nCTEQ Wish List

Fred Olness with helpful feedback from: Tim Hobbs, Tomas Jezo, Thia Keppel, Michael Klasen, Karol Kovarik, Jorge Morfin, Pavel Nadolsky, Jeff Owens, Ingo Schienbein, Efrain Segarra, Steve Sekula

nCTEQ
nuclear parton distribution functions

C T E Q

… how do we make sure the EIC can cover all we want/need

Low-Q:

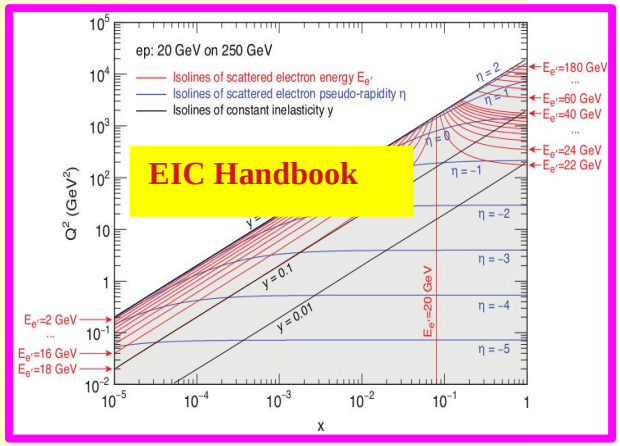
Higher-Twist, Non-Pert, Resummation

Hi-x:

TMC, Nuclear x>1, …

Strange PDF:

Disentangle: 1) proton PDF
2) nuclear corrections
3) flavor components



Gluon:

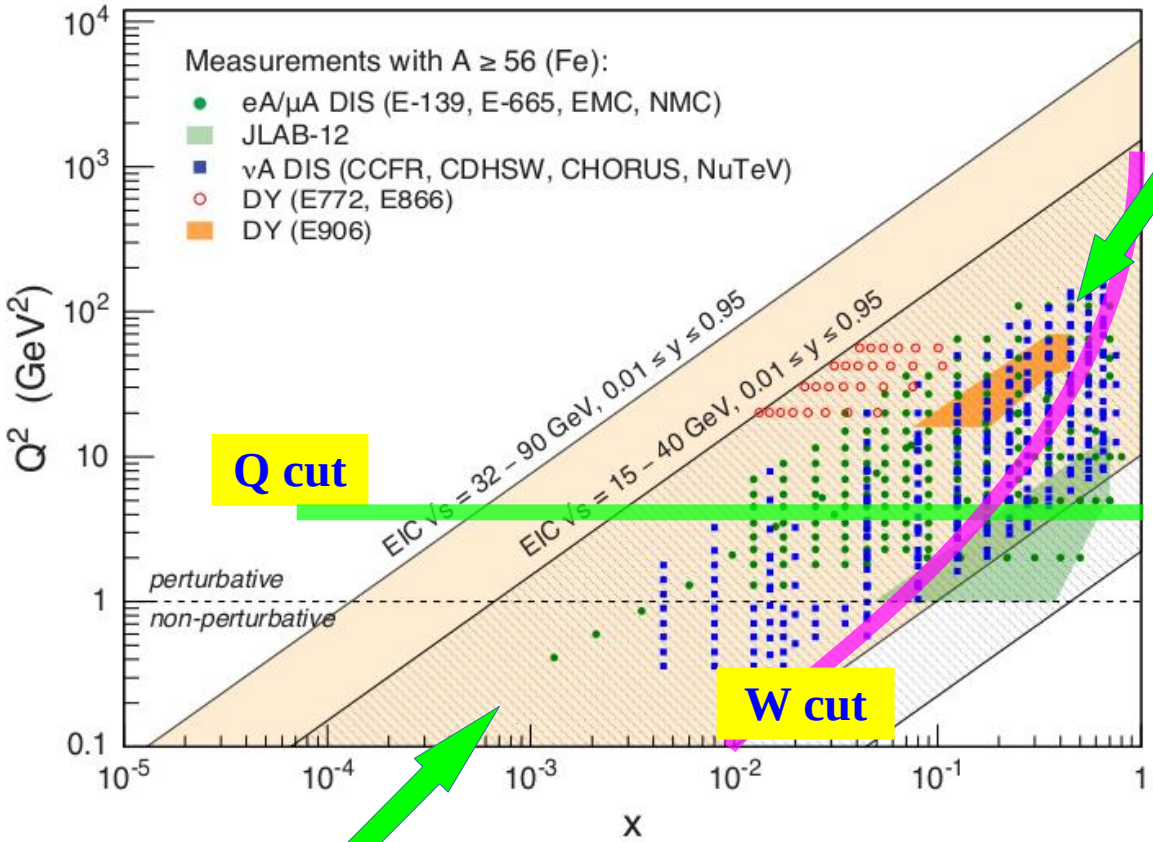
Improve R_G via F_L: window on NLO and mass effects

Nuclear A:

Map out A dependence … and maybe beyond

1st EIC Yellow Report Workshop
Temple University
19-21 March 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

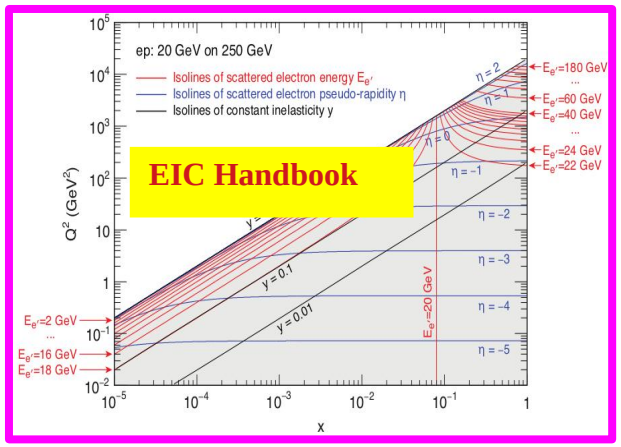
collective effects

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



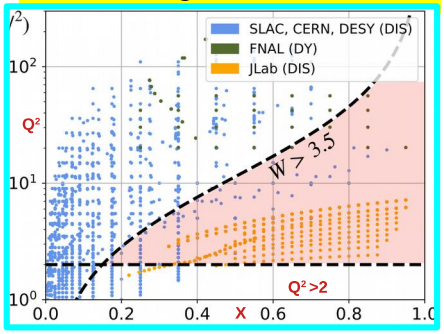
Warm-up:

JLab Data @ Hi-X Low-Q²

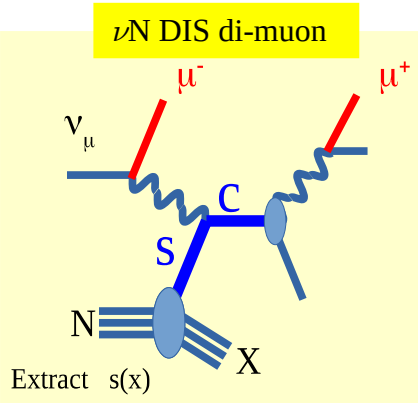
extend nCTEQ framework for this region

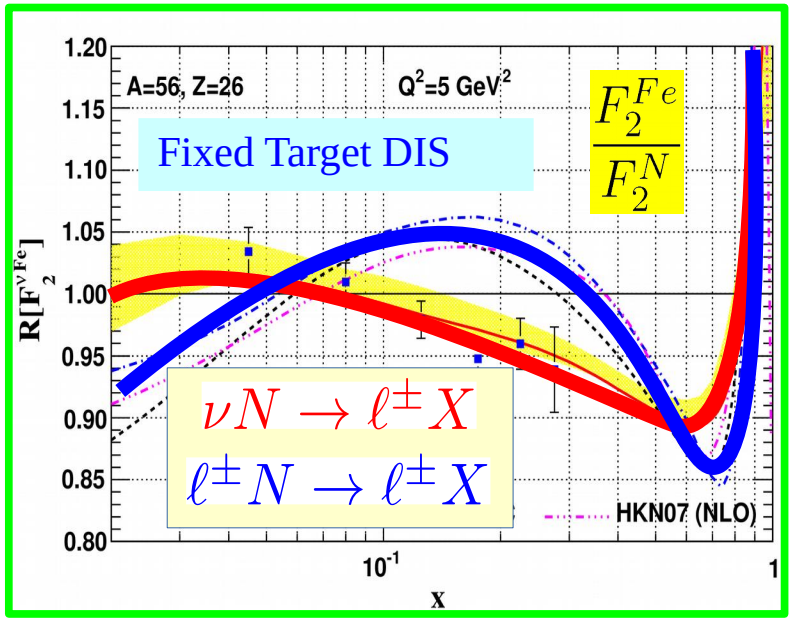
& prepare for EIC

Efrain Segarra w/ **nCTEQ**

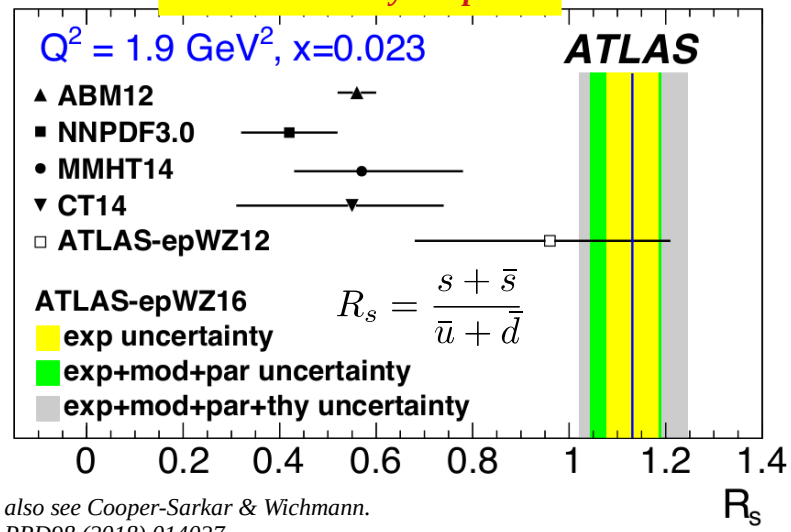


The Strange Strange PDF: disentangle 1) proton PDF, 2) nuclear corrections, 3) flavors

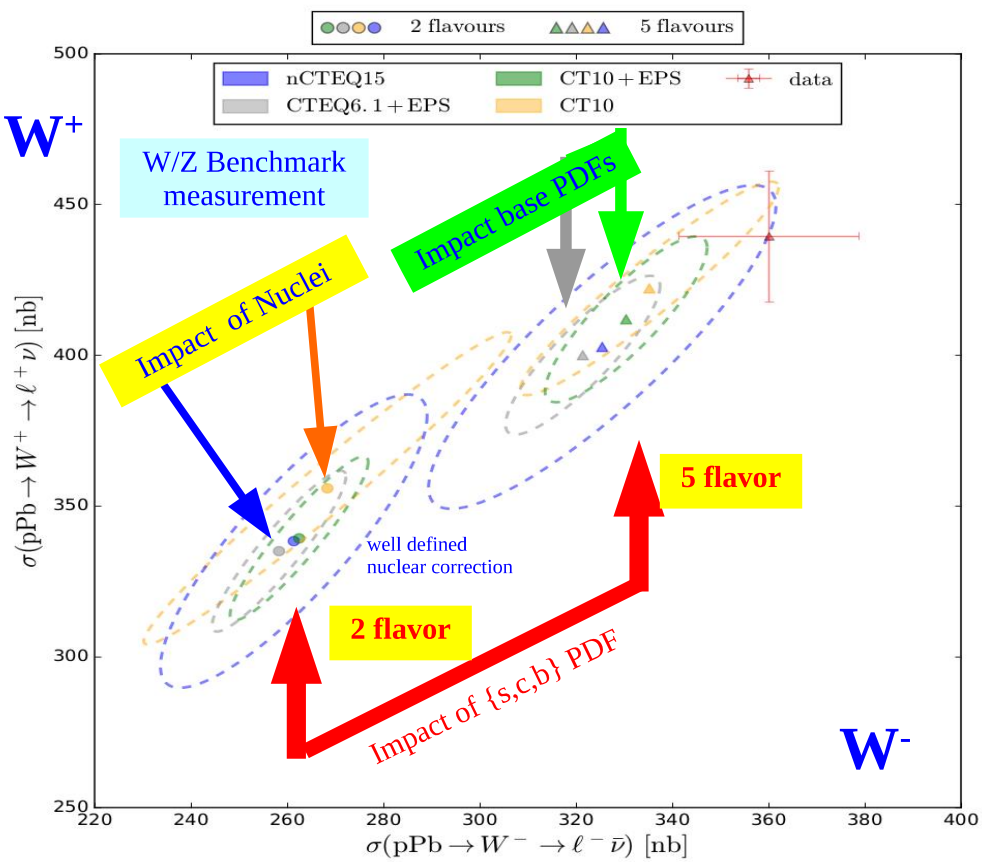




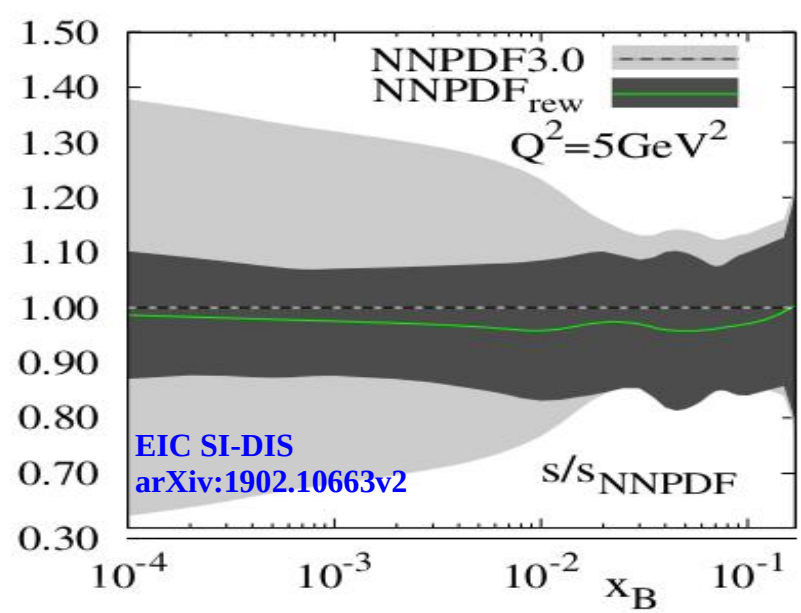
Large s(x) preferred ...
similar in heavy ion p-Pb



also see Cooper-Sarkar & Wichmann. PRD98 (2018) 014027

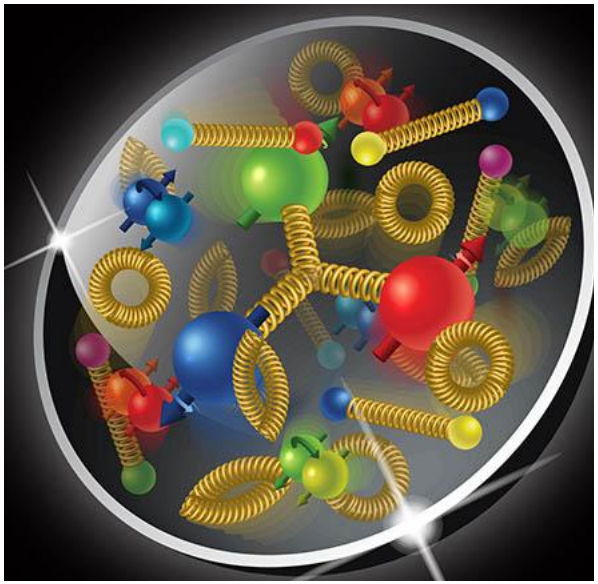


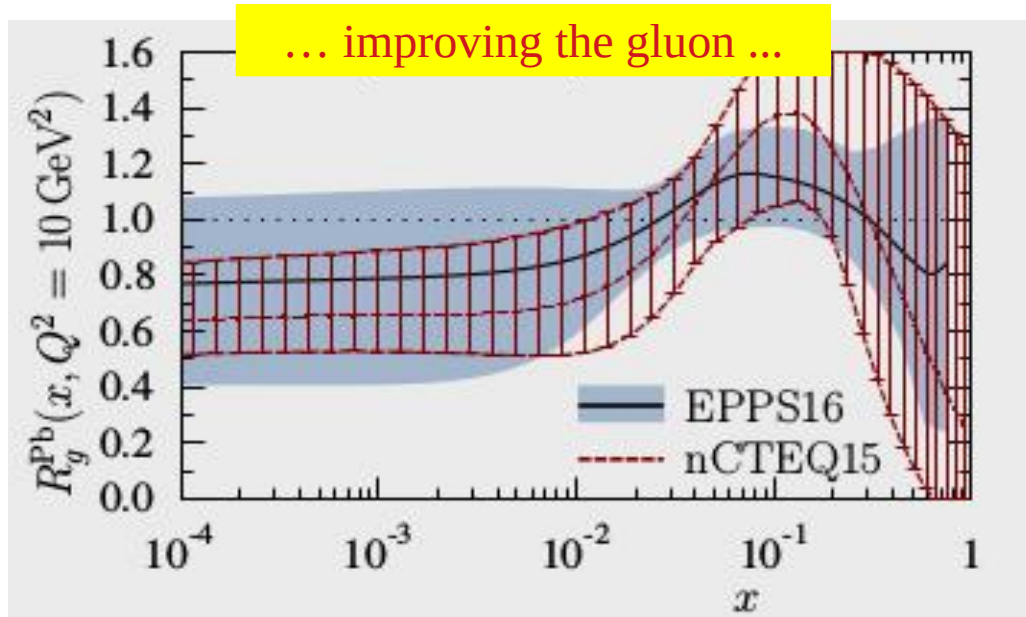
Potential EIC improvement



… how can we nail this!
would also elucidate LHC issues

g(x): The glue that binds us ...



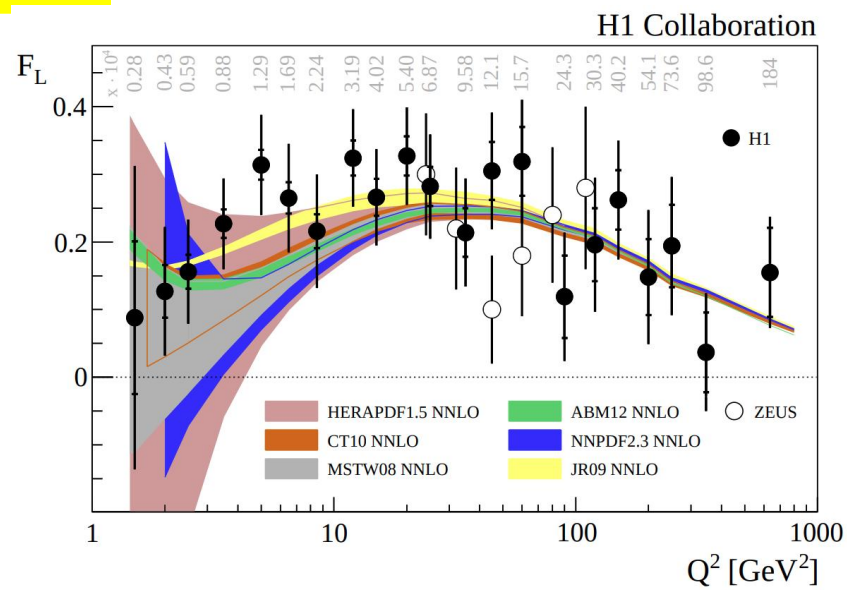


$$F_L \sim \frac{m^2}{Q^2}\, q(x) + \alpha_S\{c_g \otimes g(x) + c_q \otimes q(x)\}$$

F_L sensitive to NLO terms (gluon)
& helicity violating terms (masses)

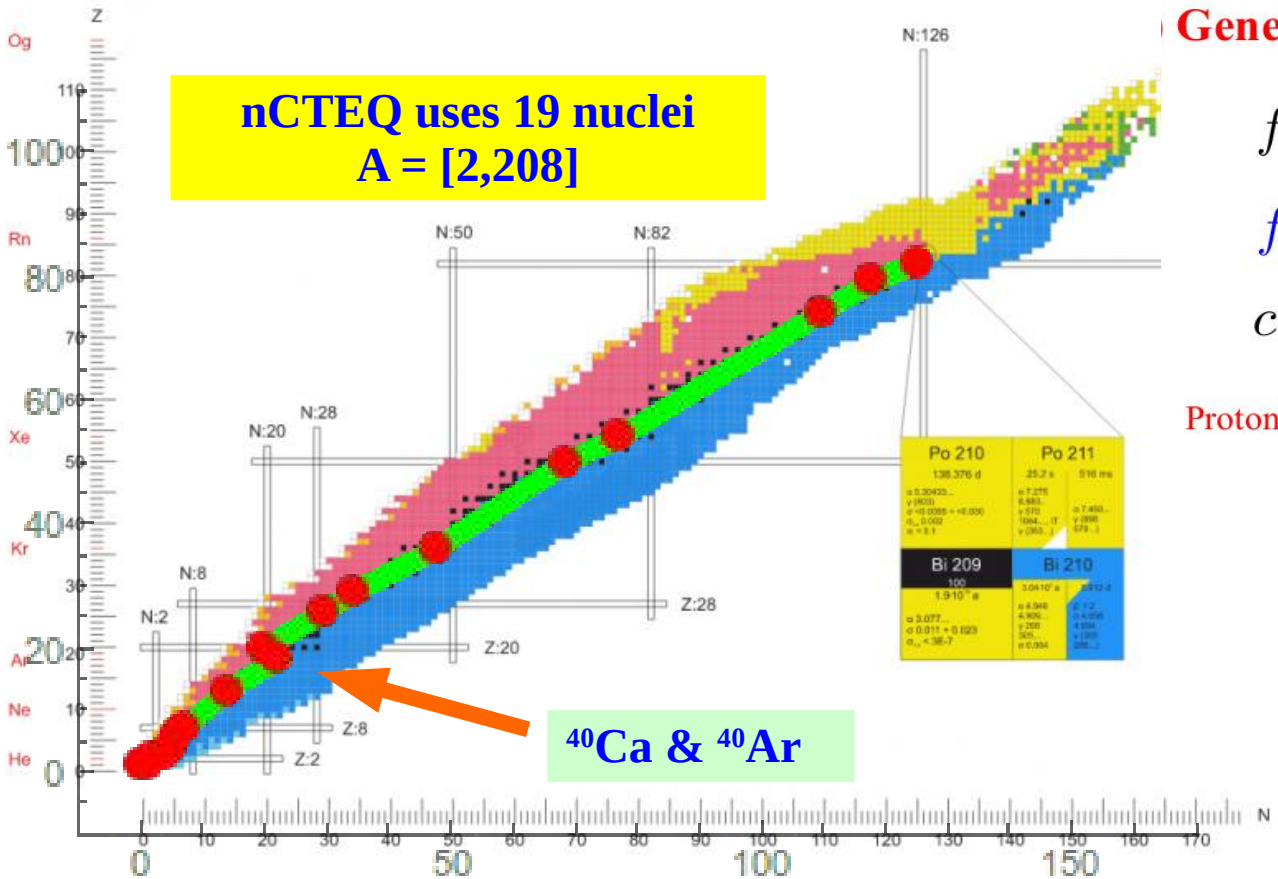
HERA used low energy run
to explore low-Q region

… other handles on g(x)
Heavy Quark Production: g→ cc



key to understanding strong interactions

Nuclear A-Dependence



Generalized A-parameterization (nCTEQ)

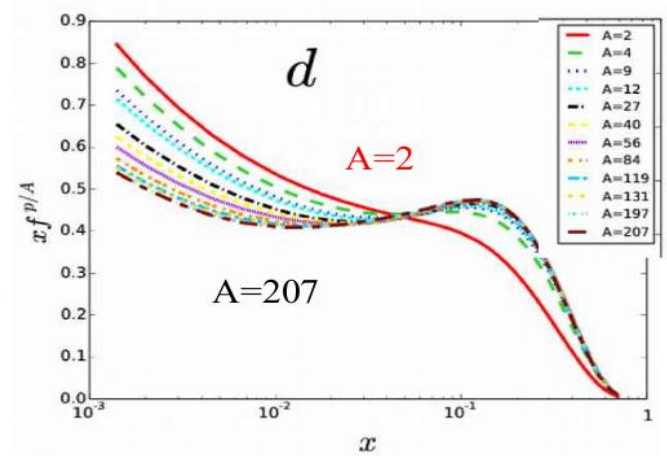
$$f_i^{p/A}(x_N, \mu_0) = f_i(x_N, A, \mu_0)$$

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

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

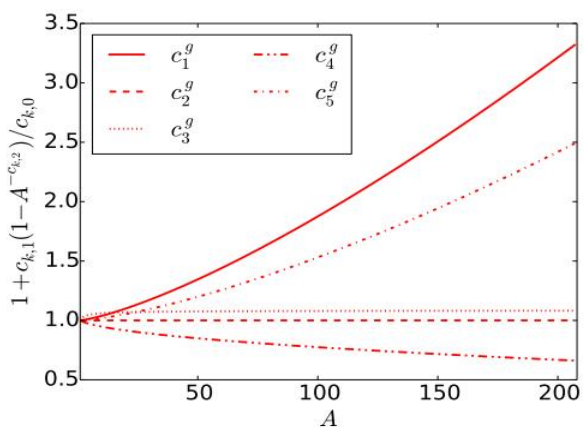
Proton

Nuclear

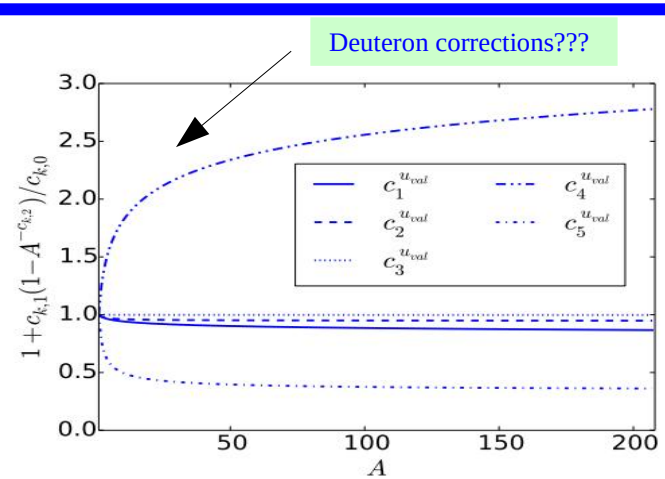


A-dependence of coefficients

Fill out A spectrum with high-stats data



(a) Gluon



(c) u-valence

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Gluon: Improve R_G via F_L: window on NLO and mass effects

... heavy quark production: charm & bottom

Nuclear A:

Map out A dependence … and maybe beyond

Need: pseudo-data

Diffractive PDFs:
See M. Klasen talk

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