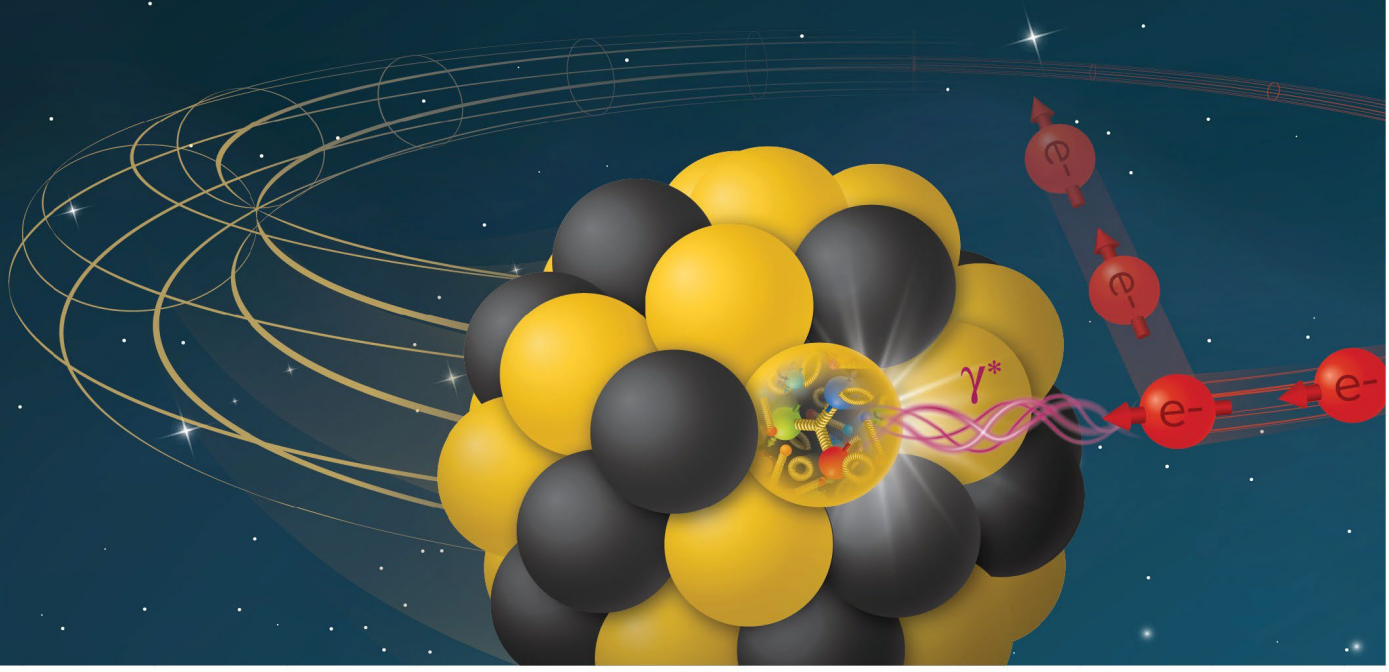
Electron-Ion Collider

Brookhaven National Laboratory | Jefferson Lab | U.S. DEPARTMENT OF ENERGY | Office of Science

Final Report

Incremental Design Review of the ME Design of ePIC

July 15, 2024



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1 Reponses to Charge Questions

Charge Question #1

Are the technical performance requirements for the detector integration, infrastructure, installation, and operations appropriately defined and complete for this stage of the project?

Response: Yes, however, we suggest that the Project Management team distribute these requirements as a design guide to the engineering and design team so that there is a uniform set of requirements used by all subsystems.

Charge Question #2

Are the plans for detector integration, infrastructure and installation sufficiently developed and documented for the present phase of the project?

Response: The design team is developing plans along with support documentation for a late September Final Design Review. While there were excellent solid models of components, detailed drawings still need to be done. While it is feasible to meet this deadline, it is very tight.

Charge Question #3

Are the current plans likely to achieve the technical performance requirements, with a low risk for cost increases, schedule delays, and technical problems?

Response: Additional budgetary quotes and a revised bottom's-up estimate should be done in order to reduce bid risk. One quote has been provided by an outside fabrication firm, but more are needed.

Charge Question #4

Are the schedule assumptions for the fabrication of the various support systems and installation plans reasonable and consistent with the overall detector schedule?

Response: Estimates for the fabrication time needed of components seems reasonable and are consistent with what we would assume for the scope described.

Charge Question #5

Have considerations for services, commissioning and maintenance been adequately incorporated into the plans at their present stage?

Response: Yes, the design team has considered installation and maintenance requirements for the steel fabrications. They will need to include all features in the design documents that address these requirements.

Charge Question #6

Have ES&H and QA considerations been adequately incorporated into the plans at their present stage?

Response: Yes, however we recommend that a formal meeting be conducted with the design team along with the appropriate safety and quality representatives. This is in order to brief them on the planned design so that any suggestions that they may have are incorporated into the final drawing and Statement of Work package.

Introduction, Overview, and Integration

Findings

- The team is working towards a Final Design Review in late September for Long Lead Item steel.
- A cost and schedule comparison was done between the present design and a design that incorporates a single back-leg sector. From that study the present design was chosen to be more beneficial to the project with regard to cost.
- Seismic loading are being considered but not defined in all talks. 0.25g was mentioned in Josh' presentation
- The weights for all components are adequately defined
- A good layout with interface dimensions was presented

Comments

- The present schedule is very aggressive. Identifying the important items to be included in the design package is paramount to a successful bid and delivery of steel.
- Interfaces seem well thought out, with a good understanding of the design team of their roles and responsibilities.
- Fabrication times seem reasonable for the scope of work.
- Floor loading requirements have been defined but the group needs to work closely with an outside structural engineering firm to determine if the floor structure is adequate. If not, a plan is needed for design changes to the detector.
- The interface with electronics cabling and cooling water were addressed and there appears to be enough space. Maybe a mockup of the tightest area should be conducted to verify there is enough space.
- Some structural calculations used a Factor of Safety (FOS) of 4 to the material Yield Strength and others used a factor of 2 as a minimum requirement. This should be consistent.
- There were no commissioning plans discussed.
- The HCAL and flux return barrels were discussed and there are plans in place to detail the exact build up sequence paying close attention to tolerance stack up and preloading.
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Recommendations

- Additional requests for budgetary quotes should go out as soon as possible so that there is more than one quote that will be used to support the estimated cost of fabrication. A

bottom's-up estimate should also be done by the design team prior to the FDR.

- Refine the delivery schedule to take credit for partial deliveries of fabricated components.

- The Project Management team should distribute a requirements design guide to the engineering and design team. This will help in having a uniform set of engineering and design parameters that can be used by all subsystems.

MARCO Magnet and Interfaces with Mechanical Structures

Findings

- Stray magnetic field flux impact on RCS beamline is well defined and analyzed. Both AISI 1020 and AISI 1008 steel will be looked at.

Comments

- There has been much work done in identifying the interface items between the magnet and the Integration team. Nicely done.

Recommendations

- None

Central Barrel Detector, Cradle, and Flux Return Steel

Findings

- A great amount of work and thought went into this endeavor.

Comments

- Integration items like the supports for the magnet and phase separator still need to be worked out. The team has a good understanding of what is needed and will be adding the important features to the design package prior to the Final Design Review.

- Putting together a design package including drawings and Statement of Work by the end of September for the planned Final Design Review is very aggressive and will pose a challenge to the design team. A critical look at the deliverables and the timeframe needed should be done by project management.

- Perform a study of the effects of welding the STAR backleg supports to the cradle to ensure tolerances are met for the 8 mrad offset requirement.

- Continue with plans to ensure that the cradle can safely support the anticipated loads. This may lead to alterations to the existing design.

Recommendations

- None

Endcaps Detector, Cradle, and Flux Return Steel

Findings

- Floor loading requirements have been defined but the group needs to work closely with an outside structural engineering firm to determine if the floor structure is adequate. If not, a plan is needed for design changes to the detector.

Comments

- Revisit the need for shimming of the HCal and EmCal towers and the impact to the overall assembly of the Forward End Cap. Having the ability to shim these components will help with any kind of unforeseen misalignment or stack up tolerance issues.

- Putting together a design package including drawings and Statement of Work by the end of September for the planned Final Design Review is very aggressive and will pose a challenge to the design team. A critical look at the deliverables and the timeframe needed should be done by project management.

- The difficulties with designing to the 8mrad rotation required are understood. The design of the cradle adapter needs to be fully vetted and the interference fix for the BS endcap and platform needs to be addressed. Tolerance for this rotation is tentatively +/- 1mrad but needs to be evaluated

Recommendations

- None

2 Appendices

2.1 Appendix A: Charge to the Review Committee

Brookhaven National Laboratory

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managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *June, 20th 2024*

to: *Reviewers*

from: *Rolf Ent (JLab) E.C. Aschenauer (BNL)*

subject: Incremental Design and Safety Review of the EIC Detector Integration, Infrastructure and Installation (I^3)

The topic of this review are the mechanical structures that are part of the ePIC central detector including those from the magnet on to the outside diameter of the barrel and those in the two endcap structures. The various detector support and installation systems that reside with detectors inside the magnet bore and/or before the forward hadron endcap are not part of the scope for this review.

This review addresses the design maturity, schedule and assumptions related to

- the flux return steel that is required for the EIC detector.
- the support structures required for the endcaps and outer barrel detectors.
- the installation activities and time sequencing of the detector activities within this scope.
- the infrastructure requirements and associated tasks for the new EIC detector.

This review is to ensure that the mechanical structures needed for the outer barrel detectors and both endcaps are well designed and have folded in proper safety factors, that tasks and time sequencing is understood, and no scope or interface is forgotten. For the steel, this acts as 60% design maturity review ("PDR") with a final design review planned for in September2024. For the other components, this acts as an incremental design review ("PDR-1") with a further 60% design maturity review including also the scope within the magnet bore and services planned in Spring/Summer 2025.

For this Incremental Design Review, you are asked to address the following questions:

1. Are the technical performance requirements for the detector integration, infrastructure, installation, and operations appropriately defined and complete for this stage of the project?
2. Are the plans for detector integration, infrastructure and installation sufficiently developed and documented for the present phase of the project?
3. Are the current plans likely to achieve the technical performance requirements, with a low risk for cost increases, schedule delays, and technical problems?
4. Are the schedule assumptions for the fabrication of the various support systems and installation plans reasonable and consistent with the overall detector schedule?
5. Have considerations for services, commissioning and maintenance been adequately incorporated into the plans at their present stage?
6. Have ES&H and QA considerations been adequately incorporated into the plans at their present stage?

Please address these questions point-by-point.
You will be supplied with the project milestones extracted from the most current EIC resource loaded P6 schedule, detector layouts and drawings, copies of presentations relevant to this subject material, and other relevant material as part of the pre-brief material.

cc: S. Nagaitsev
J. Fast
L. Lari
K. Wilson

* * *

2.2 Appendix B: Review Committee

- James Mills, Brookhaven National Laboratory, mills@bnl.gov
- Timothy Whitlatch, Thomas Jefferson National Accelerator Facility, whitey@jlab.org

2.3 Appendix E: Agenda

Incremental Design Review of the ME design of ePIC

Monday 15 Jul 2024, 07:55 → 15:00 US/Eastern

Description OPEN SESSION ZOOM LINK:

Join ZoomGov Meeting
https://bnl.zoomgov.com/j/1604238881?pwd=NGNlNHpDUWx4clE0SndDWndINFYxZz09

Meeting ID: 160 423 8881
Passcode: 187017

Charge.PDR1.I3_v2.... **PreBrief Material**

08:00 → 08:15 **Executive/Closed Session** 15m

EXECUTIVE/CLOSED SESSION ZOOM LINK:

https://bnl.zoomgov.com/j/1610461890?pwd=L0hDemRiWTFCQ3M5Vy9BQ1JXbTZGZz09

Meeting ID: 161 046 1890
Passcode: 951194

Speakers: James Mills (Brookhaven National Laboratory), Timothy Whitlatch (JLab)

Closed.Session.ME....

08:15 → 08:30 **Introductions with the Team** 15m

08:30 → 08:50 **Introduction, overview and integration** 20m

Speaker: Rahul Sharma (BNL)

Flux Return Steel Re...

09:00 → 09:15 **MARCO magnet and interfaces with mechanical structures** 15m

Speakers: Dr Renuka Rajput-Ghoshal (JLab), Sandesh Gopinath (JLab)

MARCO magnet an...

09:20 → 09:35 **Break** 15m

09:35 → 10:25 **Central Barrel Detector, Cradle, and Flux Return Steel (CD-3B Candidate)** 50m

Speakers: Nathaniel Speece-Moyer (BNL), Roland Wimmer (BNL)

PD1 Flux Return Bar...

10:45 → 11:25 **Endcaps Detector, Cradle, and Flux Return Steel (CD3B Candidate):** 40m

Speakers: Dan Cacace (BNL), Joshua Harvey (BNL)

Endcap Flux Return ... Endcap Flux Return ...

11:45 → 12:00 **Further Questions** 15m

12:00 → 14:30 **Lunch and Closed Session** 2h 30m

EXECUTIVE/CLOSED SESSION ZOOM LINK:

https://bnl.zoomgov.com/j/1610461890?pwd=L0hDemRiWTFCQ3M5Vy9BQ1JXbTZGZz09

Meeting ID: 161 046 1890
Passcode: 951194

Speakers: James Mills (Brookhaven National Laboratory), Timothy Whitlatch (JLab)

14:30 → 15:00 **Closeout** 30m

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