

Review and Findings of Run Group Proposal “Measurement of Kaon Structure Function through Tagged Deep Inelastic Scattering”

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Overview

This report summarizes the findings and recommendations for run group proposal “Measurement of Kaon Structure Function through Tagged Deep Inelastic Scattering” as part of C12-15-006: Measurement of Tagged Deep Inelastic Scattering (TDIS), Keppel et al.

Spokespeople

- Kijun Park[†] (Jefferson Lab)
- Rachael Montgomery (University of Glasgow)
- Tanja Horn (Catholic University of America)

This proposal intends to study the unknown kaon structure function through the tagged deep inelastic scattering (TDIS) reaction $p(e, e'\pi p)X$ with the πp system reconstructing to a Lambda invariant mass. The experiment will acquire data from both cryogenic temperature gaseous hydrogen and deuterium straw tube targets. The low momentum, $-t < 0.14 \text{ GeV}^2$, hadronic system is detected (tagged) using a radial time projection chamber (RTPC) in a 400 mm, 4.7 T solenoid encompassing the target. This configuration would allow coverage of $0.4 < x < 1$ at $0.5 < Q^2 < 1 \text{ GeV}^2$ of kaon structure function, of which no present data exists at any kinematics.

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A formal presentation of this experiment was made to the Super Bigbite collaboration at a regular weekly meeting on May 17, 2017. Following the presentation the proposal was provided to the collaboration and the review panel members each submitted a set of questions to the spokespeople over the proposal to which the spokespeople issued responses. The findings are based on the collective presentation, proposal, and responses.

Findings

This experiment requests no new beam time or changes to the conditionally approved C12-15-006 experimental configuration, which utilizes a similar technique to measure the pion structure function in the reaction $p(e, e'p)X$. The TDIS kaon event rate has been calculated to be suppressed by about a factor of 3 relative to the TDIS pion rate, which has been assumed for the projected results. However, there is presently no data supporting this rate and there is therefore considerable uncertainty on the anticipated statistics and final projections.

While the extraction of the kaon structure function requires unfolding based on theoretical modeling of off-shell effects, the effort is well supported in the theory community and prescriptions for this procedure exist. Kaon Drell Yan data from COMPASS is anticipated in the future, which may help constrain these systematics.

There are considerable technical challenges in doing such an experiment, in particular with the straw target and RTPC at the required luminosities. These concerns were raised in the original proposal and the conditional approval recommendation for C12-15-006 included that “the laboratory convene a rigorous technical review of the resulting optimized design before going forward with construction of this experiment.”

Recommendations

The review panel approves of this experiment as run group proposal. With the total absence of kaon structure function data, any results from this experiment will be welcome. As there are no additional costs to taking such data with the pion TDIS experiment, there is no associated additional risk, and it will help strengthen that collaboration’s efforts. The panel recognizes the considerable uncertainty on the final projections and recommends future plots showing the projections of this experiment include a qualifier of the assumed kaon TDIS rate. If the fractional kaon rates are indeed a factor of three smaller than pions, then they would be a source of background for the pion TDIS experiment that would have to be investigated carefully. A dedicated group studying this channel as their main physics goal is a benefit to the original TDIS experiment.