The Impact of NMC Data on Parton Distributions and Higgs Production at the Tevatron and the LHC: the NNPDF analysis

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on behalf of the NNPDF Collaboration
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NMC data and Higgs production

- ABKM report a 3(1)–σ shift at NNLO(NLO) on the Higgs production cross section in gluon fusion channel at the LHC (and Tevatron) related to treatment of fixed target DIS NMC data (arXiv:1101.5261)
- Structure functions (MSTW, NNPDF, CT) or cross sections (ABKM)

$$\widetilde{\sigma}(x, y, Q^2) \quad = \quad F_2(x, Q^2)\left(2 - 2y + y^2/\left[1 + R\left(x, Q^2\right)\right]\right) \; + TMCs$$

- $R = \sigma_L/\sigma_T$ extracted from NMC data for $x < 0.12$ (Q^2 independent), from empirical parametrization of SLAC data for $x > 0.12$ (Q^2 dependent)
- Can the different treatment of NMC data be the origin of ABKM/MSTW discrepancy?

NMC data and Higgs production

In this talk

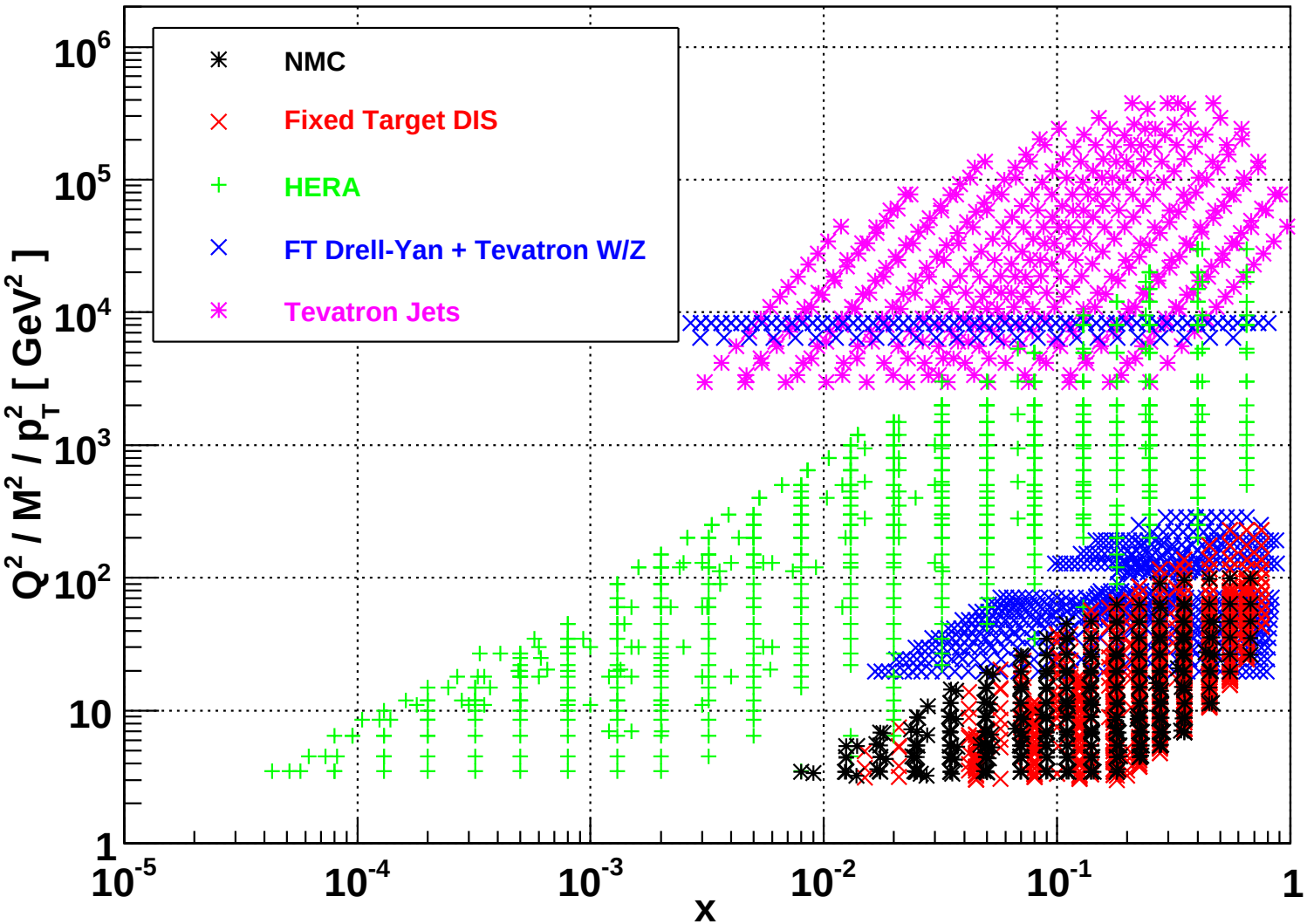
- We show that NNPDF observes a negligible impact of the treatment of NMC data on gluon PDF
- Conclusions hold both at NLO and at NNLO
- Even removing NMC data from global analysis leaves the Higgs cross section unaffected

References

1. NNPDF2.1 NLO (Nucl.Phys.B849:296-363,2011)
2. Impact of NMC treatment: NLO analysis (arXiv:1102.3182), NNLO update in preparation
3. NNPDF2.1 NNLO: .LHgrid available on NNPDF website and on LHAPDF5.4.8b6, paper in preparation

`http://sophia.ecm.ub.es/nnpdf/nnpdf2.htm`

NNPDF2.1 dataset

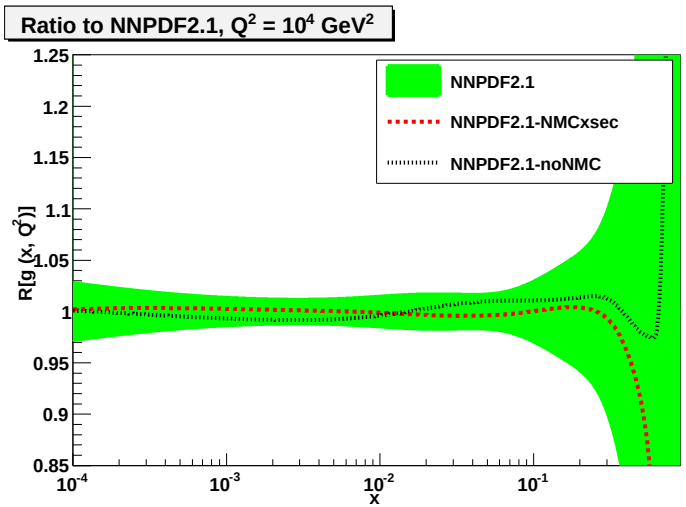


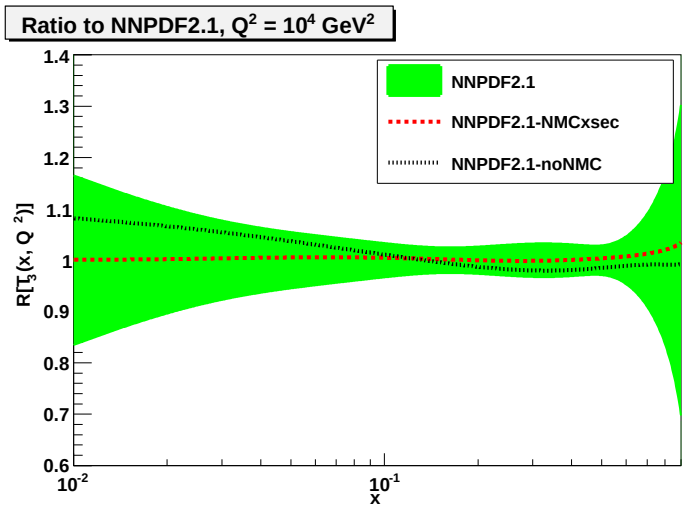
Fit quality at NLO

	NNPDF2.1 NLO		
	REF	NMCxsec	noNMC
Total	1.16	1.14	1.09
NMC-pd	0.97	0.98	-
NMCp	1.73	1.67	-
SLAC	1.27	1.27	1.28
BCDMS	1.24	1.23	1.18
HERAI-AV	1.07	1.05	1.07
CHORUS	1.15	1.11	1.07
FLH108	1.37	1.34	1.38
NTVDMN	0.47	0.51	0.42
ZEUS-H2	1.29	1.23	1.24
ZEUSF2C	0.78	0.74	0.72
H1F2C	1.51	1.48	1.49
DYE605	0.85	0.93	0.88
DYE866	1.27	1.40	1.34
CDFWASY	1.85	1.87	1.60
CDFZRAP	1.62	1.76	1.64
D0ZRAP	0.60	0.57	0.56
CDFR2KT	0.97	0.73	0.81
D0R2CON	0.84	0.90	0.96

- NMC proton data has intrinsic inconsistencies - an unbiased structure function fit finds $\chi^2 = 1.53$ (JHEP 0205 (2002) 062)
- Slightly better χ^2 for fits with reduced xsec
- All other datasets unaffected

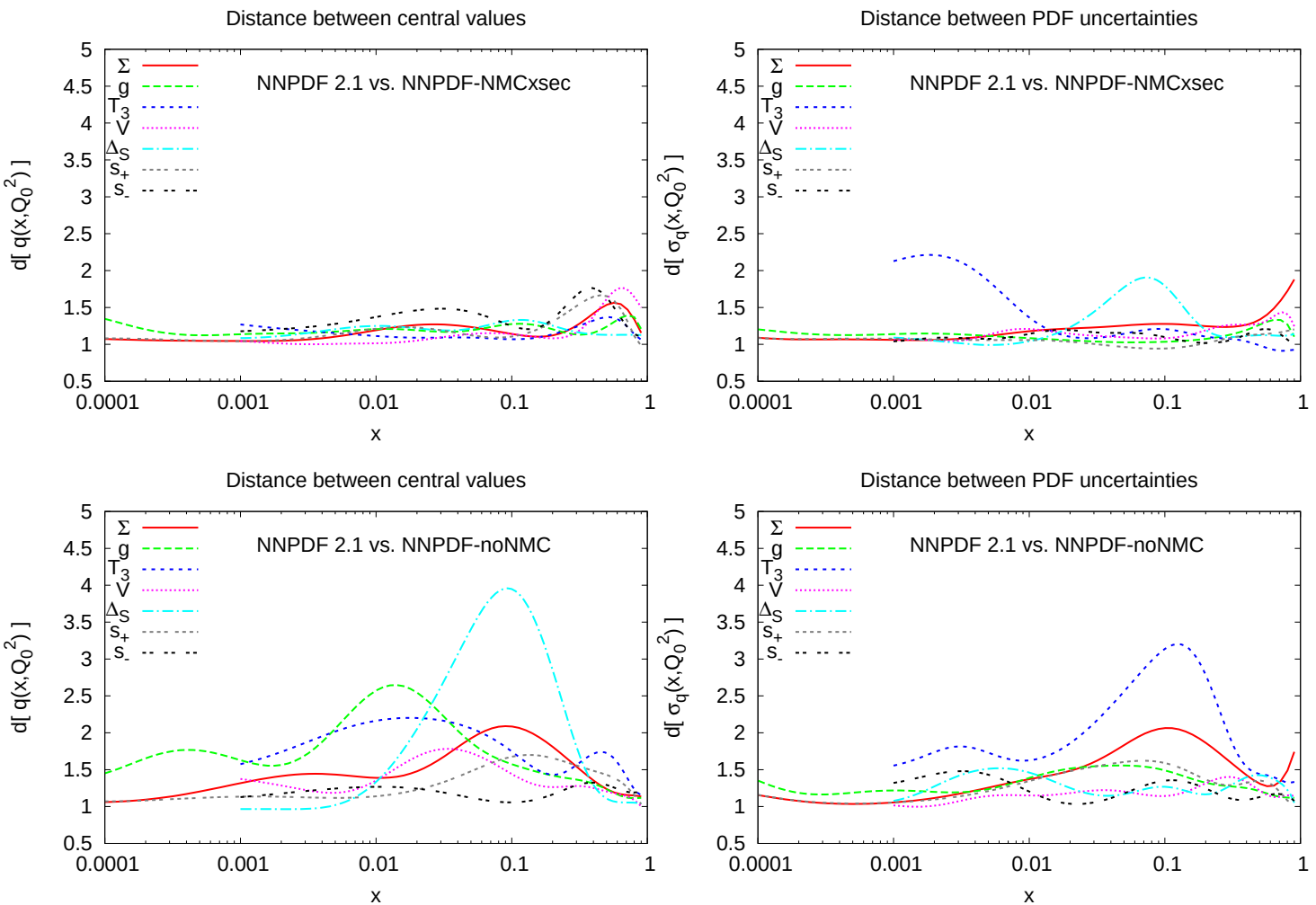
NLO PDFs at $Q^2 = 10^4$ GeV^2





- Gluon PDF unaffected by using NMC xsecs or SFs
- Impact of removing NMC data somewhat larger, but always within PDF error bands
- Similar trends for other PDFs
- Removing NMC increases sizably uncertainty on isotriplet $T_3(x)$ PDF

Statistical Distances at NLO at $Q^2 = 2$ GeV^2



Fit quality at NNLO

	NNPDF2.1 NLO			NNPDF2.1 NNLO		
	REF	NMCxsec	noNMC	REF	NMC SFs	noNMC
Total	1.16	1.14	1.09	1.16	1.16	1.12
NMC-pd	0.97	0.98	-	0.93	0.93	-
NMCp	1.73	1.67	-	1.63	1.69	-
SLAC	1.27	1.27	1.28	1.01	1.05	1.00
BCDMS	1.24	1.23	1.18	1.32	1.29	1.27
HERAI-AV	1.07	1.05	1.07	1.10	1.12	1.08
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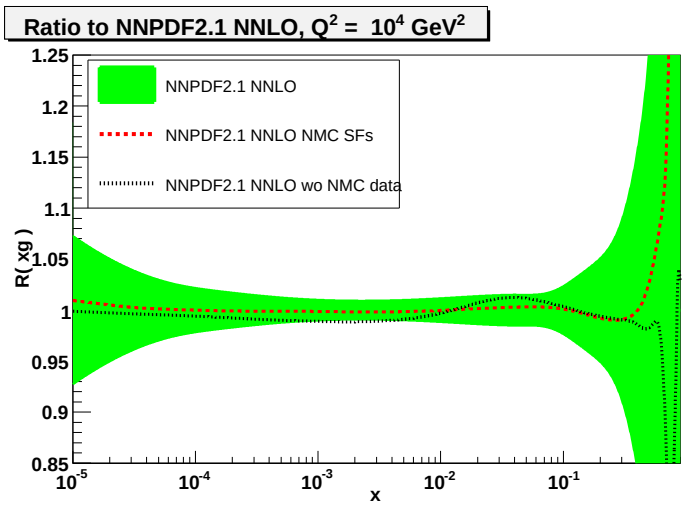
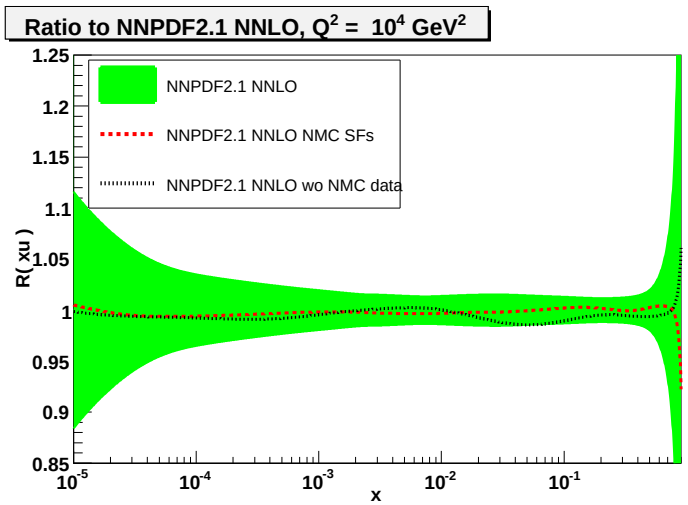
FLH108	1.37	1.34	1.38	1.26	1.27	1.29
NTVDMN	0.47	0.51	0.42	0.49	0.50	0.50
ZEUS-H2	1.29	1.23	1.24	1.31	1.32	1.30
ZEUSF2C	0.78	0.74	0.72	0.88	0.88	0.89
H1F2C	1.51	1.48	1.49	1.56	1.47	1.52
DYE605	0.85	0.93	0.88	0.81	0.81	0.81
DYE866	1.27	1.40	1.34	1.32	1.31	1.34
CDFWASY	1.85	1.87	1.60	1.65	1.55	1.41
CDFZRAP	1.62	1.76	1.64	2.12	2.16	2.18
D0ZRAP	0.60	0.57	0.56	0.67	0.67	0.67
CDFR2KT	0.97	0.73	0.81	0.74	0.79	0.80
D0R2CON	0.84	0.90	0.96	0.82	0.84	0.84

- Similar results at NNLO
- Slightly better χ^2 for fits with reduced xsec
- All other datasets unaffected

NNLO at $Q^2 = 10^4$ GeV^2





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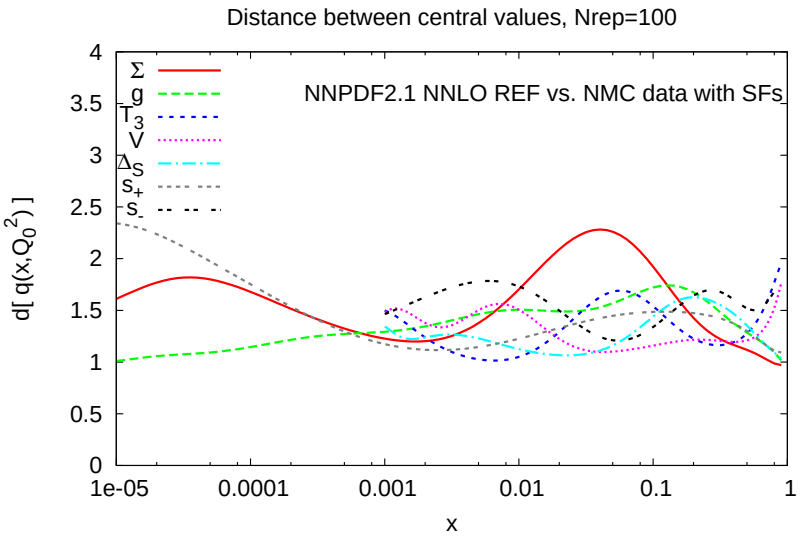
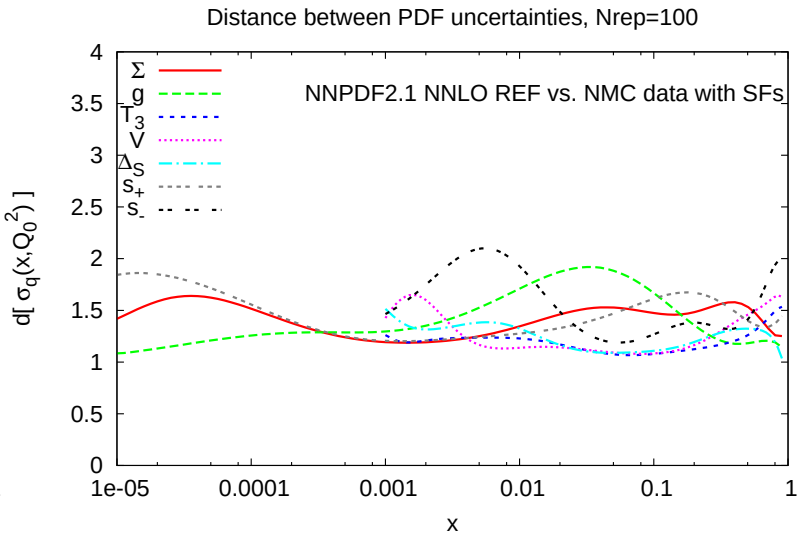
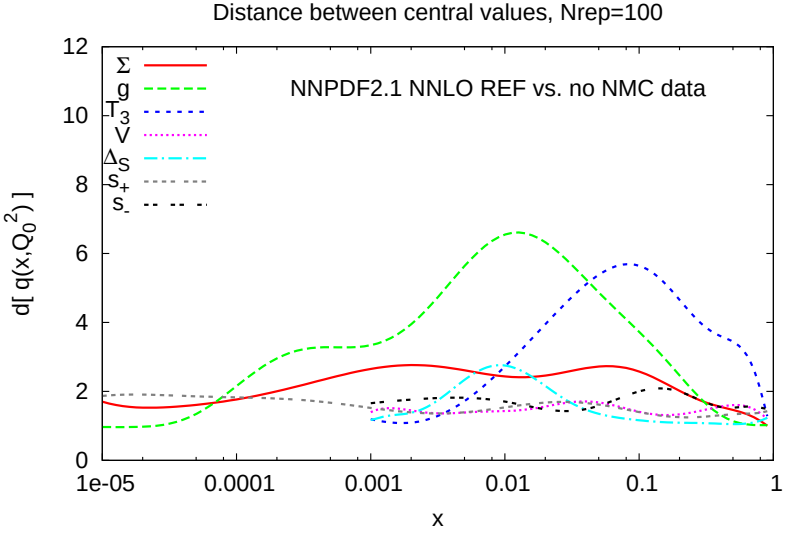
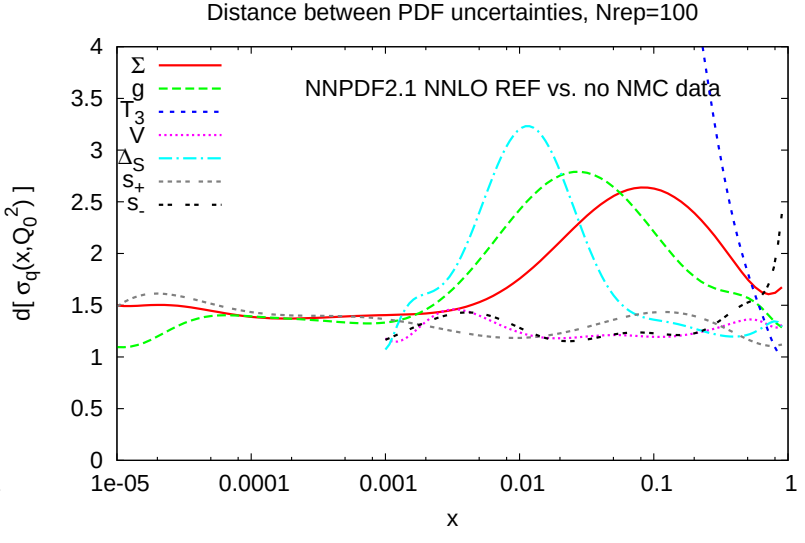
Statistical Distances at NNLO at $Q^2 = 2$ GeV^2

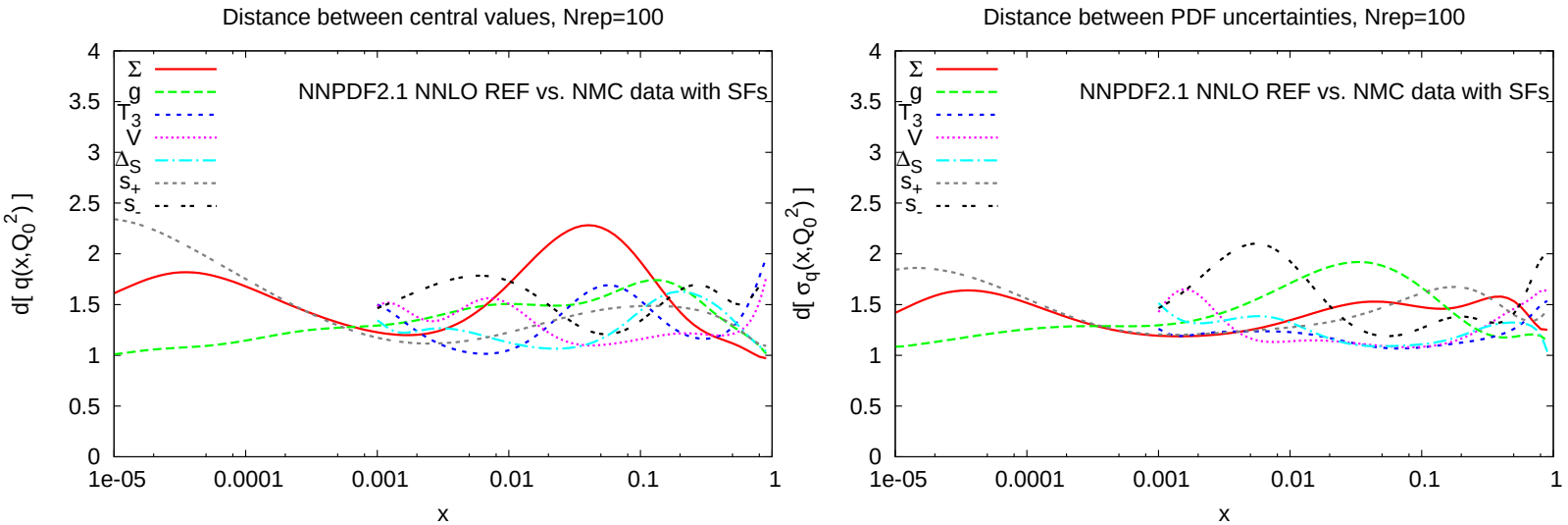






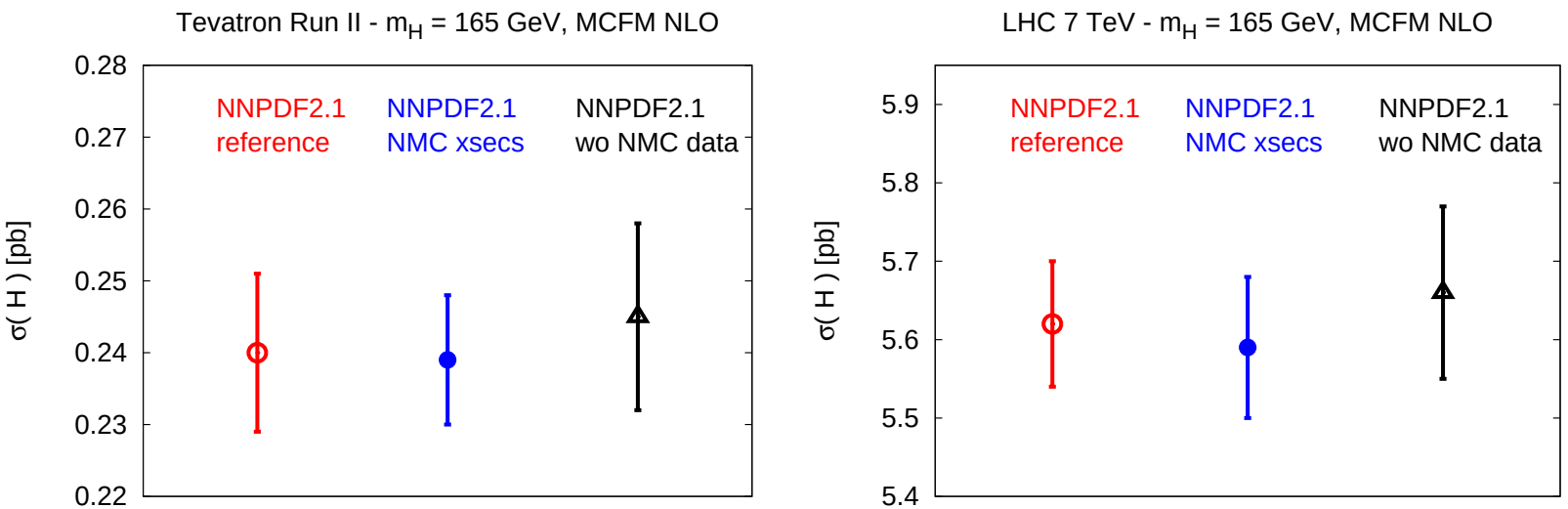


Statistical Distances at NNLO at $Q^2 = 2$ GeV^2



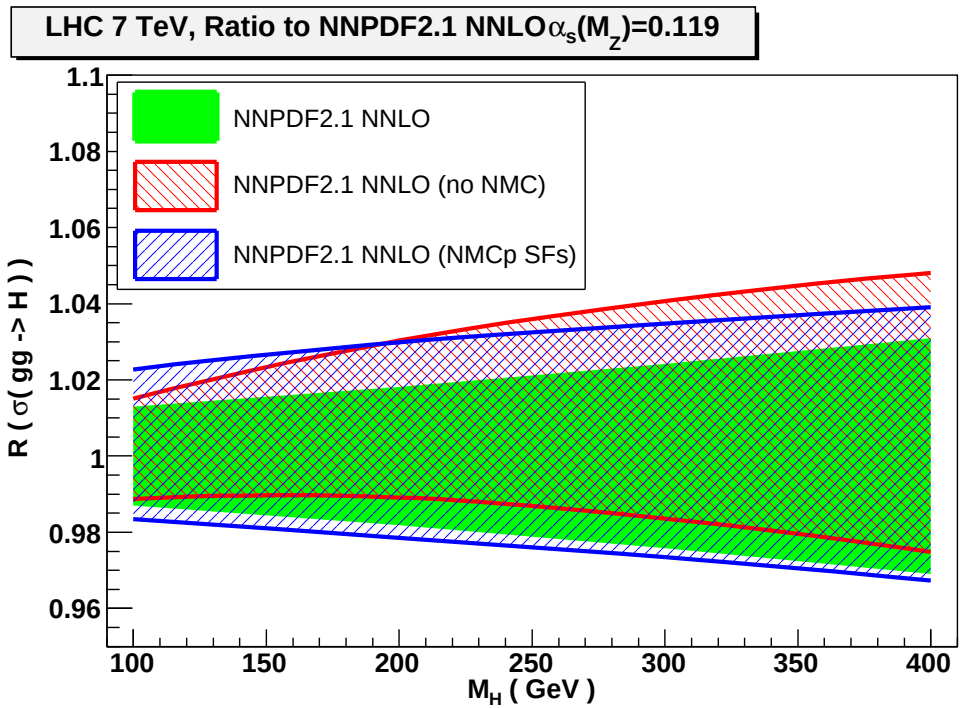
- The difference between the fits with NMC SFs and xsects is only slightly larger than a statistical fluctuation

$gg \to H$ at NLO



- Central prediction for $gg \to H$ essentially unaffected
- Sligthly smaller uncertainties if NMC cross-section data is used
- Same conclusions at NLO and NNLO

$gg \to H$ at NNLO



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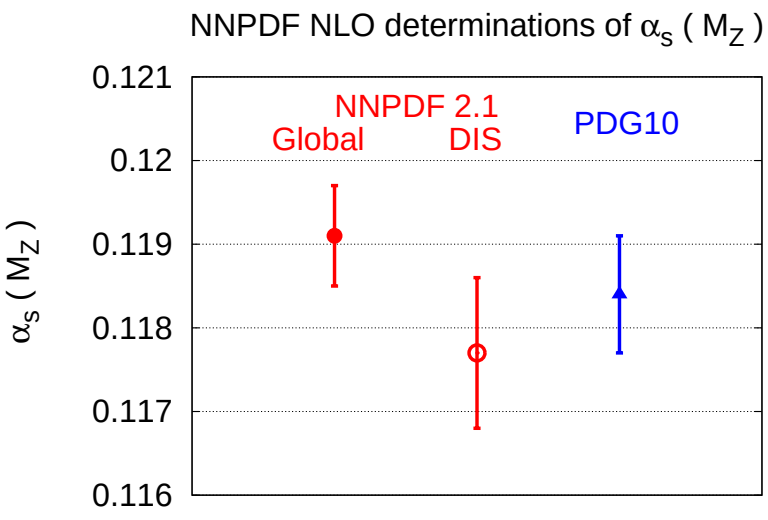
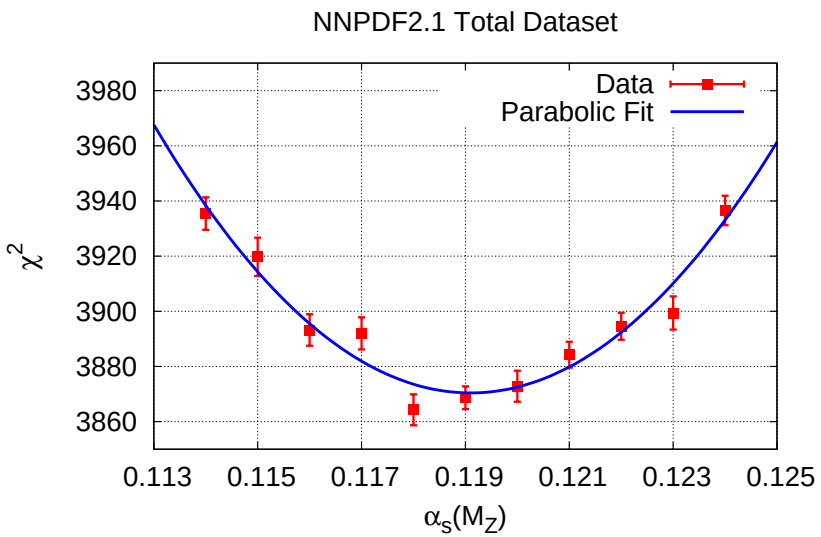
$\alpha_s(M_Z)$ from NLO PDF analysis

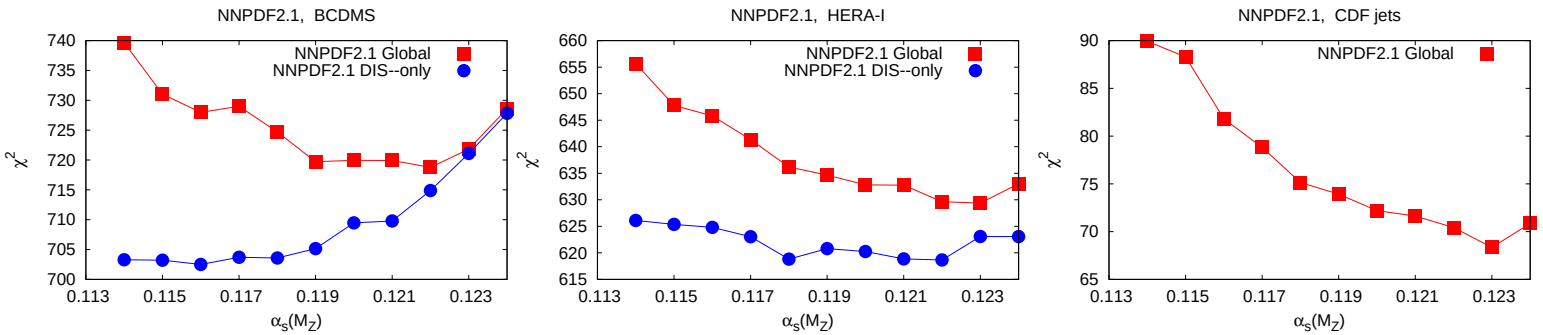
- NNPDF NLO analysis (ArXiv:1013.2369)
- Small statistical errors from large dataset
- No bias from PDF parametrization
- Studied dependence on dataset
- $\alpha_s^{\rm PDG}(M_Z) = 0.1184 \pm 0.0007$

	$\alpha_s(M_Z)$
NNPDF2.1 NLO	$0.1191 \pm 0.0006^{\rm stat}$
NNPDF2.1 NLO DIS–only	$0.1177 \pm 0.0009^{\rm stat}$





$\alpha_s(M_Z)$ for individual experiments



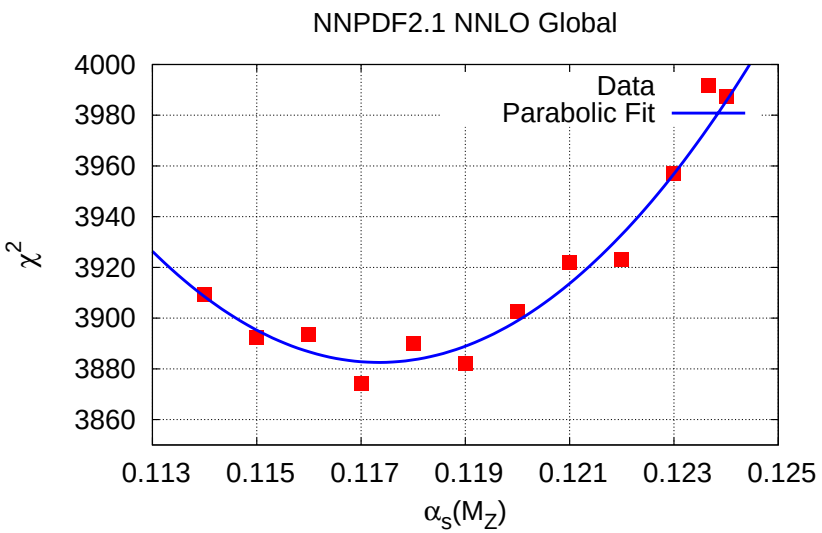
- BCDMS in a DIS–only fit sometimes has runaway direction at small $\alpha_s(M_Z)$, absent in the global fit
- HERA rather flat in α_s in DIS–only fit
- Tevatron jet experiments exclude small $\alpha_s(M_Z)$ values

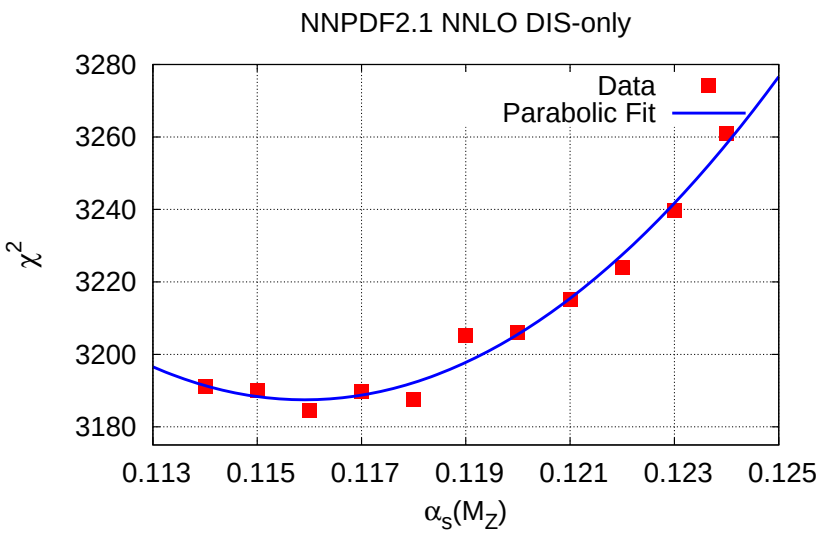
Important interplay between DIS and hadronic data

$\alpha_s(M_Z)$ from NNLO analysis (preliminary)

	$\alpha_s(M_Z)$
NNPDF2.1 NLO	$0.1191 \pm 0.0006^{\rm stat}$
NNPDF2.1 NLO DIS–only	$0.1177 \pm 0.0009^{\rm stat}$
NNPDF2.1 NNLO (prel)	$0.1172 \pm 0.0006^{\rm stat}$
NNPDF2.1 NNLO DIS–only (prel)	$0.1160 \pm 0.0010^{\rm stat}$

- Preliminary NNPDF NNLO analysis
- Only 100 replicas
- NNLO value of $\alpha_s(M_Z^2)$ still compatible with PDF average
- $\alpha_s^{\rm PDG}(M_Z) = 0.1184 \pm 0.0007$

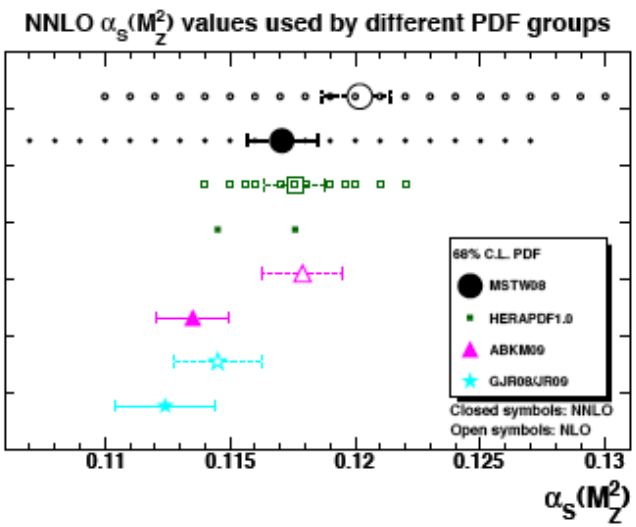


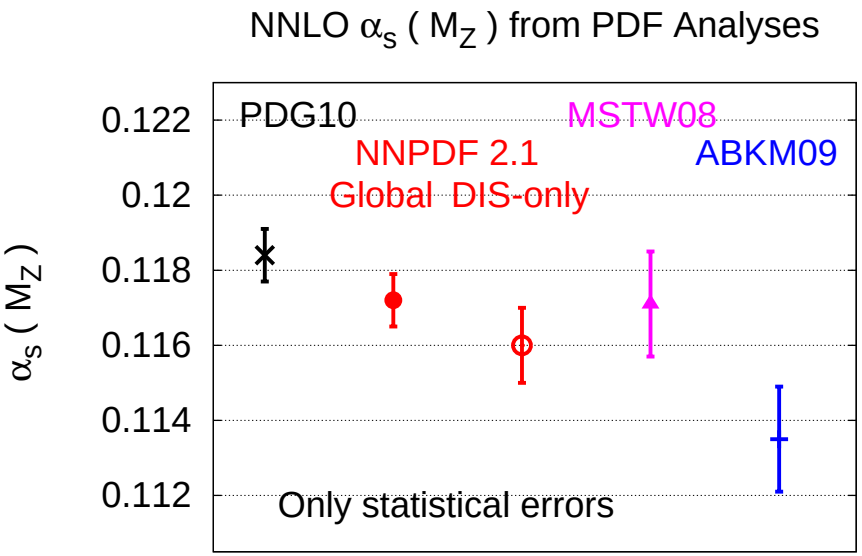


$\alpha_S(M_Z)$ from NNLO analysis (preliminary)

From ArXiv:1106.5789

- MSTW determination from DIS only fit is $\alpha_s = 0.1104$ with input gluon distribution which goes negative for $x > 0.4$ due to lack of data constraints.
- A NNLO DIS-only fit for α_s which fixed parametrization to prevent a bad behaviour of the gluon gives $\alpha_s = 0.1172$, similar to global fit.
- Preliminary NNPDF DIS-only analysis compatible with MSTW results





Summary

- The NNPDF analysis finds that the Higgs cross section at hadron colliders is very stable againts the treatment of NMC data
- Quantitatively similar conclusions at NLO and NNLO
- Similar results to those shown in Thorne & Watt analysis (ArXiv:1106.5789)
- Even completely removing NMC data altogether has a small effect
- Current estimates for NLO Higgs cross section, based on the PDF4LHC recipee, are reliable and stable