

Benchmark comparisons at NNLO (in progress)

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Comparison of (N)NLO PDF sets with data in the CT10.1 fit

- χ^2 are computed at NNLO, using the LHAPDF 5.8.6 interface and **CTEQ fitting code (very naively!)**
- Whenever possible, adjust settings to reproduce assumptions by other groups
 - ▶ Use $\alpha_s(M_z)$, $m_{c,b}$ values suggested by each PDF set
 - ▶ approximate the GM scheme in DIS if possible
- Correlated systematic errors are included according to the CTEQ method

$$\chi^2 = \sum_{e=\{\text{expt.}\}} \left[\sum_{k=1}^{N_{pt}} \frac{1}{s_k^2} \left(D_k - T_k - \sum_{\alpha=1}^{N_\lambda} \lambda_\alpha \beta_{k\alpha} \right)^2 + \sum_{\alpha=1}^{N_\lambda} \lambda_\alpha^2 \right]$$

- ▲ D_k and T_k are data and theory values ($k = 1, \dots, N_{pt}$);
- ▲ s_k is the stat.+syst. uncorrelated error; λ_α are sources of syst. errors

χ^2 values per experiment (PRELIMINARY)

PDF set	Order	All expts.	Combined HERA-1	BCDMS $F_2^{p,d}$	CDF, D0 Run-2 1-jet	D0 Run-2 A_{ch}^e , $p_T^e > 25$ GeV
CT10.1	NLO	1.11	1.17	1.10	1.33	3.72
MSTW08		1.42 (1.28)	1.73 (1.4)	1.16 (1.17)	1.31	11.38
NNPDF2.0		1.37	1.32	1.28	1.57	2.79
CT10.2	NNLO	1.13	1.12	1.14	1.23	2.59
MSTW08		1.34	1.36	1.15	1.38	9.84
NNPDF2.1		1.57	1.36	1.30	1.51	5.45
ABM'09 (5f)		1.65	1.4	1.49	2.63	23.78
HERA1.5		1.71	1.15	1.87	?	5.4

N_{points}

2798

579

590

182

12

Comments: NLO

Combined HERA-1 DIS

- χ^2 for MSTW'08 and NNPDF is larger than for CT10.1
- Tangible dependence on the GM scheme
- χ^2 for MSTW is improved visibly by tuning the rescaling variable in heavy-quark contributions

CDF+D0 Run-2 inclusive jets (NLO hard Xsec, no 2-loop thr. corr.)

- χ^2 is about the same for CTEQ, MSTW, somewhat worse for NNPDF2.0

D0 Run-2 charge asymmetry

- electron channel, most inclusive bin ($p_T^e > 25$ GeV) only
$$\chi^2(\text{NNPDF2.0}) < \chi^2(\text{CT10.2}) < \chi^2(\text{MSTW})$$
- differences may arise because of distinct NLO codes (DYNNLO, FEWZ, ResBos) employed to compute WASY (?)

Comments: NNLO, in comparison to NLO

General:

- Spread in χ^2 values remains large despite going to NNLO
- benchmarking of theory calculations is essential!

Combined HERA-1 DIS

- $\chi^2 = 1.12 - 1.15$ for CT10.1, HERAPDF1.5
- $\chi^2 = 1.35 - 1.4$ for ABM'09 (5 flavors), MSTW'08, NNPDF2.1
- S-ACOT- χ , FONLL-C, TR' schemes are numerically close at NNLO (cf. my heavy-quark talk)
 - ▶ Other differences in NNLO predictions for DIS cross sections may exist besides the GM schemes

Comments: NNLO vs. NLO (continued)

BCDMS $F_2^{p,d}(x, Q)$

$$\chi^2(CT10.2) \lesssim \chi^2(MSTW) < \chi^2(NNPDF2.1) < \chi^2(ABM) < \chi^2(HERA1.5)$$

CDF+D0 Run-2 inclusive jets (NLO hard Xsec, no 2-loop thr. corr.)

- HERAPDF1.5:

- ▶ $\chi^2/N_{pt} \approx 1.19$ for D0 Run-2
- ▶ CDF Run-2 cross sections cannot be computed – numerical issues in LHAPDF (?)

- Slight changes in χ^2 for CT10.2, NNPDF2.1, MSTW'08

- $\chi^2(ABM) \approx 2.6$; $\chi^2 < 1.6$ for other 4 sets

D0 Run-2 charge asymmetry (NLO or NLO+ Q_T resummation)

$$\chi^2(CT10.2) < \chi^2(HERA1.5) \lesssim \chi^2(NNPDF2.1) < \chi^2(MSTW) < \chi^2(ABM)$$