## 0.1 Inclusive scattering at $x > 1$.

### 0.1.1 Introduction

Inclusive scattering from nuclei at $x > 1$ has provided a great deal of information about the high momentum components of the nuclear wave function. These high momentum components are sensative to short range correlations (SRCs) in the nucleus. These correlated nucleons are an important part of nuclear structure, and represent local high-density nuclear configurations. Inclusive scattering provided one of the first experimental signatures of short range correlations in nuclei [1]. Subsequantly, short range correlations in nuclei have been probed in a variety of reactions: A(p,2p), A(e,e'p), A(e,e'NN).

Completed and planned measurements at Jefferson Lab up to 6 GeV [2] will map out the strength of two-nucleon short range correlations in nuclei. These measurements will also provide a first look at high-$Q^2$ cross sections for $2.5 \lesssim x < 3$, where the cross section is most sensative to the presence of multi-nucleon correlations. Higher beam energies will dramatically increase both the $x$ and $Q^2$ range of the data, each of which provides unique information on short range correlations.

### 0.1.2 New Physics with a 12 GeV Beam

An increase in beam energy will allow us to extend these measurements of the cross section to higher $x$ values while maintaining a fairly large momentum transfer ($Q^2 \approx$ 5GeV/c$^2$). This will increase our ability to probe the distributions of the highest momentum nucleons which will dramatically increase our sensativity to multi-nucleon correlations. Figure 1 shows the structure function for Iron at the top of the QE peak ($x = 1$), as well as in the tail of the nucleon momentum distribution ($x = 1.5$). The present data is consistent with two-nucleon SRCs being the dominant source of high momentum nucleons, and shows no indication of significant multi-nucleon correlations. At 11 GeV, the $Q^2$ coverage at $x = 1.5$ is significantly increased. This data, as well as similar data at even higher values of $x$ will provide much greater sensitivity to multi-nucleon correlations (or other, more exotic configurations?, 6q bags?). Such inclusive measurement may be the best way to identify the presence of multi-nucleon correlations, which can then be studied in detail using more exclusive reactions.

In addition to improving the sensativity to multi-nucleon correlations, higher energies will also provide a new way to study two-nucleon correlations, by allowing us for the first time to probe the *quark* structure of two-nucleon correlations. A measurement in the DIS scaling regime at $x > 1$ would allow us to measure for the first time the distributions of superfast quarks in nuclei, where the struck quark carries more momentum than an entire nucleon. These quark distributions are intrinsically related to the quark structure of the two-nucleon correlations which should dominate for $1 \leq x \leq 1.3$.

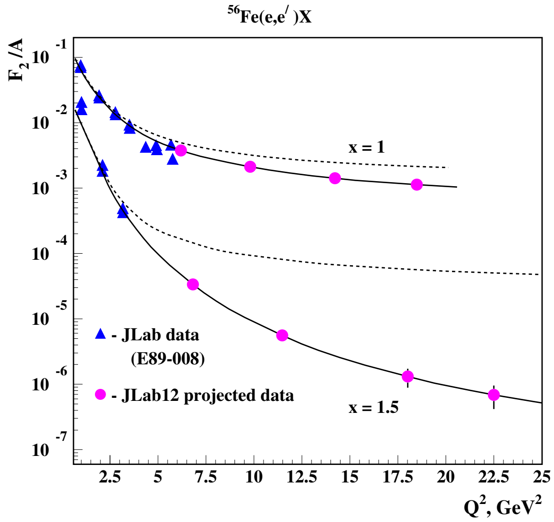


Figure 1: Structure function (per nucleon) for iron from e89008. The curves are (mean field/2N/multi-nucleon). [DO WE WANT/CAN WE GET A FIGURE WITH DIFFERENT (SMALLER) MODEL FOR MULTI-NUCLEON CORRELATIONS AND/OR CALCULATION THAT INCLUDES LARGER VALUES OF X?]

[MAYBE START BY DISCUSSING QUARK DISTRIBUTIONS IN DEUTERON AT $X > 1$, AND CONNECTION TO QUARK DISTRIBUTIONS IN REGION WHERE NUCLEONS ARE CLOSE TOGETHER. GO ON TO RATIO OF A/D IN DIS REGION $1 < X < 1.3$, AND SIMILARITY TO RATIO OF A/D IN QE REGION, $1.5 < X < 2$].

### 0.1.3 Hardware Requirements

The physics program described above involves extending current inclusive scattering measurements to the highest possible values of $Q^2$ for $x \gtrsim 1$, as well the highest $x$ possible for moderate $Q^2$ values ($\approx$ 5 GeV/c$^2$). To extend the $Q^2$ range, we need a high momentum spectrometer (6 GeV/c or more) covering a wide angular range (roughly $20^\circ < \theta < 60^\circ$). To extend the $x$ range, we need to detect extremely high momentum electrons (up to 10-11 GeV/c), with coverage of forward angles ($\theta < 30^\circ$). In both cases, the measurements will require a high luminosity, good pion rejection, and a moderate ($\sim 10^{-3}$) momentum resolution. The highest $Q^2$ data could be taken using the existing HMS spectrometer in Hall C. The data at highest $x$ could be taken in the planned SHMS spectrometer.

[ANYTHING ABOUT NON-INCLUSIVE SCATTERING? A(E,E'P) AT HIGH $P_M$ AND HIGH $Q^2$, WHERE RESULTS ARE EASIER TO INTERPRET? IN ANY CASE, WE SHOULD CONNECT ALL OF THIS TO ANYTHING ELSE IN THE 12 GEV

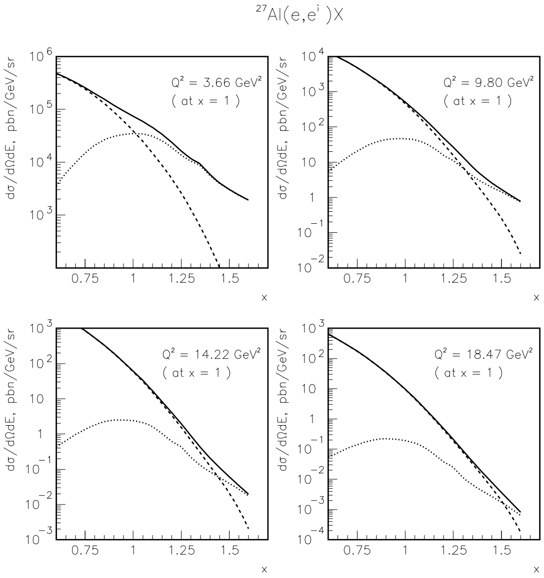


Figure 2: Calculation of the quasielastic (dotted line), inelastic (dashed), and total (solid) cross section for inclusive scattering. REF?

DOCUMENT ABOUT SRC STUDIES (COINCIDENCE AND 2N-KNOCKOUT REACTIONS) AND PROBES OF HIGH-DENSITY CLUSTERS (tagged structure functions/EMC effect measurements).]

# References


[1] Donal Day, Nucl. Phys. **A478**, 397 (1988) ; L. L. Frankfurt, M. I. Strikman, D. B. Day, and M. Sargsyan, Phys. Rev. C **48**, 2451 (1993).

[2] J. Arrington *et al.*, Phys. Rev. Lett. **82**, 2056 (1999) ; Jefferson Lab experiment E02-019: J. Arrington, D. B. Day, B. W. Filippone, A. Lung spokespersons.