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Jet energy scale calibration using photon-jet events in the ATLAS experiment

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Summary. — A precise calibration of the jet energy in the ATLAS experiment at LHC is fundamental for many physics issues. Di-jet and multi jet events will be used to cross-check the relative response across different pseudo-rapidity and transverse momentum regions. The photon+jet channel (being the one with largest cross section) is the first candidate to check *in situ* the jet absolute energy scale. In events with photon and a recoiling jet, the transverse momentum balance can be exploited to estimate the jet energy using the measurement on the photon, whose scale is much better under control. The main background to this channel is given by QCD events where one jet is misidentified as a photon. The status of this analysis with the data collected by ATLAS in 2010 will be presented.

PACS 29.40.Vj – Calorimeters.
PACS 06.20.fb – Standards and calibration.
PACS 13.85.Qk – Inclusive production with identified leptons, photons, or other nonhadronic particles.
PACS 13.87.-a – Jets in large-Q^2 scattering.

1. – Introduction

The ATLAS calorimeters were calibrated to the electromagnetic energy (EM) scale using electron test beam. A small correction derived from *in situ* calibration with $Z \to e^+e^-$ is also applied. Three energy calibrations are used for data analysis of jets in ATLAS. The simple jet energy scale (JES) calibration factors and two weighting algorithms: the Global and Local Cell Weights (GCW and LCW), both exploiting the different density of electromagnetic and hadronic showers. The JES calibration is a calibration factor derived from the dijet Monte Carlo (MC) simulation applied on top of the EM, GCW or LCW energy scales to restore the true jet energy. The resulting calibrated jets referred to as EM+JES, GCW+JES or LCW+JES.

2. – Photon-jet balance

The ATLAS Collaboration has developed two techniques to derive the detector response to hadronic jets. The Data/MC ratio is then evaluated with both methods.

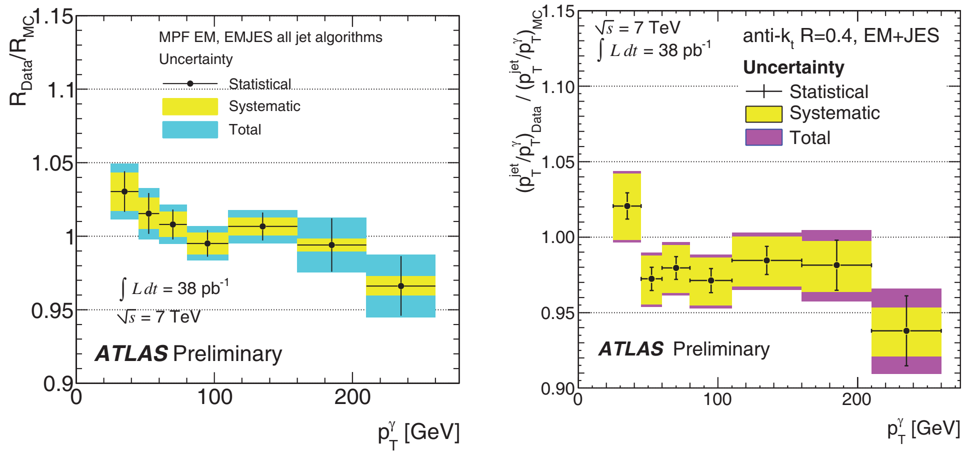

Fig. 1. – The data/MC ratio for $R = 4$ anti-k_T EM+JES jets estimated with the MPF method (left) and direct balance (right).

The missing transverse energy (E_T) projection fraction (MPF) technique exploit the transverse momentum (p_T) balance of the photon and hadronic recoil using the assumption that the only missing E_T in a γ-jet event arises from the jet misscalibration. The MPF response is independent of the jet algorithm as it does not use the jet energy directly.

The direct transverse momentum balance method exploits the transverse momentum conservation between the photon and the jet. The ratio of the jet p_T to the photon p_T ($r = p_T^{\mathrm{jet}}/p_T^{\gamma}$) is used to estimate the jet response.

3. – Event selection and systematic uncertainties

The ratio of response between data and MC is studied for central isolated photons ($\eta_\gamma < 1.37$) with $p_T^{\gamma} > 25\,\mathrm{GeV}$ and central jets $\eta_{\mathrm{jet}} < 1.2$ (events with a second jet with $p_T^{j2} > 10\%\ p_T^{j1}$ are rejected).

Systematic uncertainties that may arise due to differences between the data and MC are: soft radiation, in-time pile-up, background from jets identified as photons (fakes), missing calorimeter read-out regions and photon energy scale. They have all been taken into account and their effect has been measured [1].

4. – Analysis results

The ratio of response between data and MC, as determined using the MPF technique with the total uncertainty on the determination of the Data/MC ratio is shown in fig. 1 (left) together with the ratio Data/MC of the quantity $r = p_T^{\mathrm{jet}}/p_T^{\gamma}$ (right).

The 5% shift in the $p_T^{\gamma} < 45\,\mathrm{GeV}$ range is consistent with the systematic uncertainty on the ATLAS jet energy scale.

REFERENCES

[1] The ATLAS Collaboration, *Determination of the ATLAS jet energy measurement uncertainty using photon-jet events in proton-proton collisions at* $\sqrt{s} = 7\,\mathrm{TeV}$, ATLAS-CONF-2011-031.