

N3LO evolution and other merge requests

20th March 2024

APFELxx interface

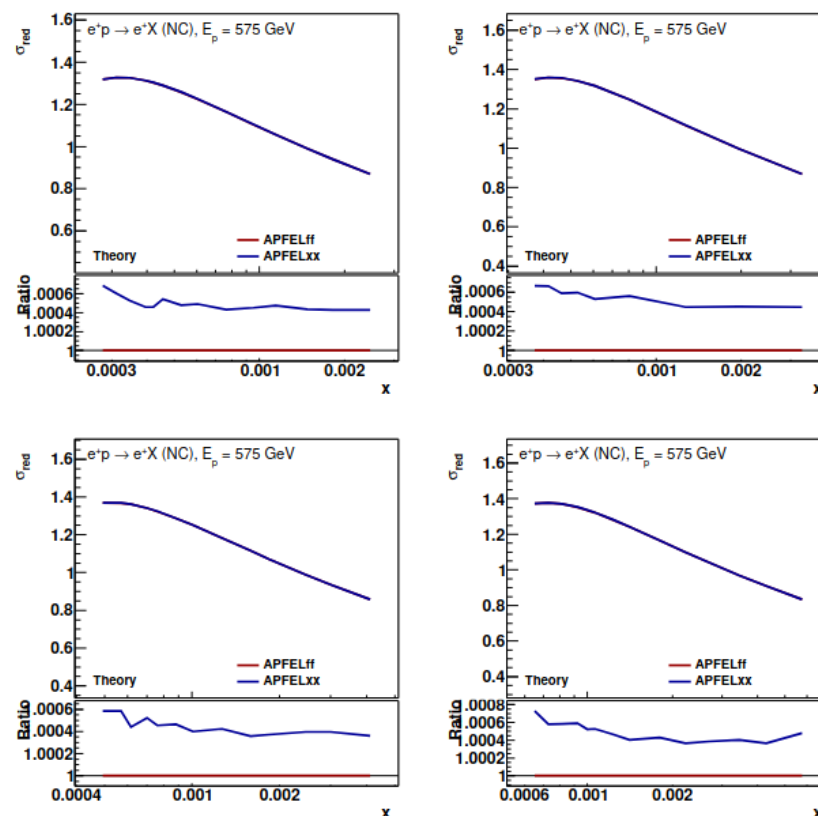
- APFELxx implements approximate N3LO evolution and N3LO DIS coefficients
- Introduced new reactions N3LO_DISCC and N3LO_DISNC, which are an interface to APFELxx 4.8.0
- FONLL scheme implemented up to N3LO, but massive coefficients are included in APFELxx only up to NNLO
- Introduced an N3LO example which minimizes a N3LO PDF

FONLL benchmark

- Benchmark of FONLL at NNLO between fortran APFEL and APFELxx
- Full set of benchmark plots here:

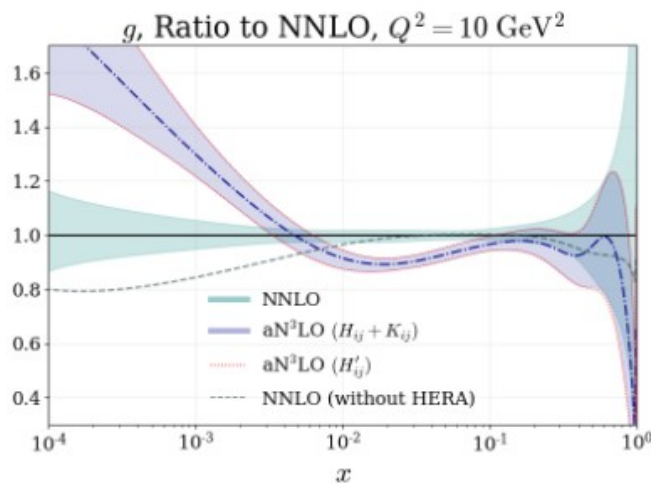
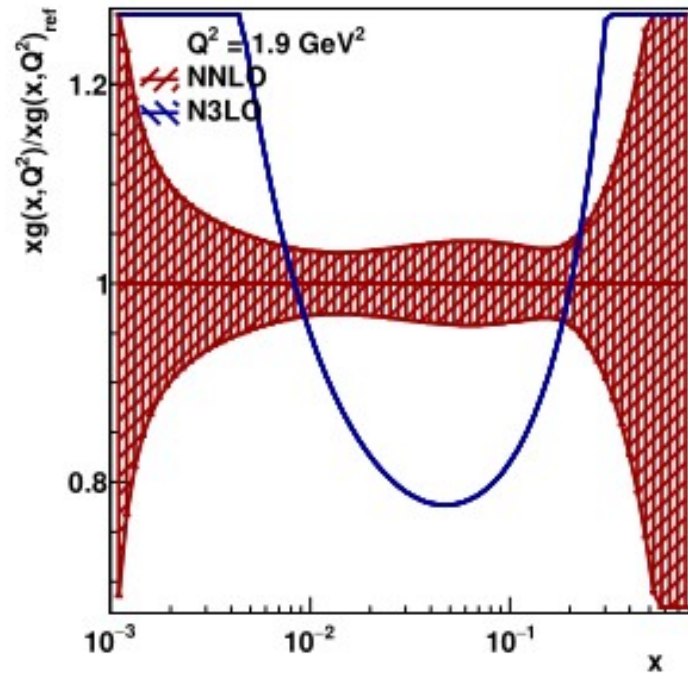
<https://gitlab.cern.ch/fitters/xfitter/uploads/cc936fd39ec03e07fd3c3845c8526308/plots.pdf>

Dataset	APFELff	APFELxx
HERA1+2 NCep 820	69 / 70	69 / 70
HERA1+2 NCep 460	224 / 204	224 / 204
HERA1+2 CCep	46 / 39	45 / 39
HERA1+2 NCem	234 / 159	234 / 159
HERA1+2 CCem	63 / 42	62 / 42
HERA1+2 NCep 575	246 / 254	246 / 254
HERA1+2 NCep 920	565 / 377	566 / 377
Correlated χ^2	206	208
Log penalty χ^2	+23	+23
Total χ^2 / dof	1676 / 1131	1679 / 1131
χ^2 p-value	0.00	0.00



N3LO PDF fit

- N3LO fit shows expected qualitative change in the gluon PDF



Dataset	NNLO	N3LO
HERA1+2 NCep 820	74 / 70	68 / 70
HERA1+2 NCep 460	223 / 204	222 / 204
HERA1+2 CCep	37 / 39	39 / 39
HERA1+2 NCem	217 / 159	222 / 159
HERA1+2 CCem	50 / 42	50 / 42
HERA1+2 NCep 575	223 / 254	216 / 254
HERA1+2 NCep 920	410 / 377	421 / 377
Correlated χ^2	79	77
Log penalty χ^2	+3.9	-10.20
Total χ^2 / dof	1317 / 1127	1303 / 1127
χ^2 p-value	0.00	0.00

N3LO fit to HERA inclusive DIS

- Would like to demonstrate the new N3LO functionality with a short xfitter paper on N3LO fits to HERA inclusive DIS data, compared to NNLO fits
- Valerio suggested to include also $F_2(\text{charm})$ data

Fix width of chi2 summary table

- Chi-square summary table are truncated and not readable
- Would like to restore the previous logic, which was always fitting the table to the page

tools/draw/src/FitPainter.cc		
↑		@@ -169,7 +169,7 @@ bool FitPainter()
169	169	fprintf(ftab, "\\begin{table}\\n");
170	170	fprintf(ftab, " \\begin{center}\\n");
171	171	fprintf(ftab, " \\rowcolors{2}{lightgray}{}\\n");
172	-	if (height < width)
	172	+ if (height >= width)
173	173	fprintf(ftab, " \\resizebox*{!}{\\textwidth}\\n");
174	174	else
175	175	fprintf(ftab, " \\resizebox*{\\textwidth}{!}\\n");
T		

Apfel evolution init

- Avoid hardcoded grid limits in Q, but rather throw an error if limits are beyond low-x interpolation grids
- Initialization freezes if alphas is not set to 0.118

```
evolutions/APFEL/APFEL_Evol.cc  +10 -5  Viewed  ⌵
↑  @@ -244,10 +244,10 @@ void APFEL_Evol::atStart()
244 244     if (nllxResummation == "0n")
245 245     {
246 246         APFEL::SetSmallxResummation(true, "NLL");
247 - APFEL::SetQLimits(1.6, 4550.0); // Hardwire for now.
248 - _Qmin = 1.6;
249 - _Qmax = 4550.0;
250 - hf_errlog(1908202201,"I: Setting APFEL grid range to 1.6 < Q < 4550 to match resummation grids.");
247 + if (_Qmin < 1.6)
248 +     hf_errlog(1506202301,"E: Lower APFEL grid range should be Q >= 1.6 GeV to match resummation grids.");
249 + if (_Qmax > 4550.0)
250 +     hf_errlog(1506202302,"E: Higher APFEL grid range should be Q <= 4550 GeV to match resummation grids.");
251 251     }
252 252
253 253     // set the ratio muR / Q (default 1), muF / Q (default 1)
↕  @@ -256,7 +256,12 @@ void APFEL_Evol::atStart()
256 256     APFEL::EnableDynamicalScaleVariations(true); // ??? somehow in the past this was needed if muRoverQ != 1, muFoverQ != 1
257 257     APFEL::SetRenQRatio(muRoverQ);
258 258     APFEL::SetFacQRatio(muFoverQ);
259 - APFEL::InitializeAPFEL_DIS(); // hamed FF
259 +
260 + // Initialize the APFEL DIS module
261 + APFEL::SetAlphaQCDRef(0.118, *Mz); //need to set alphas = 0.118 at initialization
262 + APFEL::InitializeAPFEL_DIS();
263 + APFEL::SetAlphaQCDRef(*alphas, *Mz);
264 +
260 265     APFEL::SetPDFSet("external");
261 266     gPdfDecomp = XFITTER_PARS::getInputDecomposition(_yAPFEL);
262 267     BaseEvolution::atStart();
```

Summary

- Implemented new interface to APFELxx which allows approximate N3LO fits
- With the help of Valerio, would like to publish a quick paper to demonstrate the new functionality
- Other additional small merge requests to fix issues with table output and APFEL init