TAU RECONSTRUCTION STUDIES – UPDATES

ROSE POWERS

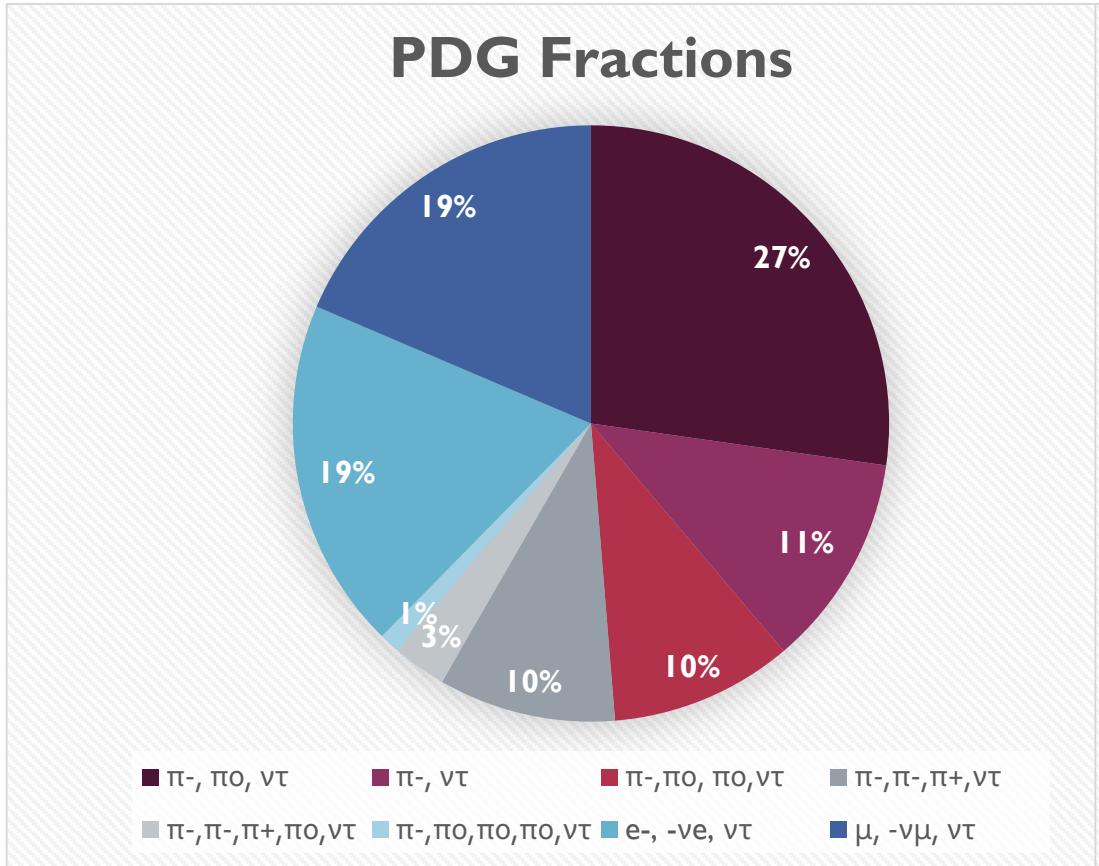
7/13/23

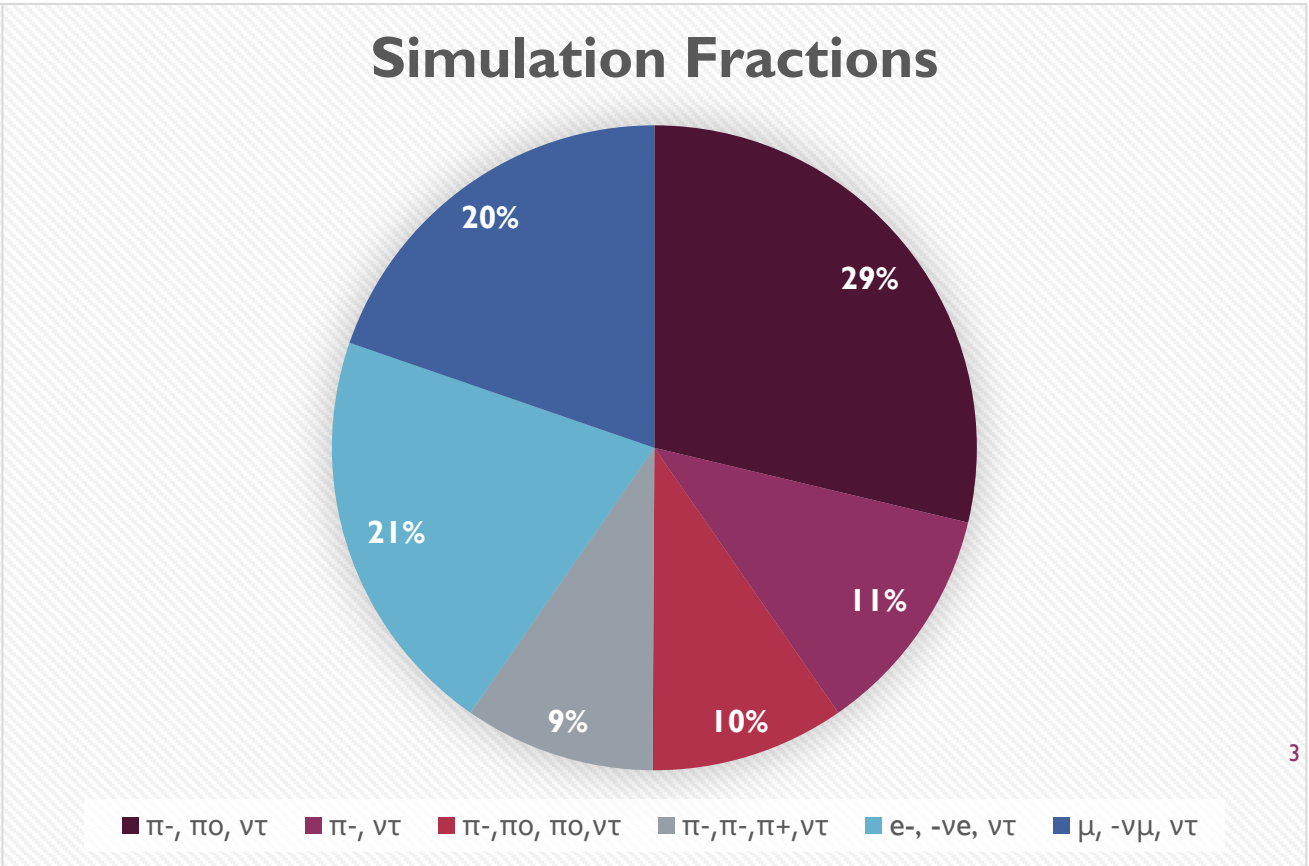
OVERVIEW

- Sergo and I have been looking at tracking performance for taus using O(100k) samples of taus fired with a flat momentum distribution between 20-200 GeV, theta distribution ~10 deg wide
- Tau simulation validation: accurate branching ratios for tau decays confirmed
- For unsmeared tau gun events, tau reco efficiency is nonzero (but not great)
- Tackling tau reco efficiency from the ground up: looked at tracking efficiency for pions coming from taus
- Preliminary efficiency study reveals expected worse performance for lower pT in addition to a duplicate track issue

SIMULATION VALIDATION

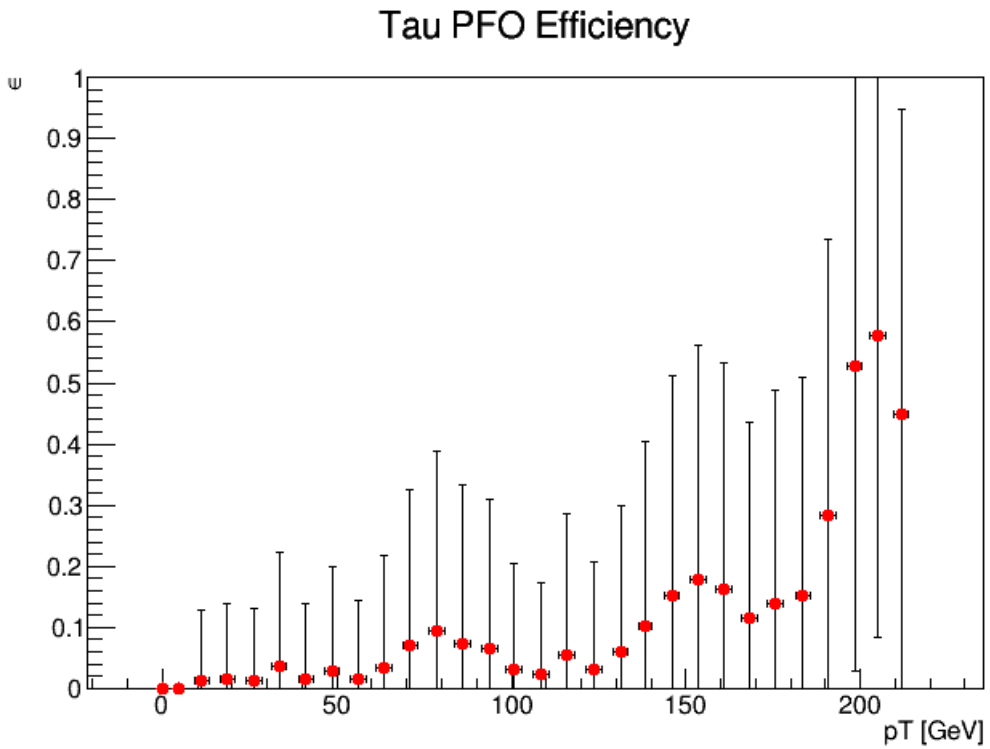
- Examined decay modes and branching ratios for 100k simulated tau events and compared to PDG rates:
  - Pretty accurate, we don't have any of the two least common hadronic decays but as nTaus grows, I would expect the rates to converge even better



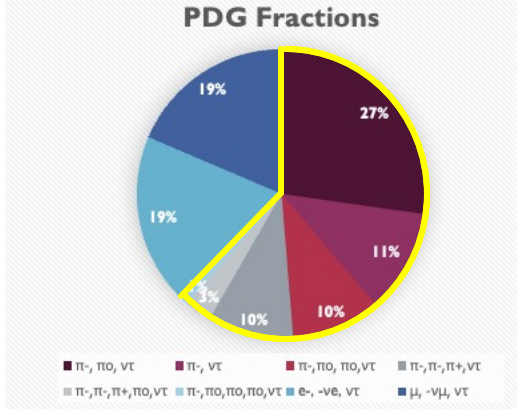


TAU EFFICIENCY BASELINE

- Had some issues due to a nonzero beamspot width in the particle gun settings
- After generating a new sample with no smearing, when running the reconstruction including the TauFinder algorithm (code), we get a nonzero amount of reconstructed taus
- Efficiency is still quite poor, but improves with pT as expected



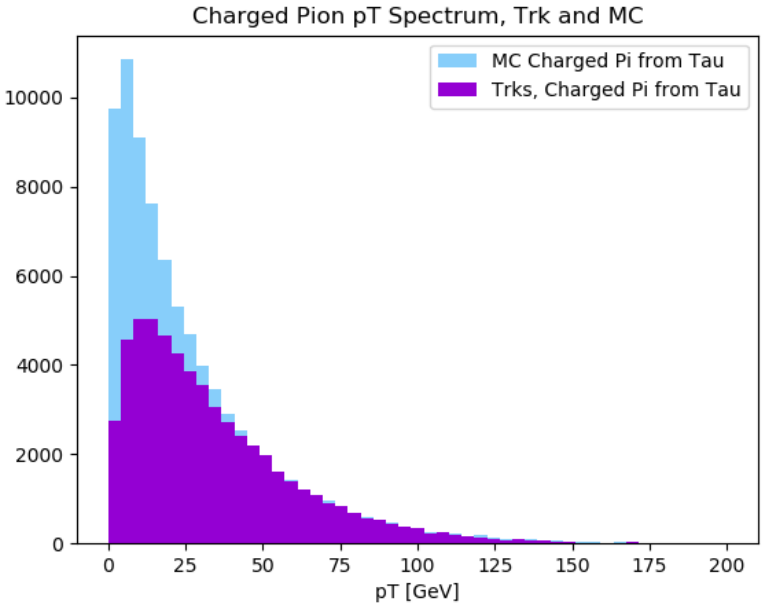
MOTIVATION FOR PION EFFICIENCY STUDY

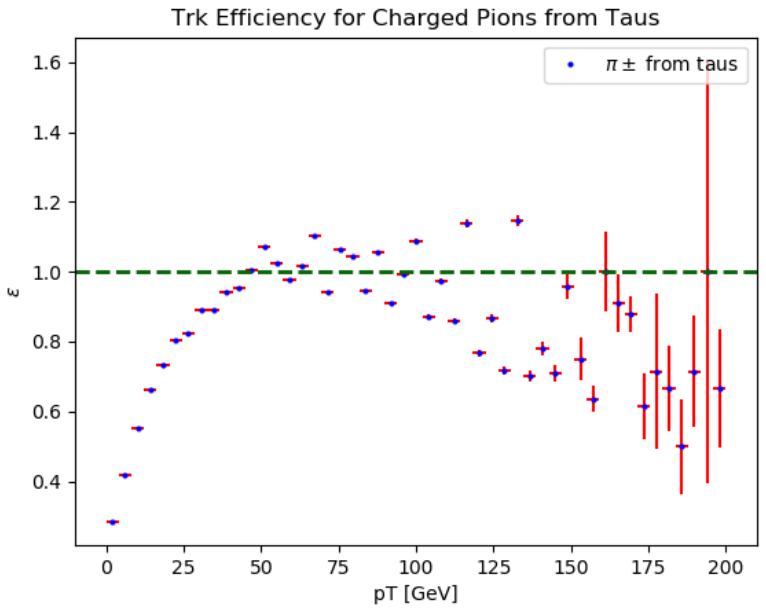


- Did a study of the reason for failure of TauFinder, and in over 95% of cases:
  - Either the input collection (all PFOs) was empty
  - Or among those PFOs, no valid candidate was found (low momentum, bad invariant mass, etc)
  - So poor tracking performance upstream is causing the TauFinder to fail
- Moreover, recall that over 60% of tau decays involve a charged pion
- In order to find taus, we need to do a good job of reconstructing pions from taus
- Examined efficiency of pion reco with tracking in hopes of identifying weak spots

TRACK EFFICIENCY FOR CHARGED PIONS FROM ~100K TAUS

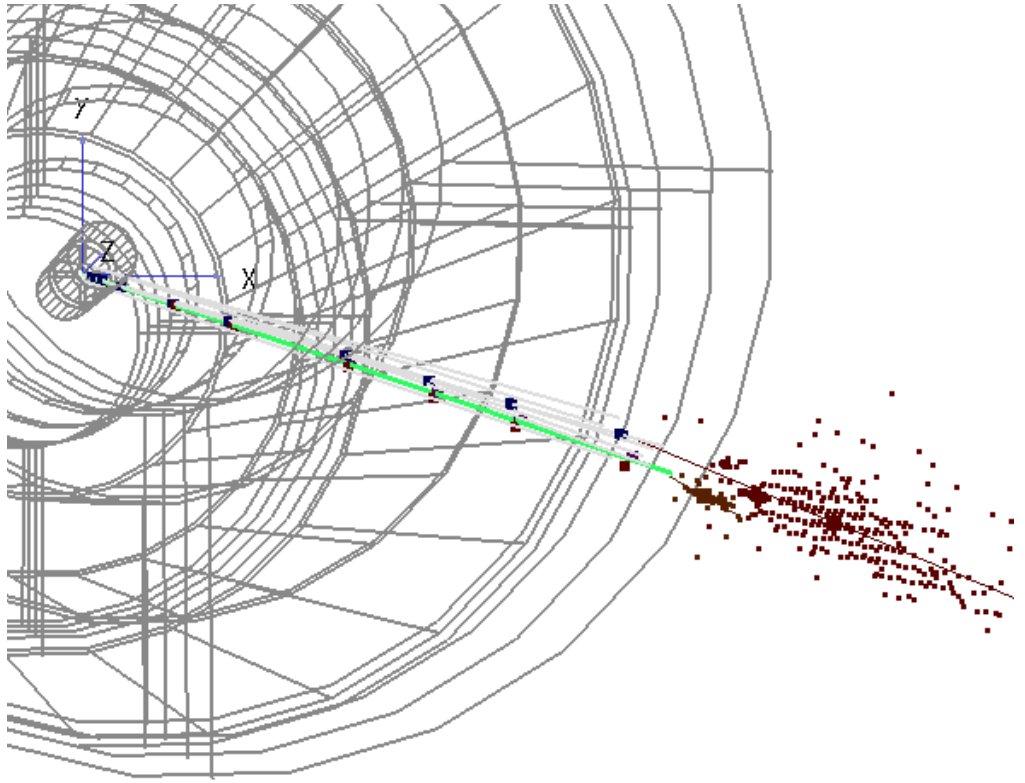
- Defined a successfully reconstructed pion following the guidelines of 2203.07964: if half the hits associated with the track came from a charged pion with tau mother, it is a valid track
- From 0 to 50 GeV, we see the expected increase in efficiency with pT
- After 50 GeV, strange behavior: combination of lower efficiency and some extra tracks (see next slide)
- Above 150 GeV, statistics too low to draw a conclusion





DUPLICATE TRACKS

- Inspected several events with efficiency > 1, always a duplicate track issue (i.e., 2 or more tracks from one MC particle) (See example of an evt display at right)
- There is a processor, ACTSDuplicateRemoval, which is supposed to handle these, evidently it is not functioning at peak efficiency
- I have grabbed a copy of this processor and started playing around with parameters and modifications, seeing if I can find a more optimal behavior



NEXT STEPS

- I want to work a bit more on the duplicate track issue
- Assess the momentum resolution as well as efficiency (from some manual inspection, it looks pretty good)
- Regarding the pion tracking efficiency, I want to get a better idea of where the tracking algorithms are failing and why, and see if we can optimize the parameters for charged pions especially in the pT region of interest
- Might generate some pion gun samples to inspect the performance in a purer environment