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LePDF: Standard Model PDFs for High-Energy Lepton Colliders

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At present the Large Hadron Collider at CERN is our only tool for direct exploration of physics at the electroweak (EW) scale and above and it proved to be a formidable machine for both searches of new heavy particles as well as precision studies at the EW scale. Nevertheless the next large-scale experiment in high-energy physics is likely to be a lepton collider and among the proposed options a multi-TeV muon collider (MuC) has the advantages of both proton-proton and electron-positron colliders, combining high energy reach with high precision measurements. Understanding the possibilities which such a machine may offer to study several processes and to search for new physics becomes then an important task. In particular processes involving collinear radiation emitted by the initial lepton (the muon or the anti-muon for the MuC, but the same holds for the electron and the positron too) can be factorized from the hard scattering process and a description in terms of parton distribution functions (PDFs) can be introduced, similarly to what is done in case of proton colliders and the parton content of a proton. Contrary to the latter, lepton PDFs (LePDFs) can be derived from first principles solving the corresponding DGLAP equations, with the complications of dealing with the full SM interactions and massive particles.
In this talk I will present our calculation of LePDFs [
]: after a brief review of the parton model for leptons and of our numerical strategy to solve the DGLAP equations, I will describe how the PDF evolution changes above the EW scale, focussing on the differences with the proton case: mixed PDFs, appearance of double logarithms and effects of the polarizations and masses of the particles. Then I will show our results and compare them with the so-called effective W approximation, which has been already used to study processes at MuC and is the only version of LePDFs implemented in computational softwares like MadGraph.

The talk is based on the following paper:

[1] F. Garosi, D. Marzocca and S. Trifinopoulos, LePDF: Standard Model PDFs for High-Energy Lepton Colliders, 2303.16964.

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