ZEUS high Q^2 e^+p NC measurements and high-x cross sections

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On behalf of the ZEUS Collaboration

First part of talk based on ZEUS paper: Phys. Rev. D 87, 052014 (2013) (DESY 12-145)

Measurement of high-Q^2 neutral current deep inelastic e^+p scattering cross sections with a longitudinally polarised positron beam at HERA

High Q^2 event selection; reconstruction based on double angle method. Focus is on covering as large a kinematic range as possible and extracting single and double differential cross sections.

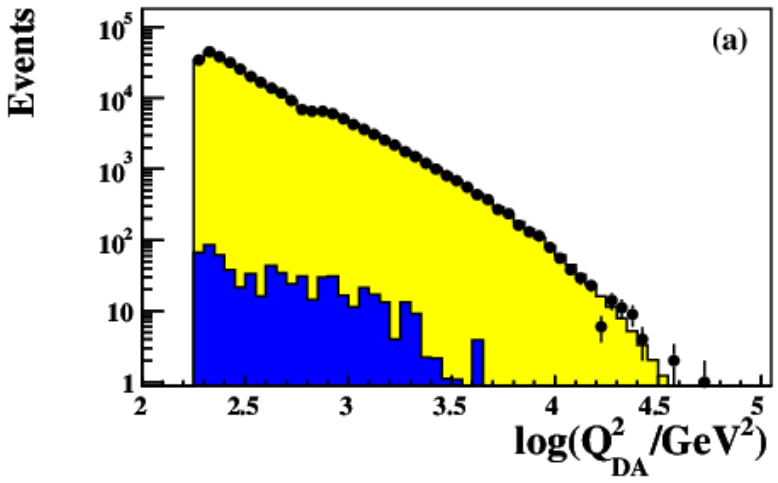
The Monte Carlo generators/event simulators used for the analysis:

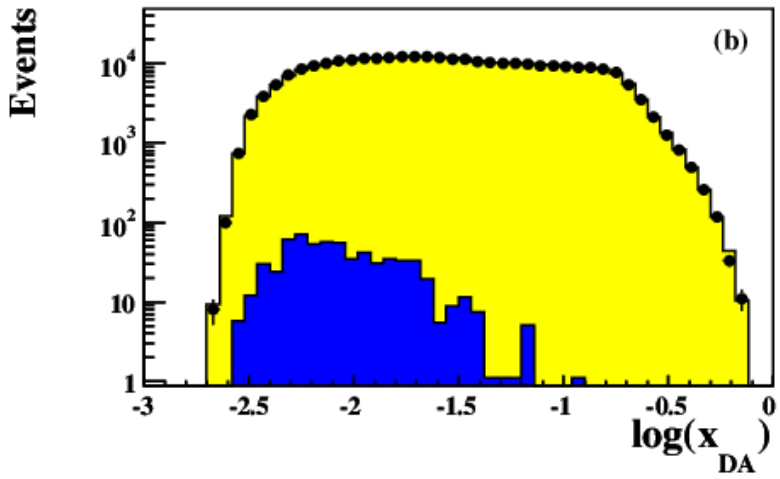
- NC DIS events
  - HERACLES + DJANGOH with CTEQ5D PDFs
- Hadronic final state
  - ARIADNE 4.12 (MEPS model of LEPTO 6.5)
- Hadronisation
  - JETSET 7.4
- Photoproduction background
  - HERWIG 5.9

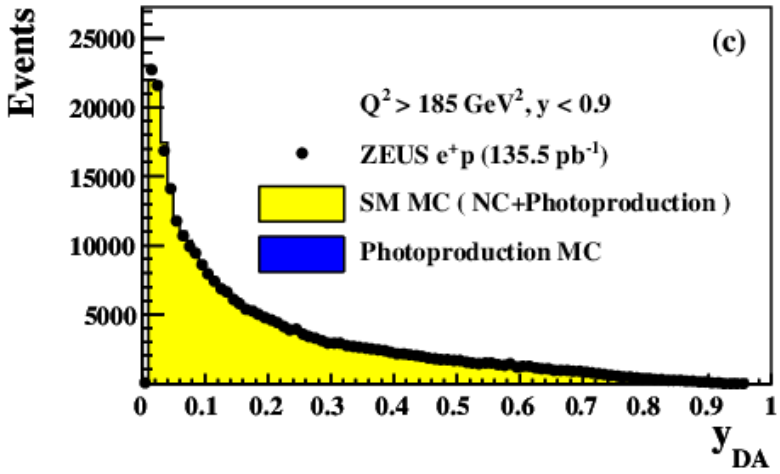
thanks to Ian Brock for letting me use his slides

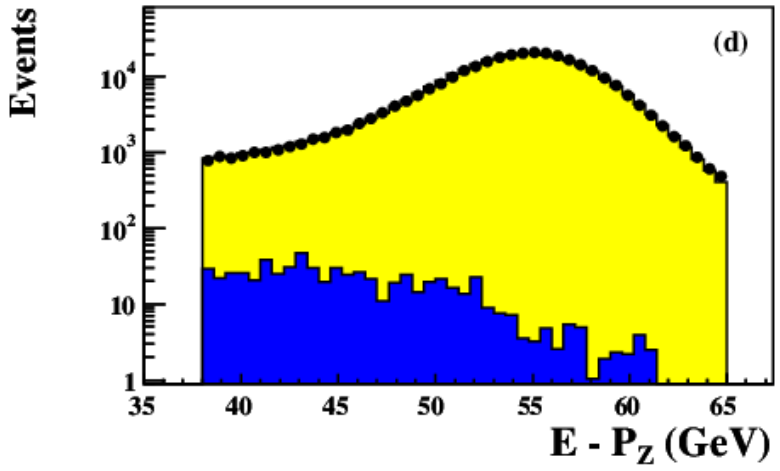
Data/MC comparisons

135.5 pb^{-1} e^+p data
$Q^2 > 185$ GeV^2









Data/MC comparisons

135.5 pb^{-1} e^+p data
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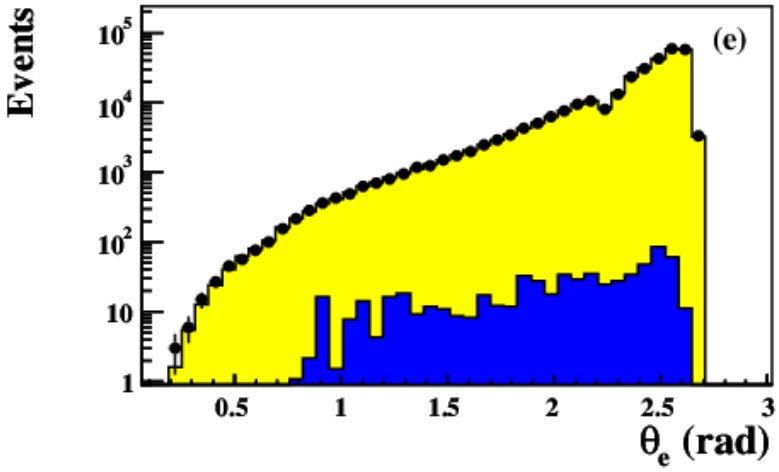
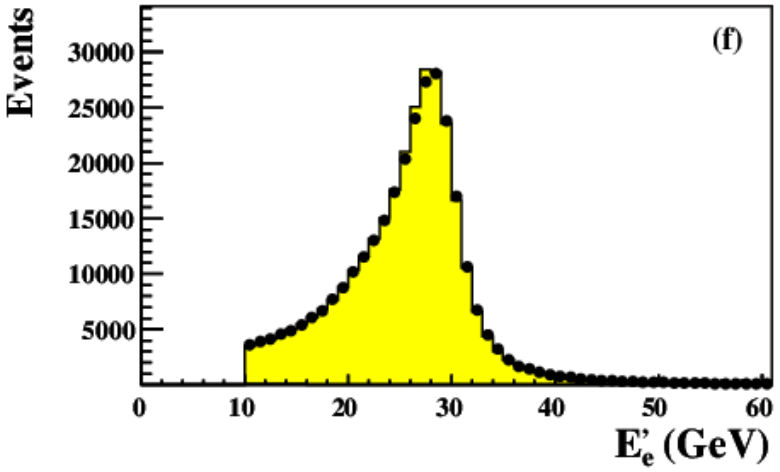
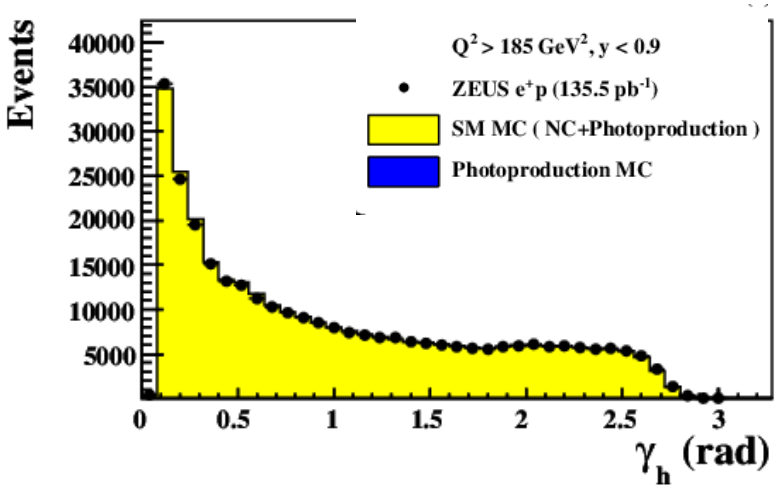
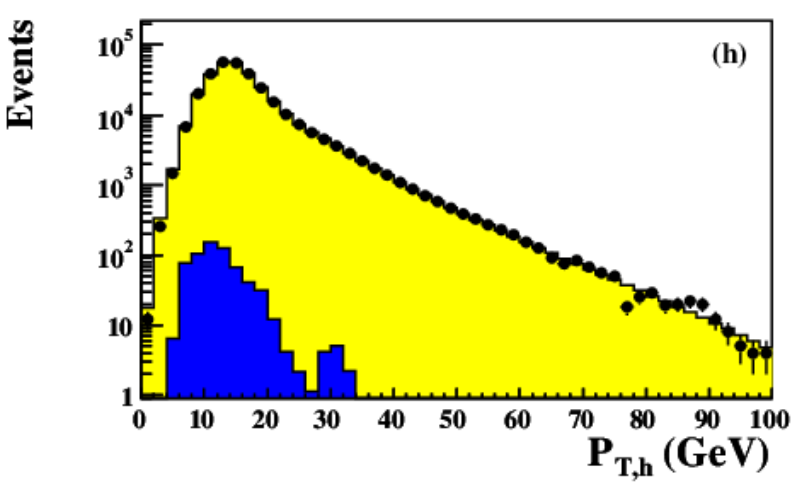
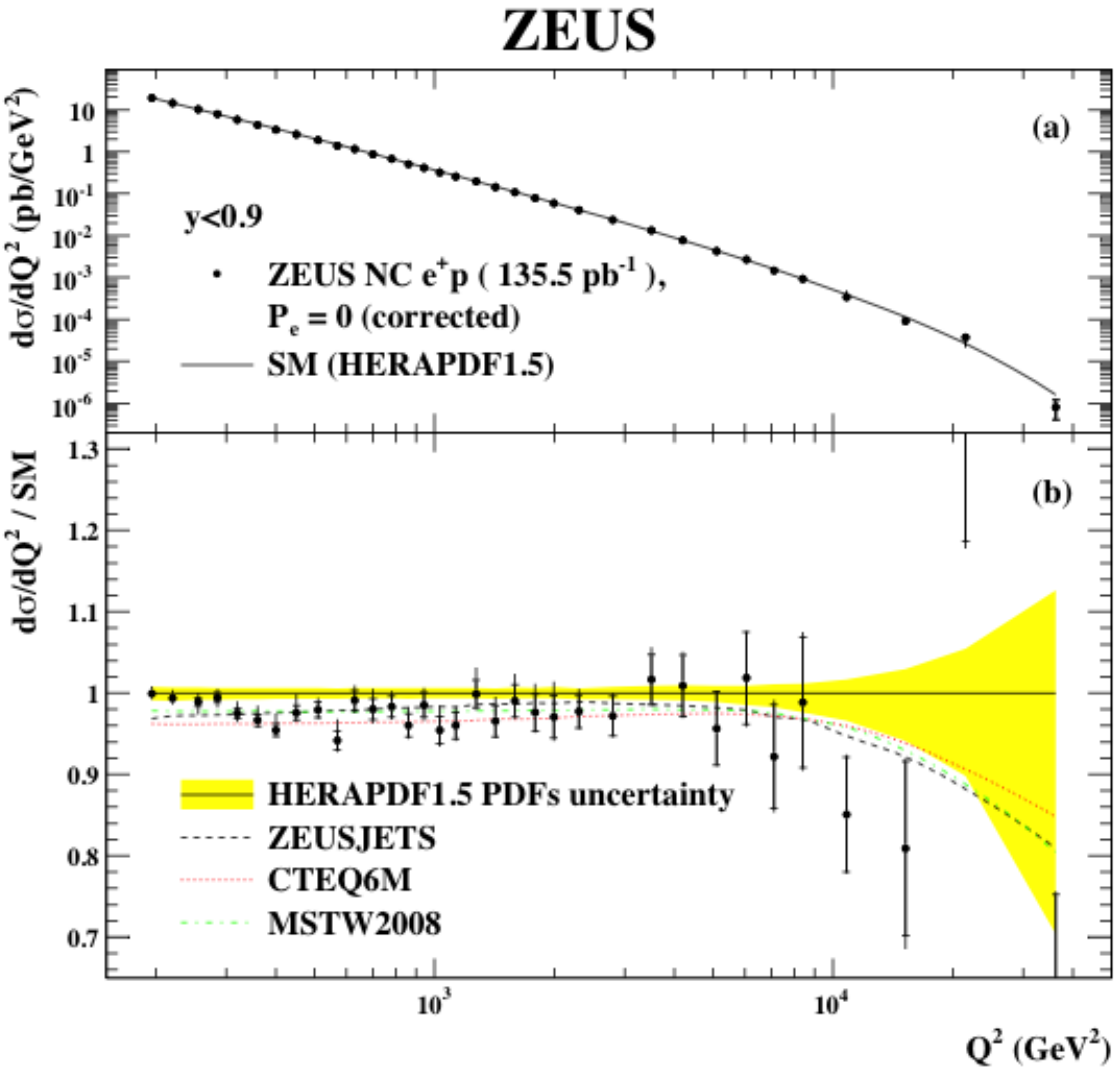






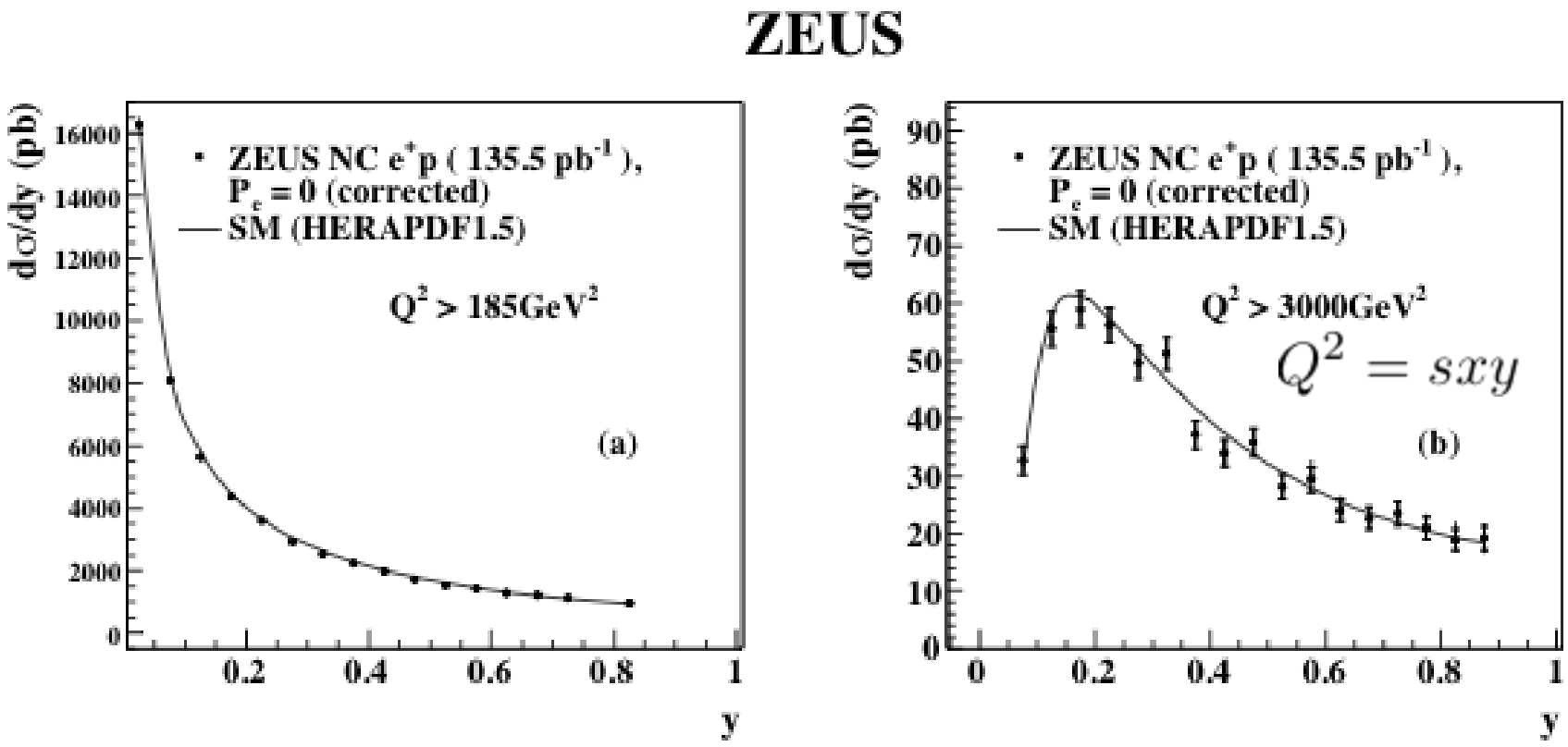


e^+p NC DIS cross-section



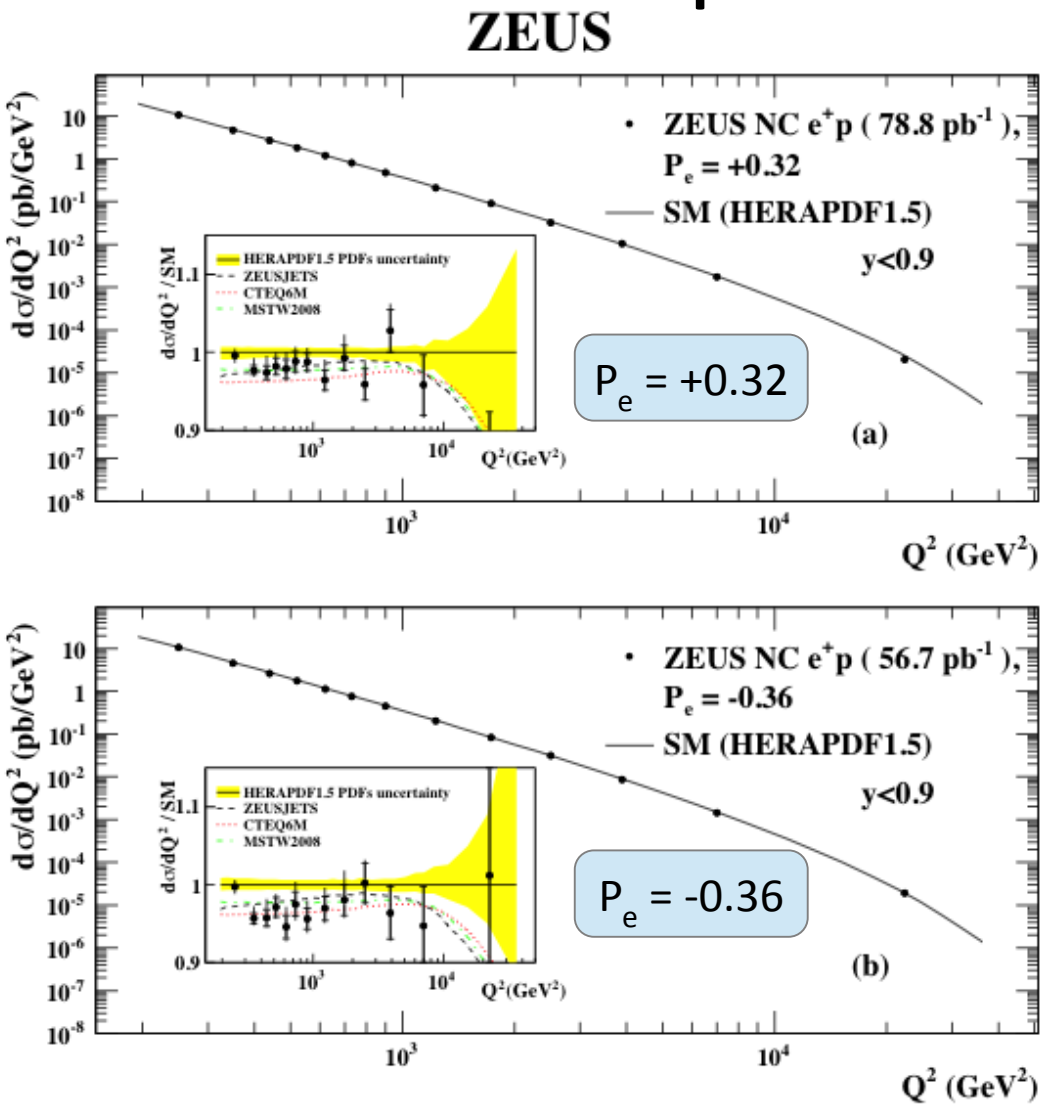
- P_e = 0 (corrected)
- Systematic uncertainties dominate at lower Q^2, statistical at very high Q^2
- Luminosity uncertainty (1.8-1.9%) not included in error band
- Deviations from expectations from pdfs not significant given residual normalization uncertainty (not shown).

e^+p NC DIS cross-section



- Compare cross-sections in dominantly electromagnetic and electroweak regimes
- Precision of measurement clearly visible

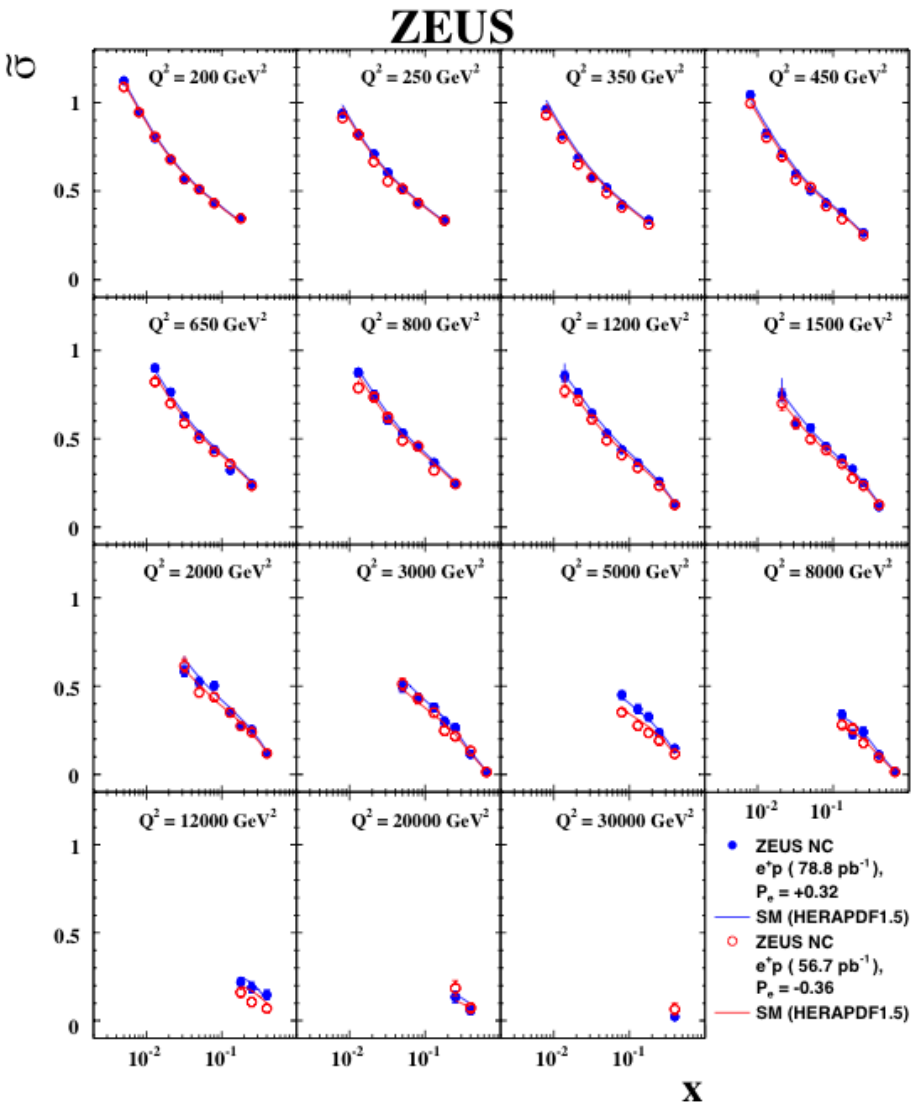
Comparing positive and negative polarisation



135.5 pb^{-1} e$^+$p data
$Q^2 > 185$ GeV^2

- Take ratio data/SM with HERAPDF1.5 as basis for comparison with other pdfs
- Deviations from expectations from pdfs not significant given residual normalization uncertainty. (Note however that pdfs disagree with each other.)

Reduced cross-sections split according to polarisation



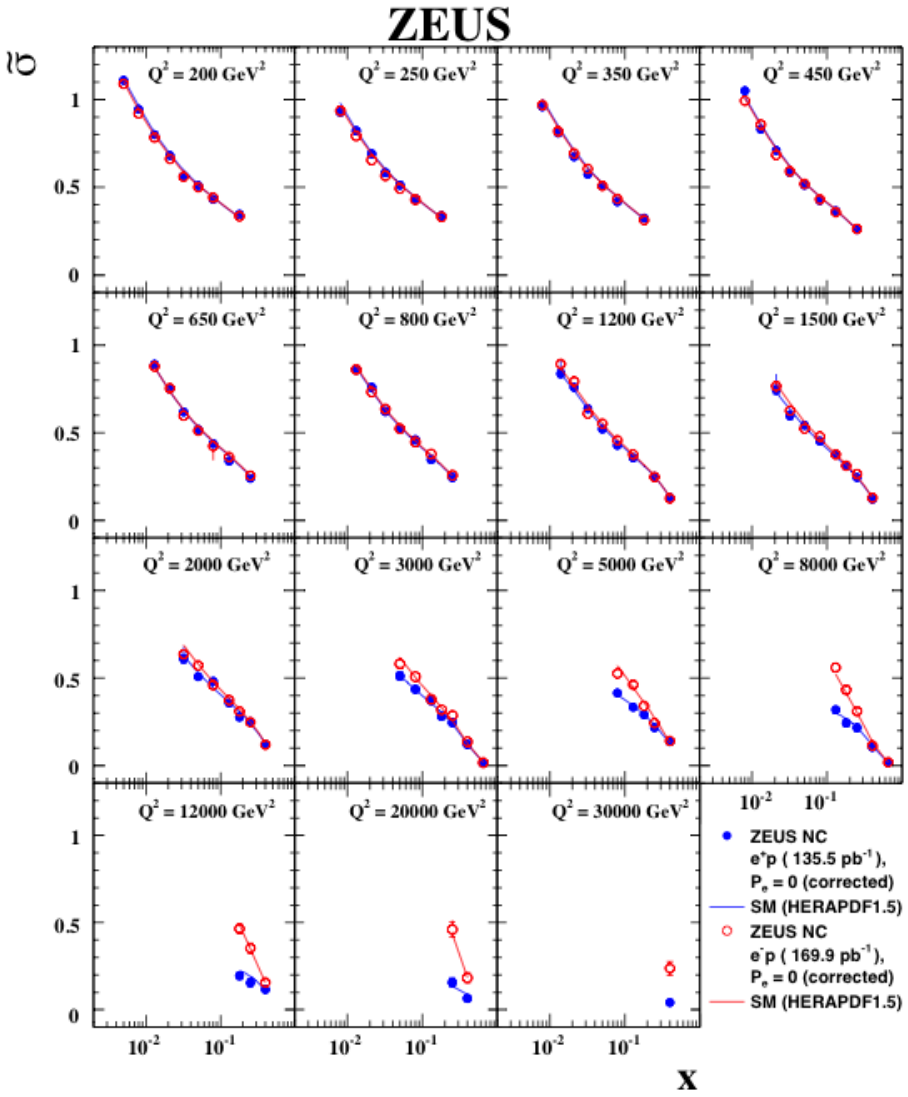
135.5 pb^{-1} e$^+$p data
$Q^2 > 185$ GeV^2

- Small, but steadily increasing difference seen for $Q^2 \gtrsim 1000$ GeV^2
- Well described by predictions

$$\tilde{\sigma}^{\pm} = \frac{xQ^4}{2\pi\alpha^2}\frac{1}{Y_+}\frac{d^2\sigma(e^{\pm}p)}{dxdQ^2}$$

$$Y_+ = 1 + (1-y)^2$$

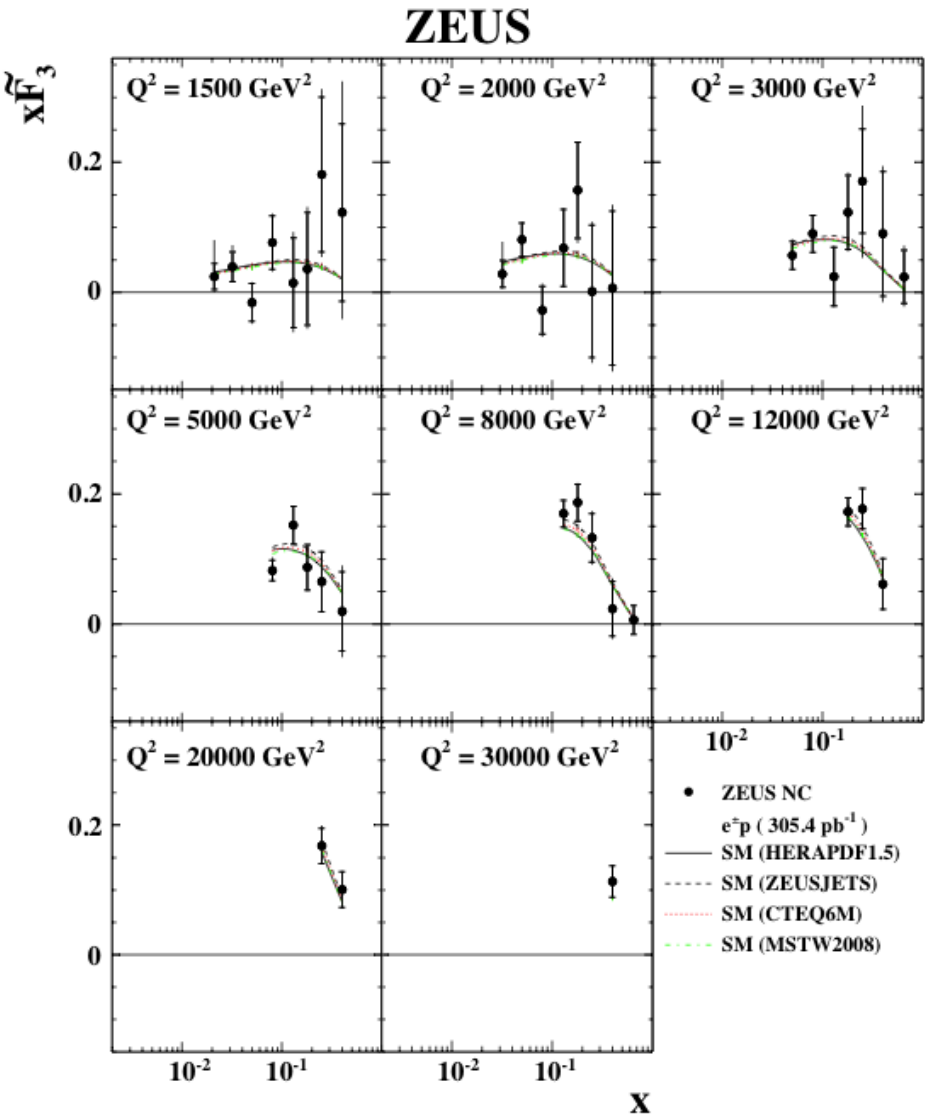
$e^{\pm}p$ reduced cross-sections



135.5 pb^{-1} e^+p data
169.9 pb^{-1} e^-p data
$Q^2 > 185$ GeV^2

- Compare e^+p with previously published e^-p results
- Clear differences between e^+p and e^-p at high Q^2 driven by γ-Z interference
- Good agreement with predictions

Structure function $x\tilde{F}_3$



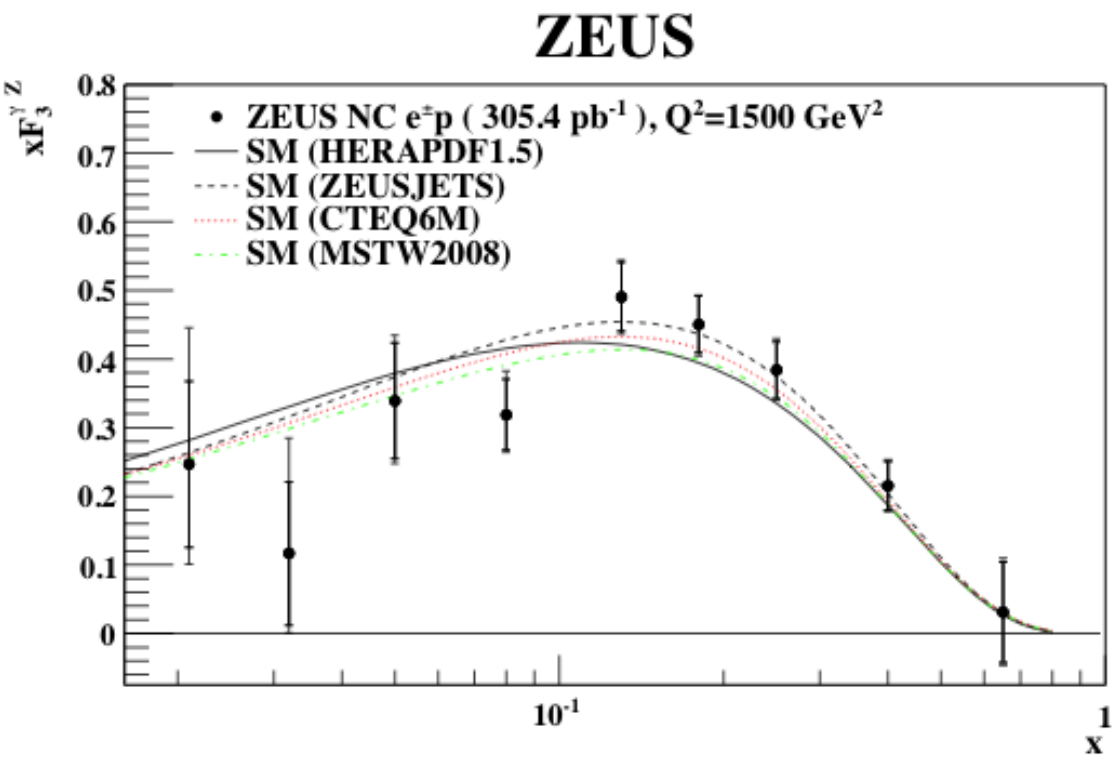
135.5 pb^{-1} e^+p data
169.9 pb^{-1} e^-p data
$Q^2 > 1300$ GeV^2

- Structure function obtained from difference of cross-sections
- Combine all bins to obtain better precision

$$x\tilde{F}_3 = \frac{Y_+}{2Y_-}(\tilde{\sigma}^{e^-p} - \tilde{\sigma}^{e^+p})$$

Structure function $xF_3^{\gamma Z}$

135.5 pb^{-1} e^+p data
169.9 pb^{-1} e^-p data
Q^2 = 1500 GeV^2

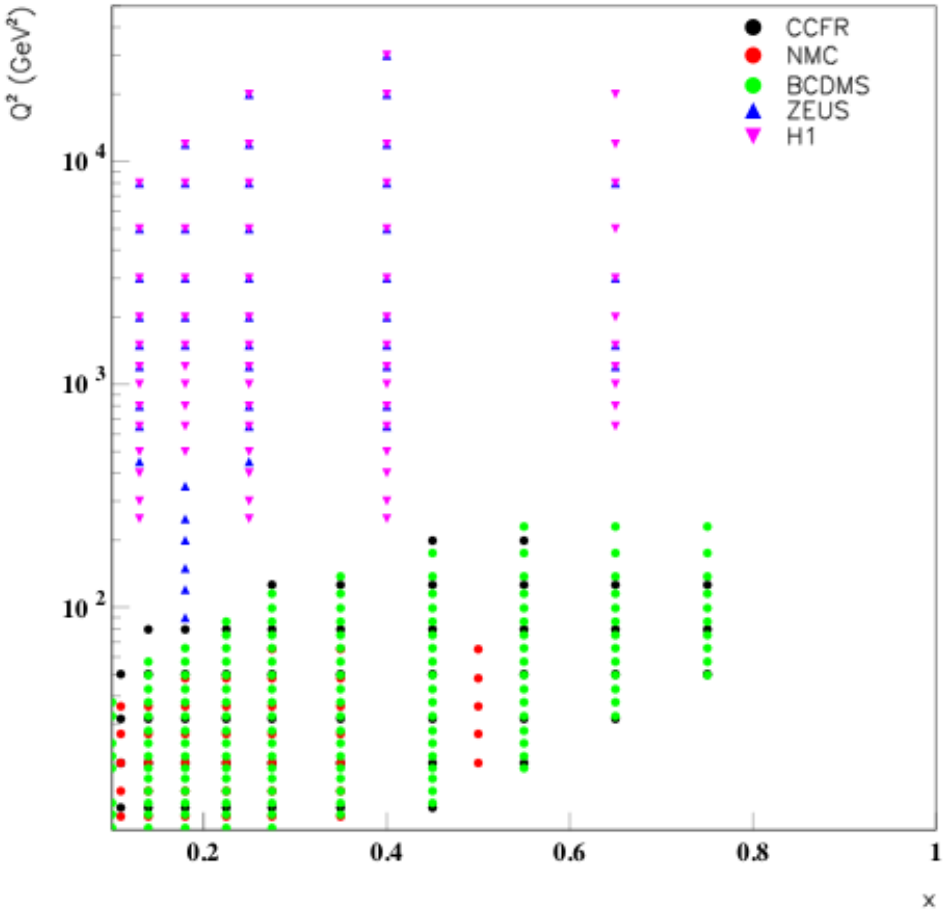


- Take out known EM coupling and relative EM and weak neutral couplings to get $xF_3^{\gamma Z}$
- PDF predictions agree well with data
- Statistical uncertainties typically >2x systematic

$$x\tilde{F}_3 \approx -a_e \chi_Z x F_3^{\gamma Z}$$

Fine-grained high-x cross sections

- There is limited data on cross sections at high-x and high Q^2

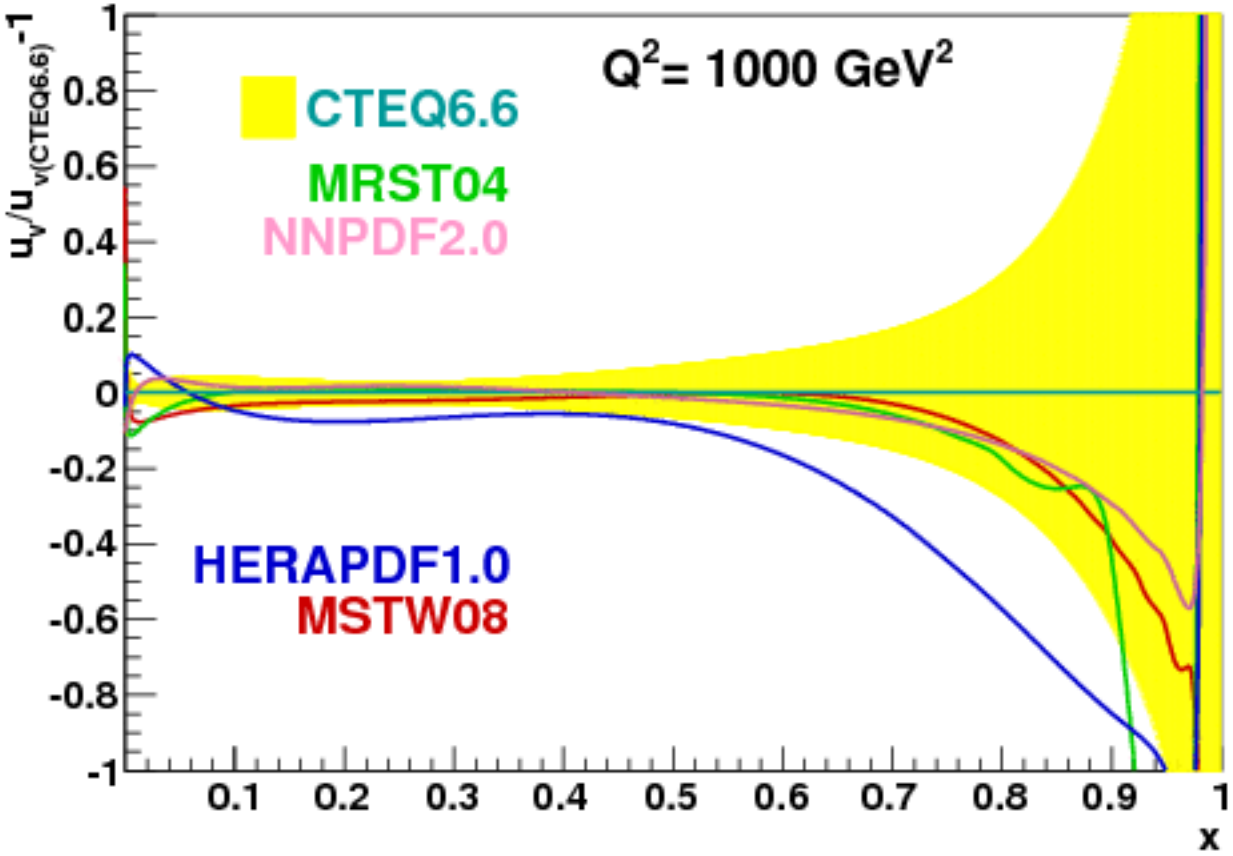


BCDMS has measured F_2 up to x=0.75

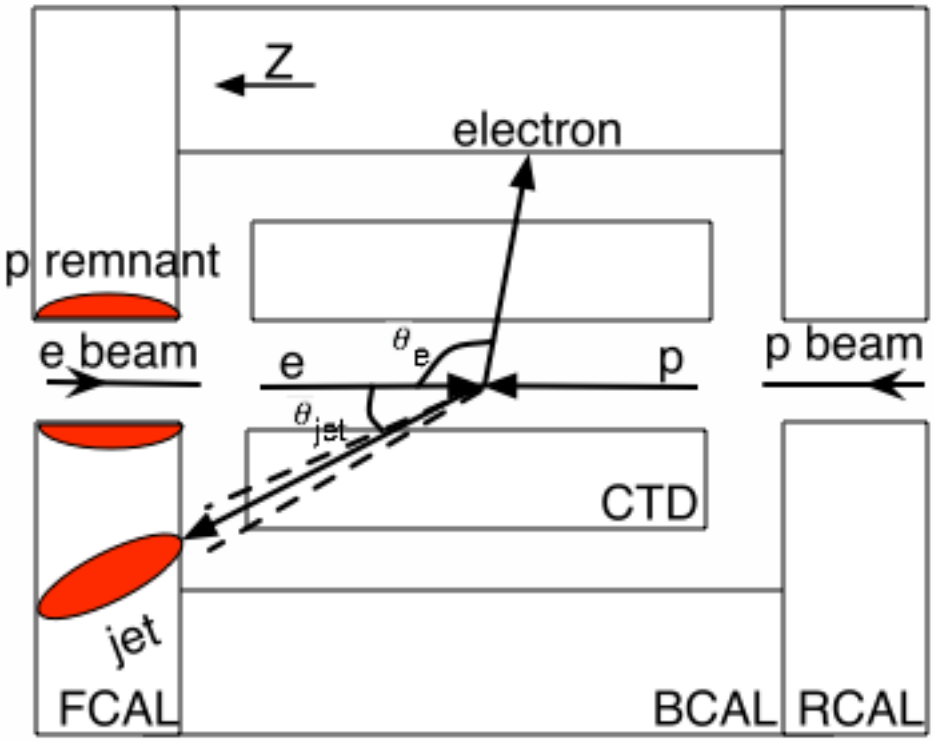
H1, ZEUS have measured F_2 up to x=0.65

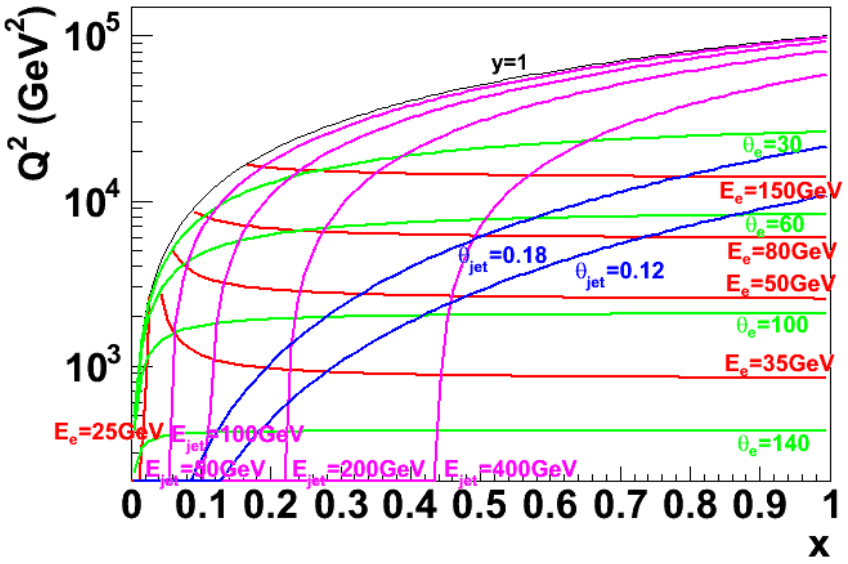
Motivation

The PDF's are poorly determined at high-x. Sizeable differences despite the fact that all fitters use the same parametrization $xq \propto (1-x)^{\eta}$. Is it possible to check this ?



HERA high-x



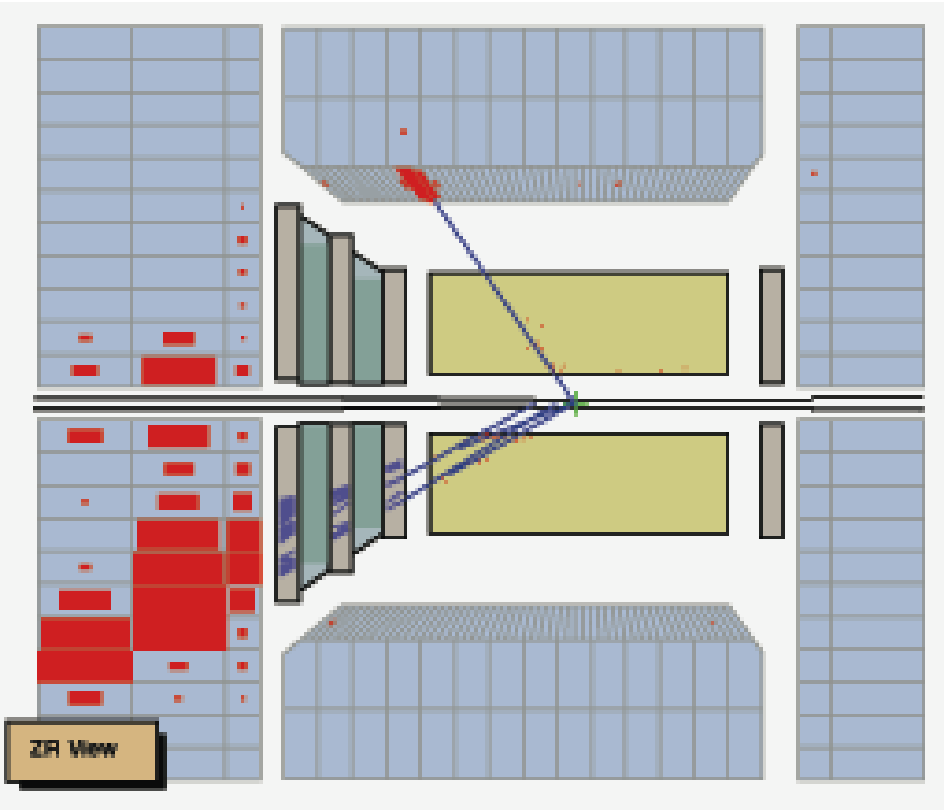


- At high Q^2, scattered electron seen with ≈100% acceptance
- For not too high x, measure x from jet: $\dfrac{d^2\sigma}{dxdQ^2}$
- For $x>x_{Edge}$, measure $\int_{x_{Edge}}^{1} \dfrac{d^2\sigma}{dxdQ^2}\,dx$

HERA kinematics

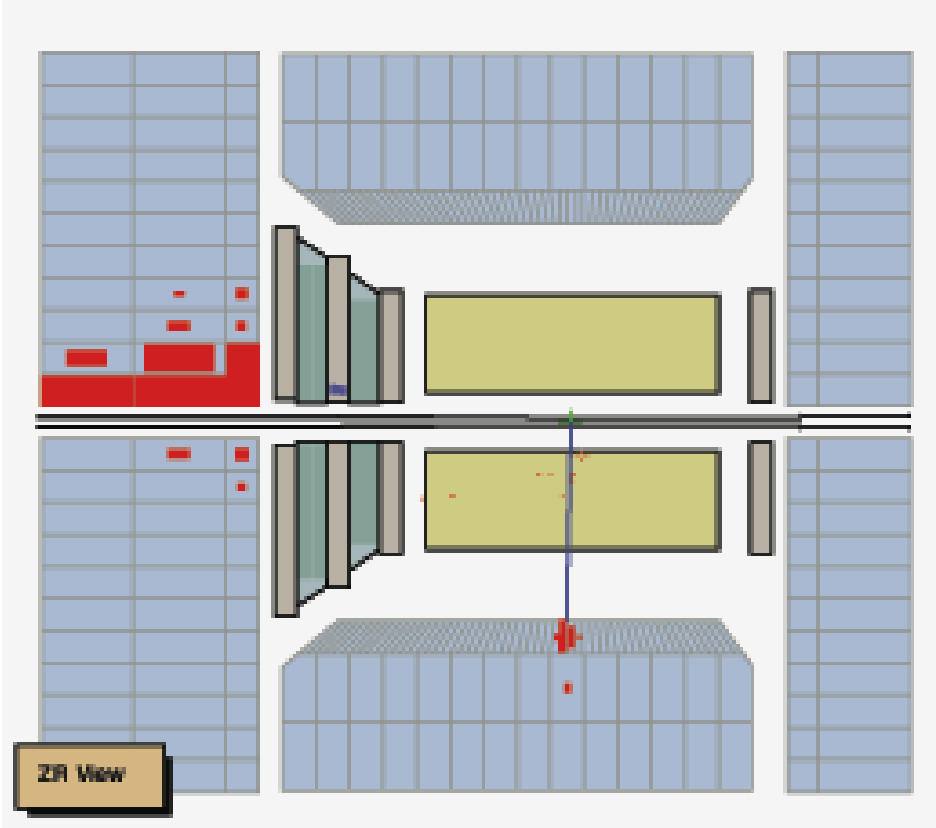
Jet found

$x<x_{Edge}$



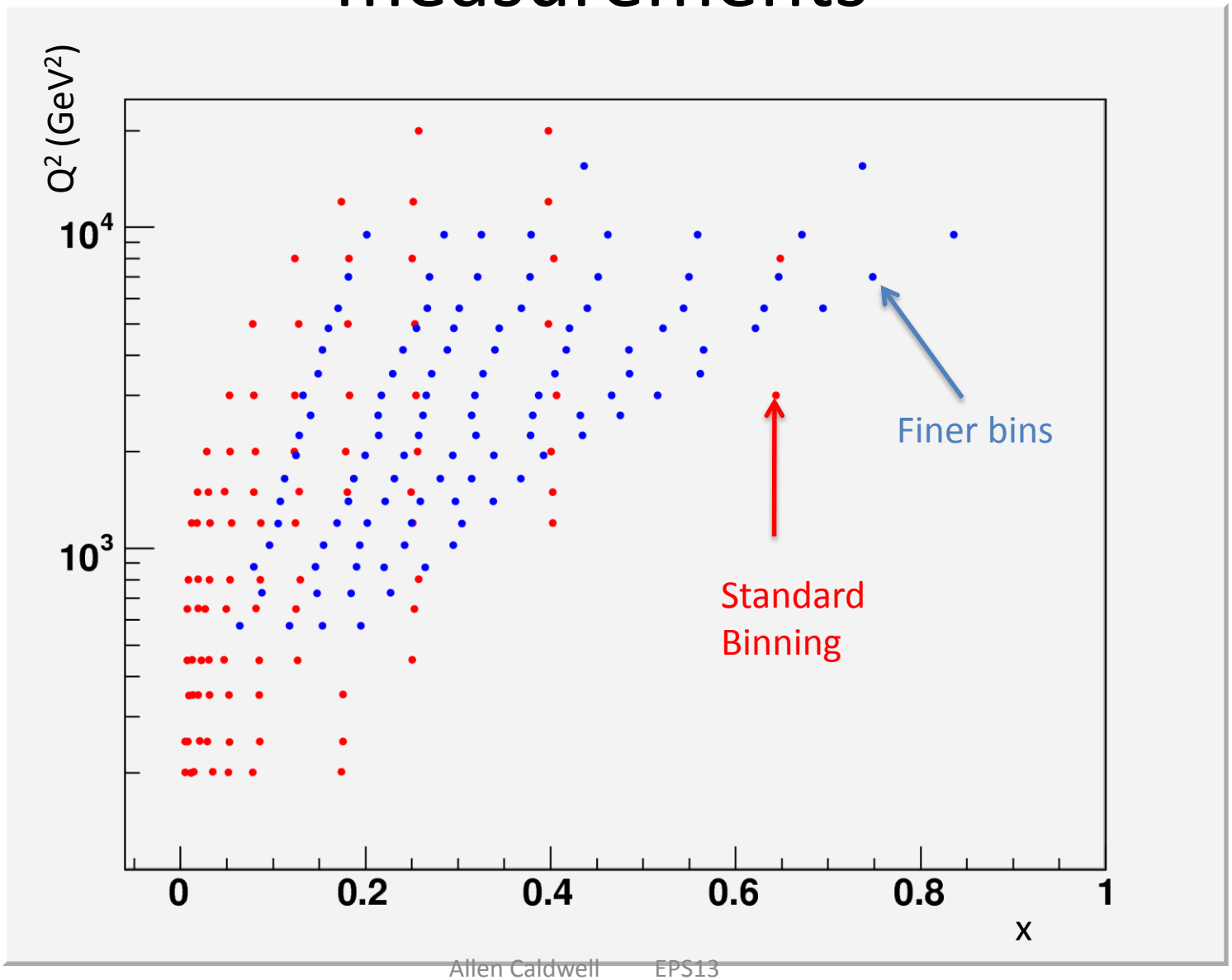
No jet found

$x>x_{Edge}$

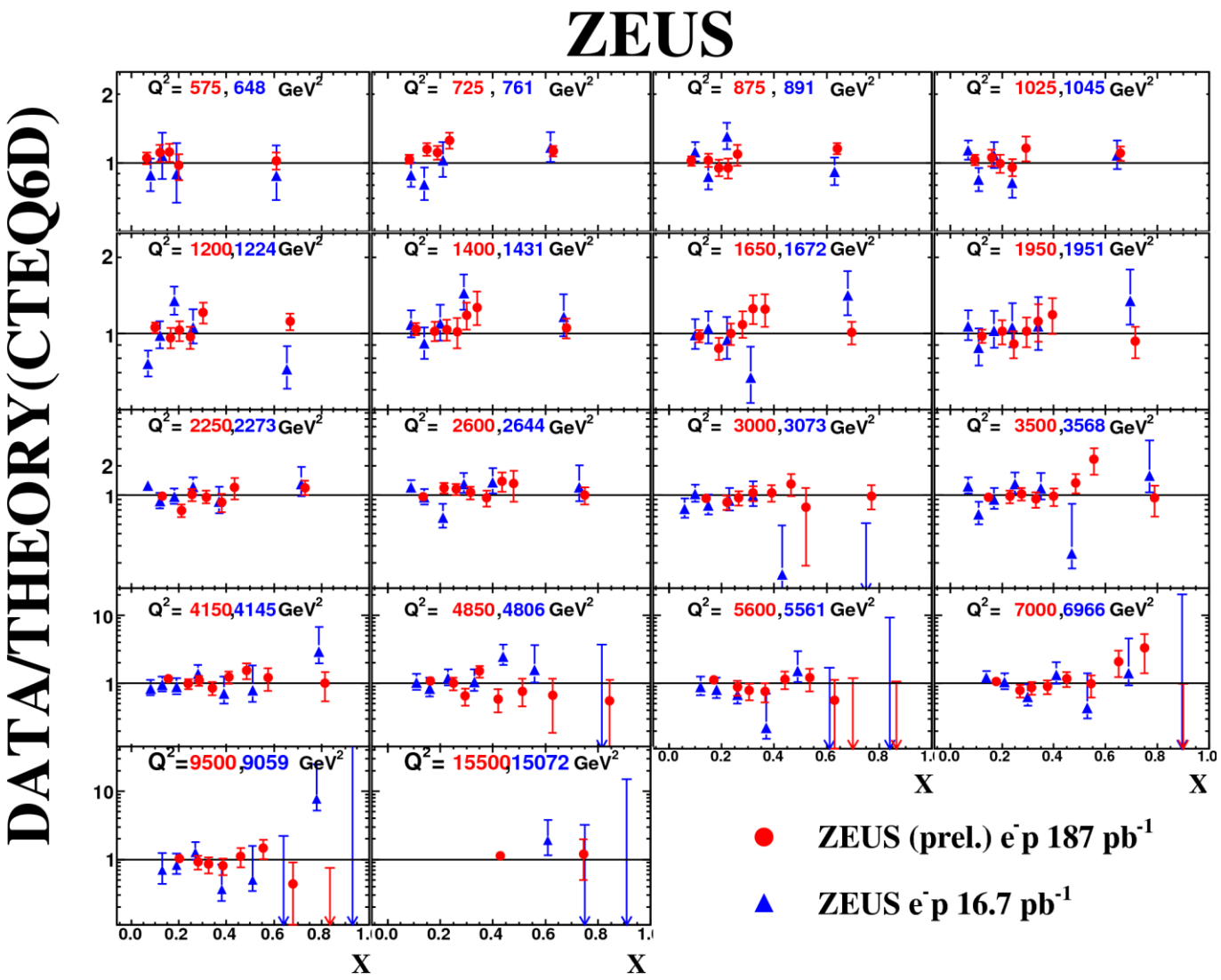


Jet definition: E_T>10 GeV, θ_{jet}>0.12only 0,1 jet events used

Fine-grained cross section measurements

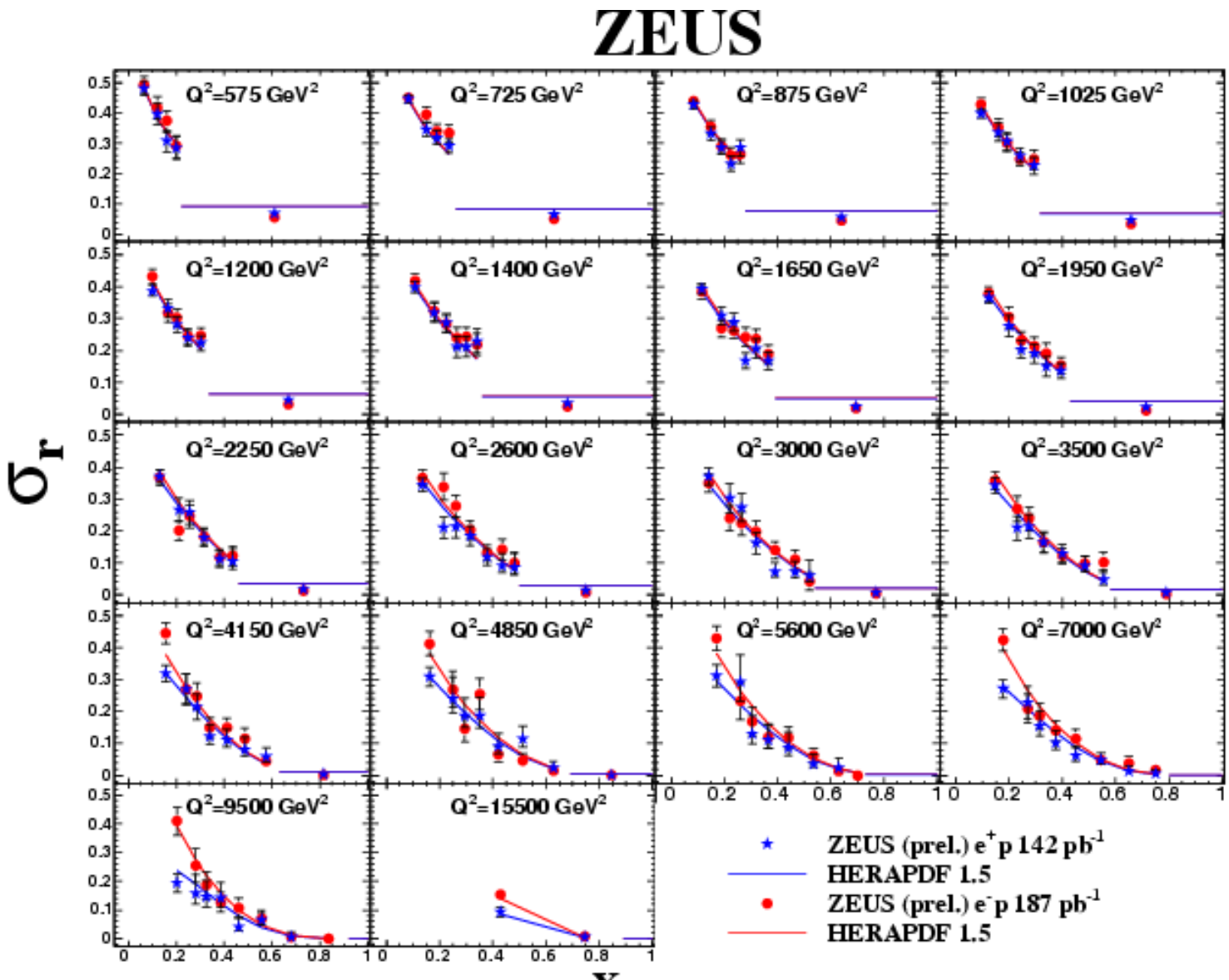


Comparison to published results



Good agreement – much more precision

Comparison e^+P and e^-P



Fine –grained cross section data at high-x should help constrain form of pdfs.

Summary

• High Q^2 inclusive cross section measurements from ZEUS are complete

- these data will be part of the combined HERA II data on high Q^2 DIS

- will be part of combined H1/ZEUS pdf fits

• Fine-grained cross section measurements at high-x are progressing; should yield new constraints on form of pdfs at high x.