Coherent Photoproduction of π^+ from ^{3}He

To understand the contribution of mesonic degrees of freedom to the various processes in nuclei, and the mechanisms of photon-induced reactions in few-body systems, an experiment was performed at Jefferson Laboratory using the CLAS detector in Hall B. In the current analysis Ref.[1] we report on the measured cross sections for $\gamma+{}^3\mathrm{He} \to \pi^+ + t$ channel with incident photon energies of 0.5 to 1.55 GeV for pion center-of-mass angles between 40 and 140 degrees. The $\gamma+{}^3\mathrm{He} \to \pi^+ + t$ channel is one of the most important pion-production channels because it is an isoelastic nuclear transition within the isodoublet (^{3}H,^{3}He) with the same quantum numbers as the elementary reaction on the nucleon. The same nuclear wave functions can be used for the initial and final states. This reaction is particularly attractive because the ^{3}He target is the lightest nucleus on which one can observe coherent π^+ photoproduction with charge exchange.

Our results are compared with the only available model calculations by Tiator and Kamalov and with previous measurements in Fig. 1. The calculations were originally suited only for the energies from threshold to the Δ resonance region. Recently this model has been extended (with MAID) to higher energies Ref.[2]. There is good agreement between the calculations and experimental data for small momentum transfers. For larger momentum transfers the calculations can describe the data only at backward angles. The old measurement at 137 degrees can be nicely extended with our data up to Q^2 =34 fm^{-2} or 1.4 GeV^2. For other angles a huge discrepancy is found, *e.g.*, at 90 or 60 degrees. These interesting results were not observed before when only high-Q^2 data were available at one angle, namely 137 degrees. Our new data suggest that there are other mechanisms that produce much larger contributions than the 1-body (impulse approximation) and the 2-body mechanisms that were proposed in Ref.[2]. It is possible that two- or even three-body effects are driving the large cross sections, but it is not precisely known to what extent. The models could be improved by including 2-body and 3-body meson-exchange currents (MEC). These processes become more important especially at high momentum transfers because the momentum is shared between two or three nucleons.

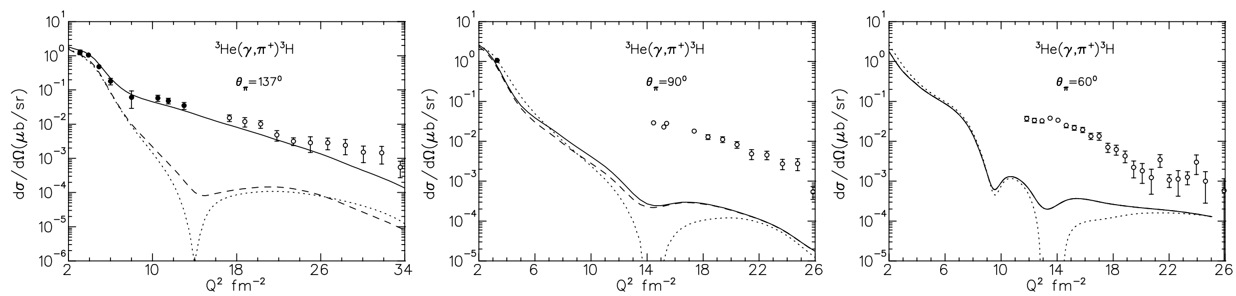

FIG. 1: Momentum-transfer dependence of the differential cross section for fixed pion angles of 137, 90, and 60 degrees in the c.m. frame. The curves show the calculations by Tiator and Kamalov for three different assumptions: plane-wave impulse approximation PWIA (dotted lines); distorted-wave impulse approximation DWIA (dashed lines); and DWIA + 2-body mechanism Ref.[2] (solid lines). Our data are shown as open circles and from Ref.[3] (left) and Ref.[4] (middle) as filled circles.

Ref.[1] R. Nasseripour *et al.* Phys. Rev. C **83**, 034001 (2011).
Ref.[2] L. Tiator *et al.* Few-Body Systems **10**, 143 (1991. Phys. Rev. Lett. **75**, 1288 (1995), and private communications (2010).
Ref.[3] D. Bachelier *et al.*, Phys. Lett. B **44**, 44 (1973), Nucl. Phys. **A251**, 433 (1975).
Ref.[4] N. d'Hose *et al.*, Nucl. Phys. **A554**, 679 (1993).