The First JLAB AAC

Feb17/18, 2016

Introduction

- Thanks for the preparation and the time you spend with us before and during the review
- Early posting of material and talks made it easier for us and we are grateful for that
- We enjoyed doing this review and having frank and open conversations
- We are grateful for the hospitality.

The Committee

Operations:

Wolfram Fischer* (BNL)

Yoshishige Yamazaki (MSU)

MEIC

Oliver Bruning* (CERN)

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Accelerator R&D

Eric Prebys* (FNAL)

Kent Paschke (Univ. of Virginia)

Norbert Holtkamp (SLAC-Chair)

Charge

CEBAF has started an intense decade of beam operations in support of the Nuclear Physics program. The AAC is asked to examine the status of CEBAF, its ability to deliver for the day-1 experimental program, and its approaches to the maintenance and development of capabilities to match the evolving program.:

- **Are the internal and external organizational support structures appropriate; if not, do you have suggestions for improvements?**
- **Are the accelerator capabilities and planned upgrades sufficient to meet the needs of the Physics program?**

An Electron Ion Collider (Jefferson Lab EIC) is being designed at Jefferson Lab as the next flagship facility both for the laboratory and for nuclear physics. The AAC is asked to review and offer comments and recommendations relative to the current status of the Jefferson Lab EIC program and the strategy for developing a successful design. More specifically we would like the Committee to comment on:

- **Is the design team addressing the right issues?**
- **Are the expectations for a conceptual design in 2018 reasonable?**
- **Are the resources sufficient? If not, assuming limitations, for which aspects should extra resources be deployed?**

The Accelerator Division has a portfolio of R&D activities focusing on technologies associated with high-power superconducting linacs (includes electron sources, ERLs, RLAs, etc.).

- **Does the present accelerator R&D program adequately support the evolution of accelerator operations?**
- **Does the present program address the most important issues for the Jefferson Lab EIC design?**
- **Are the emphases applied to the accelerator R&D program appropriately oriented to have the potential for high-impact results?**

Comment

Slides 5-14 in the original closeout presentation, dealing with the CEBAF accelerator and CEBAF Operations, have been removed from this copy of the closeout presentation. The findings, comments, and charge questions on Accelerator R&D have been fully retained to provide context for JLEIC R&D discussions.

Charge

JLEIC

- Is the design team addressing the right issues?
- Are the expectations for a conceptual design in 2018 reasonable?
- Are the resources sufficient? If not, assuming limitations, for which aspects should extra resources be deployed?

Findings JLEIC

- JLEIC design is the top priority after CEBAF operation.
- The electron storage ring recuperates magnets and vacuum equipment from PEPII. Operating energy range is 3-10 GeV.
- The ion storage design is based on the use of super-ferric magnets with an operating energy range between 20-100 GeV
- The CM energy of the EIC can go up to 65GeV.
- The ion ring storage ring energy can be increased to 200GeV with the use of a SC Cosine-Theta magnet design.
- The cost increase implied by the use of Cosine-Theta magnets wrt the use of super-ferric magnets is estimated at 40M$.
- No beam beam simulation results are presented for finite angle collisions at two interaction points

Findings JLEIC

- The existing CEBAF machine will be used as a full energy injector for the electron beam, and the ion source and linac rely on existing technologies (e.g. FRIB).
- The ion beam complex features an 8GeV booster ring based on a super-ferric magnet design.
- The ion and proton beam cooling is based on bunched beam electron cooling requiring an electron source with 200mA.
- The JLEIC operation requires the use of crab cavities. The JLEIC project plans to use a compact 952MHz crab cavity design similar to that of the HL-LHC upgrade.
- The JLEIC design work started in 2000 and the state of Virginia has given JLAB a 4M$ grant for site-specific studies.
- The total pre-project R&D cost is estimated at 5M$ and a pre-CDR is planned for the end of 2017.
- The allocated JLEIC resources are stated as 8-9 FTE per year and ca. 87k$ per year M&S

Comments JLEIC

- The design JLEIC CM energy of 65GeV is slightly low when compared to the EIC white paper specifications.
- The stated incremental project cost, which should be validated, for pushing the CM energy to 100GeV by the use of Cosine-Theta magnets would be a small fraction of the total project cost.
- The use of electron cooling for the proton and ion beams results in challenging and beyond the state of the art parameters.
- The JLEIC study does not yet properly address all the issues related to the vacuum system (ion instabilities, experimental background, synchrotron radiation, etc)

Comments JLEIC

- Simulation of finite-angle collision beam-beam interactions should be extensively conducted, particularly for halo formation. Halo can cause large background for the detectors, while adding a collimator to eliminate the noise can significantly reduce the lifetime. Since it can be very difficult to simultaneously reduce the background at both IPs and maintain a useful lifetime, an appropriate model should be created.
- The presented outline of the Pre CDR document does not seem to be complete.
- A comprehensive risk register was not presented. It should include mitigation actions and line up with the R&D plans.
- A plan on how to satisfy the DOE requirements for large construction projects (CDR, CD0, CD1, etc) was not presented.

Recommendations JLEIC

- Prepare a detailed cost comparison between the use of super-ferric and cosine-theta magnet design.
- Ensure that the Pre CDR document is complete.

Comments JLEIC replying to the charge questions

- Is the design team addressing the right issues? Mostly, but studies related to SR and beam instabilities should be expanded. It would also be advantageous to prepare plan B scenarios for the most challenging EIC components (e.g. BB electron cooling) and prepare performance projections for these.
- Are the expectations for a CDR in 2018 reasonable? This can only be answered if the requirements for the CDR are clearly laid out.
- Are the resources sufficient? Yes, for the preparation of a European style pre-CDR. But a significant ramp-up of resources will be required to meet DOE 413 requirements and expectations for CD1.

Charge

Accelerator R&D

- Does the present accelerator R&D program adequately support the evolution of accelerator operations?
- Does the present program address the most important issues for the Jefferson Lab EIC design?
- Are the emphases applied to the accelerator R&D program appropriately oriented to have the potential for high-impact results?

Findings R&D

- SRF, CIS, CASA all provide valuable support to operations. Important examples include improvements to polarized electron gun and injector performance, new tools for beam optics setup such as the automated tools to achieve design matching, development of the new 1/4 cryomodule for the planned injector upgrade, and investigation of the causes of RF gradient degradation.
- Important R&D for the JLEIC is supported, including tests for high current electron sources and design studies of RF systems.
- The SRF and Cryo groups take advantage of infrastructure and technical competence for providing valuable work for others, such as the LCLS-II cryomodules and cryoplants, FRIB cryoplants, and the prototype crab cavities for LHC (US LARP).
- A very broad R&D program is being pursued.

Comments R&D

- The breadth of the R&D program in SRF is very impressive
- Work for others plays a significant role in maintaining/attracting staff, technical capabilities and state of the art infrastructure for the SRF group.
- The SRF group is involved in many different projects and activities. Consider whether these activities are aligned with the JLab strategy.

Charge

Accelerator R&D

- Does the present accelerator R&D program adequately support the evolution of accelerator operations? Yes

- Does the present program address the most important issues for the JLEIC design? From the R&D side yes. Otherwise see comments before regarding DOE requirements.

- Are the emphases applied to the accelerator R&D program appropriately oriented to have the potential for high-impact results? It could benefit from prioritization.