Update on CRT-TPC Matching

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Outline

1. Fixes and Moving Forward
2. Update on Matching
3. Updates on SCE Measurements
4. Moving Forward

Issues and their Fixes

- Rawdecoder flips downstream x modules (Fixed in reconstruction)
- ADC hit values do not reflect approx. 250 ADC MIP (Fixed by forcing CRT module numbers to agree with CTB info and setting low ADC cut)
- Strip numbers are 0,31,1,32,2 . . . in data but 0-32 in GDML (Fixed in reconstruction)
- There are around 5-30 cm higher offsets between CRT modules than expected (Will be fixed in geometry using Filippo's CRT survey)

Two CRT Matching Methodology

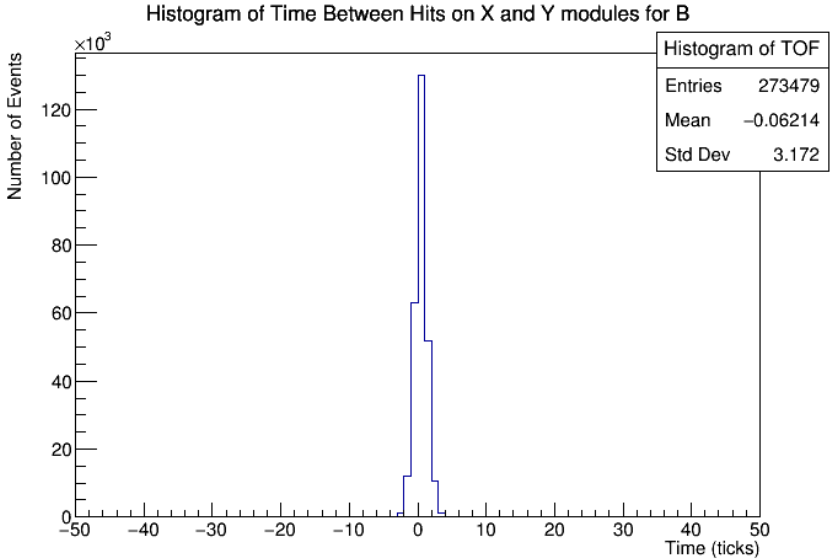
1. Collect all possible 3D hits on CRTs (Timing cuts of 60ns in data between X and Y modules due to timing offsets)
2. Make potential CRT tracks by using combinatorics to connect all CRT hits upstream to hits downstream (Timing cuts of 100 ns between upstream and downstream hits and CRT hit module numbers must match CTB trigger information in data)
3. Match these by picking CRT tracks with the highest unit vector dot product with a TPC track ($\hat{CRT} * \hat{TPC} > .998$)

Single CRT Matching Methodology

WORK IN PROGRESS

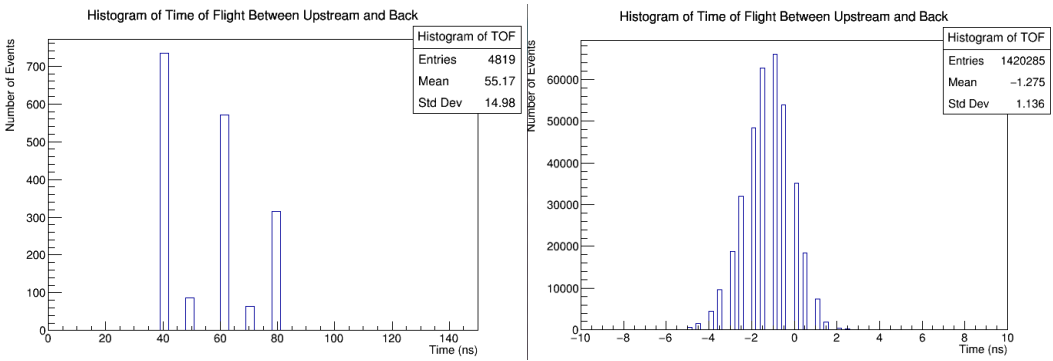
1. Collect all possible 3D hits on CRT (Timing cuts of 60ns in data between X and Y modules due to timing offsets)
2. Match these by picking CRT hits that connect to a TPC vertex with the highest dot product with the TPC track ($CRT \hat{+} Vertex * \hat{TPC} > .9998$)

Timing Information



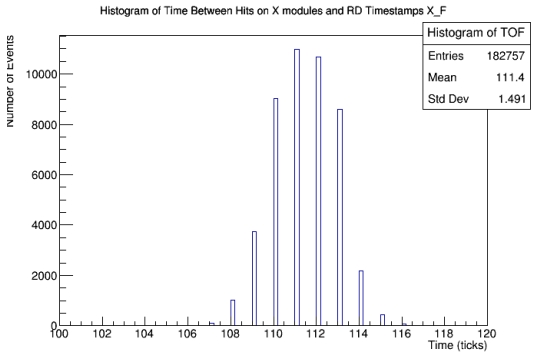
Timing Information

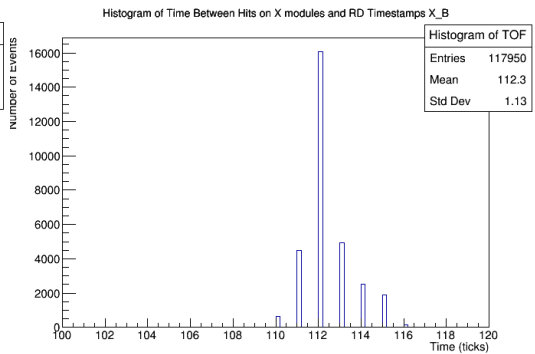
Look at incidences between upstream and downstream modules



MCC (left) and Data Run 5759 (right)

Timing Information and RD Timestamps

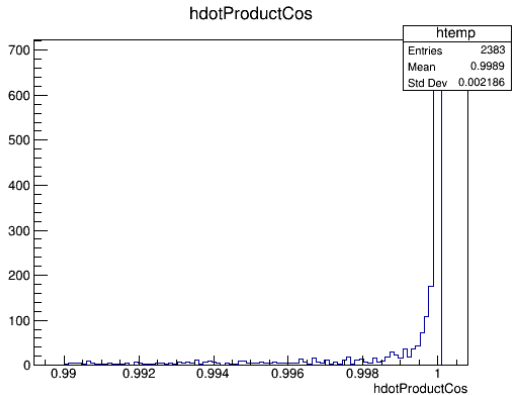


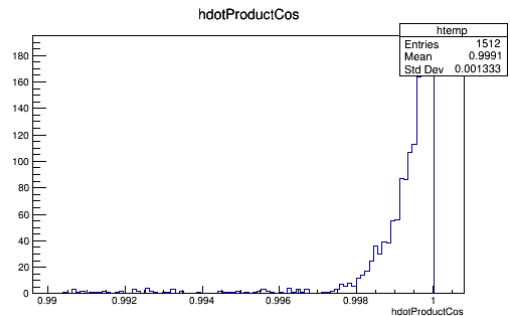


Data deltaT between RD and CRT in Run 5759

Two CRT Matching

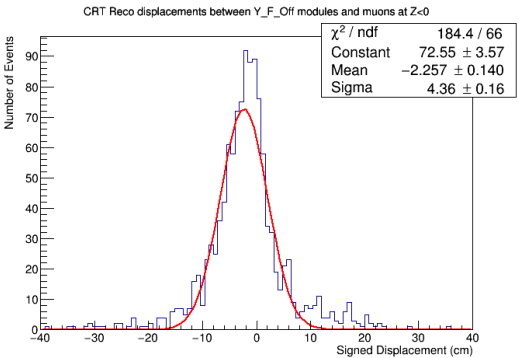
Data runs 5780, 5817, 5826, and 5841 from here on

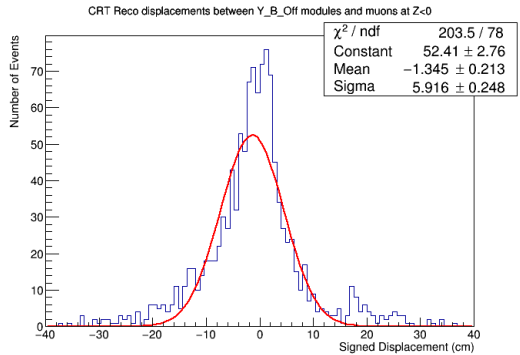




Dot product between TPC and CRT tracks with MCC SCE (left) and data runs 5780, 5817, 5826, and 5841 (right)

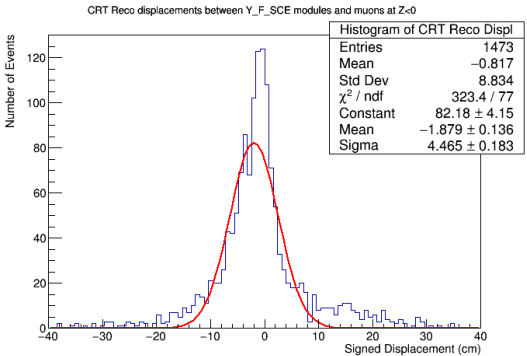
Two CRT Matching

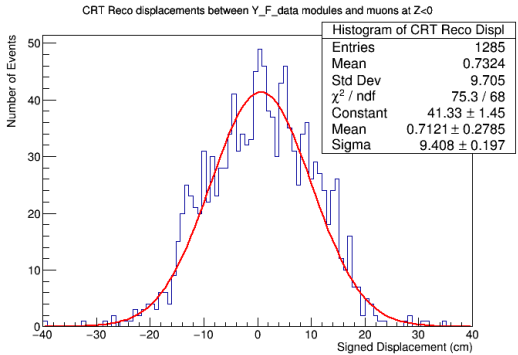




Difference between CRT hit in Y and predicted CRT hit by TPC track for MCC with no SCE

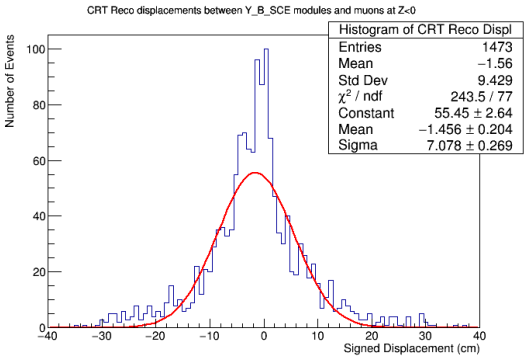
Two CRT Matching

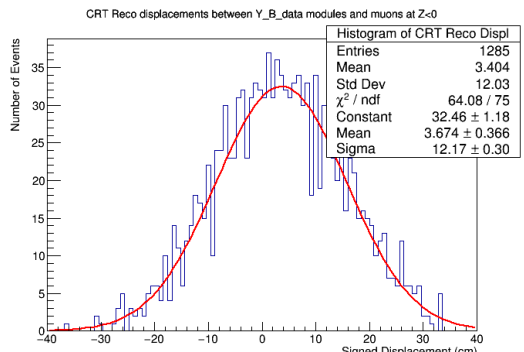




Difference between CRT hit in Y Front and predicted CRT hit by TPC track for MCC SCE (left) and data (right)

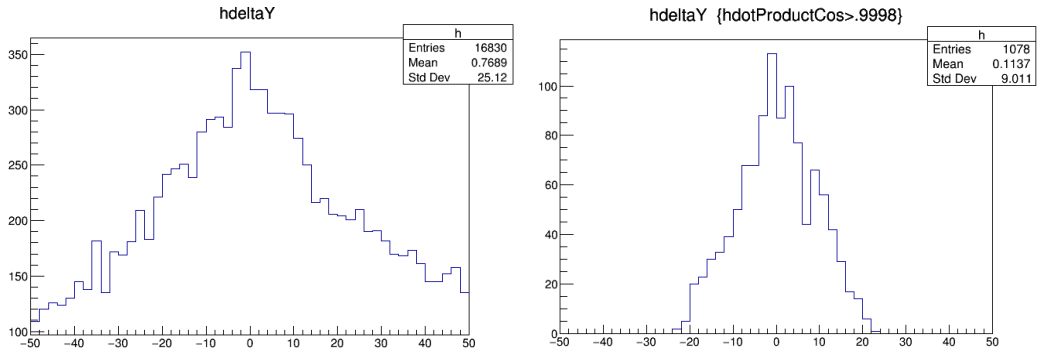
Two CRT Matching





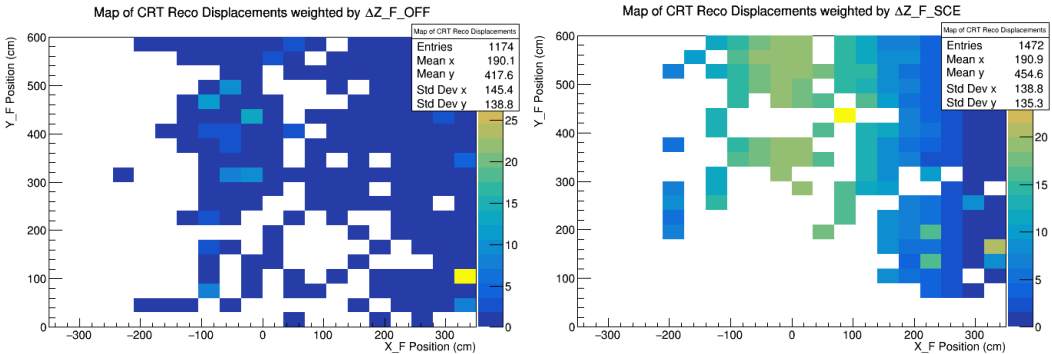
Difference between CRT hit in Y Back and predicted CRT hit by TPC track for MCC SCE (left) and data (right)

Single CRT Matching



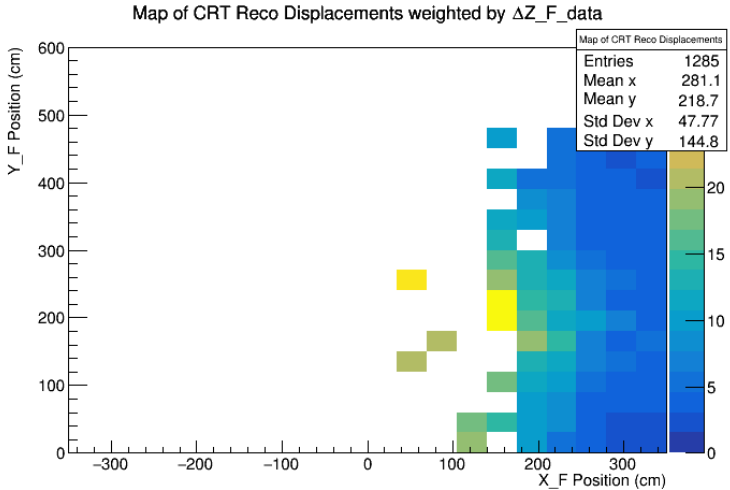
Difference between CRT hit in Y and predicted CRT hit by TPC track for MCC FLF without cuts (left) and with cuts (right)

SCE Measurements



SCE Weighted TProfile between MCC no SCE (left) and MCC with SCE (right)

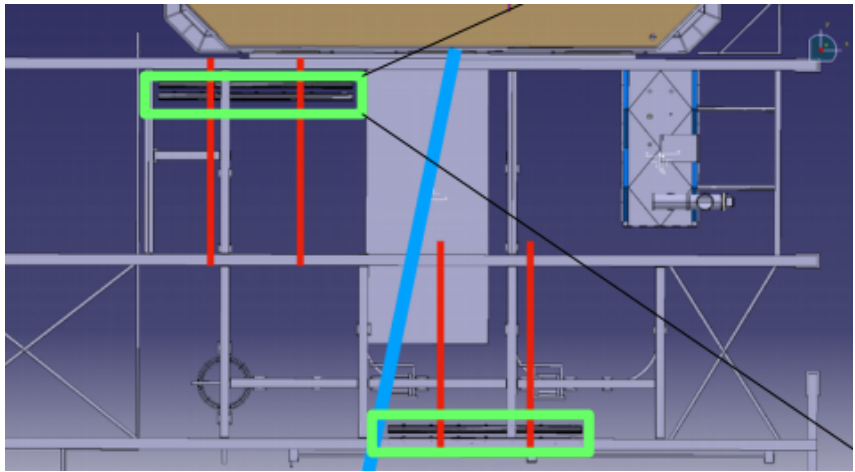
SCE Measurements



SCE Weighted TProfile for data

SCE Measurements

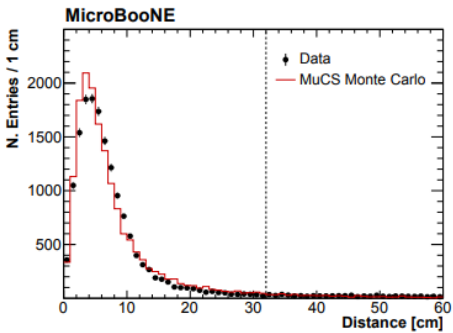
Need to use Single CRT to make map due to poor detector face coverage.

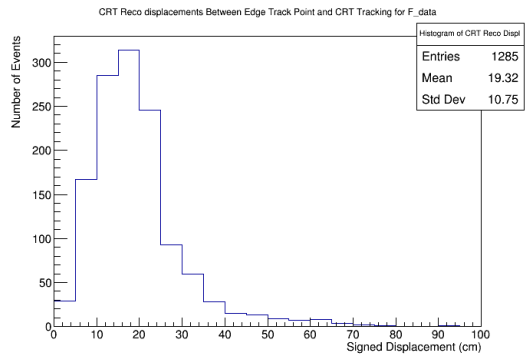


CRT orientations in the front

Comparisons with MicroBooNE (1707.09903)

MicroBooNE uses vertical tracks which are way easier to reconstruct.





Displacement between first track point and CRT predicted track point with MicroBooNE (left) and protoDUNE data (right)

Moving Forward

DONE just need to implement into a producer module

1. Provide T0-taging of through-going muons.

NOT DONE

1. Provide detailed SCE maps to calibrate.
2. Provide general T0-tagging (both single and two CRT matching).