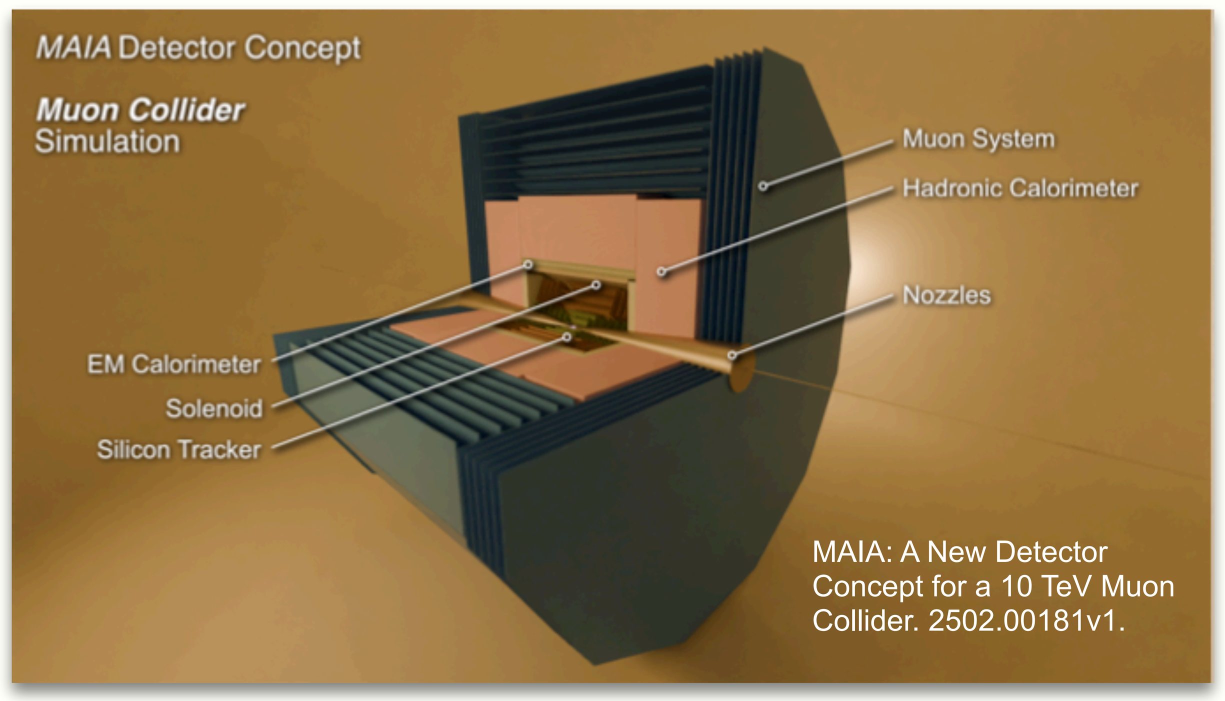
Optimizing Electron Reconstruction at a 10 TeV Muon Collider

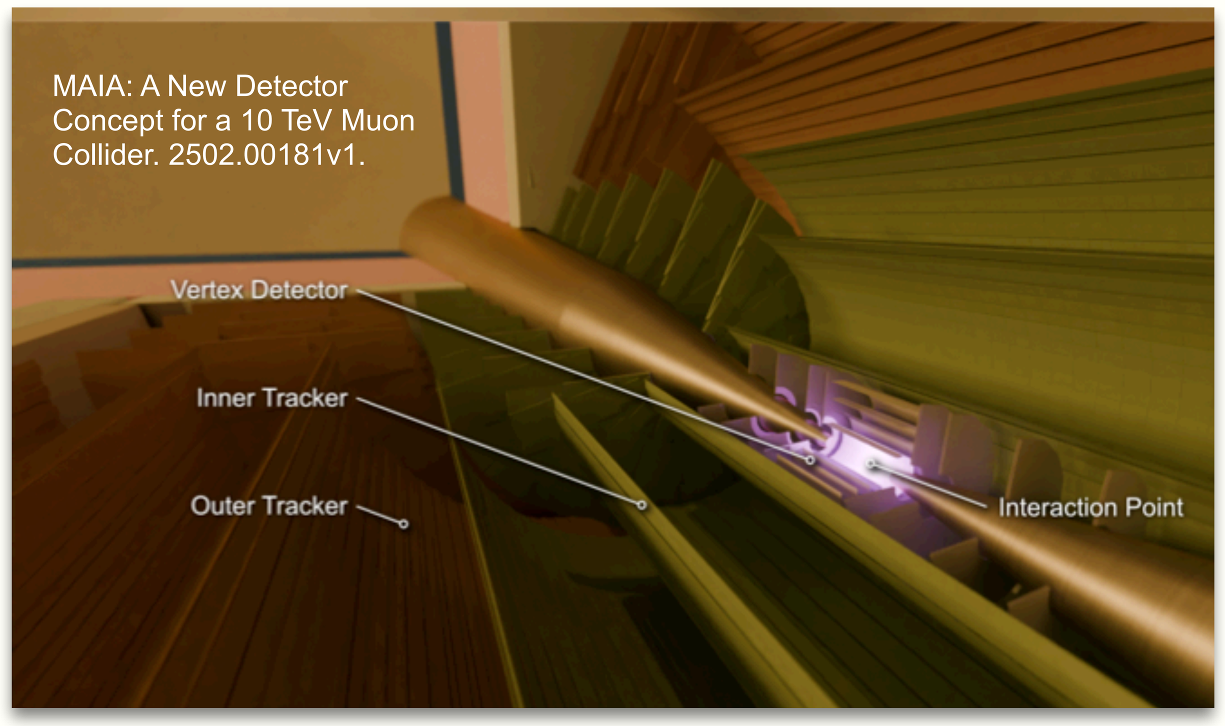
Julian Watts, Tova Holmes
University of Tennessee

USMCC

MAIA

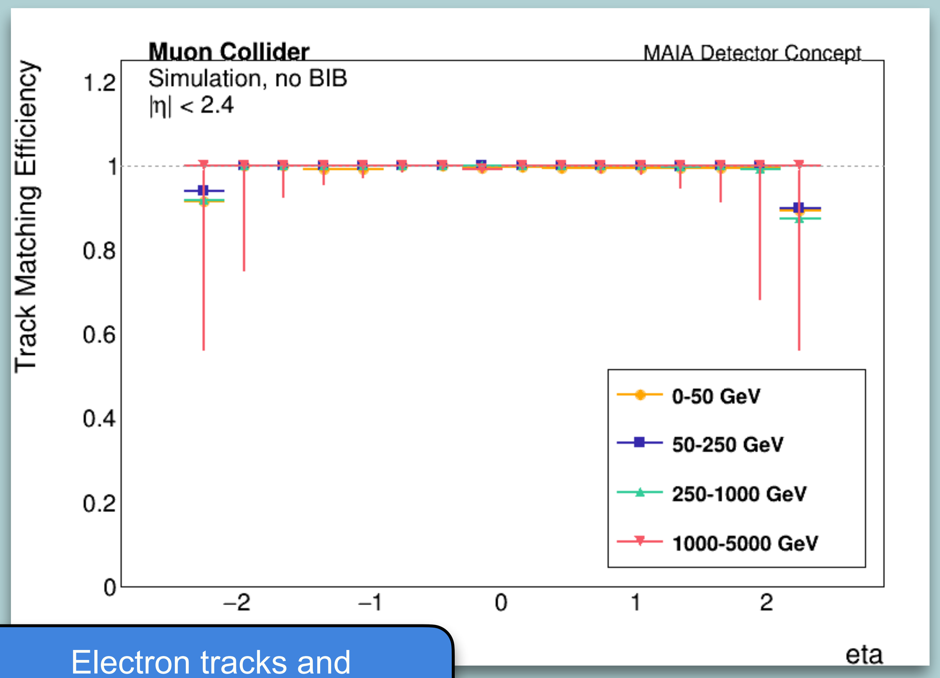


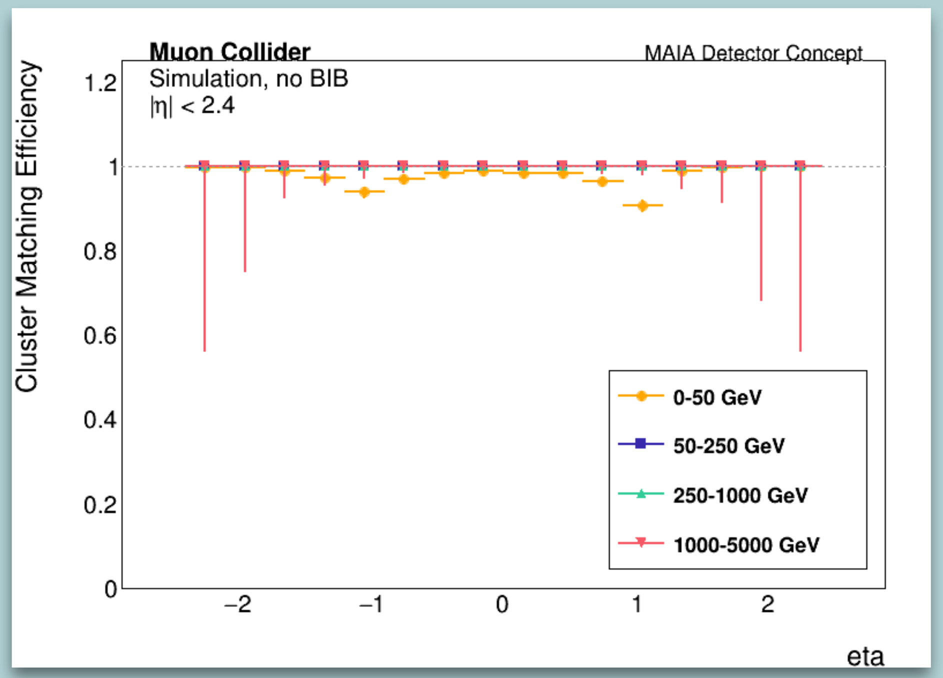
MAIA (Muon Accelerator Instrumented Apparatus) is a detector concept optimized for 10 TeV muon collisions. The detector design features a silicon tracking system, a 5T solenoid placed in front of a silicon-tungsten electromagnetic calorimeter (ECAL), an iron-scintillator hadronic calorimeter (HCAL), and a muon spectrometer placed behind them. Detector performance is currently being evaluated through simulation studies, focusing on particle reconstruction efficiency and resolution. This research specifically investigates electron reconstruction using electron gun samples and Pandora's Particle Flow Algorithm (PFA) within the simulated MAIA detector environment.



Pandora PFA

Pandora's PFA was originally developed for particle reconstruction at ee colliders, where the detector environment was relatively clean with minimal background. Pandora reconstructs particles by applying clustering algorithms to the calorimeter and combining this with track information, provided by A Common Tracking Software (ACTS)[1], using PFAs to create Particle Flow Objects (PFOs).





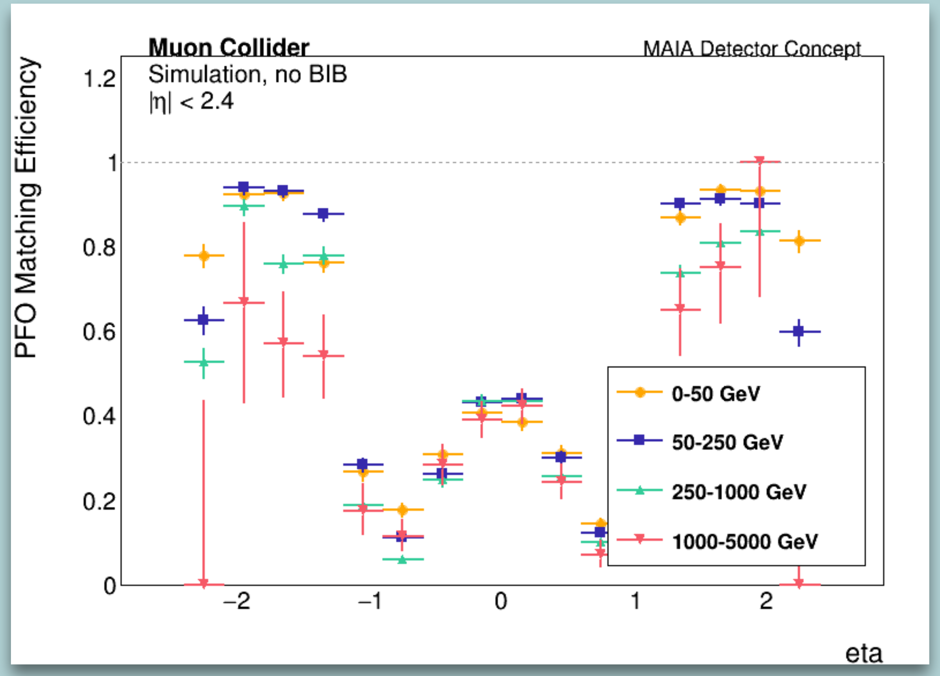
Electron tracks and clusters are efficiently reconstructed by Pandora!

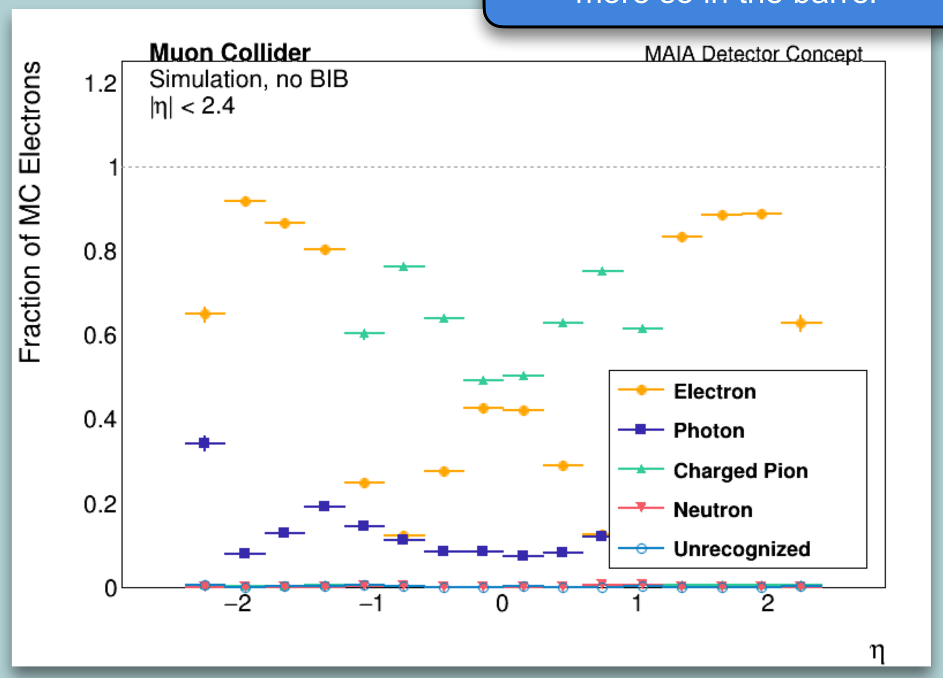
MAIA presents unique challenges to Pandora's PFA

- More material in tracker
- Significant beam-induced background (BIB)
- Solenoid in front of ECAL $\sim 4X_0$ long

With these challenges Pandora's PFA fails to accurately reconstruct electrons

Pandora incorrectly identifies electron PFOs, more so in the barrel





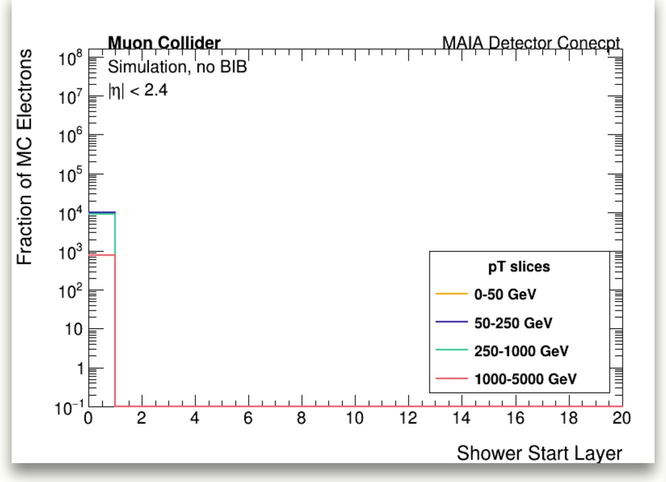
[1] ACTS: A Common Tracking Software Project. 210613593

The Goal

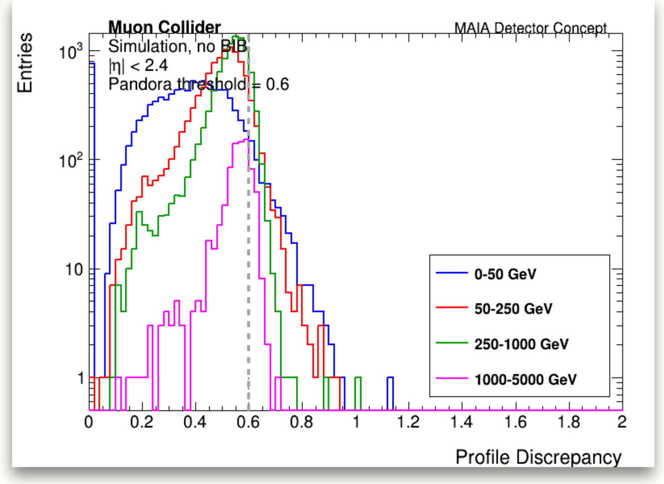
The goal is to resolve the electron misidentification issue. To do this, we can look at the variables and their values used in Pandora's PFA to create an electron PFO. If the particle passes Pandora's electromagnetic shower classification, then it must have:

- Max profile start = 4.5
- Profile discrepancy ≤ 0.6
- $0.8 < E/p < 1.2$

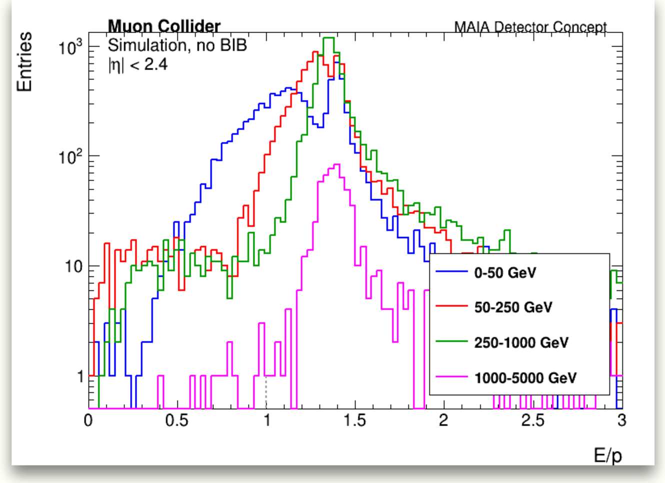
But, looking at ECAL hits and shower development:



Electromagnetic showers start within the first 2 layers of the ECAL, proving the max profile start variable **is not** a source of error.



Profile discrepancy is the ratio between reconstructed shower and generated shower. The tail to the right of 0.6 shows this **could be** a source of error, due to real electrons being cut.



The E/p ratio is centered at ~1.4, which shows that the E/p variable **is** a source of error.

Next steps: update the values for the electron identification variables above to optimize electron reconstruction without BIB, then with BIB.

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This work was supported by the US DOE Office of Science under award number DE-SC0023122