High Bjorken-x Events in Neutrino-Iron Deep Inelastic Scattering

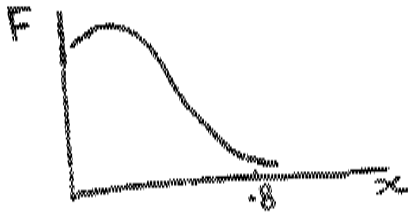
Masoud Vakili

University of Cincinnati, CCFR/NuTeV Collaboration

- Importance of Large-x Data
- Analysis Method
- Preliminary Results
- Conclusions

(2) A05751

Structure Functions have been measured in precision experiments; Due to experimental difficulty, the kinematic region $x \gtrsim .8$ is almost unexplored.

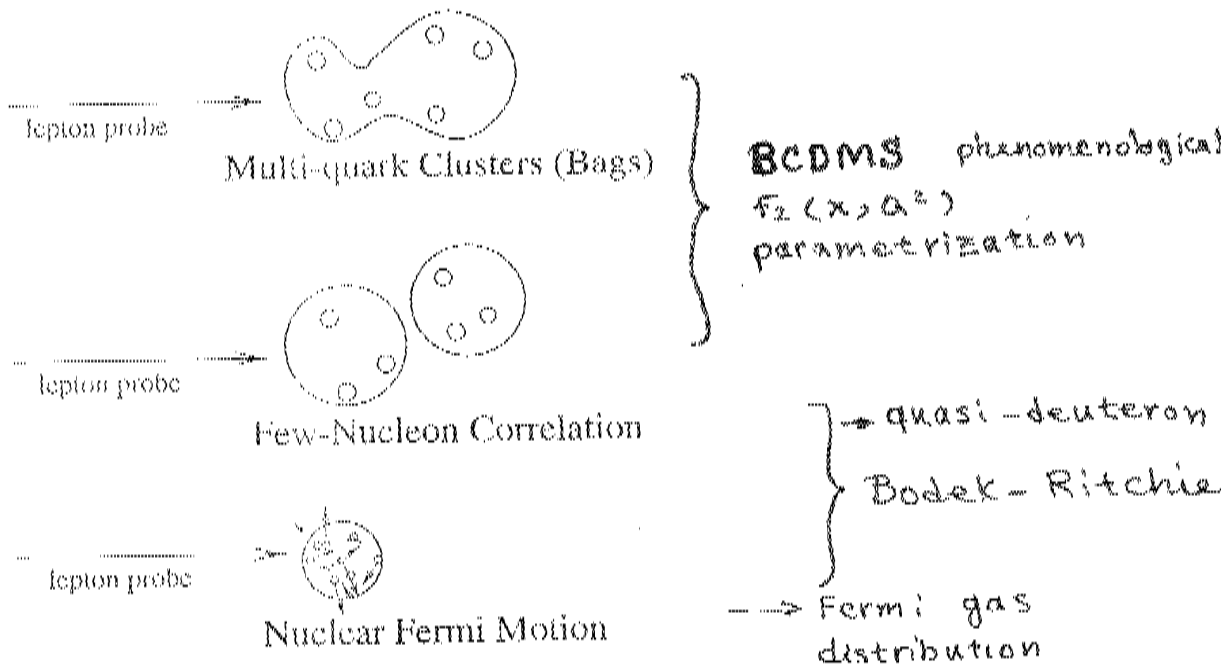


Effects like:

- High Components of Fermi Motion
- Few-Nucleon Correlation
- Multi-quark Clusters

would manifest at $x \gtrsim 0.8$.

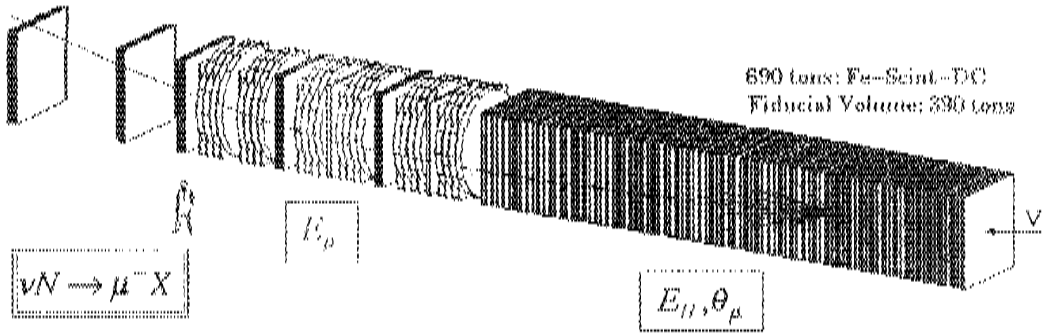
BCDMS has measured $F_2(x \sim 1) \sim 10^{-4}$.

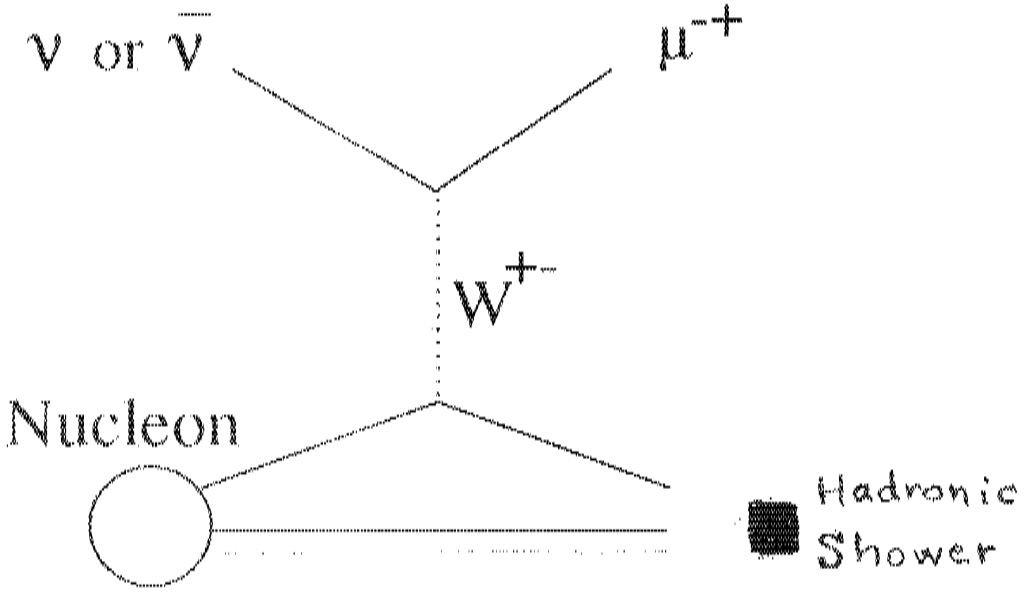


(3) A05351

CCFR/

LAB–E Detector – Fermilab E815 (NuTeV)





$$\frac{\sigma_{E_{HAD}}}{\sqrt{E_{HAD}}} = .847 + \frac{.297}{\sqrt{E_{HAD}}}$$

$$\sigma_\theta = a + \frac{b}{P_\mu} \quad \begin{cases} .25 < a < .55 \\ 35 < b < 90 \end{cases}$$

$$\frac{\Delta(1/P_\mu)}{1/P_\mu} = 11\ \%$$

(4) nu-2_1

Neutrino-Nucleon Cross Section:

$$\frac{d^2\sigma^{\nu(\bar{\nu})}}{dxdy} = \frac{G_F^2 ME}{\pi}\left\{F_2(x,Q^2)\left[1 - y + \frac{y^2}{2(1+R(x,Q^2))}\right] \pm xF_3(x,Q^2)\left[y - \frac{y^2}{2}\right]\right\}$$

Kinematic Variables:

$$\begin{aligned} E_\nu &= E_\mu + E_{HAD} \\ Q^2 &= 4E_\nu E_\mu \sin^2(\theta_\mu/2) \\ y &= E_{HAD}/E_\nu \end{aligned}$$

Definition:

$$x = \frac{Q^2}{2p\cdot q}$$

Reconstruction:

$$x = E_\mu\left(1 + \frac{E_\mu}{E_{HAD}}\right)\frac{2\sin^2(\theta_\mu/2)}{M}$$

(5) A0535\

ERROR in reconstructed "x"

$$x = E_\mu(1 + \frac{E_h}{E_{HAD}})\frac{2\sin^2(\theta_\mu/2)}{M}$$

$$(\frac{\delta x}{x})^2 =$$

$$(\frac{E_{HAD}+2E_\mu}{E_{HAD}+E_h})^2(\frac{\delta E_\mu}{E_\mu})^2 \qquad \leq \qquad 4(\frac{\delta E_\mu}{E_\mu})^2$$

$$+(\frac{E_h}{E_{HAD}+E_\mu})^2(\frac{\delta E_{HAD}}{E_{HAD}})^2 \qquad \leq \qquad (\frac{\delta E_{HAD}}{E_{HAD}})^2$$

$$+(cot\theta/2)^2(\delta\theta)^2 \qquad \cdot \quad \rightarrow_0 \rightarrow_0 \infty$$

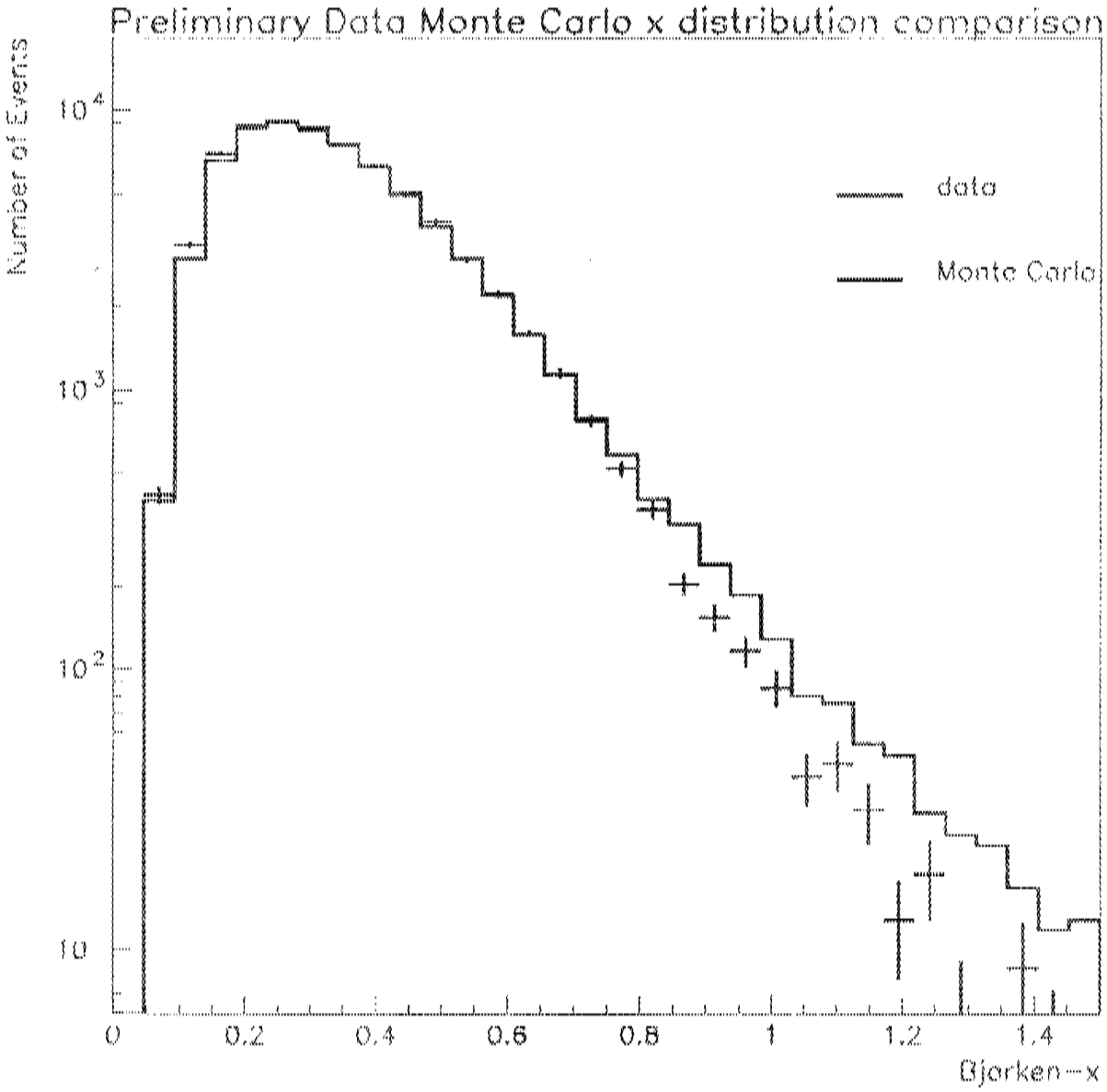
CUTS:

- $15 < E_\mu < 360\ GeV$
- Muons exiting before the end of toroid are rejected.
- $E_{HAD} > 20\ GeV$
- $\theta > 17\ mrad$

other kinematic cuts:

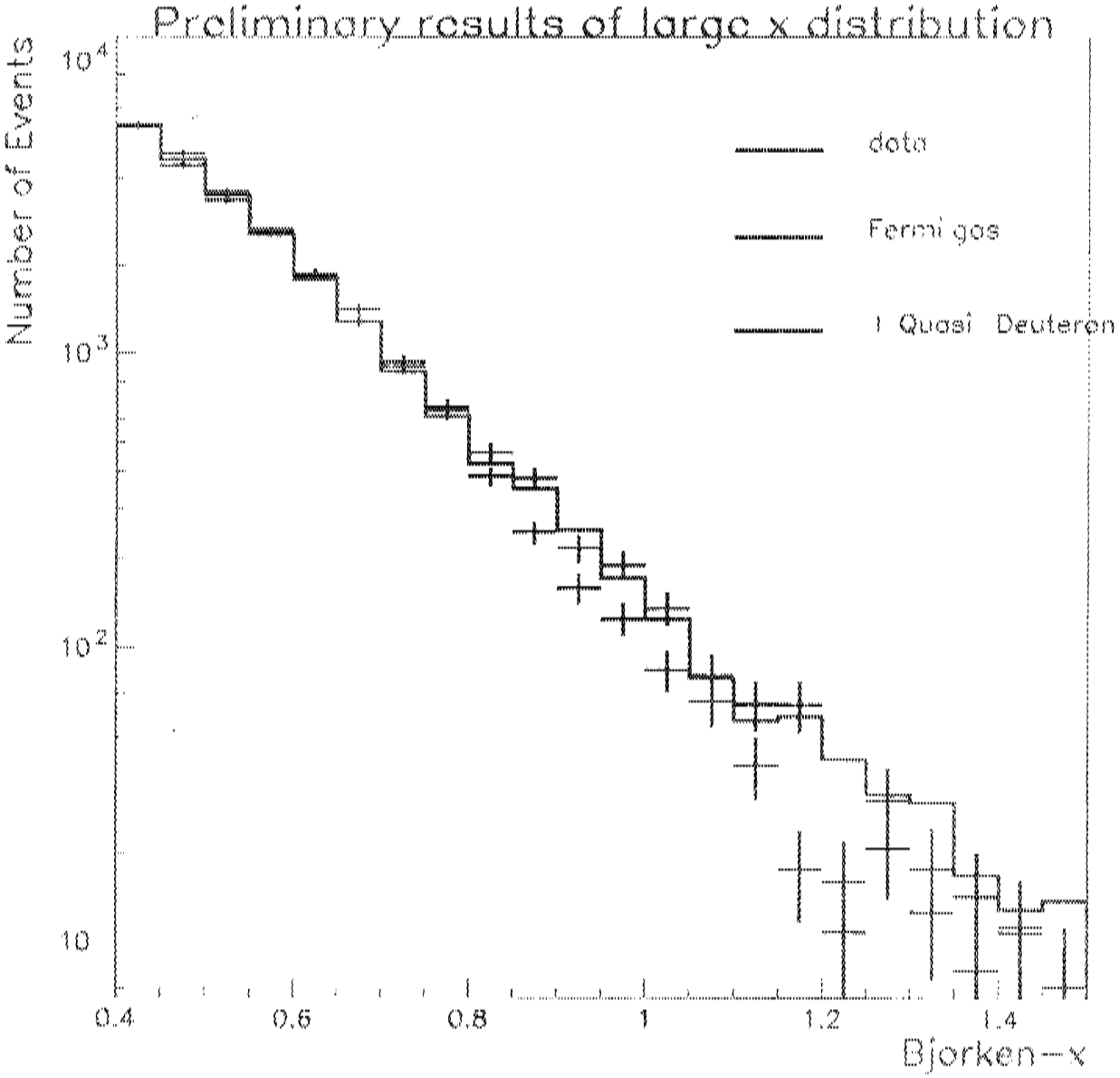
- $Q^2 > 50\ (GeV)^2$

(6) A05361

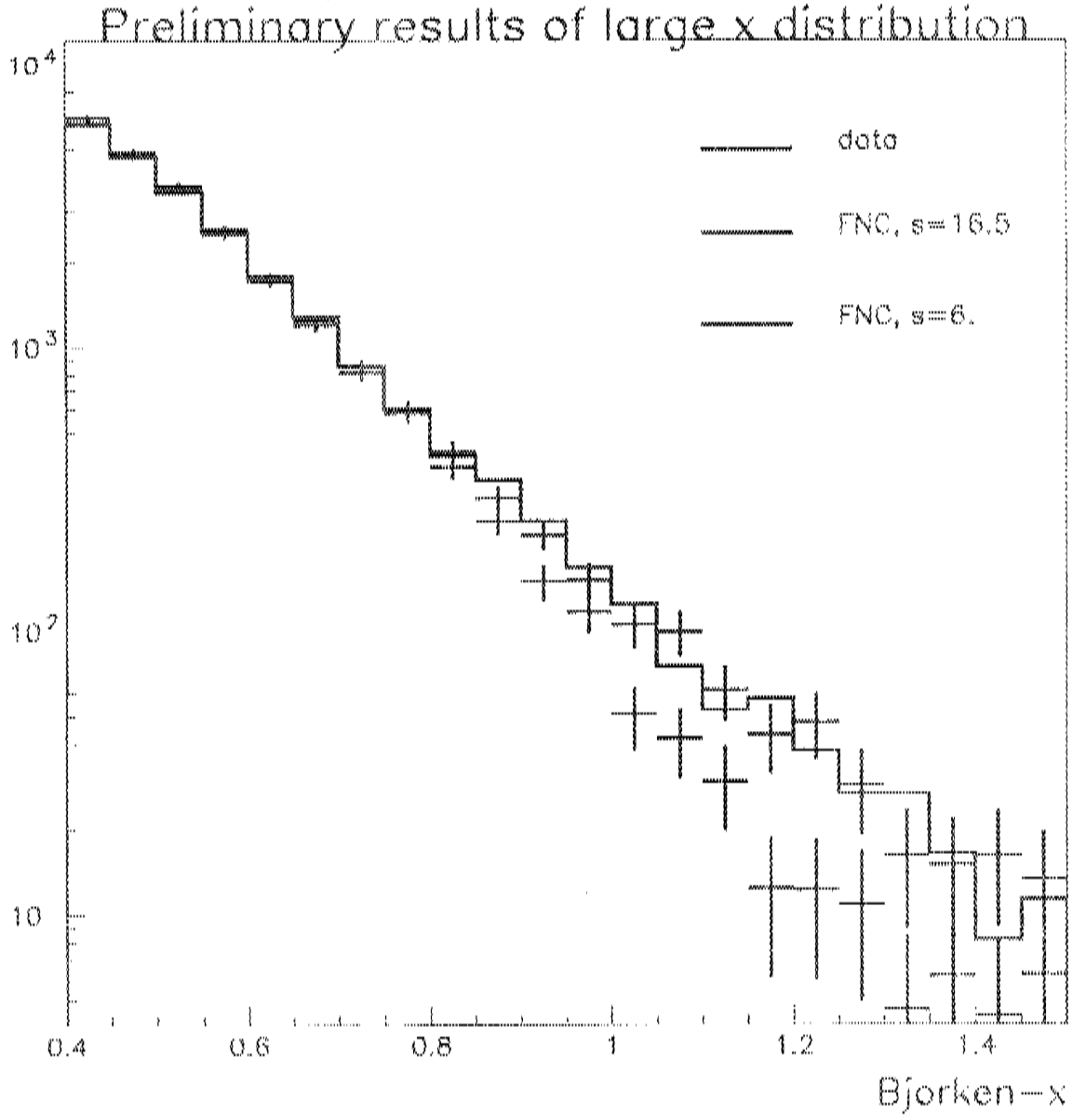


error bars statistical

(7) A05351

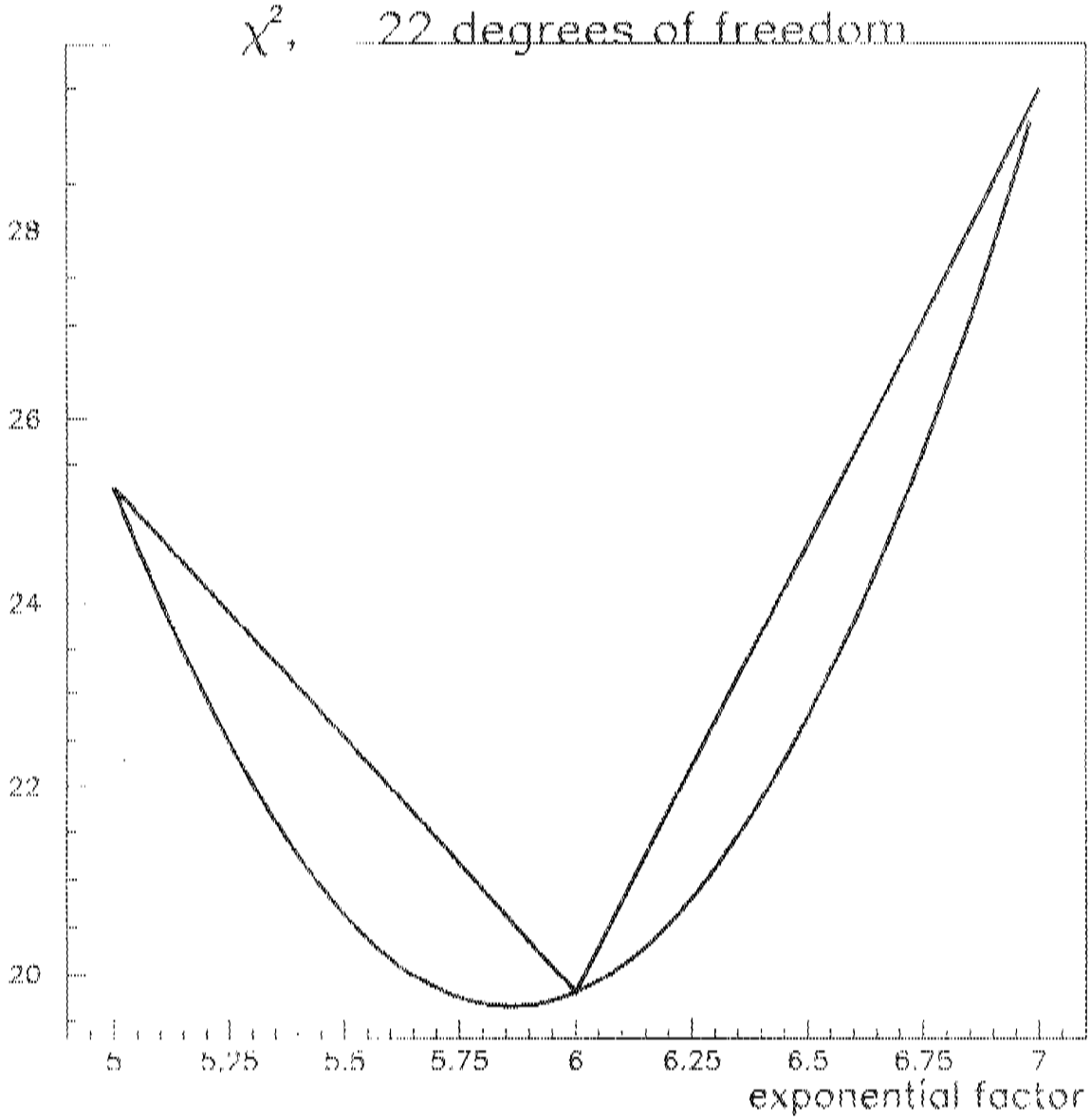


error bars statistical



error bars Statistical

$$F_2^f(x,Q^2) = (1-x)^a(b+cx+dx^2+ex^3)(Q^2)^{f+gx}, \qquad x < 0.75;$$
$$= F_2^f(x=0.75,Q^2)\cdot exp[-s(x-0.75)], \qquad x > 0,75;$$


χ^2, 22 degrees of freedom
28
26
24
22
20
5
5.25
5.5
5.75
6
6.25
6.5
6.75
7
exponential factor

Conclusions

- Data excess over Monte Carlo (that does not model $x \geq 1$ events) for $x > .8$

- Fermi gas model cannot explain the excess.
Addition of Quasi-Deuteron states *a la* Bodek-Ritchie (Phys. Rev. D24(1981) 1200) makes the Monte Carlo agree with data.

- Alternatively exponentially falling $F_2(x, Q^2)$ model for large x (used by BCDMS, Z. Phys. C 63:29 (1994)) with exponential slope parameter $s = 5.9$ gives x distribution that is compatible with the data.
This F_2 behavior is predicted by some "multiquark clusters" and "few nucleon correlations" theoretical models.
Our result of $s = 5.9 \pm .3$ indicates stronger Nuclear effects than was found in the BCDMS carbon data ($s = 16.5 \pm .5$).