Two-Particle Position Resolution Study from Backward HCal

Leszek Kosarzewski, Alexandr Prozorov, **Subhadip Pal**

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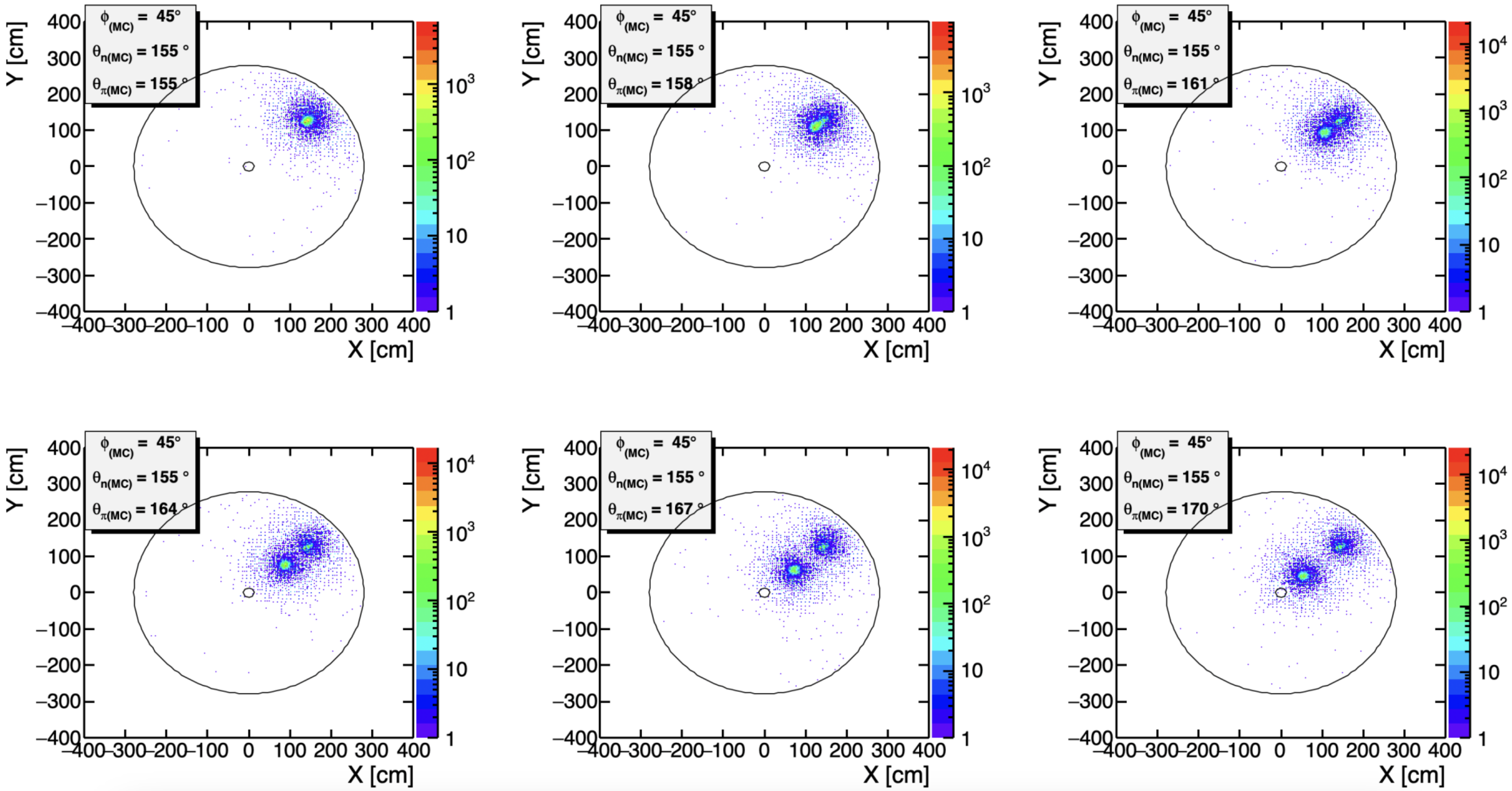
Setup

Objective *: Use clusters to distinguish between neutron/pion shower reconstruction.*

- ❑ (1 n + 1 π^-) / event. ---- *Standalone ddsim*
- ❑ φ = 45˚
  - θ_n = 155˚ (η = -1.51) ------ *fixed*
  - θ_π = 155˚ (η = -1.51), 158˚ (η = -1.64), 161˚ (η = -1.79), 164˚ (η = -1.96), 167˚ (η = -2.17), 170˚ (η = -2.44)

- Only Backward HCal was taken into account [not the whole ePIC geometry – scattering effects neglected]
- $-4.14 < \eta < -1.18$
- Alternating Steel and Scintilator slices
- 10 cm. x 10 cm. Polystyrene tiles

Cluster Positions (xy coordinates)



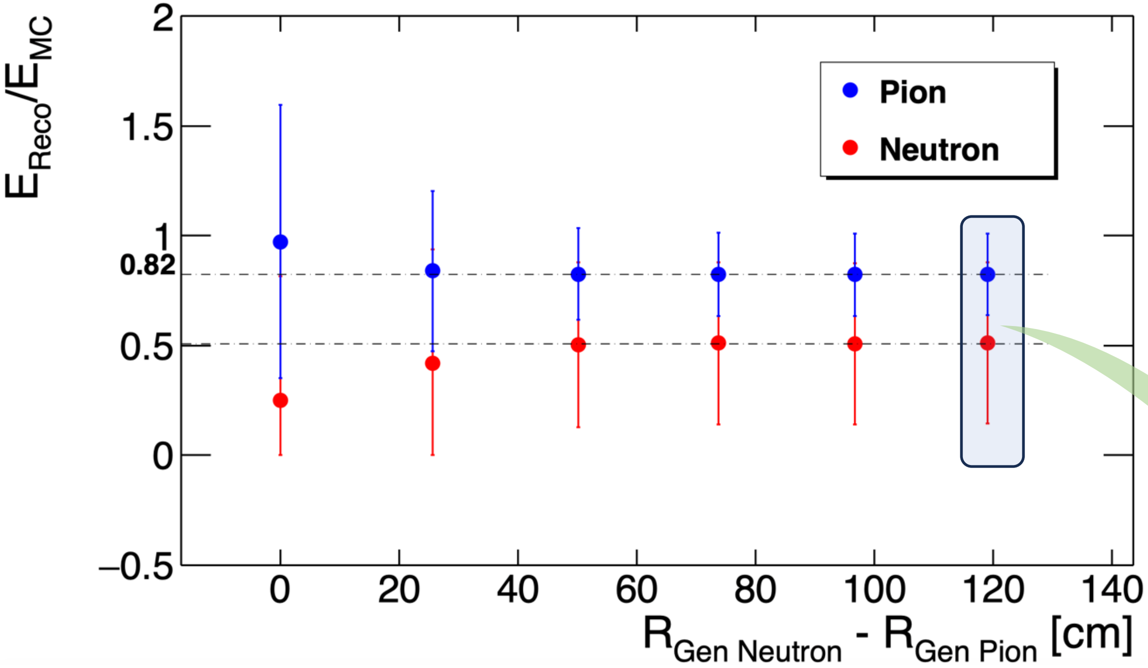
Cluster (x,y) are shown along with simulated angular coordinates

p = 1 GeV/c

[neutron showers in outer region; pion showers in inner region]

Distributions are becoming more distinguishable as (θ_{π} - θ_{n}) increases…

Cluster Reconstruction Efficiency



Individual Particle Energy Reconstruction Efficiency

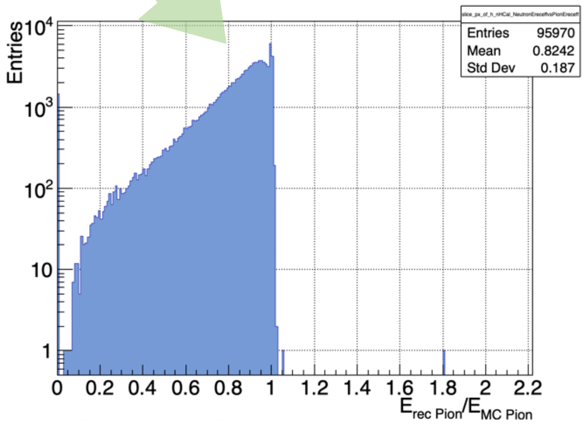
Decreases for neutron as the gap decreases. Some part being hijacked by pions.

*$E_{MC} \neq E_{gen}$

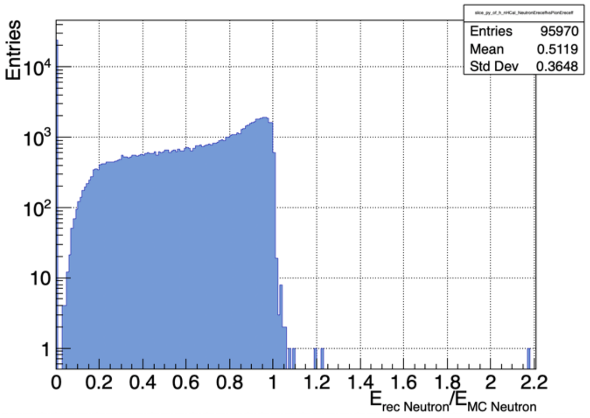
E_{MC} is the Energy deposited during Simulation by the particle

$$E_{Reco} = \sum E_{cluster}$$

*lower limit of errors for neutron have been truncated to 0 when exceeded.

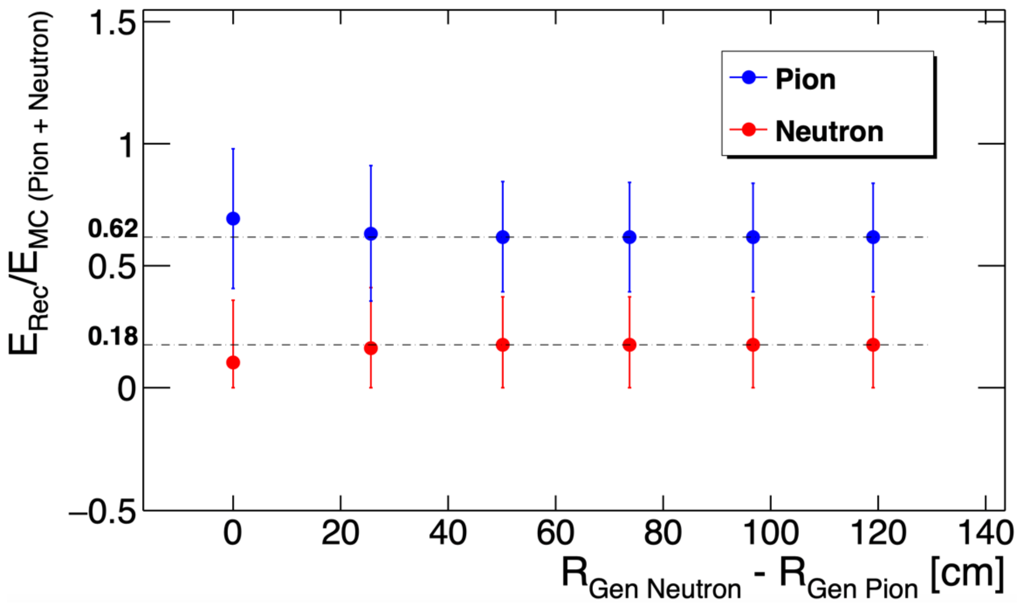


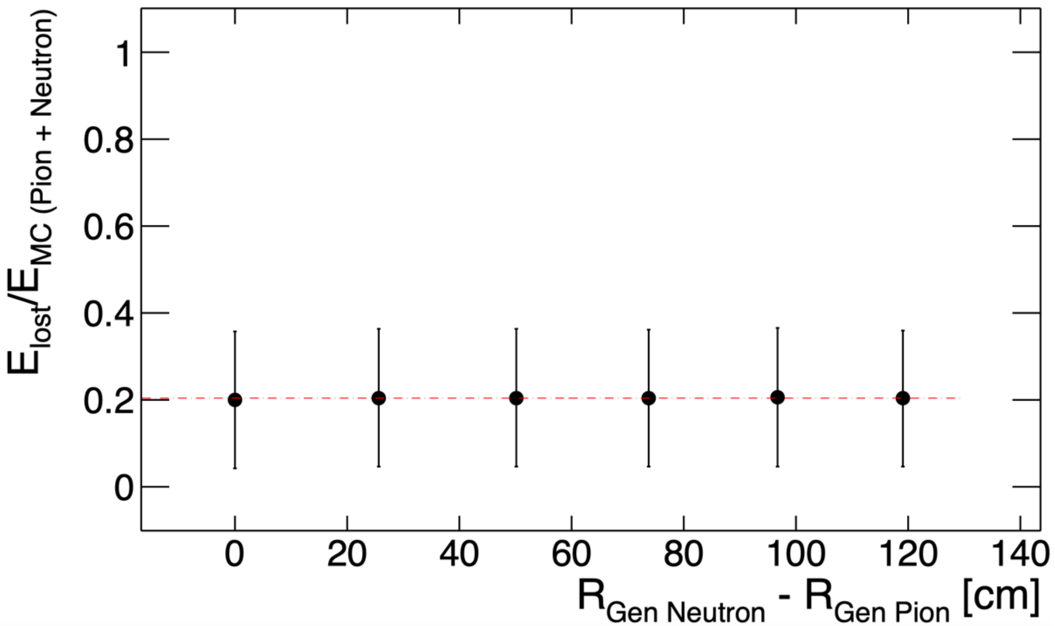
Pion



Neutron (more RMS)

Cluster Reconstruction



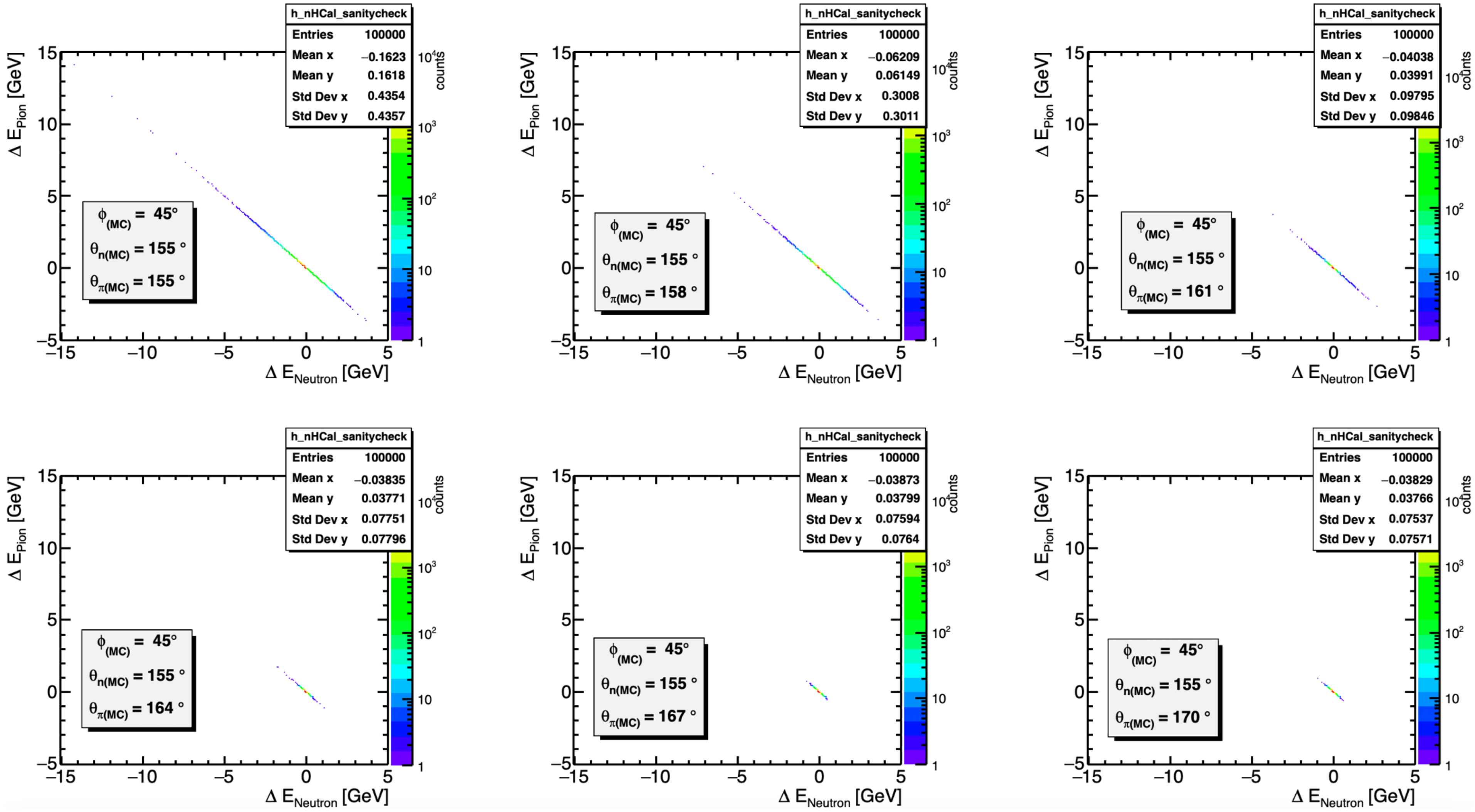


$$E_{MC(Pion+Neutron)} = E_{Rec(Pion+Neutron)} + E_{lost}$$

$$\epsilon_{global} = E_{Rec(Pion+Neutron)}/E_{MC(Pion+Neutron)}$$

$\approx$ 0.80 (Fraction of MC energy deposition that went into clustering)

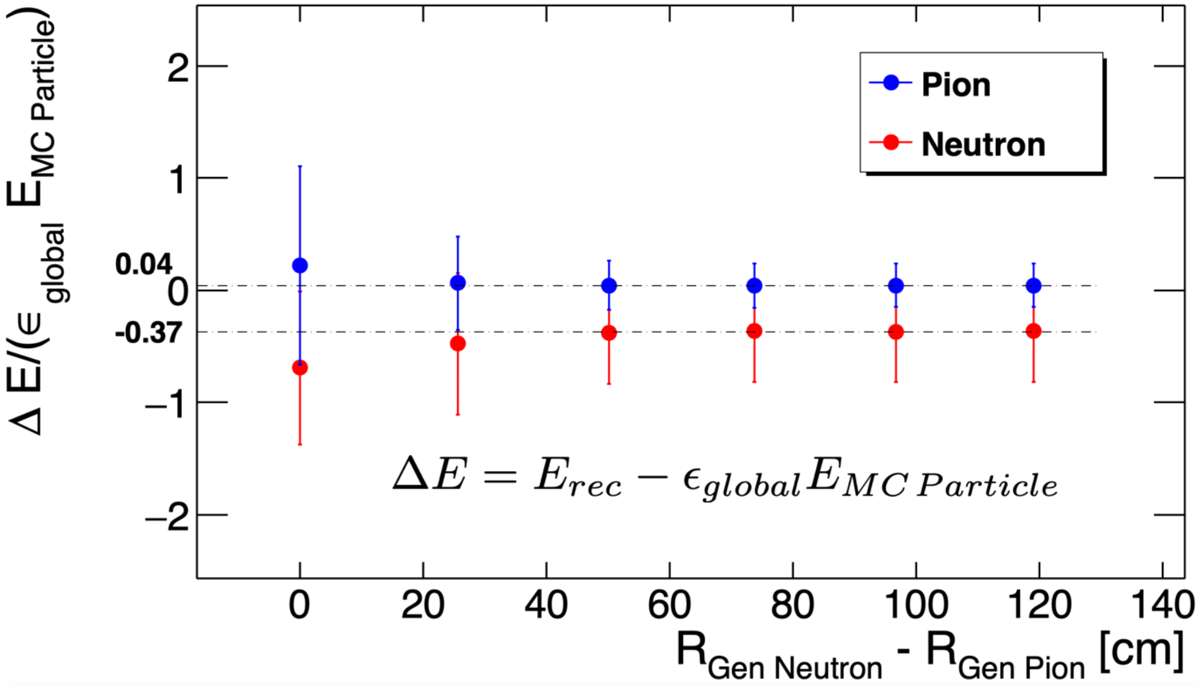
Energy transfer while clustering

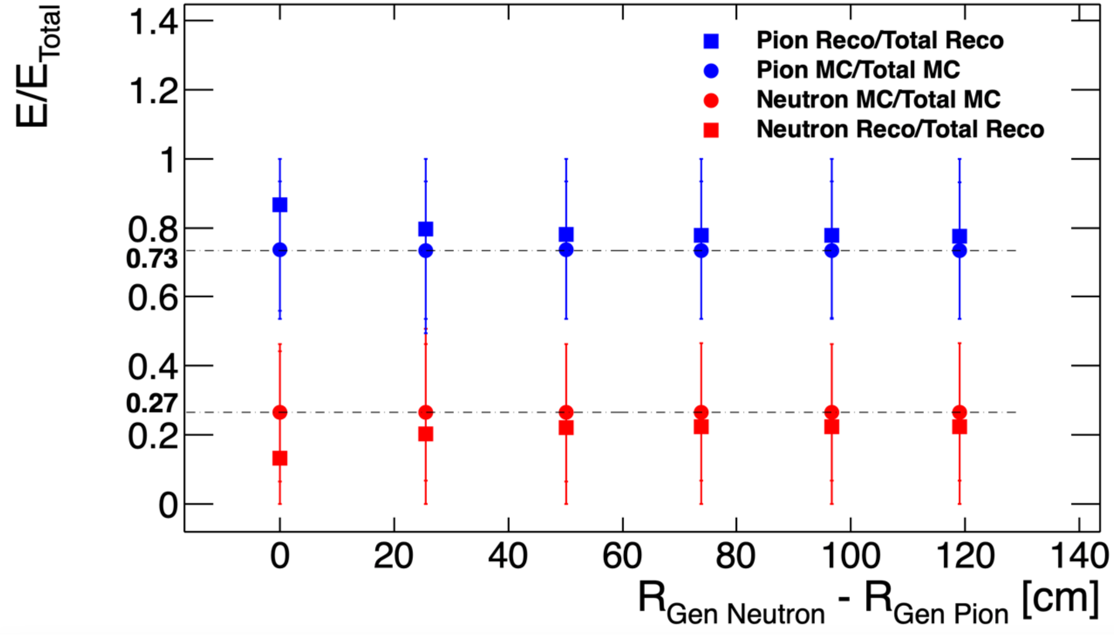


$$\Delta E = E_{rec} - \epsilon_{global} E_{MC\ Particle}$$

Distributions follow y = -x trend

Energy transfer while clustering





Due to the energy transfer during clustering, Neutron showers are affected significantly.

37% of the Neutron Energy Deposition that entered clustering are transferred to pion showers, even in the most separated case.

$$f = \frac{\epsilon_{global} E_{MC} - E_{cluster}}{E_{cluster}}$$

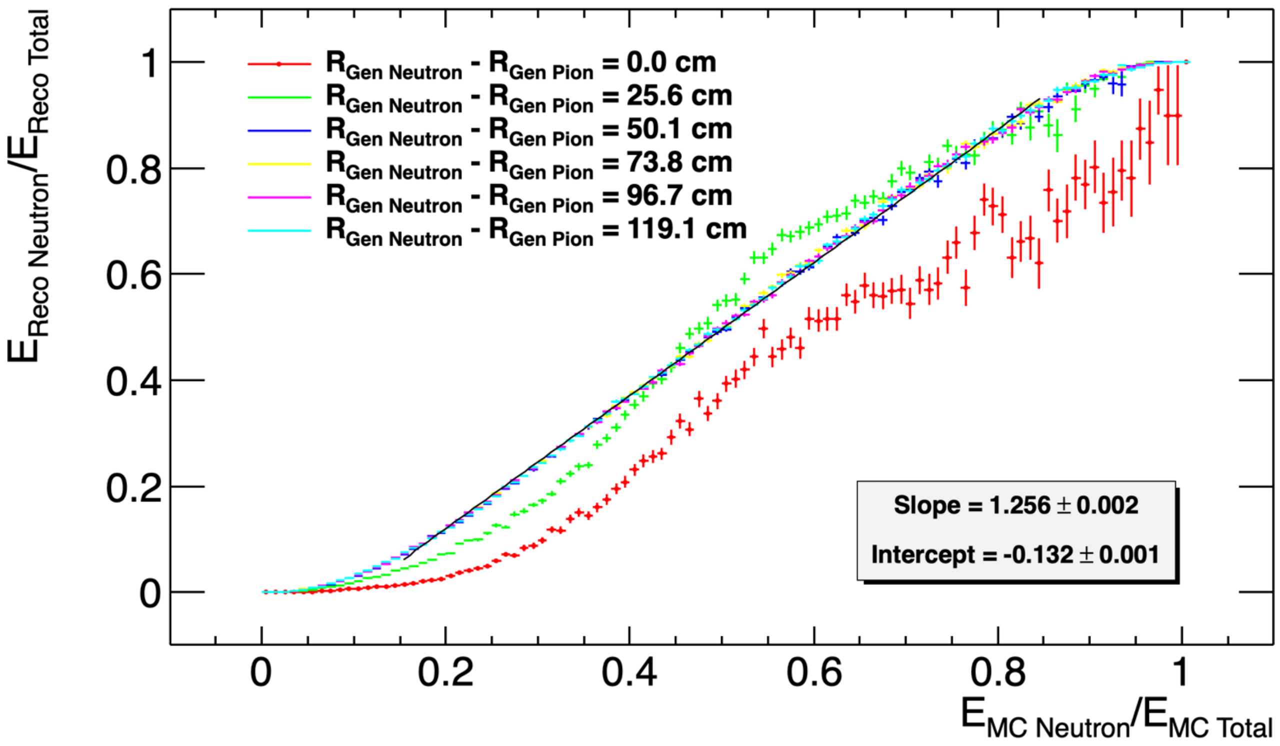
$$E_{cluster}^{corrected} = E_{cluster}(1+f)/\epsilon_{global}$$

Cluster Energy correction

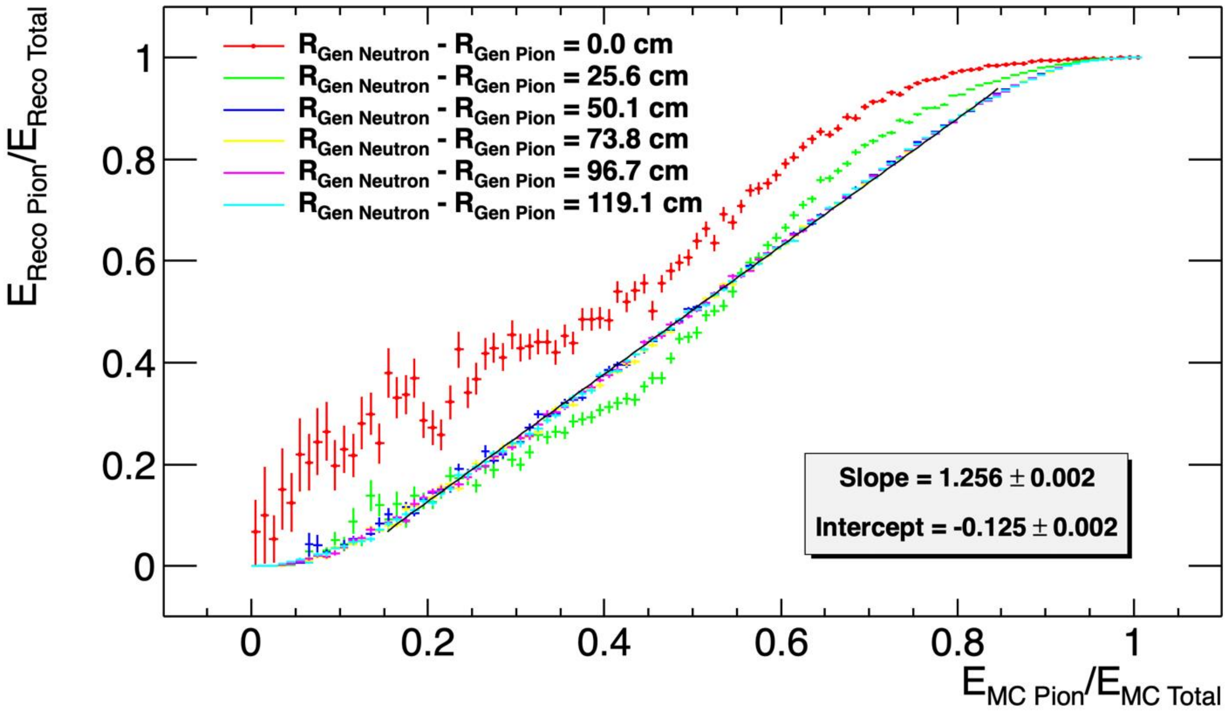
$$f = \frac{\epsilon_{global} E_{MC} - E_{cluster}}{E_{cluster}}$$

$R_{GenNeutron} - R_{GenPion} [cm]$	$f_{Neutron}$	f_{Pion}
0.00	2.230 ± 7.114	-0.182 ± 0.592
25.58	0.912 ± 2.305	-0.059 ± 0.368
50.10	0.602 ± 1.178	-0.042 ± 0.203
73.76	0.579 ± 1.116	-0.039 ± 0.181
96.70	0.585 ± 1.124	-0.041 ± 0.178
119.11	0.579 ± 1.115	-0.040 ± 0.178

$$E_{cluster}^{corrected} = E_{cluster}(1 + f)/\epsilon_{global} \qquad \epsilon_{global} = 0.796 \pm 0.158$$



Linear correlation between $E_{Reco\ particle}/E_{Reco\ total}$ and $E_{MC\ particle}/E_{MC\ total}$ when well separated



At a seperation of 25.6 cm [see the Green graphs], Neutron(Pion) overpowers the other in clustering when MC energy deposition is higher ($E_{MC\ particle}/E_{MC\ total} > 0.5$).

Summary

1. Apart from the sampling fraction, cluster energies should be corrected with respect to ϵ_{global} and f.
2. This study can be done with whole ePIC geometry also.
3. Need to compare the corrected cluster energy distribution with the uncorrected one for cross-check.
4. A study on the dependence of f on the shower separation could be useful.