TB 2022

Automatic Alignment Method

29 / 11 / 23

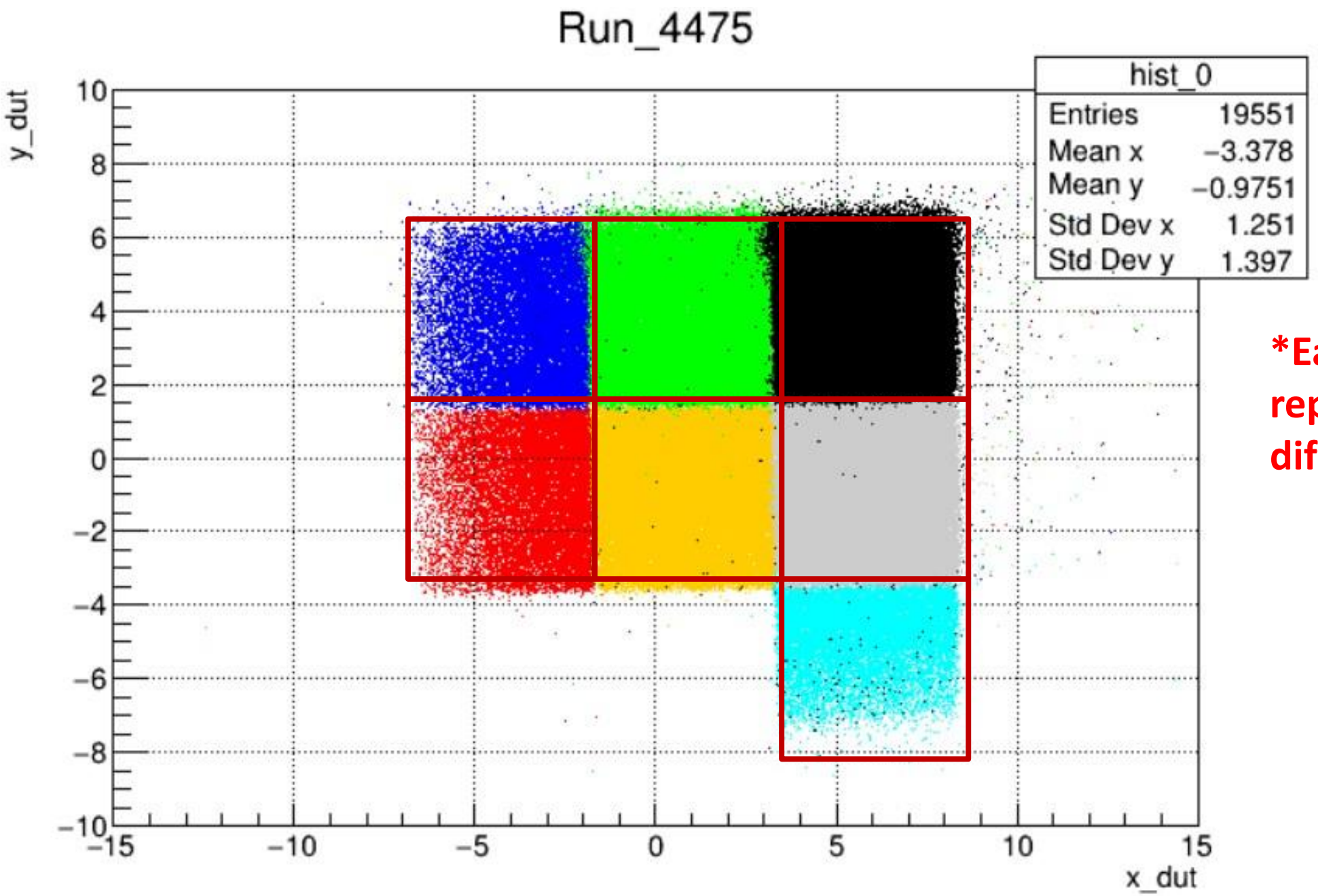
Kirill Smagloy

- Michal’s method – Hough Transform
- The method in this presentation(Itamar’s method) – Scan and search max hits in pad

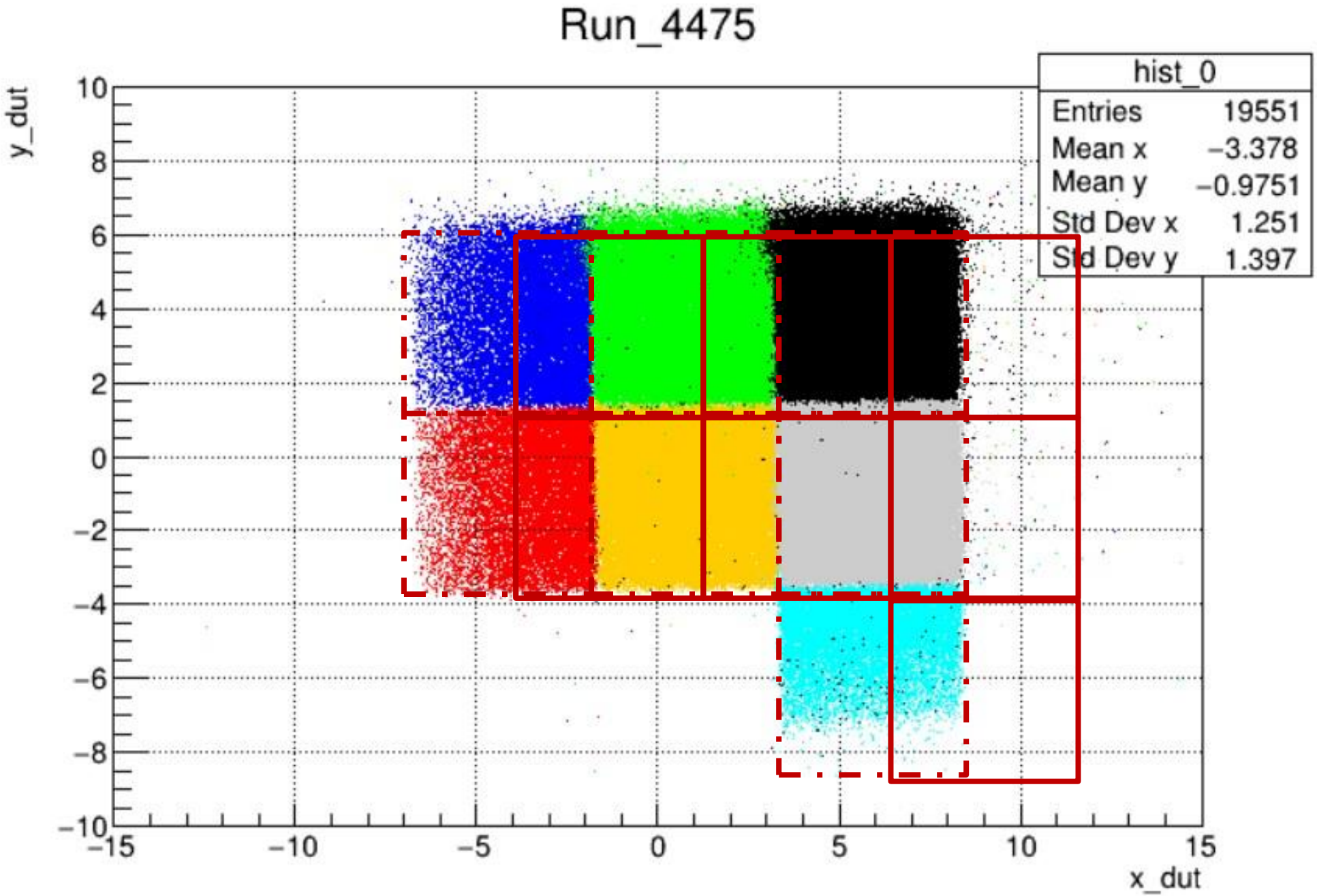
Alignment Program

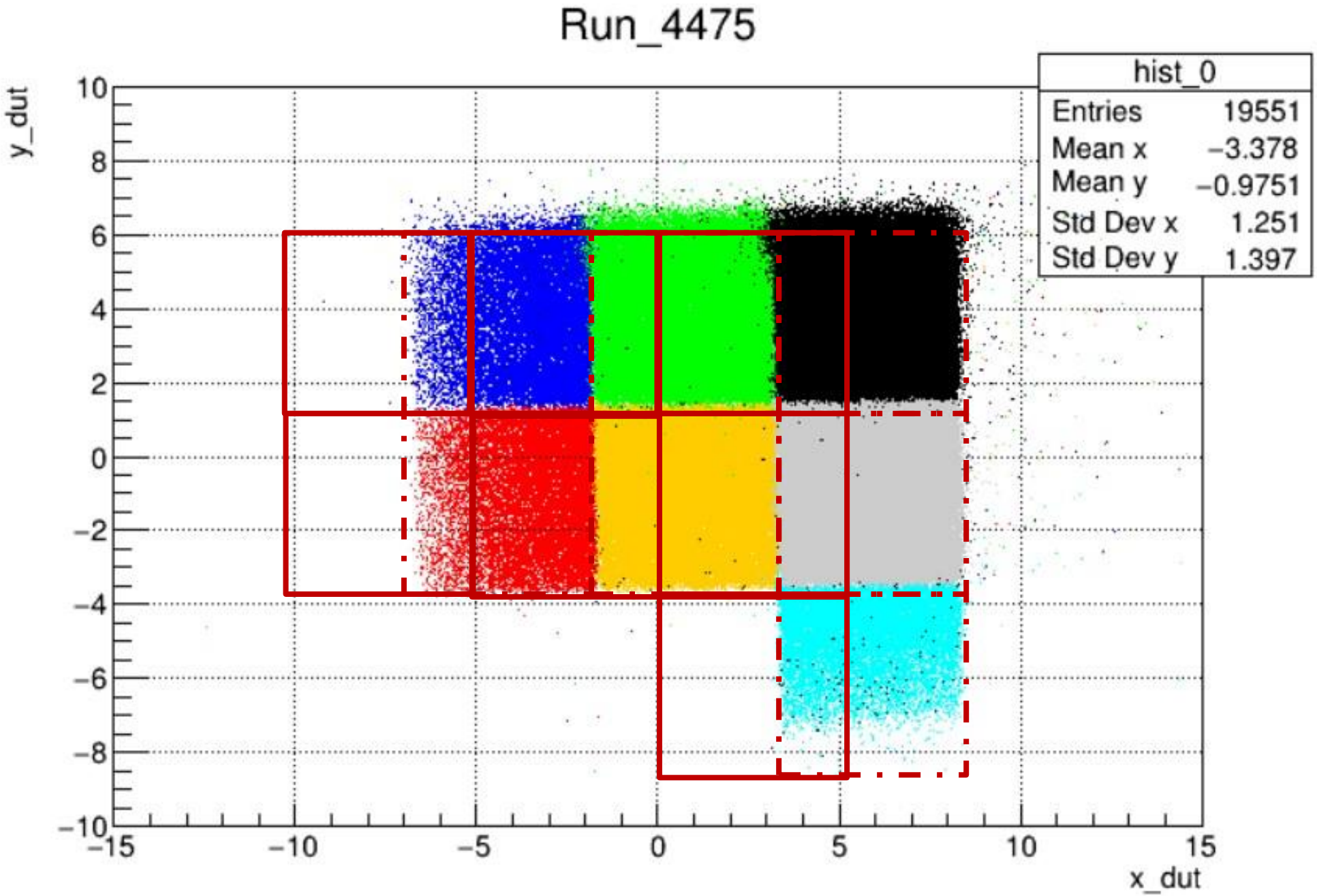
- Currently the program works with the runs on the sensors – ANTON 1, YAN 1, Calice 75, Calice 74
- The program recognizes the pad length, and the noisy/dead pads of each sensor
- For the GaAs sensors, inverts the x_dut coordinate before aligning

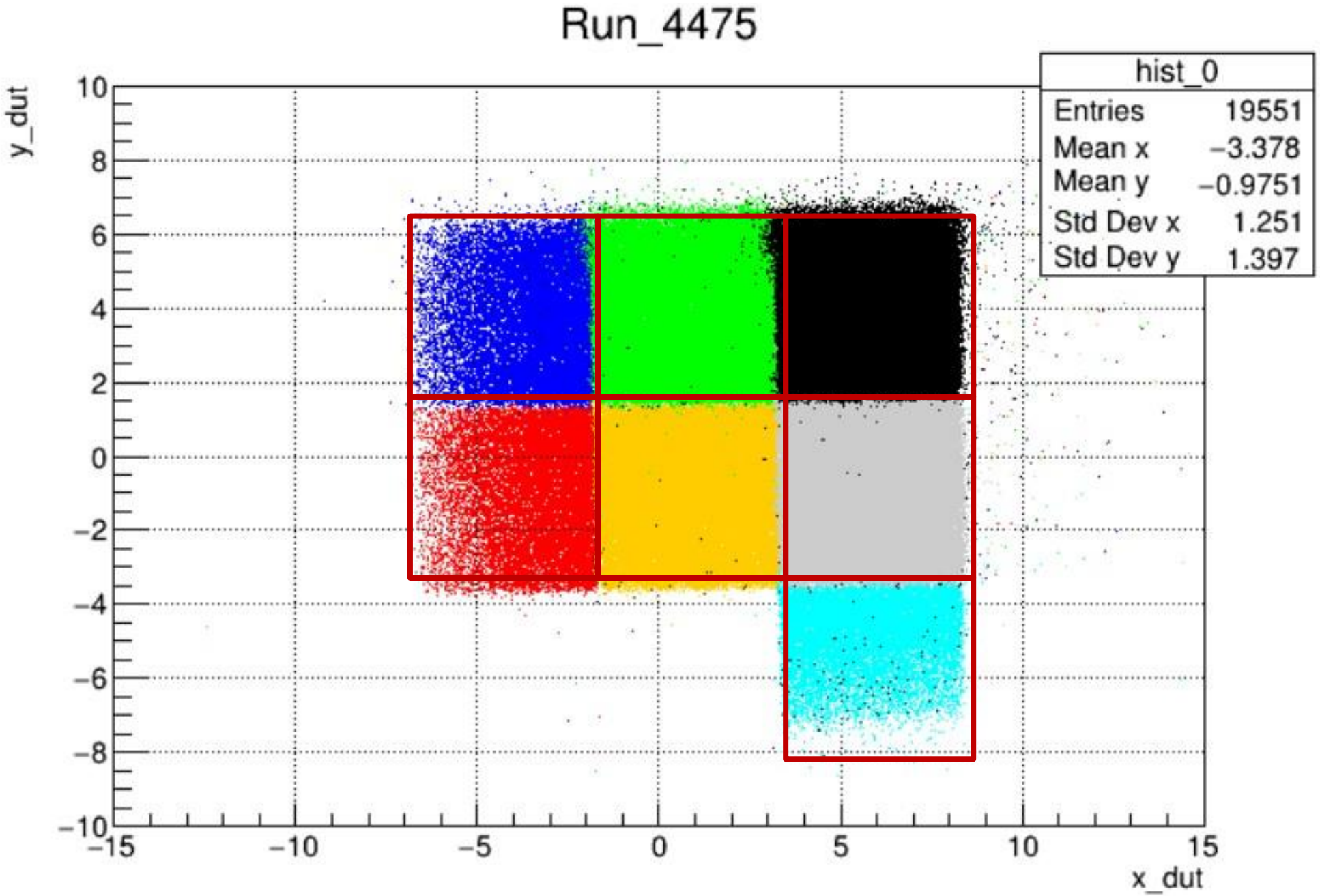
The Method

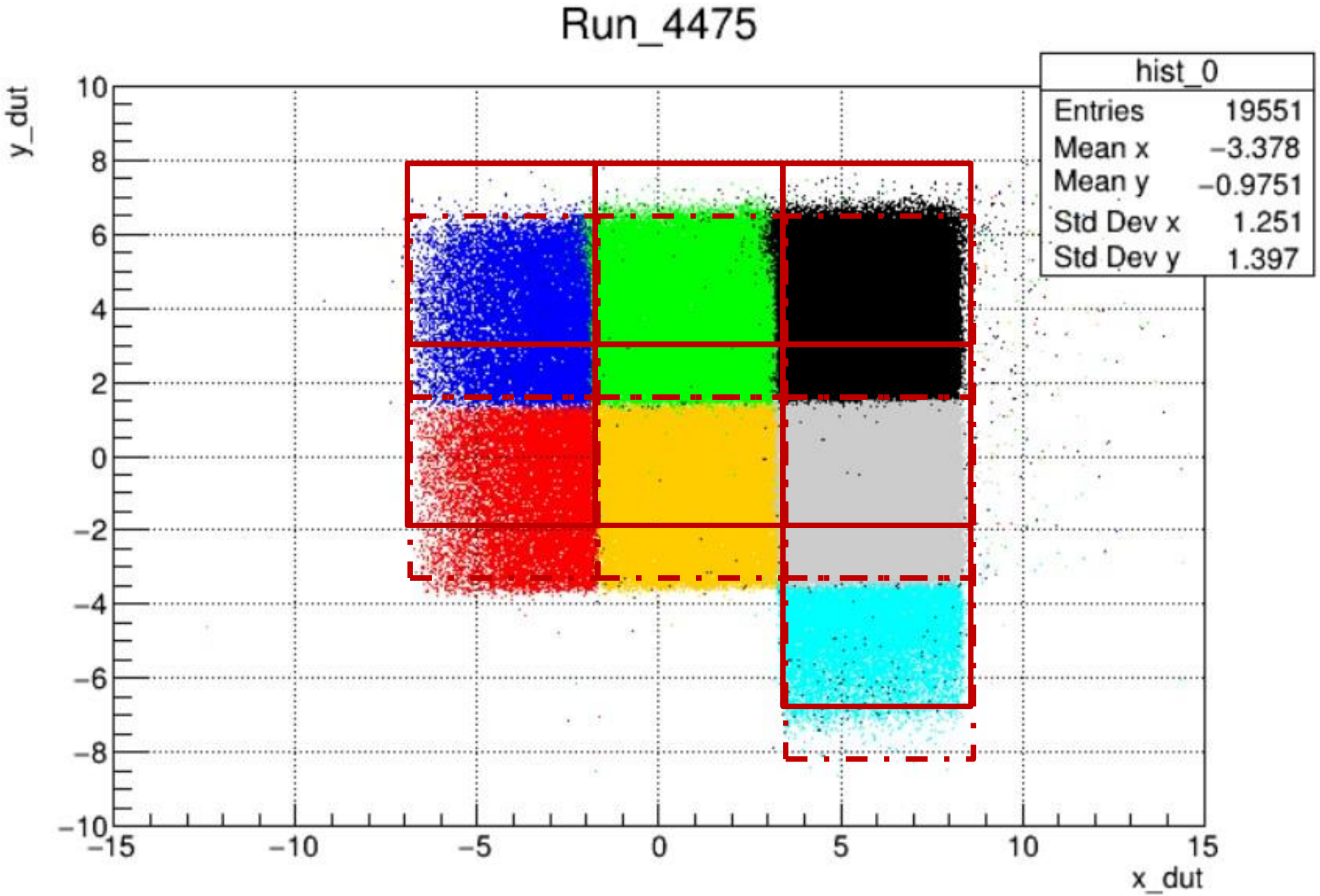


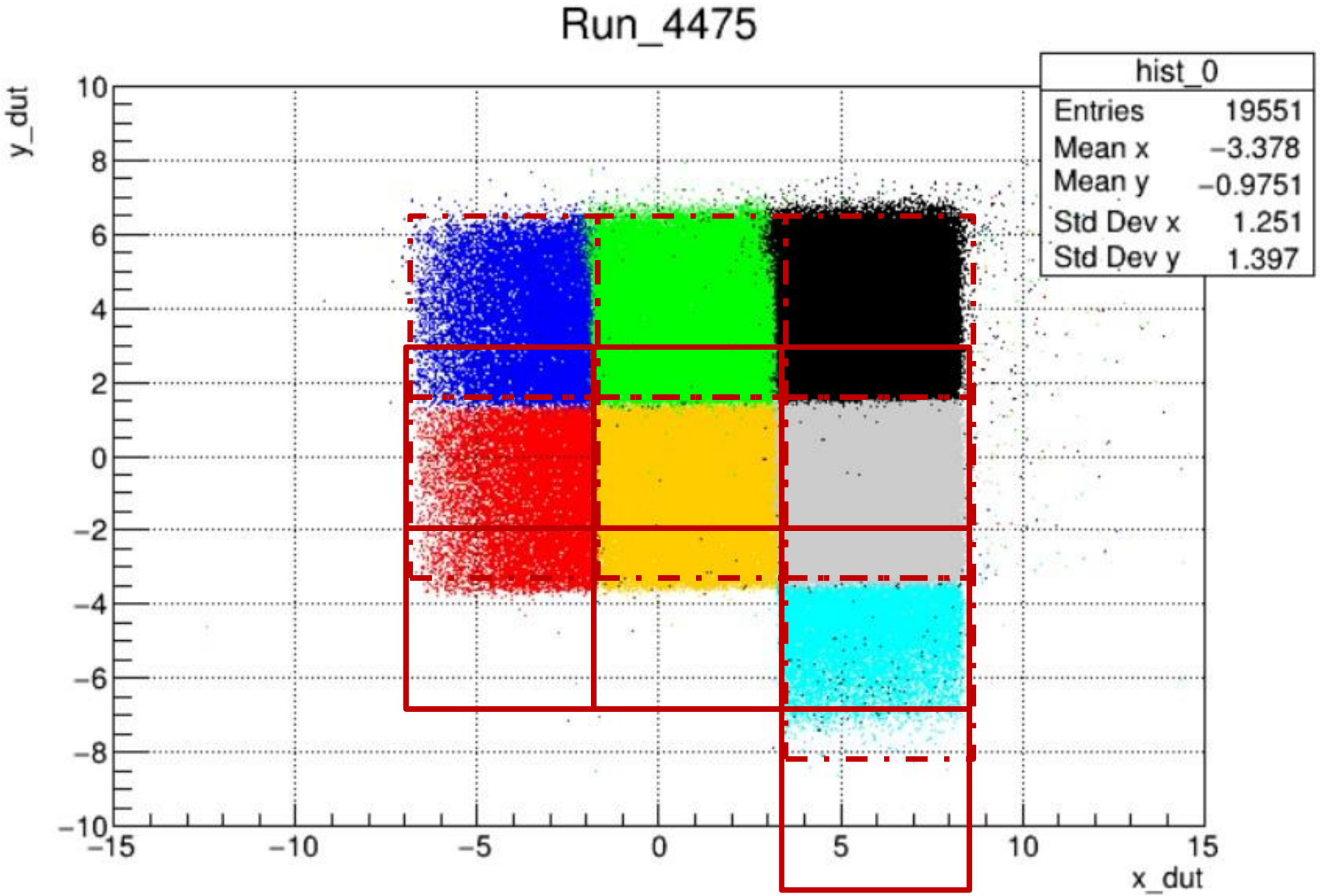
*Each color represents a different pad

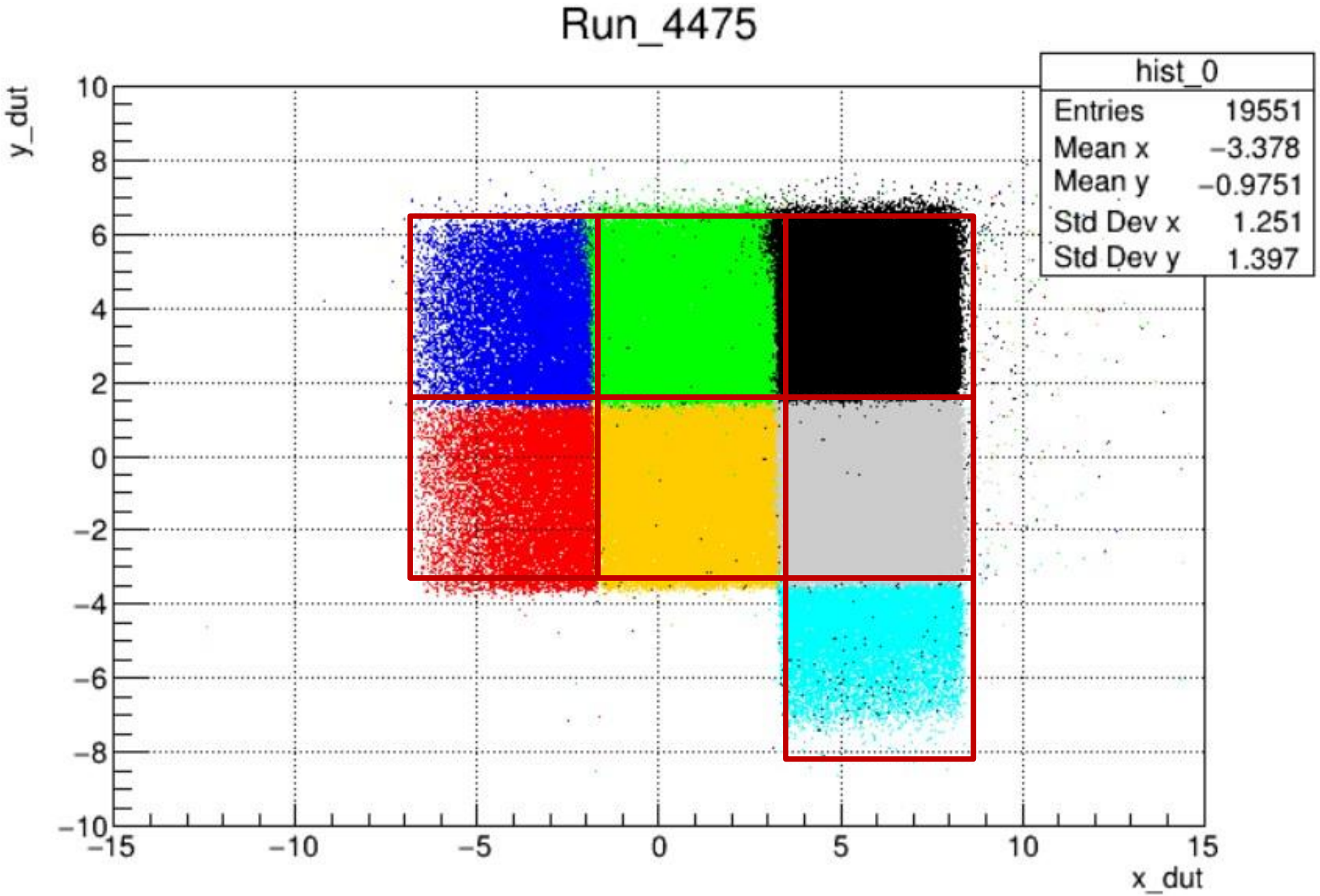

Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15

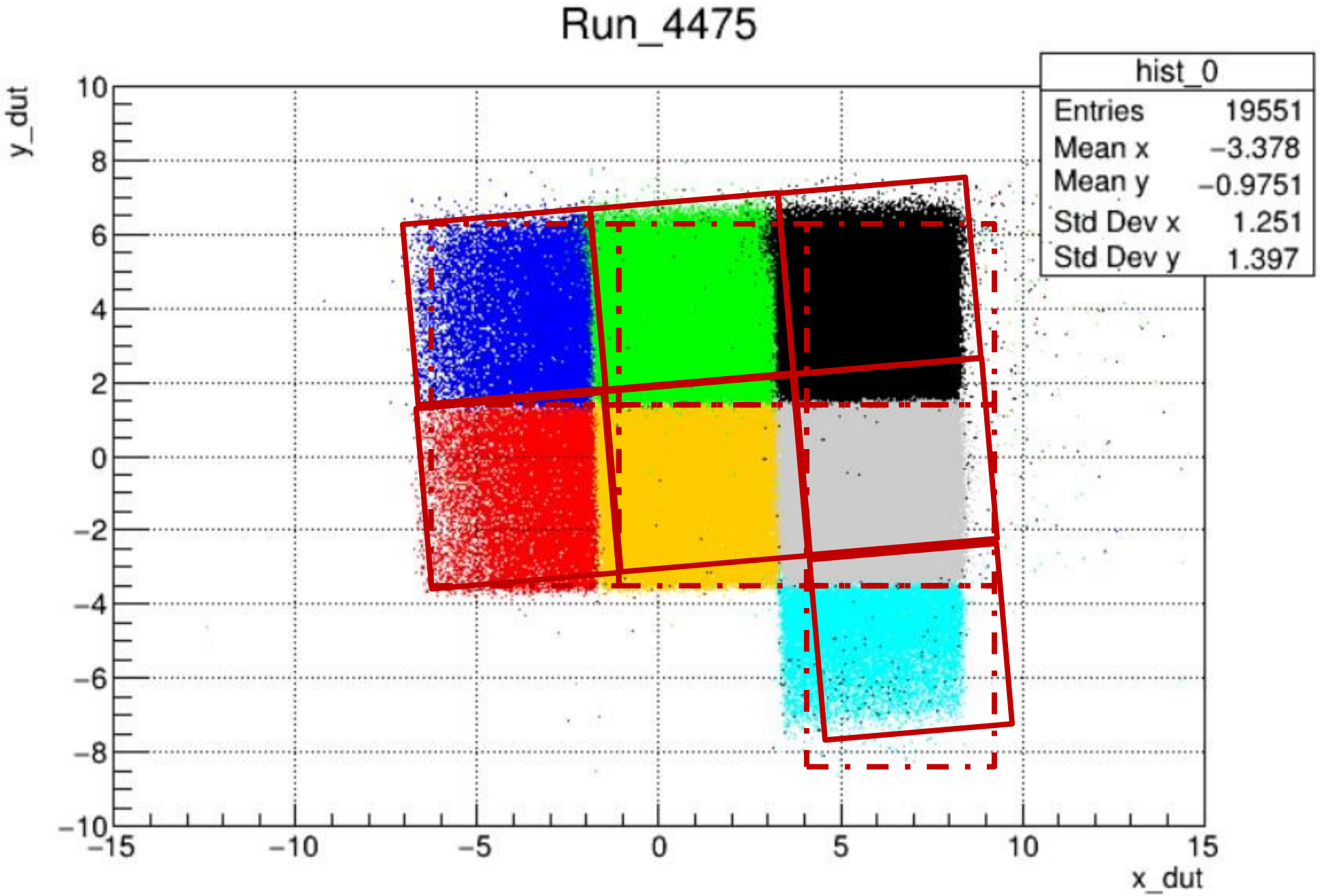

Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15

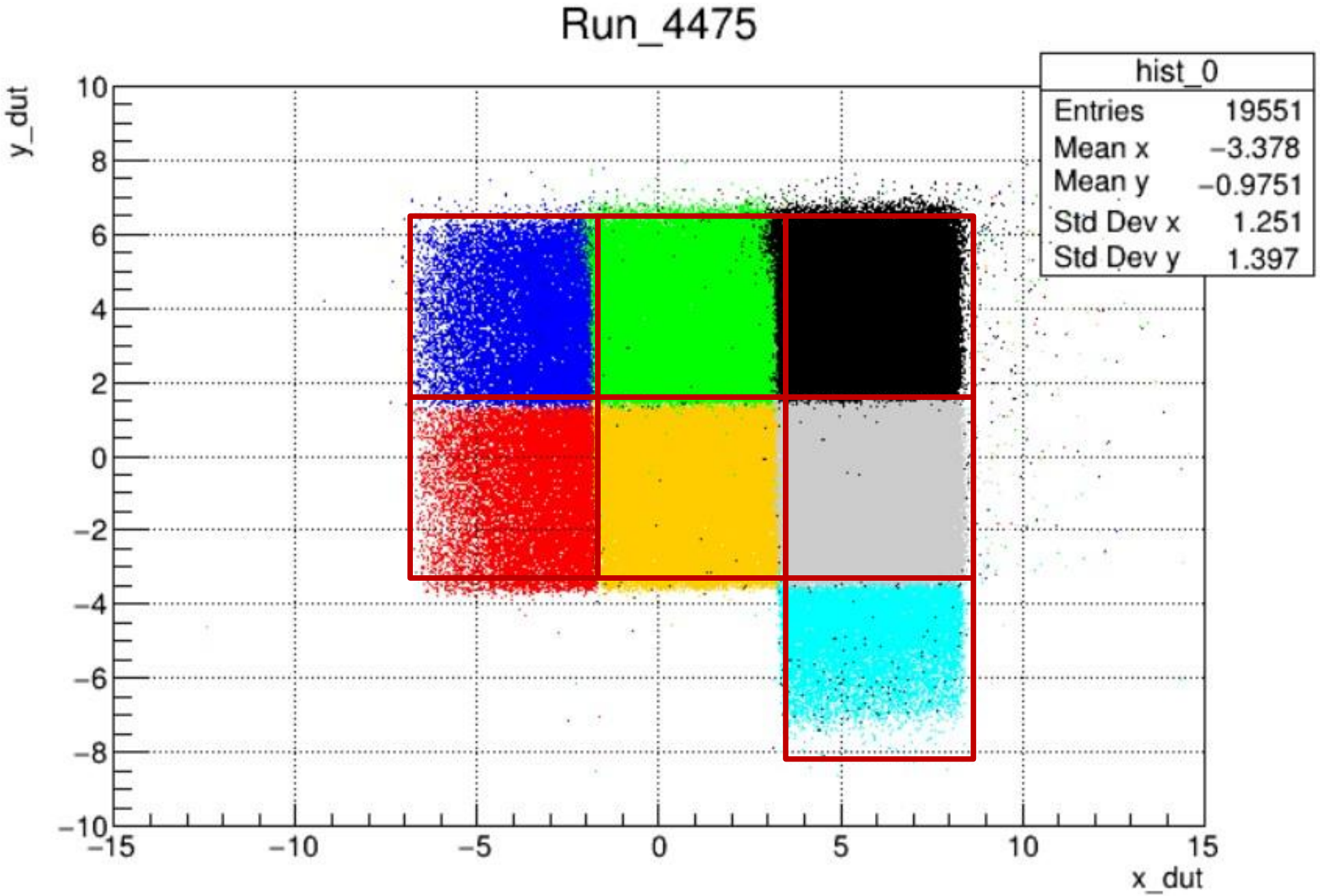

Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15


Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15


Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15


Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15


Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15


Run_4475
hist_0
Entries 19551
Mean x −3.378
Mean y −0.9751
Std Dev x 1.251
Std Dev y 1.397
y_dut
x_dut
10
8
6
4
2
0
−2
−4
−6
−8
−10
−15
−10
−5
0
5
10
15

The Alignment Process

The alignment process consists of four major steps:

- First Step – Finding the “leading” pads(Above 4.5% of the total entries)
- Second Step – Shift-aligning one corner pad, to avoid rotation effects
- Third Step – Rotating all the pads together
- Fourth Step – Final shift-alignment of the rotated pads

Run 4475 – ANTON 1 sensor

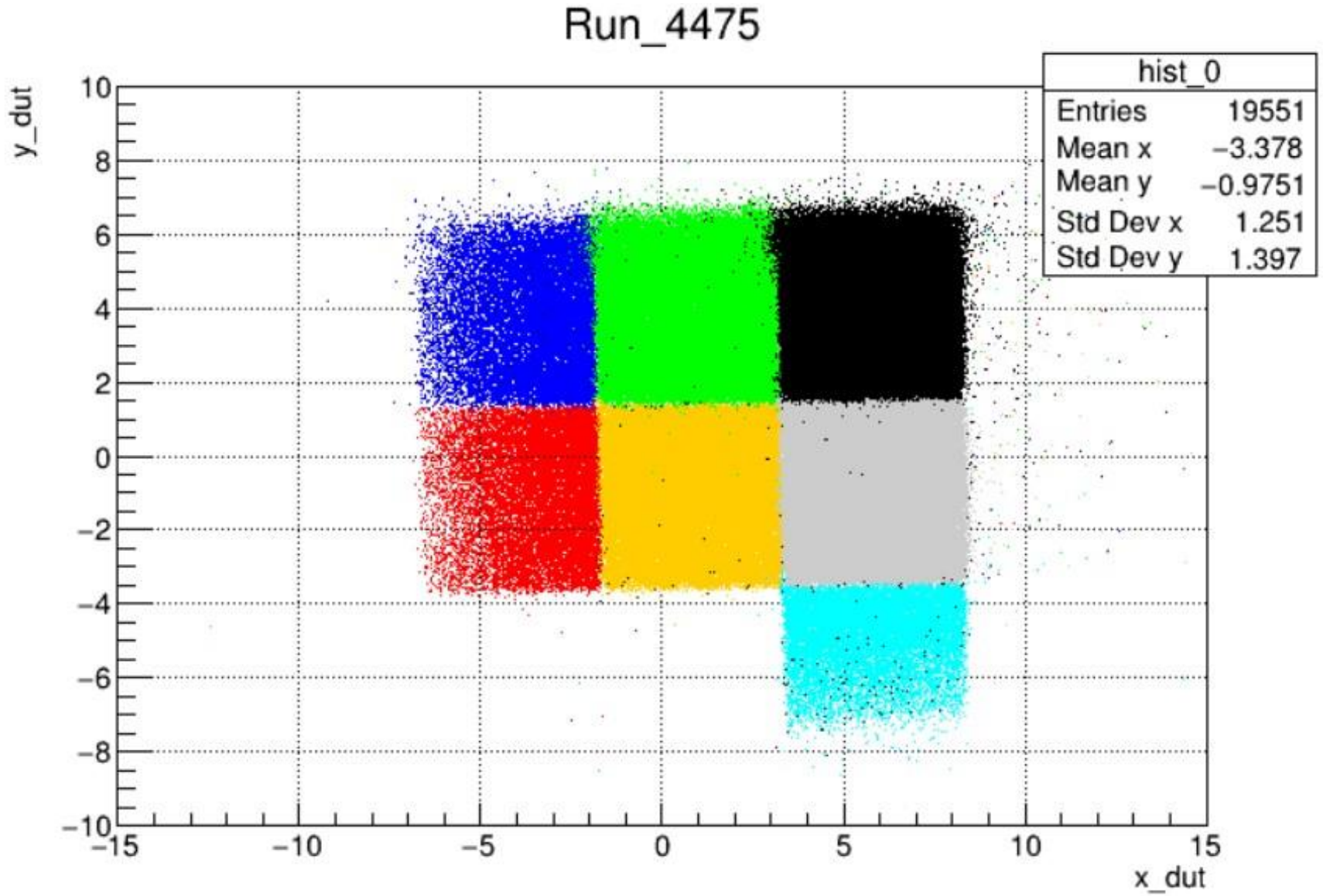
The Alignment Process

The alignment process consists of four major steps:

- First Step – Finding the “leading” pads(Above 4.5% of the total entries)
- Second Step – Shift-aligning one corner pad, to avoid rotation effects
- Third Step – Rotating all the pads together
- Fourth Step – Final shift-alignment of the rotated pads

Run 4475 – Step 1

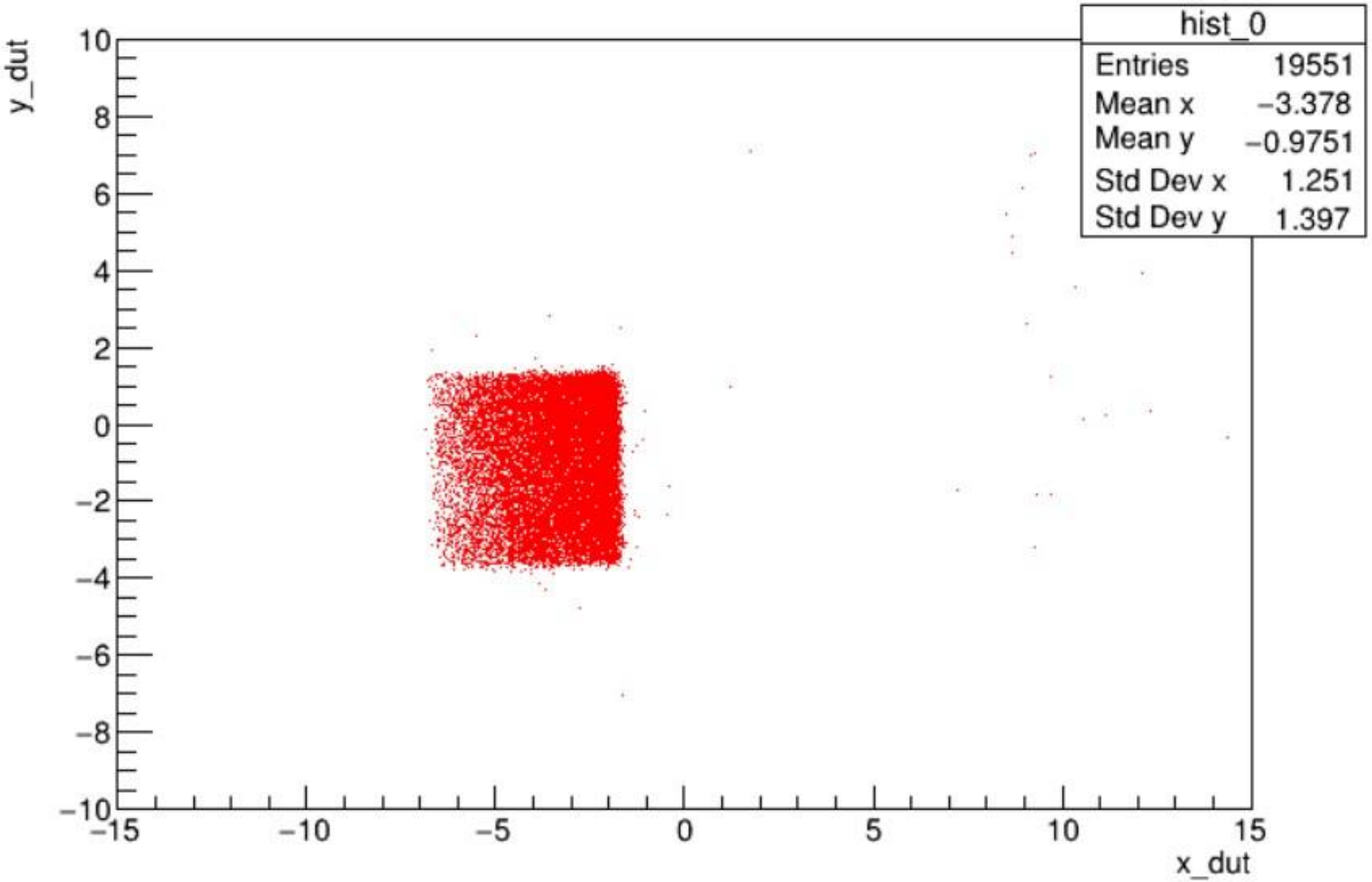
***Each color represents a different pad**



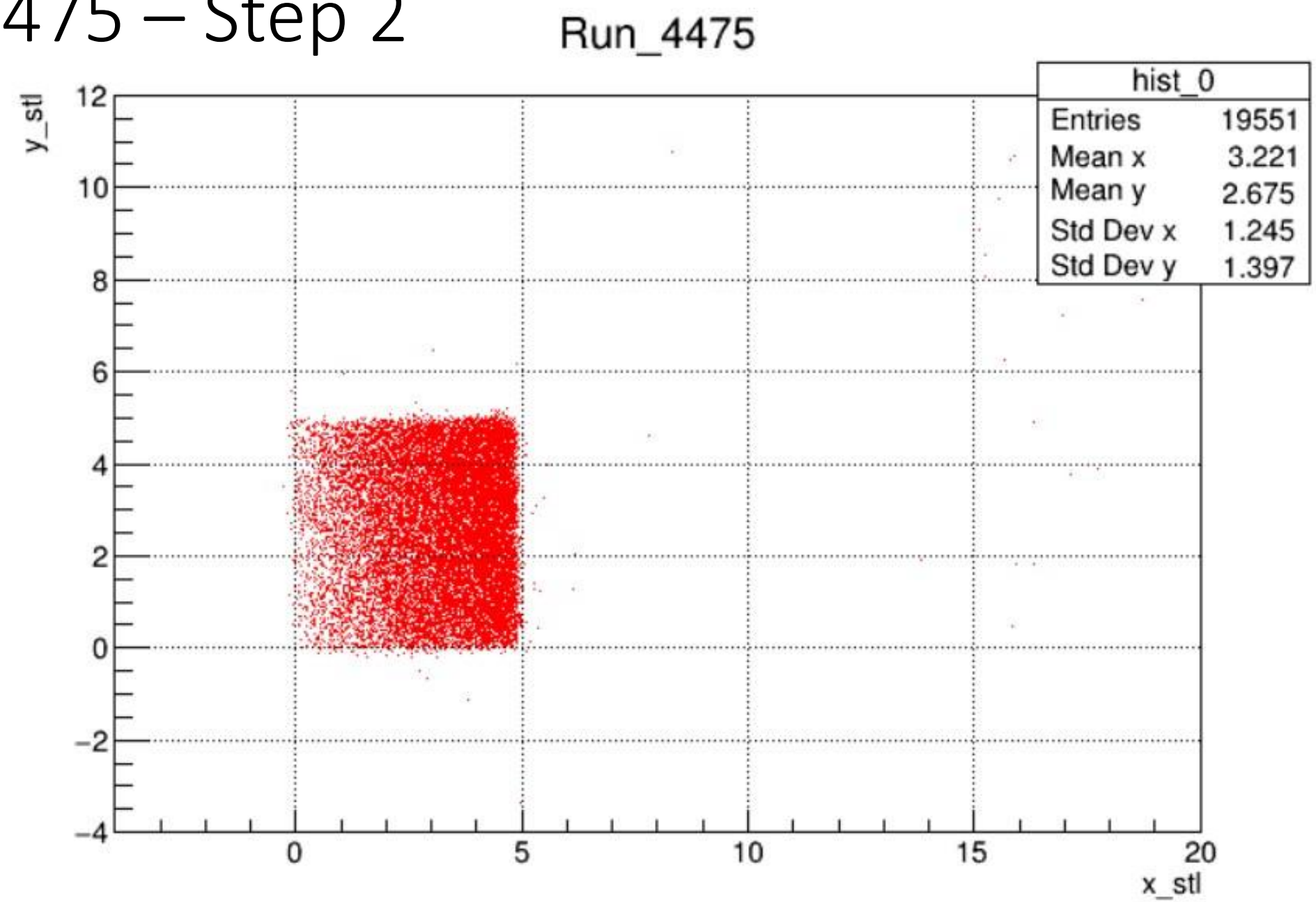
The Alignment Process

- The alignment process consists of four major steps:
- First Step – Finding the “leading” pads(Above 4.5% of the total entries)
- Second Step – Shift-aligning one corner pad, to avoid rotation effects
- Third Step – Rotating all the pads together
- Fourth Step – Final shift-alignment of the rotated pads

Run 4475 – Step 2



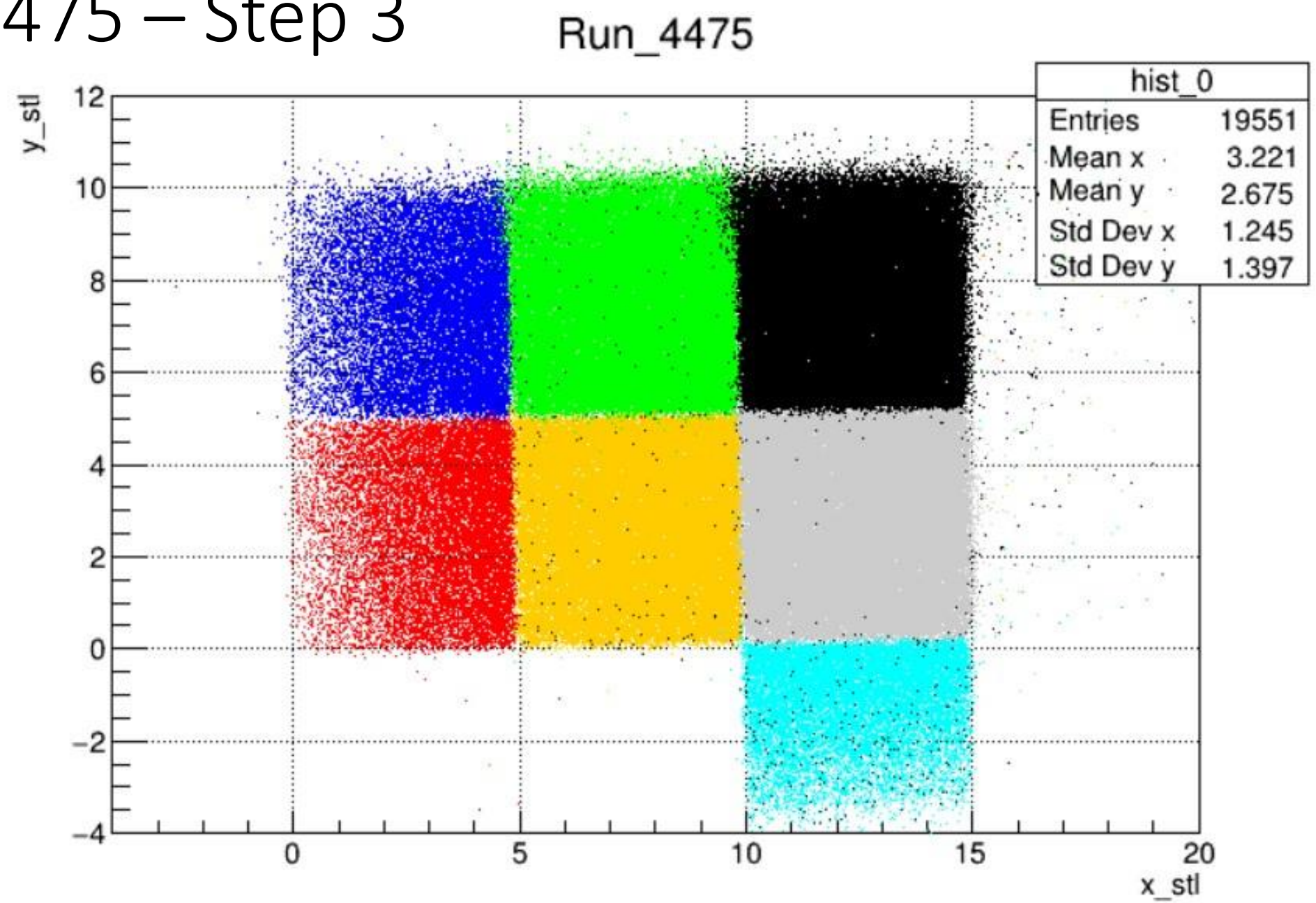
Run 4475 – Step 2



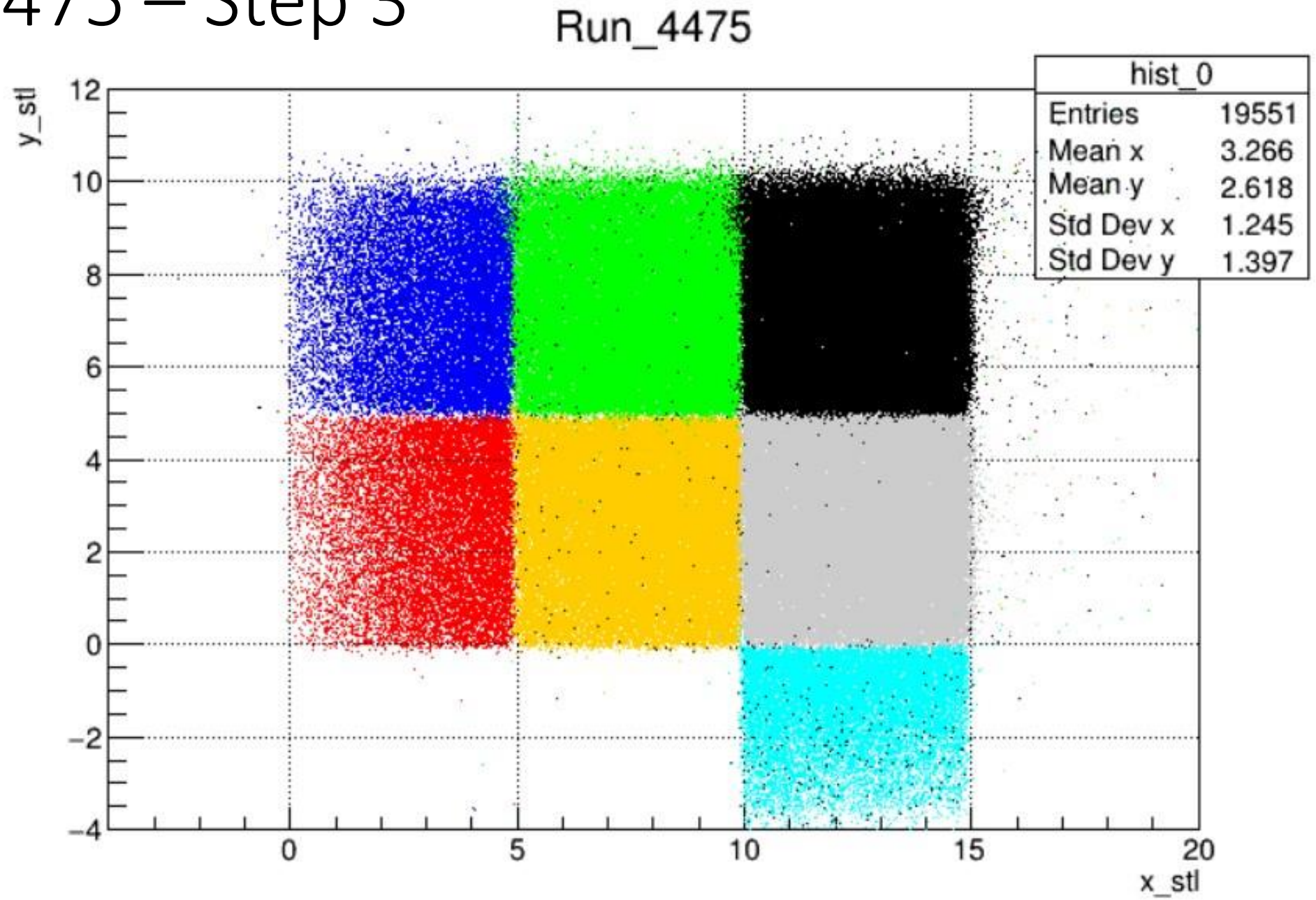
The Alignment Process

- The alignment process consists of four major steps:
- First Step – Finding the “leading” pads(Above 4.5% of the total entries)
- Second Step – Shift-aligning one corner pad, to avoid rotation effects
- Third Step – Rotating all the pads together
- Fourth Step – Final shift-alignment of the rotated pads

Run 4475 – Step 3



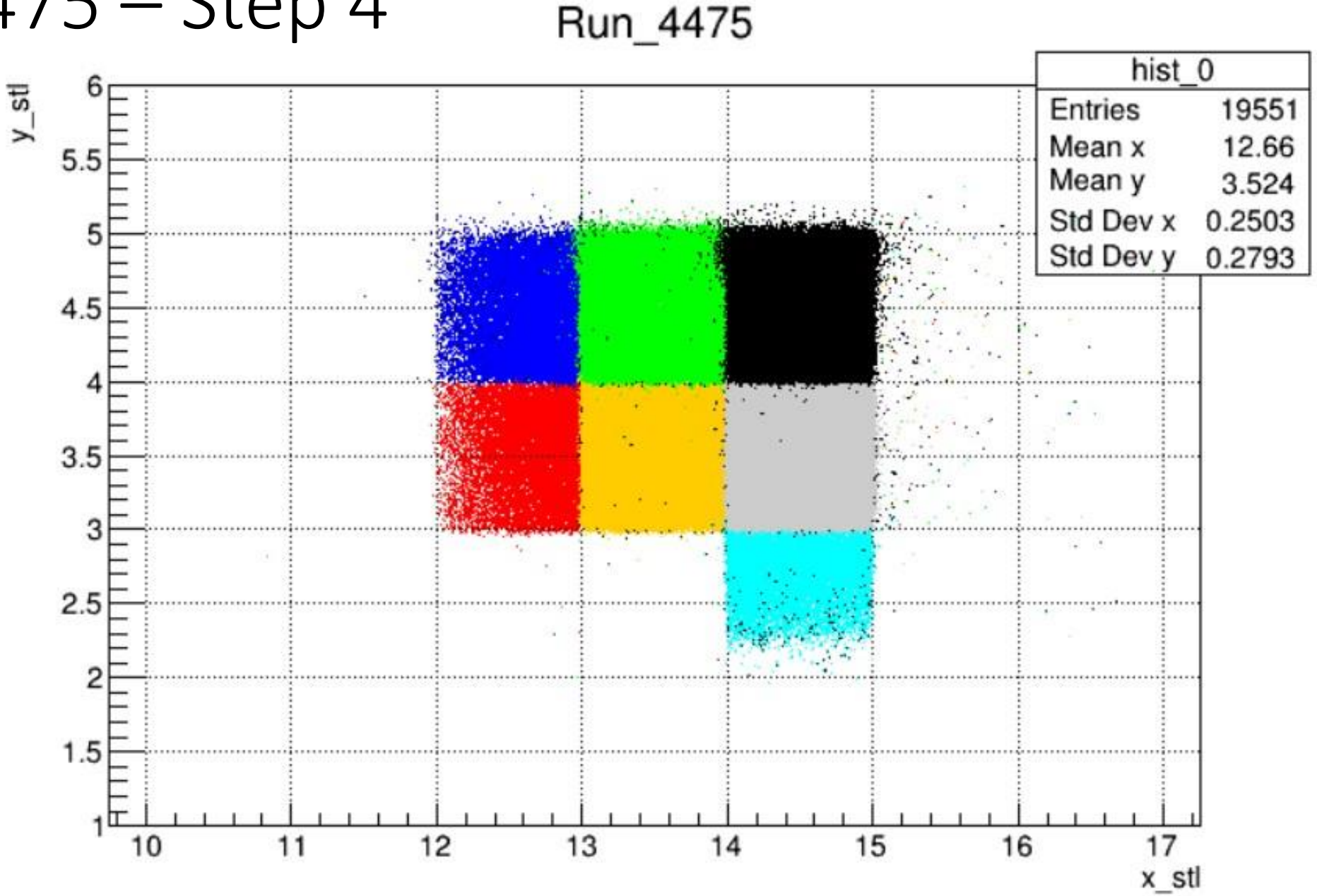
Run 4475 – Step 3



The Alignment Process

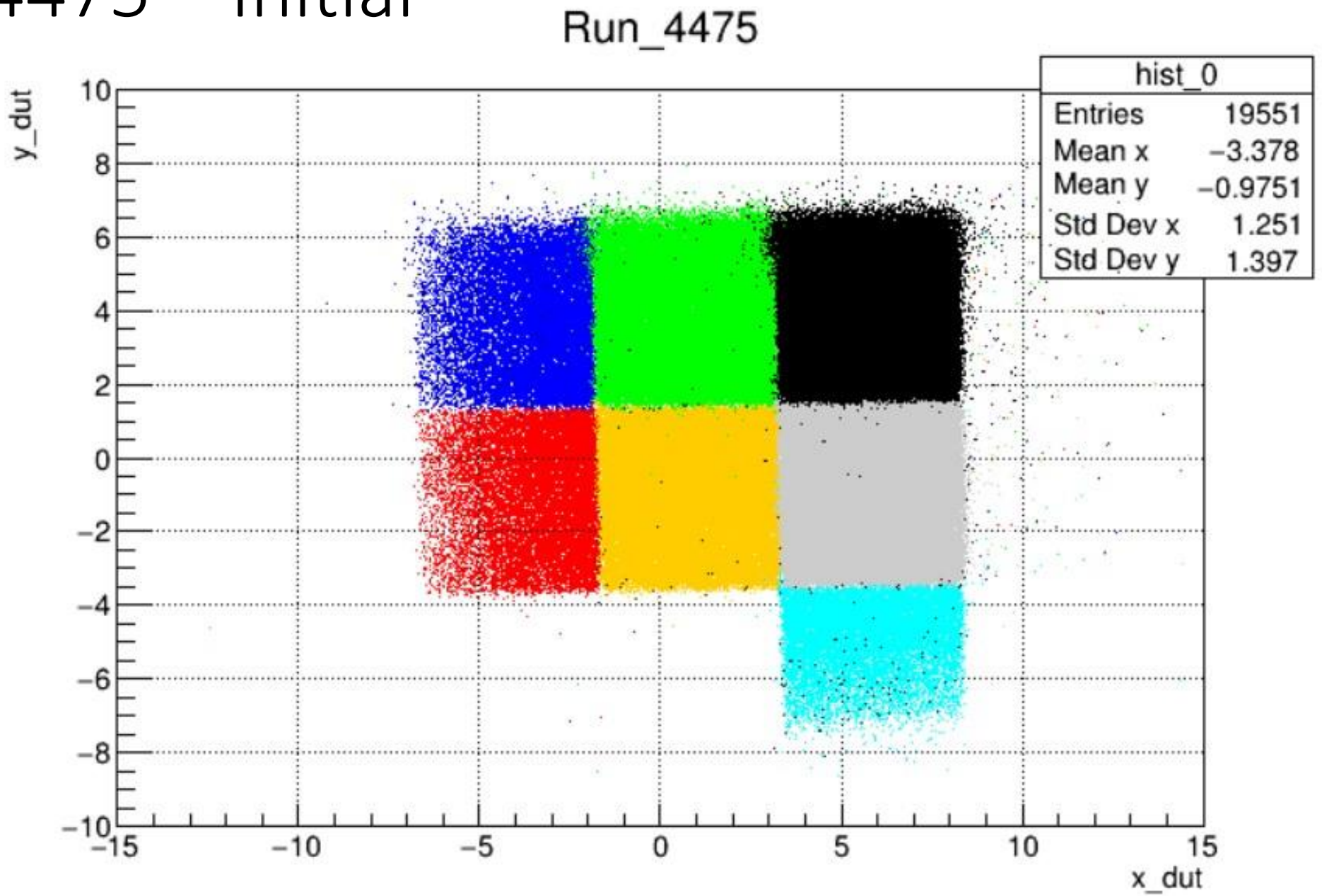
- The alignment process consists of four major steps:
- First Step – Finding the “leading” pads(Above 4.5% of the total entries)
- Second Step – Shift-aligning one corner pad, to avoid rotation effects
- Third Step – Rotating all the pads together
- Fourth Step – Final shift-alignment of the rotated pads

Run 4475 – Step 4

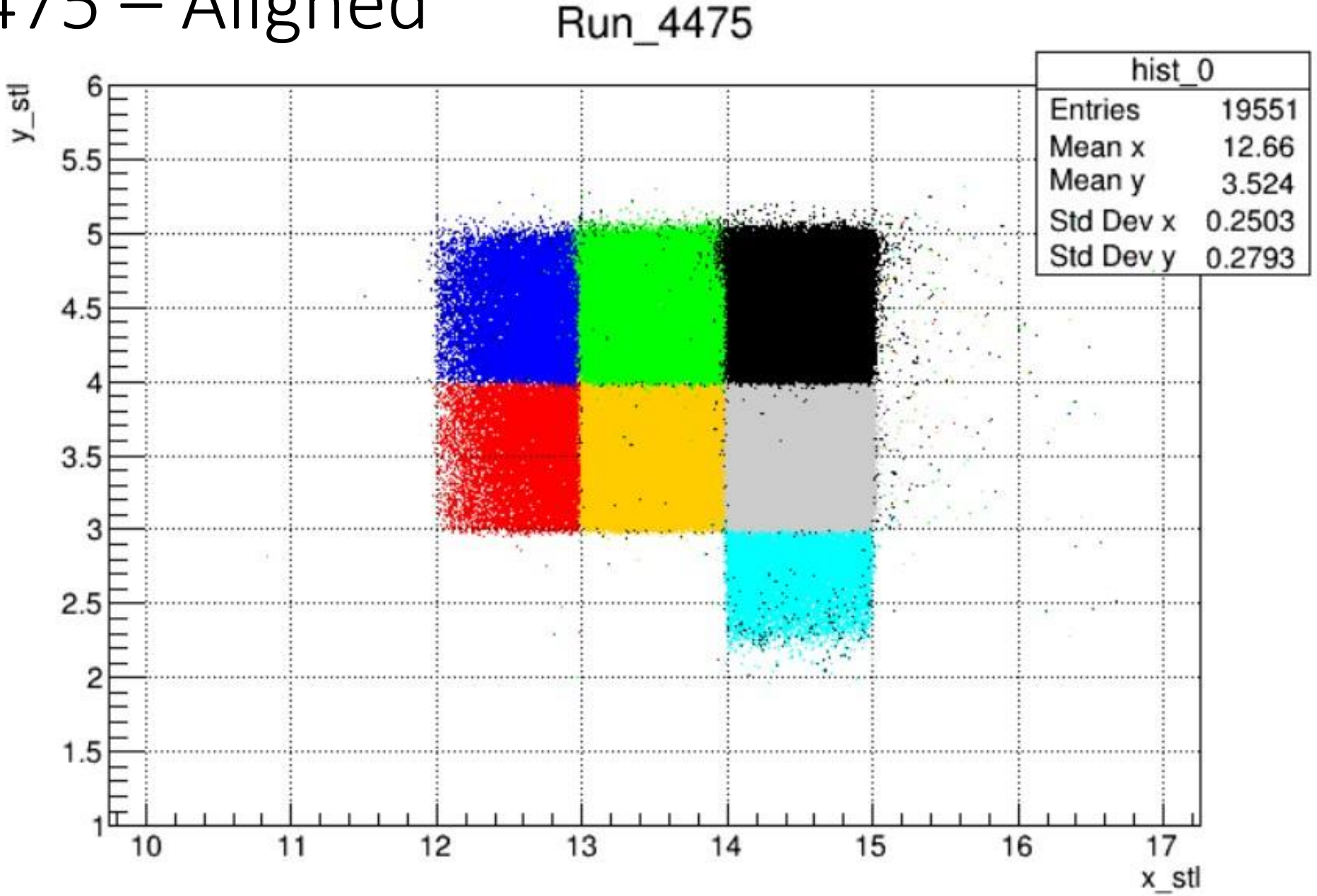


To Summarize

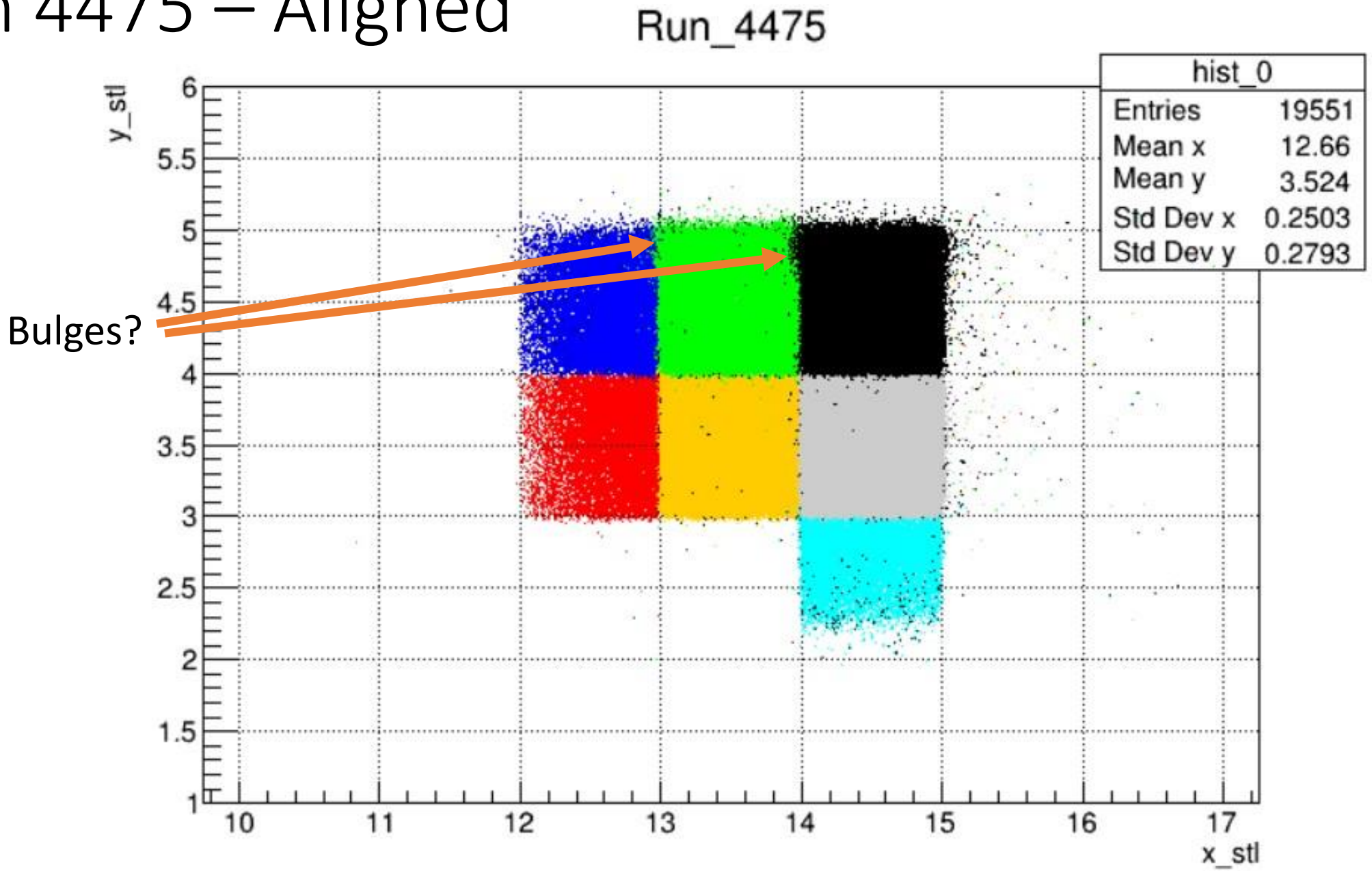
Run 4475 – Initial



Run 4475 – Aligned

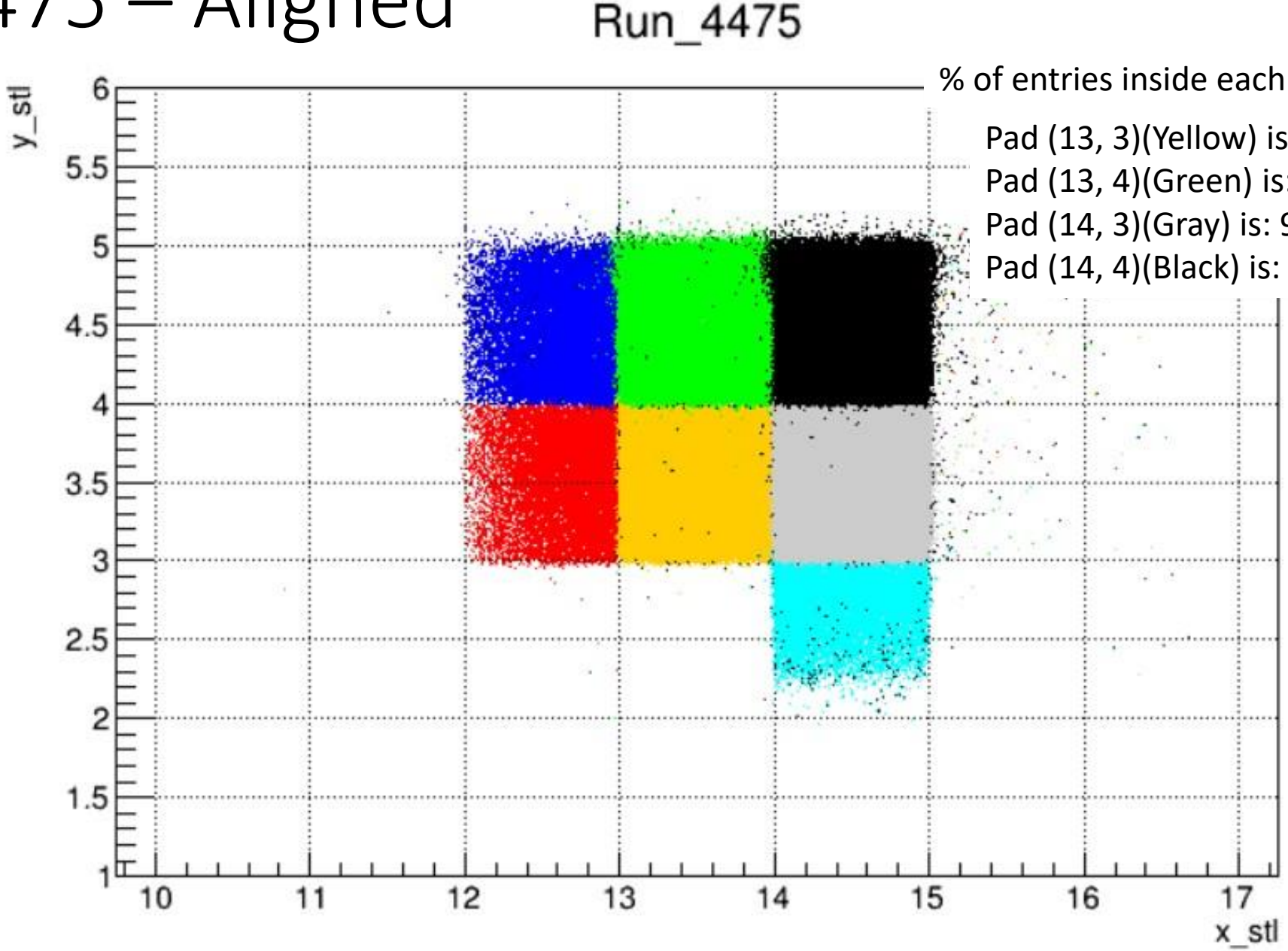


Run 4475 – Aligned



Bulges?

Run 4475 – Aligned



% of entries inside each of the four main pads:

Pad (13, 3)(Yellow) is: 99.02% out of 57483
Pad (13, 4)(Green) is: 97.61% out of 65299
Pad (14, 3)(Gray) is: 98.71% out of 80836
Pad (14, 4)(Black) is: 97.79% out of 87499

Comparing Results – Run 4475

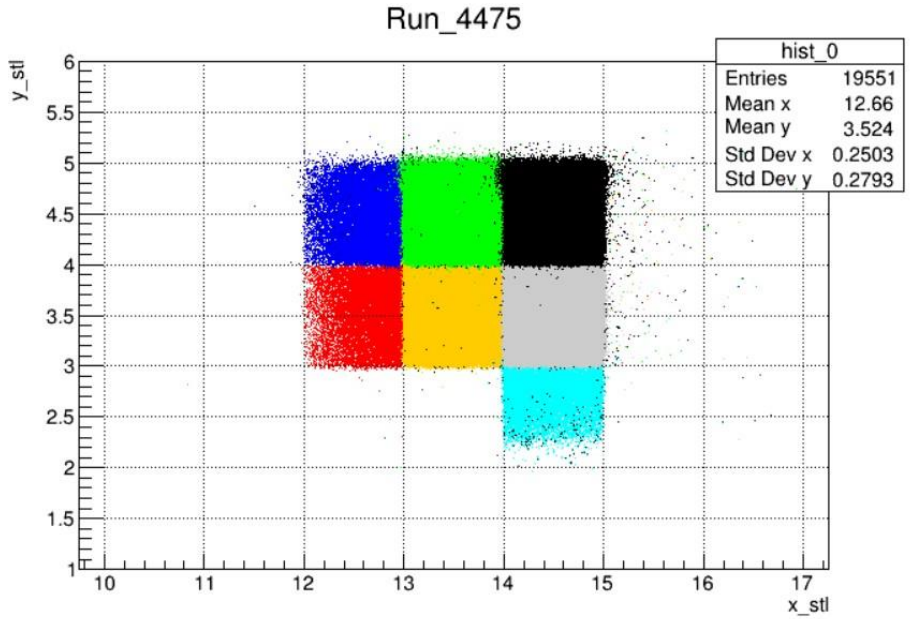
Kirill's, Michal's alignment:

Pad (13, 3)(Yellow) is: 99.02%, 99.09%

Pad (13, 4)(Green) is: 97.61% , 97.60%

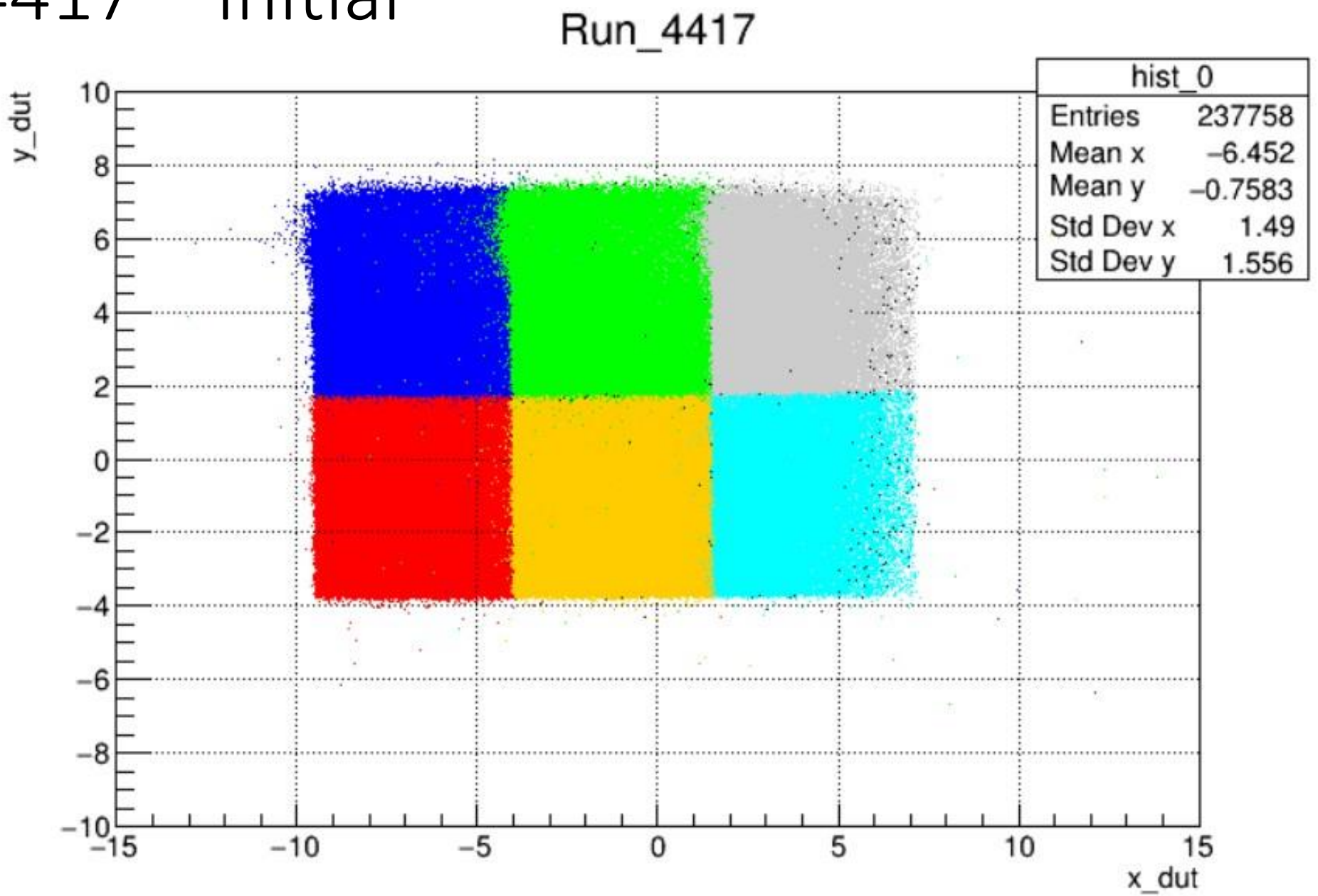
Pad (14, 3)(Gray) is: 98.71% , 98.66%

Pad (14, 4)(Black) is: 97.79%, 97.74%

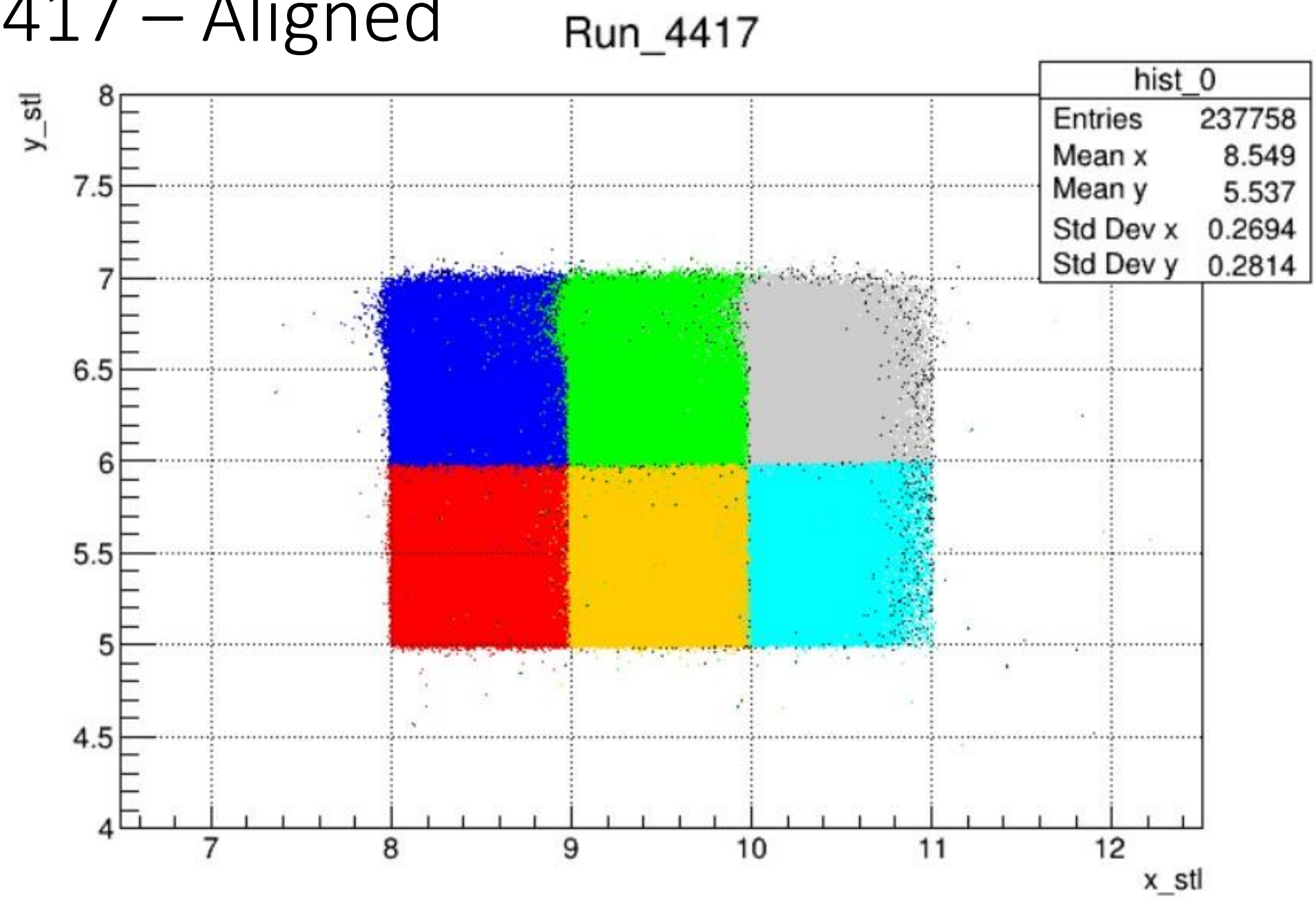


Run 4417 – Calice 75 sensor

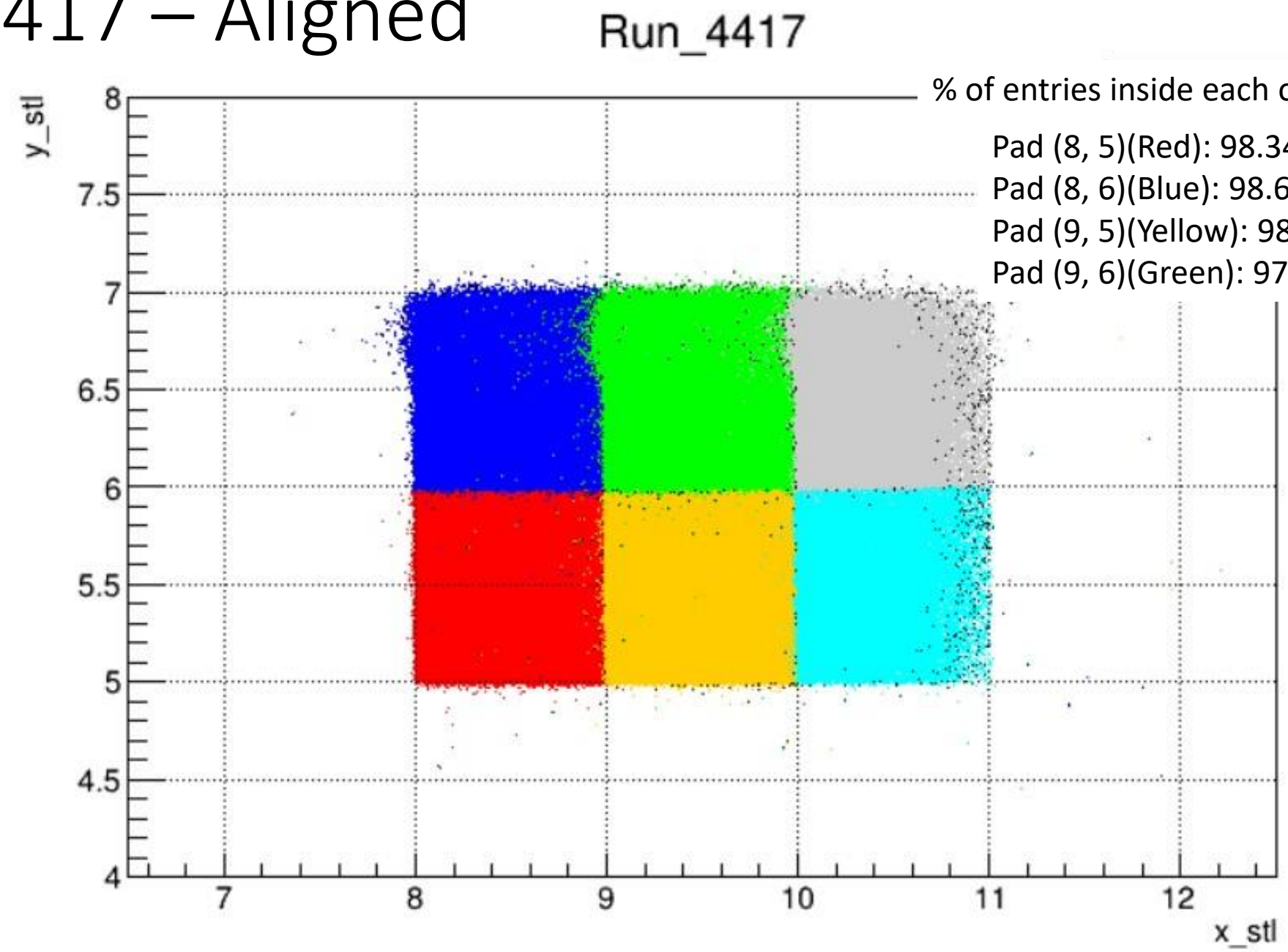
Run 4417 – Initial



Run 4417 – Aligned



Run 4417 – Aligned



% of entries inside each of the four main pads:

Pad (8, 5)(Red): 98.34% out of 237758
Pad (8, 6)(Blue): 98.6% out of 231559
Pad (9, 5)(Yellow): 98.45% out of 197998
Pad (9, 6)(Green): 97.91% out of 203907

Comparing Results – Run 4417

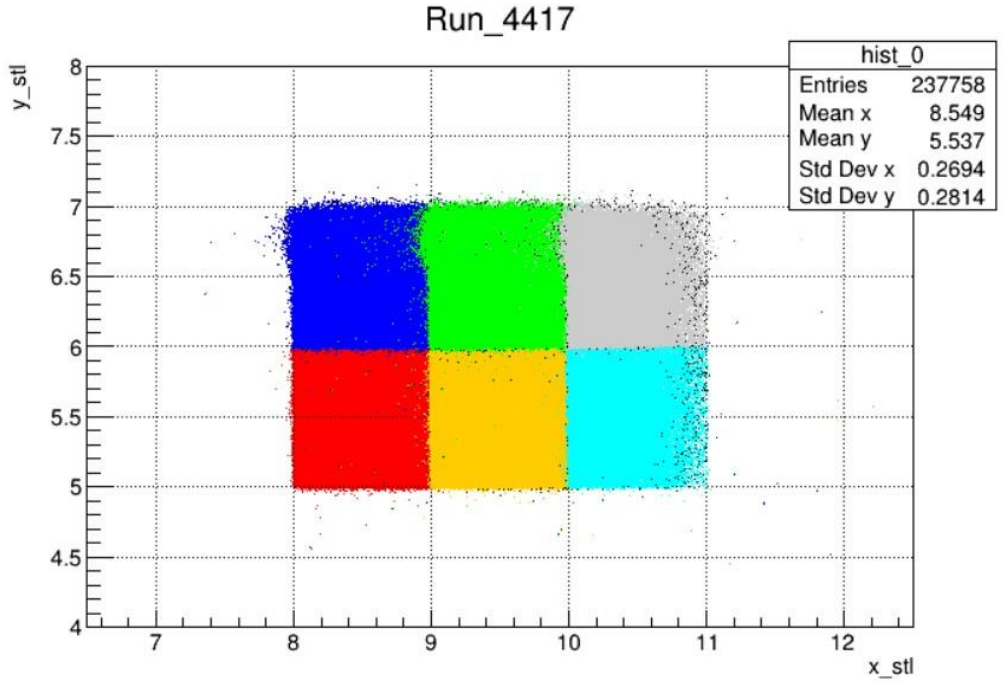
Kirill's, Michal's alignment:

Pad (8, 5)(Red): 98.34%, 98.62%

Pad (8, 6)(Blue): 98.60% , 98.65%

Pad (9, 5)(Yellow): 98.45% , 97.55%

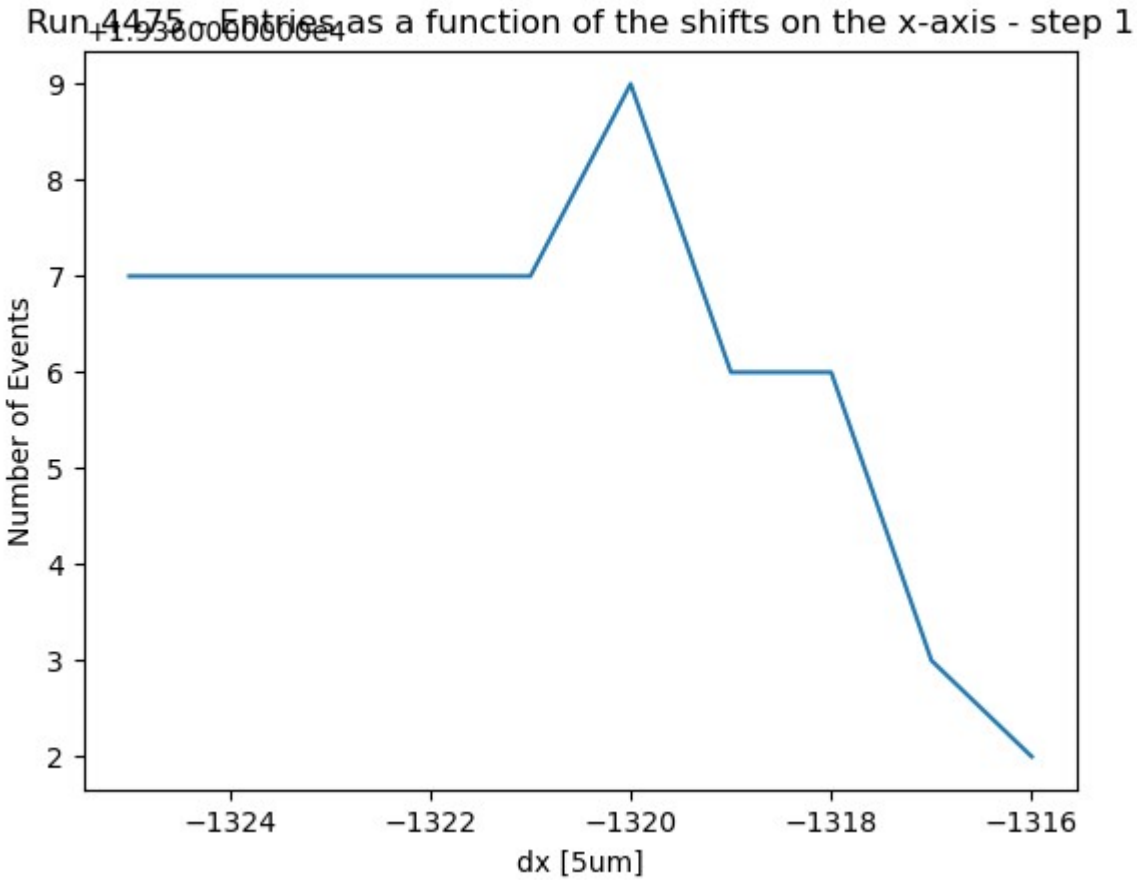
Pad (9, 6)(Green): 97.91%, 98.40%

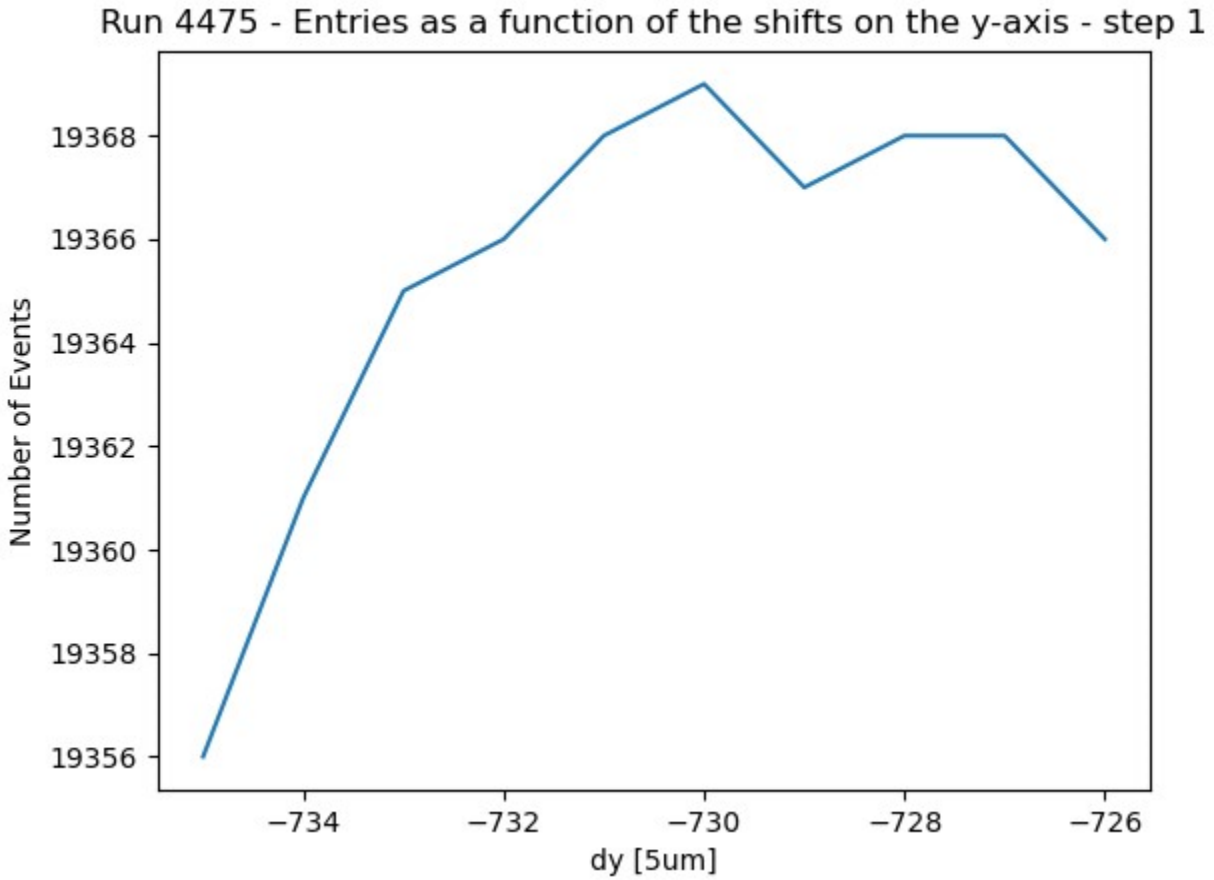


Additional Plots

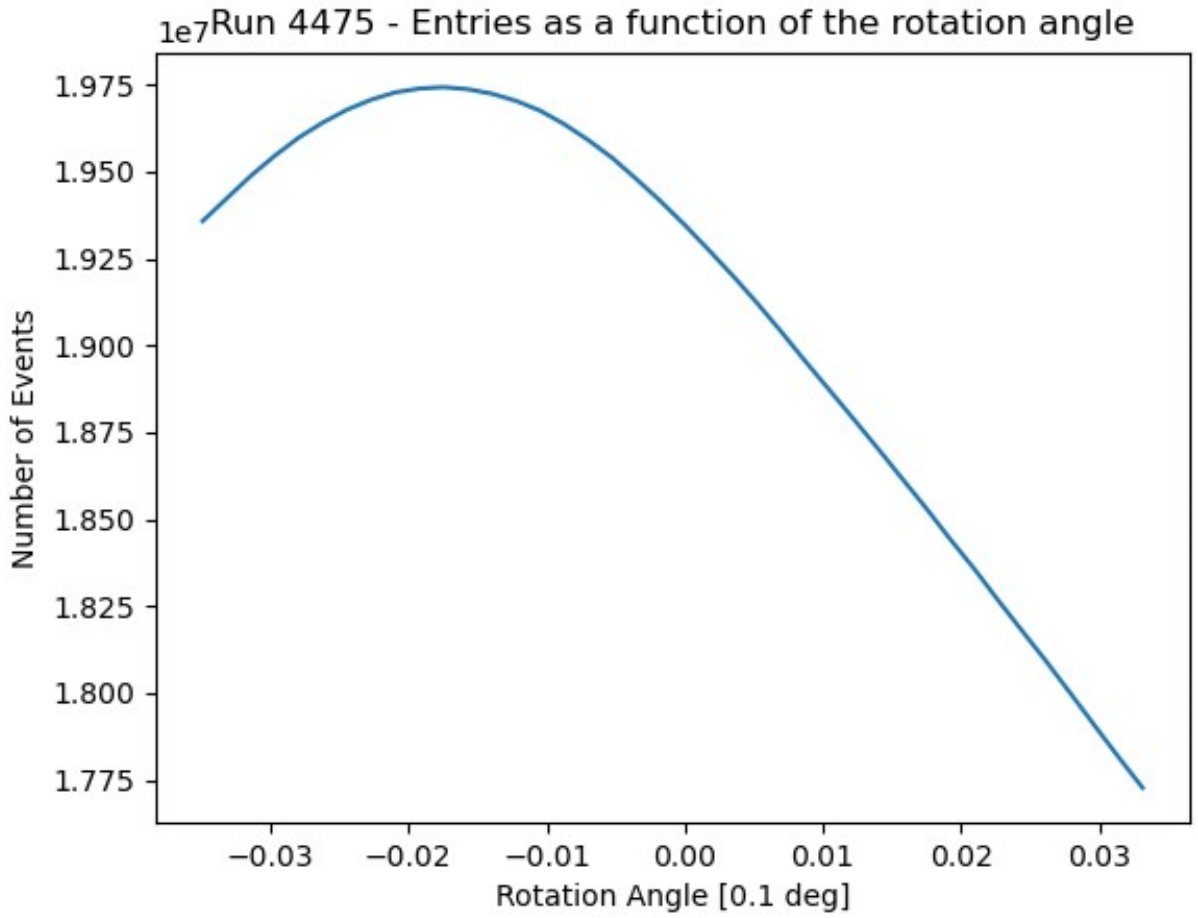
- The program plots the numbers of entries as a function of each shift for us to make sure that there was a unique maximum

Step 2 – Axis shifts for one pad

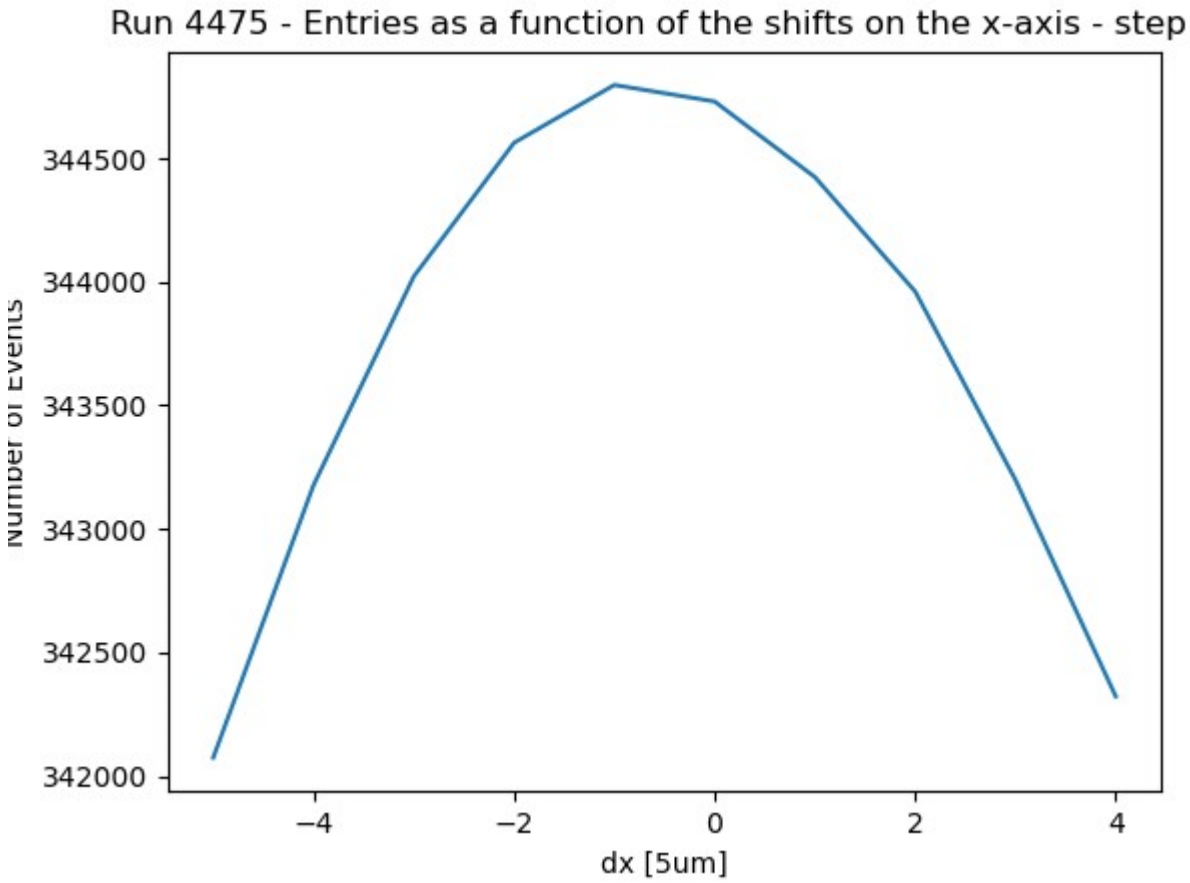


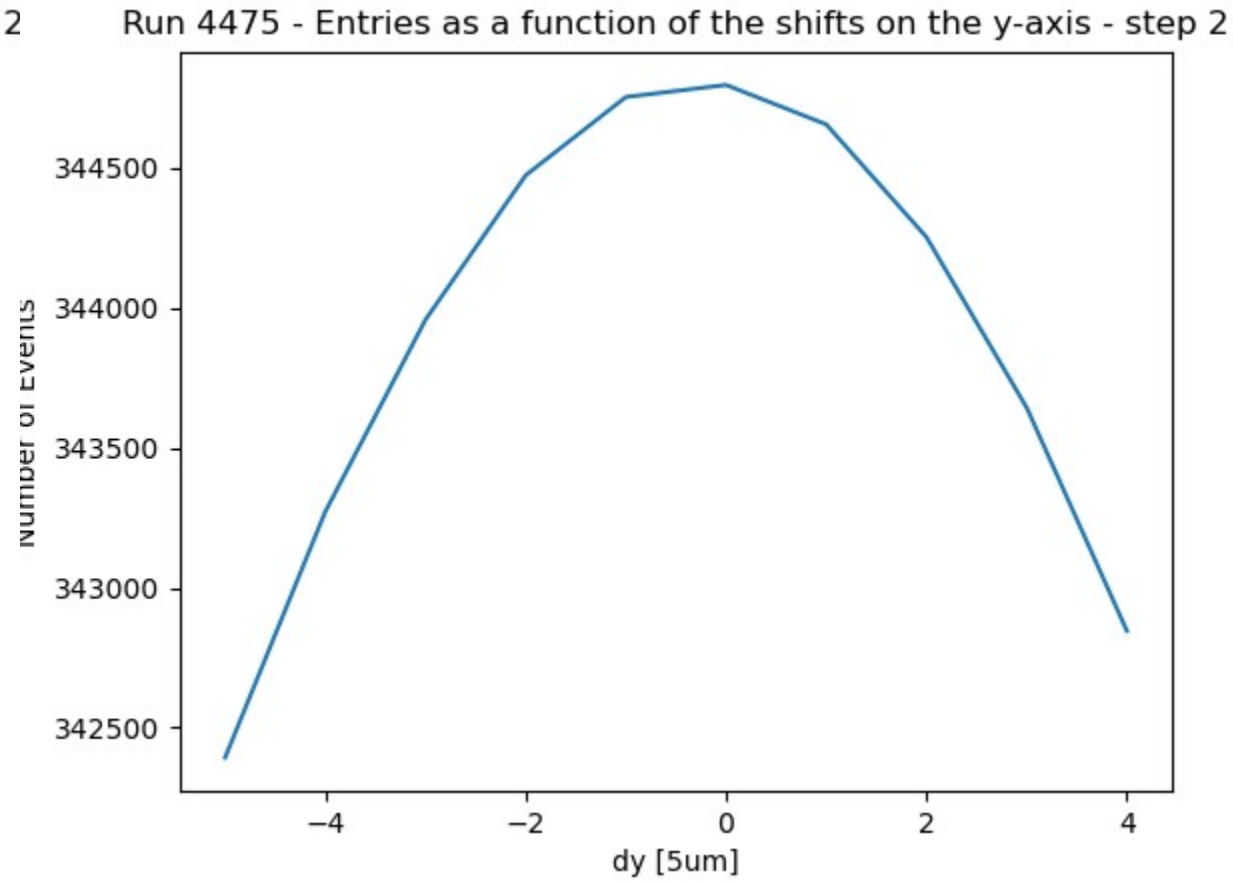


Step 3 – Rotation Shifts



Step 4 – Axis shifts for all pads





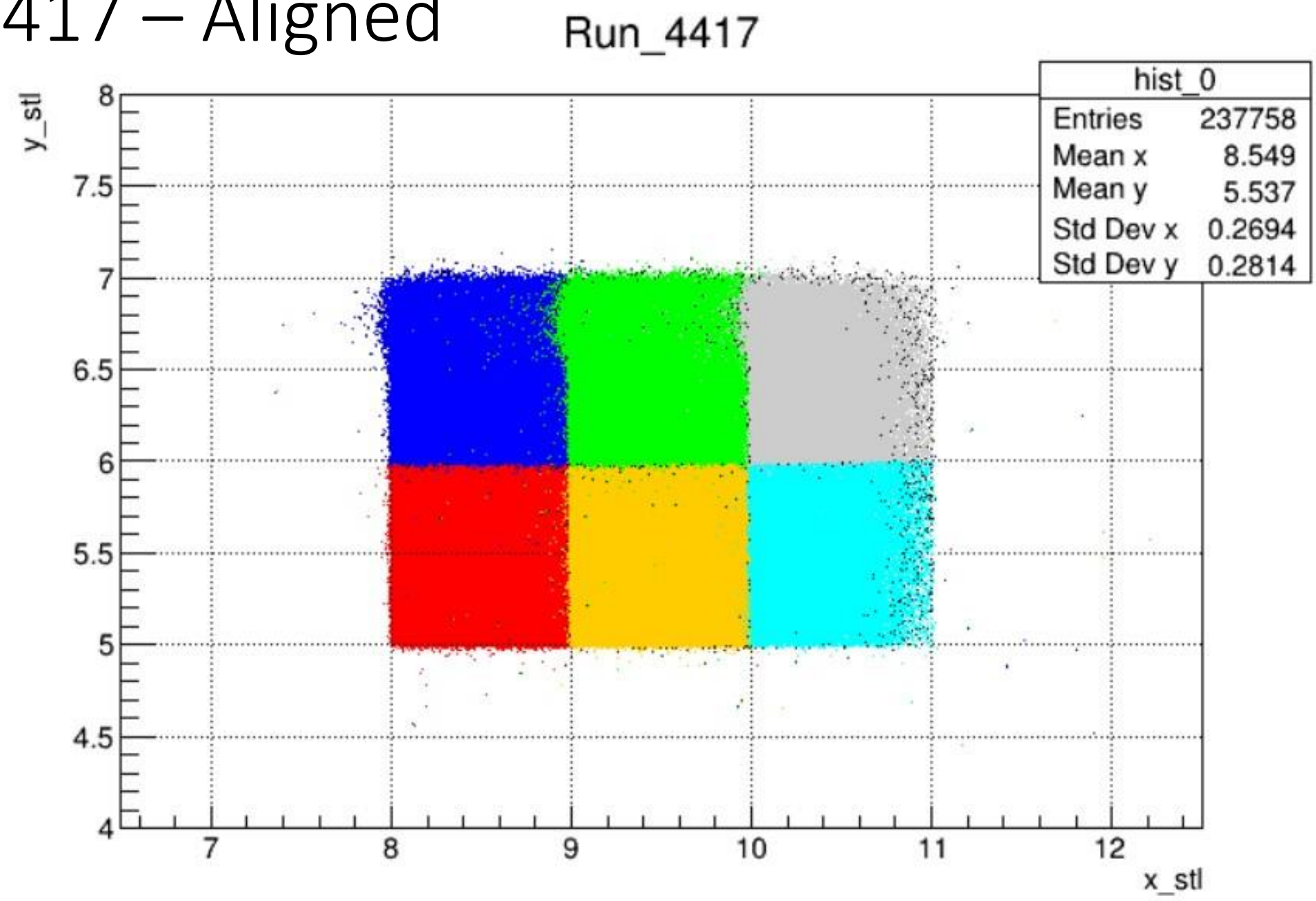
Problems

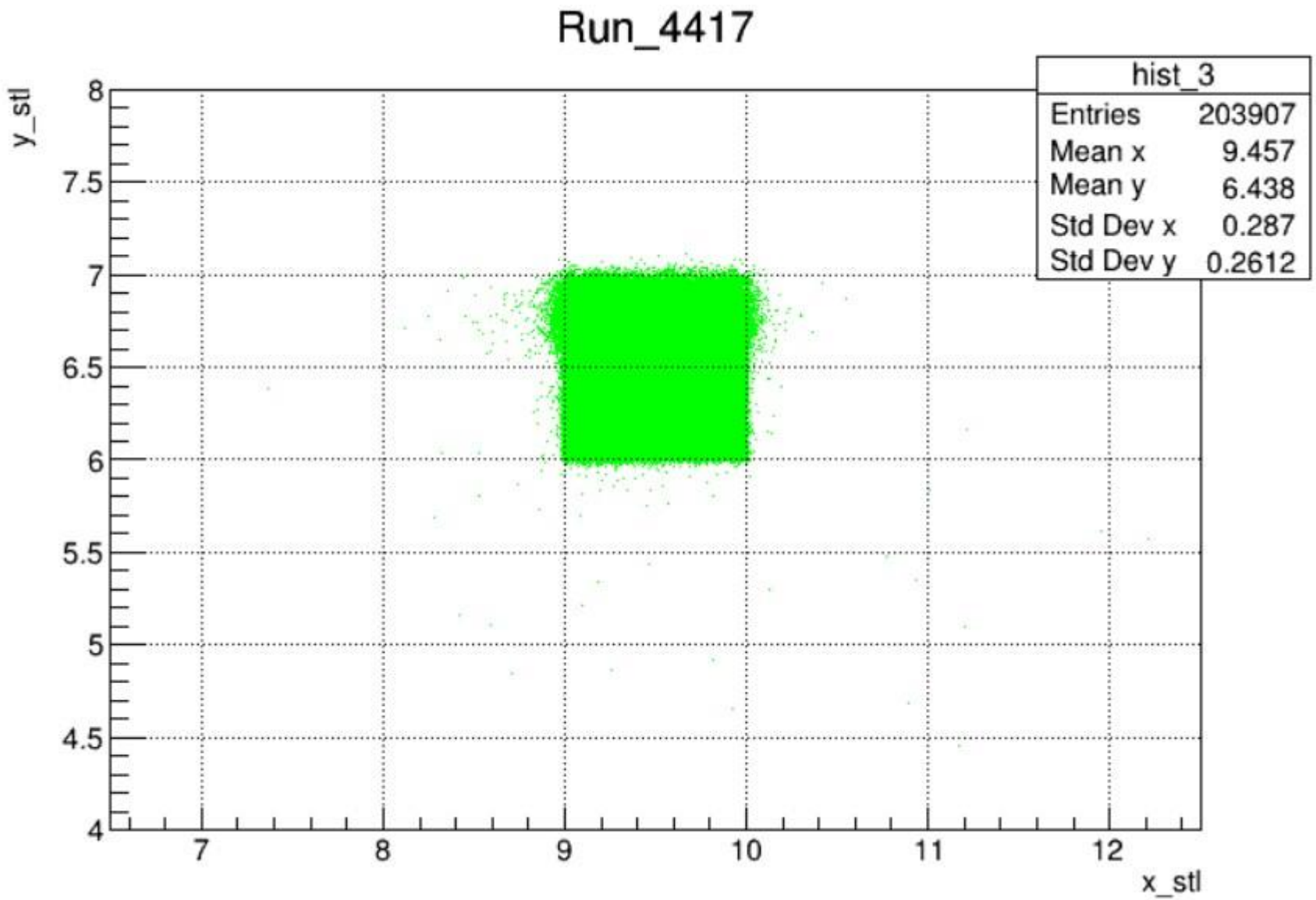
- The program takes about 5.5-7.5 minutes to align completely for each individual run
- “Bulges” on the upper row of each run

Problems

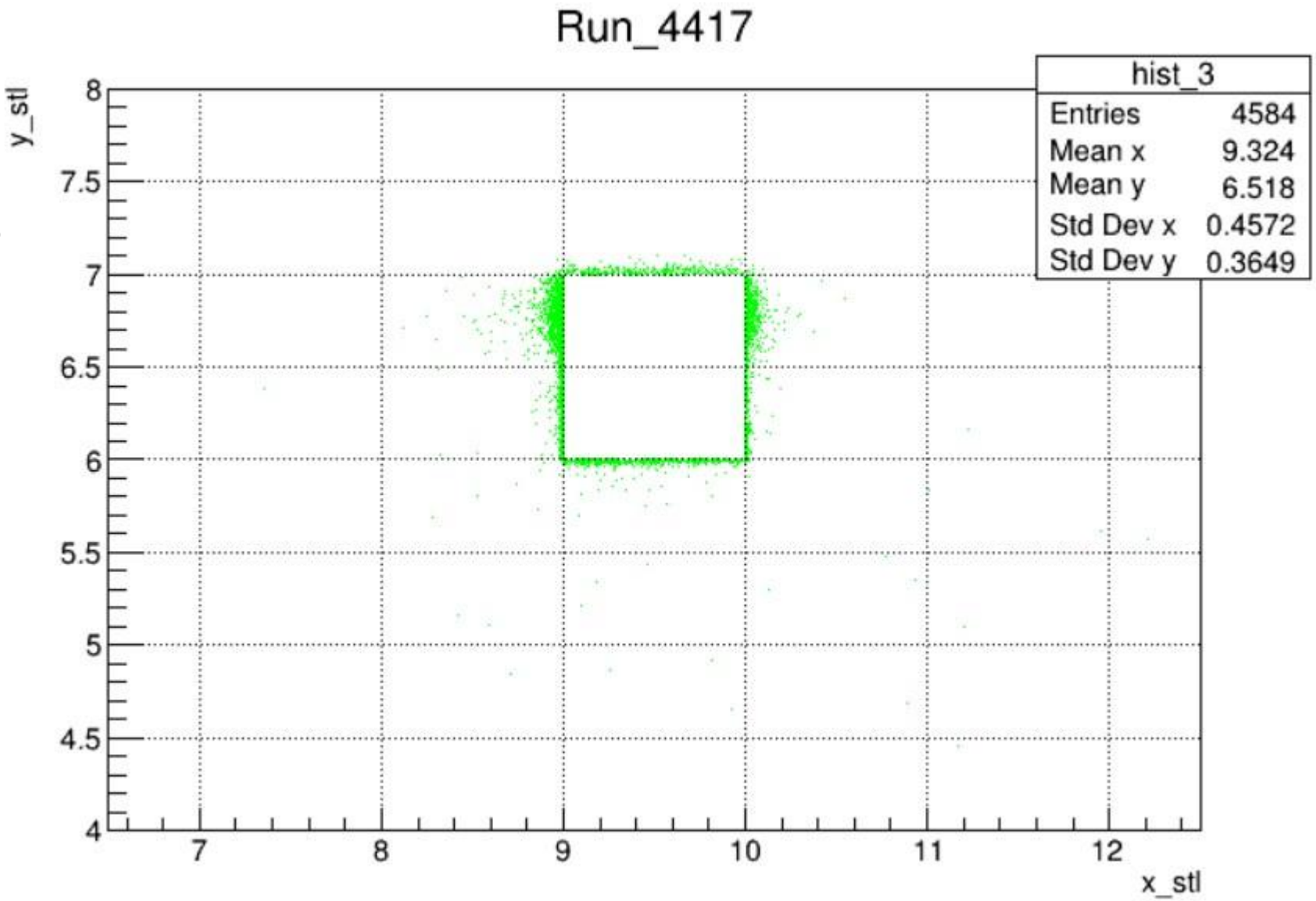
- The program takes about 5.5-7.5 minutes to align completely for each individual run
- “Bulges” on the upper row of each run

Run 4417 – Aligned



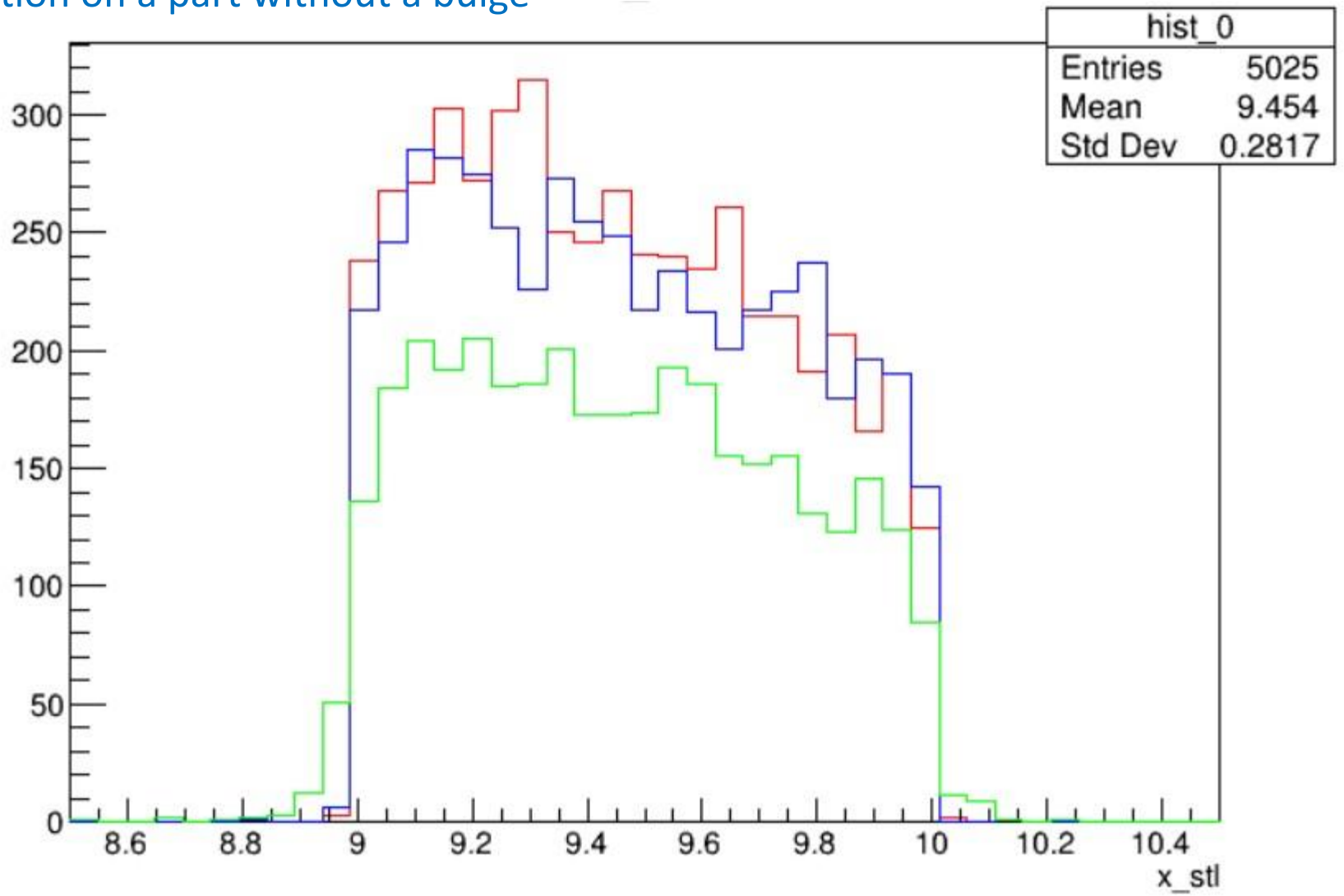

Run_4417
hist_3
Entries 203907
Mean x 9.457
Mean y 6.438
Std Dev x 0.287
Std Dev y 0.2612
y_stl
x_stl
8
7.5
7
6.5
6
5.5
5
4.5
4
7
8
9
10
11
12

% of entries outside: 2.09%

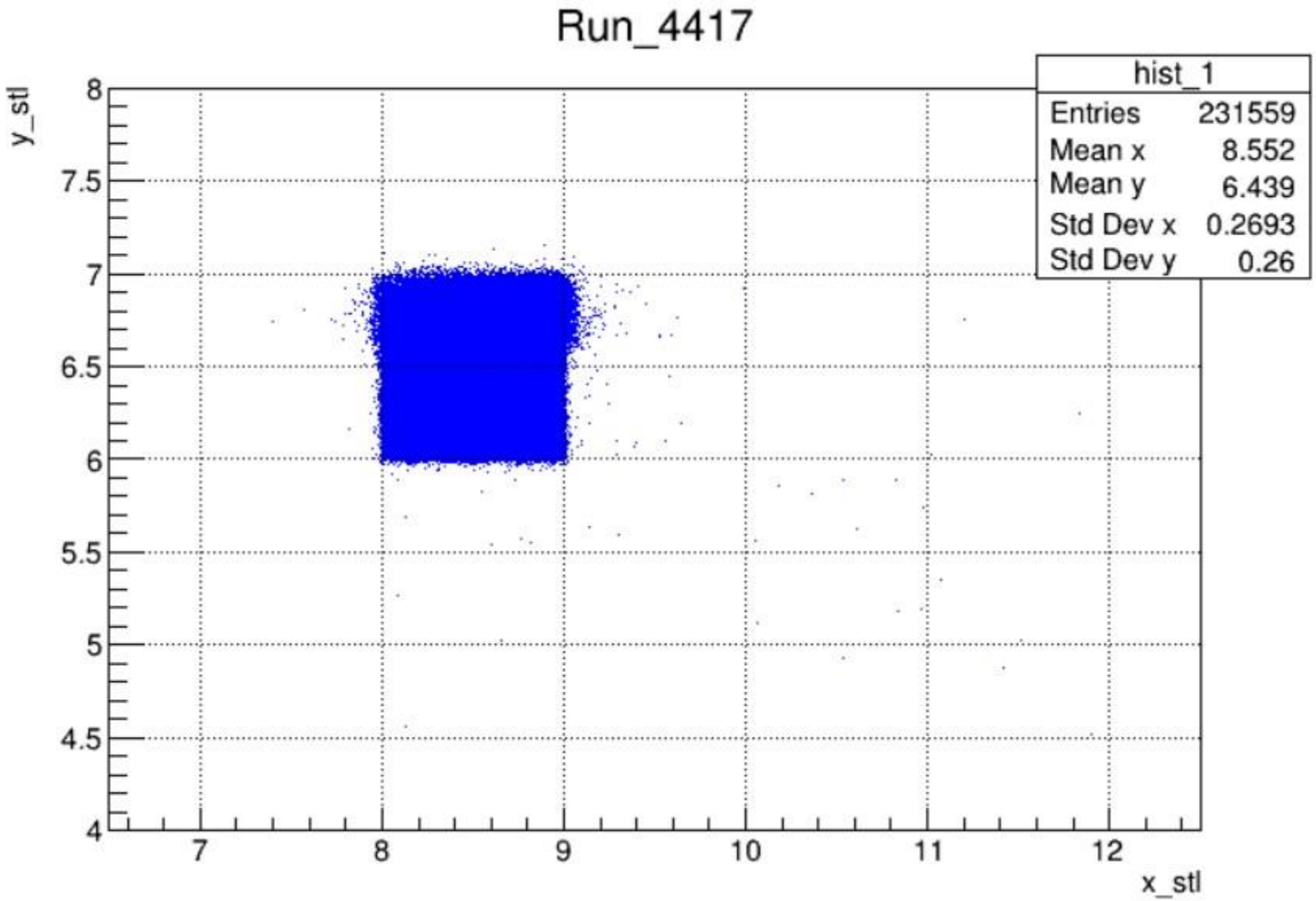


Run 4417 - Pad (9,6) (Green):

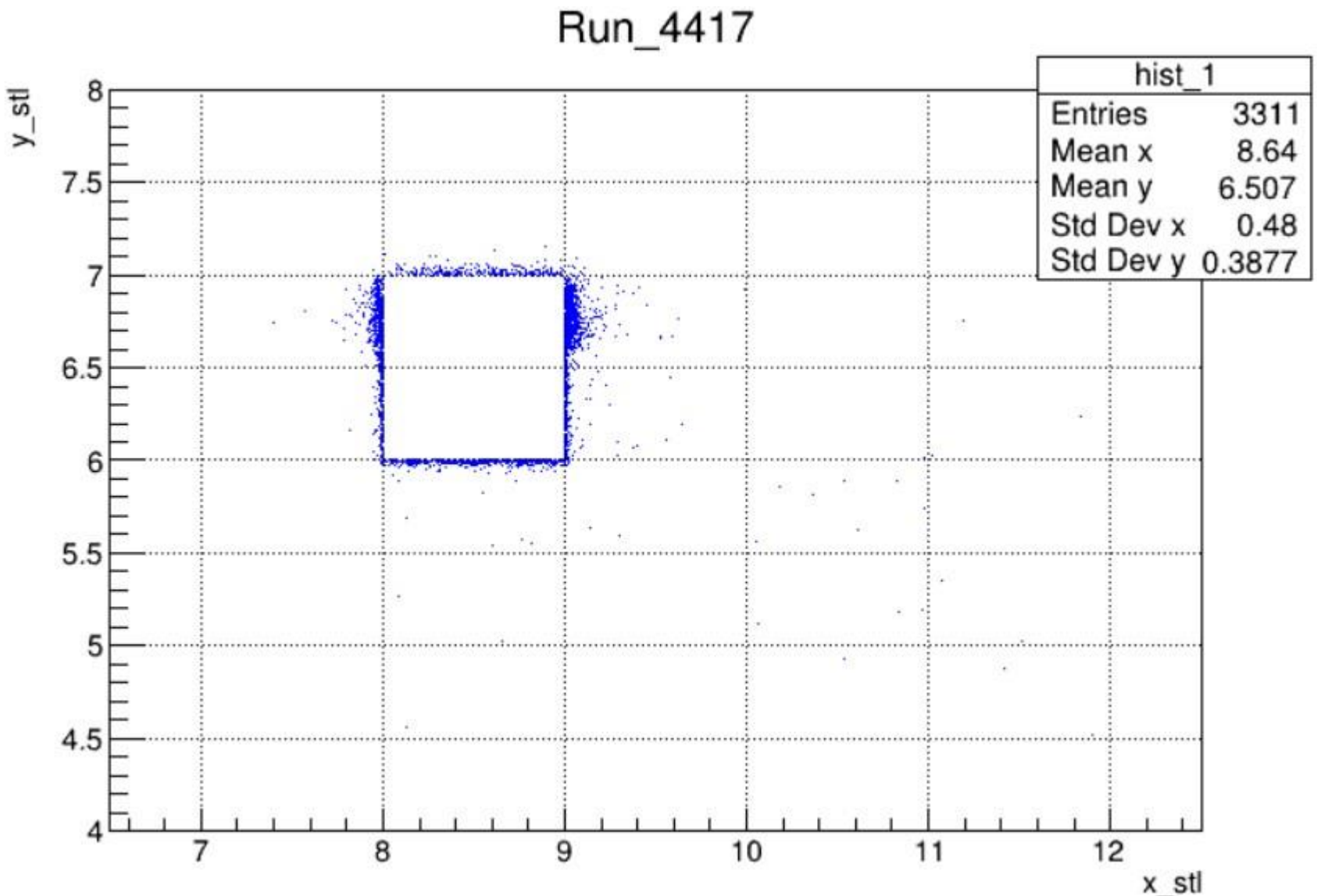
- Green Plot – Projection on the bulge
- Red Plot – Projection on the middle of the pad
- Blue Plot – Projection on a part without a bulge



- The bulges are notable visually, but the percentage is relatively low
- The bulges always occur on the upper row, independent of sensor and run number(before the alignment as well)
- We suspect that they come from a property of the telescope, and will use them to determine it’s resolution


Run_4417
hist_1
Entries 231559
Mean x 8.552
Mean y 6.439
Std Dev x 0.2693
Std Dev y 0.26
y_stl
x_stl
8
7.5
7
6.5
6
5.5
5
4.5
4
7
8
9
10
11
12

% of entries outside: 1.40%



Questions?

Thank You For Listening☺