Neutrino Data in Proton and Nuclear Global PDF Fits

4th Forward Physics Facility Meeting

Emanuele R. Nocera

School of Physics and Astronomy, The University of Edinburgh

1^{st} February 2022

Neutrino CC DIS data in proton and nuclear PDF fits

Proton PDF sets

Data set		Ref.	ABMP16	CT18	MSHT20	NNPDF4.0
CHORUS $\sigma_{CC}^{\nu,\bar{\nu}}$	Pb	[PLB 632 (2006) 65]	✗	✗	✓	✓
CHORUS	Pb	[NJP 13 (2011) 093002]	✓	✗	✗	✗
NOMAD $\mathcal{R}_{\mu\mu}$	Fe	[NPB 876 (2013) 339]	✓	✗	✗	(✓)
CCFR xF_3^p	Fe	[PRL 79 (1997) 1213]	✗	✓	✗	✗
CCFR F_2^p	Fe	[PRL 86 (2001) 2742]	✗	✓	✗	✗
CDSHW F_2^p, xF_3^p	Fe	[Z Phys C49 (1991) 187]	✗	✓	✗	✗
NuTeV $\sigma_{CC}^{\nu,\bar{\nu}}$	Fe	[PRD 64 (2001) 112006]	✓	✓	✓	✓
NuTeV F_2, F_3	Fe	[PRD 74 (2006) 012008]	✗	✗	✓	✗

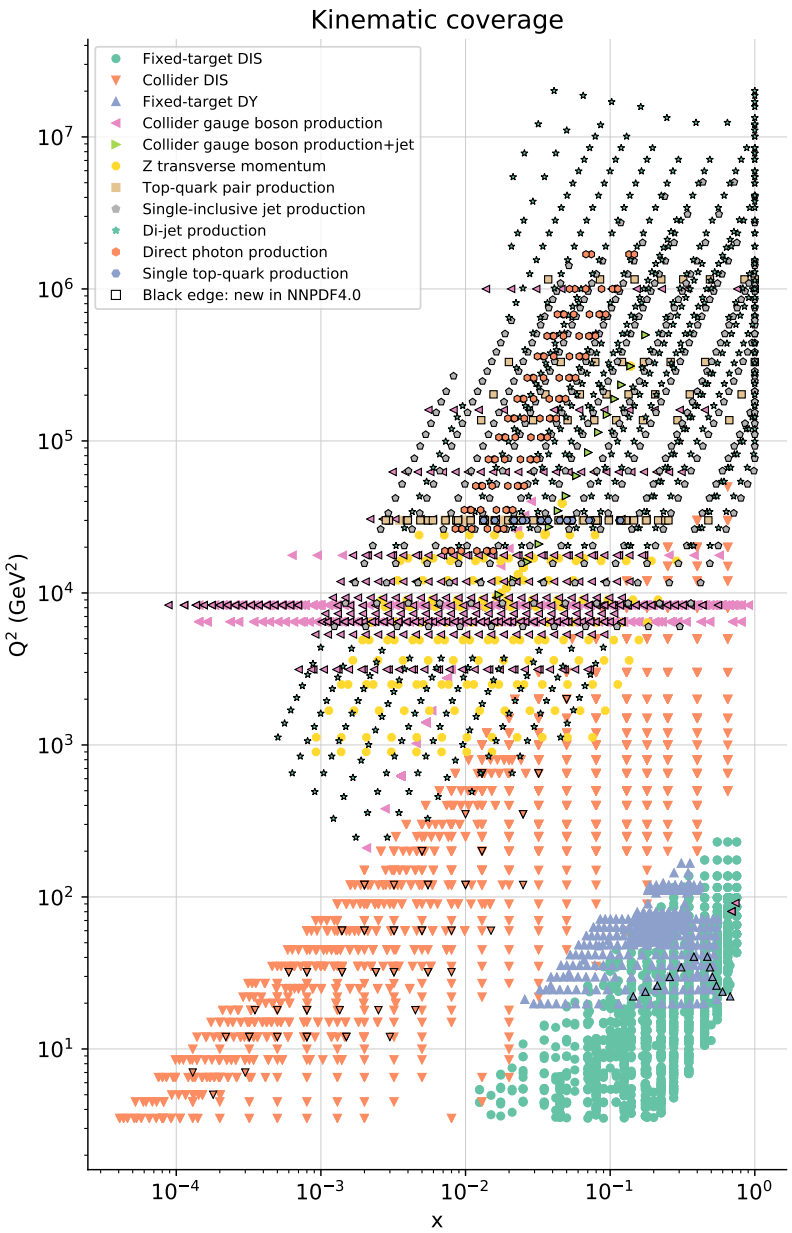
Nuclear PDF sets

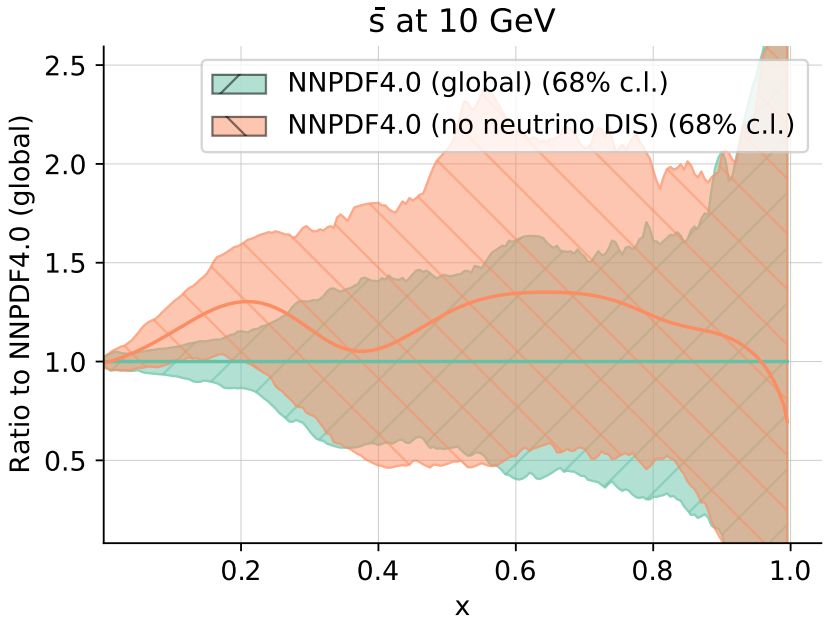
Data set		Ref.	EPPS21	nCTEQ15	nNNPDF3.0	TUJU21
CHORUS $\sigma_{CC}^{\nu,\bar{\nu}}$	Pb	[PLB 632 (2006) 65]	✓	(✓)	✓	✓
CHORUS	Pb	[NJP 13 (2011) 093002]	✗	(✓)	✗	✗
NOMAD $\mathcal{R}_{\mu\mu}$	Fe	[NPB 876 (2013) 339]	✗	✗	✗	✗
CCFR xF_3^p	Fe	[PRL 79 (1997) 1213]	✗	✓	✗	✗
CCFR F_2^p	Fe	[PRL 86 (2001) 2742]	✗	✗	✗	✗
CDSHW F_2^p, xF_3^p	Fe	[Z Phys C49 (1991) 187]	✗	✗	✗	✓
NuTeV $\sigma_{CC}^{\nu,\bar{\nu}}$	Fe	[PRD 64 (2001) 112006]	(✓)	✗	✓	✗
NuTeV F_2, F_3	Fe	[PRD 74 (2006) 012008]	✗	✗	✗	✗

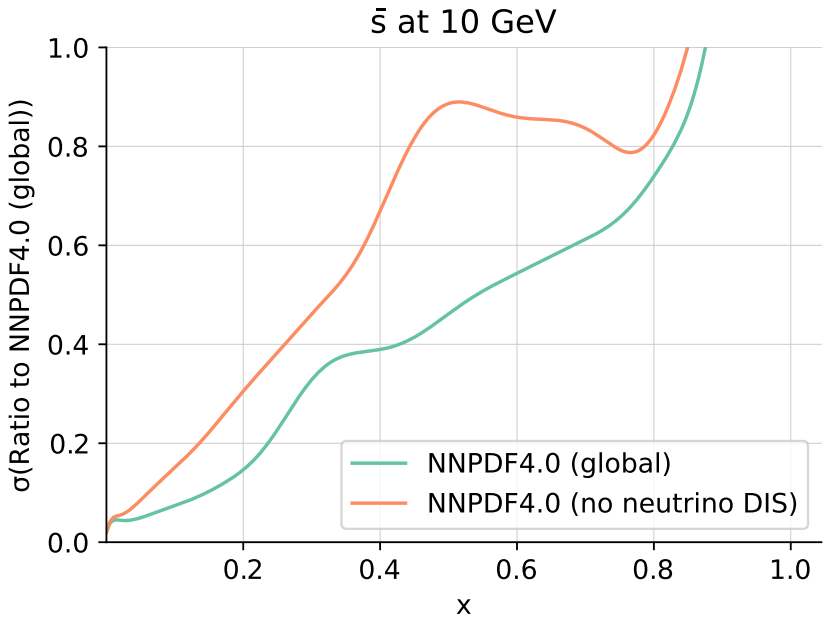
ABMP16 [PRD 96, (2017) 014011]
CT18 [PRD 103 (2021) 014013]
MSHT20 [EPJC 81 (2021) 341]
NNPDF4.0 [arXiv:2109.02653]

EPPS21 [arXiv:2112.12462]
nCTEQ15 [PRD 93 (2016) 085037]
nNNPD3.0 [arXiv:2201.12363]
TUJU21 [arXiv:2112..11904]

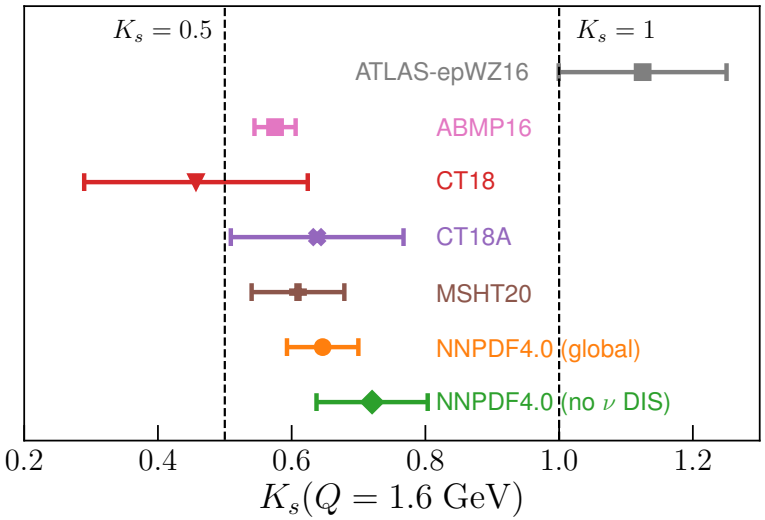
Neutrino DIS data in proton PDFs







Neutrino DIS data in proton PDFs



Good consistency of K_s across PDF sets

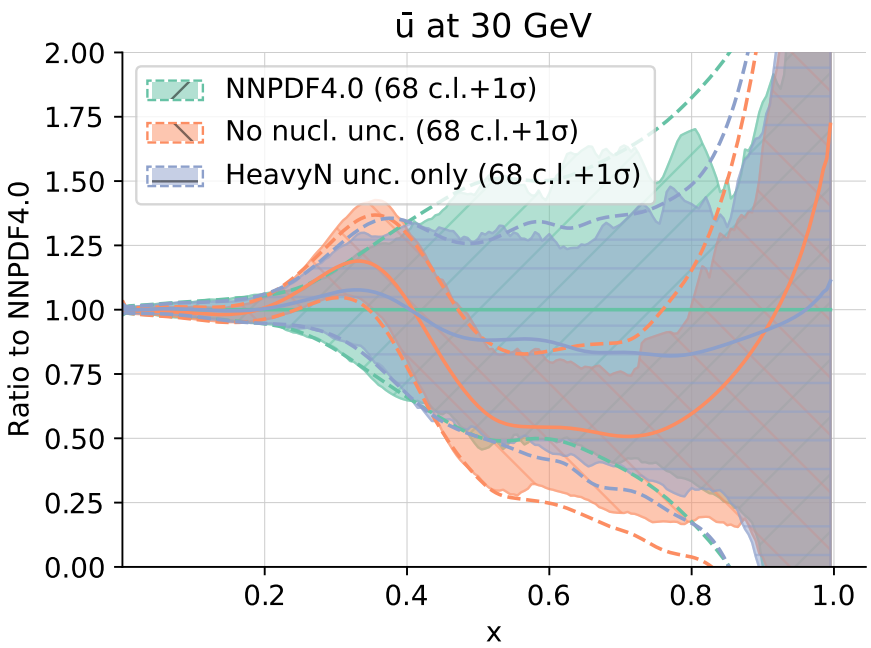
$$K_s(Q^2) = \frac{\int_0^1 dx[s(x,Q^2)+\bar{s}(x,Q^2)]}{\int_0^1 dx[\bar{u}(x,Q^2)+\bar{d}(x,Q^2)]}$$

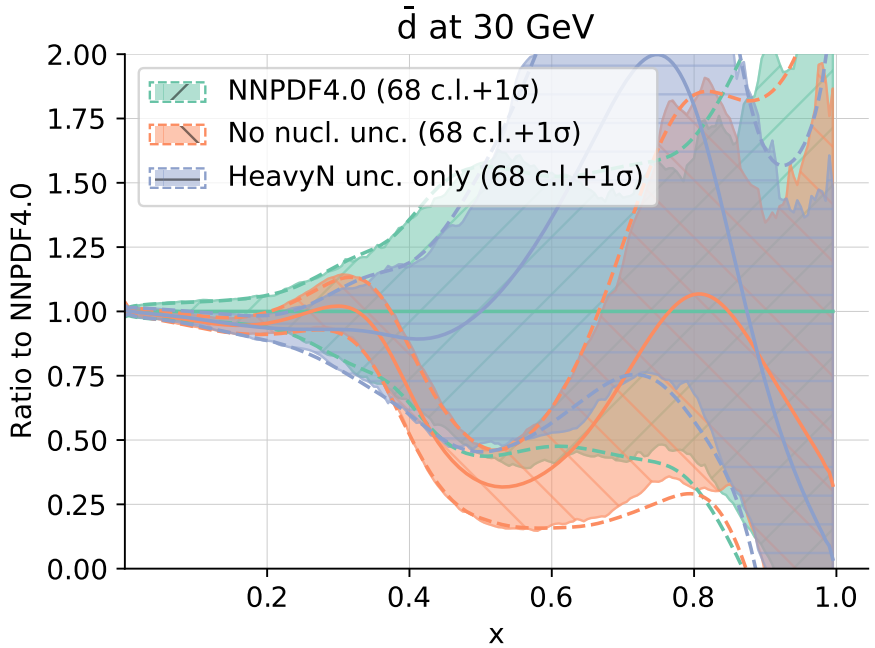
the picture can change dramatically in fits to partial datasets

See [EPJ C80 (2020) 1168]

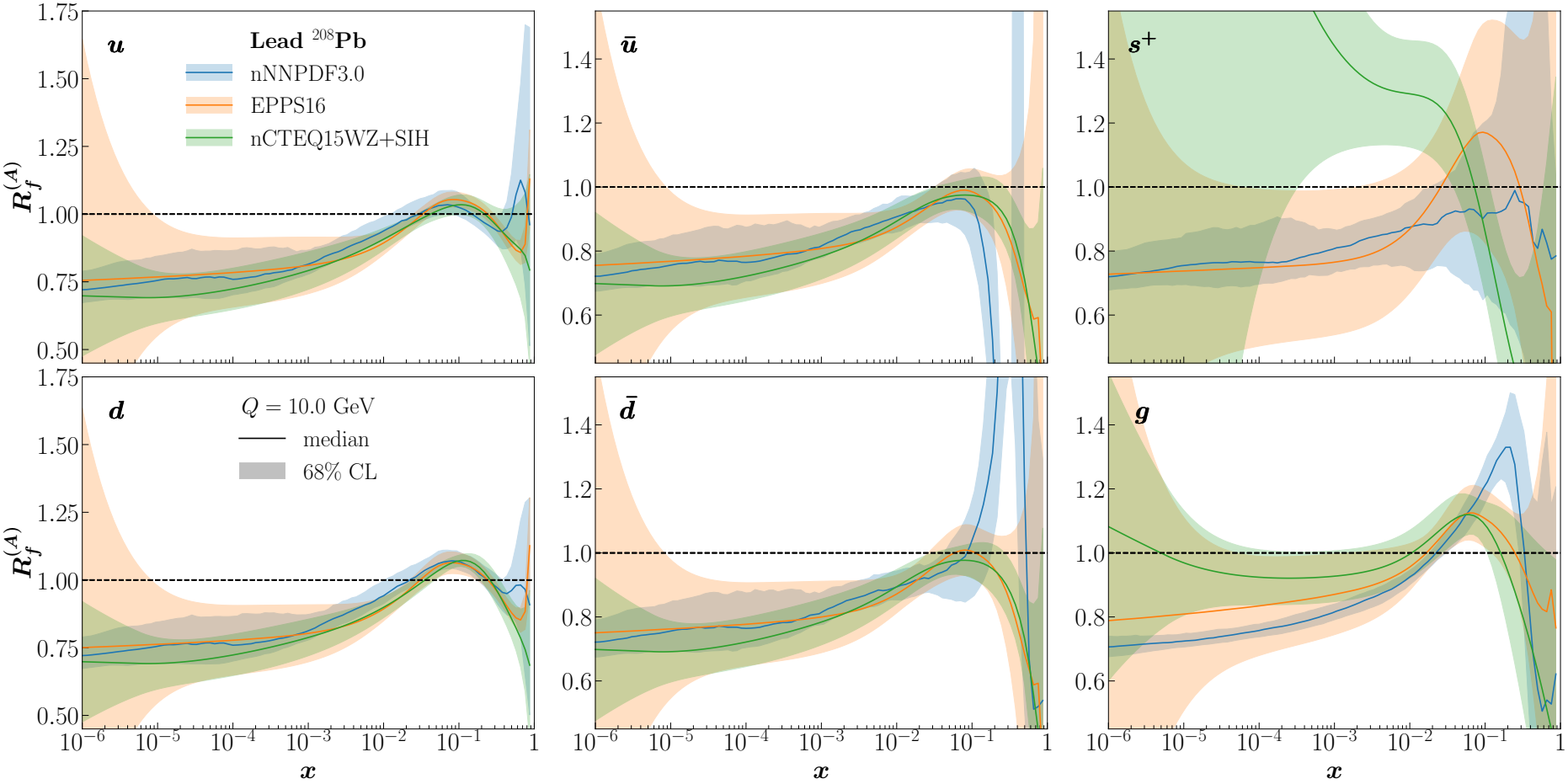
Accounting for nuclear corrections is vital

See [EPJ C79 (2019) 282]



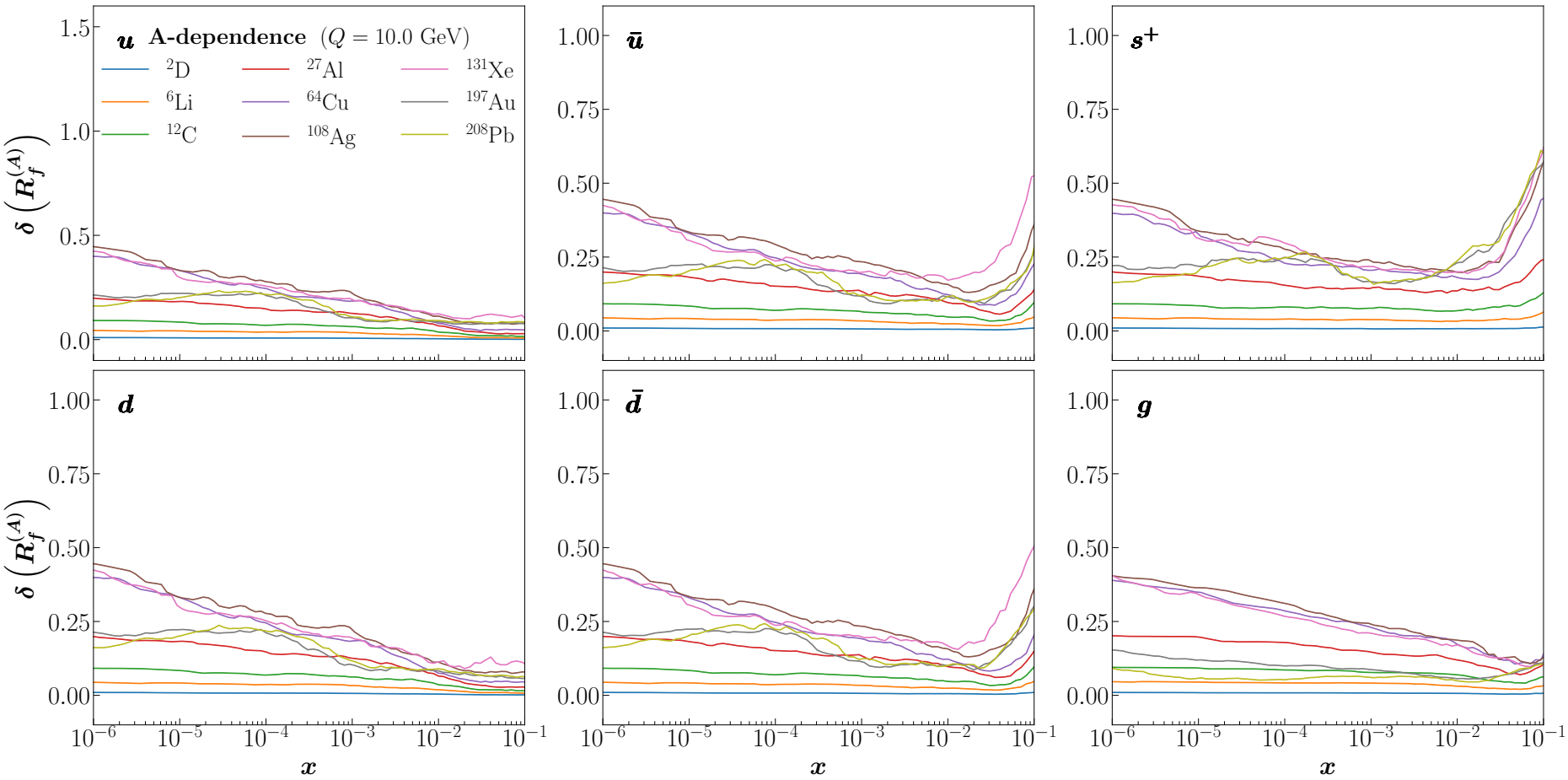


Neutrino DIS data in nuclear PDFs



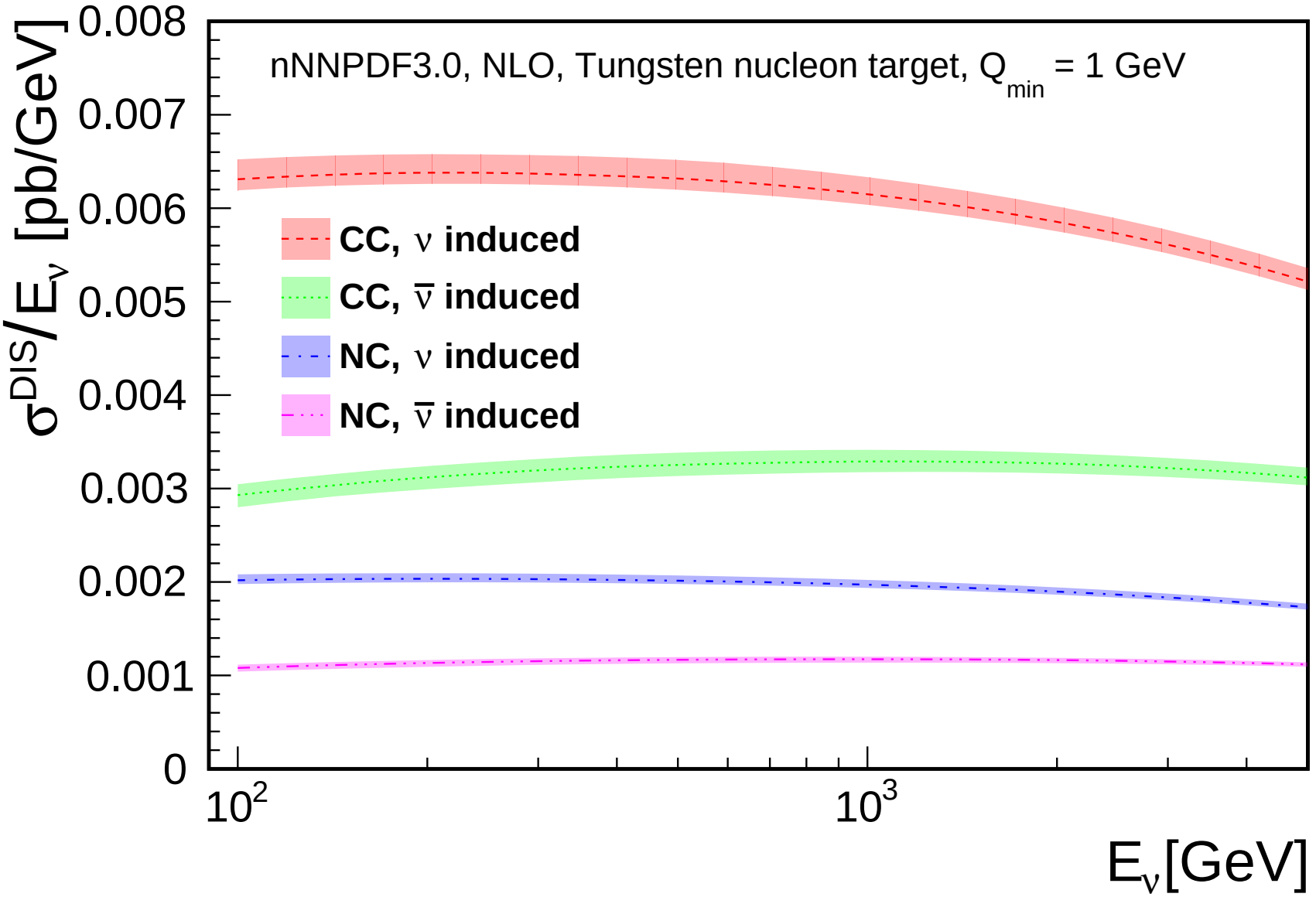
Some difficulties are reported by nCTEQ and EPPS to accommodate neutrino DIS data

Neutrino DIS data in nuclear PDFs



Relative uncertainties from nNNPDF3.0 are small for low A due to proton BC

Neutrino DIS data in nuclear PDFs



[Plot by courtesy of Rhorry Gauld]

Some general remarks

Neutrino DIS data are vital to proton and nuclear PDF determinations.

They remain the most important source of information on strangeness.

Their interplay with other datasets has not always been uncontroversial.

FPF measurements have the potential to play a leading role in this state of affairs, which is complementary to mesurements envisioned at other facilities.

FPF neutrino DIS measurements will involve a nuclear target.

A reliable treatment of nuclear effects in proton PDF fits, or of proton effects in nuclear PDF fits, is vital.

Is the continuous dependence on A a good assumption or not?

Are nuclear medium effects different between NC and CC DIS?

Some general remarks

Neutrino DIS data are vital to proton and nuclear PDF determinations.

They remain the most important source of information on strangeness.

Their interplay with other datasets has not always been uncontroversial.

FPF measurements have the potential to play a leading role in this state of affairs, which is complementary to mesurements envisioned at other facilities.

FPF neutrino DIS measurements will involve a nuclear target.

A reliable treatment of nuclear effects in proton PDF fits, or of proton effects in nuclear PDF fits, is vital.

Is the continuous dependence on A a good assumption or not?

Are nuclear medium effects different between NC and CC DIS?

Thank you