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

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for the E01 − 015 collaboration

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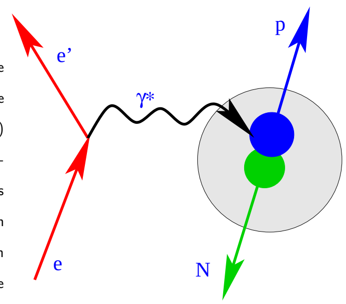
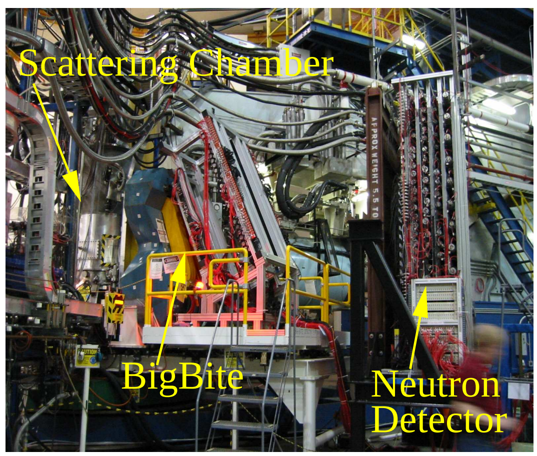
Physics Motivation

Experiment E01-015[1] aims to study the small-distance structure of nuclei, namely the short-range correlations, via the triple coincidence ^{12}C(e,e′pN) measurement. The main signature of short-range correlations is the observation of an (e,e'p) event with a large missing momentum (300 - 600 MeV/c) in coincidence with either a recoiling proton or a recoiling neutron where the recoiling nucleon's momentum is approximately equal to the missing momentum. In this experiment the kinematic setup was such that the square of the four momentum transfer was 2 GeV^2/c^2 and the Bjorken x was 1.2 in an almost anti-parallel kinematics. The choice of such kinematics, with relatively high four-momentum transfer and Bjorken x>1, was to suppress meson-exchange currents, isobar currents and final-state interactions. These two-body effects could otherwise mimic the short range correlations if they were not minimised by some clever choice of kinematics.



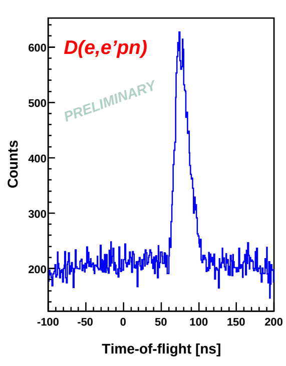
Experiment

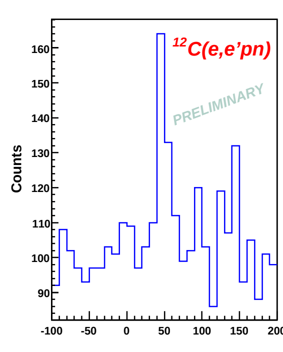
This experiment was a three-arm experiment. It utilized the standard Hall A equipment[2], the two high resolution spectrometers, as two arms and the BigBite spectrometer along with a neutron detector as its third arm. Scattered electrons and protons were detected in coincidence by the high resolution spectrometers while recoiling protons (neutrons) were detected by the BigBite spectrometer (neutron detector). The adjacent figure shows the detector system in the hall.

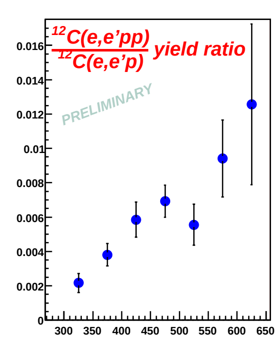


Result

The left figure below shows the time-of-flight of neutrons from liquid deuterium calibration runs while the middle one shows the same from carbon production runs. The right figure shows the yield ratio of triple to double coincidences for protons. The ratio shown has not been corrected for the finite angular acceptance of BigBite.

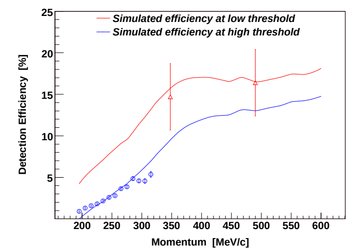




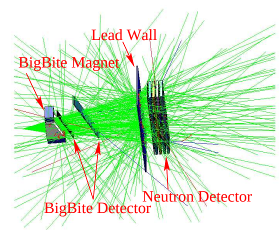


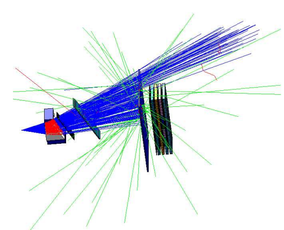
Simulation

The neutron detection efficiency is determined using a stand alone computer simulation code[3], and is about 17% for neutrons with momenta above about 350 MeV/c. The blue trace is a fit to blue data points from a simulation and extrapolated to the whole missing momentum range of the experiment. The red trace is produced by the simulation for half the discriminator threshold used in the case of blue trace. The two red data points are shown as a check of the procedure.



The detector perfermance has also been tested using the Geant4 computer simulation code. The code was instrumental in determining appropriate kinematics while running the experiment. The following figures show the tracks of neutrons or γ-rays (green), protons (blue) and electrons (red). The lead wall blocks nearly all charged particles and allows neutrals to enter into the neutron detector. It is also seen that the neutrons are not affected by the BigBite detector and illuminate the neutron detector very well while the protons are deflected by BigBite magnet.





Summary

Recoiling protons and recoiling neutrons of momenta above about 300 MeV/c in coincidence with the (e,e'p) events have been observed. This is an indication of two-nucleon short-range correlations, namely pp correlations and pn correlations in the ^{12}C nuecleus. We plan to give the final form of yield ratio of $^{12}C(e,e'pp)/^{12}C(e,e'p)$ and two other yield ratios (not shown in this poster) $^{12}C(e,e'pn)/^{12}C(e,e'p)$ and $^{12}C(e,e'pn)/^{12}C(e,e'pp)$. Analysis is ongoing.

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'pN) Measurement, Jefferson Lab Hall A Proposal **E01-015.**

[2] J.Alcorn et al., Nucl. Instr. Meth. **A522**, 294 (2004).

[3] R. A. Cecil et al., Nucl. Instr. Meth. **161**, 439 (1979).