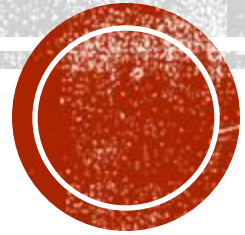
OpticSiren status

Ka Ming Tsui

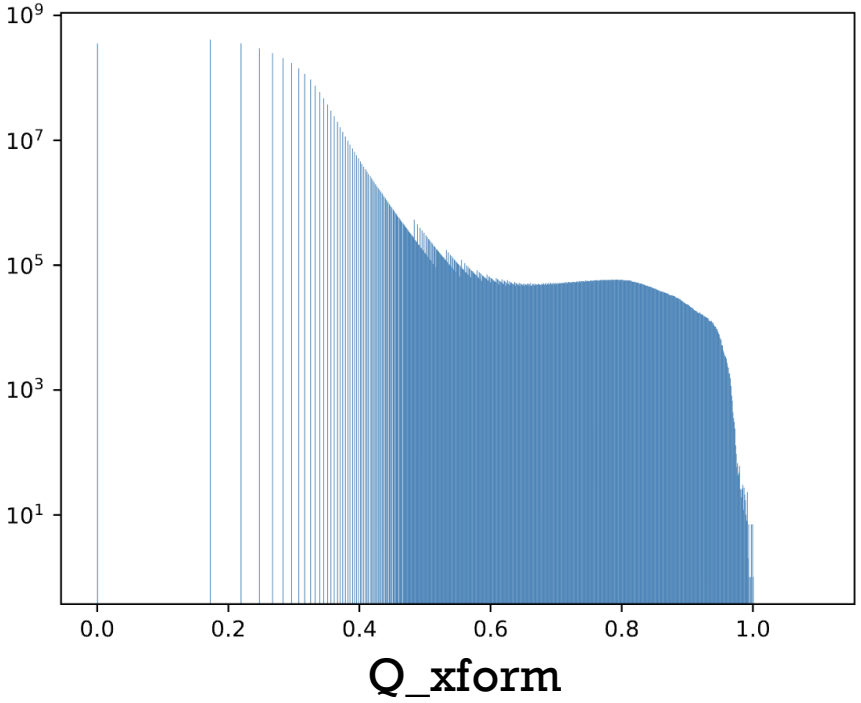
kaming.tsui@ipmu.jp



Reminder

- Total number of configs (voxels): 1551312
- Q logNorm transformation
  - ```
    eps = 0.1
    y0 = np.log10(eps)
    y1 = np.log10(self.Qmax+eps)
    digi_nph = (torch.log10(digi_nph+eps)-y0)/(y1-y0)
    ```
- Loss: Weighed MSE
  - Weight = original PMT PE
  - loss = torch.mean(w*(input-target)**2)

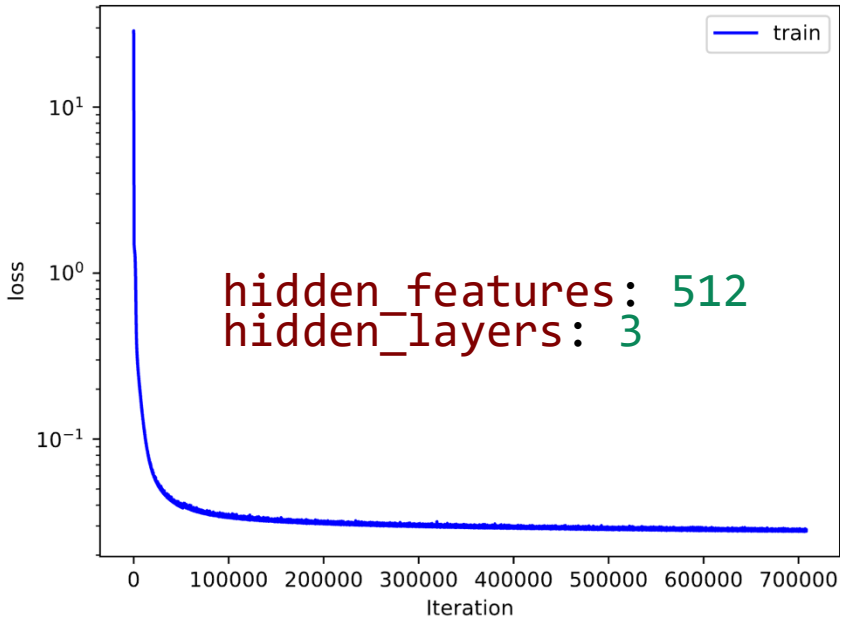
Project name: first_wcte_posdir_500000
Cylinder geometry
R: 0.0 => 1271.96
Z: -1379.118 => 1379.118
Bin in Direction: 1
Gap space: 200.0
Gap angle: 10.0
Starting n phi: 4
Sampling points: 2268
Sampling directions: 684
Sampling configs: 1551312
Photons per config: 500000


    ```

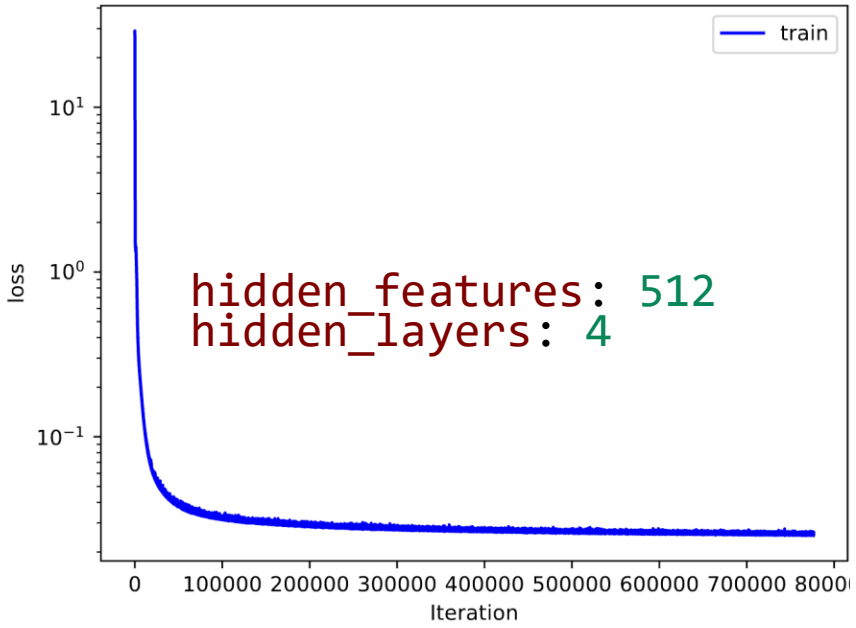
The more the better

- Need a better quality metric to assess performance

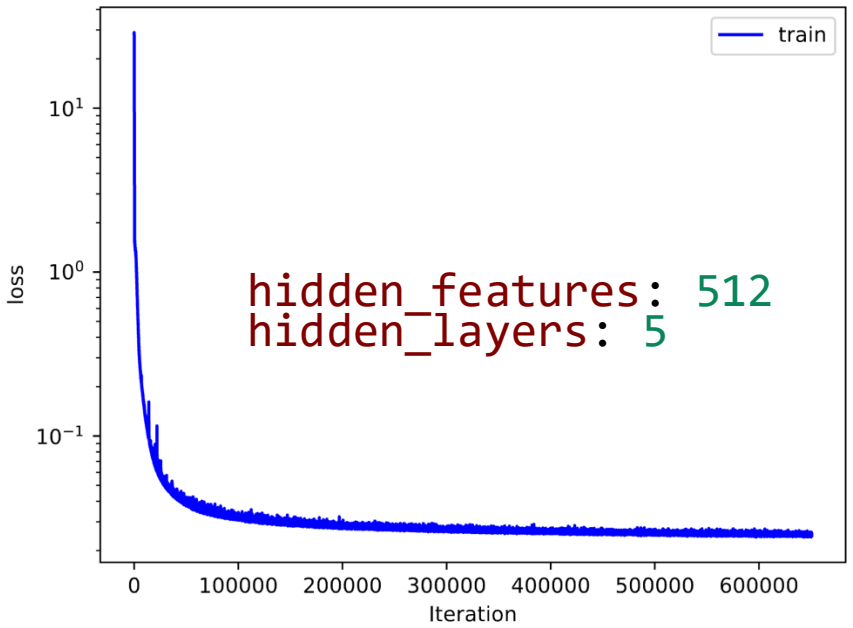
Loss=0.028126245364546776



Loss=0.026158532127738



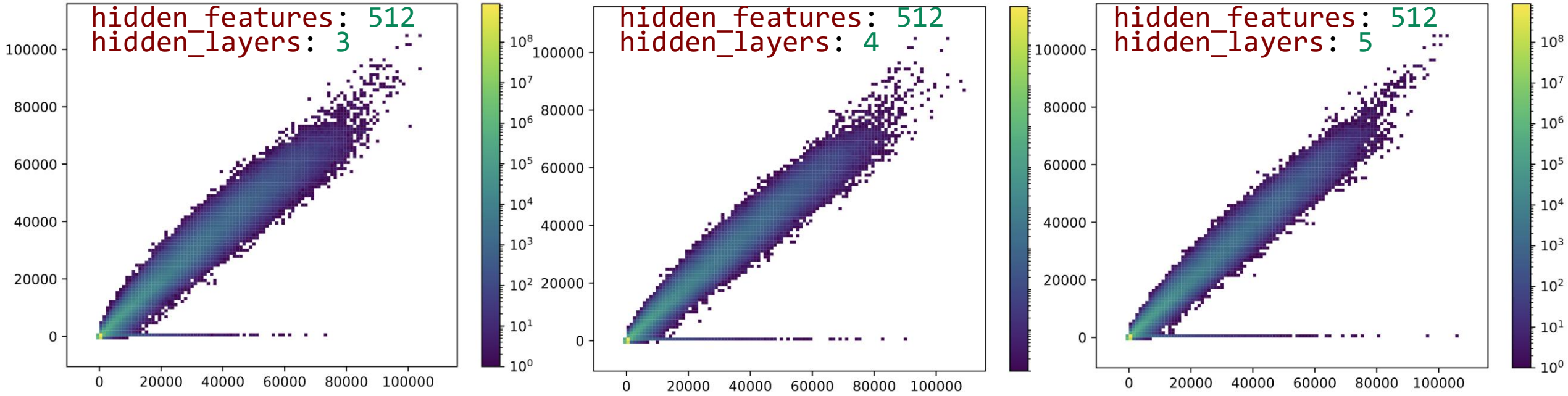
Loss=0.024971729144454002



The more the better

- Need a better quality metric to assess performance

Qtarget



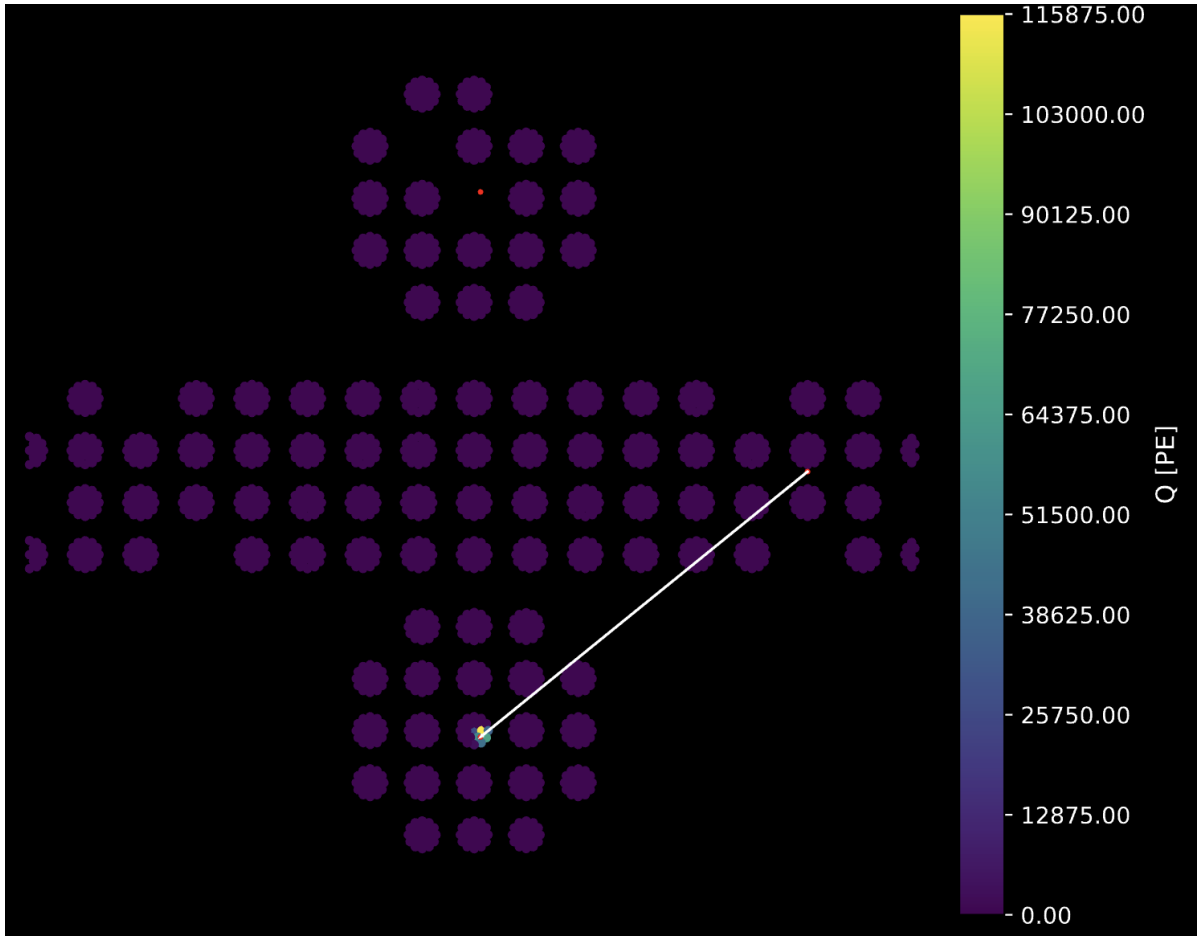
Qpred

Assess performance of single voxel

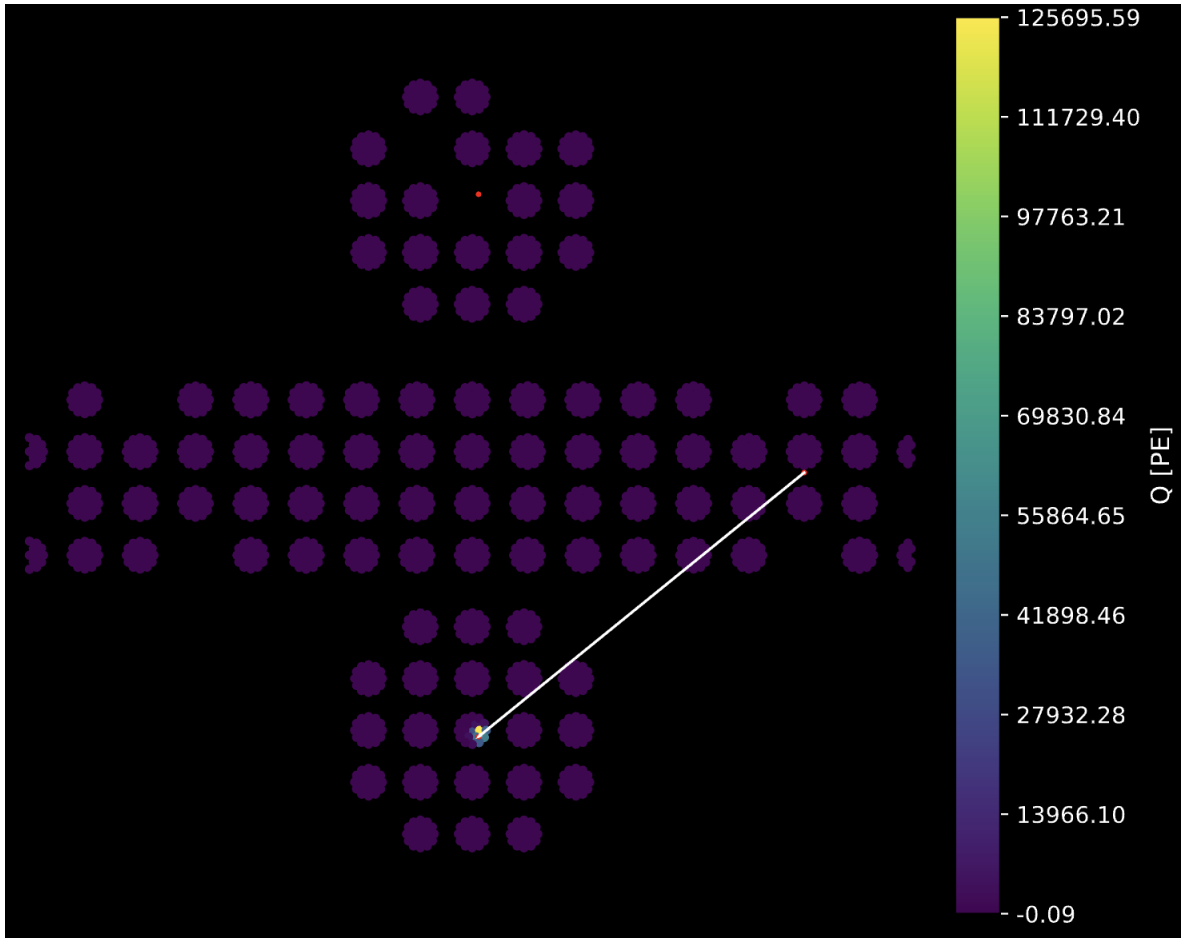
- For simplicity I am just using the existing training MC instead of generating new ones
- Figures below are generated by picking the "voxel" located roughly above the central middle mPMT, with photon direction roughly pointing downwards
  - "roughly" because each voxel has a finite volume and opening angle
  - SIREN is trained with hidden_features = 512 and hidden_layers = 5

The white arrow is drawn from the voxel position (projected on the barrel wall) to the photon incident position on wall.

Event display



Target

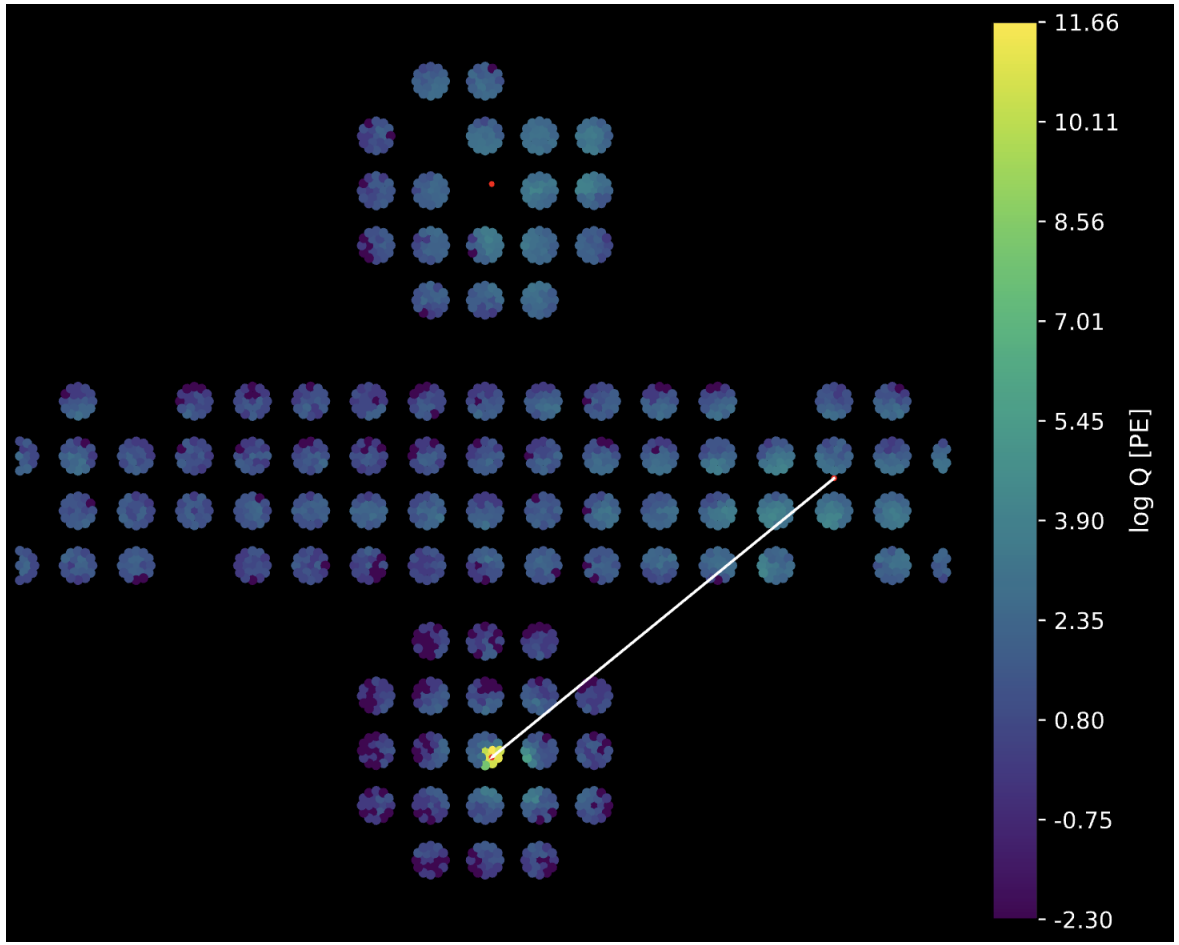


Prediction

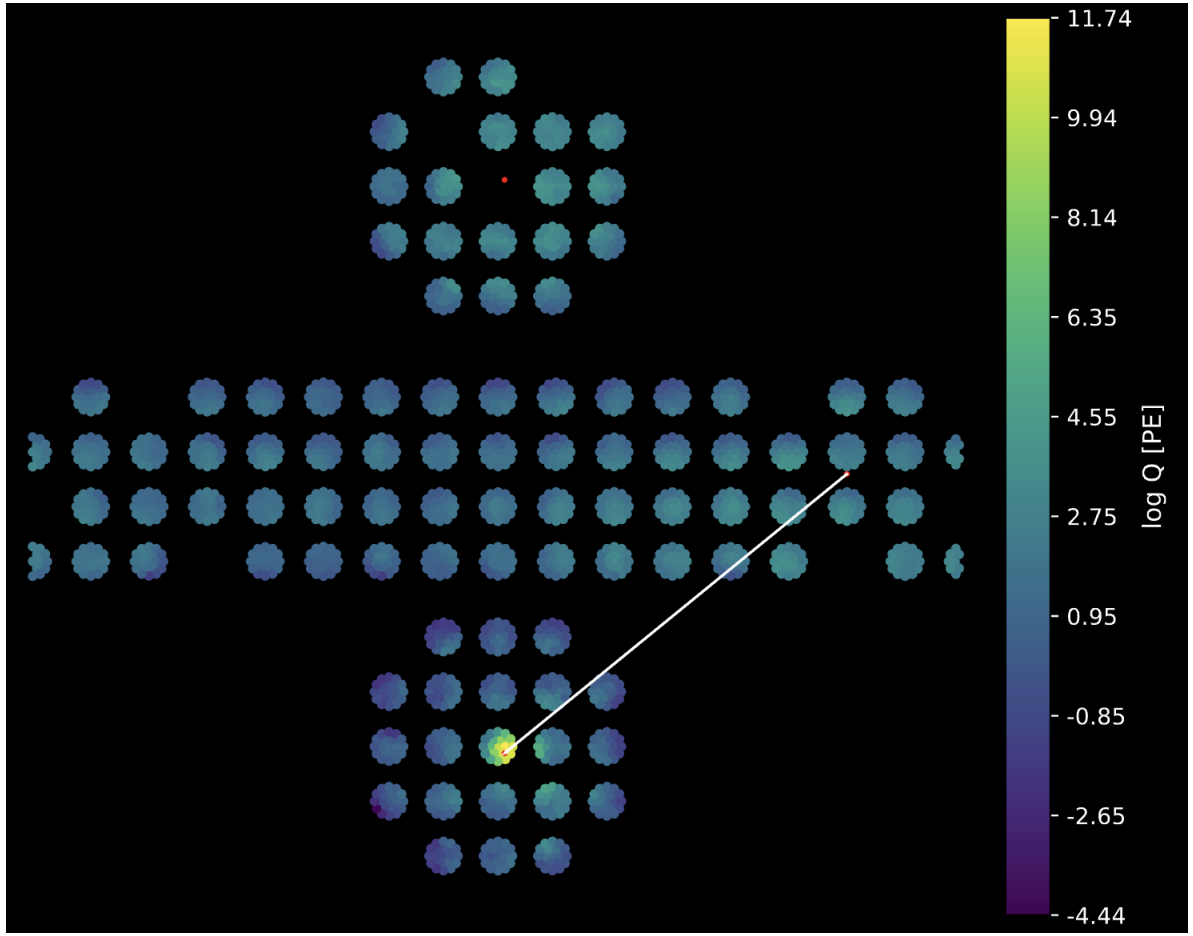
On a linear scale they look quite the same

Event display

On a log scale, the indirect light distribution is more uniform in SIREN.

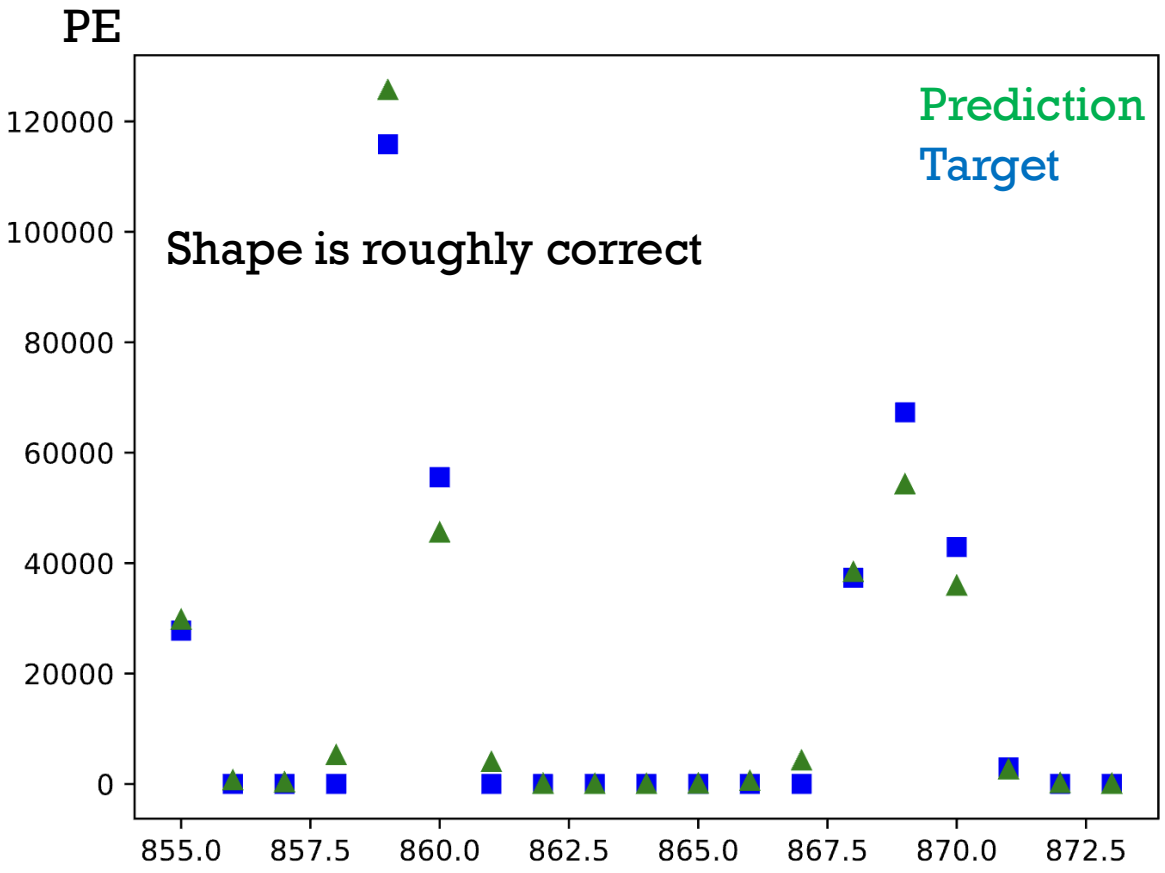


Target

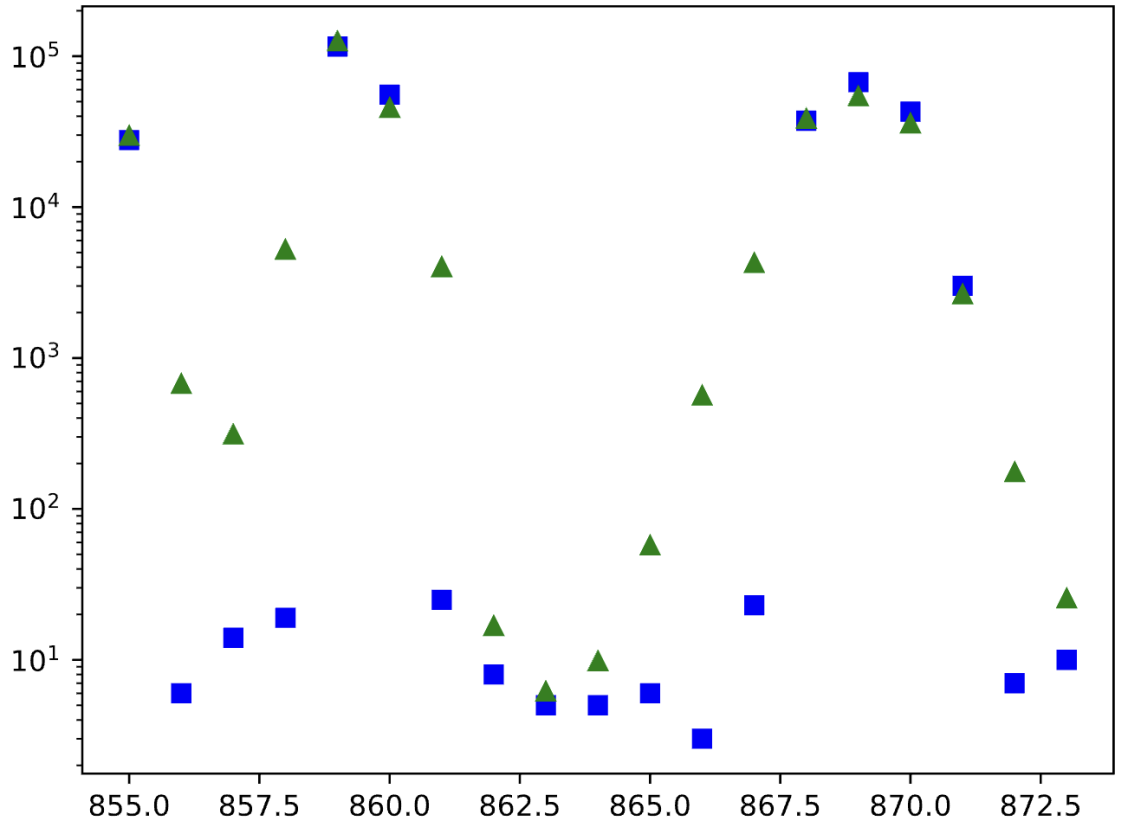


Prediction

Highest hit rate mPMT

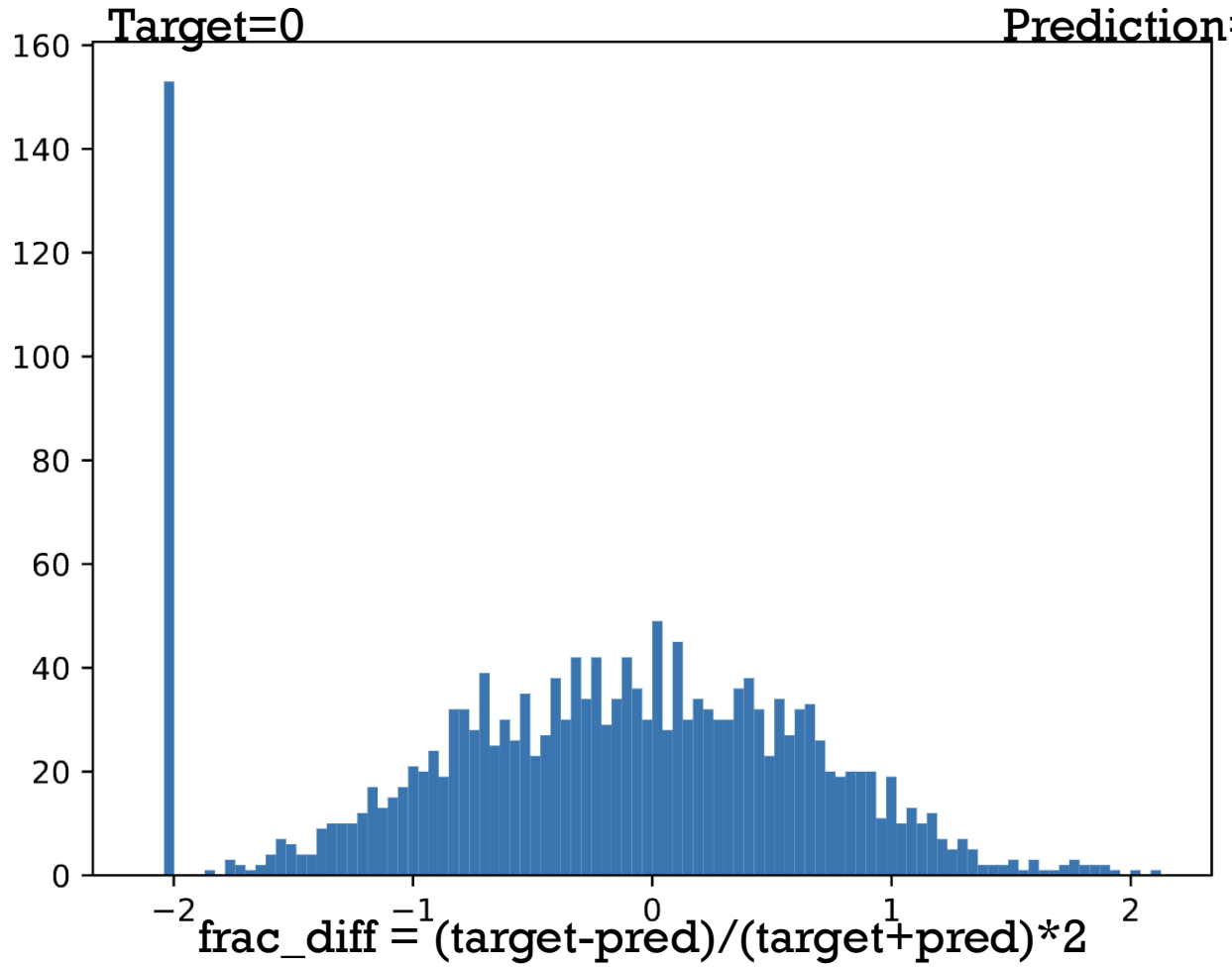


SIREN usually predicts a higher value for the low PE PMTs



PMT ID

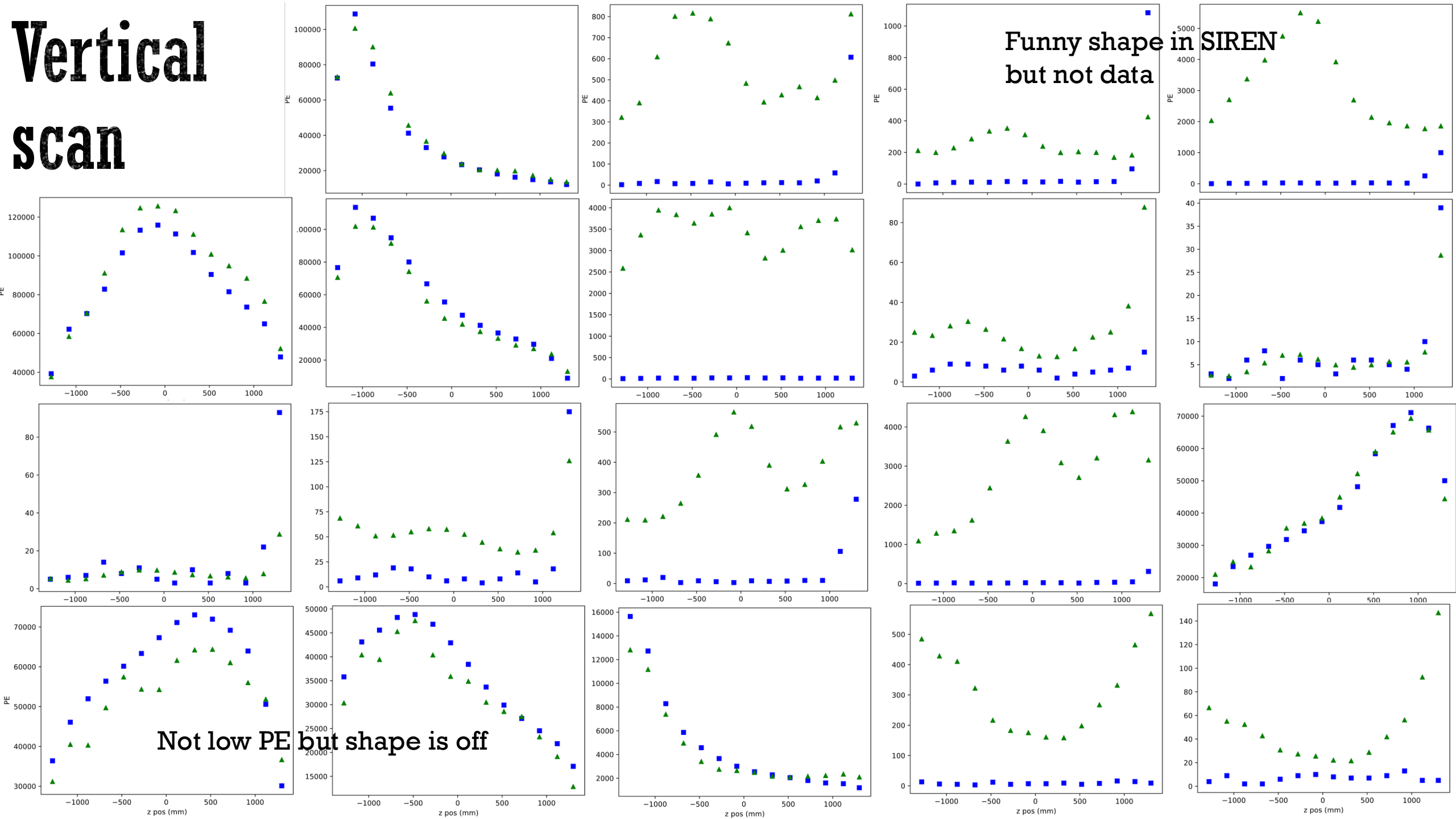
Fractional difference in all other PMTs



Assess performance of single voxel

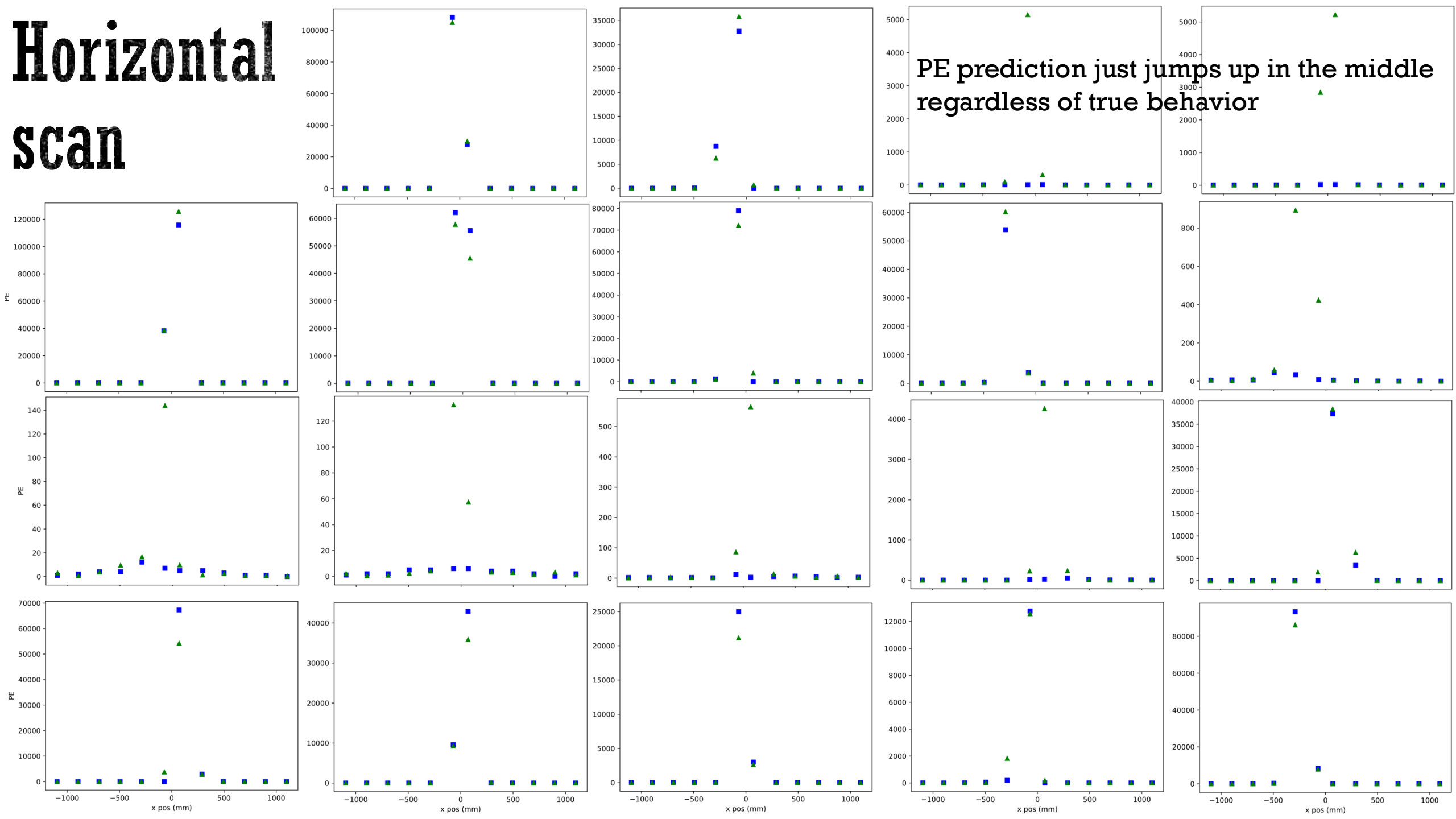
- Next is vertical/horizontal scan by moving the voxel positions along the vertical/horizontal axis, while keeping the photon direction downwards
  - Each fig corresponds to a single PMT in the mPMT module, with the x-axis be the voxel position change
- In general the shape variation is roughly correct for high PE PMTs, but can be off for low PE ones
  - For low PE, could be due to low statistics
  - High PE shape difference: need more improvement?

Vertical scan



Horizontal scan

PE prediction just jumps up in the middle regardless of true behavior

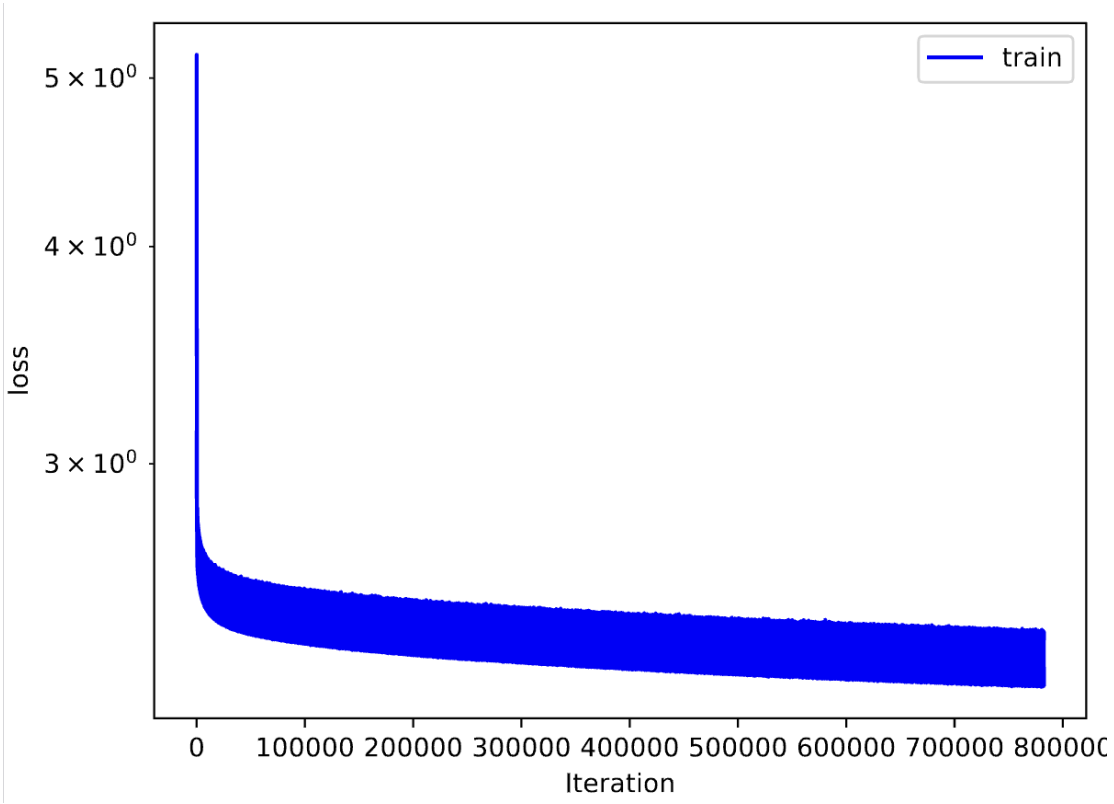


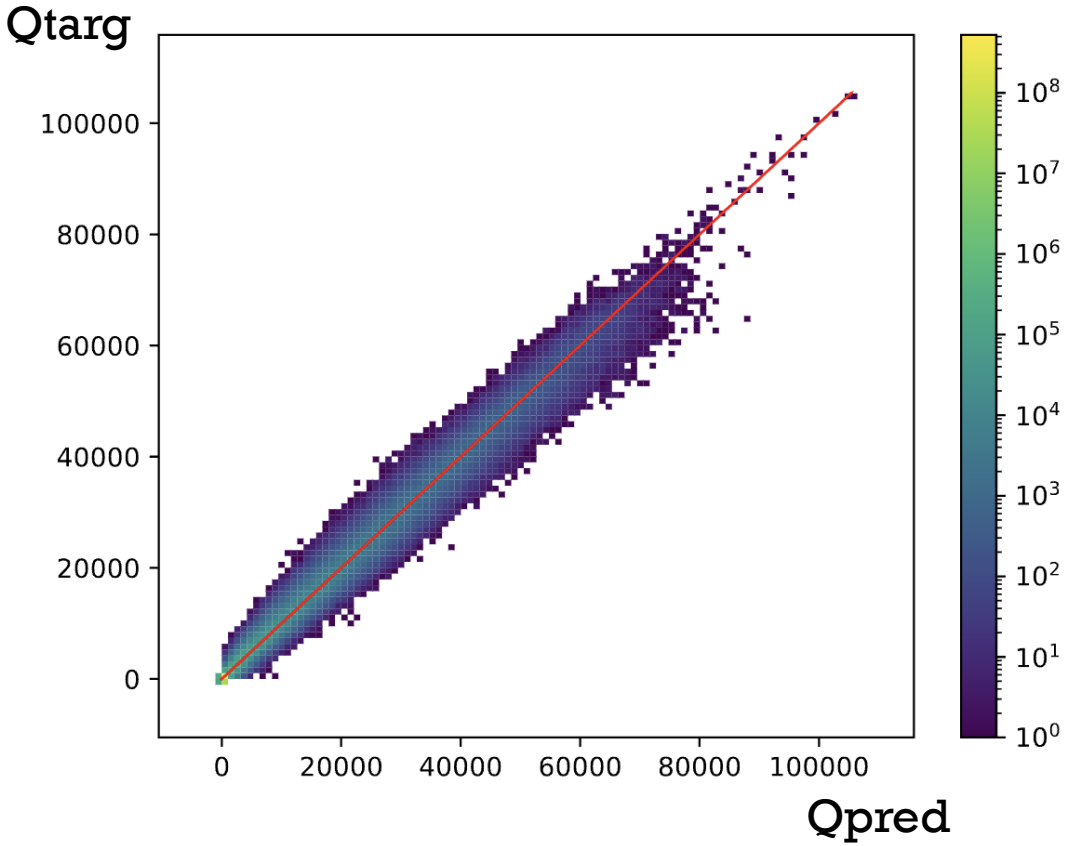
Next steps

- More data generation (in progress)
- Reconstruction
  - Forward propagation from Cherenkov SIREN to Optical SIREN (muon track first?)
  - Differentiation to get track parameters
- Calibration
  - Generate diffuser ball/LED data with different detector parameters
  - Try fine-tuning process

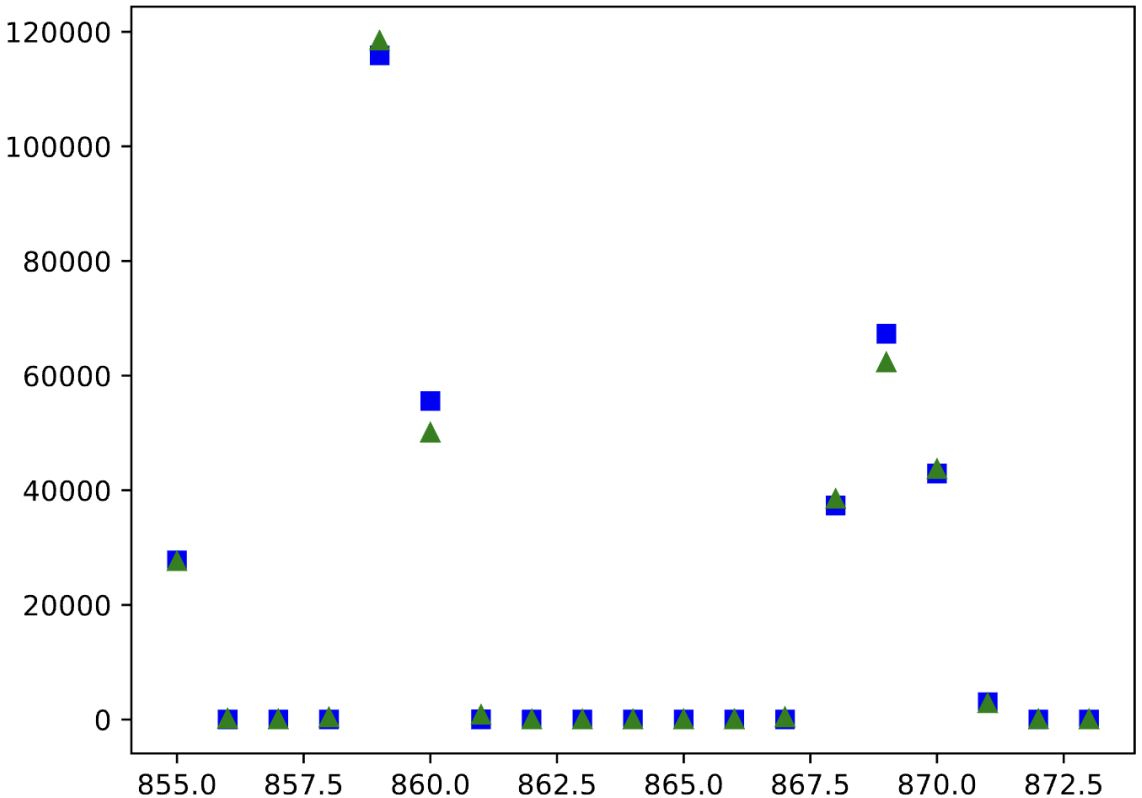
Bonus

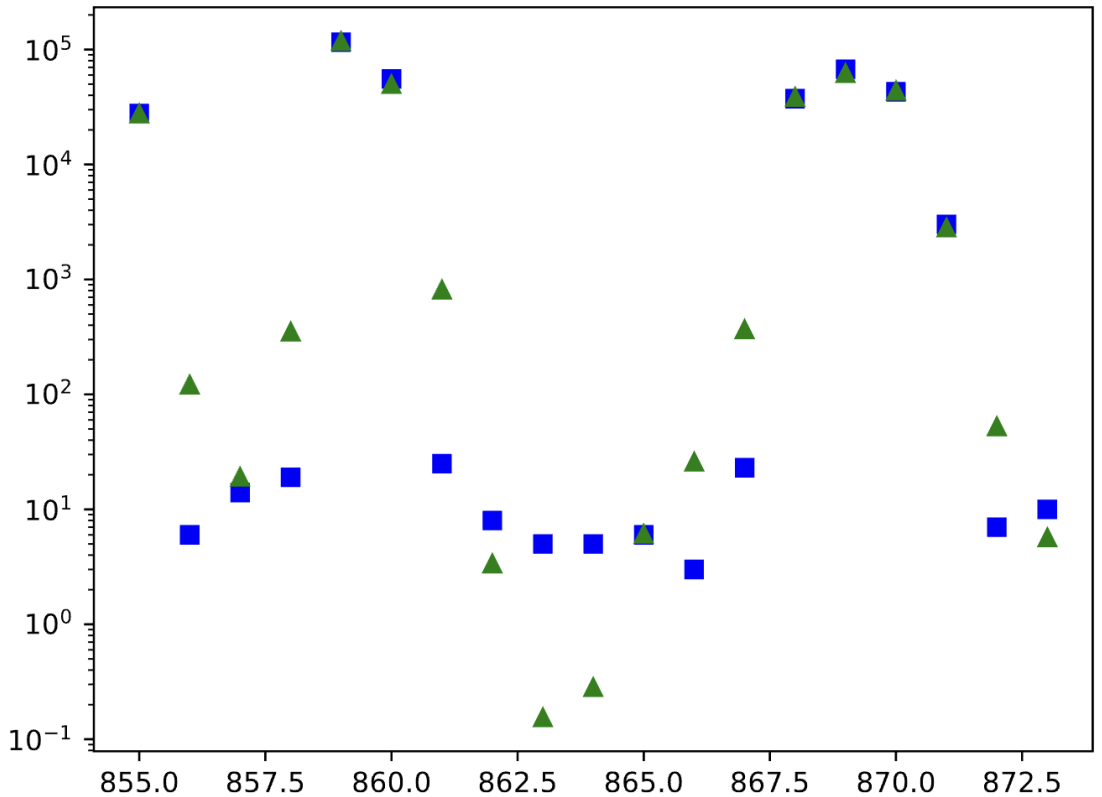
- Starting from the trained model, retrain with Poisson likelihood loss



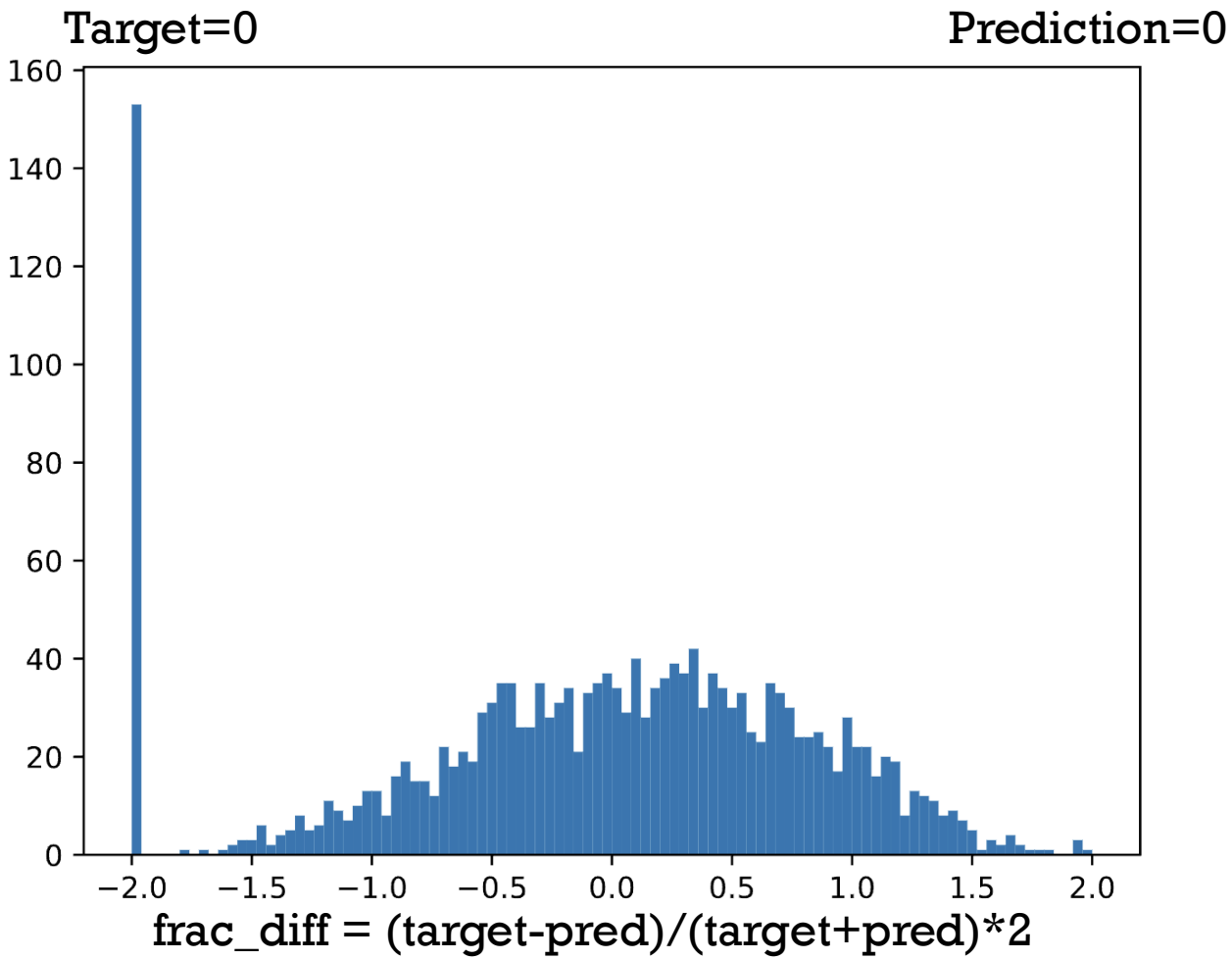


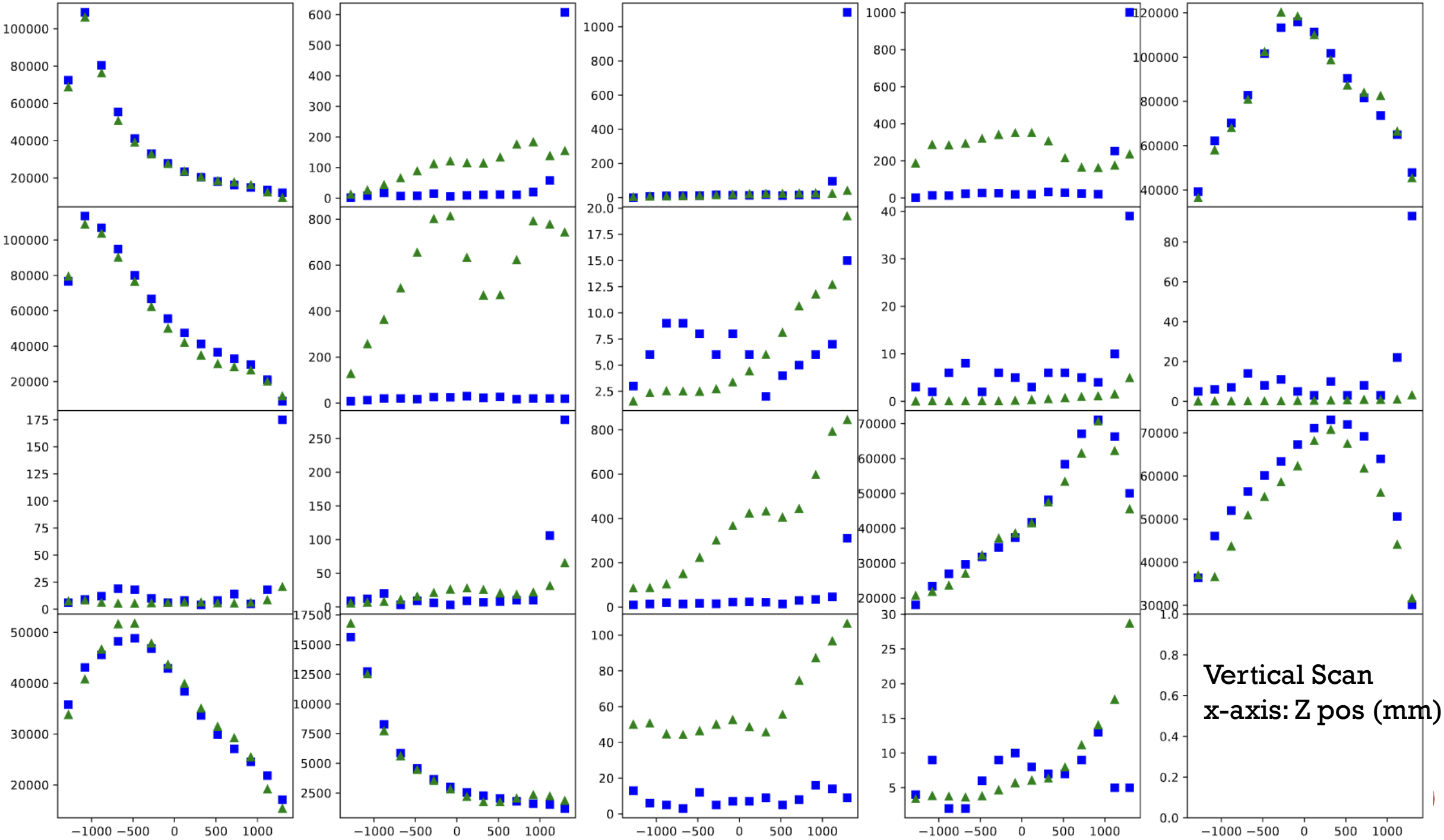
PE

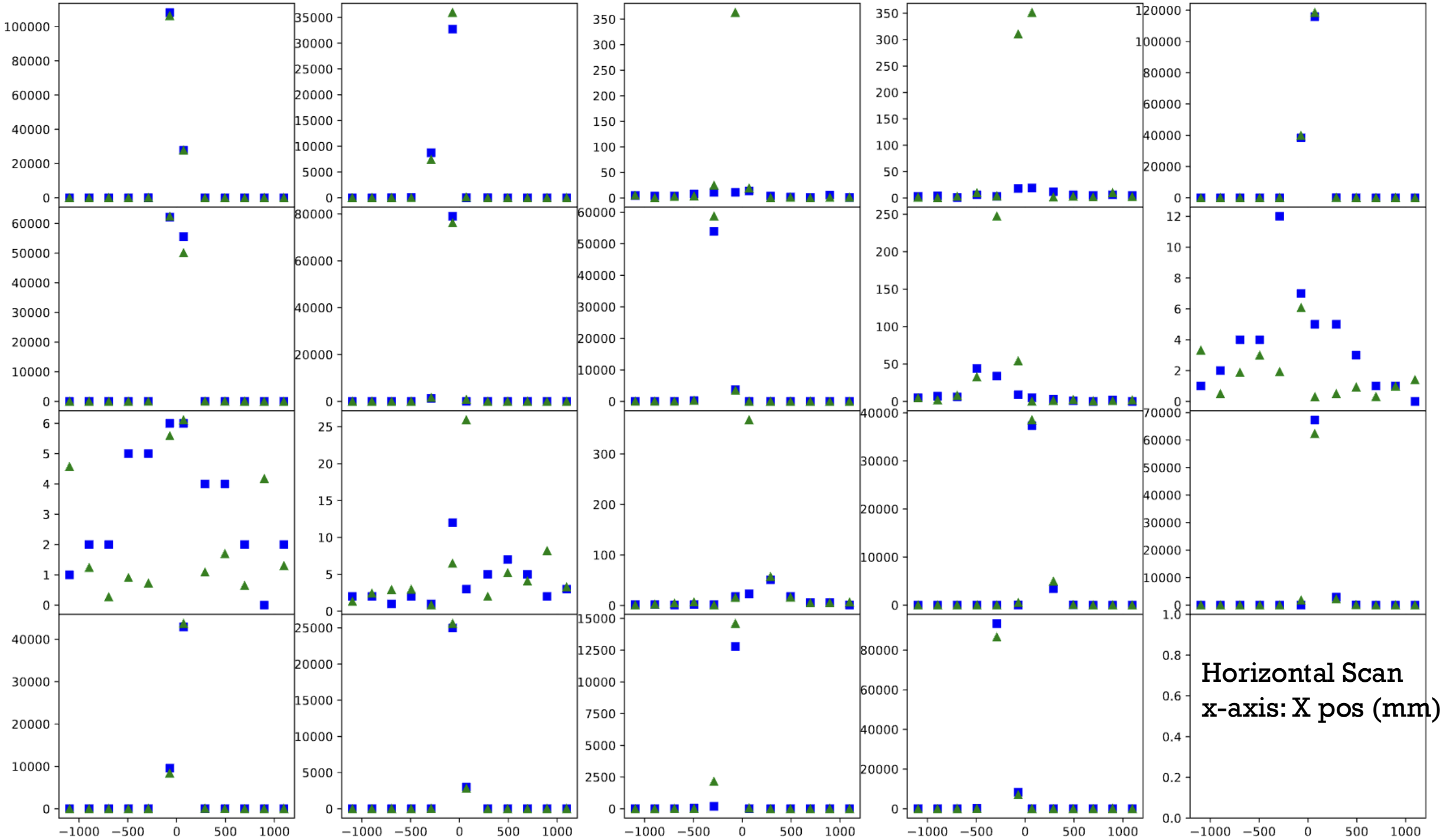

120000
100000
80000
60000
40000
20000
0
855.0
857.5
860.0
862.5
865.0
867.5
870.0
872.5


10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
855.0
857.5
860.0
862.5
865.0
867.5
870.0
872.5

PMT ID


Target=0
Prediction=0
160
140
120
100
80
60
40
20
0
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
frac_diff = (target-pred)/(target+pred)*2


Vertical Scan
x-axis: Z pos (mm)


Horizontal Scan
x-axis: X pos (mm)