Jet Energy Scale Uncertainty in ATLAS

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1 Jet Energy Scale

The jet energy scale (JES) is a correction applied to jets measured in the calorimeter to recover the true 4-vector of the original jet [1]. In ATLAS, calorimeter jets are reconstructed from topological clusters (noise-suppressed groups of calorimeter cells) using the anti-k_t algorithm. Calorimeter level energies are calibrated to the electromagnetic (EM) scale.

A combination of data-derived corrections and calibration constants derived from Monte Carlo determine the size of the JES correction. EM-scale jet energies are lower than the hadronic energy because: not all the energy deposited by hadrons is measured; energy is deposited in inactive regions upstream of the calorimeters; some deposits are not entirely contained in the calorimeter; some deposits from the jet are not included in the reconstruction.

Corrections for, among others, pileup (caused by the overlaying of multiple proton-proton interactions), angular resolution and poor instrumentated regions are applied.

The EM-scale energy response $\mathcal{R} = E_{\mathrm{calo}}^{\mathrm{EM}}/E_{\mathrm{truth}}$ is measured in bins of η_{det} and E_{truth} using jets that are matched to an isolated truth jet. For each η bin, $\langle\mathcal{R}\rangle$ and $\langle E_{\mathrm{calo}}^{\mathrm{EM}}\rangle$ are calculated and used to construct the calibration function $\mathcal{F}_{\mathrm{calib,k}}(E_{\mathrm{calo}}^{\mathrm{EM}})$.

$$E_{\mathrm{calo}}^{\mathrm{EM}} JES = \frac{E_{\mathrm{calo}}^{\mathrm{EM}}}{\mathcal{F}_{\mathrm{calib}}(E_{\mathrm{calo}}^{\mathrm{EM}})|_{\eta_{\mathrm{det}}}}$$

2 Jet energy scale uncertainties

The JES systematic uncertainty combines information from in-situ and single pion test-beam measurements, uncertainties on the material in the ATLAS detector, electronic noise, and the Monte Carlo modelling used in event simulation. Important factors include: non-closure when the JES correction is applied to reconstructed Monte Carlo; calorimeter response obtained from in-situ measurements of single particle response; accuracy of detector simulation obtained from varying calorimeter noise in Monte Carlo; physics modelling obtained from comparing the response in different

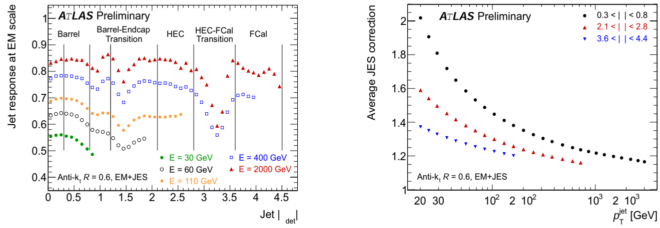

Figure 1: Simulated response at the EM scale as a function of $\eta_{\rm det}$ (l). Average correction ($\langle 1/\mathcal{F}_{\rm calib,k}(E^{\rm EM}_{\rm calo})\rangle$) as a function of calibrated jet $\rm p_T$ (r).

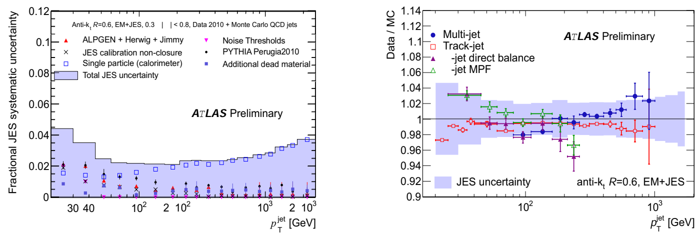

Figure 2: JES uncertainty as a function of $\rm p_T$ in $0.8 < |\eta| < 1.2$ (l). Data/Monte Carlo ratios for several in-situ techniques test the JES (r).

Monte Carlo generators; relative calibration obtained from dijet balancing in different detector regions.

The jet energy calibration is tested in-situ using a well calibrated object as reference. Techniques used are: direct transverse momentum balance between a jet and a photon; photon balance using missing transverse momentum projection; balance between a high-$\rm p_T$ jet recoiling against one or more lower-$\rm p_T$ jets; comparison between jets and the $\rm p_T$ of associated tracks. Results are found to be in agreement with expectations.

References

[1] ATLAS Collaboration, *JES and its systematic uncertainty in proton-proton collisions at $\sqrt{s} = 7$ TeV in ATLAS 2010 data*, ATLAS-CONF-2010-084, CERN, Geneva, March, 2011.