

Coherent π^+ Photoproduction on ^3He

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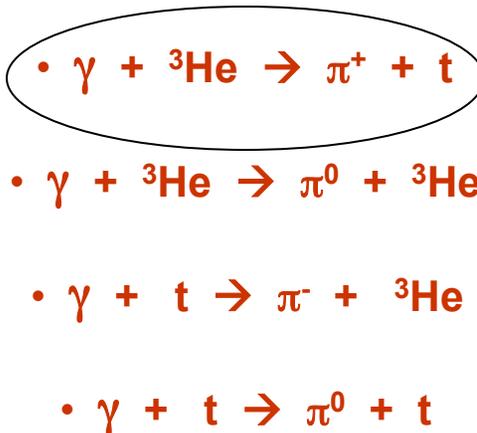
The George Washington University

for the CLAS Collaboration



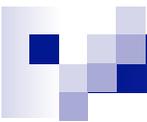
Physics Motivation:

Comparing an elementary meson production process on a free nucleon ($\gamma + p \rightarrow \pi^+ + n$) with the same process on the nucleus



- *Useful in developing our understanding of the nuclear structure and long-range part of the nucleon-nucleon interaction described by the one-pion-exchange model*
- *A good tool to explore the importance of the pion cloud and thus to investigate the contribution of mesonic degrees of freedom*

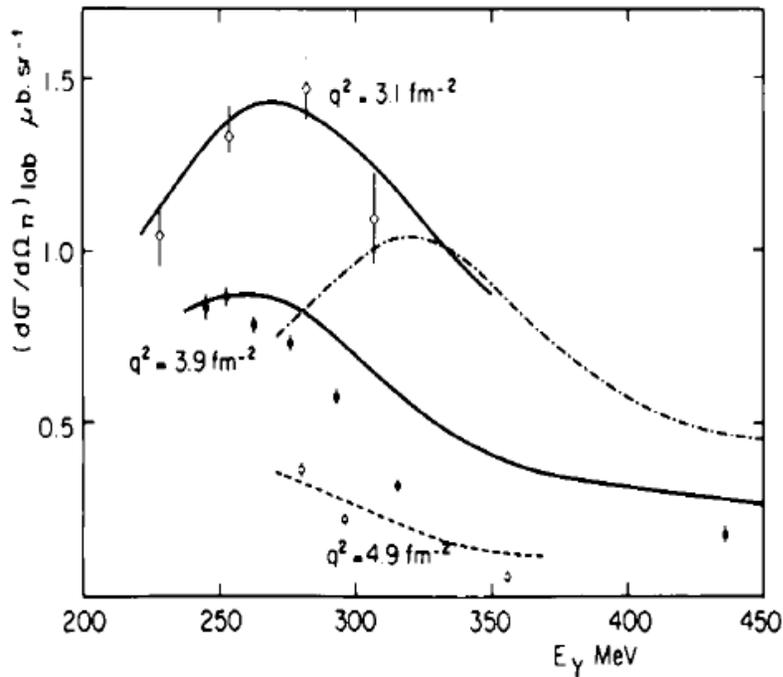
${}^3\text{He}$ and the triton are the lightest nuclei for which one can observe coherent photoproduction with charge exchange and a well defined final state that can be identified easily.



Physics Motivation:

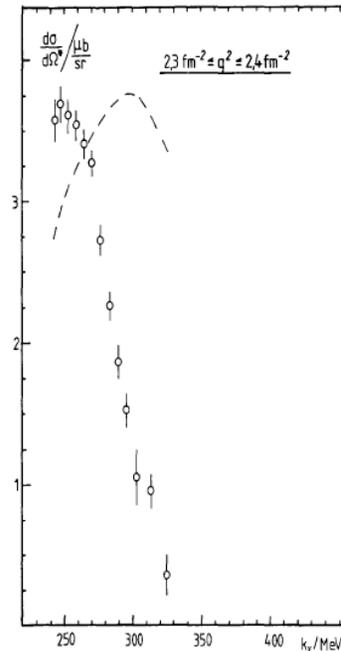
- *First experiment by O'Fallon et al. in 1965 showed that the cross section could be described by that for a single free proton times the square of the nuclear-matter form factor for ^3He , modified by the appropriate kinematic factors. (Phys. Rev. 141, 3 (1965))*
- *In 1979, Argan et al. obtained the matrix element for threshold pion photoproduction and compared it with scattering data on the proton and showed that a unique form factor cannot account for both processes. This implies that many-body contributions to pion photoproduction affect the two reactions differently. (Phys. Rev. C20, 1 (1979))*

Theoretical Calculations and Previous Measurements



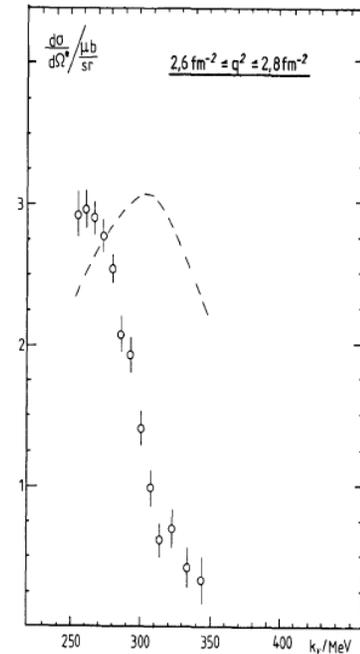
Calculations: Lazard and Maric,
Nuovo Cim. A16, 605 (1973).

Data: Bachelier et al.,
Phys. Lett. B44, 44 (1973) (Orsay).



Calculations: Sanchez-Gomez and Pascual,
Nucl. Phys. B9, 153 (1969), (Valencia).

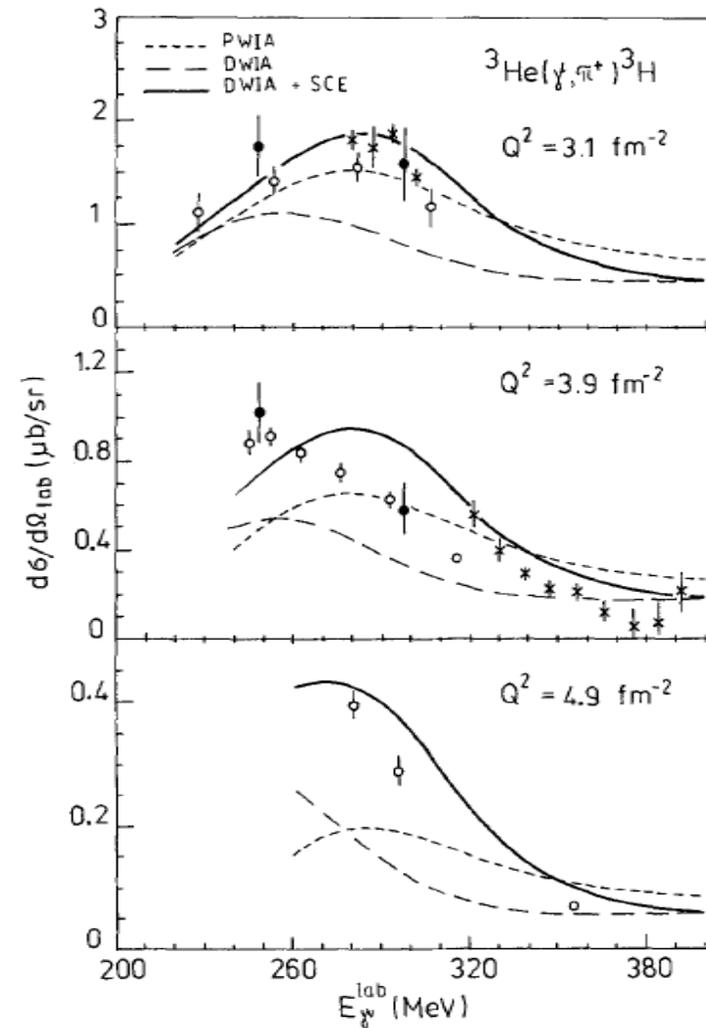
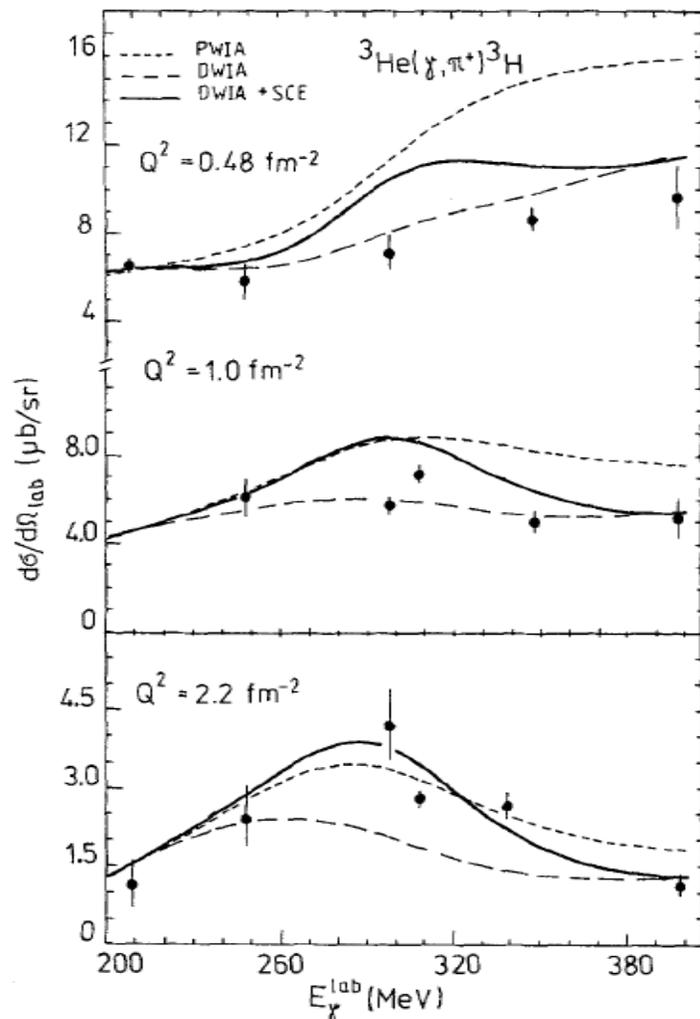
Data : Bellinghausen et al.,
Nucl. Phys. A470, 429 (1987), (Bonn).



Theoretical Calculations and Previous Measurements

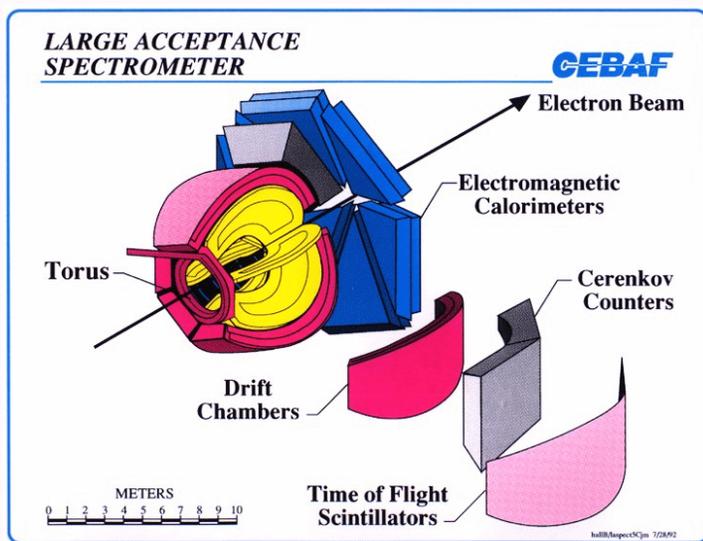
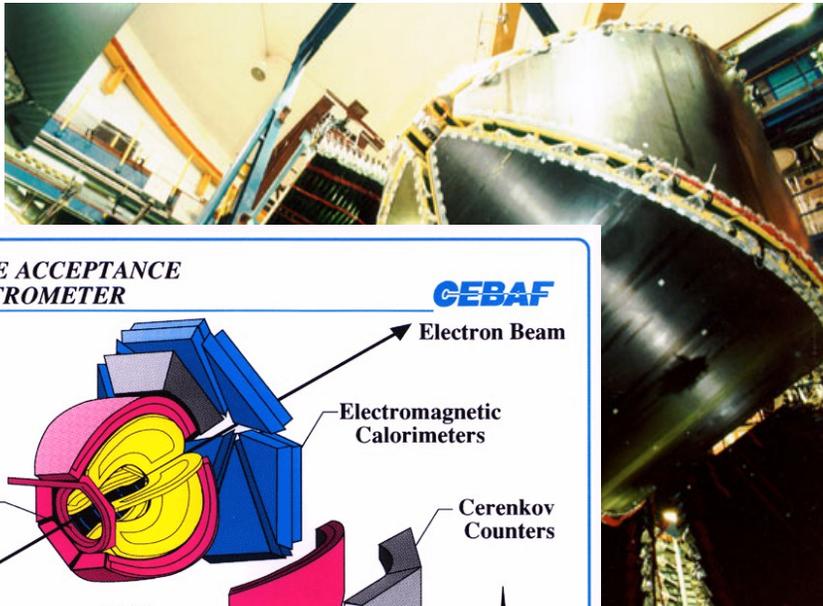
Data: *N. d'Hose, Ph.D. Thesis, Saclay 1988.*

Calculations: *Kamalov, Tiator, and Bennhold, Few-Body Systems 10, 143 (1991)*

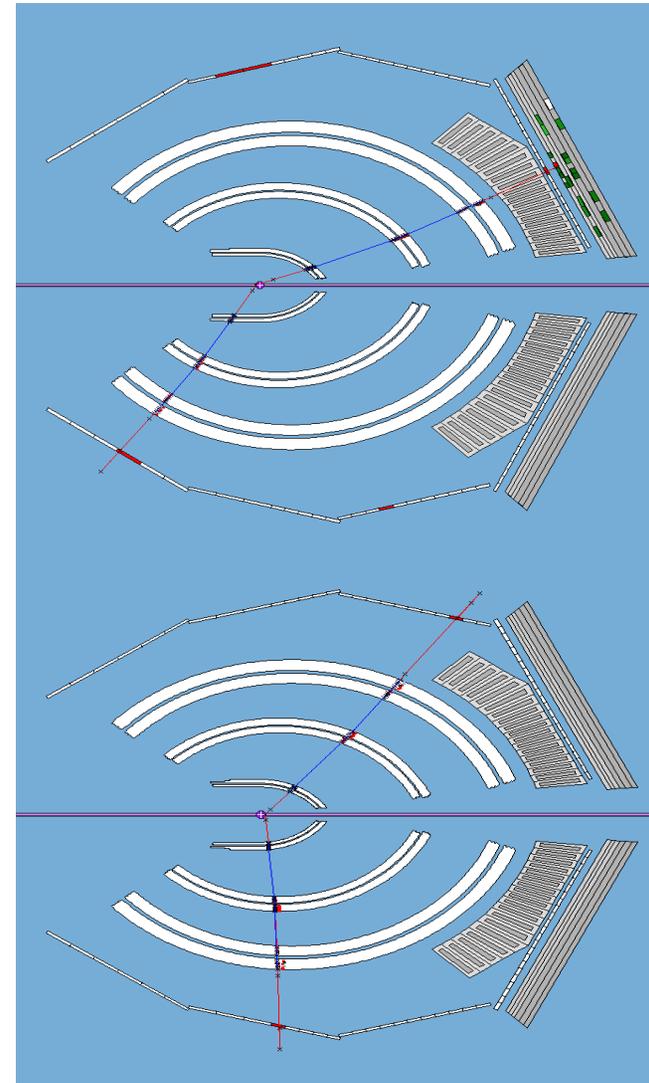


Experiment with CLAS at JLab

Six separate spectrometers consist of DC, EC, CC, SC with Toroidal Magnetic field



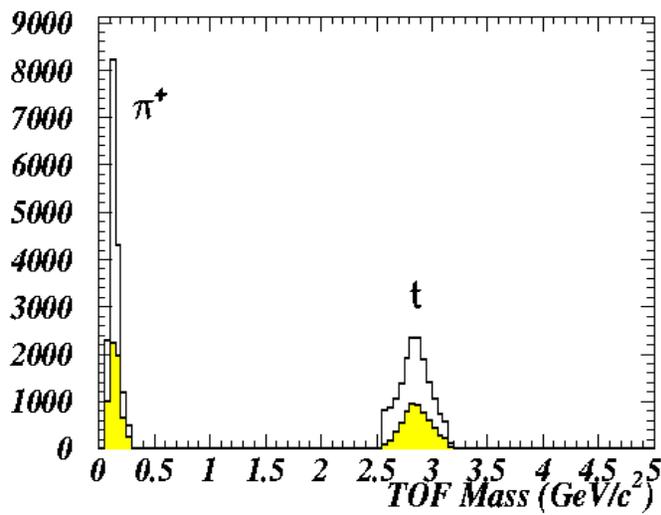
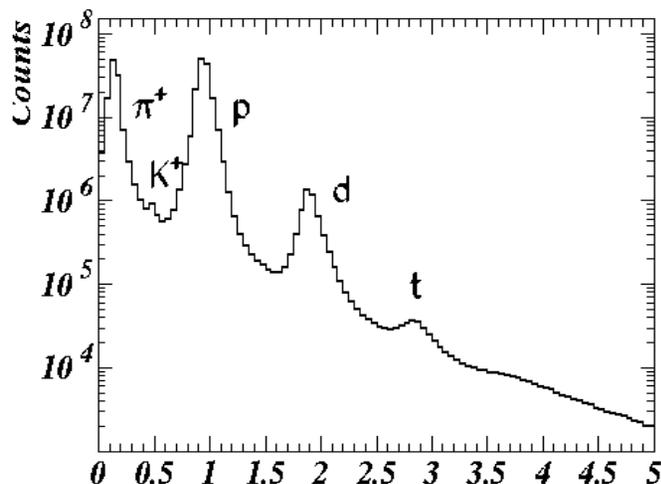
Nearly 4π multilayer spectrometer, for PID and particle tracking over full angular range.



Identify ${}^3\text{He}(\gamma, t\pi^+)$ reactions by identifying the coincident tritons and pions in the CLAS

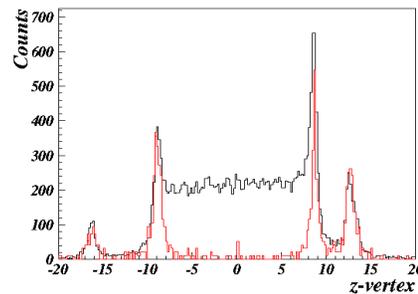
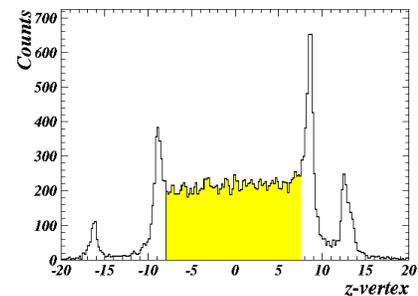
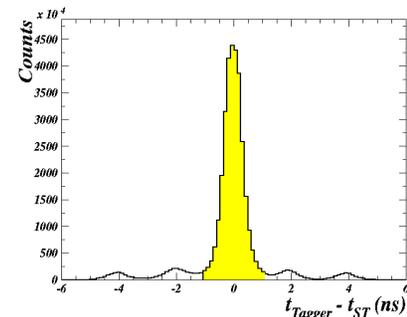
Particle Identification and Event Selection for ${}^3\text{He}(\gamma, t\pi^+)$

Data from the g3a experiment with a tagged-photon beam (0.35-1.55 GeV) on an 18-cm-liquid ${}^3\text{He}$.

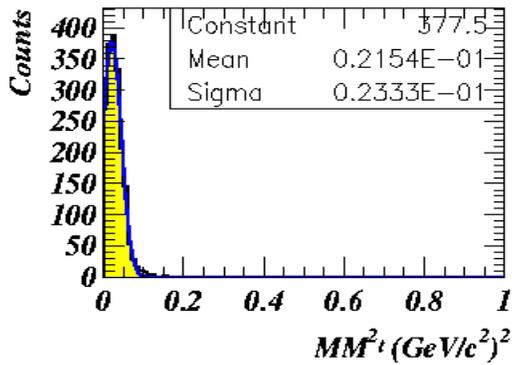


- **Only one π^+ and one t**
- **Vertex cuts**
- **Time cut**
- **Fiducial cuts**
- **Energy-loss corrections**

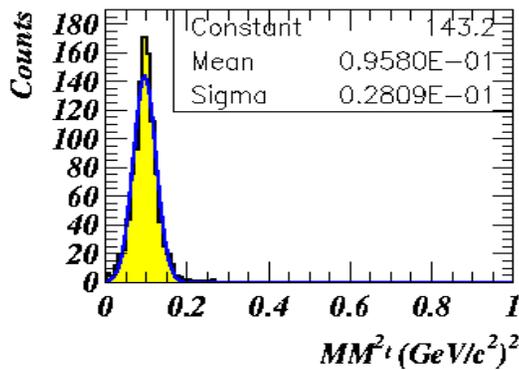
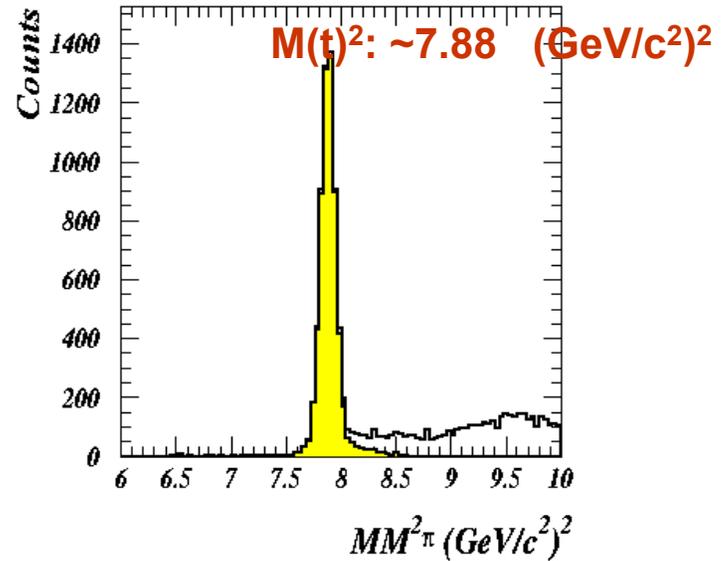
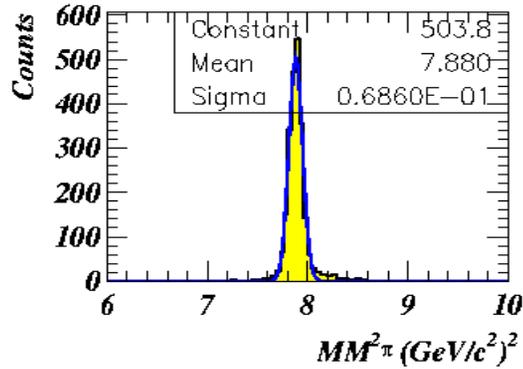
- **Use of 2-body kinematics to select the background-free $t\pi^+$ channel.**



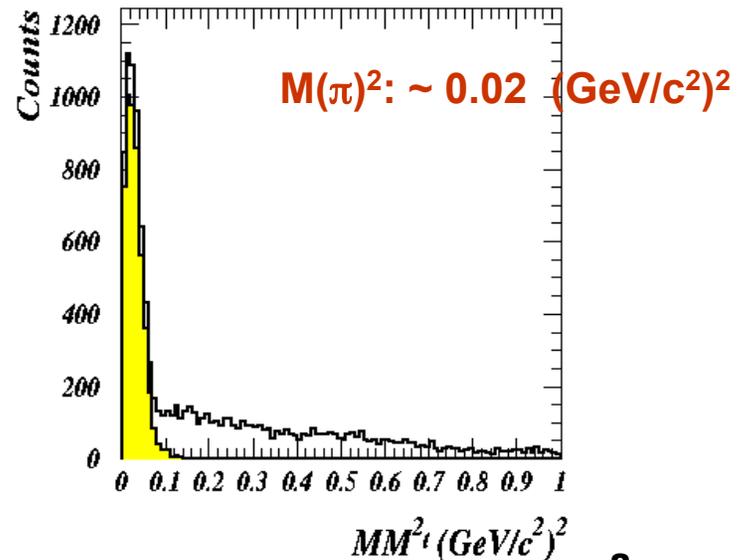
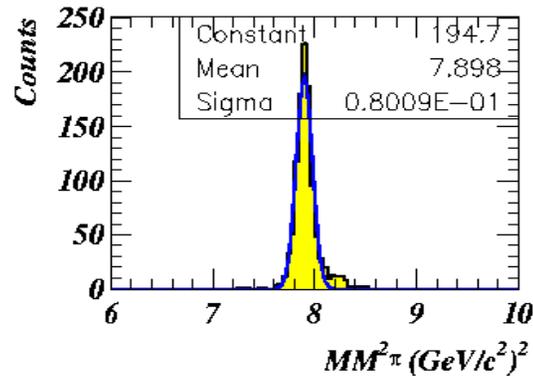
Energy-Loss Corrections



**With
Corrections**

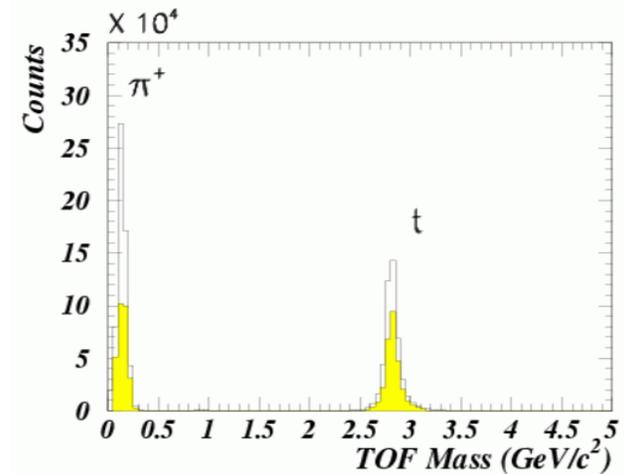
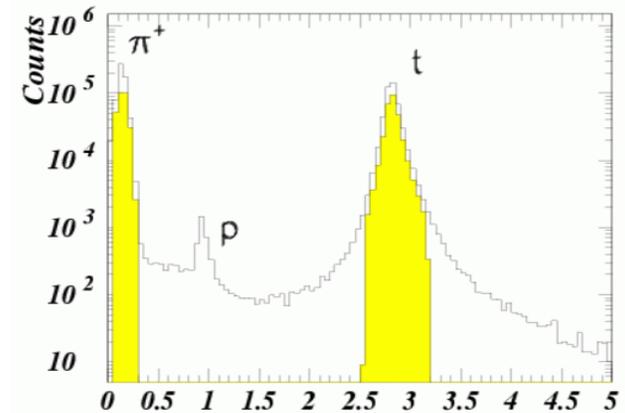
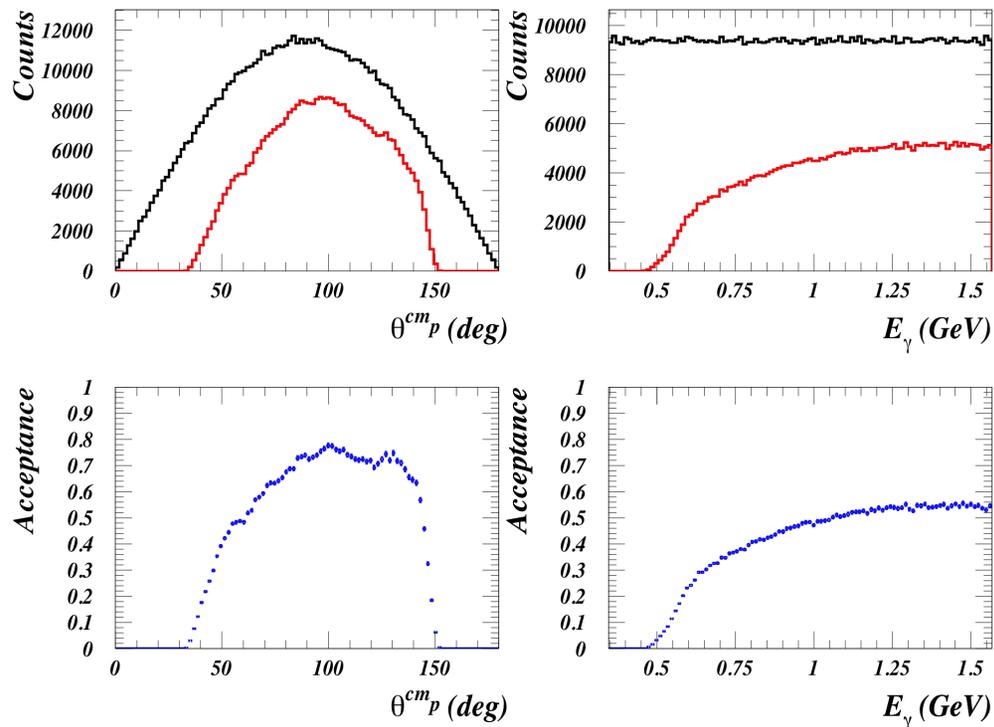


**Without
Corrections**



Simulation and Acceptance Corrections:

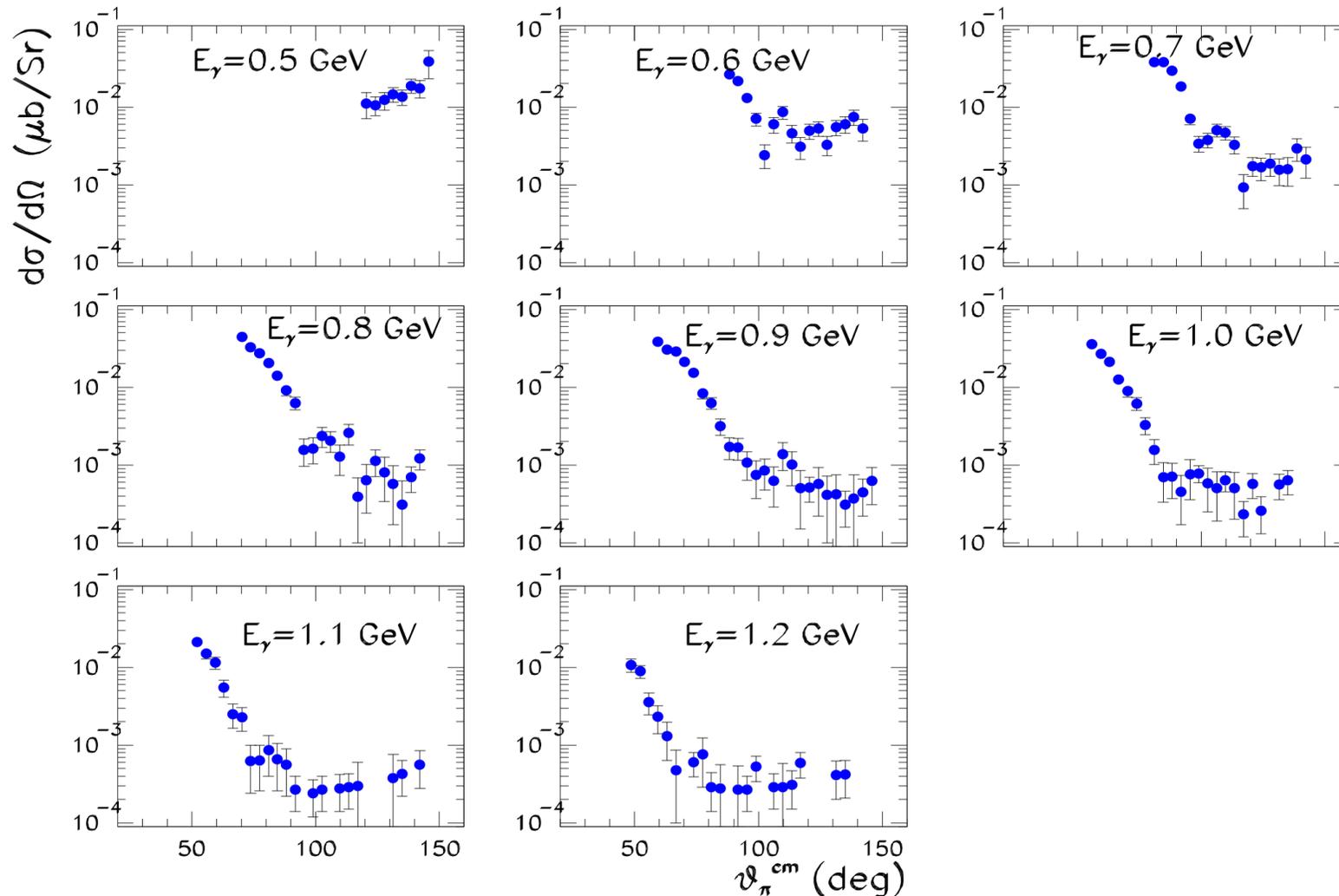
Monte-Carlo simulation of phase-space-distributed $t\pi^+$ events within 4π sr, using the standard CLAS simulation package.



Acceptance correction factors

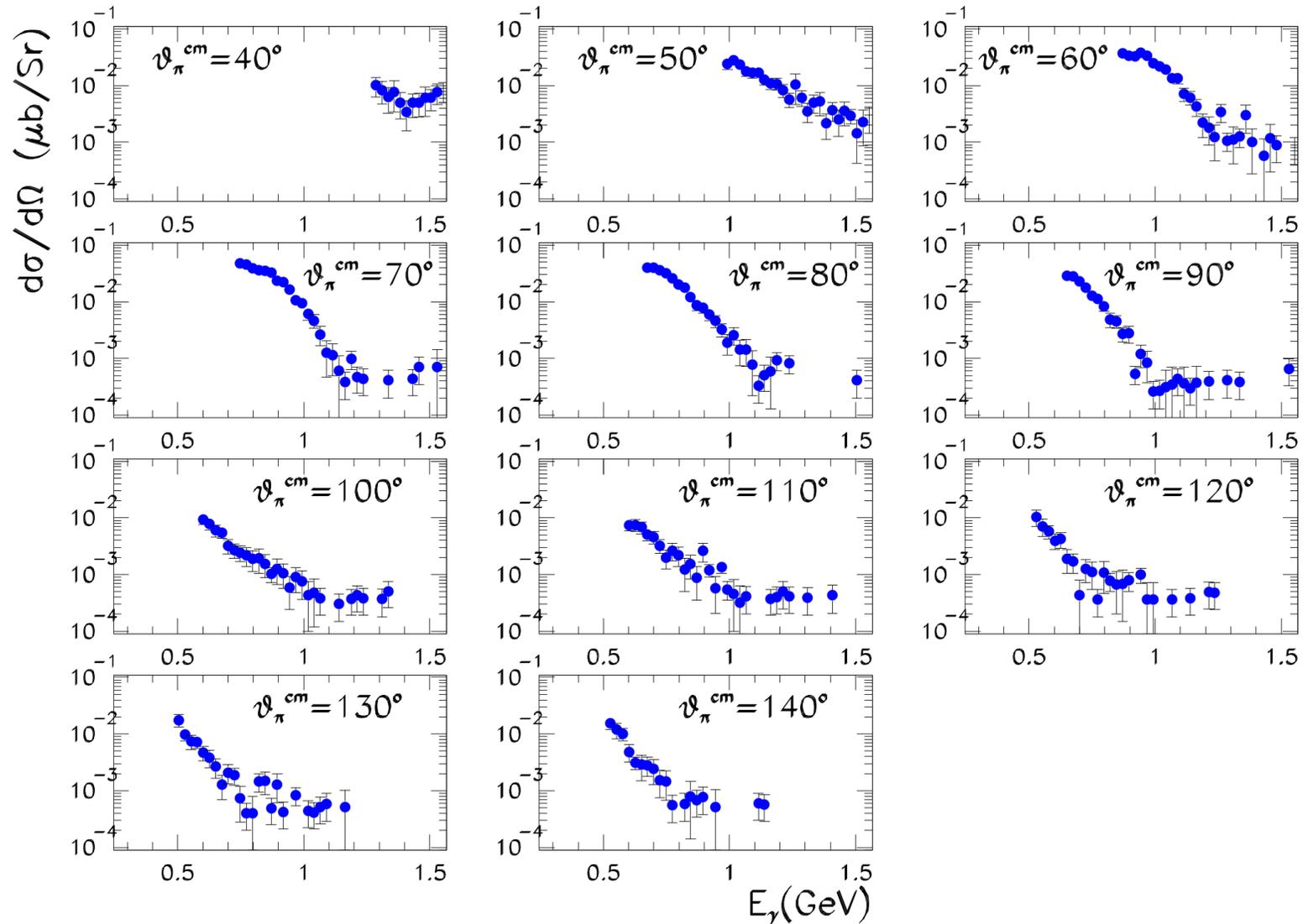
Cross Sections (Angular Dependence)

Normalized to the photon flux and target density



Cross Sections (Energy Dependence)

Normalized to the photon flux and target density





Summary:

- We have extracted the cross sections for coherent π^+ photoproduction on ^3He for photon energies between 0.5 and 1.5 GeV and pion scattering angles between 40 and 140 deg.
- These results are the first to be reported on the $^3\text{He}(\gamma, t\pi^+)$ channel with incident photon energies above 450 MeV.
- Model calculations by Tiator and Kamalov are underway.