Neutrino Vertex Reconstruction/Selection

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Introduction

- Compare two reconstruction algorithms: Pandora and PMTrack.
- 0 to multiple reco vtx stored for each ν_μ event. Define an algorithm to select the best reco vtx.
  - First check the position resolution for the closest vtx.
  - Compare the position resolution to the closest vtx.
- Using 30K MC simulation neutrino data are from: /pnfs/dune/scratch/dunepro/v06_18_00/reco/prodgenie_nu_dune10kt_1x2x6

Event Selection and Categorization

- FV defined as:
  - |x| <= 310 cm, |y| <= 550 cm, z <= 1244 && z >= 50 cm
- Events are categorized in to ν_μ CC, NC and ν_e CC.

All Events

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Event Type	# of Events	Truth in FV	Truth out	Pandora in	Pandora out	PMTrack in	PMTrack out
All (No Reco vtx)	30000	17860	12140	17306	10358 (2336)	17694	10587 (1719)
Truth in Pandora in	16940	✓		✓			
Truth in Pandora out	312	✓			✓		
Truth out Pandora in	366		✓	✓			
Truth out Pandora out	10046		✓		✓		
Truth in PMTrack in	16625	✓				✓	
Truth in PMTrack out	891	✓					✓
Truth out PMTrack in	1069		✓			✓	
Truth out PMTrack out	9696		✓				✓

ν_μ CC

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Event Type	# of Events	Truth in FV	Truth out	Pandora in	Pandora out	PMTrack in	PMTrack out
Truth in Pandora in	12929	✓		✓			
Truth in Pandora out	201	✓			✓		
Truth out Pandora in	230		✓	✓			
Truth out Pandora out	7760		✓		✓		
Truth in PMTrack in	12518	✓				✓	
Truth in PMTrack out	622	✓					✓
Truth out PMTrack in	748		✓			✓	
Truth out PMTrack out	7406		✓				✓

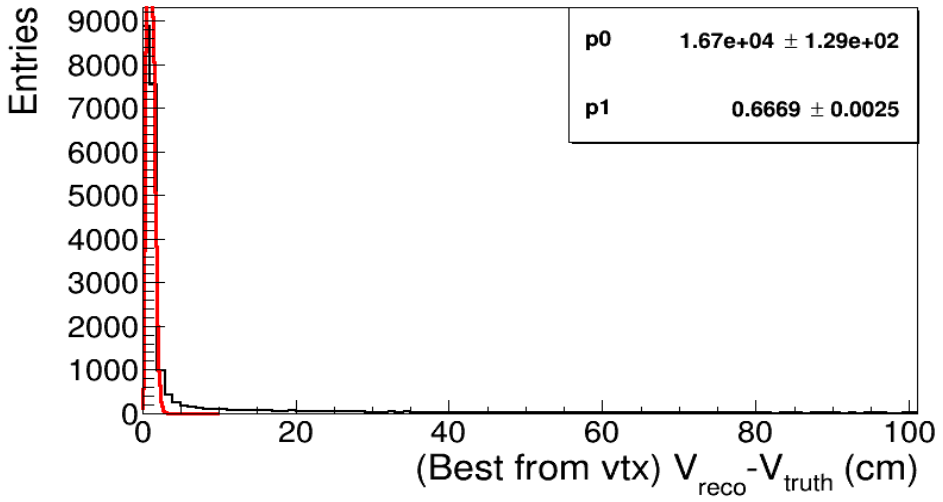
ν_μ NC

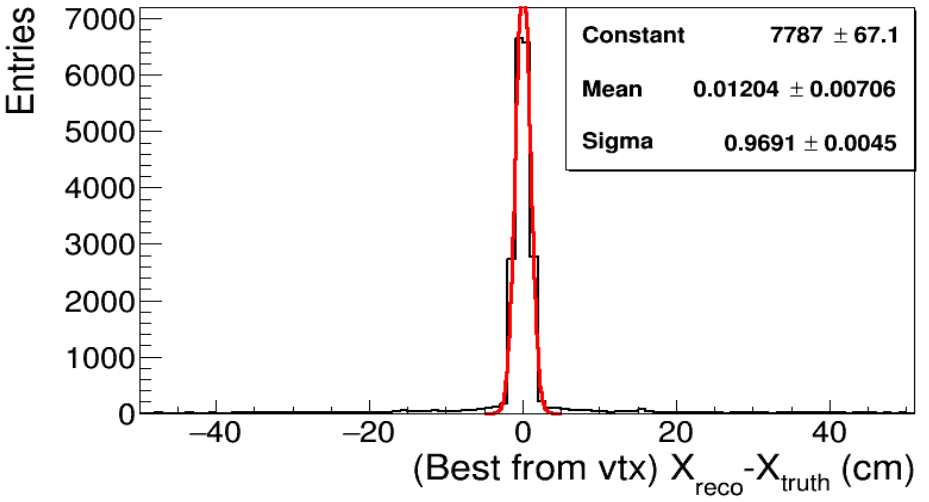
Event Type	# of Events	Truth in FV	Truth out	Pandora in	Pandora out	PMTrack in	PMTrack out
Truth in Pandora in	3521	✓		✓			
Truth in Pandora out	103	✓			✓		
Truth out Pandora in	120		✓	✓			
Truth out Pandora out	2032		✓		✓		
Truth in PMTrack in	3637	✓				✓	
Truth in PMTrack out	240	✓					✓
Truth out PMTrack in	285		✓			✓	
Truth out PMTrack out	2053		✓				✓

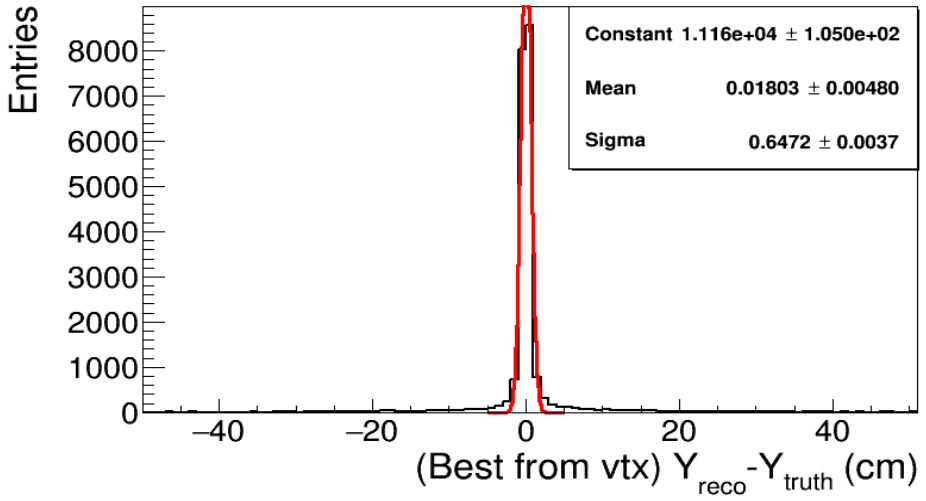
ν_e CC

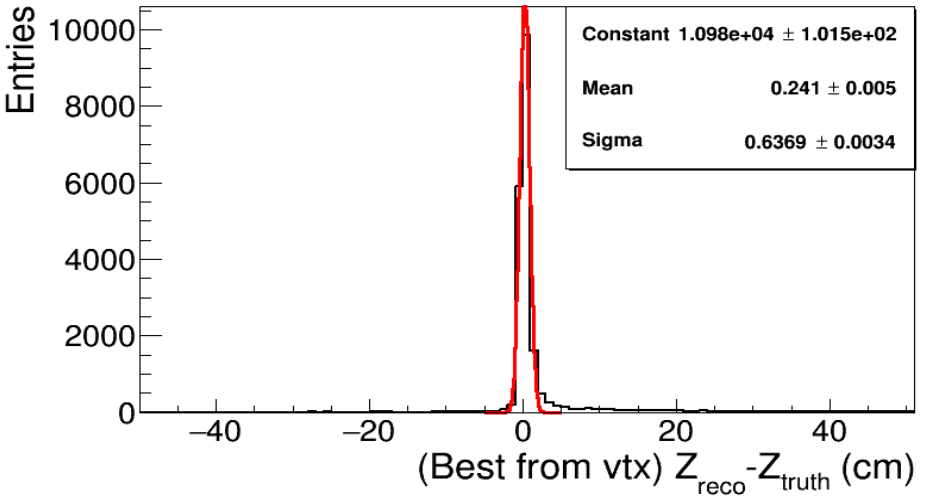
Event Type	# of Events	Truth in FV	Truth out	Pandora in	Pandora out	PMTrack in	PMTrack out
Truth in Pandora in	178	✓		✓			
Truth in Pandora out	5	✓			✓		
Truth out Pandora in	5		✓	✓			
Truth out Pandora out	89		✓		✓		
Truth in PMTrack in	173	✓				✓	
Truth in PMTrack out	10	✓					✓
Truth out PMTrack in	11		✓			✓	
Truth out PMTrack out	84		✓				✓

ν_μ CC (Closest VTX Pandora)

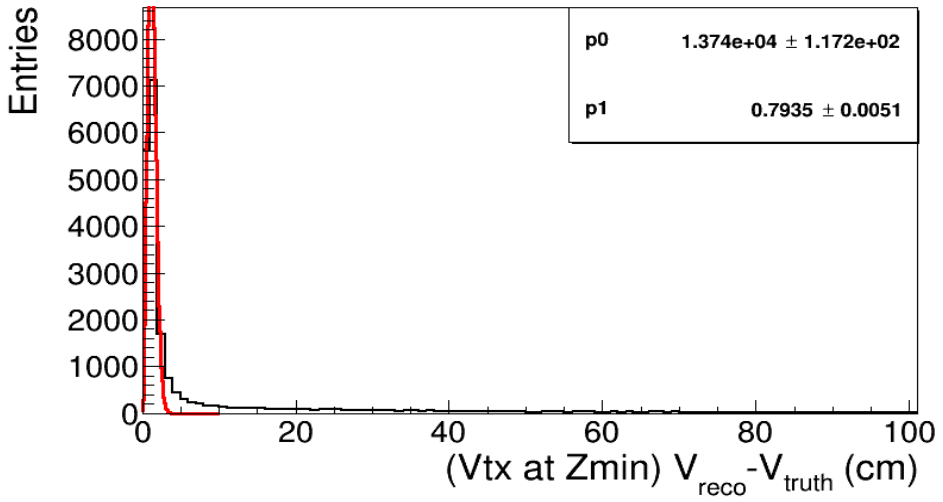


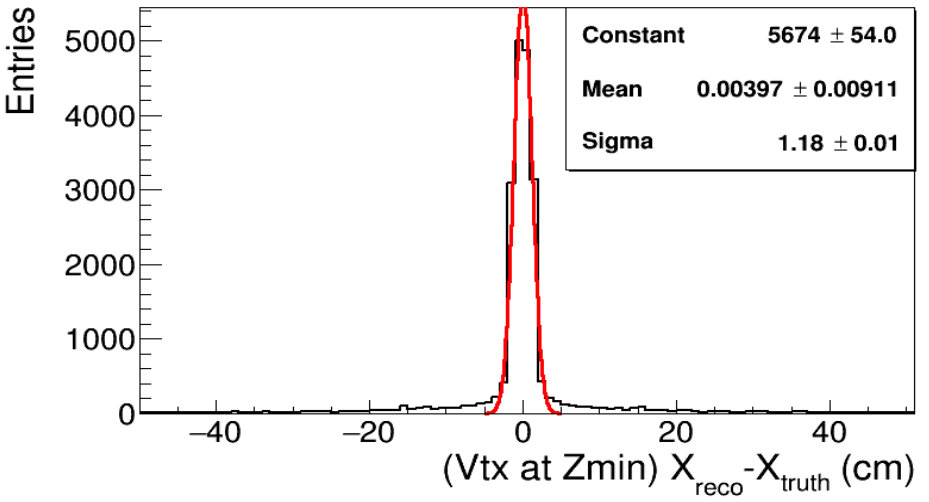


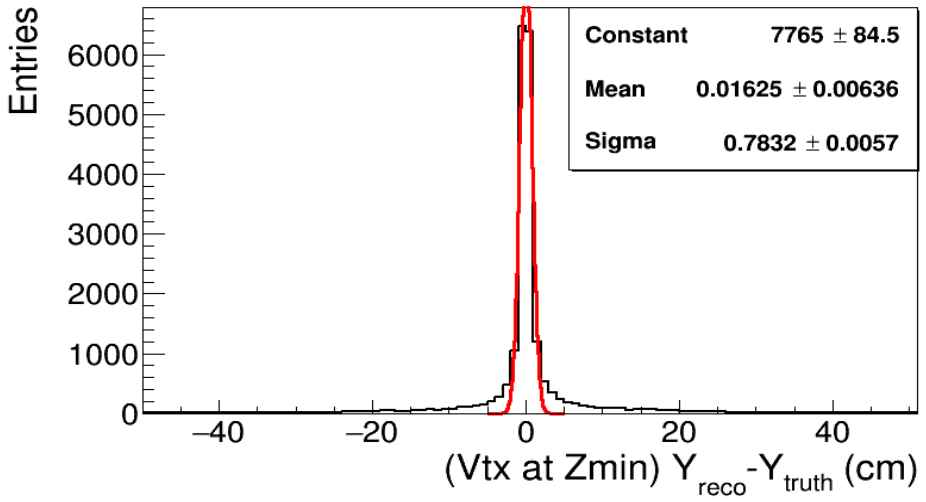


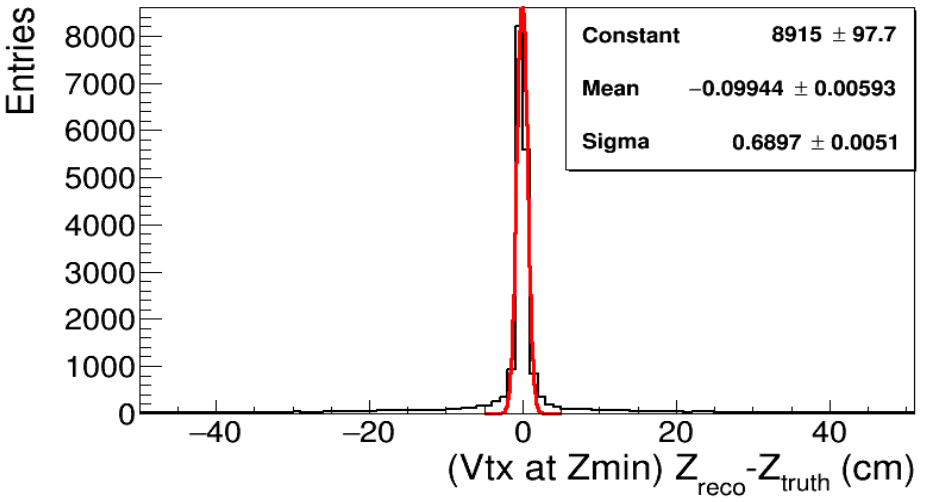


ν_μ CC (Upstream VTX Pandora)

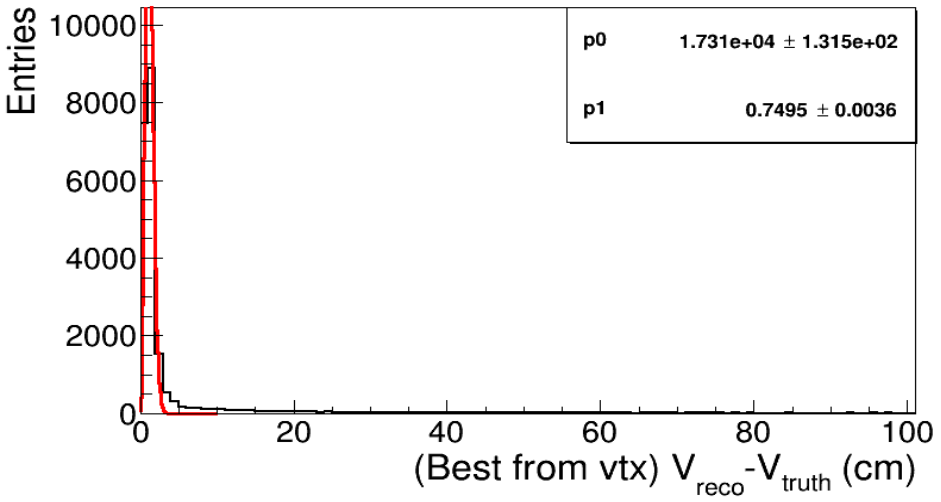


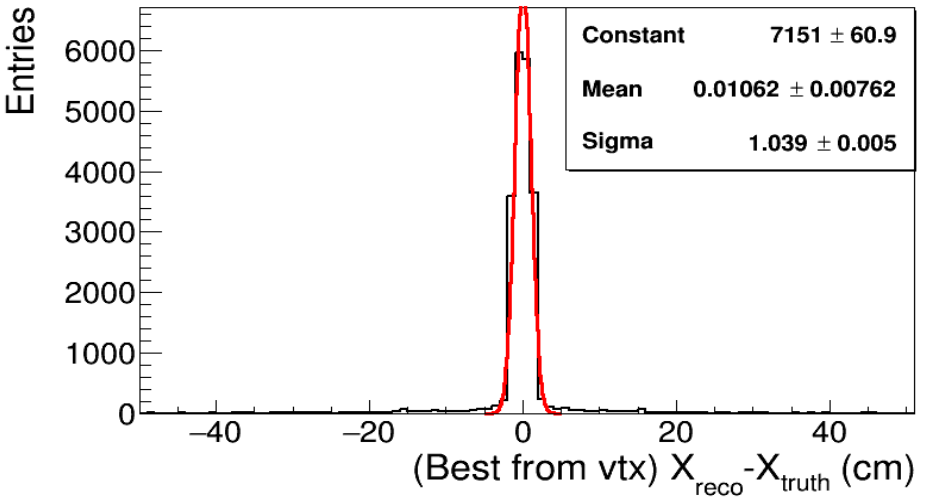


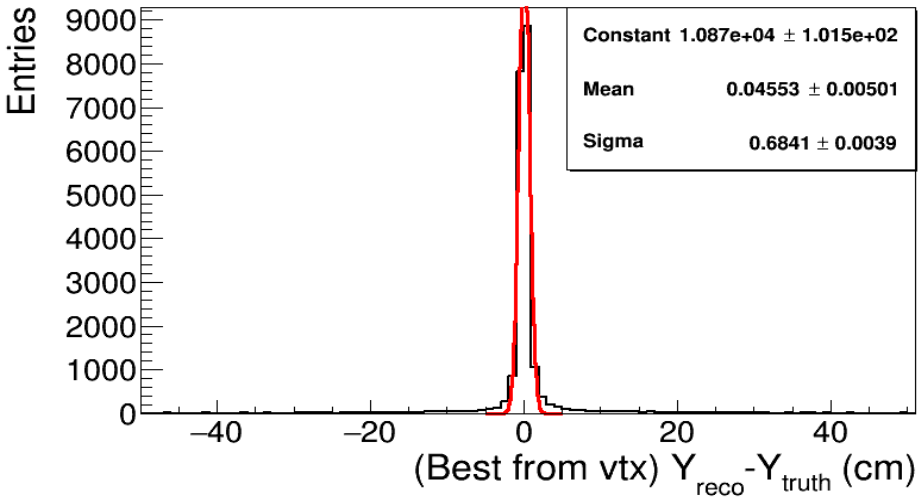


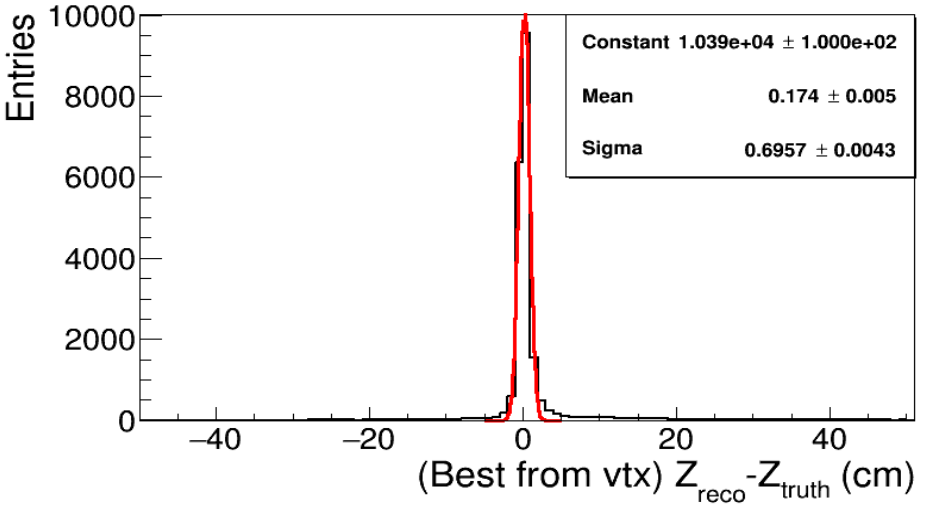


ν_μ CC (Closest VTX PMTrack)

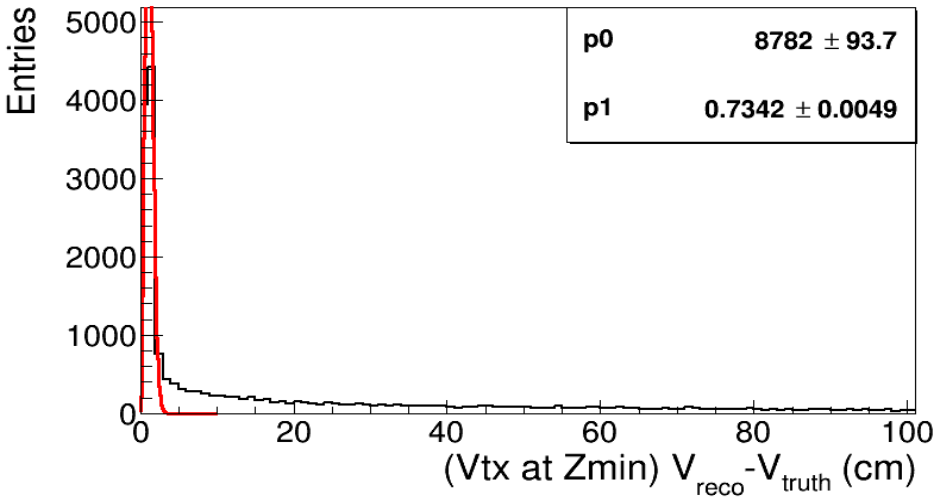


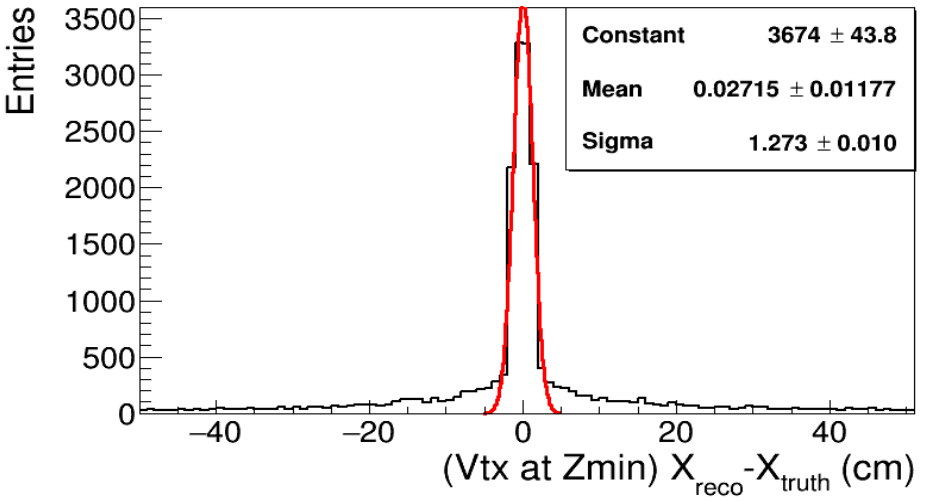


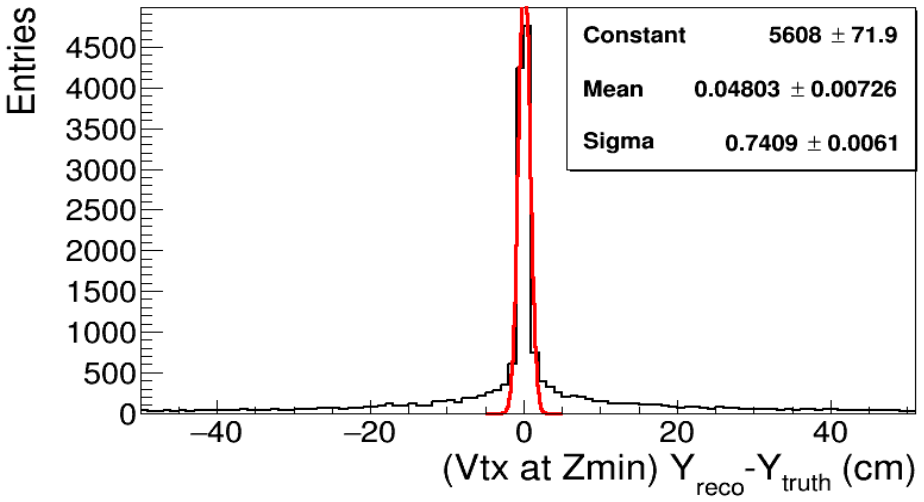


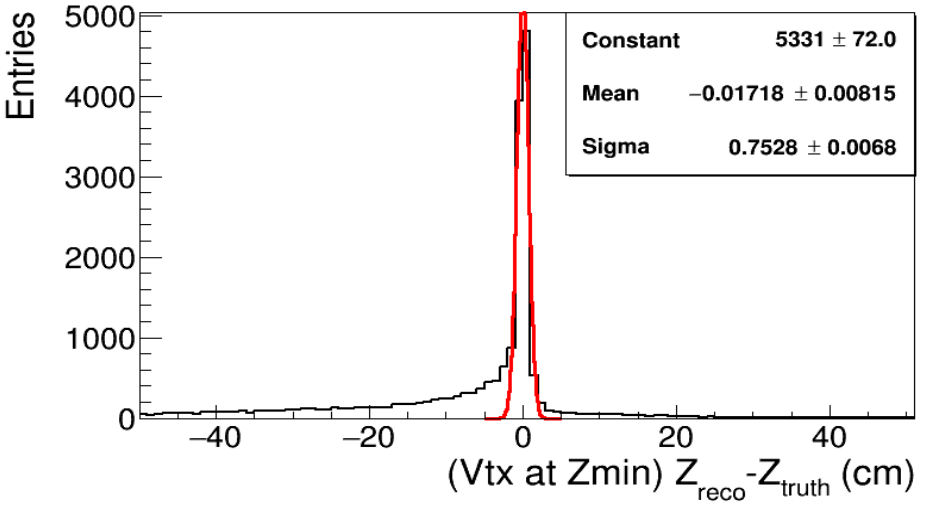


ν_μ CC (Upstream VTX PMTrack)









RMS and Gaus Fit of ΔX, Y, Z, R

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Event Type	# of Events	ΔX Upstream(best)	ΔY Upstream(best)	ΔZ Upstream(best)	ΔR Upstream(best)
ν_μ CC Pandora RMS Fit σ 5σ containment	21120	19.86 (9.29) 1.18 (0.97) 84.71% (92.14%)	23.80 (12.85) 0.78 (0.65) 78.93% (88.50%)	46.73 (45.15) 0.69 (0.64) 78.12% (86.16%)	53.97 (47.37) 0.79 (0.67) 84.34% (83.25%)
NC Pandora RMS Fit σ 5σ containment	5776	24.91 (16.13) 1.40 (1.16) 72.66% (79.5%)	25.46 (17.64) 0.87 (0.73) 64.51% (73.06%)	31.72 (28.15) 0.81 (0.71) 60.66% (67.62%)	42.50 (34.77) 0.85 (0.69) 62.14% (60.25%)
ν_e CC Pandora RMS Fit σ 5σ containment	277	26.82 (7.68) 1.12 (1.01) 81.23% (90.25%)	32.85 (11.65) 0.83 (0.65) 75.45% (83.39%)	22.50 (11.49) 0.79 (0.65) 72.56% (80.14%)	44.63 (17.12) 0.85 (0.74) 77.98% (77.26%)
ν_μ CC PMTrack RMS Fit σ 5σ containment	21294	41.18 (9.68) 1.27 (1.04) 62.36% (93.52%)	44.01 (9.77) 0.74 (0.68) 54.12% (90.91%)	40.86 (23.04) 0.75 (0.70) 53.59% (88.73%)	63.97 (26.30) 0.73 (0.75) 85.94% (86.09%)
NC PMTrack RMS Fit σ 5σ containment	6215	44.66 (20.30) 1.49 (1.20) 54.72% (84.78%)	46.95 (20.43) 0.81 (0.73) 44.91% (80.34%)	41.97 (23.83) 0.79 (0.70) 44.67% (76.83%)	64.09 (35.62) 0.74 (0.75) 70.46% (70.57%)
ν_e CC PMTrack RMS Fit σ 5σ containment	278	45.57 (7.33) 1.39 (1.05) 53.96% (93.88%)	46.05 (6.51) 0.75 (0.64) 45.68% (88.13%)	37.01 (8.97) 0.84 (0.72) 45.32% (84.89%)	61.94 (12.57) 0.79 (0.73) 82.37% (81.29%)

Summary

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- Using the most upstream reconstructed vtx, the fitted ΔX, ΔY, ΔZ and ΔR has a 1cm resolution, similar as using the closest vtx.
- Using the most upstream vtx, Pandora is better than PMTrack probably due to the short backtrack photons recostructed by PMTrack.
- Fitted histograms for NC and ν_e CC are shown in Backup Slides.

Backup Slides

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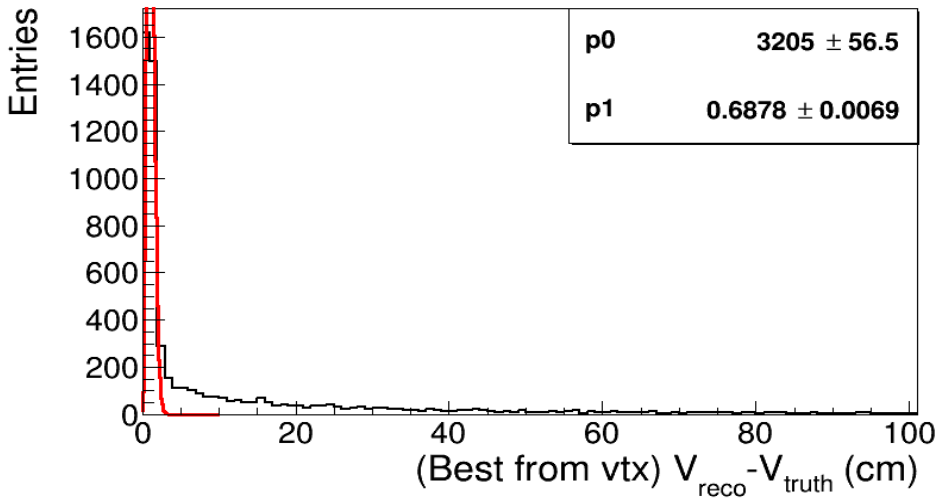
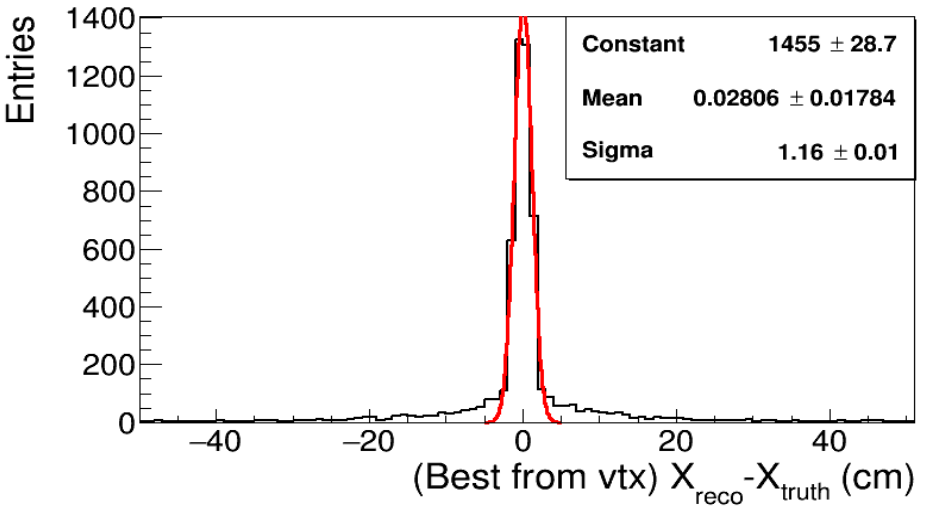
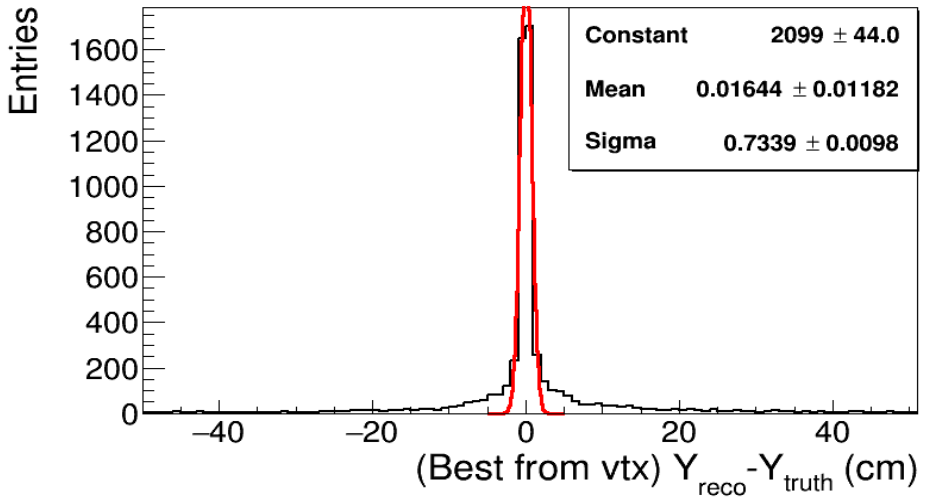
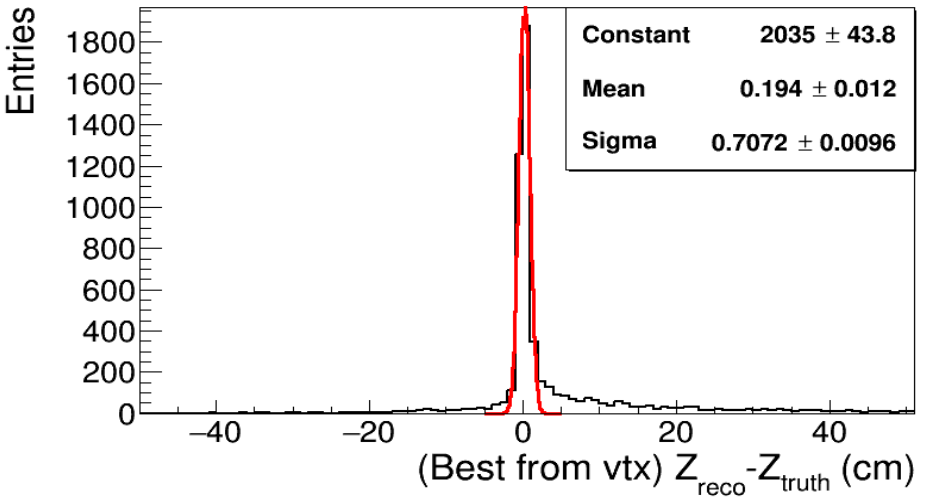
ν_μ NC (Closest VTX Pandora)

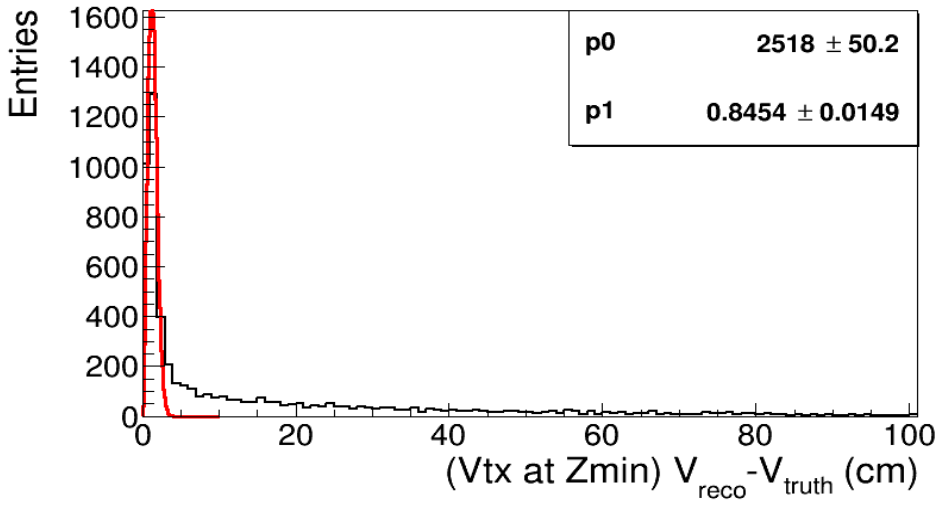


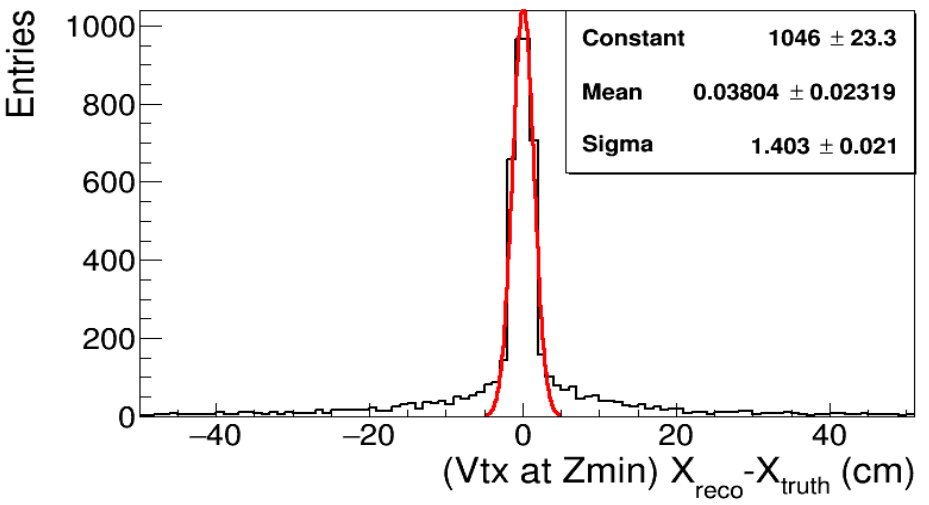


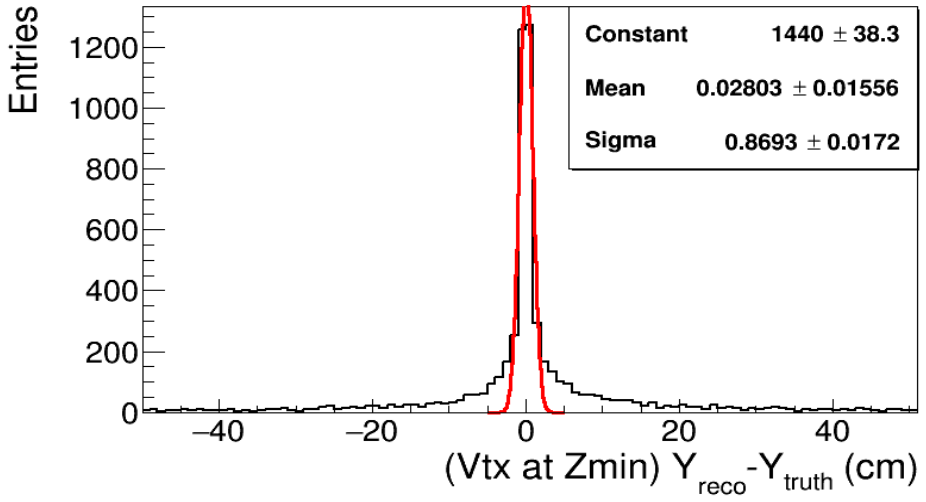


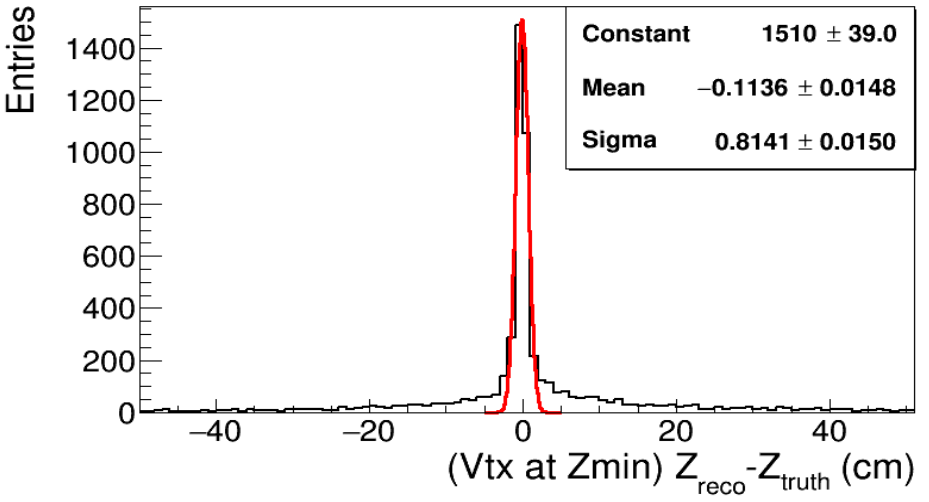


ν_μ NC (Upstream VTX Pandora)

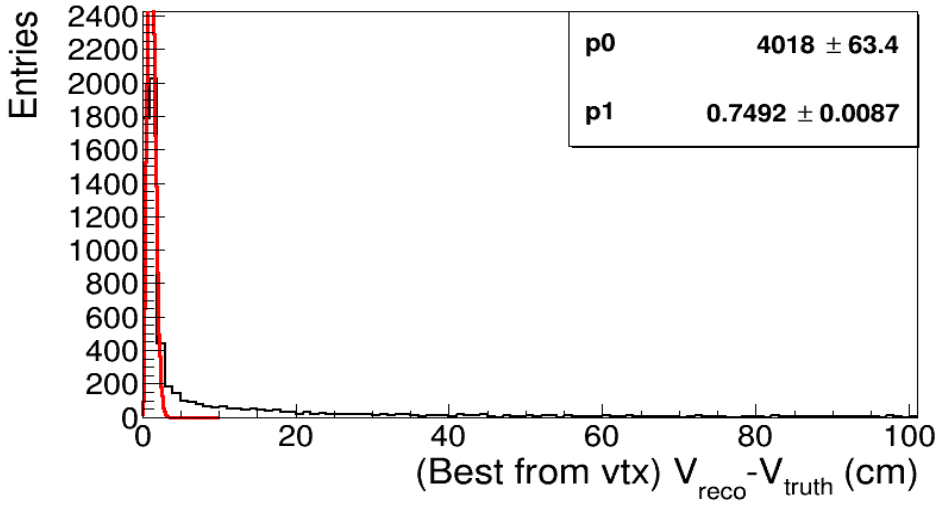


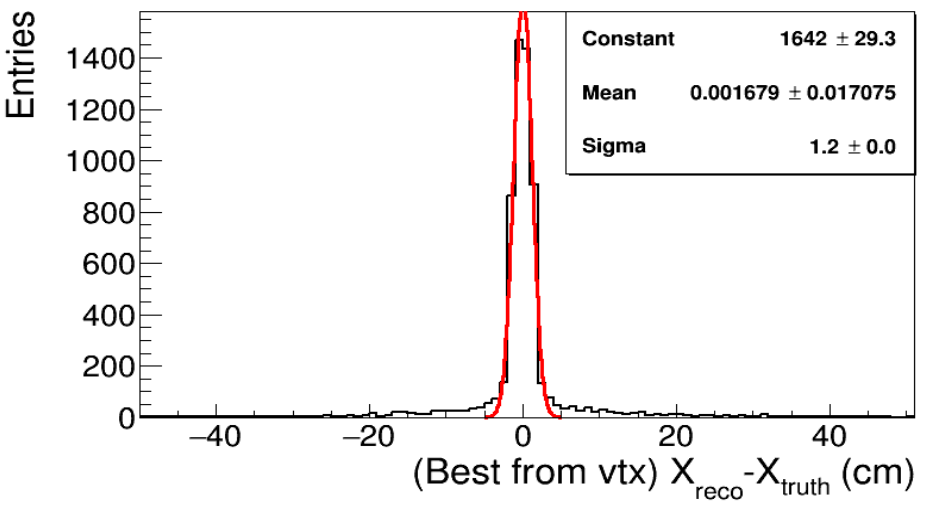


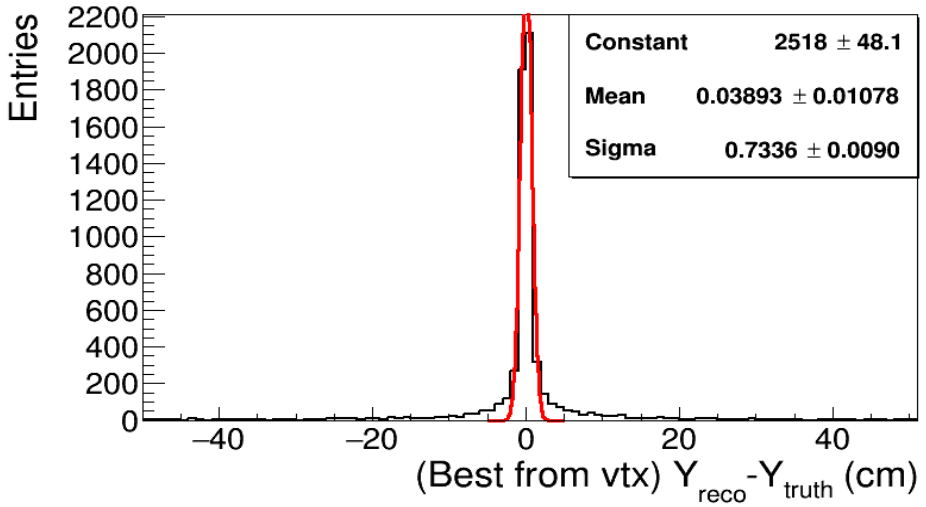


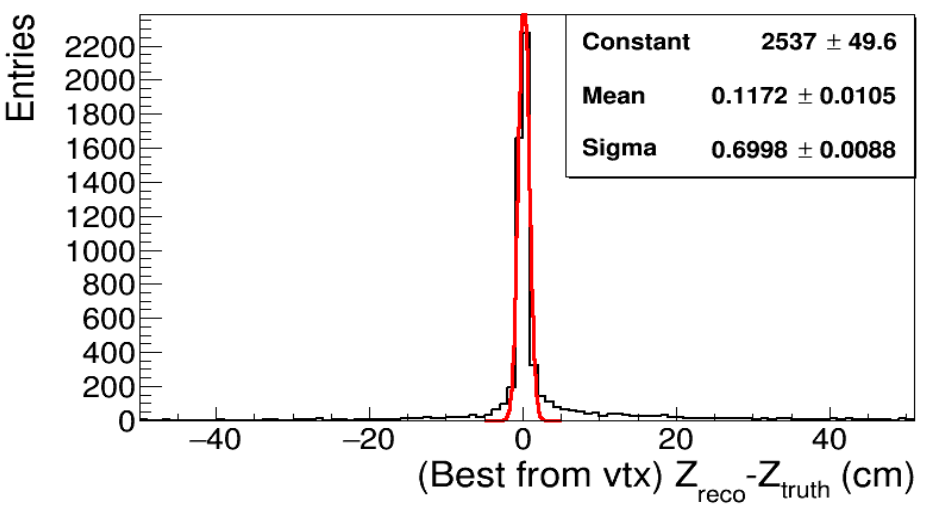


ν_μ NC (Closest VTX PMTrack)

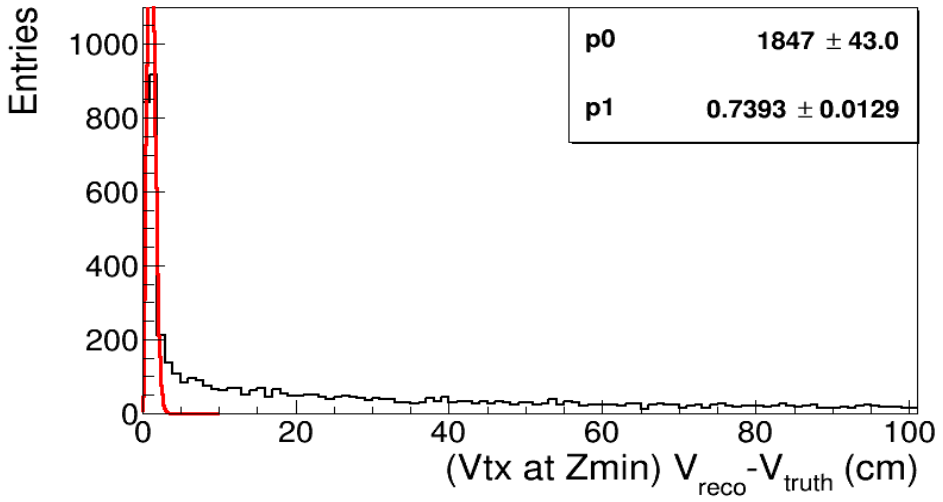


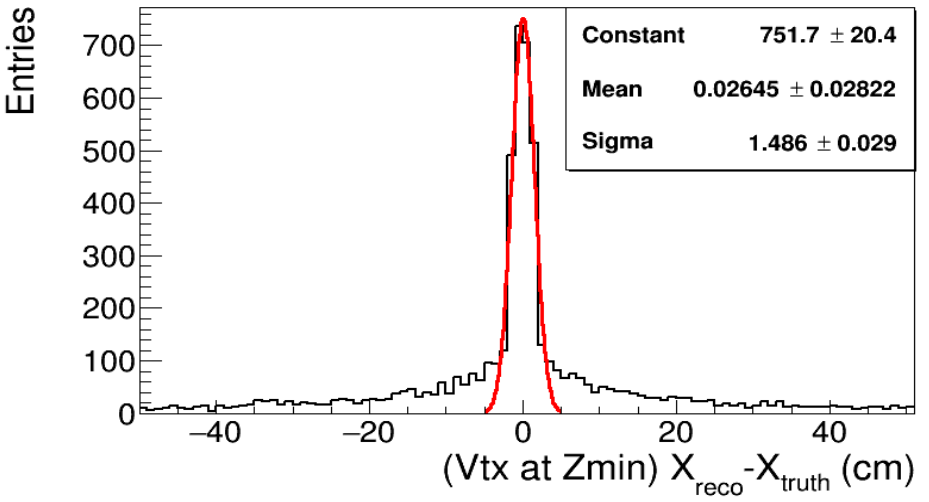


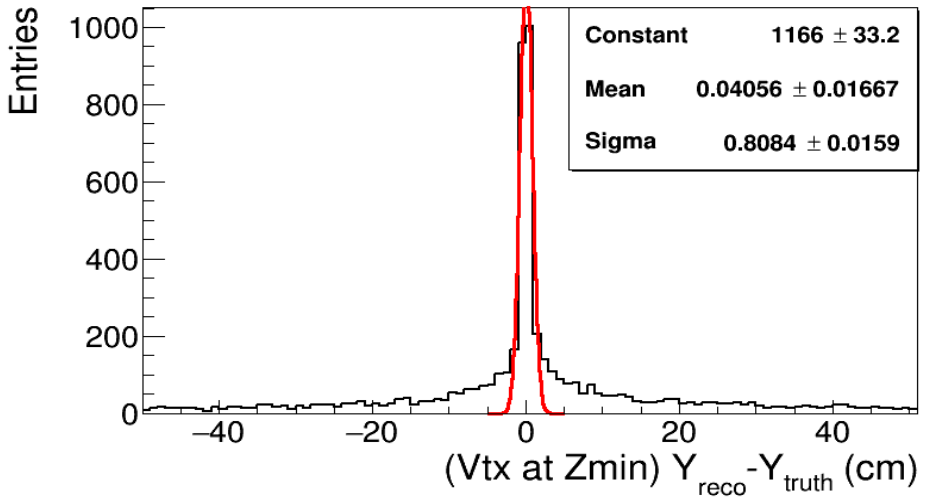


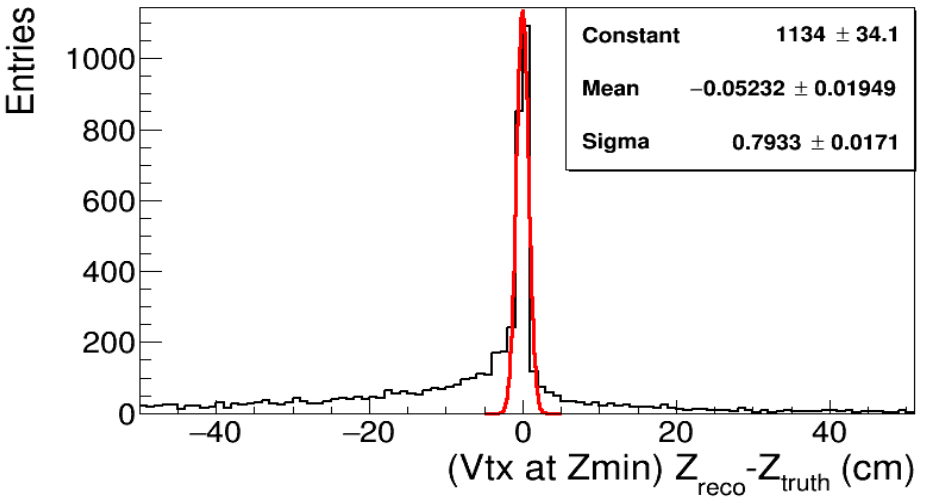


ν_μ NC (Upstream VTX PMTrack)

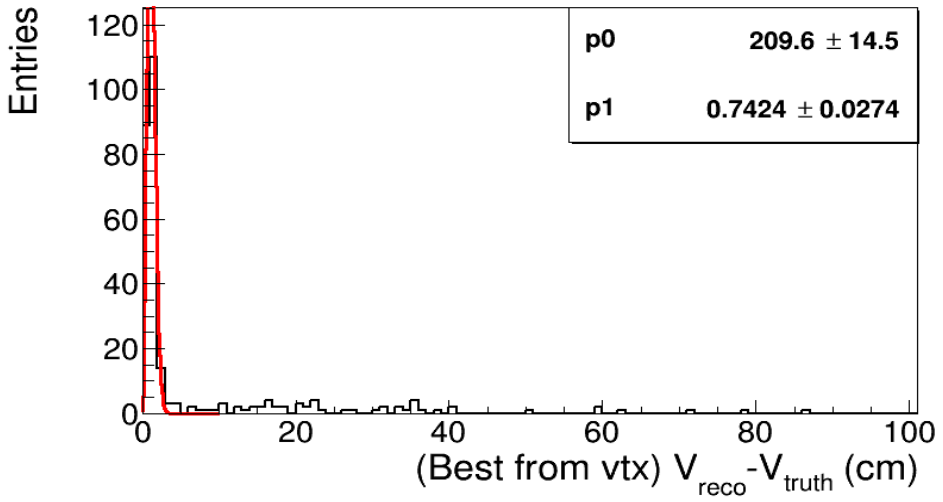


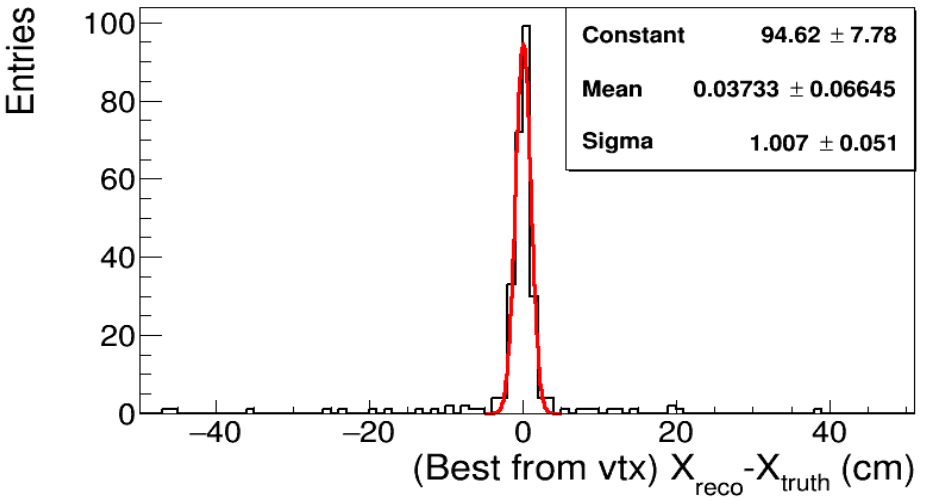


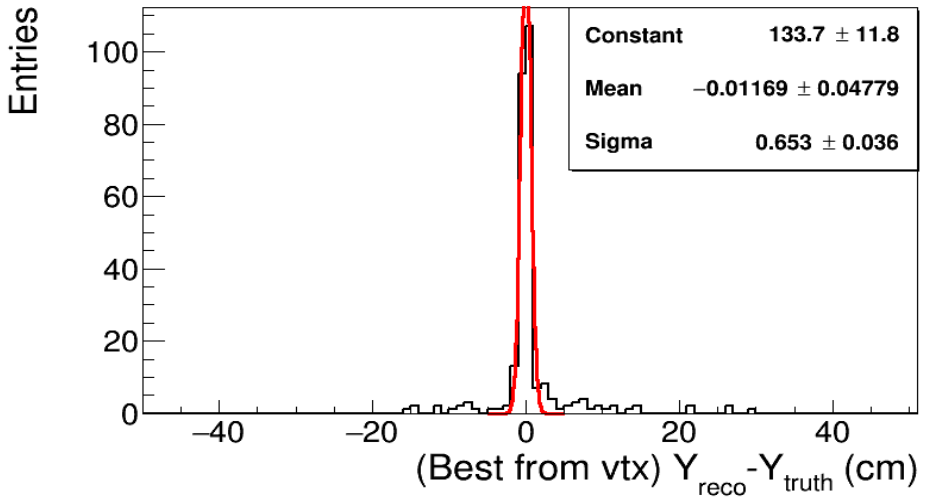


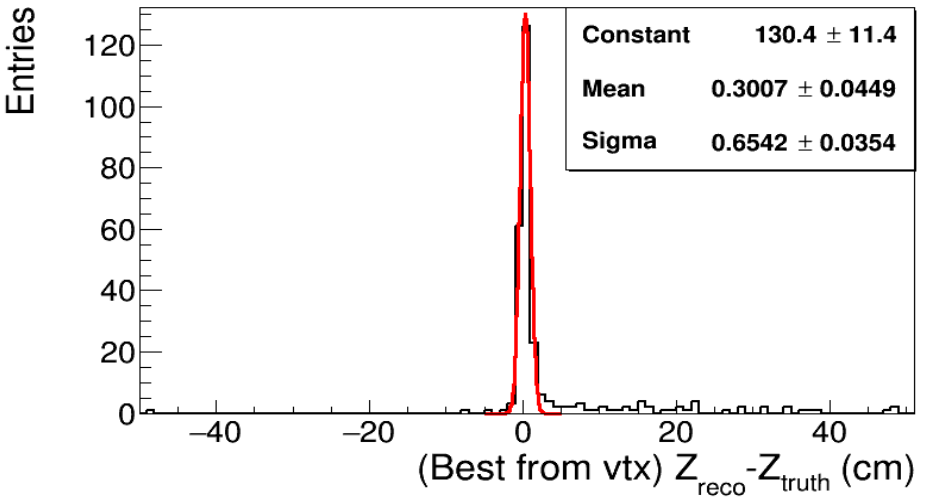


ν_e CC (Closest VTX Pandora)

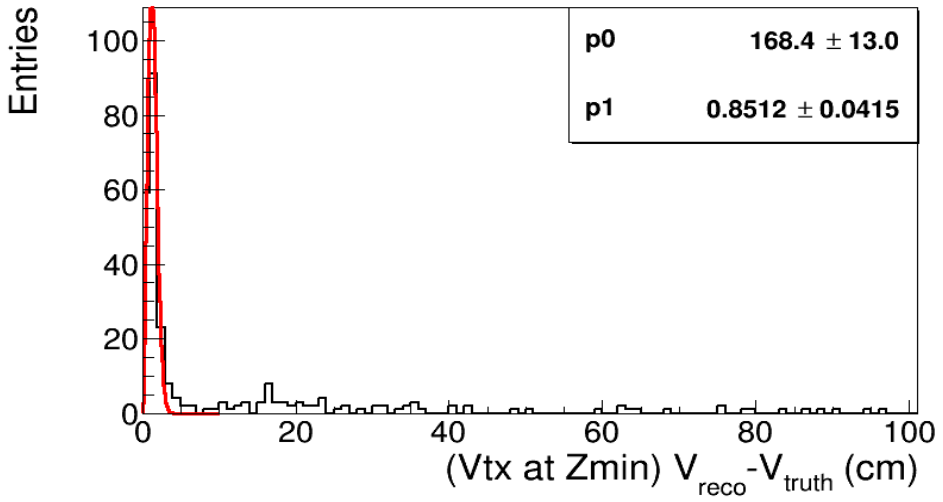


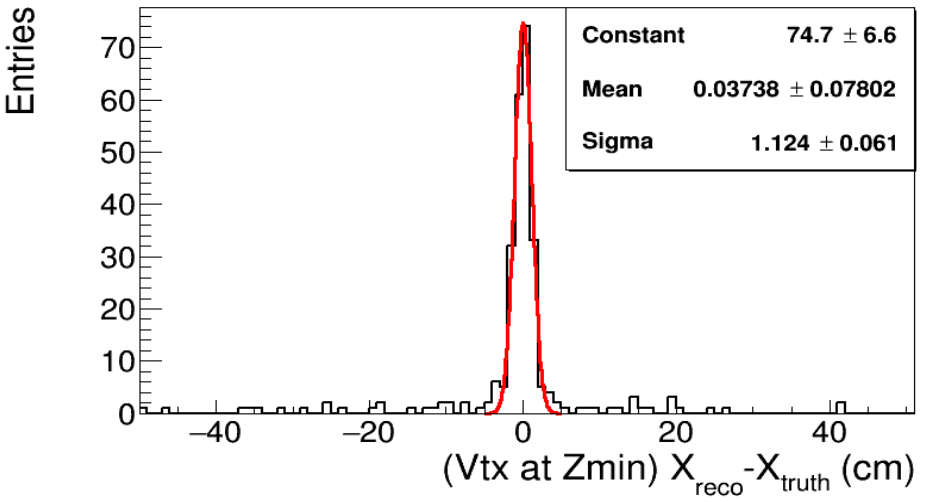


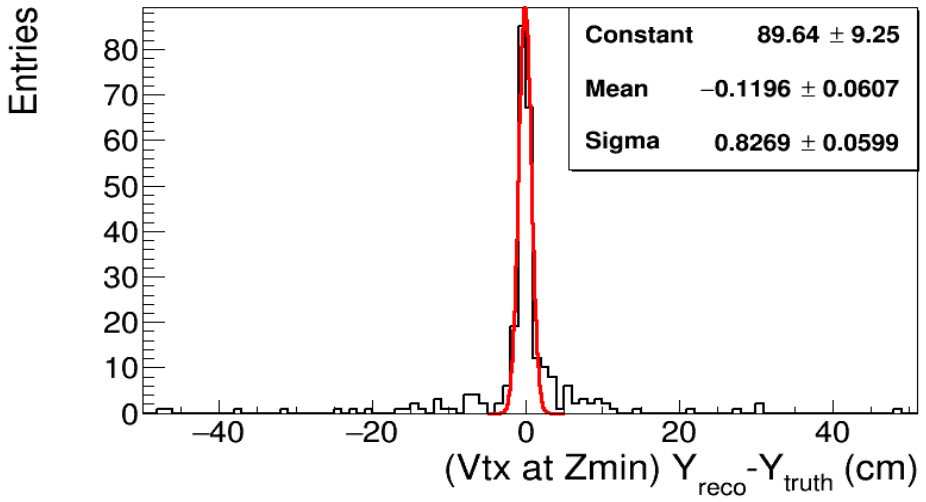


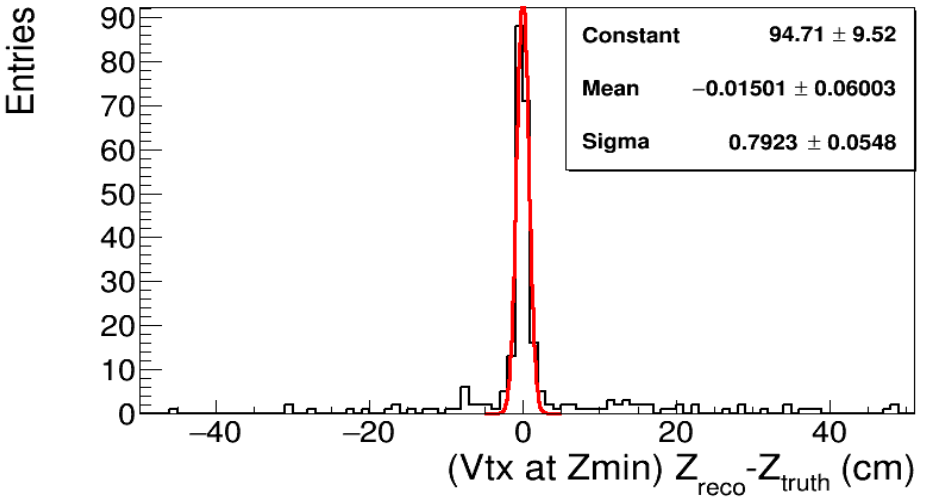


ν_e CC (Upstream VTX Pandora)

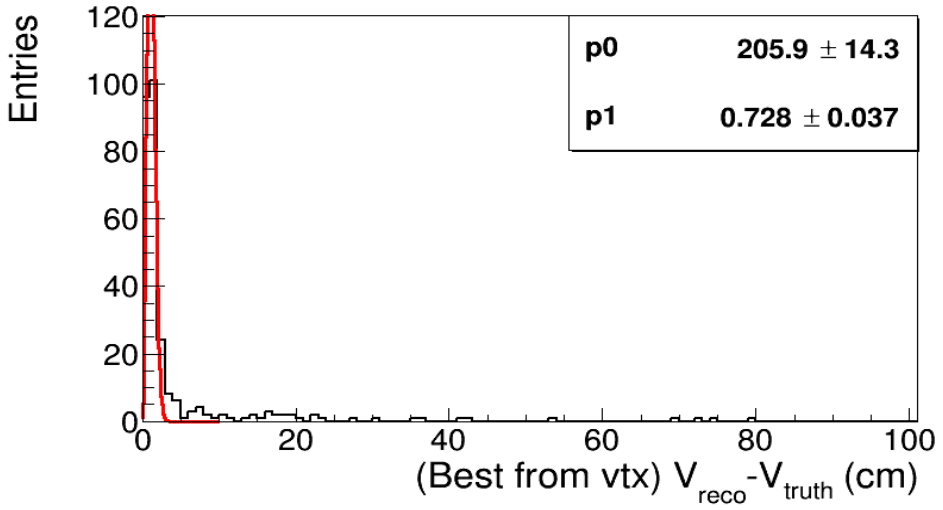


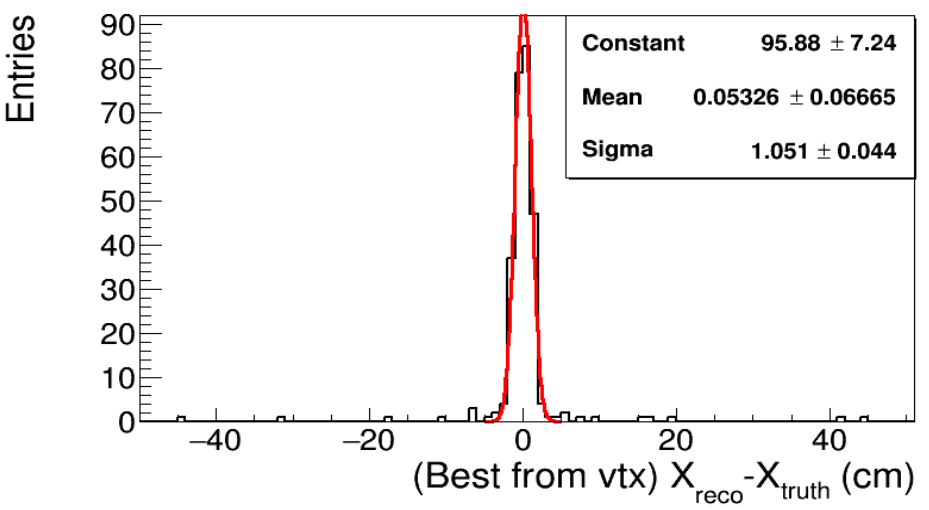


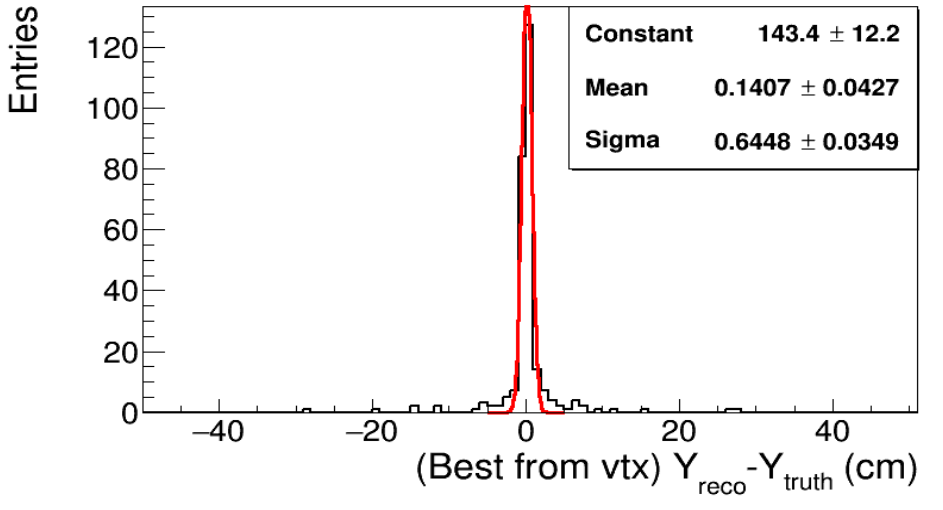


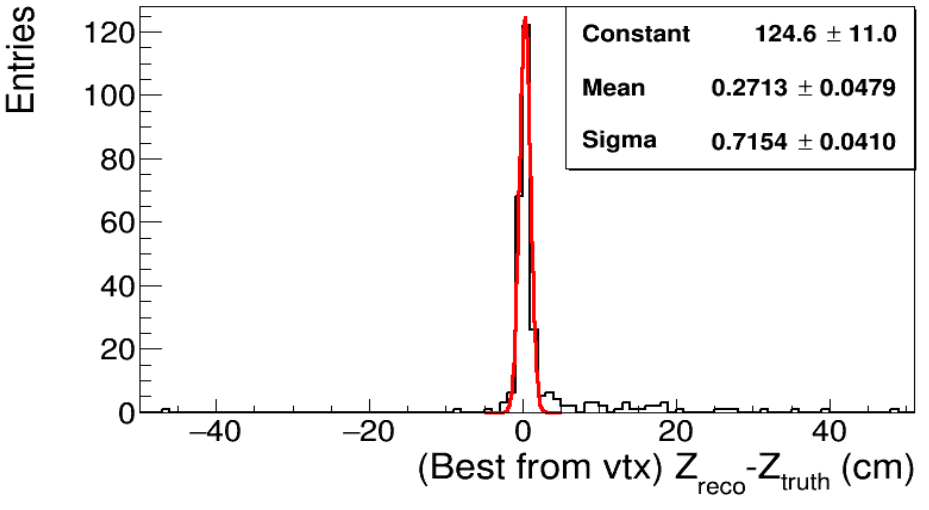
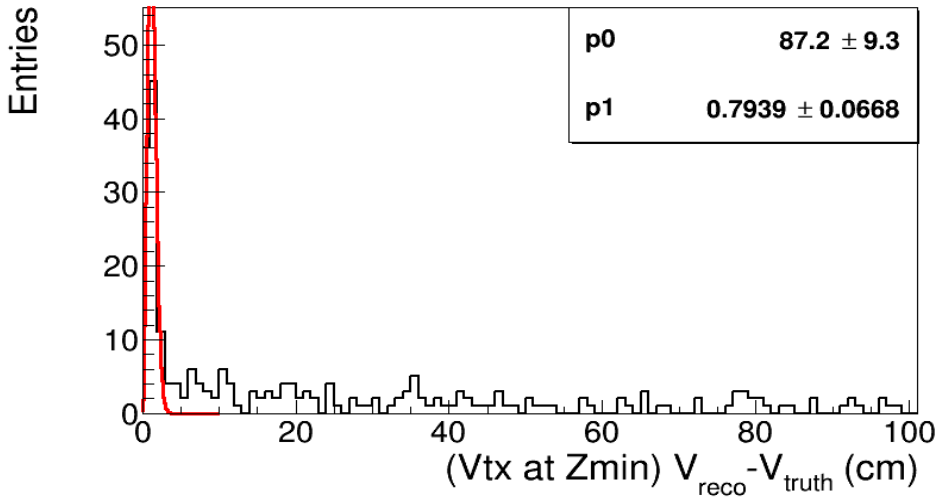
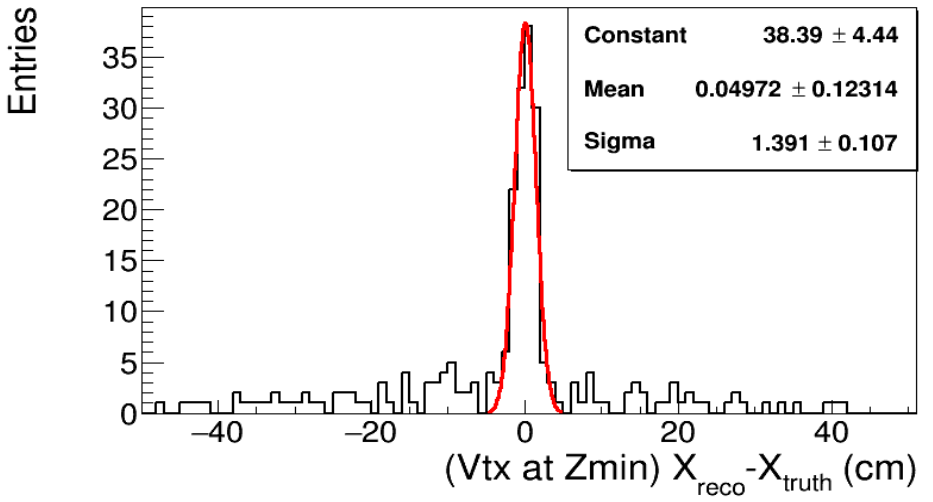
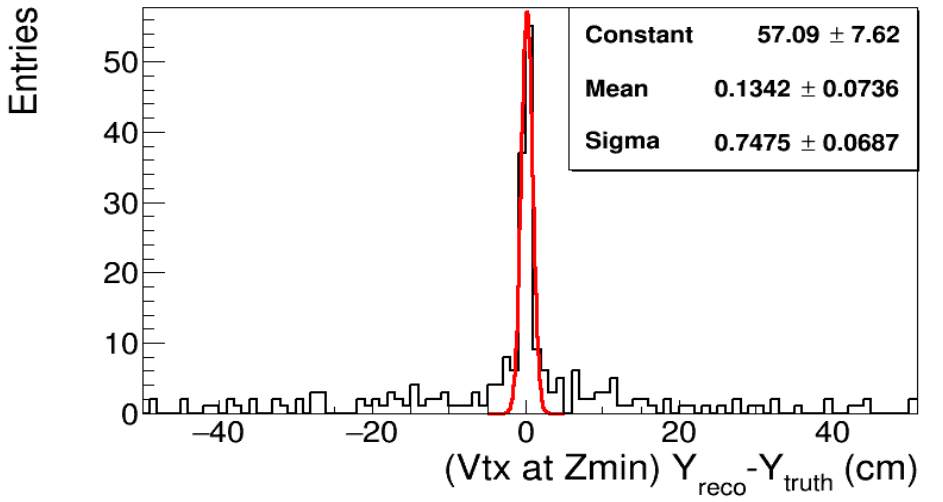
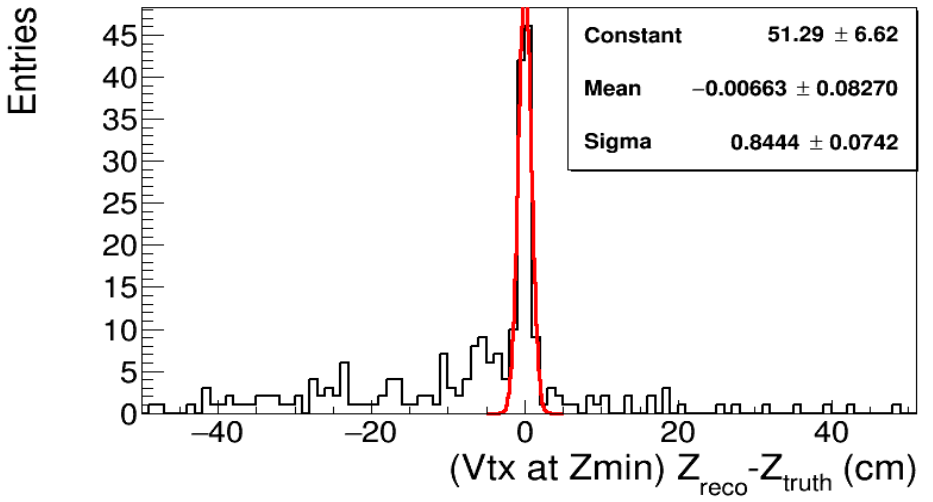


ν_e CC (Closest VTX PMTrack)









ν_e CC (Upstream VTX PMTrack)