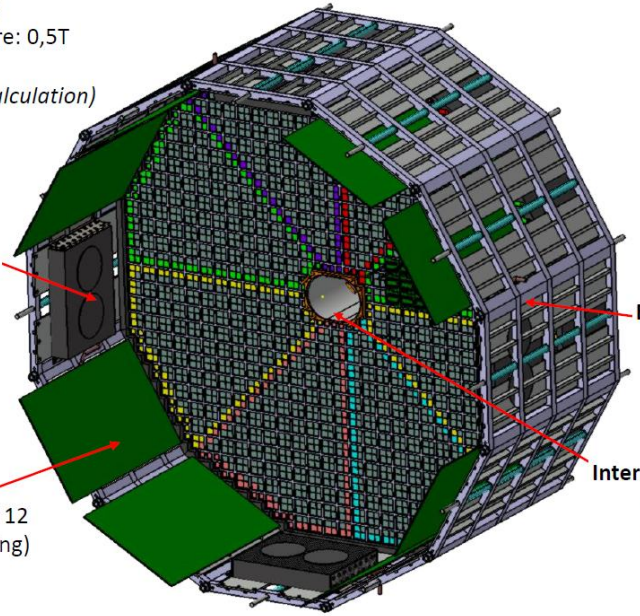
SiPM and crystals configuration



Mechanical design & Clearances

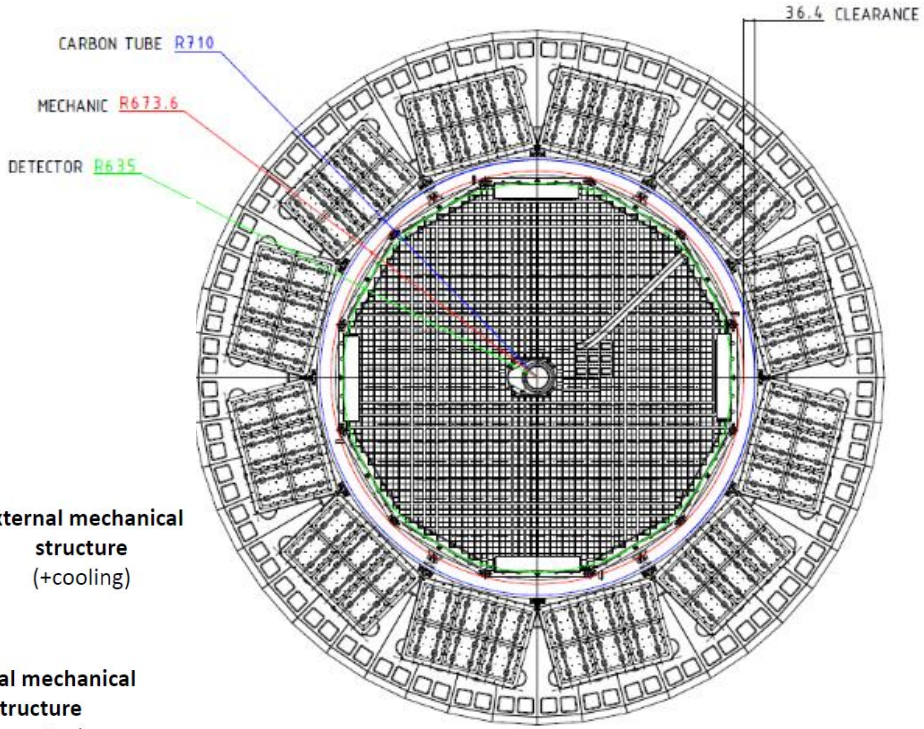


EEEMCAL detector:
Mass max of the structure: 0,5T
Mass of the crystals: 2T
(To be consolidated by calculation)

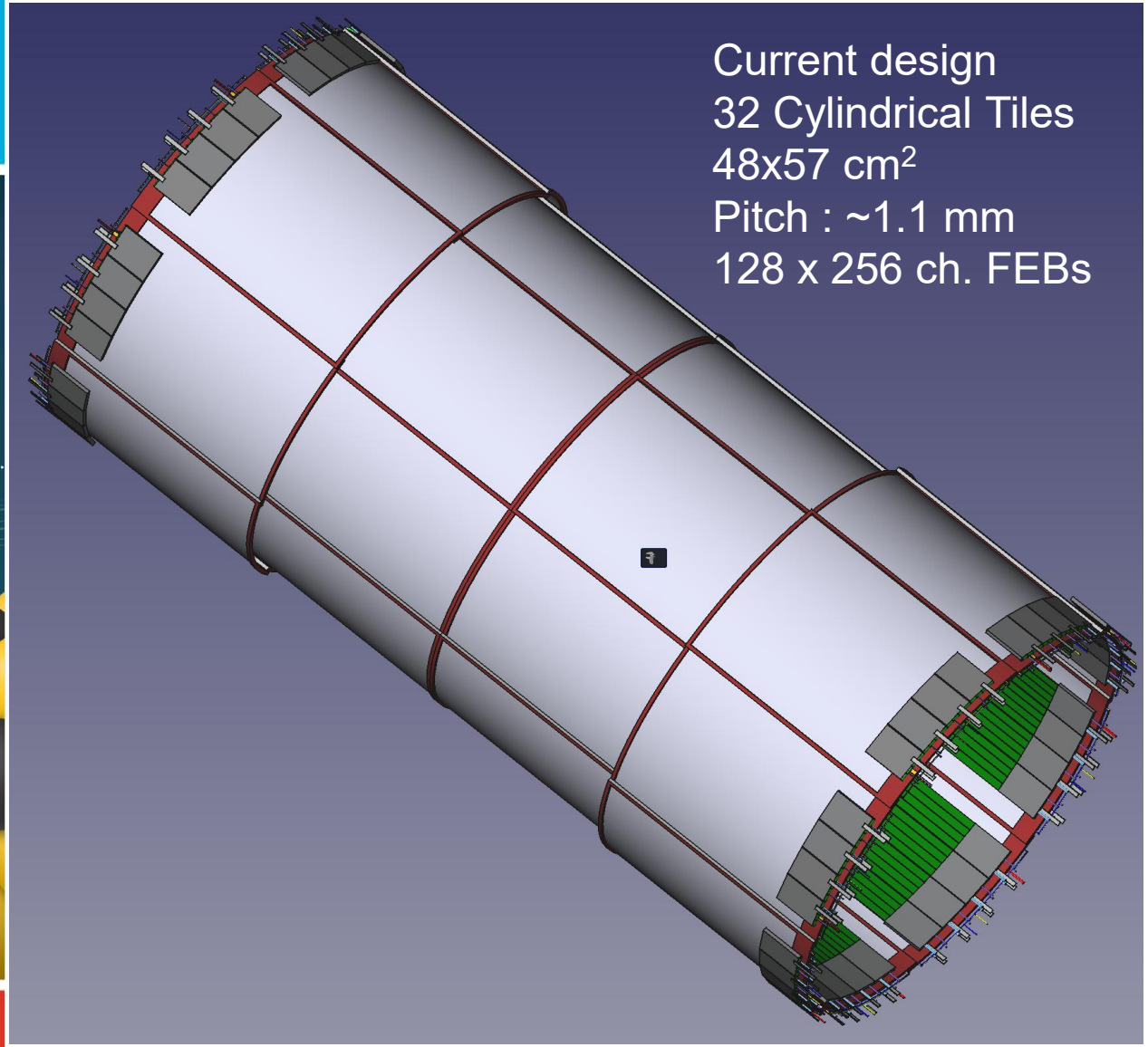


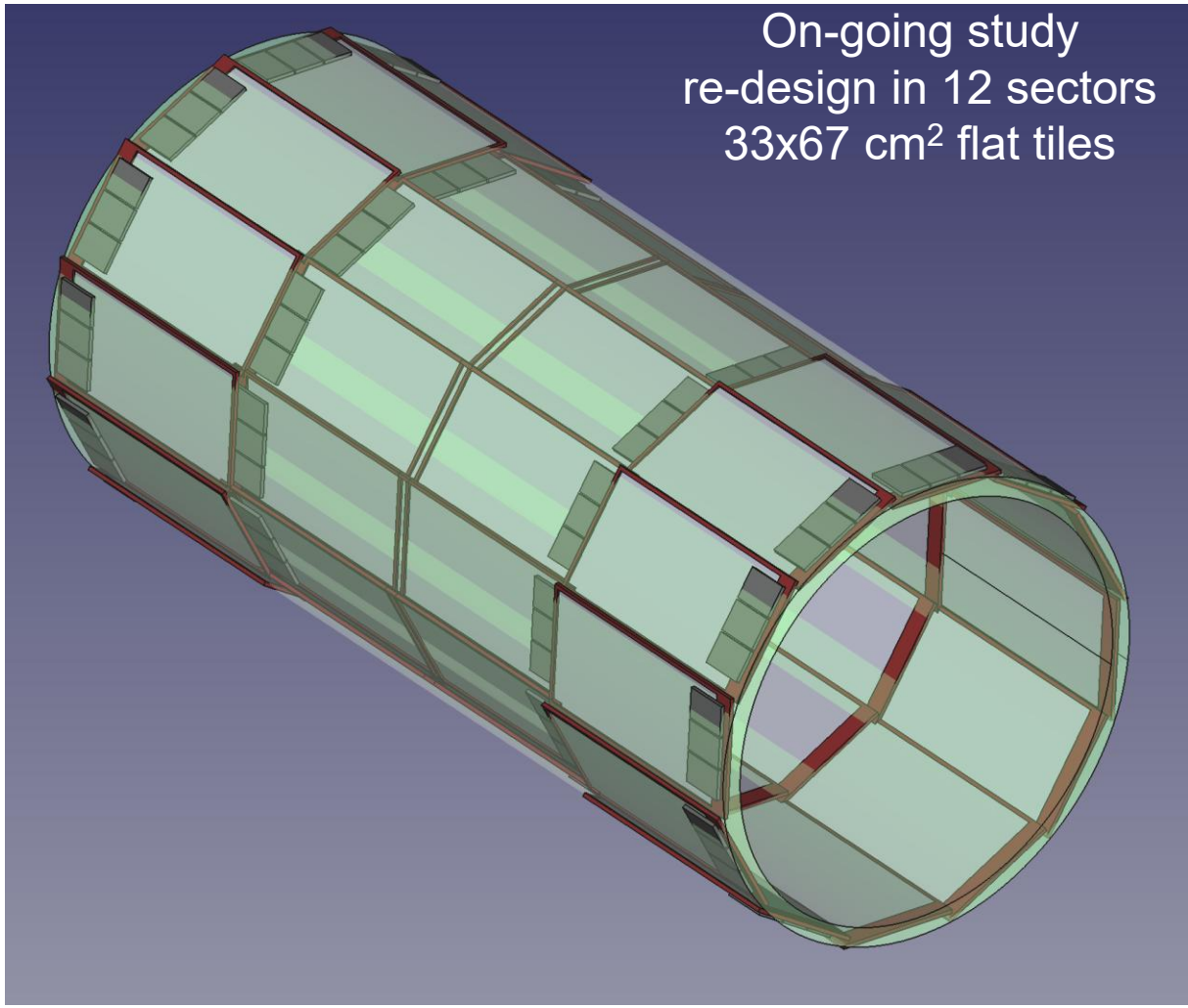
Cooling

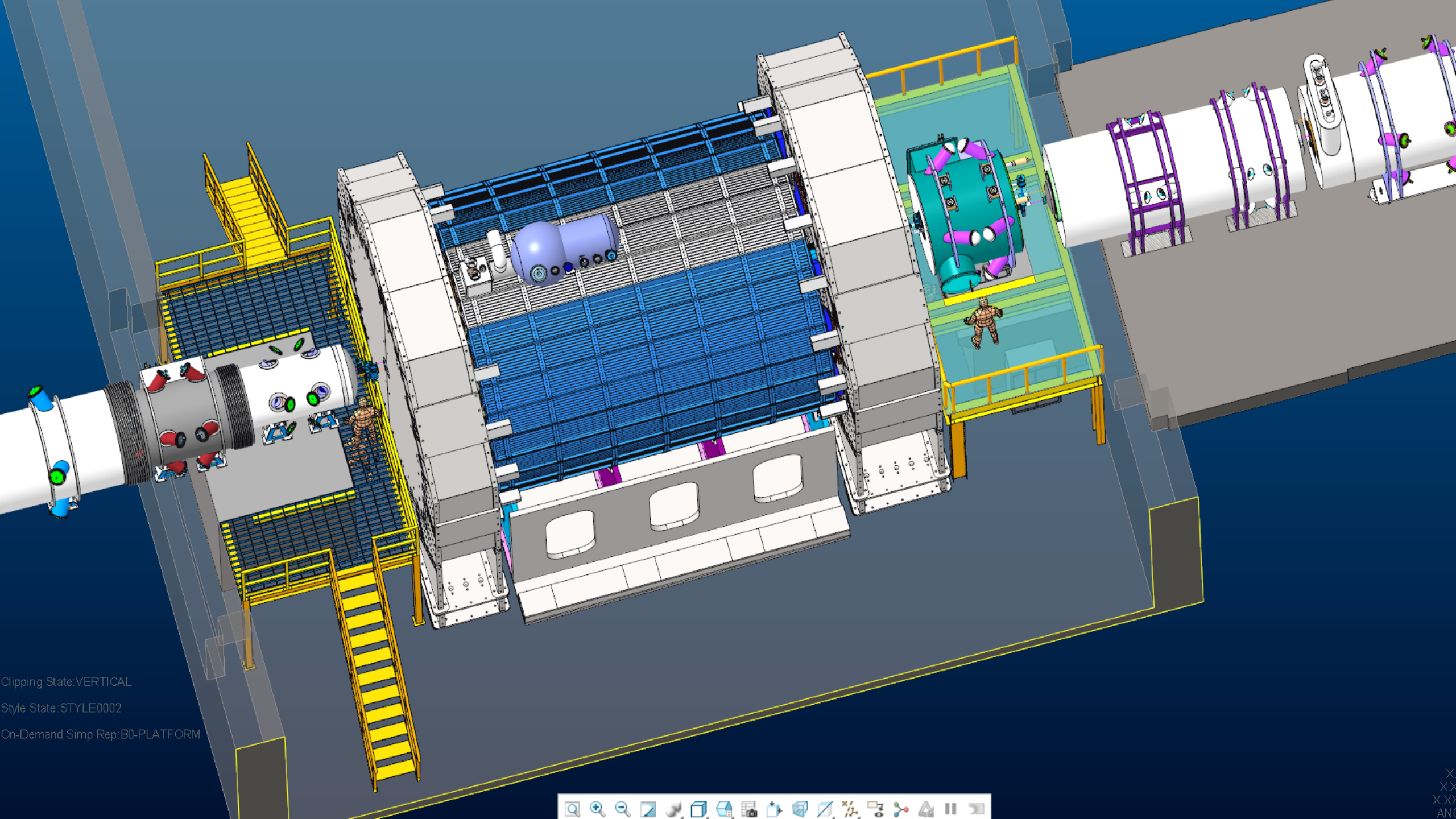
- Stability required : +/- 0,1 °C
- Power: 50 W (by box)
- Copper plate in front < 5 mm
- Water cooling plate (internal & external)
- Air cooling for the electronic boxes



From 8 to 12 inner MPGD sectors



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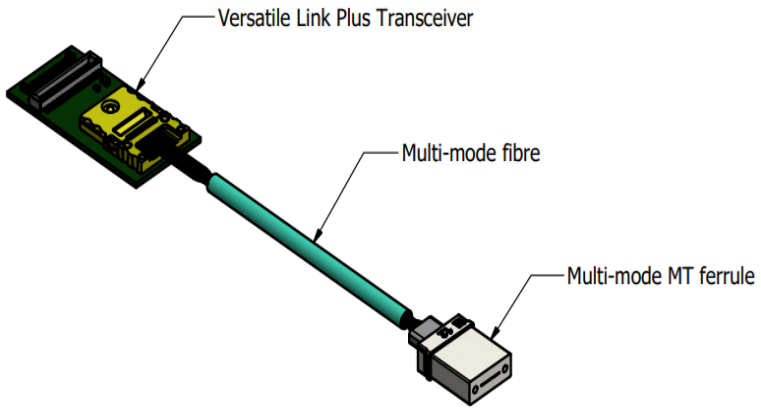
ePIC Detector Electronics Power & Services

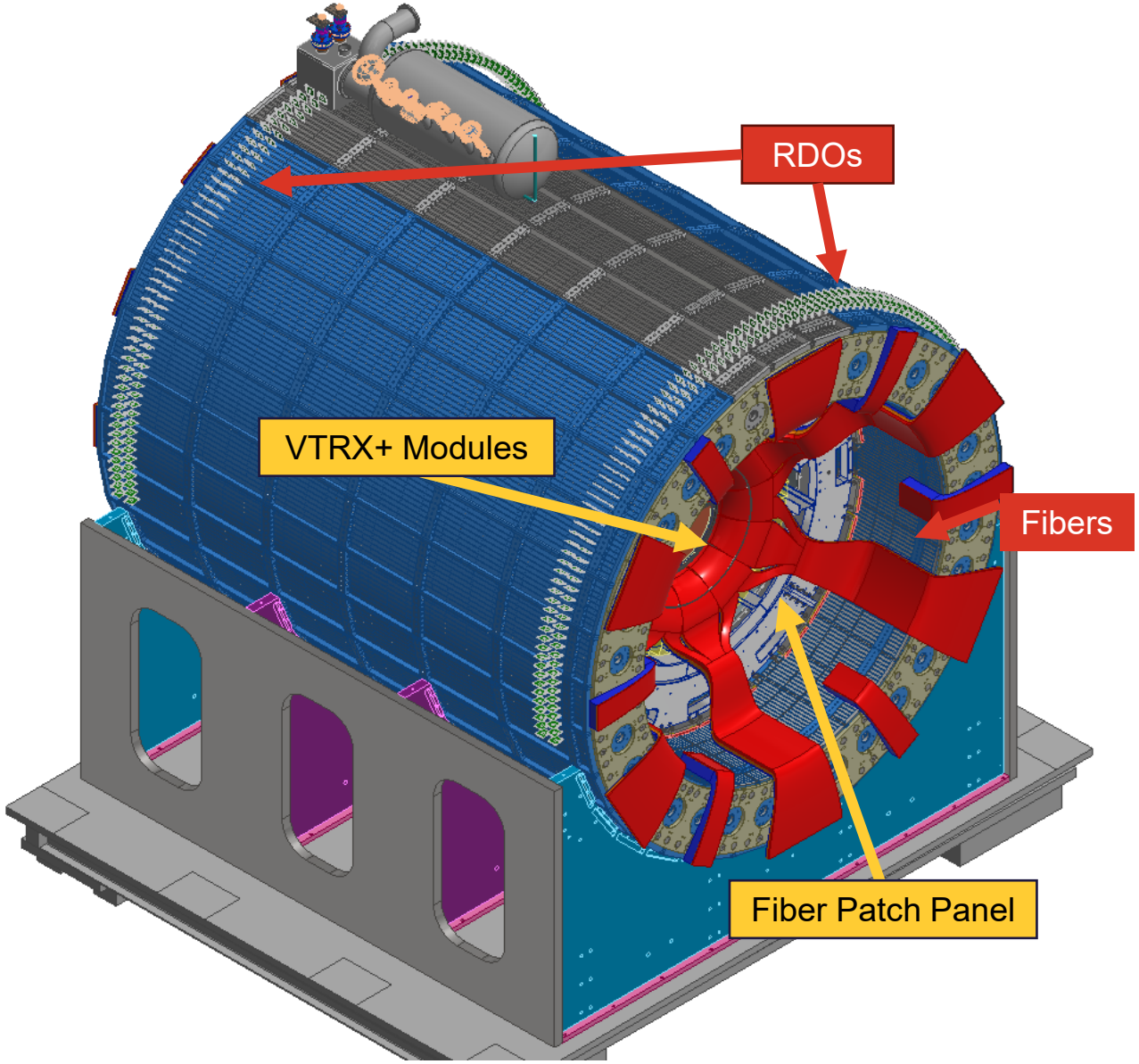
Detector	Type	Front End LV Power	HV Bias	LV Power Supply Type	HV Power Supply Type	Power Supply Location	LV Power Feed	LV Feed Cables	Cooling
EE HCAL	SiPM	200W	50W@ 50V	MPV 4016I	Wiener MPV 8120I	S. Platform, 19" rackmount	10V @ 20A	4x 14 AWG	Liquid
E-EE EMCAL	SiPM	500W	500W@50V	MPV 4016I	Wiener MPV 8120I	W. Platform, 19" rackmount	10V @ 50A	4x 12AWG	Convection
pfRICH	HRPPD	260W	70W@3kV	MPV 4018I	CAEN A1515BV	S. Platform, 19" rackmount	1.2V@ 220A	14x 12AWG	Liquid/ Neg. pressure
EE MPDG Disk	uRWELL	350W	1.5W@1.5kV	MDH-07/16	CAEN A1515BV	S. Platform, 19" rackmount	10V @ 315A	2x 10AWG	Liquid
Outer Barrel MPGD	uRWELL	1.6kW	1.5W@1.5kV	MDH-07/16	CAEN A1515BV	S. Platform, 19" rackmount	10V @160A	12x 12AWG	Liquid
Inner Barrel MPGD	uRWELL	700W	1.5W@1.5kV	MDH-07/16	CAEN A1515BV	S. Platform, 19" rackmount	10V@120A	15x 12AWG	Liquid
MAPS Disk	EIC-LAS	3kW	Derived from LV system	MPV 4018I	N/A	S. Platform, 19" rackmount	3.6V@ 960A	48x 10AWG	Liquid
MAPS Sagita Layer3	EIC-LAS	680W	Derived from LV system	MPV 4018I	N/A	S. Platform, 19" rackmount	2.4V@ 194A	16x 12AWG	Liquid
MAPS Sagita Layer4	EIC-LAS	1.4kW	Derived from LV system	MPV 4018I	N/A	S. Platform, 19" rackmount	4.8V @ 235A	18x 12AWG	Liquid
Barrel HCAL	SiPM	220W	1.6W @50V	MPV 8016I	MPV 8120I	S. Platform, 19" rackmount	10V @ 22A	8x 16AWG	Liquid
Barrel ECAL	SiPM + AstroPix	1.6kW	1W @50V & 100W @ 400V	MDH-07/16	MPV 8120I & EHS F005p	S. Platform, 19" rackmount	10V @ 160A	16x 12AWG	Liquid
DIRC	HRPPD	300W	70W@3kV	MPV 4018I	CAEN A1515BV	S. Platform, 19" rackmount	1.2V@ 250A	16x 12AWG	Liquid
Barrel TOF	AG-LGAD	2400W	4W@400V	PL506	CAEN A1625	S. Platform, 19" rackmount	10V @ 240A	12x 10AWG	Liquid
HE TOF	AG-LGAD	10.6kW	4W@400V	PL506	CAEN A1625	S. Platform, 19" rackmount	10V @ 1,060A	48x 10AWG	Liquid
dRICH	SiPM	300W	23W@70V	MPV 4016I	MPV 8120I	S. Platform, 19" rackmount	10V @ 30A	4x14AWG	Liquid
FWD ECAL	SiPM	2.8kW	750W@ 50V	PL506	MPV 8120I	W. Platform, 19" rackmount	10V @ 280A	20x 12AWG	Liquid
HE HCAL	SiPM	1.7kW	3kW@ 50V	PL506	MPV 8120I	E. Platform, 19" rackmount	10V @ 170A	12x 12 AWG	Convection

- MARCO (SC Magnet) Power:
  - New Power Supplies will be used. Existing water-cooled leads for STAR (Length 300 feet) with current capacity >4000 Amps were evaluated by ePIC Magnet Group can be used. New Magnet DAQ Rack will be placed on Third Level of South Platform and Dump Resistors on the Third Level of North Platform.
- Looking at the STAR Detector Power One Line Diagram and comparing it with the EPIC Detector power requirements for various subdetectors, it seems like we have adequate power for EPIC needs. The EPIC detector Electronics power was estimated using table above which is available on sharepoint. **Refer to ePIC Services on-line Spreadsheet for details of power distribution.**

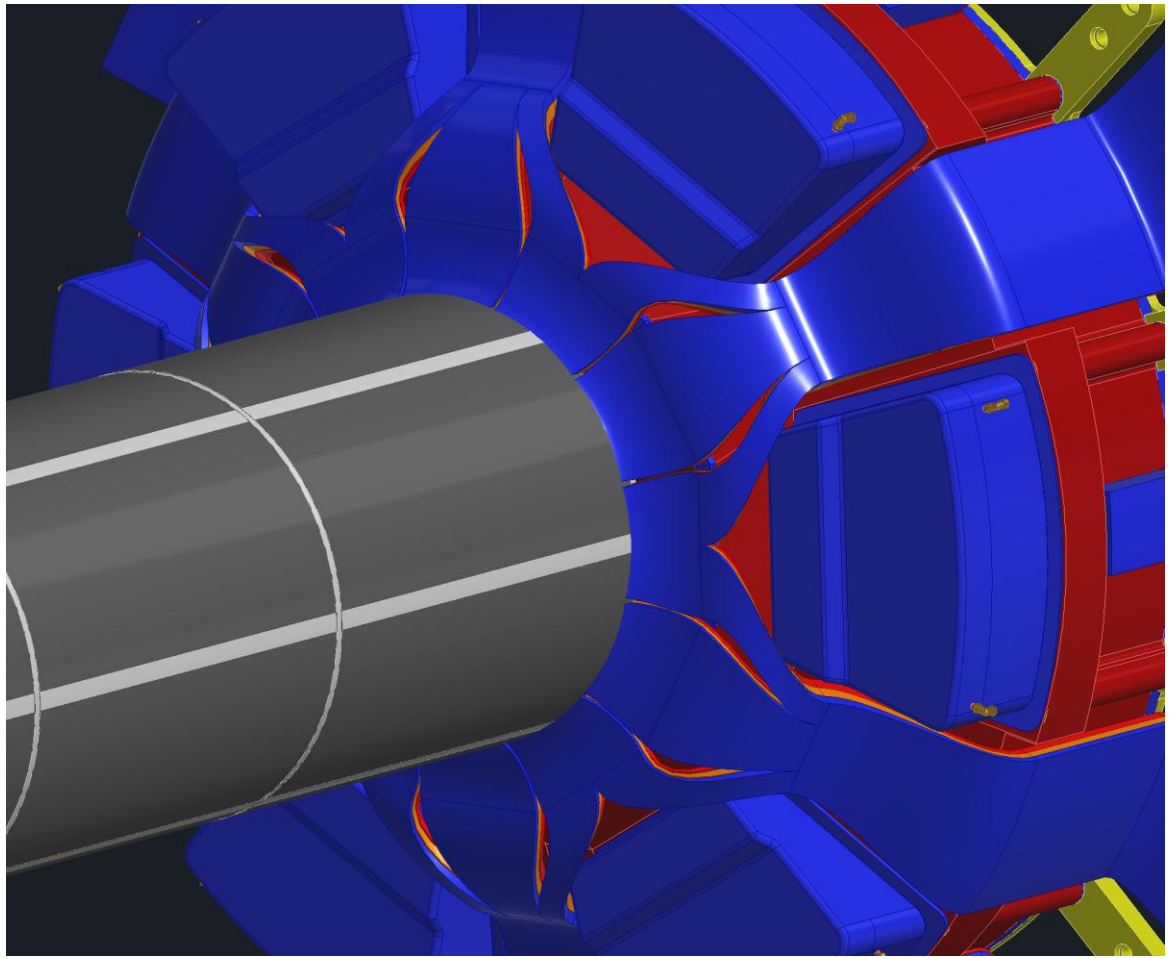
RDO Placement

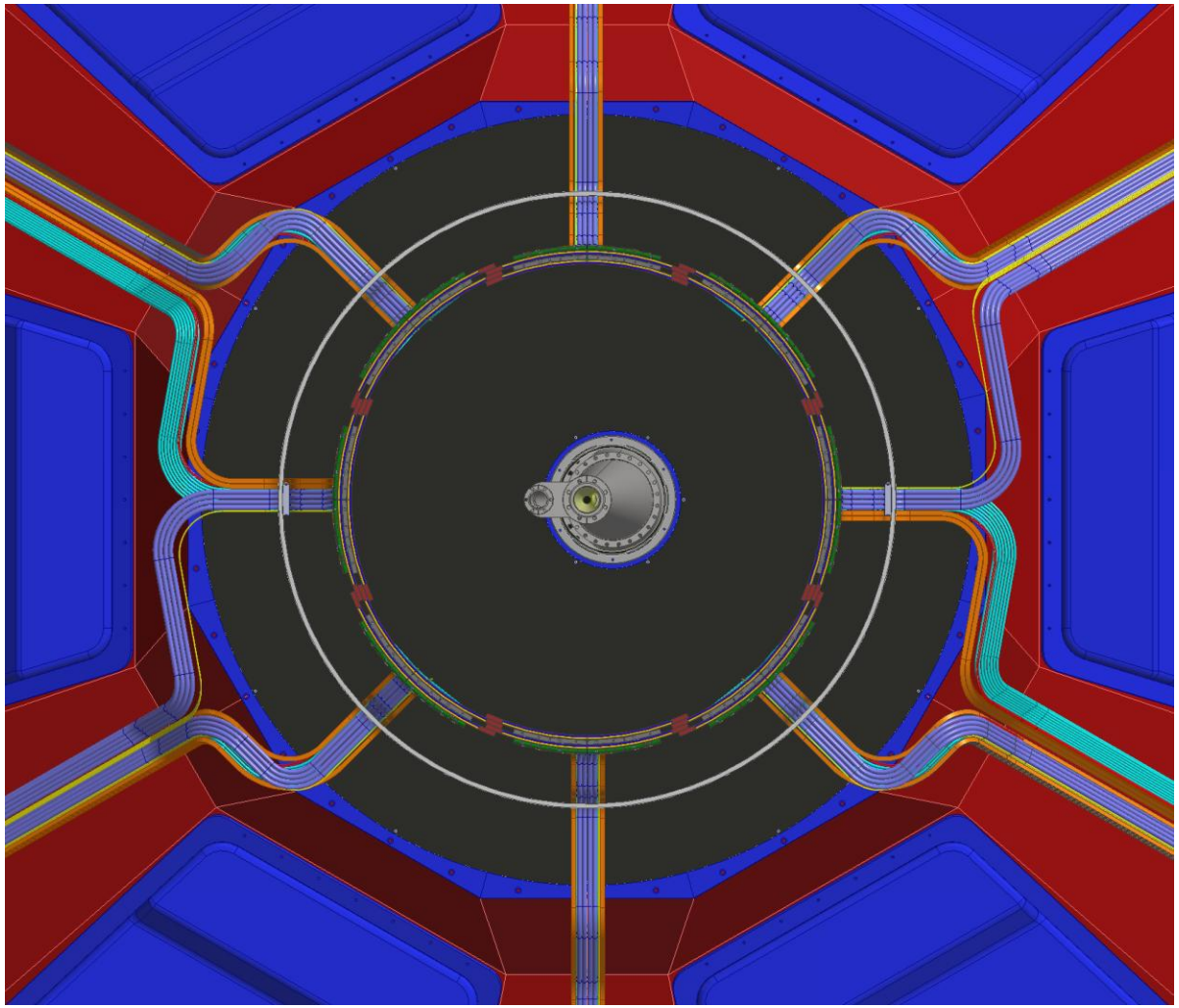
- Summer 2024 added VTRX+ modules
- The RDOs can now be placed much farther away, outside the detector
- RDOs will be mounted to the outside diameter of the sPHENIX HCAL where space is available
- VTRX+ Modules will be placed on each detector adjacent to their FEBs





Forward Service Routing





Maintenance Plan for ePIC

Detailed ePIC Installation Schedule and Maintenance Schedules were created and are posted as prebrief materials. Following maintenance plan will be followed for detectors:

- HCAL: HCAL Sectors are not removable. All the electronics will be on the exterior and is accessible for maintenance.
- Magnet: Cryostat is not removable. Chimney and Phase separator are on top of HCAL and are accessible for maintenance.
- Barrel EMCAL: Is removable only in case of full upgrade of the detector. All electronics are accessible on both ends.
- DIRC : Bar Boxes can be removed but not needed. Electronics are accessible from the backward end.
- Outer MPGD: Modules can be removed inside the experimental hall for full maintenance.
- Cymbal & Barrel TOF: Modules can be removed inside the experimental hall for full maintenance.
- EEEMCAL and pfRICH: Detectors can be removed inside the experimental hall for full maintenance.
- dRICH: Detector can be removed inside the experimental hall for full maintenance.
- Inner Detectors (Si Disks, Si Tracker, MPGD Disks): GST can be removed in the assembly hall for full maintenance.
- TOF Disk: Detector can be removed inside the experimental hall for full maintenance.
- Forward HCAL: Towers/Modules not removable. Electronics accessible from the back end.
- Forward EMCAL: Modules removable. Electronics accessible from the back end.
- Backward HCAL: Towers/Modules not removable. Electronics accessible from the front end.
- Electronics racks/chillers/cooling systems/gas systems are accessible from north and south platforms.