



中央研究院物理研究所
INSTITUTE OF PHYSICS, ACADEMIA SINICA

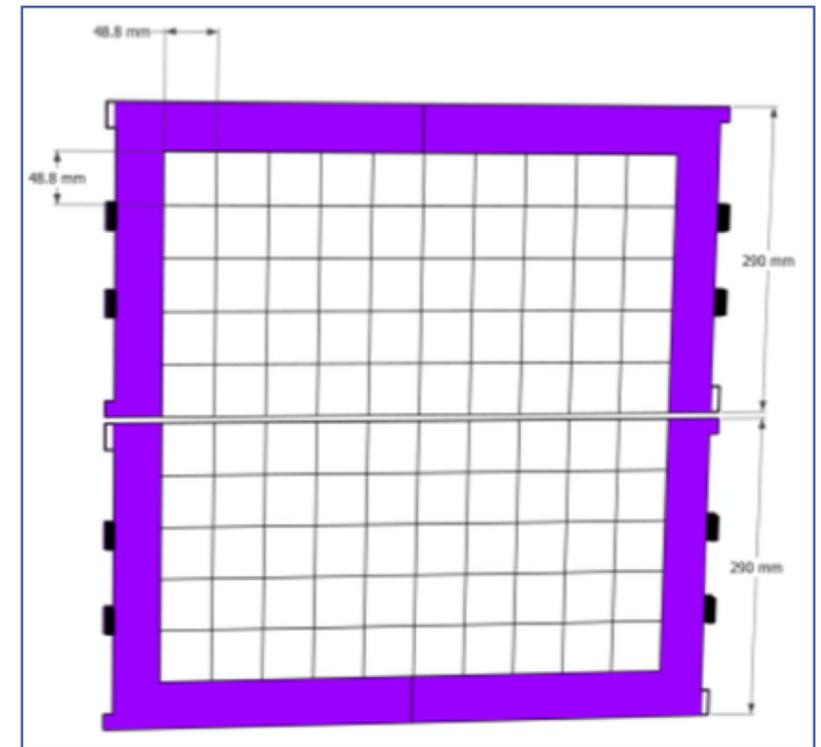
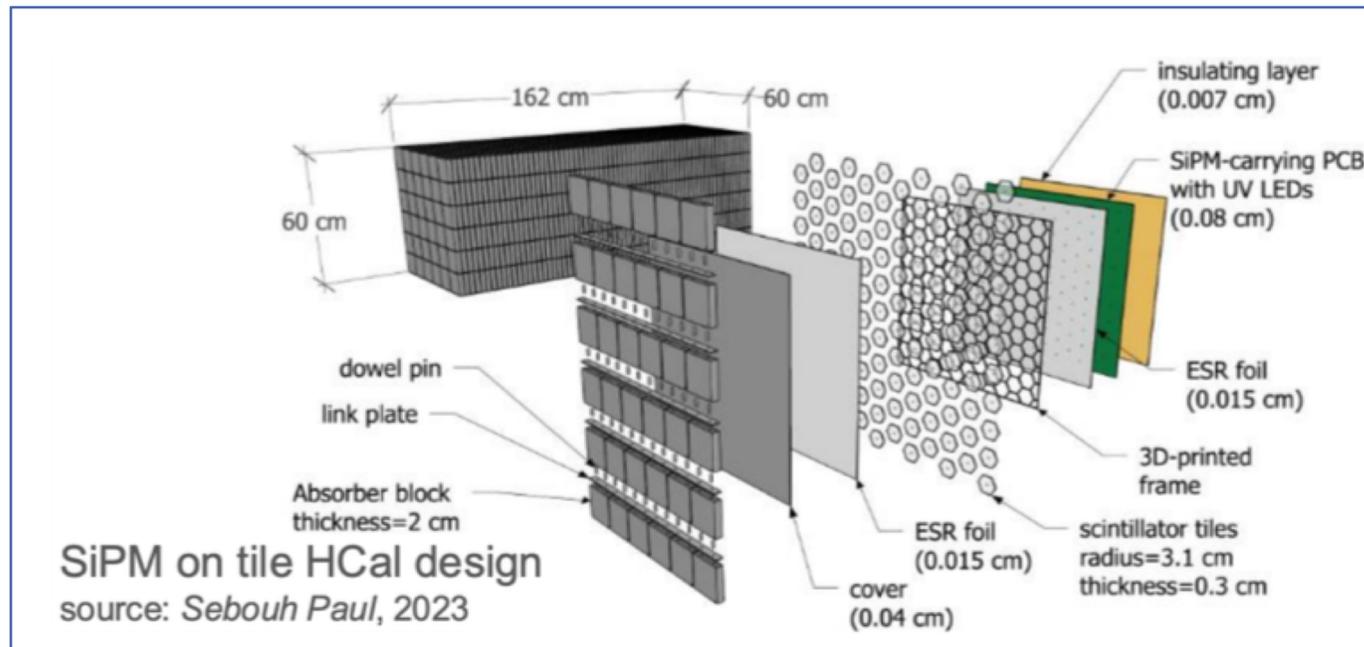
Status report

2025/10/02

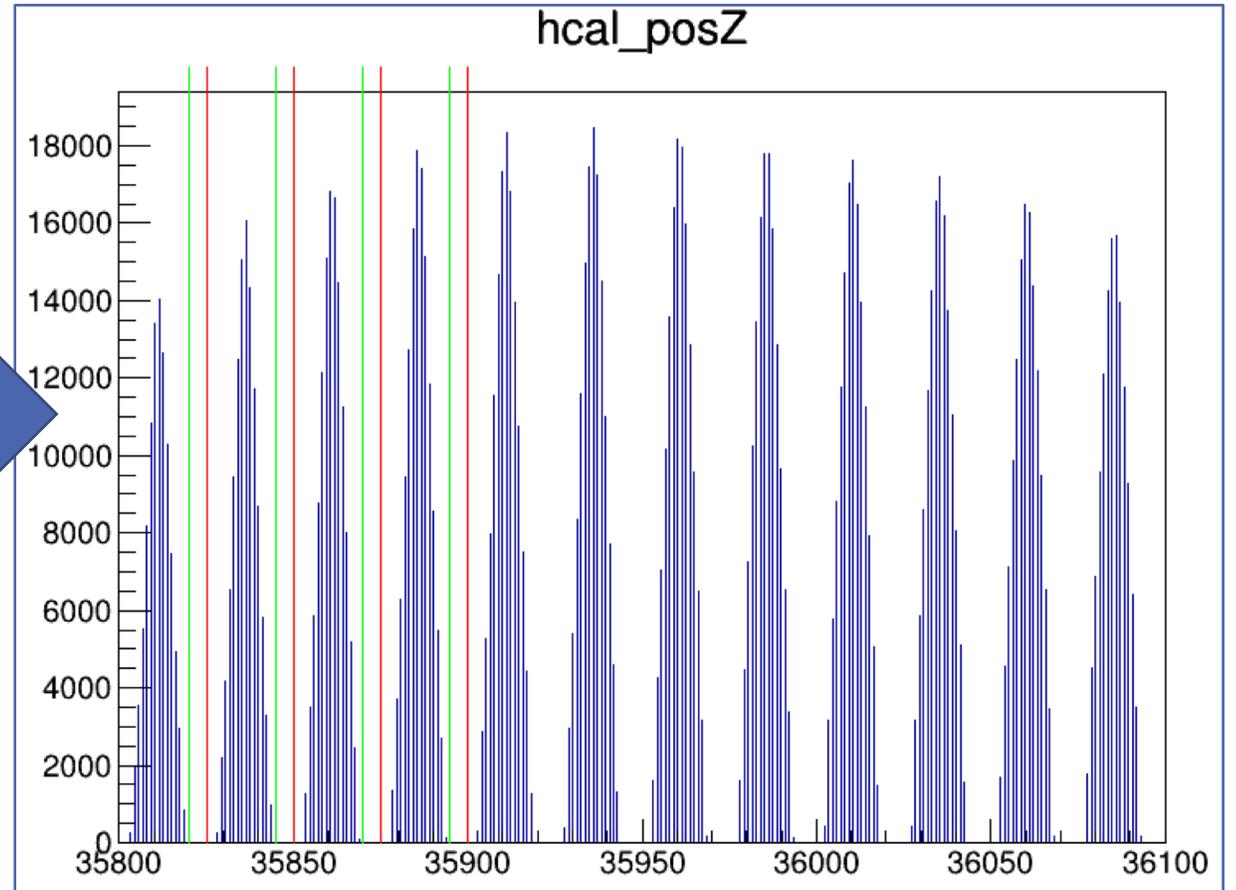
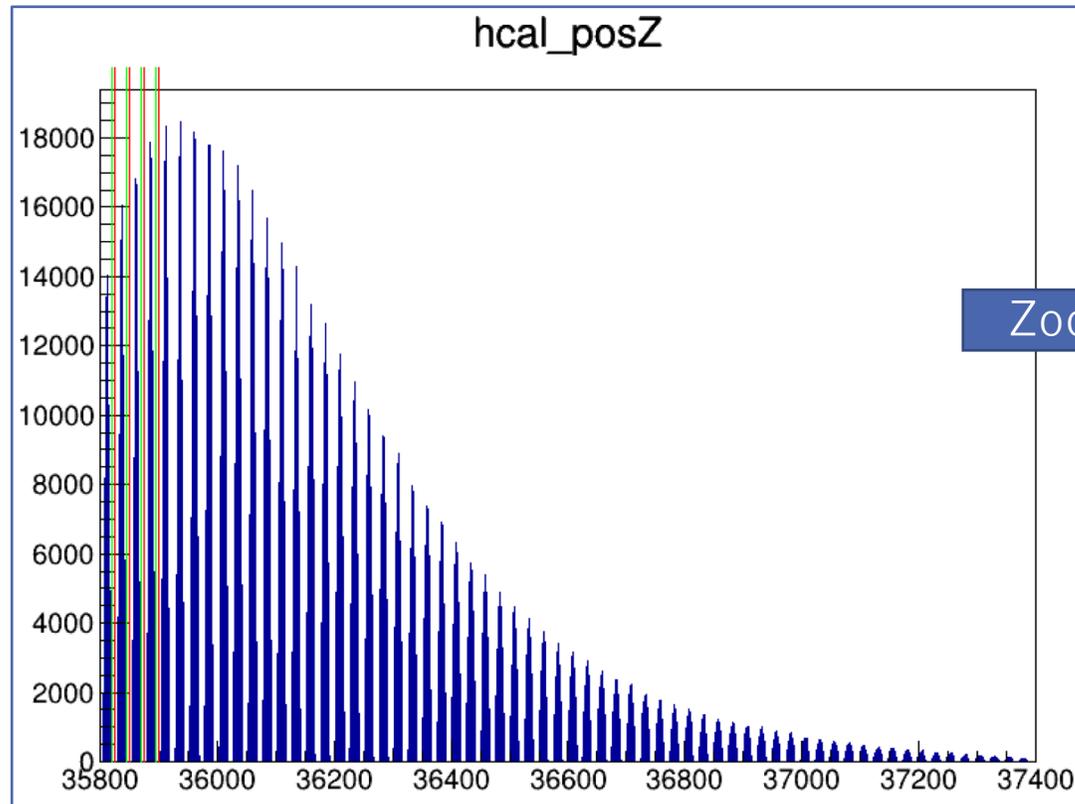
ZDC ML

WAI YUEN CHAN

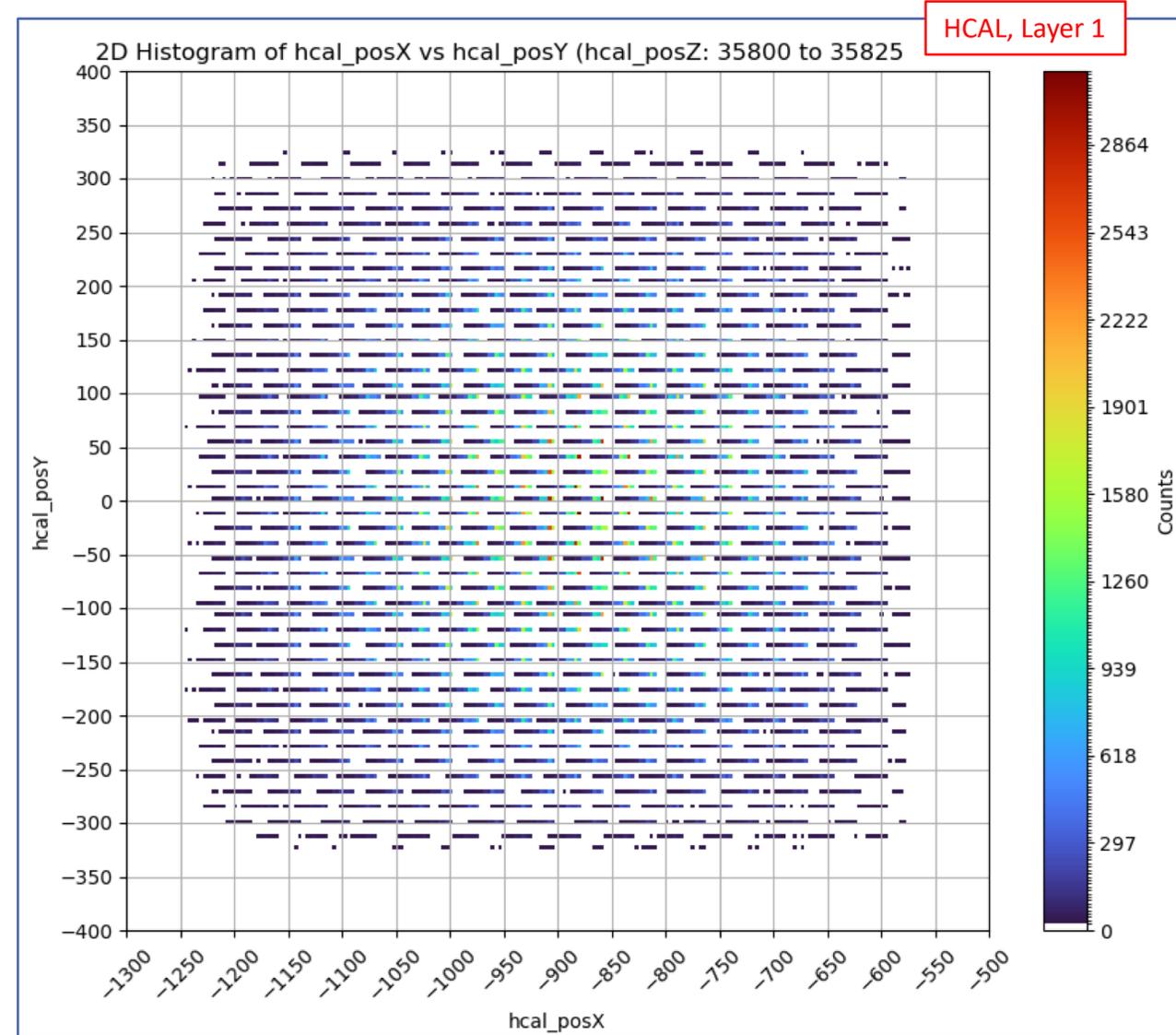
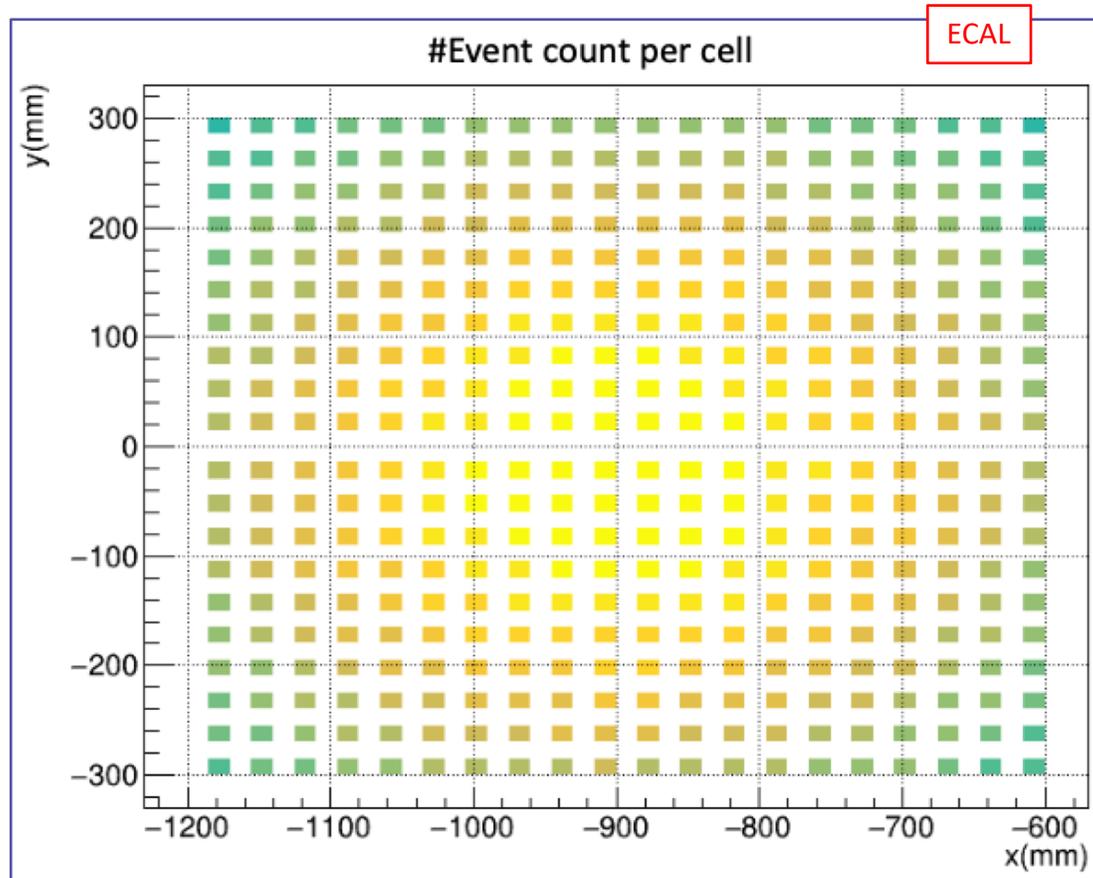
- In order to implement the HCAL info into the ML training, we first have to understand and design how to set up our grid.
- First of all we have a 2cm absorber block + 0.49cm for the rest in each layer.
- Assuming we have 2.5cm for 1 layer, and subtract the 2cm blackplate at the end, we have $(162-2)/2.5 = 64$ layers.
- In the x-y plane, we use the same grid as PCB (10 x 10).



- We plot the hit position from the 1M neutron sample.
- The green and red line represent the 2.0cm and 2.5cm mark.
- Therefore we can see that all the hits are simulated in the absorber.
- And we can define 1 layer = 2.5cm.

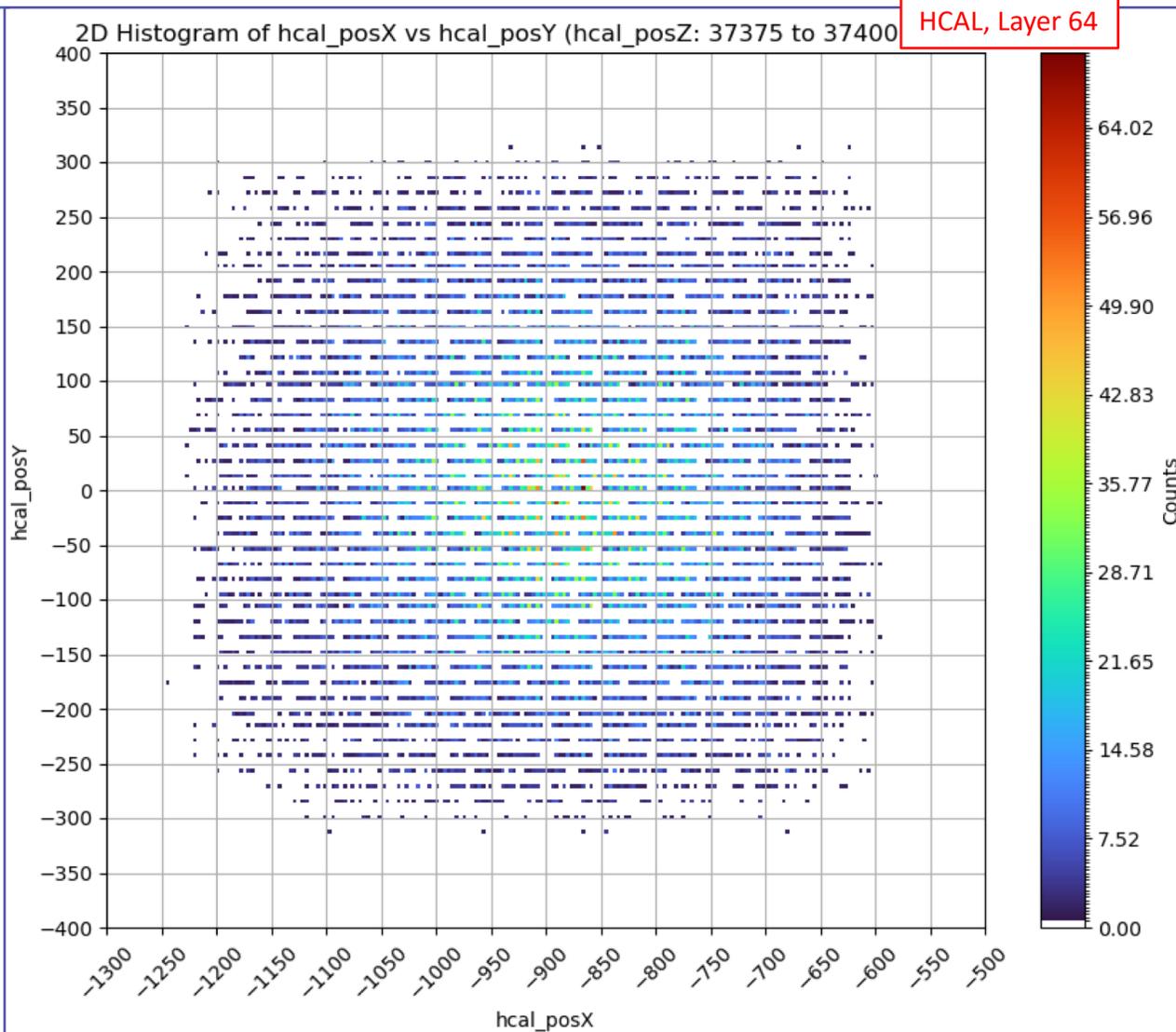
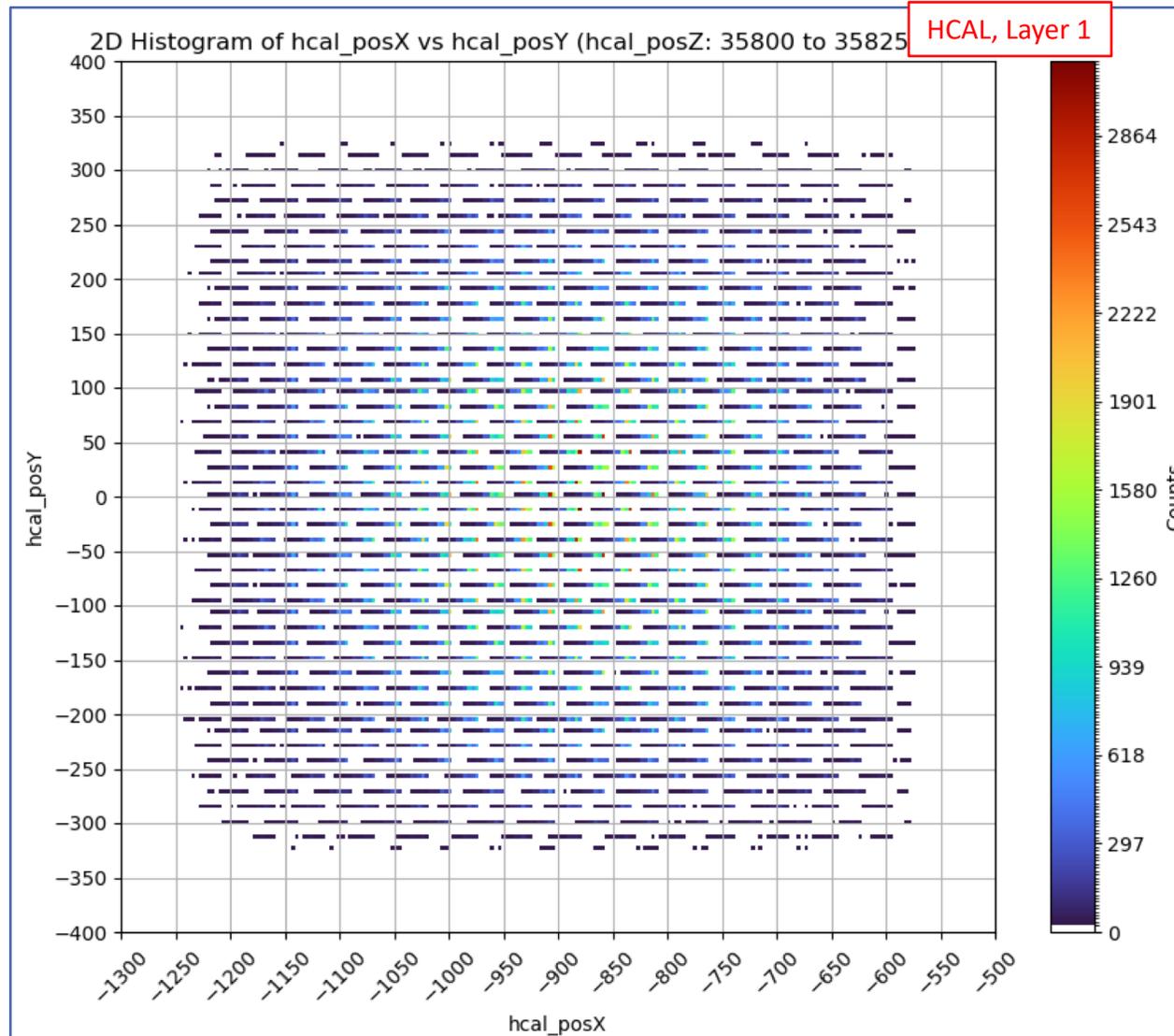


- We first plot all the hits at the first layer.
- Here we can see that the grid size in ECAL cannot capture all the hit in HCAL, we need a little bit larger grid.

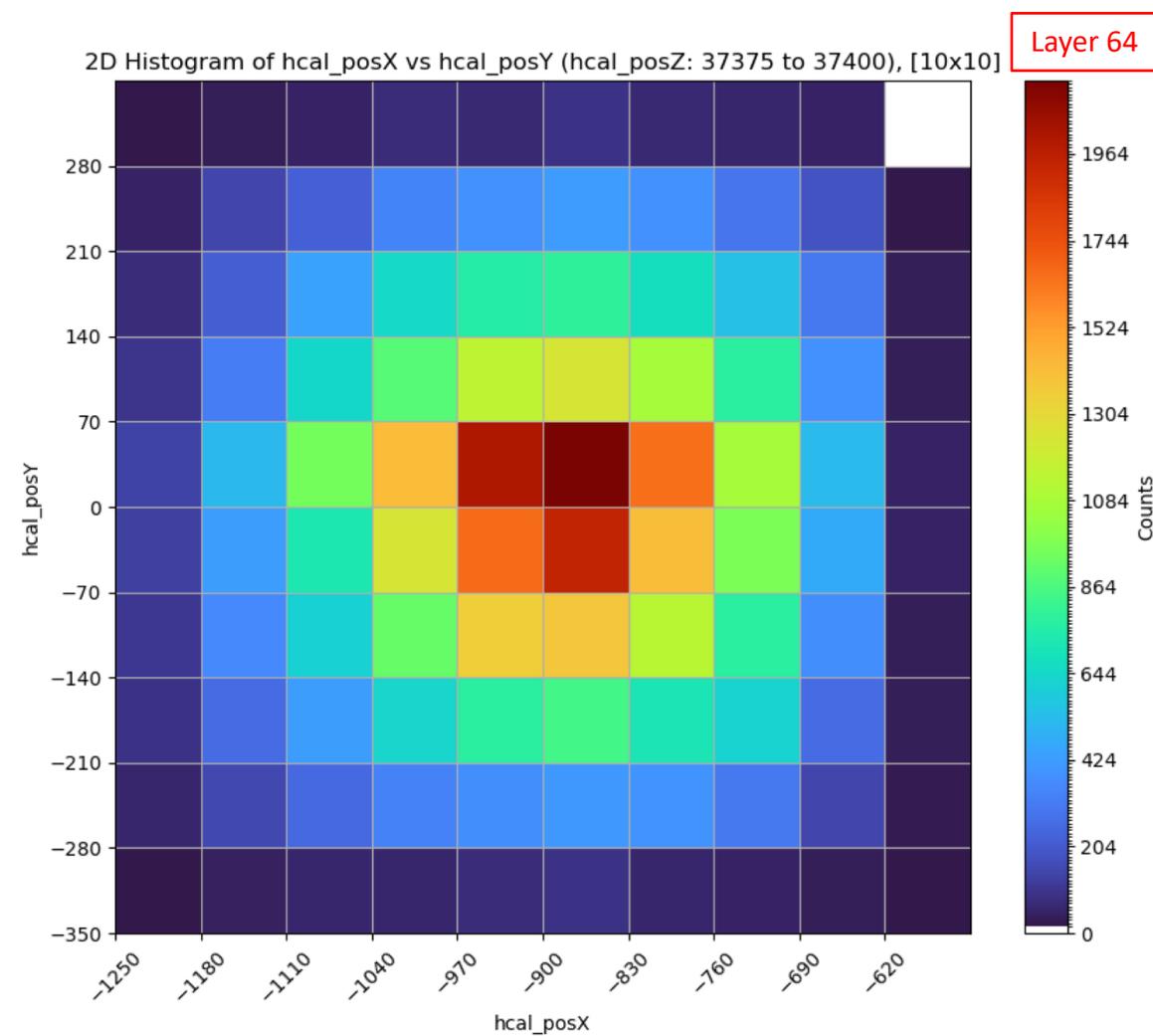
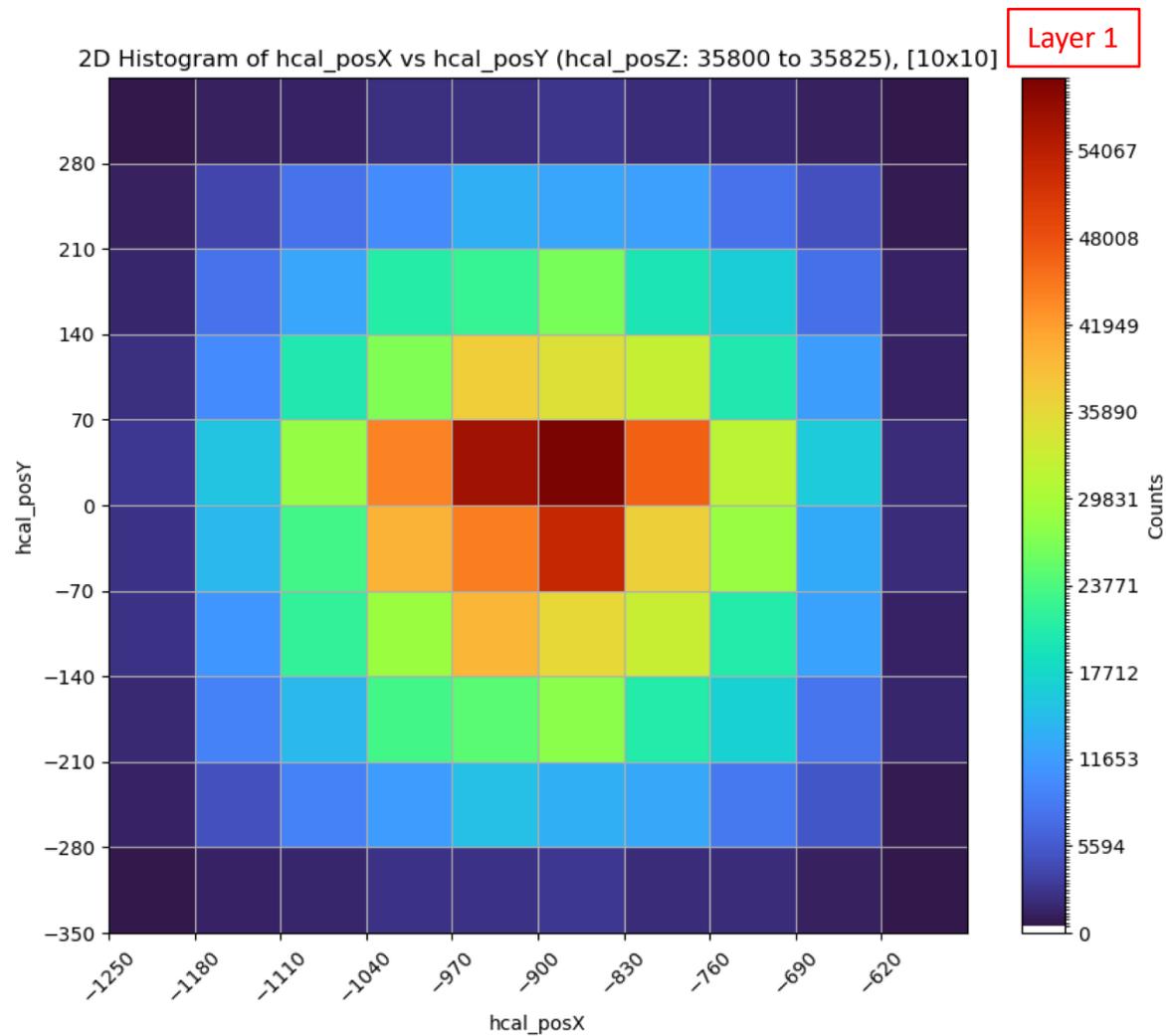


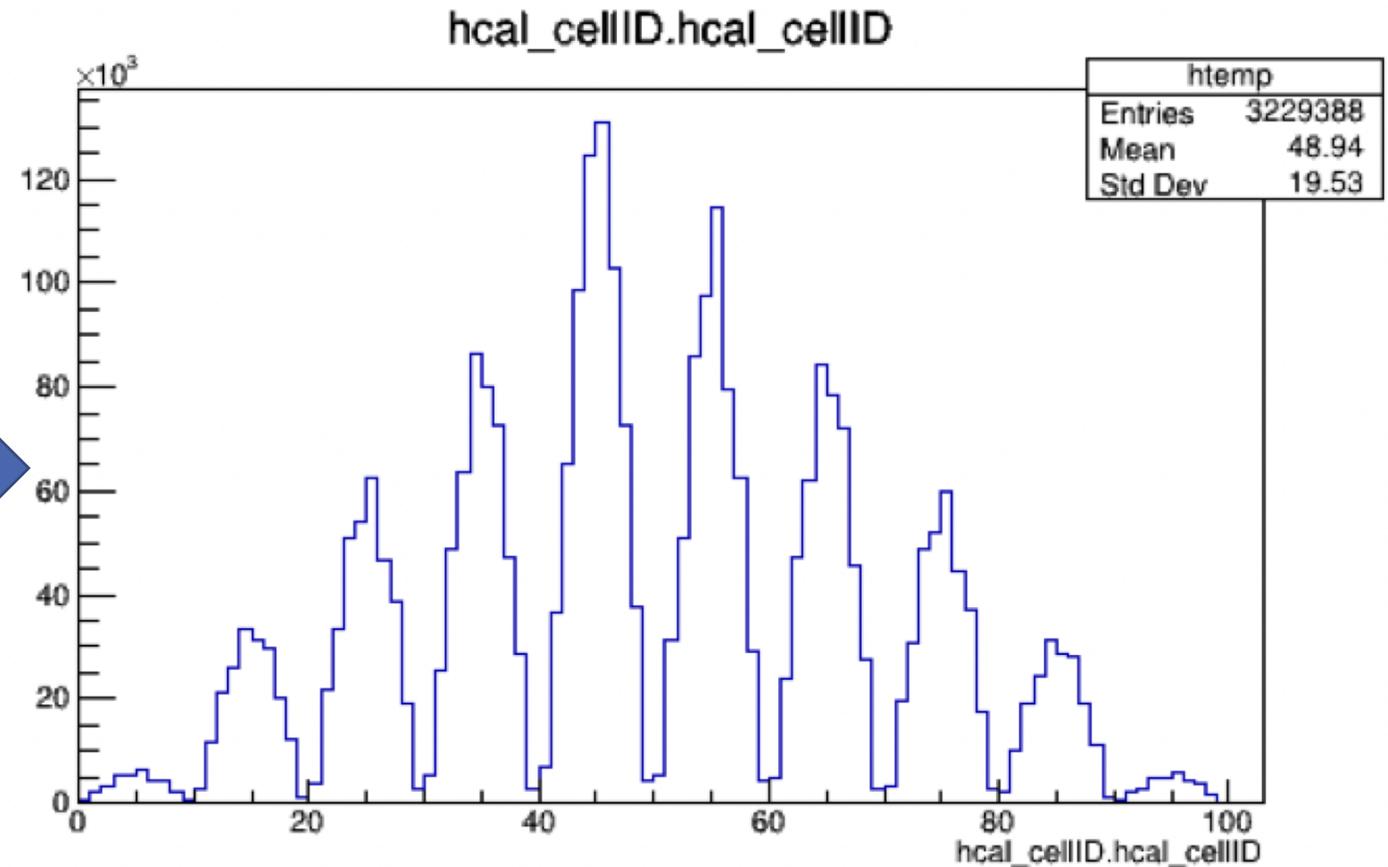
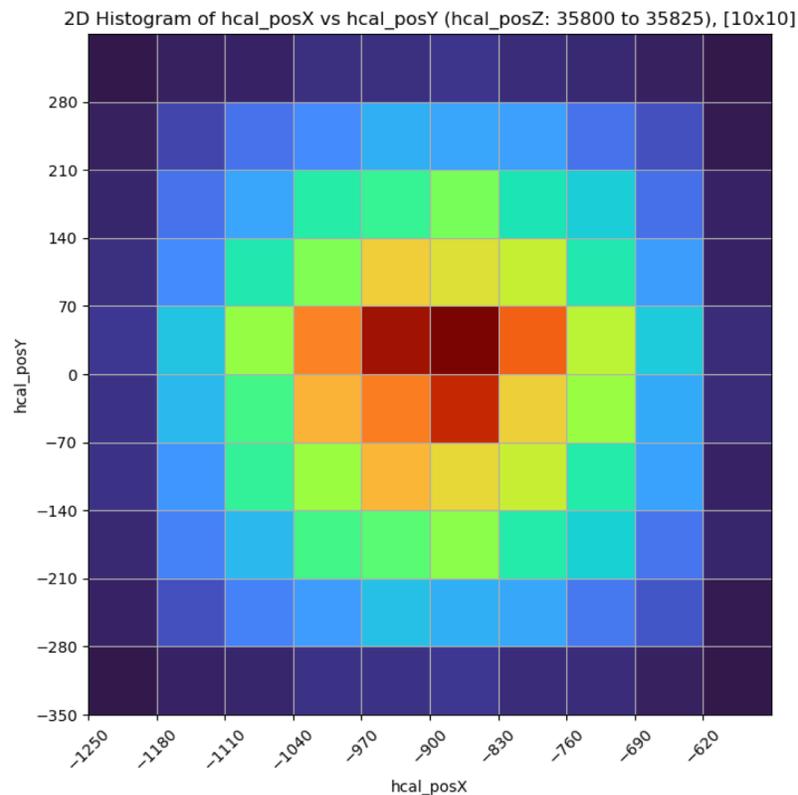
HCAL, Layer 1

HCAL, Layer 64



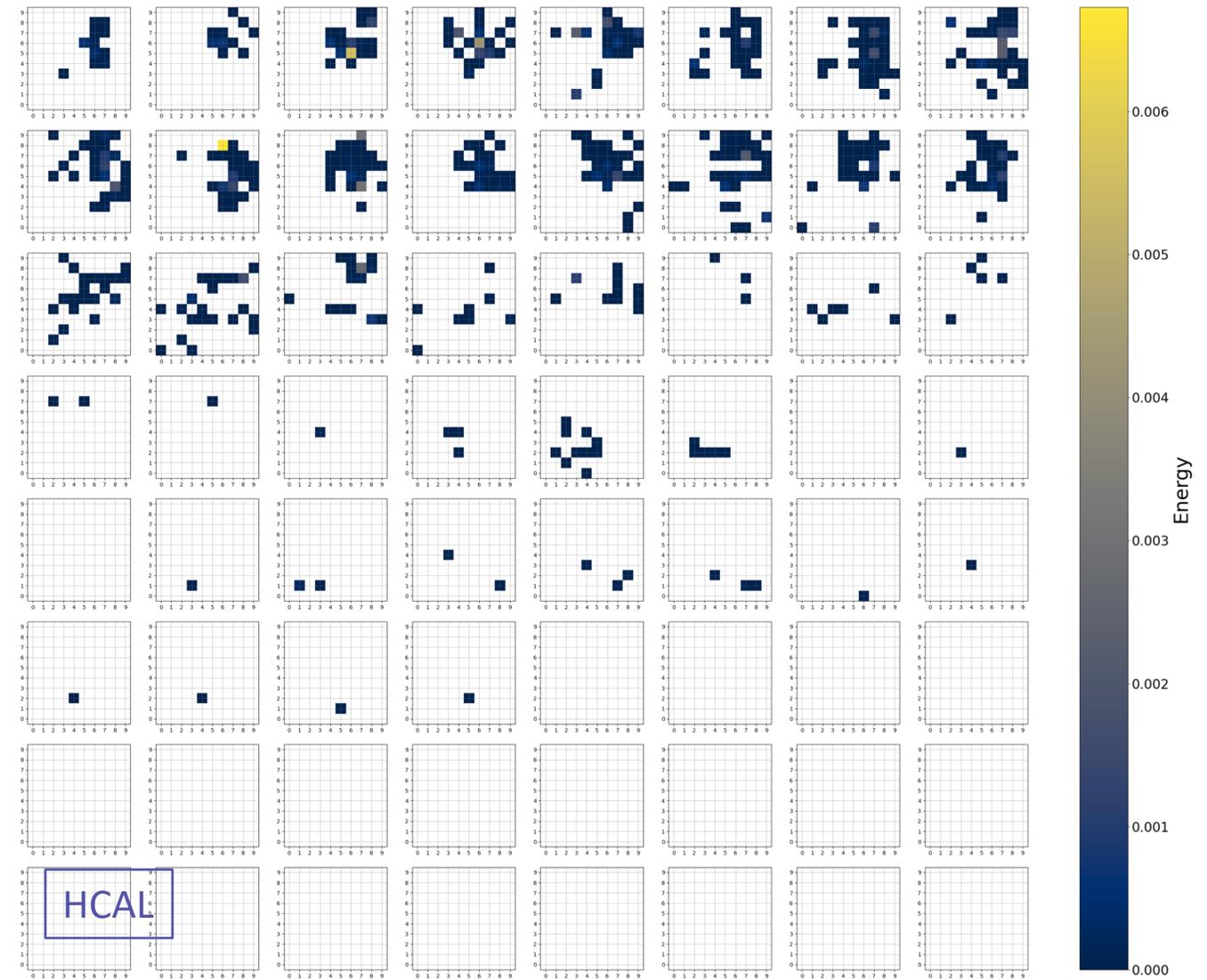
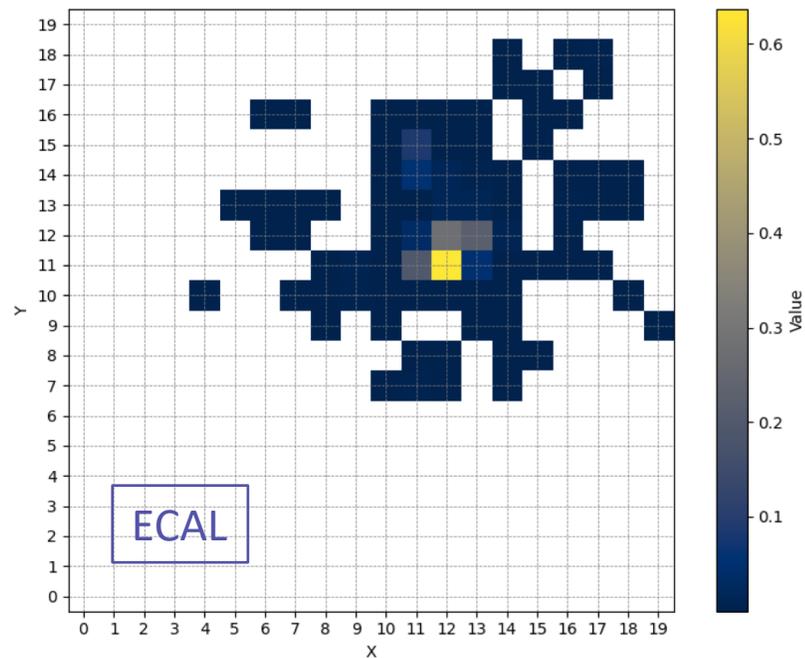
- Here we rebin them into 10x10 grid, which require a cell with 70x70mm.



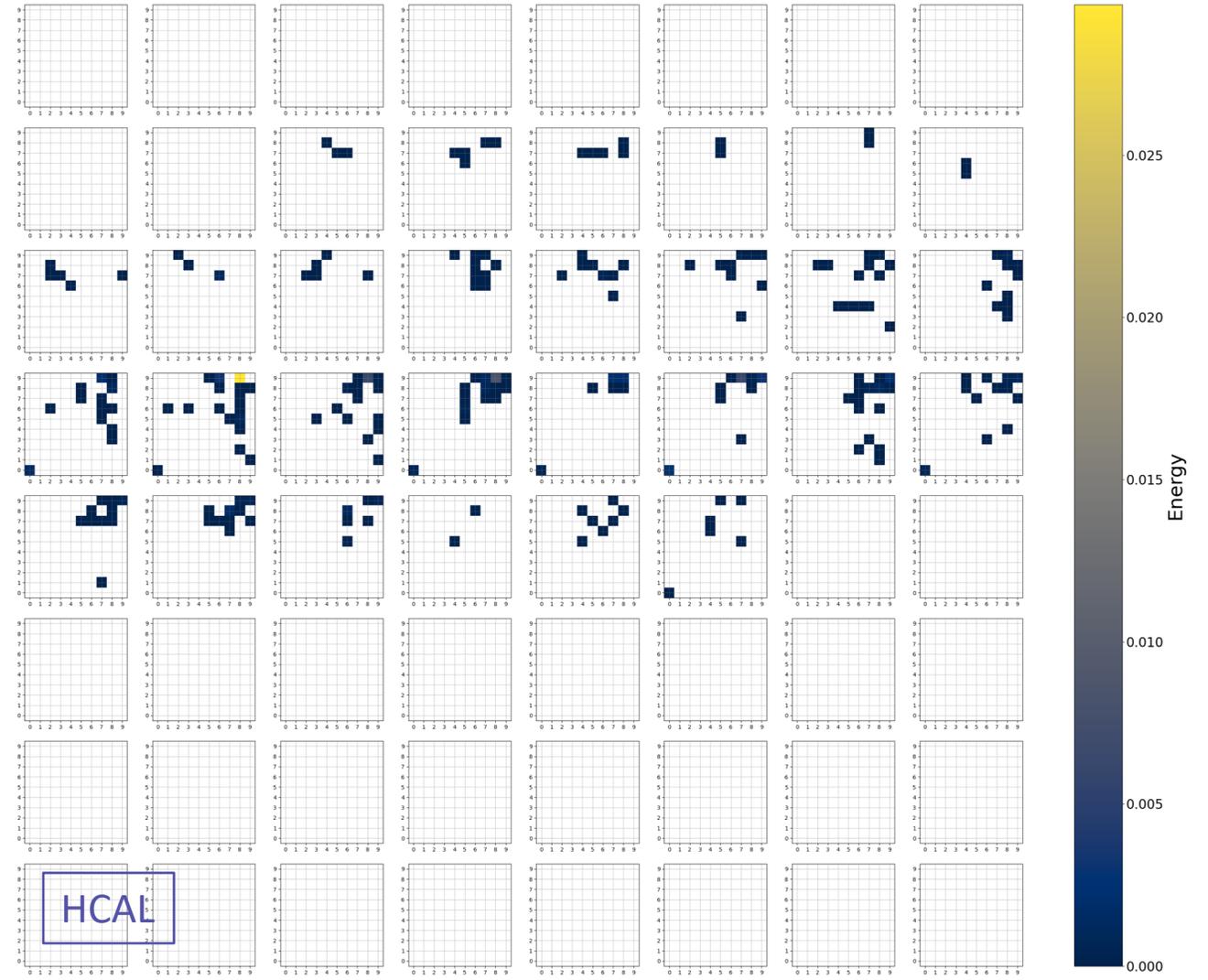
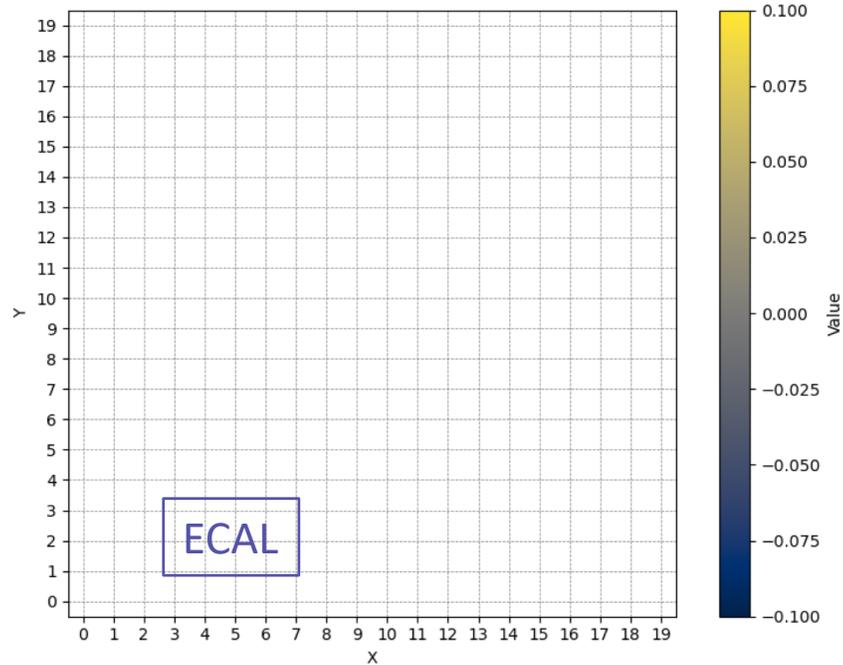


- Now we can use this cell ID to match the Energy into the grid as the ML input.
- Then we make a [10 x 10 x 64] 3D array.

- Here we try to plot the energy dump in the ECAL (2D array) and HCAL (64 layer, 3D array)
- Looks like this event have energy dump in the ECAL.



- This event we have 0 hit in ECAL, but doesn't look like all the energy are disposed in the HCAL as well...



Gamma + 7cm LYSO : Energy Dump

Neutron + LYSO : Energy Dump

ECal / Ebeam

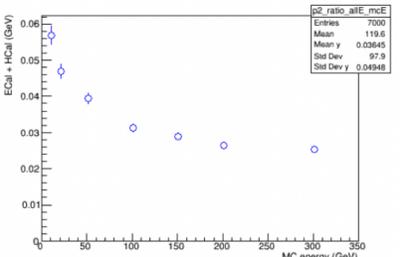
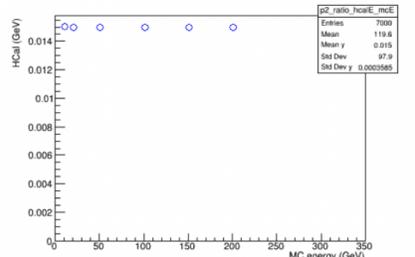
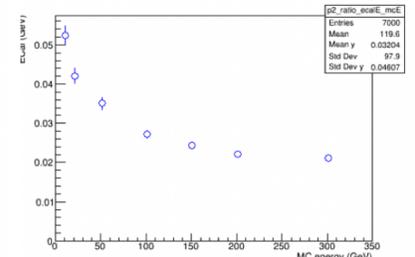
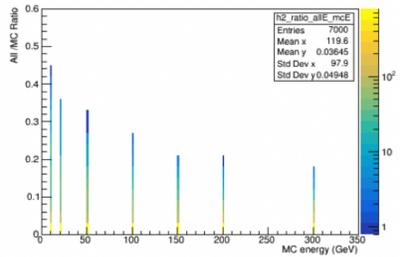
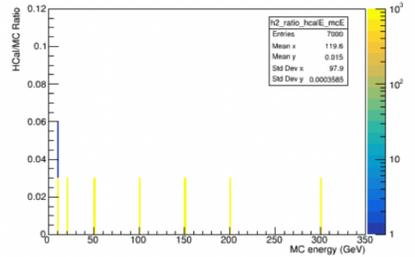
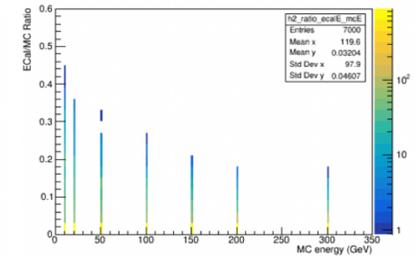
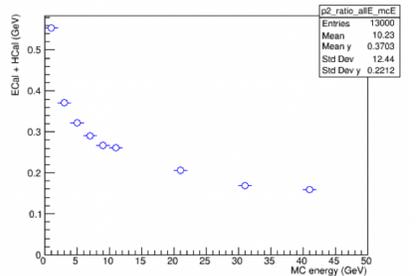
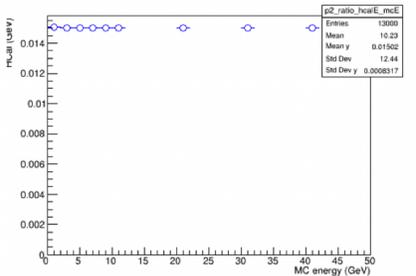
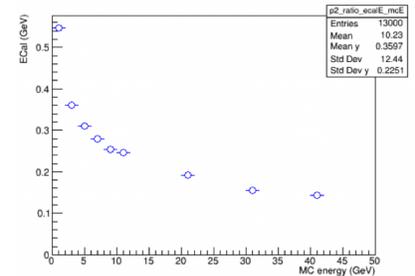
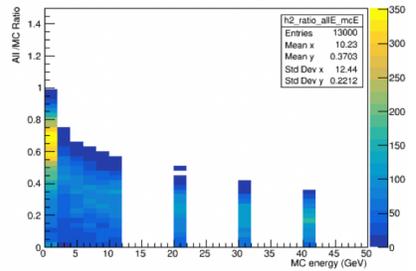
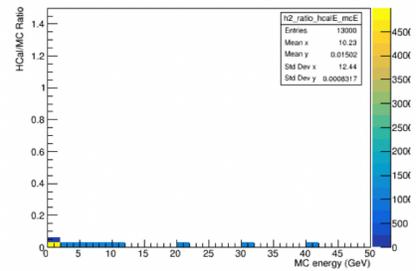
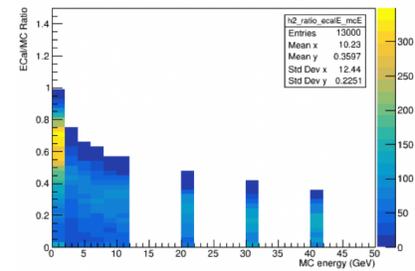
HCal / Ebeam

“ECal + Hcal” / Ebeam

ECal / Ebeam

HCal / Ebeam

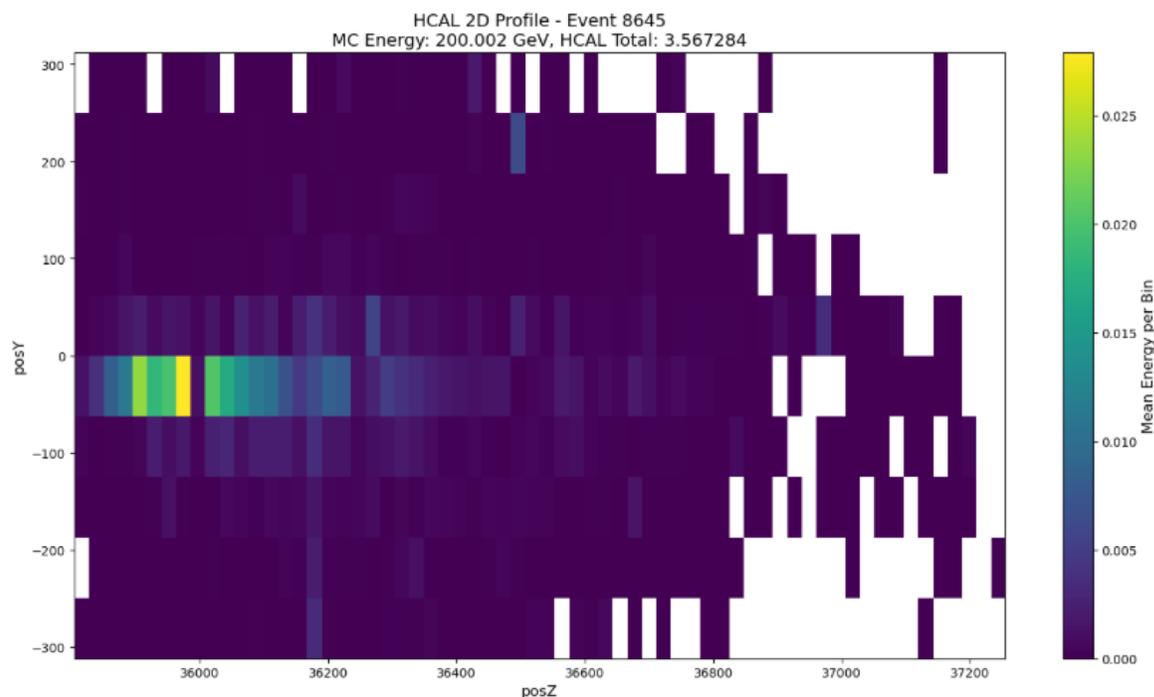
“ECal + Hcal” / Ebeam



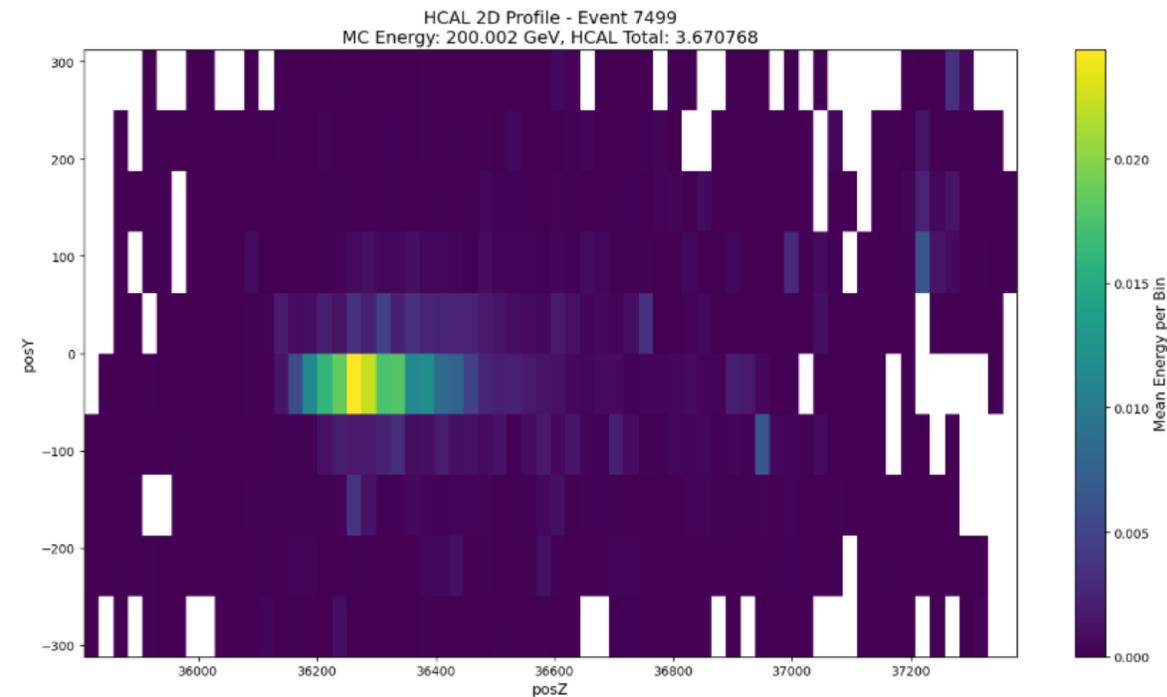
Most energy dumped in ECal → Normal

- < 6% energy dumped in ZDC.
- More energy dumped in ECal than Hcal (?)

- Chia-Yu also observed the similar behavior from her side.

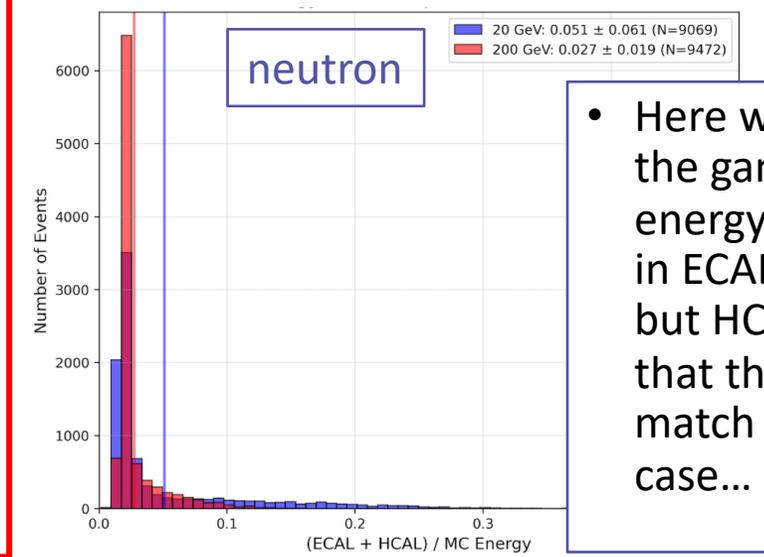
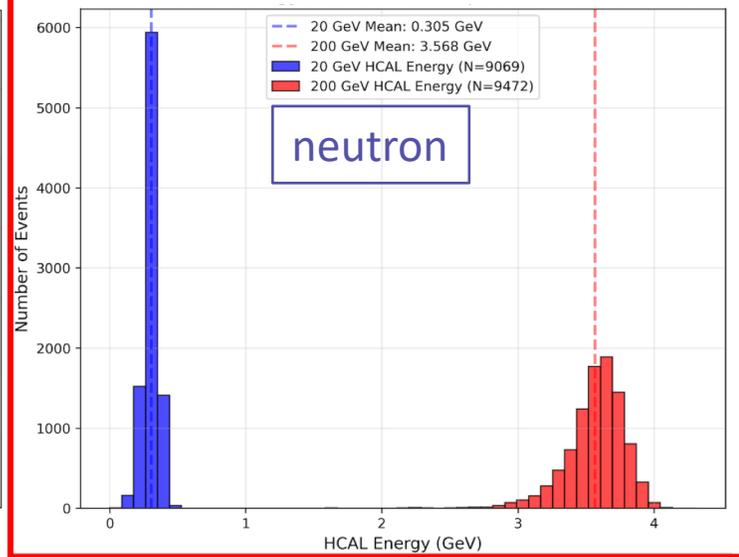
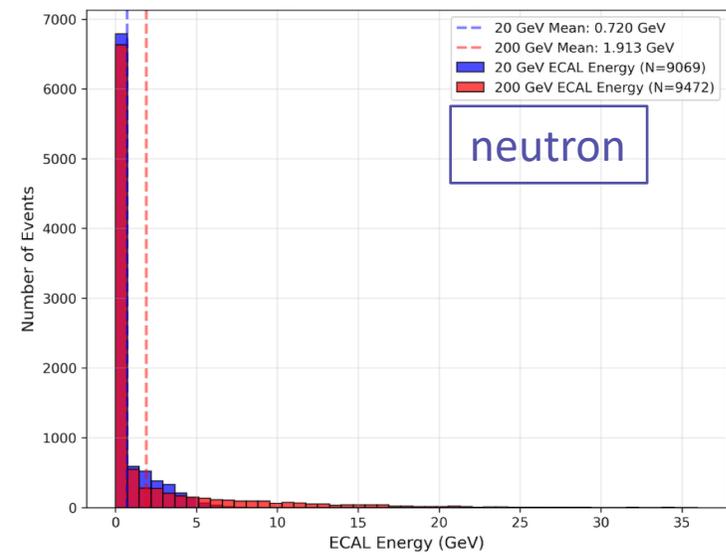
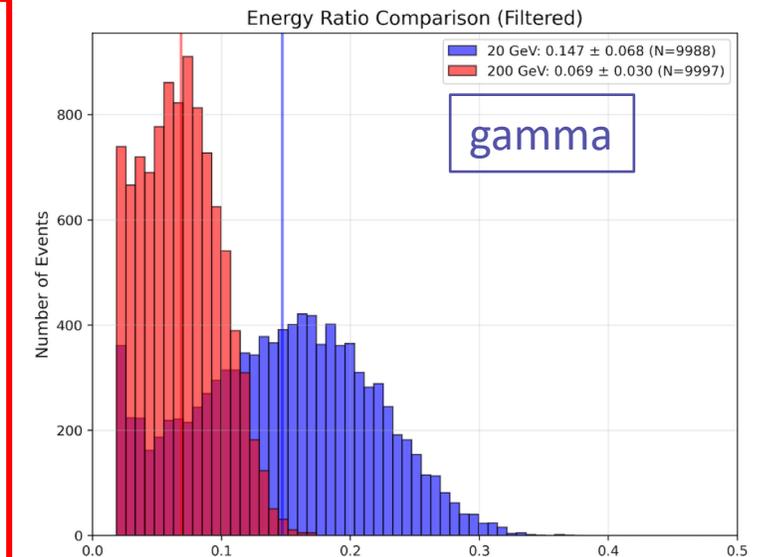
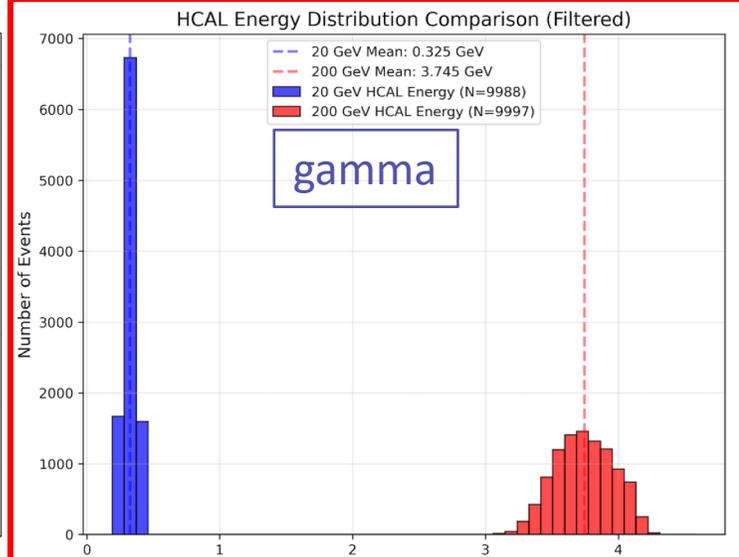
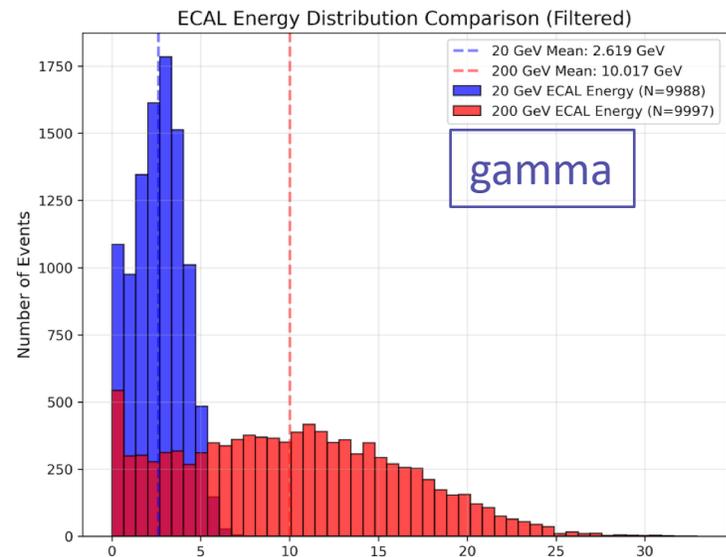


HCAL Event 8645 Statistics:
 Number of hits: 2986
 Total energy: 3.567284
 posZ range: 35804.41 to 37253.44
 posY range: -311.73 to 311.73
 Hit energy range: 0.000000 to 0.196115
 Number of non-zero bins in 2D histogram: 498
 Max mean energy per bin: 0.027897

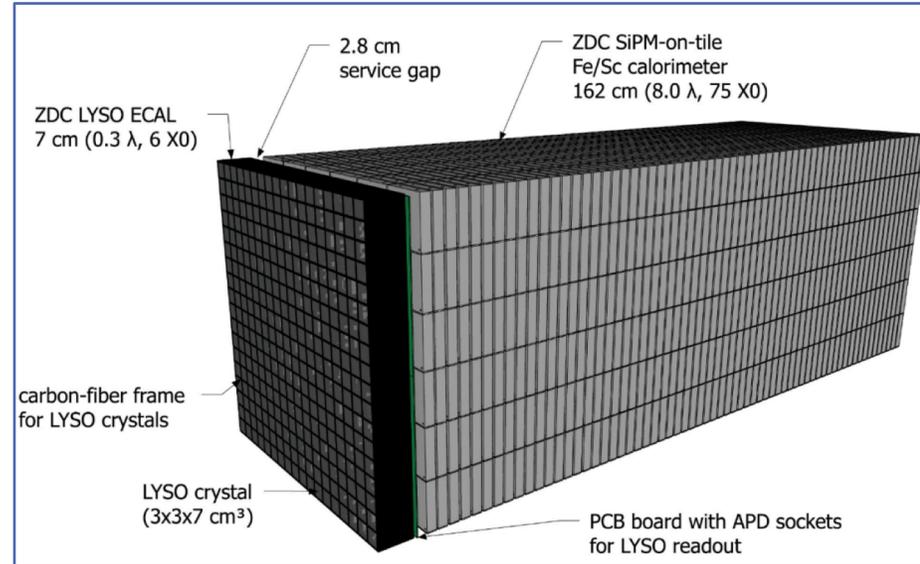
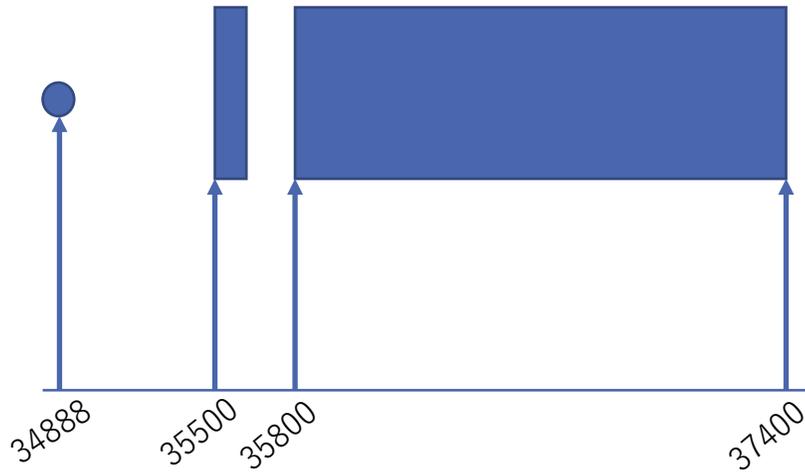


HCAL Event 7499 Statistics:
 Number of hits: 3201
 Total energy: 3.670768
 posZ range: 35806.75 to 37377.90
 posY range: -311.73 to 311.73
 Hit energy range: 0.000000 to 0.210678
 Number of non-zero bins in 2D histogram: 554
 Max mean energy per bin: 0.024360

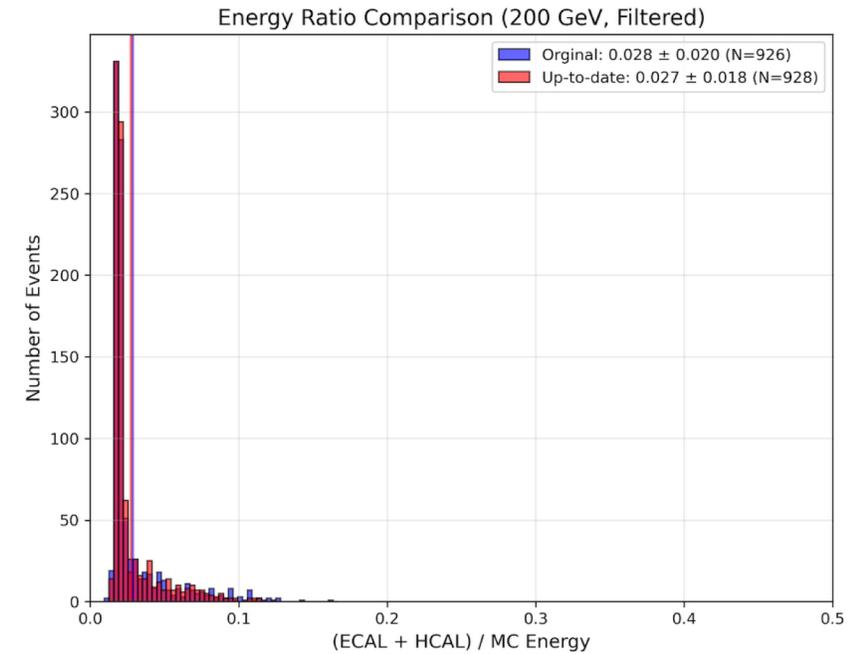
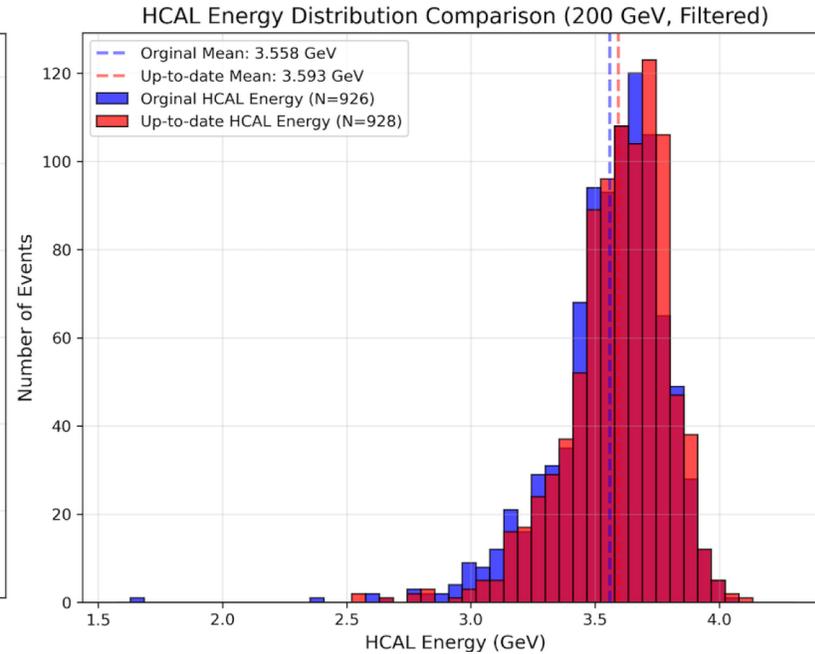
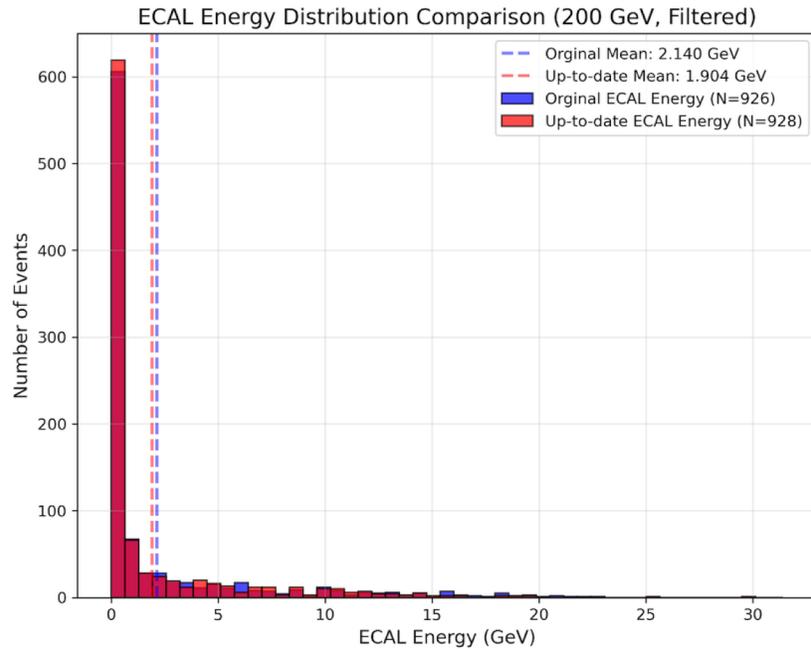
- Therefore we checked the energy profile in the Y-Z plane of HCAL (for 2 single events).
- Less than 5% energy are disposed in the HCAL...



- Here we also check the gamma, the energy distribution in ECAL looks fine but HCAL shows that the distribution match the neutron case...



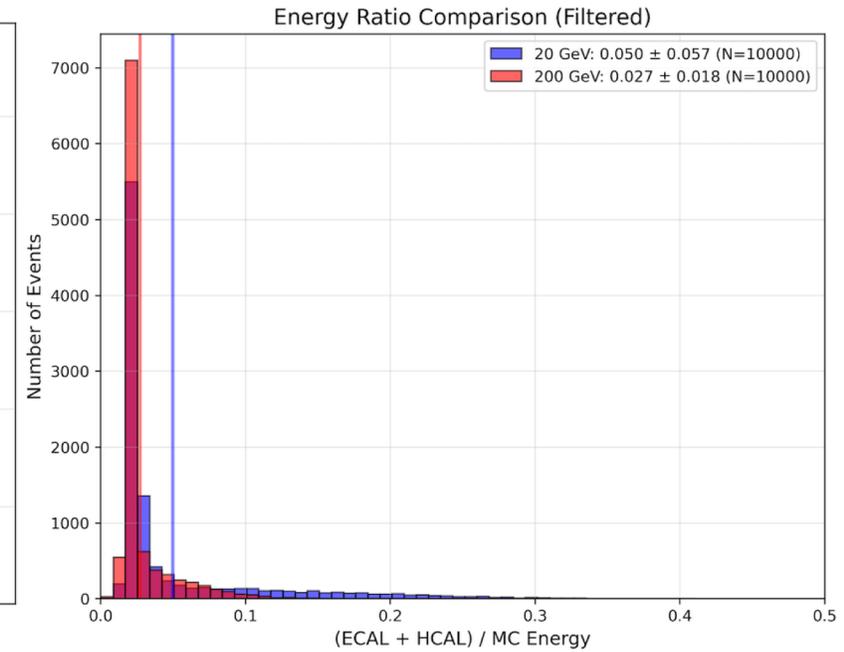
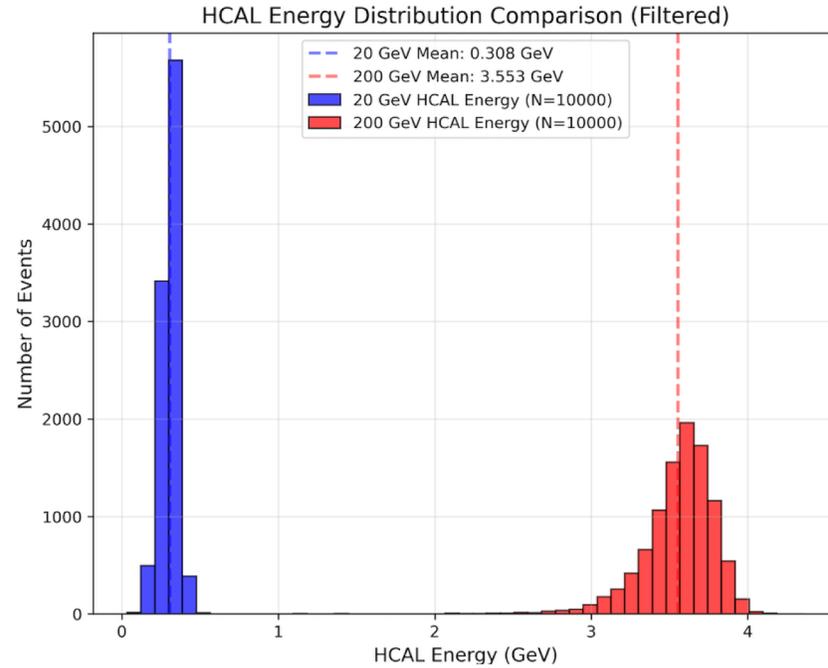
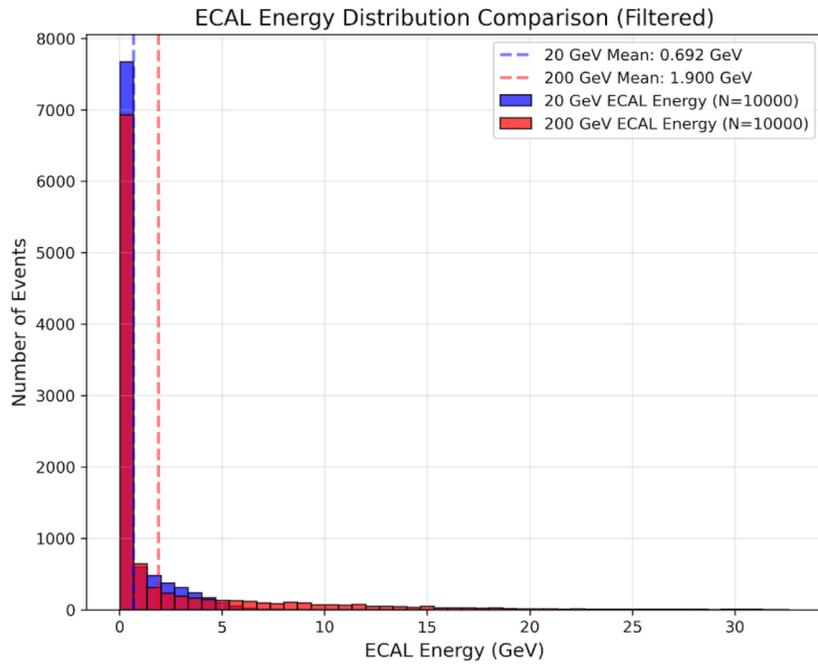
- Shouldn't have only few GeV left in the ECAL and HCAL
- Must be something wrong in the Geant4 setting but can't find anything strange so far...
- Checked:
 - Material type and thickness correct
 - Physics On
 - Distance/vertex looks right
 - Using correct xml file to setup the ECAL and HCAL



- Try to get the up-to-date version of the framework from github (Last updated at Aug).
- Generated 1000 events to compare between the original and up-to-date setup.
- Nothing changes

Outlook

- We try to implement the HCAL info into the ML as well. However the HCAL file looks wrong.
- Then we found that the energy disposed in ECAL and HCAL are much less than the expectation.
- We think that's something wrong in the G4 setting but can't find anything at the moment.
- Need to contact HCAL expert, since we have seen their plot about the energy distribution in HCAL which looks correct...



20 GeV vs 200 GeV Neutron (All Detector Layers)

