Track Matching Update

TMS Studies Meeting – Kate Hildebrandt

7/26/24

DEEP UNDERGROUND NEUTRINO EXPERIMENT

UNIVERSITY OF MINNESOTA
Driven to Discover℠

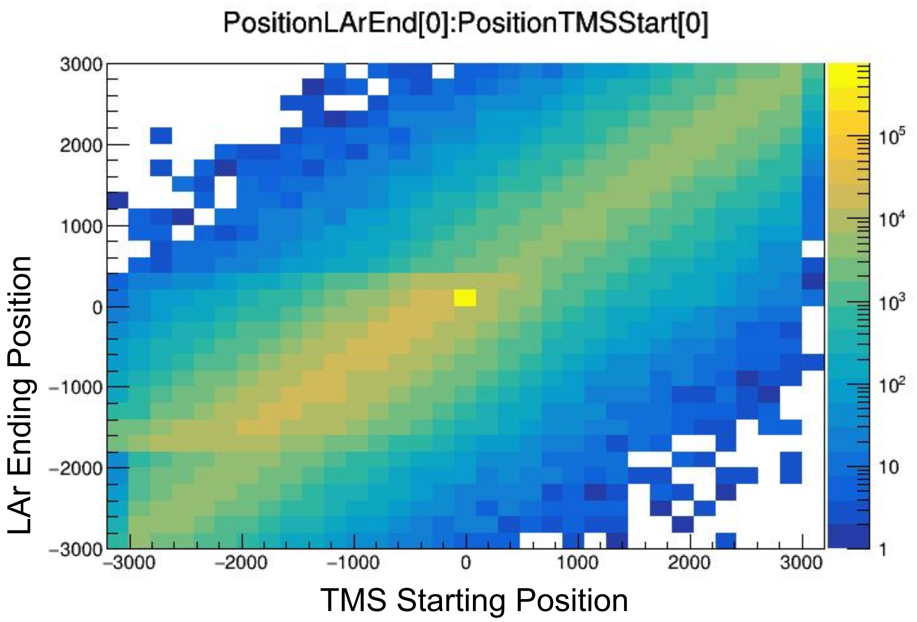
Track Matching Study

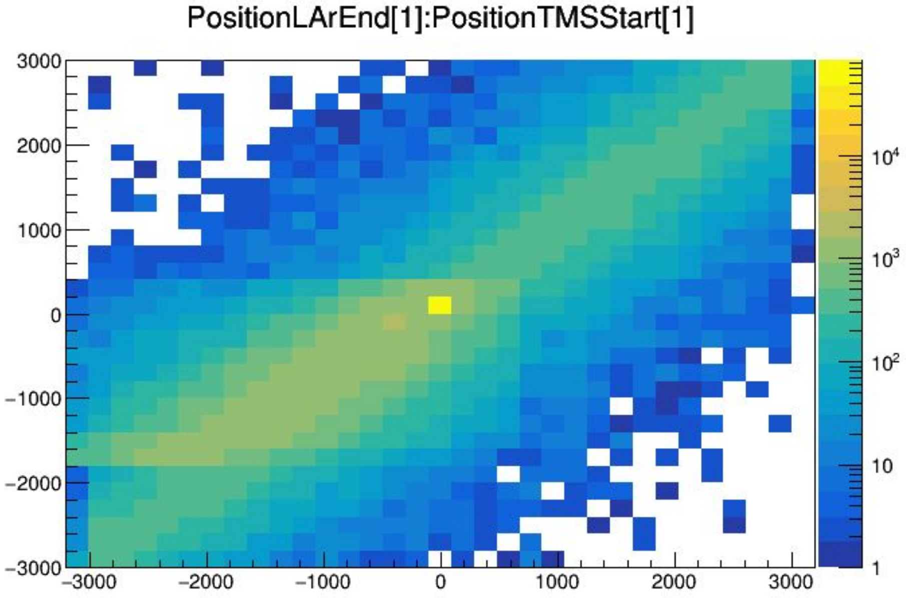
- Looked first at the relationship between different truth variables
  - True LAr end position vs. true TMS start position (X, Y)
  - True LAr end momentum vs. true TMS start momentum (X, Y, Z)
- Looked at the relationship between true and reco variables
  - True vs. reco TMS start position (X, Y)
- Looked at the relationship between true and extrapolated LAr end position
  - There is not a reconstructed LAr end position, so instead I used the reconstructed TMS start position and direction, and then extrapolated back to find a LAr end position

LAr End Position and TMS Start Position

Diagonal structure is what we want to see here

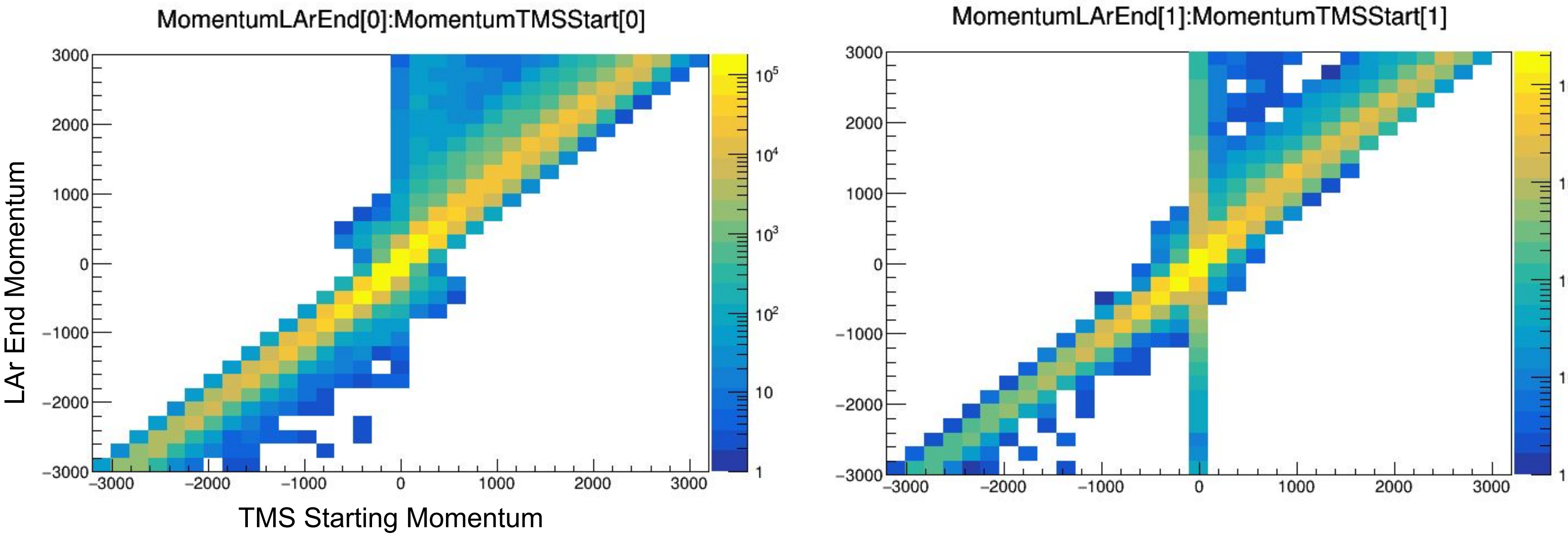
Not sure where the odd rectangular structure in the bottom left quadrant of these plots is coming from





LAr End Momentum and TMS Start Momentum

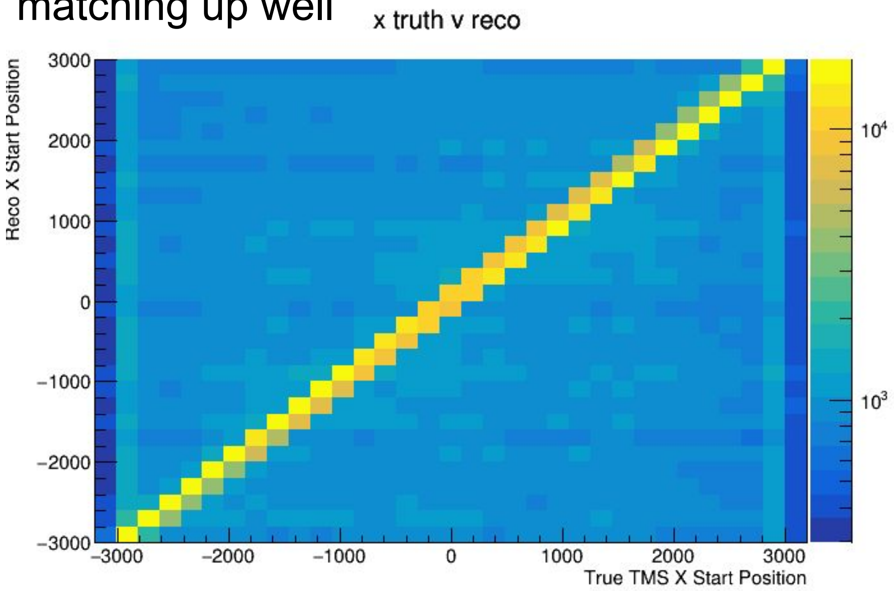
Off-diagonal portions show lost momentum

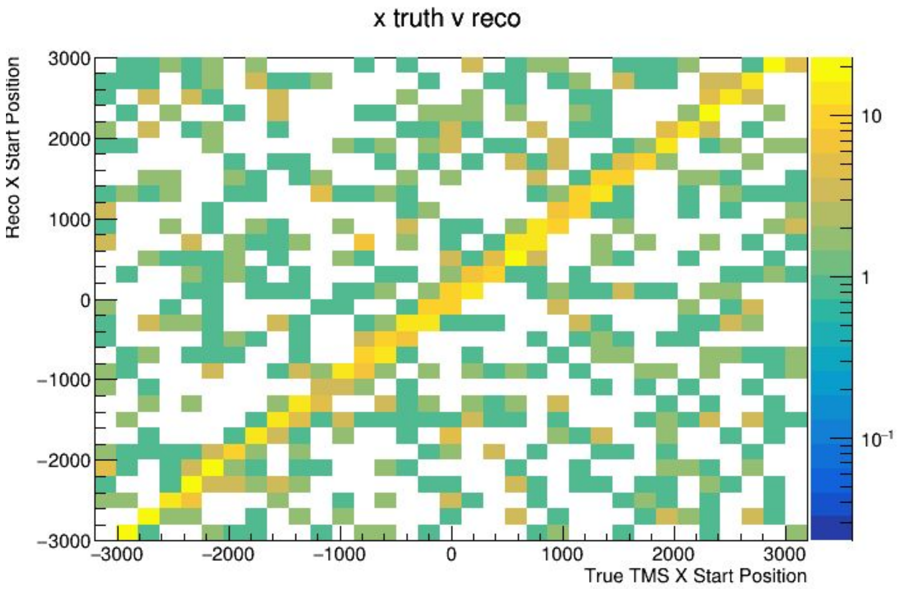


Kalman Filter

Left plot was generated from a file with significantly more events but without the Kalman filter, right plot was generated with Kalman filtered file

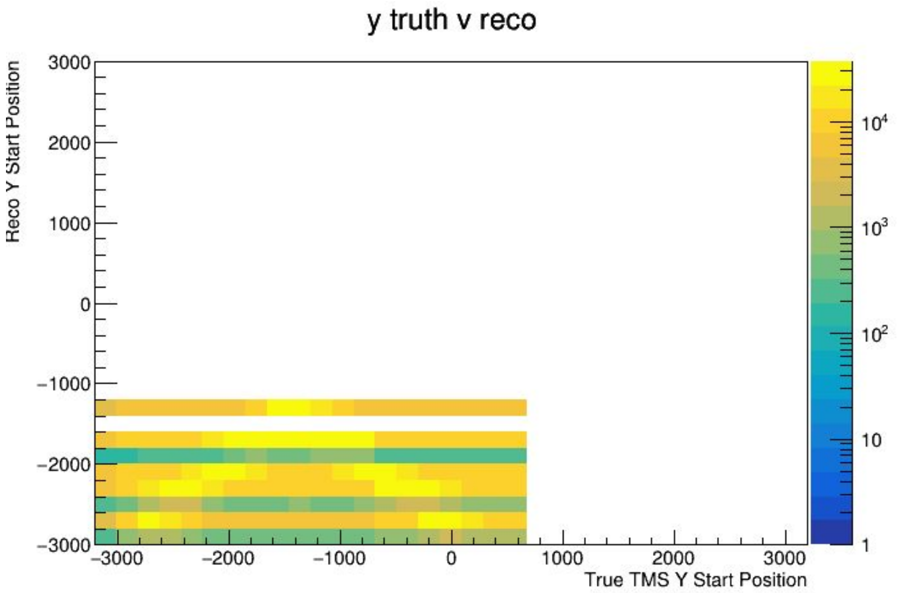
The diagonal relationship is what we want to see, as it shows that our truth and reco are matching up well

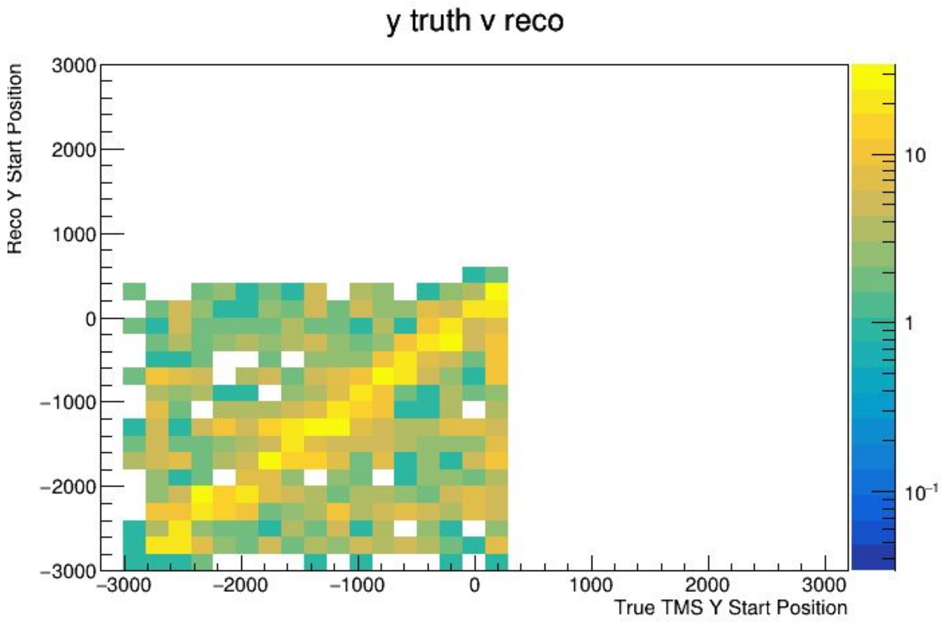




Kalman Filter

Kalman filter gives significantly improved y-resolution
Banding on the left plot (without kalman filter) likely from reco y values being set from bar overlaps in Asa's reco code



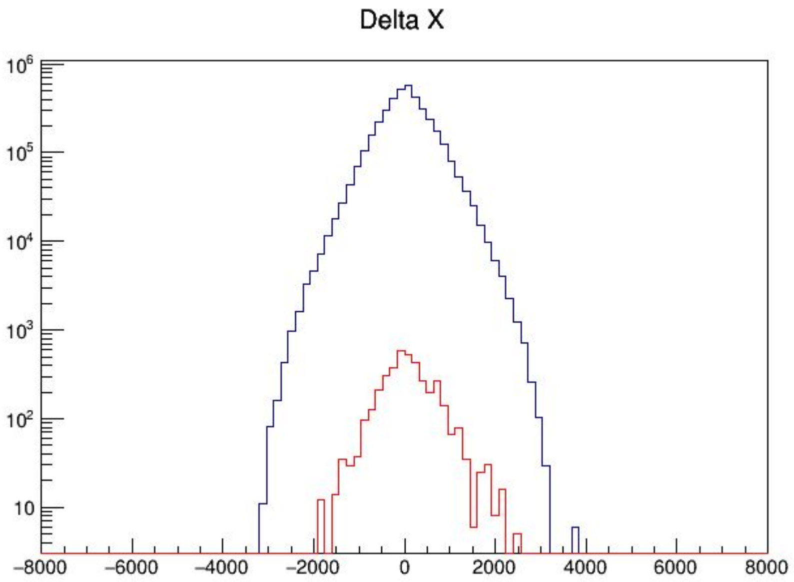


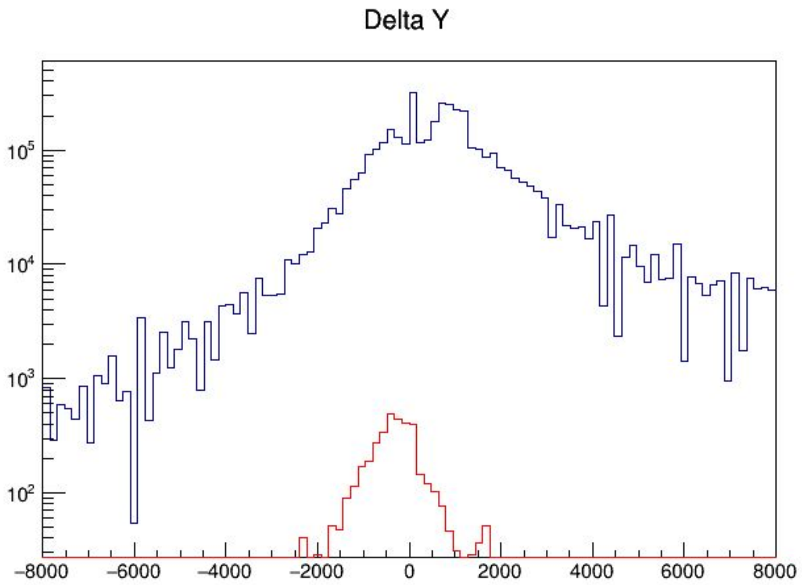
LAr End Position

- We do not have reconstructed data for the LAr exit positions, so I used the reconstructed TMS start position and extrapolated back to find a LAr exit position
  - This is then compared with the true LAr exit position
- The first step of this process was to find the distance between LAr and TMS (Δz)
  - I do not have a geometry file so I did this by finding and plotting the distance between true LAr exit point and TMS start point, and looking for the most common value
- The reconstructed starting direction in TMS was then used, along with the Δz value (defined above) to find the Δx and Δy values (distance from true TMS start position to extrapolated LAr end position)
  - These were then used to find a Δr, which is the absolute distance between the true TMS start position and extrapolated LAr end position
- Δx and Δy were then either added to or subtracted from reconstructed TMS start position, depending on the value of the direction variable, to find the extrapolated LAr exit position

Delta X, Delta Y

Red is Kalman filtered file, blue is non-Kalman file (has significantly more events)
ΔY distribution is significantly wider than Δx, as expected



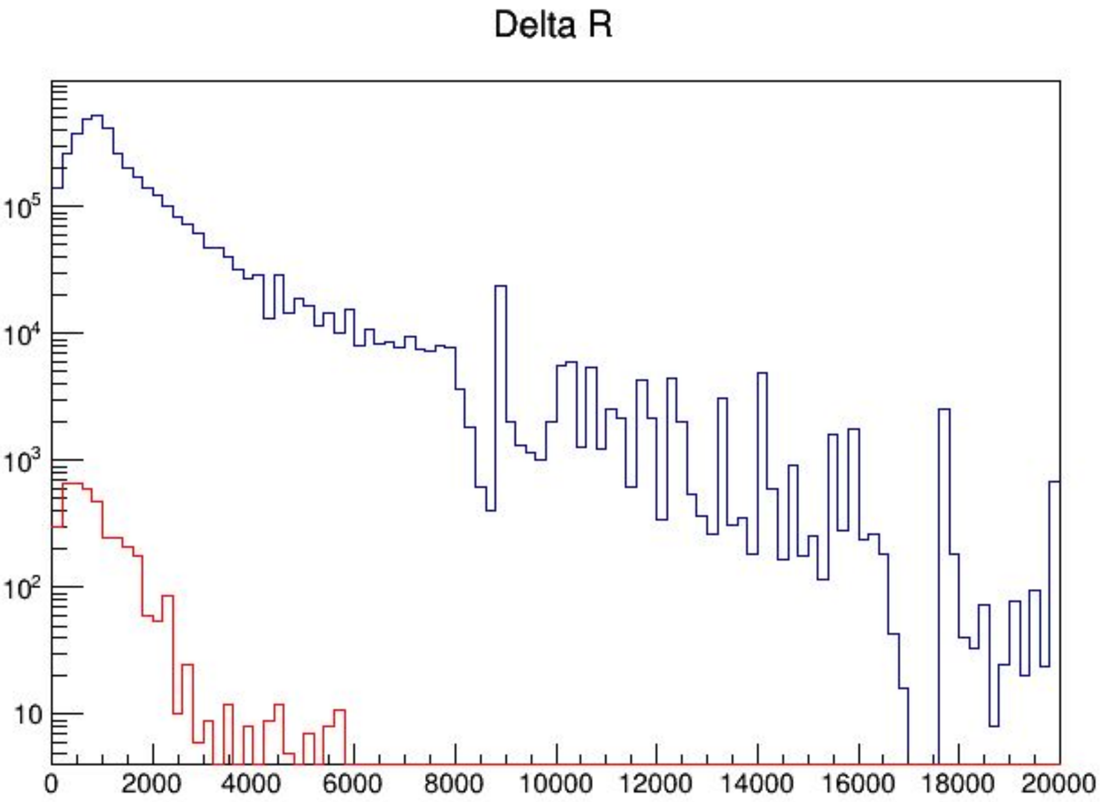


DEEP UNDERGROUND NEUTRINO EXPERIMENT

UNIVERSITY OF MINNESOTA
Driven to Discover℠

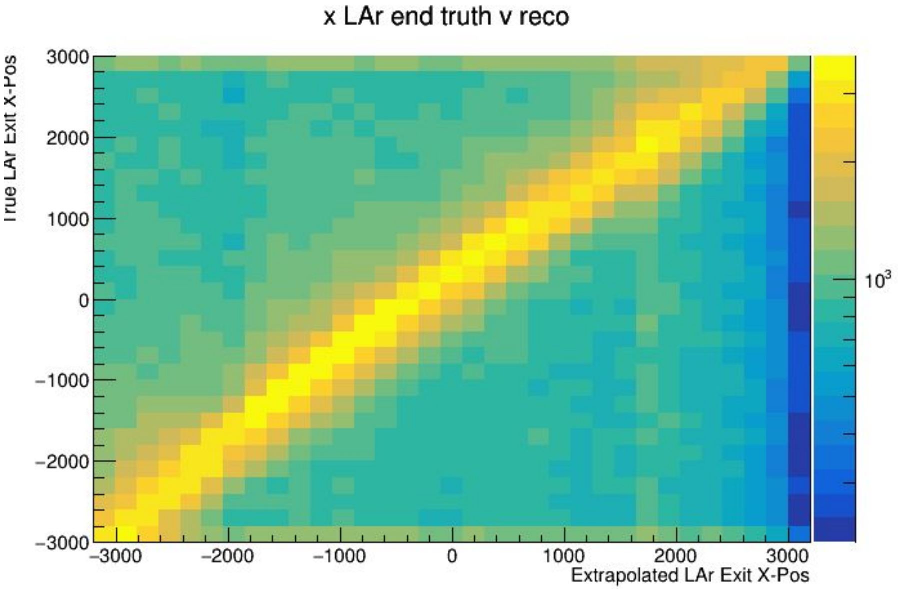
Delta R

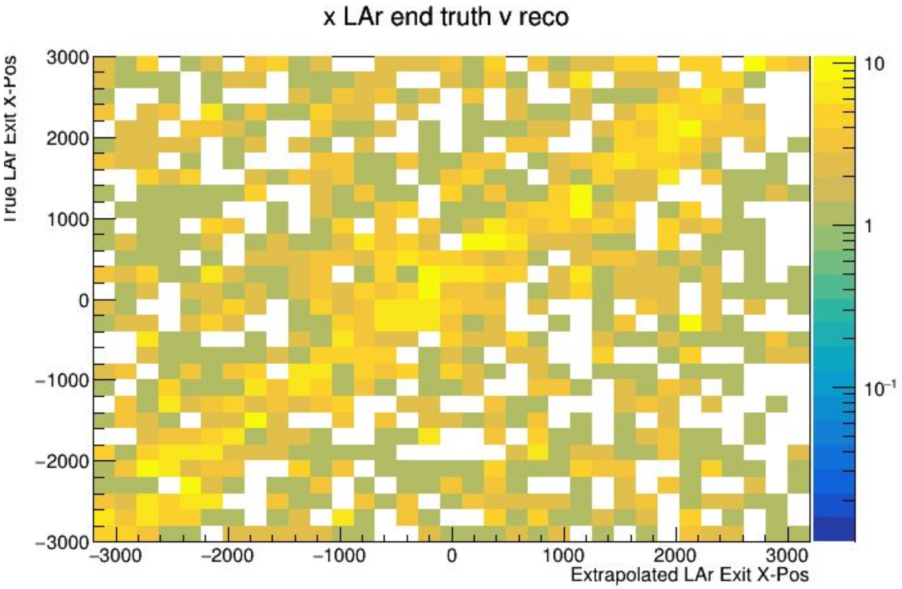
- Shows the "absolute" distance between true and extrapolated LAr exit position
- We see many extrapolated events in the larger (non kalman) file that are >10m away from the true value
  - Looking into this to make sure these aren't being caused by some sort of default value or other quirk of the code



LAr End Position

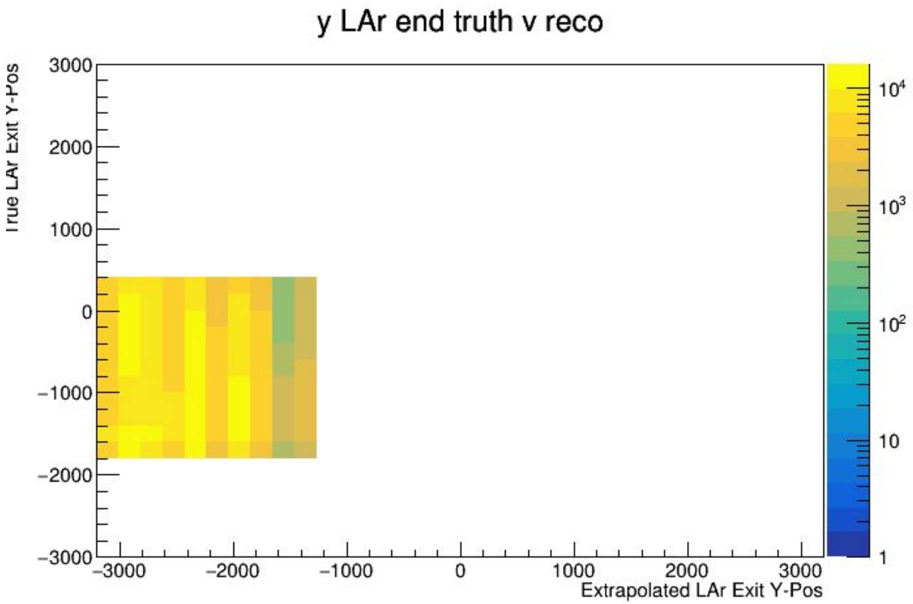
We can vaguely see the same diagonal structure in the Kalman filtered plot on the right, and I believe it is clearer on the left because of the higher statistics

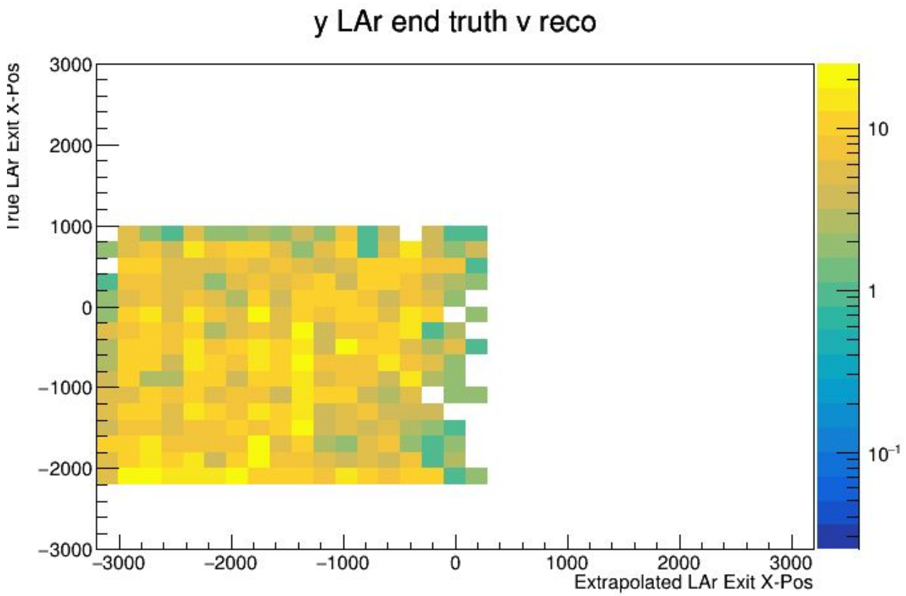




LAr End Position

Neither of these plots look great, but that makes sense when we think back to the wide Δy distributions we saw earlier



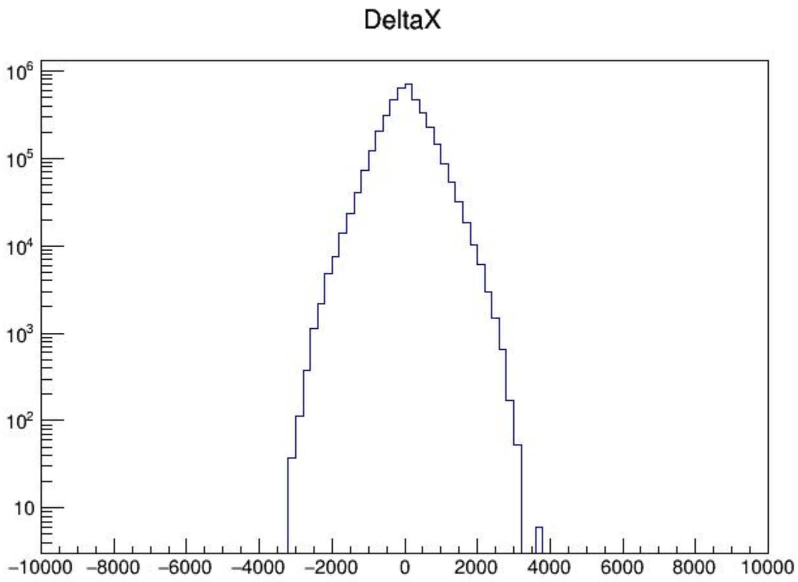


Next Steps

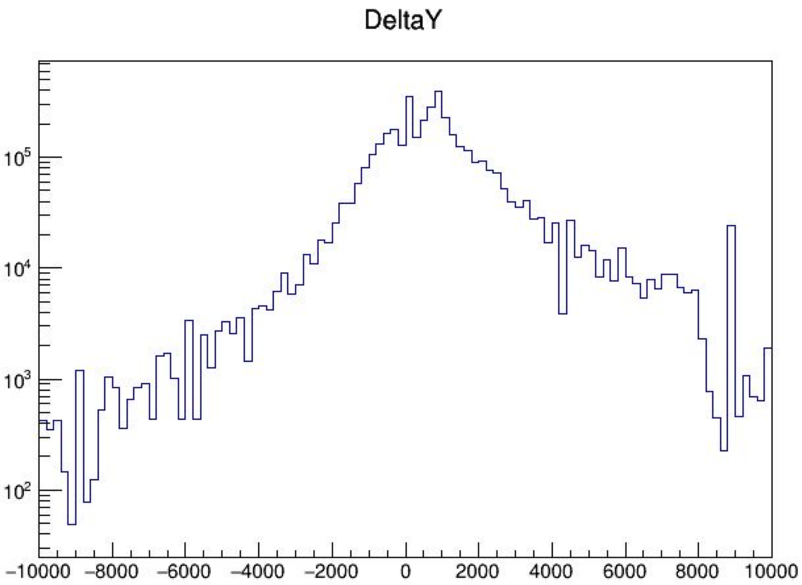
- Looking at reconstructed TMS start positions and directions individually to check for anything outside of expectation
- Plot $\Delta\theta$, the difference between reconstructed and true TMS start directions
- Dig into geometry to find true value of Δz, the LAr -> TMS distance
- I'd eventually like to look at a Kalman filtered file with more events, to be able to run plots with similar statistics to the other file I've been looking at

Backup

Δx, Δy

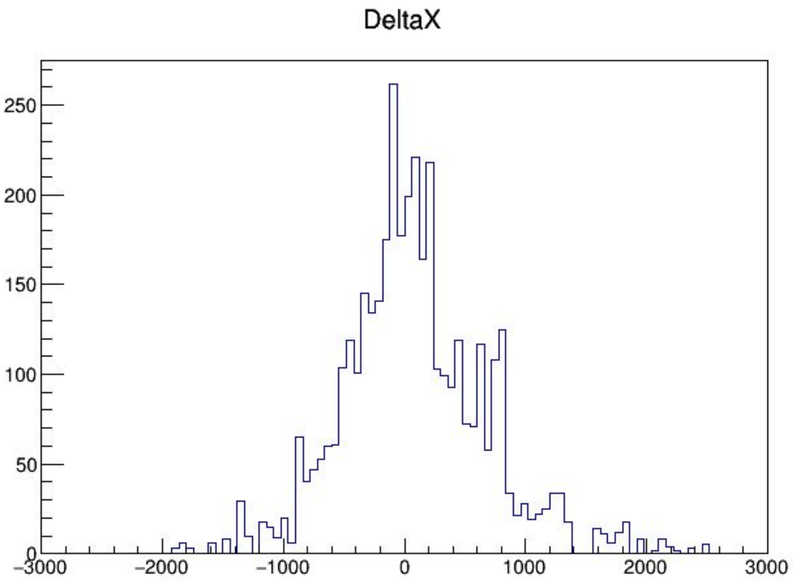


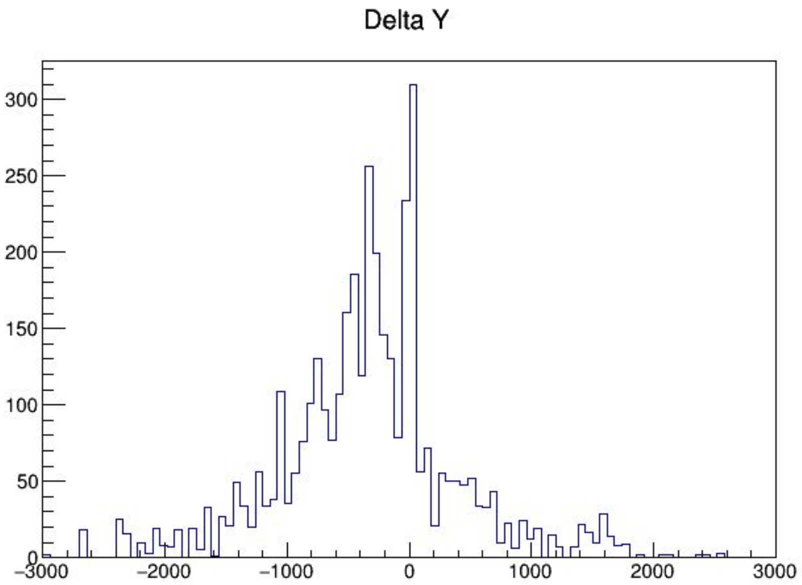
DeltaX
10^6
10^5
10^4
10^3
10^2
10
−10000 −8000 −6000 −4000 −2000 0 2000 4000 6000 8000 10000



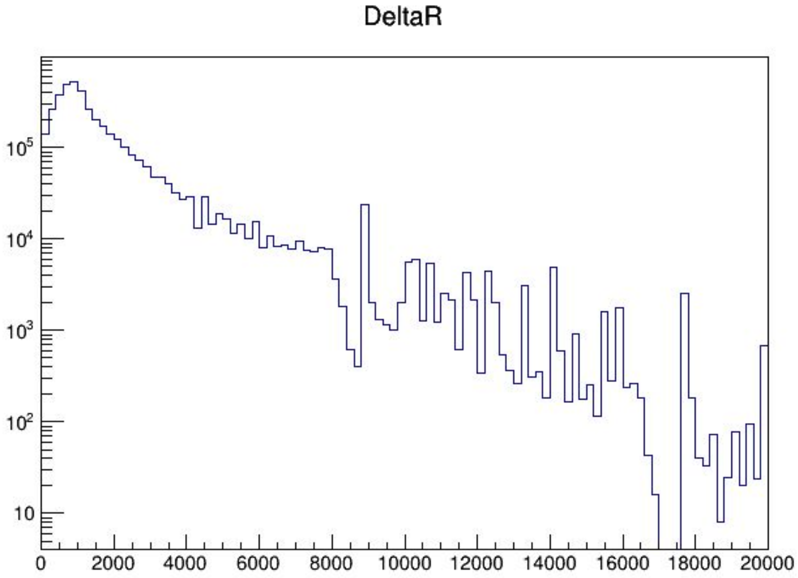
DeltaY
10^5
10^4
10^3
10^2
−10000 −8000 −6000 −4000 −2000 0 2000 4000 6000 8000 10000

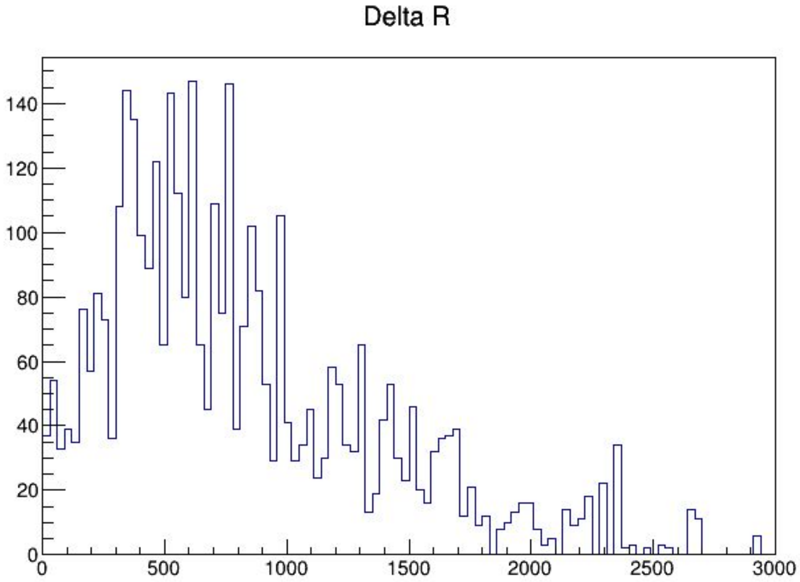
Kalman Δx, Δy


DeltaX
250
200
150
100
50
0
−3000
−2000
−1000
0
1000
2000
3000

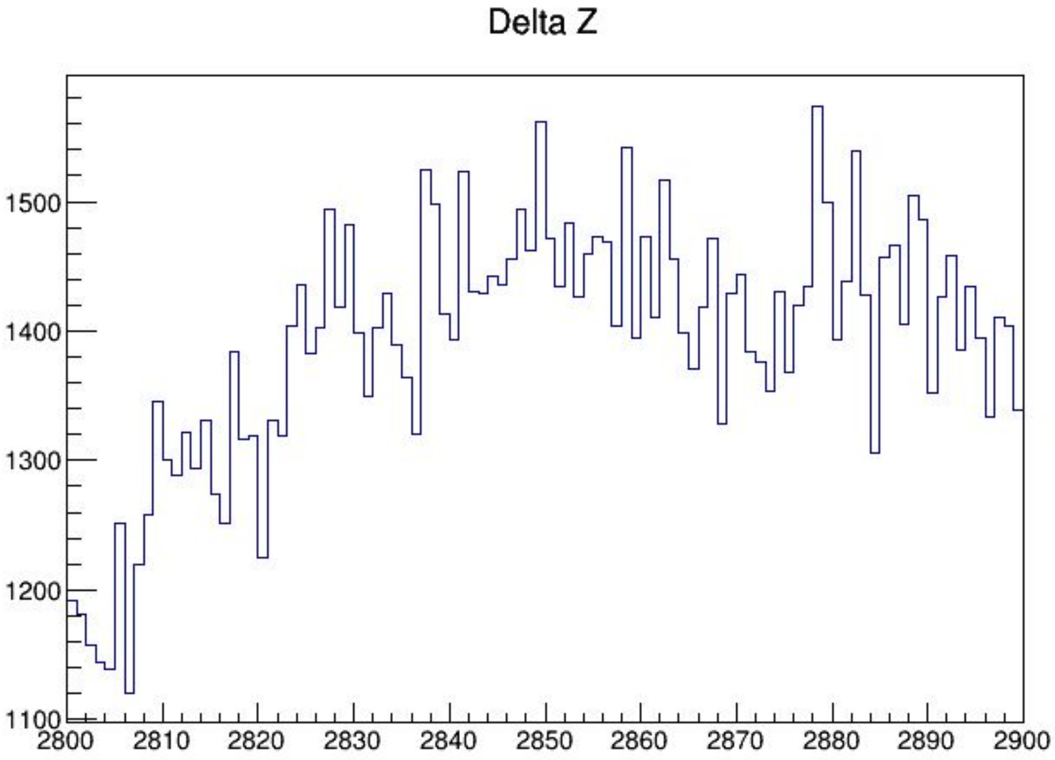

Delta Y
300
250
200
150
100
50
0
−3000
−2000
−1000
0
1000
2000
3000

Δr, Kalman Δr


DeltaR
10^5
10^4
10^3
10^2
10
0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000


Delta R
140
120
100
80
60
40
20
0
0 500 1000 1500 2000 2500 3000

Delta Z


Delta Z
1500
1400
1300
1200
1100
2800
2810
2820
2830
2840
2850
2860
2870
2880
2890
2900

LAr End Momentum and TMS Start Momentum