Electron Trigger Efficiency Determination from Data

Matthew Tamsett   RHUL
Teresa Fonseca Martin
Antonella De Santo

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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.

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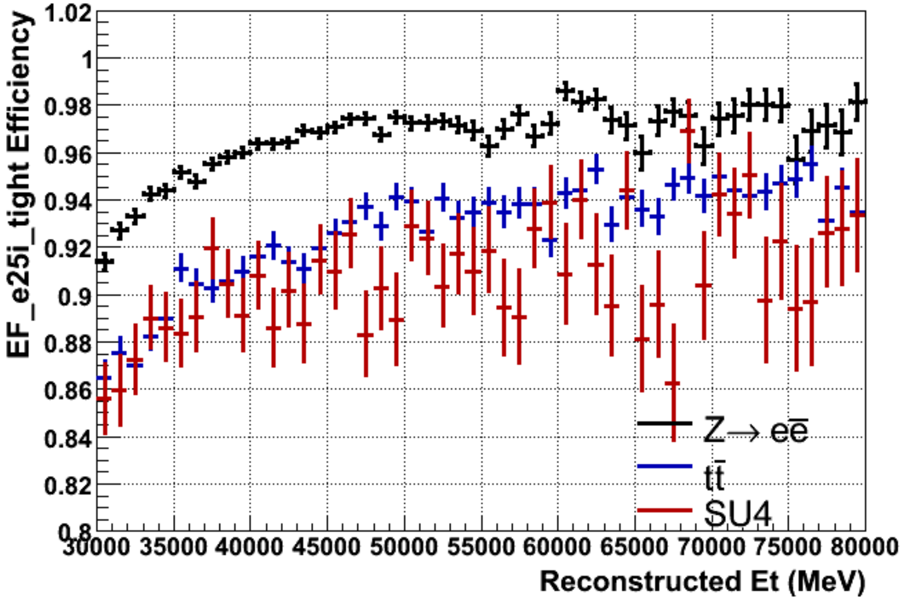
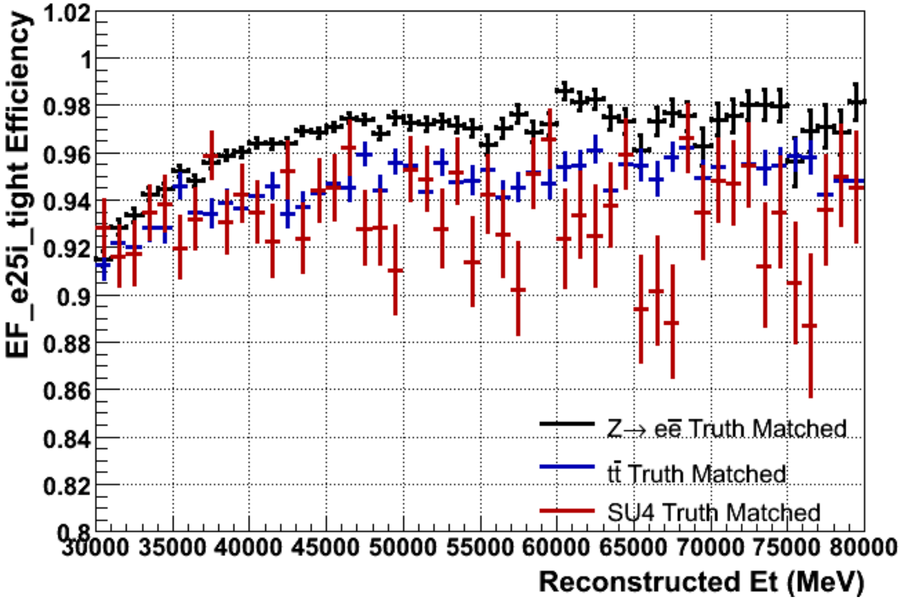


All reconstructed



Reconstructed Matched to Truth

•Where 'signal' is defined as prompt electrons from W, Z or SUSY particle decays.

Monte Carlo Trigger Efficiencies

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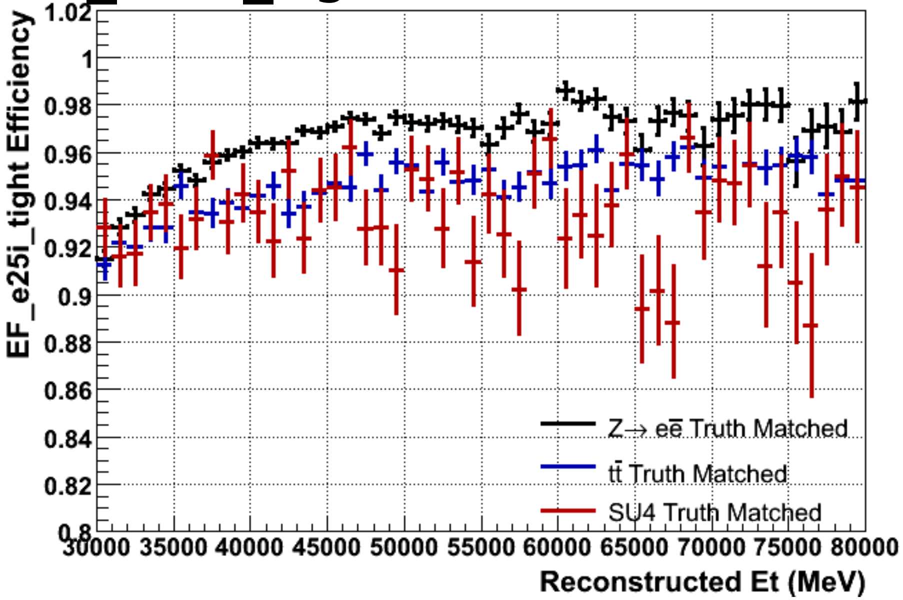
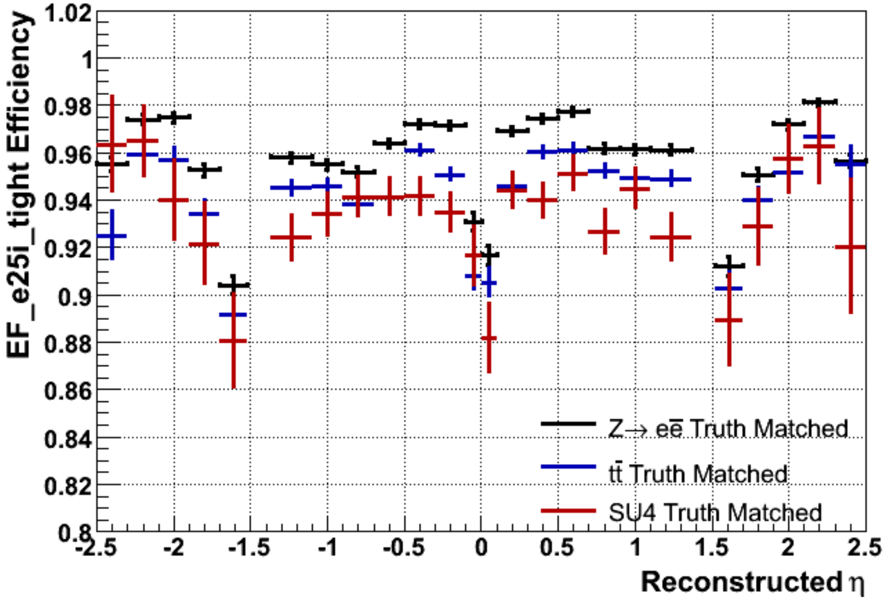




- We can see that for different samples Efficiency as a function of Et or Eta integrated over all other variables varies.

- 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.

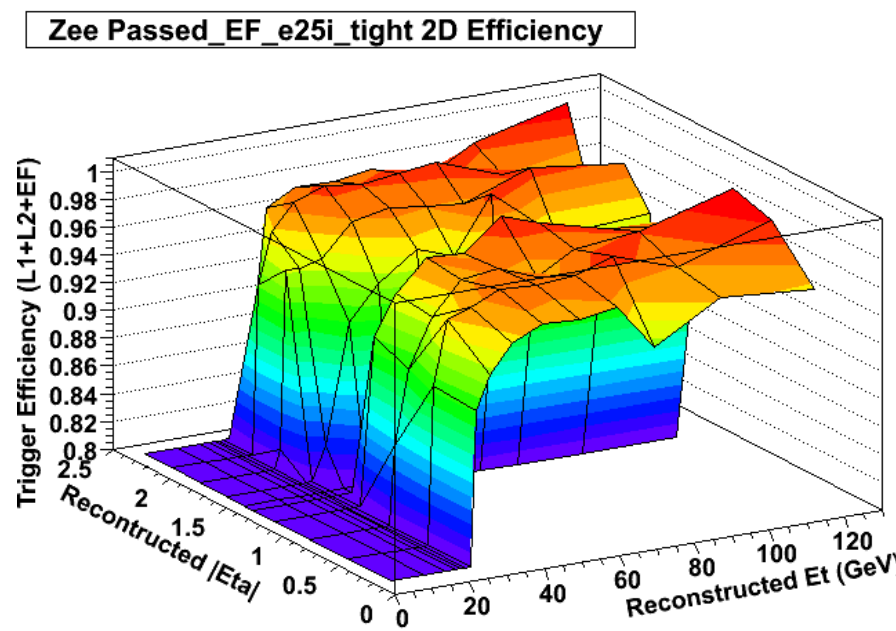
Data Driven Trigger efficiency measurement

•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.

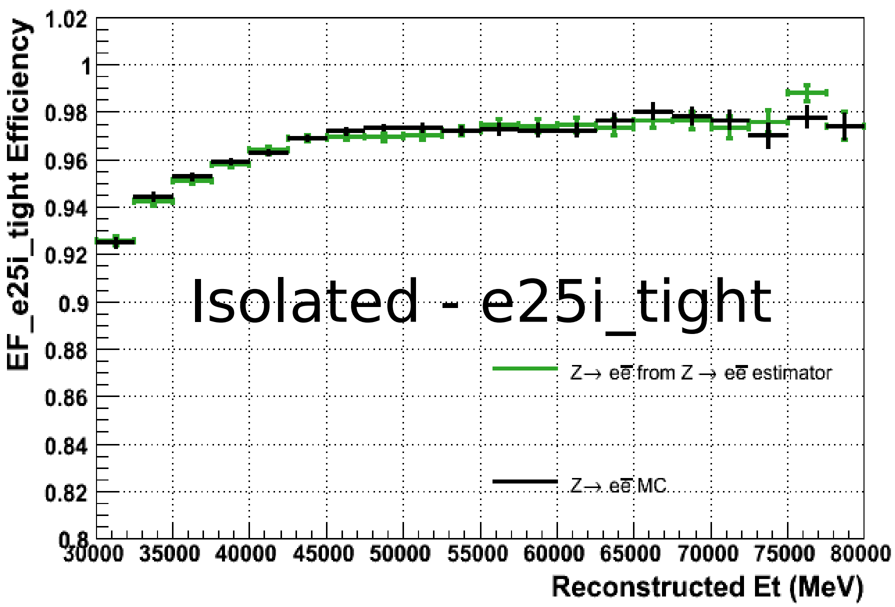
•Estimator efficiencies are then applied to electrons in other samples e.g. Z->ee, and to busier events such as ttbar, SUSY to see if the results agree with MC.

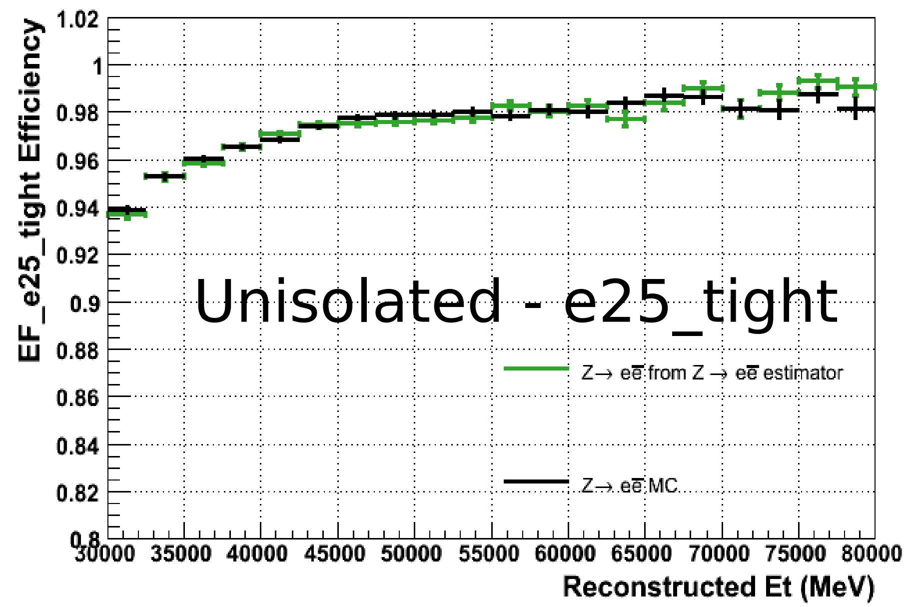


Et and Eta estimators applied to more Z->ee

- 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





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

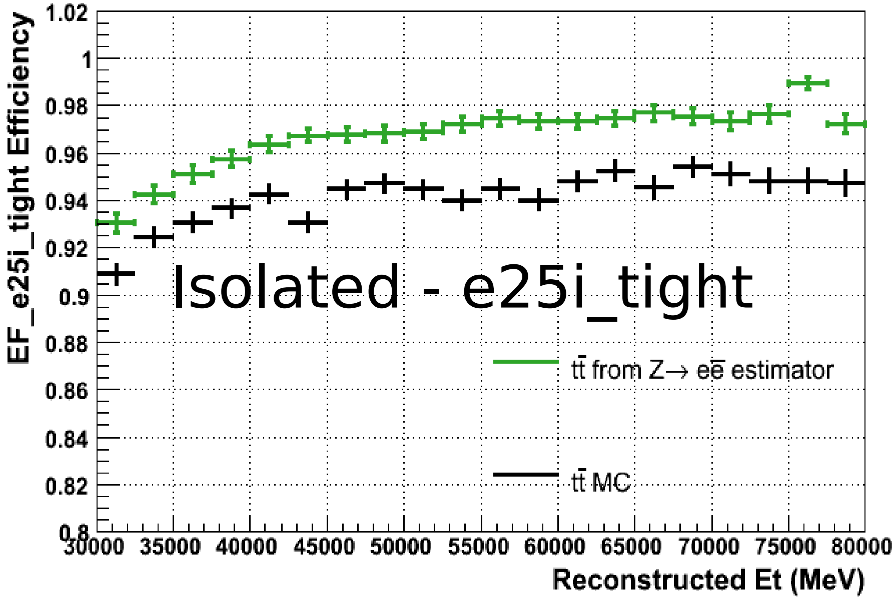
- Trigger efficiency in this case can be fully explained by Et and Eta kinematics alone.

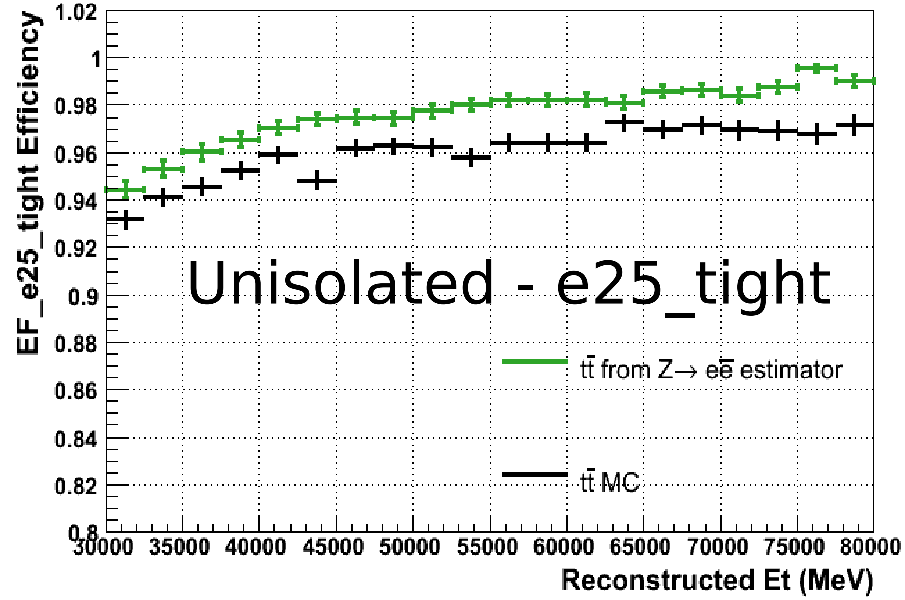
- Electrons in Z->ee are isolated electrons

Et and Eta estimators applied to ttbar

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

- Efficiency vs Et using 2D Z->ee **estimators** is compared to ttbar **MC** below.
- Isolated and unisolated triggers





- 2D **Estimators** are not fully explaining trigger efficiency as shown by disagreement between ttbar efficiency from **MC** and **estimators**.

- Trigger efficiency in more busy events such as 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

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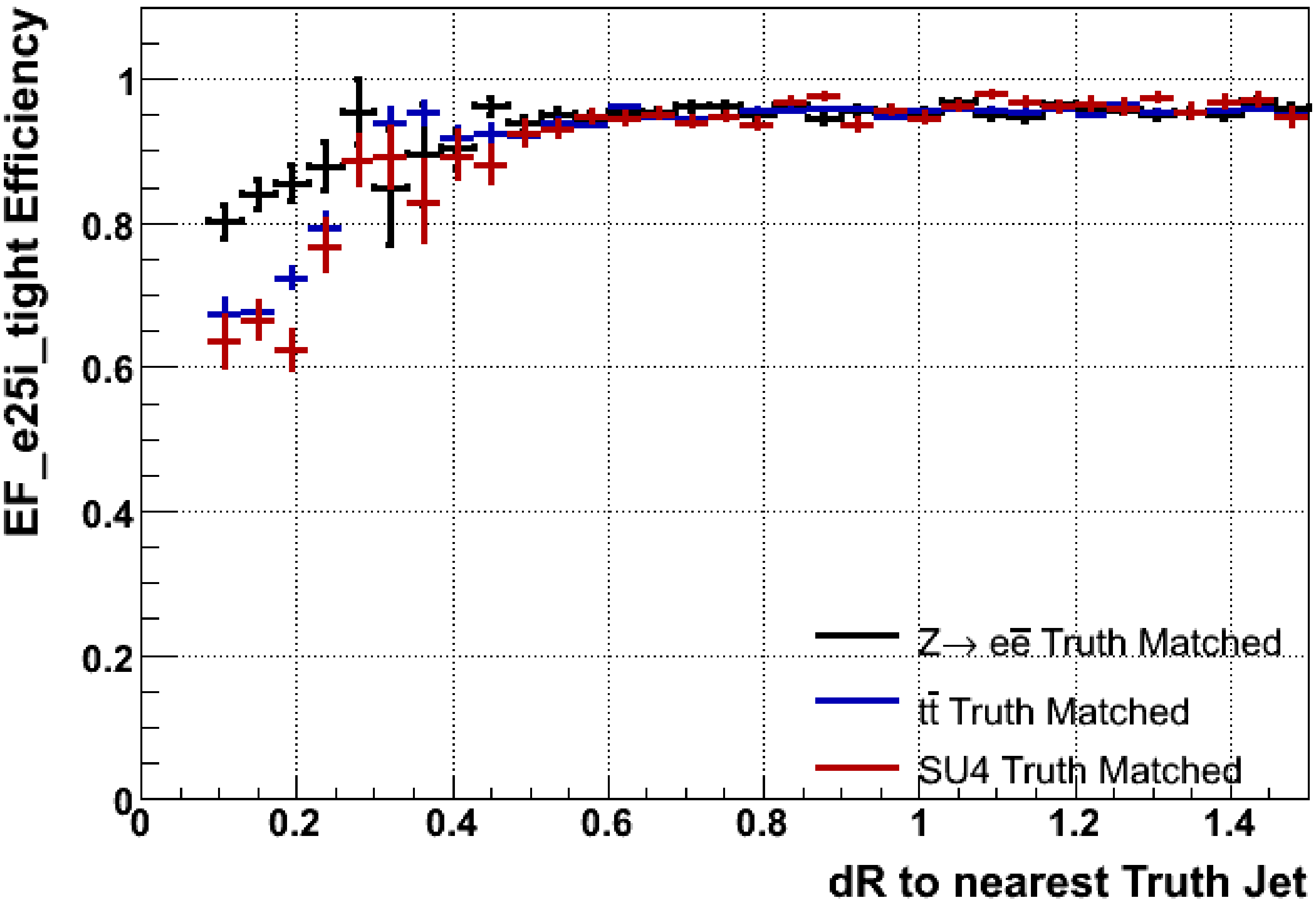

- Efficiency vs dR to nearest truth jet for Z->ee, ttbar and SU4.
- Efficiency falls and differs when truth Jets are within dR < 0.6 of an electron.

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

Isolated and Unisolated electrons

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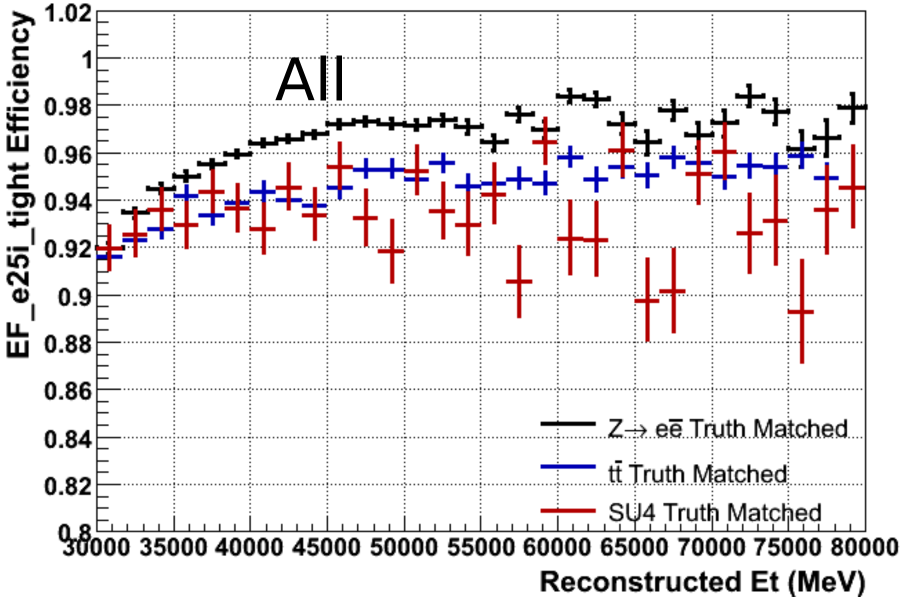

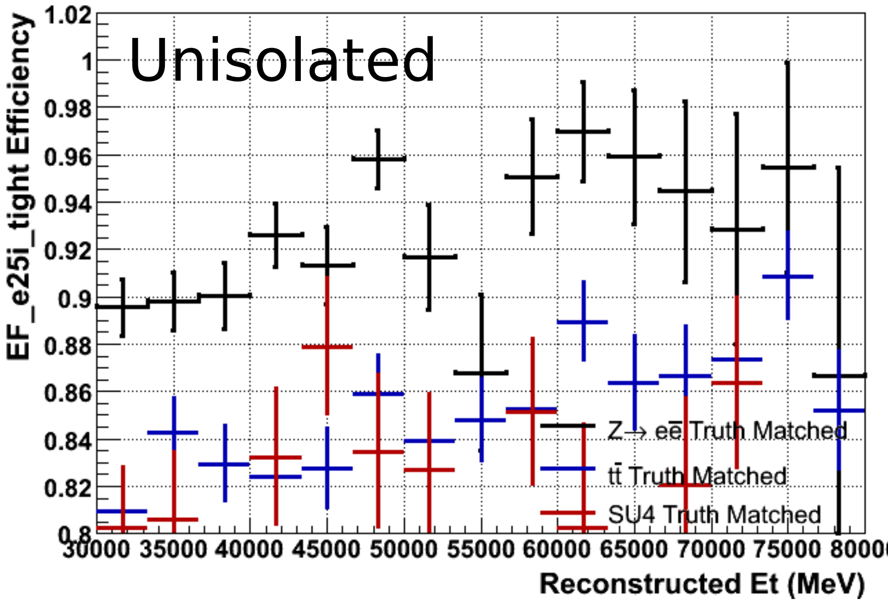

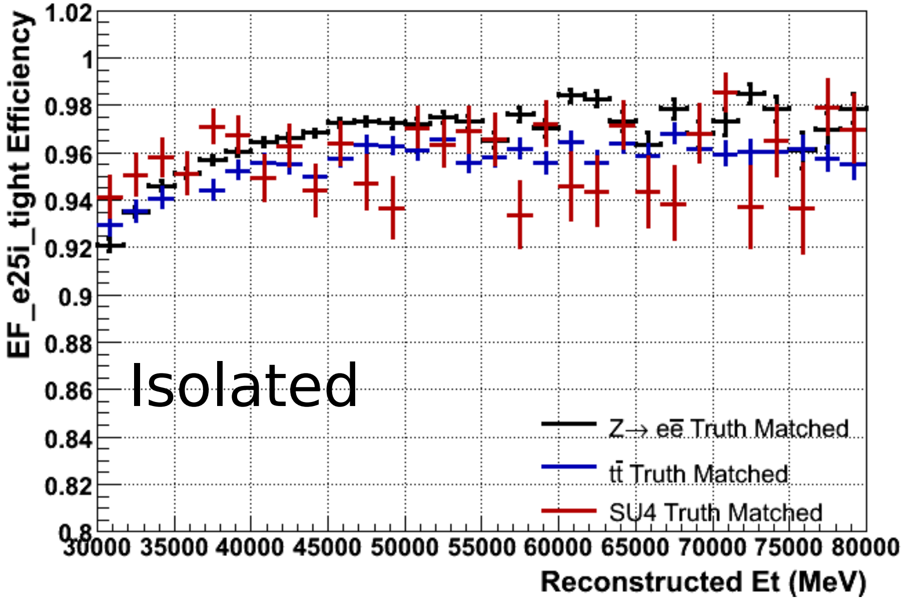

- Looking at efficiency for Isolated electrons (dR to truth jet > 0.6) and Unisolated electrons (dR < 0.6) seperately.

- Better agreement after requiring Isolation from Truth Jets.

Estimators including isolation; Et+Eta+EtconeX

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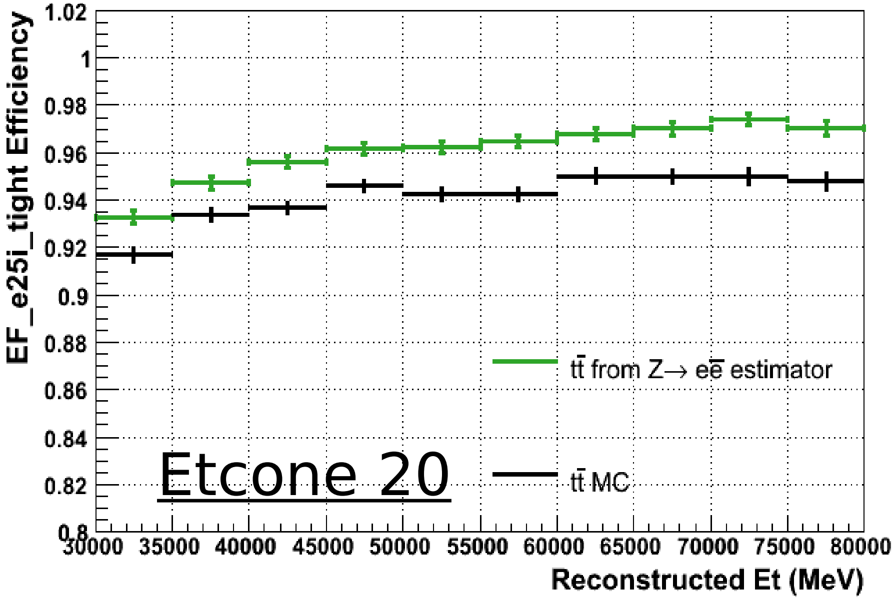
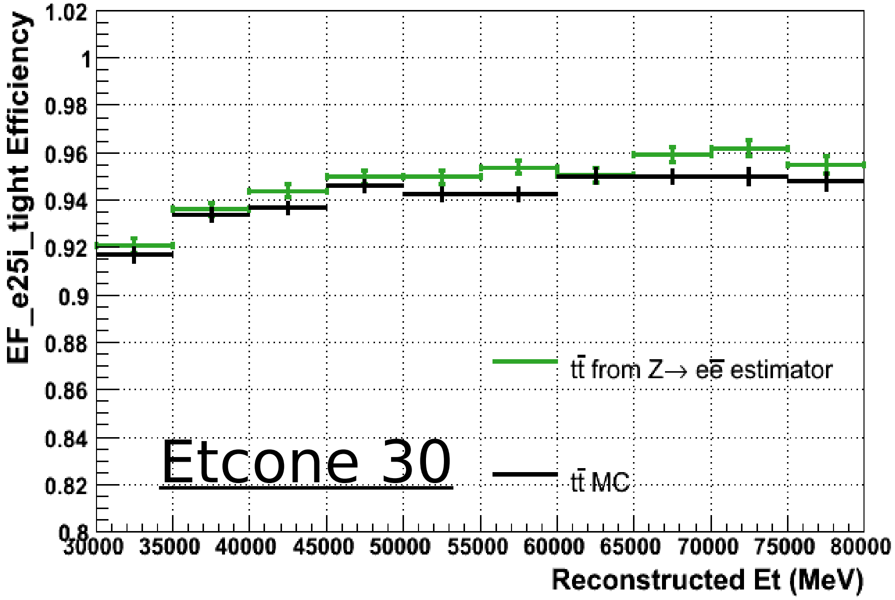
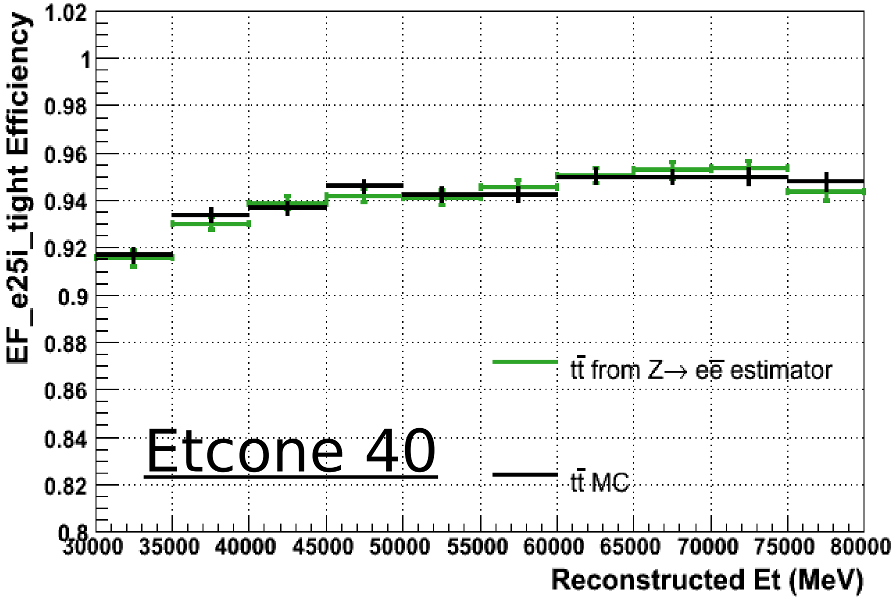
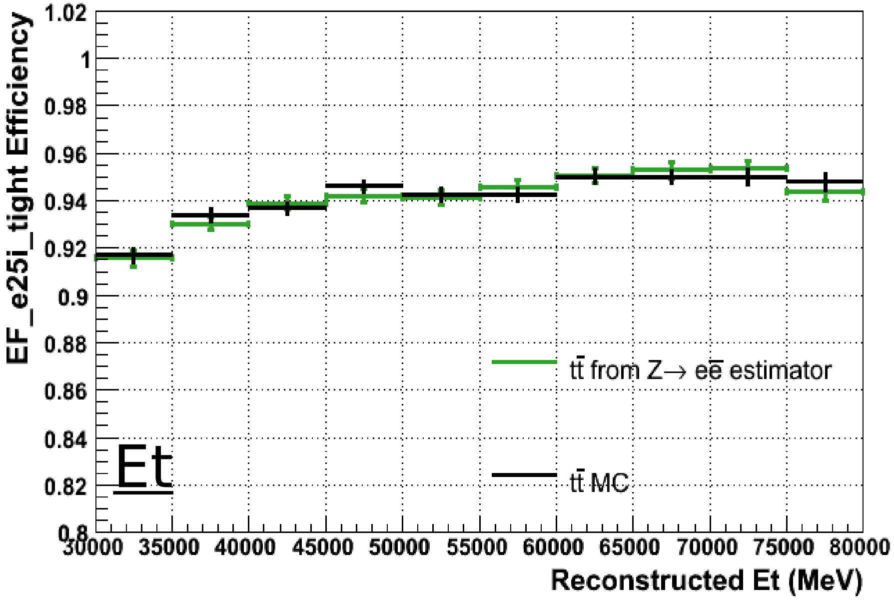


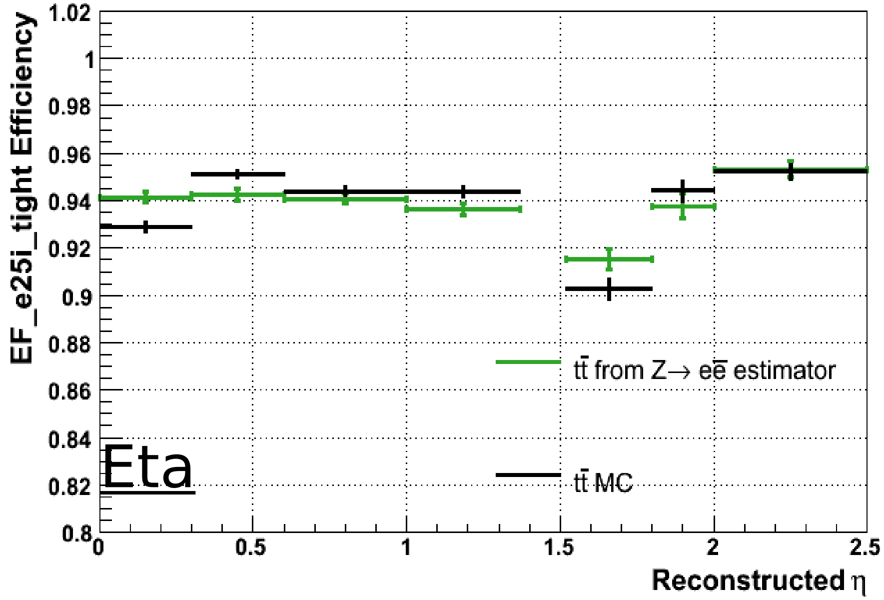


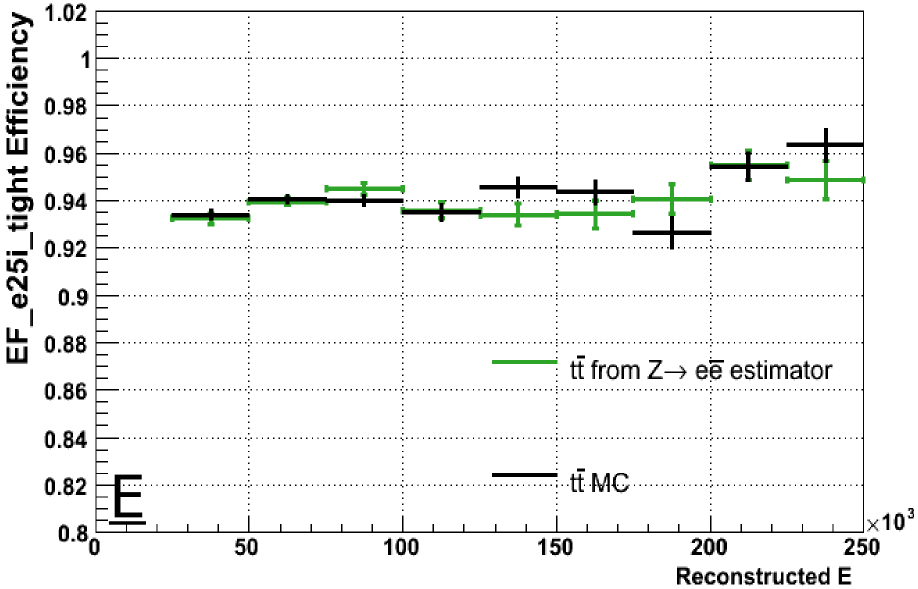


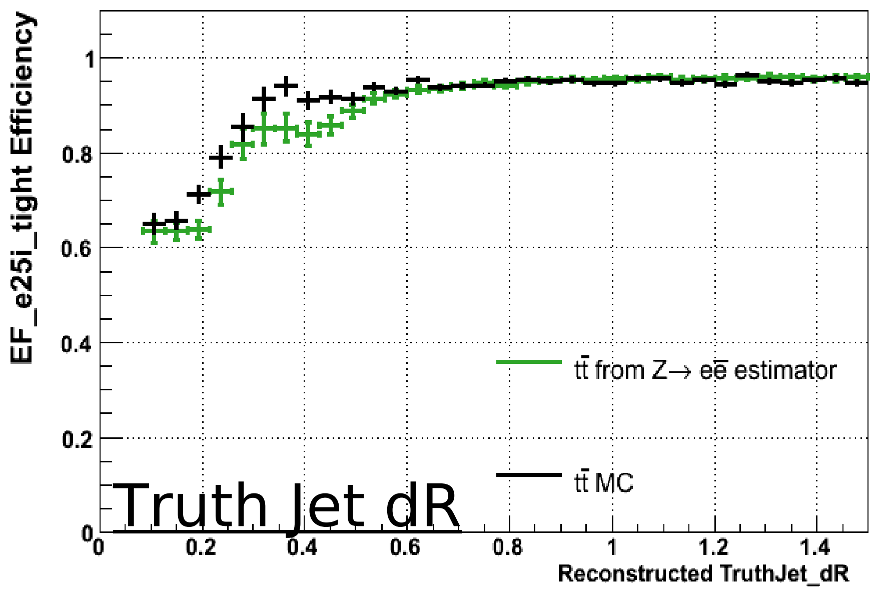
- Etcone contains information on the amount of energy in a cone around the electron.
- Different Etcones are used as a third Dimension in estimators.
- Estimator efficiencies agree with **MC** when **Etcone40** (dR cone of 0.4) is used as a third dimension.

Results EF_e25i_tight – other variables



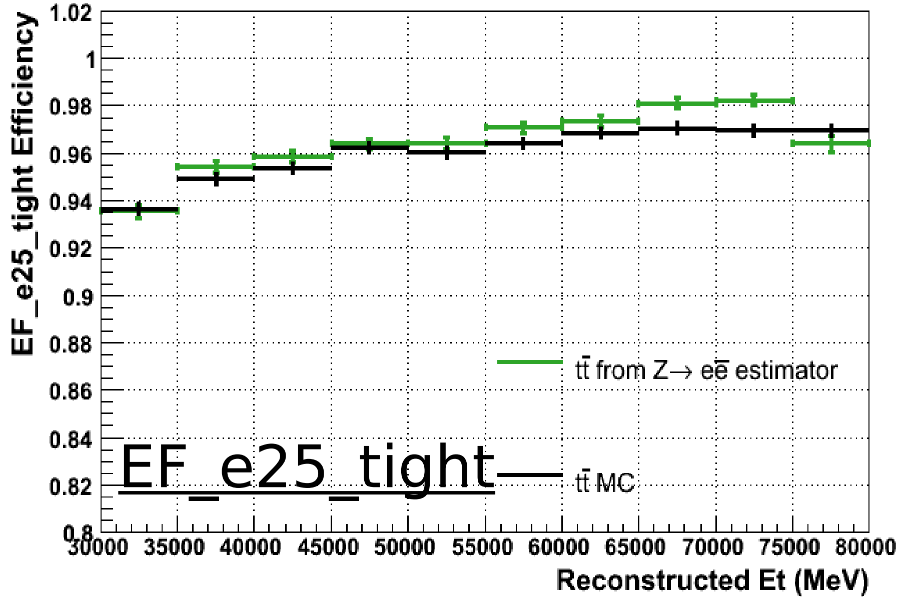


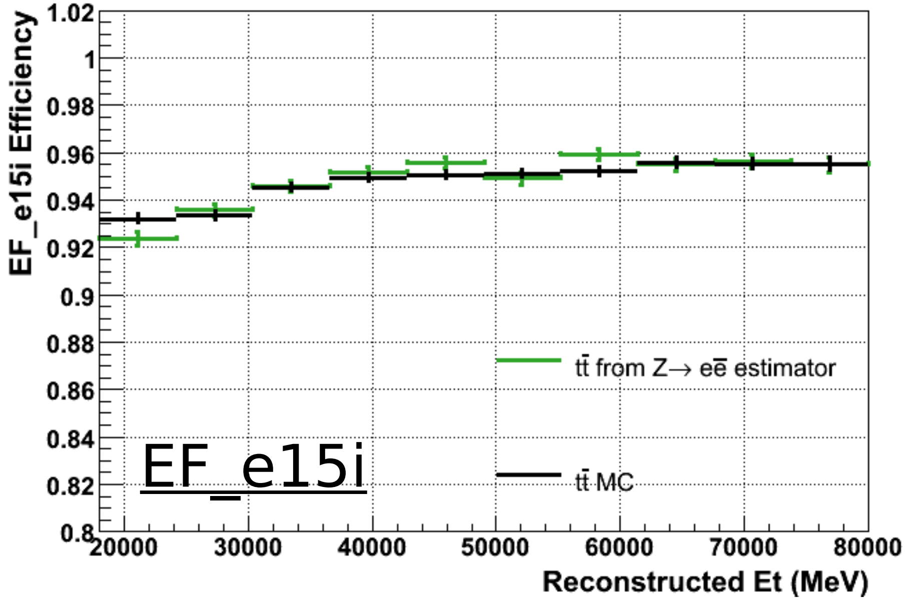


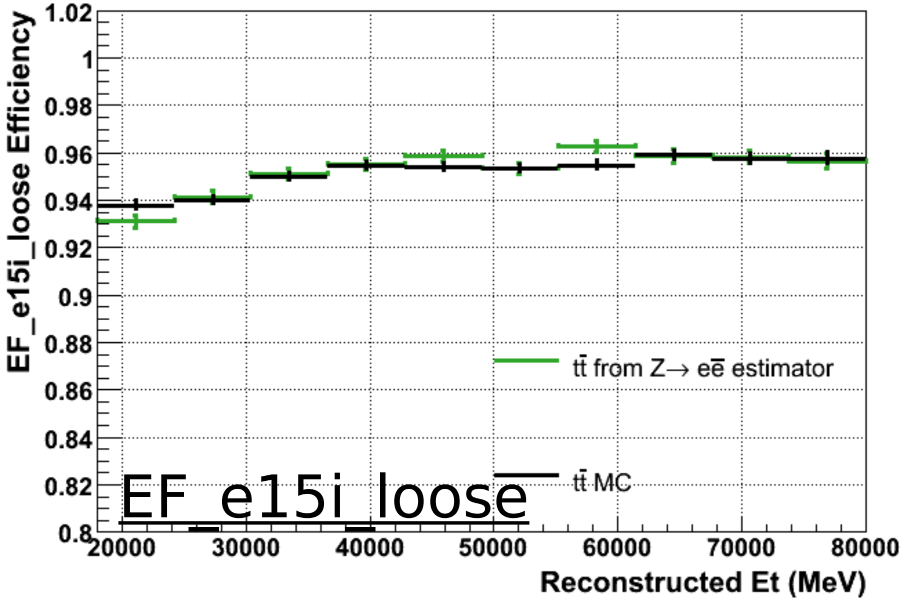


- 3D estimators describe efficiency well as a function of all variables studied

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 **Et and Eta** dependencies alone.

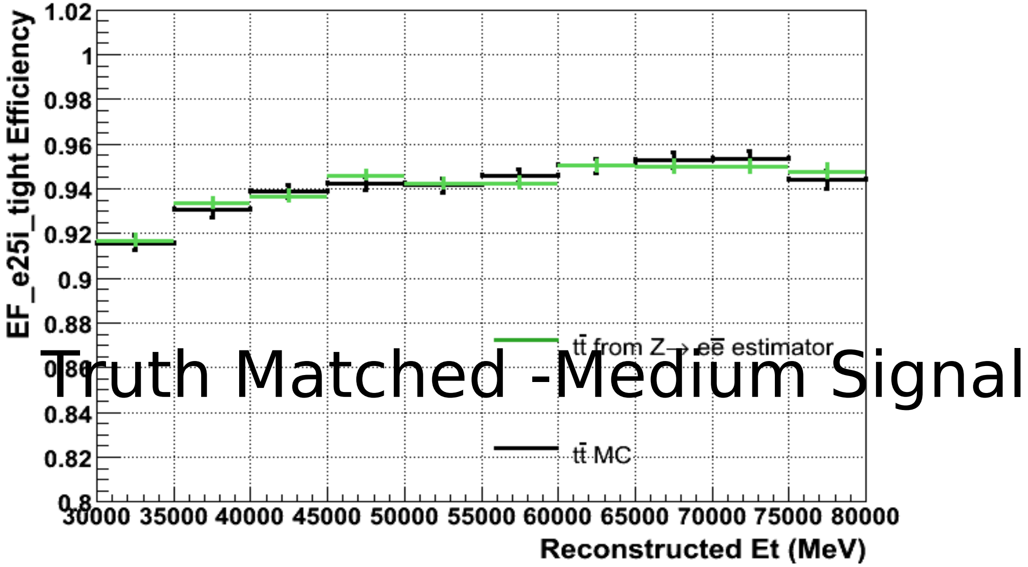
- Trigger efficiency for **unisolated** electrons ***cannot*** be described by electron **Et and Eta** alone.
  - The extension to **3D** with **Etcone40** describing isolation is a promising method.

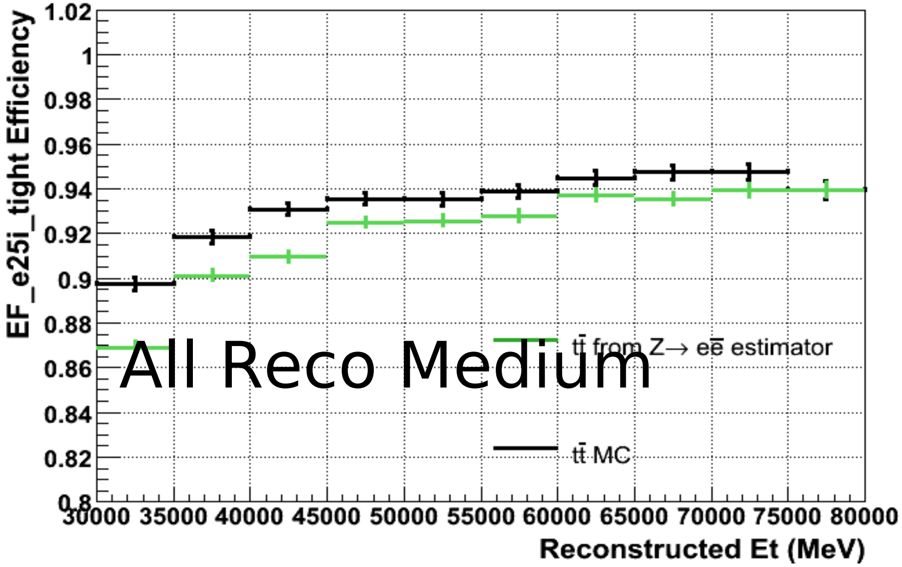
- 3D Estimators constructed from Z->ee tag and probe in real data provides a description of trigger efficiency for isolated and unisolated electrons that can be applied to different event topologies.

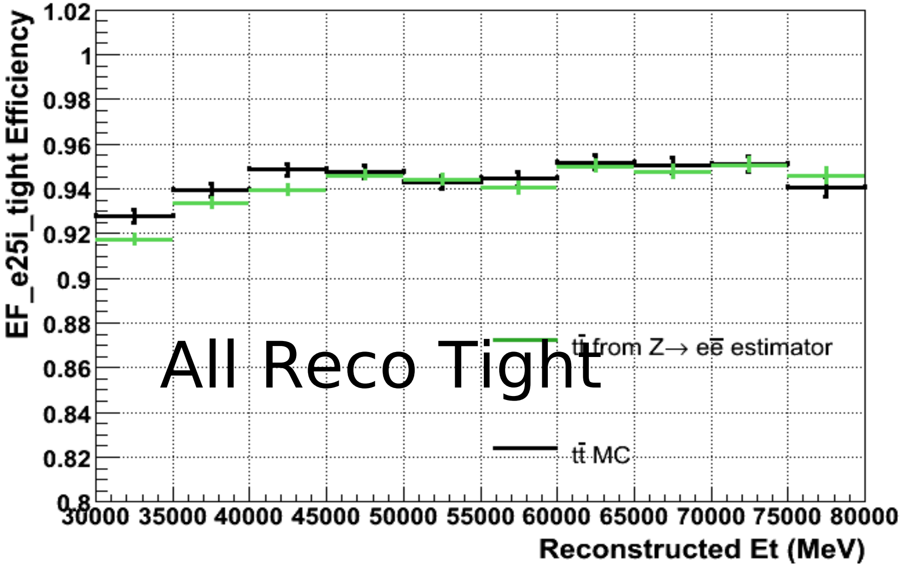
Backup slides

Back to Fakes

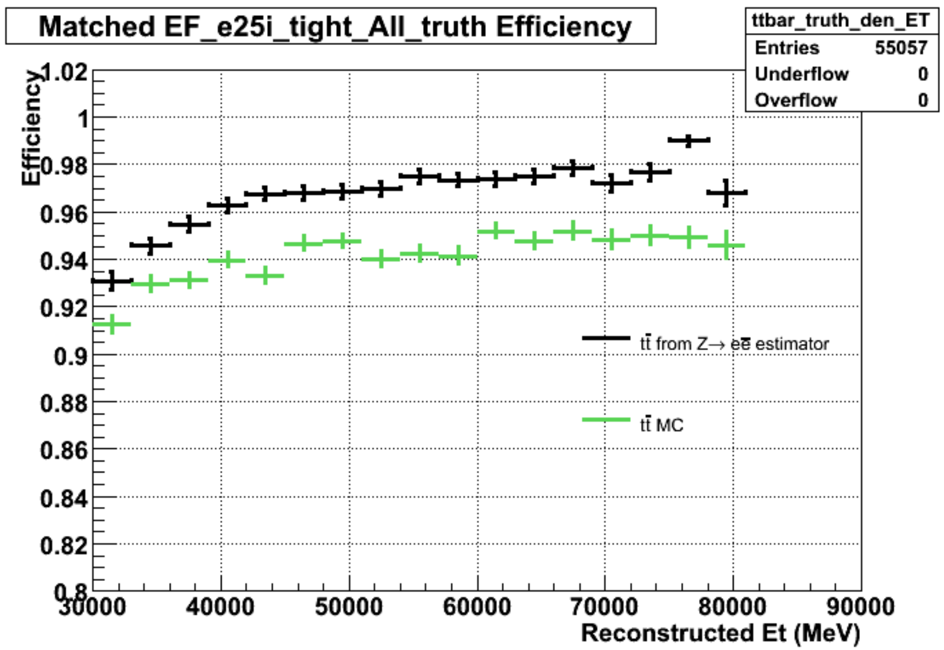
- How to deal with this?

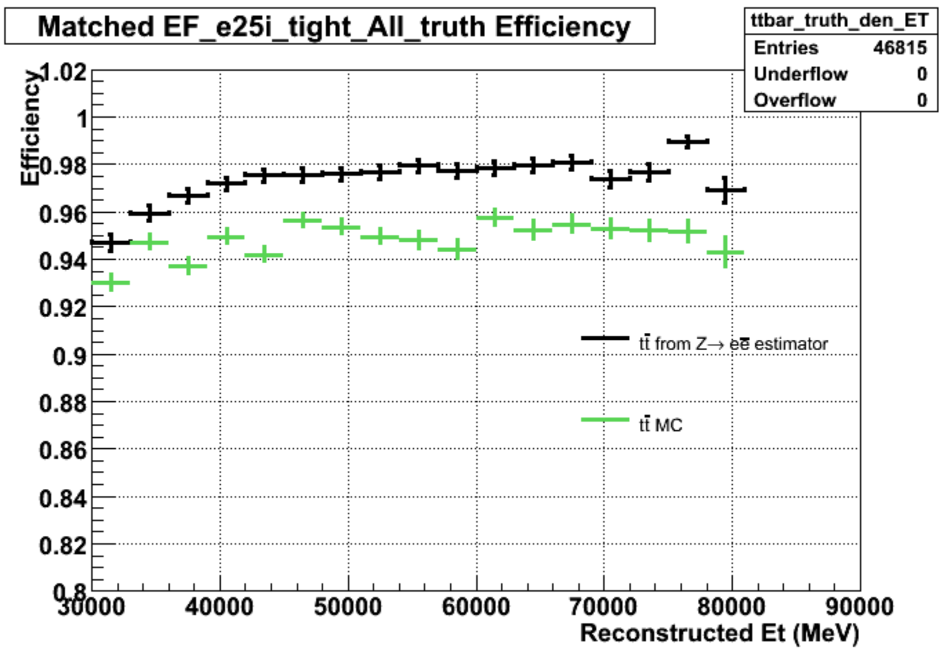






Electron Kinematics





Truth Matched -- Medium

Truth Matched -- Tight