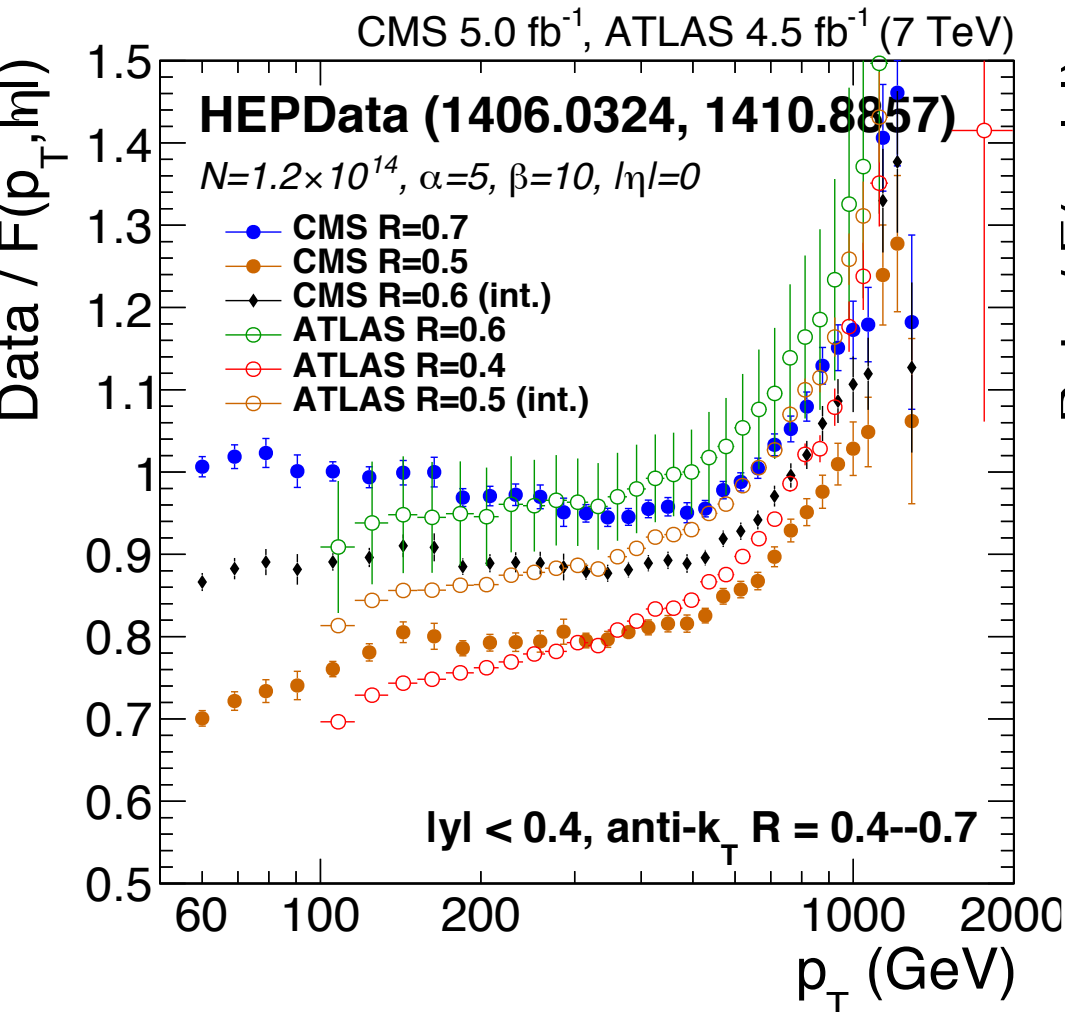


Initial studies on
**LHC combination of
inclusive jet data**
for the LHC Electroweak Working Group
June 13, 2018

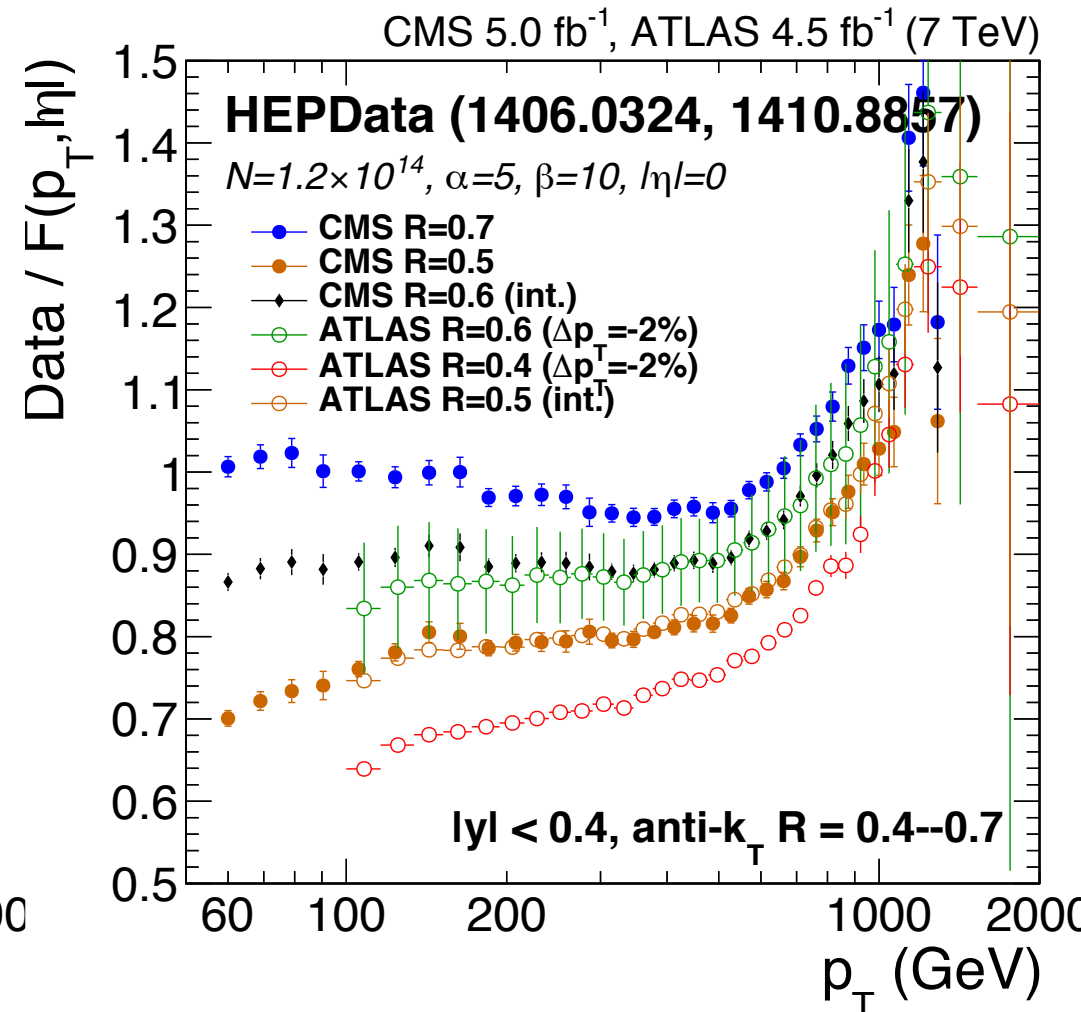
Mikko Voutilainen, U. Helsinki and HIP

- CMS and ATLAS have high quality jet data with $R=0.4, 0.5, 0.6, 0.7$ from 2.76, 7, 8, 13 TeV
- Combining data would reduce uncertainties and provide theorists a coherent reference set
- Benefit **global PDF** fits, understanding of **NNLO** predictions and **R dependence**

nominal



JEC shifted 2%



- Retrieved CMS and ATLAS 7 TeV (2011) data from HEPDATA, with stat and stat \oplus syst
 - uncertainty sources available, but provided a bit differently => adapt to common format
- Interpolated R=0.4/R=0.6 and R=0.5/0.8 to 0.4-0.5-0.6-0.7 spectrum using **log(R)** scaling
 - spectra normalised by $F(p_T, \eta) = \iint N p_T^\alpha (1 - 2p_T \cosh(\eta)/\sqrt{s})^\beta dp_T d\eta$ for plotting
- JEC uncertainty by far dominant => start by bracketing CMS/ATLAS difference as ΔJEC
 - known issues: FSR in p_T balance vs MPF, detector response vs p_T , Pythia6/8 vs Herwig++
 - can also check ΔJEC with published in-situ W mass constraints in ttbar

HEPData Search HEP Data

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Measurement of the inclusive jet cross-section in proton-proton collisions at $\sqrt{s} = 7$ TeV using 4.5 fb⁻¹ of data with the ATLAS detector

The ATLAS collaboration

Aad, Georges , Abbott, Brad , Abdallah, Jalal , Abdel Khalek, Samah , Abdinov, Ovsat , Aben, Rosemarie , Abi, Babak , Abolins, Maris , AbouZeid, Ossama , Abramowicz, Halina

JHEP 1502 (2015) 153, 2015

<http://dx.doi.org/10.17182/hepdata.69343>

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Table 1

Data from Table 3

10.17182/hepdata.69343.v1/t1

Measured double-differential inclusive-jet cross section for the range 0.0 <= |y| < 0.5 and for anti-kT jets with radius parameter...

Table 2

Data from Table 4

10.17182/hepdata.69343.v1/t2

Measured double-

HEPData Search "10.1007/JHEP02(2015)153"

Browse all Chatrchyan, Serguei et al.

Measurement of the ratio of inclusive jet cross sections using the anti-k_T algorithm with radius parameters R=0.5 and 0.7 in pp collisions at $\sqrt{s} = 7$ TeV

The CMS collaboration

Chatrchyan, Serguei , Khachatryan, Vardan , Sirunyan, Albert M , Tumasyan, Armen , Adam, Wolfgang , Bergauer, Thomas , Dragicevic, Marko , Erö, Janos , Fabjan, Christian , Friedl, Markus

Phys.Rev. D90 (2014) 072006, 2014

<http://dx.doi.org/10.17182/hepdata.68020>

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Table 1

Data from Figure 1a

10.17182/hepdata.68020.v1/t1

Inclusive Jet cross section with R=0.5 in the rapidity bin 0 < |y| < 0.5. The total uncorrelated...

Table 2

Data from Figure 1a

10.17182/hepdata.68020.v1/t2

Inclusive Jet cross section with R=0.5 in the rapidity bin 0.5 < |y| < 1. The total

HEPData About Sub

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Table 1 10.17182/hepdata.68020.v1/t1 <http://www.hepdata.net/recc>

Data from Figure 1a

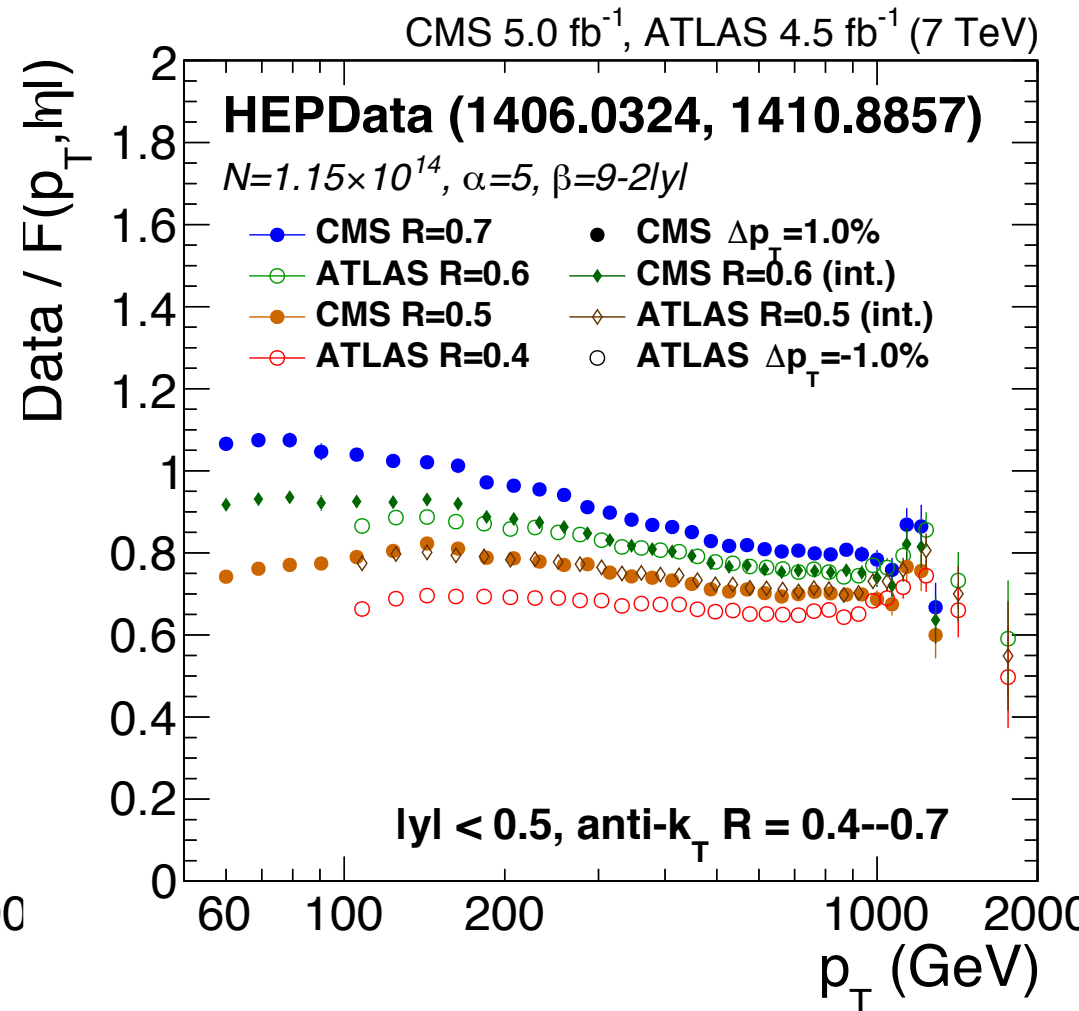
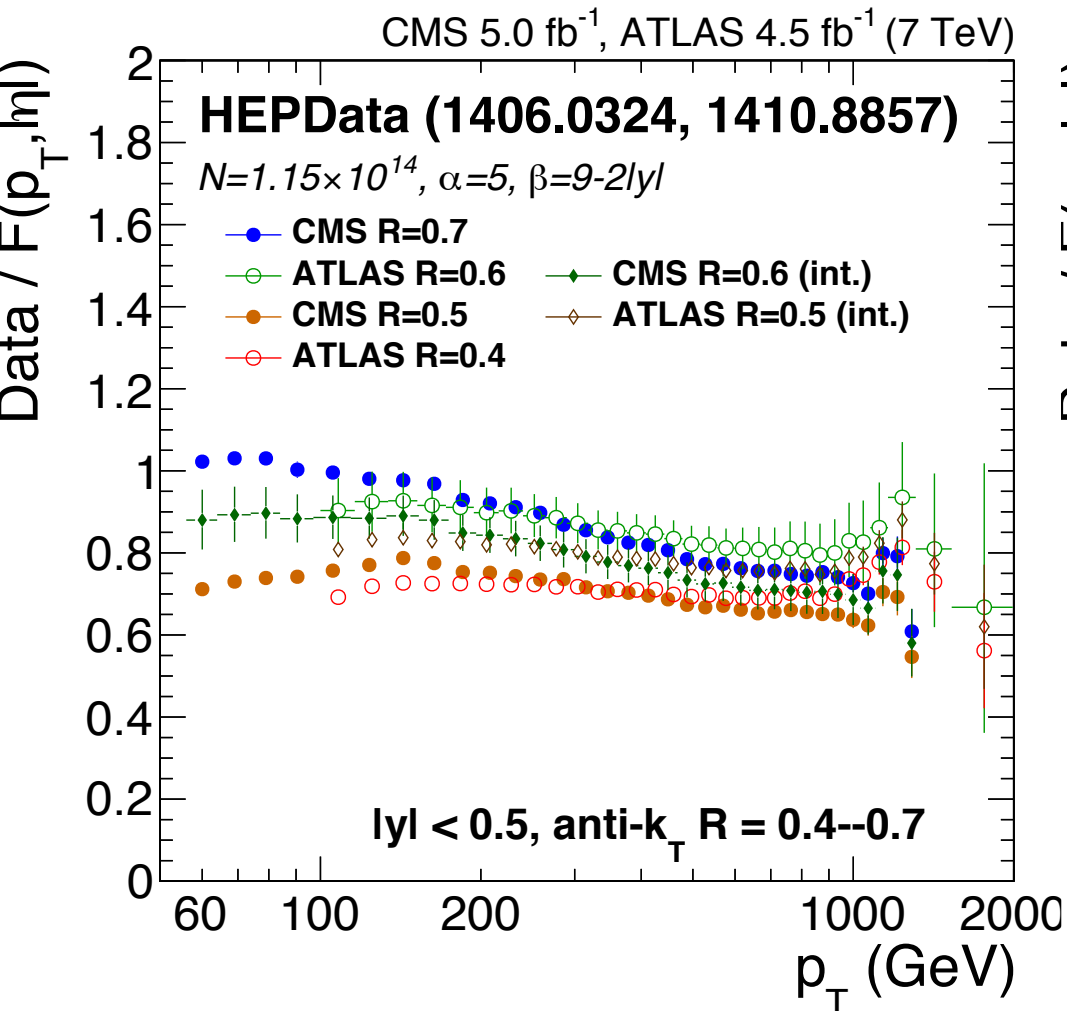
Inclusive Jet cross section with R=0.5 in the rapidity bin 0 < |y| < 0.5. The total uncorrelated uncertainty includes statistical one and systematic uncorrelated. The total systematic uncertainty includes all other sources, especially the luminosity uncertainty of 2.2%. The total error can be obtained as a quadratic sum of uncorrelated and correlated one. The NP correction can be used to scale theory prediction to compare to data at particle level.

cmenergies 7000.0

observables D2SIG/DPT/DYRAP

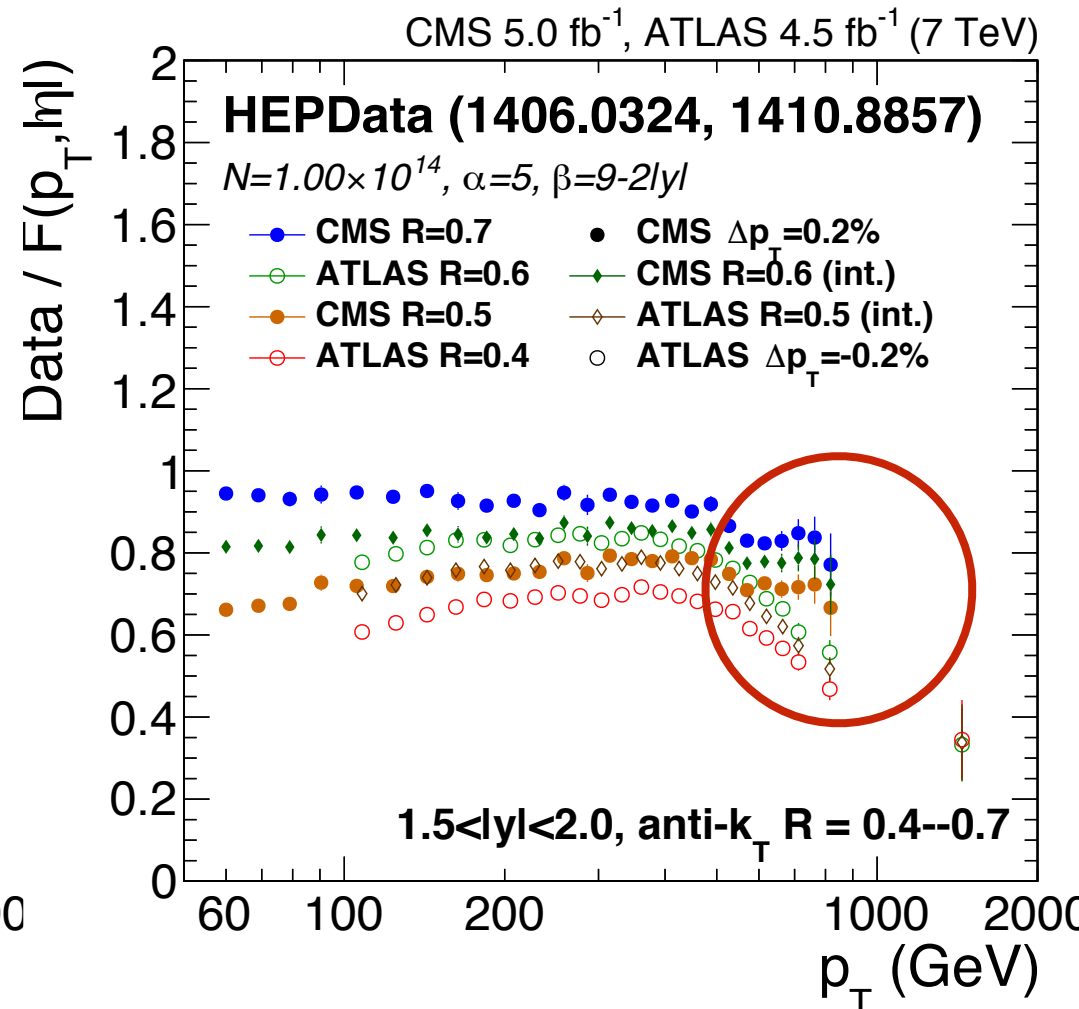
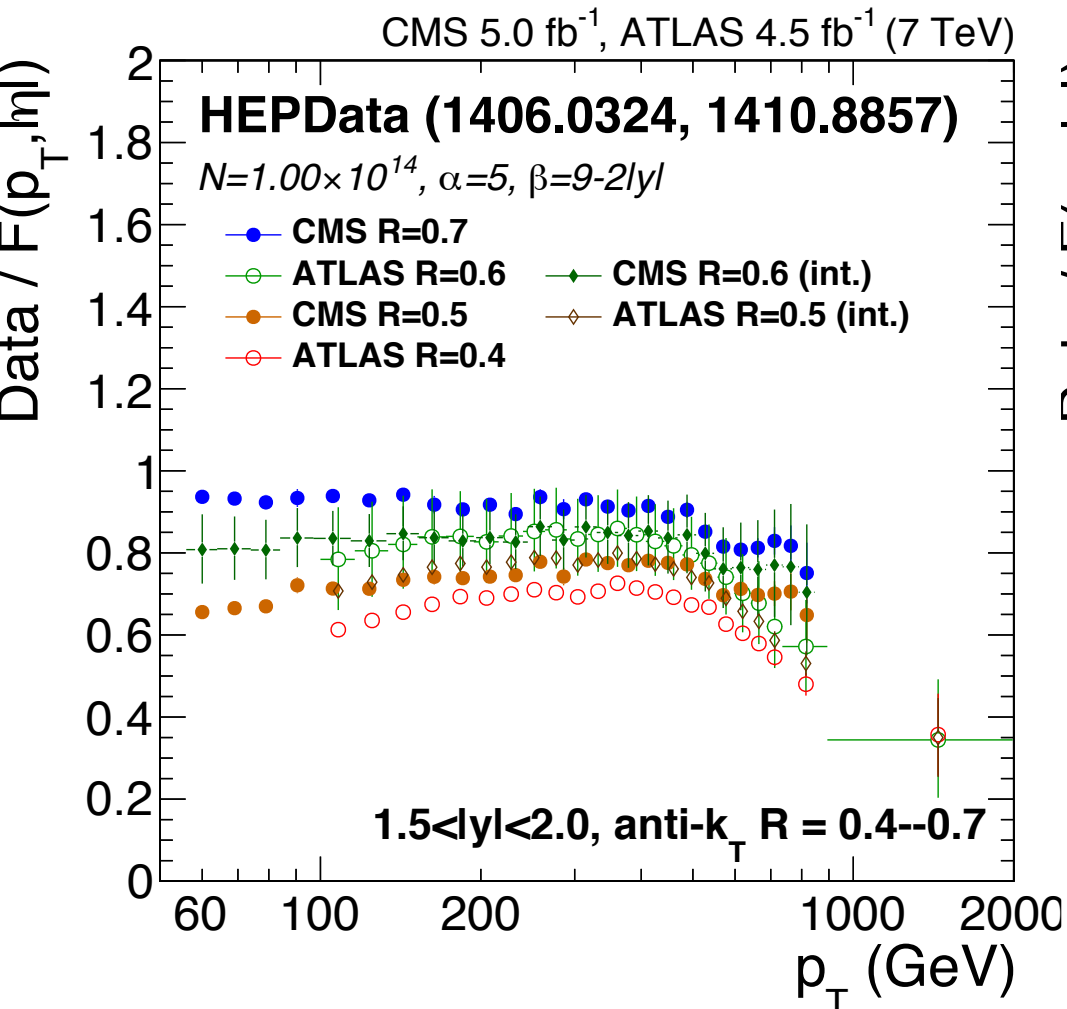
phrases Inclusive, Double Differential, Transverse, Rapidity Dependence

- Central rapidity in quite good agreement after CMS +1%, ATLAS -1%
- Possibly tracked down to:
 - ▶ ATLAS FSR bias (p_T balance method used instead of MPF)
 - ▶ CMS p_T dependence (const fit due to lack of multijet and γ +jet statistics)



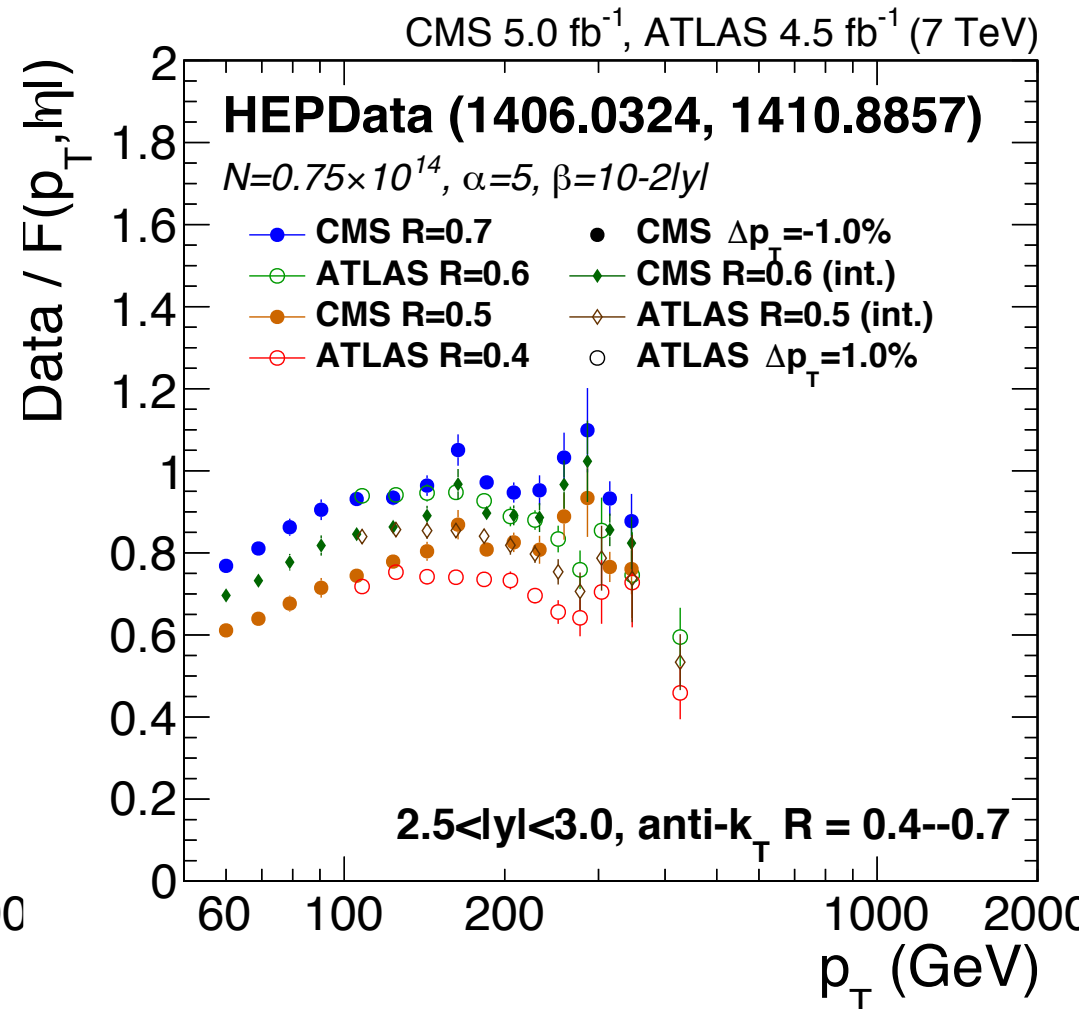
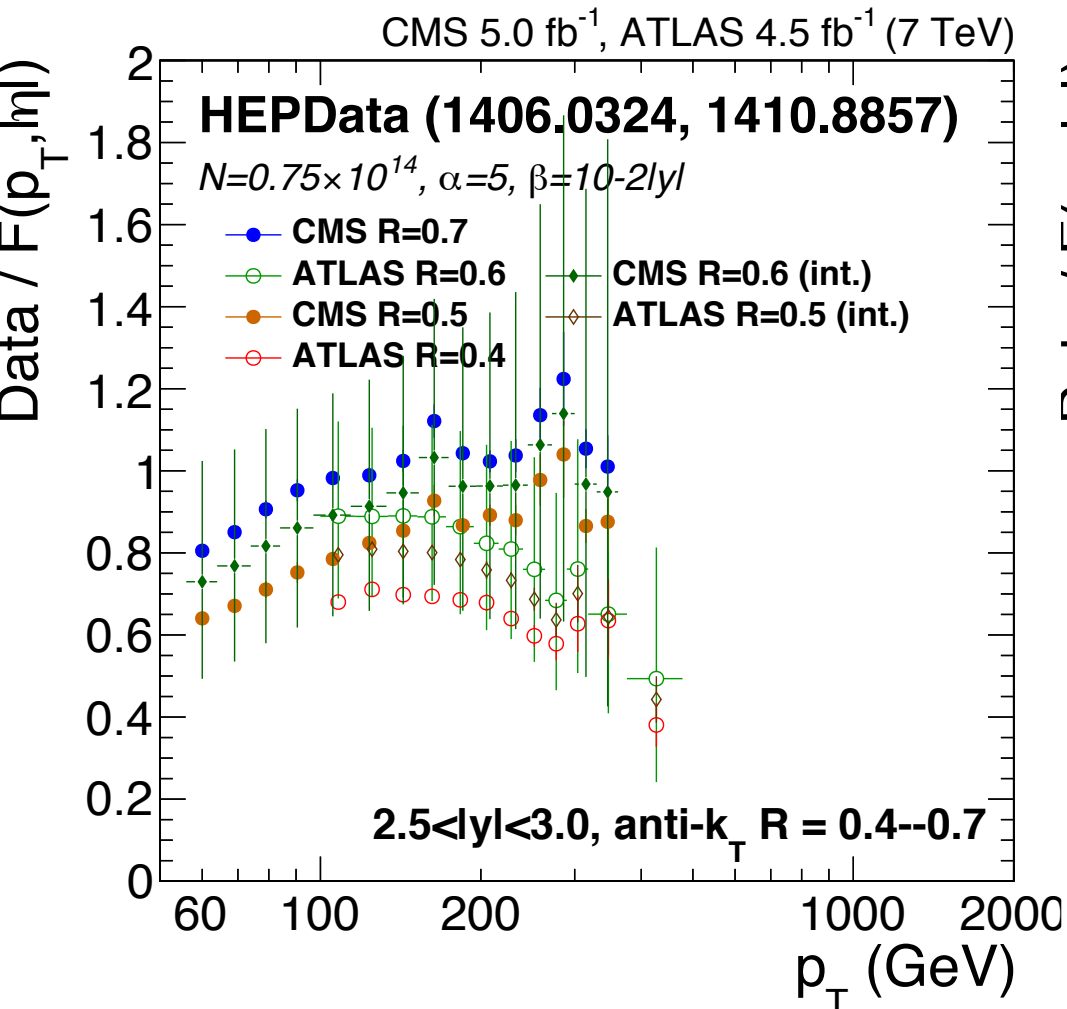
1.5 < |y| < 2.0

- Mid-rapidity $1.5 < |y| < 2.0$ has big shape different at $p_T > 500$ GeV
- Outside of direct $Z/\gamma + \text{jet}$ reach, in barrel/endcap transition \Rightarrow detector effect (JEC/JER)?
- Global PDF fits have had large χ^2/NDF for ATLAS data, could this $|y|$ bin be the reason?

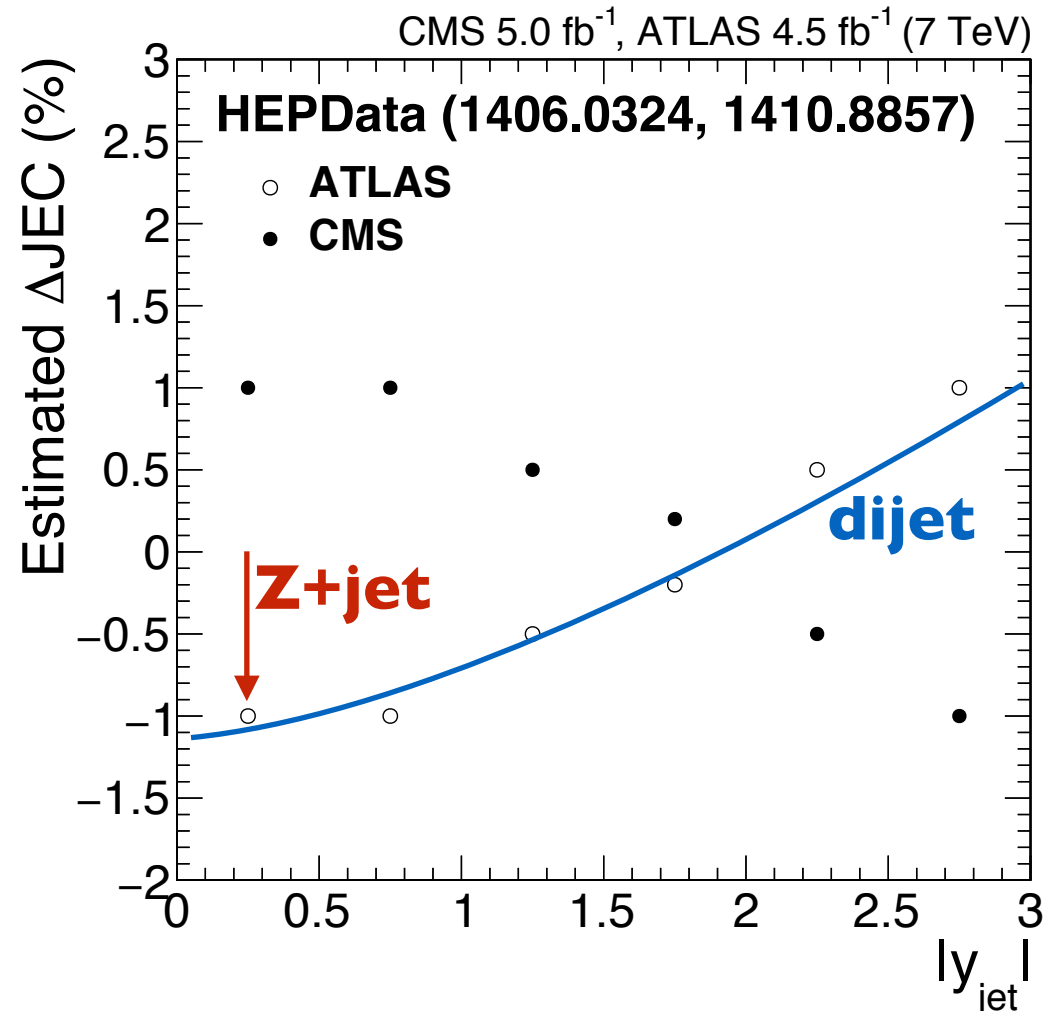
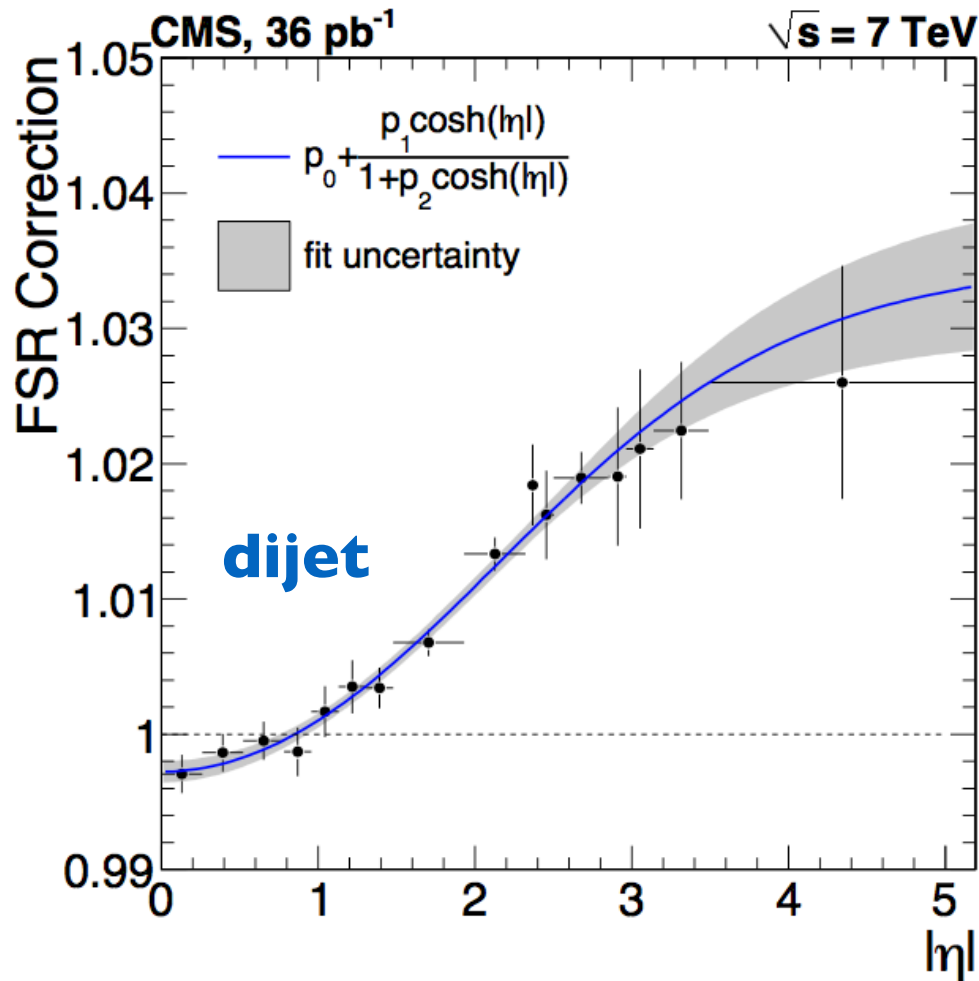
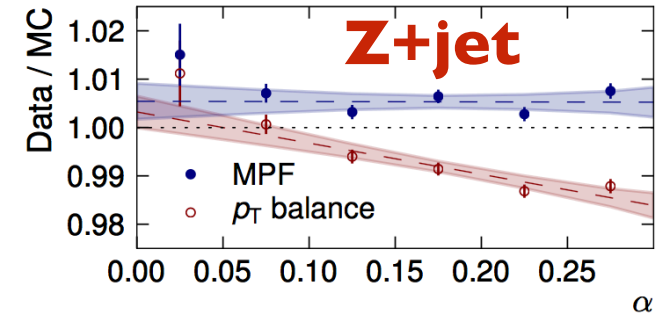


2.5 < |y| < 3.0

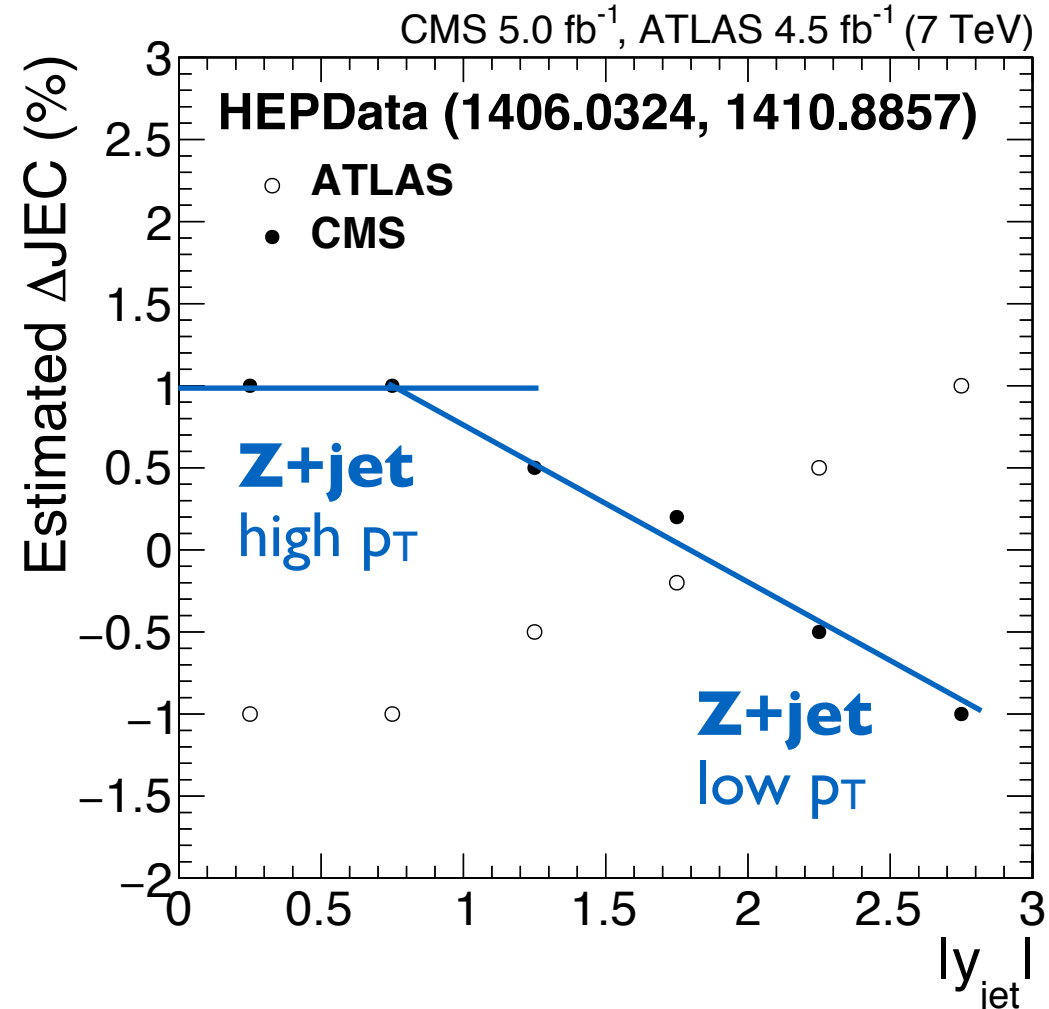
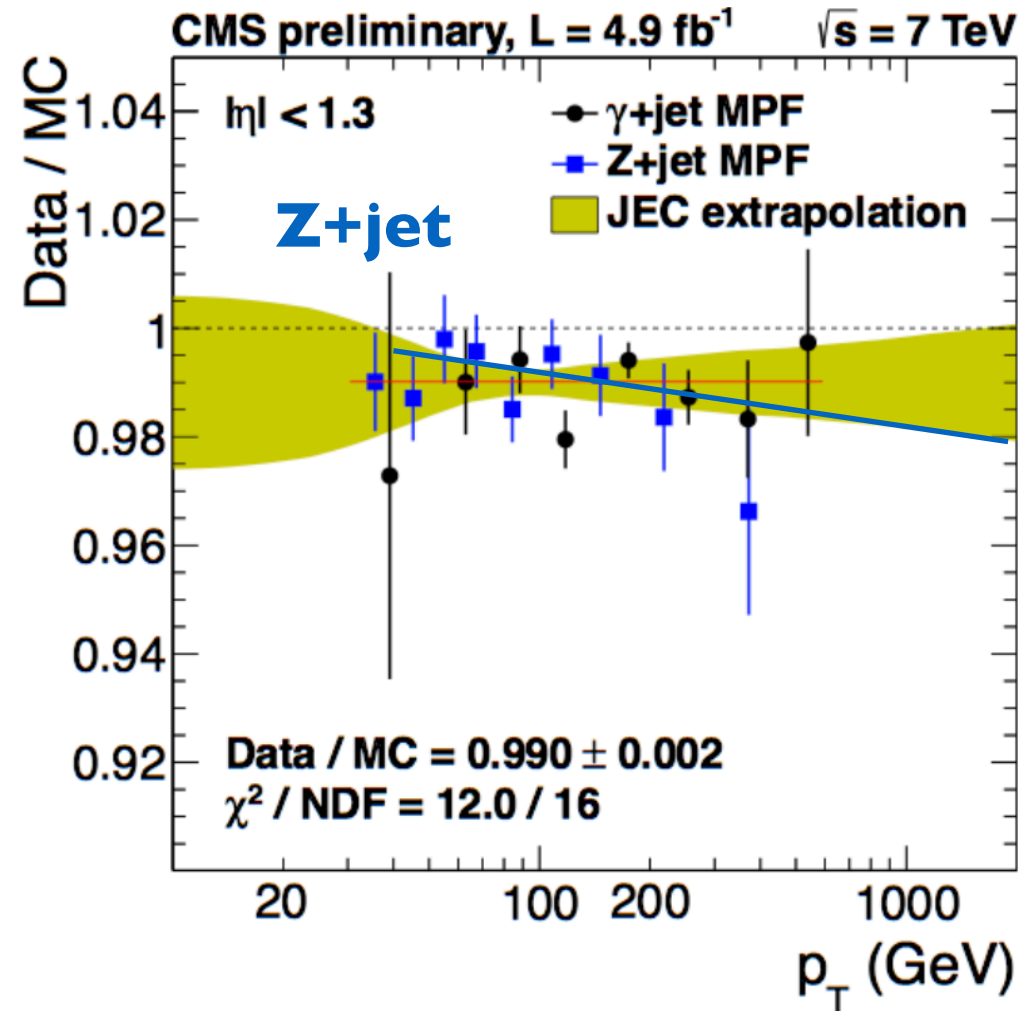
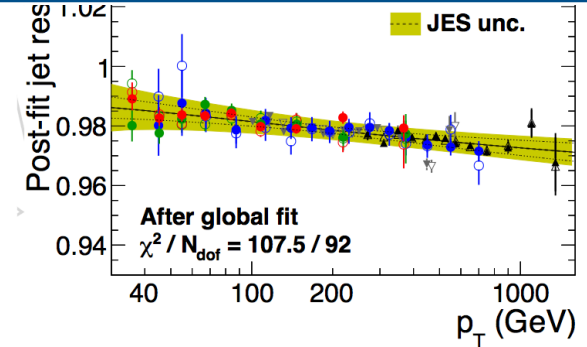
- Forward rapidity 2.5 < |y| < 3.0 in decent agreement, given large uncertainties
- $p_T \sim 200$ GeV compatible with CMS -1%, ATLAS +1%



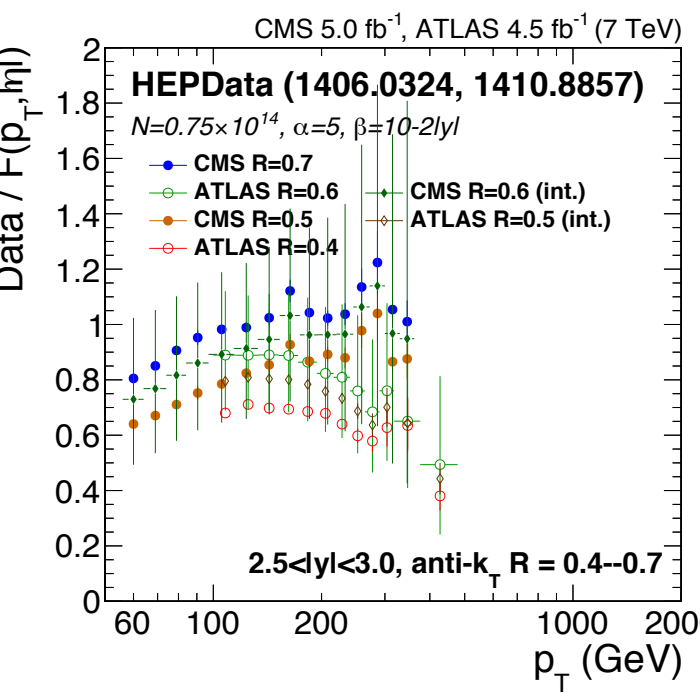
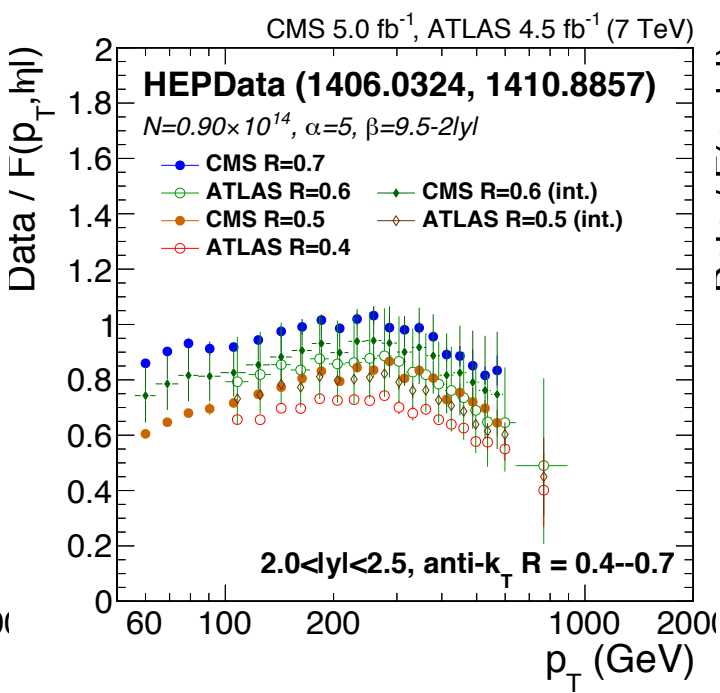
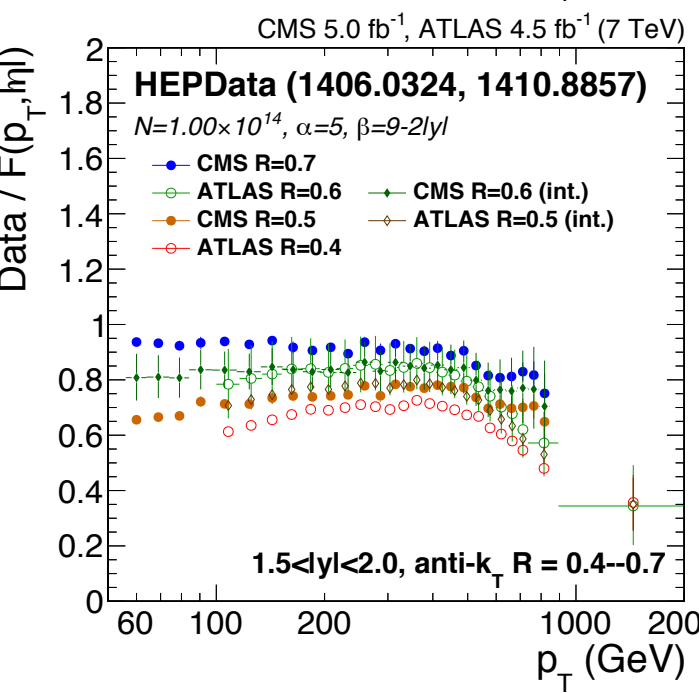
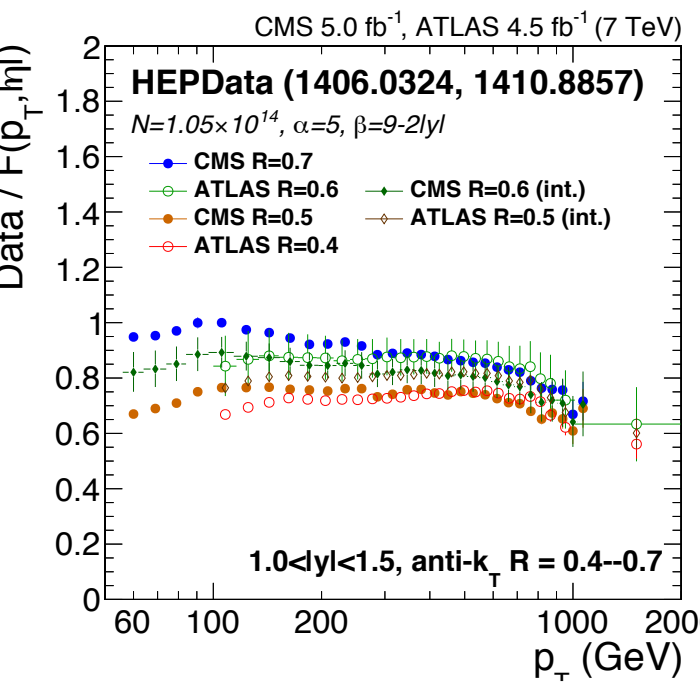
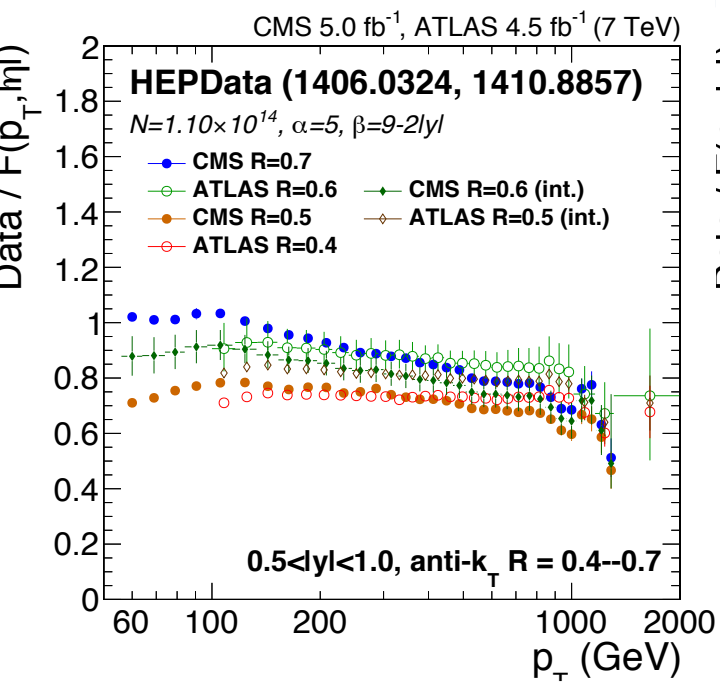
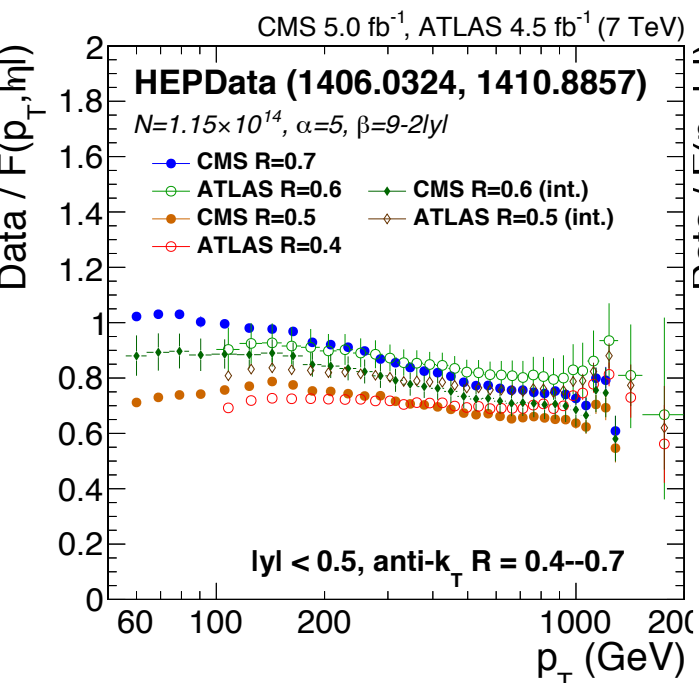
- Estimated Δ JEC as symmetric between CMS and ATLAS
- ATLAS results fit hypothesis of residual FSR bias
 - ▶ CMS used MPF, while ATLAS used p_T balance at 7 TeV
 - ▶ -1% from Z+jet, +0% ($|\eta|=0$) to +2% ($|\eta|=3$) from dijet

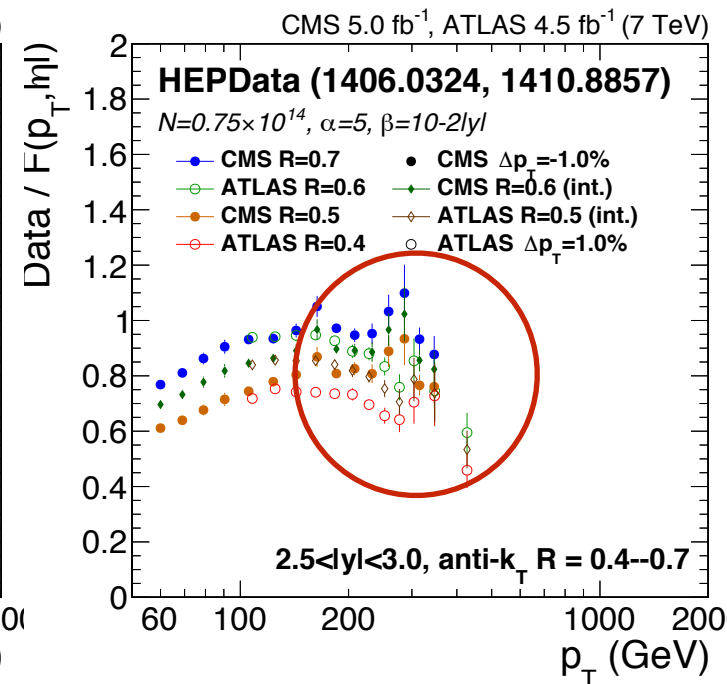
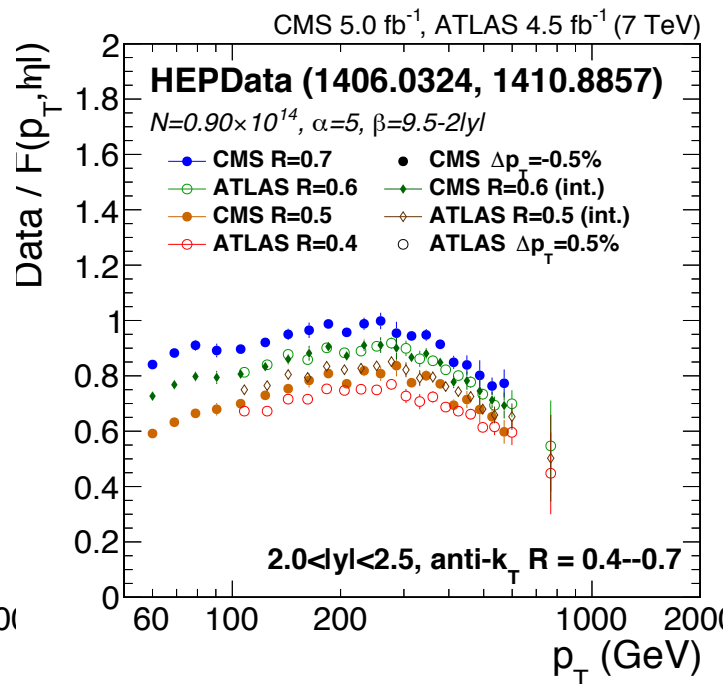
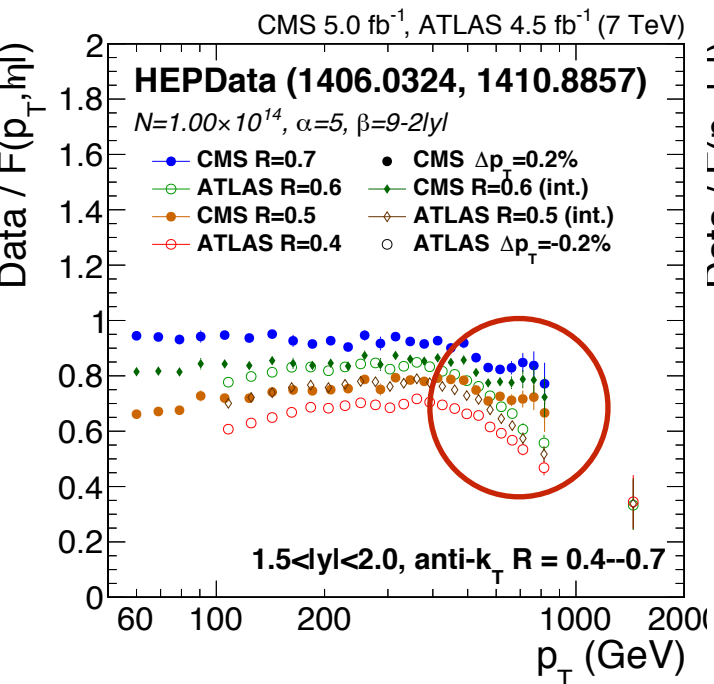
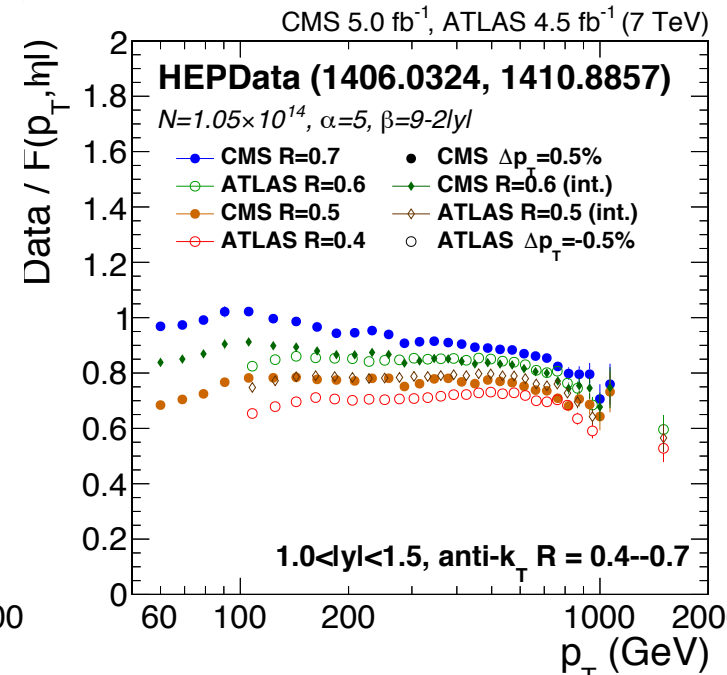
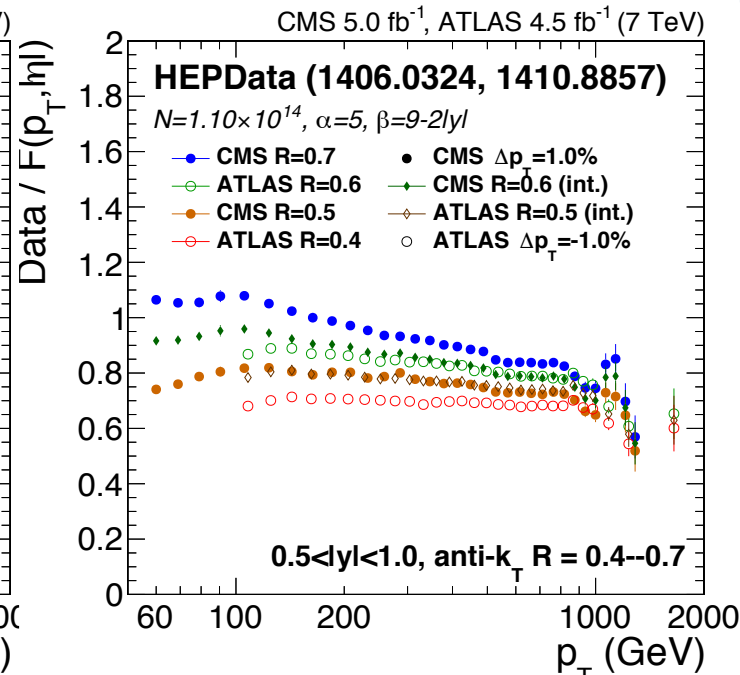
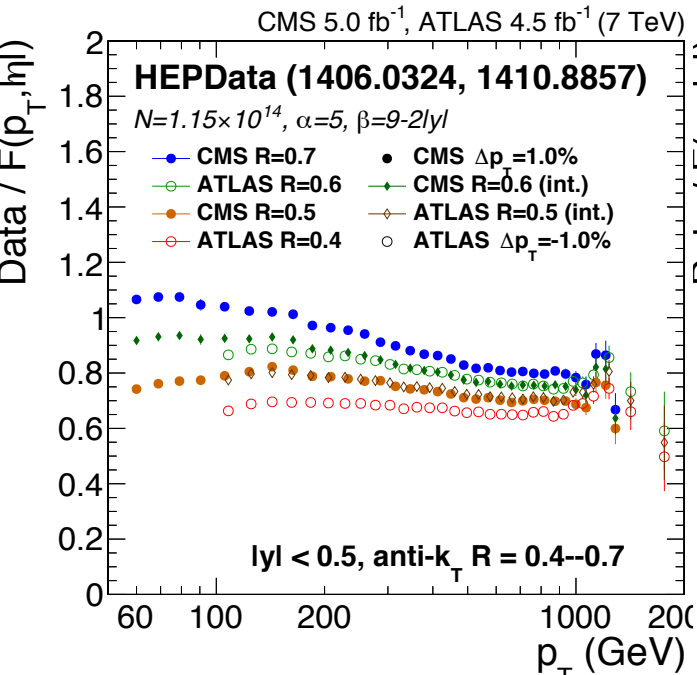


- Estimated Δ JEC as symmetric between CMS and ATLAS
- CMS results fit hypothesis of residual Z+jet p_T dependence
 - ▶ 8 TeV data showed slope vs p_T , not enough statistics at 7 TeV
 - ▶ dijet balance: low $|y| \Leftrightarrow$ high p_T , high $|y| \Leftrightarrow$ low p_T

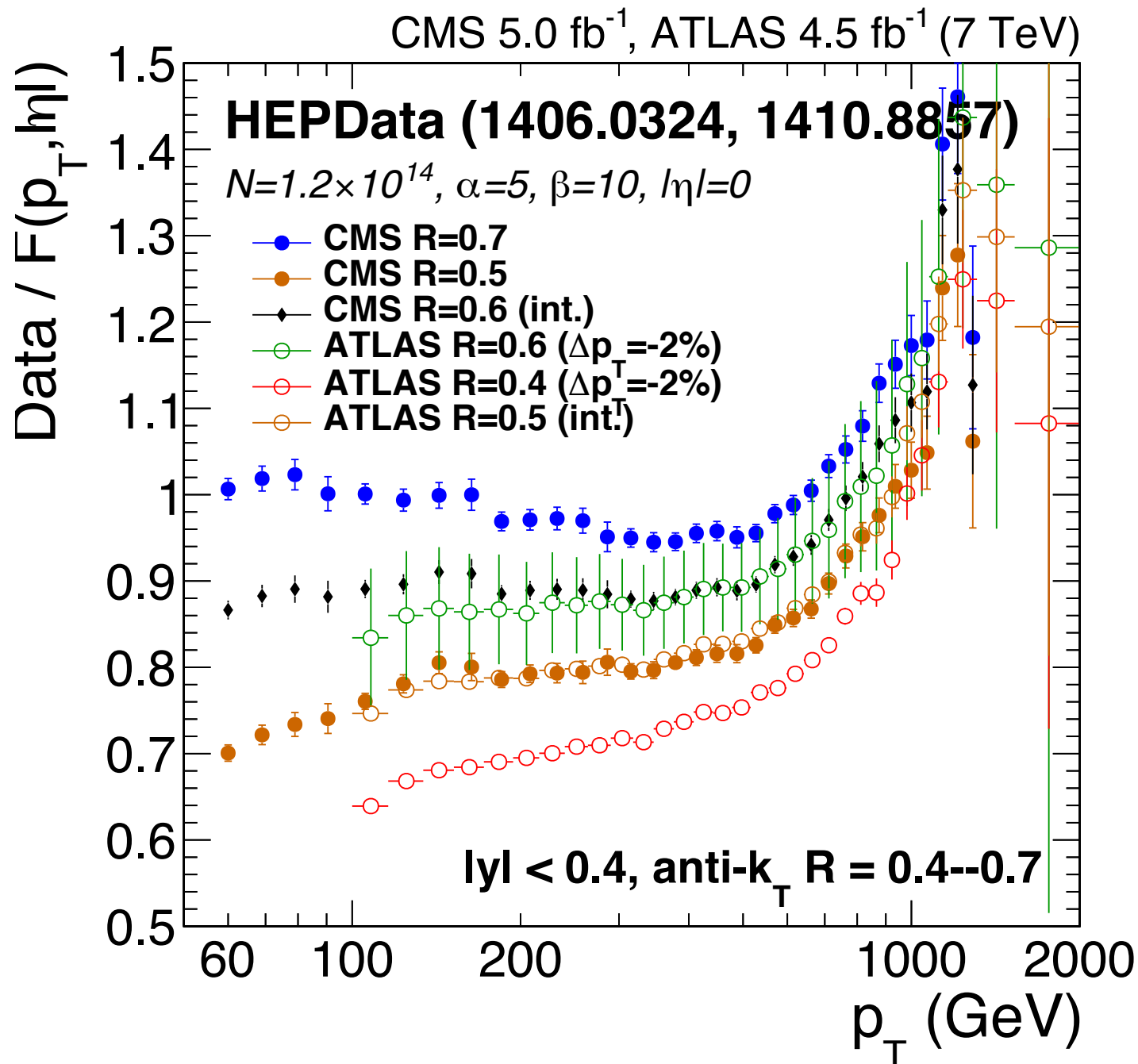


All $|\eta|$ bins: before





- Combination of 7 TeV data looks feasible
 - ▶ R difference by $\log(R)$ interpolation
 - ▶ p_T bin difference by $F(p_T, \eta)$ interpolation
 - ▶ $d\sigma/dp_T$ difference by “known” JEC biases
- Systematic uncertainties similar, uncorrelated case would be $1/\sqrt{2} = 70\%$
- Anti-correlation could reduce syst. even further
 - ▶ ATLAS limit FSR (?) (p_T balance vs MPF)
 - ▶ CMS limit JEC p_T dep. (PF vs Calo)



- Next step is to add nuisances and do χ^2 fit
 - ▶ investigate also 8 TeV data as available
- FSR bias and JEC vs p_T possible differences
 - ▶ back-propagate lessons from 8 and 13 TeV?
 - ▶ derive joint CMS/ATLAS FSR corrections?

