Inclusive Scattering from Nuclei at $x > 1$ in the quasielastic and deeply inelastic regimes.

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Inclusive scattering from nuclei at $x > 1$ is sensitive to the distribution of high momentum nucleons at low Q^2 values, and high momentum quarks at large Q^2 values. Large x data at 4 and 6 GeV are dominated by quasielastic and resonance production from high-momentum nucleons. With the 11 GeV beam, we propose to make measurements in the DIS region and provide clean measurements of the quark distributions in light and heavy nuclei for $x > 1$. The distribution of these super-fast quarks is connected to the short distance structure of nuclei, and this is a natural region to examine in looking for the importance of the underlying quark degrees of freedom in nuclear structure.

In addition, data in the quasielastic region at very large x values, up to $x = 3$, will extend previous studies of short range correlations in few-body and heavy nuclei. While focussed on mapping out the distributions of super-fast quarks and high momentum nucleons, these data also provide the large x data necessary to extract the QCD moments in nuclei at moderate to large Q^2 values.

Ratios of the structure functions at very large x are are sensitive to both the distribution of high momentum nucleons and possible medium modification. The previous 4 and 6 GeV measurements and the extremely high x QE measurements included here will constrain the high momentum nucleons and allow a study of the quark distributions in the kinematic region dominated by scattering from SRCs, which is expected to be very sensitive to modification to the nucleon structure. Note that both absolute quark distributions and EMC-style ratios for $x \gtrsim 1$ will be useful in understanding the EMC effect.

I. INTRODUCTION

Previous measurements for a range of targets have have been made at SLAC[1] and at 4 and 6 GeV at JLAB [2]. These data have been important sources of information on y-scaling and its dependence on momentum transfer and have allowed test of various theoretical models of inclusive scattering.

This proposal requests time to make inclusive electron scattering measurements with both few-body nuclei and heavy nuclei at high momentum transfers. Measurements at large x are sensitive to high momentum nucleons in the nucleus (momenta in excess of 1000 MeV/c for the kinematics of this proposal), and provide clean information on the high momentum components of the spectral function. The measurements with few-body nuclei allow comparisons with essentially exact calculations of nuclear wave functions and provide an important complement to the coincidence $A(e, e'p)$ and $A(e, e'NN)$ measurements already completed or approved. The measurements with heavy nuclei should allow extrapolation to nuclear matter where again rigorous calculations can be performed and compared to the data. In addition to using the data to directly constrain the spectral function at very high momenta, we will use the nuclear dependence of the cross section to study the nature of the short–range correlations that are the main source of the high momentum nucleons. By comparing the distribution of high momentum nucleons in heavy nuclei to those measured in ^{2}H we can look for signatures of NN short range correlations in a model independent way. The inclusion of ^{3}He and ^{4}He measurements will also allow us to look for contributions from multi–nucleon short range correlations.

In addition to studying nucleon distributions and short range correlations in nuclei, this data will allow us to extract the nuclear structure functions at large x values. This will allow us to extend measurements of duality and scaling in nuclei, which are related to the connection between the quark and hadronic pictures of nuclear structure. This experiment will also provide the data necessary to make precision measurements of the QCD moments in nuclei.

A. Connection to Deep Inelastic Scattering (DIS)

The response of the nucleus in the range $x > 1$ is expected to be composed of both deep-inelastic scattering from quarks in the nucleus and elastic scattering from the bound nucleons (quasielastic scattering). For both the bound quark and bound nucleon cases it is the non-zero momentum of the bound nucleons that permits scattering into a kinematic region that is forbidden for the free nucleon. The scattering from quarks should exhibit scaling in the Bjorken x variable (experimentally verified for $x < 1$), while the scattering from the nucleons exhibits y scaling [3]. However the respective scaling functions for the two processes appear to be dramatically different. It is the inclusive structure functions (*e.g.* νW_2^A) that scale for the quark case while it is the cross section weighted by the elastic form factors [$G_E(Q^2)$ and $G_M(Q^2)$] that exhibits scaling for the nucleon case. In a simple impulse approximation (Quark-Parton model for quark scattering, quasielastic (QE) nucleon scattering for the nucleon scattering) the DIS scaling functions are related to the *quark* momentum distributions in the nucleus, while the quasielastic scaling function is related to the *nucleon* momentum distributions. It is the weighting by the elastic form factors, which fall with a high power of Q^2, that causes the quasielastic response to vanish in the limit of $Q^2 \to \infty$. In this limit the deep inelastic scattering from quarks should dominate the response even for $x > 1$. At finite and increasing Q^2 experimental data shows that the quasi-elastic contribution to the cross section decreases substantially and the deep inelastic contribution begins to build in the $x > 1$ region. However, the remaining quasi-elastic contribution in the Q^2 range of the previous experiments (at 4 and 6 GeV) is still large enough to badly break scaling at $x > 1$.

The two types of scaling appear to be significantly different. A possible connection between the two has been suggested in several analyses of the previous data [1, 2, 4]. Here the nuclear structure function is taken versus the Nachtmann scaling variable ξ, and an interesting scaling (for all ξ) is suggested by the data [5] (Fig. 1). ξ is a modified version of the deep inelastic scaling variable ($\xi \to x$ as $Q^2 \to \infty$) that takes into account target mass effects and thus reduces scaling violations at finite Q^2 values. The Q^2 range of the previous data is too limited to draw firm conclusions about the nature of this scaling. One theoretical analysis [6] suggested that the observed scaling is accidental and would break down at larger Q^2. (See also [7].) Other work [8] explains ξ-scaling as an approximation to scaling in ξ_{QE}, which is analogous to ξ but describes scattering from quasifree nucleons in the nucleus. For both of these explanations, the scaling in ξ is described as an approximation to scaling for quasielastic scattering, where scaling violations coming from the transformation from $y(\xi_{QE})$ to ξ are either small or cancelled by other contributions. However, in the kinematics covered by the previous JLab experiments, the scaling violations that come from the change of scaling variables are much larger than the observed scaling violations [5] and it remains unclear why there is scaling observed in this "improved" Bjorken variable, the Nachtman ξ.

The connection between the inelastic and quasielastic regions may be a consequence of duality, as observed first by Bloom and Gilman [9], and studied more precisely in recent Jefferson Lab experiments [10]. In the proton, it was observed that the resonance region structure function, *averaged over the resonances*, is identical to the DIS structure function. In the nucleus, the Fermi motion of the nucleons performs this averaging and duality yields true scaling, rather than scaling on average, in regions where the intrinsic averaging is sufficient. While this explains the scaling in the resonance region, it is not clear why the scaling works so well for $\xi > 1$, where at moderate Q^2 we are sensitive only to the quasielastic contributions, and where we average only part of the quasielastic strength.

In addition to providing information about the scaling behavior at $x > 1$, these measurements will provide the necessary data to perform precise moment analyses of nuclei. Current moment analyses are limited at moderate to high Q^2 values by the knowledge of the structure function at $x > 1$, especially for the higher moments. Combining this data with lower x measurements from duality studies of hydrogen and deuterium [11–13] and other planned measurements of light nuclei [14] will allow a more precise determination of the first several moments of the nuclear structure function. A comparison of the moments of deuterium and hydrogen may allow a determination of the moments for the neutron without some of the theoretical ambiguities that arise when attempting to directly extract the neutron structure function from data on nuclei.

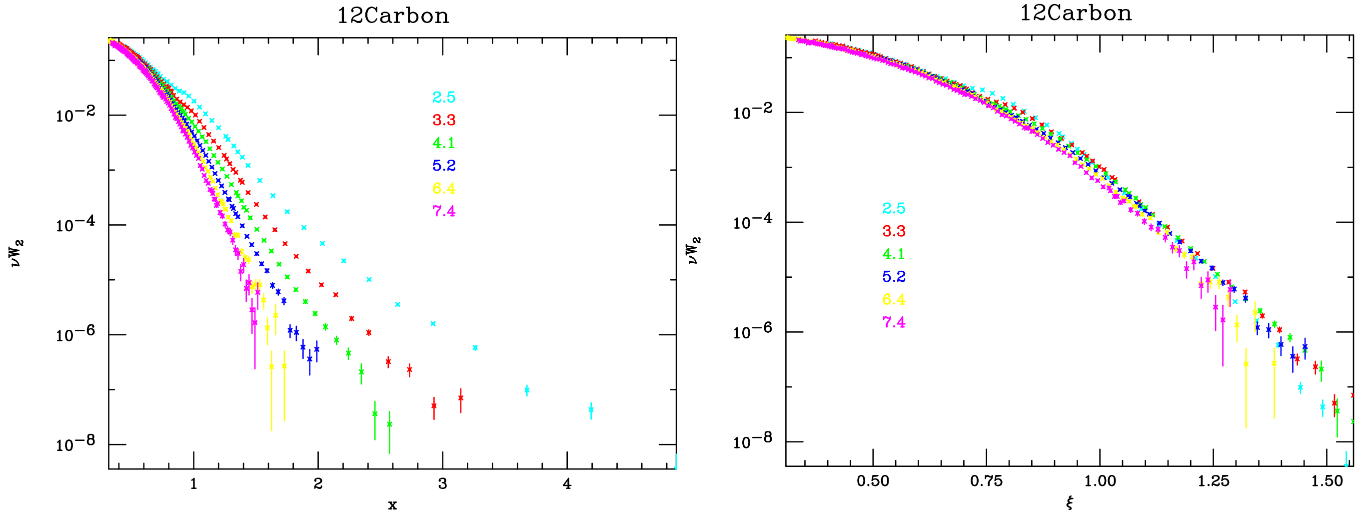

FIG. 1: Structure function per nucleon for ^{12}C vs. the Bjorken scaling variable x (left) and the Nachtmann scaling variable ξ from Jefferson Lab E02-019. The Q^2 values are given for Bjorken $x = 1$. Data is preliminary and errors shown are statistical only.

Exploring the transition from Quasielastic scattering to the DIS region requires measurements at the highest possible Q^2. Measurements with a 11 GeV beam will significantly extend the accessible Q^2 range compared to what is possible with a 6 GeV beam. Comparisons of deuterium and heavy nuclei at $x > 1$ for high Q^2 allows one to study scattering from high momentum partons, as well as allowing searches for modifications of quark distributions due to the nuclear medium in a new kinematic regime.

B. High Momentum Components in the Nucleus

High energy electron scattering from nuclei can provide important information on the wave function of nucleons in the nucleus. With simple assumptions about the reaction mechanism, scaling functions can be deduced that should scale(*i.e.* become independent of length scale or momentum transfer) and which are directly related to the momentum distribution of nucleons in a nucleus. Several theoretical studies [3, 6, 15, 16] have indicated that such measurements may provide direct access to short range nucleon-nucleon correlations.

The simple impulse approximation picture breaks down when the final-state interactions (FSI) of the struck nucleon with the rest of the nucleus are included. Previous calculations [17–25] suggest that the contributions from final state interactions should vanish at sufficiently high Q^2. The data show a clear approach to a scaling limit for both deuterium and heavy nuclei at large $-y$ for $Q^2 > 3$ GeV/c^2. For the deuteron, which is dominated by the assumed two-body breakup, we can extract the nucleon momentum distribution from the deuteron. The momentum distribution for the deuteron as extracted from experiment E89-008 is shown in Fig. 2 [26]. The normalization of the extracted momentum distribution is consistent with unity, and the high momentum components are in good agreement with calculations based on modern two-body nucleon–nucleon potentials. This sets limits on the impact of FSI, even in the region dominated by short range correlations.

While the observation of a scaling limit is suggestive of an approach to the impulse approximation limit, it is not definitive. Even if scaling is observed, that does not insure that the scaling function is directly connected to the momentum distribution In addition, several calculations [15, 27] have pointed out that while the FSI of a struck nucleon with the mean field of the rest of the nucleus is a rapidly decreasing function of Q^2, the FSI of the struck nucleon with a correlated, high-momentum nucleon may show a very weak Q^2-dependence. There is Benhar's PRL 83 3130 (1999) that states that the FSI (when including inelastic channels) has a very weak q-dependence and will persist, challenging our interpretation of F(y) Experimental measurements at higher Q^2 are essential in allowing an understanding of the role of FSI in inclusive scattering. As both the large $|y|$ cross section and the high Q^2 FSI discussed above are dominated by short range nucleon-nucleon interactions, improved data at higher Q^2 may allow direct access to this interesting many-body phenomenon. The"holy grail" of these studies is to correct or eliminate FSI so that by using the impulse approximation, the nuclear spectral function $S(p, E)$ at high values of p and E can

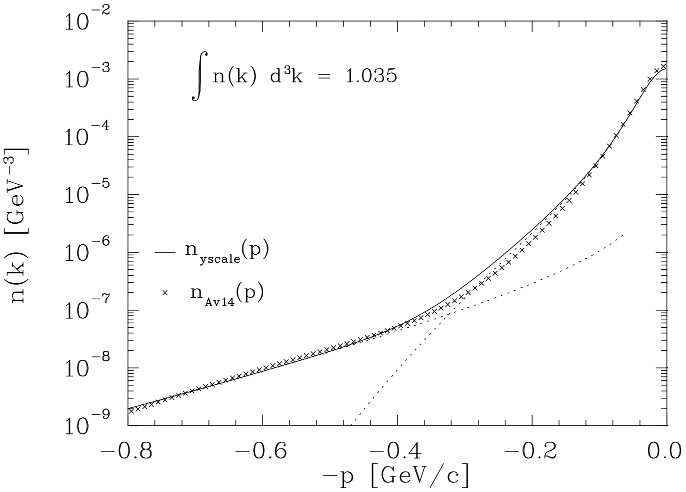

FIG. 2: The momentum distribution, n(p), for the deuteron from a fit to the E89-008 data at 4 GeV (solid line), and from a calculation using the Argonne v14 potential (crosses)

be extracted. The region of high p includes the highly interesting regime of short range correlations (SRCs) that are expected to be present within nuclei.

C. DIS scattering, Structure Function Measurements

As was shown in Fig. 1, the structure function measured in E02-019 shows scaling in the Nachtmann variable ξ. This scaling occurs even at large values of ξ, where the scattering is dominated by resonance or even quasielastic scattering. This can be understood in terms of local duality,which leads to scaling *on average* of the proton structure function, and which leads directly to scaling for the nuclear structure function (the necessary averaging coming from the Fermi motion of the nucleons). This can also be viewed in terms of a near complete cancellation of the large higher twist contributions in the resonance region. In retrospect, it is not surprising that the nuclear structure function shows ξ-scaling in the resonance region, given the quantitative success of local duality in the proton structure function. This duality is seen if one averages over the entire resonance region or even if one averages in the region of a single resonance. However, the duality breaks down if one looks only at a fixed W^2value (*i.e.* the top or side of a prominent resonance). Thus, the scaling in nuclei should break down where the Fermi motion is insufficient to average the proton structure function over a sufficient region. This occurs in deuterium (Fig. 3), where there is still a clear peak corresponding to the Δ resonance at low Q^2, as well as for the quasielastic peak in both deuterium and, to a lesser extent, carbon (Fig. 1). However, these scaling violations are not seen for $\xi > 1$, even though we are averaging over only the low energy loss side of the quasielastic peak, and one would expect the averaging to be insufficient to invoke duality to explain the scaling. Additional data at high ξ and high Q^2 (especially for light nuclei, which provide less averaging) will allow a more careful examination of scaling in this region.

This extended scaling for nuclei also means that the nuclear structure function as measured in the DIS region is the same as the structure measured at lower values of W^2. This scaling may allow measurements of the quark distributions in nuclei at lower W^2 (or equivalently lower Q^2 for fixed ξ) than accessible if one requires $W^2 > 4$ GeV^2. This may allow us to examine the ξ-dependence of the structure function for large values of ξ. This was measured at extremely high Q^2 values (~ 100 GeV^2) in μ−C scattering [28] and ν-Fe scattering [29]. Near $\xi = 1$, these experiments obtained significantly different results. The neutrino experiment (CCFR) found $F_2^{Fe} \propto \exp(-8.3\xi)$, consistent with the presence of significant SRCs, and the existence of superfast quarks in the nucleus (quarks carrying a momentum greater than that of a nucleon). The muon experiment (BCDMS) found a much faster falloff $F_2^C \propto \exp(-16.5\xi)$, which does not indicate large SRC contributions. This dependence was measured for C, Fe, and Au targets by E89-008, and for all targets the dependence was in general agreement with the BCDMS measurement ($F_2^A \propto \exp(-s\xi)$) with $s \simeq 16$. However, there are non-negligible contributions from the quasielastic peak in the vicinity of $\xi = 1$, and there is still some Q^2 variation to the structure function fall off at the largest Q^2 values from E89-008. With this experiment, we can reach Q^2 values of 20 GeV^2 and higher for $\xi \geq 1$, where quasielastic scattering is only a small contribution to the total cross section. The QE contribution will be much smaller than in the previous experiment, so we expect that the scaling violations seen in the previous data will be significantly smaller for 11 GeV running and

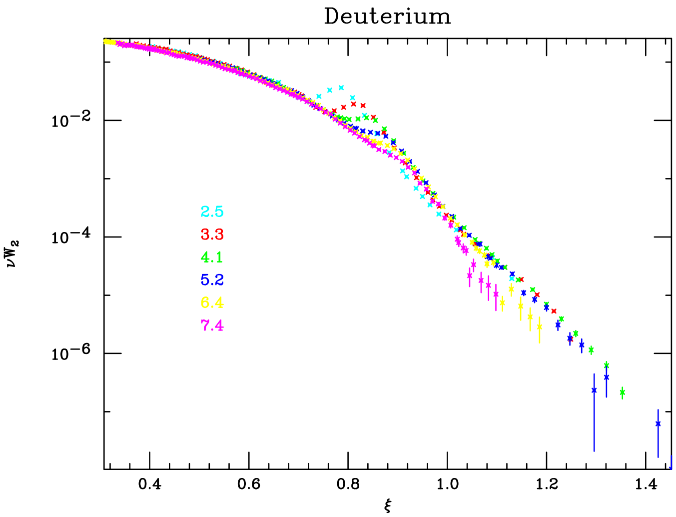

FIG. 3: Structure function per nucleon for deuterium vs. the Nachtmann scaling variable from Jefferson Lab E02-019. The Q^2 values are given for Bjorken $x = 1$. Data is preliminary and errors shown are statistical only.

that the extracted ξ-dependence to become independent (or at least nearly independent) of Q^2.

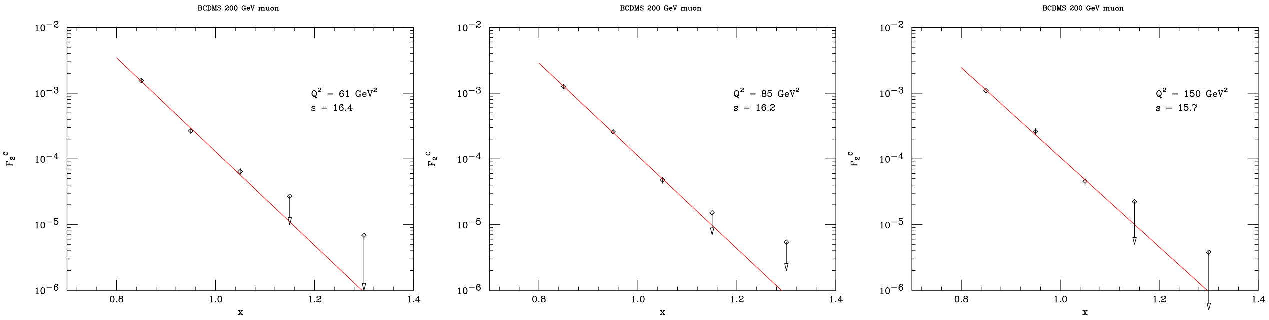

FIG. 4: BCDMS 200 GeV muon data from C. An exponential fit of $F_2^A \propto \exp(-sx))$ agrees with the JLAB 89-008 data with an exponent $s \simeq 16$ when fit in ξ

The question of the nature of the short range correlations can by directly examining the structure functions. Fig. 5 shows a calculation of the structure function per nucleon for iron, including just two nucleon correlations (solid line - from [30]), and including multinucleon correlations (dotted line - from [16]). The current data clearly indicate that the effect of multinucleon correlations is significantly smaller than estimated in the calculation. The calculation for the two nucleon SRC contributions does not include corrections for the EMC effect, but such a calculation should be available very soon [31]. The inclusion of the EMC effect will lower the calculations somewhat, making it difficult to use this data to set a strong upper limit on multinucleon components. An extension to 11 GeV will allow us to reach $Q^2 \sim 15$ GeV^2 at $x = 1.5$, where the calculation predicts very large contribution from multinucleon correlations. In addition, with data on ^{2}H, ^{3}He, and ^{4}He, it should be possible to disentangle the EMC effect from 3N correlations [31, 32]. This will allow us to either obtain a clear signal of multinucleon correlations, or set significant limits on their contributions. We can also directly compare the structure function for heavy nuclei to few body nuclei in the region where the structure function is dominated by SRCs. By comparing heavy nuclei to deuterium, we can look for deviations from the two nucleon SRCs, and by comparing to ^{3}He where the two nucleon correlations are small for $x > 2$, we can look for signatures of three nucleon correlations. This type of comparison is more direct than comparisons of the extracted momentum distribution from a scaling analysis. In addition, if there are significant final state interactions between correlated nucleons at large Q^2 values, these should cancel to first order in these ratios.

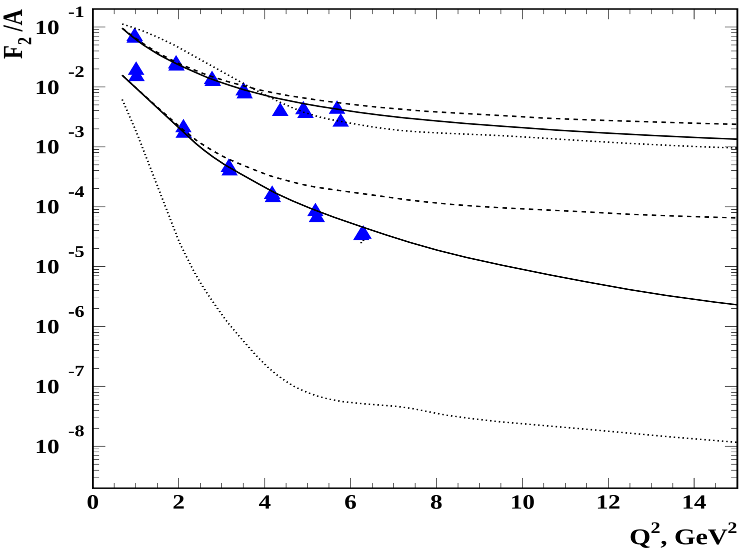

FIG. 5: Structure function for nucleon for iron from E89-008 compared to calculations without correlations (dotted lines), including two nucleon SRCs (solid lines) and multinucleon SRCs (dashed line). The upper set of data and calculations is for $x = 1$, while the lower are for $x = 1.5$.

II. DETAILS OF THE 11 GEV PROPOSED MEASUREMENTS

A. Backgrounds and Systematic Errors

We have learned a great deal from the 4 and 6 GeV running about how to improve the measurement, particularly in determining backgrounds. One source of background is the pion contamination of the electron distribution. During E89-008 this contamination was always less than 1% in the HMS when using the calorimeter and Čerenkov information for particle identification. It is estimated that during 6 GeV running this pion contamination will get somewhat worse, but is still expected to be negligible. The front two layers of the HMS calorimeter have been outfitted with phototubes on both ends of each lead glass block since the 4 GeV running was completed. This will improve our ability to distinguish electrons from pions, as will the fact that the π/e separation in the calorimeter will be better for the larger scattered electron energies of the 6 GeV kinematics.

There is also a background from secondary electrons produced in the target which was larger than expected for E89-008. The main source likely comes from electro-production and photo-production of neutral pions. These pions then decay into photons which can produce position-electron pairs. This background is charge-symmetric, and can be measured directly by changing the spectrometer to positive polarity and detecting the produced positrons. For the largest angles measured in E89-008 (55° and 74°), this background was significant and required a fit to our positron measurements and subtraction from our electron data (see Ref. [33] for more details). As a result, we will limit our running with 6 GeV beam to60°, and have included time in our beamtime request to measure this background.

The combined systematic uncertainties from the E89-008 run totaled 3.2.2 to 4.7% for the HMS data with the primary contributors being knowledge of the acceptance, radiative corrections, target thickness,and bin centering (correcting an integral number of counts within a momentum/angle bin to the measured cross section at the center of the bin). Each of these four items ranged from approximately 1% to 2%depending on the scattering angle. Table 1 below from Ref. [33]summarizes the systematic uncertainties during the 4 GeV running.We expect similar results for the 6 GeV running.

There is an additional uncertainty in the extraction of F_2 from the cross section due to the uncertainty in $R = \sigma_L/\sigma_T$. This was generally negligible, except at the largest x and Q^2 values measured.We will take a small amount of data with ~ 4 GeV beam, both as a cross calibration with the previous measurement and also to provide a rough determination of R. In the E89-008 analysis, a value of $R = 0.32/Q^2$ was assumed, with a 100% uncertainty in this value. At the

TABLE I: Systematic uncertainties in the extraction of the cross section for 4 GeV running. Entries with an asterisk indicate that a correction was made directly to the cross section which had the listed uncertainty. Entries without an asterisk indicate no correction to the cross section, just a contribution to the overall uncertainty.

Systematic	HMS
Acceptance Correction	1.0-2.2%*
Radiative Correction	2.5%*
Target Track Cuts	0.5%
Bin Centering Correction	1.0-2.2%*
PID Efficiency	0.5%*
Charge Measurement	1.0%
Target Thickness	0.5-2.0%
Target/Beam Position Offset	0.25%
Tracking Efficiency	0.5%*
Trigger Efficiency	0.05%*
Normalization	0.0%
COMBINED UNCERTAINTY	3.2-4.7%

highest Q^2 possible with 6 GeV measurements, it is not clear if this uncertainty is large enough. We expect to be able to measure R at relatively high values of Q^2 (where$R$ is quite small) with uncertainties of $50-100\%$, which will be sufficient to keep this from being a dominant source of uncertainty in the extracted structure functions.

B. Proposed Kinematics with 11 GeV Beam

Fig. 6 shows the kinematic range in x and Q^2. The region below the dashed (solid) curve is what is accessible with 4 (6) GeV beam at JLab ($\theta \leq 60^\circ$ in both cases). Experiments E89-008 and E01-029 did not cover the full Q^2 range for very large x values, so the existing data for $x > 2.2$ is limited to $Q^2 \lesssim 5$ GeV^2. Previous SLAC measurements of inclusive electron scattering from nuclei [1] were limited to $x \leq 3$ and $Q^2 \leq 3$ (GeV/c)^2. As with E02-019 we have included ^{3}He and^{4}He cryogenic targets.

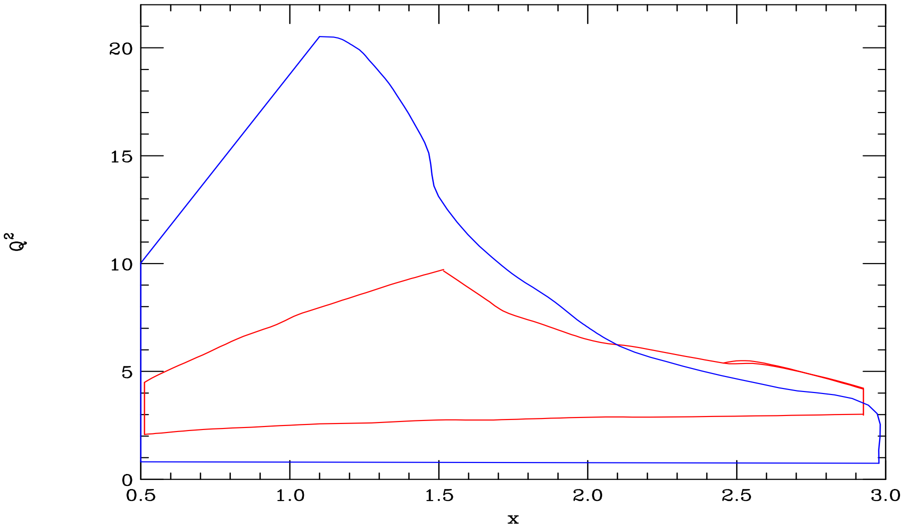

FIG. 6: The kinematic range in Q^2 and the Bjorken x variable. The region below outlined in red is the range of data accessible with 6 GeV beam, and the region outlined in blue indicates the range possible with an 11 GeV beam.

The increase in beam energy to 11 GeV will have the greatest impact on the Q^2 range for kinematic points with

$1.0 \lesssim x \lesssim 1.7$. This extended Q^2 data is critical to studies of the transition from scattering from nucleons to scattering from quarks as described in the introduction. At larger values of x, the Q^2 increase is smaller, but is crucial for studies of the nature of the short range correlations. While the Q^2 increase is not as large as for the lower x values, it is enough to allow us to reach well into the scaling region ($Q^2 \gtrsim 3$ GeV^2) out to extremely large x values. The 4 GeV measurement only reached $Q^2 \approx 3.5$ GeV^2 for $x > 2.2$, and while the Q^2 coverage for iron was much better for $1.5 < x < 2$, the deuterium data in this region was quite limited.The increased Q^2 range for large x corresponds to a similar increase inQ^2 for large negative values of y allowing direct study of the approach to the scaling limit, as well as data in the scaling region for extremely large values of $|y|$. This high x (large negative y) region is very important in determing if the high momentum components are explained by two nucleon correlations or if large multinucleon correlations are required.

C. Experimental Equipment

The experimental set-up for measurements with a 11 GeV beam would be performed using the existing HMS and new SHMS which is part of the base equipment package for the 12 GeV upgrade. The HMS would be used for the highest Q^2 measurements at large angles and the SHMS would be used for equal and less than 30 degrees and would allow the measurements at modest Q^2 but very large values of x where the role of SRC should appear. Data would be taken in the HMS spectrometer using the existing detector package which includes a threshold gas Čerenkov counter and a lead glass shower counter for rejection of pion background. The SHMS will have a similar package of nearly identical performance. Several nuclear targets (C, Cu, and Au) would be used as well as cryogenic targets. We will run at beam currents between 20 and 80 μA. While the kinematics below are calculated for a 11 GeV beam energy, we will run at whatever maximum energy is available when the experiment is scheduled. Any energy above 9 GeV would be acceptable, although there is an improvement in kinematic coverage if slightly higher beam energies are available.

A cryogenic hydrogen target is necessary for calibration and a cryogenic deuterium target for production data. These are currently part of the standard Hall C cryotarget system. ^{3}He and ^{4}He cells have been used in E02-019 We have found that theses cells can take in excess of 50 μ A.

The measurements would be done at several angles to cover the full kinematic range. Table II is a list of estimated running times for six angle settings between $\theta = 20^\circ$ and 60°. The assumptions are 60 μA of beam current (40μA for the helium targets), a spectrometer solid angle of 7 msr, a momentum bite of 16%, a fixed x bin of 0.05, and a maximum statistical error of 10%. The majority of the data will be taken in the HMS. The SOS will take some additional data at the largest angles, as well as make measurements of the pion and charge-symmetric electron/positron background.

III. REQUEST TO LABORATORY

We request approval to extend the measurements of inclusive scattering from nuclei at $x > 1$ and high Q^2 with a 6 GeV beam at Jefferson Lab. We will take data on three solid targets, focussing mainly on C and Cu, but also taking data on Au at a limited set of Q^2 values. We have replaced the iron target used in E89-008 with copper in order to run at higher currents. The combined time for data taking on these targets is 180 hours. We will also take data on deuterium, ^{3}He, and ^{4}He (focussing on deuterium and ^{3}He), for a combined running time of 270 hours. The kinematics below 40° are chosen too optimize the Q^2 coverage for the large x data, while the large angle data will give the maximum Q^2 range for $1.3 \lesssim x \lesssim 1.7$.

Check-out and commissioning time is estimated to require 20 hours, hydrogen elastic running an additional 25 hours, cross calibration to E89-008 with a 4 GeV beam (and a limited L/T separation) will require approximately 40 hours.Special runs to measure backgrounds (positron background and empty target runs)will require approximately 40 hours. The sum time for check-out, calibration,and background measurements is 125 hours. The average overhead for configurations changes will vary from approximately 15 minutes to 1 hour depending on the target changes involved and whether the magnet polarity will be changed. We estimate a total of 100 hours of overhead time for configuration changes.

Our total beam time request, including checkout, background measurements, and data taking on six targets is 675 hours, or approximately 28 beam days.

IV. SUMMARY

We propose to measure inclusive scattering at $x > 1$ on several light and heavy nuclei. The experiment will measure the cross section in the y-scaling region($Q^2 \gtrsim 3$ GeV^2) over a large y range, (corresponding to values of$x$ up to $x \approx 3$).

TABLE II: Kinematics of the proposed experiment for 6 GeV running.

θ (deg)	E' (GeV)	x_{range}	y_{min} (GeV/c)	Q^2_{range} $(\mathrm{GeV/c})^2$	time(hrs) C+Cu+Au	time(hrs) D+^{3}He+^{4}He
20.0	3.9-5.3	0.7-3.0	-1.0	2.5-3.9	18	27
25.0	3.2-4.7	0.7-2.5	-0.8	3.5-4.9	24	36
30.0	2.7-4.1	0.7-2.0	-0.7	3.5-6.8	33	48
40.0	1.9-3.0	0.7-1.7	-0.5	4.0-8.9	42	63
50.0	1.4-2.1	0.7-1.5	-0.4	4.4-9.8	42	63
60.0	1.1-1.8	0.7-1.4	-0.4	4.5-10.8	21	33

This data is sensitive to the nucleon momentum distribution, and in particular to the high momentum components of the nucleon distribution in nuclei (probing nucleons with initial momenta in excess of 1000 MeV/c). By comparison to calculations of nuclear structure, or by direct comparisons of heavy nuclei to ^{2}H and ^{3}He, we will study the nature of the high momentum components to determine to what extent two nucleon correlations explain the presence of very high momentum nucleons and to what extent multinucleon correlations are required.

This data will complement the many completed and upcoming coincidence$A(e,e'p)$ and $A(e,e'NN)$ measurements attempting to probe the high momentum components of the spectral function and short range correlations [**?**]. The inclusive measurement can reach much larger values of the missing momentum, where the coincidence measurements become cross section (or background) limited. The inclusive measurements are also cleaner,being significantly less sensitive to final state interactions, meson exchange currents, and other processes which must be modeled in the analysis of the coincidence measurements. In the inclusive measurement, one does not reconstruct the excitation energy of the final system (the missing energy of the struck nucleon), and so is sensitive to the entire missing energy distribution of the spectral function. Both inclusive and coincidence experiments are important in these studies, as inclusive measurements can provide fairly clean information on the very high momentum components of the spectral function, while the coincidence experiments can provide detailed information on the missing energy distribution (and momentum distributions for the individual shells) at lower momentum values.

In addition to the main goal of studying nucleon distributions and short range correlations in nuclei, this data will also allow us to extract the nuclear structure functions at large x values. This will allow us to extended measurements of duality and scaling in nuclei, especially for $\xi > 1$ where it is not clear that ξ-scaling is a natural consequence of local duality. In addition, measurements of the structure function in nuclei at large values of $x$will significantly improve the extraction of nuclear moments when combined with precision data in the deep inelastic and resonance region that will be taken in future JLab experiments [12–14].

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