Status of the ZEUS Collaboration

Mónica L. Vázquez Acosta
HERA: ep Collider

H1: ep interactions

HERA-B: p beam + fixed target

920 GeV protons
27.5 GeV positrons

HERMES: polarised e + fixed target

ZEUS: ep interactions
ZEUS-NIKHEF Group Structure

Seniors:
- Paul Kooijman
- Els Koffeman Tracking Coordinator
- Henk Tiecke
- Leo Wiggers

PostDocs:
- Nicola Coppola Run Coordinator
- Mónica Vázquez Radiation Monitor Coordinator

Students:
- Gabriel Grigorescu Calorimeter DQM
- Avraam Keramidas Calorimeter DQM
Sven Schagen (Jan. 2004)
"Charm in the proton: an analysis of charm production in deep inelastic scattering"

Sjors Grijpink (Apr. 2004)
"Charged current cross section measurement at HERA"

Erik Maddox (Dec. 2004)
"Study of heavy quark production at HERA using the ZEUS microvertex detector"
Background problems in HERA-II solved!

HERA-II no longer current-limited due to backgrounds

Measures taken:
- Additional collimators far upstream of IPs
- Change in masking at ZEUS (critical)
- Additional pump near IP at H1
- Increased conductance of pumping ports
- Warm up of sc magnets during scheduled maintenance
- Steady operations with high beam currents

Shutdown 2003
Peak luminosity ➞ 1.2 pb⁻¹d⁻¹
Best week ➞ 0.9 pb⁻¹d⁻¹
2004 Average ➞ 0.4 pb⁻¹d⁻¹

~50 days of operations lost
Due to major technical failures ➞

Operational efficiency needs to be improved

Problems due to large coasting beam caused by
RF problem and after a vacuum leak NR
Efficiency loss due to:

- Bad conditions in the initial tuning after luminosity is declared, which prevents to switch on the tracking chambers
- DAQ problems which now have been solved

Most of the ZEUS data is good MicroVertexDetector(MVD) data
• All vertices in the XY plane with $-25 \text{ cm} < Z < 25 \text{ cm}$
• The interactions in the material of the beampipe and the MVD are clearly seen
MVD alignment

minimize the difference between the expected track position and the measured hit position

Before alignment

After alignment

The mismatch distribution has a width of 97 µm after alignment
Impact parameter: point of closest approach of the track to the coordinate where the track is generated.

Useful quantity to tag beauty events.

Tracks with $140 < \phi < 210$ degrees are measured only with two outer cylinders: resolution significantly worse.
Impact parameter resolution from the data

After MVD alignment

Difference of two independent tracks so divide by $\sqrt{2} : \frac{83}{p_T} + 47 \, \mu m$

MC resolution  impact parameter resolution : $\frac{56}{p_T} + 18 \, \mu m$ (perfect geometry)

This satisfies the design criterium of an impact parameter resolution of 100 $\mu m$
• No evidence of significant radiation damage
  - Mean signal size stable
  - Uncontrolled proton beam loss (4 Nov 03) caused 10% drop in signal
  - Big effort of HERA to reduce the risk to <1 till end of running
  - Noise shows a shallow slope
  - Corresponds to 6 kRad in 500 days on innermost cylinder
  - 25 kRad expected by the end of HERAII
  - Front end chips tested to 300 kRads

• Detector in good shape
  - Bad channels stable <2%
  - First physics results with the MVD...
**D⁺: charm tagging with the MVD**

Erik Maddox

Submitted to ICHEP2004

The combinatorial background is reduced by a factor 45 and the signal by a factor 2.7
Event display of a DIS $D^+$ candidate

$Q^2 = 160 \text{ GeV}^2$

$pt(D^+) = 5.1 \text{ GeV}$
$D^* \rightarrow D^0 \pi_S \rightarrow k \pi \pi_S$

$p_t(D^*) > 1.5 \text{GeV}$

$p_t(D^*) > 2.5 \text{GeV}$

$0.142 < \Delta M(D^* - D^0) < 0.148$
**Beauty tagging:**

*semi-leptonic decays to muons in dijet events*

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**ZEUSS**

- ZEUS (prel.) 03-04 (31 pb⁻¹)
- beauty MC
- beauty + charm + lf MC

**beauty fraction:**

\[ 16.1 \pm 2.7 \% \]

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**Beauty mass larger:**

distribution of the transverse momentum of the muon wrt the jet axis is expected to be harder

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Status of the ZEUS Collaboration, Mónica L. Vázquez Acosta (NIKHEF)
**Impact parameter:**

distance of closest approach of the muon with respect to the primary vertex

**Expected beam width:**
\[ \sigma_X \approx 112 \, \mu m, \, \sigma_Y \approx 32 \, \mu m \]

**Measured vertex resolution:**
\[ \sigma_X \approx 100 \, \mu m, \, \sigma_Y \approx 140 \, \mu m \]

- Difference of the positive and negative \( \delta \)
- Compatible with beauty+charm prediction and the beauty fraction obtained with the \( p_t^{\text{rel}} \) fit

Combined \( p_t^{\text{rel}}, \, \delta \) fit on the way...
HERA-II: lepton beam longitudinal polarization

Polarization in collisions: 30-40%
Polarization without collisions up to 50%
Faster polarization measurements needed for better optimization

W only couples to left-handed fermions and right-handed antifermions
**PentaQuark Searches in ZEUS**

\[ \Theta^+ \rightarrow K^0_S p \]

\[ M : 1521.5 \pm 1.5(\text{stat})^{+2.8}_{-1.7}(\text{syst}) \text{ MeV} \]

**BW Fit:** \[ \Gamma = 8 \pm 4 \text{ MeV} \]
The NA49 signal ($\Xi^{--}$) search in ZEUS

Clean $\Xi_3^{0/2}(1530)$ but ... No pentaquark signal

$\Xi^{--} \rightarrow \Xi^{-}\pi^{-}$

$\Xi^{-}\pi^{-} \rightarrow \Lambda^0\pi^-$

$\Xi^{-}\pi^{-} \rightarrow p\pi^-$

$\Xi^{--} \rightarrow \Xi^{-}\pi^{-}$

$\Xi^{-}\pi^{-} \rightarrow \Lambda^0\pi^-$

$\Xi^{-}\pi^{-} \rightarrow p\pi^-$

$\Xi^{--} \rightarrow \Xi^{-}\pi^{-}$

$\Xi^{-}\pi^{-} \rightarrow \Lambda^0\pi^-$

$\Xi^{-}\pi^{-} \rightarrow p\pi^-$
The charmed pentaquark search

ZEUS sees no signal for DIS or photoproduction

Upper limit at 95% CL
\[ R = \frac{N(\Theta_C \rightarrow D^*p)}{N(D^*)} \]

- \( R < 0.23\% \)
- \( R < 0.35\% \) for \( Q^2 > 1 \text{ GeV}^2 \)
- \( R < 0.29\% \) for \( Q^2 < 1 \text{ GeV}^2 \)

Universal upper limit
\[ f(c \rightarrow \Theta_C) \cdot B_{\Theta_C \rightarrow D^*p} < 0.16\% \]

R \( \sim 1\% \) excluded at 9\( \sigma \)

\[ M(D^*p) = \Delta M^{\text{ext}} + M(D^{*+})_{\text{PDG}} \text{ (GeV)} \]
Searching for:

- $\Upsilon_c \rightarrow D^* p$
- $\Upsilon^+ \rightarrow K_S p$

in DIS events

- $Q^2 > 20 \text{ GeV}^2$
- $0.03 < y < 0.7$
- $40 < E_{-pz} < 65 \text{ GeV}$

Proton identification

**MVD $dE/dx**

**dE/dx determination**

1) Path length normalisation: $PH_{new} = PH \times \cos(\Psi)$.

2) Truncated mean: To reduce effect of the landau tail, the biggest $PH_{new}$ is discarded.

3) Final averaging: The remaining $PH_{news}$ are simply averaged.
Pentaquark searches in HERA-II data
Avraam Keramidas

\[ \Theta_C \rightarrow D^* p \]

\[ \Theta^+ \rightarrow K_s p \]
Currently in the **startup phase of electron running**
HERA has not run with electron beams since 1999 (L=17 pb\(^{-1}\))

\[
\frac{d^2\sigma}{dx\,dQ^2}(e^\pm p \rightarrow e^\pm X) = \frac{2\pi\alpha^2}{xQ^4}\left[Y_+ F_2(x,Q^2) \mp Y_- xF_3(x,Q^2) - y^2 F_L\right]
\]

\( xF_3 \) is obtained from the difference of \( \sigma(e^-p) - \sigma(e^+p) \)
Precision currently limited by low e\(^-\) statistics
### First e⁻ event (photoproduction candidate)

**Date:** 6-12-2004  
**Time:** 02:26:55

<table>
<thead>
<tr>
<th>Event 5</th>
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<tbody>
<tr>
<td><strong>Zeus Run 52258</strong></td>
<td><strong>E=114 GeV</strong></td>
<td><strong>E₁=15.4 GeV</strong></td>
<td><strong>E₂=28.2 GeV</strong></td>
<td><strong>E₃=99.7 GeV</strong></td>
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<tr>
<td></td>
<td><strong>Eₐ=13.2 GeV</strong></td>
<td><strong>p₁=0.802 GeV</strong></td>
<td><strong>p₂=-0.788 GeV</strong></td>
<td><strong>p₃=0.15 GeV</strong></td>
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<tr>
<td></td>
<td><strong>phi=2.95</strong></td>
<td><strong>t₁=-0.95 ns</strong></td>
<td><strong>t₂=-100 ns</strong></td>
<td><strong>t₃=0.0218 ns</strong></td>
</tr>
</tbody>
</table>

**XY View**

**ZR View**

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Prospects

2005 HERA runs with electrons
2006 HERA runs with positrons
2007 6-month extension of HERA run

NIKHEF contribution to ZEUS has been reduced by 50% for 2005 and 2006

After 2006 the NIKHEF ZEUS programme is officially ended