Nuclear parton densities at the EIC

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outline

- a quick reminder
- before an EIC
- the EIC era
- summary
- outlook

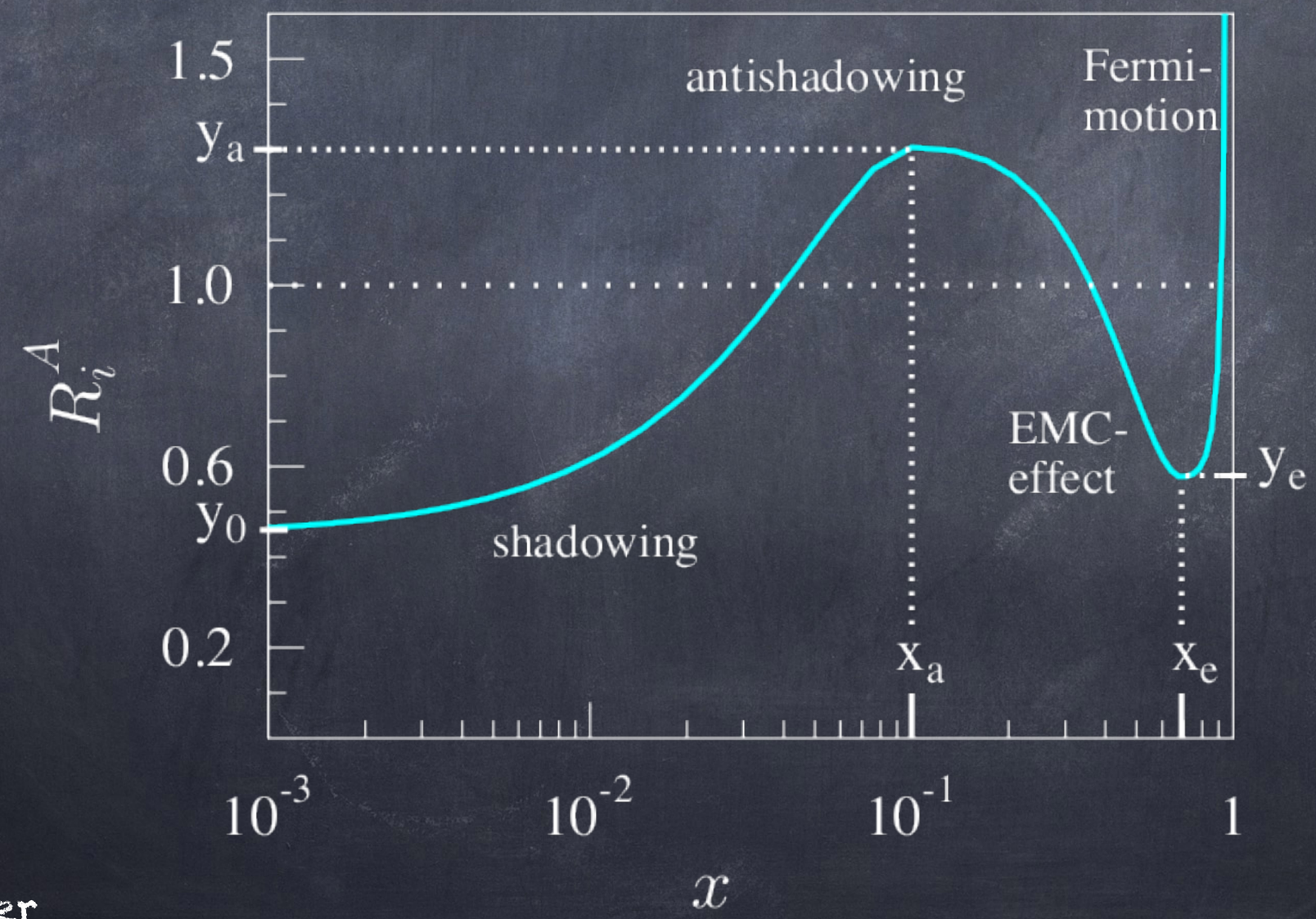
a quick reminder: what is she talking about?

nPDF: $f_i^A(x,\mu)$

- at LO: probability of finding the parton i in the nucleus A, carrying a fraction x of its momentum, when the nucleus is probed with scale μ
- non-perturbative but universal
- obtained by global fits to the world data

the procedure: parameterize the nuclear-to-proton PDF ratio at initial scale Q_0

$$f_i^{p/A}(x, Q_0) = f_i^p(x, Q_0) R_i^A(x, Q_0, A)$$



the observable:

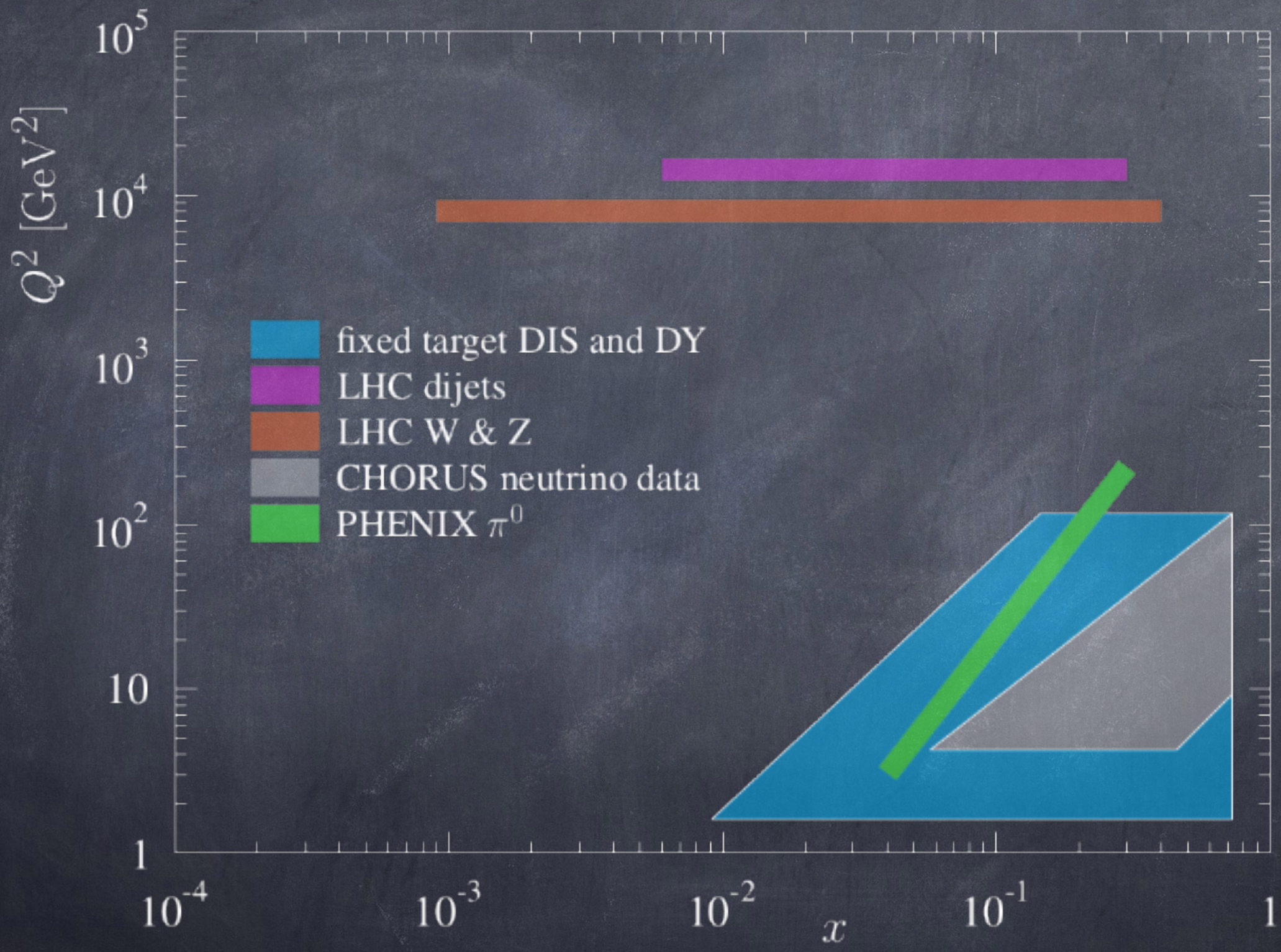
$$\sigma_{red} = F_2 - \frac{y^2}{1+(1-y)^2} F_L$$

$$F_2^{NLO} = \sum_i^{N_f} e_i^2 (q_i + \bar{q}_i) \otimes \left[\delta(1-x) + \alpha_s C_{2,q}^{(1)} \right] + \alpha_s \; g \otimes C_{2,g}^{(1)}$$

$$F_L^{NLO} = \alpha_s \left[\sum_i^{N_f} e_i^2 (q_i + \bar{q}_i) \otimes C_{L,q}^{(1)} + g \otimes C_{L,g}^{(1)} \right]$$

Little sensitivity to the gluon in fixed target experiments

before an EIC

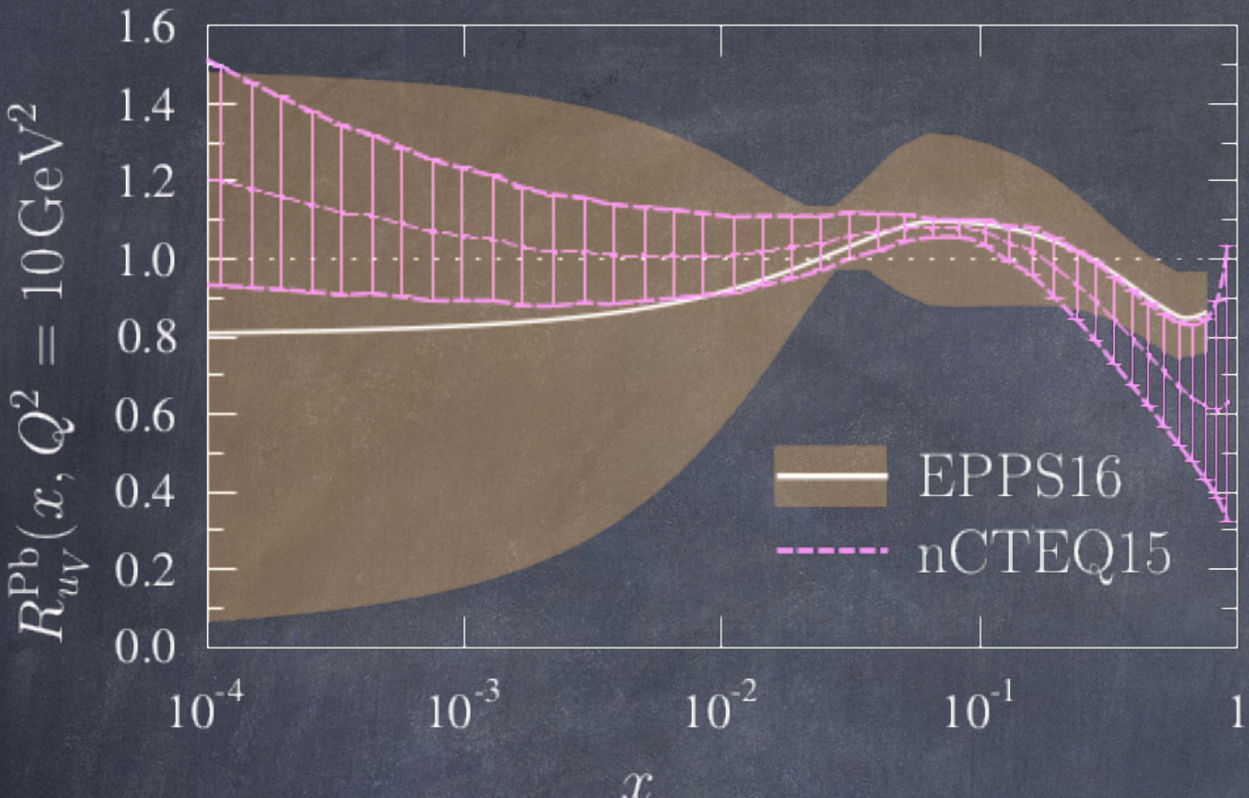


before an EIC

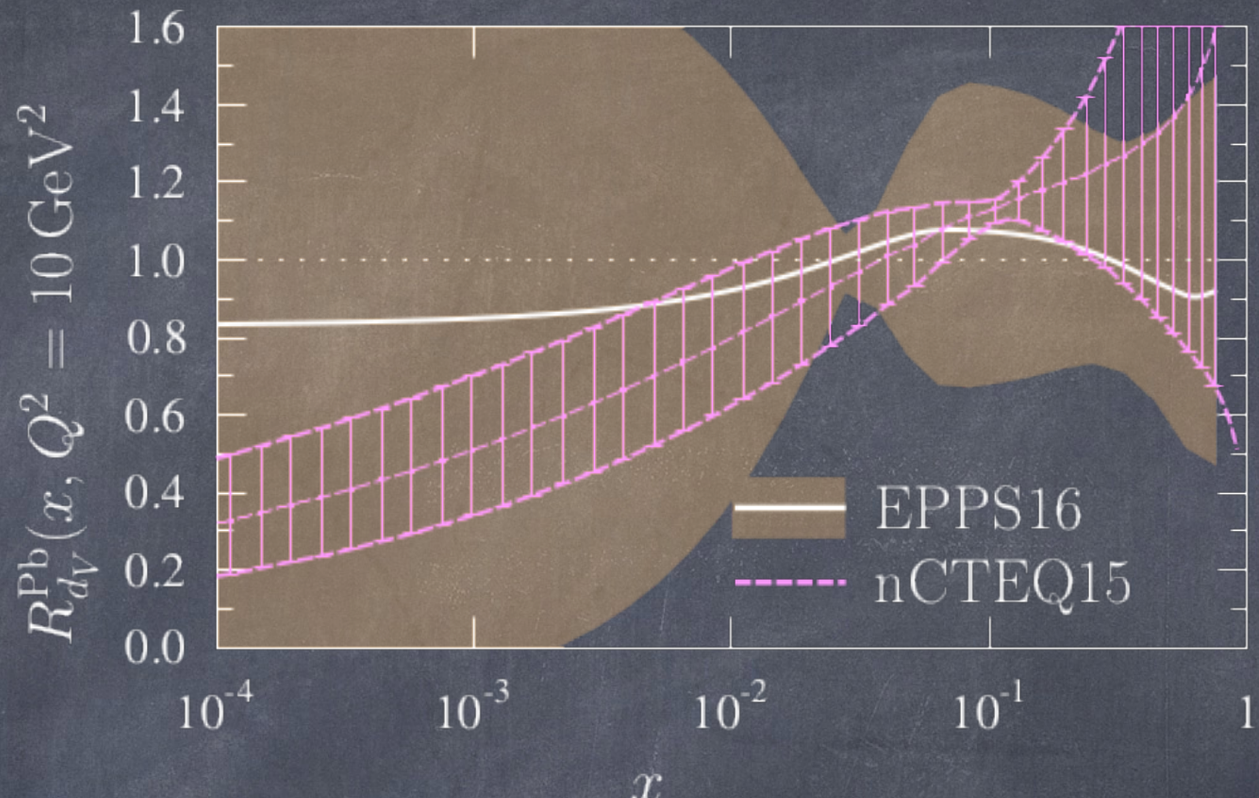
SET		before LHC	EPPS16, EPJC77 (2017) no.3, 163
data type	NC-DIS	✔ $\approx \frac{4}{9}u_v + \frac{1}{9}d_v$	✔
	D-Y	✔	✔
	pions	✔	✔
	CC-DIS	✔ $\approx u_v + d_v$	✔
	EW	✘	✔
	jets	✘	✔
accuracy		LO to NNLO	NLO
flavour separation?		not (quite) successful	✔

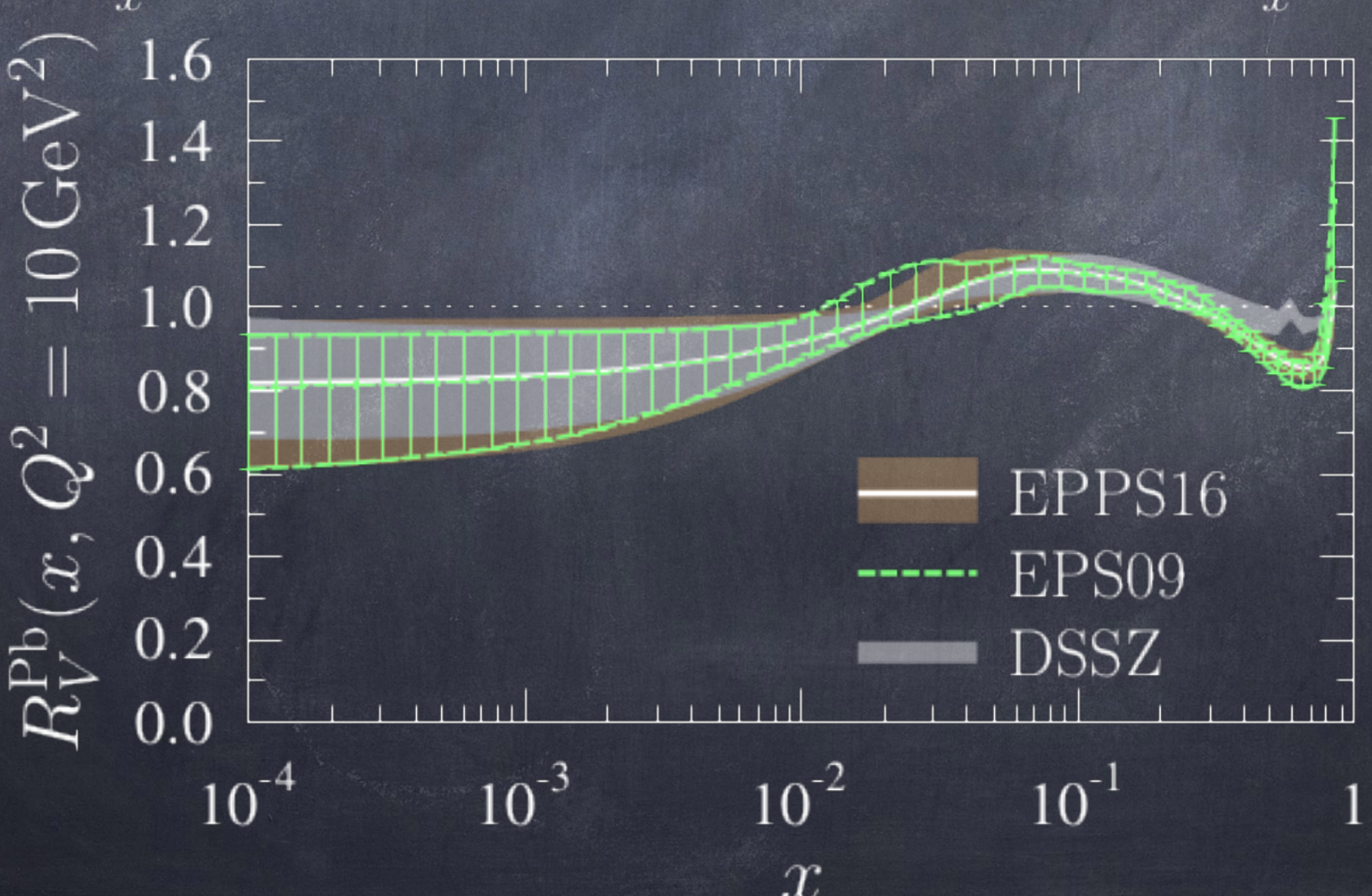
LHC data

u_V

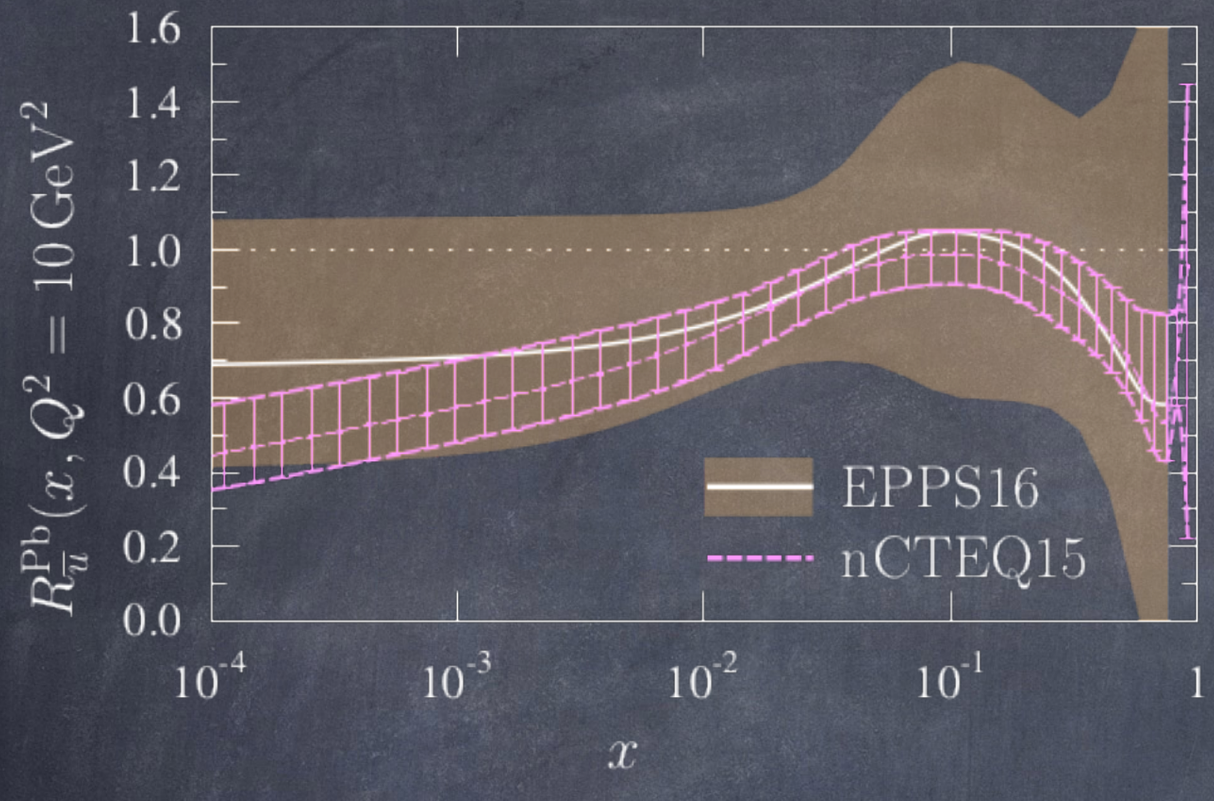

$R^{\mathrm{Pb}}_{u_V}(x, Q^2 = 10\,\mathrm{GeV}^2)$
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
x
EPPS16
nCTEQ15

d_V

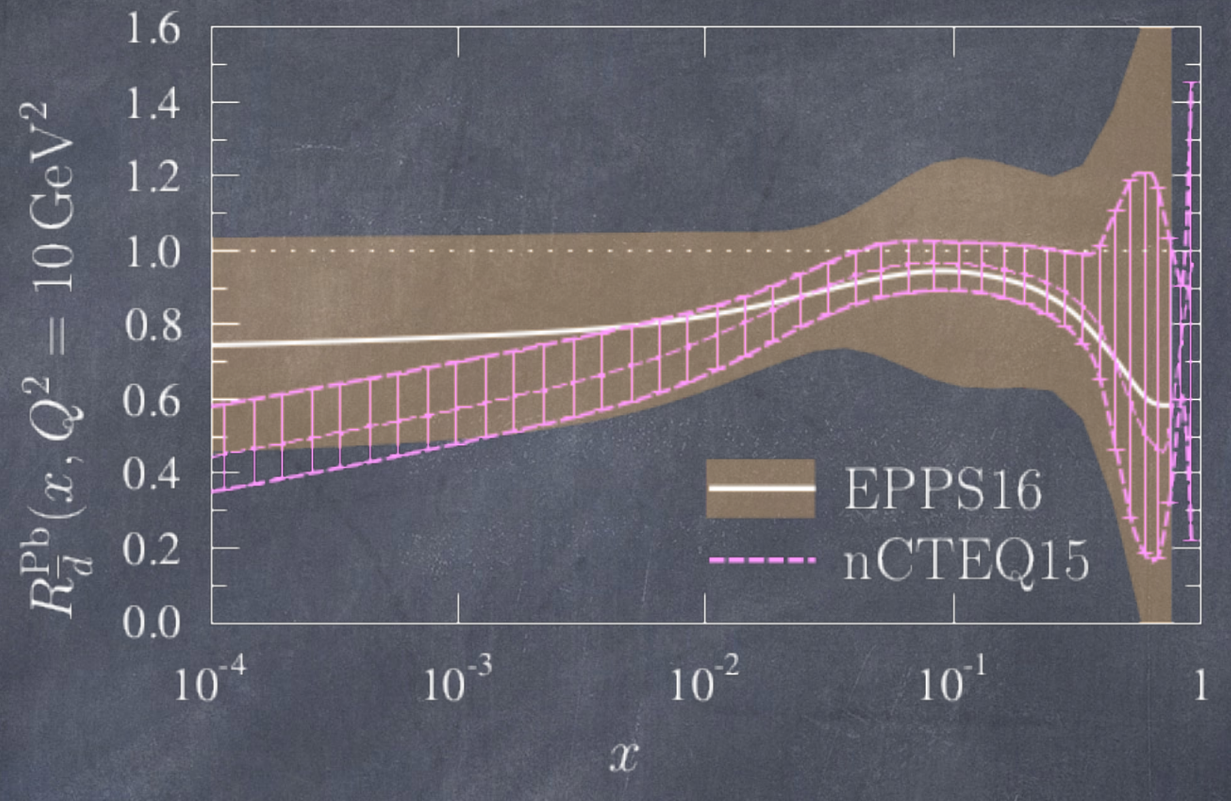

$R^{\mathrm{Pb}}_{d_V}(x, Q^2 = 10\,\mathrm{GeV}^2)$
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
x
EPPS16
nCTEQ15


$R^{\mathrm{Pb}}_{V}(x, Q^2 = 10\,\mathrm{GeV}^2)$
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
x
EPPS16
EPS09
DSSZ

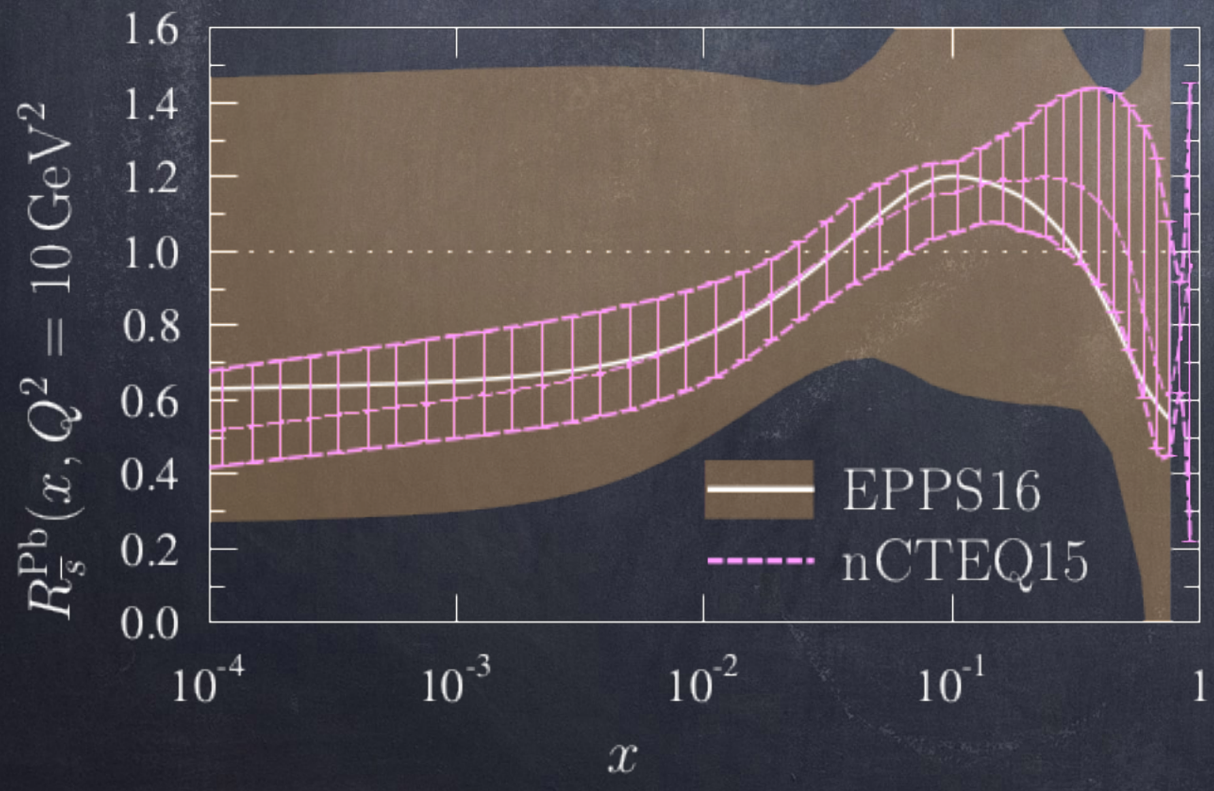
$\bar{u}$

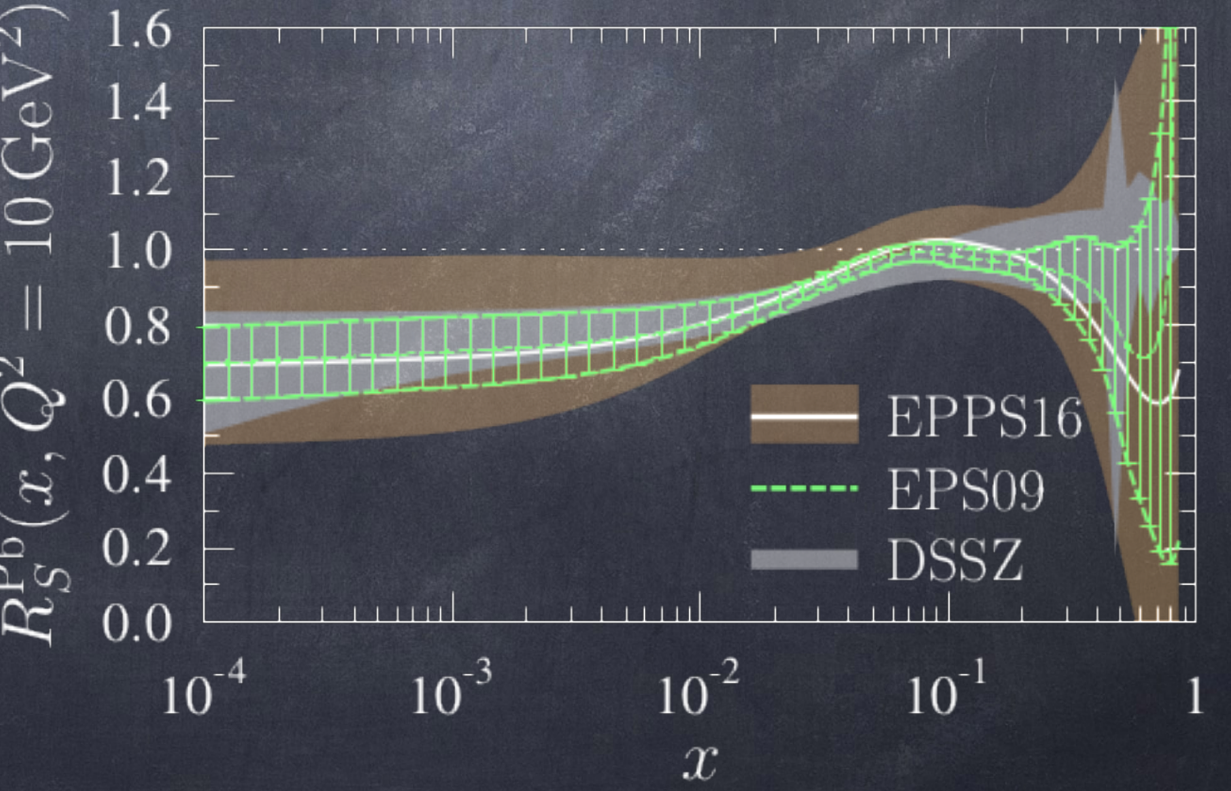


$\bar{d}$



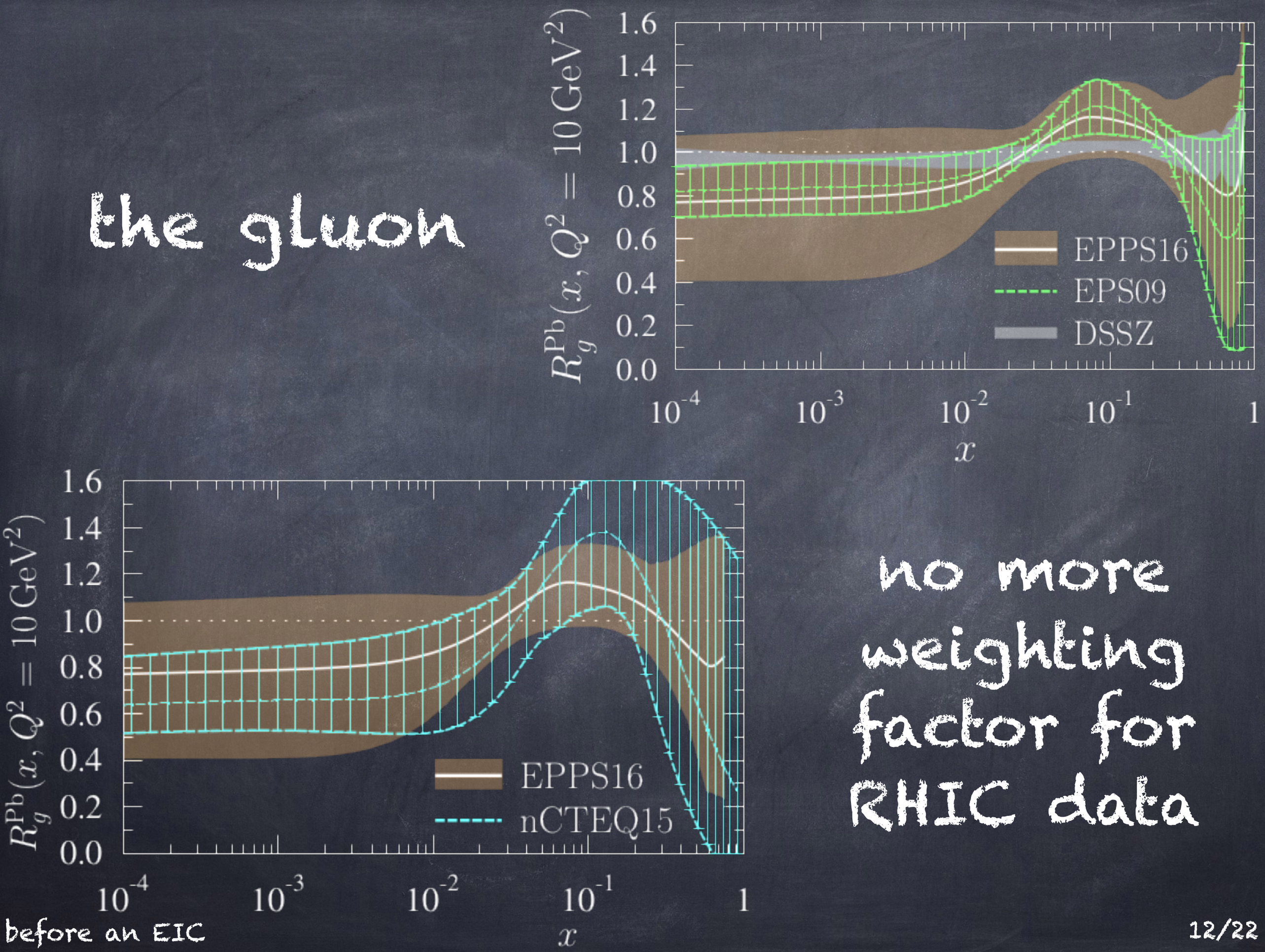
$\bar{s}$





before an EIC

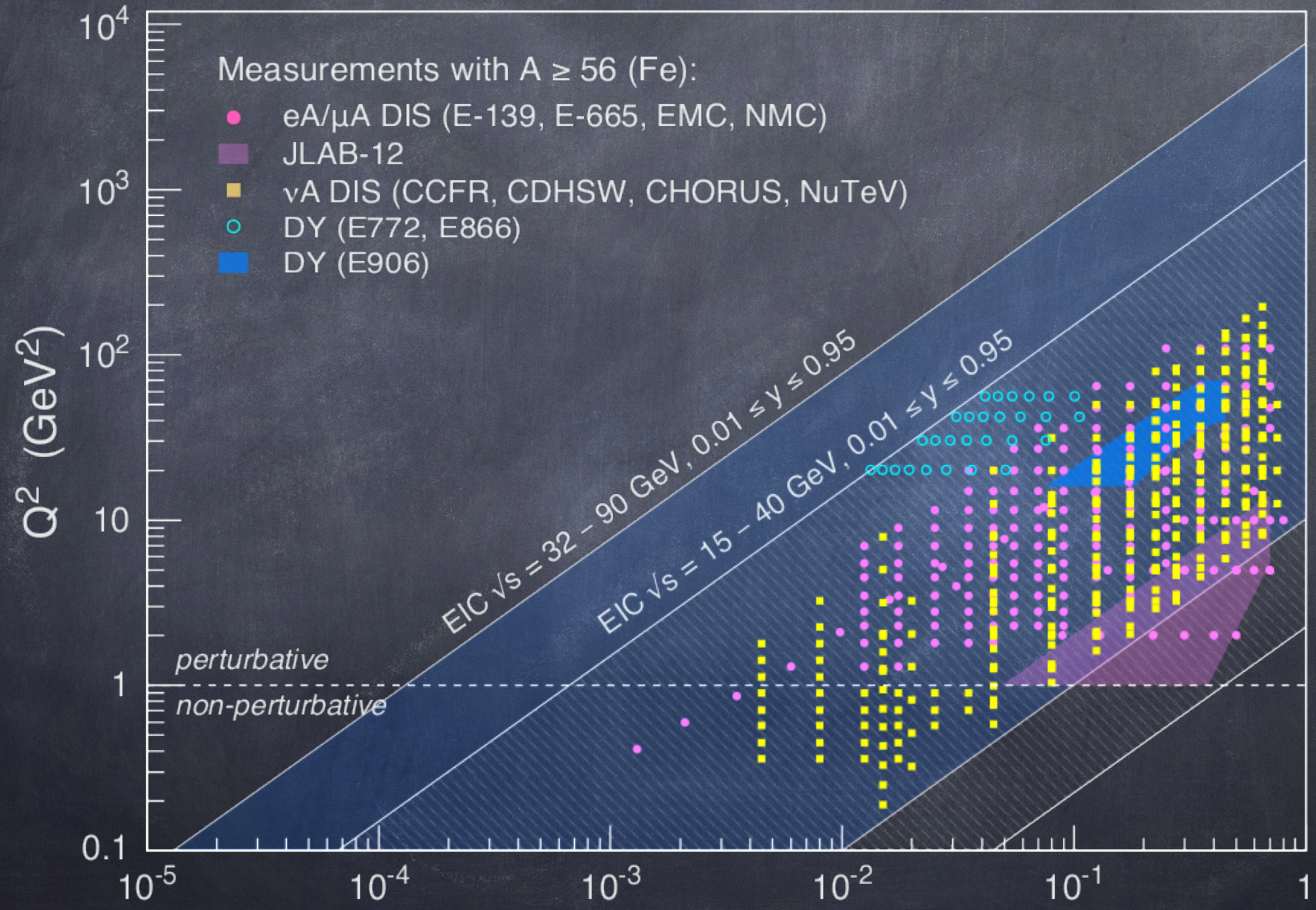
the gluon



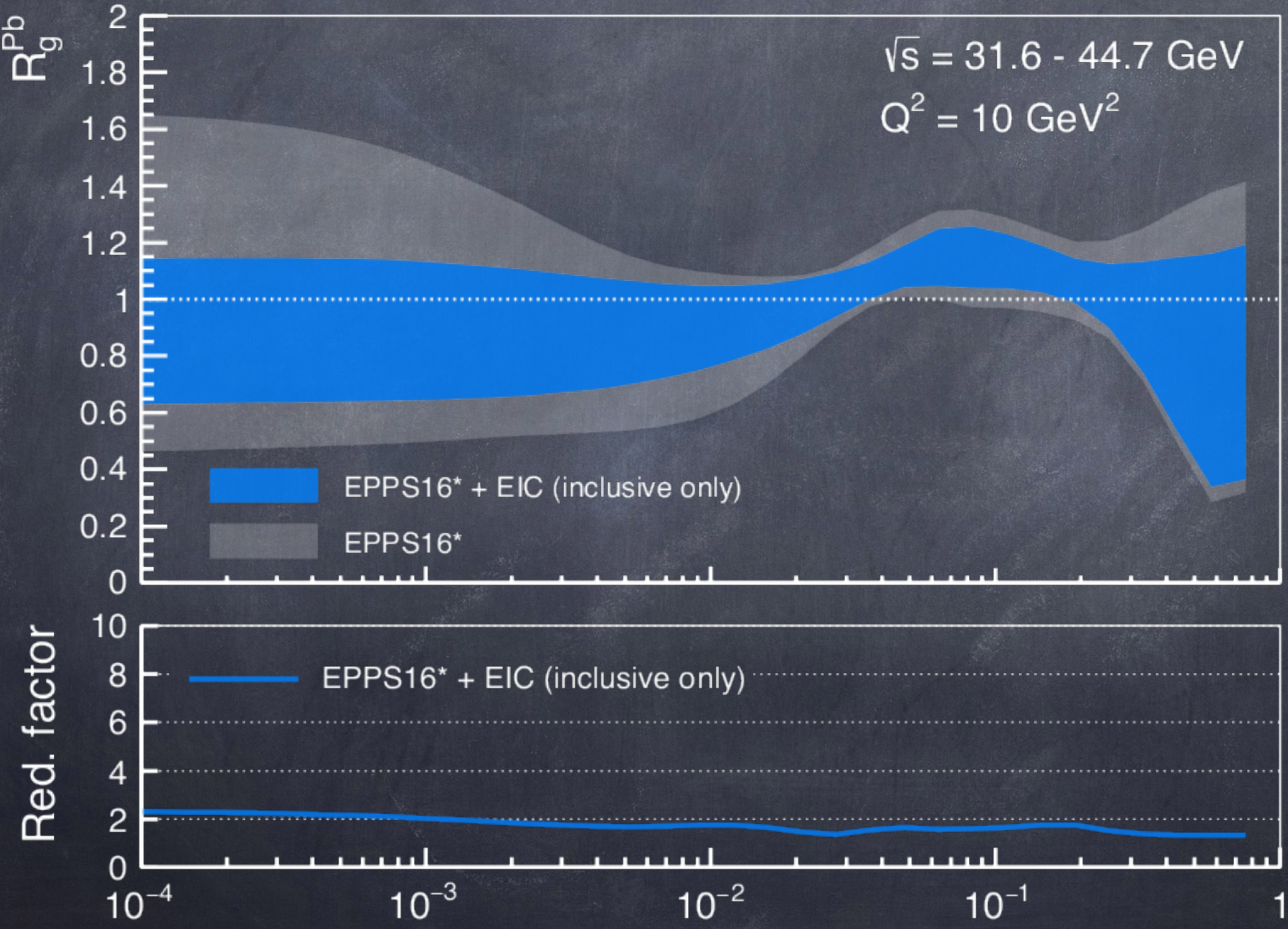
no more weighting factor for RHIC data

the EIC era

two possibilities for the energy range:



with a lower energy realization of an EIC



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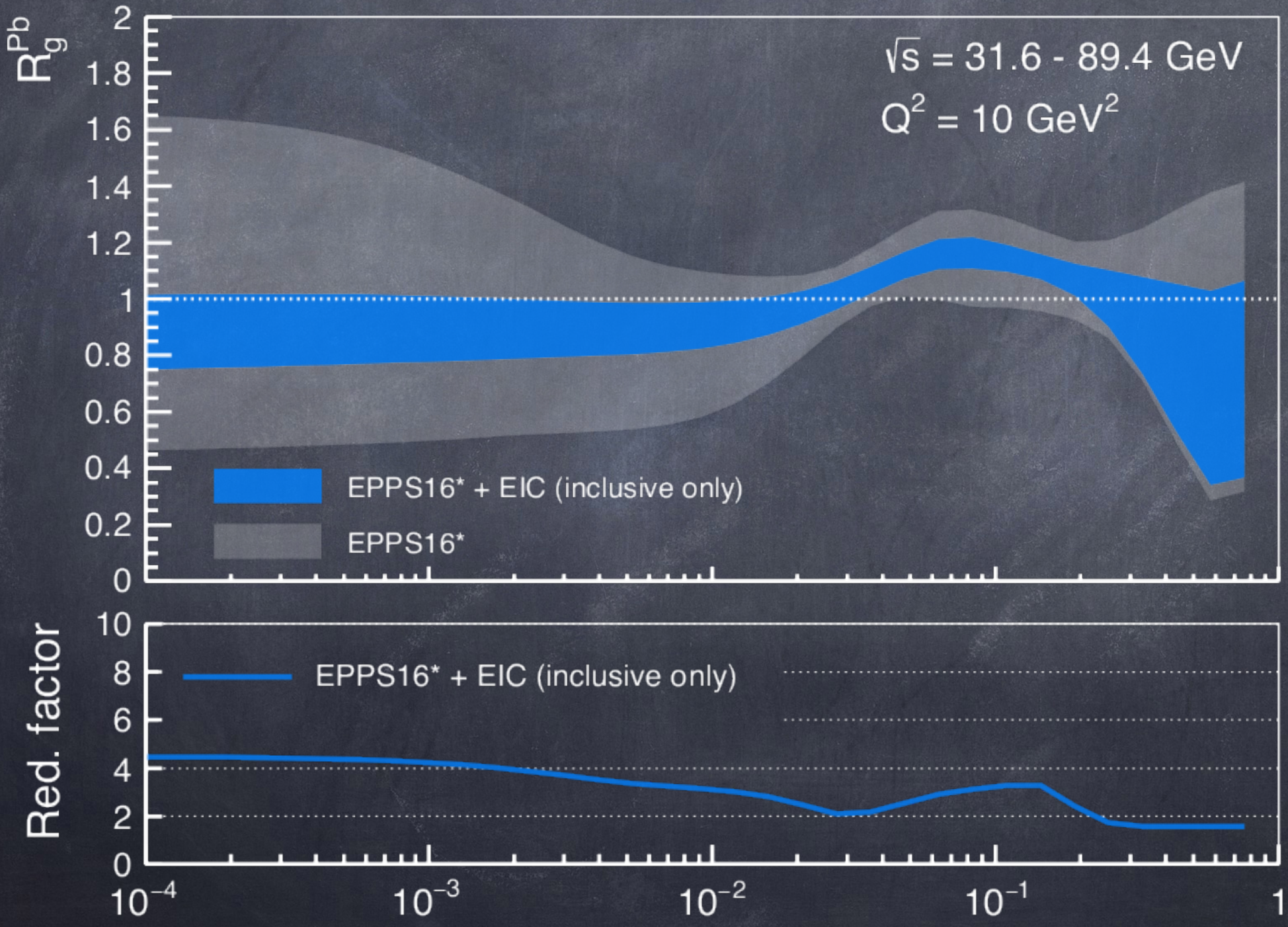
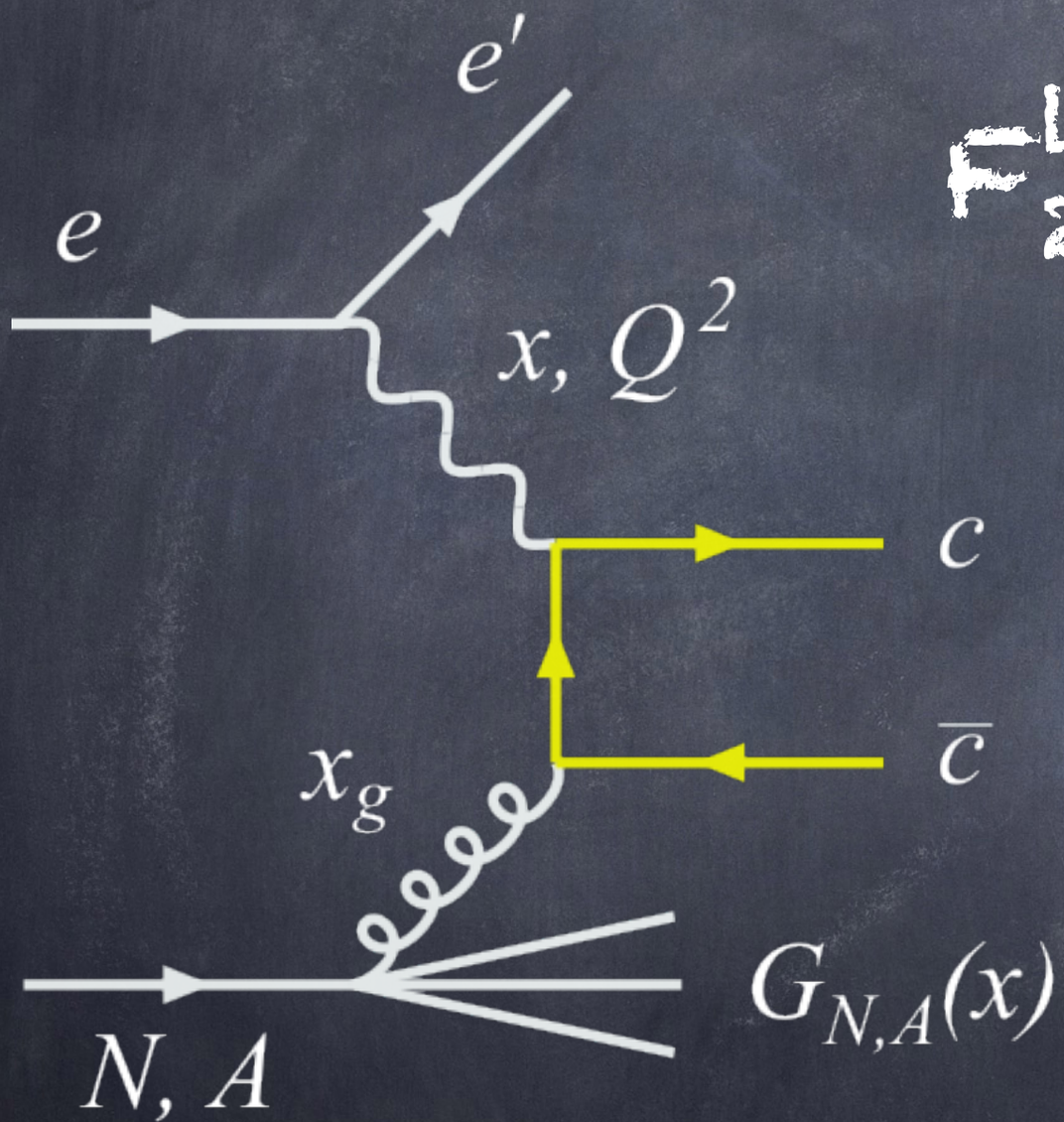


but if we're charming...

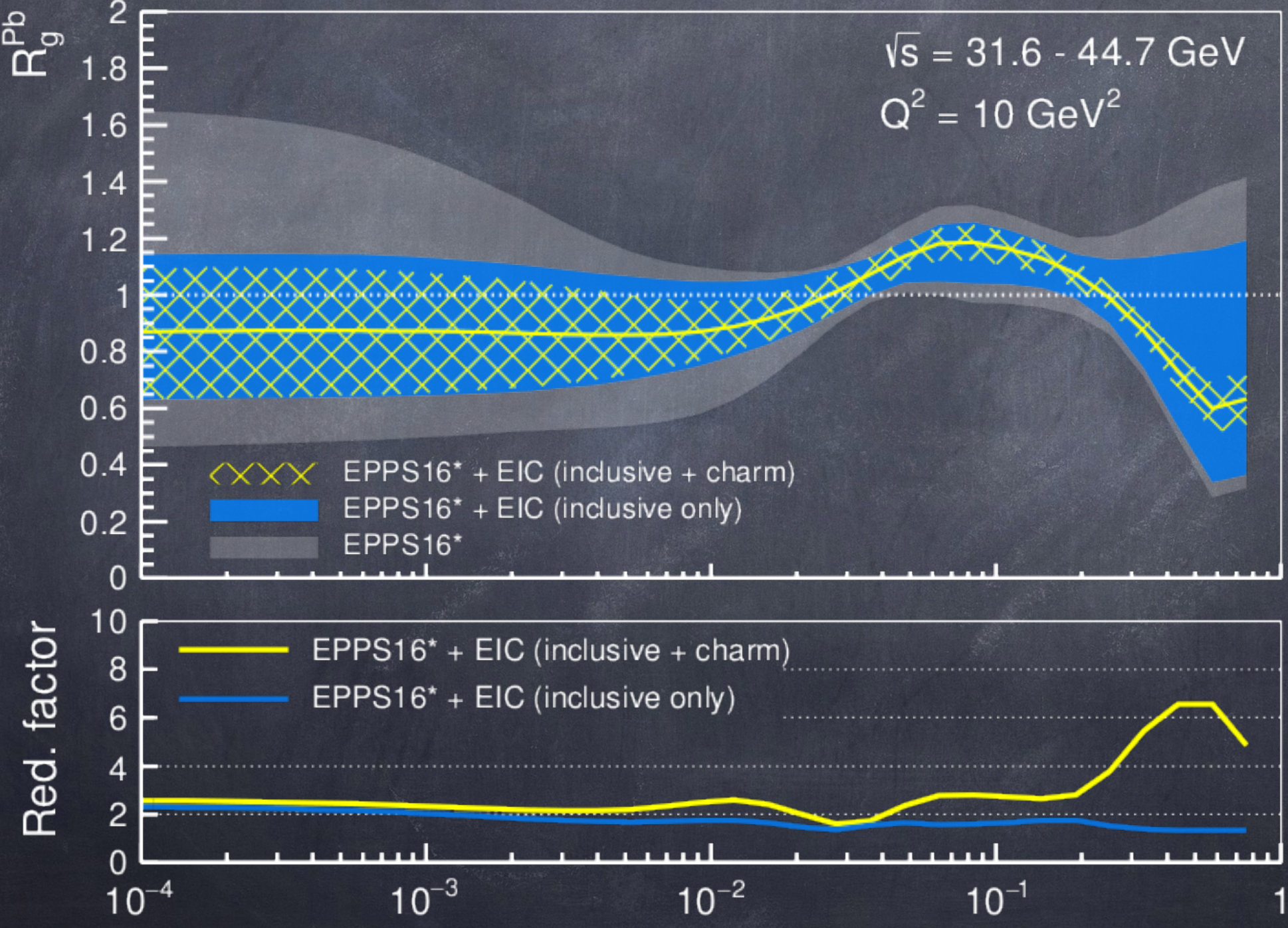


$$F_2^{LO,c\bar{c}} = \frac{\alpha_s Q^2 e_c^2}{4\pi^2 m_c^2} g \otimes C_{2,g}^{(0)}$$

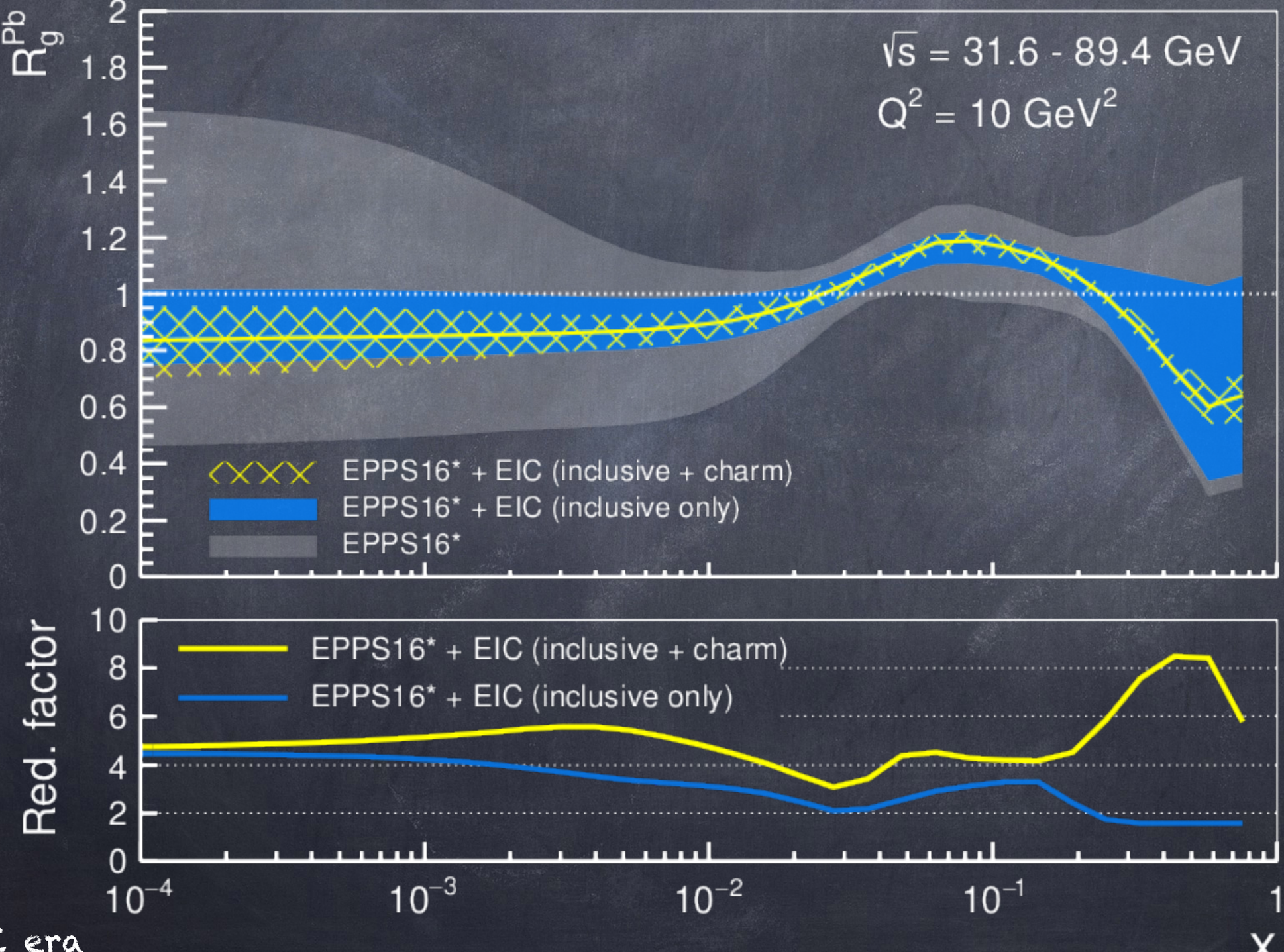
$$x < x_g$$

access to the unconstrained high-x gluon

with a lower energy realization of an EIC



with a higher energy realization of an EIC



Summary

- nuclear gluon density mostly unconstrained: an EIC is a must
- low energy:
  - kinematical range not very extended 👎
  - but high precision data 👍
- high energy:
  - kinematical range extended 👍
  - more chances of finding saturation 👍
- for charm: win-win situation 👍

outlook

still many studies to do:

- charged-current for (better) flavor separation
- impact of jets? Klasen, Kovarik, Potthoff, Phys.Rev. D95 (2017) no.9, 094013
- higher order (NNLO at least) for nPDFs?