Charged Current in polarised $e^{\pm} p$ collisions at HERA II

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HERA Upgrade: HERAII

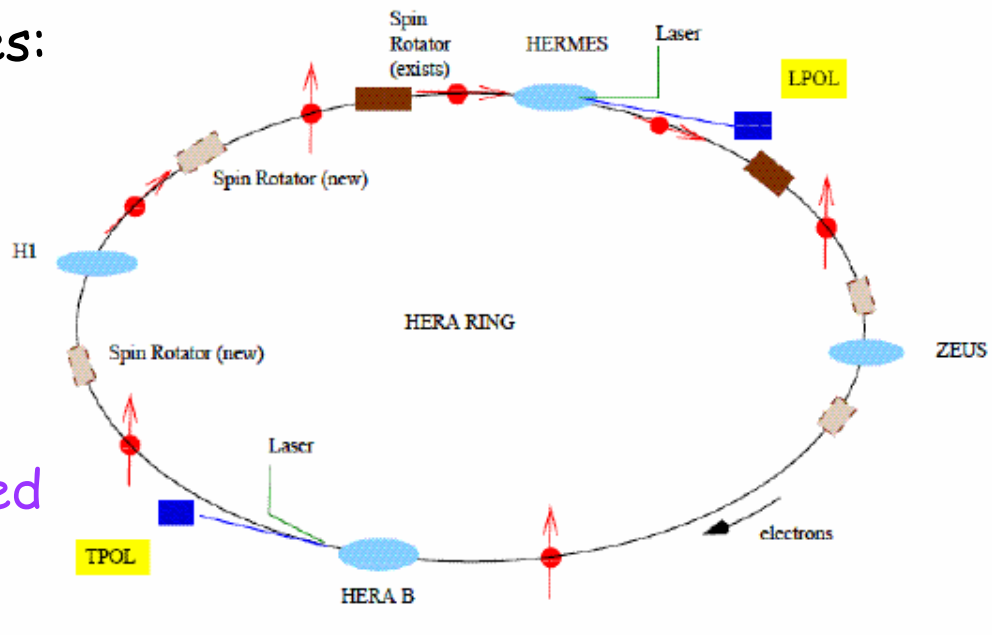
•HERA upgrade with main issues:

->increase specific luminosity
(reduce β function by placing superconducting magnets inside the H1 detector)

->provide longitudinally polarised lepton beams
(spin rotators before/after the H1/ZEUS detector

•Polarisation

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



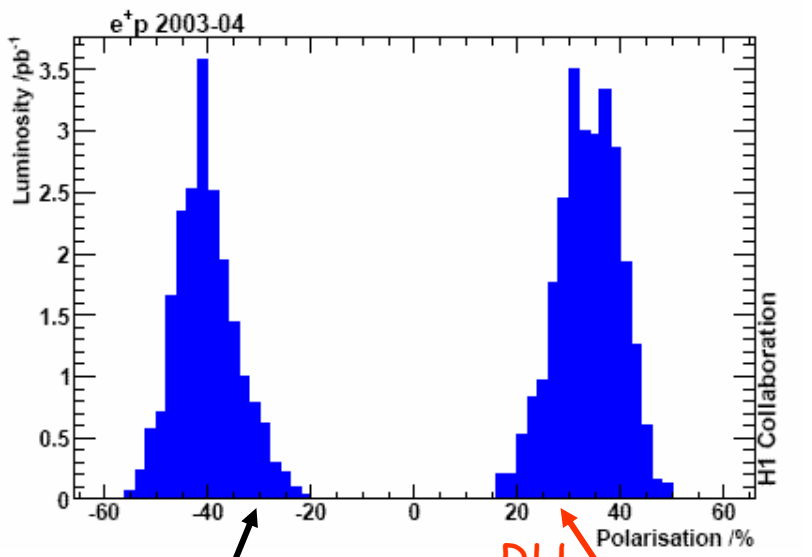
•Increased luminosity:
->increased statistics at high Q^2

•Longitudinal polarisation:

direct sensitivity to weak effects

Luminosity and Polarisation at HERA II

$2003-04\,e^{+}p$



LH

$Lumi = 20.7\,pb^{-1}$

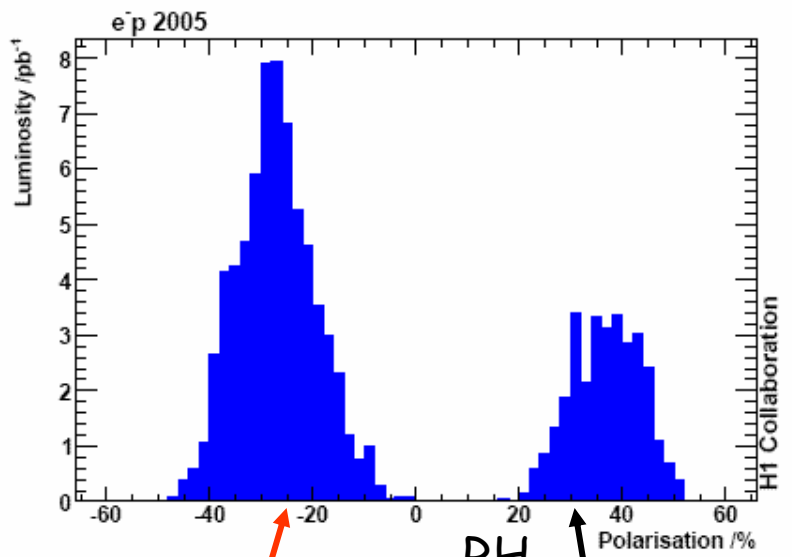
$P_e = (-40.2 \pm 1.1)\%$

RH

$Lumi = 26.9\,pb^{-1}$

$P_e = (33.6 \pm 0.7)\%$

$2005\,e^{-}p$



LH

$Lumi = 68.6\,pb^{-1}$

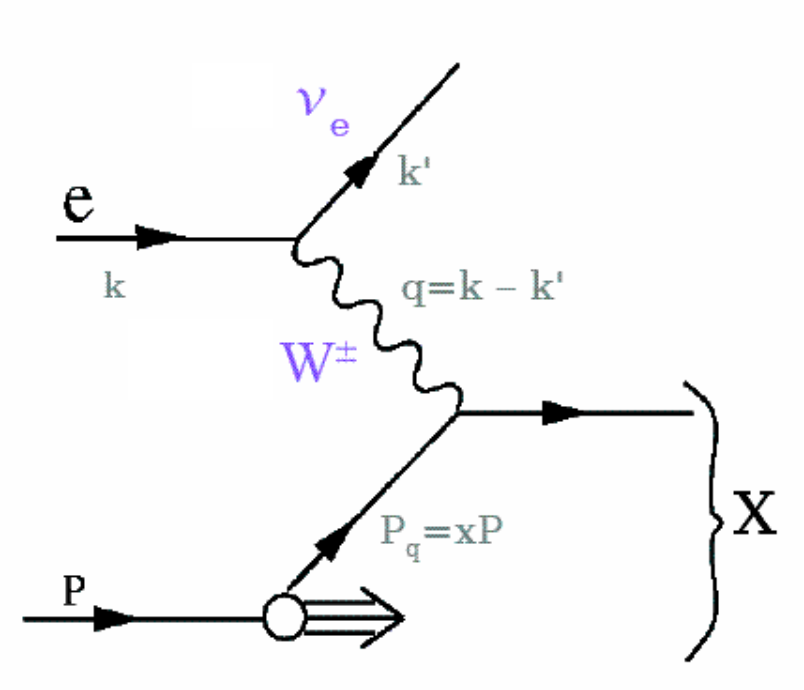
$P_e = (-27.0 \pm 1.3)\%$

RH

$Lumi = 29.6\,pb^{-1}$

$P_e = (37.0 \pm 1.8)\%$

Deep Inelastic Scattering at HERA



- squared momentum transfer

$$Q^2 = -(k - k')^2$$

- momentum fraction of proton carried by struck quark

$$x = Q^2 / 2(Pq)$$

- inelasticity of scattered lepton

$$y = (Pq)/(Pk)$$

- related kinematics quantities

$$Q^2 = sxy$$

- CC interactions:

$$e^{\pm} p \rightarrow \overset{(-)}{\nu} X$$

Polarised Charged Current Cross-Sections

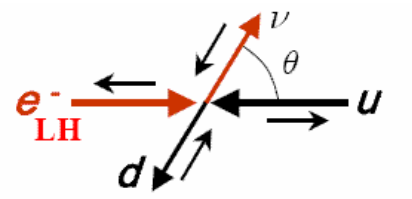
- CC cross section: depends linearly on the longitudinal polarisation P:

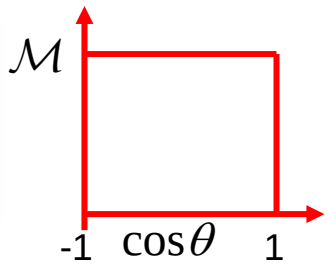
$$\frac{d^2\sigma_{cc}^{e^{\pm}p}}{dxdQ^2} = [1 \pm P]\frac{G_F^2}{2\pi x}\left[\frac{M_W^2}{Q^2+M_W^2}\right]^2 \phi_{cc}^{\pm}$$

- $e^{\pm}p$ sensitive to different quark flavors

$e^-p \rightarrow \nu X$ u-type quarks

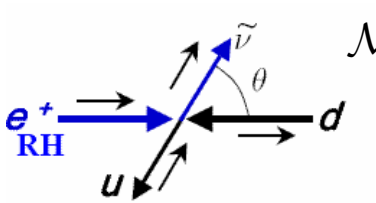
$$\phi_{CC}^{-} = u + c + (1-y)^2(\bar{d} + \bar{s} + \bar{b})$$

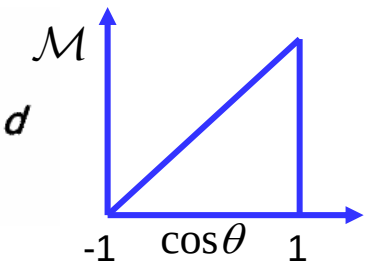




$e^+p \rightarrow \bar{\nu} X$ d-type quarks

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





- W boson couples to LH particles and RH antiparticles

Charged Current Event in H1 Detector

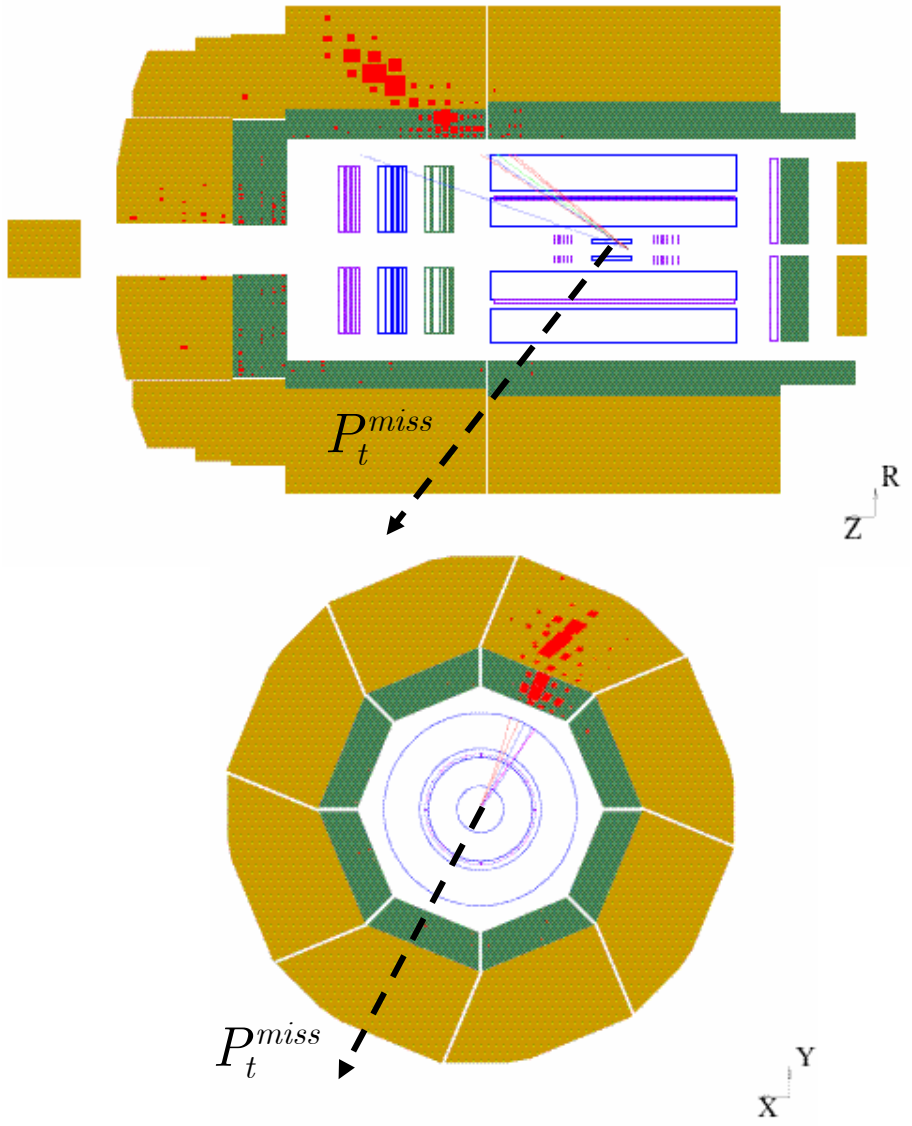
- Missing transverse momentum due to undetected neutrino

- Kinematics reconstruction:
  ->only hadrons measured
  ->Jacquet-Blondel method used

- Kinematic variables:

$$y_h = \frac{E - p_z}{2E_e} \quad , \quad Q_h^2 = \frac{(P_T^h)^2}{1 - y_h}$$

$$x_h = \frac{Q_h^2}{s y_h}$$



Charged Current Measurement

Event Selection:

- Phase Space

$$P_t^{miss} > 12GeV$$

$$0.03 < y_h < 0.85$$

$$Q_h^2 > 220GeV^2$$

- Rejection of remaining ep background:
  -> photo-production
  -> NC

- Rejection of non-ep background

Signal MC:

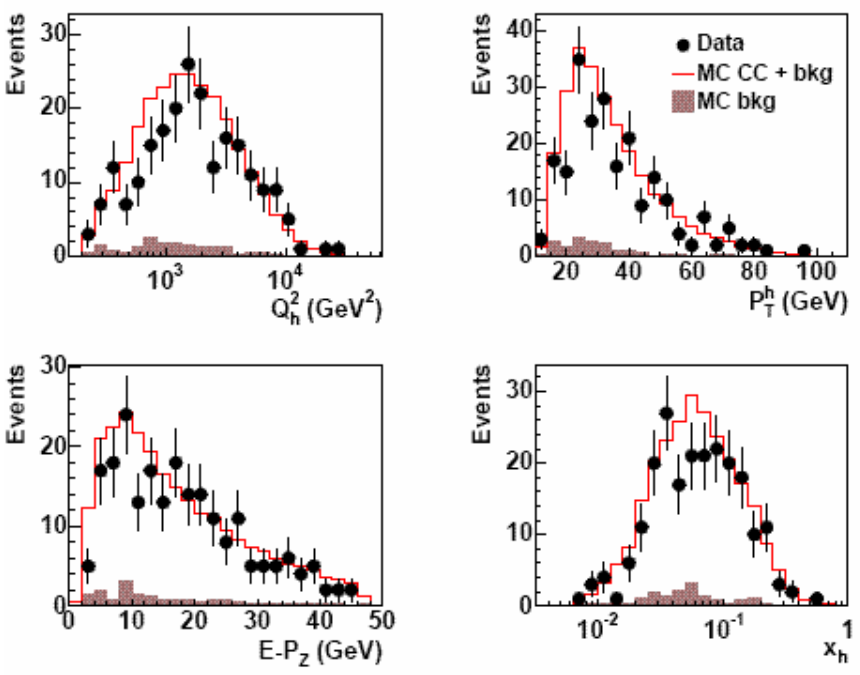
- DjangoCC:
  ->DIS modeled at parton level
  ->interface LEPTO & HERACLES (ARIADNE)

Background MCs:

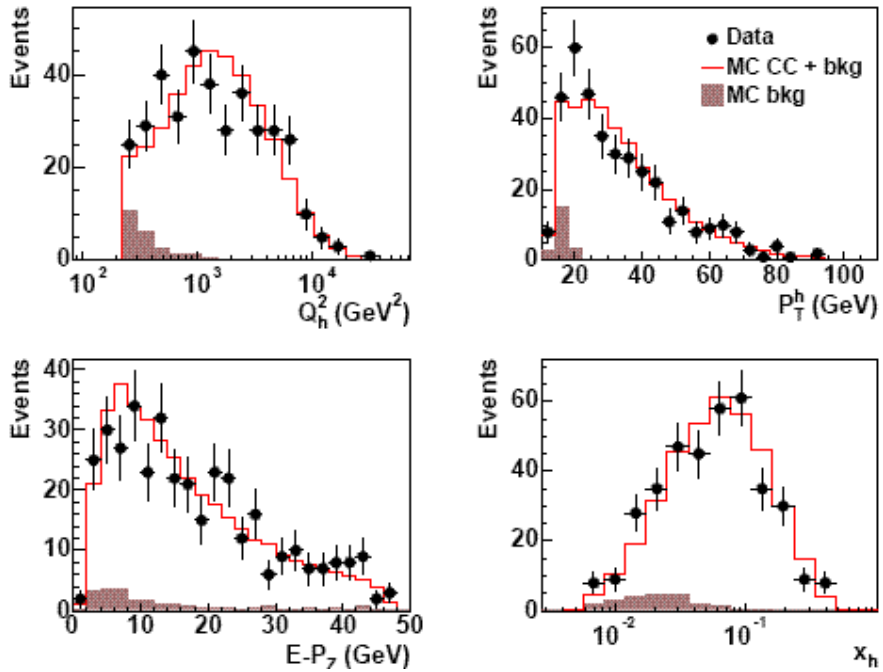
- Photo-production: Pythia
- NC: DjangoNC
- Lepton pair: Grape
- W production: Epvec

2003-2004 $e^+ p$ Charged Current

$P_e = (-40.2 \pm 1.1)\%$



$P_e = (33.6 \pm 0.7)\%$



Data are well described by Monte Carlo

2003-2004 e^+p CC Total Cross-Section

- Theory expectation:

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

- H1 measurements:

$$P_e = (33.6 \pm 0.7)\%$$

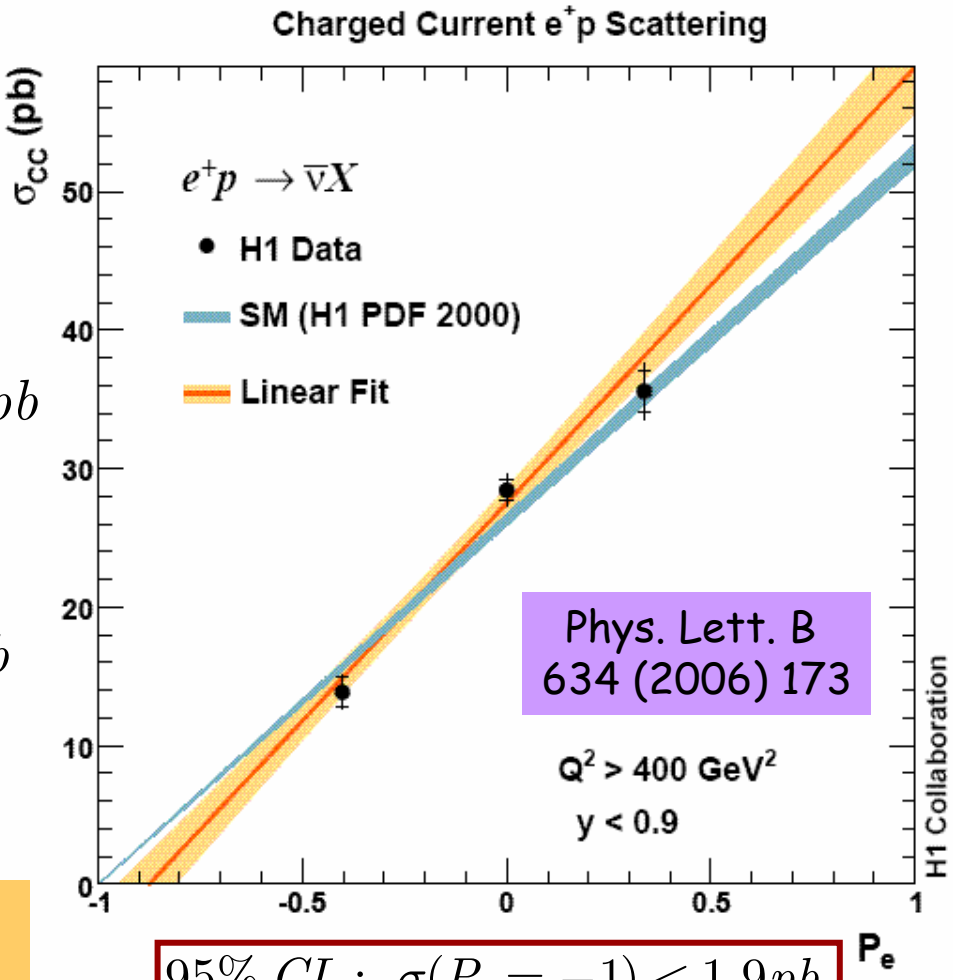
$$\sigma_{CC}^{e^+p} = 35.6 \pm 1.5(sta) \pm 1.4(sys)pb$$

$$P_e = (-40.2 \pm 1.1)\%$$

$$\sigma_{CC}^{e^+p} = 13.9 \pm 1.1(sta) \pm 0.6(sys)pb$$

- Consistent with H1 PDF 2000
- A linear fit:

$$\sigma_{CC}^{tot}(P_e = -1) = -3.9 \pm 2.3(sta) \pm 0.7(sys) \pm 0.8(pol)pb$$

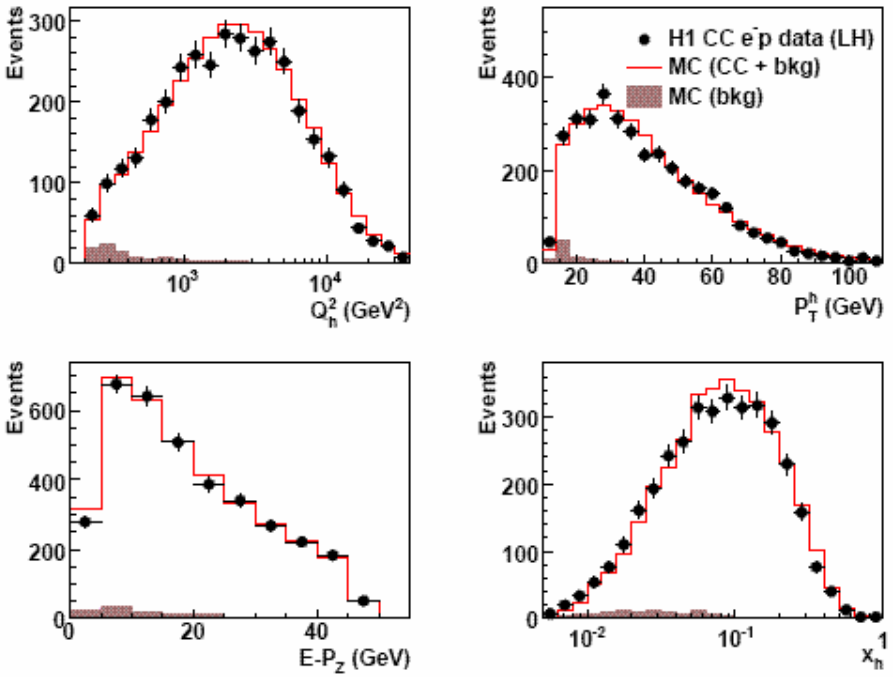


$$95\%\ CL:\ \sigma(P_e = -1) < 1.9pb,$$

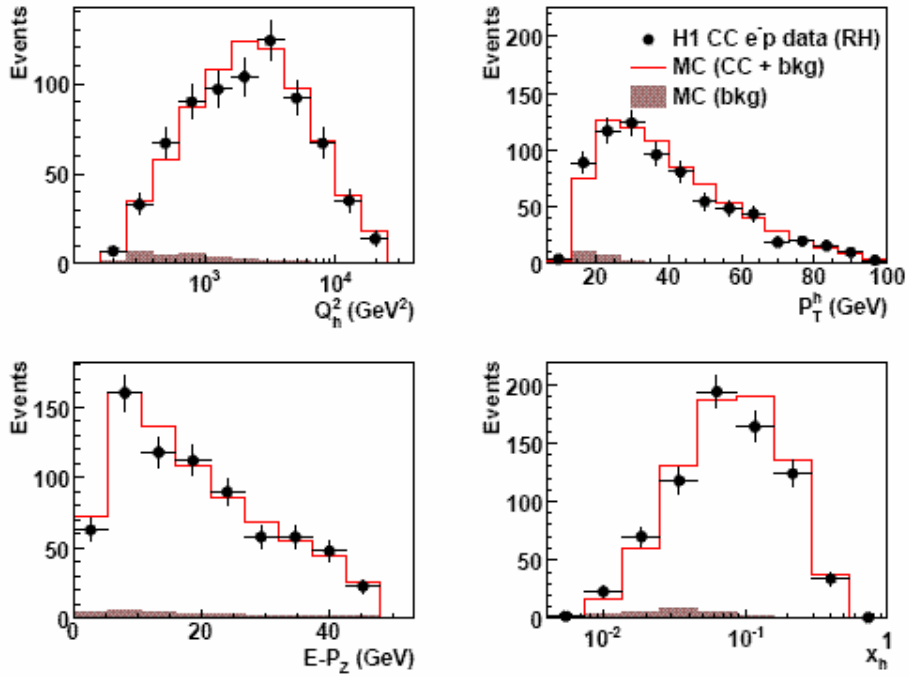
$$M(W_R) > 208GeV$$

2004-2005 $e^- p$ Charged Current

$P_e = (-27.2 \pm 0.5)\%$



$P_e = (+37.0 \pm 0.7)\%$



Data are well described by Monte Carlo

2005 $e^- p$ CC Total Cross-Section

- Theory expectation:

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

- H1 measurements:

$$P_e = (-27.0 \pm 1.3)\%$$

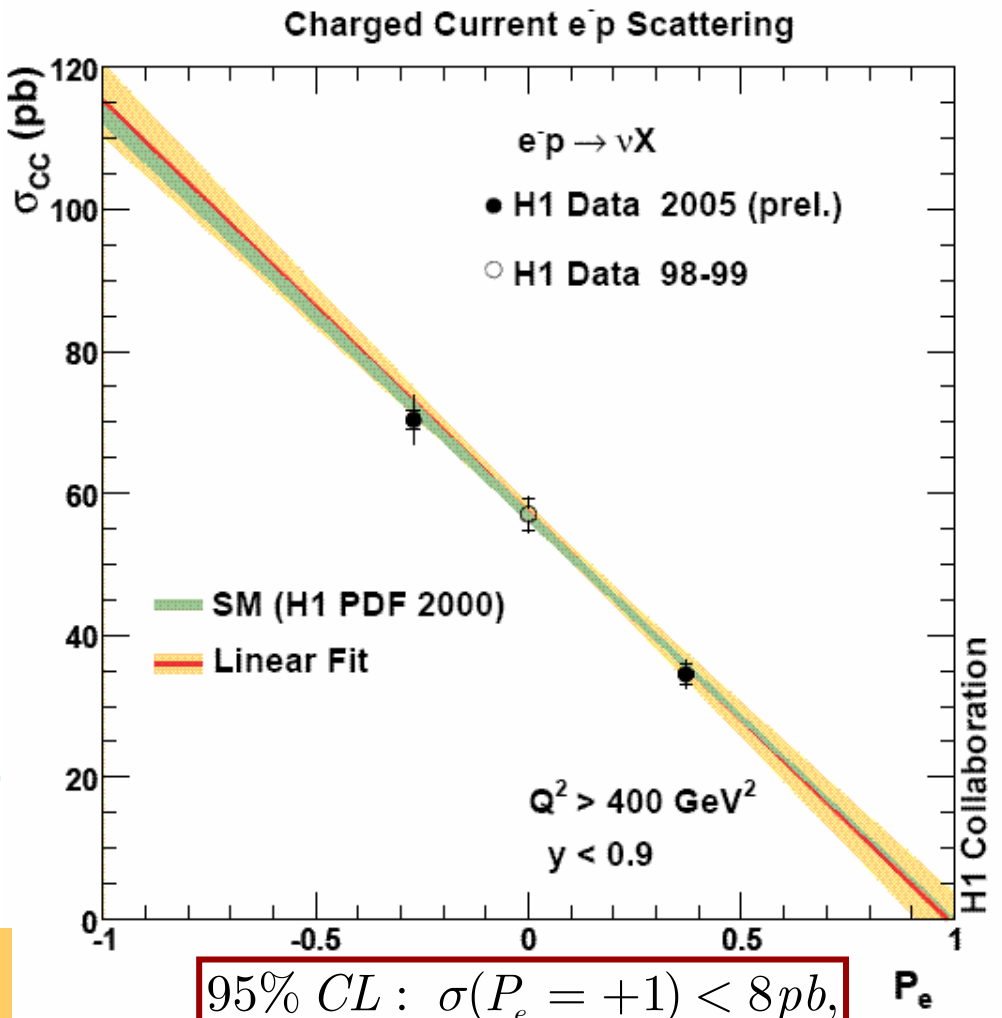
$$\sigma_{CC}^{e^- p} = 70.4 \pm 1.2(sta) \pm 3.1(sys)\, pb$$

$$P_e = (37.0 \pm 1.8)\%$$

$$\sigma_{CC}^{e^- p} = 34.5 \pm 1.4(sta) \pm 1.5(sys)\, pb$$

- Consistent with H1 PDF 2000
- A linear fit:

$$\sigma(P_e = 1) = -0.9 \pm 2.9(sta) \pm 1.9(sys) \pm 2.9(pol)\, pb$$



$$95\%\ CL:\ \sigma(P_e = +1) < 8\, pb,$$

$$M(W_R) > 186\, GeV$$

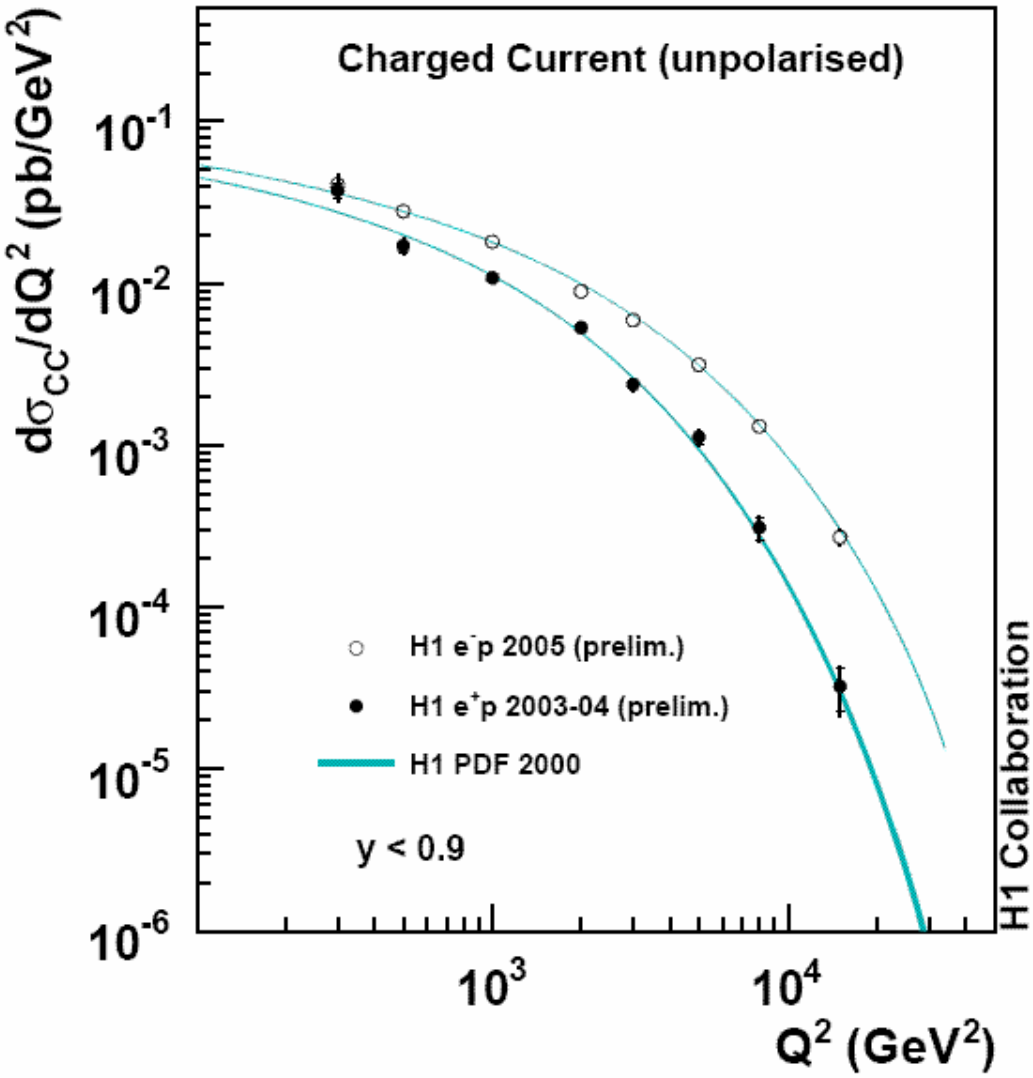
2003-2005 Single Differential Cross-Sections

- For HERAII positron and electron data :

->unpolarised single differential cross-sections measured separately
->LH & RH data combined
->corrected for residual polarisation

- $e^- p$ higher than $e^+ p$ cross-sections

- Standard Model describes data well

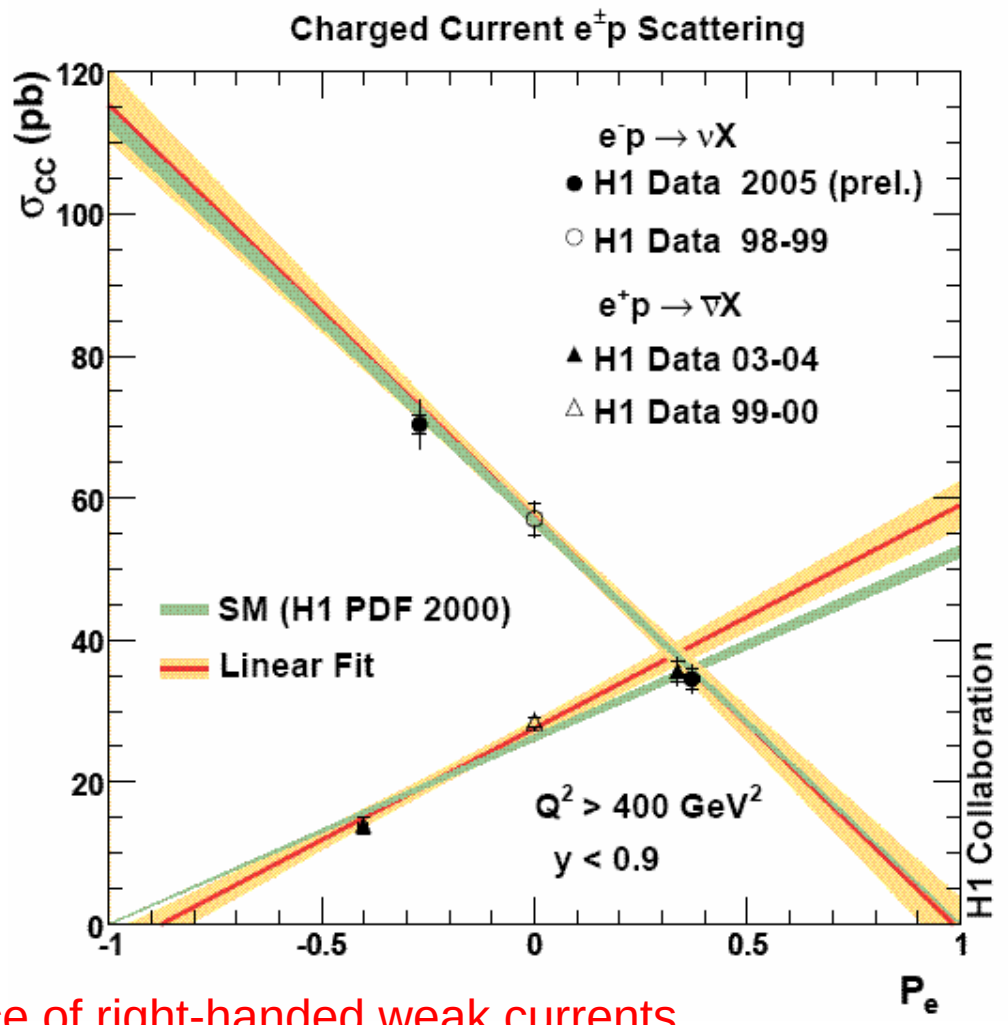


Summary

- At HERAII, H1 has collected about the same luminosity as at HERAI, and 6 times more for electron data

- HERAII CC cross-sections with longitudinally polarised lepton beams measured:
  - ->2003-04 $e^+ p$
  - ->2005 $e^- p$

- The cross-sections are well described by the Standard Model



->consistent with absence of right-handed weak currents