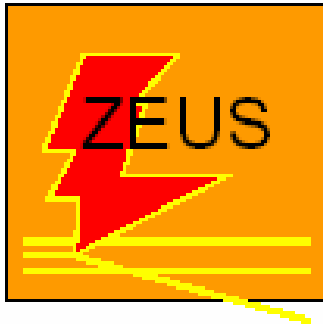


Neutral and Charged Currents at High Q^2 in Collisions of Longitudinally Polarized Positrons with Protons at HERA II



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On behalf of the ZEUS Collaboration

DIS 2004

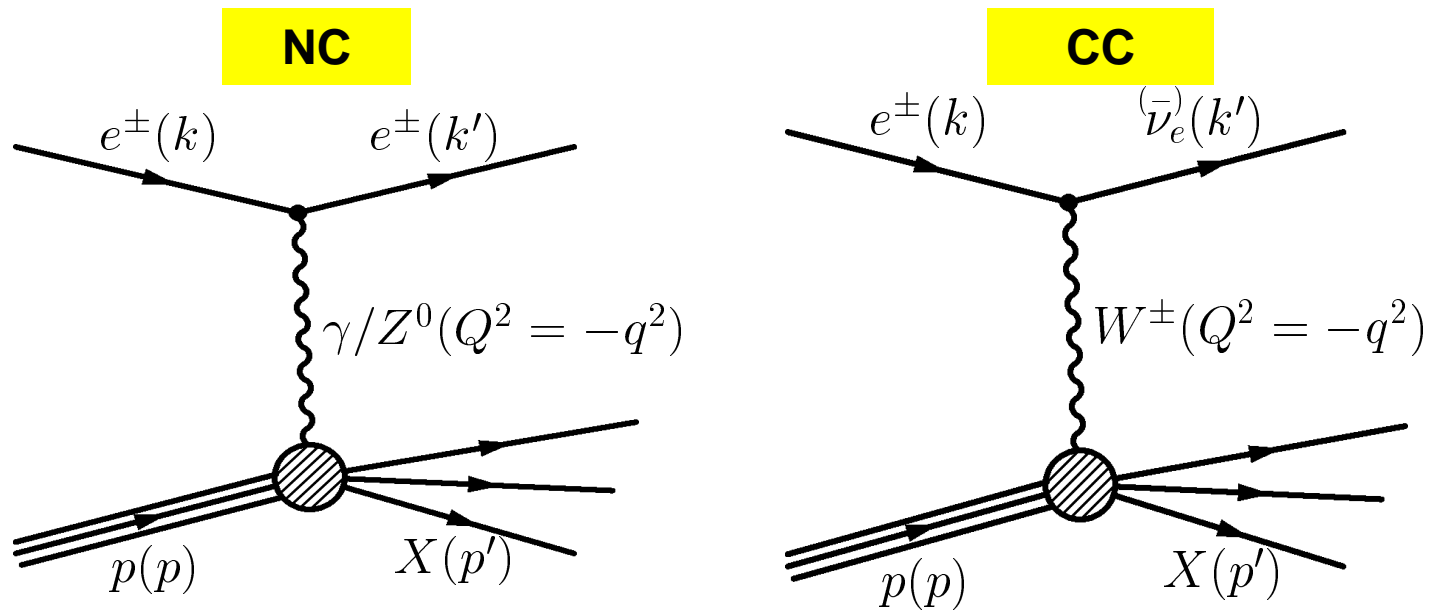
Štrbské Pleso,
High Tatras, Slovakia

14-18 April 2004

Contents

- Introduction
- Event selection
- Cross section
- Conclusion

Deep Inelastic Scattering in HERA \sim NC & CC



Polarized lepton(HERA II) in SM

Neutral Current :

-- Z^0 couples differently to the left and right handed lepton.

-- **Effect of polarization in high Q^2 only.**

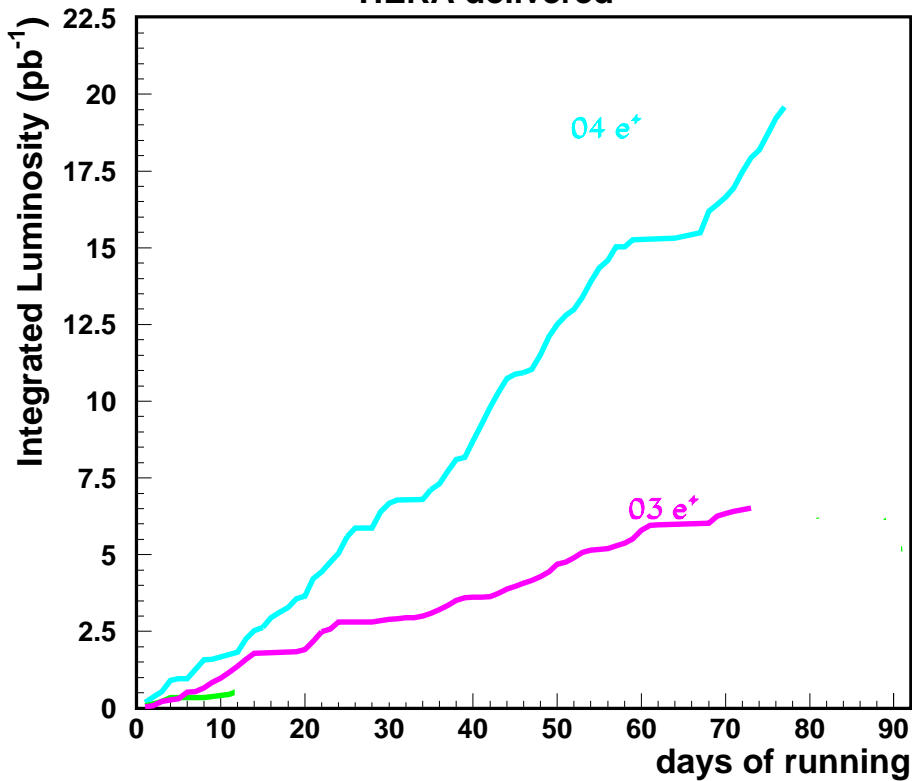
Charged Current :

-- W couples only to the left handed lepton.

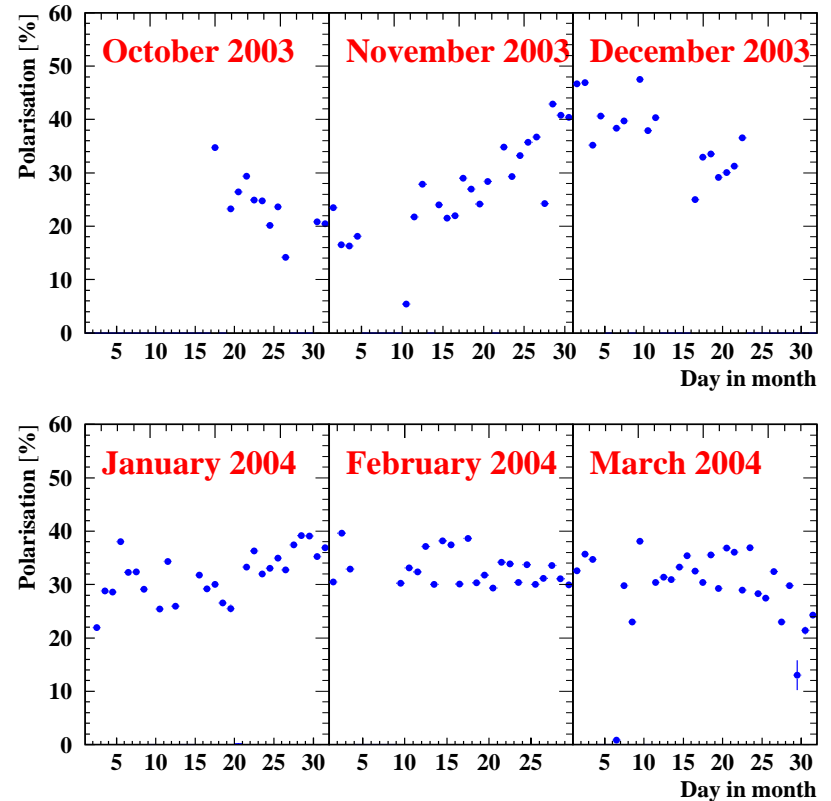
-- **Effect of polarization largely in all Q^2 region.**

Luminosity and polarization in HERA II

HERA delivered



Average HERA polarisation (longitudinal polarimeter)

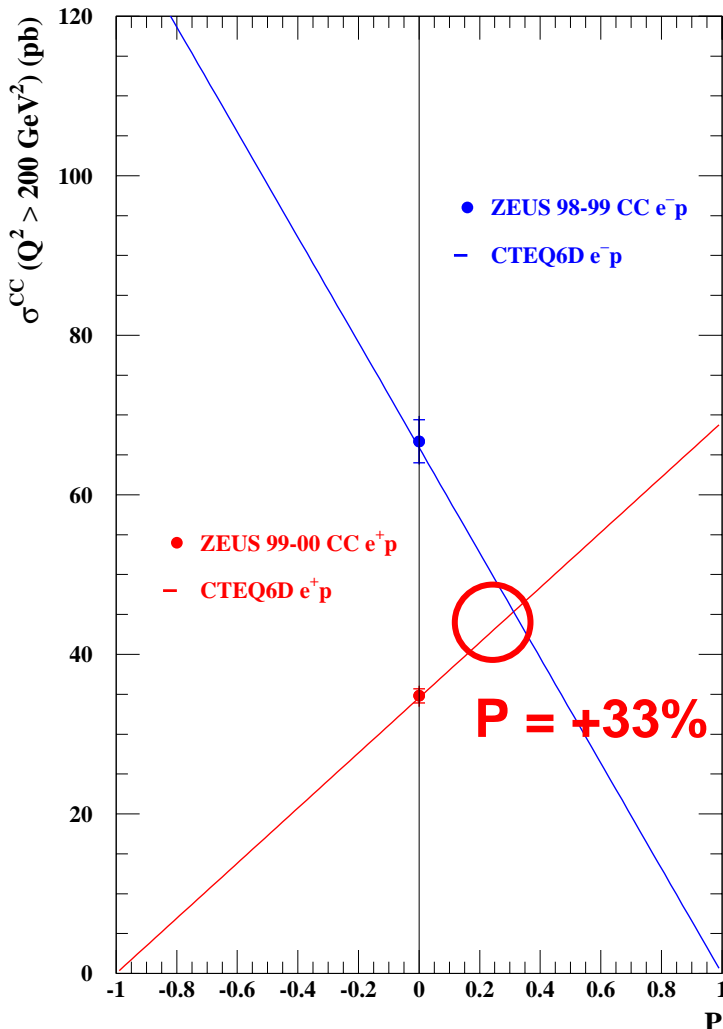


03-04 polarized data : 6.6 pb⁻¹

Polarization : 33%±2.0%

CC cross section expectation in SM

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In the Standard Model,

* electron: $\sigma_{CC}(p = P) = (1 - P) \sigma_{CC}(p = 0)$

* positron: $\sigma_{CC}(p = P) = (1 + P) \sigma_{CC}(p = 0)$

-- Unpolarized lepton (HERA I)

CC cross section (e^+ , e^-) were measured

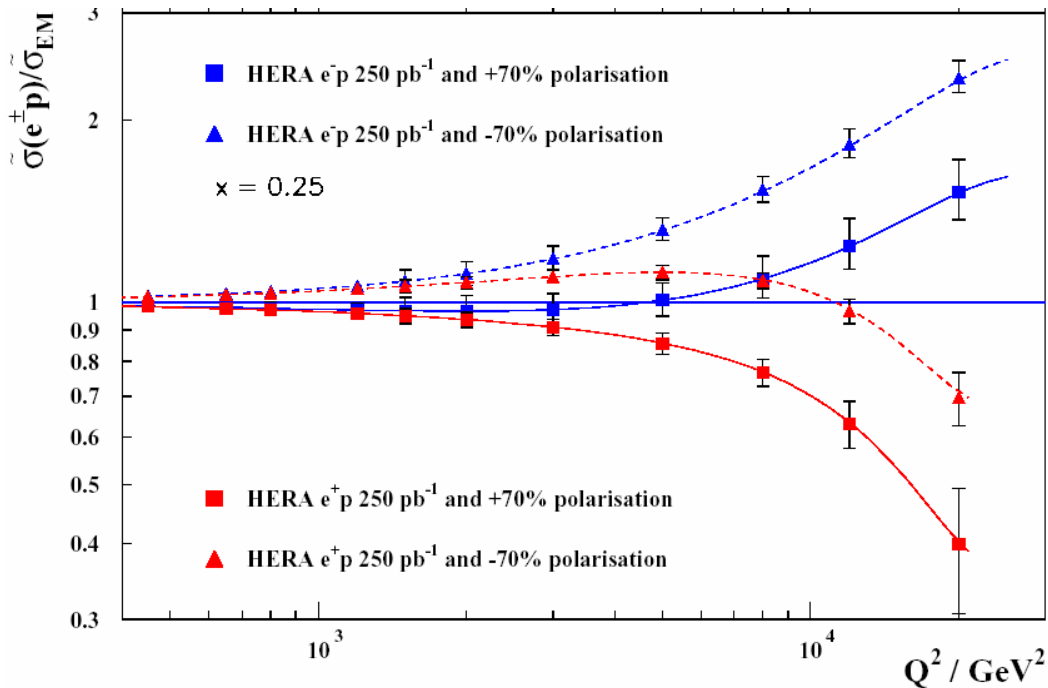
-- Polarized lepton (HERA II)

→ test the Standard Model

-- Cross section were measured @ $P = 33\%$

NC cross section expectation in SM

Simulation at Lumi.=250pb⁻¹, P=+-70%

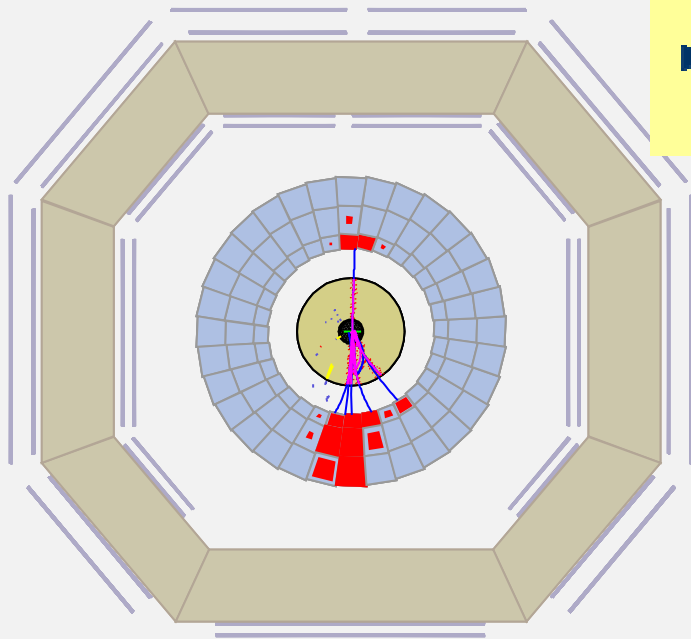


- ▶ NC cross section in high Q^2 changed by polarization in SM largely.
- ▶ need large luminosity to see polarization effect.
- ▶ With about 7pb⁻¹, do not see effect of polarization yet.
- ▶ NC events are important to check detector response.

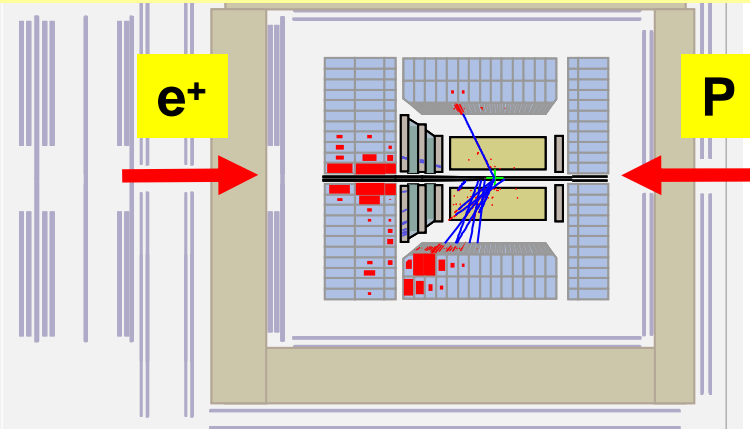
Neutral Current event selection

- ▶ Positron finding
 - Positron energy ($E_e > 10$ GeV)
 - CAL-track matching
- ▶ Reconstruction method:
Double angle method ($\theta_e + \gamma_h$)
- ▶ $Q^2 > 200 \text{ GeV}^2$

Zeus Run 48087 Event 38541		
$E=181$ GeV	$E_\tau=108$ GeV	$E-p_z=54.5$ GeV
$E_r=0$ GeV	$p_t=5$ GeV	$p_x=-2.63$ GeV
$\phi=2.12$	$t_\tau=0.0788$ ns	$t_b=-1.74$ ns
$E_e=60.2$ GeV	$\theta_e=1.07$	$\phi_e=1.54$
$Q_{e,DA}^2=4812$ GeV ²		



XY View



ZR View

Neutral Current events

-- Observed about 15000 events in $Q^2 > 200 \text{ GeV}^2$

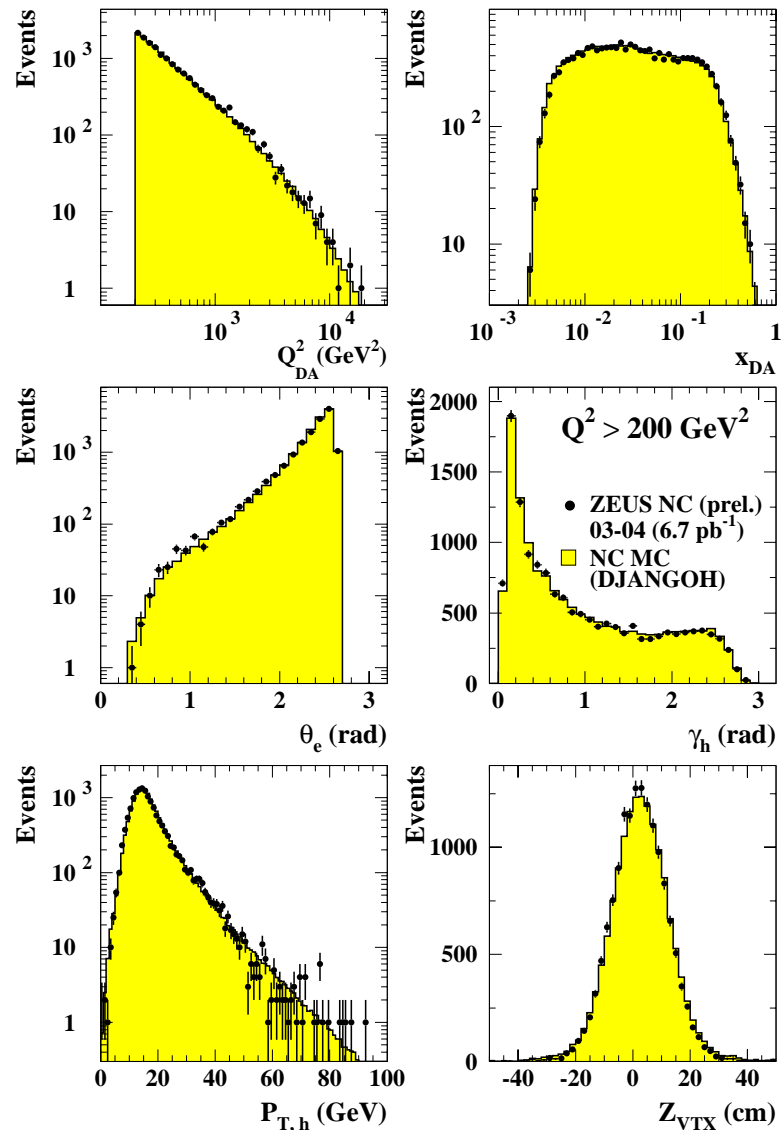
(Lumi. = 6.7 pb^{-1}).

-- DATA has good agreement to MC (luminosity normalized).

-- Reconstruction of the hadron system is fine ($P_{T,h}, \gamma_h$ distribution).

→ let's see CC event

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Kinematic Variables of Charger Current

Missing transverse momentum
due to escaping neutrino

$$\cancel{P}_T$$

The Jaquet Blondel method
(Hadron system only)

$$y_{JB} = \frac{E - P_Z}{2E_e}$$

$$Q_{JB}^2 = \frac{P_T^2}{1 - y_{JB}}$$

$$\gamma = \text{acos} \left(\frac{P_T^2 - (E - P_Z)^2}{P_T^2 + (E - P_Z)^2} \right)$$

$$P_T = \sqrt{\left(\sum_i P_{x,h}^i \right)^2 + \left(\sum_i P_{y,h}^i \right)^2}$$

CC event selection

γ : scattering angle of the struck quark

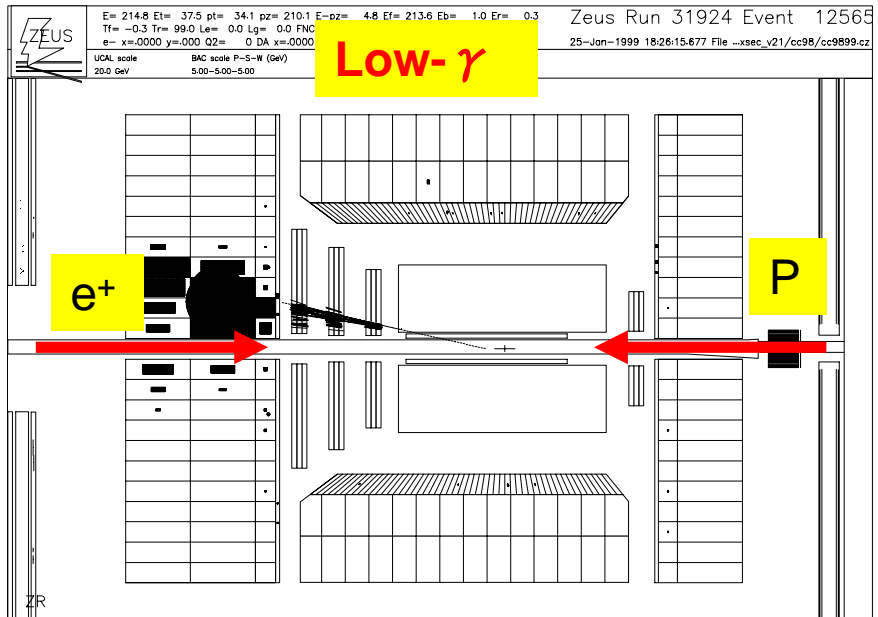
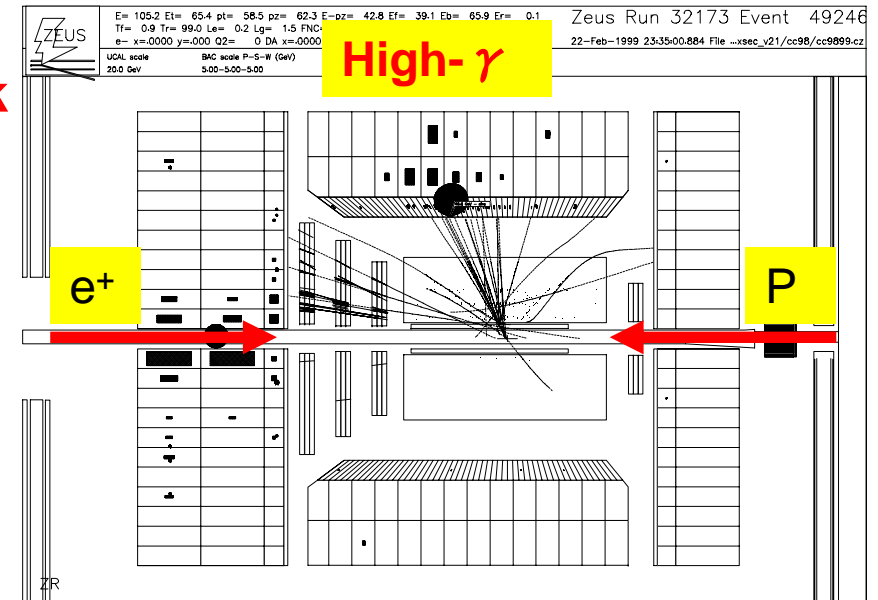
High- γ ($\gamma > 23$ deg.)

- ▶ Struck quark in central region
- Use **tracking information**
- ▶ $\cancel{p}_T > 12\text{GeV}$ + tracking cuts against beam-gas.

Low- γ ($\gamma < 23$ deg.)

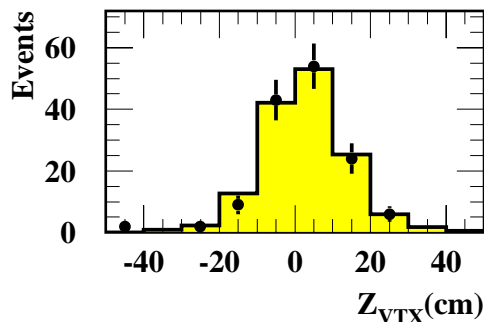
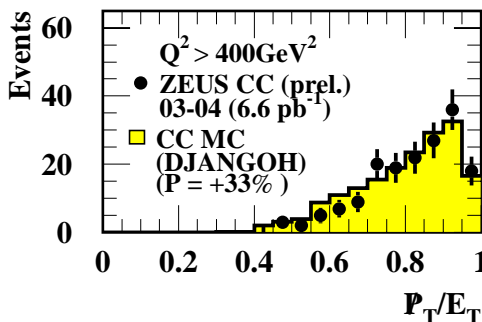
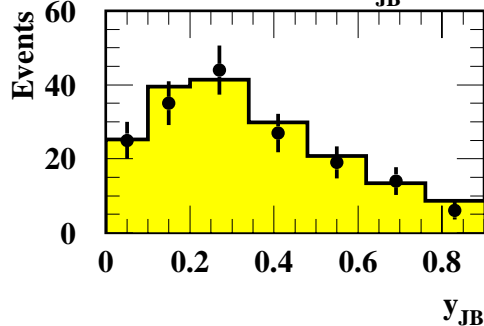
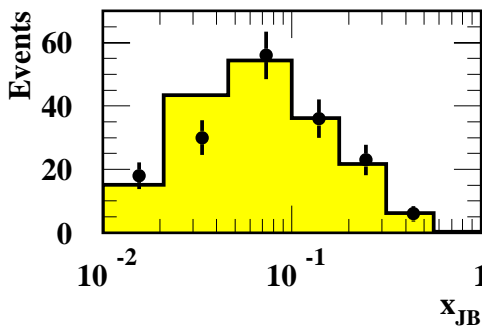
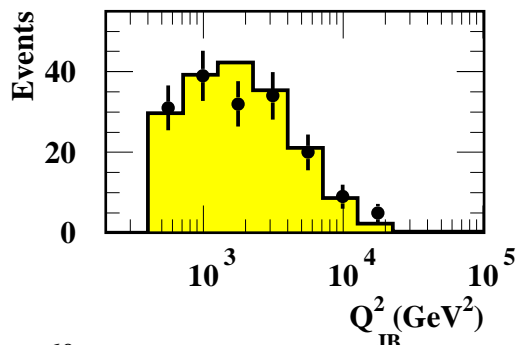
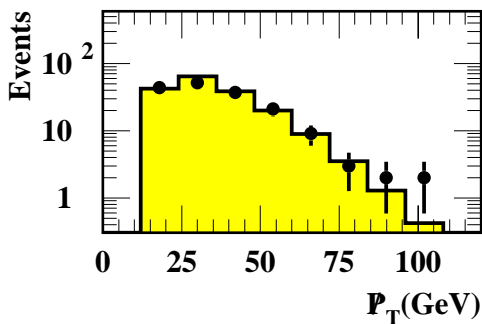
- ▶ Struck quark in forward (high-x)
- **do not use tracking cut**

Tighter \cancel{p}_T cut ($\cancel{p}_T > 14\text{GeV}$) + Halo-mu rejection based on shower shape in CAL.



Charged Current variables

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Data :

Lumi = 6.6 pb^{-1} , P = 33%

Kinematic region :

-- $Q^2_{JB} > 400 \text{ GeV}^2$

-- $y_{JB} < 0.9$

CC MC @ P= 33% reproduced Data well.

Charged Current cross section

$$\sigma_{Born}^{CC}(pol. = P) = \frac{N_{DATA}}{N_{MC}} \cdot \sigma_{SM}^{CC}(pol. = 0)$$

- ▷ N_{DATA} : Number of CC events measured
- ▷ N_{MC} : Number of CC events expected at $pol. = 0$
- ▷ $\sigma_{Born}^{CC}(pol. = 0)$: SM CC cross section at $pol. = 0$

Systematic checks :

- CAL energy scale
- CC selection threshold **Total ~2%**
- PDF uncertainty
- Trigger uncertainty

Lumi. = 6.6 pb^{-1} , pol. = 33%, $Q^2 > 400 \text{ GeV}^2$,

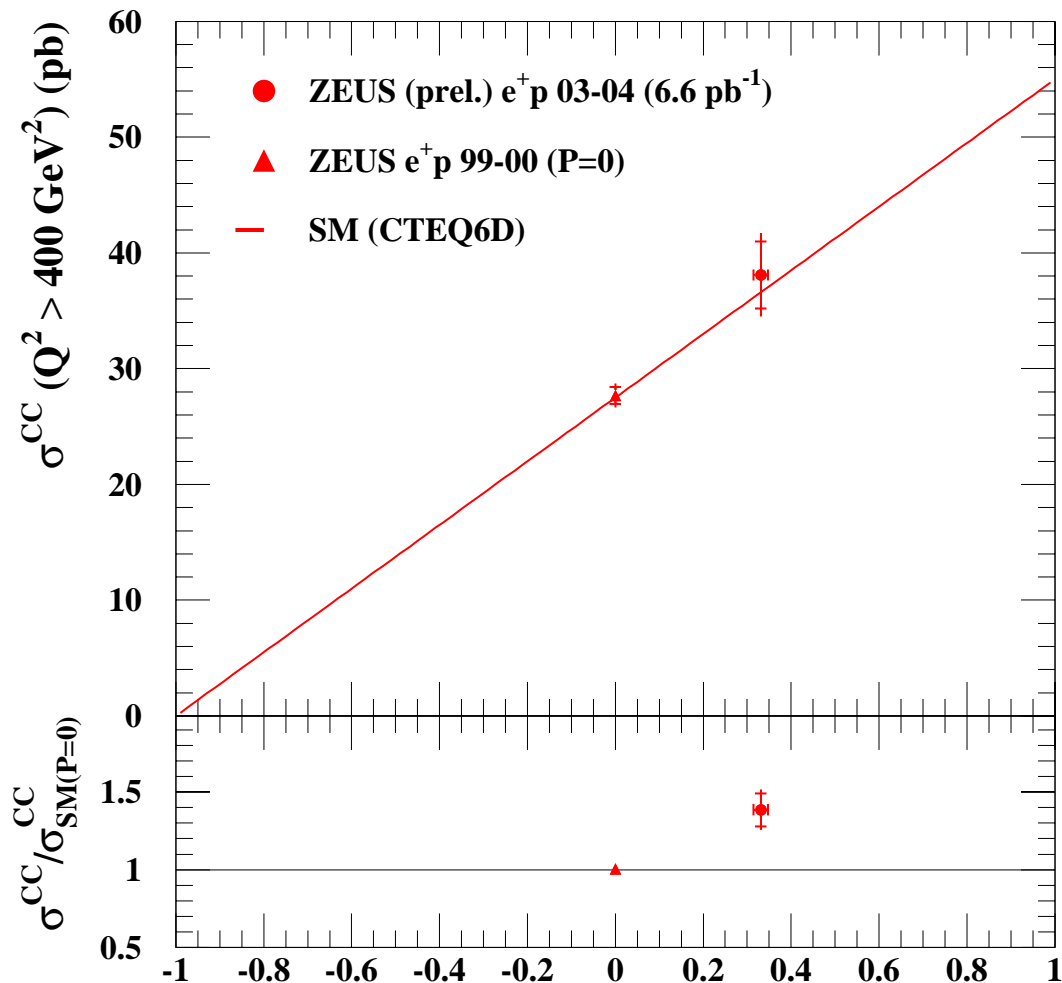
$$\sigma_{CC}^{Q^2 > 400 \text{ GeV}^2} = 38.1 \pm 2.9(\text{stat.}) \pm 0.8(\text{sys.}) \pm 2.0(\text{lumi.}) \pm 0.8(\text{pol}) \text{ pb}$$

CC cross section vs. polarization

ZEUS

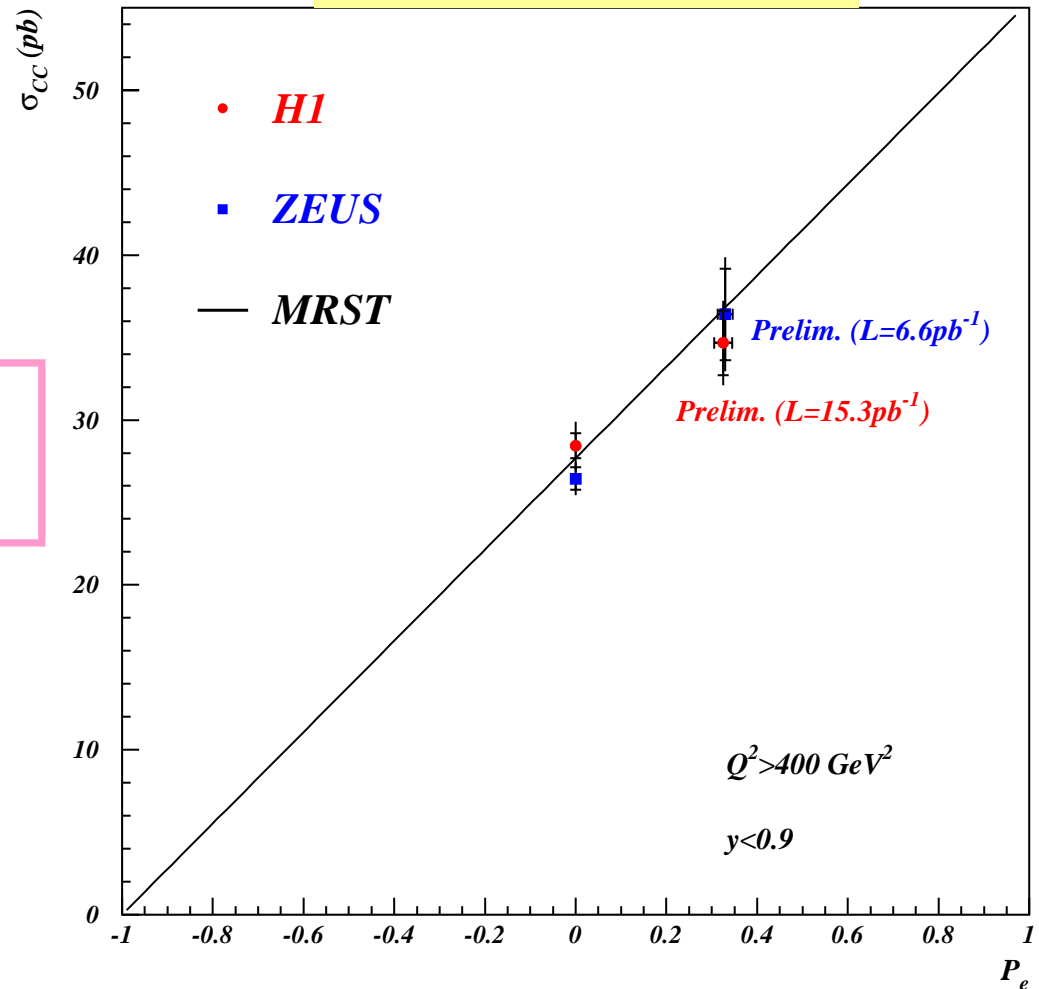
2.8 σ above the
HERA I results with
unpolarized lepton
(99-00 data)

Consistent with SM
(pol.=33%)



Comparison with H1 result

$Q^2 > 400 \text{ GeV}^2, y < 0.9$



**ZEUS and H1 :
Good agreement**

Summary

▶ First measurement of CC cross section with polarized positron and proton scattering was presented.

▶ The cross section at P=33% was

$$\sigma_{cc}^{Q^2 > 400 \text{ GeV}^2} = 38.1 \pm 2.9(\text{stat.}) \pm 0.8(\text{sys.}) \pm 2.0(\text{lumi.}) \pm 0.8(\text{pol}) \text{ pb}$$

Consistent with the SM prediction

▶ **Good agreement with H1 result**