Intermediate Experiment Readiness Review
of the Hall D experiment E12-10-001 (KLF)

Committee Report

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Reviewers:

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The review committee thanks the KLF collaboration for preparing the presentations, providing ancillary information, and patiently answering our questions during the review. Below are our answers to the Review Charge questions in the form of findings, comments, and recommendations.

Review Charge:

1. Data taking
   What is the bunch space required to run the E12-19-001 experiment?
   What is the trigger configuration?
   What is the expected data volume?

Recommendation:

- Unless compelling evidence is presented that a 128 ns bunch spacing significantly enhances the physics reach, further discussion and R&D of a 128 ns option should be stopped, and efforts must be directed towards successfully implementing the 64 ns beam spacing for KLF.
- To understand the effect of the bleed-through beam, two distributions must be studied: (a) the momentum distribution of the K_L beam from a single bunch with the imposed sum of 16 such distributions scaled by 1/1000 and spaced by 4 ns; (b) the time distribution of K_L (red curve in the beam bunch plot) for one bunch in log scale with the imposed sum of 16 such distributions spaced by 4 ns.
- The trigger rate and occupancy in the detectors must be evaluated using a realistic profile of secondary beams from KPT at the GlueX. Interactions of neutrons and

K_L particles with materials of the target cell and around the target must also be considered.

- The impact of the trigger thresholds on the momentum dependence of the track reconstruction efficiency should be studied with a focus on the low-momentum region.

2. Simulations
   What are the event generators used? I.e. do they adequately generate the events of interest and the background? Is the experimental setup fully simulated?
   K_L beam momentum and profile
   Beam neutrons and photons background
   Target, spectrometer and trigger

Recommendations:

- Interactions of various particles (n, γ) with detector elements must be carefully evaluated. With the realistic profile of particles from KPT at GlueX, the rates in detectors and radiation on SiPMs must be evaluated.

3. Reconstruction of both the main spectrometer and flux monitor. How are the detectors calibrated? (Daniel, Veronique)
   Energy of the calorimeters
   Timing calibration
   How are the detectors aligned?
   How is the PID performed?
   Is the reconstruction software adapted to the KLF configuration, considering the different target size and the timing structure of the beam with respect to GlueX?

Recommendations:

- With the use of the start counter in GlueX, the PID scheme follows the nominal GlueX approach that relies mainly on dE/dX for the central detector and timing for the forward detector. However, if the rates in the start counter prove a limitation and it must be removed, it is not clear how PID will proceed in the forward detector without requiring a track in the central. This should be considered and fully fleshed out.
- The physics simulations should be redone, including all backgrounds from neutrons and physics reactions.

4. Data analysis

What is the status of the analysis chain?

The above questions has to be answered for each of the following reactions:

- S=-1 Hyperon Spectroscopy: $K_L p \rightarrow Y^{+*} \rightarrow \pi^+ \Lambda$ or/and $\pi\Sigma$
- S=-2 Hyperon Spectroscopy: $K_L p \rightarrow K^+ \Xi^{0*}$
- $K\pi$ Spectroscopy from threshold up to 2 GeV
- Pentaquark $K_L p \rightarrow P \rightarrow K^+ n$

Recommendations:

- We were only shown results for the ground states using signal MC for one channel at a time. Physics backgrounds need to be included, and MC samples, including hadron resonances, need to be produced to demonstrate that the current reconstruction and analysis software can reconstruct all key resonances, including exotics.
- To be relevant to hyperon spectroscopy, simulations and analysis should be extended to at least one excited Y* and one Xi* states, and prove the feasibility of measuring mass, width, and quantum numbers of the resonance from energy and angular distributions.
- The simulations of the K*(892) show a good progress with respect to the original proposal, in particular because of the implementation of a robust model for the production mechanism. However, the error projection for the kappa pole position is currently not backed up by simulations. To prove that, one needs to:
  1) Extend the study to the KL pi- Delta++ final state, to achieve isospin separation.
  2) Show that the isolation of pion exchange is under control, despite a) large isoscalar natural exchanges for the K+ pi- final state, and b) the large accessible minimum value of -t for the KL pi- Delta++ final state.
  3) Show that a PWA allows the separation of S- from the dominant P-wave.

5. Are the manpower and skill set assigned to the calibration and analysis tasks adequate? Please provide a detailed and realistic evaluation of the available FTE with names if possible.

Recommendations:

- The KLF proponents must form a formal, structured collaboration with real commitments from institutions/collaborators.
- To organize the preparations for the run, working groups with coordinators must be formed. Each group should have a clear work plan, with breakdown of tasks, timelines/milestones, and assigned responsibilities.