High Q^2 structure functions at HERA

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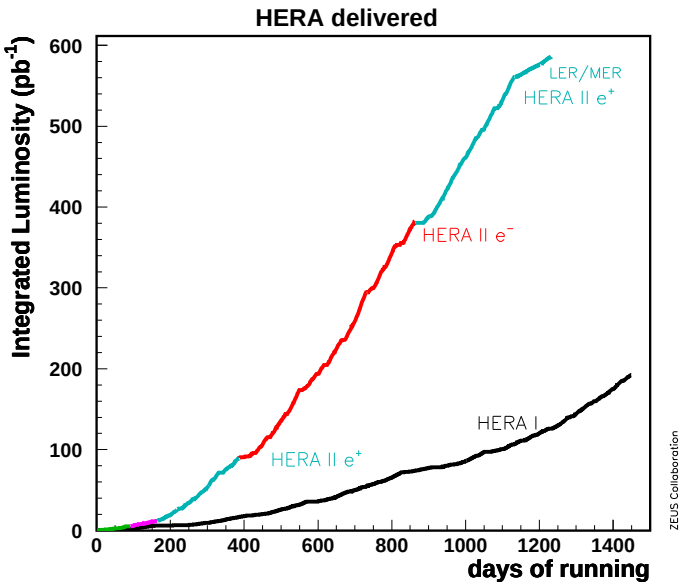
on behalf of the H1 & ZEUS collaborations

Moriond QCD, La Thuile, Thursday 13.Mar.2008

HERA - H1 & ZEUS

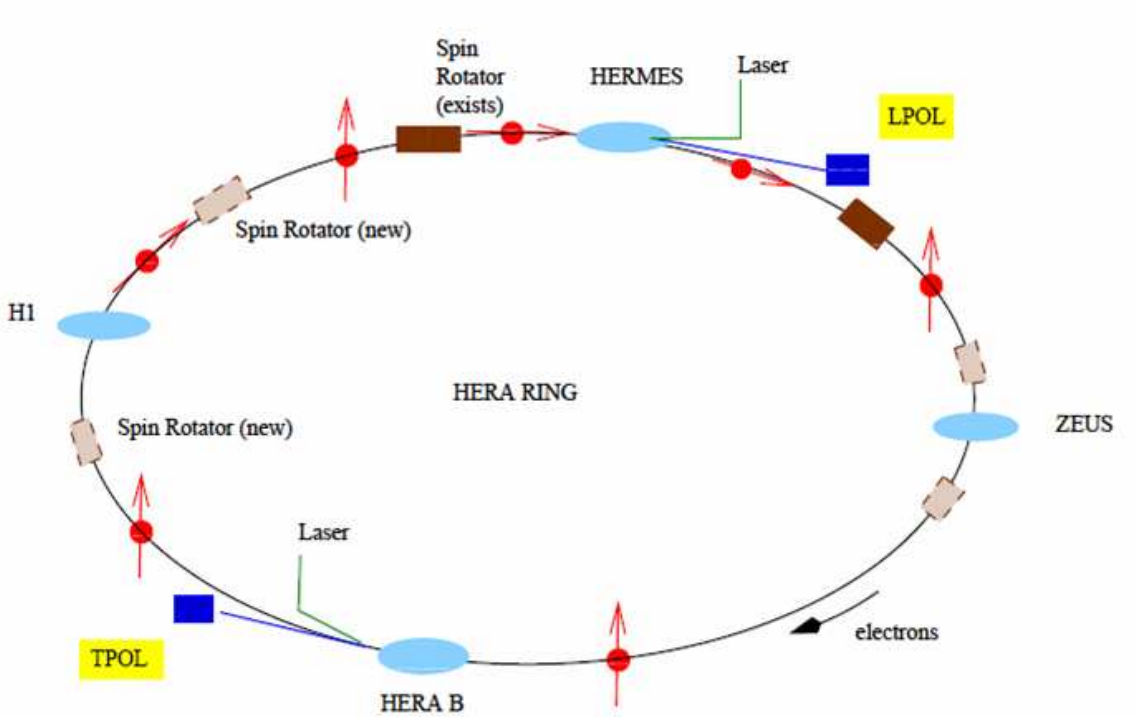


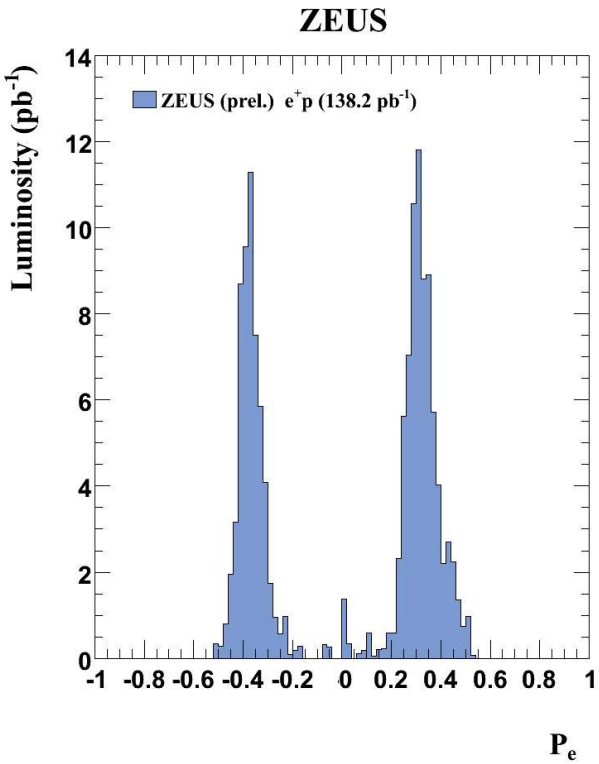
$E_e = 27.6$ GeV

HERA	E_p [GeV]	$\sqrt{s}$ [GeV]
I	820	300
I,II	920	318

Upgrade between HERA I & II: longitudially polarised $e^{\pm}$ beams

Polarised electron beam



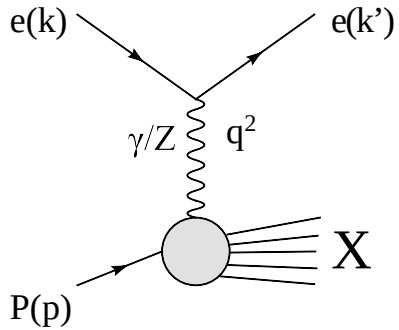


Sokolov-Ternov effect $\longrightarrow$ $e^{\pm}$-beam transversely polarised
Spin rotators turn it into longitudinal polarisation.

$$P_e = \frac{N_R - N_L}{N_R + N_L}$$

Kinematic variables & structure functions

Kinematic variables:



$$Q^2 = -q^2, \qquad x = \frac{Q^2}{2pq}, \qquad y = \frac{pq}{pk}$$

Dependence of unpolarised reduced xsec on structure functions:

$$\sigma_r(e^{\pm}p) = \frac{d^2\sigma}{dxdQ^2}\frac{Q^4 x}{2\pi\alpha^2 Y_+} = F_2 \mp \frac{Y_-}{Y_+}xF_3 - \frac{y^2}{Y_+}F_L$$

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

F_2	:	dominates cross section	$F_2 \propto \Sigma(q + \bar{q})$
xF_3	:	contributes at high Q^2	$xF_3 \propto \Sigma(q - \bar{q})$
F_L	:	contributes at high y	$F_L \propto \alpha_s xg(x, Q^2)$

Recent results

- Neutral Current (NC) & Charged Current (CC) in $e^{\pm}p$ at high Q^2 and with longitudinally polarised electron
- Electroweak & QCD fits
- Combination of H1 & ZEUS published HERA I cross sections

H1 NC & limit on quark radius

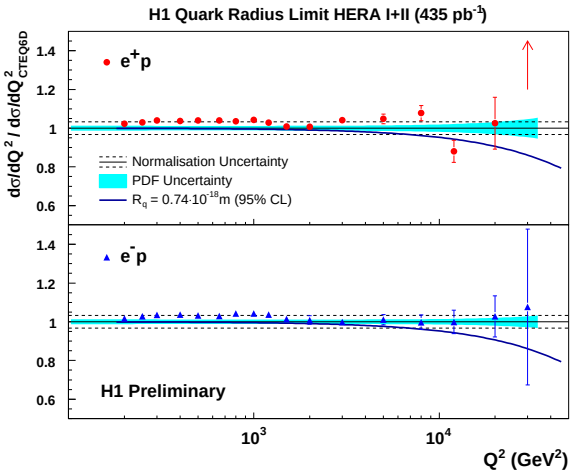
Data:

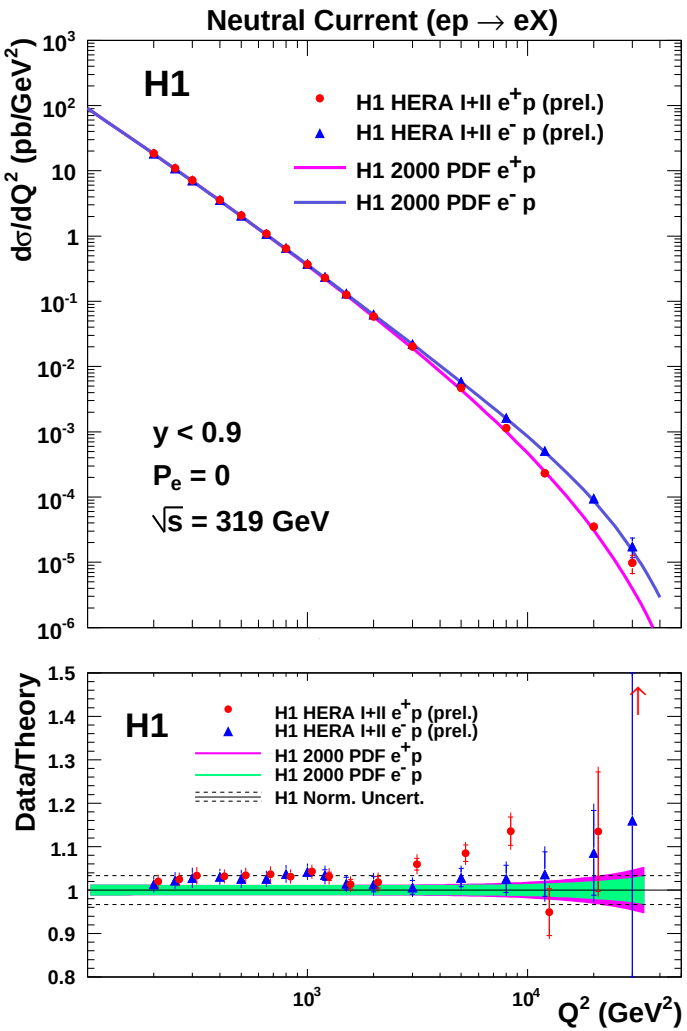
NC $e^{\pm}p$ from HERA I+II
with $Q^2 >= 200$ GeV^2, $y < 0.9$

Lumi:

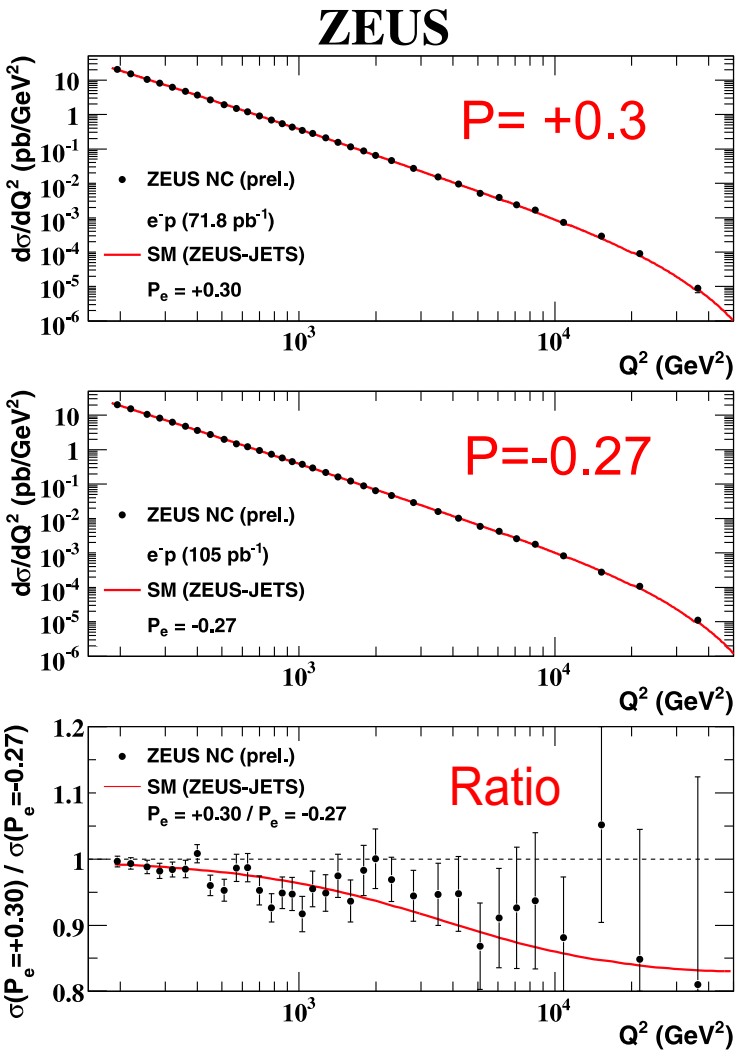
270 pb^{-1} (e^+p), 165 pb^{-1} (e^-p)

$R_q < 0.74 * 10^{-18}$ m @ 95% CL





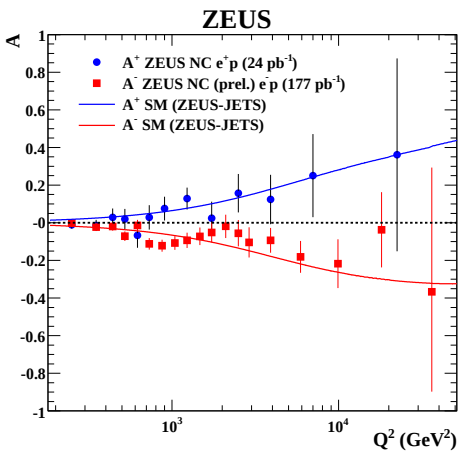
ZEUS NC with longitudinally polarised electrons ($P_e \neq 0$)



Asymmetry:

$$A \equiv \frac{\sigma(P_e = +1) - \sigma(P_e = -1)}{\sigma(P_e = +1) + \sigma(P_e = -1)}$$

HERA II $e^- p$, $e^+ p$:



$\longrightarrow$ Parity violation in NC at high Q^2

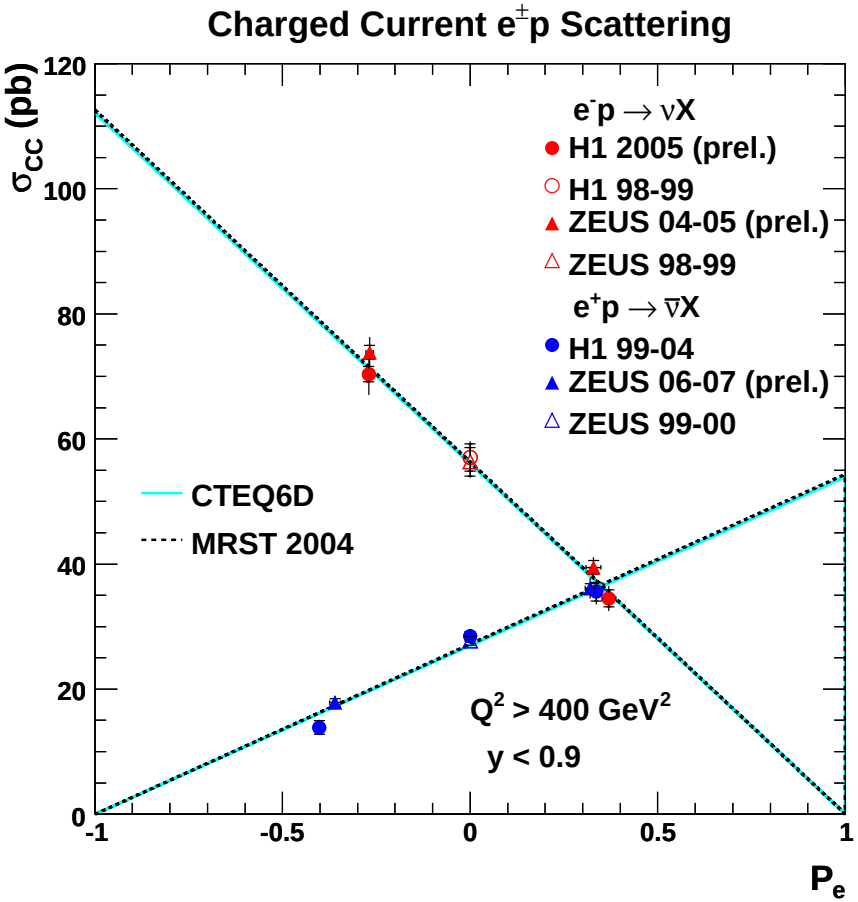
ZEUS CC with $P_e \neq 0$

$$\sigma_{CC}^{e^\pm p}(P_e) = (1 \pm P_e)\sigma_{CC}^{e^\pm p}(P_e = 0)$$

Linear dependence as expected.

Extrapolate to full polarisation.

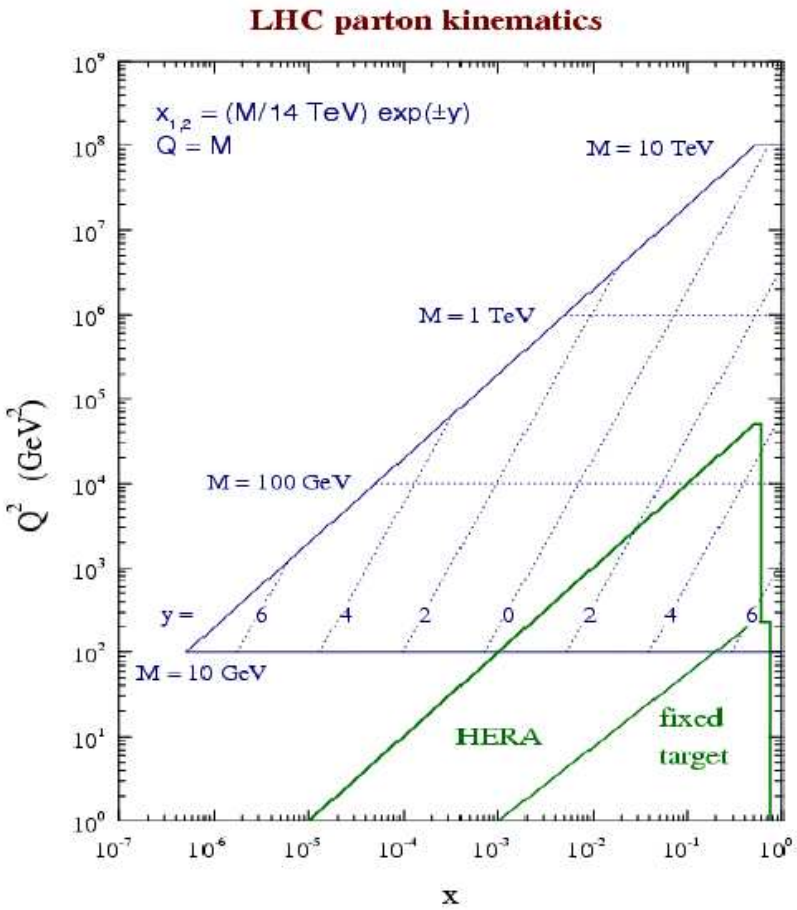
$\longrightarrow$ No RH charged currents.



Electroweak & QCD fits

Method:

- Measure $\frac{d^2\sigma^{\pm}}{dxdQ^2}(P_e \neq 0)$
- Obtain F_2, xF_3
- Extract PDFs $q(x, Q^2)$, $\bar{q}(x, Q^2)$
- Fit v_i, a_i quark couplings

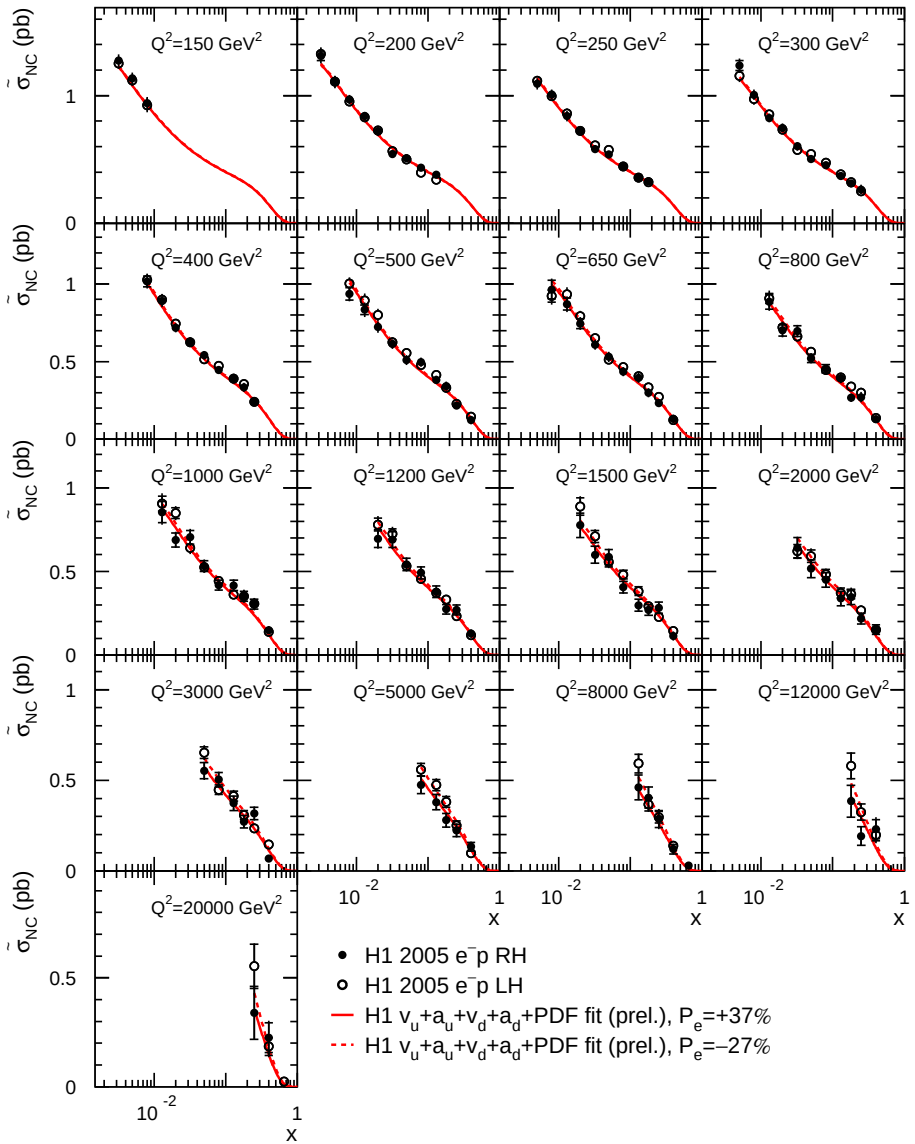


NB: H1 and ZEUS fits use their respective data sets.

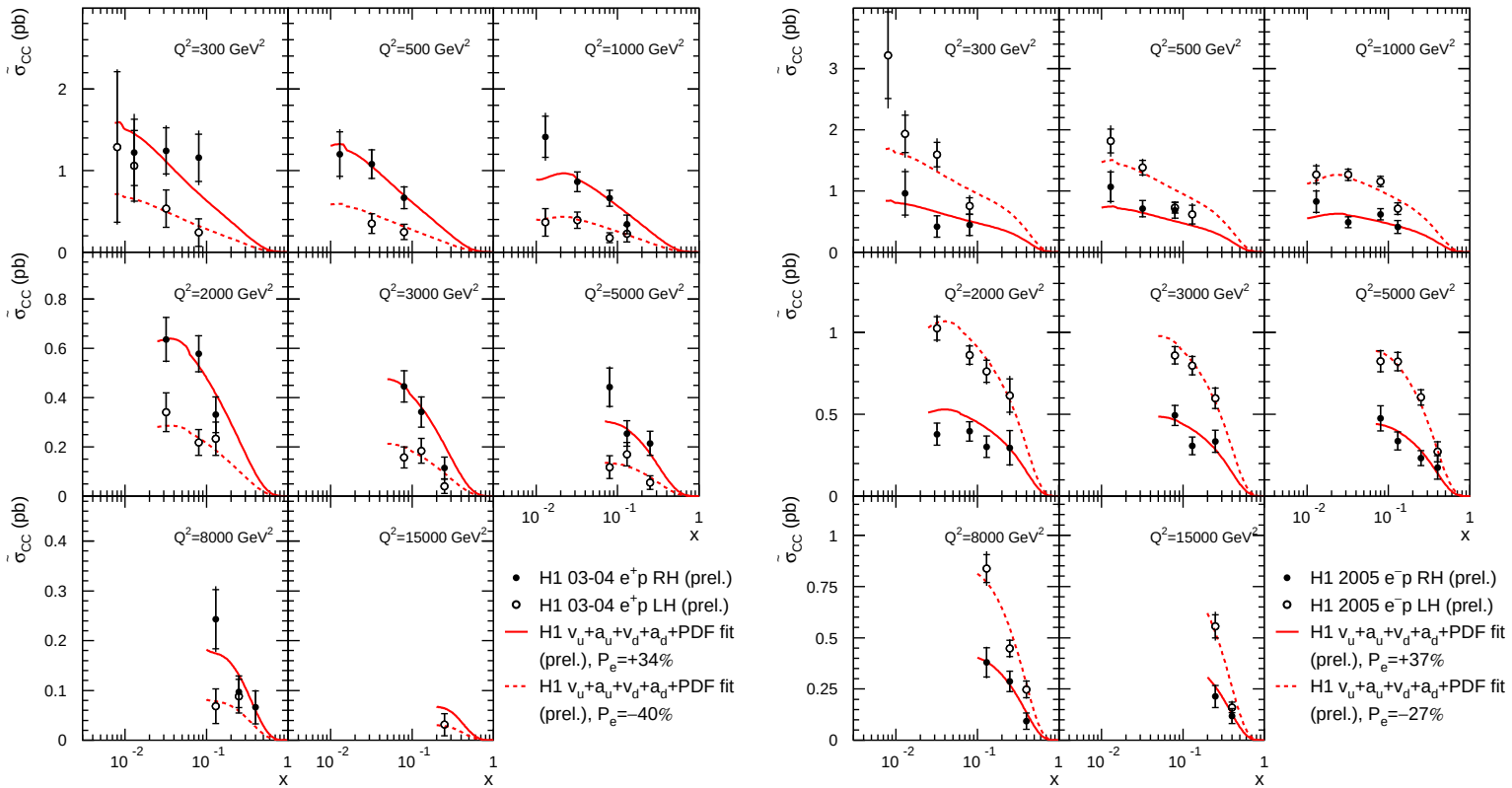
H1: $\tilde{\sigma}_{NC}$ for $e^{\pm}p$

Measure NC over large range of Q^2.

Use data as input to fit.

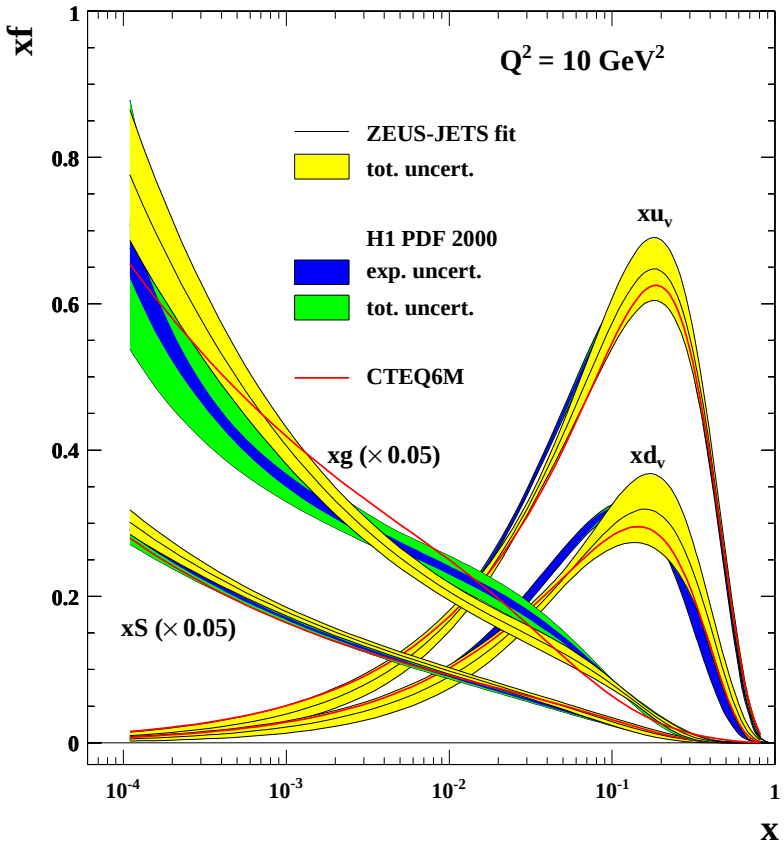


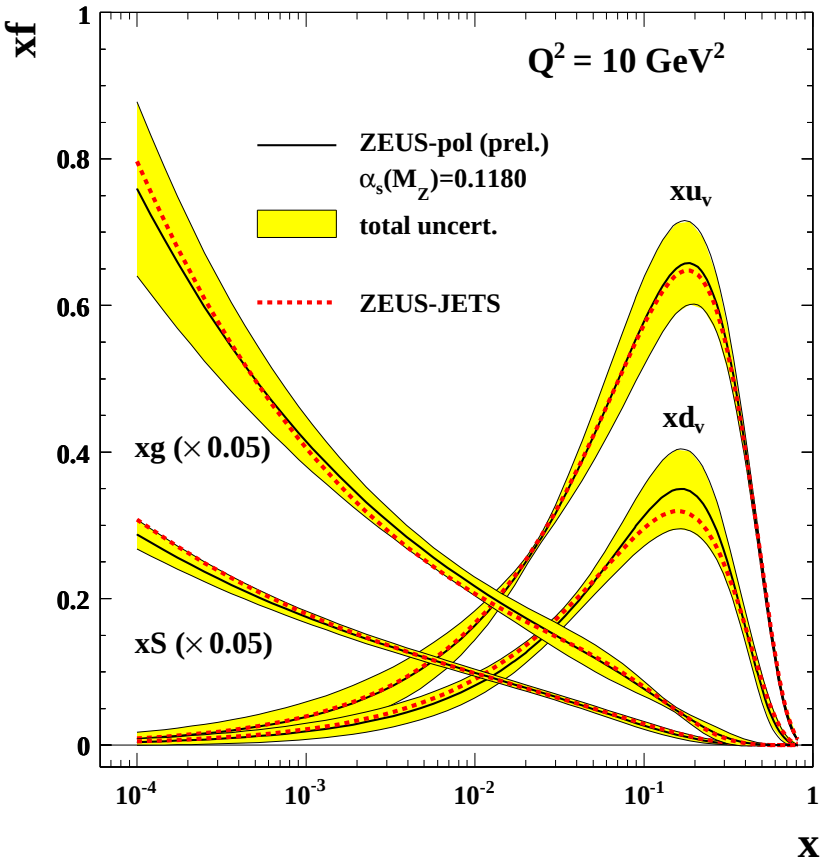
H1: $\tilde{\sigma}_{CC}$ for $e^{\pm}p$



NB: RH data dominates $\tilde{\sigma}$ in e^+p, LH dominates in e^-p.

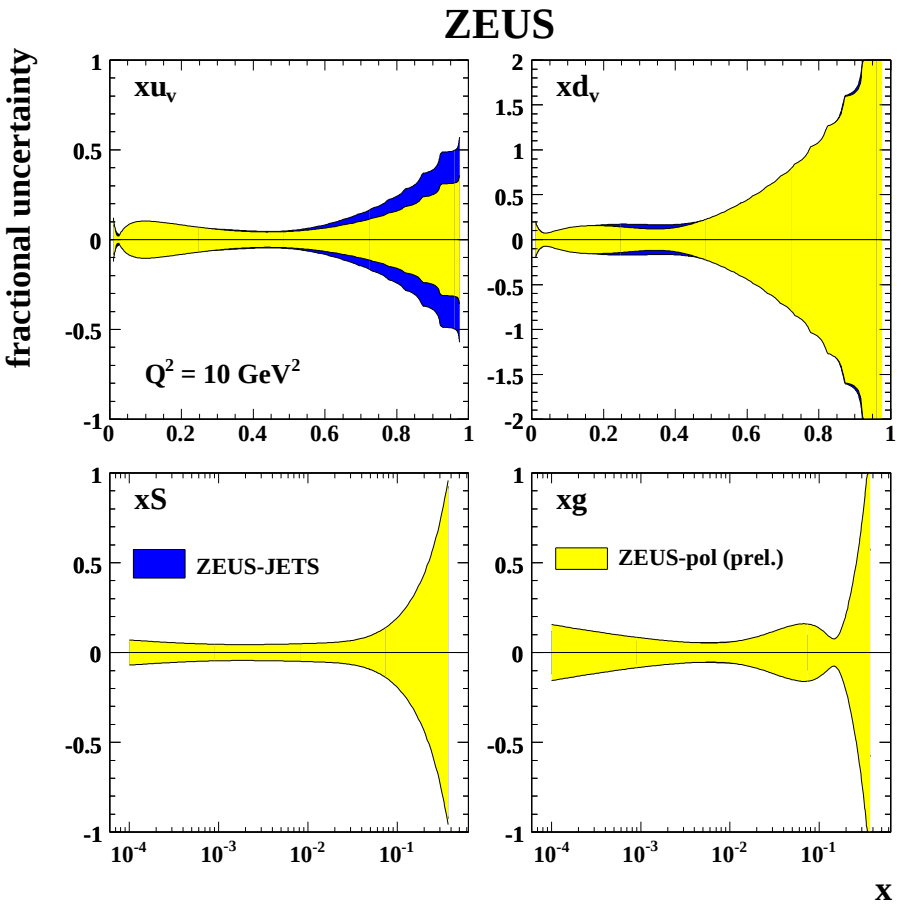
Extracted PDFs - H1 & ZEUS

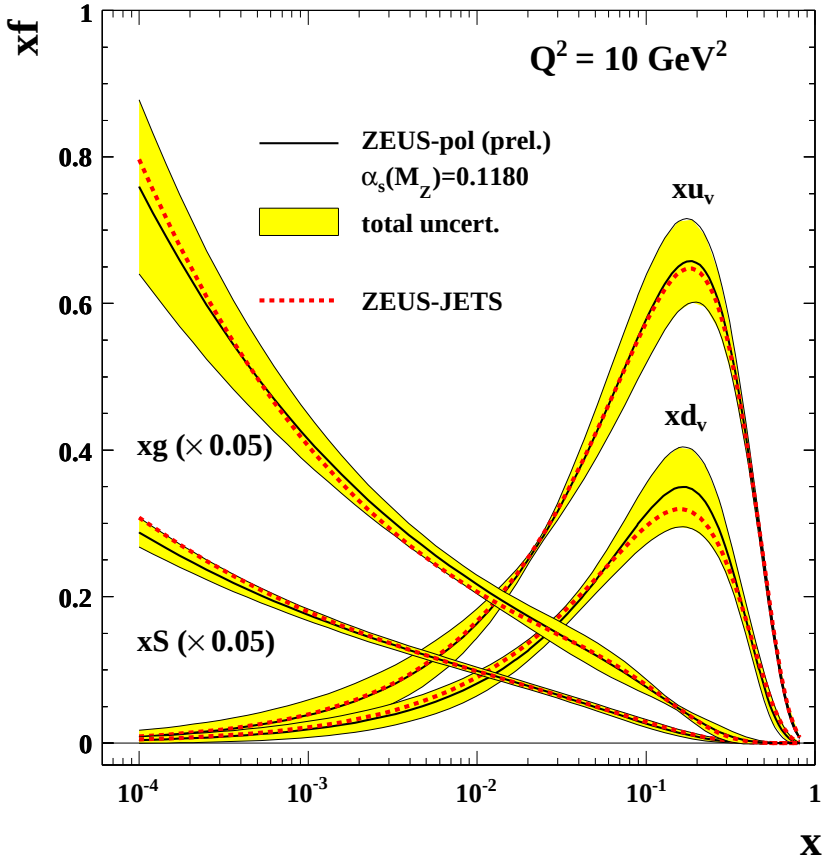




ZEUS-pol = new fit including polarised data, ZEUS-JETS = old fit.

Fractional uncertainties





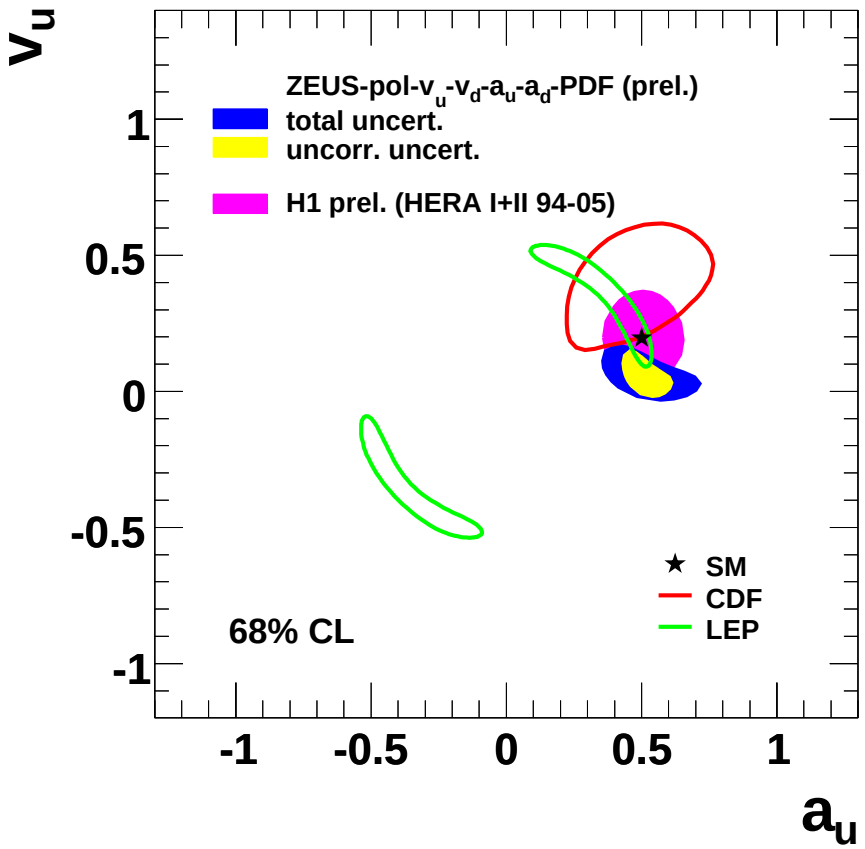
Uncertainty on u_v improved.

Extraction of electroweak parameters

$F_{2,3} = F_{2,3}(v_e, a_e, v_i, a_i)$

Extract couplings of u, d quarks:
vector (v) & axial vector (a)

4-param. fits from ZEUS & H1 compared to other experiments.

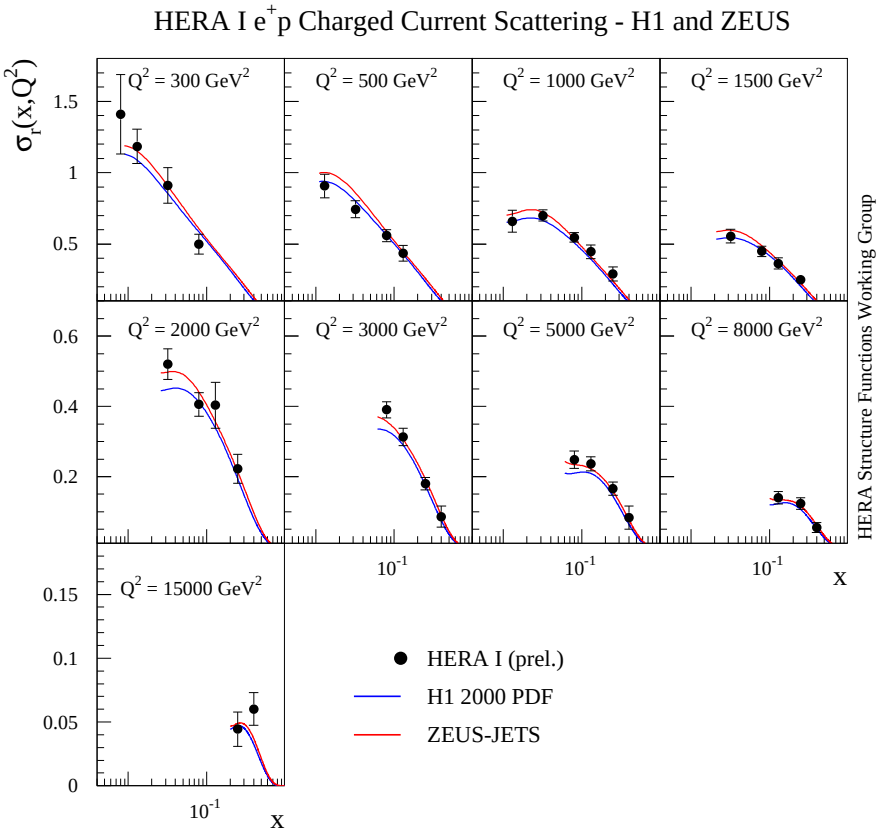


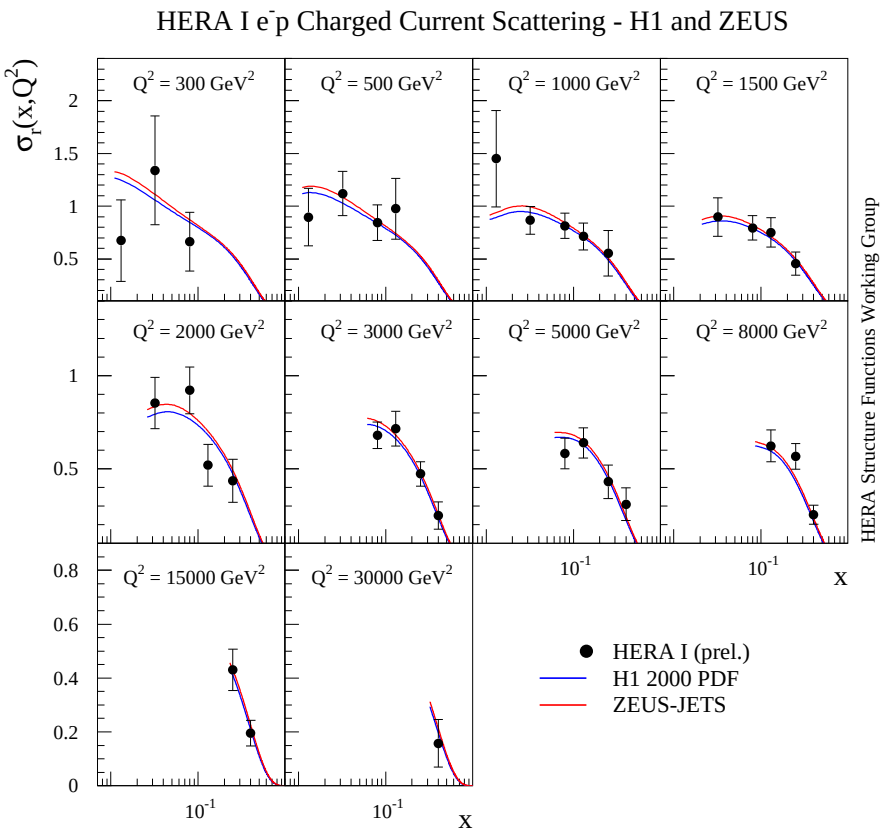
H1-ZEUS combination results

- Combine published DIS σ from H1 & ZEUS
- Data from HERA I (96-00) with $Q^2 > 1.5$ GeV^2
- Systematic correlations are taken into account
  $\longrightarrow$ significant reduction of overall uncertainty
- Will form final word from HERA on fits.

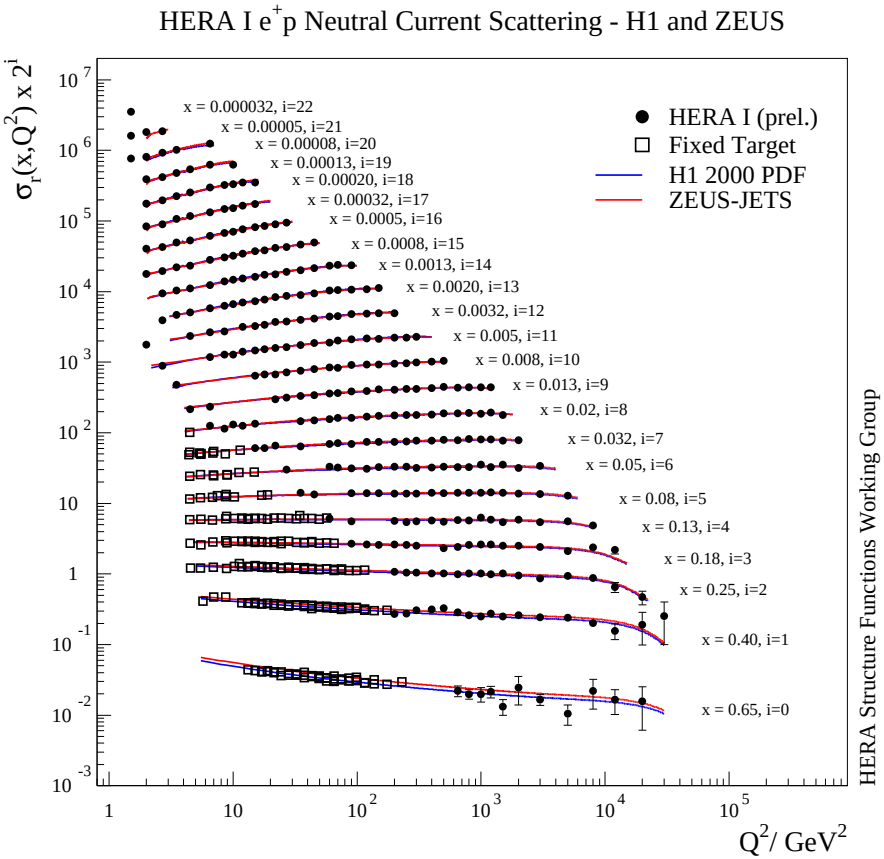
Method see: *S.Glazov XIII International Workshop on Deep Inelastic Scattering*

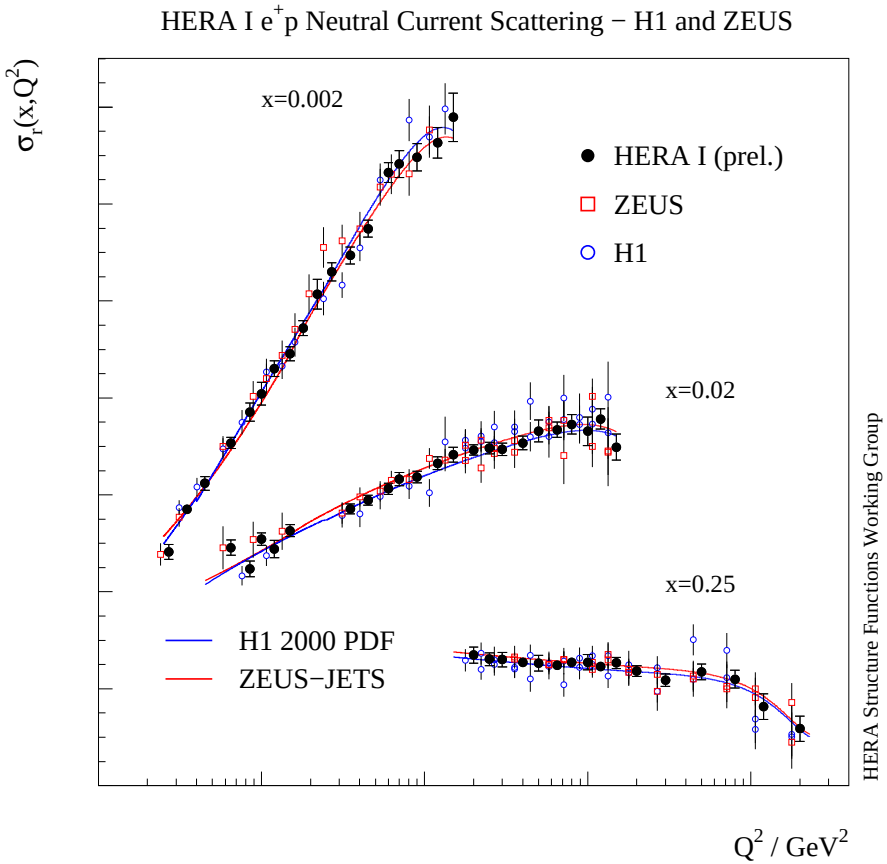
CC $\sigma_r(e^{\pm}p)$





Good agreement with both H1 2000 PDF and ZEUS-JETS.





Strength of method:

@ low Q^2: dominant systematic uncert. reduced

@ high Q^2: dominant statistical uncert. reduced

Summary

Presented here:

- $\tilde{\sigma}(NC)$, $\tilde{\sigma}(CC)$ with $P_e \neq 0$
  $\rightarrow$ H1, ZEUS individually & combined
- Asymmetry, Parity violation, no right-handed CC
- Parton density functions
- Electroweak fit of couplings

Outlook:

- Combine HERA II data.
- Final word from HERA with 1 fb^{-1}