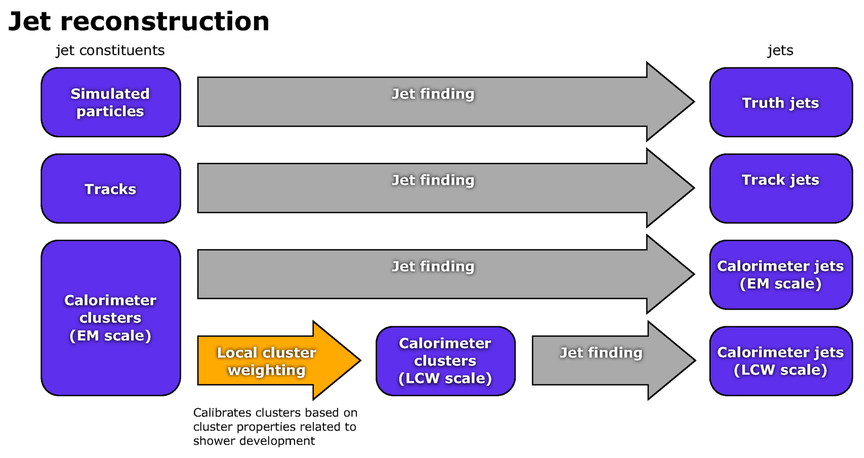
LHCC Poster Session - CERN, 4 March 2015

Determination of the Jet Energy Scale and Jet Energy Resolution using data collected by the ATLAS detector in 2012

Jets are collimated sprays of hadrons coming from the fragmentation of quarks and gluons. They are formed from topologically related energy deposits in calorimeter cells (topo-clusters). The input topo-clusters can be calibrated either at the electromagnetic scale (**EM**) or with the local cluster weighting scheme (**LCW**), which tries to correct for the differences between electromagnetic and hadronic shower responses. Further corrections are applied in multiple steps using techniques driven by both Monte Carlo simulations and data. The Jet Energy Scale(**JES**) and Resolution(**JER**), and corresponding uncertainties are then evaluated.



Origin correction → Pileup correction → MC JES calibration → Global sequential calibration → In-situ calibration

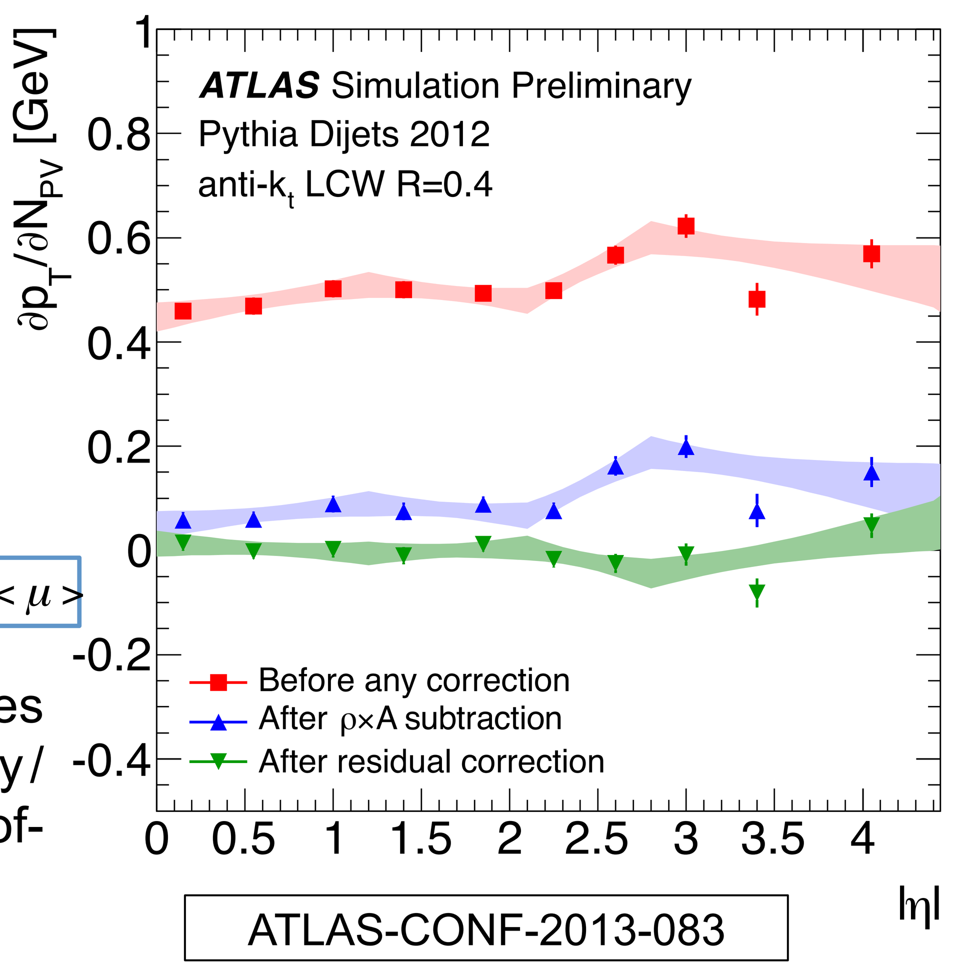
Jet calibration chain in ATLAS

Pileup correction

Jet Areas correction estimates the pileup density and corrects the jet according to its area, significantly reducing the effect of pile-up fluctuations and improving the jet energy resolution.

$$p_T^{corr} = p_T - \rho \bullet A_T - \alpha \bullet (N_{PV} - 1) - \beta \bullet \langle \mu \rangle$$

Residual correction takes into account topology/threshold effects, and out-of-time pileup effects.



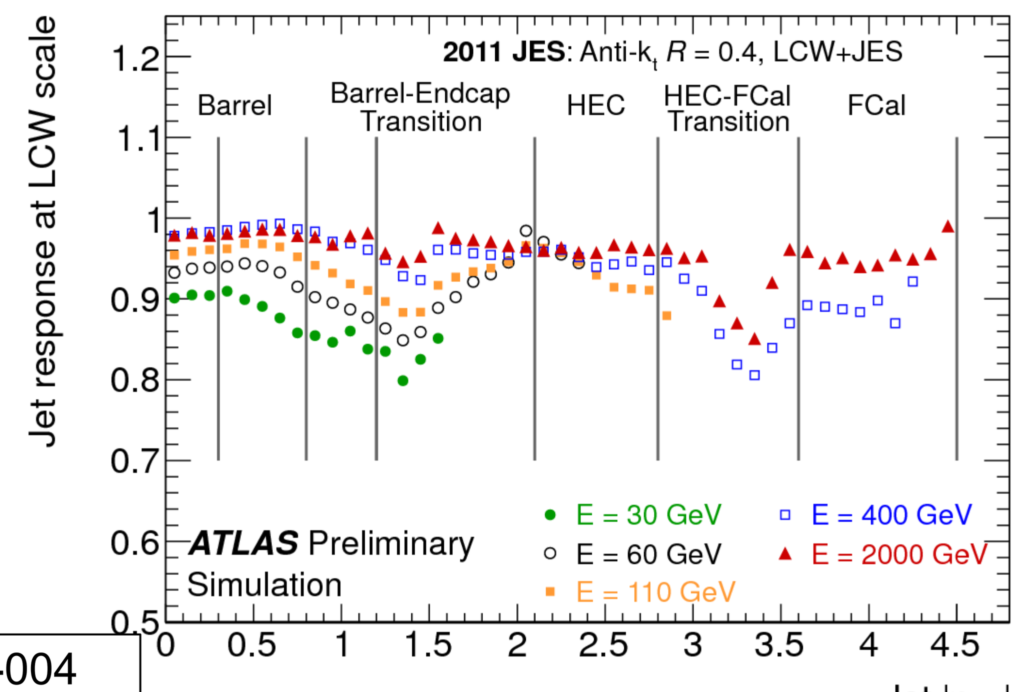
ATLAS-CONF-2013-083

Origin correction

A correction to the calorimeter jet direction is applied that makes the jet point back to the primary event vertex instead of the center of the ATLAS detector.

Monte Carlo Jet Energy Scale Calibration

The **JES** calibration corrects for detector effects that bias the jet energy measurement, such as noncompensation, energy leakage outside of jet cone, and dead material.



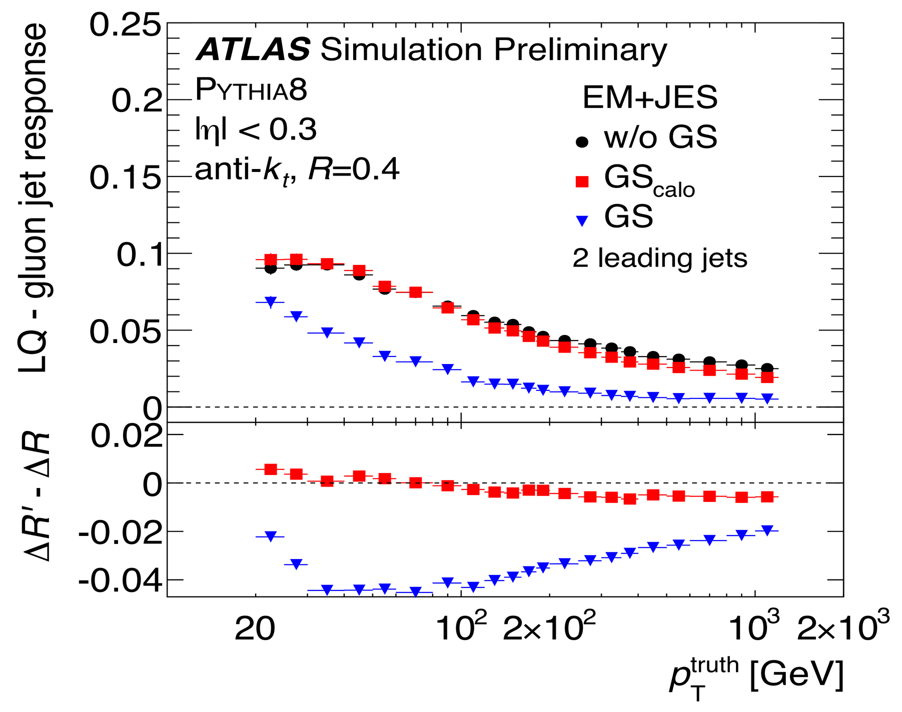
ATLAS-CONF-2013-004

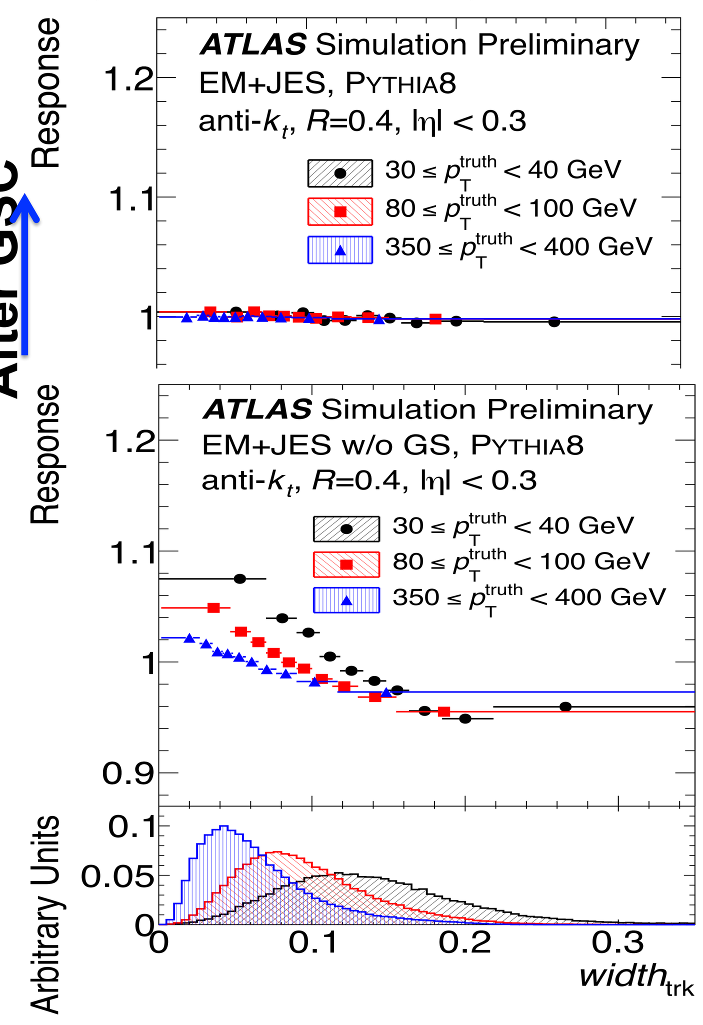
The **jet response** $E_{jet}^{EM/LCW} / E_{jet}^{truth}$ is studied as a function of jet pseudorapidity (η). The inverse of the response shown in each bin is equal to the average jet energy scale correction.

Global Sequential Corrections

Quarks and gluons have different jet responses. Global sequential calibration (GSC) is a sequence of corrections applied at the jet level that reduces the **JES** dependence on the flavor of the initiating parton. It also improves the **JER**.

$$\text{track width} = \sum_i p_T^{track_i} \, \Delta R(track_i, jet) / \sum_i p_T^{track_i}$$

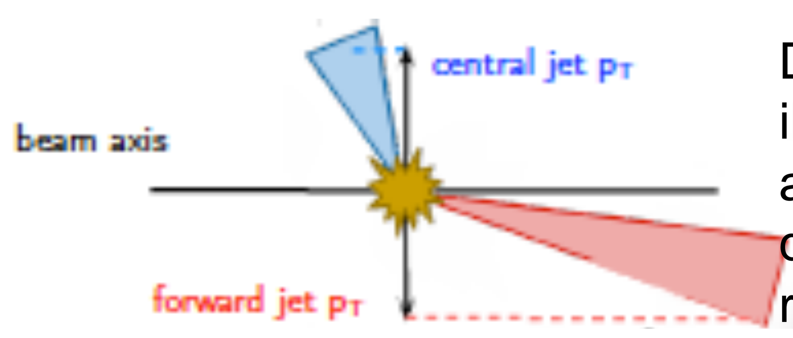




Jet response is parameterized as a function of n_{trk}, $width_{track}$, fraction of energy in Tile0 Layer and EM3 layer (only for EM scale jets) and number of muon segments behind jet.

Residual in situ corrections

Dijet, Z+jet, and γ+jet events are used to derive an in situ residual correction and set the jet energy scale uncertainty. p_T balance of the jet recoiling against a well calibrated reference object is studied in bins of p_T of the reference object.

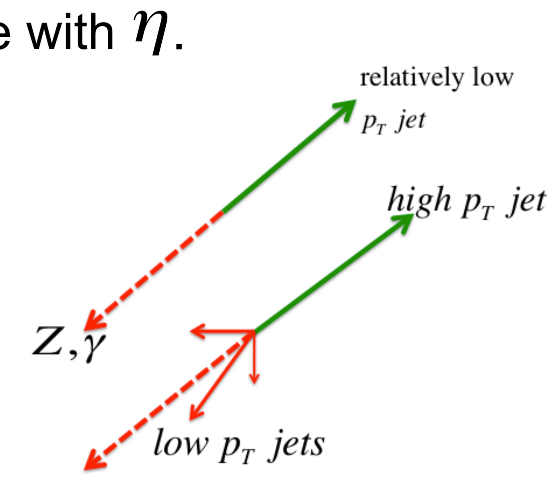


Relative

Dijet **η**-intercalibration: calibrate the forward jets against a central jet to remove the dependence of the calorimeter response with η.

Absolute

Central jets are calibrated using γ/Z bosons up to a p_T~ 800 GeV. Higher p_T jets are calibrated using a system of low-p_T jets recoiling against a higher p_T jet.



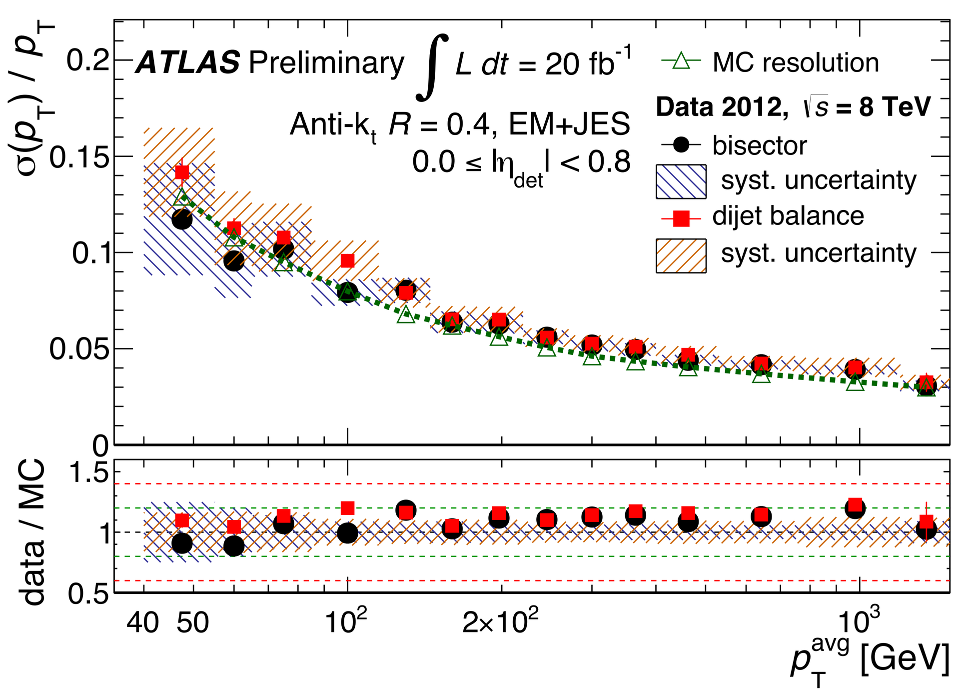
Jet Energy Resolution

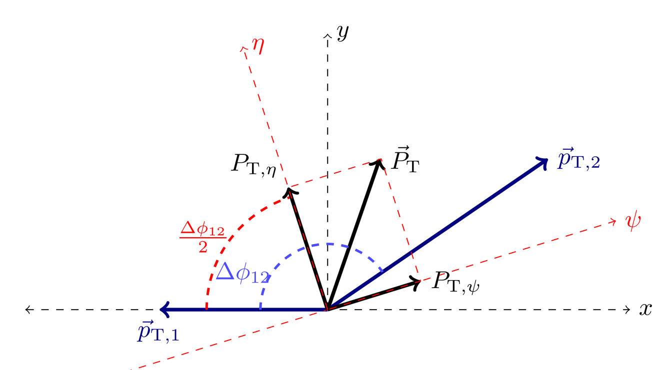
JER is measured in di-jet events using two in situ methods.

1. Measure p_T asymmetry

$$A = \frac{p_T^1 - p_T^2}{p_T^1 + p_T^2}$$

2. "bisector" method: uses the same principle after projecting the vector sum p_T onto an orthogonal coordinate system.

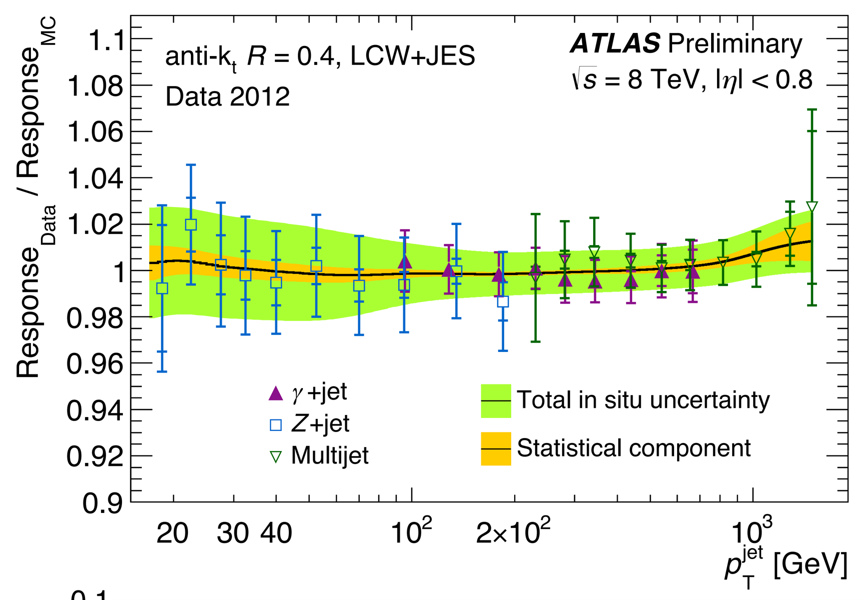




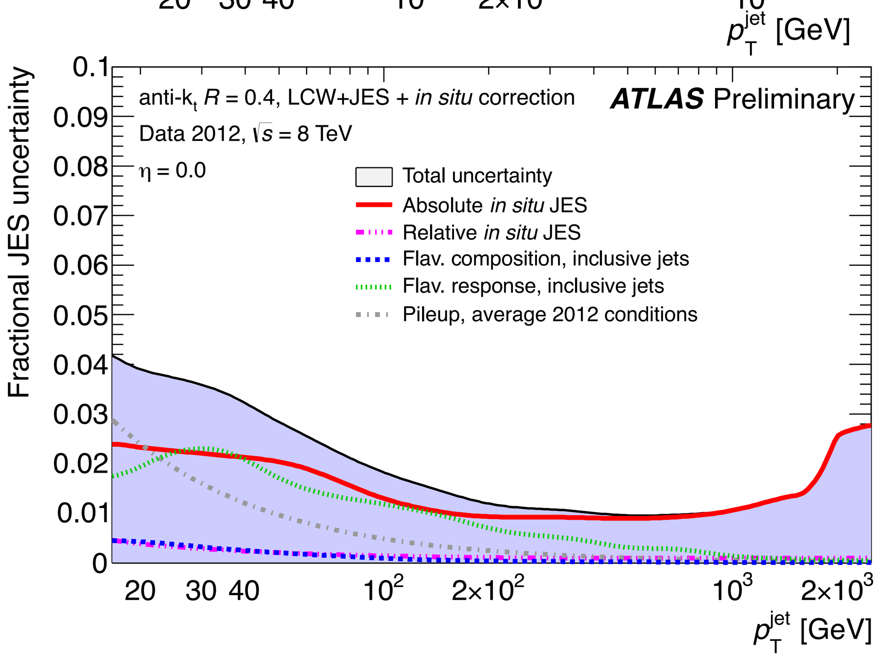
Angular variables used in the bisector method

Fractional JER: is below 10% for jets with p_T > 100 GeV. JER is also being measured in other processes including γ+jet and Z+jet.

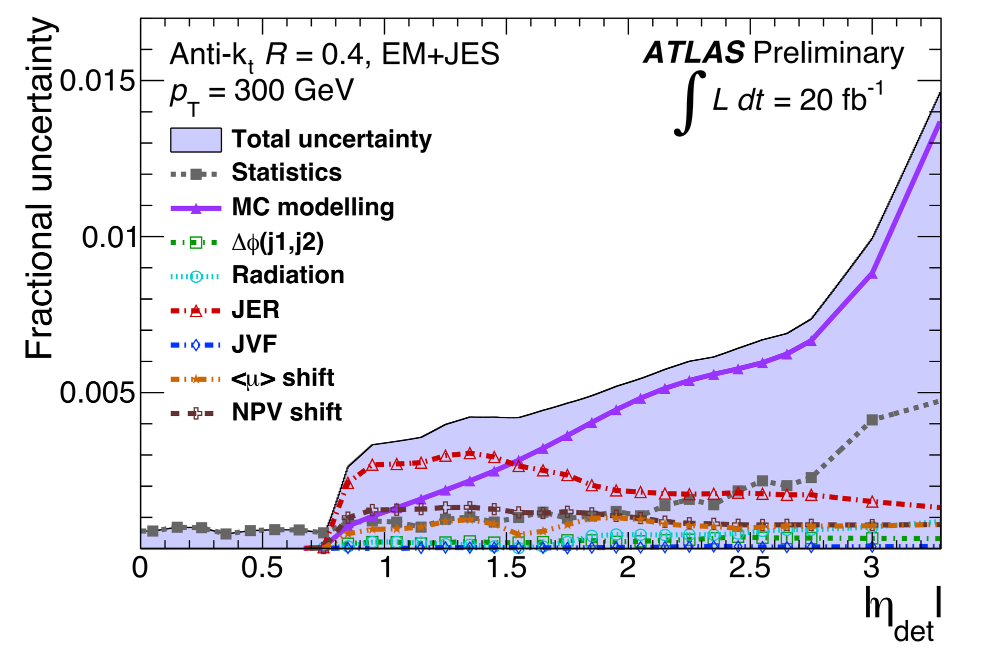
Final JES uncertainties



Jet response ratio of the data to the Monte Carlo simulation as a function of p_T for three in situ techniques combined to determine the in situ energy scale correction.



JES uncertainty is less than 3% for jets with p_T >100 GeV. Forward jet uncertainties are reduced to about 3% at 20 GeV.



Aparajita Dattagupta (Indiana University), for the ATLAS Collaboration