# Correlations

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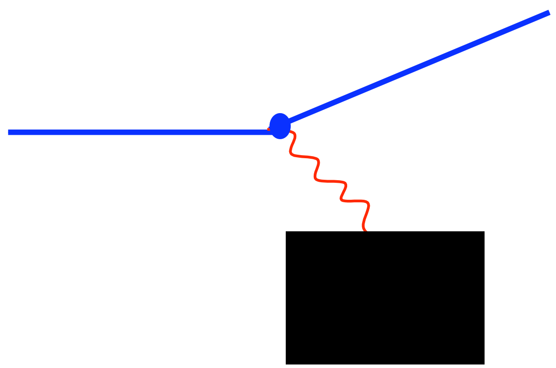
# Inclusive Scattering

## Inclusive Scattering From the Black Box



What we can learn
about BB without observing it ?

Black Box has constituents

Probe knocks-out one of such constituents
without breaking it

Remnant of the BB was a spectator to this action

$$p_i = P_{BB} - P_R$$

$$(q + p_i)^2 = m_c^2$$

$$-Q^2 + 2qp_i + m_i^2 = m_c^2$$

$$-Q^2 + q_+ p_{i-} + q_- p_{i+} + m_i^2 = m_c^2$$

$$p_{i-} = \frac{Q^2}{q_+} - \frac{q_-}{q_+} p_{i+} + \frac{m_c^2 - m_i^2}{q_+}$$

$$p_{i-} = \frac{Q^2}{q_+} = \frac{Q^2}{2q_0}$$

$$z || q$$

$$p_{i\pm} = E_i \pm p_{iz}$$

$$q_\pm = q_0 \pm q$$

$$\frac{Q^2}{q_+} = fixed$$

$$q_0 \longrightarrow \infty$$

$$q_+ = 2q_0, \quad q_- = 0$$

$$p_{i-} = \frac{Q^2}{q_+} = \frac{Q^2}{2q_0}$$

$$p_{i-} = ? \longrightarrow \frac{p_{i-}}{P_{BB-}}$$

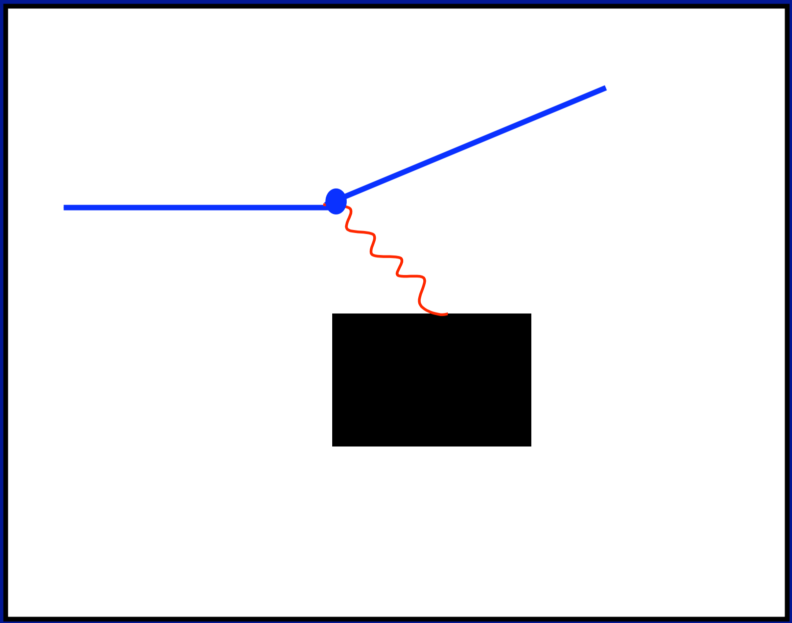
Invariant with respect to Lorentz transformation in z

$$\frac{p_{i-}}{P_{BB-}}\Big|_{LAB} = \frac{Q^2}{2q_0 M_{BB}}$$

$$\frac{p_{i-}}{P_{BB-}}\Big|_{IMF} = \left(\frac{E_i + p_i^z}{E_{BB} + P_{BB}^z}\right)_{IMF} \approx \left(\frac{p_i^z}{P_{BB}^z}\right)_{IMF}$$

$$p_{i\perp} \ll p_{iz}^{IMF}$$

$$Y = \left(\frac{Q^2}{2q_0 M_{BB}}\right)_{LAB} = \left(\frac{p_{iz}}{P_{BBz}}\right)_{IMF}$$



$$\frac{\sigma_{e,BB}}{\sigma_{e,c}} \sim F(Y)$$

If BB = nucleon

$$Y \equiv x_{Bj} = \frac{Q^2}{2mq_0}$$

$$F(Y) = f(x_{Bj})$$

If BB = nucleus

$$\alpha = A \cdot Y \approx \frac{Q^2}{2mq_0} \equiv x_{BJ}$$

IMF momentum fraction of nucleus carried by nucleon

Each nucleon in average carries $Y = \frac{1}{A}$ or $x_{Bj} = 1$

$$\frac{\sigma_{e,A}}{\sigma_{e,N}} \sim F(\alpha) \equiv \rho_A(\alpha)$$

# Correlations

$x > 1$ at least 2 nucleons are needed

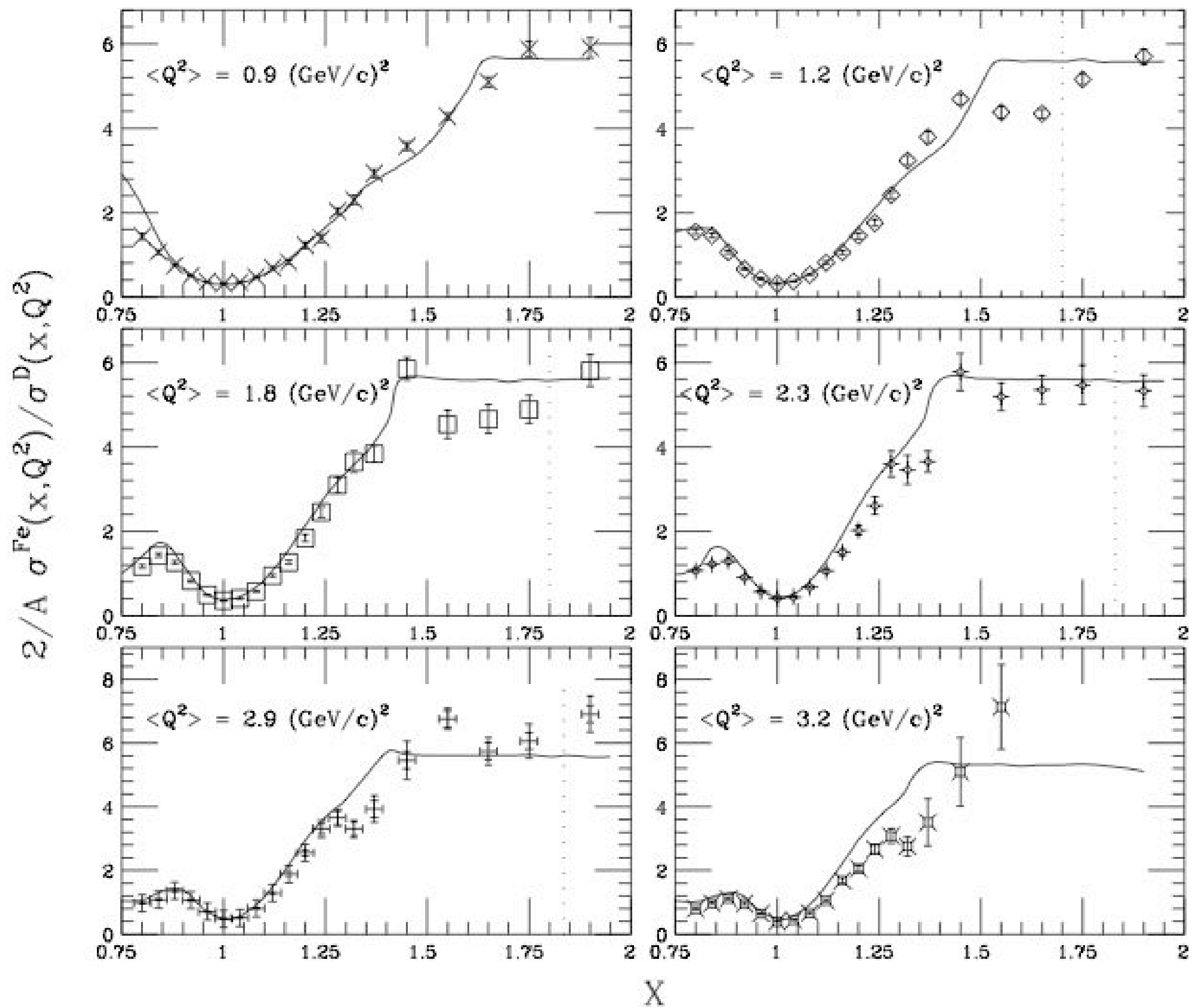
$x > 2$ at least 3 nucleons are needed

$x > j$ at least j+1 nucleons are neede

$x > 1$ if only 2 nucleons then $\frac{\sigma_A}{\sigma_D}$ scales

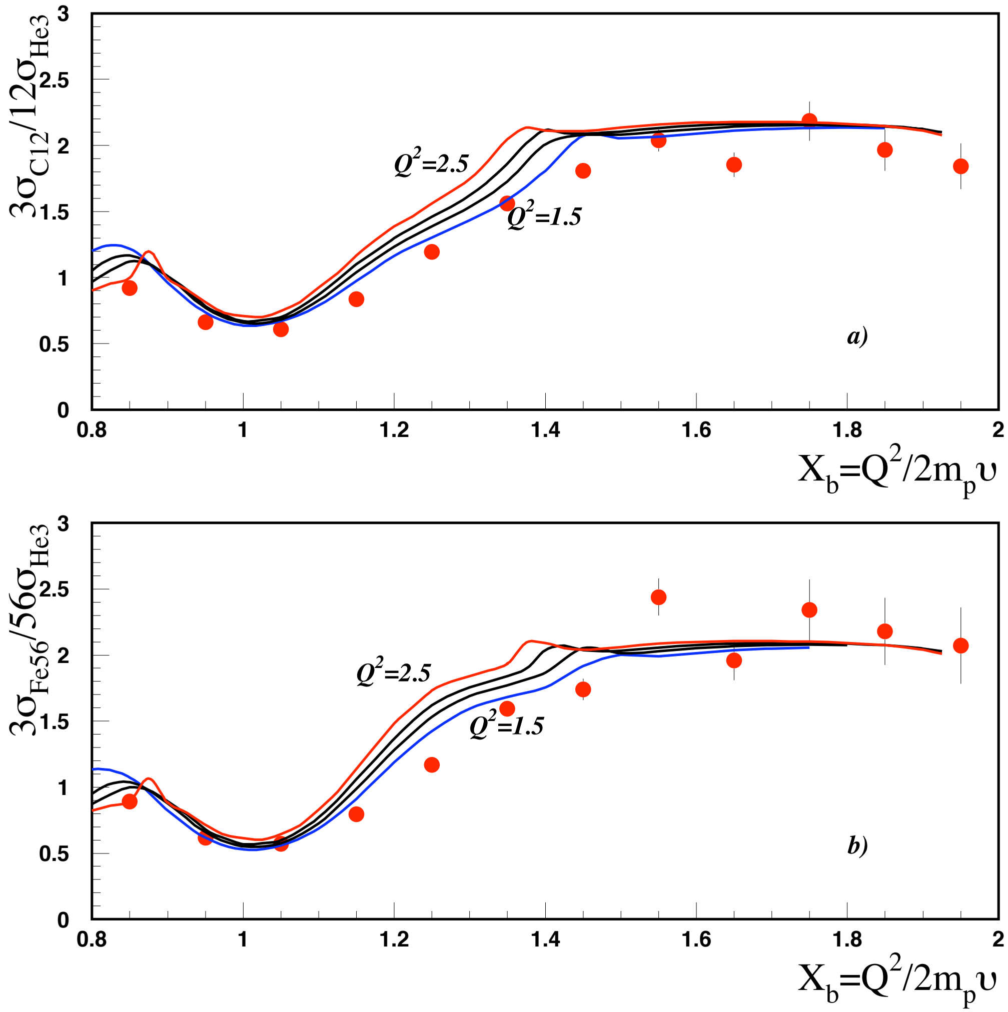
$x > 2$ if only 3 nucleons then $\frac{\sigma_A}{\sigma_{A=3}}$ scales

$x > j$ if only j+1 nucleons then $\frac{\sigma_A}{\sigma_{j+1}}$ scales

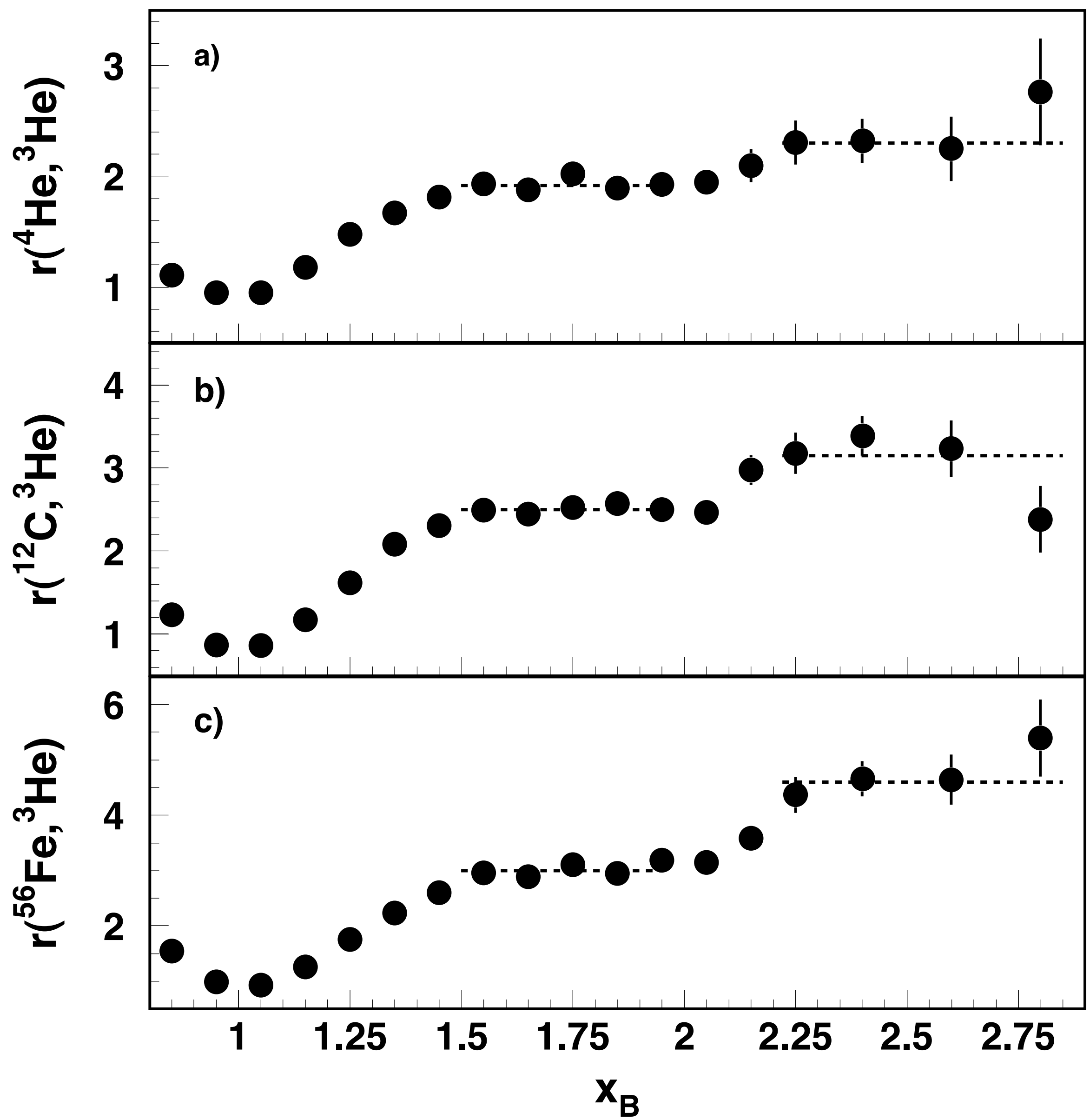


$<Q^2> = 0.9\ (GeV/c)^2$
$<Q^2> = 1.2\ (GeV/c)^2$
$<Q^2> = 1.8\ (GeV/c)^2$
$<Q^2> = 2.3\ (GeV/c)^2$
$<Q^2> = 2.9\ (GeV/c)^2$
$<Q^2> = 3.2\ (GeV/c)^2$
$2/A\ \sigma^{Fe}(x,Q^2)/\sigma^{D}(x,Q^2)$
X

# A(e,e′)



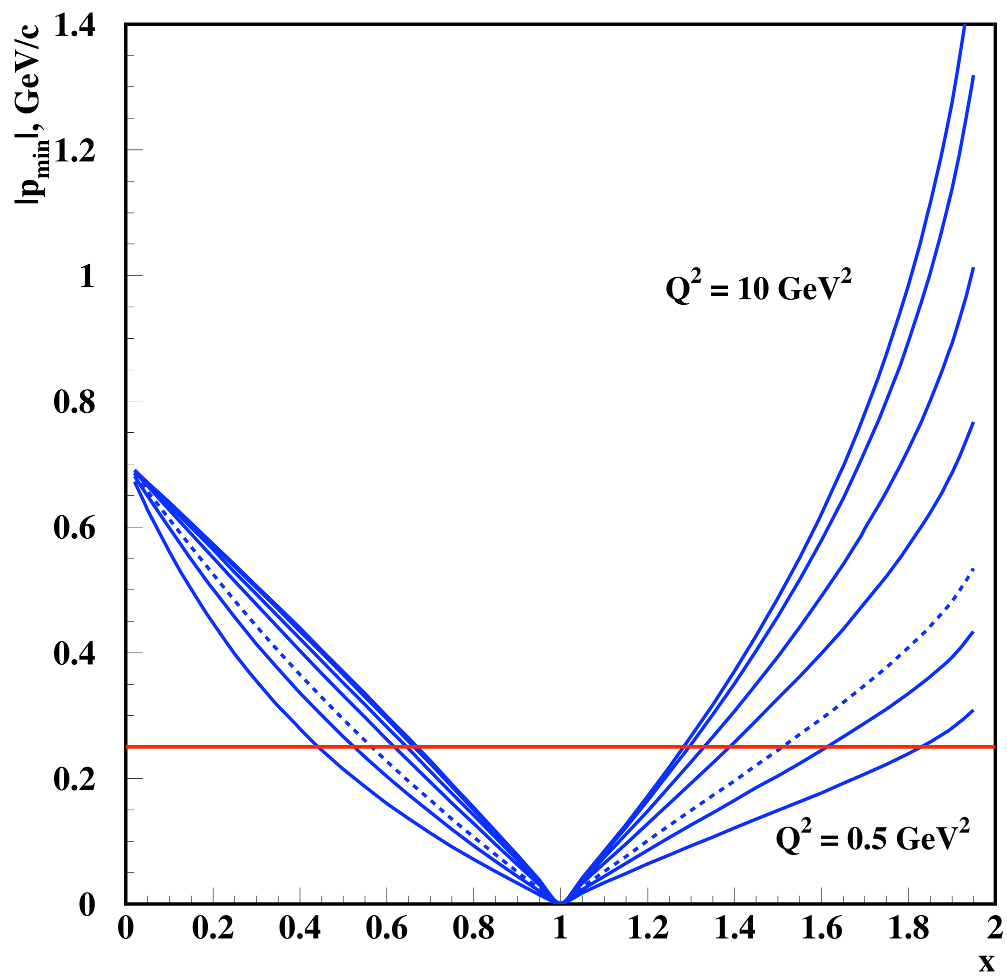
$3\sigma_{C12}/12\sigma_{He3}$
$Q^2$=2.5
$Q^2$=1.5
a)
$X_b=Q^2/2m_p\upsilon$
$3\sigma_{Fe56}/56\sigma_{He3}$
$Q^2$=2.5
$Q^2$=1.5
b)
$X_b=Q^2/2m_p\upsilon$



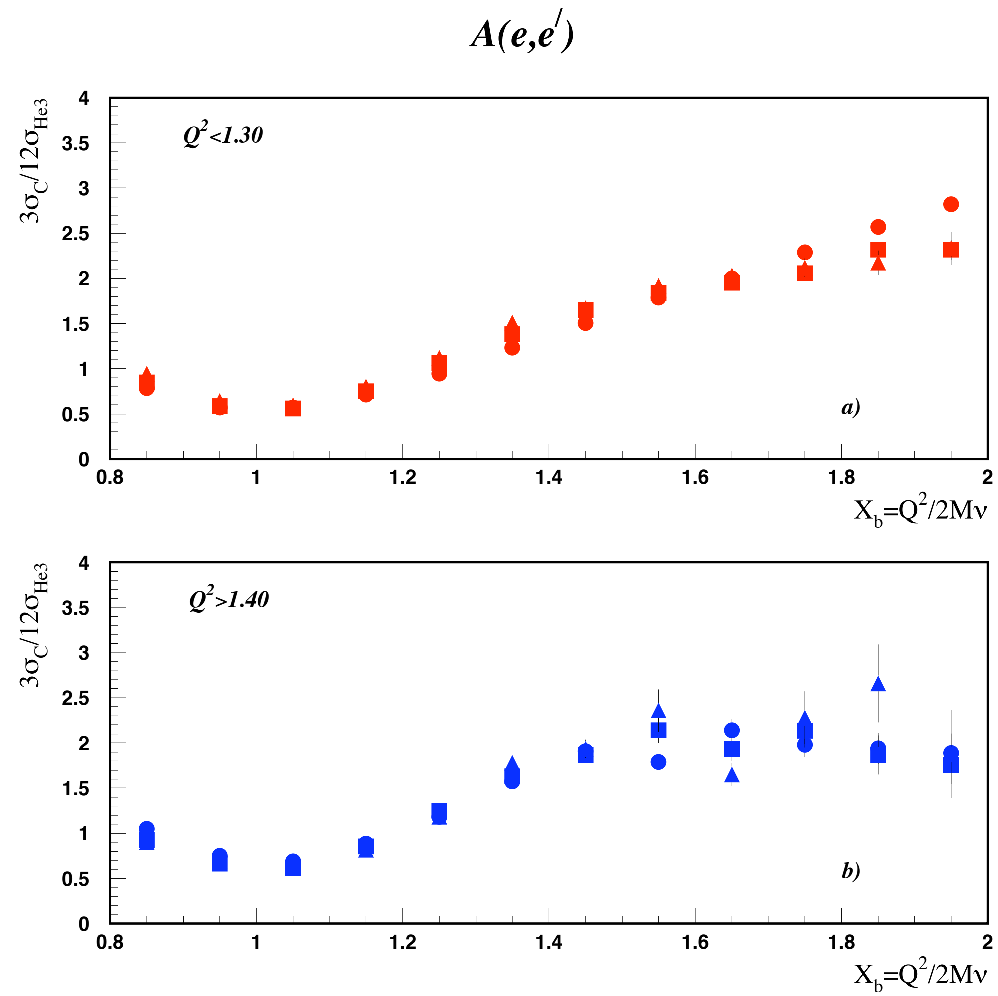
a)
b)
c)
r($^4$He, $^3$He)
r($^{12}$C, $^3$He)
r($^{56}$Fe, $^3$He)
1
2
3
4
6
1.25
1.5
1.75
2.25
2.5
2.75
$x_B$

# Bjorken Limit is note achieved

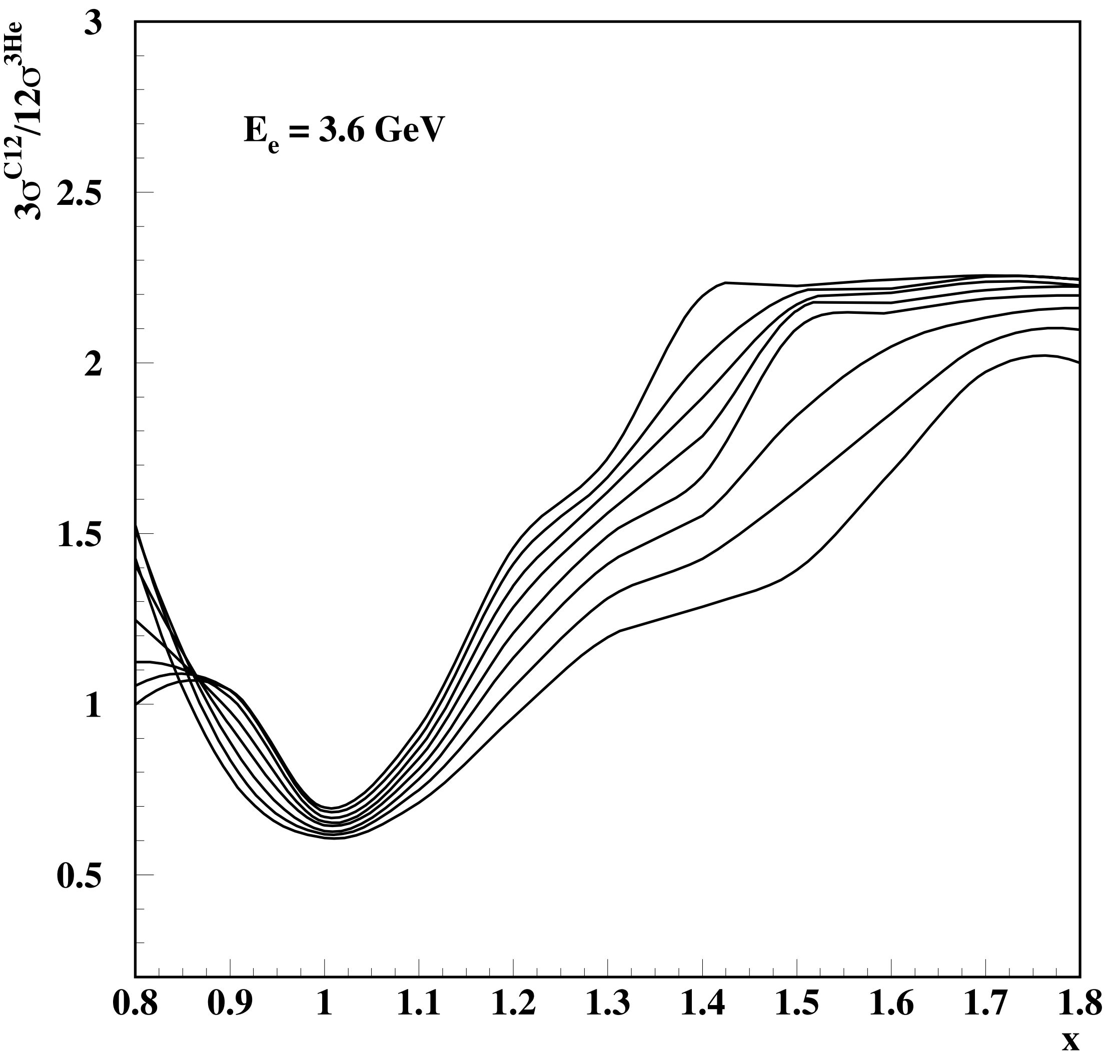
x> 1 is not automatically means 2N SRC




$q_+ \gg q_-$



A(e,e')
Q²<1.30
a)
3σ_C/12σ_He3
X_b=Q²/2Mν
Q²>1.40
b)
3σ_C/12σ_He3
X_b=Q²/2Mν

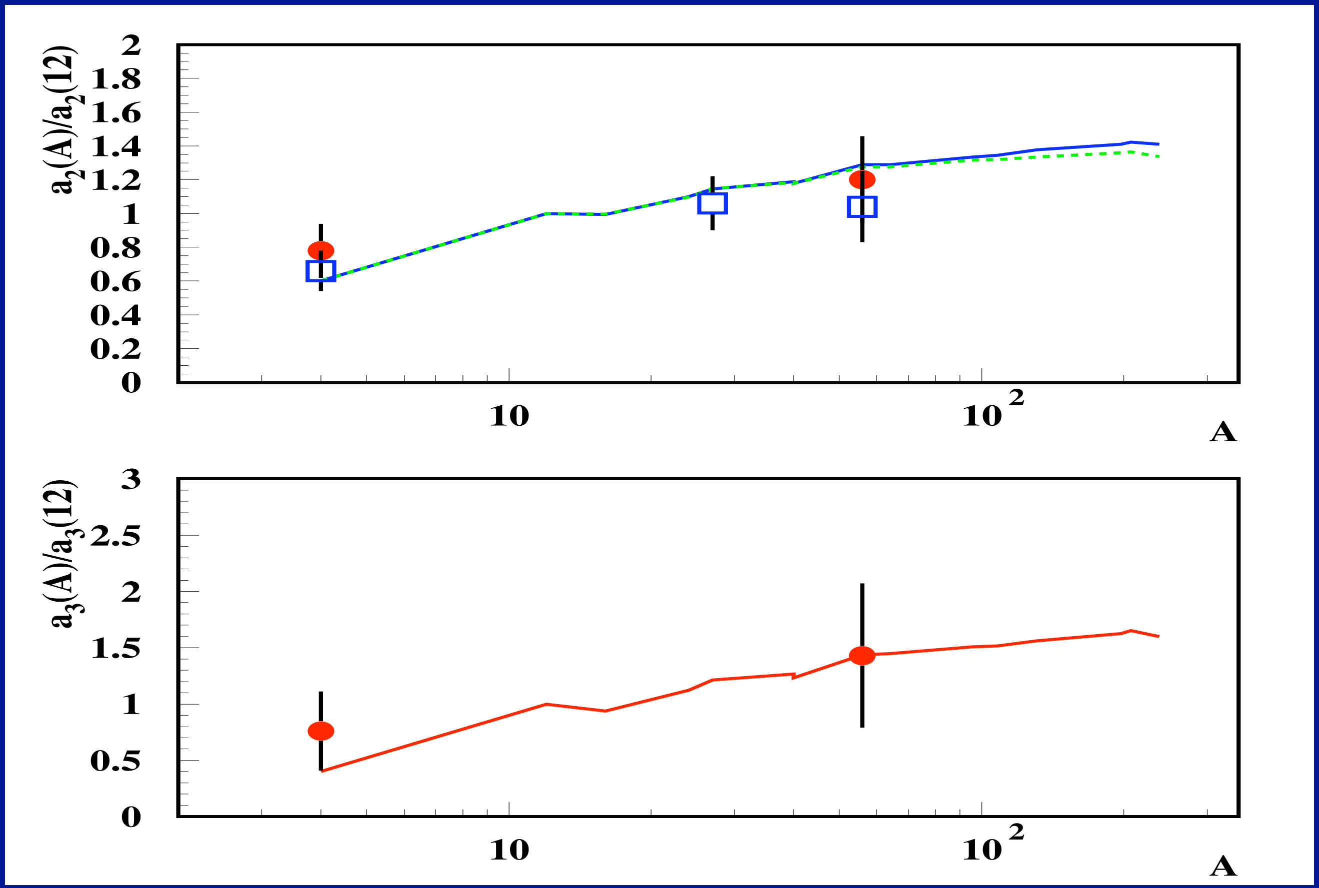


$3\sigma^{C12}/12\sigma^{3He}$
$E_e = 3.6$ GeV
3
2.5
2
1.5
1
0.5
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
x

# Measuring SRC probabilities

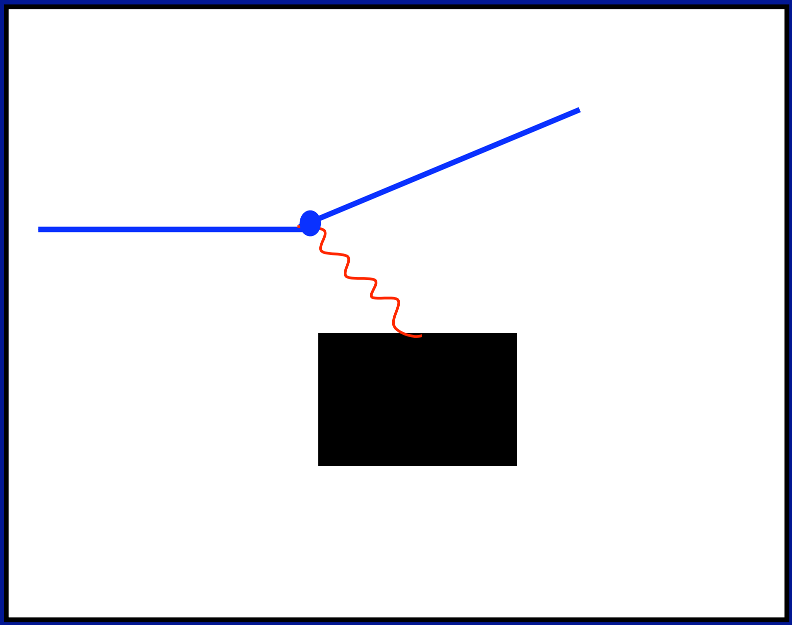
$$\frac{2}{A}\frac{\sigma(eA\to e'X)}{\sigma(e^2H\to e'X)}_{|2>x\geq 1.5} = a_2(A) \qquad \frac{3}{A}\frac{\sigma(eA\to e'X)}{\sigma(eA=3\to e'X)}_{|3>x\geq 2} = a_3(A)$$

$$a_j(A) \propto \int \rho_A(r)^j d^3r \approx \int \rho^j_{A,mf}(1 + j\frac{\rho_{A,src}}{\rho_{A,mf}})d^3r$$



# Measuring $\rho_A(\alpha)$ - Distribution

Bjorken limit is not achievable for nucleons
as a constituents



Probe knocks-out one of such constituents
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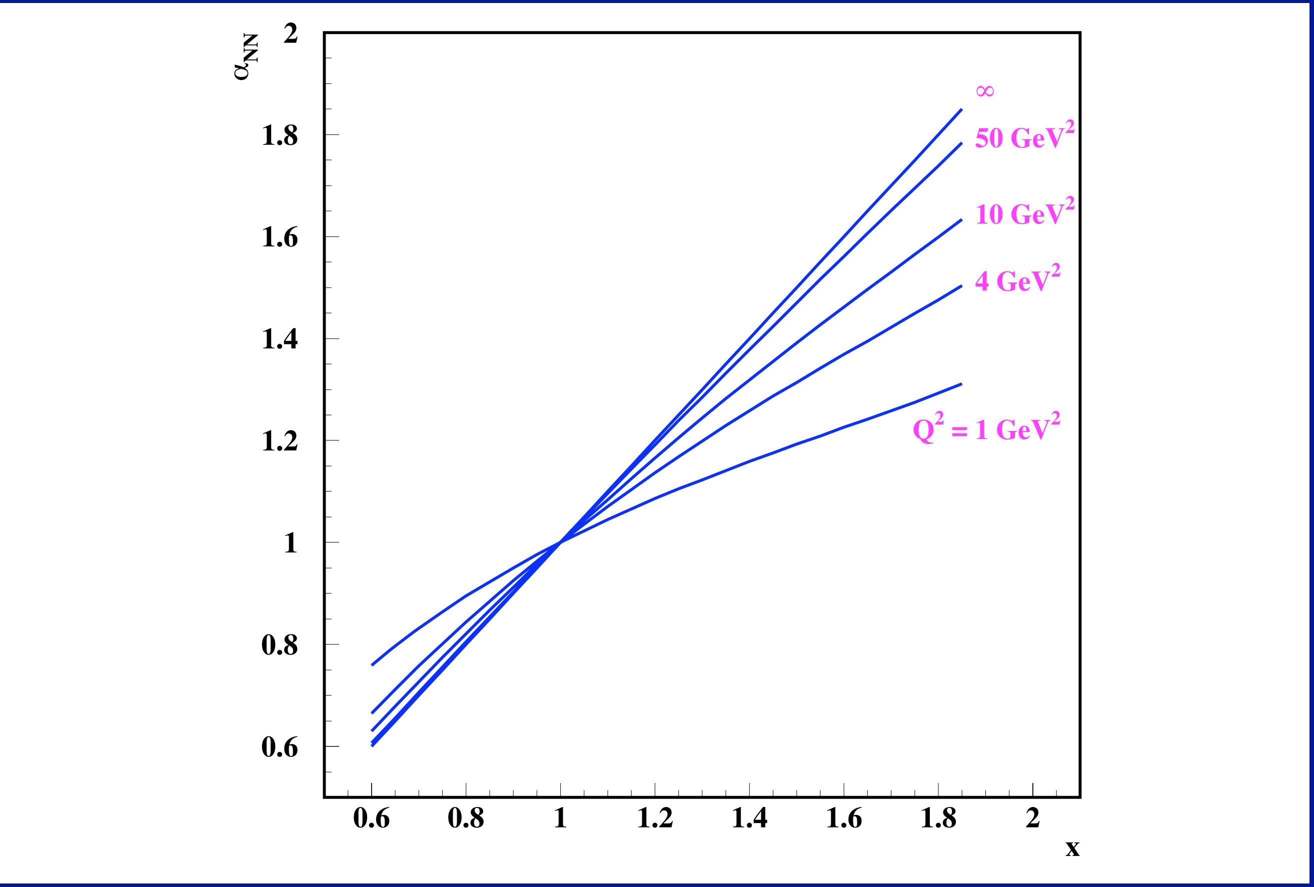
$$p_{i-} = \frac{Q^2}{q_+} - \frac{q_-}{q_+} p_{i+} + \frac{m_N^2 - m_i^2}{q_+}$$

$$\alpha = \frac{2q_0}{q_+} x_{Bj} - \frac{q_-}{m_N q_+} p_{i+} + \frac{m_N^2 - m_i^2}{m_N q_+}$$

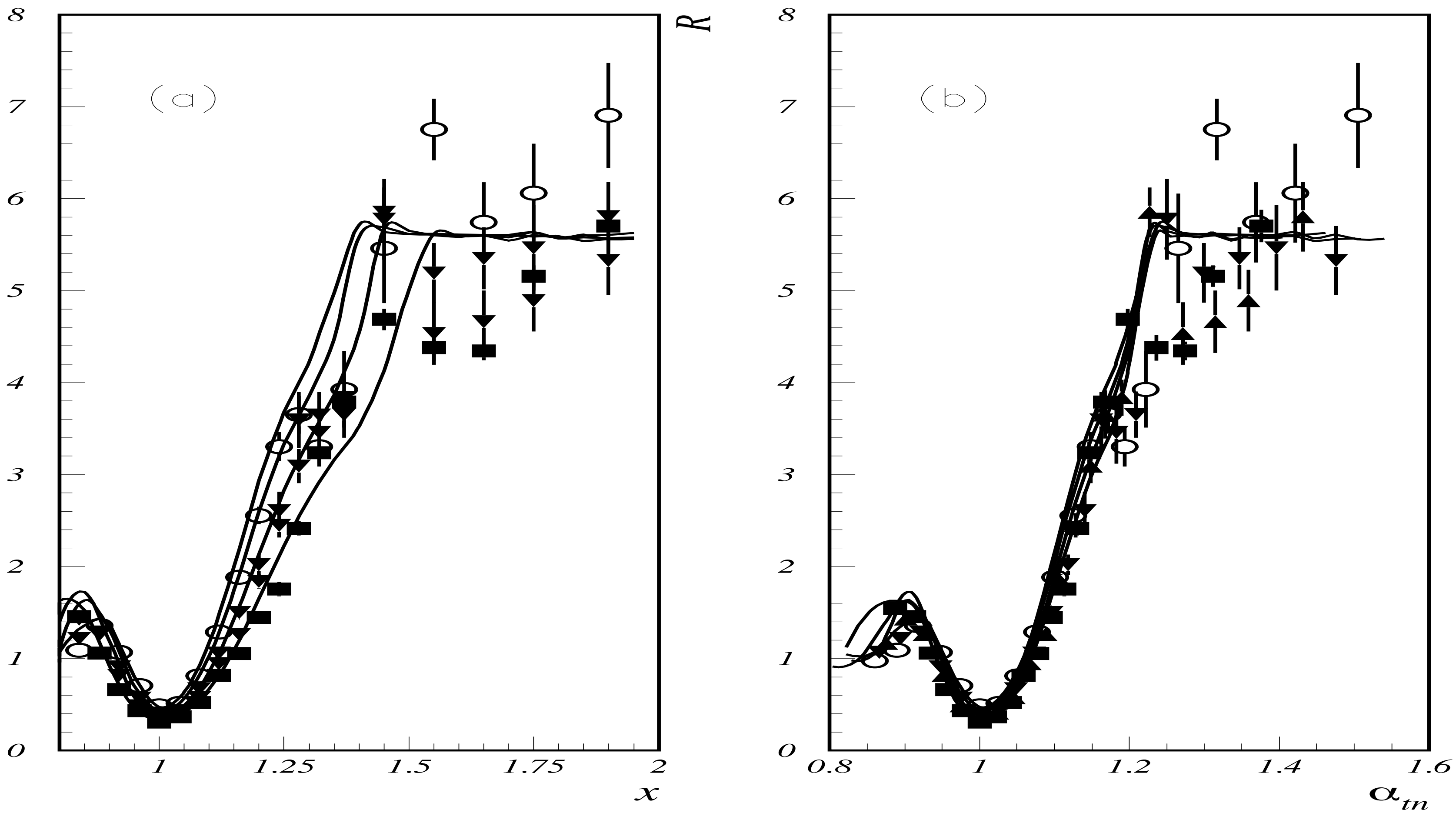
Modeling $p_{i+}$ and $m_i^2$

# 2N Correlation at Rest Model

$$\alpha_{tn} = 2 - \frac{q_- + 2m_N}{2m_N}\left(1 + \frac{\sqrt{W^2 - 4m_N^2}}{W}\right)$$



$$\frac{2\sigma_{Fe}}{A\sigma_d} \qquad Q^2 = 1.2 - 2.9 GeV^2$$



# Conclustions

Inclusive Data allows to extract SRC probabilities

It allows to extract light cone momentum distributions

This  distributions are necessary for studying
parton distribtions in nuclei