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DIJETS IN PHOTOPRODUCTION*

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Dijet cross sections as functions of several jet observables are measured in photoproduction using the H1 detector at HERA. The data sample comprises ep data with an integrated luminosity of 34.9 pb^{-1}. Jets are selected using the inclusive $k_{\rm t}$ algorithm with a minimum transverse energy of 25 GeV for the leading jet. The phase space covers longitudinal proton momentum fraction x_p and photon longitudinal momentum fraction x_γ in the ranges $0.05 < x_p < 0.6$ and $0.1 < x_\gamma < 1$. The predictions of next-to-leading order perturbative QCD, including recent photon and proton parton densities, are found to be compatible with the data in a wide kinematical range.

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1. Introduction

In QCD (Quantum Chromo Dynamics) the photoproduction of jets is described by the hard interaction of real photons with partons inside the proton. The photon can either interact directly or first split into partons and one of the resulting partons subsequently participates with only a fraction x_γ of the photon momentum in the hard interaction. This classification into *direct* and *resolved* processes can only unambiguously be defined in leading order (LO).

Calculations of photoproduction processes have been performed up to Next-to-Leading Order (NLO) [1]. High transverse energy jets provide a natural hard scale for perturbative QCD calculations. The jet cross sections can be written as a convolution of the proton and photon parton density functions (pdfs) with the partonic hard cross sections.

This article summarizes measurements of dijet cross sections in photoproduction with mean jet transverse energies $20 < E_{\rm T} < 80$ GeV. The dijets

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are selected using the inclusive k_t algorithm [2,3] with minimum transverse energy of 25 GeV for the highest E_T jet and 15 GeV for the second highest E_T jet in the pseudorapidity range $-0.5 < \eta < 2.5$. The longitudinal momentum fraction y of the electron taken by the interacting photon is restricted to the range $0.1 < y < 0.9$. The details of the analysis can be found in [4,5].

2. Measurements

The measured cross sections for inclusive dijet photoproduction are given as single differential cross sections. The data are corrected for detector effects. The inner error bars of the data points in the figures denote the statistical, the outer error bars the total uncertainty. All results are compared to next-to-leading order (NLO) QCD predictions. The predictions of NLO QCD corrected for hadronization effects NLO $(1+\delta_{\rm hadr})$ are also shown. The NLO QCD calculations use the CTEQ5M parameterization of the proton pdf and the GRV-HO parameterization of the photon pdf. The renormalization scale and the factorization scales were set to the sum of the transverse energies of the outgoing partons divided by two. This scale was varied from 0.5 to 2 times the default scale to estimate the NLO scale uncertainty shown as a grey band in the figures.

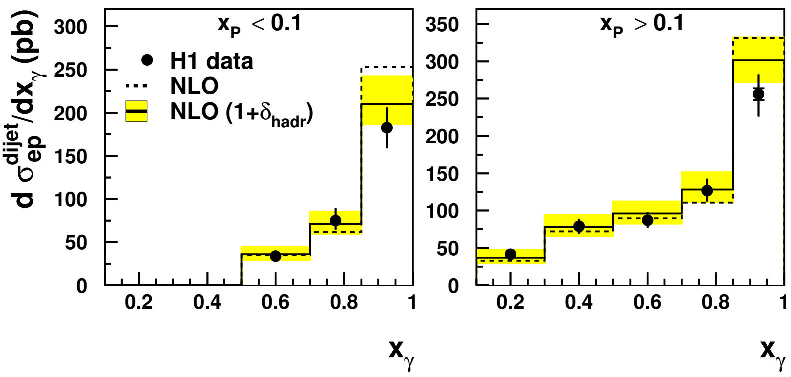

Fig. 1. Dijet cross section $d\sigma/dx_\gamma$ as a function of x_γ.

Figure 1 shows the dijet cross section $d\sigma/dx_\gamma$ as a function of x_γ for two different x_p regions. The calculation exceeds the data, still remaining within the uncertainties, only at high x_γ, where the hadronization corrections are large. The gluon uncertainty has a 15% uncertainty on the dijet cross section at high x_p.

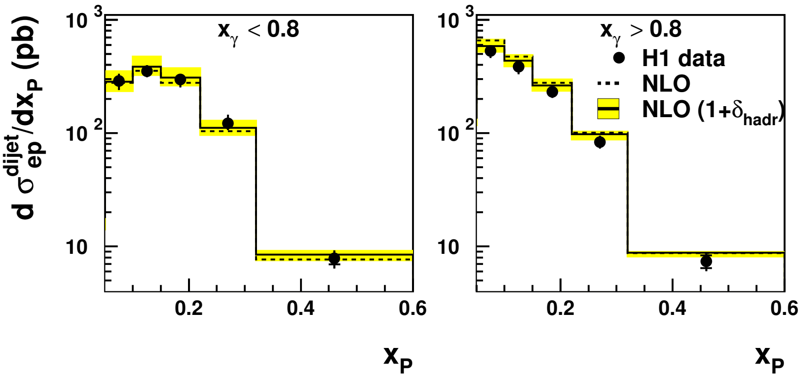

Fig. 2. Dijet cross section $d\sigma/dx_p$ as a function of x_p.

Figure 2 displays the dijet cross section $d\sigma/dx_p$ as a function of x_p for two different x_γ regions. NLO QCD gives a good description of the data up to the highest x_p, where about 40% of the cross section are due to processes induced by gluons in the proton.

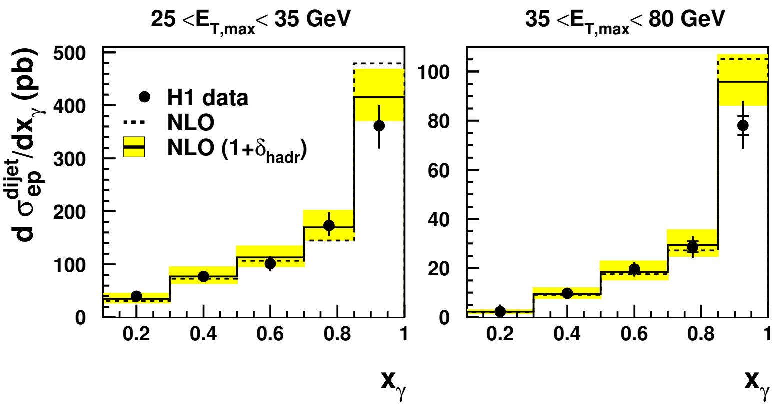

Fig. 3. Dijet cross section $d\sigma/dx_\gamma$ as a function of x_γ.

Figure 3 displays the dijet cross section $d\sigma/dx_\gamma$ as a function of x_γ for two regions of $E_{\mathrm{T,max}}$, representing different factorization scales for the photon and proton pdfs. The NLO scale uncertainty has a significant effect. Moreover the hadronization effects are sizeable at high x_γ and improve the agreement between the NLO prediction and the data.

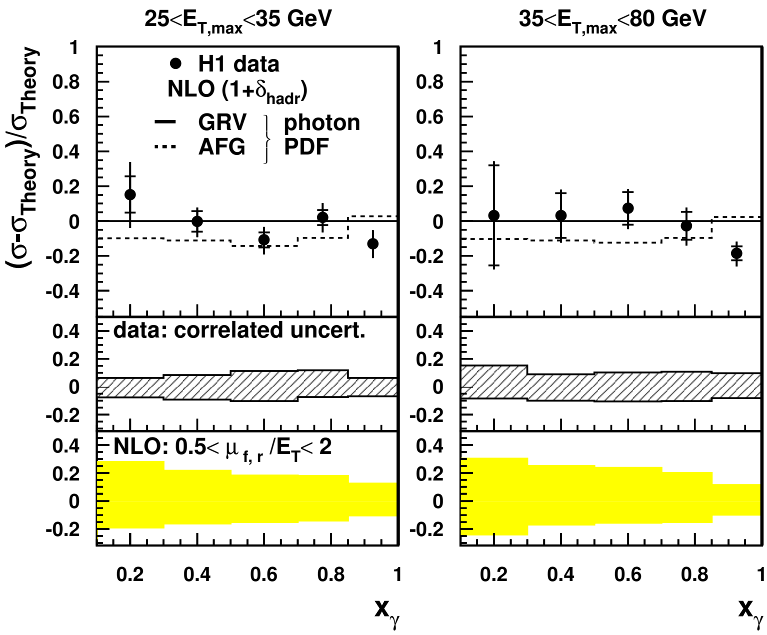

Fig. 4. Dijet cross section $d\sigma/dx_\gamma$ as a function of x_γ.

Figure 4 shows the relative difference between data and theory for the above distributions. In addition to the GRV-HO parameterization of the photon pdf the AFG parameterization is shown. At variance to the other plots the error bars of the data contain only the uncorrelated systematic errors, while the correlated errors due to the calorimeter energy scale uncertainty of 2% are shown as a hatched band. The NLO scale uncertainty is the dominant source of uncertainties. The NLO prediction exceeds the data only at high x_γ and high $E_{\mathrm{T,max}}$, but the two parameterizations of the photon structure still describe the data within the given uncertainties.

Figure 5 displays the dijet cross section $d\sigma/d\cos\theta^*$ as a function of $\cos\theta^*$, where θ^* is the scattering angle in the center-of-mass-system of the partonic two body reaction. It is presented for two regions of x_γ subdivided in two regions of the invariant dijet mass M_{JJ}. These distributions are sensitive to the dynamics of the hard subprocess. At high x_γ the NLO predictions overshoots the data at small $\cos\theta^*$. At high M_{JJ} the phase space effect is restricted and the shape follows the QCD matrix elements expectation.

Figure 6 shows the dijet cross section $d\sigma/dE_{\mathrm{T,mean}}$ as a function of $E_{\mathrm{T,mean}}$. NLO QCD describes the data up to the highest scales. Moreover it is remarkable that the NLO scale uncertainty is less than 5% in the highest $E_{\mathrm{T,mean}}$-bin.

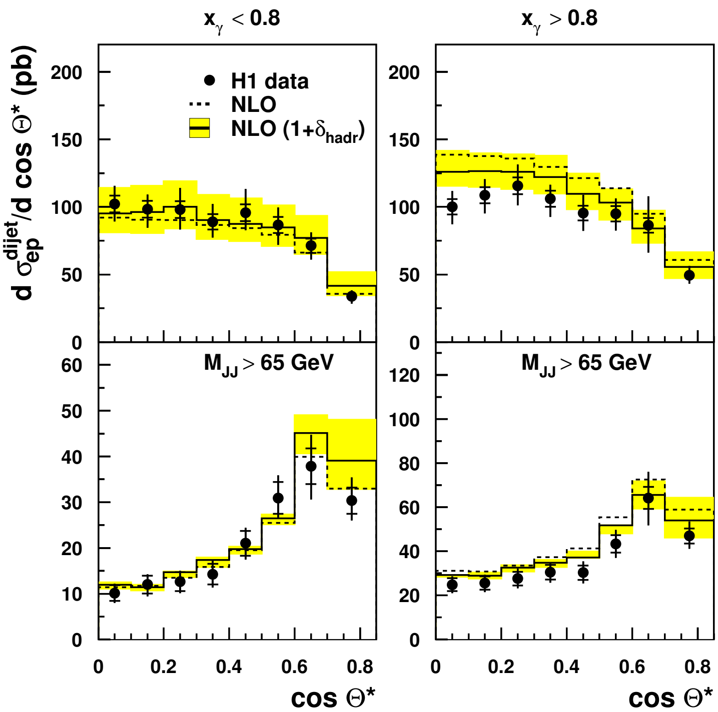

Fig. 5. Relative difference of the measured dijet cross section $d\sigma/dx_\gamma$ to the NLO prediction.

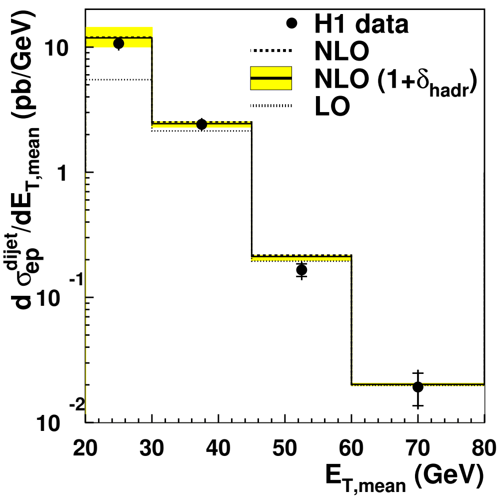

Fig. 6. Dijet cross section $d\sigma/dE_{\mathrm{T,mean}}$ as a function of $E_{\mathrm{T,mean}}$

3. Conclusions

Several dijet observables have been measured in photoproduction at different values of the scale E_{T} and at different x_γ and x_p. The measurements show an overall agreement with NLO QCD. The precision of the data, which is mainly due to the small hadronic energy scale uncertainty, is of the same order of magnitude as the theoretical precision.

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