DECORRELATION OF DIJETS AT LOW x AND Q^2

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Correlations in the azimuthal angle between dijets produced in deep inelastic e^+p scattering events have been investigated. Cross sections are presented as a function of the azimuthal separation between the two jets in the hadronic center of mass frame, $\Delta\phi^*$, in different regions of the photon virtuality Q^2 and in different regions of the Bjorken scaling variable x_{Bj}. The results are compared to the predictions of QCD models implementing LO matrix elements, matched parton showers and hadronisation as well as to NLO di-jet (α_s^2) and NLO three-jet (α_s^3) parton level calculations corrected for hadronisation effects.

1. Introduction

Dijet production in deep inelastic ep-scattering is at low x dominated by the boson gluon fusion process. In the DGLAP approximation, the dijets are in LO produced back-to-back in the hadronic center of mass (HCM) frame, i.e. the azimuthal angle between the two jets is[a] $\Delta\phi^* = 180°$, and configurations with $\Delta\phi^* < 180°$ can only originate from higher order initial or final state radiation. At low x, initial state radiation is in the DGLAP approximation ordered in k_t which implies that the transverse momentum of the interacting gluon is restricted. However, at low x there may be non-ordering in k_t such that the gluon interacting with the photon may take any kinematically allowed transverse momentum. This would give a broader $\Delta\phi^*$ spectrum[1] compared to that predicted by DGLAP. Also, in approximations using unintegrated gluon densities the gluon has an initial transverse momentum already in LO. Hence, azimuthal correlations at low x could be used to distinguish between various models describing parton dynamics and also to constrain the unintegrated gluon density.

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[a] Observables in the HCM frame are labeled with a *

2. Event Selection

In this analysis, positron-proton data collected by the H1 experiment during 1999-2000 are used, corresponding to an integrated luminosity of $\mathcal{L}_{int} = 64.3$ pb^{-1}. Deep inelastic scattering (DIS) events are selected by requiring $E_e^{'} > 9$ GeV, $156° < \theta_e < 175°$, $5 < Q^2 < 100$ GeV^2 and $0.1 < y < 0.7$ where $E_e^{'}$ and θ_e is the energy and polar angle of the scattered positron, Q^2 is the virtuality of the exchanged photon and y is the inelasticity. Jets are found using the inclusive k_t-algorithm[2] in the HCM frame and must fulfill $-1 < \eta_j < 2.5$ and $E^*_{T,j} > 5$ GeV. If more than two jets are found, the two jets closest to the scattered positron in η are chosen as the dijet system. The data are corrected for limited detector resolution and acceptance using detector simulated QED radiative events generated with the Monte Carlo (MC) programs DJANGOH[3] (with ARIADNE[4]) and RAPGAP[5].

3. Results

The dijet cross section as a function of the azimuthal angle $\Delta\phi^*$ in bins of x_{Bj} is compared to the NLO 2-jet (α_s^2) and NLO 3-jet (α_s^3) calculations obtained using the NLOJET++[6] program. The CTEQ6M[7] PDF is used and the renormalisation and factorisation scales are chosen as $\mu_r = \mu_f = \left(\frac{E^*_{T1}+E^*_{T2}}{2}\right)$. Scale uncertainties are estimated by varying μ_r and μ_f simultaneously a factor 2 up and 1/2 down. The calculations are corrected for hadronisation effects using CASCADE[8]. Because of infrared sensitivity, the NLO calculations give no meaningful predictions in the back-to-back bin ($170° < \Delta\phi^* < 180°$). As seen in Figure 1 the NLO 2-jet calculation, which effectively is a LO prediction for this observable, is clearly not sufficient to describe the data. The NLO 3-jet calculation, effectively being an NLO prediction, is closer to the data, but is systematically low for $\Delta\phi^* < 150°$. However, the scale uncertainties are large, typically 20 - 50%, and cover the data in most bins. When normalising the data to the total cross section between $0° < \Delta\phi^* < 170°$ in each x_{Bj} bin, there is partial cancellation of the scale uncertainties for the NLO calculations. As can be seen in Figure 2, the data is no longer within the scale uncertainties of the NLO 3-jet calculation.

Figure 3 shows the same data as in Figure 1 compared to the predictions of the CCFM based CASCADE MC generator, using A0[9] and J2003 set2[10] for the unintegrated gluon density. Whereas CASCADE (J2003 set2) describes the data fairly well in all but the lowest x_{Bj} bin, CASCADE (A0) fails to describe the data in all bins, predicting too many jets with small

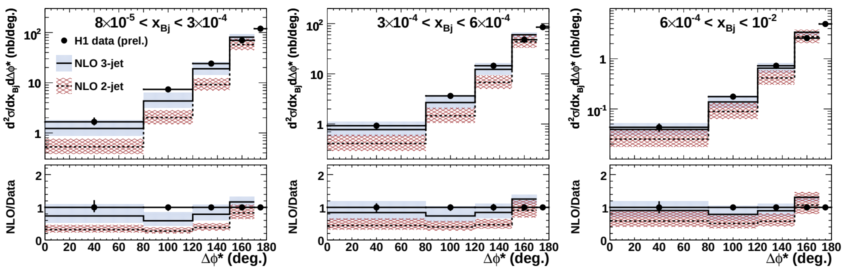

Figure 1. *Dijet cross sections as a function of $\Delta\phi^*$ in bins of x_{Bj}. Data are compared to NLO 3-jet (full line) and NLO 2-jet (dashed line) calculations.*

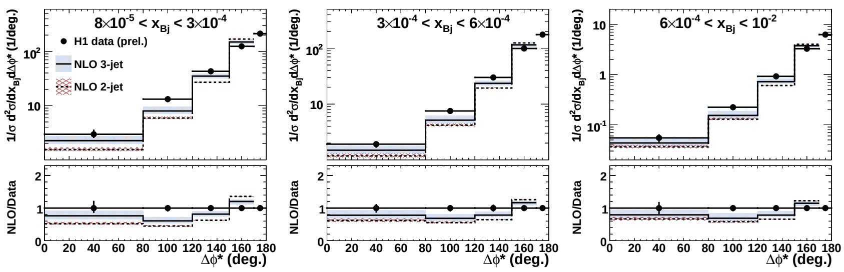

Figure 2. *Dijet cross sections as a function of $\Delta\phi^*$ in bins of x_{Bj} normalised to the visible cross section between $0^\circ < \Delta\phi^* < 170^\circ$ in each x_{Bj} bin. Data are compared to NLO 3-jet (full line) and NLO 2-jet (dashed line) calculations.*

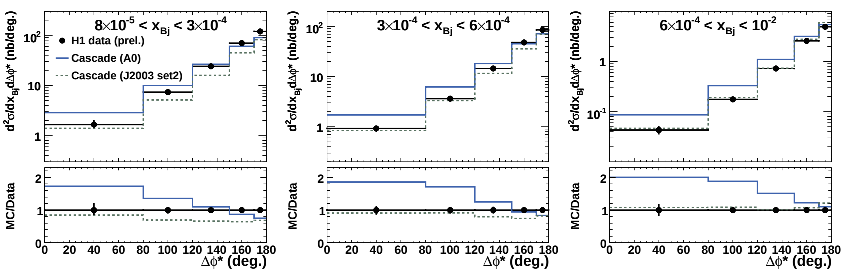

Figure 3. *Dijet cross sections as a function of $\Delta\phi^*$ in bins of x_{Bj} compared to the predictions of CASCADE using two different unintegrated gluon densities.*

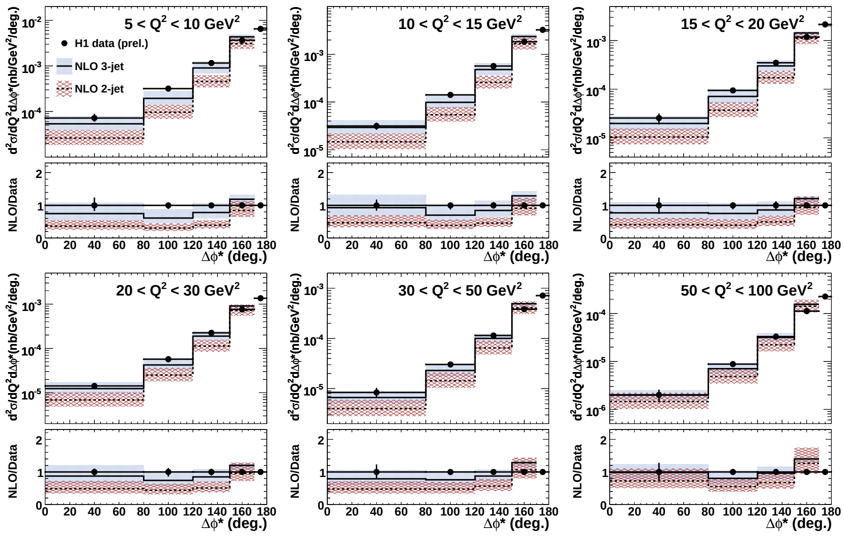

Figure 4. *Dijet cross sections as a function of $\Delta\phi^*$ in bins of Q^2. Data are compared to NLO 3-jet (full line) and NLO 2-jet (dashed line) calculations.*

$\Delta\phi^*$. This indicates that the k_t-spectrum of the gluon distribution of A0 is too hard. In addition to the dijet cross sections in bins of x_{Bj}, the same observable has also been measured in bins of Q^2, shown in Figure 4. The same tendencies are seen as above, also when comparing to CASCADE (not shown).

To summarise, NLO 3-jet calculations are not sufficient to describe the azimuthal decorrelation of dijets at low $\Delta\phi^*$, indicating the need for higher orders. Also, a sensitivity to the unintegrated gluon density is observed.

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