

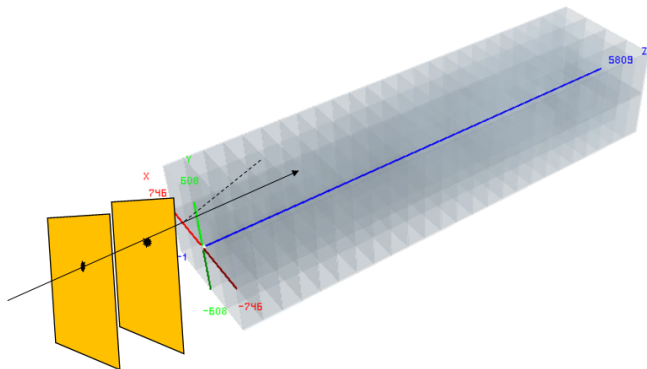
Update on EMT

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Serves as a check on reconstruction and calibration.



Example of doing reconstruction analysis with DUNE-FD and EMTs (dashed line represents reco track, solid line the EMT track)

Software details

- dune_{tpc} v06_45_00
- Analysis done with a "refurbished" protoDUNE CRT analysis package created by Arbin Timilsina.
- Drift velocities changed by altering the electric field in the Geant4 and the Detector Simulation stages of MC generation.
- MC generation now occurs on cluster. 10,000 cosmic (5 days) and 10,000 rock muons simulated. 7000 rock muons pass EMTs and DUNEFD (10 years), 1000 cosmic muons pass both with 75% simulated top coverage.



DUNE-FD EMT

Motivations for
an EMT

Questions from
Collaboration
Meeting

Angular
Displacement

Determining
Average Time
for "Calibration"

Atmospheric
Muon
Reconstruction

Additions to analysis module

- Angular displacement in all 3D Cartesian planes.
- Displacement analysis in 3D. Previous analysis for DUNE and protoDUNE focused on YZ plane.
- Functions to create randomly sampled datasets to look at longevity until bias "observed."

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- Where do we place the EMT?
- How many muons need to be reconstructed before we "see" a bias?
- Can we use it for cosmic muons?

Where do we place the EMT?

- Front:** There is a meter of space between the iron and the wall. The EMT will be able to fit.
- Back:** There is twelve meters of space without the septum. Unfortunately, the flux of muons hitting the EMT is a fraction of the rock muon flux.
- Side:** The foot between the rock and the iron is too small to fit both EMT planes. It would be possible but space between the EMTS would be reduced.
- Top:** Possible but would likely need to reduce fraction of surface area covered significantly due to lack of planes and construction limits. However, a top EMT can help calibrate the middle of the detector.

DUNE-FD EMT

Motivations for
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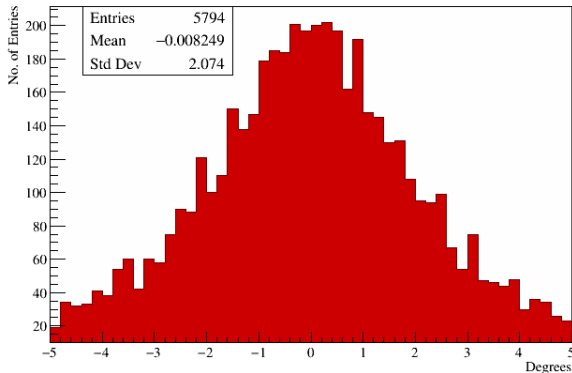
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Angular Displacement in XY Between Reco Track and EMT Prediction



Angular displacement for rock muons in XY with expected drift velocity

DUNE-FD EMT

Motivations for
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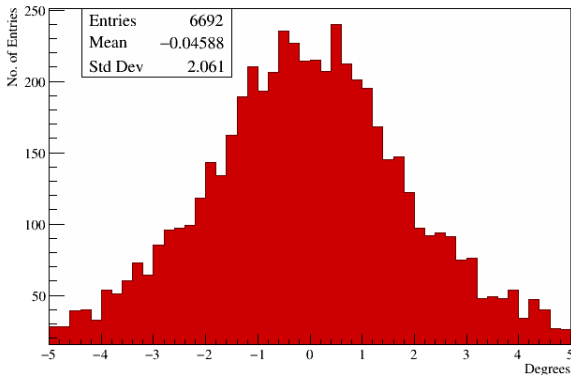
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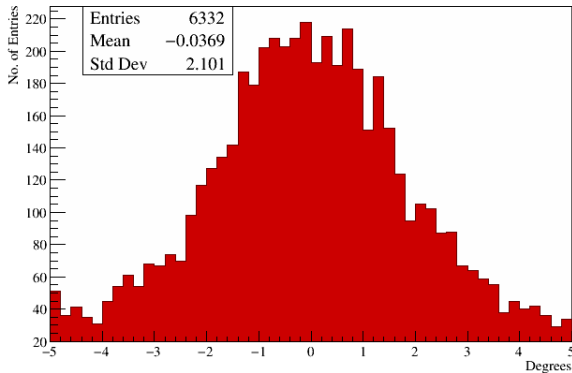
Atmospheric
Muon
Reconstruction

Angular Displacement in XY Between Reco Track and EMT Prediction



Angular displacement for rock muons in XY with 1% higher drift velocity

Angular Displacement in XY Between Reco Track and EMT Prediction



Angular displacement for rock muons in XY with electric field magnitude unchanged but each field vector altered by 1%

Sampling Events until Significance

DUNE-FD EMT

Motivations for an EMT

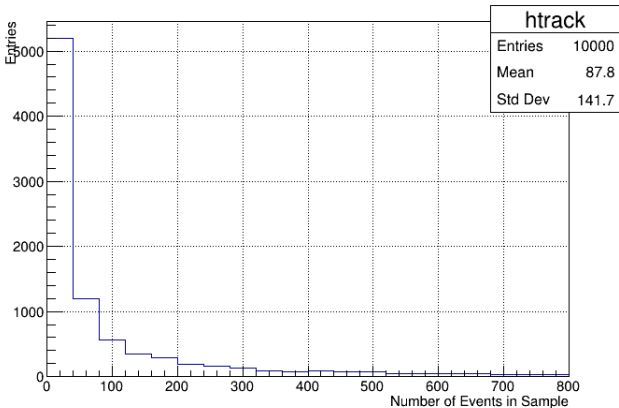
Questions from Collaboration Meeting

Angular Displacement

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Atmospheric Muon Reconstruction

Samples of Spatial Displacement until EMT and Reco Differ by 3 Sigma (Median: 36.0)



Random sampling of 7000 rock muons until significance with expected drift velocity and 1% higher drift velocity.

Sampling Events until Significance

DUNE-FD EMT

Motivations for an EMT

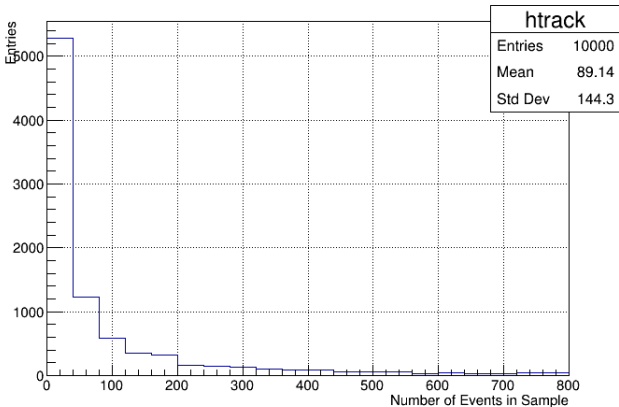
Questions from Collaboration Meeting

Angular Displacement

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Samples of Spatial Displacement until EMT and Reco Differ by 3 Sigma (Median: 34.0)



Random sampling of 7000 rock muons until significance with expected drift velocity and 1% different electric field unit vector.



DUNE-FD EMT

Motivations for
an EMT

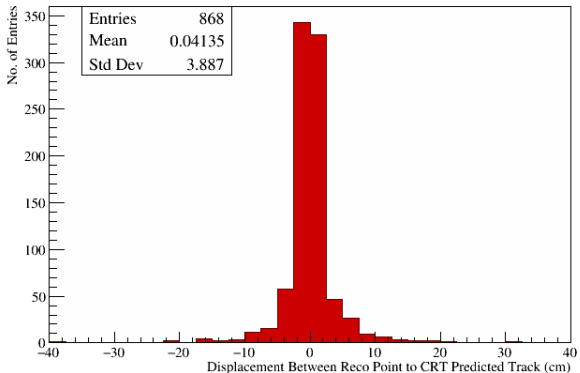
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Average Displacement Between Reco Track and EMT Prediction



Spatial displacement in 3D for cosmic muons with expected drift velocity

DUNE-FD EMT

Motivations for
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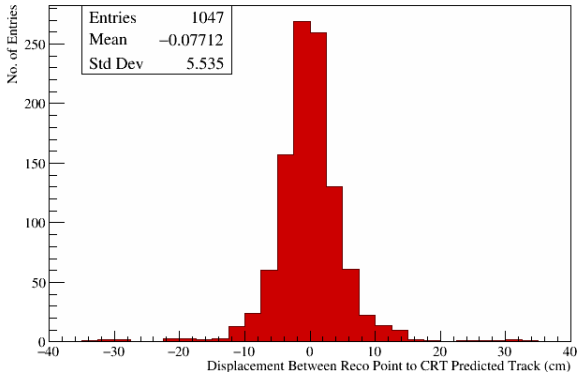
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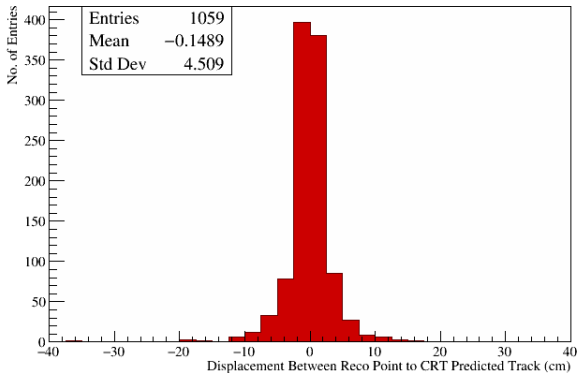
Atmospheric
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Average Displacement Between Reco Track and EMT Prediction



Spatial displacement in 3D for cosmic muons with 1% higher drift velocity

Average Displacement Between Reco Track and EMT Prediction



Spatial displacement in 3D for cosmic muons with unchanged magnitude but altered electric field unit vectors by 1%

DUNE-FD EMT

Motivations for
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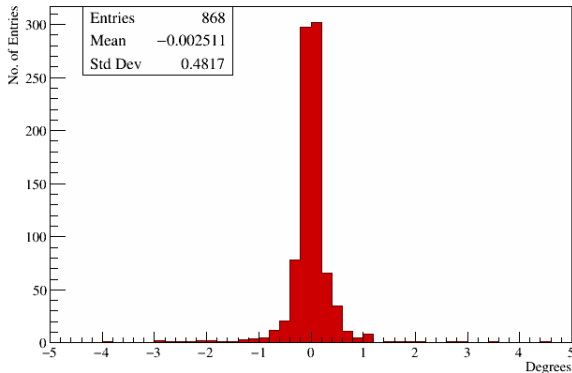
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Angular Displacement in XZ Between Reco Track and EMT Prediction



Angular displacement XZ for cosmic muons with expected drift velocity



DUNE-FD EMT

Motivations for an EMT

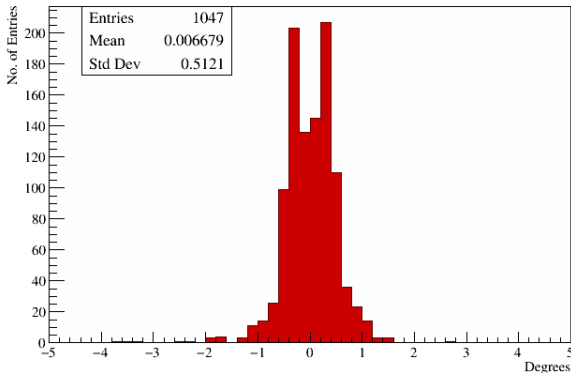
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Determining Average Time for "Calibration"

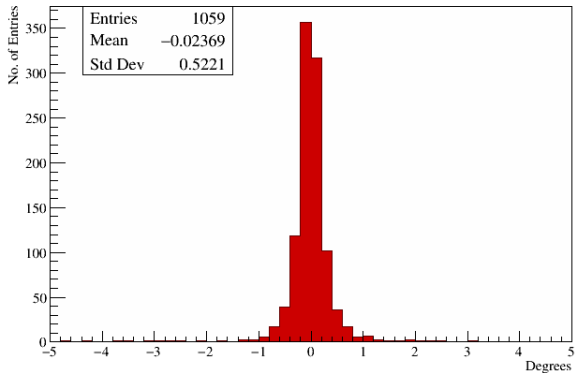
Atmospheric Muon Reconstruction

Angular Displacement in XZ Between Reco Track and EMT Prediction



Angular displacement XZ for cosmic muons with 1% higher drift velocity

Angular Displacement in XZ Between Reco Track and EMT Prediction



Angular displacement in XZ for cosmic muons with unchanged magnitude but altered electric field unit vectors by 1%



DUNE-FD EMT

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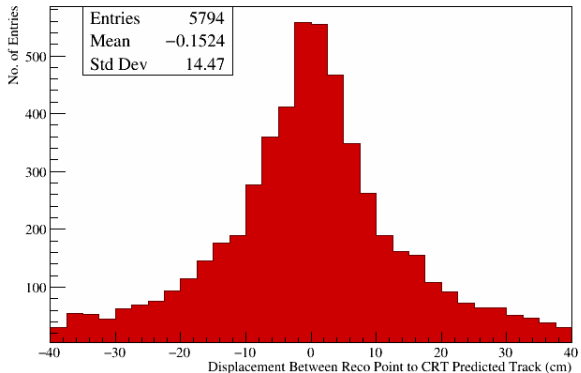
Atmospheric
Muon
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- Moved to DUNE 10kT since moving to the cluster, plots from collaboration meeting from 1x2x6.
- However, displacements in 10kT strangely have the higher drift velocity with less bias from zero than the expected drift velocity.

DUNE-FD EMT

[Motivations for an EMT](#)[Questions from Collaboration Meeting](#)[Angular Displacement](#)[Determining Average Time for "Calibration"](#)[Atmospheric Muon Reconstruction](#)

Average Displacement Between Reco Track and EMT Prediction



Spatial displacement in 3D between EMT and reco with expected drift velocity

DUNE-FD EMT

Motivations for an EMT

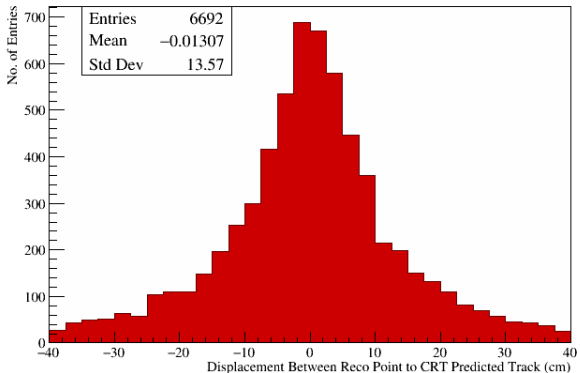
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Average Displacement Between Reco Track and EMT Prediction



Spatial displacement in 3D between EMT and reco with 1% higher drift velocity

DUNE-FD EMT

Motivations for an EMT

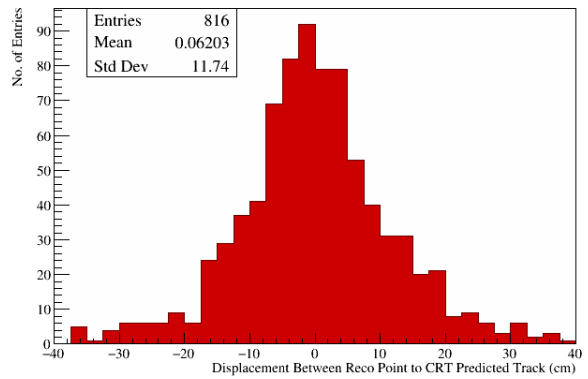
Questions from Collaboration Meeting

Angular Displacement

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Atmospheric Muon Reconstruction

Average Displacement Between Reco Track and CRT Prediction (YZ Plane)



Spatial displacement in YZ between EMT and reco with expected drift velocity with 1x2x6

DUNE-FD EMT

Motivations for an EMT

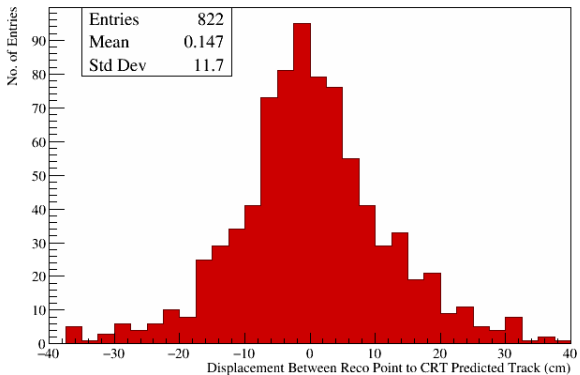
Questions from Collaboration Meeting

Angular Displacement

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Average Displacement Between Reco Track and CRT Prediction (YZ Plane)



Spatial displacement in YZ between EMT and reco with 1% higher drift velocity with 1x2x6

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- Investigate reconstruction. Concept is proved, but simulations need to be more precise.
- More analysis on cosmics and start exiting muon analysis
- Long term: A technical document explaining simulations so far as a preliminary for TDR.
- Long long term: Simulate with iron in front of the cryostat and with scintillator.