Electroproduction of π^0 at high momentum transfers in non-resonant region with CLAS

Alex Kubarovskiy (for CLAS collaboration)

Rensselair Polytechnic Inctitute

Abstract. Generalized Parton Distributions (GPDs) offer a new way to access quark and gluon nucleon structure. The nucleon-to-meson transition distribution amplitudes (TDAs) are extensions of the GPD concept to three quark operators. In this talk we report the first preliminary results of studies of the reaction $ep \to ep\pi^0$ using the CEBAF Large Acceptance Spectrometer (CLAS) at Jefferson Lab with an electron beam energy of 5.75 GeV. Differential cross sections were extracted for $1.5 < Q^2 < 4.5$ GeV^2, $0.1 < x_B < 0.6$ and $-t$ up to 6.0 GeV^2 in non-resonant region ($W > 2.0$ GeV). Results will be discussed in the framework of a u-channel TDA model.

Keywords: TDA, pion electroproduction
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INTRODUCTION

The study of the deep structure of the nucleon has been the subject of many developments in the past years and the concept of generalized parton distributions (GPD) has allowed a breakthrough in the 3 dimensional description of the quark and gluon content of hadrons. The nucleon to pion transition distribution amplitudes (TDAs) may be seen as further development of the GPD concept and defined through πN matrix element of the three-local quark operator on the light-cone: [1], [2]:

$$\hat{O}^{\alpha\beta\gamma}_{\rho\tau\chi}(\lambda_1 n, \lambda_2 n, \lambda_3 n) = \Psi^{\alpha}_{\rho}(\lambda_1 n)\Psi^{\beta}_{\tau}(\lambda_2 n)\Psi^{\gamma}_{\chi}(\lambda_3 n), \quad (1)$$

The extensive studies of the properties and physical interpretation of πN TDAs are presented in Refs. [3, 4, 5, 6, 7]. Baryon to meson TDAs are supposed to encode new information on the hadron structure in the transverse plane. Also there are hints [8] that πN TDAs may be used as a tool to perform the femto-photography [9] of the nucleon's pion cloud.

E1-6 EXPERIMENT AND DATA SELECTION

The measurement was carried out with the CEBAF Large Acceptance Spectrometer (CLAS) [10]. The specific experimental data set "e1-6" used for this analysis was collected in 2001 with the electron beam of 5.754 GeV. The kinematic requirements for the accepted data were: $Q^2 \geq 1$ GeV^2, center-of-mass energy $W \geq 2$ GeV, and scattered electron energy $E' \geq 0.8$ GeV. The corresponding range of x_B was from 0.15 to 0.6.

After identification of all final particles, the exclusive reaction $ep \to e'p'\pi^0$ was selected as follows: 3σ cuts were made on the missing mass $M^2_X(ep \to e'p'X) = m^2_{\pi^0}$,

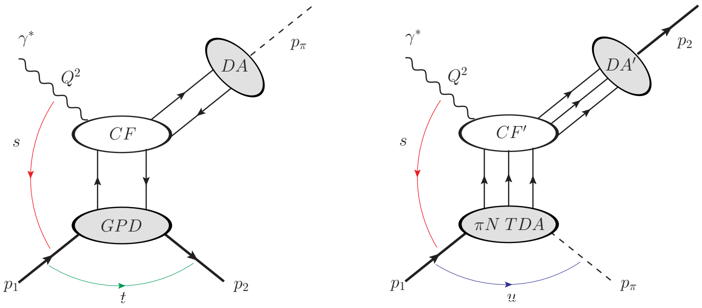

FIGURE 1. Collinear factorization for hard production of pions off nucleon in the conventional hard meson production (HMP) kinematics (left) versus the collinear factorization in the backward kinematics regime (right). DA (DA') denote pion (nucleon) distribution amplitudes; CF (CF') are coefficient functions computable in perturbative QCD.

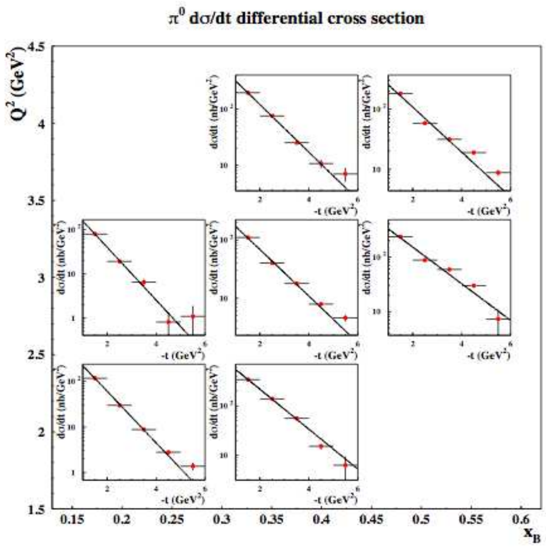

FIGURE 2. Preliminary ds/dt differential cross section for different Q^2 and x_B bins

the missing mass $M_X(ep \to e'\gamma\gamma X) = M_p$. The missing energy $E_X(ep \to e'p'\pi^0) = 0$ and invariant mass $M_{\gamma\gamma} = m_{\pi^0}$. The acceptance was calculated using the standard GEANT3-based CLAS Monte-Carlo simulation software (GSIM).

For the differential cross section $\frac{d^3\sigma}{dQ^2 dx_B dt}$ 3 bins in Q^2, 3 bins in x_B and five bins in $-t$ were used.

RESULTS

The preliminary differential cross sections of the $ep \to e'p'\pi^0$ reaction is shown on Fig. 2. The cross section for each bin was fitted by the exponential Ae^{Bt} function and the

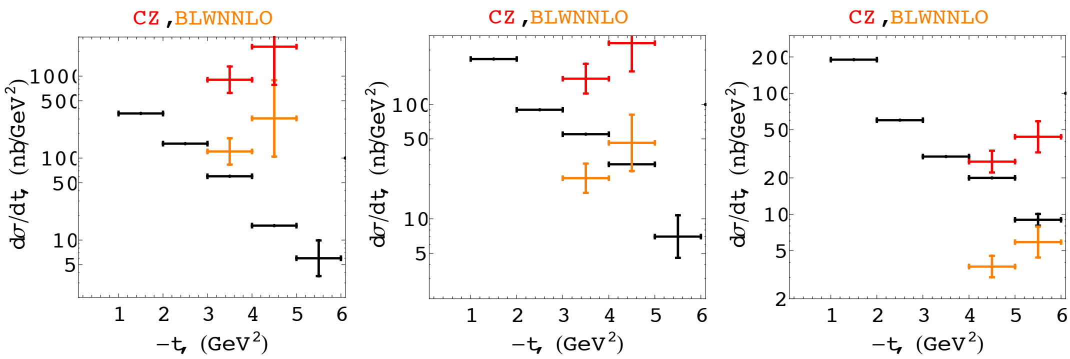

FIGURE 3. The $d\sigma/dt$ differential cross section compared with theoretical calculations for different Q^2 and x_B bins. Black error bars - data, orange error bars - TDA model with Braun-Lenz-Wittmann nucleon DAs as input and red error bars - TDA model with Chernyak-Zhitinsky nucleon DAs as input. Form left to right: ($Q^2 = 2$ GeV^2 $x_B = 0.375$), ($Q^2 = 3$ GeV^2 $x_B = 0.525$), ($Q^2 = 4$ GeV^2 $x_B = 0.525$)

slope parameter B was extracted. It was found that the value of this slope parameter is almost independent of Q^2, that is the indication of scaling onset. Extracted cross sections were compared with theoretical calculations provided by K. Semenov-Tian-Shansky [11]. This comparison for different kinematics is shown on Fig. 3. The magnitude of the cross sections seems to be correct, but t-slopes do not appear to agree with the data, however more data is needed to understand the behavior of the cross section in high-t region.

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