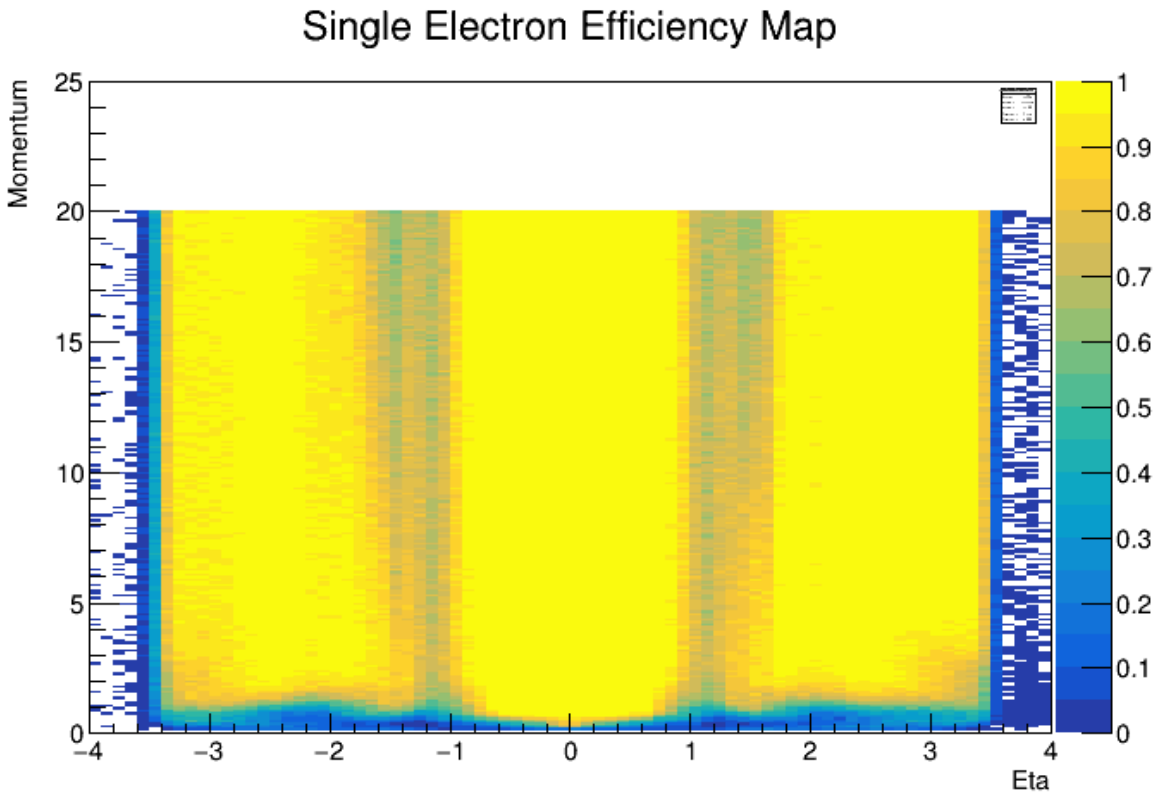
Track Efficiency and Jets: First Look

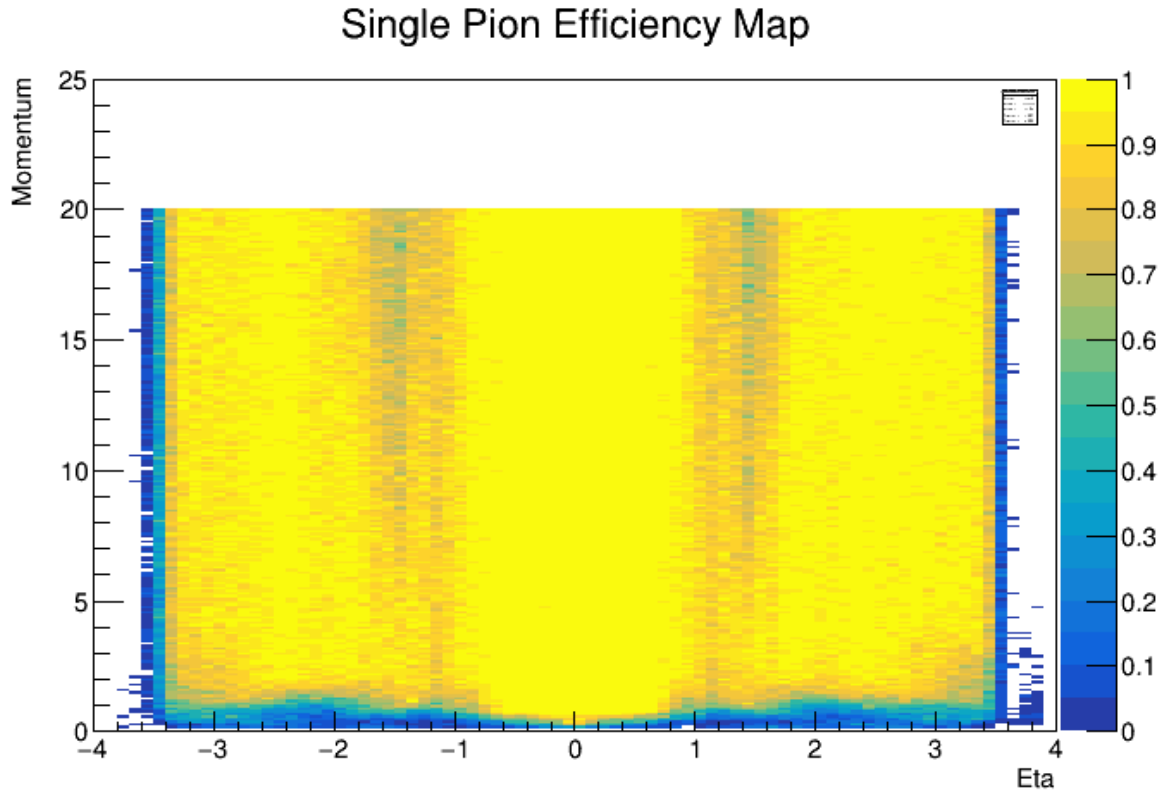
Brian Page

8/25/2022

Single Particle Efficiencies

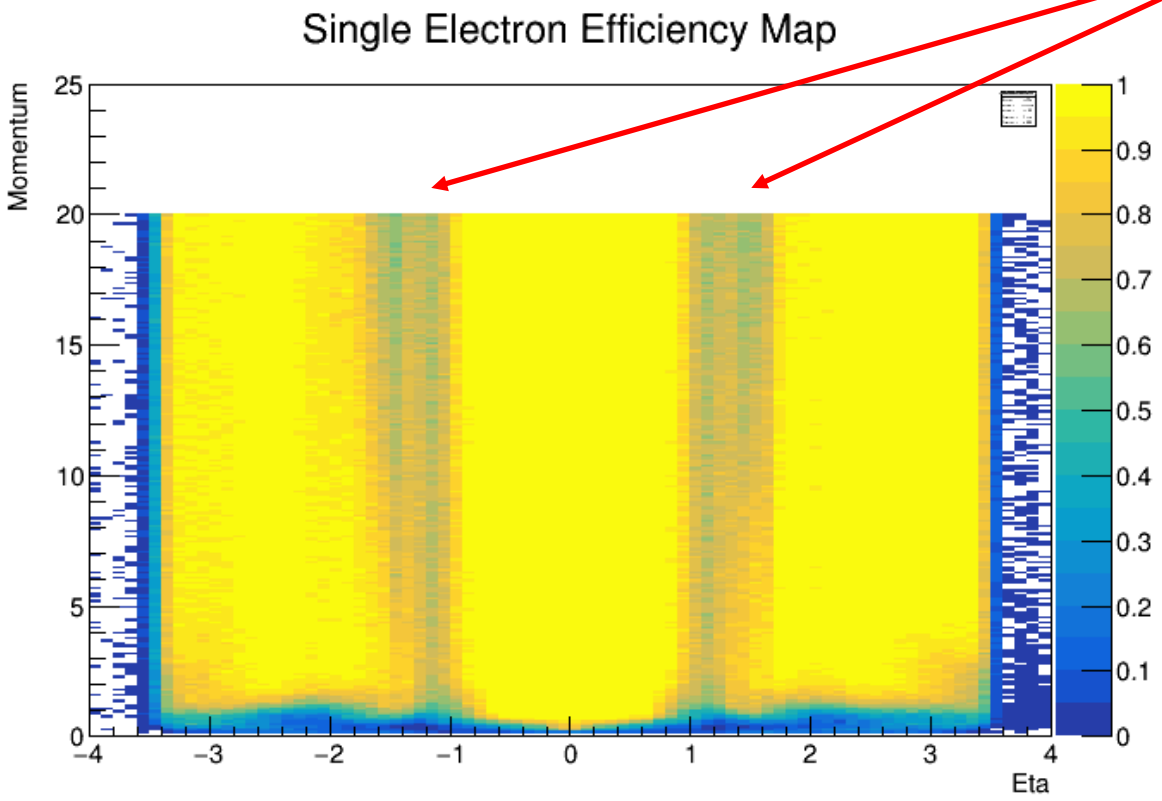


- Get electron and pion tracking efficiencies from single particle simulation – fun4all simulations currently residing on S3
- Particles thrown flat in eta and momentum



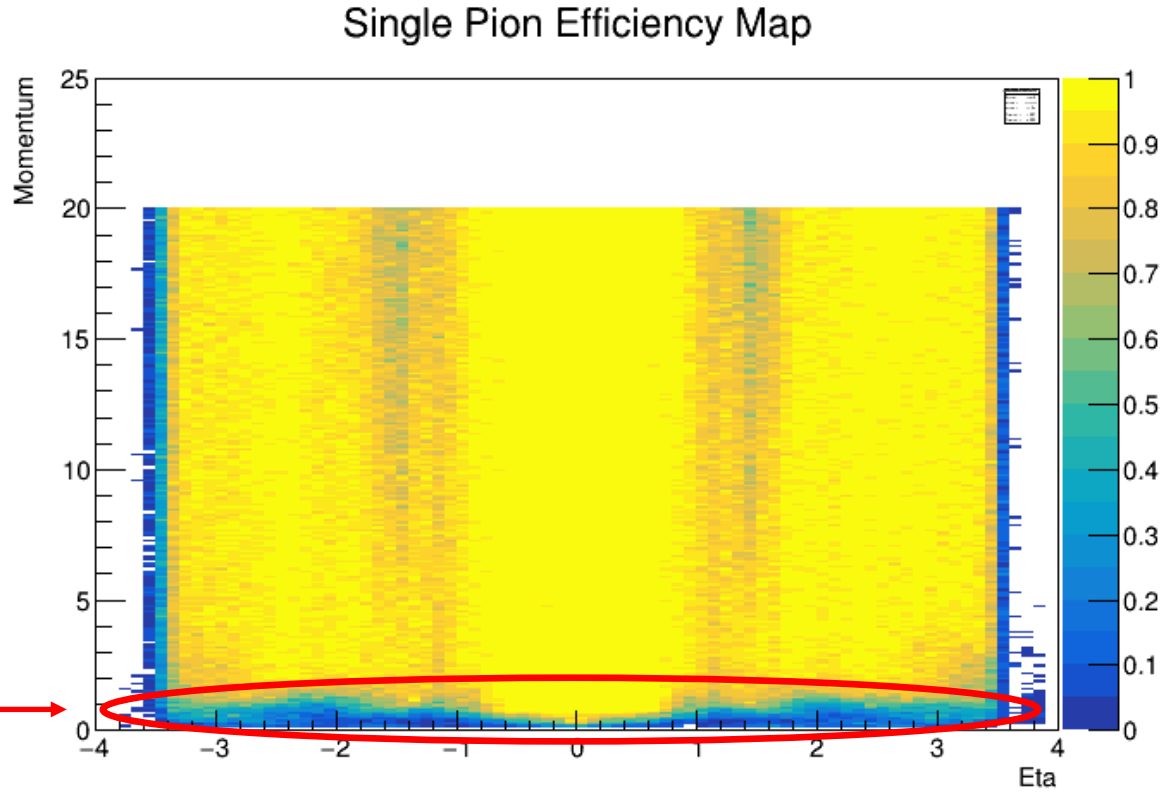
- True track momentum vs eta plotted for thrown tracks and reconstructed tracks – efficiencies are ratio
- Technical point: reconstructing tracks with ‘TrackSource = 0’ – would be good to look at hit points along the track

Single Particle Efficiencies

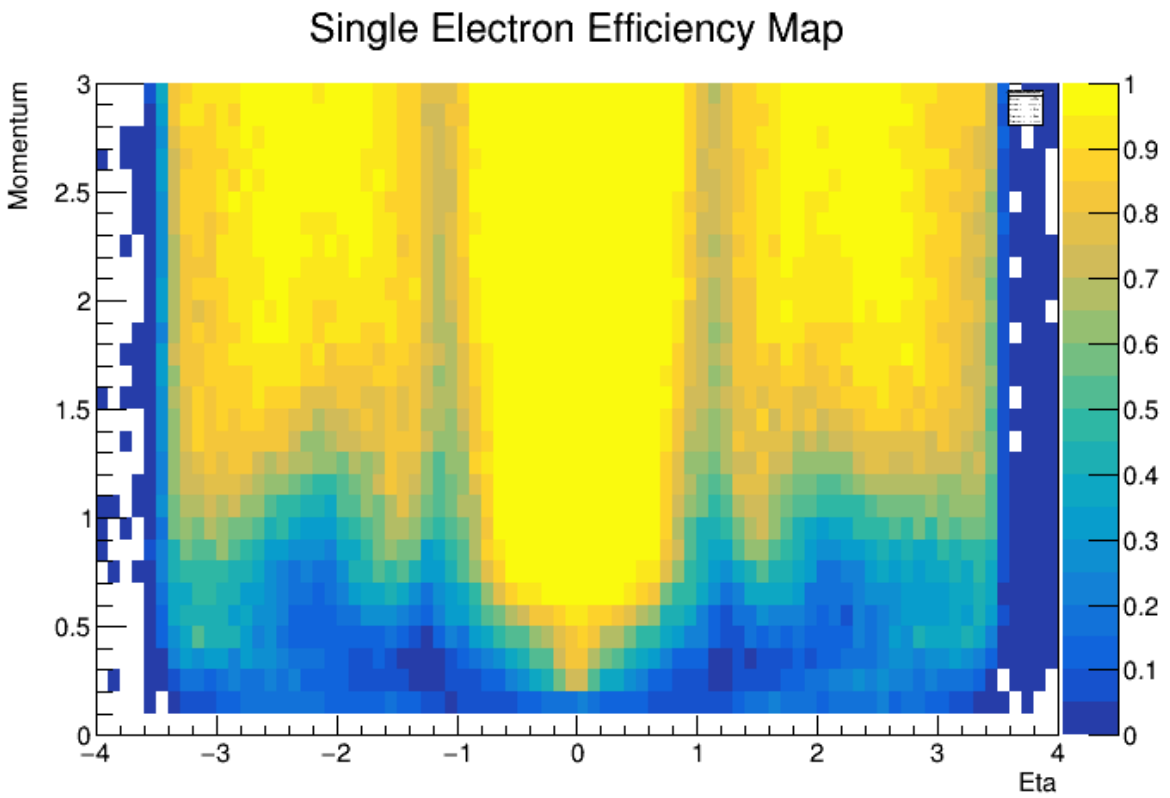


- After communication with Nicolas, it seems these inefficiency bands were caused by improper alignment between barrel layers and disks in the geometry used in single particle simulation – has been fixed in subsequent (private) simulations

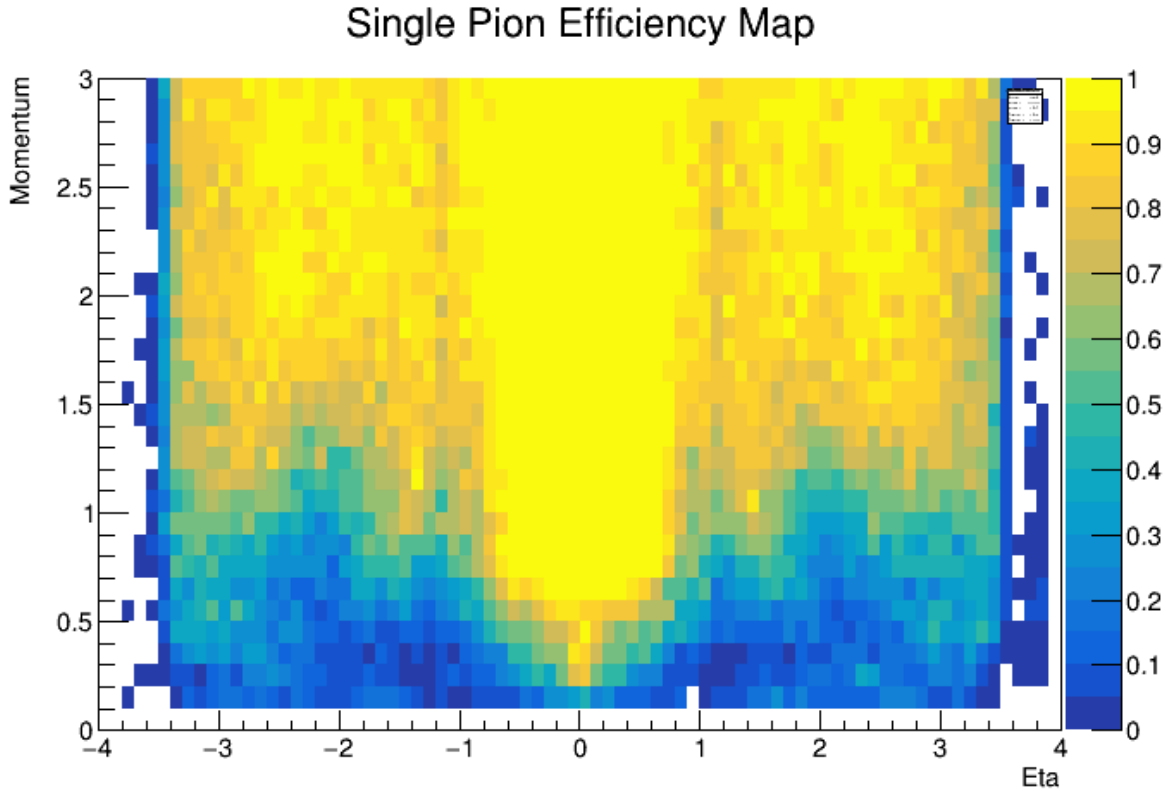
- Also claim that the poor tracking efficiency at low momentum is due to reconstruction issues in fun4all and not an intrinsic property of the tracker design



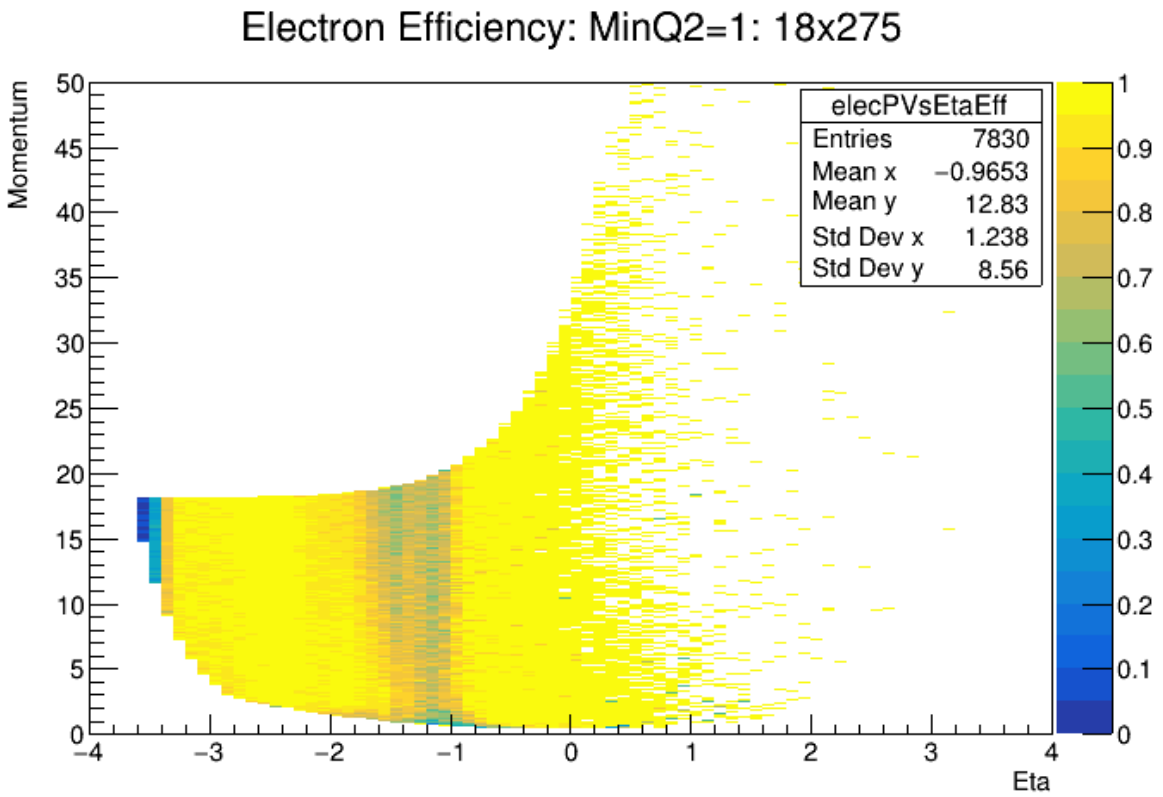
Single Particle Efficiencies (Zoomed In)



- Zoom in to better see low momentum behavior

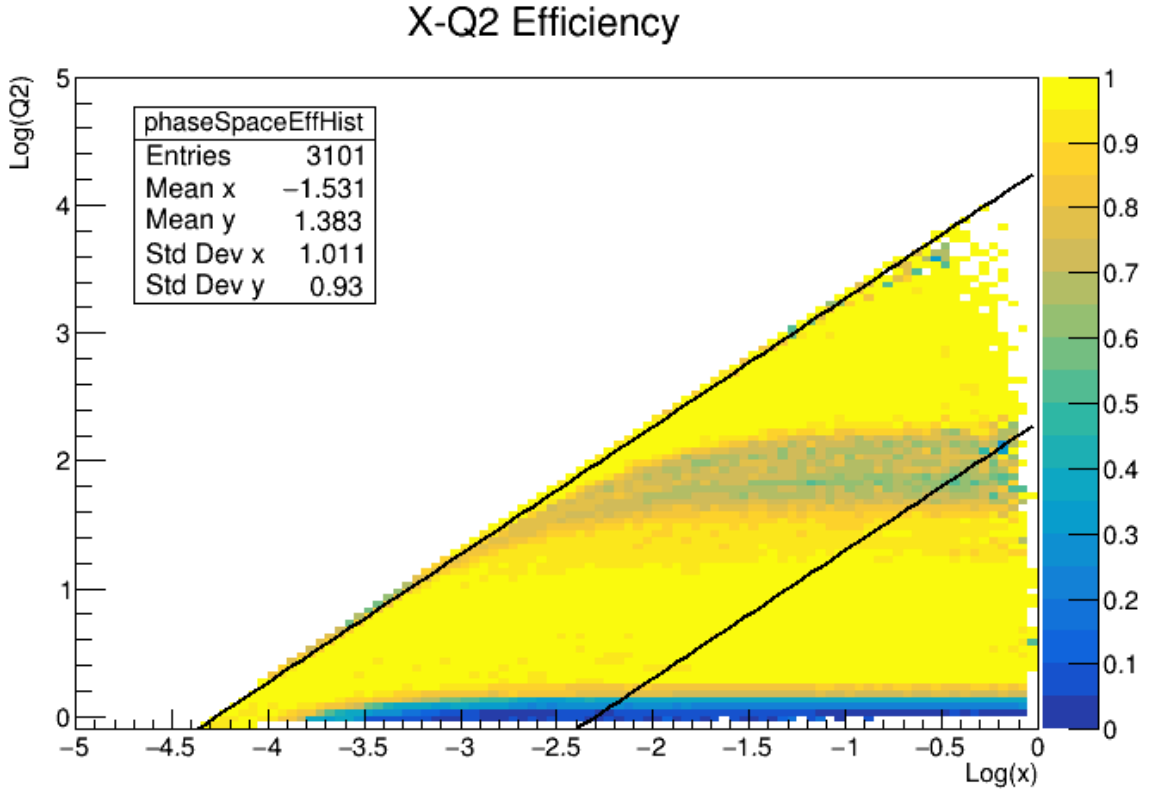


Electron Efficiency and Phase Space Impact



- Assume electron track finding efficiency corresponds 100% to kinematic reconstruction – see how inefficiency maps onto x-Q2 plane
- This is NOT the final electron finding efficiency or kinematic reconstruction performance

- Used single-particle simulation to get track efficiencies, now apply these to DIS simulation (Pythia8)
- See the efficiency for detection of the scattered electron as a function of momentum and eta



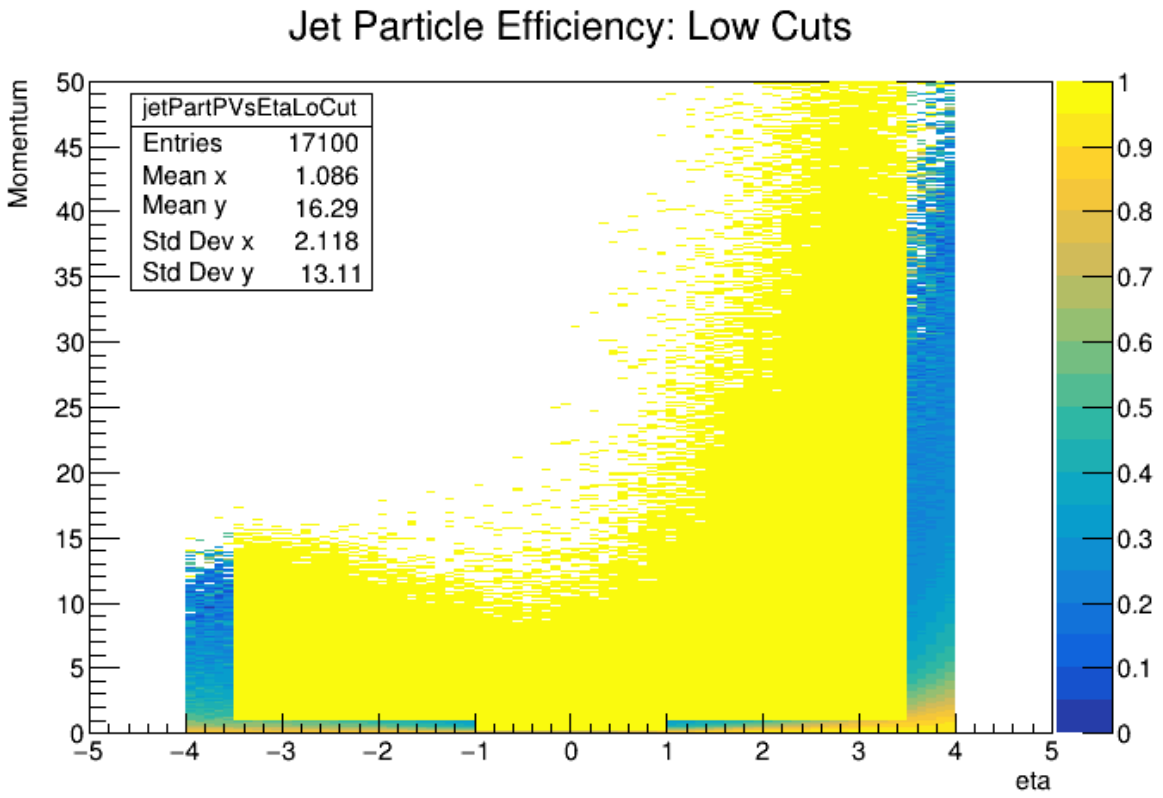
Impact on Jet Reconstruction

- Look at impact that tracking efficiency _only_ has on jet reconstruction
  - Drop tracks based on the Momentum Vs Eta efficiency maps
  - Assume tracks that are found are reconstructed perfectly – no momentum smearing
  - Assume all other particles (photons, neutral hadrons) are found with 100% efficiency and reconstructed perfectly

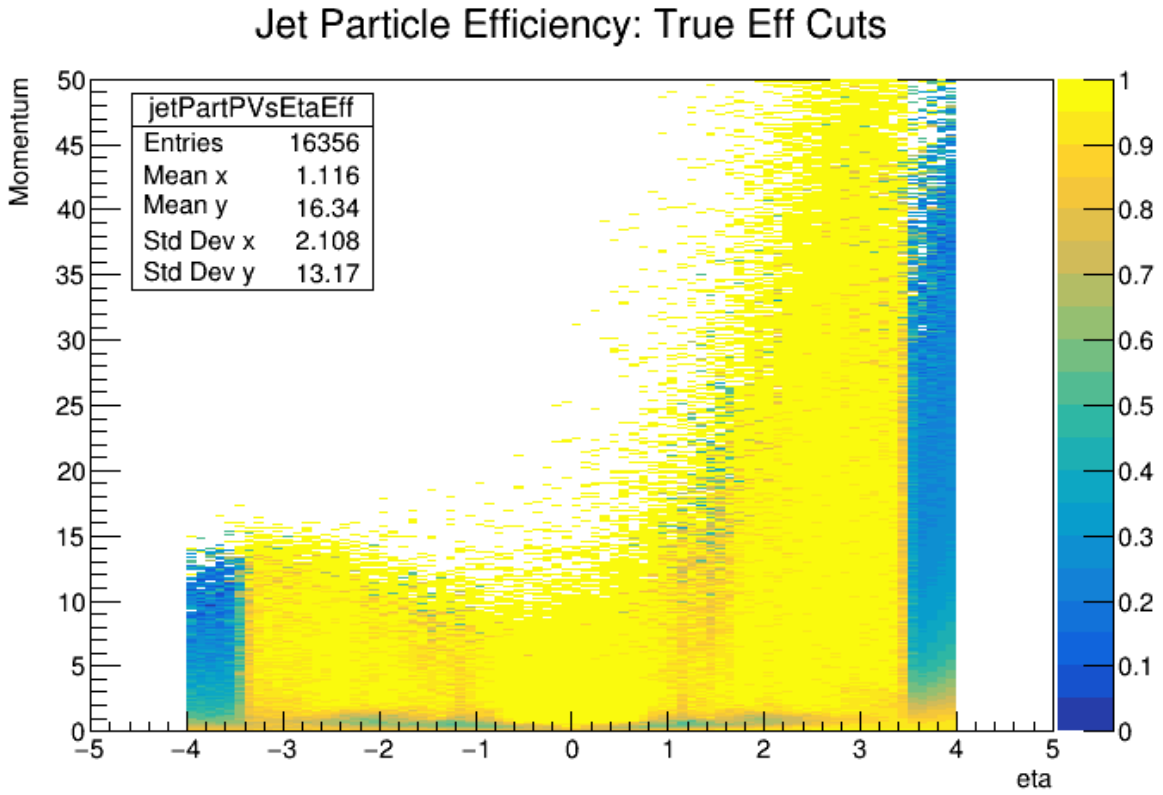
- Compare jet reconstruction using two efficiency maps
  - 'Lo Cut' map has zero track efficiency for (|eta| < 1 && p < 200 MeV) and for (1 < |eta| < 3.5 && p < 1 GeV) and for (|eta| > 3.5)
  - 'True Efficiency Cut' map is the one obtained from the single particle simulation – low momentum efficiency is low but not zero and additional inefficiencies around eta +/- 1-2

- The two maps allow to gauge the relative importance of low momentum efficiency as compared to inefficiencies around eta = 1

Jet Particle Efficiency: Q2 > 1: 18x275

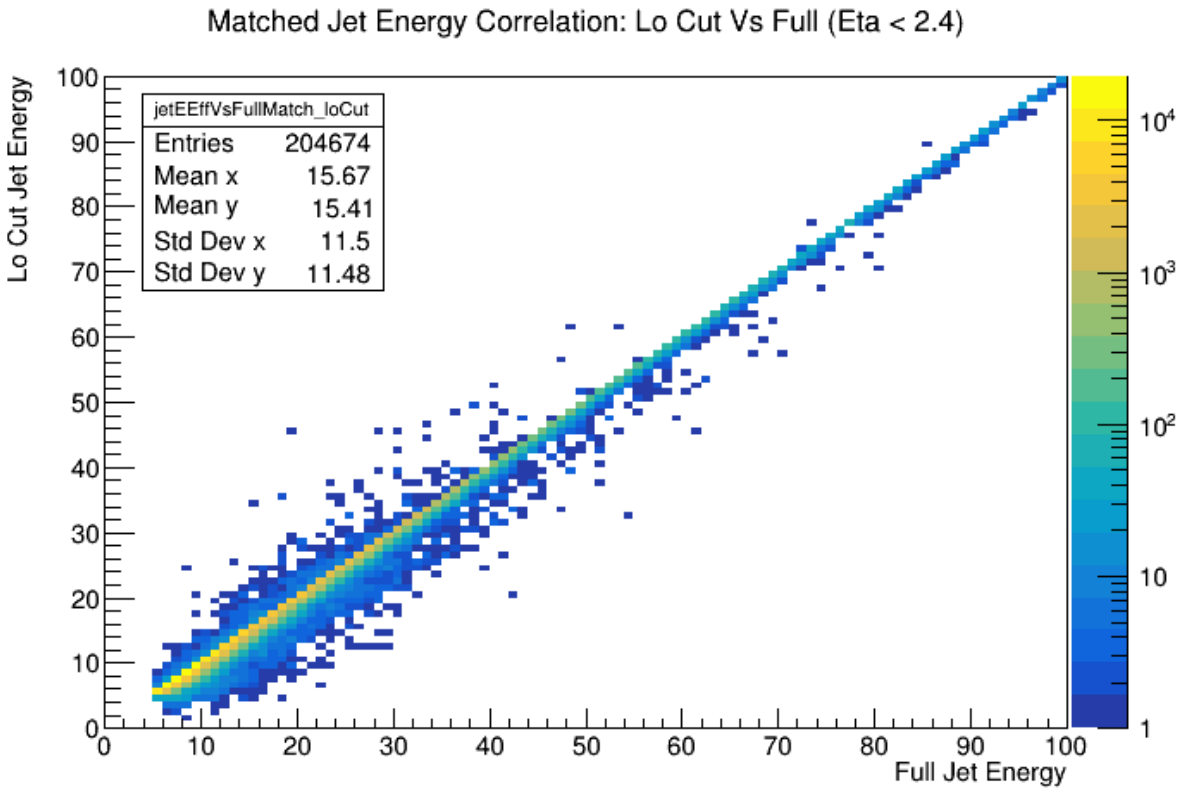


- Lo cut map to the left removes all tracks at low momentum and beyond eta of 3.5
- Perfect efficiency everywhere else

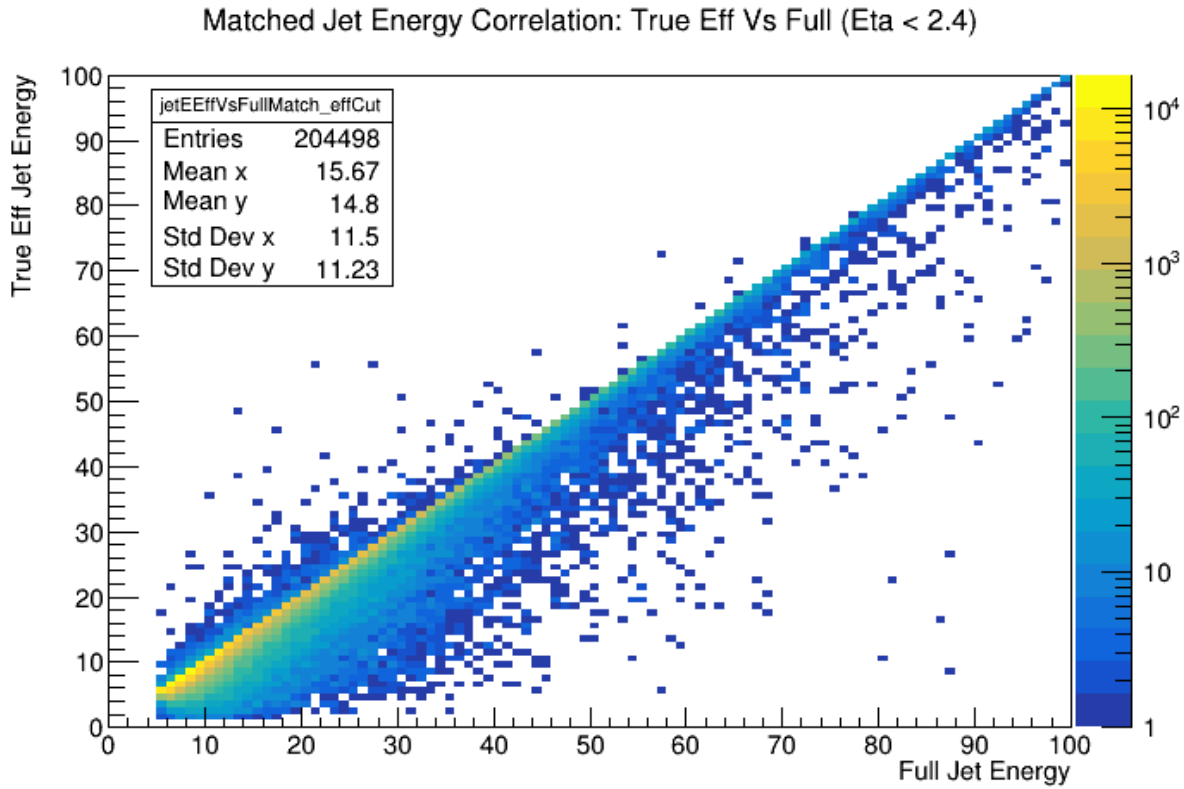


- True efficiency map from single particle simulation has some acceptance for low momentum tracks but also has inefficiencies between |eta| 1 and 2 for all momenta

Jet Energy Correlation: Q2 > 1: 18x275

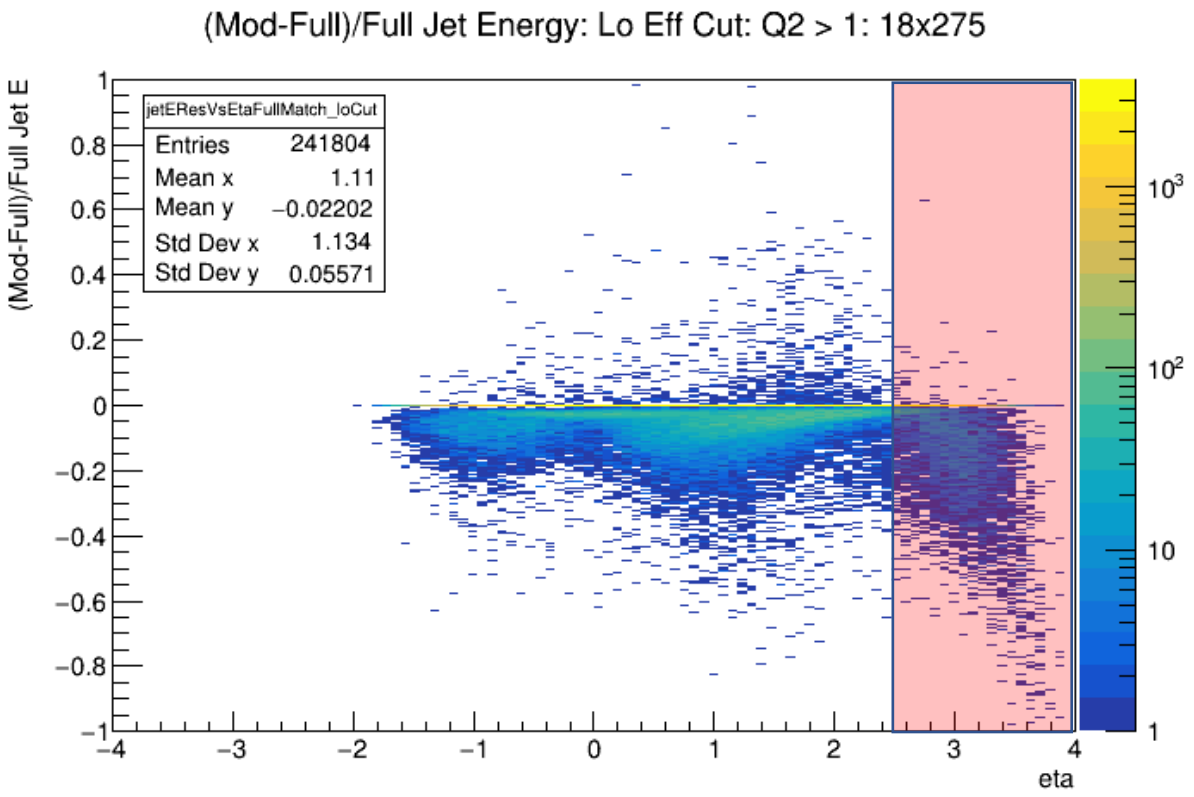


- For each true jet with an energy greater than 5 GeV, find the altered jet closest in eta-phi space
- Plot the altered vs true jet energy for the matched pair

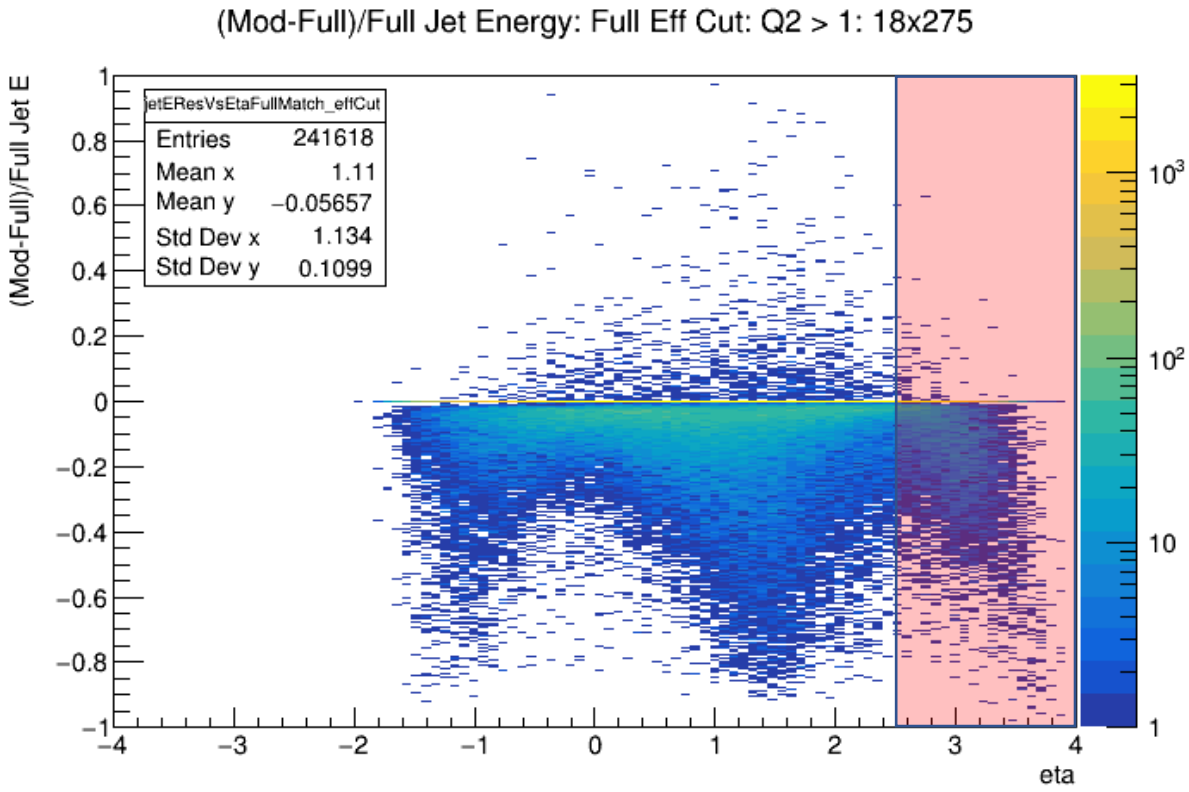


- See that the deviations are much less pronounced for the Lo Cut map as opposed to the true inefficiency map
- Note: Require jet eta < 2.4 to avoid edge of tracking acceptance at eta = 3.5

Jet Energy ‘Resolution’: Q2 > 1: 18x275

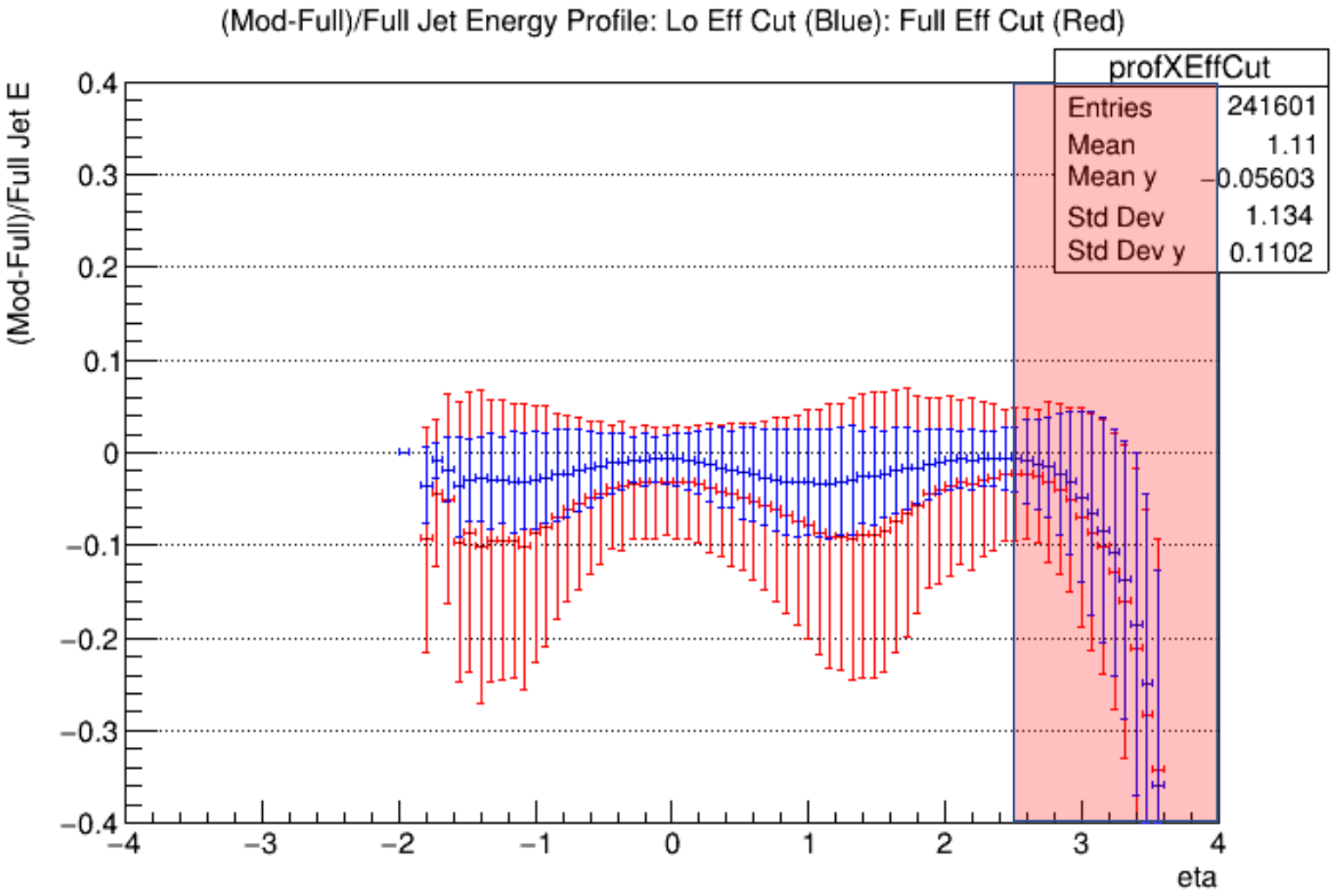


- For each matched jet pair look at the (Modified – True)/True jet energy as a function of eta
- Red boxes show region where resolution is influenced by tracker acceptance limit



- See much larger deviations for the true efficiency map plot
- Largest excursions are centered around the inefficiency bands at 1 < |eta| < 2

Jet Energy ‘Resolution’: Q2 > 1: 18x275

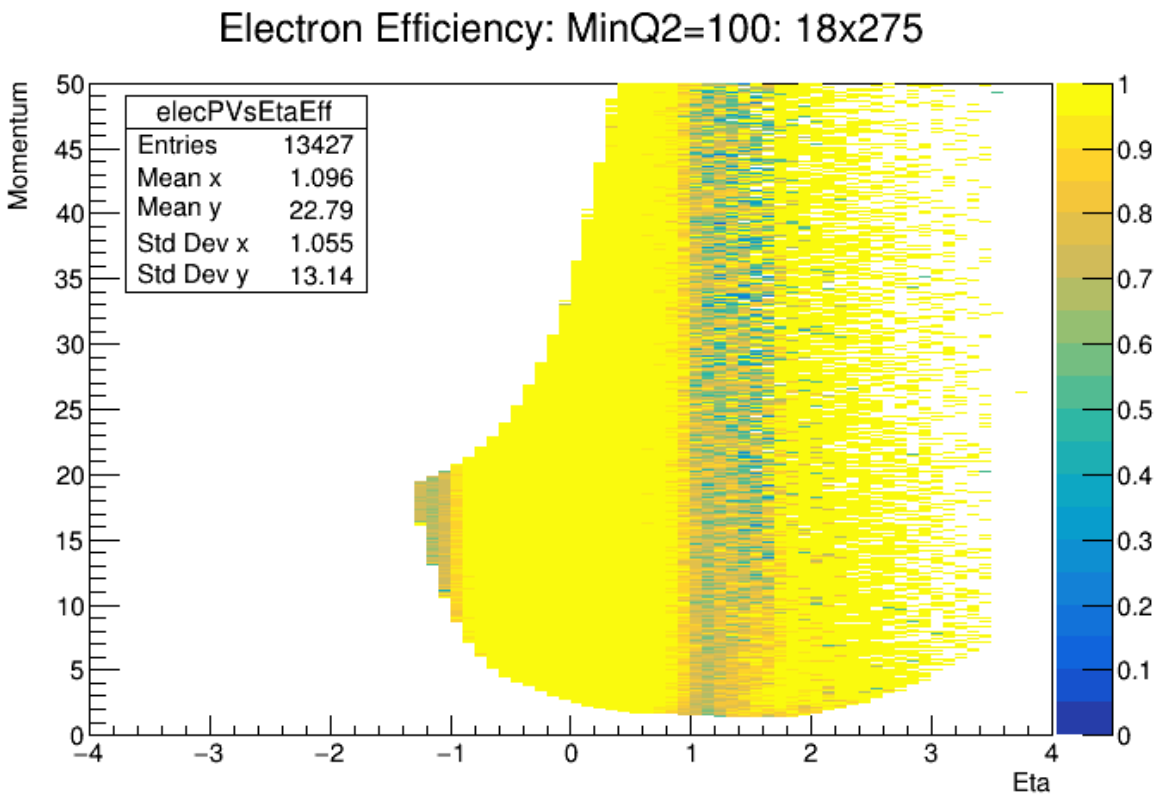


- Take profiles from previous page to get a better idea of the shift and scatter
- Blue is for the ‘Lo Cut’ map while Red is for the true efficiency map

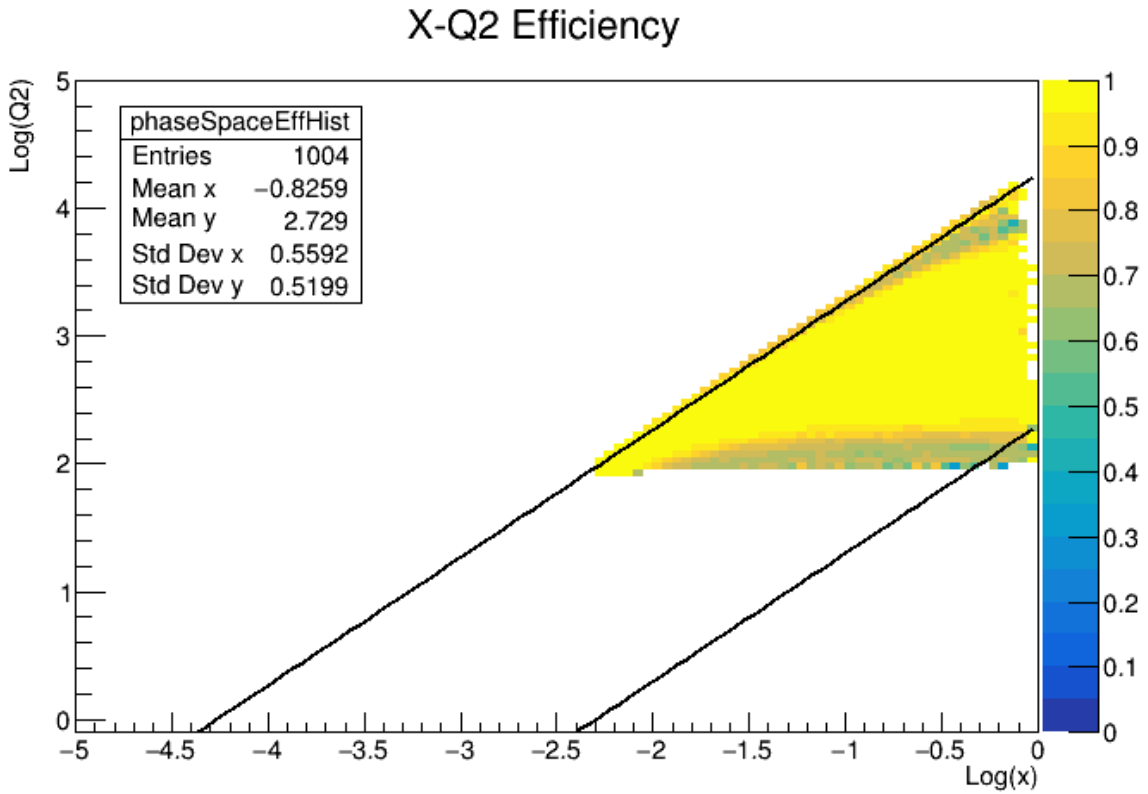
Summary

- Looked at the impact of tracking efficiency on electron finding / kinematic reconstruction and on jet reconstruction
- Used ~~realistic~~ efficiencies obtained from single particle simulations generated using fun4all currently on S3 – also used artificial efficiency map to isolate effects from low momentum inefficiencies
- See that low momentum inefficiencies have a modest negative effect on jet reconstruction. Also see that inefficiencies at ~1 < |eta| < ~2 have the potential to severely impact jet and kinematic reconstruction
- It will be important to minimize the dead areas due to service routing and support cones in both the forward and backward regions as the tracker design solidifies

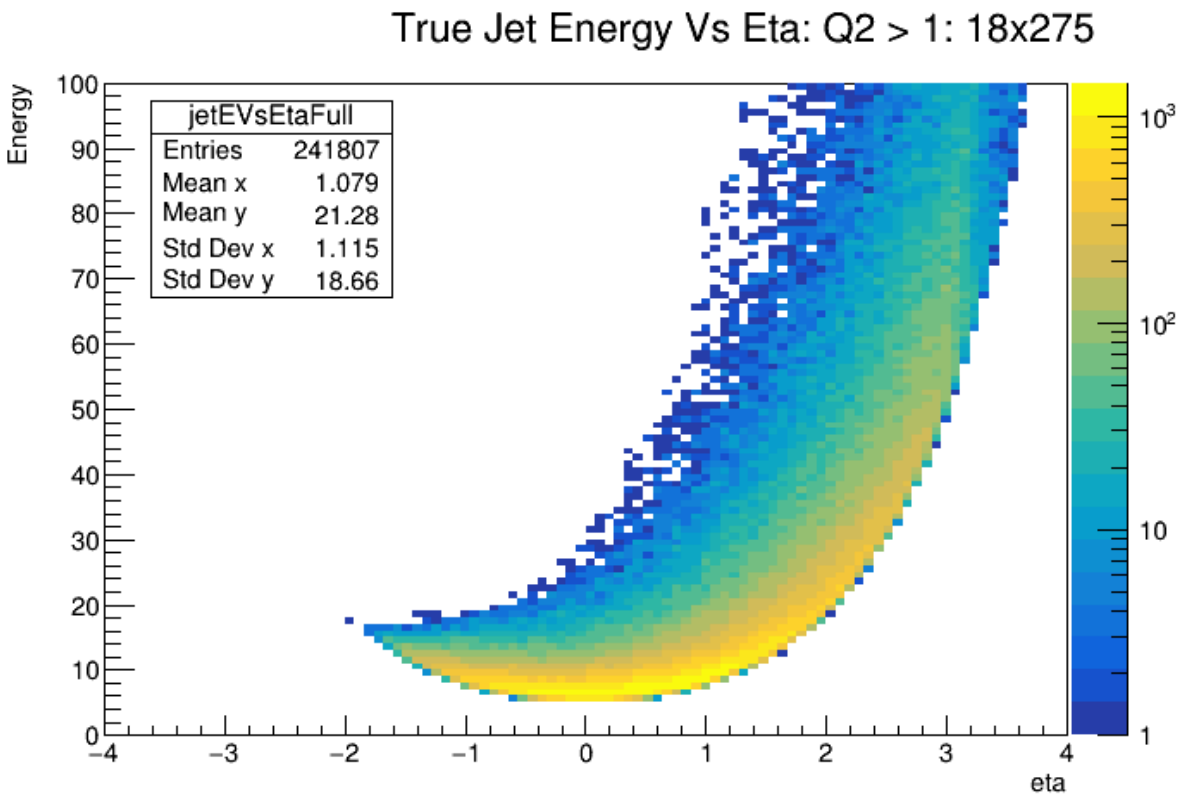
Electron Efficiency and Phase Space Impact (High Q2)



- At high Q2, electrons start scattering into forward part of the detector and hit inefficiency band starting at eta = 1
- This maps to the high Q2 – high x region of phase space



Jet Eta Spectra: 18x275



- Note that the maximum of the jet distribution is directly in the region where we see the band of inefficiency for all momenta