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on behalf of the ATLAS Collaboration

Hadronic final states in high-pT QCD with the ATLAS detector

McGill University

Outline

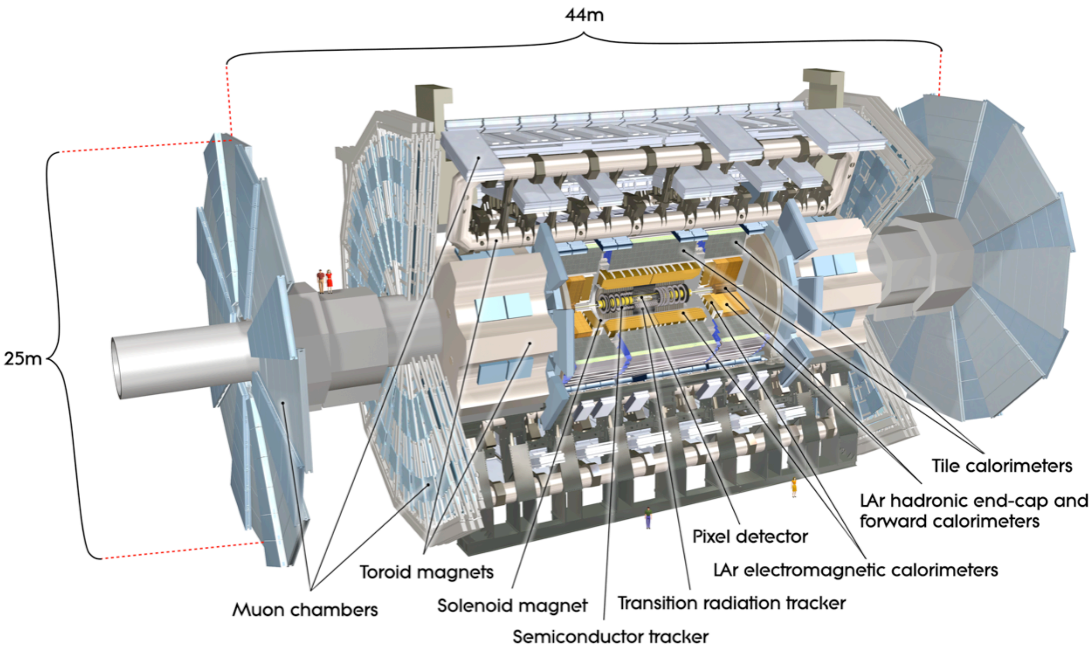
- Introduction
- Inclusive Jet Cross Section
- Dijet Cross Section
- Jet Flavour in Dijet Events
- Multi Jet Cross Section Ratio
- α_s Measurement
- Summary and Conclusion

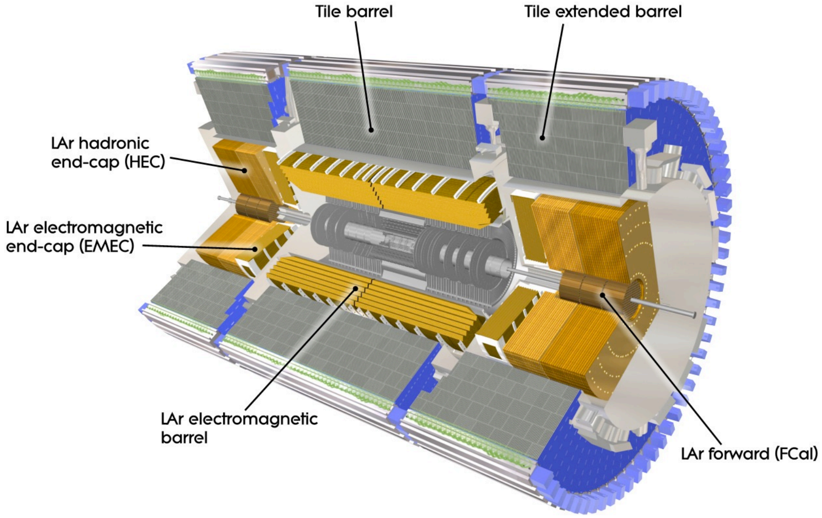
McGill University

The ATLAS detector

pp LHC runs:

- 2010, $\sqrt{s}$ = 7TeV , $L_{INT} = 39pb^{-1}$
- 2011, $\sqrt{s}$ = 7TeV (2.76TeV) , $L_{INT} = 4.6fb^{-1}$ ($0.2pb^{-1}$)
- 2012, $\sqrt{s}$ = 8TeV, $L_{INT} = 23fb^{-1}$

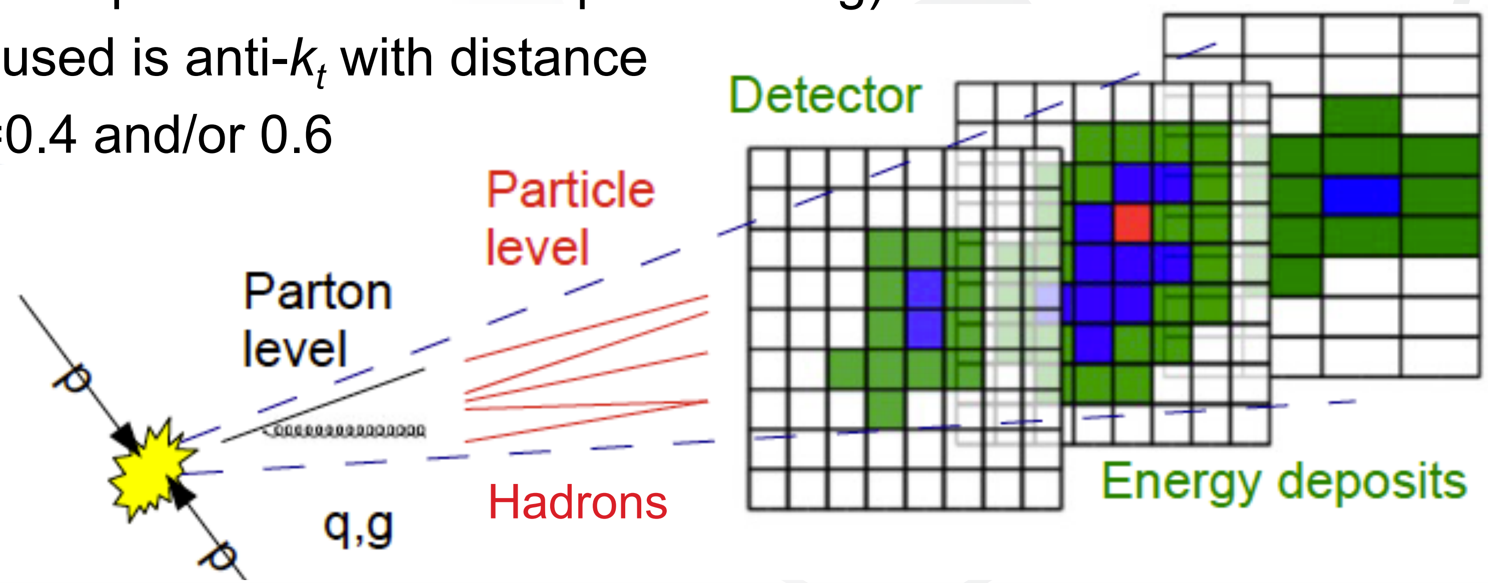




- Tracking |η| < 2.5
- Calorimeter |η| < 4.9
  - Presampler <1.8
  - Lead/LAr EM Calo <3.2
  - Steel/scintillator Tile Calo <1.7
  - Copper/LAr and Tungsten/LAr elements for forward coverage
- Muon spectrometer |η| < 2.7

Jet Reconstruction

- Calorimeter jets are built using three dimensional topological clusters
- Correct for calorimeter non-compensation and pile-up effects
- Constant improvement of jet algorithm, modeling and detector understanding allows for robust analysis with different pile-up conditions (2011 up to 20 interactions per crossing)
- Jet algorithm used is anti-k_t with distance parameter R=0.4 and/or 0.6



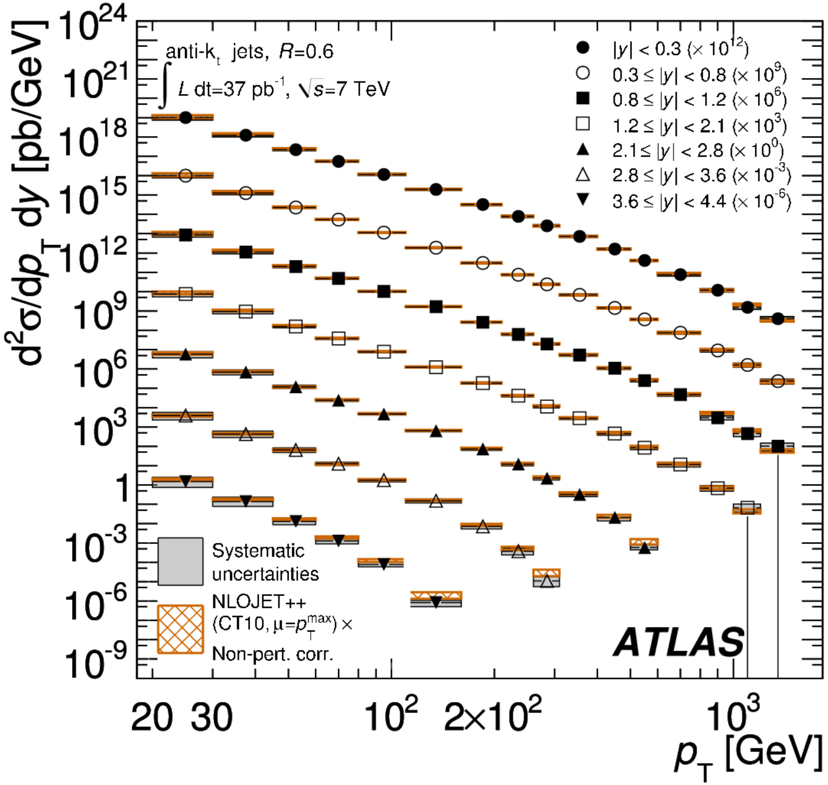
Inclusive Jet Cross Section

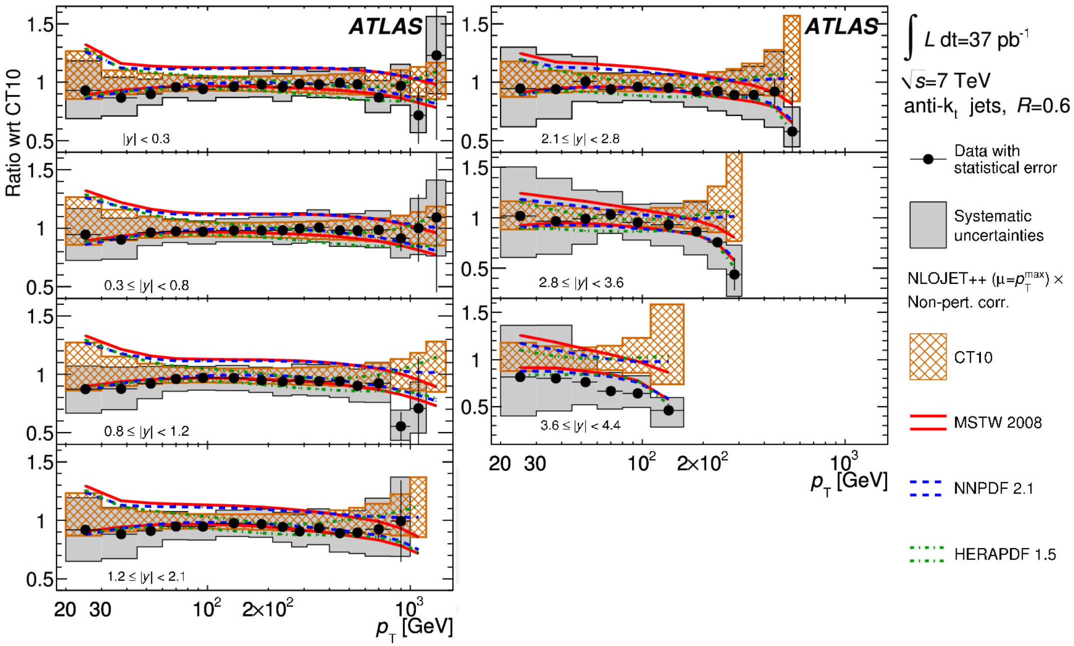
Phys.Rev. D86 (2012) 014022

R = 0.4 and R = 0.6

7 TeV 2010 measurement
Comparison to NLO

Some differences at high rapidity
but still within uncertainties



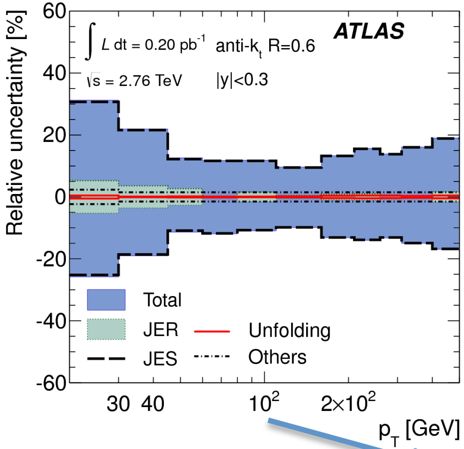


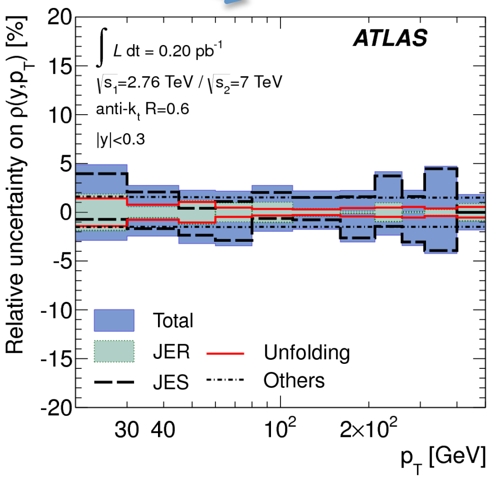
Inclusive Jet Cross Section Ratio

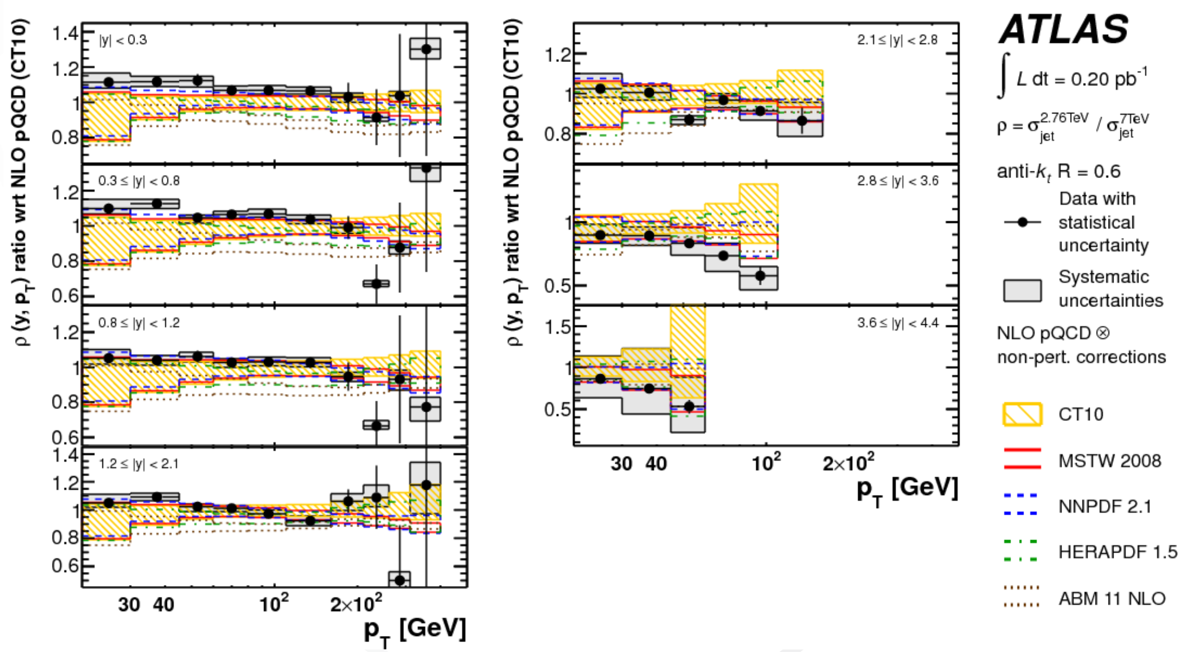
EPJC (2013) 73 2509

R = 0.4 and R = 0.6

Ratio of 2.76 and 7 TeV reduces systematic uncertainties significantly





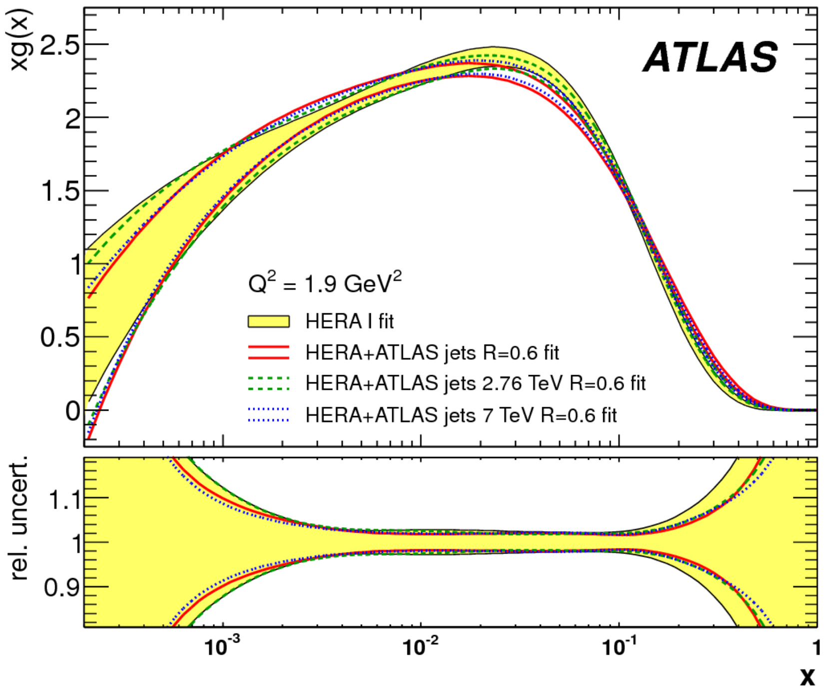


EPJC (2013) 73 2509

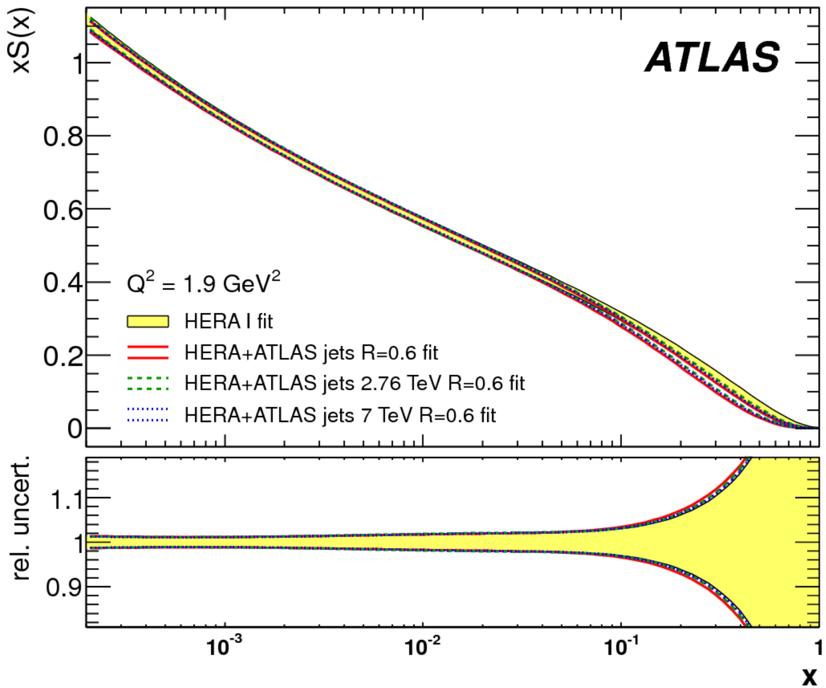
PDF sensitivity

R = 0.4 and R = 0.6

Momentum distribution of the gluon



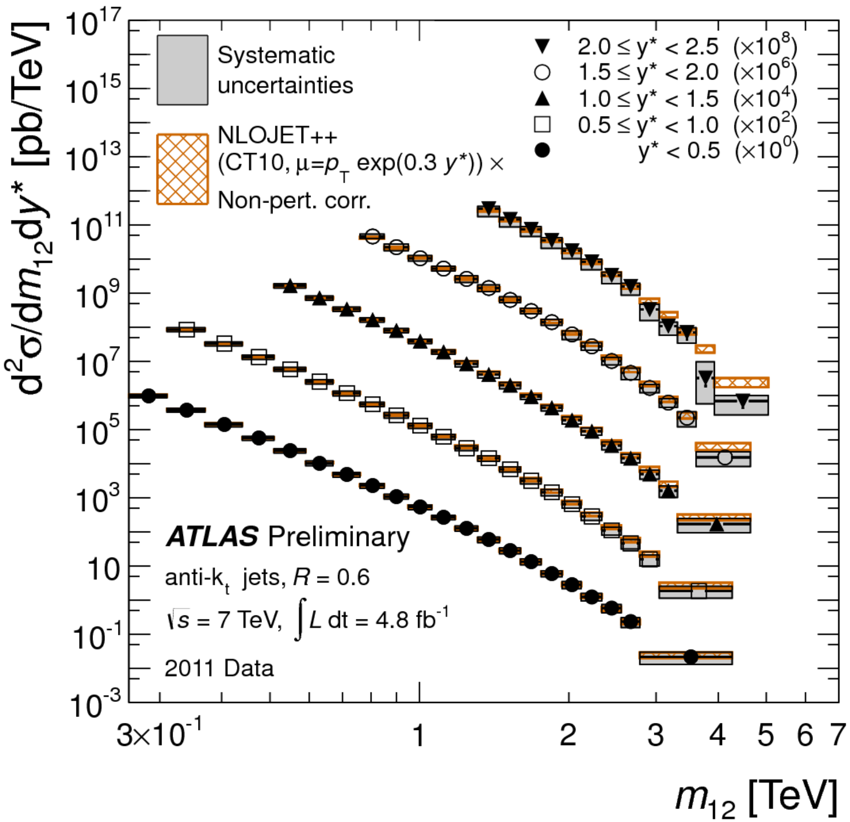
Momentum distribution of the sea-quarks

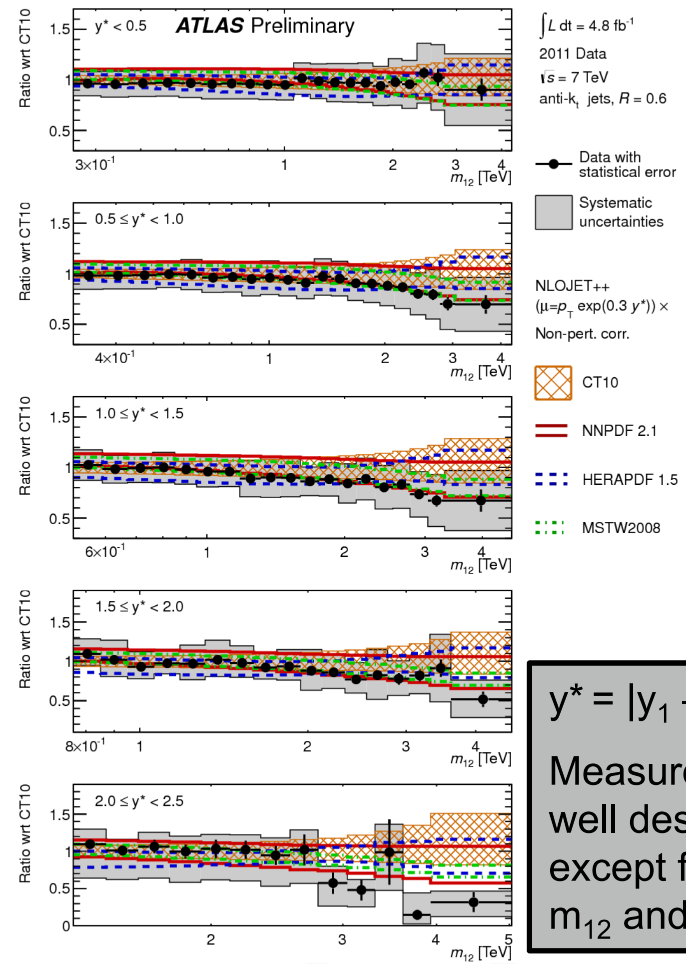


Dijet Cross Section

R = 0.4 and R = 0.6

7 TeV 2011 measurement
Comparison to NLO





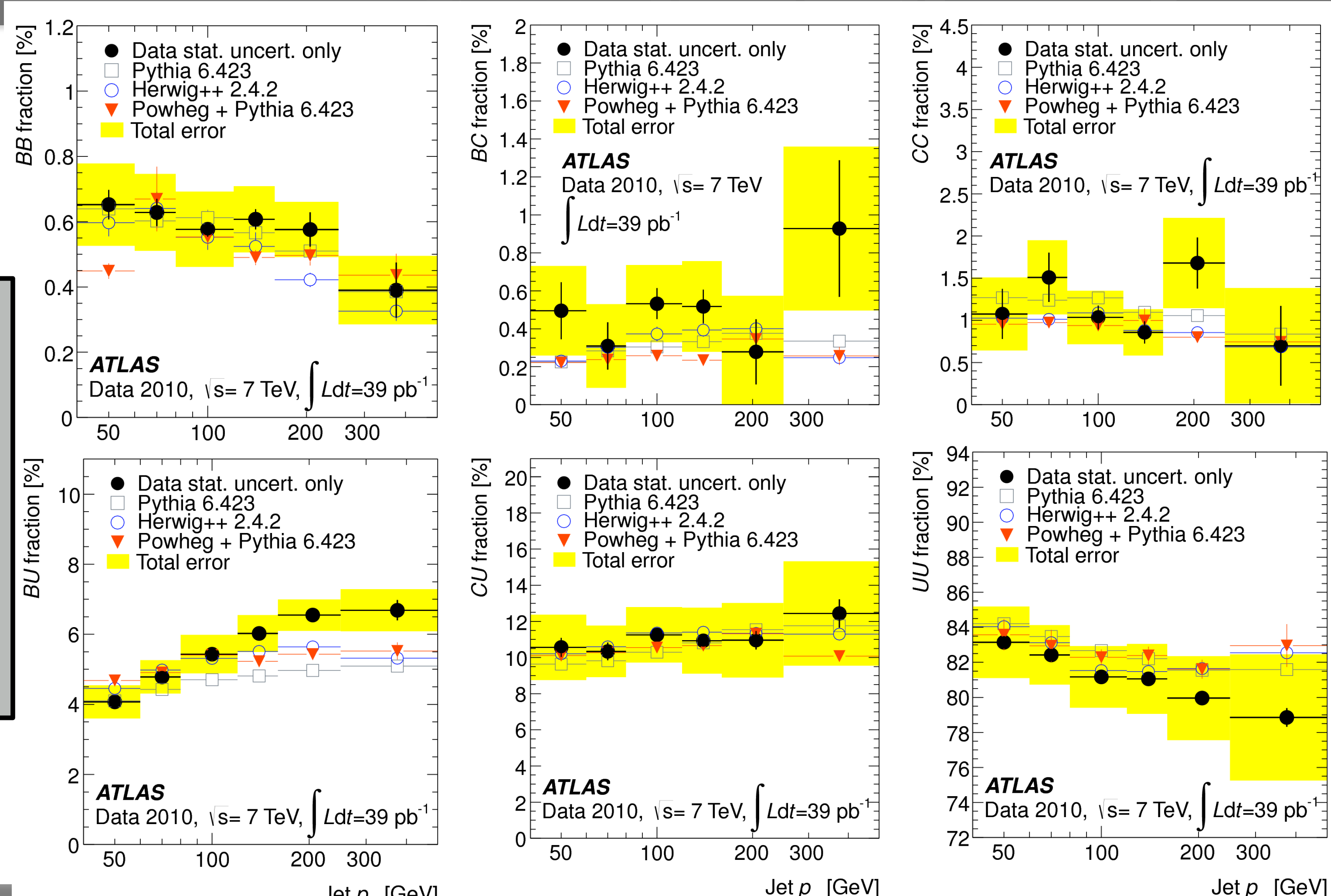
$y^* = |y_1 - y_2| / 2$

Measurements generally well described by NLO except for high m_{12} and large y^*

Eur. Phys. J. C (2013) 73:2301

Jet Flavour in Dijet Events

R = 0.4



7TeV 2010 measuerment

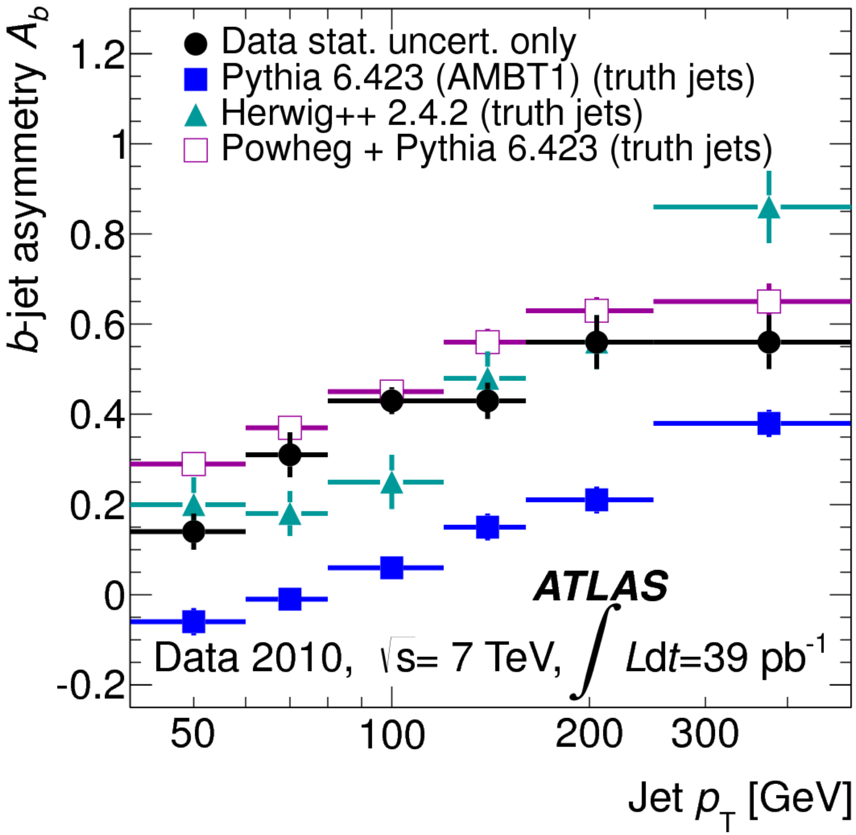
Unfolded fractions compared to MC at particle level

Good data/MC agreement except for BU at high pT

Jet Flavour in Dijet Events

Eur. Phys. J. C (2013) 73:2301

R = 0.4



$$A_b = \frac{N_b^{sub-leading}}{N_b^{leading}} - 1$$

$A_b > 0$: more subleading b-jets in the dijet system
$A_b = 0$ balance between leading and sub-leading
$A_b < 0$ more leading than sub-leading b-jets in the dijet system

A greater number of sub-leading b-jets can be explained by:

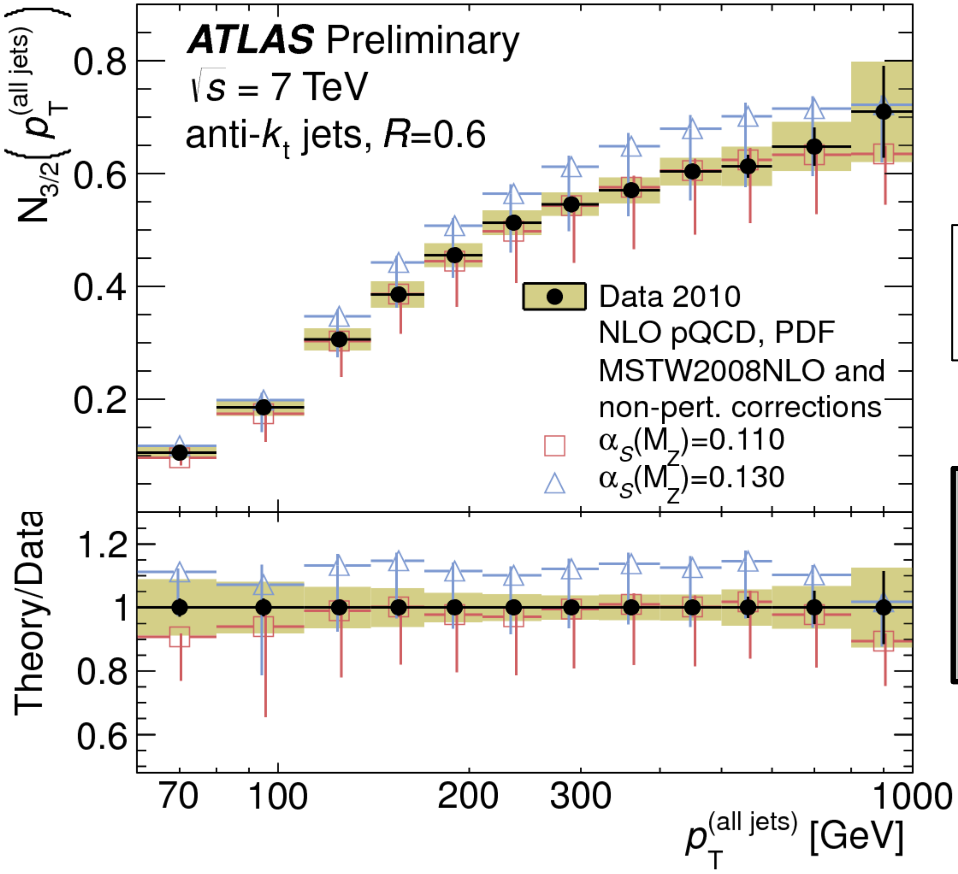
- Semileptonic decays → neutrinos
- Jet Fragmentation (e.g. gluon splitting) can lead to fat jets and parts of the energy can lay outside the jet volume

Powheg (NLO) is able to describe the asymmetry seen in data

Multi Jet Cross Section Ratio

ATLAS-CONF-2013-041

R = 0.6



7TeV 2010 measuerment

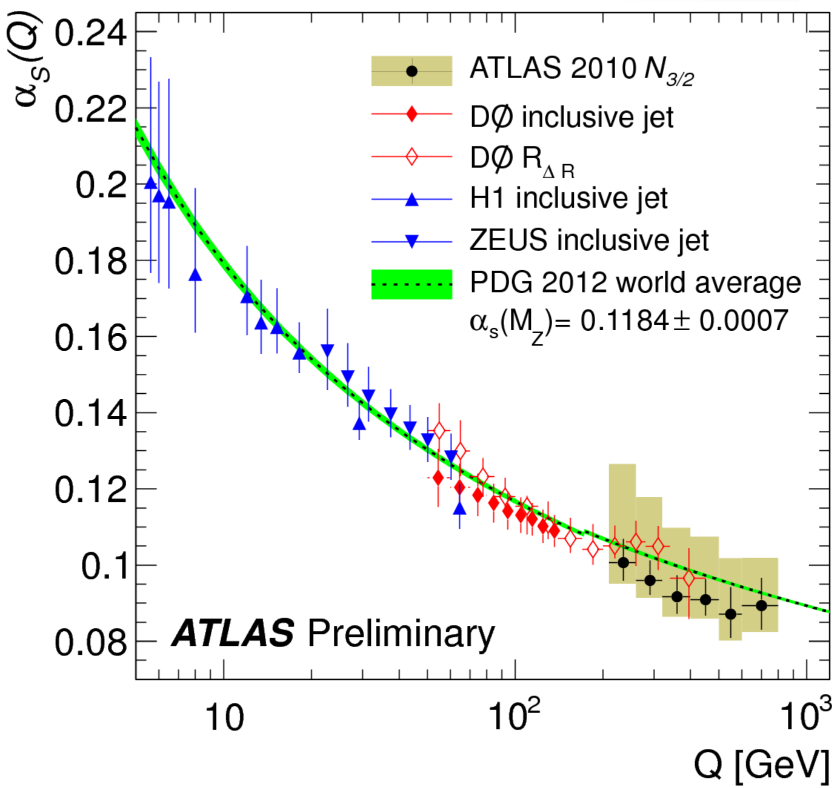
$$N_{3/2}(p_T^{(\text{all jets})}) = \sum_i^{N_{\text{jet}}} \frac{d\sigma_{N_{\text{jet}}\geq 3}}{dp_{T,i}} \Bigg/ \sum_i^{N_{\text{jet}}} \frac{d\sigma_{N_{\text{jet}}\geq 2}}{dp_{T,i}} \sim f(\alpha_s)$$

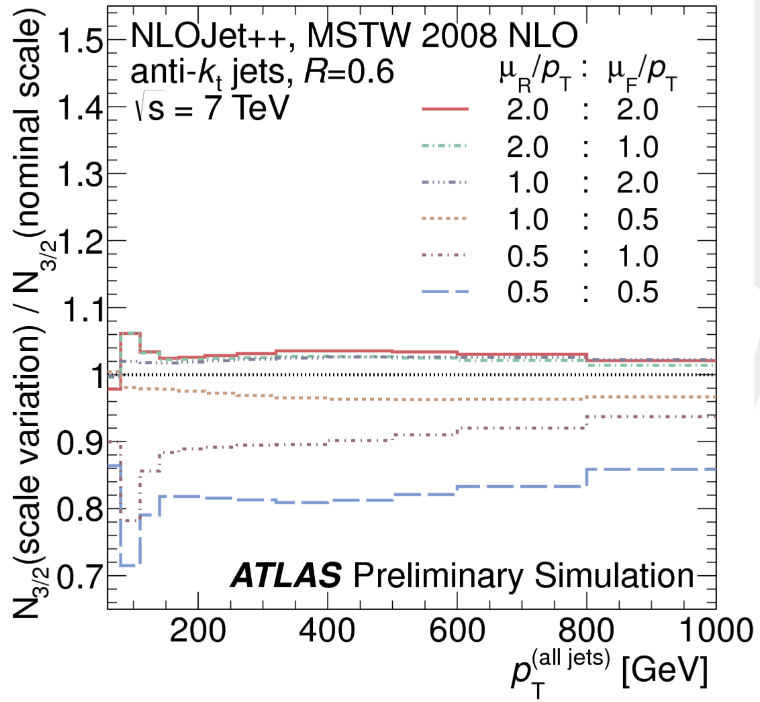
Beside the Benchmark $R_{3/2}$ measurement ATLAS also explores $N_{3/2}$ which turns out to have a smaller dependency of scale choice and theoretical prediction

α_s Measurement

R = 0.6

Using $N_{3/2}$ for α_S extraction due to smaller dependency of scale choice compared to $R_{3/2}$
Measurement of running of α_S < 0.8TeV (good agreement)





$$\alpha_s(M_Z) = 0.111 \pm 0.006(\text{exp.})^{+0.016}_{-0.003}(\text{theory})$$

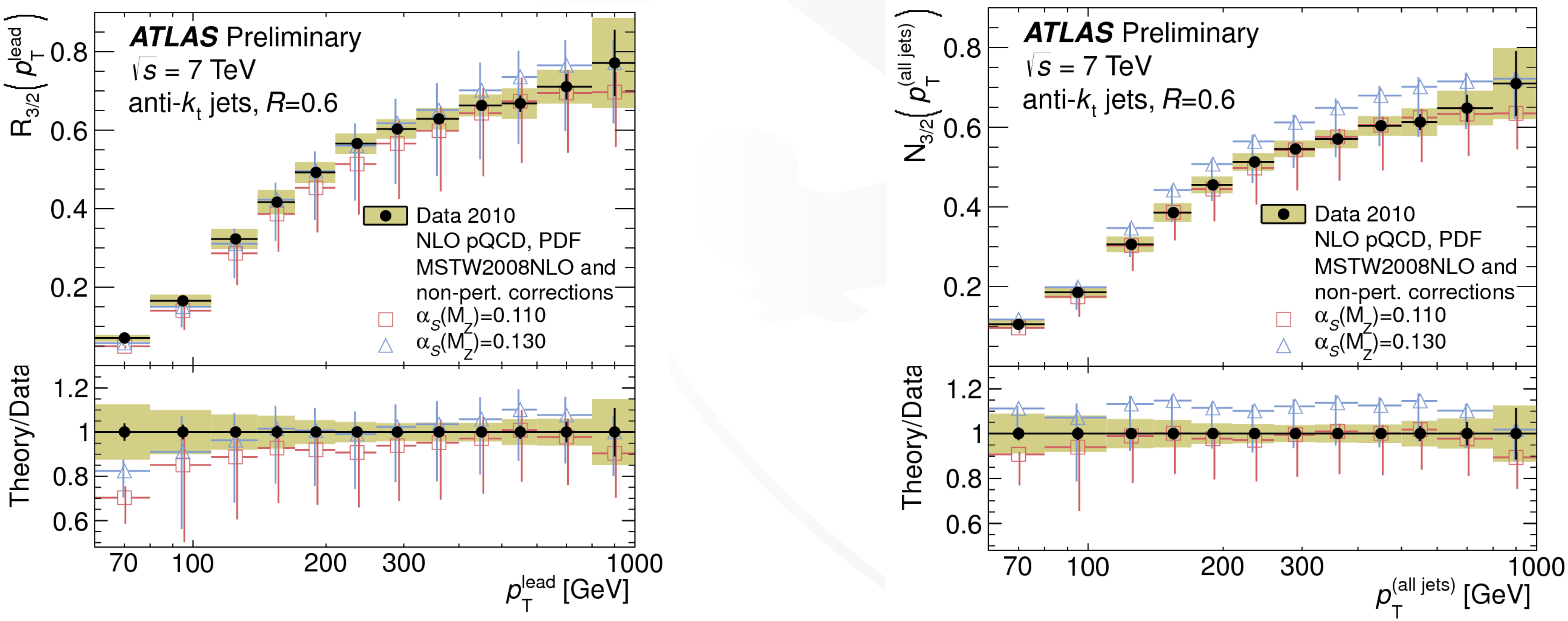
Summary and Conclusion

- Measurements exhibit similar uncertainties to the theoretical predictions
  - Close interaction with theorist to improve both
- Fundamental measurements are probing the SM to unprecedented precision
  - Help improving simulations and detector understanding
- Phase space continues to expand (timescales of ~1year)
  - Yet another example of the great success of ATLAS and the LHC

Multi Jet Cross Section Ratio

$$R_{3/2}(p_T^{lead}) = \frac{d\sigma_{N_{jet}\geq 3}}{dp_T^{lead}} \Big/ \frac{d\sigma_{N_{jet}\geq 2}}{dp_T^{lead}} \sim \alpha_s$$

$$N_{3/2}(p_T^{(all\,jets)}) = \sum_i^{N_{jet}} \frac{d\sigma_{N_{jet}\geq 3}}{dp_{T,i}} \Big/ \sum_i^{N_{jet}} \frac{d\sigma_{N_{jet}\geq 2}}{dp_{T,i}} \sim f(\alpha_s)$$



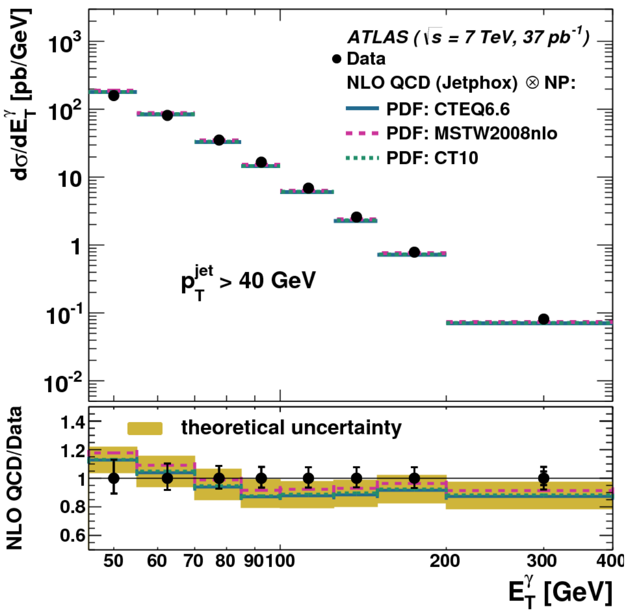
Isolated Photon + Jet Production

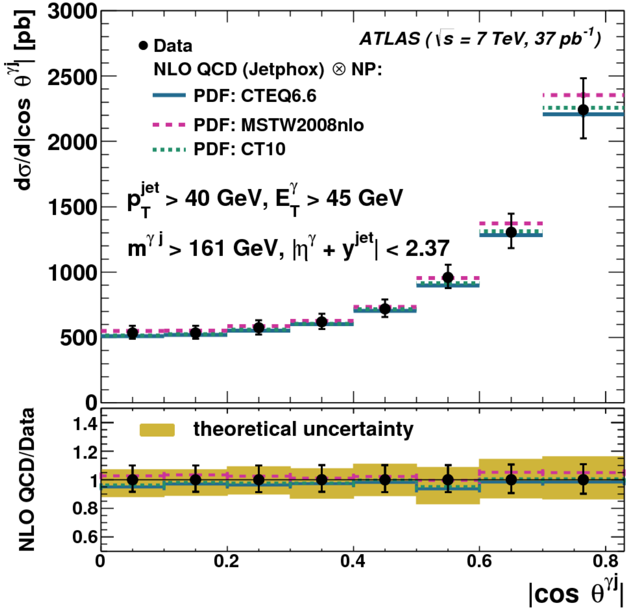
Nucl. Phys. B 875 (2013) 483-535

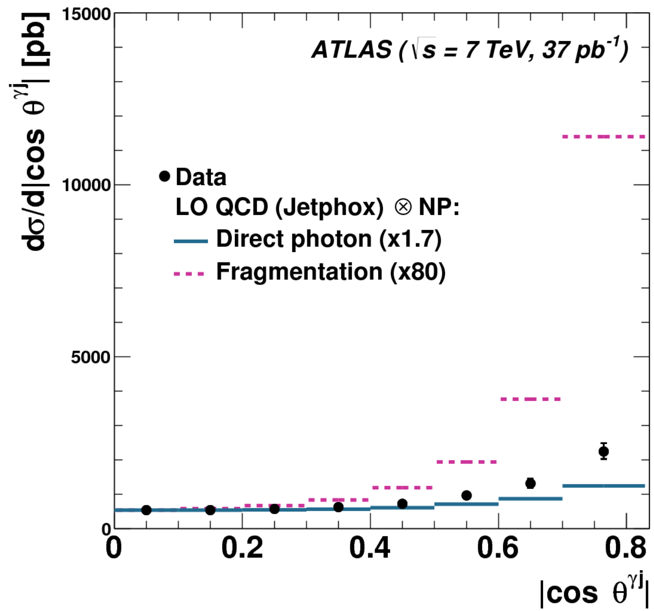
7 TeV 2011 measurement
Comparison to NLO and different PDF

Good agreement between data and NLO prediction

The disagreement could be totally due to different proportions of fragmentation in theory and data







JES uncertainty