tcMET: 16X→22X transition

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with

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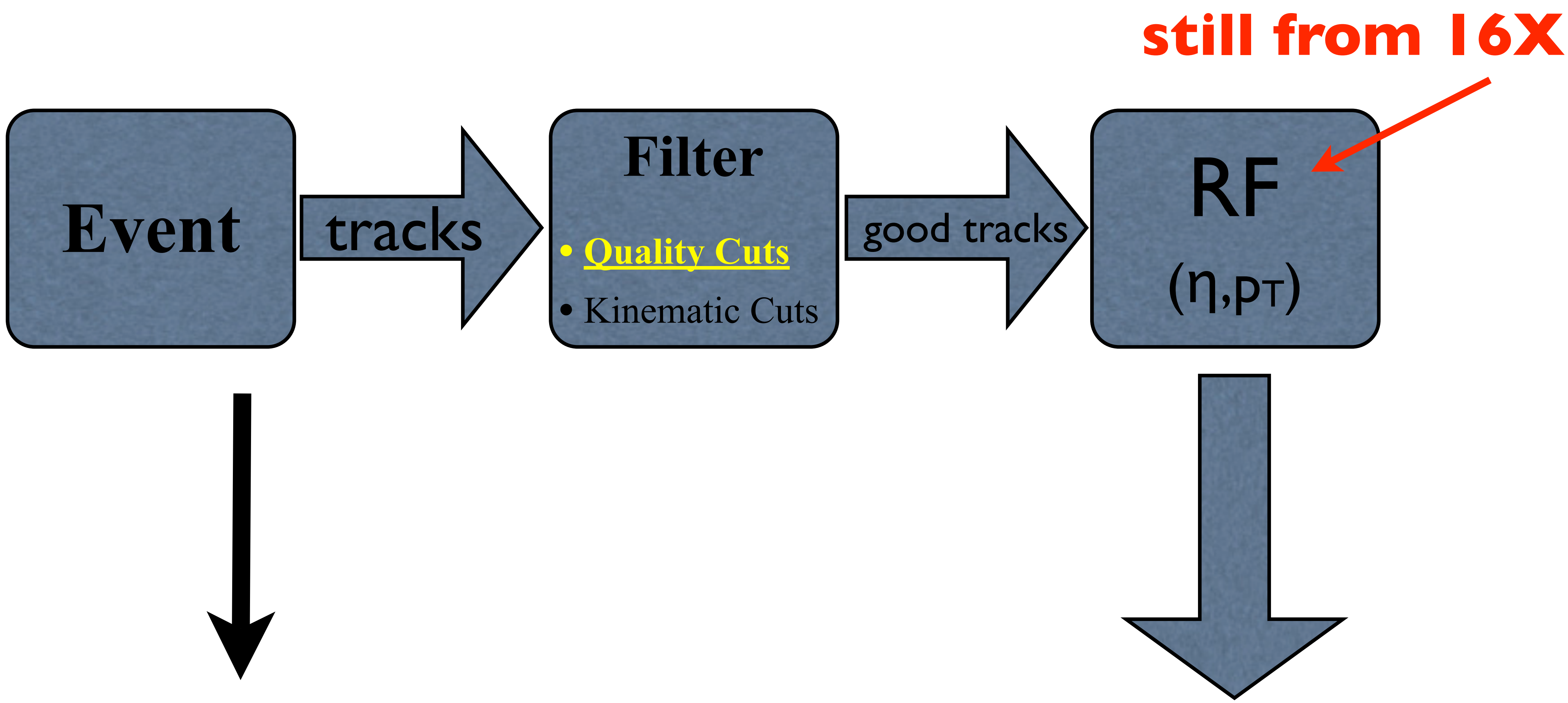
Outline

- Review of tcMET
- Muon Corrections
  - changed algorithms to UCSB corrections
- “Electron” Corrections
  - things still the same
- Track (pion) corrections
  - new quality cuts
- Results
  - Application to DY, WW
  - MET resolution
  - Comparison to patMET
- Current Status

tcMET - Implementation



tcMET = MET - p + ⟨E⟩

$$\text{tcMET} = \text{MET} - p + \langle E \rangle$$

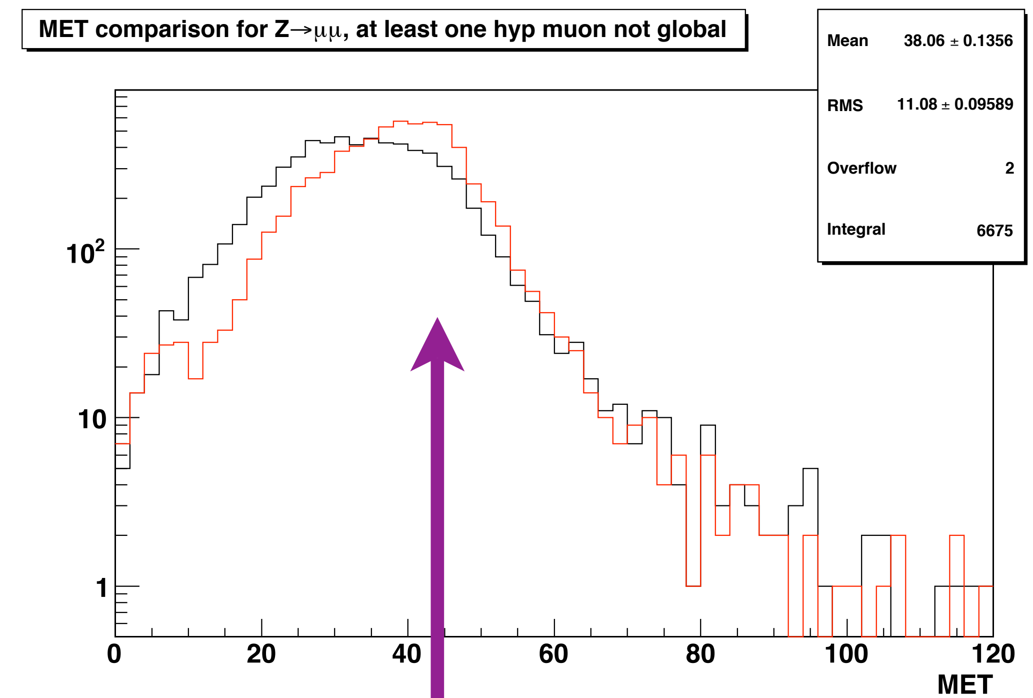
track corrected MET	momentum of good track	expected energy deposited

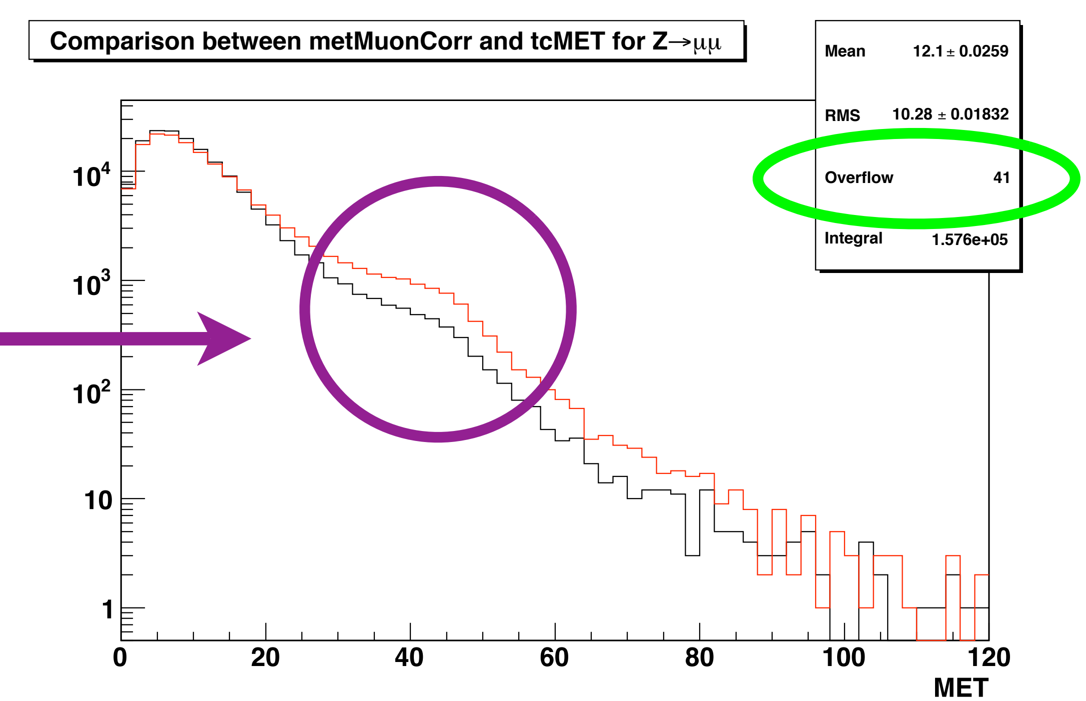
Implementation Details

- **Identify and correct muons**
  - Correct at outset using standard methods
- **Identify and do not correct "electron-like" objects**
  - PixelMatchGsfElectron with h/e < 0.1
  - skip since nearly all energy already deposited in ECAL
- **Ignore tracks with p_T outside of [2, 100] GeV**
  - avoid *generating* large fake MET (quality cut on high p_T tracks)
  - for tracks with pT < 2 GeV, only add track at vertex

Muon Corrections

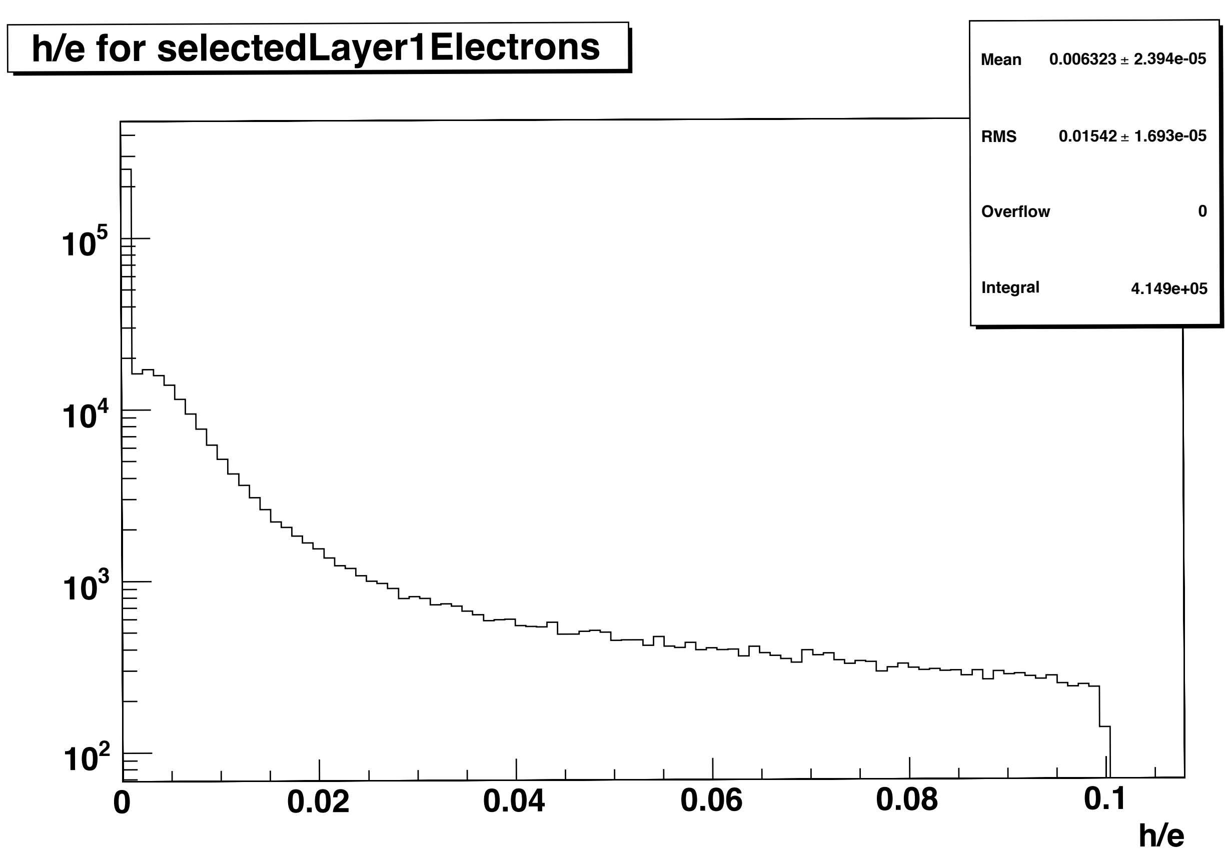
- Muons corrected using UCSB algorithm
  - MetMuonCorrections_cff.py
- Algorithm corrects for muons that pass:
  - nhits > 5
  - pt > 10 (global fit), |η| < 2.5
  - qoverp error < 0.5
  - global muons
- **Important**: use good **<u>global</u> <u>muons</u>**
  - Allowing none global muons in final state distorts MET distribution
  - Large MET in tails from global muons with high reconstructed pt
    - Check bad global fit, compare to tracker pt





Electron Corrections

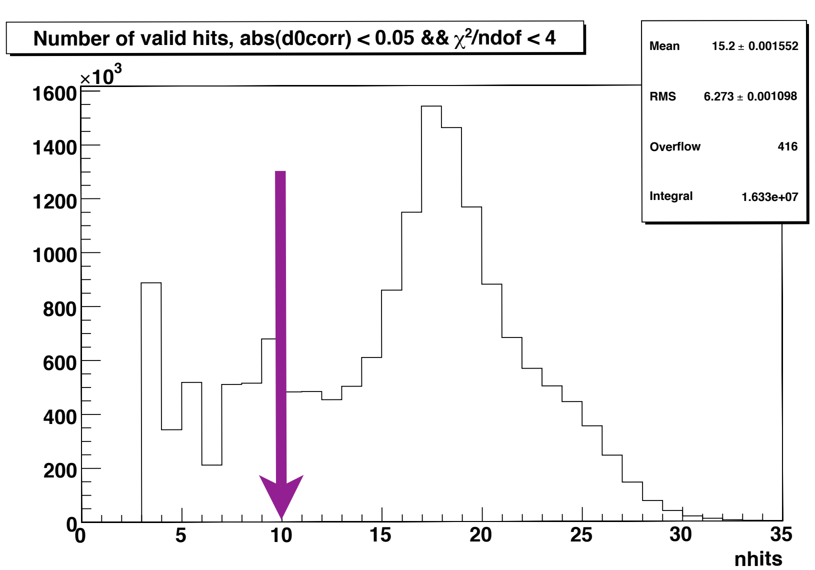
- **Identify and do not correct "electron-like" objects**
  - PixelMatchGsfElectron with h/e < 0.1
  - skip since nearly all energy deposited in ECAL
  - no change since 16X

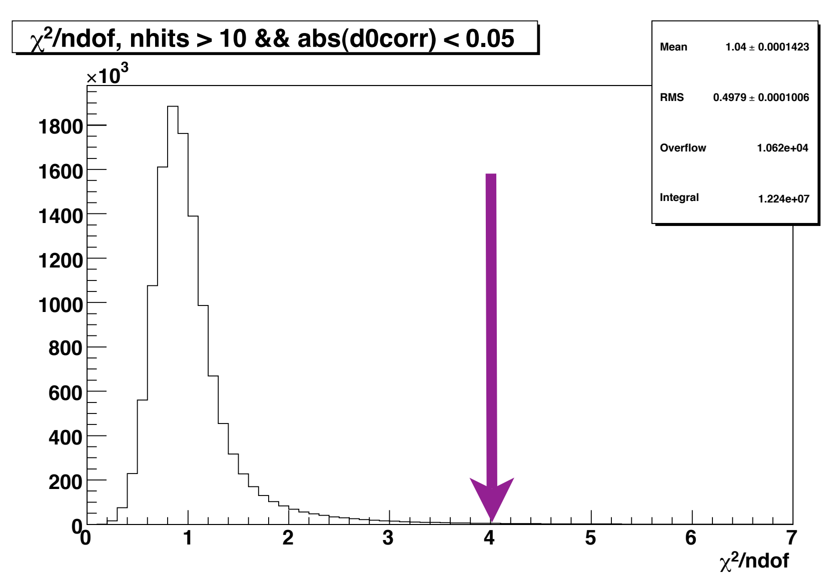


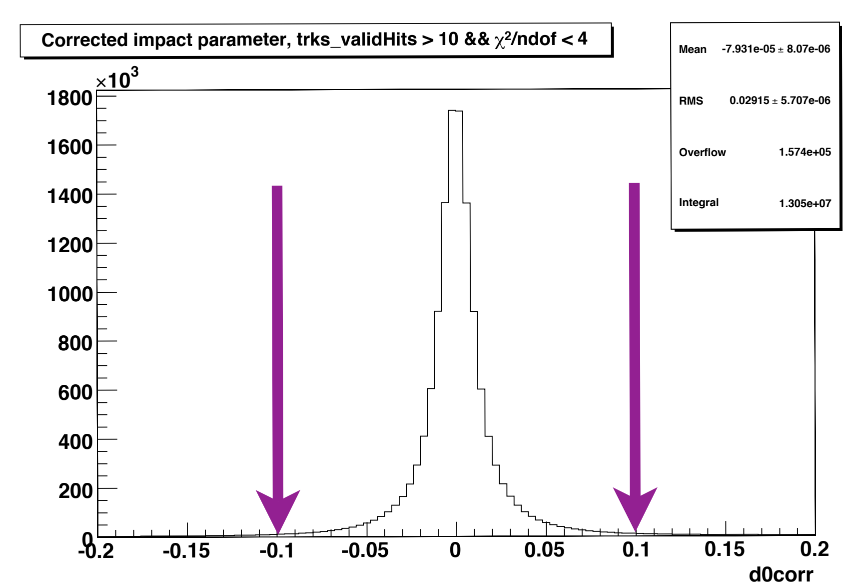
- Plot to right show h/e for electrons used in CMS2
- Looks to be an implicit cut of same magnitude on h/e in constructing the collection

Track Corrections

- **Ignore tracks with p_T outside of [2, 100] GeV**
  - avoid *generating* large fake MET (quality cut on high p_T tracks)
  - for tracks with pT < 2 GeV, only add track at vertex
  - unchanged from 16X
- **New track quality cuts to get in line with 22X tracking**
  - 16X: nhits > 5, chi2/ndof < 5, |d0| < 0.05
  - **displaced beamSpot: d0 → d0corr**
  - **22X: nhits > 10, chi2/ndof < 4, |d0corr| < 0.1**



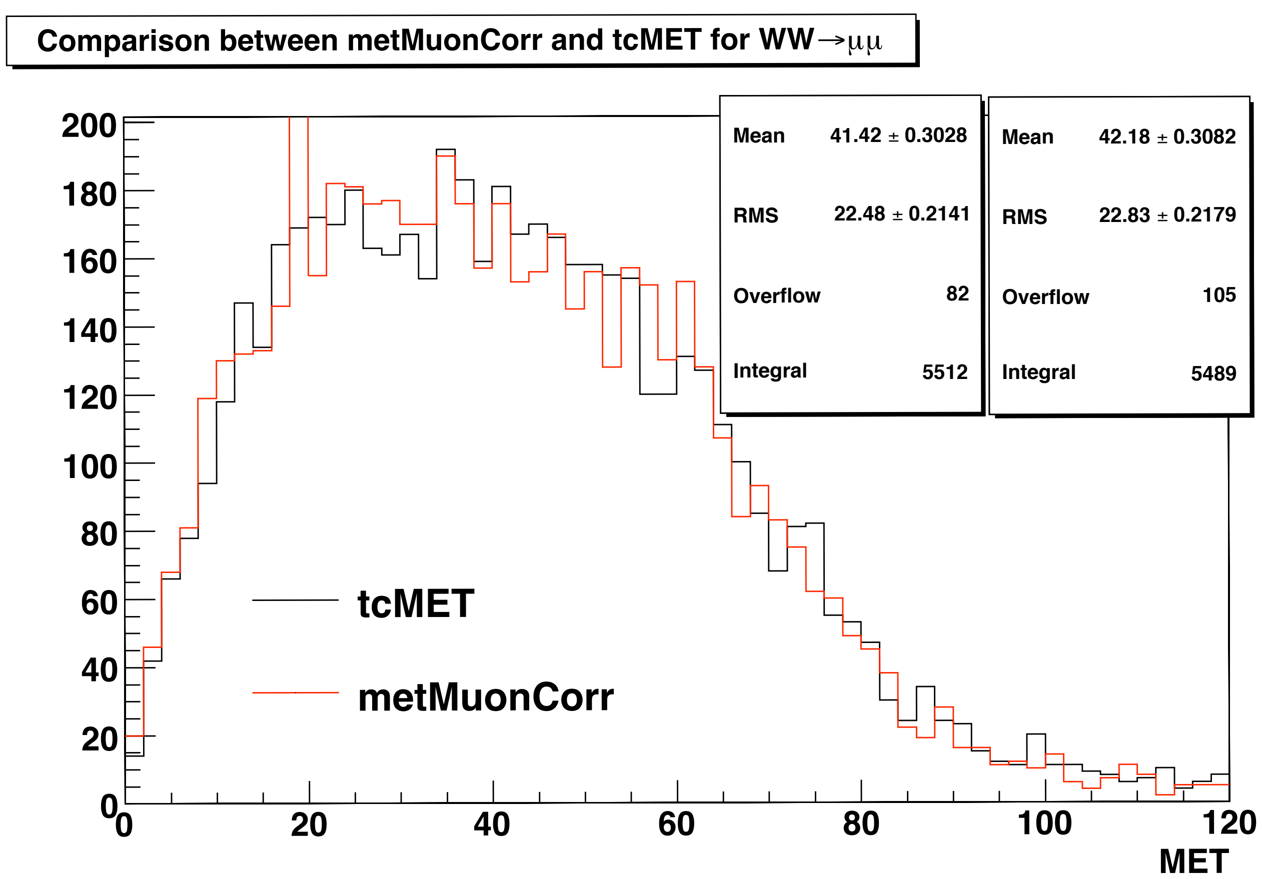


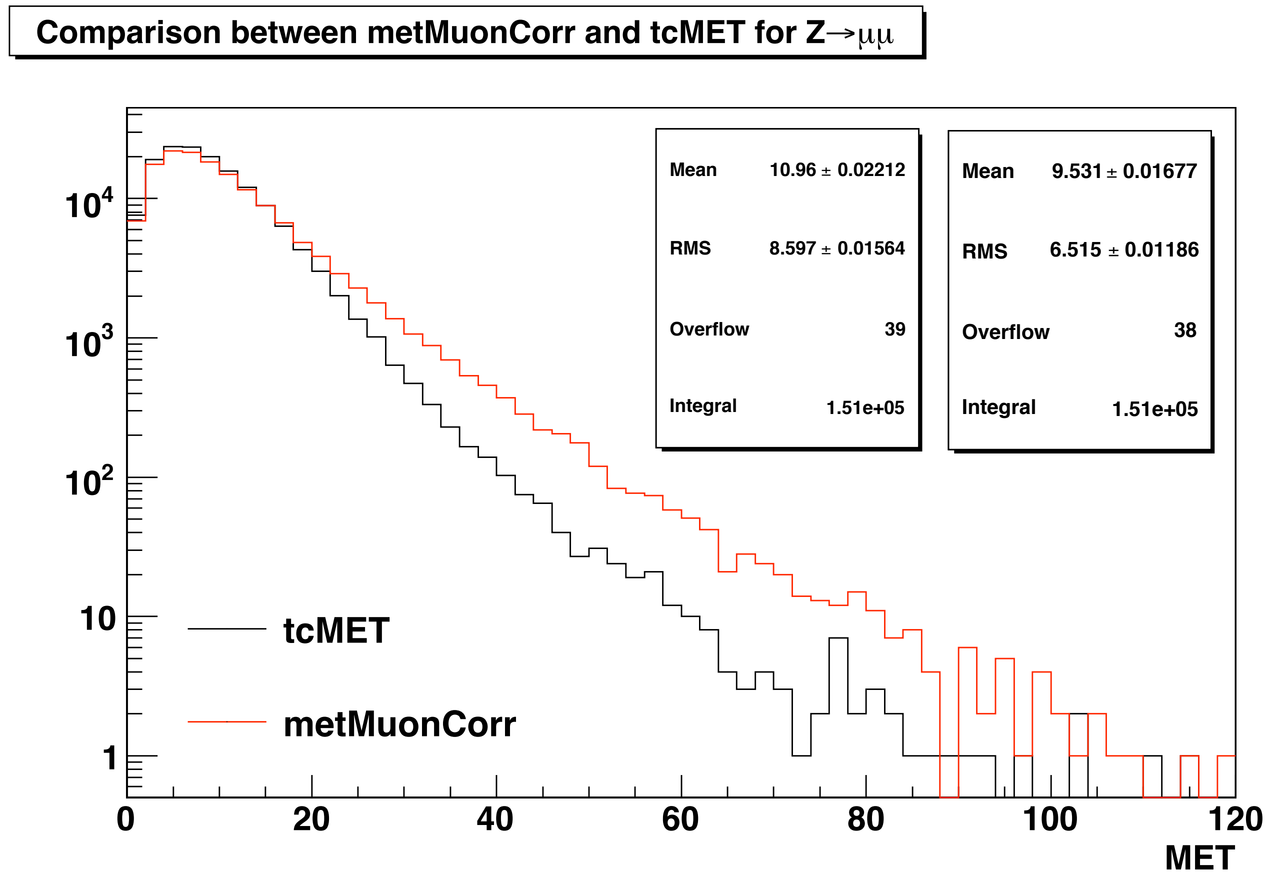


Testing tcMET

- **Background sample : Drell-Yan (Fake MET)**
  - /ZJets-madgraph/Fall08_IDEAL_V9_reco-v2/GEN-SIM-RECO
  - 1.3M events
  - Require two leptons with $p_T > 20$ GeV
    - Require muons to be **global**
- **Signal sample : WW (Real MET)**
  - /WW_2l/Summer08_IDEAL_V9_v2/GEN-SIM-RECO (pythia)
  - 100k WW events
  - Same requirements on final state leptons

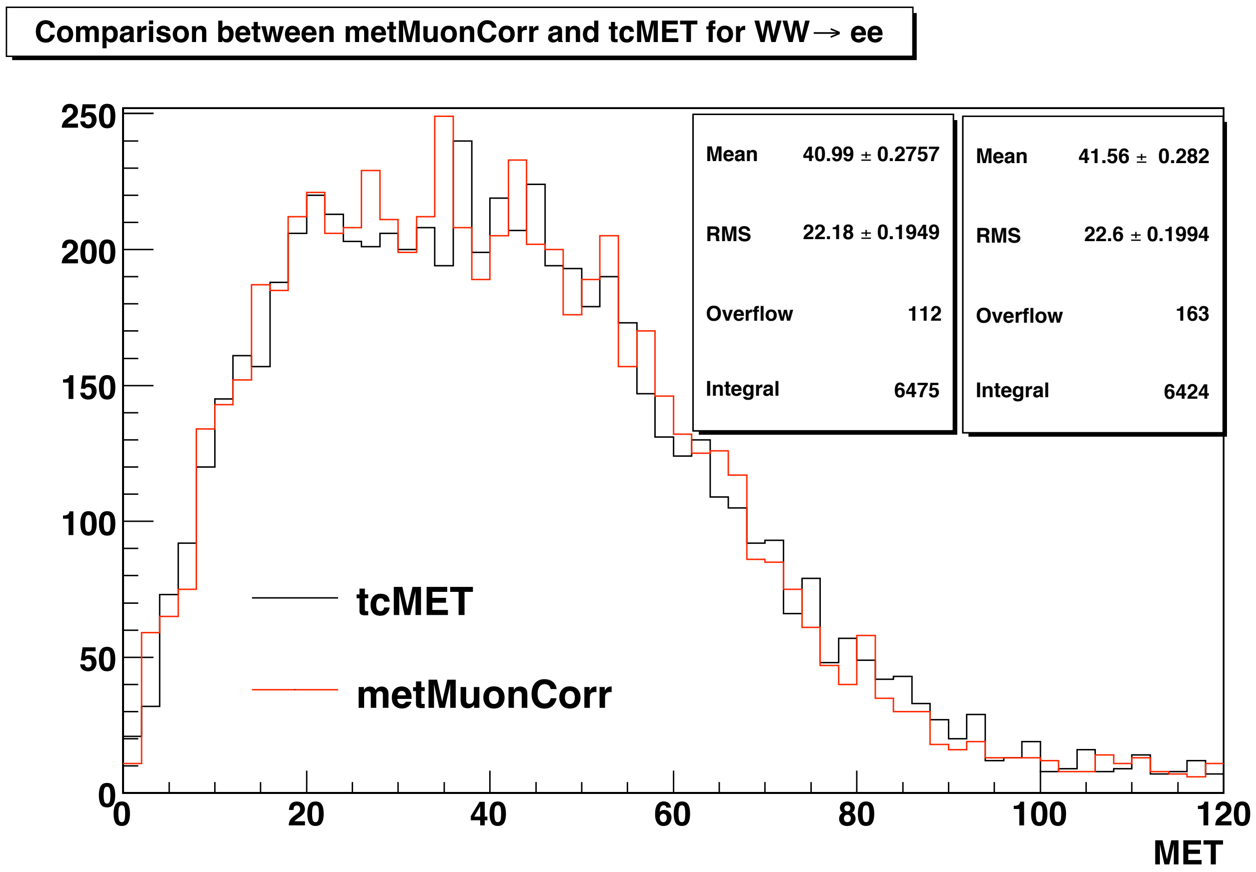
“Signal” and “Background” Samples - muons

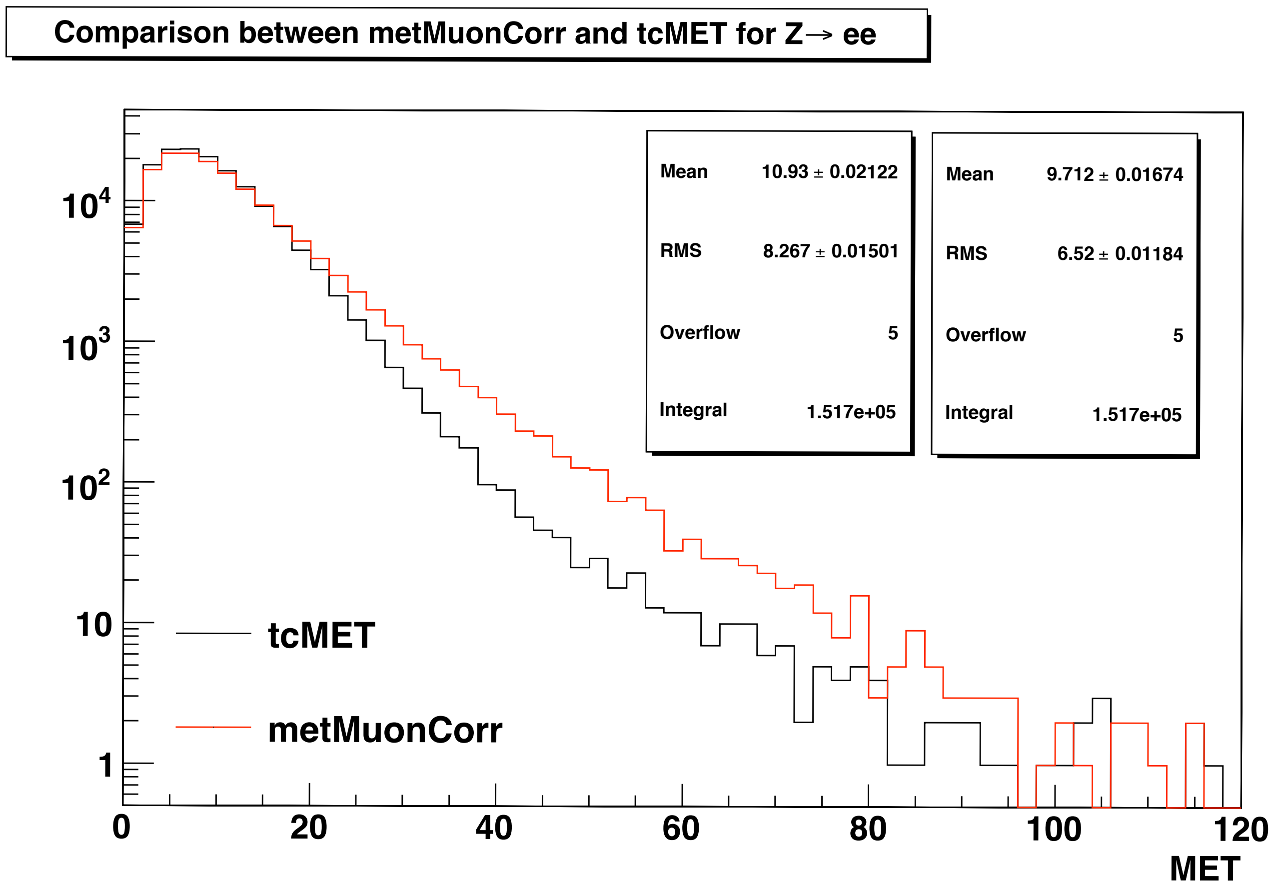




- Baseline is metMuonCorr
- **WW: Remains essentially unchanged**
  - increases by a couple percent for cuts at MET > 30 (50)
- **Z : Decrease # events with MET > 30 (50) by factor of 3.1 (3.7)**
  - compared to decrease by factor of 2.7(4.7) in 16X

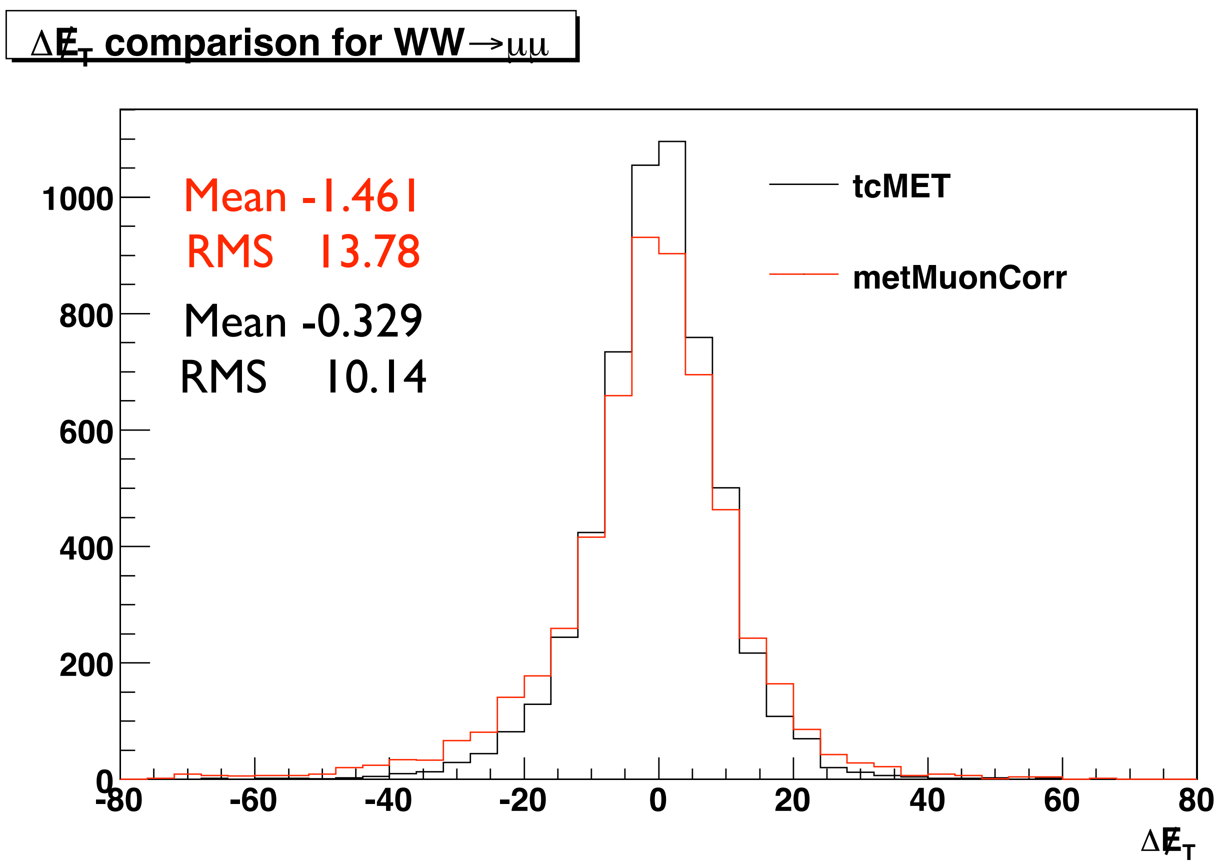
“Signal” and “Background” Samples - electrons

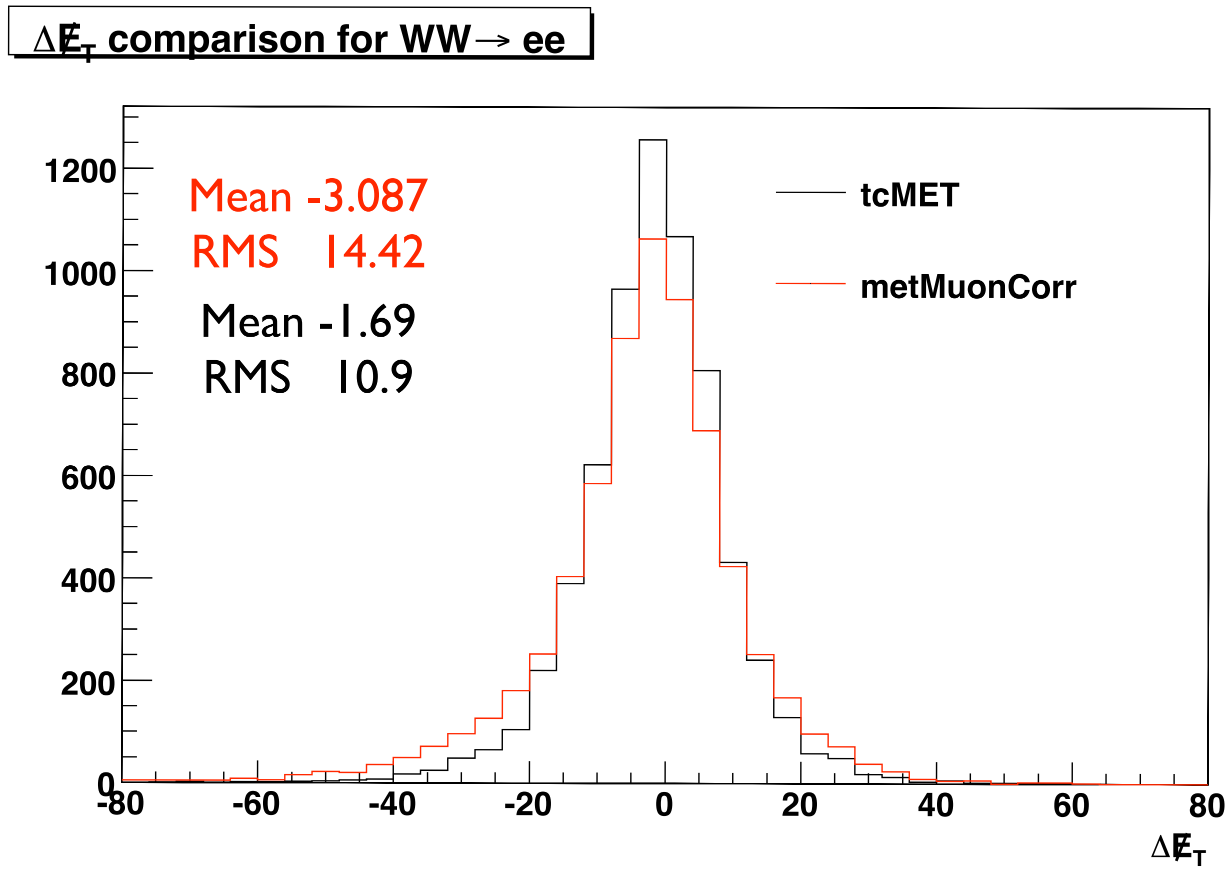




- Baseline is metMuonCorr
- **WW: Remains essentially unchanged**
  - increases by a couple percent for cuts at MET > 30 (50)
- **Z : Decrease # events with MET > 30 (50) by factor of 2.9 (3.4)**
  - compared to decrease by factor of 2.7(3.1) in 16X

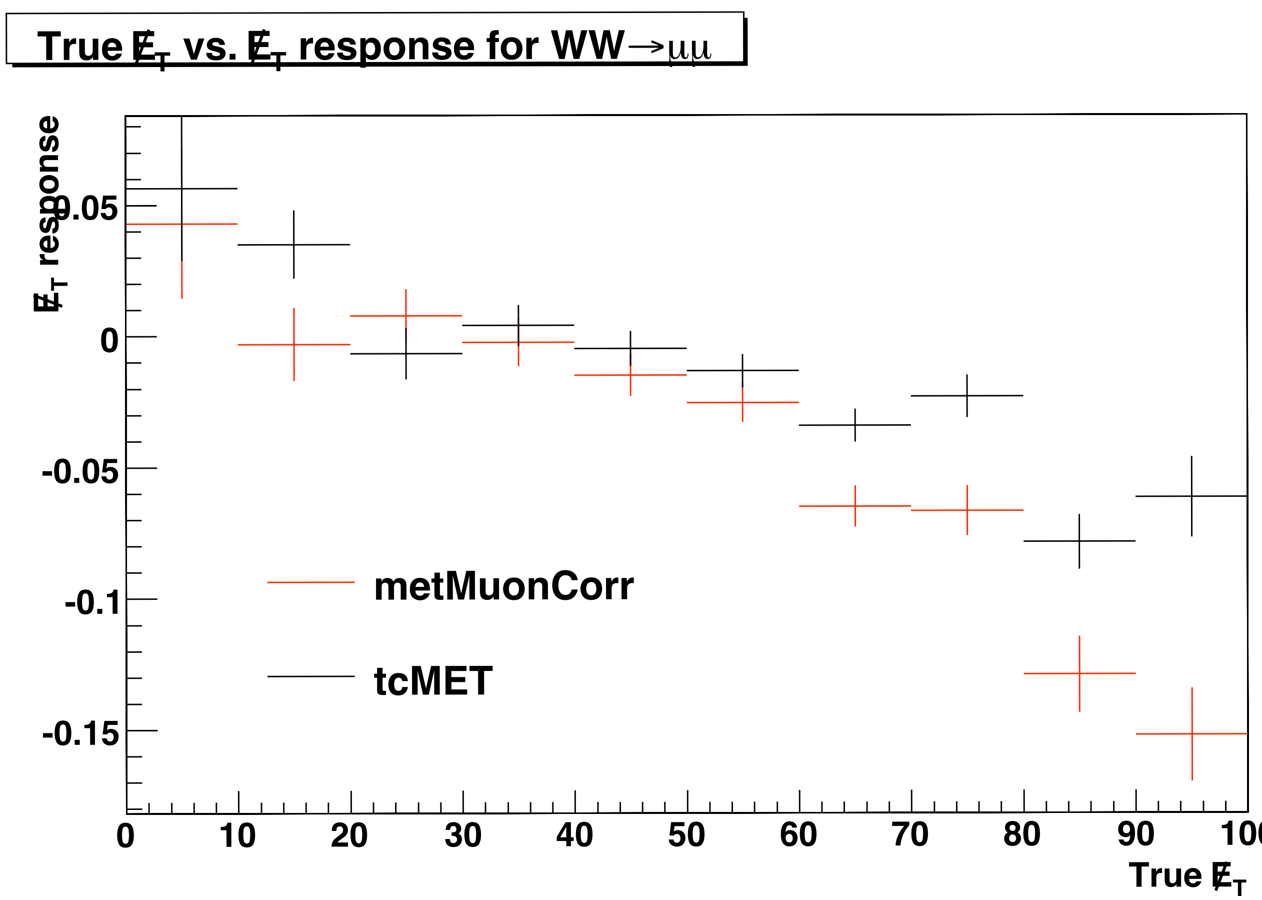
MET Resolution

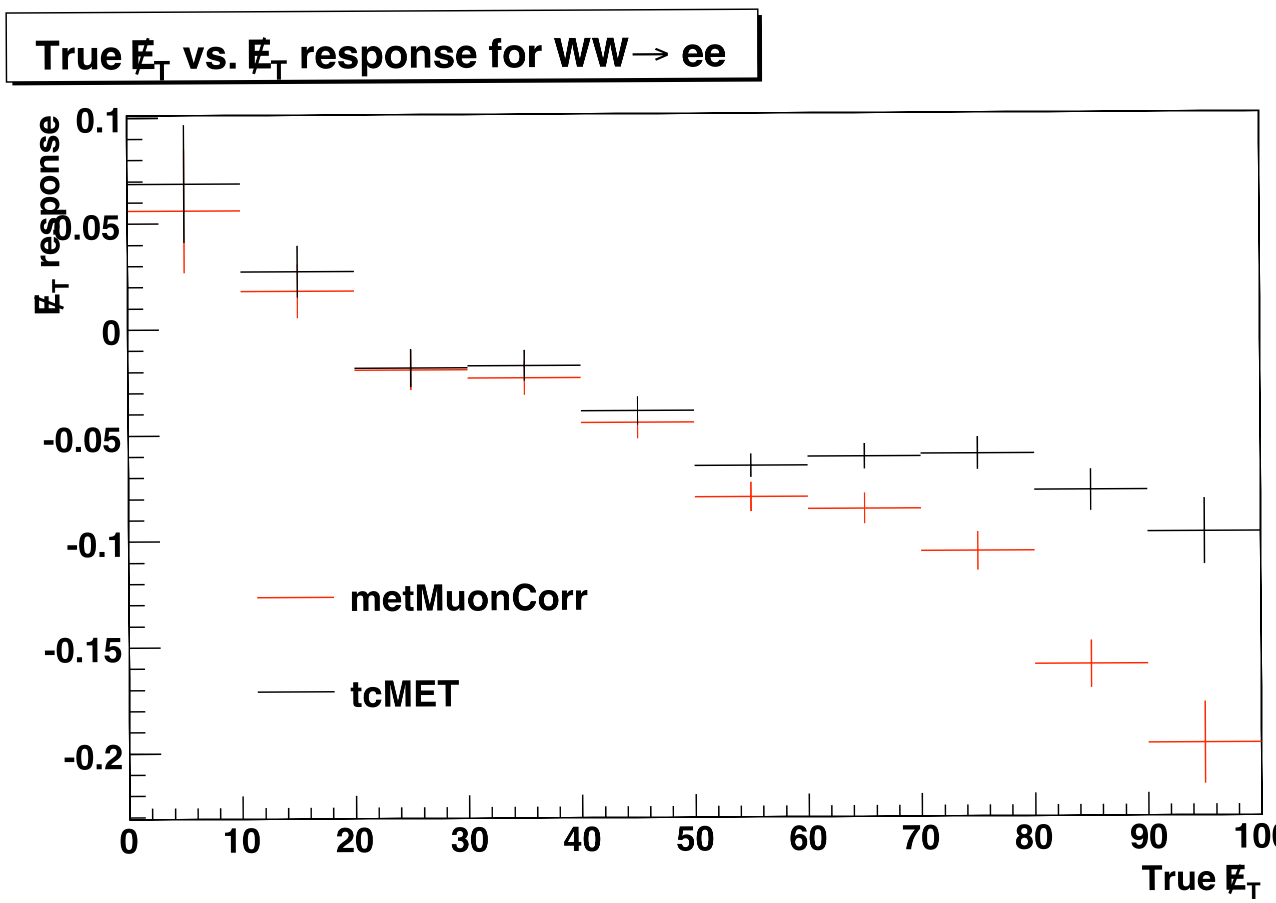




- Plots above show difference between corrected MET, true MET
- **In both final states, tcMET shifts mean closer to 0**
- **In both final states, tcMET improves resolution (decreases RMS) ~25%**

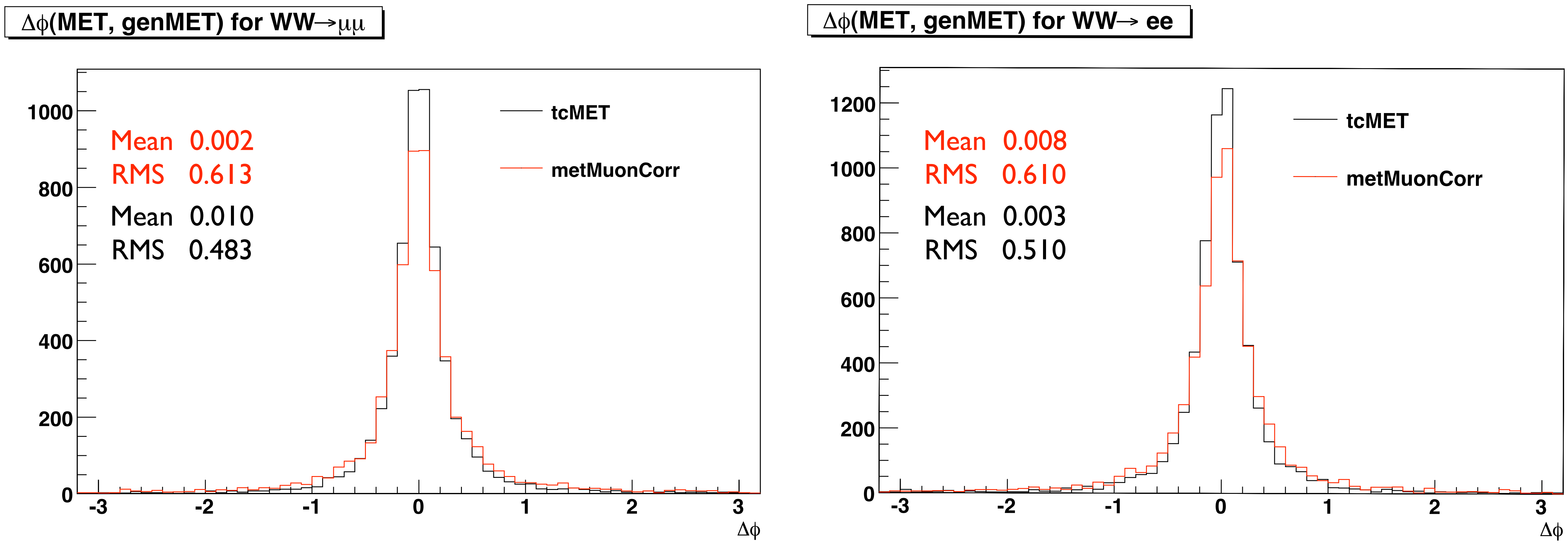
MET Resolution





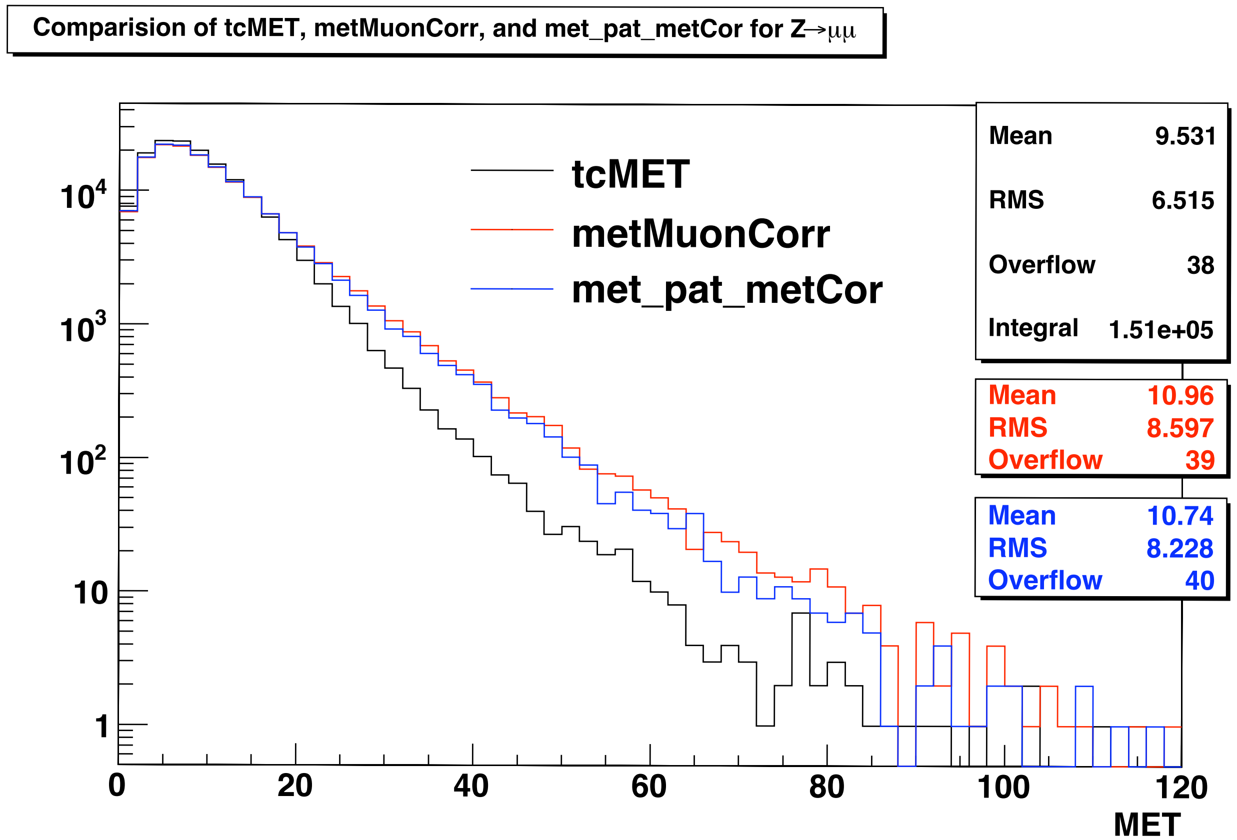
- Plots above show MET response (ΔMET/genMET) versus genMET
- **Improvement over baseline**
- Response looks good at median values of genMET
- Overcorrecting at low values of genMET, undercorrecting at high values
  - see wish list (end slide) for list of things that may address these problems

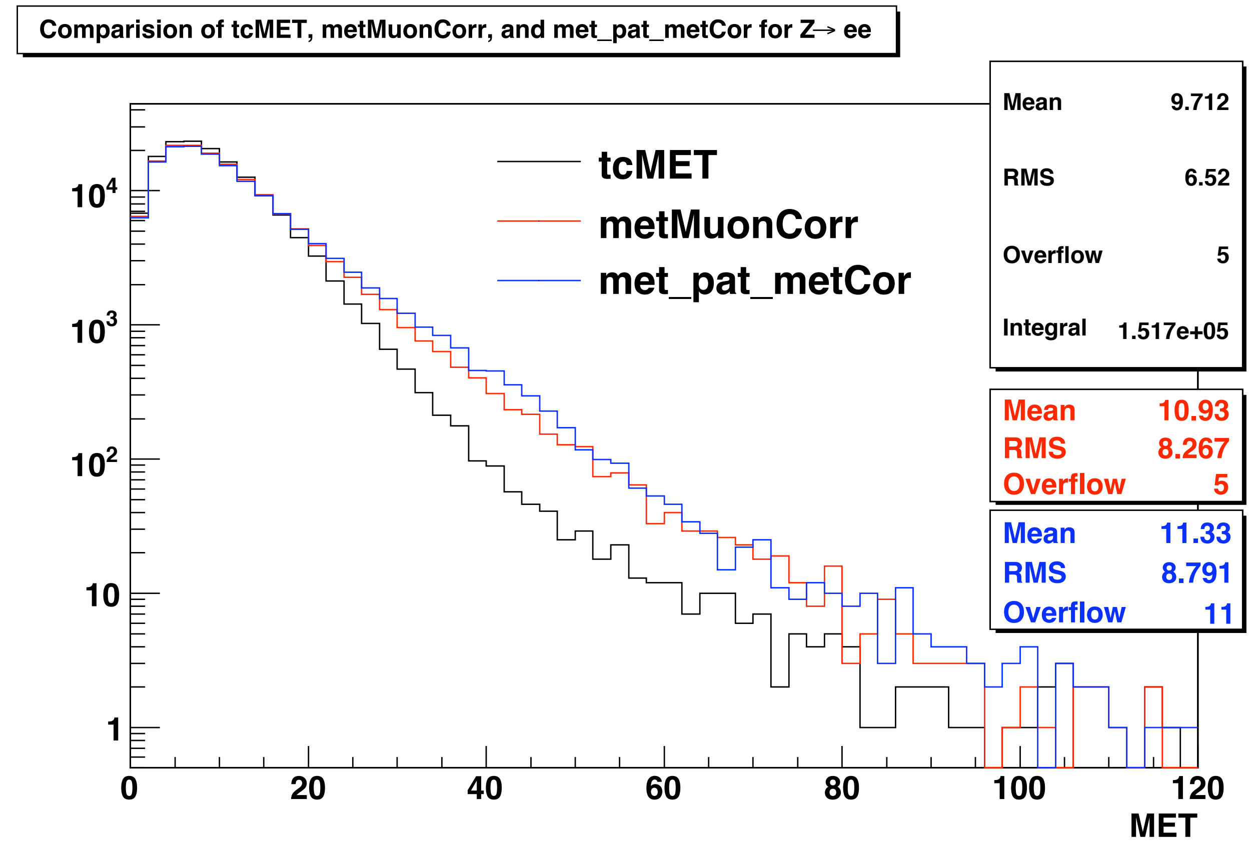
MET Direction



- Plots above show difference between corrected MET φ_{corr}, true MET φ_{true}
- Improves direction in muon final state by ~20%
- Improves direction in electron final state by ~15%
- **In both final states, tcMET improves determination of MET direction**

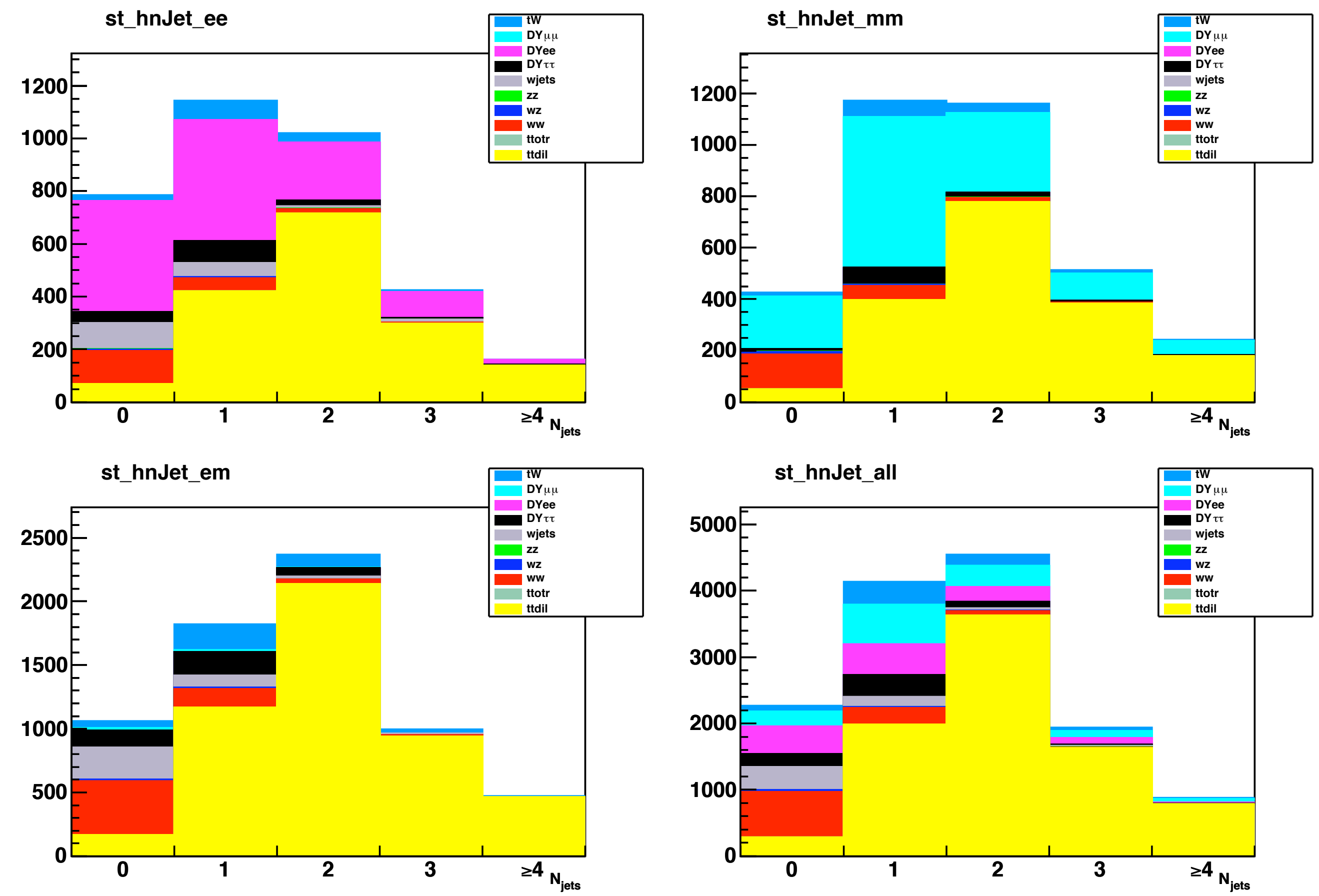
Comparison of tcMET and patMET

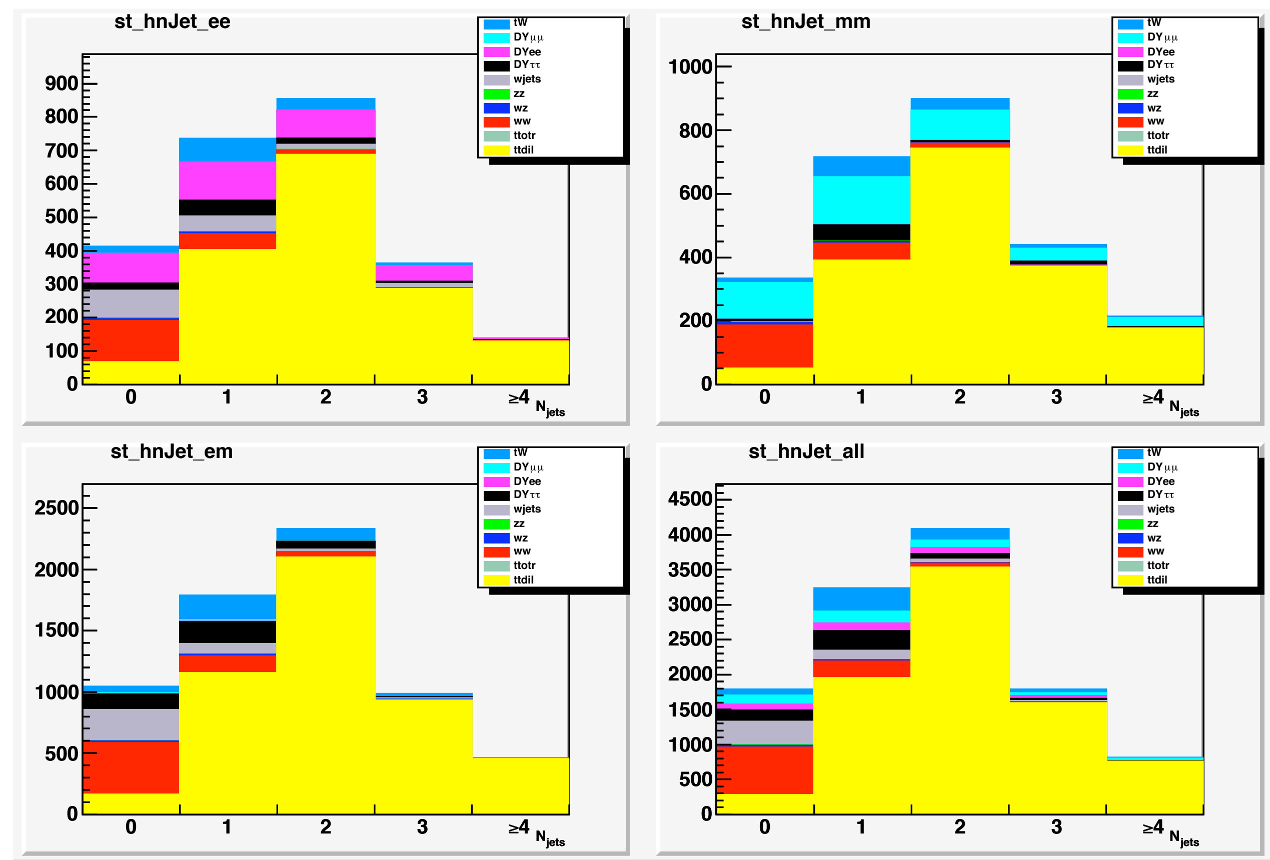




- Plots above compare metMuonCorr (baseline), pat_metCor, and tcMET
- pat_metCor is metMuonCorr+JES
- tcMET performs better than patMET in both final states
  - **For cut MET > 30(50), tcMET reduces tail by factor of 2.7(2.9) in di-muon final state**
  - **For cut MET > 30(50), tcMET reduces tail by factor of 3.7(3.7) in di-electron final state**
- patMET performs better than metMuonCorr in muon final state by factor 1.1(1.3) but performs worse in electron final state by factor of 1.3(1.1)
  - this is consistent with what we saw from JES corrections for MET in 16x

Comparison of tcMET and patMET, cont.





- Claudio ran ttbar looper with patMET (left) and tcMET (right)
- Observe significant reduction of Drell-Yan in both ee, μμ final states
- As announced to the group via Avi's iChat, this was a last minute addition and thus I do not know all the details that went into making these plots - perhaps Claudio can comment?

Wish List

- handling of tracks with high pt (> 100), low pt (< 2)
- closer look at electron-like objects
- **compare tcMET with PFMET**
- derivation of new response function in 22X?
- **hybrid implementations (JPT, non-ZSP RF)**
- tails of tcMET distribution
- **compare tracker muons and global muons**
- cut on nhits as function of detector geometry

more details on twiki:
http://omega.physics.ucsb.edu/twiki/bin/view/CMS/TCMET22XValidation