Electroproduction generator in the forward scattering configuration of $G0$ experiment

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Abstract

An event generator of inclusive electroproduction of pions on proton is developed in the forward scattering configuration of $G0$ using the photoproduction code of Graal from pion threshold up to 4 GeV. The extension to the charged pion-pair electroproduction in the backward scattering configuration is also discussed. Compatibility with the G0-GEANT code has been checked successfully.

1 Event generator

We describe an event generator which simulates inclusive electroproduction of pions on proton, in the forward scattering configuration of $G0$ where only the protons are detected in the final state.

Due to the large proton mass compared to the pion mass, it is very difficult to distinguish the elastic protons from the inelastic ones. The time of flight cut is useful and very efficient to separate the π^+ and the proton, but it is insufficient to isolate the elastic proton from the background. It means that one must carrefully take into account all inelastic channels in the allowed kinematic region of the $G0$ experiment (Fig. 1). The contamination from multipions and vector mesons production channels should be important. The motivations for this study are the following :

1) The photoproduction simulation results [1] are in good agreement with the SOS data taken in December 1999 [2]. The electroproduction simulation

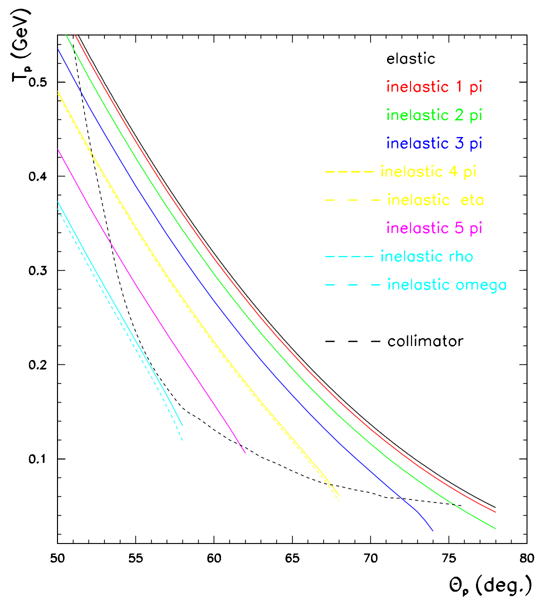

Figure 1: Kinetic energy of the recoil protons (elastic and inelastic) versus the proton angle.

using the O'Connell and Lightbody code [3] shows a much less important contribution than the photoproduction.

2) Until now, the popular code of O'Connell and Lightbody (EPC) has been intensively used to simulate electroproduction. The version which has been implanted in the $G0$-GEANT code assumes the Wiser [4] photoproduction fit in the high energy region far from the Δ-threshold. We have found and fixed some errors in this version and it is important to compare the corrected EPC code with the Orsay generator results.

In the kinematic region of our interest ($E_e = 3.$ GeV), there are no reliable theoretical models for electroproduction of pions. We adopt the Graal photoproduction generator [5] from the pion threshold up to 4 GeV. Our code contains the following channels with a proton in the final state:

$$\gamma\ p \rightarrow \pi^0 p \tag{1}$$

$$\gamma\ p \rightarrow \Delta^{++}\pi^- \tag{2}$$

$$\gamma\ p \rightarrow \rho^0 p \tag{3}$$

$$\gamma\ p \rightarrow \pi^+\pi^- p \tag{4}$$

$$\gamma\ p \to \pi^+ \pi^- \pi^0 p \tag{5}$$

The differential cross section for each channel is obtained from the Graal generator and our procedure previously developed [6] in pion pair electroproduction is used to connect photo-and electroproduction channels. Let us mention that this procedure is free of singularities when the Q^2 transfer of the photon is going to zero.

We display in Fig. 2 and 3, the cross sections predicted with our code and a comparison with O'Connel-Lightbody, including the Wiser fit, is shown for $\Theta_p = 60$ and 70 degrees. The two codes give similar results except in the Δ region. This may be due to the use in the EPC code, of a parametrization of the Δ-resonance strictly valid on the Δ-mass peak [3]. In principle, this domain is not dangerous for the $G0$ experiment because it is suppressed by the collimators.
In Fig. 4, we also show our results for different values of Θ_p.

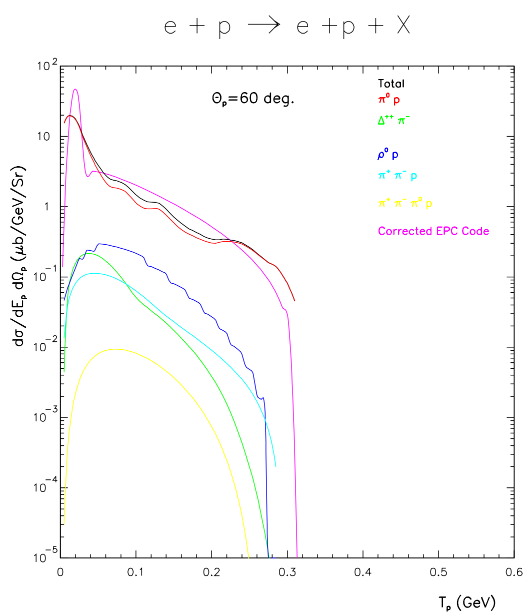

Figure 2: Contribution of different channels in the Orsay Code and Comparison with the corrected EPC results.

Let us summarize here the main result of our analysis. With the Orsay code, electroproduction channel contribution dominated by the process (1), remains small compare to the photoproduction simulation result which is in good agreement with the SOS data. However, the dilution factor from the inelastic protons in the measured asymmetry can be determined with our code. On the basis of this analysis, an event generator for ep scattering can be performed.

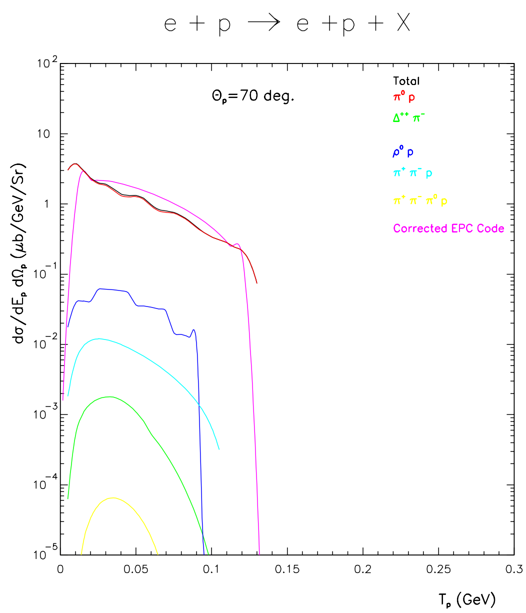

Figure 3: Same as Fig. 2 for $\Theta_p = 70$ degrees.

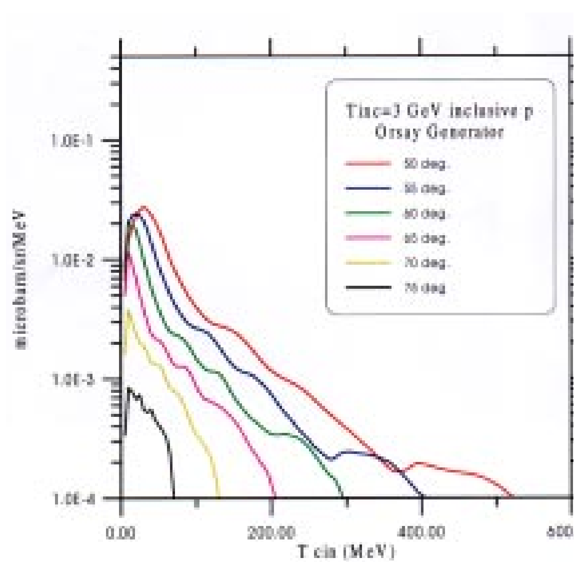

Figure 4: Differential cross sections vs the kinetic energy of the recoil proton in $e\,p \rightarrow e\,p\,X$.

2 Compatibility with G0-GEANT

In order to simulate physical backgrounds, we need to implant the Orsay generator code in the G0-GEANT code. The Orsay subroutine (GEP-ORS) should be included in complement of the O'Connell and Lightbody code (EPC-O). They have the same arguments transported to GEANT. For each channel considered, the running programme is automatically GEP-ORS (or EPC-O, if this channel is not included in our generator).
In conclusion, the EPC code is corrected and it has been validated in this corrected version by comparing with the Orsay generator. We have produced in combination with the GEANT code, an event generator for inclusive electroproduction reactions.

The Orsay code may also generate the π^- from double pion electroproduction channel. This mode will be very useful to simulate the π^- background in the $G0$ backward configuration, with an electron beam energy in the range of 0.335-0.810 GeV. This study will be described in detail in a forthcoming report.

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