Charged Pions in MAIA

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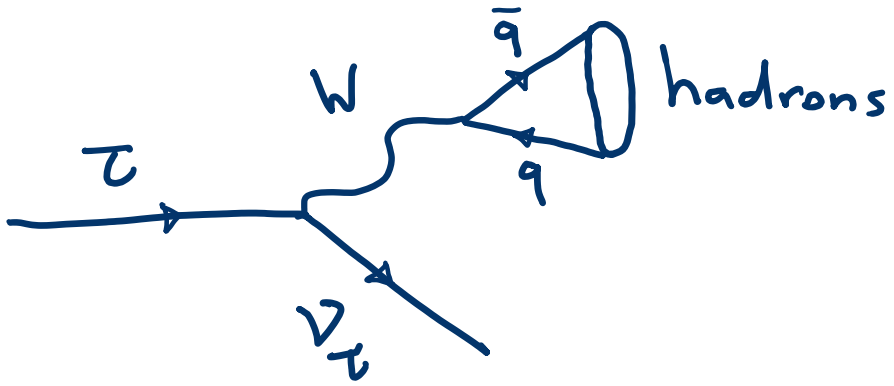
Quick Reminder

- Of course: hadronic taus decay predominantly into an odd number of charged pions (+ neutral hadrons)
- Tau reconstruction is dependent on the ability to reconstruct and identify charged pions



Hadronic Decays

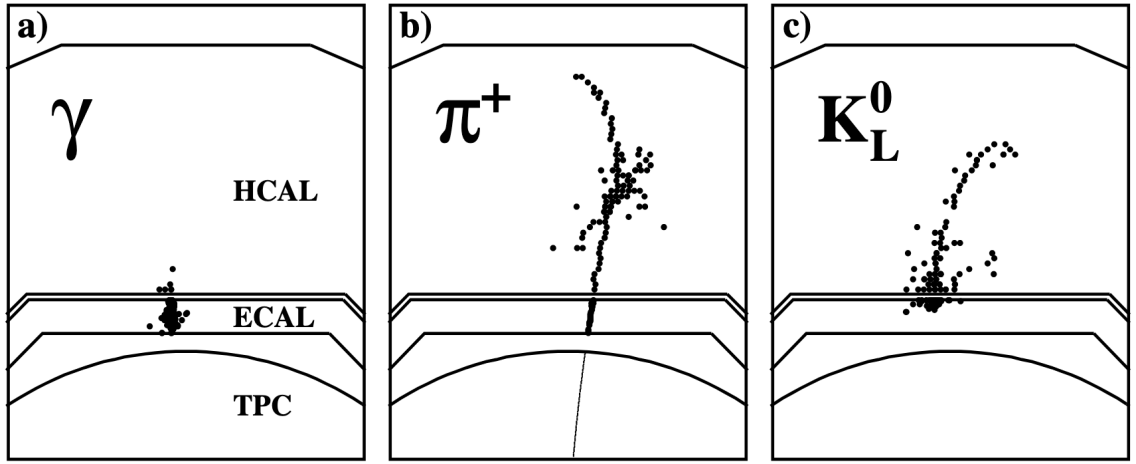
(numbers for $h^- = \Sigma\pi^-, K^-\Sigma$)

Final State	Intermediate Meson	Branching Fraction
$\tau^- \to h^- \nu_\tau$	——	11.5%
$\tau^- \to h^- \pi^0 \nu_\tau$	$\rho(770\ MeV)$	25.9%
$\tau^- \to h^- \pi^0 \pi^0 \nu_\tau$	$a_1(1260\ MeV)$	9.3%
$\tau^- \to h^- h^+ h^- \nu_\tau$	$a_1(1260\ MeV)$	9.4%
$\tau^- \to h^- h^+ h^- \pi^0 \nu_\tau$	——	2.8%
Other hadronic		5.9%

64.8% total

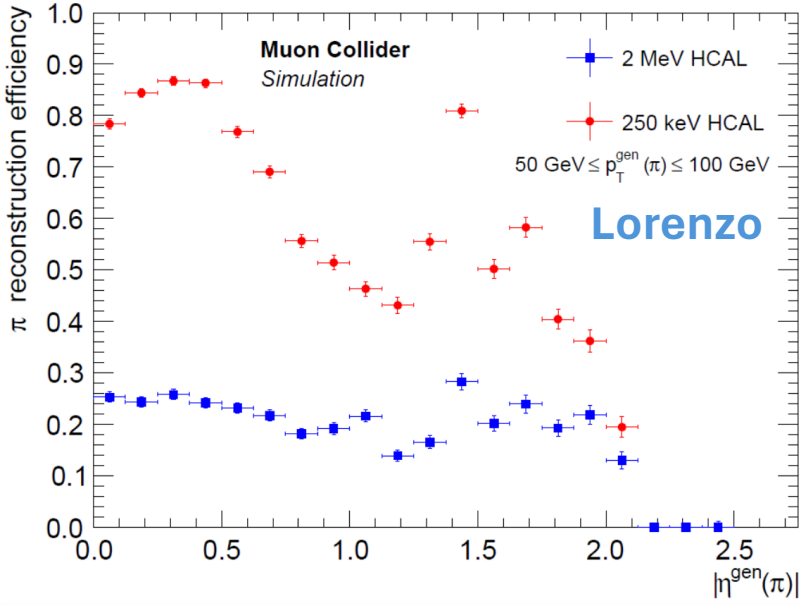
The Algorithm

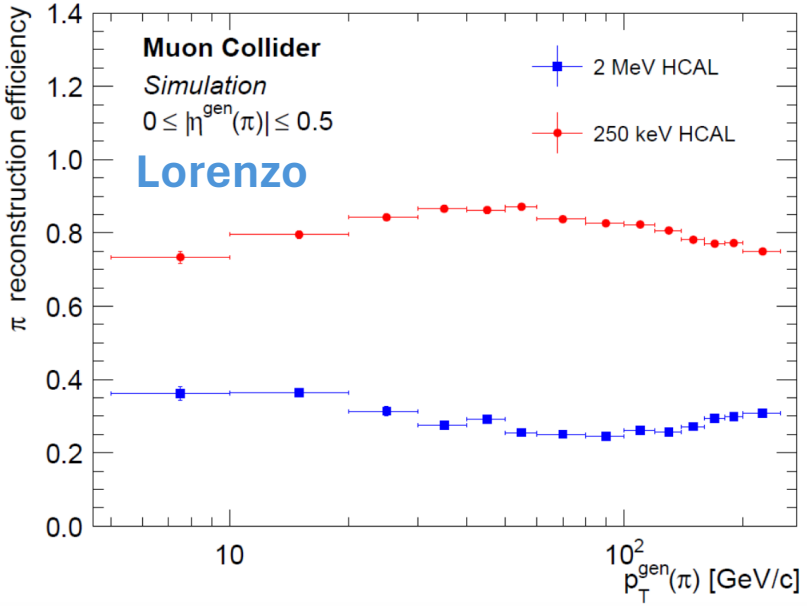
- Pions are reconstructed and identified using the *Pandora* Particle Flow Algorithm
- More details in my IMCC talk
  - Includes short overview of particle flow
- Designed for a detector (ILD) at the International Linear Collider
  - 500 GeV (ish) e^+e^- linear collider – very different from our environment!
- *Very complicated algorithm:* 10,000 lines of C++, sub-algorithms talking to one another in unclear ways
  - Some hard-coded assumptions about detector technology
- Requires optimization for a 10 TeV muon collider environment
- Work for optimization in MAIA is very much ongoing

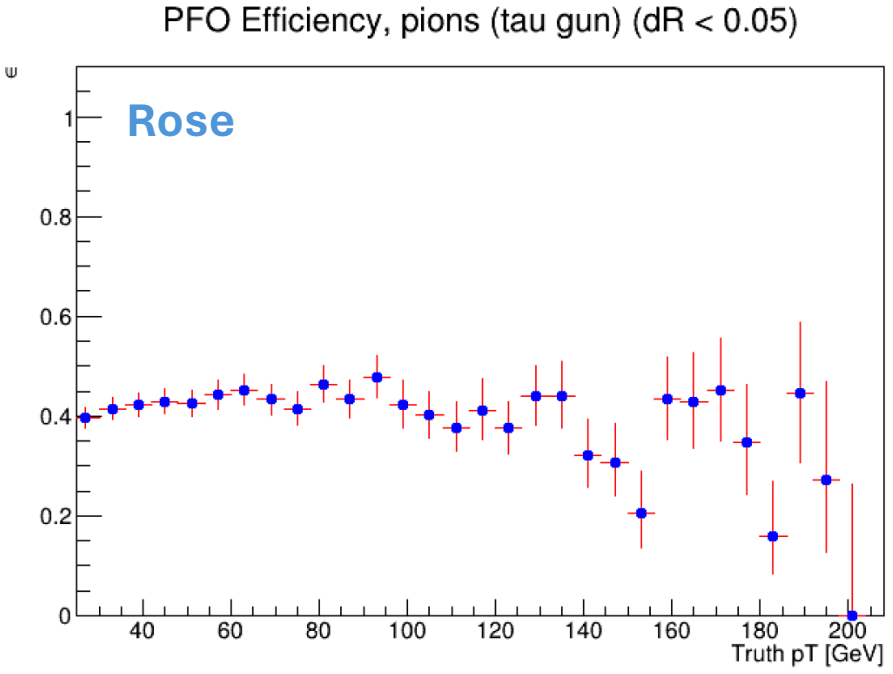


Previous Work

- Previous studies on taus (Lorenzo Valla @ 3 TeV, Rose Powers @ 10 TeV) revealed fundamental limitation caused by charged pion reconstruction and identification inefficiency (from Pandora)
  - Default reconstruction efficiency: O(25%)
  - Lorenzo's studies lowered the HCal threshold → recovered efficiency, not intended as permanent solution
  - Rose isolated the problem to track-cluster matching → moved to study different objects

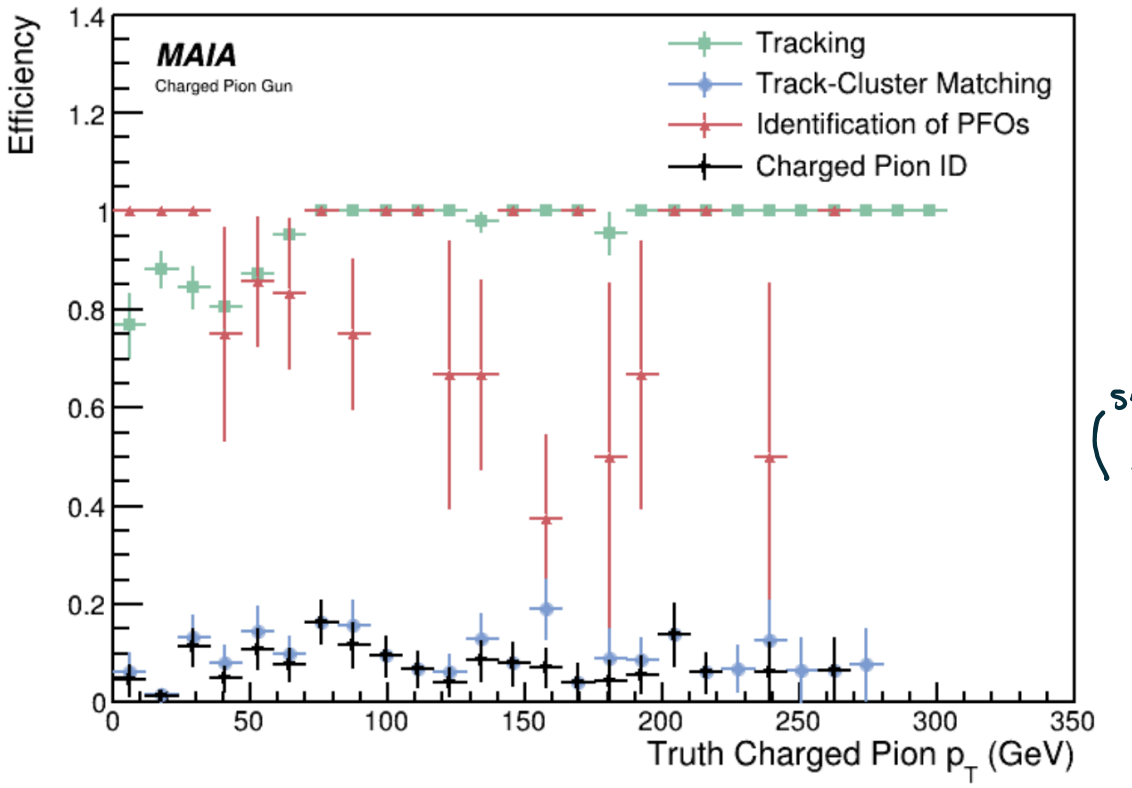




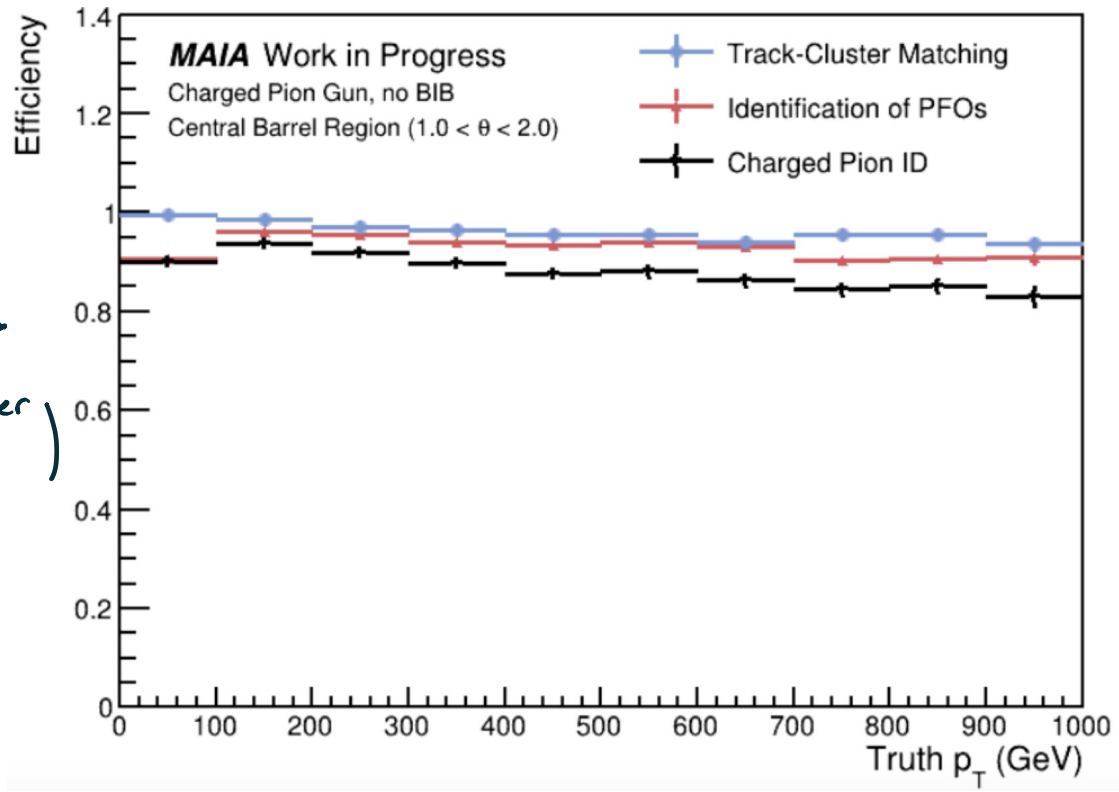


Bug-finding

- Ethan and I quickly reproduced the same problem
- Solution: We found a bug that filled the track position @ the calorimeter face to ***zero***
  - This caused much of track-cluster matching to fail
  - This required a *switch* of the tracking container from *SiTracks* to *SiTracks_Refitted* (not bugged)



some other work involved



Current Status

- Pandora results are difficult to interpret
  - Foresight / advice from other groups: Things will get particularly confusing when BIB is added
- Current strategy:
  - Develop and compare two *versions* of Pandora:
    - **Out-of-the-box** (with some parameter modifications): OK performance without BIB, expected to be confusing to interpret with BIB
    - **"Minimal Pandora"**: Run just the algorithms that are required. Simpler and easy to interpret, may take a small hit in efficiency
  - Current status: understanding results without BIB
    - Comparison of charged pion tracks to muons
    - Understanding of clustering performance
      - Calorimeter energy associated to the charged pion vs. truth energy
      - Cluster fragmentation
  - Soon: Add BIB, comparing the two Pandora versions