Electro- and Photoproduction of $\omega(783)$ Mesons Using CLAS at Jefferson Lab

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Electro- and photoproduction of $\omega(783)$ from a proton target have been measured in the CLAS detector at the Thomas Jefferson National Accelerator Facility in Newport News VA. The photoproduction data were taken over a photon energy range from 0.5 to 2.3 GeV, while the electroproduction data was obtained over a W range of 1.8-2.5 GeV/c^2. Preliminary acceptance corrected center-of-mass angular distributions have been examined for both data sets.

1. Introduction

Electro- and Photo-production of $\omega(783)$ from a proton target have been measured in a search for so-called "missing baryon resonances." Experimentally, the ωp system is an excellent choice for analysis. The $\omega(783)$ is a narrow (8 MeV) resonance making it easy to identify in the final state, and because the omega has I=0, only I=1/2 baryon resonances are allowed to decay to ωp. Due to the lack of experimental data, no resonances are known to decay to ωp.

Electro- and photoproduction data was taken in the CEBAF Large Acceptance Spectrometer (CLAS) during the spring and summer of 1998. The CLAS is designed around a six-coil super-conducting toroidal magnet. The gaps between each of the six coils (called 'sectors') are instrumented with drift chambers with angular coverage extending from 8–140°. Surrounding the drift chambers is a time-of-flight system with a nominal resolution of 150 ps. In the forward direction are Cerenkov counters and electromagnetic calorimeters extending from 6–45°, used primarily for electron identification. For photon running, a bremsstrahlung photon tagger capable of identifying photons between 20-95% of the incident beam energy was used to provide the photon beam and a start counter was placed around the target.

2. Photo-production data

Photo-production data were taken over a photon energy range from 0.5 to 2.3 GeV. Approximately 250M production triggers were accumulated. The trigger requirements were for a triple coincidence between the tagger, start counter and time-of-flight system.

From this data set, three-track events consistent with the presence of a $p\pi^+\pi^-$ coincidence were selected. Particle identification was achieved through combining time-of-flight and momentum measurements. In addition, a cut was made requiring greater than 70 MeV of missing energy in the final state to eliminate exclusive $p\pi^+\pi^-$ events. A cut was then made requiring a missing mass consistent with the presence of a π^0 in the final state, yielding approximately 6×10^5 exclusive three-pion events with a signal-to-background ratio of approximately 4:1. A background subtraction was then made for each bin as a function of $\cos\theta^*_\omega$, and acceptance corrections were then applied to obtain the center-of-mass angular distributions for the ωp system.

Shown in Fig. 1 is the differential cross-section for various bins in $\sqrt{s}$. Only statistical errors are shown, and because of the limited acceptance of the CLAS at the extreme forward and backward angles the differential cross-section between $-0.8 < \cos\theta^*_\omega < 0.8$ is displayed. From Fig. 1 one can see that near threshold ($\sqrt{s} < 1.9$ GeV) the angular distributions are fairly flat, with little evidence for t-channel omega production. As the beam energy increases, t-channel processes begin to account for more and more of the total cross section. However, there is evidence for s-channel processes throughout the region of interest.

3. Electro-production data

For the CLAS electro-production data set, 40M triggers were accumulated with a 4 GeV electron beam incident on a liquid hydrogen target. The trigger was constructed by a signal in the Cerenkov counters accompanied by significant energy deposition in the forward electromagnetic calorimeter. Events of the type $ep \rightarrow e'p\pi^+X$ were selected by requiring an electron, a proton and a π^+ to be identified in the final state. To reduce contributions from the ρ, a cut on missing mass above the two pions was made. A clear omega signal was observed with a signal to background ratio of approximately 1:1, approximately 15000 $e'\omega p$ remained after data selection. A background subtraction was made in a similar fashion to the photo-production data set, and an acceptance corrected yield was obtained. Shown in Fig 2 are the center-of-mass angular distributions for the electro-production data. The electro-production data is characterized by a larger acceptance at small values of $\cos\theta^*_\omega$ and a less rapid onset of t-channel processes.

4. Conclusions

High statistics data of the exclusive reaction $\gamma p \rightarrow \pi^+\pi^-\pi^0 p$ have been obtained by the CLAS detector. There is clear evidence for non-t-channel processes contributing to omega photoproduction for gamma energies from threshold to 2.2 GeV. Electro-production data has also been examined and qualitatively exhibits similiar behavior to the photo-production data set, with s-channel contributions dominating at lower W and progressively more t-channel production at higher values of W.

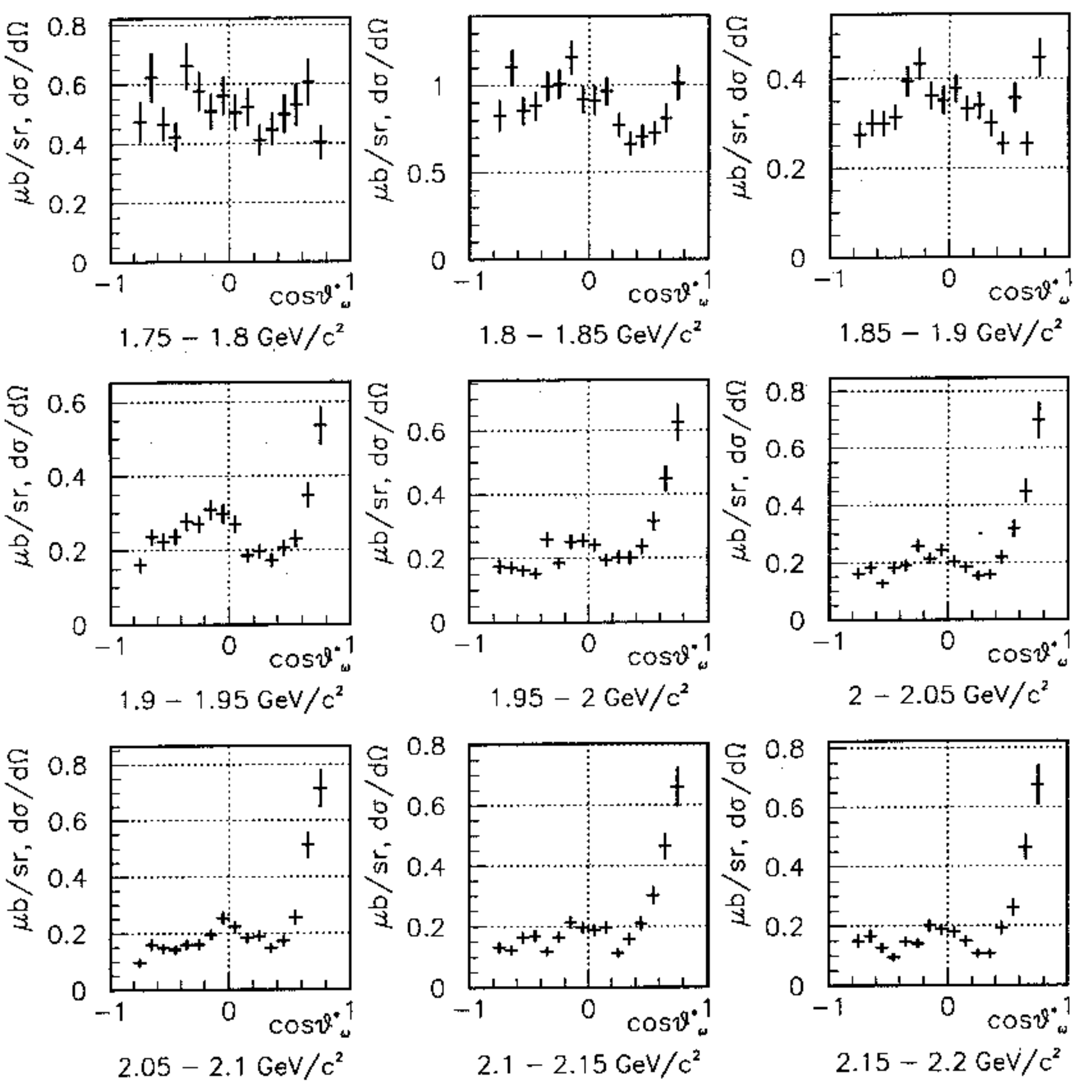

Figure 1. Acceptance corrected center-of-mass angular distributions for $\gamma p \to \omega p$ final state for various regions in $\sqrt{s}$

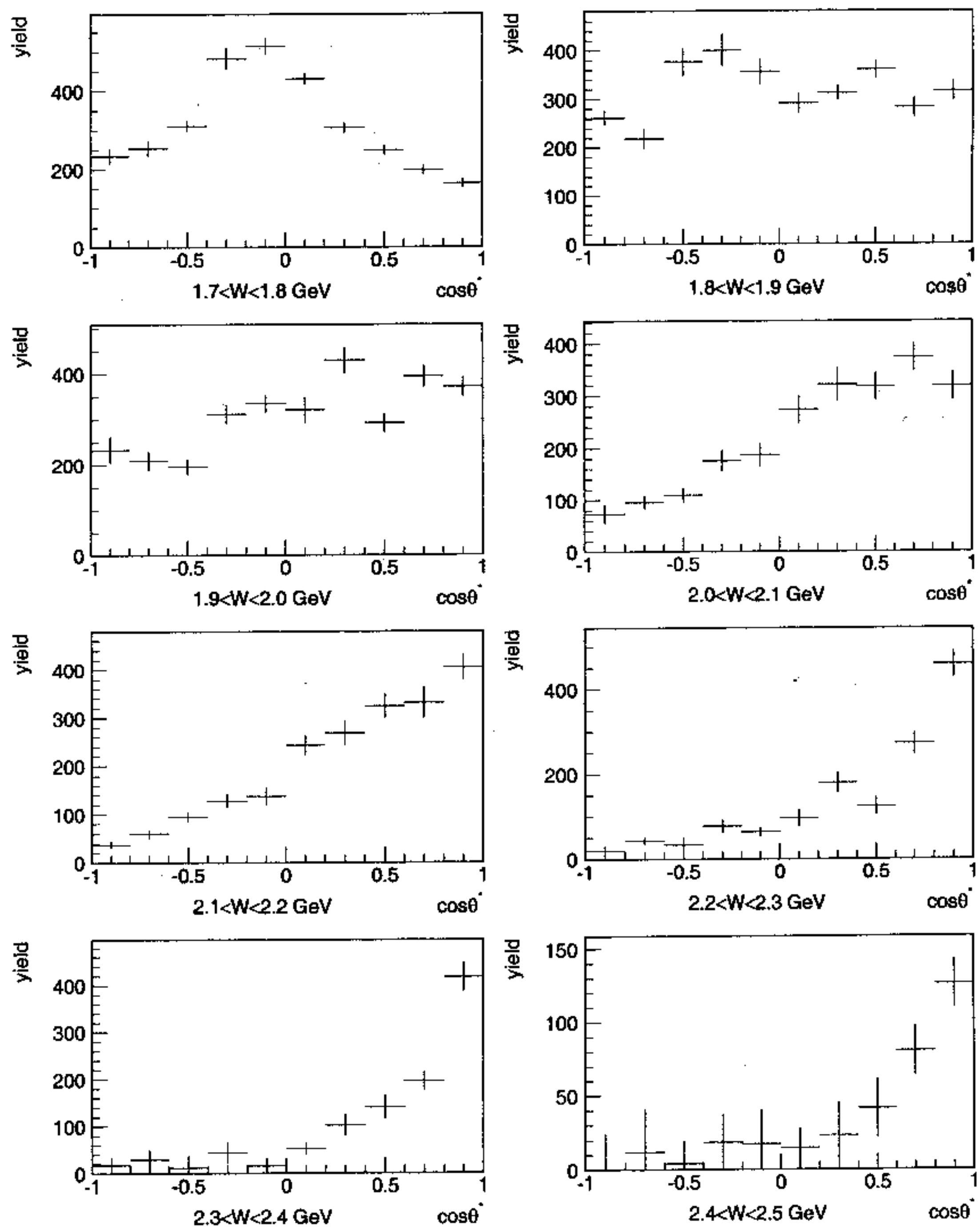

Figure 2. Acceptance corrected center-of-mass angular distributions for the $ep \to e\omega p$ final state for various regions in $\sqrt{s}$