Future of nuclear PDFs: nCTEQ perspective:

Fred Olness w/ help from: Tim Hobbs, Aleksander Kusina, Pavel Nadolsky, Tomas Jezo, Thia Keppel, Michael Klasen, Karol Kovarik, Jorge Morfin, Ingo Schienbein, Efrain Segarra, Steve Sekula

nCTEQ
nuclear parton distribution functions

C T E Q

nCTEQ Wish List

Preparing for HL-LHC, EIC, LHeC, FCC...

Synergy w/ EIC Yellow Book Report Activities

Low-Q:

Higher-Twist, Non-Pert, Resummation

Hi-x:

Target Mass Corr. (TMC), Nuclear x>1, …

Strange PDF:

W/Z, W+c, Charm Jets

Gluon (& Charm+Bottom):

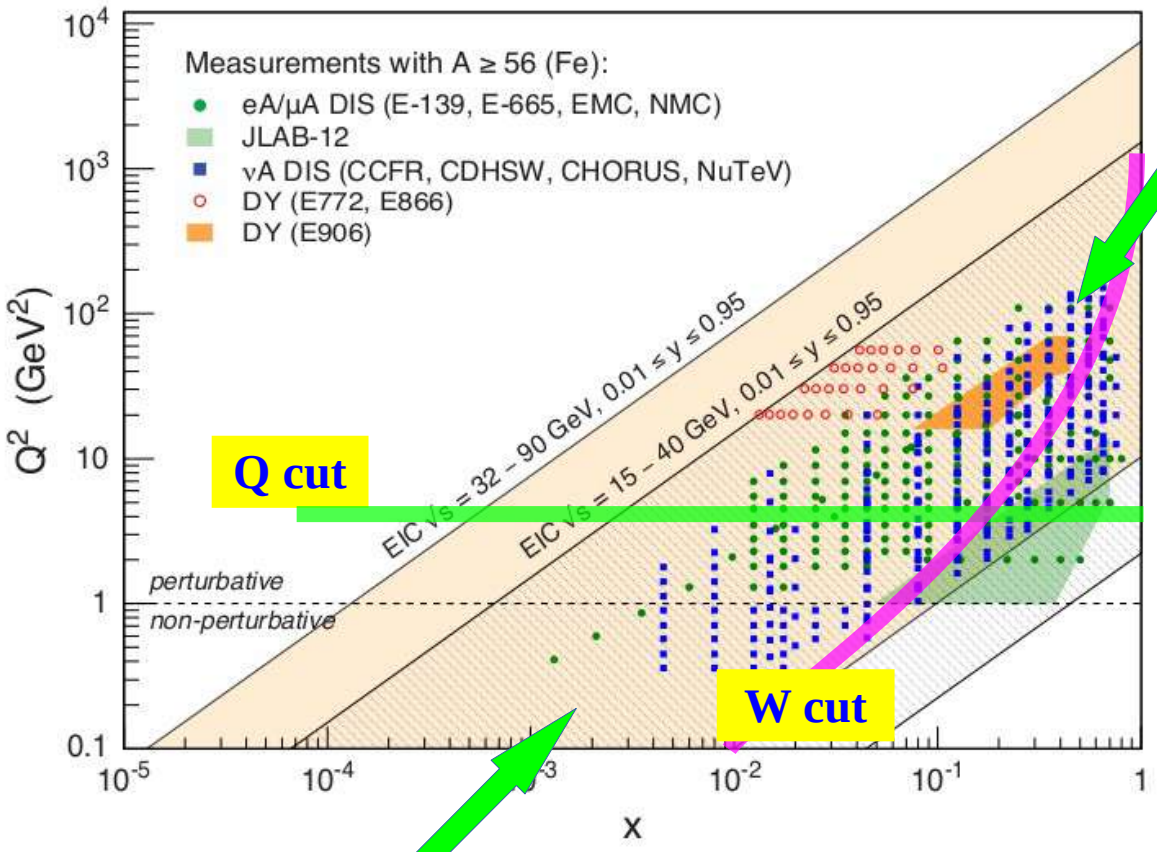
Improve R_G via F_L: window on NLO and mass effects

Nuclear A:

Map out A dependence … and maybe beyond

EF06/EF07 meeting:
Polarized and
nuclear PDFs
11 November 2020

nPDFs: Extend Kinematic Reach in {x,Q²}



High-x:

Nuclear PDFs: x>1 allowed;

impacts F_2^{Nuc}/F_2^{Iso} in Fermi region

Target Mass Corrections

pick up M^2/Q^2 higher twist

Deuteron Corrections

impacts $F_2^{Nuc}/F_2^{Deuteron}$ ratio

Low-Q²:

Non-Perturbative inteface

collective effects

Target Mass Corrections

pick up M^2/Q^2 higher twist

F_L at low Q^2 access to g(x)

Run at multiple energies

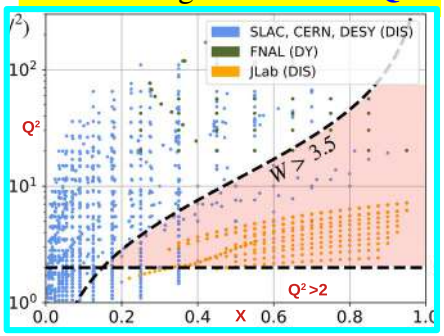
Warm-up:

JLab Data @ Hi-X Low-Q²

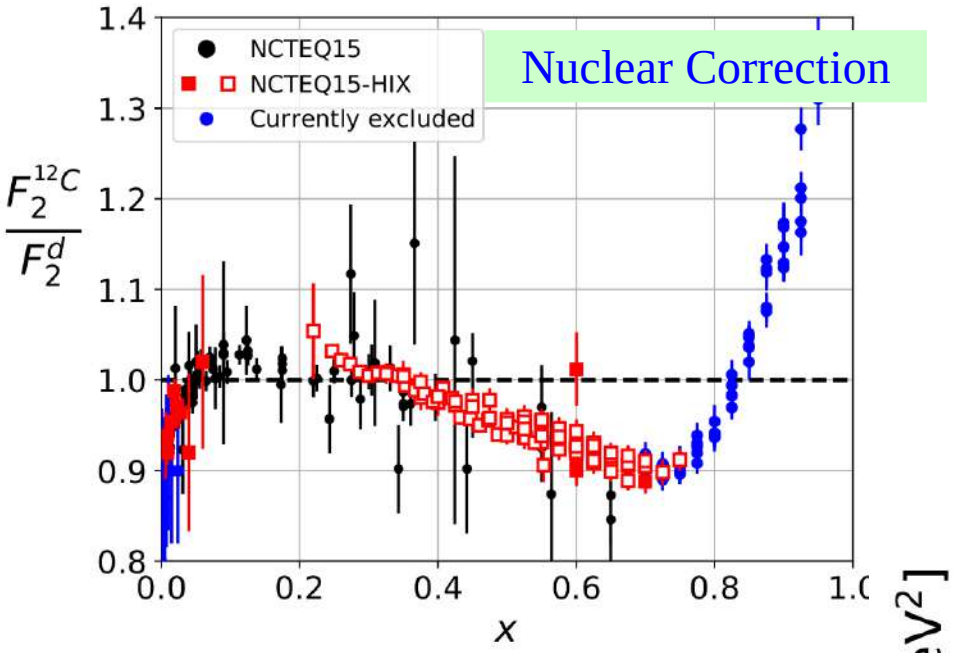
extend nCTEQ framework for this region

& prepare for EIC

Efrain Segarra w/ **nCTEQ**

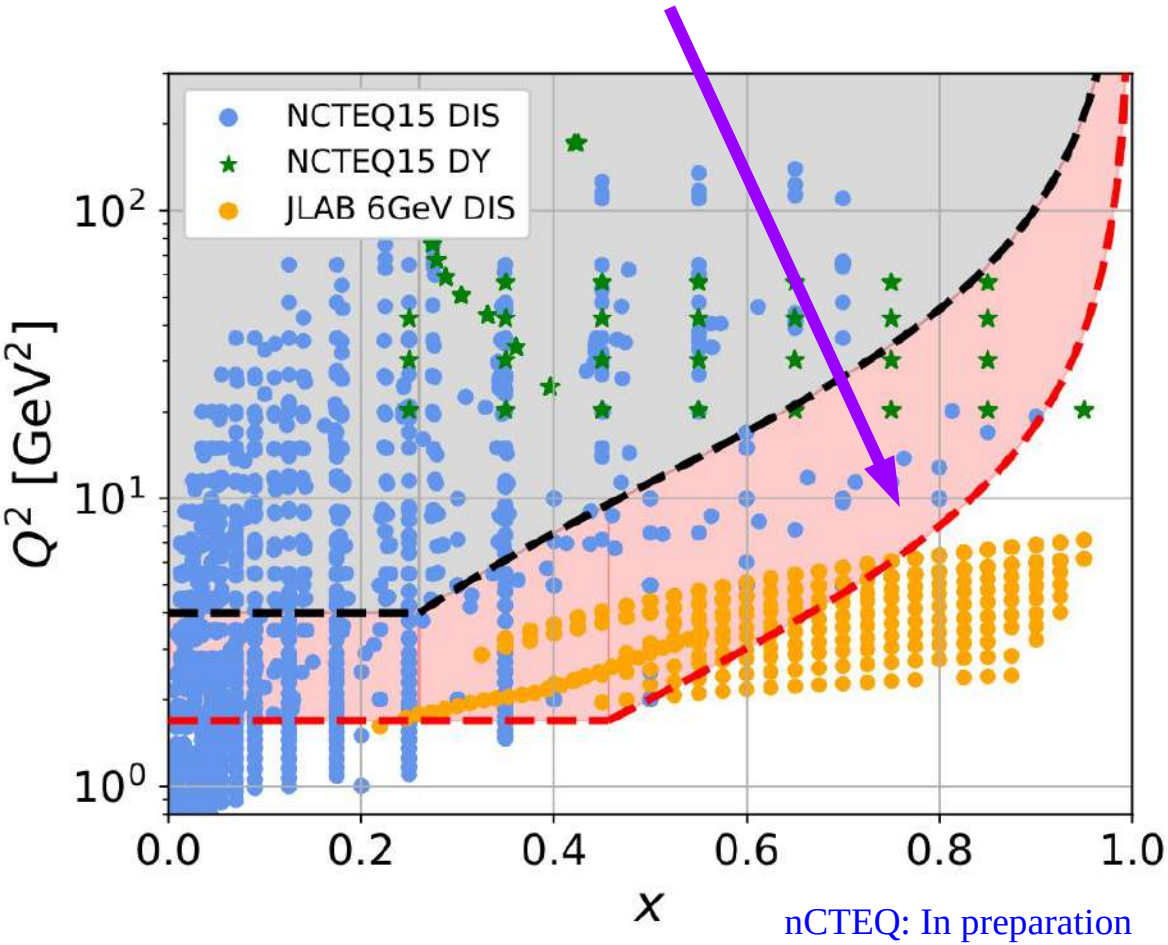


nPDFs: High x & Low Q^2

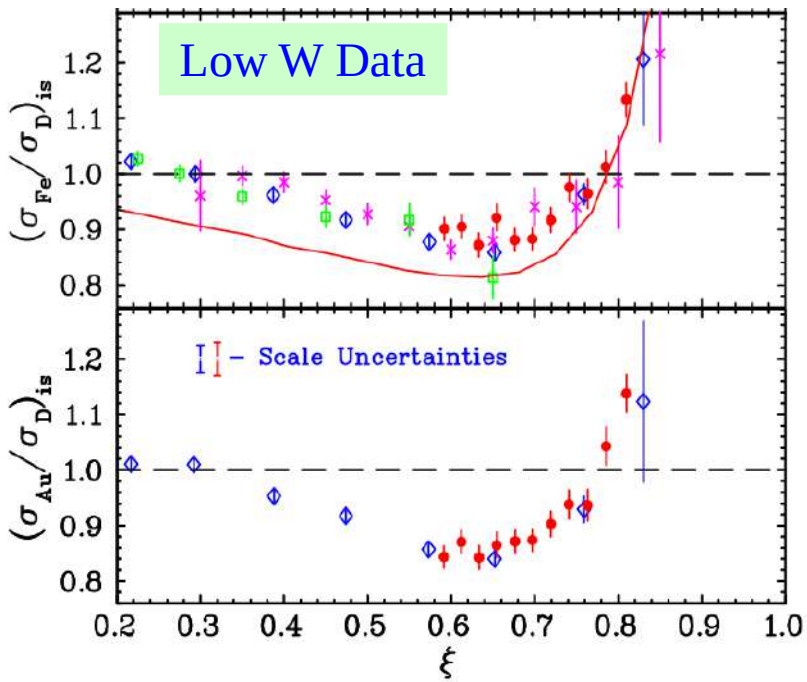


Nuclear Correction

JLab data can help us expand the kinematic reach



nCTEQ: In preparation



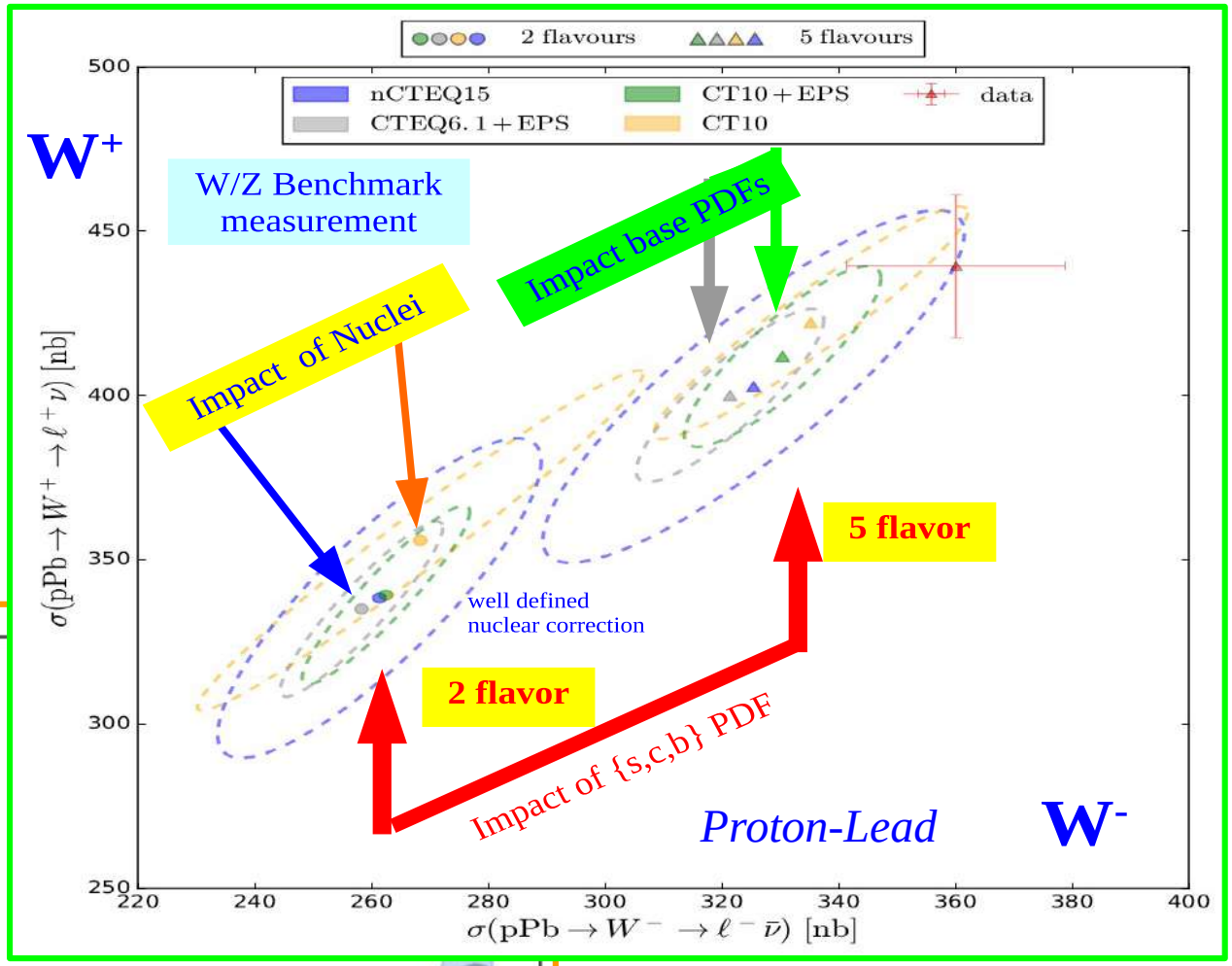
J. Arrington, Phys.Rev.C.64.014602

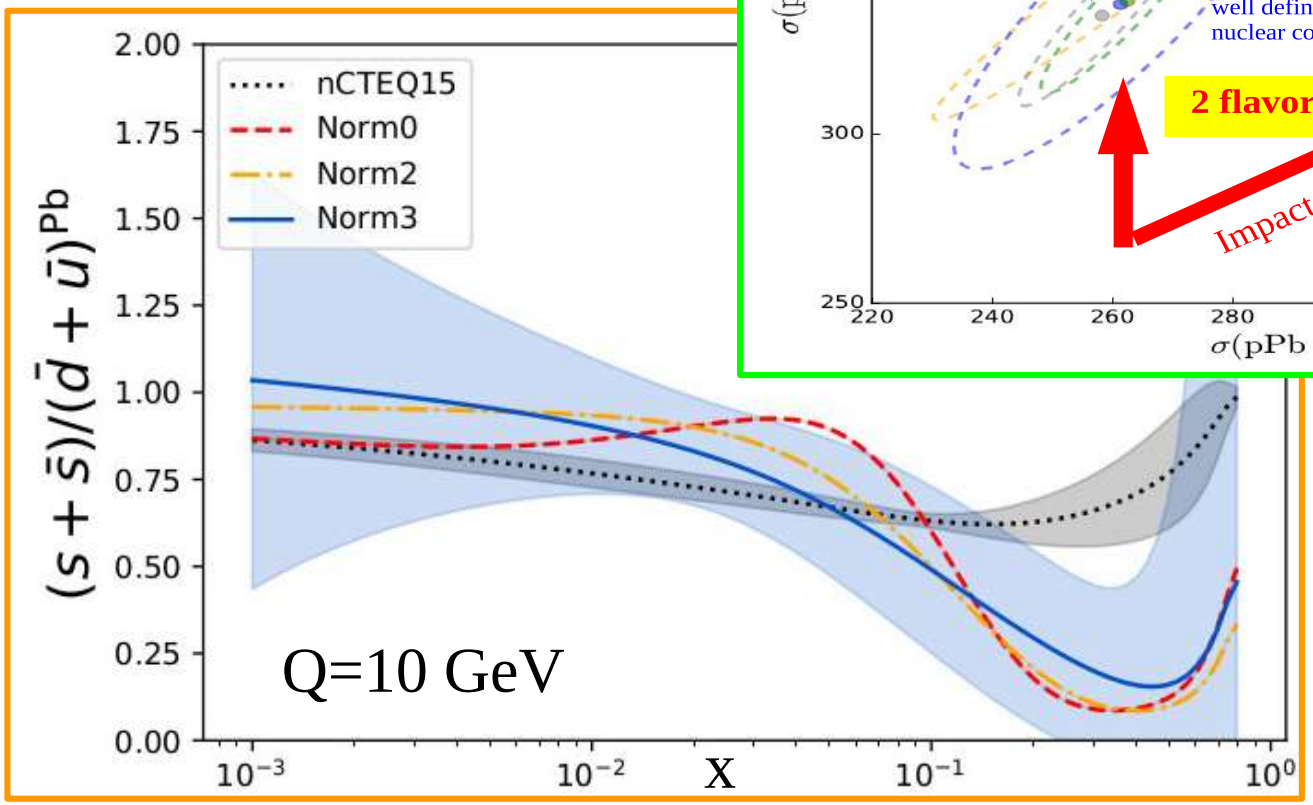
The Strange PDF: LHC Heavy Ion: W/Z Production *pPb*

Sensitive to:

- Base proton PDF
- Nuclear Correction
- Heavy Flavors

$$R_s(x,Q) = \frac{s(x,Q)+\bar{s}(x,Q)}{\bar{u}(x,Q)+\bar{d}(x,Q)}$$



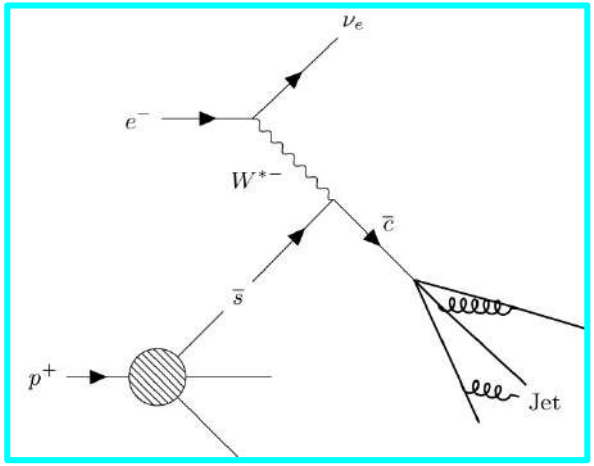


nCTEQ: Eur.Phys.J.C 77 (2017) 7, 488.

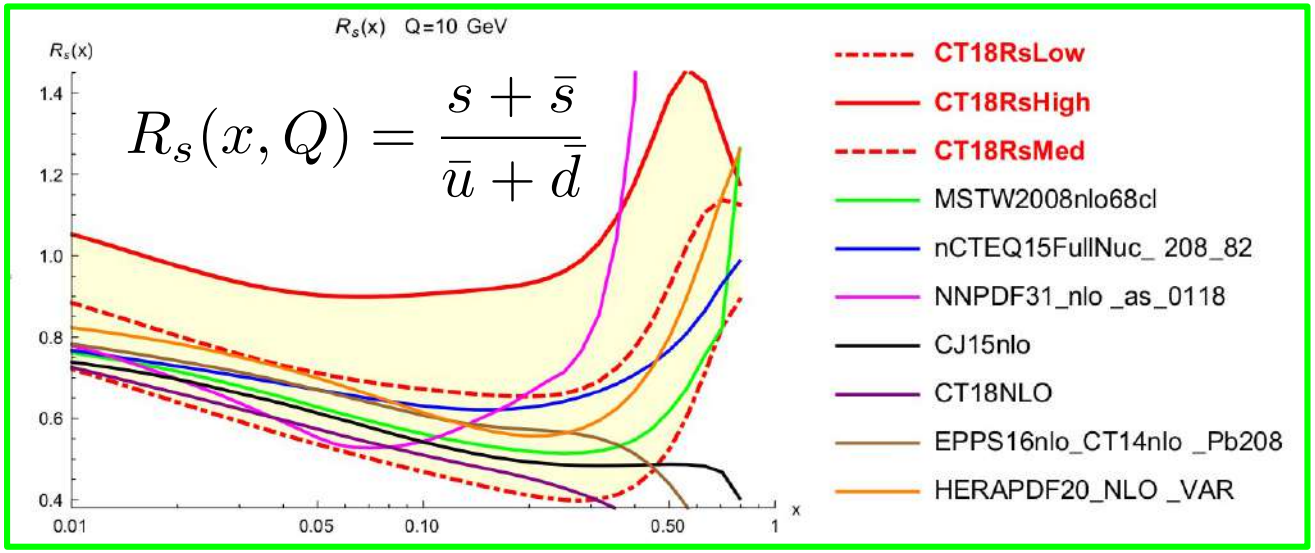
Sensitive to relative W/Z normalization

nCTEQ15-WZ: A. Kusina, et al., arXiv:2007.09100

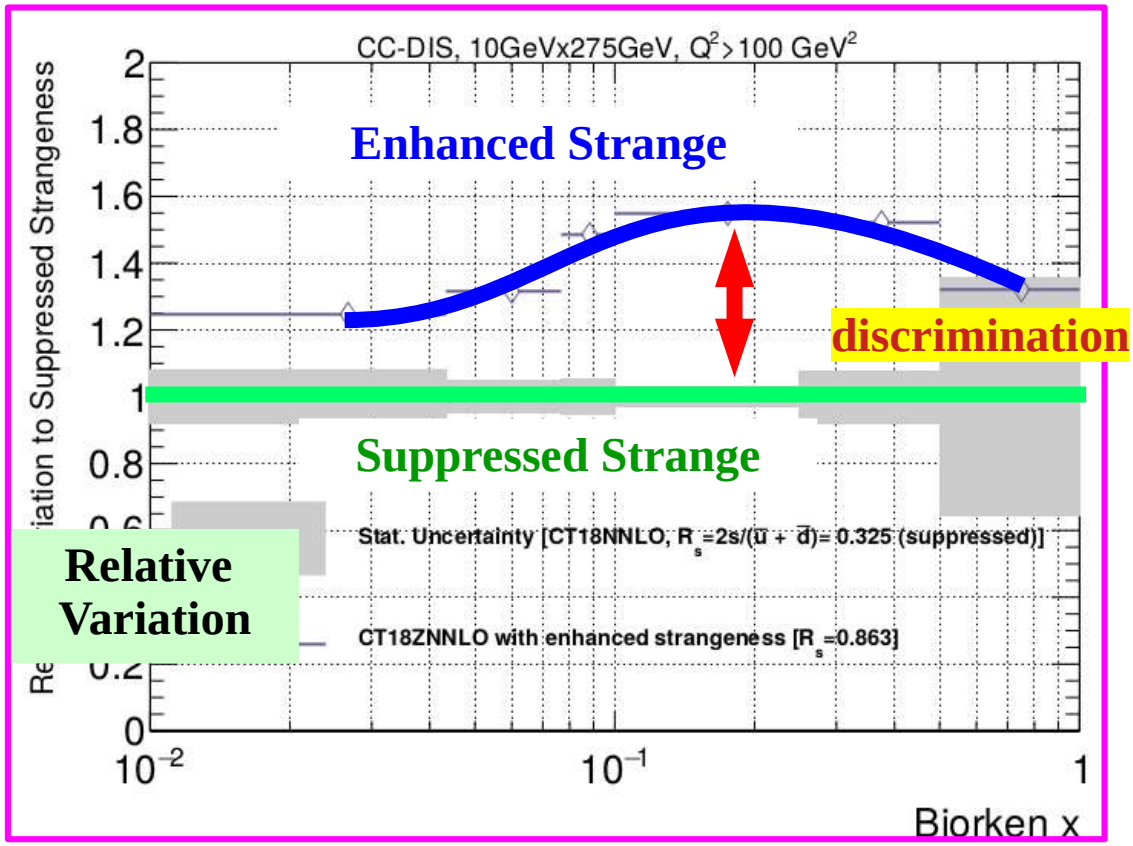
The Strange PDF: Charm Jets at the EIC



W s → c-jet

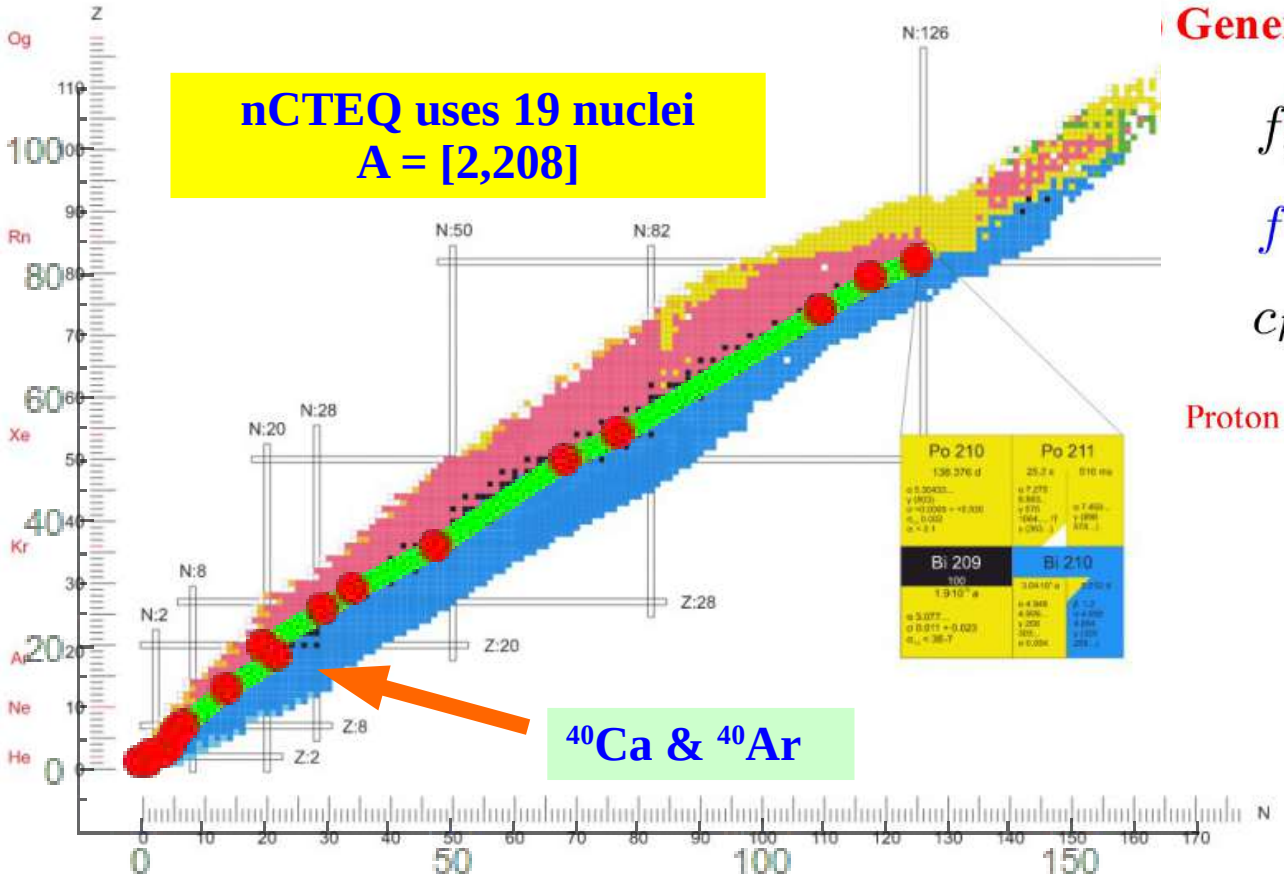


Clear measure of Strange PDF beyond uncertainties



arXiv:2006.12520, M. Arratia, Y. Furletova, T.J. Hobbs, F. Olness, S.J. Sekula

Nuclear A-Dependence



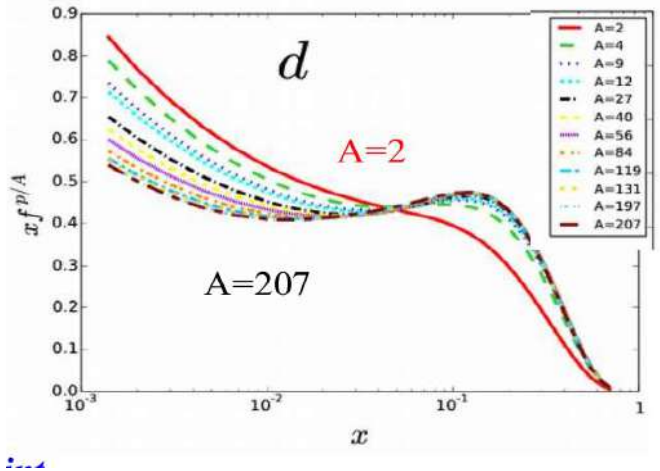
Generalized A-parameterization (nCTEQ)

$$f_i^{p/A}(x_N,\mu_0) = f_i(x_N, A, \mu_0)$$

$$f \sim ...x^{c_1(A)}(1-x)^{c_2(A)}...$$

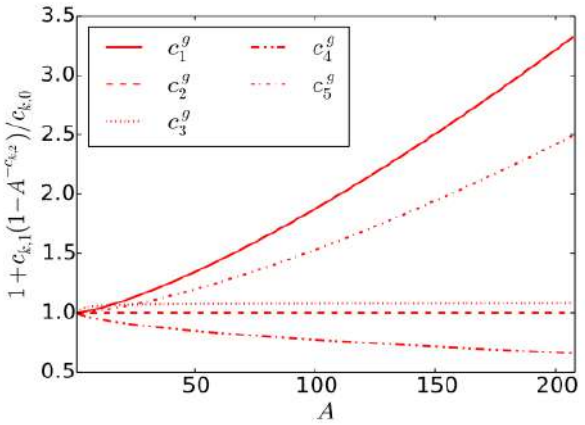
$$c_k \sim c_{k,0} + c_{k,1}\left(1 - A^{-c_{k,2}}\right)$$

Proton — Nuclear



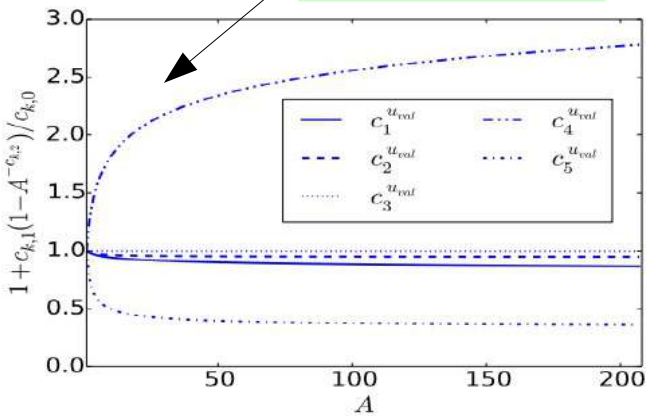
A-dependence of coefficients

Fill out A spectrum with high-stats data



(a) Gluon

Deuteron corrections???



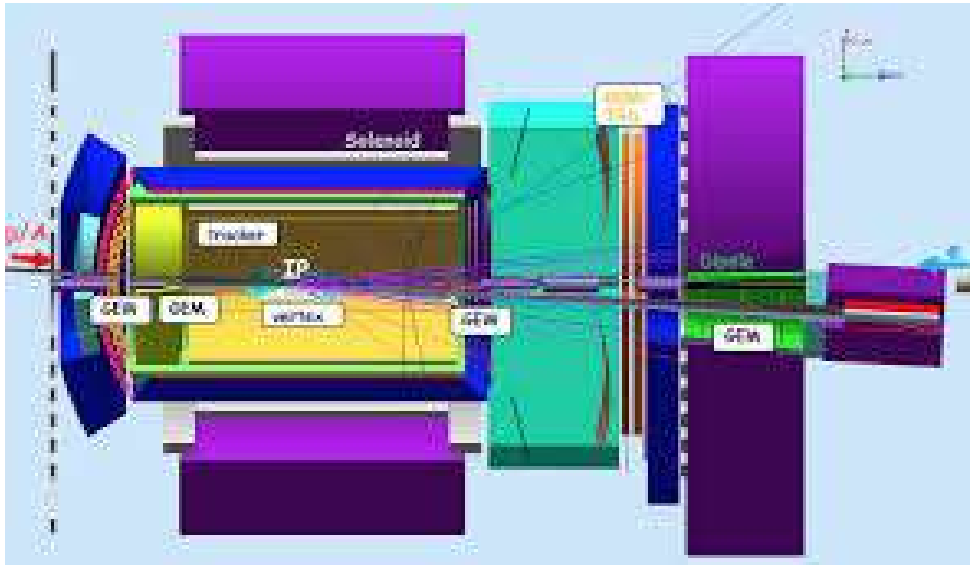
(c) u-valence

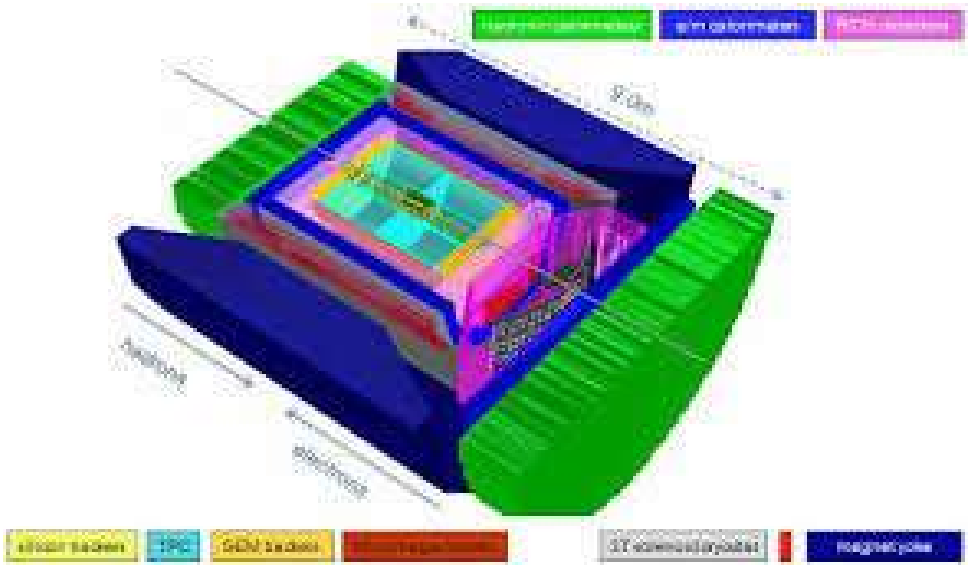
Electron-Ion Collider User Group

The world's most powerful microscope for studying the "glue" that binds the building blocks of visible matter.

Yellow Report Initiative

The purpose of the Yellow Report Initiative is to advance the state and detail of the documented physics studies (White Paper, INT program proceedings) and detector concepts (Detector and R&D Handbook) in preparation for the realization of the EIC. The effort aims to provide the basis for further development of concepts for experimental equipment best suited for science needs, including complementarity of two detectors towards future Technical Design Reports (TDRs).





*Very careful planning is ongoing so the above does **NOT** happen!!!*

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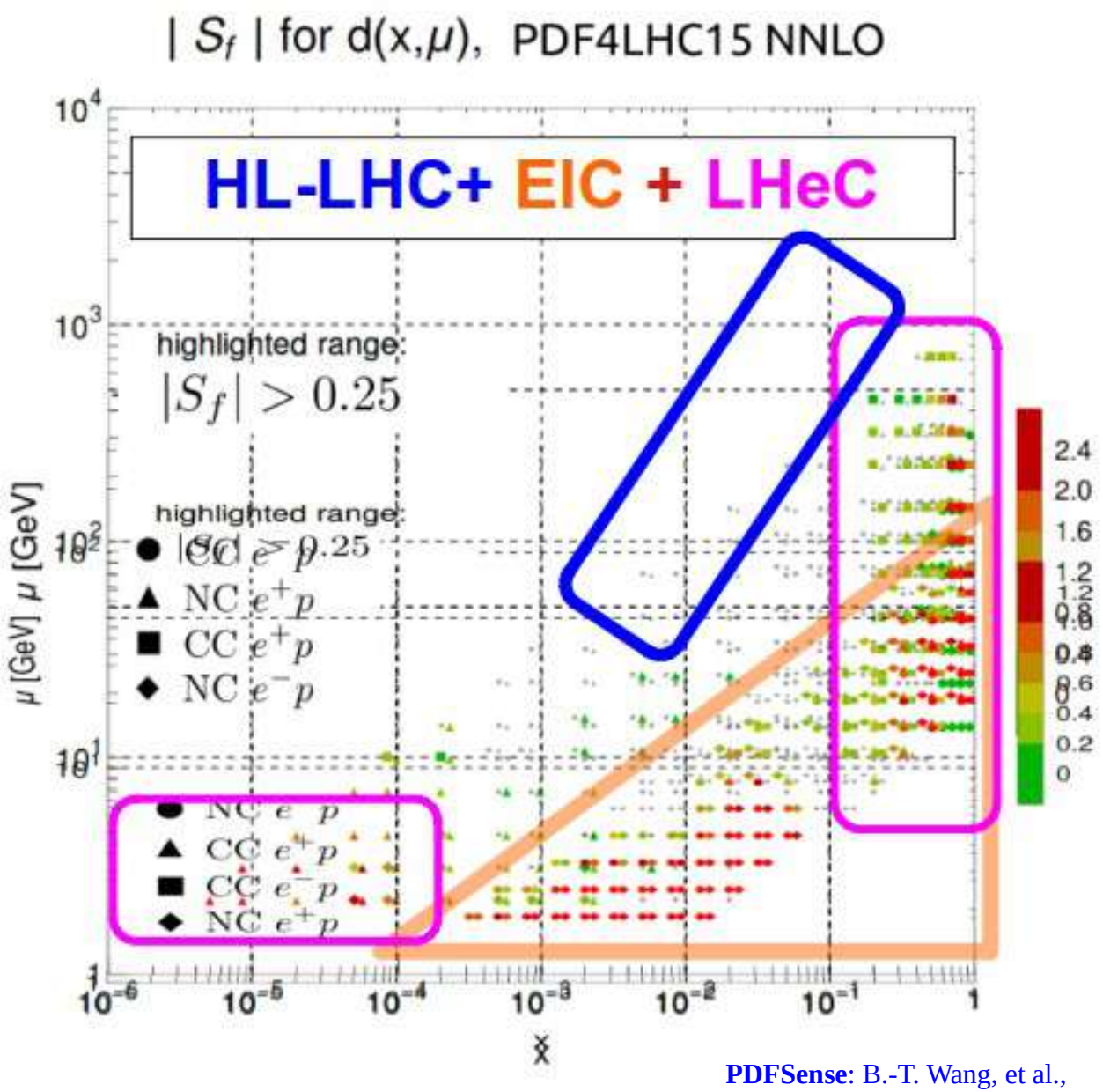
Complementary: HL-LHC + EIC + LHeC/FCC

Sensitivity S^F:

Correlation times
the scaled residual:

$$S_F \sim C_f \frac{\delta r}{\langle r \rangle_{exp}} \qquad \delta r \sim \frac{T - D}{\sigma}$$

EIC + LHeC + HL-LHC
Maximal coverage



Thanks to Tim Hobbs for these plots

PDFSense: B.-T. Wang, et al., Phys.Rev. D98 (2018) no.9, 094030