MISSING TRANSVERSE MOMENTUM RECONSTRUCTION IN 2017 DATA AT THE ATLAS EXPERIMENT

LHCC poster session, 28 February 2018, CERN

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: miscalibration or mismeasurement of the physics objects.
- Backgrounds arising from fake MET are important in many measurements and new physics searches.

Missing Transverse Momentum (MET)

- Transverse momentum imbalance $\vec{E}_T^{miss} = -(\Sigma\vec{P}_T^{e} + \Sigma\vec{P}_T^{muon} + \Sigma\vec{P}_T^{jet} + \Sigma\vec{P}_T^{tau} + \Sigma\vec{P}_T^{\gamma} + \Sigma\vec{P}_T^{soft})$

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.

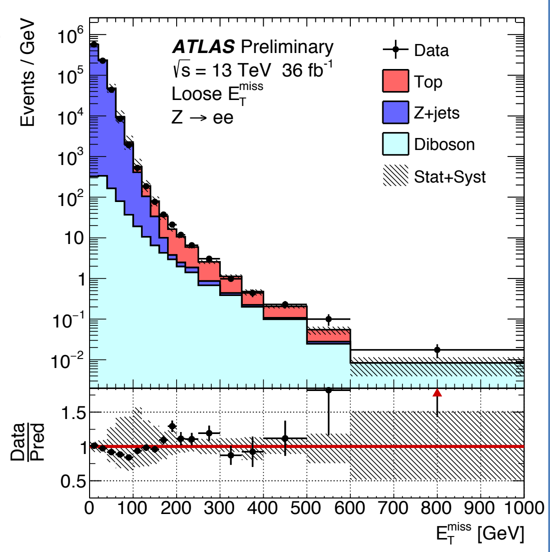
Input jets:

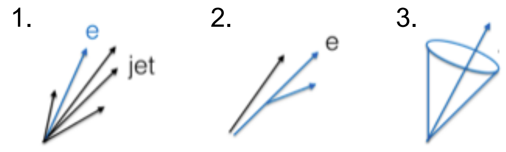
Jet selection affects MET performance and systematic uncertainties.
Treatment in MET performance:

- 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.



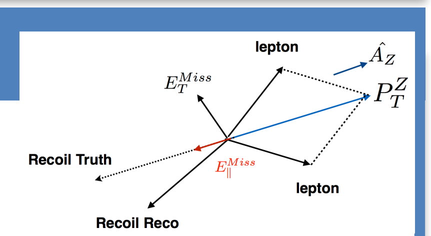


1.Real jet close to real electron. 2.Jet from pileup or electron radiation. 3.Real jet and fake electron.

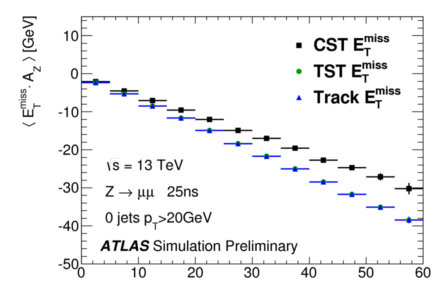
Scale

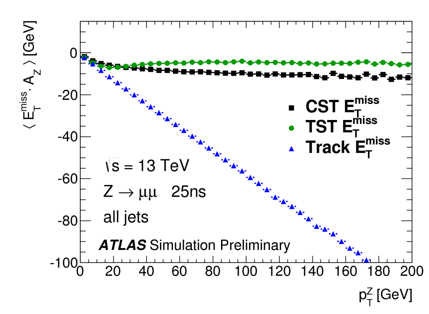
The balance between leptons and MET

- Ideally calibrated MET is 0 in Z → ℓℓ events.



$$-\vec{R} = \vec{E}_T^{Miss} + \vec{P}_T^Z$$

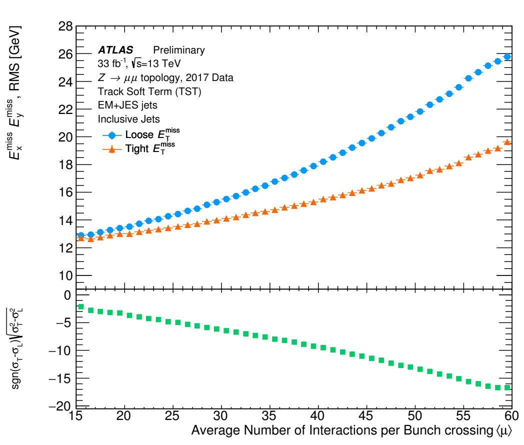


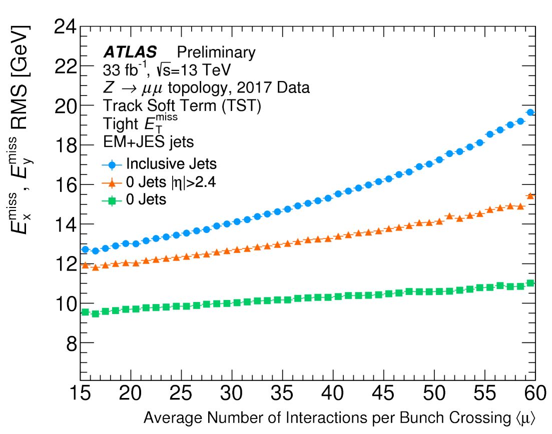


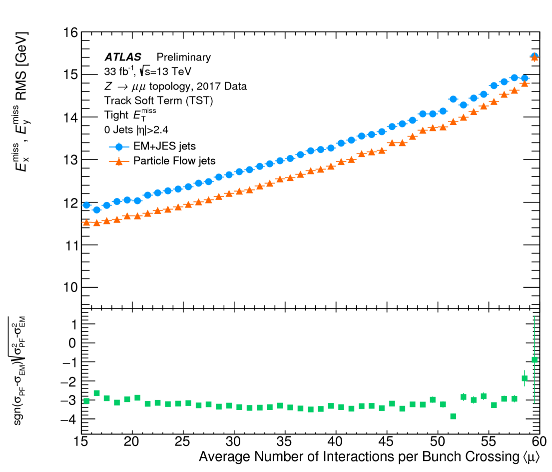
- Track based algorithms perform worse since they miss neutral particles in the soft term.
- Using the calorimeter measurement of the jets recovers the MET scale relative to using the tracks from those jets.

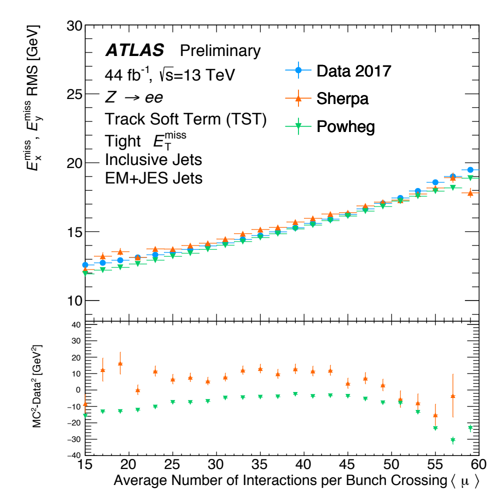
Resolution

The width of MET distribution quantities the performance of MET reconstruction. Each point is obtained by taking the RMS of the MET distribution.





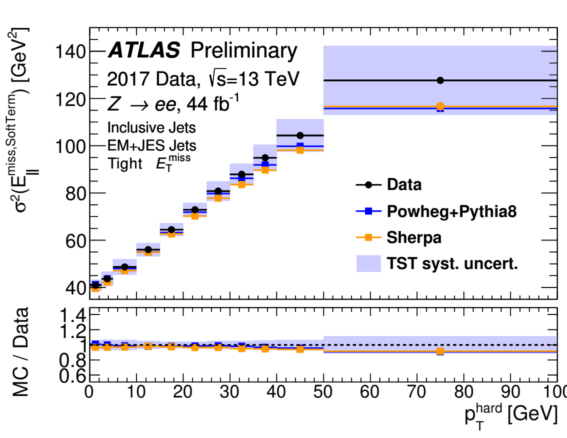


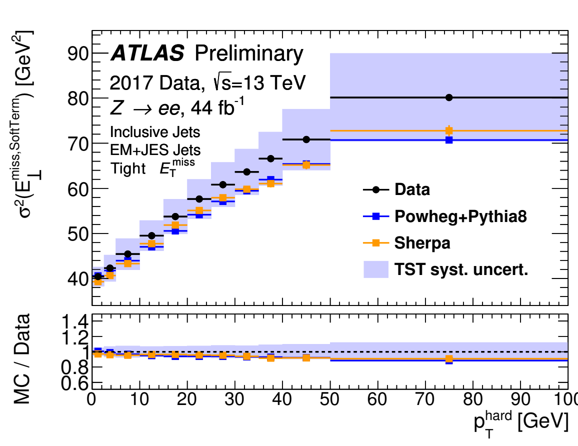


- Tight MET operating point raises the jet p_T from 20 to 30 GeV for |η|>2.4.
- Tight working point has a smaller dependence on pileup.
- Most pileup dependence comes from forward jets.
- PFlow jets improve the MET resolution.
- Data 2017 and MCs agree in MET resolution vs Average number of interactions per bunch crossing <μ>. (similar results for EMTopo and EMPFlow)

TST Systematic Uncertainty

Balance MET soft term with hard term in the transverse plane





- The largest disagreement between simulation and data is used as the systematic uncertainties in the soft term.
- Average number of interactions per bunch crossing <μ> increased from 25 to 38 from 2015+16 to 2017, but the systematic bands remained the same.

References

[1] MET performance in the ATLAS detector using 2015-2016 LHC p-p Collision CONF-JETM-2017-02
[2] Expected performance of MET for the ATLAS detector at √s=13 TeV. Technical Report ATL-PHYS-PUB-2015-023, CERN, Geneva,Jul 2015
[3] Jet reconstruction and performance using particle flow with the ATLAS Detector, Eur. Phys. J. C (2017)

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