Performance of missing transvers momentum reconstruction: muon-jets overlap removal

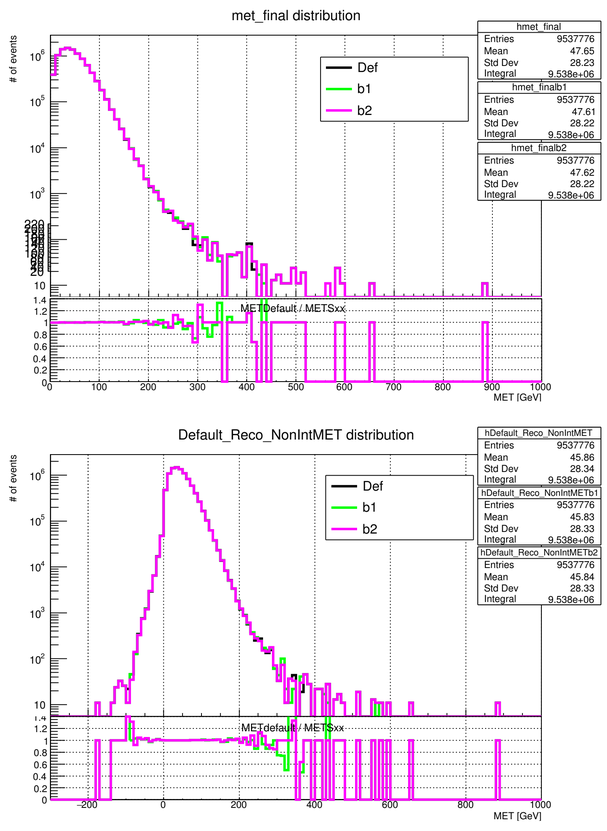
Mohamed Zaazoua, Farida Fassi
Faculty of sciences Rabat, University Mohammed V, Morocco
mohamed.zaazoua@cern.ch

Abstract

The missing transverse energy (MET) is associated with production of particles that escape detection : neutrinos as well as a number of exotic particles predicted by extensions of the Standard Model. Thus, MET is of crucial importance for a number of physics analyse. The reconstruction of MET is very sensitive to the particle momentum measurements, detector malfunctions, particles impinging on poorly instrumented regions of the detector, beam-halo particles, and cosmic-ray particles. Missing transverse energy resolution, which historically has played an important role in the W-boson discovery and the search for new phenomena at hadron colliders, is closely related to the calorimeter jet energy response. MET is computed using fully calibrated electrons, muons, photons, hadronically decaying -leptons, and jets reconstructed from calorimeter energy deposits and charged-particle tracks. These are combined with the soft hadronic activity measured by reconstructed charged particle tracks not associated with the hard objects. A detailed description the missing transverse energy performance, including muon-jets overlap removal, is studied in $Z \rightarrow \mu\mu$ events that is a source of clean final state with two energetic, isolated muons and no intrinsic missing transverse energy.

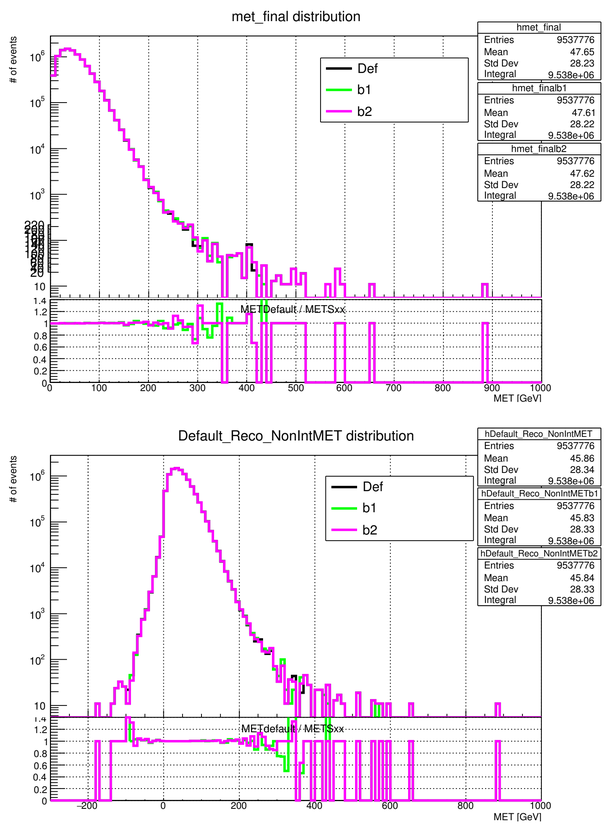
EMTopo jet collection

Jets are reconstructed from 3d topoclusters of energy deposits using the the $anti-k_t$ algorithm with R=0.4.



EMPFlow jet collection

Jets and soft activity are reconstructed by combining information from the calorimeter and the ID.



References

[1] ETmiss performance in the ATLAS detector using 2015-2016 LHC ppCollisions.(2017)

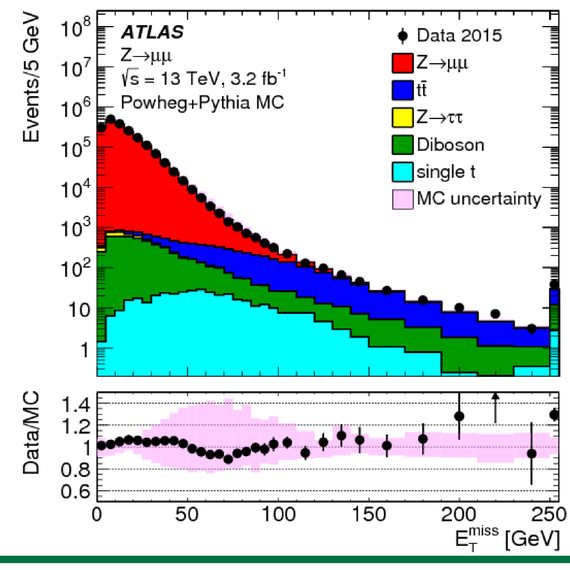
[2] Performance of missing transverse momentum reconstruction with the ATLAS detector using proton-proton collisions at $\sqrt{s} =$ 13 TeV. (2018)

Introduction

$$MET = -(\sum P_T^e + \sum P_T^\mu + \sum P_T^\gamma + \sum P_T^\tau + \sum P_T^{jet} + \sum P_T^{soft})$$

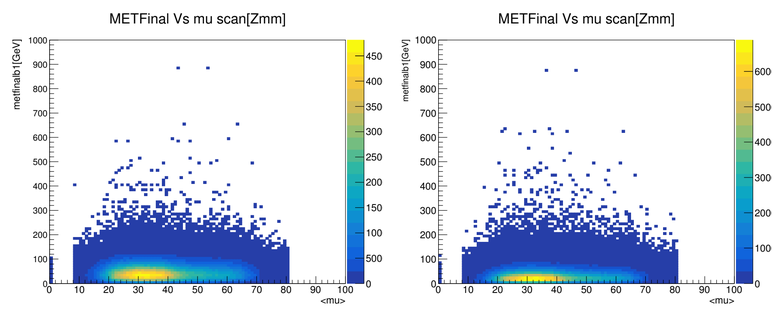
Overlapping leptons and jets can cause fake tails in the MET distribution.
Jet close to muon:

- Jets representing a significant energy loss along the path of the μ through the calorimeter need to be rejected for MET reconstruction.
- pile-up jets need to be rejected for MET reconstruction.
- Jets reconstructed from FSR of the μ need to be included into MET reconstruction.



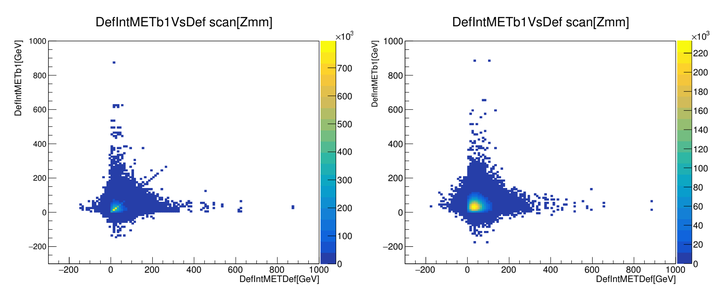
Pileup dependancy

The pileup study shows no dependency of results on the pileup.



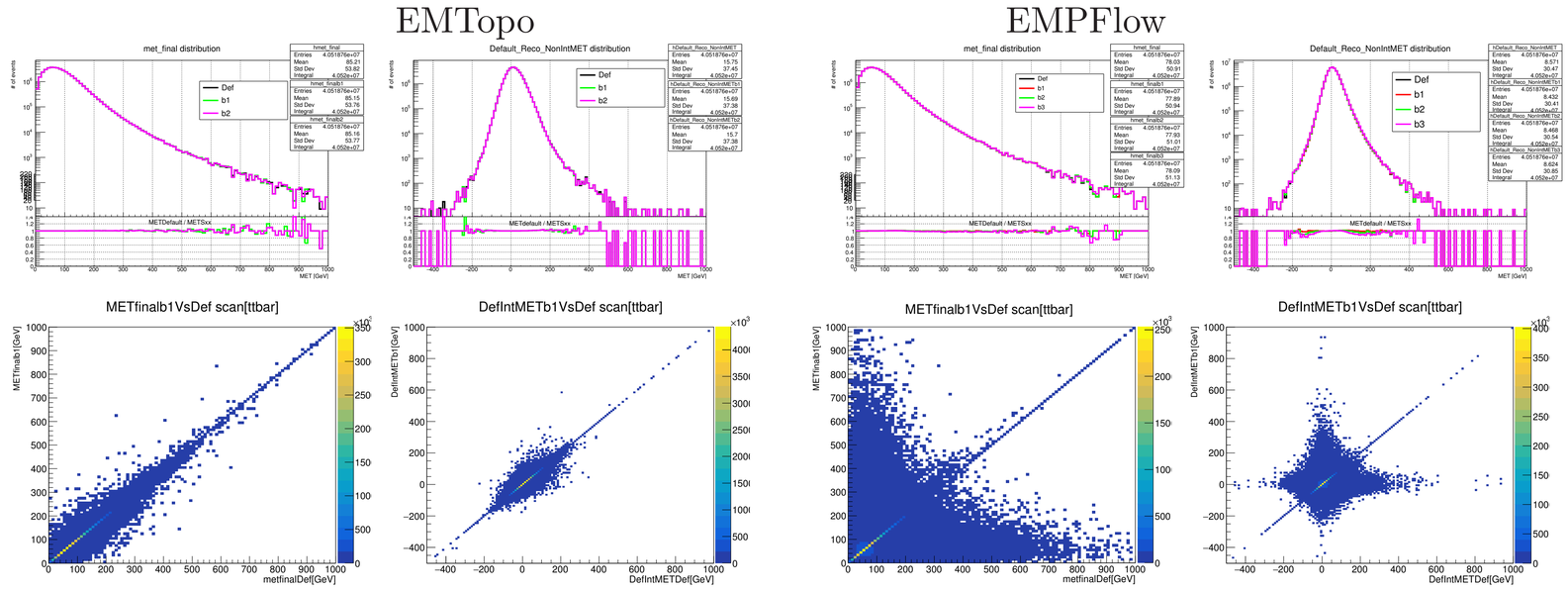
Correlation

No correlation found between this result (new tuning values) and oldest one.



Verification for ttbar topology

The same process used for $Z \rightarrow \mu\mu$ events was applied on ttbar MC samples:



Conclusions

The obtained results of the overlap removal study improve the MET performance.

1. The improvement on the MET integral value is about **7.23%** and **0.43%** using PFlow and EMTopo respectively.
2. The improvement on the MET average value is about **1.46%** and **0.065%** using PFlow and EMTopo respectively.

To validate the resulting overlap removal tuning values, ttbar dense environment was investigated. In addition, to Other $Z \rightarrow \mu\mu$ MC samples (Sherpa and Powheg).

Results have been confirmed using Bootstrap statistical method.