NC/CC deep inelastic ep-scattering at high Q^2 with ZEUS at HERA

Amaya López-Durán Viani

DESY Zeuthen

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Deep inelastic scattering

Kinematic variables

Virtuality of the process.

$$Q^2 = -q^2 = -(k - k')^2$$

Four momentum transfer between lepton and proton.

-0-

Momentum transfer between lepton and proton.

$$y = (p \cdot q)/(p \cdot k)$$

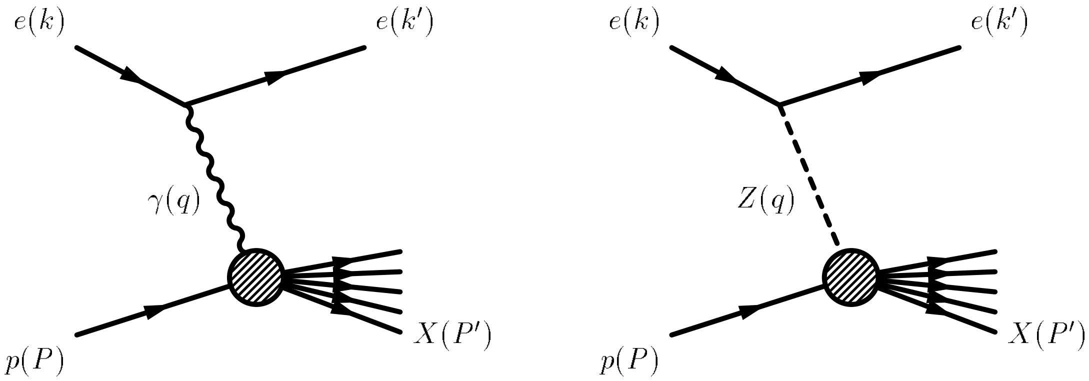
Gives the inelasticity of the process.

-0-

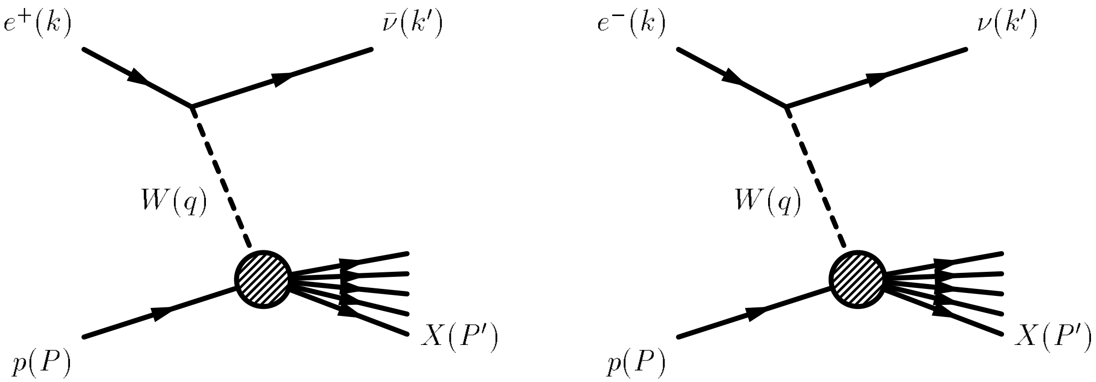
Bjorken x.

$$x = Q^2/2p \cdot q$$

Momentum fraction of the proton carried by the quark.



NC DIS processes



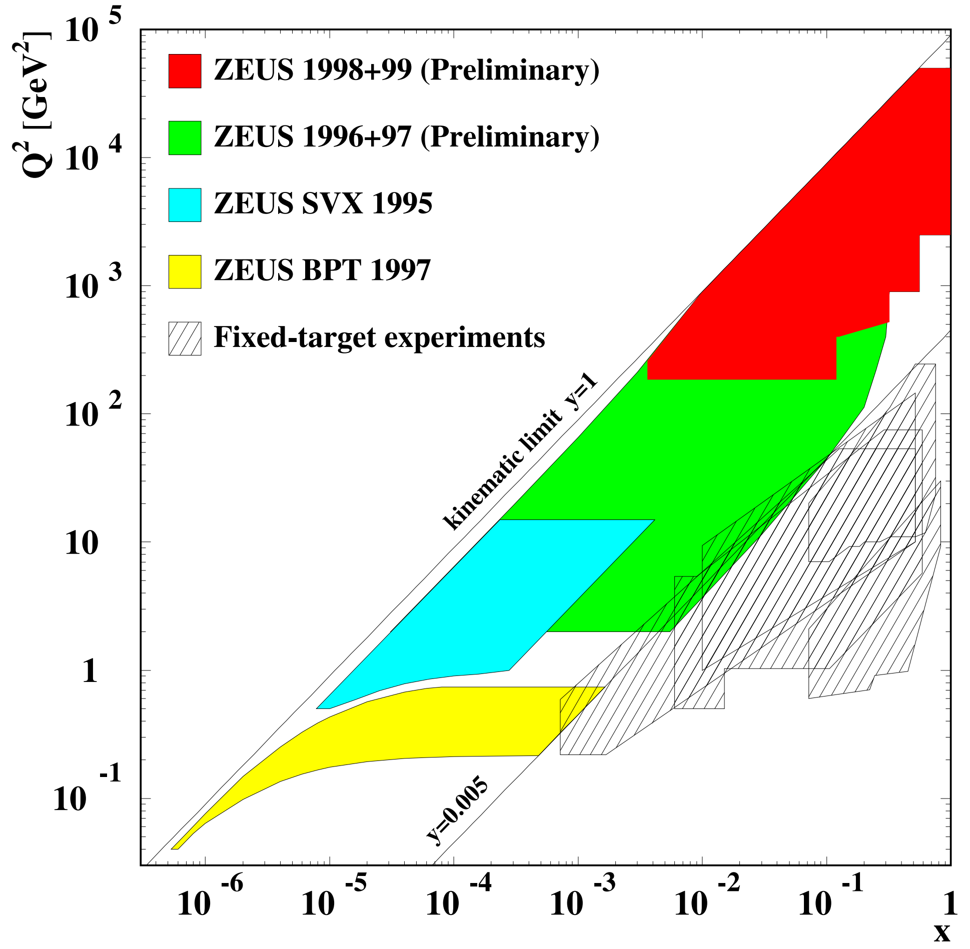
CC DIS processes

Data Samples

1994 - 1997	1998 - 1999	1999 - 2000
Positrons	Electrons	Positrons
$E_p = 27.5$ GeV	$E_p = 27.5$ GeV	$E_p = 27.5$ GeV
$E_p = 820$ GeV	$E_p = 920$ GeV	$E_p = 920$ GeV
$\sqrt{s} \approx 300$ GeV	$\sqrt{s} \approx 320$ GeV	$\sqrt{s} \approx 320$ GeV
$\mathcal{L} = 48$ pb^{-1}	$\mathcal{L} = 16$ pb^{-1}	$\mathcal{L} = 60$ pb^{-1}

Results to be presented

- Preliminary results for NC and CC from $(e^+p)^{920}$ data
- Extraction of $xF_3(x, Q^2)$ from NC $(e^+p)^{820}$ and $(e^-p)^{920}$ data



HERA Kinematic regime

Charged Current Events

LO cross-sections

Propagator term

$$P(M_W^2) = \frac{G_F^2}{2x\pi}\left[\frac{M_W^2}{Q^2+M_W^2}\right]^2$$

$e^+p \to \bar{\nu}X \longrightarrow$ Probe d valence

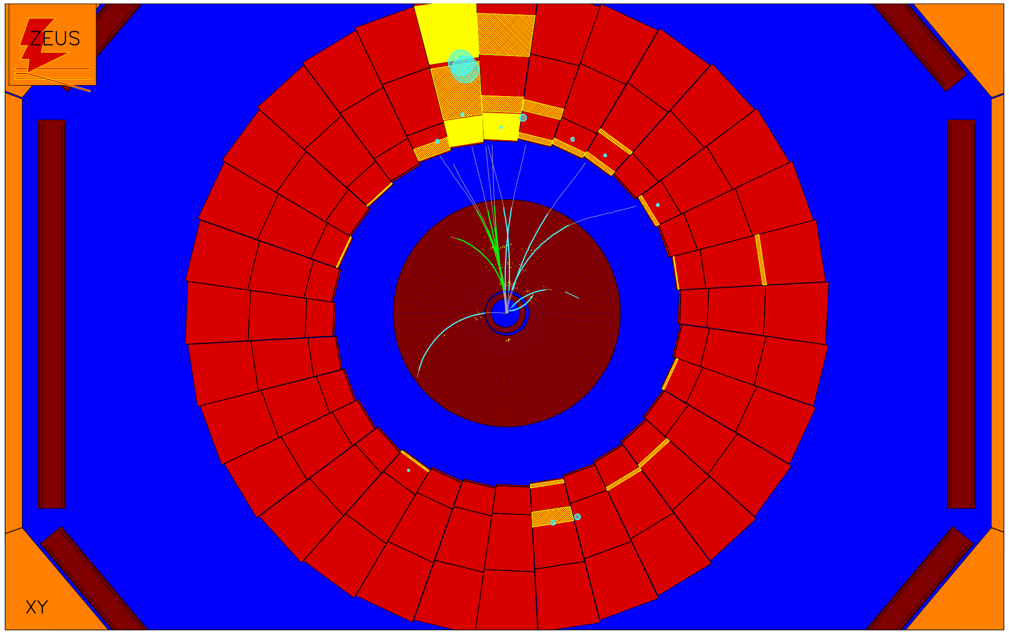
$$\frac{d^2\sigma}{dx\,dQ^2} = P(M_W^2)\left[\bar{u}+\bar{c}+(1-y)^2(d+s)\right]$$

$e^-p \to \nu X \longrightarrow$ Probe u valence

$$\frac{d^2\sigma}{dx\,dQ^2} = P(M_W^2)\left[u+c+(1-y)^2(\bar{d}+\bar{s})\right]$$

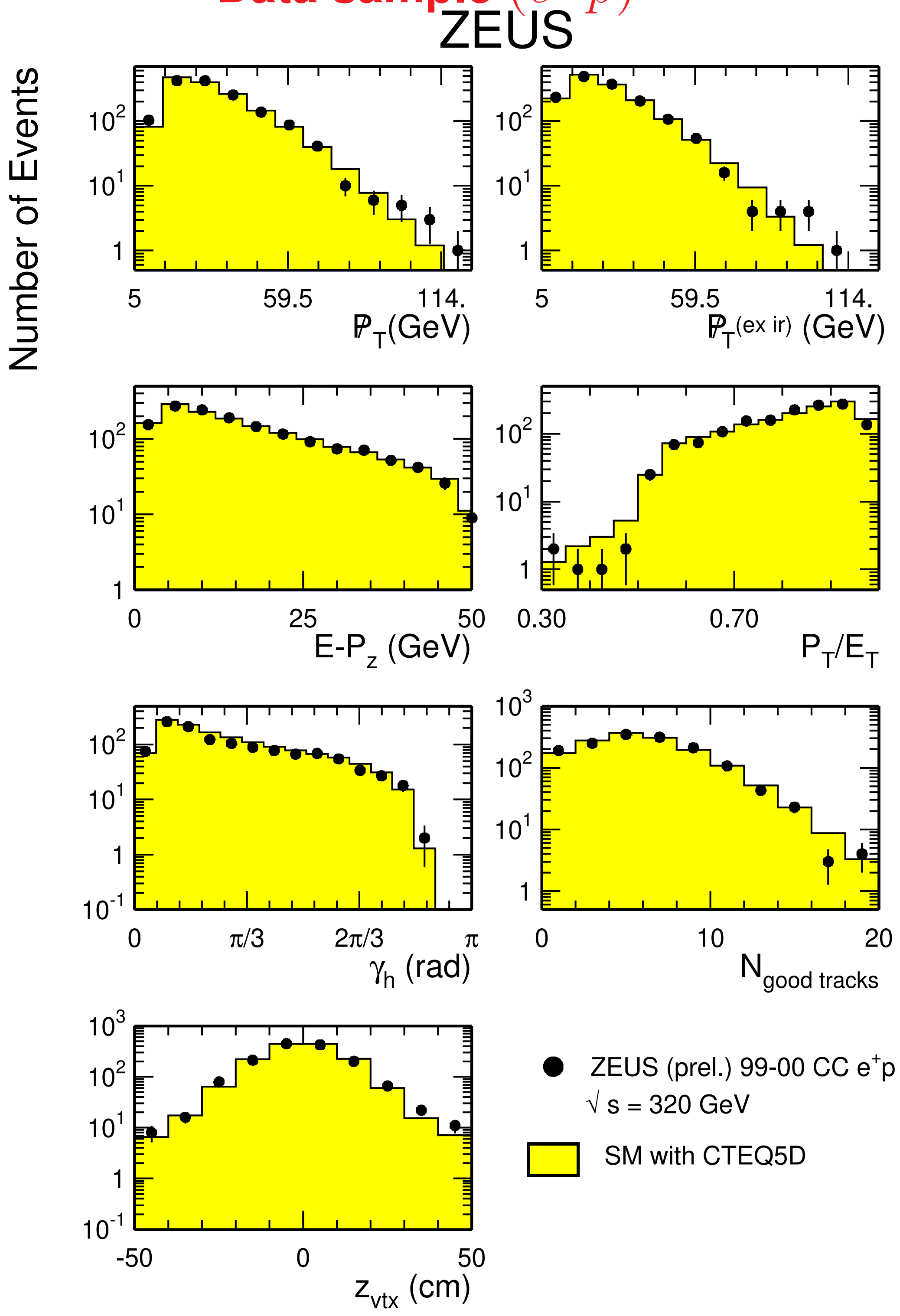
Reduced cross-section

$$\tilde{\sigma} = \frac{1}{P(M_W^2)}\frac{d^2\sigma}{dx\,dQ^2}$$

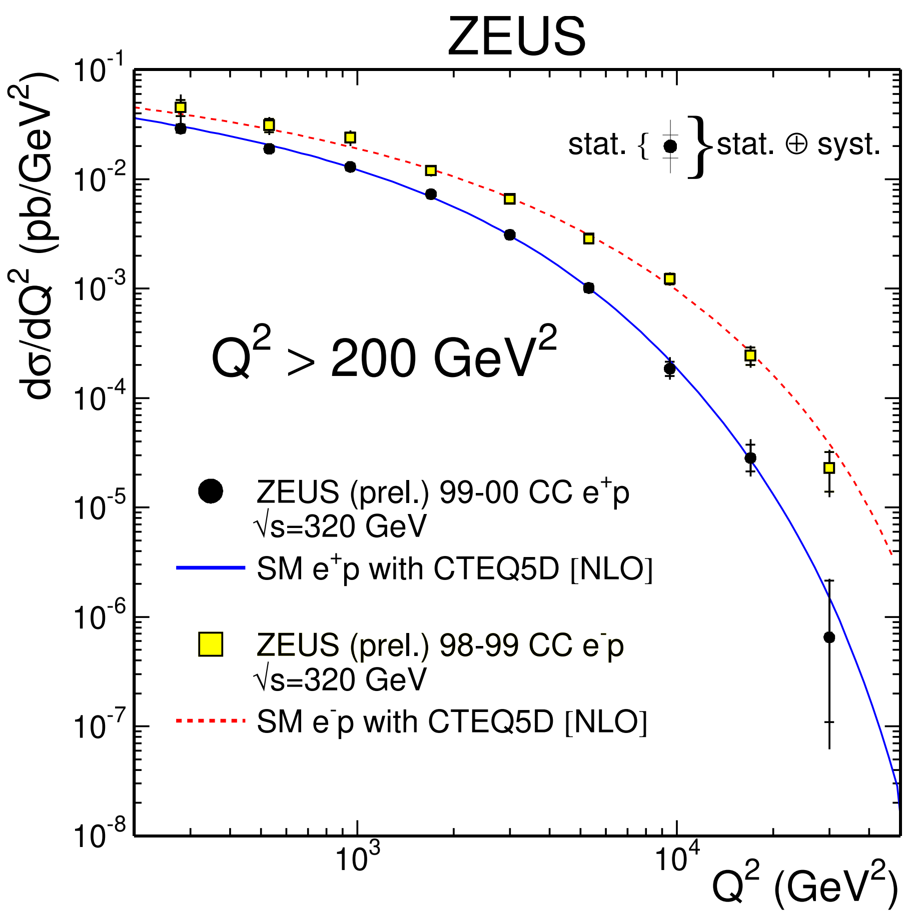


Charged current event

Charged current control plots.
Data sample $(e^+p)^{920}$



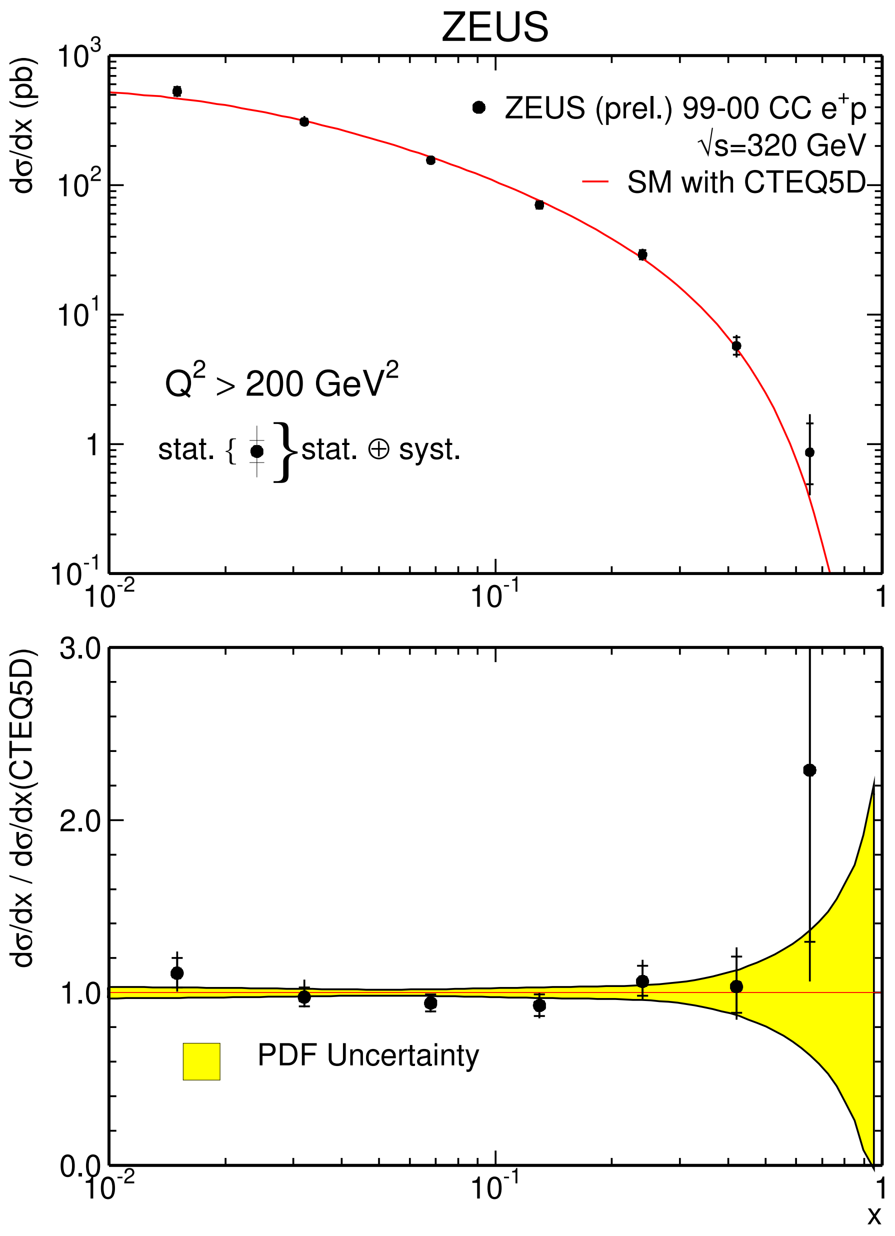
$\frac{d\sigma}{dQ^2}$ for CC events.
Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$



Low $Q^2 \rightarrow e^-p$ cross-section $\approx$ twice e^+p

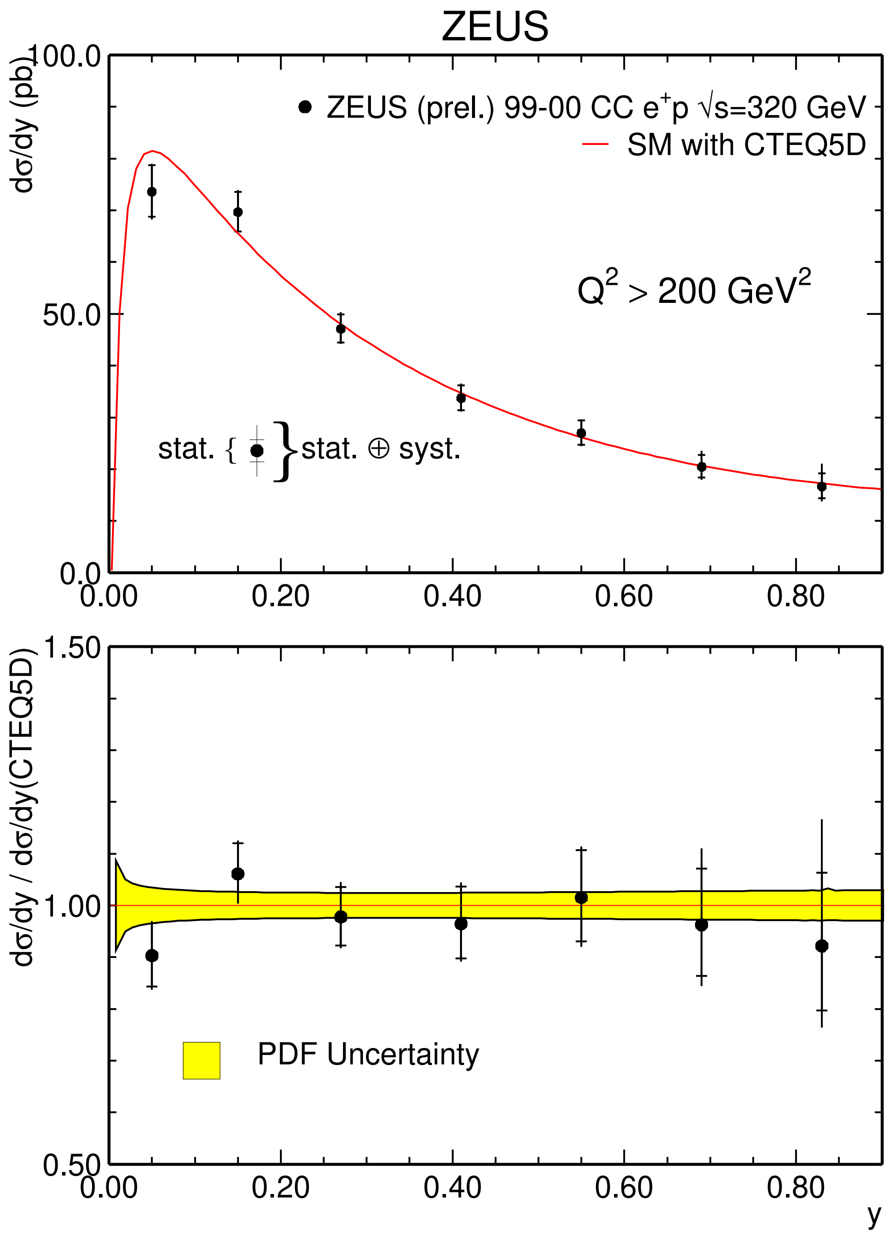
High $Q^2 \rightarrow (1-y)^2$ term dumps e^+p cross-section

$\frac{d\sigma}{dx}$ for CC events.
Data sample $(e^+p)^{920}$



Agreement with CTQ5D prediction at high x

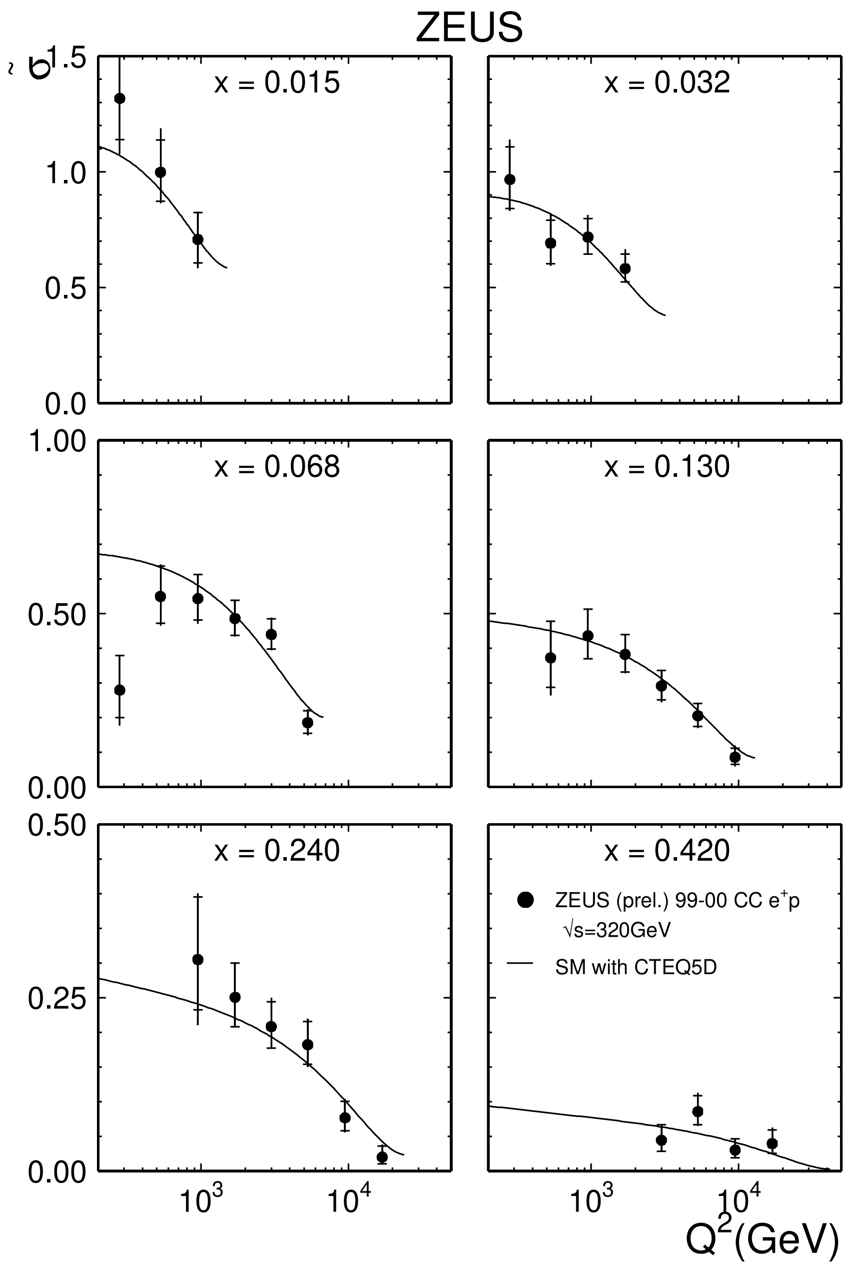
$\frac{d\sigma}{dy}$ for CC events.
Data sample $(e^+p)^{920}$



Agreement with Standard Model for all y range

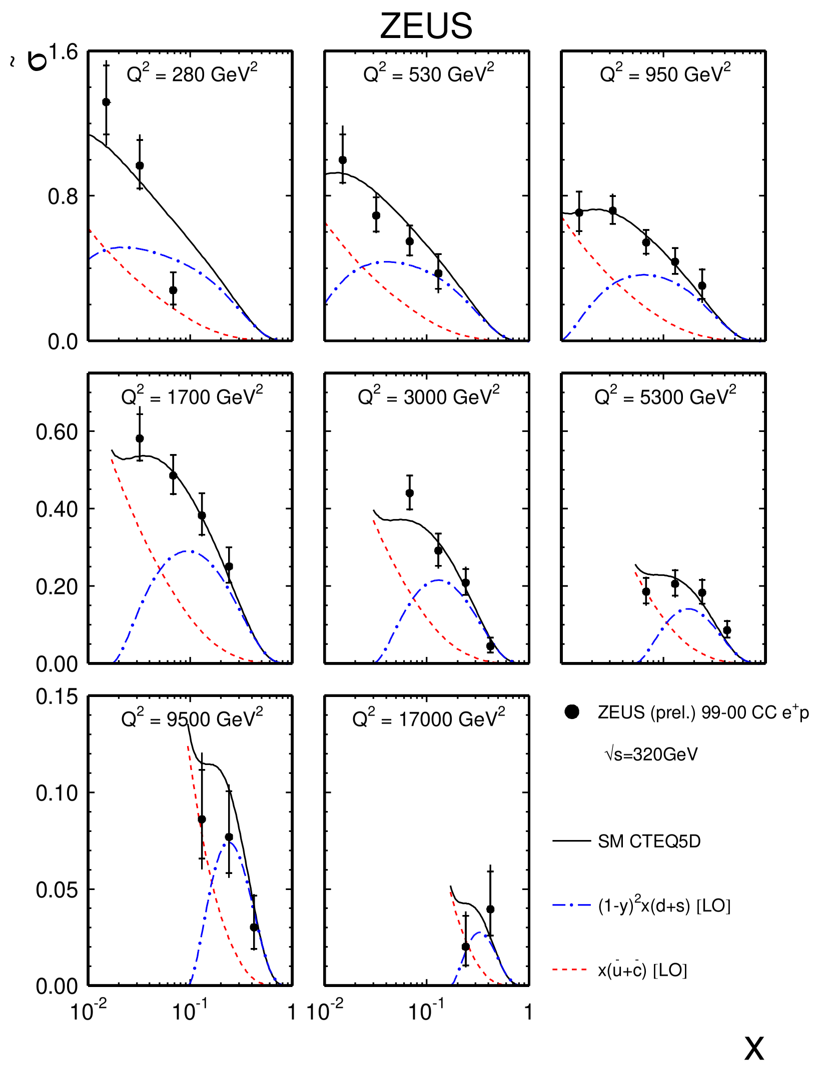
$\frac{d^2\sigma}{dx\,dQ^2}$ in x bins for CC events.

Data sample $(e^+p)^{920}$



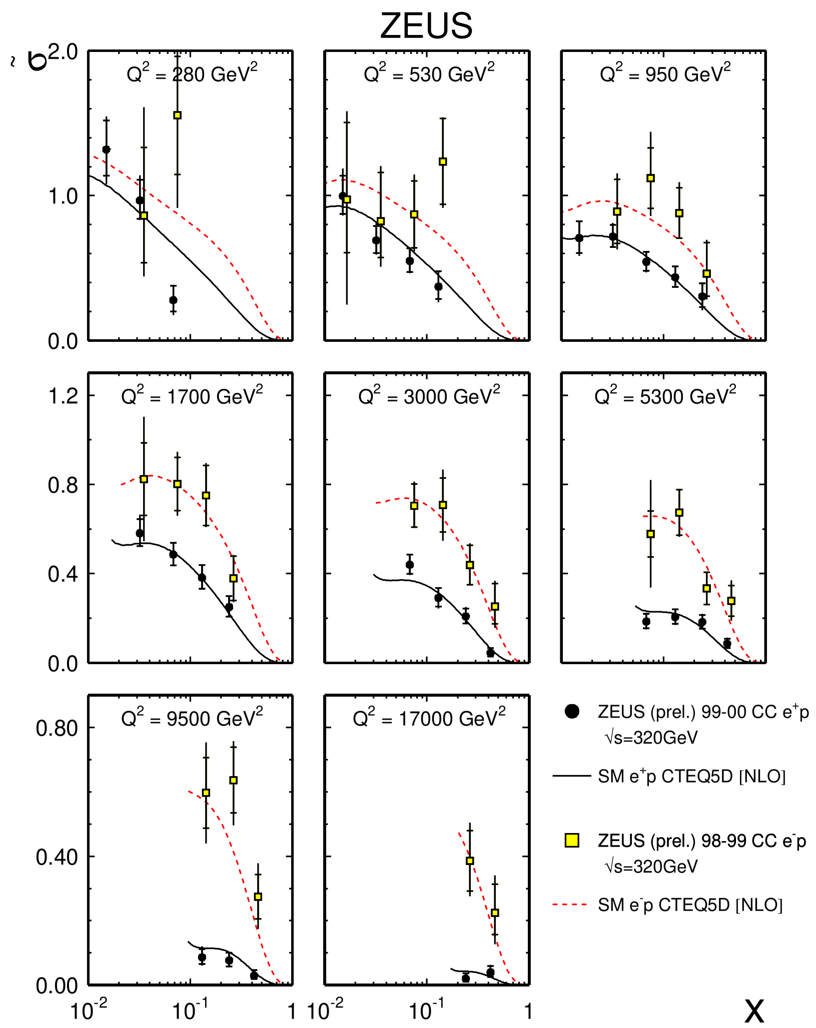
Good agreemet with Standard Model for the new e^+p data

$\frac{d^2\sigma}{dx\,dQ^2}$ in Q^2 bins for CC events. Data sample $(e^+p)^{920}$



Sensitivity to the u quark distribution at high x

$\frac{d^2\sigma}{dx\,dQ^2}$ in Q^2 bins for CC events. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$



Possibility to extract the u and d distribution from proton target data only

Neutral Current Events

LO cross-section

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

$$F_2 = \sum_f A_f(Q^2)\left[xq_f(x,Q^2) + x\bar{q}_f(x,Q^2)\right],$$

$$xF_3 = \sum_f B_f(Q^2)\left[xq_f(x,Q^2) - x\bar{q}_f(x,Q^2)\right]$$

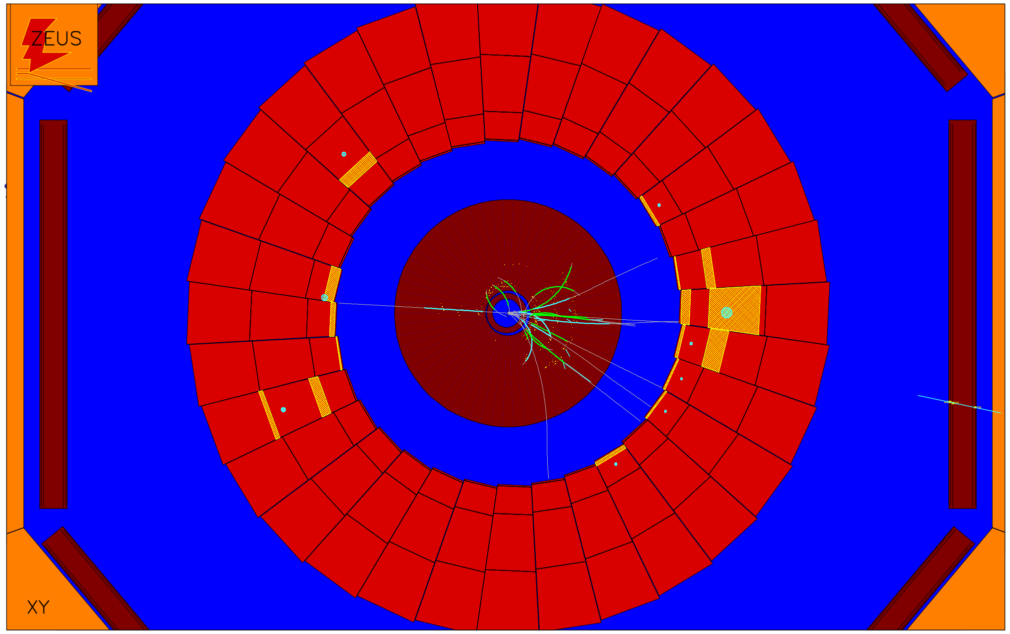
$$F_L = 0$$

$A_f(Q^2)$ and $B_f(Q^2)$ electroweak couplings with terms

$$\chi_z(Q^2) = \frac{Q^2}{Q^2 + M_z^2}$$

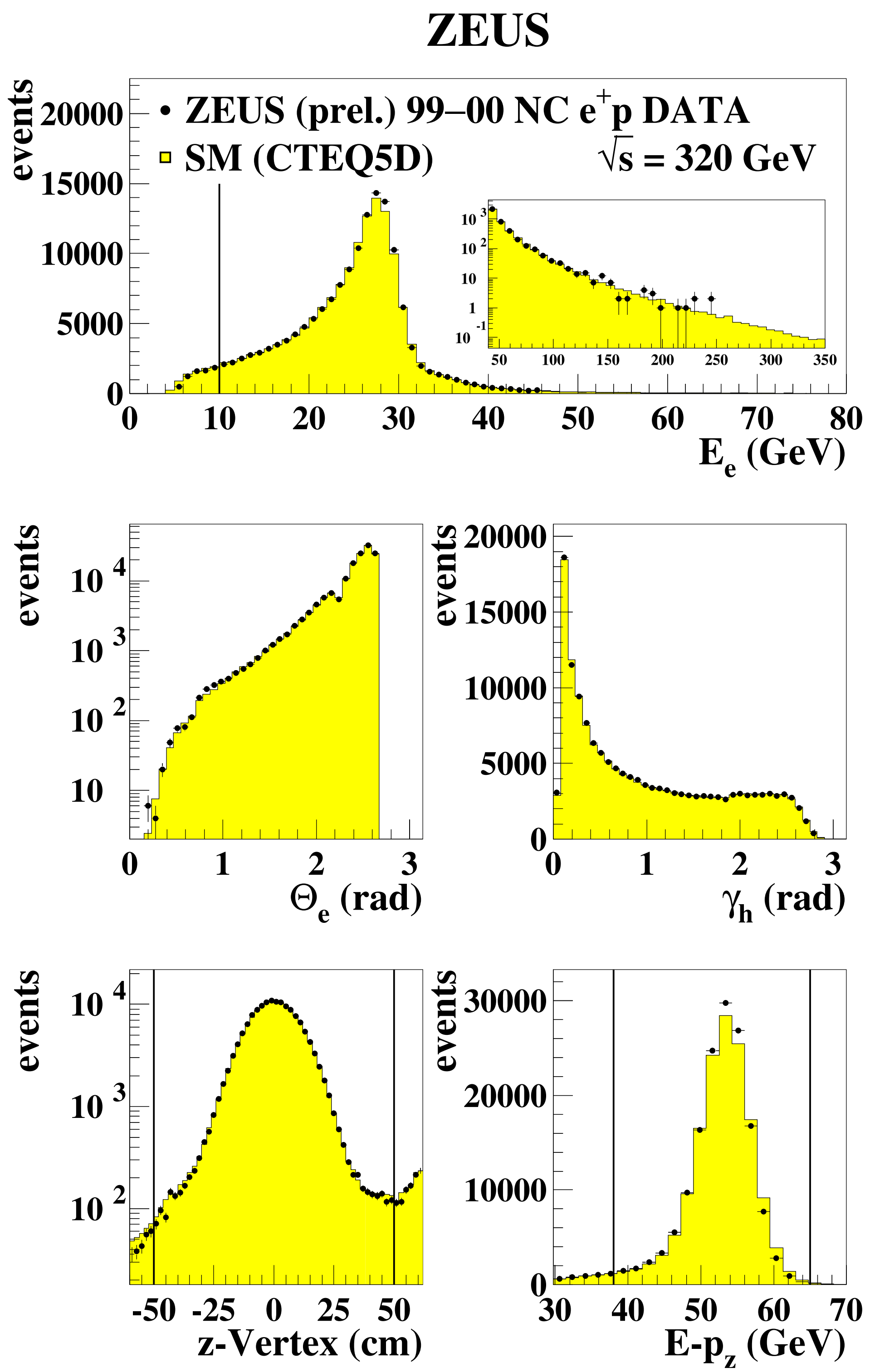
Reduced cross-section

$$\tilde{\sigma}^{\pm} = \frac{xQ^4}{2\pi\alpha^2(Q^2)}\frac{1}{Y_+}\frac{d^2\sigma^{\pm}}{dx\,dQ^2}$$

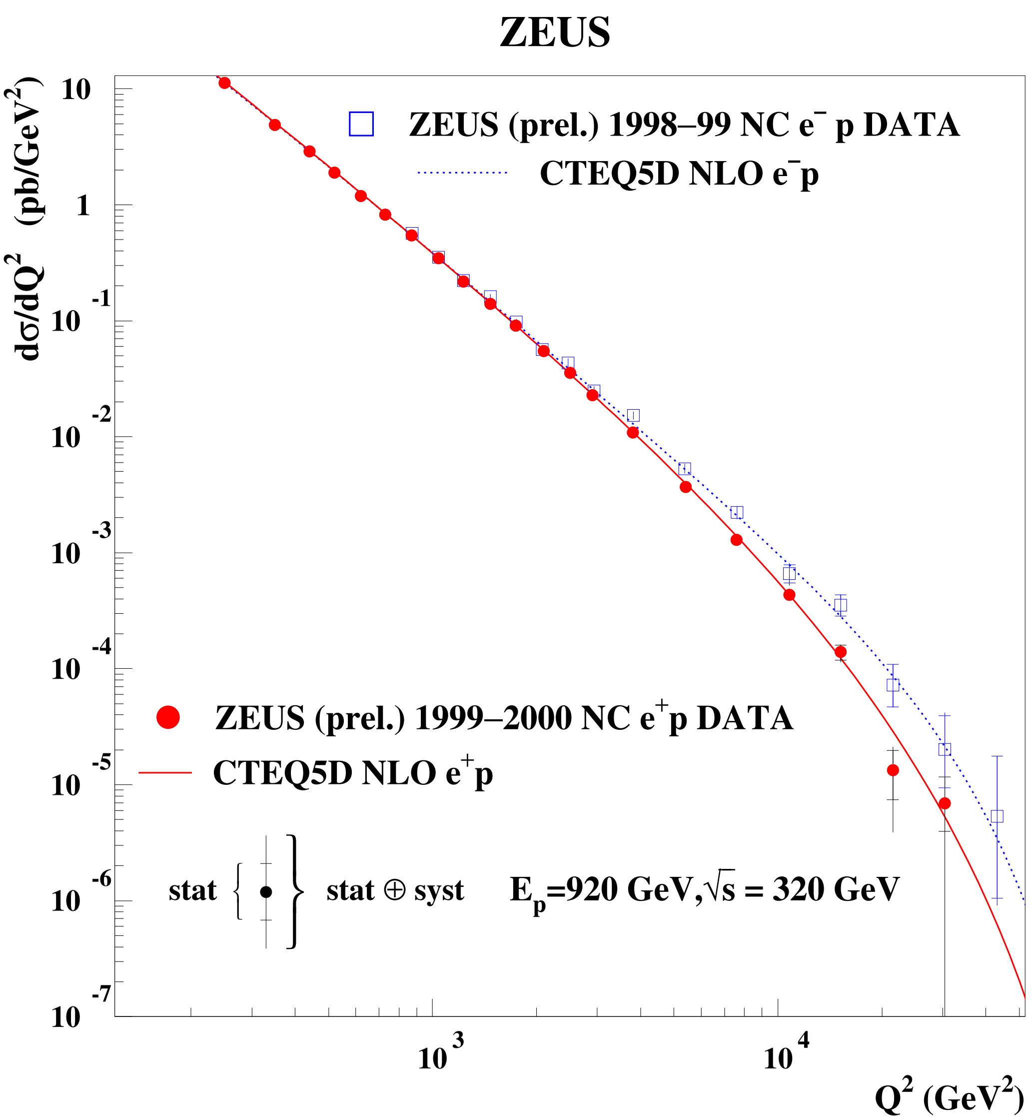


Neutral current event

Neutral current control plots.
Data sample $(e^+p)^{920}$

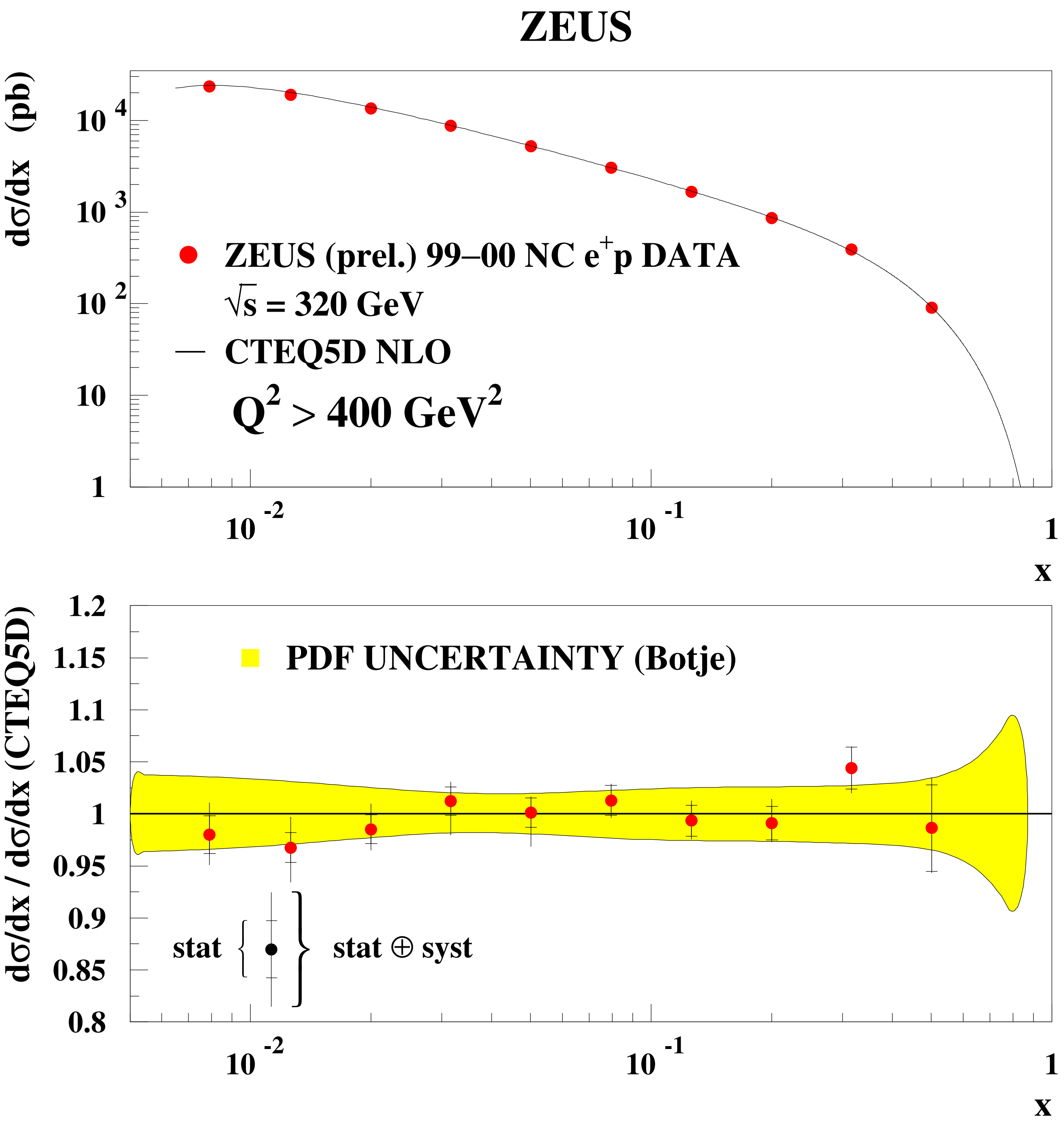


$\frac{d\sigma}{dQ^2}$ for NC events. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$

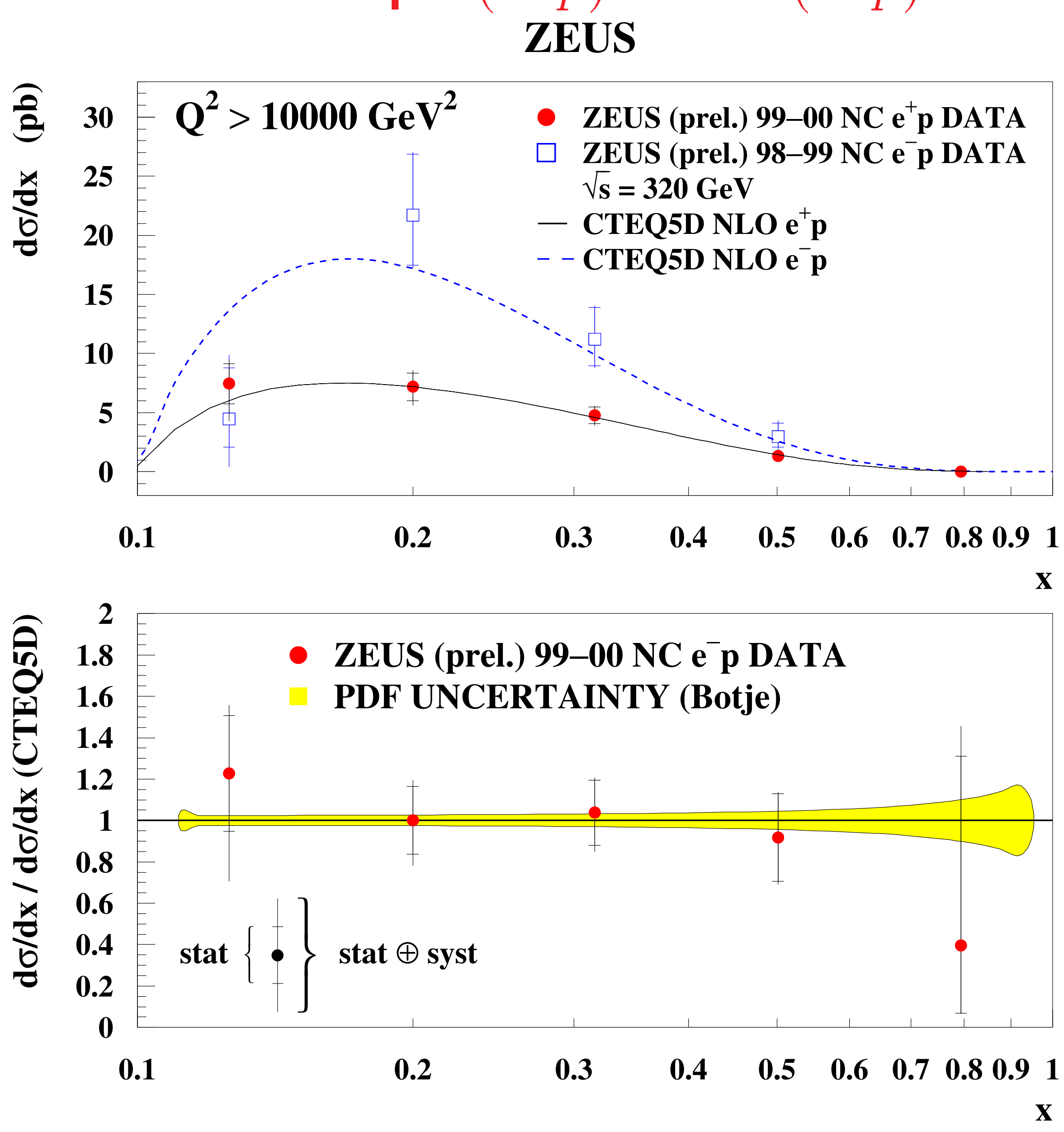


Contribution of the Z^0 exchange at high Q^2

$\frac{d\sigma}{dx}$ for NC events for $Q^2 \geq 400$ GeV^2. Data sample $(e^+p)^{920}$

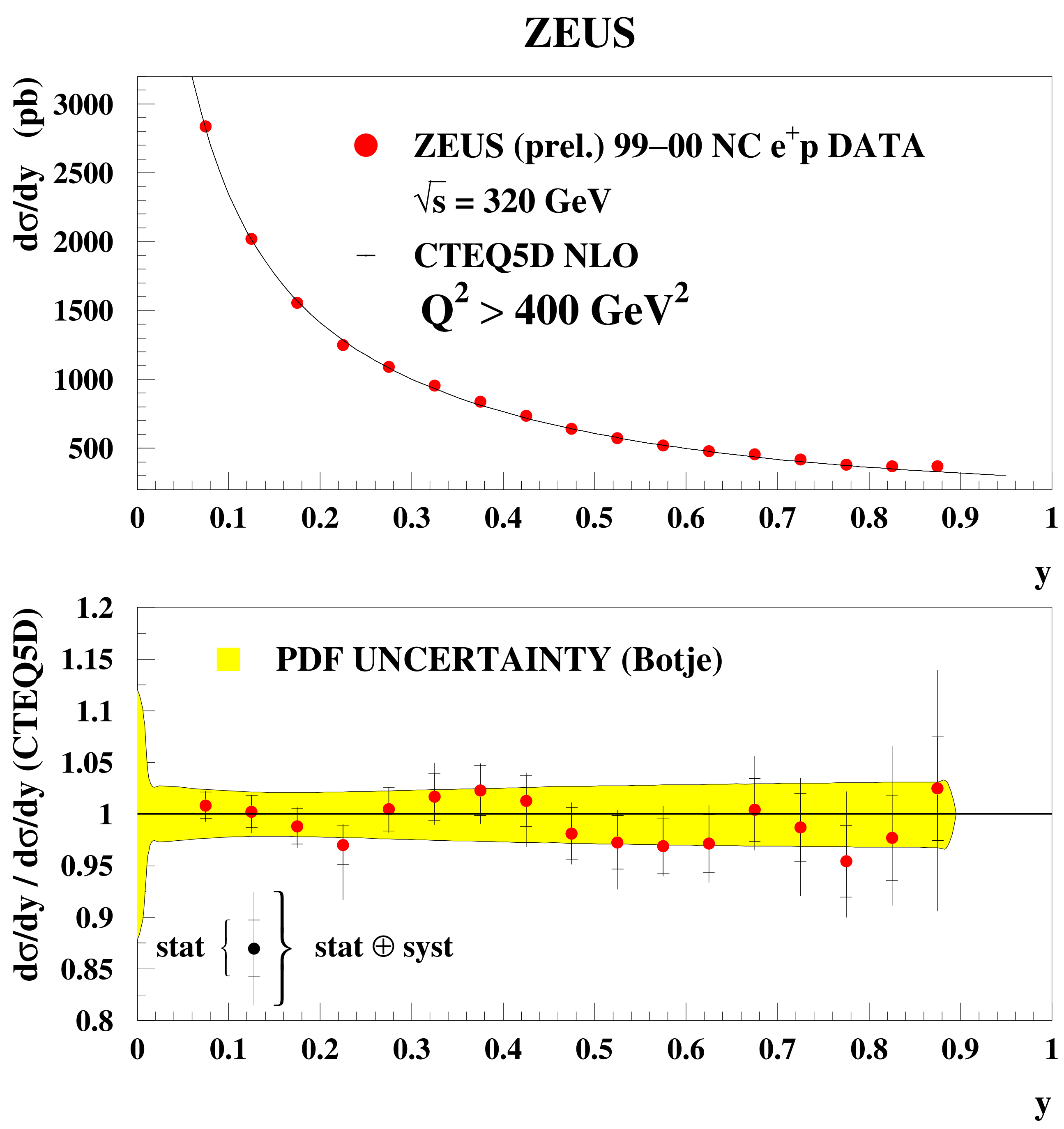


$\frac{d\sigma}{dx}$ for NC events for $Q^2 \geq 10000$ GeV^2. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$

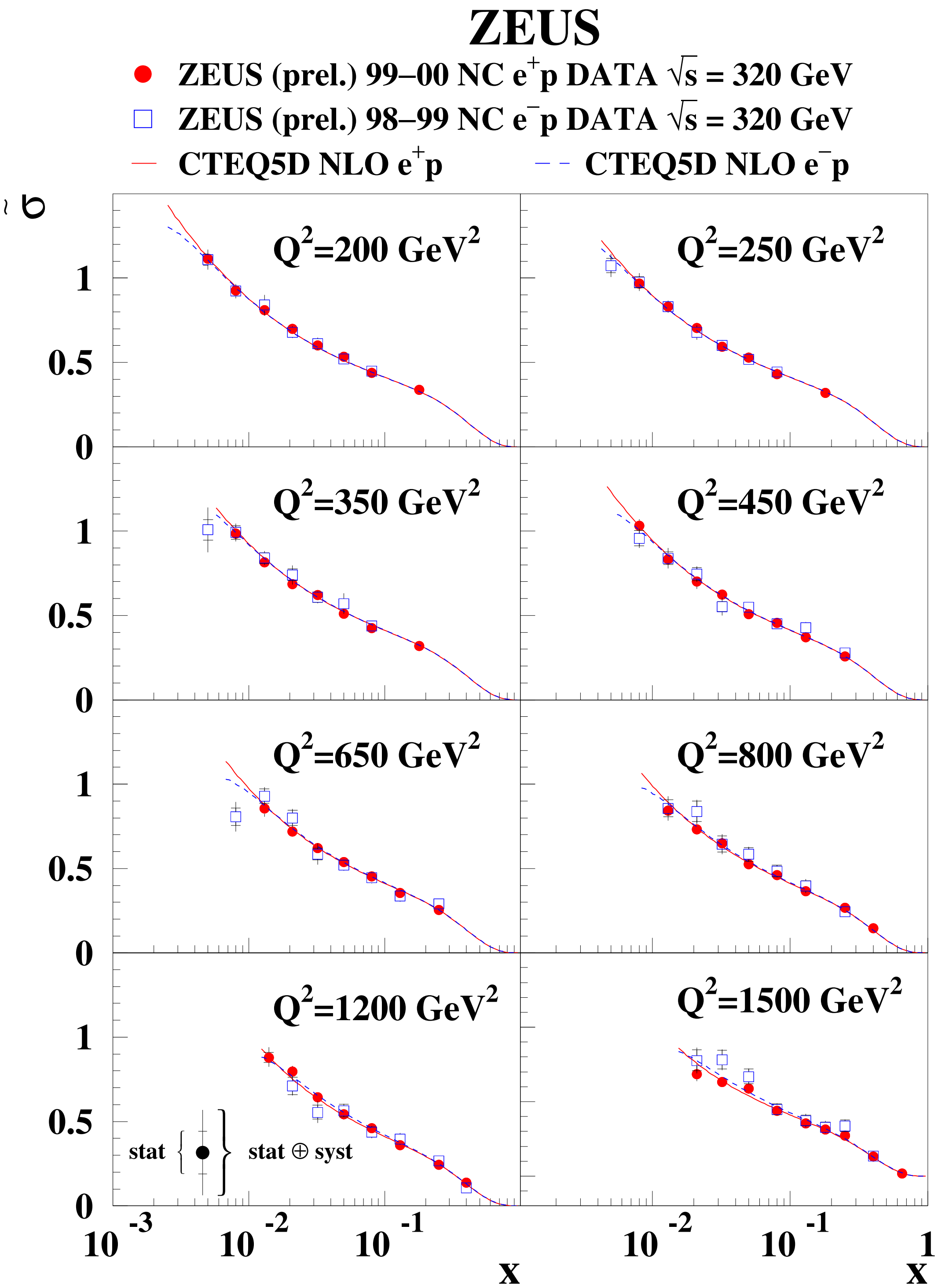


$\gamma - Z^0$ interference at high Q^2 constructive for e^-p data, destructive for e^+p data

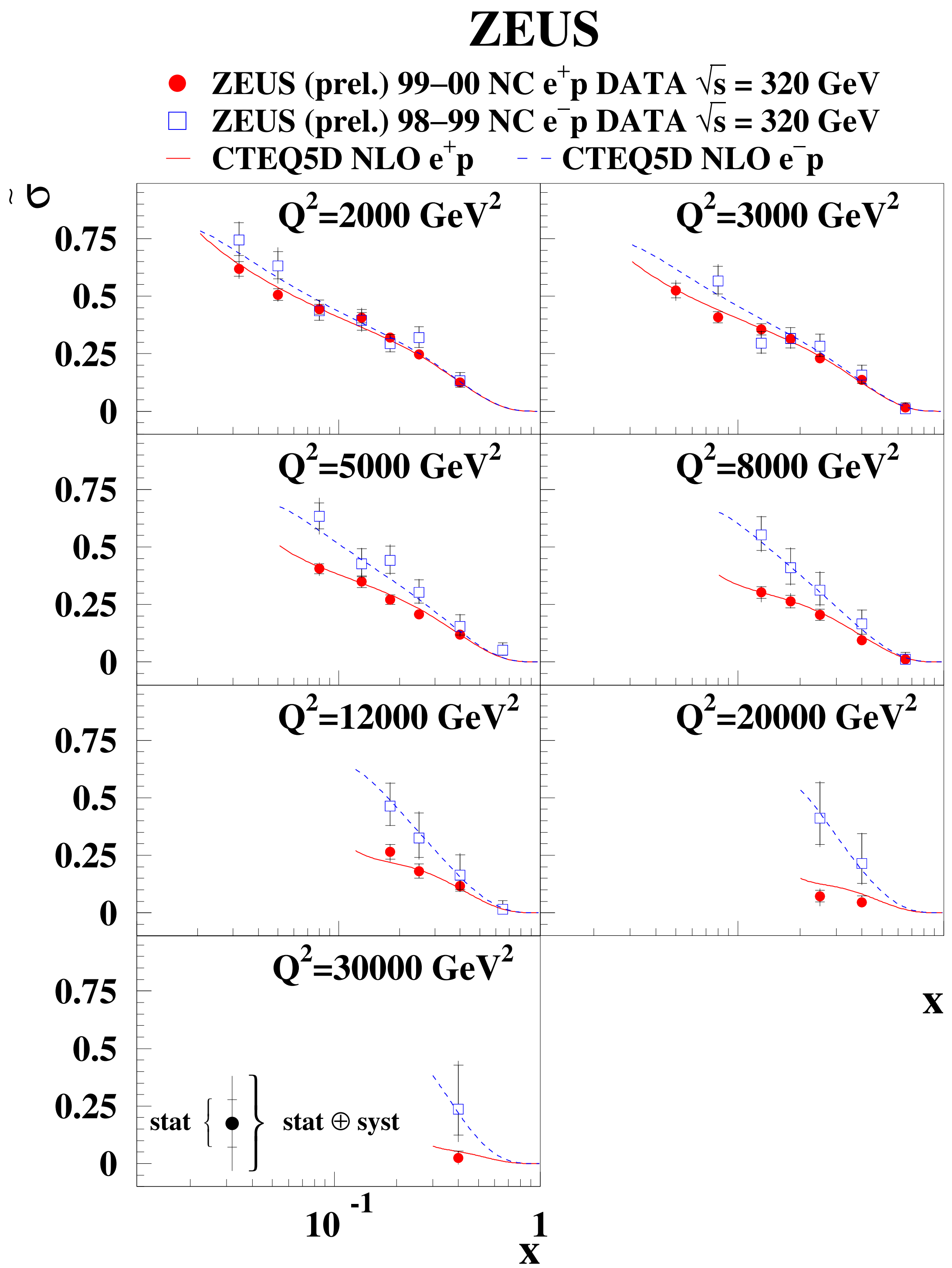
$\frac{d\sigma}{dy}$ for NC events for $Q^2 \geq 400$ GeV^2. Data sample $(e^+p)^{920}$



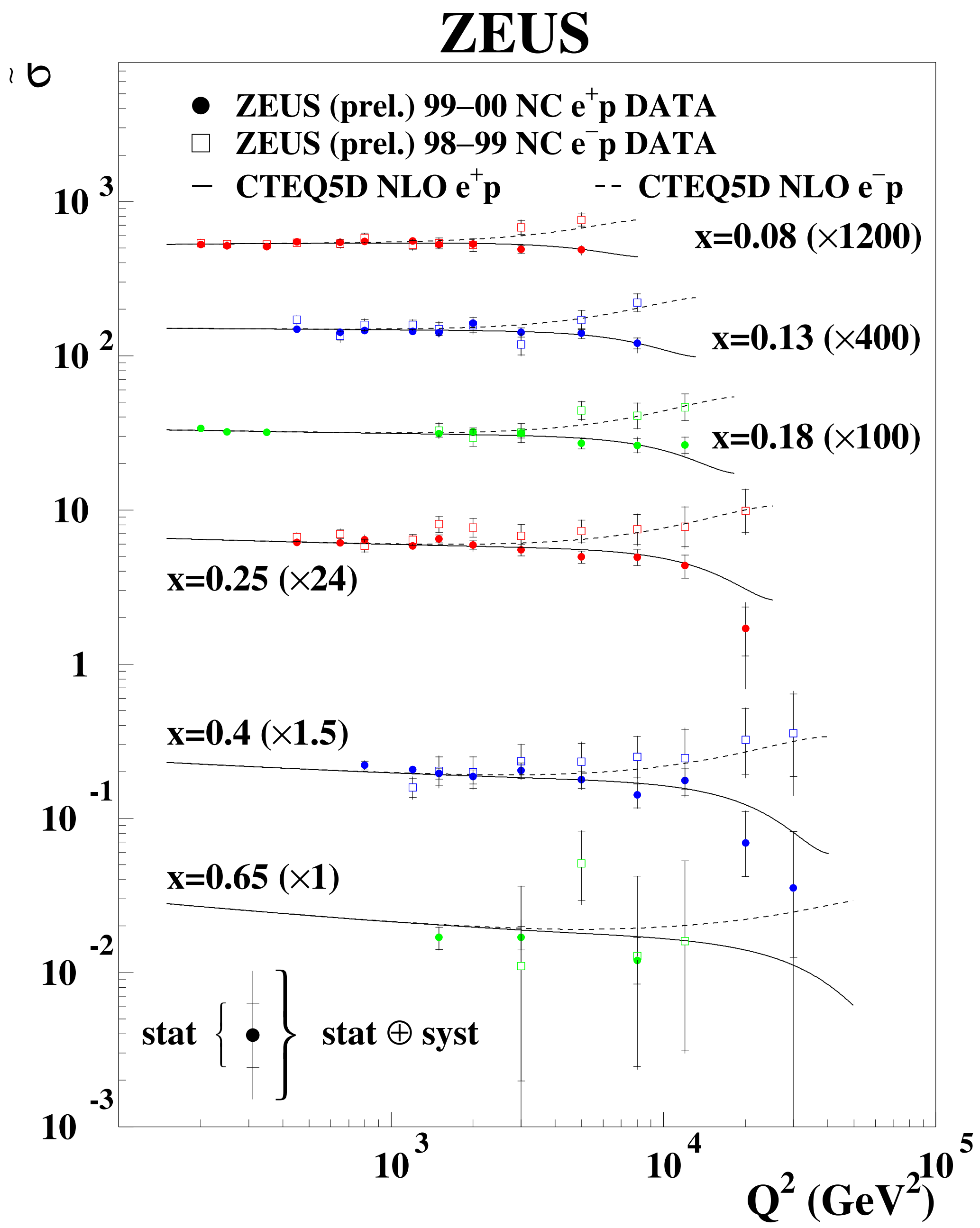
$\frac{d^2\sigma}{dx\,dQ^2}$ in Q^2 bins for NC events. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$



$\frac{d^2\sigma}{dx\,dQ^2}$ in Q^2 bins for NC events. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$. Cont.



$\frac{d^2\sigma}{dx\, dQ^2}$ in x bins for NC events. Data sample $(e^+p)^{920}$ and $(e^-p)^{920}$



$xF_3(x, Q^2)$ contribution to the cross-section at high Q^2

$xF_3(x,Q^2)$ extraction. Data sample $(e^+p)^{820}$ and $(e^-p)^{920}$

Want to extract $xF_3(x,Q^2)$

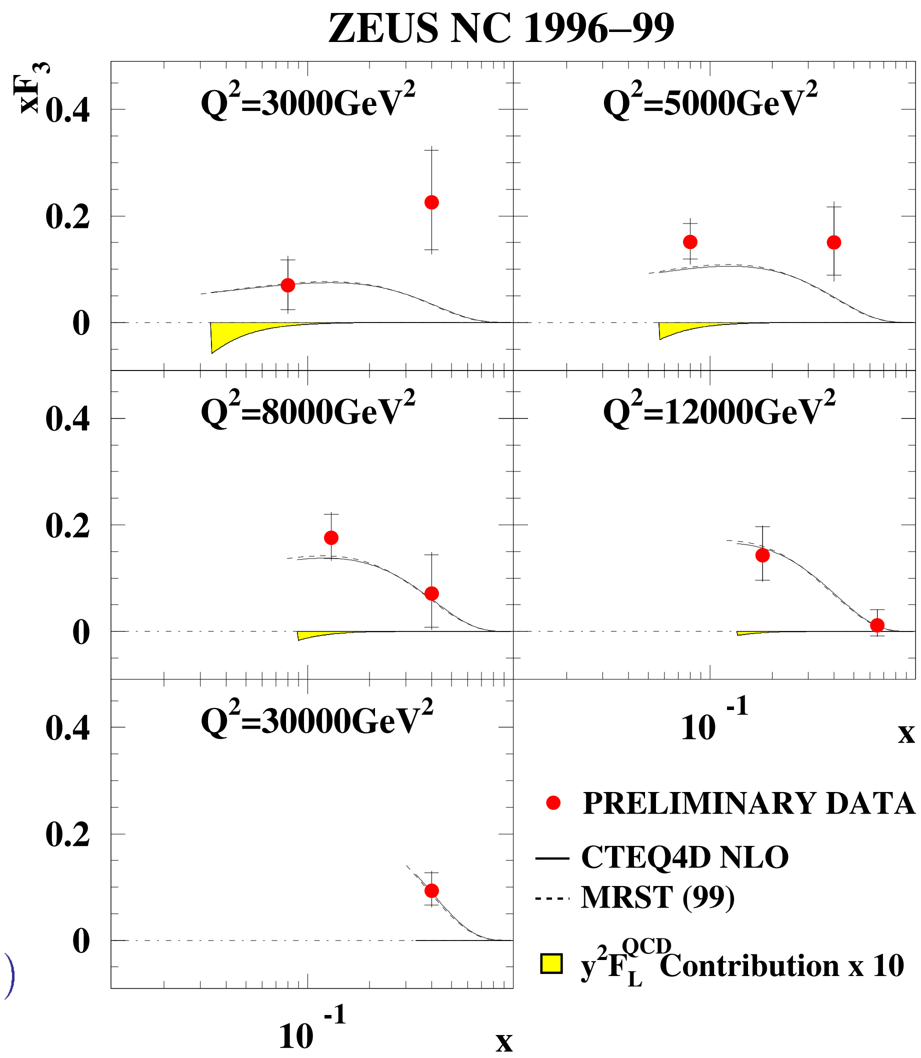
$$\frac{d^2\sigma^{\pm}}{dx\,dQ^2} = \frac{2\pi\alpha^2(Q^2)}{xQ^4}\left[Y_+F_2 \mp Y_-xF_3 - y^2F_L\right]$$

Taking care of the different center-of-mass energy

$$\begin{aligned} xF_3(x,Q^2) \quad = \quad & \left(\frac{xQ^4}{2\pi\alpha^2}\right)\left(\frac{Y_-^{920}}{Y_+^{920}} + \frac{Y_-^{820}}{Y_+^{820}}\right)^{-1} \\ & \left(\frac{1}{Y_+^{920}}\frac{d^2\sigma^-}{dx\,dQ^2} - \frac{1}{Y_+^{820}}\frac{d^2\sigma^+}{dx\,dQ^2}\right) \\ & -\Delta F_L(x,Q^2) \end{aligned}$$

Where

$$\Delta F_L(x,Q^2) = \frac{Y_+^{820}\cdot(y^{920})^2 - Y_+^{920}\cdot(y^{820})^2}{Y_-^{920}\cdot Y_+^{820} + Y_-^{820}\cdot Y_+^{920}}\cdot F_L(x,Q^2)$$



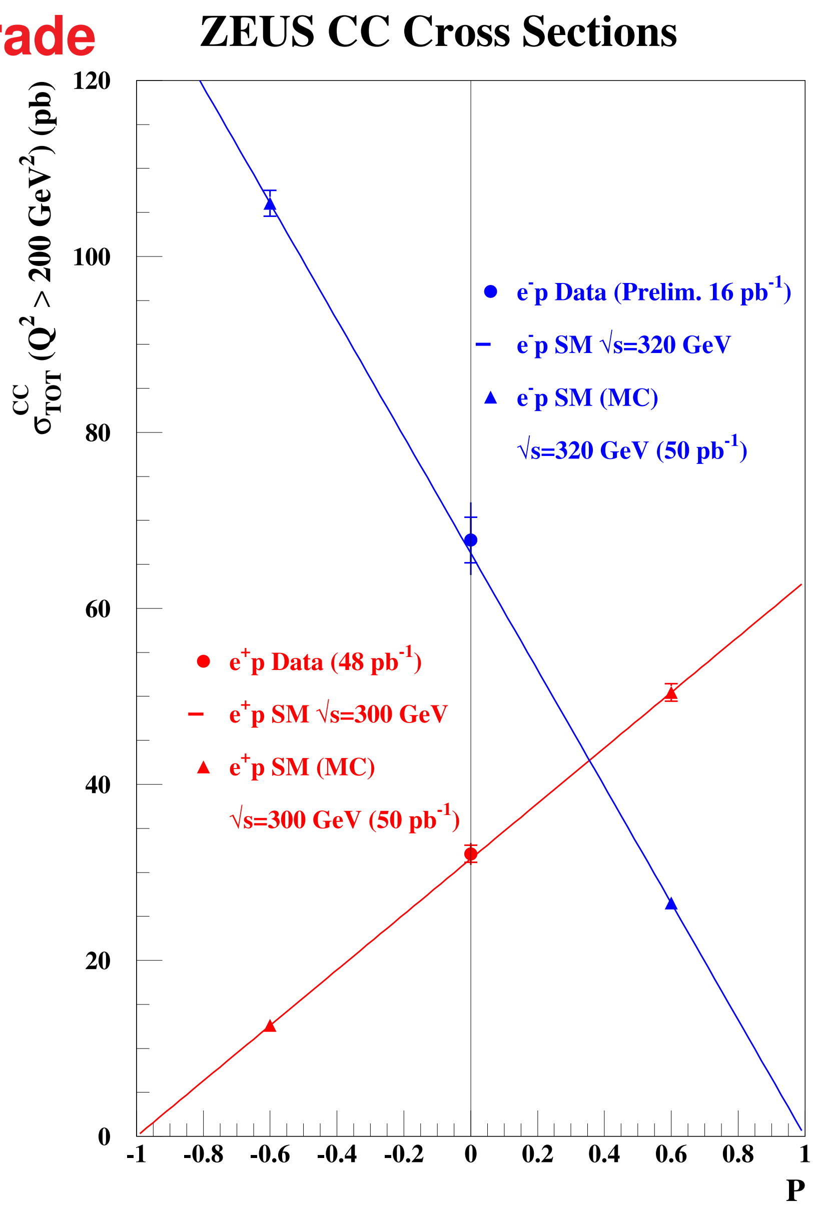
Lumi upgrade

Lumi Upgrade

- Lumi upgrade $\rightarrow$ 150 pb^{-1} per year
- After six years of running accumulated $\mathcal{L} \approx 1$ fb^{-1} of e^+p and e^-p data
- Polarized beams (designed goal 70$\%$)

New Physic results

- Dependence of the total CC cross-section with the polarization
- Smaller errors for xF_3 $\rightarrow$ better understanding of the valence quark distributions for high x.
- Measurement of structure functions with high statistic



Summary and outlook

Summary

- Preliminary results of 60 pb^{-1} from NC and CC e^+p data.
- Cross-sections presented for both analysis for $Q^2 \geq 200$ GeV^2
- Both NC and CC analysis show good agreement between data and standard model predictions
- Extraction of $xF_3(x, Q^2)$ with $(e^+p)^{820}$ and $(e^-p)^{920}$ data

Outlook

- New e^+p and e^-p data sets with high luminosity and polarized lepton beam will be available
- Possibility of very precise measurement of the double differential cross-sections for both NC and CC events.
- From NC $\rightarrow$ possibility of extracting $xF_3(x, Q^2)$
- From CC $\rightarrow$ precise measurement of the d/u ratio
- Constrain pdfs at high x.