



Contribution ID: 1232

Type: Poster

New QCD physics from the LHeC and FCC-he

Monday 8 August 2016 18:30 (2 hours)

Energy-frontier deep inelastic scattering at 1000 times higher luminosity than HERA is considered with the LHeC and further the FCC-he. These collider configurations provide steps in the kinematic range, characterised by the 4-momentum squared Q^2 and Bjorken- x , which are so huge that qualitatively new phenomena are expected to appear and much more thorough and precise measurements can be pursued than was possible with HERA. Specifically, we will show recent results on the determination of proton PDFs with complete flavour decomposition and of the value of the strong coupling constant with per mille accuracy. The implications of such measurements on Higgs physics and on high mass BSM searches at the HL-LHC will be discussed. New QCD physics is predicted to occur at small x which will be illustrated through several unique possibilities for discriminating standard DGLAP approaches from resummation and gluon saturation scenarios. The LHeC has also an outstanding potential for new physics in diffraction and for analysing the 3D proton structure through measurements of generalised parton distributions.

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Session Classification: Poster Session

Track Classification: Strong Interactions and Hadron Physics