Benchmarking ZDC design with Lambda

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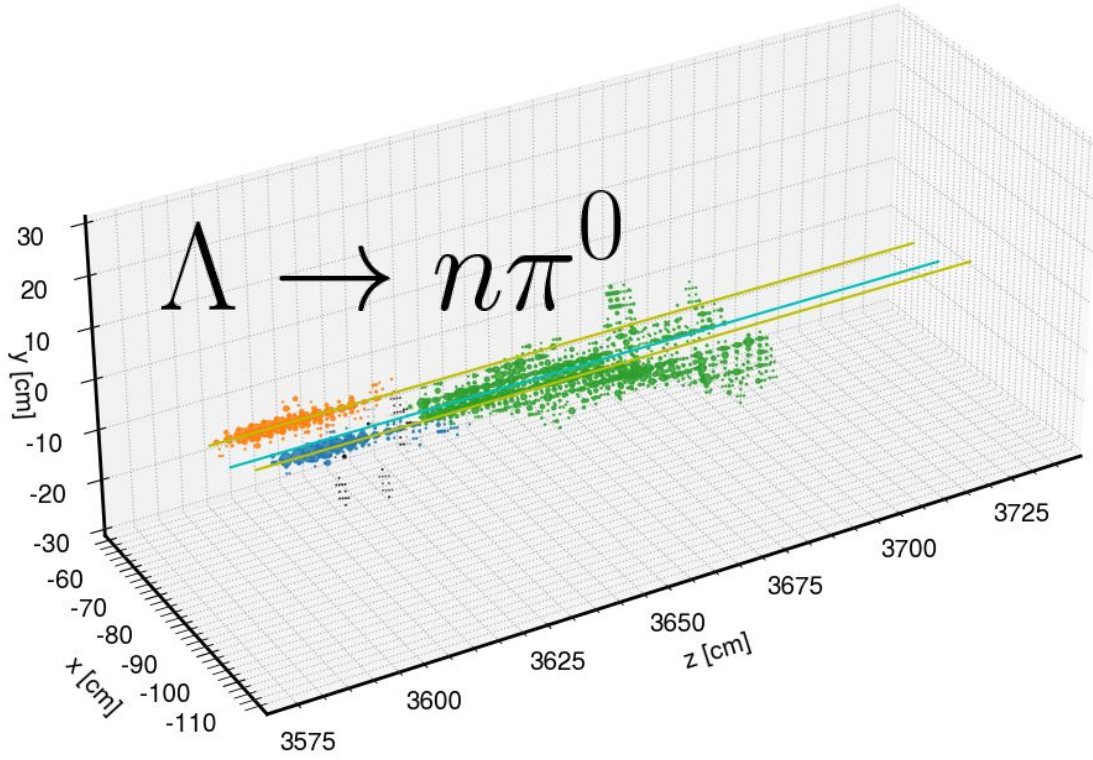
Credit: Sebouh Paul, Sebastian Vasquez, Ryan Milton, Barak Schmookler

UC RIVERSIDE

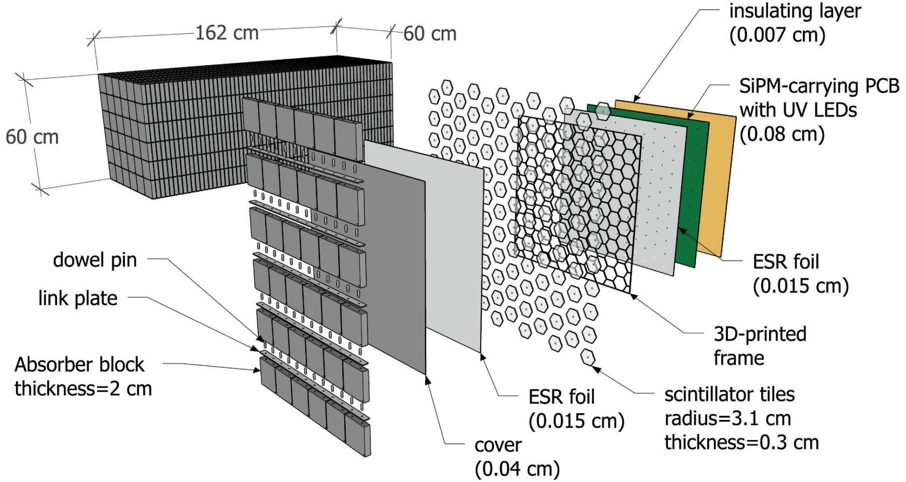
E_Λ = 100 GeV, θ_Λ=1.1 mrad, z_{vtx}=19.2 m

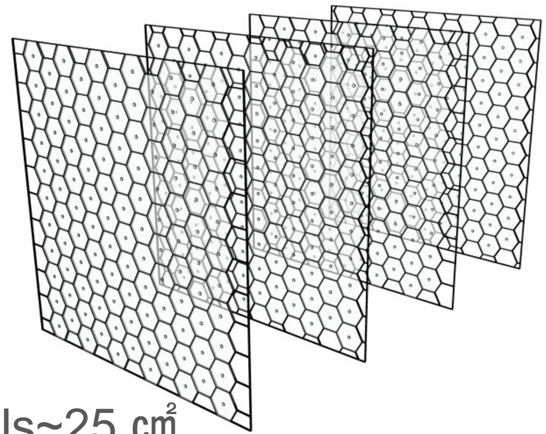


ePIC meting, July 27th 2024

SiPM-on-tile Fe/Sc ZDC

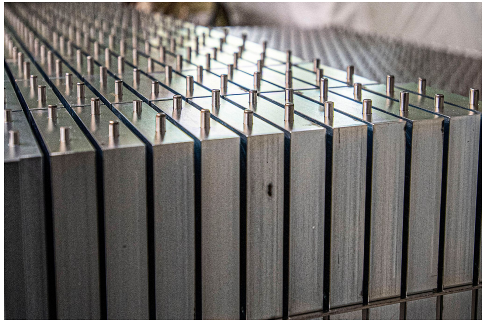
High-granularity from CALICE-style tech
Staggered design as in *NIMA 1060 (2024) 169044*
Design and performance in arXiv:2406.12877

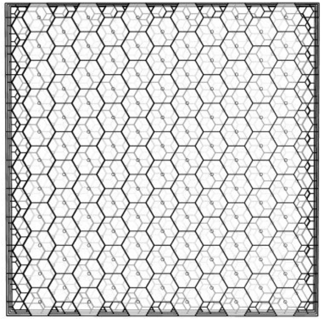


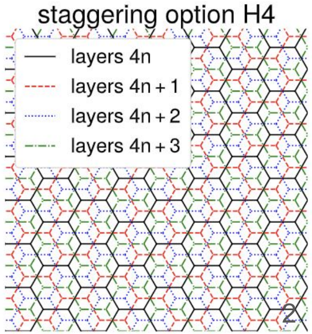


Cells~25 cm²

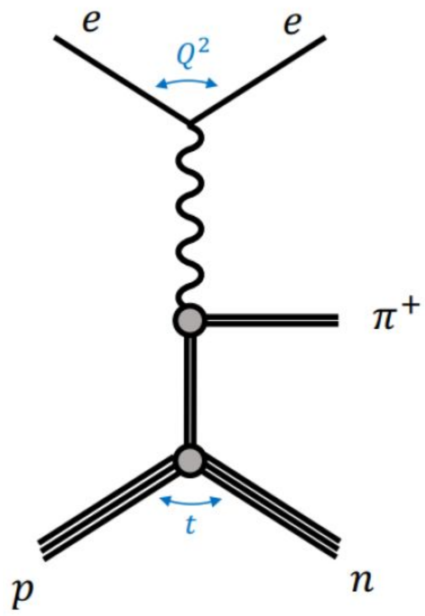
Fe blocks from STAR

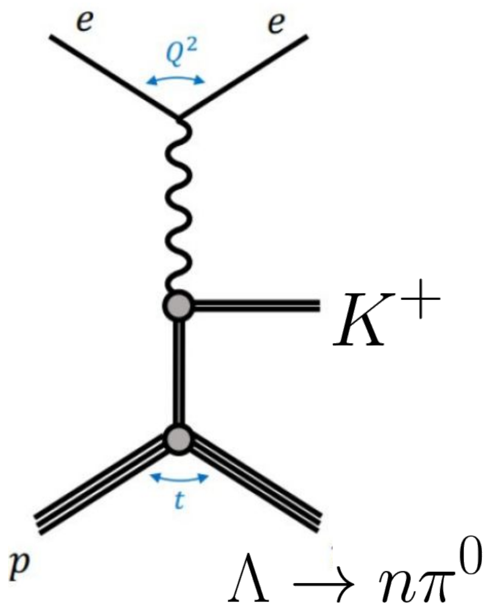




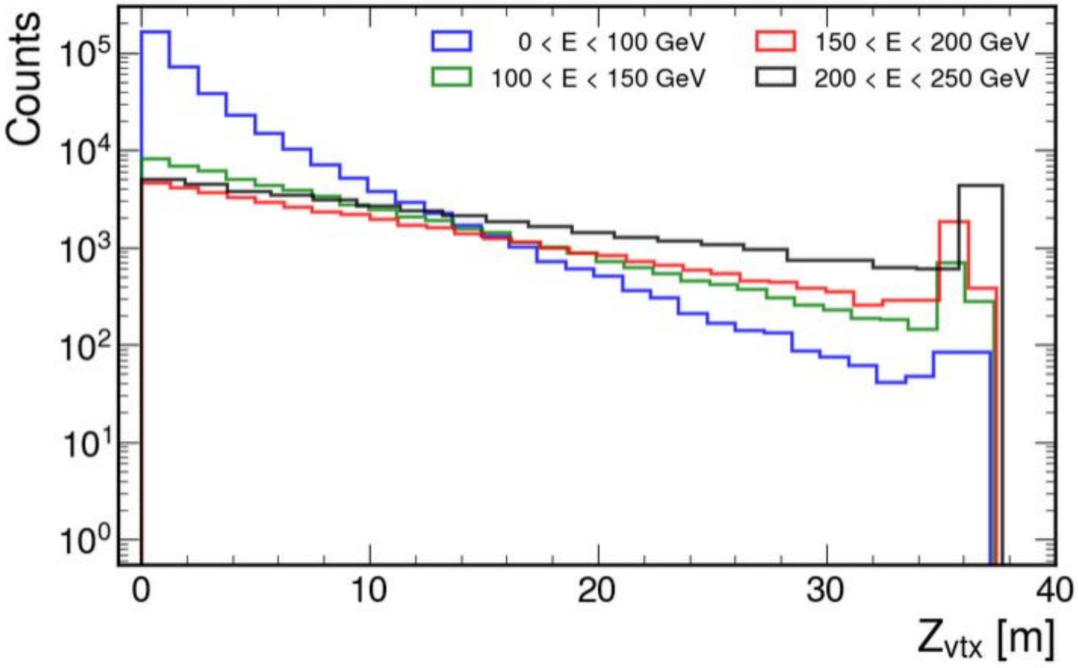


Key ZDC Physics Benchmarks





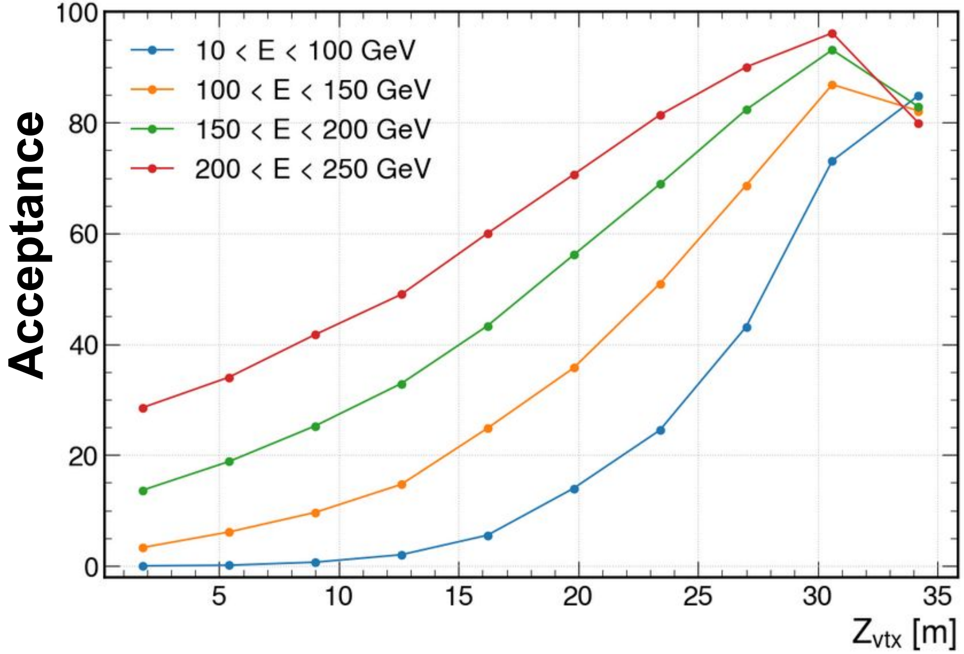
$\Lambda \to n\pi^0$ challenge: displaced vertex



We need to know Z_vertex to properly measure polar angle!

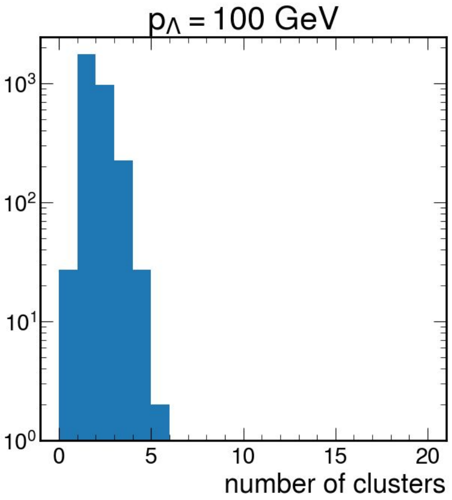
Efficiency (Fraction of events with neutron and 2 photons in ZDC area)

$$\Lambda \rightarrow n\pi^0$$

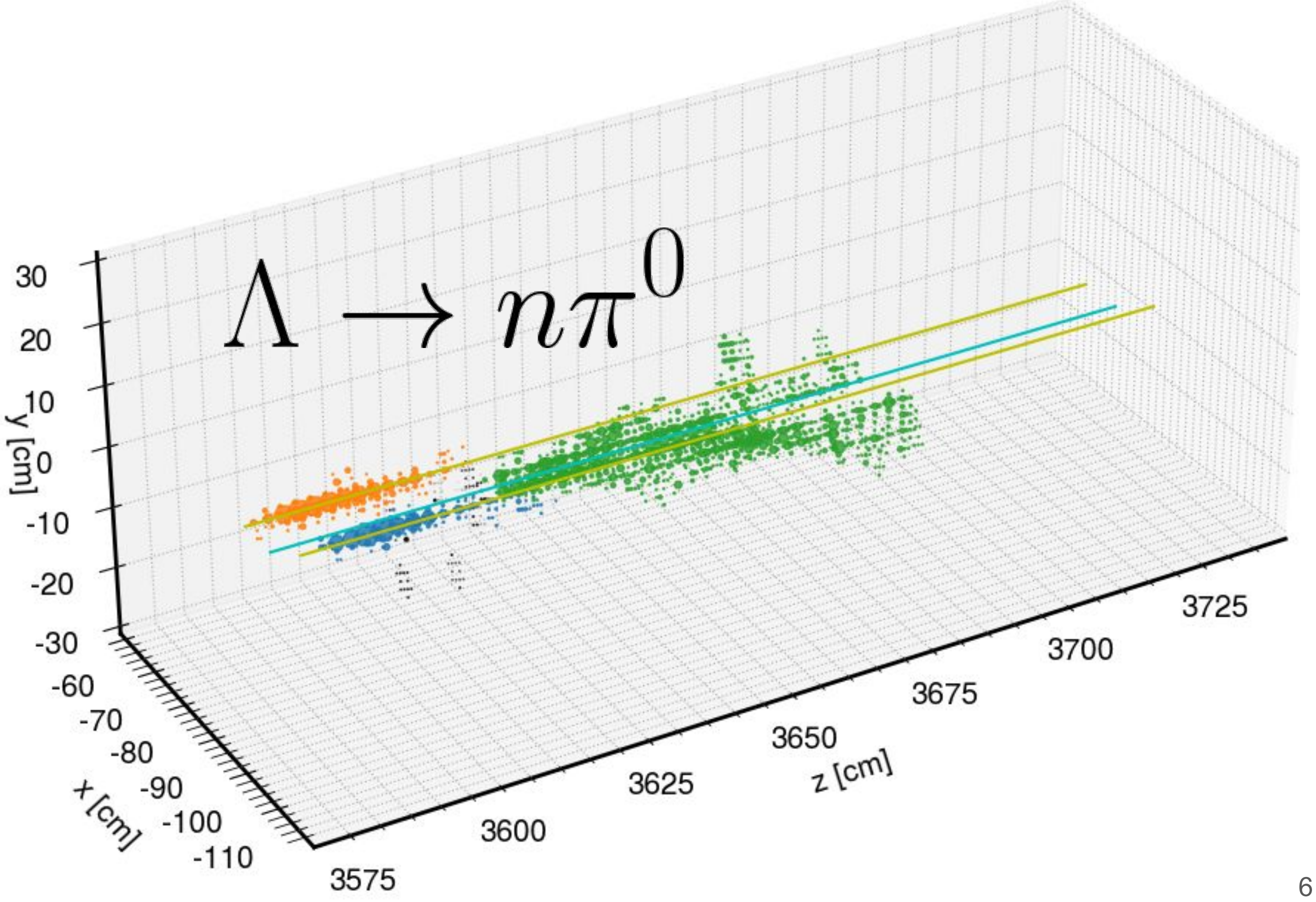


- Higher energy -> higher boost, which increases lifetime and collimates decay particles.
- Higher z position -> increases solid angle

3D TopoClustering Run on SiPM-on-tile only (no crystal)

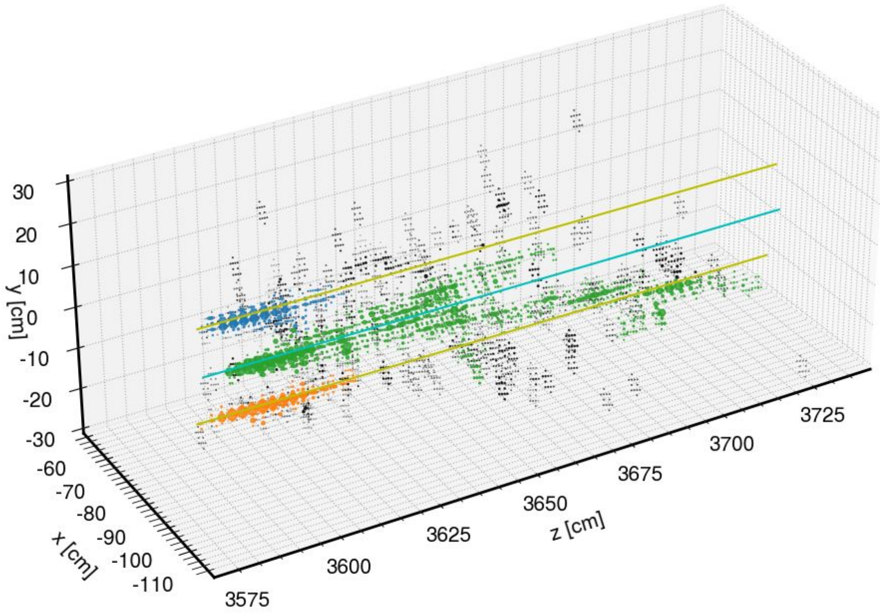


E_Λ = 100 GeV, θ_Λ=1.1 mrad, z_{vtx}=19.2 m

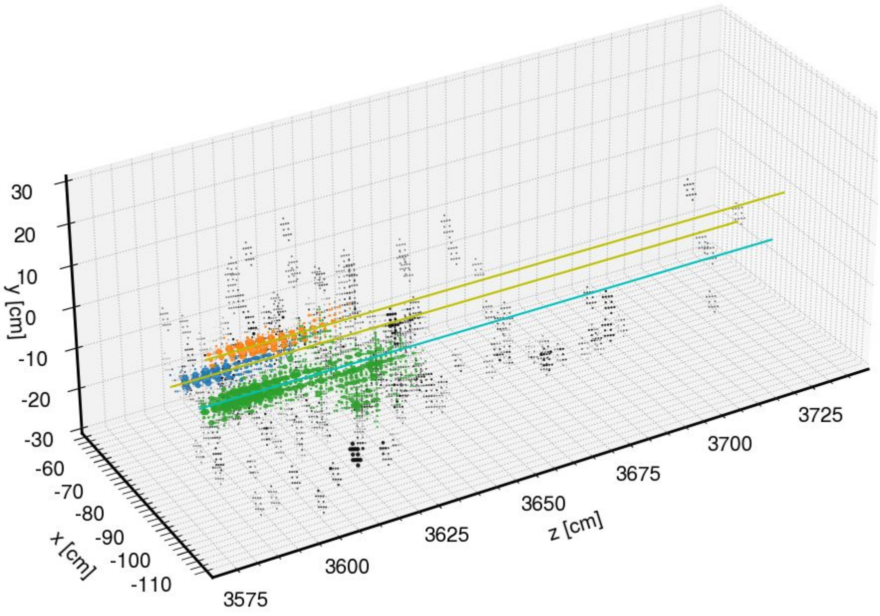


More Examples

E_Λ = 100 GeV, θ_Λ=2.1 mrad, z_{vtx}=15.0 m

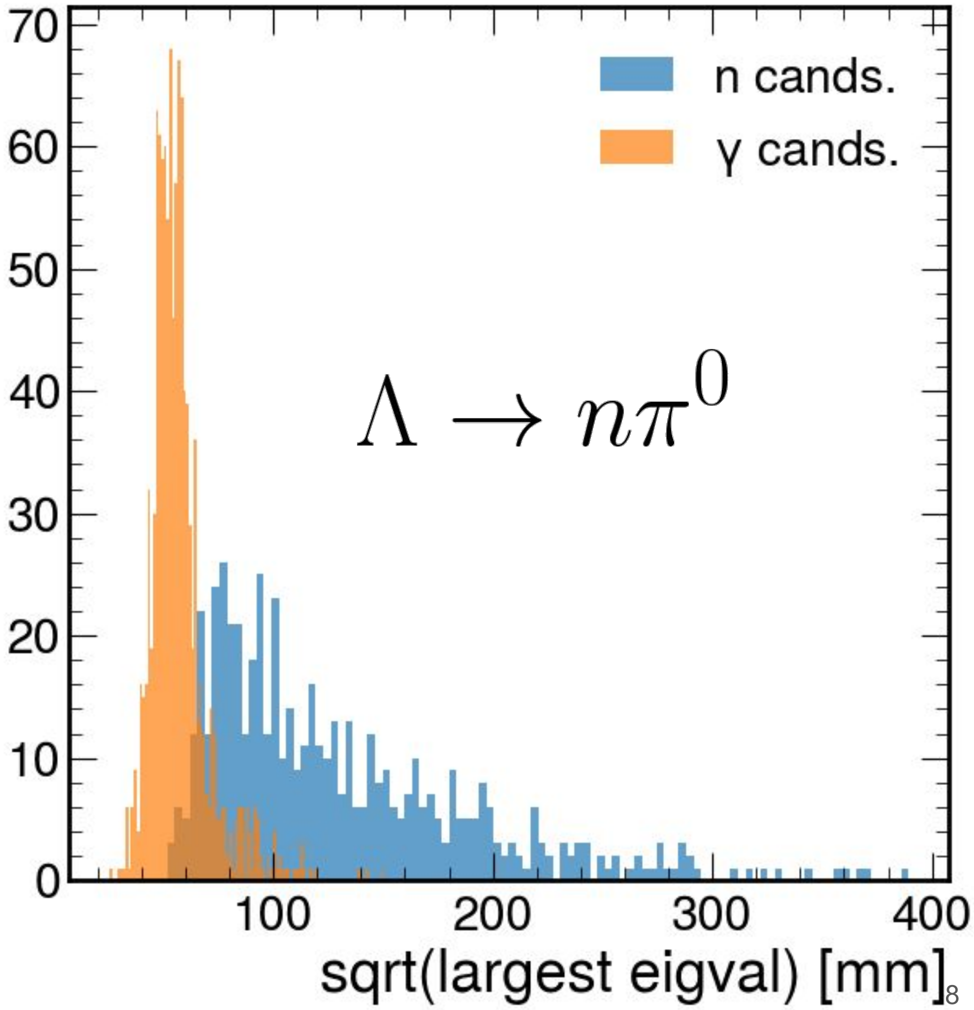


E_Λ = 100 GeV, θ_Λ=2.4 mrad, z_{vtx}=17.3 m



Lambda Reco Step 1:

Select events with 3 topoclusters
Identify neutron candidate as cluster with largest eigenvalue
Other 2 are photons



Lambda Reco Step 2:

“Kinematic fitting”
Force diphoton mass to pi0 PDG, which constraints longitudinal-vertex position.

Use this constraint while calculating mass of

$$\Lambda \rightarrow n\pi^0$$

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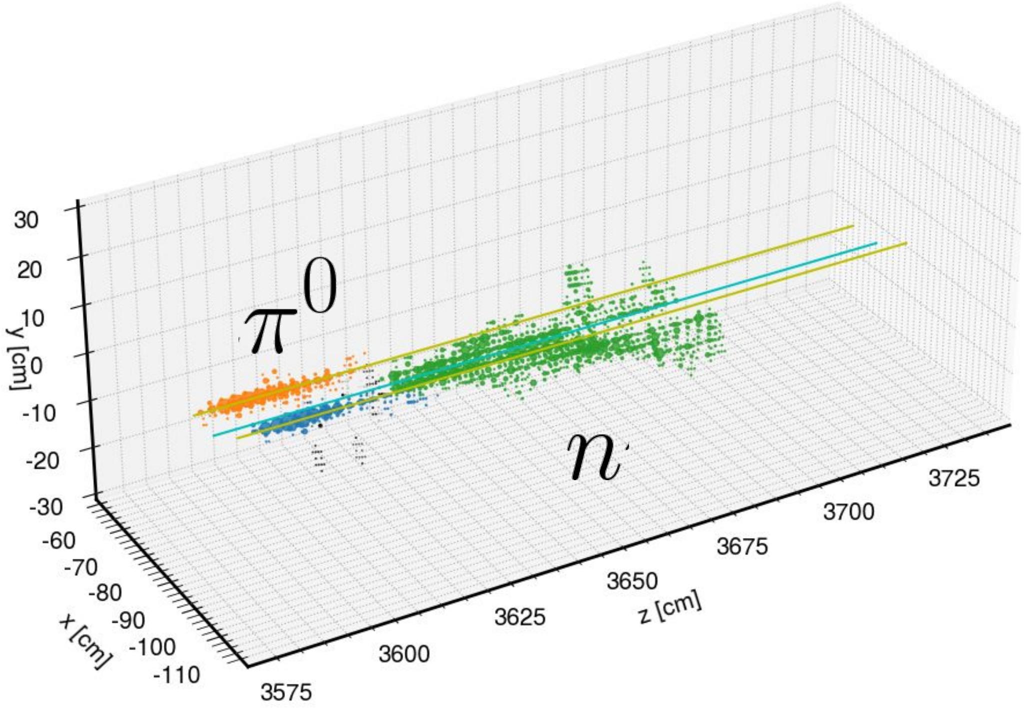
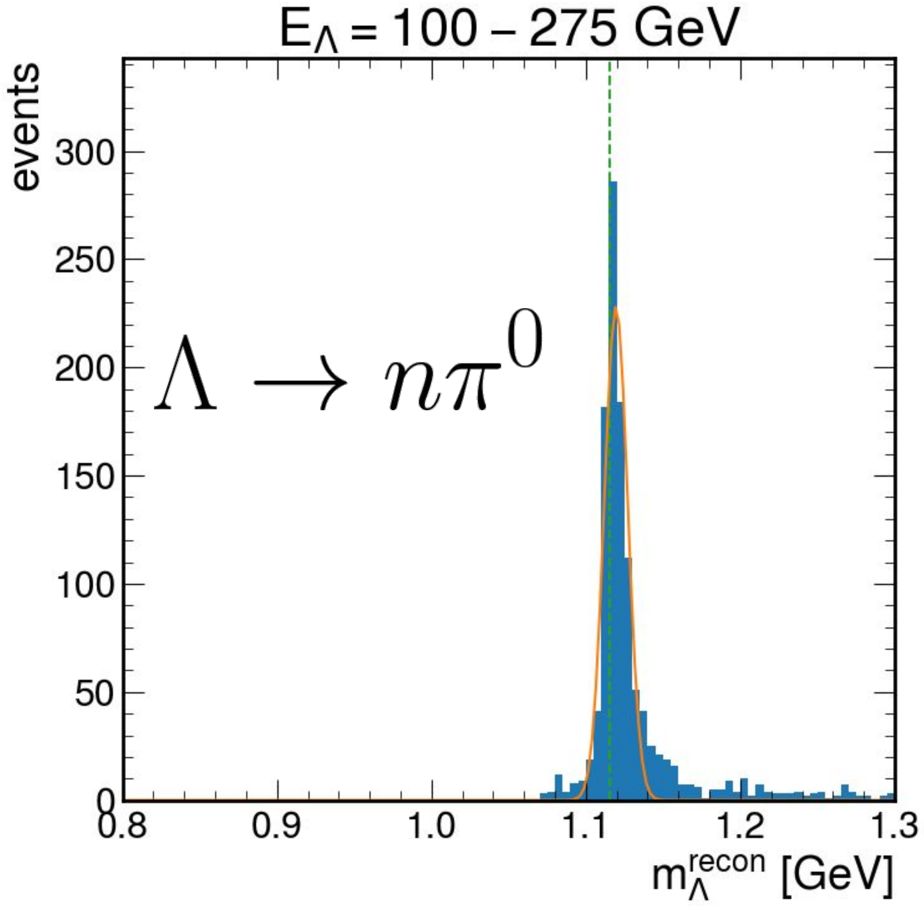
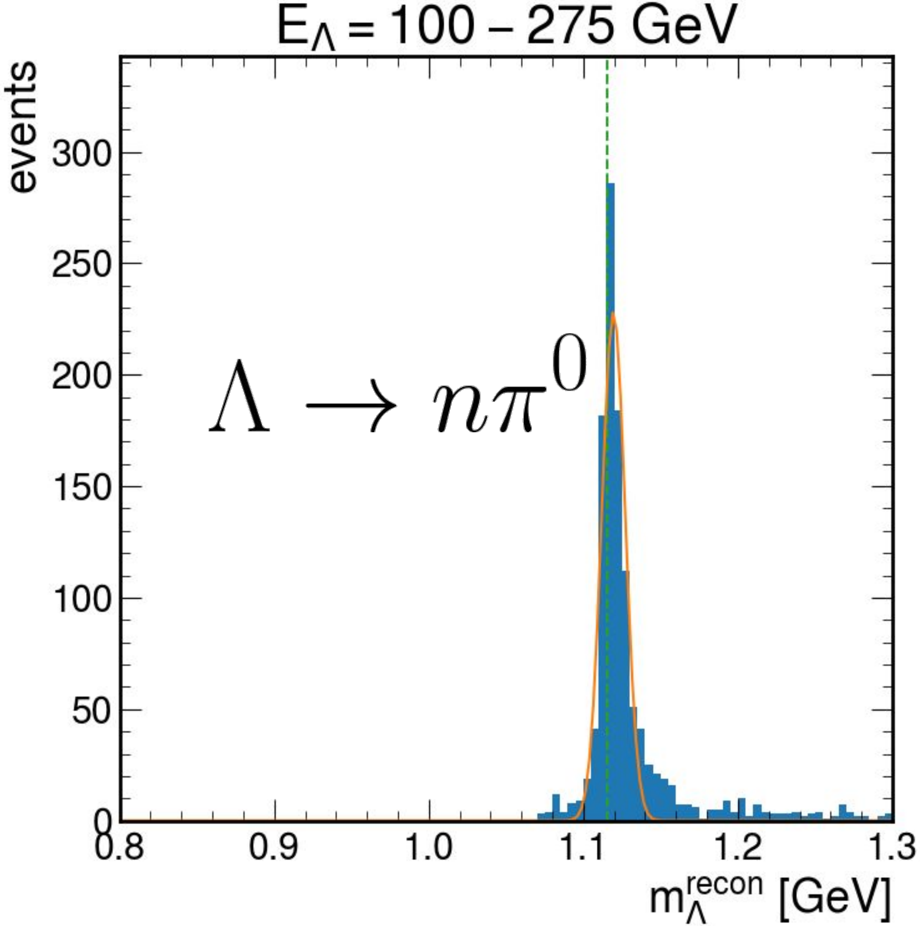


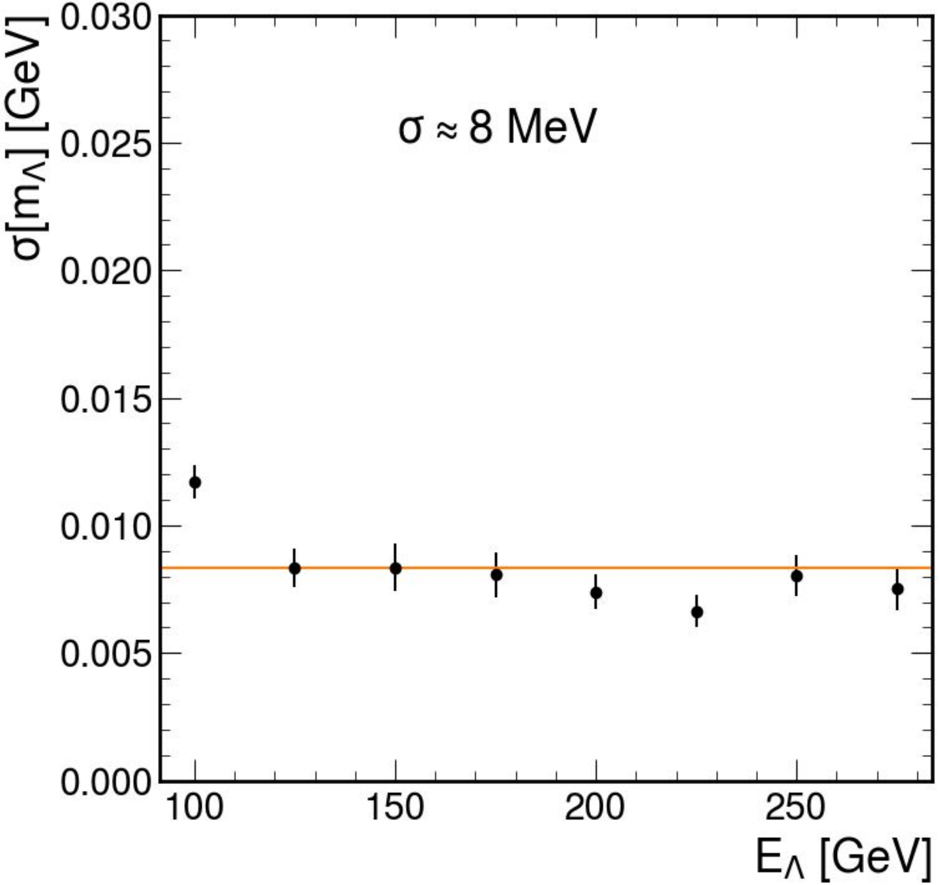
Lambda mass with SiPM-on-tile standalone (no crystal)



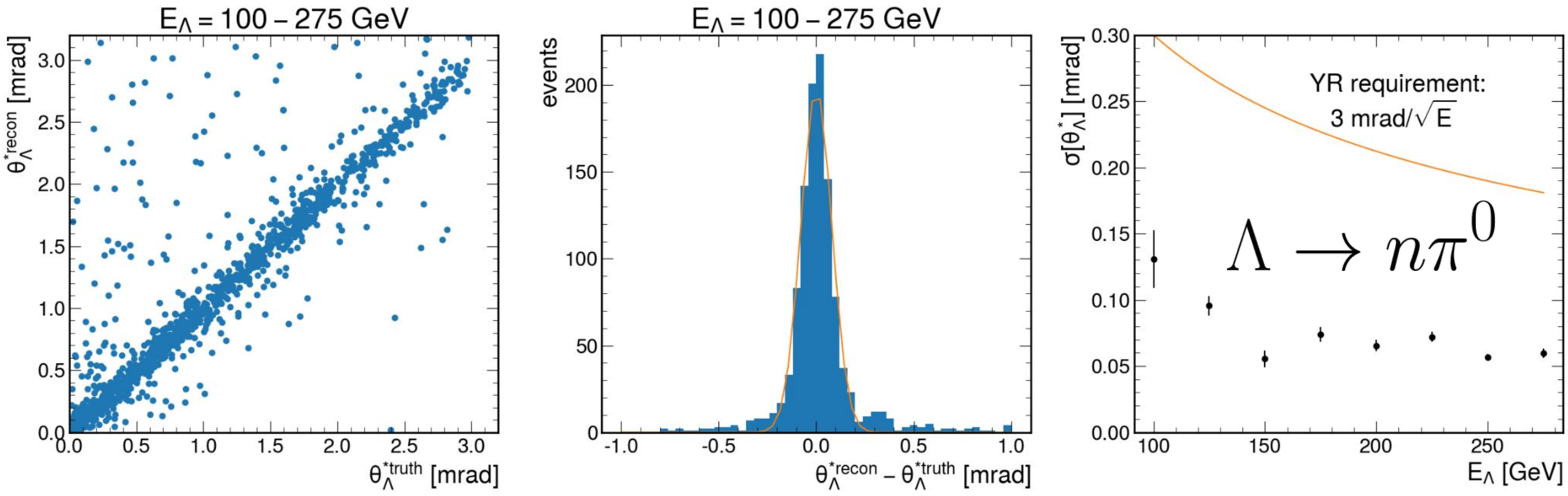
Credit: Sebouh Paul

Energy dependence

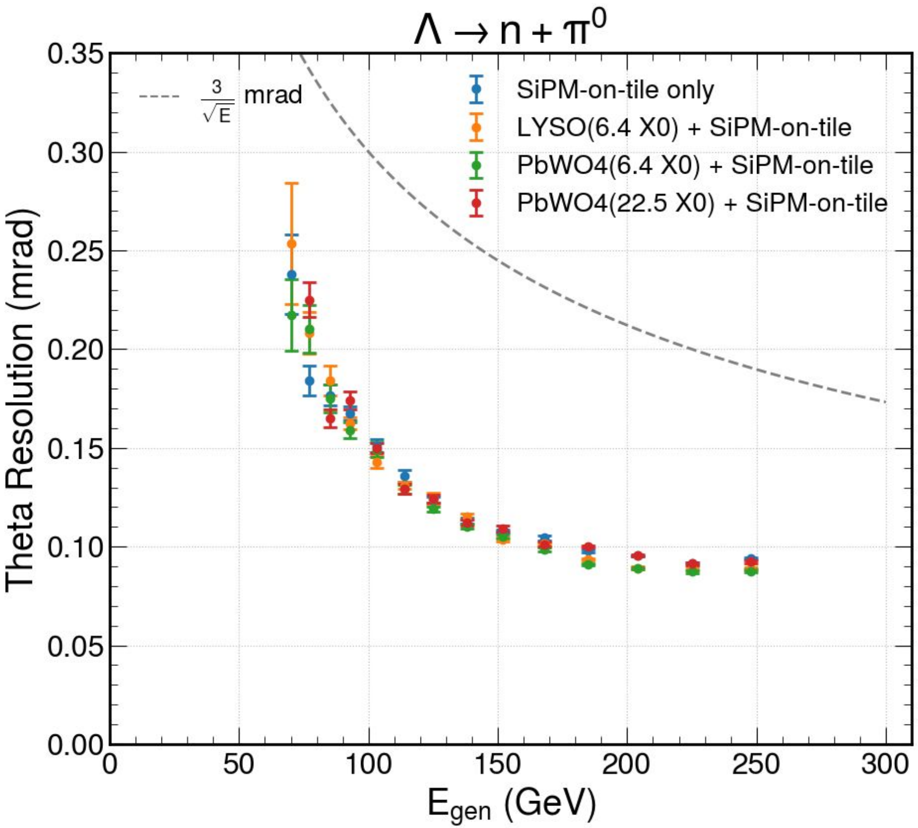


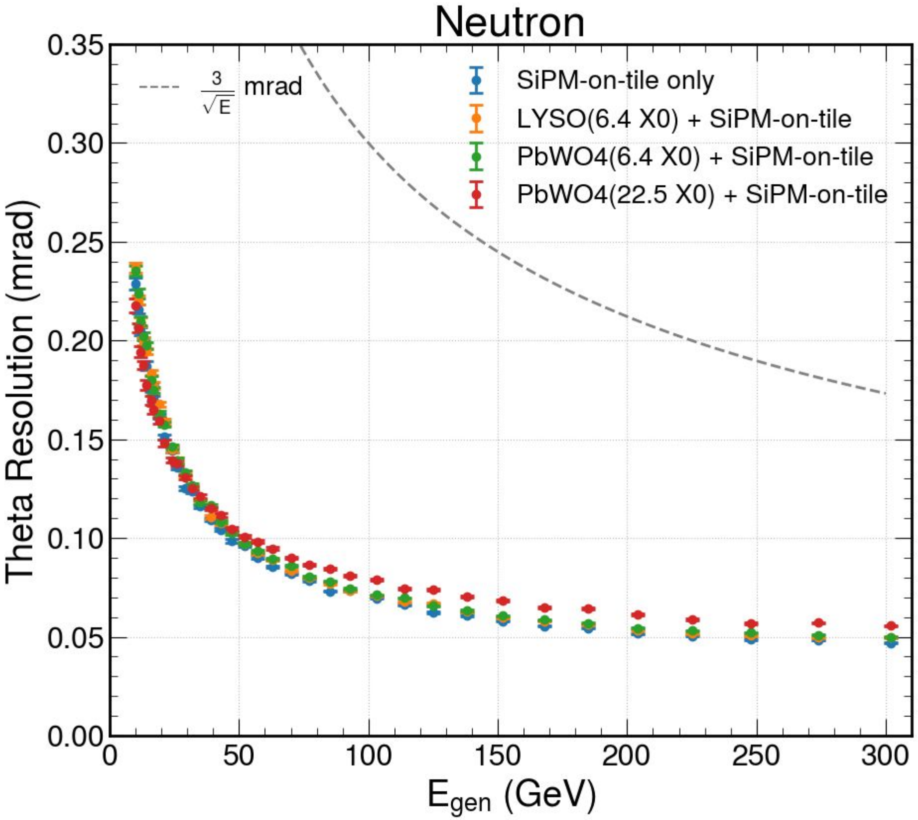


Lambda polar angle with SiPM-on-tile standalone (no crystal)



Angle resolution with GNN reconstruction





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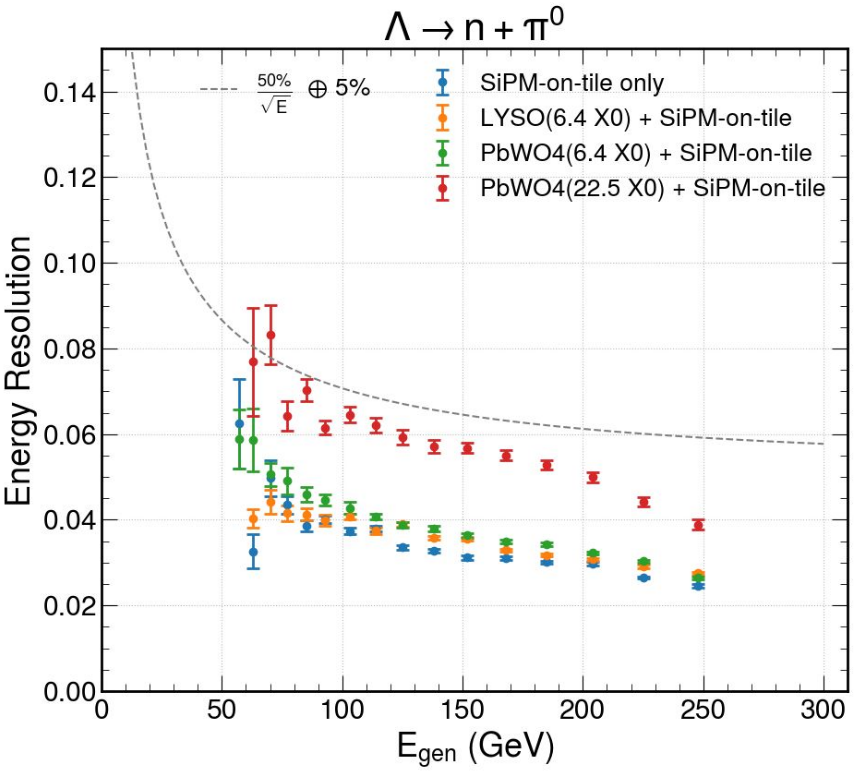
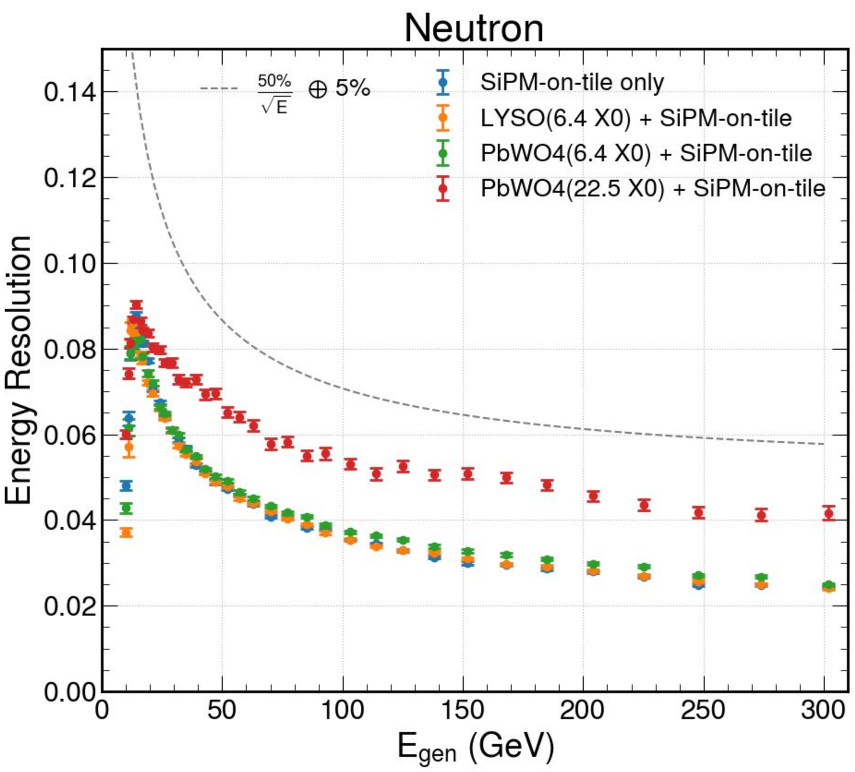
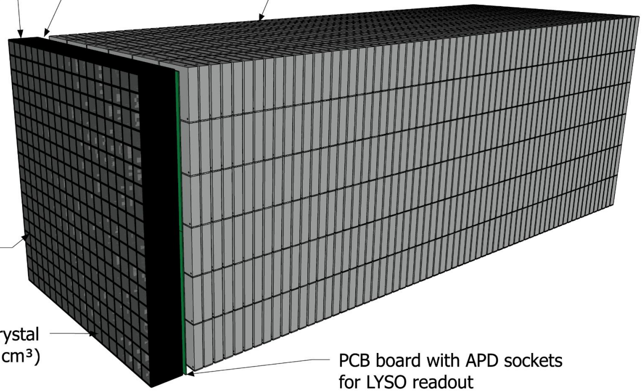




Take-Home Message

SiPM-on-tile Fe/Sc and <u>short</u> LYSO crystal meet all physics requirements,
We have found no good reason to keep long PbW04 crystal in baseline.



Low-energy [1 MeV-O(1) GeV] ɣ→ LYSO
High-energy ɣ and π0 → Fe/Sc
High-energy neutrons, Lambda → Fe/Sc

Backup

Angle bias with GNN reconstruction