The PDF4LHC2021 combination

Emanuele R. Nocera
School of Physics and Astronomy, The University of Edinburgh
on behalf of the PDF4LHC21 Combination Group

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Towards PDF4LHC21

Input: CT18, MSHT20 and NNPDF3.1

common, fixed value of strong coupling and quark masses:
$\alpha_s(M_Z) = 0.118$, $m_c = 1.4$ GeV, $m_b = 4.75$ GeV, $m_t = 172.5$ GeV

all three parton sets are accurate to NNLO in the strong coupling
all three parton sets incorporate NNLO charm-quark mass corrections relevant to CCFR/NuTeV
other theoretical and methodological details are as in the published parton sets

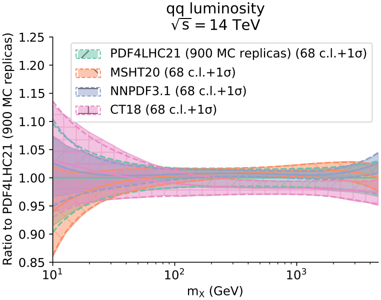
NNPDF3.1 data set has been extended to resemble CT18 and MSHT20
ATLAS W, Z 7 TeV; CMS single-inclusive jets 8 TeV; CMS 2D top pair 8 TeV

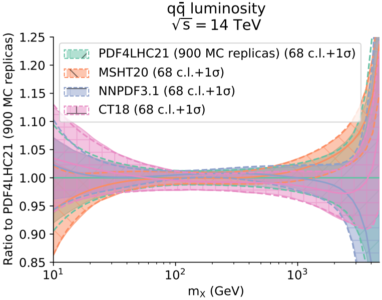
Output: the PDF4LHC21 combination

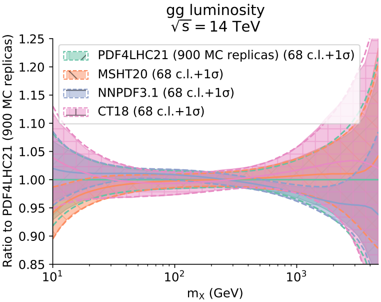
the combination closely follows the procedure adopted for the PDF4LHC15 combination
generate 300 Monte Carlo replicas for each of the three parton sets and collate them
CT18 use the CTEQ-TEA algorithm [JHEP 1703 (2017) 099]
MSHT20 use the Thorne-Watt algorithm [JHEP 1208 (2012) 05]
compression and conversion: 100 Monte Carlo replicas and 40 Hessian eigenvectors
compression: CMC algorithm [Eur.Phys.J. C75 (2015) 474]
conversion: META-PDF algorithm [JHEP 1407 (2014) 035]; [mc2h algorithm [Eur.Phys.J. C81 (2021) 530]]

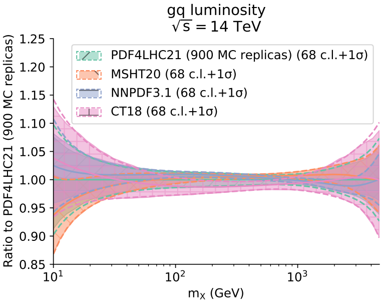
1. Construction

Constructing PDF4LHC21

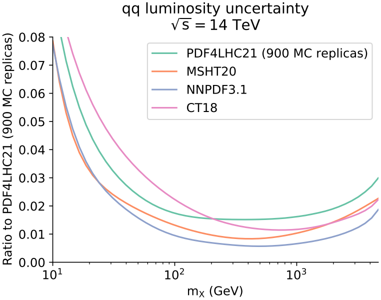


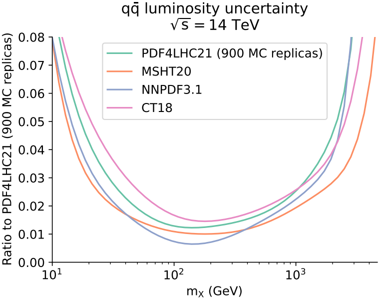


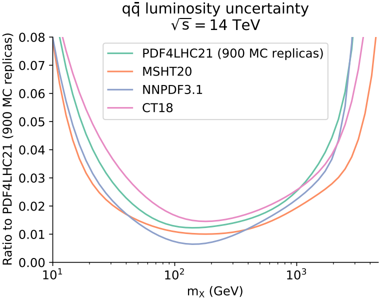


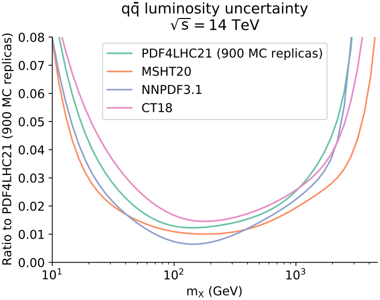


Constructing PDF4LHC21



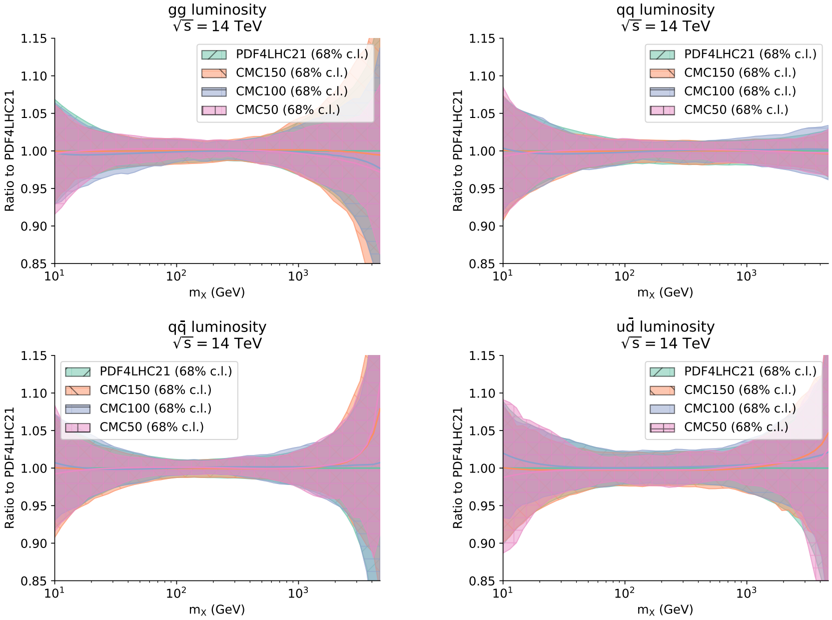




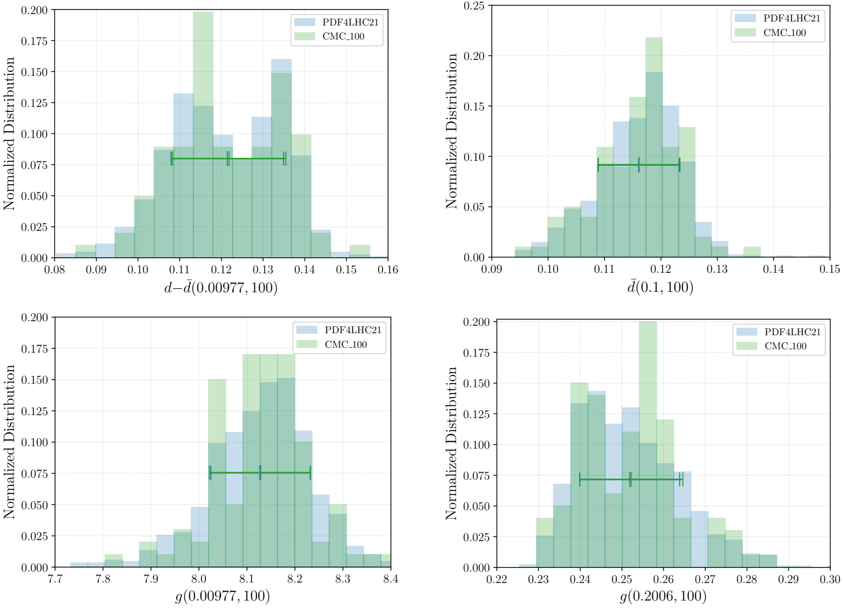


2. Compression

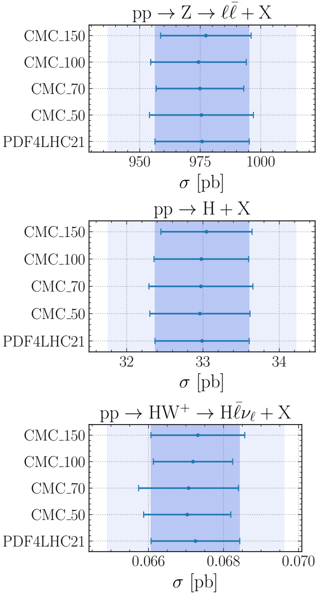
Compressing PDF4LHC21

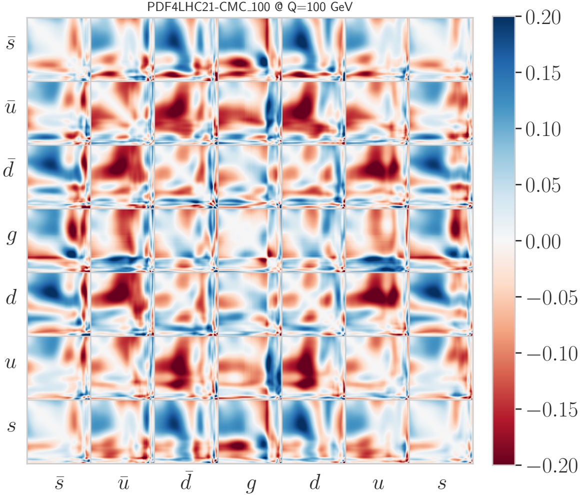


Compressing PDF4LHC21



Compressing PDF4LHC21

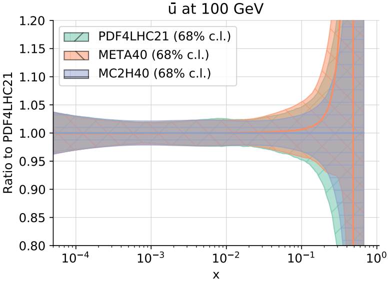


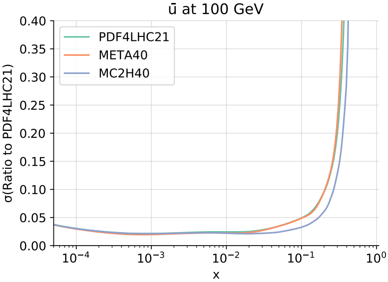


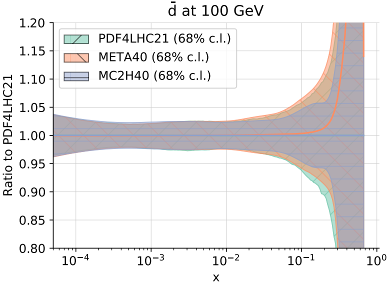
Less than 100 MC replicas may distort uncertainties for key LHC processes and PDF correlations a little too much

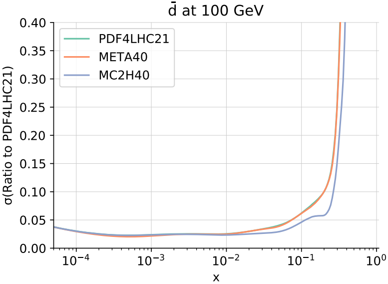
3. Conversion

Converting PDF4LHC21

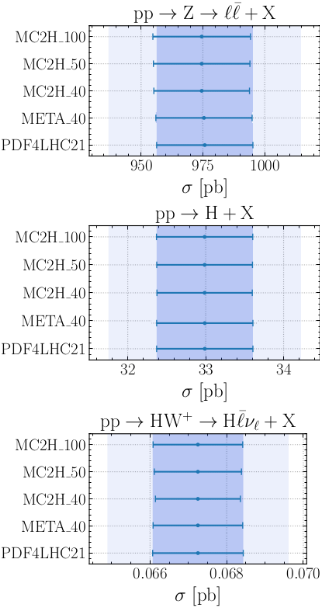


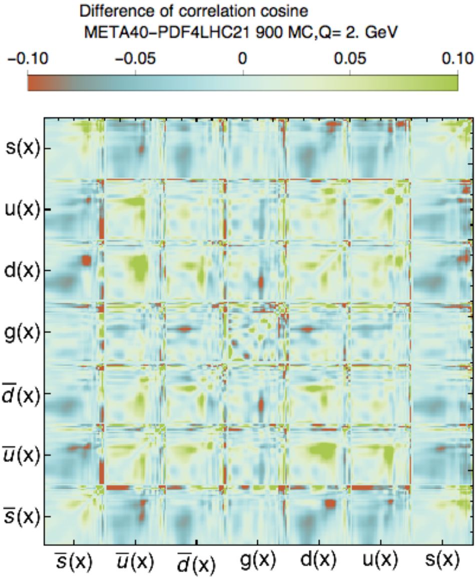




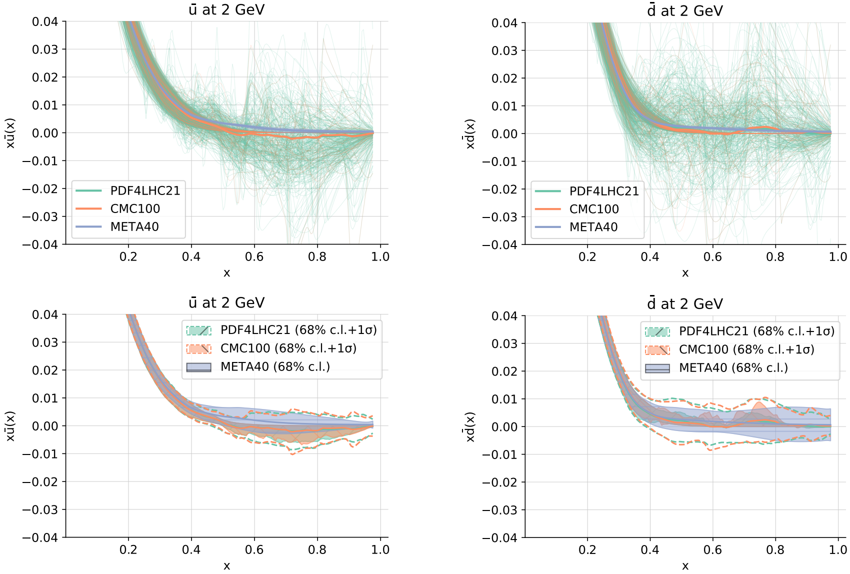


Converting PDF4LHC21



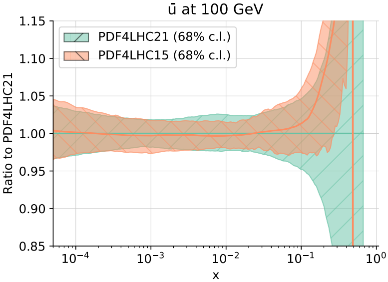


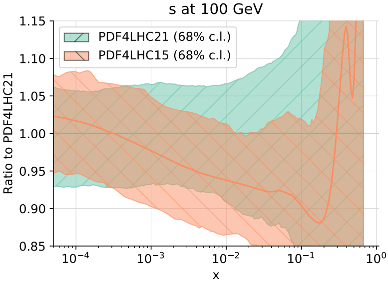
Converting PDF4LHC21

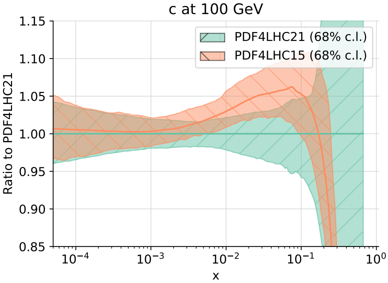


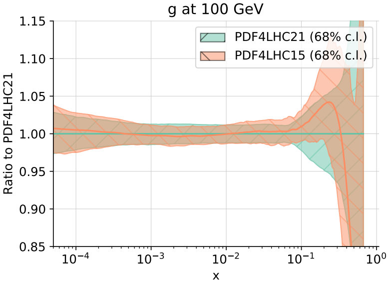
4. Comparison with PDF4LHC15

Comparing PDF4LHC21 and PDF4LHC15

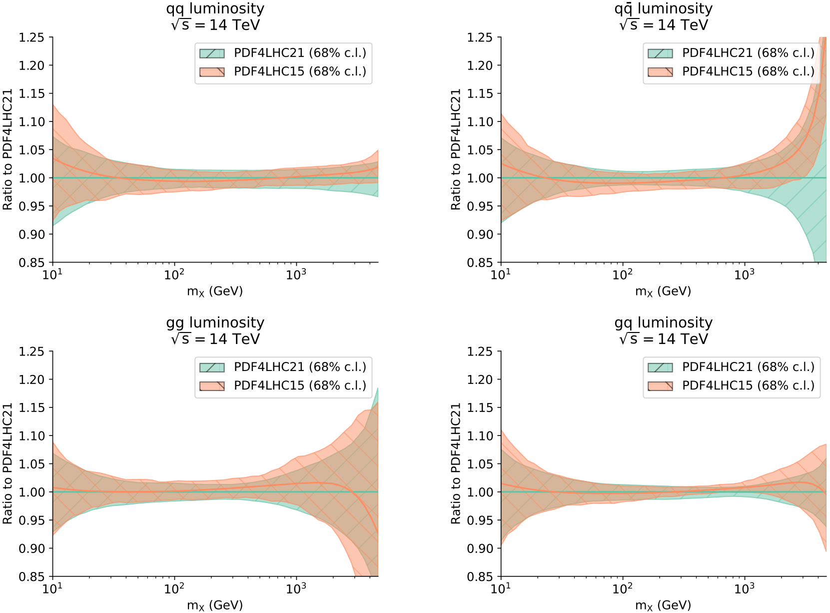




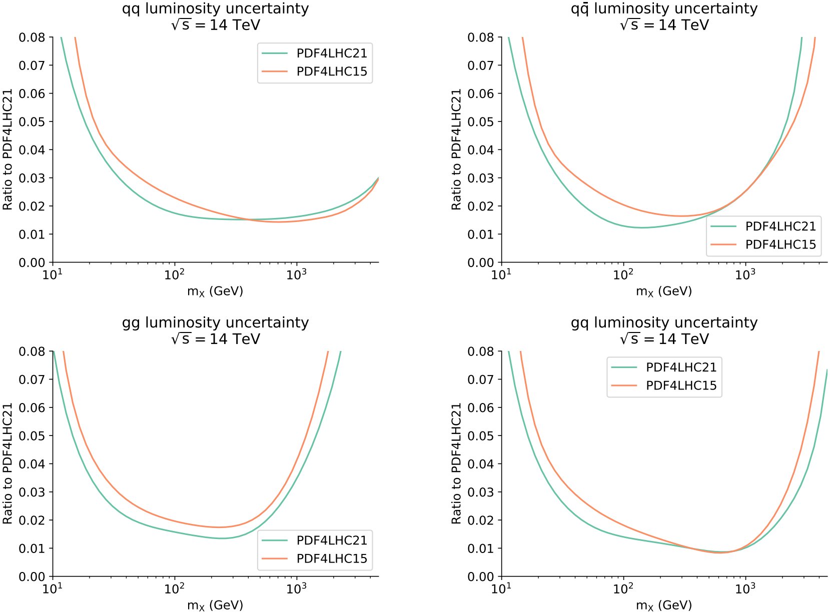




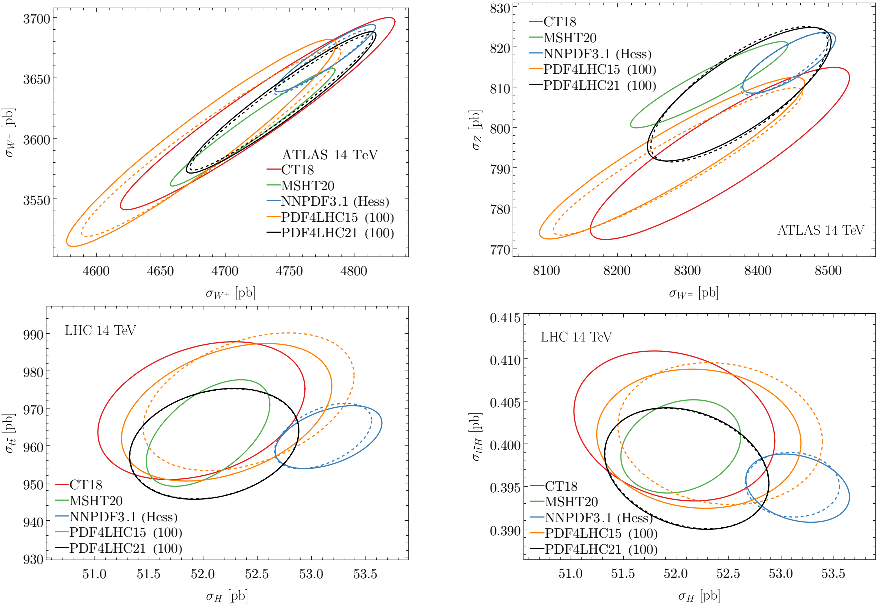
Comparing PDF4LHC21 and PDF4LHC15



Comparing PDF4LHC21 and PDF4LHC15



Comparing PDF4LHC21 and PDF4LHC15



5. Conclusion

Summary and delivery

The features of the three partons sets entering the PDF4LHC21 conbination are well understood

Excellent compatibility between PDF4LHC21 and PDF4LHC15, increase in precision

Extensive tests of the statistical features of the Monte Carlo and Hessian parton sets

LHAPDF6 grid name	Pert. order	$n_f^{\max}$	ErrorType	N_{mem}	$\alpha_s(m_Z^2)$
PDF4LHC21_nnlo_mc	NNLO	5	replicas	101	0.118
PDF4LHC21_nnlo_40	NNLO	5	symmhessian	41	0.118
PDF4LHC21_nnlo_mc_pdfas	NNLO	5	replicas+as	103	mem 0:100 $\to$ 0.118 mem 101 $\to$ 0.117 mem 102 $\to$ 0.119
PDF4LHC21_nnlo_40_pdfas	NNLO	5	symmhessian+as	43	mem 0:40 $\to$ 0.118 mem 41 $\to$ 0.117 mem 42 $\to$ 0.119
PDF4LHC21_nnlo_mc_nf4	NNLO	4	replicas	101	0.118
PDF4LHC21_nnlo_40_nf4	NNLO	4	symmhessian	41	0.118
PDF4LHC21_nnlo_mc_nf4_pdfas	NNLO	4	replicas+as	102	mem 0:100 $\to$ 0.118 mem 101 $\to$ 0.117 mem 102 $\to$ 0.119
PDF4LHC21_nnlo_40_nf4_pdfas	NNLO	4	symmhessian+as	43	mem 0:40 $\to$ 0.118 mem 41 $\to$ 0.117 mem 42 $\to$ 0.119