IN SITU MEASUREMENTS OF THE ATLAS JET ENERGY RESOLUTION USING 13 TeV PP DATA

CAP Congress - SFU, 4 June 2019

JER Parametrization

$$\frac{\sigma_{p_T}}{p_T} = \frac{N}{p_T} \oplus \frac{S}{\sqrt{p_T}} \oplus C$$

N: noise term → pile-up and electronics noise

S: stochastic term → sampling calorimeter

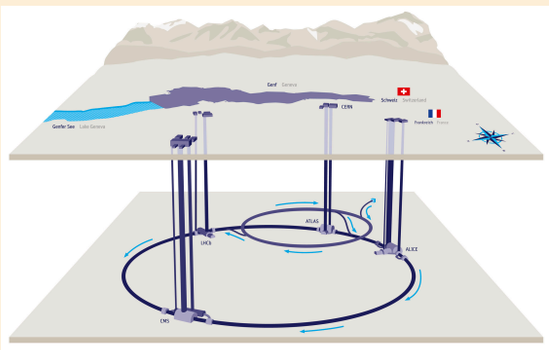
C: constant term → p_T indep. term due to passive material

The quarks and gluons produced in proton-proton collisions form collimated sprays of particles, known as jets. They are produced at a very high rate at the Large Hadron Collider (LHC, at CERN in Geneva, Switzerland) and thus are part of almost all interesting *pp* collision analyses. Due to the complex structure of jets, only a part of their energy can be measured directly in the ATLAS detector. A sophisticated calibration chain is used to correct the energy scale of a jet to that of the initial quark or gluon. An important part of this calibration is to understand the typical range of energy values a given jet can deposit in the detector. This quantifies the Jet Energy Resolution (JER) and this poster presents a measurement of the JER at low transverse moment.

The ATLAS Experiment at the LHC

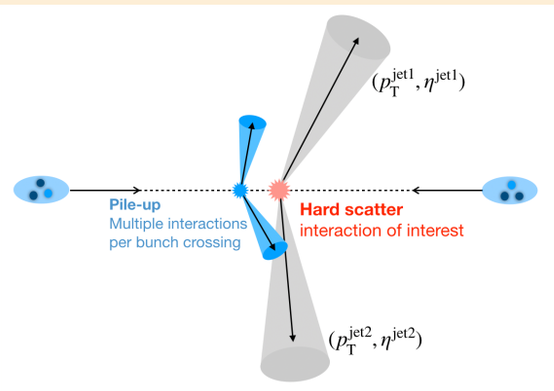
The collider

The LHC is a 27 km circular particle collider that collides protons at a center-of-mass energy of 13 TeV



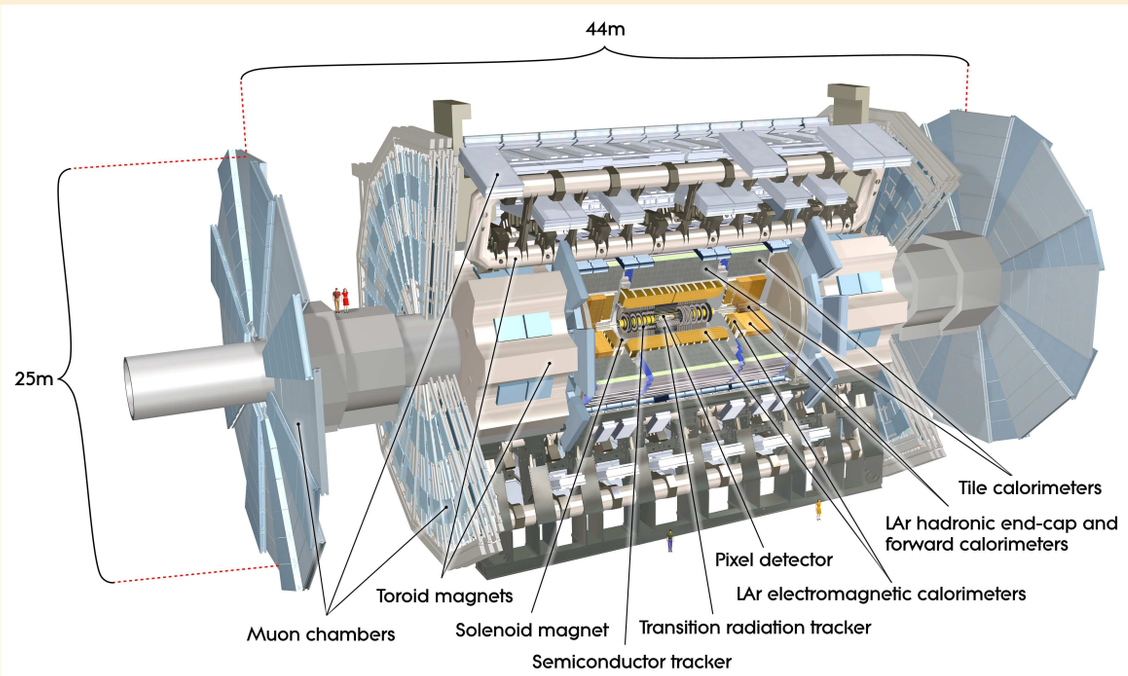
The *pp* collisions

Various different physical processes can occur and new particles are created



The ATLAS detector

Multipurpose detector for measuring signals from various particles



JER Noise Term Measurement

$$N_{full} = N_{pile-up} \oplus N_{\mu=0}$$

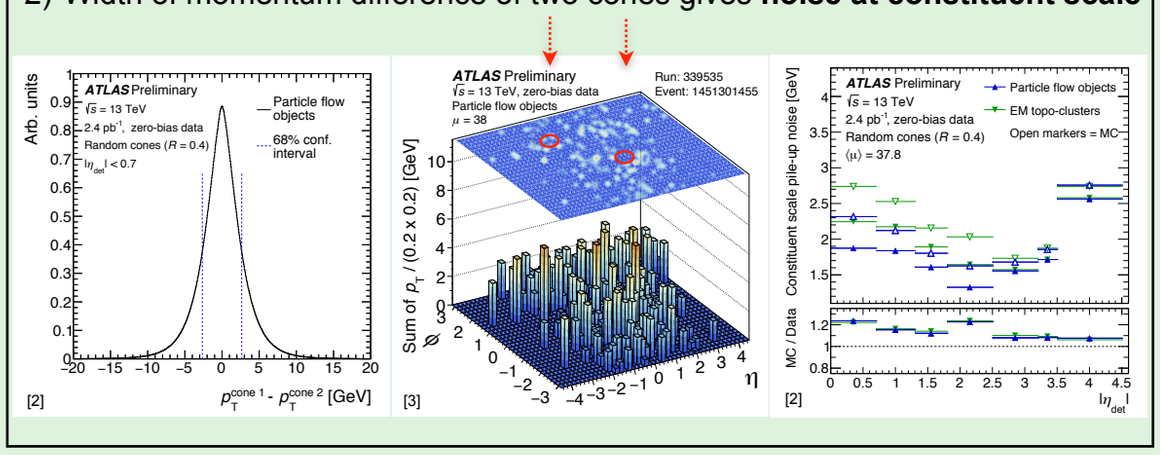
→ **Noise from electronics**

Extracted from JER of MC with no pile-up

Noise from pile-up

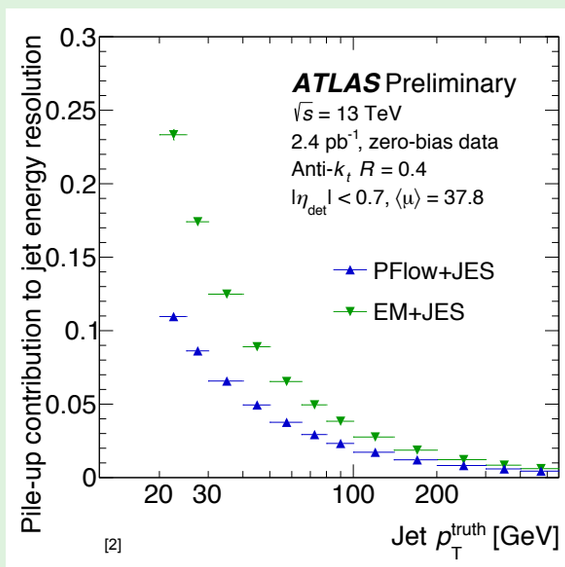
Random cones method:

1) Sum energies within randomly distributed and non-overlapping pairs of cones (R = 0.4) in **zero-bias data** (sample of randomly chosen collision events)
2) Width of momentum difference of two cones gives **noise at constituent scale**



Extraction of N_{full}

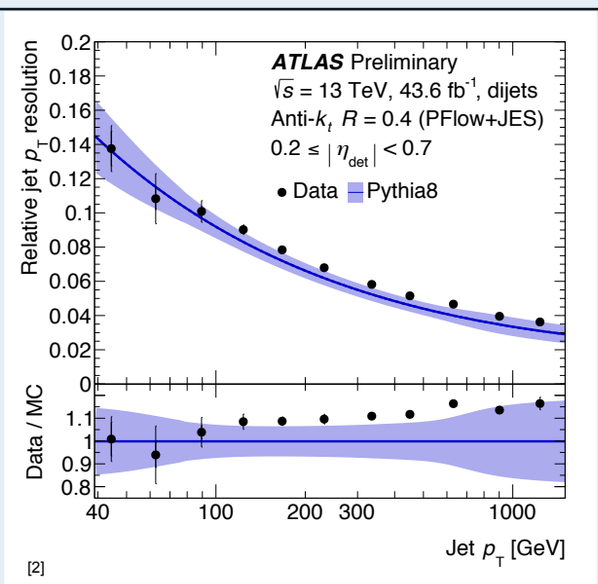
The random cones noise is scaled to the jet energy scale in bins of particle-level jet p_T. **The pile-up noise term** is extracted from a fit to the pile-up resolution and added in quadrature to the noise from electronics.

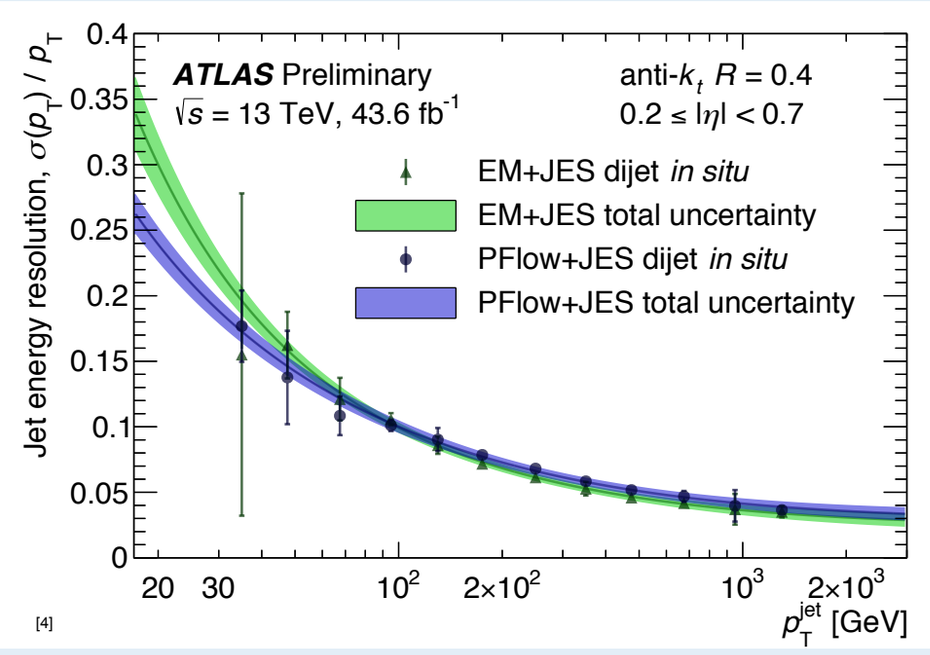


JER Combination

Dijet Direct Balance

Measure the p_T dependent JER with the dijet direct balance method in Data and MC





Combined fit

Dijet results fitted with N, S, C parametrization with fixed noise term from the random cones measurement. Particle flow jets show lower JER and smaller uncertainties at low p_T, which is driven by the noise term. After the combination, the average JER in MC is smeared to match data.

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References: [1] CERN-EP-2017-024, https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PLOTS/… [2] …= JETM-2019-01, [3] … = JETM-2019-04, [4] … = JETM-2018-005

ATLAS EXPERIMENT