MEASUREMENT OF HIGH-X NEUTRAL CURRENT CROSS SECTIONS WITH THE ZEUS DETECTOR

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A new method is employed to measure the neutral current cross section up to Bjorken-x values equal to one with the ZEUS detector at HERA using an integrated luminosity of 82 pb^{-1}. Cross sections have been extracted for $Q^2 > 500$ GeV^2 and are compared to Standard Model predictions using different parton density functions.

1. Introduction

There is only limited data on cross sections at high-x and high Q^2. In the DIS regime, the BCDMS Collaboration [1] has measured structure functions up to $x = 0.75$, while the ZEUS [2] and H1 [3] Collaborations have reported structure function measurements up to $x = 0.65$. This leads to poorly determined PDFs at the highest x. Figure 1 shows the ratio of the cross section calculated from selected PDFs to that calculated from CTEQ6D [4] as a function of x. There are large differences, despite the fact that the parametrizations used in extracting these PDF's are very similar. Data at the highest possible values of x are needed to pin down the parton densities in this region. A new method is presented which allows the extraction of cross sections up to $x = 1$. The method is applied in a re-analysis of ZEUS data from 1998-2000.

2. Method

At high Q^2, the HERA kinematics dictates that the electron is scattered at a large angle and with typically high energy. This is clear from Fig. 2, where contours of constant electron scattered energies and angles are displayed in the x, Q^2 plane. The scattered electron (or positron) is therefore seen with

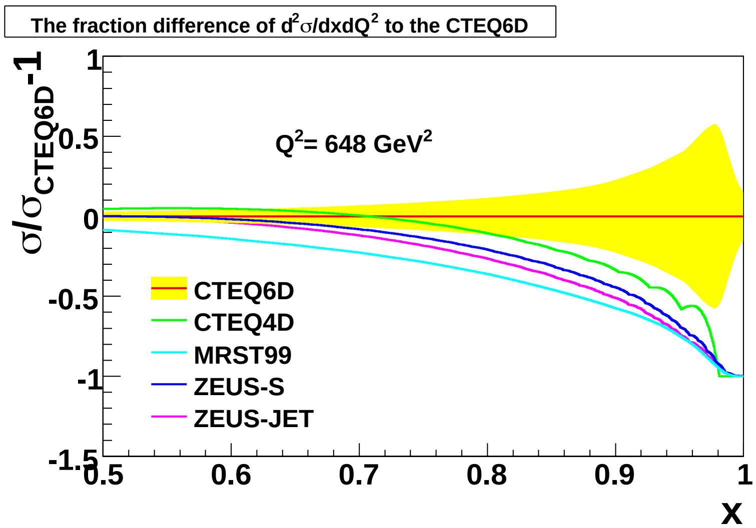

Figure 1. Ratio of the NC cross section at $Q^2 = 648$ GeV^2 calculated using different PDFs as labeled in the figure to that calculated using CTEQ6D. The band shows the uncertainty arising from the CTEQ6D one sigma error.

approximately 100% acceptance, independently of x. The contours for the scattered quark energy and angle are also shown in the figure. For not too high x, the jet resulting from the scattered quark is seen clearly in the detector and the jet energy and angle can be used to measure x. As x increases, a part of, and eventually the whole of the jet disappears in the beam hole. While these events can be counted, it is no longer possible to measure x. We define a Q^2 dependent x cut, x_{edge}. For $x < x_{\text{edge}}$, the value of x is calculated from the scattered jet energy and angle and a double differential cross section, $\frac{d^2\sigma}{dxdQ^2}$ is measured. For $x > x_{\text{edge}}$, an integrated cross section is measured:

$$\int_{x_{\text{edge}}}^{1} \frac{d^2\sigma}{dxdQ^2} dx \quad .$$

Q^2 is calculated from the electron angle and energy in both cases.

3. Results

Electron-proton and positron-proton scattering data collected by ZEUS in the years 1998-2000 have been reanalyzed using this new measurement technique. The results are shown in Figs. 3 as the ratio to the Standard Model

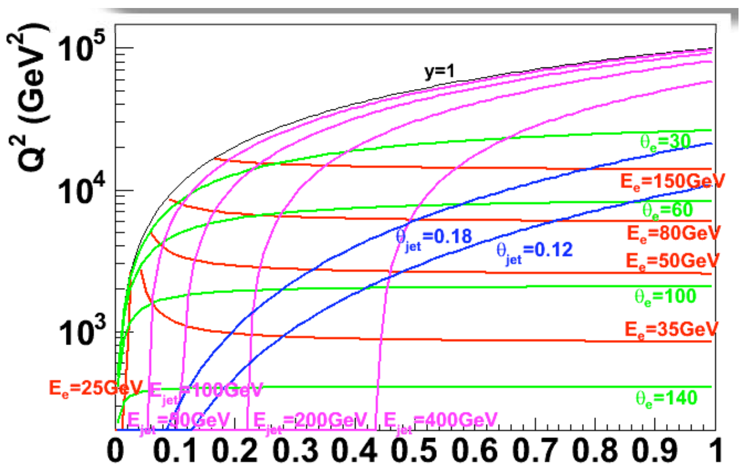

Figure 2. Contours of constant electron and jet angle and energy in the $x - Q^2$ plane.

expectations using the CTEQ6D PDFs. For the highest x bins, the measured data is plotted at the center of the bin, but they should be understood as integrated cross sections for the bin. The uncertainty is dominated by the statistical uncertainty almost everywhere. The systematic uncertainty is dominated by the knowledge of the jet energy scale (1% uncertainty), which results in a 0-7% systematic uncertainty on the cross section.

At the lower values of x, the data are in good agreement with the expectations. There is a tendency for the data to lie above the expectations at the highest values of x. In the region where measurements with this technique overlap the previous measurements, excellent agreement has been found. These data are expected to have an impact on the extraction of the PDF's at the highest values of x, and, via sum rules, also on the PDF's at smaller x.

References

1. BCDMS Coll., A.C. Benvenuti et al., *Phys. Lett.* **B223**, 485 (1989).
2. ZEUS Coll., S. Chekanov et al., *Phys. Rev.* **D70**, 052001 (2003).
3. H1 Coll., C. Adloff et al., *Eur. Phys. J.* **C30**, 1 (2003).
4. J. Pumplin et al., *JHEP* **0207**, 012 (2002).

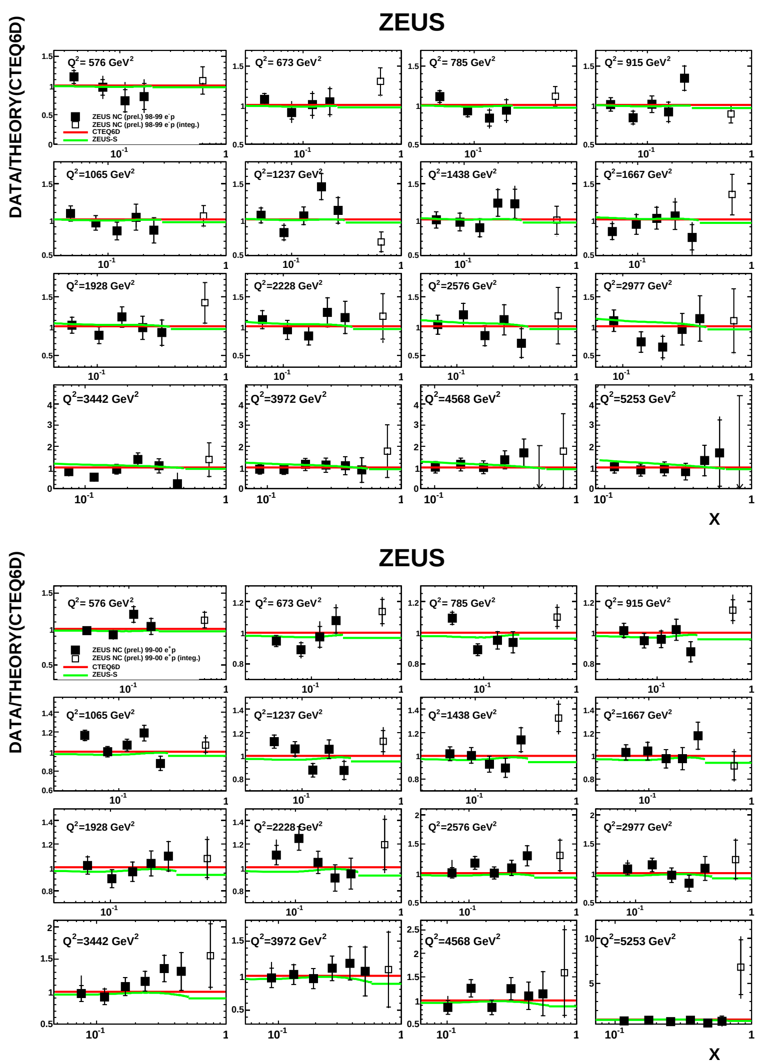

Figure 3. Ratio of the double differential cross sections for 98-99 e^-p (top) and 99-00 e^+p (bottom) NC scattering (solid squares) and the integral of the double differential cross section divided by the x bin width (open squares) to the Standard Model expectation evaluated using the CTEQ6D PDF. The inner error bars show the statistical uncertainty while the outer error bars show the statistical and systematic uncertainty added in quadrature. The ratio of the expectations using the ZEUS-S PDFs to those using the CTEQ6D PDFs are also shown. For bins with zero measured events, a 68% probability limit is given.