ECal & Track X Position Disagreement Update 2

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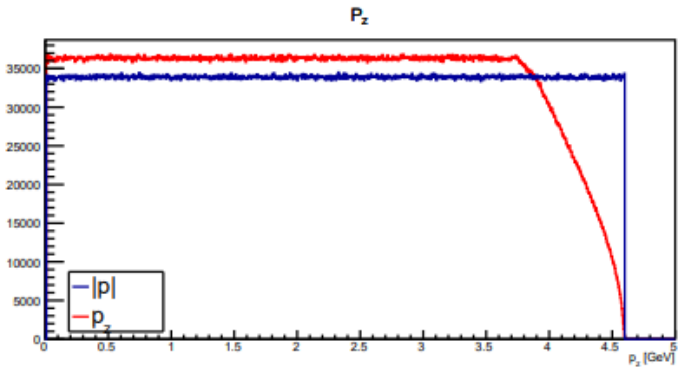
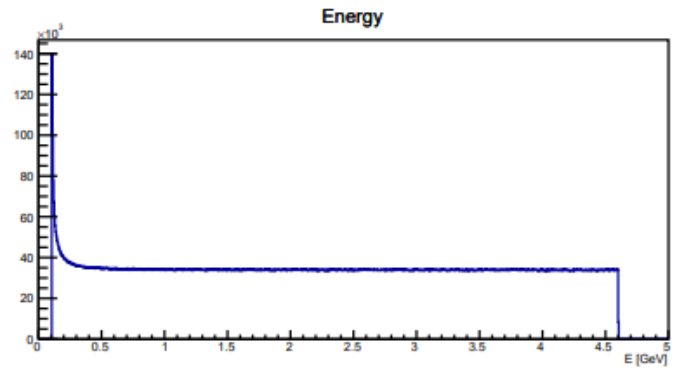
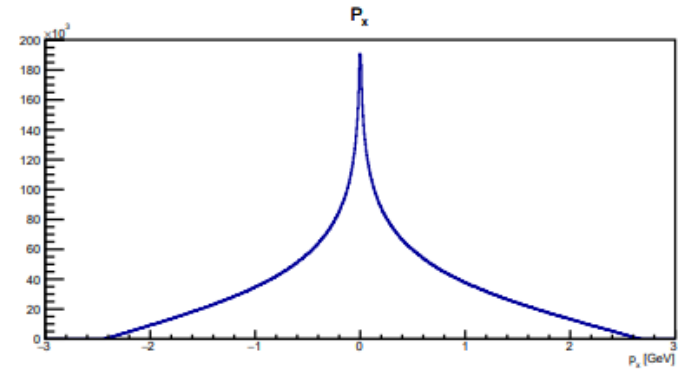
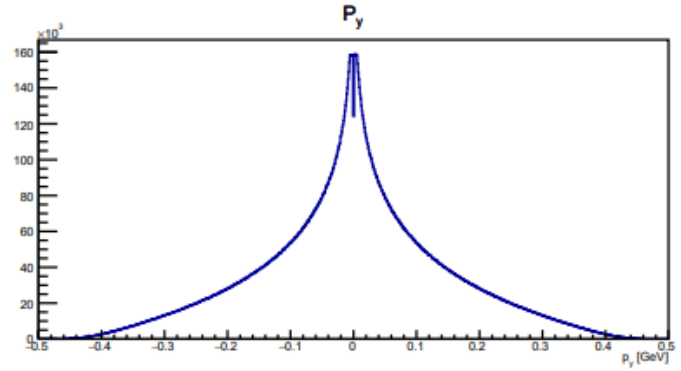
3/19/24

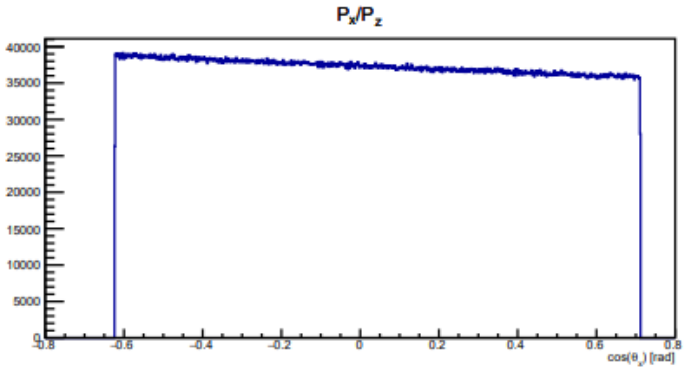
MC Distributions

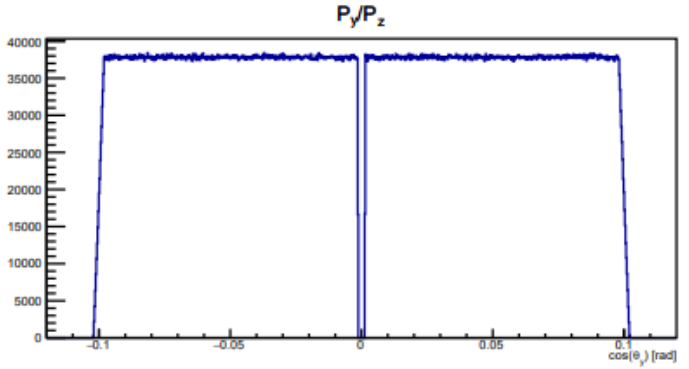


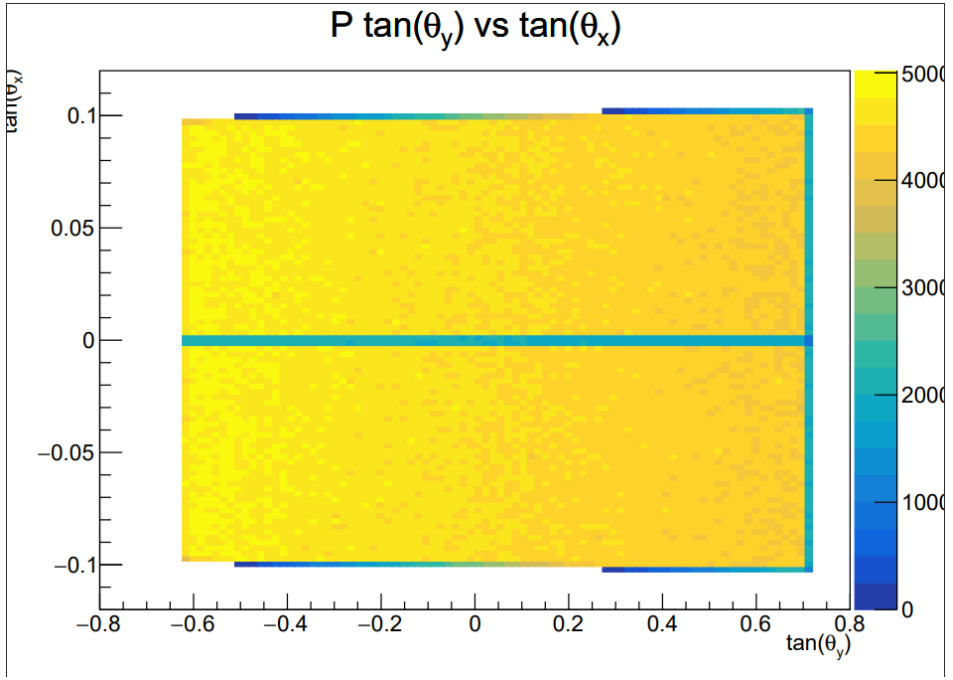


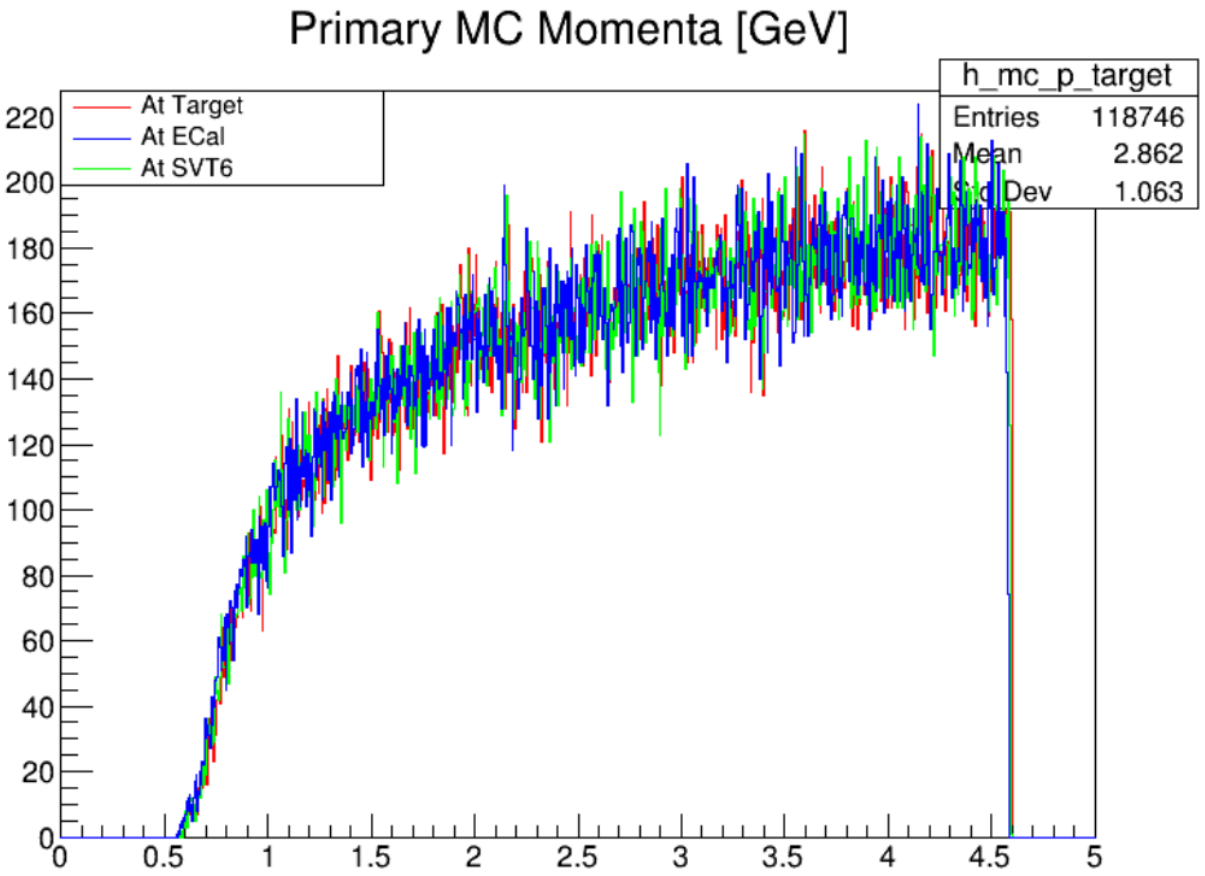


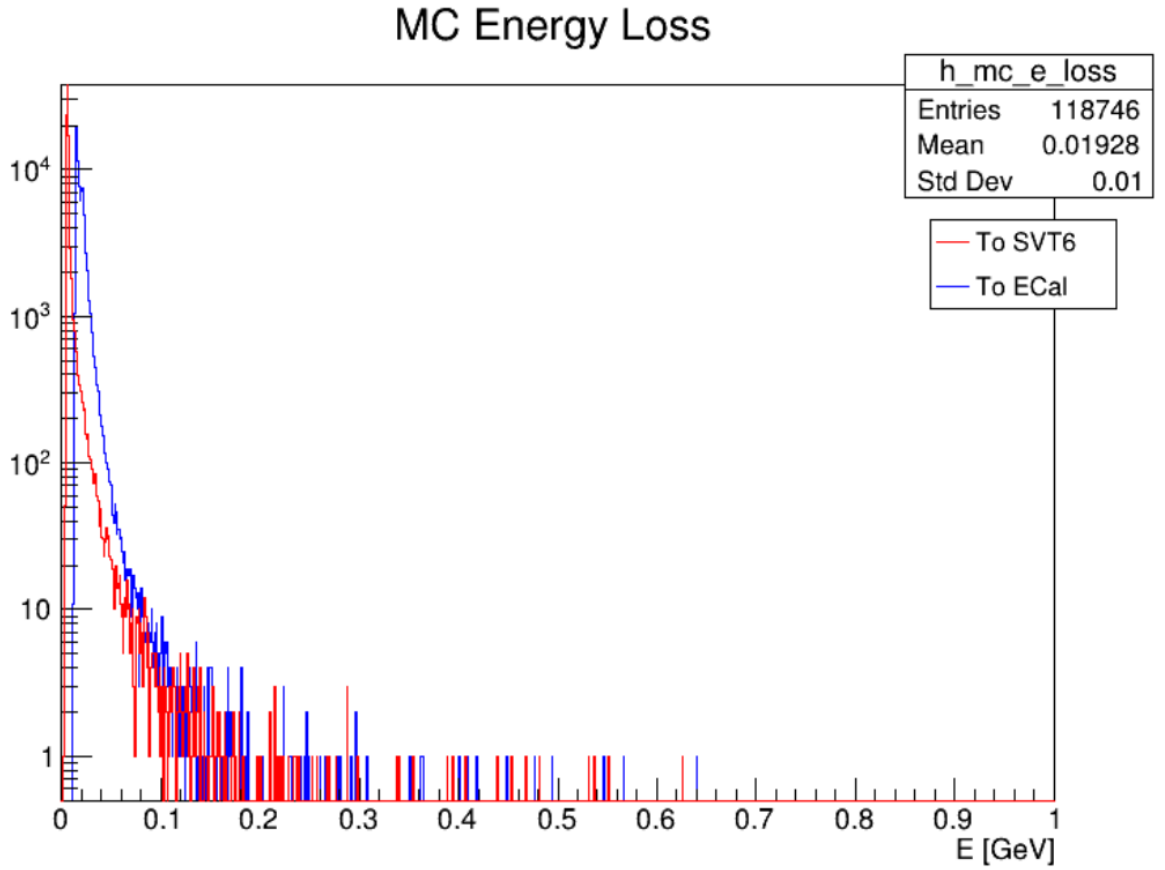




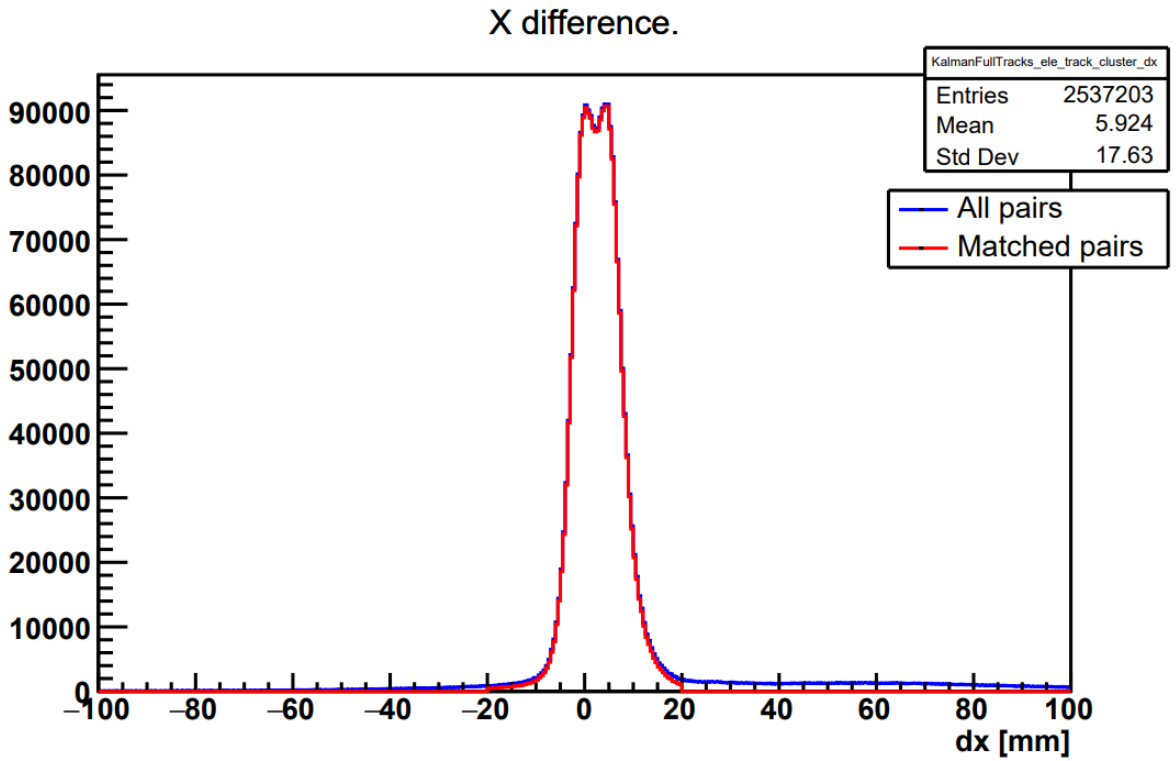


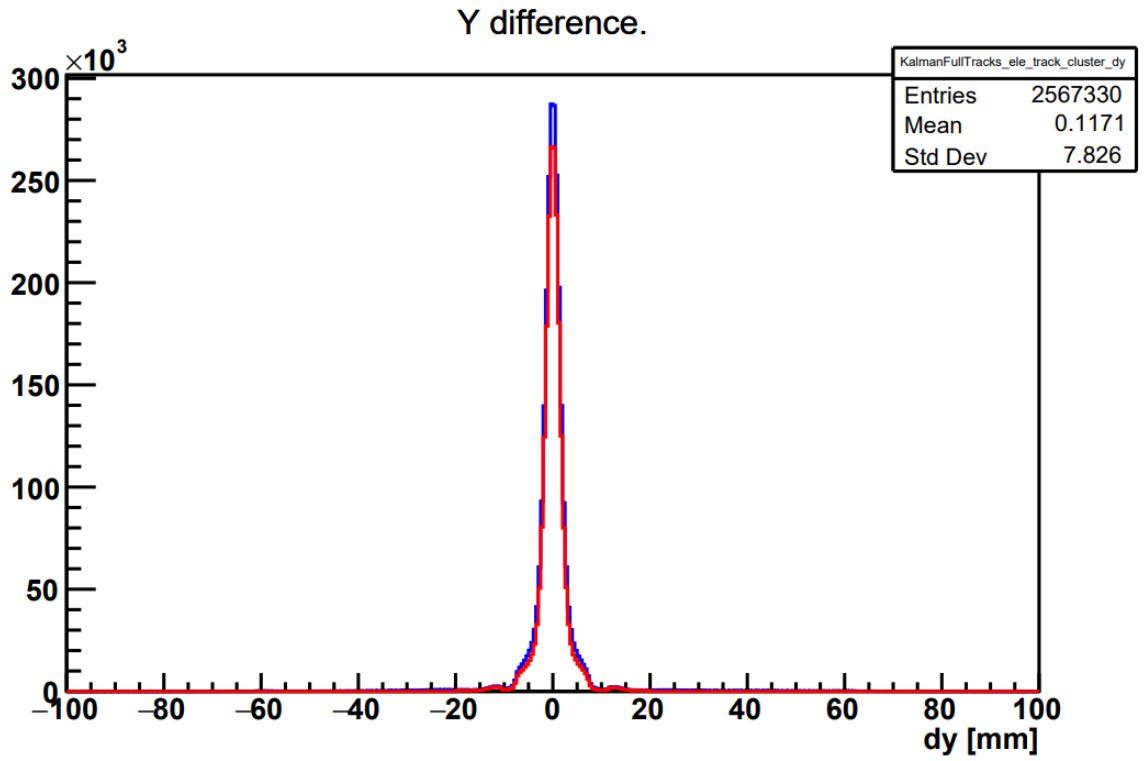



Primary MC Momenta [GeV]
h_mc_p_target
Entries 118746
Mean 2.862
Std Dev 1.063
At Target
At ECal
At SVT6
0 20 40 60 80 100 120 140 160 180 200 220
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5

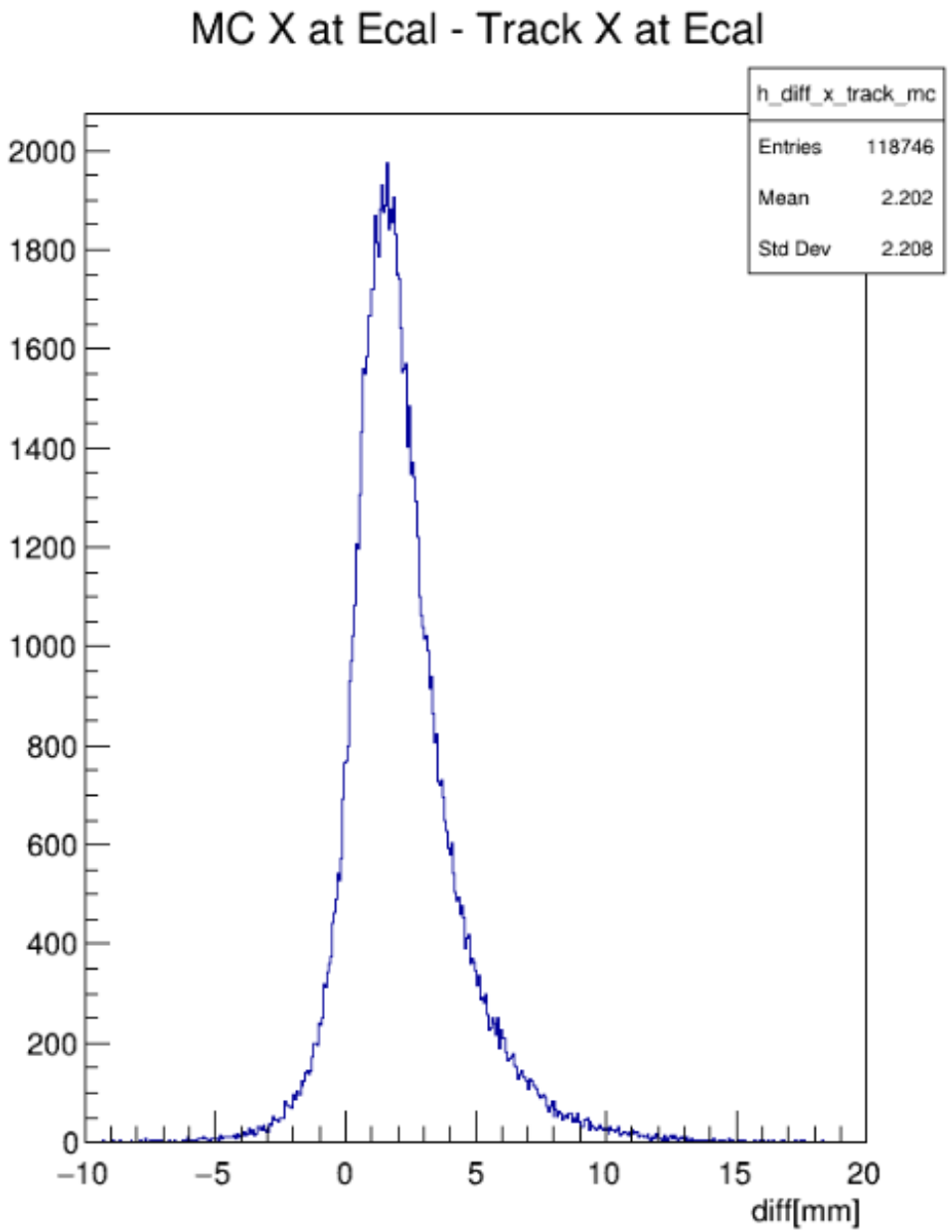

MC Energy Loss
h_mc_e_loss
Entries 118746
Mean 0.01928
Std Dev 0.01
To SVT6
To ECal
10^4
10^3
10^2
10
1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
E [GeV]

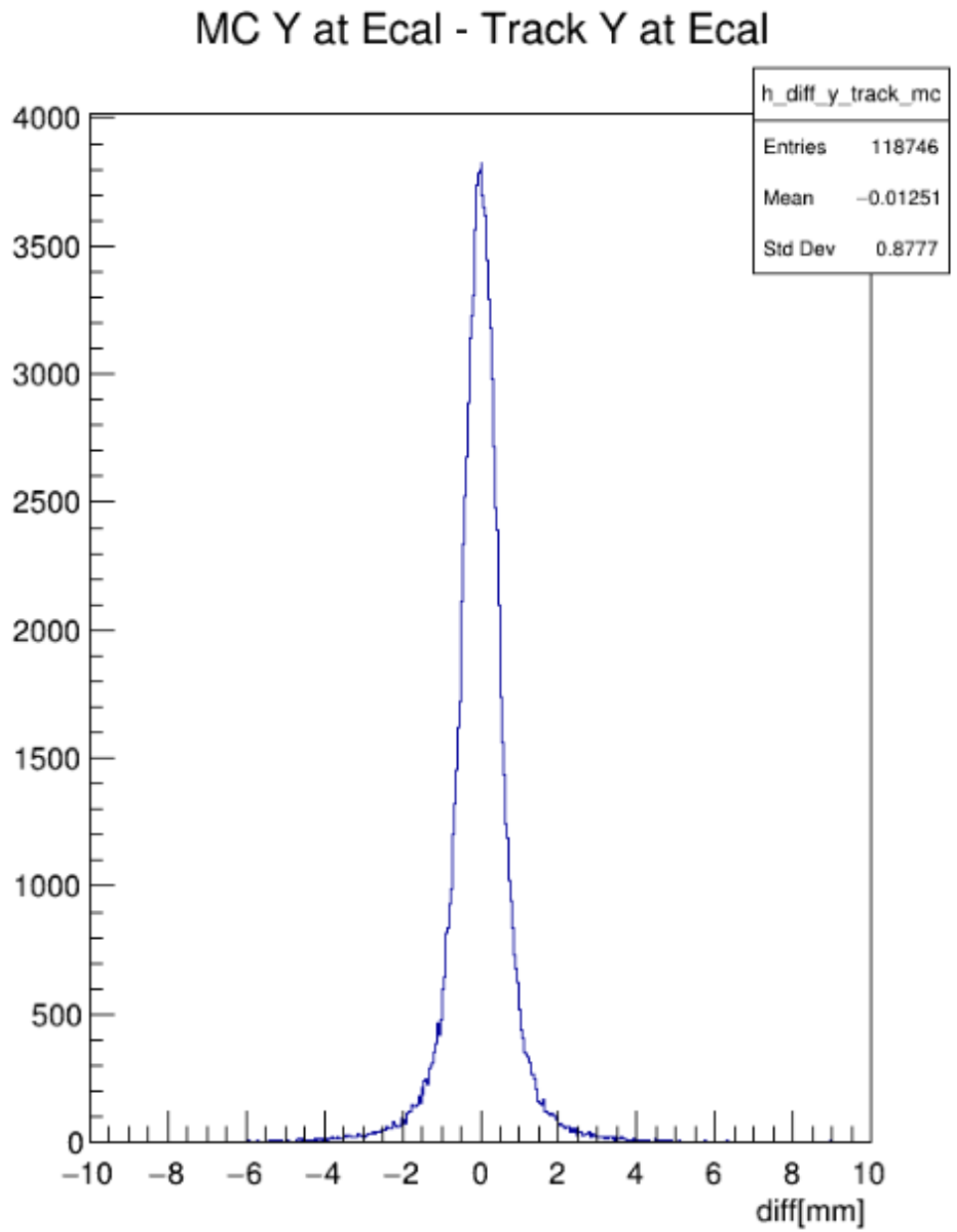
HPS Java histograms of the discrepancy

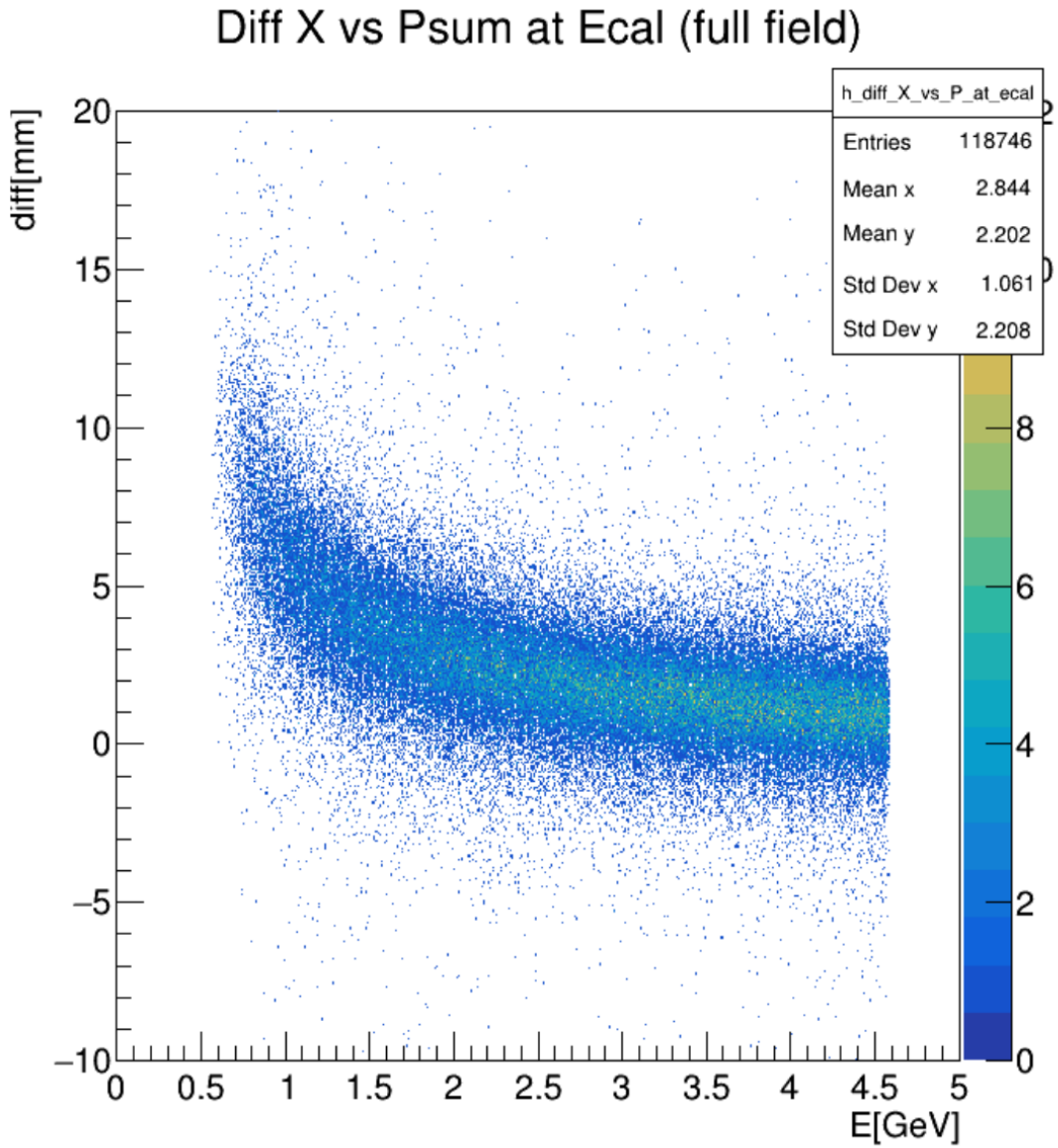


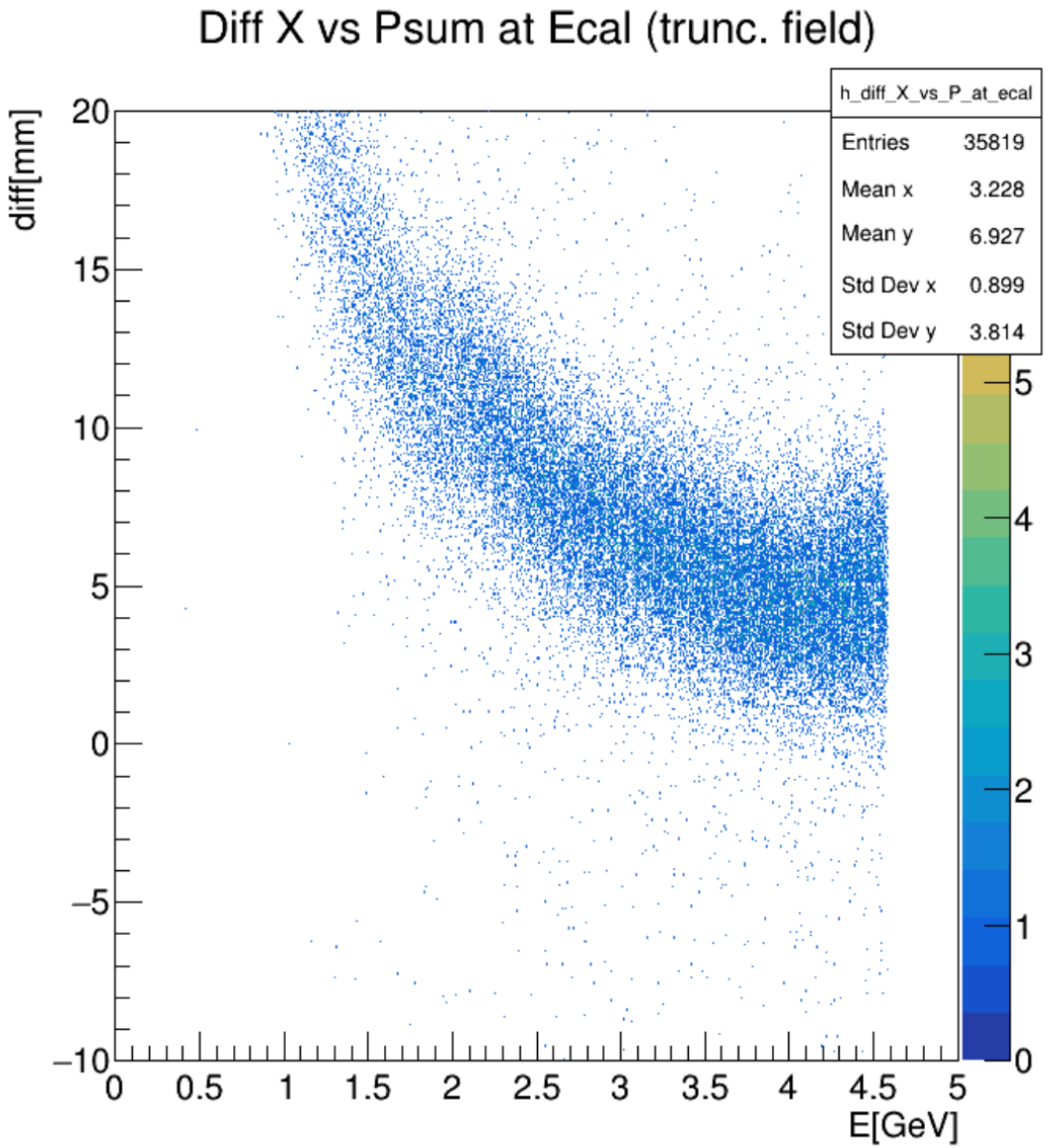


- This is made in trackClusterMatcherMinDistance.java. Previously this was not observed because there was an equal amount of positive/negatively charged tracks that broadens the peak in X.
  - This was pointed out by Alic in a presentation from March 2021

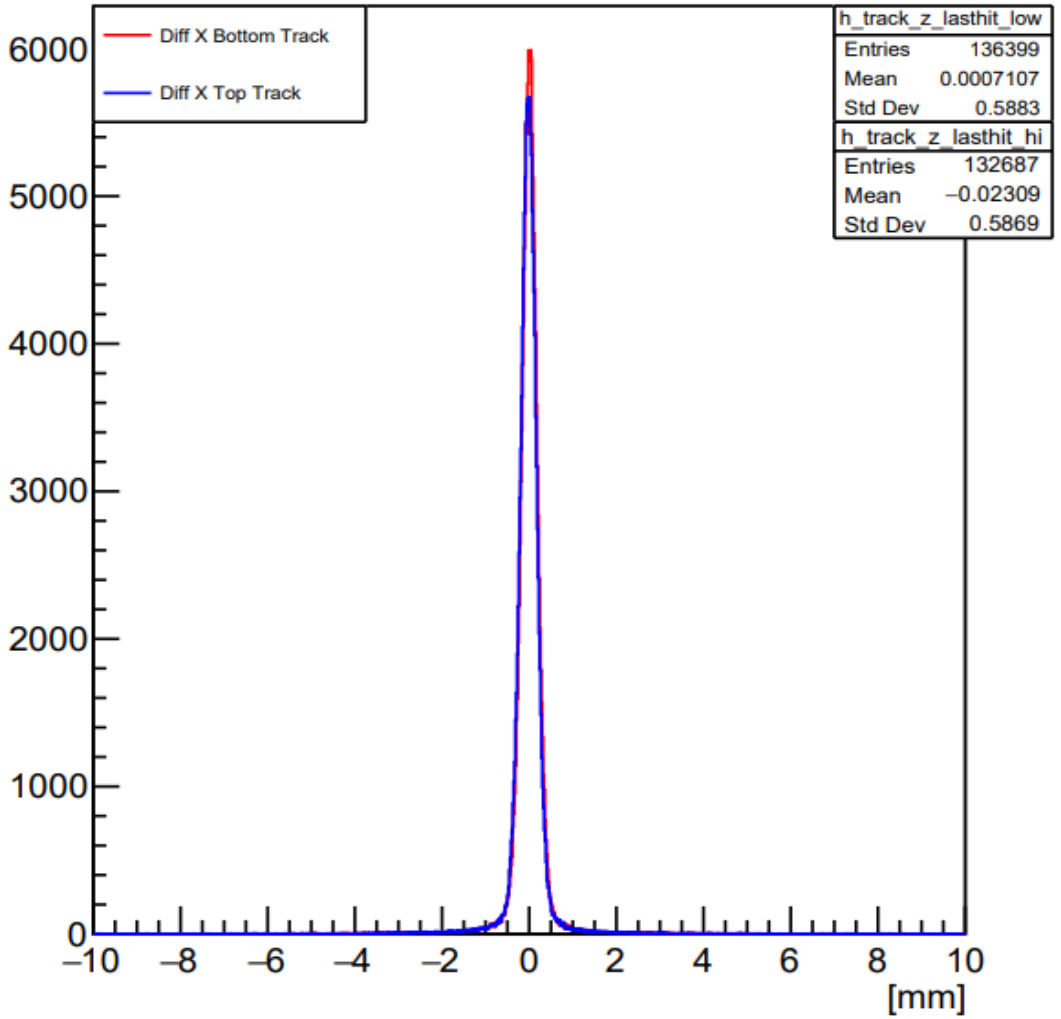

MC X at Ecal - Track X at Ecal
h_diff_x_track_mc
Entries 118746
Mean 2.202
Std Dev 2.208
2000
1800
1600
1400
1200
1000
800
600
400
200
0
−10
−5
0
5
10
15
20
diff[mm]


MC Y at Ecal - Track Y at Ecal
h_diff_y_track_mc
Entries 118746
Mean −0.01251
Std Dev 0.8777
4000
3500
3000
2500
2000
1500
1000
500
0
−10
−8
−6
−4
−2
0
2
4
6
8
10
diff[mm]

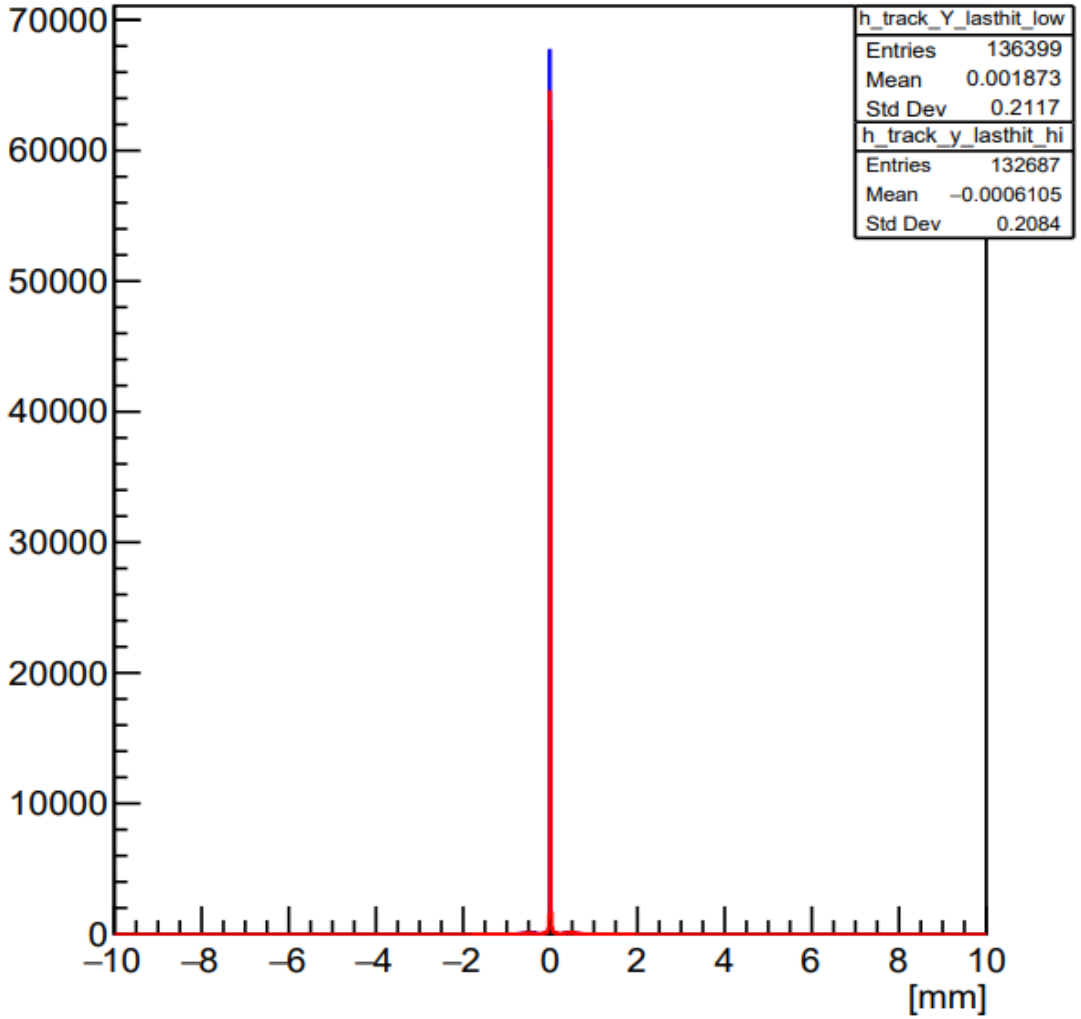

Diff X vs Psum at Ecal (full field)
h_diff_X_vs_P_at_ecal
Entries 118746
Mean x 2.844
Mean y 2.202
Std Dev x 1.061
Std Dev y 2.208
diff[mm]
E[GeV]


Diff X vs Psum at Ecal (trunc. field)
h_diff_X_vs_P_at_ecal
Entries 35819
Mean x 3.228
Mean y 6.927
Std Dev x 0.899
Std Dev y 3.814
diff[mm]
E[GeV]

Diff X: Track X at lasthit - MC Score X at lasthit

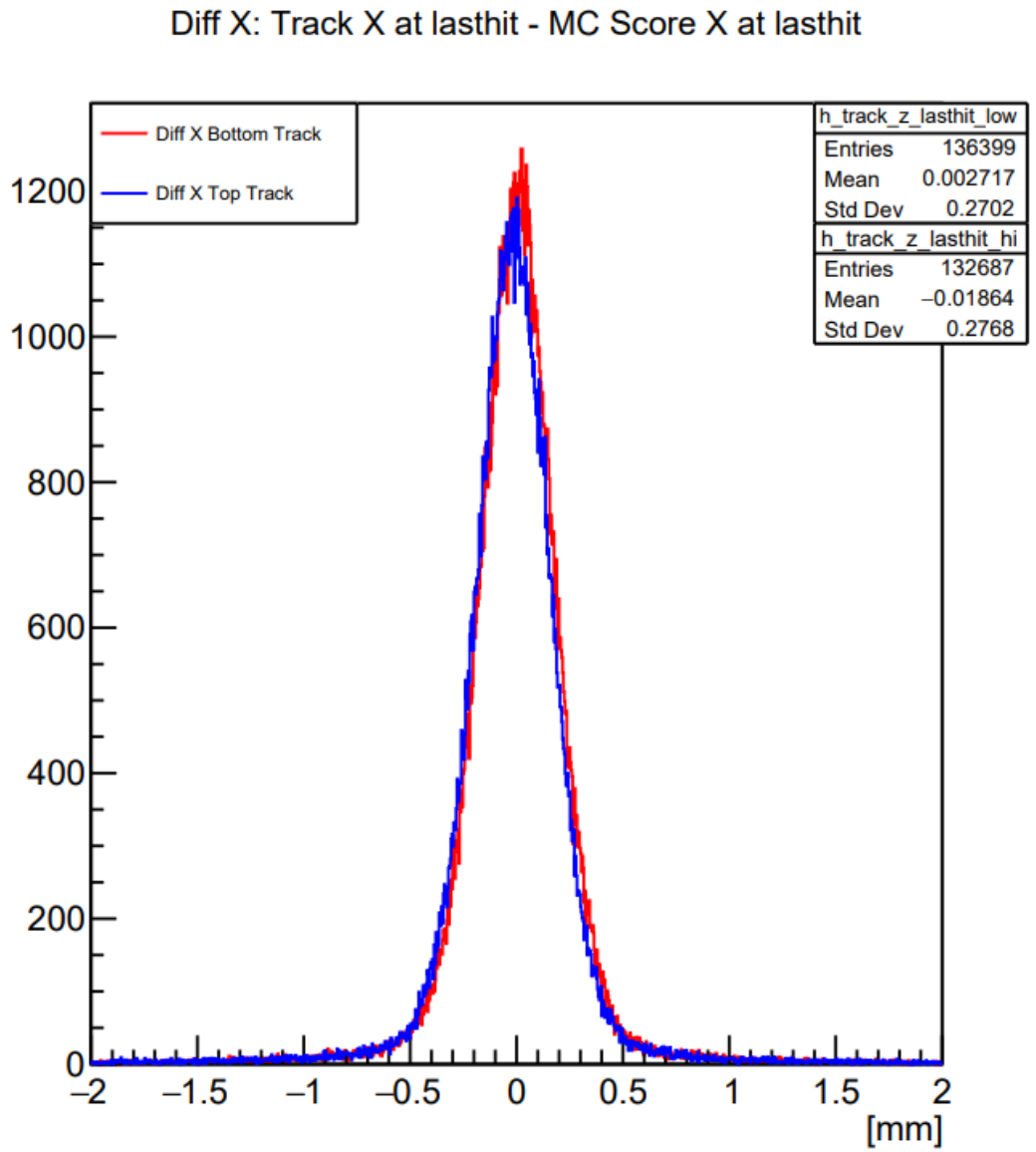


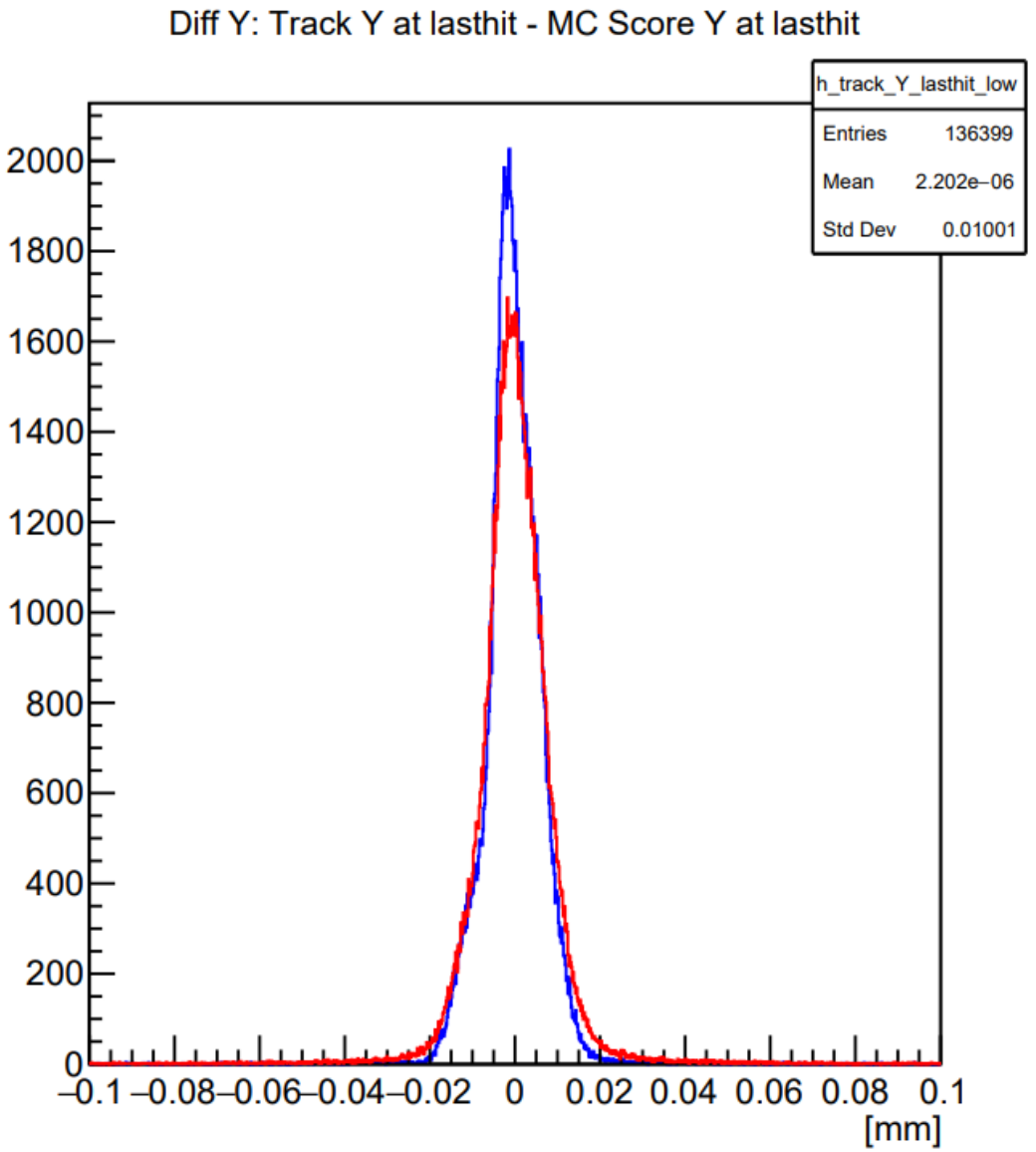
Diff Y: Track Y at lasthit - MC Score Y at lasthit



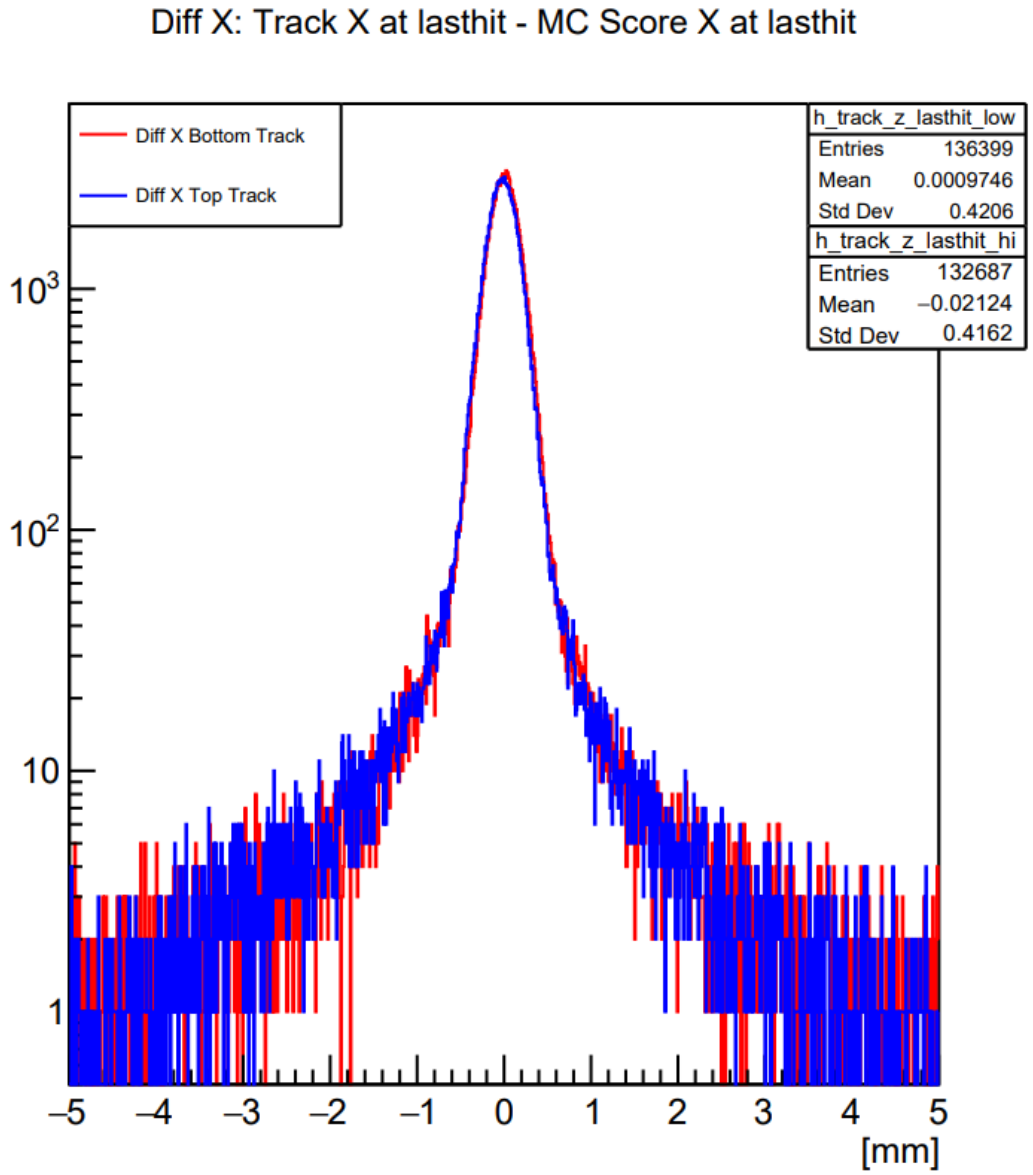
- Cut on only 1 MC particle in the lasthit scoring plane and on only 1 track_x_at_lasthit to compare a single MC muon that went through the scoring plane with a single track

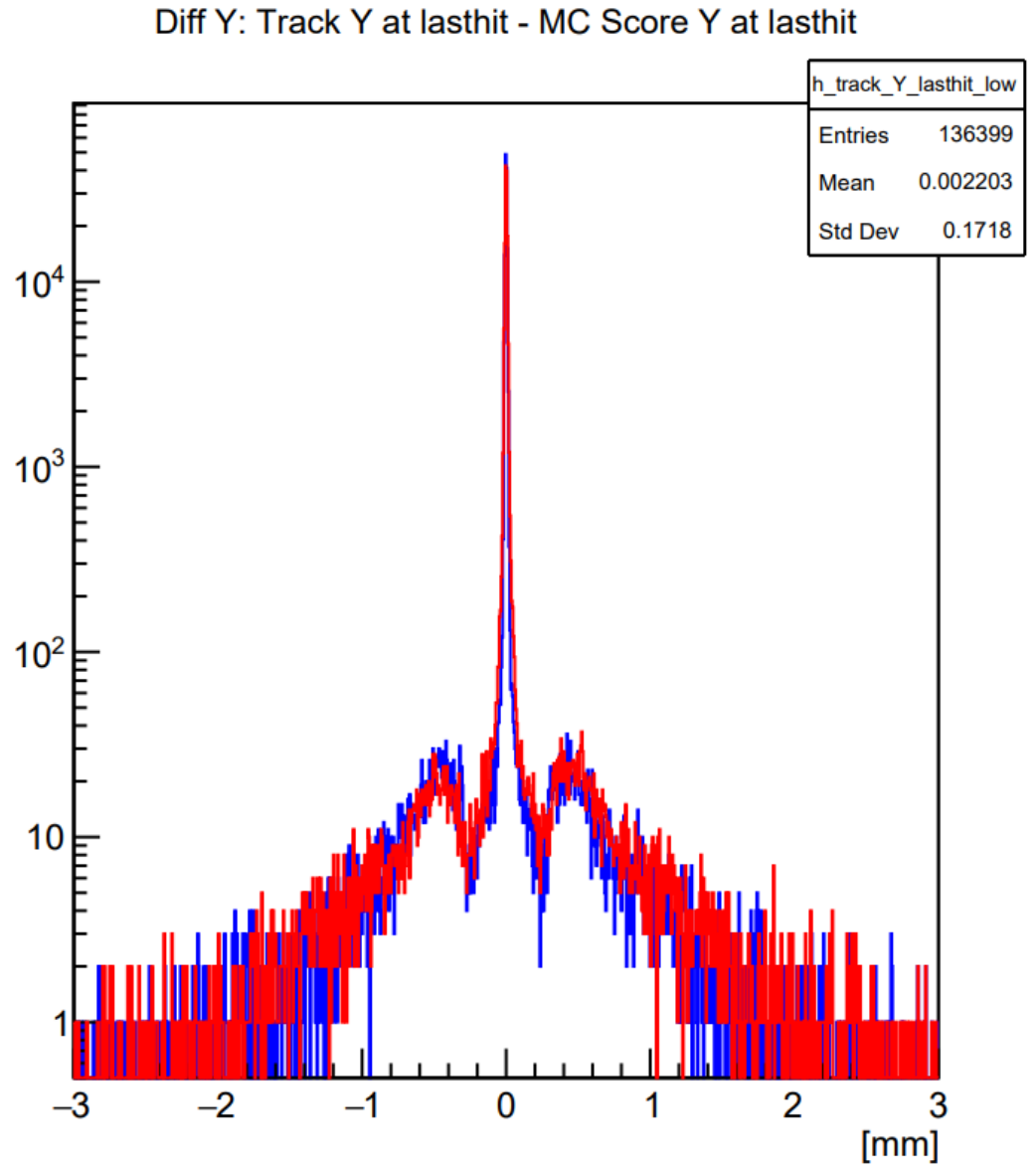
Same plots, just zoomed in





Same plots but with log scale on y axis





Previous presentation slides start here

Motivation

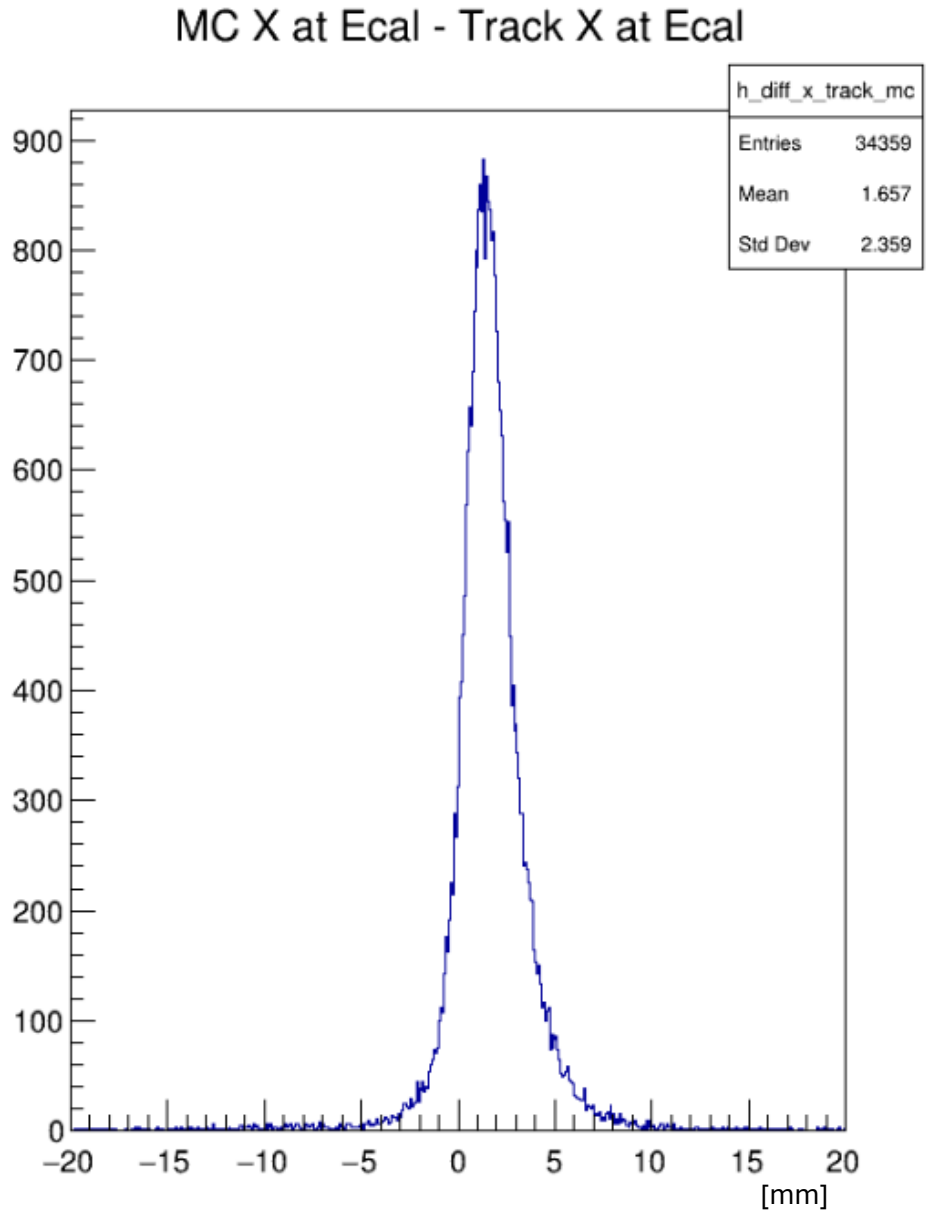
- Discrepancies between Ecal X and track X(at ecal) positions have been noticed for some time
  - Note that Y does not seem to have this issue

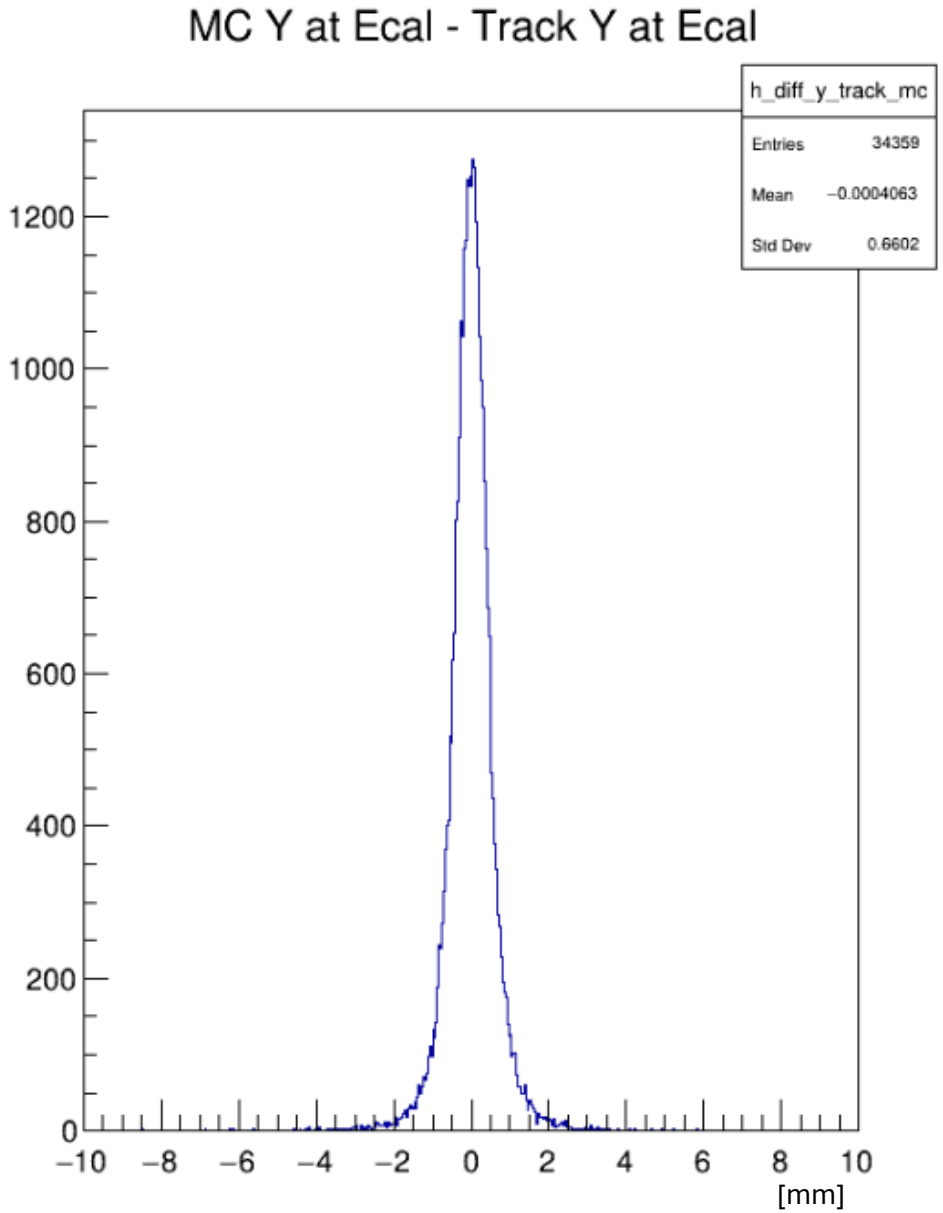
- Maurik and I looked at this discrepancy with MC muons to first see if momentum loss of the particle was the source of this discrepancy

Data Efficiency and cut flow

```
Select only 1 Primary MC particle: pass=251224     all=251509     -- eff=99.89 % cumulative eff=99.89 %
Select only 1 KF track.: pass=95638      all=251224     -- eff=38.07 % cumulative eff=38.03 %
Select only 1 Primary MC particle at ECal: pass=82800      all=95638      -- eff=86.58 % cumulative eff=32.92 %
Select only 1 Primary MC particle at SVT6: pass=35381      all=82800      -- eff=42.73 % cumulative eff=14.07 %
Select only 1 ECal cluster: pass=34359      all=35381      -- eff=97.11 % cumulative eff=13.66 %
```

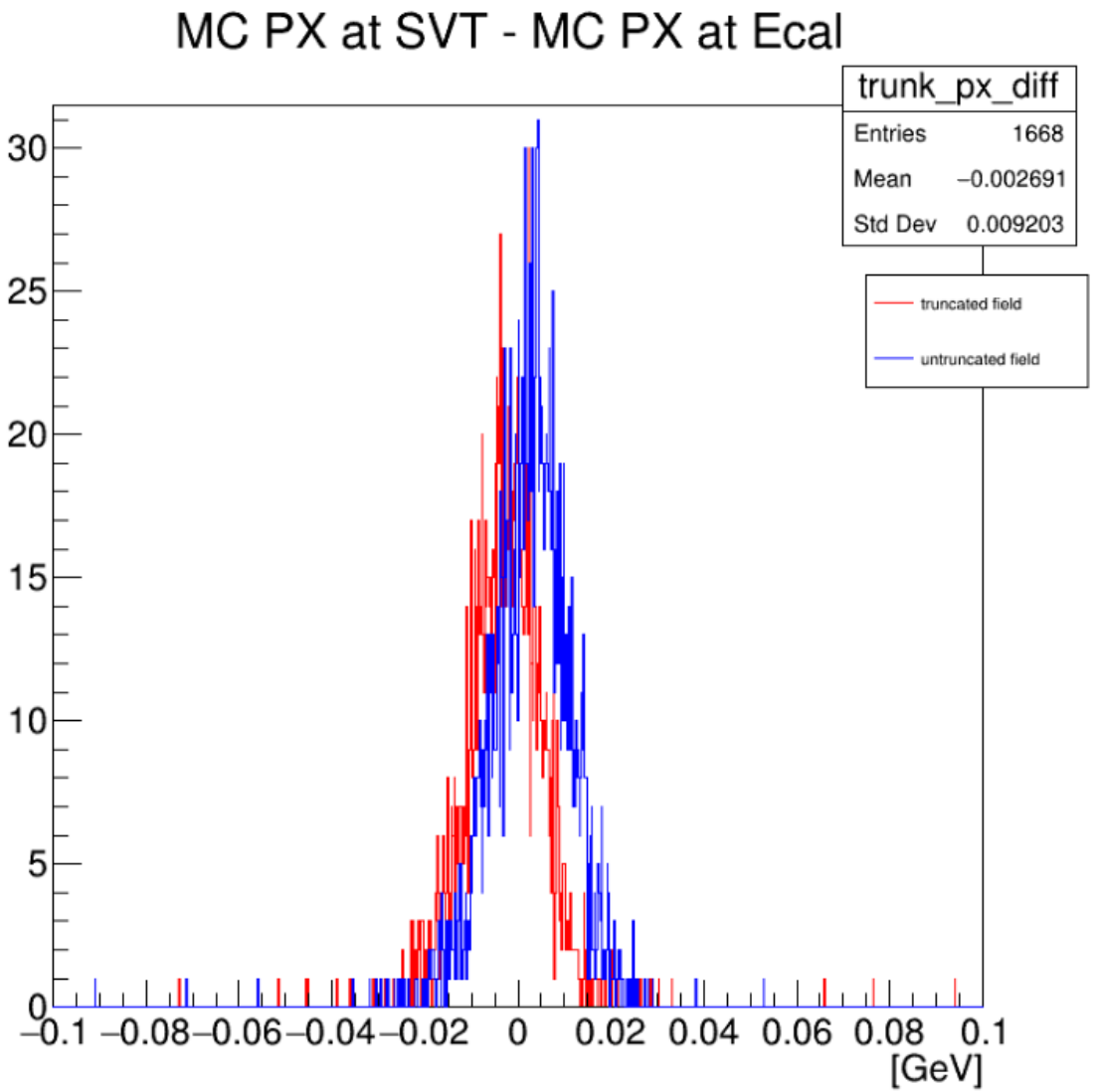
- We want to be sure that a single muon went through the detector and made it to the ecal, so we perform a series of cuts to ensure this

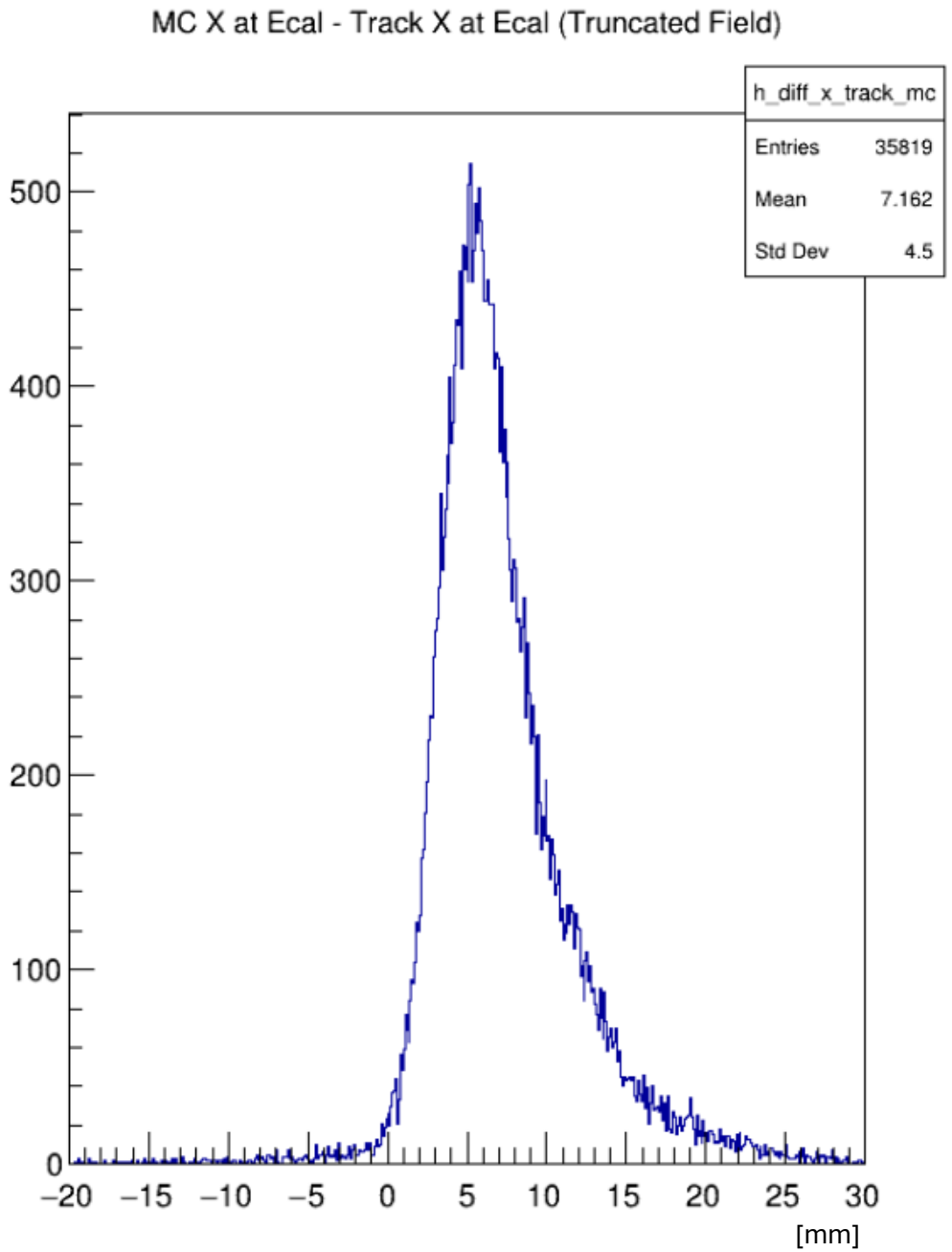

MC X at Ecal - Track X at Ecal
h_diff_x_track_mc
Entries 34359
Mean 1.657
Std Dev 2.359
900
800
700
600
500
400
300
200
100
0
−20 −15 −10 −5 0 5 10 15 20
[mm]

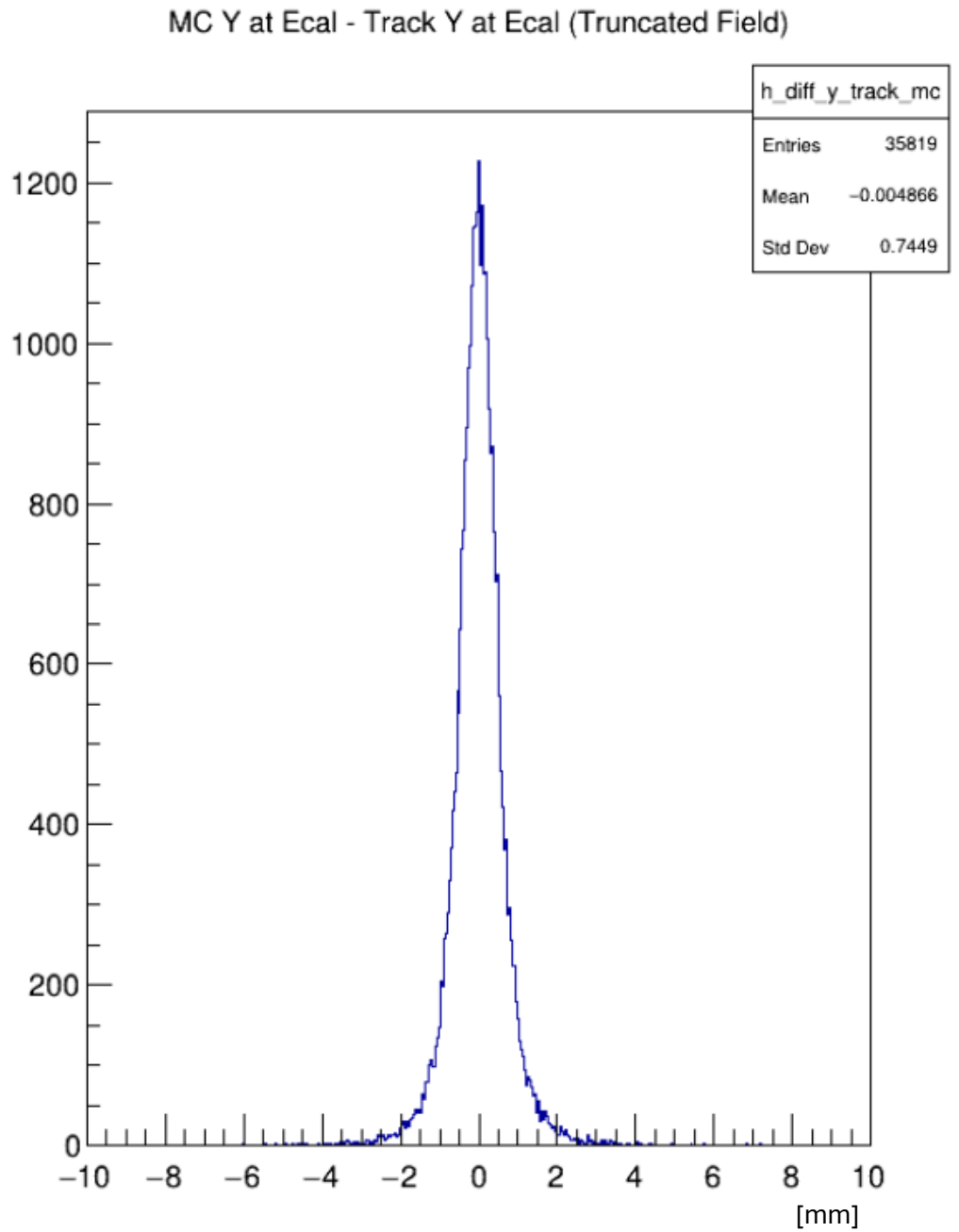

MC Y at Ecal - Track Y at Ecal
h_diff_y_track_mc
Entries 34359
Mean −0.0004063
Std Dev 0.6602
1200
1000
800
600
400
200
0
−10 −8 −6 −4 −2 0 2 4 6 8 10
[mm]

Truncated B field at SVT Layer 6

- Perhaps the discrepancy has something to do with the extrapolation algorithm from the last SVT layer to the Ecal?
- Made an identical MC sample except with a nonphysical B field that abruptly stops at SVT layer 6 to investigate

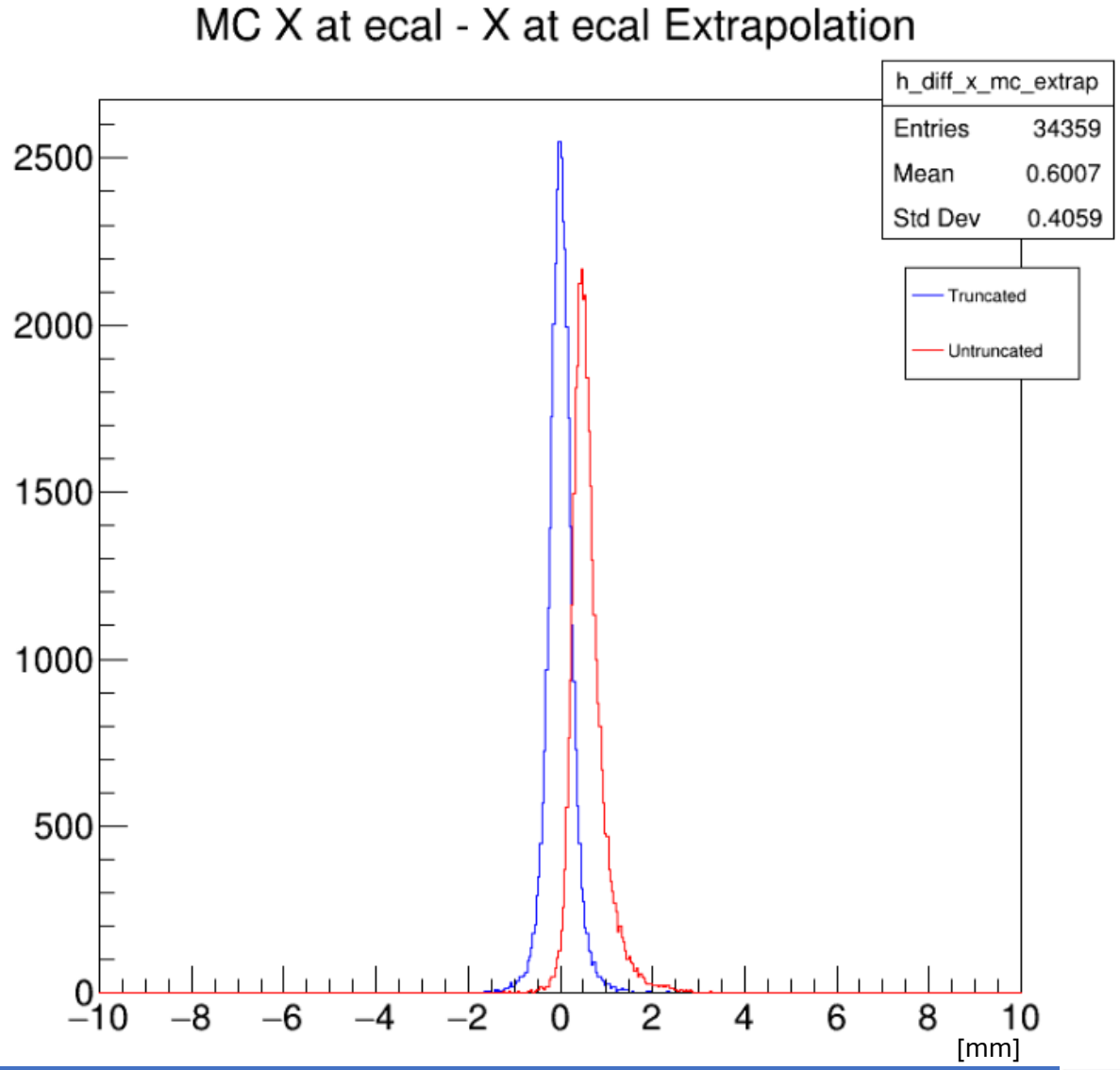


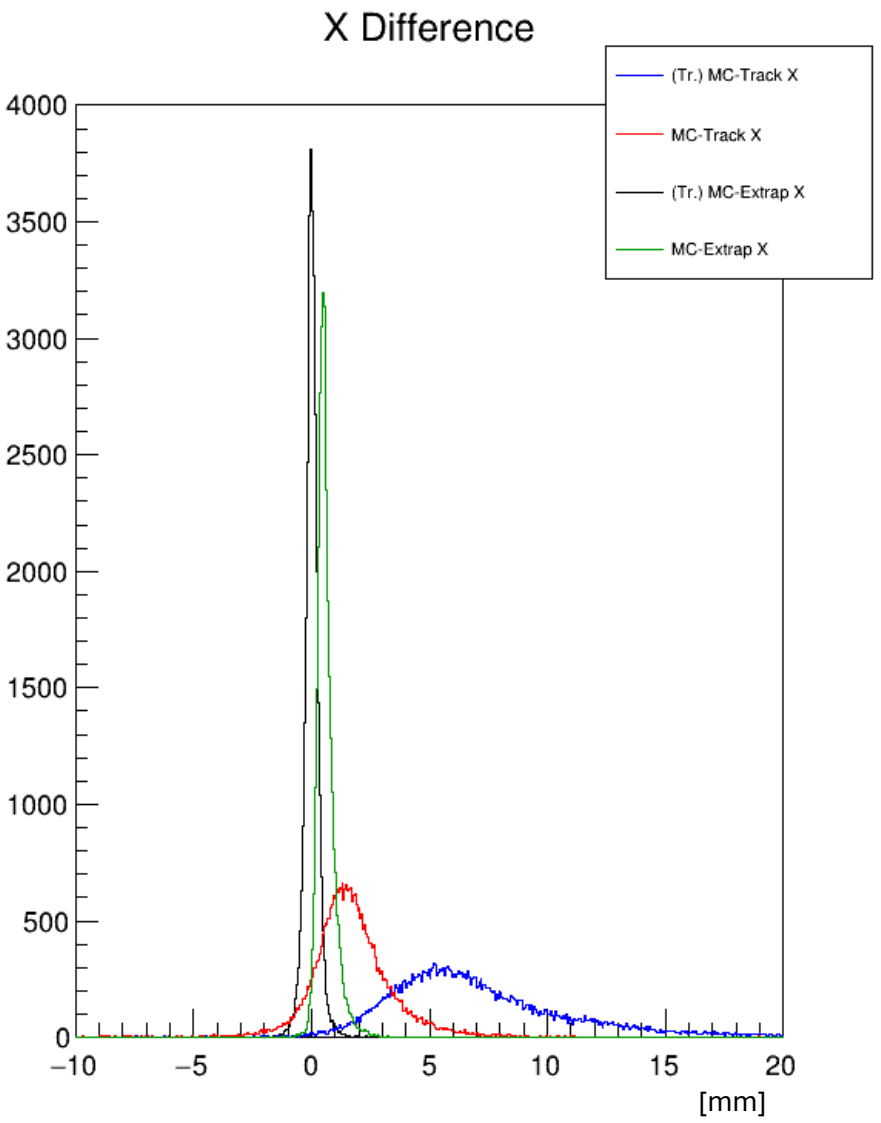

MC X at Ecal - Track X at Ecal (Truncated Field)
h_diff_x_track_mc
Entries 35819
Mean 7.162
Std Dev 4.5
500
400
300
200
100
0
−20 −15 −10 −5 0 5 10 15 20 25 30
[mm]

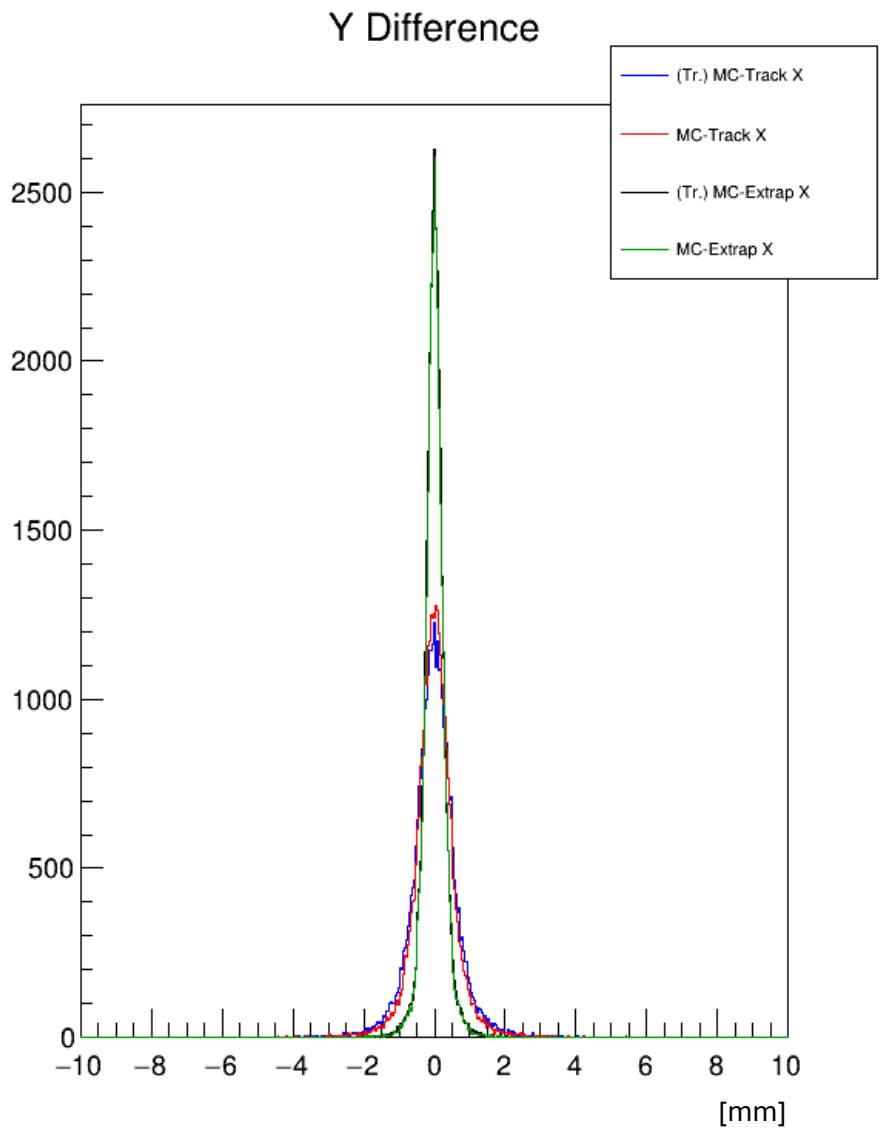

MC Y at Ecal - Track Y at Ecal (Truncated Field)
h_diff_y_track_mc
Entries 35819
Mean −0.004866
Std Dev 0.7449
1200
1000
800
600
400
200
0
−10 −8 −6 −4 −2 0 2 4 6 8 10
[mm]

Manual Extrapolation to Ecal face

- In the MC sample with no B field between svt6 and the Ecal, the momentum vector can be easily extended
- This is a cheat: does not require the track and uses only MC truth information




X Difference
(Tr.) MC-Track X
MC-Track X
(Tr.) MC-Extrap X
MC-Extrap X
4000
3500
3000
2500
2000
1500
1000
500
0
−10
−5
0
5
10
15
20
[mm]

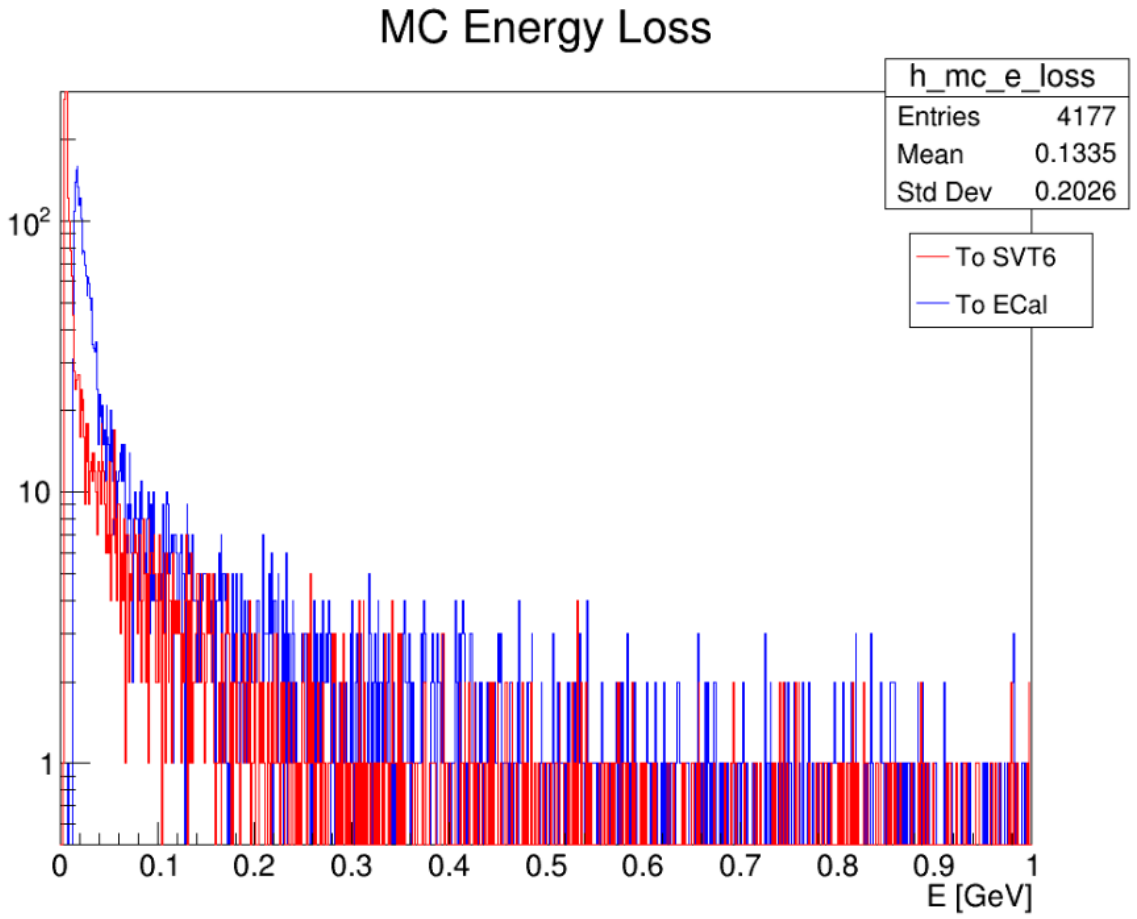

Y Difference
(Tr.) MC-Track X
MC-Track X
(Tr.) MC-Extrap X
MC-Extrap X
2500
2000
1500
1000
500
0
−10
−8
−6
−4
−2
0
2
4
6
8
10
[mm]

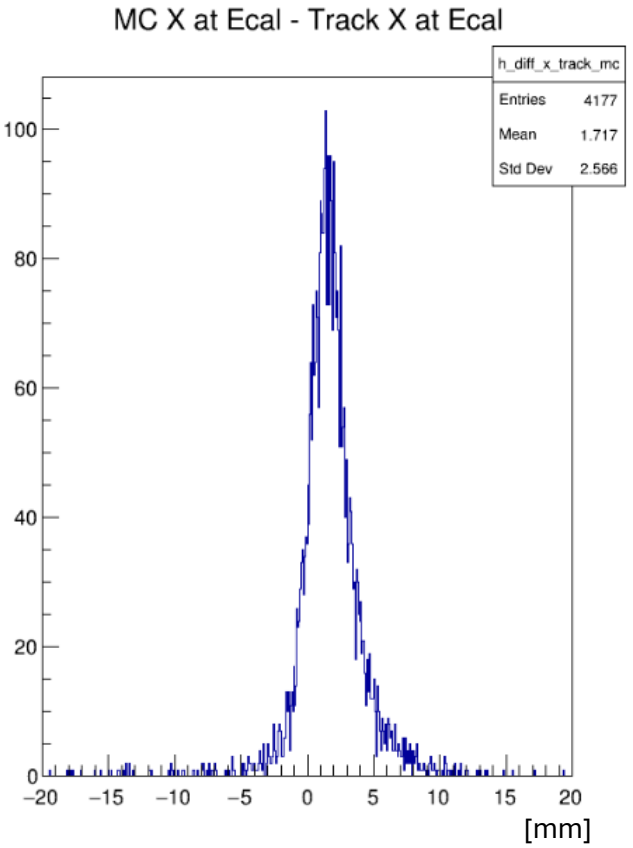
Next Steps

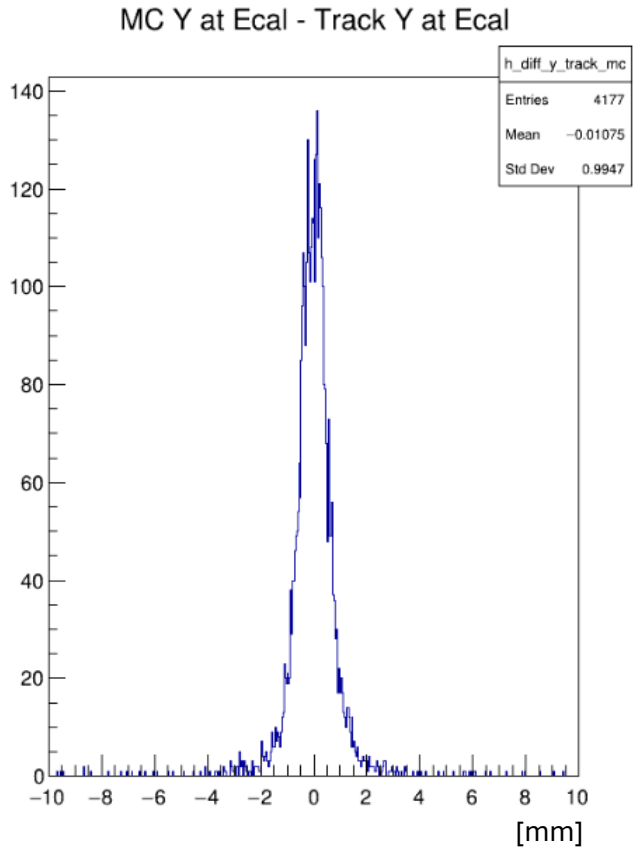
- Look at difference between mc truth data and track x at svt6 to confirm that the track is good at svt6

- Use track information at svt6 to extend the track to the ecal face using something other than HPS java

electrons


MC Energy Loss
h_mc_e_loss
Entries 4177
Mean 0.1335
Std Dev 0.2026
To SVT6
To ECal
10^2
10
1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
E [GeV]


MC X at Ecal - Track X at Ecal
h_diff_x_track_mc
Entries 4177
Mean 1.717
Std Dev 2.566
100
80
60
40
20
0
−20 −15 −10 −5 0 5 10 15 20
[mm]


MC Y at Ecal - Track Y at Ecal
h_diff_y_track_mc
Entries 4177
Mean −0.01075
Std Dev 0.9947
140
120
100
80
60
40
20
0
−10 −8 −6 −4 −2 0 2 4 6 8 10
[mm]