# MIPP
# Collaboration Meeting
# TPC Cluster Fitter

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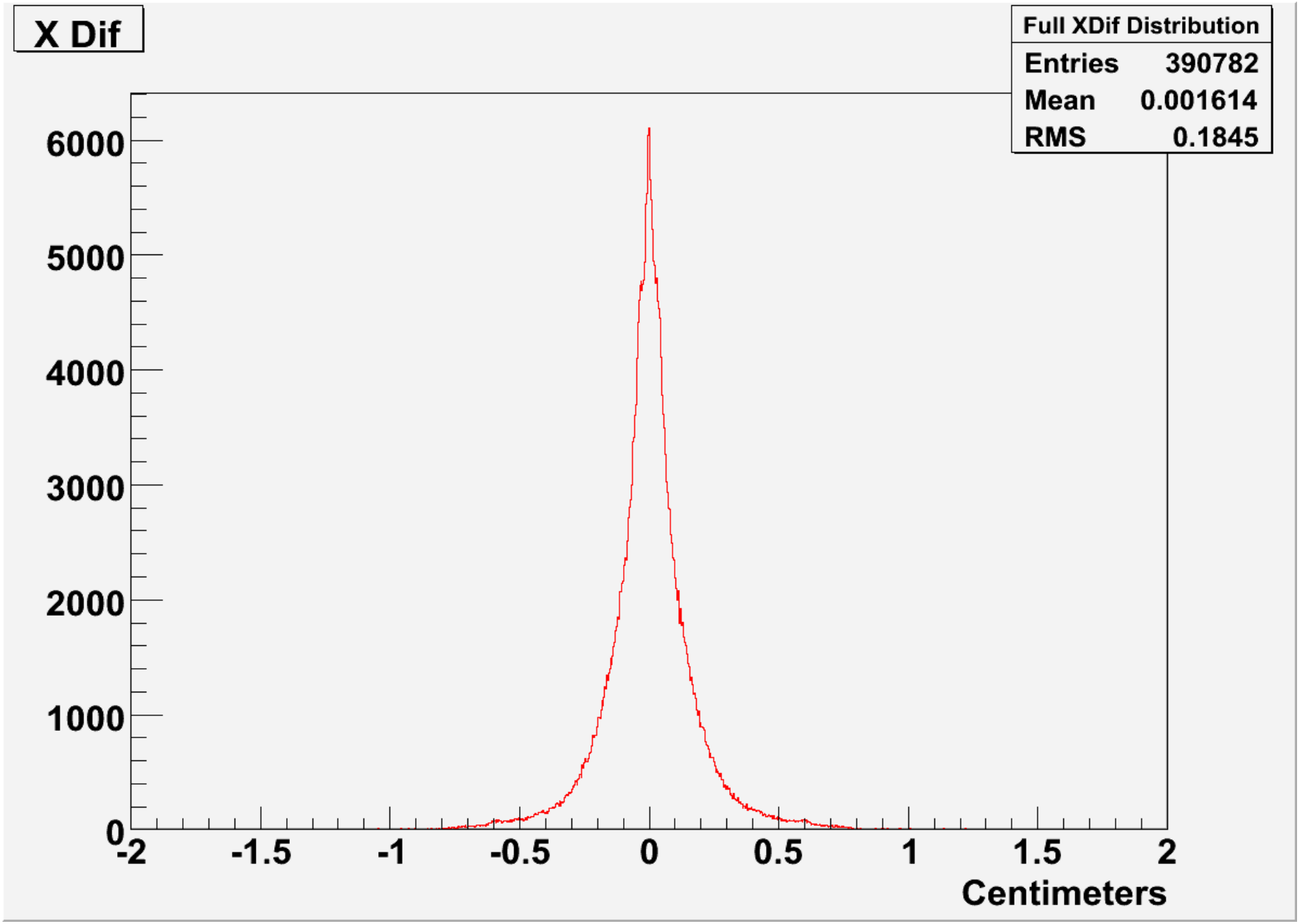
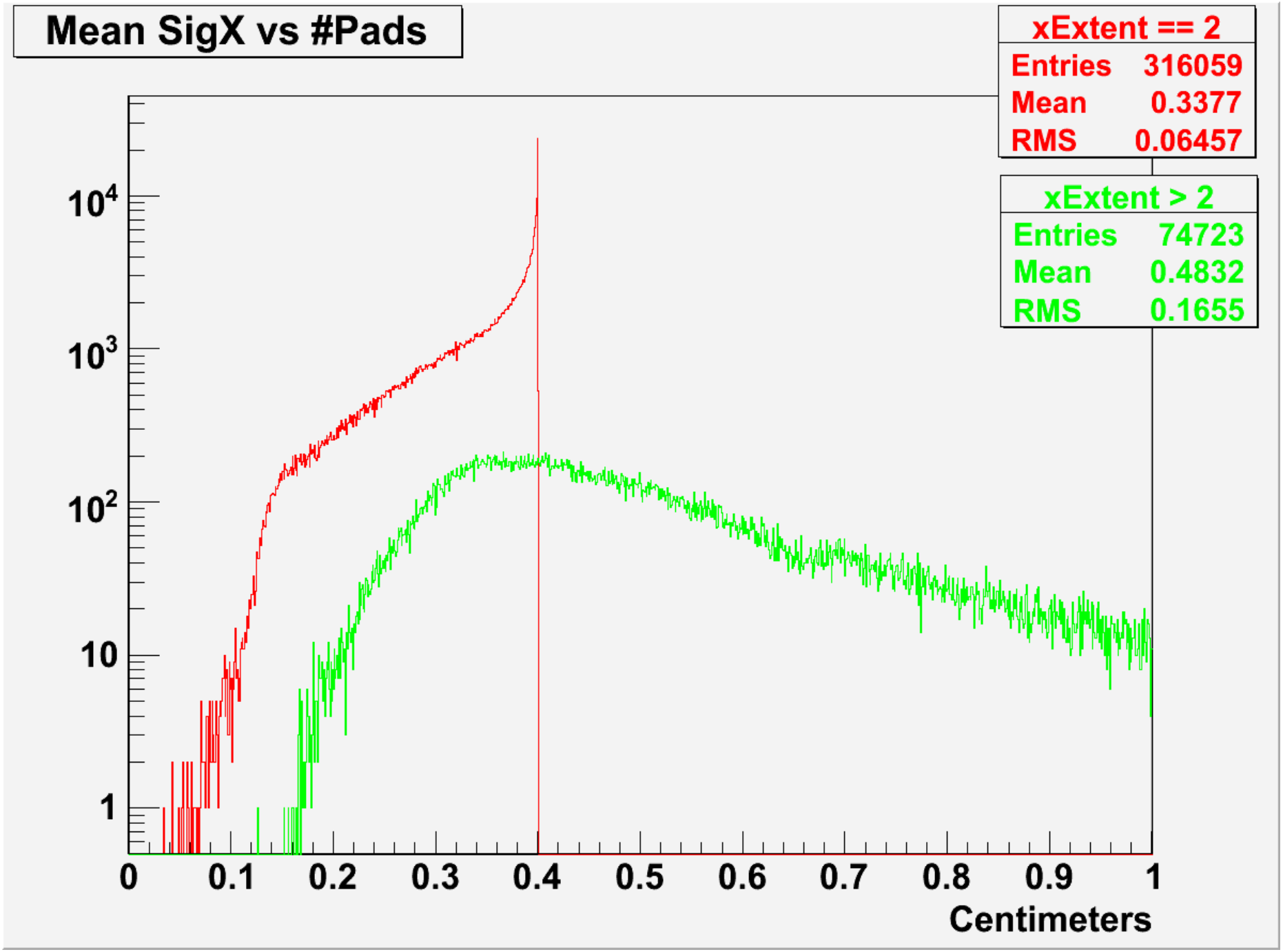
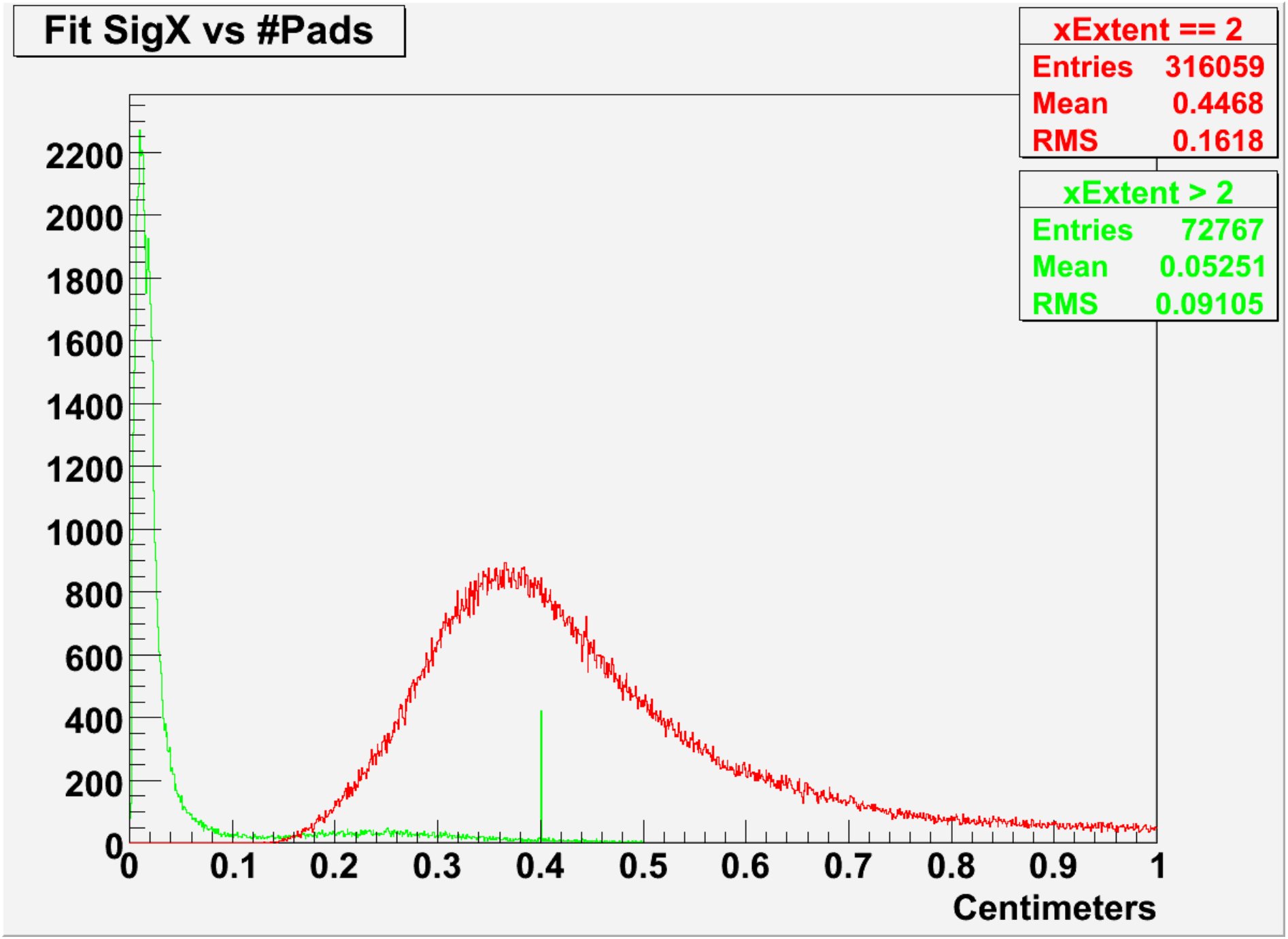
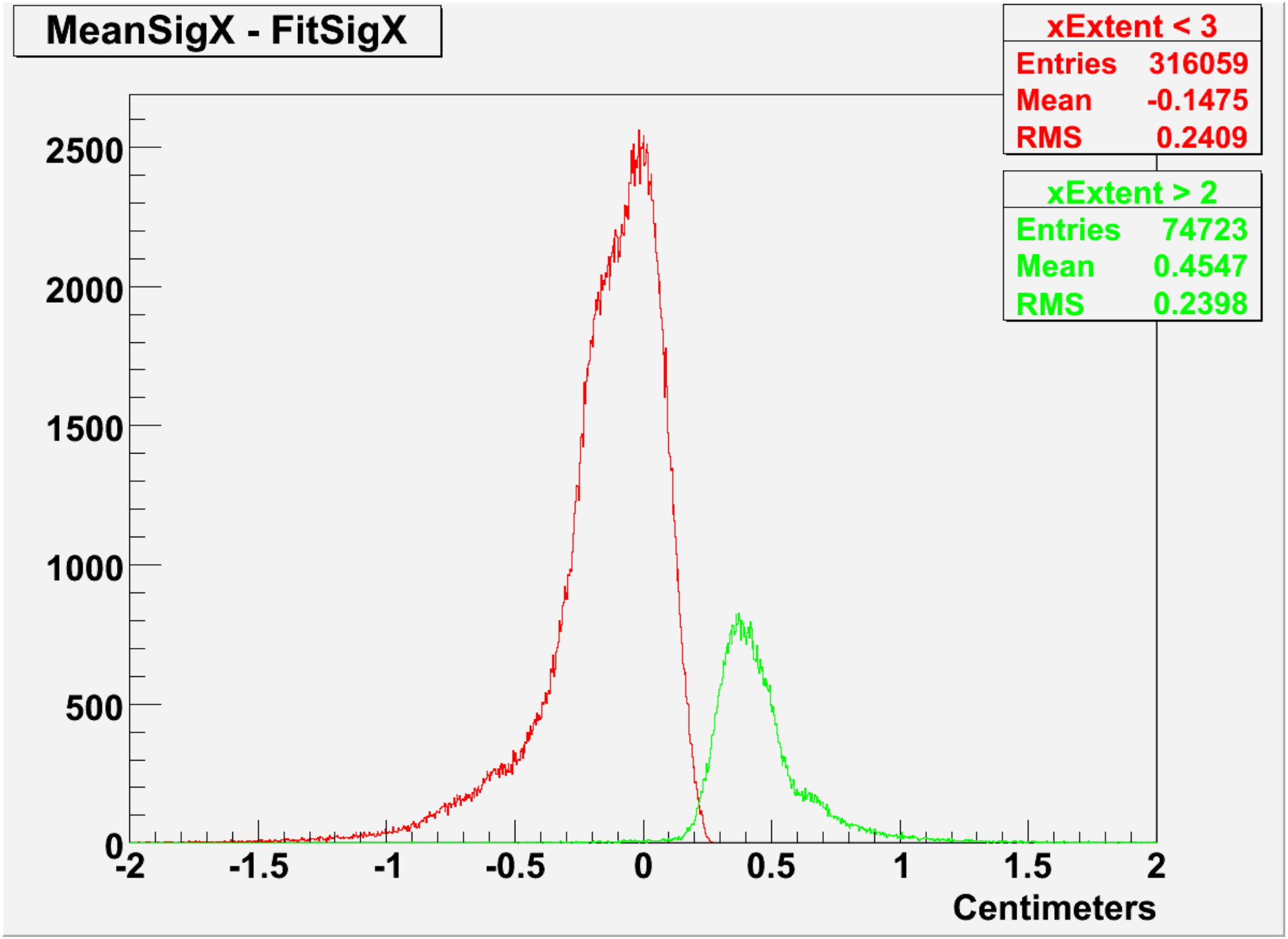
# X-Mean – X-Fit

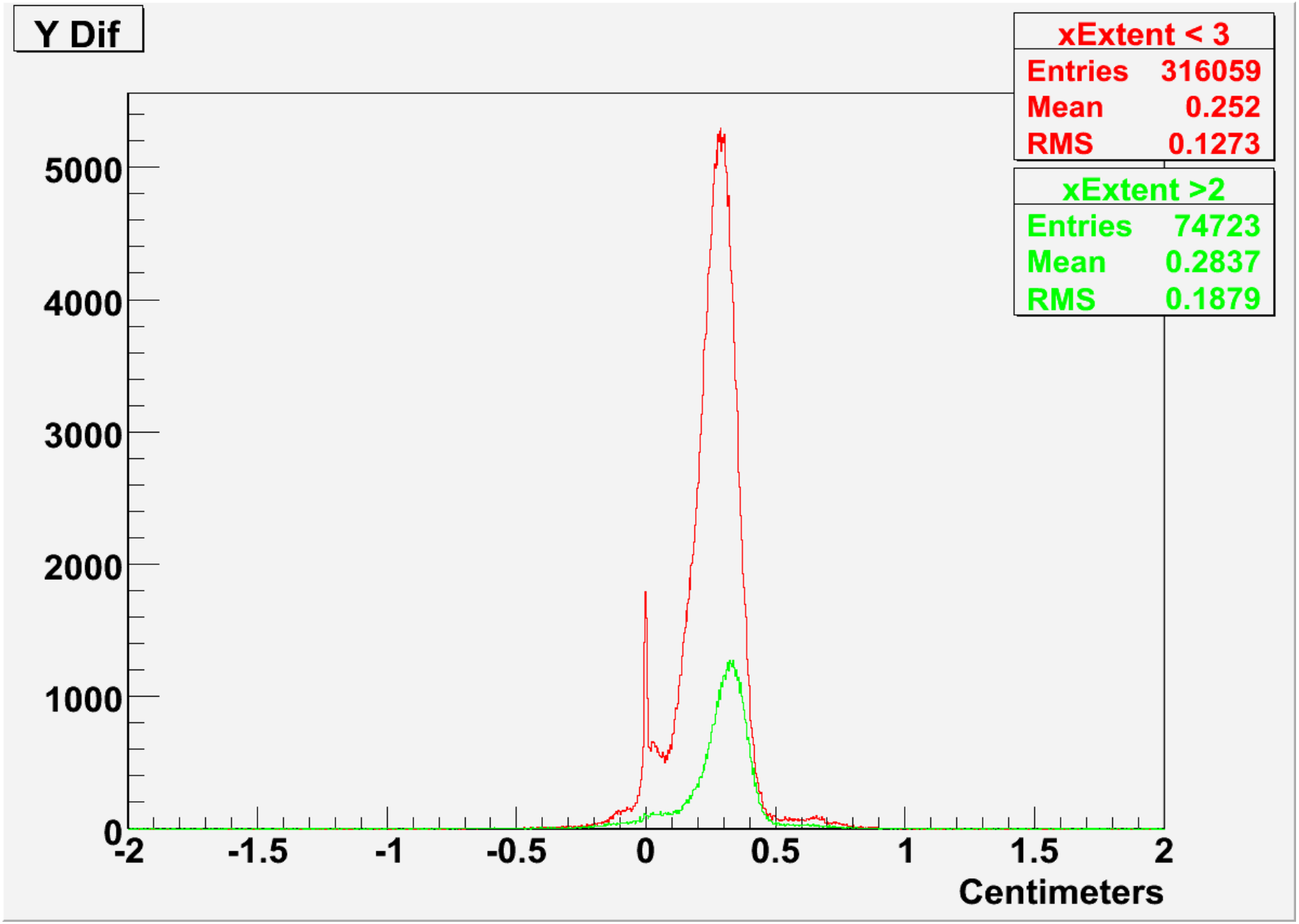

X Dif
Full XDif Distribution
Entries 390782
Mean 0.001614
RMS 0.1845
6000
5000
4000
3000
2000
1000
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Centimeters

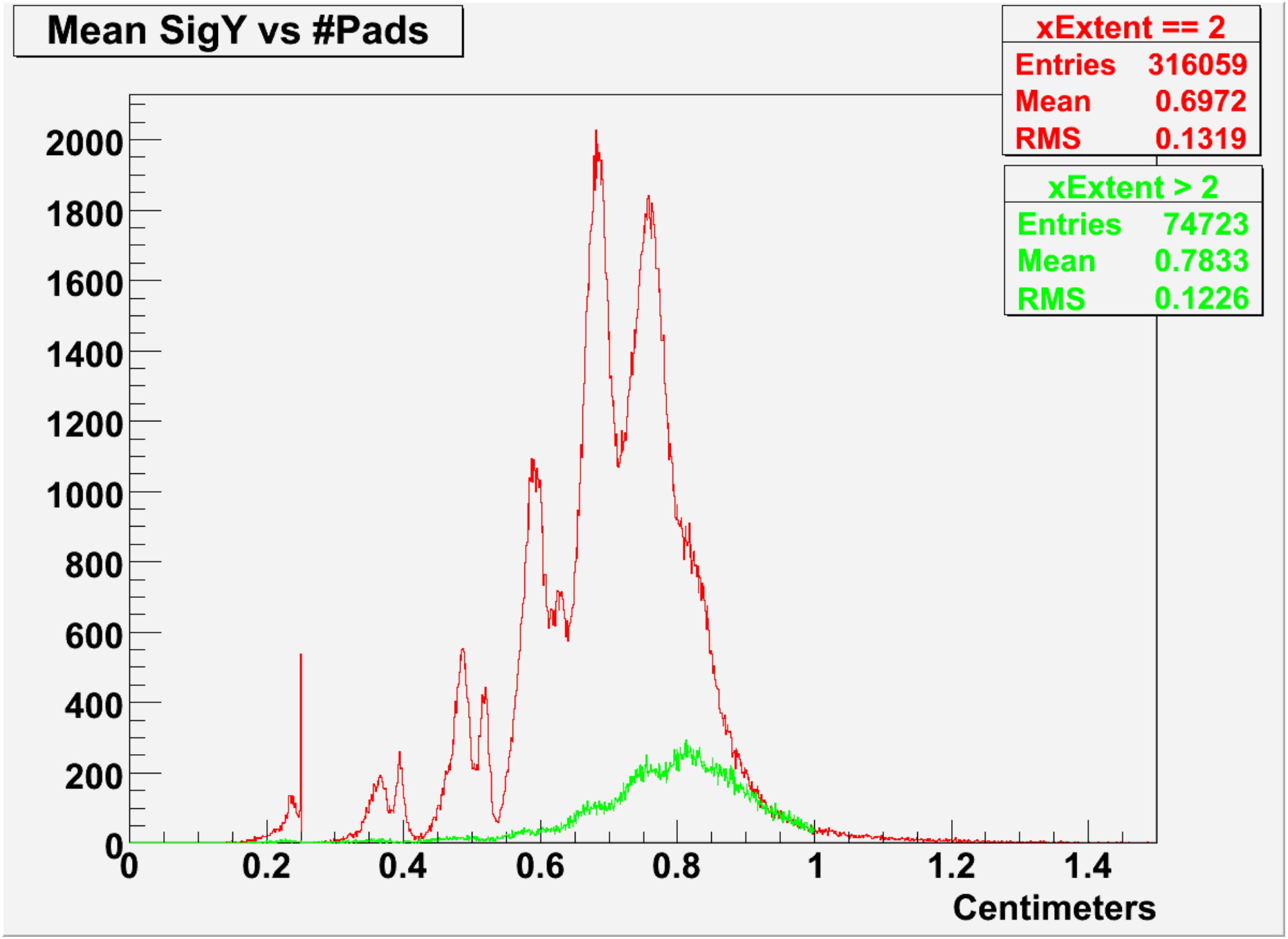

Mean SigX vs #Pads
xExtent == 2
Entries 316059
Mean 0.3377
RMS 0.06457
xExtent > 2
Entries 74723
Mean 0.4832
RMS 0.1655
$10^4$
$10^3$
$10^2$
10
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Centimeters

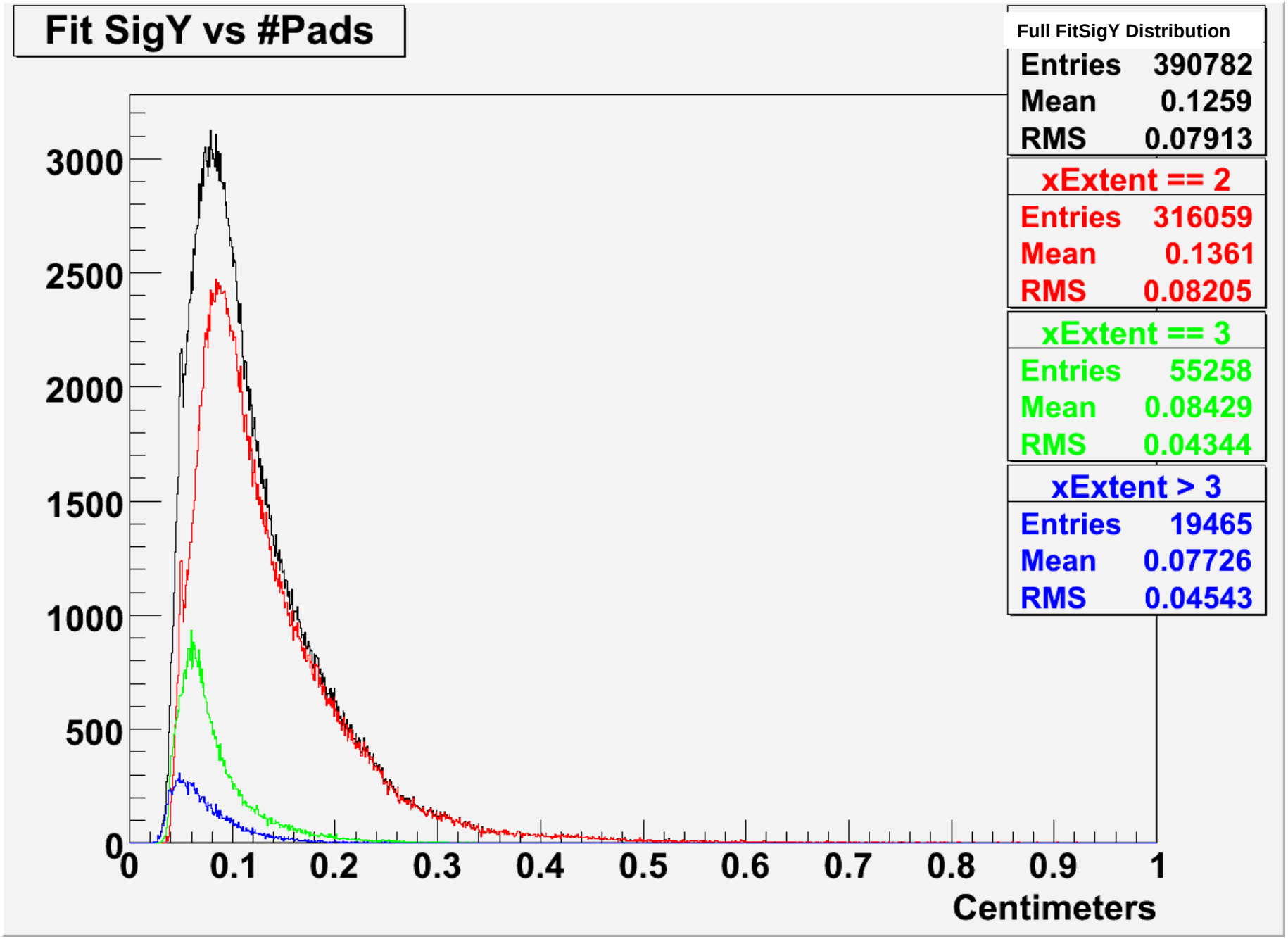

Fit SigX vs #Pads
xExtent == 2
Entries 316059
Mean 0.4468
RMS 0.1618
xExtent > 2
Entries 72767
Mean 0.05251
RMS 0.09105
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Centimeters

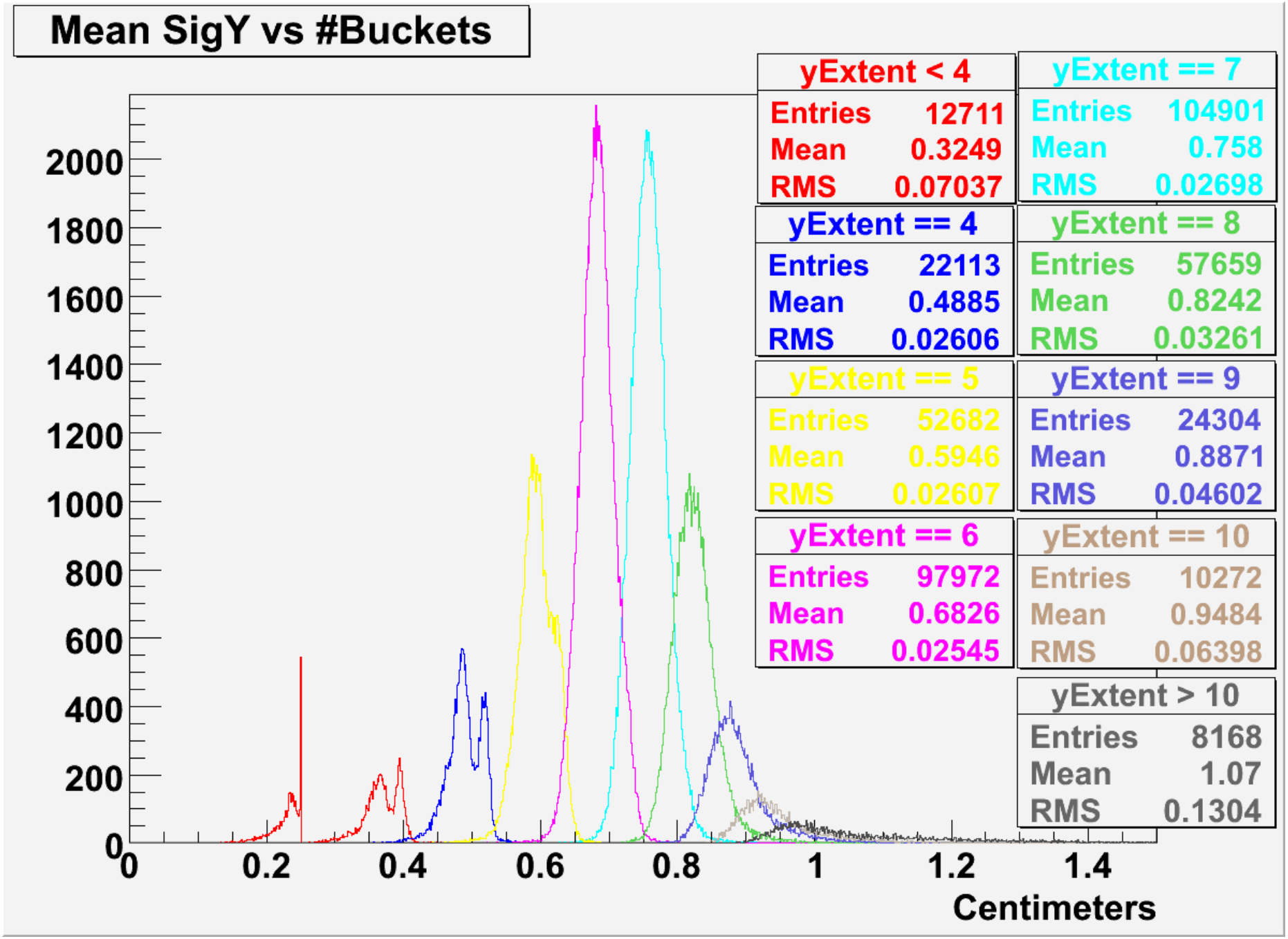

MeanSigX - FitSigX
xExtent < 3
Entries 316059
Mean -0.1475
RMS 0.2409
xExtent > 2
Entries 74723
Mean 0.4547
RMS 0.2398
2500
2000
1500
1000
500
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Centimeters

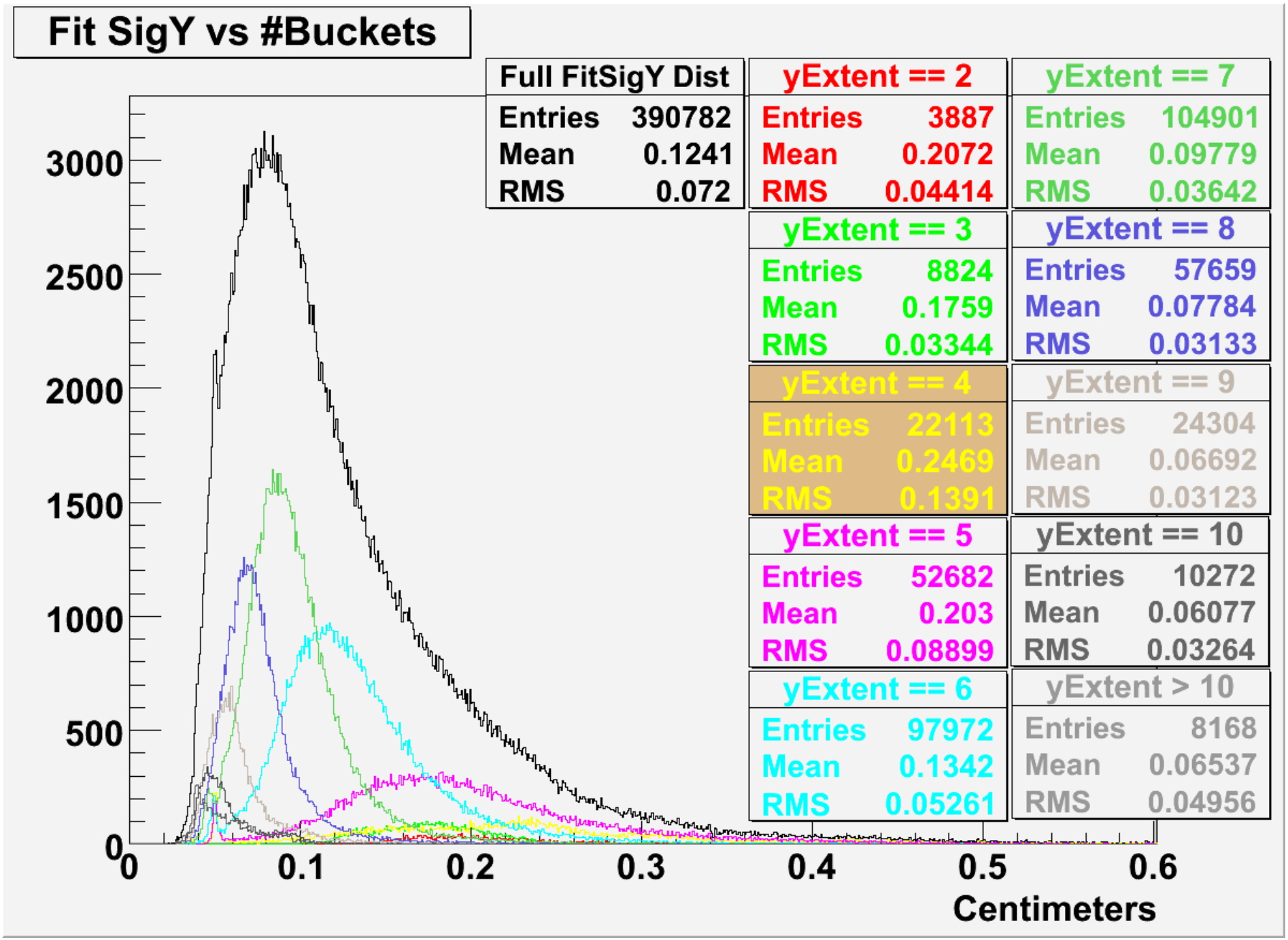
# Y-Mean – Y-Fit vs #Pads

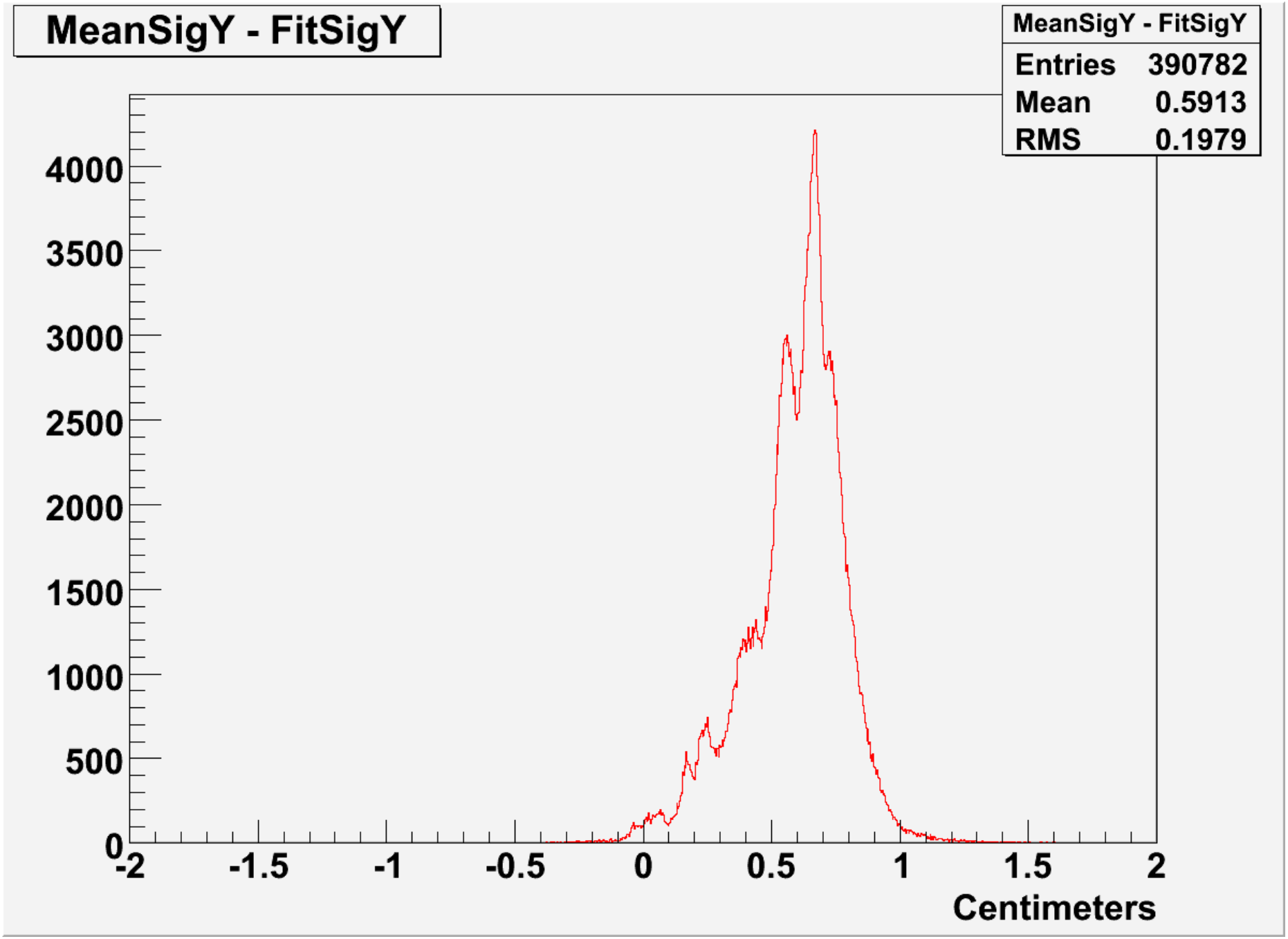


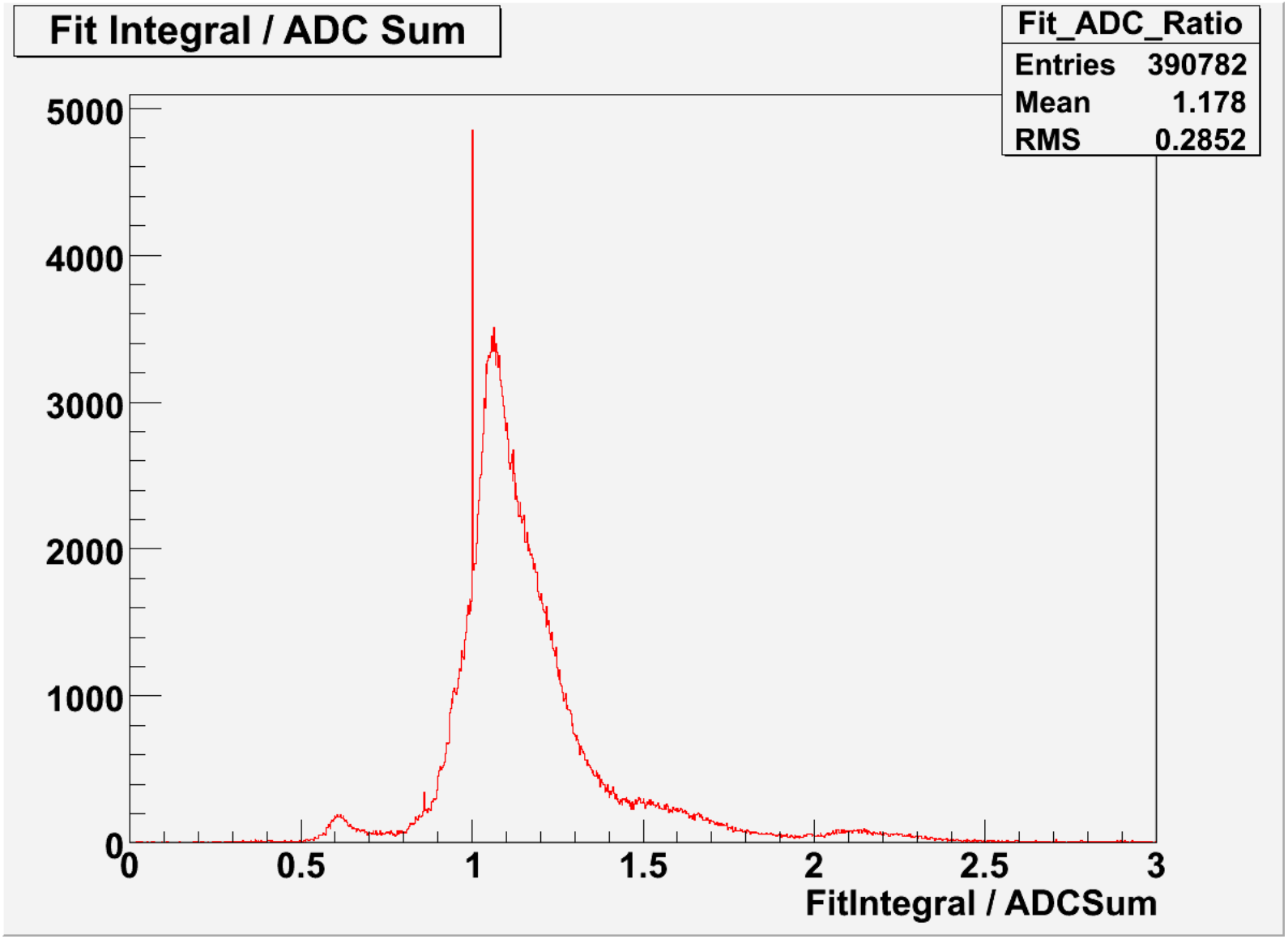

Mean SigY vs #Pads
xExtent == 2
Entries 316059
Mean 0.6972
RMS 0.1319
xExtent > 2
Entries 74723
Mean 0.7833
RMS 0.1226
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Centimeters


Fit SigY vs #Pads
Full FitSigY Distribution
Entries 390782
Mean 0.1259
RMS 0.07913
xExtent == 2
Entries 316059
Mean 0.1361
RMS 0.08205
xExtent == 3
Entries 55258
Mean 0.08429
RMS 0.04344
xExtent > 3
Entries 19465
Mean 0.07726
RMS 0.04543
3000
2500
2000
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Centimeters


Mean SigY vs #Buckets
yExtent < 4
Entries 12711
Mean 0.3249
RMS 0.07037
yExtent == 4
Entries 22113
Mean 0.4885
RMS 0.02606
yExtent == 5
Entries 52682
Mean 0.5946
RMS 0.02607
yExtent == 6
Entries 97972
Mean 0.6826
RMS 0.02545
yExtent == 7
Entries 104901
Mean 0.758
RMS 0.02698
yExtent == 8
Entries 57659
Mean 0.8242
RMS 0.03261
yExtent == 9
Entries 24304
Mean 0.8871
RMS 0.04602
yExtent == 10
Entries 10272
Mean 0.9484
RMS 0.06398
yExtent > 10
Entries 8168
Mean 1.07
RMS 0.1304
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Centimeters

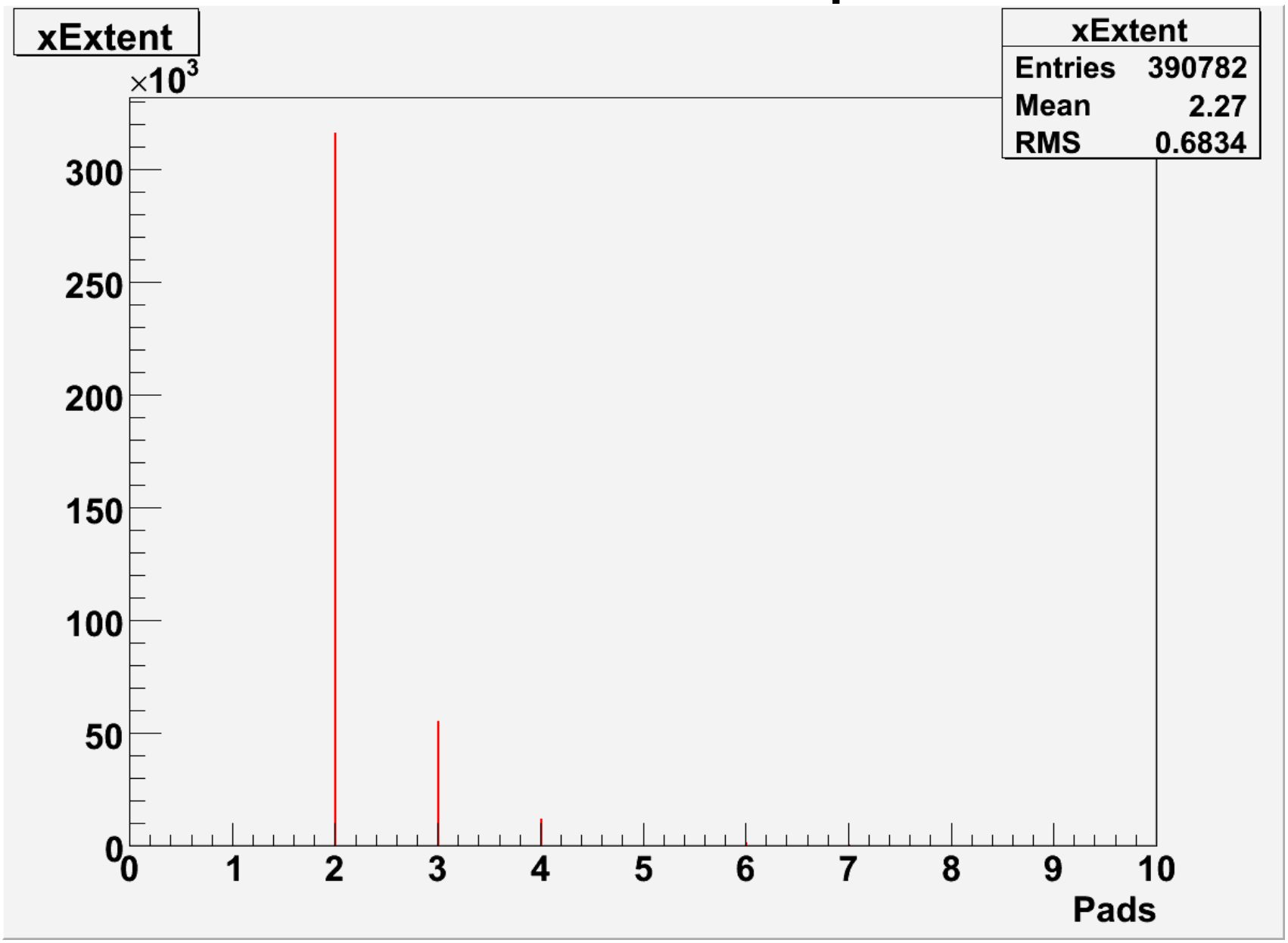

Fit SigY vs #Buckets
Full FitSigY Dist
Entries 390782
Mean 0.1241
RMS 0.072
yExtent == 2
Entries 3887
Mean 0.2072
RMS 0.04414
yExtent == 3
Entries 8824
Mean 0.1759
RMS 0.03344
yExtent == 4
Entries 22113
Mean 0.2469
RMS 0.1391
yExtent == 5
Entries 52682
Mean 0.203
RMS 0.08899
yExtent == 6
Entries 97972
Mean 0.1342
RMS 0.05261
yExtent == 7
Entries 104901
Mean 0.09779
RMS 0.03642
yExtent == 8
Entries 57659
Mean 0.07784
RMS 0.03133
yExtent == 9
Entries 24304
Mean 0.06692
RMS 0.03123
yExtent == 10
Entries 10272
Mean 0.06077
RMS 0.03264
yExtent > 10
Entries 8168
Mean 0.06537
RMS 0.04956
3000
2500
2000
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Centimeters


MeanSigY - FitSigY
MeanSigY - FitSigY
Entries 390782
Mean 0.5913
RMS 0.1979
4000
3500
3000
2500
2000
1500
1000
500
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Centimeters

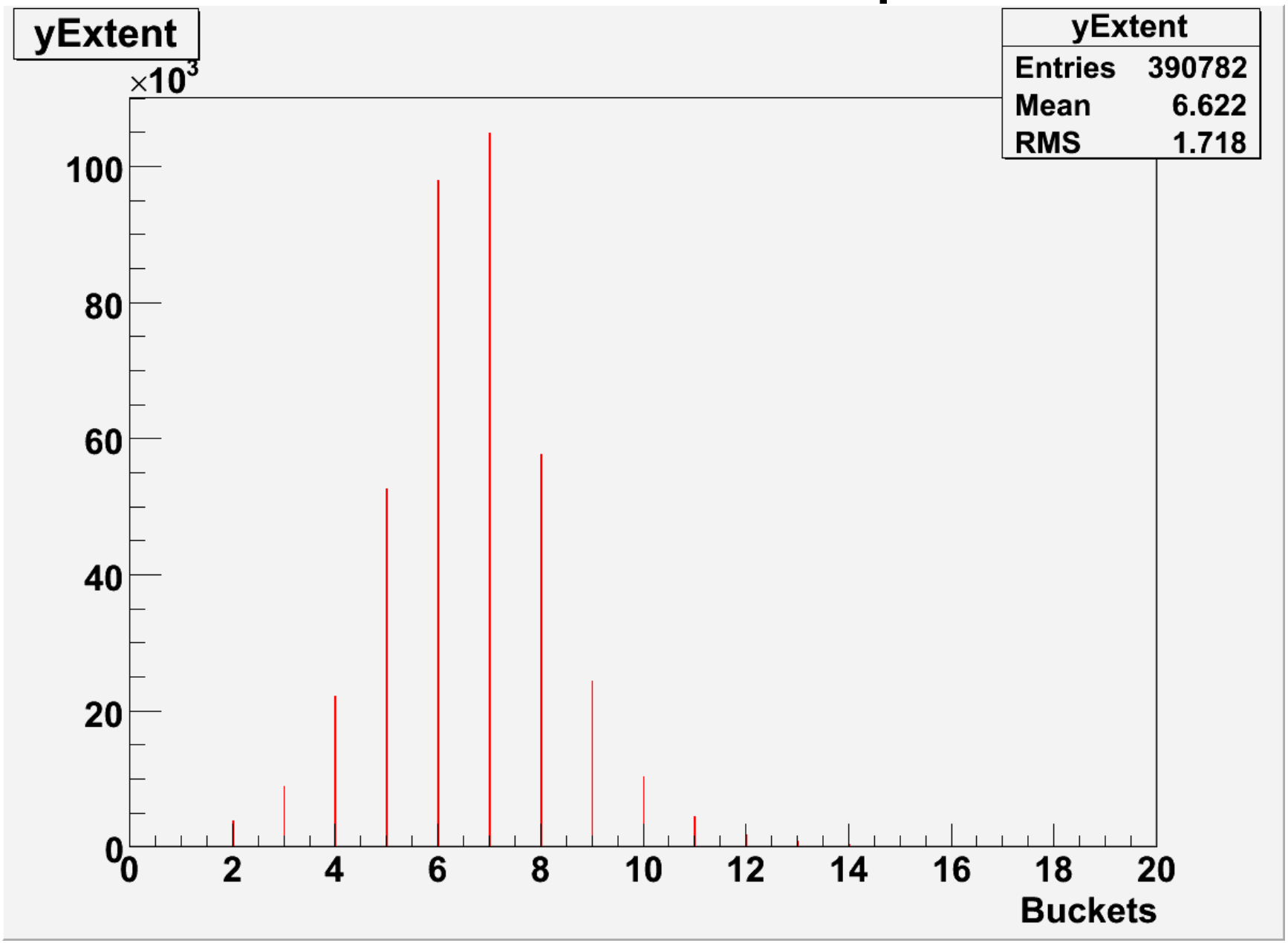


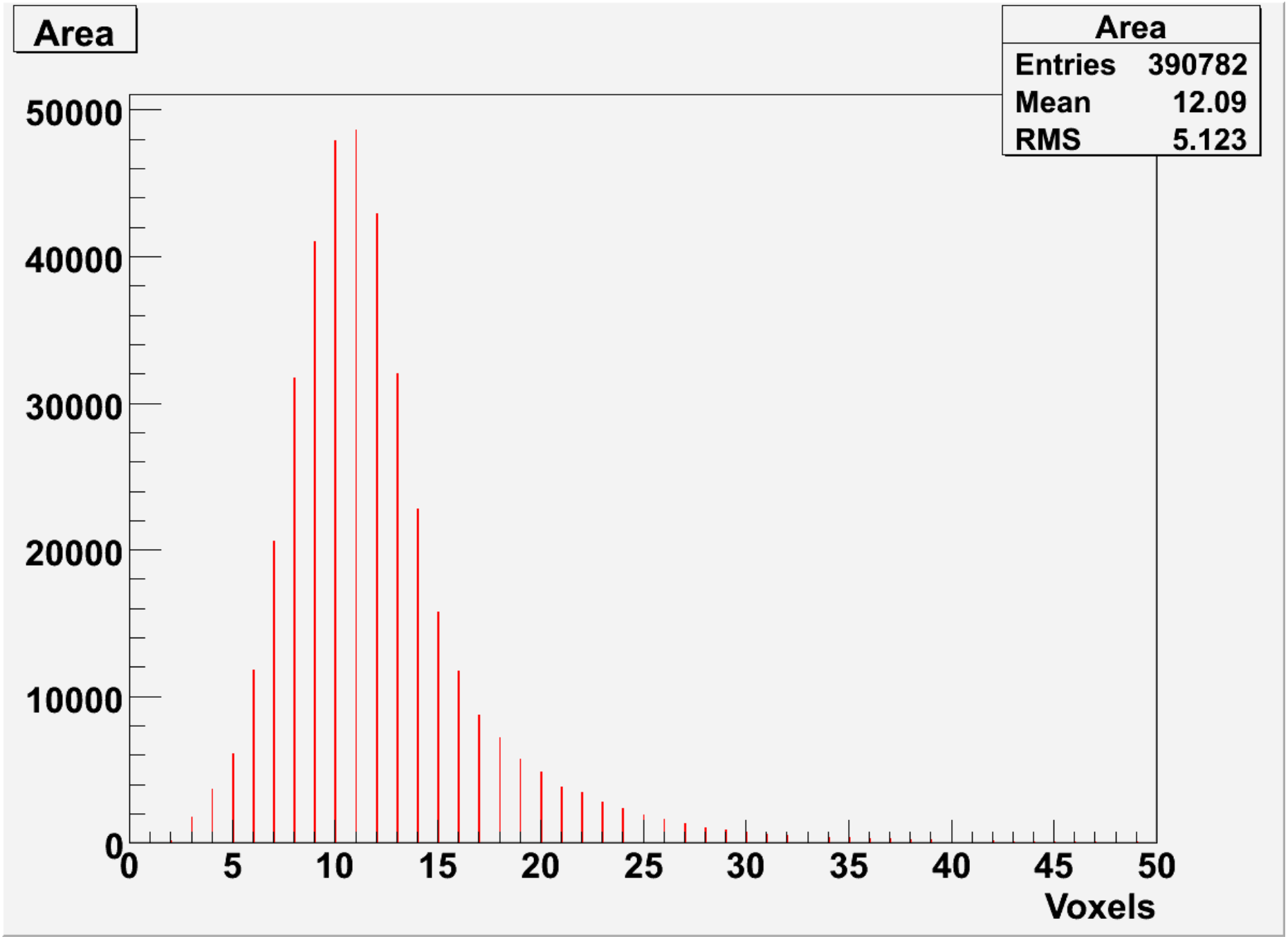

The spike at 1 is due to Failed Fits defaulting to the Centroid Calculation ~1.3% of the time.

# Number of Pads per Hit

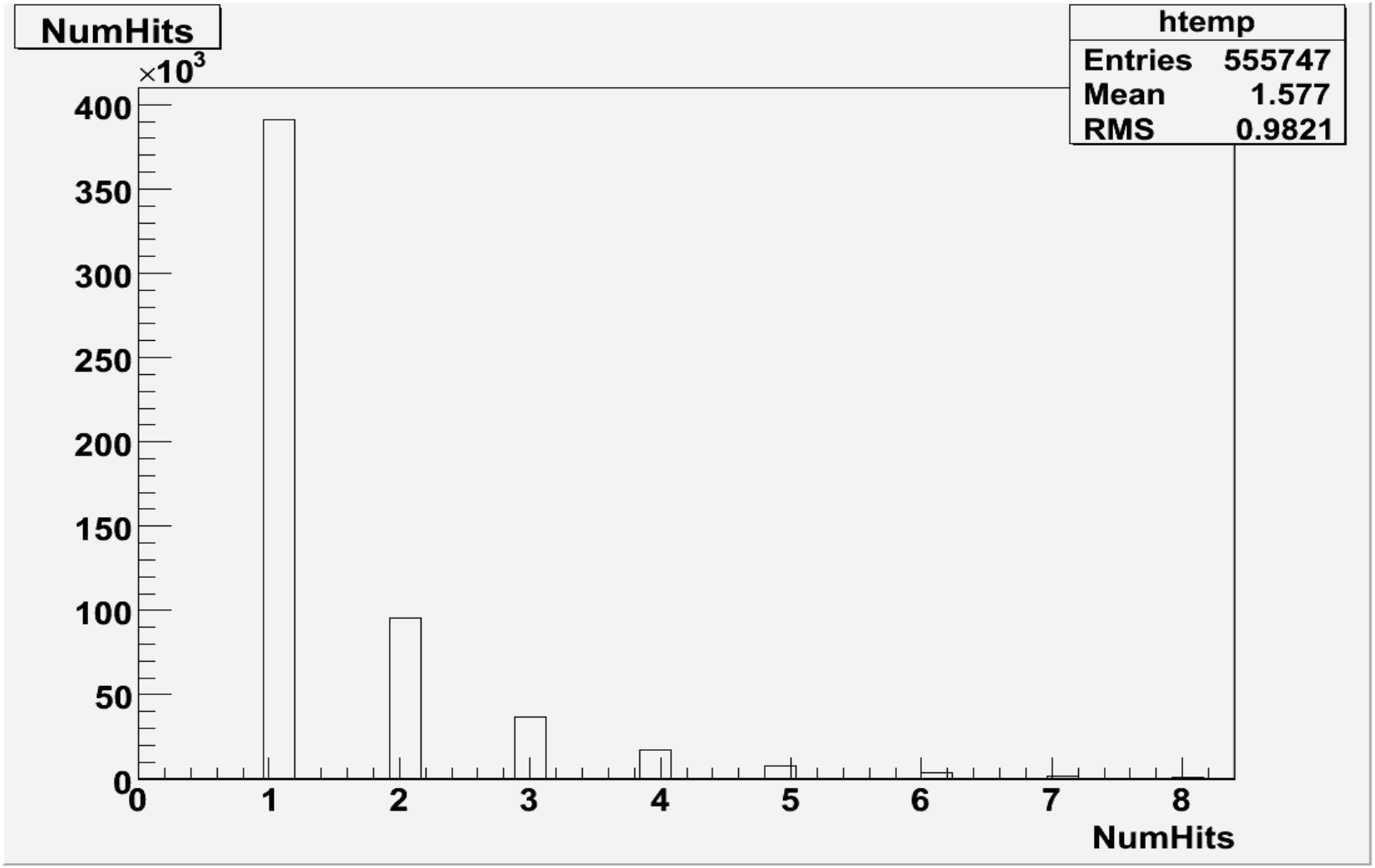


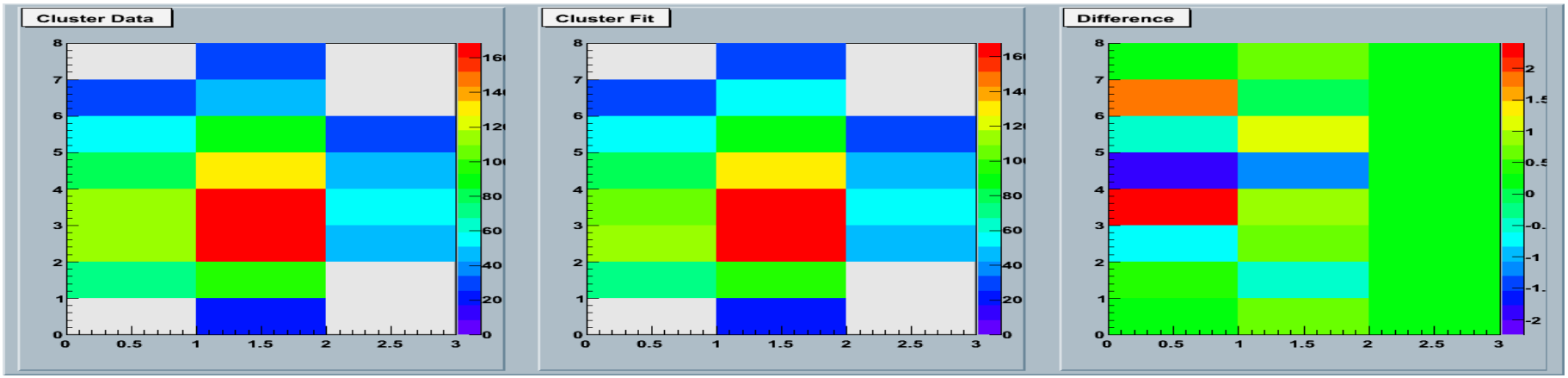
# Number of Buckets per Hit




Area
Area
Entries 390782
Mean 12.09
RMS 5.123
50000
40000
30000
20000
10000
0
0
5
10
15
20
25
30
35
40
45
50
Voxels

# NuMI Target Events






Cluster Data

ncol = 3 nbkt = 8

| | | | |
|---|---|---|---|
| 7 | | 27.04 | |
| 6 | 32.92 | 49.92 | |
| 5 | 52.04 | 87.36 | 30.42 |
| 4 | 78.59 | 130 | 44.62 |
| 3 | 110.4 | 168.5 | 52.73 |
| 2 | 112.6 | 164.3 | 42.59 |
| 1 | 71.15 | 99.84 | |
| 0 | | 22.88 | |
| | 0 | 1 | 2 |

ADC
Sum 457.7 749.8 170.4

Fit Cluster

| | | | |
|---|---|---|---|
| | | 26.7 | |
| | 31.42 | 50.29 | |
| | 52.71 | 86.48 | 30.42 |
| | 80.83 | 131.5 | 44.62 |
| | 108 | 167.8 | 52.73 |
| | 113.6 | 163.8 | 42.59 |
| | 71.04 | 100.5 | |
| | | 22.43 | |
| | 0 | 1 | 2 |
| Integral | 500.1 | 773.6 | 221.6 |
| +/- | 10.9 | 14.4 | 17.4 |
| yChi2 | 0.9 | 0.15 | 0.0 |

Residuals Above

Results Below

| | |
|---|---|
| XMean - XFit | 0.03363 cm |
| YMean - YFit | 0.3306 cm |
| MeanSigX | 0.5148 cm |
| FitSigX | 0.013 cm |
| MeanSigY | 0.7713 cm |
| FitSigY | 0.176 cm |
| ADCSum | 1320 |
| FitIntegral | 1568 |

| xPos | Sum | +/- | yPos | eyPos |
|---|---|---|---|---|
| 0 | 500.1 | 10.87 | 2.322 | 0.5363 |
| 1 | 773.6 | 14.43 | 2.551 | 0.5237 |
| 2 | 221.6 | 17.36 | 2.954 | 1.03 |

Gauss xChi2 1.009e-19

Fit Hit Result:
X Pos 0.7587 +/- 0.01625
Y Pos 2.499 +/- 0.3521
dE 1568 +/- 25.69

# An Example

ncol = 15 nbkt = 16

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | -1 | 21.68 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 14 | 21.14 | 36.94 | 27.04 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 13 | 28.97 | 53 | 40.56 | 15.53 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 12 | 31.32 | 68.25 | 60 | 22.95 | -1 | 18.59 | 22.65 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 11 | 23.49 | 68.25 | 73.52 | 29.7 | 18.26 | 26.2 | 34.73 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| 10 | -1 | 50.59 | 68.45 | 35.78 | 25.73 | 40.56 | 54.36 | 23.63 | 27.59 | -1 | -1 | -1 | -1 | -1 | -1 |
| 9 | -1 | 20.07 | 36.34 | 28.35 | 25.73 | 51.55 | 74.74 | 33.76 | 43.61 | 23.9 | -1 | -1 | -1 | -1 | -1 |
| 8 | -1 | -1 | -1 | 14.85 | 19.09 | 57.46 | 94.37 | 49.8 | 66.75 | 41.2 | 19.66 | 18.4 | -1 | -1 | -1 |
| 7 | -1 | -1 | -1 | -1 | -1 | 45.63 | 87.58 | 57.39 | 90.78 | 60.98 | 28.67 | 24.53 | 21.7 | -1 | -1 |
| 6 | -1 | -1 | -1 | -1 | -1 | 19.44 | 49.83 | 50.64 | 105.9 | 84.87 | 44.23 | 49.06 | 36.46 | 24.51 | -1 |
| 5 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 25.32 | 85.44 | 86.52 | 54.87 | 75.34 | 58.16 | 35.13 | -1 |
| 4 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 36.49 | 63.45 | 58.15 | 102.5 | 88.54 | 56.37 | -1 |
| 3 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 18.95 | 41.77 | 109.5 | 108.5 | 76.8 | 20.72 |
| 2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 18.02 | 78.84 | 105 | 93.14 | 30.67 |
| 1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 26.28 | 61.63 | 84.97 | 30.67 |
| 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 50.65 | 24.87 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Sum | 104.9 | 318.8 | 305.9 | 147.2 | 88.81 | 259.4 | 418.3 | 240.5 | 456.6 | 379.9 | 265.4 | 484.4 | 480 | 421.6 | 106.9 |

X Pos 1.537 +/- 0.05885
Y Pos 10.85 +/- 0.2579
dE 1105 +/- 36.86

X Pos 7.035 +/- 0.2787
Y Pos 6.612 +/- 0.137
dE 1899 +/- 569.7

X Pos 11.85 +/- 0.0469
Y Pos 2.732 +/- 0.1438
dE 2304 +/- 54.46

# Another Example

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 43.4 | -1 |
| 26 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 84 | -1 |
| 25 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 35.61 | 152.6 | -1 |
| 24 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 31.58 | 71.23 | 281.4 | 35.59 |
| 23 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 29.26 | 49.26 | 112.1 | 483 | 59.31 |
| 22 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 47.54 | 73.25 | 179.4 | 771.4 | 93.58 |
| 21 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 53.64 | 93.46 | 236.1 | 1081 | 130.5 |
| 20 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 46.32 | 89.67 | 261.2 | 1284 | 150.3 |
| 19 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 50.52 | 196.5 | 1091 | 126.5 |
| 18 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 76.5 | 490 | 56.67 |
| 17 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 60.2 | -1 |
| 16 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 29.02 | -1 | -1 |
| 15 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 44.85 | -1 | -1 |
| 14 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 72.55 | 46.2 | -1 |
| 13 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 108.2 | 81.2 | -1 |
| 12 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 149 | 123.2 | -1 |
| 11 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 166.2 | 149.8 | -1 |
| 10 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 139.8 | 138.6 | -1 |
| 9 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 36.57 | 29.05 | 55.4 | 72.8 | -1 |
| 8 | -1 | -1 | 35.2 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 70.7 | 47.99 | -1 | -1 | -1 |
| 7 | -1 | -1 | 57.73 | 31.44 | 32.26 | 39.93 | -1 | -1 | -1 | -1 | 118.2 | 87.15 | -1 | -1 | -1 |
| 6 | -1 | 34.83 | 92.93 | 61.57 | 53.76 | 77.2 | 41.27 | 31.51 | 36.59 | -1 | 188.9 | 135.1 | -1 | -1 | -1 |
| 5 | 33.17 | 55.47 | 142.2 | 104.8 | 88.7 | 125.1 | 61.19 | 50.9 | 62.33 | 30.91 | 246.2 | 170.5 | -1 | -1 | -1 |
| 4 | 43.26 | 79.98 | 194.3 | 144.1 | 127.7 | 191.7 | 88.23 | 82.42 | 101.6 | 43.79 | 257.2 | 174.3 | -1 | -1 | -1 |
| 3 | 40.38 | 87.72 | 207 | 158.5 | 150.5 | 235.6 | 105.3 | 104.2 | 134.1 | 45.08 | 165.8 | 103.6 | -1 | -1 | -1 |
| 2 | -1 | 63.21 | 143.6 | 120.5 | 130.4 | 220.9 | 102.5 | 116.4 | 150.4 | 45.08 | 43.88 | -1 | -1 | -1 | -1 |
| 1 | -1 | -1 | 42.24 | 41.92 | 59.14 | 114.5 | 56.92 | 75.14 | 116.5 | 33.49 | -1 | -1 | -1 | -1 | -1 |
| 0 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 | 40.65 | -1 | -1 | -1 | -1 | -1 | -1 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Sum | 116.8 | 321.2 | 915.2 | 662.9 | 642.4 | 1005 | 455.4 | 460.6 | 642.3 | 198.4 | 1304 | 1135 | 1934 | 6433 | 652.4 |

X Pos 6.08 +/- 0.1486
Y Pos 3.234 +/- 0.05779
dE 7796 +/- 2339

X Pos 12.68 +/- 0.01105
Y Pos 20.53 +/- 0.09524
dE 3976 +/- 40.33

X Pos 12.27 +/- 0.3251
Y Pos 10.9 +/- 0.1314
dE 1465 +/- 439.6

# Some more Metrics.

- We find ~85% Single Hit Clusters in the TPC.
- We find an Average of ~1.2 Hits per Cluster.
- For Multiple Hit Clusters, we find an Average of ~2.3 Hits per Cluster. (~2.4 for NuMI)
- We Find ~1.3% Fit Failures falling back to the Centroid method.
- The TPCRHitFind is 6.7 times slower with the Fitter turned on. This is a small effect to the overall TPCReco Runtime.