Updated Electron ID for MAIA

Results and Updates

Jullian Watts 1/29/26

Overview

Last summer, I studied **how electrons are reconstructed** in the MAIA detector.

- Electrons are reconstructed using a pre-existing particle flow algorithm (PFA), called **Pandora PFA**. Pandoras default identification values were being used

These default values contributed to the low electron reconstruction efficiency in the MAIA detector. I proposed an **update to two of these values,** with the goal for more electron particle flow objects (PFOs) to be identified.

Note: I will refer to the original electron identification algorithm, which is v2.9.7 of the singularity. When I refer to the updated electron ID, I am referring to v2.9.7 with the updated electron values, implemented like this

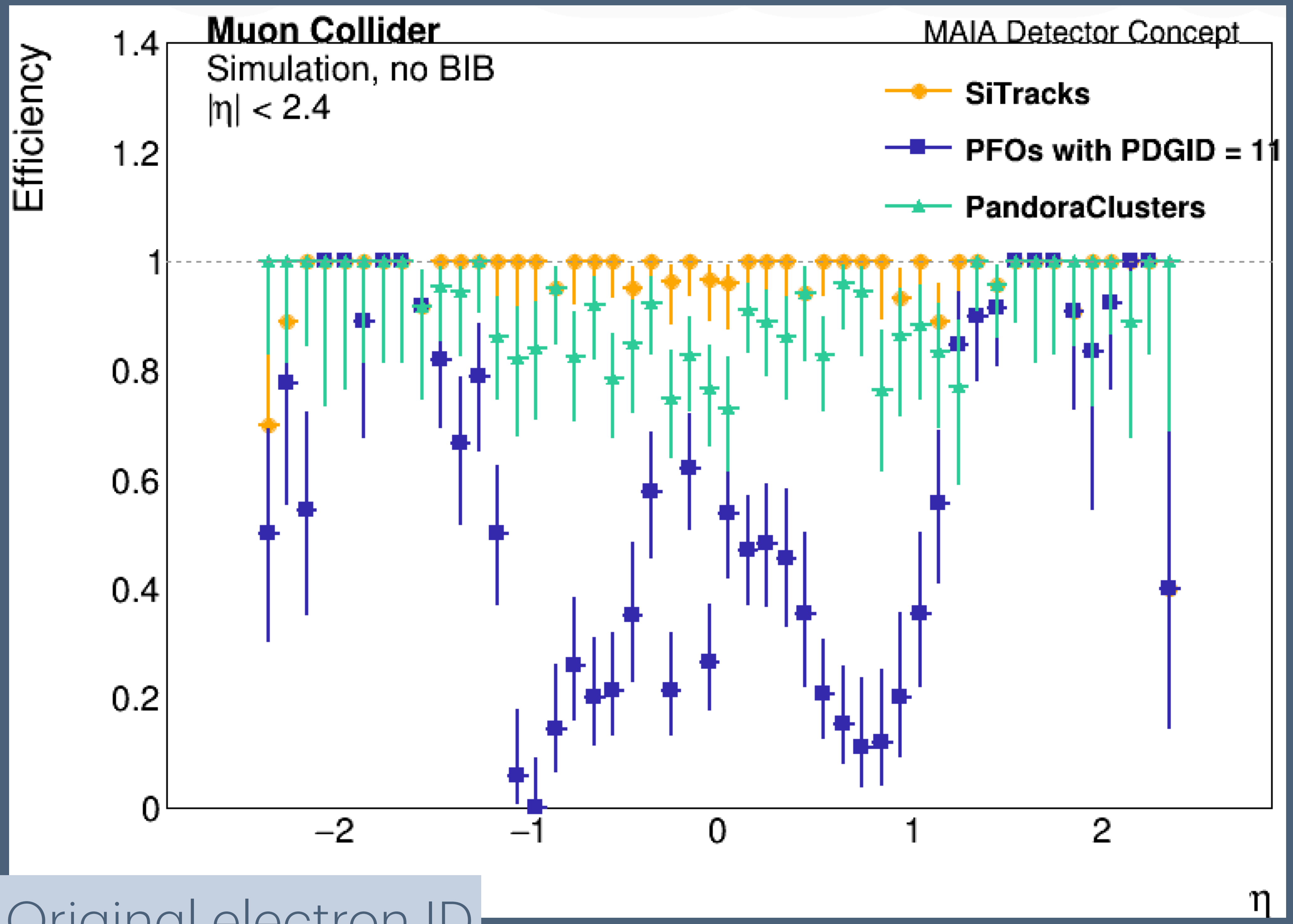
Updated Electron Values

Below are the **variables** and **values** Pandora uses to identify a PFO as an electron. The proposed change is in purple, and slides on this can be found here and here .

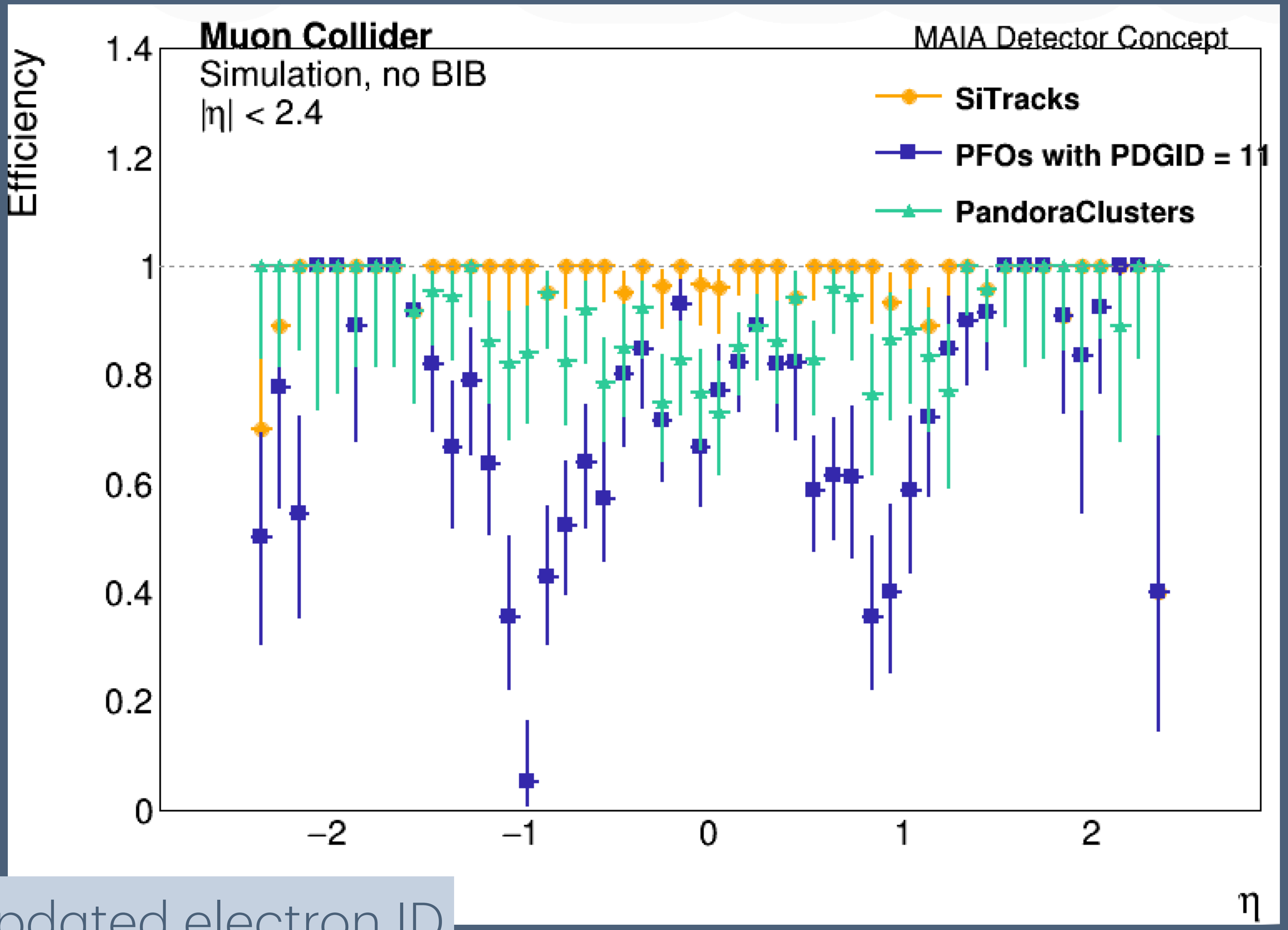
Variable	Simple Explination	Value
Maximum Inner Layer	Which layer of ECAL does the shower start to leave more than a certian % of its energy?	4
Maximum Energy	What is the max energy of one of the cluster cells? (GeV)	5
Maximum Profile Start	Which layer of ECAL does the shower start to spread out longitudinally?	4.5
Maximum Profile Discrepancy	How much does the shower shape differ from the expected electron shower?	0.6 to 0.8
Maximum Residual E/p	How much does the energy of the cluster and mometum of the track differ?	0.2 to 0.4

Implementing Updated Values

Studies are done using simulated electron gun of range 0 - 50 GeV, no BIB. Below shows the efficiency of reconstructing electron tracks, clusters, and PFOs. A track or cluster is considered reconstructed as an electron if its energy is > 10 GeV, and it's within ΔR < 0.2 of a truth electron. A truth electron is identified when its generator status = 1 (stable) and its pdgID = 11.



Original electron ID



Updated electron ID

Electron reconstruction efficiency rises from **50.5% to 72.4%**

Statistics

Below are statistics from the plots in slide 4

Particle Type	Total PFO Count	Avg/Event	Avg Energy/ PFO (GeV)
Electron	470	0.47	47.84
Photon	961	0.96	7.45
Charged Pion	434	0.43	21.96
Neutron	666	0.67	0.70
Total # of PFOs	2531		

Original electron ID

Particle Type	Total PFO Count	Avg/Event	Avg Energy/ PFO (GeV)
Electron	658	0.66	41.79
Photon	1030	1.03	7.03
Charged Pion	247	0.25	14.13
Neutron	832	0.83	0.67
Total # of PFOs	2767		

Updated electron ID

Findings to note:

- Electron reconstruction rose (pink), while charge pion reconstruction dropped.
- Unfortunately, photon and neutron reconstruction also rose.
- Neutron PFO average energy (blue) is low in comparison to other PFOs

The Issue

- Pandora efficiently reconstructs tracks and clusters, but not PFOs. Although electron reconstruction rose (now at 72% efficiency) with the updated electron ID, efficiency can still be improved.

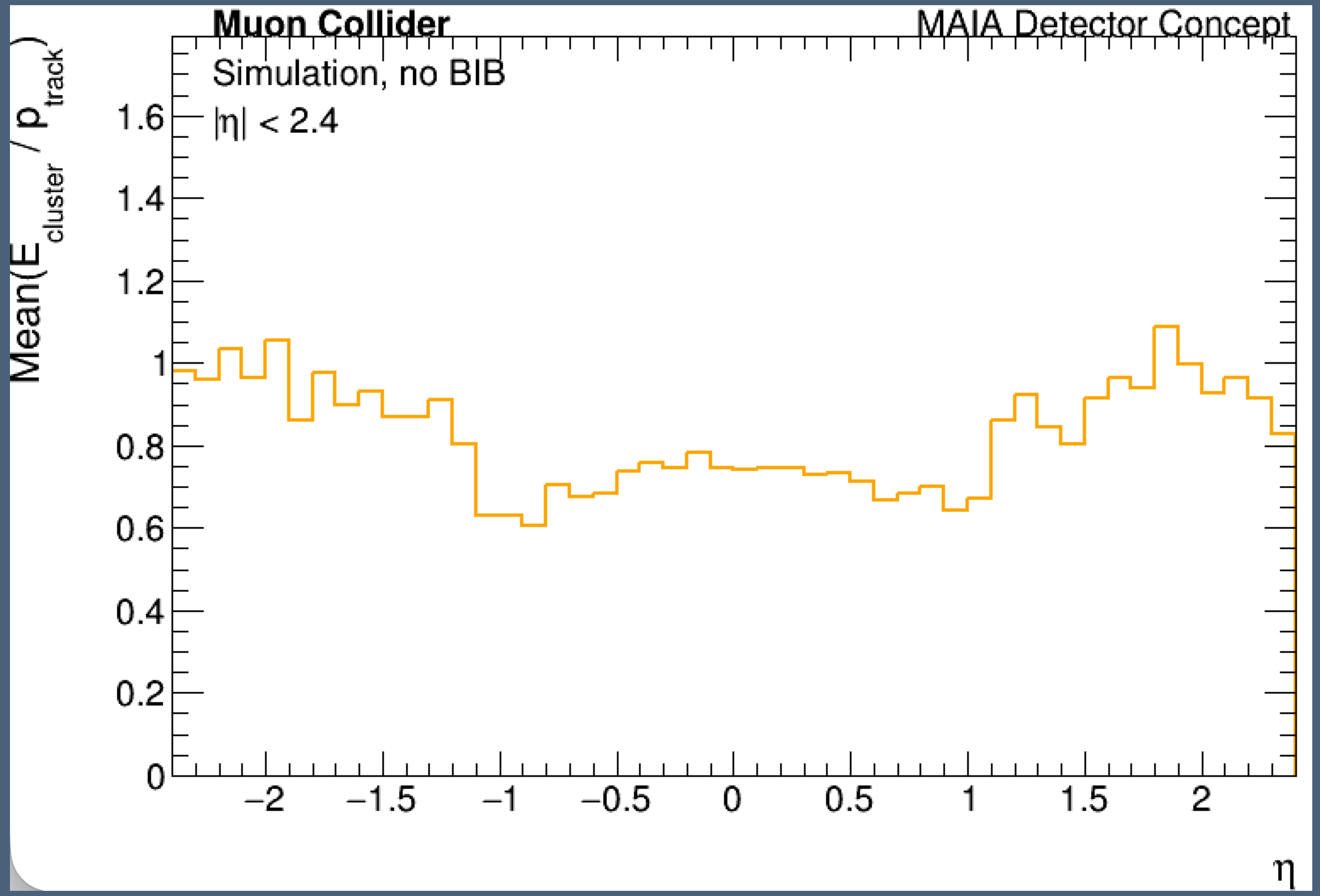
- To understand why Pandora can't associate tracks and clusters, I am studying the ratio of energy and momentum for matched tracks and clusters

Goal: loop through all MCPs and find the closest track and cluster.

- Record the clusters energy and tracks momentum as the "truth" energy and momentum, compute E/p, average for each bin

- This plot shows what areas of the calorimeter need calibration

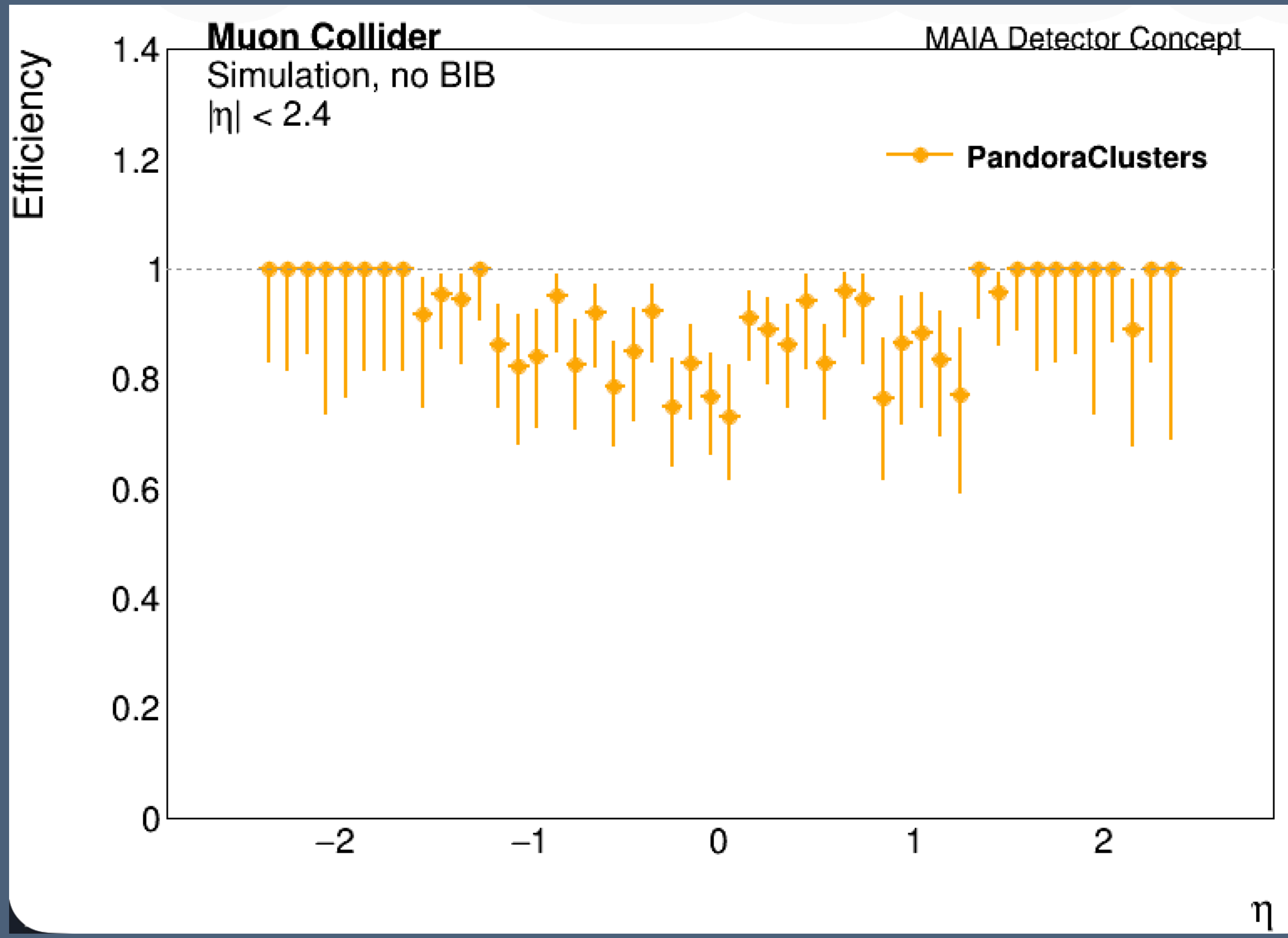
- Barrel regions and transition regions are what stand out

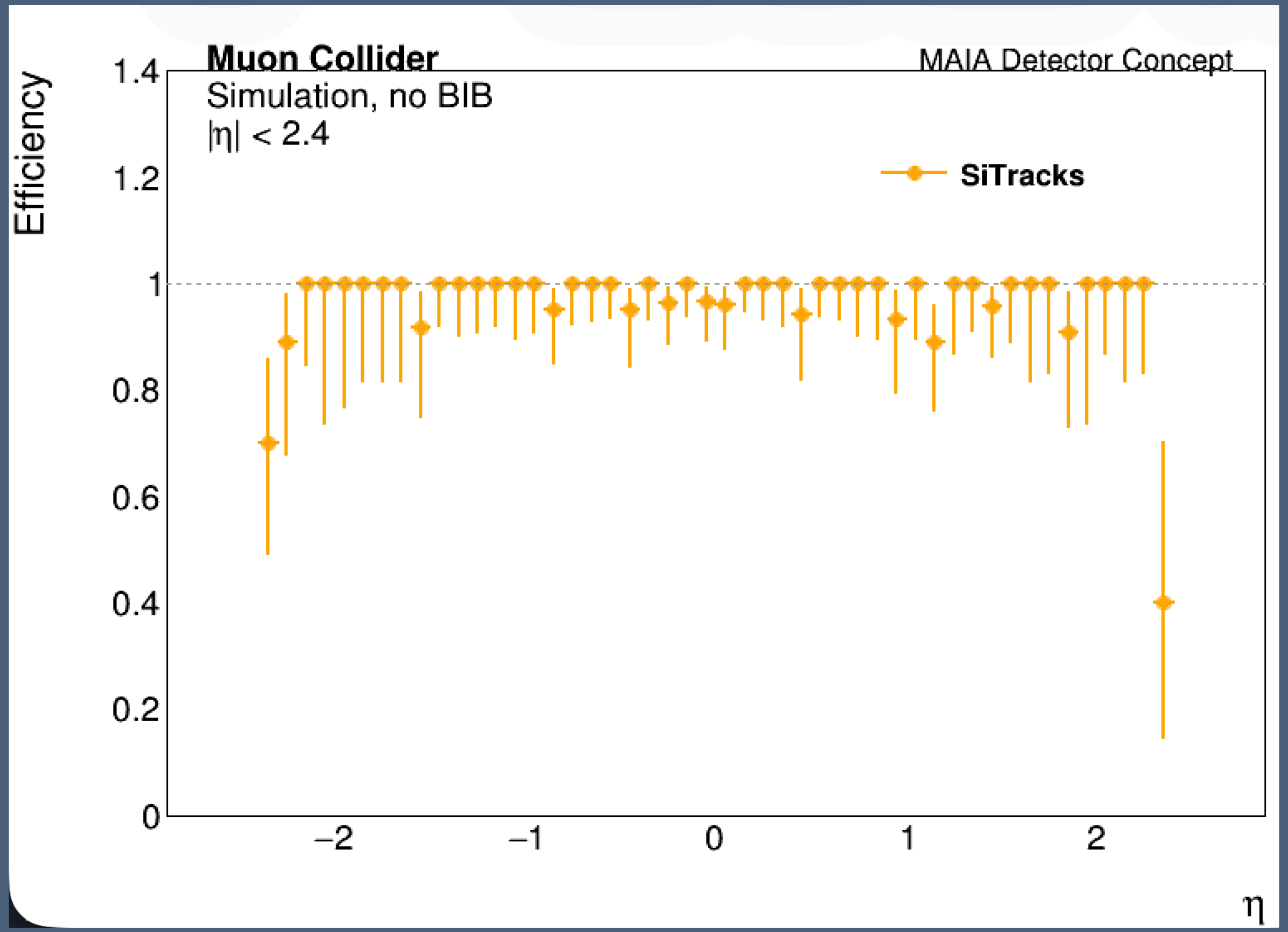


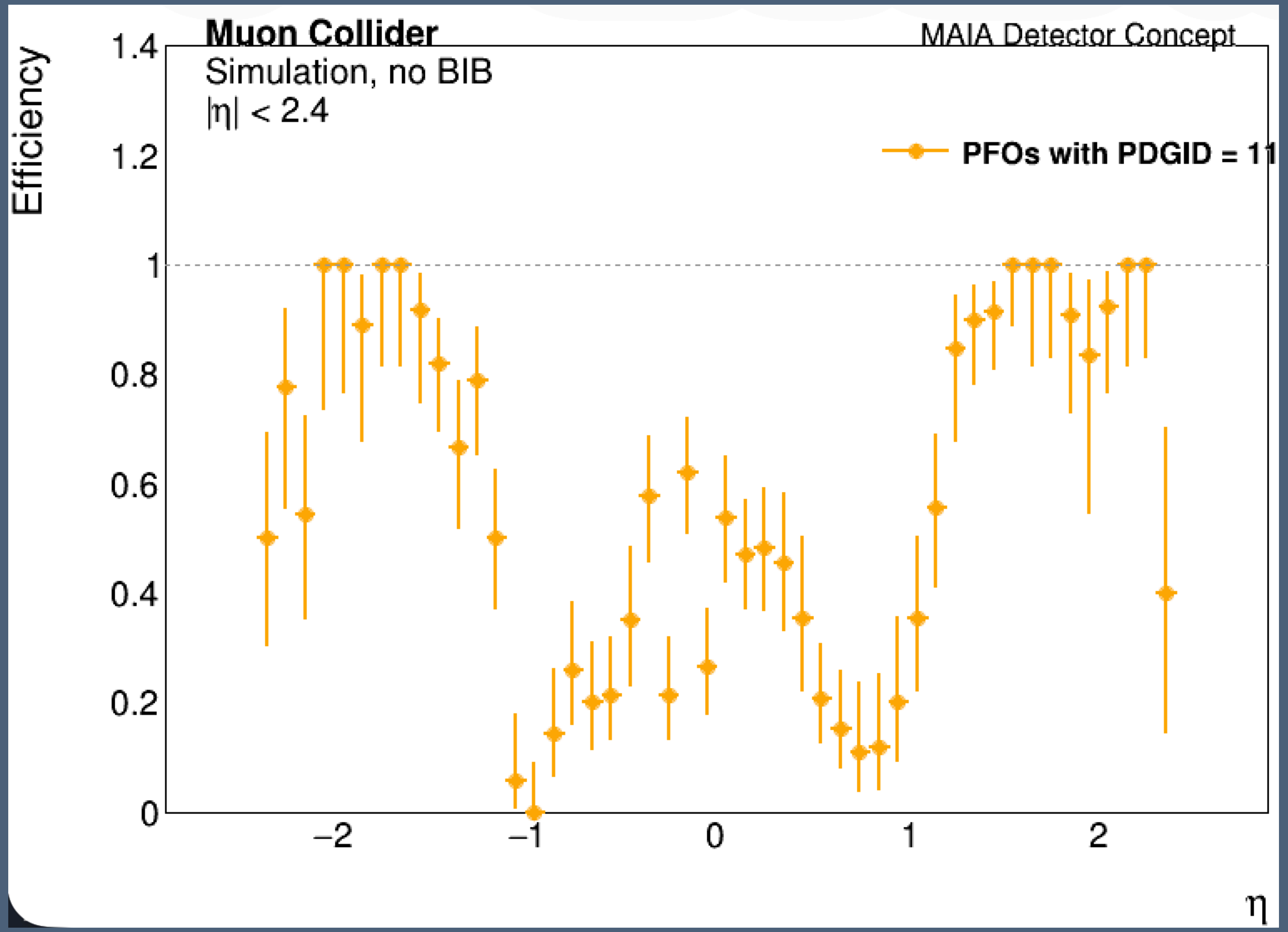
Thank you!

Original ID Individual Plots

Backup



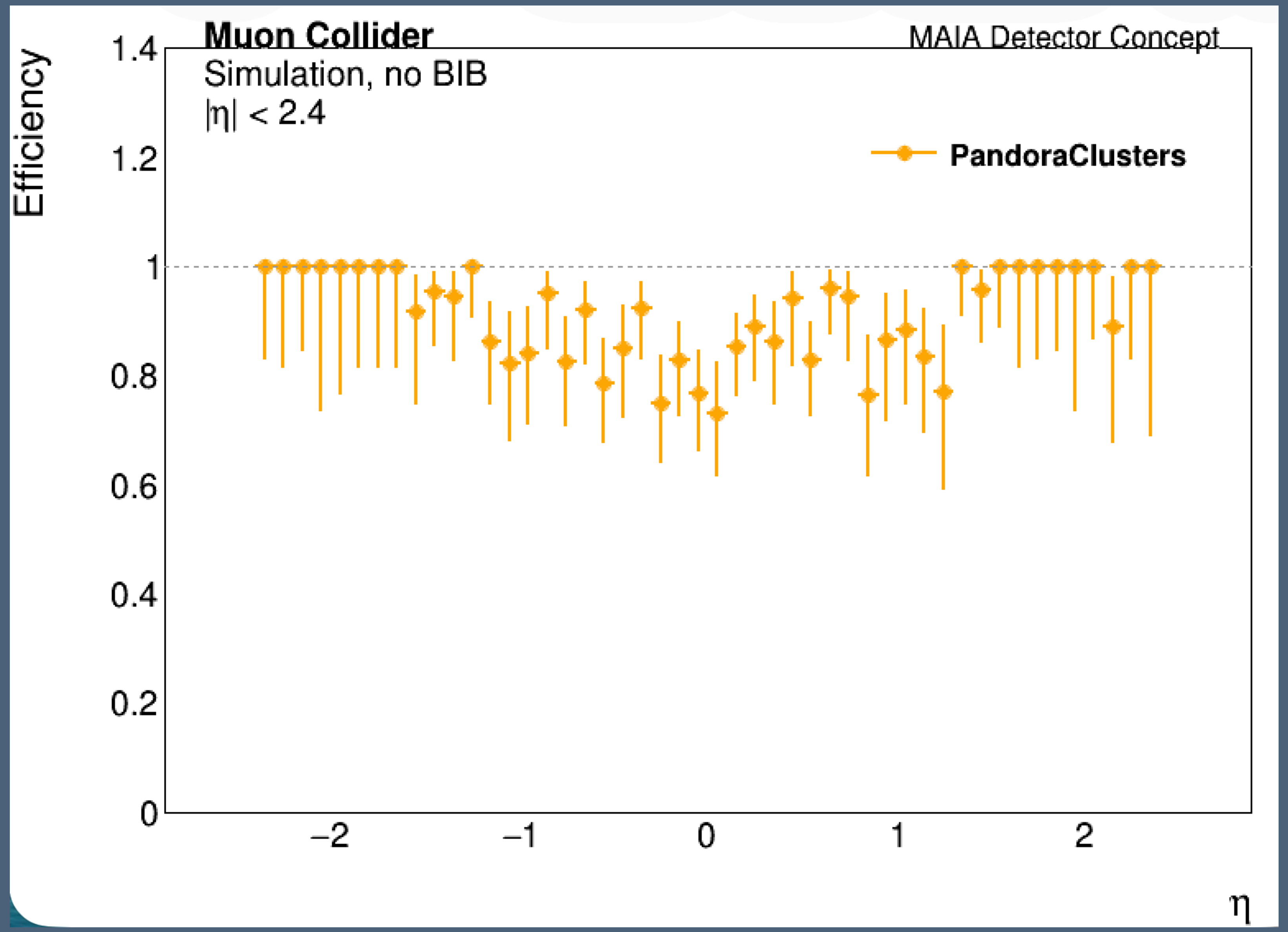


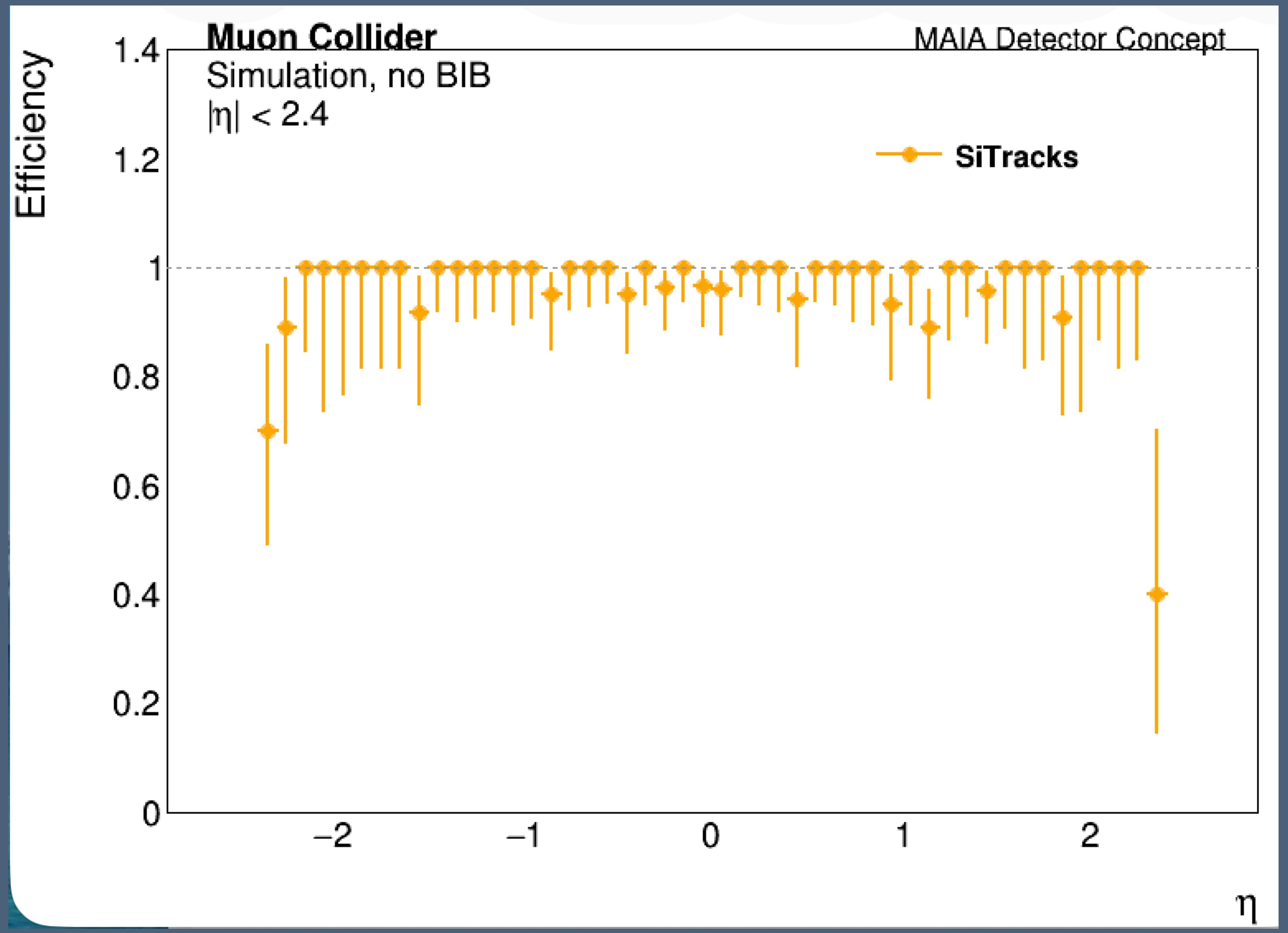


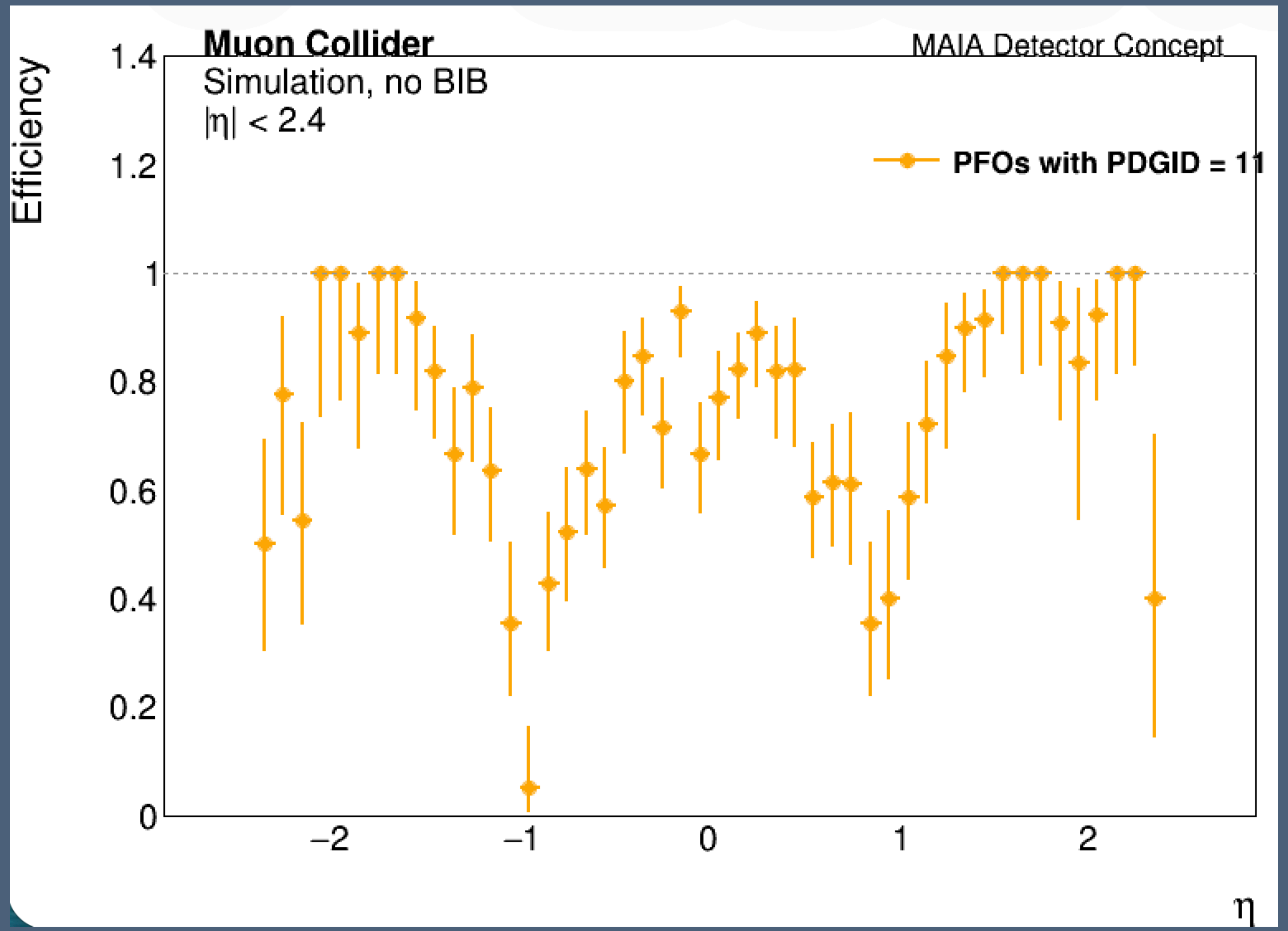

```
TRACK: matched = 821, total = 840, eff = 0.977
PFO: matched = 424, total = 840, eff = 0.505
CLUSTER: matched = 751, total = 840, eff = 0.894
```

Updated ID Individual Plots

Backup








```
TRACK: matched = 821, total = 840, eff = 0.977
PFO: matched = 608, total = 840, eff = 0.724
CLUSTER: matched = 749, total = 840, eff = 0.892
```