Recent Topics from Structure Function Measurements at HERA

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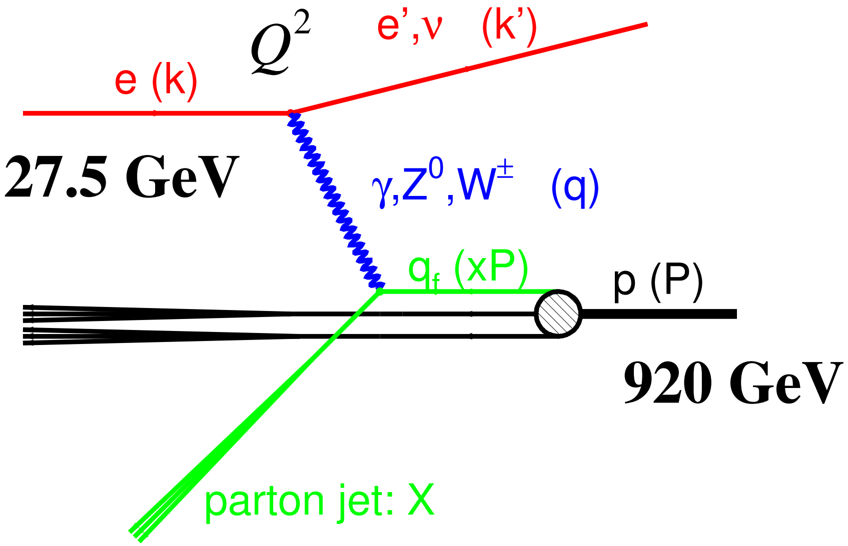
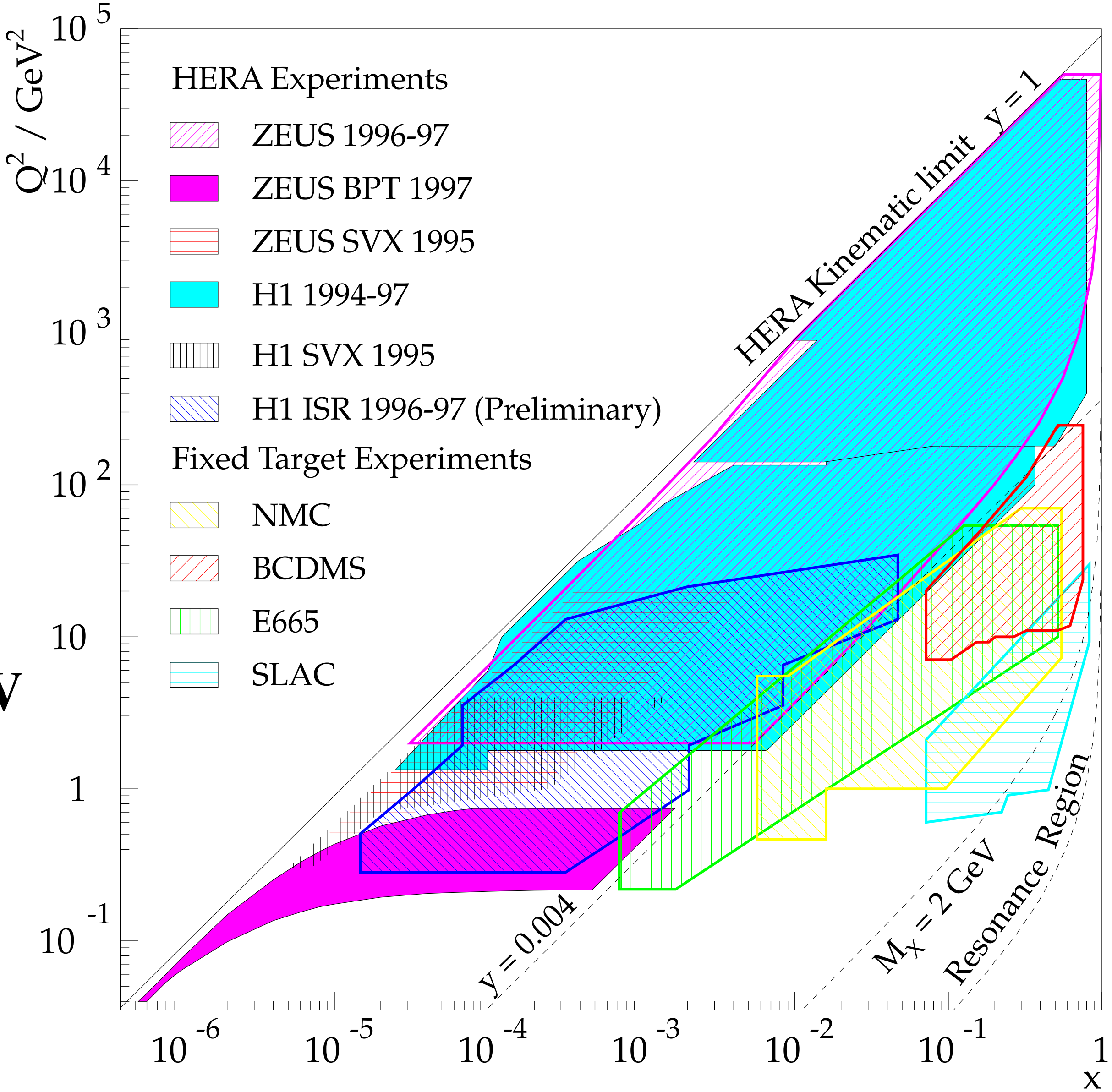
on behalf of

- **F2 data sets**
- **NLO QCD Analysis (α_s and pdf's)**
- **Rise of F2 towards small x**

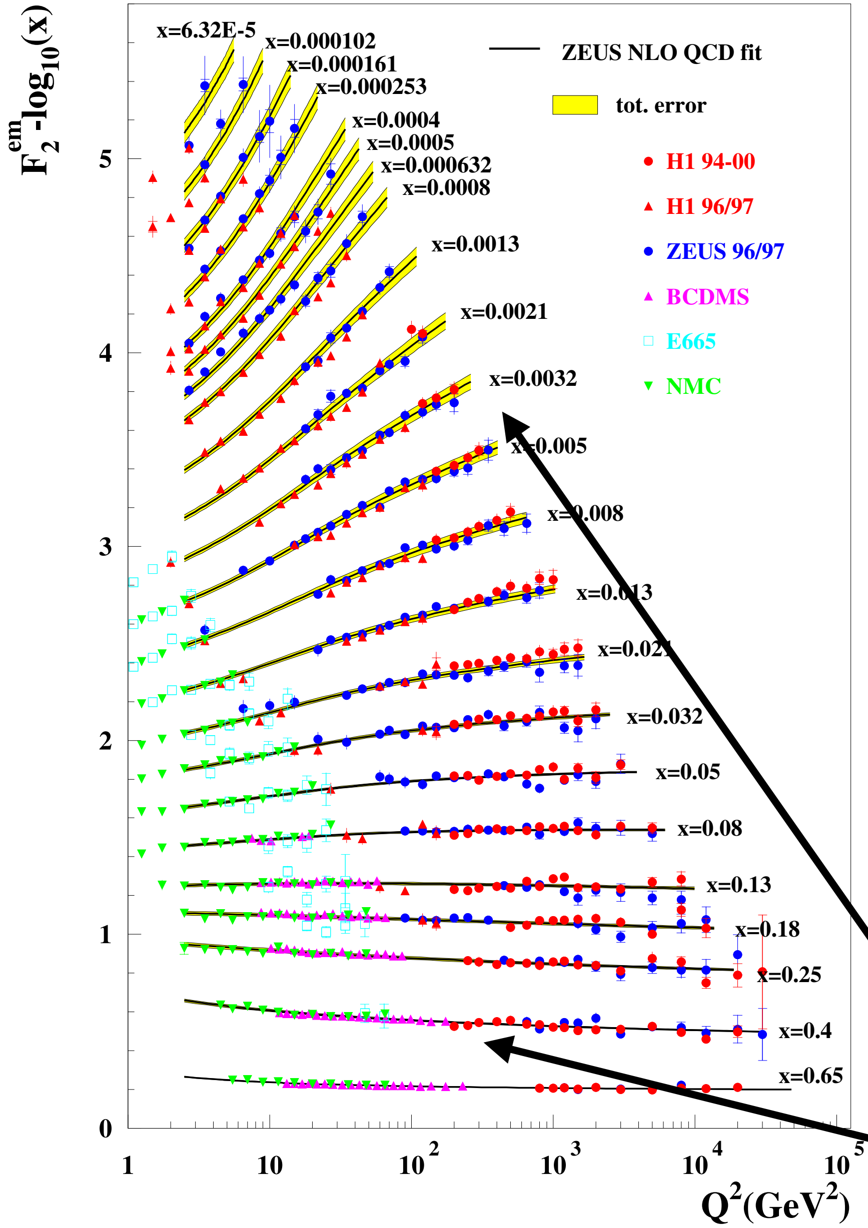
Kinematic Plane

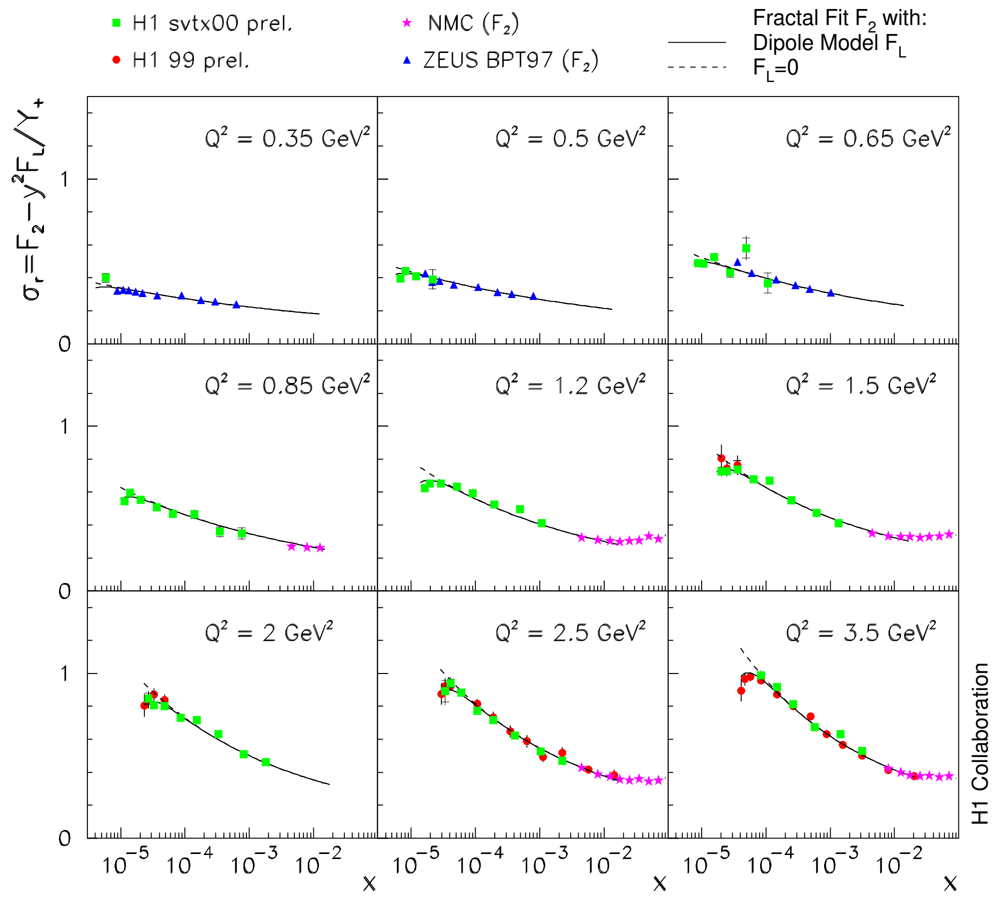




$$\frac{d^2\sigma^{\pm}_{NC}}{dx\,dQ^2} = \frac{2\pi\alpha^2}{xQ^4} \cdot \left[Y_+ \cdot \tilde{F}_2 \mp Y_- \cdot x\tilde{F}_3 - y^2 \cdot \tilde{F}_L \right]$$

F2 data sets

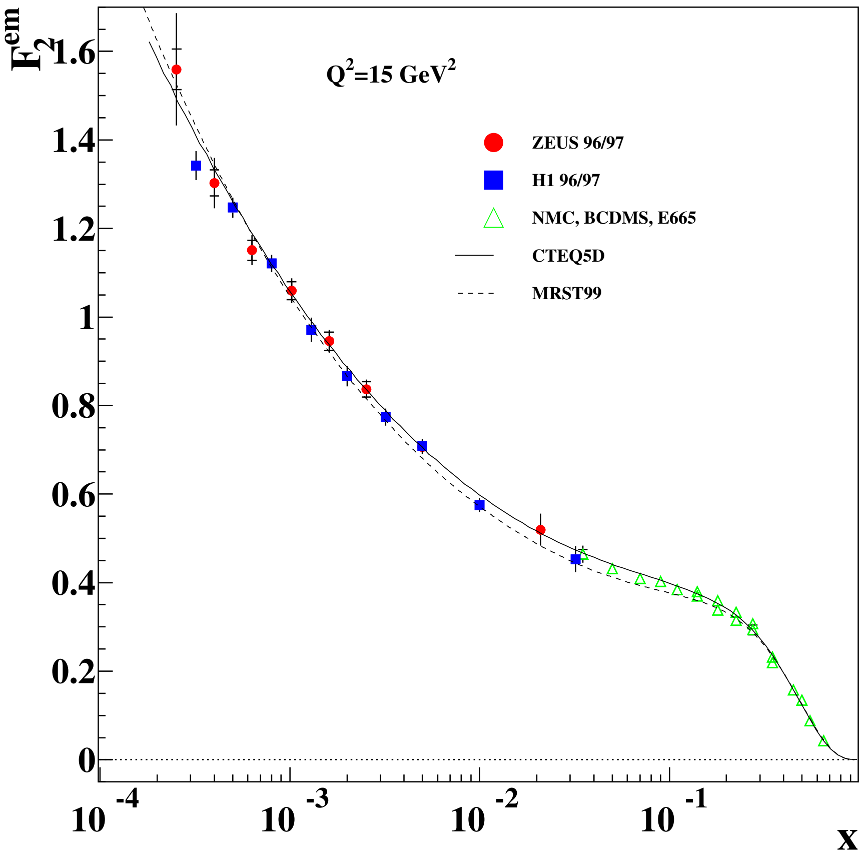


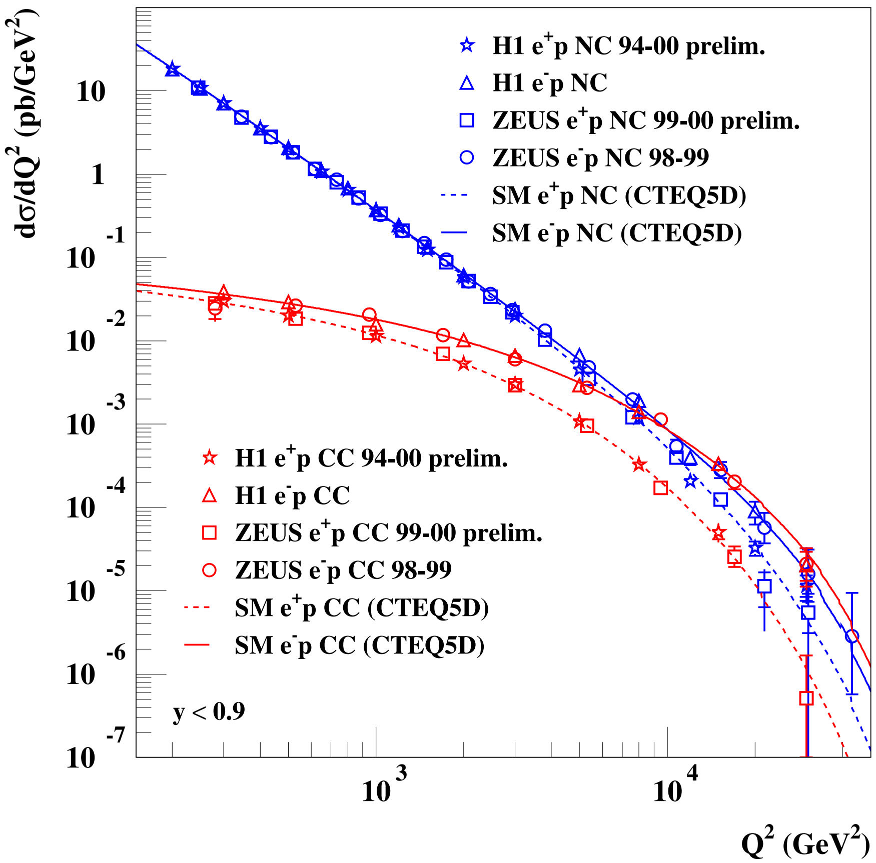


–> precise low Q² data

scaling violations (QCD radiation)

F2 data sets





high precision data at medium Q²

uncertainty: 2–3%

NC cross cross section has similar size as CC cross section at $Q^2 \sim M_Z^2$

QCD Analysis

NC and CC cross sections are sensitive to parton densities

$$F_2 = \frac{4}{9} \cdot (xU + x\bar{U}) + \frac{1}{9} \cdot (xD + x\bar{D})$$

$$\phi^-_{CC} = xU + (1-y)^2 x\bar{D} \qquad \phi^+_{CC} = x\bar{U} + (1-y)^2 xD$$

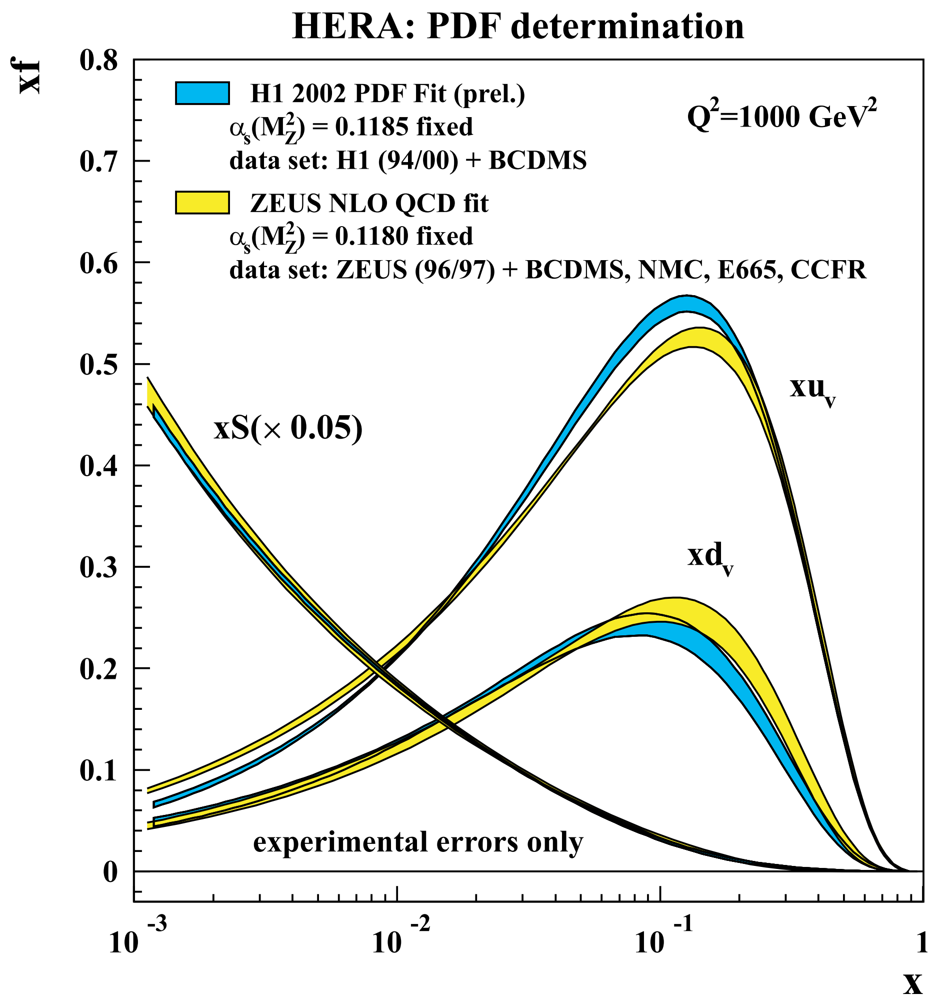
$$U = u + c$$

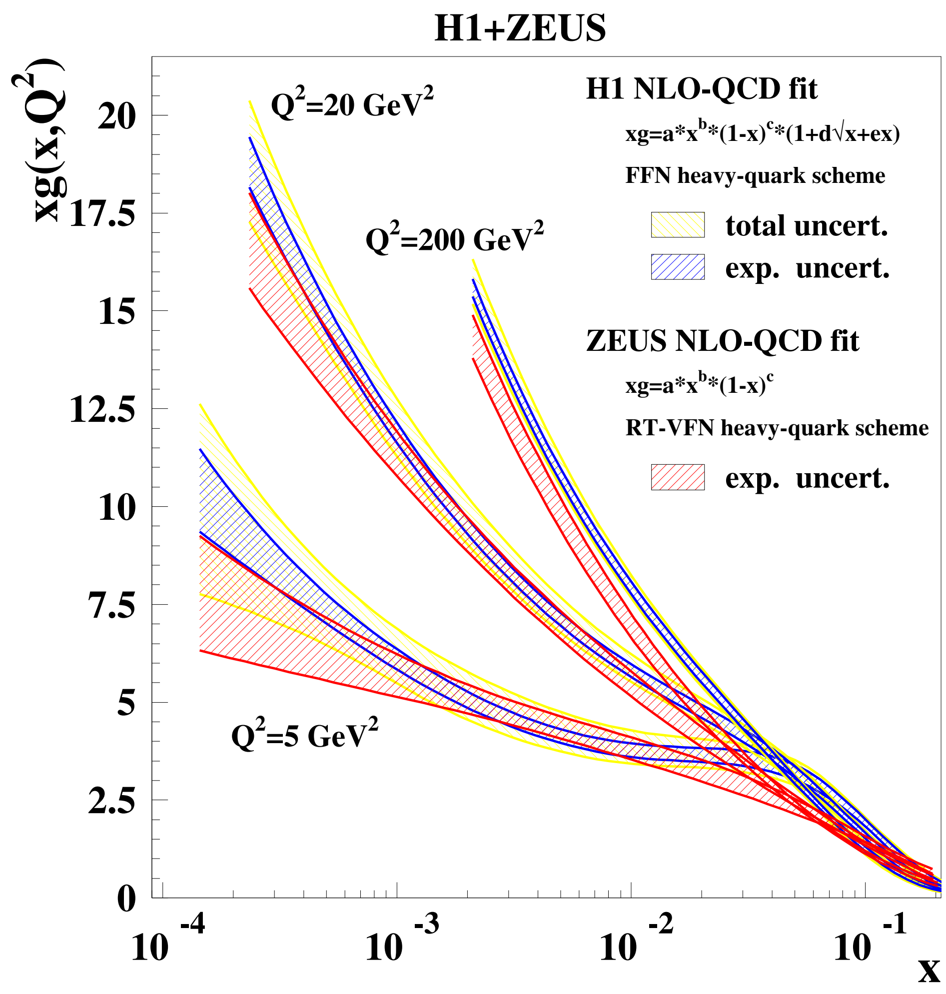
$$D = d + s$$

–> assumption on parametric forms of pdf's
–> fit to present data using DGLAP evolution
–> extraction of parton densities and α_s

–> $u_v = U - \bar{U}$ $\qquad d_v = D - \bar{D}$ $\qquad g$

QCD Analysis: H1 vs. ZEUS





–> good agreement (note: different parametric forms, different heavy quark treatment, different data sets)

QCD Analysis: α_s

H1: proton data: H1 and BCDMS

$$\alpha_s(M_Z^2) = 0.1150 \pm 0.0017(exp.)^{+0.0009}_{-0.0005}(model)$$

ZEUS: proton and deuteron data: ZEUS, BCDMS, NMC, E665, CCFR

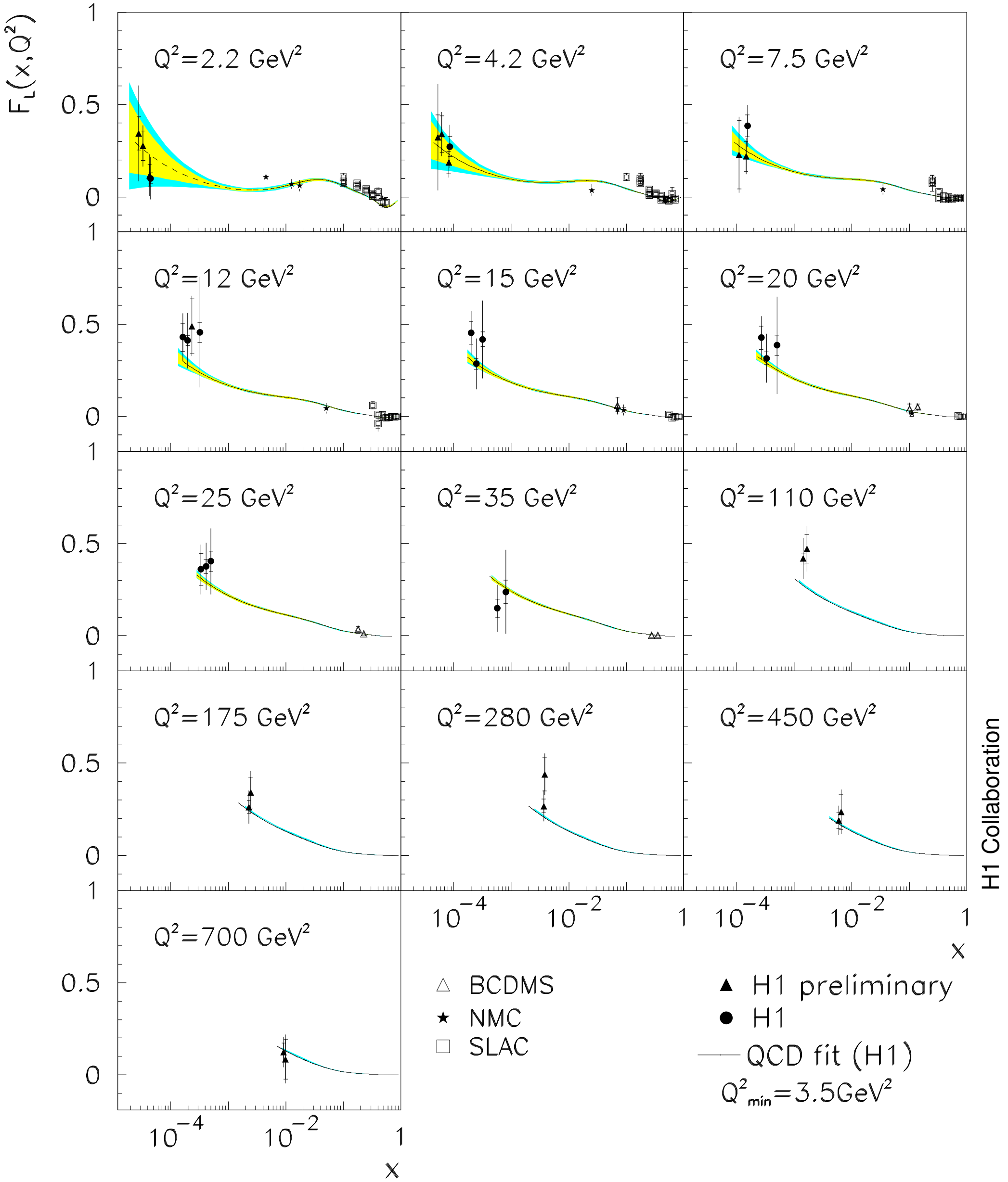
$$\alpha_s(M_Z^2) = 0.1166 \pm 0.0008(unc.) \pm 0.0032(corr) \pm 0.0036(norm) \pm 0.0018(model)$$

change of renormalisation scale Q^2:

H1 (1/4 – 4) Q^2 –> +– 0.005
ZEUS (1/2 – 2) Q^2 –> +– 0.004

–> need NNLO calculations

Measurement of FL

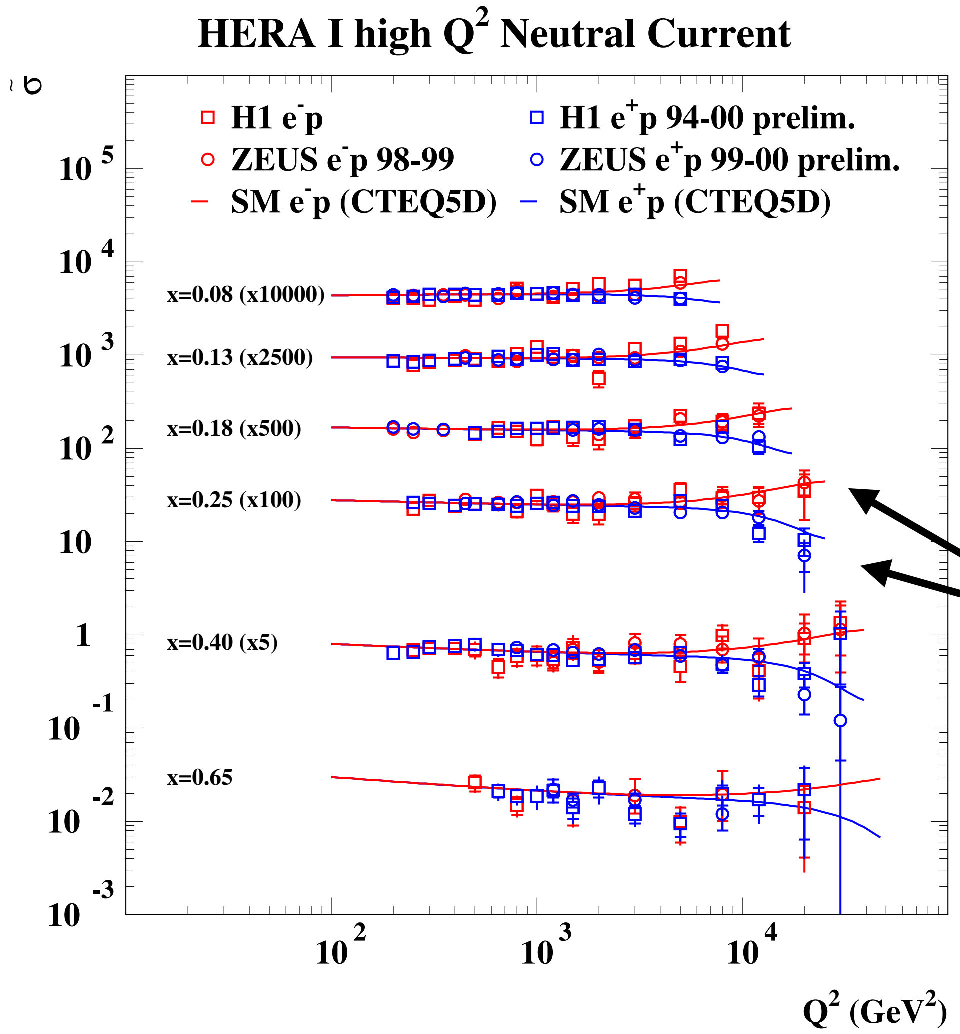


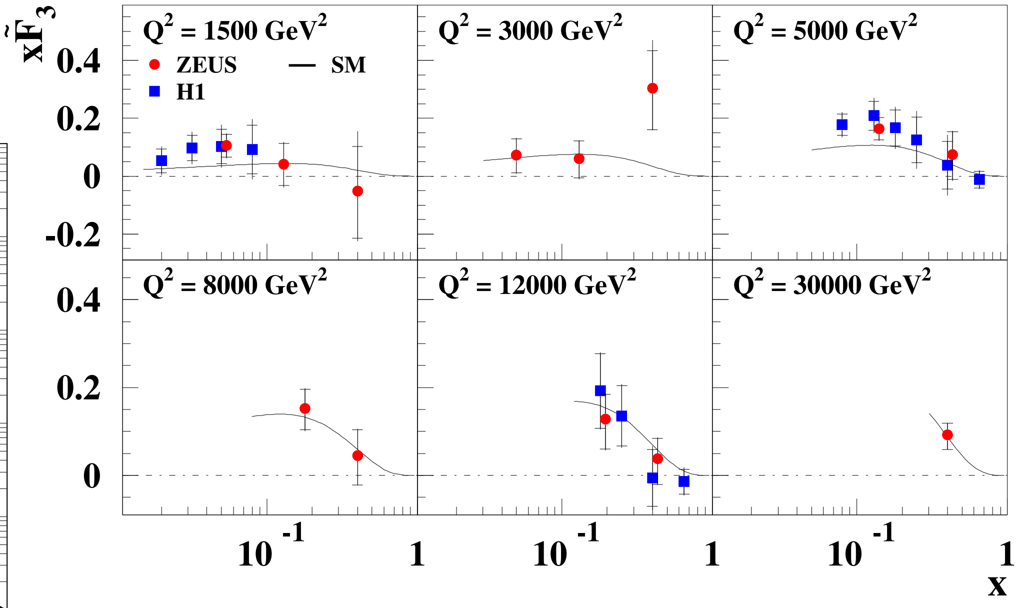
–> observable which is most sensitive to the gluon distribution

$$\frac{F_L}{x} = C_q^L \otimes F_2 + C_g^L \otimes g$$

–> data (not included in fit) well described by QCD fit

Measurement of xF3





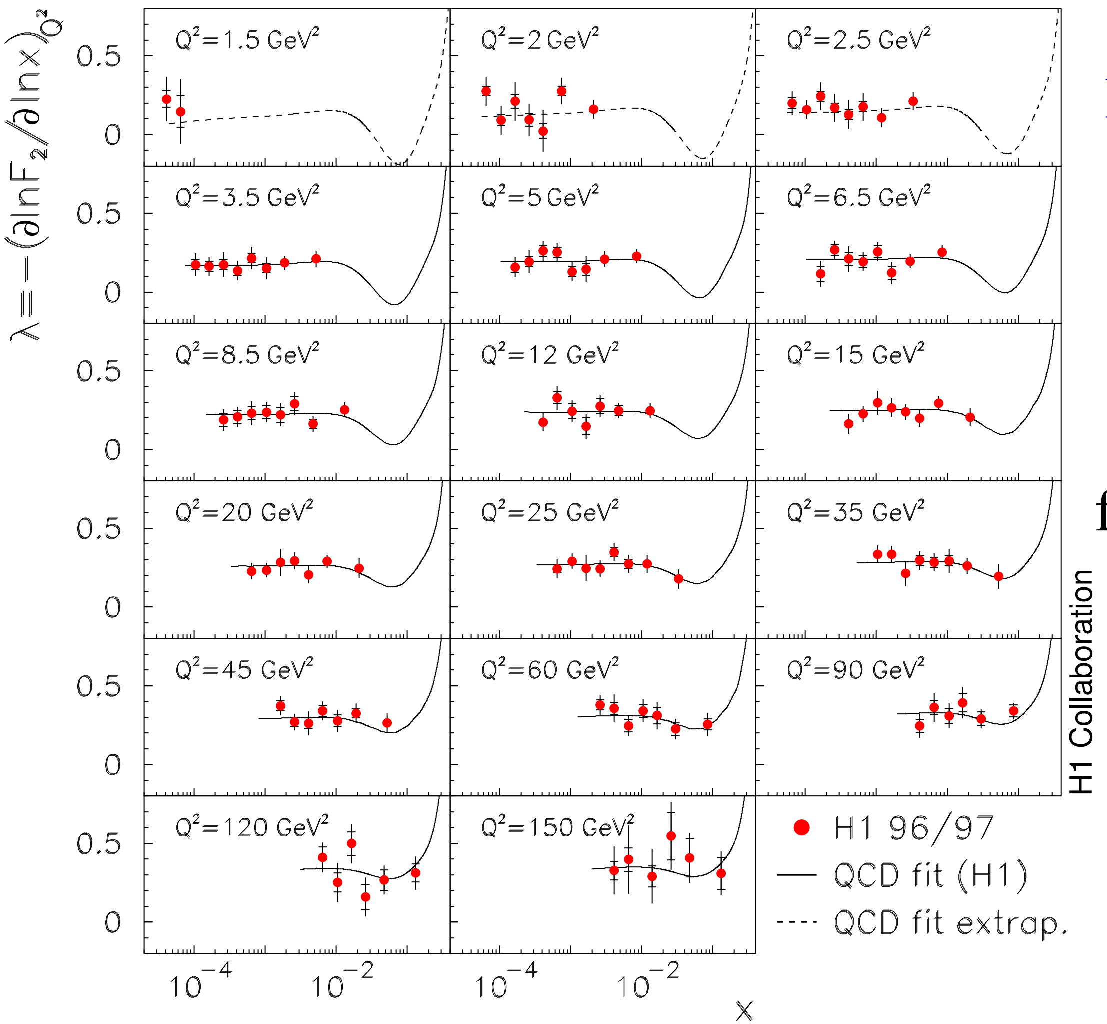
γZ – Interference

electroweak effects visible at highest Q²

$$xF_3 \sim x\sum_q (q-\bar{q})$$

–> HERA II

Rise of F2 towards small x



local derivatives (Mueller, Navelet) :

$$\lambda = -(\delta \ln F_2 / \delta \ln x)_{Q^2}$$

fixed Q^2, $x < 0.01$: $\lambda \approx const$

–> no taming of rise visible yet for $0.5 \leq Q^2 \leq 150\, GeV^2$

Summary

- HERA data have reached precision (large phase space)
- All HERA I data analysed (100 pb–1)
- QCD Analysis based on DGLAP provides:
  - parton densities with error estimation
  - precise α_s
- Data are well described by QCD and EW expectations

–> HERA II: 1fb–1 polarised