2012 Tau Detector Performance Plots

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CMS Performance Note

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03 April 2013

Tau Performance Plots for 2012

CMS Collaboration

Abstract
This note includes performance plots for CMS tau reconstructions algorithms in use during the 2012 data taking period.
2012 Tau Performance Information

- Recipes: https://twiki.cern.ch/twiki/bin/view/CMSPublic/SWGuidePFTauID
- Recommendations: https://twiki.cern.ch/twiki/bin/view/CMS/TauIDRecommendation
- Plots available: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsPFT
**Tau Efficiency Curves**

- Efficiency of three most-common ID algorithms vs. truth $p_T$ with respect to truth-matched taus.
- Computed using $Z \rightarrow \tau \tau$ simulated events.
Tau MVA Isolation Performance

- Marginal efficiency-vs.-fake rate for cut-based vs. MVA isolation with respect to tau candidates passing the “decay mode” selection
- Efficiency from $Z \rightarrow \tau\tau$ simulated events
- Fake rate from multi-jet data
Tau MVA Isolation Motivation

- MVA splits isolation region into rings in $\Delta R$
- Isolation deposits in real taus are typically from leakage (low $\Delta R$) or pile-up/underlying-event (high $\Delta R$)
Tau Energy Pileup Stability

- $E_T$ resolution for different bins of reconstructed vertices in $Z \rightarrow \tau\tau$ simulated events
- Reconstructed tau energy is nearly independent of PU

![Graph showing $E_T$ resolution for different bins of reconstructed vertices in $Z \rightarrow \tau\tau$ simulated events. The graph compares the ratio of reconstructed to generated tau transverse momentum ($p_T^{\text{reco}} / p_T^{\text{gen}}$) for different pileup (PU) conditions: $n_{PU} < 5$, $5 < n_{PU} < 10$, $10 < n_{PU} < 15$, $15 < n_{PU} < 20$, $20 < n_{PU} < 25$, $25 < n_{PU}$, with CMS Simulation 2011 and $\sqrt{s} = 7$ TeV.]
Tau Cut-based Efficiency Pileup Stability

- Cut-based ID efficiency versus number of reconstructed vertices
- Efficiency is nearly flat w.r.t. PU
- Efficiency is defined with respect to truth-matched taus with visible $p_T > 20$ GeV

![Graph showing efficiency versus number of reconstructed vertices](image)

CMS Simulation 2012, $\sqrt{s} = 8$ TeV
Tau MVA Efficiency Pileup Stability

- MVA Iso ID efficiency vs. $N_{\text{vtx}}$
- Efficiency is nearly flat w.r.t. PU
- Efficiency is defined with respect to truth-matched taus with visible $p_T > 20$ GeV

![Efficiency Graph](image-url)
Tau MVA Retraining

- Efficiency-vs.-fake rate for cut-based vs. MVA isolation
- Efficiency from simulated $Z \rightarrow \tau \tau$ events
- Fake rate from multijet data
- MVA2 is a new MVA training with improved performance for high Pt taus (not shown in the plot)
Tau Invariant Mass Reconstruction

- Reconstructed $\tau$ invariant mass, split by decay mode
- In enriched $Z \rightarrow \tau\tau$ events, using the selections in the CMS $H \rightarrow \tau\tau$ search (CMS-PAS-HIG-13-004)
- This variable is sensitive to the reconstruction of the tau decay mode and the tau energy scale