Short Range Correlations In ^{12}C(e,e′pn)

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for the E01 − 015 collaboration

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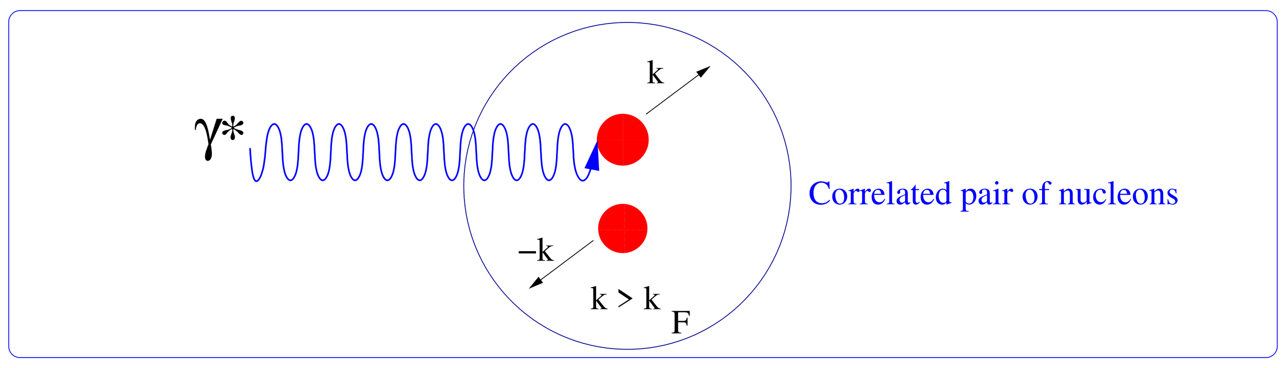
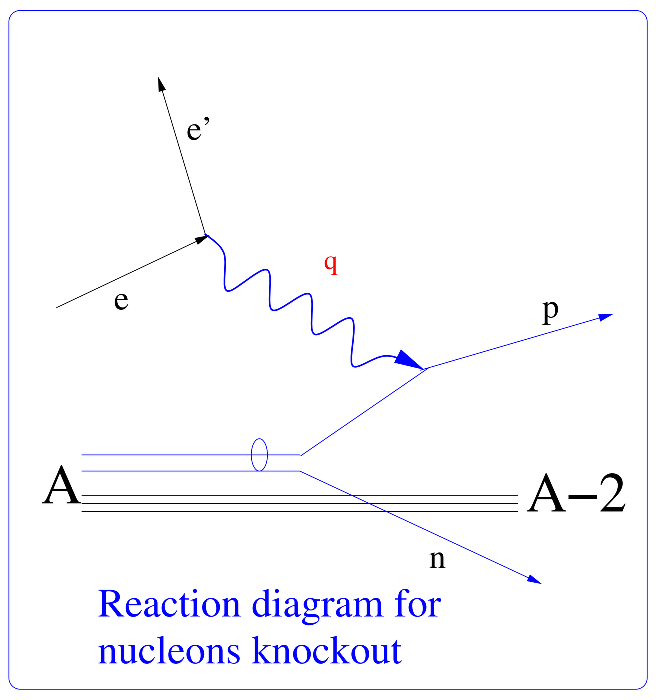
Physics Motivation

The wavefunctions of nucleons overlap significantly when the nucleons are in higher momentum states compared to the fermi momentum. This gives rise to short-range correlations in nuclei. Experiment E01-015 at Jefferson Lab Hall A seeks short-range nucleon-nucleon correlations in ^{12}C through the reaction ^{12}C(e,e′pN). Two high resolution spectrometers (HRS) in the hall are used to see double coincidences via ^{12}C(e,e′p) whereas the triple coincidence (e,e′pn) is observed using the high resolution spectrometers along with a Neutron Detector.

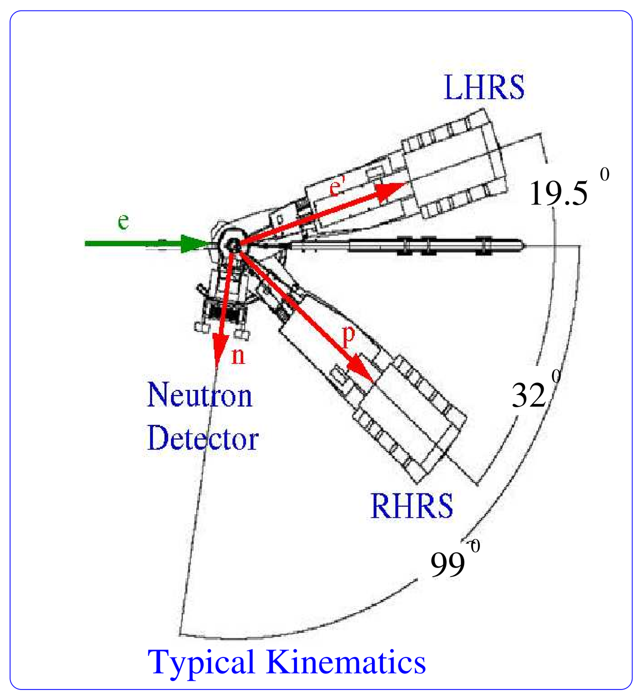
Short range correlations can be obscured by various two-body effects such as meson-exchange currents (MEC), isobar currents (IC) and final-state interactions (FSI) if one fails to select appropriate kinematics. Desirable choices would be high Q^2 which minimizes MEC and Bjorken-$x > 1$ which minimizes IC and FSI [1,2,3]. In this experiment data were taken at $Q^2 \sim 2$ GeV^2/c^2 in almost anti-parallel kinematics with x ∼ 1.2.



Correlated pair of nucleons



Reaction diagram for nucleons knockout

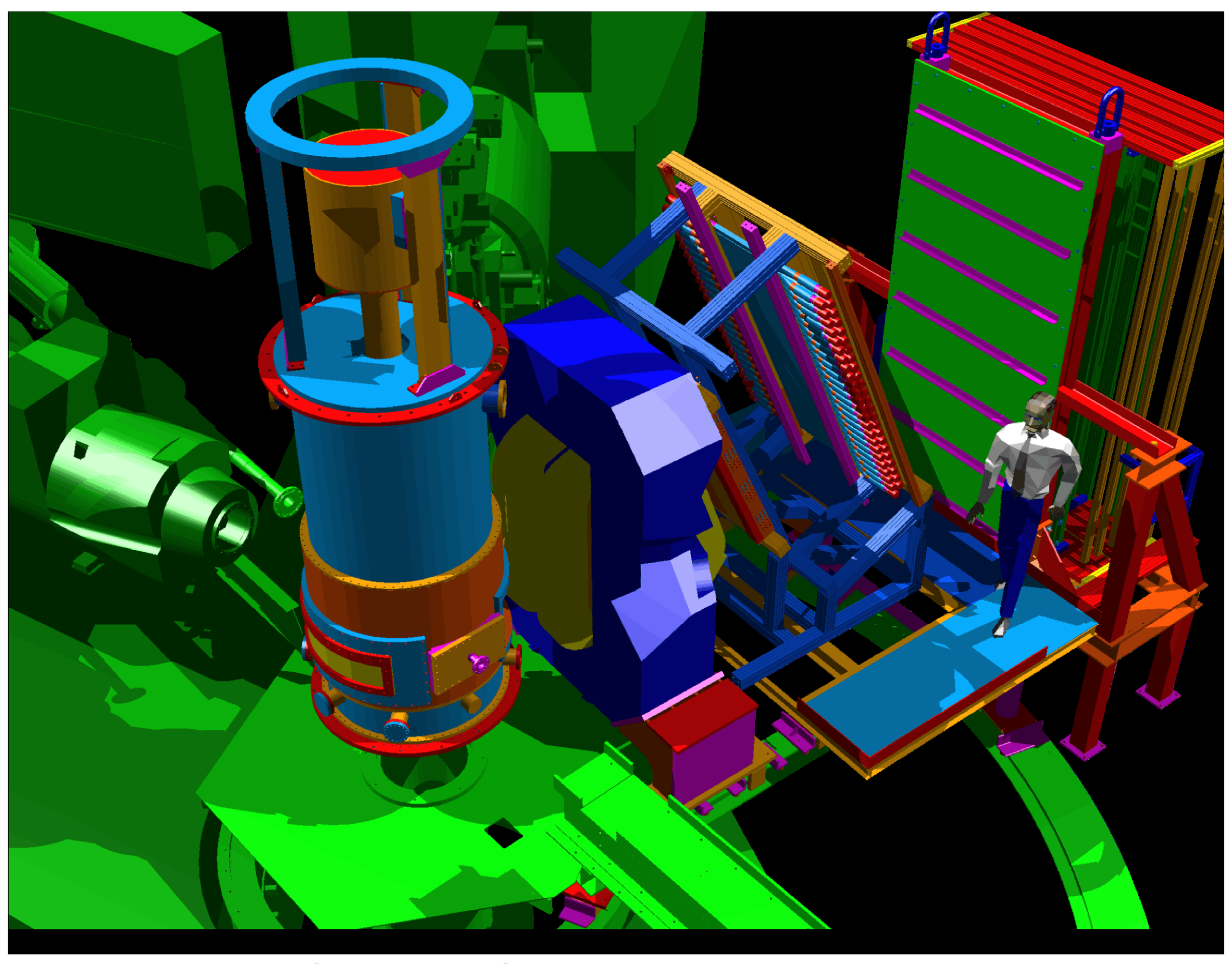


Typical Kinematics

Experiment

The experiment ran January through April of 2005 and used 4.6 GeV electron beam for most of the production runs. The left HRS detected scattered electrons while the right HRS detected ejected protons in coincidence with the electrons.

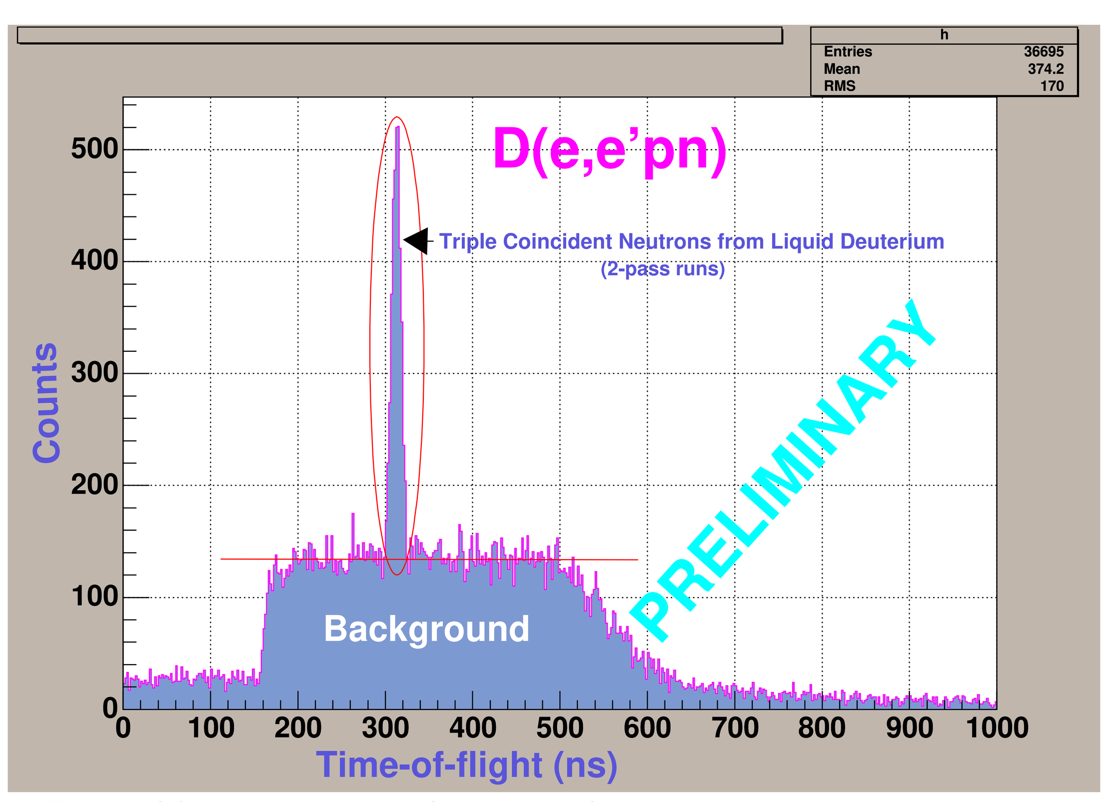
The neutron detector was placed six meters from the target at 99 degrees to the right of the beam line. The active scintillator detection volume for the neutrons was 40 cm x 100 cm x 300 cm. In front of the Neutron Array was a 5 cm thick lead wall which was designed to block low-energy photons as well as most of the charged particles that are produced in the target and are incident on the Neutron Array.



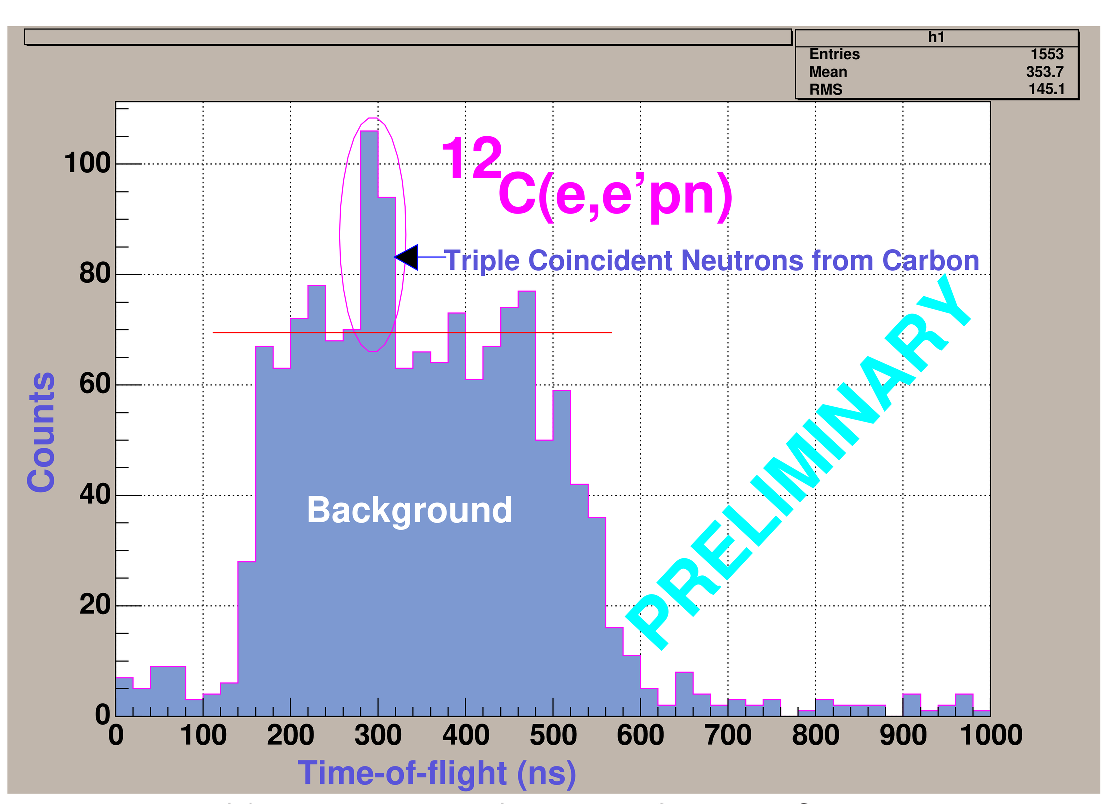
Short Range Correlations Experiment layout

Results

We are in the detector calibration phase of data analysis. The results shown here are preliminary. For calibration purposes we took several runs with a liquid deuterium target. The following spectra show the preliminary triple-coincident neutrons from liquid deuterium and carbon targets.



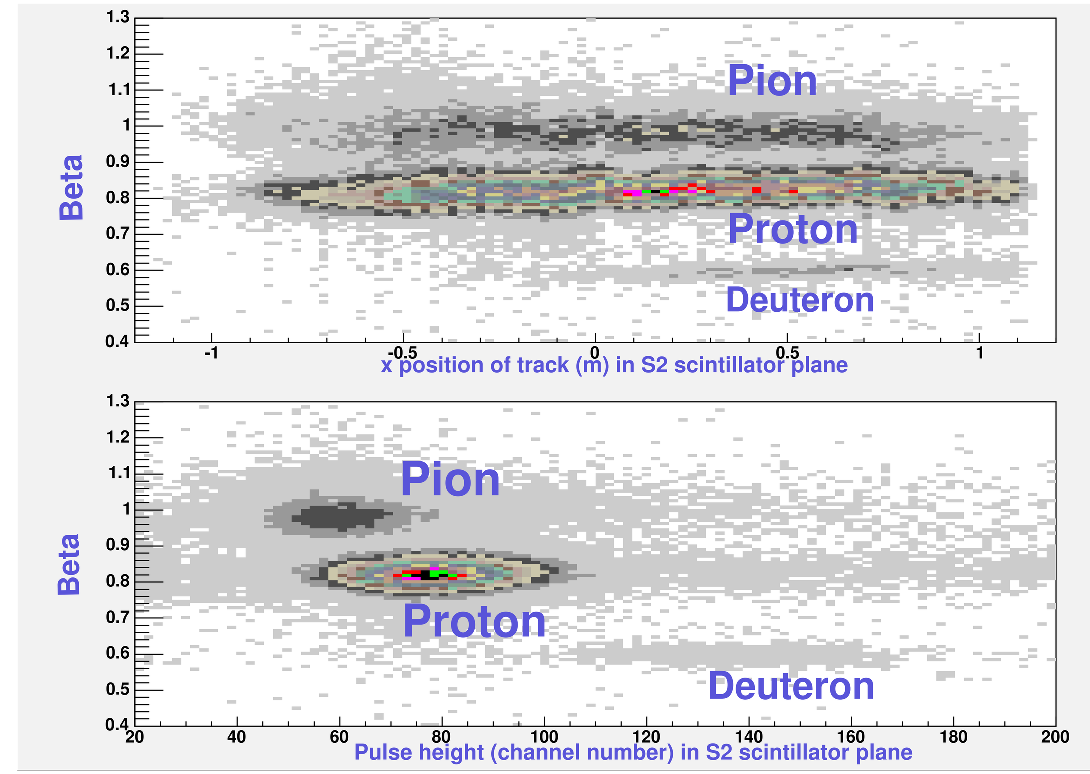
Time-of-flight spectrum of neutrons from the liquid Deuterium target to the Neutron Detector



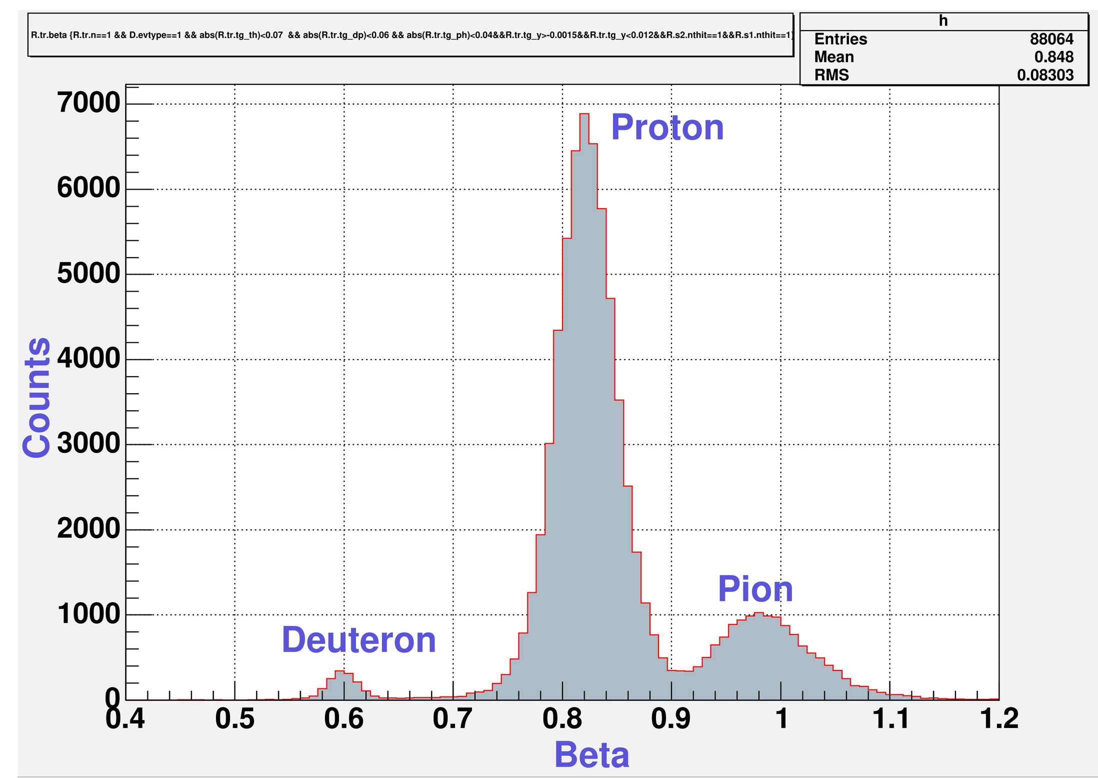
Time-of-flight spectrum of neutrons from the Carbon target to the Neutron Detector

Right HRS Particle Identification

The right HRS was set to positive polarity. Only the scintillator planes S1 and S2 could be used to separate protons from the pion and deuteron background. The S0 scintillator plane was used to calculate the efficiency of the other two planes.



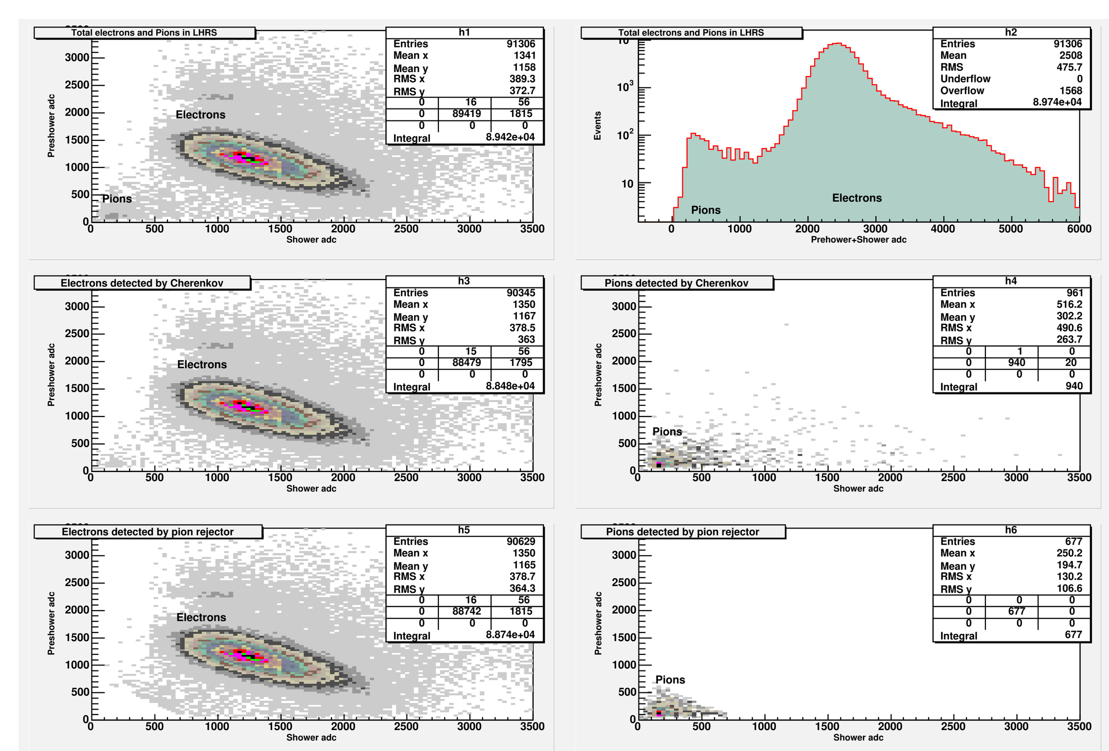
β versus x position of tracks (top) and beta versus pulse height (bottom) in the S2 scintillator plane of the right HRS



β for different particle species detected by the right HRS

Left HRS Particle Identification

The left HRS was run in negative polarity. This arm had a gas Cherenkov detector and a Pion Rejector to identify good electrons.



Electrons and pions detected by the Gas Cherenkov detector (middle row) and the Pion Rejector (bottom row). The top row shows all electrons and pions incident on the left HRS.

Summary

The pairs removed from the carbon nucleus may be neutron-proton or proton-proton pairs in the shells $(1p_{3/2})^2, (1p_{3/2}, 1s_{1/2}), (1s_{1/2})^2$ in shell-model configuration. We showed the signature of preliminary triple-coincident neutrons. The modest number of events in the expected peak on top of a large background shows that there is further work to be done to isolate true triple coincidences from the accidental coincidence background.

References:

[1] W.Bertozzi, E.Piasetsky, J.Watson and S.Wood, Studying the Internal Small-Distance Structure of Nuclei via the Triple Coincidence(e,e'p+N) Measurement, Jefferson Lab Hall A Proposal **E01-015**.

[2] M.Sargsian, Selected Topics in High Energy Semi-Inclusive Electro-Nuclear Reactions,Int.J.Mod.Phys. **E10 (2001) 405-458.**

[3] M.Sargsian, et al. Hadrons in the Nuclear Medium,J. Phys.G: Nucl. Part. Phys.29 **R1-R45.**