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Q.C.D fit, $F_2^{c\bar{c}}$ & F_L in H1

(already published topics)

- Fit Program used in H1
  ➡ contents & numerical precision
- 1993 & 1994 H1 F_2 fits
  ➡ difficulties
- $F_2^{c\bar{c}}$ measurement
  ➡ new informations
- F_L extraction

• Fit program •

- DGLAP eq. solved in x space
  - → N.LLA Kernels ($\overline{MS}$)
- 6 Parton density functions are evolved.
  - g
  - $\Sigma = \sum_{i=1}^{n} (q_i + \bar{q}_i)$
  - $Up^+ = u^+ + c^+ = (u + \bar{u} - \frac{\Sigma}{n}) + (c + \bar{c} - \frac{\Sigma}{n})$
    ($= u^+$ if $n=3$)
  - $\Delta^+ = u^+ - d^+ = (u + \bar{u}) - (d + \bar{d})$

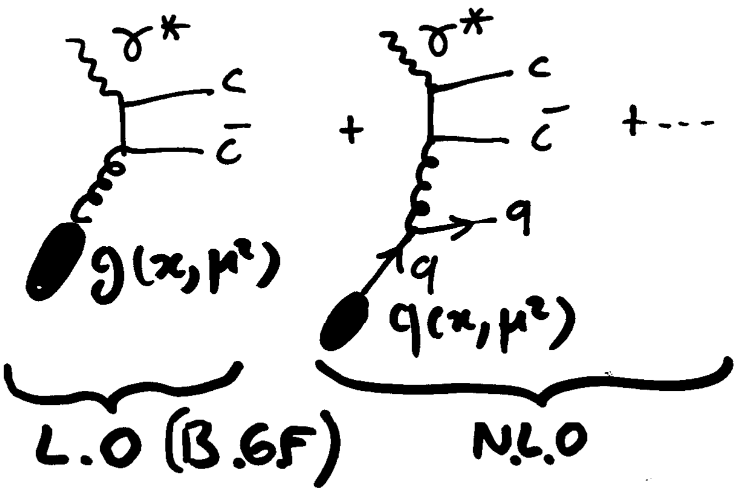
  (the first four: $F_2^{\ell^\pm p}$; all of them: $F_2^{\ell^\pm p}$ & $F_2^{\ell^\pm n}$)

  - $V^+ = u^- + d^- = u^v + d^v$
  - $V^- = u^- - d^- = u^v - d^v$

  (necessary for HERA ↗Q^2 X-section)
- P.d.f ⊗ L.O Wilson coefficients
  - → $F_2^{\ell^\pm p}, F_2^{\ell^\pm n}, \ldots$ For light partons

- HEAVY quarks
  - Fixed Flavor Scheme : $n = 3$ ("$b = 0$")

$F_2^{c\bar{c}}$:



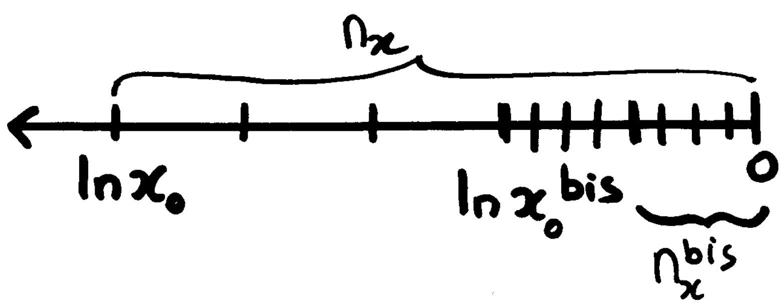
(• Massless prescription)

- numerical details
  - x net equidistant in $\ln x$
  - P.d.F expended using Lagrange (hat) basis functions ($\Leftrightarrow$ linear interpolation of pdf)

$\Rightarrow$ DGLAP solution without troncated series.
& C.P.U $\propto n_x^2$ (instead of n_x^3)

- Precision improvement at high-x

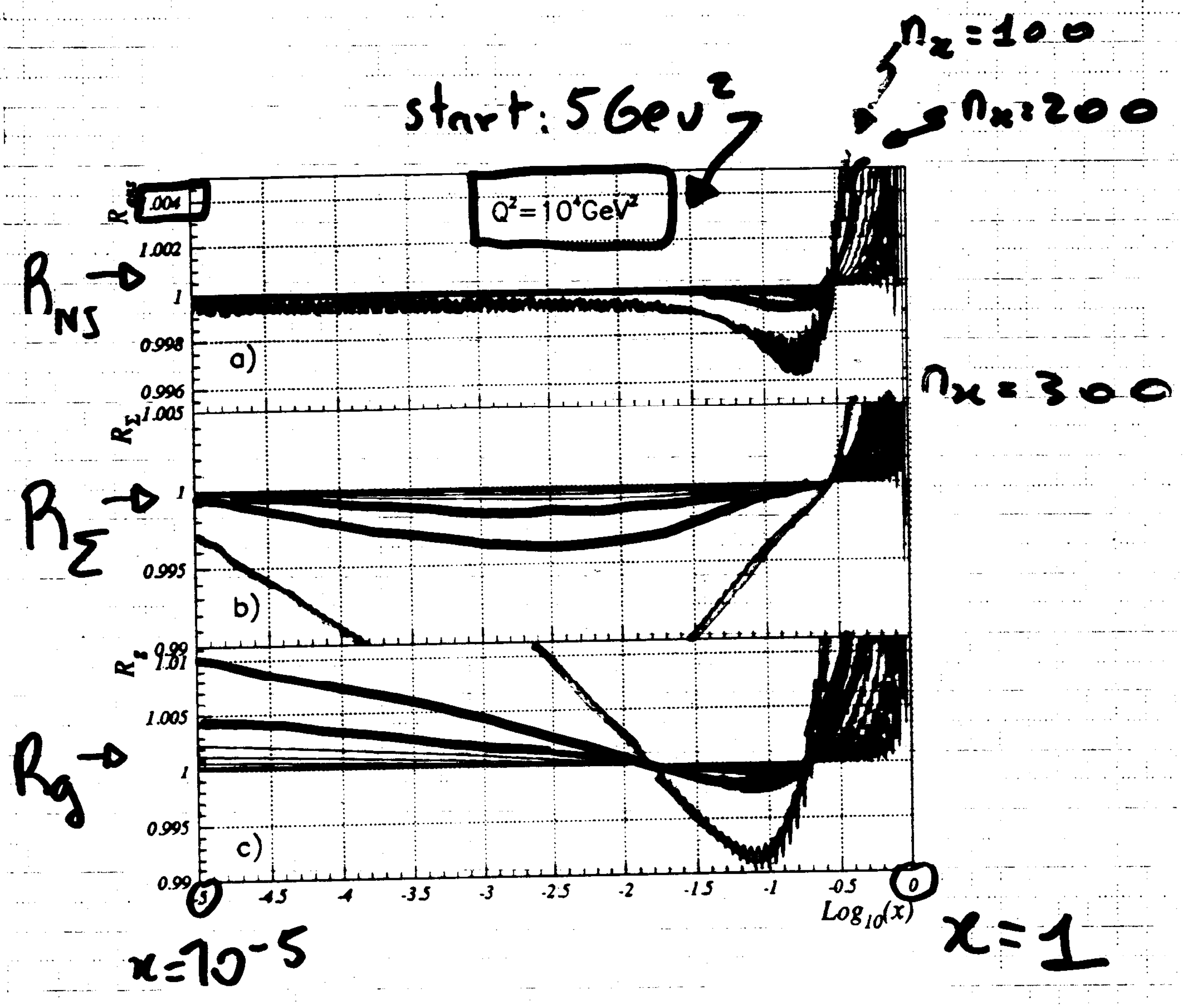
$\Rightarrow$ Second x-net introduced



$\Rightarrow$ For $x_0 = 10^{-5}$:

$\underbrace{n_x = 50, n_x^{bis} = 6}_{\text{minimum search}} \longrightarrow \underbrace{n_x = 250, n_x^{bis} = 6}_{\text{Final result}}$

$$R_{pdf} = \frac{pdf(n_x)}{pdf(n_x = 900)} \quad \begin{matrix} \leftarrow \text{less precise} \\ \leftarrow \text{"more" precise} \end{matrix}$$



$n_x = 100$

$n_x = 200$

$n_x = 300$

$\vdots$

$n_x = 900$ $\quad (R_{pdf} \equiv 1)$

- χ^2 definition

$$\chi^2 = \sum_{\substack{exp,\\ data}} \frac{\left(\frac{F_2^{QCD}}{\left[1+\sum_i \delta_{data}(\Delta_i)+n_{exp}\right]} - F_2^{data} \right)^2}{\sigma_{stat.}^2 + \sigma_{uncor.}^2} + \sum_i \Delta_i^2 + \sum_{exp} n_{exp}^2$$

- with

$\delta_{data}(\Delta_i)$ = F_2 relative shift induced by Δ_i standard deviations of the i^{th} syst.

n_{exp} = overall normalization standard deviatio

- ⇒ IN H1 1993 & 1994 F_2 analysis:

  - $\Delta_i \equiv 0$ (BUT $\frac{\partial \chi^2}{\partial \Delta_i} \neq 0$ ⇒ error band)

  - n_{exp} : fitted

- **Gluon** error band

$$\Delta G^{\pm}\Big|_{x_i, Q_i^2} = \Big| G(\{p_0\}) - G(\{p_0 \pm \Delta p\}) \Big|$$

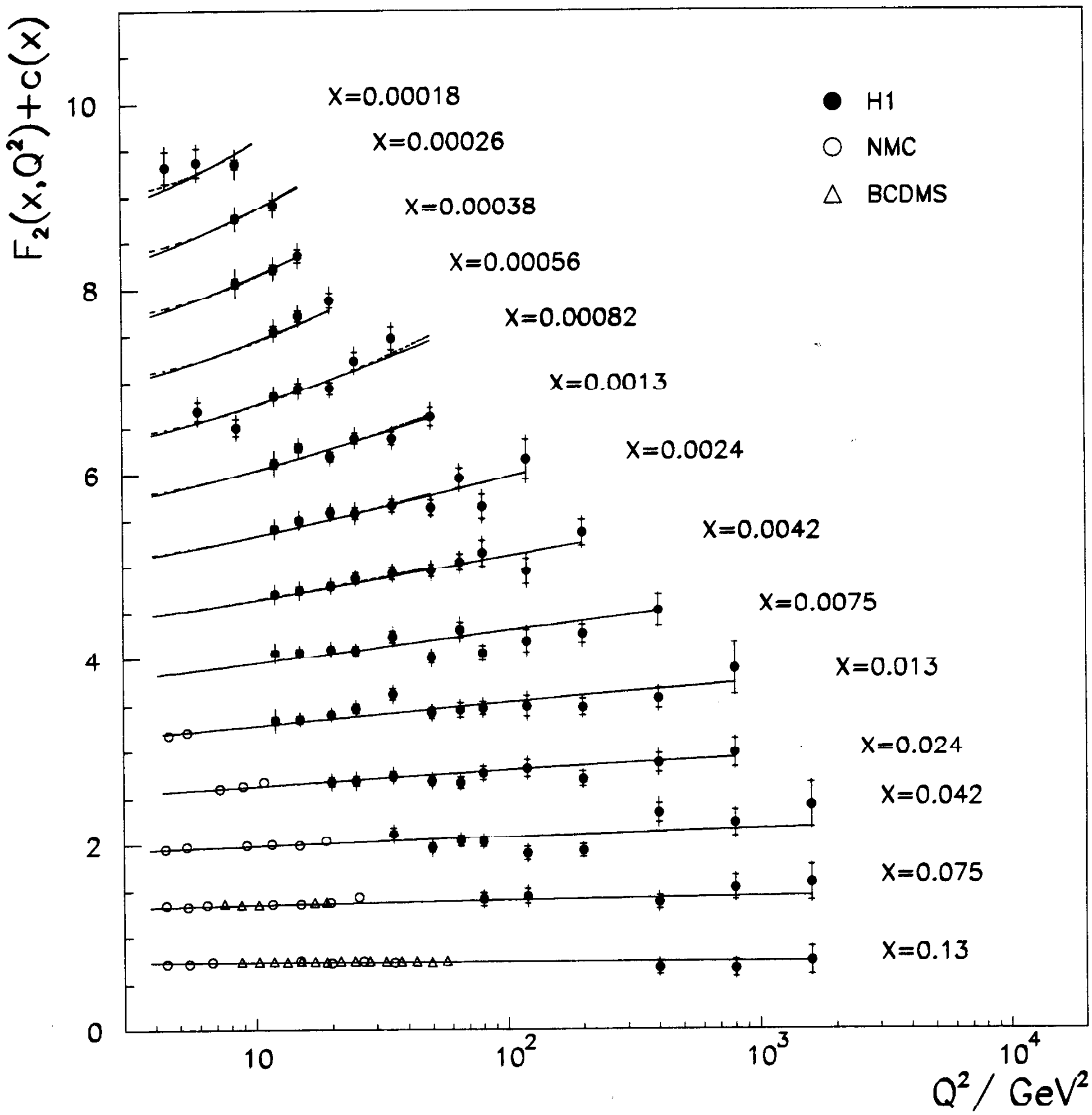
- with

$$\Delta p_i = \frac{\left[M^{-1} + M^{-1} C C^T M^{-1}\right] \frac{\partial \vec{G}}{\partial p}}{\sqrt{\frac{\partial \vec{G}}{\partial p} \cdot \left(M^{-1} + M^{-1} C C^T M^{-1}\right) \frac{\partial \vec{G}}{\partial p}}}$$

- $M_{ij} = \frac{1}{2} \frac{\partial^2 \chi^2}{\partial p_i \partial p_j}$; $C_{ij} = \frac{1}{2} \frac{\partial^2 \chi^2}{\partial p_i \partial a_j}$ ↳ systematics.

⇒ IF a_i fitted ; C does not exist.

H1 1993 data analysis



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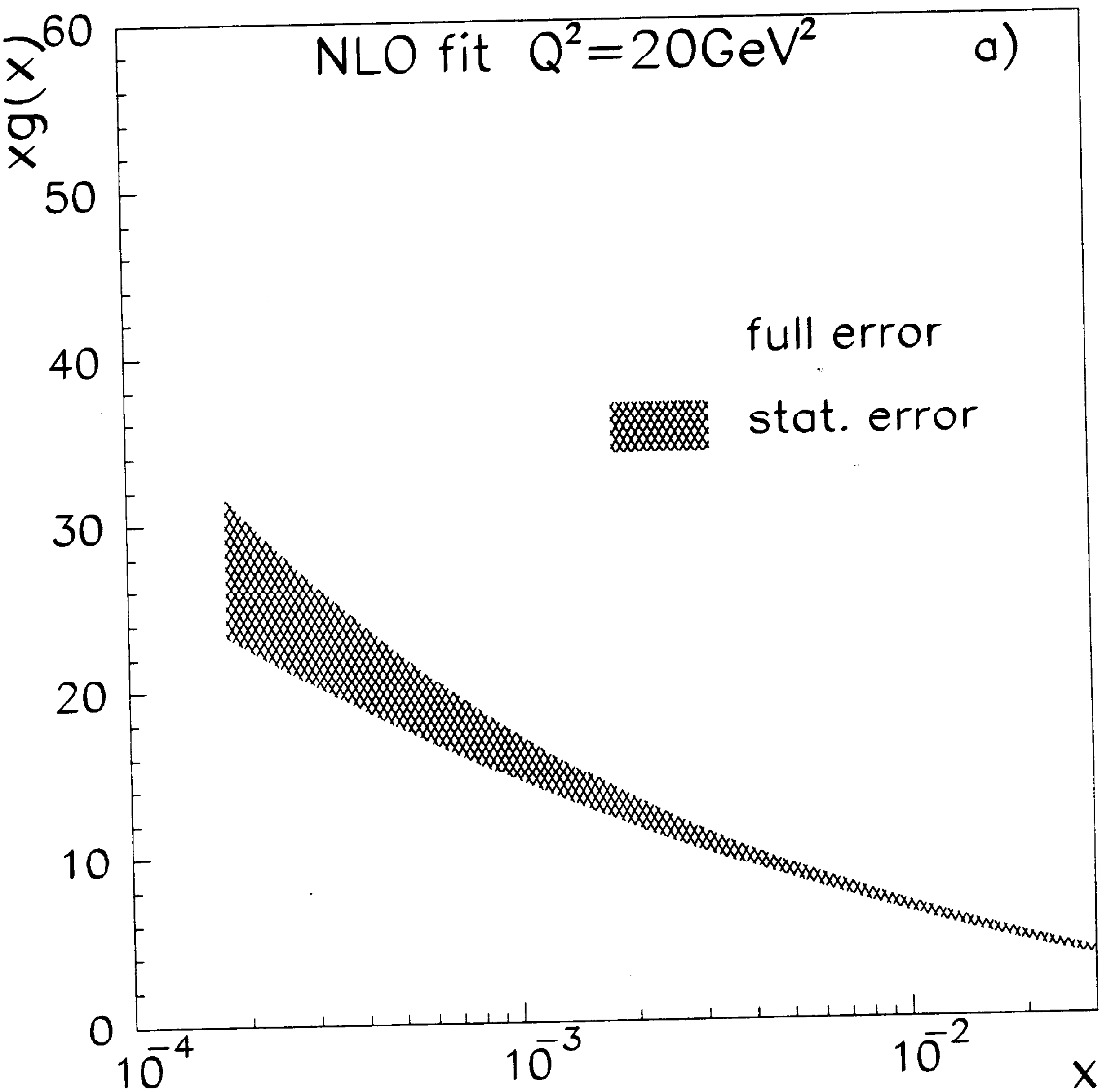
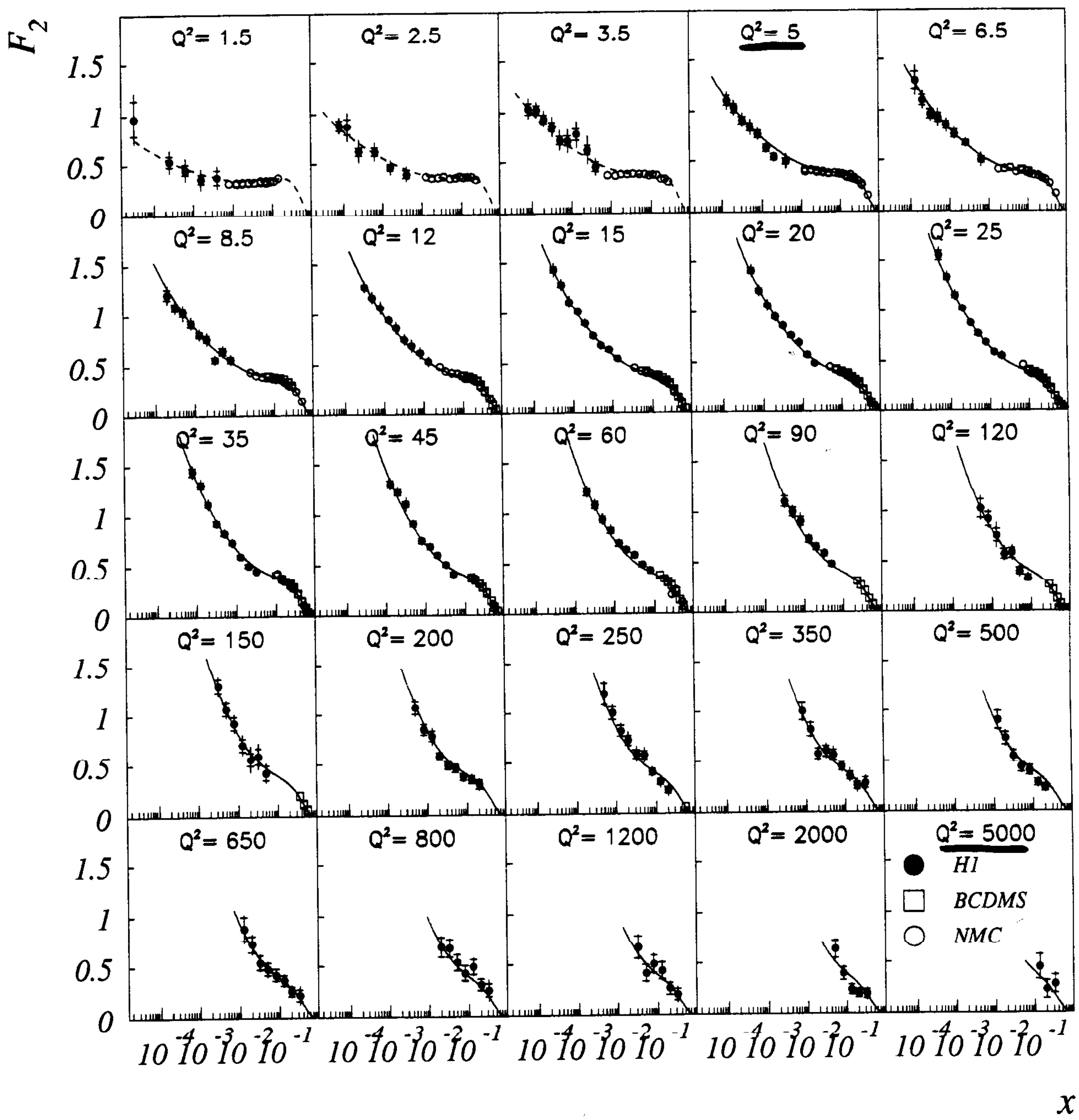
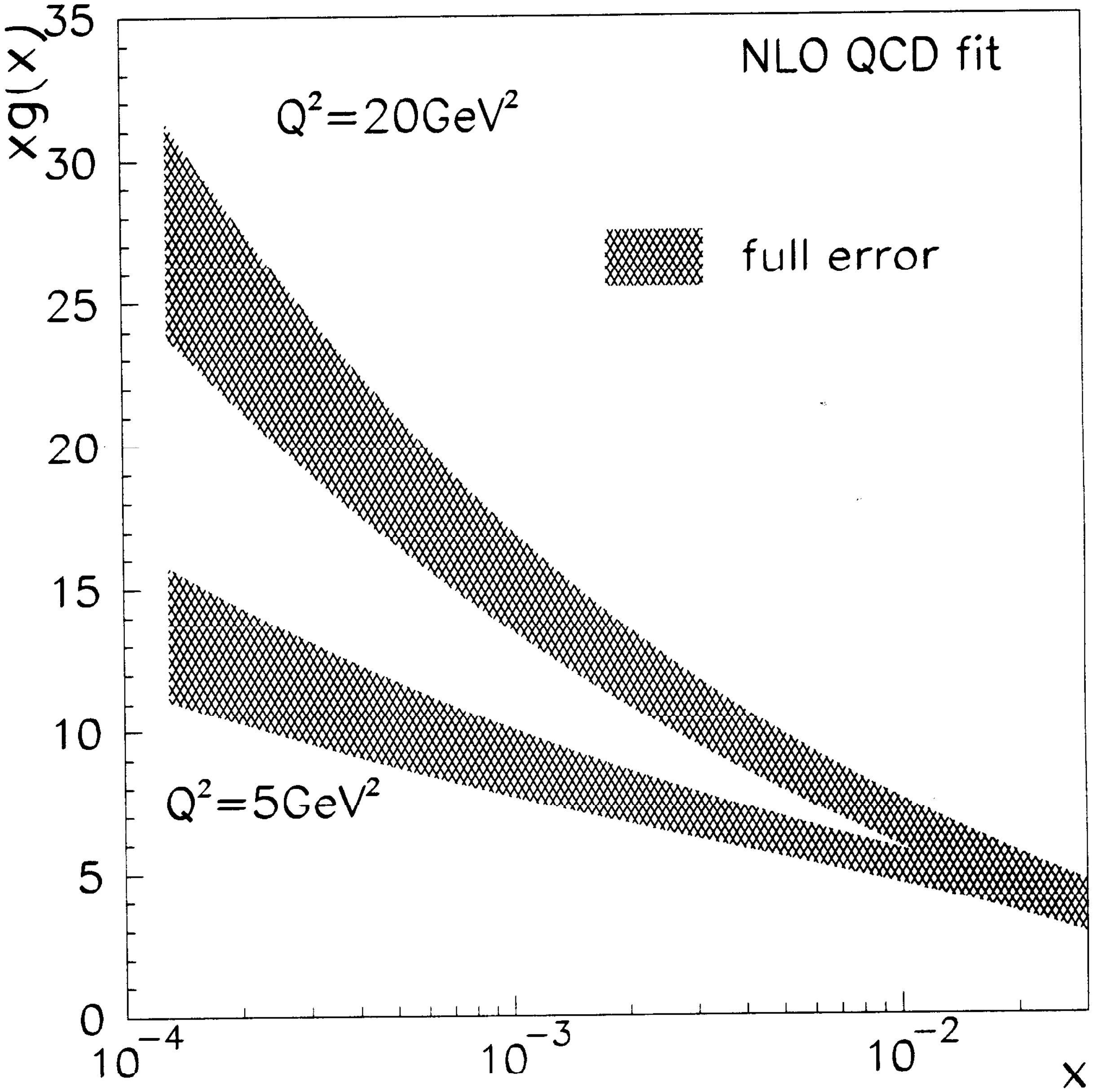
H1 1993 data analysis



H1 1994 data analysis



H1 1994 data analysis



- Difficulties

- 1993 analysis

  - F_2^p data only

  - xg, $x\Sigma$ & xu^+ parametrized at

    $Q_0^2 = 4\,GeV^2$ $\quad (\Lambda^{(4)}_{\overline{MS}} = 255\,MeV)$

  - with

$$\int_0^1 dx\,(xg + x\Sigma) = 1$$

&

$$\int_0^1 dx\,(xg) = 0.44 \text{ at } Q_0^2$$

(0.44 → (NMC result))

(!) ⇒ IF not: $\int_0^1 dx\,(xg) \longrightarrow 0.6\ \ldots$

- 1994 analysis
- F_2^p & F_2^D data

➡ Counting rules on u_v & d_v

- But : $\bar{u} = \bar{d} = 2Q$ ....

(!) ➡ $x g(x, Q_0^2 = 5\,\text{GeV}^2) = 2.24\, x^{-0.2} (1-x)^{8.52}$

(!) inconsistent with Prompt γ data

- Question.

- Can we "blindly" parametrize xg, $x\Sigma$, xU^+, $x\Delta^+$ and extract α_s ?

- can we still use the F.F.N.S for heavy(s) quark(s)?

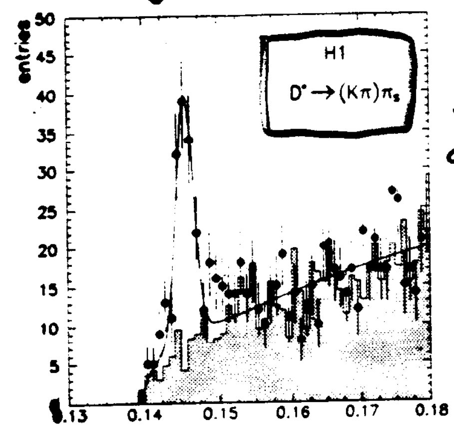
• $F_2^{c\bar{c}}$ •

- **Measurement:** $10\ \text{GeV}^2 \leq Q^2 \leq 100\ \text{GeV}^2$
  $y_e < 0.53$

- **Signature**

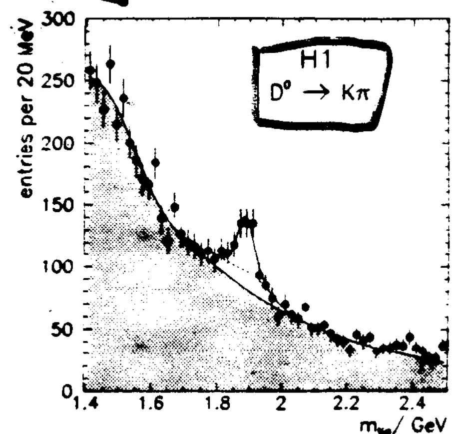
$ep \to e D^* X$, $D^* \to D^0 \pi_{slow}$, $D^0 \to K\pi$

$ep \to e D^0 X$, $D^0 \to K\pi$



$(m_{K\pi\pi} - m_{K\pi})/\text{GeV}$

$\mathcal{L}_{int} = 2.7\ pb^{-1}$



$m_{K\pi}/\text{GeV}$

$$\frac{d\sigma}{dx\,dQ^2}(ep \to eDX)$$

⇓ $(P(c \to D) \times B_r)$

$$\frac{d\sigma}{dx\,dQ^2}(ep \to ec\bar{c}X) \Longrightarrow F_2^{c\bar{c}}(x, Q^2)$$

$(R=0)$

- Massless Versus Massive Prescription

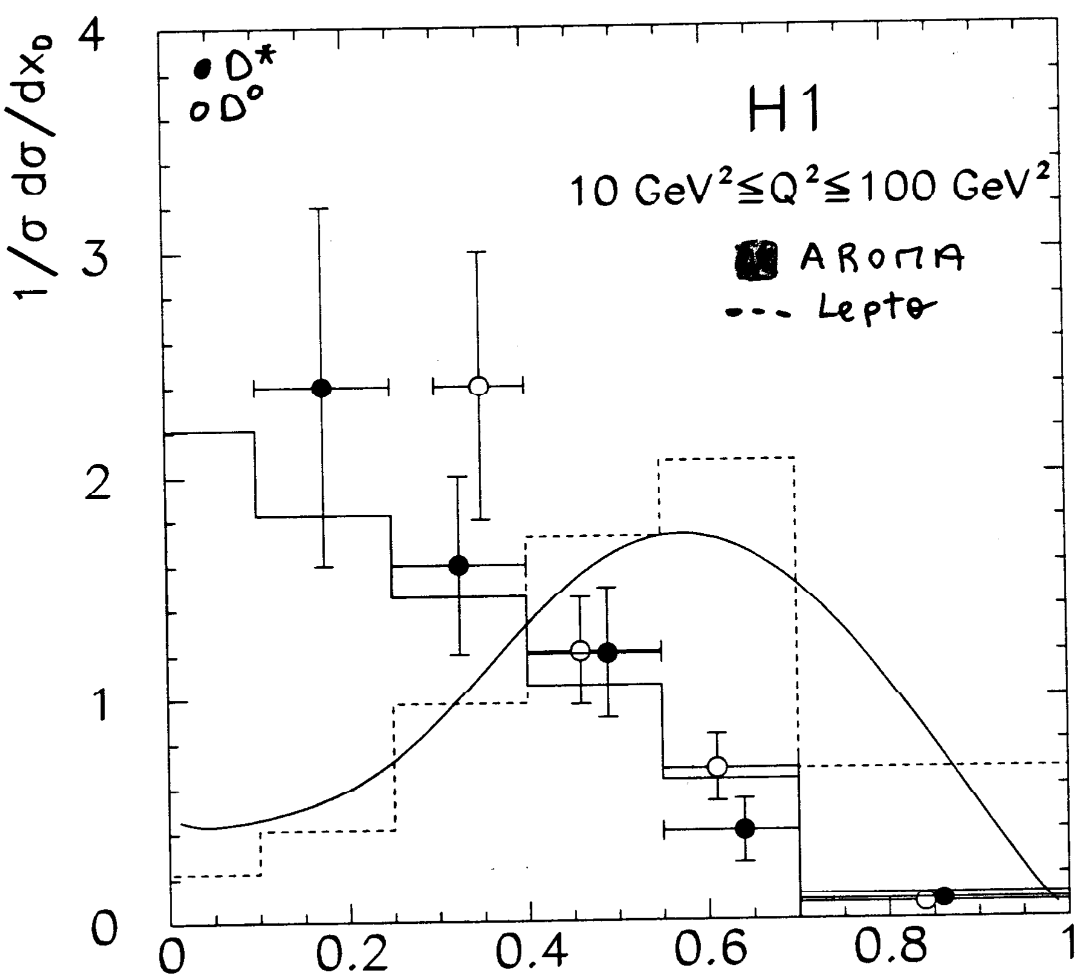
Massless ↓ LEPTO M.C (massless M.E.+P.S.)

Massive ↓ AROMA M.C (L.O B.G.F + P.S.)

➡ Fit: $\frac{1}{\sigma}\frac{d\sigma}{dx_D} = (1-\varepsilon)\frac{1}{\sigma}\frac{d\sigma}{dx_D}\Big|_{BGF} + \varepsilon\frac{1}{\sigma}\frac{d\sigma}{dx_D}\Big|_{massless}$

to Fragmentation distribution

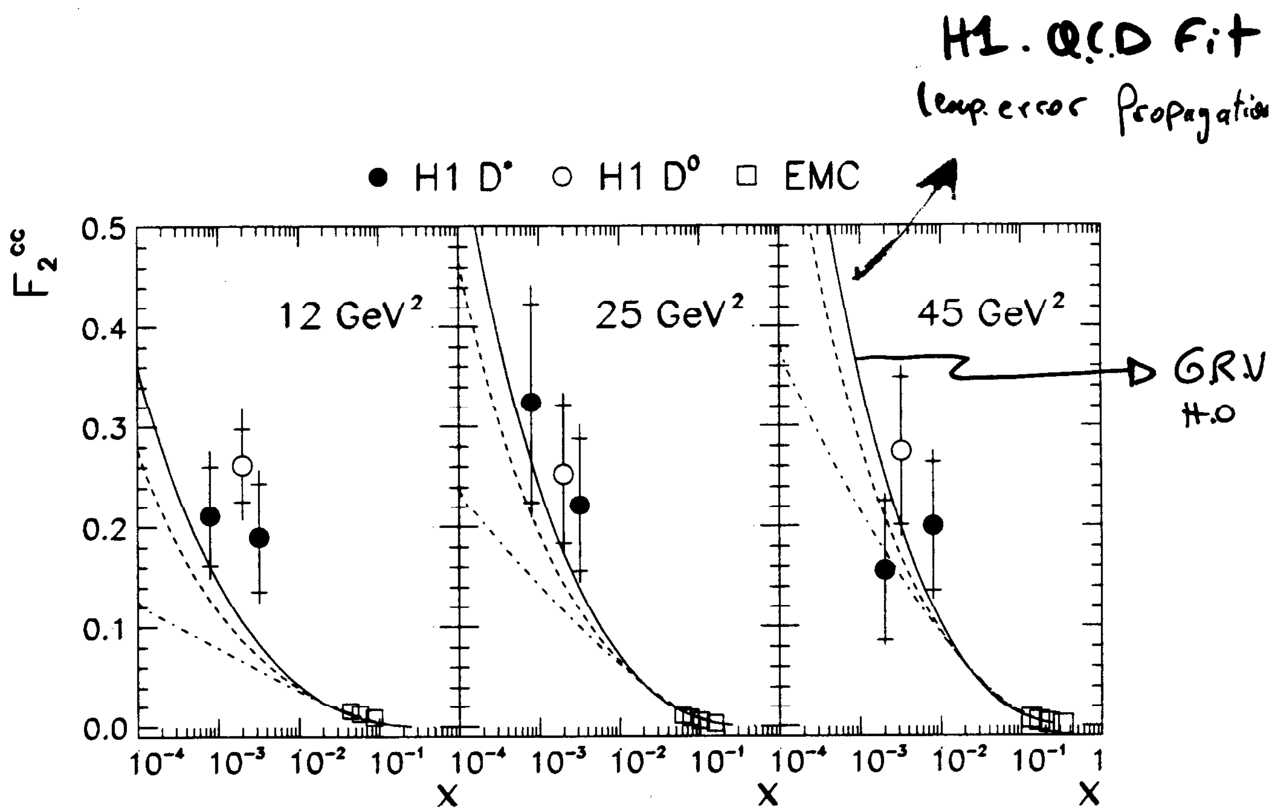
➡ **$\varepsilon < 5\%$ @ 95% C.L**



$x_D = \frac{|p^*_D|}{|p^*_p|}$

• ⇒ comparison with p.g.f using B.G.F (NLO) process :

• $m_c = 1.5$ GeV ; $\mu^2_{BGF} = Q^2 + m_c^2$



⇒ $\left\langle \frac{F_2^{c\bar{c}}}{F_2} \right\rangle = 23.7\% \pm 2.1\% \Big|_{stat.} \pm 4.1\% \Big|_{syst.}$

• F_L extraction •

• DIS X-section:

$$K \frac{d\sigma}{dx\,dQ^2} = F_2 - \frac{y^2}{Y_+} F_L$$

• with

• $K = \frac{Q^2 x}{2\pi\alpha_{em}^2 Y_+}$; $Y_+ = 2(1-y) + y^2$

• idea: if "we know" F_2 at high y

⇒ F_L determined from $\frac{d\sigma}{dx\,dQ^2}$

⇒ NEW X-section measurement:

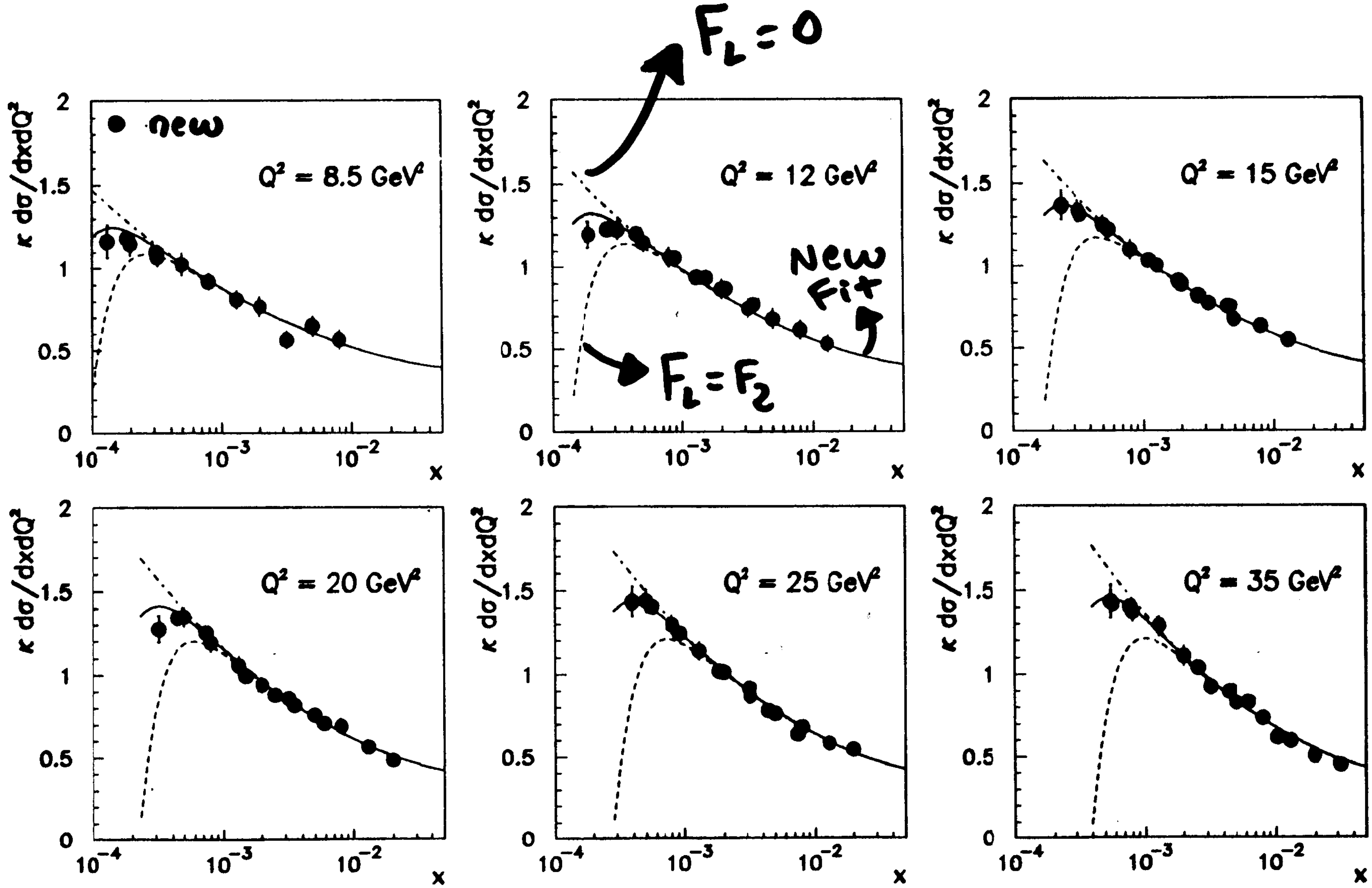
high y & small-x

$0.6 < y < 0.78$ $\quad 1.3\,10^{-4} \leq x \leq 5.5\,10^{-4}$

$(8.5\ \mathrm{GeV}^2 \leq Q^2 \leq 35\ \mathrm{GeV}^2)$

⇒ New F_2 Fit (repeat 1994 analysis)

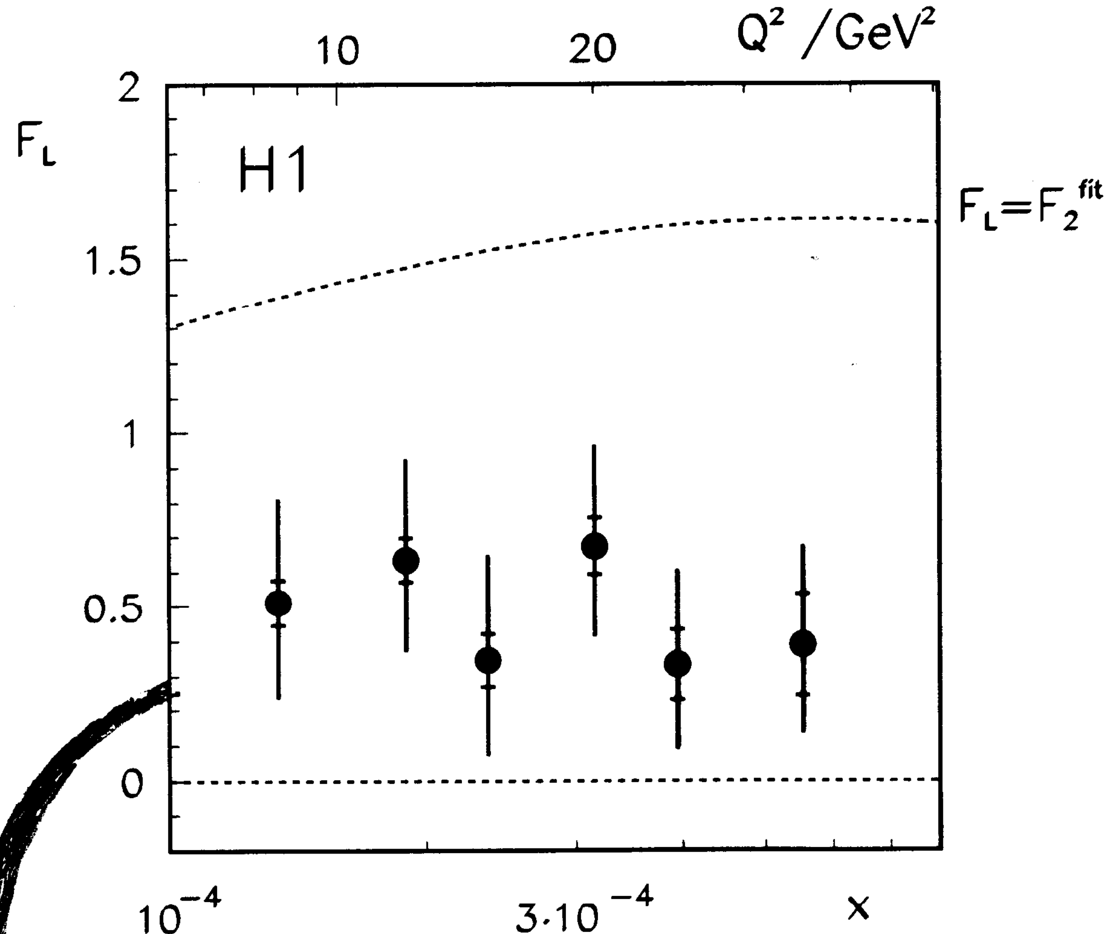
using { H1 F_2 at $y < 0.35$
 BCDMS



F_L = 0
new
Q² = 8.5 GeV²
Q² = 12 GeV²
Q² = 15 GeV²
Q² = 20 GeV²
Q² = 25 GeV²
Q² = 35 GeV²
New Fit
F_L = F_2
κ dσ/dxdQ²
x

• Extrapolation of new F_2 fit at high y

(+ syst. studies on extrapolation)



Cross-section Fit excluding our new high y measurement & using N.L.O F_L calculation

• Summary •

- F_2 fit :
  - up to now : - QCD test ;
    - gluon extraction with experimental error band
  - near futur : α_s extraction , BUT :
    Do we need other observable ?
- F_2^c :
  - very promessing observable
    ⇒ more statistic required
    ⇒ work is going on!
- F_L :
  - "new" method ⇒ consistency test of DGLAP.
    ⇒ NEW measure is being performed
    ⇒ lower Q^2 & higher y domain