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Measurement of the 1-jettiness event shape observable and of empty hemisphere events in deep-inelastic electron-proton scattering at HERA

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The Breit frame provides a natural frame to analyze lepton–proton scattering events. In this reference frame, the parton model hard interactions between a quark and an exchanged boson defines the coordinate system such that the struck quark is back-scattered along the virtual photon momentum direction. In Quantum Chromodynamics (QCD), higher order perturbative or non-perturbative effects can change this picture drastically. The 1-jettiness event shape observable τ_1^b is mapping out the transition from single-jet events with $\tau_1^b = 0$ up to extreme configurations where the current hemisphere is empty and hence $\tau_1^b = 1$. The data sample was collected at the HERA ep collider in the years 2003–2007 with center-of-mass energy of $\sqrt{s} = 319$ GeV, corresponding to an integrated luminosity of 351.1 pb^{-1}. Triple differential cross sections are provided as a function of τ_1^b, event virtuality Q^2, and inelasticity y, in the kinematic region $Q^2 > 150$ GeV^2. Double differential cross sections are measured, in contrast, integrated over τ_1^b and represent the inclusive neutral-current DIS cross section measured as a function of Q^2 and y. The data are compared to a variety of predictions and include classical and modern Monte Carlo event generators, predictions in fixed-order perturbative QCD where calculations up to $\mathcal{O}(\alpha_s^3)$ are available for τ_1^b or inclusive DIS, and resummed predictions at next-to-leading logarithmic accuracy matched to fixed order predictions at $\mathcal{O}(\alpha_s^2)$. The fraction of inclusive neutral-current DIS events with an empty hemisphere is also determined and is found to be $0.0112 \pm 3.9\%_{\text{stat}} \pm 4.5\%_{\text{syst}} \pm 1.6\%_{\text{mod}}$ in the selected kinematic region of $150 < Q^2 < 1500$ GeV^2 and inelasticity $0.14 < y < 0.7$. It is also measured differentially and compared to a variety of QCD models.

Secondary track

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