Preliminary results for observation of exclusive π^0 electroproduction

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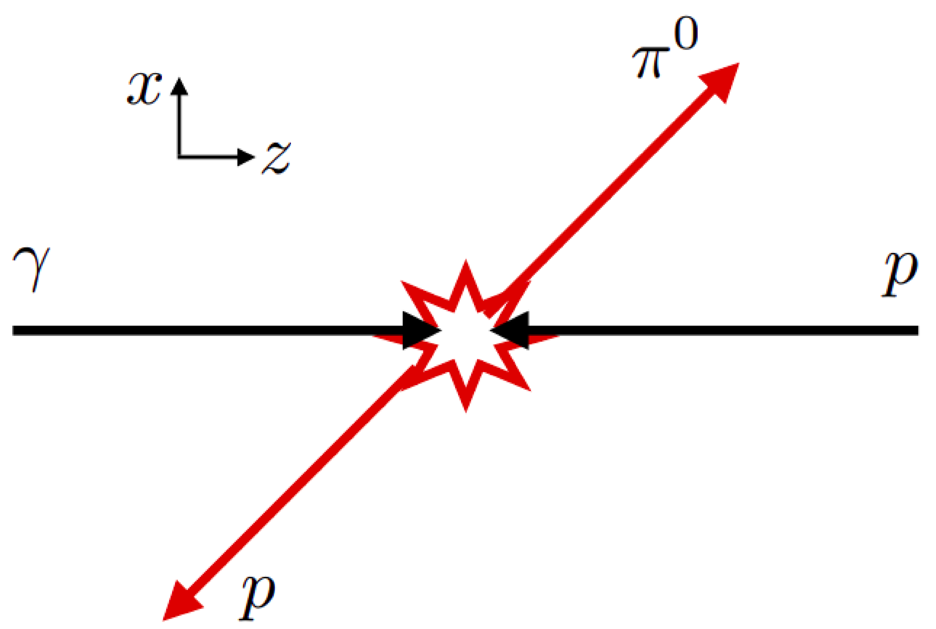
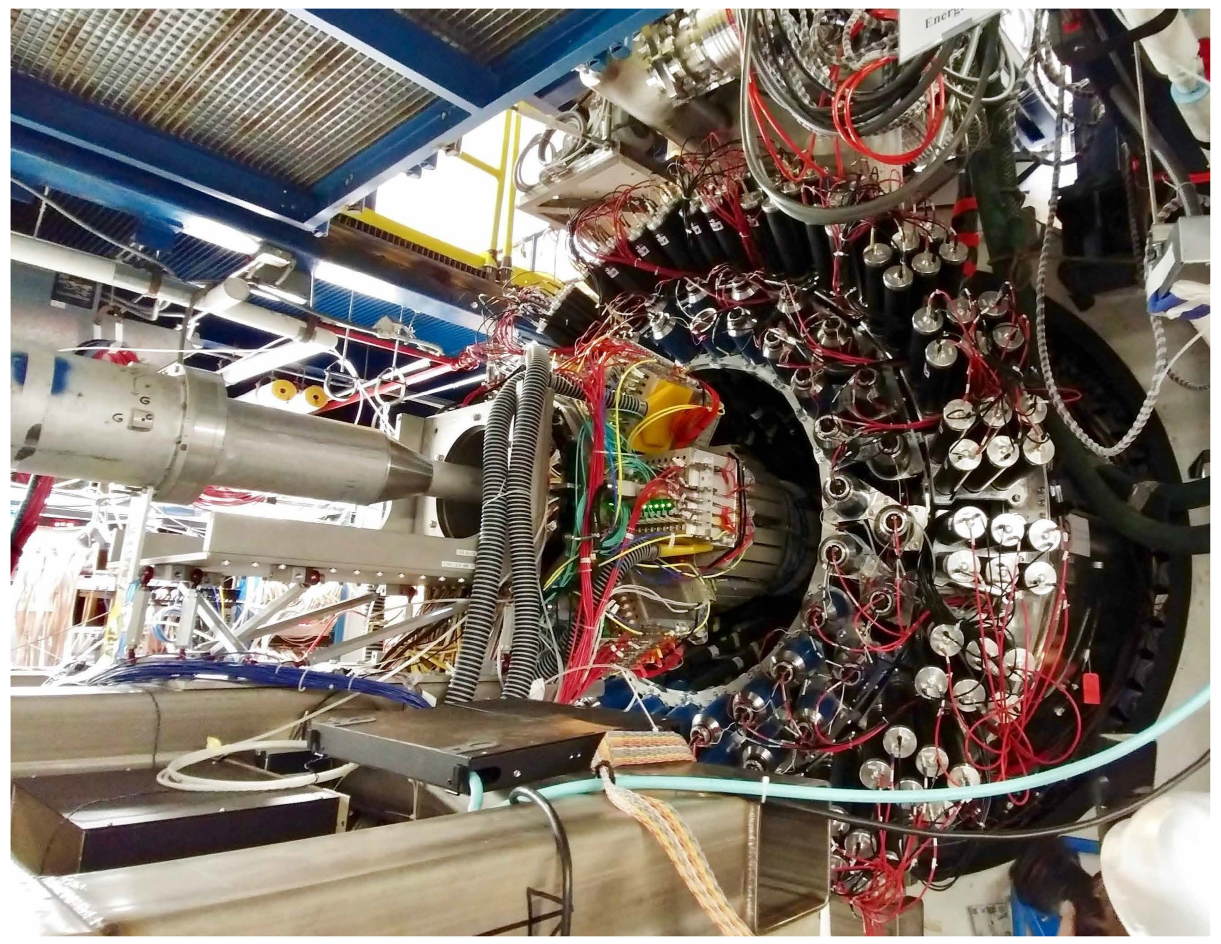
Exclusive π^0 Production



MesonEx experiment at CLAS12 studies exotic mesons production. Investigating exclusive π^0 production is crucial to understand the viability of the fundamental $\eta\pi$ reaction. These studies aim at the beam asymmetry Σ calculation and the comparison of the latter with the same obtained by GlueX and SLAC experiments.[1] As the outcomes of these experiments shows significant discrepancies, the results provided by CLAS12 can be critical in the exotic meson production studies.

CLAS12 Detector

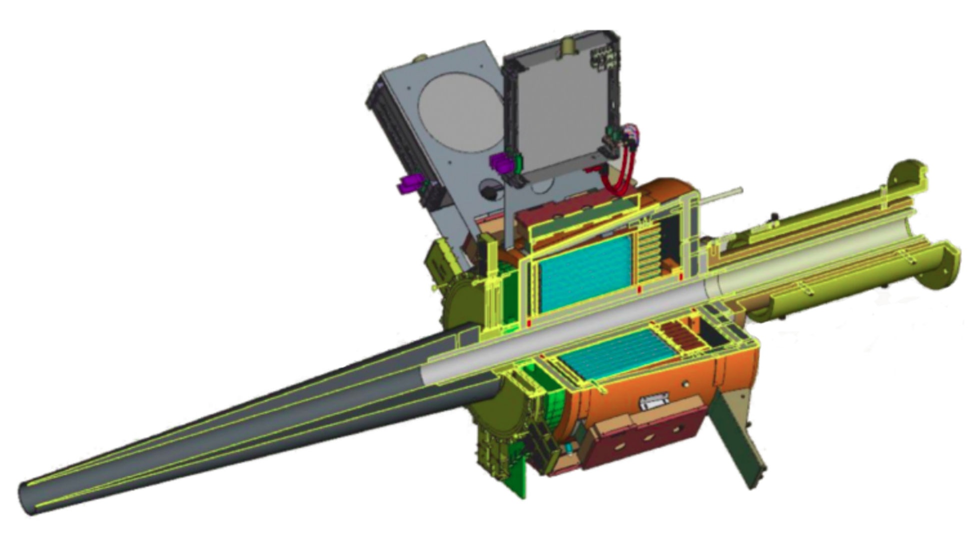
The CEBAF Large Acceptance Spectrometer for operation at 12 GeV beam energy (CLAS12) in Hall B at Jefferson Laboratory is used to study electro-induced nuclear and hadronic reactions.



This spectrometer provides efficient detection of charged and neutral particles over a large fraction of the full solid angle (forward polar angle up to 125° with full azimuthal coverage)[2].

Forward Tagger

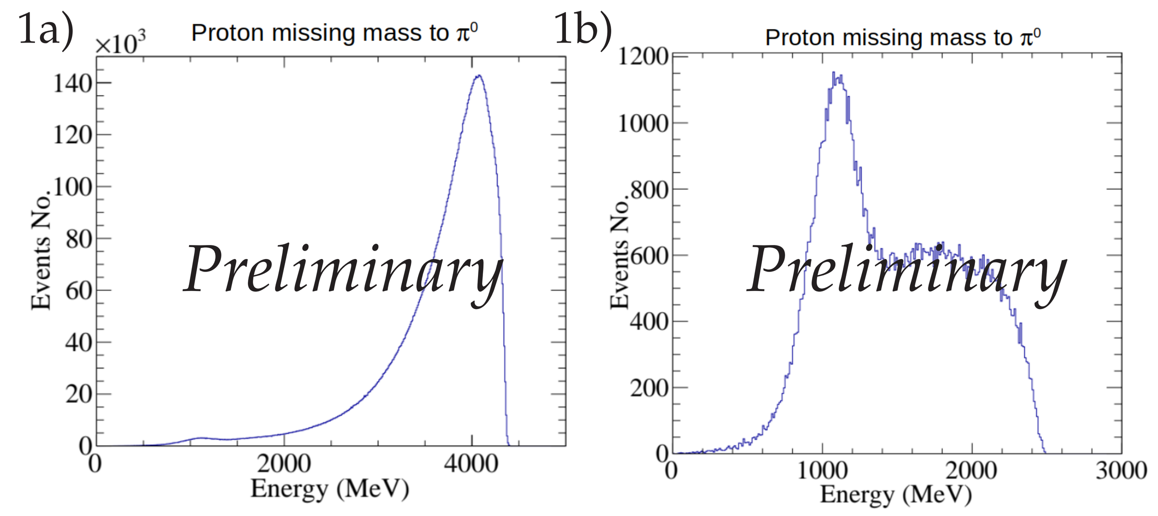
The Forward Tagger (FT), composed of an electromagnetic calorimeter based on PbWO 4 crystals (FT-Cal), a scintillation hodoscope (FT-Hodo), and several layers of Micromegas trackers (FT-Trk), is part of the CLAS12 Foward Detector.



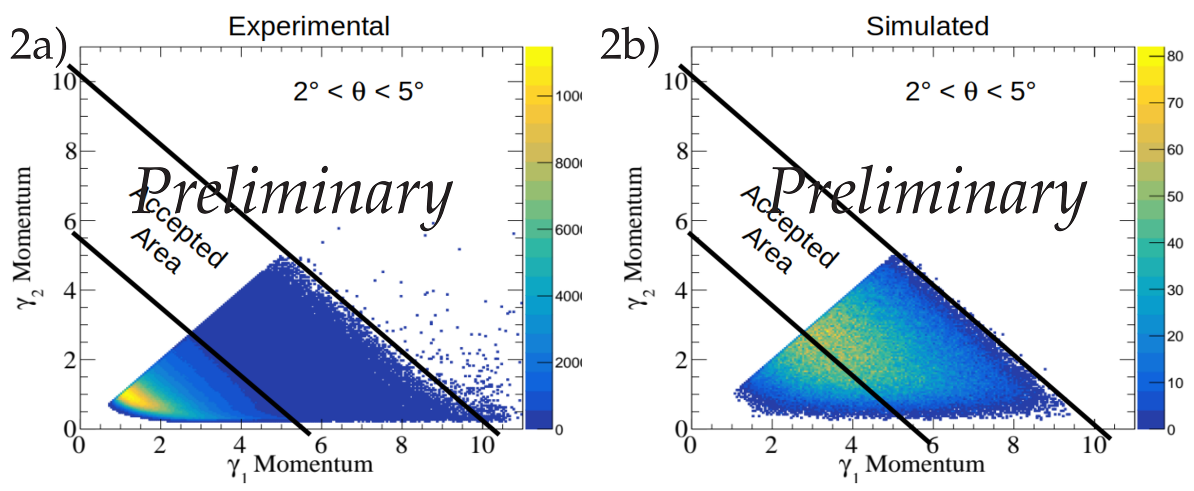
The FT has been designed to detect electrons and photons scattered at polar angles from 2° to 5° and to meet the physics goals of the hadron spectroscopy program.[2][3]

Selection Criteria

Basic selection criteria (e^- & 2γ detected in FT + 2ns coincidence between the three particles) were not enough to select exclusive π^0 production, as shown in fig. 1a.

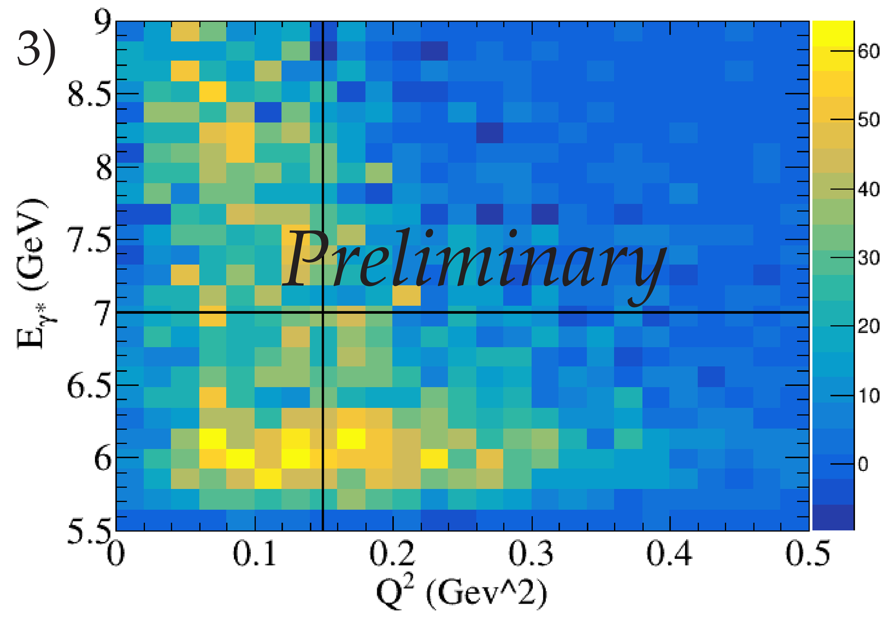


Applying additional selection criteria, as the one on the two photons momenta shown in fig 2a, helped to increase the Signal/Background ratio, fundamental in this step of the analysis.

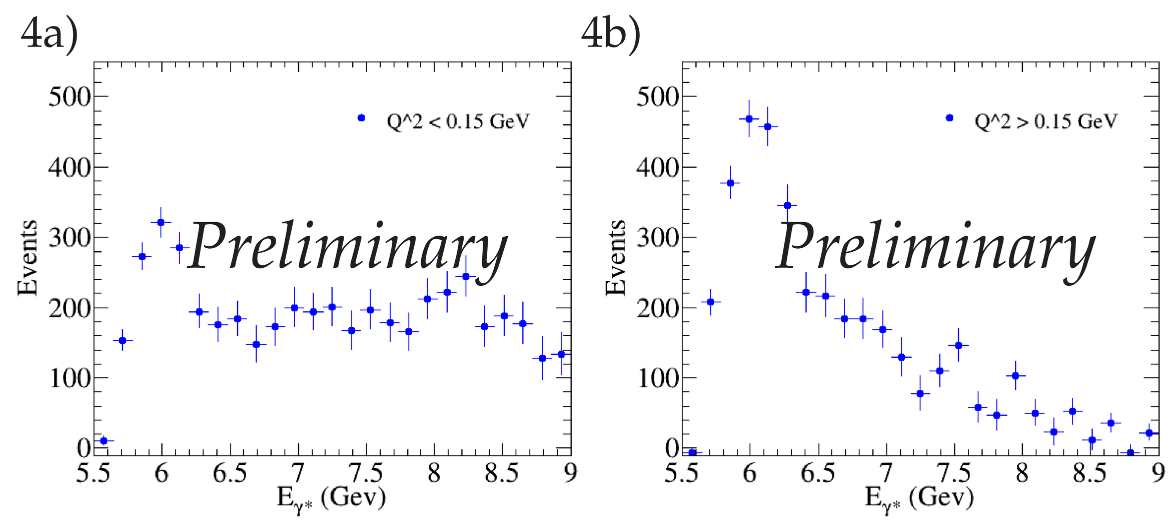


Kinematic Intervals

In order to extract the beam asymmetry from the data, it has to be understood what kind of kinematic region it's under examination, knowing also the dependency from kinematic factor as the virtual photon energy $E_{\gamma v}$ and square mass (q^2), the Mandelstam variables t and s, the electron azimuthal scattering angle (ϕ'_e).

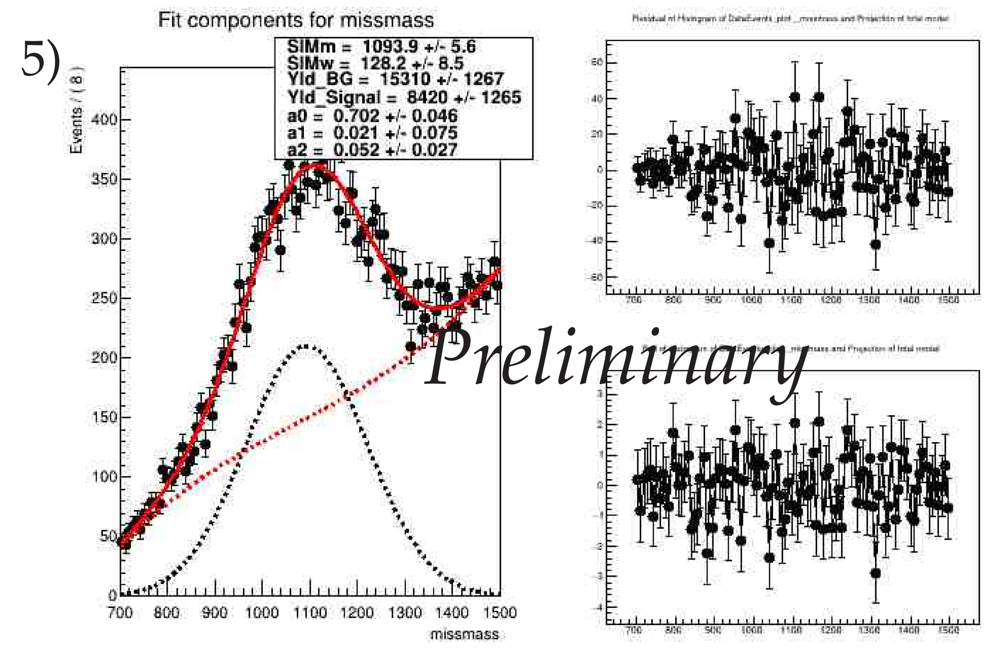


As can be seen in Fig. 3, the data can be divided in 4 different kinematic intervals, among which it's possible to distinguish two different regions: the first one, with high virtual photon energy and low q^2, is the sector where photoproduction events can be found, while the second one is populated mainly by electroproduction events.

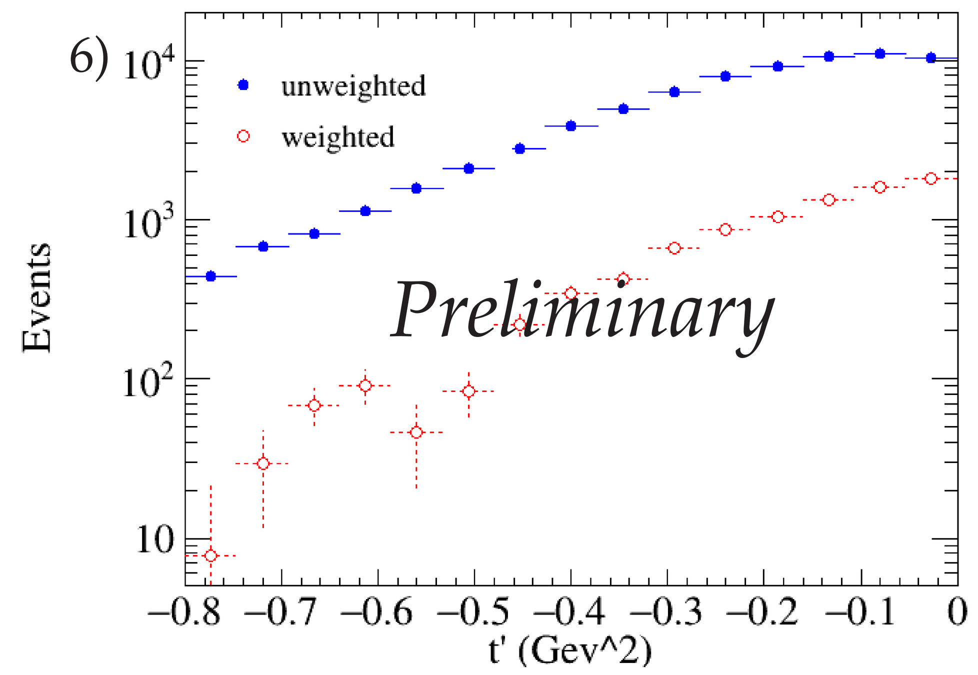


Each region has peculiar features that have to be investigated, but as seen in Fig. 2b a huge background should be removed before moving on to further analysis.

Signal/Backg. Optimization



Using sPlot, a useful tool from Brufit[4], it was possible to extract clean data from the Fig. 2b. The sPlot procedure is shown in Fig. 5, where the proton peak, in black, is clearly extracted from the background, in red. Another example of the cleaning process is shown in Fig.6.



Conclusions and Outlook

Thanks to data analysis, it has been possible to clearly identify the reserched reaction, improving the Signal/Background ratio and selecting π_0 exclusive reaction only. The beam asymmetry calculation are ongoing, focusing on the different intervals selection. Studies on the variation of the cross section with transferred p are also ongoing.

References

[1] Al Ghoul et al. Measurement of the beam asymmetry Σ for π^0 and η photoproduction on the proton at $E_\gamma = 9$ gev. *Phys. Rev. C*, 95:042201, Apr 2017.

[2] V.D. Burkert et al. The clas12 spectrometer at jefferson laboratory. *Nucl. Inst. Meth. A*, 959:163419, 2020.

[3] A. Acker et al. The clas12 forward tagger. *Nucl. Inst. Meth. A*, 959:163475, 2020.

[4] D.Glazier. Brufit: A roofit based event based maximum likelihood fitting package. github.com/dglazier/brufit.