ATLAS Jet Energy Scale

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on behalf of the ATLAS Collaboration

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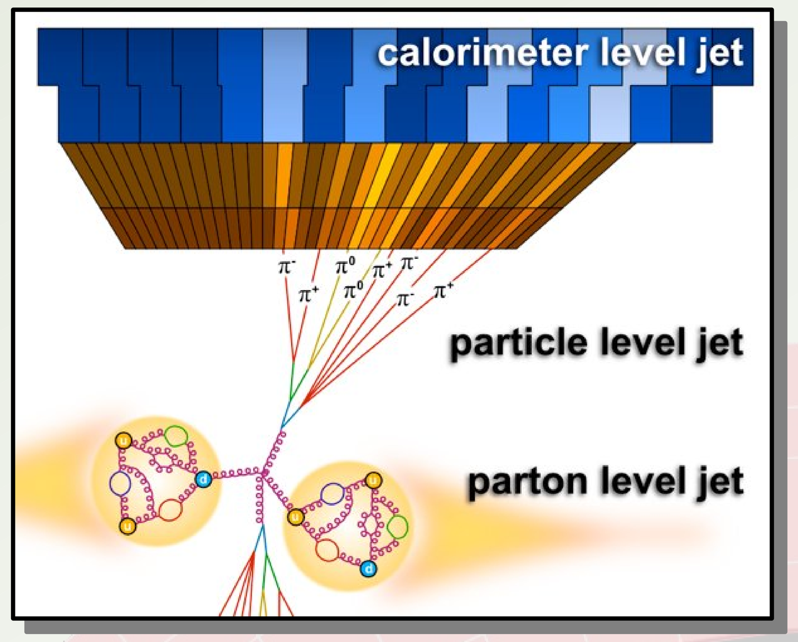
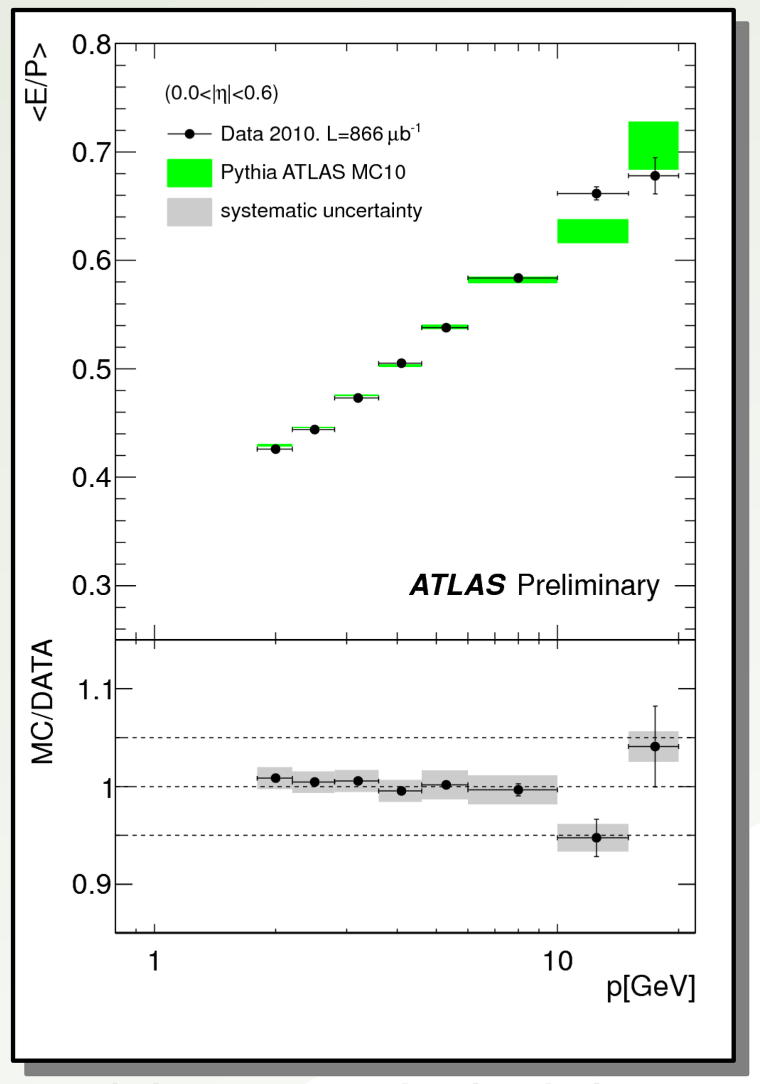
Introduction

Jets originating from the fragmentation of quarks and gluons are the most common, and complicated, final state objects produced at the LHC. A precise knowledge of their energy calibration is therefore of great importance at ATLAS, and is very difficult to ascertain. A number of approaches are employed to demonstrate an understanding of the jet energy scale: single particle calorimeter response, QCD dijet relative response, direct scale determination in photon + jet events, and comparisons of track and calorimeter jets.



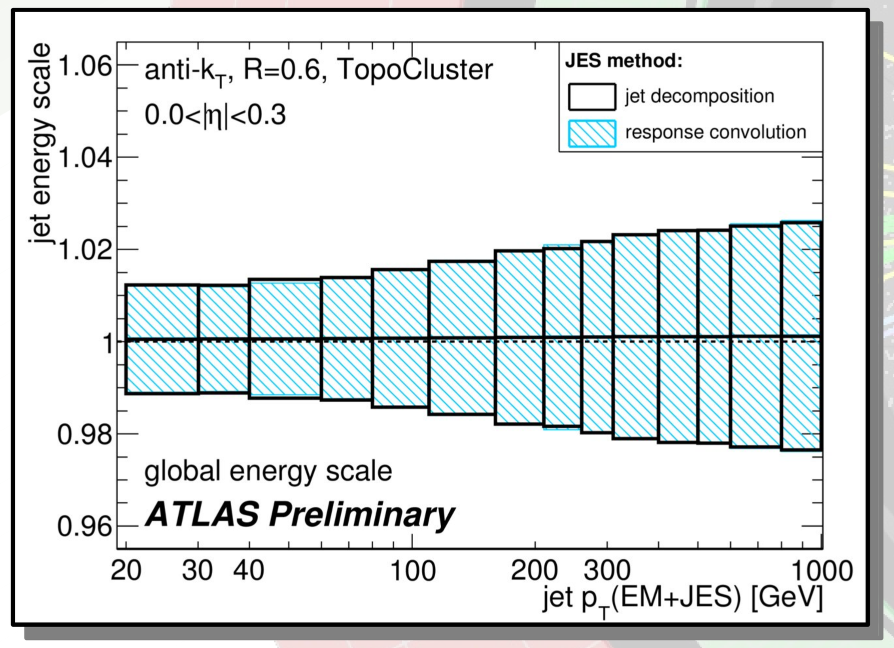
What is a jet?

From Single Particles to Jets



E/p in Monte Carlo simulations and in 2010 data

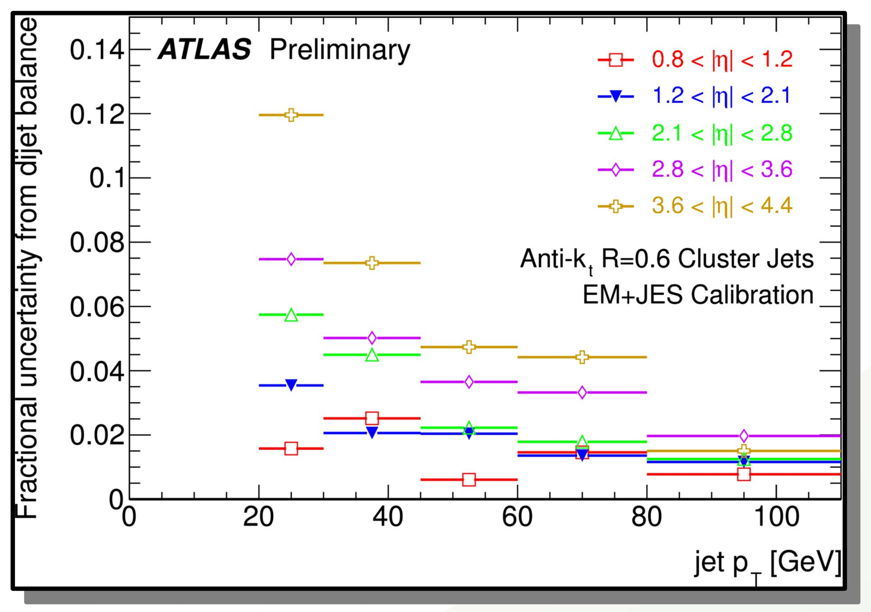
In the data collected in 2010, the jet energy scale (JES) in the central region was validated using measures of single particle response from in situ *E/p* measurements and testbeam results. The uncertainty was determined by considering all effects in the measurement of the single particle response and extrapolation to the jet level correction. The correction factors for JES are derived from Monte Carlo simulations.



Central JES uncertainty derived from single particle response

QCD Dijet Relative Response

For jets in the region with pseudorapidity larger than 0.8, the response for the central region is extrapolated using a dijet balance technique. This procedure derives a calibration for a jet relative to the central region under the assumption of momentum balance of the dijet system at the particle (reference) level.

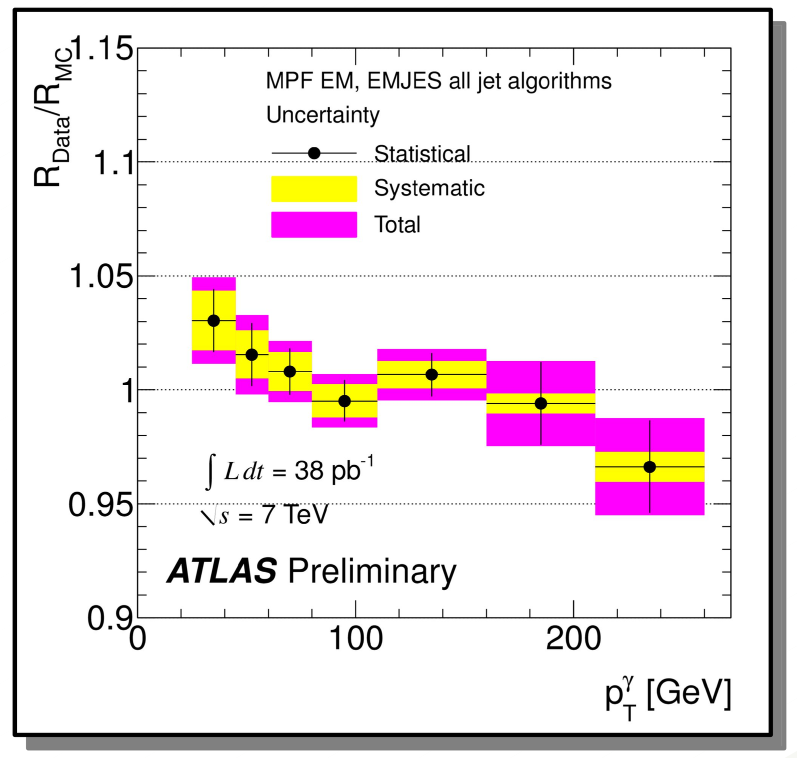


The JES uncertainty in the endcap region is the sum in quadrature of the uncertainties in the central region and the dijet relative response measurements. Currently, the 2nd component (shown on the plot to the left) is the dominant one in the forward region, due to a disagreement in modelling the reference balance assumption between different Monte Carlo generators.

Photon + Jet

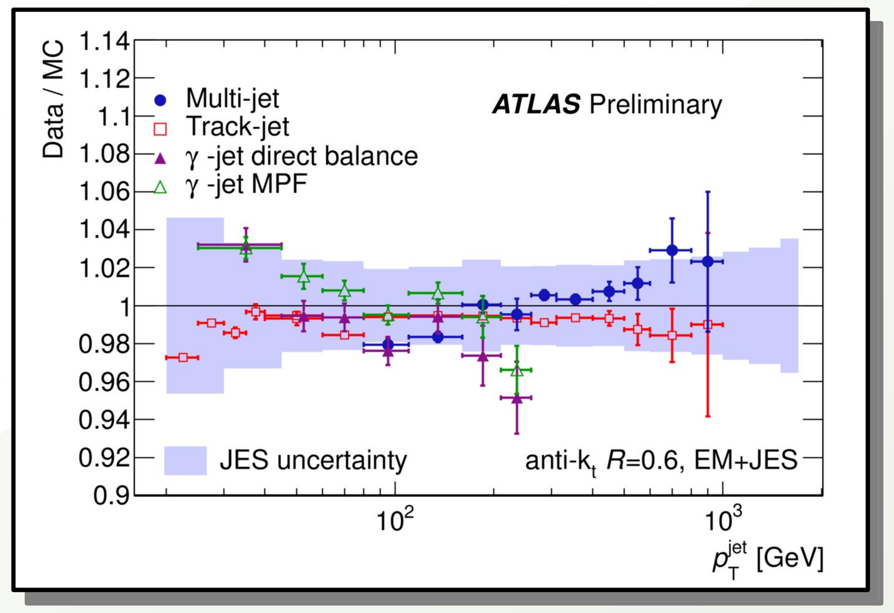
Because photons are well-measured objects, one can directly measure the jet response by using the principle of momentum balance between a photon and recoil jet in photon + jet events. One technique, known as the missing ET projection fraction (MPF) directly measures the total calorimeter response to jets by balancing the hadronic recoil against the photon. The MPF equation is:

$$R_{jet}(E_{jet}) = 1 + \frac{\hat{n}_{\gamma} \cdot \vec{E}_T^{miss}}{p_T^{\gamma}}$$



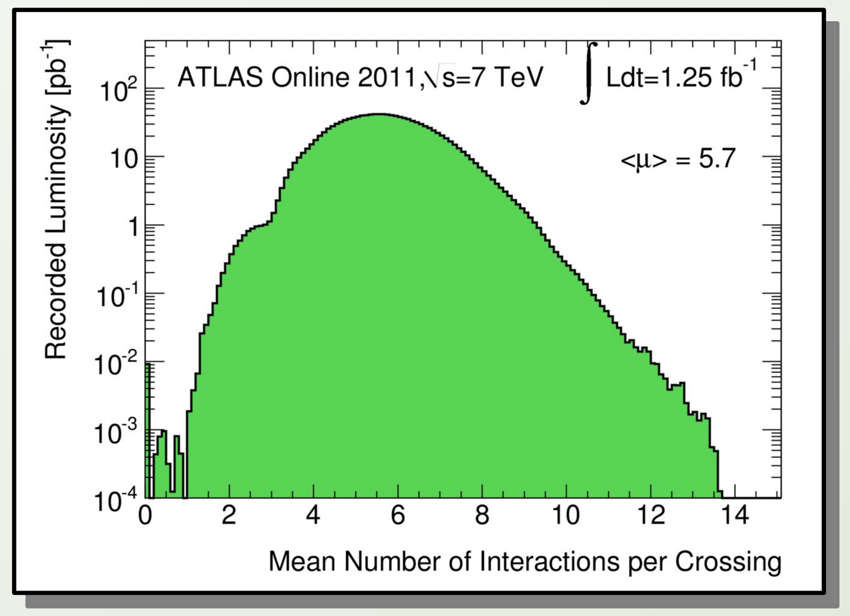
MPF in 2010 data and Monte Carlo

The JES uncertainty derived from single particle and dijet relative response measurements is validated by comparing various in situ measurements, such as MPF. By combining all of these results, a 3% relative uncertainty for jets above 25 GeV can be confidently established in the central region.

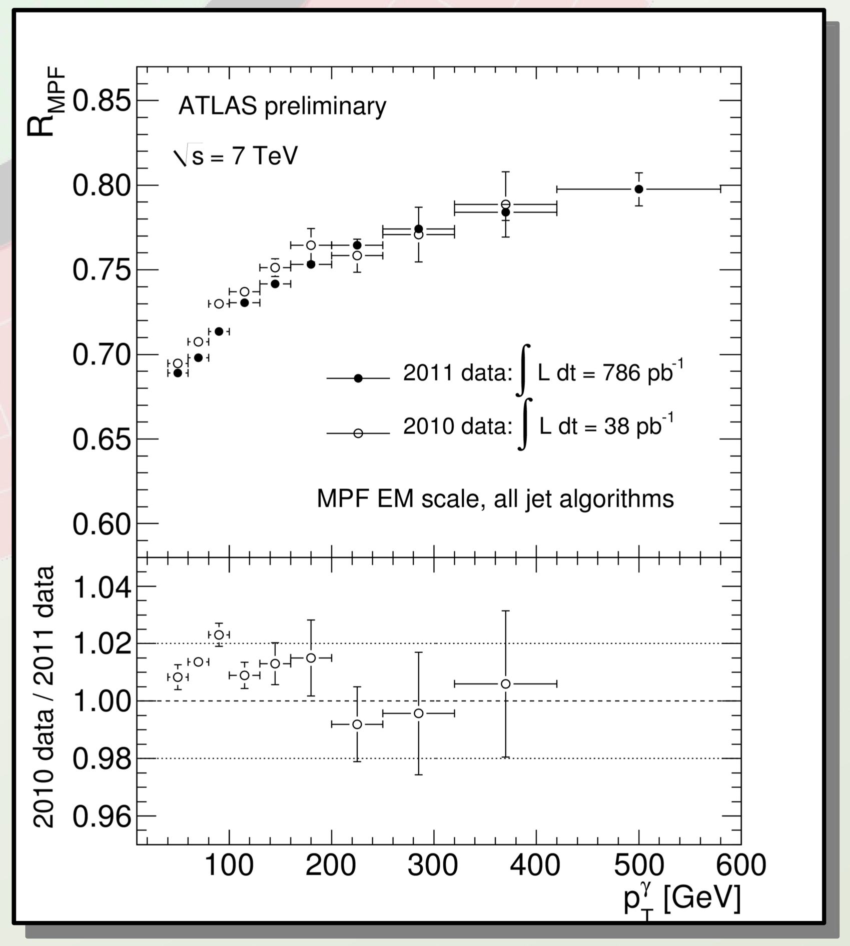


High Luminosity & Pileup

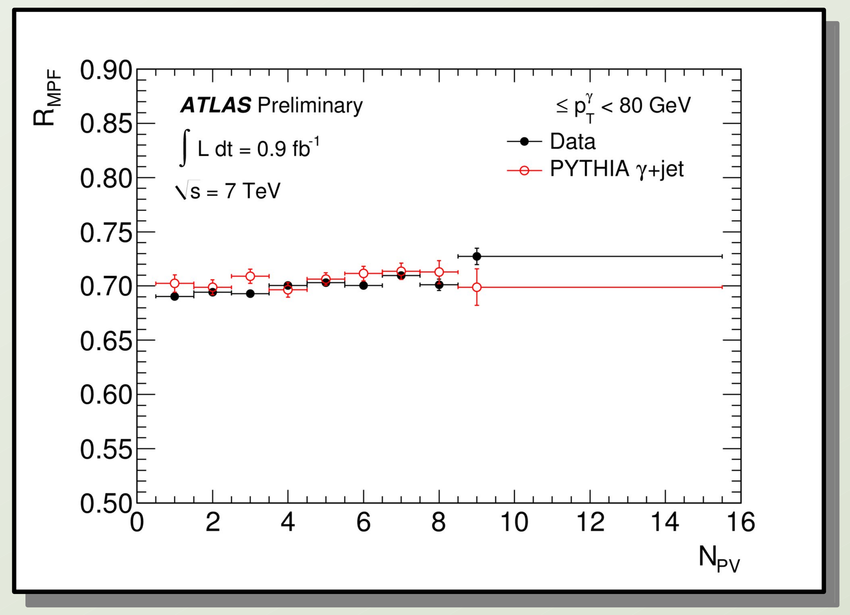
The LHC has been steadily increasing the instantaneous luminosity and has also decreased the bunch spacing in 2011. This has resulted in a large increase in the effect of pileup on the JES in ATLAS. Much effort is currently devoted to extending the JES measurements from 2010 to accommodate the larger pileup effect. Photon + jet events are very useful in two ways. First, the MPF is (to 1st order) insensitive to pileup, and so can be used to determine the calorimeter response. Second, by measuring the difference in pT between the photon and jet as a function of the level of pileup, an offset correction due to pileup can be determined.



Average # of interactions per crossing in 2011 data



Comparison of MPF in photon + jet events in 2010 and 2011 data



MPF in photon + jet events, as a function of # of primary vertices

see ATLAS-CONF-2011-032, ATLAS-CONF-2011-031, ATLAS-CONF-2011-030, ATLAS-CONF-2011-029, ATLAS-CONF-2011-028, ATLAS-CONF-2011-014 for more details