LHCC Poster Session - CERN, 23 March 2011

Jet Calibration at ATLAS

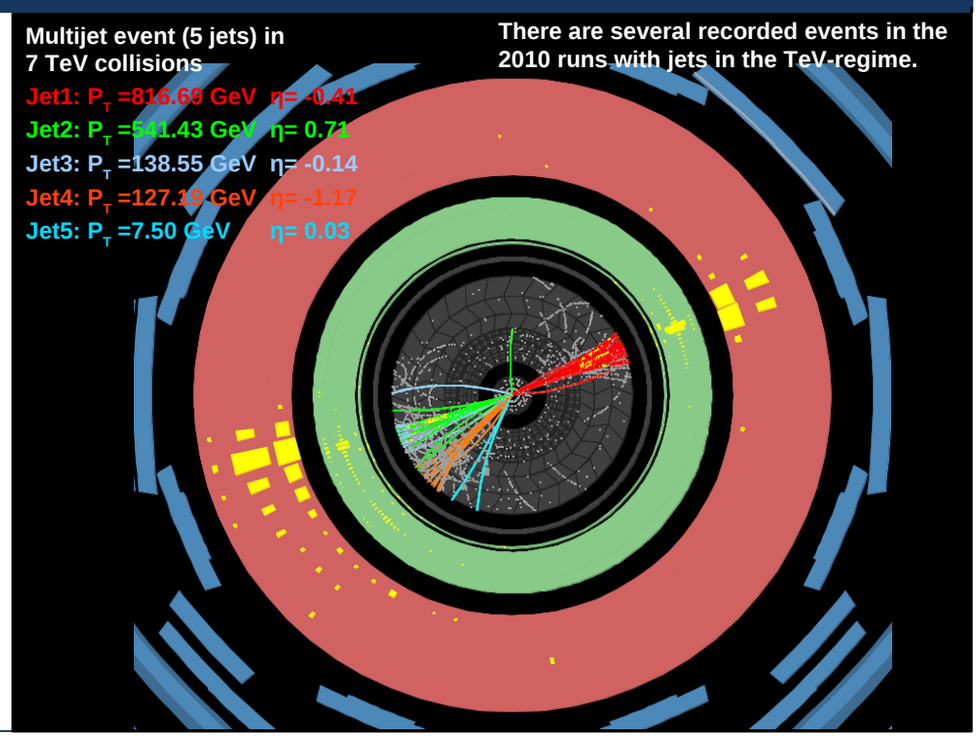
Introduction

A **jet** is a bunch of particles coming from the hadronization of quarks and gluons, grouped together by a jet algorithm. An accurate measurement of jets at high transverse momentum produced in ***pp*** collisions is important in many physics analyses at LHC. To achieve this goal several jet calibration strategies have been developed in ATLAS. The performances of the various calibration schemes in real data and simulation as well as an evaluation of the modelling of the properties used in each calibration will be presented.

Jets in ATLAS

Jets are reconstructed using the energy deposited in the ATLAS calorimeters by the particles produced in the collisions. Due to the non-compensating nature of the ATLAS calorimeter, signal losses due to noise thresholds and in dead material the jet energy needs to be calibrated. Four different calibration schemes have been developed in ATLAS. Their general characteristics are summarized below.

	EM+JES	GCW	LCW	GS
Good resolution	😐	😀	😀	😀
Easy systematic uncertainty derivation	😀	😐	🙂	🙂
Flavour non sensitivity	😐	🙂	🙂	😀
Possible derivation of calibration from data	😀	😀	😐	😀
Ease of subjet calibration	😐	🙂	😀	😐
Ease in use for Missing transverse energy E_T	😐	🙂	😀	😐



Jet energy scale (EM+JES)

Presently, ATLAS derives the jet calibration from Monte Carlo simulation using a **simple correction** that restores the reconstructed jet energy to the particle jet energy, referred to as **EM+JES**. In this scheme each jet is scaled by a correction factor which is a function of the reconstructed jet energy and η. In addition to this energy correction a pile-up and a jet origin correction are also applied.

The EM+JES systematic uncertainty is easily evaluated combining in situ, single pion test-beam measurements and variations in the Monte Carlo simulation [2] (see Figure 1).

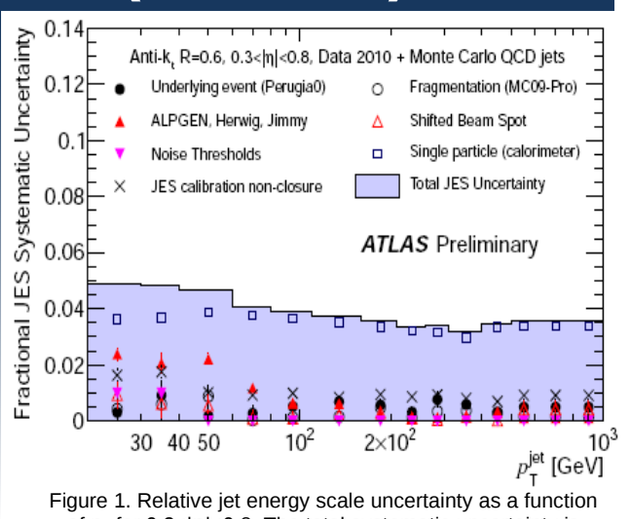


Figure 1. Relative jet energy scale uncertainty as a function of p_T for 0.3<|η|<0.8. The total systematic uncertainty is shown as a solid light blue area.

Jet resolution

A precise measurement of jets also requires a precise knowledge of the jet energy resolution and a good agreement between data and simulation. The performance in resolution for the four different jet calibration strategies in ATLAS: EM+JES, GCW, LCW and GS have been measured in Monte Carlo simulation and real data using in-situ techniques [3]. Figure 2 shows the fractional jet resolution vs p_T in data.

The relative improvement in resolution in data is found to be up to **30 % at 400 GeV** for the three JES schemes. The jet resolution agreement between data and Monte Carlo is within 10% for p_T>40GeV.

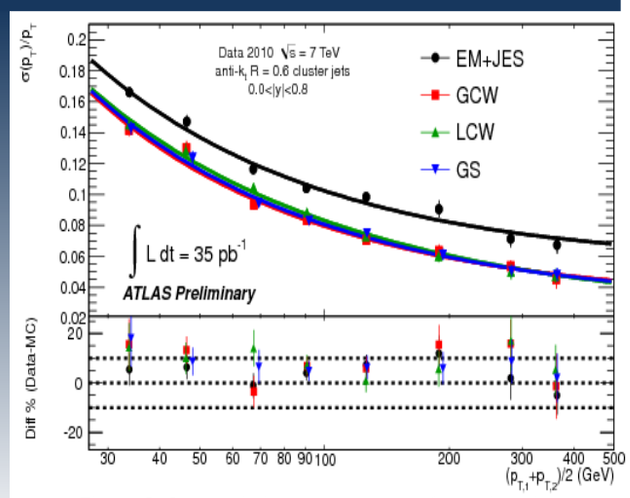


Figure 2. Jet resolution vs average p_T for various jet calibrations in real data. The lower plots shows the difference between Monte Carlo and the data.

Optimized jet calibration schemes

Other Monte Carlo based calibrations use hadronic cell calibrations or the topology of the jet constituents to reduce fluctuations in the jet response, therefore improving the jet energy resolution (see Figure 2). **Three different schemes have been investigated in early 2010 data:**

- **Global Sequential (GS) calibration**: It is built on top of the EM+JES and uses longitudinal and transverse properties of the jet structure sequentially to improve the resolution, while leaving the jet energy scale unchanged.
- **Global Cell Weighting (GCW+JES)**: it attempts to compensate for the different calorimeter response to hadrons and electromagnetic particles by weighting each jet constituent cell according to its energy density. A final jet energy scale correction is applied to achieve response linearity.
- **Local cluster weighting (LCW+JES)**: it uses properties of clusters (such as their energy density, isolation and depth in the calorimeter) to calibrate them individually before applying jet reconstruction. Similarly to the GCW+JES scheme, a final correction of the jet energy is applied.

These jet calibration schemes can be **validated** by comparing real data and Monte Carlo using in situ techniques such as **direct p_T balance techniques in γ+jet or di-jet events**. These techniques also allow us in some cases to calculate the calibration constants. Some recent results are presented in this section[4,5].

Application test in di-jet events

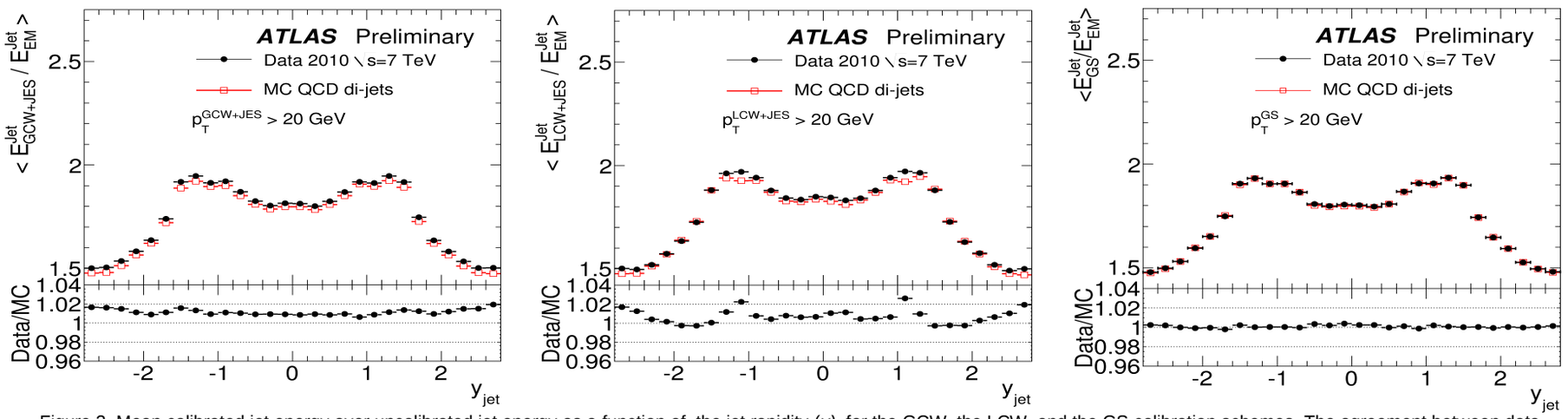


Figure 3. Mean calibrated jet energy over uncalibrated jet energy as a function of the jet rapidity (*y*) for the GCW, the LCW, and the GS calibration schemes. The agreement between data and Monte Carlo evaluates the modelling of the properties used to derive each calibration. The disagreement for all the schemes is lower than 3% in the whole kinematic region studied.

γ+jet validation

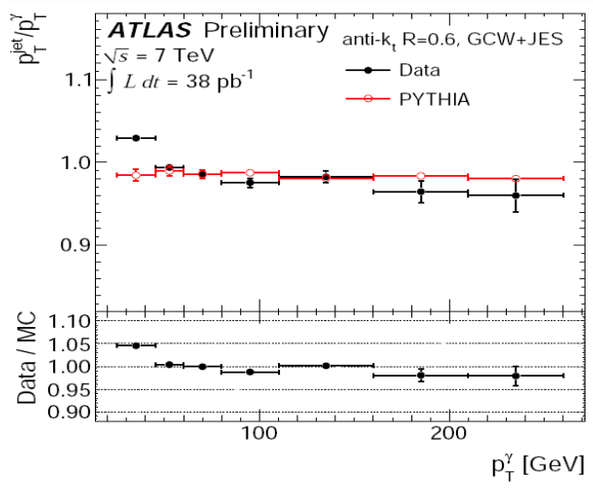


Figure 4. Jet response as determined in γ+jet events from the GCW corrected jet energy scale vs the γ transverse momentum in data and Monte Carlo.

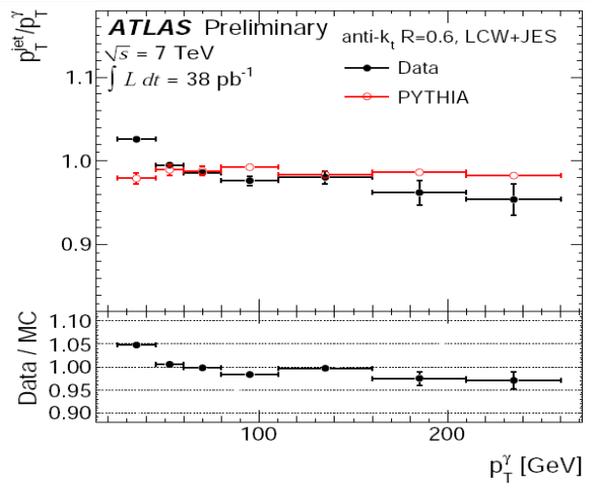


Figure 5. Jet response as determined in γ+jet events from the LCW corrected jet energy scale vs the γ transverse momentum in data and Monte Carlo.

Derivation of calibration constants

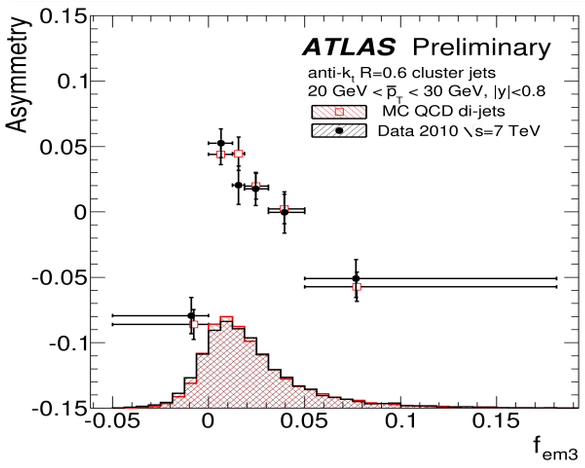


Figure 6. Asymmetry vs the energy fraction deposited in the 3rd layer of the EM calorimeter (variable used in the GS calibration) in data and Monte Carlo for a di-jet system. The asymmetry is directly used to calculate the jet response.

References

[1] M.Cacciari, G.P. Salam and G. Soyez, The *anti-kT* jet clustering algorithm, JHEP 04 (2008) 063, arXiv:0802.1189
[2] The ATLAS collaboration. Update on the jet energy scale systematic uncertainty for jets produced in proton-proton collisions at a centre of mass energy of 7 TeV measured with the ATLAS detector, ATLAS-CONF-2011-007
[3] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/JetResolutionPreliminaryResults
[4] The ATLAS collaboration. Determination of the ATLAS jet energy measurement uncertainty using photon-jet events in proton-proton collisions at sqrt{s} = 7 TeV, ATLAS-COM-CONF-2011-011
[5] The ATLAS collaboration. Properties of Jets and Inputs to Jet Reconstruction and Calibration with the ATLAS Detector Using Proton-Proton Collisions at a centre of mass energy of 7 TeV, ATLAS-COM-CONF-2010-055

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