Comparison between Simulations and Data for Neutral Meson Photoproduction on the Proton

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Introduction

The photoproduction of π^0 and η mesons from the proton over an incident photon energy range of 0.5-2.3 GeV is being studied using data from the CEBAF Large Acceptance Spectrometer (CLAS) [1] in Hall B at Jefferson Lab. This work is part of a systematic study of neutral meson photoproduction from the proton and light nuclear targets to investigate nuclear medium modifications of nucleon resonances and the meson-nucleon interaction. The π^0 and η mesons are reconstructed from their two-photon decay and from the $\gamma + p \rightarrow p + X$ missing mass. Monte Carlo simulations are being performed to determine the acceptance of the CLAS detector. The physics distributions generated from the simulations are being compared to those obtained from the data to tune the simulations. The experiment and Monte Carlo calculations are described and comparisons between the data and simulations are presented.

Experiment

The data used in this study were taken during the g1c run of the CLAS Collaboration. A 2.4 GeV electron beam from the CEBAF accelerator was used to produce a photon beam with energies between 0.5 and 2.3 GeV with the photon tagging system in Hall B. The photons were incident on a target of liquid hydrogen at the center of CLAS. The reaction products were detected with CLAS.

The CLAS detector is shown in Figure 1. 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.

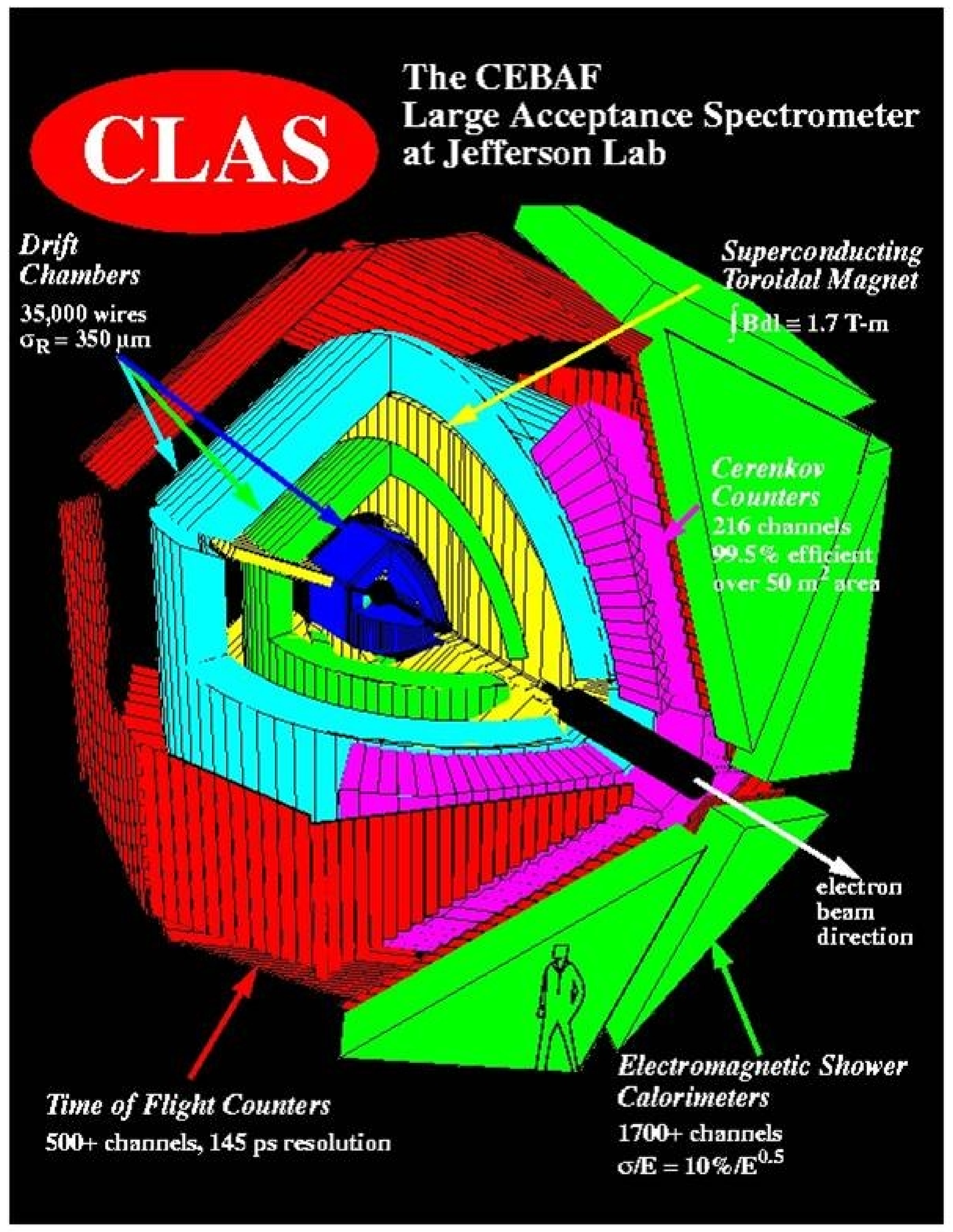

Figure 1:Diagram of the CEBAF Large Acceptance Spectrometer in Hall B at Jefferson Lab.

Simulations

Monte Carlo simulations are being performed with the CLAS GEANT simulation code GSIM [2] to determine the acceptance of CLAS for the reactions of interest. A flow chart showing the steps in the simulations is shown in Figure 2. The π^0 and η photoproduction events were generated with the code genbos [3]. The generated events were run through GSIM to simulate the CLAS response. Then the events were run through the code gpp to account for dead channels in the spectrometer. Next the simulated data were processed with the CLAS data analysis code a1c. Ntuples and ROOT [4] trees were then created for the physics analysis. The ROOT files were used to generate distributions for comparisons between the data and the simulations. Some of these comparisons are shown in Figures 3 – 6.

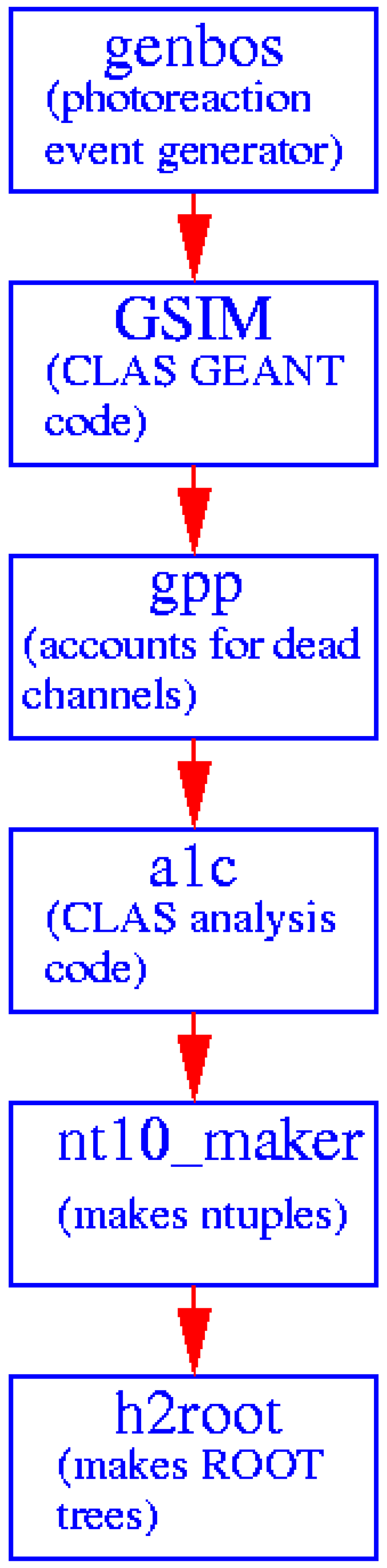

Figure 2: Flow chart of the simulation sequence.

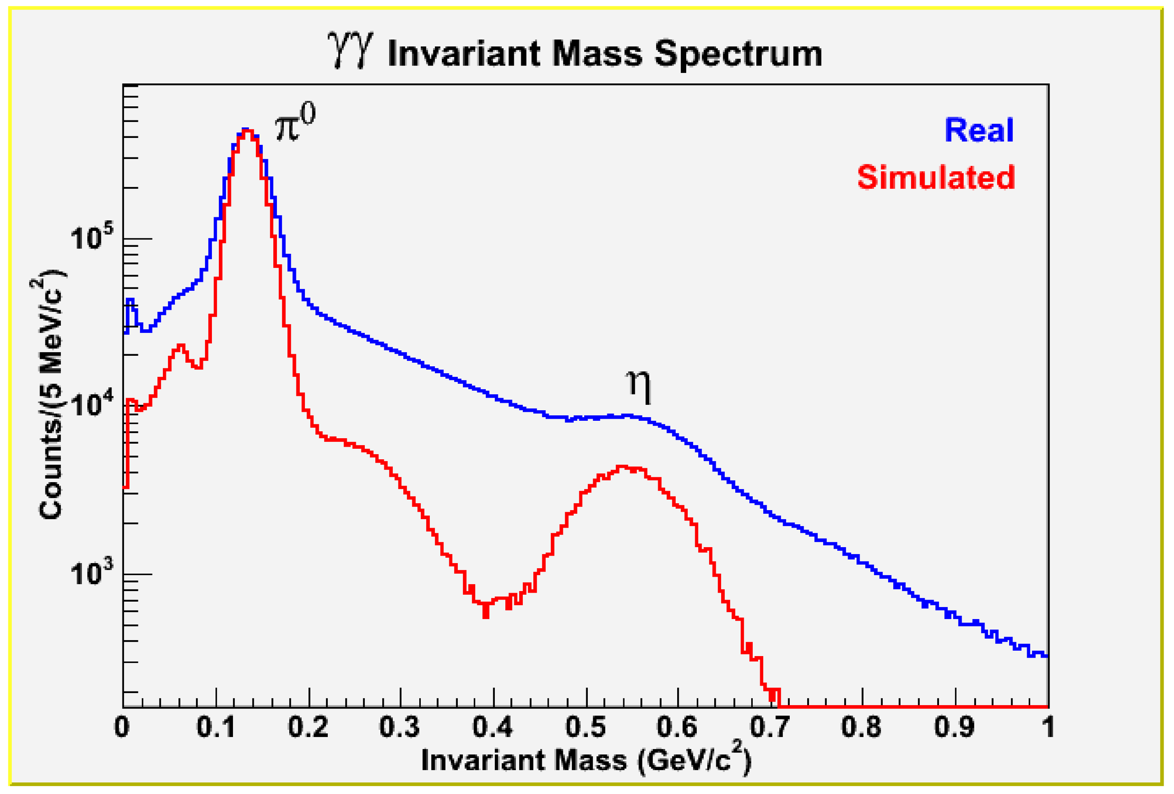

Figure 3: A two-photon invariant mass spectrum with distinct π^0 and η peaks.

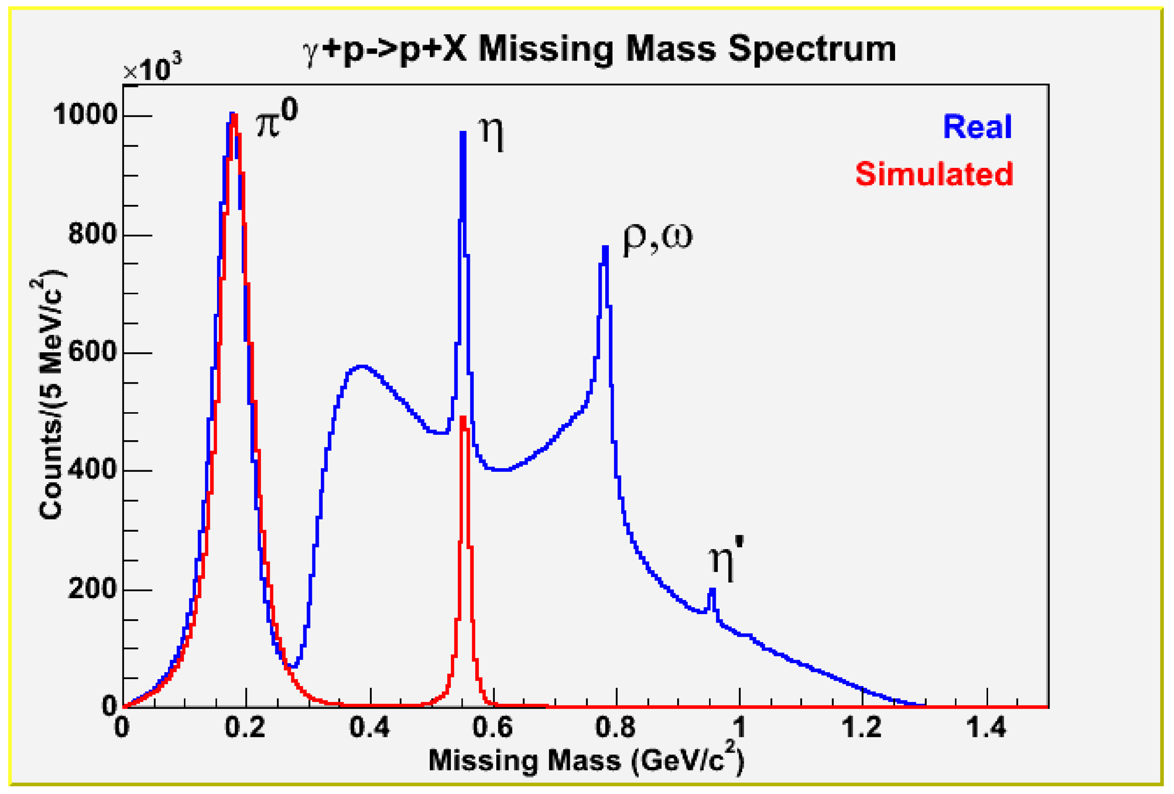

Figure 4: A missing mass spectrum for the $\gamma + p \rightarrow p + X$ reaction.

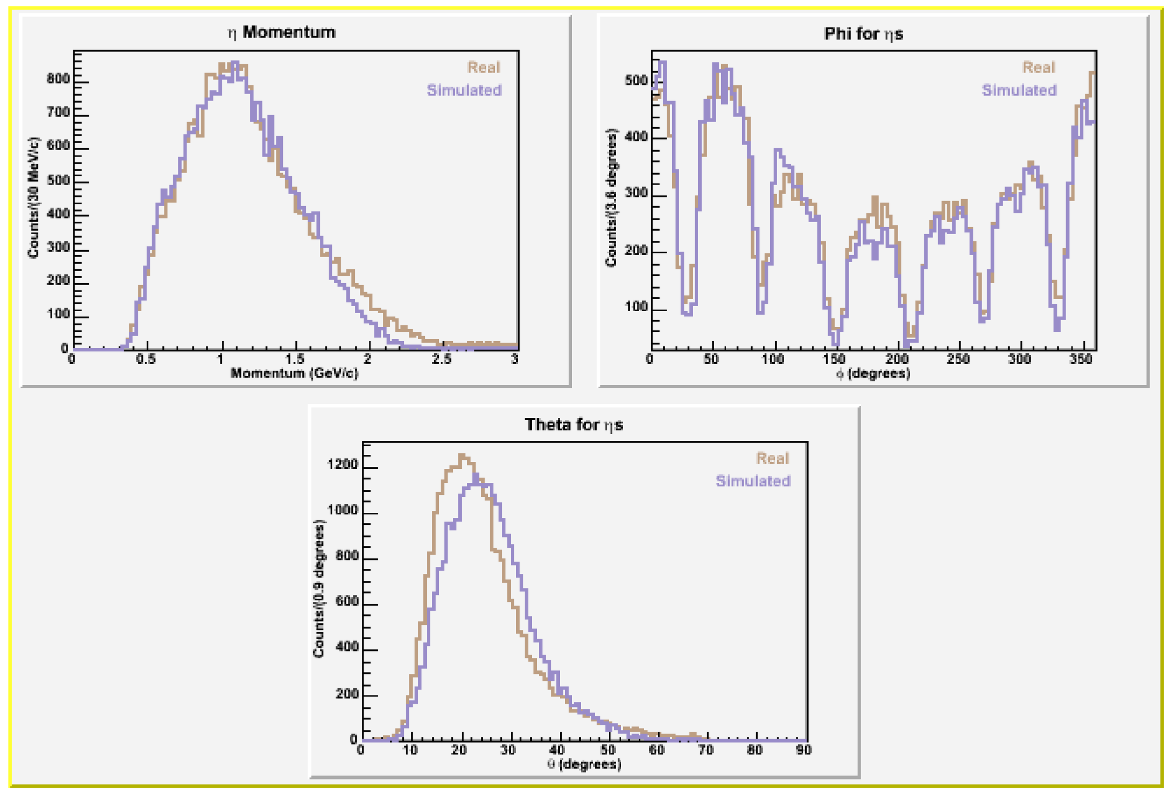

Figure 5: Momentum, azimuthal angle, and polar angle distributions for η mesons reconstructed from two photons in coincidence with a proton.

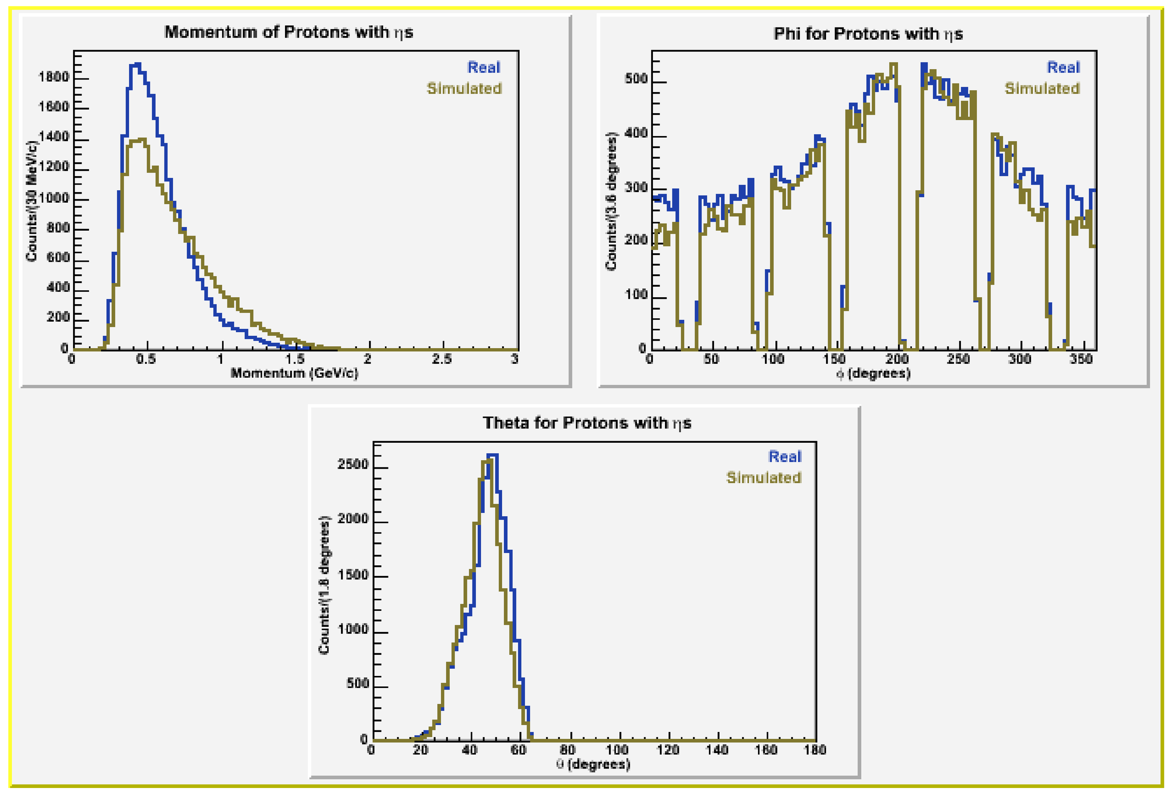

Figure 6: Momentum, azimuthal angle, and polar angle distributions for protons in coincidence with η mesons reconstructed from two photons.

Summary

Comparisons between data and Monte Carlo simulations for π^0 and η photoproduction on the proton have been performed. Based on the good agreement between the simulations and the data, these Monte Carlo calculations are being used to determine the acceptance of CLAS for these reactions. Preliminary results for the cross sections from a missing mass analysis are in good agreement with the SAID database [5].

References

[1] B. Meckling *et al*. (The CLAS Collaboration), "The CEBAF Large Acceptance Spectrometer," Nuclear Instruments and Methods **503/3**, 513 (2003).
[2] CLAS GEANT Simulation Code, http://www.physics.unh.edu/~maurik/gsim_info.shtml
[3] A.S. Iljinov *et al*., Nuclear Physics **A616**, 575 (1997).
[4] The ROOT System Home Page, http://root.cern.ch/
[5] SAID Database, http://gwdac.phys.gwu.edu/

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