MIPP

Drift Velocity and Distortion Corrections

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MIPP Software Meeting

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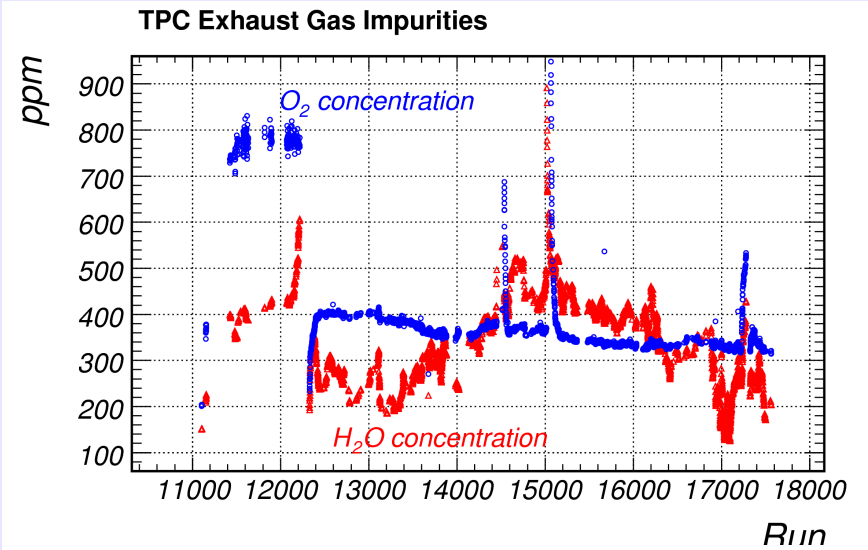
Activities in the past week

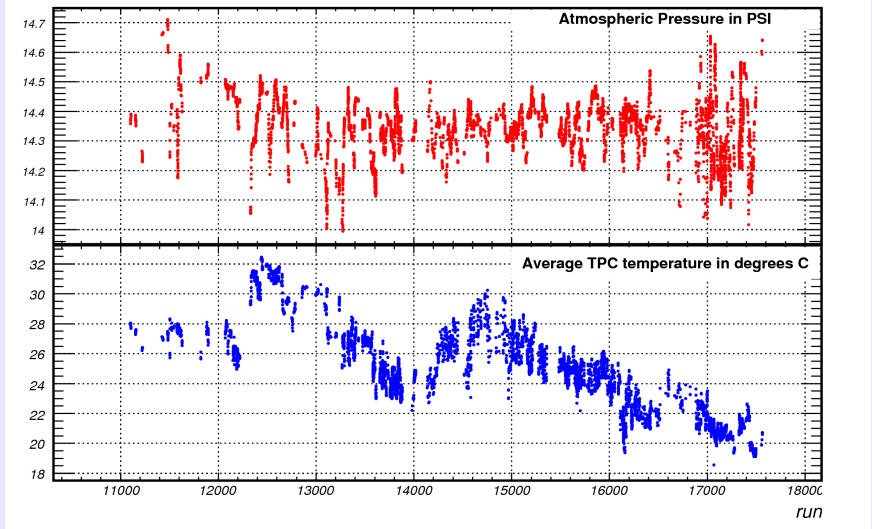
- >4400 subruns processed through pass 2
- We realized that drift velocity was strongly affected by water contamination of P10 and oxygen to lesser degree
  - This mandates different drift velocity for different runs
- Mike Heffner simulated electron drift using Magboltz
  - Magboltz corrects distortions very well, does not require artificial shift of pad plane in y
  - Distortions depend on the amount of H_2O, requiring further study to select the right correction map

Measuring v_0

- In this discussion, v_0 is electron drift in absence of magnetic field or perfectly collinear magnetic and electric fields
- In pass2 tracks are fit using chamber info only, so matching efficiency aside (we used v_0=5.24 cm/μs) there should be no bias in measurement of drift velocity
- Cuts require 3+ track vertex consistent with target location, at least 10 wire chamber hits in the track and TPC hits in the first 8 and the last 8 padrows

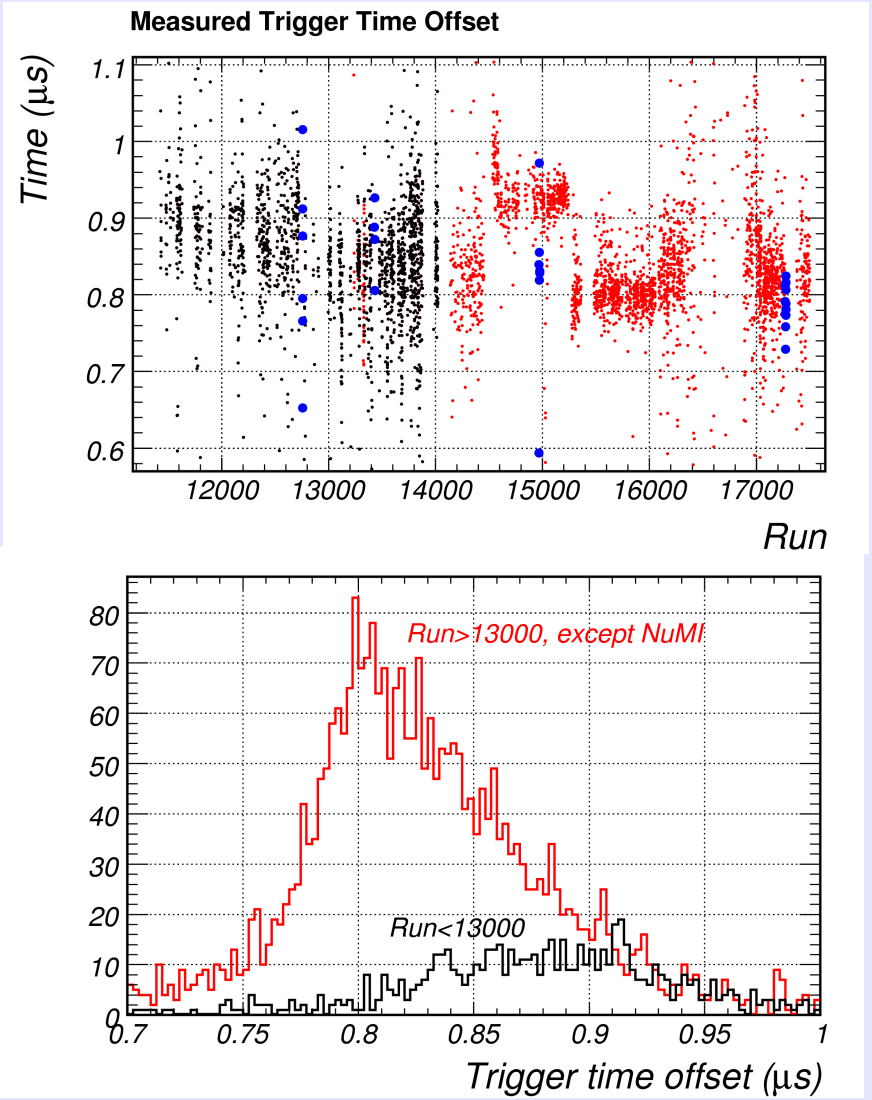
TPC Environment



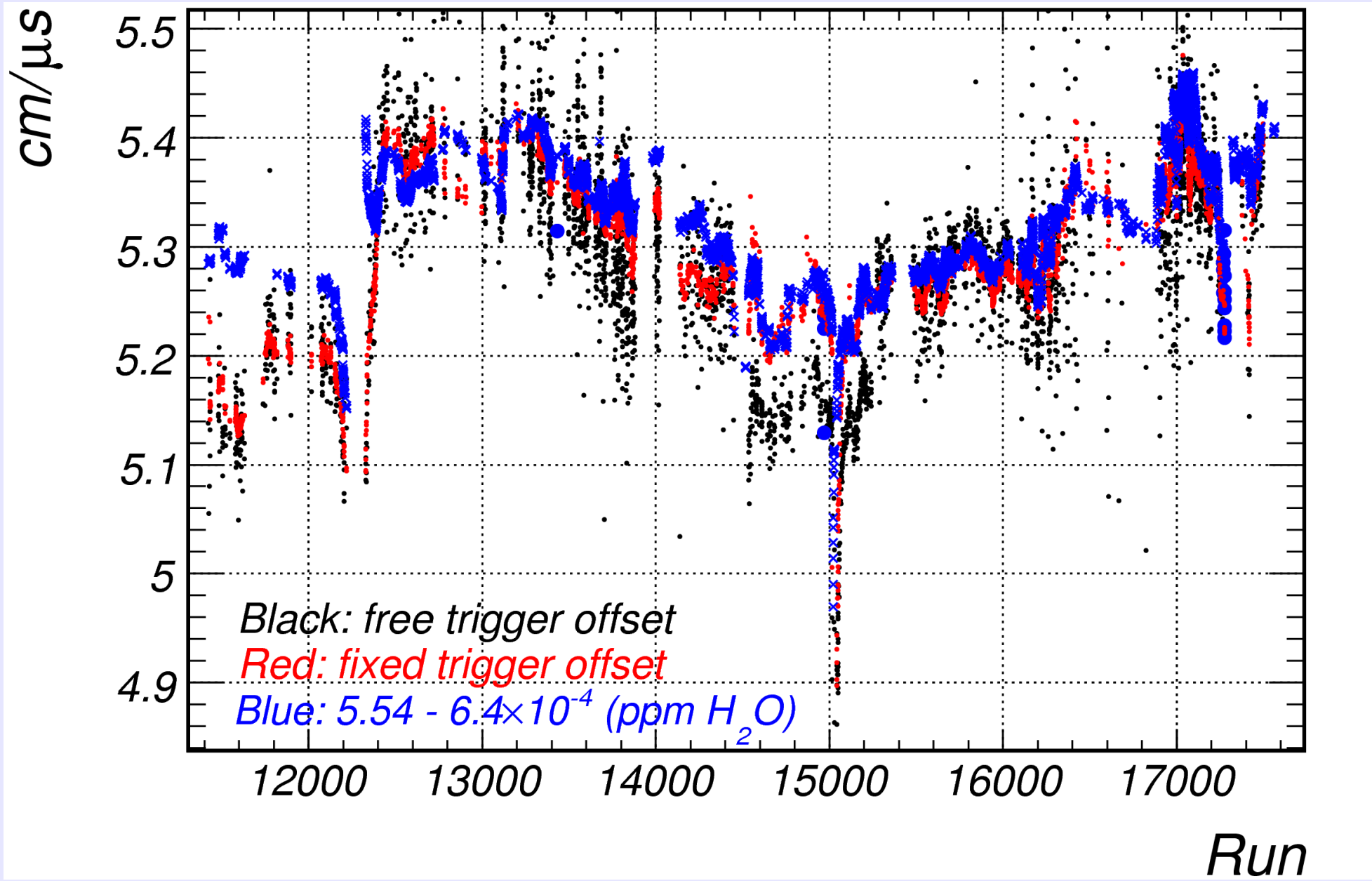


- In the early production running, TPC flow was at 10 cc/min. Was increased to 20 cc/min around run 12300
- Around run 15000 exhaust valve was shut off causing very high levels of contamination

Trigger Time Offset



- Fixing trigger offset time is not as simple as one would hope
  - NuMI runs are a special case, but somewhat puzzling
  - Offset in early runs is 70 ns larger. Seems like a delay cable was removed, but nothing in logbook, except Peter fixed damaged BitBus cable.


cm/μs
5.5
5.4
5.3
5.2
5.1
5
4.9
12000
13000
14000
15000
16000
17000
Run
Black: free trigger offset
Red: fixed trigger offset
Blue: 5.54 - 6.4×10^-4 (ppm H2O)

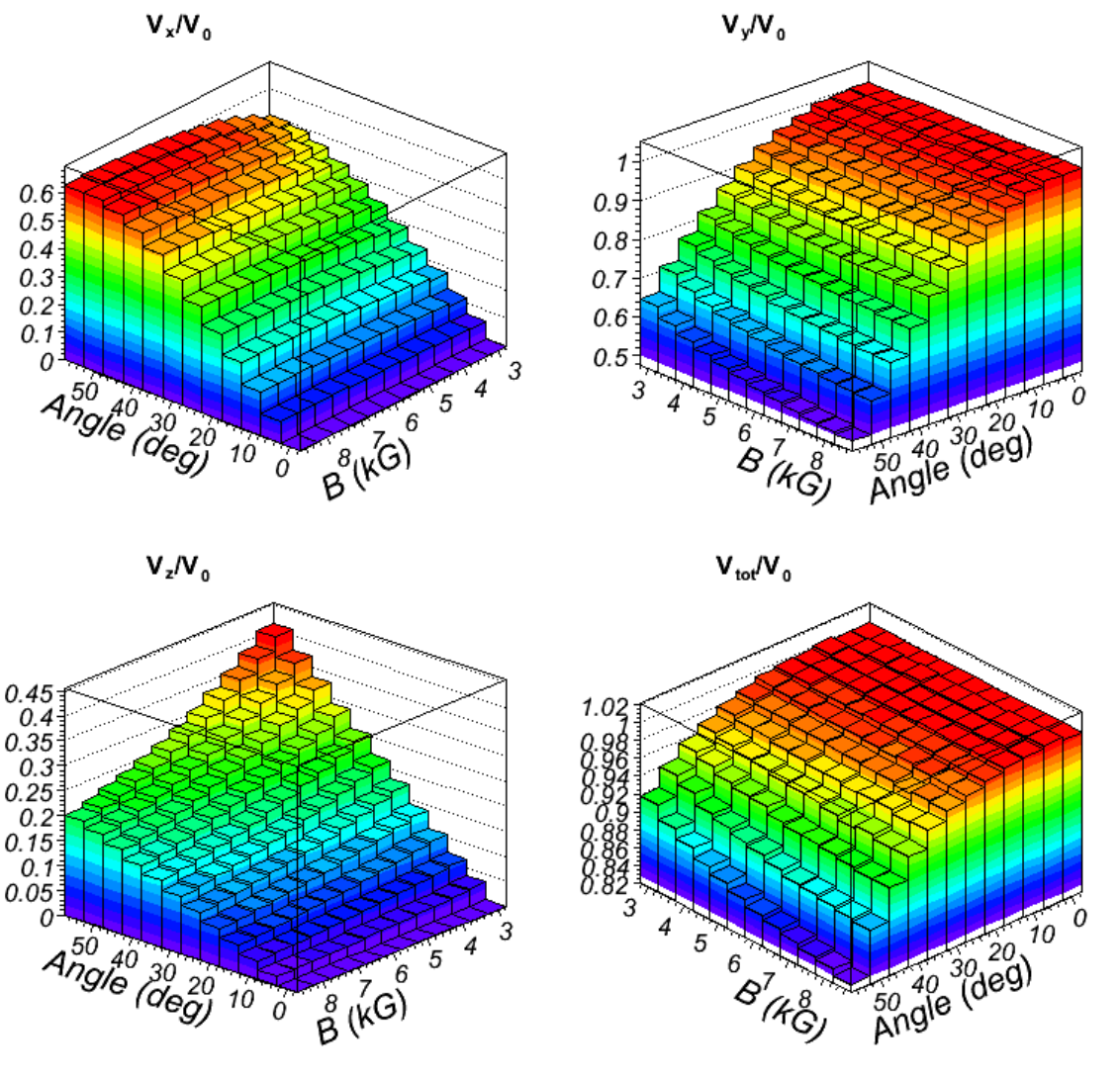
Drift Velocity Summary

- Drift velocity correlates with water vapor content in exhaust gas. This is nice to confirm, because correlations with pressure and temperature are much smaller and do not explain large variations in measured drift velocity
  - Rapid transients are notable exceptions
- Using different trigger time offset for runs before 13000 although not justified by logbook entries, seems consistent with data
  - No systematic bias in fits with trigger offset fixed

Distortion Corrections

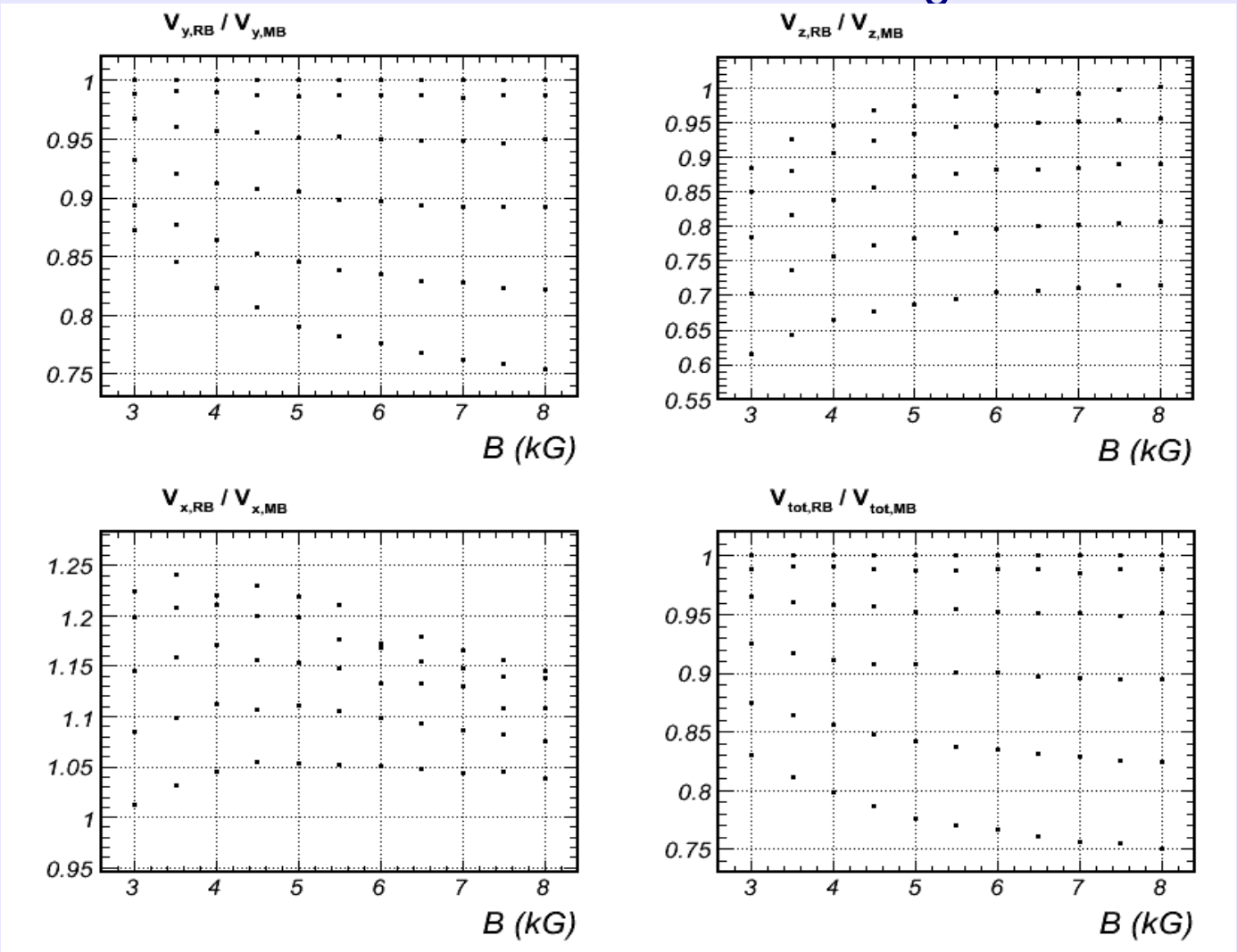
- Rolandi&Blum formulation assumes that resistance is linearly proportional to velocity vector for stochastic average of electrons
  - This is not so in P10 with water and oxygen impurities
- Magboltz bounces electrons around to simulate the observed drift velocity vector given gas mixture, pressure, and electromagnetic field
  - A scan of |B| and the angle between $(B_x,B_y,0)$ and $(0,E_y,0)$ vectors produces a map of drift velocity components

Magboltz Map



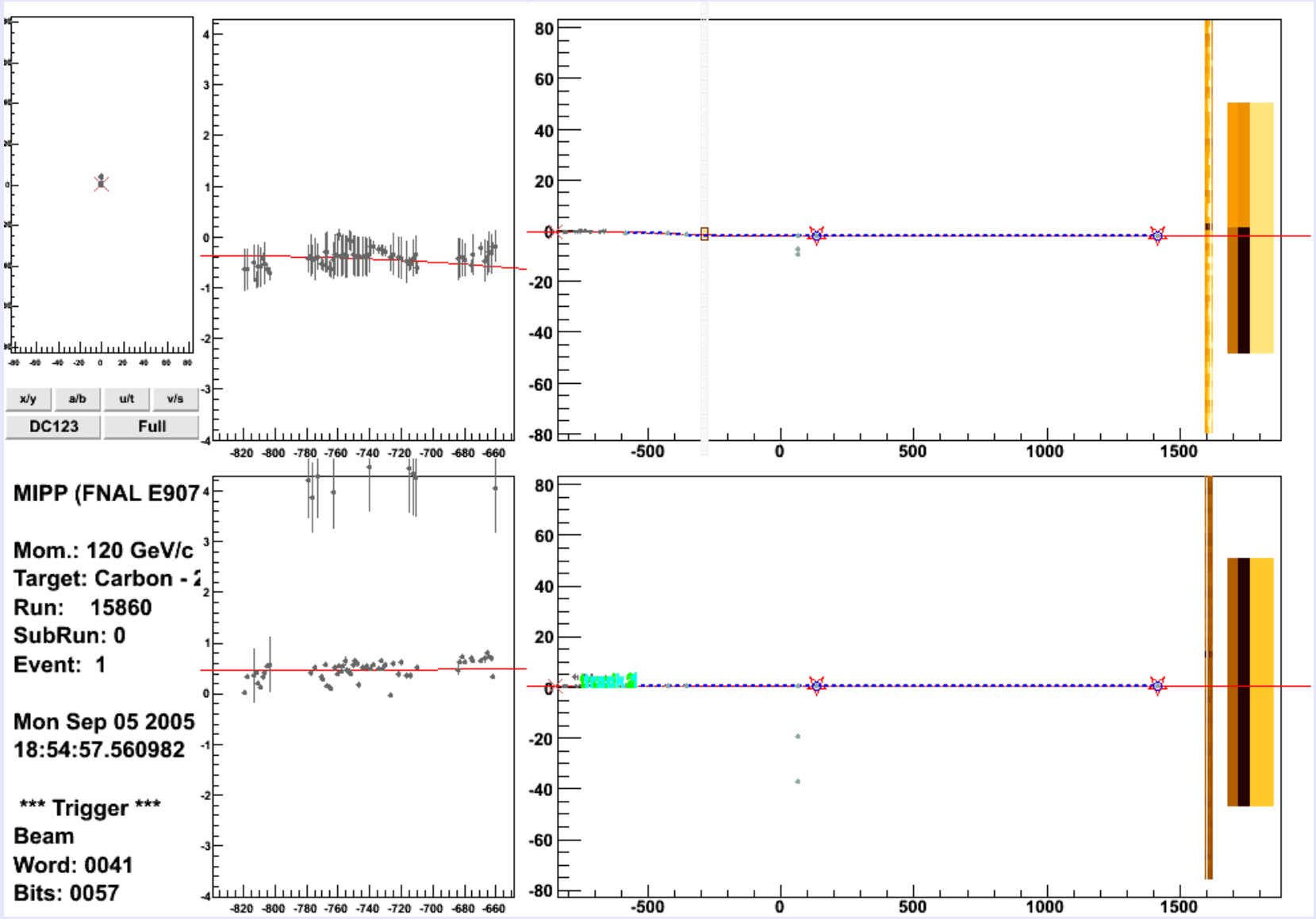
- The relevant quantity in each map is the ratio of drift velocity component to v_0
- This map for v_0=5.362 cm/μs is on a 0.5 kG by 5 degree grid
- Components look sufficiently smooth for linear interpolation

Linear model vs Magboltz for 0.5 kGx10° grid, V_0=5.452 cm/μs

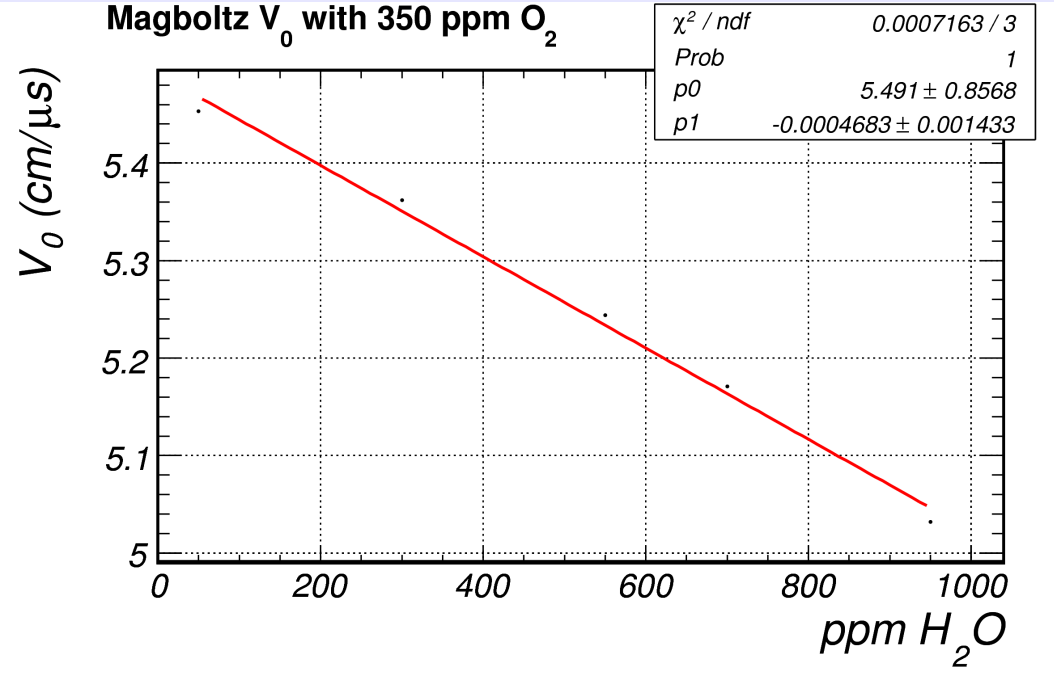


- Comparison to linear model shows large differences in all 3 components

Applying 5.452 map to run 15860, V_0 scaled to 5.29cm/μs

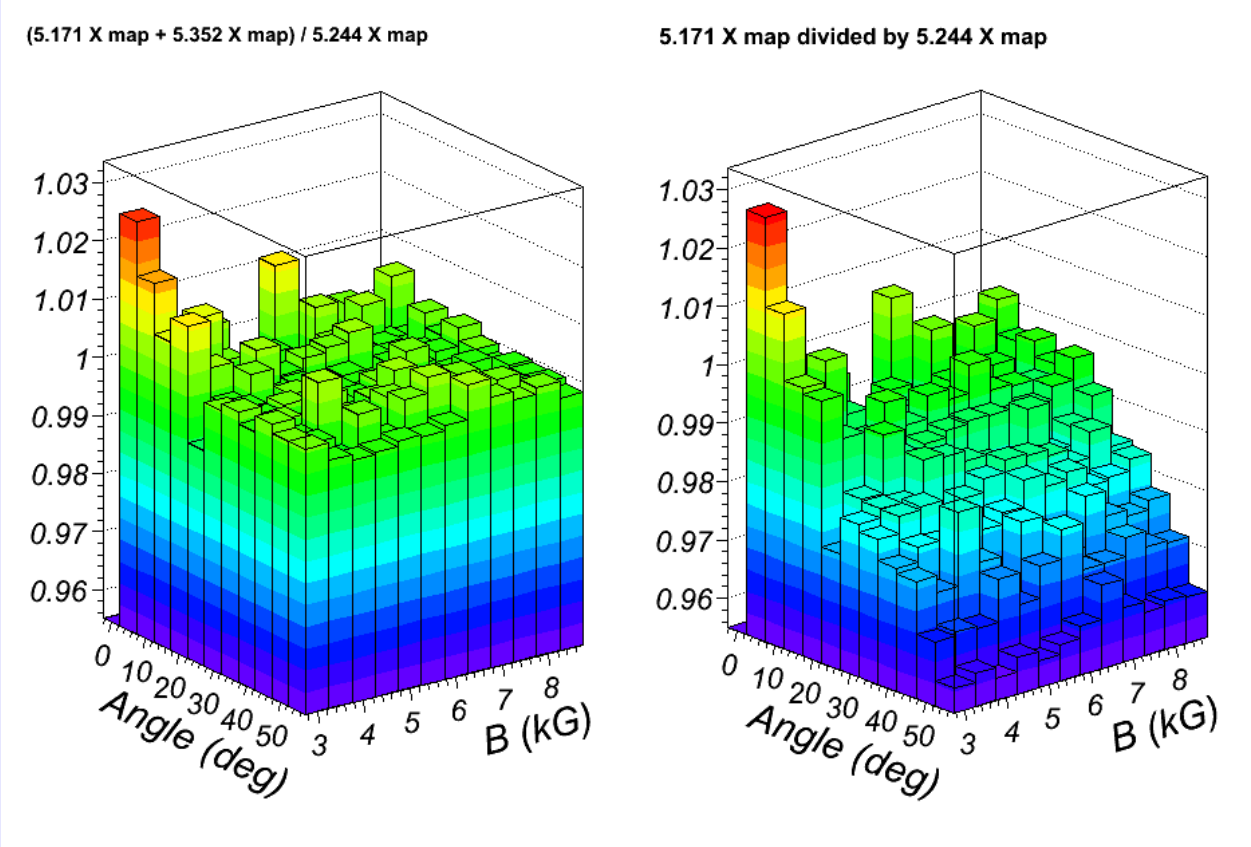


Magboltz v_0 and H_2O content



- The data suggests that the coefficient between v_0 and water content ppm is 6.4×10^{-4}
- Magboltz predicts 4.7×10^{-4}, which is good, but it also implies that there may not be a one-to-one correspondence of measured and Magboltz v_0

Making a map for arbitrary v_0



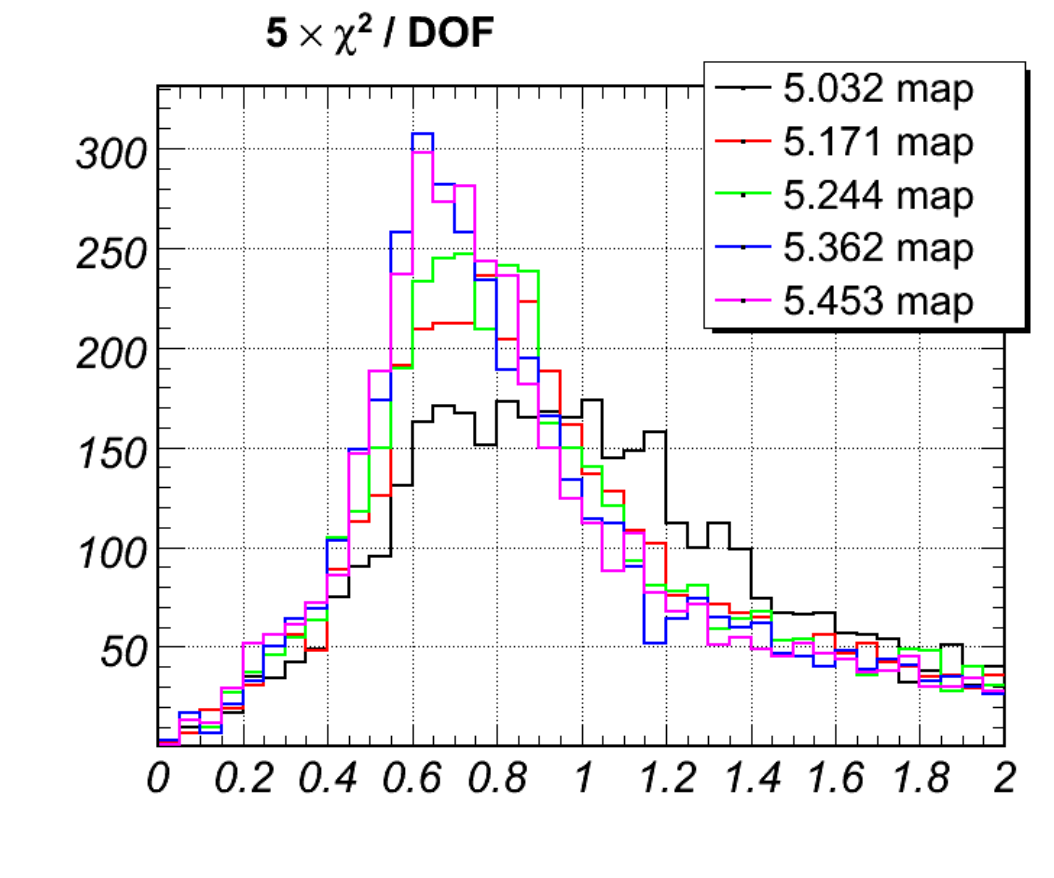
- Drift velocity vector will depend on v0 as well as magnetic field
- Appropriately weighted sum of two maps reproduces a third map to 1% in the region of interest

Work in Progress

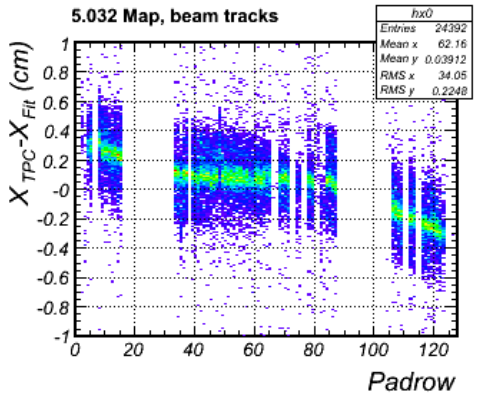
- Set run by run drift velocity with numbers from fixed trigger offset [done]
- Determine the correspondence between Magboltz v_0 and measured v_0
  - Residuals from different maps is a start [next few pages]

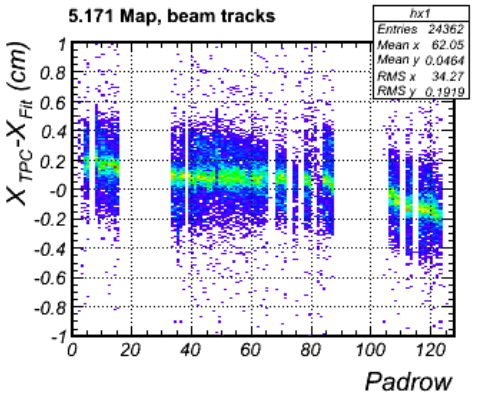
1000 triggers of run 15860

- Mike generated five maps with different v_0
- Run 15860 v_0=5.278 cm/μs
- χ squared distributions favor the two maps at higher v_0
  - Slight preference for 5.362 map



X Residuals


5.032 Map, beam tracks
hx0
Entries 24392
Mean x 62.16
Mean y 0.03912
RMS x 34.05
RMS y 0.2248
X TPC-X Fit (cm)
Padrow


5.171 Map, beam tracks
hx1
Entries 24362
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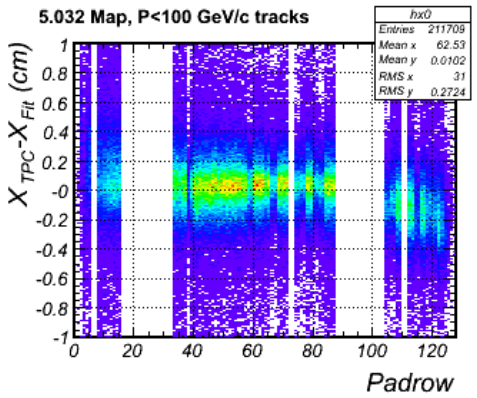
Mean y 0.0464
RMS x 34.27
RMS y 0.1919
X TPC-X Fit (cm)
Padrow


5.032 Map, P<100 GeV/c tracks
hx0
Entries 211709
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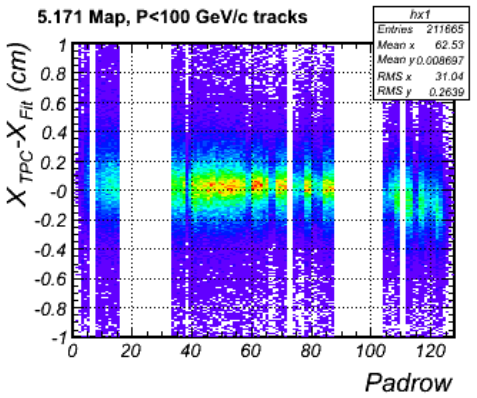
Mean y 0.0102
RMS x 31
RMS y 0.2724
X TPC-X Fit (cm)
Padrow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hx1
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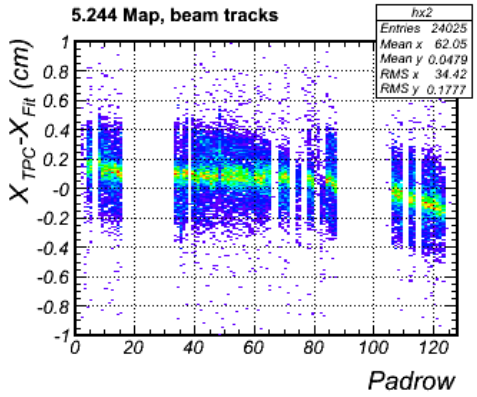
Mean y 0.008697
RMS x 31.04
RMS y 0.2639
X TPC-X Fit (cm)
Padrow


5.244 Map, beam tracks
hx2
Entries 24025
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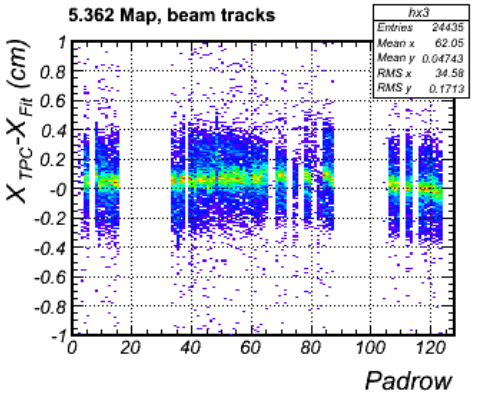
Mean y 0.0479
RMS x 34.42
RMS y 0.1777
X TPC-X Fit (cm)
Padrow


5.362 Map, beam tracks
hx3
Entries 24435
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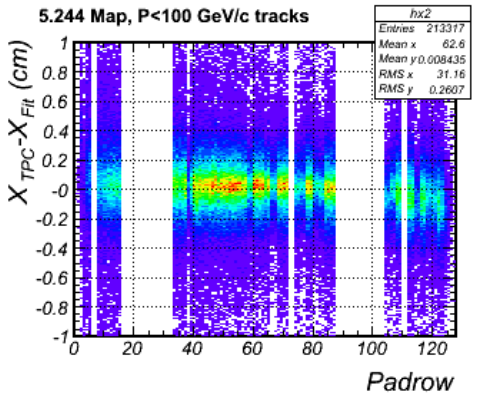
Mean y 0.04743
RMS x 34.58
RMS y 0.1713
X TPC-X Fit (cm)
Padrow


5.244 Map, P<100 GeV/c tracks
hx2
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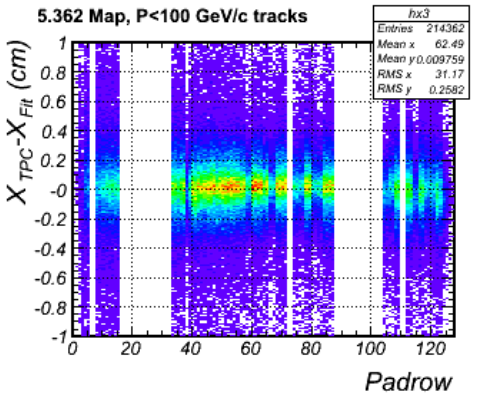
RMS x 31.16
RMS y 0.2607
X TPC-X Fit (cm)
Padrow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hx3
Entries 214362
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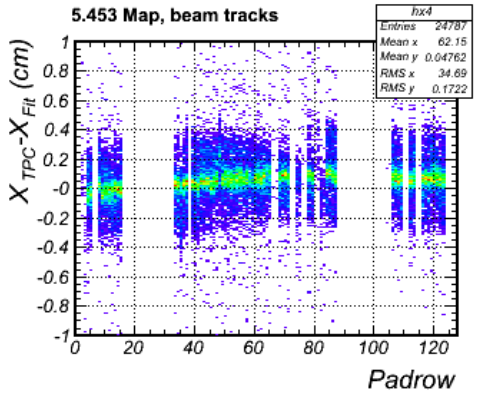
RMS y 0.2582
X TPC-X Fit (cm)
Padrow


5.453 Map, beam tracks
hx4
Entries 24787
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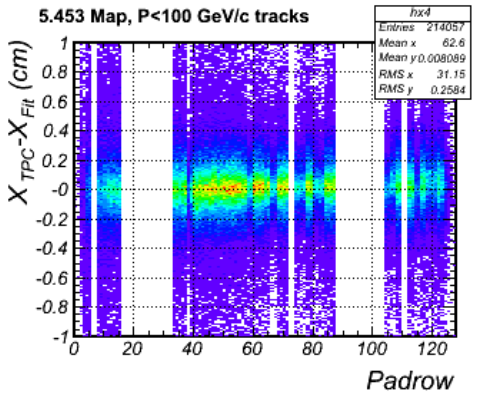
Mean y 0.04762
RMS x 34.69
RMS y 0.1722
X TPC-X Fit (cm)
Padrow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hx4
Entries 214057
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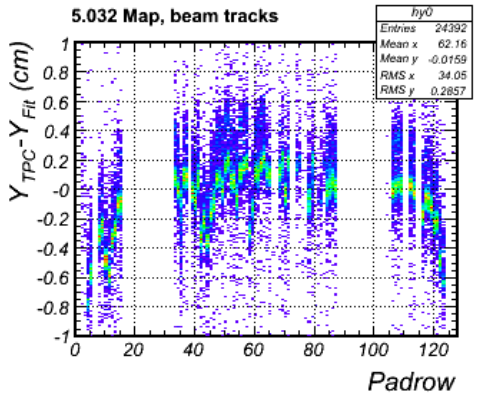
Mean y 0.008089
RMS x 31.15
RMS y 0.2584
X TPC-X Fit (cm)
Padrow

Y Residuals


5.032 Map, beam tracks
hy0
Entries 24392
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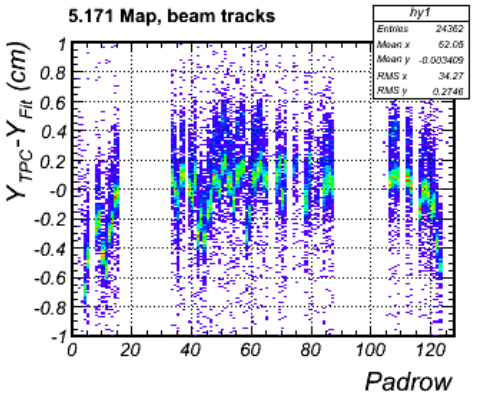
Mean y -0.0159
RMS x 34.05
RMS y 0.2857
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.171 Map, beam tracks
hy1
Entries 24362
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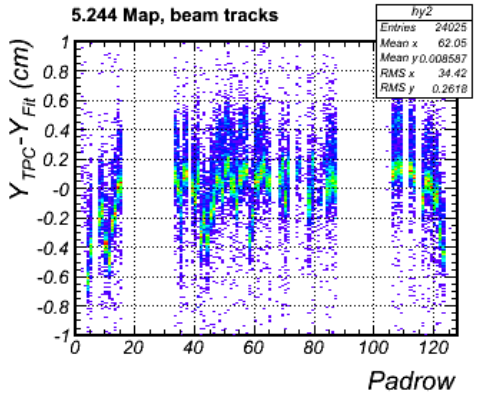
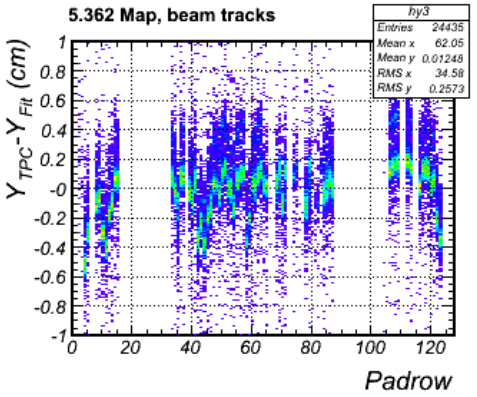
Mean y -0.003409
RMS x 34.27
RMS y 0.2746
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.244 Map, beam tracks
hy2
Entries 24025
Mean x 62.05
Mean y 0.008587
RMS x 34.42
RMS y 0.2618
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.362 Map, beam tracks
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Entries 24435
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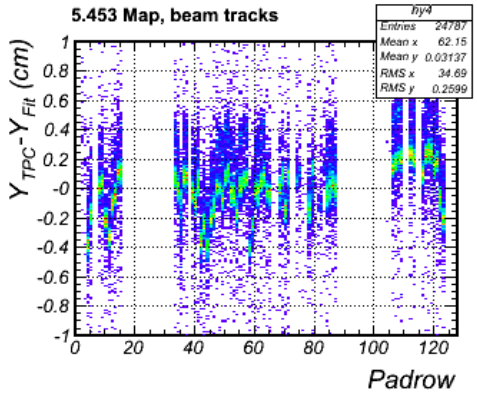
Mean y 0.01248
RMS x 34.58
RMS y 0.2573
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.453 Map, beam tracks
hy4
Entries 24787
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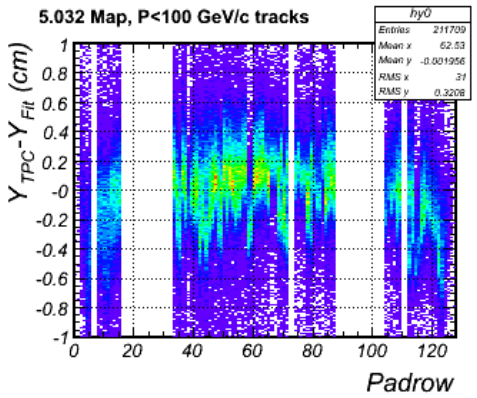
Mean y 0.03137
RMS x 34.69
RMS y 0.2599
Y_{TPC}-Y_{Fit} (cm)
Padrow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hy0
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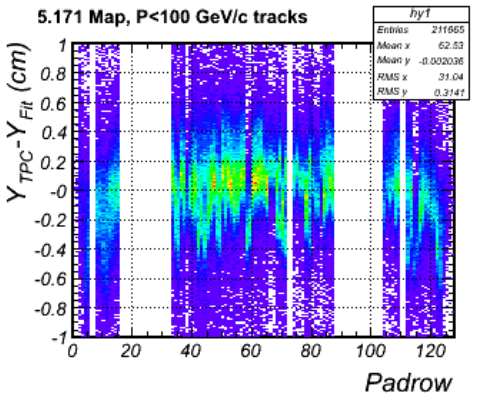
Mean y -0.001956
RMS x 31
RMS y 0.3208
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.171 Map, P<100 GeV/c tracks
hy1
Entries 211665
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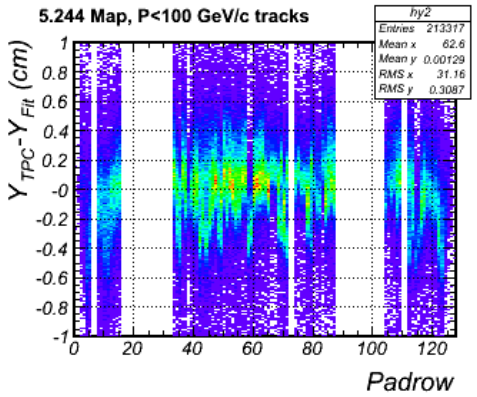
Mean y -0.002036
RMS x 31.04
RMS y 0.3141
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.244 Map, P<100 GeV/c tracks
hy2
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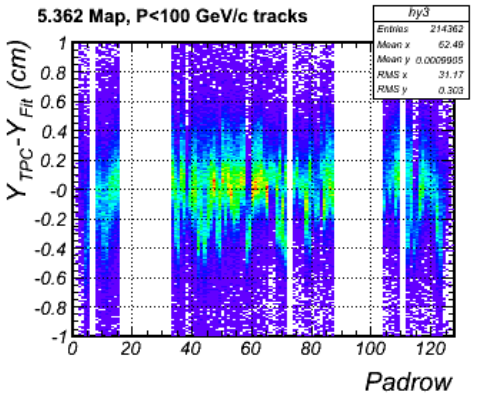
Mean y 0.00129
RMS x 31.16
RMS y 0.3087
Y_{TPC}-Y_{Fit} (cm)
Padrow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hy3
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Mean y 0.0009985
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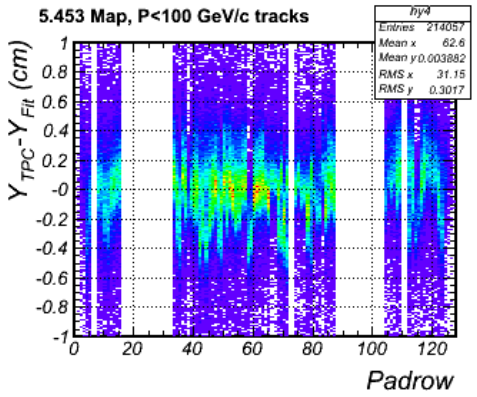
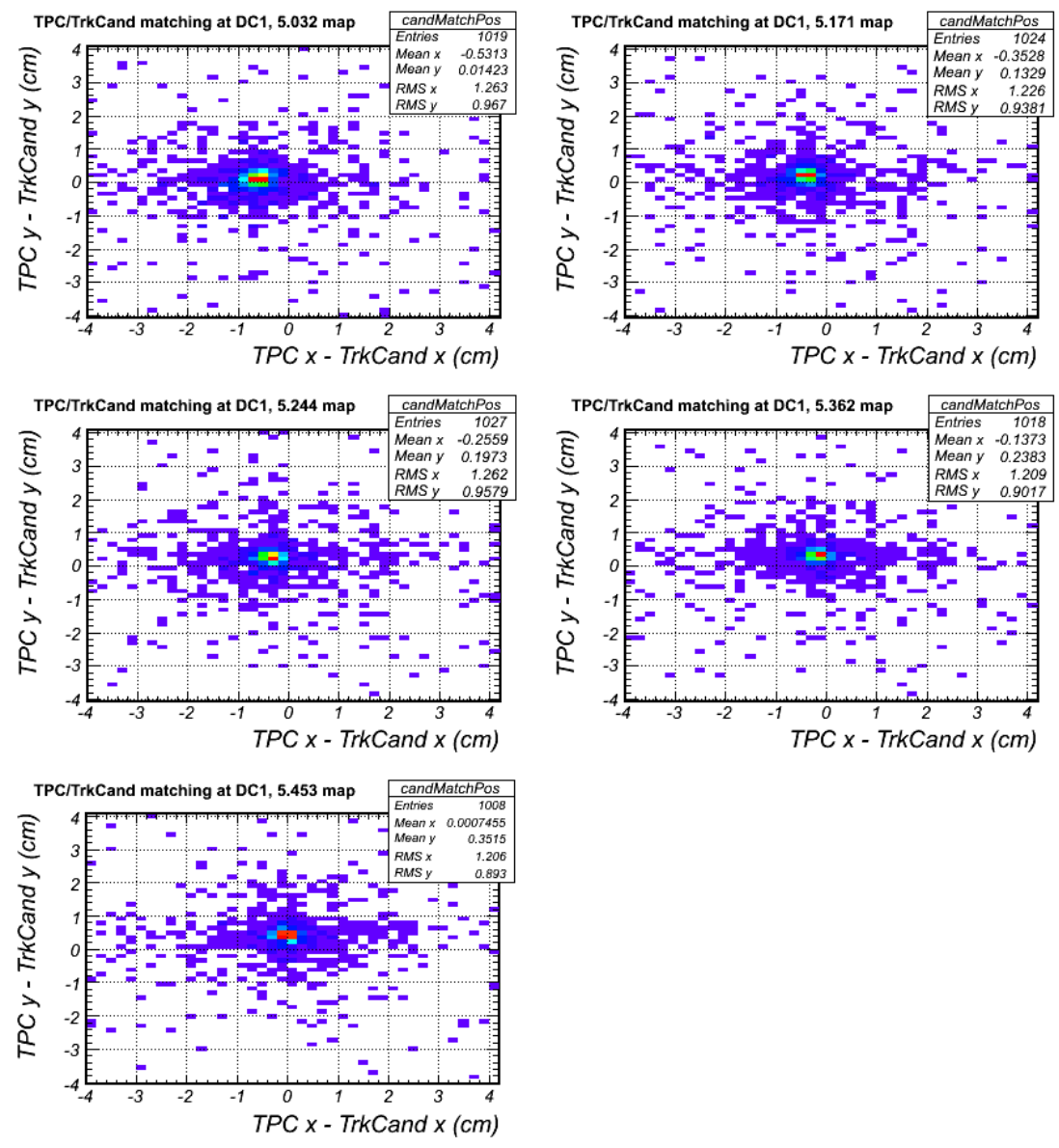
RMS y 0.303
Y_{TPC}-Y_{Fit} (cm)
Padrow


5.453 Map, P<100 GeV/c tracks
hy4
Entries 214057
Mean x 62.6
Mean y 0.003882
RMS x 31.15
RMS y 0.3017
Y_{TPC}-Y_{Fit} (cm)
Padrow



- Neither of the 5 maps gets corrections "perfectly", but this is far better than what the linear model did
- Residuals seem to indicate that X corrections of 5.453 map are too large and 5.244 map too small
- Y corrections are harder to judge because of jitter
- Matching to TrkCand's is phenomenally good

Plans

- Need to look at a few runs with different v0 to determine which maps work for which v0
- Implement weighted sum of nearby maps to scale corrections appropriately
- Iron out mm-size residuals with TPCResCor
  - I think this is still necessary, but corrections are going to be small