Re-weighting at the LHC: the p-Pb data impact

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VII Jornadas CPAN

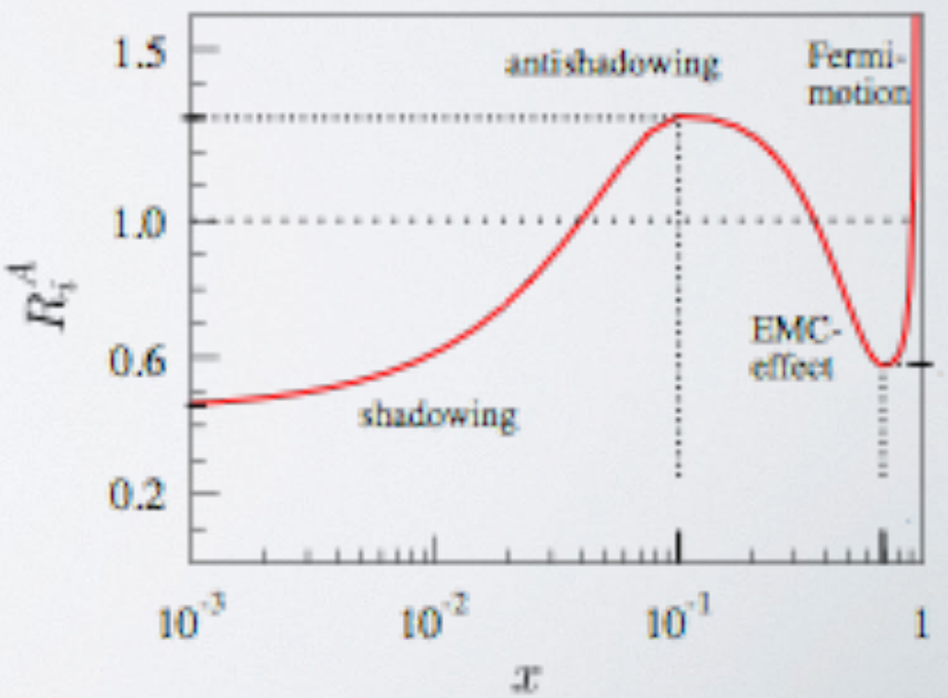
December 1st - 3rd, 2015
Segovia, Spain

OUTLINE

- What?
- Why?
- How?
- Results
- Summary

We know that:

- e+p ≠ e+A, p+p ≠ p+A
- we **need** something to describe this
- nPDFs sets at NLO (DSSZ, EPS09, HKN, nCTEQ)
- few data, gluons quite unconstrained
- the LHC runs also with lead beams!!



So, **WHAT** do we want to do?

- check if data from the p-Pb Run I can help improve our picture

- preferably, before the Run II results arrive

- provide a new set of nPDFs (if possible)

And, **WHY** do we want to do it?

- if we don't understand the initial state, how can we understand the measurements?
- at which point the collinear factorization stops being valid?
- p-Pb collisions are the benchmark for Pb-Pb (and QGP!!)
- future colliders using nucleus are planned/approved
- cosmic rays also have a heavy nuclei component

Then, **HOW** do we do it?

- we take data from the p-Pb run:

jets (ATLAS)
dijets (CMS)

Z (ATLAS, CMS)
W (ALICE, CMS)

charged hadrons (ALICE, CMS)
charged pions (ALICE)

- compute the observables in pQCD with different proton and nuclear PDFs

MSTW2008 : EPJC 63 (2009) 189
CT10 : PRD 82 (2010) 074024
DSSZ : PRD 85 (2012) 074028
EPS09 : JHEP 0904 (2009) 065

MCFM : JHEP 1107 (2011) 018
FR : NPB 467 (1996) 399
NPB 507 (1997) 295
NPB 507 (1997) 315

- apply the Bayesian re-weighting technique to study data/theory compatibility and/or tension

    - purely statistical methods

    - provides quantitative estimator

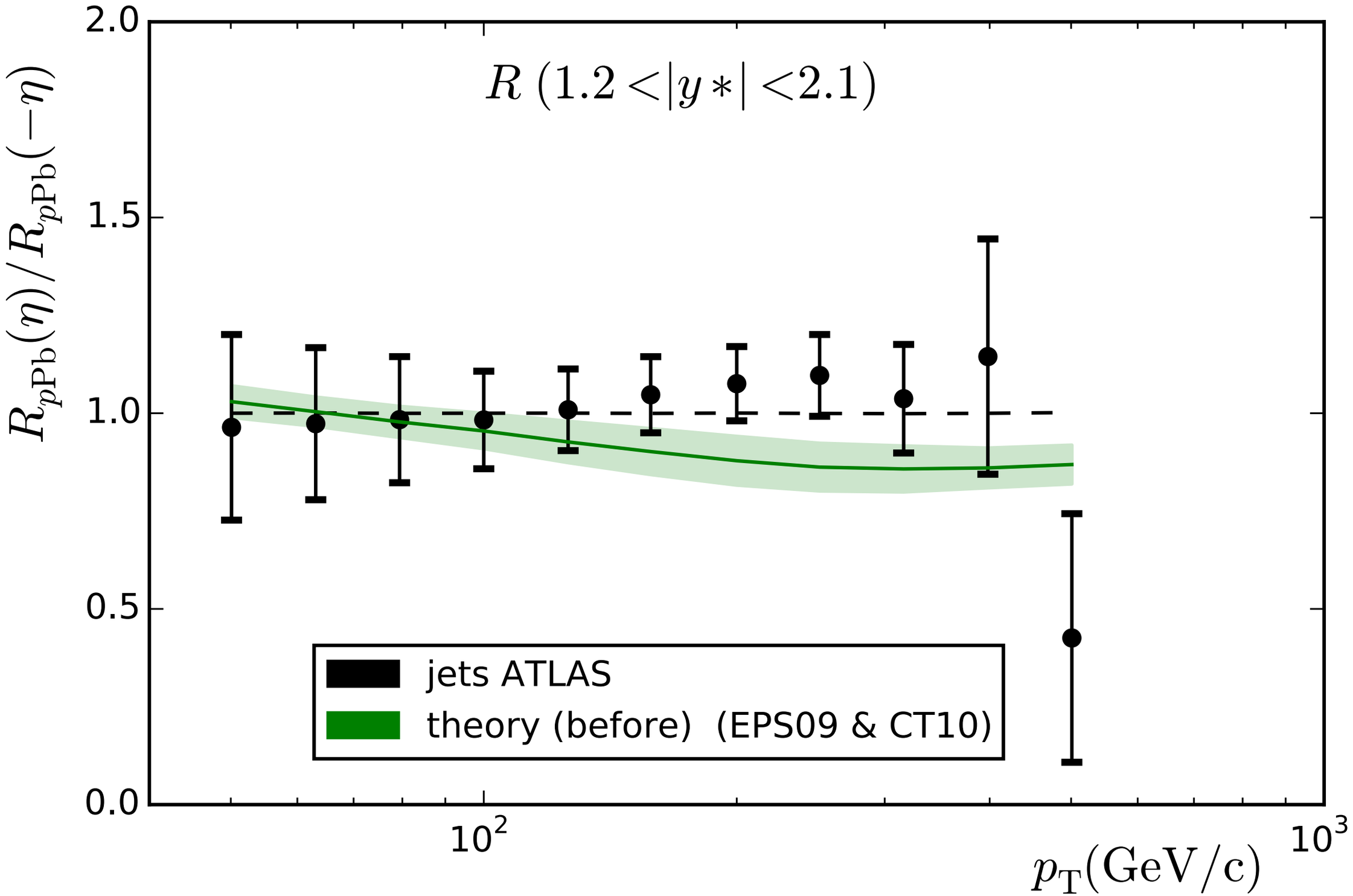
    - powerful time-saving tools

JHEP 1412 (2014) 100 (and references therein)

- ponder on what numbers and plots tell us

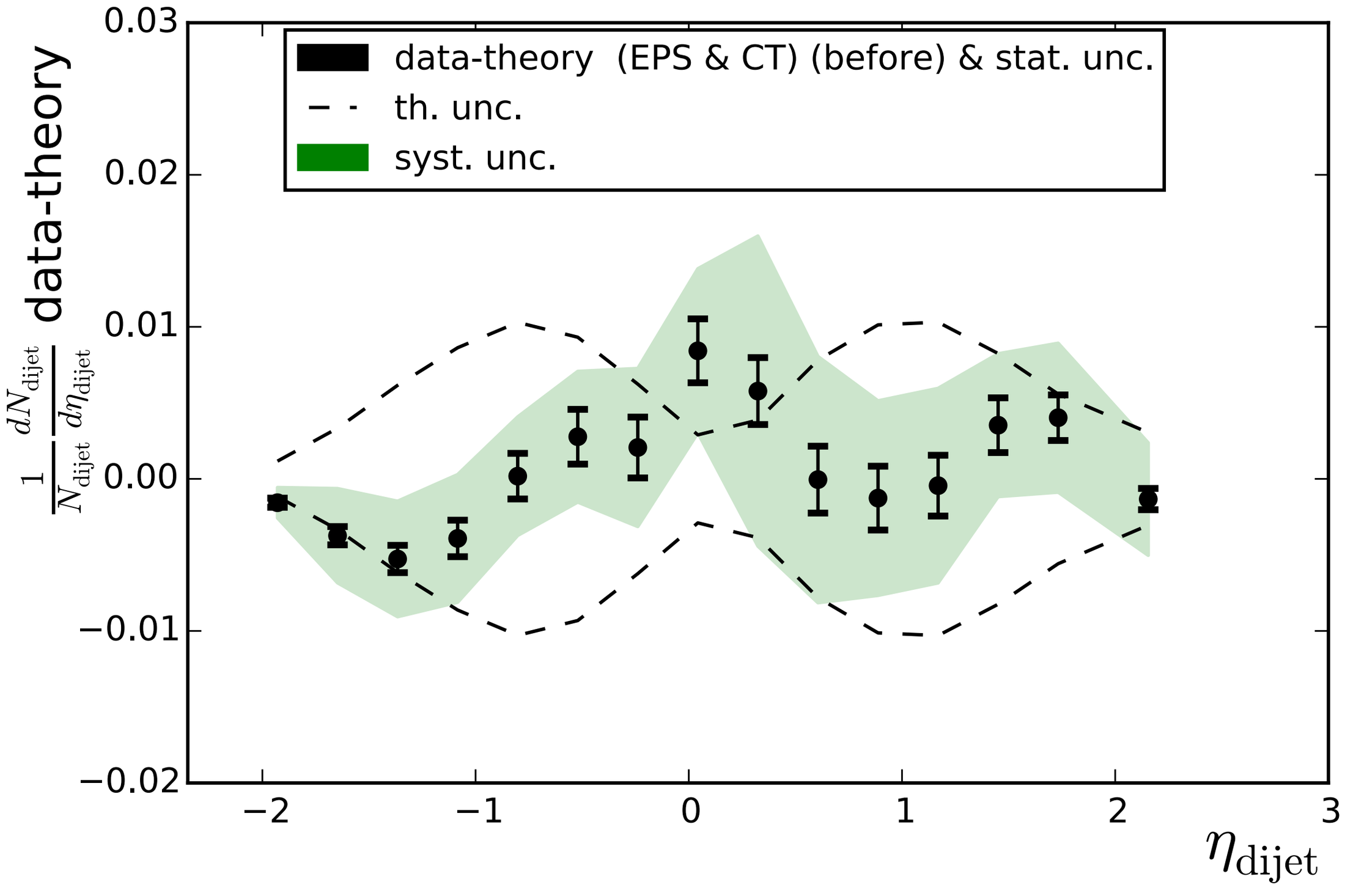
JETS BY ATLAS

ATLAS Collaboration
PLB 748 (2015) 392



DIJETS BY CMS

CMS Collaboration
EPJC 74 (2014) 7, 2951



data-theory

$\frac{1}{N_{\mathrm{dijet}}}\frac{dN_{\mathrm{dijet}}}{d\eta_{\mathrm{dijet}}}$ data-theory

data-theory (DSSZ & CT) (before) & stat. unc.

th. unc.

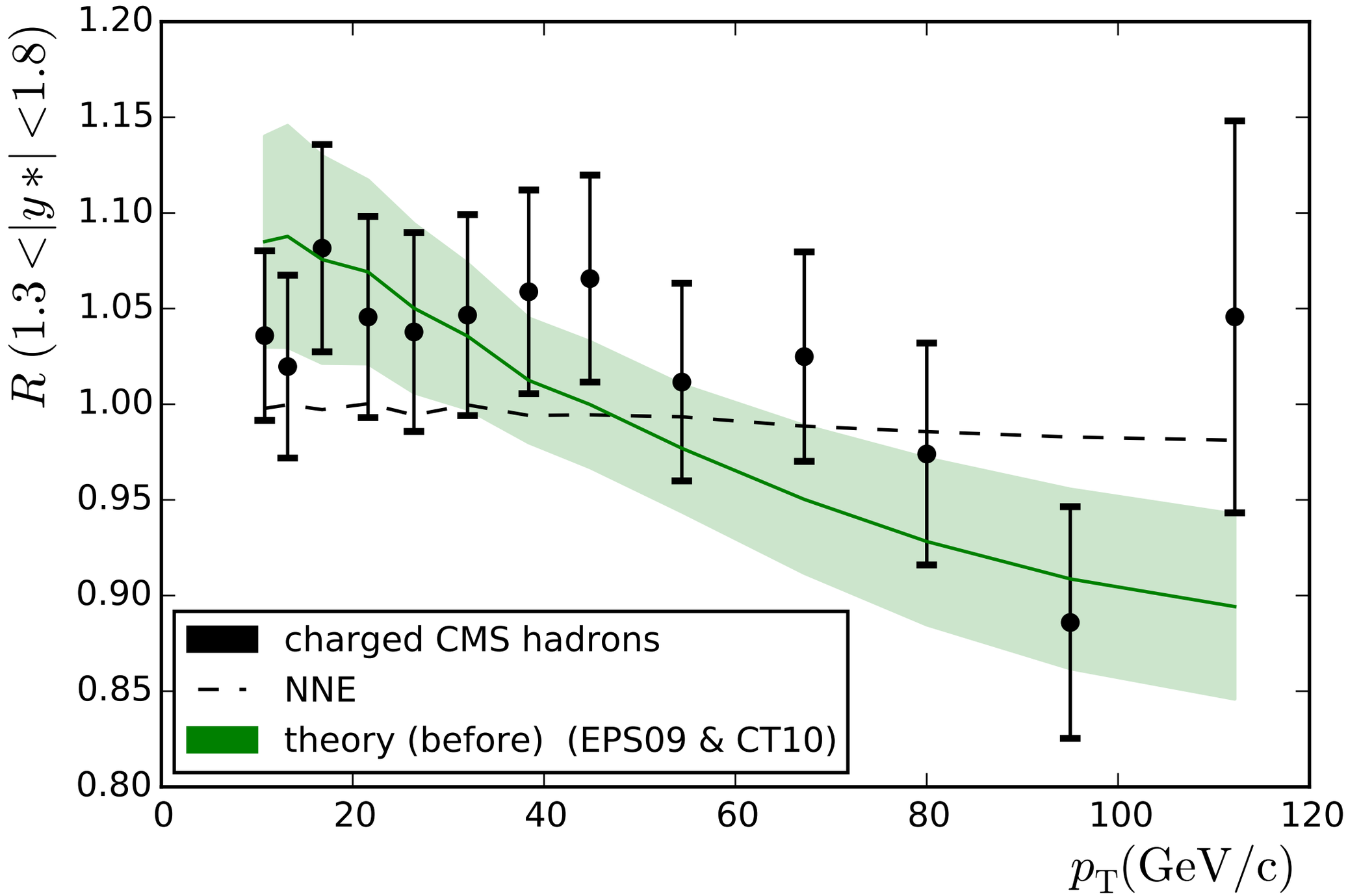
syst. unc.

0.03
0.02
0.01
0.00
−0.01
−0.02

−2
−1
0
1
2
3

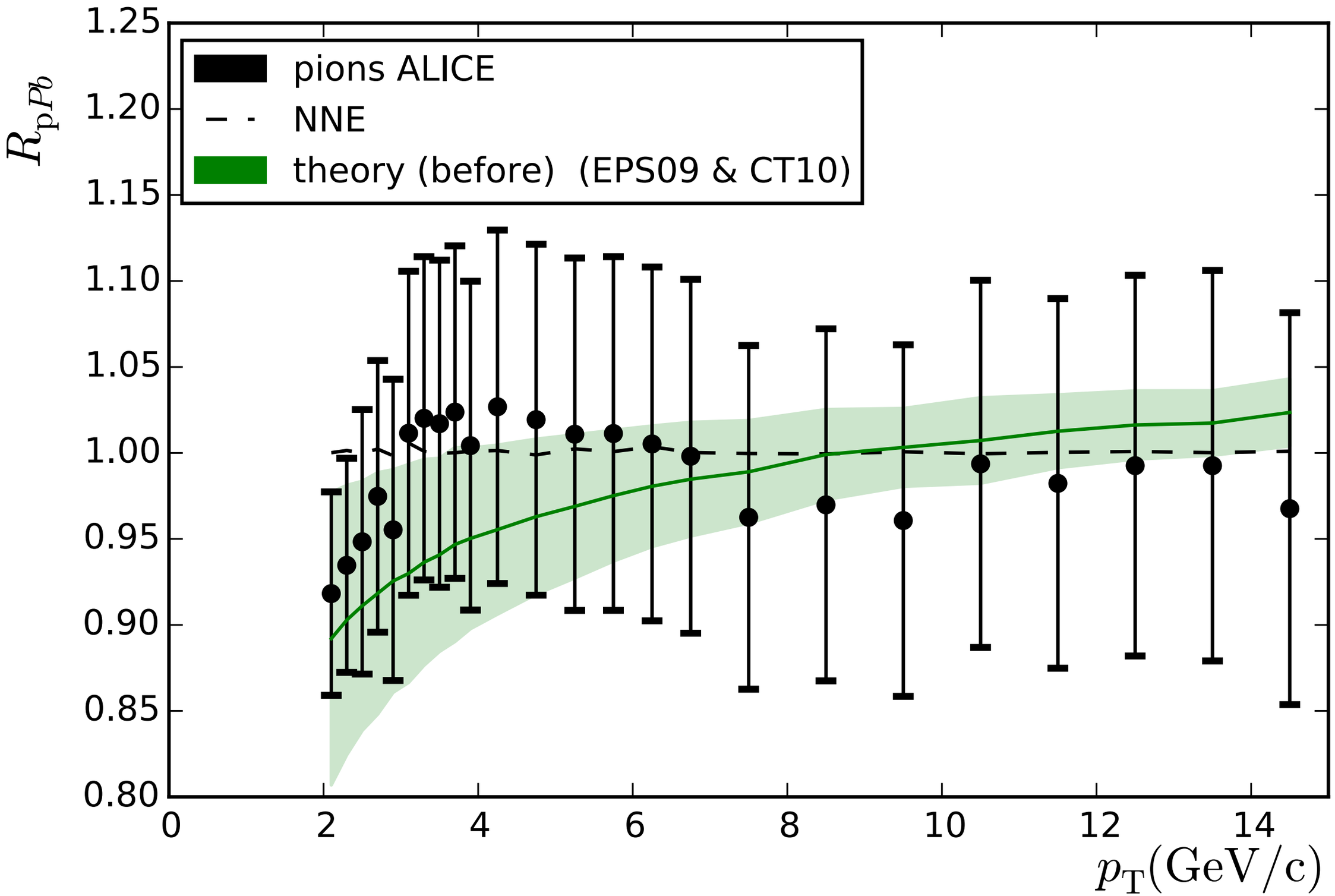
η_{dijet}

CHARGED HADRONS BY CMS



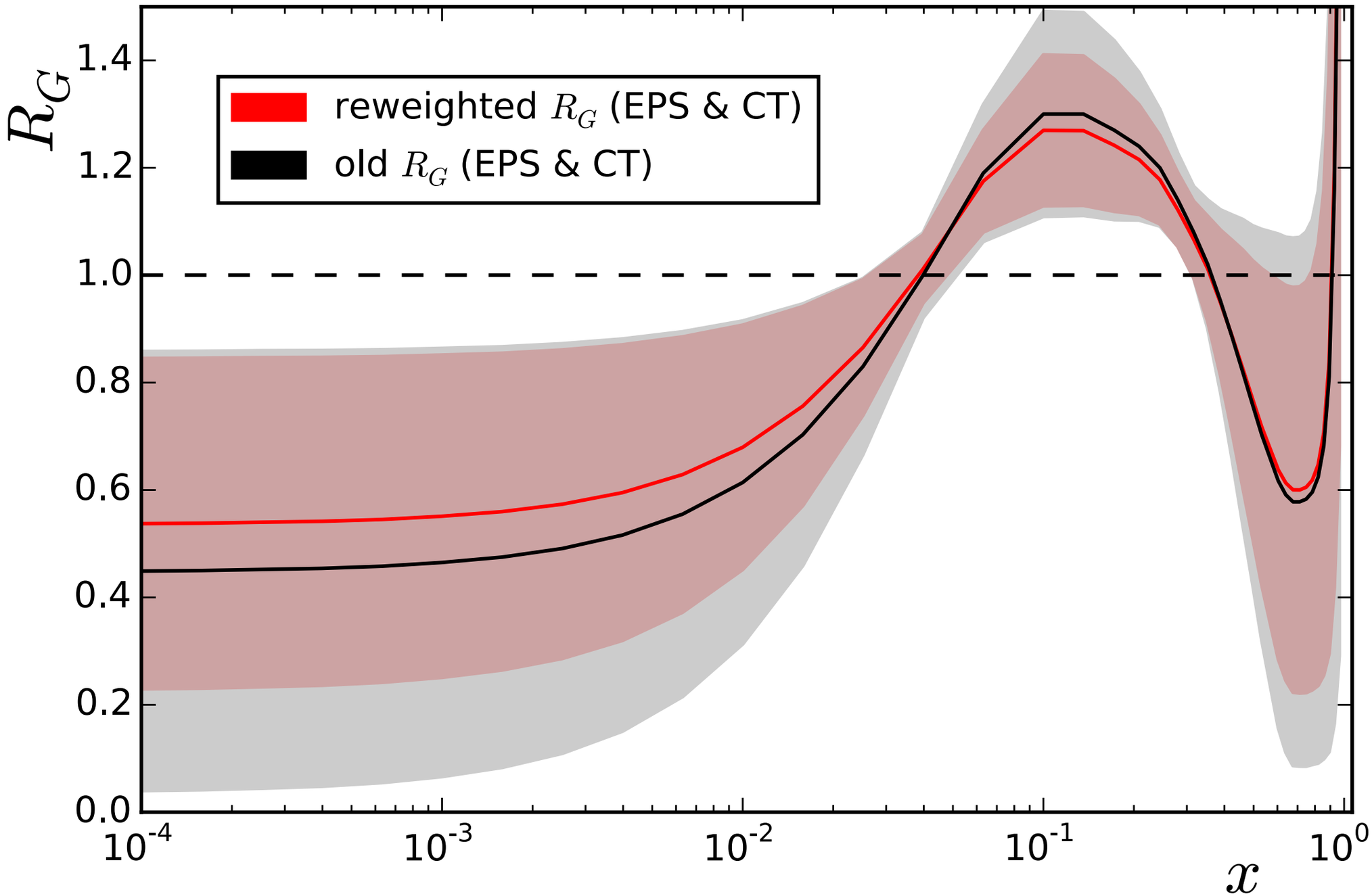
CMS Collaboration, CMS-PAS-HIN-12-017

PIONS BY ALICE



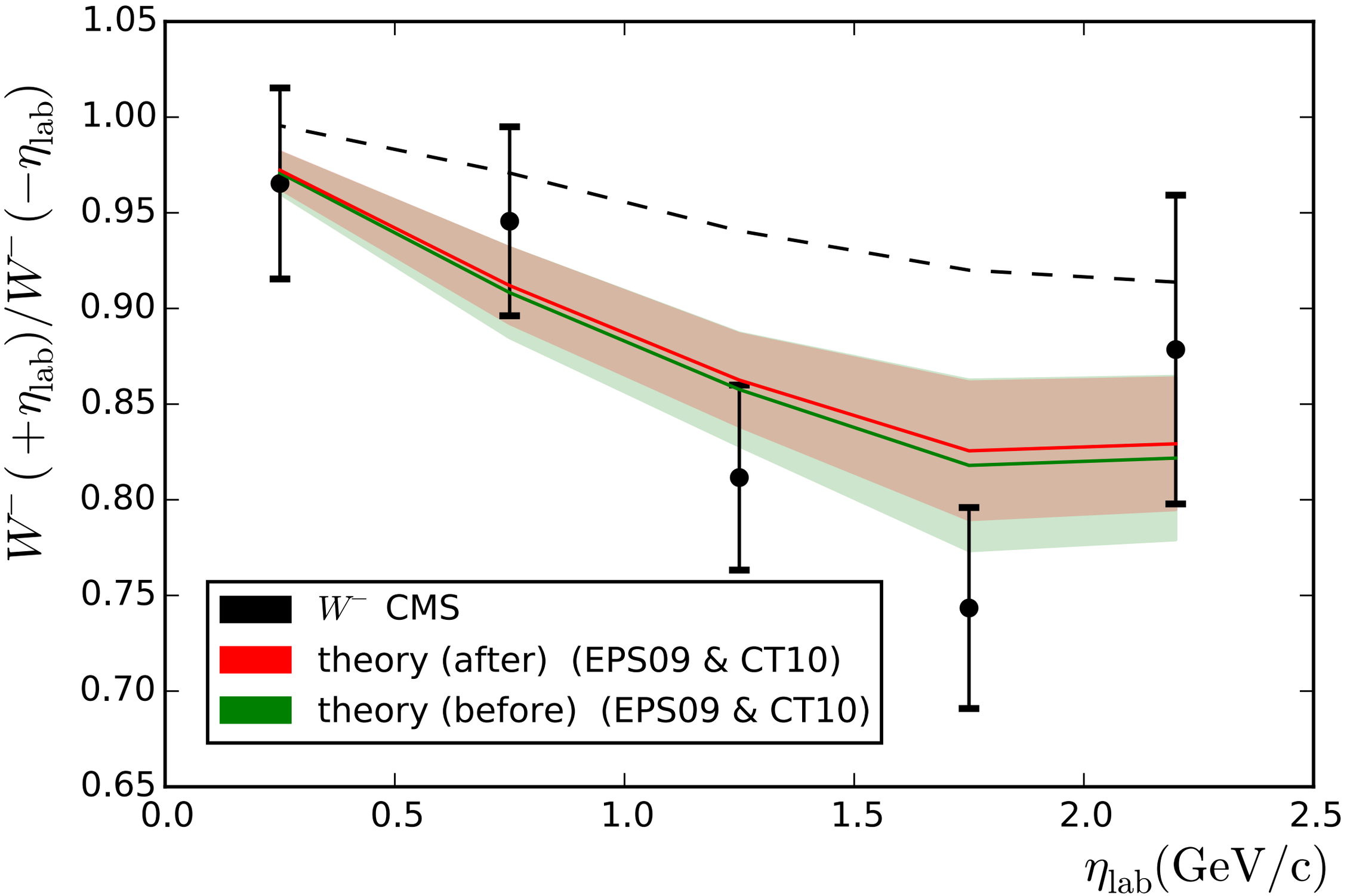
ALICE Collaboration, EPJC 74 (2014) 9, 3054

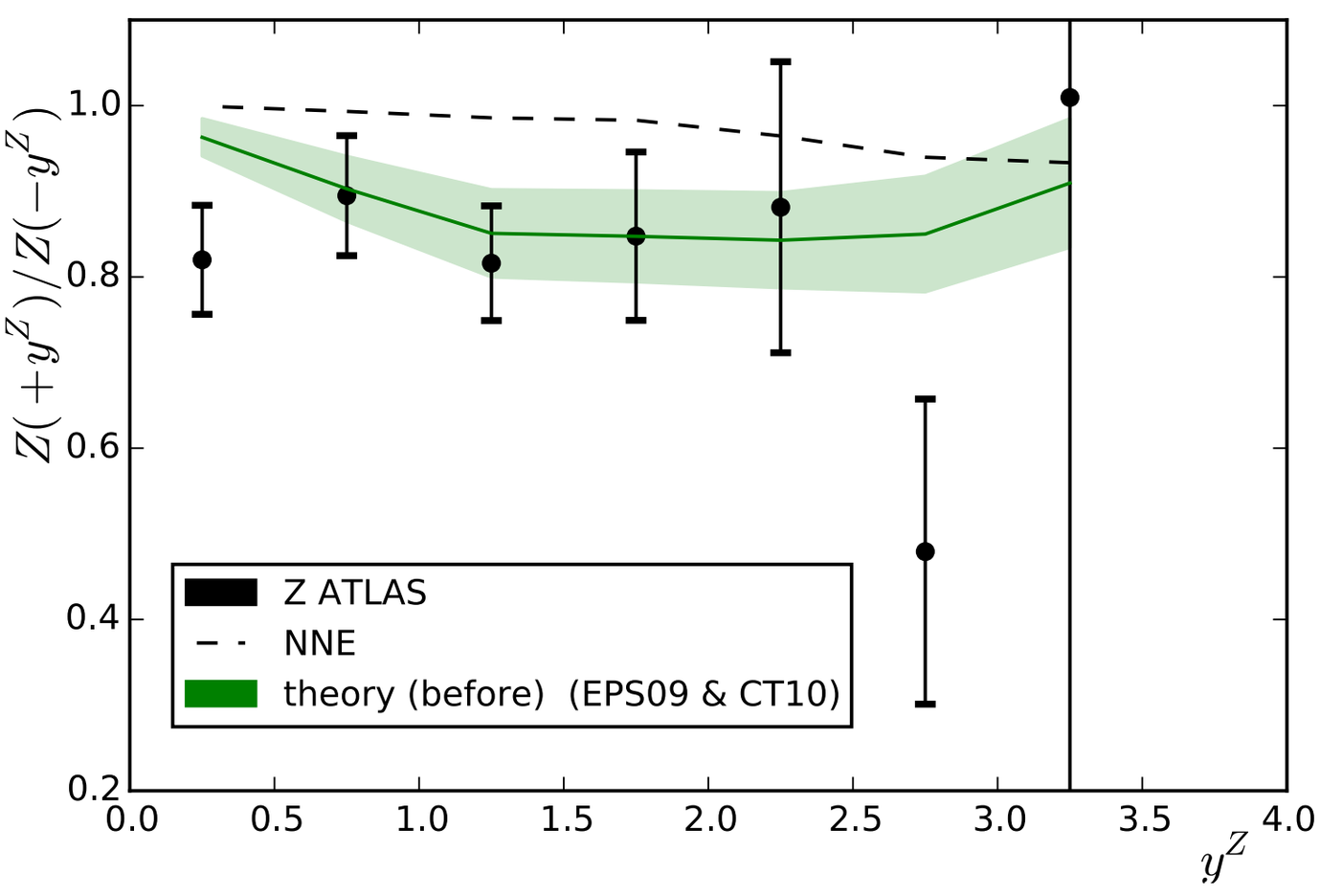
GLUON


R_G
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
reweighted R_G (EPS & CT)
old R_G (EPS & CT)
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
x

W'S BY CMS

CMS Collaboration,
arXiv:1503.05825 [hep-ex].



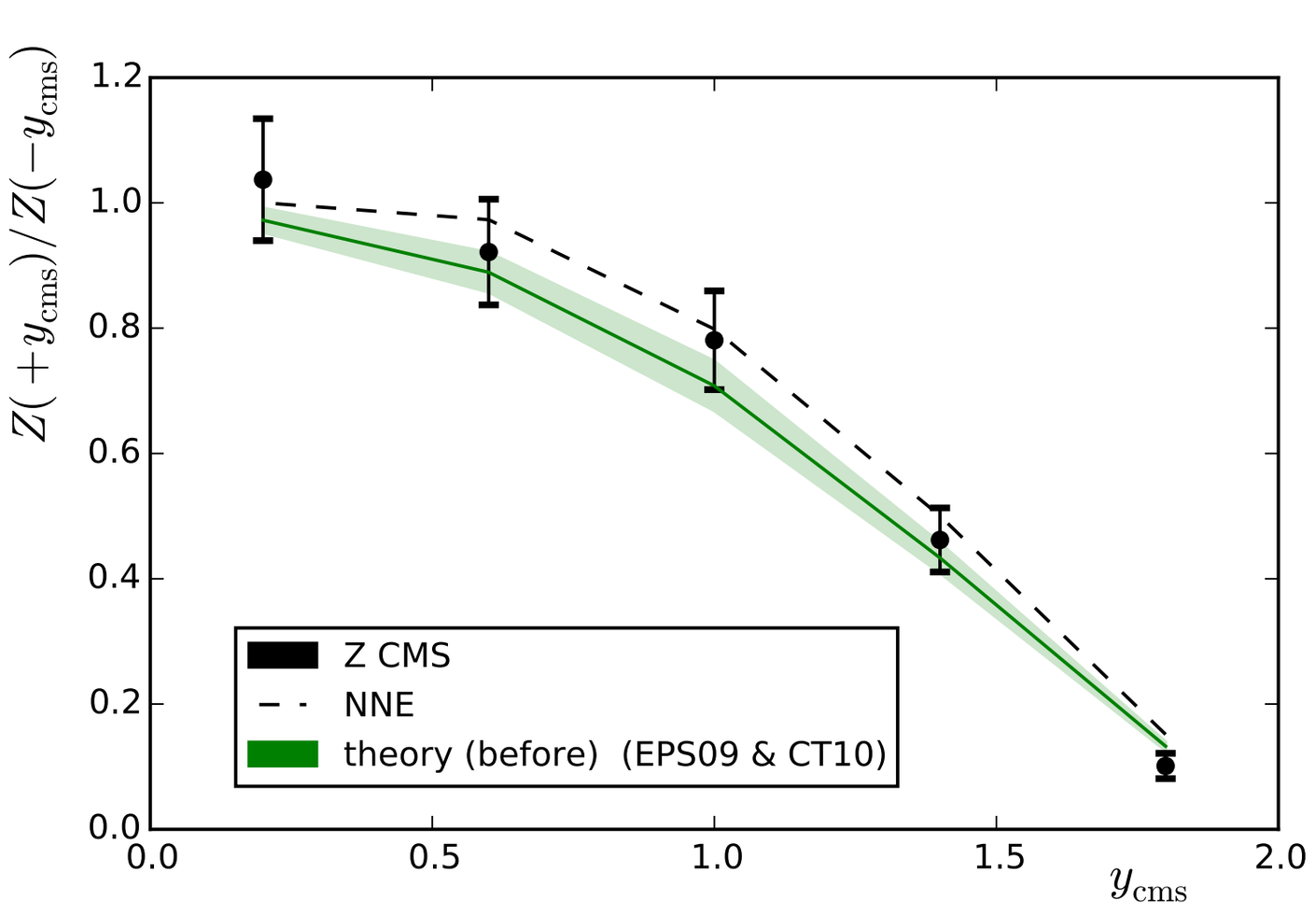


Z BY CMS

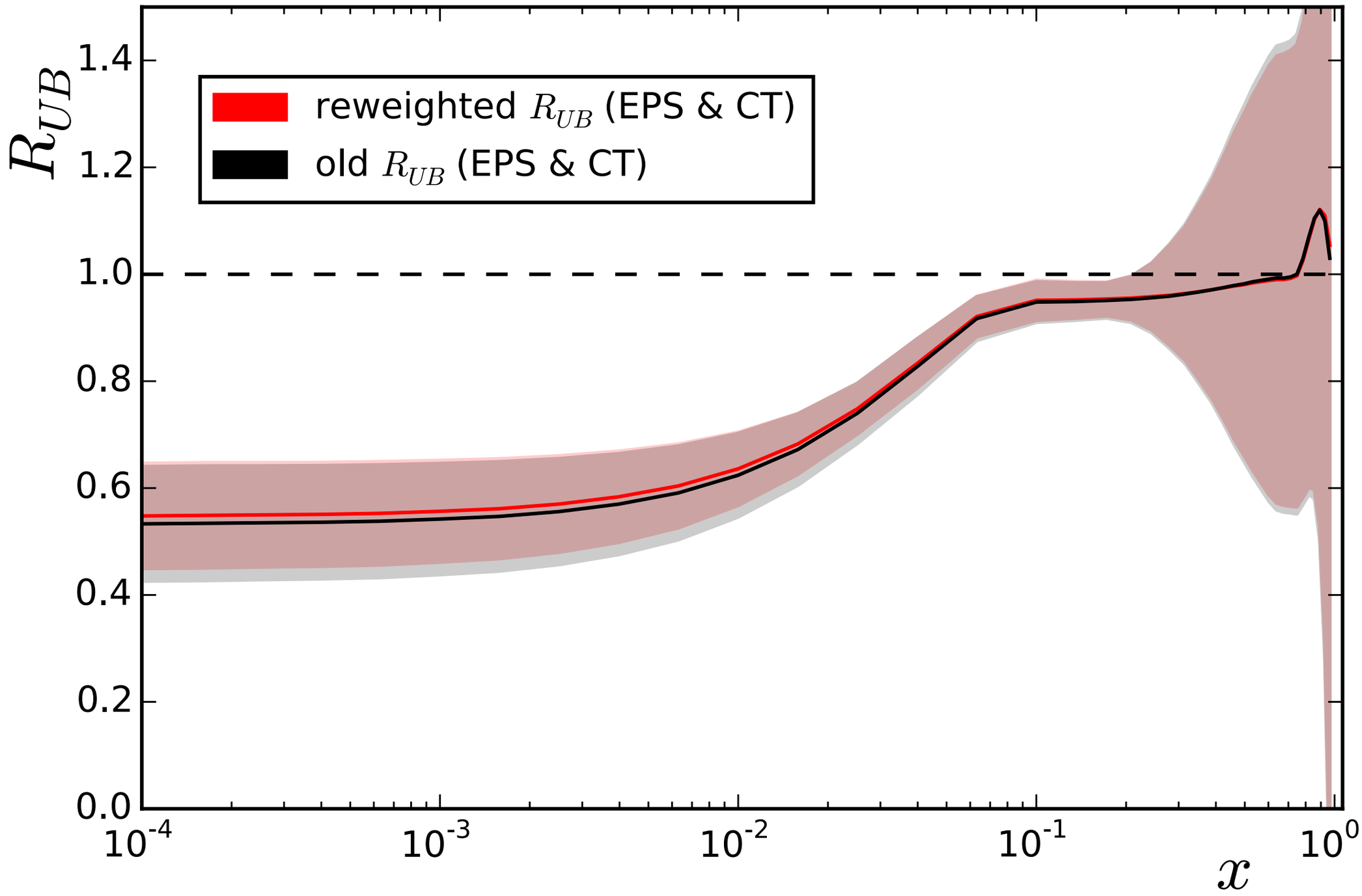
CMS collaboration
CMS-PAS-HIN-15-002

Z BY ATLAS

ATLAS collaboration
arXiv:1507.06232 [hep-ex]



SEA QUARKS


reweighted R_{UB} (EPS & CT)
old R_{UB} (EPS & CT)
R_{UB}
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
x

IN NUMBERS

PDF+nPDF	X^2	$X^2_{\text{re-weighted}}$
CT10+DSSZ	1.074	1.016
CT10+EPS09	0.674	0.632
CT10 only	1.425	——
MSTW2008+DSSZ	0.876	0.826
MSTW2008+EPS09	0.649	0.583
MSTW2008 only	1.138	——

SUMMARY

- We analyzed p-Pb data from LHC with four combinations of proton and nuclear PDFs

- W bosons and dijets call for a new fit with flavour separation

- The impact seems rather small due to the systematic uncertainties

- The trend is a flatter gluon, less shadowing and anti-shadowing