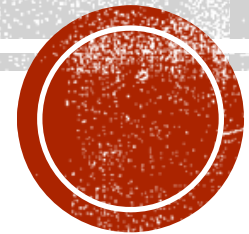


bHCAL Meeting — Neutron Calibration Update

Jan Vanek

University of New Hampshire

08/21/2026



OVERVIEW

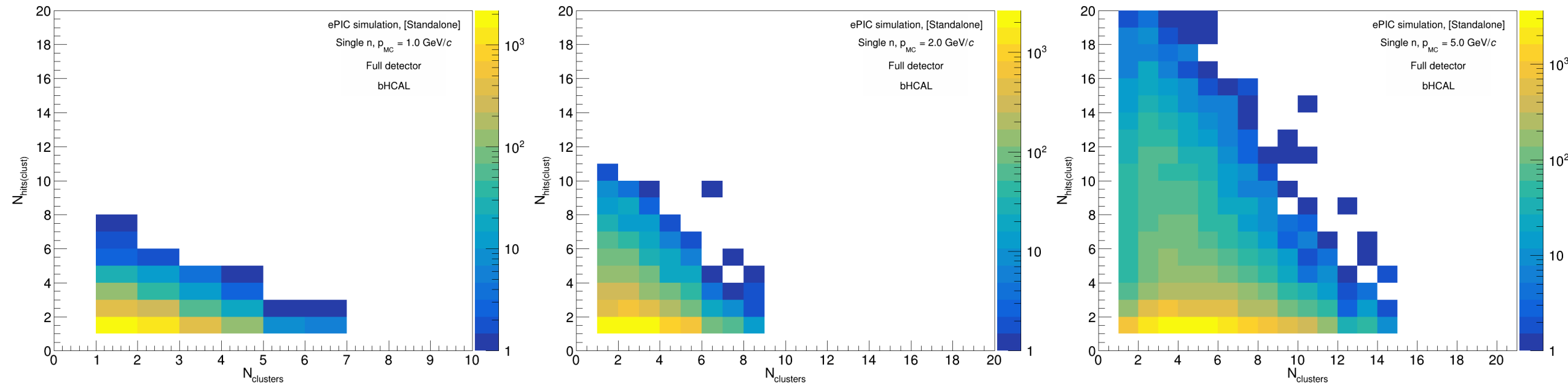
- More detailed QA of clusters and hits in bHCAL
 - Cluster sizes
 - Energy deposition in leading clusters

SIMULATION SETUP

- Standalone simulation with default setup
 - Latest detector geometry, EICRecon, etc. inside the EIC shell container
 - Motivation: Central simulations do not contain raw bHCAL hits needed for part of this study
- Single neutrons
 - Energies: 1 GeV, 2 GeV, 5 GeV
 - Uniform in ϕ
 - $\cos \theta$ distribution in range $33.5 < \theta < 146$ deg

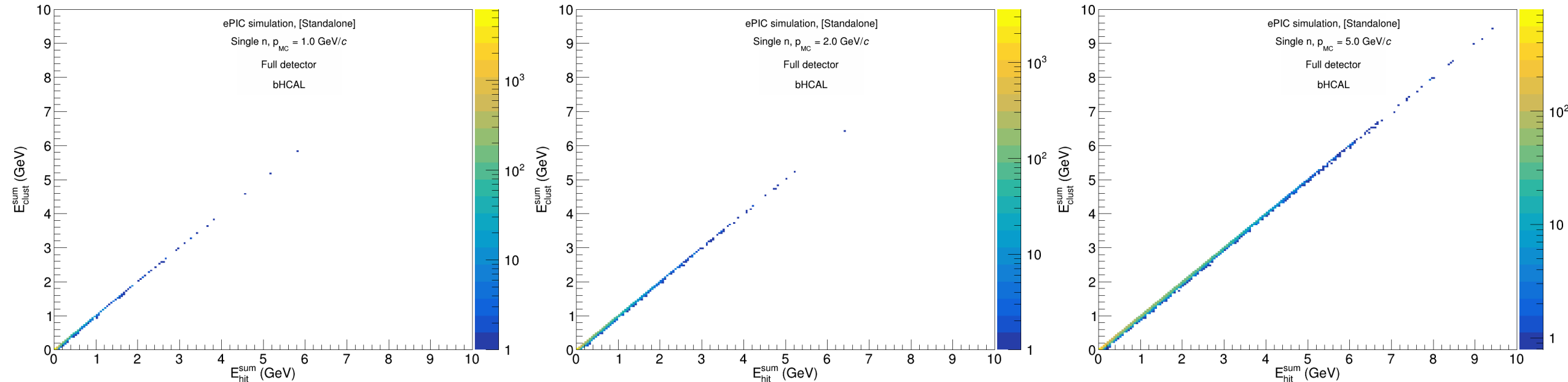
NUMBER OF CLUSTERS VS. HITS IN bHCAL

- Number of hits per cluster for different number of clusters single neutrons
 - **Horizontal axis:** Number of clusters, **Vertical axis:** Number of hits (tiles) per cluster
- All single neutron events **dominated by single tile clusters**
- **Showing only hit statistics**
 - Does not consider energy deposition



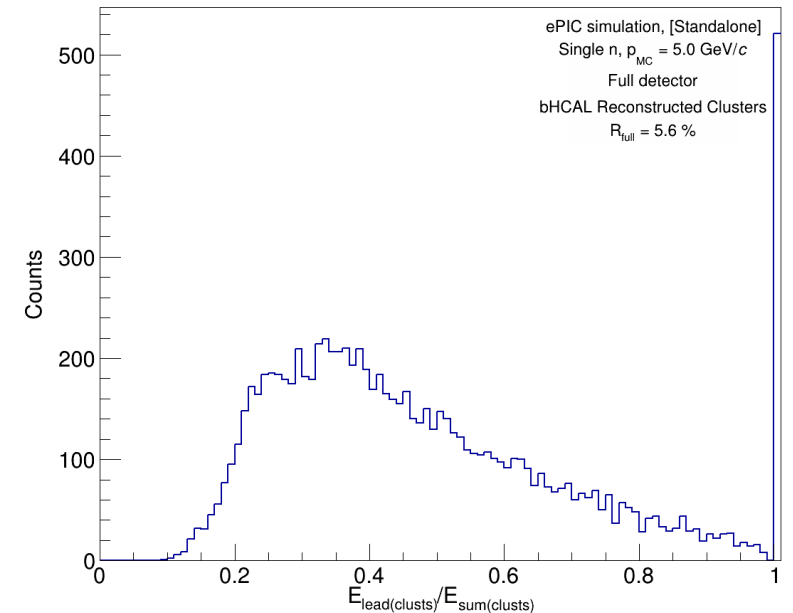
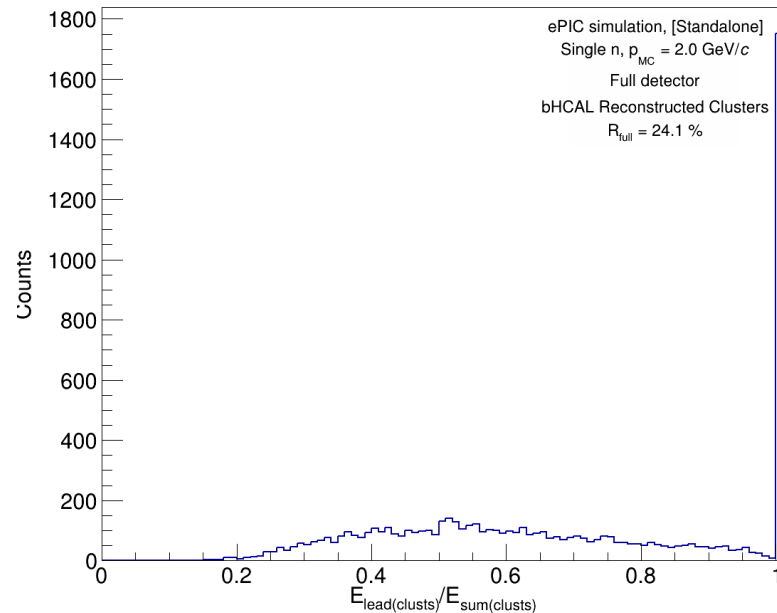
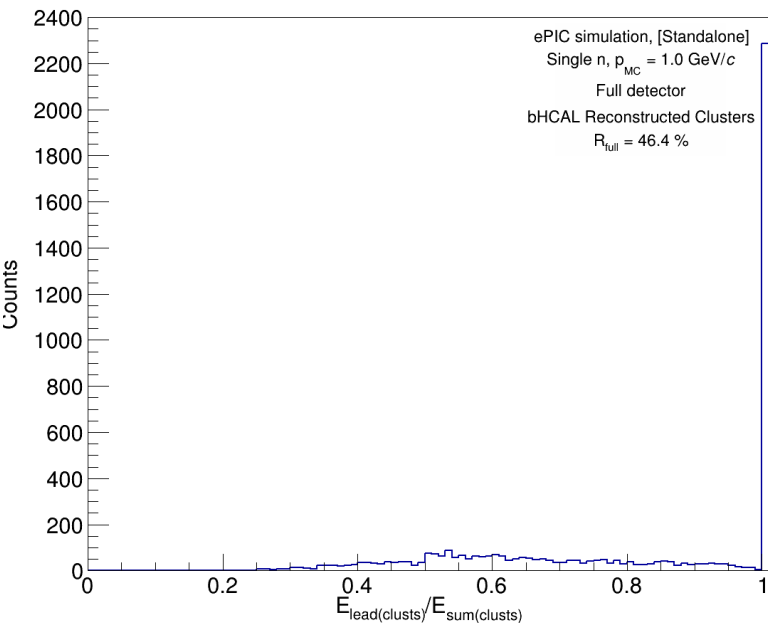
ENERGY DEPOSITION FROM HITS VS. CLUSTERS

- Deposited energy in bHCAL from hits and all clusters for single neutrons
 - Horizontal axis:** Sum of all hits (tiles), **Vertical axis:** Sum of all clusters
- All clusters contain almost full energy deposited by neutrons**
 - Energy split between several clusters
 - How is energy distributed between the clusters?
 - Following slides: Energy from leading cluster vs. all clusters



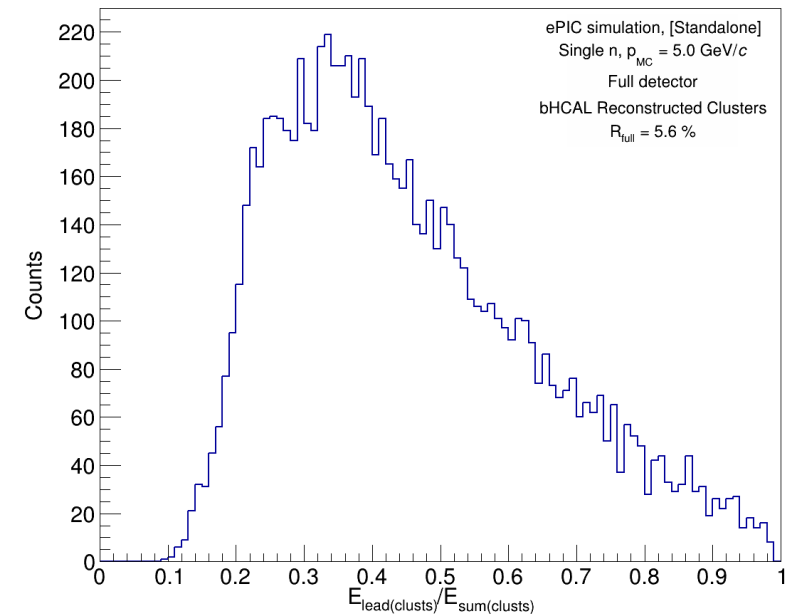
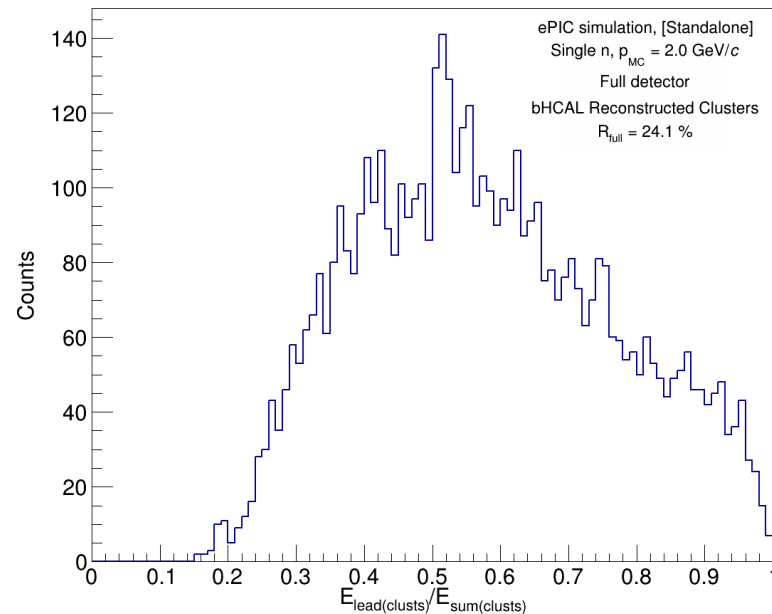
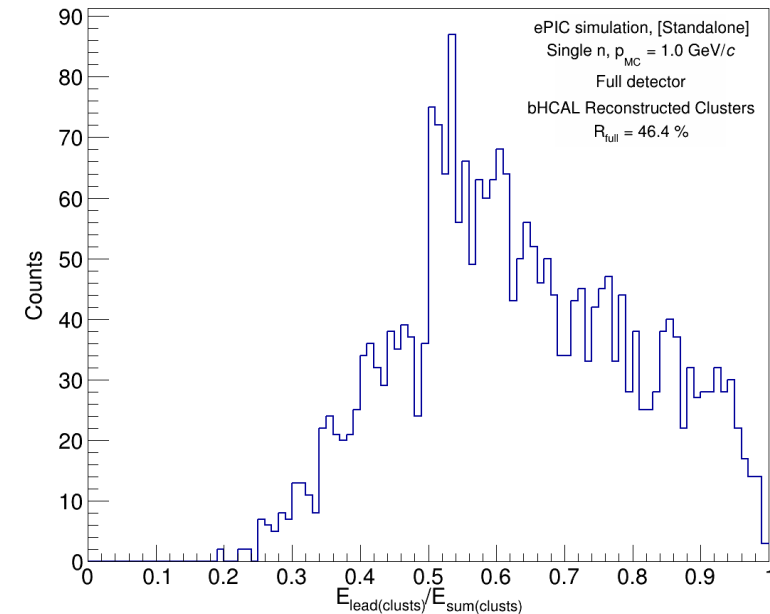
ENERGY DEPOSITION FROM HITS VS. CLUSTERS

- Comparison of energy in leading cluster vs. sum of all clusters
 - $E_{\text{lead}(\text{clust})}/E_{\text{sum}(\text{clust})}$
- **Relatively small number of events have all (most) energy contained in the leading cluster**



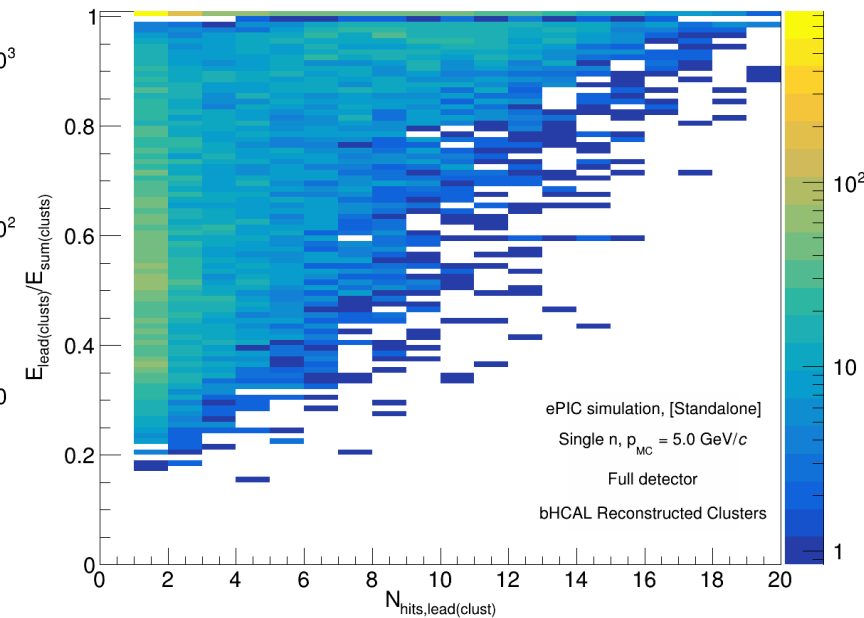
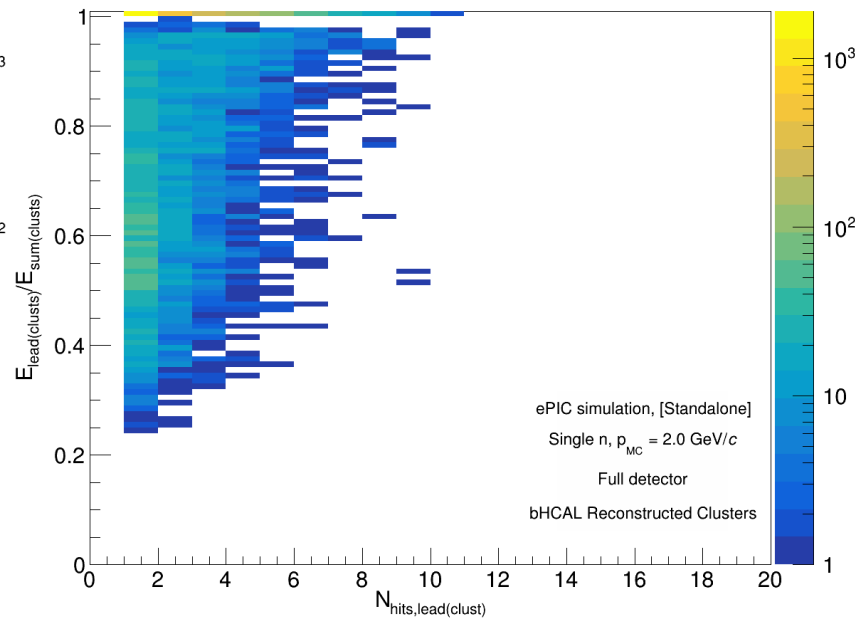
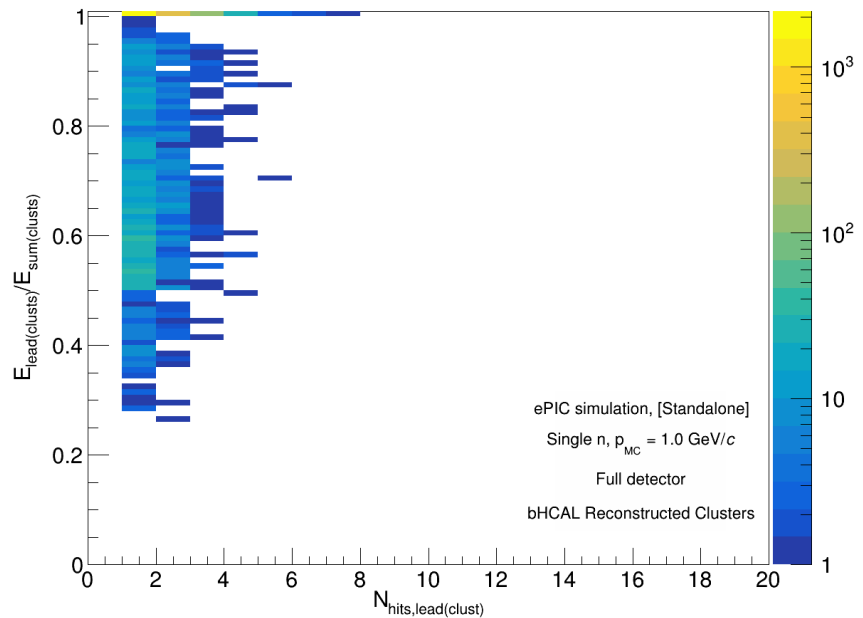
ENERGY DEPOSITION FROM HITS VS. CLUSTERS

- Comparison of energy in leading cluster vs. sum of all clusters
 - $E_{\text{lead}(\text{clust})}/E_{\text{sum}(\text{clust})}$
- **Relatively small number of events have all (most) energy contained in the leading cluster**
 - Wide distribution of relative energy deposition in leading cluster
 - Average is around/below 50%



SIZE OF LEADING CLUSTERS

- Relative energy deposition for different leading cluster sizes
 - Horizontal axis:** Number of hits (tiles) in leading cluster, **Vertical axis:** $E_{\text{lead}(\text{clust})}/E_{\text{sum}(\text{clust})}$
- Longer tail for small leading clusters**



STATUS OF CLUSTERING IN bHCAL

- Reconstructed clusters in bHCAL:
 - Discussed with Derek
 - Island Clustering based on method used by CMS
 - Adjacency matrix and thresholds updated to tile-based readout in 2023
 - **Some parameters** based on sPHENIX
 - **Clustering is tile based, but requires optimization for ePIC specific setup**
- **Outlook:**
 - Use truth cluster information to determine hit patterns in bHCAL for different particles
 - Adjust reconstructed clustering parameters with help of truth information
 - Aim is to recover as much of true cluster in reco., without any explicit true MC info
 - Initial development with single particle simulations
 - Future adjustments in physics simulations with more challenges:
 - Overlapping clusters from close particles
 - Background

SUMMARY AND OUTLOOK

- Most reconstructed clusters in bHCAL contain only one tile
- Sum of energy of all reconstructed clusters contains (almost) all energy deposited in bHCAL
- Leading bHCAL clusters contain only fraction of the total deposited energy for large fraction of events
 - Wide distribution with mean around/below 50%, primarily from events with small leading cluster
- **Outlook:**
 - Optimize of clustering in bHCAL
 - Compare reconstructed and truth clusters
 - Evaluate energy dependent sampling fraction for neutrons
 - Make absorber sensitive in simulation and evaluate fraction of energy seen by tiles

THANK YOU FOR ATTENTION