Deep exclusive π^+ electroproduction off the proton at CLAS

One of the major challenges in contemporary nuclear physics is the study of the transition between hadronic and partonic pictures of the strong interaction. At asymptotically short distances, the strong force is actually weak and the appropriate degrees of freedom are the quarks and gluons (partons) whose interaction can be quantified very precisely by perturbative Quantum Chromodynamics (pQCD). However, at larger distances on the order of one Fermi, effective theories that take hadrons as elementary particles whose interactions are described by the exchange of mesons appear more applicable. The connection between these two domains is not well understood.

In order to make progress, a systematic study of a series of hadronic reactions probing these intermediate distance scales is necessary. We present our results for the cross sections of the $p(e, e'\pi^+)n$ reaction in the invariant mass region $W > 2$ GeV. We have extracted the differential cross sections as a function of several variables (t, Q^2, and W or x_B). The angle ϕ_π^* is always integrated over in the following. The extraction of the interference cross sections σ_{TT} and σ_{TL} is the subject of an ongoing analysis and will be presented in a future article.

Figure 1 shows the differential cross section $d\sigma/dt$ as a function of t for different (x_B, Q^2) bins. We define the reduced differential cross section:

$$\frac{d\sigma}{dt} = \frac{1}{\Gamma} \frac{d^3\sigma}{dQ^2 dx_B dt} \ ,$$

where the virtual photon flux factor has been factored out.

We have included in Fig. 1 the JLab Hall C data, which cover only the very small t domain. We note that there is generally reasonable agreement between the results of the two experiments. The blue solid points are the present work. The error bars (outer error) on all cross sections include both statistical (inner error) and systematic uncertainties added in quadrature. The black open squares ($d\sigma/dt$) and open stars ($d\sigma_L/dt$) are JLab Hall C data. The red thick solid ($d\sigma/dt$), and dashed ($d\sigma_L/dt$) curves are the calculations from the Laget model with (Q^2, t)-dependent form factors at the photon-meson vertex. The black thin solid ($d\sigma/dt$) and dashed ($d\sigma_L/dt$) curves are the calculations from the Kaskulov *et al.* model.

We have measured the cross sections of exclusive elec-

troproduction of π^+ mesons from protons as a function of $-t = 0.1$ - 5.3 GeV^2, $x_B = 0.16$ - 0.58, and $Q^2 = 1.6$ - 4.5 GeV^2. We have compared our differential cross sections to four recent calculations based on hadronic and partonic degrees of freedom. The four models give a
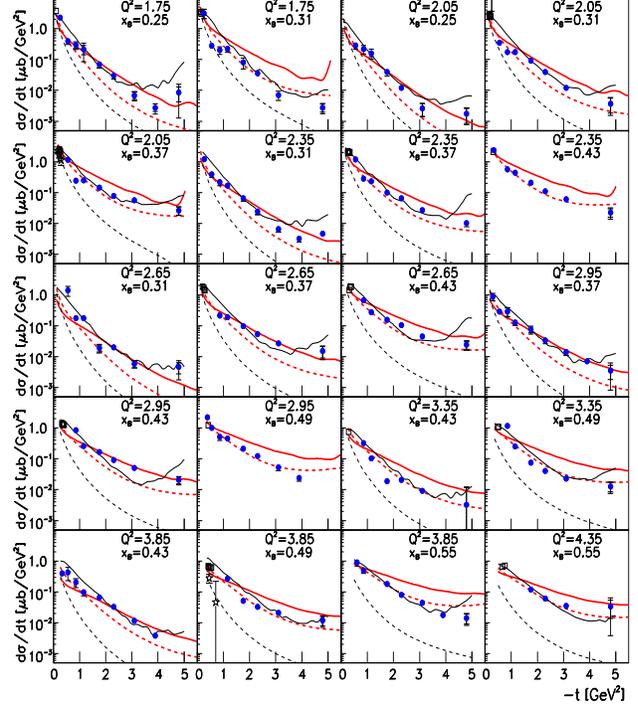

FIG. 1: Differential cross sections $d\sigma/dt$ [μb/GeV^2] integrated over ϕ_π^* for various (Q^2, x_B) bins.

qualitative description of the overall strength and of the t-, Q^2- and x_B- dependencies of our unseparated cross sections. There is an obvious need for L-T separated cross sections in order to distinguish between the several approaches. These separations will be possible with the upcoming JLab 12-GeV upgrade. In particular, if the handbag approach can accomodate the data, the $p(e, e'\pi^+)n$ process offers the outstanding potential to access transversity GPDs.

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