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Measurement of Multijet Production in ep Collisions at Low Q^2 at HERA

H1 Collaboration

Abstract

The production of jets is studied in neutral current deep-inelastic scattering for photon negative four-momentum-transfer squared $5 < Q^2 < 100$ GeV^2 and inelasticity $0.2 < y < 0.65$, using HERA data taken by the H1 detector in the years 2006 and 2007, corresponding to an integrated luminosity of $184\,pb^{-1}$. Jets are defined in the Breit frame using the inclusive k_T cluster algorithm and have a minimum jet transverse momentum P_T of 5 GeV and a pseudorapidity in the laboratory frame of $-1.0 < \eta^{jet}_{lab} < 2.5$. Inclusive jet cross sections are obtained as a function of Q^2 and P_T in the range $5 < P_T < 45$ GeV . Dijet and trijet cross sections are obtained as a function of Q^2 and the average transverse momentum of the two leading jets $\langle P_T^{jet} \rangle$in the range $5 < \langle P_T^{jet} \rangle < 45$ GeV with an additional requirement on the invariant mass of the two leading jets of $M_{\rm jj} > 18$ GeV. The data are corrected for acceptance and resolution effects using a regularised unfolding procedure. The measured cross sections are compared to next-to-leading order QCD predictions using NNPDF3.0 PDF set. Overall good agreement is found.

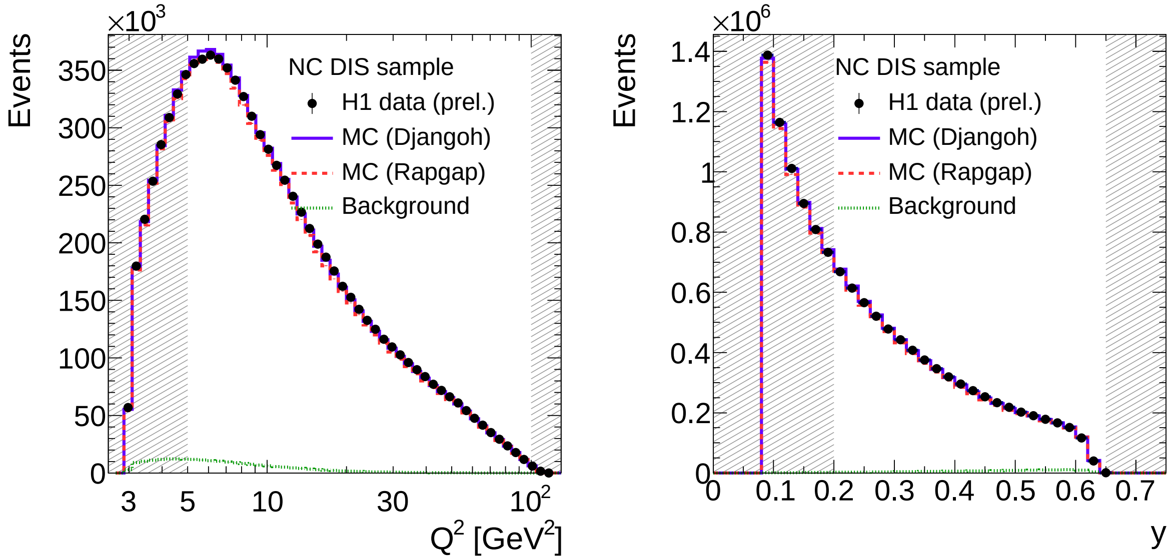

Figure 1: Distributions of Q^2 and y for the selected neutral current DIS data on detector level. The data are compared to predictions obtained from the Rapgap and Djangoh MC generators, which are weighted to achieve a better description of the data. The background is obtained from simulated photoproduction events where the normalisation is obtained from a sample of photoproduction enriched events. The shaded areas indicate kinematic regions which are considered in the extended phase space of the unfolding procedure.

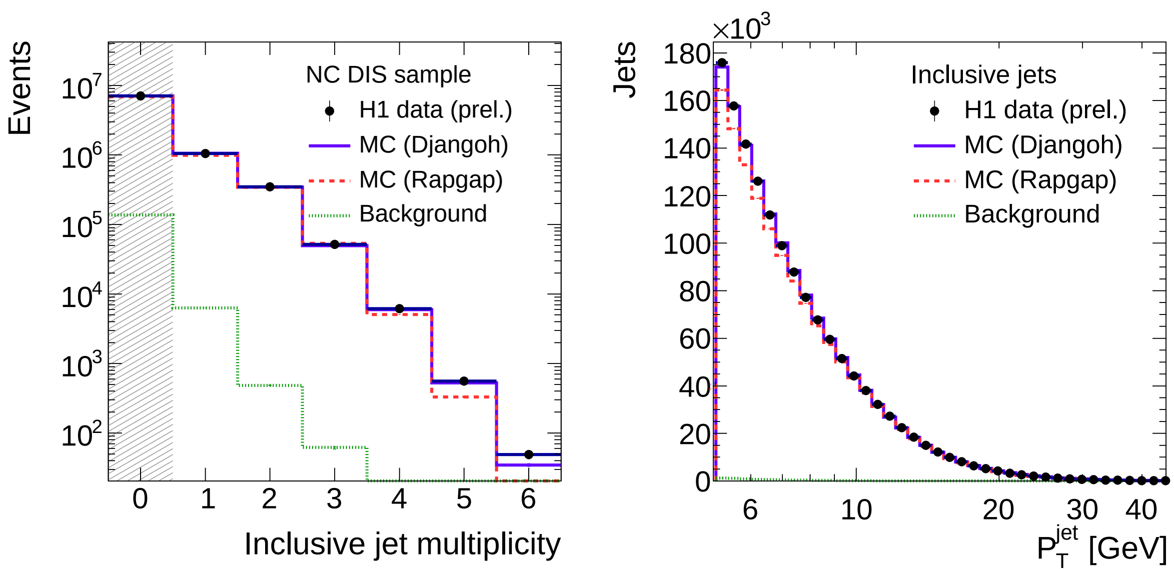

Figure 2: Distributions of the inclusive jet multiplicity for the NC DIS kinematic data and the transverse momenta P_T of the inclusive jet measurement on detector level. Other details as in fig. 1.

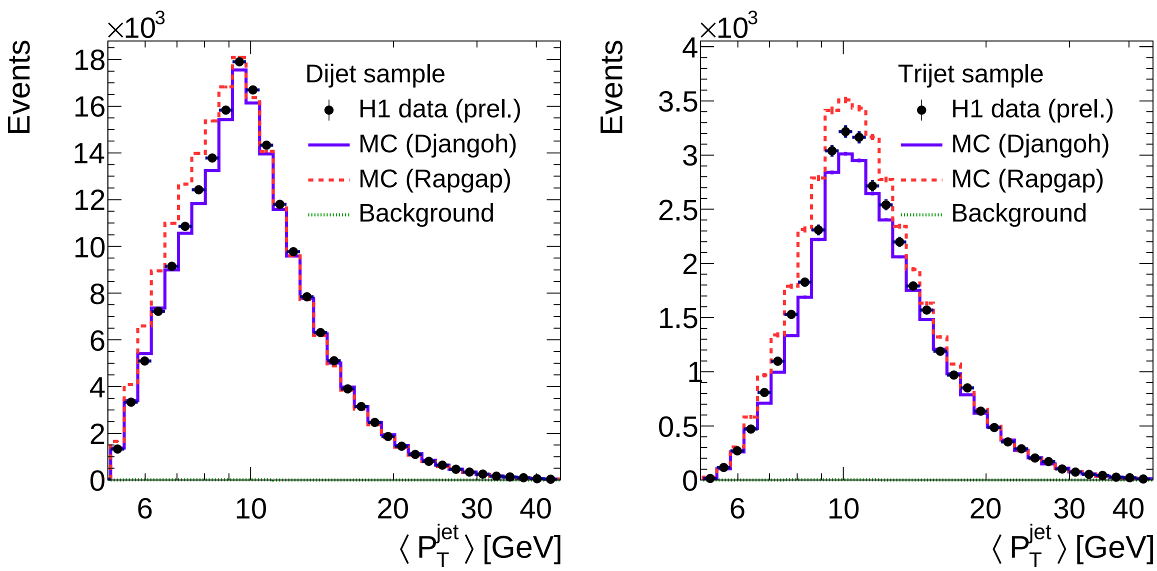

Figure 3: Distributions of $\langle P_T^{jet} \rangle$ of the dijet and trijet data on detector level in the measured phase space. Other details as in fig. 1.

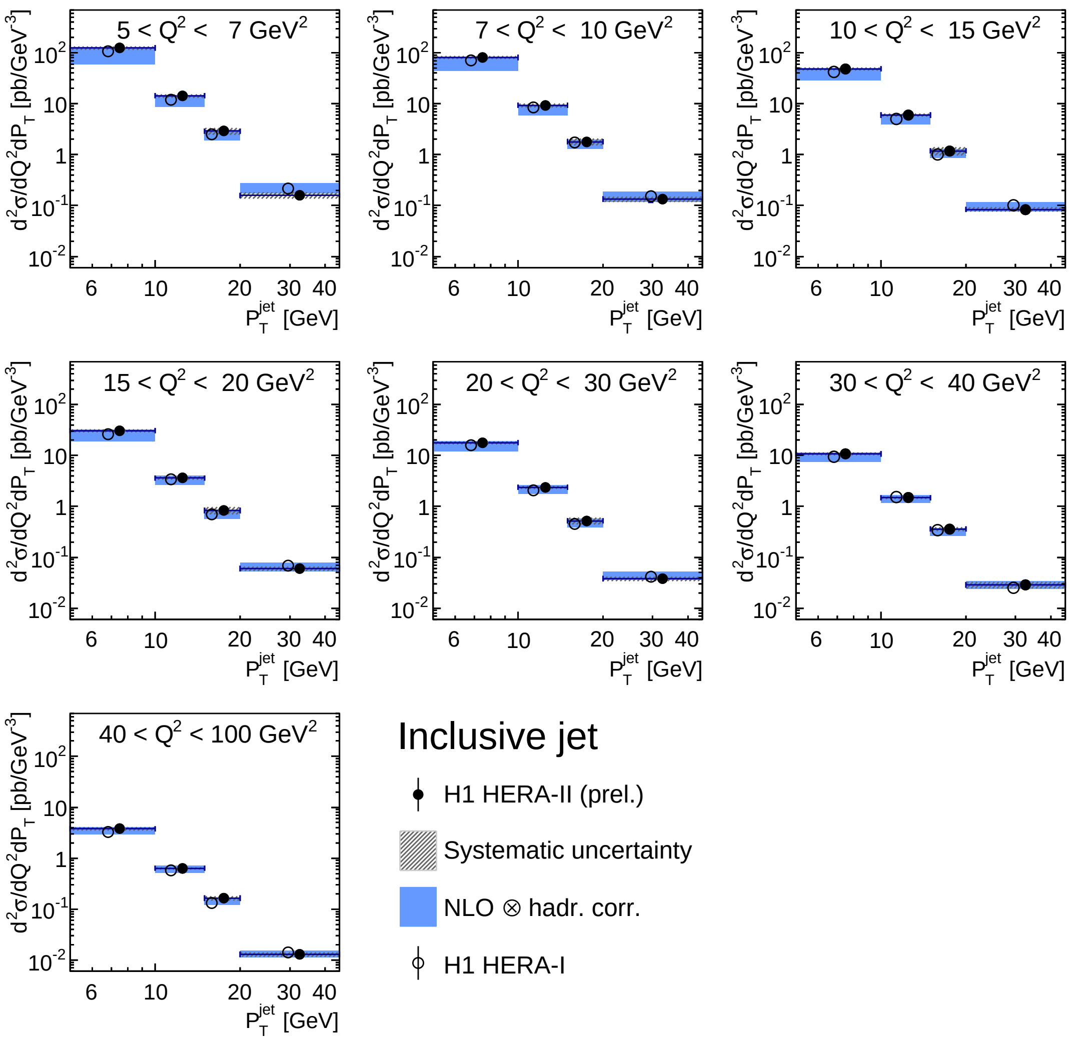

Figure 4: Double-differential cross sections for jet production in DIS as a function of Q^2 and P_T compared to NLO predictions obtained from nlojet++ [1] using NNPDF3.0 PDF set [2], corrected for hadronisation effects. The data are corrected for migration and acceptance effects using a regularised unfolding procedure [3, 4] and are further corrected for QED radiative effects. The band indicates the uncertainty from the so-called 'asymmetric 6-point' scale variation, where the renormalisation and factorisation scales are varied by a factor two, while a simultaneous up- or down-variation is not considered, and the largest deviations from the nominal predictions are taken as uncertainty. The vertical error bars indicate the statistical uncertainties, while there are considerable correlations between adjacent data points (see fig. 7). The shaded areas shows the systematic uncertainties from the variation of the jet energy scale, cluster energy scale, electron angle and electron energy as well as the model uncertainty. The largest systematic uncertainties are the jet and cluster energy scale variation, as well as the model uncertainty. The open circles show the H1 HERA-I measurement in an alomst identical phase space [5]. The statistical correlation towards the dijet and trijet measurements are shown in figure 7.

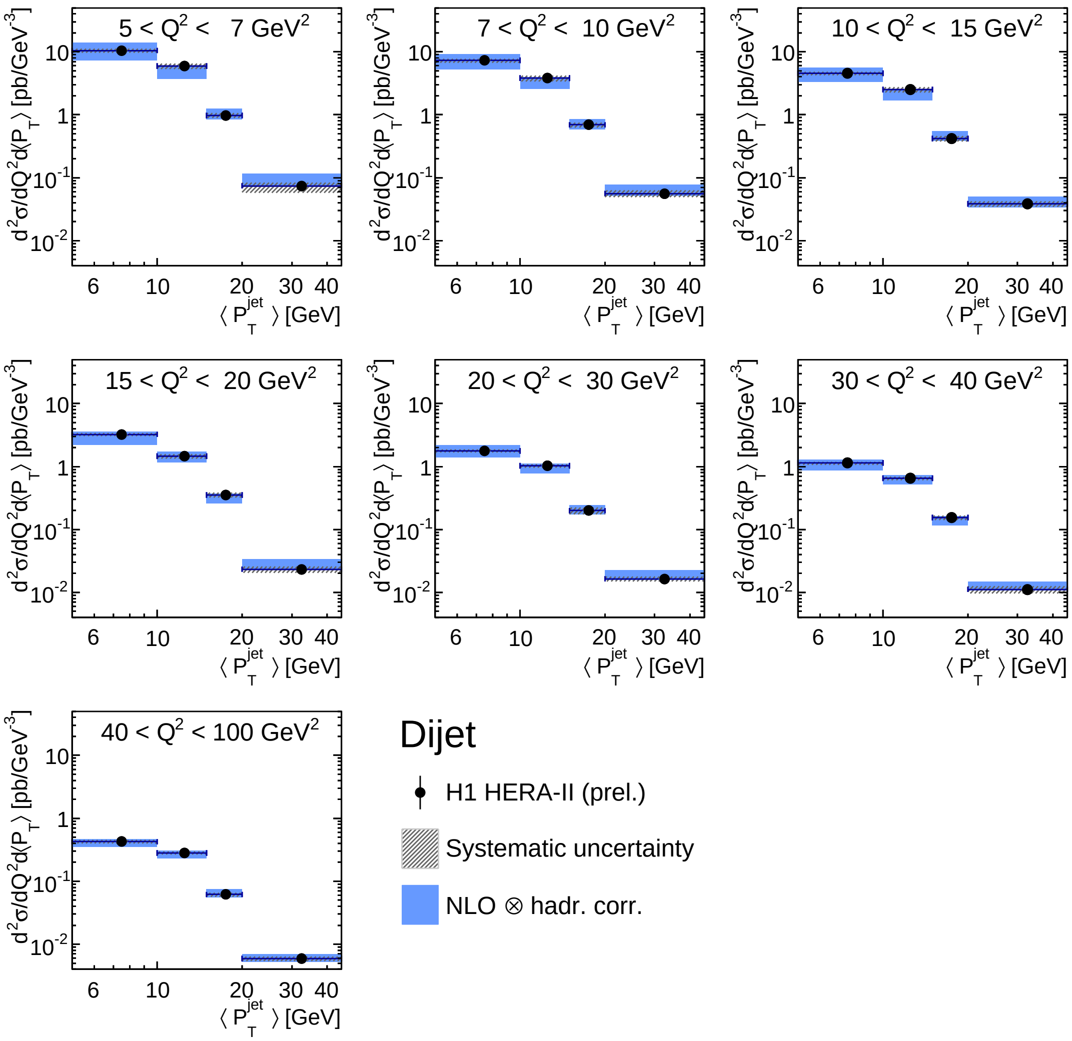

Figure 5: Double-differential cross sections for dijet production in DIS as a function of Q^2 and $\langle P_T^{jet} \rangle$. Other details as in fig. 4.

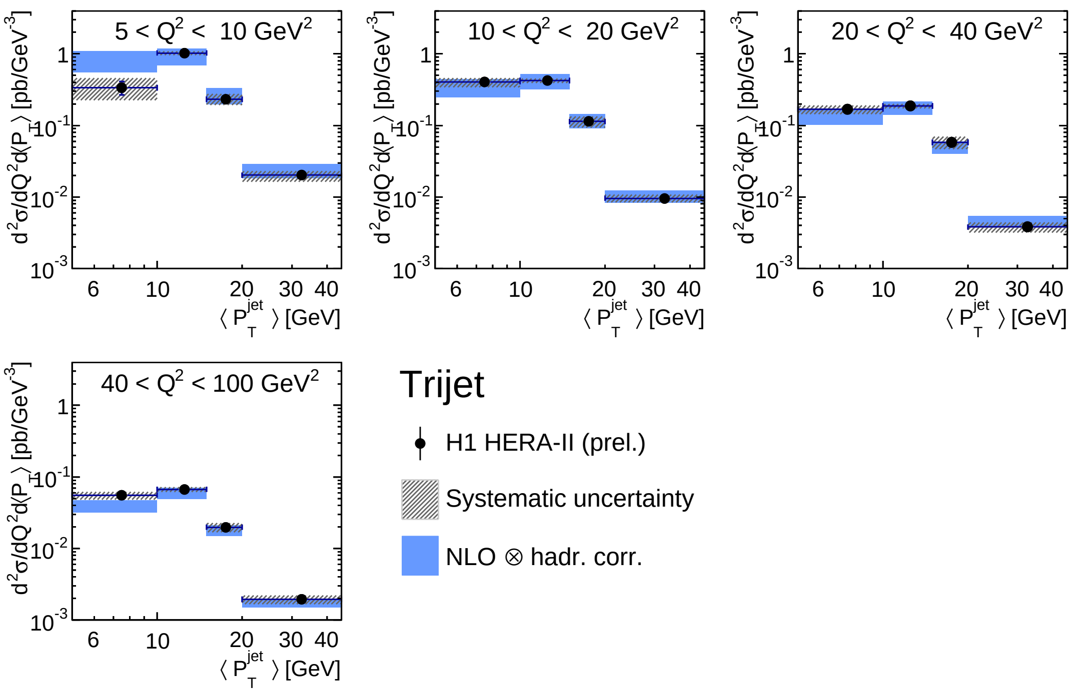

Figure 6: Double-differential cross sections for trijet production in DIS as a function of Q^2 and $\langle P_T^{jet} \rangle$. Other details as in fig. 4.

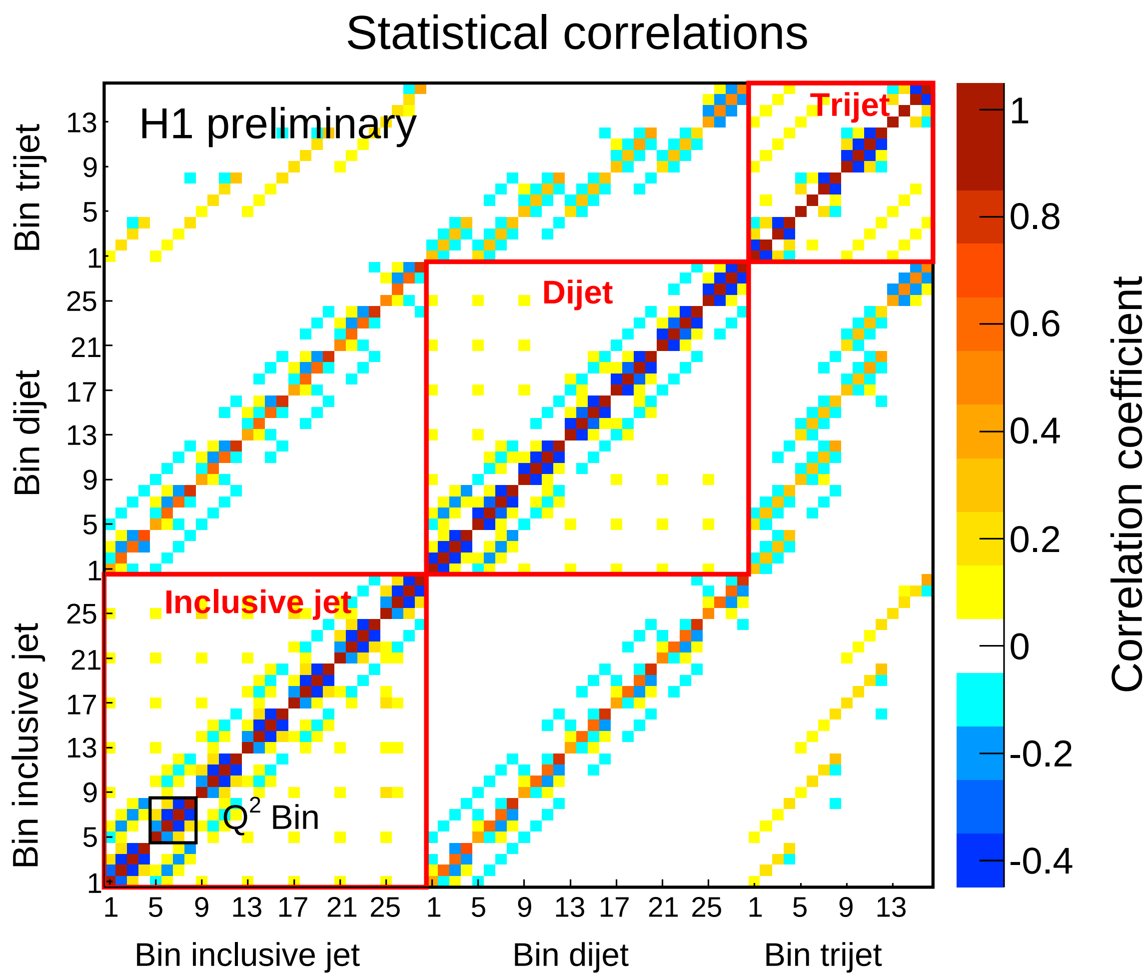

Figure 7: Correlation coefficients of the statistical uncertainty of the three unfolded cross section measurements. The axis labels denote the bin numbers of the respective jet measurement. As an example, the black box indicates the four P_T bins in one Q^2 bin of the inclusive jet data. The correlations between the measurements are known since they are measured on detector-level and propagated through the unfolding procedure.

References

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