JLab Experiments E12-13-007

Measurement of Semi-Inclusive π^0 Production as Validation of Factorization

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The **E12-13-007** experiment is aimed to take advantage of several experimental advantages of neutral-pion production to confirm the potential for studies of the 3D momentum structure of the proton (nuclear femtography). **E12-13-007** will provide precise measurements of the probabilities to produce neutral pions following electron-quark scattering, and compare this with our theoretical understanding of this process in a kinematical region where the QCD factorization scheme is expected to hold – this, together with results from E12-09-017 that will provide similar basic semi-inclusive charged-pion and kaon cross sections, will be critical in validating the entire 12-GeV science program of 3D momentum femtography.

Neutral pion production offers multiple experimental benefits: a lack of diffractive $\rho \rightarrow \pi\pi$ contributions, no pion-pole contributions, reduced nucleon resonance contributions, and proportionality to an average fragmentation function. These are all points in favor of an accurate semi-inclusive neutral-pion production program to validate the 3D momentum femtography science output. We know by now, based on initial data, based on lattice QCD calculations, and based on nucleon models, that the transverse momentum widths of quarks with different flavor (and polarization) in the proton can be different.

The goal of the **E12-13-007** experiment is to measure the basic Semi-Inclusive Deep Inelastic Scattering neutral-pion cross sections off the proton, including a map of the P_T dependence ($P_T \sim \Lambda < 0.5$ GeV). This provides a cornerstone for the further 12-GeV science program related to Transverse Momentum Dependent Parton Distributions. In the end, mapping the transverse momentum dependence will allow to, together with the equivalent charged-pion data, perform a flavor decomposition of the transverse momentum (k_T) dependence of (un-polarized) up and down quarks. The use of longitudinally polarized beam will simultaneously allow measurements of the azimuthal single beam spin asymmetries at low $\mathbf{P}_T$. The experiment will use the combination of Hall C's High Momentum Spectrometer and the new Neutral Particle Spectrometer.