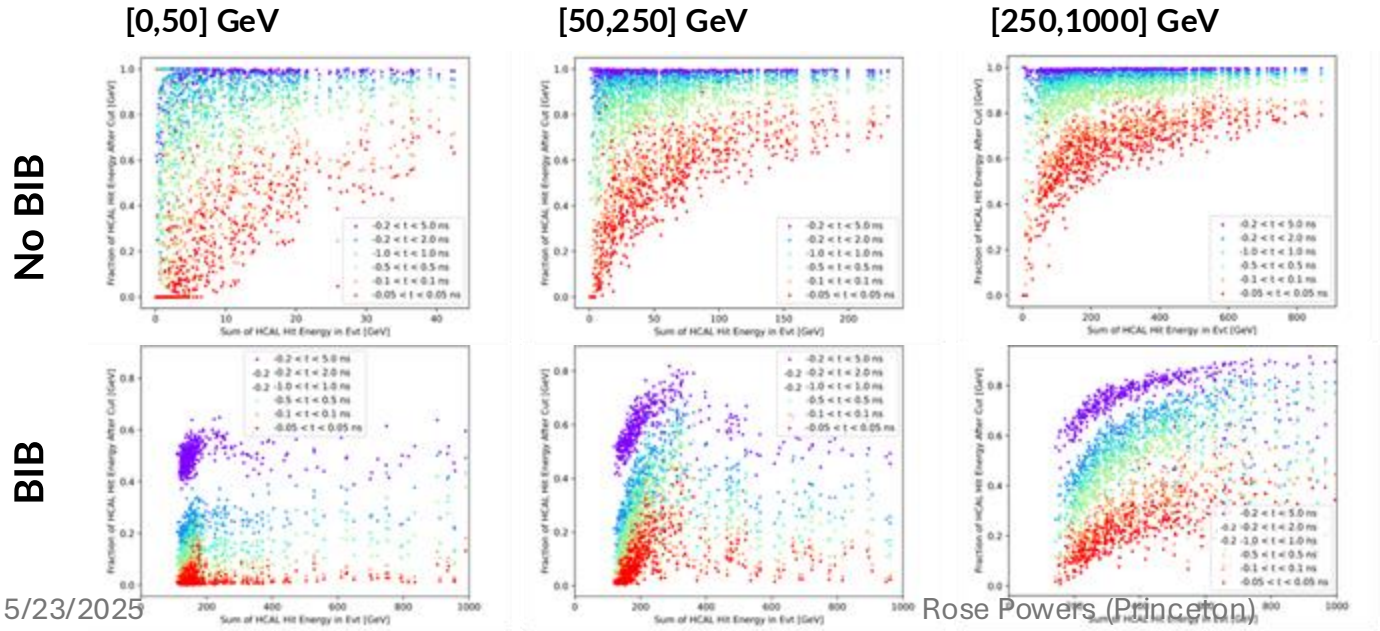
Neutrons 5/23

A final attempt at decent resolution for EU24 neutrons

- Recall: abysmal energy resolution for neutrons with and without BIB after upgrade to EU24 lattice
- Individual energy bins not Gaussian-distributed, resolution data points meaningless
- Kiley's event display revealed a total cluster fragmentation disaster for the with-BIB sample
- Attempted a time-aware reclustering algorithm which helped but did not fix the problem
- This week: modified the **truth-assisted** cone-clustering we performed for photons with BIB, adding a **time-awareness condition,** and assessed resolution only for neutrons I consider **well-matched**

Truth-assisted, time-aware clustering

- Sum energy of **HCAL hits** which pass **two** conditions…
  - Within a cone of dR<0.1 from the truth neutron
  - Within a time window of [-0.5, 2] ns
- Time window was chosen based on these studies:

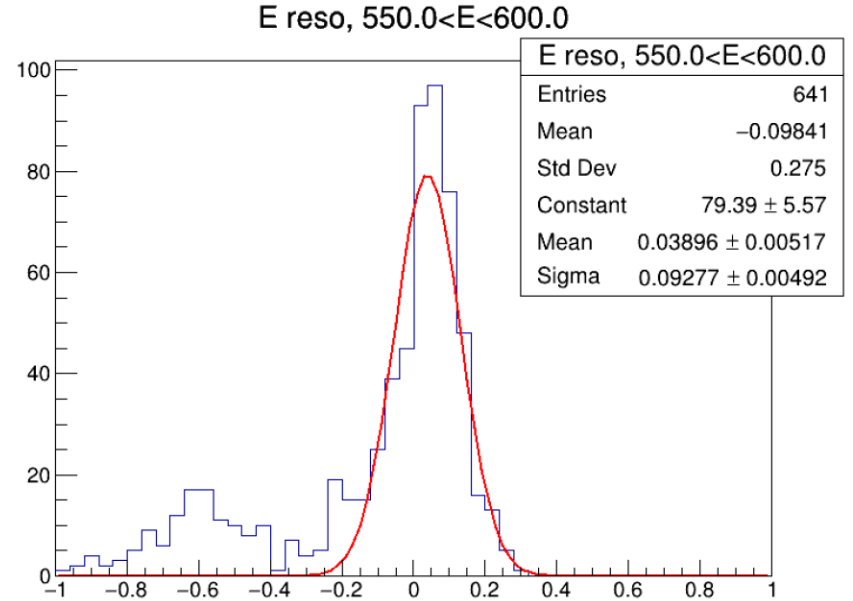


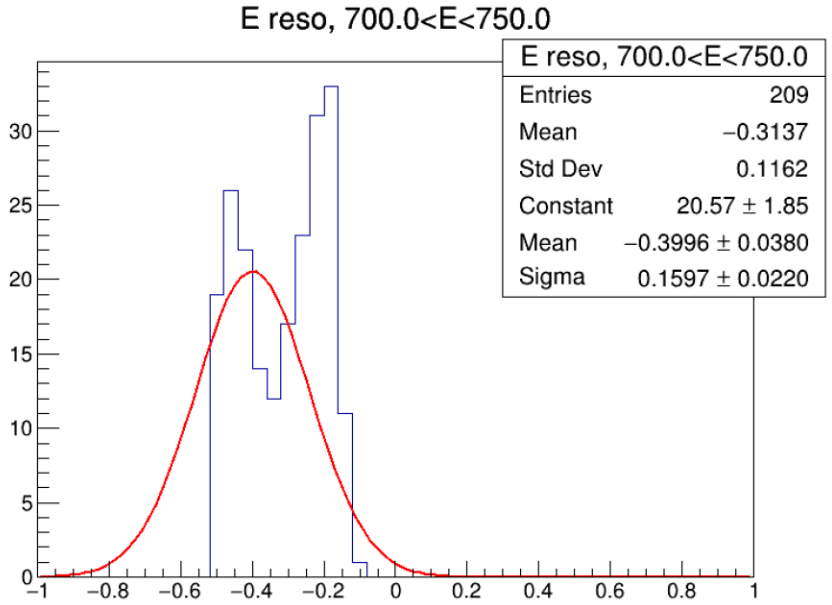
Very stringent matching criteria

- For no-BIB, required reco neutron to be:
  - Neutron-identified (pdgid = 2112)
  - Maximum pT PFO in the event
  - Within dR=0.1 of the truth neutron
  - E_{reco} *is no less than 60% of* E_{true}
- For truth-assisted BIB reco, required:
  - E_{reco} *is no less than 60% of* E_{true}
- This energy cut is somewhat arbitrary, but motivated by bimodality in the resolution studies…

Bimodality

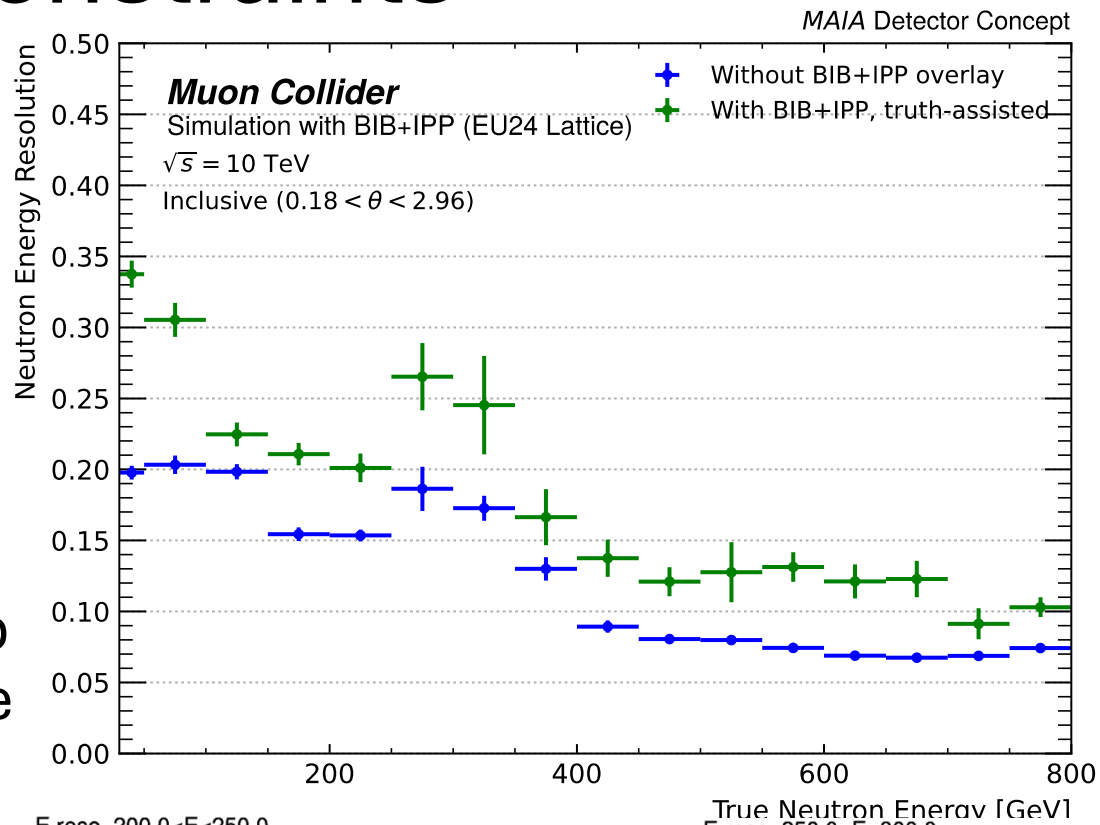
- Without the energy requirements, individual binned histograms of $(E_{reco}-E_{true})/E_{true}$ are **bimodal** across endcap, barrel, and transition region
  - Taller peak has mean closer to zero, indicating it corresponds to correctly-matched neutrons
  - Smaller peak has mean less than -0.5 (mismatched neutron)
- The split between peaks looks to be roughly at deltaE/E~-0.4, which corresponds to a cut on response of 0.6
- Want to assess the resolution of only **properly matched** neutrons, since we want to show the resolution capabilities of our detector given the assumption that we figure out how to properly match and reconstruct our neutrals

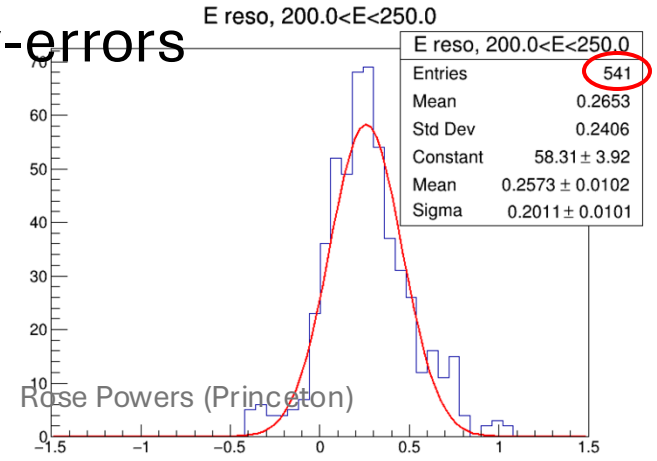


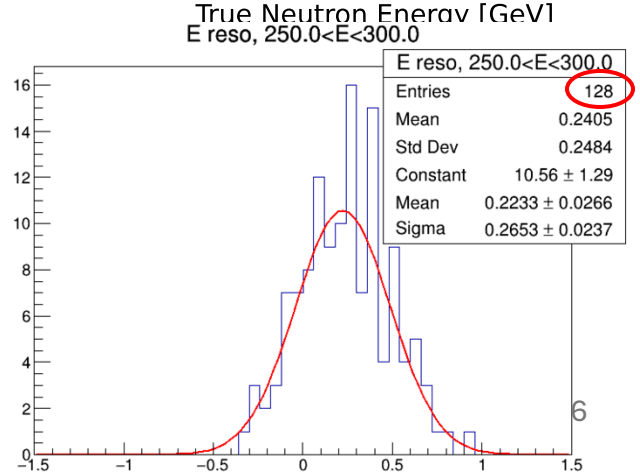


Resolution with these constraints

- First, note y-axis: **best** resolution for neutrons we've seen yet
- Truth-assisted sits nicely on top of no-BIB
- Bad features at the crossover between the 50-250GeV and 250-1000GeV slices
  - I attribute it in part to the huge drop in **statistics per bin** between these two slices
    - Note significantly larger y-errors







Matching Efficiency: where we pay for the better resolution

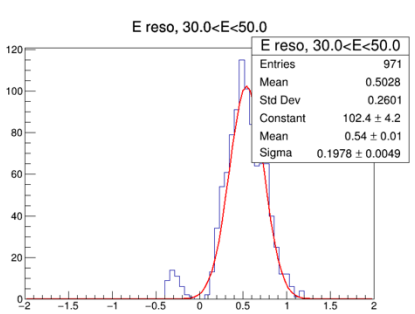
- Of course, the stringent requirements on a “well-matched” PFO damage matching efficiency significantly
- However, to the point Simone made at IMCC, we can be more clear about reconstruction efficiency vs matching efficiency
  - i.e. we almost always **find** a neutron-identified PFO (reconstruction efficiency → 1)
  - But we know these PFOs are not always well-matched/accurately reconstructed, and this is reflected in our poor matching efficiency
  - Don’t have the plots now but can generate if this is something we want to report

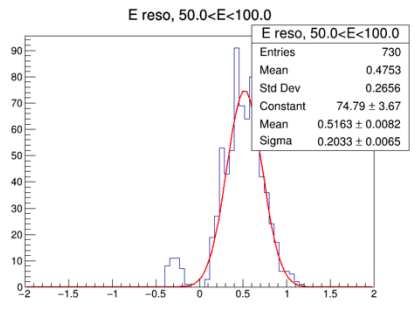
Pros/Cons of this approach

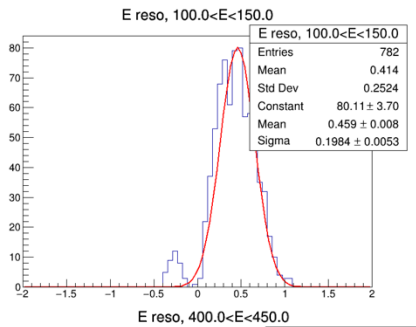
Pros	Cons
We achieve good resolution for matched neutrons	Matching efficiency is horrible
As long as we are transparent about the procedure, we are not presenting anything misleading or meaningless (i.e. all individual fits are now Gaussian)	Procedure might seem over-engineered; lots of in-between steps, truth-assistance, and data selection, which also causes our stats to drop
We demonstrate that reconstruction/matching troubles (software problems) are **separable** from detector performance; not fundamentally limited	Still not a very compelling result for our progress with neutral reconstruction

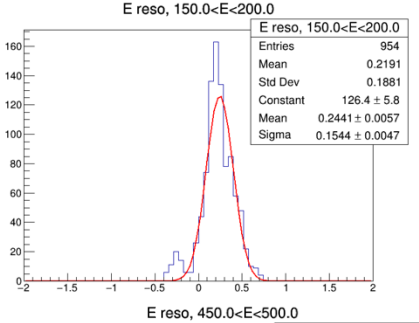
Let me know what you think!

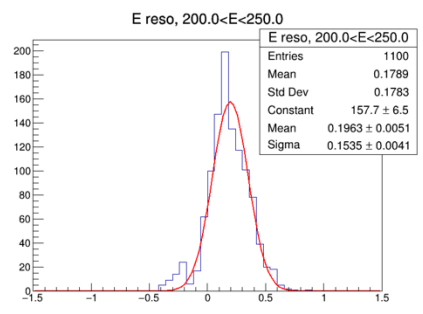
Backup: Individual Gaussians (no BIB, response-calibrated

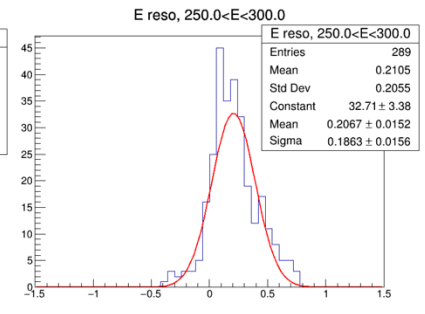


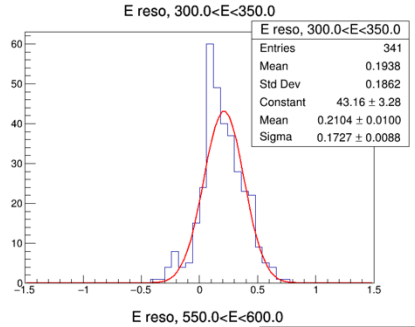


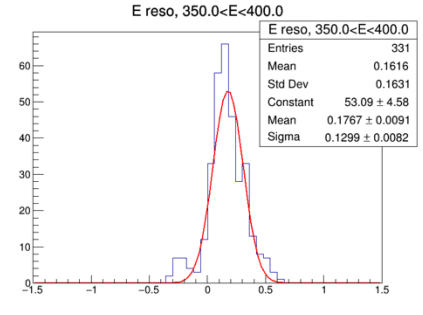


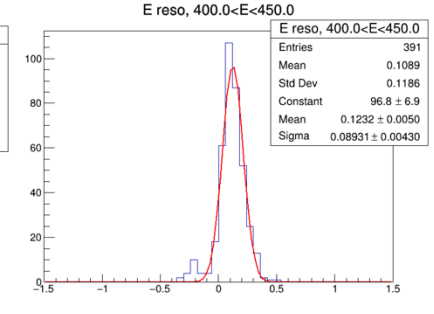


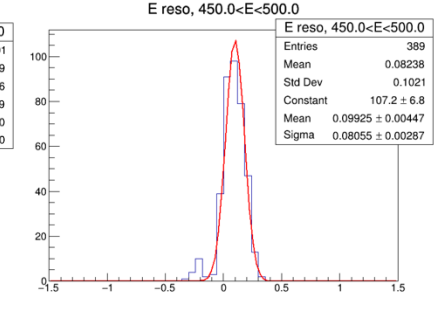


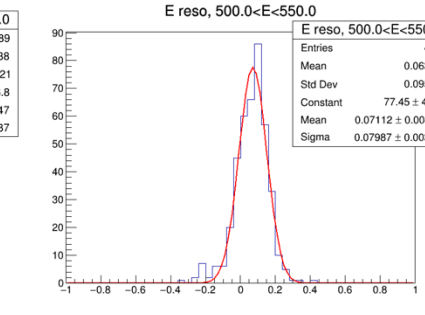


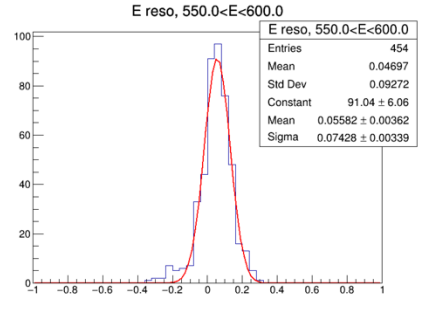


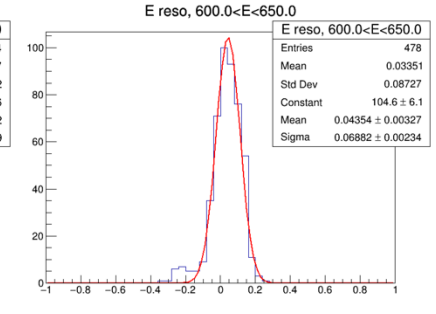


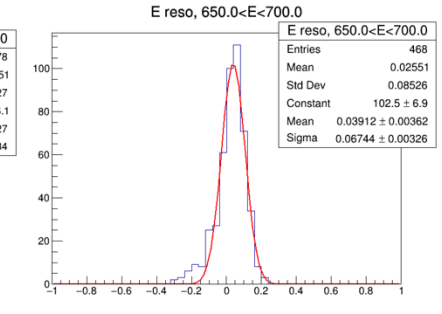


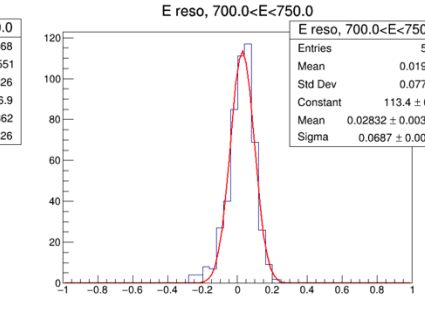


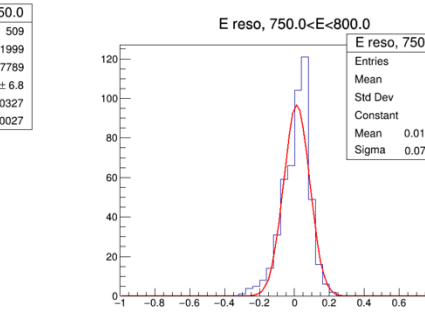












Backup: Individual Gaussians (BIB, response-calibrated, truth-assisted)