Date: April 13, 2020

For Proposal for JLab PAC48

*Strange Hadron Spectroscopy with Secondary KL Beam in Hall D*

Cover Letter for KLF Proposal Submission to PAC48

This Proposal follows the Letter-of-Intent LoI12–15001 and Proposals PR12–17–001, PR1218002, and C21901 presented to PAC43, PAC45, PAC46, and PAC47, respectively. The Issues and Recommendations included in the PAC47 Final Report document read as follow:

**Motivation:** *The spectroscopy of strange baryons and mesons, including their fundamental strong interactions, is the focus of this proposal. New and unique data can be obtained with an intense KL beam aimed at a hydrogen/deuterium target, using the GlueX apparatus to detect final state particles.*

**Measurement and Feasibility:** *The most significant technical aspect of this proposal is the addition of a Compact Photon Source (CPS) in the beamline leading into Hall D, which will have significant attendant cost and will impose an estimated six months changeover time for alternate running of GlueX. It is also important to be sure that GlueX can handle the background rates from neutrons and other beam-induced contaminants. It seems quite feasible that the GlueX detector can manage to detect the final state particles with enough particle discrimination to meet the spectroscopy needs.*

**Issues:** *Several points of discussion concerned the PAC.*

*A) the missing mass technique to replace the direct proton detection at very low values of |t| was only presented in the open session and the details of the underlying simulations should be clarified;*

*B) a realistic simulation including beam backgrounds is to be presented with details to be spelled out and documented thoroughly;*

*C) A realistic project management plan needs to be developed to realize the experiment;*

*D) The analysis and extraction of key physics parameters requires theory guidance, which is now included within the group of proposing authors and makes use of JPAC. This facility will add a new physics reach to JLab, and the PAC is looking forward to see the idea being materialized, in conjunction with the plans for Hall D as spelled out in the white paper provided to us.*

**Summary:** *The collaboration should return to the PAC with a well documented proposal. Simulations addressing backgrounds and the low |t| region are necessary. Also, a well-formed plan is needed to build the beamline and prepare for data taking with GlueX.*

The KLF Collaboration believes that the current proposal addresses all of concerns following the recommendations expressed by the PAC47:

**Q1**: *The most significant technical aspect of this proposal is the addition of a Compact Photon Source (CPS) in the beamline leading into Hall D, which will have significant attendant cost.*

**A1**: ………..

Recently, a conceptual design study of a CPS for JLab was published in Nucl. Instrum. Meth. A **957**, 163429 (2020) by D. Day, P. Degtiarenko, S. Dobbs, R. Ent, D.J. Hamilton, T. Horn, D. Keller, C. Keppel, G. Niculescu, P. Reid, I. Strakovsky, B. Wojtsekhowski, and J. Zhang. Similar, a conceptual design of beryllium target for the KLF project was presented in arXiv:2002.04442 [physics.ins-det] by I. Strakovsky, M. Amaryan, M. Bashkanov, W. J. Briscoe, E. Chudakov, P. Degtyarenko, S. Dobbs, A. Laptev, I. Larin, A. Somov, and T. Whitlatch. In particular, the optimization of the KPT resulted in the weight of the device 12 t and the estimated cost of $0.134M (note that the final total cost depends on the cost of tungsten).

**Q2**: *It is also important to be sure that GlueX can handle the background rates from neutrons and other beam-induced contaminants.*

**A2**: It seems to us that PAC47 report missed the fact that all was done and presented in the Appendix. Now we move it to the main body of the proposal (Sec. 4.3) and presented the extension version.

**Q3**: *It seems quite feasible that the GlueX detector can manage to detect the final state particles with enough particle discrimination to meet the spectroscopy needs.*

**A3**: We performed many MC simulations presented in the C21901. Now we added more simulations to prove a quality of our detection the final state particles to meet hadron spectroscopy needs (see supplemental document KLF\_Analysis\_ Report).

**Q4**: *The missing mass technique to replace the direct proton detection at very low values of |t| was only presented in the open session and the details of the underlying simulations should be clarified.*

**A4**: Shankar & Moskov

**Q5**: *A realistic simulation including beam backgrounds is to be presented with details to be spelled out and documented thoroughly.*

**A5**: A large set of reactions was simulated and reconstructed using GlueX GEANT and analysis software both on proton and neutron (deuteron quasi free) targets (Sec. 4 and Ref. [25]). Some of the reactions were further analyzed theoretically utilizing partial wave analysis (Appendix A3). Possible backgrounds were studied thoroughly through similar simulations. An outcome of these studies is the following: photon induced background is tiny (less than 4 photoproduction reaction per second); neutron induced background is small – 94% of neutron flux does not contribute to production reactions, only 1% of neutron flux can lead to strangeness production, an exclusivity condition suppresses neutron induced background below per mill level for all reactions of interest, neutron background suppression at trigger level is unnecessary (Sec. 4.3 and references within).

The flux of secondary photons is not sufficient to provide any significant background in the case of p or d interactions in the cryogenic target (Sec. 5.2).

**Q6**: *A realistic project management plan needs to be developed to realize the experiment.*

**A6**: Following to Bob McKeown, the PAC’s target is wrong – that is a JLab management job.

**Q7**: *The analysis and extraction of key physics parameters requires theory guidance, which is now included within the group of proposing authors and makes use of JPAC. This facility will add a new physics reach to JLab, and the PAC is looking forward to see the idea being materialized, in conjunction with the plans for Hall D as spelled out in the white paper provided to us.*

**A7**: It seems to us that PAC47 report missed the fact that experimentalists and theorists are working closely to each other. In particular, several members of JPAC are co-authors of our proposal (Vincent Mathieu, Viktor Mokeev, Alessandro Pilloni, Arkaitz Rodas, and Adam Szczepaniak).

**Q8**: *A well-formed plan is needed to build the beamline and prepare for data taking with GlueX.*

**A8**: Obviously, the real schedule depends on the PAC48 decision. It does require a JLab management contribution while our tentative schedule is attached. We have updated the details of the KL Facility and are happy to discuss any additional questions the PAC may have about them. Our estimation for the construction on new equipment is $**3**M (see a New Equipment document).