Hall D K-Long Facility E12-19-001
Experiment Readiness Review Phase I
Jefferson Lab August 2nd, 2023

Charge

1. Is there any R&D needed to be done prior to start the construction of the K-Long Facility? No (unless beryllium in the KPT cannot be fully enclosed in copper or similar).

2. What is the status of the Compact Photon Source (CPS)? Specifically:
   a) the conceptual design Complete, but significant effort is need to complete final design.
   b) the evaluation of the produced radiation. In particular, the following points should be discussed:
      A. the approximations made in the Monte Carlo simulations and which code has been used;
      B. the energy deposition and the absorber temperature;
      C. the prompt dose and activation around the CPS and the Tagger Hall;
      D. the magnet performance and its coils lifetime;
      E. the water-cooling system and possible contaminations.

3. Will civil constructions be needed to contain the radiation in the Tagger Hall? No.

4. What will the photon beam quality be?
   The proposed CPS will provide an adequate photon beam quality with incident 6 MHz (64 ns bunch spacing) and 0.32 pC/bunch (5uA) electron beam. Photon beam size of of σ_y~1.5 cm is shown to meet requirement of < 6 cm at the KPT.

5. What is the status of the Kaon Production Target (KPT)? Specifically:
   a) the conceptual design Complete. Part of final design should include exploring thermal cycling impacts on beryllium (work hardening, fatigue). In addition, decommissioning plans need to be looked at prior to further design development to assure the final design can be decommissioned and disposed of.
   b) the evaluation of the produced radiation. In particular, the following points should be discussed:
      A. the approximations made in the Monte Carlo simulations and which code has been used;
      B. the energy deposition and the temperature in the KPT;
      C. the prompt dose and activation around the KPT and the Cave;
      D. the water cooling system and possible contaminations.

The radiation (prompt and activation) calculations are well advanced. The dose rates and activation are significant and a number of concerns need further effort and consideration, including radiation damage to existing equipment remaining in the target hall and management of radioactive waste after the experiment is completed.

6. Will civil constructions be needed in the Cave to contain the radiation? No

7. What is the estimated annual boundary dose when running the E12-19-001 experiment? Surface dose is estimated at 0.2 mrem/hr, but the boundary dose was not presented. It is not expected to be an issue.

8. What is the status of the conceptual design of the Flux Monitor? If more than one option is considered, please discuss each of them. Baseline design is TOF+Tracking from in-kind contributions. The decision about inclusion of the (optional) MRI magnet depends on grant proposal in the UK. The outcome of that proposal should be known in 2-3 months. If funded, additional design effort will be needed for the MRI magnet magnetic environment assessment and installation.

9. What is the bunch space required to run the E12-19-001 experiment? 64 ns

10. What are the requirements of the electron beam on the CPS? Up to 0.32 pC bunches at 16 MHz (5 uA), 0.2 mm position tolerance, 1.0±0.5 mm round at face of CPS.

11. Would the existing lasers work to run the E12-19-001 experiment, and if not, what is the solution? No. Hall D laser will be upgraded to support low frequency operation.

12. What is the decommissioning plans for the K-Long Facility (CPS, KPT,….) and the activated components? A brief outline is sufficient. The plan presented was to push equipment to the side indefinitely. See comments and recommendations.

13. What are the cost and schedule estimates for the construction of the K-Long Facility? Have the resources been identified? Capital cost of $2.4M and 3 years. However, estimates are not current so it is anticipated the cost could be significantly higher due to atypical escalation of costs for many of the required materials. Labor plan assumes a modest increase in labor beyond what can be identified.

Comments

- In several critical areas the cost basis presented is dated (2-3 years old). Given the significant inflation experienced in 2020-2023 the cost estimate presented may no longer be accurate. Material availability and procurement lead time impacts on the installation schedule should also be considered.
- Where possible, reduce use of lead for both personnel safety and mixed-waste disposal. Whenever possible, encapsulate lead for personnel safety.
- Consider value engineering options such as Fe-loaded concrete vs Ba-loaded concrete, segmented beryllium, W-Cu rather than pure tungsten plug. Consideration of life-cycle costs (including labor and decommissioning) should be part of this evaluation.
- If the MRI is an option, fringe fields must be evaluated and accounted for, e.g. in magnet supports and ferrous materials in the vicinity of the magnet, as well as in vicinity of TOF PMTs.
- A fully encapsulated design for the beryllium target should be pursued.
- As preliminary and final designs are developed, ESH, personnel safety and ergonomics should be factored in design (e.g. lead and beryllium handling).
- Following ALARA, consider alternative vacuum seals to reduce personnel exposure to decouple vacuum flanges to move the CPS and KPT out of the way to restore GlueX.
- Pressure drops in cooling circuits should be calculated to specify chiller (pump) requirements. Assure the dump chiller has sufficient performance parameters.
- There is remaining uncertainty about compatibility with the MOLLER experiment. It is advisable to have the KLF team reach out to the Parity Quality Beam team (one POC is Kent Pashke) to establish a working group to identify concerns for PQB and ensure questions are addressed to the satisfaction of that team.
- Fatigue failure is a concern for the targets and high-power blockers as failures could impact thermal and mechanical performance.
- The beam line design assumes no field from the sweeper dipole that is typically used for Hall D operations. Achieving zero field is challenging and may require additional cost (effort and/or bipolar power supplies) that are not in the project plan at this time.
- There is a significant quantity/value of equipment that will remain in the tagger hall where radiation levels will be quite elevated. Assessment of potential damage to equipment and potential radiological cooldown requirements during decommissioning before GlueX restoration are incomplete.
- Hall D BPM operability with KLF beam should be further evaluated in conjunction with electron beam stability requirements at CPS to determine necessary BPM hardware modifications, such as additional attenuation.
- Consider inclusion of a halo/beam offset monitor (similar to Hall B) near the CPS to monitor delivered electron beam quality and limit CPS face activation.

Recommendations

1. Complete a bottom-up cost estimate (30% accuracy) and deliver to Physics Division management by the end of September 2023 – prior to awarding any major procurements.

2. Work with lab management, including RadCon, to document requirements for decommissioning and disposal of the KLF apparatus and incorporate this information to develop designs that are compatible with required timelines for removal and disposal of equipment. Make all efforts to obtain this guidance from lab management by the end of September 2023.
3. Proceed with detailed engineering work.
4. A report of relevant beam studies results from the 2024 run period should be delivered to Physics Division management by June 2024 (compatibility with MOLLER).
5. Perform time-dependent and thermal cycling (e.g. from beam trips) simulations of targets (copper and beryllium) and blockers (tungsten) that receive high (kW) power deposition to assure that thermal and mechanical performance is adequately understood. Fatigue, cracking, etc. Provide report to Physics Division management by June 2024.
6. Include residual field from dipole in beam optics calculations and determine extent of degaussing that will be required to operate KLF. Provide report to Physics Division management by March 2024.
7. Perform an FMEA including safety assessment of off-normal events, e.g, cooling system failures, power supply failures, beam excursions etc. Provide results at next ERR.
8. Within 2 months, assign a dedicated scientist or team to assess radiation tolerance of equipment, in the tagger hall in particular, and assess if any components will need to be shielded or potentially replaced to restore GlueX.