Inclusive hadron production at the LHC

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Outlook

- The method
- Experimental results vs. QCD
- Some kinematics
- Predictions

$$p + p \to X + \pi^{\pm}, K^{\pm}, p, \bar{p}$$

$$p + p \to X + hadrons$$

- Hadron production in nuclear media

$$p + Pb \to X + \pi^{0}$$

- Conclusions

The Method: factorization

$$E\frac{d^3\sigma^H}{d\vec{p}} = \sum_{a,b,c} f_a(x_a,\mu_f) \otimes f_b(x_b,\mu_f) \otimes D_c^H(z_c,\mu_{f'}) \otimes$$

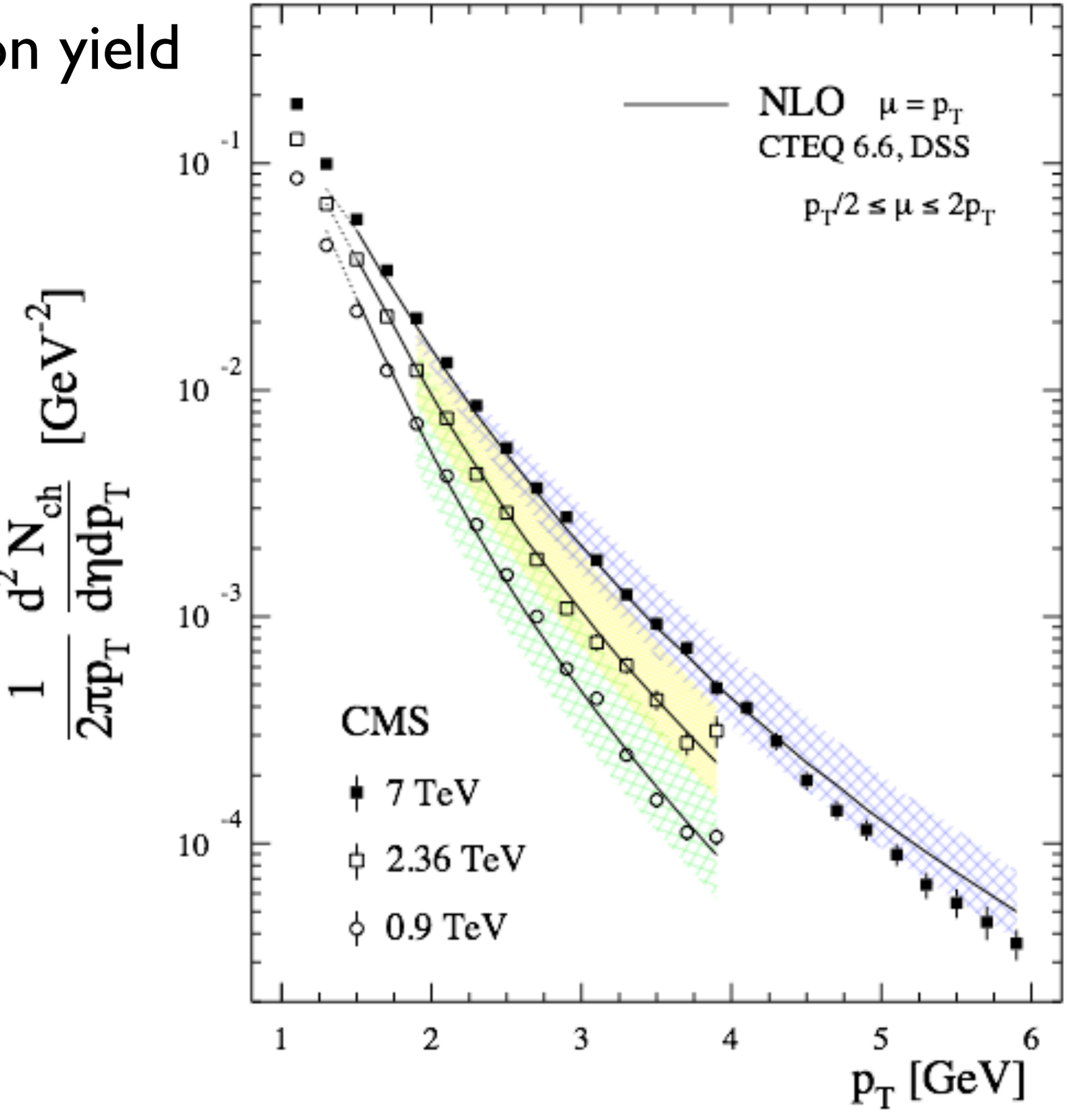
$$d\hat{\sigma}_{ab\to cX}(S,\alpha_s,x_a,x_b,z_c,\mu_f,\mu_{f'},\mu_r)$$

- PDFs CTEQ6.6 — Nadolsky et al. Phys. Rev. D 78, 013004 (2008)
- FFs DSS — Florian, Sassot, Stratmann, Phys. Rev. D 76, 074033 (2007)
- $\mu_f = \mu_{f'} = \mu_r = p_T$

Experimental results vs. QCD

(it's a tie)

Invariant hadron yield

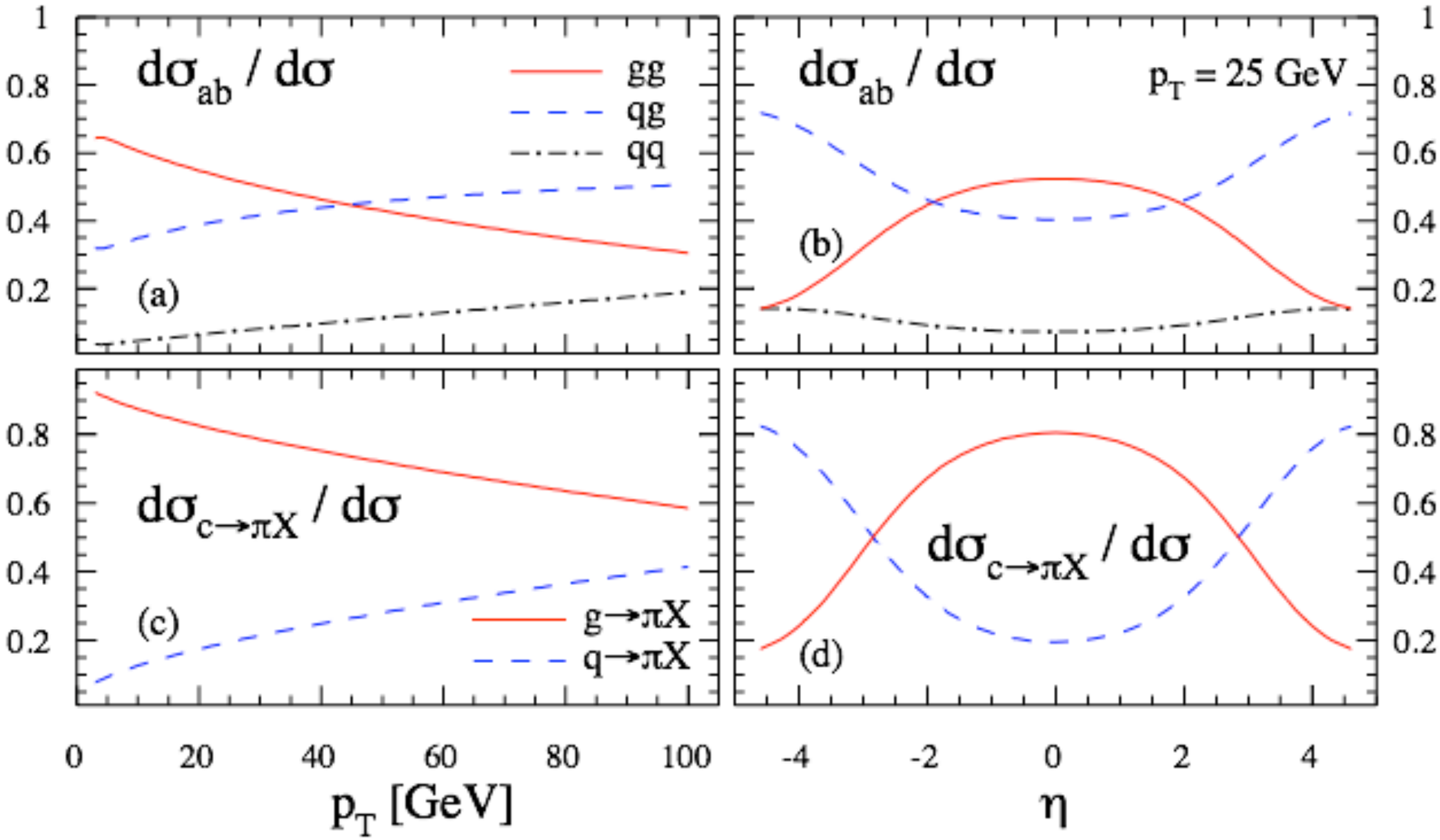


V. Khachatryan et al. (CMS Collaboration) J. High Energy Phys. 02 (2010) 41 Phys. Rev. Lett. 105, 022002 (2010)

R. Sassot, M. Stratmann, P. Z., Phys. Rev. D82:074011,2010

Kinematics

$p + p \rightarrow hadrons$

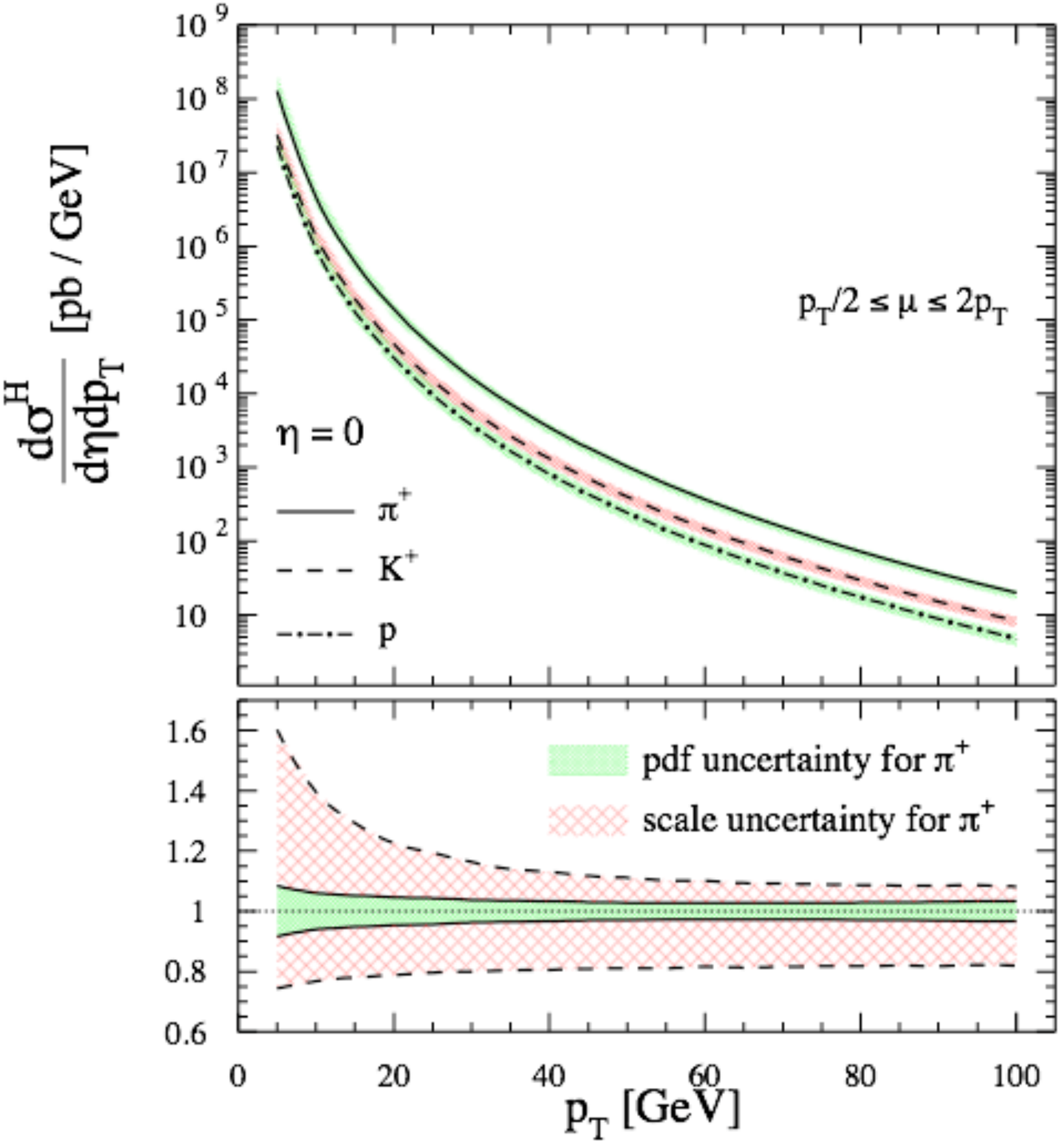


Gluons play a crucial role in both the initial and final state

We can study the PDFs and FFs for all partons

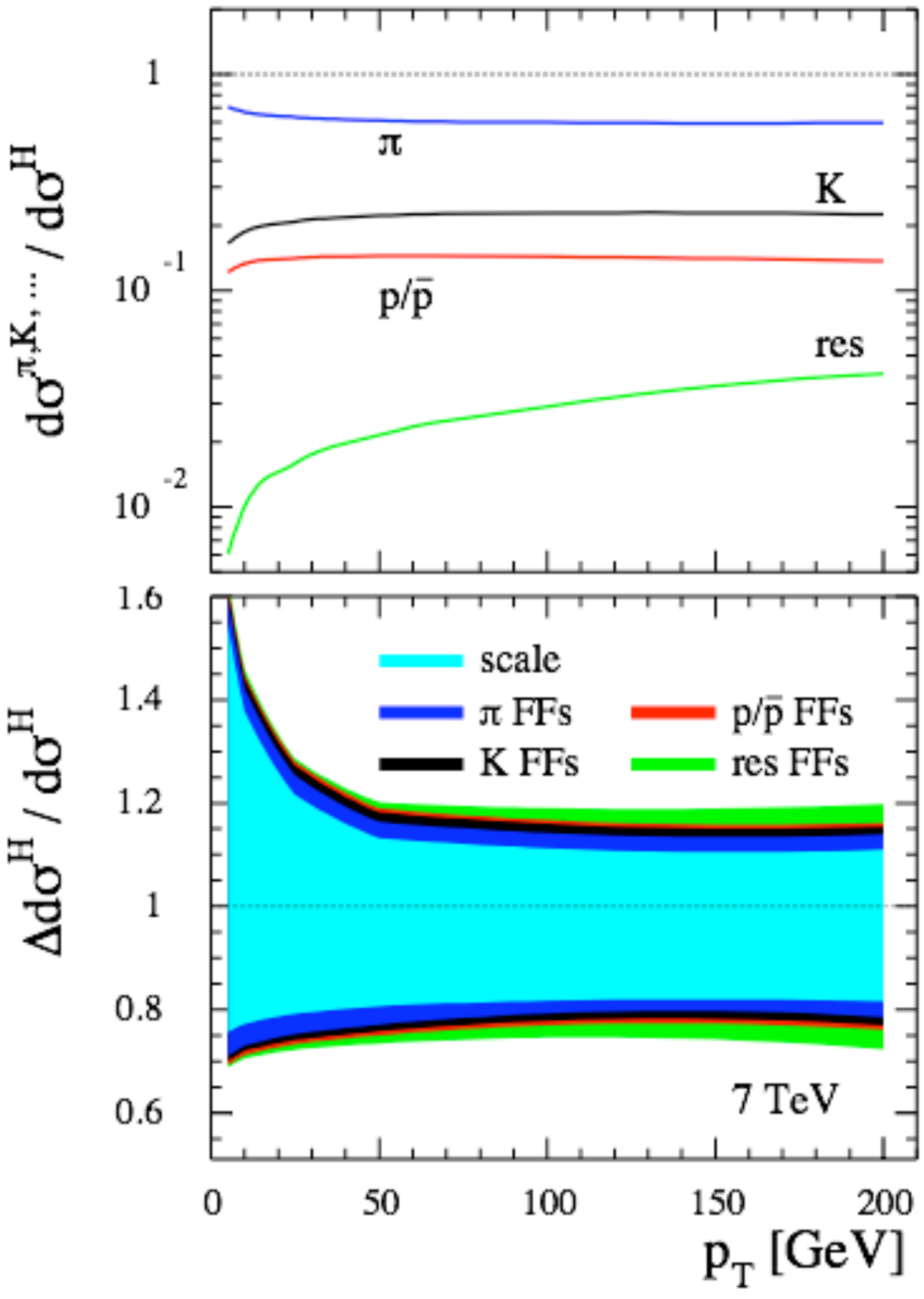
Predictions

Identified charged hadron production



the PDFs uncertainty is smaller than the scale uncertainty

Un-identified charged hadron production



$$H = \pi^+ + \pi^- +$$

$$K^+ + K^- +$$

$$p + \bar{p} +$$

all other charged hadrons

FFs uncertainty is smaller than the scale uncertainty

Nuclear media

p-Pb: predictions at

$$\sqrt{S} = 8.8 \;\; TeV$$

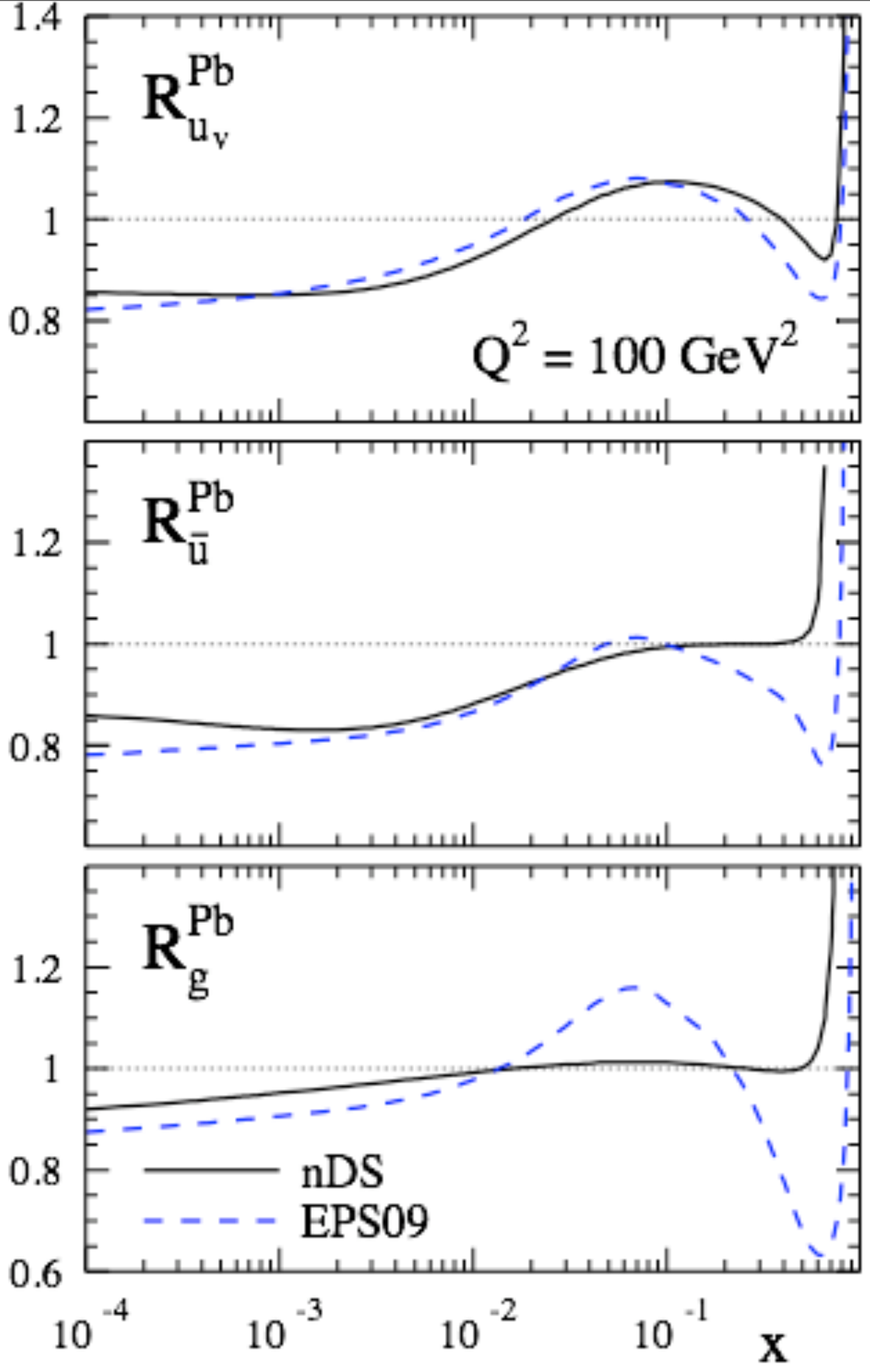
per nucleon

nuclear PDFs: well known effect

$$R_i^A(x, Q^2) = \frac{f_i^A(x, Q^2)}{f_i^p(x, Q^2)}$$

nDS — D. de Florian, R. Sassot, Phys.Rev.D69, 074028, 2004

EPS09 — K. J. Eskola, H. Paukkunen, C. A. Salgado, J. High Energy Phys. 04 (2009) 065



Fitted to experimental data

Differences due to different data sets

Given as rates to the proton PDFs

Similar shape for a large range of Q^2

Not enough to reproduce nuclear SIDIS data nor inclusive hadron production in nuclear media

One possible solution: nFFs

SSZ

R. Sassot, M. Stratmann, P. Z.,
Phys.Rev.D81, 054001,2010.

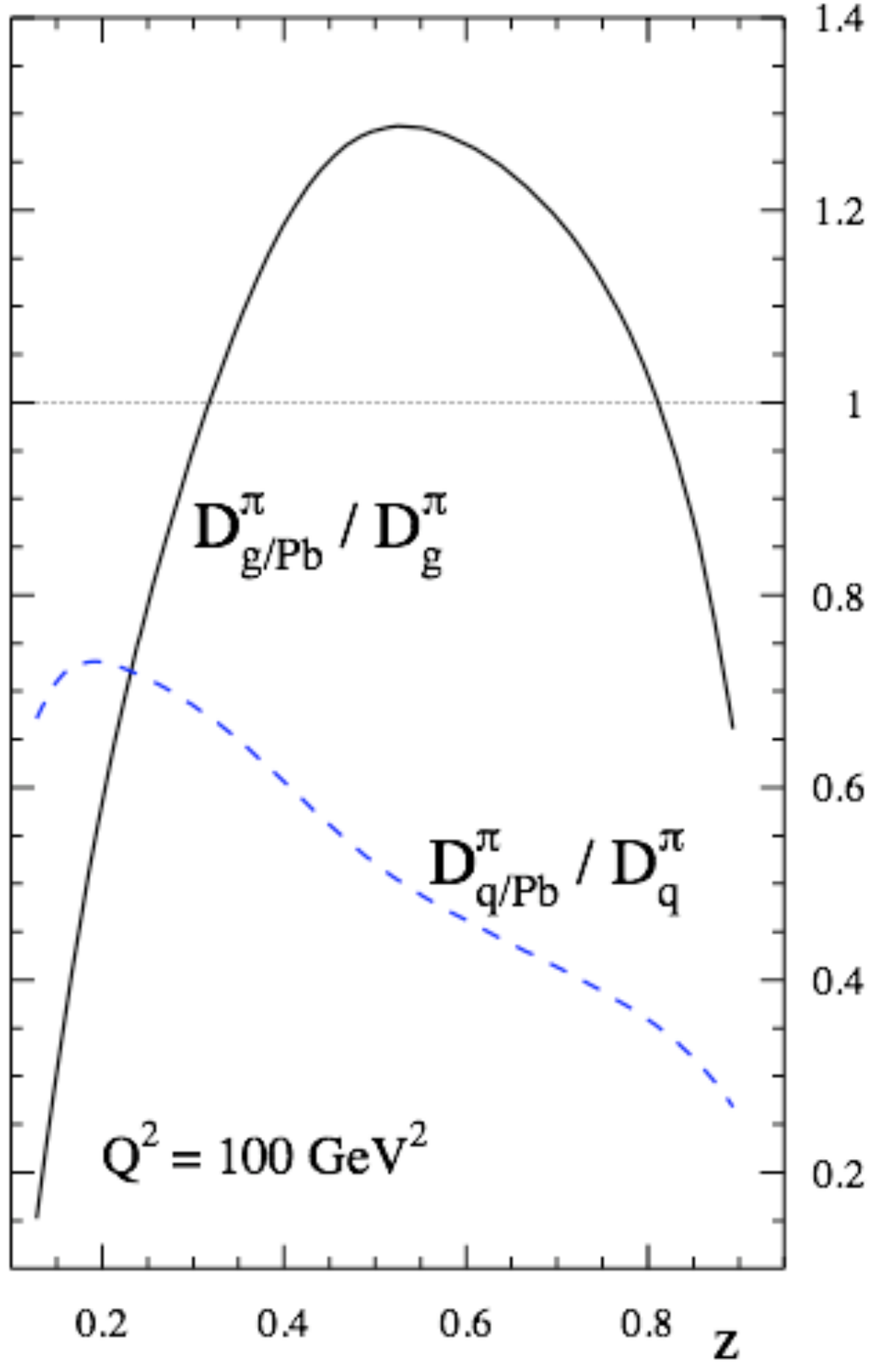
The rates to the vacuum FFs have:

- suppression and enhancement of gluons

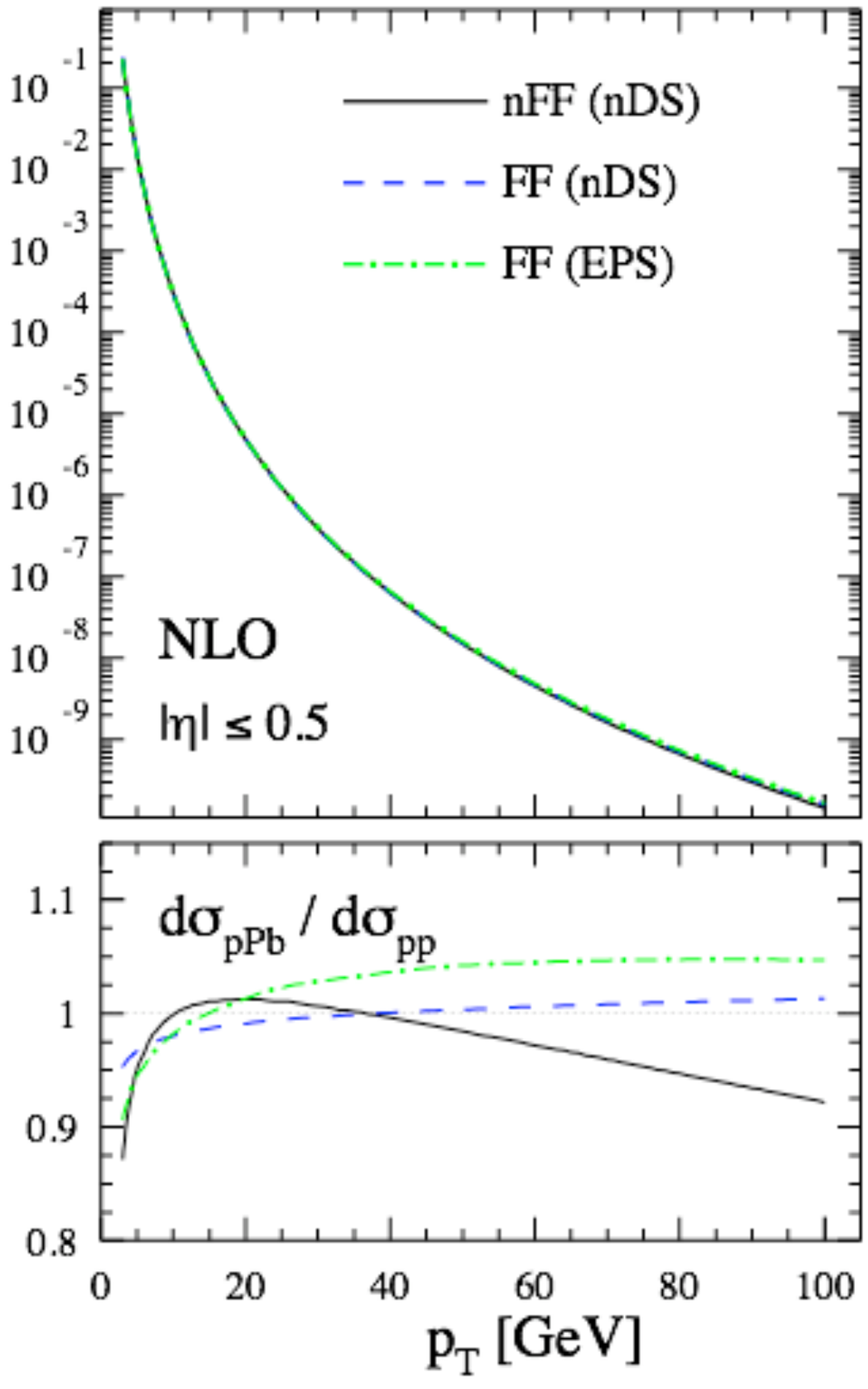
- suppression of quarks

both of them **z** dependent

z is the final state equivalent of **x**



Cross section prediction



is not enough to discriminate different choices

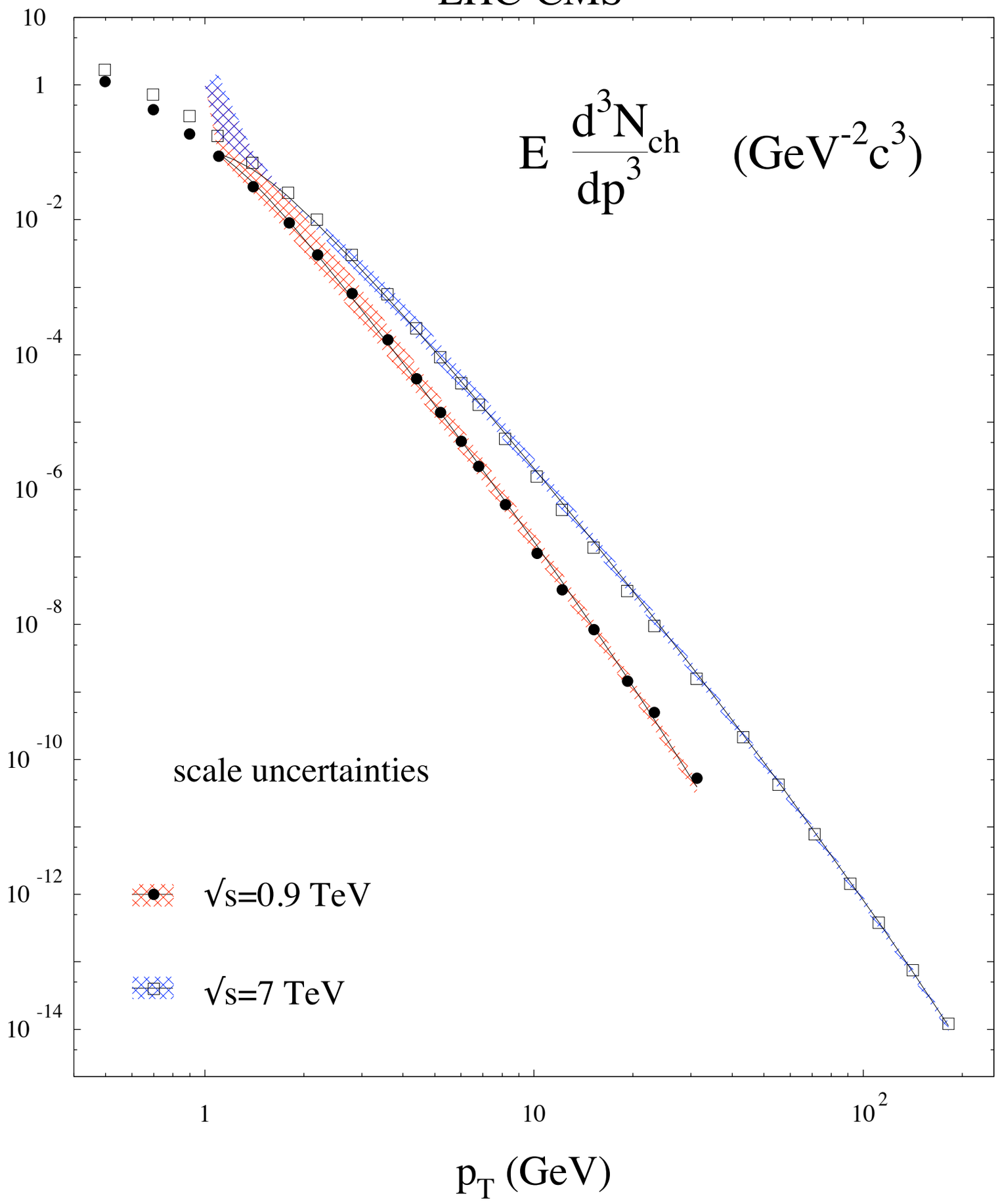
we compute the rate to pp

Conclusions

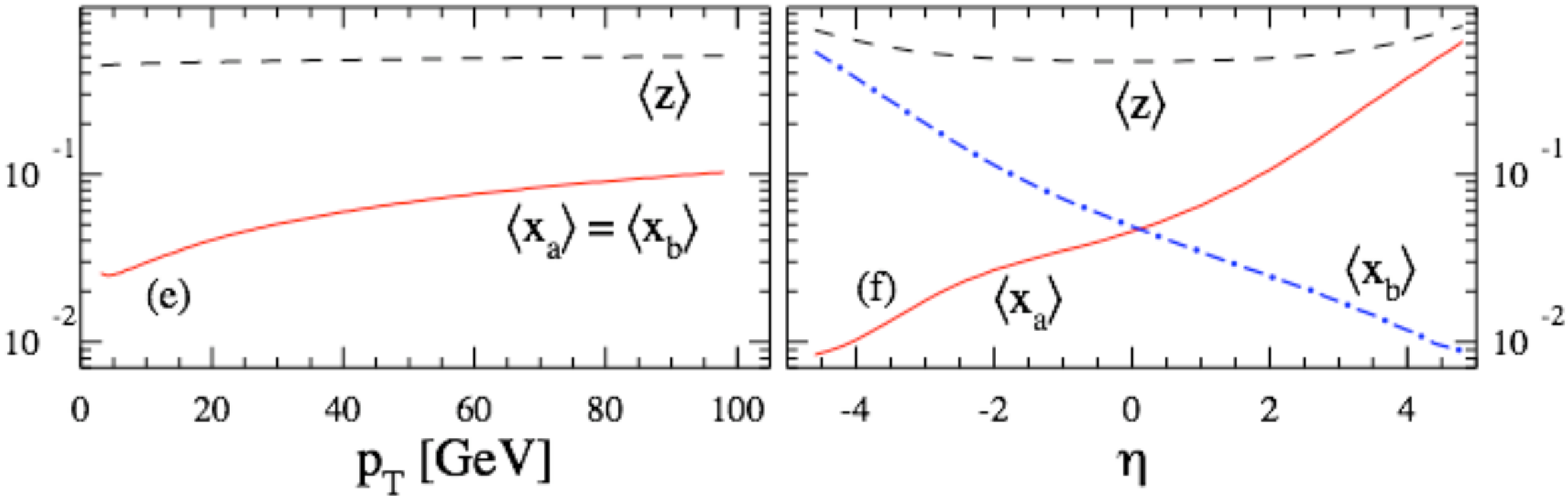
(at last)

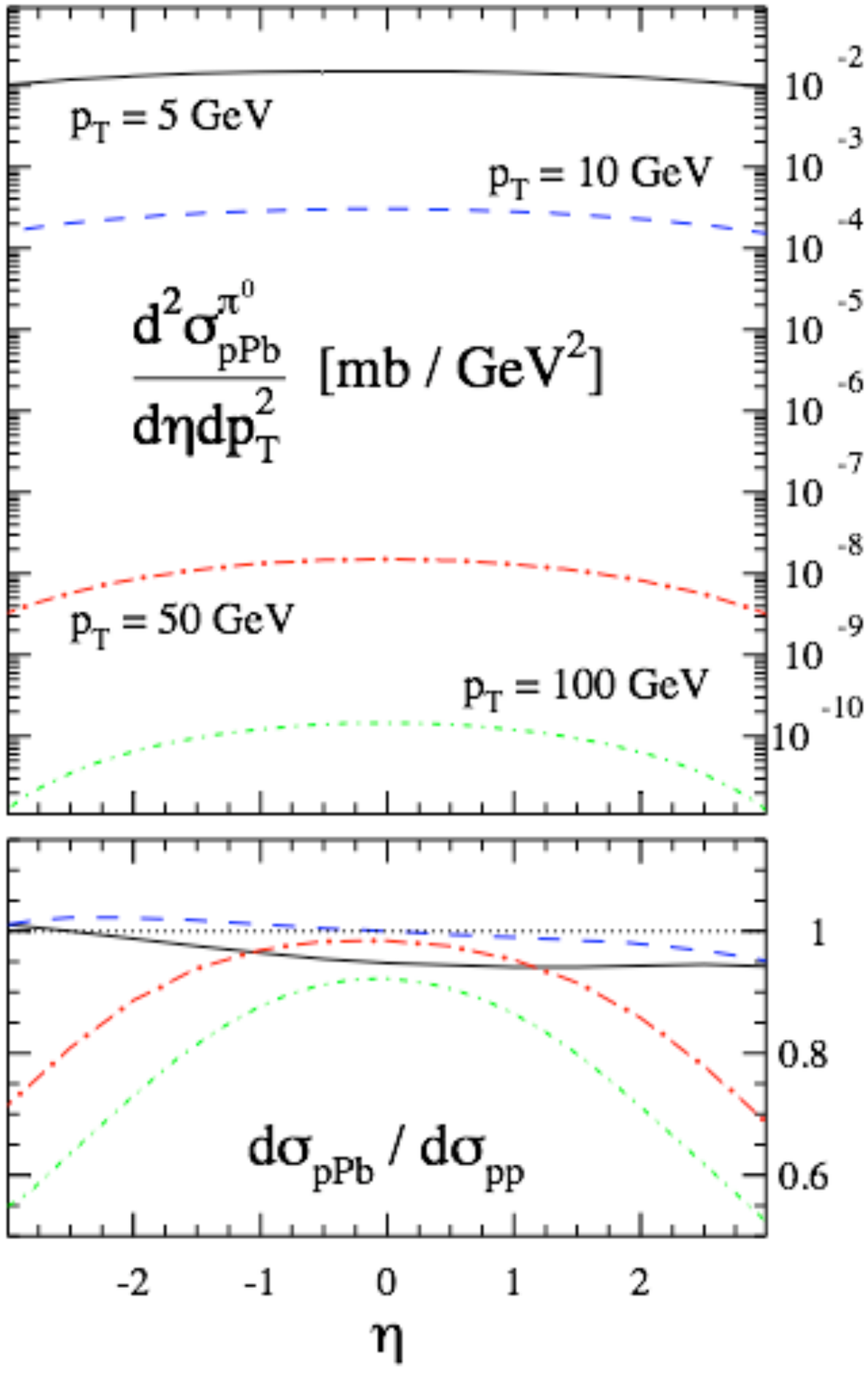
- First experimental results are in agreement with NLO pQCD. More importantly: the factorization scheme is valid in the kinematic range probed (so far) at the LHC.
- The LHC results will be very helpful in the extraction of gluon PDFs and FFs.
- The biggest uncertainty comes from the choice of renormalization and factorization scales.
- We provide predictions for the future p-Pb program at ALICE. This shall improve our knowledge of the hadronization phenomena and will be crucial at determining the background for QGP creation.

S. Chatrchyan et al. (CMS Collaboration)
arXiv: 1104.3547 hep-ex

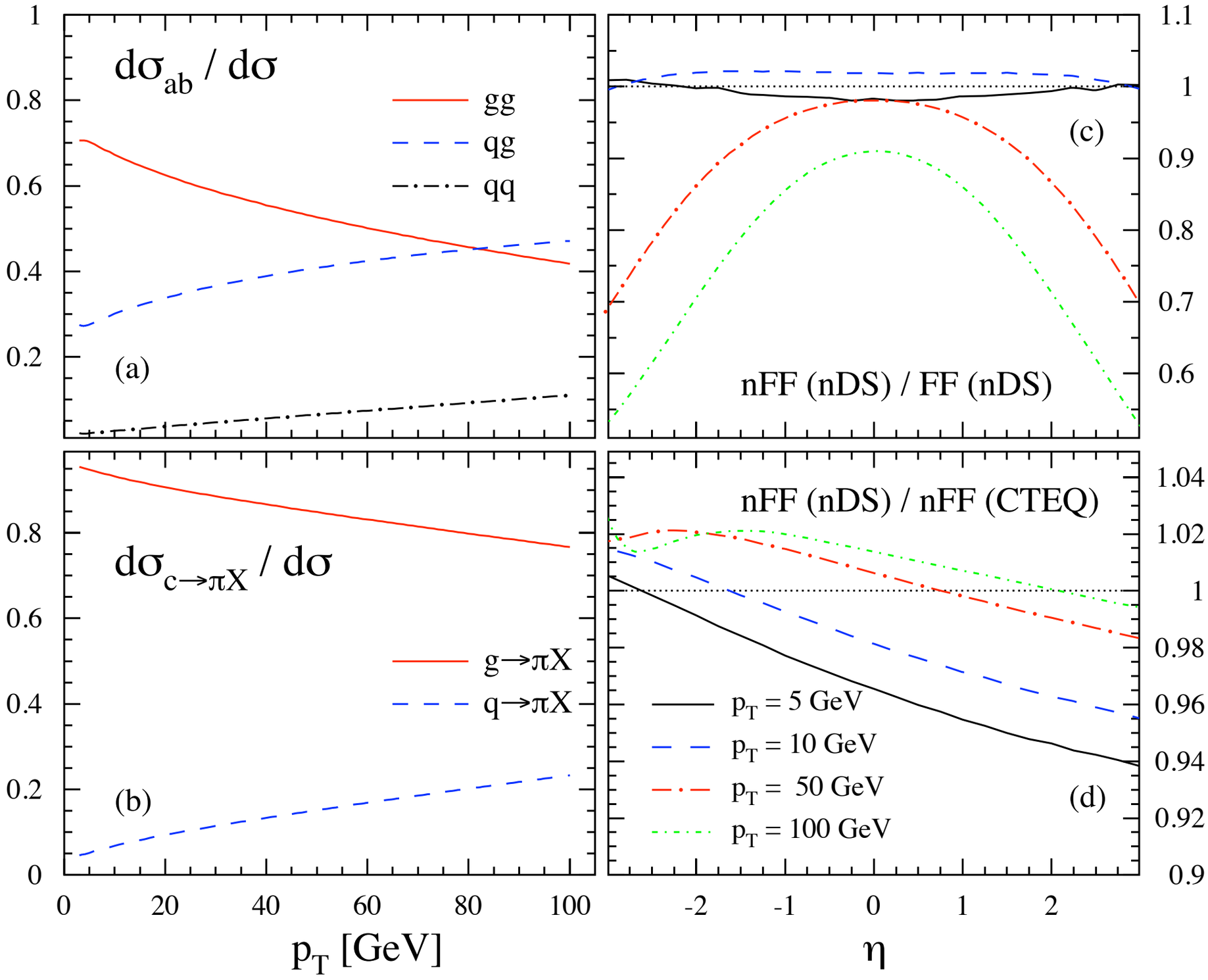


Mean values for **x** and **z** at the LHC




p_T = 5 GeV
p_T = 10 GeV
$\frac{d^2\sigma^{\pi^0}_{pPb}}{d\eta dp_T^2}$ [mb / GeV^2]
p_T = 50 GeV
p_T = 100 GeV
$d\sigma_{pPb} / d\sigma_{pp}$
η

Contributions to the "nuclear" cross section



Mean values of **x** and **z** in nuclear media