Two-Particle Position Resolution Study from Backward HCal

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

CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

ePIC nHCal-DSC meeting – October 25, 2024

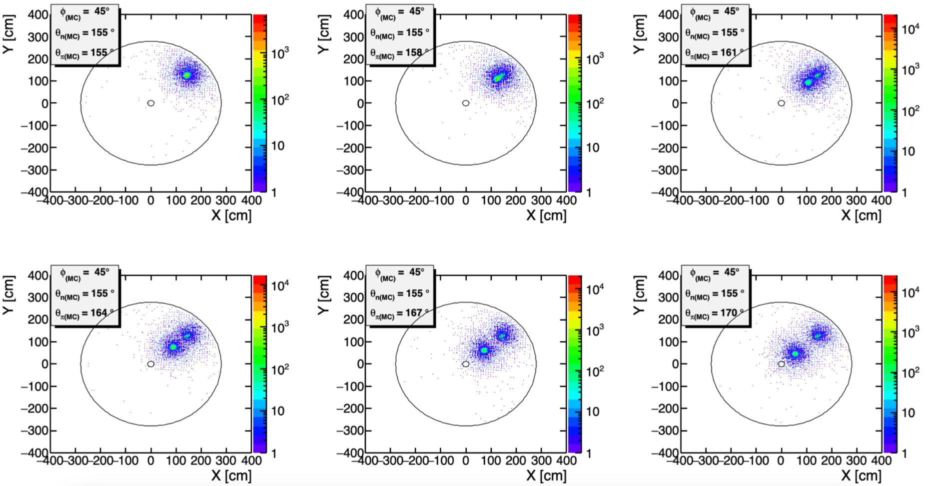
Setup

- (1 n + 1 π^-) / event. ---- ***Standalone ddsim***
- $\varphi = 45^\circ$
  - $\theta_n = 155^\circ$ ($\eta = -1.51$) ------ ***fixed***
  - $\theta_\pi = 155^\circ$ ($\eta = -1.51$), 158° ($\eta = -1.64$), 161° ($\eta = -1.79$), 164° ($\eta = -1.96$), 167° ($\eta = -2.17$), 170° ($\eta = -2.44$)

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

- 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)



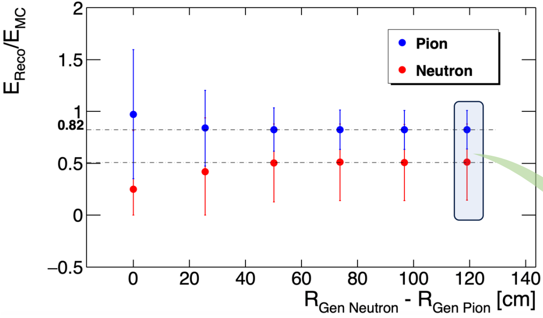
Cluster (x,y) are shown along with simulated angular coordinates

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

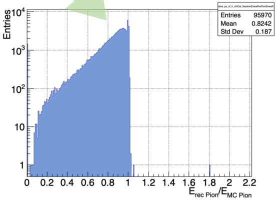
Decreases for neutron as the gap decreases. Some part being hijacked by pions.

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

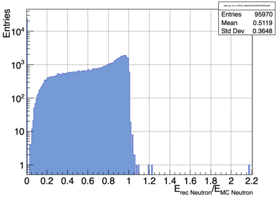
E_{MC} is the Energy deposited during Simulation by the particle

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

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

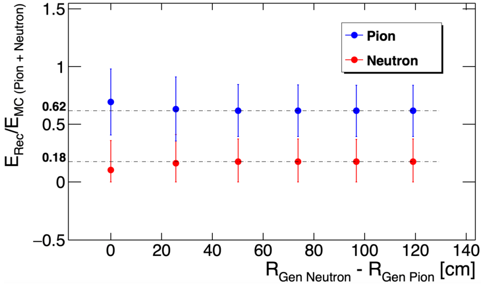


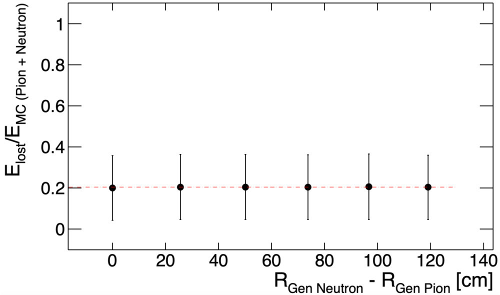
Pion



Neutron (more RMS)

Cluster Reconstruction



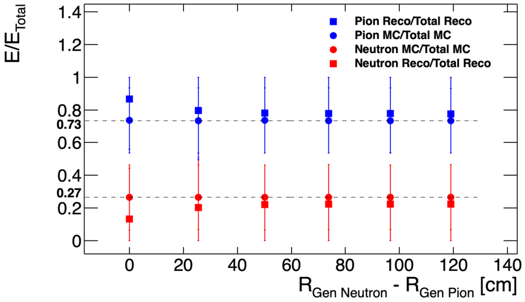


$$E_{MC(Pion+Neutron)} = E_{Rec(Pion+Neutron)} + E_{lost}$$

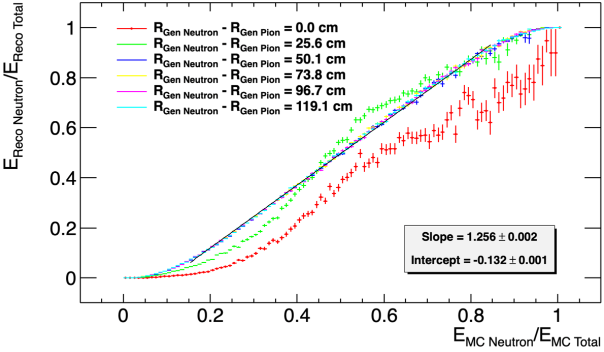
$$\epsilon_{global} = E_{Rec(Pion+Neutron)}/E_{MC(Pion+Neutron)}$$

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

Energy transfer while clustering

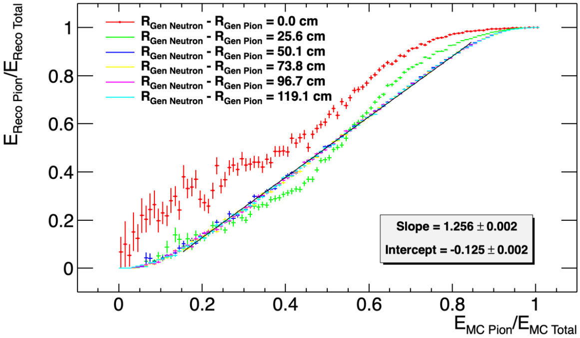


Cluster Reconstruction



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 ($E_{MC\ particle}/E_{MC\ total} > 0.5$).

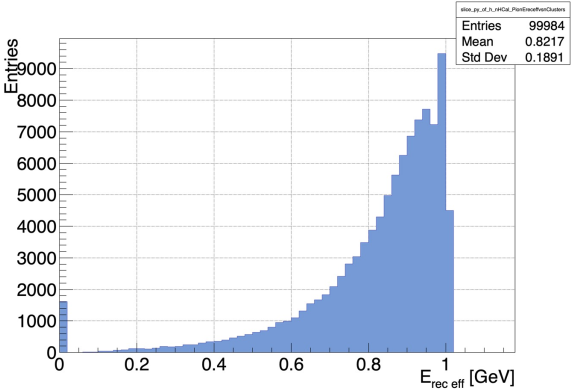


Update – from single particle simulation

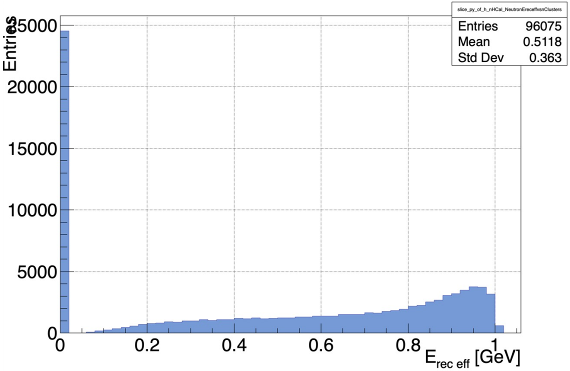
$\epsilon_{\text{global}} \neq$ a global property

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

≈ 0.80 (Fraction of MC energy deposition that went into clustering)

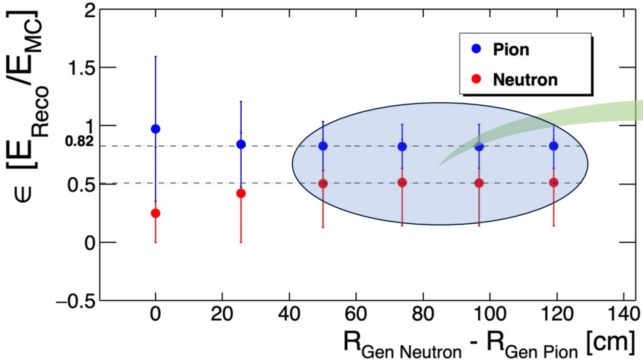


$$\epsilon_{\pi} = E^{\pi}_{Reco}/E^{\pi}_{MC}$$



$$\epsilon_{n} = E^{n}_{Reco}/E^{n}_{MC}$$

Update –



Similar values as the single particle simulations.

Since, no energy hijacking is involved here.

E_{π} can be obtained from tracking and PID

$$E_{n}^{cluster} = E_{total}^{cluster} - \epsilon_{\pi single} E_{\pi}$$

$< E_{cluster}/p > \approx 0.82/1.0$ For pions

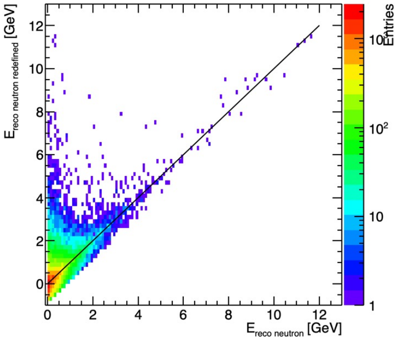
$\epsilon_{\pi single} = 0.82 \pm 0.18$ at 1 GeV

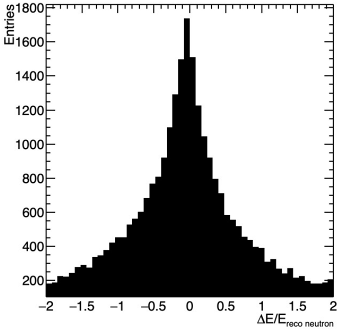
$E_{\pi} = E_{\pi}^{MC}$ when corrected with sampling fraction

$R_{gen\ Neutron} - R_{gen\ Pion} = 119.11$ cm

$$E_n^{cluster} = E_{total}^{cluster} - \epsilon_{\pi single} E_\pi$$; when, $R_{cluster\ Neutron} - R_{cluster\ Pion} < 50$ cm.

$$E_n^{cluster} = E_{total}^{cluster} - E_\pi^{cluster}$$; when, $R_{cluster\ Neutron} - R_{cluster\ Pion} >= 50$ cm.





Study energy dependence of $\epsilon_{\pi single}$ and sampling fraction of pion.
Replicate this for full geometry.