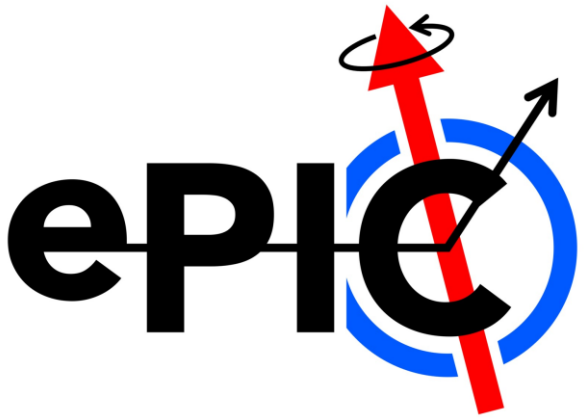


ePIC BHCal
Simulation Status

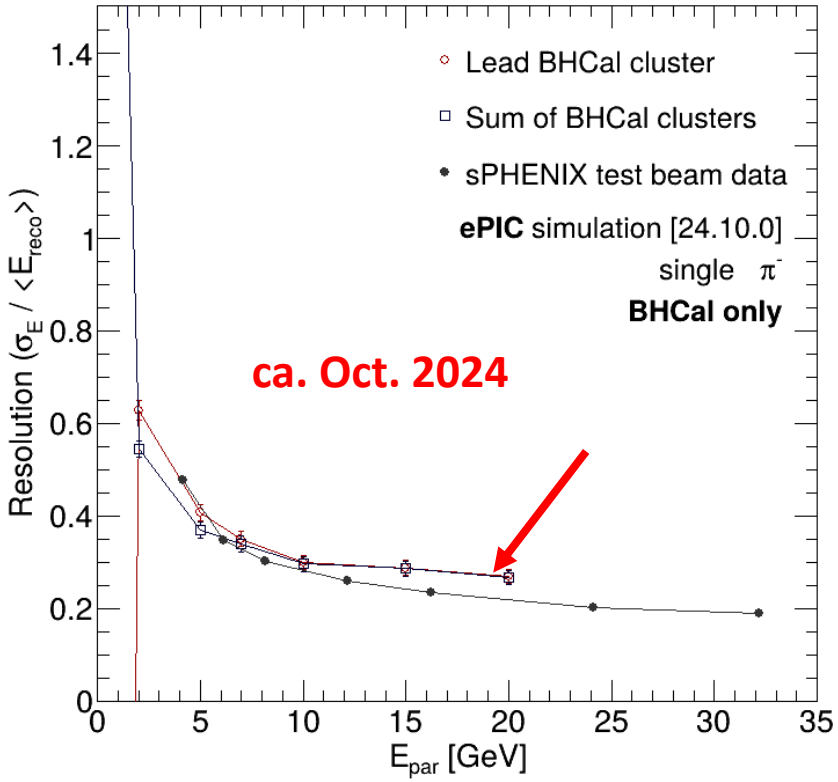
Derek Anderson

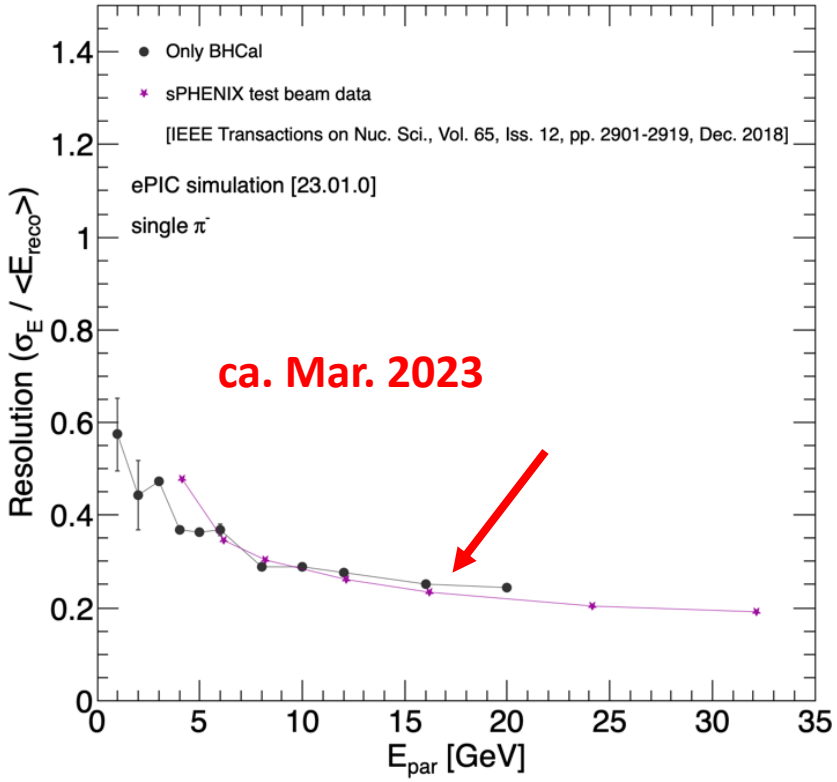
05.30.2025

Reminder | Regression in Energy Resolution

Ongoing mystery: a seeming regression in energy resolution

- **Where did it come from?** My first thoughts:
  - ☒ Post-GDML hole? **[NO]**
  - Clustering inefficiencies?
    - Cluster splitting?
    - Need to merge tiles?
  - Difference in cuts?
  - Fitting issues?

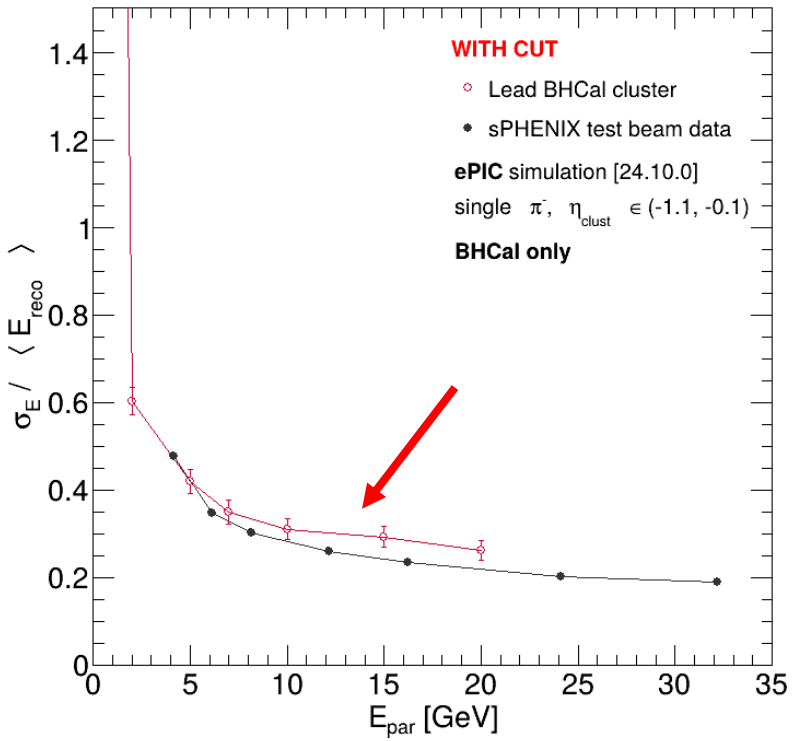


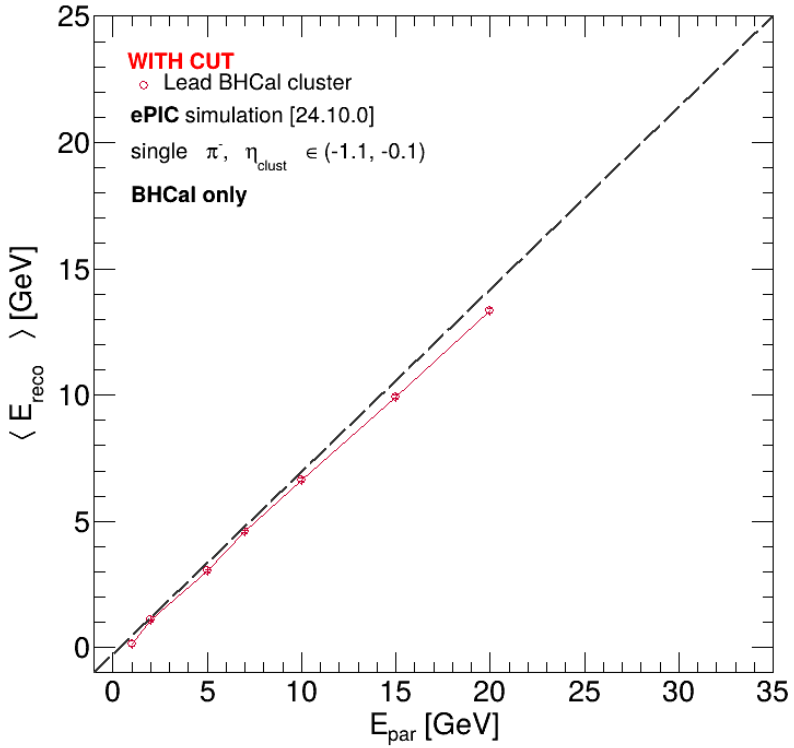


Post-GDML Hole | Energy Resolution With Hole

- From 05.23.2025 slides
  - Energy resolution **(left)** and linearity **(right)** with eta < -0.1 (so no hole).

☞ **Regression seemingly NOT due to hole**

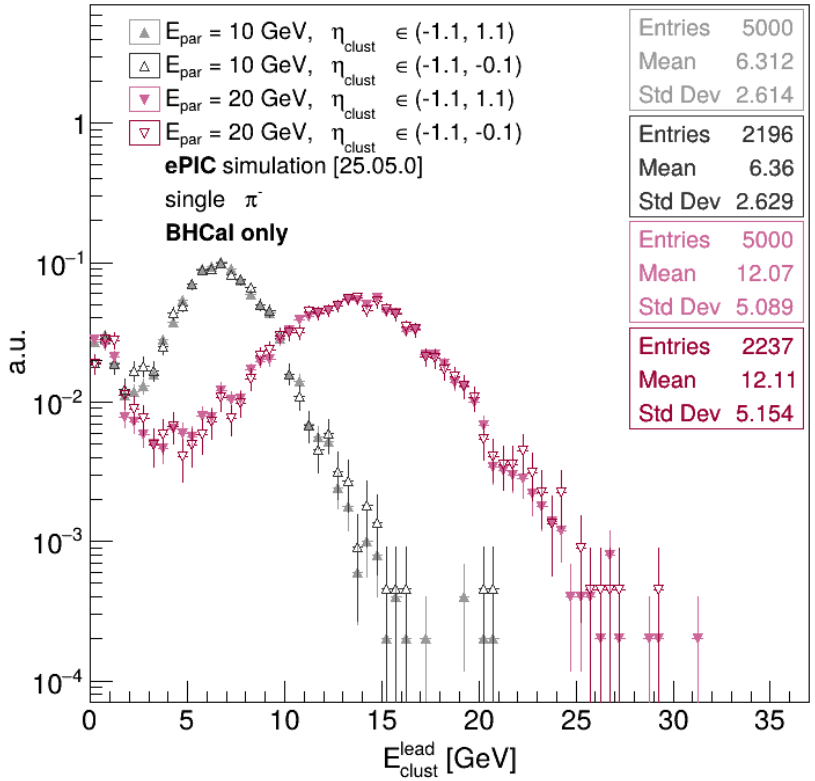


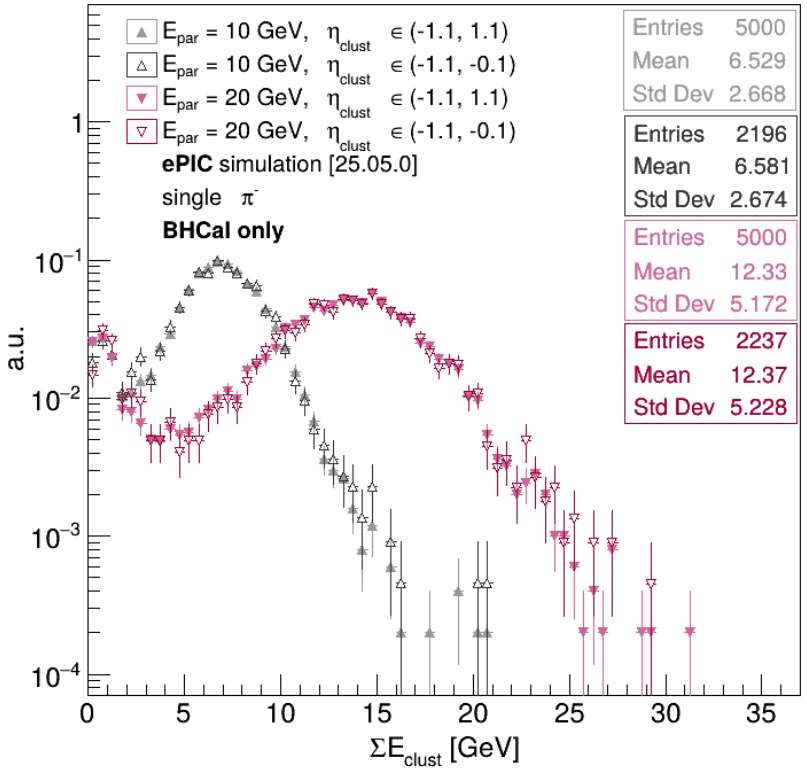


Post-GDML Hole | Hole vs. Cluster Energy Spectra

- **Does hole have impact on clustered energy?**
  - **Left:** lead cluster energy
  - **Right:** sum of cluster energies
  - Closed markers are **with no eta cut**
  - Open markers are with **eta < -0.1** (no hole)

☞ **Hole does NOT seem to have impact on energy**

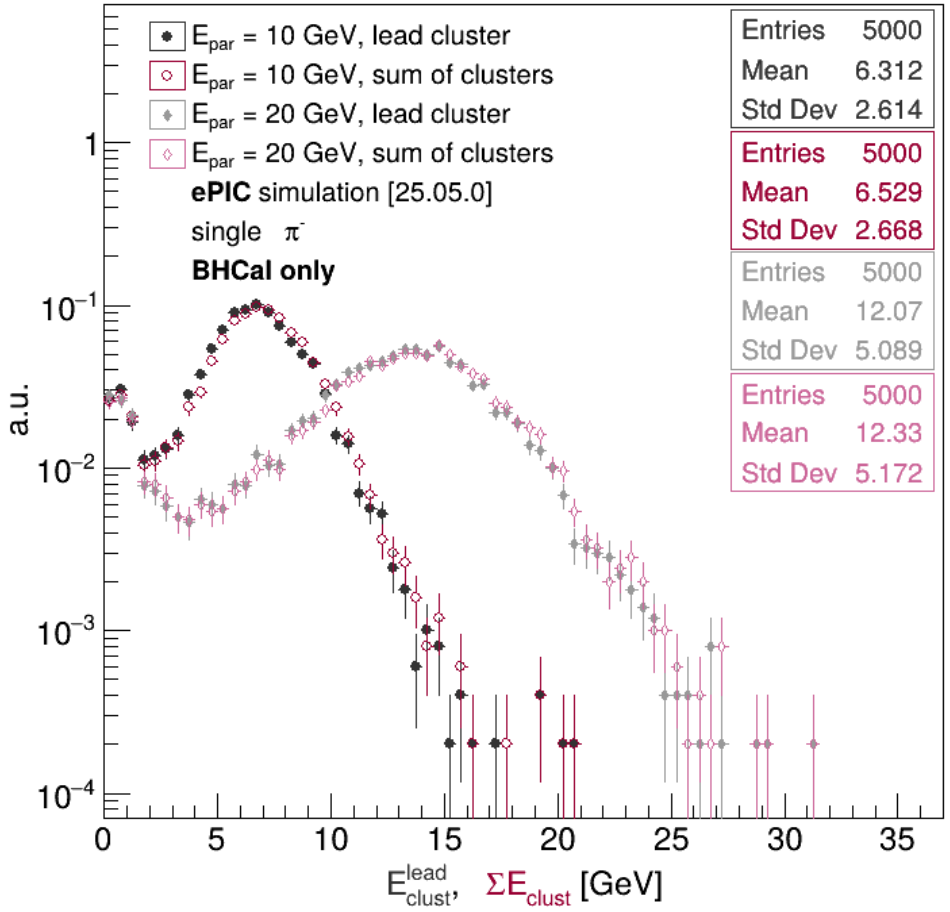




Clustering Inefficiency | Lead vs. Sum of Clusters

- **Are we severely impacted by cluster splitting?**
  - If so, would expect **significant difference between lead cluster & sum of cluster energies**
  - **Right:** lead cluster (solid markers) vs. sum of cluster energies (open markers)
  - All cases are **with no eta cut**

☞ **Cluster splitting does NOT seem to be an issue**

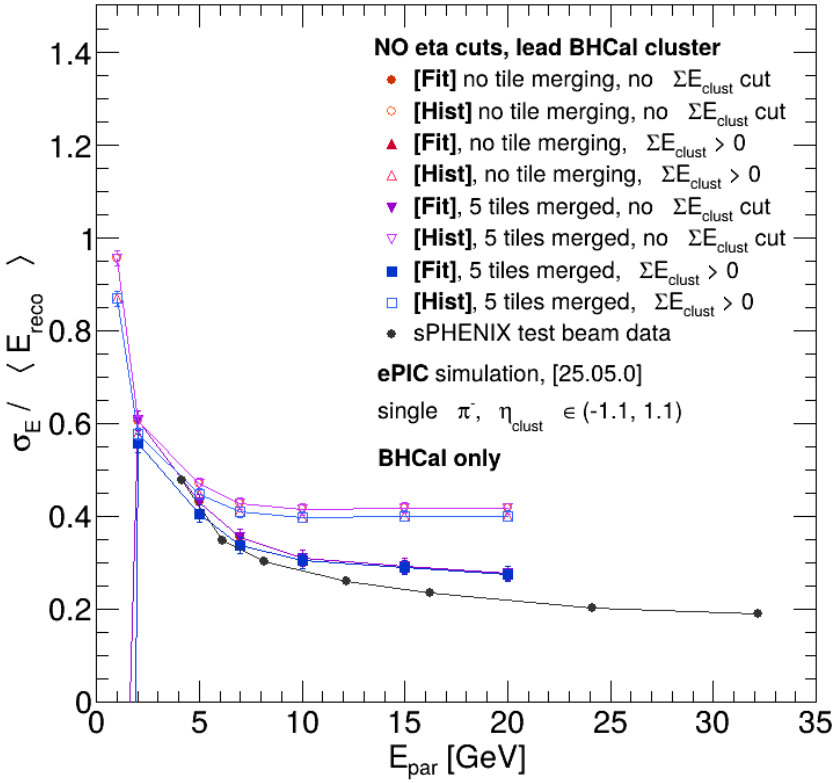


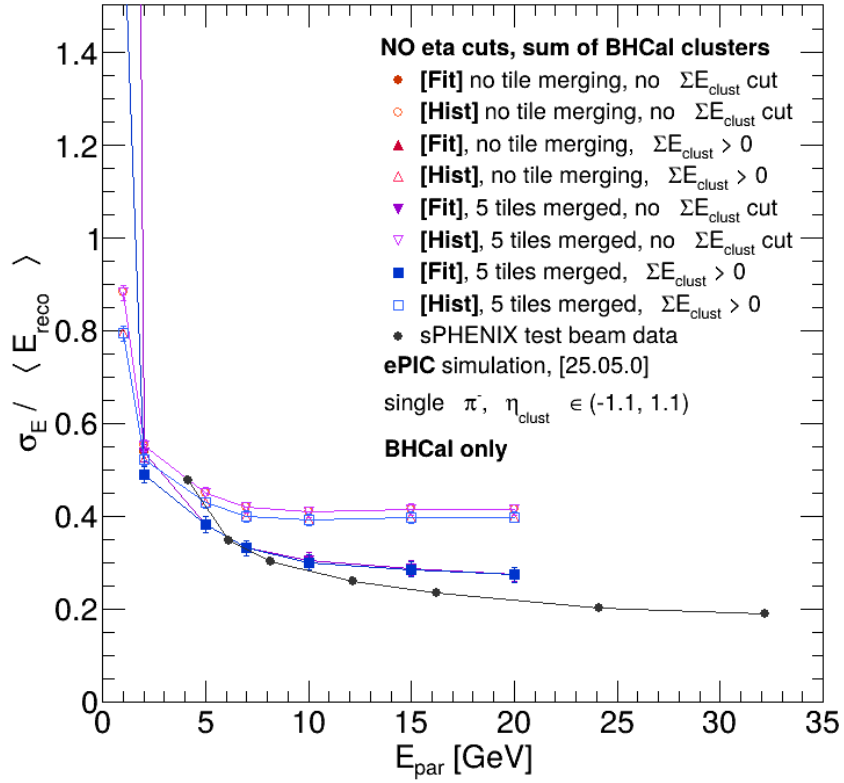
Clustering Inefficiency | Do We Need to Merge Tiles?

- **Do we need to merge tiles?** Is our clustering algorithm not picking up energy?
  - **Left:** resolution for lead cluster energy w/ vs. w/o tile merging
  - **Right:** same but for the sum of clusters

☞ **Merging tiles does NOT fix regression AND does NOT improve resolution!**

☞ **Resolution NOT affected by clustering splitting**



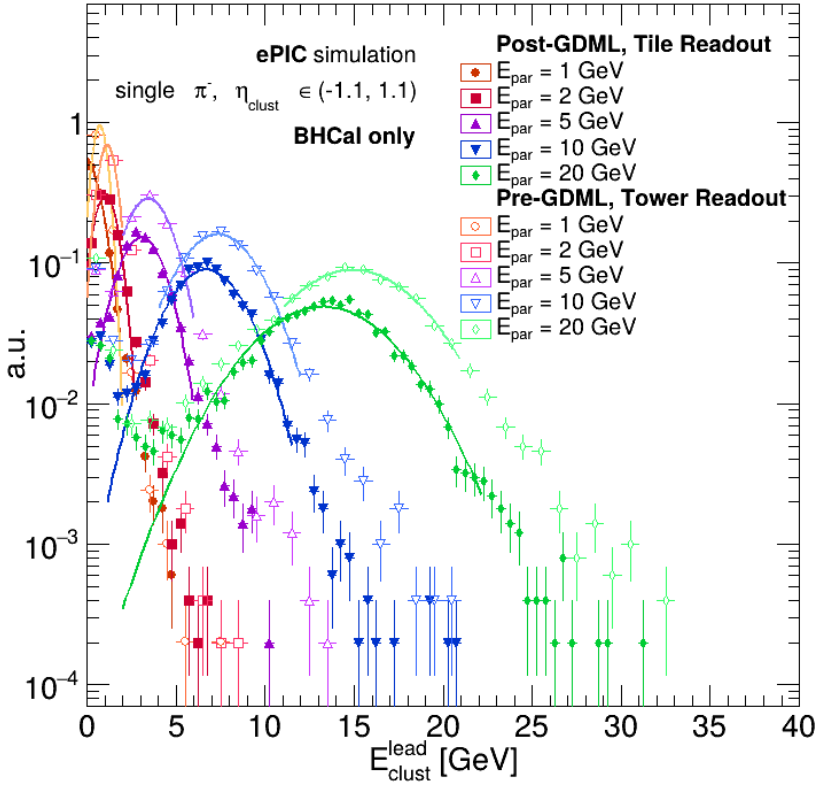


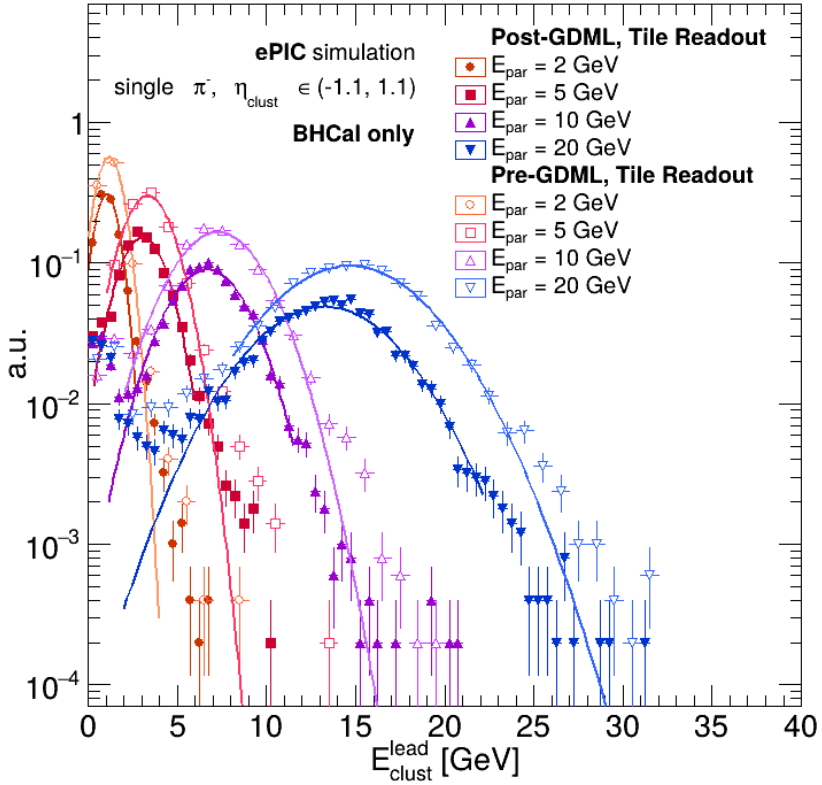
- Also checks impact of requiring nonzero in energy in BHCal vs. not on resolution
  - Did former in earlier studies to improve TMVA training

☞ **This cut does NOT affect energy resolution**

Fitting Issues | Old vs. New Resolutions

- **Could regression be due to a difference in fitting?**
  - Used different fit ranges for tower vs. tile resolution studies!
  - **Left:** comparing lead cluster energies for post-GDML tiles (solid markers) vs. pre-GDML towers (open markers)
  - **Right:** same but for pre-GDML tiles (open markers)

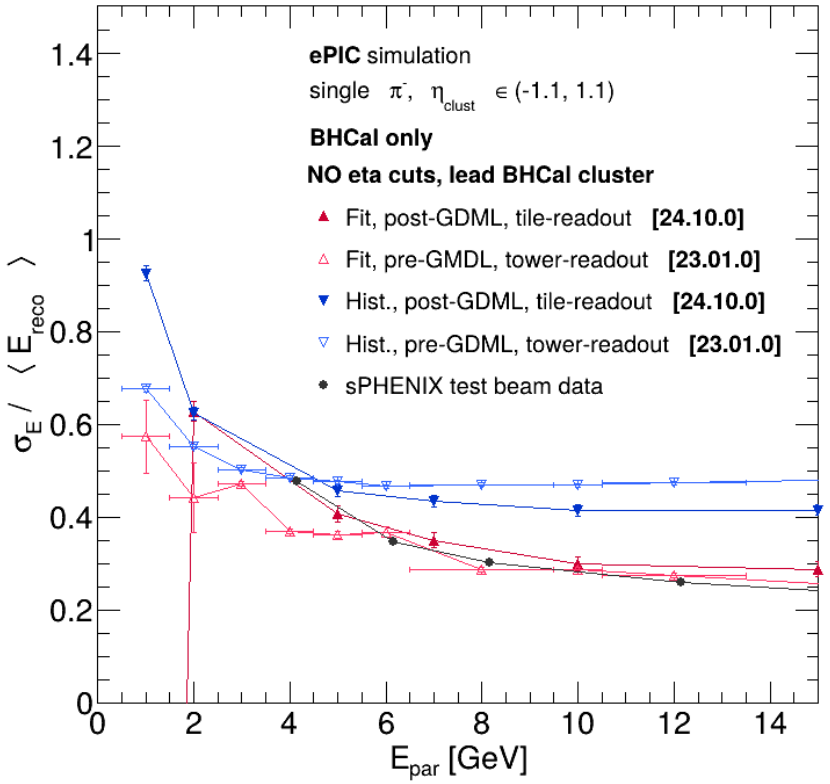


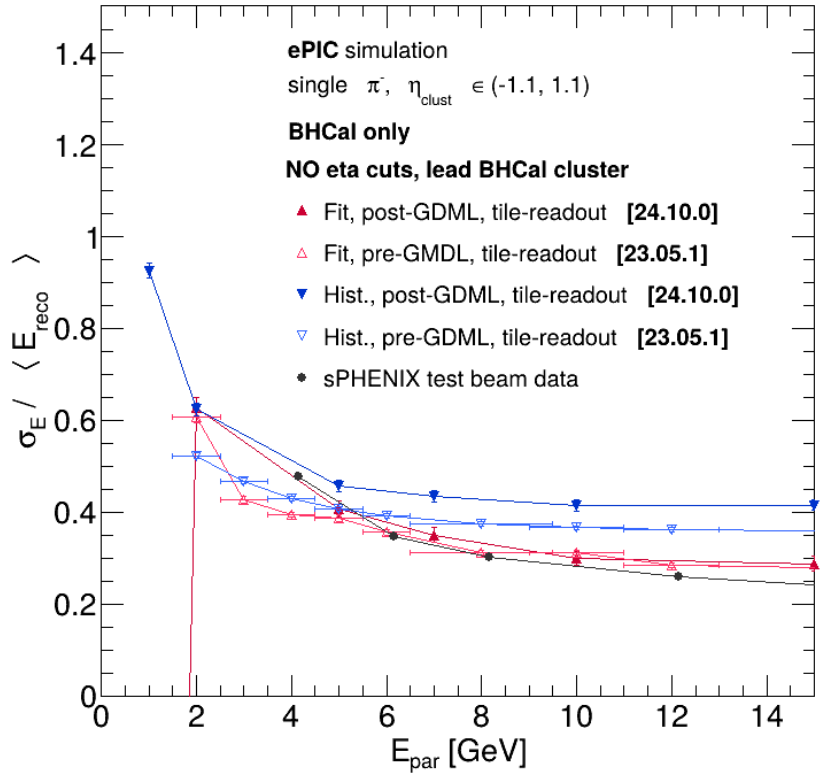


Fitting Issues | Old vs. New Resolutions

- **Could regression be due to a difference in fitting?**
  - **Left:** comparing resolution for post-GDML tiles (solid markers) vs. pre-GDML towers (open markers)
  - **Right:** same but for pre-GDML tiles (open markers)

☞ **Pre-GDML tile resolution is CONSISTENT with post-GDML tile resolution!**



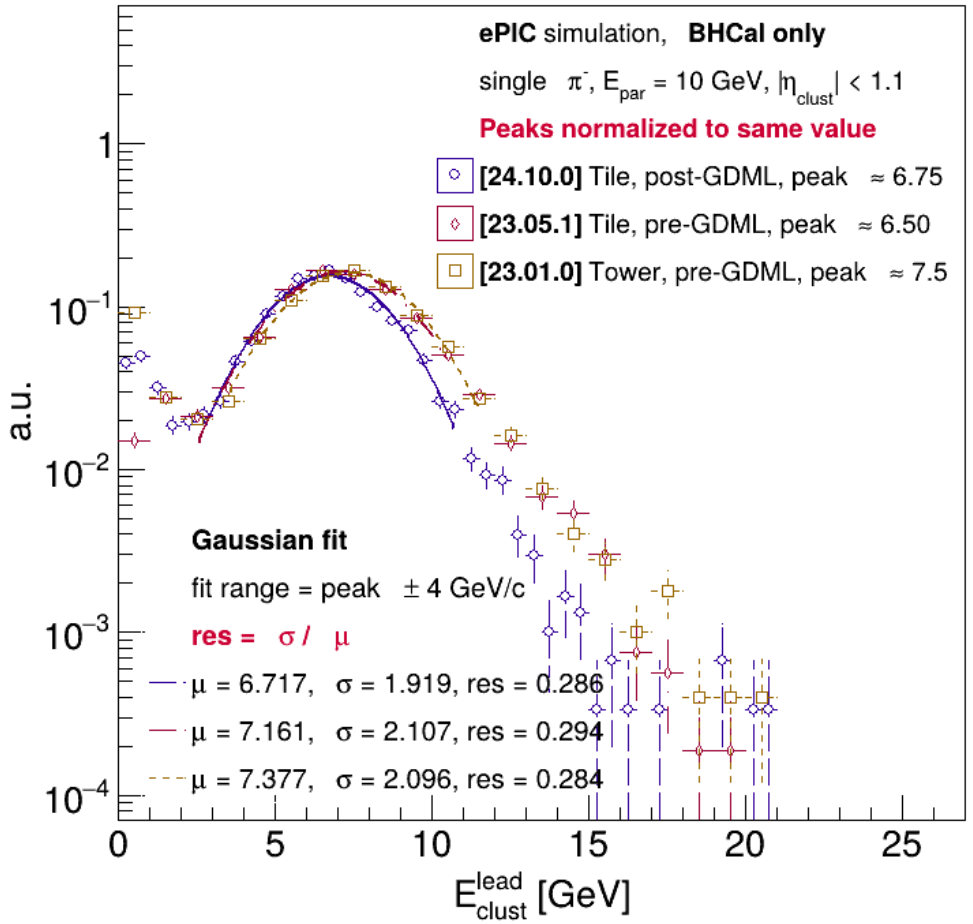


Fitting Issues | Focus on 10 & 20 GeV Particles

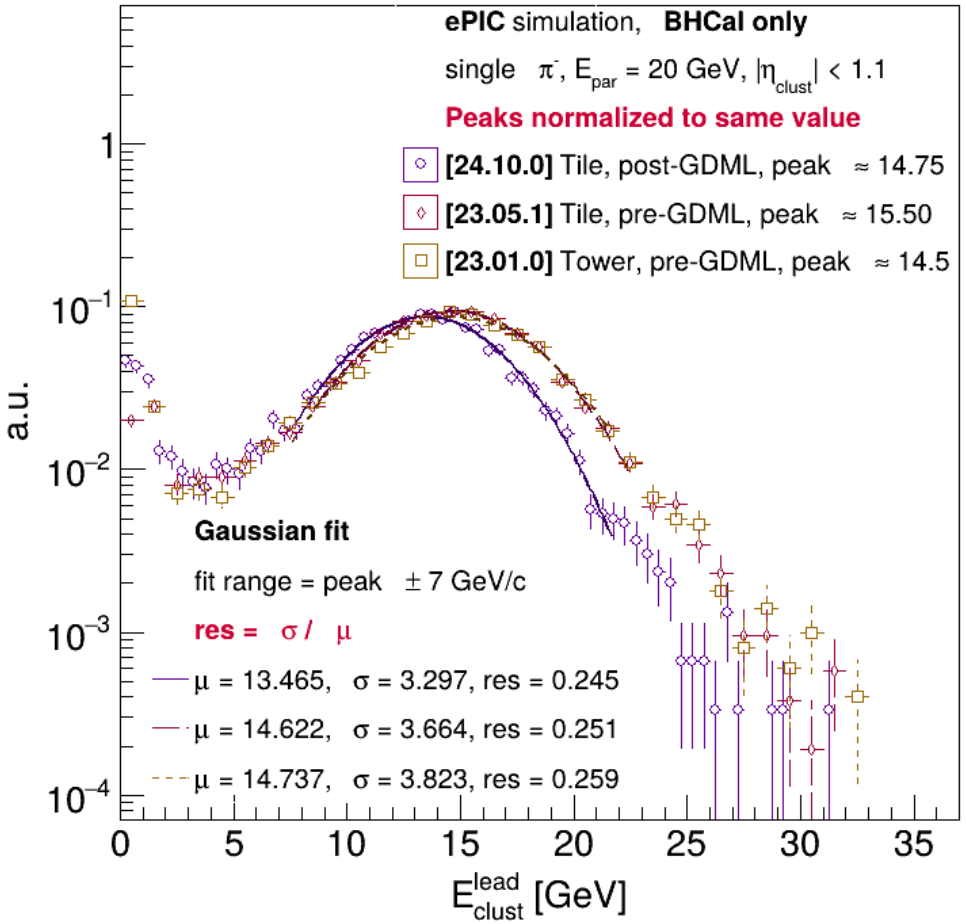
- **Redid resolution calculation for all 10 & 20 GeV pi- in all 3 cases…**
  - This time was consistent in fitting procedure…

☞ **Resolutions are ALL CONSISTENT with each other!**

TB Reso @ 12 GeV: 0.261



TB Reso @ 16 GeV: 0.235



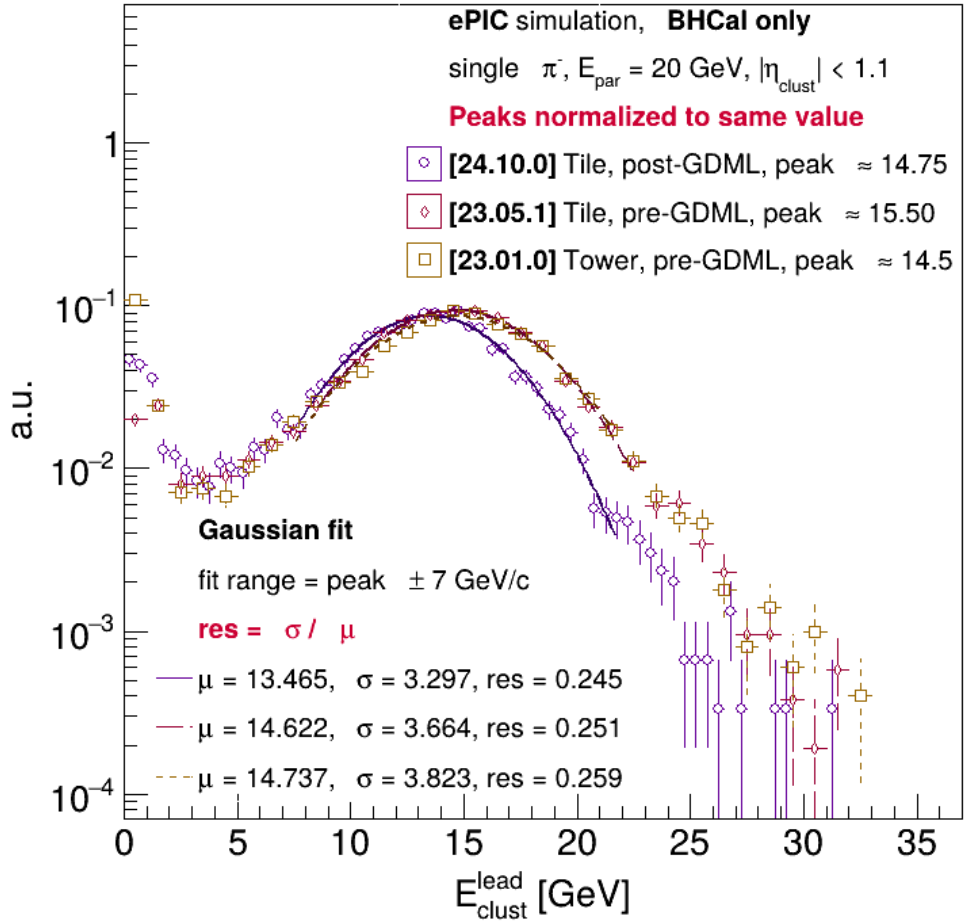
Conclusion

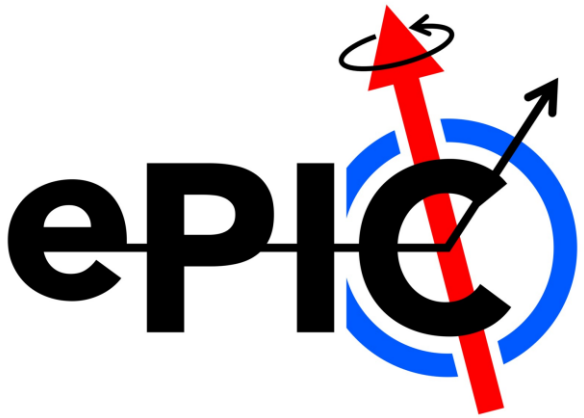
In conclusion:

- Seeming regression in resolution due to fitting issues
- Transition to GDML did NOT cause regression in resolution
- Transition to tile-readout did NOT cause

Note: mean E/p *has* dropped in GDML transition, not immediately clear to me why…

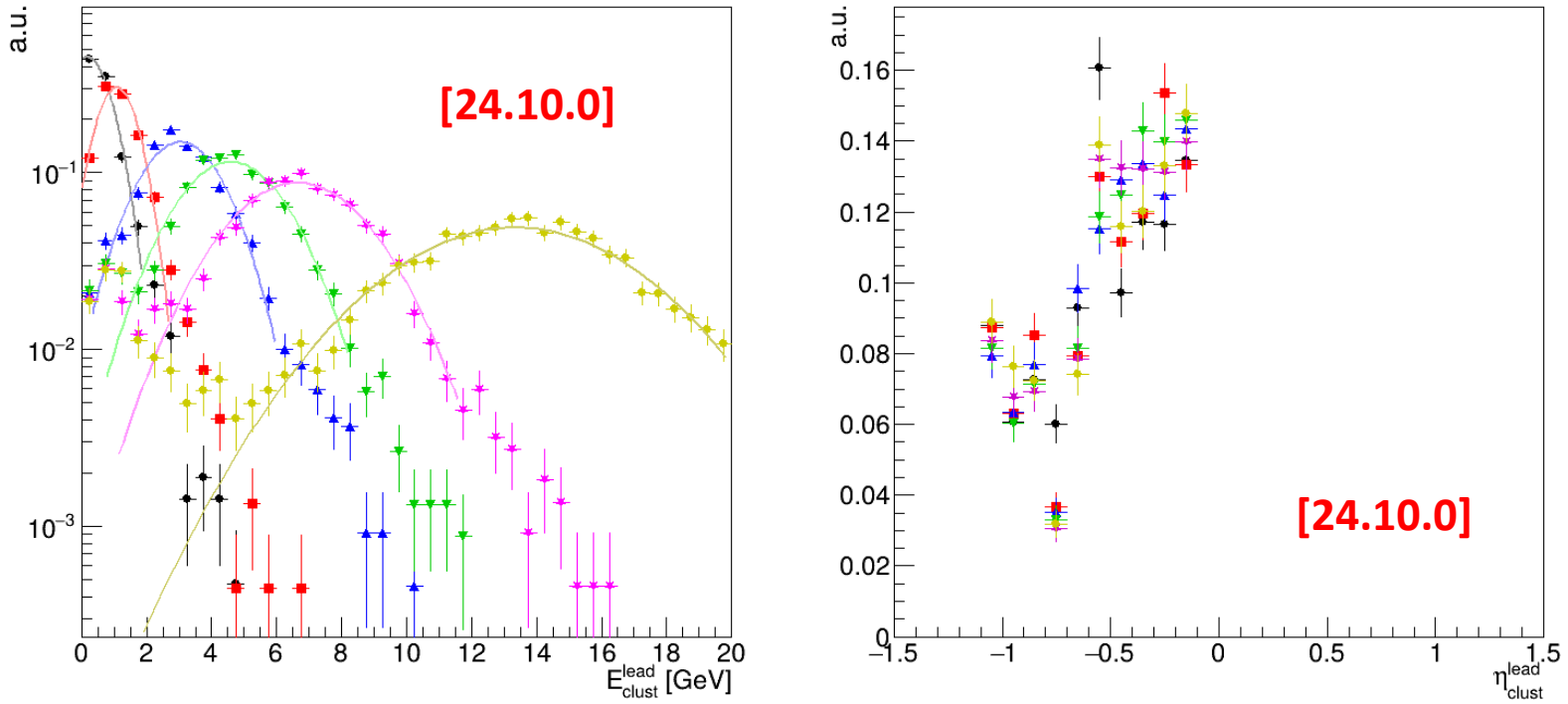
- More dead material? Change in thresholds/digitization parameters?
- But somebody else will need to investigate further…





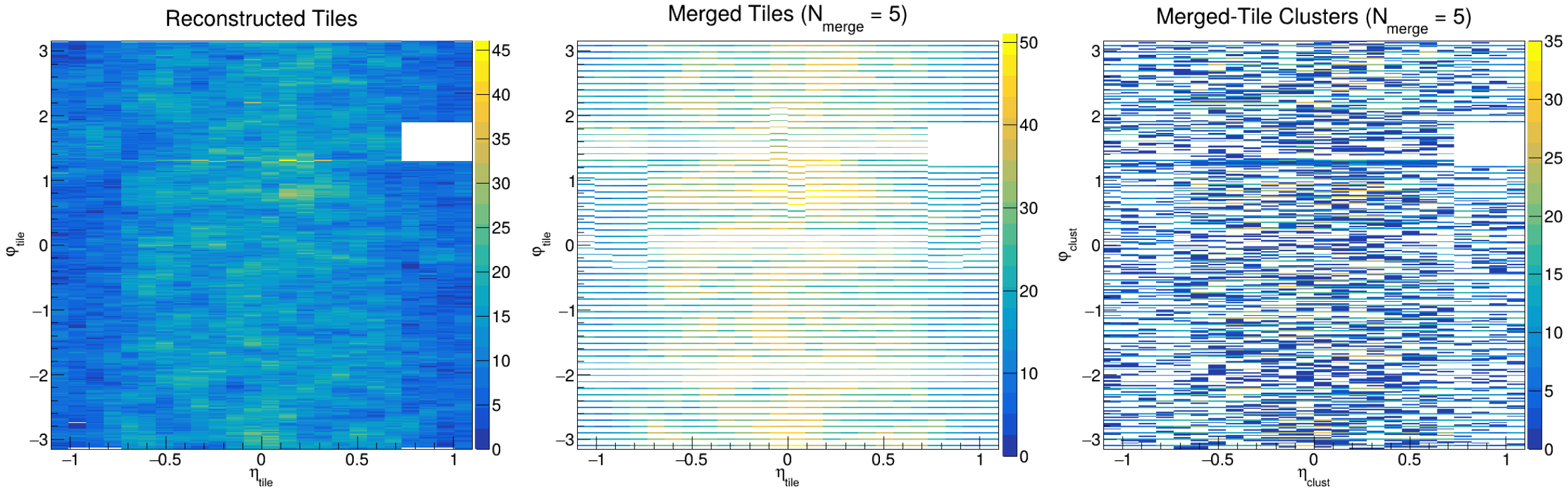
Backup

Backup | Cluster Energy & Eta Without Hole



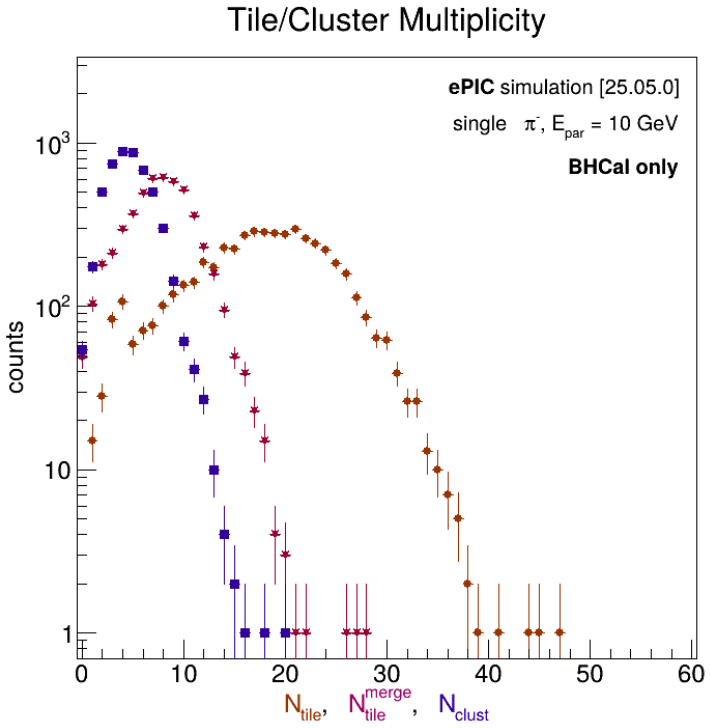
- **Above:** lead cluster energy (left) and eta (right) with eta < -0.1 (so no hole)…

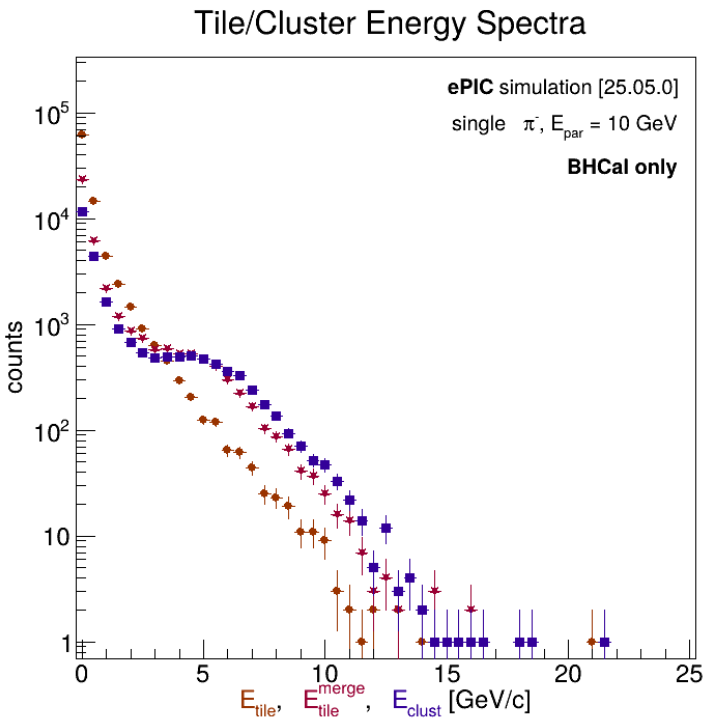
Backup | Checking Merging (1/2)



- Checking eta/phi of tiles, clusters before/after merging tiles

Backup | Checking Merging (2/2)

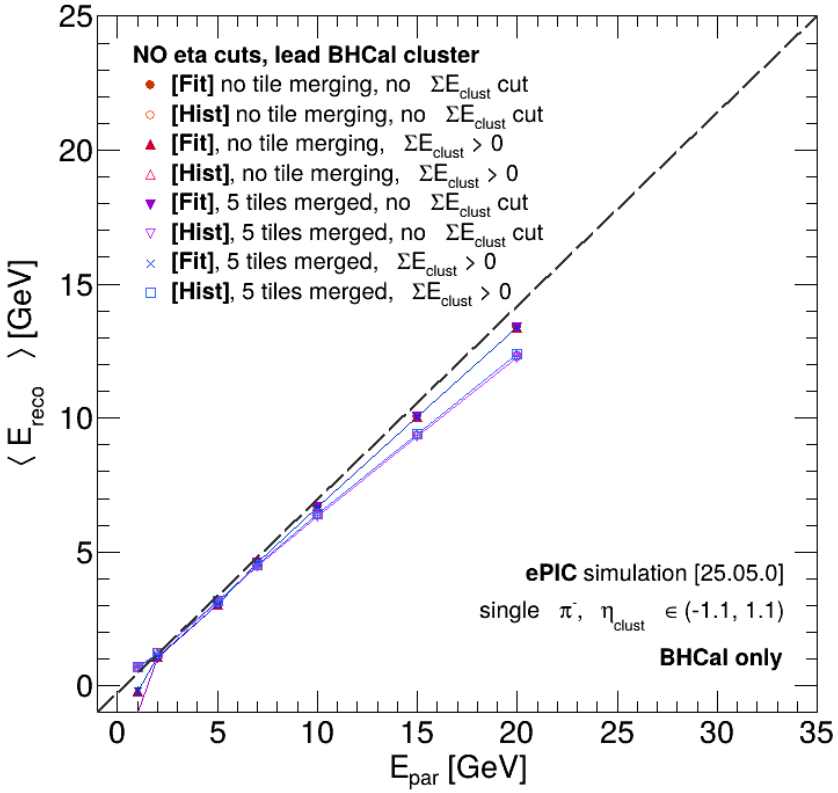


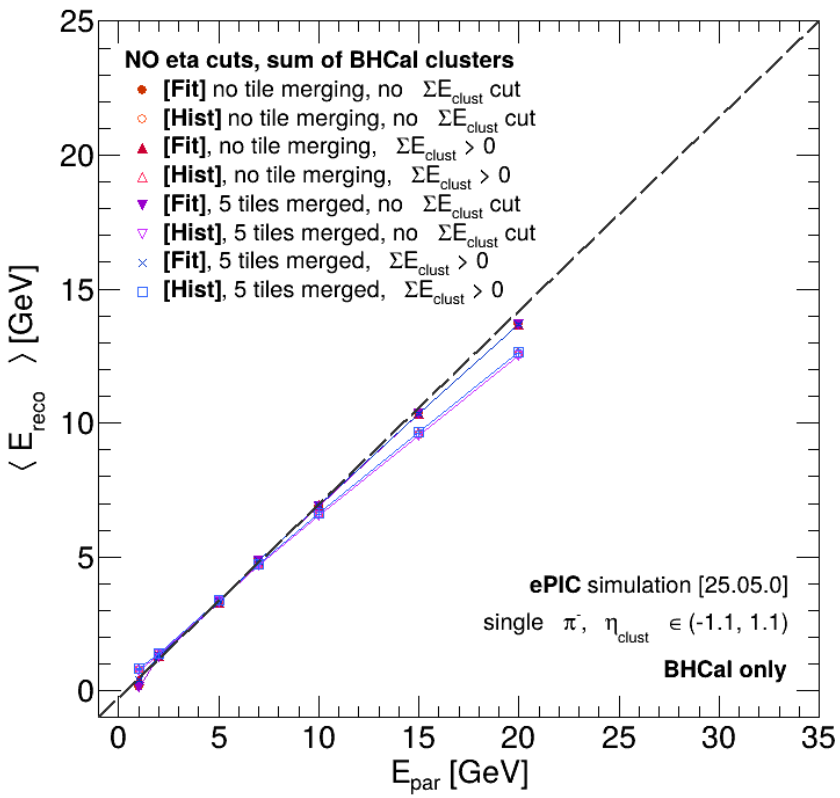


- Checking multiplicity/energy of tiles, clusters before/after merging tiles

Backup | Linearity for Various Cases

- **Left:** linearity for
  - Merging vs. not-merging tiles
  - Requiring nonzero energy in BHCal vs. not
  - Using lead (left) vs. sum of clusters (right)





Backup | Using Histogram Width vs. Fit

- **Left:** resolution as calculated using the lead cluster
  - W/ the fit to the main peak of the spectrum (red)
  - Vs. w/ the width of the entire histogram (blue)
  - This is **with no eta cut**