PR12-13-007: *"Measurement of Semi-Inclusive π^0 Production as Validation of Factorization"*

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Experiment proposal PR12-13-007 "Measurement of Semi-Inclusive π^0 Production as Validation of Factorization" intends to use the neutral pion electroproduction reaction as an important yet often neglected tool in the study of hadron structure by semi-inclusive deep inelastic scattering (SIDIS). The neutral pion will be detected by measurement of its $\gamma\gamma$ decay products in a dedicated new neutral-pion detector.

This proposal is part of a run group with a companion DVCS/DVNP proposal (which is a rather unique arrangement within Hall C). The 25 days of beam time request are fully compatible with the DVCS/DVNP companion proposal.

The physical goal of the experiment is to check so called factorization of SIDIS cross section into quark distribution $f(x)$ for the initial nucleon and final pion fragmentation function $D(z)$. The precision of such a factorization is crucial for experimental determination of fragmentation functions and applications of QCD theory to meson production experiments. The accuracy of factorization is expected to increase with energy, and an important question is to which extent it is settled at JLab energies. The use of neutral pions for this purpose has several advantages, in particular, absence of contamination from pion generated from diffractively produced ρ mesons, and reduced nucleon resonance contribution.

We stress that the measurement of basic SIDIS process is a fundamental testing ground of our understanding of the mere reaction mechanism. Thus the experiments must be performed at JLab 12. We advise however the authors of the proposal to rephrase the motivation accordingly and in particular refrain from using simple parton model considerations.

The authors of this experiment proposal should address in more detail the following issues.

1. As it is noted in the proposal, there are various sources of pion production that lead to additional contributions to the cross section in the $z \to 1$ limit. In particular, exclusive limit of π^+ and π^- production is affected by a large contribution from resonance region, thus complicating a simple parton model interpretation. As evident from Fig.

2 in the proposal, the maximum of this contribution comes from the region $z \in [0.8, 1]$. Yet only the $z \in [0.4, 0.8]$ region for π^0 production is considered in the proposal. It is not clear how large is the difference between charged and neutral pion production in that region.

2. An important part of the proposed experiment is to check the following relation:
$$\sigma^{\pi^0}(x, z) = (\sigma^{\pi^+}(x, z) + \sigma^{\pi^-}(x, z))/2 \ . \quad (1)$$
In order to demonstrate experimental feasibility of this check, one should compare uncertainties for π^+ and π^- measurements and demonstrate that a similar precision is possible in case of π^0.

3. Another observation is that the region $z \to 1$ receives a non-negligible QCD correction due to resummation of threshold logs $\ln(1 - z)$ that can be large when $z \to 1$. This phenomenon affects the predictions for production of pions of all pion types, π^+, π^-, and π^0. As pointed out in Refs.[1, 2], the lowest orders estimates for the production cross sections are not valid anymore in the $z \to 1$ region even for the QCD improved parton model calculations.

We conclude that the proposed measurement is very valuable and important, certainly of high scientific interest. The authors of the proposal should address the issues raised above.

References

[1] D. P. Anderle, F. Ringer and W. Vogelsang, arXiv:1304.1373 [hep-ph].

[2] D. P. Anderle, F. Ringer and W. Vogelsang, arXiv:1212.2099 [hep-ph].