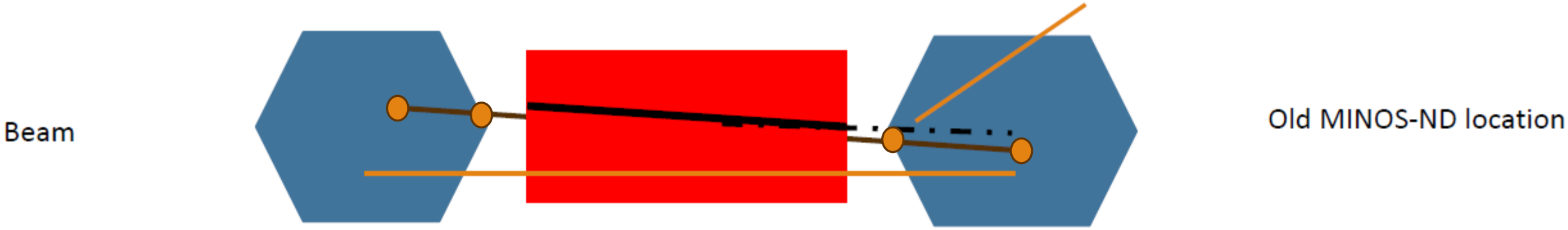
First Tests with Sandbox Data and Mx2

Int. with Muon Candidate Matched to MINERvA

- Based on matching information between two external tracks, like with a CRT or TMS.

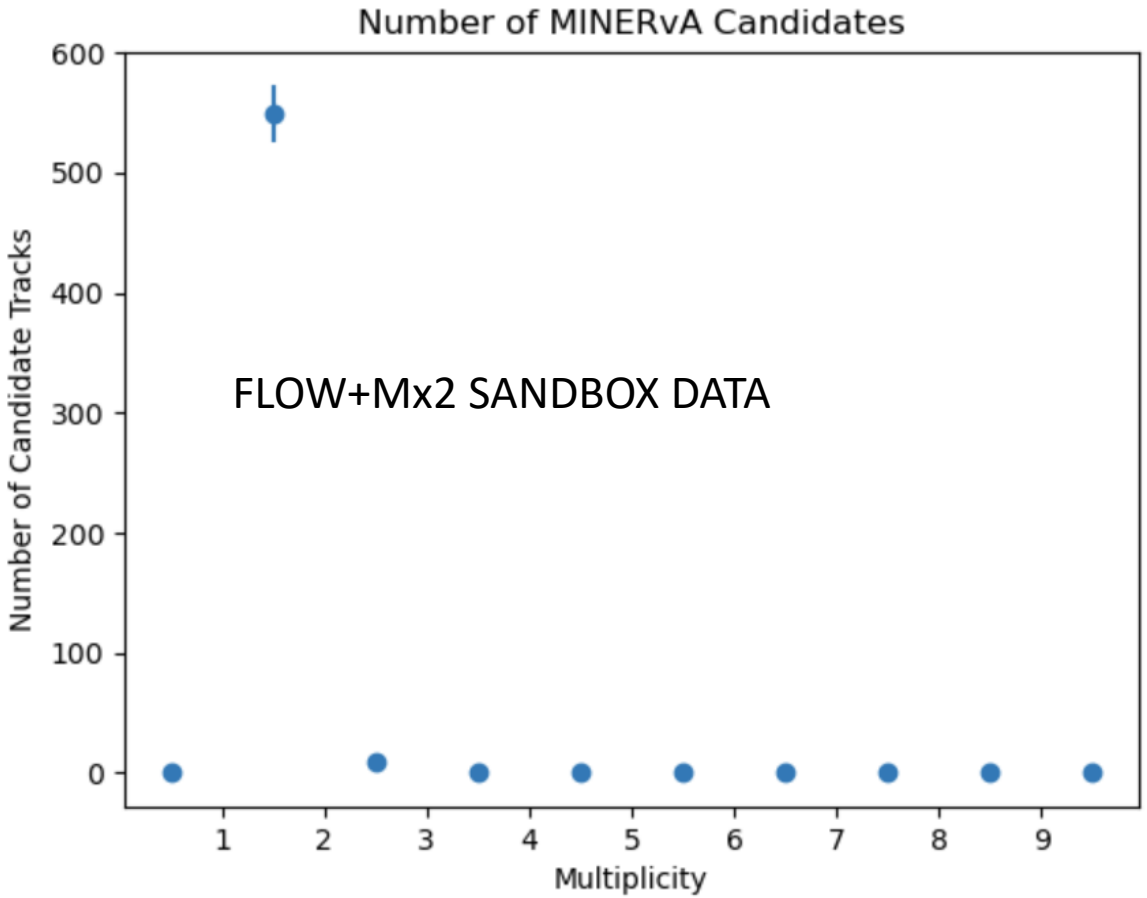


Noë Roy, Anna Fedorova, and myself working on CAF-integration of this matching.

I will only use files in reference to the sandbox times, regardless if more files are allowed.

Rock Muon Flow vs. MLReco CAFs Through-going

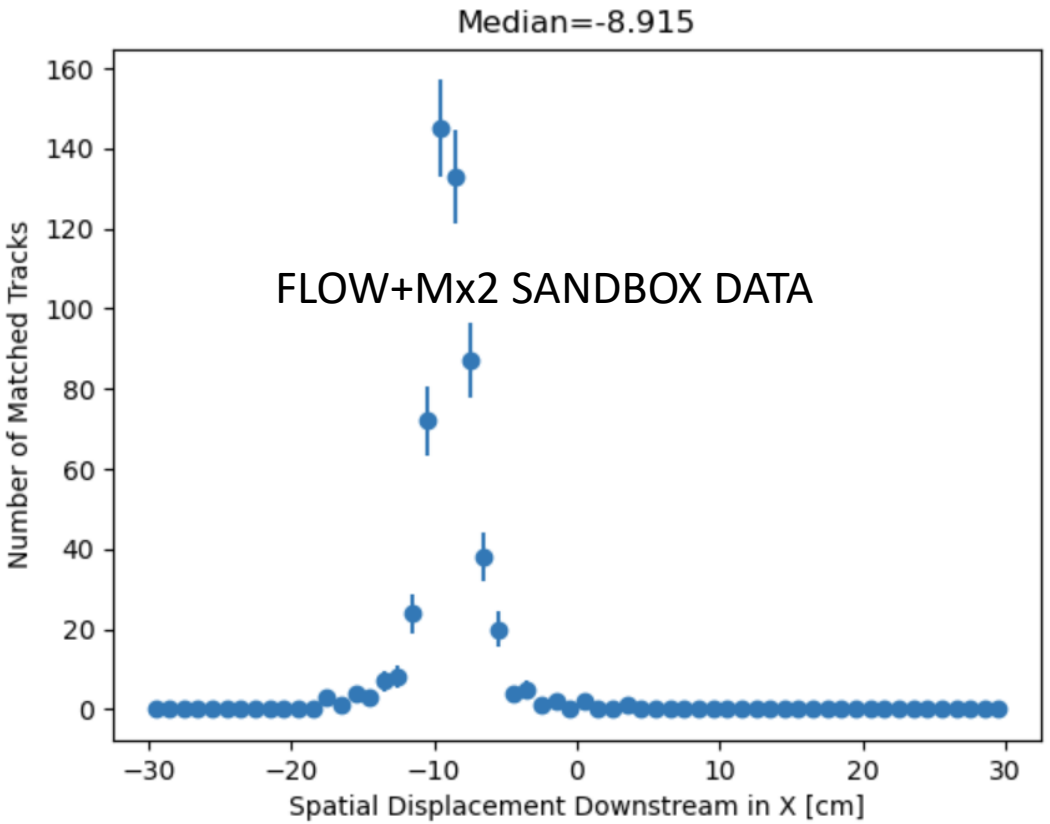
- I corrected for the offsets observed
  - ~-10 cm in X and ~5 cm in Y.
- Same cuts used for flow and CAFs:
  - <0.9s between Mx2 and LAr events.
  - Beam reports a spill.
  - The FW is 30 cm in X and Y.
  - Mx2+TPC tracks must agree in XZ and YZ directions within 0.06 radians.
  - The best angular agreement determines which track is selected (never needed).
- Algorithm in CAFs has a purity of 99.3% of selecting the same muon.

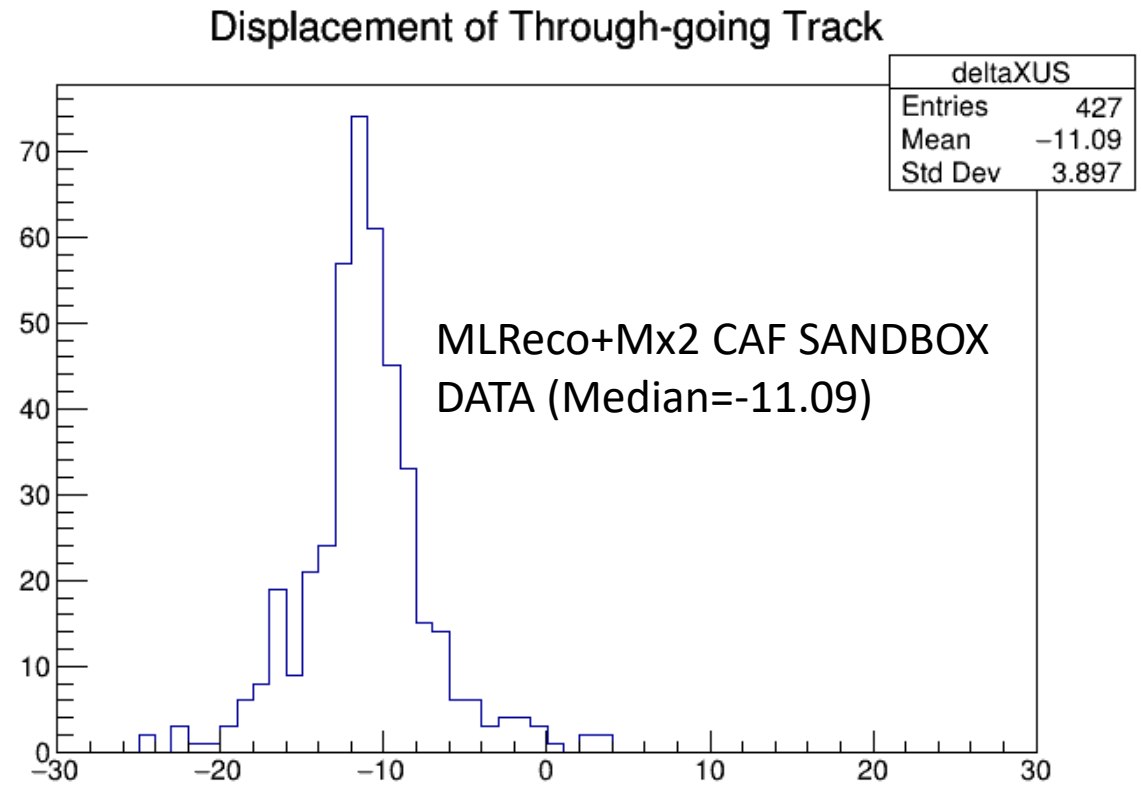


Number of candidate Mx2 tracks for DeMario's rock muons could select. The best candidate has the lowest angular displacement.

Rock Muon Flow vs. MLReco CAFs Through-going

- Displacement of TPC track extrapolated to the downstream end of the MINERvA track.
- Flow (560 matched tracks) and MLReco+Mx2 (427 matched tracks)
  - Possibly a 1-2 cm timing offset between the two.





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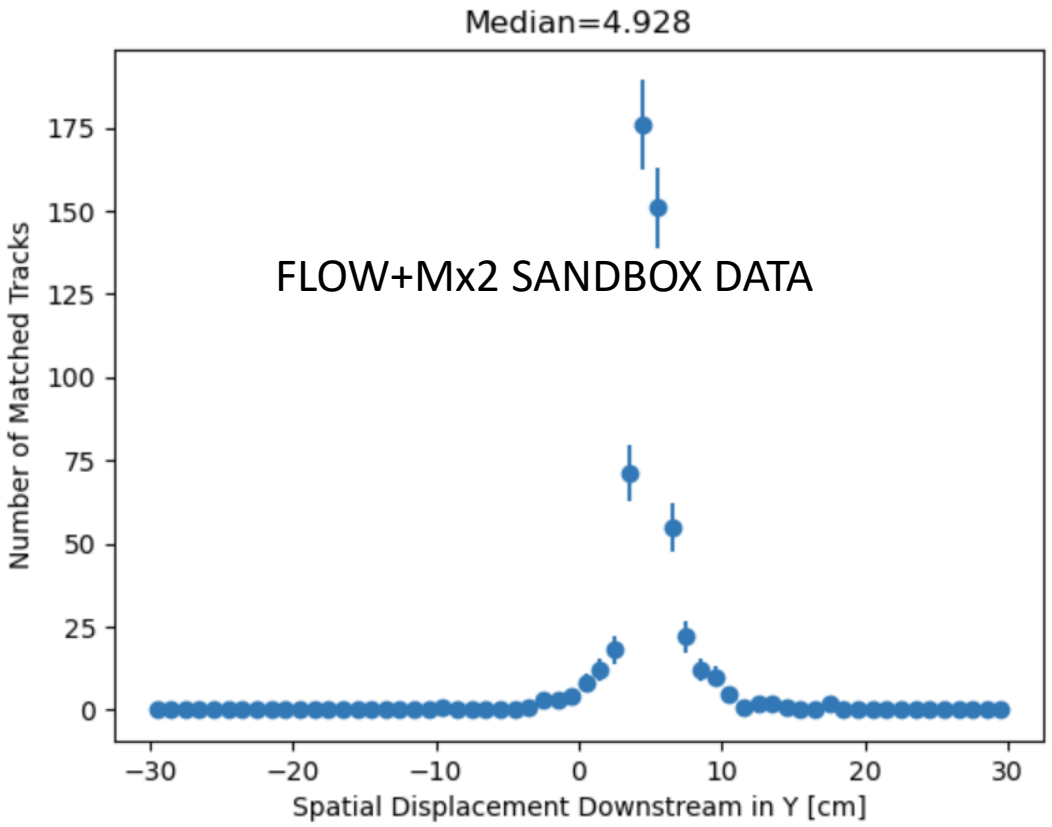
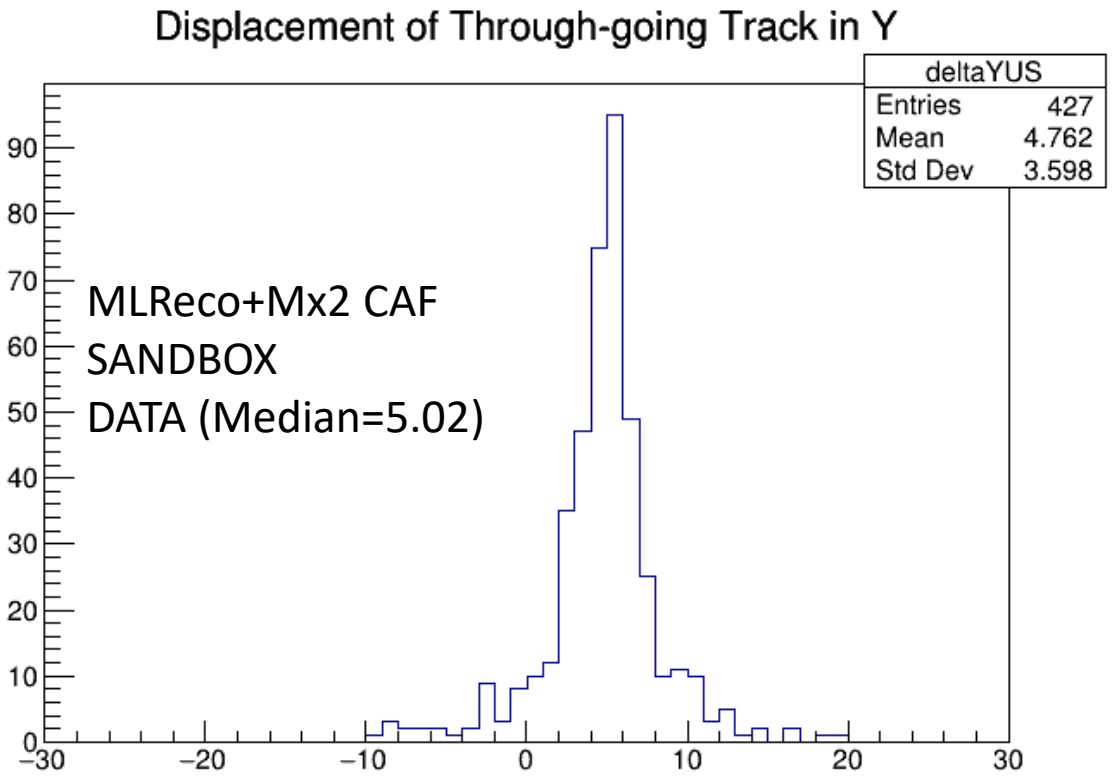
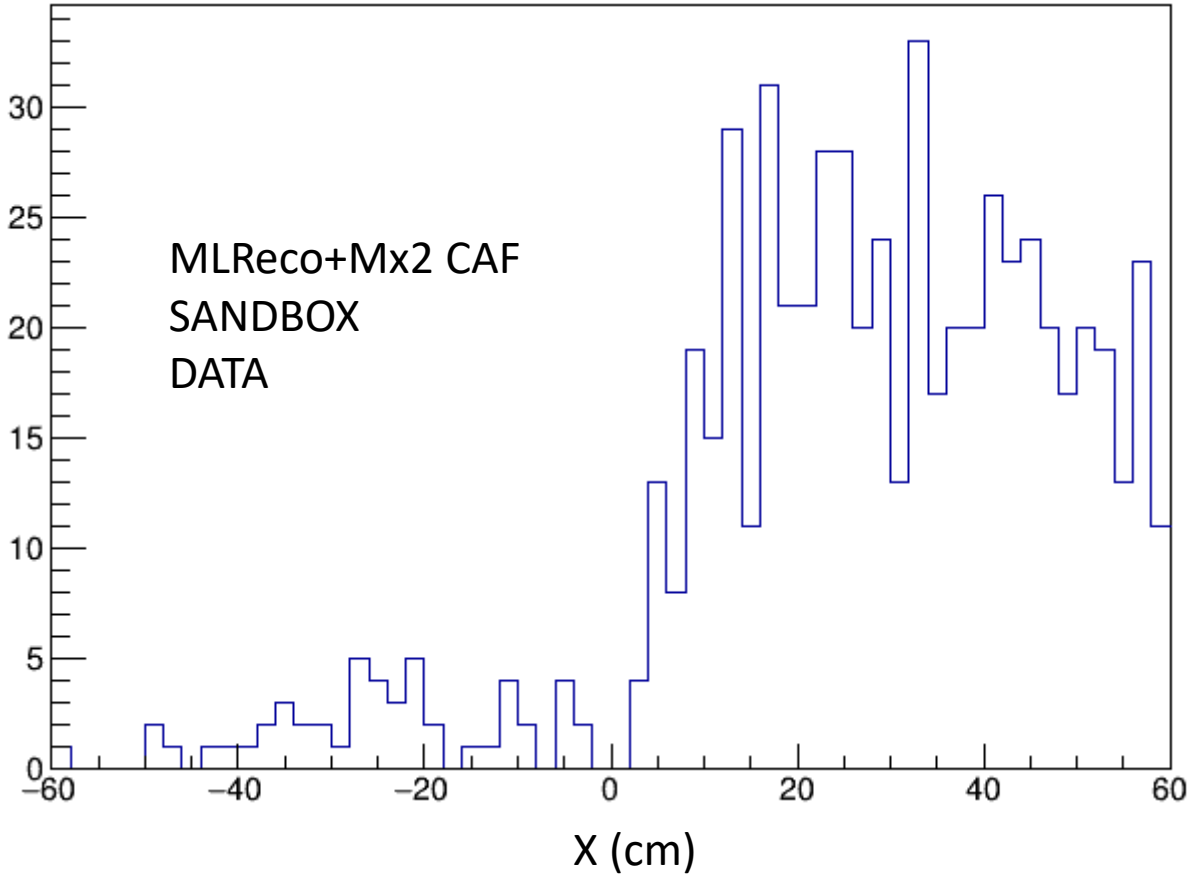




Issues with LHS of 2x2

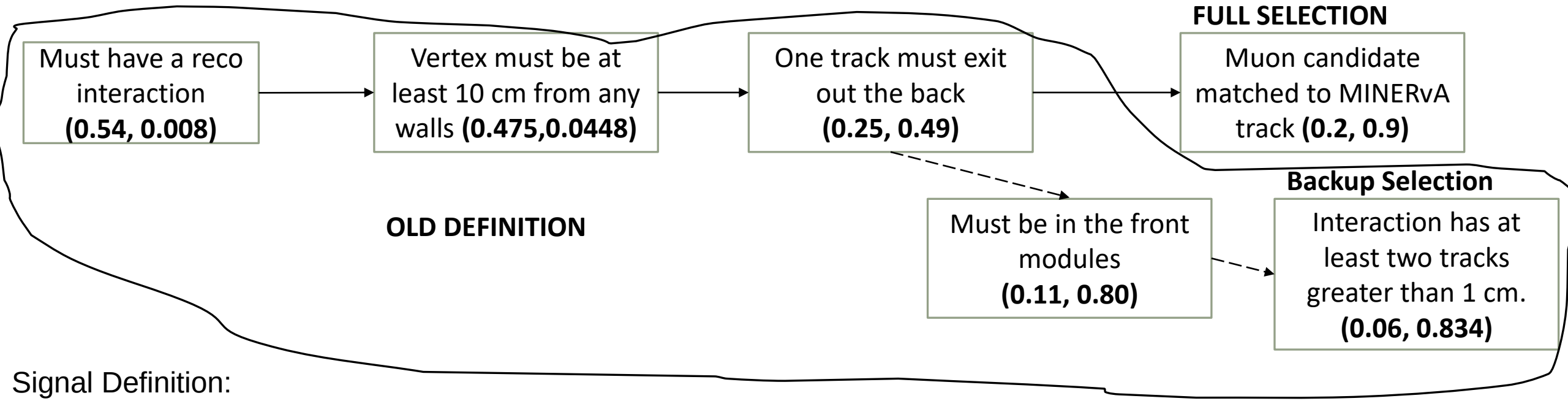
The starting position location of all through-going muons as reconstructed by MLReco (>120 cm in Z), no additional selection with Mx2 is applied. 621 tracks in total.



This is not observed at flow level.
Likely MLReco fighting Module 2?

Event Selection from MiniRun5 (Old Slide)

- Total of ~5k true CC muon (anti)neutrino events (~90 per hour, ~3% of spills).
- Purity of reconstructing those neutrino interactions is 0.8% without additional event selection.
- Therefore, an event selection was developed both with and without MINERvA (**efficiency, purity**)



Signal Definition:

- A CC muon (anti)neutrino interaction with a vertex 10 cm away from a detector wall (incl. walls between modules).
  - **We will change this to 5 cm for this study because of the low statistics.**
  - This requires muon to have energy>1 GeV and cosine of >0.9

Value of fid. vol. cut w.r.t. walls set from vertex purity studies (see backup)

Neutrino Interaction Event Selection (CAF-only)

- Using back-of-the-envelope calculations, we can expect 180 CC muon neutrino interactions with perfect reco.
  - Given the efficiencies, we expect only 35 of those to be reconstructed and identified.

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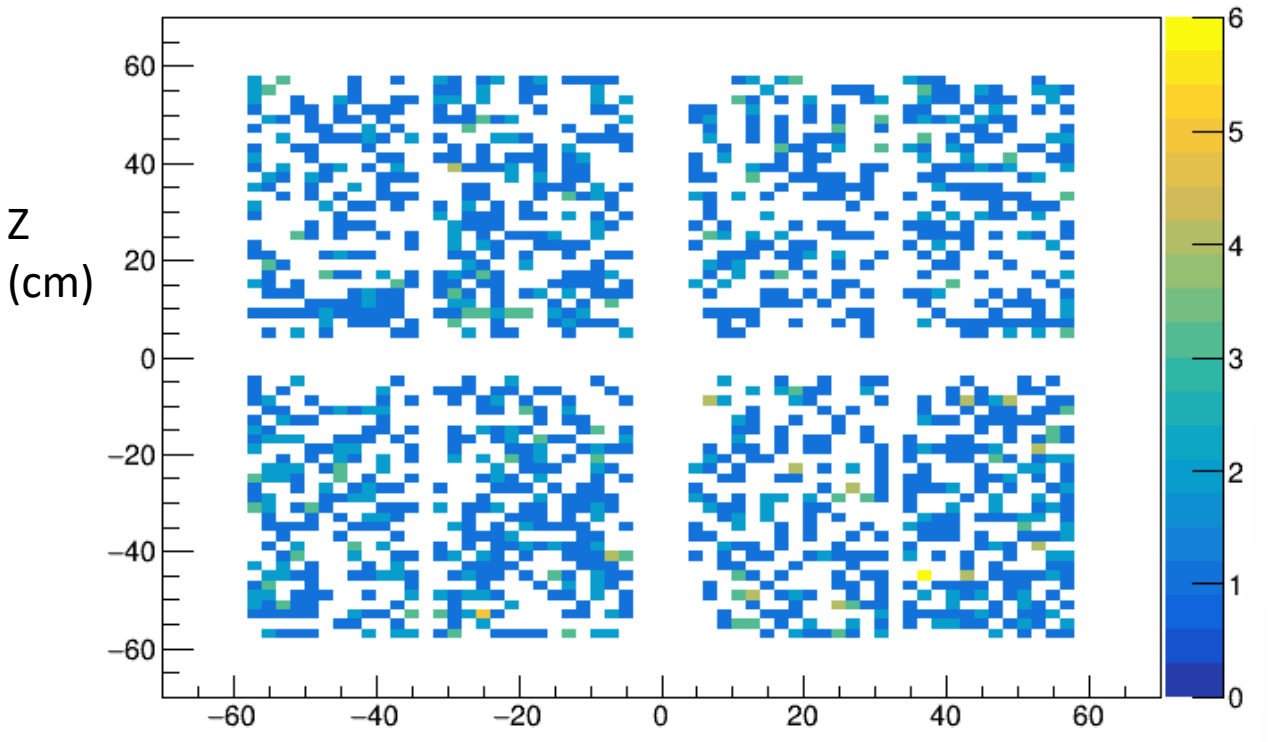
  - Given the efficiencies, we expect only 35 of those to be reconstructed and identified with pure reco.
- The sandbox data with Mx2 found 34 neutrino interactions that have a muon candidate matched to Mx2.
  - However, that includes the 10% impurity so with background subtraction it is closer to 30 interactions.
  - Simulation reports 1.3% of spills to have a selected interaction, data has 0.8% (remember low statistics in data)
  - Of these, 16 had one or more hadronic tracks. Simulation had 54% of events with one or more hadrons.

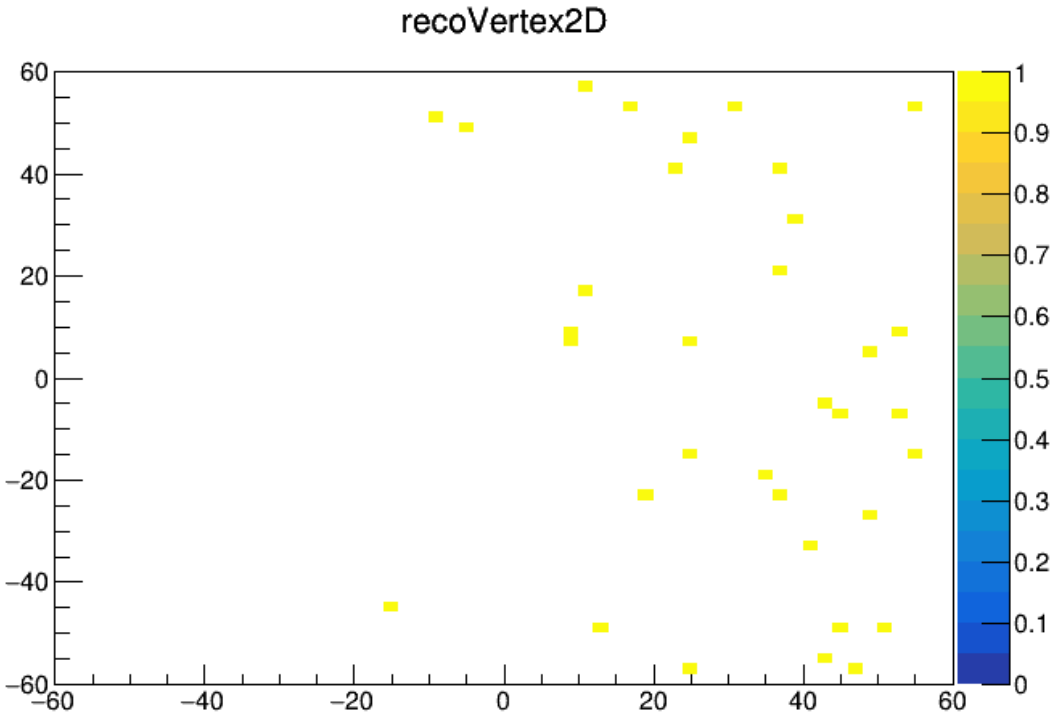
Vertex Distribution

- Only on two modules?

Distribution of Vertices from MLReco Interactions with no Selection Applied

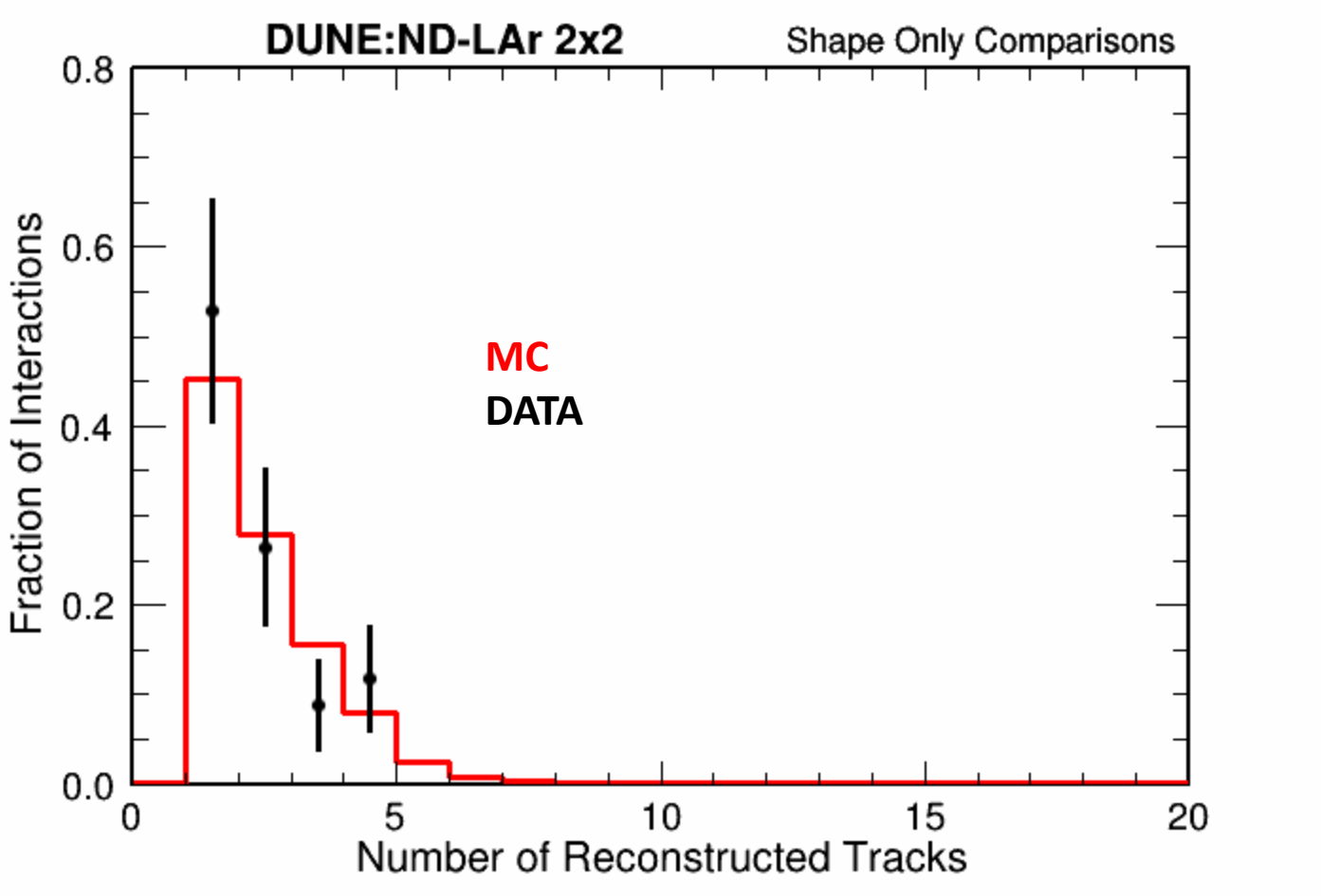


Distribution with full selection



X (cm)

Neutrino Interaction Event Selection (CAF-only)



Conclusion

- Slight offset and low normalization when comparing Mx2 with CAF MLReco vs. Flow.
- There are simply not enough events to investigate further.
  - I would request more hours to be opened to this group for neutrino analyses.
  - In the short term, focus explicitly on Mx2 through-going as a sideband.
- Distribution close to prediction.

Backup Slide (Nominal Result in Simulation)