Momentum Corrections for Charged Particles Photoproduced on Hydrogen and Helium Targets in CLAS

Christian Shultz, Richard Bonventre, Elliot Imler, and Michael F. Vineyard
Union College, Schenectady, NY, 12309
(The CLAS Collaboration)

Abstract

Momentum corrections have been implemented and tested for charged particles photoproduced on Hydrogen and Helium targets in the CEBAF Large Acceptance Spectrometer (CLAS) at the Thomas Jefferson National Accelerator Facility. This is part of a systematic study of meson photoproduction from the proton and light nuclear targets to investigate possible nuclear-medium modifications of nucleon resonances and meson-nucleon interactions. The momenta of charged particles detected in CLAS are corrected for energy losses in the cryogenic targets and start counters. These corrections yield the momenta at the reaction vertices and improve the identification of the reaction channels.

CEBAF Accelerator

The Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab is a superconducting, 6-GeV, electron accelerator. A schematic of the facility and brief description of how it works is shown in Figure 1. The electron beam at CEBAF is used simultaneously for scattering experiments in three halls that contain complimentary experimental equipment.

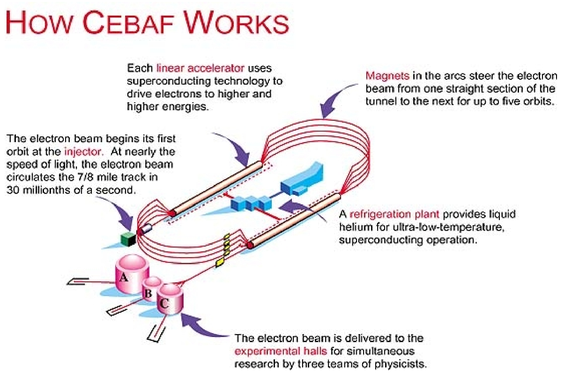

Figure 1: Schematic of the Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab.

CLAS Detector

The primary instrument in Hall B is the CEBAF Large Acceptance Spectrometer (CLAS) [1] shown in Figure 2. Six superconducting coils produce a toroidal magnetic field around the beam axis. The spaces between the coils are filled with three regions of drift chambers to track charged particles, Cerenkov counters for electron identification, scintillation counters for time-of-flight measurements, and electromagnetic calorimeters to detect electrons, photons, and neutrons. Hall B also houses a photon tagging system that allows for experiments with real photon beams.

Experiments

In the experiments considered here, beams of real photons with energies between 0.3 and 2.3 GeV were incident on cryogenic, liquid targets of Hydrogen and Helium. Start counters were positioned around the target as shown in Figure 3. Also shown in Figures 2 and 3 is a $\gamma + p \rightarrow \pi^0 + p$ event simulated with the CLAS GEANT simulation code GSIM [2].

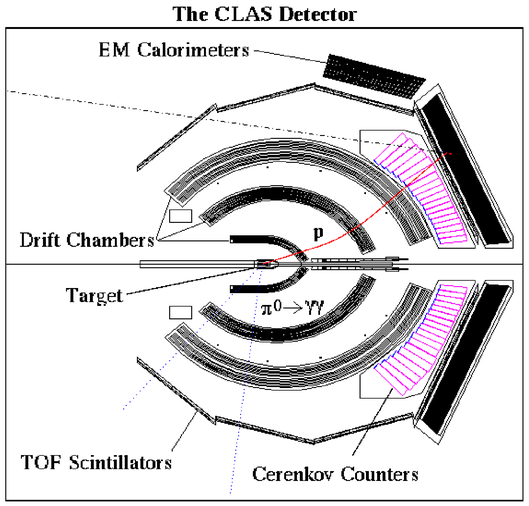

Figure 2: Schematic of the CEBAF Large Acceptance Spectrometer in Hall B at Jefferson Lab.

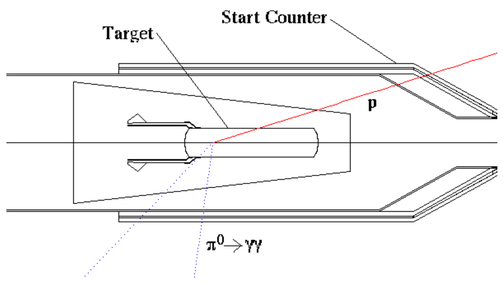

Figure 3: Schematic of the target region of CLAS.

Momentum Corrections

The measured momenta of charged particles detected in CLAS were corrected for energy losses in the cryogenic target material, target wall, carbon cylinder, and start counters to determine the momenta at the reaction vertices. This was accomplished by integrating a FORTRAN code [3] developed for this purpose into our ROOT-based [4] C++ analysis code.

Results

Some of the results of the momentum corrections are illustrated in Figures 4-7. Shown in Figure 4 is a comparison of proton momentum spectra before and after corrections for protons photoproduced on a Hydrogen target. Missing mass spectra for the $\gamma + p \rightarrow p + X$ and $\gamma + p \rightarrow \pi^+ + \pi^- + X$ reactions on a Hydrogen target before and after corrections are shown in Figures 5 and 6, respectively. In Figure 7 is a comparison of missing mass spectra for the $\gamma + {}^3He \rightarrow p + p + X$ reaction. The momentum corrections clearly provide for improved identification of the reaction channels.

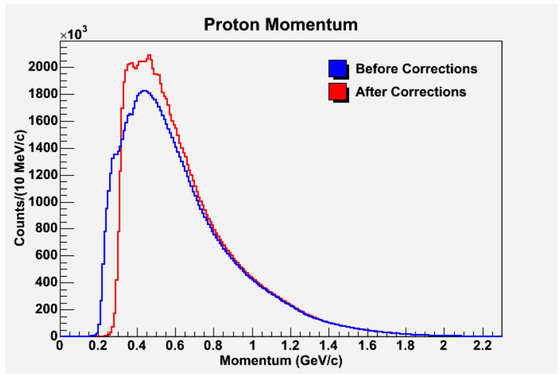

Figure 4: Corrected (red) and uncorrected (blue) proton momentum spectra for protons photoproduced on a Hydrogen target.

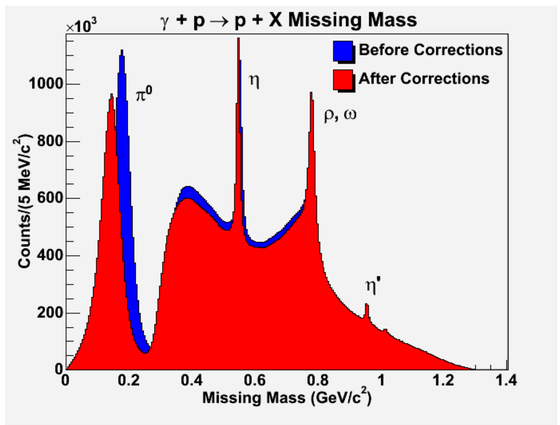

Figure 5: Missing mass spectra for the $\gamma + p \rightarrow p + X$ reaction before (blue) and after (red) momentum corrections.

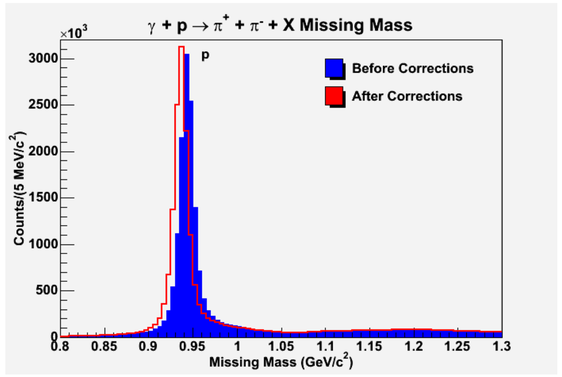

Figure 6: Missing mass spectra for the $\gamma + p \rightarrow \pi^+ + \pi^- + X$ reaction before (blue) and after (red) momentum corrections.

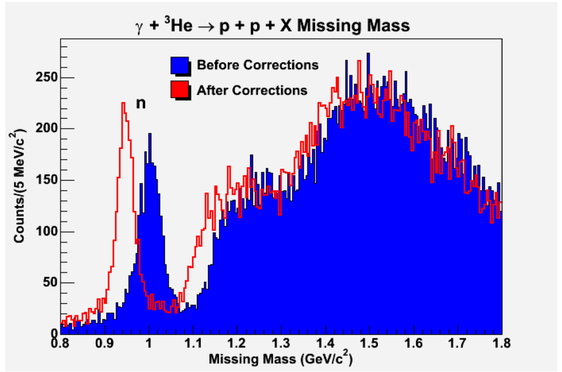

Figure 7: Missing mass spectra for the $\gamma + {}^3He \rightarrow p + p + X$ reaction before (blue) and after (red) momentum corrections.

References

[1] B. Meckling *et al.* (The CLAS Collaboration), Nuclear Instruments and Methods **503/3**, 513 (2003).

[2] CLAS GEANT Simulation Code, http://www.physics.unh.edu/~maurik/gsim_info.shtml

[3] E. Pasyuk, momcor.F (2003).

[4] The ROOT System Home Page, http://root.cern.ch/

Acknowledgements

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