XI Rencontres de Blois 1999

Deep Inelastic Scattering at High Q^2

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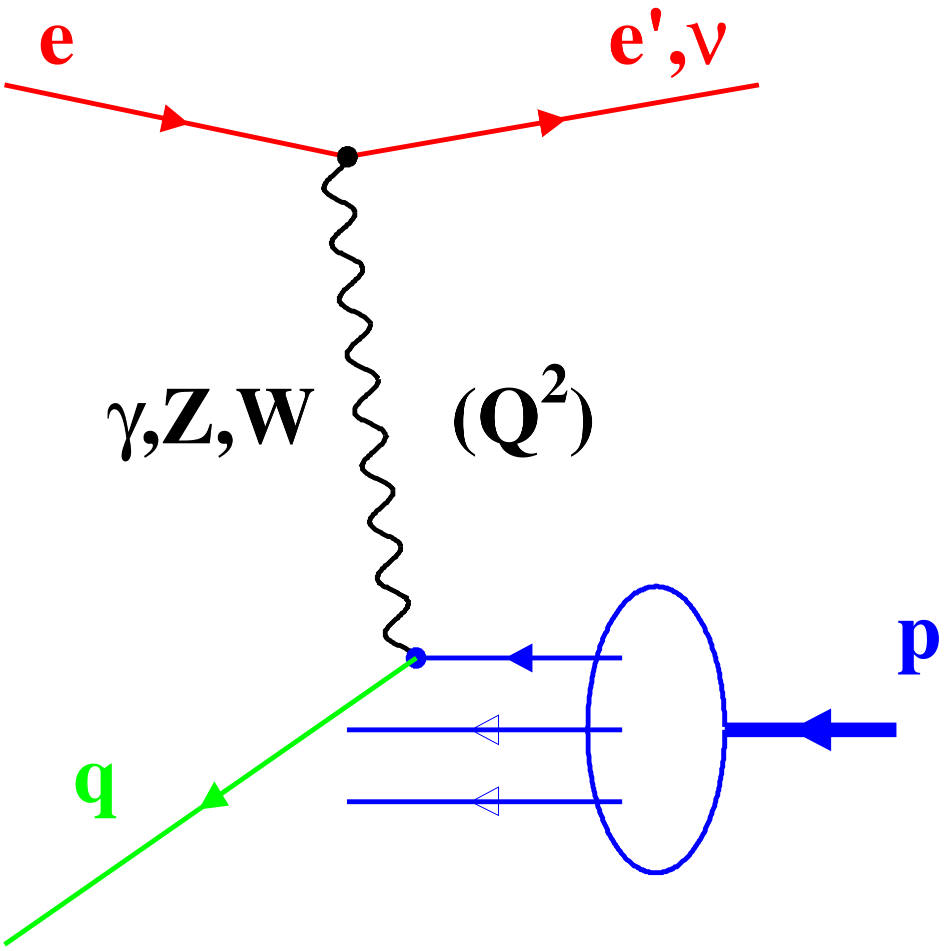
on behalf of the H1 and ZEUS Collaborations

- Introduction
- Neutral Current e^+p
  Results: $\frac{d\sigma}{dQ^2}$, $\frac{d\sigma}{dx}$, $\frac{d\sigma}{dy}$, M_Z-dependence
- Charged Current e^+p
  Results: $\frac{d\sigma}{dQ^2}$, $\frac{d\sigma}{dx}$, $\frac{d\sigma}{dy}$, $\frac{d^2\sigma}{dx\,dQ^2}$, EW fits
- First e^-p Results
- Summary

HERA NC(CC) Events



$$\sqrt{s} = \text{300 or 320 GeV}$$

centre-of-mass energy

$Q^2 \rightarrow$ 4-momentum transfer

$x \rightarrow$ Bjorken-variable

$$Q^2 = sxy$$

Introduction

use Bjorken-x and momentum transf. Q^2

Born level NC DIS cross section ($e^{\pm}p \to e^{\pm}X$):

$$\frac{d^2\sigma^{NC(e^{\pm})}}{dx dQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left[Y_+ F_2^{NC}(x,Q^2) \mp Y_- xF_3^{NC}(x,Q^2)\right]$$

$$(Y_{\pm} = 1 \pm (1-y)^2)$$

PDFs, couplings, $\frac{Q^2}{Q^2+M_Z^2}$ (wk.part) $\Rightarrow F_2^{NC}$, F_3^{NC}

Born level CC DIS cross section ($e^+p \to \bar{\nu}_e X$):

$$\frac{d^2\sigma^{CC(e^+)}}{dx dQ^2} = \frac{G_F^2}{4\pi x}\left(\frac{M_W^2}{M_W^2+Q^2}\right)^2 \cdot$$

$$\cdot\left[(\bar{u}+\bar{c}) + (1-y)^2(d+s)\right]$$

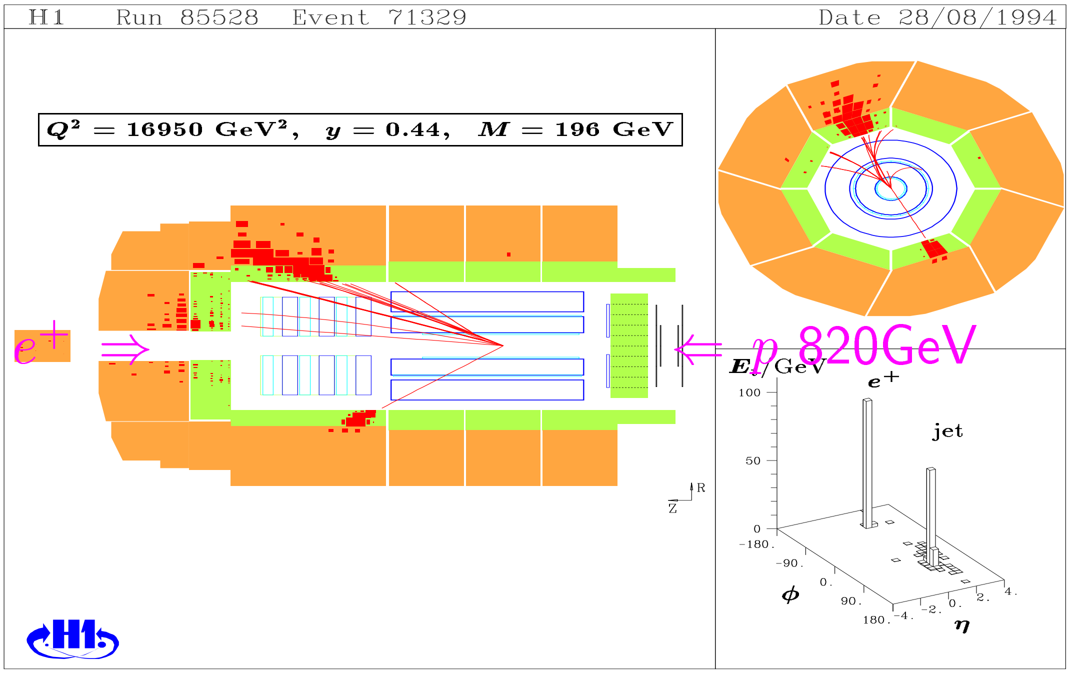
for $e^-p \to \nu_e X$: $\bar{u} \to u$ etc.

- parton distribution at high photon,boson virtuality Q^2
- weak sector: weak couplings; NC: M_Z, CC: M_W

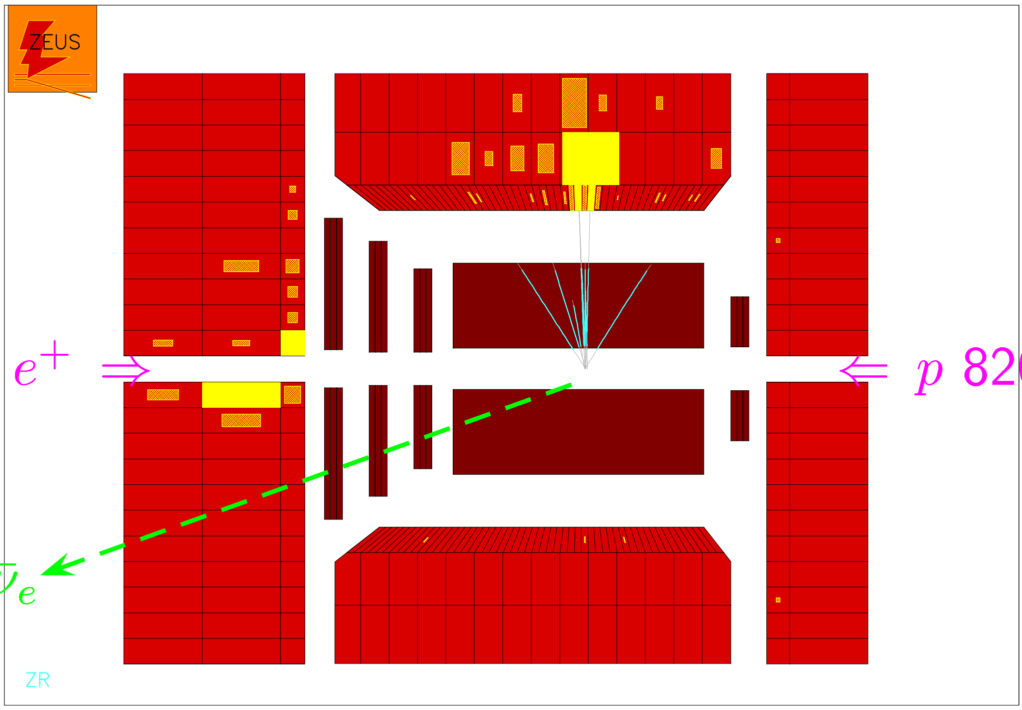
CC & NC Events for e^+

1994 – 1997 data $\rightarrow$ $37\,\mathrm{pb}^{-1}$ (H1), $47.7\,\mathrm{pb}^{-1}$ (ZEUS)

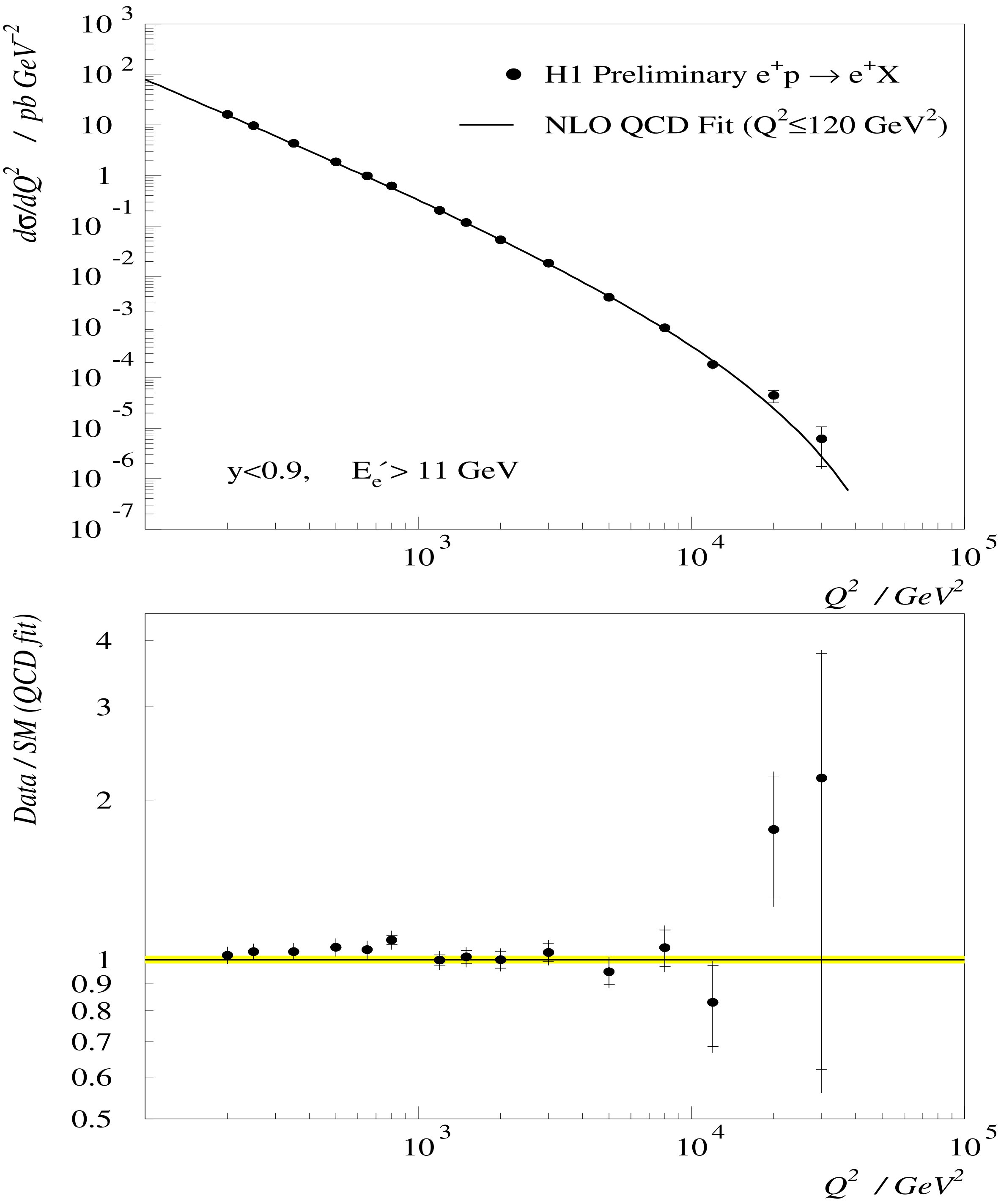
$e^+p \rightarrow e^+X$ $\rightarrow$ require scattered positron



$e^+p \rightarrow \bar{\nu}_e X$ $\rightarrow$ require missing transverse momentum

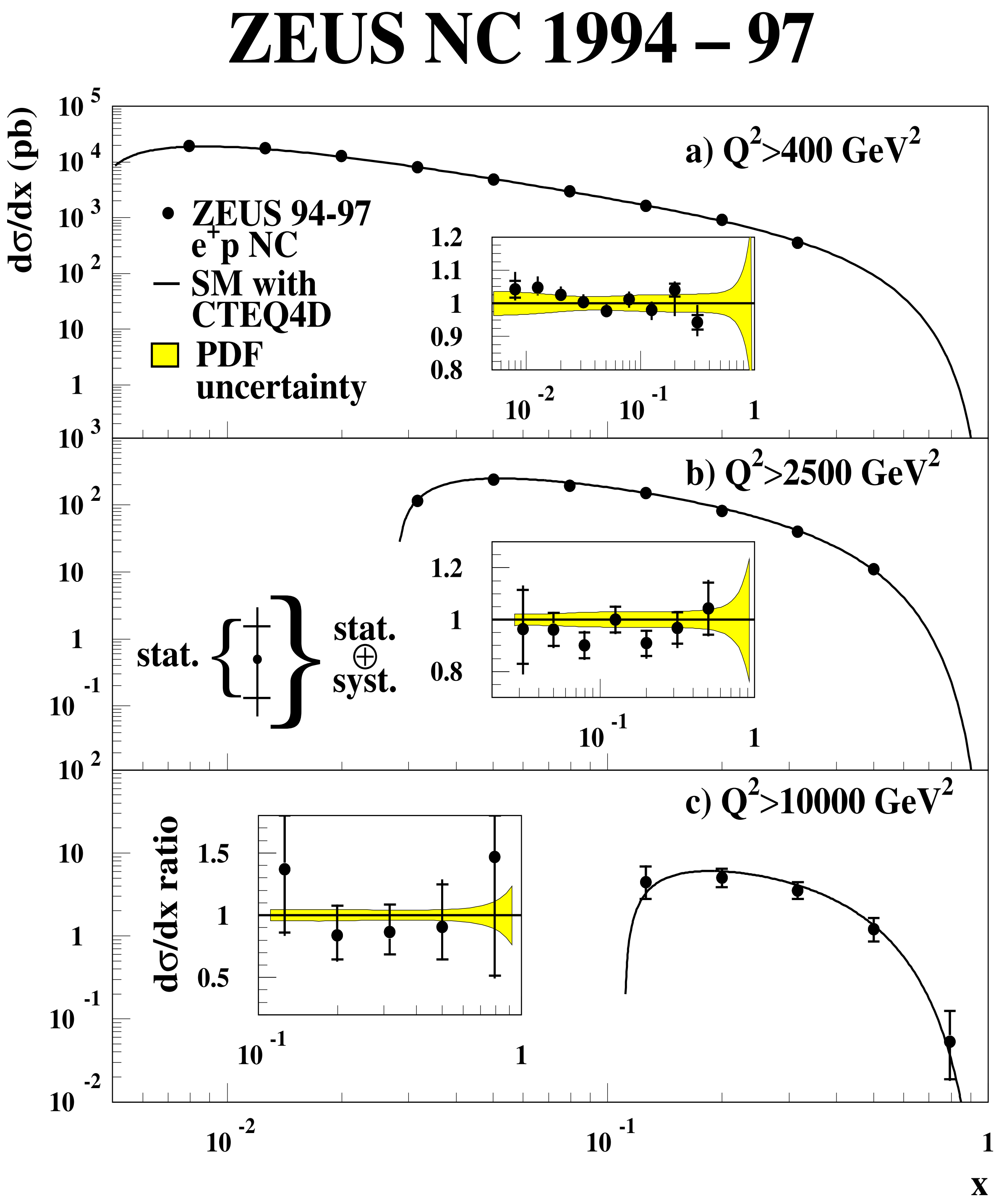


NC Cross Section in Q^2



data ↔ SM: good agreement

NC Cross Section in x

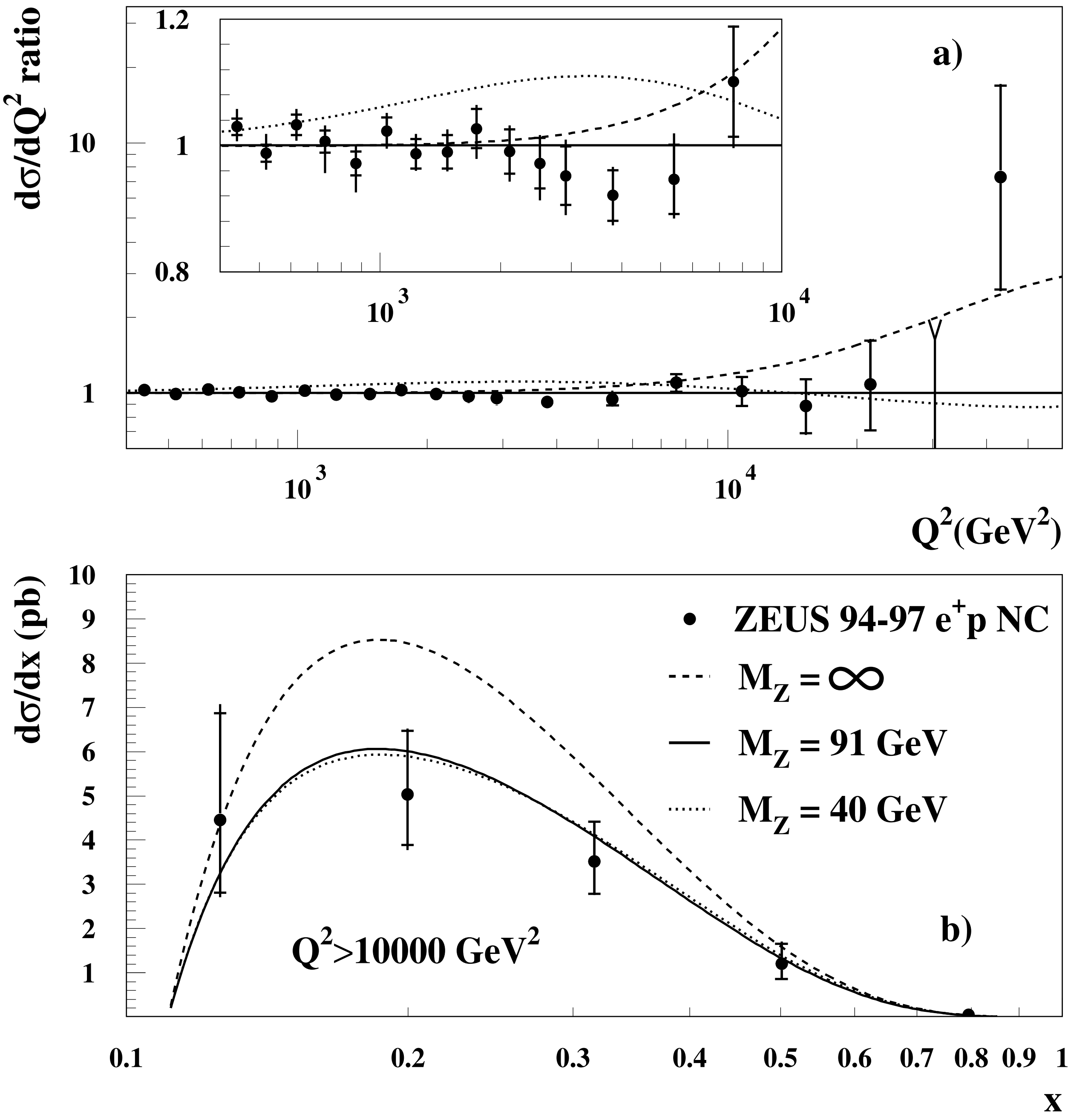


follows parton distribution – good agreement

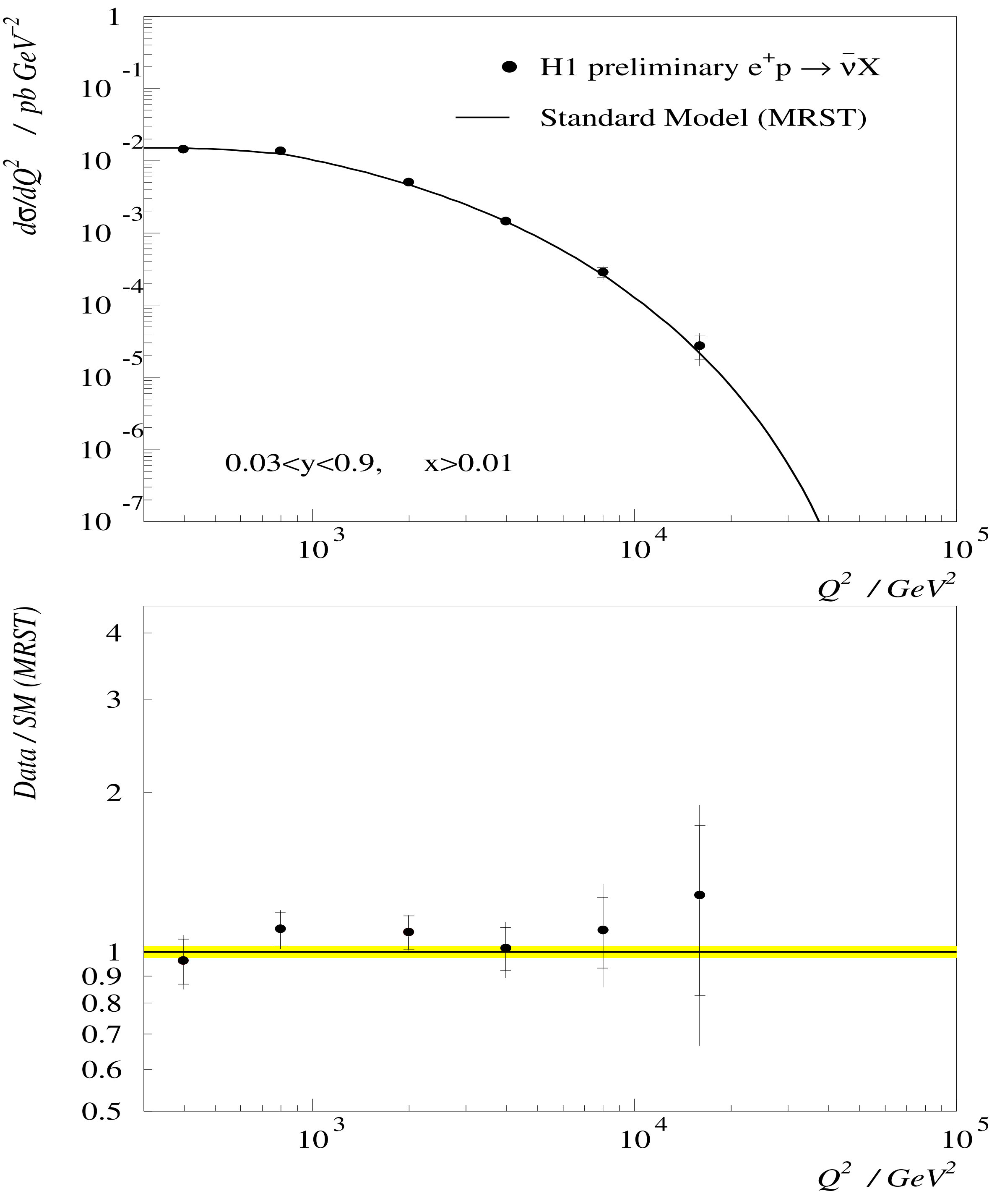
NC – Electroweak Contributions

sensitive to propagator ratio $\frac{Q^2}{Q^2+M_Z^2}$ in F_2, xF_3

ZEUS NC 1994 – 97

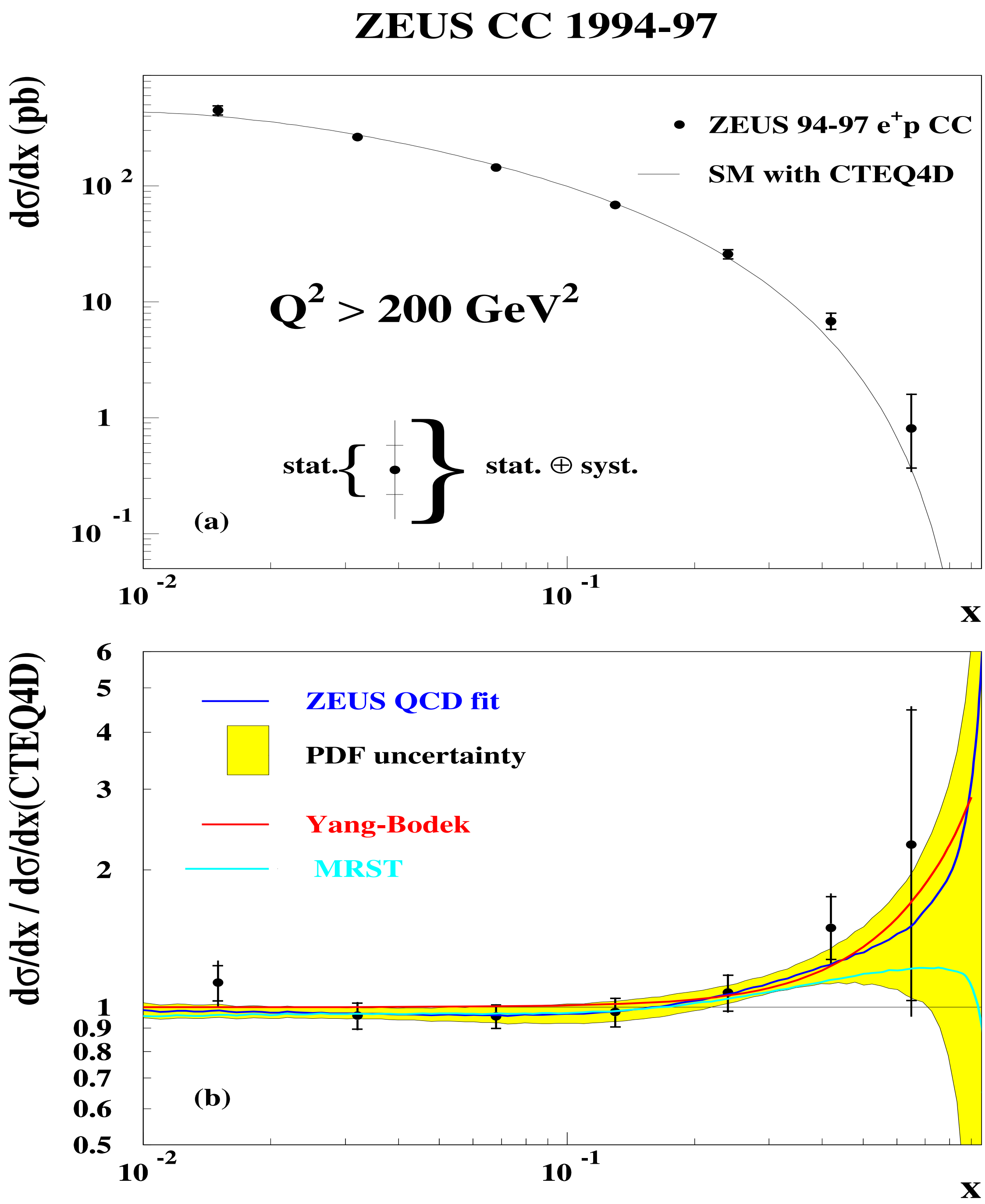


CC Cross Section in Q^2



good agreement

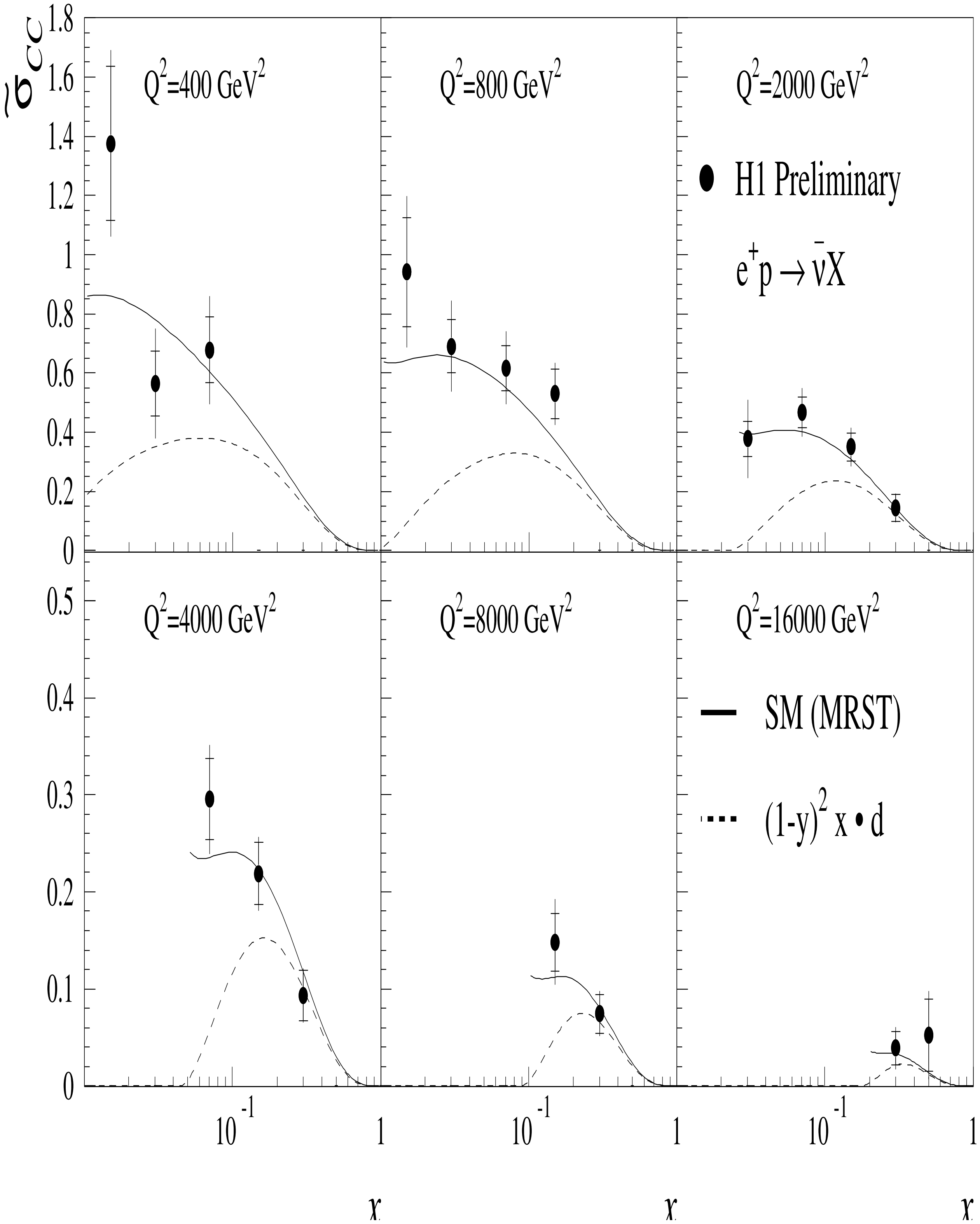
CC Cross Section in x



data/SM: tendency to increase at high x wrt CTEQ4

– new information about d-distribution

CC – Reduced Cross Section



sensitive to distribution of certain flavours

CC – EW Fits

cross section is sensitive to W mass (Q^2-slope) and G_F (norm.) – fit to $\frac{d\sigma}{dQ^2}$ (ZEUS) or $\frac{d^2\sigma}{dQ^2 dx}$ (H1)

two-parameter fit:

$G_F =$
$(1.171^{+0.034}_{-0.034}(\text{stat.})^{+0.026}_{-0.032}(\text{sys.})^{+0.016}_{-0.015}(\text{PDF})) \times 10^{-5}\,\text{GeV}^{-2}$

$M_W = 80.8^{+4.9}_{-4.5}(\text{stat.})^{+5.0}_{-4.3}(\text{sys.})^{+1.4}_{-1.3}(\text{PDF})\,\text{GeV}$ (ZEUS)

only M_W, G_F fixed:

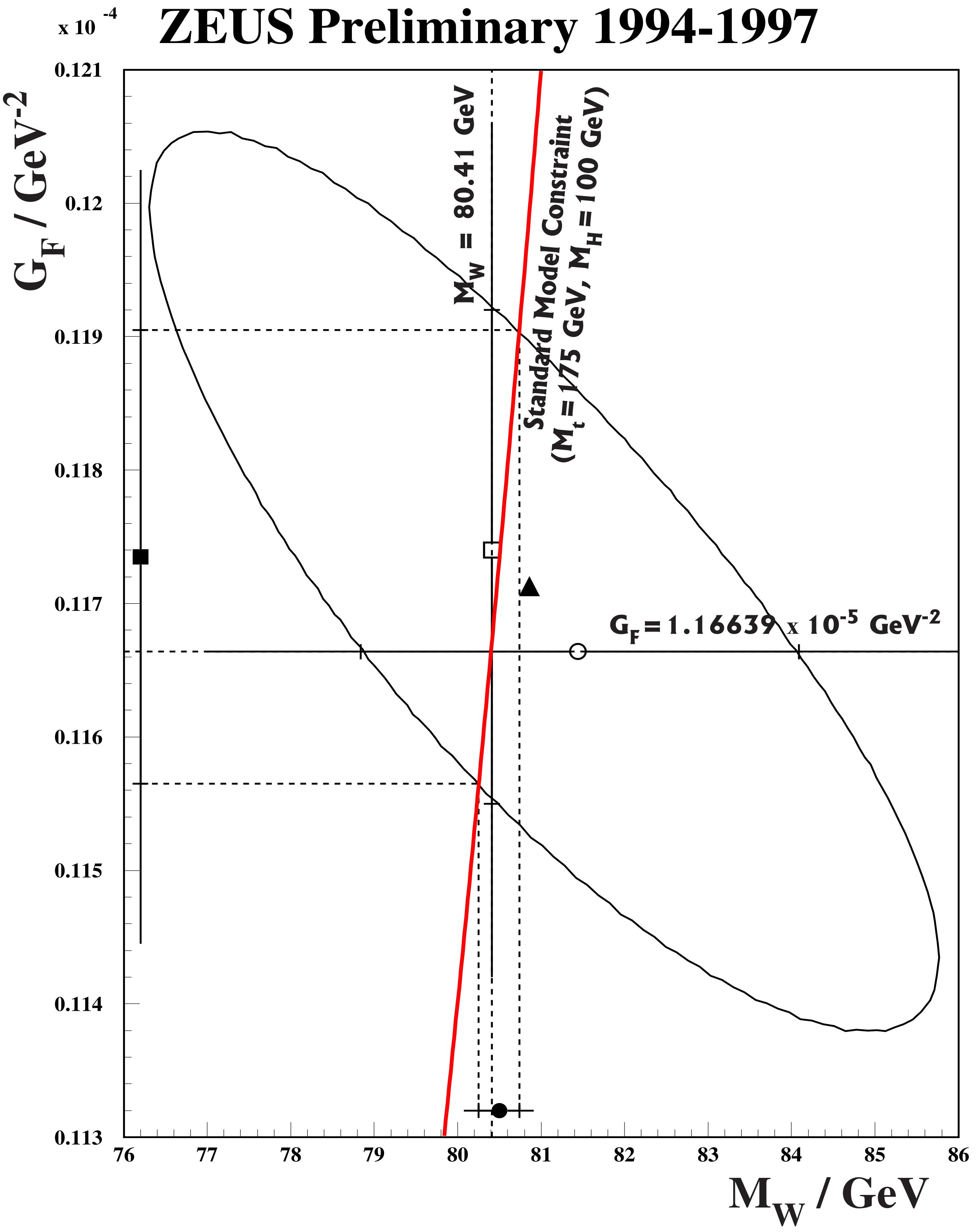
$M_W = 81.2 \pm 3.3(\text{stat.}) \pm 4.3(\text{sys.}) \pm 2.8(\text{th.})\,\text{GeV}$ (H1)

$M_W = 81.4^{+2.7}_{-2.6}(\text{stat.})^{+2.0}_{-2.0}(\text{sys.})^{+3.3}_{-3.0}(\text{PDF})\,\text{GeV}$ (ZEUS)

SM constraints between M_W and G_F:

$M_W = 80.50^{+0.24}_{-0.25}(\text{stat.})^{+0.13}_{-0.16}(\text{sys.})^{+0.30}_{-0.31}(\text{PDF})$
${}^{+0.05}_{-0.06}(\Delta M_{t,H,Z})\,\text{GeV}$ (ZEUS)

good agreement with PDG: $M_W = 80.41 \pm 0.10\,\text{GeV}$


ZEUS Preliminary 1994-1997
x 10 -4
0.121
0.12
0.119
0.118
0.117
0.116
0.115
0.114
0.113
G_F / GeV^-2
76
77
78
79
80
81
82
83
84
85
86
M_W / GeV
M_W = 80.41 GeV
Standard Model Constraint
(M_t = 175 GeV, M_H = 100 GeV)
G_F = 1.16639 x 10^-5 GeV^-2

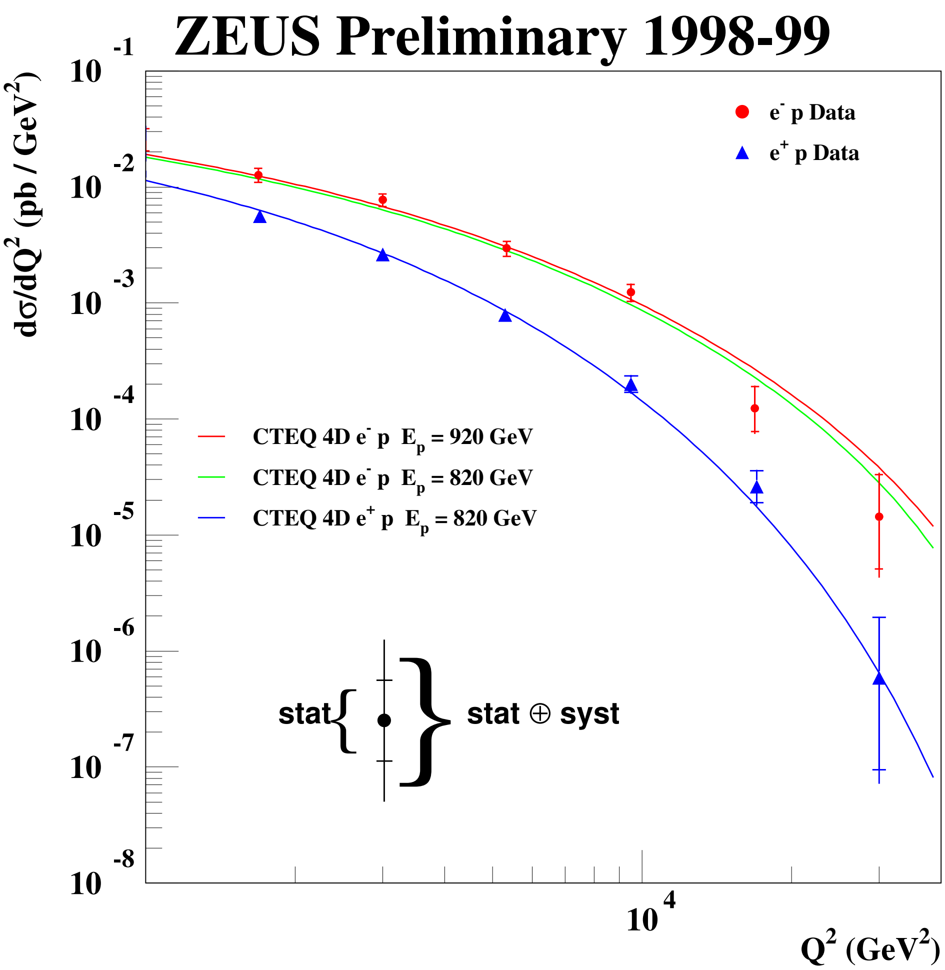
Analysis of Electron Data

during 1998-1999: data taking with e^-; $\sqrt{s} = 320$ GeV

$\rightarrow$ NC: xF_3 enters with opposite sign

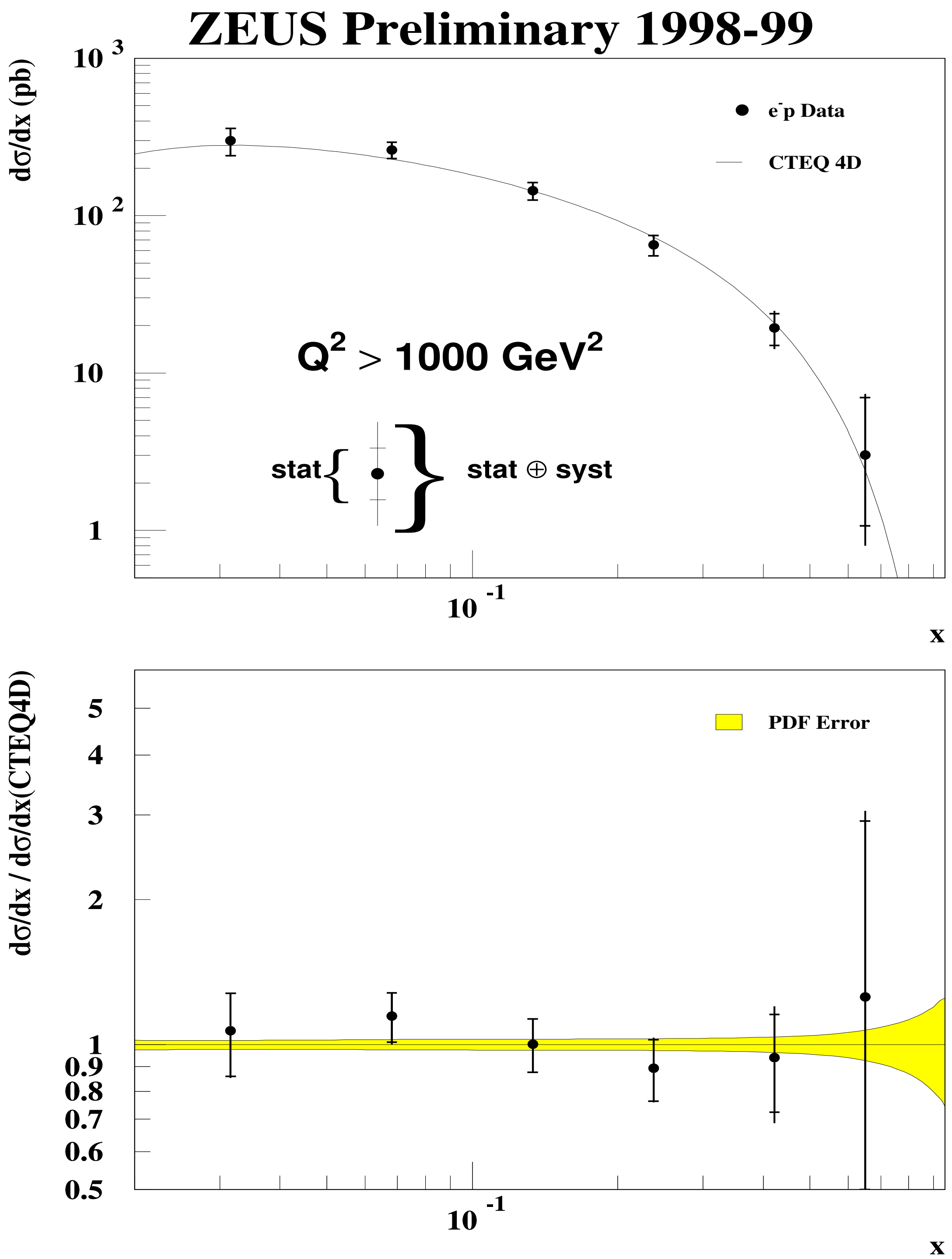
CC: coupling to u-quark, not $(1-y)$ suppressed

ZEUS result for 6pb^{-1} – CC in Q^2:



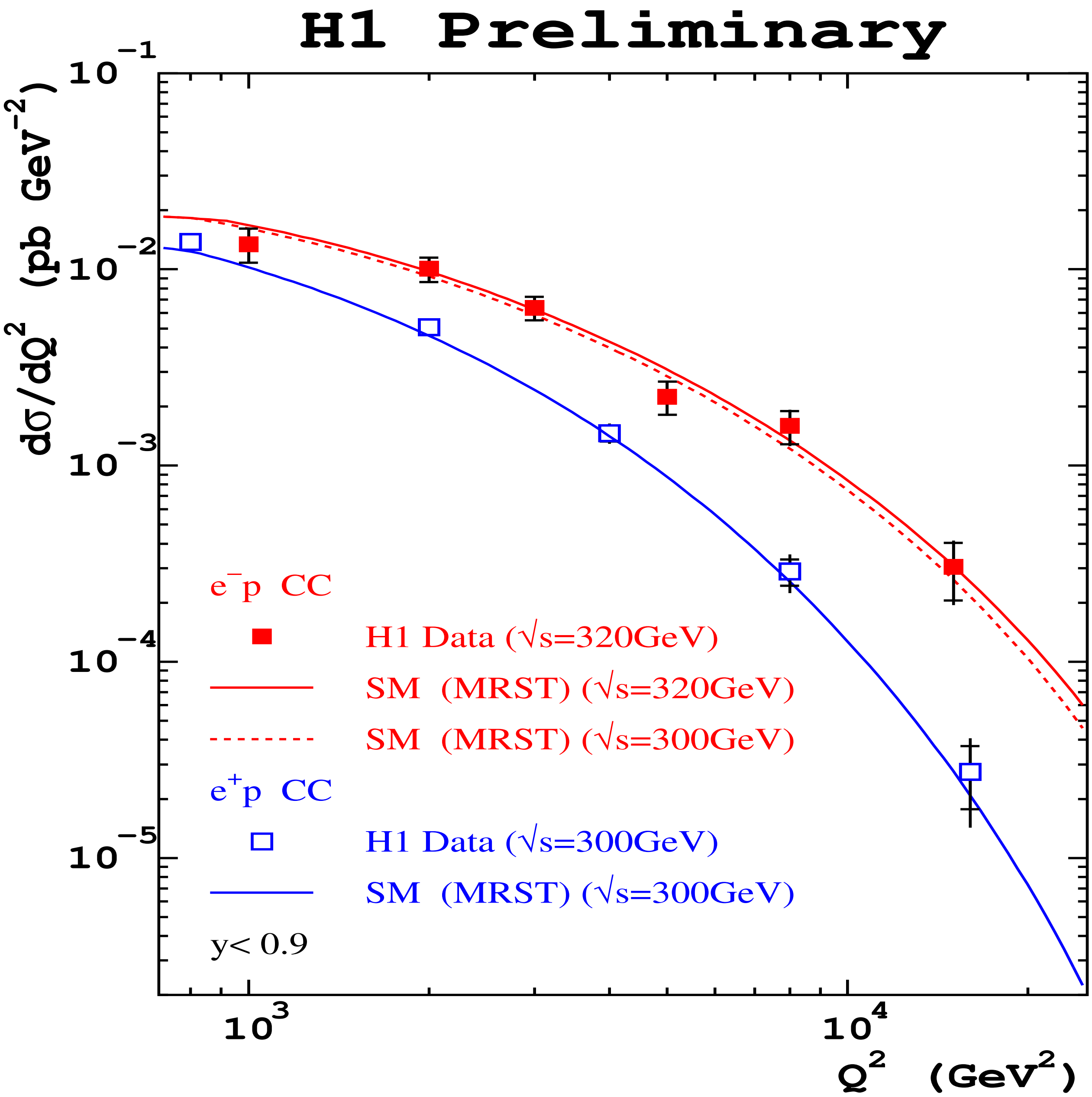
Electron Data (contd.)

CC in x:



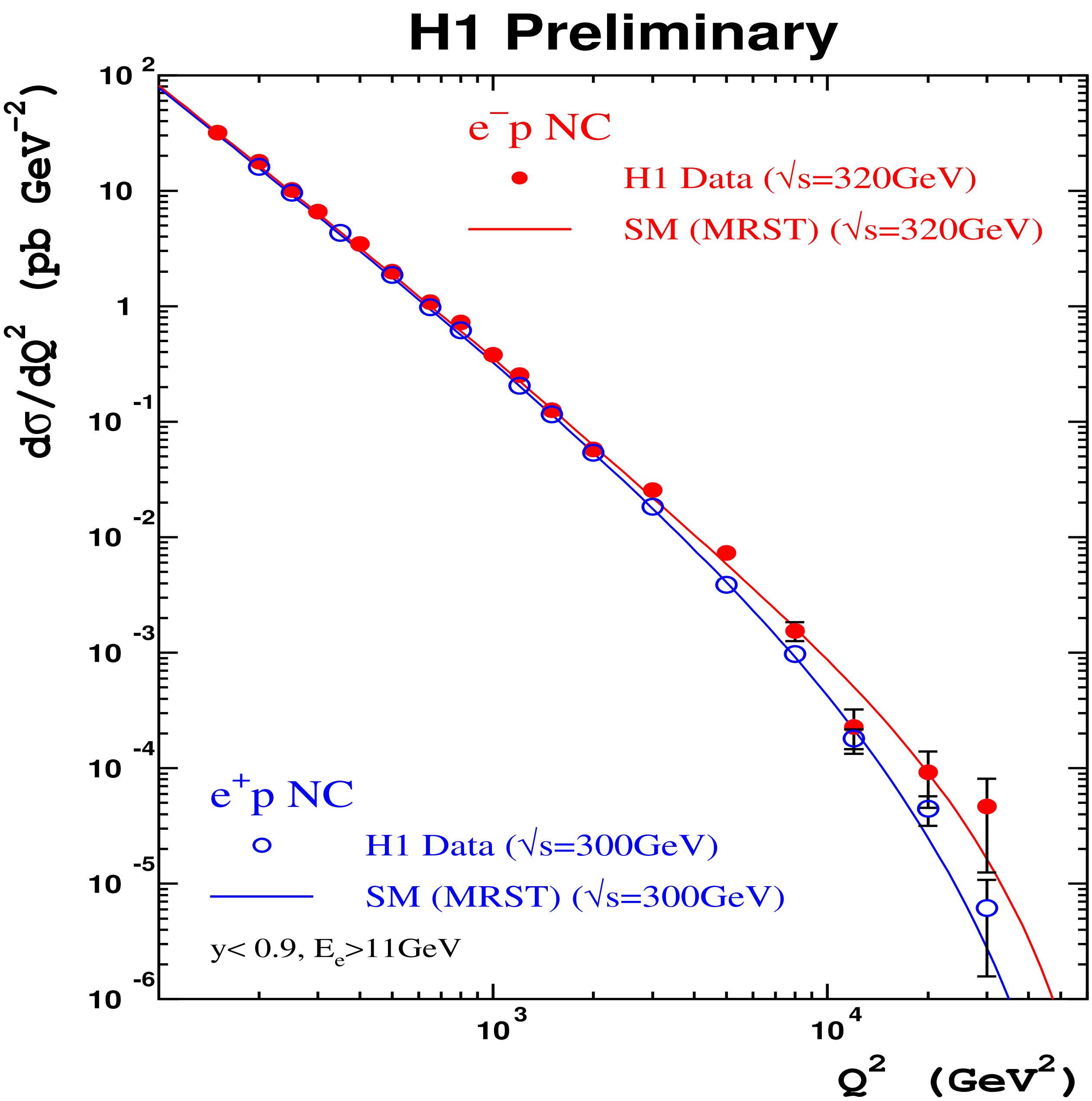
Electron Data (contd.)

H1 results on CC for $\sim 5\text{pb}^{-1}$:



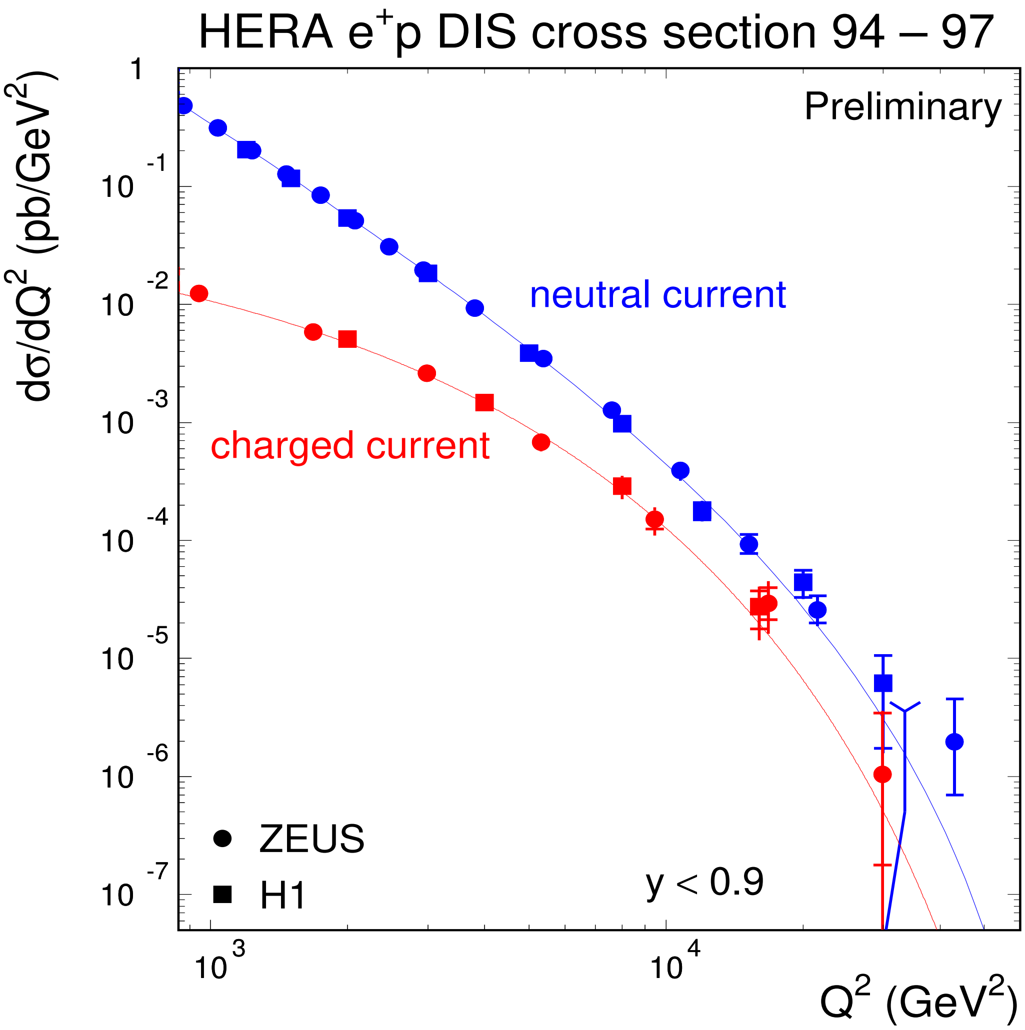
Electron Data (contd.)

NC – xF_3 flipped sign $\rightarrow e^-$ increased



Summary and Outlook

NC and CC cross sections in good agreement
with prediction from standard model
over a range of several orders of magnitude



electroweak physics at HERA within reach

more exciting physics
from electron data (1998/99) coming up