

Cherikov & Optic Siren Pipeline

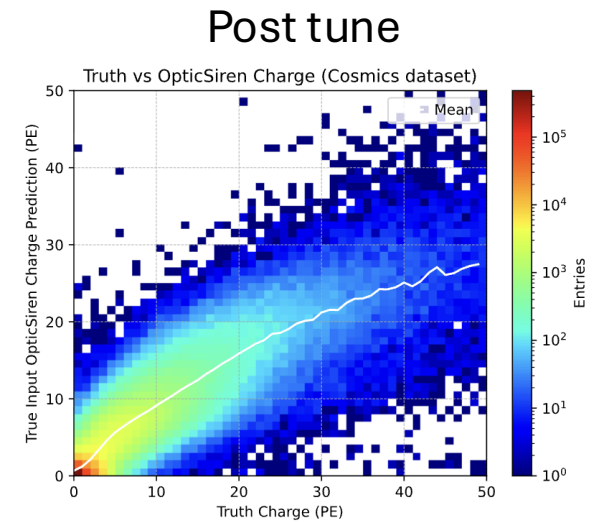
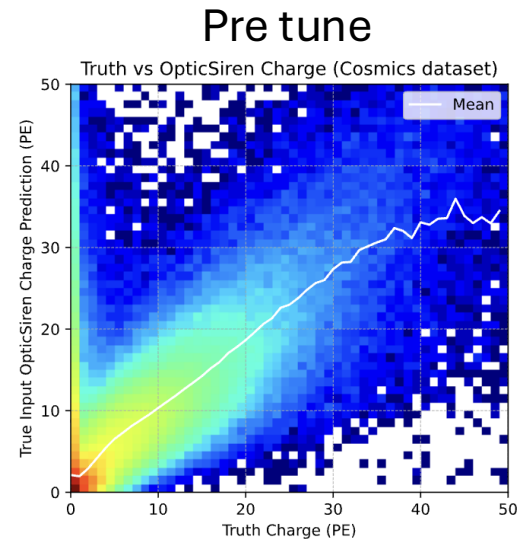
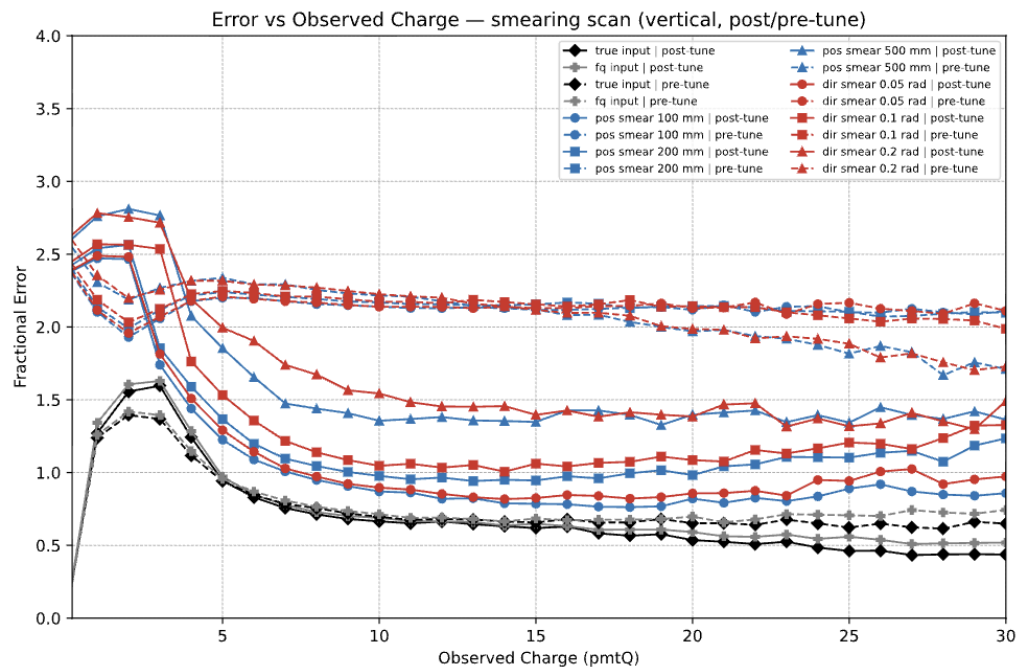
CIDeR-ML workshop

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Validation of OpticSiren Performance

To validate the performance of the OpticSiren, some comparisons of the PMT response by followed simulation process have been done in the past month

| | Input | Output |
|----------------------------|---------------------------------|--------------------------|
| True (Geant4 simulated MC) | True vertex, direction | Geant4 PMT charge (P.E.) |
| Siren | True vertex, direction | Siren PMT charge (P.E.) |
| fiTQun input Siren | fQ reco vtx, dir | Siren PMT charge (P.E.) |
| Smearred input Siren | Smear the true input (vtx, dir) | Siren PMT charge (P.E.) |



Though the uncertainty of Geant4 vs Siren get decreased after tuning, a bias observed in the post tune Optic Siren simulation

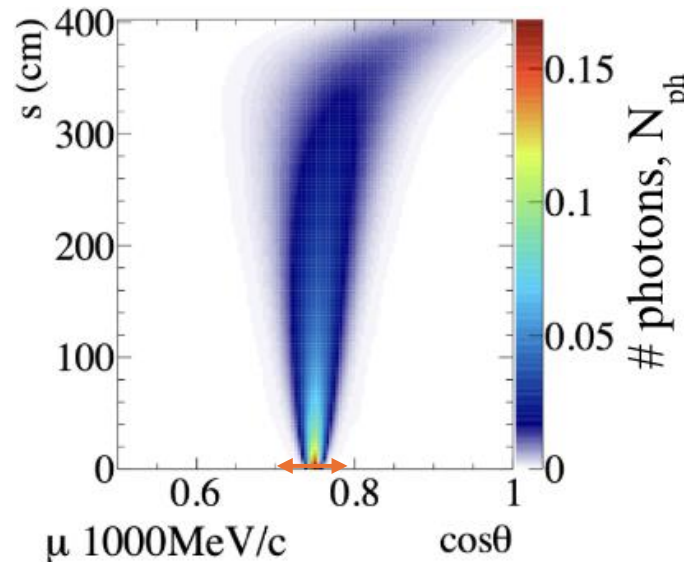
Update the Cherenkov Profile

What was done before this workshop:

Cherenkov Siren was trained by inputting WCSim simulated Cherenkov profiles from 50 MeV to 1000 MeV.

For the cosmic calibration, the muon momentum is mostly higher than 1 GeV

Fix the momentum to 1 GeV and use the pdf from s at the first bin no matter what s is, sampling $\cos\theta$ from 0.7 to 0.8.



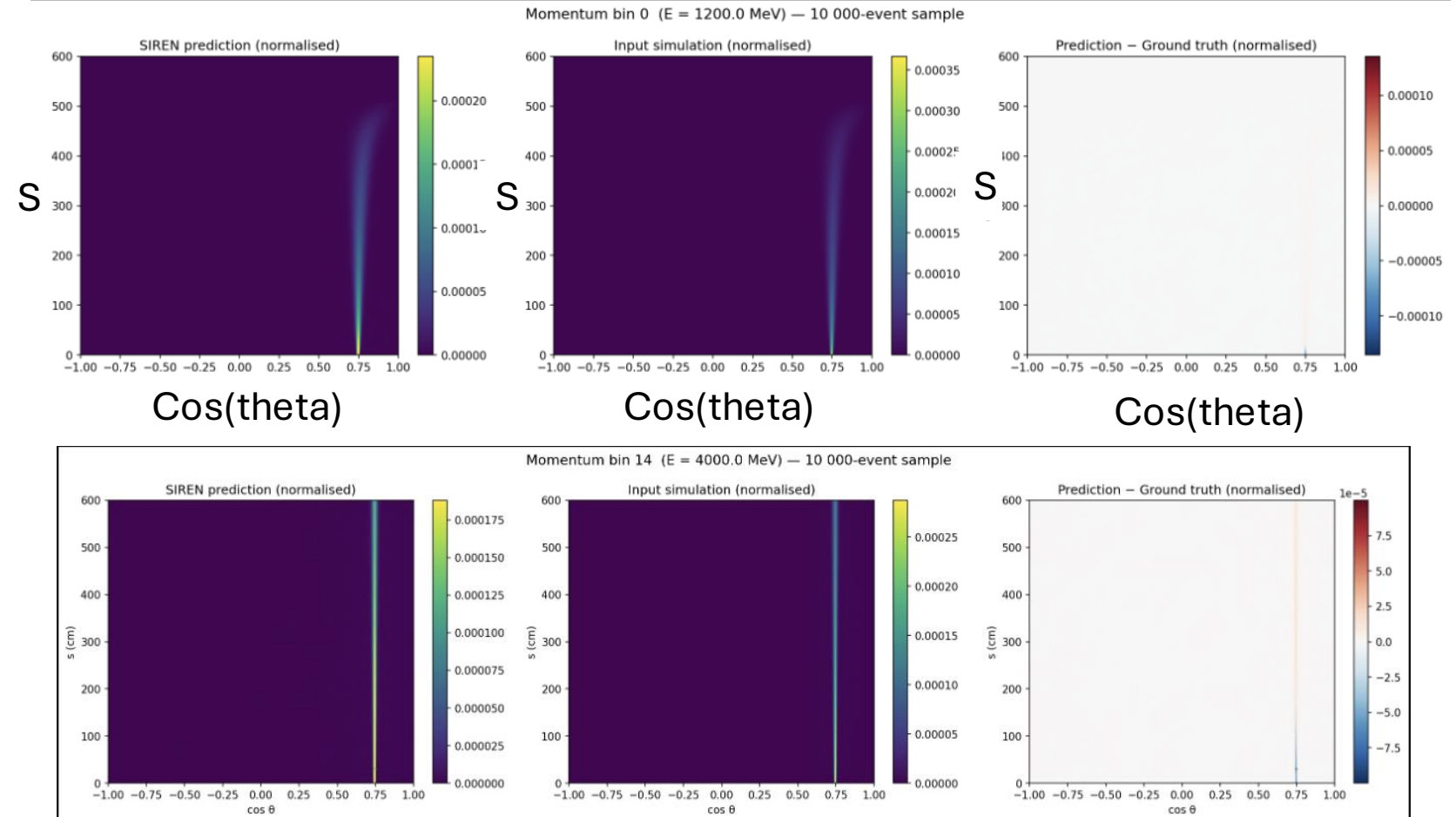
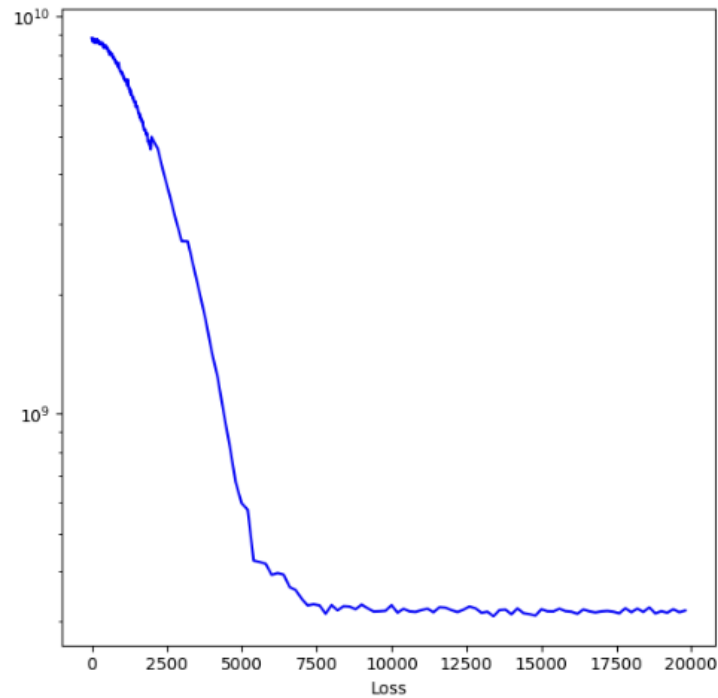
Some other validations on the sampling have been done before the workshop, however they don't impact on the result too much and are not the reason causing the bias.

Extending the Cherenkov profile to high energy range may improve the result.

- Train the Cherenkov Siren with high energy muon Cherenkov profiles
- Make a lookup table of the high energy muon Cherenkov profiles

Train Cherenkov Siren

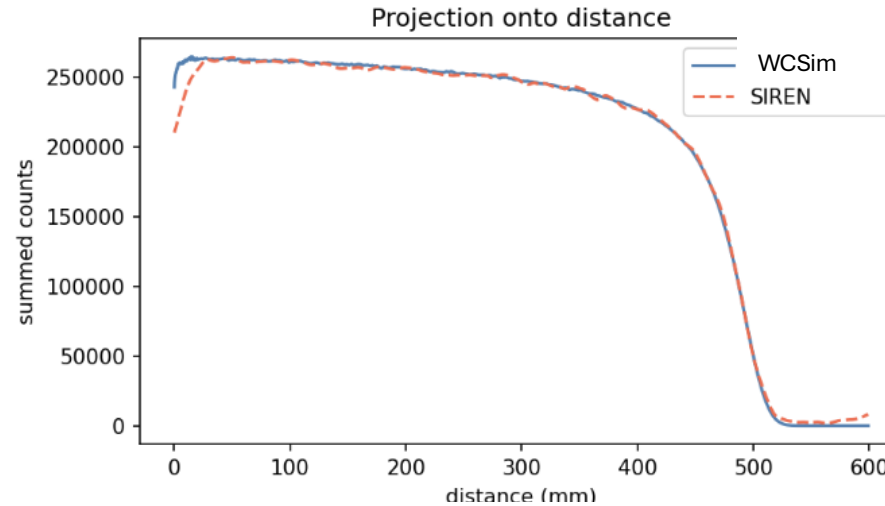
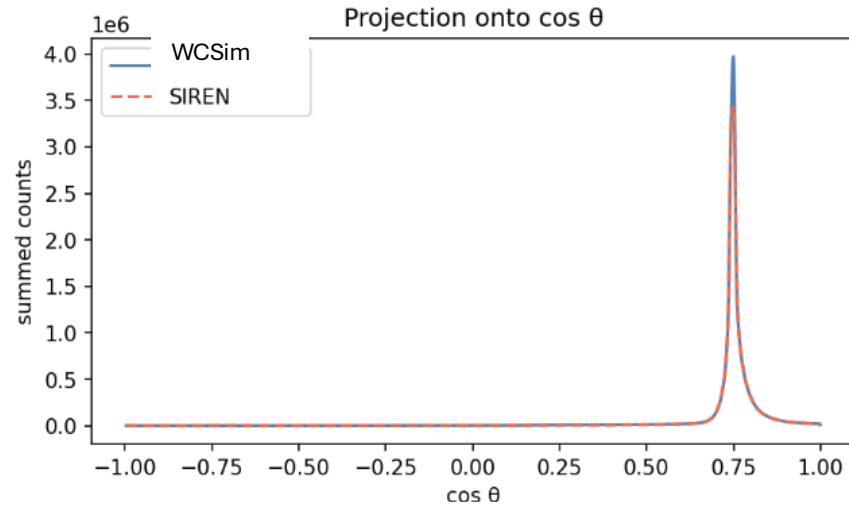
Trained the Cherenkov Siren with 1-10 GeV muon Cherenkov profiles



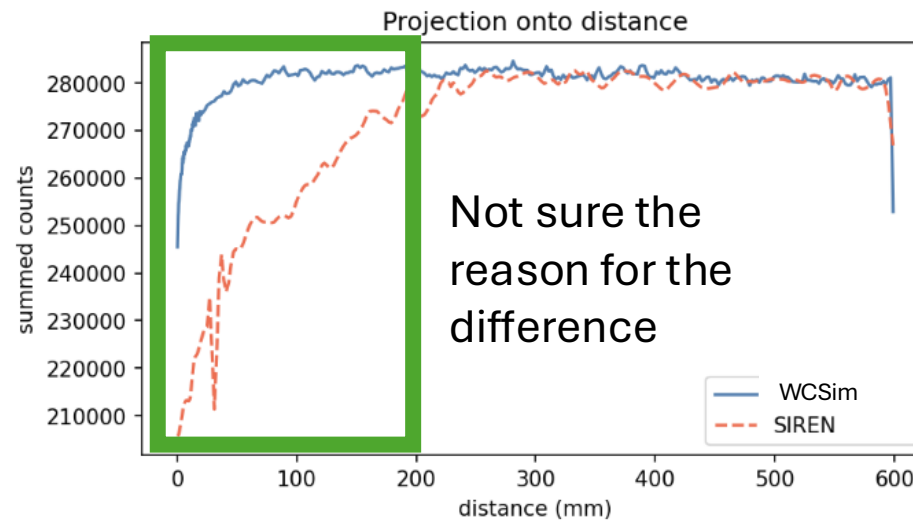
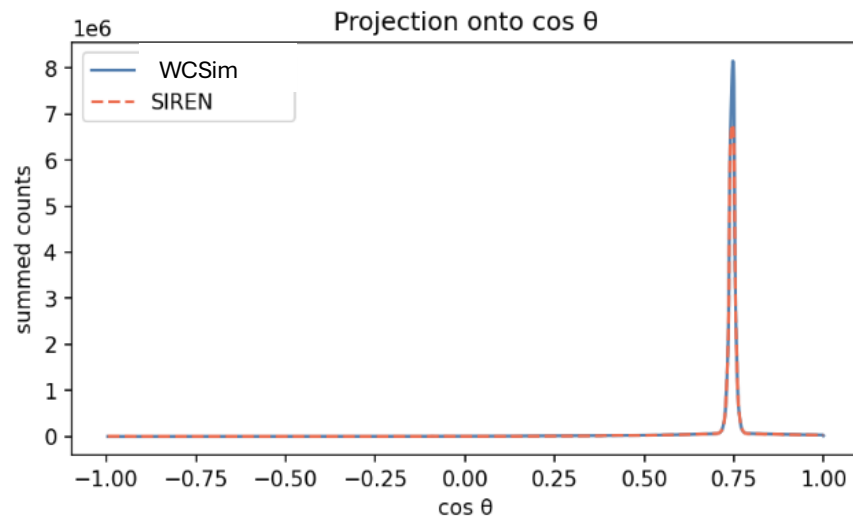
With the energy increasing the difference between prediction and WCSim input get higher

1-D projection of the Cherenkov Siren prediction

1-D projections (mom bin 0, E = 1200.0 MeV)



1-D projections (mom bin 14, E = 4000.0 MeV)

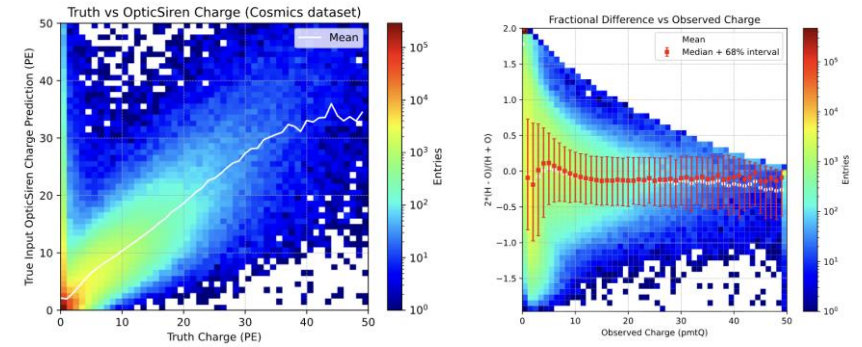


Lookup table

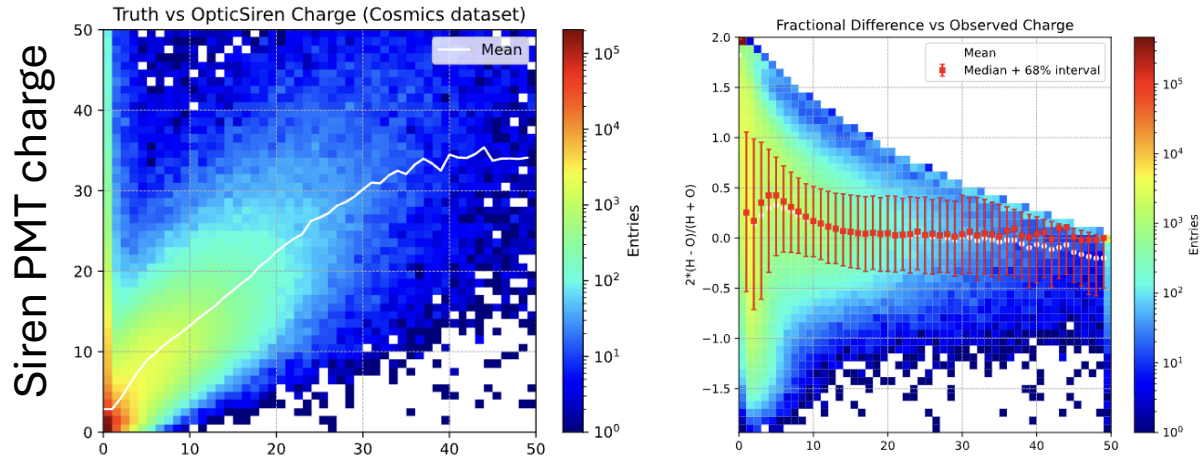
$$2 * (\text{Siren} - \text{Geant4}) / (\text{Siren} + \text{Geant4})$$

The tuning is not finished yet
 However, by comparing with the old Geant4 vs Siren pre tune, it is not improved by varied the momentum to high energy and it's not what we expected....

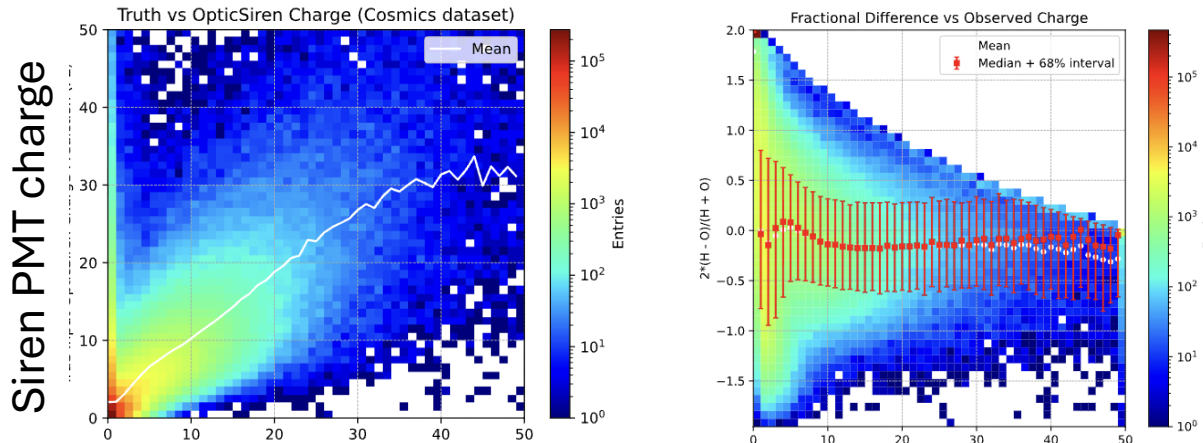
Pretune with fixed momentum



pretune

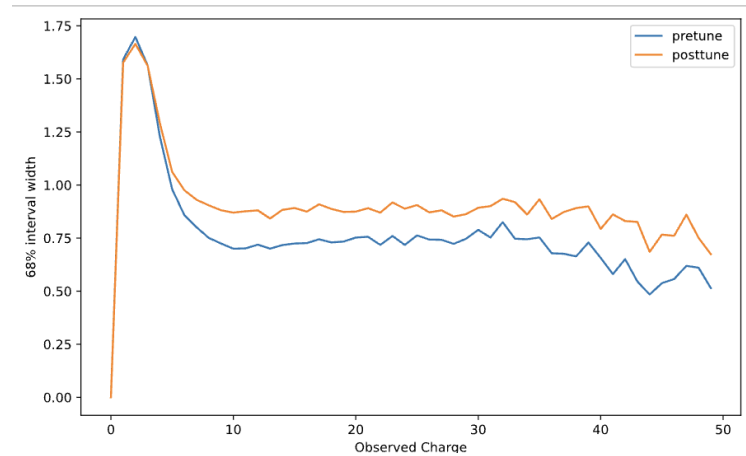


posttune



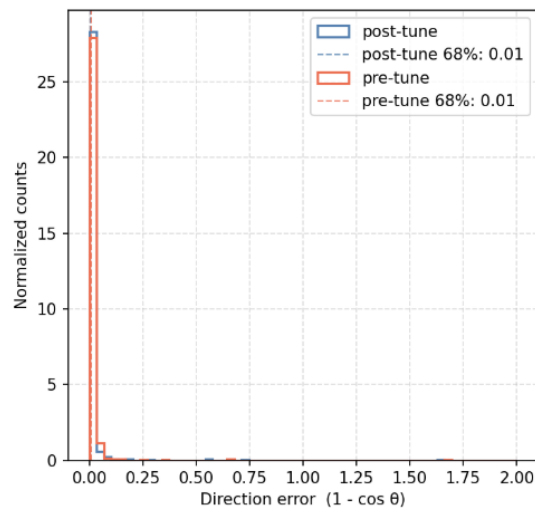
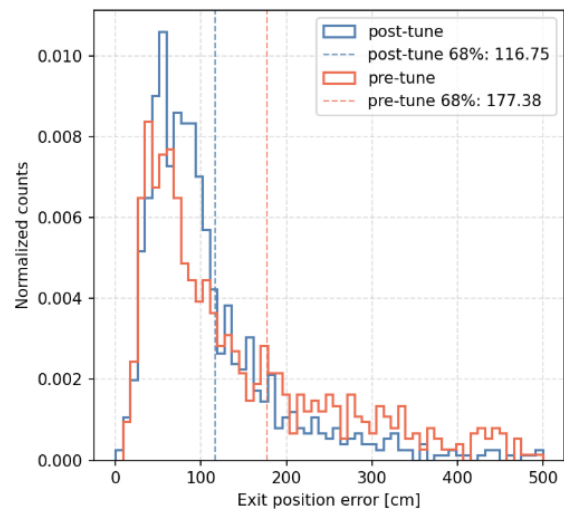
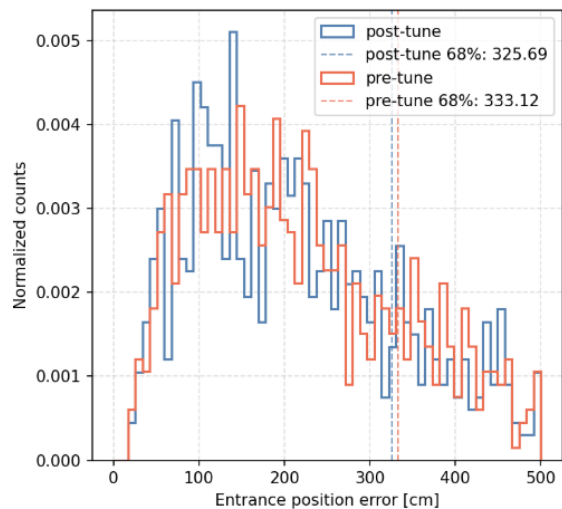
GEANT4 PMT charge

GEANT4 PMT charge

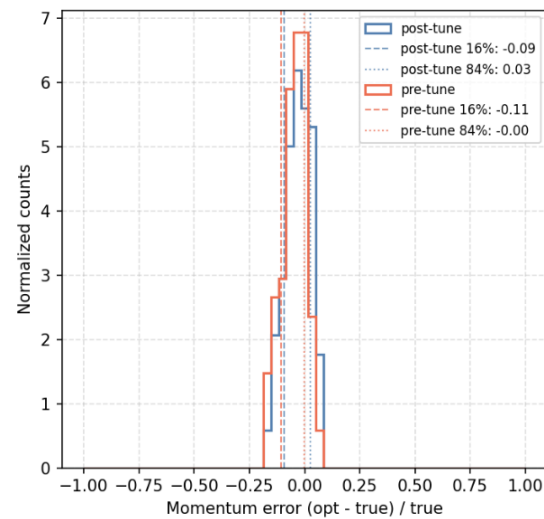
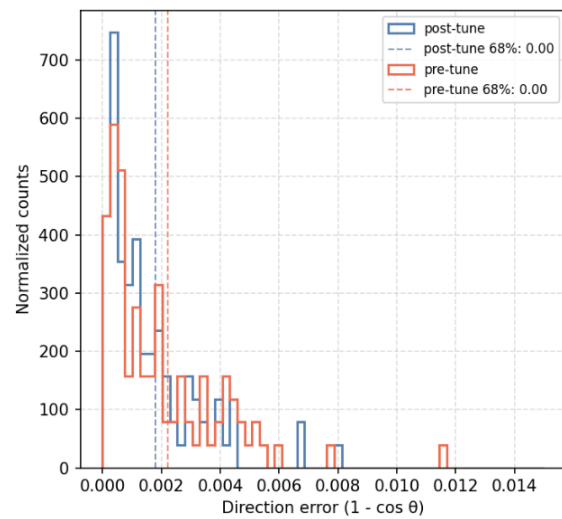
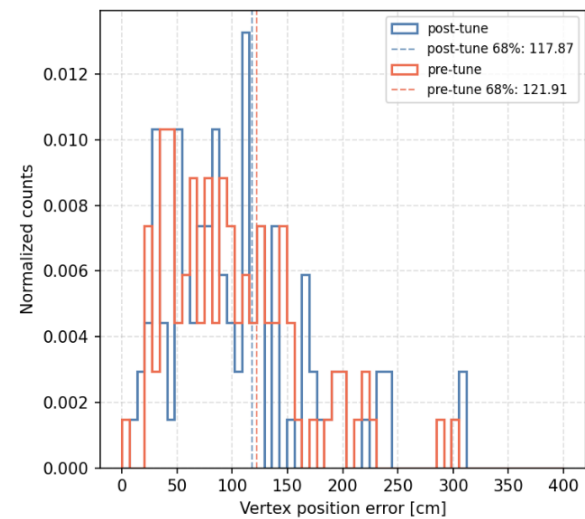


Reconstruction

OpticSiren cosmic reconstruction errors



OpticSiren beam reconstruction errors



Summary

- Cherenkov Profile for cosmic muons
 - Some studies have been done, including extending the energy range of Cherenkov profile and making a lookup table for muon energy up to 10 GeV.
 - Some problems observed which may need to be explored in the future:
 - Cherenkov Siren simulation differs with WCSim simulation when energy goes higher
 - Demonstrate the lookup table into OpticSiren to enable it varied in high energy doesn't improve the pre-tune
- Reconstruction
 - Reconstruction w/ pretune and posttune Siren for both cosmic and beam MC samples. The post-tune shows slightly better resolution.
- Demonstrate the pipeline with WCTE data
 - Not finished in this workshop