Fiducial Volumes for Photons Detected in the Forward Calorimeters of the CLAS Detector at JLAB

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

Introduction

Fiducial volumes have been determined for photons detected in the electromagnetic calorimeters of the CEBAF Large Acceptance Spectrometer (CLAS) [1] at the Thomas Jefferson National Accelerator Facility. This work is part of a systematic study of neutral meson photoproduction from the proton and light nuclear targets over an incident photon energy range of 0.5 – 1.5 GeV to investigate nuclear medium modifications of nucleon resonances and the meson-nucleon interaction. In this analysis the neutral mesons are reconstructed from their two-photon decay. The fiducial volumes define regions of the calorimeters with full photon detection efficiency. The volumes were determined by examining the photon hit distributions along the different scintillator planes in the sampling calorimeters.

Experiment

The data used in this study were taken during the g1c and g3 runs of the CLAS Collaboration. In the g1c run 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. During the g3 run a 1.6-GeV electron beam was used to produce photons in the energy range 0.3 – 1.5 GeV. The photons were incident on cryogenic liquid targets of hydrogen (g1c) and ^{3}He (g3) at the center of CLAS. The reaction products were detected with CLAS 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.

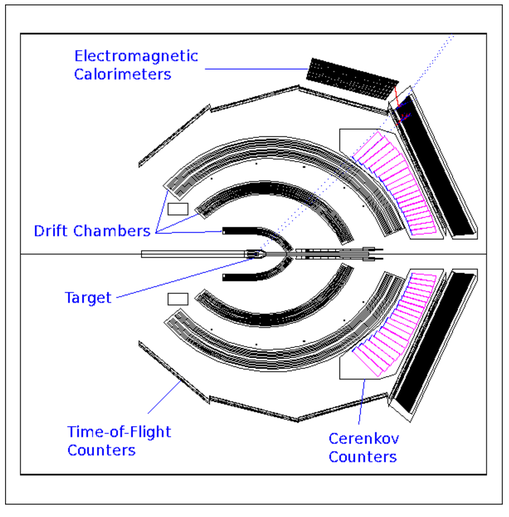

Figure 1: A schematic top view of the CLAS detector cut along the beam line. Two simulated photon showers in one of the forward-angle calorimeters are shown.

Fiducial Volumes

In order to accurately reconstruct neutral mesons from their two-photon decay, it is important to limit the analysis to photons that strike the regions of the electromagnetic calorimeters with full photon detection efficiency. To illustrate this, consider the two simulated photon hits in one of the forward-angle calorimeters shown in Figure 2 [2]. The electromagnetic shower due to the lower photon is completely contained and the detector will provide accurate information on this photon. However, the shower from the upper photon leaks out the side of the detector and therefore this photon should be excluded from the analysis.

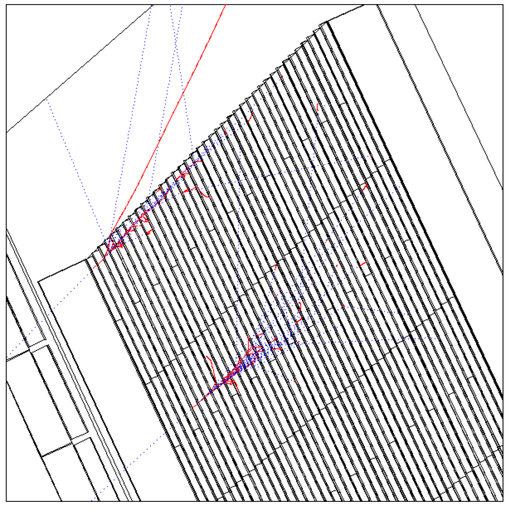

Figure 2: An expanded view of the edge of one of the forward-angle calorimeters with two simulated photon showers.

Procedure

Shown in Figure 3 is an exploded view of one of the six forward calorimeter modules [3]. The sampling calorimeter consists of alternating layers of scintillator strips and lead sheets. The orientation of the scintillator strips is rotated by 120° in successive layers forming three views labeled U, V, and W. These overlapping views form triangular pixels that provide information on the location of hits in the detector. The fiducial volumes were determined by examining the hit distributions in the U, V, and W views and eliminating regions where the efficiency is changing rapidly. This is illustrated in Figure 4 which shows the photon hit distributions in the three views before (red) and after (blue) the fiducial volumes were determined. The fiducial volumes also excluded a region of one of the modules that contained a hot PMT.

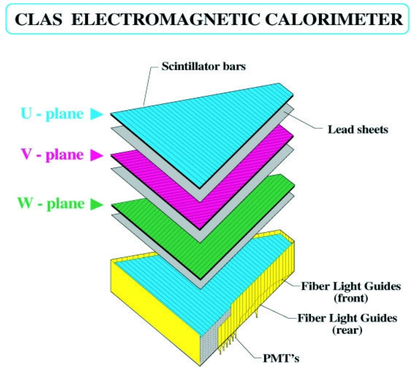

Figure 3: An exploded view of one of the six CLAS forward-angle calorimeter modules.

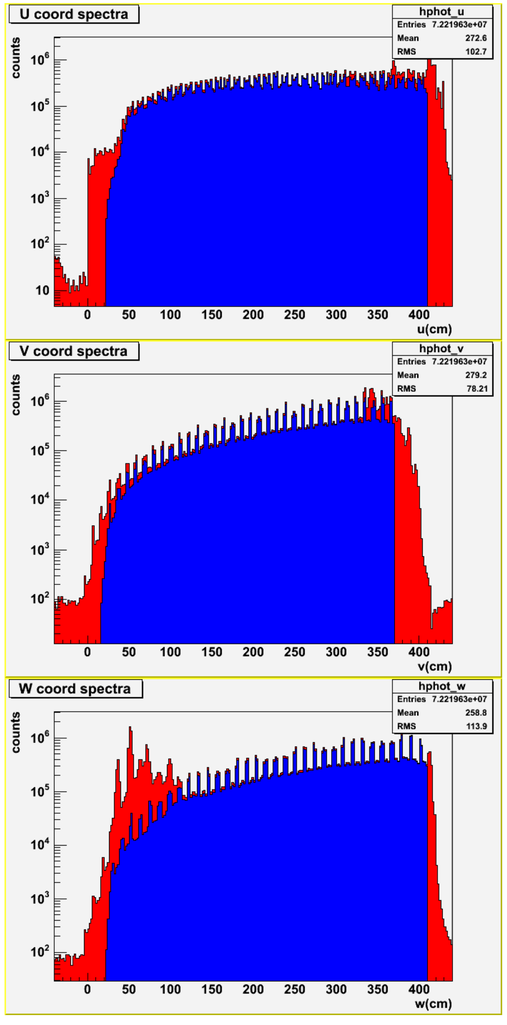

Figure 4: Photon hit distributions in the U, V, and W views of the forward-angle calorimeters before (red) and after (blue) cuts were applied to define the fiducial volumes.

Results

The effects of the cuts defining the fiducial volumes on the photon hit distributions in the CLAS coordinate system are illustrated in Figures 5 and 6. The fiducial volumes successfully maximize the number of photons detected while eliminating data from regions of the detector with nonuniform efficiency.

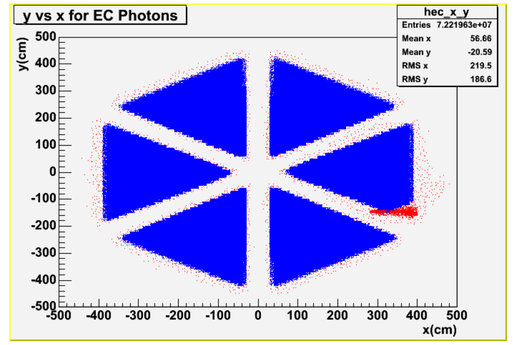

Figure 5: Distribution of photon hits in the forward-angle calorimeters using the CLAS coordinate system before (red) and after (blue) cuts were applied to define the fiducial volumes.

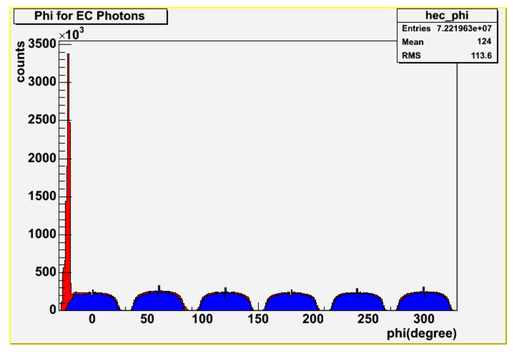

Figure 6: Azimuthal angle distributions for photons detected in the forward-angle calorimeters before (red) and after (blue) the fiducial volumes were defined.

References

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

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

[3] M. Amarian *et al.*, "The CLAS Forward Electromagnetic Calorimeter," Nuclear Instruments and Methods **A460**, 239 (2001).

*Supported by the U.S. Department of Energy under contract number DE-FG02-03ER41252.