Intersections of beam halo and cosmic muons in protoDUNE

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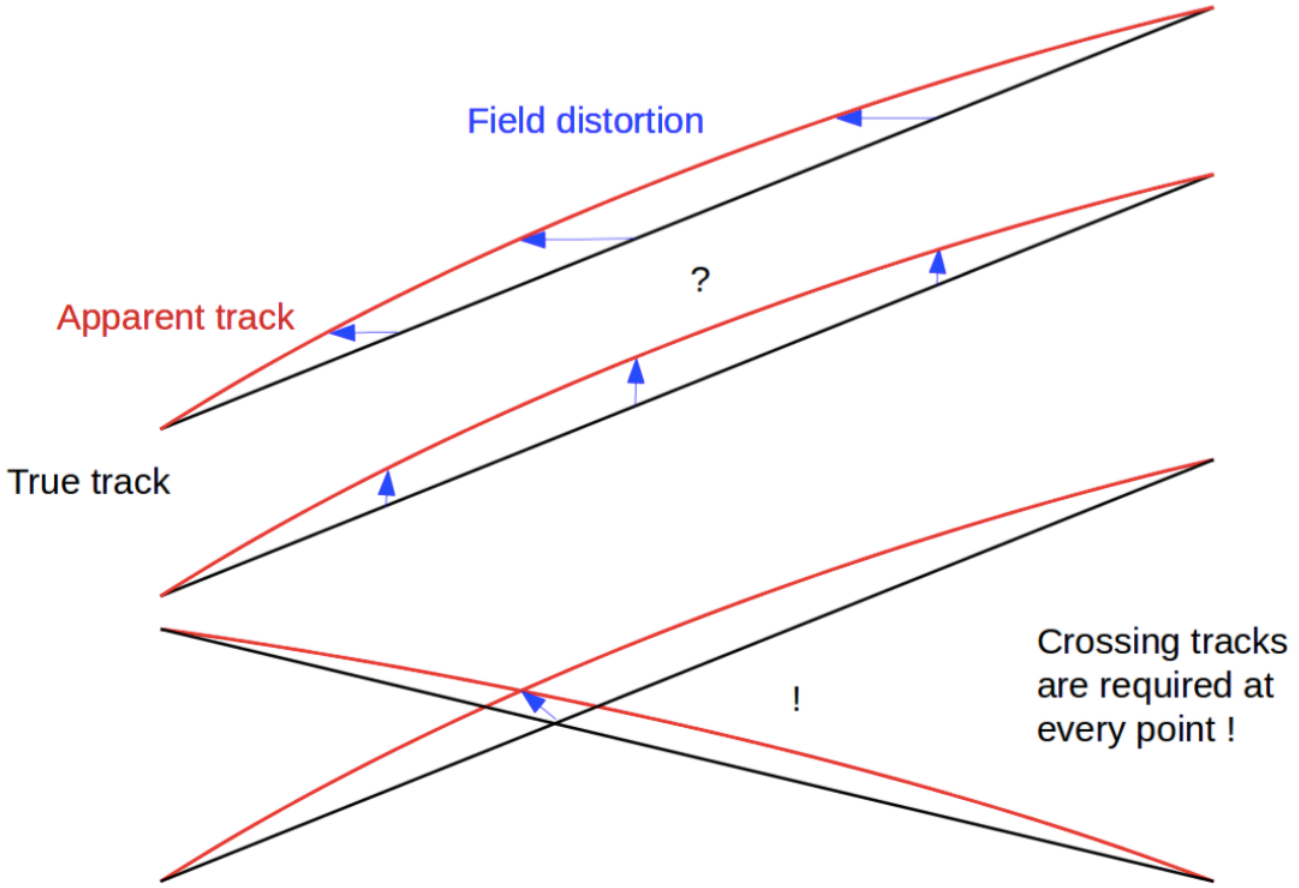
Outline

- Goals
- Simulations
- Analysis
- Plots
- Conclusions

Goals

Make preliminary estimate of whether we need the top counters for calibrating space charge effect



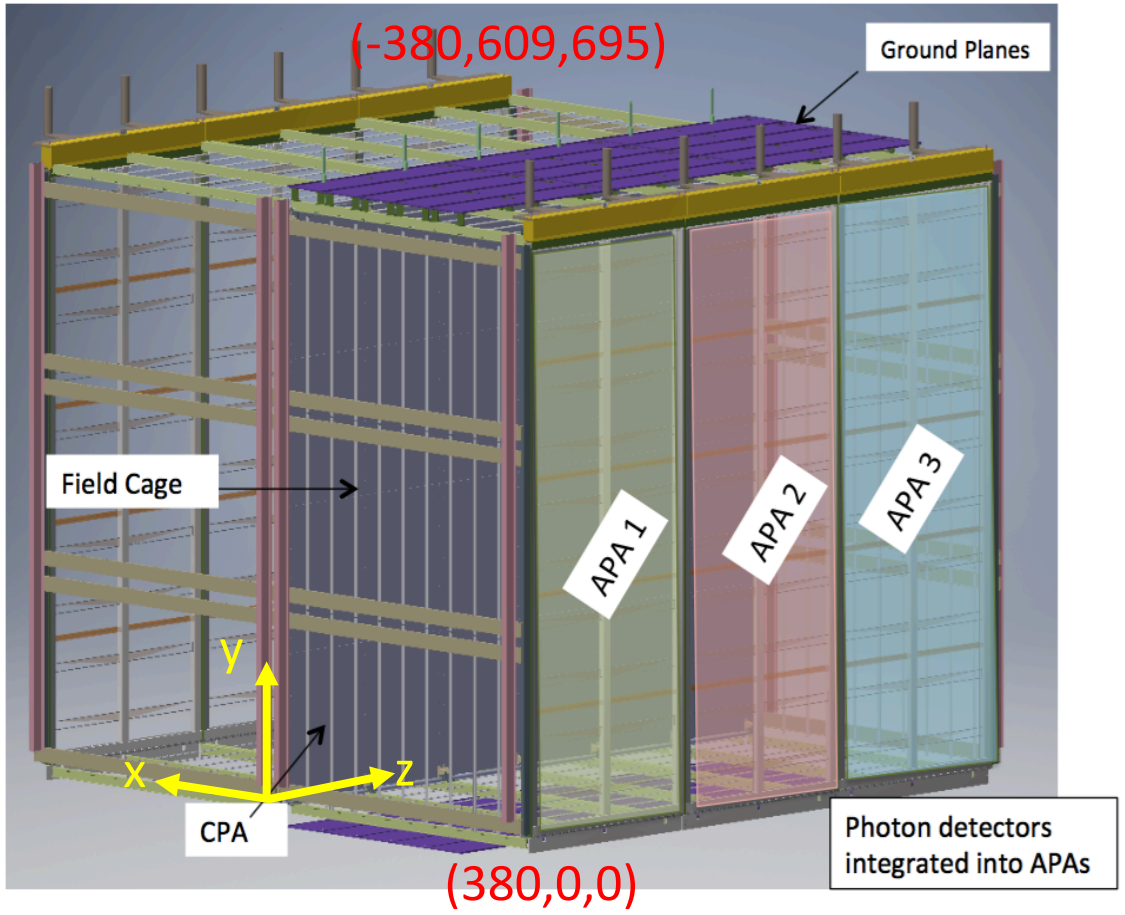
Source: Igor Kreslo

Simulations

- Assumed that there is a uniform distribution of beam halo muons in the unit z direction
- Unambiguous muon track provided by cosmic ray tagger (CRT) detectors at the front, back and top of the TPC
- Cosmic muons were generated by CORSIKA in LArSoft
- 1000 readout windows were used to give us a total of 145,997 cosmic ray muons
- Sample of anode to anode cosmic ray tracks not considered in this study

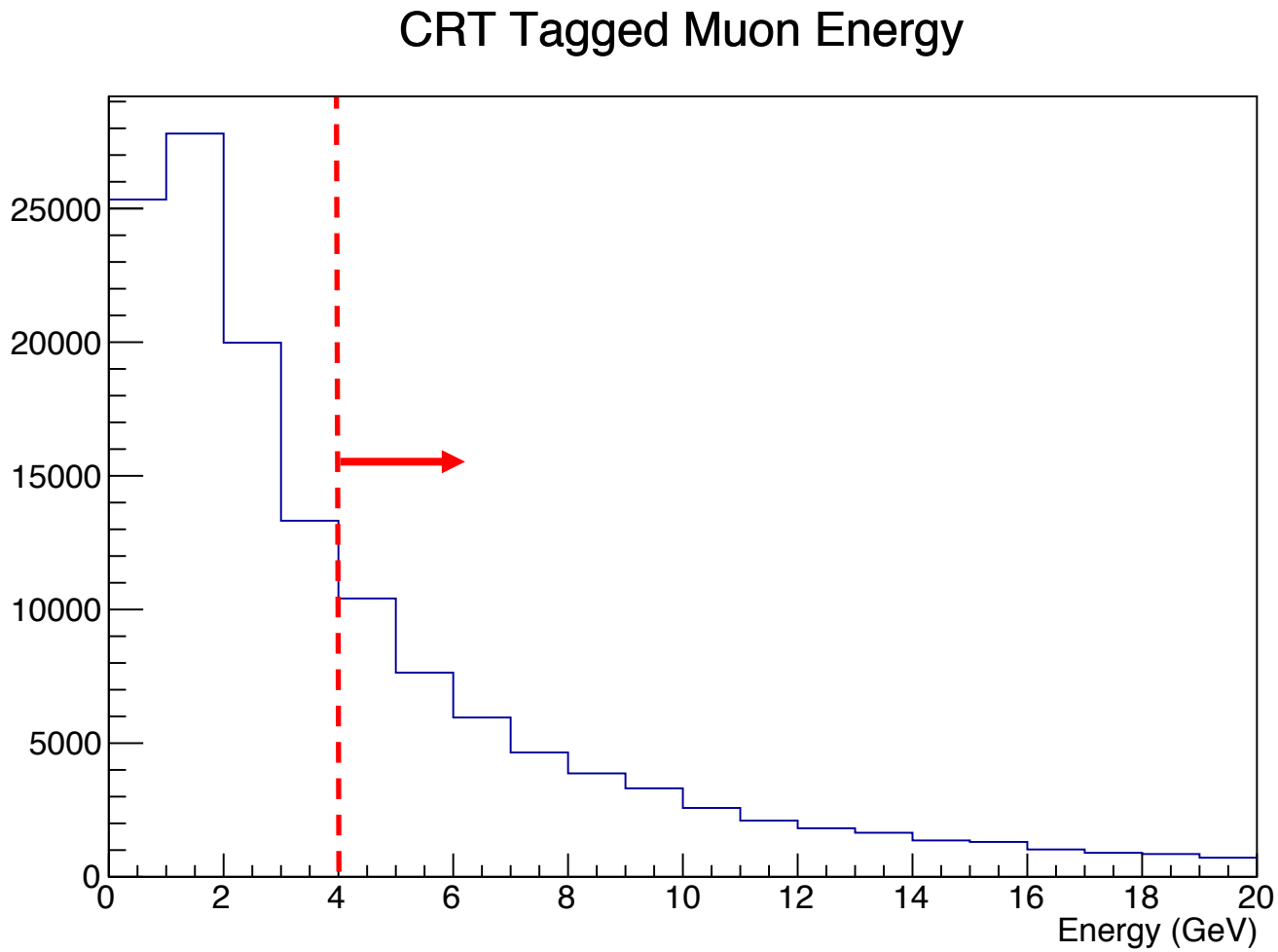
Analysis

- A sample of tagged muons was extracted from the generated sample with a geometric simulation of the CRTs
- CRTs placed on
  - top (y = 861 cm)
  - front (z = -202 cm)
  - back (z = 944 cm)
- Found angle θ and intersection points between the assumed beam halo distribution and the tagged cosmic ray sample
- Used 76 x 61 x 70 cm bins for intersection points



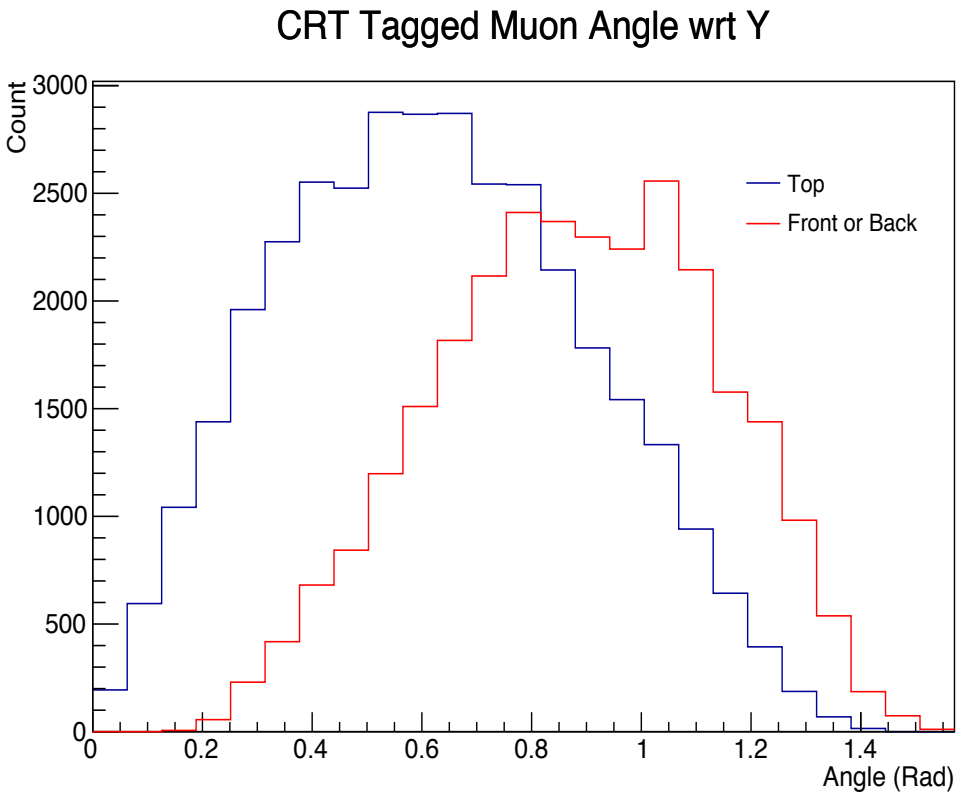
Energy

Selected a sample of straight cosmic ray tracks with the E > 4 GeV cut.

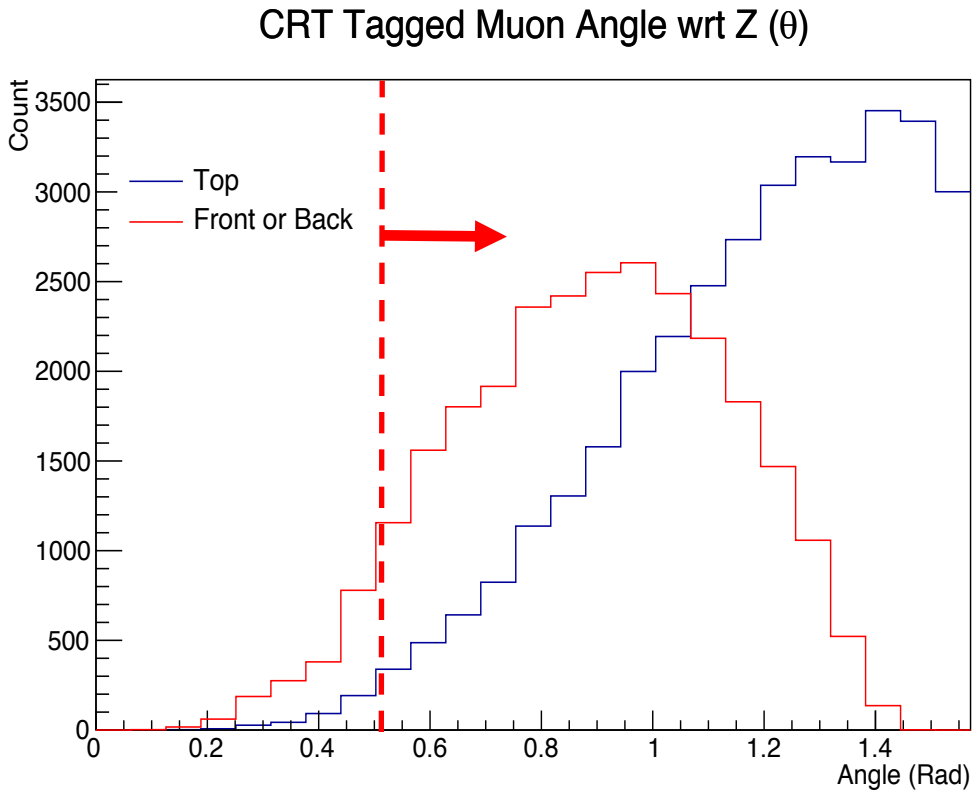


Angles

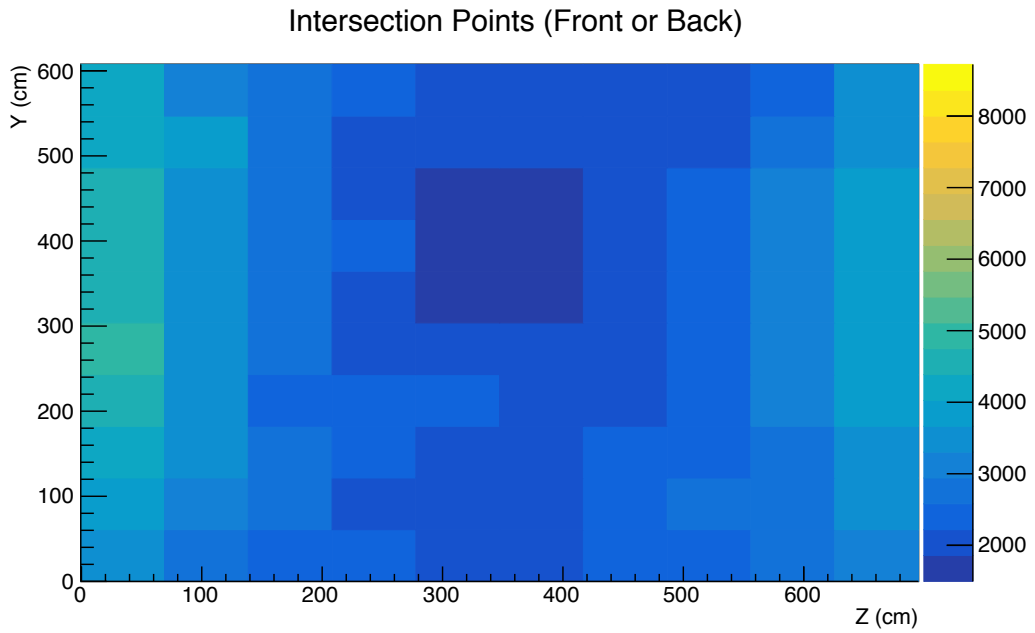
- The top counter configuration selects more vertical muons than the front or back counters

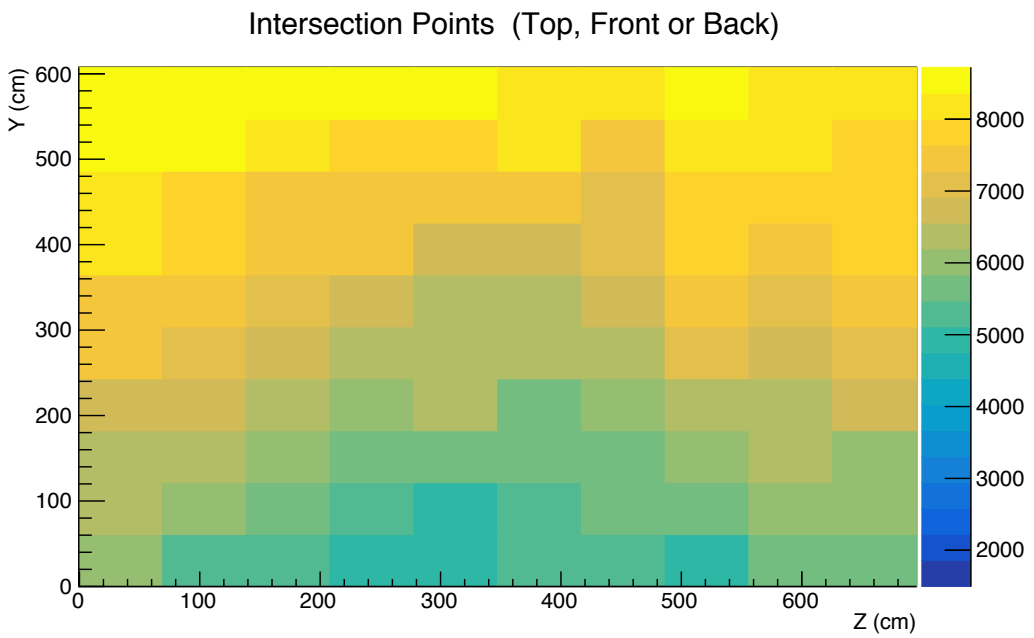


- A $\theta > 30°$ angular cut to ensure a sufficiently large angle for the space charge calibration



Y vs Z



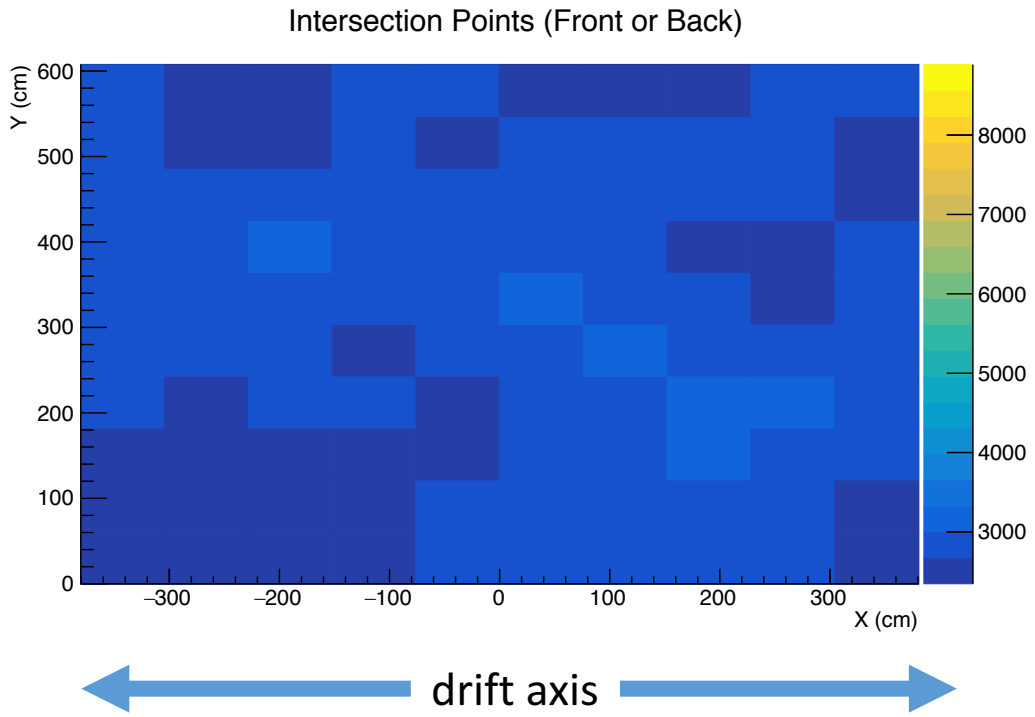


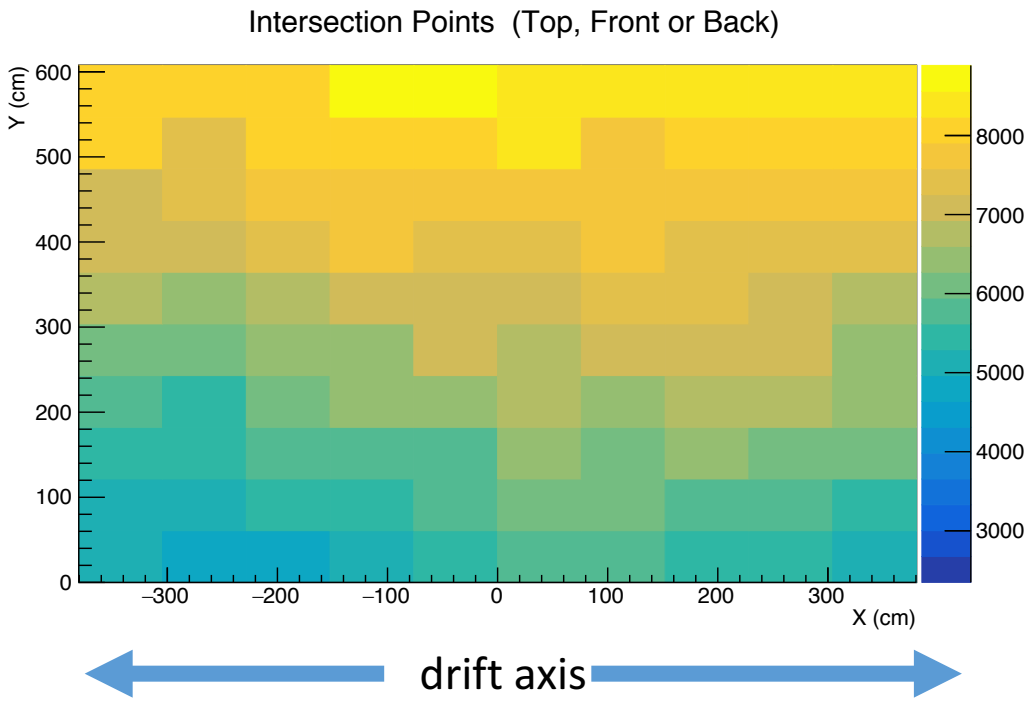
beam direction

drift axes into and out of the page

Y vs X

beam direction out of the page





Conclusions

- The Front and Back configuration provides space charge intersection points over the entire TPC.
- However, from these plots it is clear that there is an advantage in using the Top counters since there are more tracks intersecting the beam halo over the whole volume of the TPC.
- Increased statistics from further cosmic ray muon samples will need to be considered. (See Mike Mooney's talk next)