ePIC HCal Update

ePIC Calorimetry Meeting

February 1st, 2022

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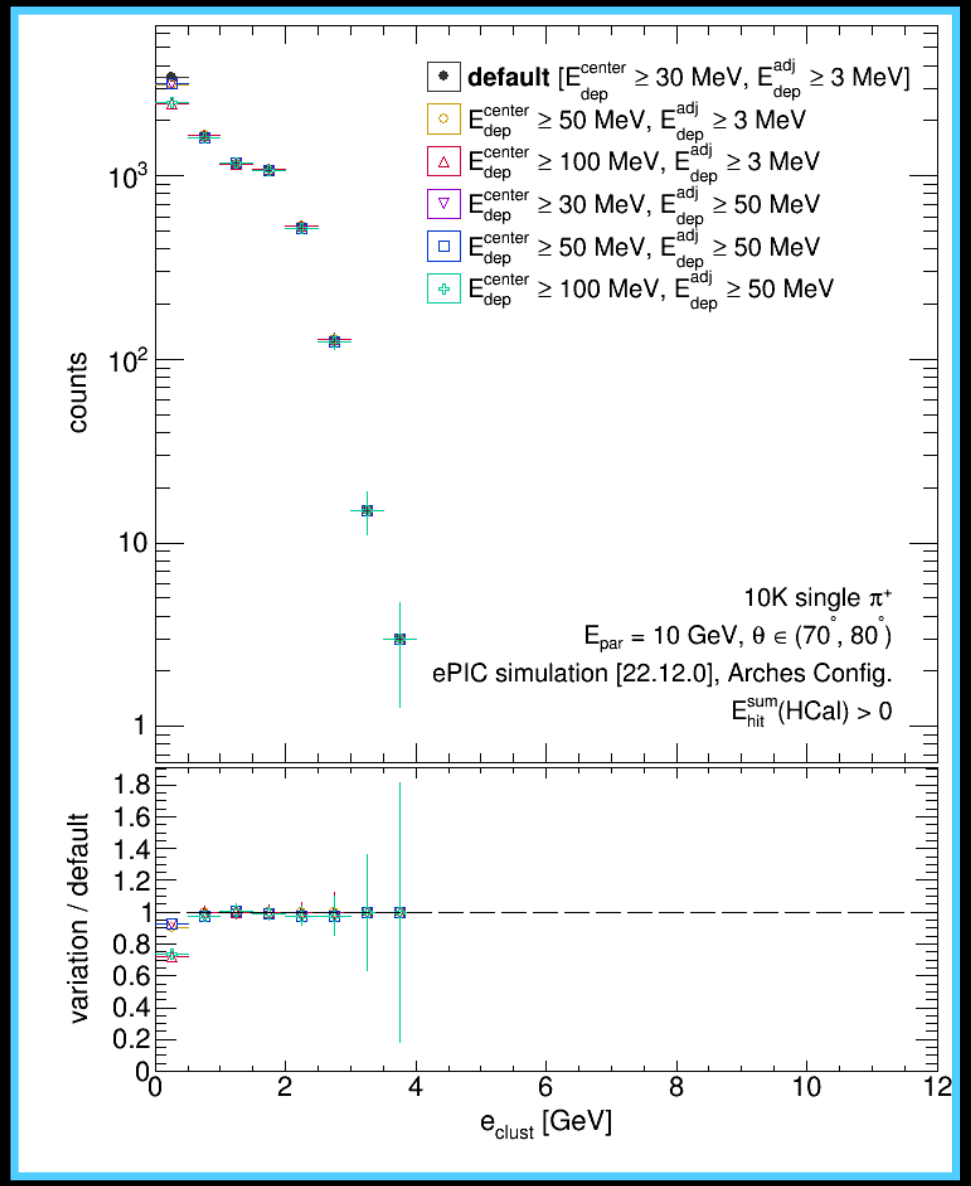
Varying Energy Parameters | cluster energy

- Checking clustering in HCAL:
  - Varied energy thresholds:
    a) **minClusterHitEdep**
    b) **minClusterCenterEdep**
- Variations:
  - minClusterHitEdep
    - 3 MeV*, 50 MeV
  - minClusterCenterEdep
    - 30 MeV*, 50 MeV, 100 MeV
  - ☞ (* = Default)

- **Shown:** reconstructed cluster energy
  - 10 GeV single π^+
  - Parameters in backup
  - Additional energies in backup



Varying Energy Parameters | no. of towers in cluster

- Checking clustering in HCAL:
  - Varied energy thresholds:
    a) **minClusterHitEdep**
    b) **minClusterCenterEdep**
- Variations:
  - minClusterHitEdep
    - 3 MeV*, 50 MeV
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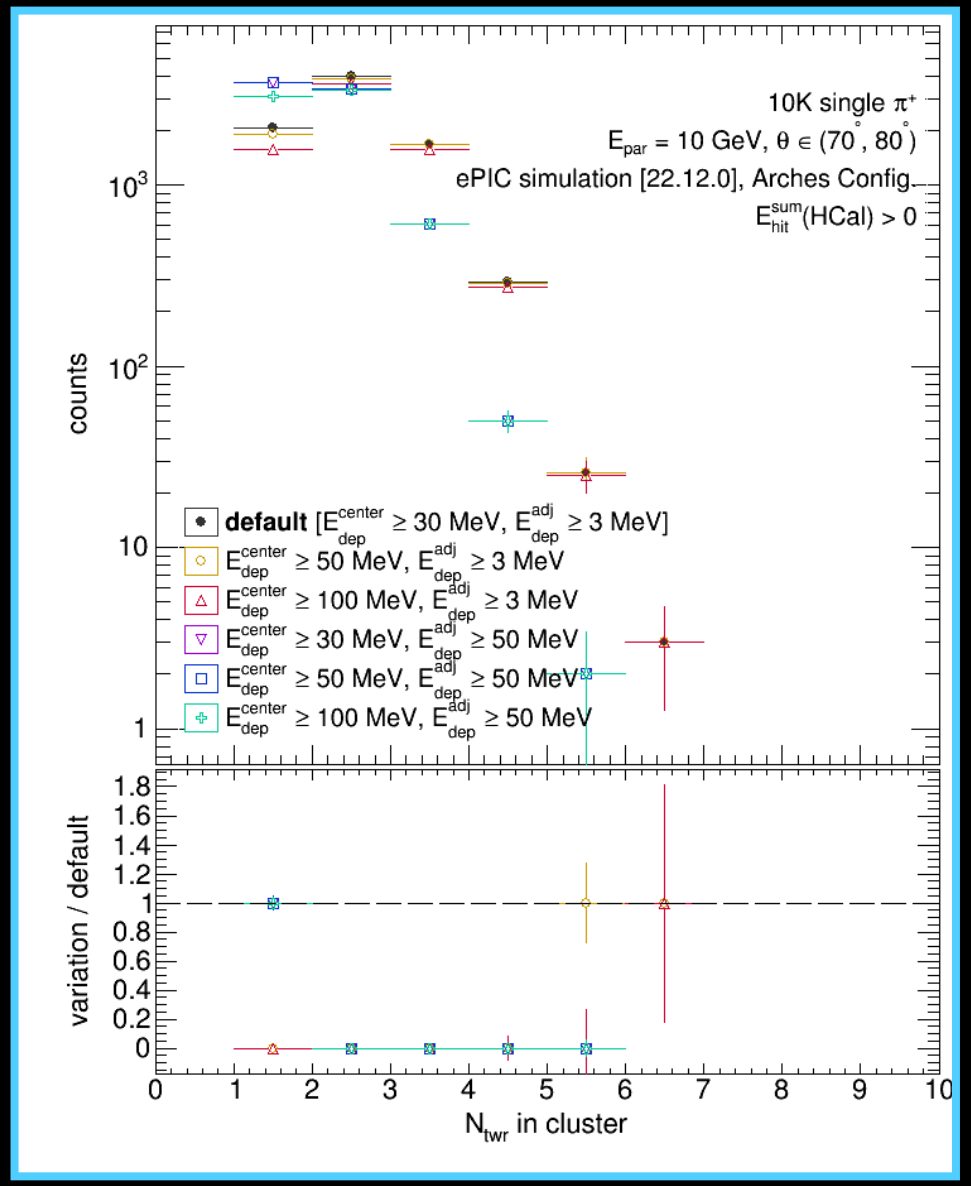
  - ☞ (* = Default)

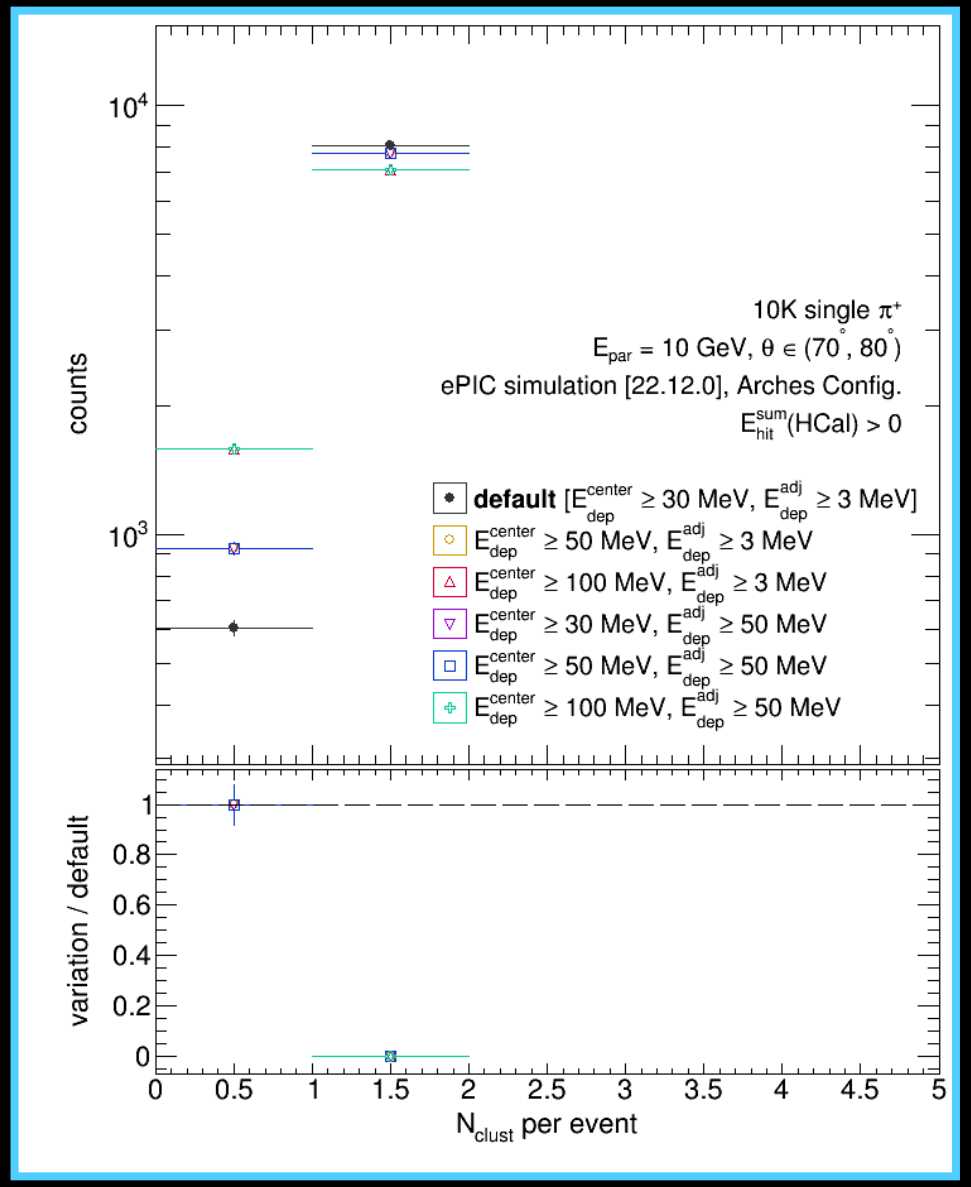
- **Shown:** no. of towers in a reconstructed cluster
  - 10 GeV single π^+
  - Parameters in backup
  - Additional energies in backup



Varying Energy Parameters | no. of clusters in event

- Checking clustering in HCAL:
  - Varied energy thresholds:
    a) **minClusterHitEdep**
    b) **minClusterCenterEdep**
- Variations:
  - minClusterHitEdep
    - 3 MeV*, 50 MeV
  - minClusterCenterEdep
    - 30 MeV*, 50 MeV, 100 MeV
  - ☞ (* = Default)

- **Shown:** no. of reconstructed clusters in an event
  - 10 GeV single π^+
  - Parameters in backup
  - Additional energies in backup

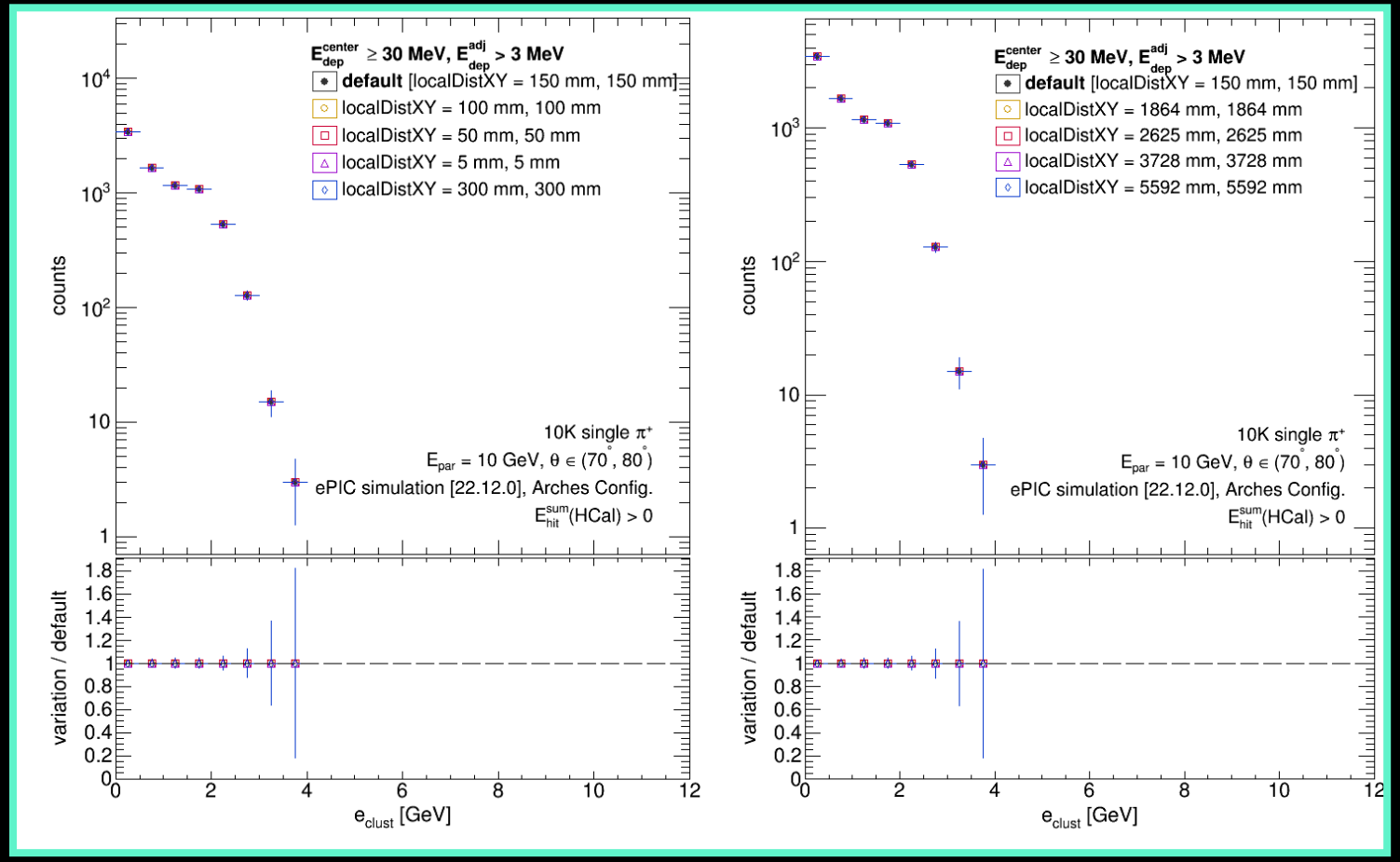


Varying Distance Parameters | cluster energy

- Checking clustering in HCAL:
  - Varied distance scales:
    a) **localDistXY**
    b) **dimScaledLocalDistXY**
    c) **sectorDist**

☞ Varying them doesn't change anything?

- **Shown:** reconstructed cluster energy
  - 10 GeV single π^+
  - Parameters in backup



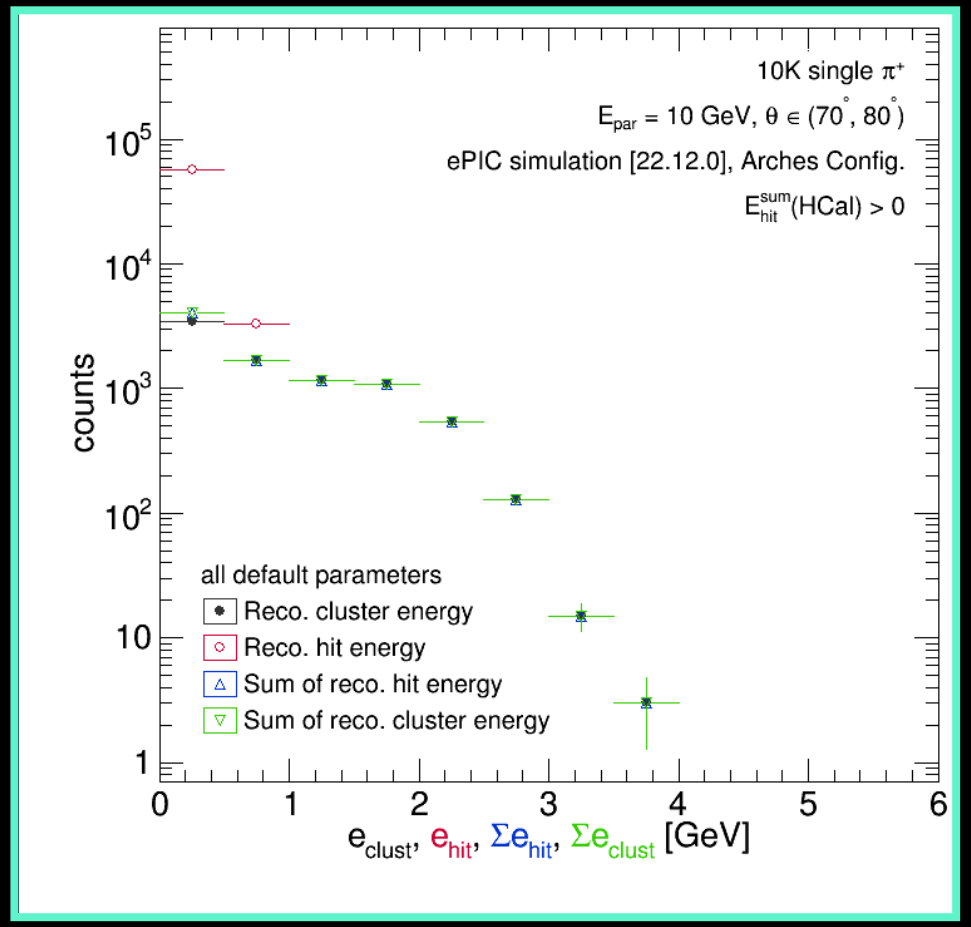
Varying Distance Parameters | cluster energy vs. hits/sums

- Checking clustering in HCAL:
  - Varied distance scales:
    a) **localDistXY**
    b) **dimScaledLocalDistXY**
    c) **sectorDist**

☞ Varying them doesn't change anything?

- **Shown:** cluster energy vs. sum of hit/cluster energies vs. hit energy
  - Using default clustering parameters
    - localDistXY = 15 mm, 15 mm
    - dimScaledLocalDistXY = 50 (mm), 50 (mm)
    - sectorDist = 5 cm

  ☞ **Clusters get almost everything in BHCal despite small distance scales?**



Next Steps

Keep looking into clustering

- Resolve what's going on w/ distance scales
- Look at displacement b/n clusters and inciting track

Study impact of Barrel EMCal design on HCal response

- Compare resolution of HCal clusters for both choices of Barrel EMCal

Backup

Backup | simulation parameters

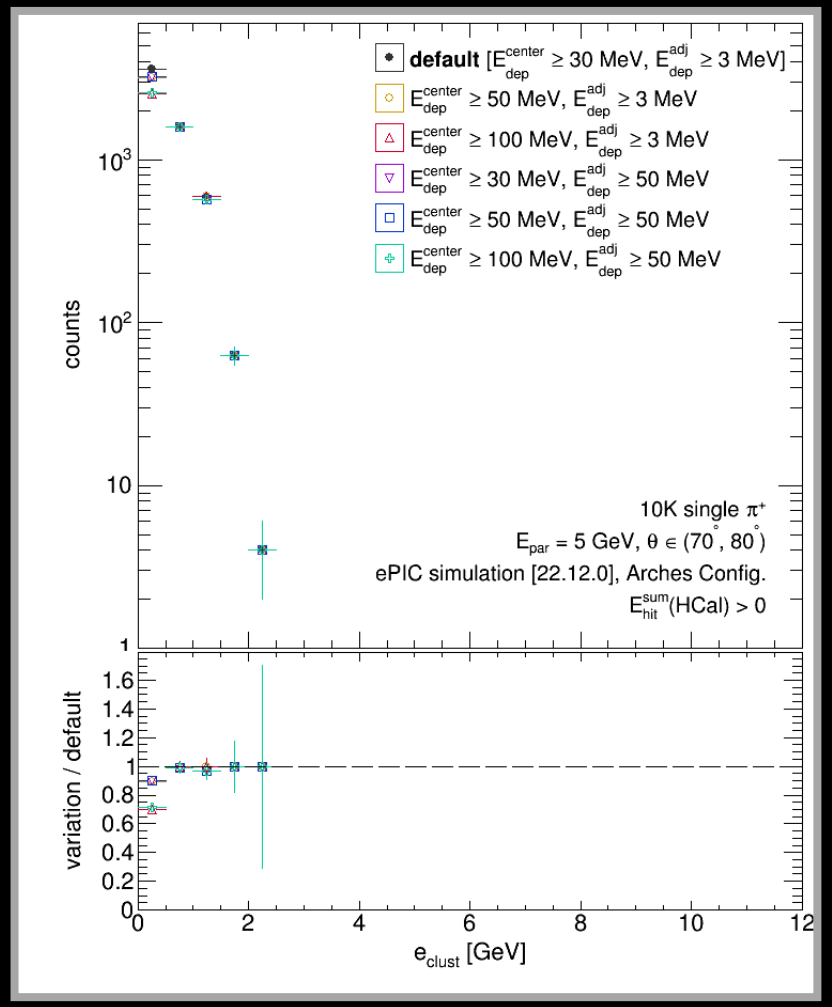
Simulation Parameters

- gun.energy = 2*GeV, 5*GeV, 10*GeV
- gun.particle = "pi+"
- gun.distribution = "cos(theta)"
- gun.thetaMin = 70*degree [$\eta \sim 0.35$]
- gun.thetaMax = 80*degree [$\eta \sim 0.18$]
- **22.12.0 Geometry [Arches]**

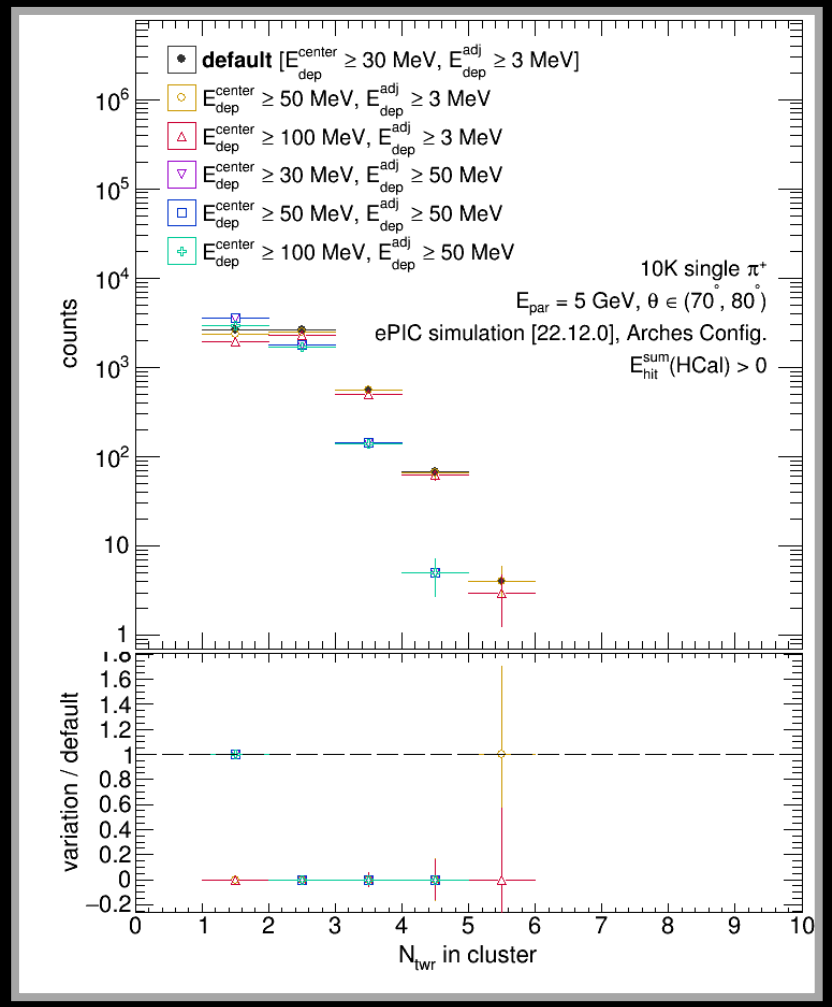
Reconstruction

- EICRecon

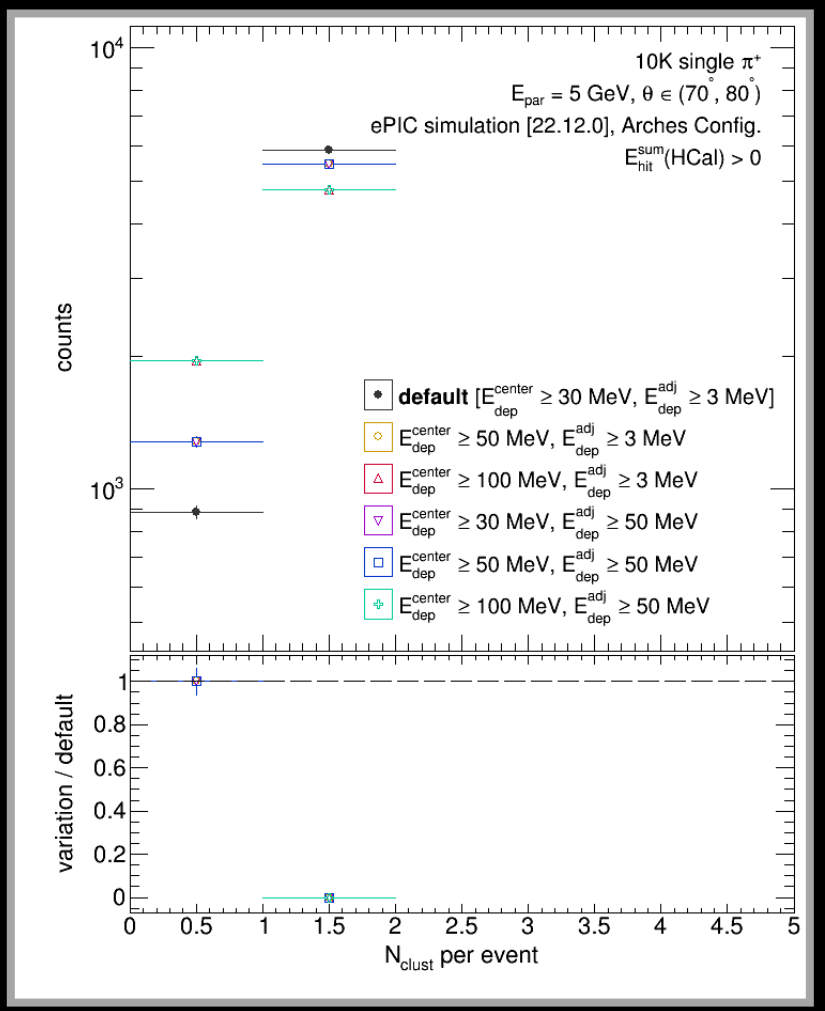
Backup | 5 GeV single π^+



Cluster Energy

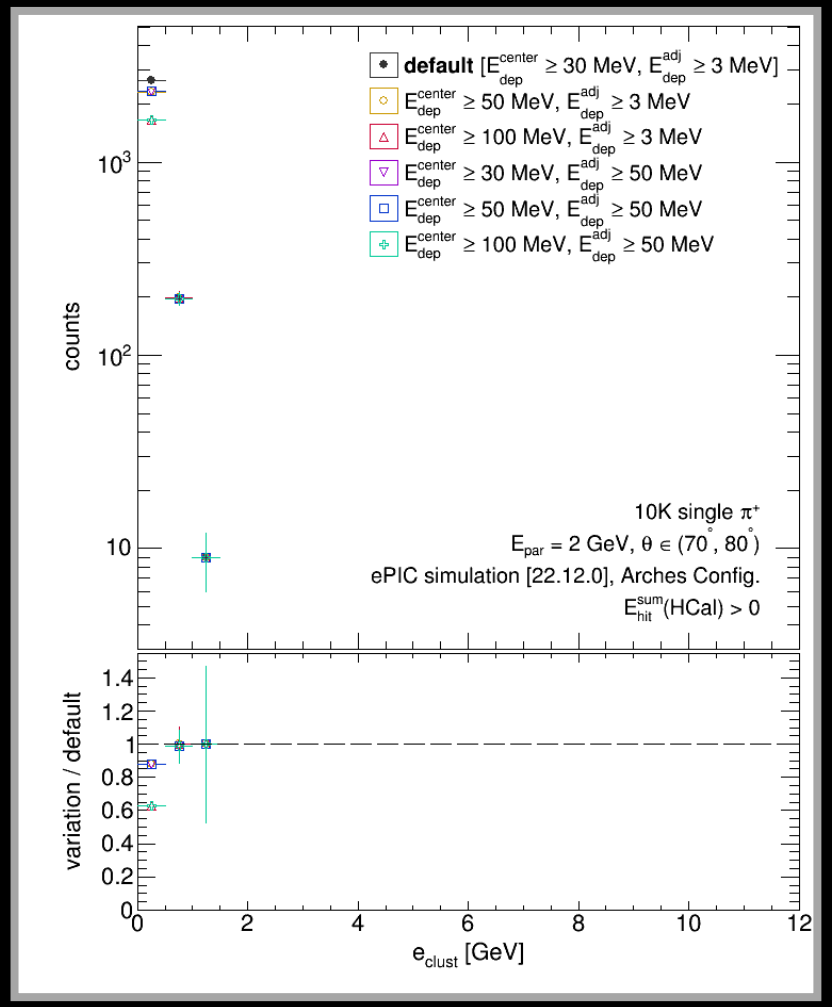


No. of towers in cluster

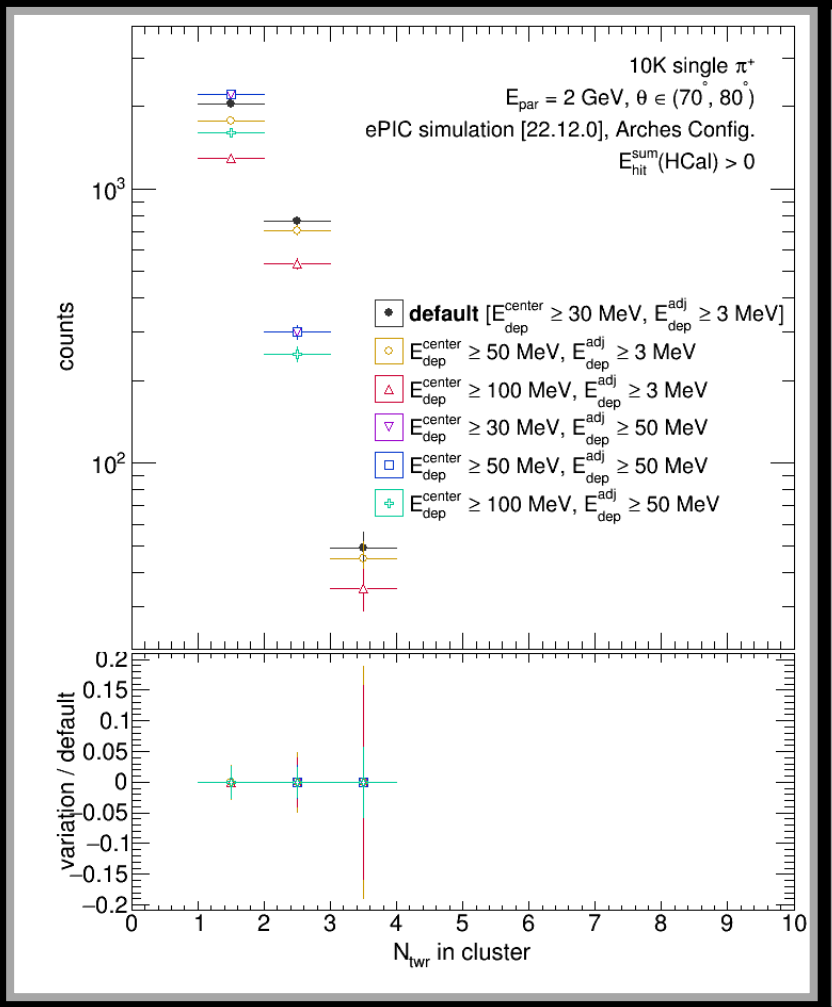


No. of clusters in event

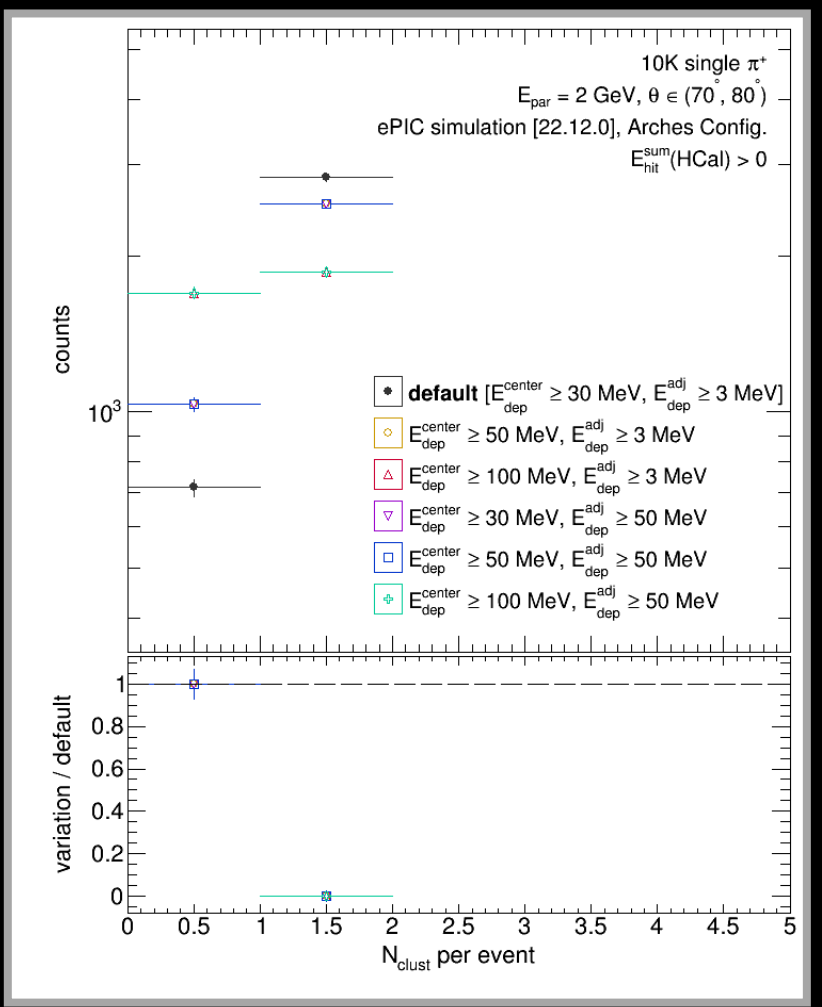
Backup | 2 GeV single π^+



Cluster Energy



No. of towers in cluster



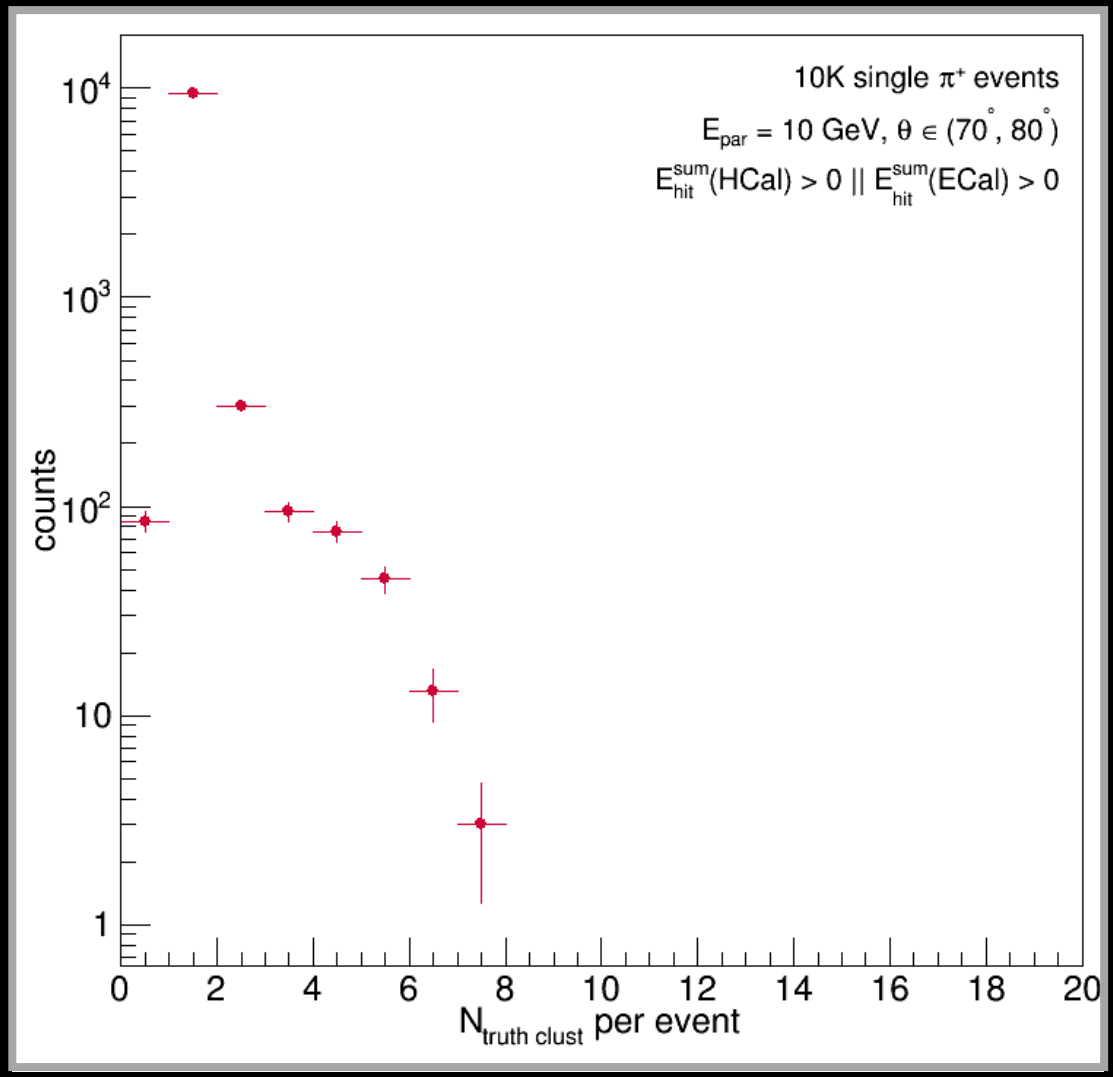
No. of clusters in event

Previous Slides

ePIC HCal Update | looking into the HCal response

- Working on better understanding response of current HCal implementation

- Noticed tiny number of events have more than 1 truth cluster per event
  - ∴ **Following plots split events into 2 categories:**
    a) No. of truth clusters == 1
    b) No. of truth cluster >= 2
  - Included distributions from Barrel ECal (SciGlass) as well

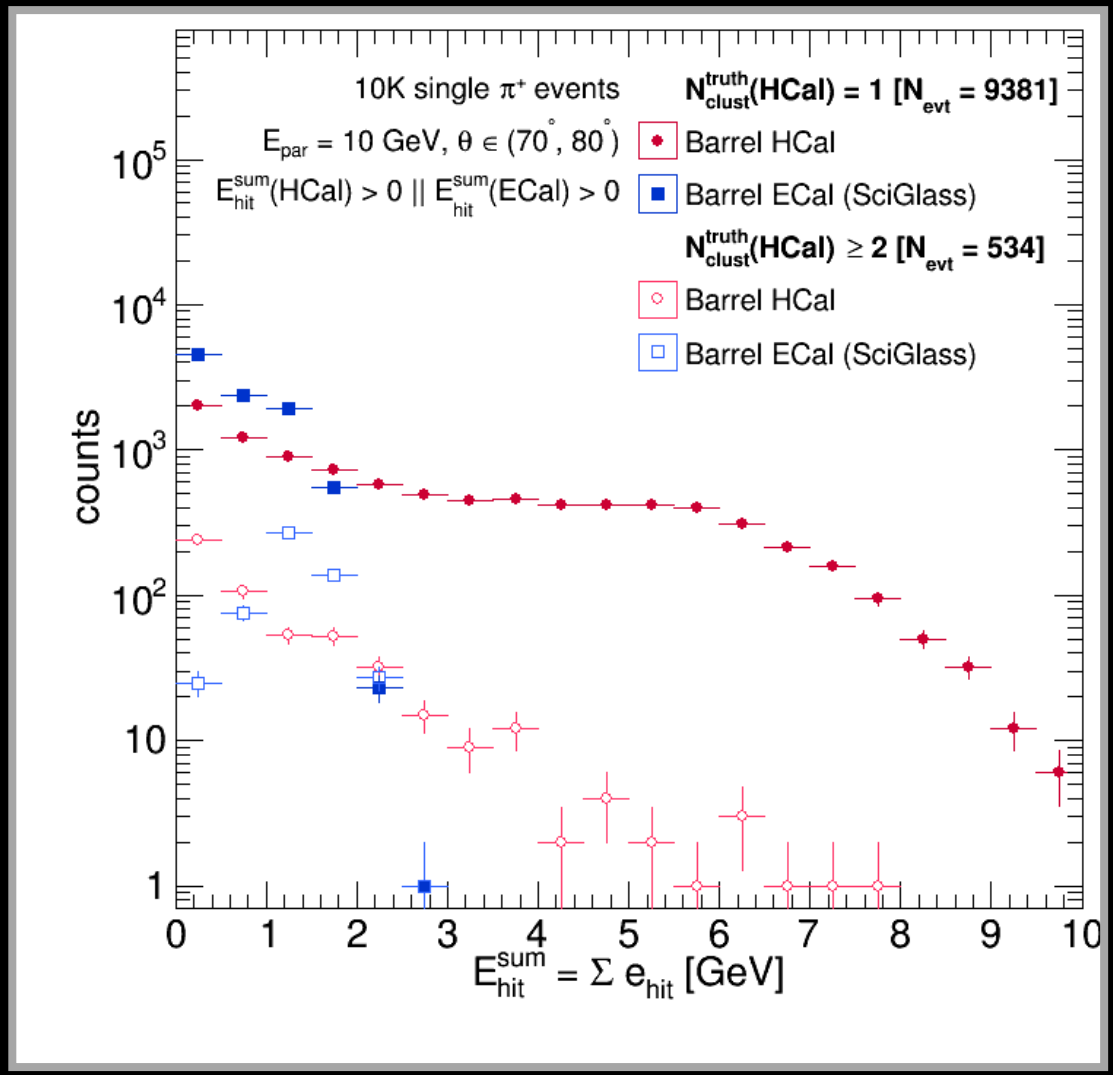


ePIC HCal Update | sum of hit energies

- Sum of reconstructed hit energies:
  - ☞ Not unreasonable for 10 GeV π^+…

- **Solid Markers:**
  - ⇒ No. of truth HCal clusters == 1
- **Open Markers:**
  - ⇒ No. of truth HCal clusters >= 2

- **Red Markers:**
  - ⇒ Barrel HCal
- **Blue Markers:**
  - ⇒ Barrel ECal (SciGlass)

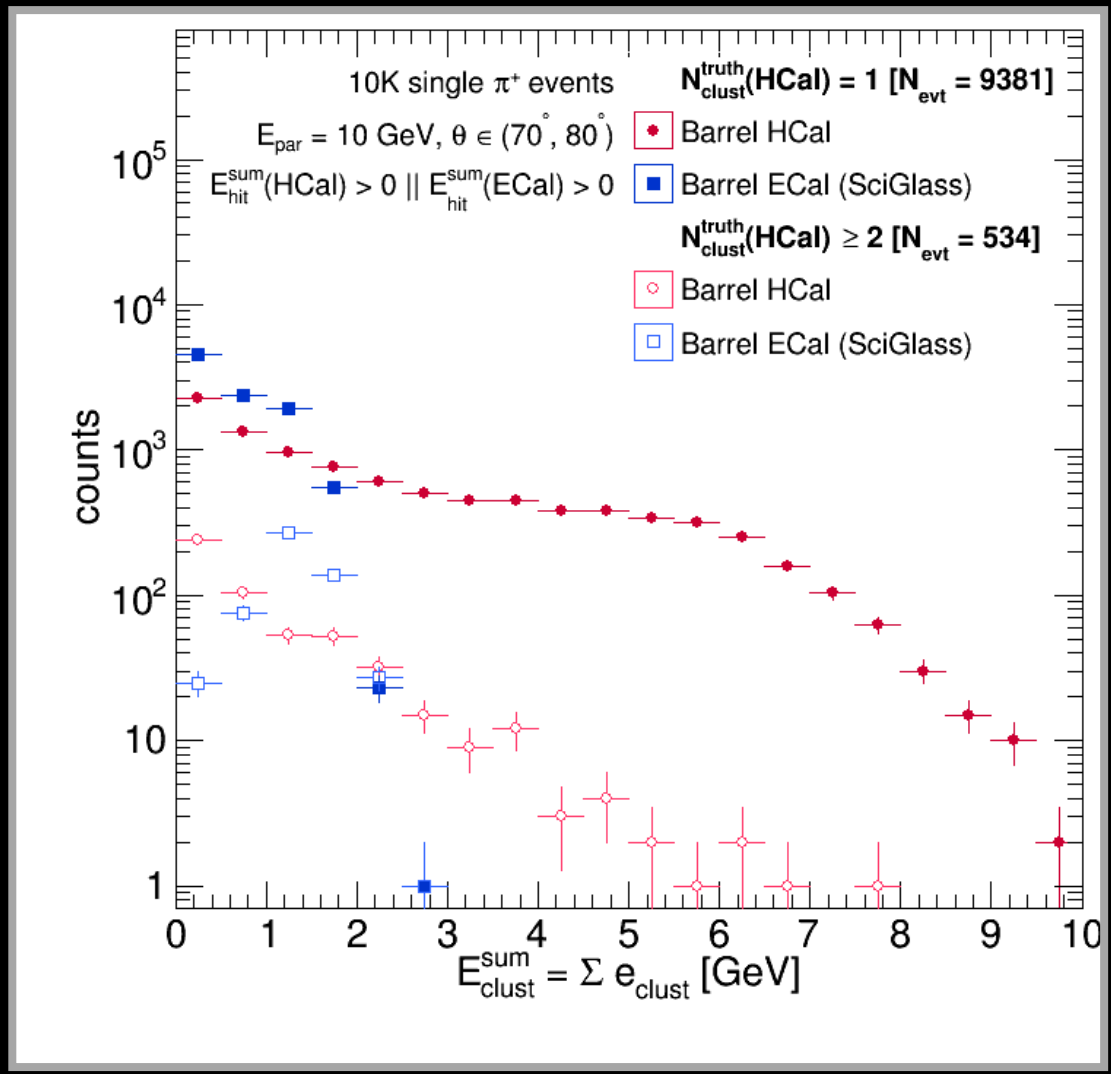


ePIC HCal Update | sum of cluster energies

- Sum of reconstructed cluster energies:
  - 👉 Looks suspiciously close to the summed hit energies…

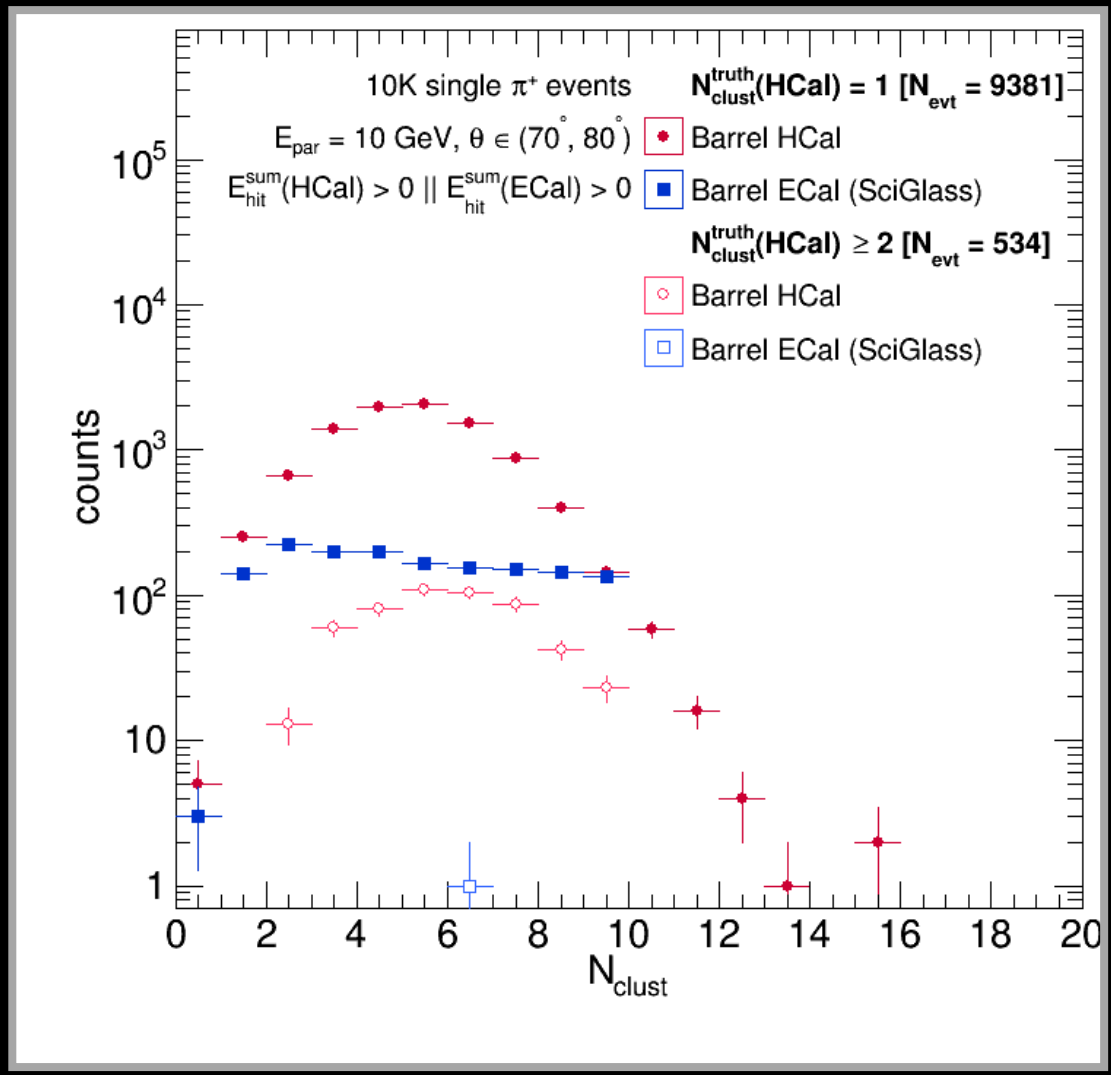
- **Solid Markers:**
  - ⇒ No. of truth HCal clusters == 1
- **Open Markers:**
  - ⇒ No. of truth HCal clusters >= 2

- **Red Markers:**
  - ⇒ Barrel HCal
- **Blue Markers:**
  - ⇒ Barrel ECal (SciGlass)



ePIC HCal Update | number of clusters per event

- Number of reconstructed clusters per event:
  - ☞ Very high for a single π^+!
- **Solid Markers:**
  - ⇒ No. of truth HCal clusters == 1
- **Open Markers:**
  - ⇒ No. of truth HCal clusters >= 2
- **Red Markers:**
  - ⇒ Barrel HCal
- **Blue Markers:**
  - ⇒ Barrel ECal (SciGlass)



ePIC HCal Update | take-aways/next steps

- **Take-Aways:**
  - At the very least, **clustering needs to be tuned**

- **Next Steps:**
  - Carry out more thorough study of clustering parameters
  - Begin looking at Simulation Campaign output…

Backup | simulation parameters

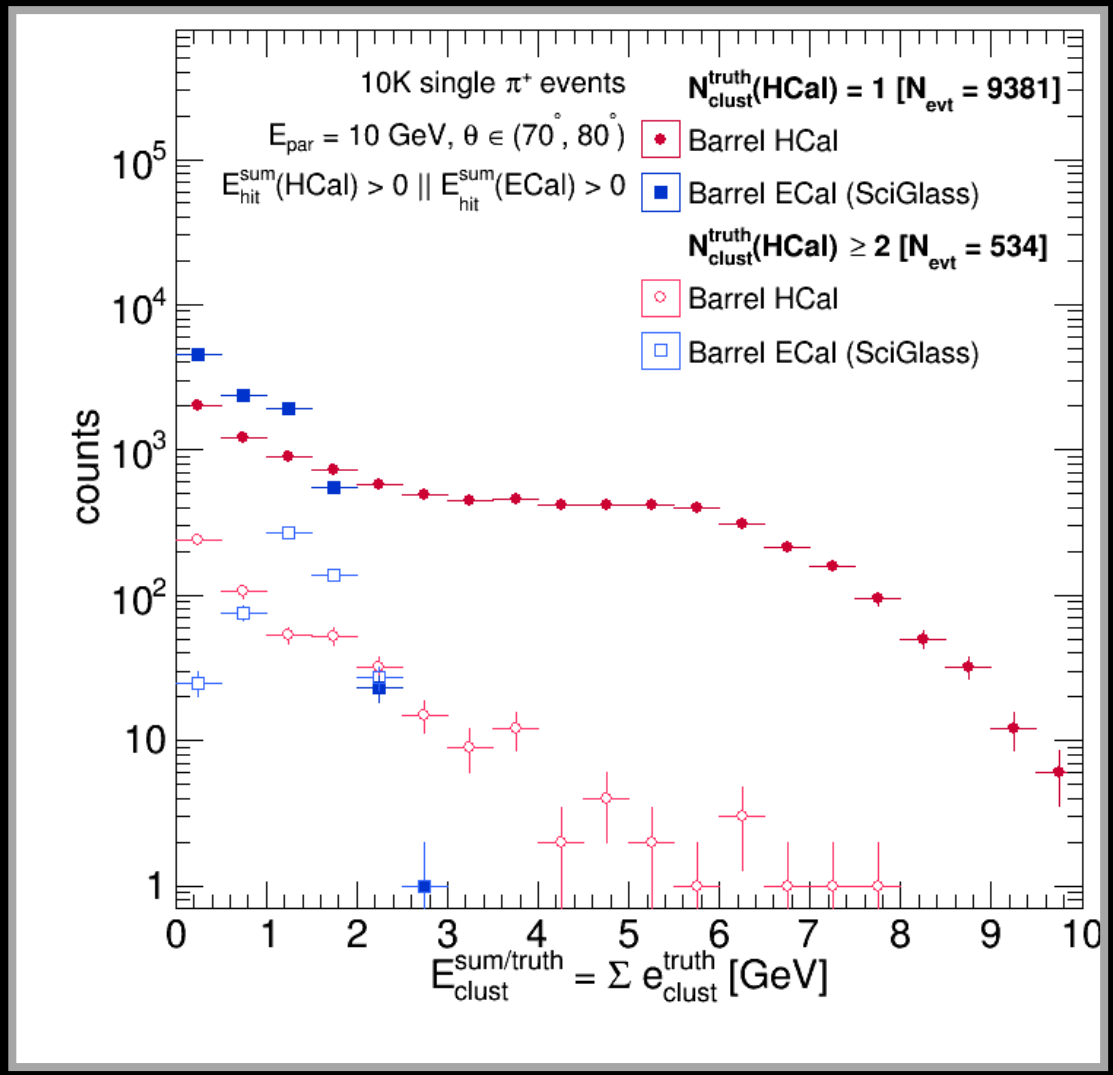
Simulation Parameters

- gun.energy = 10*GeV
- gun.particle = "pi+"
- gun.distribution = "cos(theta)"
- gun.thetaMin = 70*degree [$\eta \sim 0.35$]
- gun.thetaMax = 80*degree [$\eta \sim 0.18$]
- **22.11.2 Geometry**

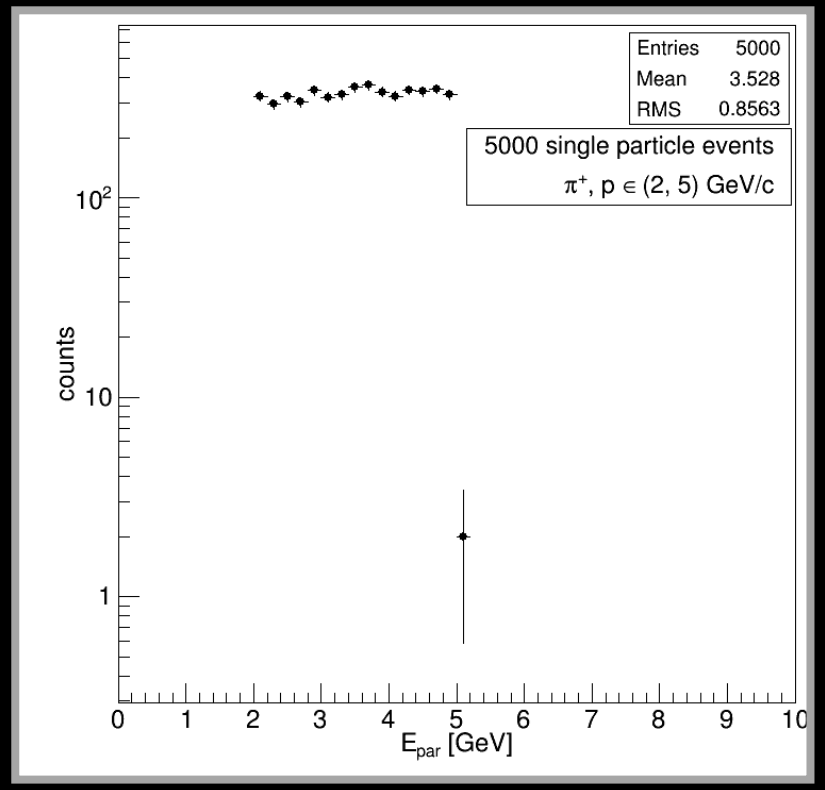
Backup | sum of truth cluster energies

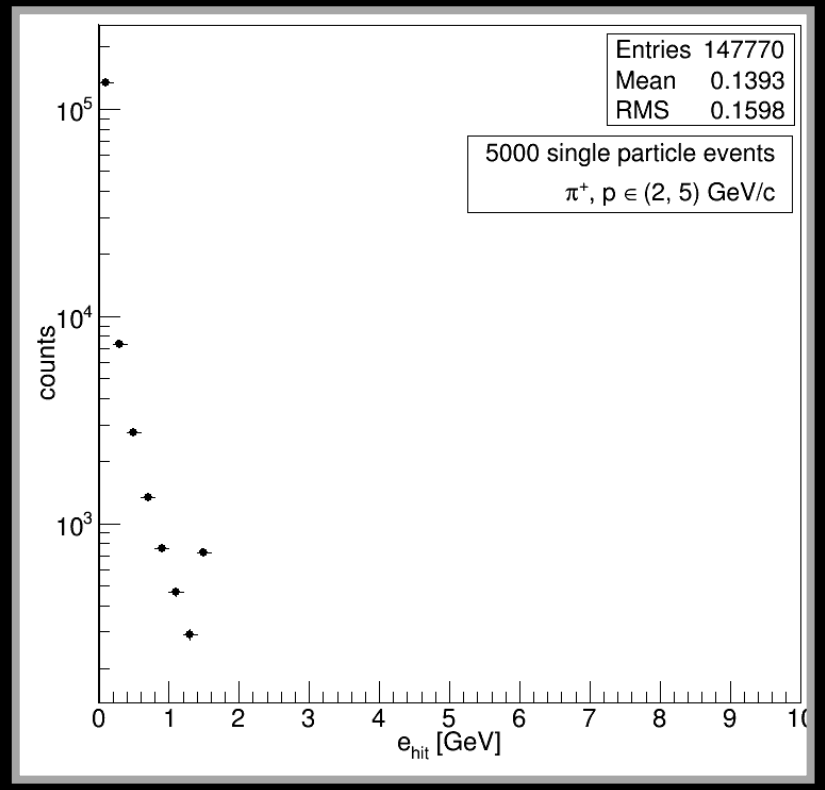
- **Solid Markers:**
  - ⇒ No. of truth HCal clusters == 1
- **Open Markers:**
  - ⇒ No. of truth HCal clusters >= 2

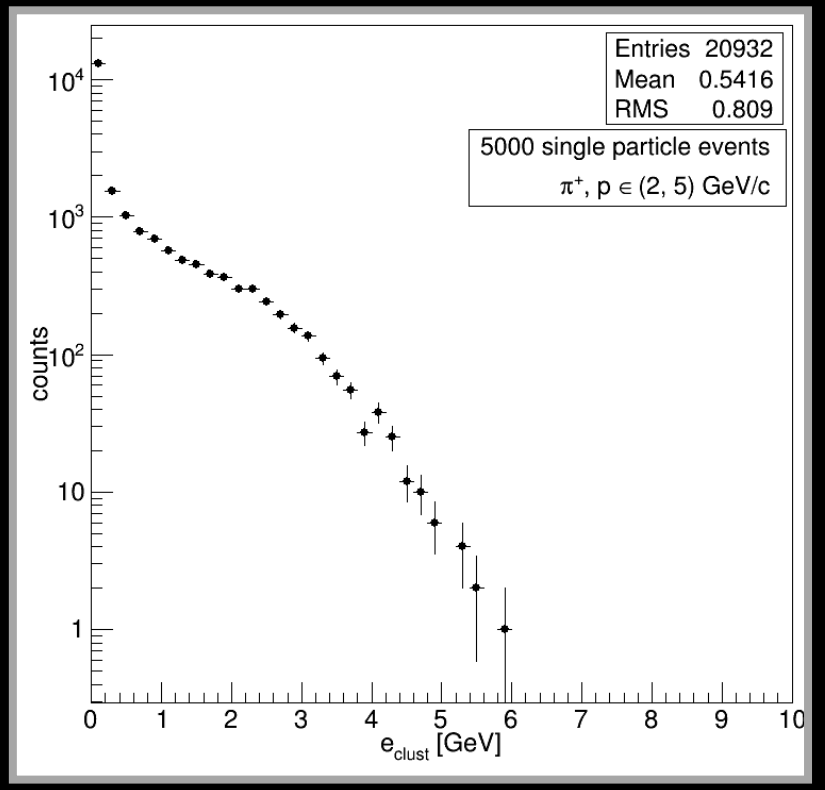
- **Red Markers:**
  - ⇒ Barrel HCal
- **Blue Markers:**
  - ⇒ Barrel ECal (SciGlass)



ePIC HCal Update | energy spectra







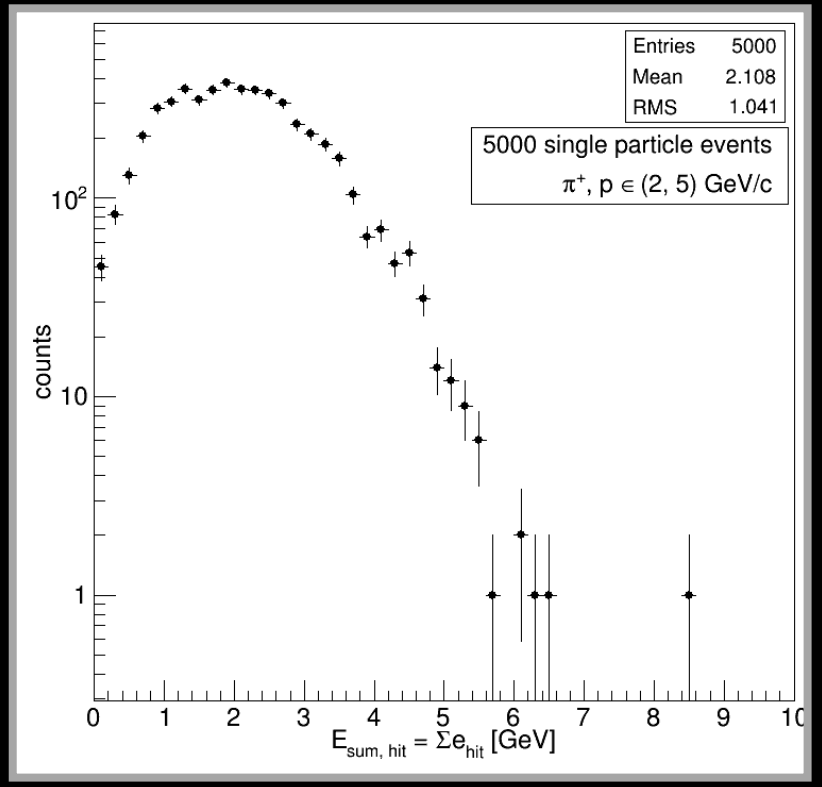
MC Particles

Reconstructed Hits

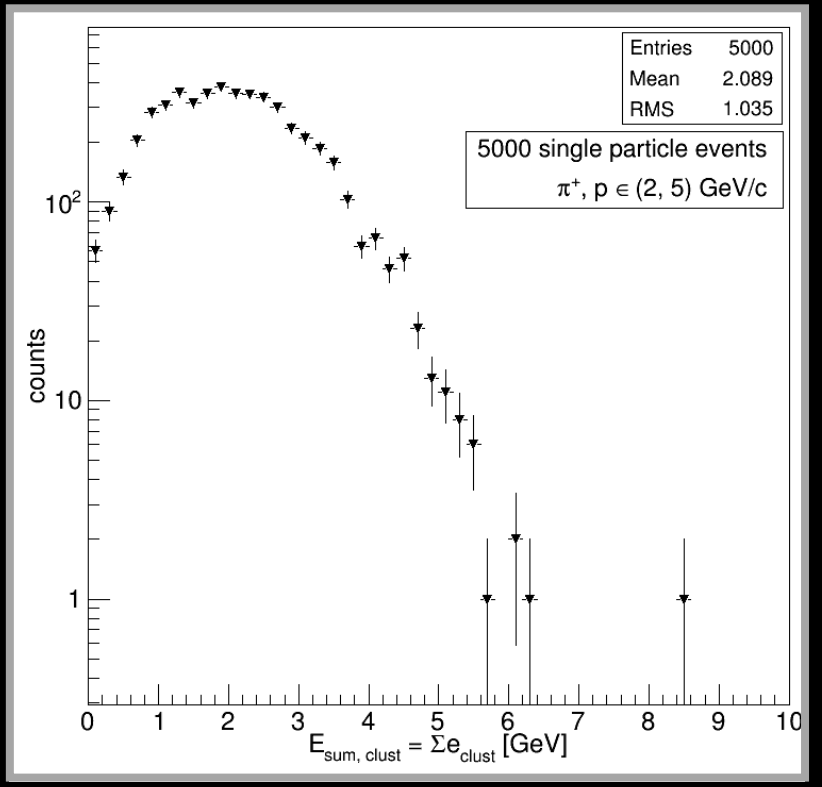
Clusters

ePIC HCal Update | sum of hit/cluster energy

- Summed hit **(right)** and cluster **(left)** energies to compare against particle energy



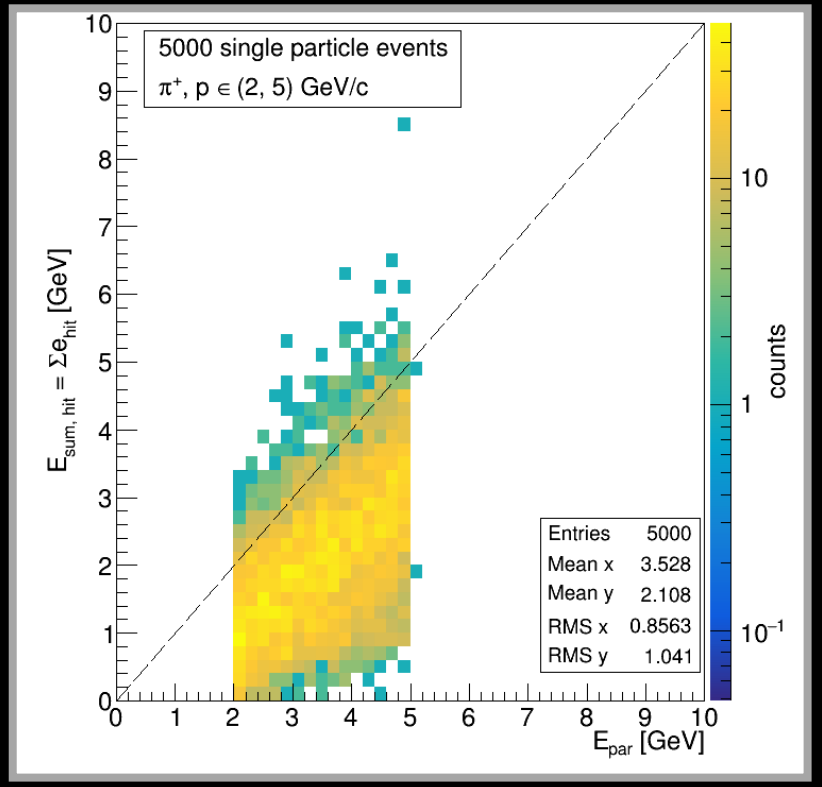
Reconstructed Hits



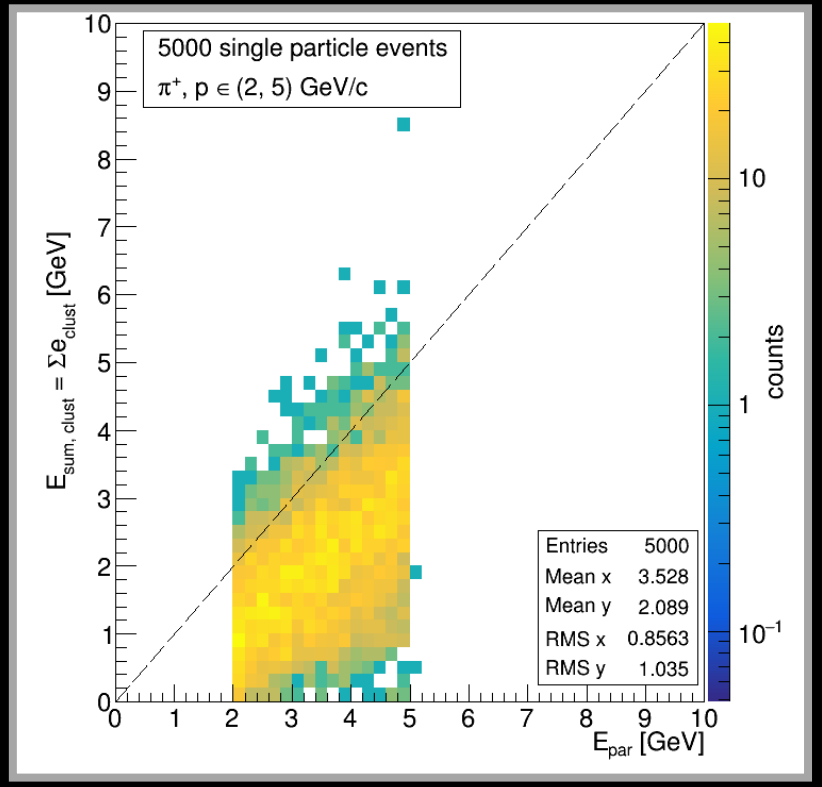
Clusters

ePIC HCal Update | sum of hit/cluster energy vs. particle energy

- 2D distribution of particle **(x axis)** vs. summed hit/cluster energy **(y axis)**



Reconstructed Hits

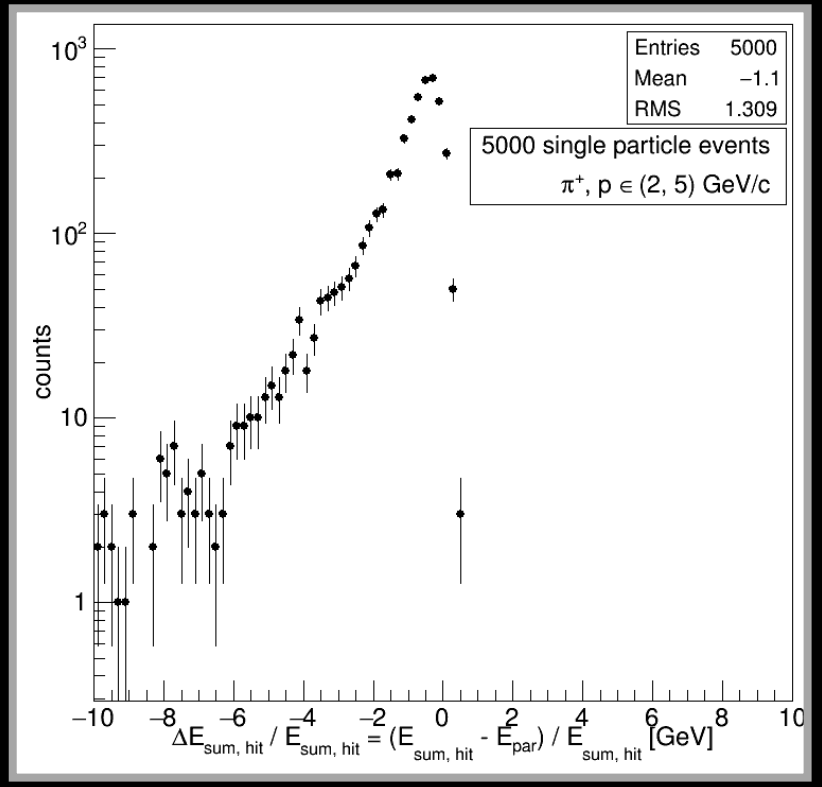


Clusters

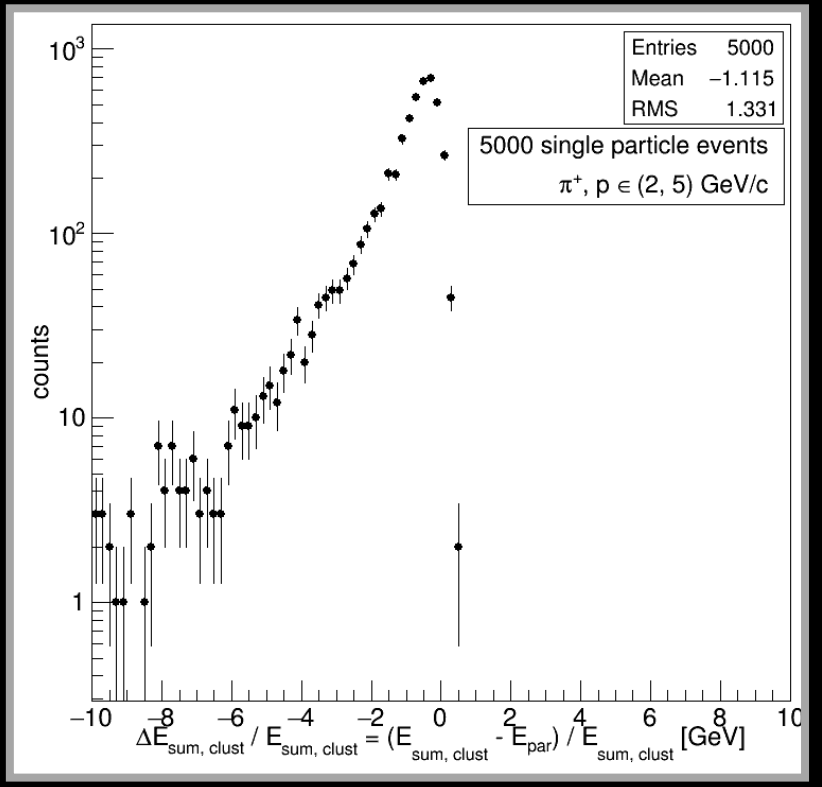
ePIC HCal Update | sum of hit/cluster energy vs. particle energy

- Difference between summed hit/cluster energy and particle energy:

$$\frac{E_{sum,clust/hit} - E_{par}}{E_{sum,clust/hit}}$$

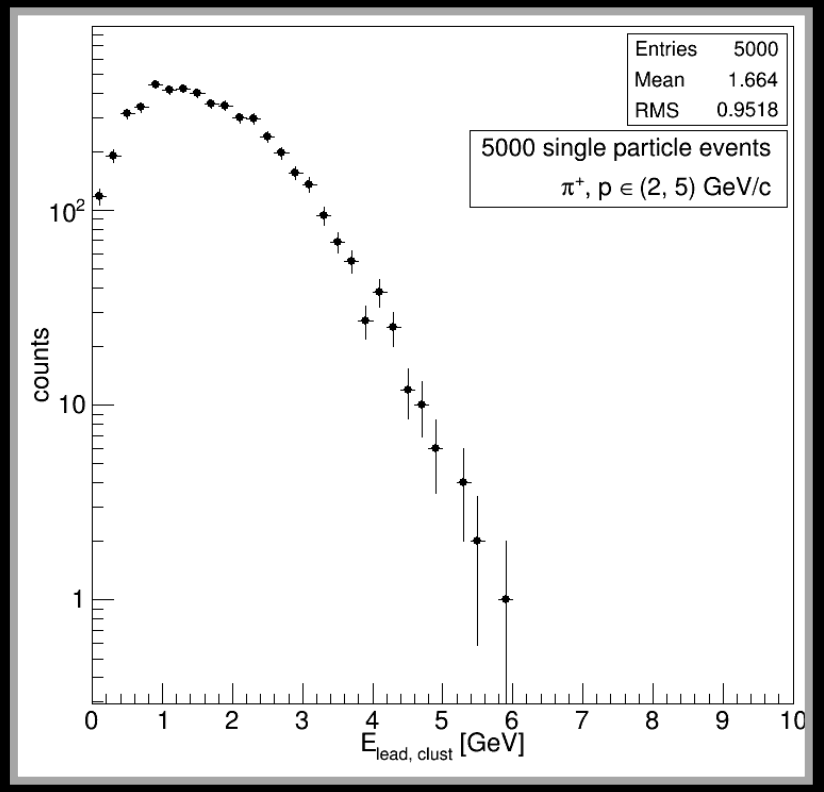


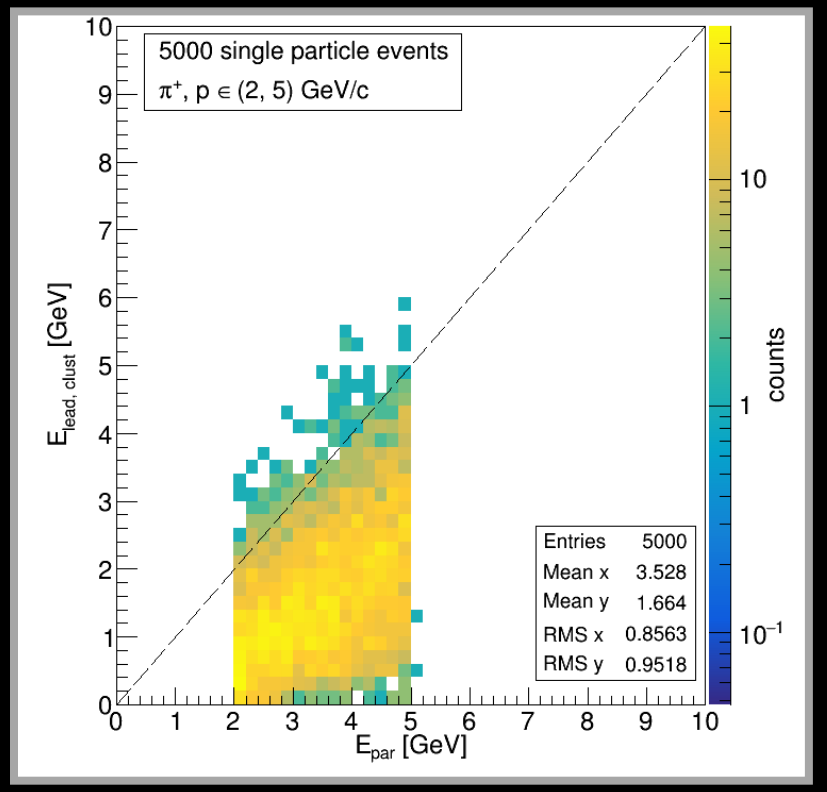
Reconstructed Hits

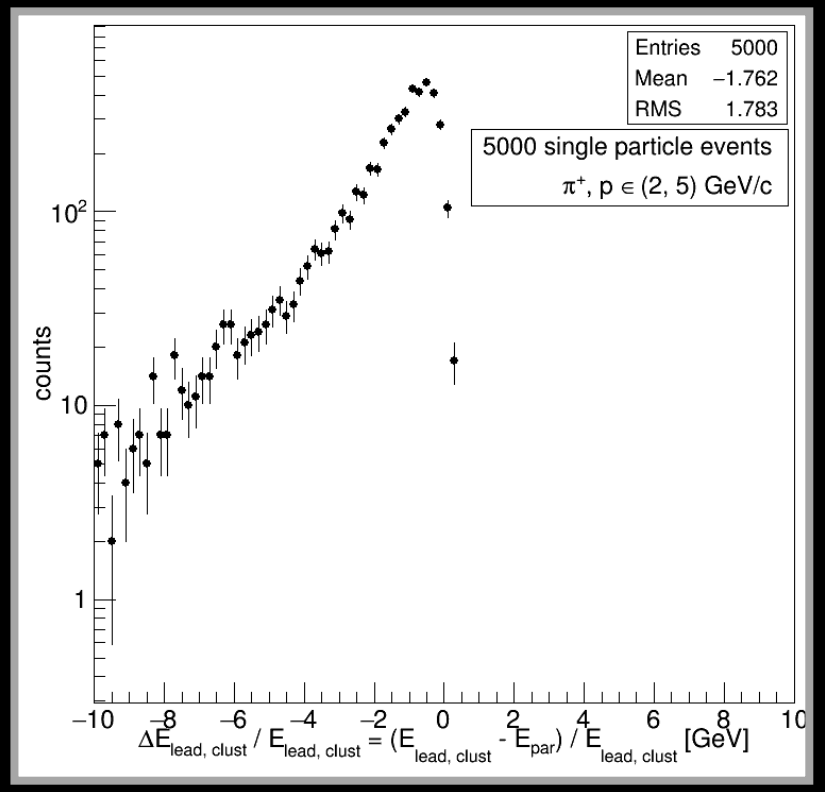


Clusters

ePIC HCal Update | lead cluster vs. particles







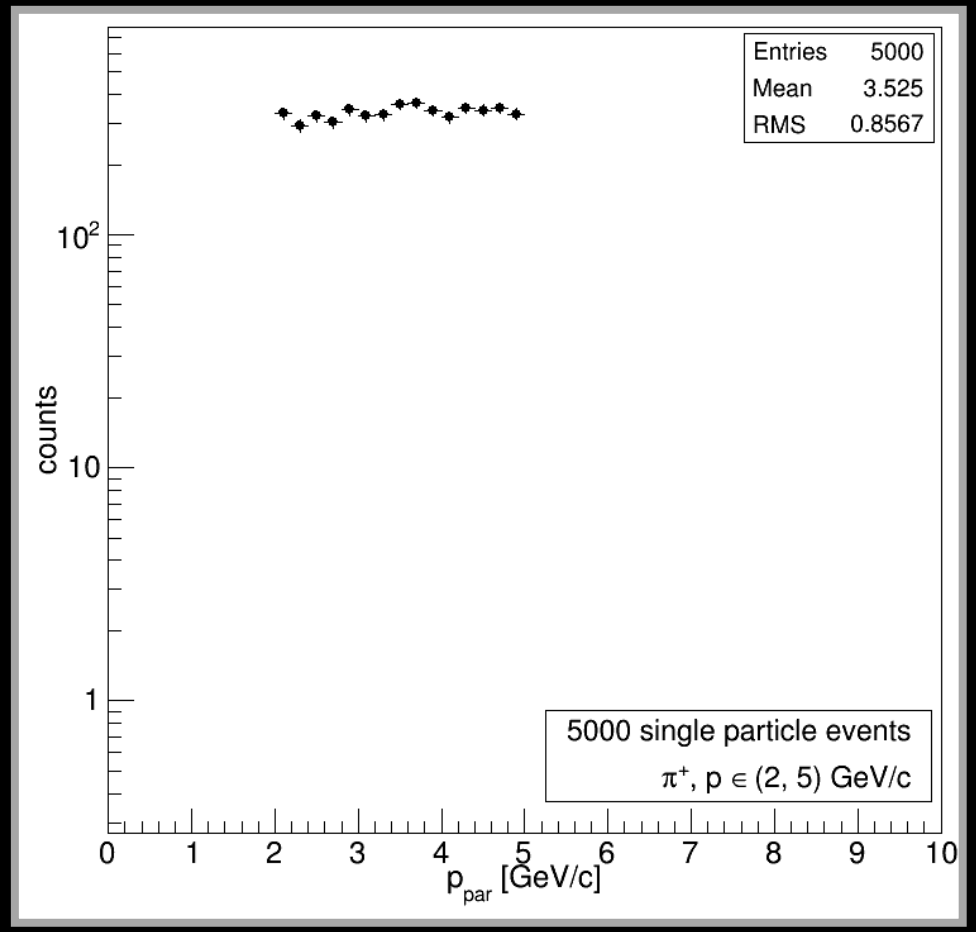
- Compared lead **(highest energy)** cluster against particle

ePIC HCal Update | take-aways and next steps

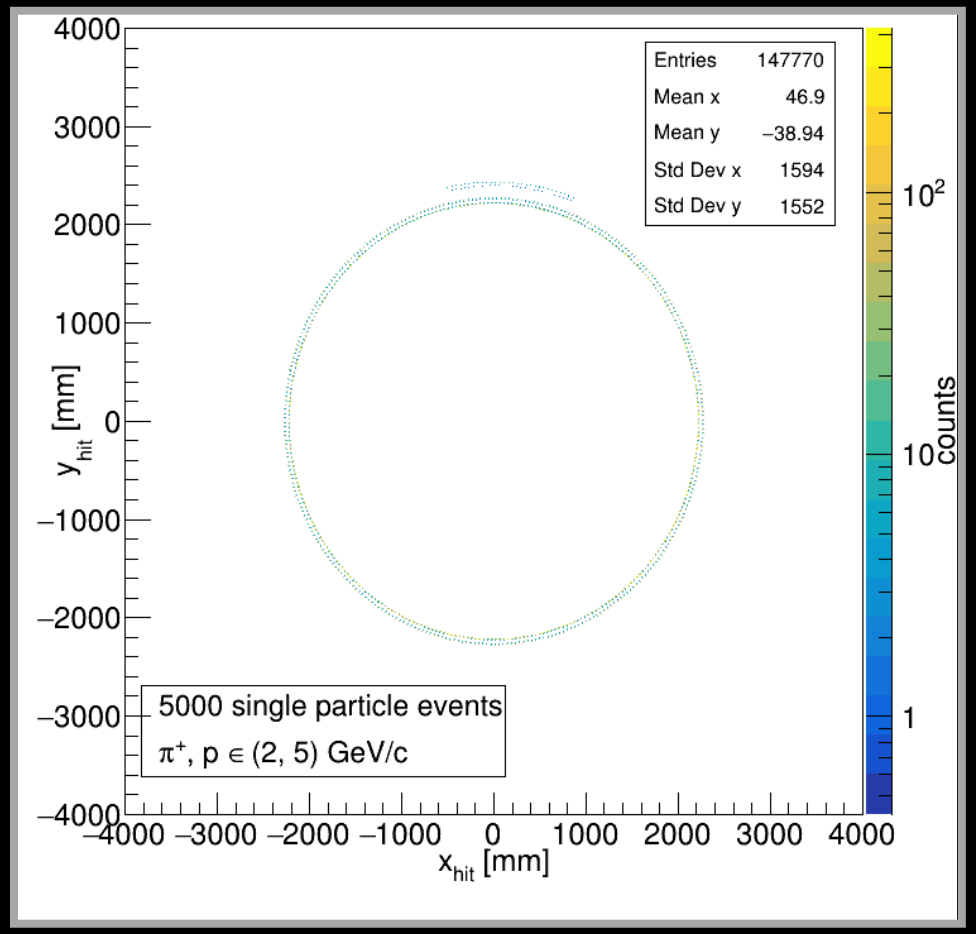
- **Take-aways:**
  - Hits look reasonable
  - Sum of hit/cluster energies get close to particle energy
  - ⇒ Current implementation will work for this simulation campaign

- **Next steps:**
  - Implement calculation of energy resolution
  - Analyze official single-particle files

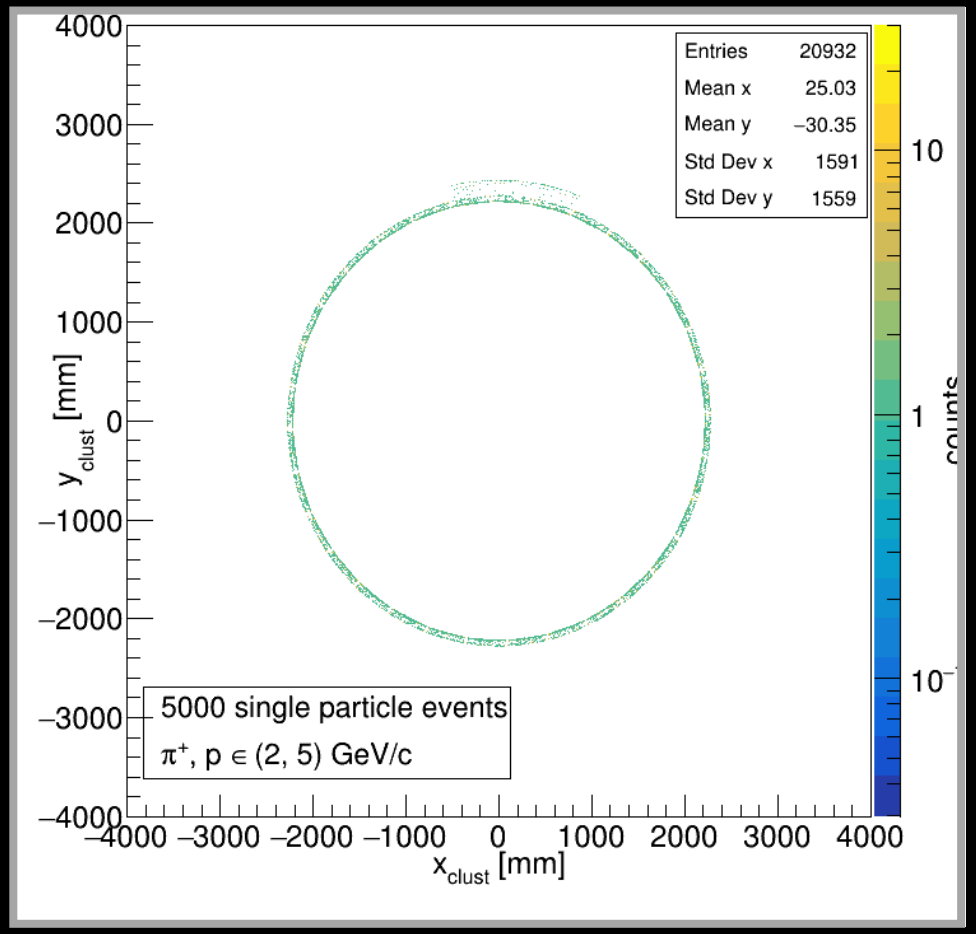
Backup | particle momentum



Backup | hit/cluster Y vs. X



Reconstructed Hits



Clusters