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The structure of the proton in the LHC precision era

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ABSTRACT

We review recent progress in the determination of the parton distribution functions (PDFs) of the proton, with emphasis on the applications for precision phenomenology at the Large Hadron Collider (LHC). First of all, we introduce the general theoretical framework underlying the global QCD analysis of the quark and gluon internal structure of protons. We then present a detailed overview of the hard-scattering measurements, and the corresponding theory predictions, that are used in state-of-the-art PDF fits. We emphasize here the role that higher-order QCD and electroweak corrections play in the description of recent high-precision collider data. We present the methodology used to extract PDFs in global analyses, including the PDF parametrization strategy and the definition and propagation of PDF uncertainties. Then we review and compare the most recent releases from the various PDF fitting collaborations, highlighting their differences and similarities. We discuss the role that QED corrections and photon-initiated contributions play in modern PDF analysis. We provide representative examples of the implications of PDF fits for high-precision LHC phenomenological applications, such as Higgs coupling measurements and searches for high-mass New Physics resonances. We conclude this report by discussing some selected topics relevant for the future of PDF determinations, including the treatment of theoretical uncertainties, the connection with lattice QCD calculations, and the role of PDFs at future high-energy colliders beyond the LHC.

Contents

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