Hall-B CLAS12 Run Group A - Summary

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The CLAS12 run group A comprises twelve experiments, among which seven are related to 3D-imaging of the nucleon, three are focused on hadron spectroscopy, and two on the structure of nucleon resonances.

3D-Imaging in the run group A[E12-06-108, E12- 06-112, E12-06-112A, E12-06-112B, E12-06-119, E12-12-001 and E12-12-007]

Generalized Parton Distributions (GPDs) correlate the information on the longitudinal momentum and transverse position of partons in the nucleon. As such, they provide the tools to gain insight on fundamental aspects of QCD dynamics in the nucleon. In particular, the knowledge of GPDs allows picturing the nucleon in 3 dimensions at the femto-metric scale. In addition, Ji's sum rule, which uses GPDs as inputs, may well solve the spin pazzle by providing information on the total orbital angular momentum carried by quarks. Four of the five 3D-imaging experiments in run group A aim at providing complementary information on GPDs through the cross section and asymmetry observables of the deep exclusive processes such as Deeply Virtual Compton Scattering, Timelike Compton Scattering, and pseudoscalar and vector meson production. In addition, we plan to study Semi-Inclusive Deep Inelastic Scattering in order to access the Transverse Momentum Dependent PDFs. The knowledge of these functions will provide insight into the dynamics of quarks inside hadrons and will provide yet another angle of 3D imaging by correlating information on the transverse momentum and longitudinal momentum of quarks inside the nucleon.

Spectroscopy in the run group A [E12-11-005, E12-11-005A, E12-12-008]

Understanding quark and gluon confinement in Quantum Chromodynamics is one of the outstanding issues in physics. To this end, hadron spectroscopy is a powerful tool to investigate how the QCD partons manifest themselves under the strong interaction at the energy scale of the nucleon mass (GeV). The first experiment aims to study the meson spectrum, searching for exotic states, with precise determination of resonance masses and properties with a high statistics and high-resolution experiment. The CLAS12 spectrometer augmented by a Forward Tagger (FT) allows for electro-scattering at very low Q^2 ($10^{-2} - 10^{-1}$ GeV^2), which provides a high photon flux and a high degree of linear polarization, complementary to the capabilities of Hall D. The quantum numbers of meson resonances will be defined via partial wave analysis (PWA) of their decay products. The second experiment aims at studying the large statistics sample of Ξ baryons photo-produced in the LH2 target. The data will be used to search for new and missing excited Ξ states with the possibility to measure their quantum numbers, as well as the mass splitting of ground state and excited Ξ doublets. These data samples will also provide the statistics necessary for measuring, for the first time as a function of kinematic variables, the beam polarization transfer and induced polarization of the ground state Ξ^- in the reaction $\gamma p \rightarrow \Xi^- K^+ K^-$.

Nucleon resonances in the run group A [E12-09-003, E12-06-108A]

The goal of these experiments is to explore the evolution of the active degrees of freedom in excited nucleon states from meson-baryon dressing to dressed quark contributions, and to learn how the strong interaction creates dressed quark cores in various N* and how they emerge from QCD. To this end, the experiments will measure exclusive single-meson (N□, N□, KY) and double-pion electroproduction cross sections off a proton target. From the measurements, the electromagnetic transition form factors will be extracted for all prominent N* states that couple to the different exclusive final states in the unexplored domain of Q^2 from 5 to 12 GeV^2.