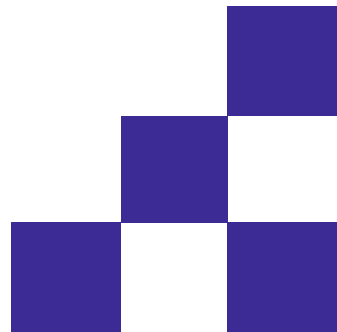
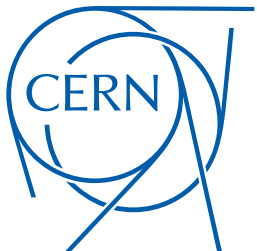


# ProtoDUNE SP

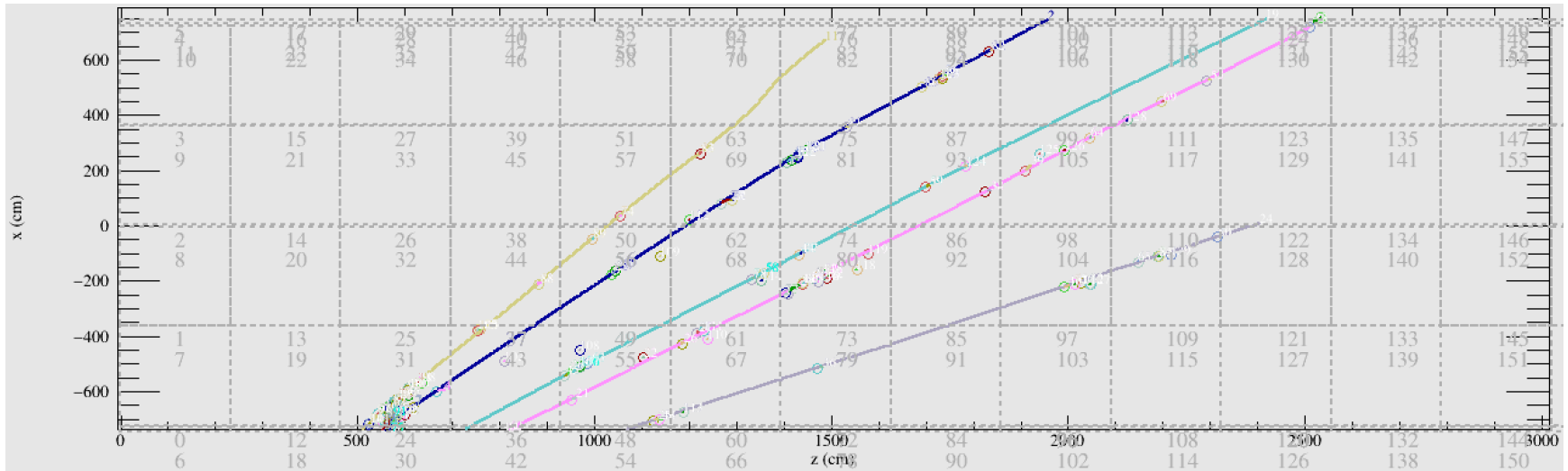
## PMA Track Stitching and Cosmic Reco

Leigh Whitehead  
ProtoDUNE SP Reconstruction  
Meeting  
22/02/17



# Introduction

- Since last time, Robert has made some changes to actually produce a single recob::track from stitched tracks.
- Things now look more like you would expect when looking in the event display.
  - Continuous lines for tracks stitched in multiple places.



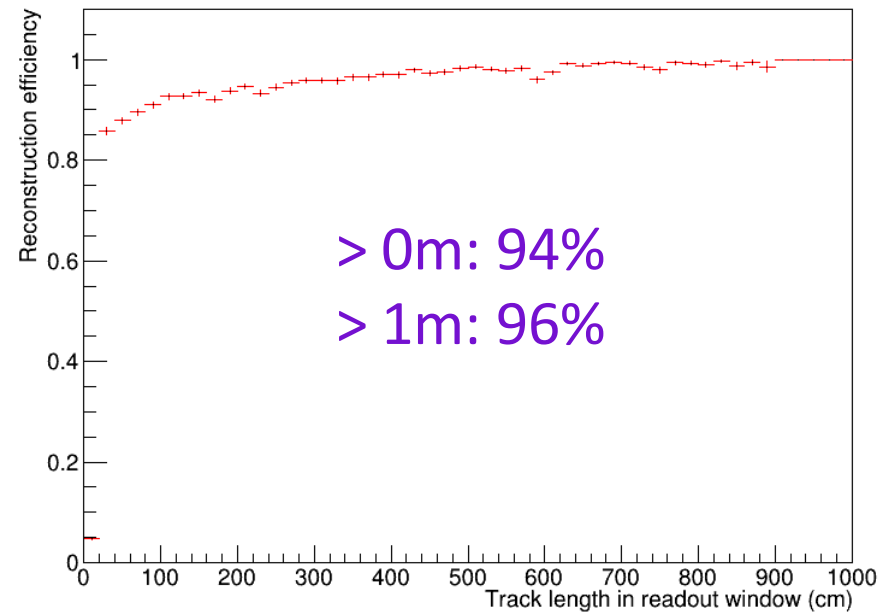
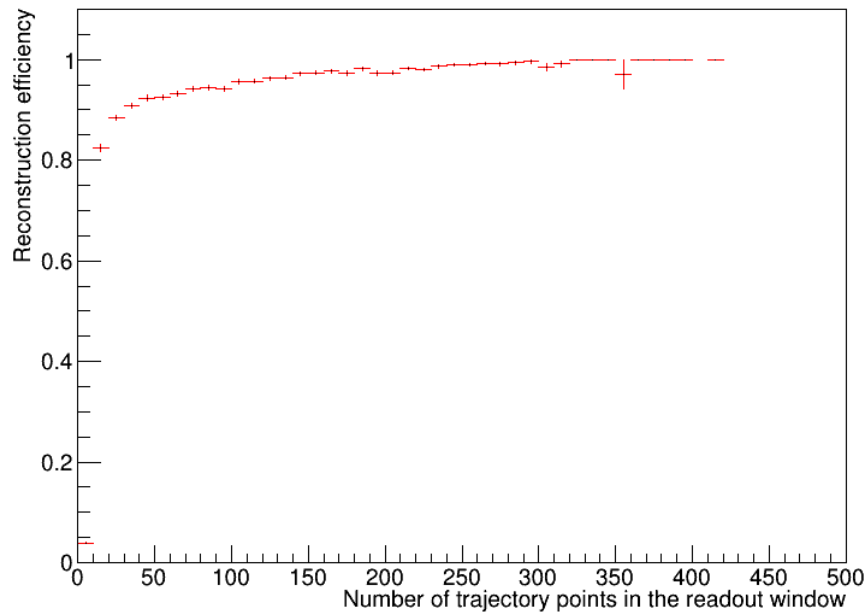
# Introduction

- I hand-scanned a number of FD events to see how often the stitching was successful:
  - Saw 97 +/- 1 % success rate
    - Some failures occurred where the CPA or APA cross occurs at the join of 4 TPCs
  - Some tracks were also broken for other reasons
    - Missing segments through large delta / bremsstrahlung showers
    - Small missing segments where the track clips a TPC
- Have requested the track stitching branch be added to LArSoft
  - Will be included in the next release (v06\_26\_00).
  - It is currently disabled by default for now.
  - Can enable with:
    - MatchT0inCPACrossing: true
    - MatchT0inAPACrossing: true (of course, has no effect in protoDUNE)

# Cosmic Reconstruction

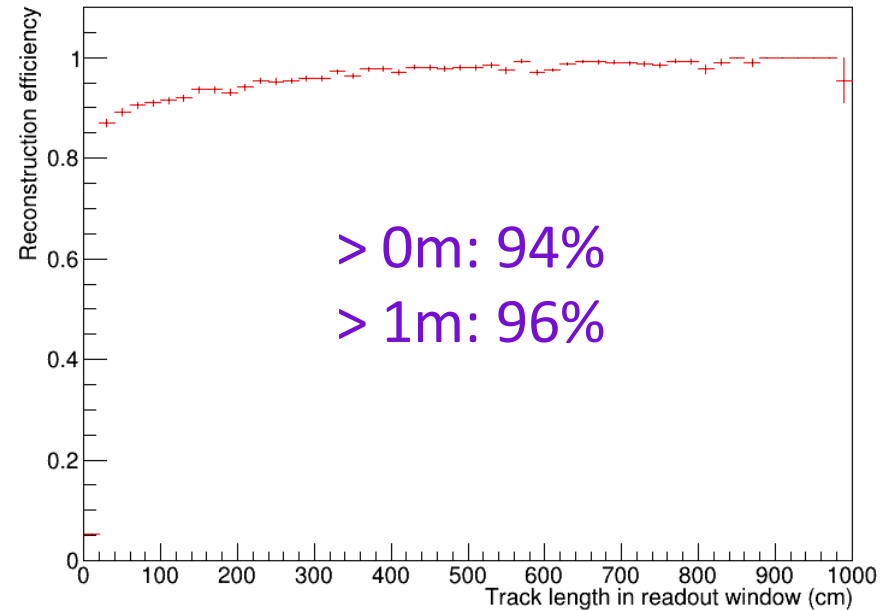
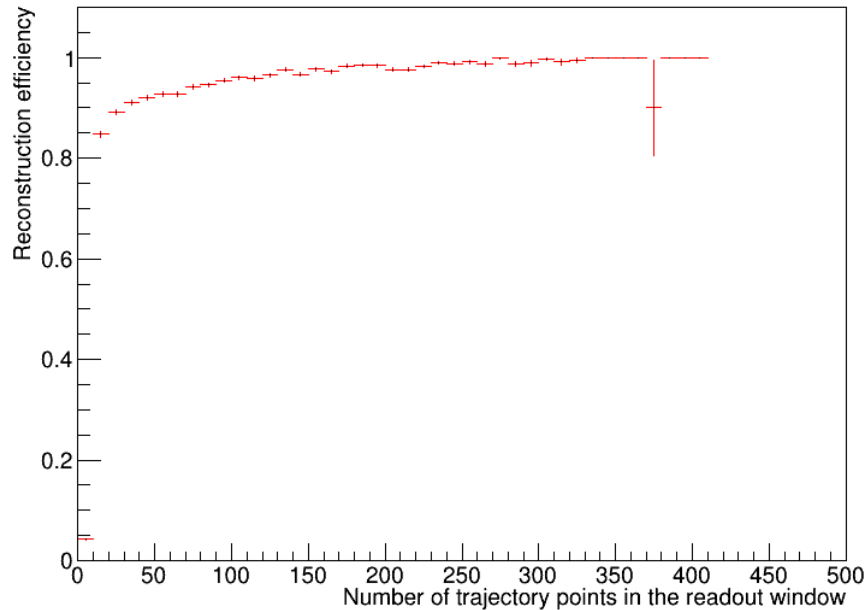
- I wanted to show a few distributions comparing the muon reconstruction with and without space charge.
- Note that there is no attempted space charge correction here, so this shows the real worst case.
  - I just wanted to get a feel for the size of the effect.
- Clearly not yet a complete list of useful plots, but just the ones I had to hand that I used to check the stitching.

# Tracking Efficiency



- Efficiency to reconstruct a true muon (including those broken into multiple reconstructed tracks).

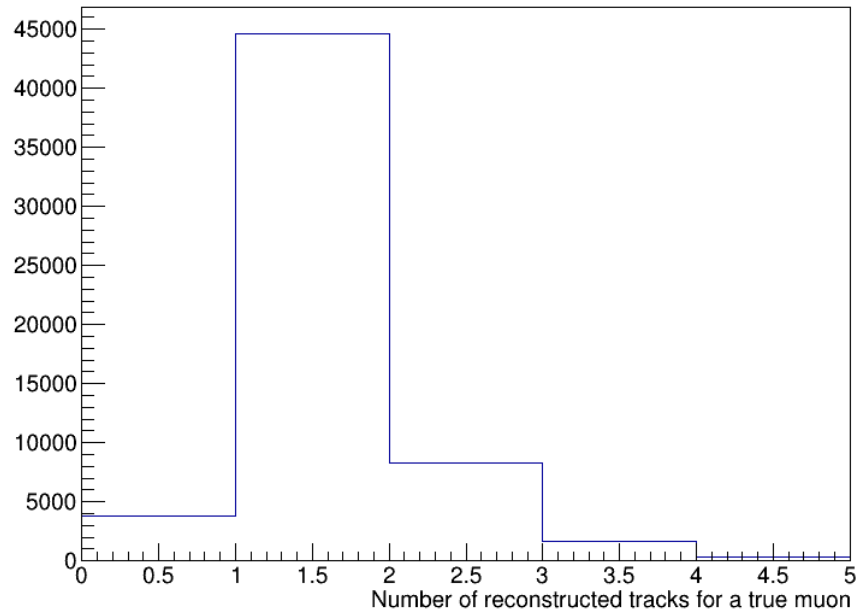
# Tracking Efficiency – with SCE



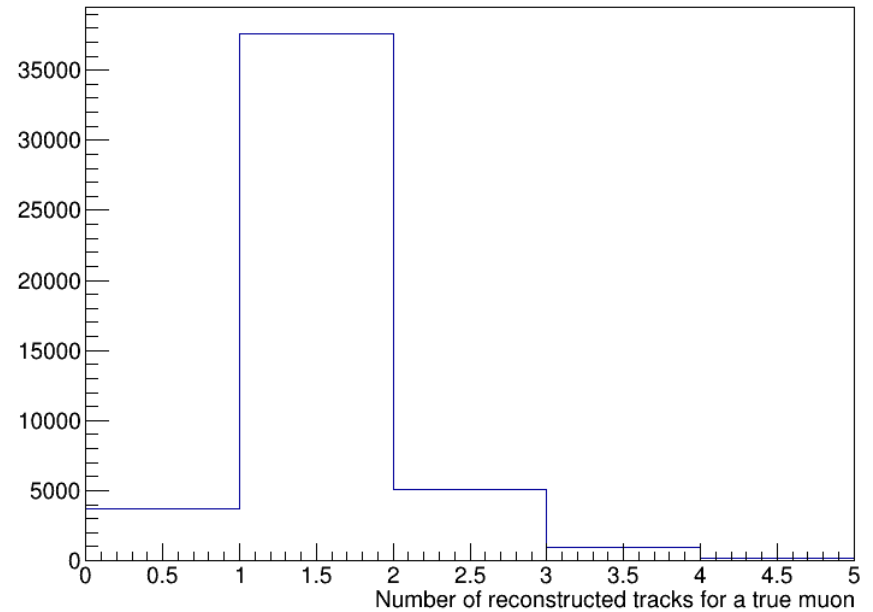
- Efficiency to reconstruct a true muon (including those broken into multiple reconstructed tracks).
  - Doesn't appear to degrade with space charge enabled.

# Number of Reco Tracks

All Tracks



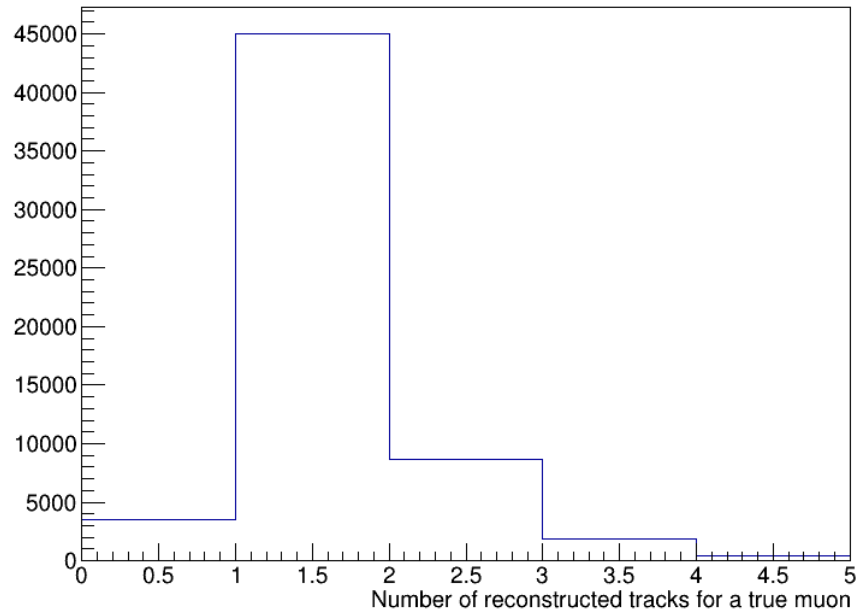
Non Cathode-Crossing Tracks



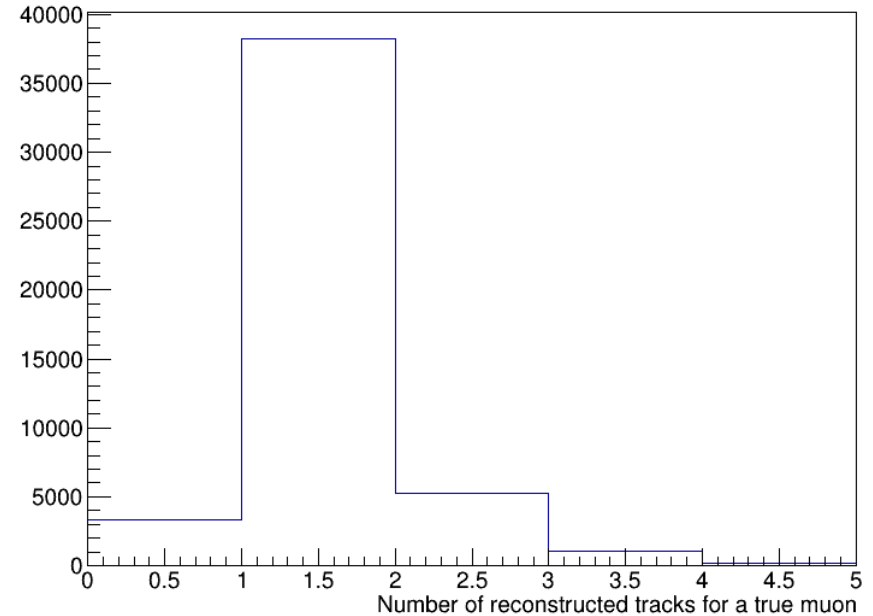
- Number of reconstructed tracks per true cosmic muon.

# Number of Reco Tracks – with SCE

All Tracks



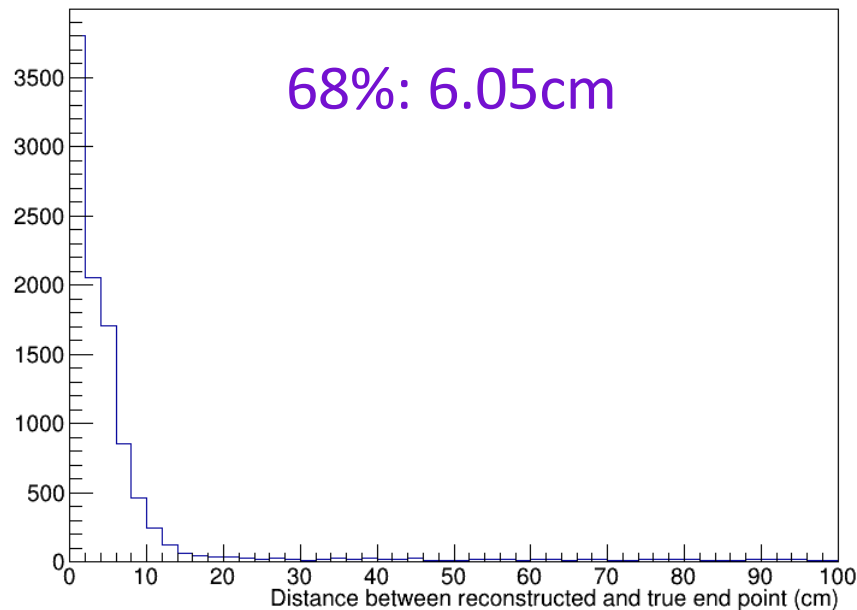
Non Cathode-Crossing Tracks



- Number of reconstructed tracks per true cosmic muon.
  - Again, differences appear very small when enabling the space charge effect.



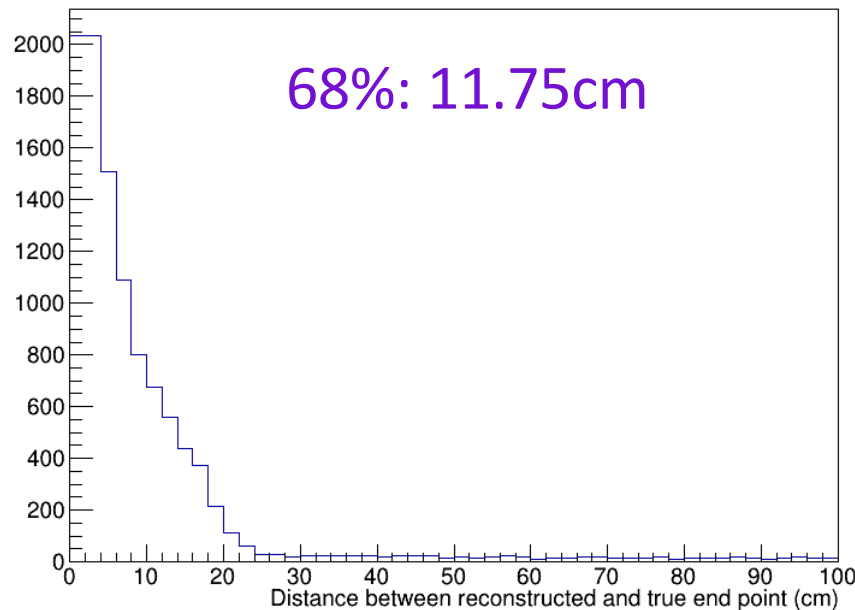
# Track End Point Resolution



In the case of multiple reconstructed tracks, I pick the track end point closest to the true vertex and true end point

- Track end point resolution (in the  $y, z$  plane). Note that this also includes some ambiguity in determining the true active volume entry / exit points.

# Track End Point Resolution – with SCE

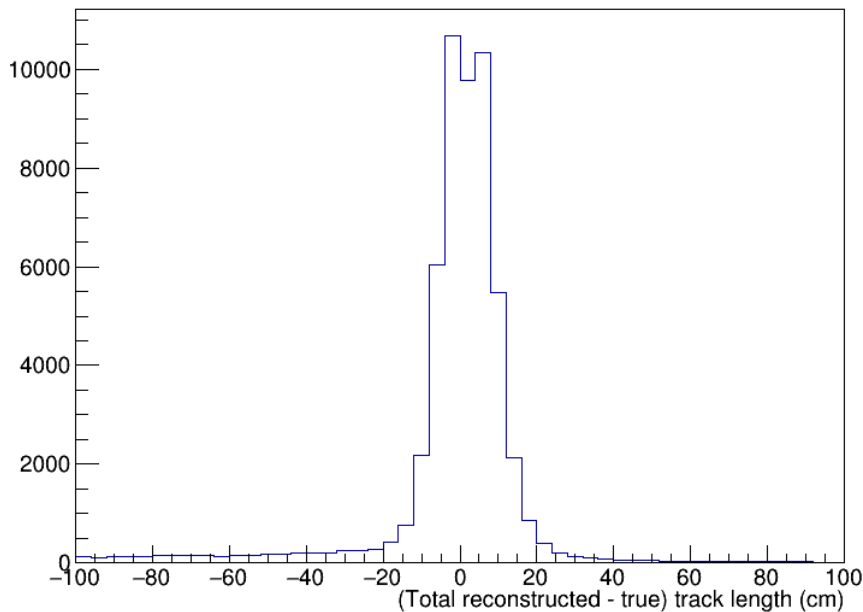


In the case of multiple reconstructed tracks, I pick the track end point closest to the true vertex and true end point

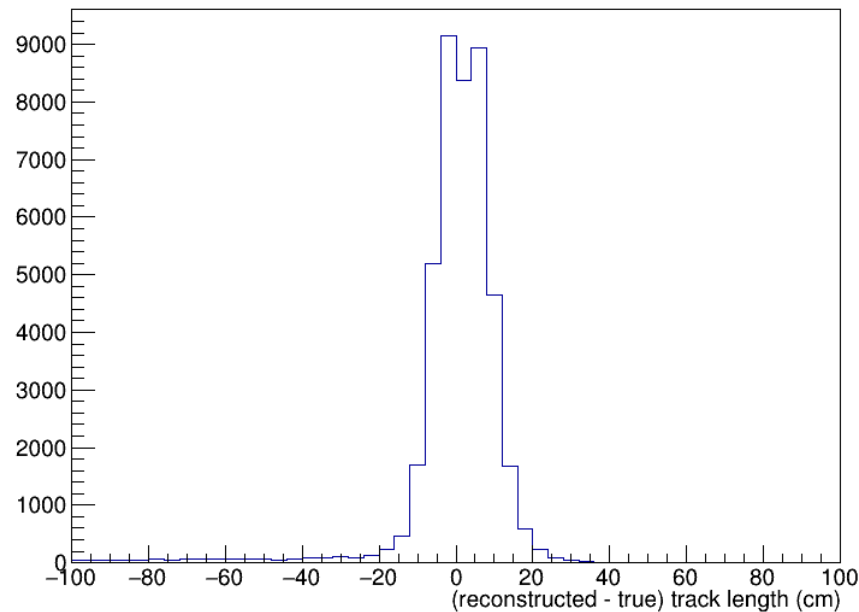
- Track end point resolution (in the y, z plane). Note that this also includes some ambiguity in determining the true active volume entry / exit points.
  - Clear degradation in performance.

# Track Length Resolution

Muons with any number of matched tracks



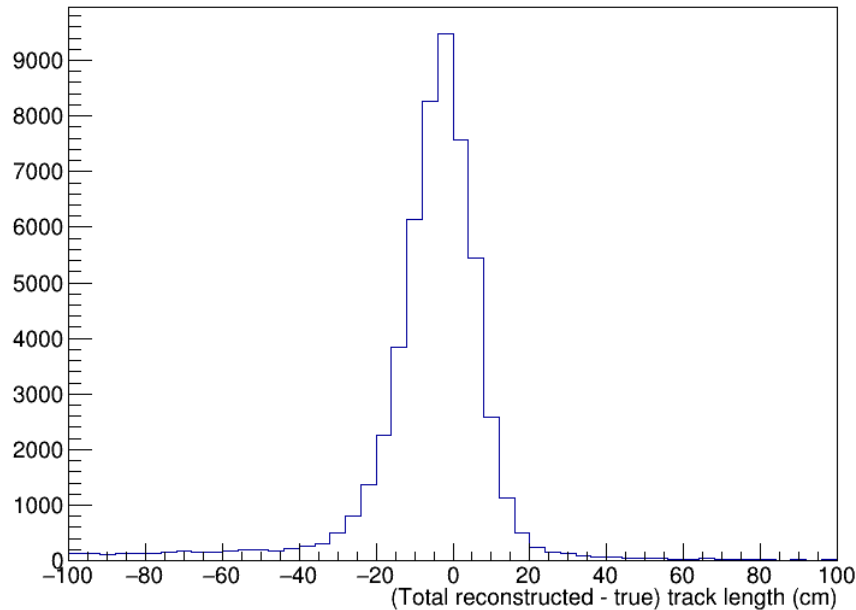
Muons with a single matched track



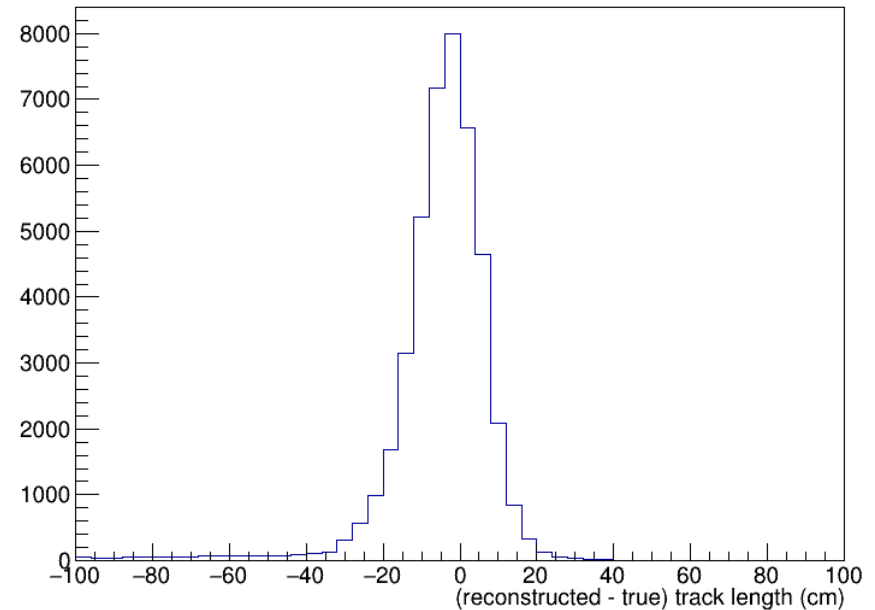
- Track length resolution (in the case of multiple reconstructed tracks, I sum the lengths together).

# Track Length Resolution – with SCE

Muons with any number of matched tracks



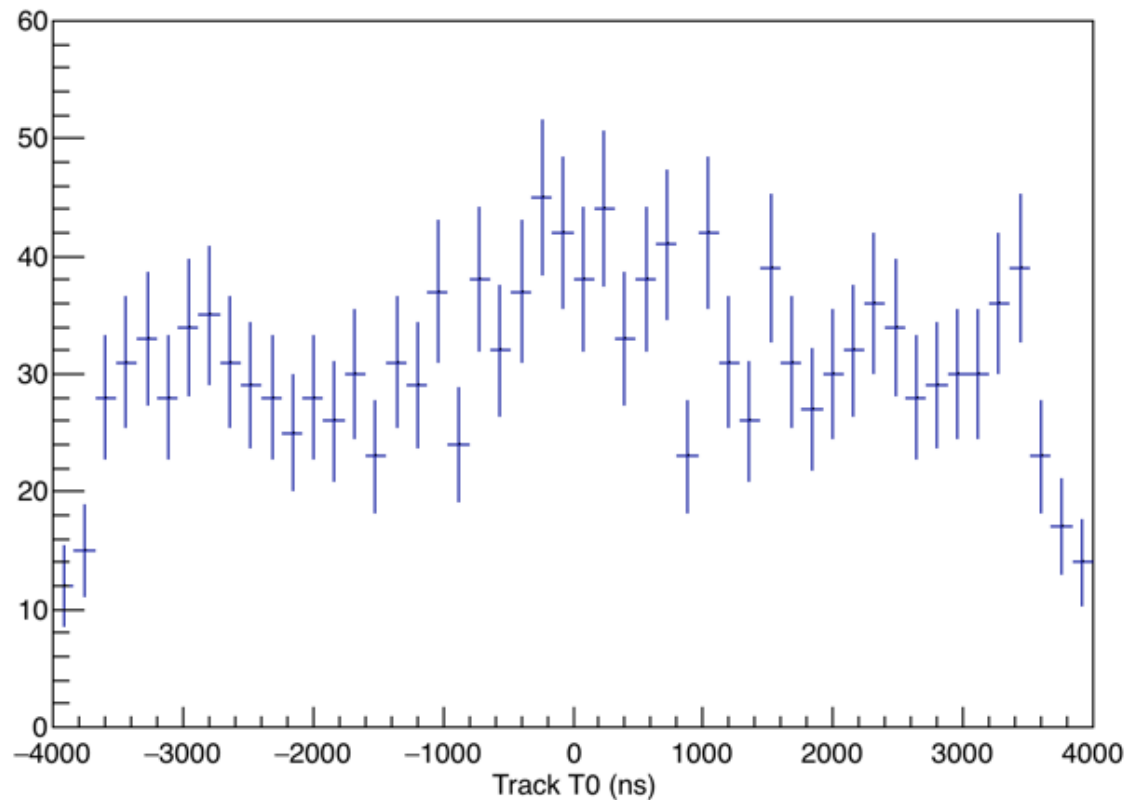
Muons with a single matched track



- Track length resolution (in the case of multiple reconstructed tracks, I sum the lengths together).
  - Noticeable degradation here, wider and increased low tail.

# Next Steps

- Cosmic muon tagging:
  - We can tag those tracks that cross the cathode with T0 distinct from the beam trigger as cosmic muons.
- For example, allowing  $\pm 200$  ns around the trigger time lets us tag 95% of these tracks as cosmic.



# Next Steps

- Cosmic muon tagging:
  - We can tag those tracks that cross the cathode with T0 distinct from the beam trigger as cosmic muons.
- Clearly, the full cosmic muon tagging will have many components:
  - CRT matched tracks
  - Cathode crossing tracks
  - Michel electrons
  - ...etc