Toward N3LO accuracy of collinear nucleon PDFs

N3LO predictions are becoming available for Higgs and DY pair production, etc. and will eventually require N3LO PDFs

Some physics questions will require N3LO accuracy in QCD and NLO accuracy in EW: HL-LHC Higgs and EW precision studies, measurement of m_{charm} in DIS, determination of sea PDFs at large x

The progress toward N3LO accuracy requires numerous advancements beyond the current frameworks for global QCD fit, on the top of implementing N3LO radiative contributions.

Many of these advancements will take time and are already necessary at NNLO to satisfy goals of the HL-LHC physics program.

Recall that it took >10 years after implementing the first NNLO contributions in global fits to obtain benchmark PDF fits at NNLO accuracy in ~2015

PDF-related topics in Snowmass'13 [arXiv:1310.5189] and 21' studies

Topic	Status, 2013	Status and plans, 2020
Benchmarking of PDFs for the LHC	Before PDF4LHC'2015 recommendation	In progress toward PDF4LHC'2X recommendation
PDFs with NLO EW contributions	MSTW'04 QED, NNPDF2.3 QED	Needs an update using LuXQED and other photon PDFs; PDFs with leptons and massive bosons
PDFs with resummations	Small x (in progress)	Needs an update for PDFs with small-x and threshold resummations
Parton luminosities at 14, 33, 100 TeV	CT10, MSTW2008, NNPDF2.3 Update at 100 in CERN YR (1607.01831)	Need an update based on the latest PDFs
LHC processes to measure PDFs	W/Z, single-incl. jet, high-p_T Z, $t\bar{t}$, $W+c$ production	updates on these processes + $Q\bar{Q}$, dijet, $\gamma/W/Z$ +jet, low-Q DY, …
Future experiments to probe PDFs	LHC Run-2 DIS: LHeC	LHC Run-3 DIS: EIC, LHeC, …

NEW TASKS in THE HL-LHC ERA:

Obtain complete NNLO and N3LO predictions for PDF-sensitive processes	Improve models for correlated systematic errors	Find ways to constrain large-x PDFs without relying on nuclear targets
Develop and benchmark fast NNLO interfaces	Estimate NNLO theory uncertainties	Develop an agreement on comparing and combining PDF fits