Inclusive Jet Cross Section in Neutral Current Deep Inelastic Scattering

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The differential inclusive jet cross sections for the reaction $ep \to e + jet + X$ have been measured by the ZEUS detector at HERA for $Q^2 > 125$ (500, 1000, 2000) GeV^2. The sample of analysed events corresponds to an integrated luminosity of 42.5 pb^{-1}. Jets were identified in the laboratory frame using k_T cluster algorithm. Jets were required to have axis in the pseudorapidity range $-1 < \eta < 2$ and the transverse momentum greater then 14 GeV. The differential inclusive jet cross sections were measured as a function of the jet pseudorapidity η, transverse energy E_T and Q^2.

1. INTRODUCTION

The Deep Inelastic Neutral Current scattering is mediated by an exchange of a virtual boson ($\gamma^\star$, Z^0) between the electron and a parton in the proton. In the naïve Quark-Parton-Model, this process leads to the final state which consists of the struck quark and the proton remnant. In the first order in α_s these are the processes: QCD-Compton scattering (QCDC), where a gluon is radiated by the scattered quark and Boson-Gluon Fusion (BGF), where the virtual boson and a gluon fuse to form a quark-antiquark pair. Both processes have 2 partons and proton remnant in the final state. But at HERA energies the higher order QCD processes contribute significantly.

At HERA, multijet events are observed mainly at large virtuality of the exchanged boson Q^2. Thus the measurement of cross sections for high Q^2 and high E_T jets in NC DIS allowes to test the perturbative QCD calculations.

The differential inclusive jet cross sections $d\sigma/d\eta$ and $d\sigma/dE_T$ are presented for $E_T >$ 14 GeV, $-1 < \eta < 2$ and for different Q^2 regions ($Q^2 > 125$, 500, 1000, 2000 GeV^2). The differential inclusive jet cross section $d\sigma/dQ^2$ was measured for $E_T > 14$ GeV and $-1 < \eta < 2$.

2. JET SEARCH AND DATA COLLECTION

The jets were reconstructed using k_T cluster algorithm [1] in the laboratory frame. At the detector level, the jet finding was performed using the calorimeter (CAL) cells after excluding those containing energy deposited by the scattered positron. The same algorithm was also applied to the hadrons of the MC samples. The reconstructed jets were required to have a minimum transverse energy of $E_T > 14$ GeV and a pseudorapidity in the range -1 $< \eta <$ 2.

The events from the neutral current DIS interactions were selected off-line using the similar criteria as reported in [2]. The scattered positron candidate is identified by using the pattern of energy deposits in the CAL and it is required to have an energy larger than 10 GeV. The Q^2 variable is determined using double-angle method [3], which uses the angle of the scattered positron and the angle of the scattered quark. Both angles are determined from the CAL measurements. The event sample was limited to the kinematic range $Q^2 > 125\,\mathrm{GeV}^2$.

3. RESULTS

The measurement of the inclusive differential jet cross sections for the reaction $e^+p \to e^+ + jet + X$ were done at the hadron level.

The presented differential cross sections $d\sigma/d\eta$ and $d\sigma/dE_T$ for the kinematical region: $E_T >$ 14 GeV, jets pseudorapidity $-1 < \eta < 2$ and for different Q^2 regions ($Q^2 > 125$, 500, 1000, 2000 GeV^2). $d\sigma/d\eta$, as shown in the Fig. 1 decreases as Q^2 increases, however the shape of the distribution remains approximately unchanged.

The Monte Carlo Ariadne 4.08 prediction describes well the data.

$d\sigma/dE_T$ cross section is presented for different Q^2 regions in Fig. 2.a. For $Q^2 > 125\ \mathrm{GeV}^2$ MC Ariadne 4.08 describes the data well. However, for high Q^2 and low E_T jets this model is not sufficient to reproduce measurements. For $Q^2 \approx 2000\ \mathrm{GeV}^2 \gg (E_T)^2 \approx (14\ \mathrm{GeV})^2 \approx 200\ \mathrm{GeV}^2$ the QCD is tested in the kinematical region where E_T^2 scale is order of magnitude lower than Q^2 scale. The differences between the Ariadne 4.08 and the measurement for $Q^2 > 2000\ \mathrm{GeV}^2$ are quantified in Fig. 2.b.

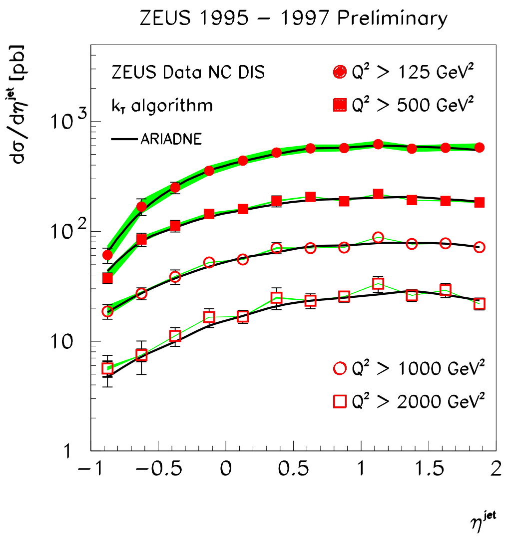

Figure 1. The differential inclusive jet cross section $d\sigma/d\eta$ at the hadron level for different Q^2 regions. The inner (outer) bars indicate the statistical error (statistical and systematical errors added in quadrature). The shaded area shows the jet energy scale uncertainty. The measured cross sections corrected to hadron level (open and black points or squares) are compared to the MC model Ariadne 4.08 (solid line).

The differential inclusive jet cross section $d\sigma/dQ^2$, is shown in Fig. 3.a, for $E_T > 14$ GeV and $-1 < \eta < 2$. For low Q^2 MC Ariadne 4.08 reproduces well the data, however the high Q^2 tail seems to be underestimated. The discrepancies between Ariadne 4.08 and the data are summarized in Fig. 3.b.

4. SUMMARY

In this paper the differential inclusive jet cross sections in NC DIS using the data collected by ZEUS detector were presented. They correspond to integrated luminosity of $42.5\mathrm{pb}^{-1}$. The measured cross sections $d\sigma/d\eta$, $d\sigma/dE_T$, $d\sigma/dQ^2$ are based on the jets search at the hadron level, using the k_T cluster algorithm. The Monte Carlo Ariadne 4.08 predictions give overall good description of the shape and magnitude of the measured cross sections, except for high Q^2 (Fig. 3) and low E_T jets (Fig. 2), where deviations can be observed.

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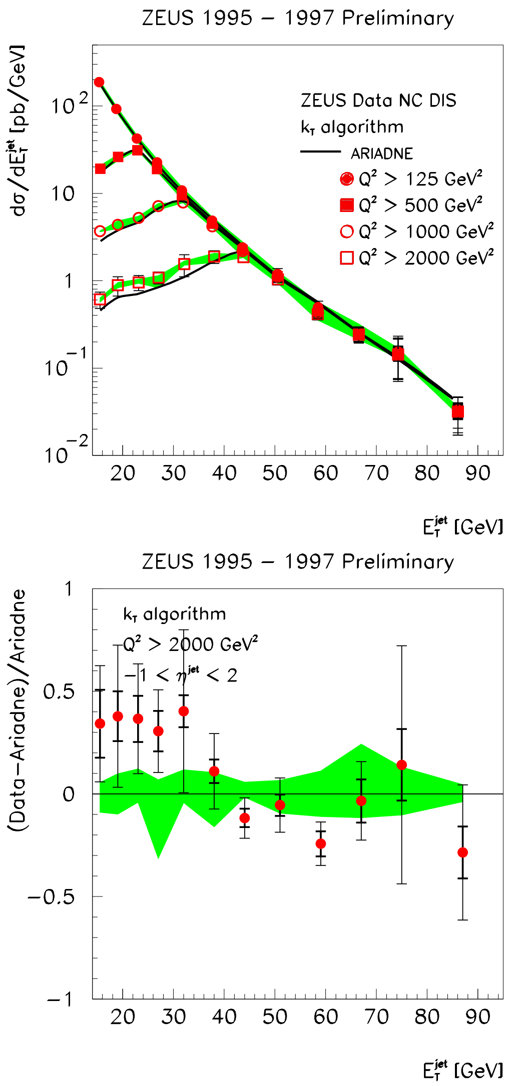

Figure 2. a) The differential inclusive jet cross section $d\sigma/dE_T$ at the hadron level for different Q^2 regions. The inner (outer) bars indicate the statistical error (statistical and systematical errors added in quadrature). The shaded area shows the jet energy scale uncertainty. The measured cross sections corrected to the hadron level (open and black points or squares) are compared to MC model Ariadne 4.08 (solid line). b) The difference between the measurement and Ariadne 4.08, normalized do Ariadne 4.08 predictions.

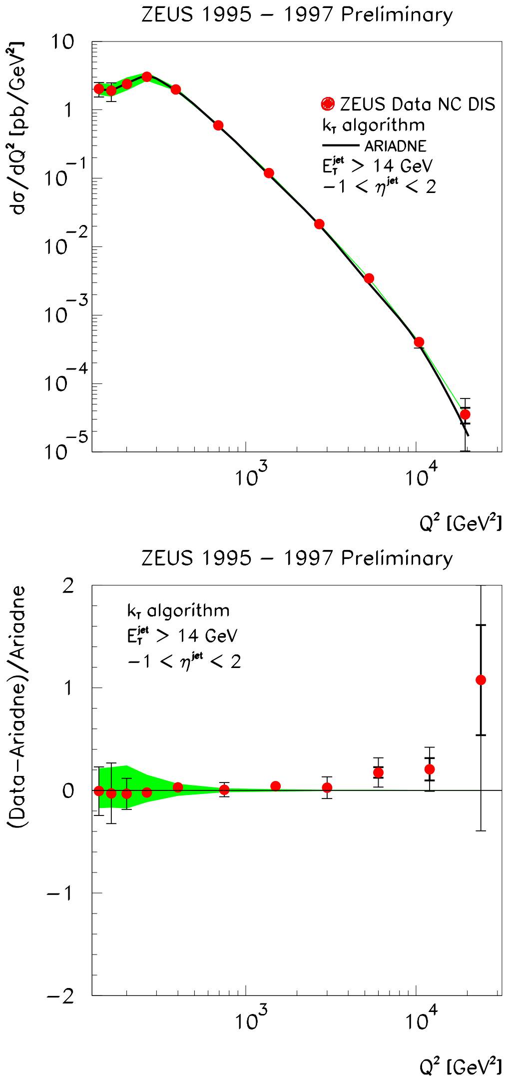

Figure 3. a) Differential inclusive jet cross section $d\sigma/dQ^2$ at the hadron level. The inner (outer) bars indicate the statistical error (statistical and systematical errors added in quadrature). The shaded area shows jet energy scale uncertainty. The measured cross sections corrected to the hadron level (black points) are compared to MC model Ariadne 4.08 (solid line). b) The difference between measurement and Ariadne 4.08, normalized do Ariadne 4.08 predictions.