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# INCLUSIVE-JET AND DIJET CROSS-SECTIONS IN HIGH-$Q^2$ DIS AT HERA

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A new ZEUS measurement of inclusive-jet and dijet cross-sections in the Breit frame performed in deep-inelastic ep scattering data is presented. The data correspond to an integrated luminosity of about 82 $\text{pb}^{-1}$ and are resctricted to the kinematic regime $Q^2 > 125$ GeV$^2$ and -0.65 $< \cos\gamma_{had} <$ 0.65, where $Q^2$ is the photon virtuality and $\cos\gamma_{had}$ corresponds to the polar angle of the hadronic system. The cross-sections are measured as functions of various kinematic and jet observables and are compared to NLO QCD calculations which describe the data well within all uncertainties.

## 1. Introduction

Jet measurements provide stringent tests of the concepts of perturbative QCD and factorisation and offer access to the central parameter of QCD, the strong coupling constant $\alpha_S$. In addition, jet cross-sections as measured in ep collisions at HERA are sensitive to the proton parton distribution functions (PDFs). This fact has been exploited recently by the ZEUS collaboration who included jet cross-section measurements from both photoproduction and deep-inelastic scattering (DIS) into their NLO QCD fits for the PDFs[1].

In this contribution a new measurement of inclusive-jet and dijet cross-sections in DIS at high values of the negative squared four-momentum of the exchanged boson, $Q^2 > 125$ GeV$^2$, is presented. The data used in the analysis extend previous analyses both in statistics, considering almost three times that of an earlier analysis of inclusive-jet cross-sections at ZEUS[2], and in kinematic range (proton energy $E_p$ of 920 GeV instead of 820 GeV).

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For both the inclusive-jet and dijet measurement the data are presented as double-differential cross-sections in $Q^2$ and in the jet transverse energy in the Breit frame, $E_T$ (for the inclusive-jet analysis) and in $Q^2$ and $\xi$ (for the dijet analysis, $\xi \equiv x_{Bj} \cdot \left(1 + M_{jj}^2/Q^2\right)$ is the momentum fraction carried by the struck parton). These observables provide optimal sensitivity to the parton distributions functions and might therefore serve as input to future QCD fits of the proton PDFs.

## 2. Data Selection, Correction and Theoretical Predictions

The data used in the analysis were collected with the ZEUS detector at HERA in the years 1998-2000 and correspond to an integrated luminosity of 81.7 $\text{pb}^{-1}$. The phase space of the analysis is defined by the following two requirements: $Q^2 > 125$ GeV$^2$ and -0.65 $< \cos\gamma_{had} <$ 0.65. Here, $\cos\gamma_{had}$ is the polar angle of the hadronic system which, in events of the Quark-Parton Model type, corresponds to the angle of the struck quark. In case of the dijet analysis $Q^2 < 5000$ GeV$^2$ was required in addition in order to restrict the data to a regime where the $Z^0$ exchange can savely be neglected. Jet reconstruction is performed using the longitudinally invariant $k_T$ algorithm[3] in the inclusive mode[4] in the Breit frame. Jets were then selected requiring their pseudorapidity to be in the interval -2 $< \eta_{Breit} <$ 1.5 and to have transverse jet energies of at least 8 GeV (inclusive-jet analysis) or 12 GeV and 8 GeV (dijet analysis).

The data were corrected for detector efficiency and acceptance effects using the LEPTO[5] (dijet analysis) or ARIADNE[6] Monte Carlo (MC) models (inclusive-jet analysis). Also higher-order QED effects were taken into account using these MC models.

The NLO QCD calculations used for the comparison with the data were performed with the DISENT program[7] using the latest CTEQ6 proton PDFs[8]. Since the calculations provide jets of partons whereas the corrected data correspond to jets of hadrons, the NLO QCD calculations were corrected to the hadron level using the average of the corrections predicted by the LEPTO and ARIADNE models. The inclusive-jet predictions were in addition corrected for the effects of the $Z^0$ exchange.

## 3. Systematic Checks

On the theory side, the uncertainty of the hadronisation correction, the uncertainties due to the uncertain knowlegde of the strong coupling parameter $\alpha_S$ and on the input proton PDFs and the uncertainty due to neglected

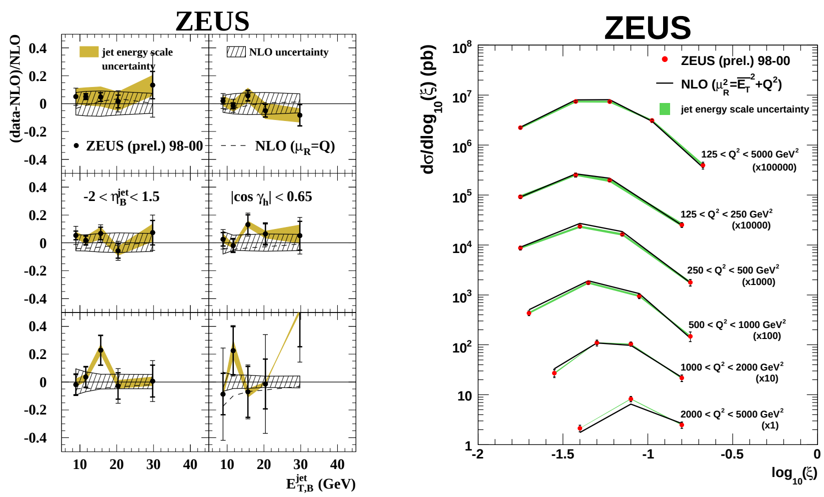


Figure 1. Left: Ratio $(data - NLO)/NLO$ for the inclusive-jet analysis in 6 different regions of $Q^2$ as functions of $E_T$. Right: Double-differential dijet cross-sections in different regions of $Q^2$ as functions of $\log \xi$. The data points are compared to the NLO QCD calculations. See text for more details.

higher orders in the perturbative expansion were considered. The last contribution, which was estimated by a variation of the renormalisation scale by a factor 2 up and down, is dominating, with effects on the predicted cross-sections of up to 20% in certain kinematic regions. In a few regions, especially at high $Q^2$, also the PDF uncertainty gets significant, reaching up to 4%.

The main experimental uncertainty comes from the uncertainty on the hadronic energy scale. This uncertainty, which is assumed to be the only correlated uncertainty leads to effects on the cross-sections of typically 10%.

## 4. Results

Inclusive-jet cross-sections were measured double-differentially in regions of $Q^2$ as functions of $E_T$. The data are well described by the NLO QCD calculations within all uncertainties. Figure 1 (left) shows, in 6 different regions of $Q^2$, the ratio $(data - NLO)/NLO$ together with statistical and uncorrelated systematic uncertainties. The shaded band indicates the correlated systematic uncertainty due to the jet energy scale, and the hashed area gives the theoretical uncertainty.

The dijet cross-sections were measured single-inclusively in various kinematic and dijet observables like $Q^2$, invariant dijet mass $M_{jj}$ or $\log \xi$ and are in general well described by the QCD calculations. In addition, double-differential dijet cross-sections as functions of $\log \xi$ in 5 different regions of $Q^2$ were measured. Also these distributions are well reproduced by the theoretical predictions, although at high values of $Q^2$ statistical effects start to dominate. Figure 1 (right) shows the measured double-differential cross-sections together with the NLO predictions.

The contribution of gluon-induced events to the total cross-section was also estimated as a function of $Q^2$ separately for both the inclusive-jet analysis and for the dijet analysis. It was observed that even for very high $Q^2$ values around 3000 GeV$^2$ there is still a substantial contribution from gluon-induced processes of about 30% for the dijet case and about 20% for the inclusive-jet analysis. The observed theoretical uncertainties due to the uncertainty in the gluon density were sizeable; therefore these data promise further constraints on the gluon density when included in QCD fits.

## 5. Conclusion and Outlook

Dijet cross-sections at high values of $Q^2 > 125$ GeV$^2$ have been measured single- and double-differentially in various kinematic and dijet quantities. In addition, inclusive-jet cross-sections were studied double-differentially in bins of $Q^2$ as functions of the jet transverse energy.

The very precise data extend former ZEUS measurements of inclusive-jet and dijet cross-sections in high-$Q^2$ DIS. They are well described by the NLO QCD calculations and provide access to the parton distribution functions of the proton, especially the gluon density at high values of the proton momentum fraction. Therefore, the measurements are natural candidates for future use in NLO QCD fits of the parton densities.

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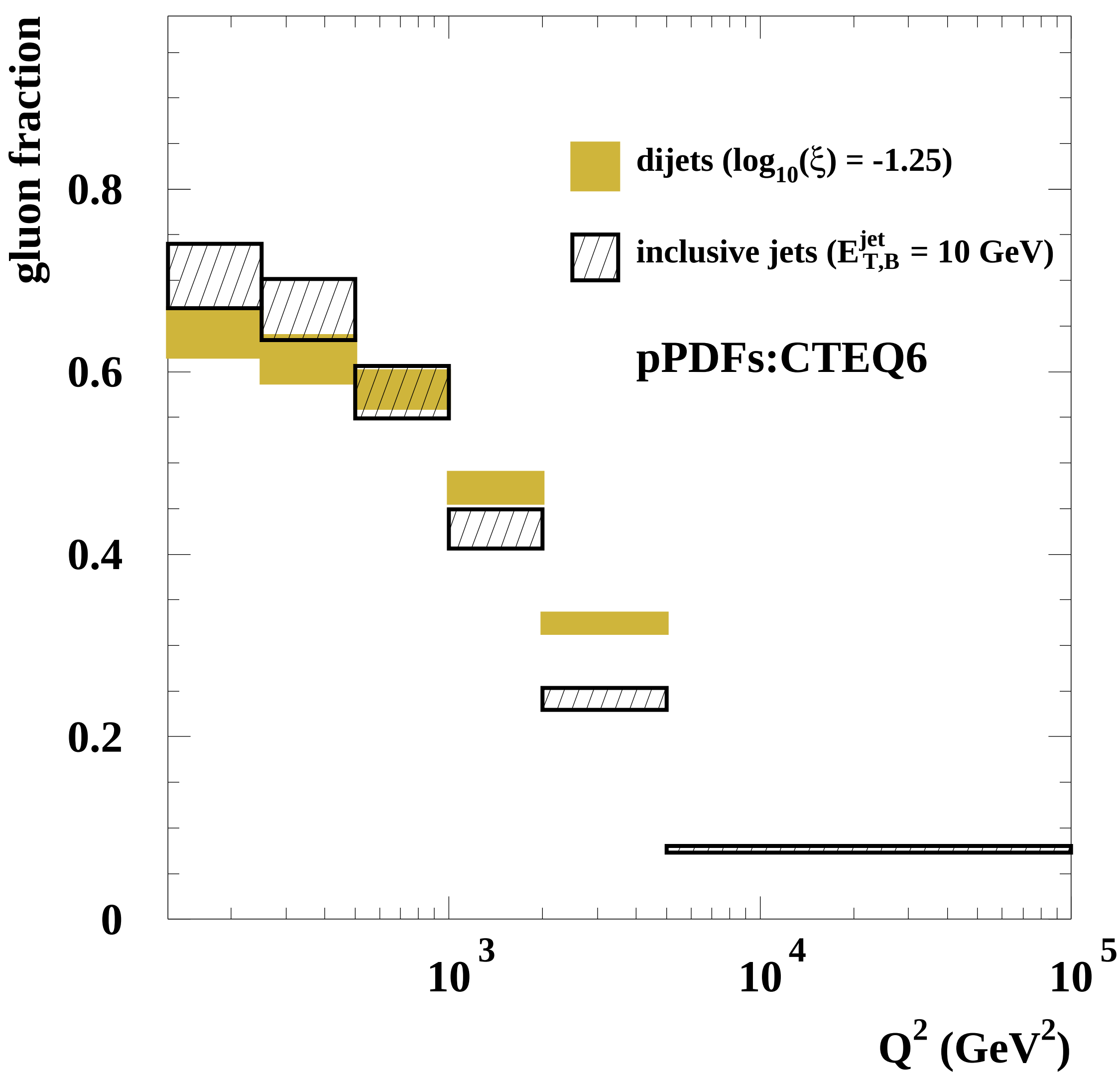

gluon fraction
0.8
0.6
0.4
0.2
0
dijets ($log_{10}(\xi)$ = -1.25)
inclusive jets ($E_{T,B}^{jet}$ = 10 GeV)
pPDFs:CTEQ6
$10^3$
$10^4$
$10^5$
$Q^2$ ($GeV^2$)