RESEARCH CORPORATION *for* SCIENCE ADVANCEMENT

U.S. DEPARTMENT OF ENERGY | Office of Science

Neutron PFOs

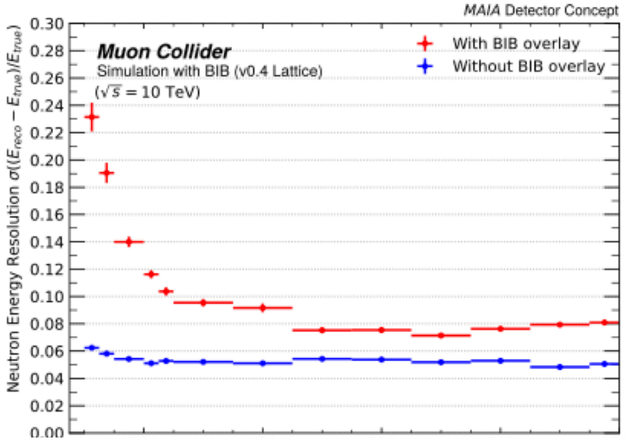
TOVA HOLMES, U. OF TENNESSEE

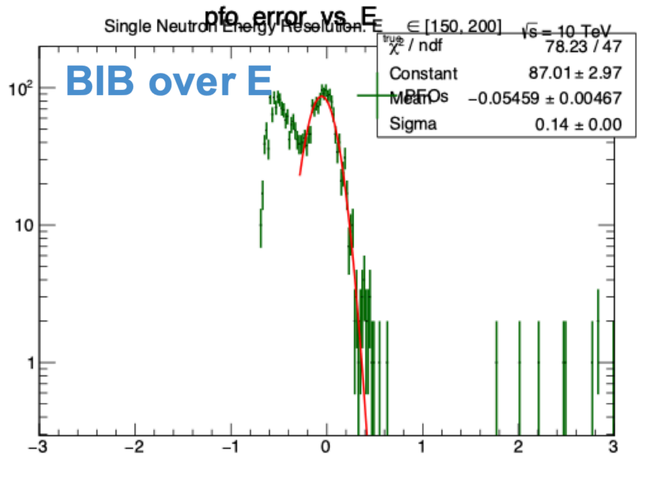
MAIA DETECTOR CONCEPT

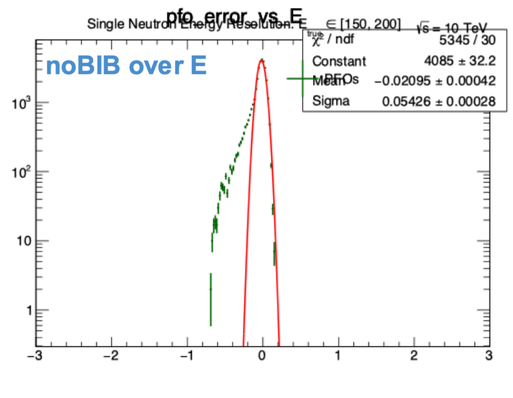
17 DECEMBER, 2024

What do we know?

- Having trouble correctly matching neutrons with E < 80 GeV
- Even at higher energies, see bad resolution and double-peaked structure, suggesting we may not be doing matching correctly
  - This only occurs when we add BIB
- Questions:
  - What are the environments near neutrons like?
  - How big are neutron showers?
  - Can we refine our matching algorithm?
  - Are high E neutrons even reasonable objects that relate to our reco algorithms?

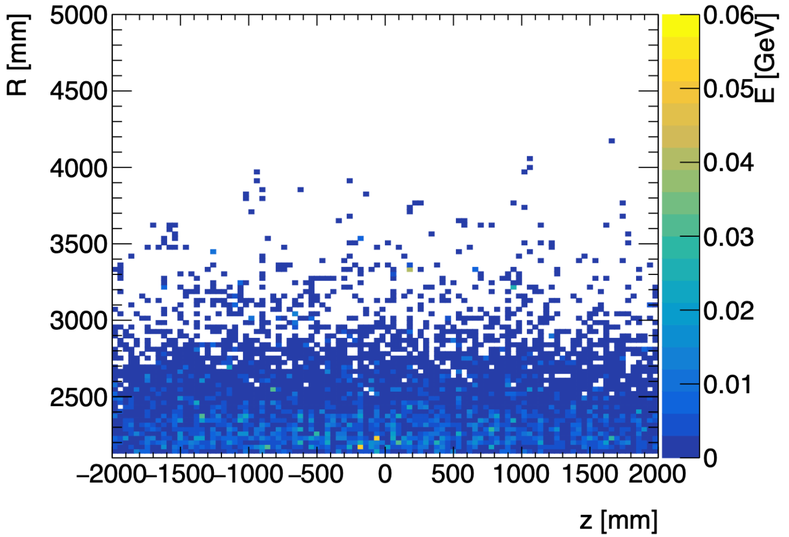






What do we expect?

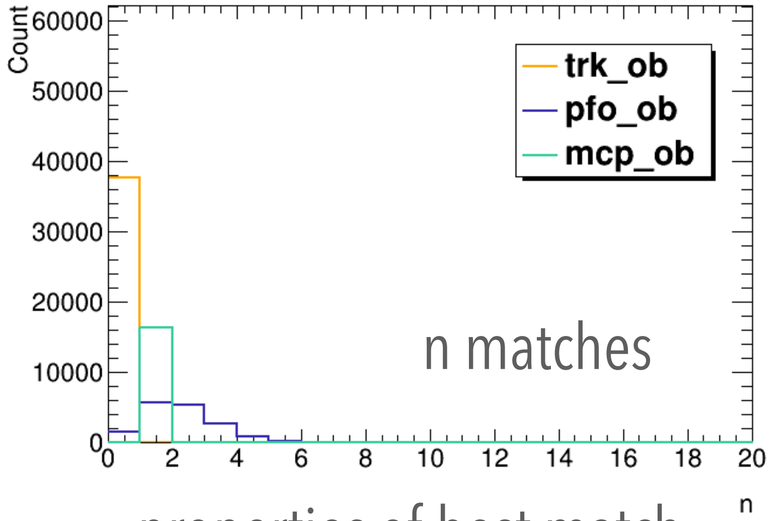
Energy in the HCAL in one 0.4 slice of phi



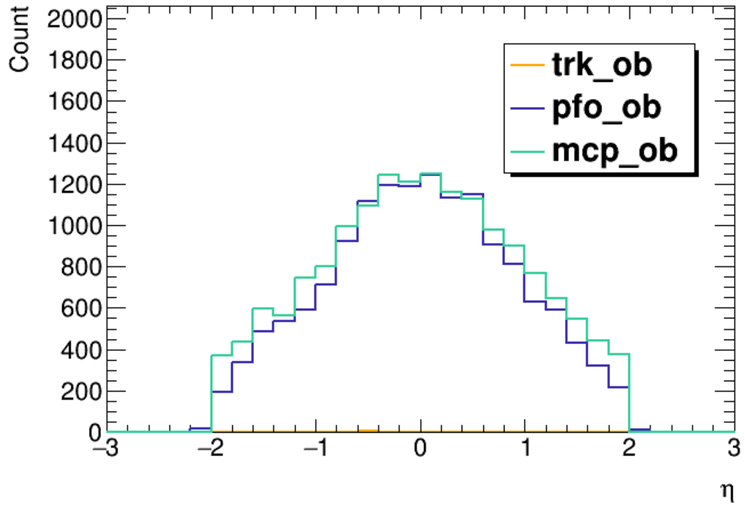
- Using the plot on the right:
  - 100 bins in z, roughly 15 bins in R that are well populated, around 0.01 GeV in each bin
  - 15 GeV total. We have a sim→ digi factor of 50 so that's the equivalent of 750 GeV of particle energy
  - Dividing this full eta range into squares of 0.4, → 60 GeV per square
- So, we expect to have very roughly the equivalent of 50 GeV of particle energy deposited in every jet area
  - It makes sense that we wouldn't be able to do consistent matching below this scale without better subtraction

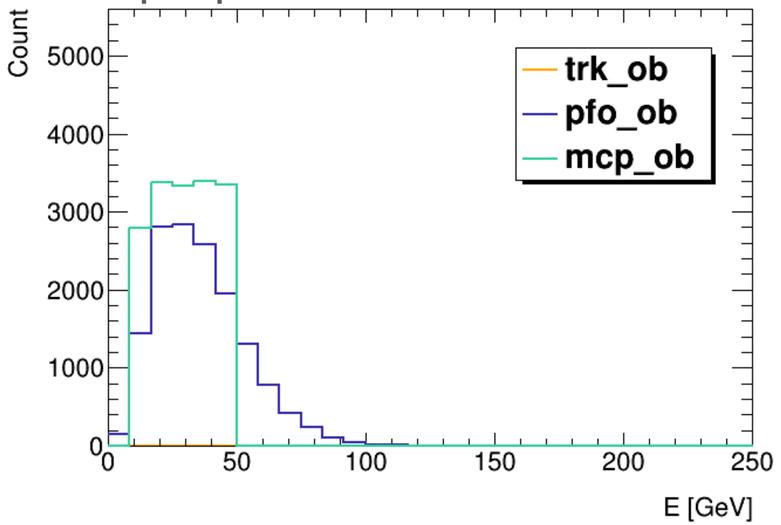
First looking at this low energy slice with BIB

- True particles must have eta < 2, E >10 GeV
- Matching requires cluster to have E > 5 GeV, dR < 0.1
  - Highest E PFO with this requirement is kept
- Lots of matches, typical to have more than one PFO



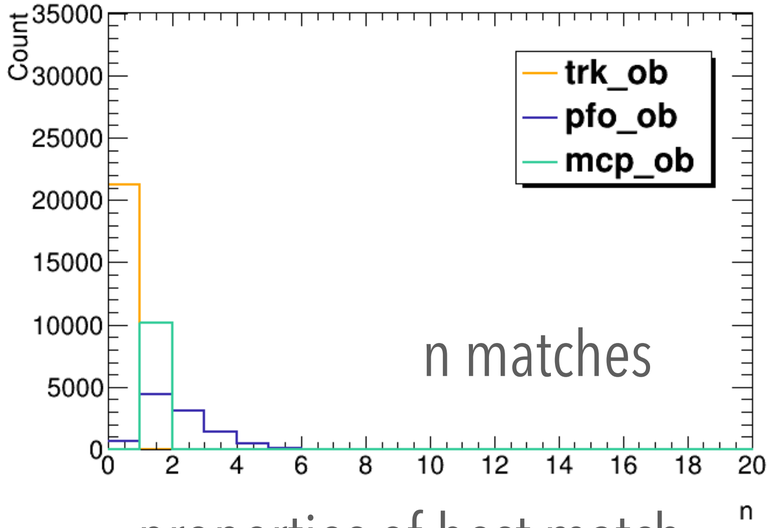
properties of best match



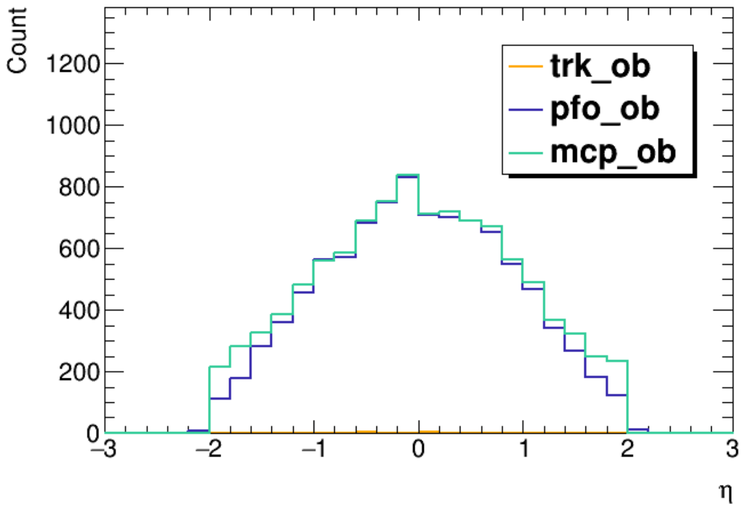


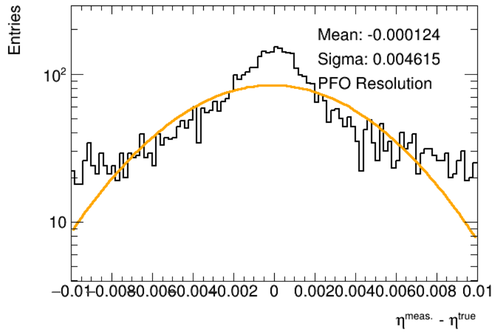
What does this look like in the next slice up?

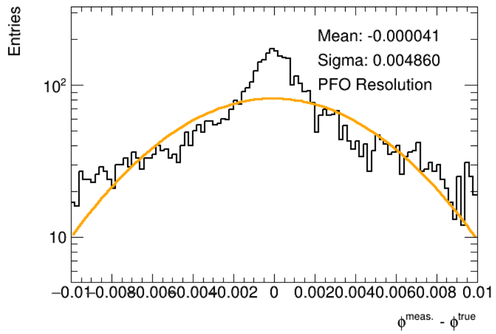
- Same matching requirements
  - Could probably do much tighter dR matching – will try with 0.005

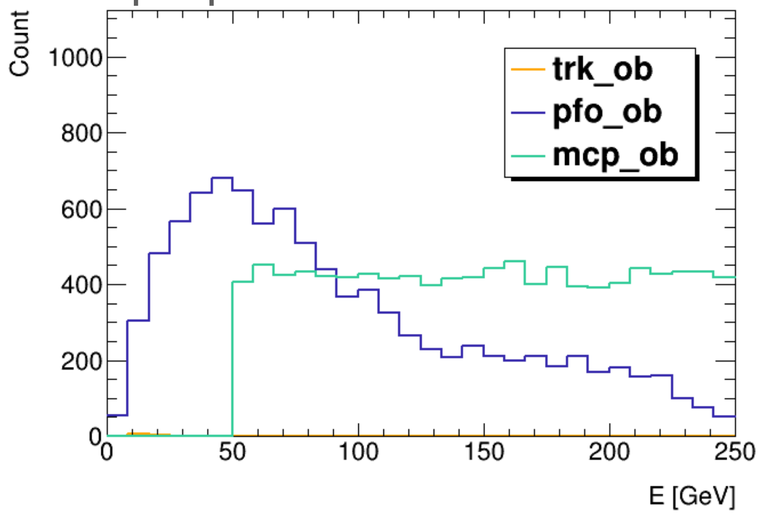


properties of best match



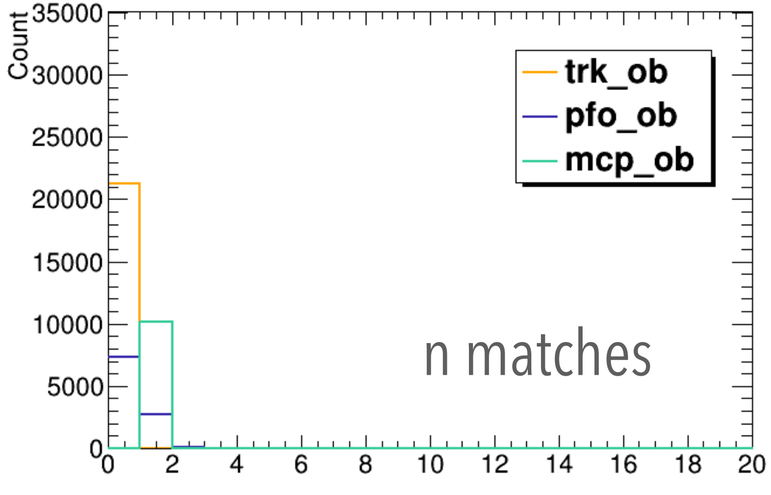


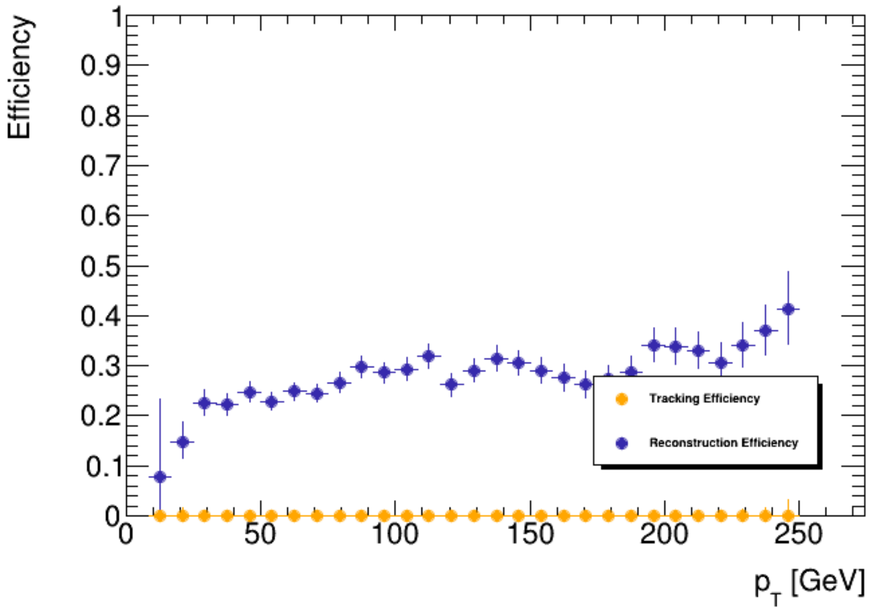




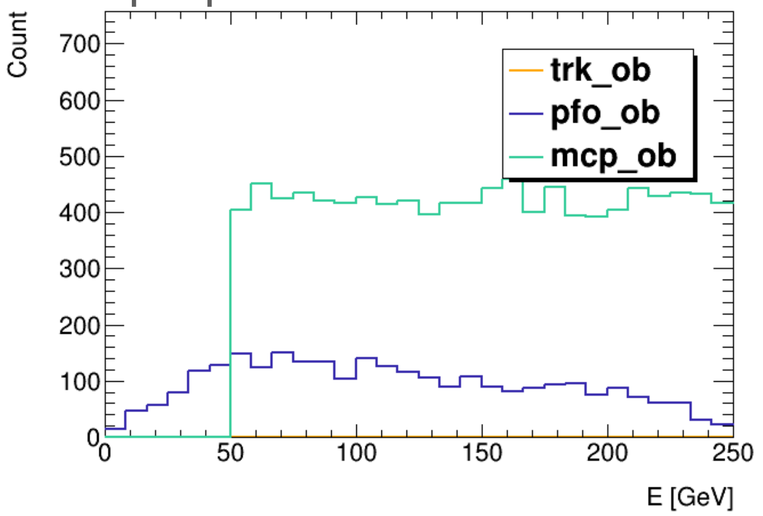
What does this look like in the next slice up?

- Trying with dR < 0.005 – no more multiple matches or big lumps in E, but much lower efficiency
- We clearly need a different plan



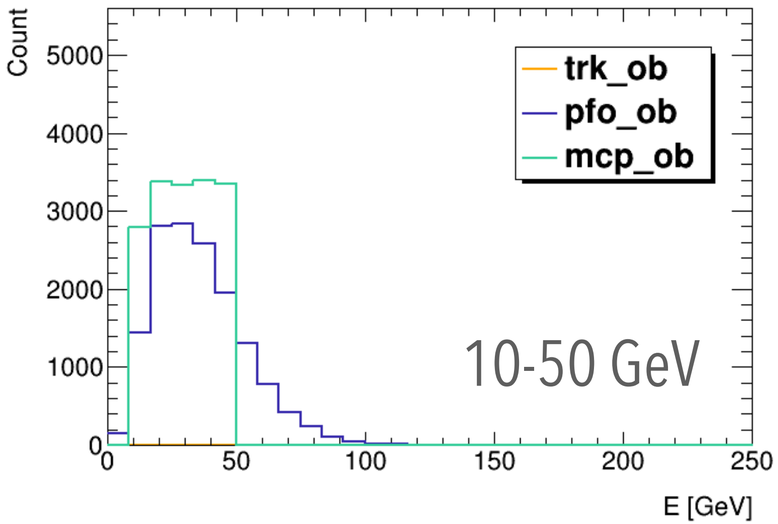


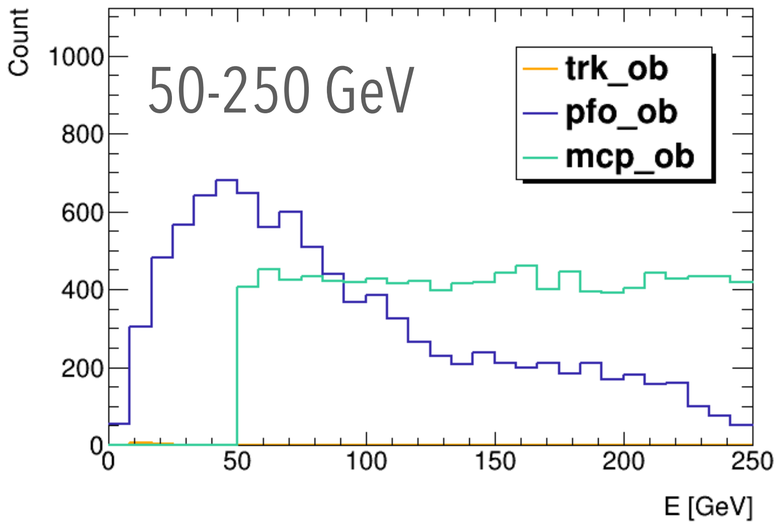
properties of best match



What happens here?

- Energy of best match neutron PFO, in two slices, both with 0.1 dR matching
- Not just simply BIB: the energy of the sample impacts the energy of these badly matched clusters. Is it splitting?

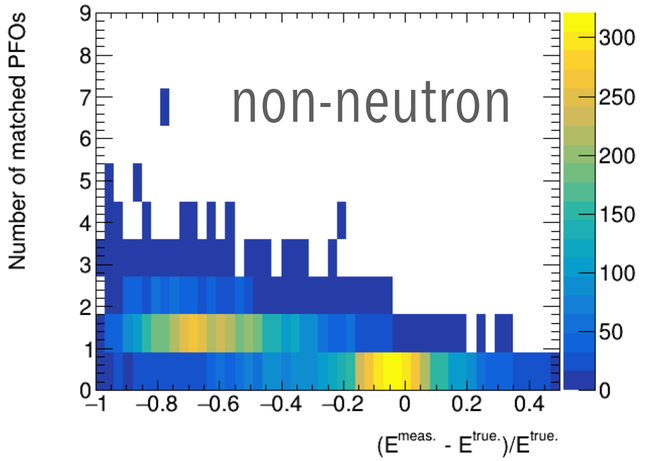


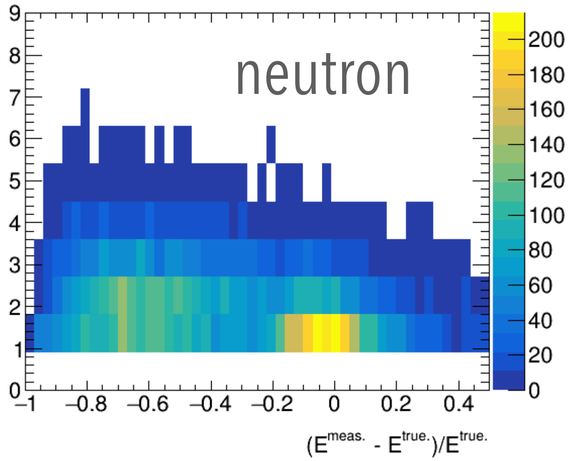


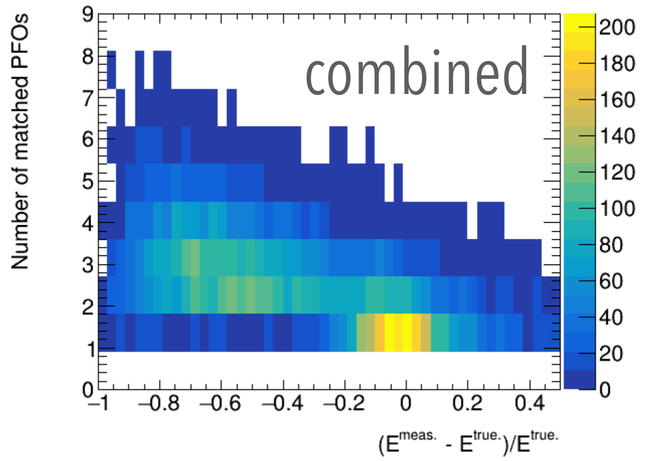
What happens here?

- Looks like there is some evidence of cluster splitting into two
  - can we merge these back together?

50-250 GeV

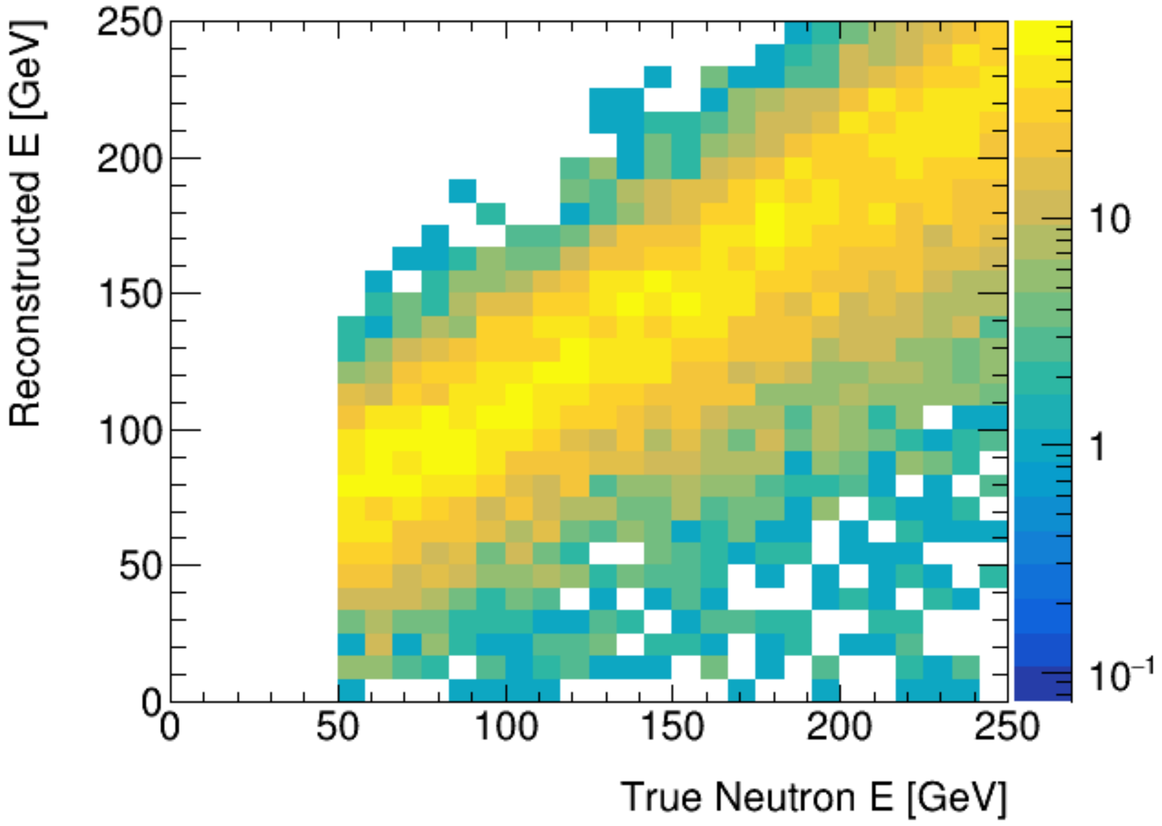


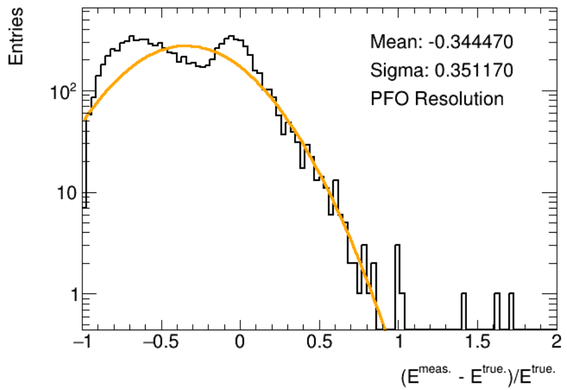




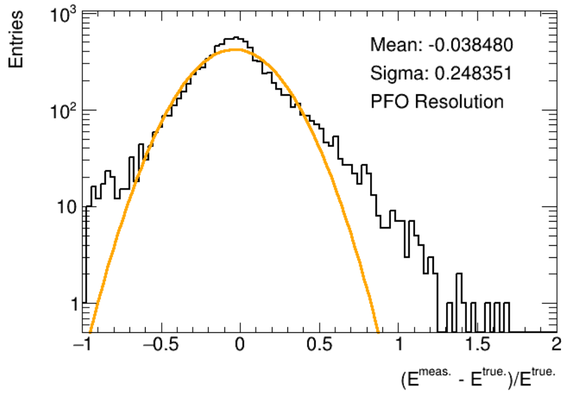
Merging PFOs

- For a first pass, taking all PFOs (of any kind) within 0.1 R, >5 GeV, and summing their energy





Without summing

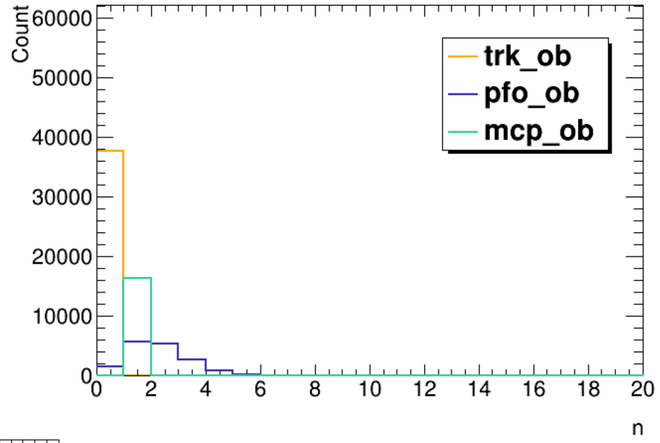


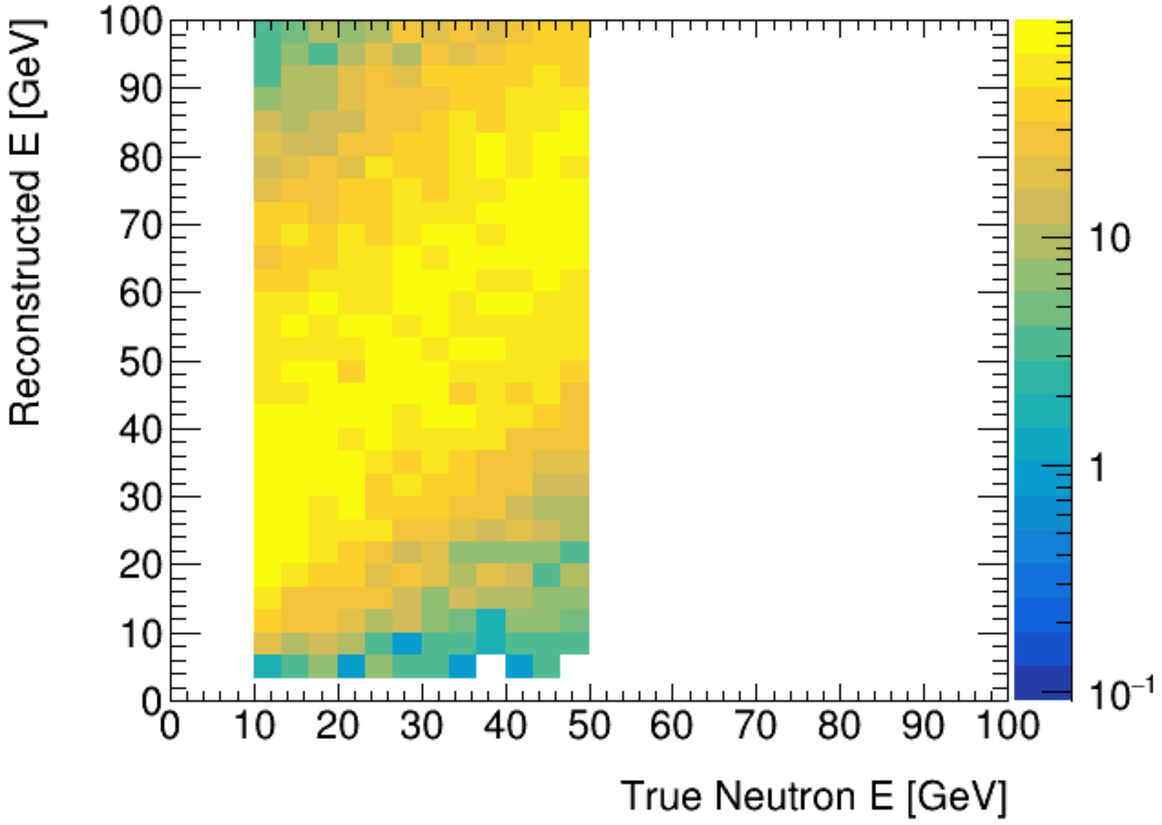
With summing

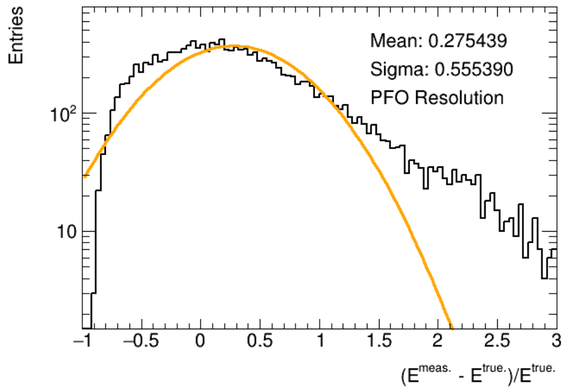
50-250 GeV

Merging PFOs

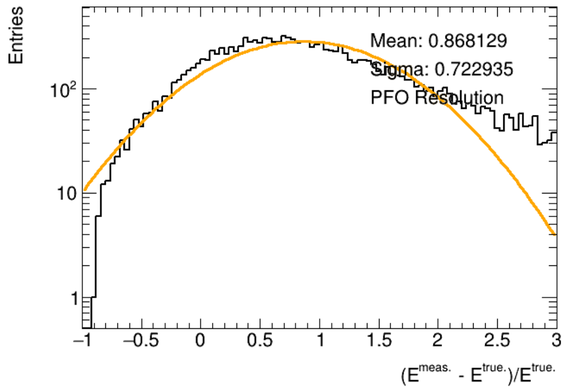
- What does this look like in our lowest energy bin (10-50 GeV)?







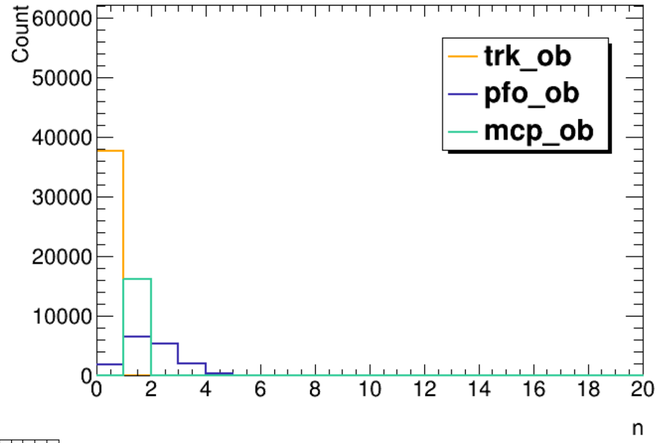
Without summing

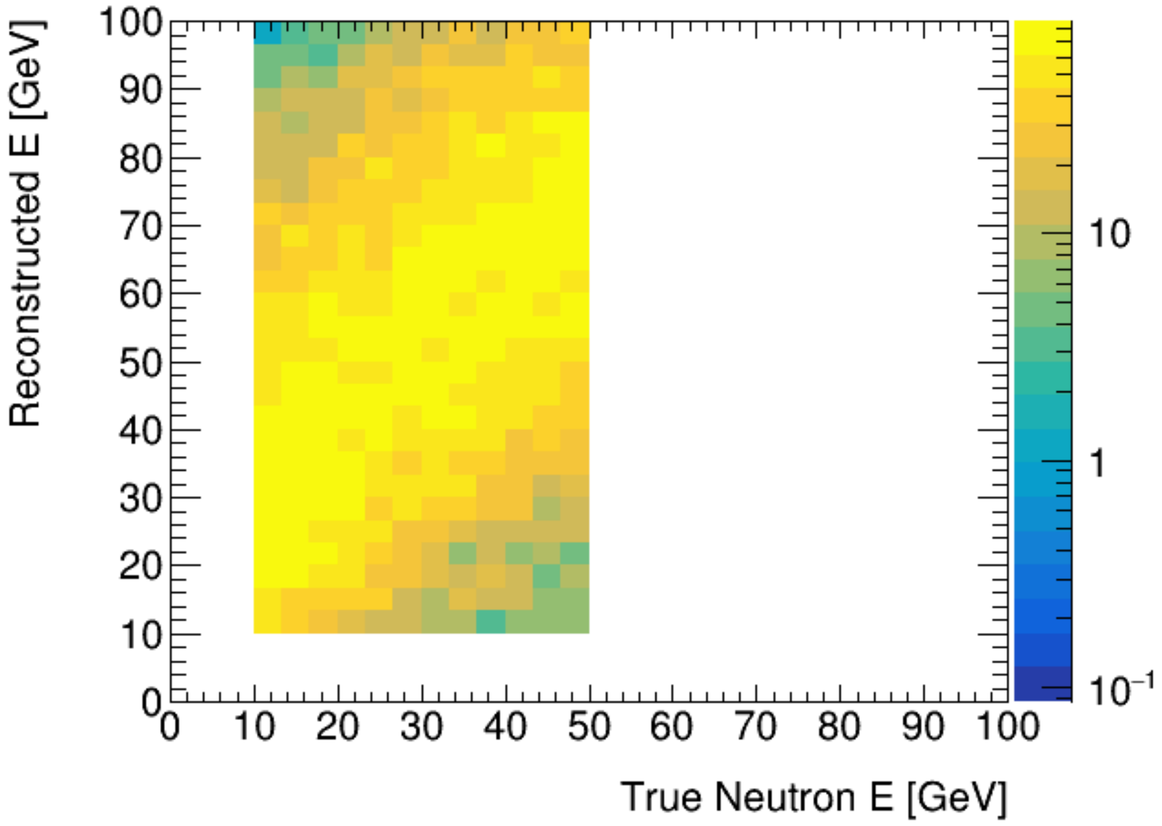


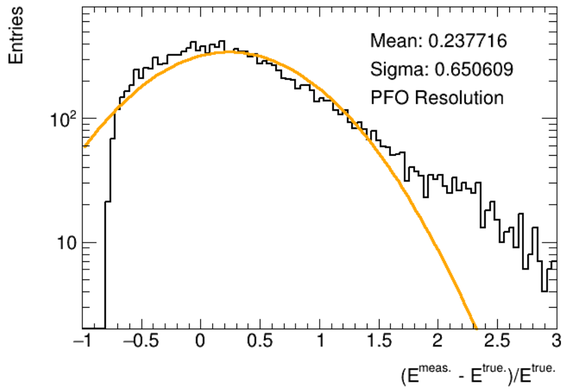
With summing

Merging PFOs

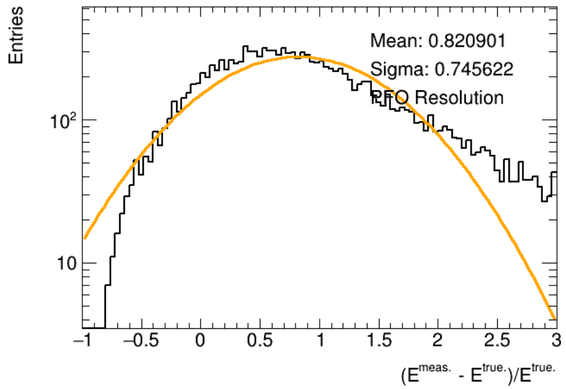
- Same thing with 10+ GeV requirement on clusters







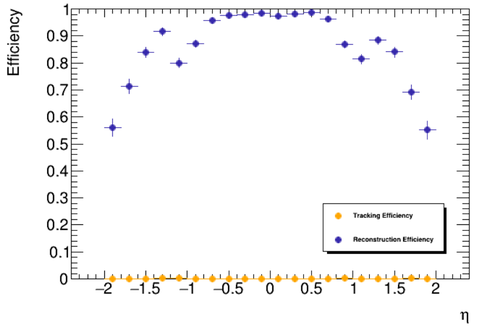
Without summing

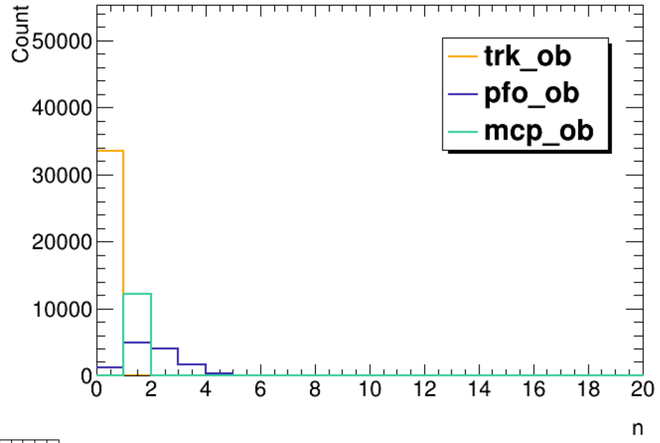


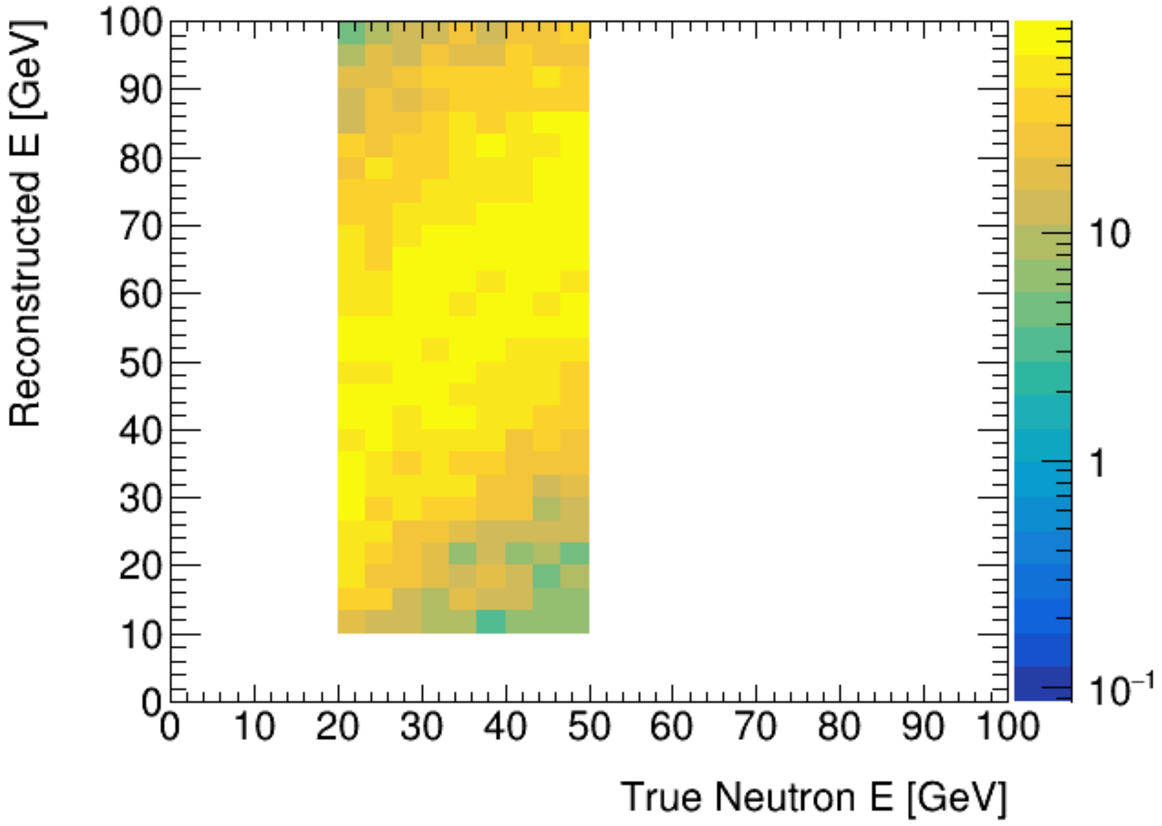
With summing

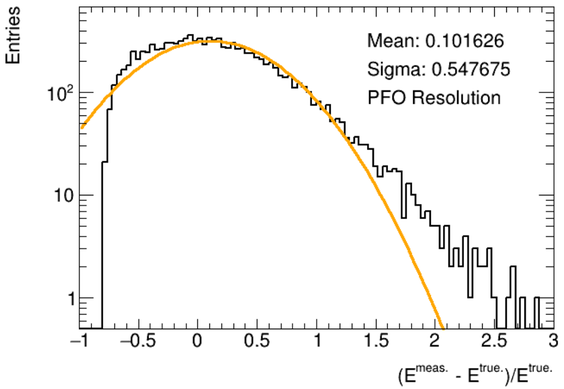
Merging PFOs

- Now only looking at truth particles with 20+ GeV

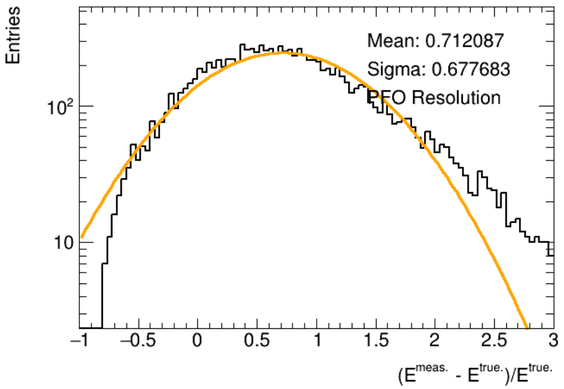








Without summing



With summing

Proposal

- Switch to calculating the matched E by summing all the PFOs with E > 5 GeV (regardless of PFO ID)
  - Re-run the fits and see if things look more sane – should be able to go to much lower energies now!
  - Elise did this already! Amazing!
- Open question is if we should fiddle with the min E cut. I think we could do this to be a bit more conservative if we want to.
  - Also, my studies still require a neutron PFO to exist, and all quantities besides the E sum are taken directly from that – do we want to include that?