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High Q^2 Neutral and Charged Current in Polarised Collisions at HERA II

Shiraz Habib
on behalf of the

H1 Collaboration

High Q^2 Neutral and Charged Current in Polarised Collisions at HERA II

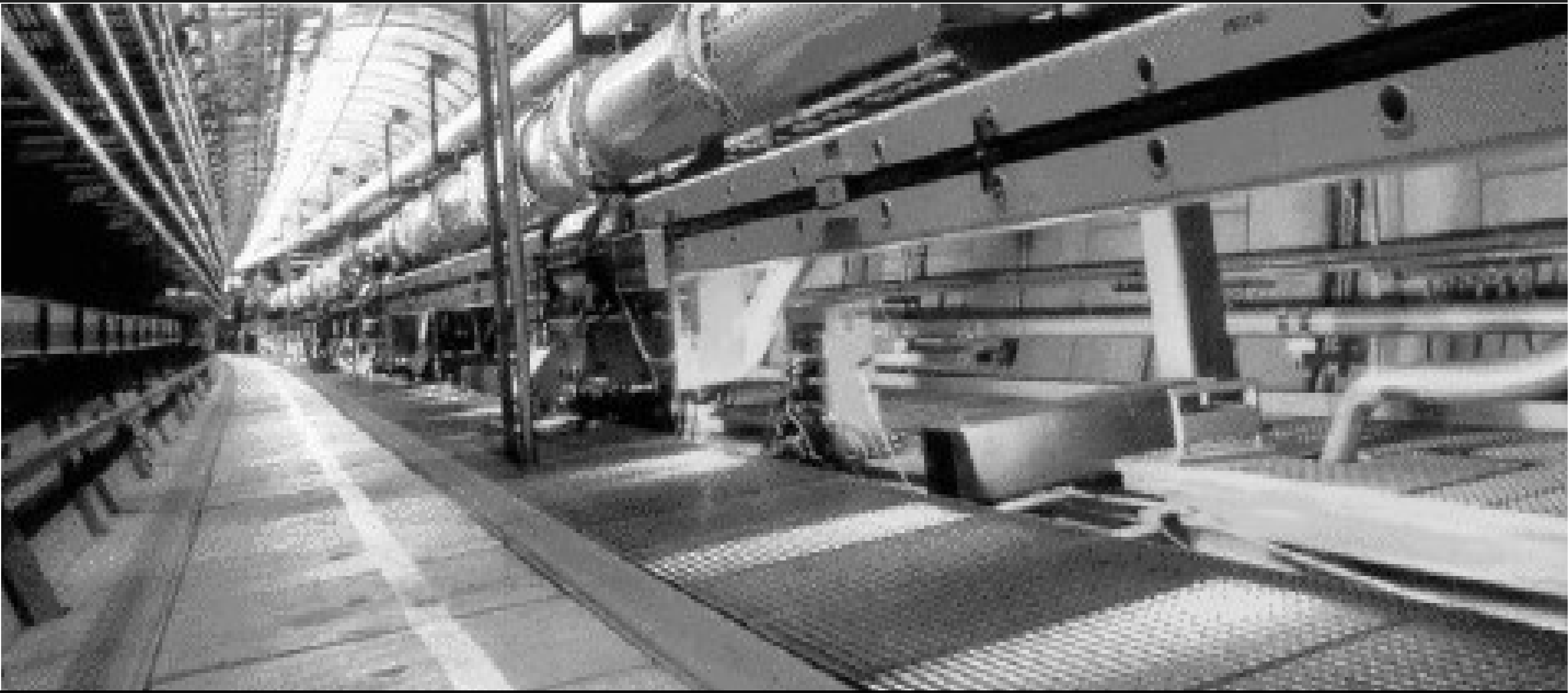
Outline:

- HERA & HERA Physics
- H1 Detector
- Neutral Current Measurements
- Charged Current Measurements
- Conclusions & Outlook

Shiraz Habib on behalf of the H1 Collaboration

HERA Collider

HERA : A 6.3 km $e^{\pm}p$ collider located in Hamburg, Germany.



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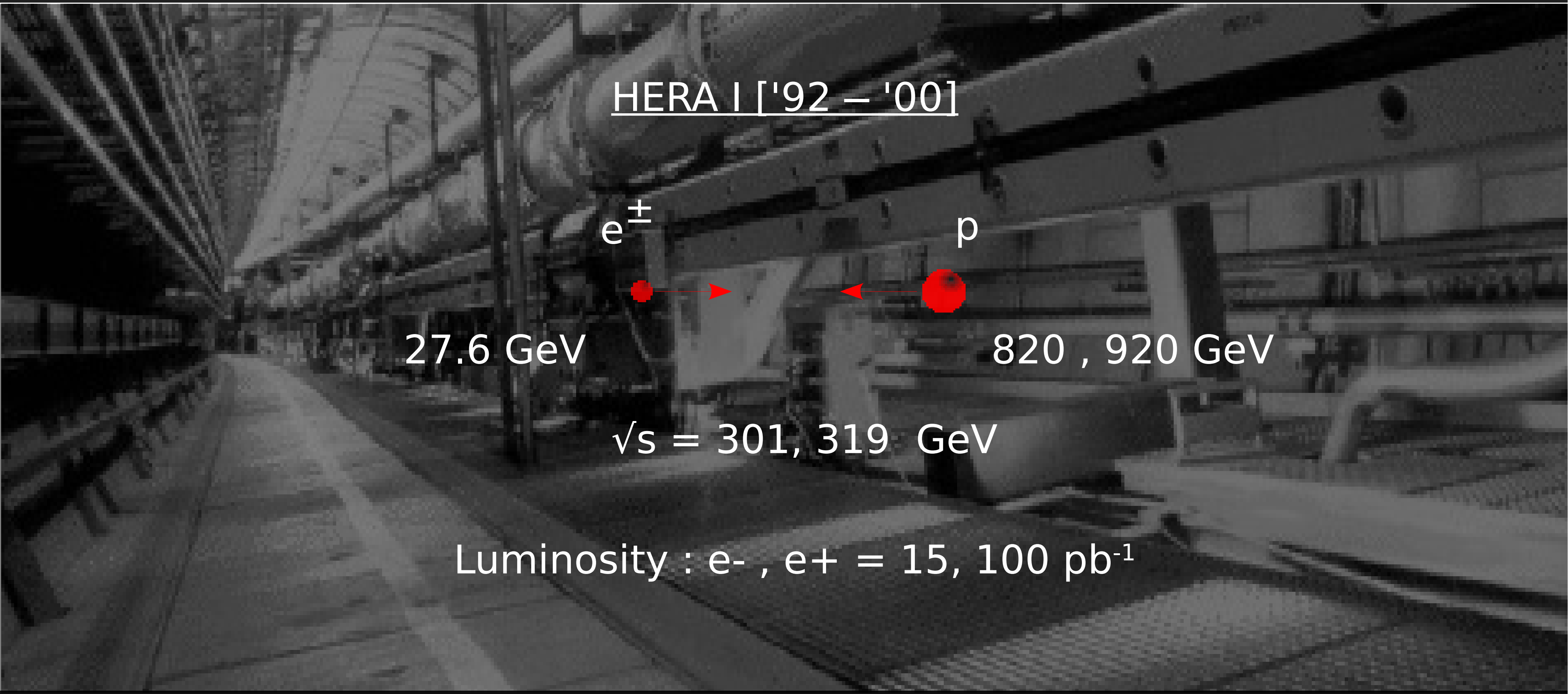

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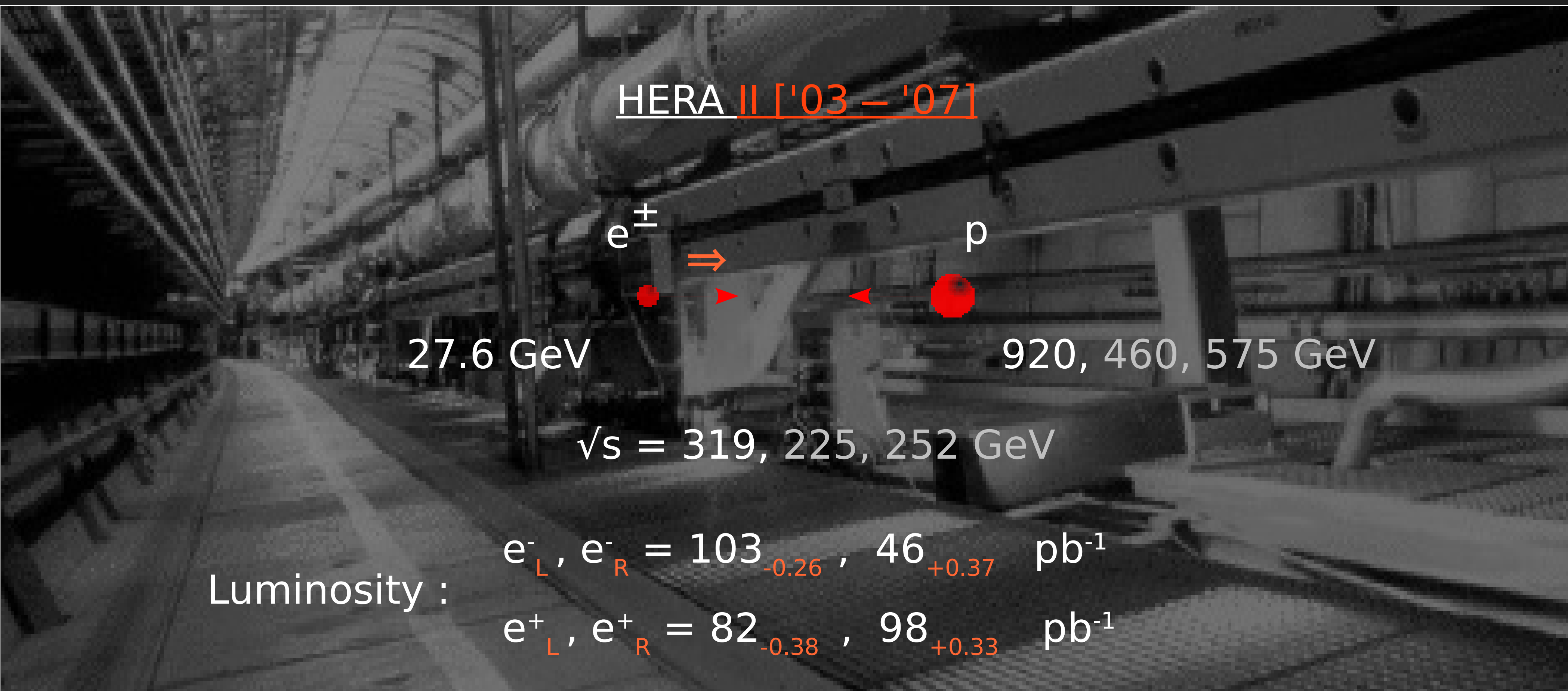
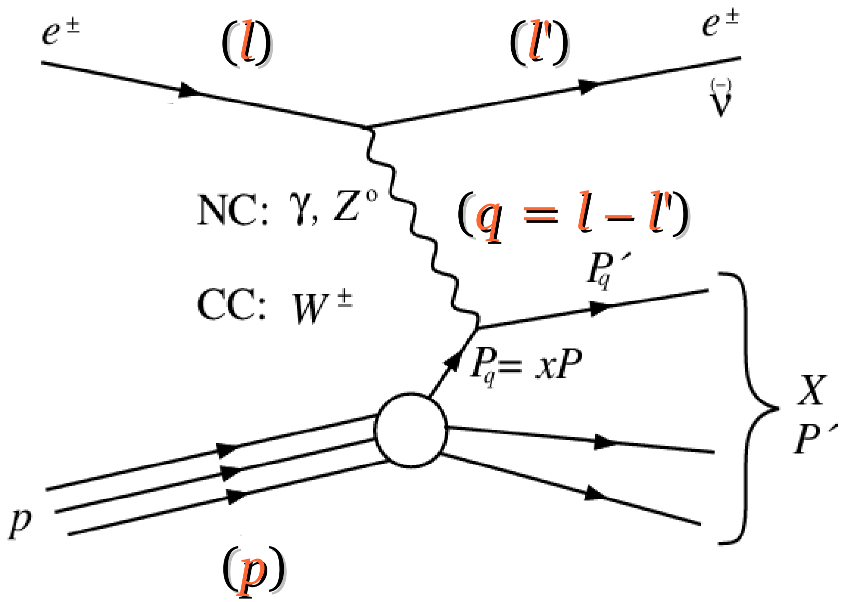
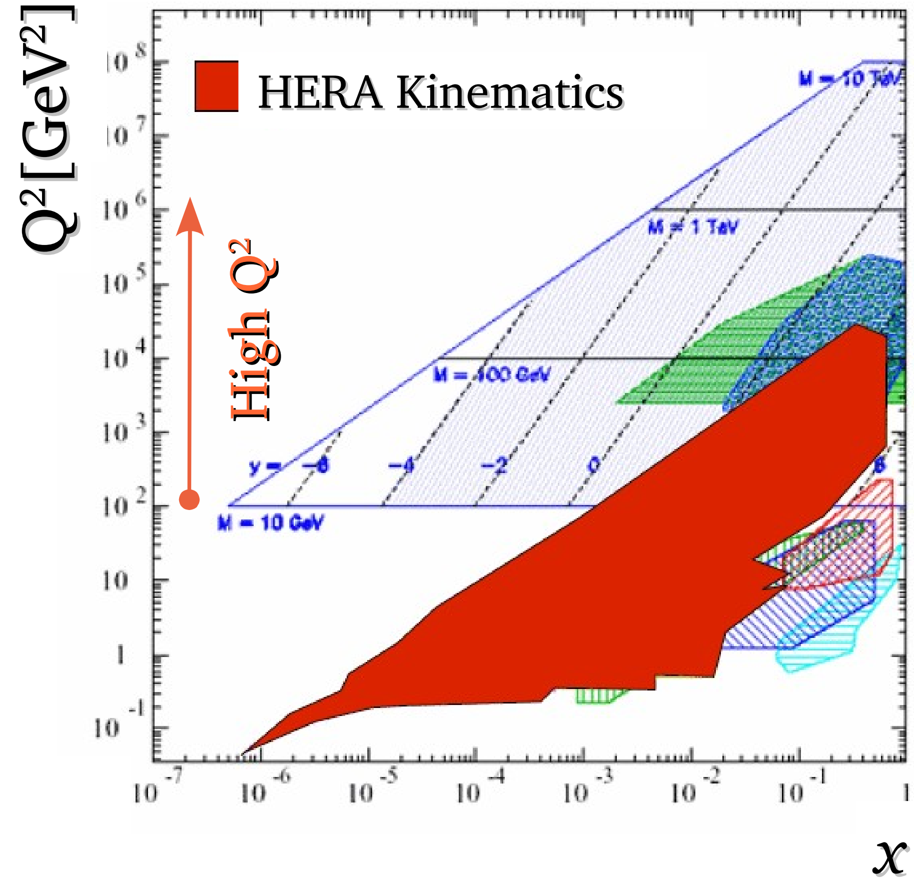


HERA Physics

Neutral / Charged Current DIS:
$ep \rightarrow e'X$ / $ep \rightarrow \nu X$





Range :
6 orders of magnitude in x and Q^2

Kinematics

Momentum Transfer : $Q^2 = -q^2$

Bjorken x : $x = Q^2/(2p\cdot q)$

Inelasticity : $y = (p\cdot q)/(p\cdot l)$

HERA Physics

$e^{\pm}p$ NC Cross Section Contributions:

Proton Structure Functions :
(q(x,Q²), g(x,Q²))

$$\frac{d^2\sigma^{\pm}_{NC}}{dx dQ^2} = \frac{2\pi\alpha^2}{xQ^4}(Y_+\tilde{F}_2 - y^2\tilde{F}_L \mp Y_- x\tilde{F}_3)$$

Parity Violating Terms : Polarization P_e of a sample

$$P_e = f_R - f_L \quad ; \quad f_R + f_L = 1$$

$$x\tilde{F}_3^{\pm} = -(a_e \pm P_e v_e)\kappa \frac{Q^2}{Q^2 + M_Z^2} xF_3^{\gamma Z} + (2a_e v_e \pm P_e[v_e^2 + a_e^2])\kappa^2 \left[\frac{Q^2}{Q^2 + M_Z^2}\right]^2 xF_3^Z$$

Neglect the pure Z contribution

$$xF_3^{\gamma Z} \simeq x\tilde{F}_3 \frac{(Q^2 + M_Z^2)}{a_e \kappa Q^2}$$

HERA Physics

$e^{\pm}p$ NC Cross Section Contributions:

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Neglect the pure Z contribution

Reduced Cross Section :

$$\tilde{\sigma}^{\pm}(x,Q^2) \equiv \frac{d^2\sigma^{\pm}_{NC}}{dxdQ^2}\frac{xQ^4}{2\pi\alpha^2}\frac{1}{Y_+} \equiv \tilde{F}_2 \mp \frac{Y_-}{Y_+}x\tilde{F}_3 - \frac{y^2}{Y_+}\tilde{F}_L$$

HERA Physics

$e^{\pm}p$ NC Cross Section Sensitivities:

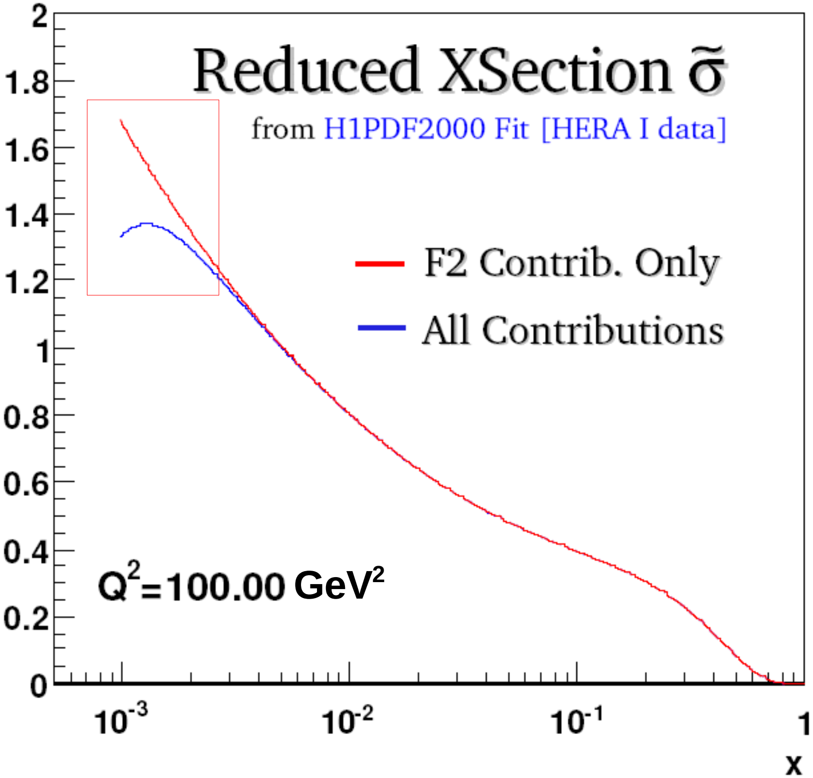
Proton Structure Functions :
($q(x,Q^2)$, $g(x,Q^2)$)

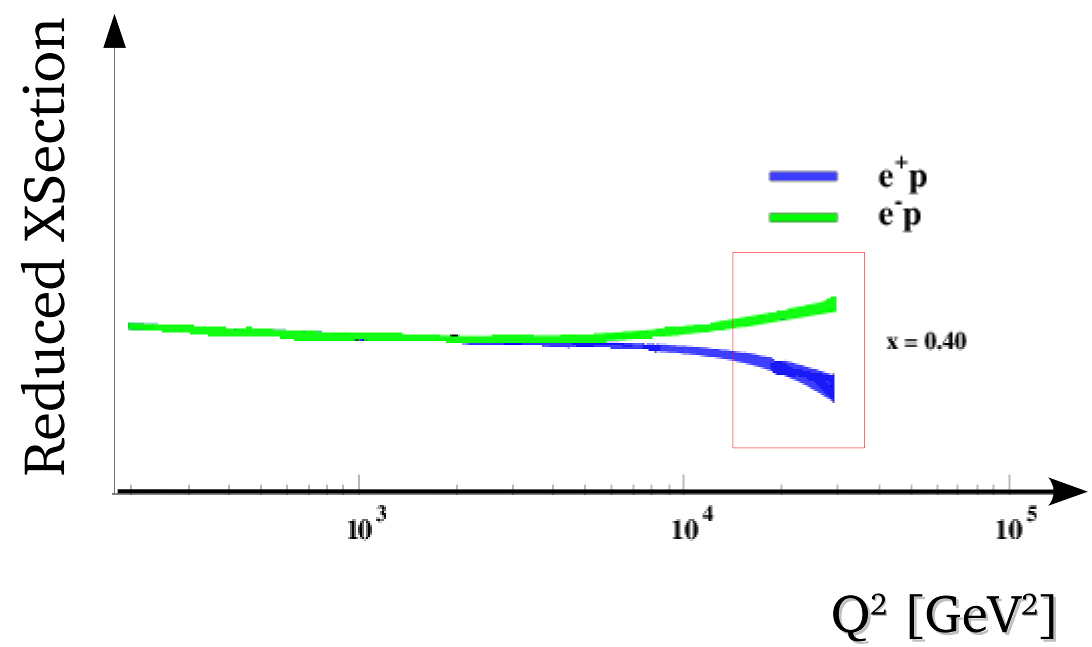
$$\frac{d^2\sigma^{\pm}_{NC}}{dx\,dQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left(Y_+\tilde{F}_2 - y^2\tilde{F}_L \mp Y_- x\tilde{F}_3\right)$$

F_2 is everywhere

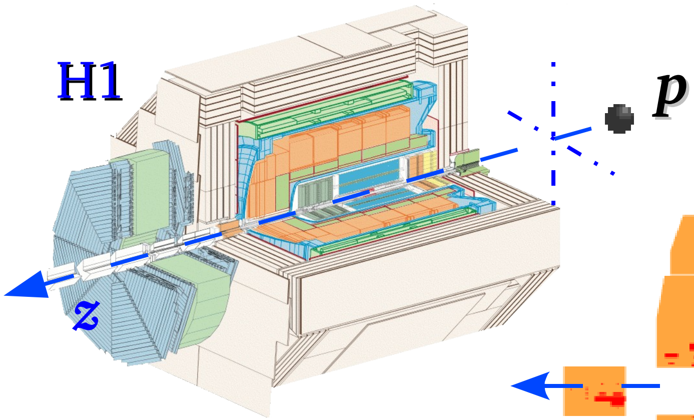
F_L appears at high y

xF_3 separates the e^+p and e^-p cross sections appearing at high Q^2.

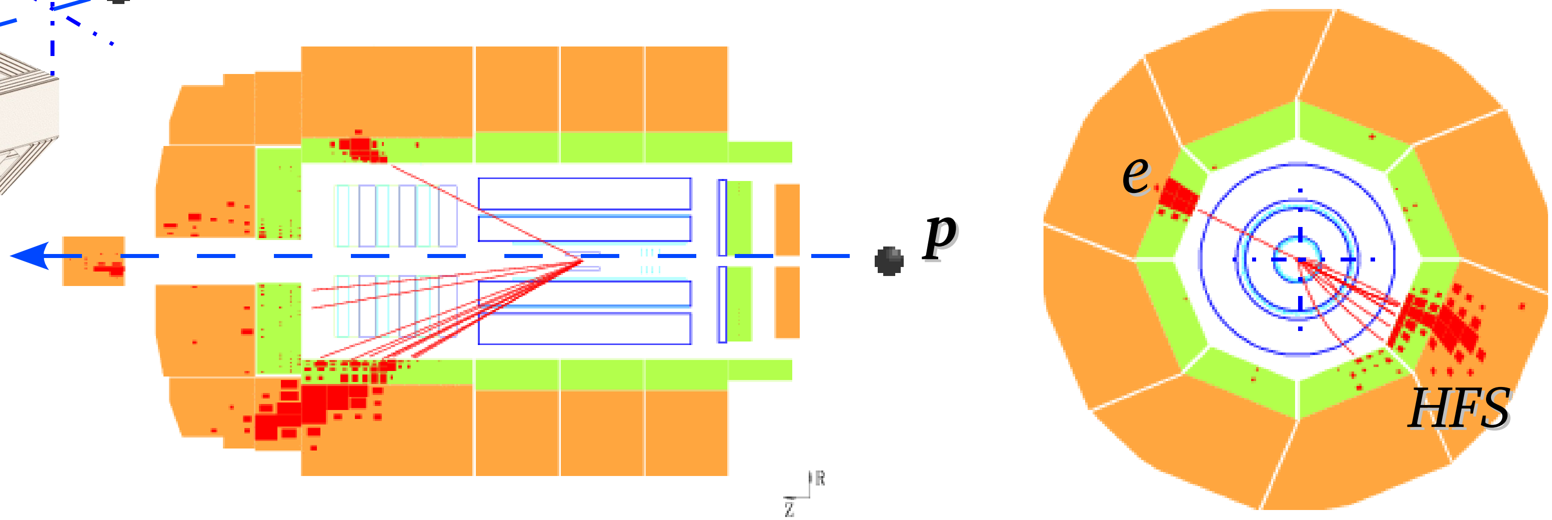




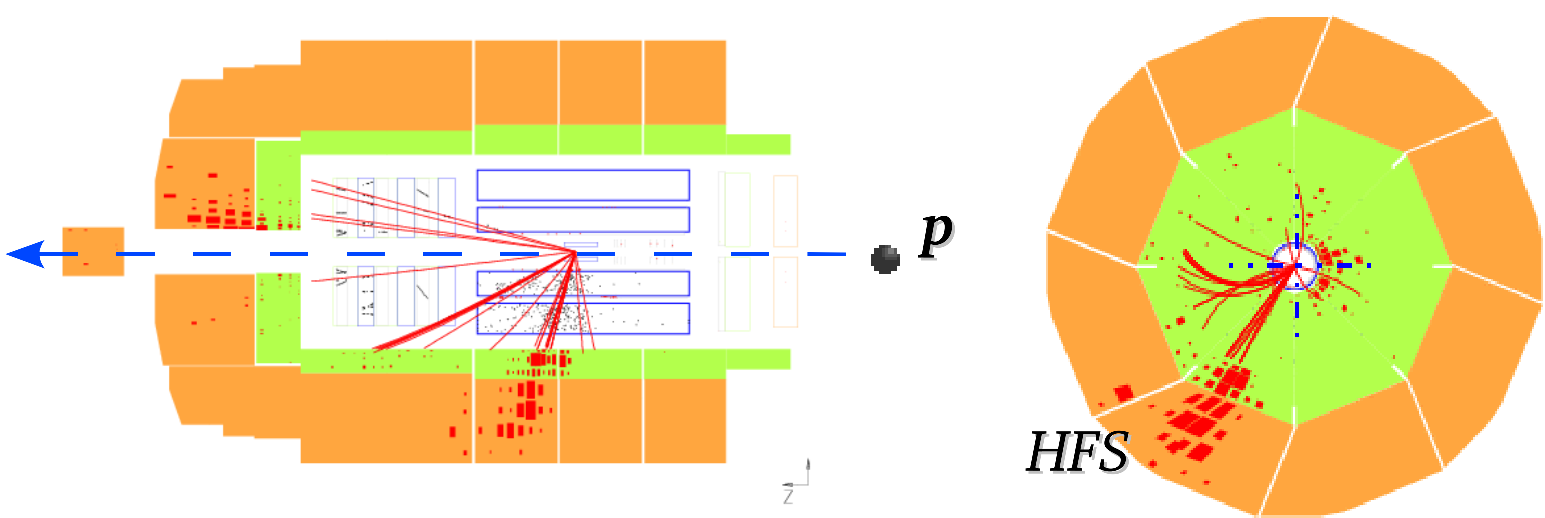
H1 Detector



Neutral Current Event



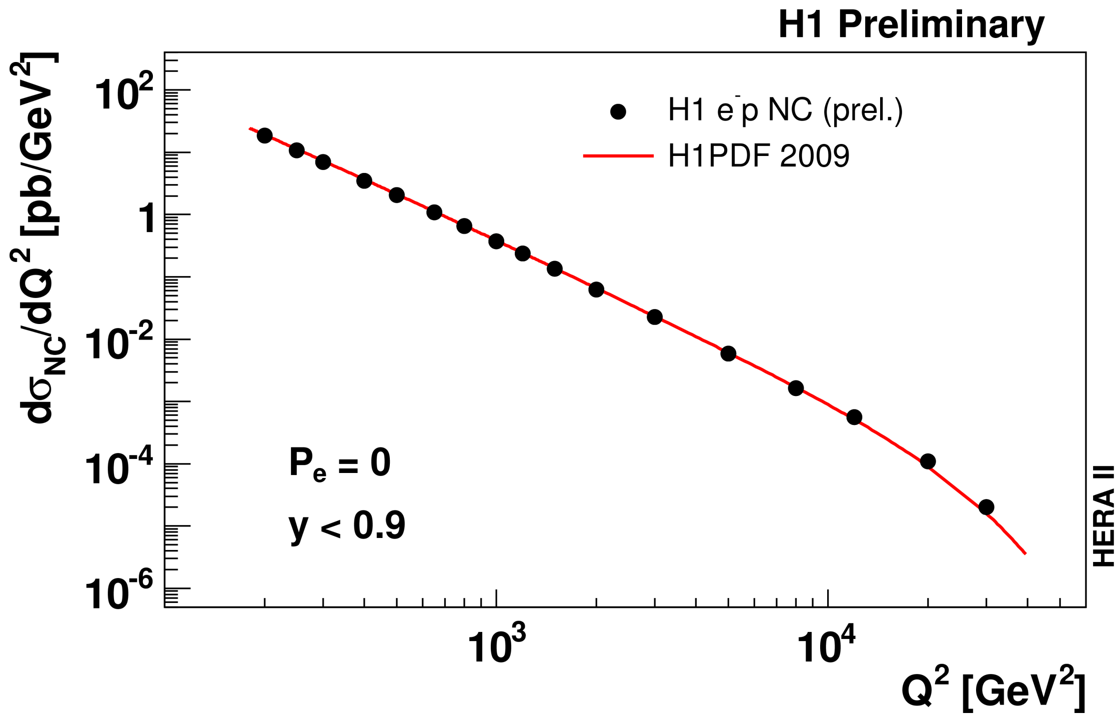
Charged Current Event



H1 Measurements

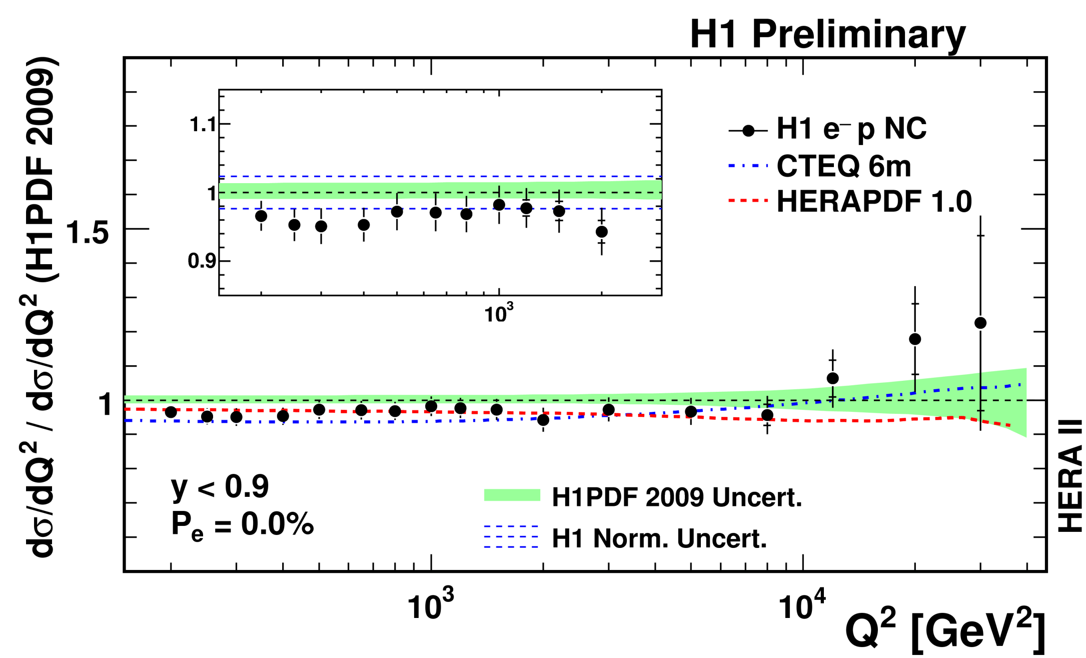
Unpolarized Single Differential Cross Sections [HERAII]

6 orders of mag.



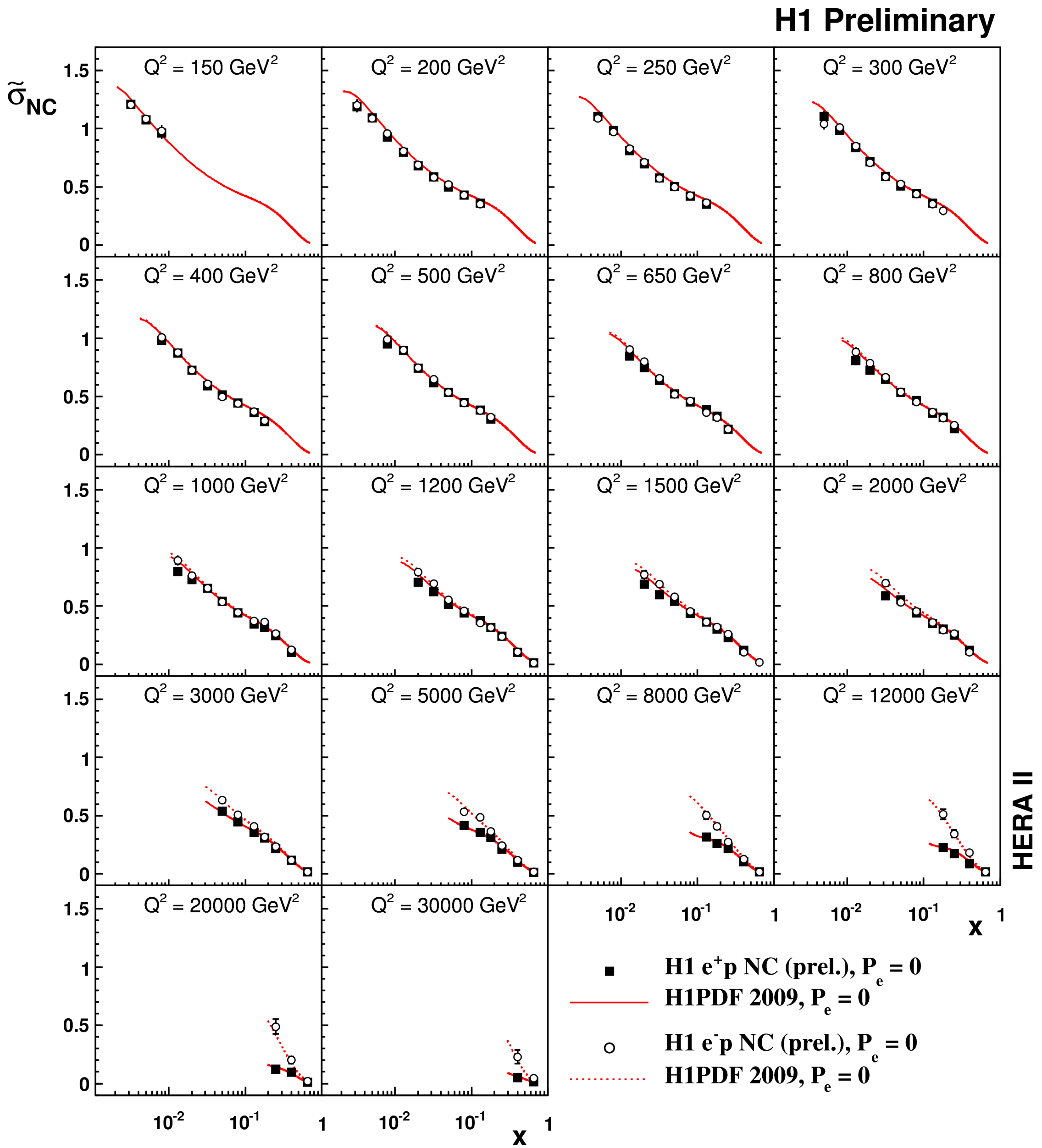
The data is well described in shape by H1PDF2009.

Better description given by **HERAPDF1.0**.



Neutral Current Cross Sections

Unpolarized Reduced Cross Sections [HERAII]

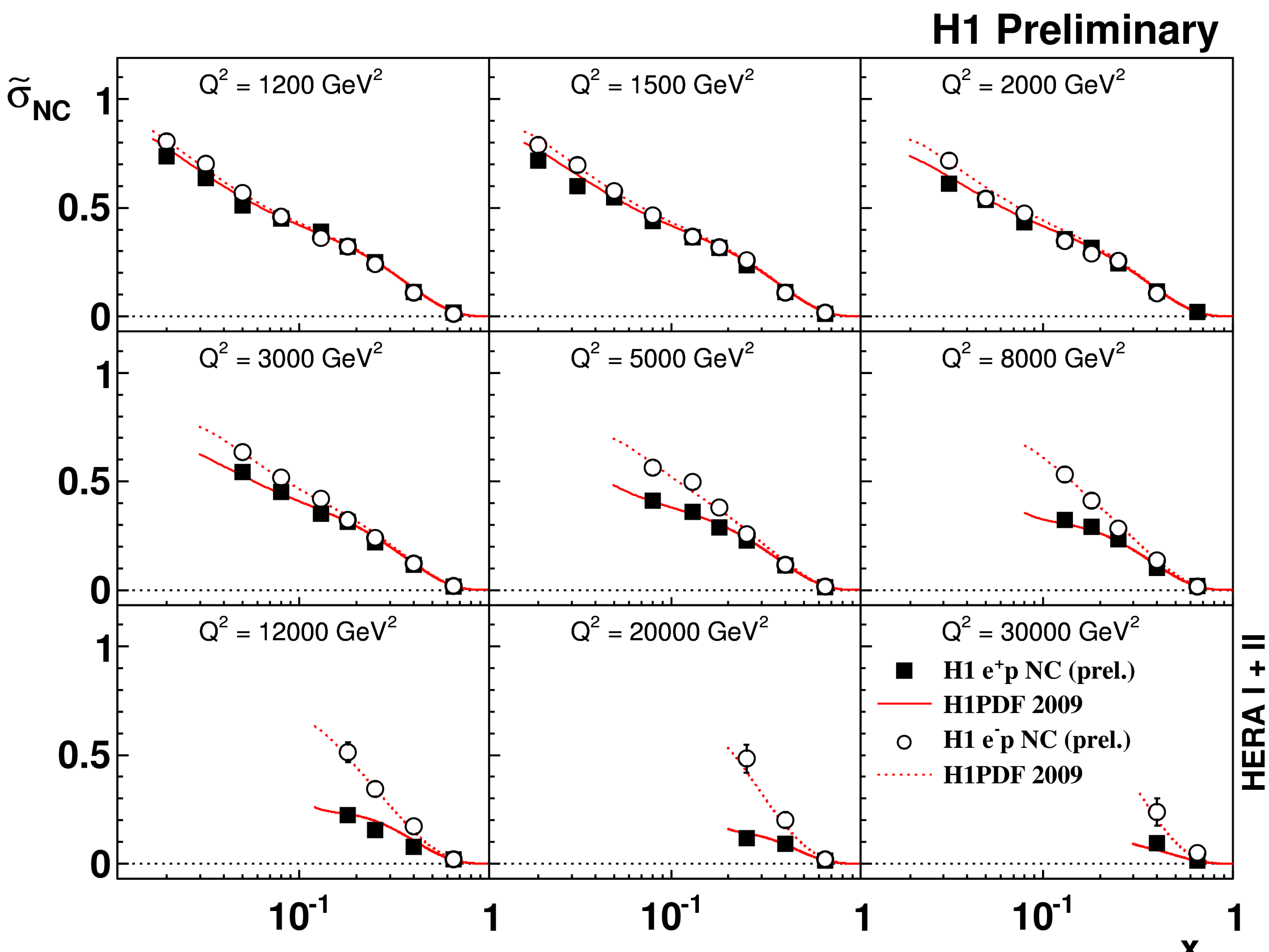


H1 Measurements

Neutral Current Cross Sections

Reduced Cross Sections [HERA I+II]

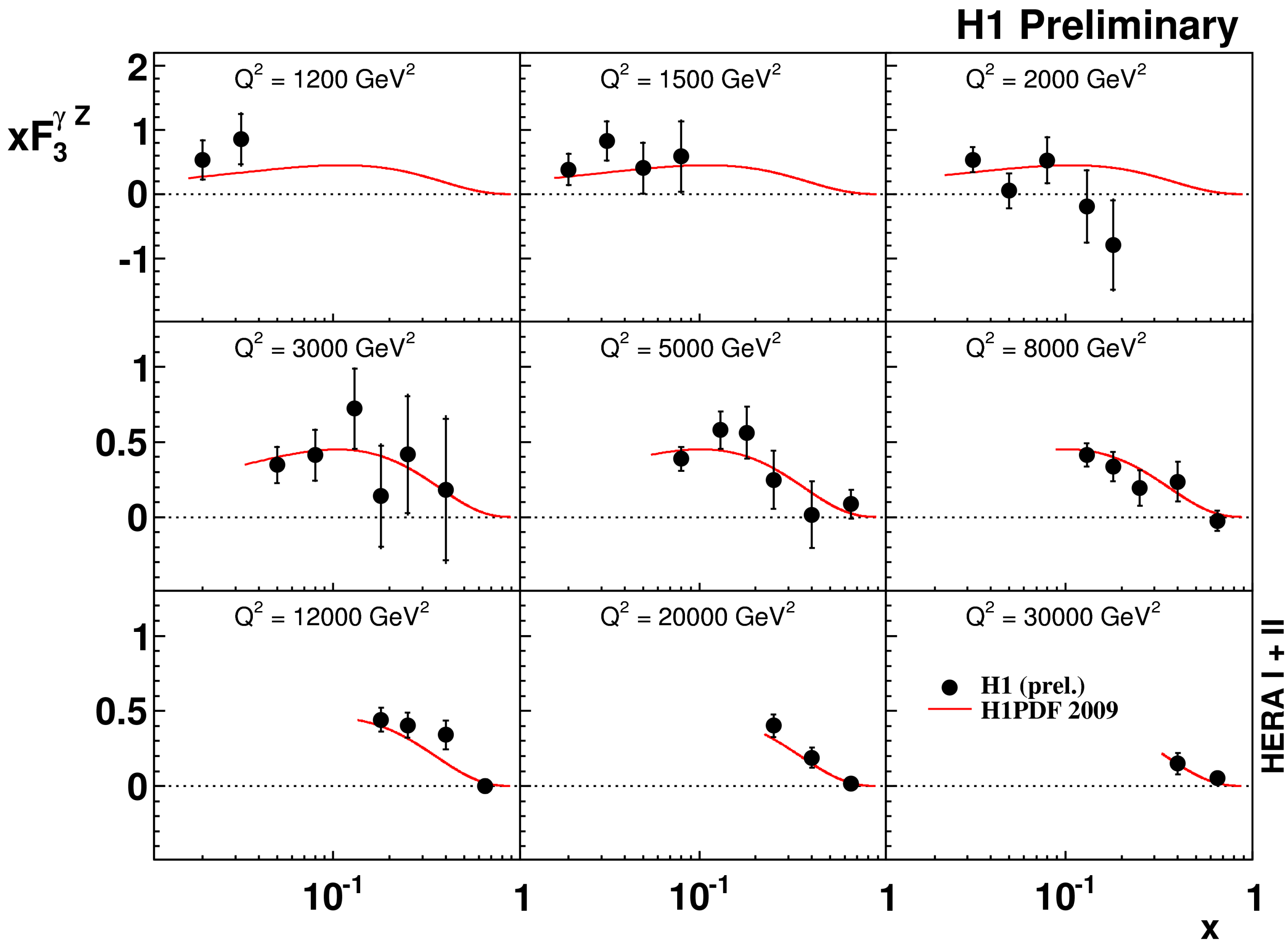
Combination: HERA I + HERA II → HERA I+II



$$x\tilde{F}_3 = \frac{Y_+}{2Y_-}\left[\tilde{\sigma}^-(x,Q^2) - \tilde{\sigma}^+(x,Q^2)\right]$$

H1 Measurements

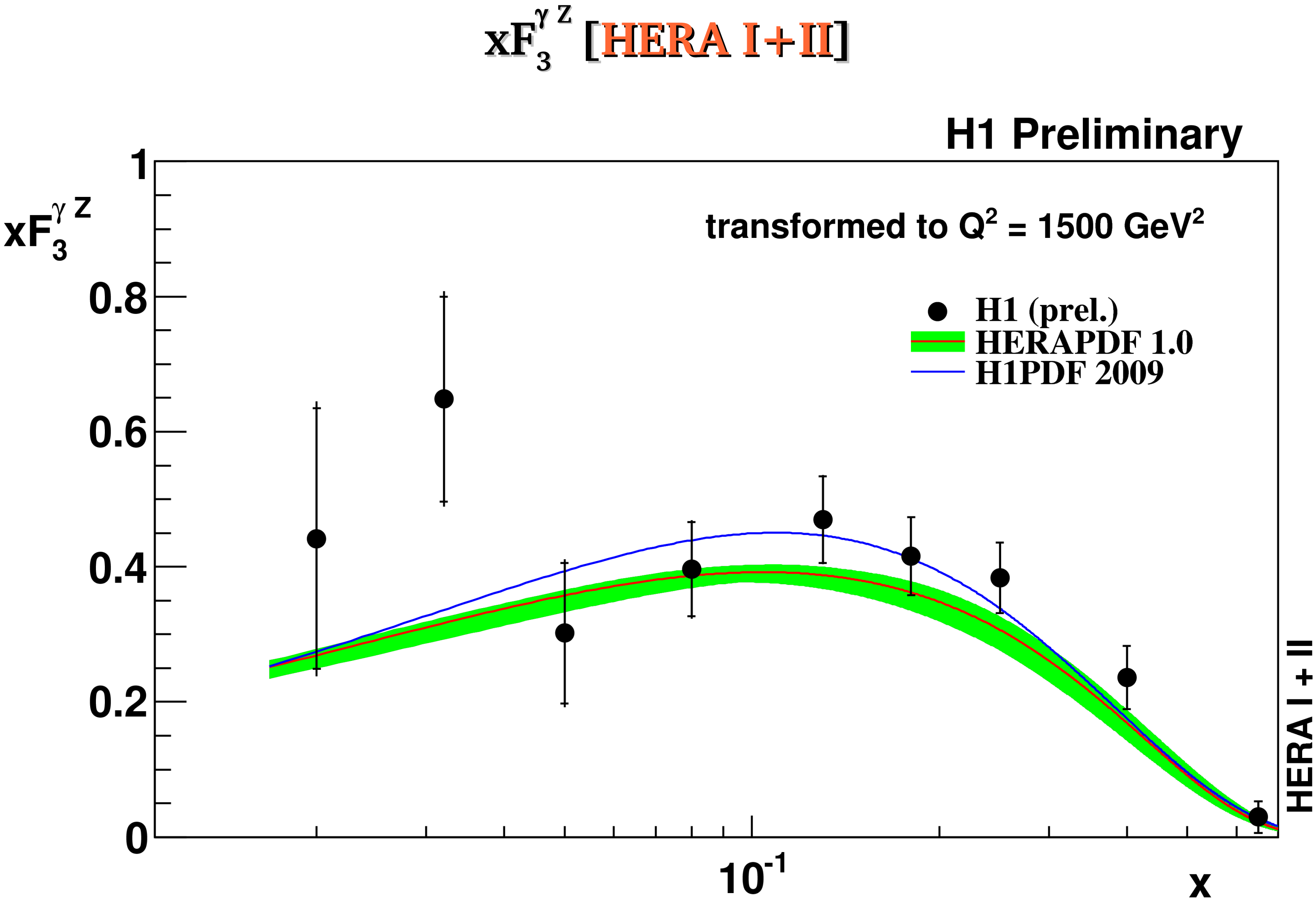
$xF_3^{\gamma Z}$ [HERA I+II]



Weak dependence in $Q^2 \rightarrow$ Correct all points to $Q^2 = 1500$ GeV^2

H1 Measurements

Neutral Current Cross Sections

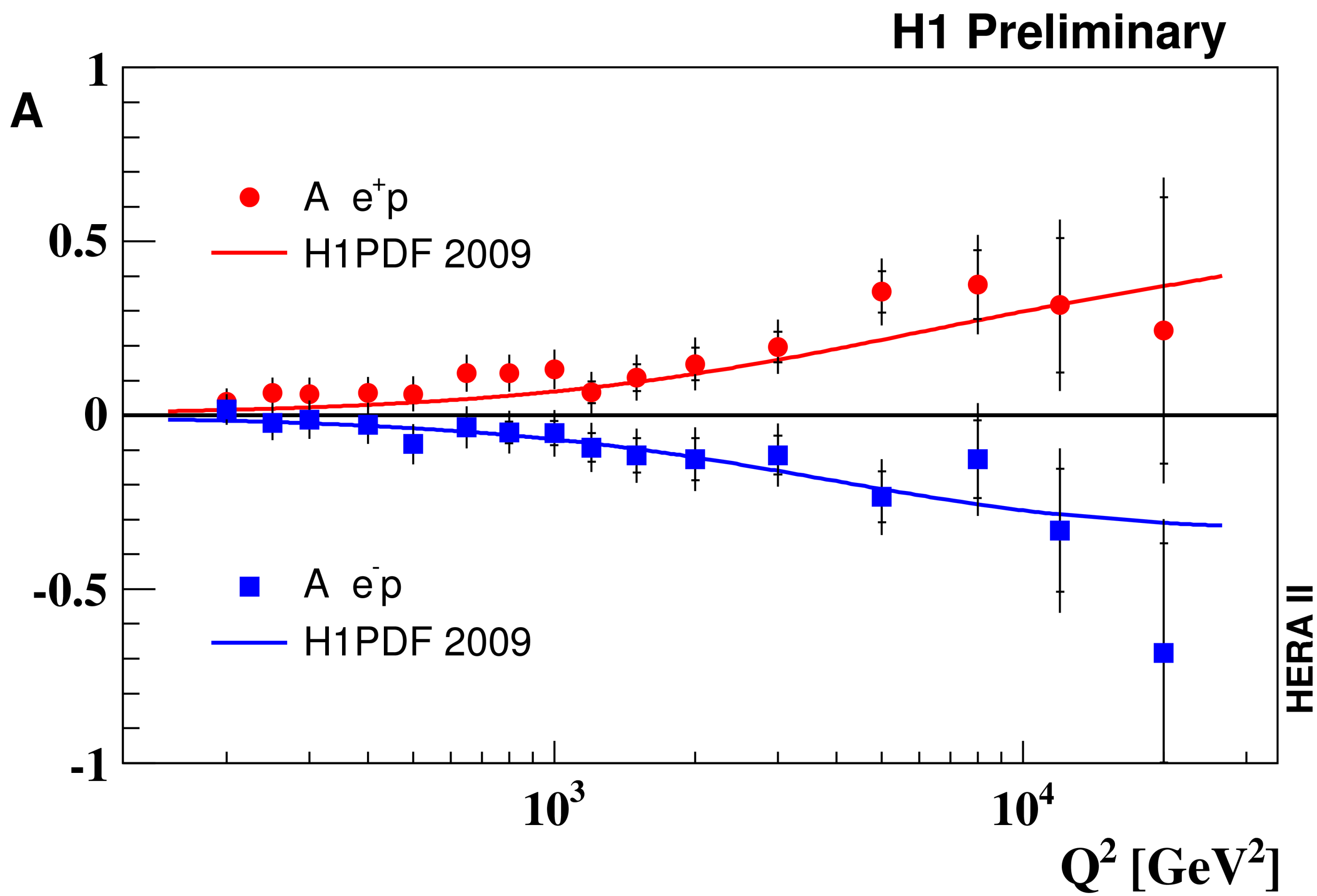


Data is well described by the expectation. Valence quarks nicely visible.

H1 Measurements

Polarization Asymmetry A

$$A = \frac{2}{P_R - P_L} \cdot \frac{\sigma^{\pm}(P_R) - \sigma^{\pm}(P_L)}{\sigma^{\pm}(P_R) + \sigma^{\pm}(P_L)}$$ $\rightarrow$ Direct Measure of Parity Violation



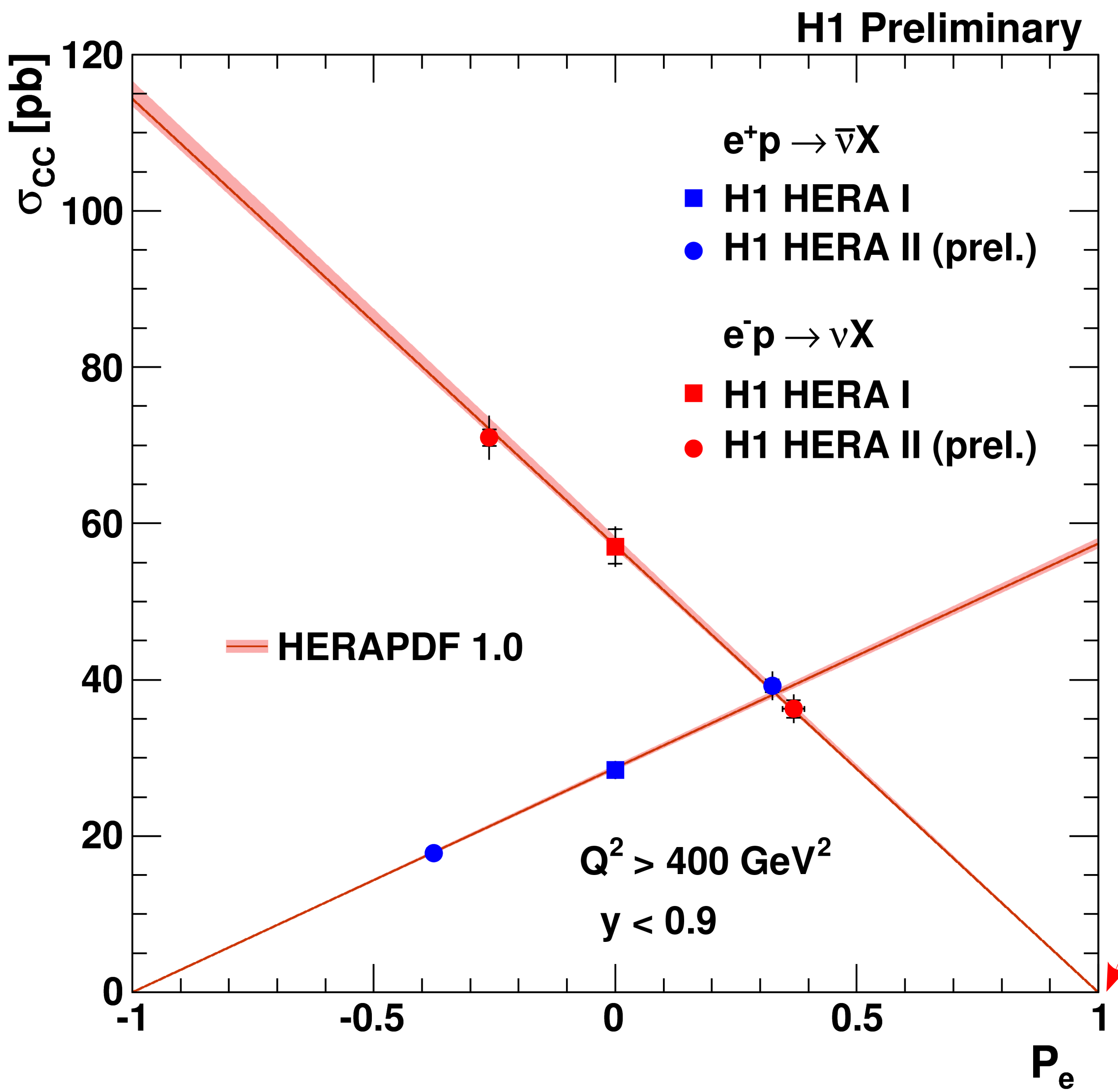
Standard Model Expectation is well supported by the data.

H1 Measurements

Charged Current Cross Sections

Total Cross Sections (P_e)

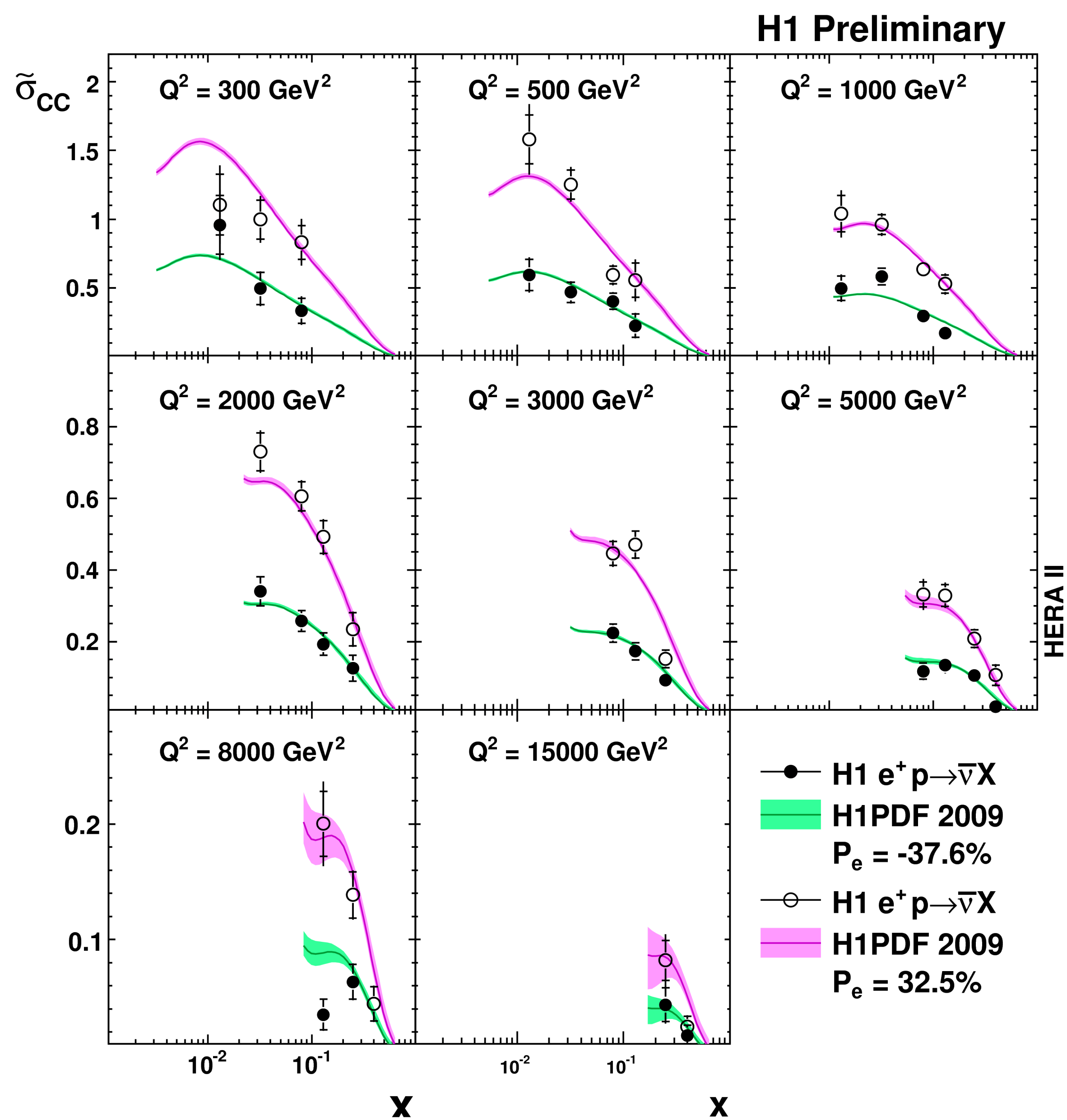
[HERA I , II]



W^- does not couple to R particle.

Reduced Cross Sections (P_e)

[HERA II]

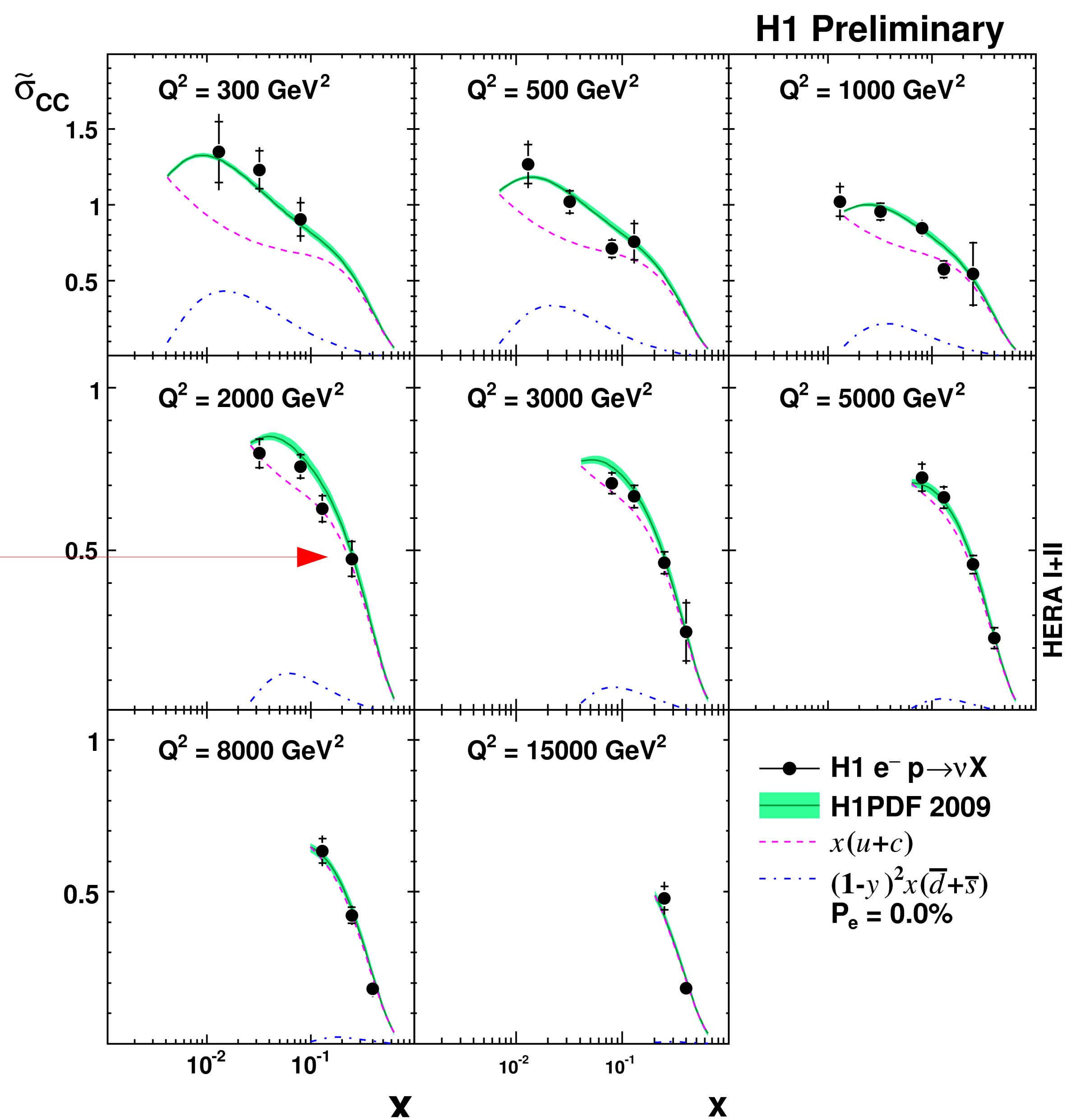


H1 Measurements

Charged Current Cross Sections

Unpolarized Reduced Cross Sections [HERA I+II]

Measurement constrains u(x) at high x.

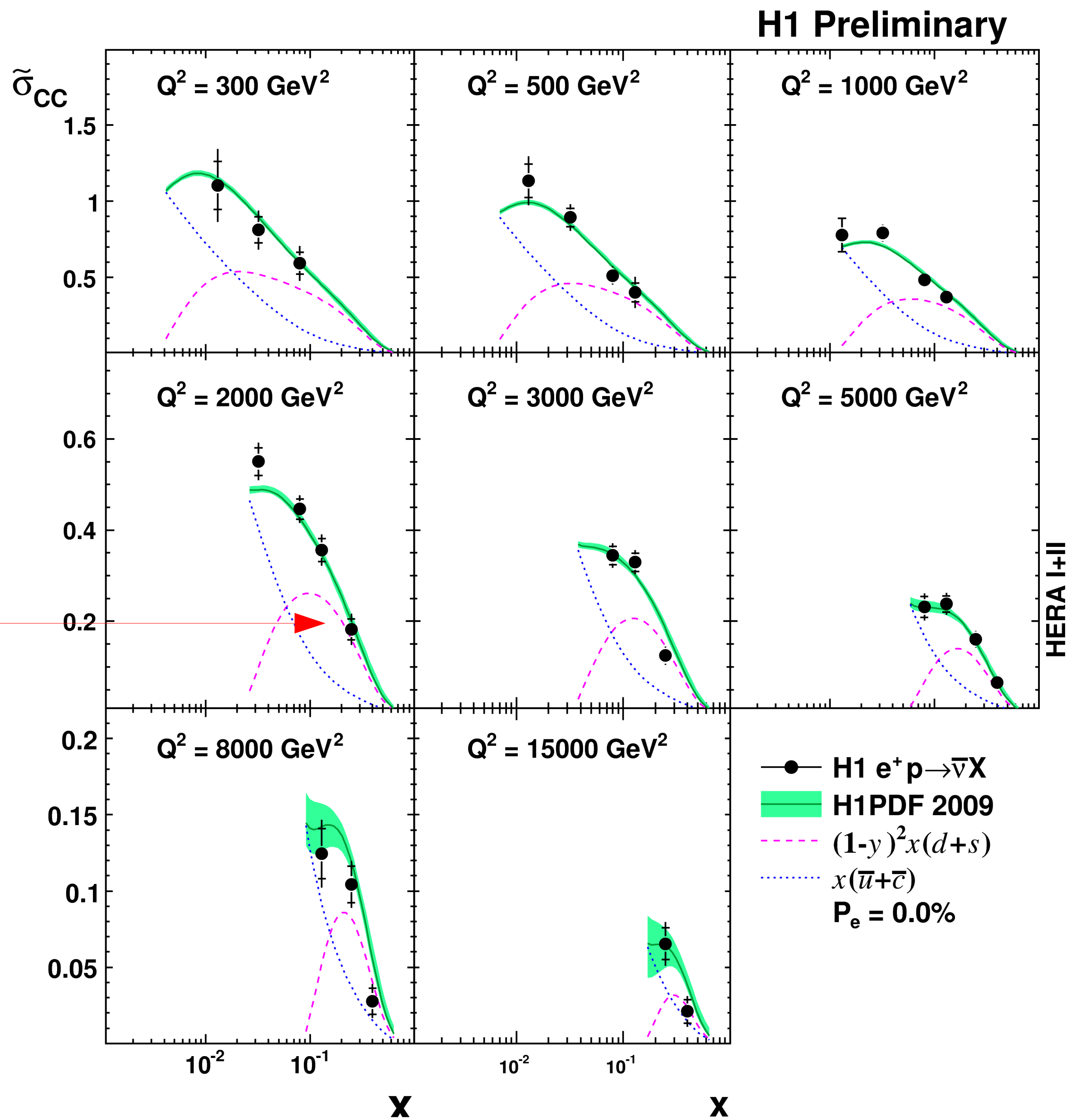


H1 Measurements

Charged Current Cross Sections

Unpolarized Reduced Cross Sections [HERA I+II]

Measurement constrains d(x) at high x.



Conclusions & Outlook:

- H1 Measurements demonstrate the Parity Violating nature of the Electroweak force showing good agreement to the Standard Model predictions.

- Preliminary results for HERAII (and HERA I+II) Inclusive Cross Sections have been shown and is well described by various QCD Fits.

- The full H1 HERA results provide significant constraints on the proton's structure.

These measurements will play a significant role in establishing our image of the proton!

Thank You!