Applying cuts with new "split Chi2" variables

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Overview
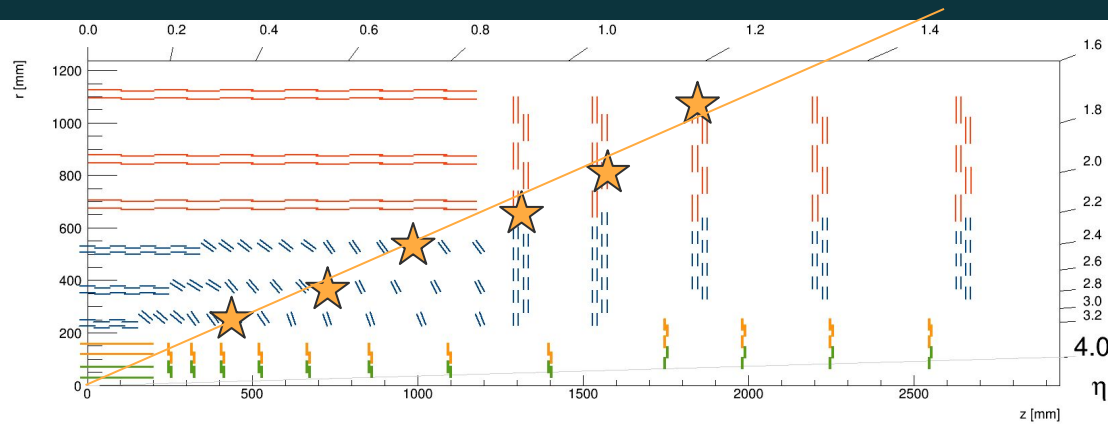
- **New Variables**
  - Propagated downstream from Kalman Filter to TTTrack (along with hitpattern)
    - Origin: Ian's earlier presentation https://indico.cern.ch/event/866759/contributions/3655375/
  - $\chi^2_{r\phi}$: chi2 fit in the phi plane
  - χ^2_{rz}: chi2 fit in the r-z plane

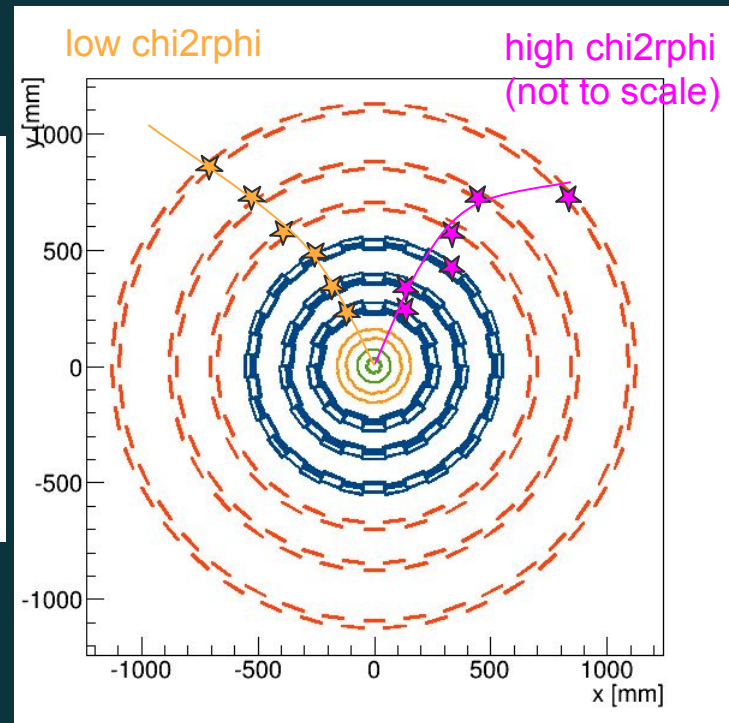- **Plots I did** *(Sample: <u>1000x TTbar PU200 D49</u> unless otherwise noted)*
  - Chi2 distributions
    - Muons vs. electrons, barrel vs. central vs. endcap
    - Fake proportion (using *trk_fake* and *trk_genuine*) histograms
  - ROC Curves (plot different cuts through efficiency vs. rake rate space)
    - Fake track: *trk_genuine == 0*
  - Efficiency, loose fake, and "strict" fake binned by pT and eta for varying chi2 cuts
    - $\chi^2_{r\phi}$ cut == 23, χ^2_{rz} cut == 7
    - Cuts were chosen so that samples had the same integrated efficiency
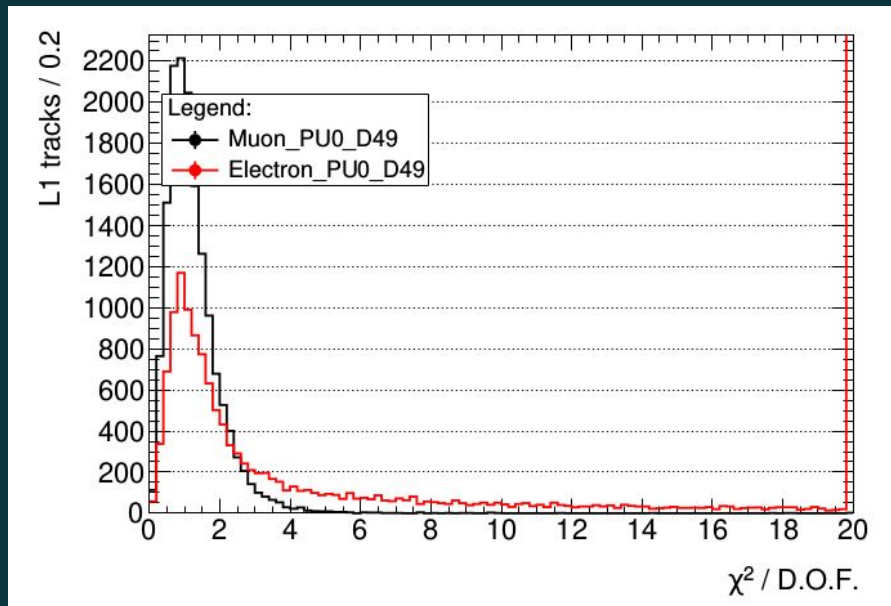
For anyone in need of a visual

Chi2rz measures fit in the r-z plane...

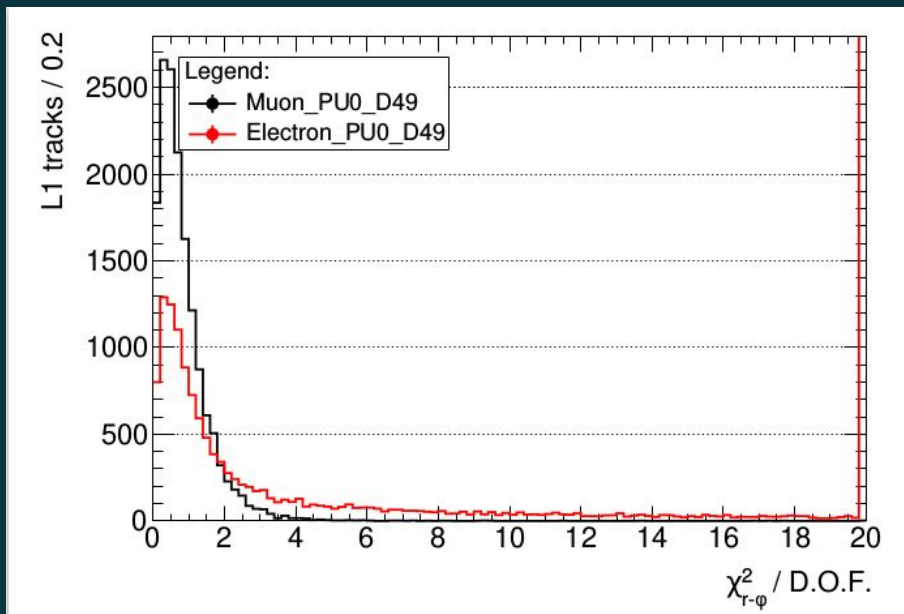...and chi2rphi measures fit in the r-phi plane.
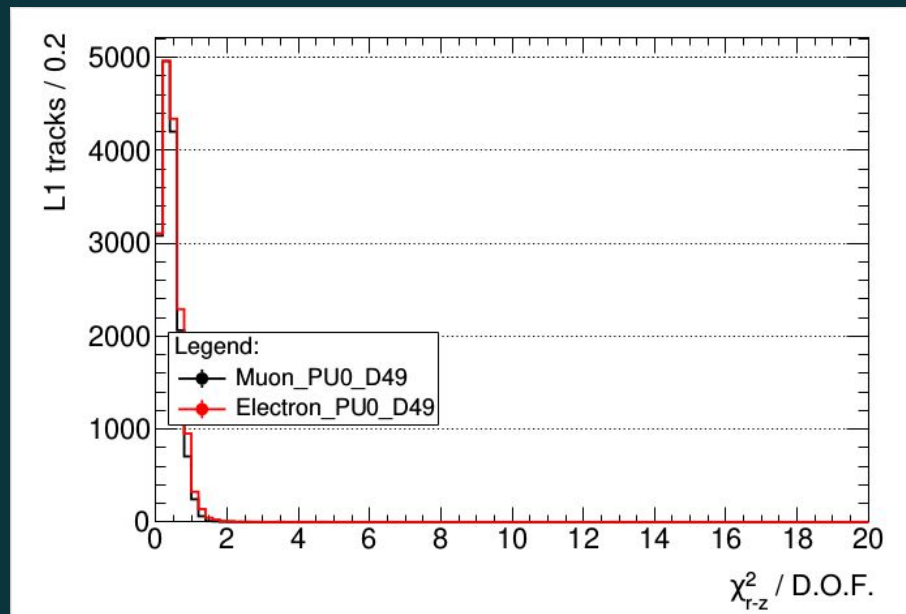
Chi2 Distributions

Joint chi2/DOF for Muons and Electrons.

Chi2 Distributions

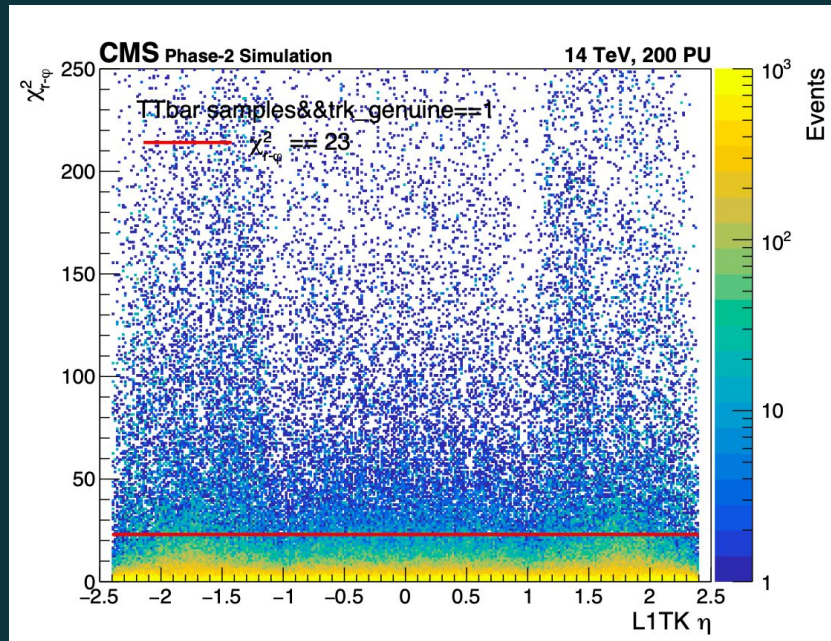Chi2rphi/DOF for Muons and Electrons.

Chi2rz/DOF for Muons and Electrons.

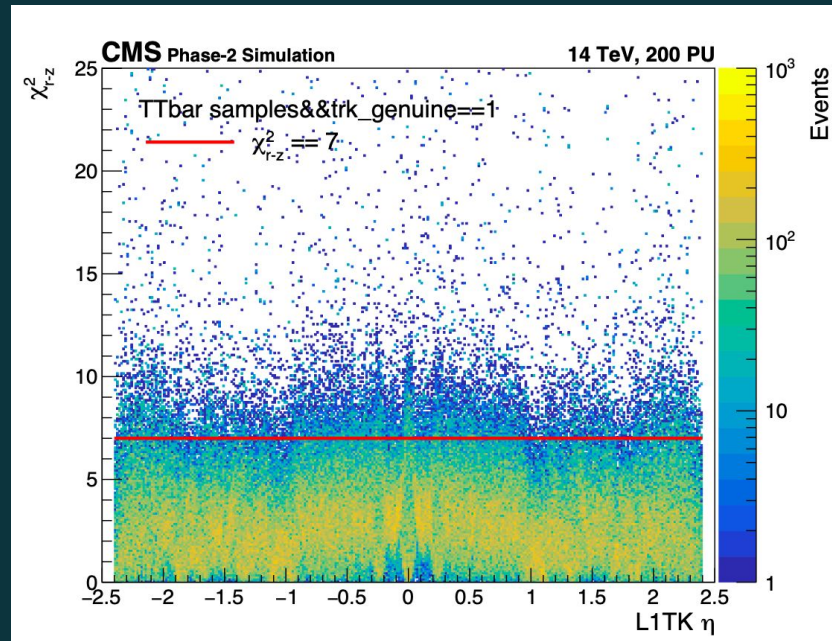**NB:** Chi2rz cuts treat muons and electrons in the same way!

Electrons and Muons from a TTbar sample can be found in the backup.

Chi2 Distributions

Chi2rphi vs eta.

Chi2rz vs eta.

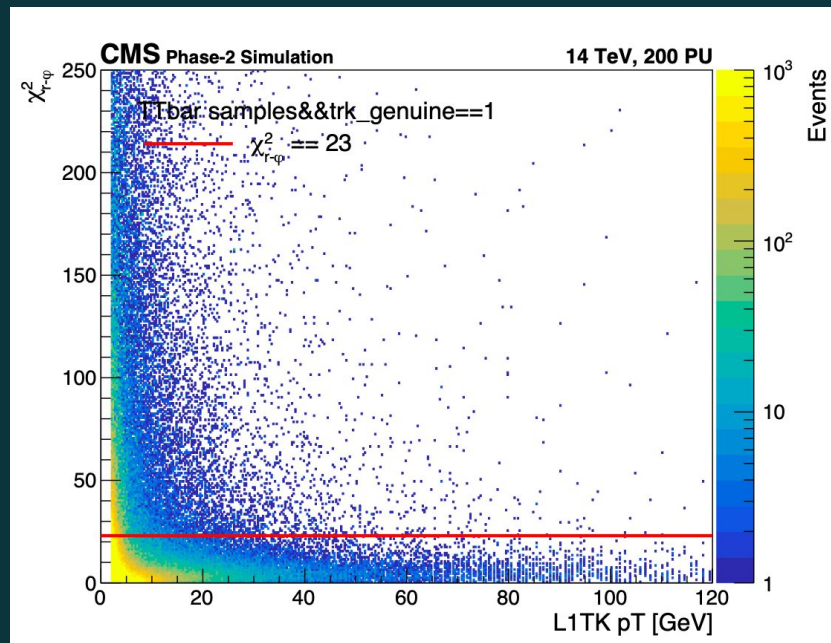**NB:** Chi2rphi is higher at high eta, chi2rz is higher at low eta.
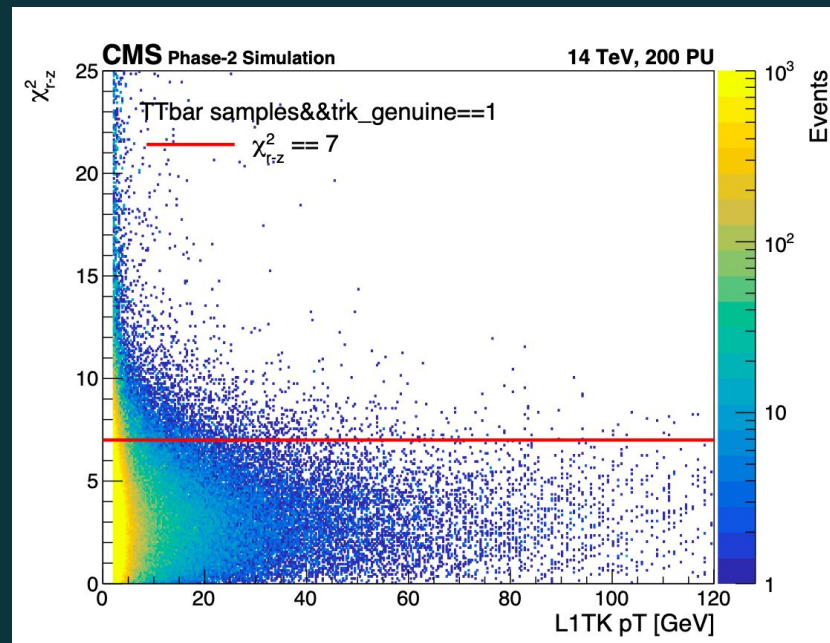Here, there are **10,000 TTbar PU200 D49** events. (And these plots were created by Jack, not me.)
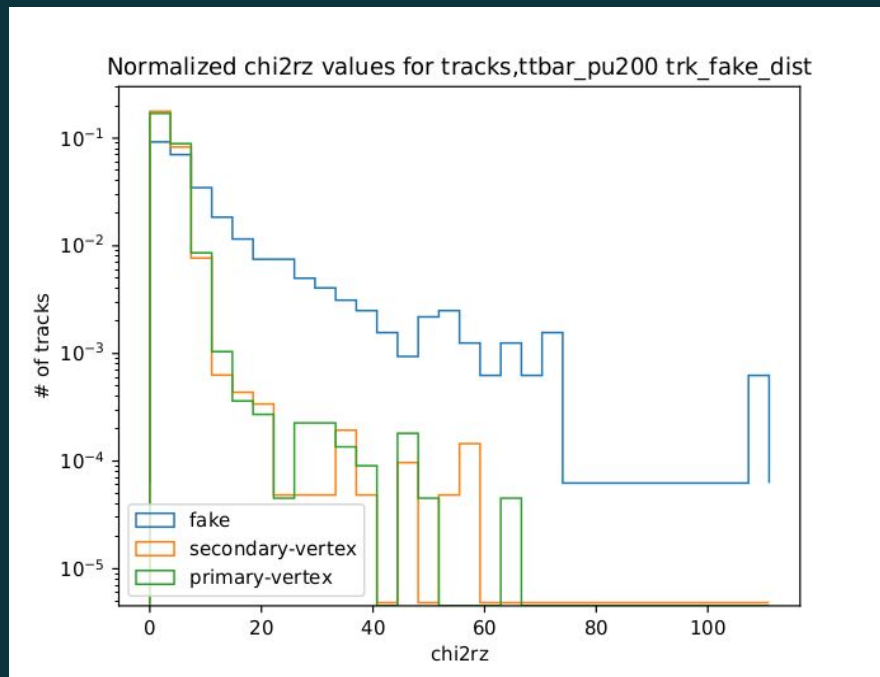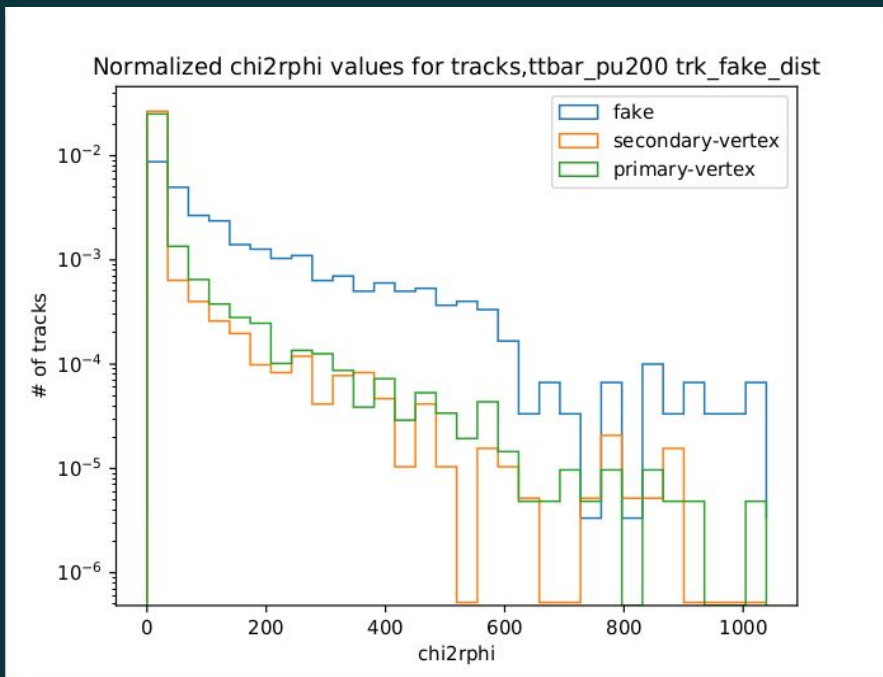
Chi2 Distributions

Chi2rphi vs eta.

Chi2rz vs eta.

NB: There are far fewer (proportionally) high chi2rz tracks than there are chi2rphi tracks.
Here, there are **10,000 TTbar PU200 D49** events. (And these plots were created by Jack, not me.)

Fake Proportion

NB: Both split chi2 variables are similar for primary and pileup interactions.
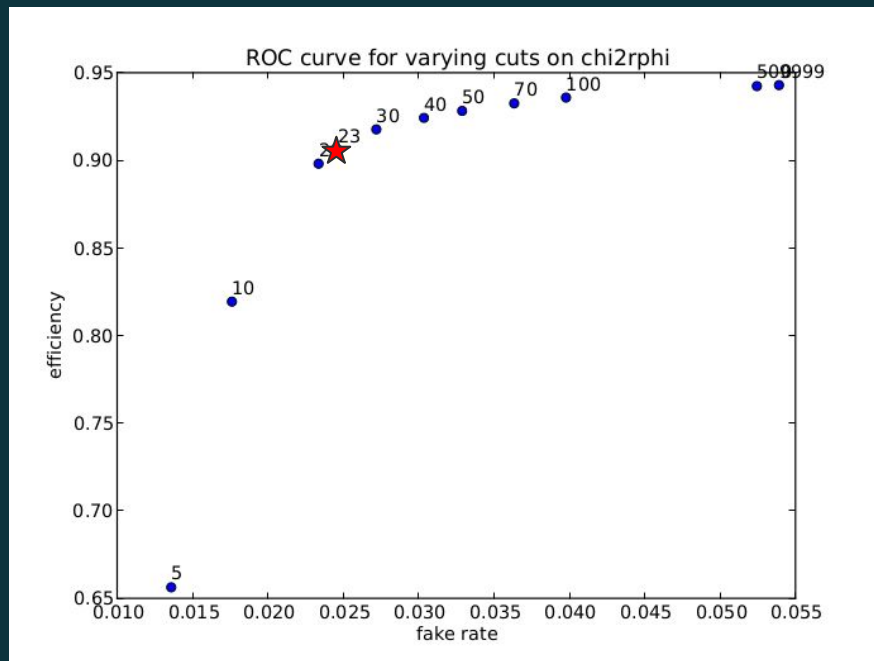**NB:** It's not just that electrons look similar to muons for chi2rz — fake tracks still have long tails
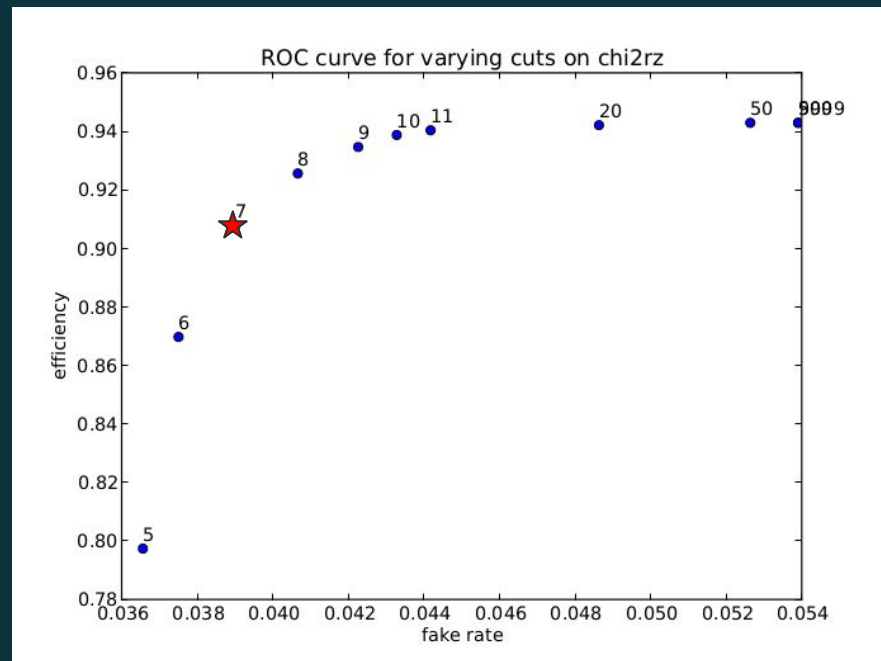This is with 400 TTbar PU200 D49 events rather than 1000.
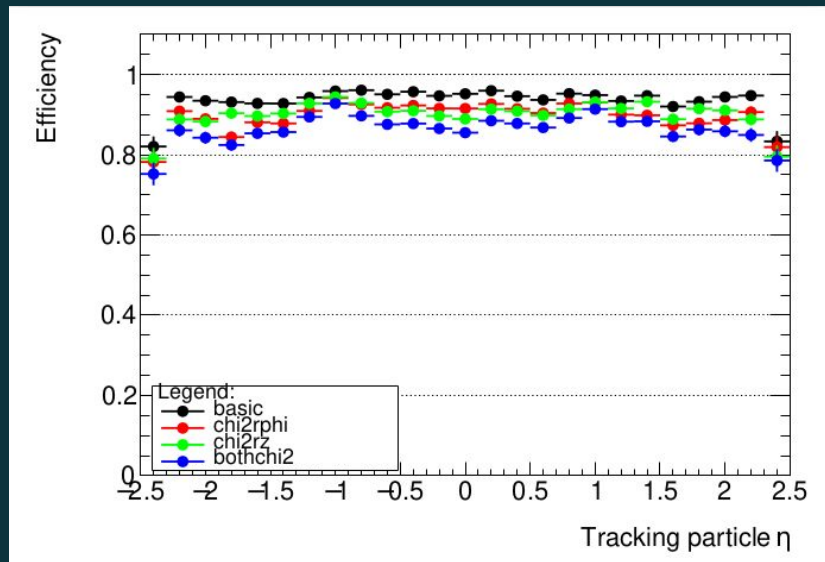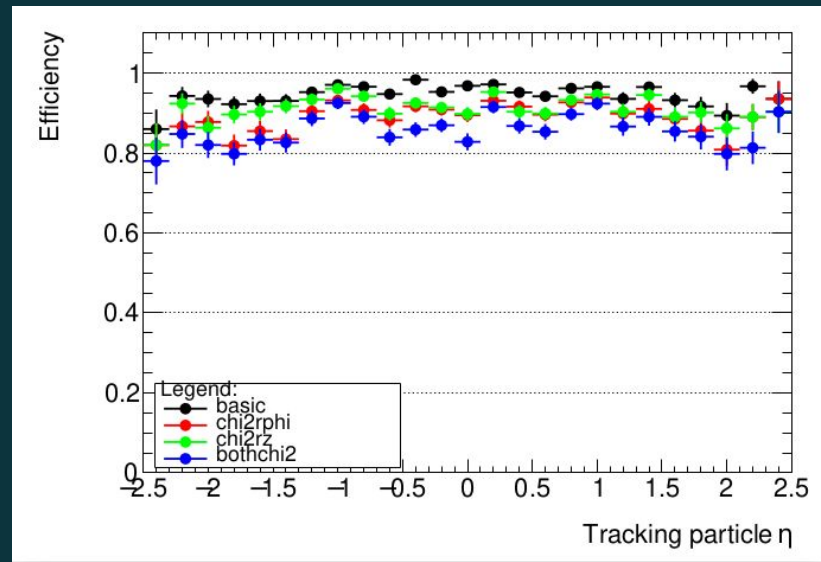
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ROC Curves

chi2rphi

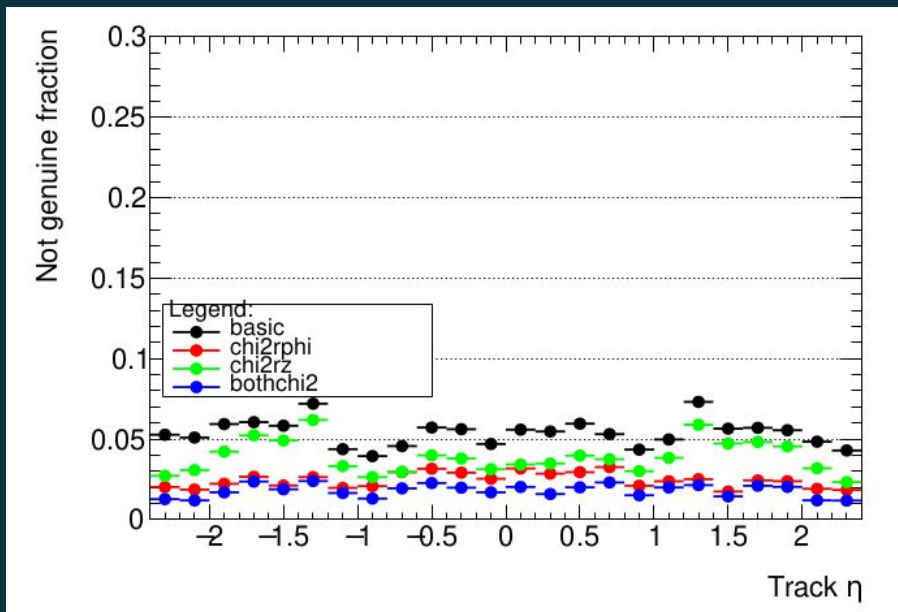chi2rz

ROC Curves
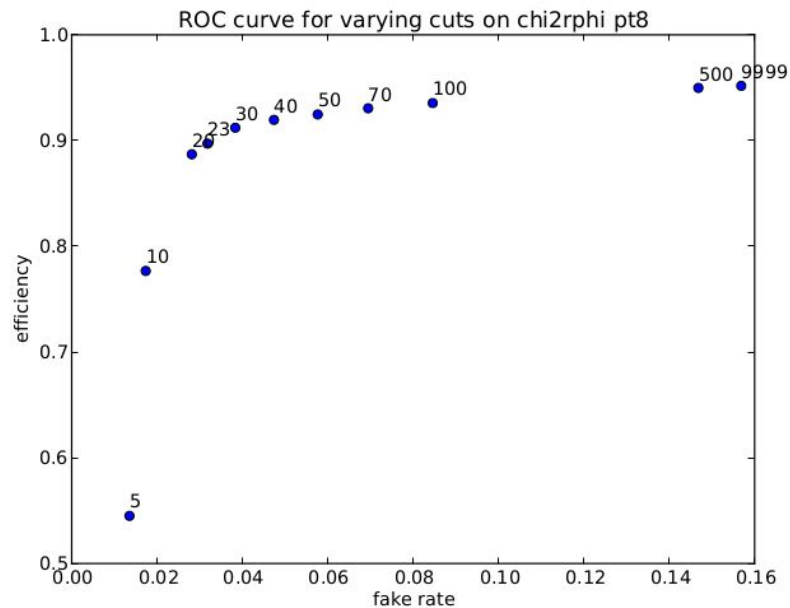
chi2rphi
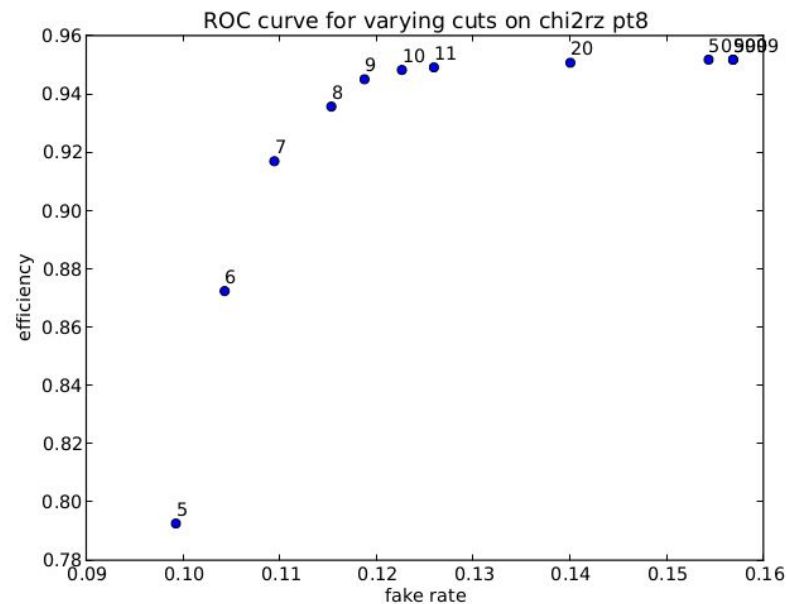
chi2rz

Efficiency

All pT

pT > 8 GeV

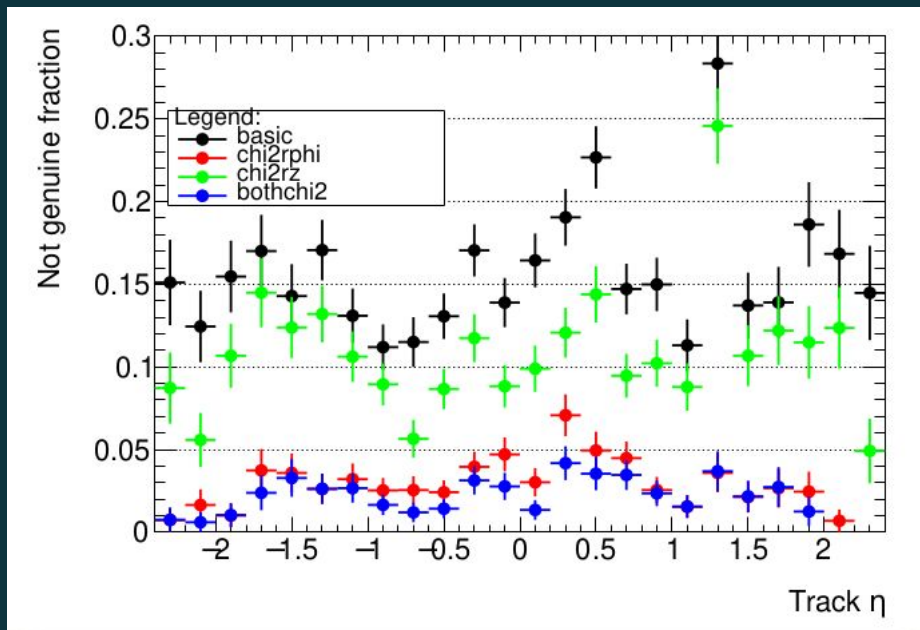Efficiency, loose fake, and "strict" fake binned by pT and eta for varying chi2 cuts

- $\chi^2_{r\phi}$ cut == 23, χ^2_{rz} cut == 7
- Cuts were chosen so that samples had the same integrated efficiency

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Fake rate (strict)

All pT

pT > 8 GeV

Q: "5-layer gap" eliminated by chi2rphi cuts, but not chi2rz cuts. What's up with that?

These are using limited statistics – I need to check what's going on with the eta asymmetry.

Conclusions

- **Chi2rz is better than Chi2rphi for identifying real electrons**
  - No Chi2 cut used in the trigger at all for electrons due to efficiency hit
    - Now, with Chi2rz, this isn't as big of a problem
  - Tracks with high chi2rphi still account for a large portion of fake tracks
- **Eta dependence in how cuts affect efficiency**
  - Chi2rphi hurts efficiency more in the endcap region
  - Chi2rz hurts it more in the barrel
- **Chi2rphi and chi2rz (and hitpattern) are now all in TTTrack**
- **The future:**
  - Incorporating this into BDT/neural net studies
    - See Claire's presentation last week

Backup

Chi2 Distributions
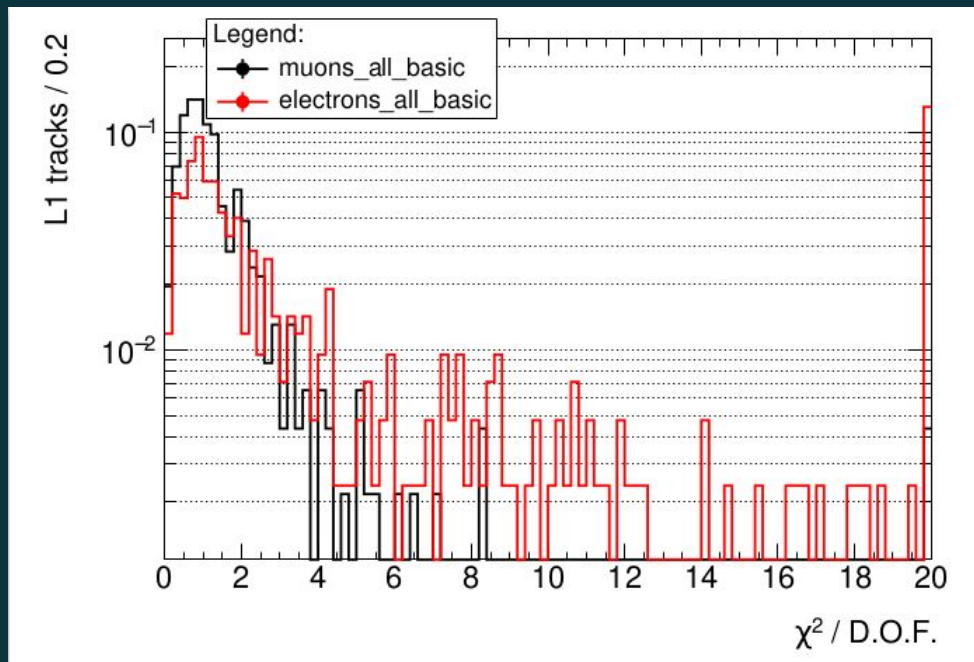
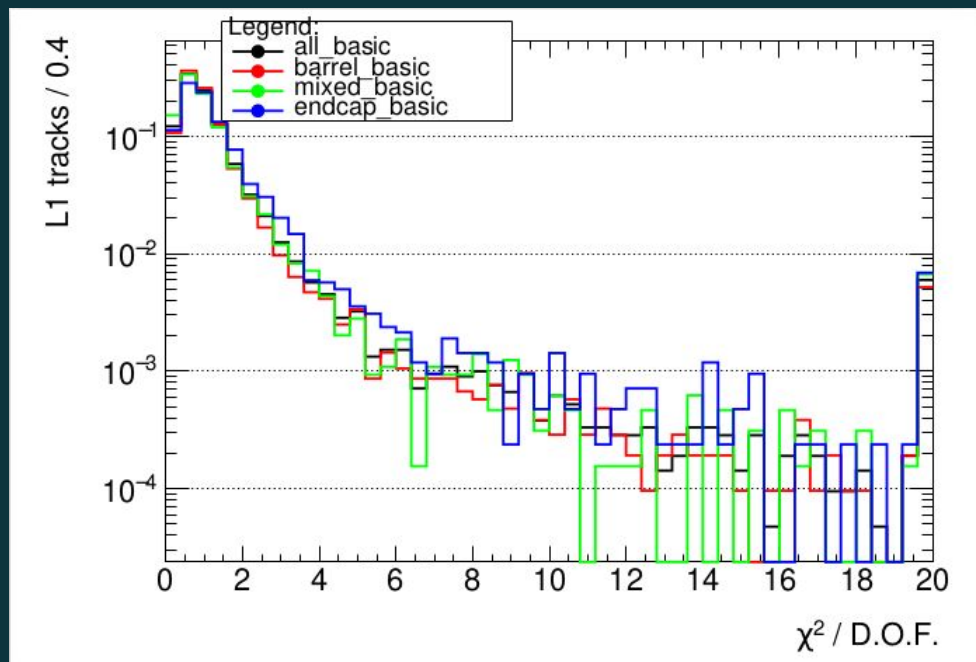Joint chi2/DOF for Muons and Electrons.

Chi2 Distributions
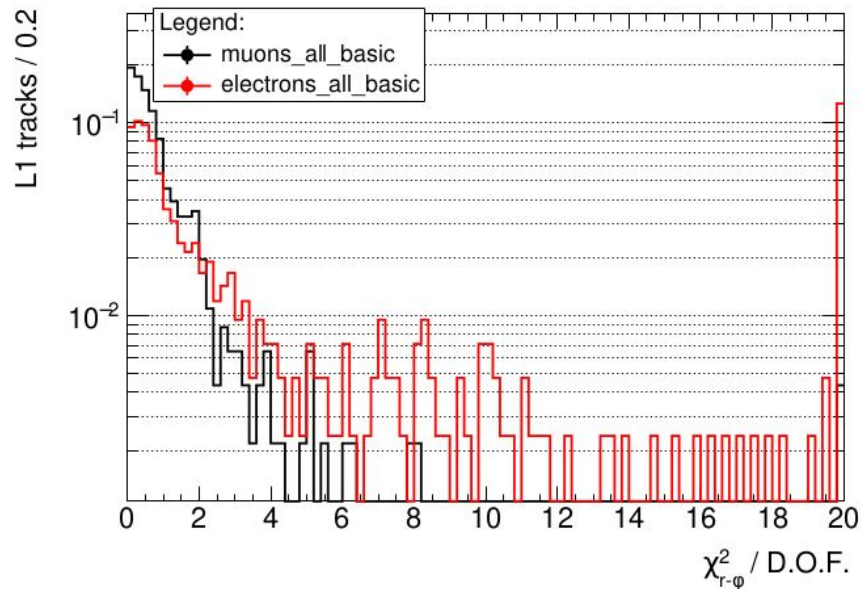
Chi2rphi/DOF for Muons and Electrons.
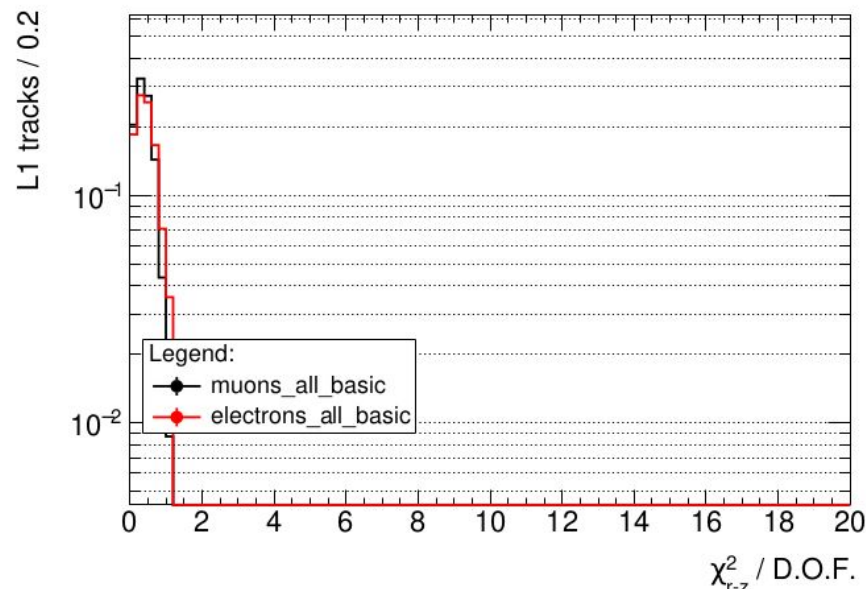
Chi2rz/DOF for Muons and Electrons.

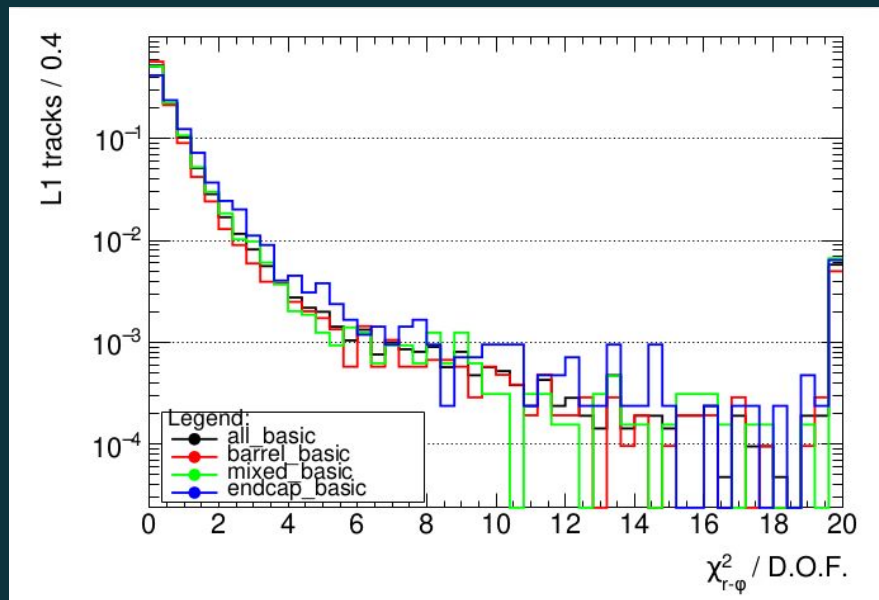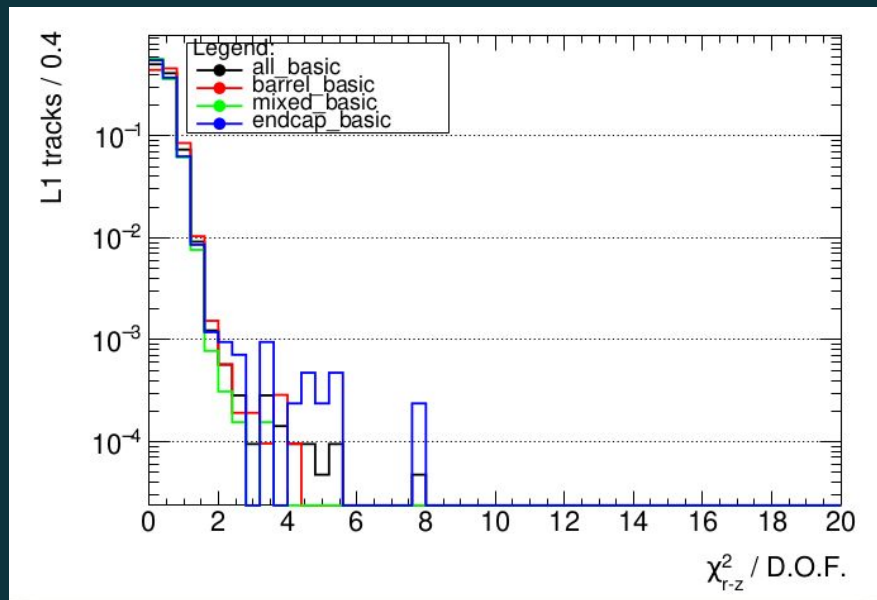Here, "basic" means tracks with 2 > pT > 100, -2.4 > eta > 2.4, nstub/track ≥ 4.

Chi2 Distributions

Joint chi2/DOF for different eta regions

Chi2 Distributions

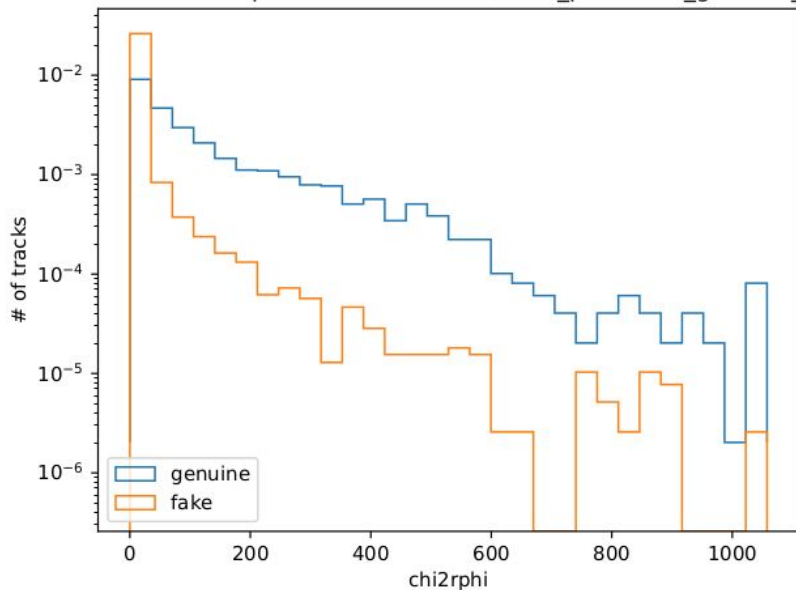Chi2rphi/DOF for different eta regions.

Chi2rz/DOF for different eta regions.

Here, "basic" means **1000 TTbar** tracks cut with 2 < pT < 100, nstub/track ≥ 4.
Barrel: 0 < |eta| < 0.9   **Mixed:** 0.9 < |eta| < 1.6   **Endcap:** 1.6 < |eta| < 2.4

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Fake Proportion
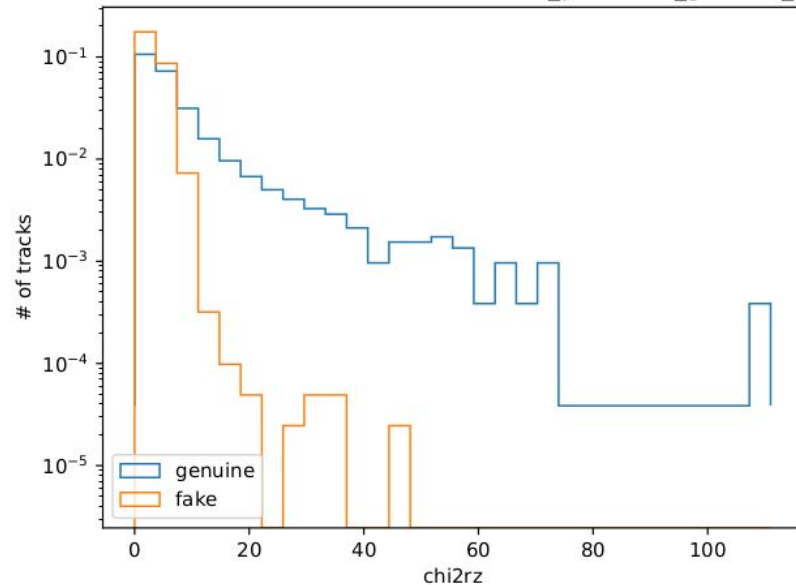
Due to negligence on my part, the genuine and fake tracks are switched.

Efficiency
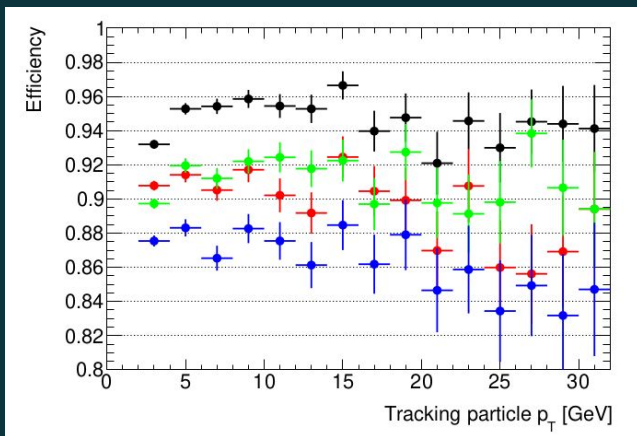
All eta
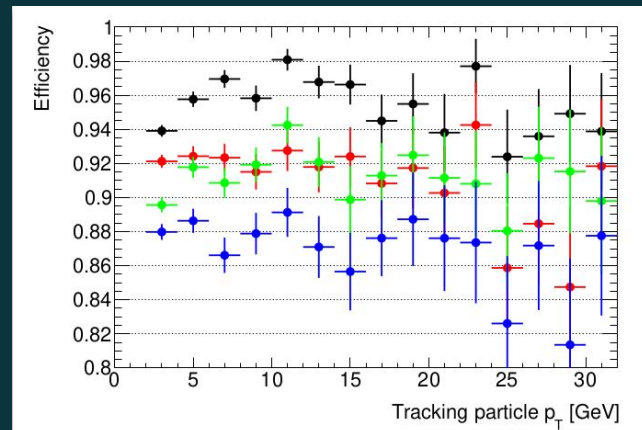
Barrel (0 - 0.9 eta)
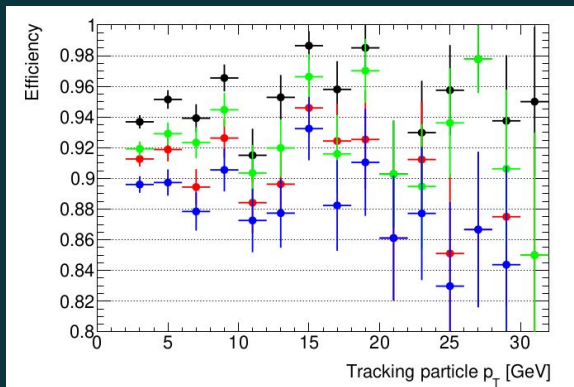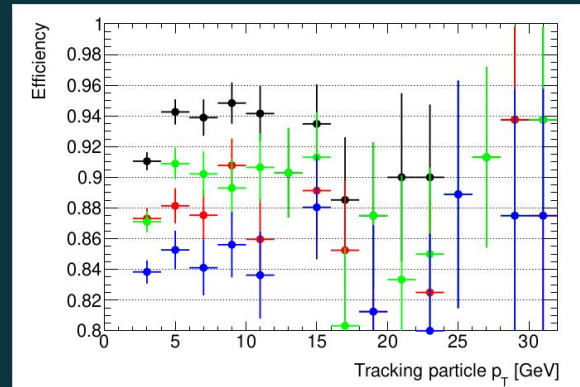
Mixed (0.9 - 1.6)

Endcap (1.6 - 2.4)

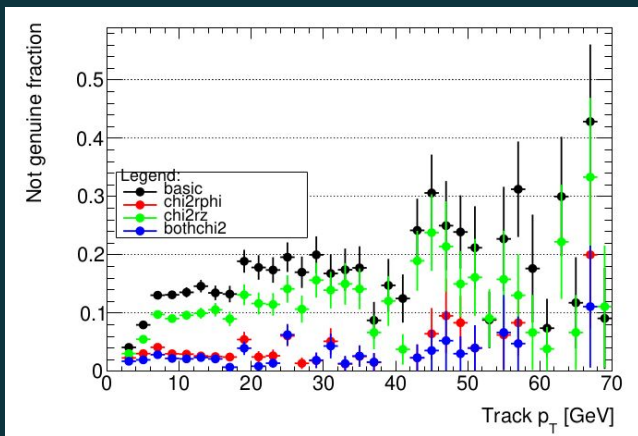# Fake rate (strict)
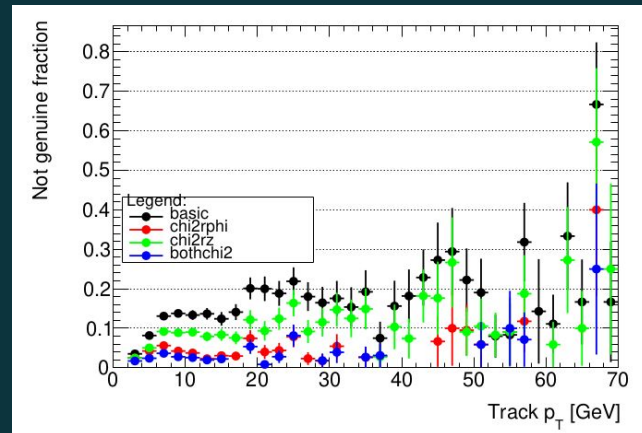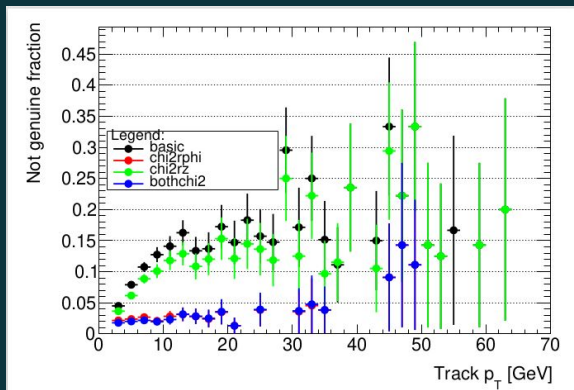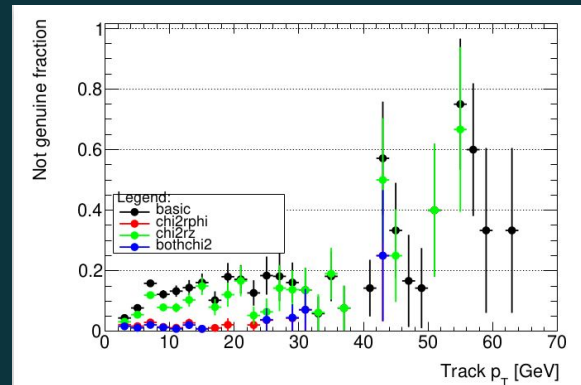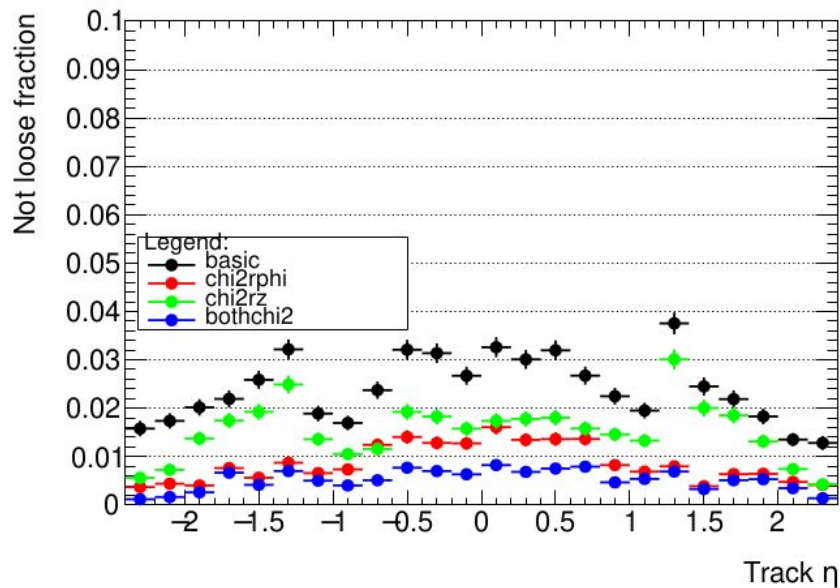
All eta

Barrel (0 - 0.9 eta)

Mixed (0.9 - 1.6)

Endcap (1.6 - 2.4)

Fake rate (loose)

All pT

pT > 8

Fake rate (loose)

All eta
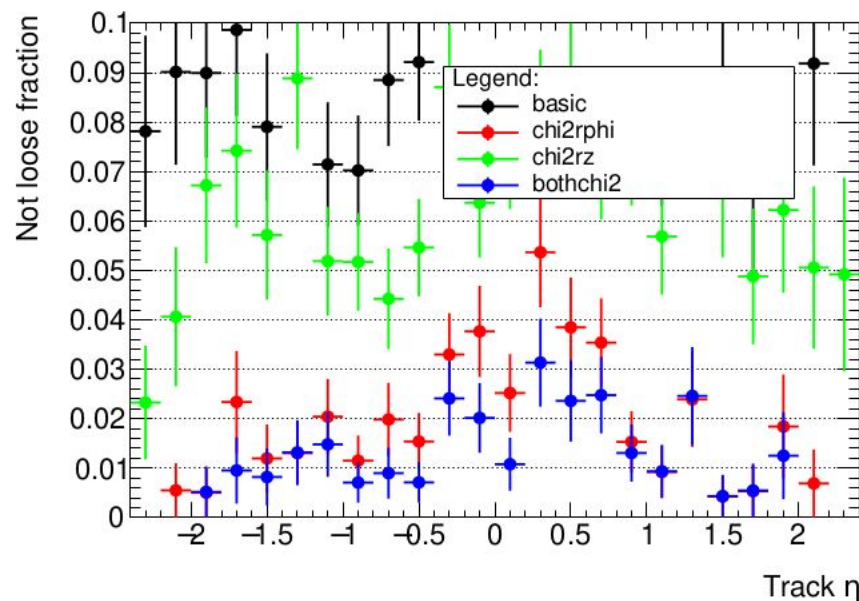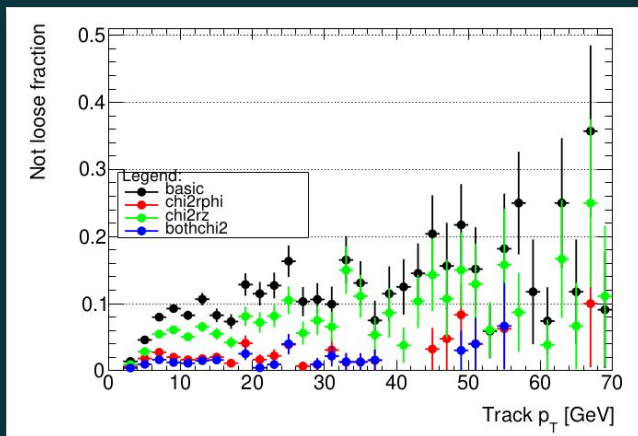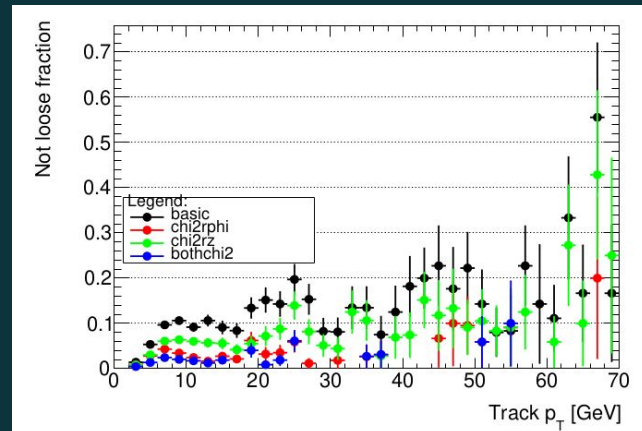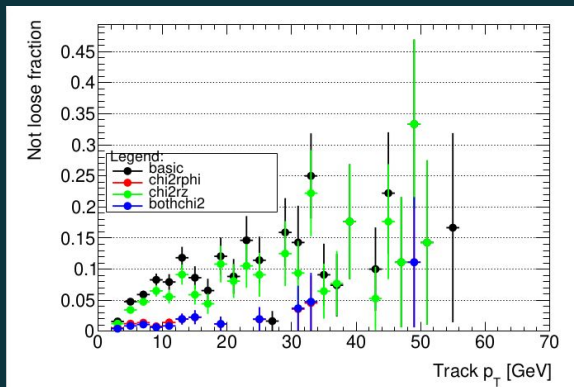
Barrel (0 - 0.9 eta)

Mixed (0.9 - 1.6)

Endcap (1.6 - 2.4)