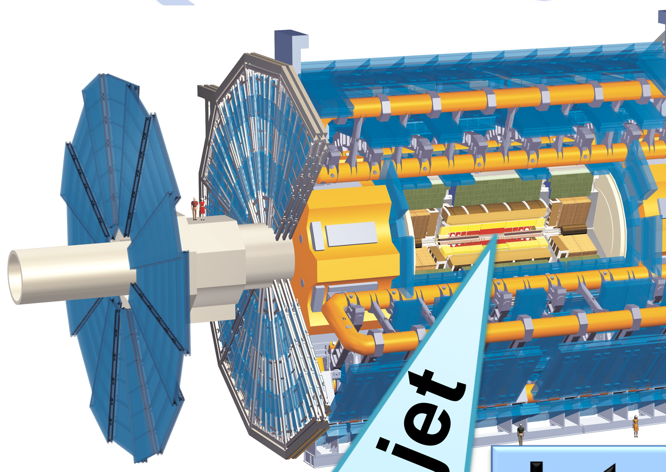
INSTR17, Novosibirsk, 27 February – 3 March, 2017

ATLAS jet and missing energy reconstruction, calibration and performance in LHC Run-2

Jets

Collimated sprays of hadrons are the dominant physics objects arising in LHC collisions. Jets are playing a key role in many Standard Model (SM) physics analyses and searches of new phenomena, e.g. ATLAS jets measurements provide a valuable test of QCD in the multi-TeV regime



Uncalibrated jet

Jet reconstruction and calibration

Jets are reconstructed in ATLAS with the anti-k_t jet algorithm, taking topologically connected calorimeter cells, called clusters, as the input, exploiting its main advantage of effective noise suppression. The jet energy scale (JES) calibration brings measured jet energies to that of particle level. JES calibration is implemented as the step by step correction procedure taking the inputs from various detectors.

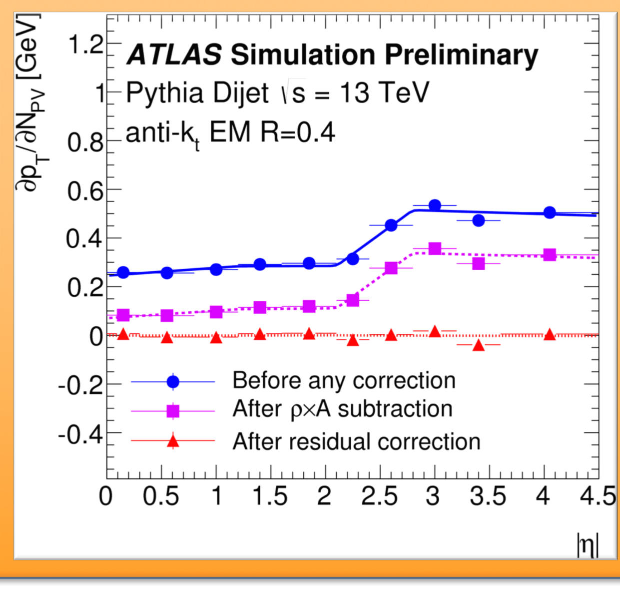
Jet calibration flow

Calibrated jet

Origin correction

Corrects the jet to point to the primary event vertex instead of the geometrical center of ATLAS detector

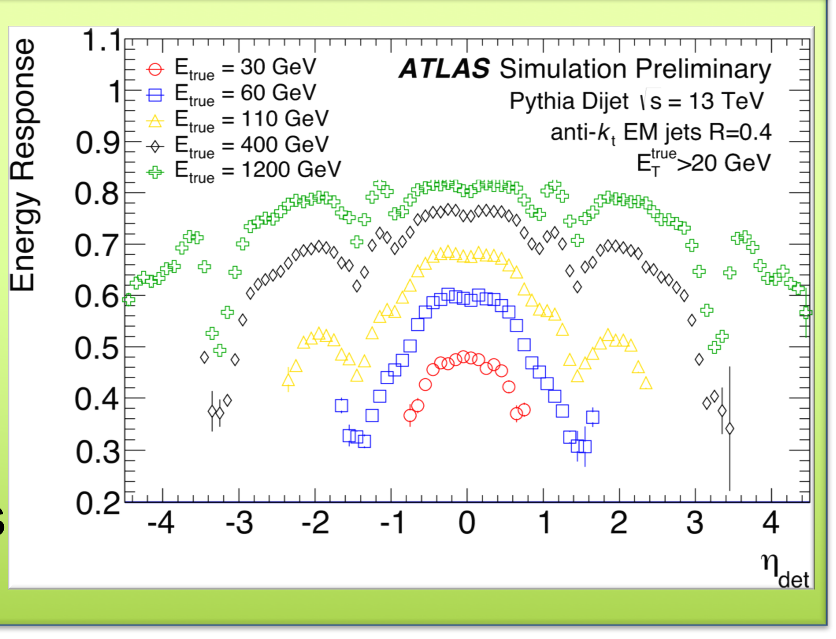
Pile-up correction



- Removes the effect of pile-up exploiting the average energy density ρ and the area of the jet A.
- Residual correction removes NPV and <μ> dependence

MC JES and η correction

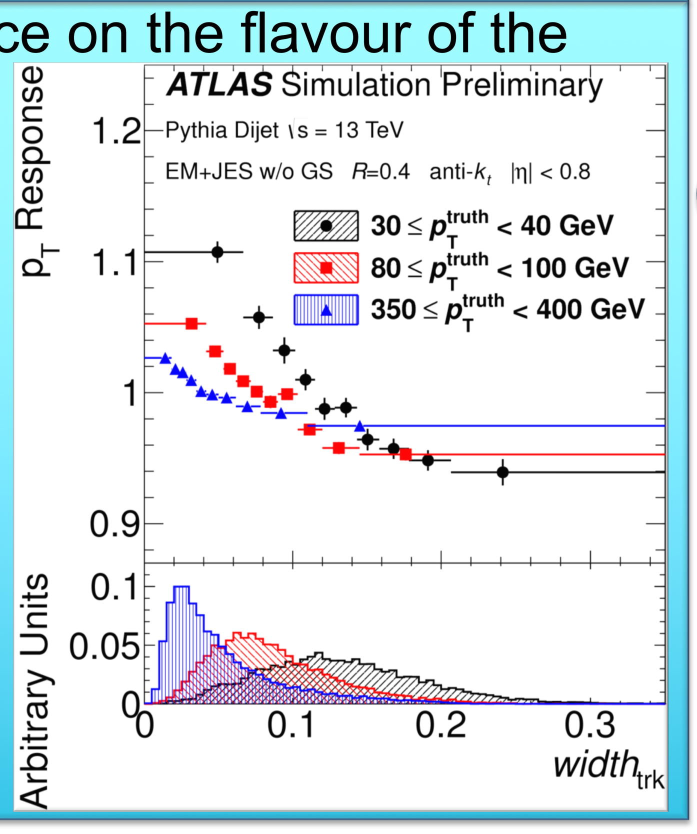
- Corrects jet energy for the relative reco-truth difference of calorimeter energy response in simulation
- Corrects η direction of the jet in specific detector regions where the jet η bias is observed



Global sequential correction

Reduces jet response dependence on the flavour of the initiated-jet parton. Flattens the jet response dependence on the:

1. energy fraction in the last electromagnetic calorimeter layer
2. energy fraction in the first hadronic calorimeter layer
3. number of tracks
4. track width ($width_{trk}$)
5. number of muon segments behind jet

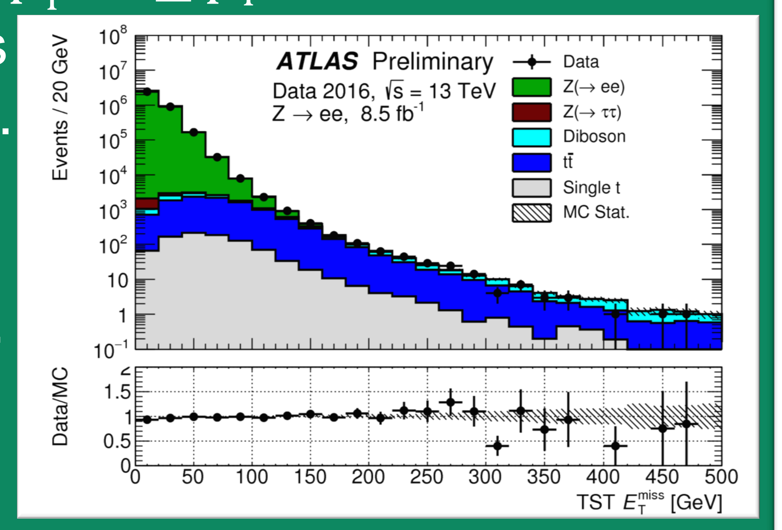


Missing energy (E_T^{miss})

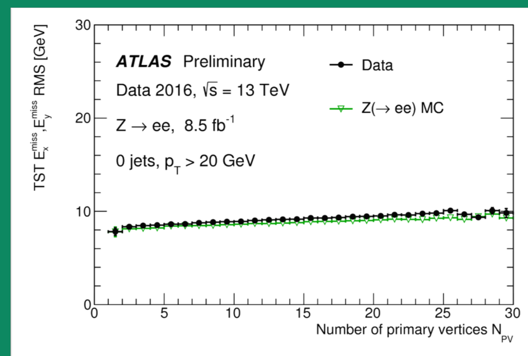
Missing energy is the measure of transverse momentum imbalance created by the detected and well measured objects in an event

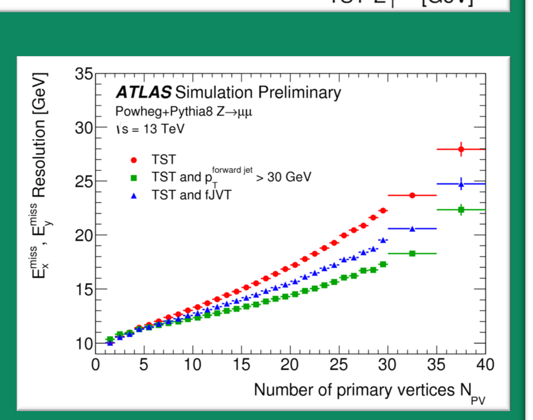
$E_T^{miss} = -\sum p_T^e - \sum p_T^\gamma - \sum p_T^\tau - \sum p_T^\mu - \sum p_T^{jet} - \sum p_T^{soft}$.

The missing energy performance drives SUSY and dark mater searches in LHC.

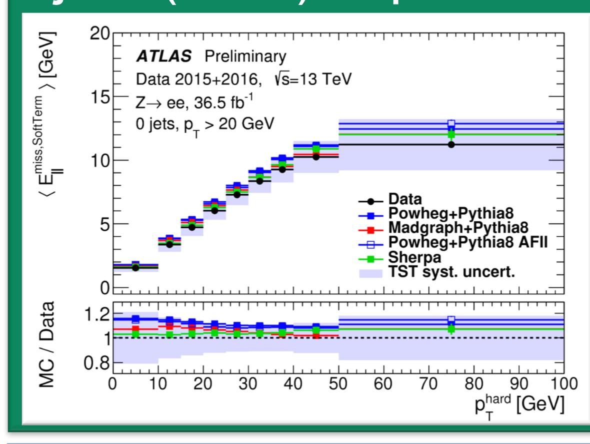


- Reconstruction and performance is estimated in events with small E_T^{miss} such as Z→(ee/μμ), W →(eν/μν) and $t\bar{t}$.
- The soft term (p_T^{soft}) in ATLAS is built from tracks not associated to any reconstructed hard object → Track Soft Term (TST) E_T^{miss}.
- TST E_T^{miss} is insensitive to pile-up, but missing contributions from soft neutral particles.





- The Run-2 brand new technique for suppressing forward pile-up jets (fJVT) improves E_T^{miss} resolution in high pile-up conditions.



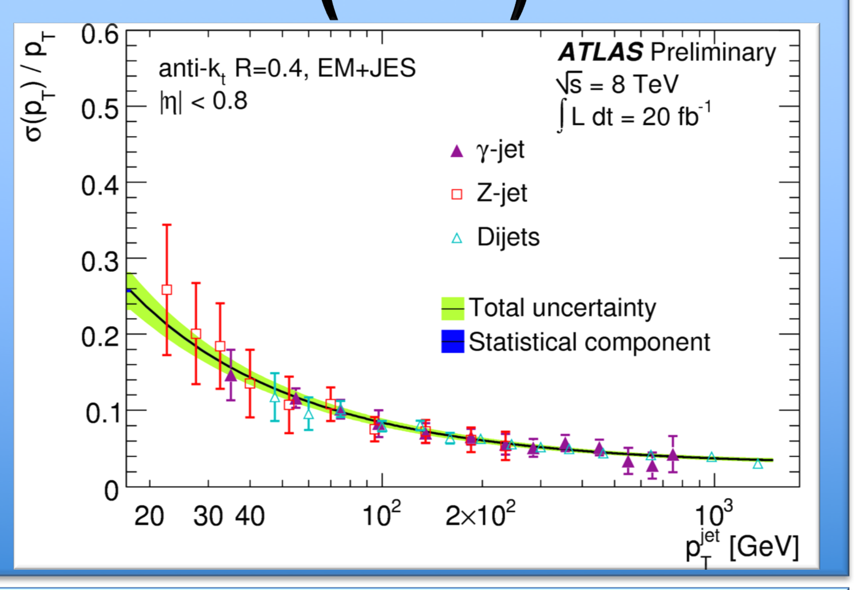
- The hard object systematics uncertainties are propagated to E_T^{miss}.
- The balance of the soft term with the calibrated physics objects is used to estimate the soft-term systematic uncertainties by studying data and MC discrepancies.

Jet Energy Resolution (JER)

The JER is parametrised with the function:

$$\frac{\sigma(p_T)}{p_T} = \frac{N}{p_T} \oplus \frac{S}{\sqrt{p_T}} \oplus C$$

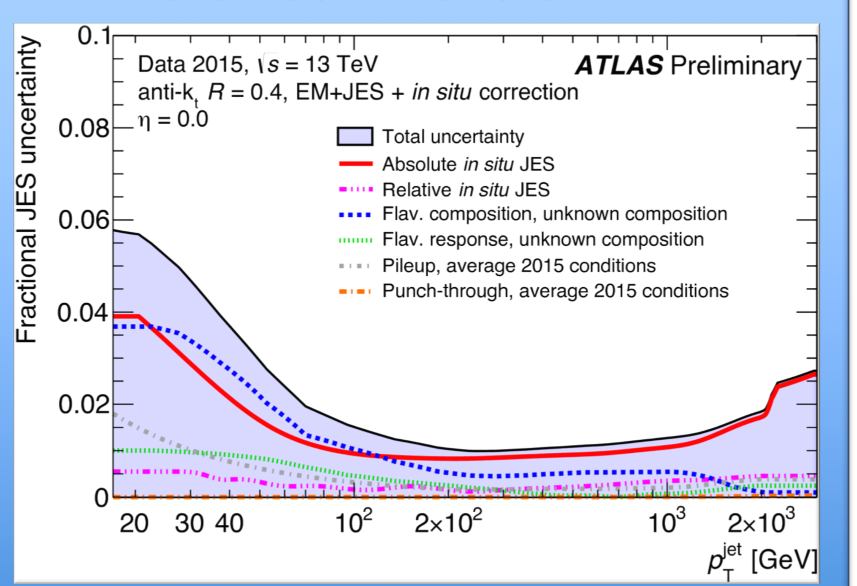
The noise (N), stochastic (S) and constant (C) terms were measured in situ with Z/γ+jets and dijet events.



JES Systematic uncertainties

The jet calibration is supplied with the set of 88 independent sources of systematics uncertainties to correctly account for all correlations in jet calibration.

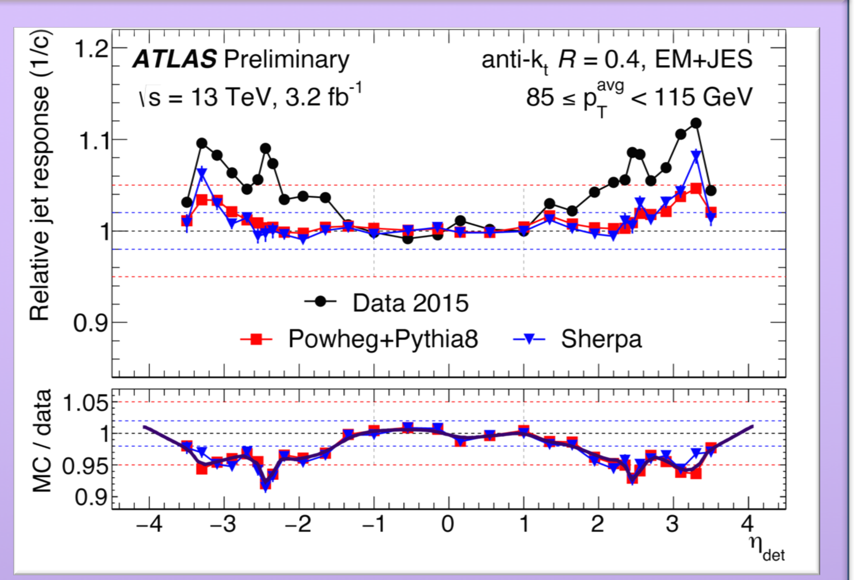
A reduced set of systematic uncertainties is produced to simplify physics analyses while keeping the loss of correlation information to a minimum.

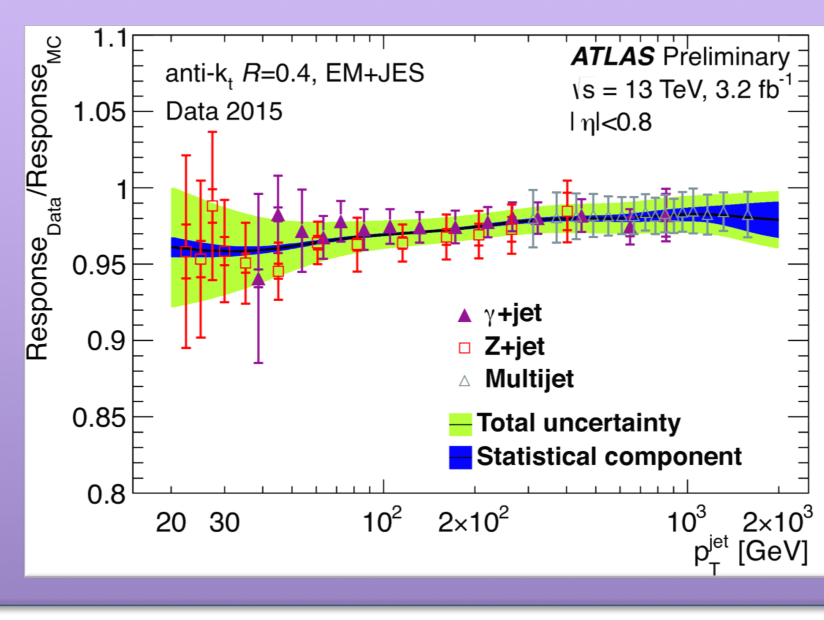


In situ residual correction

Corrects the jet pT in data using a well calibrated reference object in dijet, Z/γ and multijet events

- **η-intercalibration** exploits central jets to calibrate forward jets





- **Z/γ** transverse momentum **balance** is used to correct jets with pT < 800 GeV
- **Multijet balance** w.r.t. calibrated low pT jets is used to correct jets with highest pT

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ATLAS EXPERIMENT