High Energy Event Reconstruction

Michinari Sakai

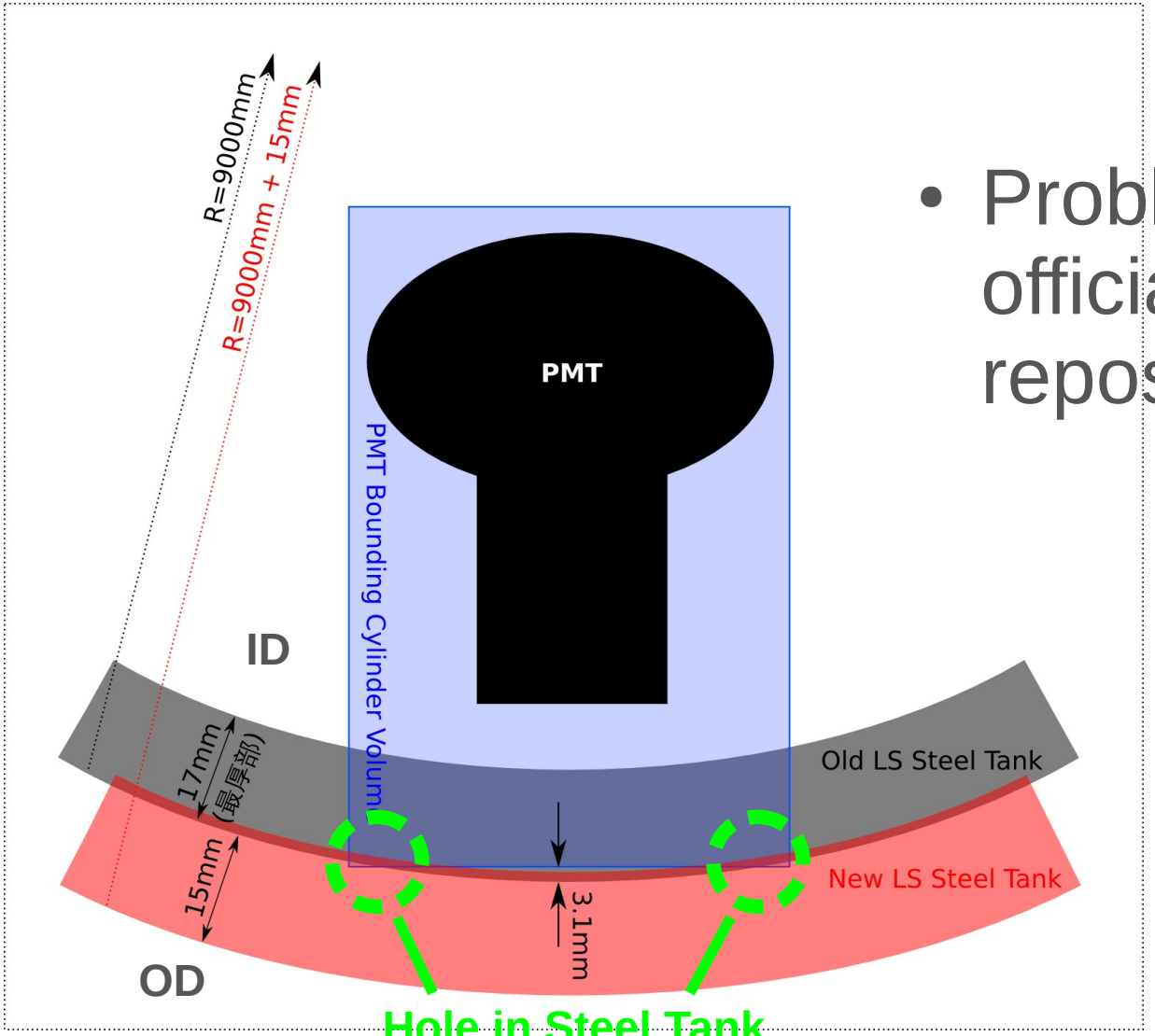
Known Geometry Problem with KLG4 for High Energy Analysis

- High energy event produces many photons
→ photons “warp" from ID to OD

- This is a problem when placing OD cuts to find fully contained events

- Cause due to PMT geometry overlap in KLG4

Known Geometry Problem with KLG4 for High Energy Analysis

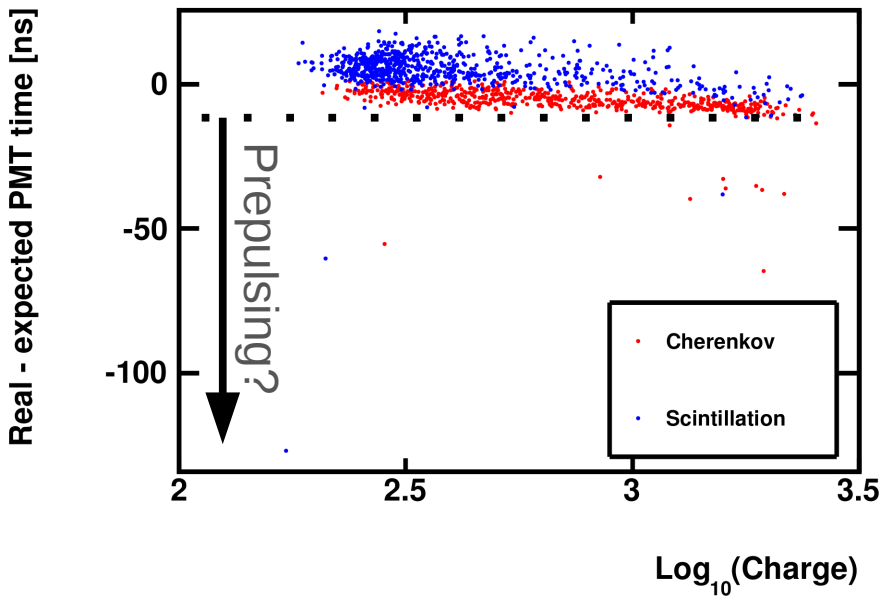


- Problem will be officially fixed in repository.

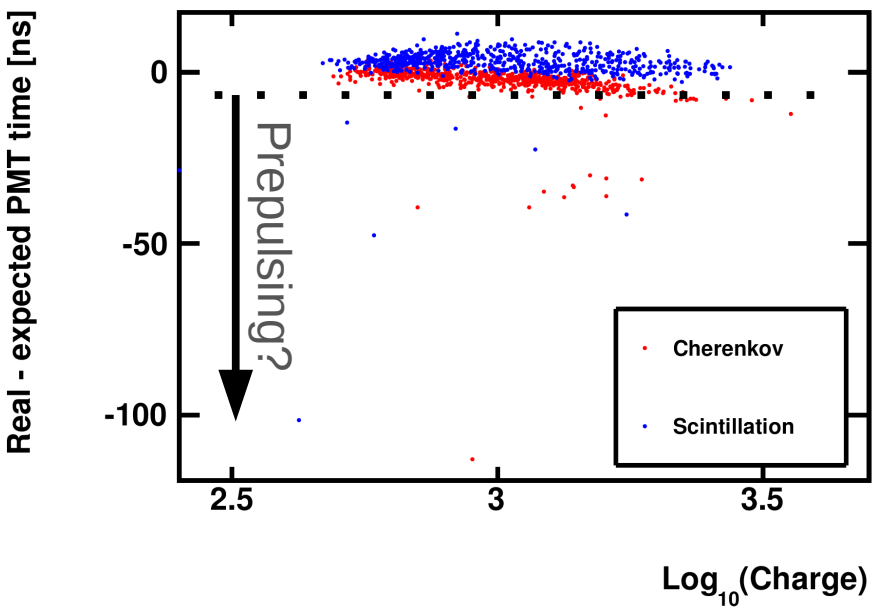
PMT Prepulsing at High Energies

- PMT prepulsing occurs when many photons (>~100)
- Prepulsing is most probable when photons hit dynode along dynode axis.
- Prepulsing can give wrong bias to fitters that use PMT hit timing

PMT Prepulsing at High Energies



Sample muon #1
Run 5000
Event 25663
Recon Energy 2512.59 MeV
Badness 13.706
Impact Param 396.618 cm

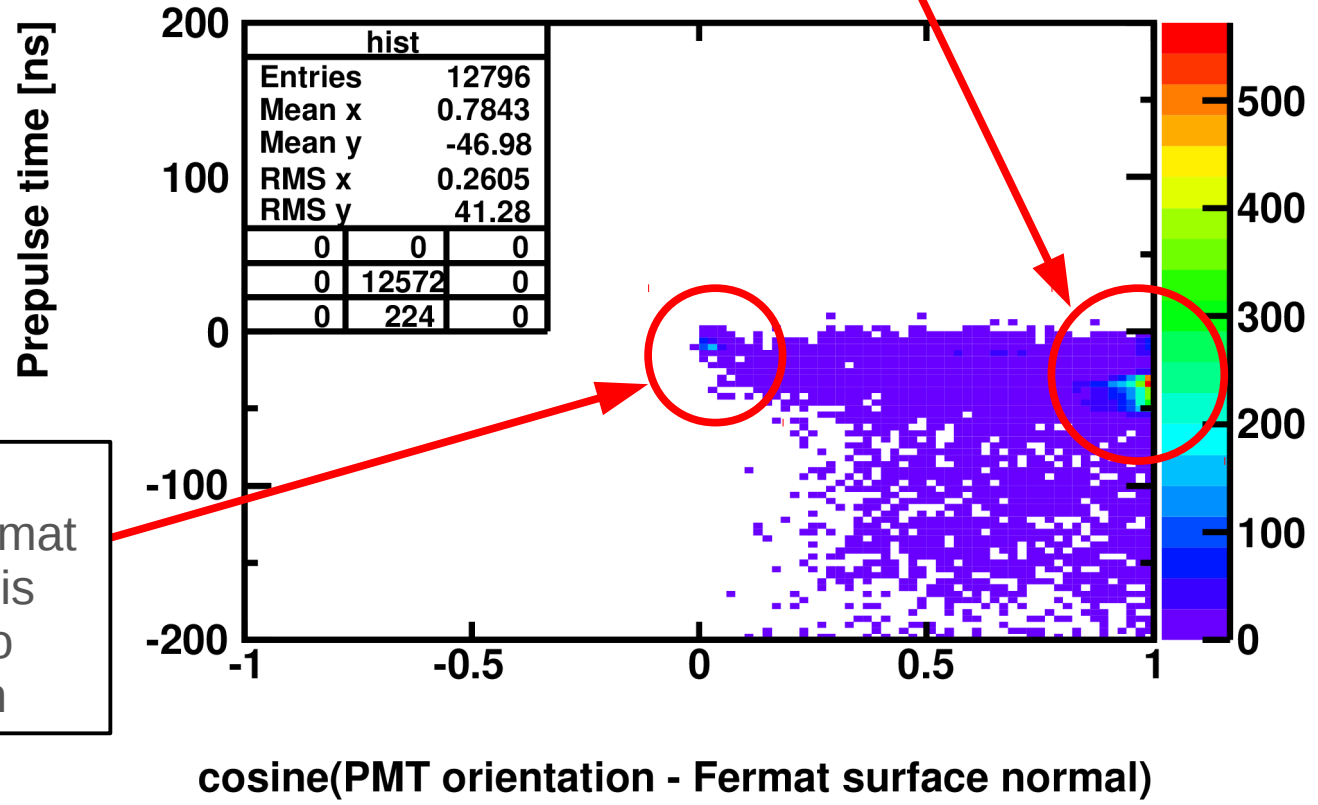


Sample muon #2
Run 5000
Event 37715
Recon Energy 5031.46 MeV
Badness 16.4625
Impact Param 187.912 cm

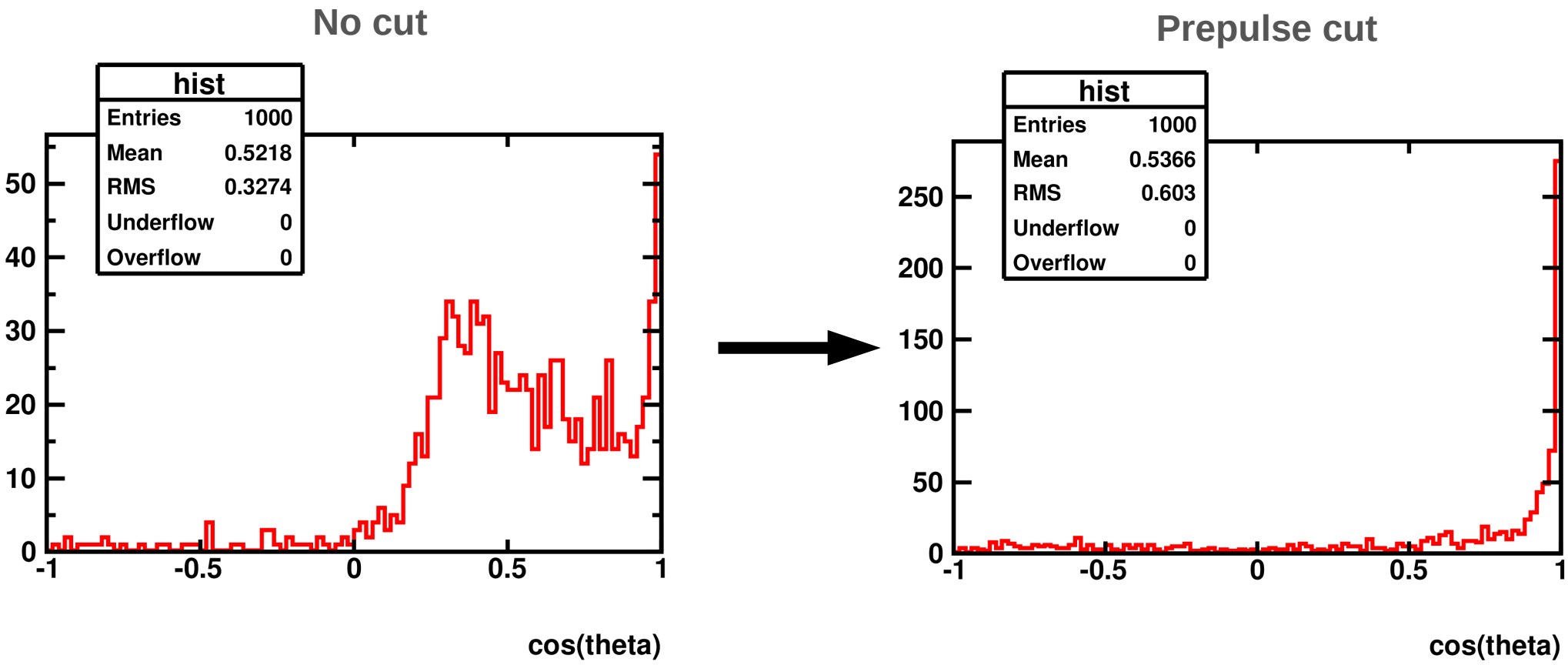
PMT Prepulsing at High Energies (1000 muons from RTQ run 5000~)

Early hit times (-30 ~ -50 ns of neighbor PMTs) when Fermat surface normal is parallel to PMT orientation.

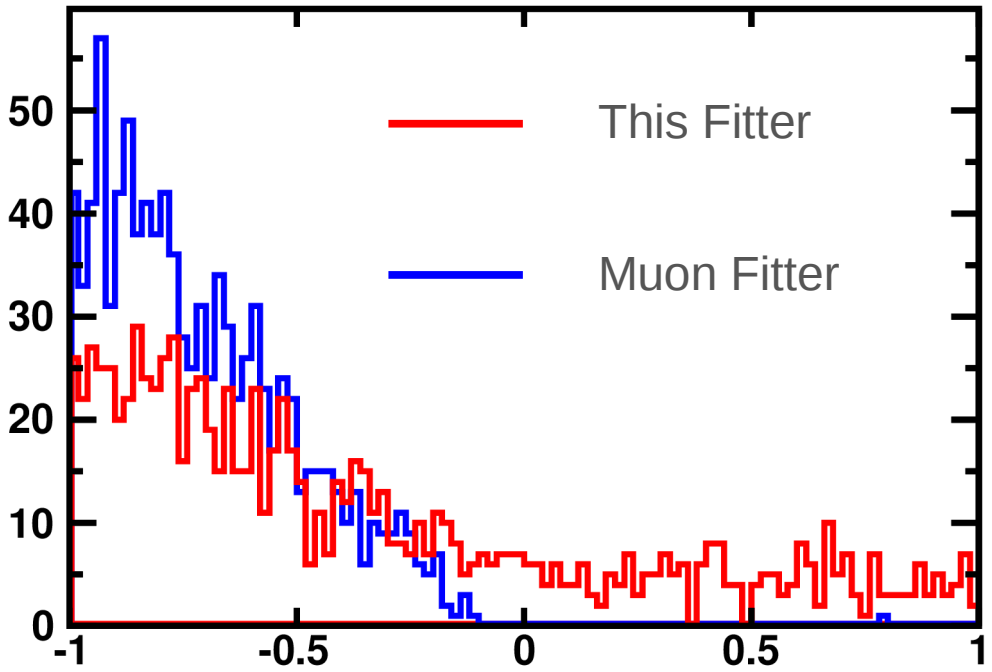
Some early hit times when Fermat surface normal is perpendicular to PMT orientation



Agreement of Michi Fitter / Muon Fitter (1000 muons, RTQ run 5000~)



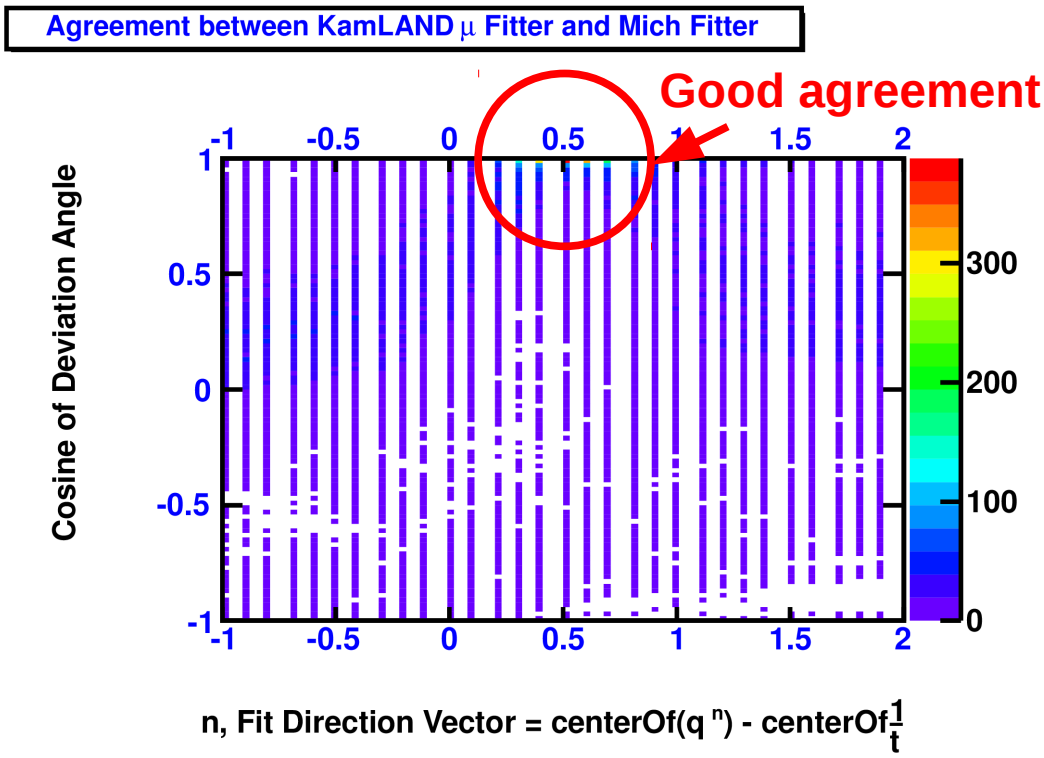
Zenith Angle of Both Fitters (1000 muons, RTQ run 5000~)

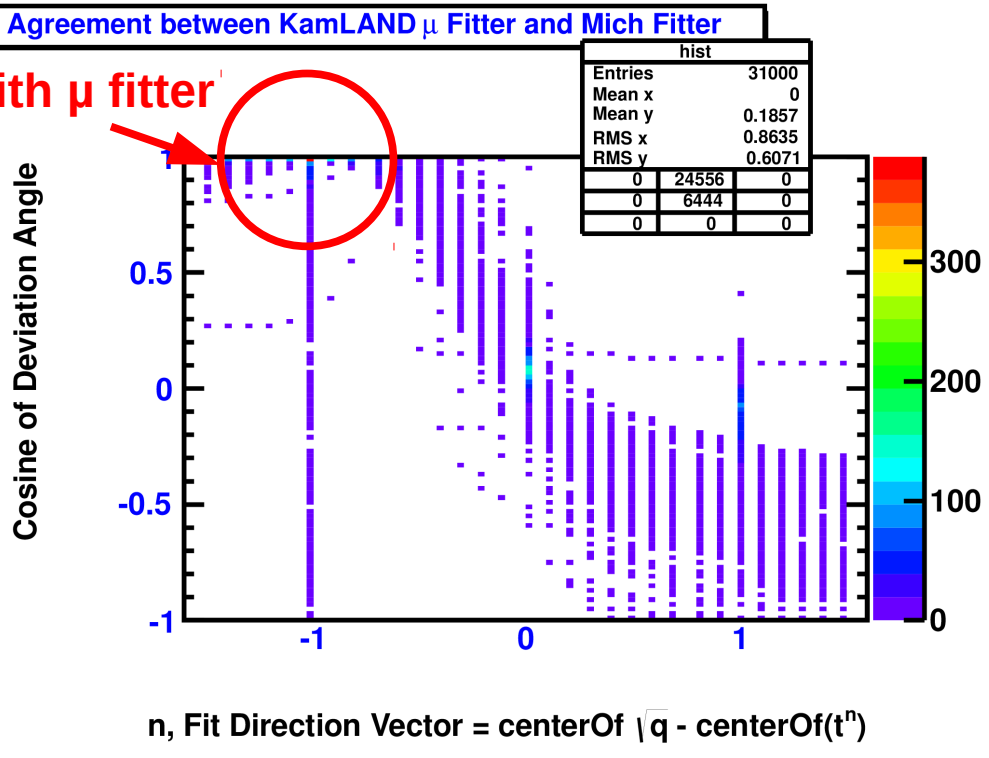


- Muon Fitter is fitting through-going muons well.
- New fitter is less accurate for through going muons..

Center of time/charge vs. muon fitter (1000 muons, RTQ run 5000~)

- Exponent modifier m,n for center of (time^{m}) and (charge^{n}) was varied in steps of 0.1
- Vector pointing from center of time^{-1} to center of charge$^{0.5}$ gave best result

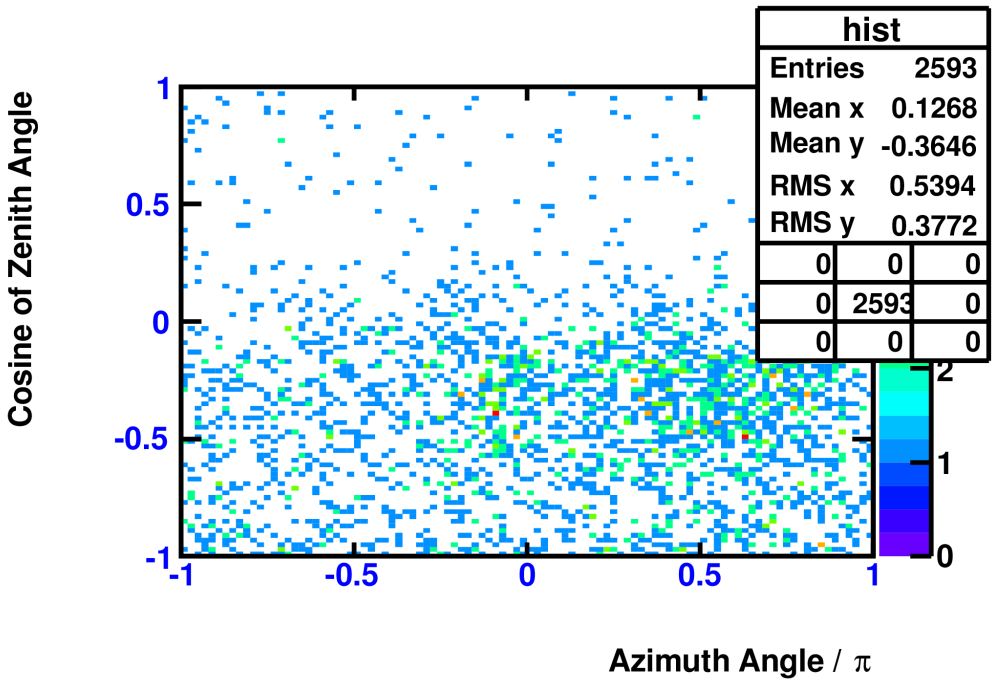




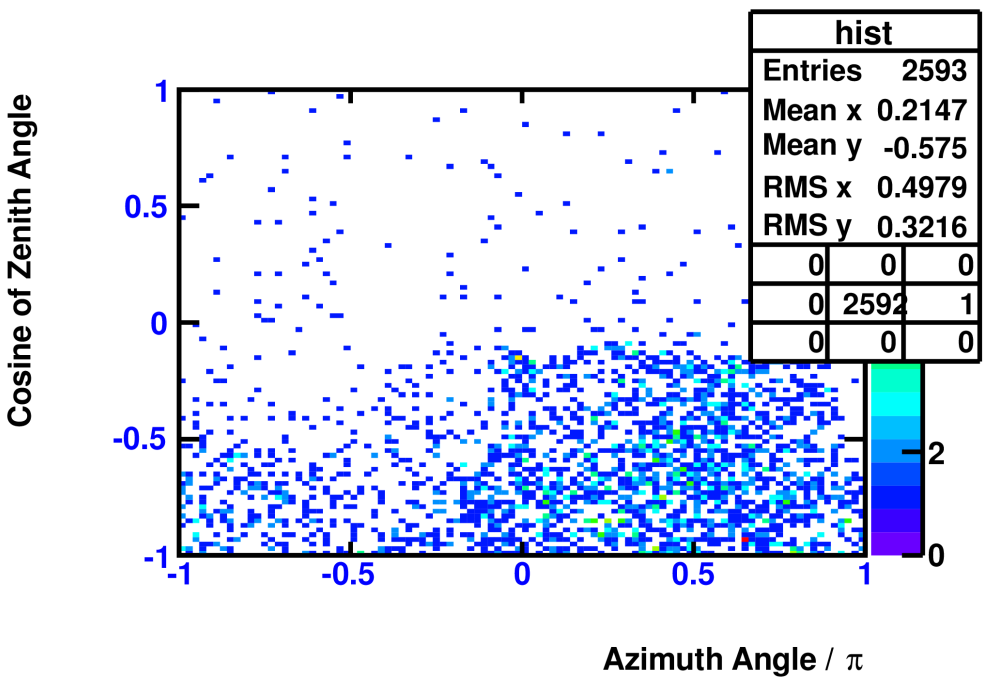
Atmospheric Neutrino

Events from Tamae, Shimizu

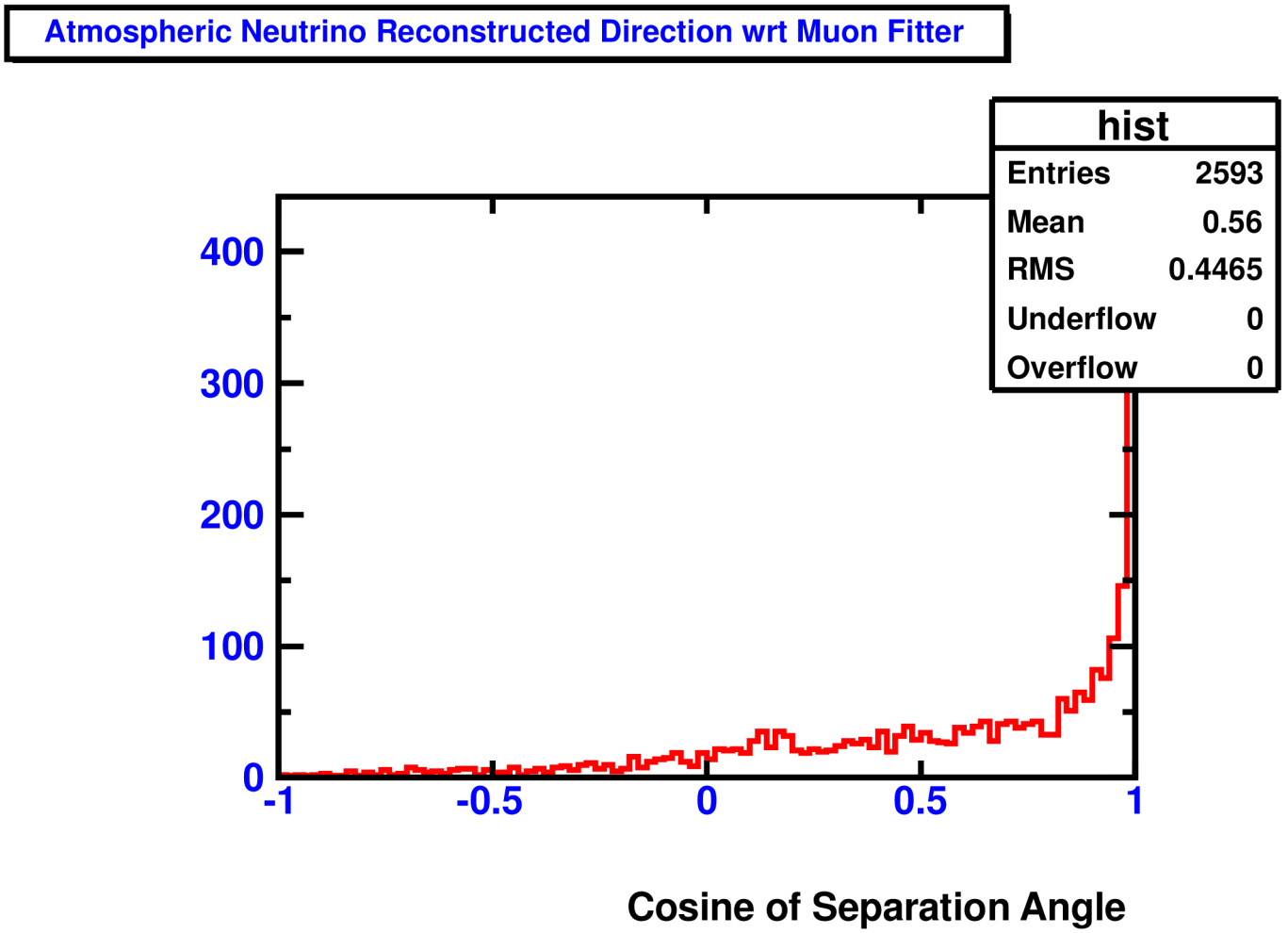
Michi ν Fitter



KamLAND μ fitter



Atmospheric Neutrino



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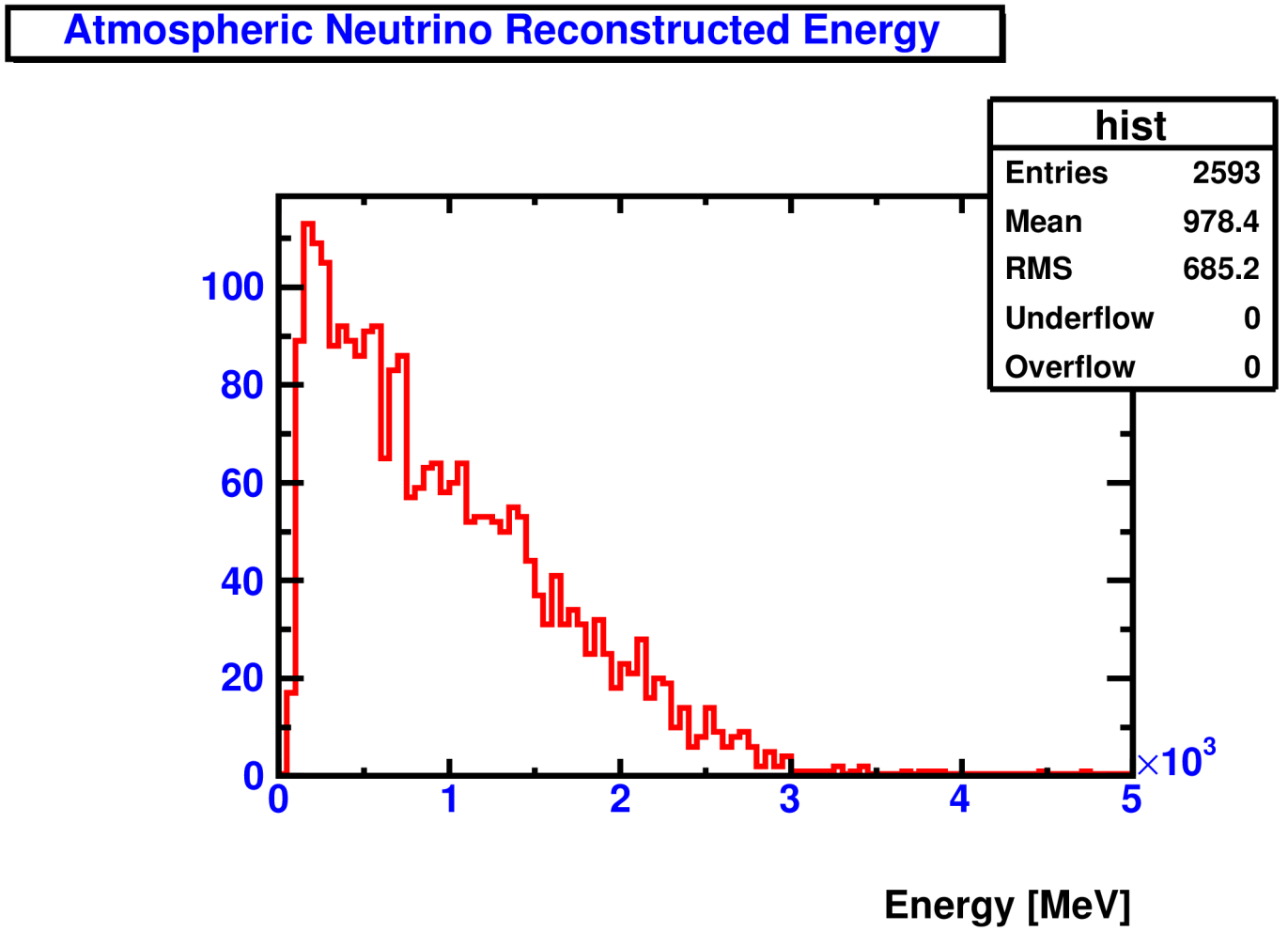
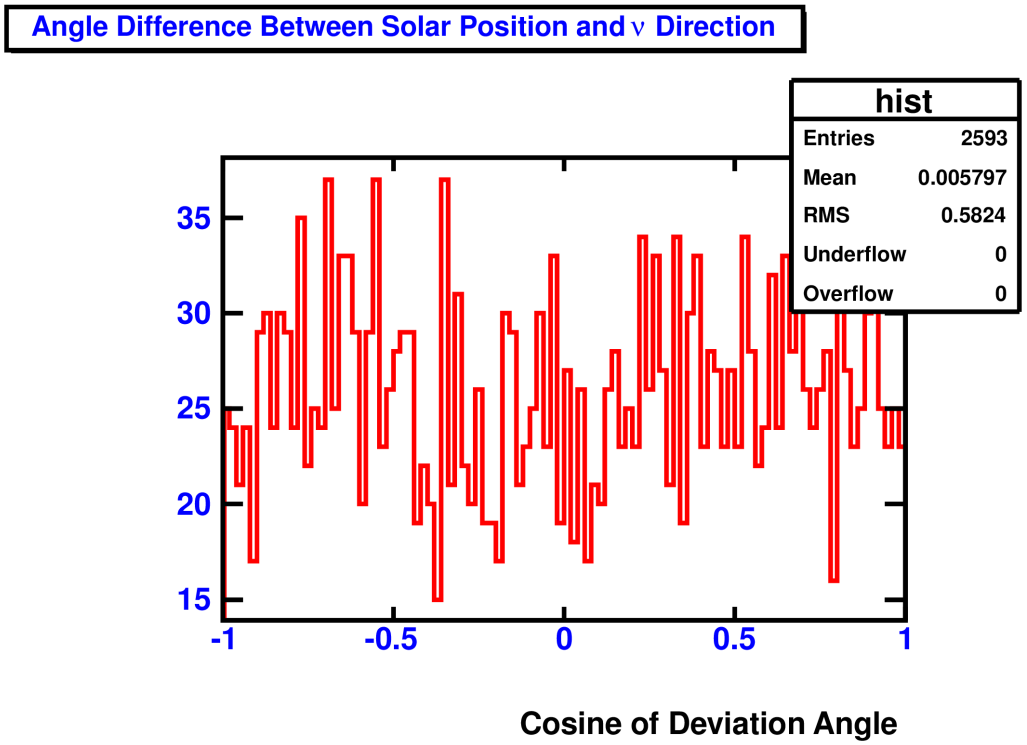
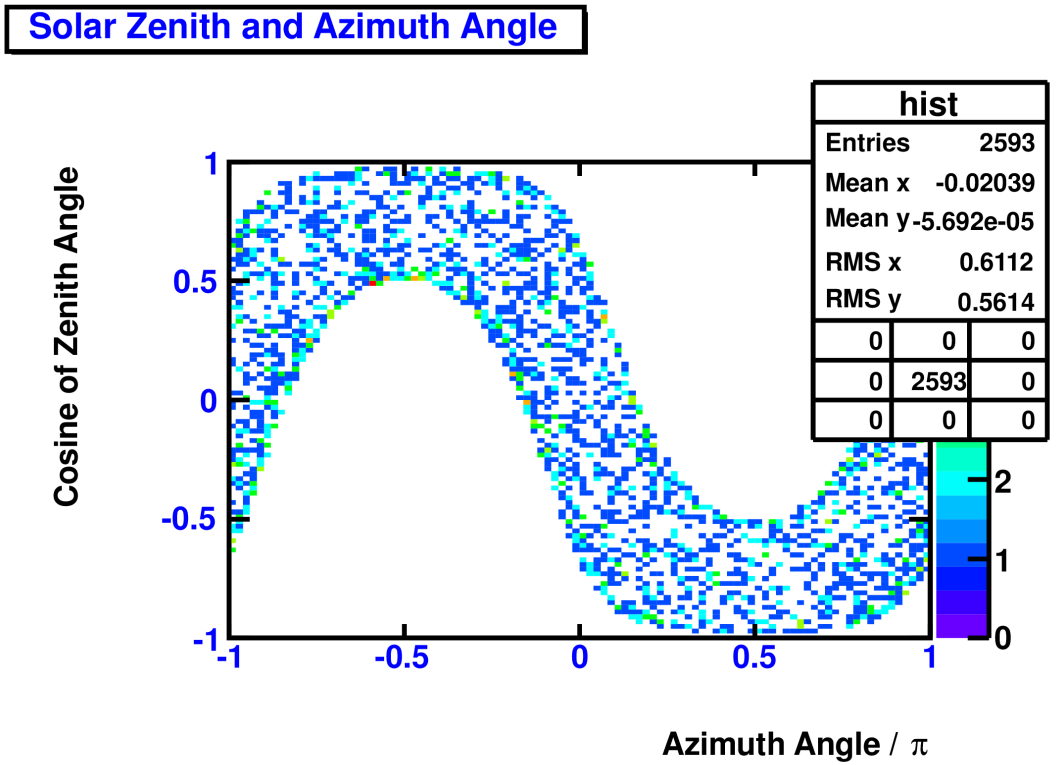


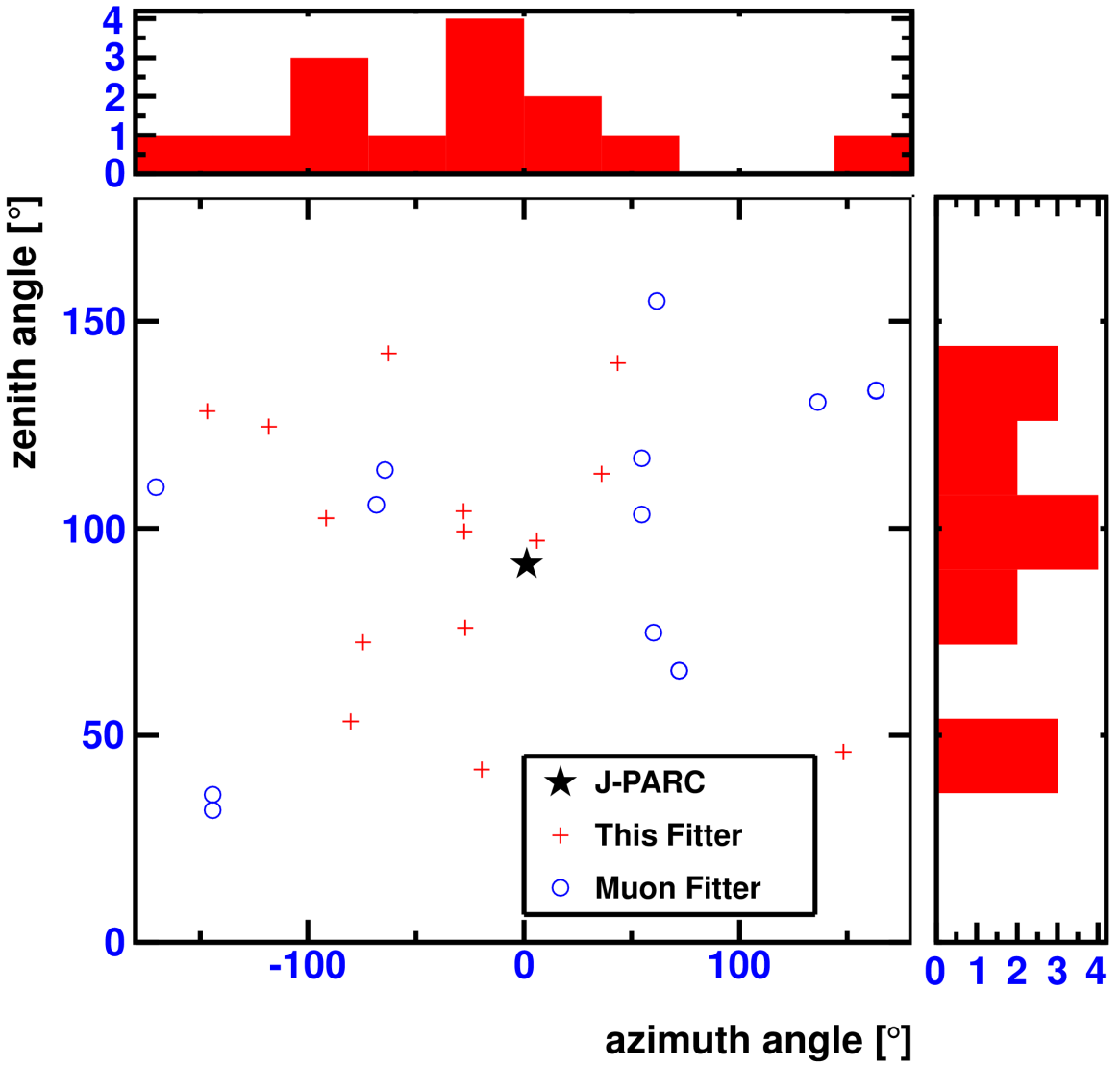
Atmospheric Neutrino





Reconstructed T2K Event Direction

Events from Ikeda Haruo



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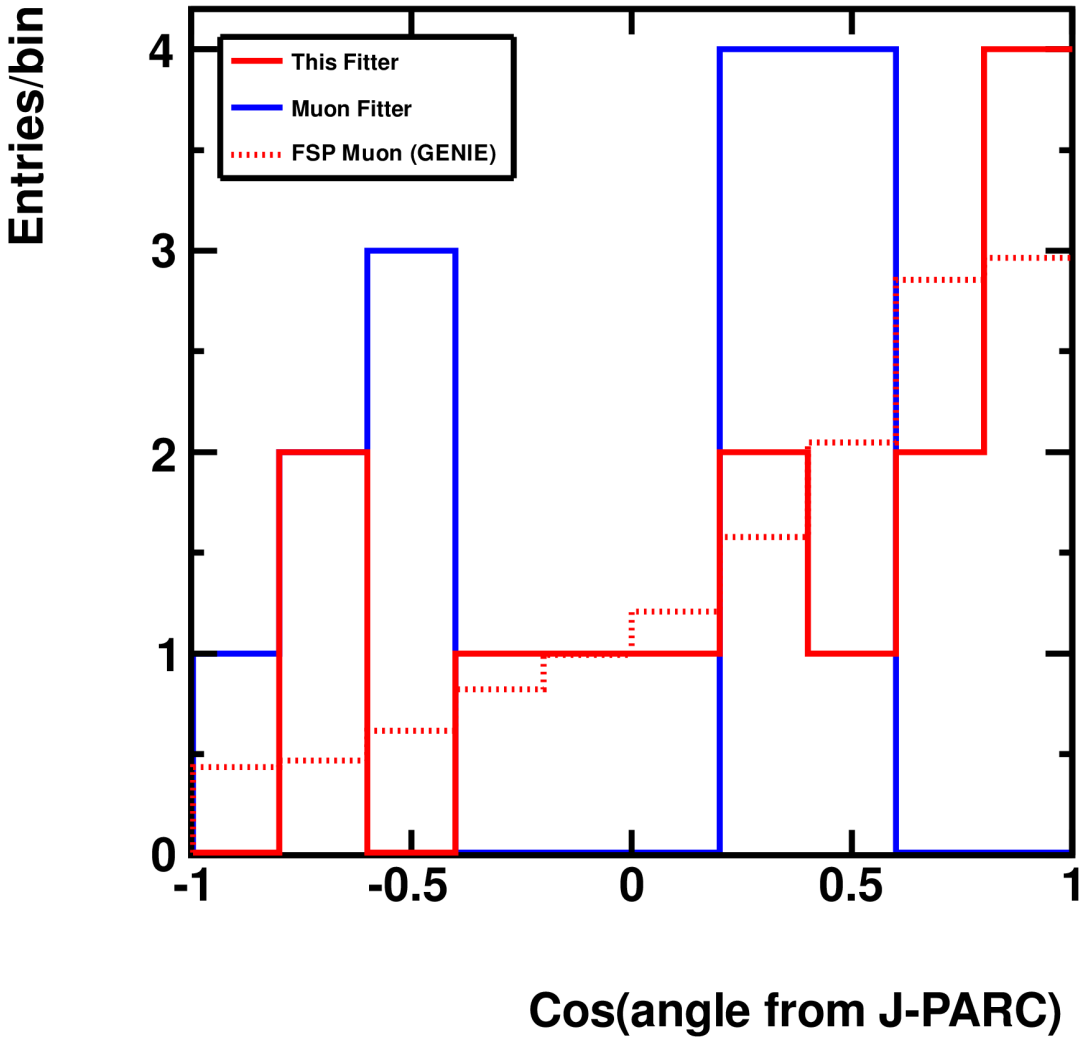


Summary

- Identified KLG4 geometry problem causing photon “warp” from ID to OD.
- Identified PMT prepulse problem → Solved by placing cut outside of mean ± 3σ of neighbor PMTs.
- Atmospheric/T2K event candidates direction fitted with μ fitter and new fitter.

To Do

- Explore flavor discrimination using Deep Neural Network

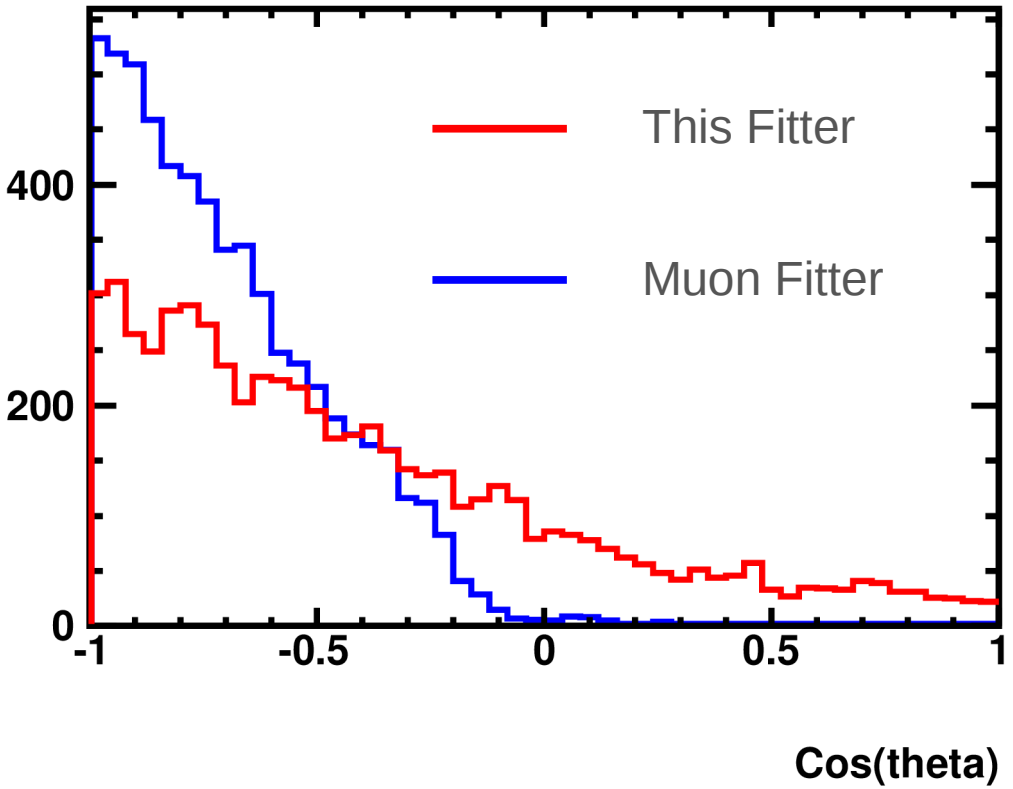
- Improve direction fitter by improving t_0 used in center of 1/Time.

- Constrain Dark Matter mass (using WIMP Sim?).

- Also look at specifically very high energy events (~50 GeV?) b/c backgrounds are lower at higher energies.

Backup Slides

Zenith Angle of Both Fitters (muons from RTQ run 5000~5099)



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