Electron Trigger Efficiency Determination from Data

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Introduction

• Trigger efficiency is an important systematic

• In order to reduce reliance on Monte Carlo (MC) it is important to have ways of determining this from data.

• For both isolated and unisolated triggers.

• Need to know what affects electron trigger efficiency.

• Important factors are, for example;
  • Fakes
  • Electron Kinematics; Et, eta, phi etc
  • Event topologies; Jet N, Jet Pt etc

• In this talk I will present a method for determining electron trigger efficiency from data that takes all of these into account.

• All results shown are for rel 13.0.X L1+L2+EF.
Definitions

• Trigger efficiency is calculated w.r.t 'good offline' reconstructed electrons;
  • Where a good offline reconstructed electron is defined as;
    • **SUSY CSC note electron definition**, (tighter than for typical trigger studies).
      • egamma electrons
      • IsEM medium
      • Pt > 10 GeV
      • Eta < 2.5
      • No crack (exclude 1.37 < |eta| < 1.52)
      • Isolation; require etcone20 < 10 GeV
      • Jet Veto in cone 0.4; electron is discarded if within a jet

• Efficiency (as a function of Et) is defined as;

  Efficiency = N1(Et) / N2(Et)

• Where;
  N1 = Good offline reconstructed electrons associated to objects passing trigger, (using Delta R matching).
  N2 = Good offline reconstructed electrons.
Truth Match definitions

• Use truth matched 'signal' electrons for now.

**EF_e25i_tight**

All reconstructed

Reconstructed Matched to Truth

• Where 'signal' is defined as prompt electrons from $W$, $Z$ or SUSY particle decays.
Monte Carlo Trigger Efficiencies

**EF_e25i_tight**

- We can see that for different samples Efficiency as a function of Et or Eta integrated over all other variables varies.
- **Ttbar** and **SU4** samples show lower efficiency than **Z->ee**.
- When studying trigger efficiencies we need to account for these differences.
- Do differences come from different electron kinematics or something else.
Data Driven Trigger efficiency measurement

• Z->ee tag and probe is an example of a way to determine efficiency from data, validation against MC methods lots of times by lots of people, including by me.

• I will use Z->ee MC and assume these results can be determined from data.

• Z->ee MC will be used to construct an efficiency estimator.
  • This will provide a measurement of the trigger efficiency for an electron with given values of the N variables that affect trigger efficiency.

• Estimator efficiencies are then applied to electrons in other samples e.g. Z->ee, and to busier events such as ttbar, SUSY to see if the results agree with MC.
Et and Eta estimators applied to more Z->ee

• Estimators constructed in 2D using **only Et and eta**.

• Efficiency vs Et using 2D Z->ee **estimators** is compared to **MC** below.
• For isolated (left) and unisolated (right) e25_tight triggers

![Graphs showing efficiency vs reconstructed Et](image)

• 2D **Estimators** seem to fully explaining trigger efficiency as shown by agreement between Z->ee efficiency from **MC** and estimators.

• Trigger efficiency in this case can be fully explained by Et and Eta kinematics alone.

• Electrons in Z->ee are isolated electrons
Et and Eta estimators applied to $\text{ttbar}$

- Studies done in 2D using only Et and eta.

- Efficiency vs Et using 2D $Z\rightarrow ee$ estimators is compared to $\text{ttbar}$ MC below.
- Isolated and unisolated triggers

- 2D Estimators are not fully explaining trigger efficiency as shown by disagreement between $\text{ttbar}$ efficiency from MC and estimators.

- Trigger efficiency in more busy events such as $\text{ttbar}$ cannot be fully explained by Et and Eta kinematics alone.

- Other sources of differences... eg Different event topology leading to differences in isolation.
Event Topologies -- Isolation

**EF_e25i_tight**

- Efficiency vs dR to nearest truth jet for $Z\rightarrow ee$, $ttbar$ and SU4.
  - Efficiency falls and differs when truth Jets are within $dR < 0.6$ of an electron.

- Efficiency differences are caused by nearby truth jets.
  - i.e Non-Isolation of electrons.
Isolated and Unisolated electrons

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• Looking at efficiency for Isolated electrons (dR to truth jet > 0.6) and Unisolated electrons (dR < 0.6) separately.

• Better agreement after requiring Isolation from Truth Jets.
Estimators including isolation; $E_t + \eta_t + E_{cone}\times X$

$E_{25i\_tight}$

- $E_{cone}$ contains information on the amount of energy in a cone around the electron.
- Different $E_{cones}$ are used as a third Dimension in estimators.
- Estimator efficiencies agree with MC when $E_{cone 40}$ ($dR_{cone}$ of 0.4) is used as a third dimension.
Results EF_e25i_tight - other variables

- 3D estimators describe efficiency well as a function of all variables studied
Other Triggers

- **3D estimators** describe efficiency well for all other triggers studied.
Conclusions

• Trigger efficiency for isolated electrons can be described by taking into electron $E_t$ and $\eta$ dependencies alone.

• Trigger efficiency for unisolated electrons cannot be described by electron $E_t$ and $\eta$ alone.
  • The extension to 3D with $E_{\text{cone}40}$ describing isolation is a promising method.

• 3D Estimators constructed from $Z\to ee$ tag and probe in real data provides a description of trigger efficiency for isolated and unisolated electrons that can be applied to different event topologies.
Back to Fakes

• How to deal with this?
Electron Kinematics

Truth Matched -- Medium

Truth Matched -- Tight