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 Parametrization
\[
\frac{\sigma_{p_T}}{p_T} = \frac{N}{p_T} + \frac{S}{\sqrt{p_T}} + C
\]

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.

JER Noise Term Measurement

\[ N_{\text{null}} = N_{\text{pile-up}} \oplus N_{\mu=0} \]

Noise from pile-up
Extracted from JER of MC with no pile-up

Random cones method:
1) Sum energies within randomly distributed and non-overlapping pairs of cones \((R = 0.4)\) in zero-bias data
2) Width of momentum difference of two cones gives noise at constituent scale

Extraction of \(N_{\text{null}}\)
The random cones noise is scaled to the jet energy scale in bins of particle-level \(p_T\). The pile-up noise term is extracted from a fit to the pile-up resolution and added in quadrature to the noise from electronics.

Dijet Direct Balance
Measure the \(p_T\) dependent JER with the dijet direct balance method in Data and MC

JER Combination

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.