(n)PDF Studies with Open Charm at the EIC

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Outline

1) Intrinsic charm PDF studies with fast-simulation

2) Impact on gluon nPDF using a Bayesian PDF re-weighting technique

Intrinsic Charm Studies

Intrinsic charm (IC) in the proton still a long-standing open question*

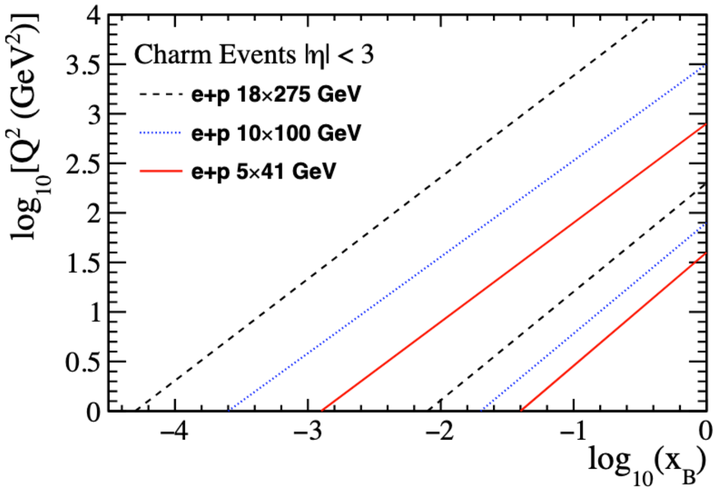
- Non-perturbative $|QQ\bar{u}ud\rangle$ Fock state
- Hints from DIS and p+p, nothing conclusive

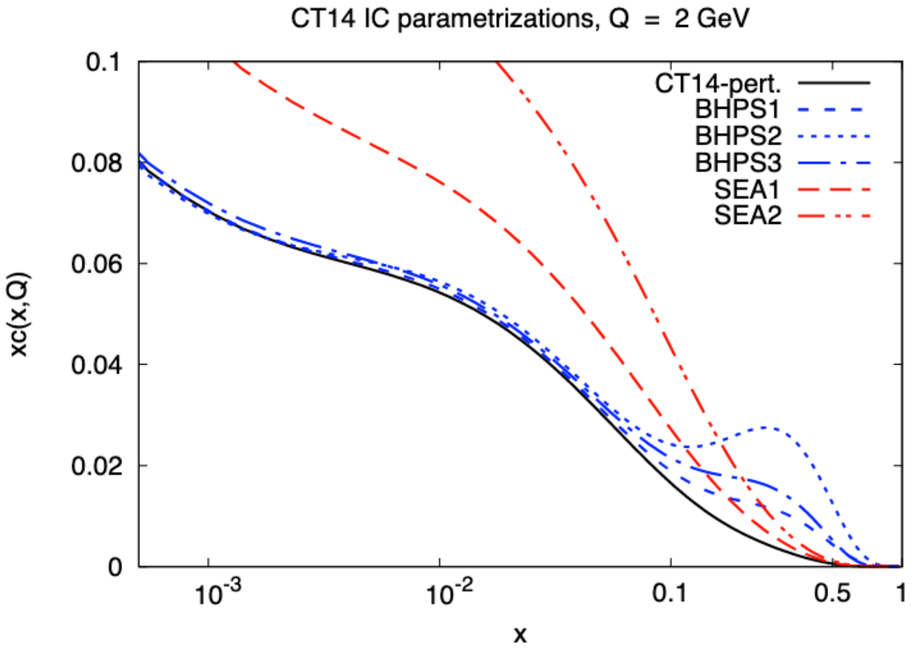
Various models for IC - "valence-like" and "sea-like" valiant features

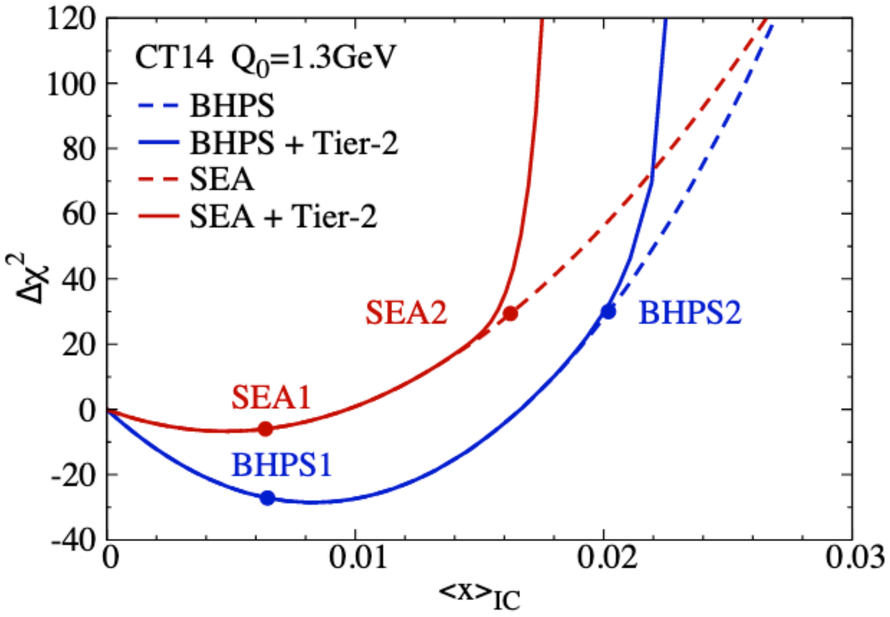
- $\langle x \rangle \sim O(1\%)$
- Open charm will probe high-x region with high statistics

Studied impact on charm structure functions using the CT14 PDFs w/ IC**

- PYTHIA Process: $\gamma + c \rightarrow c$







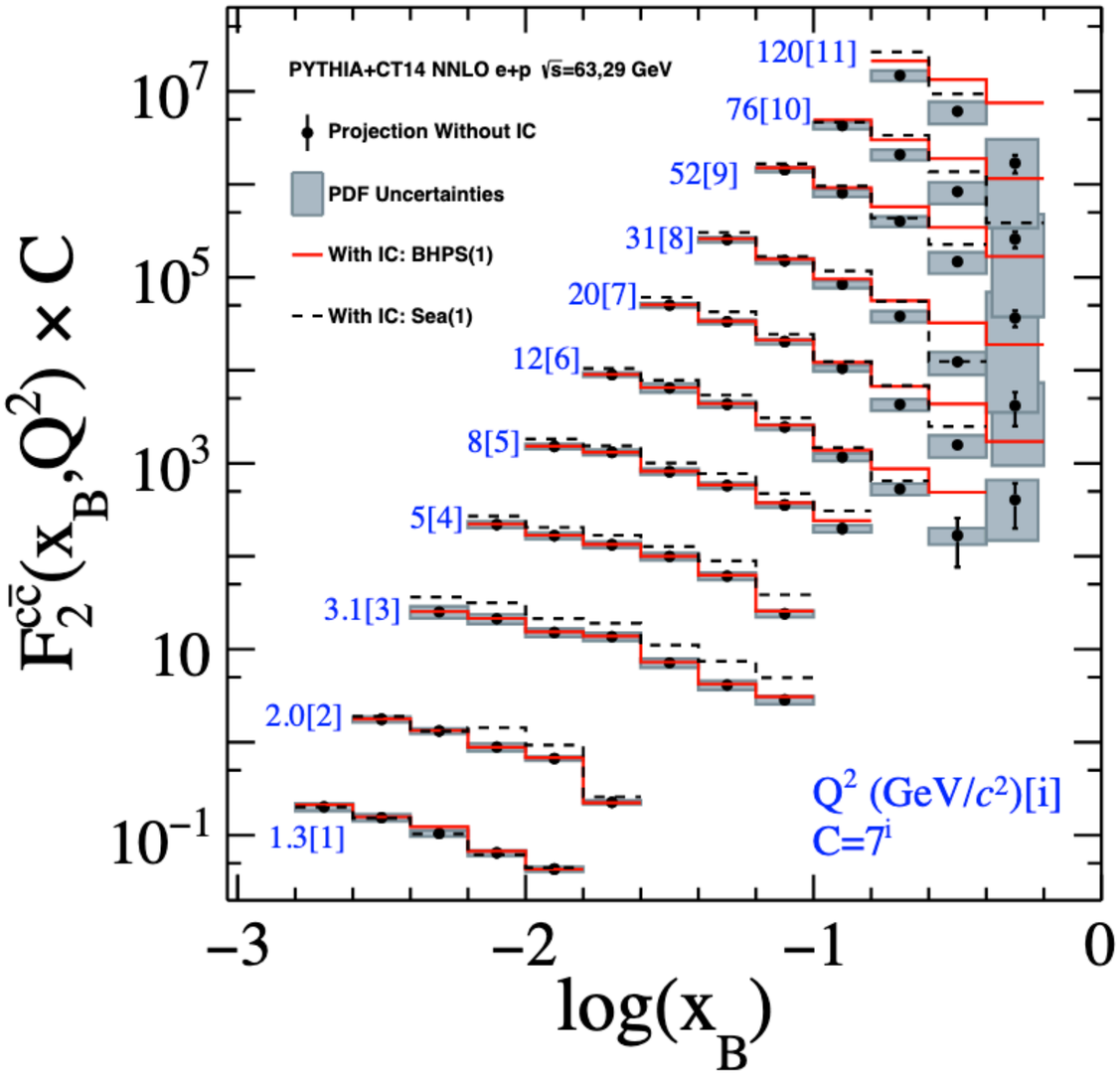
*Brodsky et al. https://doi.org/10.1016/j.ppnp.2016.12.001
**Hou et al. *JHEP* 02 (2018) 059

Intrinsic Charm Studies Cont.

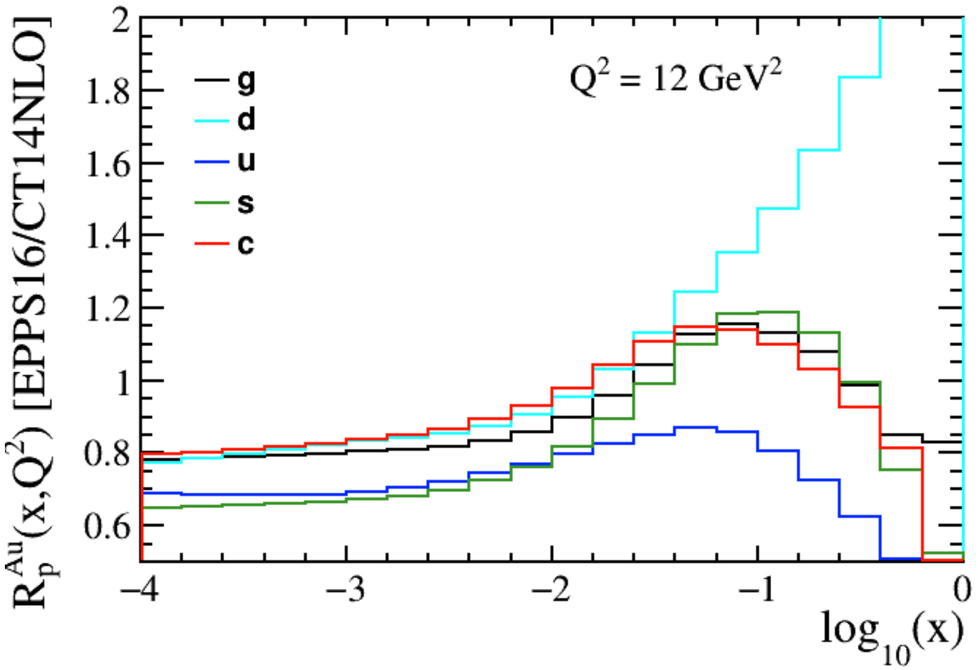
Sea-like IC PDF enhances charm structure function by factor of two across Q2/x

BHPS(valence-like) enhances charm structure function at high-x values, up to an order of magnitude

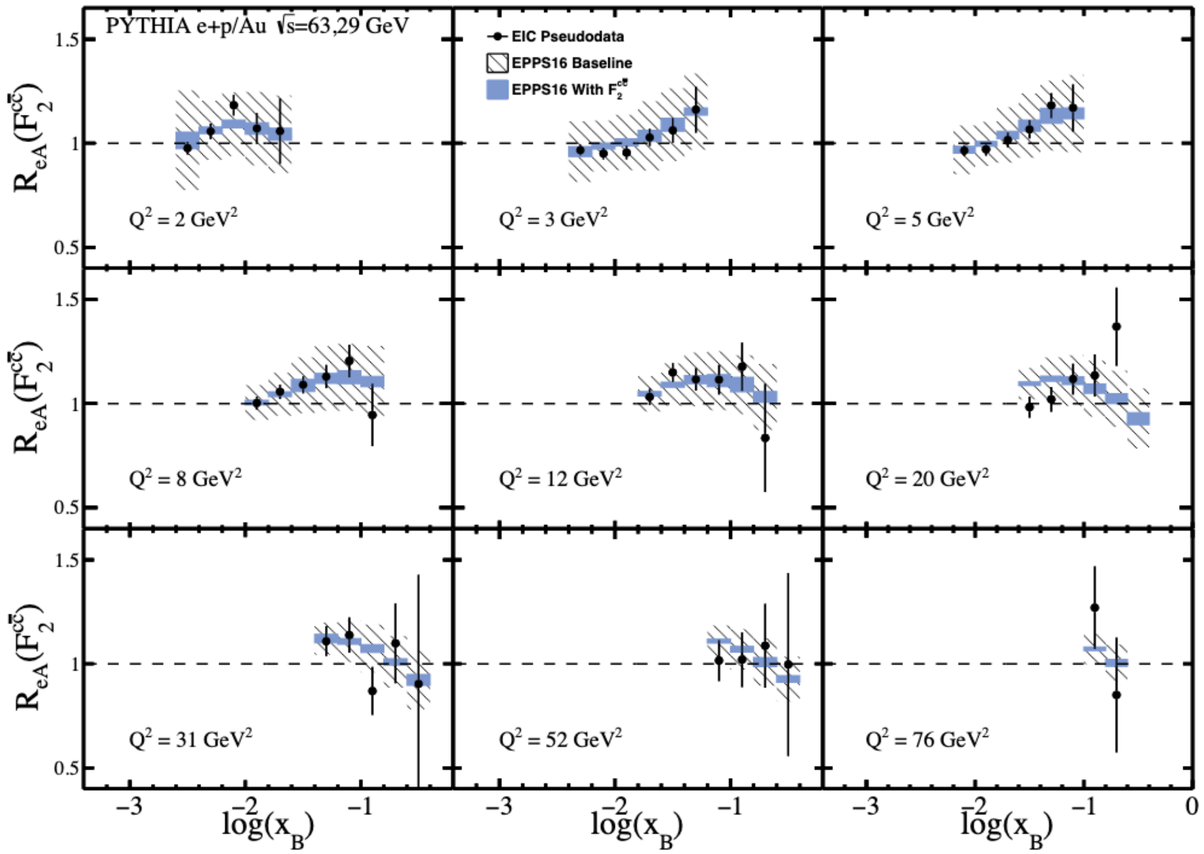
Uncertainties from statistics/PDFs small w.r.t. enhancement



Application of nPDFs in Fast-Sim



Pseudo-data



Event re-weighting according to x, Q², struck parton flavor

EPPS16 shown for example, but repeated studies with nCTEQ15 and nNNPDF2.0

Pseudo-data: Randomly displace F2 ratio points from central value by statistical errors

Bayesian PDF Re-weighting

doi:10.1007/JHEP12(2014)100

Central value

Symmetrized Hessian errors

$$f_k \equiv f_{S_0} + \sum_i^{N_{\rm eig}} \left(\frac{f_{S_i^+} - f_{S_i^-}}{2} \right) R_{ik}$$

k = replica index (1000/PDF set)

Random Gaussian value

$$\omega_k^{\rm GK} = \frac{\exp\left[-\chi_k^2/2\right]}{(1/N_{\rm rep}) \sum_{k=1}^{N_{\rm rep}} \exp\left[-\chi_k^2/2\right]}$$

$$f_{\rm new} = f_{S_0} + \sum_i^{N_{\rm eig}} \left(\frac{f_{S_i^+} - f_{S_i^-}}{2} \right) \left(\frac{1}{N_{\rm rep}} \sum_k^{N_{\rm rep}} \omega_k R_{ik} \right)$$

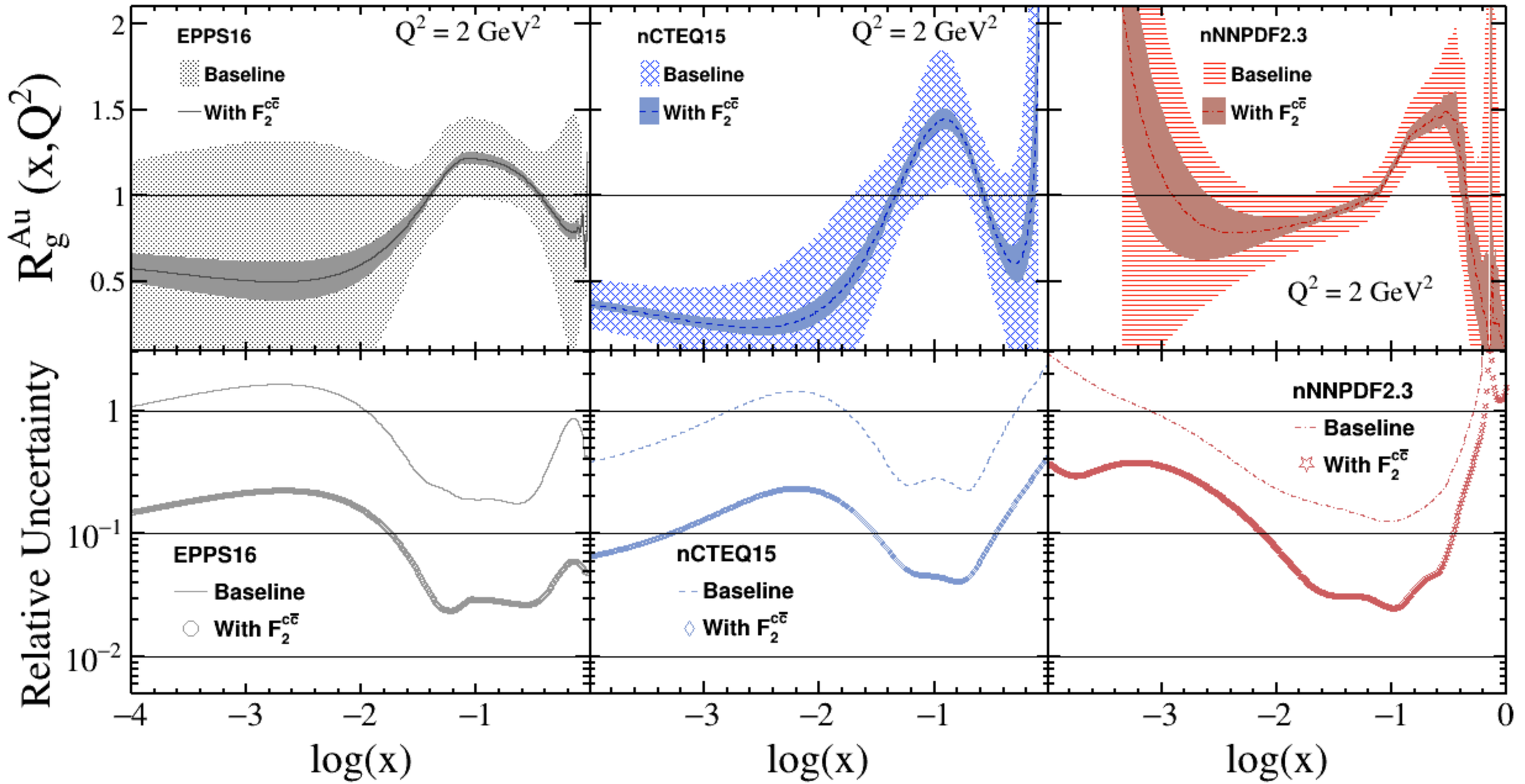
Note: Slightly different for nNNPDF

Using photon-gluon fusion events exclusively, re-weighted to conserve estimated cross-section (and errors) in 10x100 and 5x41 collisions

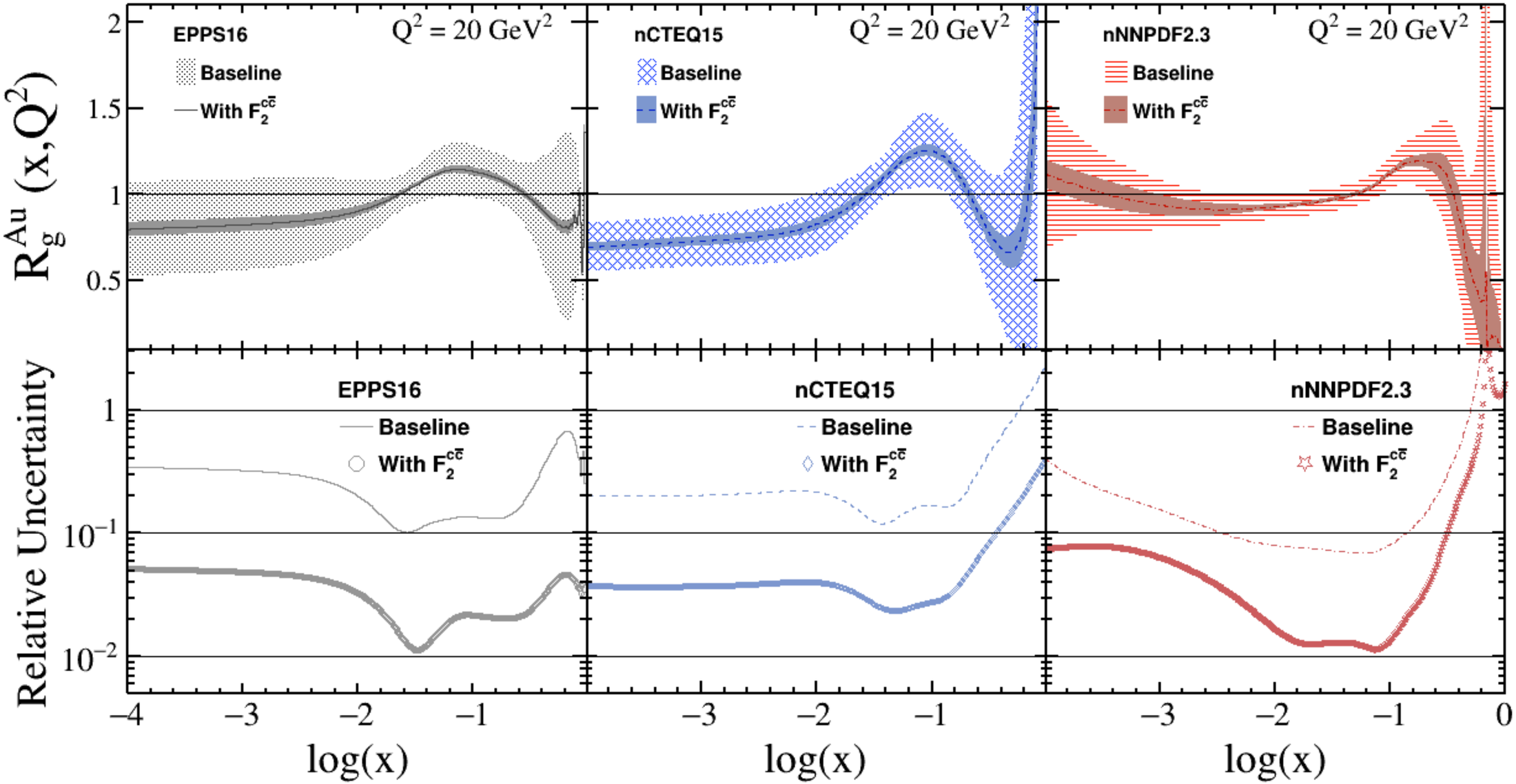
- Might cause some over-estimation of error reductions

Scaling all error bars to 1 fb^{-1}; removed points with rel. error >40%

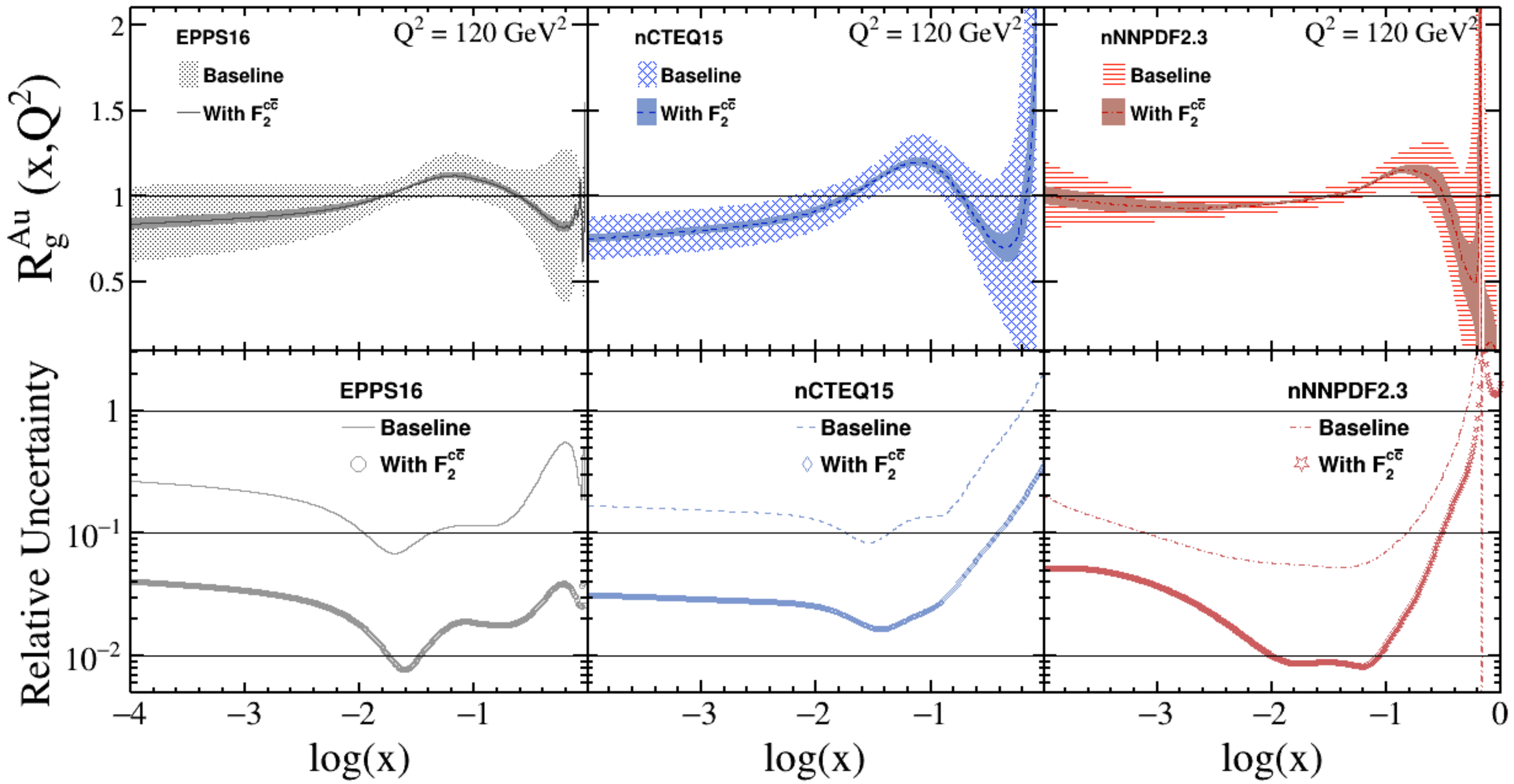
Gluon nPDF Impact



Gluon nPDF Impact

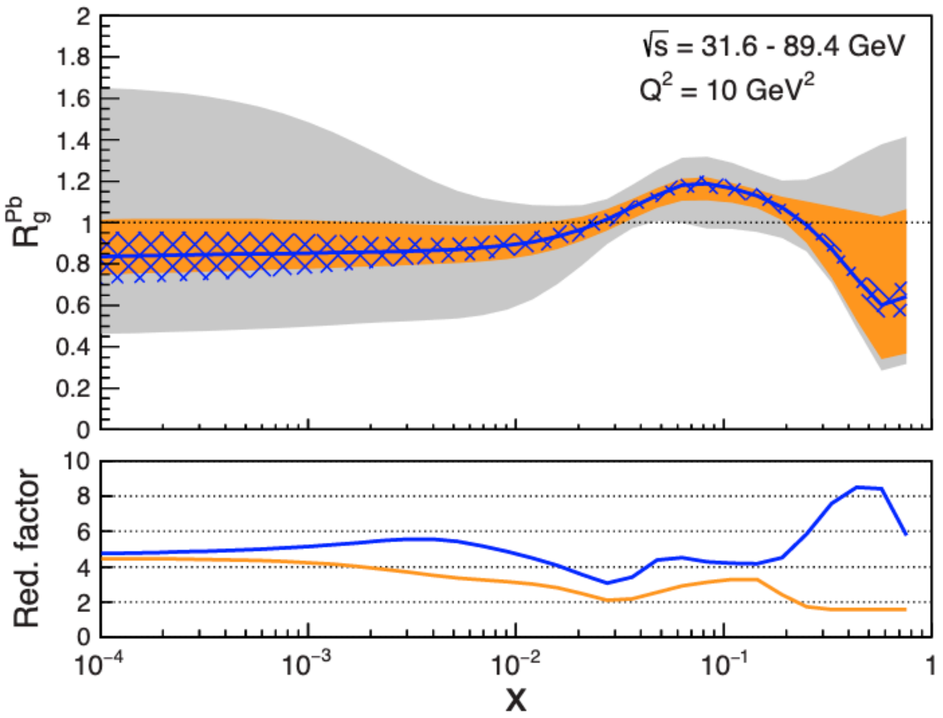


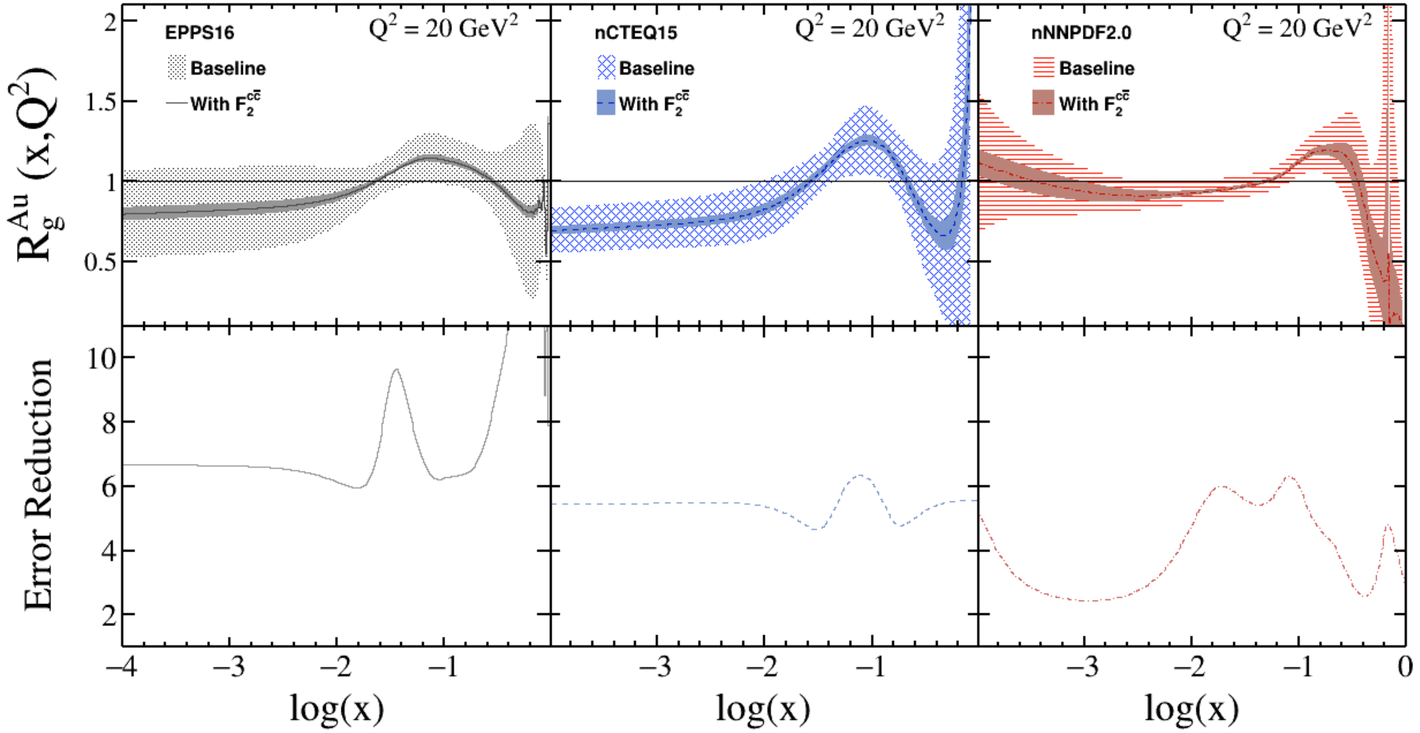
Gluon nPDF Impact



Comparisons to Previous Studies

arXiv:1708.01527

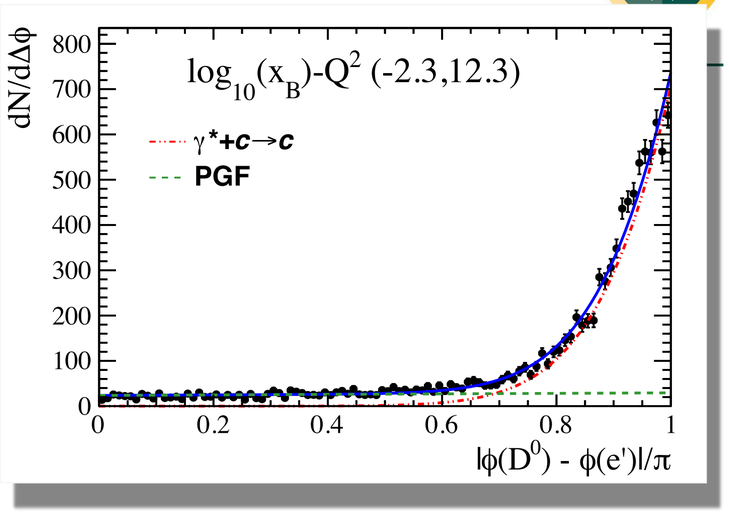




Comparable reduction in uncertainties

- Not an apples-to-apples comparison....

Summary

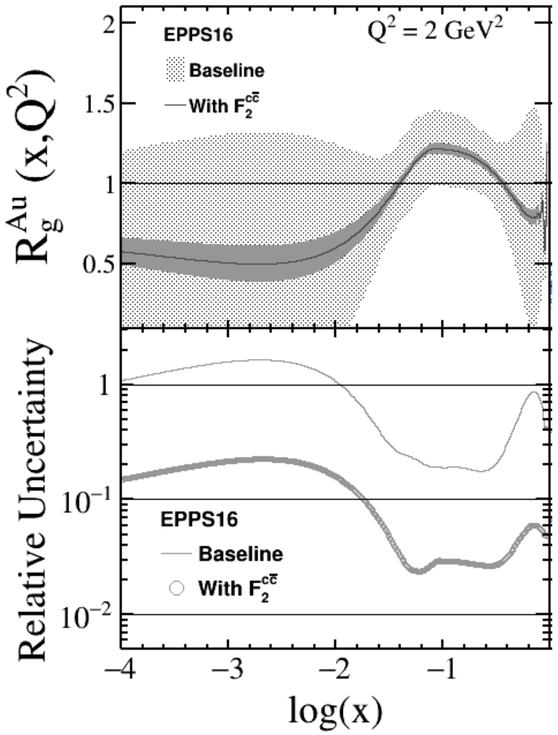


Large impact on charm structure function from IC

- Simple PYTHIA study, could be explored farther to incorporate other potential observables

Impact on gluon nPDF studied by using a Bayesian PDF re-weighting technique

- First projection using with full implementation of detector resolutions on charm reconstruction (tagging)
- Comparable reduction in uncertainties at large-x as previous studies



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