MISSING TRANSVERSE MOMENTUM RECONSTRUCTION IN 2017 DATA AT THE ATLAS EXPERIMENT

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Introduction
- Missing transverse momentum (MET) performance is evaluated in 2015 - 2017 data at a centre-of-mass energy of 13 TeV.
- Momentum imbalance could imply:
  - Real MET undetectable particles, new stable particles.
  - Fake MET: misidentification of particles.
- Backgrounds arising from fake MET are important in many measurements and new physics searches.

**Missing Transverse Momentum (MET)**

- **Transverse momentum imbalance**: 
  \[ \Delta p_T^{\text{miss}} = \left( \sum \Delta p_T^{\text{lepton}} + \sum \Delta p_T^{\text{muon}} + \sum \Delta p_T^{\text{jet}} + \sum \Delta p_T^{\text{lepton}} + \sum \Delta p_T^{\text{muon}} + \sum \Delta p_T^{\text{jet}} \right) \]

  **Hard term:** consists of electron, muon, tau, gamma and jet.
  **Soft term:** purpose of the soft term is to include the momenta of particles not included in the selected hard objects and excluding pile-up activity as much as possible.

  Two soft term reconstruction algorithms:
  - **Track Soft Term (TST):**
    - Soft Term constructed from tracks not included in hard objects, and matched the hard scatter primary vertex. More robust to pile-up but does not contain neutral particles.
  - **Calorimeter Soft Term (CST):**
    - Soft Term constructed from the calorimeter topoclusters not included in the hard objects. Contains neutral particles but less pile-up robust.

**Input Jets:**
- Jet selection affects MET performance and systematic uncertainties.
- Treatment in MET performance:
  - Using the anti-kt4 algorithm to build jets from either EM-scale topoclusters or PFlow objects.
  - \( p_T \) threshold 20 GeV.
  - Applying a JVT (Jet Vertex Tagger) on the jets to suppress pileup contributions.

**Overlap Removal**
- Overlapping leptons and jets can cause fake tails in the MET distribution.
- Jet close to electron:
  - Electrons also create jets in the calorimeter so care has to be taken that they are not counted twice. If there is a real jet near the electron we need to make sure we do not also remove it.
  - Fake electrons and pile-up would lead to both miscalibration and double counting.

  1. Real jet close to real electron.
  2. Jet from pileup or electron radiation.
  3. Real jet and fake electron.

**Scale**
- The balance between leptons and MET
- Ideally calibrated MET is 0 in \( Z \rightarrow \ell \ell \) events.

**Resolution**
- The width of MET distribution quantifies the performance of MET reconstruction. Each point is obtained by taking the RMS of the MET distribution.

- **Tight MET operating point** raises the jet \( p_T \) from 20 to 30 GeV for \( \eta > 2.4 \).
- **Tight working point** has a smaller dependence on pileup.

- Most pileup dependence comes from forward jets.
- PFlow jets improve the MET resolution.

**TST Systematic Uncertainty**
- Balance MET soft term with hard term in the transverse plane

- The largest disagreement between simulation and data is the systematic uncertainties in the soft term.
- Average number of interactions per bunch crossing \( \langle p_T \rangle \) increased from 25 to 38 from 2015 to 2017, but the systematic bands remained the same.

**References**


Fang-Ying Tsai (DESY), for the ATLAS collaboration.