E99-015: Inclusive Scattering from Nuclei at $x > 1$ and High Q^2 with a 6 GeV Beam

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This proposal was originally submitted as an extension to E89-008 which was one of the commissioning experiments for Hall C. This was a measurement of inclusive electron–nucleus cross sections (H, D, C, Fe, and Au) in a four-momentum transfer (Q^2) range between 0.8 and 7.3 (GeV/c)^2 and Bjorken $x > 1$. Additional measurements with a 6 GeV beam will allow study of the scaling behavior at large Q^2 and provide important constraints on the components of the nuclear wave function at large momentum and removal energy. For the resubmission of the proposal as part of the Jefferson Lab jeopardy review, measurements on a ^{3}He target were added. Measurements with few-body nuclei and a range of heavy nuclei allow contact with theoretical calculations via essentially "exact" calculations for few-body systems and extrapolation of the heavier systems to potentially calculable nuclear matter.

The cross section measurements from E89-008 were first converted to a scaling function [F(y)] and studied as a function of y and of Q^2. The data show an approach to scaling up to $y = -0.5$(GeV/c). These data can be used to constrain calculations of the nucleon momentum distribution in the nucleus at very large values of the nucleon momenta. The same cross sections were then used to extract the nuclear structure function, $\nu W_2/A$, and scaling in both Bjorken x and Nachtmann ξ were studied. Also the Q^2 dependence of the structure function for fixed bins of x and ξ has been studied. No x scaling is seen at these high Q^2 values indicating the dominance of the quasi-elastic scattering component. However clear ξ scaling is seen in the transition region from the quasi-elastic to the deep-inelastic scattering at higher Q^2.

An increase in beam energy to 6 GeV would have the greatest impact on the Q^2 range for kinematic points with $x < 1.6$. For example, at $x = 1.4$ the Q^2 range would increase from 6.5 to 11.0 (GeV/c)^2. This extended Q^2 data is critical to studies of the transition from scattering from nucleons to scattering from quarks. This corresponds to a significant increase in the Q^2 range accessible for large negative values of y allowing direct study of the approach to the scaling limit.