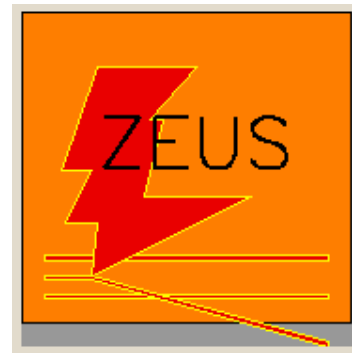


Charged Current Interactions in Deep Inelastic Scattering at ZEUS



DIS2002 Cracow

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on behalf of the ZEUS collaboration

Charged Current Interactions in Deep Inelastic Scattering at ZEUS

- DIS kinematics
- Charged Current event selection
- Charged Current cross sections
 - 98/99 e^-p data (final results)
 - 99/00 e^+p data
- results on M_w

Deep Inelastic Scattering Kinematics

Lorentz invariant variables:

four momentum transfer:

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

relative energy transfer:

$$y = \frac{P \cdot q}{P \cdot k}$$

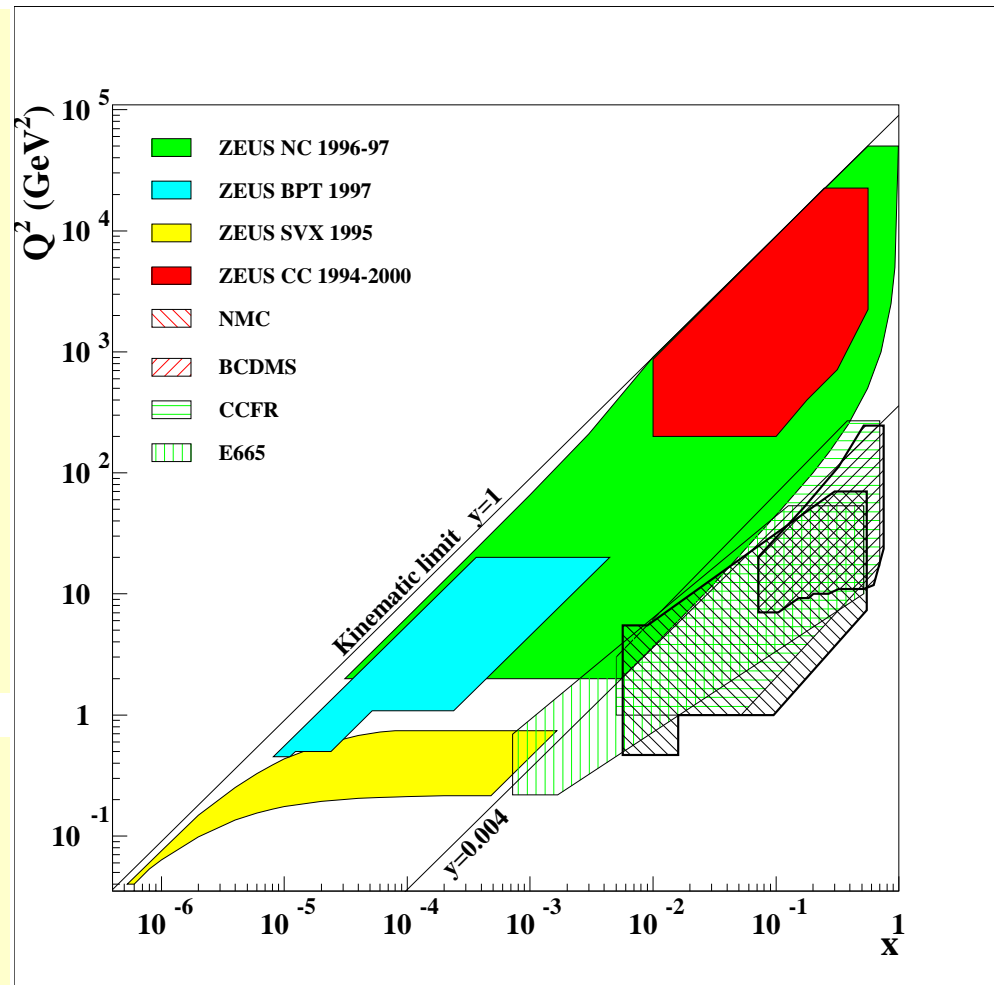
momentum fraction quark:

$$x_{Bj} = \frac{Q^2}{2P \cdot q}$$

Related through:

center of mass energy:

$$s = Q^2 / xy$$



Data Samples

1994 – 1997: Positrons

$E_e = 27.5 \text{ GeV}$, $E_p = 820 \text{ GeV}$

- 47.7 pb^{-1}

1998 – 1999: Electrons

$E_e = 27.5 \text{ GeV}$, $E_p = 920 \text{ GeV}$

- 16.4 pb^{-1}

1999 – 2000: Positrons

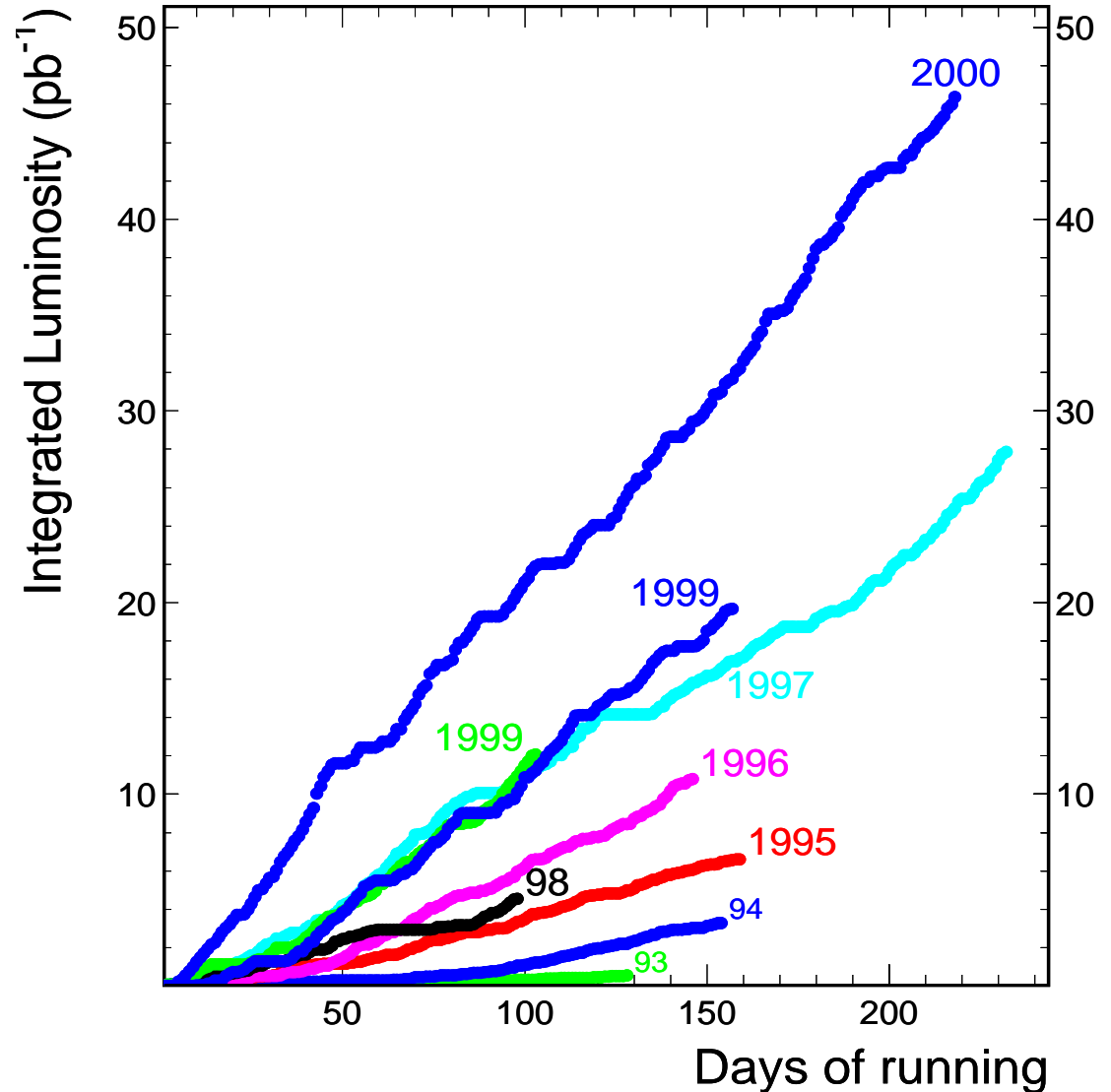
$E_e = 27.5 \text{ GeV}$, $E_p = 920 \text{ GeV}$

- 61.0 pb^{-1}

In this talk:

- 98/99 electron data
- 99/00 positron data

Physics Luminosity 1993 – 2000



CC in DIS

Electron scattering

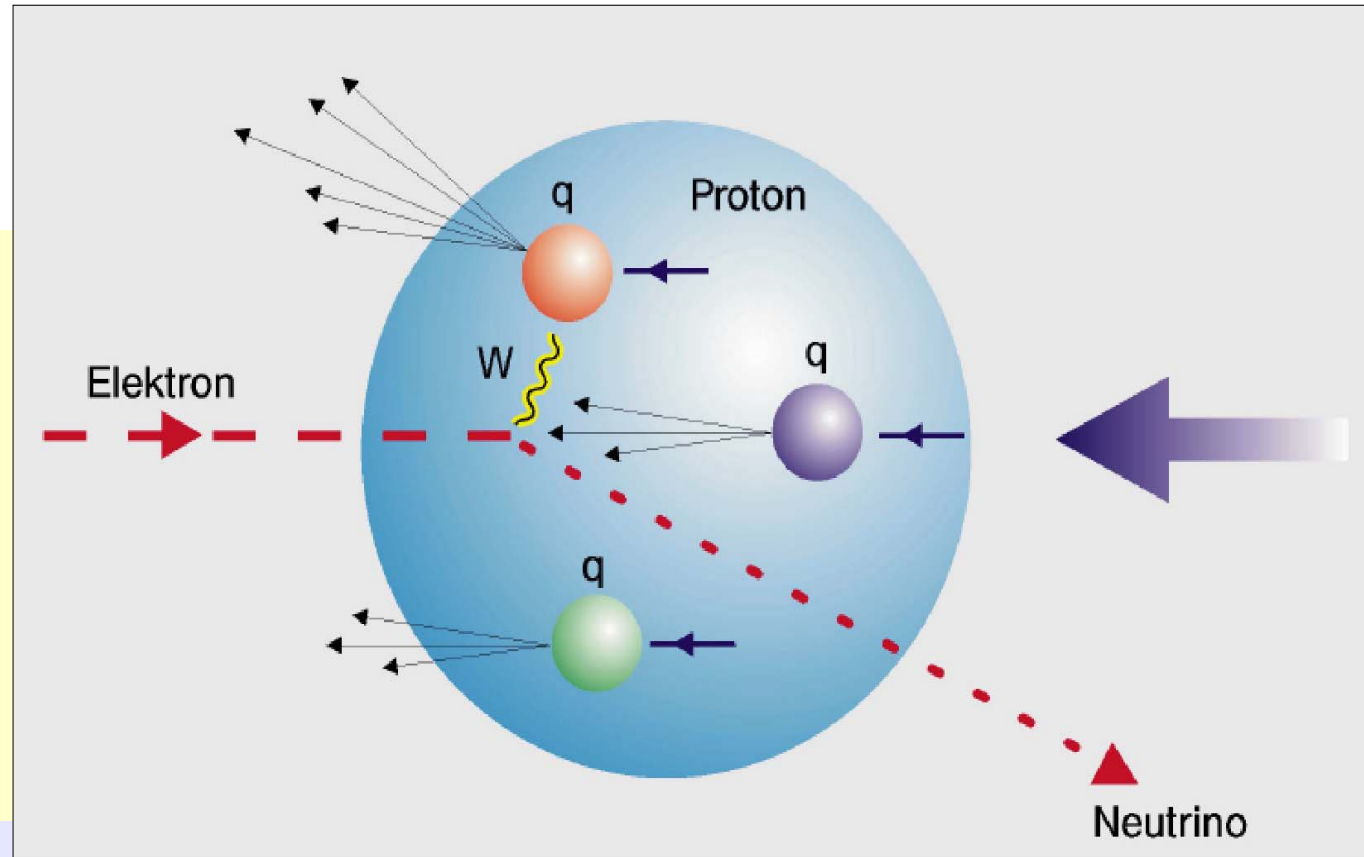
- probe u valence
- positively charged sea

Positron scattering

- probe d valence
- negatively charged sea

cross section (L.O.)

$$\frac{d^2 \sigma_{CC}}{dx dQ^2} = \frac{G_F^2}{2\pi} \left(\frac{M_W^2}{M_W^2 + Q^2} \right)^2 \times \begin{cases} [x(u+c) + (1-y)^2 x(\bar{d}+\bar{s})] & e^- p \rightarrow \nu_e X \\ [x(\bar{u}+\bar{c}) + (1-y)^2 x(d+s)] & e^+ p \rightarrow \bar{\nu}_e X \end{cases}$$



Event Selection (1)

CC signature:

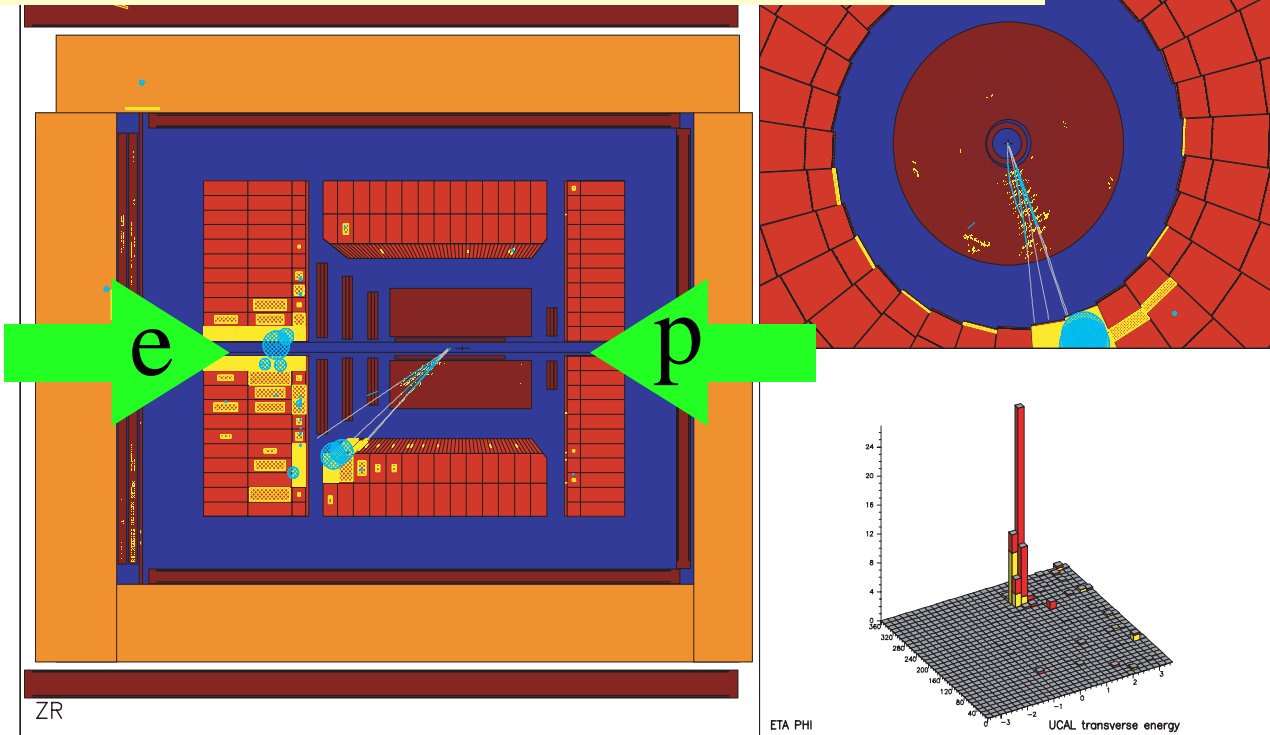
$$ep \rightarrow \nu_e X$$

Escaping Neutrino:

- Missing transverse momentum ($P_{T\text{miss}}$)

Use Hadronic system for kinematics reconstruction:

- Jacquet Blondel Method



ep backgrounds:

- Photo production events
- Neutral Current events

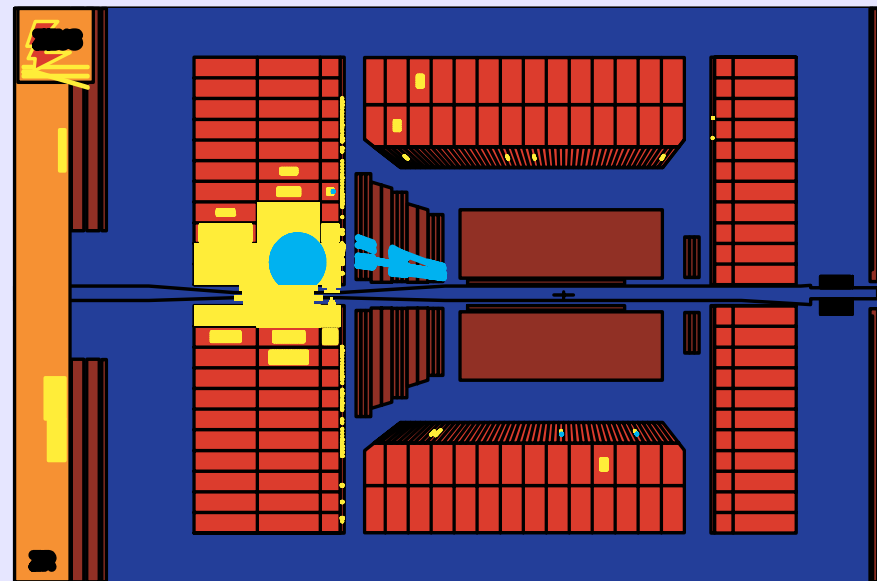
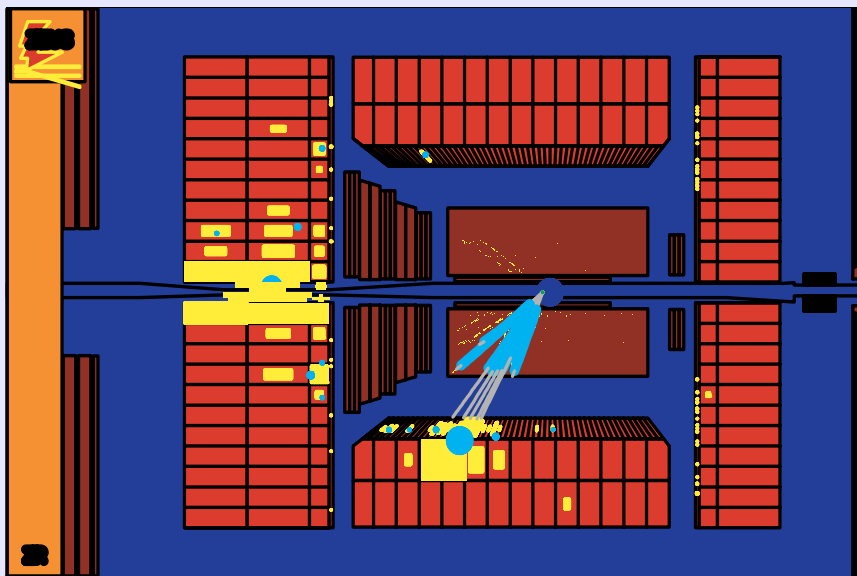
Non ep backgrounds:

- Beamgas events
- Halo muon events
- Cosmic muon events

Event Selection (2)

High γ_0 region ($\gamma_0 > 23^\circ$):

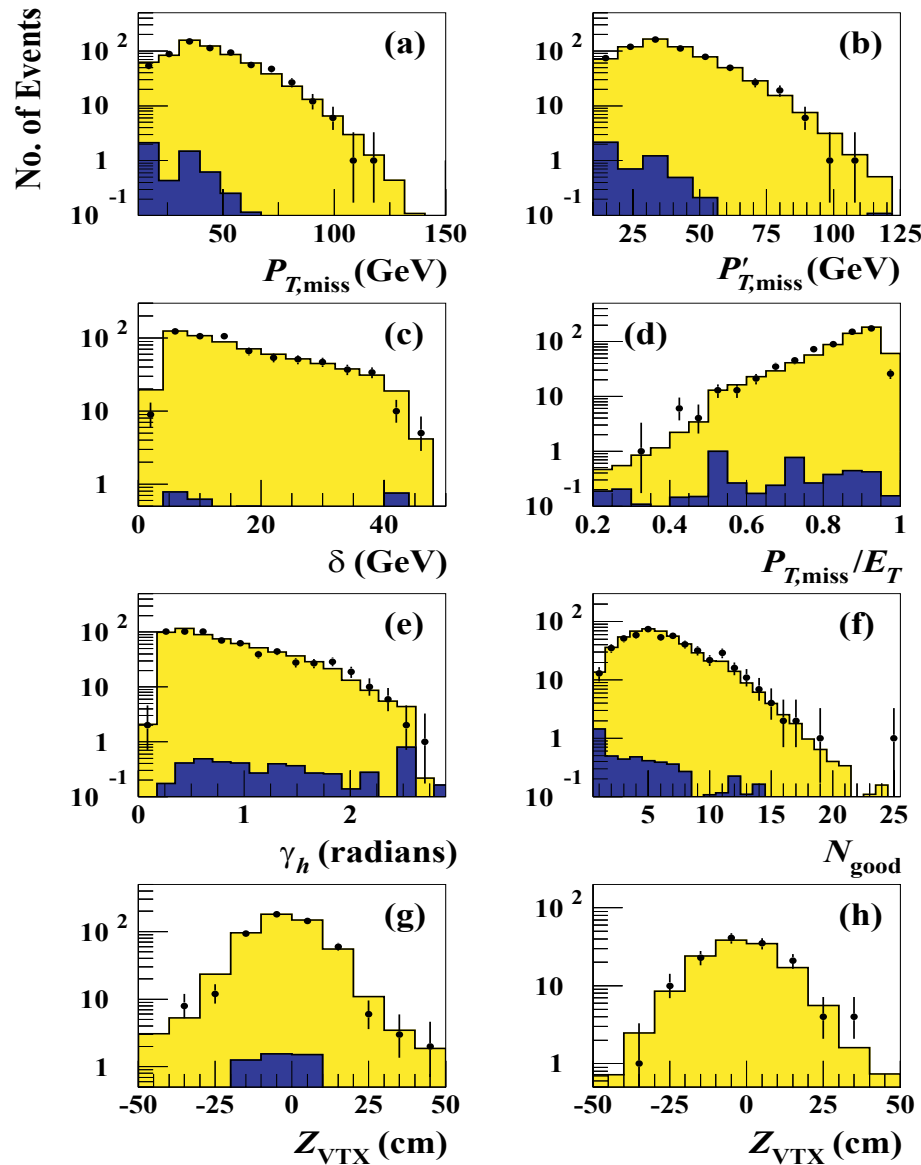
- Event vertex from tracking
- $P_{T\text{miss}} > 12 \text{ GeV}$



Low γ_0 region ($\gamma_0 < 23^\circ$):

- Event vertex from CAL timing
- $P_{T\text{miss}} > 25 \text{ GeV}$

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Event distributions CC 98/99 electron data

- e^-p data (16.4 pb^{-1})
- CC MC (CTEQ5D PDFs)
- background MCs

- a) missing transverse momentum
- b) $P_{T,miss}$ excluding forward cells
- c) $E - P_Z$
- d) $P_{T,miss}/E_T$
- e) angle of hadronic system
- f) number of good tracks
- g) Z position of vertex, high γ_0
- h) Z position of vertex, low γ_0

Final results CC 98/99 electron data

Charged Current cross section

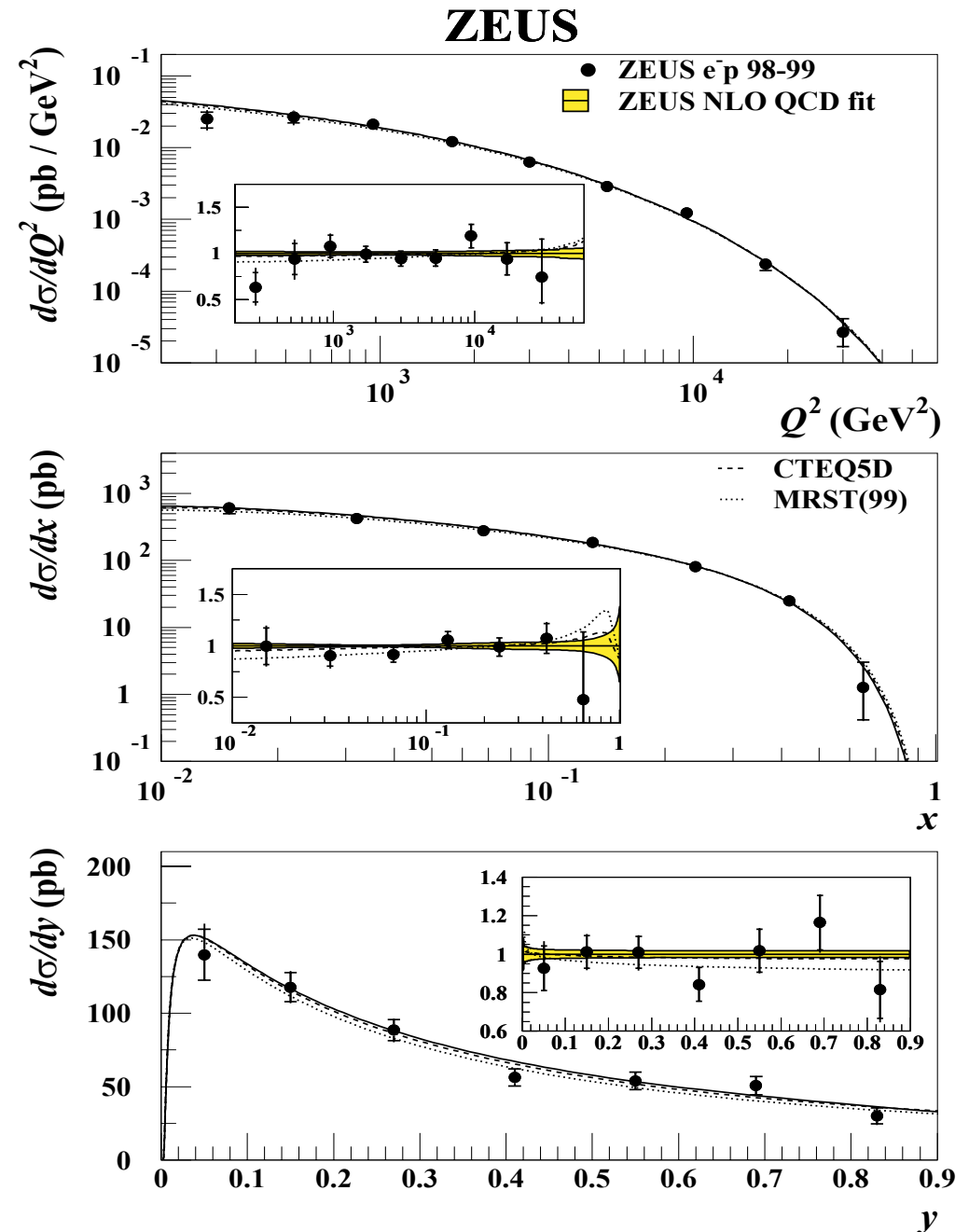
$$\frac{d\sigma_{CC}}{dQ^2} = \frac{G_F^2}{4\pi} \times \left(\frac{M_W^2}{M_W^2 + Q^2} \right)^2 \times F(Q^2)$$

Cross section extraction

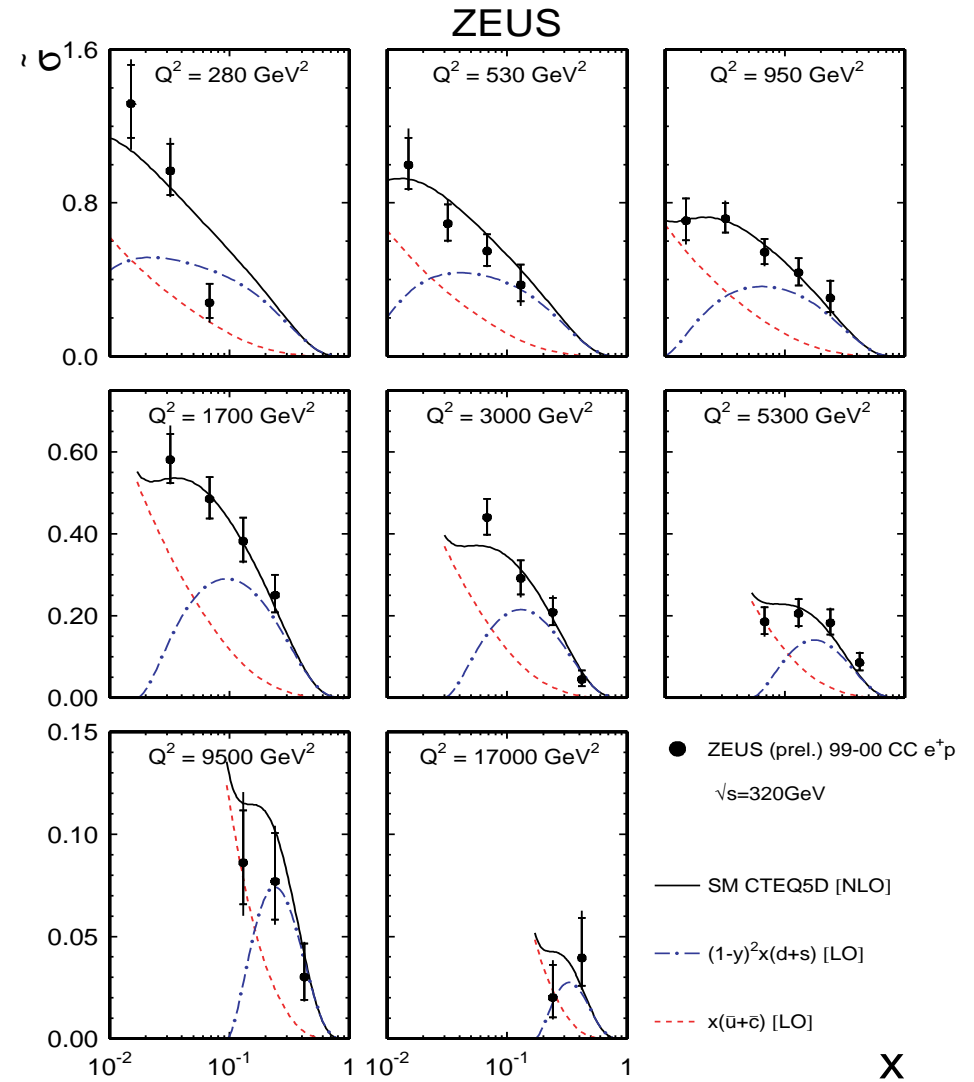
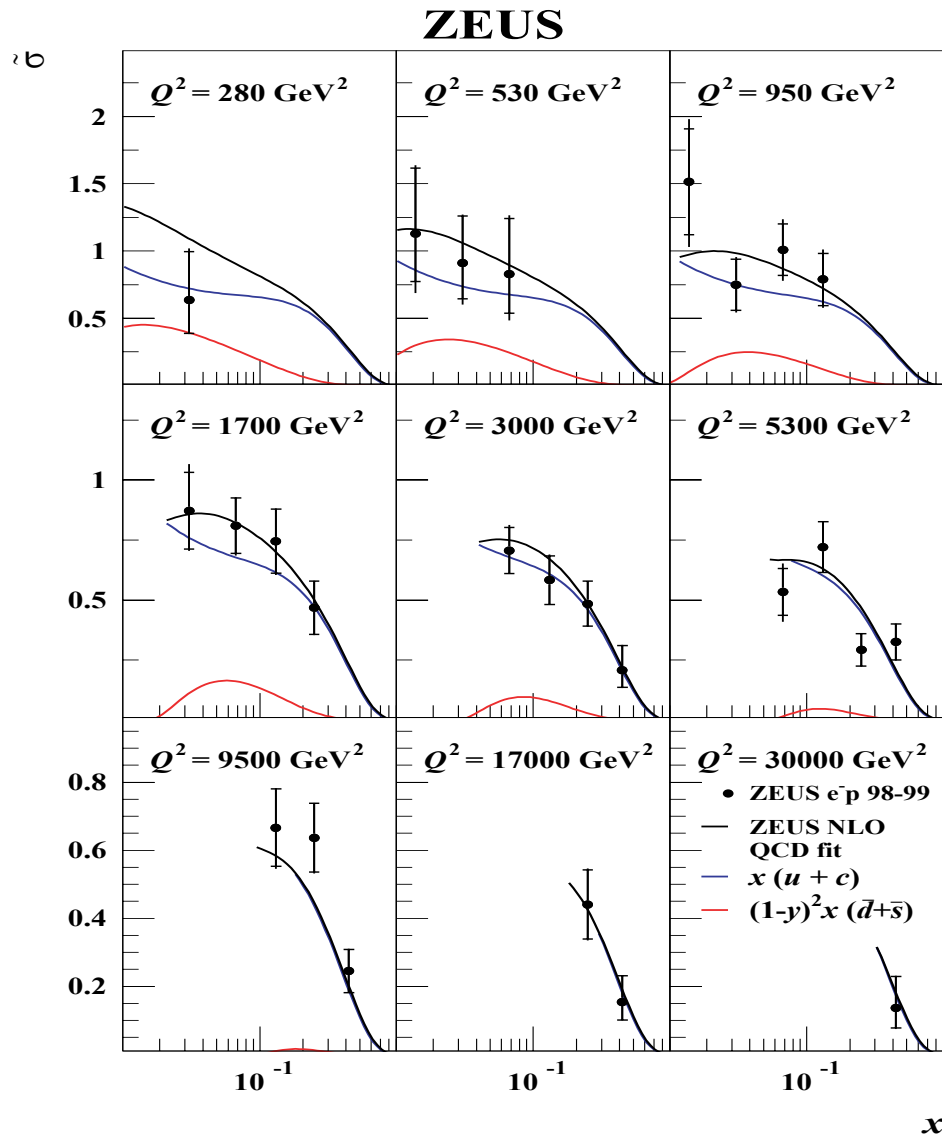
$$\frac{d\sigma_{Born}^{data}}{dQ^2}(Q_q^2) = \frac{N_{obs} - N_{bg.}}{N_{MC}} \cdot \frac{d\sigma_{Born}^{SM}}{dQ^2}(Q_q^2)$$

from Monte Carlo simulation

- acceptance corrections
- bin-centering corrections
- radiative corrections



Final results CC 98/99 electron data



$$\tilde{\sigma}_{CC}(e^- p) = \left[x(u+c) + (1-y)^2 x(\bar{d}+\bar{s}) \right]$$

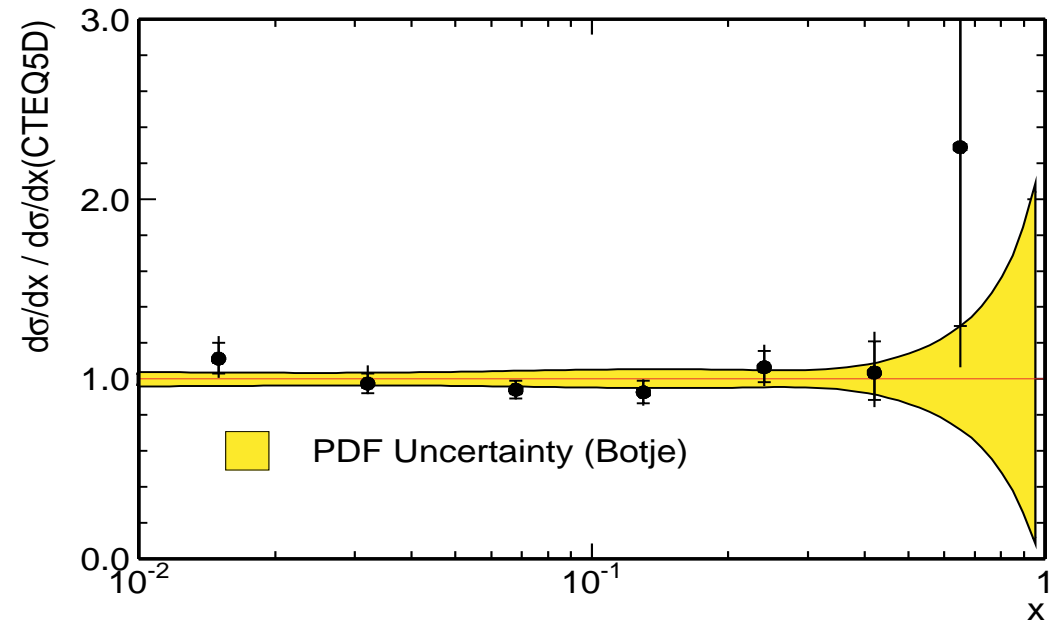
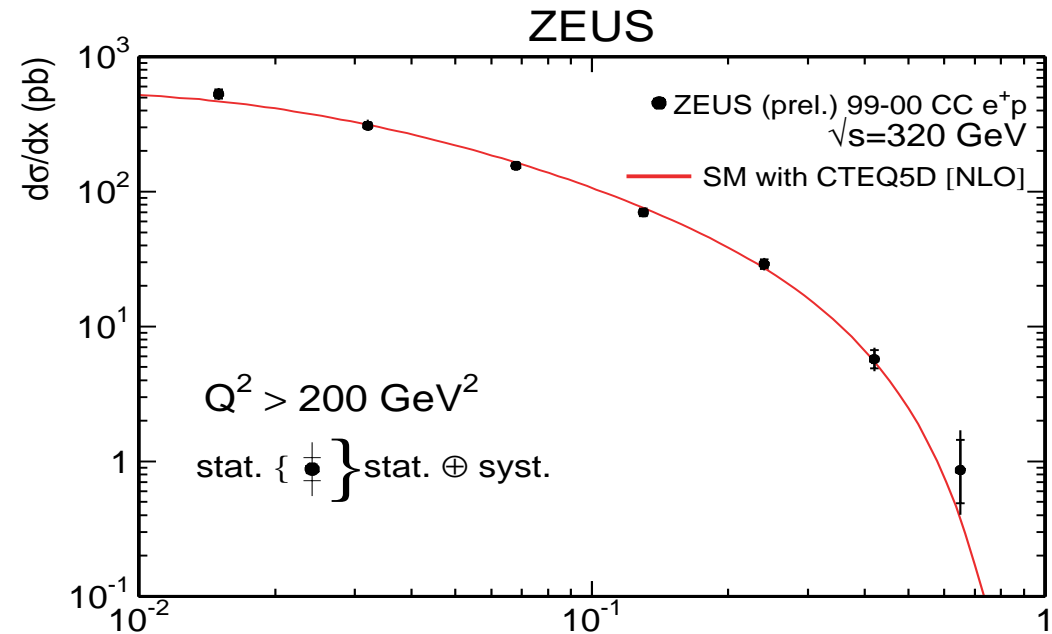
$$\tilde{\sigma}_{CC}(e^+ p) = \left[x(u+\bar{c}) + (1-y)^2 x(d+s) \right]$$

High x measurement

CC e^+p at high x :

- Mainly sensitive to **d valence**

Highest x measurement of d valence in proton!



Final results

CC 98/99 electron data

Chiral structure of EW interaction:

- e^-p (W^-): anti-particles helicity suppressed
- e^+p (W^+): particles helicity suppressed

Helicity plot: Fix x , Plot $\tilde{\sigma}_{CC}$ versus $(1-y)^2$

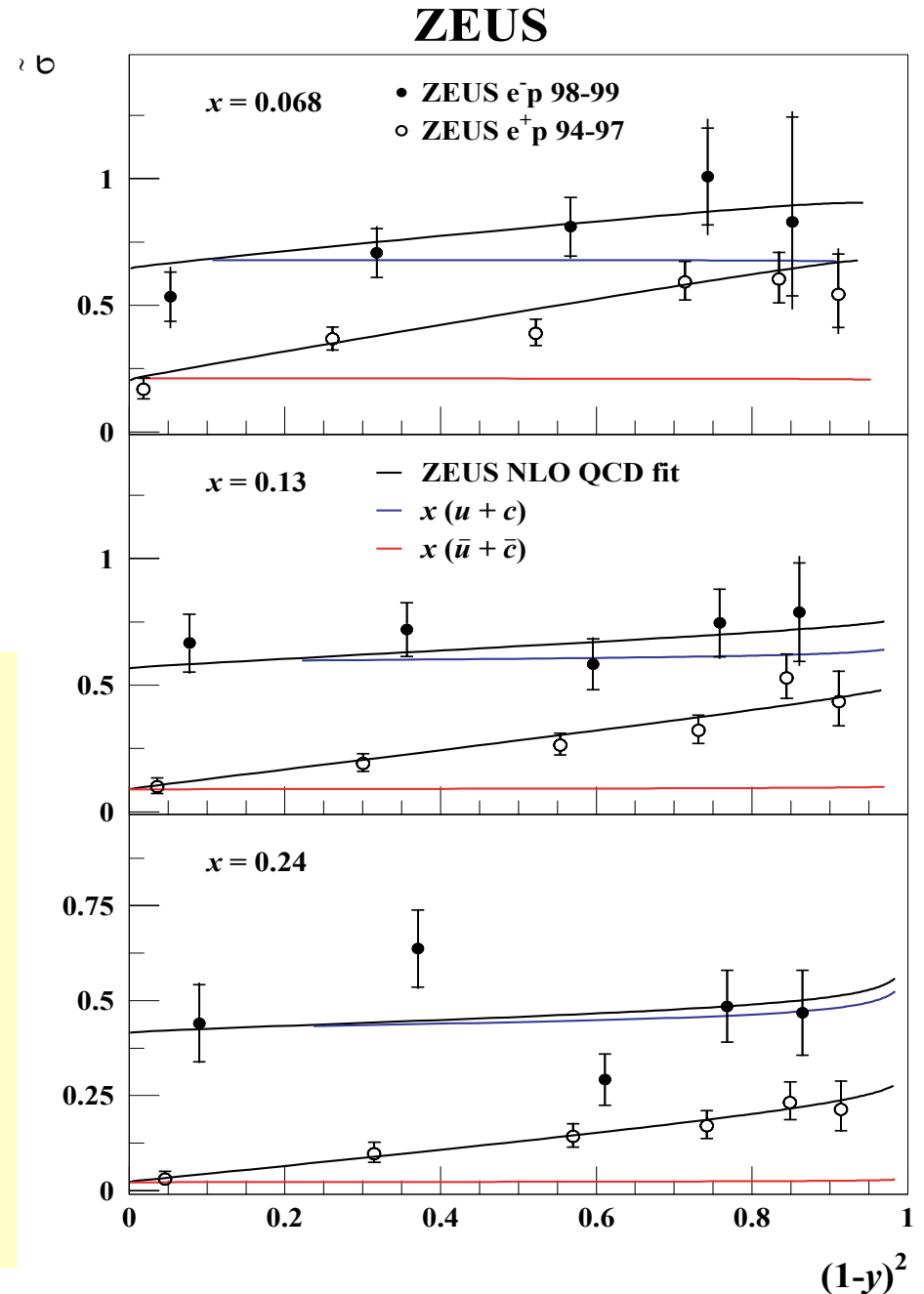
$$\tilde{\sigma}_{CC}(e^-p) = \left[x(u_v + u_s + c_s) + (1-y)^2 x(\bar{d}_s + \bar{s}_s) \right]$$

$$\tilde{\sigma}_{CC}(e^+p) = \left[x(\bar{u}_s + \bar{c}_s) + (1-y)^2 x(d_v + d_s + s_s) \right]$$

$$\tilde{\sigma}_{\pm}(CC) = \tilde{\sigma}_{CC}(e^-p) \pm \tilde{\sigma}_{CC}(e^+p)$$

$$\Rightarrow \tilde{\sigma}_-(CC) = x u_v - (1-y)^2 x d_v$$

- Intercept \rightarrow read off u valence
- Slope \rightarrow read off d valence



M_W from $d\sigma/dQ^2$

Fit shape of cross section:

- mass of spacelike W (LEP timelike)

$$\frac{d\sigma^{CC}}{dQ^2} = \frac{G_F^2}{4\pi} \times \left(\frac{M_W^2}{M_W^2 + Q^2} \right)^2 \times F(Q^2)$$

$$G_F = 1.16639 \times 10^{-5} \text{ GeV}^{-2}$$

(fixed to PDG value)

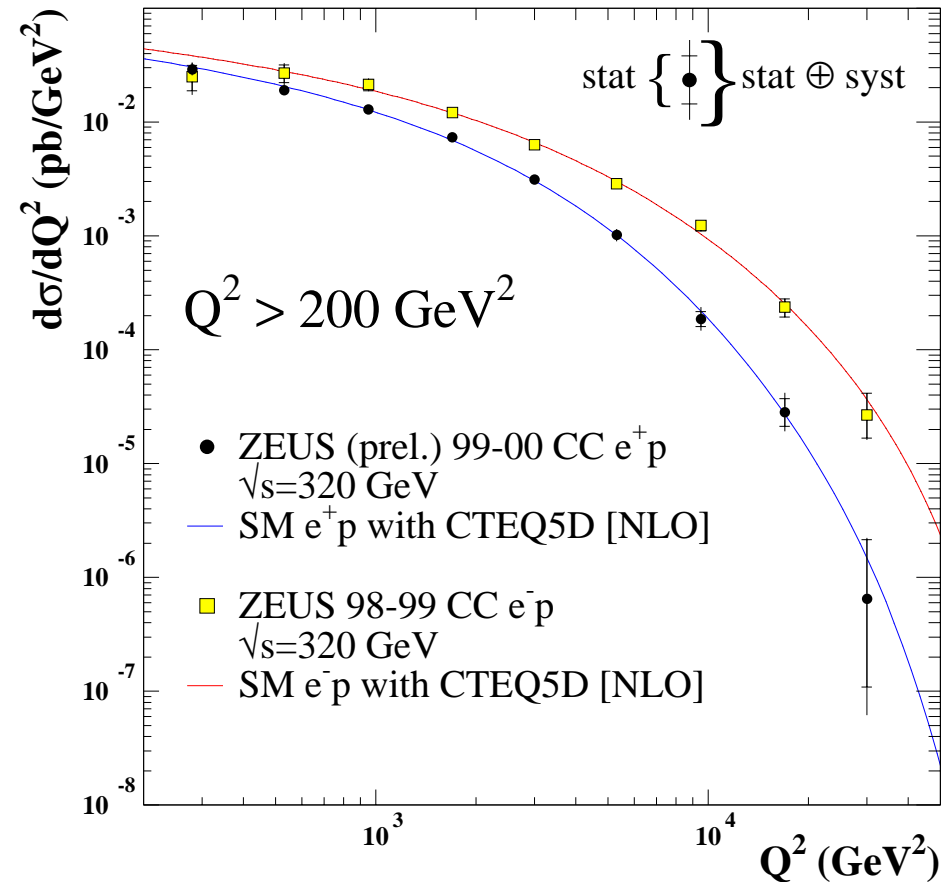
- Final result for 98/99 electron data

$$M_W = 80.3 \pm 2.1 (\text{stat.}) \pm 1.2 (\text{syst.}) \pm 1.0 (\text{pdf}) \text{ GeV}$$

- Compared to 94–97 positron data

$$M_W = 81.4^{+2.7}_{-2.6} (\text{stat.}) \pm 2.0 (\text{syst.})^{+3.3}_{-3.0} (\text{pdf}) \text{ GeV}$$

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- PDG Value: $M_W = 80.422 \pm 0.047 \text{ GeV}$

Summary

Charged Current cross sections for the 98/99 e^-p data (final) and 99/00 e^+p data

- $d\sigma/dQ^2$, $d\sigma/dx$, $d\sigma/dy$
- reduced cross sections $\tilde{\sigma}_{CC}$
- In agreement with SM over many orders of magnitude

Results on the M_W from fit to $d\sigma/dQ^2$

- 98/99 e^-p data

$$M_W = 80.3 \pm 2.1 (\text{stat.}) \pm 1.2 (\text{syst.}) \pm 1.0 (\text{pdf}) \text{ GeV}$$