

Detector Integration and Design

Alex Eslinger, Dan Cacace,
Rahul Sharma, & Roland Wimmer
EIC User Group Meeting

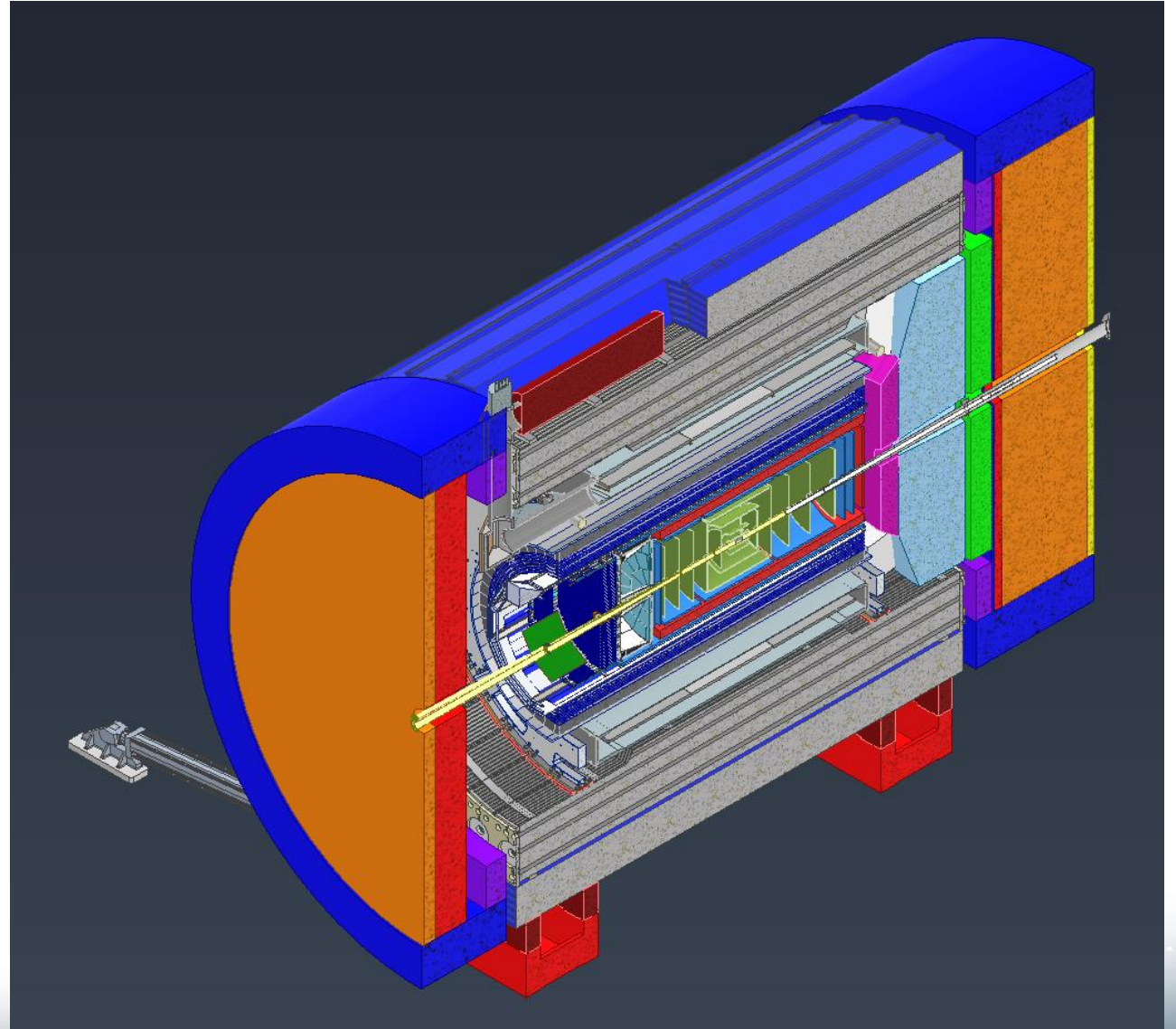
July 26, 2023

Electron-Ion Collider



Outline

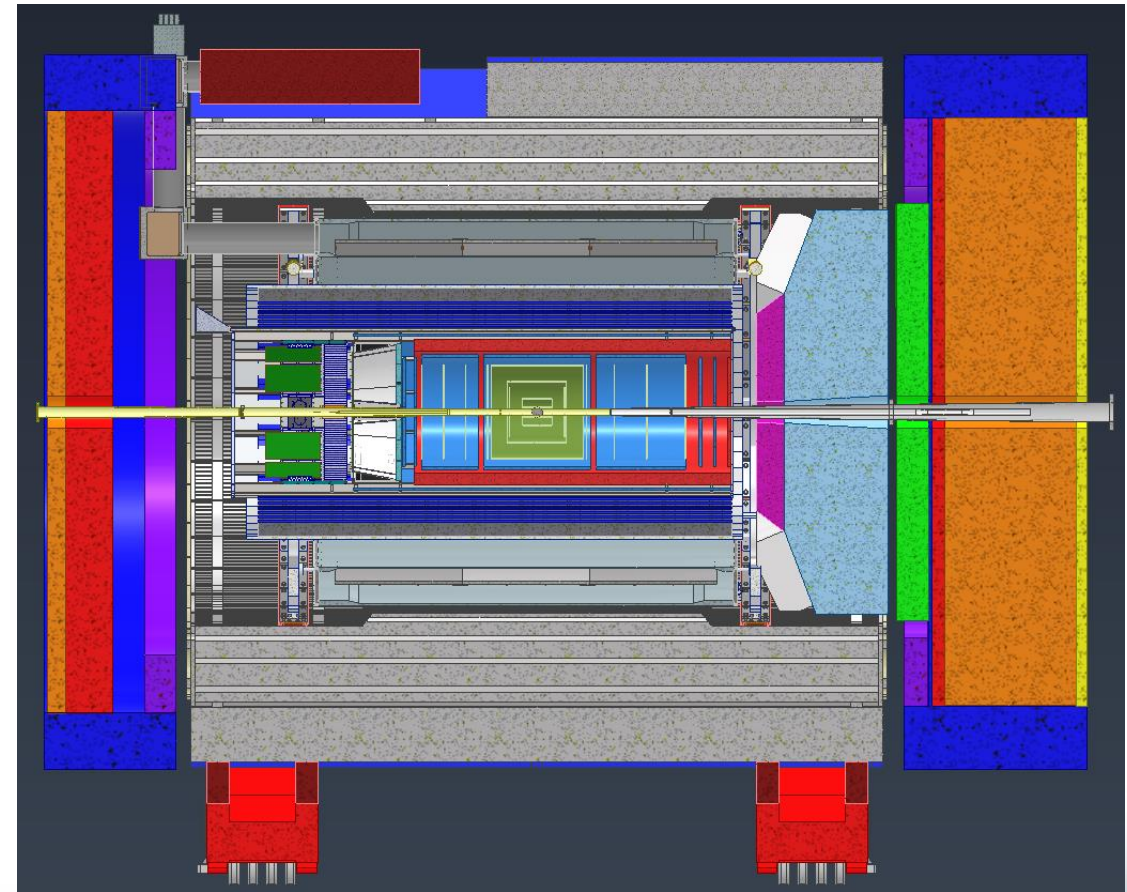
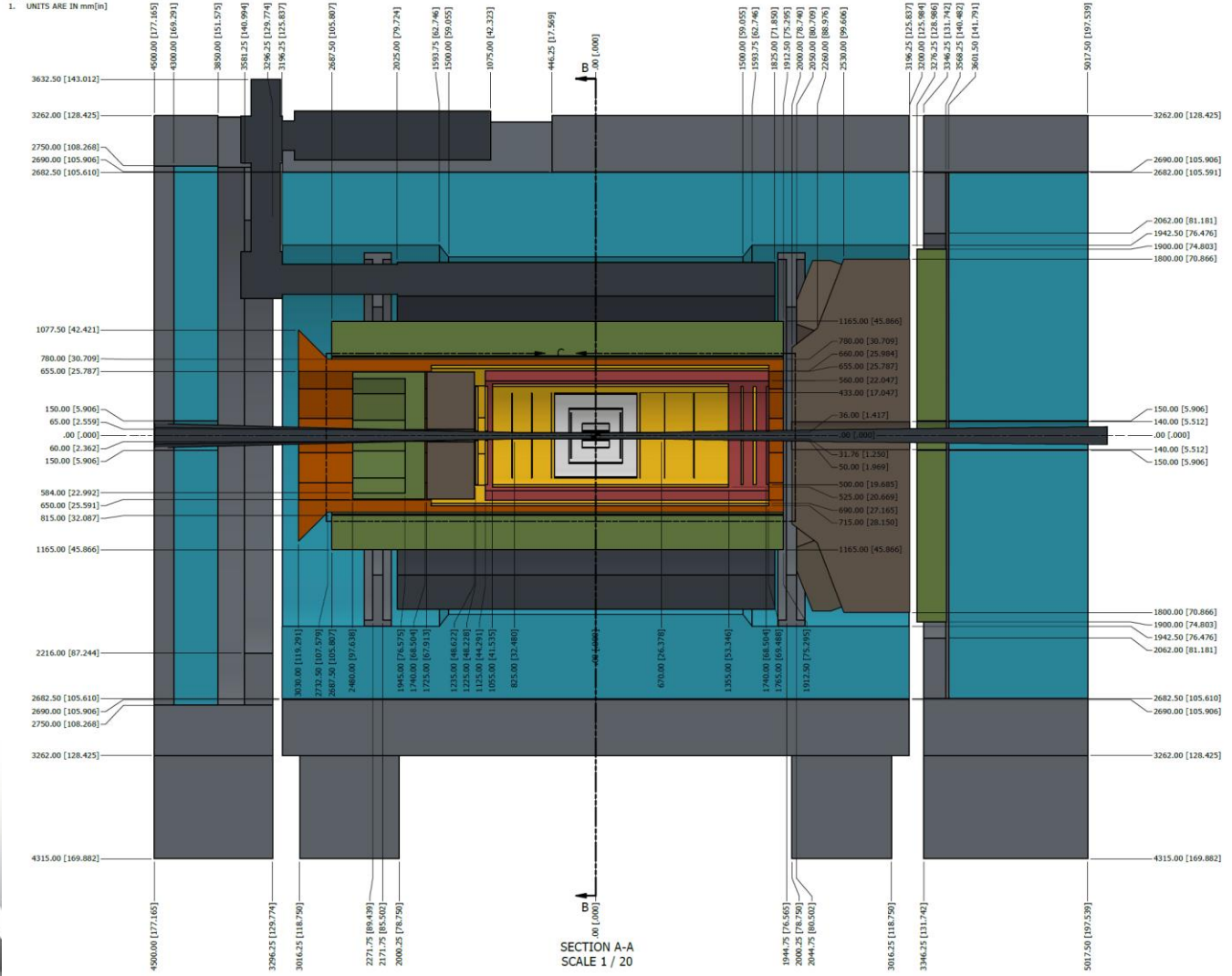
- CAD Models
 - Full model
 - Model overviews
 - dRICH
 - pfRICH prototype
 - DIRC Support
- Services Layout & Management
- Platform Modifications
- Endcap Tasks
- Next Steps



Full Model Overview

NOTES:

1. UNITS ARE IN mm(in)



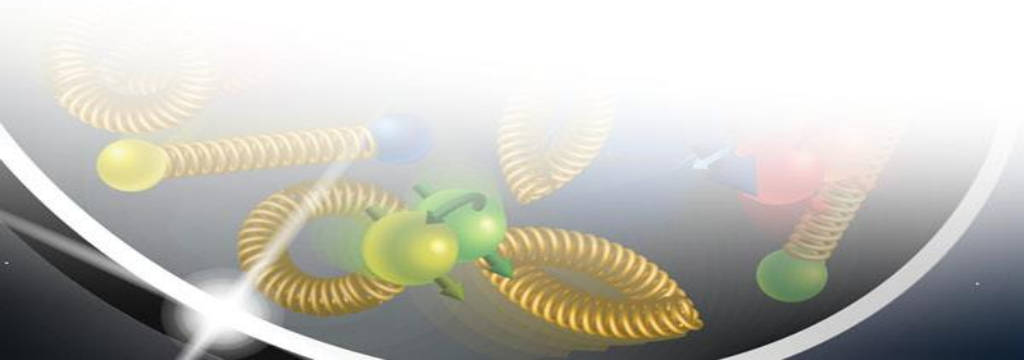
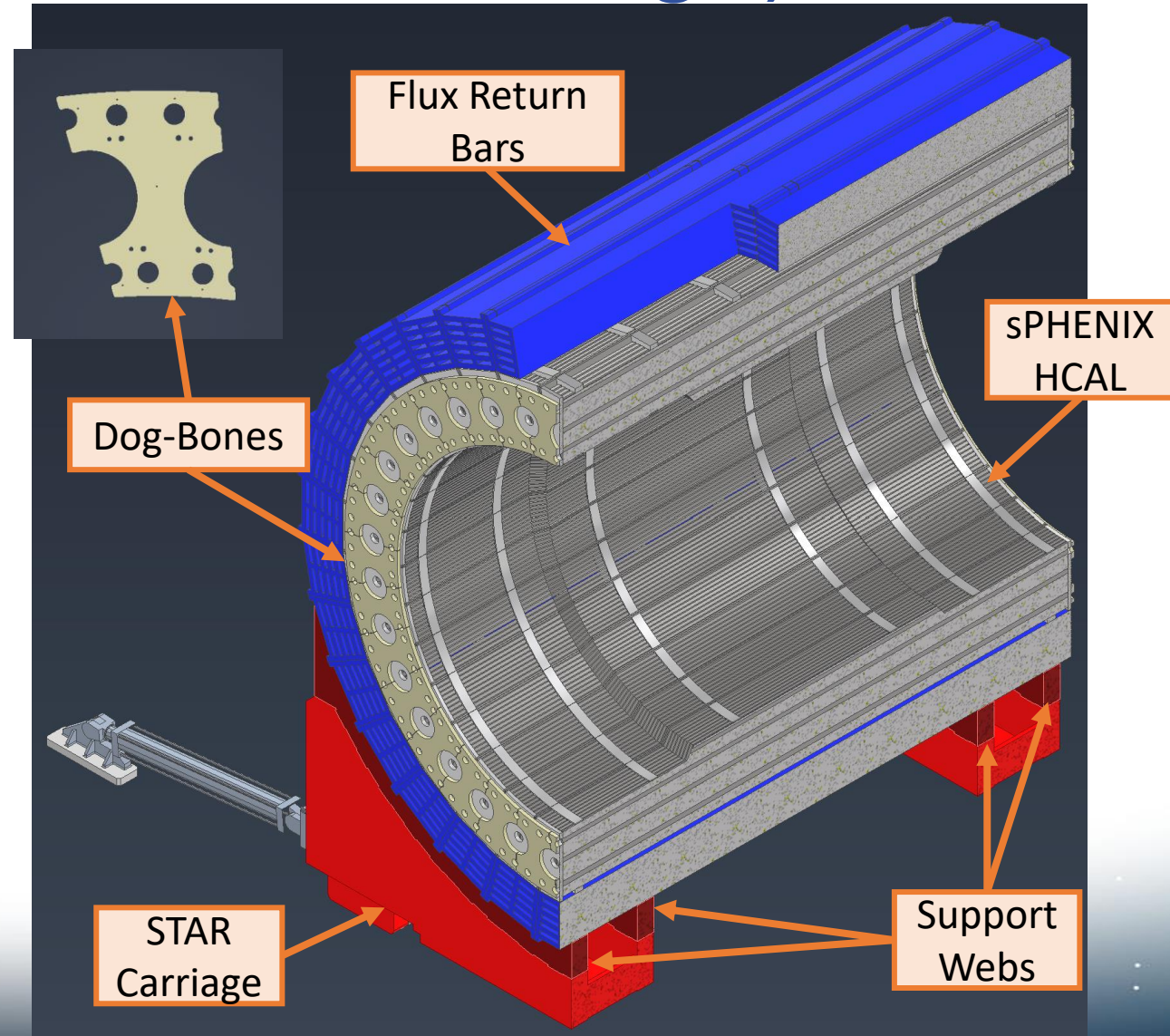
Model Overviews (HCAL & Carriage)

- **Barrel HCAL:**

- We will be reusing the sPHENIX barrel HCAL
- The sPHENIX dog-bones and inner support rings (shown on next slide) provide support for the HCAL

- **Barrel Carriage:**

- The STAR carriage will be the base that the detector is rolled into and out of the experimental hall on



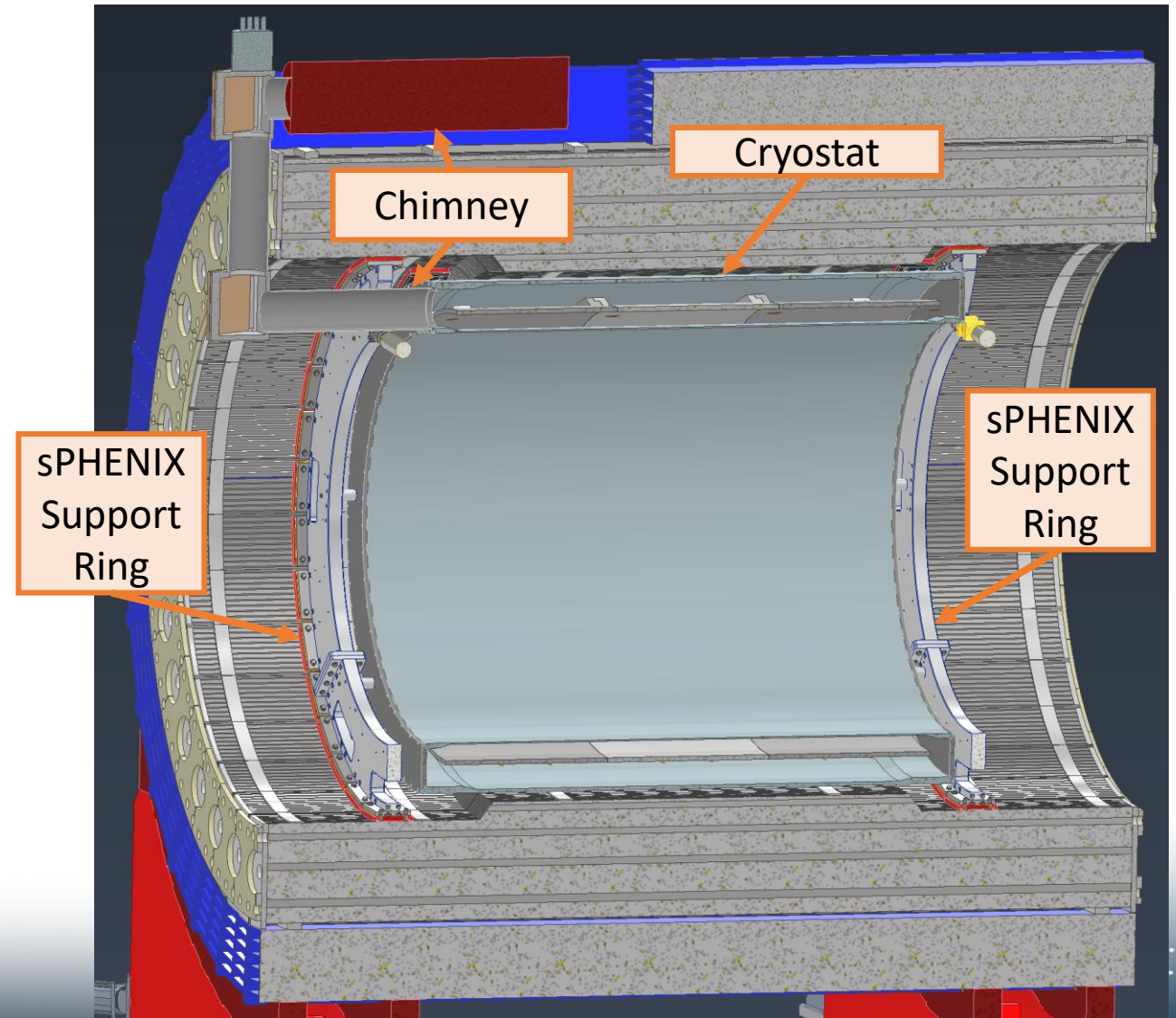
Model Overviews (Cryostat)

- **Solenoid :**

- Will be using the same jack placement and leveling system that sPHENIX used for its magnet

- **Support Rings:**

- Reusing the sPHENIX support rings
- Will have to be altered slightly to accommodate end rings for the barrel EMCAL supports



Model Overviews (Outer Detectors)

- **EMCAL:**

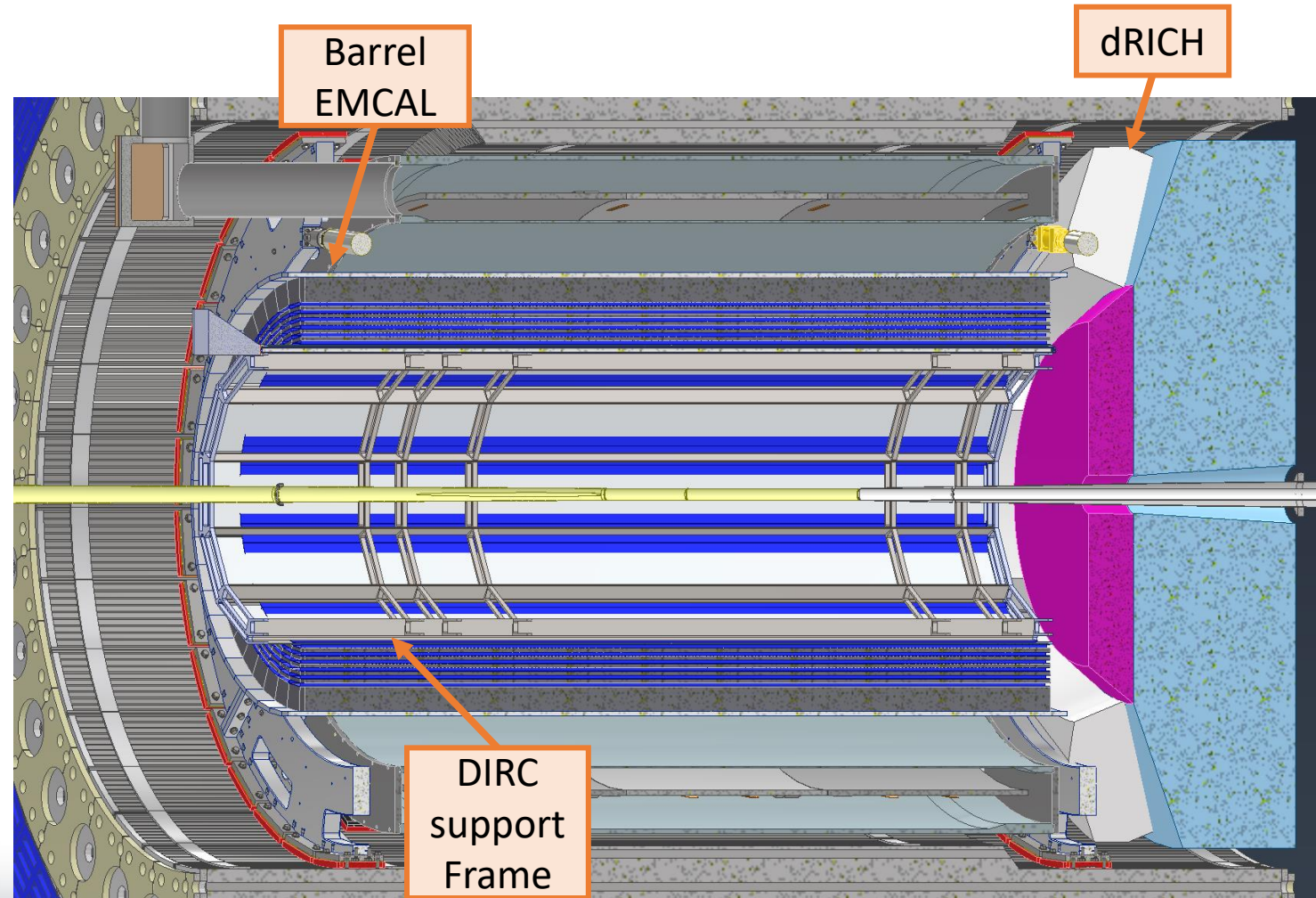
- Will be supported by the inner support rings from sPHENIX
- There will be 2 end rings that will mount the EMCAL to the support rings

- **dRICH:**

- Currently there are slight interference issues that are being addressed.
- Services from the inner detectors need space to pass in between the sensor boxes
- Will be discussed in more detail in later slides

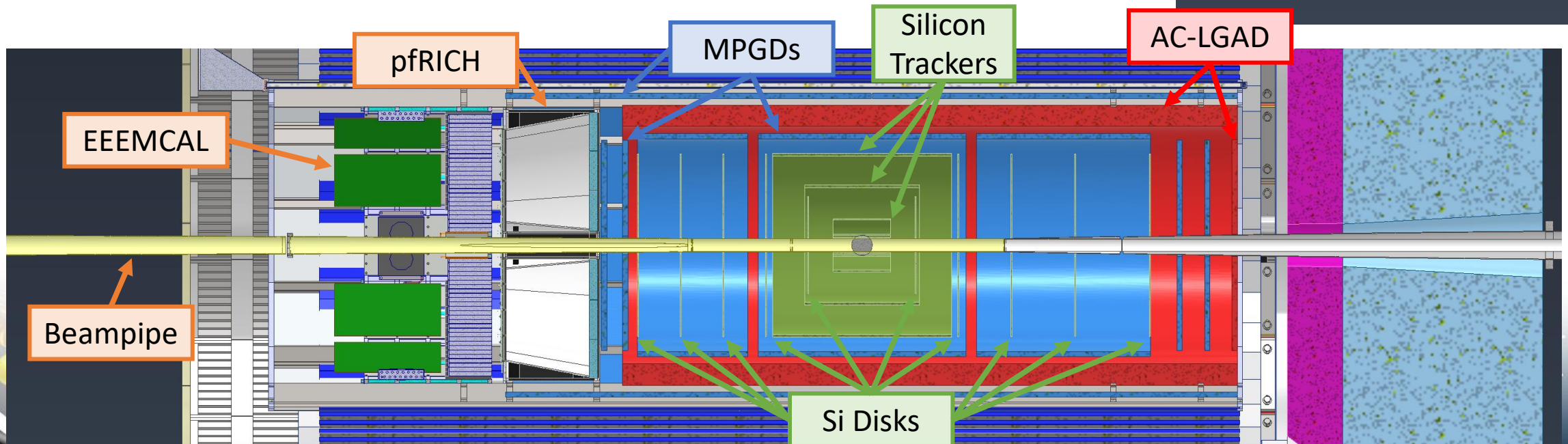
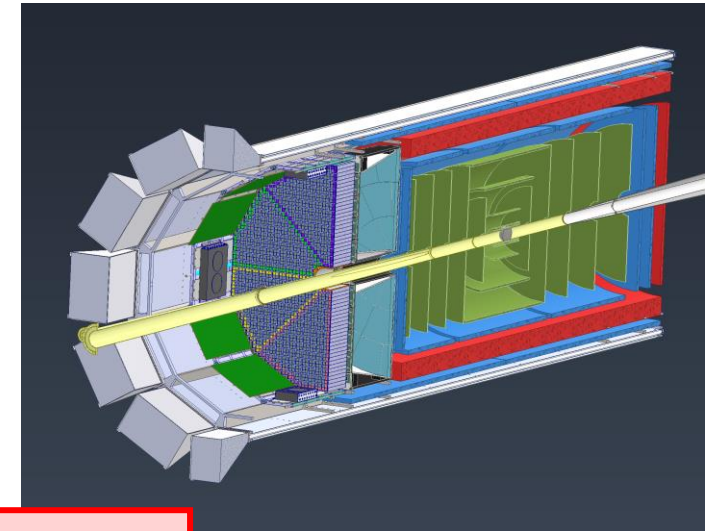
- **DIRC:**

- Still being developed and is being modified heavily as constraints change
- Will be discussed in more detail in later slides

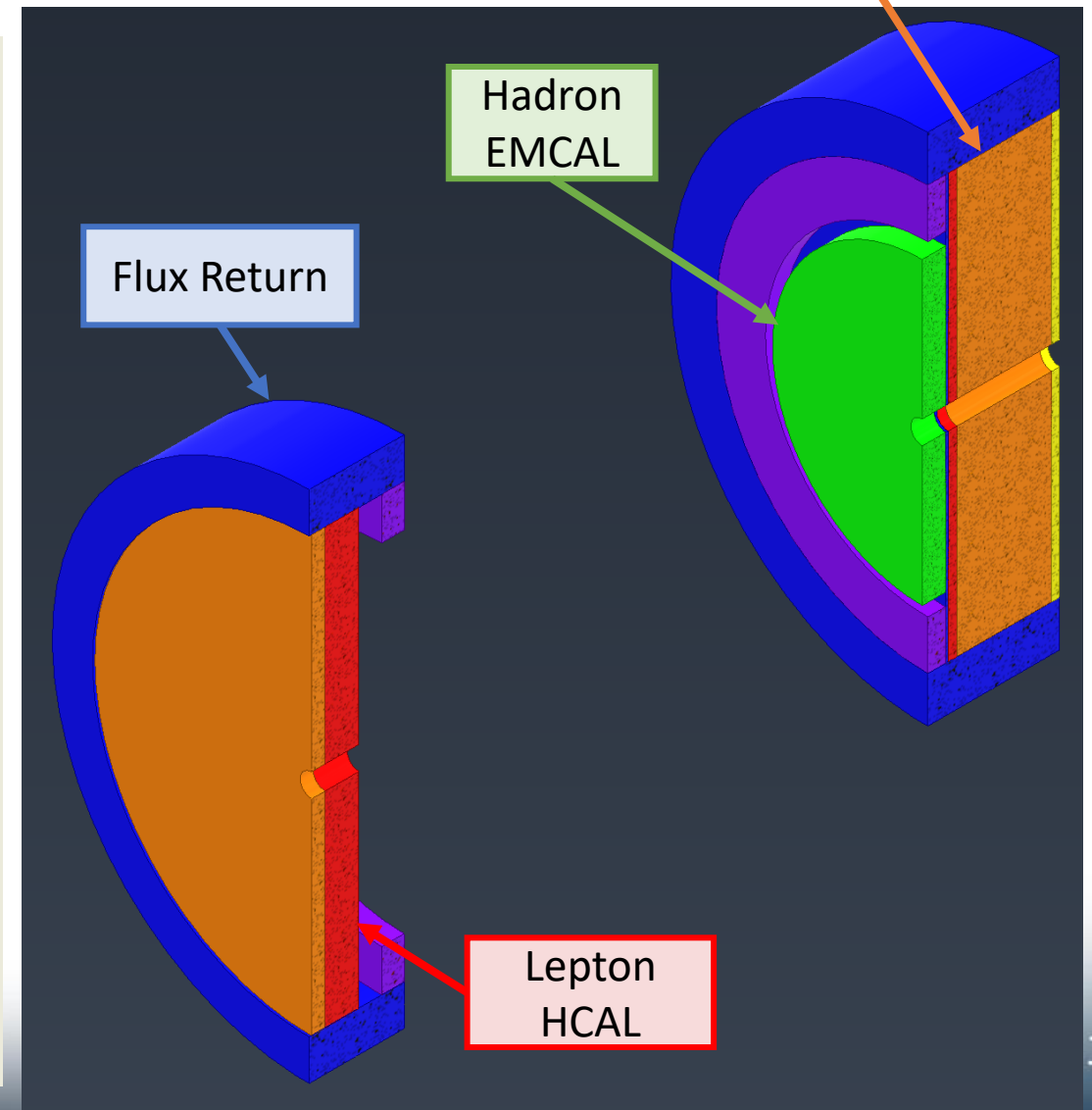
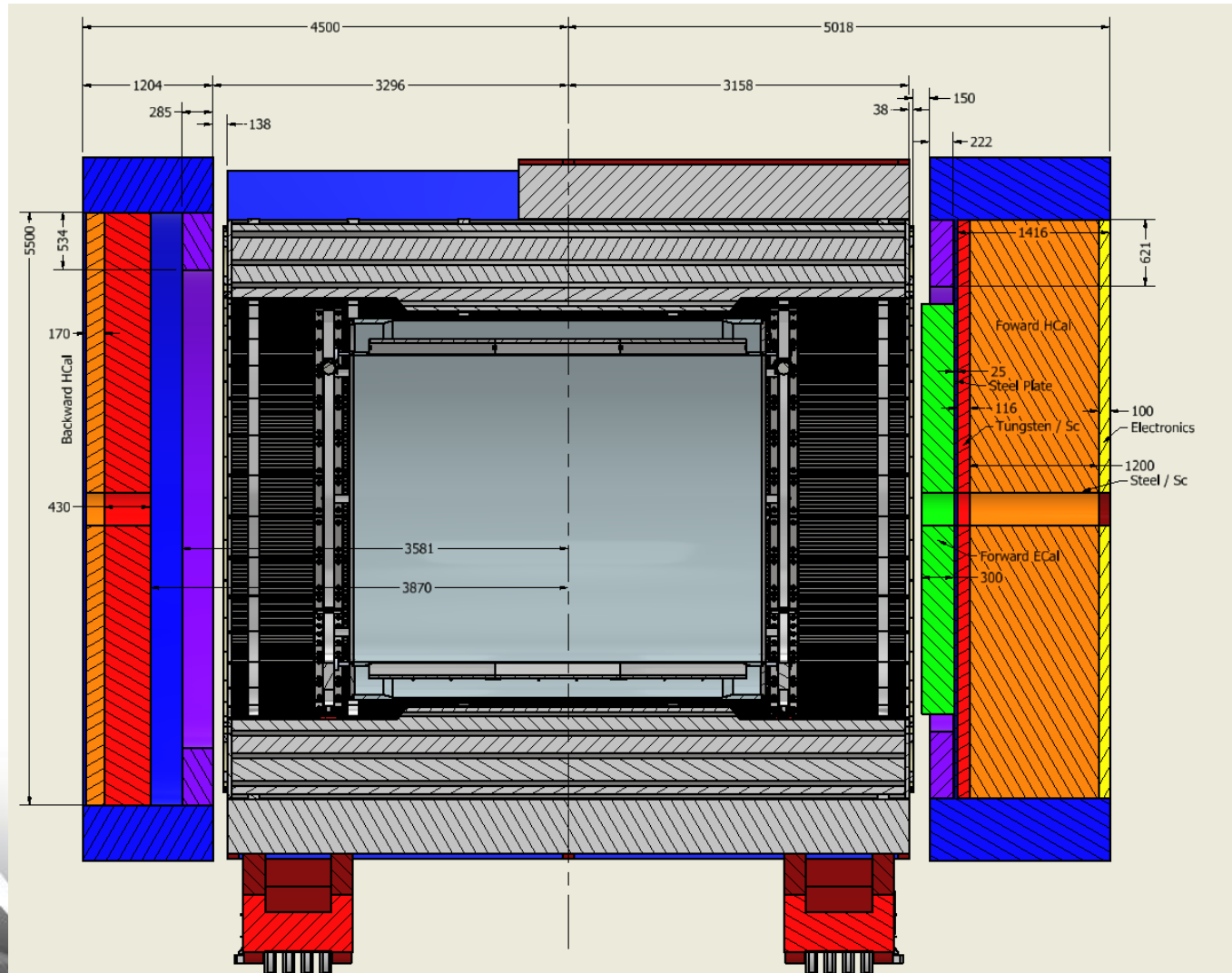


Model Overviews (Inner Detectors)

- **EEEMCAL:** Will be slid in on rails at 3 & 9 O'clock positions
- **pfRICH:** Will most likely use the same rail structure that the EEEMCAL uses
- **AC-LGAD:** Cylinder and disk models are placeholders. A support structure is being developed that will house the AC-LGAD, Inner MPGDs & disks and all the Silicon Trackers
- **MPGDs:** Consists of outer and inner barrel layers along with 4 disks, 2 on each end. Outer layer will use DIRC support
- **Silicon Vertex & Sagita Silicon:** Will use same support structure as other inner detectors
- **Si Disks:** 10 Disks total, 5 each side, using same support structure as other inner detectors

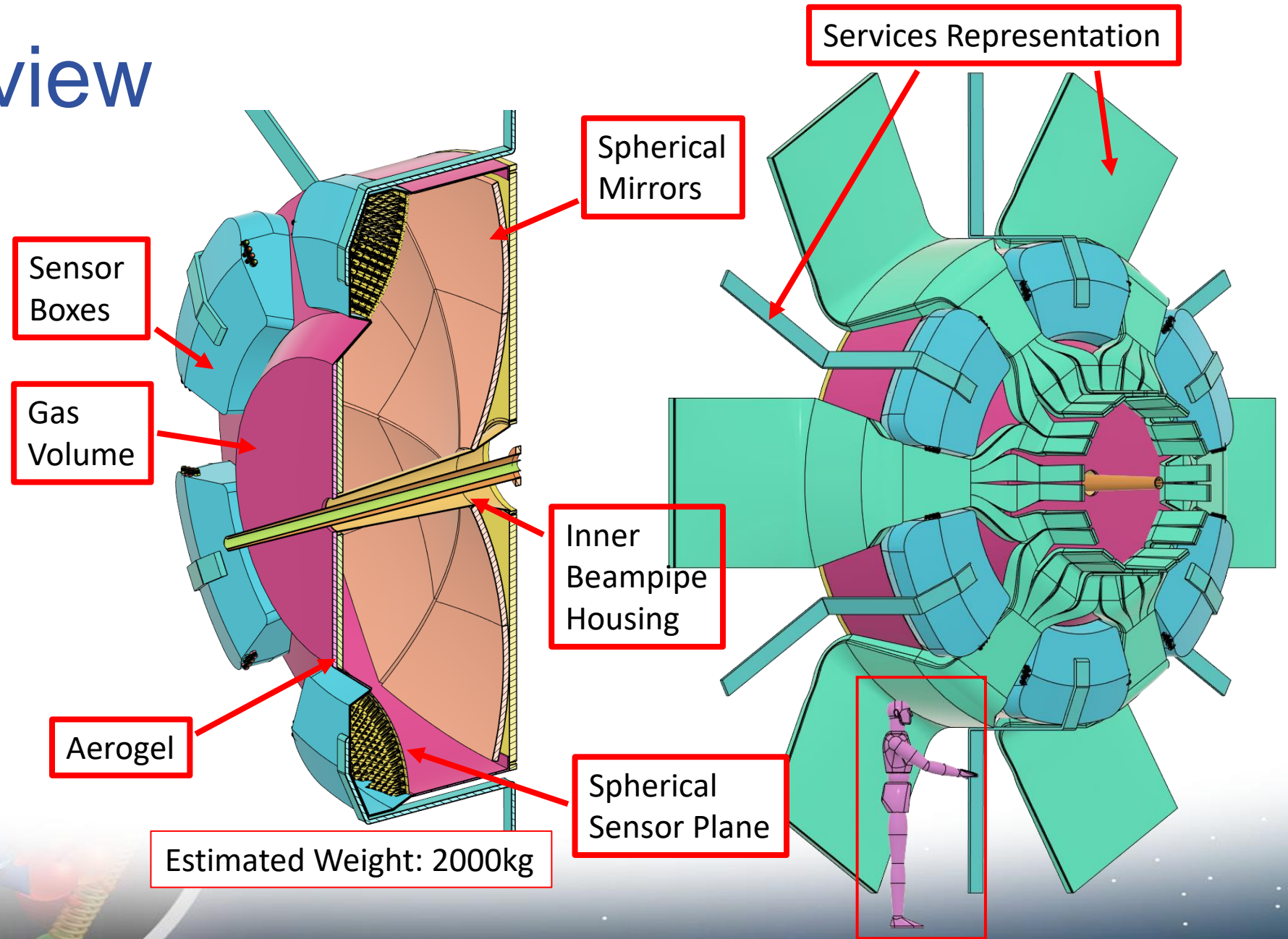


Model Overviews (Endcaps)



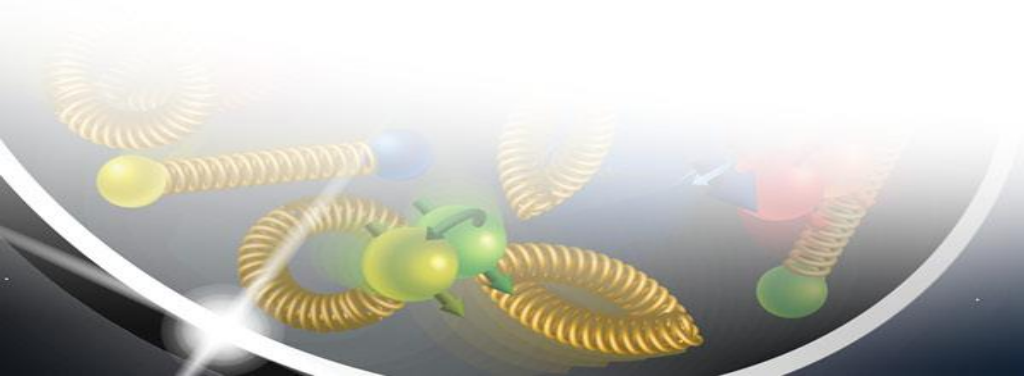
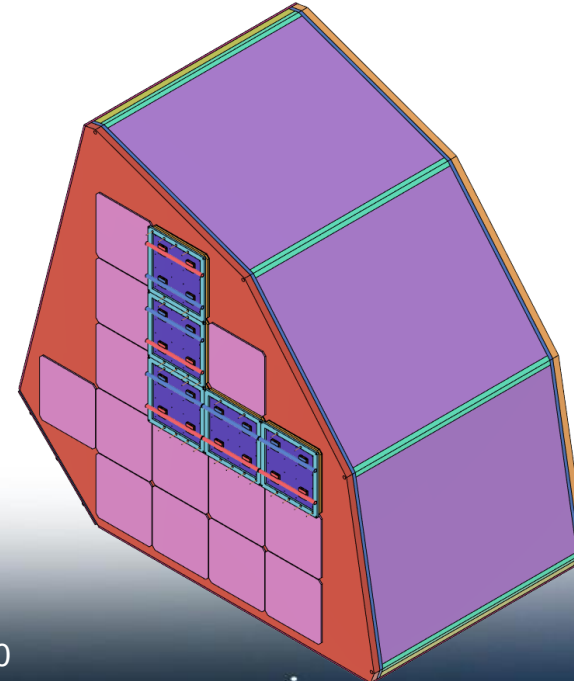
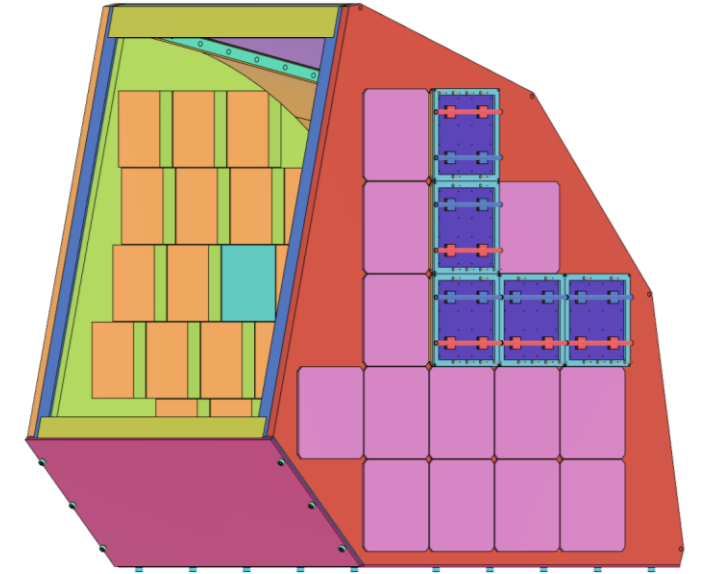
dRICH Overview

- Recent global positional changes have reduced integration interferences, however there are still a few minor areas of concern that are being addressed
- Installation and support designs for the dRICH are still being developed but consistent with the overall design schedule



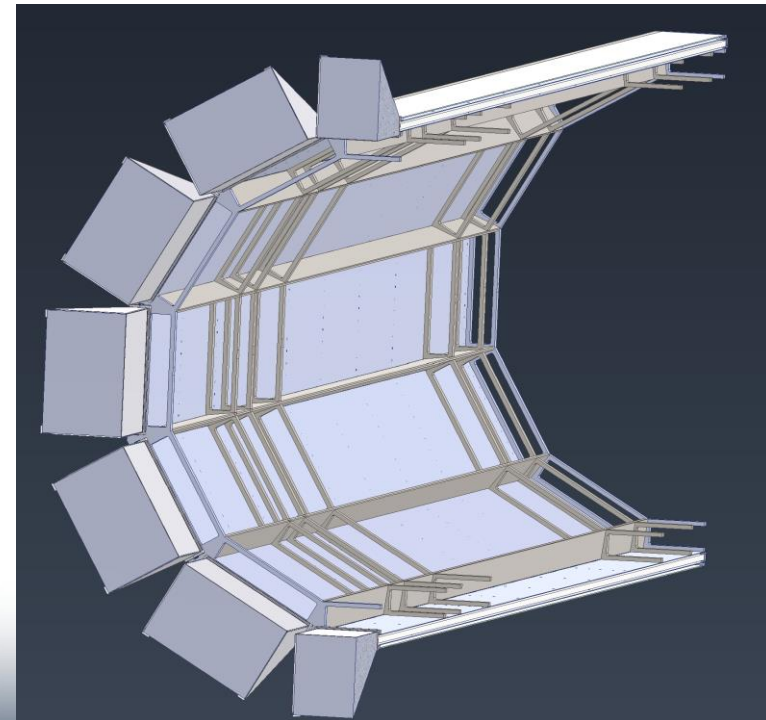
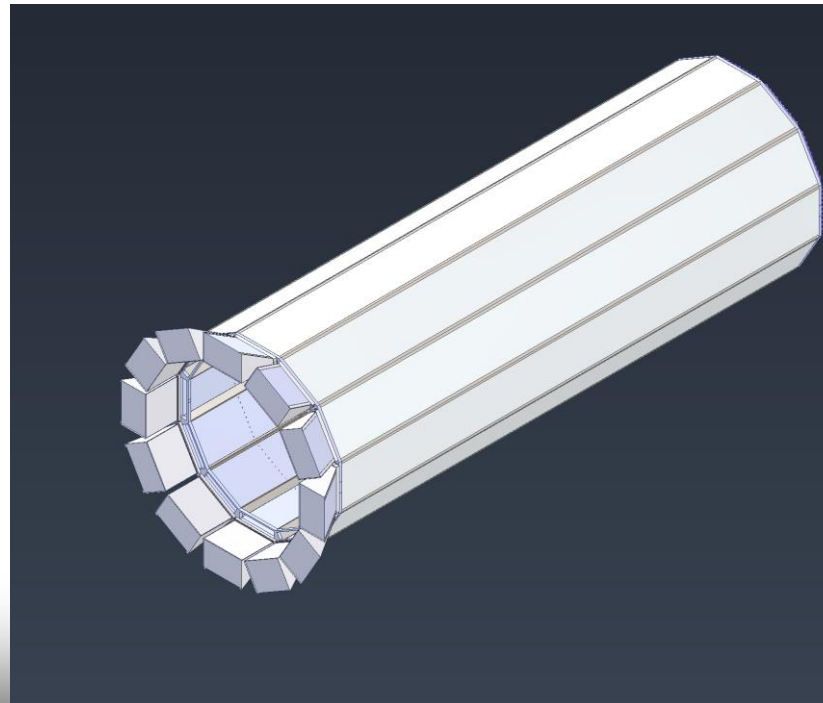
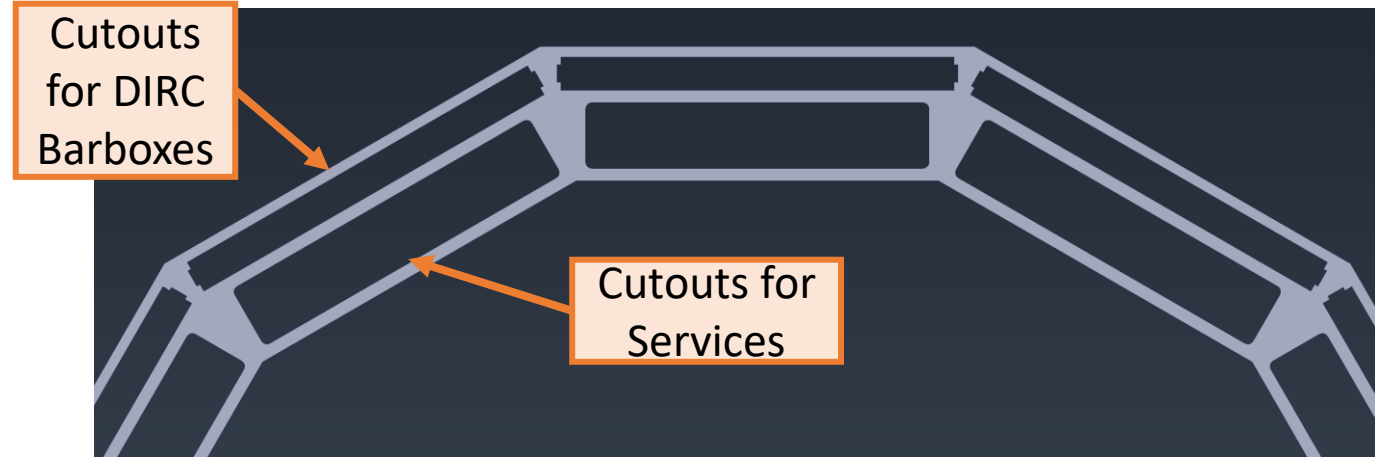
pfRICH Prototype Design

- We plan to build and test a prototype pfRICH at Fermilab in 2024.
- The purpose is to address technical risks associated with the pfRICH detector.
- Specific parameters of its main components will be evaluated for their impact on performance, such as the HRPPD photosensors, the aerogel tiles and the Time-of-Arrival (ToA)/ADC based electronics.



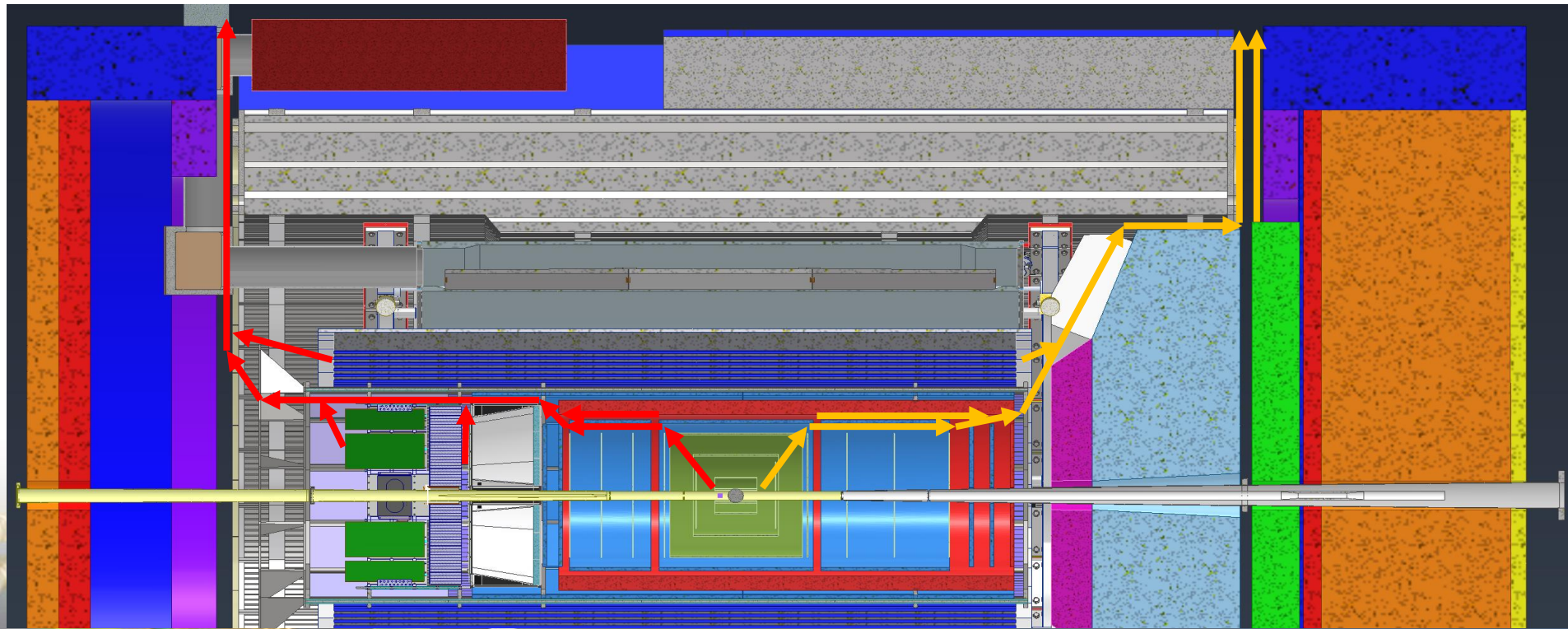
DIRC Support

- Each 'section' has cutouts for cables and cooling, except for the 3 & 9 O'clock sections which will be used for the EEEMCAL rails
- Service cutouts are ~33 cm wide and ~6 cm tall
- Working on figuring out total space needed for services
- Slots for the Outer MPGDs are being designed currently



Services Layout and Management

- Using service estimates from the detector groups
- 2 common paths (red and orange) for service routing
- Calculated service bundle volumes at bottleneck locations

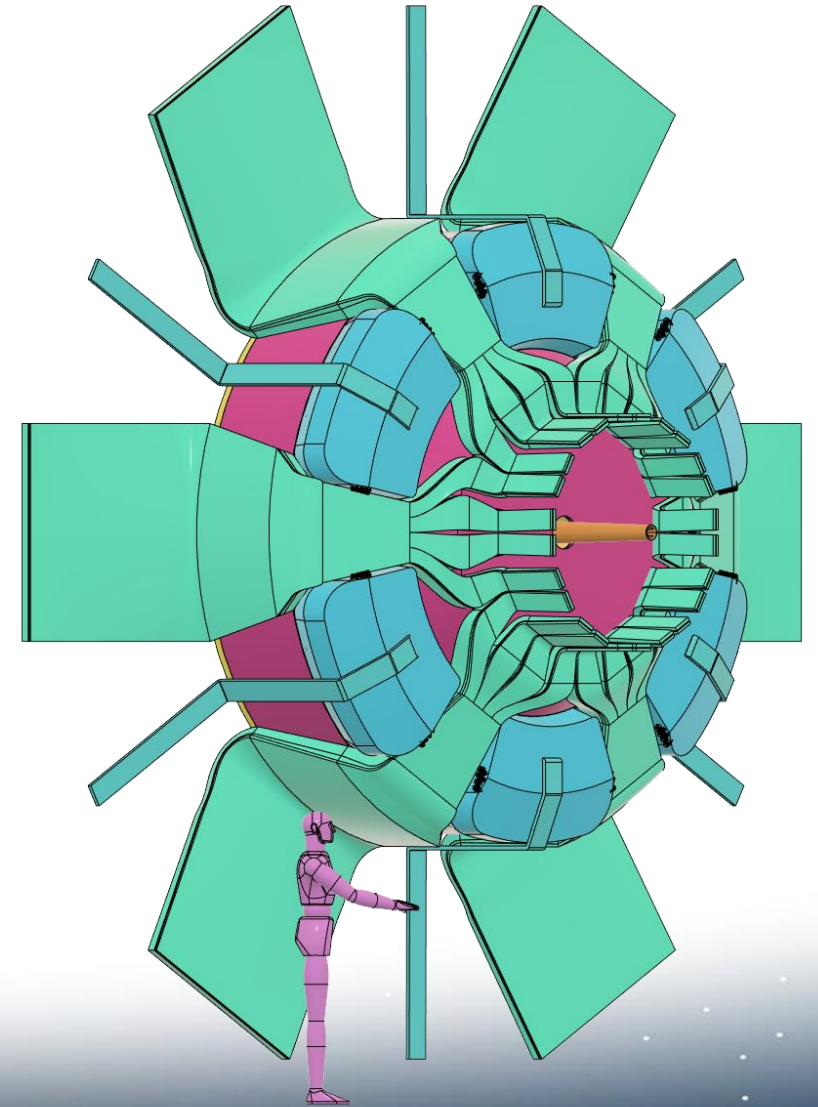
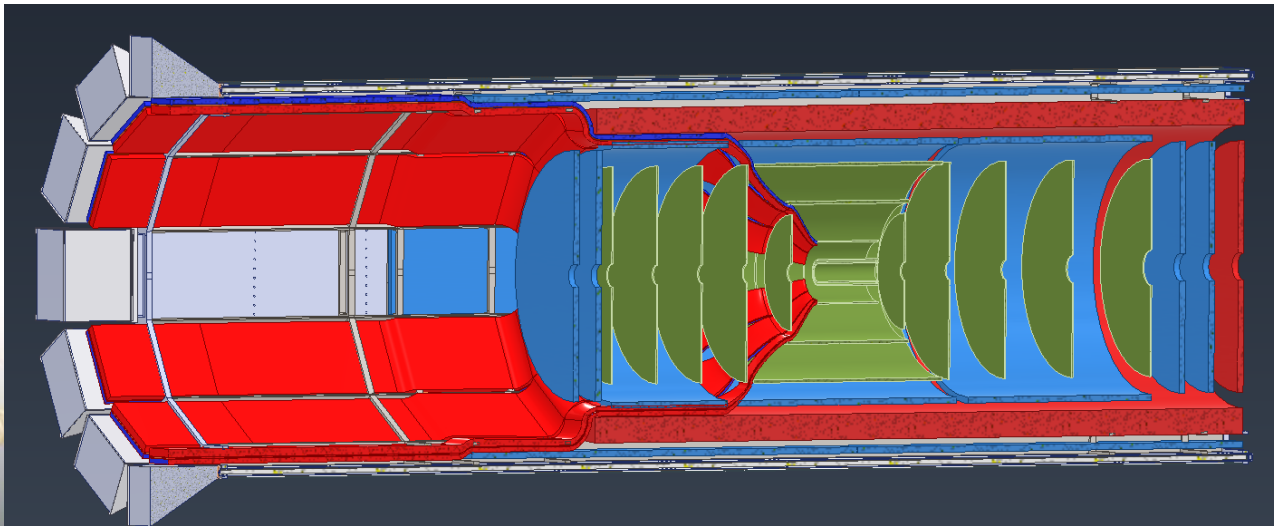
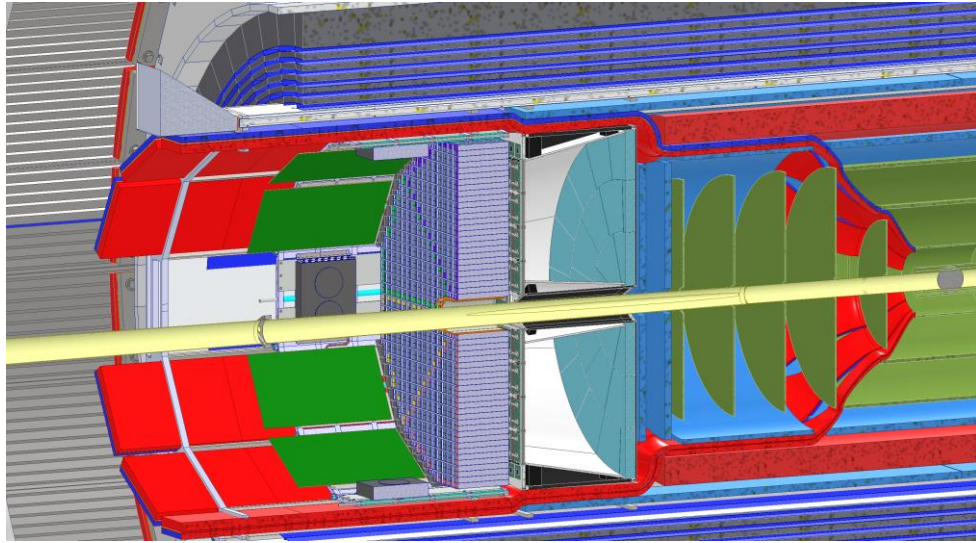


Services Layout and Management

- Totals for services passing from one point to the next are shown below
- There are a few locations where more space is needed based off current estimates

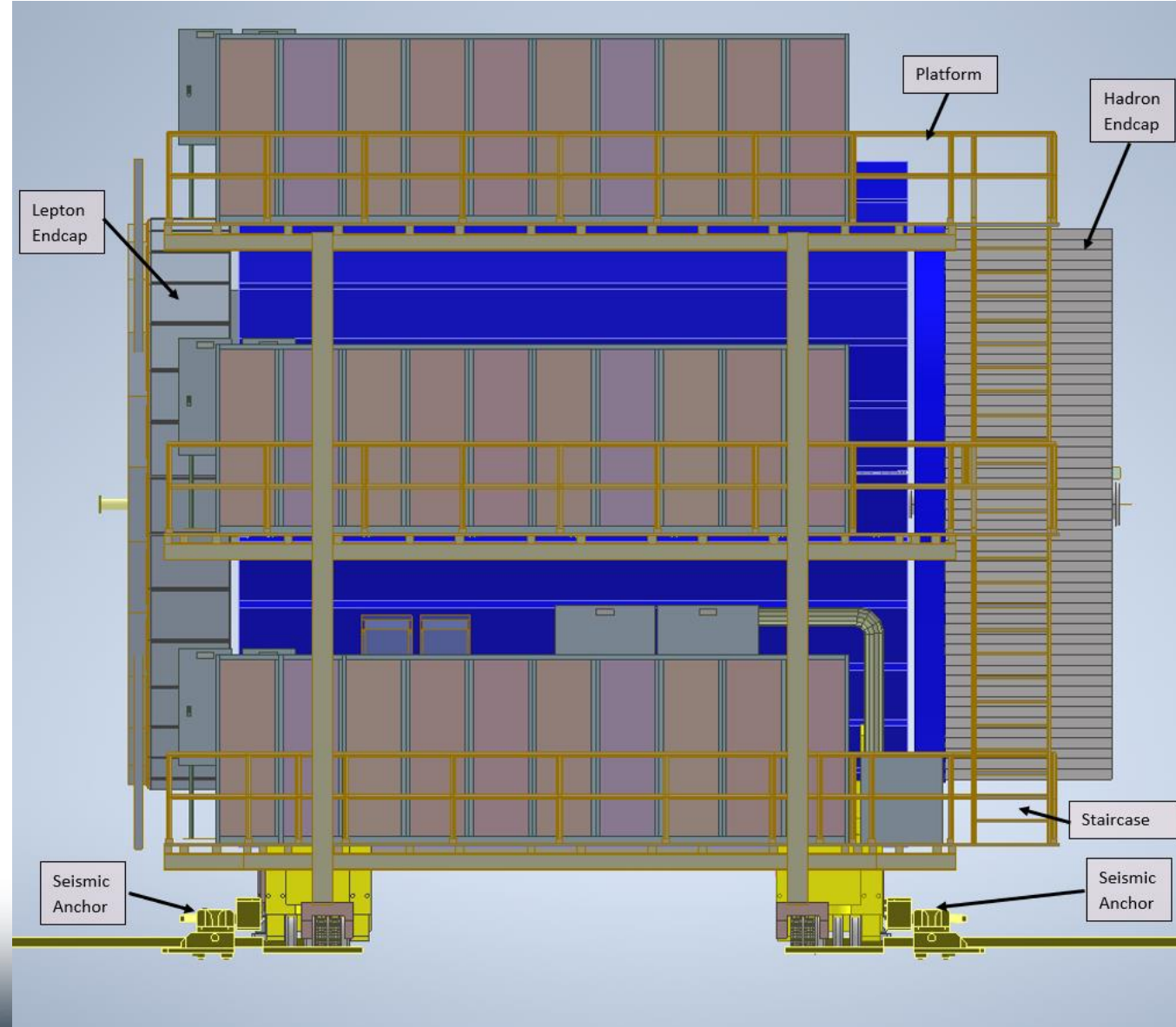
Subsystem	Type	Quantity	Cross Area (cm ²)	+50% Packing for Bundles	+50% for MISC spacing needs	Average Length (in)	lb / ft	Total weight (lbs)
Red Path IP to pFRICH Inner face								
Total		3515	905.35	1358.03		1800.00	Used space:	75.45%
Red Path From pFRICH to EEEMCAL Inner face								
Total		4401	1189.46	1784.18	2230.23	2240.00	Used space:	99.56%
Red Path From EEEMCAL to Flux Return Bars								
Total		14832	3608.71	5413.07	7227.51	12063.72	Used space:	59.91%
Orange Path From IP to AC-LGAD Disk								
Total		2904	858.26	1287.39		1998.05	Used space:	64.43%
Orange Path From AC-LGAD disk to Aerogel								
Total		5138	1550.77	2326.16	2845.55	4084.07	Used space:	69.67%
Orange Path From dRICH Aerogel to Dogbones								
Total		7394	2242.21	3363.31	4401.27	3965.46	Used space:	110.99%
Orange Path From 4 to 5								
Total		11884	2919.47	4379.21	5925.11	12189.38	Used space:	48.61%

Services Layout and Management



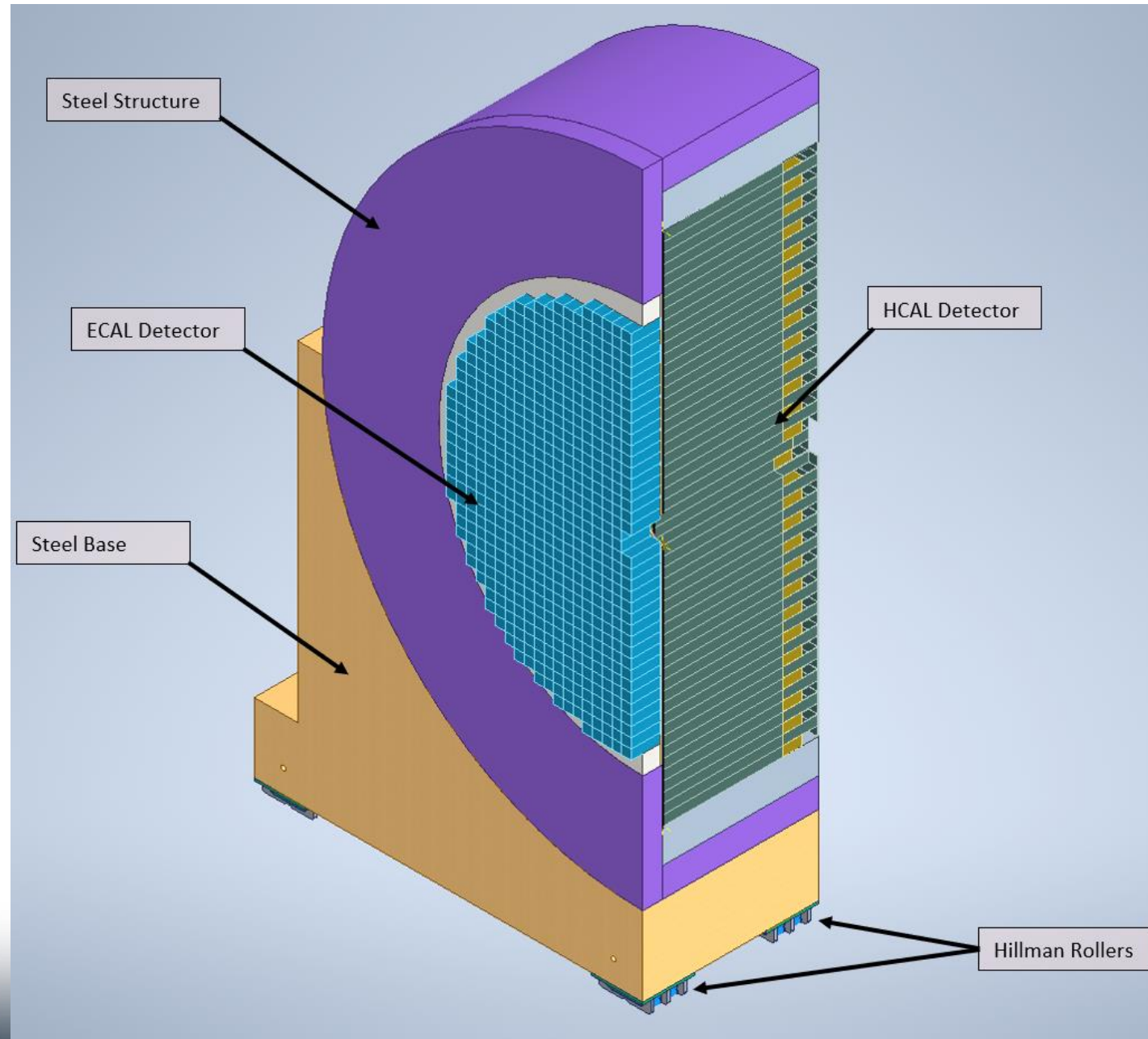
Platform Modifications

- North and South Platform for STAR will be modified and used for EPIC.
- Modifications needed to clear the path for opening of End Caps
- Seismic Anchors will also have to be moved and repositioned
- Plan on using same pistons and moving mechanism from STAR.
- New Hydraulic Control Units will be needed for moving End Caps and Detector.



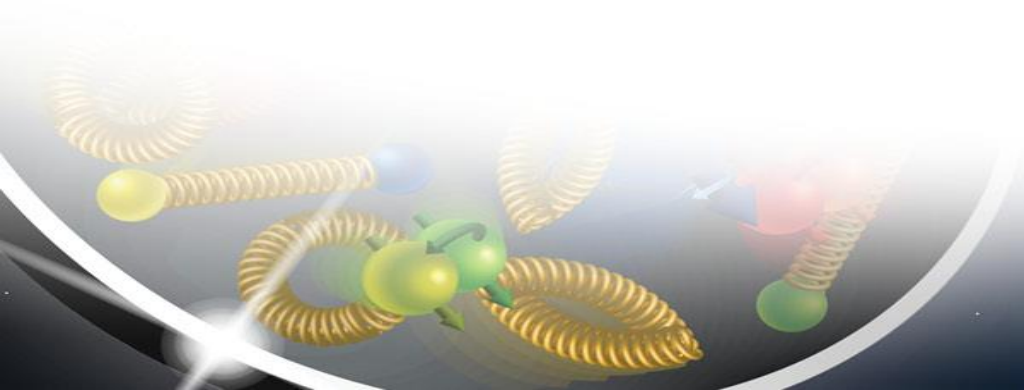
Endcap Tasks

- End Cap Structures accommodate HCAL and EMCAL Detectors
- End Caps will be designed as two halves with a vertical split that will allow opening of End Caps for maintenance of detectors in the Barrel
- Following Design and Analysis tasks need to be completed as next steps:
 - Seismic Analysis
 - Analysis of Magnetic Forces
 - Pinning/Securing of HCAL/EMCAL detector Blocks
 - Design of Rails for Endcaps
 - Design of Guiding Mechanism for Endcaps
 - North and South Platform Modifications to resolve interference issues

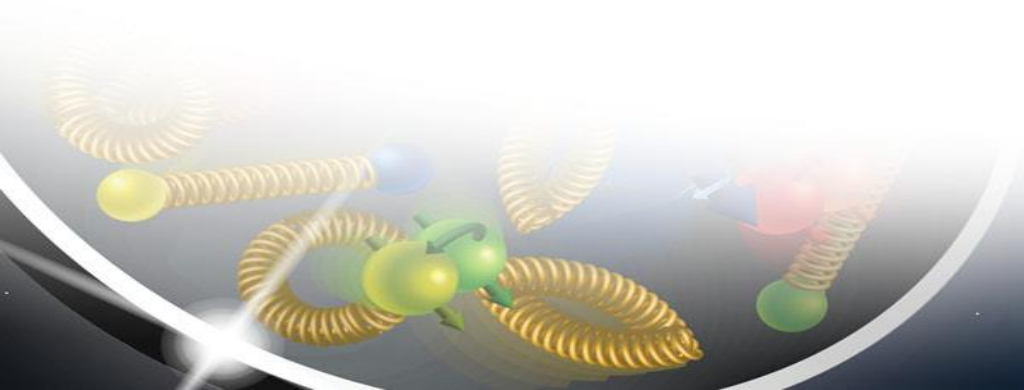


Next Steps

- Continuing to design the DIRC support & Silicon Tracker support, both designs are being heavily influenced by services
- Developing the barrel EMCAL support system and incorporating the support rings into the design
- Reducing integration interferences between the dRICH and the inner support rings
- Looking into ways to support the Flux return bars on the outside of the barrel HCAL
- Continuing the design of the prototype for the pfRICH
- Working on the design and analysis tasks for both sets of endcaps



End – Questions?



Backup slides

