Recent results and progress from ZEUS

Matthew Wing (Bristol University)

Summary and outlook

Recent physics highlights

Detector and running conditions

Look at the latest data
Look at last week's data

- Clear physics events seen
- Increased $L/E_{\text{jet}}$
- Simple cleaning cuts
- Photoproduction
- The shutdown
- Have $0.5 \, \text{pb}^{-1}$ of data since

0.5

0

0.5

0

50

100

-100

50

100

-100

50

100

-100

50

100

-100

50

100

-100

50

100

-100

50

100

-100

50

100

-100

50

100
Reasonably clean DIS events

More new data
Background reduction

Redesign of C5a collimator during shutdown

Synchrotron radiation drastically reduced

Not seen in central tracker

z dir

100 50 0

2.75 GeV

N/hits/100 events

Sept 2002

Sept 2003
Running conditions

Need to run below safe CTD current limit

Improved pumping and gradual cleaning of the beam will allow us to run at the maximum currents can run at 100 × 35 mA pre-shutdown level can run at highest expected currents for this year.

Can run up to highest expected improvement in background to improvement.

Improvements in background to pre-shutdown level can run at 100 × 35 mA.

Graphs showing CTD to le (mA) relationship.
State of the detector

Microvertex Detector:
- Rate of radiation damage currently within limits
- No. bad channels < 2%
- Rate of radiation damage currently
- MVD being aligned
- First data coming in
- Repairs have been successful

Straw Tube Tracker:
- MVD being aligned

State of the detector
Global Tracking Trigger (GTT) will give improved triggering

Comparison with previous SLT (NB. real data, online algorithm, no MVD so far)

Resolution improved by factor 6

Inst. Lumi. (10^30 cm^-2 s^-1)

FLT rate (Hz)

2003 Fall

width = 13.83 ± 0.352 cm

2003 Spring

width = 2.354 ± 0.198 cm
Physics results

Physics results

Adendum: Have produced 6.25 papers since the last PRC.

HEP

Search for single-top production in $ep$ collisions at HERA

Isolated tau leptons in events with large missing transverse momentum at HERA

Observation of $K^0\bar{K}^0$ resonances in deep inelastic scattering at HERA

Measurement of Bose-Einstein correlations in one and two dimensions in deep inelastic scatter-

Measurement of the open-charm contribution to the diffractive proton structure function

Measurement of $D^*\rightarrow D^{\pm}\pi^0$ production in deep inelastic scattering at HERA

Measurement of high-$p_T\phi$ charged current cross sections in deep inelastic scat-

Measurement of elastic scattering at HERA

Physics results
Charged current reactions in e+p DIS

CC reactions provide flavour-specific probes of the PDFs

Excellent description of the data by the Standard Model

In agreement with the more precise measurements in time-like region

\[ M_W \approx 78.9^{+2.0}_{-2.0} \mathrm{GeV} \]

Fixing \( p_t \) and using:

\[ \frac{\Gamma(W^+)}{\Gamma(W^- + Z)} \propto \frac{\Gamma(p/\bar{p})}{\Gamma(p/\bar{p})} \]

Standard Model

Excellently describes the data by the equation:

\[ \left( s + p \right) (s - t) + 2 + n \Rightarrow (X^{d+} \leftrightarrow d + \bar{d}) \]

of the PDFs

CC reactions provide flavour-specific probes.
Final inclusive measurement $d_+\phi (x, Q^2)$ to come soon

Large potential for new data

Reasonable agreement of NLO fit with data

Combine with $d_+\phi$ structure function for data

Charge current structure function

Reasonable agreement of NLO fit with data

Combine with $d_+\phi$ structure function for data
D* production in DIS

Have about 5500 \(D^*\) mesons for analysis

Some difference in shape; can the PDF be fitted to describe the data?

Good description by NLO QCD

Direct sensitivity to the gluon in the proton

D* production in DIS
used as additional constraint uncertainty comparable data can be
At lowest $Q^2$, data and theory density increasing indicative of large gluon steep rise of data to low $x$ with
Reasonable description by NLO QCD fit
Have good(ish) precision up to 30 GeV
Extending up to $Q^2 = 500$ GeV
Recently added extra 31 points,

\[
\frac{G(z,x)}{G(z,\text{theo})} \times \frac{\delta G(z) \equiv \frac{X \cdot G \leftarrow d \varepsilon_{\text{theo}}}{\delta} \frac{\delta G(z)}{\delta \varepsilon_{\text{meas}}}}{\frac{X \cdot G \leftarrow d \varepsilon_{\text{theo}}}{\delta} \frac{\delta G(z)}{\delta \varepsilon_{\text{meas}}}} = \frac{G(z,x)}{G(z,\text{meas})}
\]
D*production indiffractive DIS

Diffractive processes contribute to the total DIS cross section.

Events have clear experimental signatures — large rapidity gap.

QCD factorization has been proven (Collins) for these class of events can measure „diffractive parton distributions”.

Evolution with according to DGLAP equations.

Extract parton densities and predict charm production.

Events have clear experimental signature — large rapidity gap.

D* production in diffractive DIS.
Data shows sensitivity to parton density parametrisations. Some parametrisations are ruled out. One parametrisation is consistent with data. Factorisation approach works. Data can be used in future PDF fits. ZEUS 98-00 NLO QCD ACTW fit B, 1.3 < m_c < 1.6 GeV. ZEUS 98-00 ACTW, fit D. ZEUS, fit SG. Q^2 = 25 GeV^2 x_{IP} = 0.02. D* production in diffractive DIS.
Bose-Einstein correlations are related to the spatial dimensions of the production source. Use BE correlations to get handle on size and shape of hadronisation region.

Dependence on $p_T$ and $x$ on the hard process?

Change partonic-interaction size; what happens to hadronic-source size?

$H(Q^2)$: ratio of particle densities

$R(Q^2)$: 4-momentum separation

$Q^2$: ratio of particle densities

$Q^2$: 4-momentum separation

BE correlations are related to the spatial dimensions of the production source.
No dependence on $Q^2$ heavy-ion collisions
Not the same as in hadronic and

$Q^2 (\text{GeV}^2)$

ZEUS 96 - 00

H1 6 $Q^2 > 100 \text{ GeV}^2$

ZEUS 96 - 00

Not the same as in hadronic and

$Q^2 (\text{GeV}^2)$

ZEUS

Bose-Einstein correlations

The size of the quark scattering region does not depend upon the region of the Breit frame

Same in the current and target

$\lambda = 0.78 \pm 0.01(\text{stat.}) \pm 0.16(\text{syst.}) \text{ fm}$

$\gamma = 0.66 \pm 0.09(\text{stat.}) \pm 0.036(\text{syst.}) \text{ fm}$

Not the same as in hadronic and
Search for flavour-changing neutral current processes and other processes beyond the Standard Model and hadronic channels. Have looked in positron, muon channels.

Multivariate method used to extract high tau leptons.

Clear experimental signature.

Isolated tau leptons

Neutral current processes

Search for flavour-changing
Look forward to more data and better tagging (of heavy flavours) at HERA II

Production of isolated leptons consistent with Standard Model

<table>
<thead>
<tr>
<th>1 $\mu^+$ / 0.07 $\pm 0.02$ (71%)</th>
<th>0 $\pm 0.95$ / 1.16 (61%)</th>
<th>0 $\pm 0.94$ / 1.11 (61%)</th>
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<tbody>
<tr>
<td>2 $\pm 0.2$ / 0.5 (49%)</td>
<td>5 $\pm 2.15$ / 0.5 (50%)</td>
<td>$\cancel{\text{expected}}$</td>
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An excess of $\mu^+$ events seen

<table>
<thead>
<tr>
<th>$\tau^+$ contribution</th>
<th>$\tau^-$ contribution</th>
<th>$\tau^+$ contribution</th>
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</thead>
<tbody>
<tr>
<td>Obs. / Exp. $\tau^-$</td>
<td>Obs. / Exp. $\tau^+$</td>
<td>Obs. / Exp. $\tau^-$</td>
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Electron

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<th>$L = 1.30 \times 10^3 \text{pb}^{-1}$</th>
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<td>$d_{\tau^+} = 1.994-2000 , \text{GeV}$</td>
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ZEUS

Isolated leptons
Search for single top production

Final combination of muon, positron and hadronic channels

Assuming $\lambda_1^2 = \lambda_2^2$

ZEUS providing competitive limits;

Improved simulation of $Z$-exchange process providing substantial region excluded, (soon)

ZEUS (prel.) 94-00

and hadronic channels

Excluded by CDF

Excluded by L3

Excluded by ZEUS

0.2 0.4 0.6 0.8 1

$M_{\text{top}} = 170$ GeV

$M_{\text{top}} = 175$ GeV

$M_{\text{top}} = 180$ GeV

CDF

ZEUS

CDF

ZEUS

CDF

ZEUS

$K_{\text{exp}} = 0.0$

Exclusion region

Assuming $Z_{\text{exp}} > 0.174$ at 95% CL

Final combination of muon, position

search for single top production
Ready for lots more data like:

ZEUS physics output is high, producing a wealth of new results

Summary and outlook