In Situ Measurements of Jet Energy Scale in ATLAS

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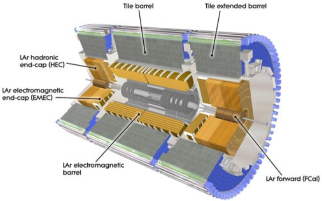
Physics in Collisions 2011 - Vancouver

Introduction

- the jet energy scale strongly dependent on details of ATLAS calorimetry, but these will not be discussed here
- see *2008 JINST 3 S08003* for details of the ATLAS detector, if interested



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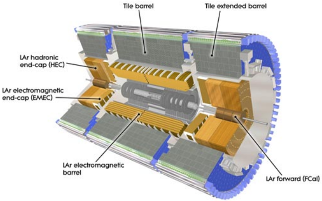
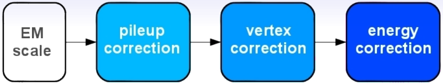


- this presentation: **jet energy scale derived from 7 TeV collision data**, also using input from 2004 combined testbeam (CTB) and 900 GeV data
- **focus for the scale is on robustness**
  - resolution improvements with offline compensation techniques have recently arrived in ATLAS
  - overall uncertainty will continue to shrink as γ + jet, multi-jet and track-jet *in situ* techniques mature, and as data accumulates

EM+JES Scheme



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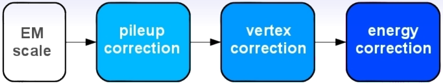

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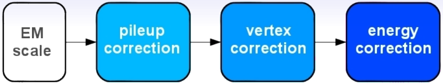

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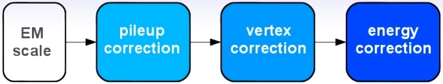

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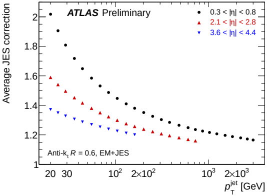
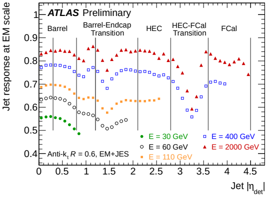
Finally, a Monte Carlo based **energy correction**, $C(E, \eta)$, is applied that corrects to the particle level, within $\pm 2\%$[a]





[a] See extra slides for more details on the procedure for extracting these corrections from the Monte Carlo.

Evaluating the EM+JES

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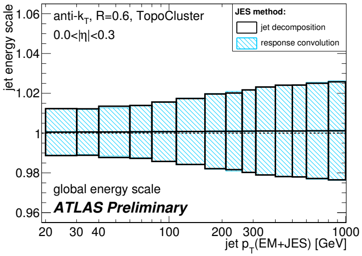
in situ measurement	JES uncertainty component
E/p single particle response	**central calorimeter response**
dijet relative calibration	extrapolation to endcap and forward region
$\langle E \rangle_{tower}$ & track-jets	multiple interactions

In Situ Results:



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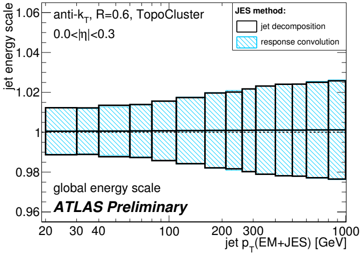

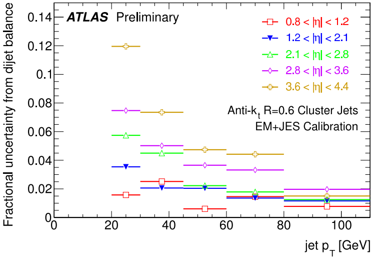

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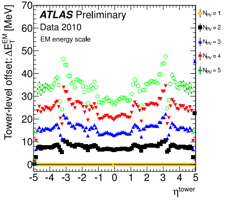
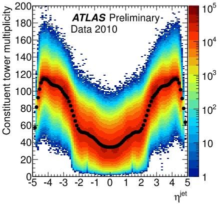
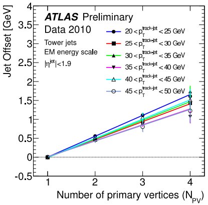
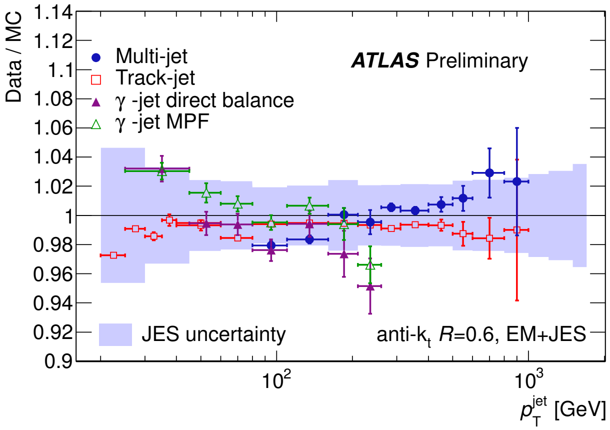






JES Summary


Data / MC
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
Multi-jet
Track-jet
γ -jet direct balance
γ -jet MPF
ATLAS Preliminary
JES uncertainty
anti-k_t R=0.6, EM+JES
10^2
10^3
p_T^{jet} [GeV]

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1. using a scheme based on single particle response, ATLAS has developed a defensible 3% uncertainty on the jet energy scale in the central barrel region

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3. local calibration scheme has been commissioned
   - results for local and sequential schemes already tested at jet level, and show good resolution improvement

EXTRA SLIDES

References

1. *Jet energy scale and its systematic uncertainty in proton-proton collisions at sqrt(s)=7 TeV in ATLAS 2010 data*, **ATLAS-CONF-2011-032**, 22 March 2011
2. *Determination of the ATLAS jet energy measurement uncertainty using photon-jet events in proton-proton collisions at sqrt(s) = 7 TeV*, **ATLAS-CONF-2011-031**, 18 March 2011
3. *In-situ jet energy scale and jet shape corrections for multiple interactions in the first ATLAS data at the LHC*, **ATLAS-CONF-2011-030**, 22 March 2011
4. *Probing the jet energy measurement at the TeV-scale with the multi-jet balance technique in proton-proton collisions at sqrt(s)=7 TeV with the ATLAS detector*, **ATLAS-CONF-2011-029**, 16 March 2011
5. *ATLAS Calorimeter Response to Single Isolated Hadrons and Estimation of the Calorimeter Jet Scale Uncertainty*, **ATLAS-CONF-2011-028**, 20 March 2011
6. *In-situ pseudorapidity intercalibration for evaluation of jet energy scale uncertainty using dijet events in proton-proton collisions at sqrt(s) = 7 TeV*, **ATLAS-CONF-2011-014**, 10 March 2011

Ingredients & Definitions

The goal of the JES calibration is to correct E and $\vec{p}$ of jets measured in the calorimeter to the corresponding truth reference jets.

Ingredients

- response non-compensation ($e/h > 1.3$ in ATLAS)
- inactive regions, leakage, and punch through
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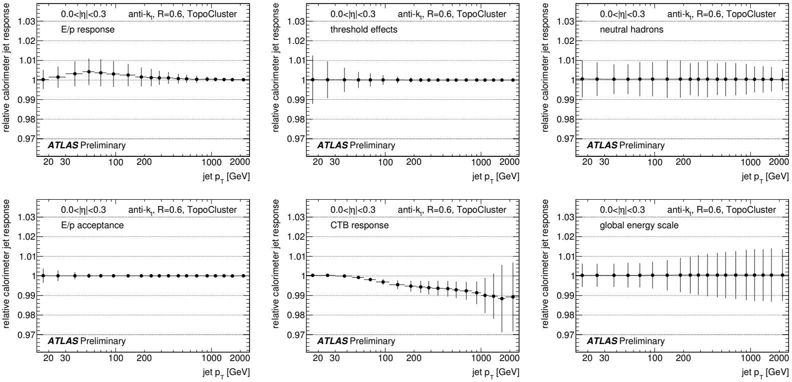
Definitions

- the JES is defined for a particular class of "nominal" jets[a]:
  - in QCD dijet events (mostly jets from gluons)
  - isolated jets: $\Delta R(jet_i, jet_{j \neq i}) > 2.0$
  - nominal pileup scenario: $N_{PV} = 1$
- and with respect to a particular truth reference:
  - jets from final state, stable particles[b] excepting μ's and ν's
  - matched to measured jets in $\Delta R < 0.3$

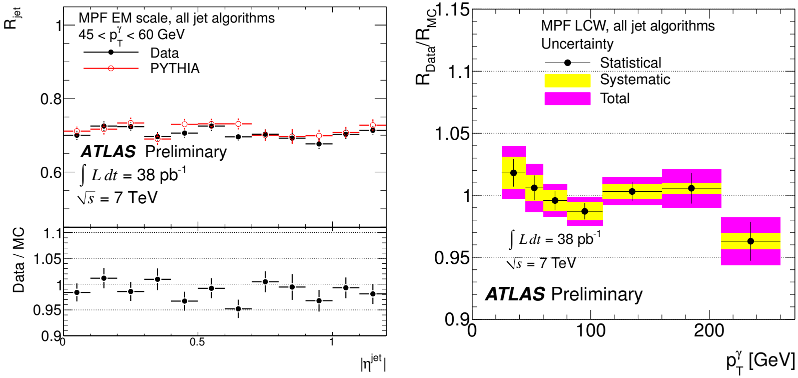
[a] unless otherwise specified, all results shown are for jets defined with the anti-k_T algorithm[?], with a width parameter $D = 0.6$, built from 4/2/0 topological clusters

[b] stable is defined as $\tau > 10$ ps

Components of JES Uncertainty from Single Particle Response



Extra Plots



Validating JES in η with MPF (left) and other calibration scheme, based on local hadronic response correction (right).