Polarisation Dependence of the Total CC $e^{\pm}p$ Cross Section

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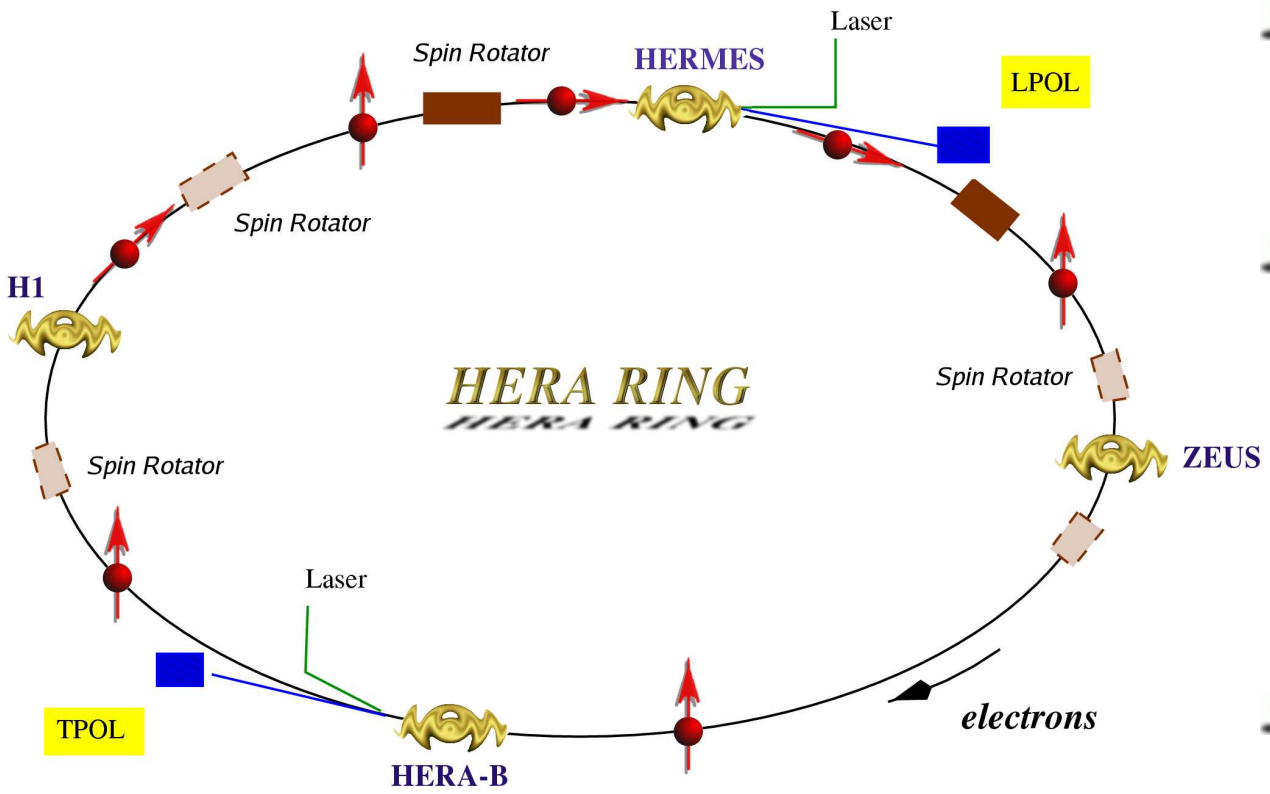
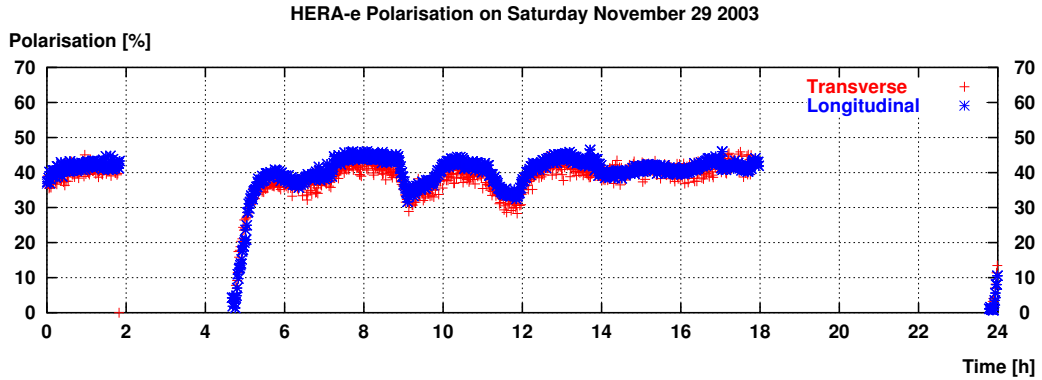
MPIM

DIS 2005, Madison

Longitudinally polarised lepton beam at HERA II





- *Sokolov-Ternov effect → Lepton beam has transverse polarisation*
- *Spin rotator before/after the H1/ZEUS/HERMES detectors*

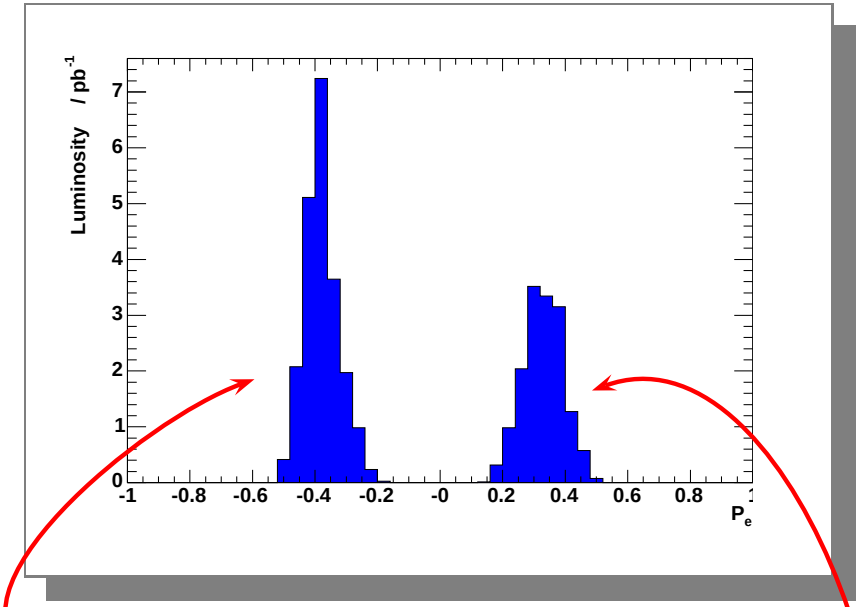
Polarisation:

$$P = \frac{N_{RH} - N_{LH}}{N_{RH} + N_{LH}}$$

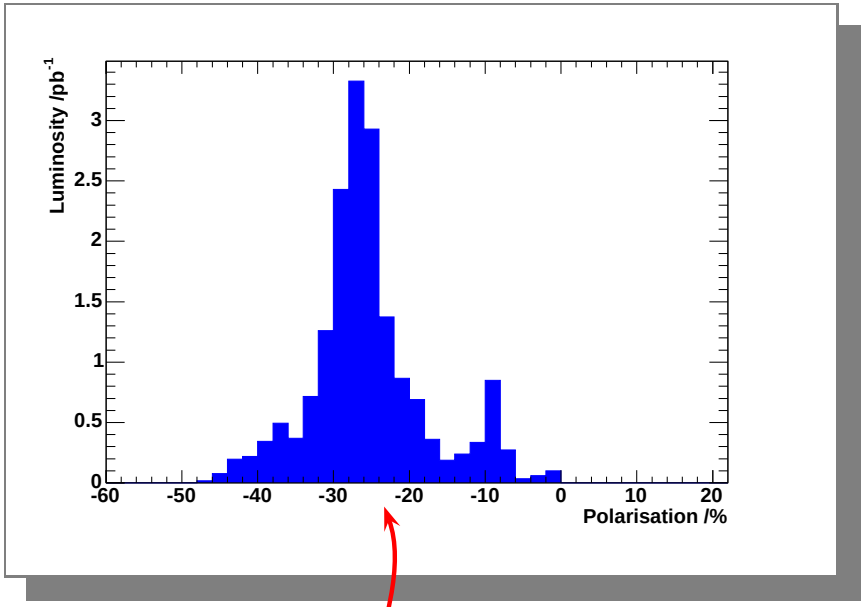
- *Typical HERA II polarisation is 40%, built-up time 30 minutes*
- *Monitoring by two independent Compton polarimeters*

Luminosity and polarisation at HERA II

2003-04: e^+p



2005: e^-p



Negative P:

- $P_e = (-40.2 \pm 0.6)\%$
- *Lumi:* $21.7 \pm 0.6\ pb^{-1}$

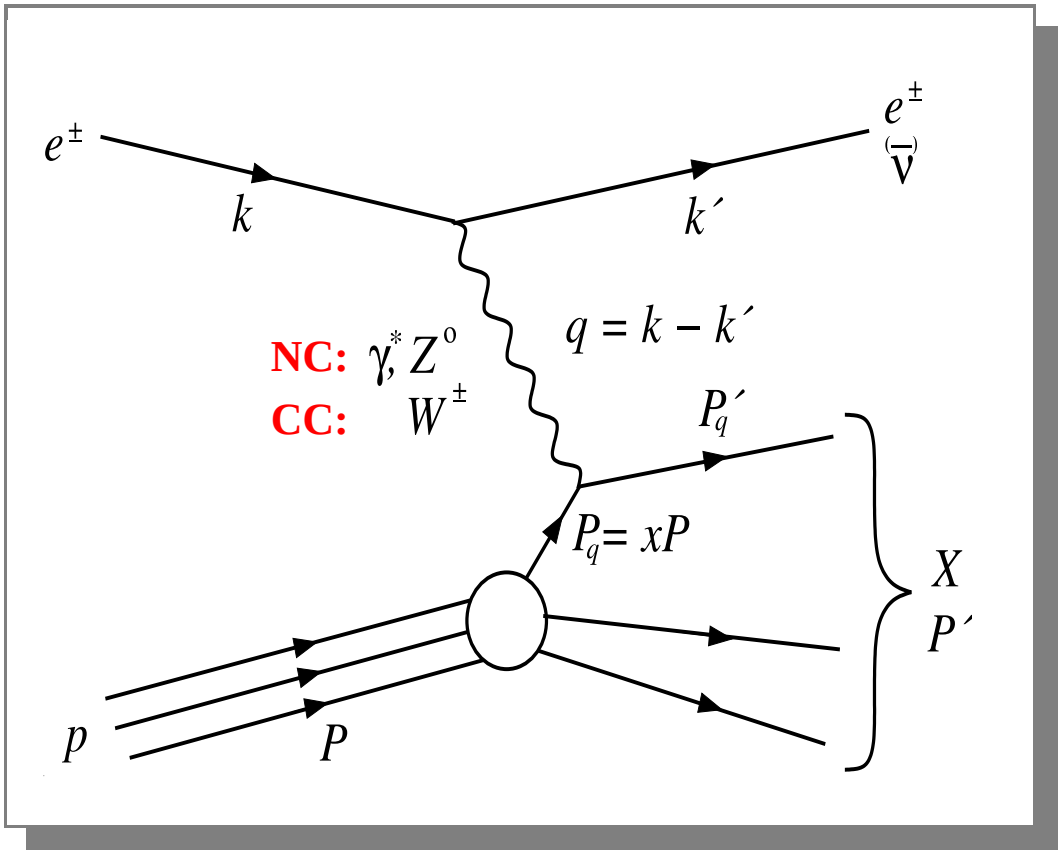
Positive P:

- $P_e = (+33.0 \pm 0.7)\%$
- *Lumi:* $15.3 \pm 0.4\ pb^{-1}$

Negative P:

- $P_e = (-25.4 \pm 0.4)\%$
- *Lumi:* $17.8 \pm 0.2\ pb^{-1}$

Deep Inelastic Scattering at HERA



Neutral, Charged Current DIS

- $Q^2 = -(k - k')^2$ *virtuality of* $\gamma^*, Z^0, W^{\pm}$
- $x = Q^2/2(pq)$ *momentum fraction of proton carried by struck quark*
- $y = (Pq)/(pk)$ *inelasticity*
- $Q^2 = sxy$

Polarised Physics at HERA

- *CC cross-section depends linearly on polarisation*

$$\frac{d^2\sigma^{e^\pm}_{CC}}{dxdQ^2} = [1 \pm P]\frac{G_F^2}{2\pi x}\left[\frac{M_W^2}{Q^2+M_W^2}\right]^2 \Phi^\pm_{CC}$$

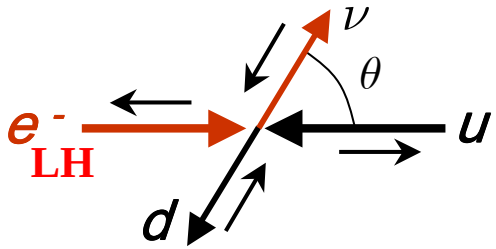
- *Weak charged currents are LH*
- *$e^\pm$ sensitive to different quark flavours*

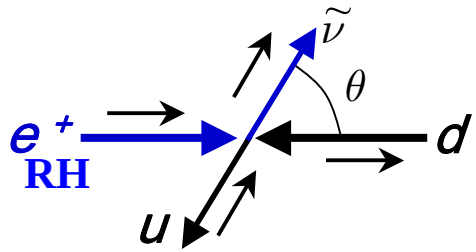
Electrons:

$$\Phi^-_{CC} = u + c + (1-y)^2(\bar{d} + \bar{s} + \bar{b})$$

Positrons:

$$\Phi^+_{CC} = \bar{u} + \bar{c} + (1-y)^2(d + s + b)$$

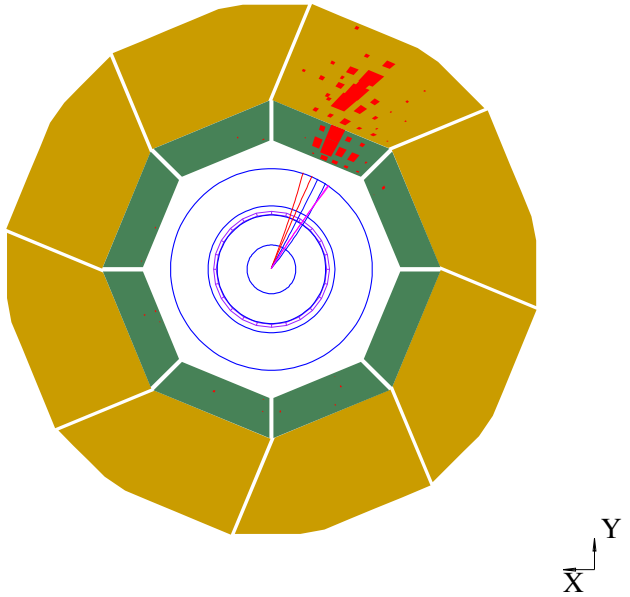


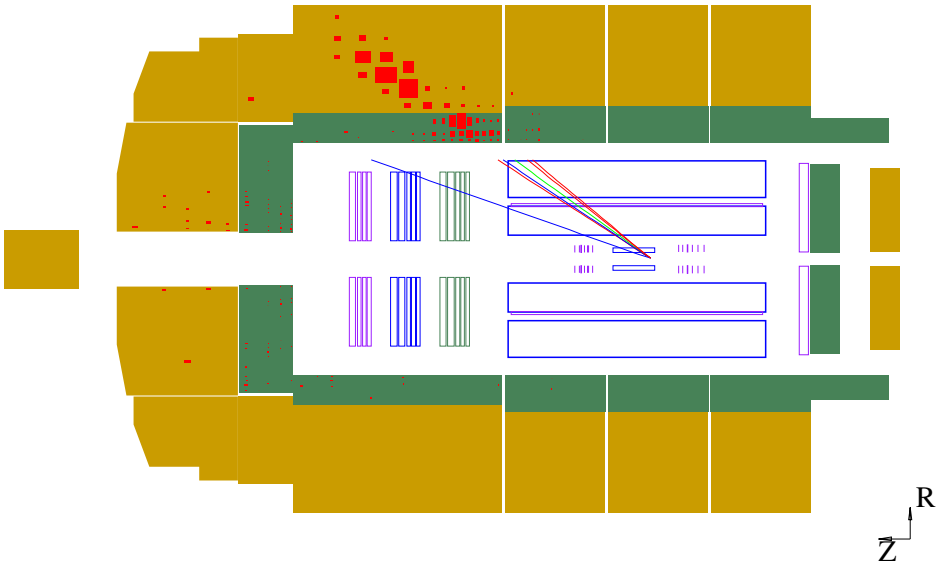


- *CC cross-section for e^-_{RH} and e^+_{LH} vanishes*

Charged Current in H1 Detector

- *Neutrino is not detected, only hadrons*
- *Large missing transverse momentum, attributed to neutrino*





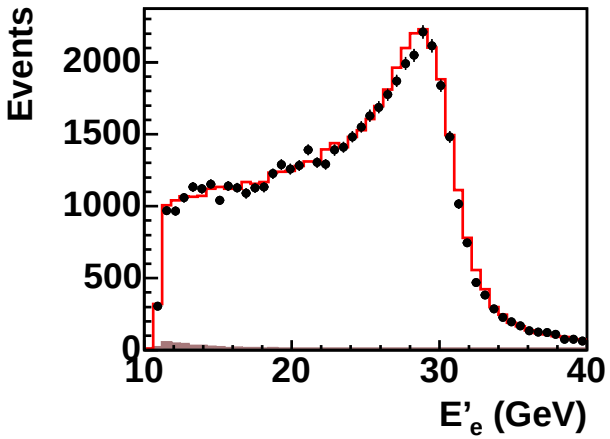
- *Kinematics reconstructed from hadrons:*

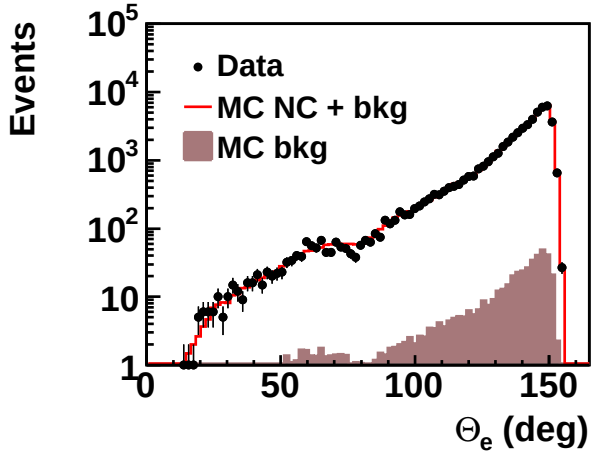
$$y_h = \frac{E - P_z}{2E_e},\ x_h = \frac{Q_h^2}{s y_h},$$

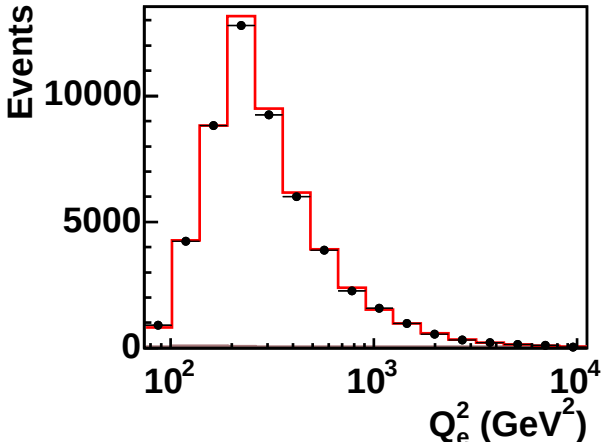
$$Q_h^2 = \frac{P_{T,h}^2}{1 - y_h}$$

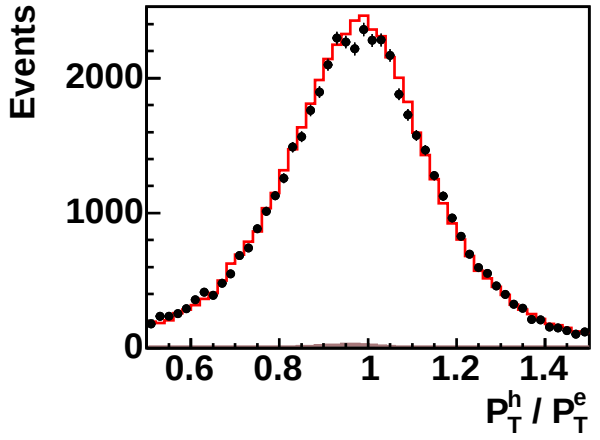
2005 $e^- p$ Neutral Current

- *CC: Hadronic energy measurement is crucial. Well understood and checked with NC data!*
- *NC interactions are studied to check the detector response*
- *NC events are used to study systematic uncertainties and efficiencies*









- *Electron energy (E'_e), scattering angle (θ_e), etc. are described by MC*

Charged Current Measurement

Event Selection:

- $P_t^{Miss} > 12$ *GeV*
- $0.03 < y_h < 0.85$
- $Q_h^2 > 220$ *GeV*^{2}
- *No scattered electron*
- *Rejection of non-*ep *background*

Signal MC:

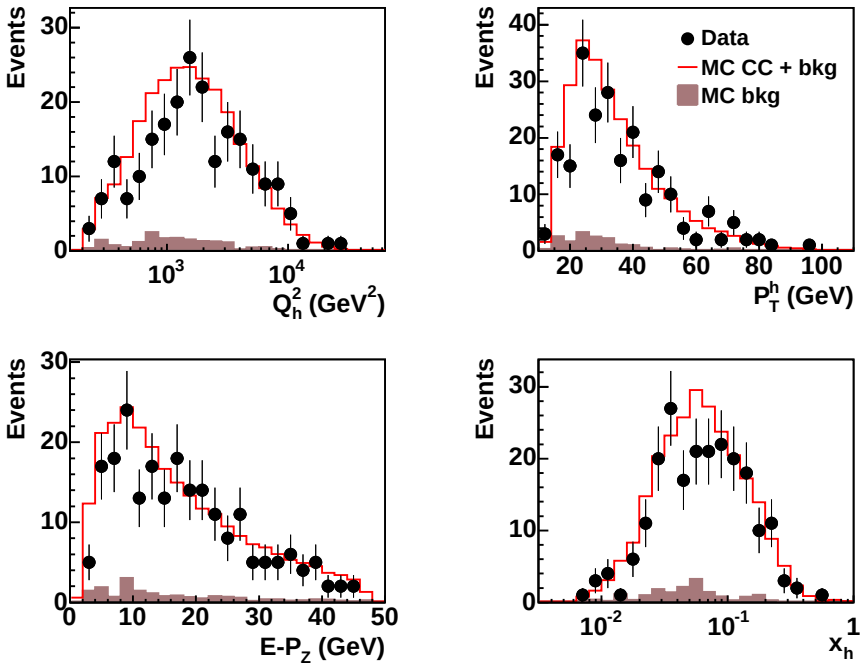
- *DjangoCC*

MC for Backgrounds:

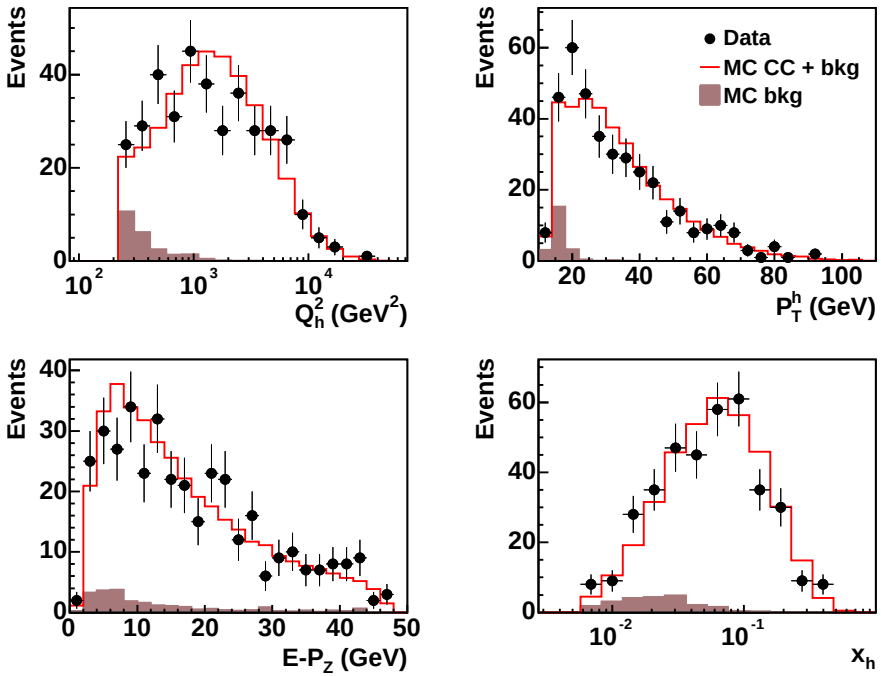
- *NC: DjangoNC*
- *Photoproduction*(γp)*: Pythia*
- *Lepton-pair* (e, μ, τ) *production: Grape*
- *W production: Epvec*

2003-2004 e^+p Charged Current

$P_e = (-40.2 \pm 0.6)\%$

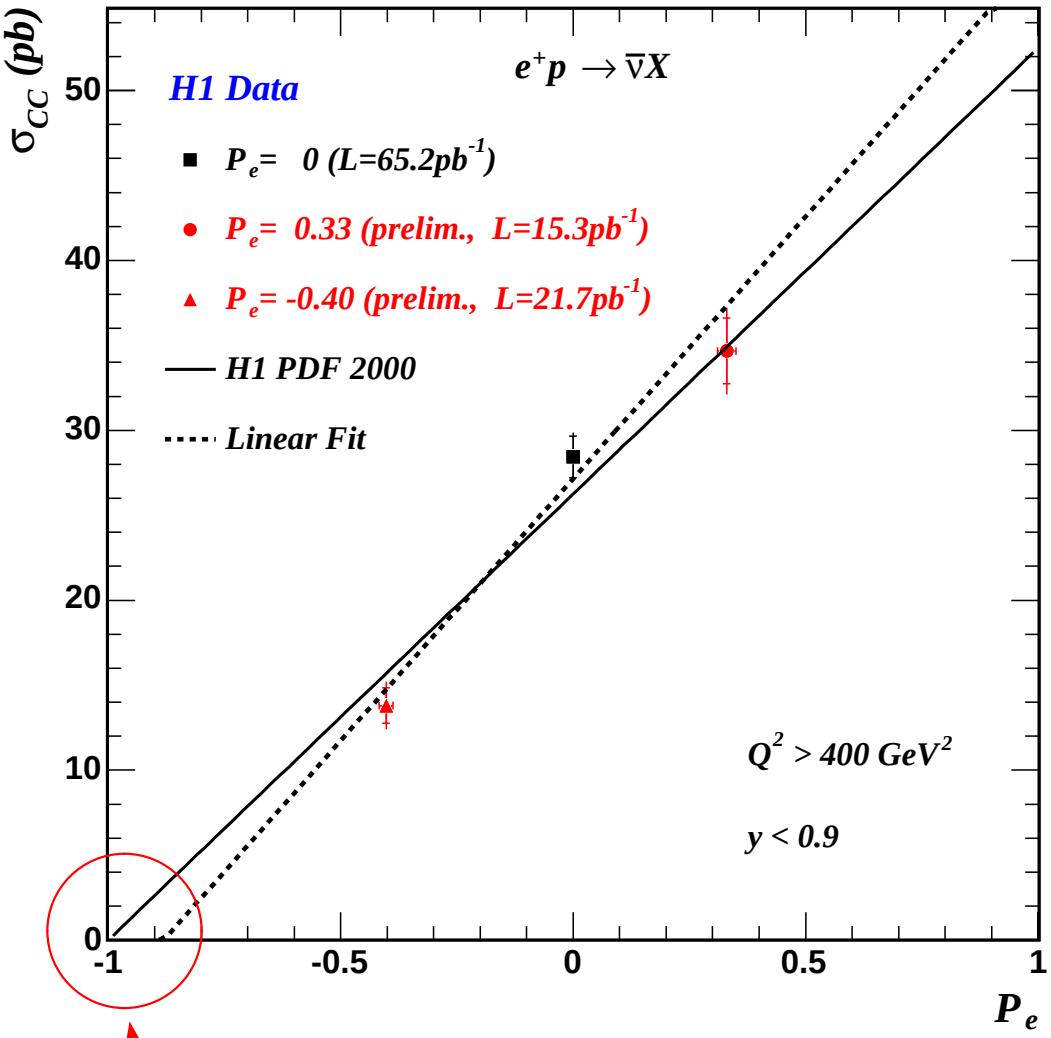


$P_e = (+33.0 \pm 0.7)\%$



Data are described by Monte Carlo

2003-04 CC e^+p Total Cross-Section



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

P_e = (+33.0 ± 0.7)%

$$\sigma_{CC}^{e^+p} = 34.7 \pm 1.9 \pm 1.7 \text{ pb}$$

P_e = (-40.2 ± 0.6)%

$$\sigma_{CC}^{e^+p} = 13.8 \pm 1.0 \pm 0.9 \text{ pb}$$

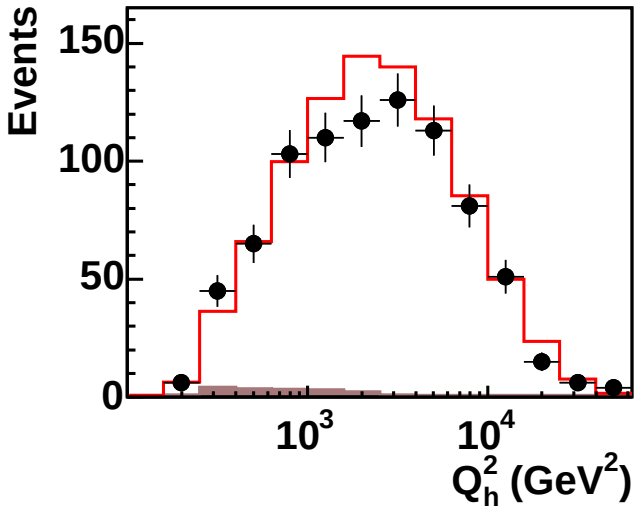
- **Consistent with H1 PDF 2000**
- **A linear fit $\sigma_{CC} = \alpha + \beta(1+P_e)$:**

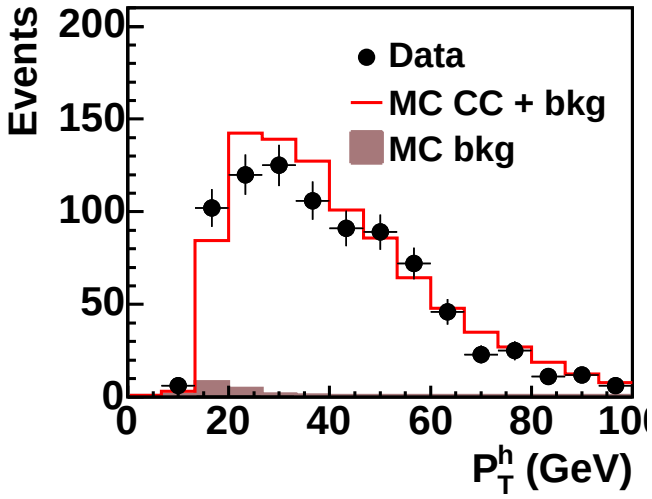
$$\sigma_{CC}(P_e = -1) = -3.7 \pm 2.4 \pm 2.7 \text{ pb}$$

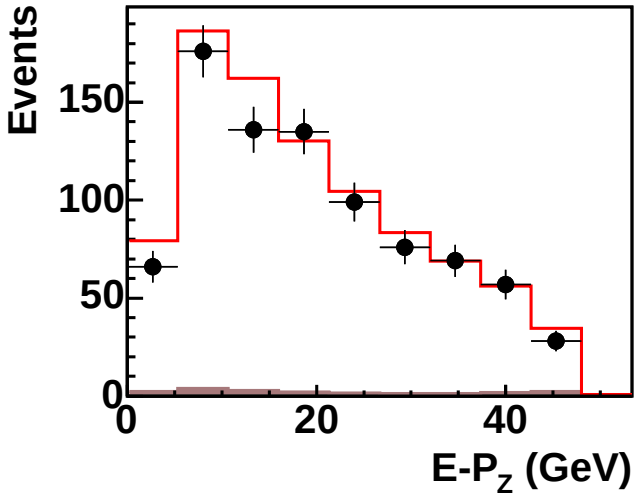
Consistent with
- linear $(1 + P_e)$ dependence
- intercept of 0

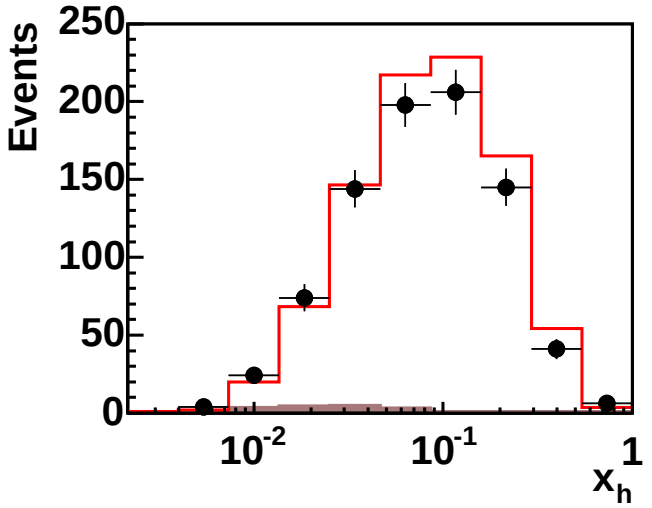
Extrapolation to $P_e = -1$: no indication of right-handed weak currents

2005 $e^- p$ Charged Current



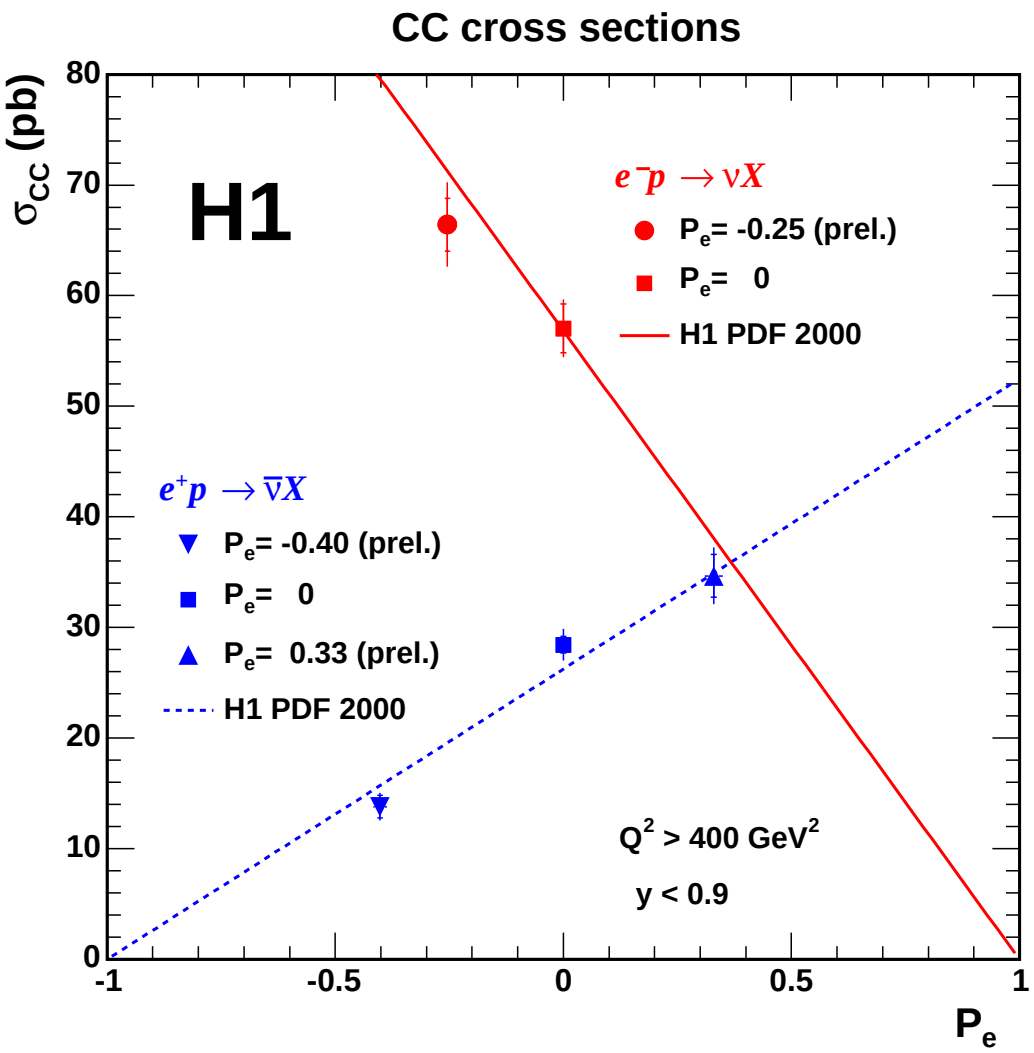






Data are described by MC

CC $e^{\pm}p$ Total Cross-Section



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

- *First measurement of e^-p CC cross section at HERA II*

$$P_e = \mathbf{(-25.4 \pm 0.4)\%}$$

$$\sigma_{CC}^{e^-p} = 66.4 \pm 2.4 \pm 3.0 \text{ pb}$$

- *Consistent with H1 PDF 2000*

Consistent with Standard Model

Summary

- *Hera II CC cross-sections for 2003-04 e^+p and 2005 e^-p interactions with longitudinally polarised lepton beams were presented*
- *The CC cross-sections are consistent with Standard Model*