Target and Beam-Target Spin Asymmetries in Exclusive Pion Electroproduction for $Q^2 > 1$ GeV^2. I. $ep \to e\pi^+ n$

In a recent paper [1], we reported measurements of the beam-target double-spin asymmetries and target single-spin asymmetries for the exclusive π^+ electroproduction reaction $\gamma^* p \to n\pi^+$. The results were obtained from scattering of 6 GeV longitudinally polarized electrons off longitudinally polarized protons using the CLAS detector at Jefferson Lab. The kinematic range covered spans invariant energies $1.1 < W < 3$ GeV and squared four-momentum transferred $1 < Q^2 < 6$ GeV^2, significantly extending the kinematic range of previous data in both W and Q^2. Results were obtained for about 6000 bins in W, Q^2, and the pion-nucleon decay angles $\cos\theta^*$and ϕ^*.

The beam-target asymmetries are in reasonable agreement with empirical fits to world data in the framework of unitary isobar models only for $W < 1.6$ GeV. Our new data will help to constrain the relative importance of a myriad of nucleon excited states with masses above 1.6 GeV at relatively high values of Q^2, where the transition form factors are poorly known.

Except at forward angles, very large target-spin asymmetries are observed over the entire W region. Sample results are shown in Fig. 1. As for the beam-target asymmetries, reasonable agreement is found with phenomenological fits to previous data for $W < 1.6$ GeV, but large differences are observed at $W > 1.6$ GeV. From the theoretical viewpoint of models based on generalized parton distributions, our results indicate that strong higher-twist contributions are needed to describe the target-spin asymmetries.

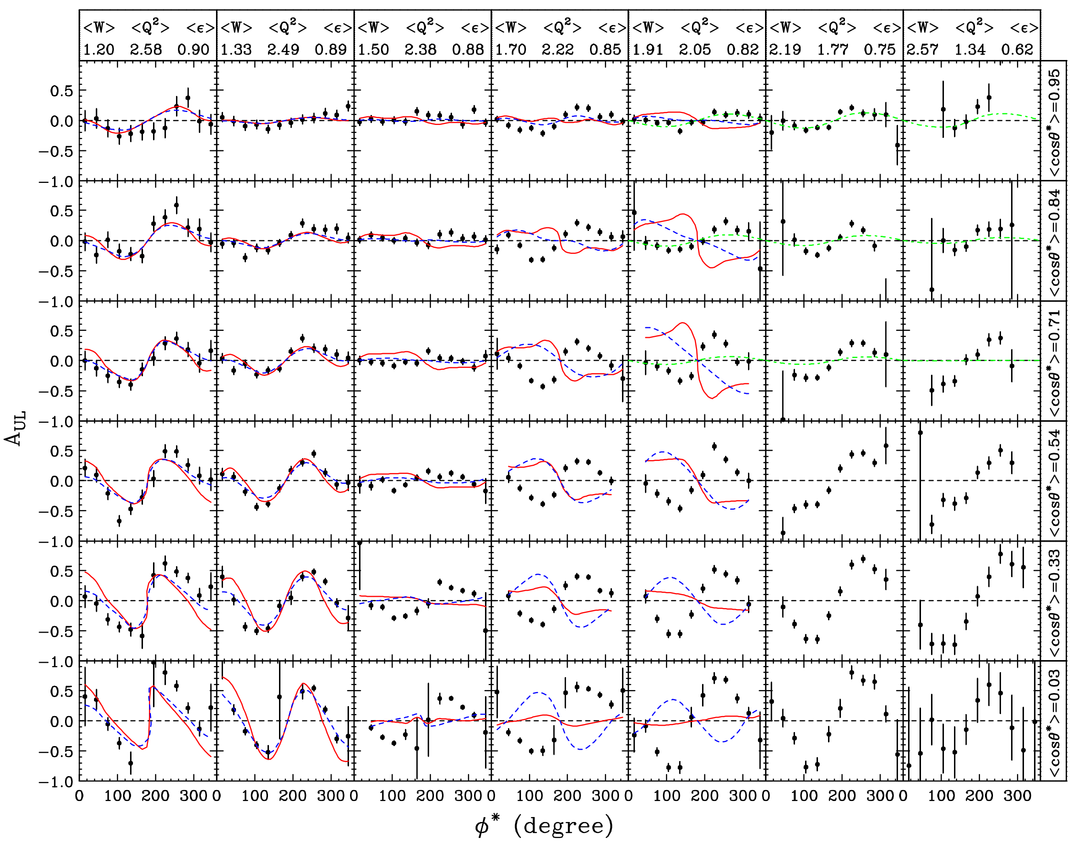

Figure 1: Target single-spin asymmetry A_{UL} for the reaction $ep \to e\pi^+ n$ as a function of ϕ^* in seven bins in W (columns) and in six bins in $\cos\theta^*$ (rows). The results are from the two lower Q^2 bins of this analysis. The solid red curves are from the MAID 2007 unitary isobar fit, the blue long-dashed curves are from a JANR fit, and the green short-dashed curves are for the GPD-inspired model from Goloskokov and Kroll.

[1] P. Bosted *et al. (CLAS Collaboration)*, Phys. Rev. C **95**, 035206 (2017).