Zeus UK Status Report
— Part II —

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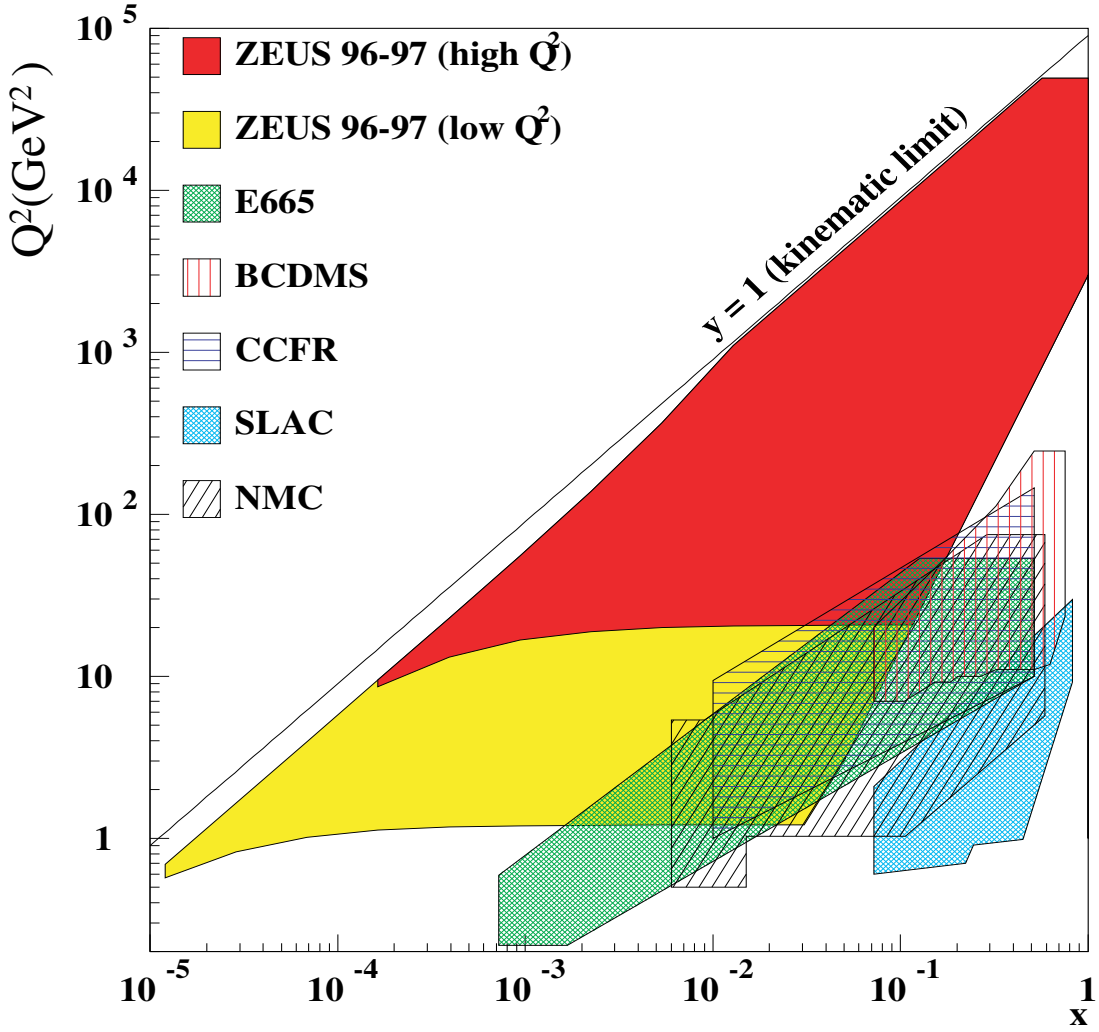
15th May 2000

- Physics activities.
- Post-upgrade physics opportunities with polarised beams.
- Polarimeter upgrade.

HERA Kinematic Plane

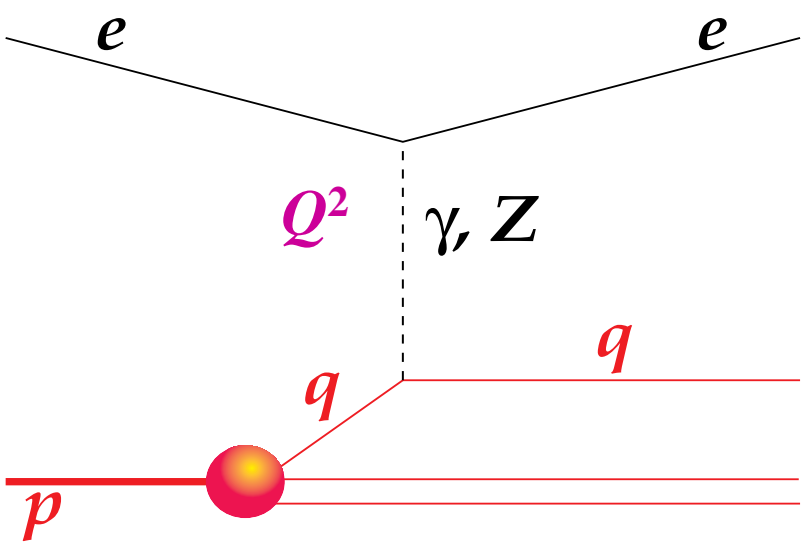
- High Q^2 and x region probed.
- Overlap with fixed target data.



Deep inelastic scattering

Neutral Current

Photon/Z exchange

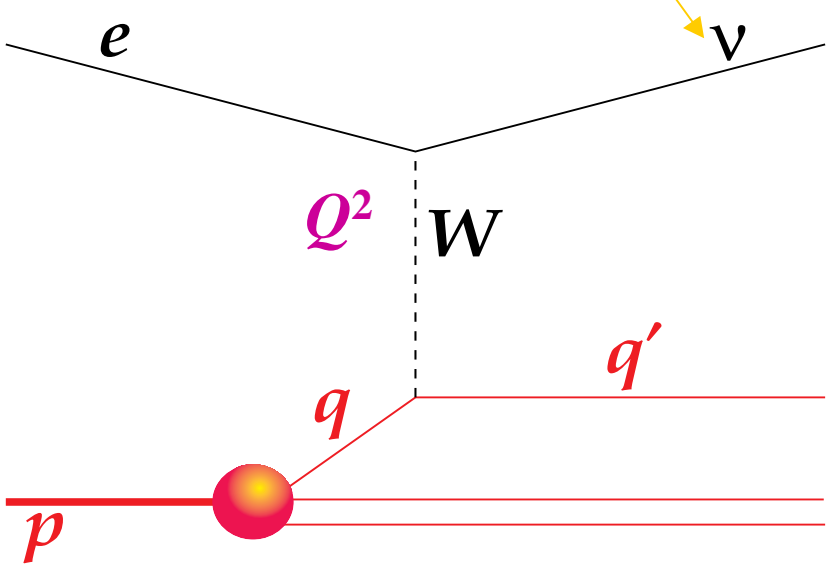


$e^{\pm}p$: **All flavours contribute**

Charged Current

W exchange

`invisible`⇒ Missing P_T



$e^{+}p$: d, s and $\bar{u}$, $\bar{c}$

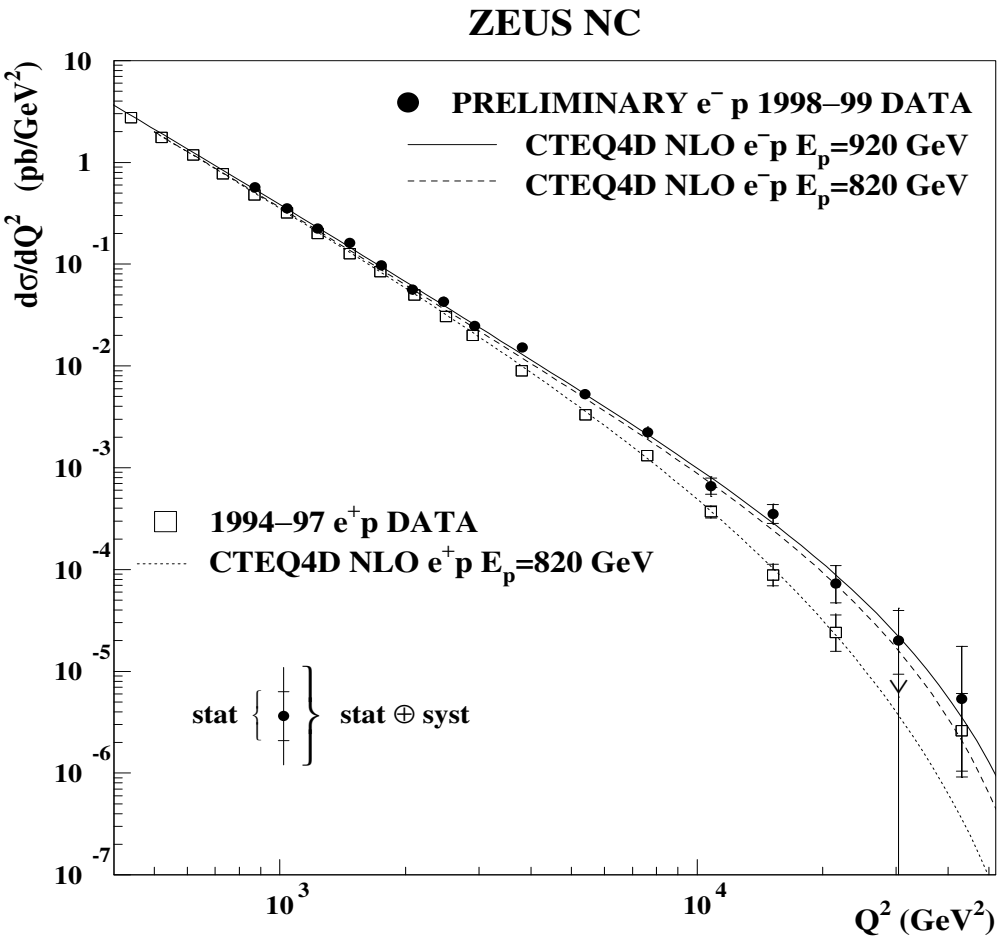
$e^{-}p$: u, c and $\bar{d}$, $\bar{s}$

NC cross section

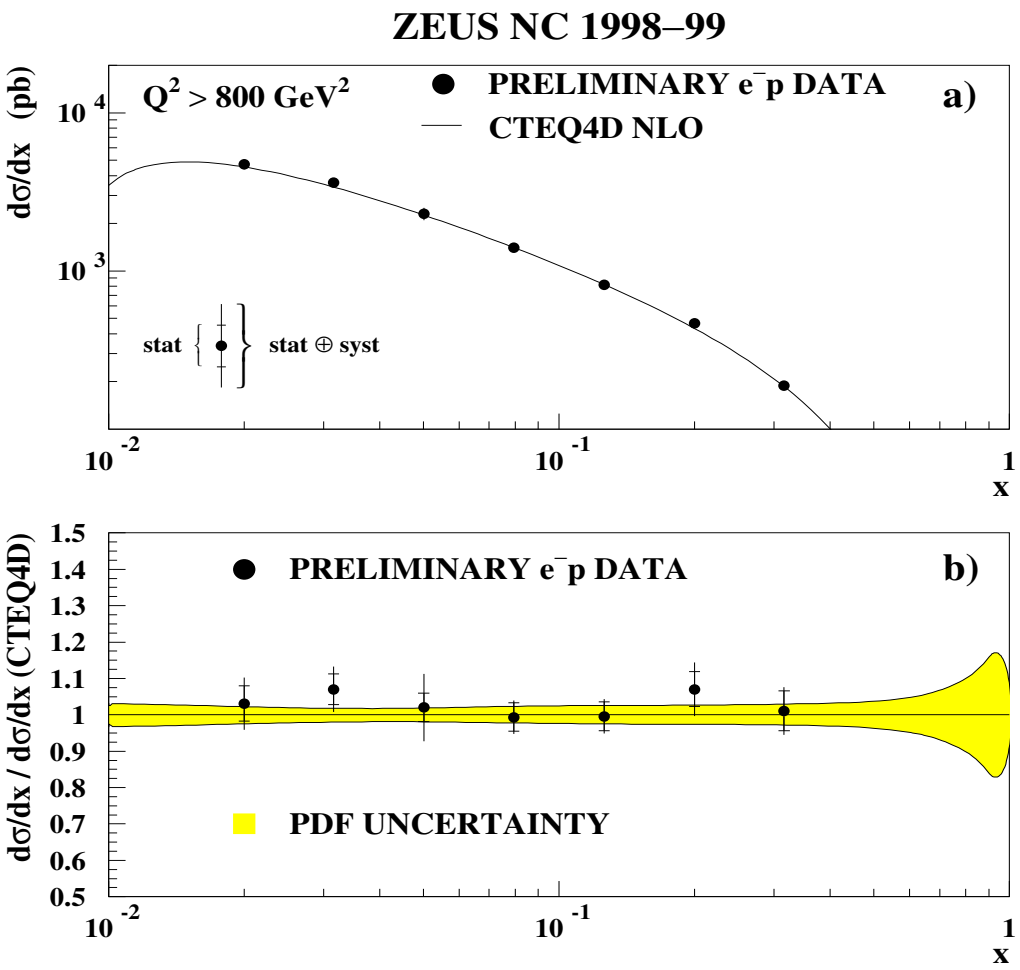
$$\frac{d^2\sigma^{NC}_{Born}(e^{\pm}p)}{dxdQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left[Y_+ F_2^{NC}(x,Q^2) \mp Y_- xF_3^{NC}(x,Q^2) - y^2 F_L^{NC}(x,Q^2)\right]$$

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

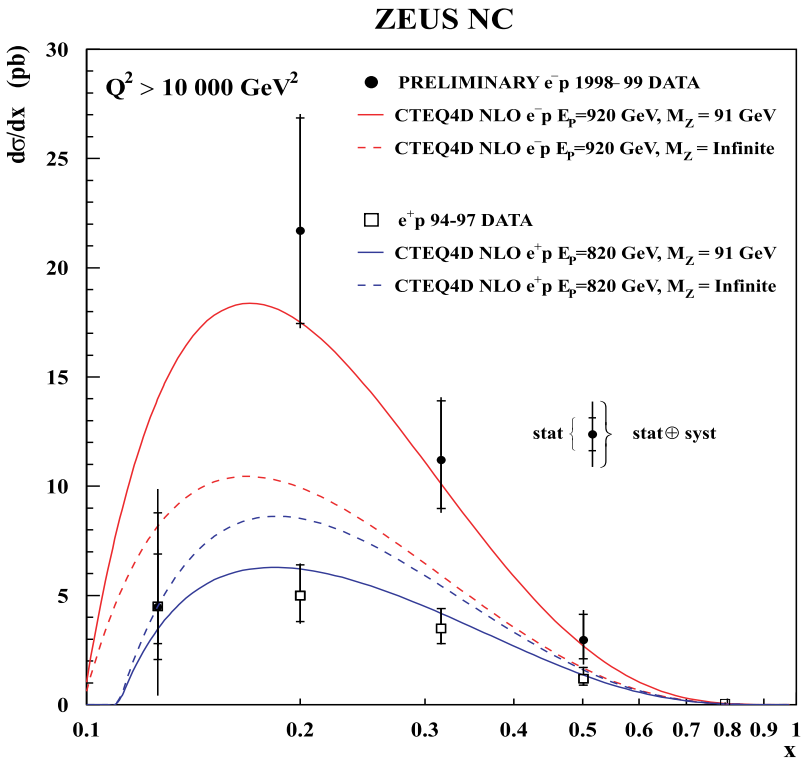
- e^+p & e^-p data.
  - 48pb^{-1} e^+p (94-97)
  - 16pb^{-1} e^-p (98-99)
  - $\sigma(e^-p) > \sigma(e^+p)$
  - Good agreement with SM over 6 orders of magnitude.



NC: dσ/dx

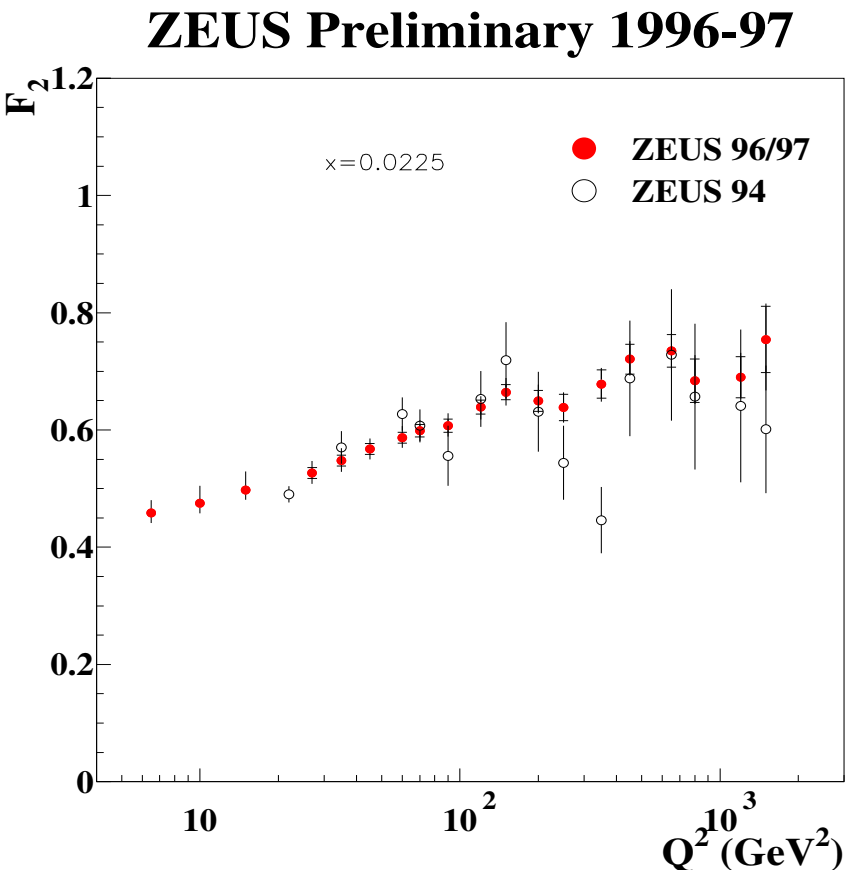


- Agreement with SM
- Zγ interference at High-Q^2

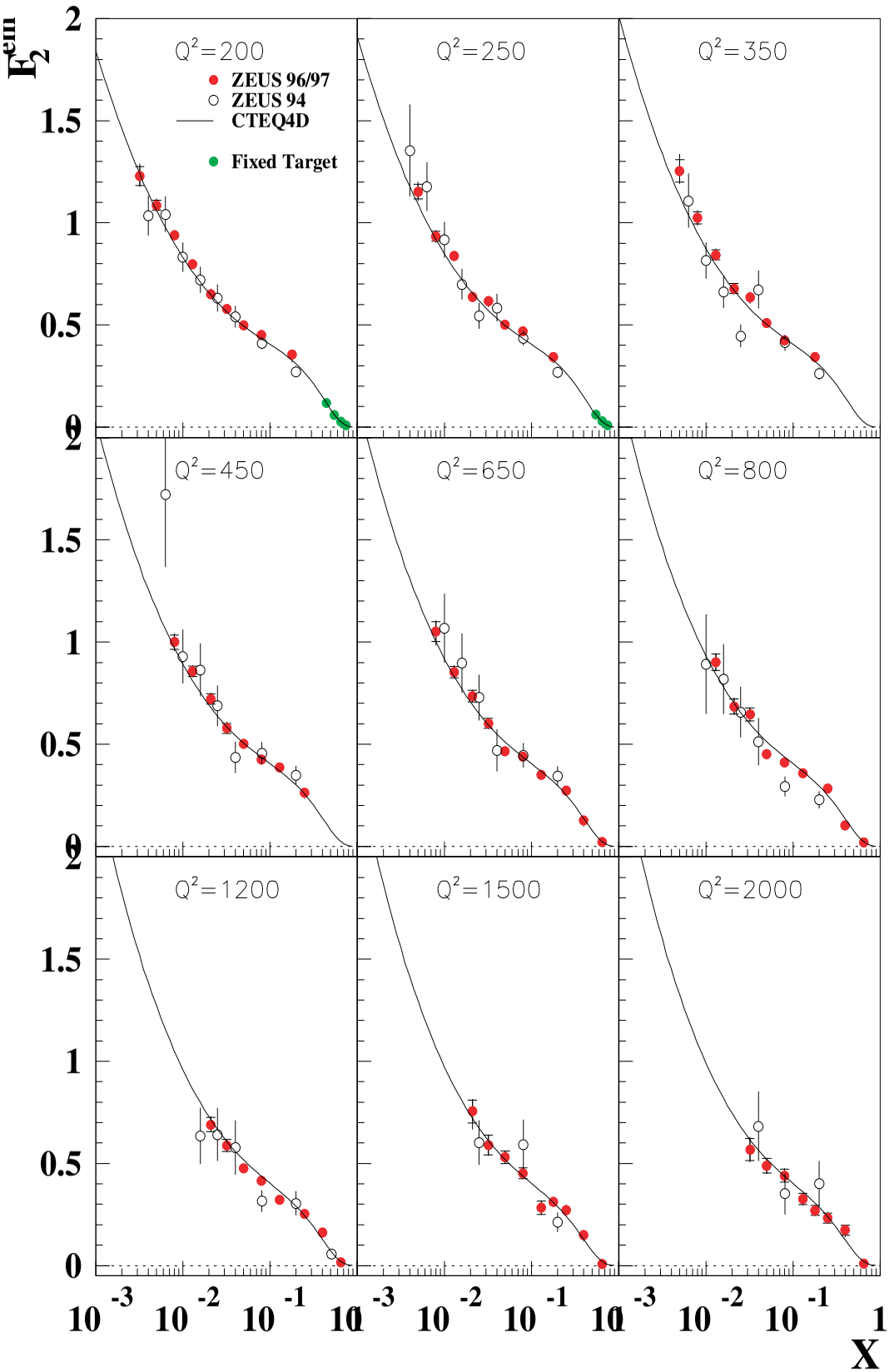


F_2

- 94 F_2
  - QCD fits
  - Strong scaling violations
- New 96/97 F_2
  - 12x published lumi
  - Improved precision at high-Q^2
  - Extend to higher-x at high-Q^2.

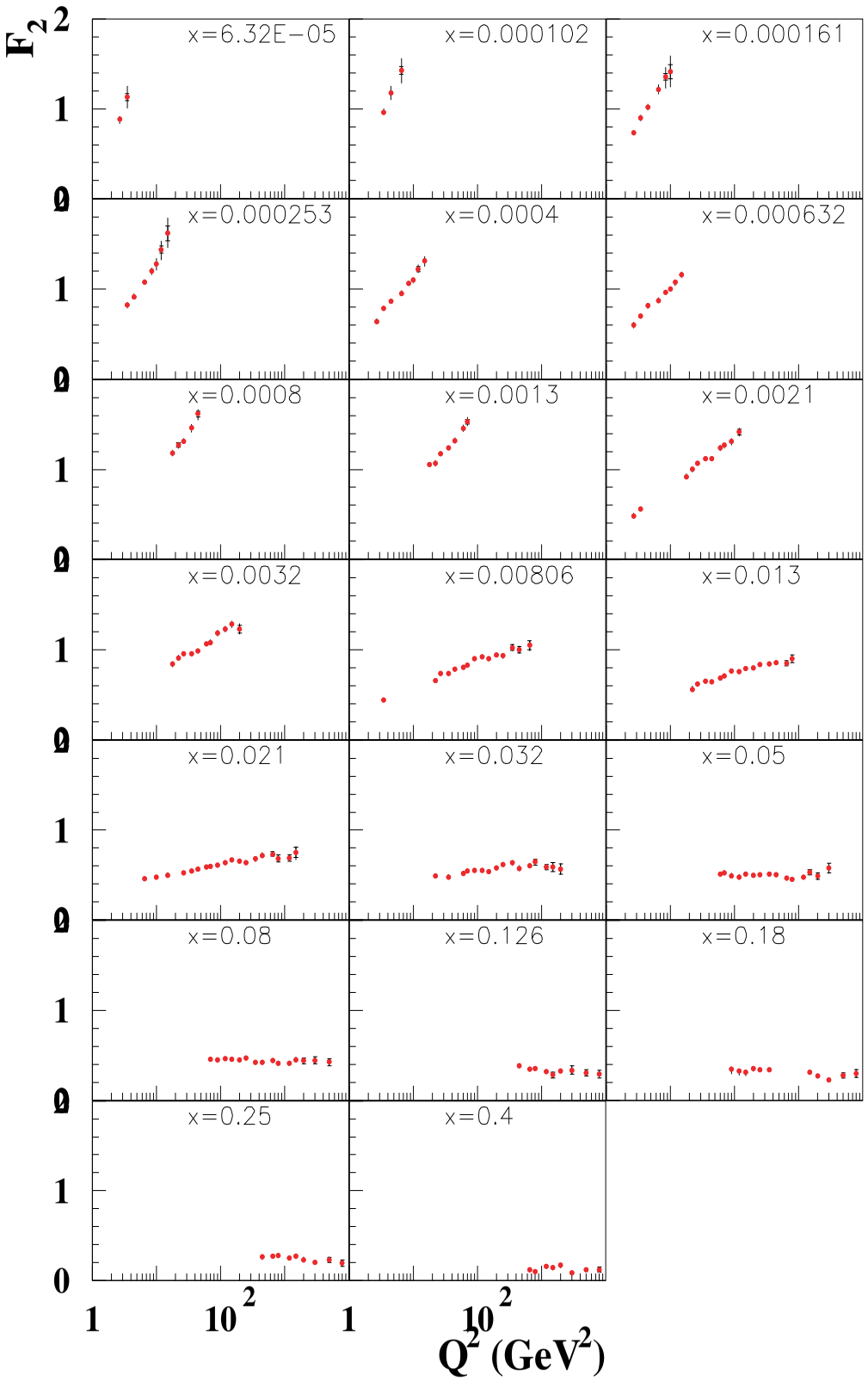


ZEUS Preliminary 1996-97



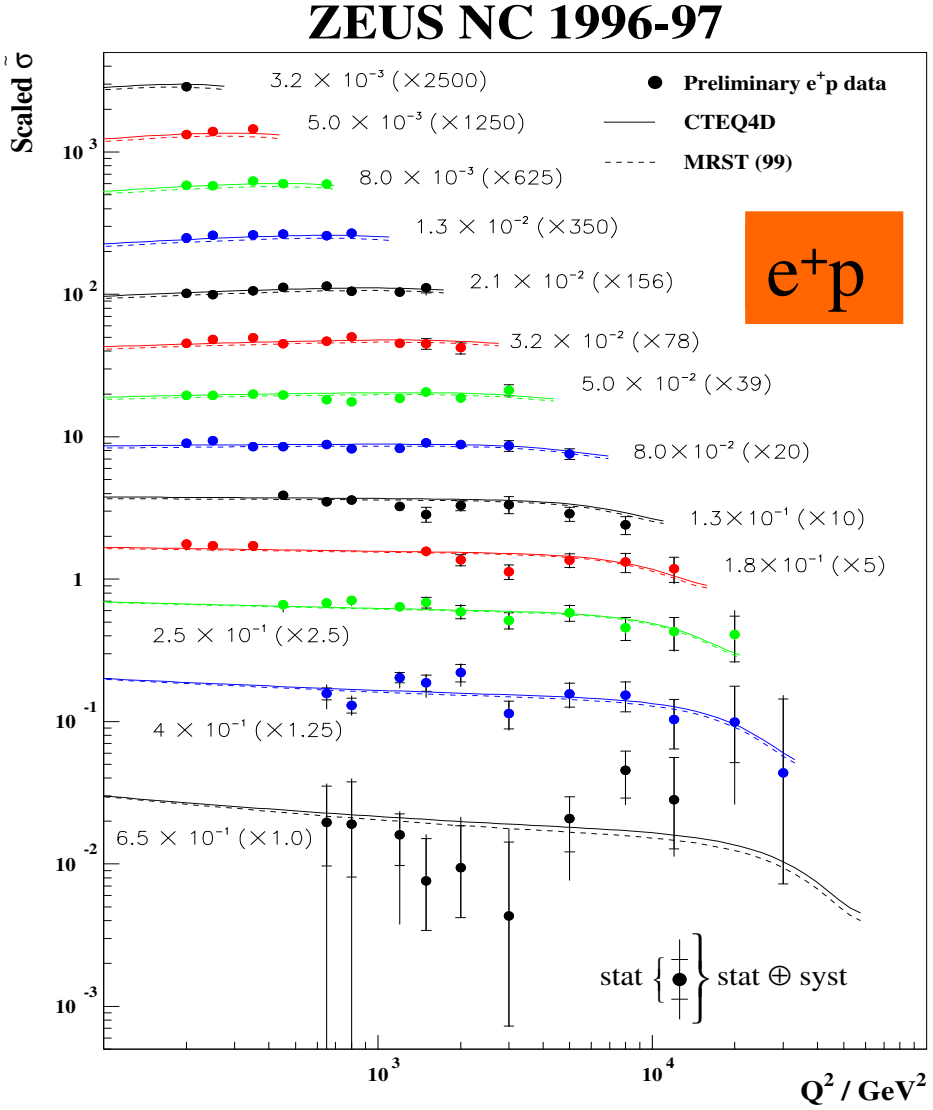
Rise of F_2 at low x measured with high precision.

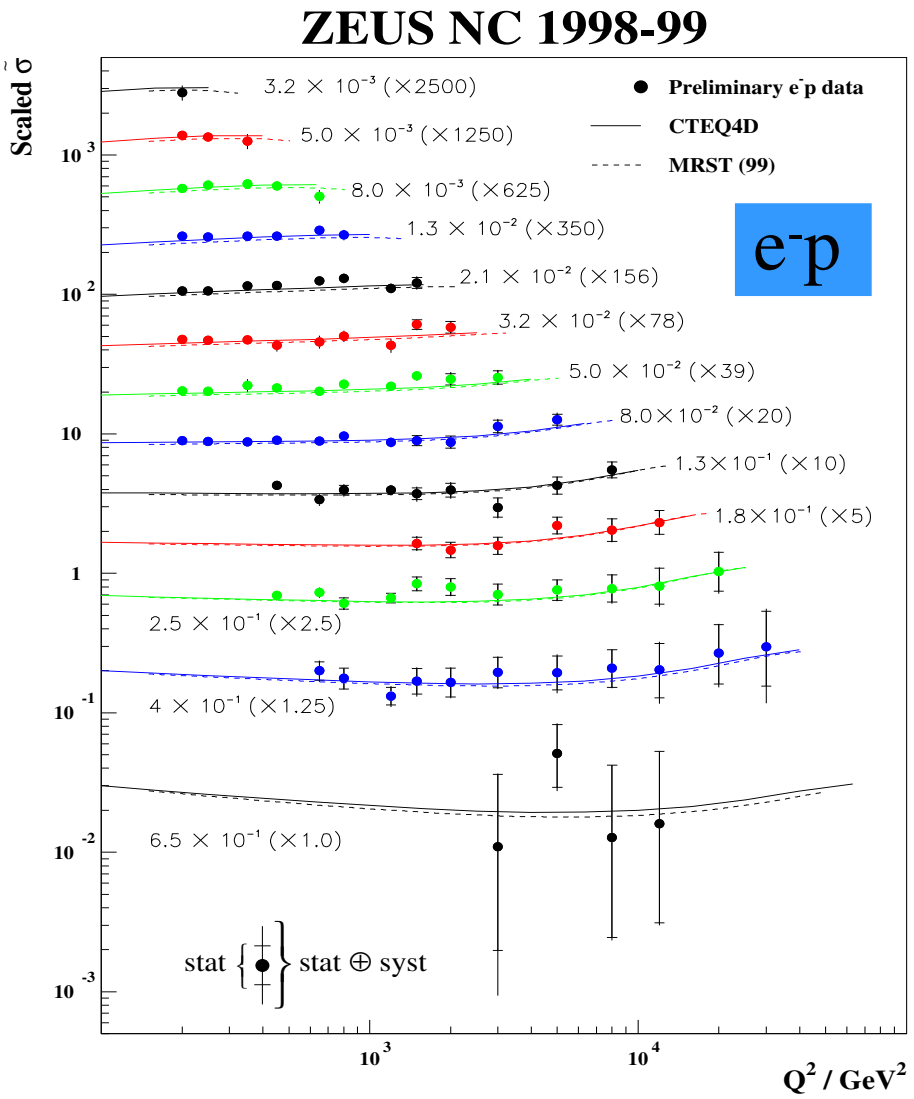
ZEUS Preliminary 1996-97



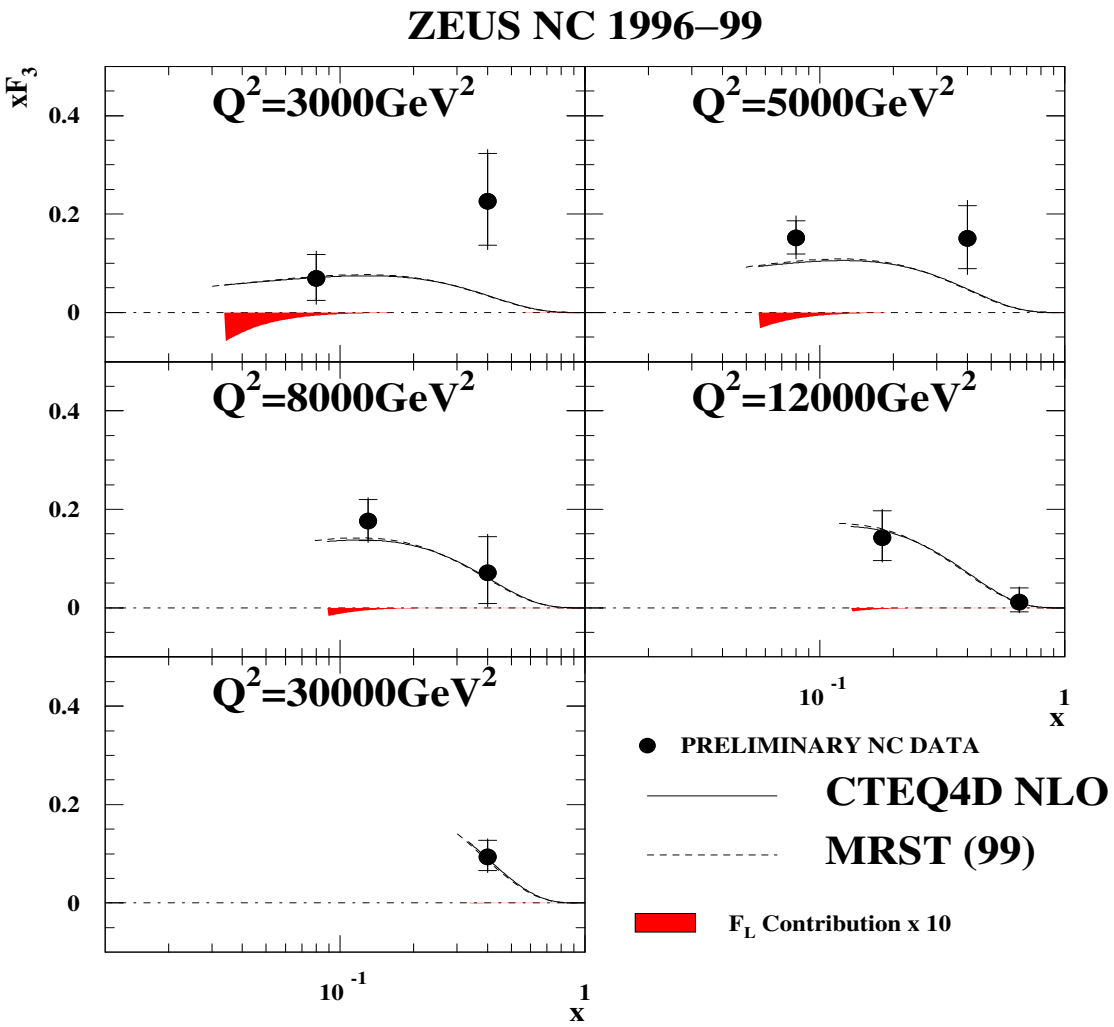
Strong scaling violations

Double differential cross sections





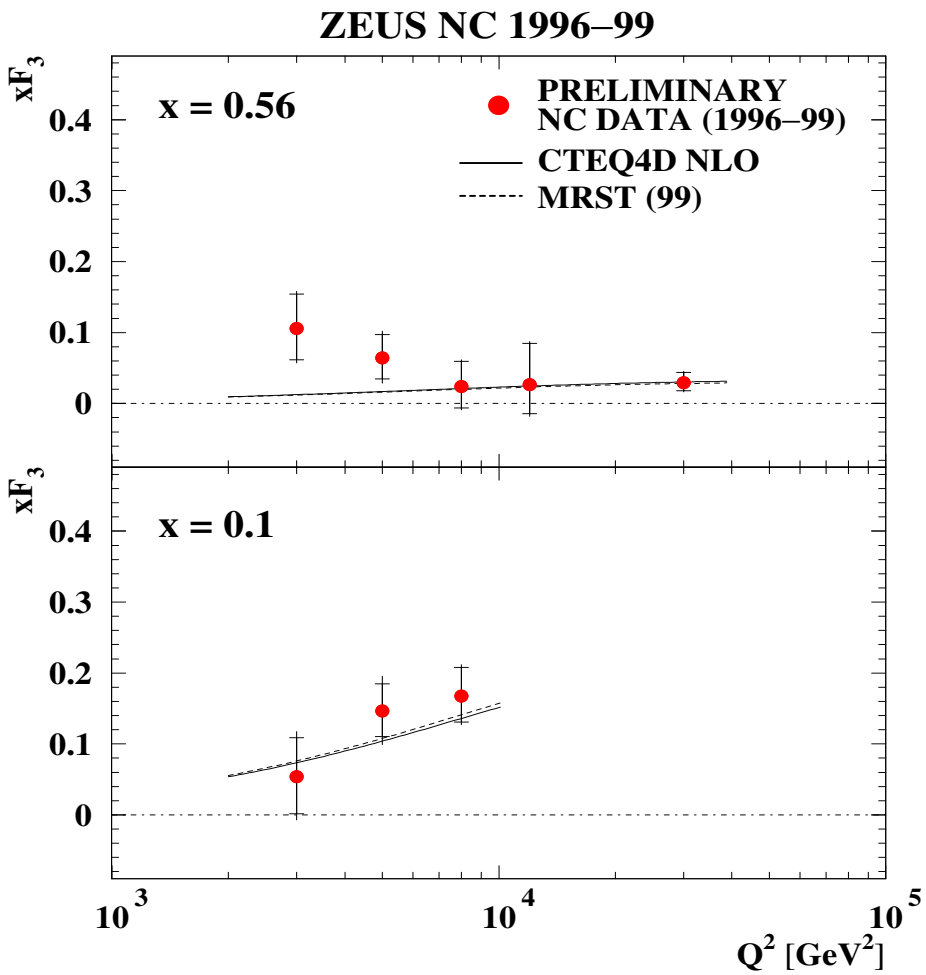
First extraction of xF_3 at high-Q^2 and x.



- Precision comparable to first F2 extraction.
- F_L contribution is negligible.
- Sensitive to valence quarks at high-x.

First extraction of xF_3 at high-Q^2 and x.

- Can extract α_s from the slope.
- Much improved precision after upgrade.



Charged Current

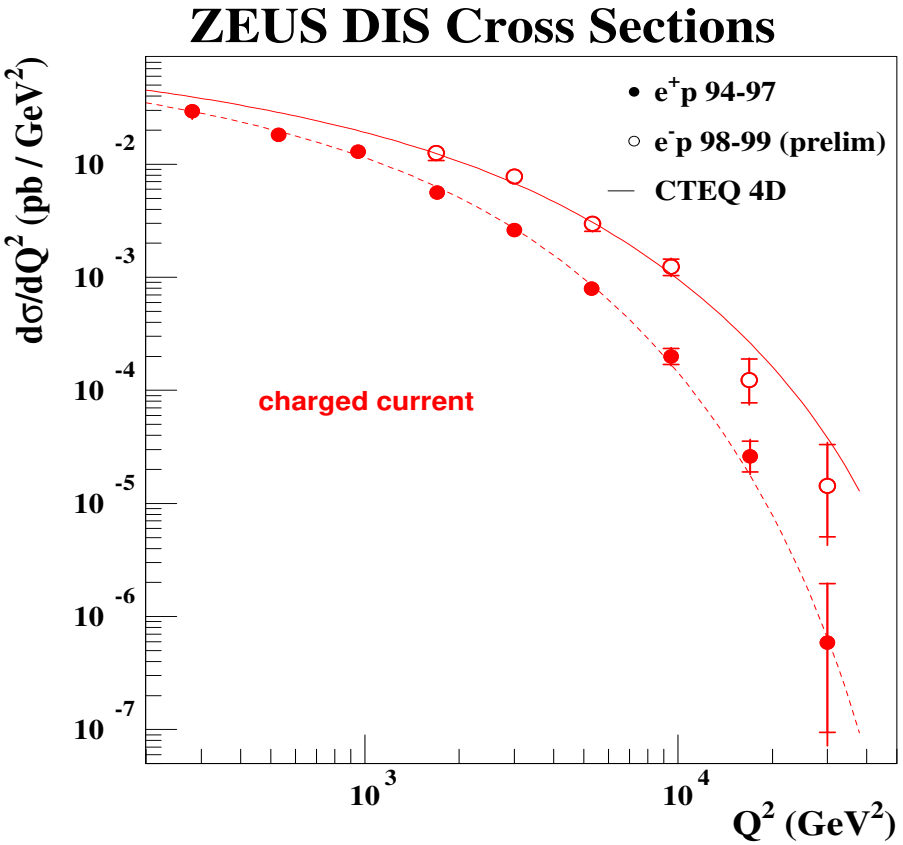
e^+p $\quad \dfrac{d^2\sigma_{CC}}{dxdQ^2} \propto x\left[(\bar{u}+\bar{c})+(1-y)^2(d+s)\right]$

Sensitive to quark flavours. → **Valence d probed.** → **d/u ratio**

u unsuppressed

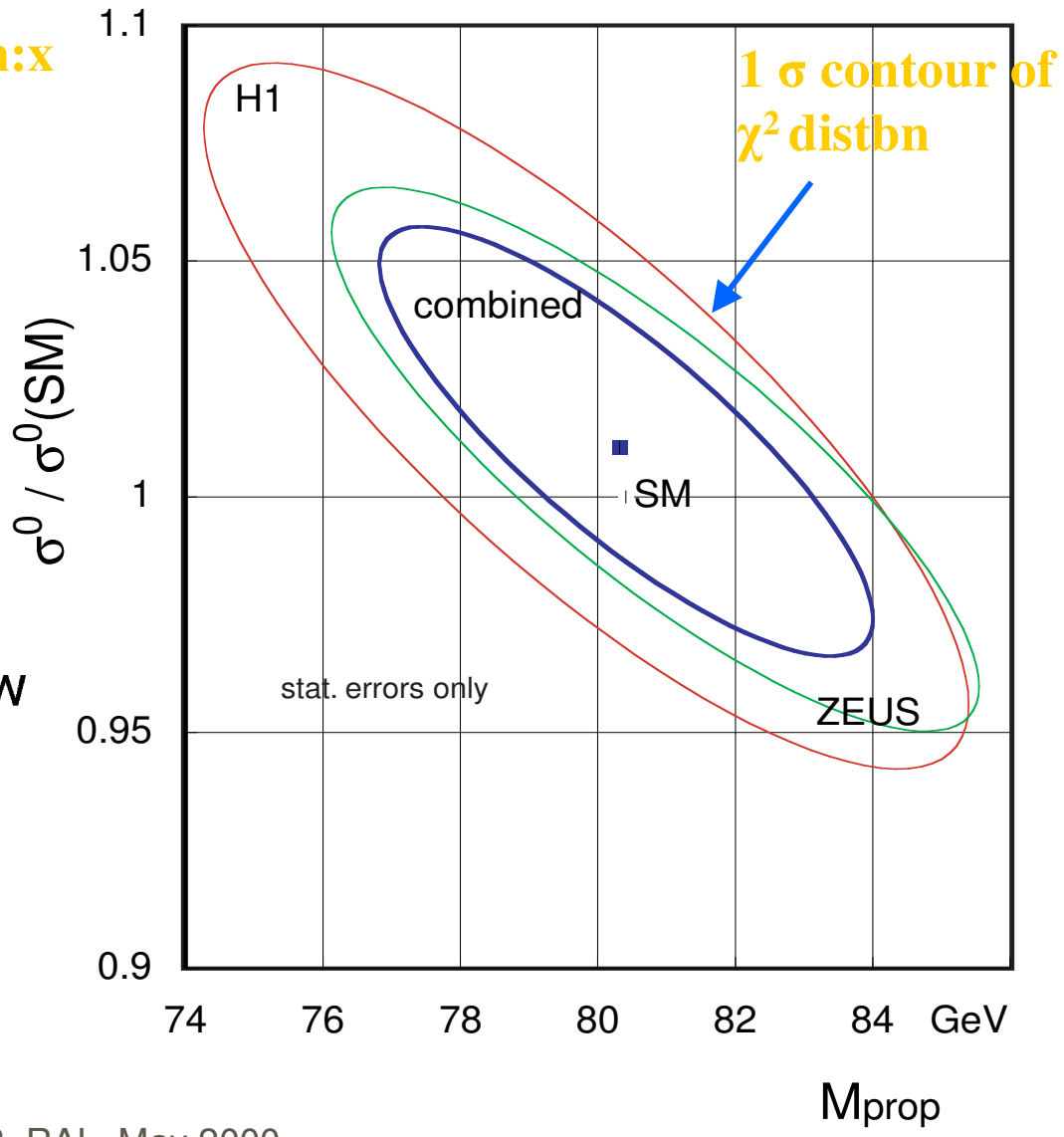
e^-p $\quad \dfrac{d^2\sigma_{CC}}{dxdQ^2} \propto x\left[(u+c)+(1-y)^2(\bar{d}+\bar{s})\right]$

$$\frac{d\sigma_{CC}}{dQ^2} \propto G_\mu^2\left[\frac{M_W^2}{Q^2+M_W^2}\right]^2 \rightarrow M_W$$

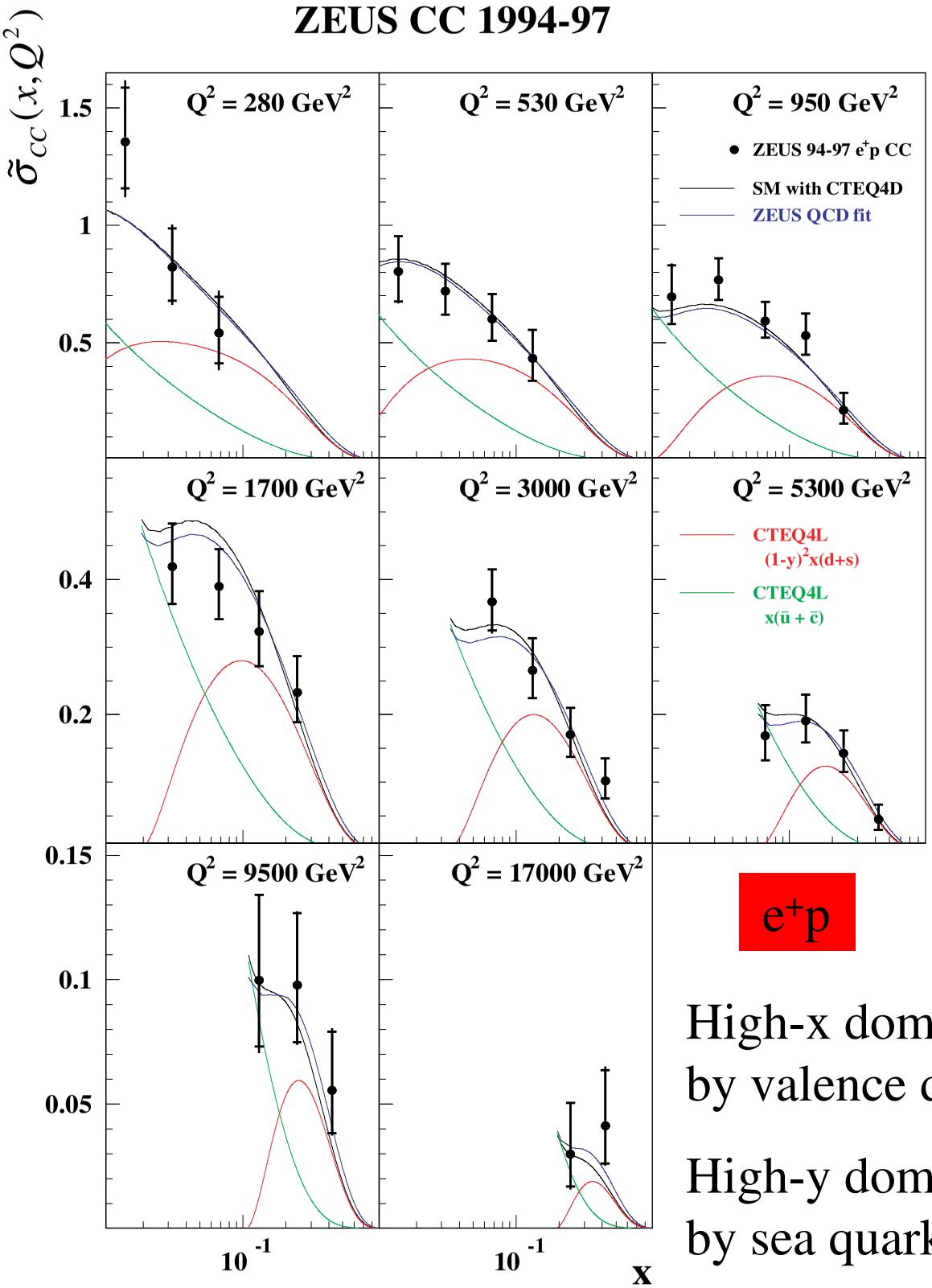


M_w measurement

- Fit normalisation and shape.
- Direct measurement of M_w in space-like region.



Double differential cross section



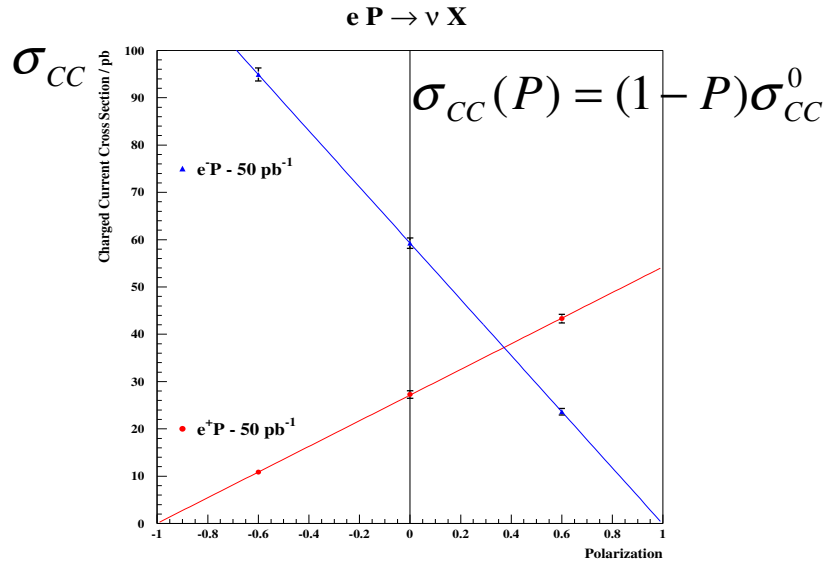
e$^+$p

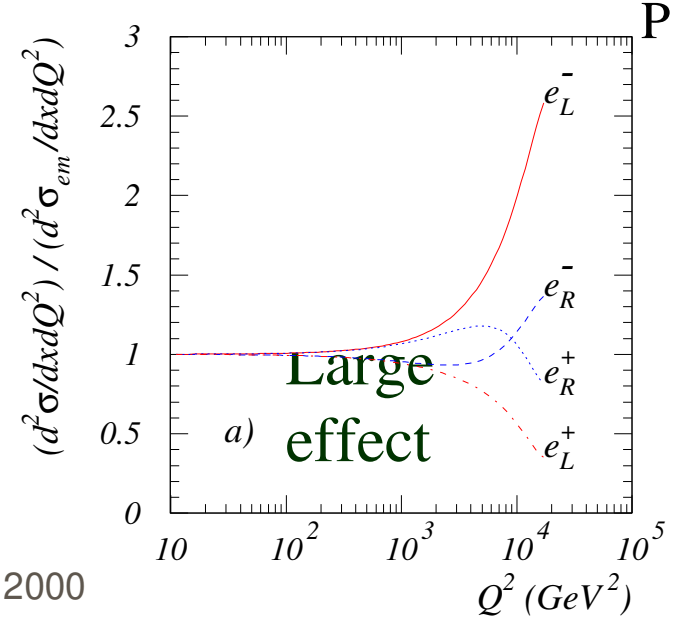
High-x dominated by valence d quarks.

High-y dominated by sea quarks.

Future Physics:- Lepton Polarisation

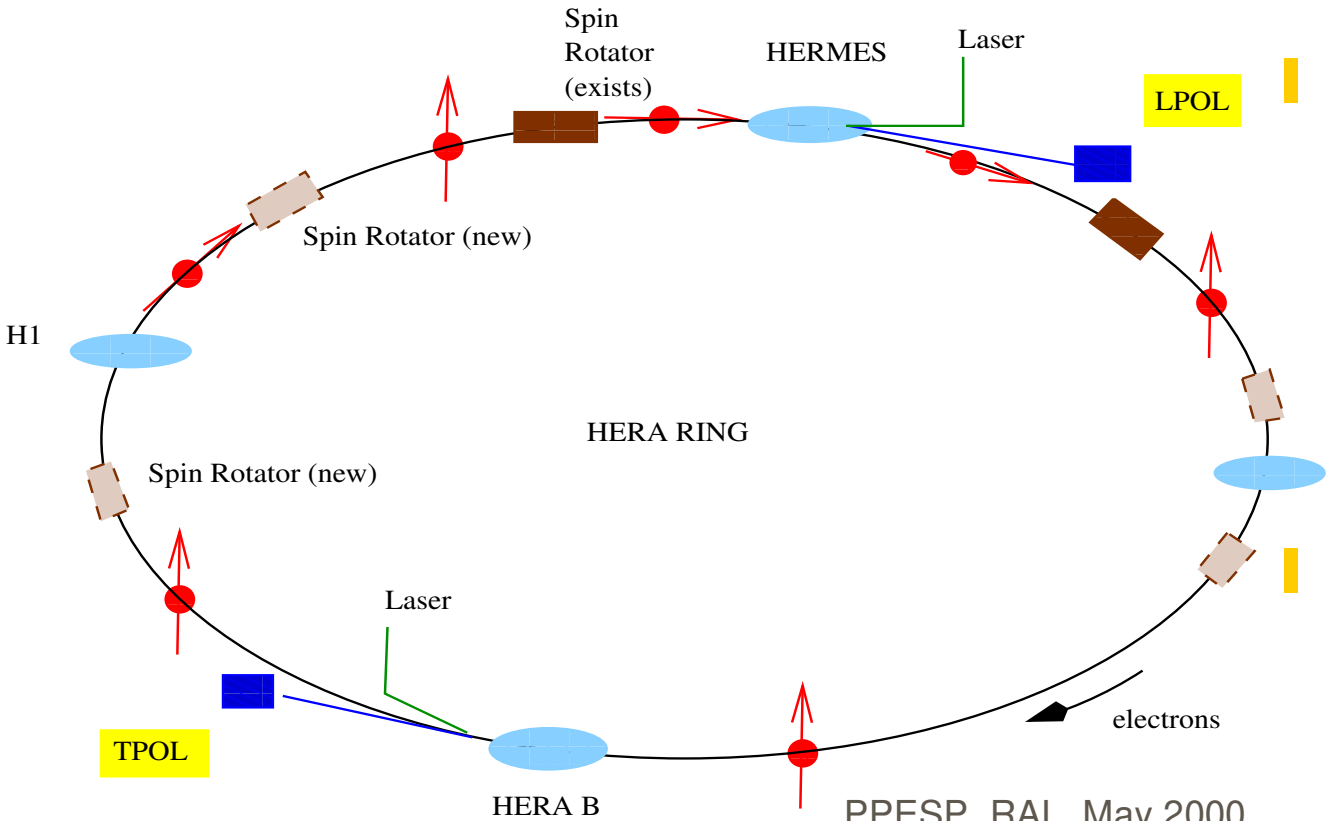
- Parity violation in CC
  - SM $e^-_L\, p \rightarrow \nu\, X$ $\quad$ $e^-_R\, p \not\rightarrow \nu\, X$
  - RH W^- limit Mw>400GeV
- Light quark couplings
  - Fits to NC&CC cross sections for R&L pol.
- Polarisation measurement.
  - Require 1-2% precision
  - Currently only 4%





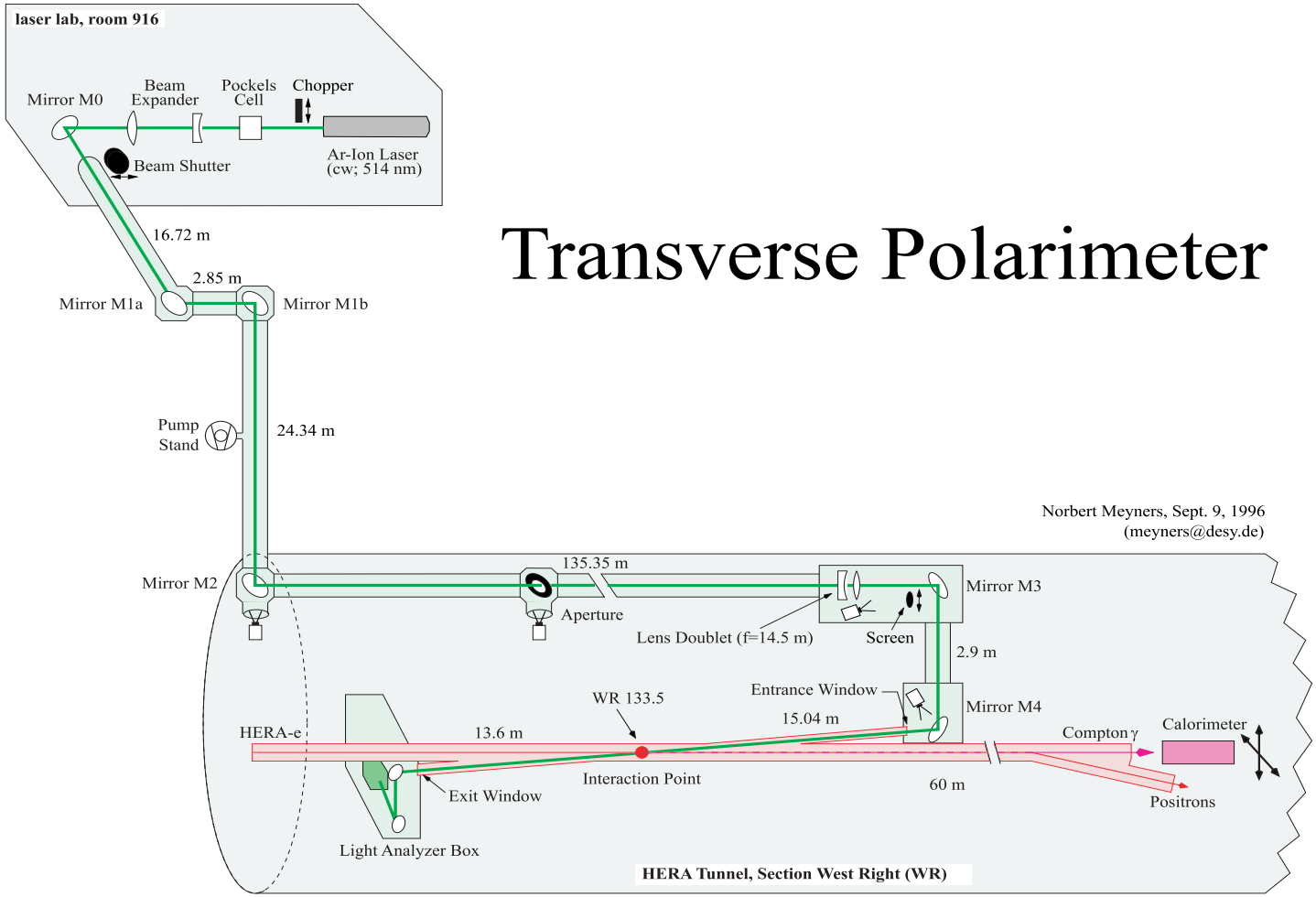
Polarimeter

- Longitudinal &Transverse POLs exist.
  - Circularly polarised laser shone on lepton beam.
  - Detect back-scattered compton photons.



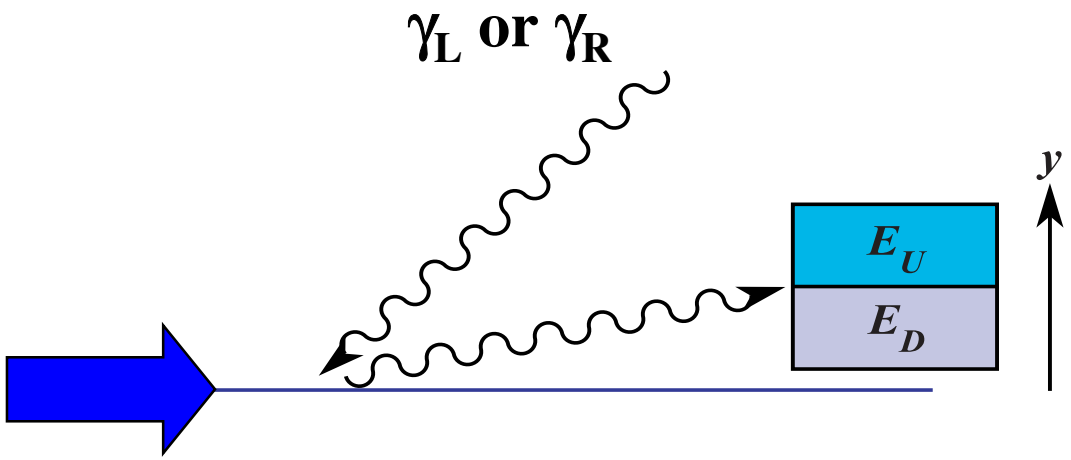
- TPOL- uses up/down asymmetry between L&R circularly polarised laser to measure lepton polarisation.
- Can improve TPOL.

TPOL



Transverse Polarimeter

Vertical asymmetry ⇒ Polarisation

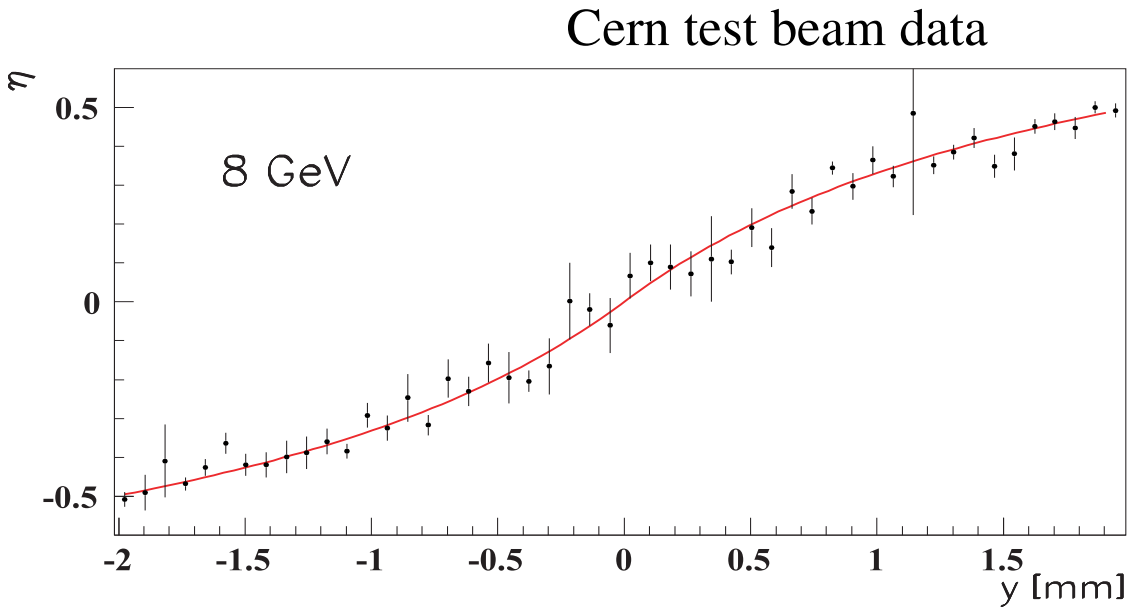


$$P = \left(\langle y \rangle_L - \langle y \rangle_R \right) \mathrm{K}_\eta$$

From angular dependence of polarised compton scattering.

- $\langle y \rangle_{L,R}$ determined from E_U - E_D

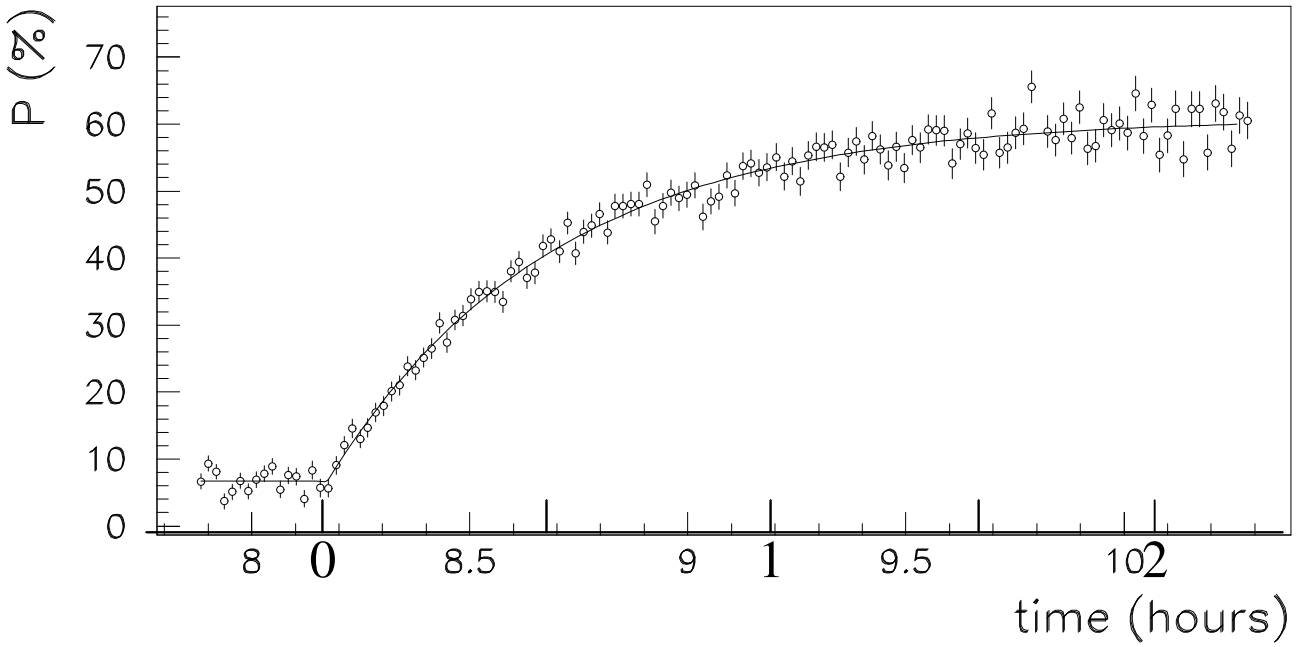
$$\eta_v(y) = \frac{E_U - E_D}{E_U + E_D}$$



- K_η determined polarisation rise-time data in 'flat-machine'.
- $\eta_v(y)$ key input

Calibration

- Currently:
  - **Fit to rise time in `flat-machine' gives $P_\infty \Rightarrow$ extract K_η**
  - **Dominant uncertainty in K_η comes from $\eta_v(y)$**

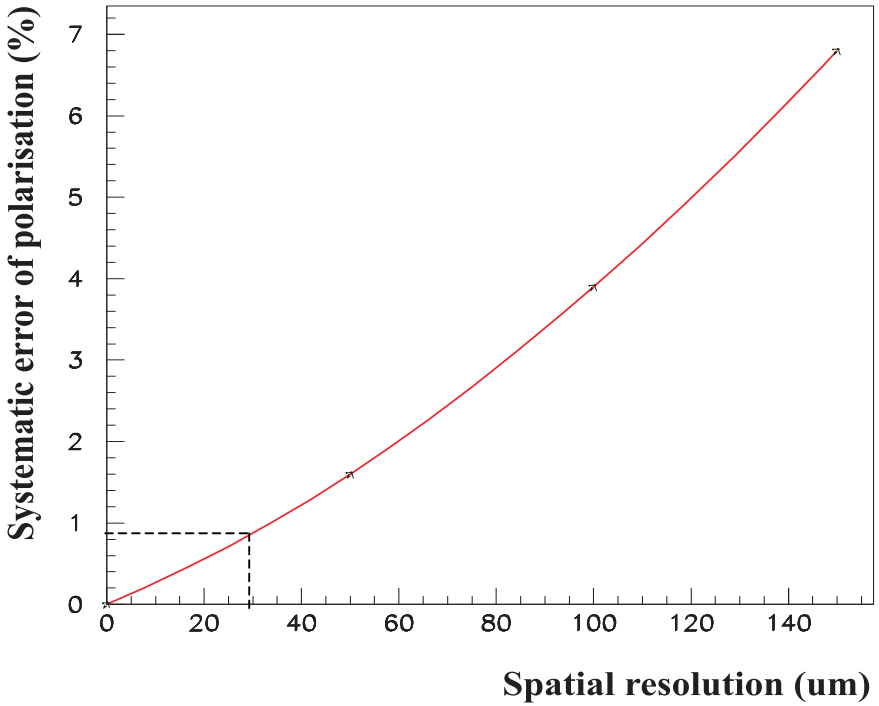


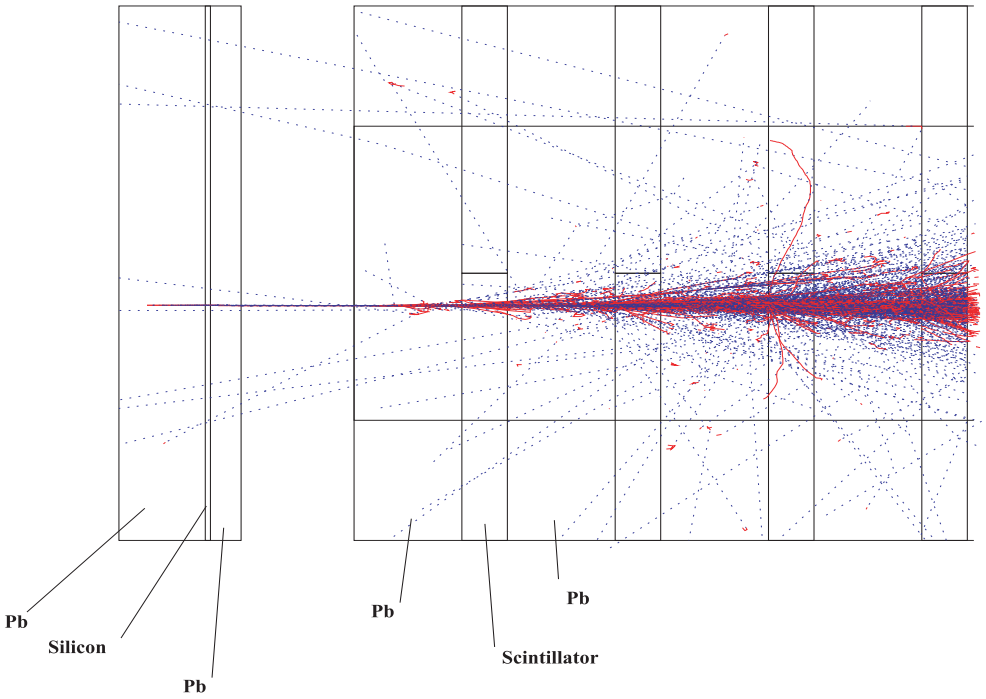
$\Rightarrow$

In-situ, real-time measurement of $\eta_v(y)$ will reduce systematic error

Position sensitive detector

- Give precise position of TPOL calorimeter in real time in situ.

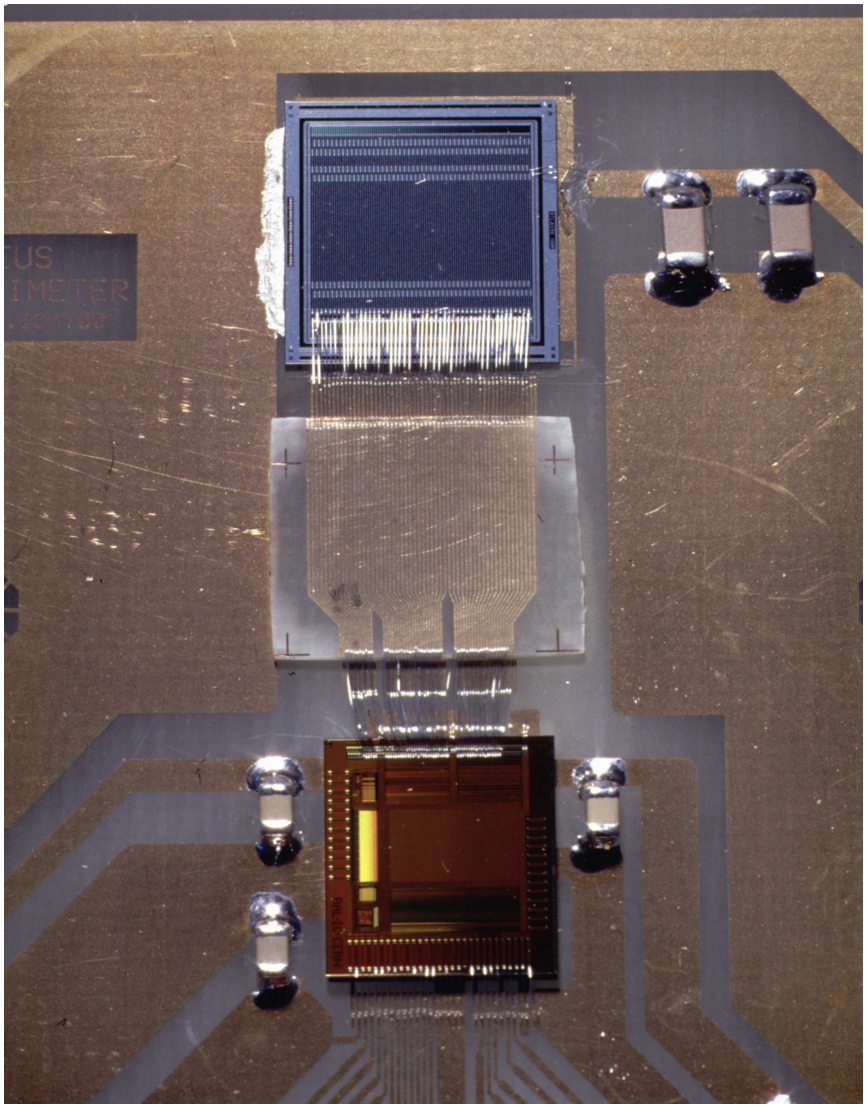




- **Minimise systematic error by making a real-time determination of $\eta_v(y)$**

Silicon detector

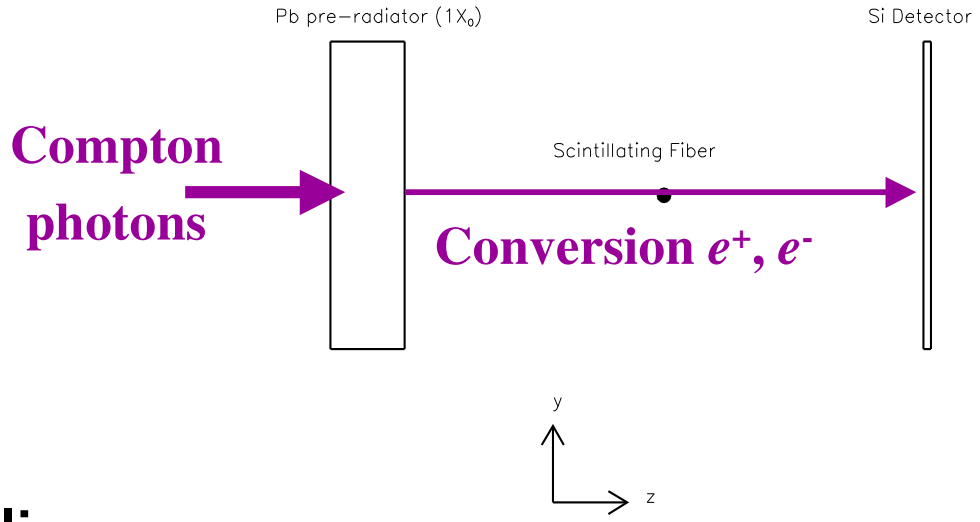
- **Preparation & procurement of electronics for silicon detector test complete.**
- **Test stand is ready at Imperial.**
  - **Silicon detector on the front-end board works.**



Silicon Position Calibration

- Intense Compton beam.
  - Radiation hard silicon and chips.
  - But characteristics may change.
  - Need in-situ calibration.

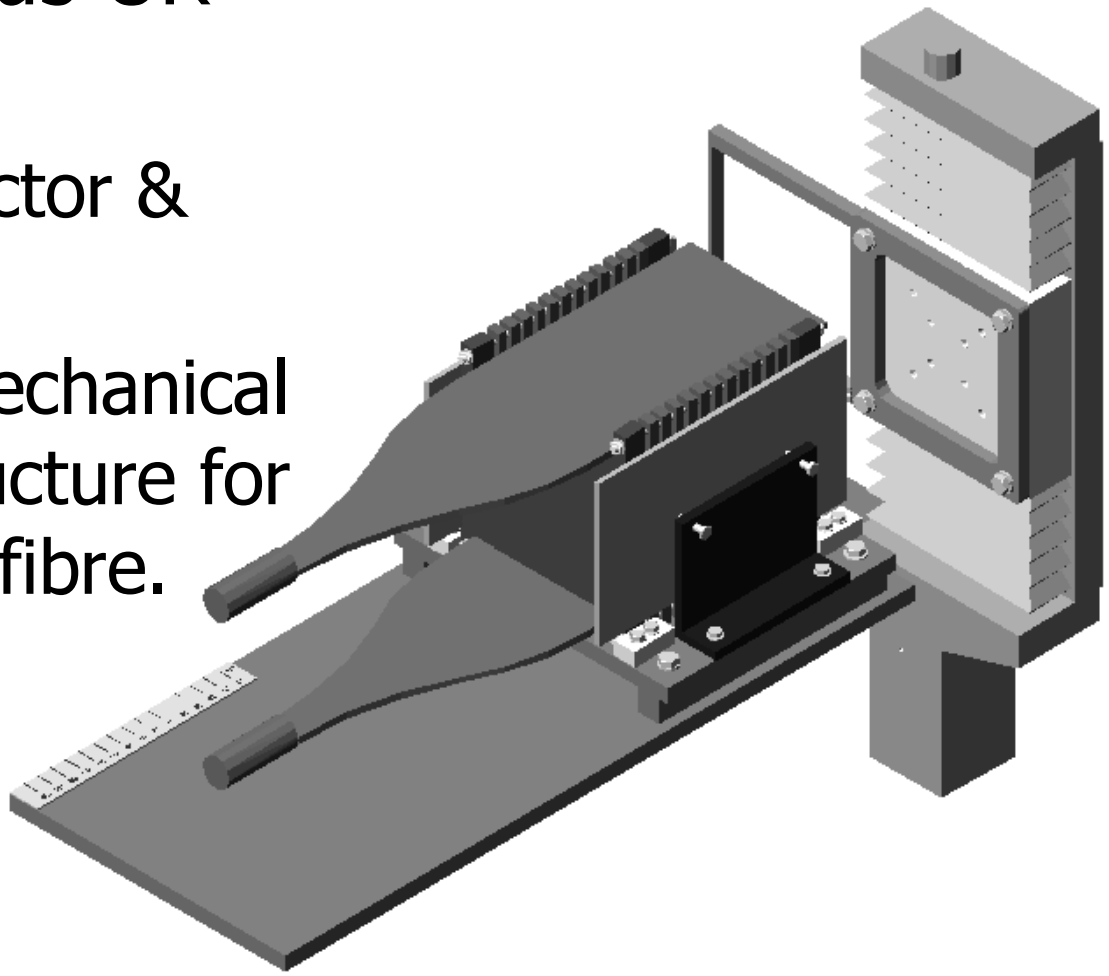
Solution: Scintillating fibre on precision table.



- Periodically scan in y.
- Precisely calibrate the silicon response.
- Better than 20μm

Post-upgrade TPOL

- Proposed Zeus UK contribution
  - Silicon detector & read-out.
  - Precision mechanical support structure for scintillating fibre.



Costing & Manpower

Front-End Electronics	
Two front-end boards(1 spare)	£10,000
Off-Detector Electronics	
VME Crate	£5,500
Processor	£7,500
Modified SEQSI board	£1,000
I2C board	£1,000
Five CAEN V686 (Sirocco) ADCs	£12,500
Precision Mechanics	
Precision stage, supports etc.	£8,000
Sundry	
Readout computer, power supplies, etc.	£5,000
Total	£50,000

- Responsive RA.
- Design and fabricate front-end board.
  - 4 man months.
  - Provided by Imperial College.
- Design and build precision mechanical items.
  - ½ man year .
  - Provided by Imperial College.

Summary of PartII

- Current knowledge of proton & EW physics.
  - Definitive F_2 measurement
  - First measurement of xF_3 at high Q^2 and x.
- Physics after upgrade.
  - Improve xF_3, F_L, M_W measurements.
  - Parity violation, light quark couplings, searches.
- Polarimeter upgrade crucial to these physics goals.

Summary of Resources Requested

- Continued support for Maintenance, Operation and travel for the ZEUS group.
- £55k to complete the UK MVD tasks, including the greatly expanded active patch box.
- £50k for the UK participation in the upgrade of the HERA polarisation measurement.