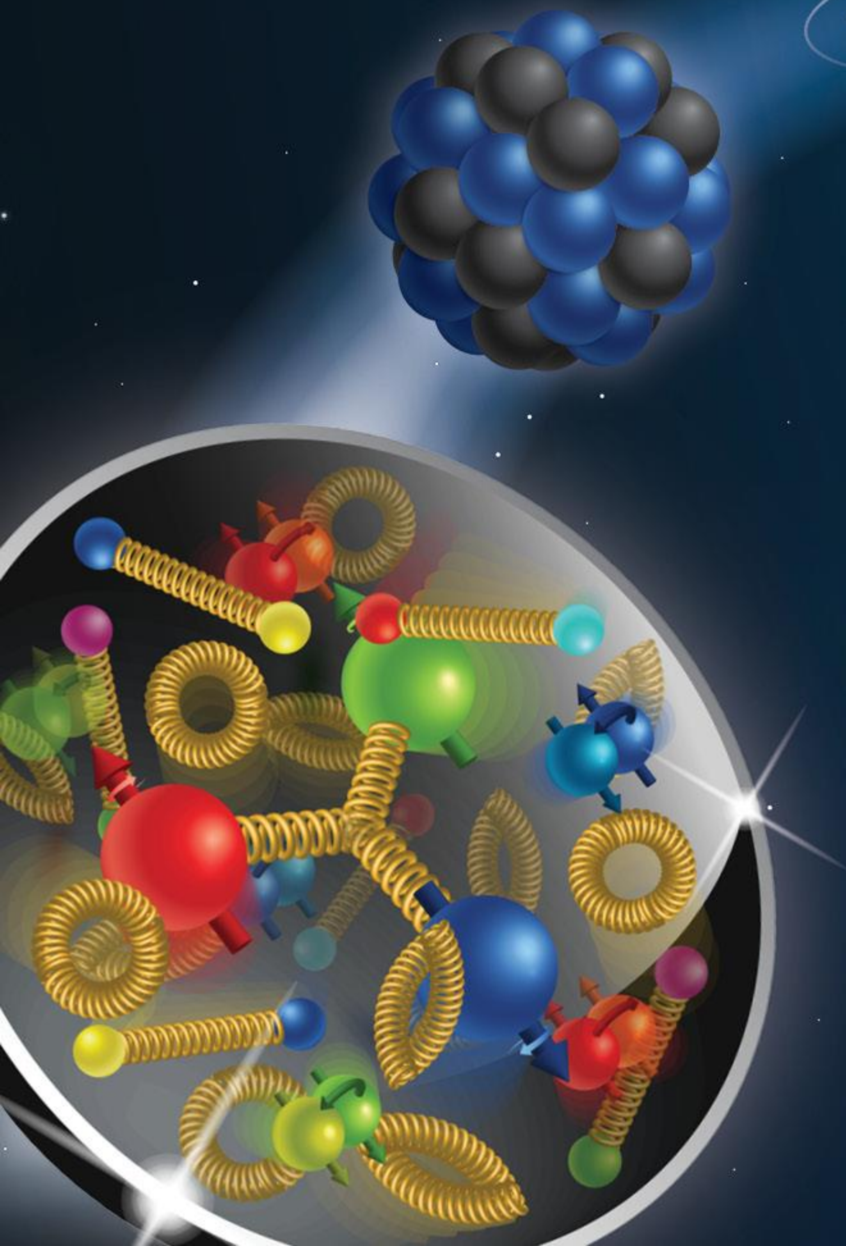


EIC Project Update

Elke Aschenauer and Rolf Ent

Co-Associate Directors for the Experimental Program

ePIC General Meeting

June 23rd 2023

Electron-Ion Collider

BROOKHAVEN NATIONAL LABORATORY · Jefferson Lab · U.S. DEPARTMENT OF ENERGY | Office of Science

Focus of Recent Activities

- Experimental Program Project Stuff
  - Upcoming Reviews
  - Project Information
- Integration
  - Finalize solenoid design
    - flux return layout
    - cryo-can design
  - Tracker optimization
  - optimizing PID detectors
    - optimizing installation procedure to ease design
  - Integrating barrel imaging calorimeter
  - continued optimization of far-forward and far-backward region
  - generating as much room for services as possible with keeping acceptance maximized

Upcoming in your EIC Detector Arena

- July 5 + 6: Particle Id Detectors Interim Design Review
  - Reviewers: Peter Krizan (U Ljubljana), Floris Keizer (CERN), Ana Amelia Machado (UniCamp), Koji Nakumura (KEK), Justin Stevens (W&M)
- July 21: Final Design Review of the PbWO4 Crystals for the ePIC Backward EM Calorimeter
  - Reviewers: Eugene Chudakov (JLab), Dipangkar Dutta (MSU)
- August (TBD): Likely one-two further Final Design Reviews for Long-Lead Procurement candidate items
- August 28 + August 31: DAC Review of Detector R&D – had to split in two separate days to make it work with DAC
  - FY23 progress
  - FY24 continuation requests
- August 29 + 30: DOE CD-3A Design Review by DAC
- October 5 + 6: Final Design Review of Magnet (MARCO)
- October 10-12: DOE CD-3A Director's Review
- TBD : DOE CD-3A Independent Cost Review
- November 14-16: DOE CD-3A Independent Project Review
- December 7 + 8: 2nd Resource Review Board meeting @ GWU
- December (TBD): Preliminary Design Review of Far-Forward/Far-Backward Detectors

Long Lead Procurements Overview

Selection already accounts for design changes and recent technology choices

- WBS 6.10.07 1.7 T Solenoid
  - Magnet is long-lead as the detector assembly and installation requires the availability of the fully-tested magnet
  - Limited world-wide vendors and long production time (estimated from 12 GeV magnets)
- Electromagnetic and Hadronic Calorimeters and SiPMs
  - WBS 6.10.04, 05, 06 SiPMs for calorimeters and dRICH
    - Need 735000 SiPMs of 6 different types
  - WBS 6.10.05 $PbWO_4$ – crystals
  - WBS 6.10.05 fECAL and Barrel ECal SciFi need in total ~8000 km
  - WBS 6.10.06 forward HCal: Steel and Tungsten plates and backward HCal steel

All these long-lead items are driven by

- limited world-wide vendors → competition by other projects around the world
- production times and capability and/or labor-intensive manufacturing tasks
- SiPMs staggered procurement

Final Design Reviews for LLPs to justify specifications for procurement on the July – August time frame

PbWO4 Crystals FDR

Final Design Review of the PbWO4 Crystals for the ePIC Backward EM Calorimeter

The Electron-Ion Collider (EIC) is a major facility, fully international in character, being designed and built at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL) in partnership with the Thomas Jefferson National Accelerator Facility (Jefferson Lab). The accelerator and one general purpose detector will be constructed over the next 10 years as a DOE construction project augmented with non-DOE in-kind contributions. The ePIC collaboration in cooperation with the EIC project is designing the detector systems to meet the goals as outlined in the 2015 NSAC Long Range Plan. The detector design work is currently in full swing.

The Backward EM Calorimeter (EEEMCAL) will provide high-precision detection of the scattered electron that is critical to determine event kinematics at the EIC in the range of particle energies of hundreds of MeV to 18 GeV. The EEEMCAL is designed to be in the electron endcap of the EIC detector, at a distance of 175 cm from the EIC interaction point. It is installed around the EIC beamlines in a roughly cylindrical geometry. The particles of interest impinge on the front face of the detector and pass through a PbWO4 radiator with adapted geometrical dimensions to contain the major part of the electromagnetic shower. The produced scintillation photons are detected at the back of the radiator using an array of Silicon Photomultipliers (SiPMs) and readout with back- and front-end electronics. The detector is enclosed in a mechanical frame that provides services like thermal cooling, light, and thermal monitoring.

The EEEMCAL radiator consists of ~3000 PbWO4 crystals. These will be the base of a procurement based on the ongoing EIC EEEMCAL design that includes requirements, specifications, and control drawings. We are ready to proceed with the Final Design Review of the PbWO4 crystals for this ePIC detector subsystem.

EST	Topic	Presenter	Duration (Min)
8:00-8:20 AM	Introduction: Backward EMCal physics goals, requirements, expected physics performance with PbWO4	Alexander Bazilevsky	20
8:20-8:40 AM	Mechanical Design	Carlos Munoz	20
8:40-9:00 AM	PbWO4 Specs and QA	Tanja Horn	20
9:00-9:20 AM	Discussion	All	20
9:20-9:50 AM	Executive Session	Review Committee	30
9:50-10:00 AM	Close-out		10
10:00 AM			

Committee: Eugene Chudakov (JLab), Dipangkar Dutta (M…

Charge to the Committee:

The scope of this review is …
asked to respond to the foll…

1. Are the EEMCAL tec…

Findings: The requirements ar…

Comments: The PWO crystals …

Recommendations: The project … procurement.

2. Are the plans for achiev… performance and construction sufficiently developed and documented for the present phase of the project? (I.e., are they commensurate with the initiation of the PbWO4 procurement?)

Findings: Yes, plans for the crystals are in place and well documented.

Comments: A) Non-pointing (flat) geometry may cause performance degradation at the edges

B) Although the current solutions seem to be the best available at this time, direct in-beam measurements of pi/e suppression would be beneficial for the whole project.

Recommendations: The following recommendations do not apply to the LLP and are only for the benefit of the final design optimization.

A) Calculations of the impact of the thermal gradients on detector performance caused by shower fluctuations should be performed.

B) The carbon-fiber mesh (or something similar to the final design) should be used in the prototype being tested for temperature stabilization.

Passed – planning in place, design sufficiently mature

Two recommendations are to improve overall design

Other LLP reviews will be very similar

…ector

…endations: None

5. Are the plans for detector integration in the EIC detector appropriately developed to initiate the PbWO4 procurement?

Findings: Yes

Comments: None

Recommendations: The project should proceed with the PWO long lead procurement.

6. Have previous review recommendations been adequately addressed to initiate the PbWO4 procurement?

Findings:

Comments: not applicable

Recommendations: None

7. Have ES&H and QA considerations been adequately incorporated in the PbWO4 procurement planning? (This includes a quality assurance plan for receipt of material meeting specifications.)

Findings: QA has been developed

Comments: No comments about ES&H

Recommendations: None

8. Is the procurement approach sound and the procurement schedule credible?

Findings: Yes

Comments: No comments

Recommendations: None

We would appreciate receiving the committee's report within 14 days of the review's conclusion.

You will be supplied with the report from the earlier calorimetry preliminary design review, with the EEMCAL PbWO4 specifications table, with a copy of ongoing similar PbWO4 crystal procurements, and the crystal performance spreadsheet illustrating the quality assurance process of those crystals.

EIC Project Detector R&D

2024 https://wiki.bnl.gov/conferences/index.php/ProjectRandDFY24

Project:	eRD101	eRD102	eRD103	eRD104	eRD105	eRD106	eRD107	eRD108
Title:	mRICH	dRICH	hpDIRC	Silicon Service reduction	SciGlass	Forward ECal	Forward HCal	Cylindrical MPGD
Contact:	X. He (GSU)	E. Cisbani (INFN-RM1), M.Contalbrigo (U. Ferrara), A. Vossen (Duke)	G. Kalicy (CUA), J. Schwiening (GSI)	L. Gonella (B'ham)	T. Horn and .L. Pegg (CUA)	H.Z. Huang (UCLA), O. Tsai (UCLA)	Friederike Bock (ORNL)	K. Gnanvo (UVA)
Proposal/ Progress Report:	v1 (pdf)	v1 (pdf)	v1 (pdf)	v1 (pdf)	-	v1 (pdf)	v1 (pdf),	v1 (pdf)

Project:	eRD109	eRD110	eRD111	eRD112	eRD113	eRD114	eRD115
Title:	ASIC/Electronics	Photosensors	Si-Vertex	AC-LGAD	Si-Sensor Development and Characterization	pfRICH	Imaging Cal
Contact:	Fernando Barbosa (JLab)	Y. Ilieva (SC), C. Zorn (JLab), J. Xie (ANL), A. Kiselev (BNL), Pietro Antonioli (INFN)	Nicole Apadula (LBNL)	Zh. Ye (UIC)	Grzegorz Deptuch (BNL)	A. Kiselev (BNL)	Maria Zurek (ANL), Sylvester Joosten (ANL), Zisis Papandreou (ANL)
Proposal/ Progress Report:	v1 (pdf)	v1 (pdf)	v1 (pdf)	v1 (pdf)	v1 (pdf)	v1 (pdf)	v1 (pdf)

Review by DAC:

Monday August 28 and Thursday August 31.

Preliminary agenda: https://indico.bnl.gov/event/20113/

DAC Membership:

Edward Kinney (Chair)	Boulder CO
Ken Wyllie	CERN
Petra Merkel	FNAL
Antonis Papanestis	Rutherford Appleton Laboratory
Peter Krizan	U Ljubljana
Ana Amelia Machado	University of Campinas, Brazil
Heidi Schellman	Oregon State
Brigitte Vachon	McGill
Stefano Miscetti	INFN Frascati
Etiennette Auffray	CERN
Andrew White	U. Texas Arlington
Chi Yang	SDU China

new members

Remember:

exchange 1/3 of the committee every year

DOE CD-3A Design Review

Reviewers: DAC

EIC Detector Comprehensive Design Review – 6th DAC meeting

August 29-30, 2023

Charge

The EIC Detector Advisory Committee (DAC) provides advice to the EIC project managed by BNL in partnership with Thomas Jefferson National Accelerator Facility (TJNAF) on the experimental equipment and on overall matters with respect to the scientific collaboration, ePIC. This includes advice on the suitability of the experimental equipment for the EIC science, on cost, schedule and technical risk of detector components and design choices, and relative importance of technical tasks, on evaluation of complementary EIC detector technologies and the sub-detector integration, detector-interaction region integration, and detector commissioning, and on the EIC-related detector R&D.

Critical Decision-One (CD-1) for the EIC was awarded on June 29 2021 and allowed for release of Project Engineering and Design (PED) funds. This initiated the next phases of design of accelerator and detector. The 2022 EIC funding from the Inflation Reduction Act allowed the EIC project to stay on pace, with the EIC project aiming to receive CD-3A (start of long-lead procurements) early 2024 and CD-2/CD-3 (baseline approval and start of construction) roughly one year later.

The 6th and 7th DAC meeting will occur in the same week, where two days will be dedicated to a comprehensive design review of the ePIC detector where you will also hear the overall progress and status of the EIC Project, and two days dedicated to the review of the ongoing EIC project detector R&D and possible continuations.

For the 6th DAC meeting that serves as comprehensive EIC detector design review, the DAC is asked to answer the following charge questions:

- Given the detector progress over the last two years and the status of the ePIC detector, are the projected timelines of the Electron-Ion Collider detector feasible? Do there remain significant open detector technology questions?
- Are the requirements for the detector and their flow down sufficiently comprehensive for this stage of the project to complete the design of the various detector technologies?
- Are the interfaces between the elements of the design adequately defined for this stage of the project and to proceed with the detector long-lead procurement items?
- Is the design of these long-lead procurement items sufficiently advanced and mature to start procurement in 2024? Are the technical specifications complete?
- Is the projected design maturity of the further detector components likely to be accomplished by the end of 2024 for CD-2 and CD-3?
- Is the overall schedule for completion of the design, production, and installation of detector components realistic?

We welcome any other suggestions you can make for additions and changes that will improve the quality of the EIC detector design. Note that there is no dedicated charge element related to detector R&D and their risk mitigation as the DAC will separately review and advice on this.

The committee is requested to organize their assessment in terms of findings, comments, and recommendations and provide a written report by September 30, 2023.

EIC Detector Comprehensive Design Review – 6th DAC meeting

August 29-30, 2023

Agenda: (note that this agenda assumes a hybrid meeting format with worldwide attendance)

09:00 – 09:30		Executive Session	
09:30 – 10:00		Project Overview	Jim Yeck
10:00 – 10:45	6.10.01	Detector Overview and Requirements	Elke/Rolf
10:45 – 11:00	6.10.01	Requirements and Interfaces Flow	Walt
11:00 – 11:15	6.10.01	CAD status	Roland
11:15 – 11:30	6.10.02	Detector R&D Status and Milestones	Thomas
11:30 – 12:00	6.10.07	Magnet	Renuka
12:00 – 12:30		Break	
12:30 – 13:00	6.10.03	Tracking Detectors	Brian
13:00 – 13:30	6.10.04	Particle Identification Detectors	Beni
13:30 – 14:00	6.10.05	Electromagnetic Calorimetry	Sasha
14:00 – 14:30	6.10.06	Hadronic Calorimetry	Alexander
14:30 – 15:30		Executive Session	
09:00 – 09:30		Vacuum, Backgrounds, Machine-Detector Interface	Elke?
09:30 – 10:00	6.10.11	Interaction Region integration and Ancillary Detectors	Yulia
10:00 – 10:30	6.10.14	Polarimetry	Oleg/Dave
10:30 – 11:00	6.10.08	Electronics	Fernando
11:00 – 11:30	6.10.09	DAQ and Scientific Computing	David/Jeff
11:30 – 12:00	6.10.10	Infrastructure, Integration and Installation	Rahul
12:00 – 12:15	6.10.12	Pre-Ops planning	Elke/Rolf
12:15 – 12:45		Break	
12:45 – 15:00		Executive Session	
15:00 – 15:30		Closeout	

Follow up on recent ePIC technology choices

The path to integrate the recent technology changes, Barrel Ecal and backward RICH, by ePIC into the EIC Project baseline

Remember: five-step change control process

1. The detector collaboration initiates a possible change in baseline scope
2. The collaboration technical board or equivalent ensures the change is consistent with the NAS science requirements and initiates the change request

→ prepare input for the TCCB
detailed changes in cost, schedule and risk → implement in P6
science and technical justification for the change ← input from ePIC
started with backward RICH as it is a less complex case

3. The detector TCCB collects wide input, discusses, and gives advise
4. The Project Technical Director gives approval
5. The EIC Management Team needs to approve the formal baseline change control

→ process for both detectors needs to be complete by the DAC technical design review

Follow up on recent ePIC technology choices

backward RICH:

- fully integrated in P6 (changes to WBS 6.10.03 and 6.10.08)
  - no changes in either cost, schedule or risk

→ no change request needed

→ will document change in detector technology through filing a record of decision

Barrel ECal:

- nearly fully integrated in P6 (changes to WBS 6.10.05 and 6.10.08)
  - WBS 6.10.05 = P6 cost ($19.1M) + ~$2.5M
  - WBS 6.10.00 = P6 cost reduced by ~$0.4M
- WBS 6.10.10 – Detector Infrastructure & Integration
  - expect some reduction in labor and materials

→ Expect imaging calorimeter costs to be P6 + ~$2M

→ Sci-Glass based calorimeter due to geometry change would also require P6 + ~$4.5M
($4.435M was already added to 11/28/22 in EIC scope cost changes list)

→ Expect to require lite version of change control request for detector technology change

What Is Coming Up – TDR

We will start the process of writing a draft TDR later this year, and then this will continue towards a first version of a TDR in 2024.

Working model will be similar as we used to create the CDR, Elke/Rolf with engagement of ePIC leadership, and a mix of the project CAMs and EPIC WG representatives. At the late phases the editing rights will become more restricted. We plan to use where we can input from the CDR, YR, proposals, technical notes, etc.

Chapter 2: Physics Goals and Requirements *(should be short, < 50 pages)*
- 2.1 EIC Context and History (like CDR 2.2 or YR section 1)
- 2.2 The Science Goals of the EIC and the Machine Parameters (like CDR 2.3)
- 2.3 The EIC Science (follow YR structure)
- 2.4 Scientific Requirements

Chapter 3: Interaction Region 6 Overview (Elke/Rolf contributing)

Chapter 8: Experimental Systems *(can be long such that we can use as standalone detector TDR)*
- 8.1 Experimental Equipment Requirements Summary (like CDR 8.2)
- 8.2 General Detector Considerations and Operations Challenges (YR 10, CDR 8.3)
- 8.3 EIC Detector
- 8.4 Detector R&D Summary
- 8.5 Detector Integration
- 8.6 Detector Commissioning and Pre-Operations

Chapter 11: Commissioning (Elke/Rolf contributing)

Appendix-B: Integration of a Second Experiment (mainly emphasizing feasibility, luminosity sharing, polarization with two experiments, and first-order checks of magnets/acceptance)

(Draft) TDR – more details on section on Experimental Systems

8.1 Experimental Equipment Requirements Summary (like CDR 8.2)

8.2 General Detector Considerations and Operations Challenges (YR 10 and CDR 8.3)

- 8.2.1 Beam Energies, Polarization, Versatility, Luminosities (like YR 10.1)
- 8.2.2 Rates and Multiplicities (like CDR 8.3.1)
- 8.2.3 Interaction Region Integration, Vacuum and Backgrounds (like CDR 8.3.2)
- 8.2.4 Systematic Uncertainties (like YR 10.5)

8.3 EPIC Detector **CAM(s) and ePIC collaboration contact(s)**

- 8.3.1 Magnet **For each subsection end with R&D and design maturity**
- 8.3.2 Tracking
- 8.3.3 Electromagnetic Calorimetry
- 8.3.4 Hadronic Calorimetry
- 8.3.5 Particle Identification
- 8.3.6 Far-Forward Detectors
- 8.3.7 Far-Backward Detectors
- 8.3.8 Polarimetry and Luminosity Detector
- 8.3.9 Readout Electronics and Data Acquisition
- 8.3.10 Software, Data Analysis and Data Preservation **(EICUG SWG?)**

8.4 Detector R&D Summary

8.5 Detector Integration **(Walt, Rahul, Tim/Christian, Fernando, Roland, Dan, Elke, Rolf)**

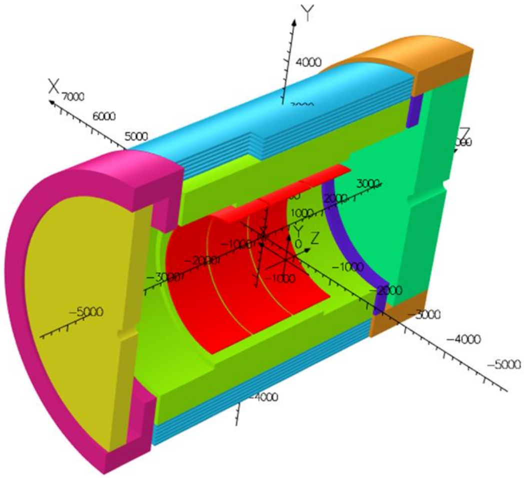
- 8.5.1 Experimental and Assembly Hall Infrastructure (like CDR 8.7.1, YR 13.1)
- 8.5.2 Interaction Region and Protection (include also YR 13.2)
- 8.5.3 Support Frames and Installation Fixtures *(new, ask Roland and Walt to draft)*
- 8.5.4 Detector Alignment (like YR 13.4)
- 8.5.5 Schedule and Installation (like CDR 8.7.2, YR 13.3)
- 8.5.6 Access and Maintenance (like CDR 8.7.3, YR 13.5)
- 8.5.7 System Engineering and Interface Controls *(links to later global Section 12 on System Engineering)*

8.6 Detector Commissioning and Pre-Operations

Non-DOE Interest & In-Kind - Updated

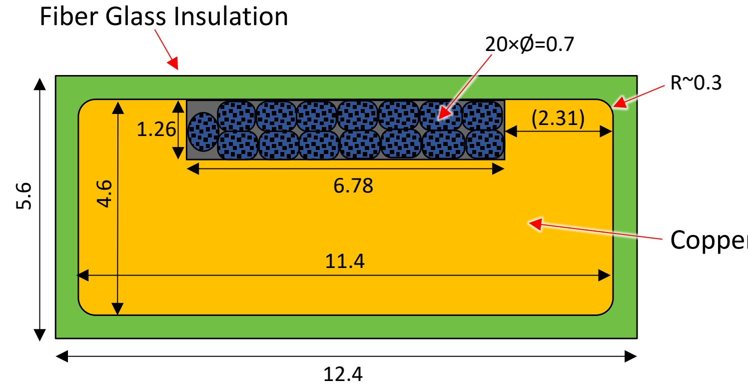
Entity	Interest and Important Facts
NSF	NSF-MSRI pre-proposal submitted by 10 US universities – aims at full scope of backward EM calorimetry (eECal). Armenia, Czech, France/IN2P3 as unfunded contributors. Invited to submit proposal. Final NSF review is ongoing.
CERN	MAPS sensor design developed by CERN/ITS-3 Group providing synergy with ALICE. Synergy of gaseous-based Cherenkov detectors and photon-sensors with ALICE & LHCb. Synergy of Forward AC-LGAD design with CMS endcap timing layer.
Armenia	Contributions, mainly labor to eECal and many EM calorimetry and particle id detectors component tests.
Canada	EIC included in 2022 Canadian Subatomic Physics Long-Range Plan; Interested in Compton Polarimetry, Barrel Electromagnetic Calorimetry and Software
China	Forward EM Calorimeter
Czech	Working with funding agency; Interested in eECal (PbWO4 crystals and glass) and Silicon
France/IRFU	Interested in MPGD/racking, electronics. Provided in-kind contributions to SC magnet design and interested to continue labor oversight during magnet construction.
France/IN2P3	International contribution to backward EM calorimetry (including in-kind design) and to readout electronics (two ASICs for AC-LGAD detectors and Calorimetry). IRFU & IN2P3 discussing together for higher-level contributions.
India	Consortium is working with Funding agency; Interested in detector software (non-project scientific contribution), contributions to DAQ/slow controls. Investigating further hardware contributions (including possible links with Si plants).
Italy/INFN	Aims at major scope of forward particle identification detector (dRICH), at (part of) the Si/MAPS tracker scope, and at photo-sensor contributions. Further investigating possible interest in EIC detector magnet scope.
Israel	B0 Detectors (Si tracking and PbWO4)
Japan	Interested in a US-Japan agreement; Aims at full scope of Zero-Degree Calorimeter in collaboration with Taiwan/Korea. Pursuit of full scope of barrel AC-LGAD detector as EIC-Asia consortium. Contribution to DAQ/streaming. Possible aerogel.
Korea	Aims at major scope for fiber-based barrel EM calorimeter, Also work packages for barrel AC-LGAD and Si-based hadronic calorimetry for ZDC.as part of EIC-Asia consortium (includes also Japan,Taiwan), Collaboration on Si tracking detector.
Poland	Actively working with ministry/funding agency; Interested in detectors along the beam line (luminosity detector, Roman Pots)
Taiwan	Pursuit of full scope of barrel AC-LGAD as part of EIC-Asia consortium. LYSO-based EM calorimeter for ZDC, Also optical readout/fiber. Possible later interest in PCBs. Computing.
UK	STFC seed funding for UK detector R&D (3M£). Interest in Si/MAPS tracker, polarimetry and detectors along the beams (Low-Q2/TimePix). Follow-up STFC/UKRI request for 5-7 years submitted early 2023 (includes accelerator part).

MARCO Magnet Design Details

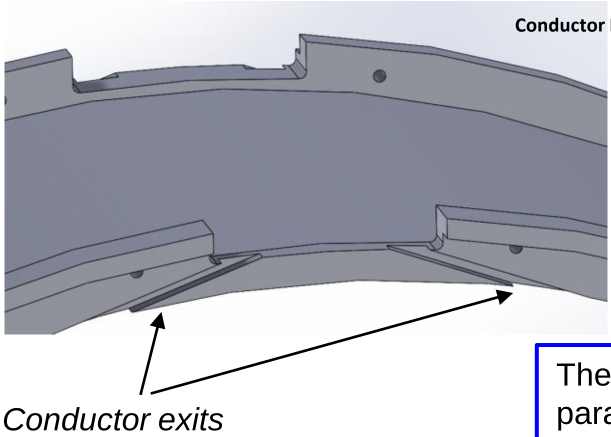


Coil is divided in 3 modules with 557 Turns each. This is done mainly to accommodate possible conductor length. Flux return steel layout fully defined to minimize forces and fringe fields (~10G)

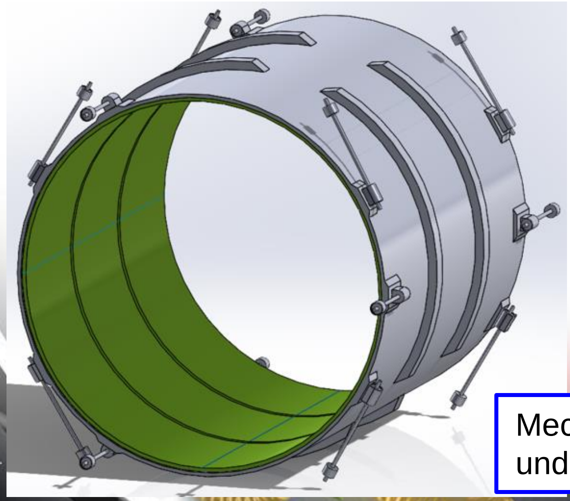
Conductor is based on CEA-Saclay experience as used for previous magnets.
Contract for conductor test samples in place with viable vendor.



Conductor Dimensions are in mm



See solenoid report by Valerio Calvelli on Thursday morning



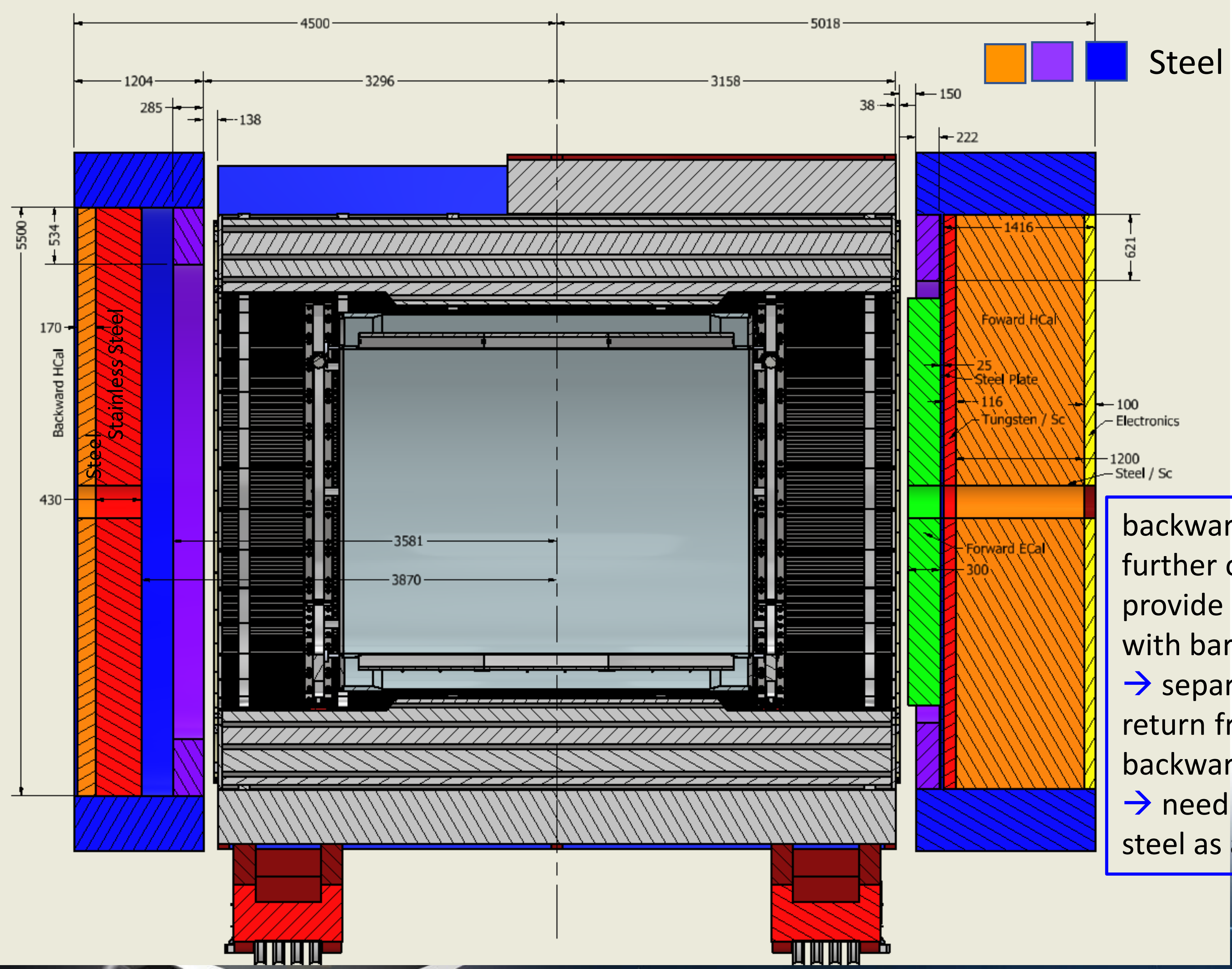
Mechanical analysis undergoing final checks

The two most important design parameters are conservative: large temperature margin and large critical current margin

B_0	1.5 T	1.7 T	2.0 T	Units	
Current	2900	3296	3924	A	
B_{peak}	1.925	2.187	2.602	T	
Temp. margin	3.1	2.9	2.5	K	> 1.5 K
Load line margin	60.6	55.3	46.8	%	
/ Ic(T_m,B_{peak})	17.3	21.3	28.8	%	<30 %

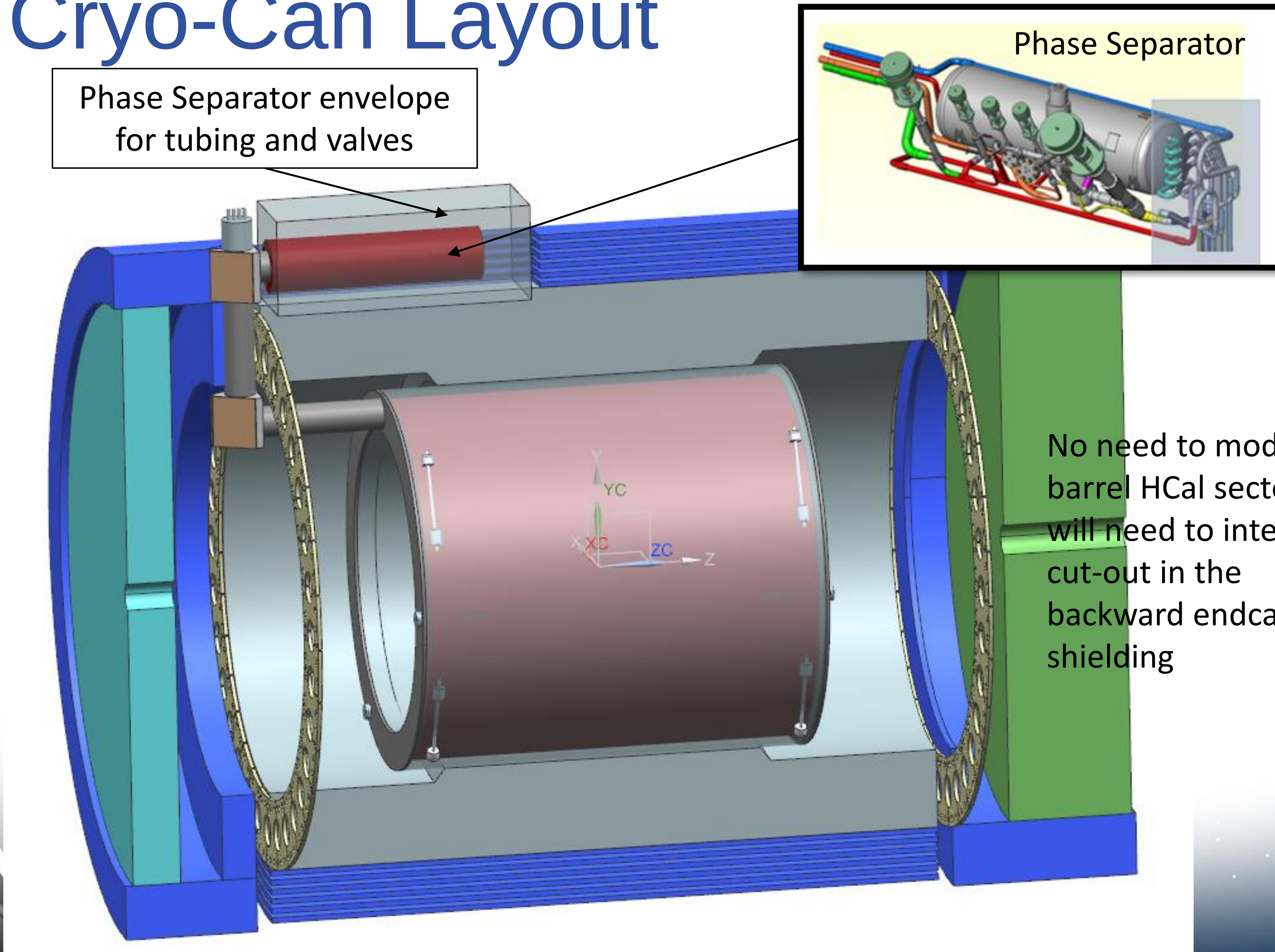
Final Layout of Flux Return and HCals

Note: detector is aligned with electron beam → 8mrad rotation also for endcaps



backward HCal was further optimized to provide better overlap with barrel Hcal
→ separated the flux return from the backward HCal
→ need to use stainless steel as absorber

Cryo-Can Layout

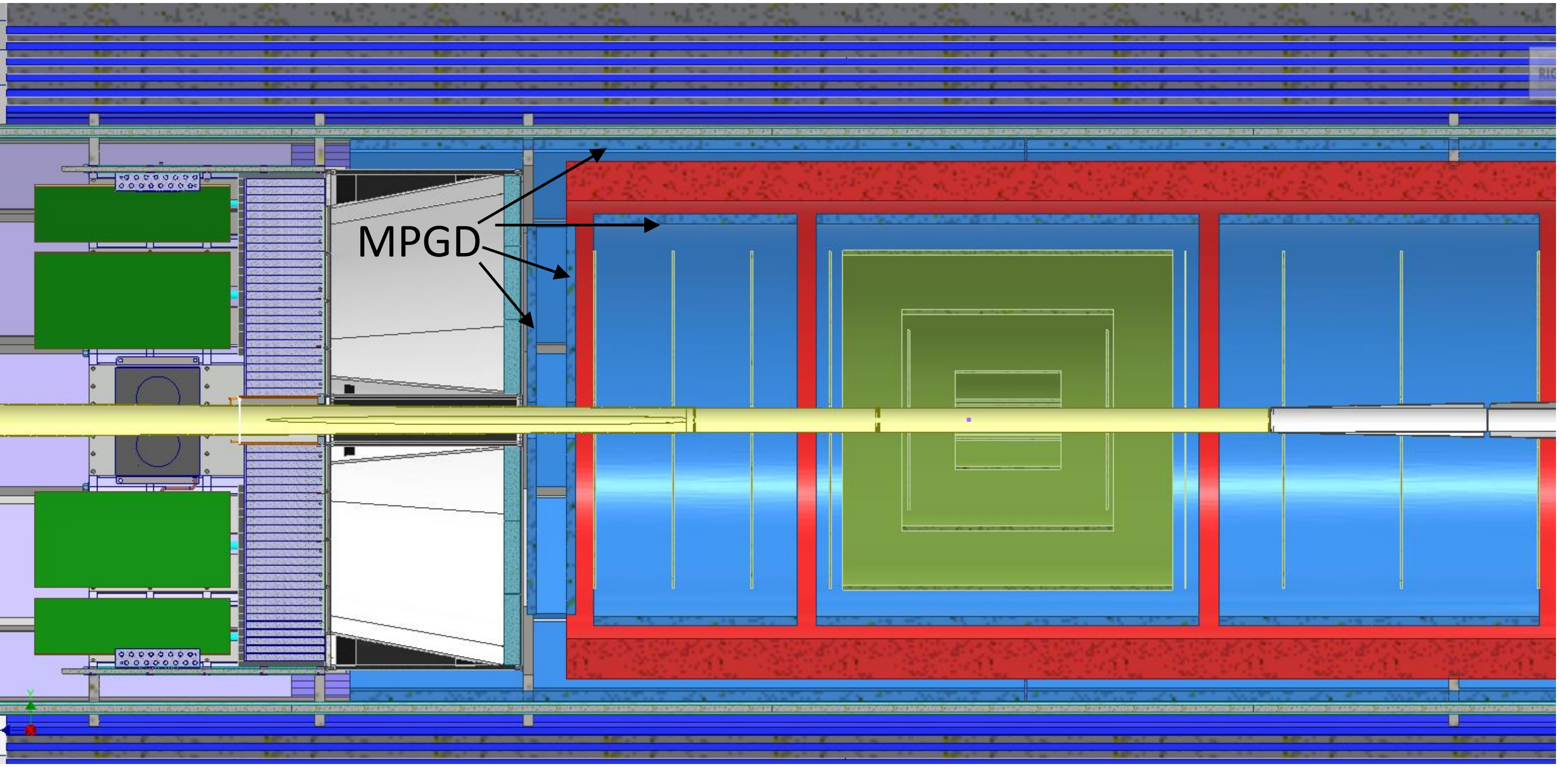


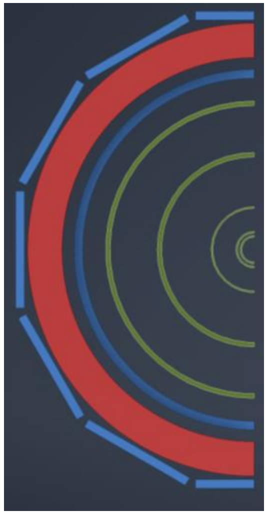
No need to modify any barrel HCal sectors will need to integrate cut-out in the backward endcap shielding

Integration of optimized tracking

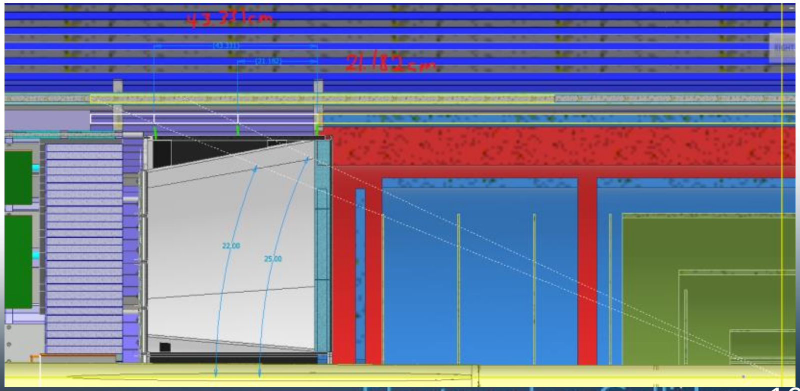
For details on the why see Ernst talk today and

https://indico.bnl.gov/event/19854/contributions/77603/attachments/48017/81517/20230615%20-%20ePIC%20Tracking%20WG.pdf

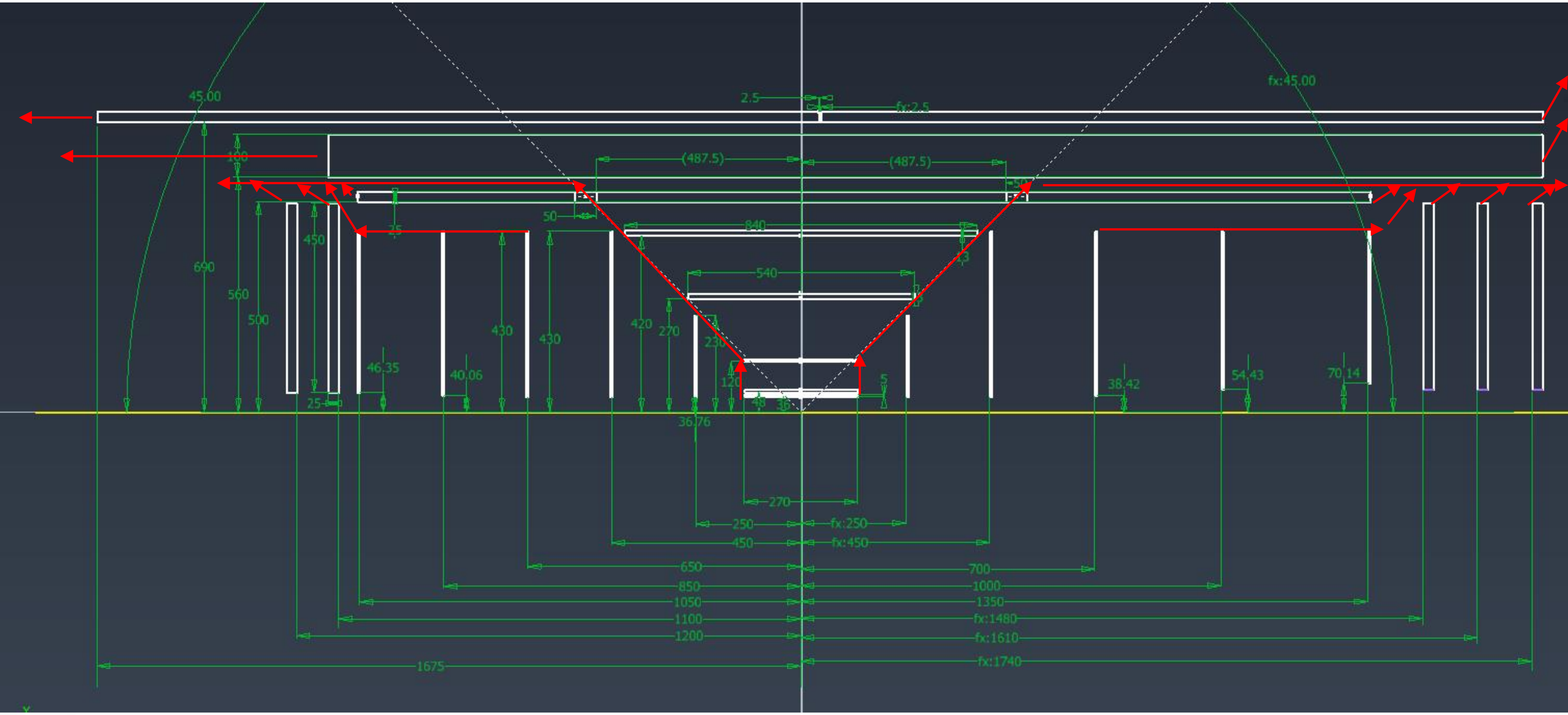




- Outer-MPGD Barrel extended to cover active region of DIRC → will be integrated in DIRC support
- Outer MPGD barrel is composed from flat detectors following the DIRC segmentation
- Inner MPGD Barrel and ToF will have one support also supporting all Discs and MAPS barrels



Integration of optimized tracking

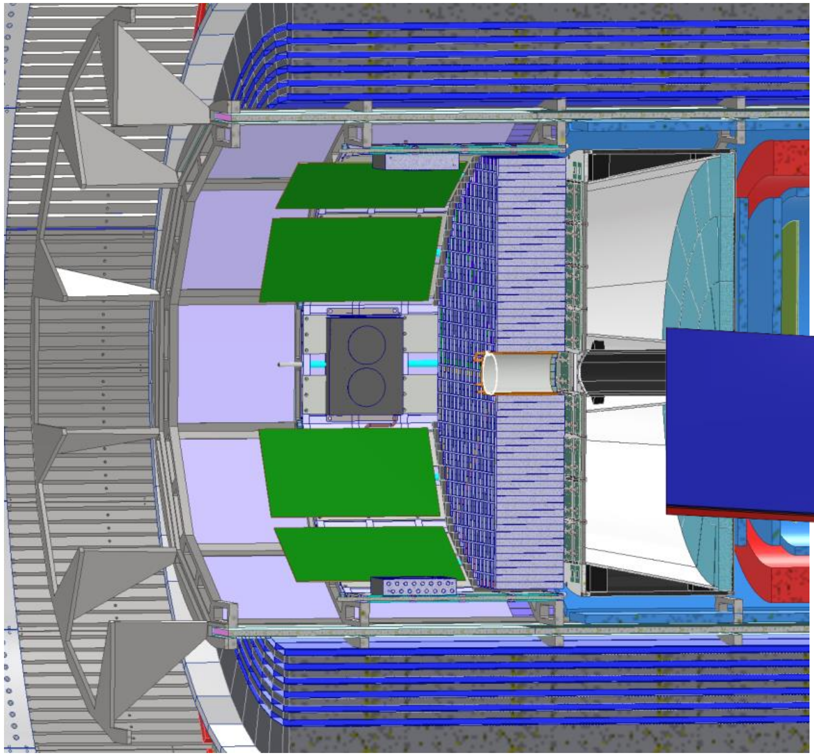


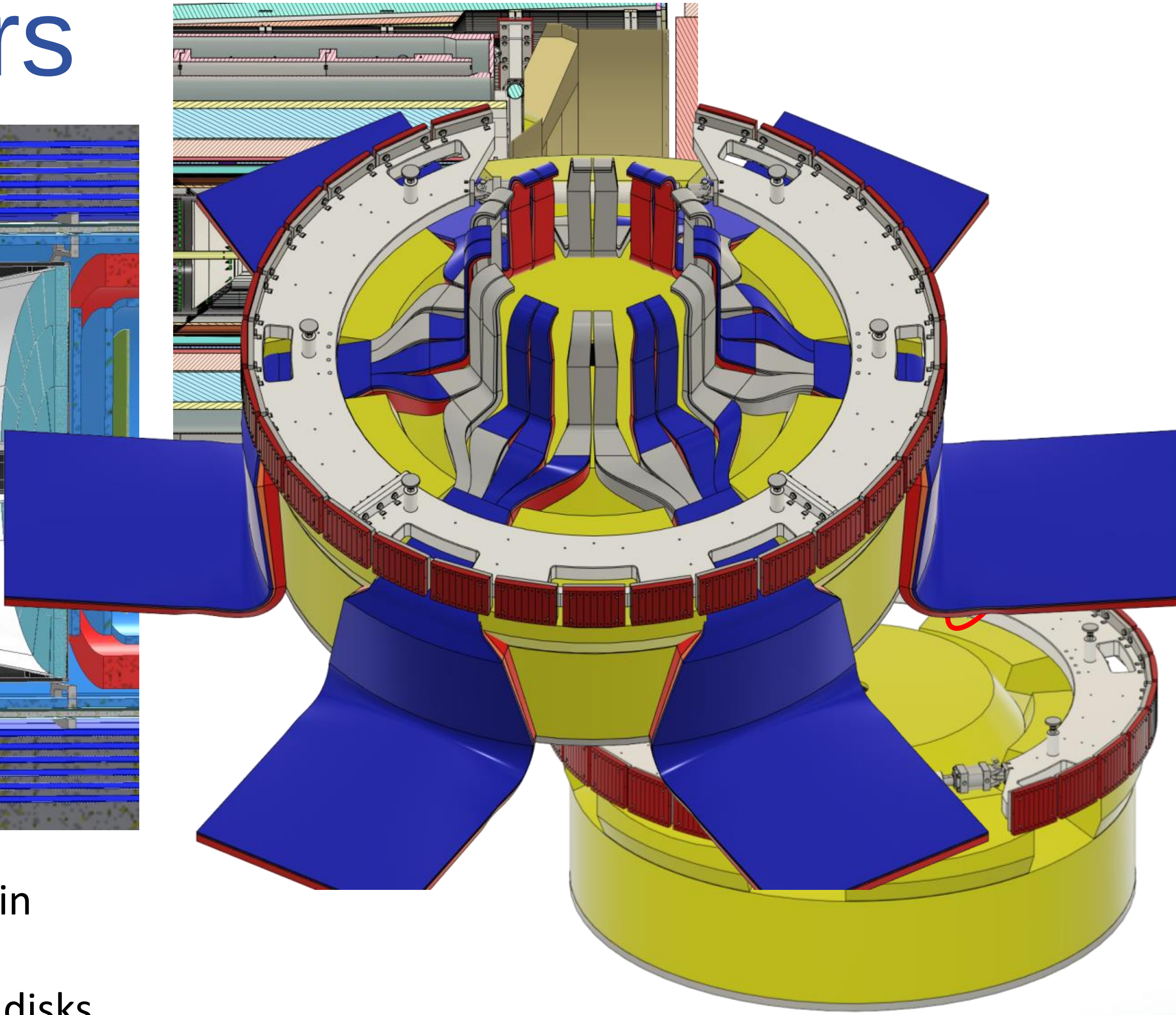
Have met with MAPS and MPGD DSCs to update services

[ePIC.Interface Control Document for Services.052023.xlsx]

Note: the tracker starting from the ToF inwards will be installed as one piece together with the beam pipe

PID Detectors



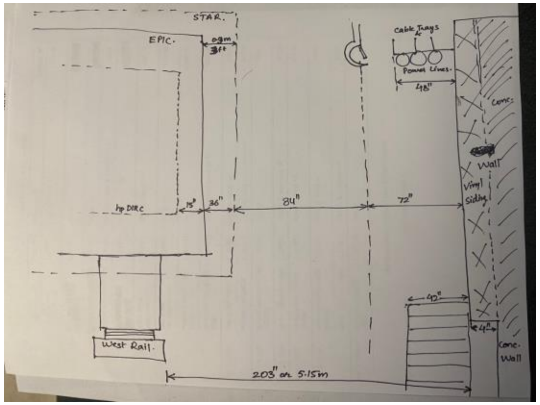


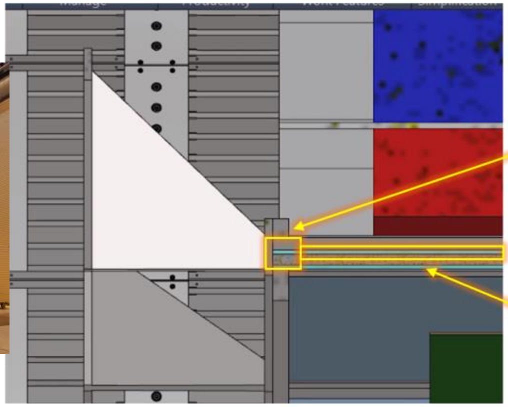
pfRICH needed to be shortened in expansion volume by 5cm to accommodate the 2 new MPGD disks

dRICH was moved 5cm in z to minimize interference with support rings
Remaining small interference still needs to be resolved → modify rings and/or optimize sensor boxes

DIRC

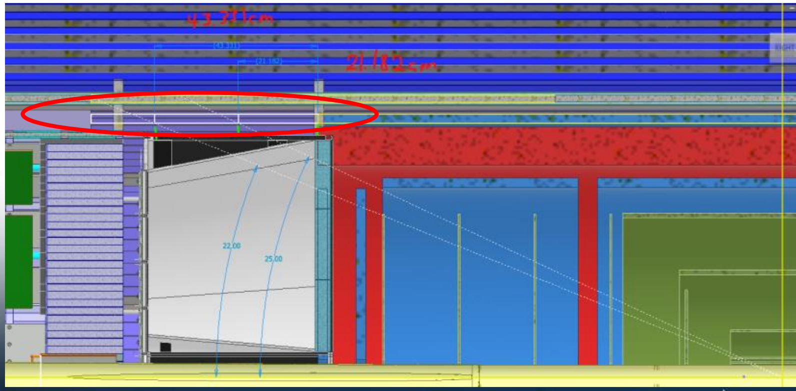
- New Installation plan:
  - after careful evaluation found the place to install from the lepton side tight but doable





- Further optimization ongoing:
  - frame is optimized to integrate outer MPGD barrel
  - to provide as much space as possible for services
  - minimize material before imaging ECal

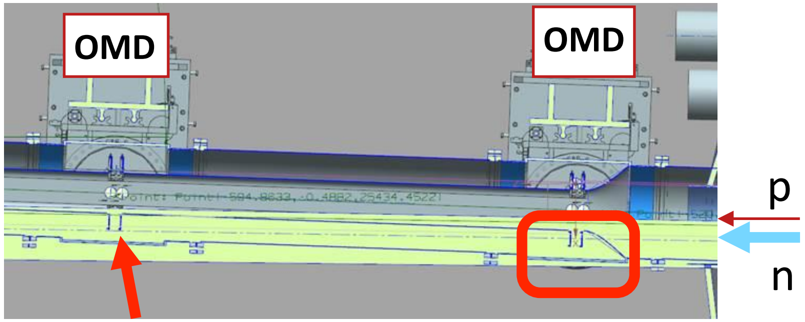
If more space for services is needed after recent update, will have to bite the bullet and move DIRC and Barrel ECal to larger radii



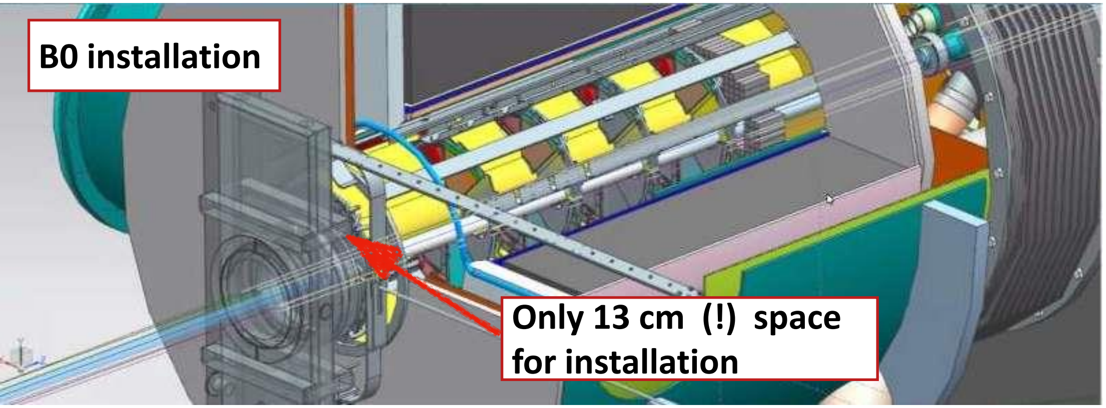
Far-forward/far-backward integration

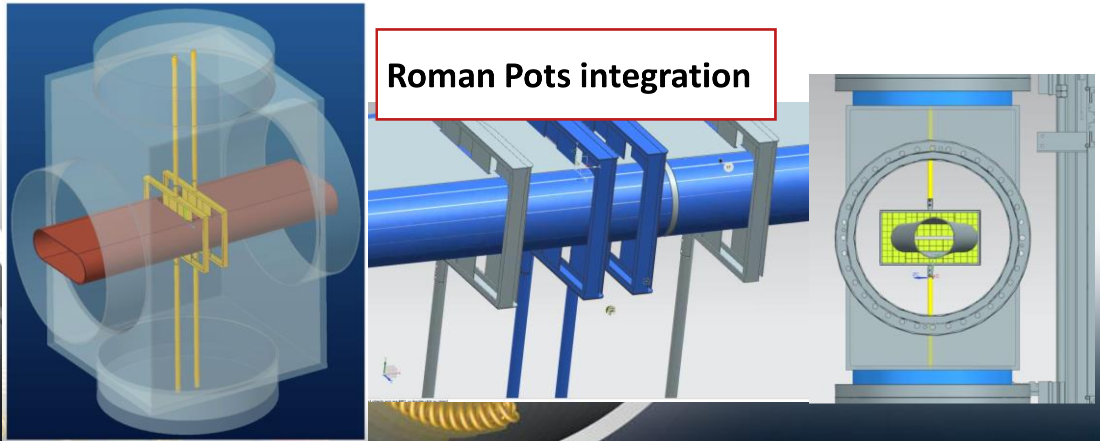
(courtesy Yulia)

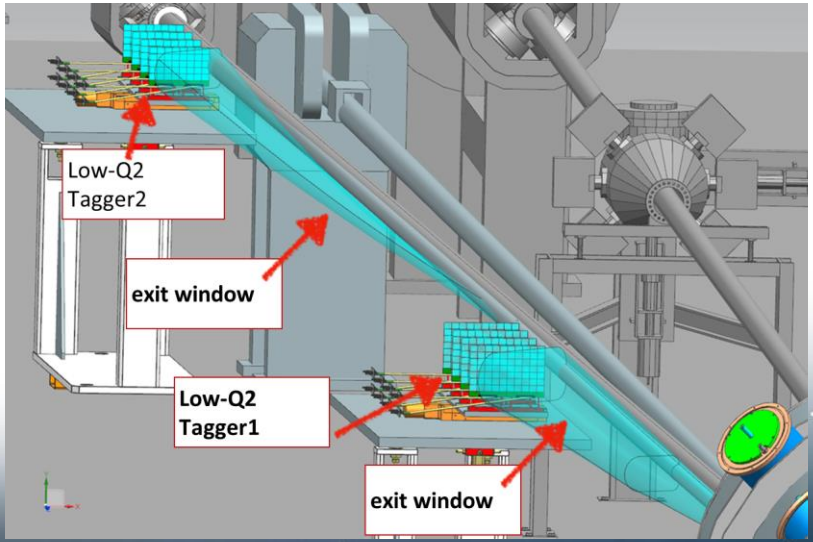
1. Integration with accelerator/RF / impedance calculations
   - hadron line : Roman Pots/Off-Momentum detectors
   - electron line: exit window for low-Q2 taggers
2. B0-detectors support and installation (only 13cm in front!)
3. Detector placement (accelerator design is still a bit in flux): ZDC
4. Off-Momentum detectors (OMD) and the neutron cone



Negative side of OMD



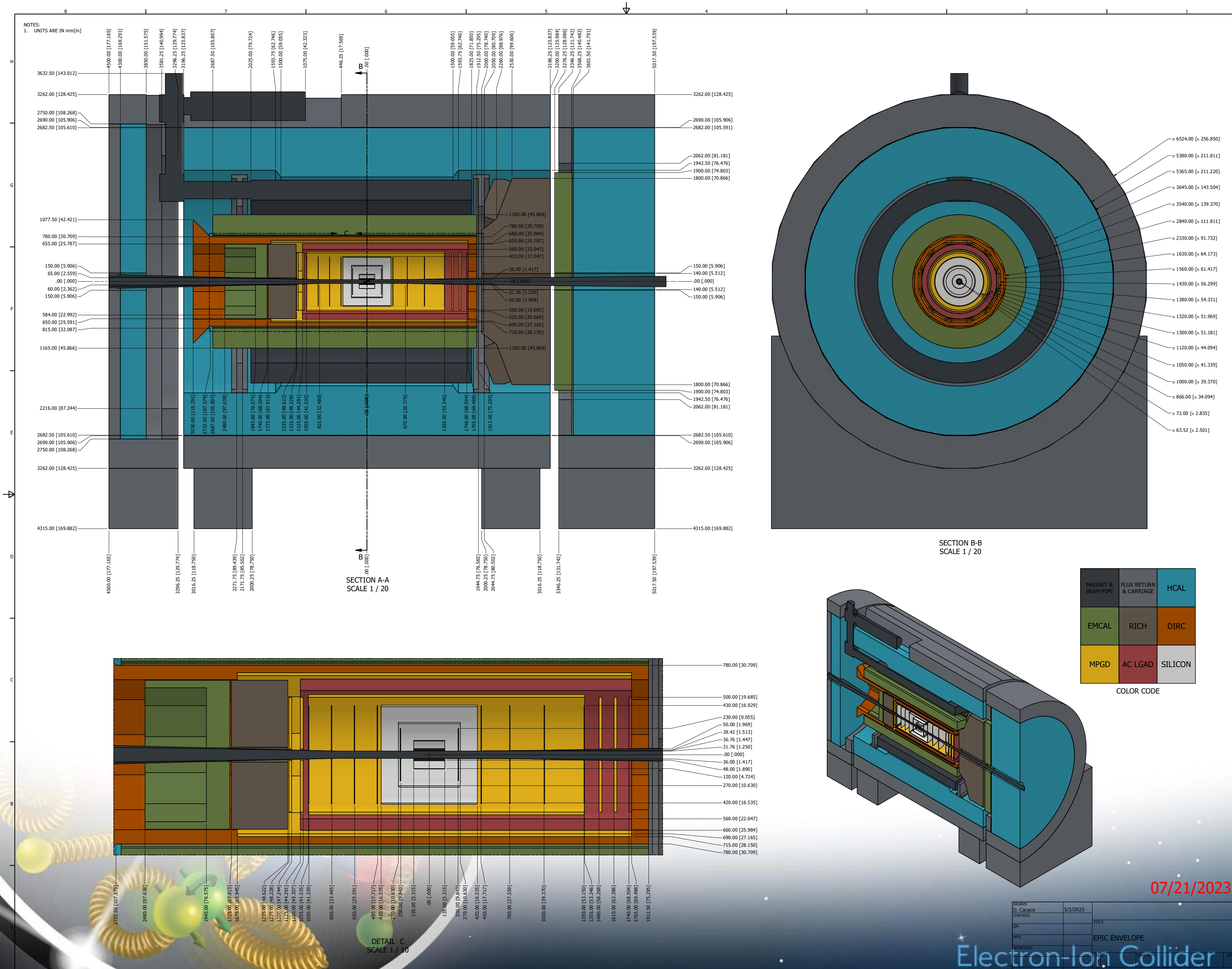




What Else

- Design support for Barrel-ToF and inner MPGD barrel including support for inner tracker barrels and disks
- integrate ROBs in the detector volume → needed now locking down design
- Finalize readout chains for different subdetectors
- layout racks on south platform and DAQ room
- optimize how to open endcaps and provide full access to collider equipment in the tunnel also during operation
- update geometry data base, all figures and provide 2d space allocation plots → see next slide
- Organize meetings with sub-systems per category, i.e. Tracking, HCals, ECals & PID, to discuss services, readout chain, requirements, …

  → "finalize" as much information as possible before DAC design review in late August/early September


NOTES:
1. UNITS ARE IN mm[in]
SECTION A-A
SCALE 1 / 20
SECTION B-B
SCALE 1 / 20
DETAIL C
SCALE 1 / 10
MAGNET & BEAM PIPE
FLUX RETURN & CARRIAGE
HCAL
EMCAL
RICH
DIRC
MPGD
AC LGAD
SILICON
COLOR CODE
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D. Cacace
5/3/2023
CHECKED
QA
MFG
APPROVED
TITLE
EPIC ENVELOPE
SCALE 1 / 20

07/21/2023

Where to find Information

- Wiki-page: https://wiki.bnl.gov/EPIC/index.php?title=Project_Information
- Public Sharepoint: ePIC
- Detector Requirements: https://eic.jlab.org/Requirements/
- Geometry Database: https://eic.jlab.org/Geometry/Detector/Detector-20230108185912.html
- Updated ePIC figures: Updated ePIC Figures

Big Thanks to the ME engineering team

Alex, Andy, Avishay, Chinmay, Dan, Elliot, Julien, Jonathan, Josh, Karim, Kevin, Peter, Roland, Rahul, Ron, Tom

and to the collaboration for all the help


QUESTIONS?
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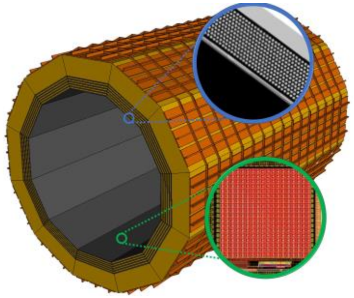
BACK UP

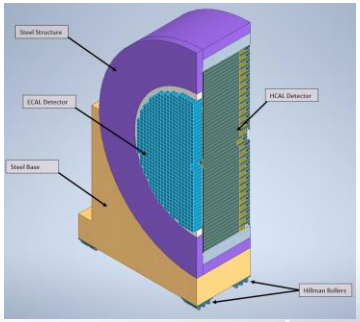
US National Laboratory Partnerships

- ❑ Argonne National Lab – Barrel (Imaging) EM Calorimeter
  - ➢ Pb/SciFi (with SiPM as photonsensor) with a hybrid imaging part (w. 6 layers of ASTROPIX)
  - ➢ Led by ANL in collaboration with Canada and Korea Groups



- ❑ Lawrence Berkeley National Lab – Monolithic Active Pixel Silicon (MAPS)
  - ➢ MAPS Vertex and Barrel layers (led by LBNL and UK Groups)
  - ➢ Synergy with MAPS forward and backward disks

- ❑ Oak Ridge National Lab – Forward Hadron Calorimeter
  - ➢ Longitudinally separated Steel/Sc & W/Sc sandwich with SiPMs embedded in Scintillator, with a high-resolution W/Sc insert
  - ➢ Led by ORNL in collaboration with 10 other US institutions



- ❑ Other partnerships to mention: Los Alamos National Lab, MIT-Bates Research and Engineering Center

International Engagement

We have had many meetings and site visits in 2022 & 2023, including:

- Japan - EIC Collaboration Meeting via Zoom on June 22, 2022 (Elke & Rolf)
- US-Israel BSF visit to BNL on September 12, 2022 (Haiyan, Rolf, Mike F/DOE)
- Visit to meet and discuss EIC -South Africa consortium at INPC (International Nuclear Physics Conference) in Cape Town, South Africa Sep 9-17, 2022 (Elke)
- EIC-Project - Taiwan Exp. Program Informational Mtg Sept 19, 2022 (Elke & Rolf)
- Visit to BNL by Japan representatives on November 01-02, 2022: two persons (Okamura and Kadotani) from Embassy of Japan (working under Koji Aribayashi), together with one (Sakuraba) from Japan Consulate of NY (Elke participating)
- APCTP Workshop on the Physics of Electron-Ion Collider (First EIC-Asia meeting) at ACTP-Korea from November 2-4, 2022 (Jim, Abhay, Mike F/DOE, also Tim H/DOE and Rolf remote) https://indico.knu.ac.kr/event/592/
- Visit to meet and discuss EIC-Latin America consortium at the Latin American Symposium on High Energy Physics November 14-18, 2022 (Elke)
- Visit to meet and discuss EIC-India participation in EIC from December 18-20, 2022 (Abhay, Elke)
- EIC-Asia workshop in RIKEN-Wako, Japan from March 16-18 (Elke, Rolf, Abhay)
- Visit to Brazil as part of POETIC-X, discuss EIC-Brazil opportunities - 10th Int'l Conf. on Physics Opportunities at an Electron-Ion Collider, May 2-6, 2023 (Abhay, Elke)

Technical Change Control Process - Detector

- Copy process as has been used for the accelerator as it works well.
- will have more people with detector expertise in the TCCB for such change requests. We need to involve the detector collaboration to *initiate documentation* for change requests and use their technical board or equivalent to ensure the change request is consistent with the NAS science requirements, and then use the "detector TCCB" to ensure the project part.
  As final step it goes to the EMT for the formal approval.

Proposed detector TCCB:

From January 9th ePIC meeting

- Qiong Wu (chair)
- Person with detector experience to take notes and help Qiong
- Elke Aschenauer
- Rolf Ent
- detector lead mechanical engineer (Rahul Sharma, 6.10.10 CAM)
- detector lead electronics engineer (Fernando Barbosa, 6.10.08 CAM)
- two members of the ePIC collaboration (for example the lead of the detector/technical board, perhaps a technical coordinator if there is one) **– TIME TO ASSIGN NAMES**
- three accelerator L2 leads or alternate: HSR, ESR and IR to ensure overlap
- relevant L3 CAM of the WBS the change is requested for
- add subject matter experts as needed (for example Charlie Folz for infrastructure).

Always included in TCCB process: Ferdinand Willeke and Todd Satogata

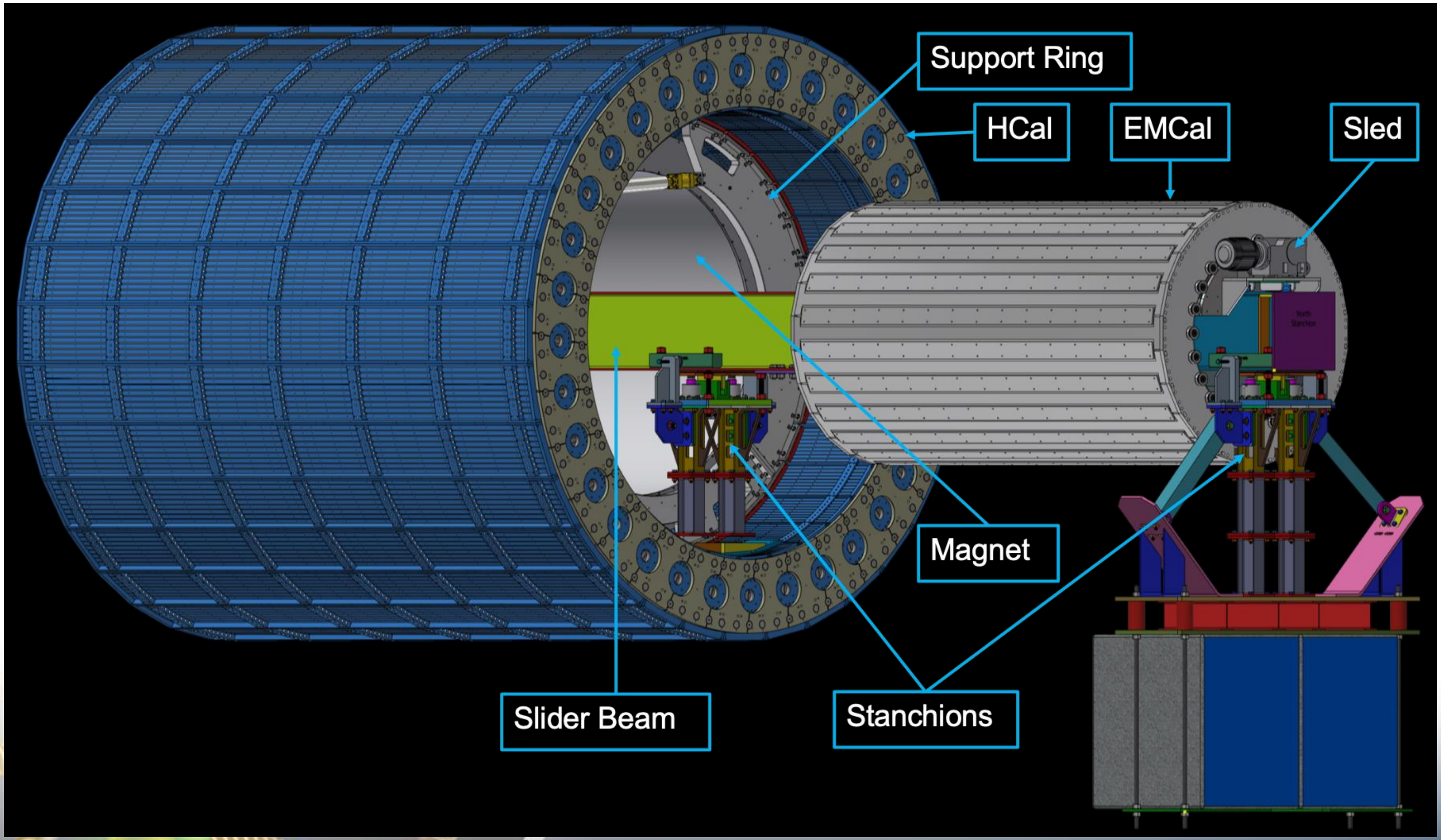
Note: After the TCCB advise, the formal baseline change control is done through the EMT but in obeyance of the various thresholds in the Project Execution Plan.

(Draft) TDR – more details on Appendix B

Appendix B	Integration of a Second Experiment
B.1 2nd Interaction Region (high-level goal on ensuring feasibility - 2021 position paper)	
	(Rolf, Elke, Angelika)
B.2 Luminosity sharing and requirements	(Christoph, Todd)
B.3 Polarization with two experiments	(Eliana)
B.4 IR definition and layout (include 3D CAD/Sketchup)	(Randy, Scott, Vasiliy, Angelika)
B.5 Magnet and forward-detection checks	(Renuka, Alex, Elke/Rolf)
B.6 Outstanding issues	(Elke/Rolf)
B.7 Experiment Complementarity	(like YR 12 or like new EIC White Paper)

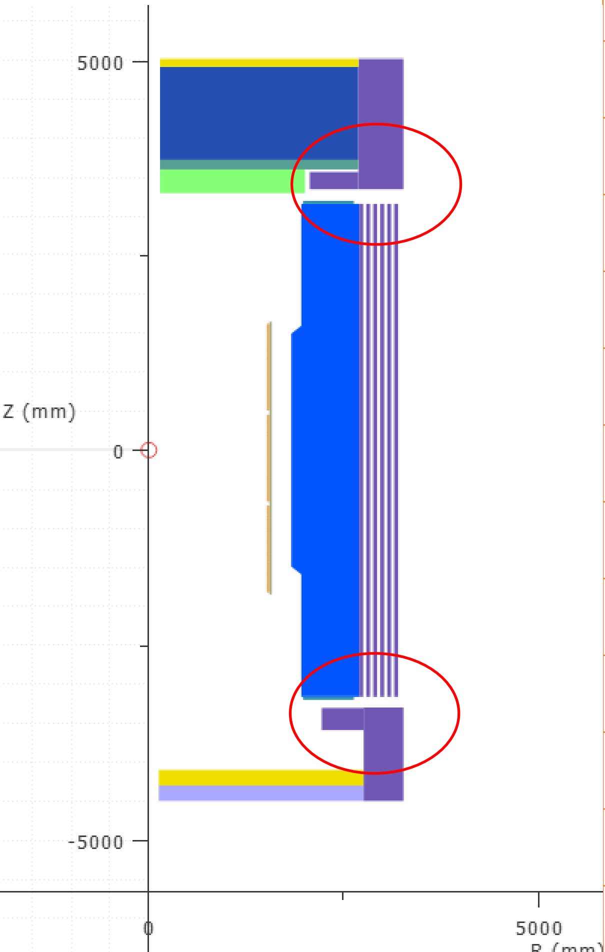
Barrel ECal Integration

- Great progress on the mechanical engineering, integration and first installation ideas during Barrel ECal focus week
- A lot more work to be done, but of to an excellent start
- exact radial position will be fixed after next iteration of DIRC support structure and next all service iteration is done



Layout of Magnetic Materials now given

(courtesy Valerio, Renuka et al)



Parameter	V7.6.2.2.7	V7.6.2.2.8	V7.6.2.2.9	V7.6.2.2.10a	Units
Current			3924		A
# turns			1668		
B_0	2.000	2.008	2.007	2.007	T
Bpeak MOD 1	2.672	2.657	2.638	2.660	T
Bpeak MOD 2	2.476	2.478	2.478	2.478	T
Bpeak MOD 3	2.651	2.670	2.656	2.671	T
Energy	45.294	45.369	45.352	45.524	MJ
Inductance	5.8839	5.8929	5.8907	5.877	H
Fz MOD 1	11.98	11.86	11.94	11.92	MN
Fz MOD 2	458	45238	52776	58.4	kN
Fz MOD 3	-11.98	-12.00	-12.06	-12.00	MN
Fz tot	-5.6	-104.376	-63.7	-29.3	kN
B5300	14.3	17.9	16.9	15.8	G
B7200	8.7	11.5	11.5	11.0	G
B3400	1.0	2.0	2.2	2.8	G

Remaining deltas to fringe field specifications (10G) we will fix locally (as needed)

Backup as likely included in Valerio's talk