

Track Finding Efficiency for 2019/21 pass0

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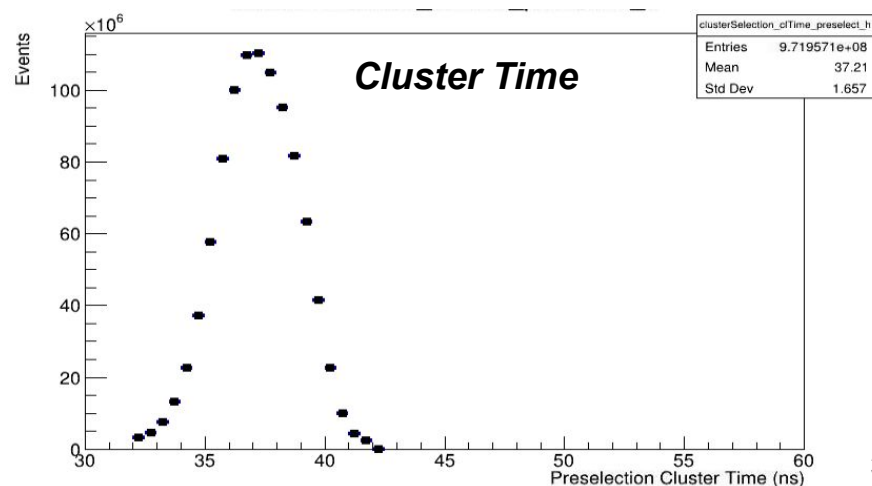
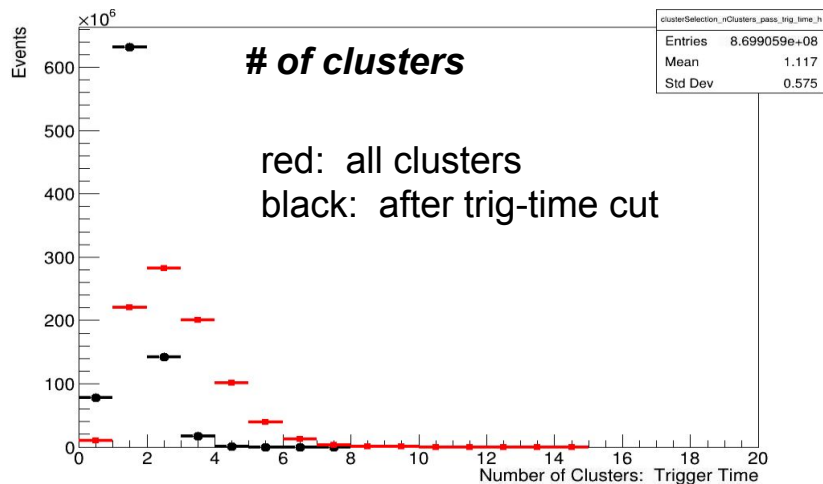
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Overview

- As I've done in the past, I'm using tag-and-probe to explore the track finding efficiency in data
- Norman has shown a bit of this in various talks; this follows up on that work
 - one thing he saw was that efficiency is worse later in the run...I see that too
- Previously I just looked at 2-prong tridents, tagging with positron cluster+track and probing electron track-finding
- Expanded this to WABs (still electron efficiency) and 3-prong tridents
 - 3-prong potentially lets us look at positron efficiency
 - I don't fully understand what I'm seeing in 3-prongs so I'm not including them here
- This does NOT cover the tracks that miss the ECal...
- This is all done in hpstr using 2019/21 pass0 data

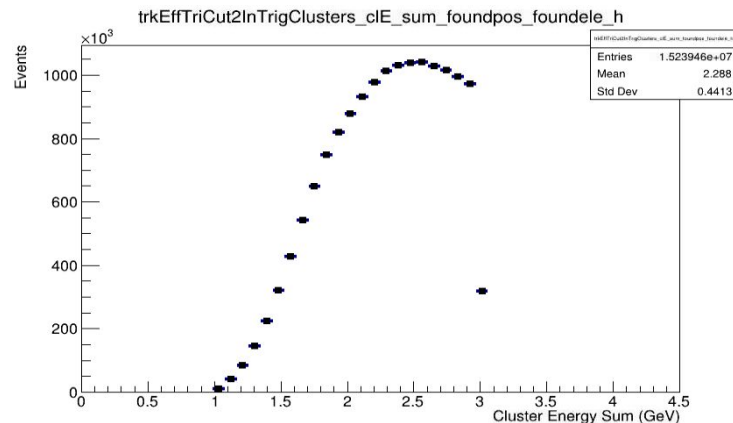
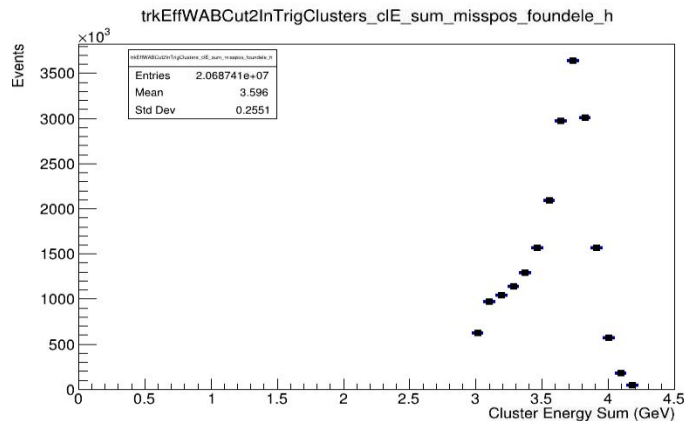
Cluster selection

- Selection starts with clusters...I require:
 - cluster have energy > 500 MeV (this is a pretty high energy cut)
 - must be within “trigger time” ~ 32 - 42 ns (sorry, don't have plot before selection)
- After energy & time cuts...most of our event have only 1 cluster



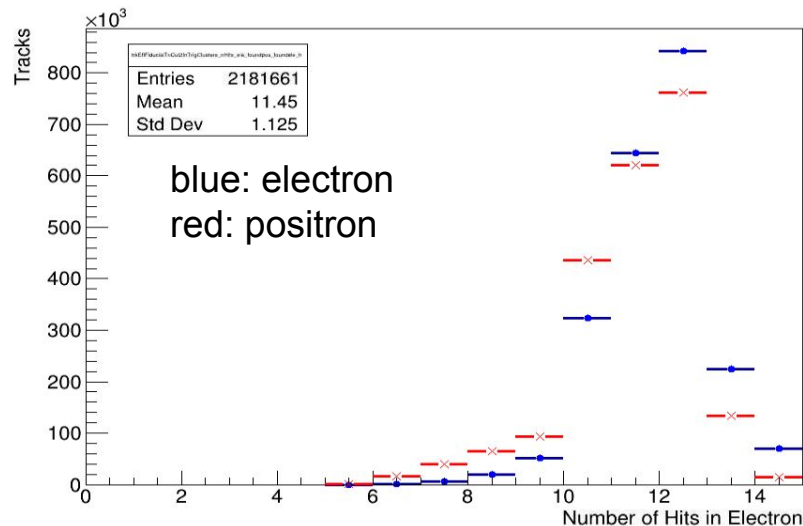
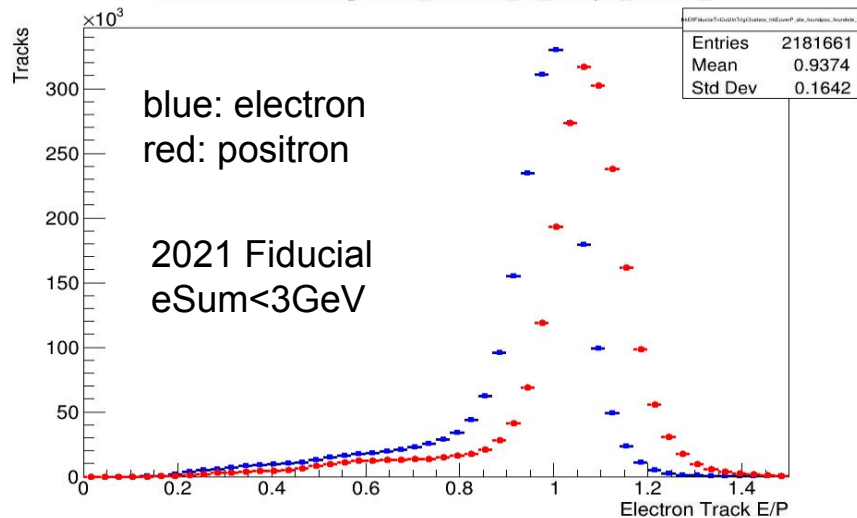
Pair Selection

- require 2-and-only-2 in-trigger-time clusters in the event
- require cluster pairs to be top/bottom left/right and have $dt < 2.5$ ns
- From here, I start slicing up the data
 - “WABs”
 - cluster $E_{\text{Sum}} > 3.5$ (3.0) GeV for 2019 (2021)
 - “Tridents”
 - cluster $E_{\text{Sum}} < 3.5$ (3.0) GeV for 2019 (2021)
 - Both of these have Fiducial-or-not categories...”Fiducial” requires both clusters to be in fiducial region of ECal...”not” has no requirements



Tracks

- I don't do much with the tracks...us standard KF tracks from recon, no extra selection
 - KF requires ≥ 6 hits on track but peak is ~ 12 hits
- Tracks are “found” if they have a cluster match from recon in FinalStateParticles...if cluster does not have a track associated to it, it is “missed”



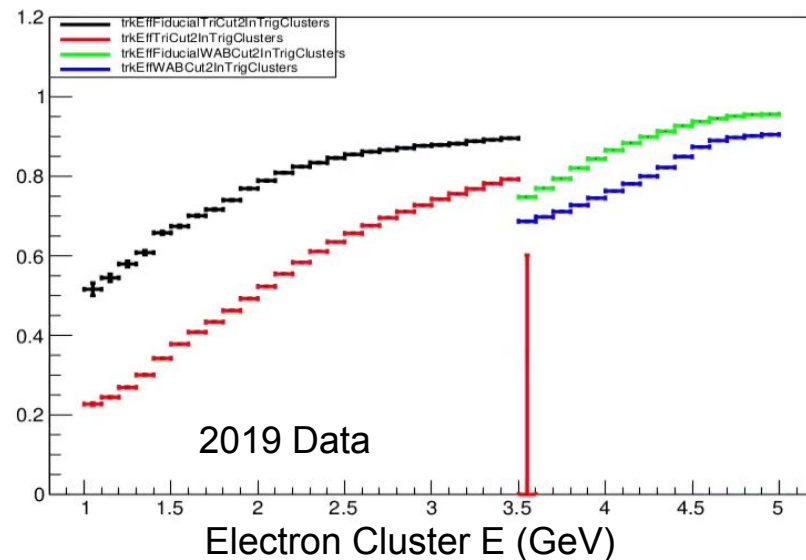
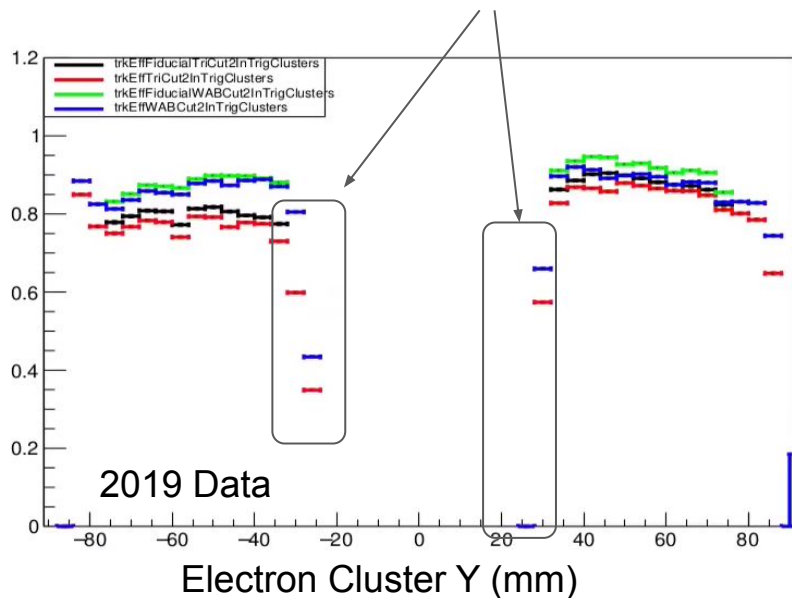
Efficiencies: 1D

To get efficiencies, I take:

$$\epsilon_{tri} = \frac{N(foundpos, foundele)}{N(foundpos, foundele) + N(foundpos, missele)}$$

$$\epsilon_{WAB} = \frac{N(misspos, foundele)}{N(misspos, foundele) + N(misspos, missele)}$$

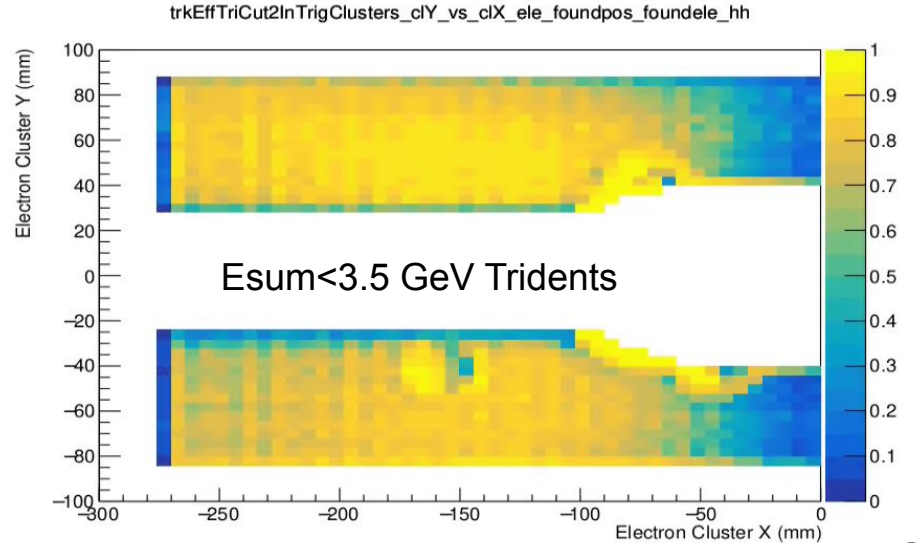
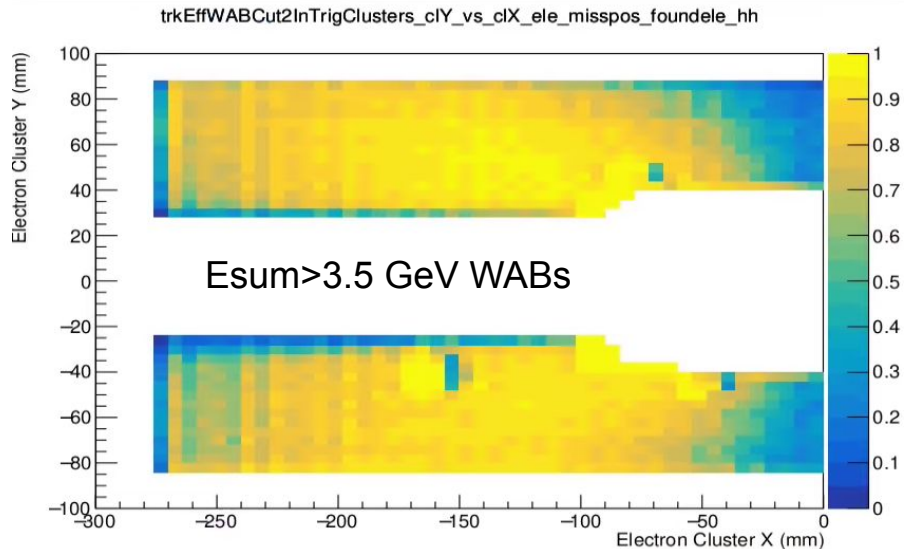
Efficiency really drops at low Y non-fiducial regions



Efficiencies: 2D

These plots are better to look at...showing efficiency where the electron clusters are are.

No fiducial cuts here so you can see at low $|Y|$, low and high (negative) X have poor efficiency.

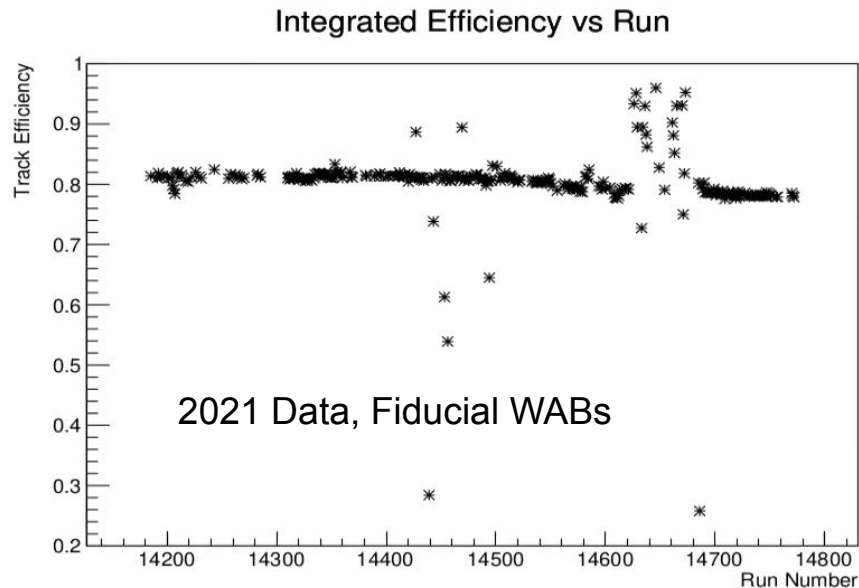
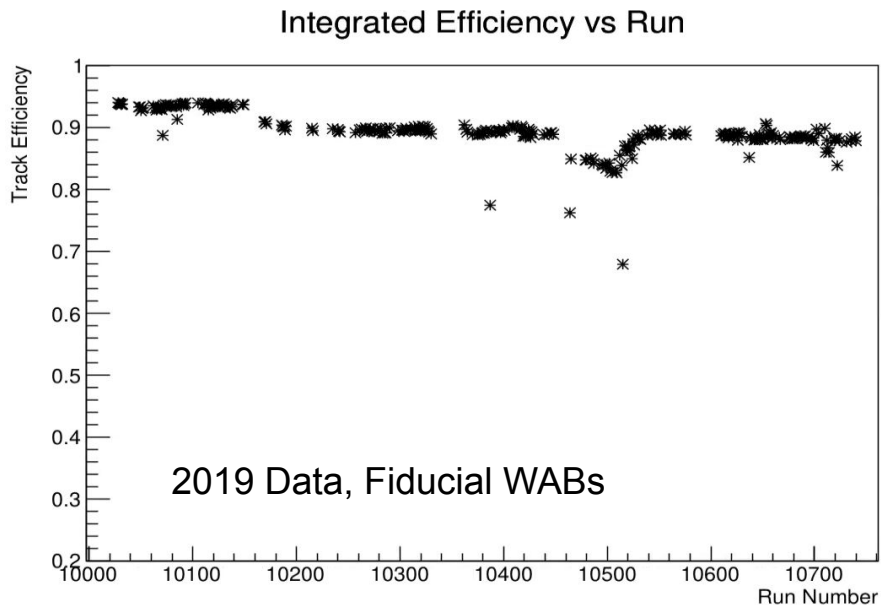


Why Inefficiency?

- There are lots of reasons tracks show up as “inefficient” in these plots..
 - Acceptance...the just didn't hit enough layers
 - at inside edges of calorimeter, particle missing tracker can hit vacuum box and shower
 - Hit inefficiency ... don't reco enough hits to make track (though lower limit is 6 for this...I don't think this is a huge effect)
 - Tracking algorithm...seeding strategies miss some tracks
 - mis-alignment... χ^2 cuts for hit-finding and/or full tracks are removing tracks
 - clusters are actually photons so assumptions are wrong...
 - there is definitely some of this, probably more at low energies

Efficiencies vs. Run

We see a ~smallish loss in efficiency for later run numbers
2019 shows higher efficiency than 2021 data...

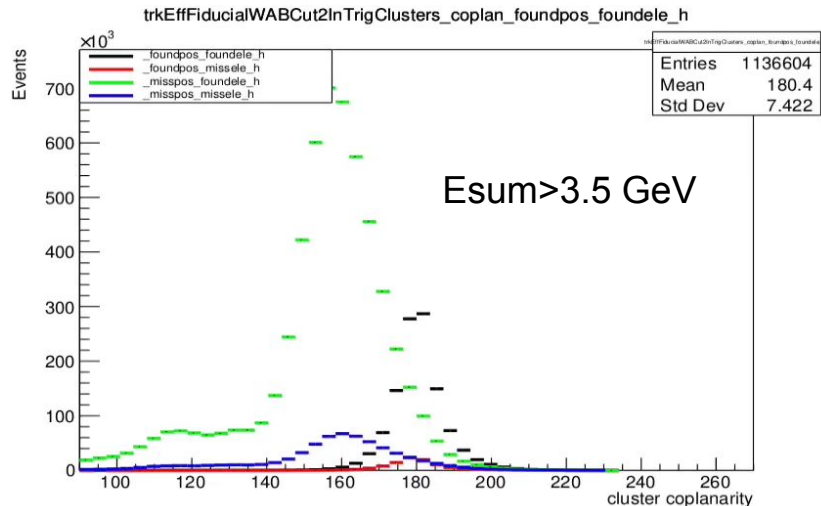
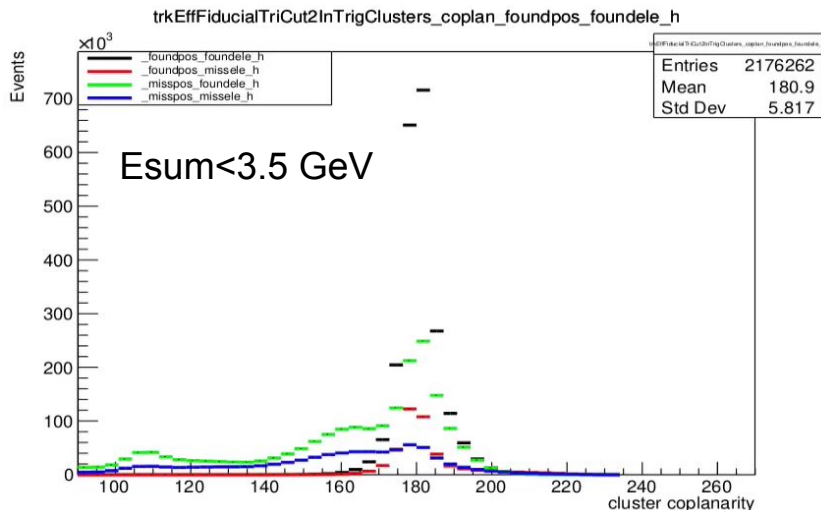


Cluster Coplanarity

- One handle I haven't used (but have in the past) is the cluster pair coplanarity, fined as:

$$\phi_{coplan} = atan2(clY_1, clX_1 - photX) - atan2(clY_2, clX_2 - photX)$$

- ...where $photX$ is the nominal X position for a straight-going photon
 - I used 42.52mm...this may not be correct for 2019/2021 detectors, but it's close I bet
- Tridents peak at 180° while (non-converted) WABs at $\sim 160^\circ$ (but broad)



Efficiencies vs. Run # ... tridents no fiducial cut

