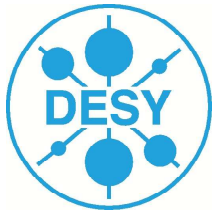

ATLAS jet energy scale uncertainties

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DESY

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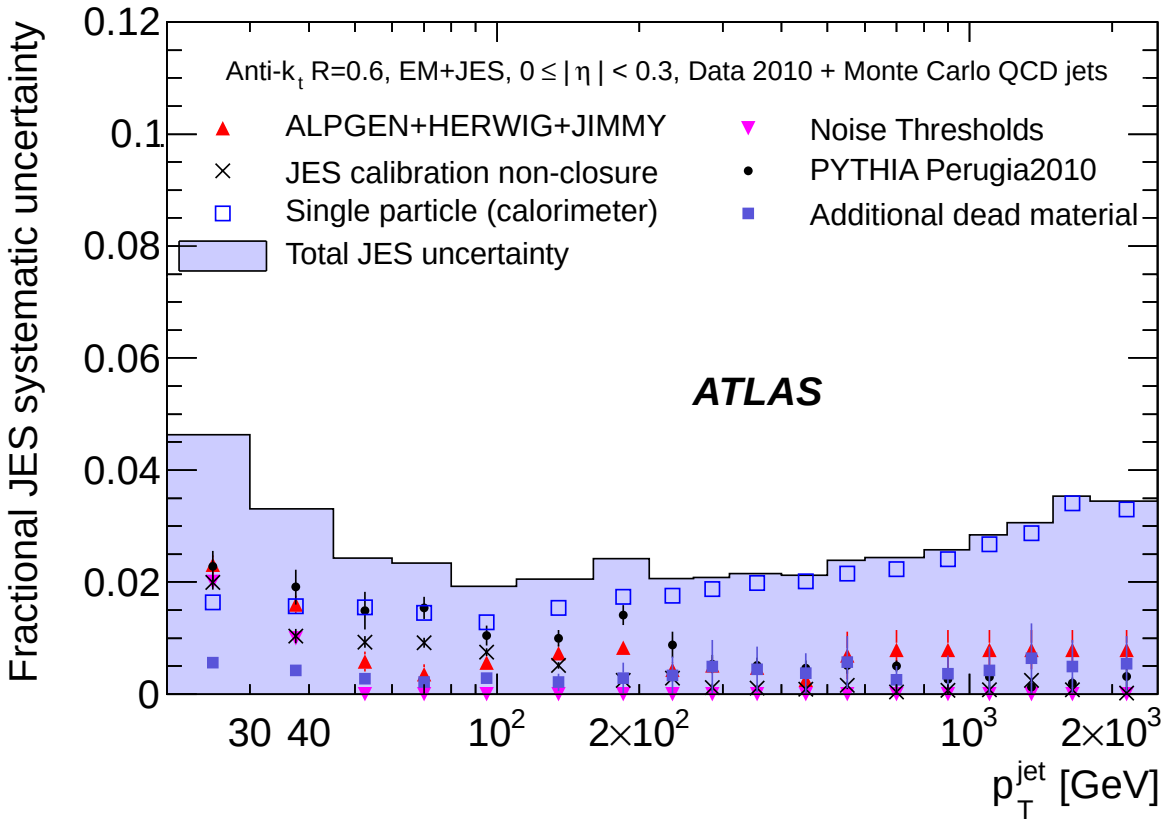
Outline

1. Jet energy scale uncertainty in 2010 dataset
2. Probing jet energy using in-situ techniques in 2011 dataset
3. Summary

Jet energy scale uncertainty in 2010

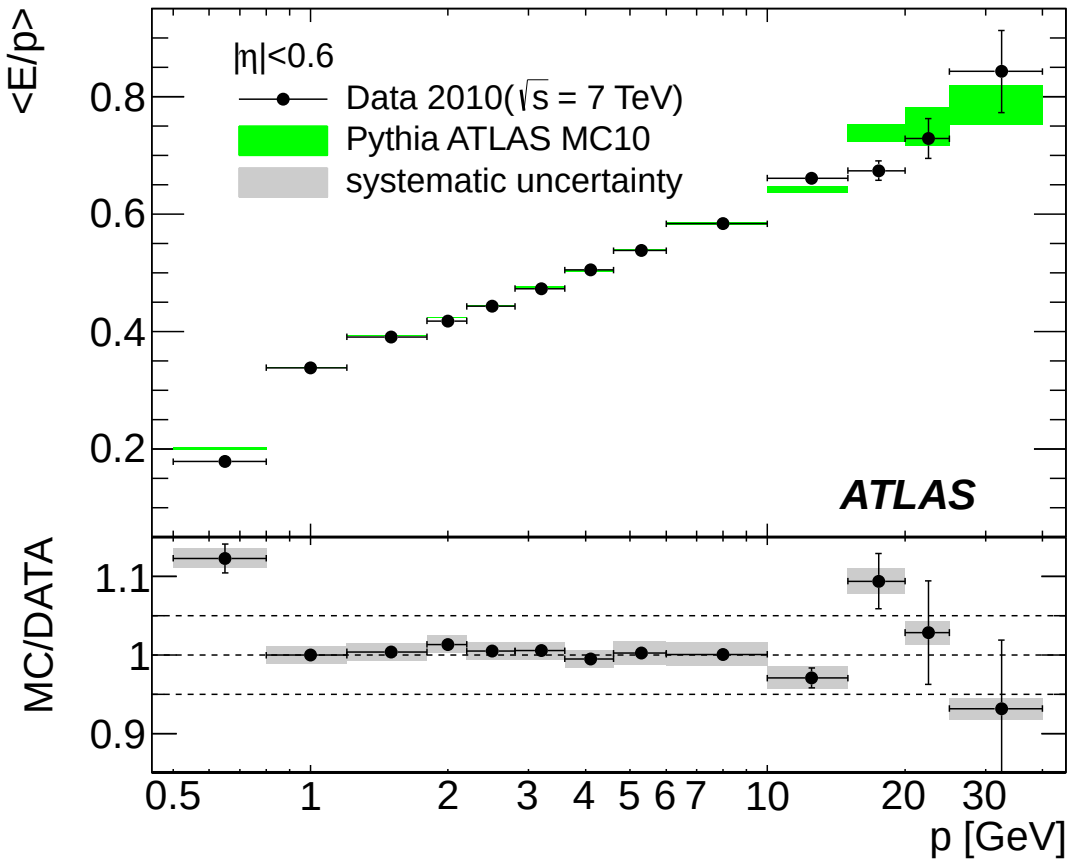


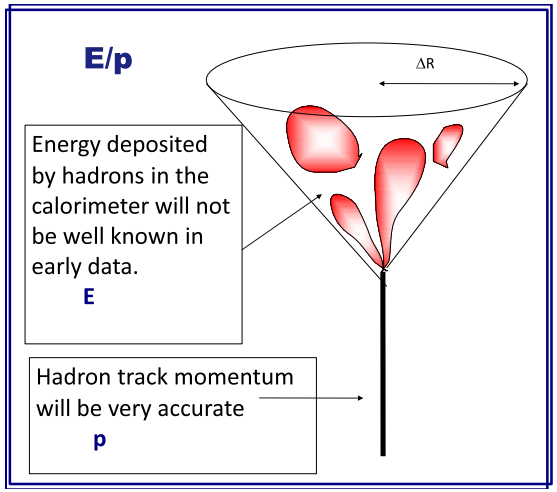
arXiv:1112.6426

- Six (+1 in forward bins) components
- Calorimeter response is the dominating one with complex correlation (see next few slides)
- The rest are independent and 100% correlated between bins

Single hadron response measurement

JES calorimeter response uncertainty was determined from the uncertainty of the in-situ measurement of single hadron response



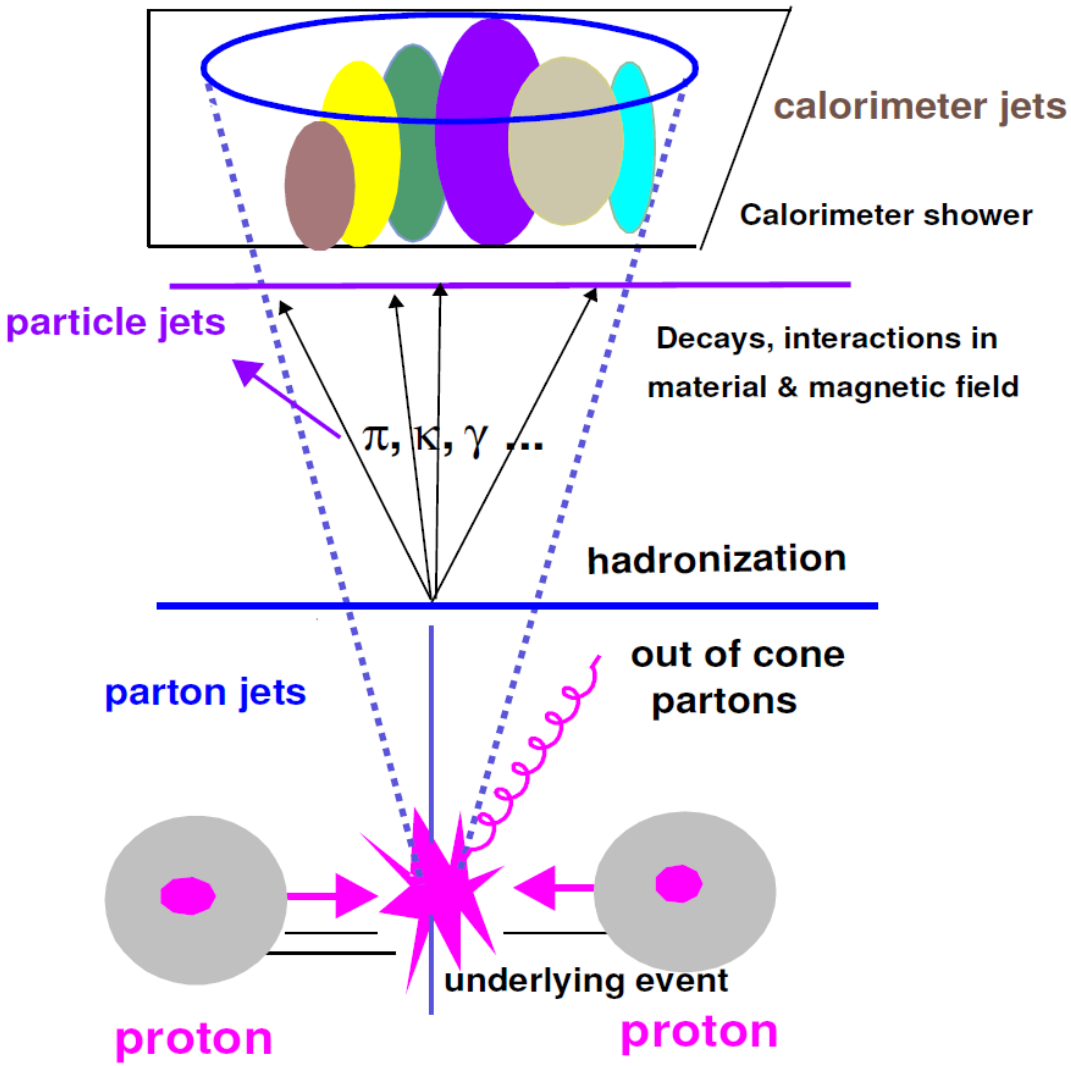


- $0.5 < p[GeV] < 40$
- $|\eta| < 2.3$
- very small statistical uncertainty
- $\sim$ 2% systematic uncertainty

arXiv:1203.1302

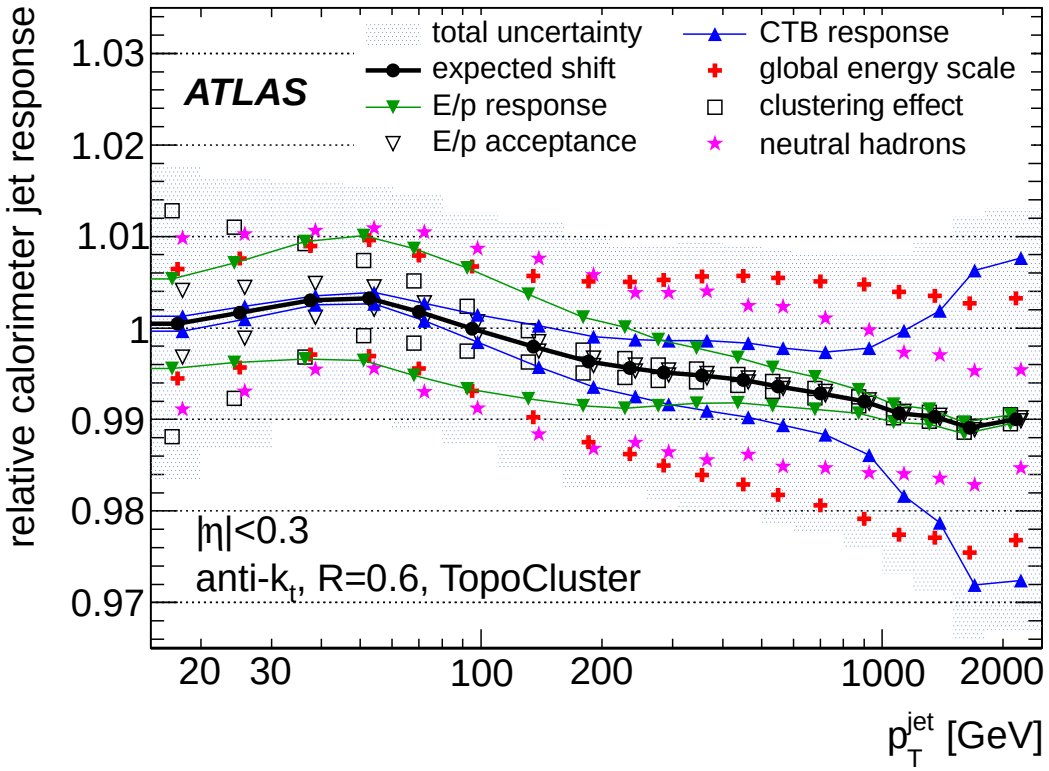
Calorimeter component of jet energy scale uncertainty

CalibrationHit concept in simulation: assign true energy depositions in calorimeter to true particles in an event



- Jets are selected requiring an isolation of $\Delta R > 2.0$ to any other jet with $p_T(\text{EM scale}) > 7$ GeV.
- The jet energy is decomposed into the energy of the constituent particles of the jet.
- The uncertainty on the JES is determined by propagating the uncertainties of the single particle measurements (see prev. slide) to the particles of the jet

Total calorimeter jet energy scale uncertainty



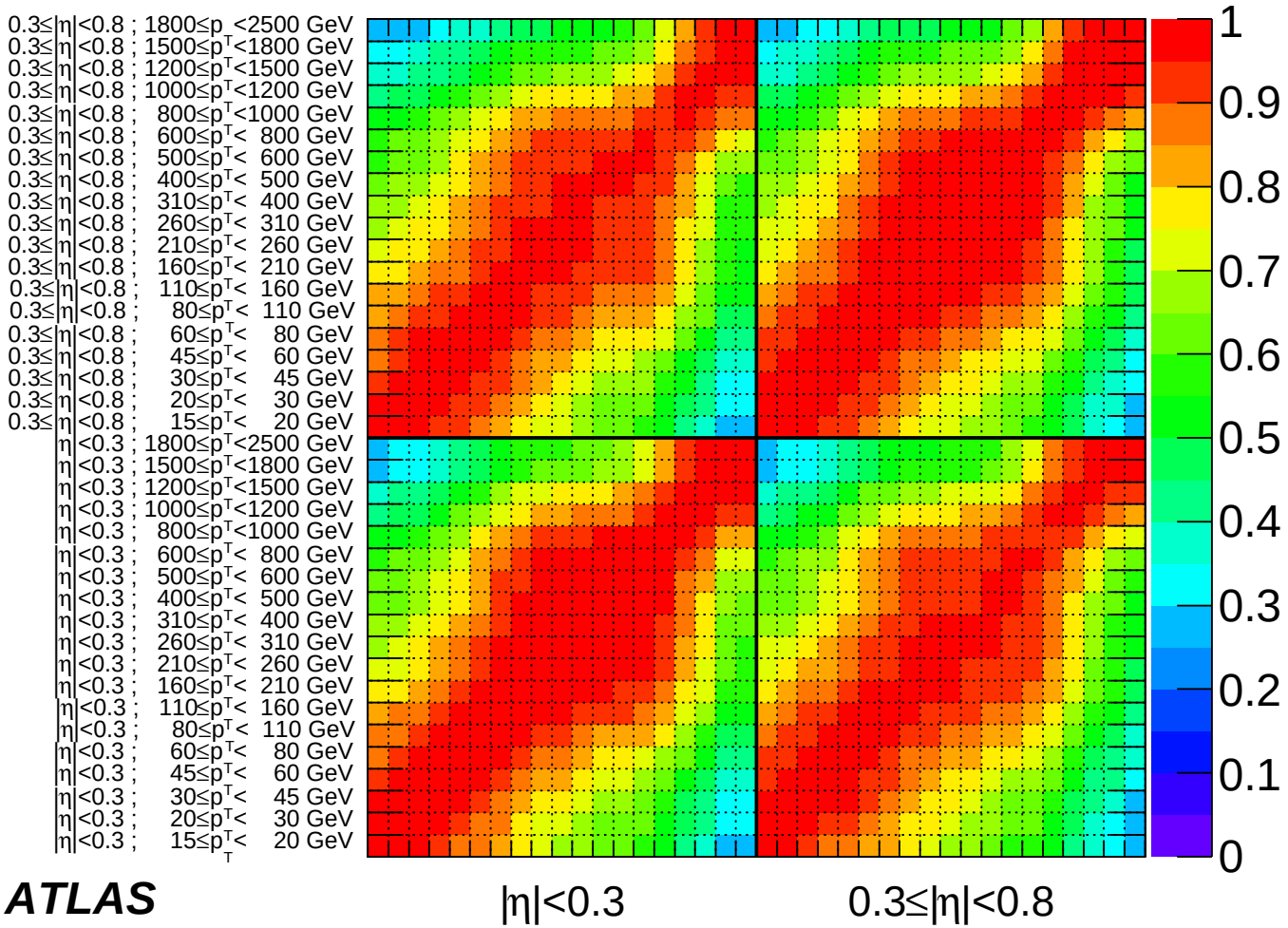
Components of calorimeter uncertainty

- E/p response($p < 20$ GeV)
- test beam response ($20 < p < 350$ GeV)
- E/p acceptance
- global energy scale, e.g. from $Z \to e^+e^-$
- noise threshold effects
- neutral hadrons response

Calorimeter jet response with associated uncertainties for jets reconstructed with the anti-k$_t$ jet algorithm ($R = 0.6$) in the range $0.0 < |\eta| < 0.3$ as function of jet transverse momentum.

Correlation of total calorimeter JES uncertainty

The use of pseudo-experiments for the determination of the JES uncertainty allows a direct extraction of the correlation of uncertainties



correlation of the JES uncertainty between different η and p bins for anti-k_t jet of the jet size R=0.4.

Nuisance parameters decomposition

The calorimeter uncertainty component is split into seven subcomponents:

- uncorrelated between each other
- each is 100% correlated between p_T and η bins

$$C_{ij} = s_i s_j \delta_{ij} + \sum_{\alpha=1}^{N_{\text{sources}}} \sigma_{i\alpha}\sigma_{j\alpha}.$$

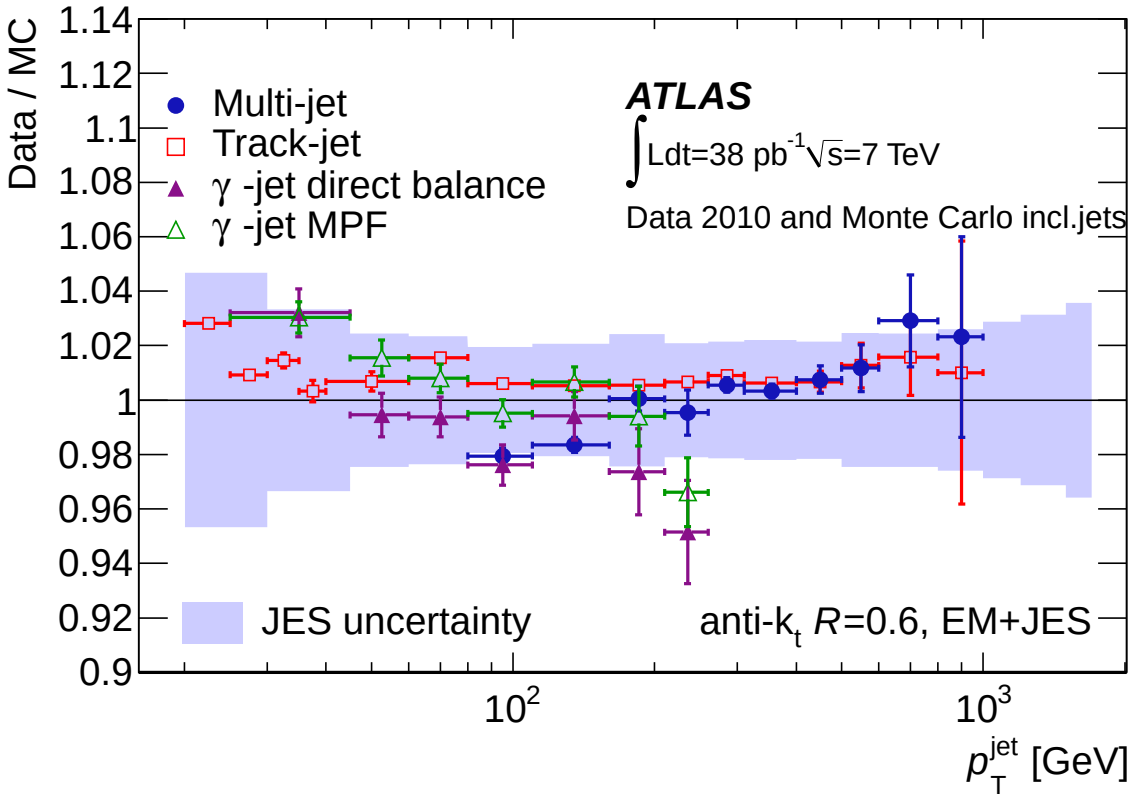
$$\sigma_{i1} = C_{ik}/\sqrt{C_{kk}}$$

$$C_{ij}^{(n)} = C_{ij}^{(n-1)} - \sigma_{i(n-1)}\sigma_{j(n-1)}, \quad \sigma_{in} = C_{ik'}^{(n)}/\sqrt{C_{k'k'}^{(n)}},$$

The total uncertainty is reproduced exaclty (by construction) and the correltaions are reproduced to $\sim 2\%$

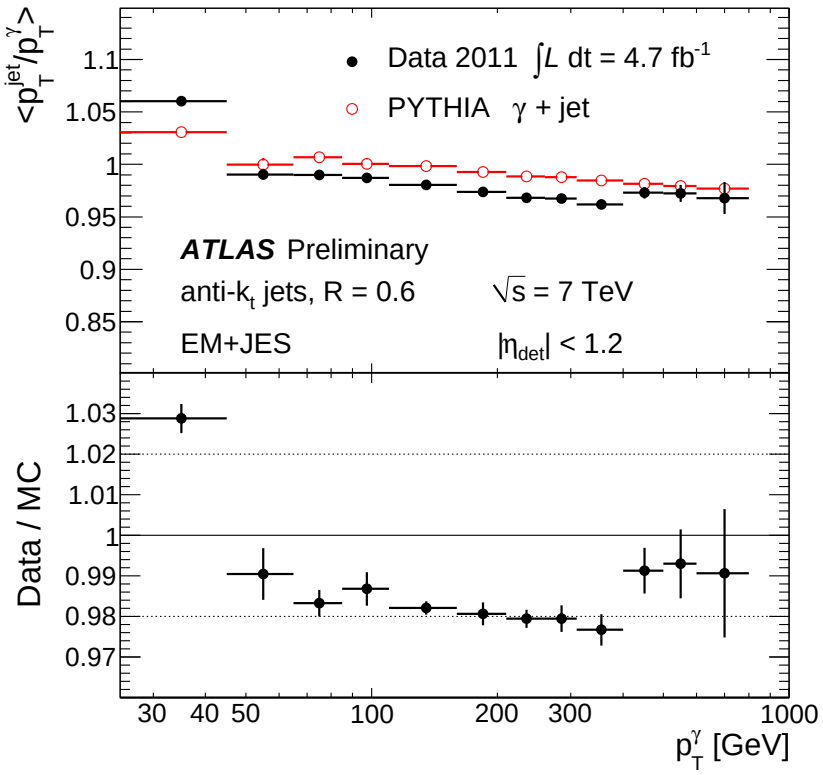
2010 JES validation with in-situ techniques

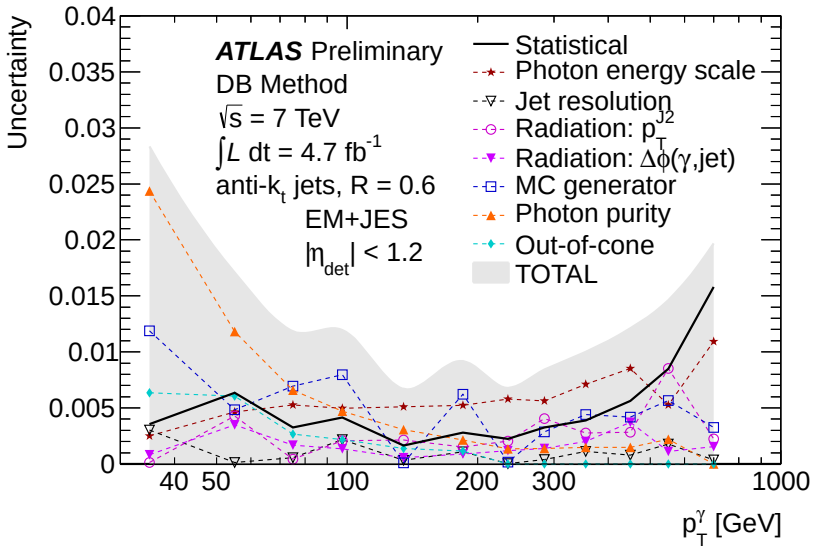
arXiv:1112.6426



In-situ techniques support the single particles based JES uncertainty

Probing jet energy with γ+jet balance in 2011





- data-to-MC ratio is shifted by $\sim 2\%$
- uncertainty of the method $< 1\%$, dominated by the photon energy scale

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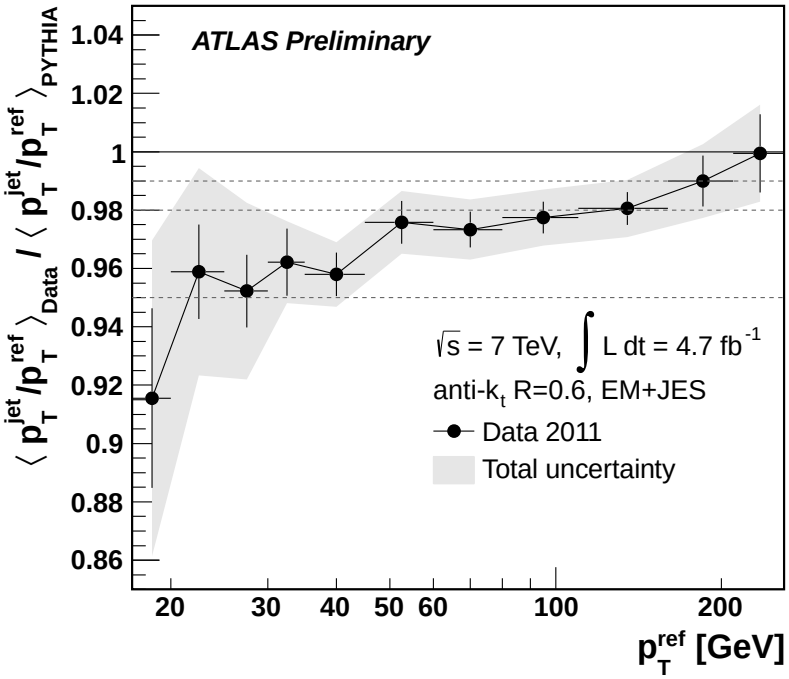
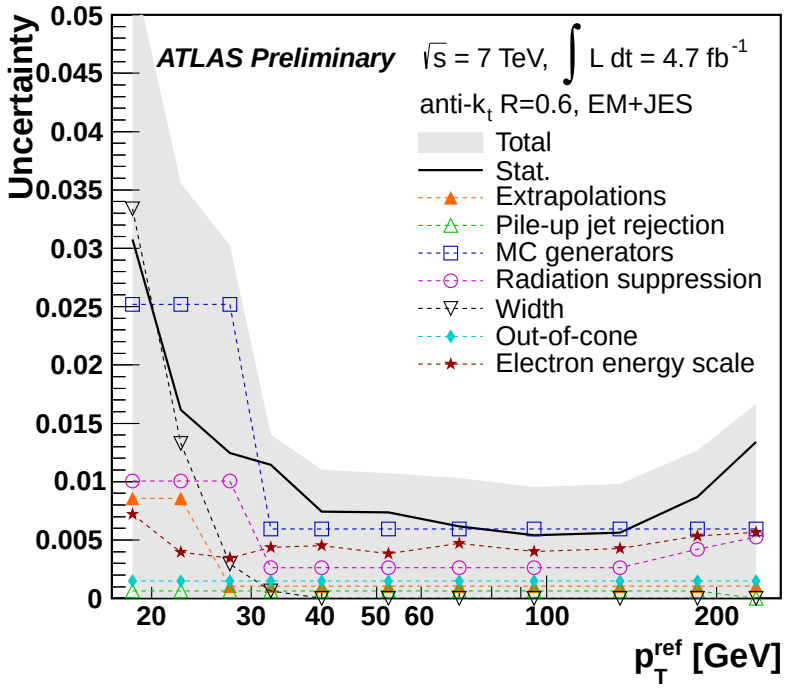
Z+jet balance in 2011





- data-to-MC ratio is shifted down by $\sim 2\%$
- uncertainty of the method $\sim 1 - 2\%$, dominated by (1) statistical (2-3) MC generator, (2-3) electron energy scale uncertainties

ATLAS-CONF-2012-053

Summary

- The JES uncertainty in 2010 dataset is estimated using single hadron response measured in-situ.
  - The JES uncertainty is less than 4.6% for low p_{T}'s and less than 2.5 % in $60 < p_{\mathrm{T}}[\mathrm{GeV}] < 800$
  - The JES uncertainty up to $1\mathrm{TeV}$ is validated in-situ to a few percent level.
  - Correlation information for jet cross section measureemnts is provided in form of nuisance parameters
- Jet energy calibration in 2011 dataset was probed with several in-situ techniques to a $\sim 1\%$ accuracy.