

Final results from the NMC

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Results published during last winter

Nucleonstructure

Measurement of R and F_2^P, F_2^d

NPB 483(97) 3

Measurement of $R^d - R^p$ and F_2^d/F_2^p

NPB 487(97) 3

Nuclear effects

First measurement of the

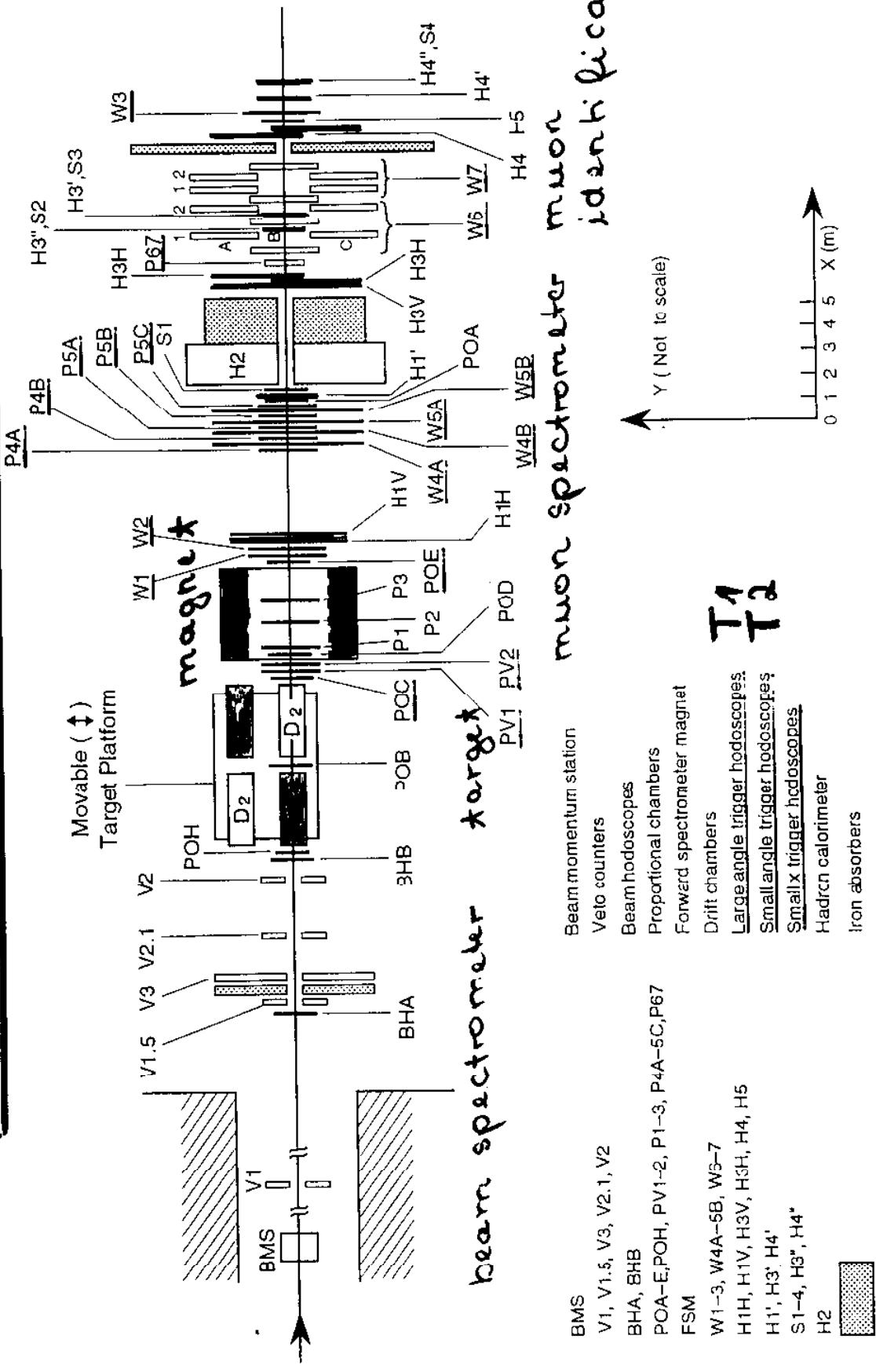
Q^2 dependence of F_2^{Sn}/F_2^C

NPB 481(96) 23

Study of the A dependence of
nuclear effects

NPB 481(96) 3

1989 NMC SPECTROMETER (TOP VIEW)

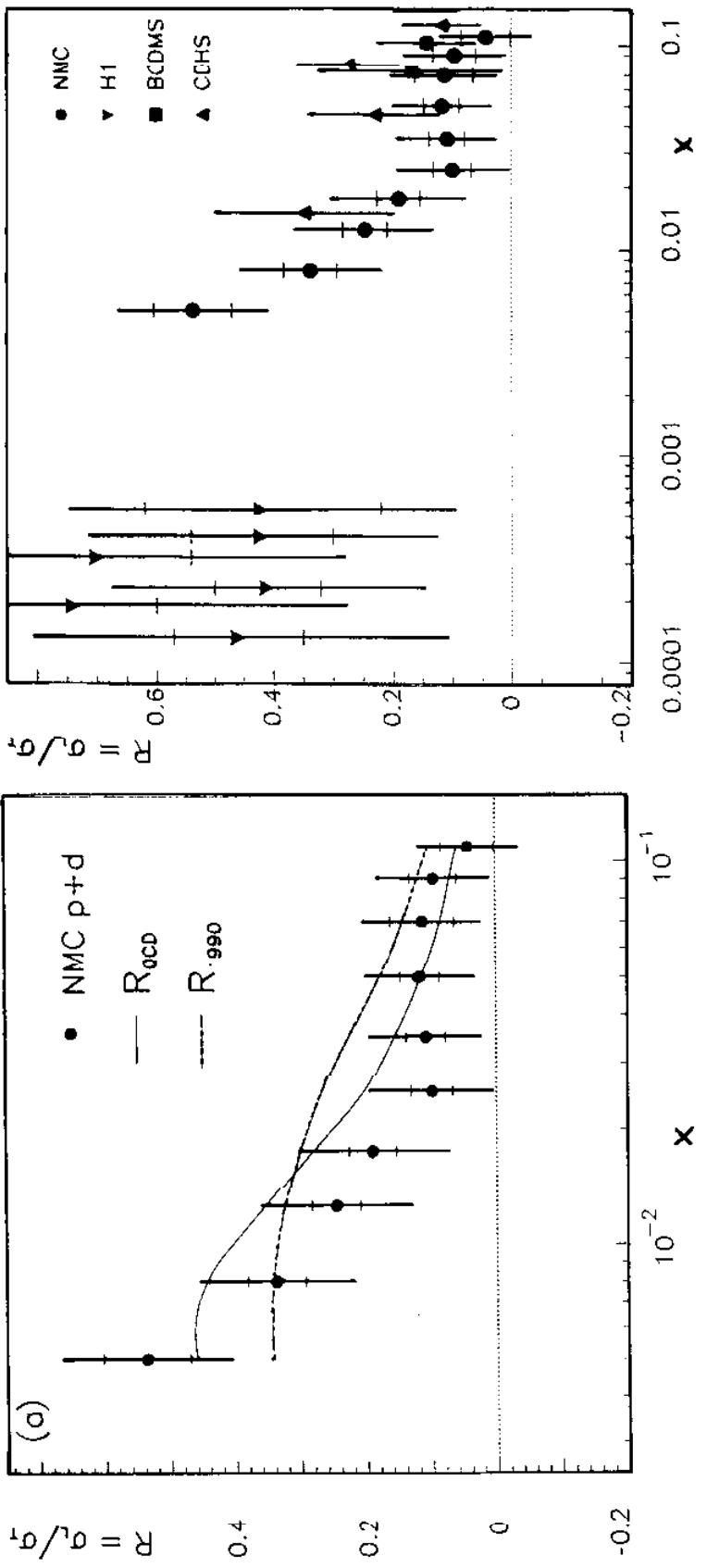


Study of nucleon structure

- measurement with hydrogen and deuterium at 4 energies
280, 200, 120 and 90 GeV
 \Rightarrow Separation of F_2 and R
- large overlap between energies due to addition of low angle trigger + accessible kinematic range enlarged
- method for F_2 and R determination
 - extraction of $\Sigma^{\text{tot}}(x, Q^2, E)$ taking acceptance into account
 - extraction of $F_2(x, Q^2)$ and $R(x)$ taking radiative corrections into account using all data
- two independent measurement done simultaneously
 \Rightarrow good control of systematic errors

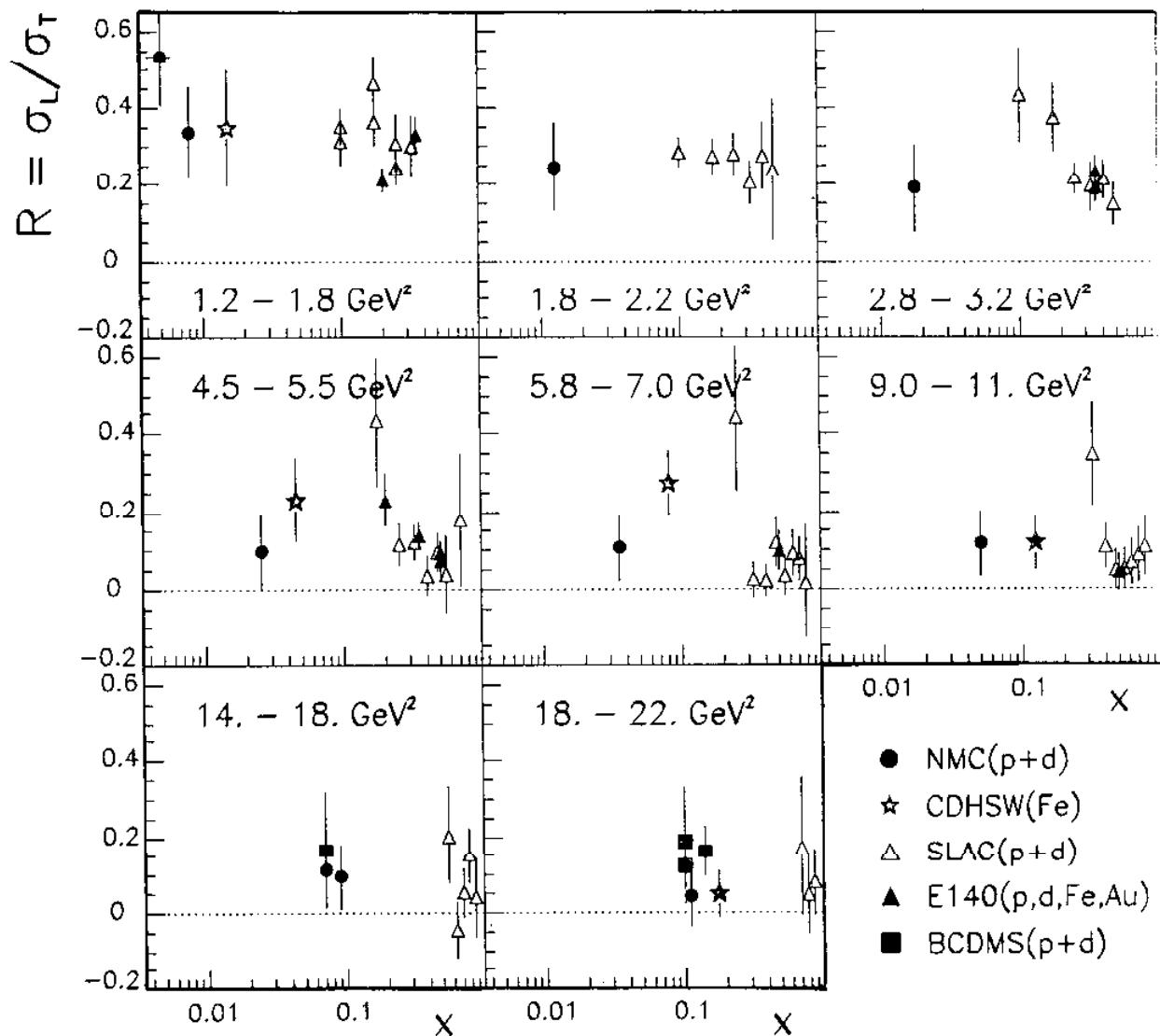
Results for $R(x)$

- $R^d = R^P$ assumed
- limited overlap of Q^2 ranges $\Rightarrow R(x, Q^2)$



- Sensitivity to R at small x (due to y range of data)
- x range: $0.005 < x < 0.12$
- systematic errors ~ 0.1 (dominant source: 2% rel. norm.)

Comparison of R results at fixed Q^2

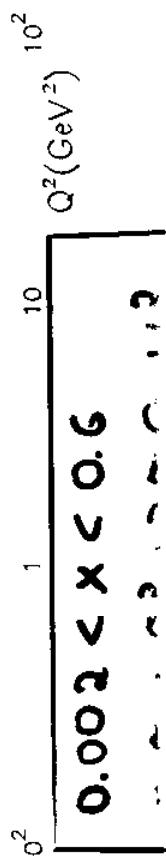
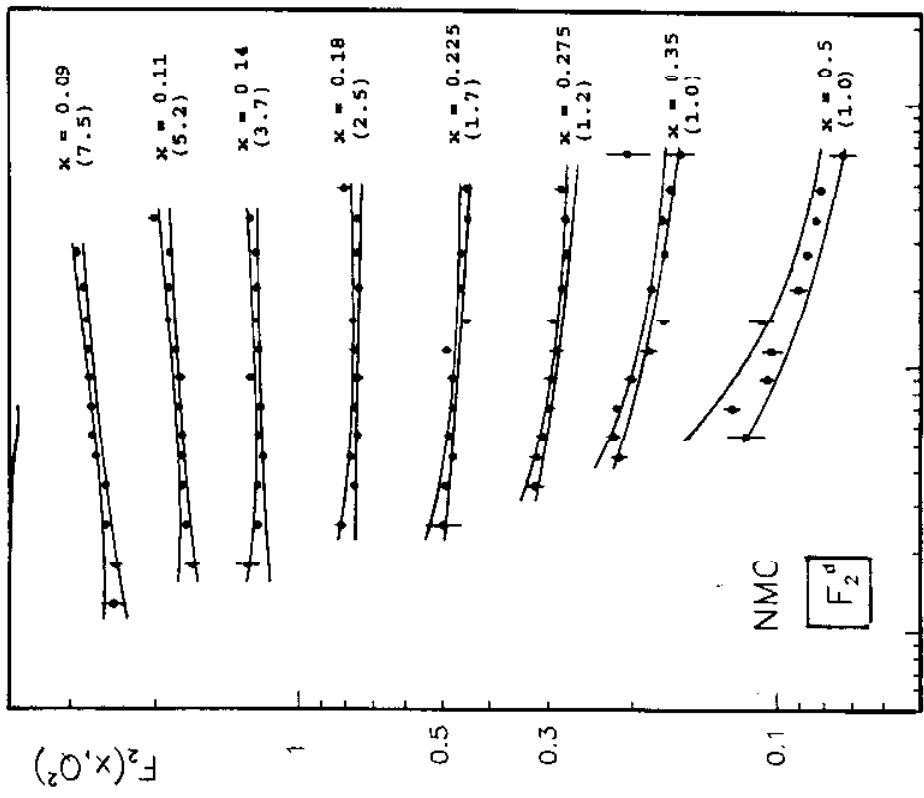
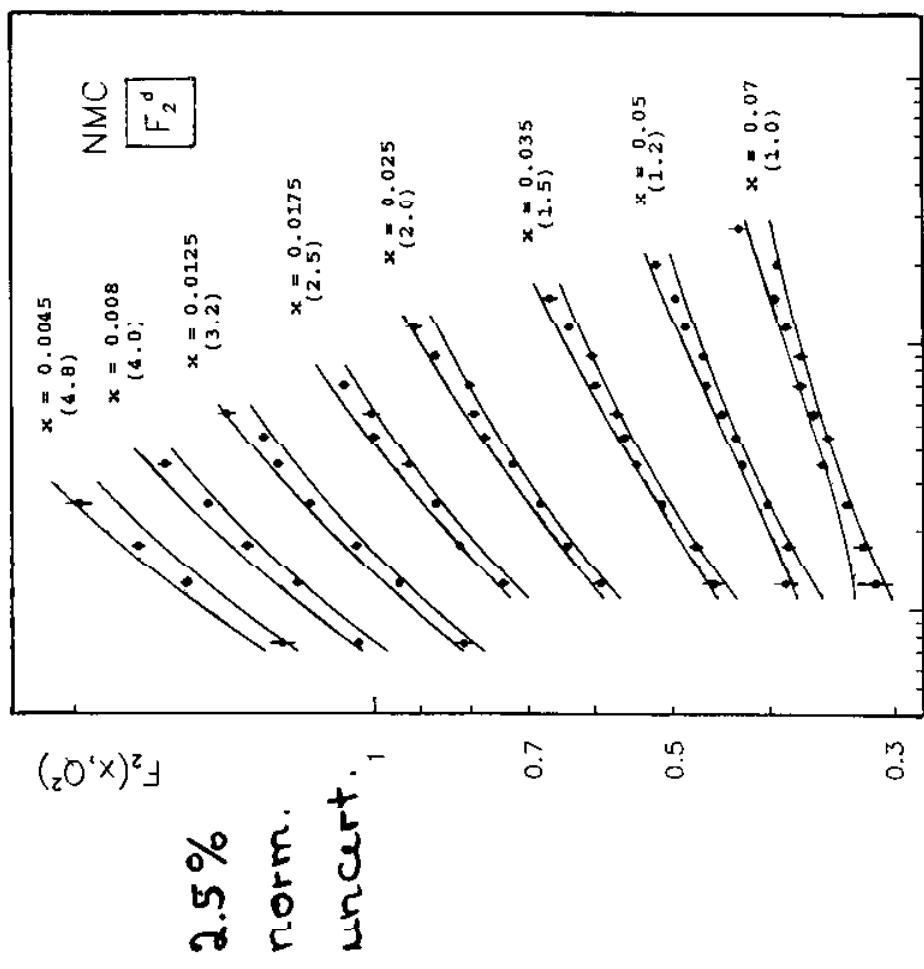


- hardly any x dependence of R observed

Results for $F_2^d(x, Q^2)$

R_{NMC} used for $x < 0.12$, R_{SLAC} for $x \geq 0.12$

System
errors



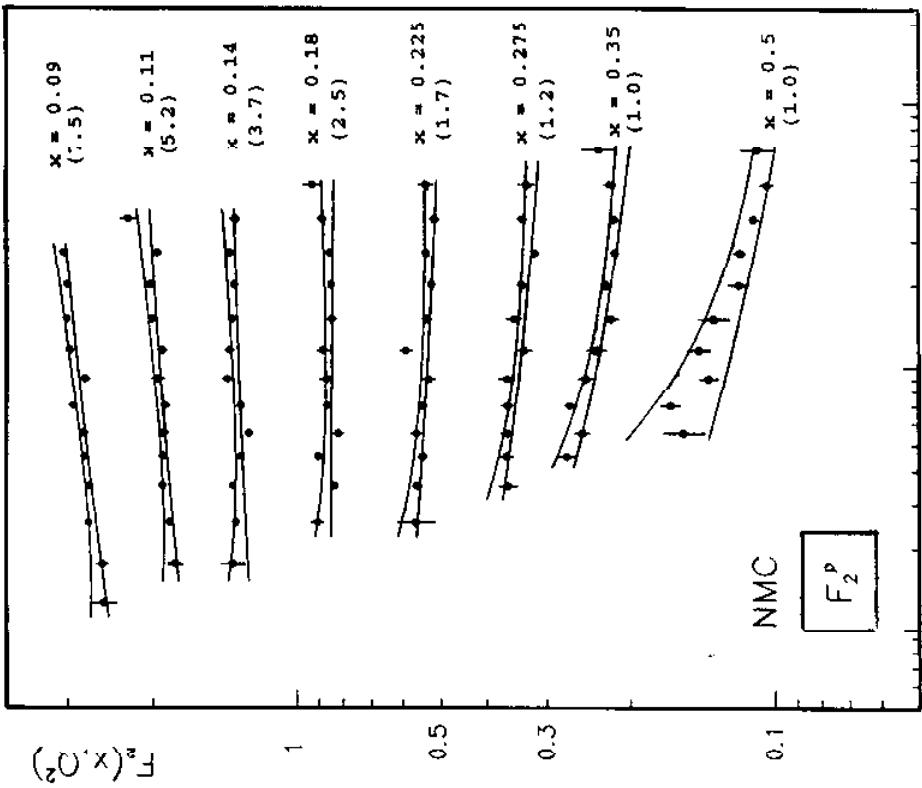
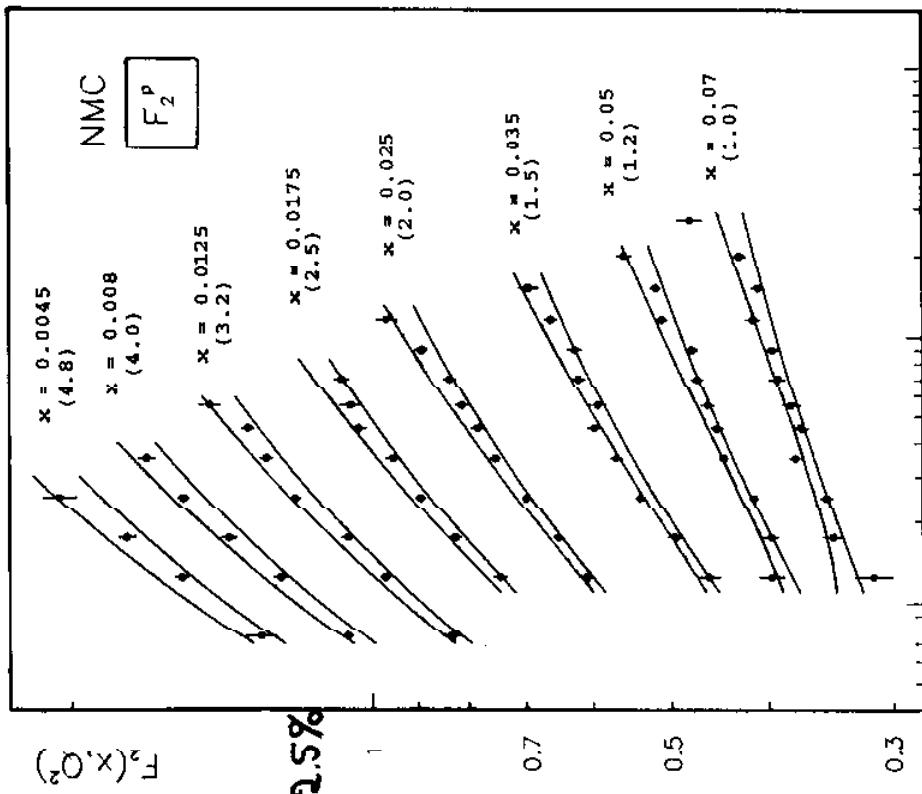
Kinematic range:

Results for $F_2^P(x, Q^2)$

Kinematic range

$$0.002 < x < 0.6 \\ 0.5 < Q^2 < 75 \text{ GeV}^2$$

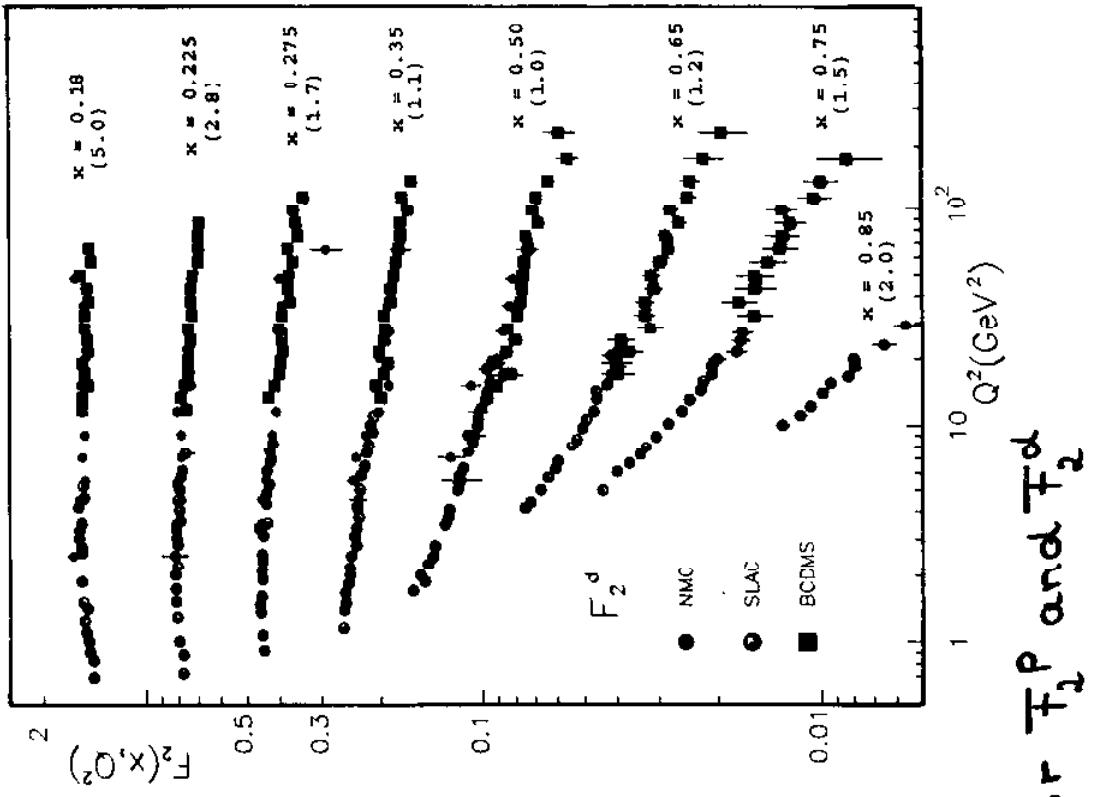
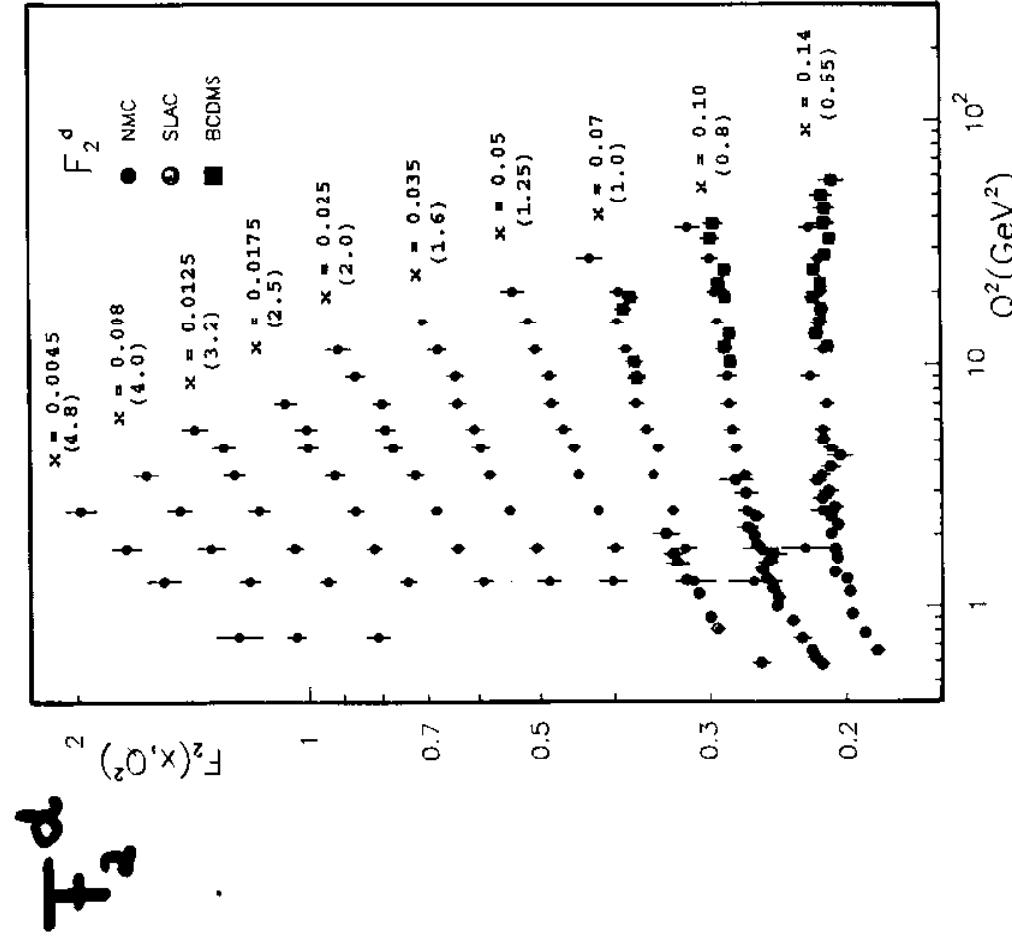
System errors



R_{NMC} used for $x < 0.12$, R_{SLAC} for $x \geq 0.12$

$$10^2 \quad Q^2 (\text{GeV}^2)$$

Comparison with SLAC / BCDMS data



- excellent agreement for F_1^P and F_2^d

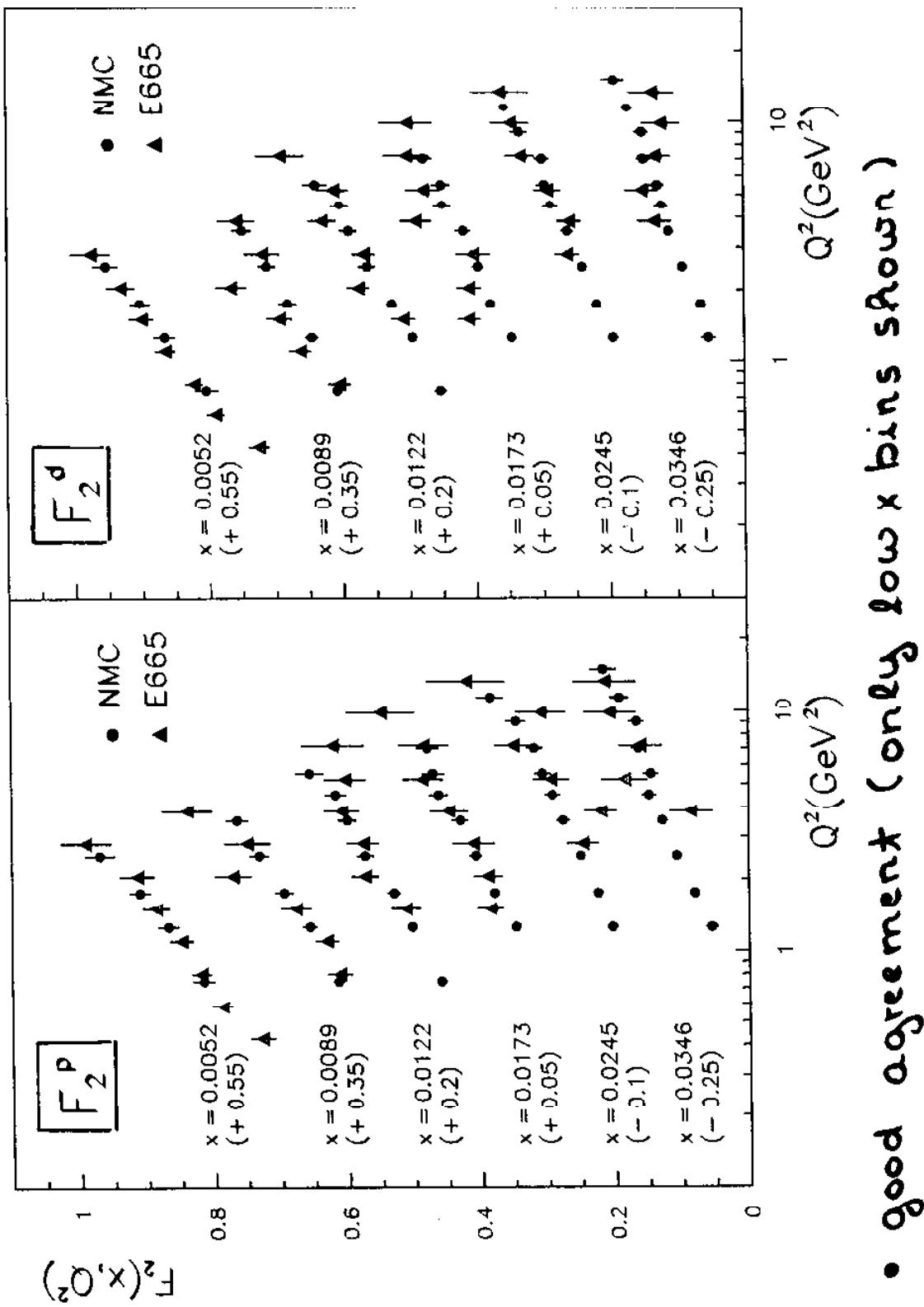
10² 10¹ 10⁰ 10⁻¹ 10⁻²

$Q^2(\text{GeV}^2)$

10² 10¹ 10⁰ 10⁻¹ 10⁻²

$Q^2(\text{GeV}^2)$

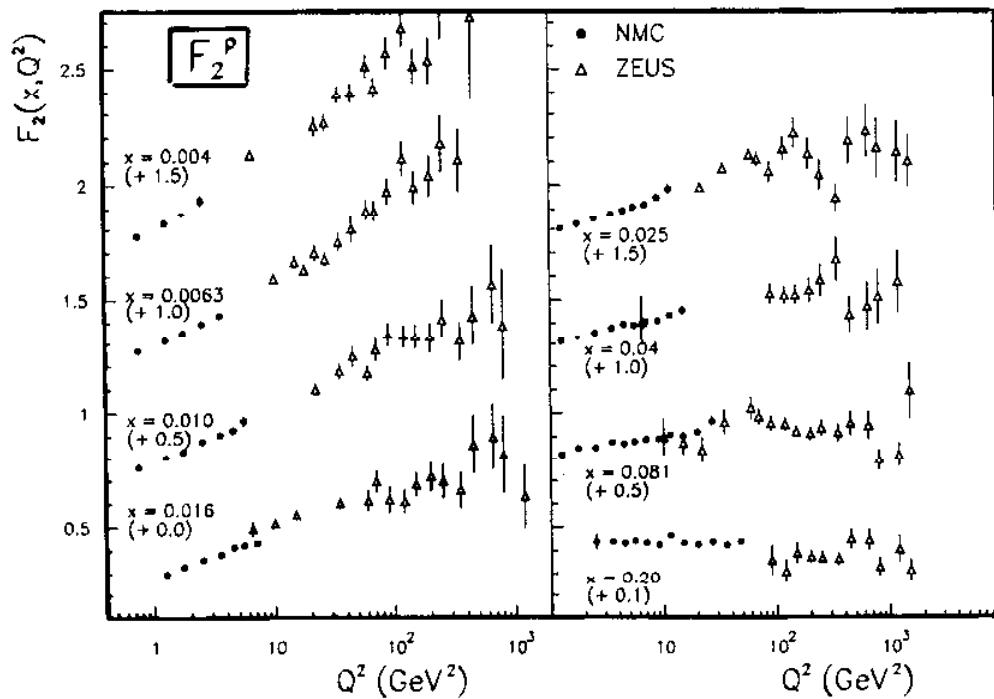
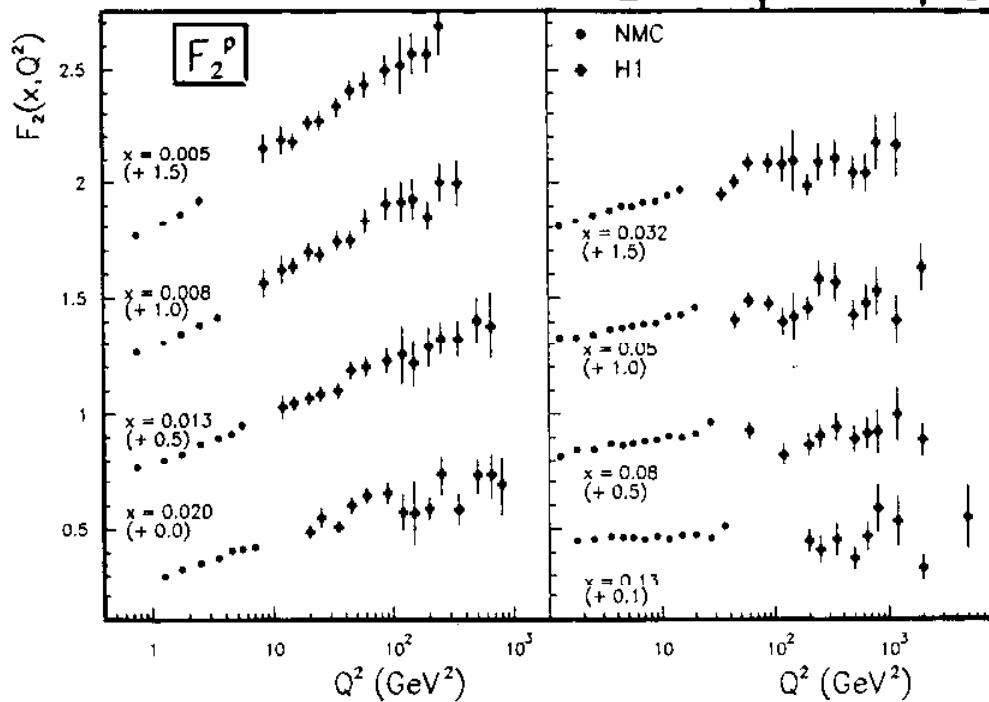
Comparison with E665 data



- good agreement (only low x bins shown)

Comparison with H1 and Zeus data

also very good agreement for F_2^P and F_2^d with E665, SLAC, BCDMS



Measurement of structure function ratios

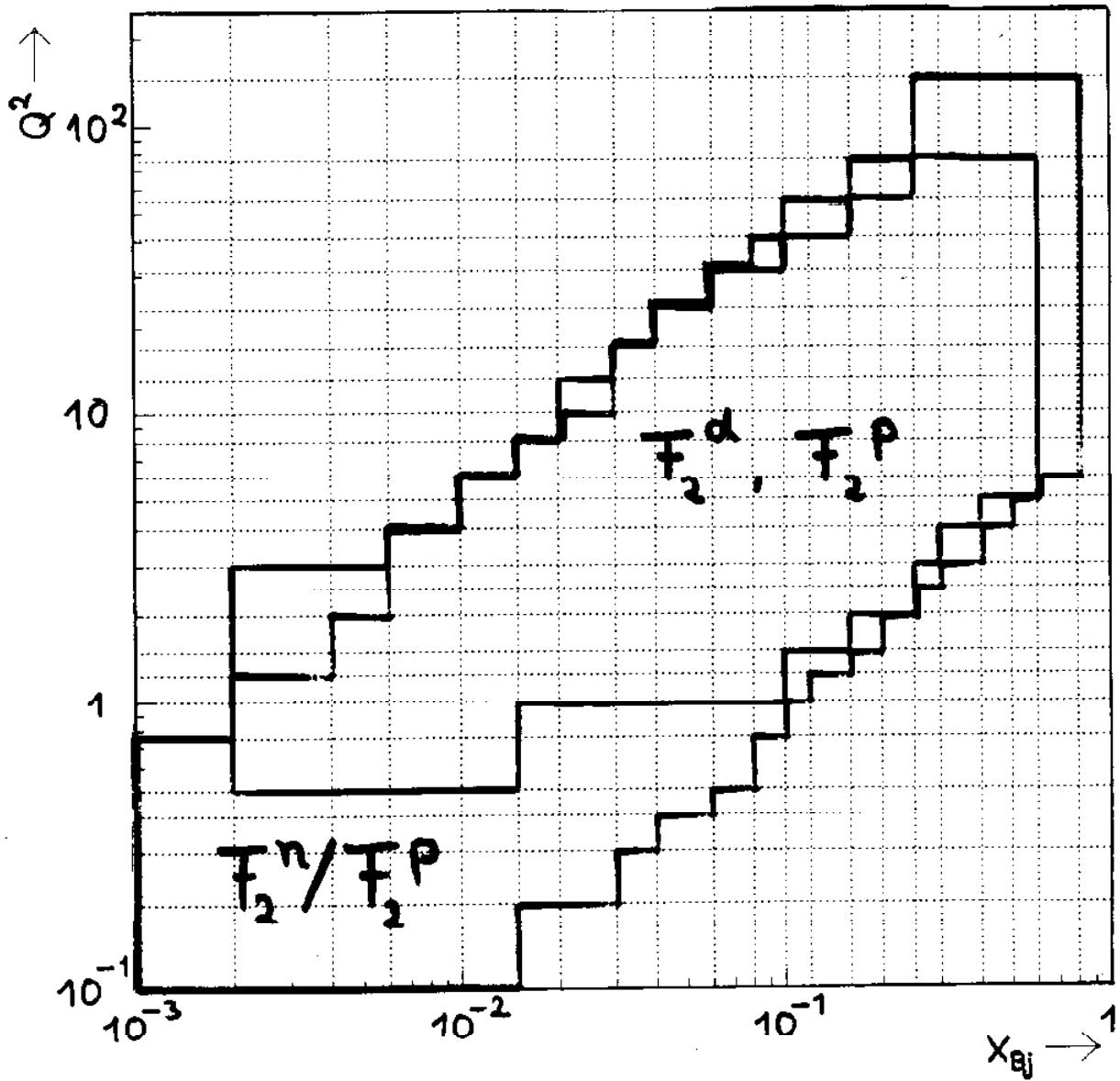
- complementary target setup
 - \Rightarrow cancellation of acceptance and flux
 - \Rightarrow no acceptance correction
 - \Rightarrow only small corrections to data
- extended kinematic range
 - due to use of all spectrometer comp and low acceptance regions
- main sources of systematic errors
 - radiative corrections
 - vertex migration
 - kinematic smearing
 - energy calibration
- normalisation errors typically $\approx 0.3\%$
- if measurements at ≥ 2 energies
 - \Rightarrow determination of $\Delta R = R^{F_1} - R^{F_2}$

via

$$\frac{F_1}{F_2}(E, x, Q^2) = \frac{F_2^{F_1}}{F_2^{F_2}}(x, Q^2) \left(1 - \frac{(1-\varepsilon)\Delta R}{(1+R)(1+\varepsilon R)}\right)$$

Kinematic range

- data at 90, 120, 200, 280 GeV



- Kinematic range for F_2^n/F_2^P

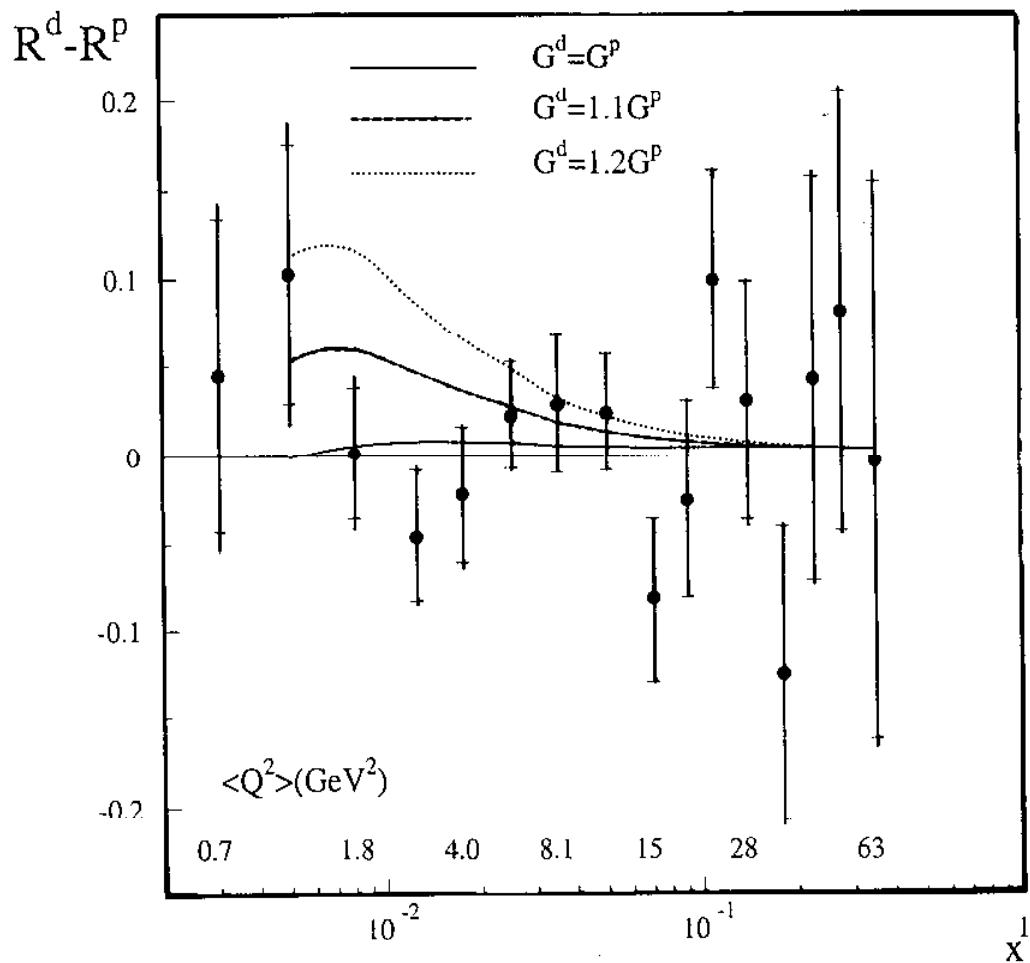
$$0.001 < x < 0.8, 0.1 < Q^2 < 145 \text{ GeV}^2$$

Results for proton and deuteron

- measurements at 4 energies:

$$\Delta R = R^d - R^p \quad \text{for} \quad 0.003 < x < 0.35$$

- systematic errors \ll stat. errors



- no x dependence

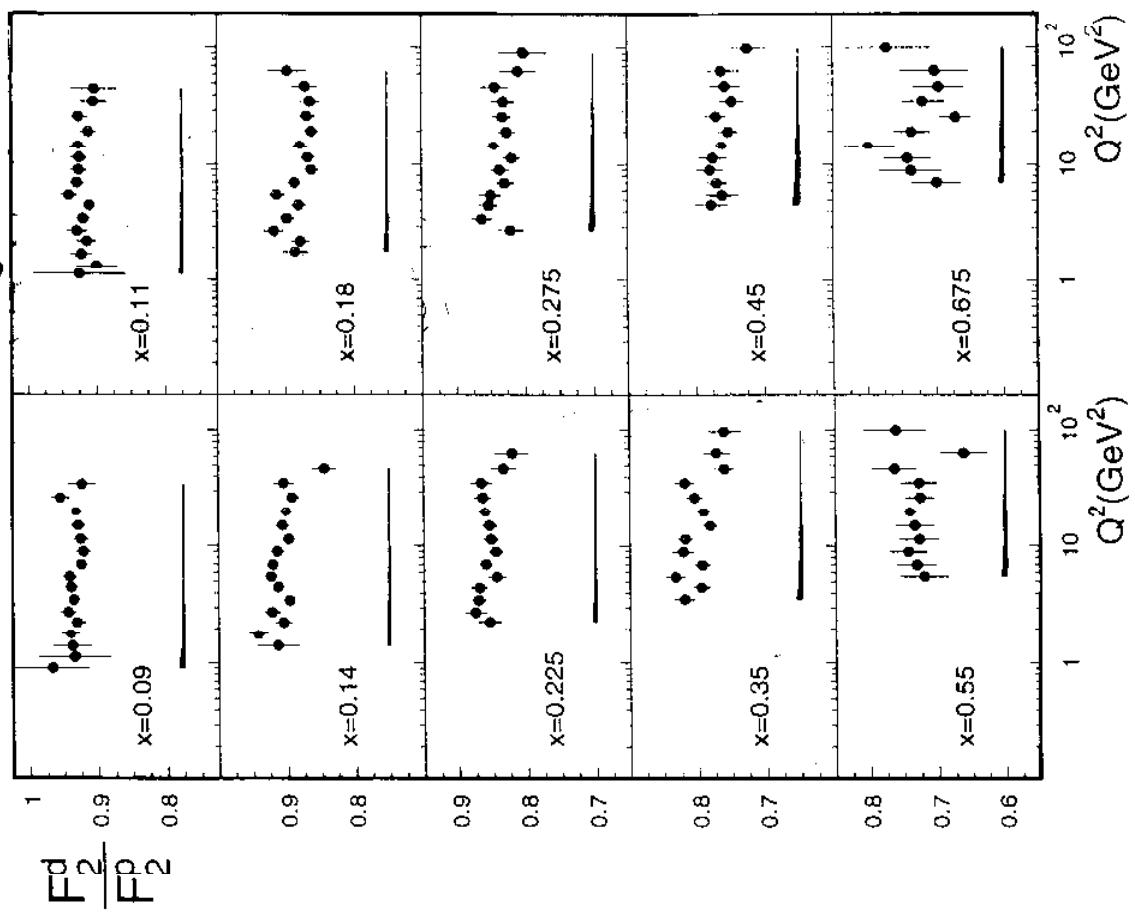
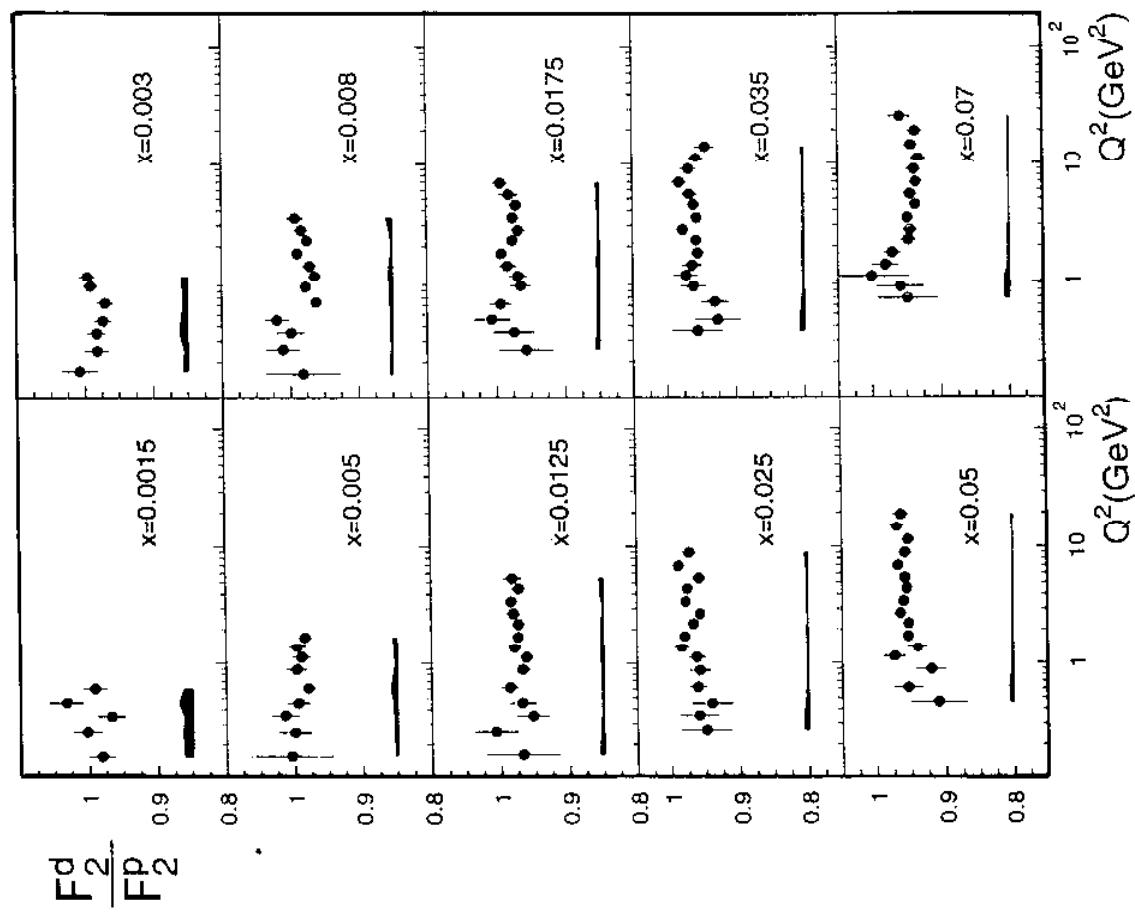
$$\Delta R = 0.004 \pm 0.012 \text{ (stat.)} \pm 0.011 \text{ (syst.)}$$

at $\langle Q^2 \rangle = 5 \text{ GeV}^2$

- no hint for sizeable diff. of gluondistr. in D and d

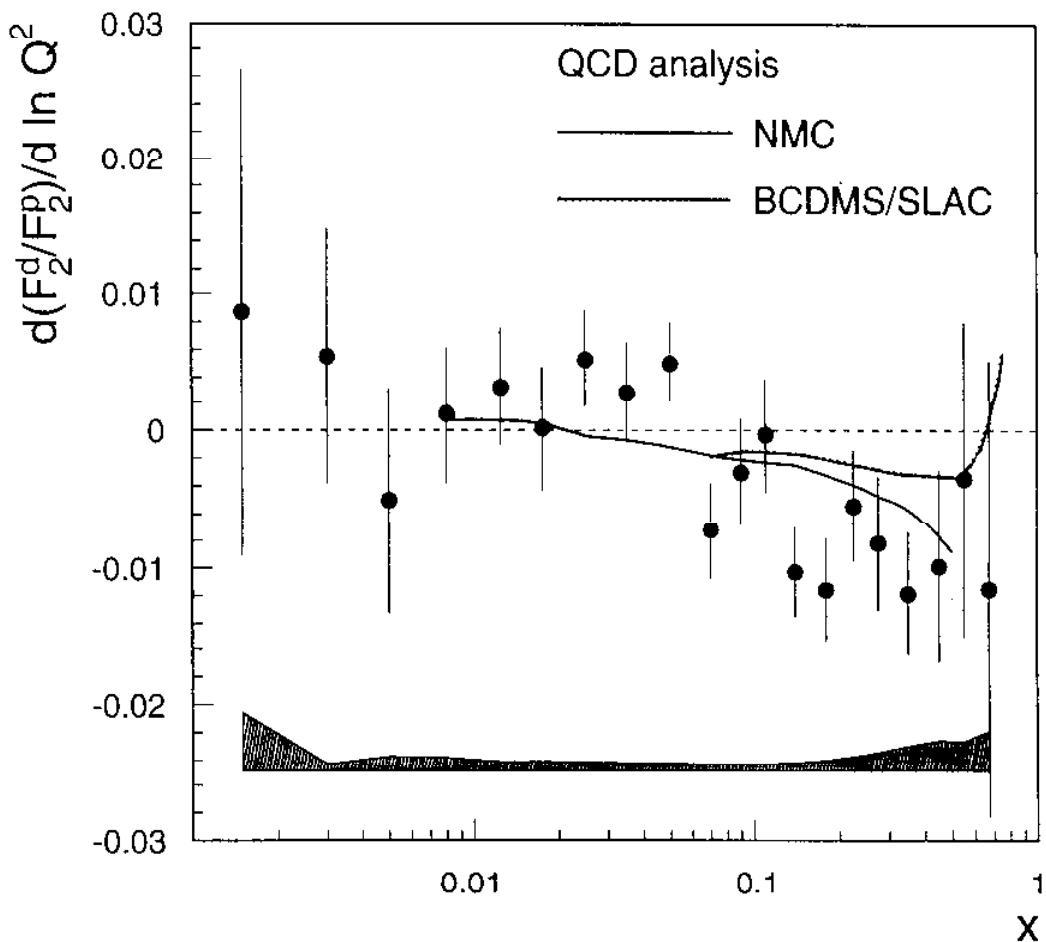
Result for F_2^d / F_2^p (x, Q^2)

— syst. errors



Results for $\frac{dF_2^d/F_2^p}{d \ln Q^2}$

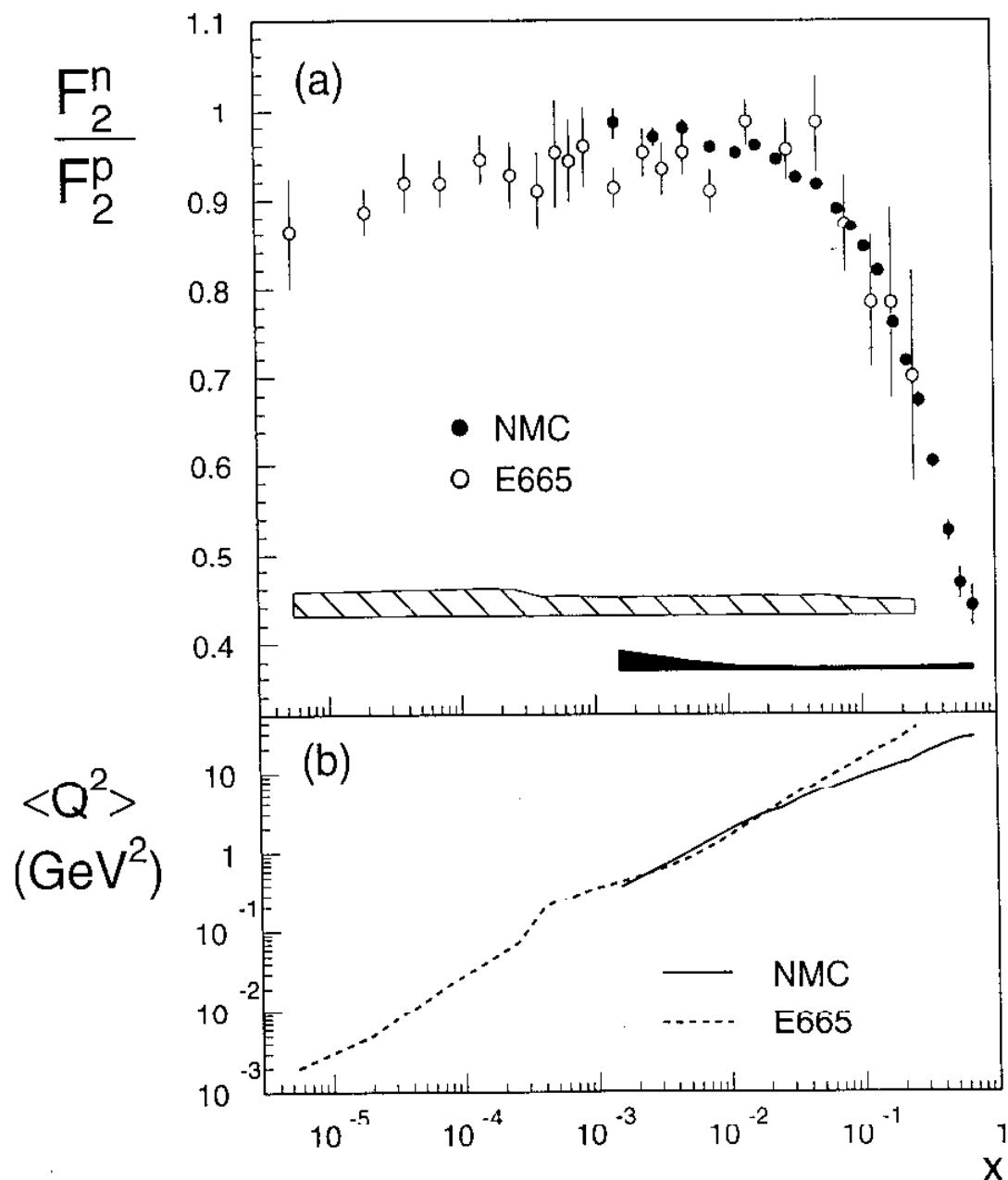
- F_2^d/F_2^p measured for $0.001 < x < 0.8$
 $0.1 < Q^2 < 145 \text{ GeV}$
- slope consistent with pQCD



- possible deviations for $x > 0.1$
 \Rightarrow higher twists ?

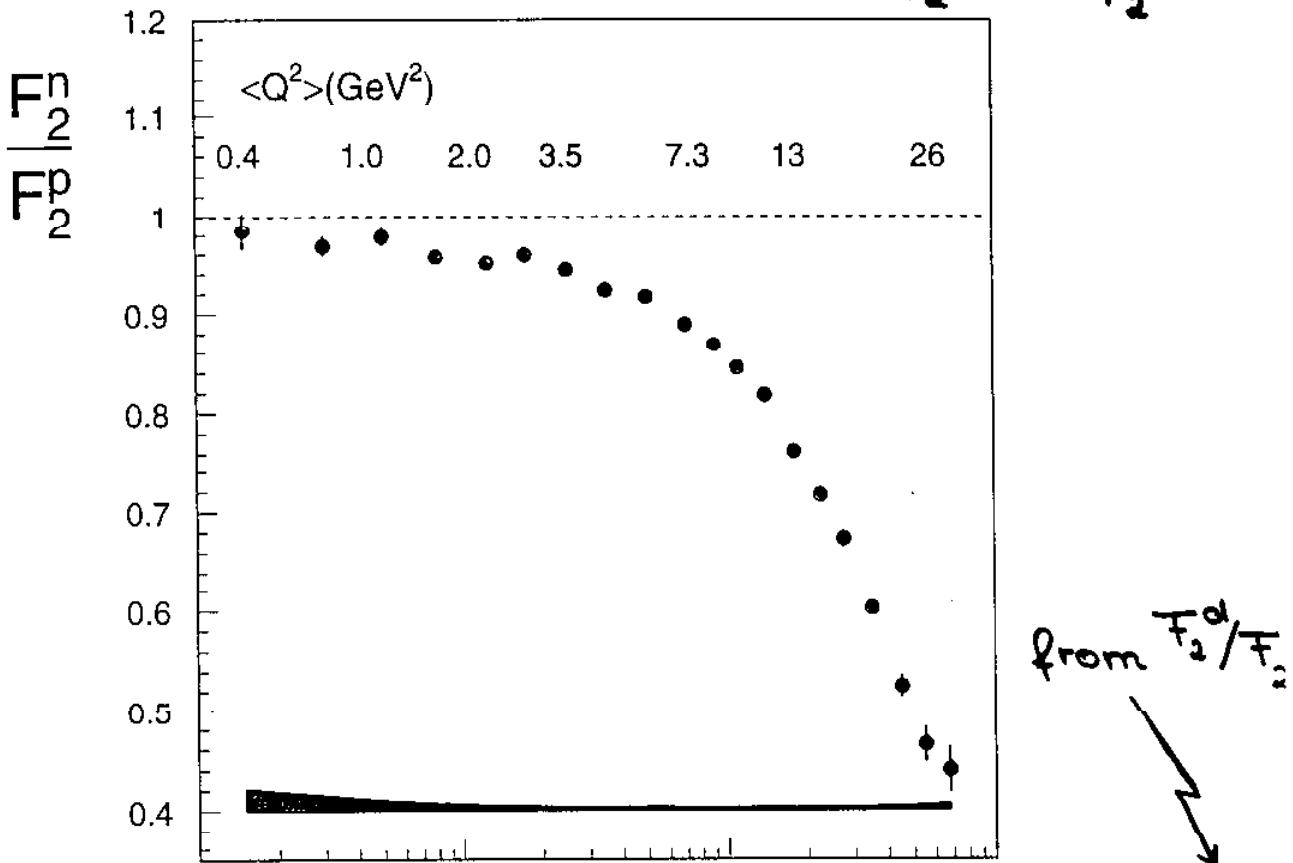
Comparison with E665 data

$$F_2^n/F_2^p = 2 F_2^d/F_2^n - 1$$



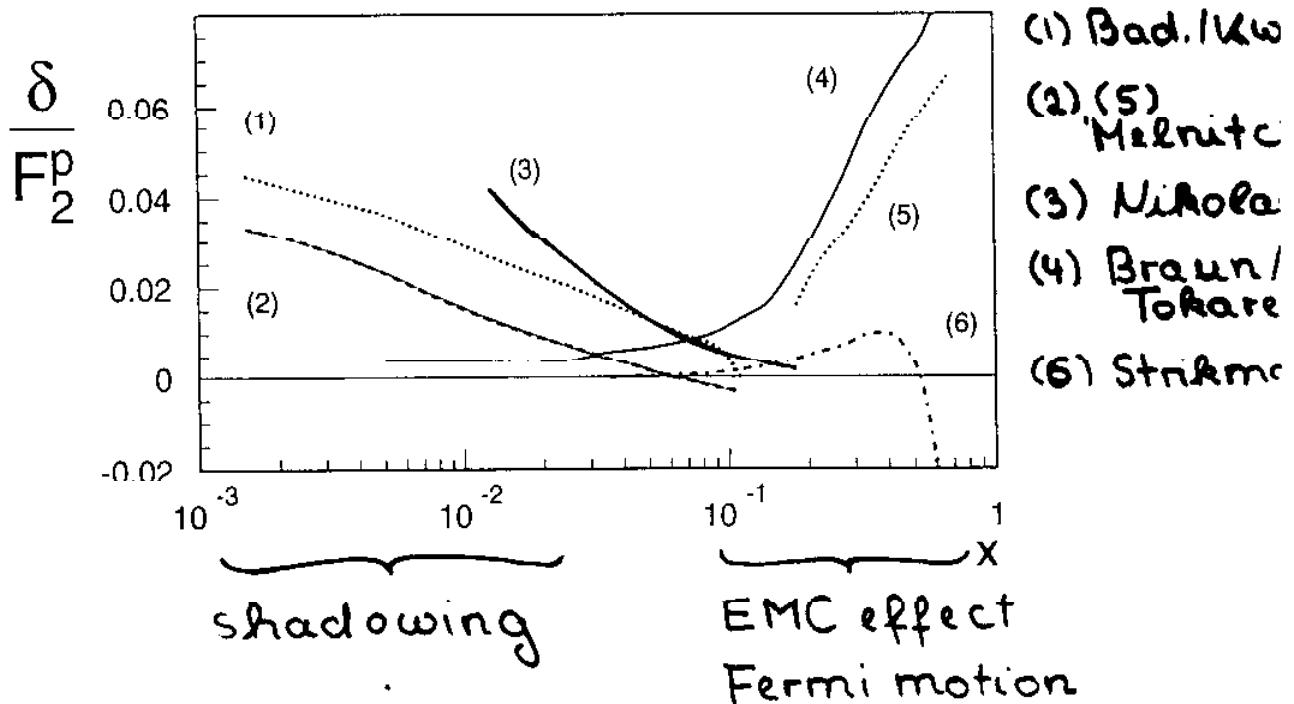
Results for $\frac{F_2^n}{F_2^p}(x)$

- nuclear effects neglected: $\frac{F_2^n}{F_2^p} = 2 \frac{F_2^d}{F_2^p} - 1$



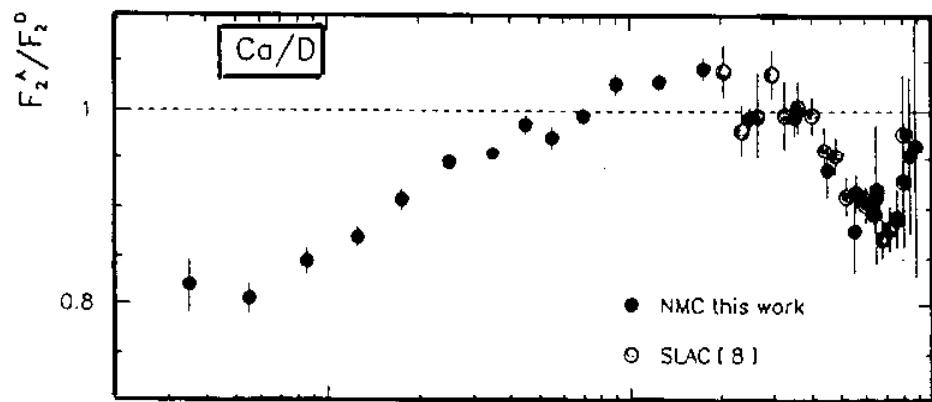
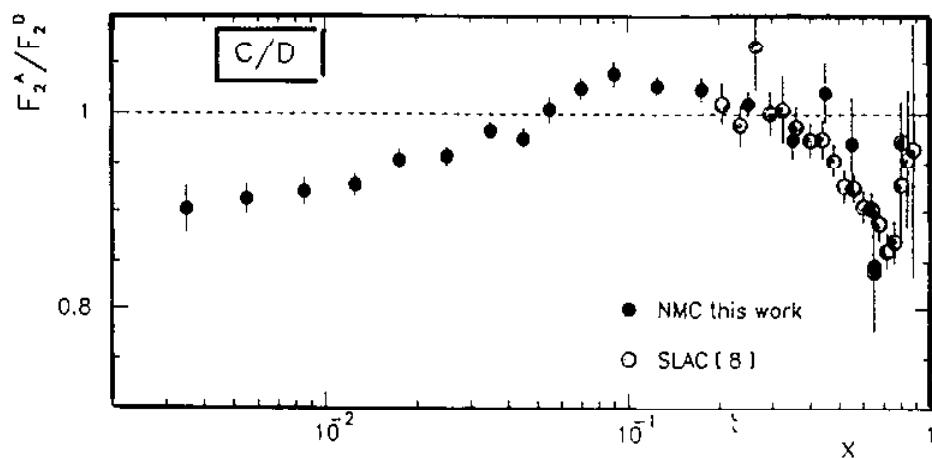
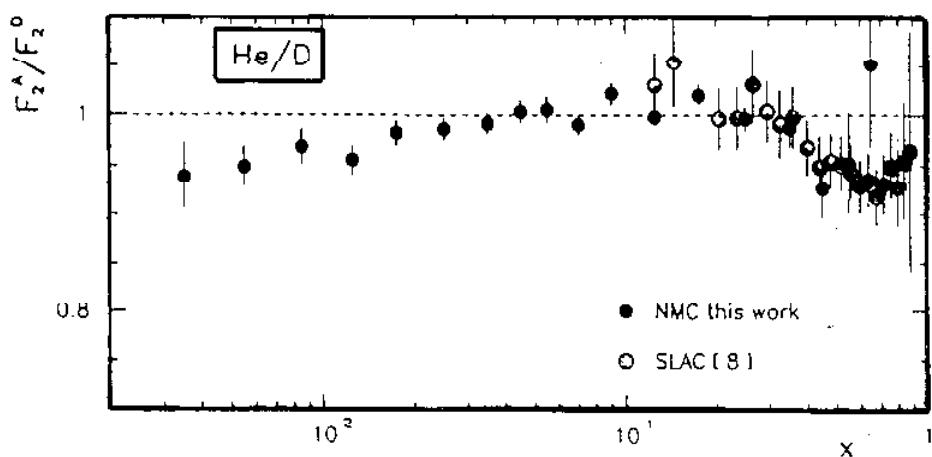
from $\frac{F_2^d}{F_2^p}$

- nuclear corrections ($\delta / F_2^p = (F_2^n / F_2^p)_{\text{free}} - F_2^n / F_2^p$)



Study of nuclear effects

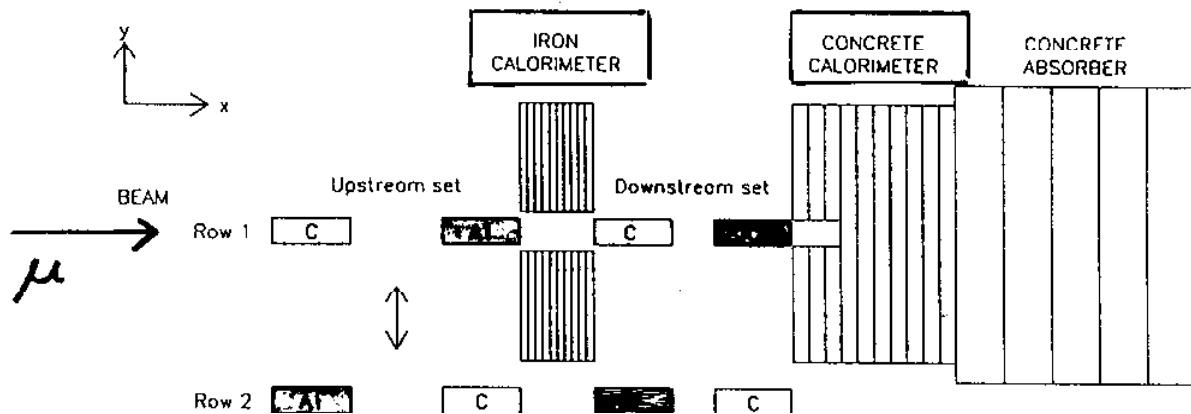
- precise measurement of x dep. of F_2^A/F_2^D at 200 GeV
- $R^A = R^D$ assumed



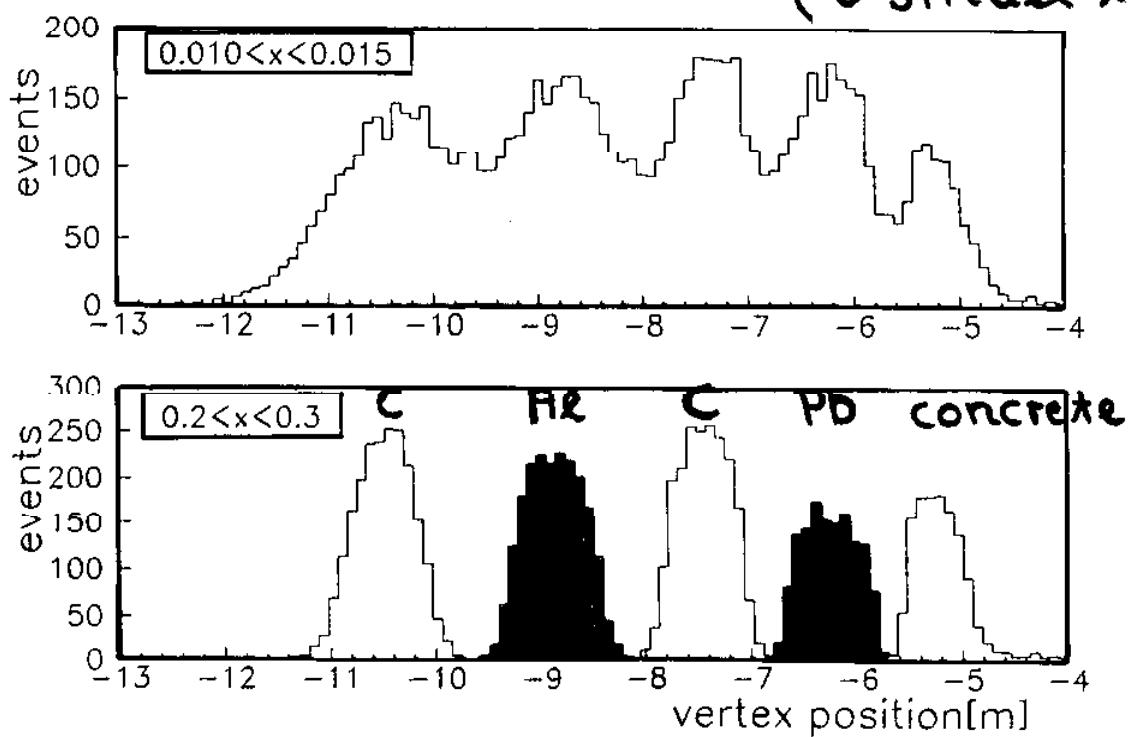
shadowing EMC effect xFermi motion

High luminosity measurements

- target thickness $\sim 600 \text{ g/cm}^2$
- active target with hadron absorption



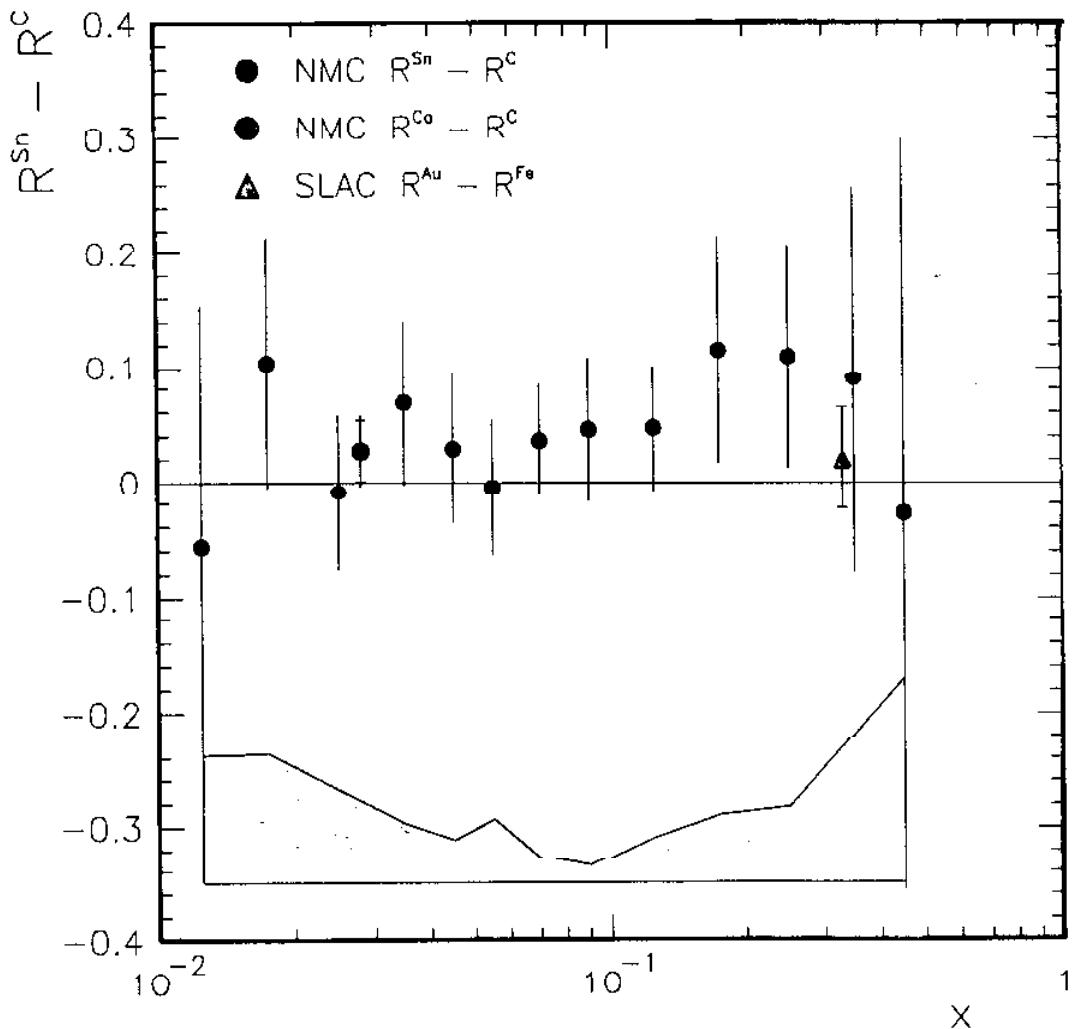
- problem: vertex resolution at low $p'\theta$
(\sim small x')



\Rightarrow tighter kinematic cuts
Detailed MC sim. of vertex migration

Results for $R^{Sn} - R^c(x)$

- measurement with C and Sn at 280, 200 and 120 GeV
- total $8.4 \cdot 10^6$ events



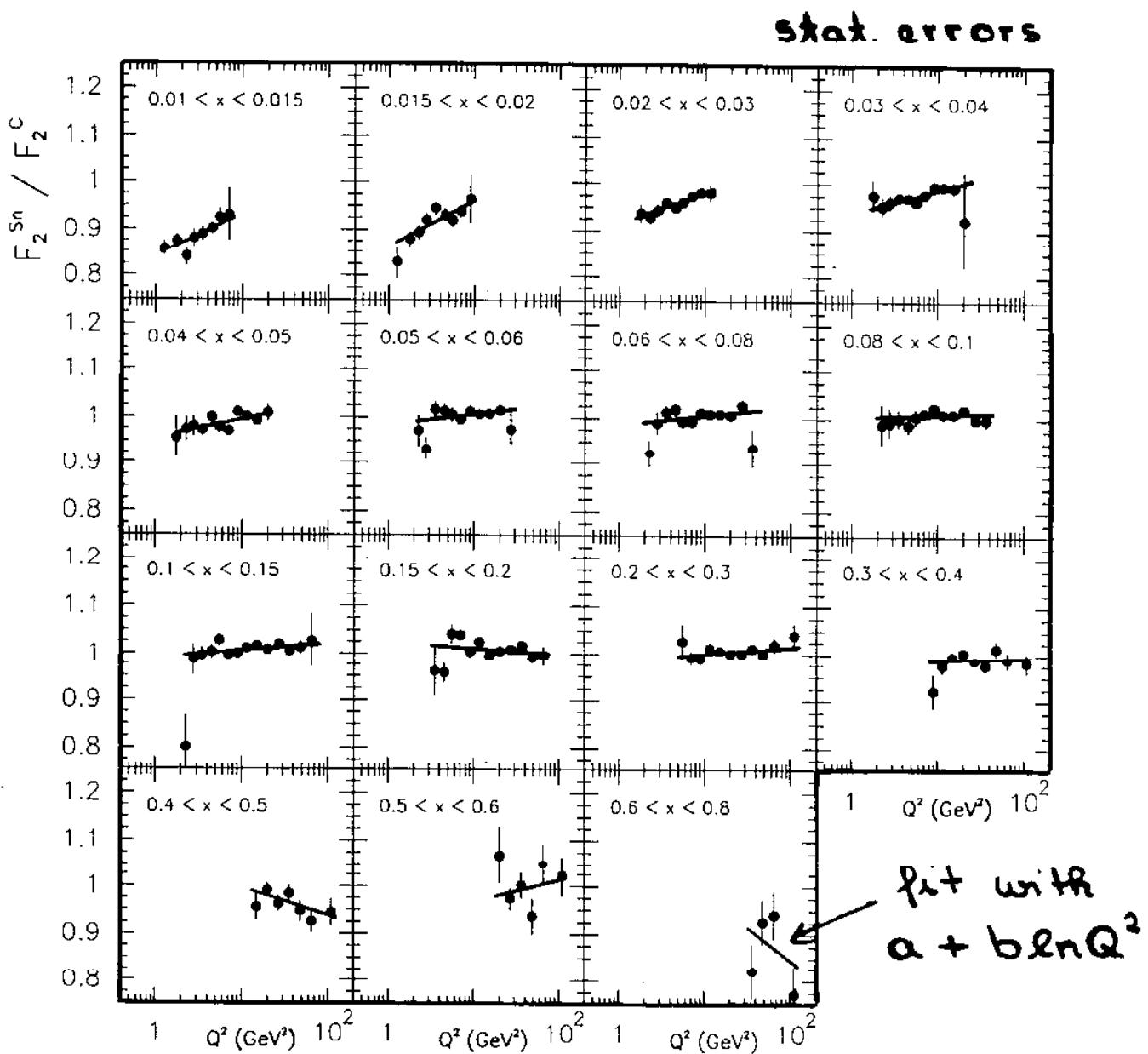
- no x dependence observed

$$\Delta R = 0.040 \pm 0.021 \text{ (stat.)} \pm 0.026 \text{ (syst.)}$$

Results for $F_2^{Sn}/F_2^C(x, Q^2)$

- kinematic range
- $R^{Sn} = R^C$

$0.01 < x < 0.8$
 $1 < Q^2 < 140 \text{ GeV}^2$

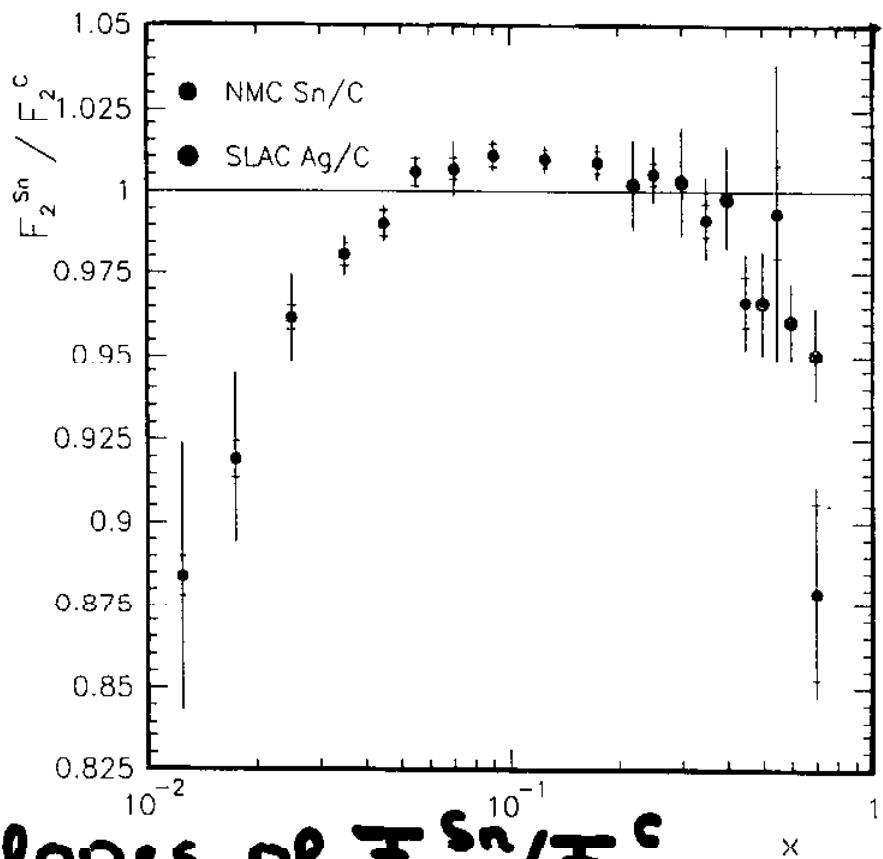


- systematic errors (main contributions):
 low x rad. correction, smearing (kinematic + vertex)

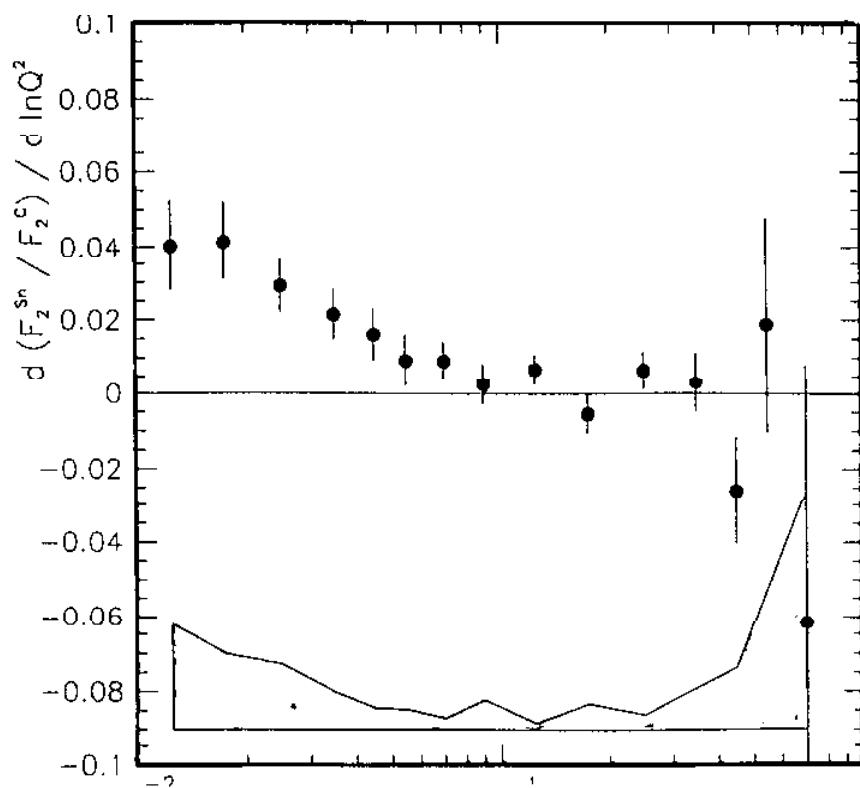
x-dependence of $F_2^{\text{Sn}}/F_2^{\text{C}}$

- 1

- significant enhancement of 1% at $x \approx 0.1$



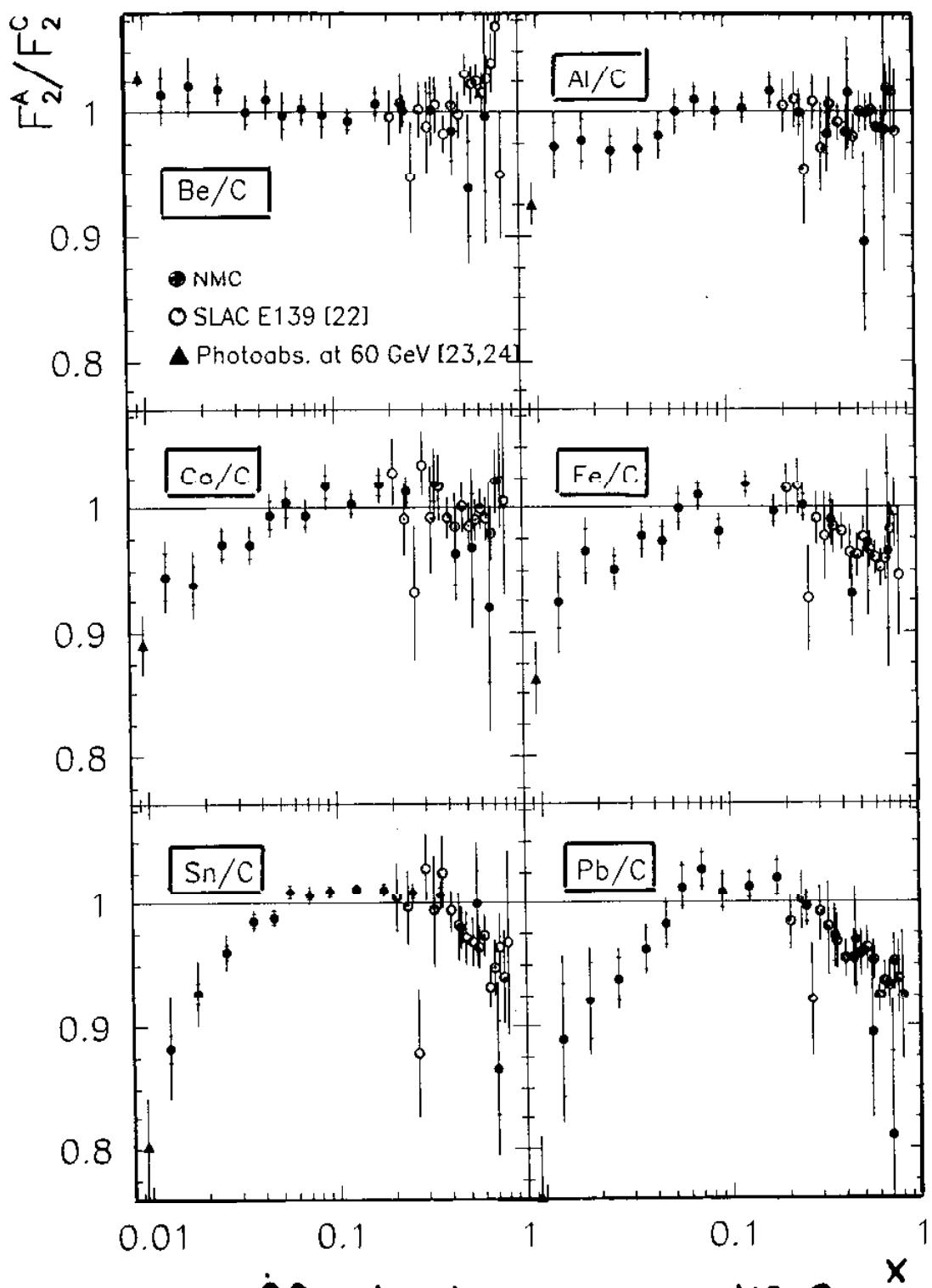
Q^2 -slopes of $F_2^{\text{Sn}}/F_2^{\text{C}}$



- signific. slopes at small Q^2
- compat. with pQCD expectat due to x-dependenc of F_2

Study of H dependence

- measurements with high luminosity
setup at 200 GeV
- Be, Al, Ca, Fe, Sn, Pb compared with C



- all nuclear effects increase with A