Report of the

EIC Preliminary Design and Safety Review of the EIC Auxiliary Far-Forward/Far-Backward Detectors

Technical Review

Performed Remotely at Jefferson Lab
Newport News, Virginia

February 12, 2024

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1. Executive Summary

The committee was chaired by Fuliva Pilat (ORNL), and included Wolfram Zeuner (CERN), Gerrit van Nieuwenhuizen (BNL) and Eugene Chudakov (JLab).

- Thanks for the detailed and well-prepared presentations, and for the frank and open discussions
- The Committee is impressed with the high quality of physics simulations in general and in particular with the high quality of background analysis
- We recognize the complexity of the task and the challenge in designing and finalizing multiple systems while the accelerator design is not completed
- We appreciate that the team recognizes and leverages synergies among different systems within ePIC
- A very good team is in place, and we will comment on that later
- We were excited to see the extent and good quality of CAD modeling beyond the institution borders that is being used on the project

2. Reponses to Charge Questions

Responses to Questions

Charge Question 1:

Are the technical performance requirements appropriately defined and complete for this stage of the project?

Yes, for most components.

Comments

- The requirements are generally well done and credible for all systems
- Concerning the hadron calorimeter good decisions have been taken. The decision on the crystal type should be taken as soon as possible as it affects the readout
- The DAQ is very challenging in general

Recommendations

- Ensure that WBS 6.06 continues to develop comprehensive dynamic aperture evaluations including effect of crab cavities, auxiliary components and imperfections to demonstrate the requirements technical feasibility before CD-2

Charge Question 2:

Are the plans for achieving detector performance and construction sufficiently developed and documented for the present phase of the project?

Yes for plans, but not yet for construction.

Comments

- The plans for achieving detector performance are appropriately developed but the construction plan is not sufficiently developed
- More elaboration and explanation on how to achieve 1% luminosity precision with the calorimeter is needed
- The justification for requirements of the direct photon calorimeter at high luminosity is not convincing
- The insertion mechanism of the tracker into the B0 appear extremely challenging and need major development work

Recommendations

- Develop plans for insertion of tracker and calorimeter readout into B0 magnet, including decision whether the device should be serviceable as soon as possible but not later than the next review

Charge Question 3:

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

Yes, for performance; for risks we need to see the risk matrix.

Comments

- The current designs are sound and likely to achieve the stated goals
- We need more information, in particular a comprehensive discussion of risk management and risk matrix, to answer this question
- We suggest to provide an assessment of competence, readiness and resources (number of FTEs etc.) for all collaborating groups
- The Committee support the hiring of an expert in cooling and temperature stabilization and encourage the project to pursue this as soon as possible
- We advise to follow up with an analysis of humidity control in the tunnel enclosures

Recommendations

- Prepare and present a comprehensive risk analysis for the next FF-FB system review

Charge Question 4:

Are the fabrication and assembly plans for the various detector systems appropriately developed for the present phase of the project?

No.

Comments

- Fabrication and assembly plans were not presented and we look forward to hearing at the next review

Recommendations

- Present fabrication and assembly plans at the next review

Charge Question 5:

Are the plans for detector integration in the interaction region appropriately developed for the present phase of the project?

Yes, for this phase of the project, but plans will have to be developed in more details when the IR accelerator design is finalized.

Comments

- Design and installation of far-forward and far-backward systems are quite challenging
- The Committee commends the systematic approach adopted and the good progress in planning
- We commend in particular the good work done in developing a 3D CAD model of the FF and FB regions
- We suggest to add specific details about site services and ancillary systems
- Installation during construction and maintenance/repair of systems during operations will be critical and challenging because of the limited access space
- It could be beneficial to extend the use of 3D CAD model to include assessment of space needed for installation, maintenance and repair, possibly including realistic dynamic process modeling
- It will be important to create the culture and expectation that the collaborating institutions be active not only in delivering systems but partnering in the installation and commissioning of systems

Recommendations

- None

Charge Question 6:

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

Yes, but plans will need to be refined as the design is finalized.

Comments

- The ESH&Q plans will need to evolve and focus as the system designs will progress and finalize
- The next Review could benefit from an overall presentation focused on ESH for the FF/FB regions as a complete an integrated system, and that shows as the ESH&Q plans are integrated with the overall ESH&Q project plans
- The QA plans should be developed and presented system by system, and once the production plans are better developed

Recommendations

- None

3. Appendices

3.1 Appendix A: Charge to the Review Committee

Jefferson Lab
Thomas Jefferson National Accelerator Facility

MEMO

Date: February 12, 2024

To: Fulvia Pilat (ORNL), Wolfram Zeuner (ZEUS/CMS), Gerrit Van Nieuwhuizen (BNL), and Eugene Chudakov (JLAB)

From: Elke Aschenauer (BNL) and Rolf Ent (JLab)

Subject: Preliminary design and Safety Review of the EIC Auxiliary Far-Forward/ Far-Backward Detectors

The scope of this review includes all aspects of the auxiliary detectors along the beam line: the luminosity monitor, the backward small-angle electron tagging detectors, the Zero-Degree Calorimeter, the Roman Pots and off-momentum detectors, and the detector systems in the B0 magnet.

The review may include design and fabrication choices and their cost-effectiveness, the construction schedule, considerations for safety and quality assurance, levels of redundancy, front-end electronics and interface to the data acquisition system, commissioning and calibration procedures, considerations for materials and labor, operational reliability and longevity, and any other considerations that may influence the construction, maintenance and operation of these particle identification detectors.

This review also includes aspects of the integration of the detector with the interaction region such as expected vacuum and backgrounds, beam safety and abort systems, ongoing beam pipe and detector support structure concepts.

You are asked to address the following questions:

1. Are the technical performance requirements appropriately defined and complete for this stage of the project?
2. Are the plans for achieving detector performance and construction sufficiently developed and documented for the present phase of the project?
3. Are the current designs and plans for detectors and electronics readout likely to achieve the performance requirements with a low risk of cost increases, schedule delays, and technical problems?
4. Are the fabrication and assembly plans for the various detector systems appropriately developed for the present phase of the project?
5. Are the plans for detector integration in the interaction region appropriately developed for the present phase of the project?
6. Have ES&H and QA considerations been adequately incorporated into the designs at their present stage?

Please address these questions point-by-point.

You will be supplied with a 3D pdf file of the IR layout, the detailed schedule and labor assumptions, drawing packages, copies of presentations relevant to this subject material, and the project milestones extracted from the most current EIC resource loaded P6 schedule as part of the pre-brief material.

cc: J. Fast

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3.2 Appendix B: Review Committee

Reviewer Name	Affiliation	Email Address
Eugene Chudakov	JLab	gen@jlab.org
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Fulvia Pilat	ORNL	pilatfc@ornl.gov

3.3 Appendix E: Agenda

Preliminary Design and Safety Review of the EIC Auxiliary Far-Forward/Far-Backward Detectors
February 12, 2024

Time	Topic	Speaker
08:00 am – 08:30 am	Executive Session	Closed Session
08:30 am – 09:00 am	Far-forward/far-backward overview and requirements	Yulia Furletova (JLab)
09:00 am – 09:20 am	3D layout of IR	Douglas Holmes (BNL)
09:20 am – 09:40 am	Summary of Backgrounds	Elke Aschenauer (BNL)
09:40 am – 10:10 am	Roman Pots and Off-Momentum Detectors	Alex Jentsch (BNL)
10:10 am – 10:30 am	Break	
10:30 am – 11:00 am	B0 Detectors	Zvi Citron (Ben-Gurion University, Israel)
11:00 am – 11:30 am	Zero-Degree Calorimeter	Michael Murray (Univ of Kansas)
11:30 am – 11:50 am	Luminosity Detector Pair spectrometer	Nick Zachariou (York, UK)
11:50 am – 12:10 pm	Luminosity Detector: direct photon calorimeter	Krzysztof Piotrzkowski (AGH, Poland)
12:10 pm – 12:30 pm	Break	
12:30 pm –1:00 pm	Low Q2 detector	Ken Livingston (Glasgow, UK)
1:00 pm – 1:25 pm	Engineering design and mechanical support structures	Jonathan Smith (JLab)
1:25 pm – 1:45 pm	DAQ and synchronization	David Abbott (JLab)
1:45 pm – 2:00 pm	Further Questions	All
2:00 pm – 3:30 pm	Executive Session	Closed Session
3:30 pm – 4:00 pm	Closeout	