Hall-B CLAS12 Run Group B – Experiment Summaries

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The CLAS12 Run group B, electroproduction on unpolarized deuterium, includes 4 PAC-approved proposals (items 1-4 below) and 3 run-group proposals (items 5-7) focused on the study of neutron structure and nuclear medium effects.

(1) E12-11-003 (Niccolai): Measuring **Deeply Virtual Compton Scattering on a neutron target** is one of the necessary steps to complete our understanding of the structure of the nucleon in terms of Generalized Parton Distributions (GPDs). DVCS on a neutron target allows to obtain a flavor decomposition of the GPDs, and plays a complementary role to DVCS on a transversely polarized proton target in the determination of the GPD E, the least known and least constrained GPD that enters Ji's angular momentum sum rule. To start the experimental program of DVCS on the neutron, we will measure beam-spin asymmetries for n-DVCS ($ed \rightarrow e'n\gamma(p)$) with the 11-GeV CEBAF polarized-electron beam and the CLAS12 detector. For the detection of the recoil neutron, necessary to ensure the exclusivity of the reaction after having detected the scattered electron and the DVCS photon, we will use the Central Neutron Detector (CND), which was constructed for this goal. In order to provide an accurate mapping of the n-DVCS beam-spin asymmetry over the available 4-dimensional (Q^2, x_B, $-t$, φ) phase space, we request 90 days of running on a deuterium target with the maximum available beam energy, 11 GeV. This experiment was labeled "high impact" by the PAC because of its unique sensitivity to the elusive and poorly known GPD E.

(2) E12-07-104 (Gilfoyle): The experiment will measure the **magnetic form factor of the neutron** (G_M^n) using the 11 GeV electron beam in the upgraded CEBAF and CLAS12 detector. The measurement will cover the range $Q^2 = 3-14$ GeV^2. The neutron's magnetic form factor is one of the fundamental quantities of nuclear physics and its value is an important constraint on the generalized parton distributions that hold the promise of dramatically expanding our understanding of the nucleon. The form factors are also important challenges for lattice QCD to meet. This measurement is part of a broad assault on the four, elastic, electromagnetic, nucleon form factors at Jefferson Lab. We will use the ratio of quasielastic e−n to e−p scattering on deuterium. The ratio method is less vulnerable to uncertainties than previous methods and we will have consistency checks between different detector components and an overlap with our previous CLAS6 measurements. The neutron detection efficiency will be measured with a hydrogen target simultaneously with the deuterium data using a unique, LD_2-LH_2 dual-cell target to ensure the calibrations have the same running conditions as the production data. Precise measurements of G_M^n have already been made by our group and others at lower Q^2.

(3) E12-09-008 (Contalbrigo): The experiment is a comprehensive program to study transverse momentum dependence of valence quark transverse spin distributions through measurements of **spin-azimuthal asymmetries in semi-inclusive electroproduction of kaon**s using the upgraded JLab 11 GeV polarized electron beam and the CLAS12 detector with unpolarized proton and deuteron targets. Main objective is the study of correlations of the transverse spin of quarks with their transverse momentum, leading to observable spin and azimuthal asymmetries. The measurement of the $\cos2\varphi$ azimuthal moments of the semi-inclusive production of hadrons in DIS with unpolarized targets, in particular, will provide direct information on spin-orbit correlations by measuring the leading twist transverse momentum dependent (TMD) parton distributions related to the interference between states with different orbital momenta. Measurements with kaons are complementary to measurements with pions and will provide additional information on the Collins fragmentation mechanism. The x, z, P_T and Q^2 dependences of the $\cos2\varphi$ moment will be studied to probe the underlying T-odd distribution and fragmentation functions. The experiment will use the upgraded CLAS12 detector, 11 GeV highly polarized electron beam, unpolarized hydrogen and deuteron, targets. Kaon identification in the complete kinematic range will be

done by the CLAS12-RICH proximity-focusing detector. The large acceptance of CLAS12 would allow simultaneous detection of the scattered electrons and leading hadrons from the hadronization of the struck quark, providing information on its flavor and transverse momentum.

(4) E12-09-007(a) (Hafidi): The goal of this experiment is to measure the multiplicities for several hadron species (π^+, π^-, π^0, K^+, K^-, K^0s) on deuterium. These data will enable control of the **fragmentation functions** used in the extraction of the individual quark and antiquark contributions to the nucleon spin. In addition, one can extract the shape (x dependence) of the **strange parton distribution function** for several z and Q^2 bins with three independent measurements ($\pi^+ + \pi^-$, $K^+ + K^-$ and K^0s). The measurements will cover an x range from $0.05 < x < 0.7$. An important part of the experiment requires good charged kaon identification for the whole momentum range. To ensure a good particle identification, the RICH detector will be used.

(5) E12-09-008A: The run-group proposal entitled “Hadron production in the target fragmentation region” (M.Mirazita, contact person) will use semi-inclusive electroproduction of hadrons to investigate Fracture Functions which represent the probability of producing the final hadron from the remnants of the target after a hard scattering on a parton by the virtual photon.

(6) E12-09-008B: The run-group proposal entitled “Collinear nuclear structure at twist-3” (S.Pisano, contact person) will study semi-inclusive electroproduction of pion pairs on hydrogen and deuterium to focus on higher twist Parton Distribution Functions and subleading-twist Di-hadron Fragmentation Functions. These measurements will probe the largely-unexplored quark-gluon correlations.

(7) E12-11-003A: The run-group proposal entitled “In medium structure functions, SRC, and the EMC effect” (O.Hen, contact person) will study the EMC effect by measuring the structure functions of bound protons in deuterium as a function of their initial momentum by tagging the backward-going neutrons to select deep inelastic scattering.