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# First simultaneous analysis of transverse momentum dependent and collinear parton distributions in the proton

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## Abstract

We present the first simultaneous global QCD analysis of unpolarized transverse momentum dependent (TMD) and collinear parton distribution functions (PDFs) in the proton. Our study incorporates data from deep-inelastic scattering, Drell-Yan, inclusive weak boson,  $W + \text{charm}$ , and jet production involving PDFs, as well as TMD Drell-Yan and Z-boson production data from fixed target and collider experiments sensitive to both TMD and collinear distributions. The analysis is performed at next-to-next-to-leading logarithmic accuracy for QCD resummation in TMD observables and next-to-leading order for observables described in collinear factorization. The combined analysis improves knowledge of both TMD and collinear PDFs, particularly in the sea-quark sector, providing a consistent simultaneous description of both types of observables.

