PRad HyCal Calibration Update

PRad weekly meeting

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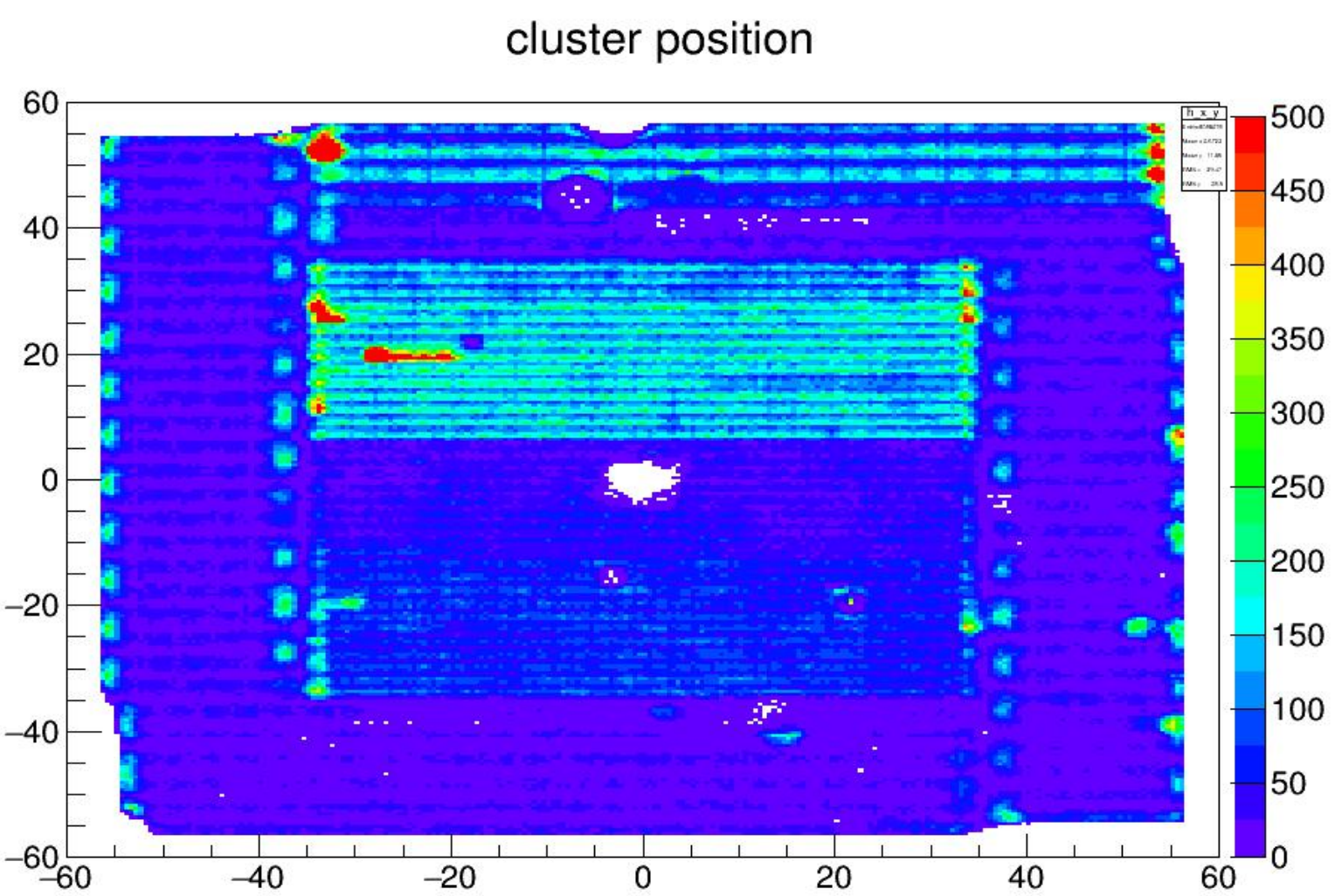
Mississippi State University

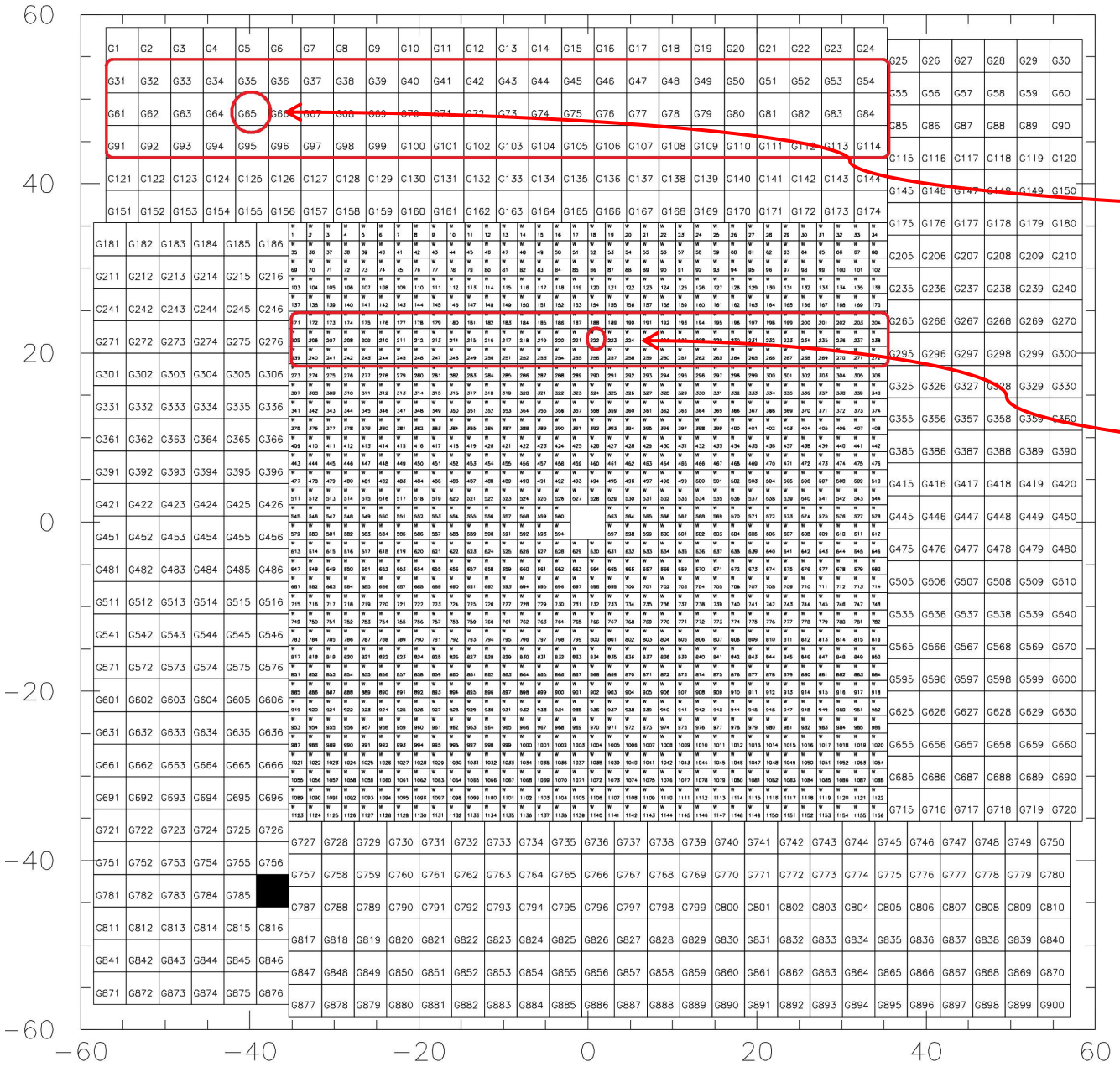
2016-09-16



12 channels have abnormal ADC distribution

G130 G131 G132 G133 G134 G135 G171 G572 G732 W528 W630 W891

find our the reason is dead Dynode channel



use Run#890 893 894

100% data study G65

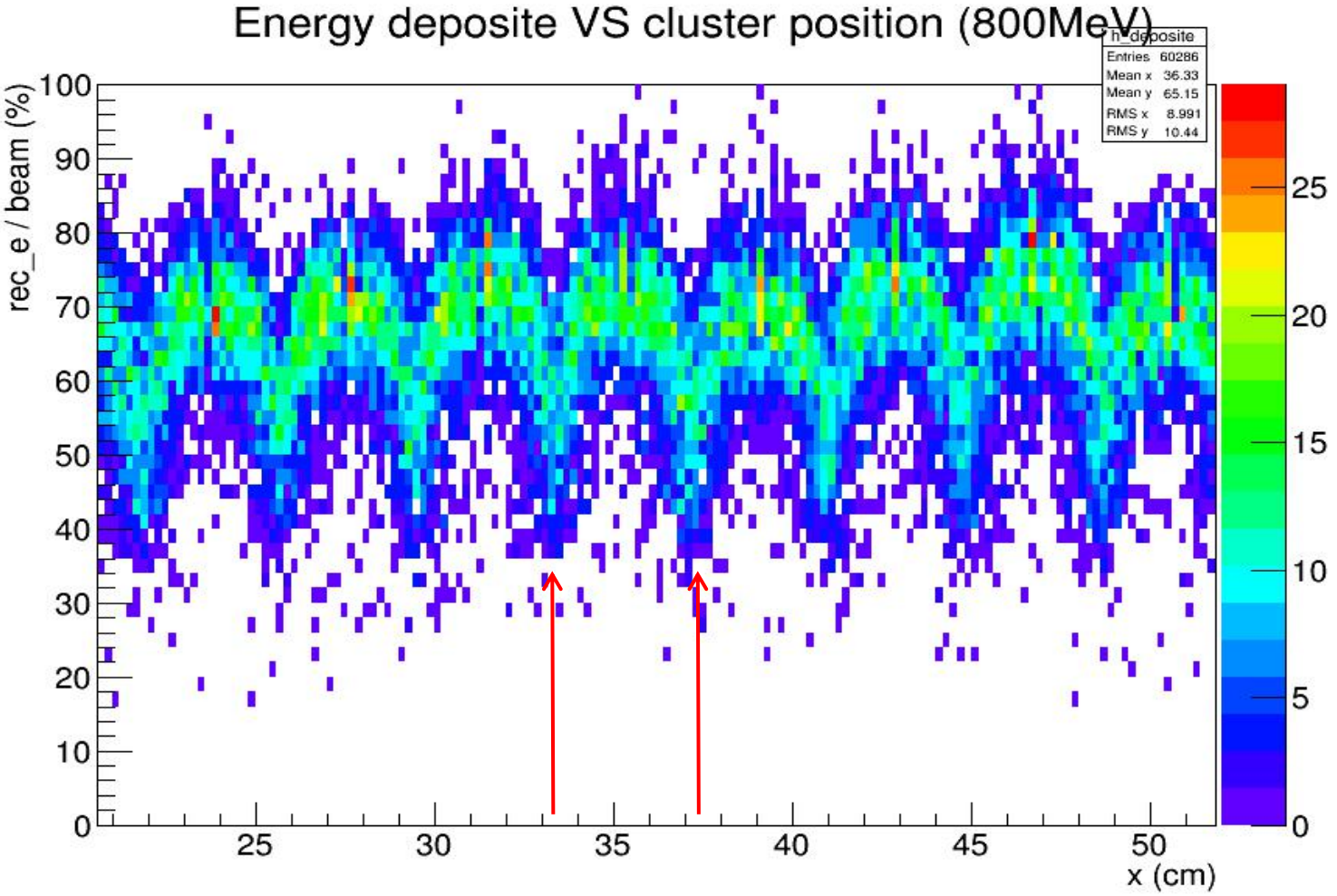
use Run#926 927 928

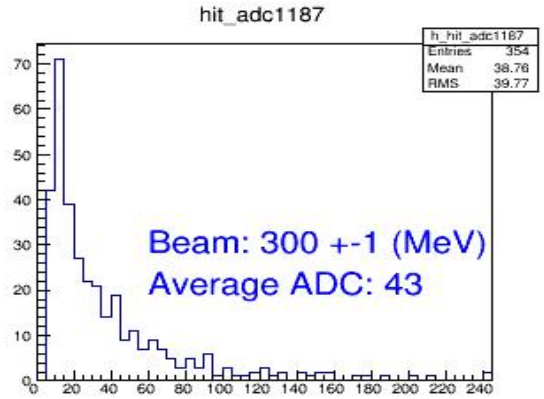
100% data study W222

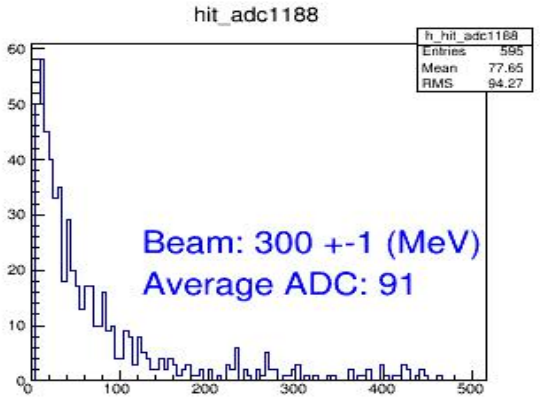
Calculate center module energy deposit percentage :

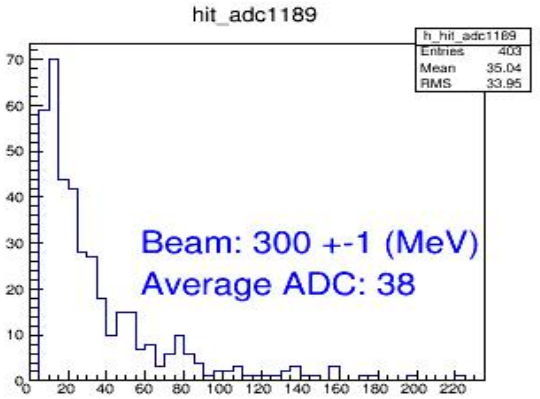
Percentage = reconstructed energy of this module*100 / beam energy

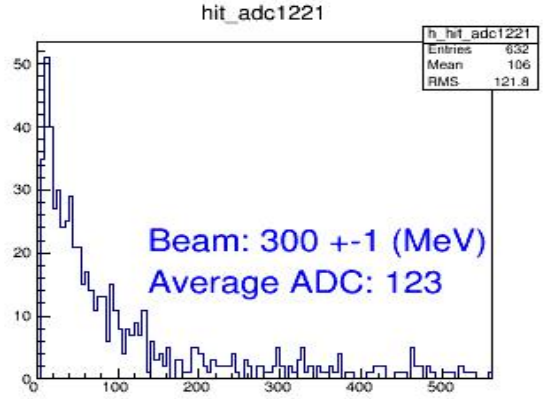
choose the best candidates

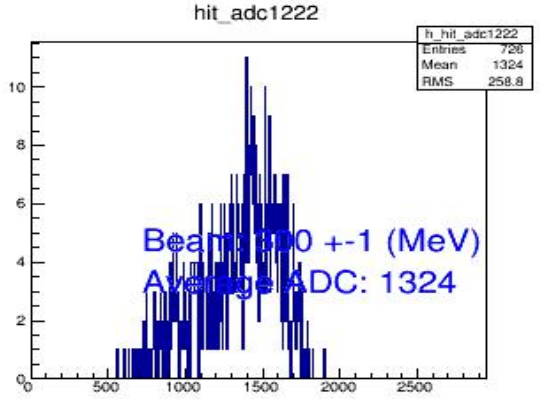


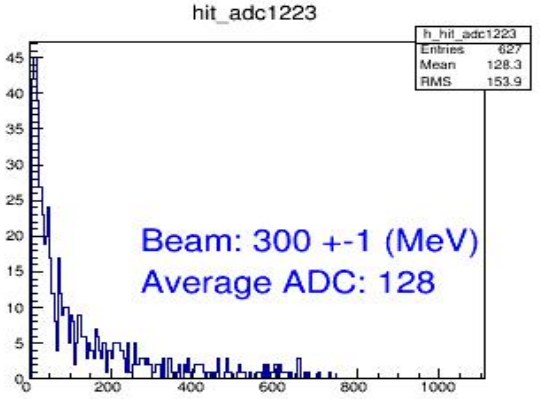

hit_adc1187
h_hit_adc1187
Entries 354
Mean 38.76
RMS 39.77
Beam: 300 +-1 (MeV)
Average ADC: 43

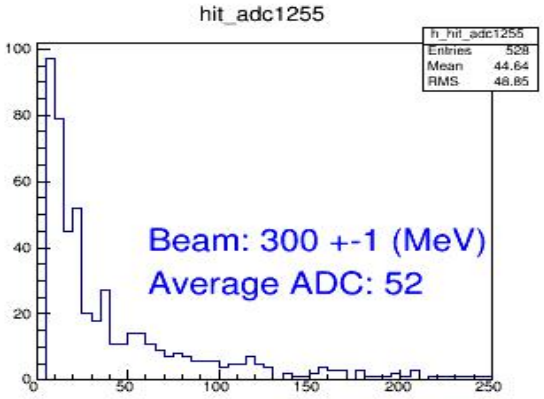

hit_adc1188
h_hit_adc1188
Entries 595
Mean 77.65
RMS 94.27
Beam: 300 +-1 (MeV)
Average ADC: 91

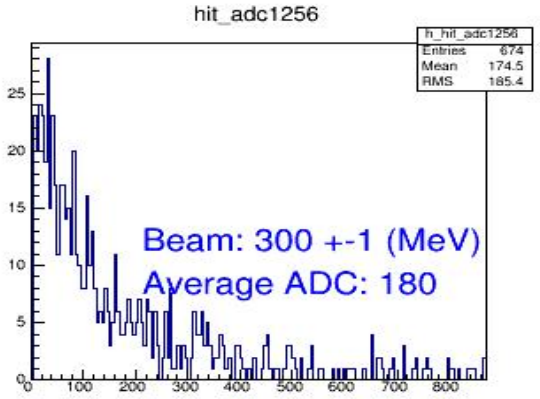

hit_adc1189
h_hit_adc1189
Entries 403
Mean 35.04
RMS 33.95
Beam: 300 +-1 (MeV)
Average ADC: 38

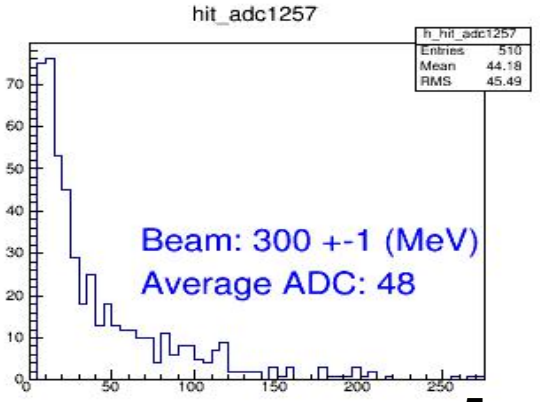

hit_adc1221
h_hit_adc1221
Entries 632
Mean 106
RMS 121.8
Beam: 300 +-1 (MeV)
Average ADC: 123

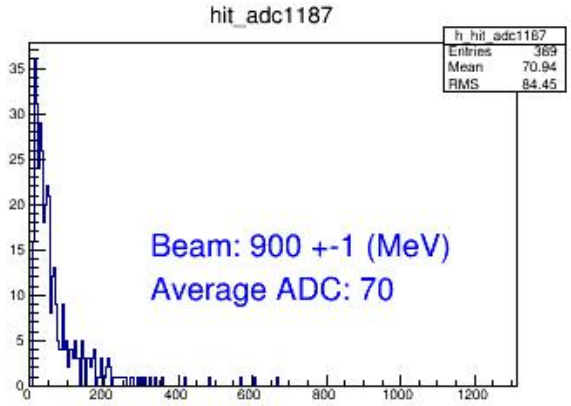

hit_adc1222
h_hit_adc1222
Entries 726
Mean 1324
RMS 258.8
Beam: 300 +-1 (MeV)
Average ADC: 1324

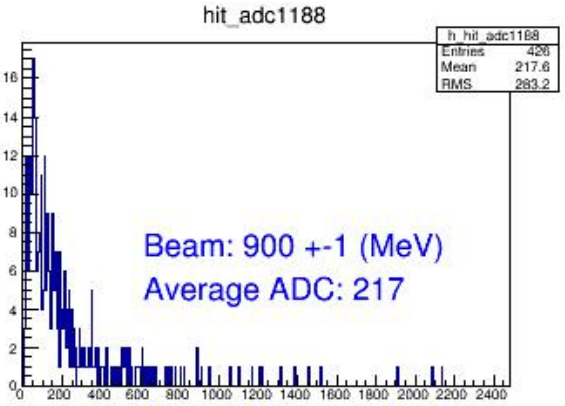

hit_adc1223
h_hit_adc1223
Entries 627
Mean 128.3
RMS 153.9
Beam: 300 +-1 (MeV)
Average ADC: 128

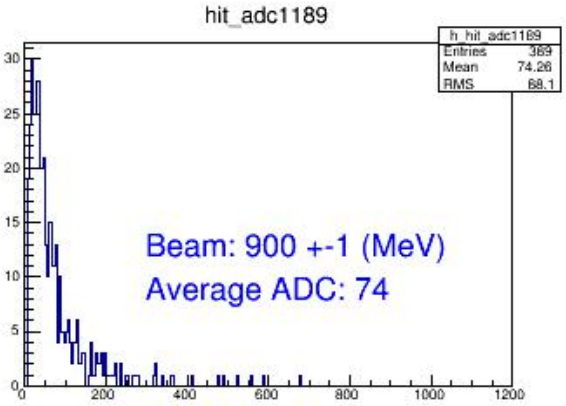

hit_adc1255
h_hit_adc1255
Entries 528
Mean 44.64
RMS 48.85
Beam: 300 +-1 (MeV)
Average ADC: 52

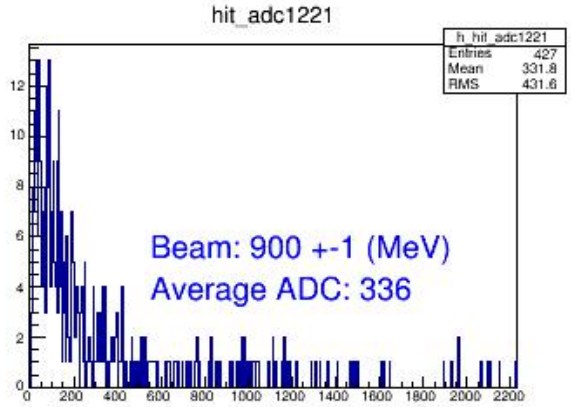

hit_adc1256
h_hit_adc1256
Entries 674
Mean 174.5
RMS 185.4
Beam: 300 +-1 (MeV)
Average ADC: 180

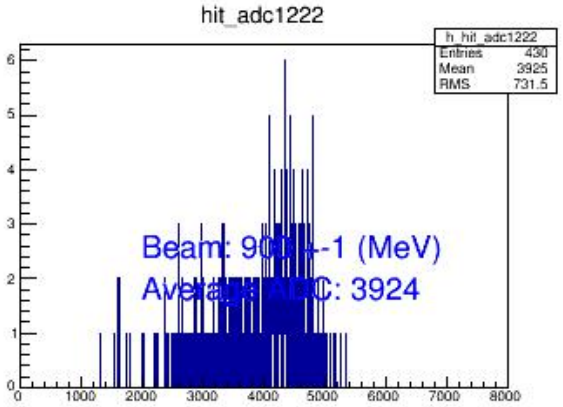

hit_adc1257
h_hit_adc1257
Entries 510
Mean 44.18
RMS 45.49
Beam: 300 +-1 (MeV)
Average ADC: 48

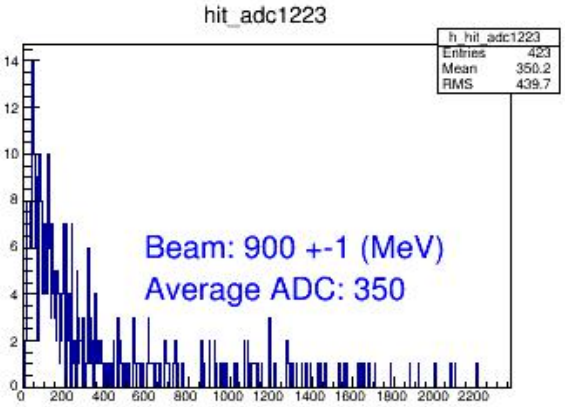

hit_adc1187
h_hit_adc1187
Entries 389
Mean 70.94
RMS 84.45
Beam: 900 +-1 (MeV)
Average ADC: 70

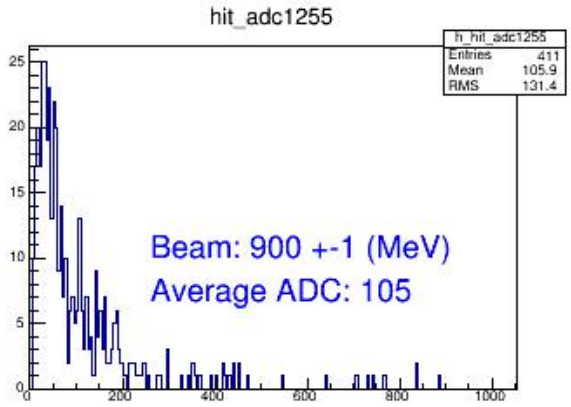

hit_adc1188
h_hit_adc1188
Entries 426
Mean 217.6
RMS 283.2
Beam: 900 +-1 (MeV)
Average ADC: 217

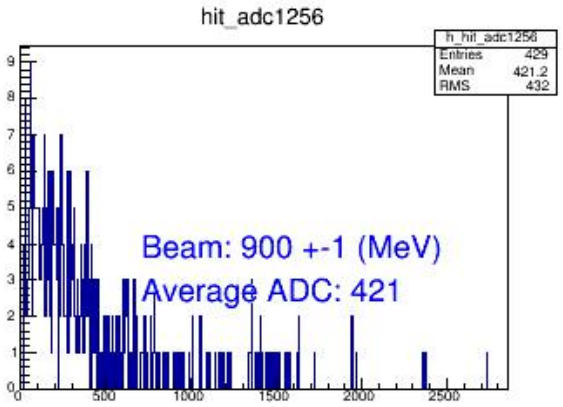

hit_adc1189
h_hit_adc1189
Entries 369
Mean 74.26
RMS 88.1
Beam: 900 +-1 (MeV)
Average ADC: 74

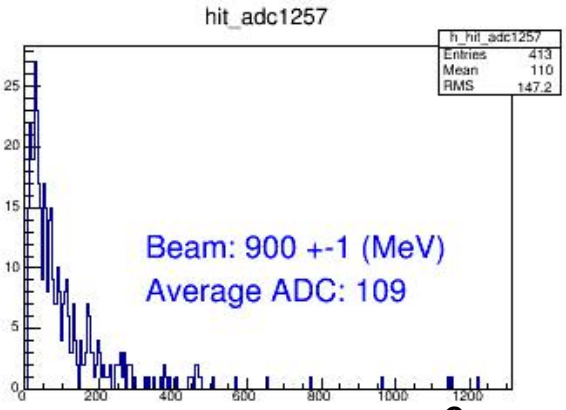

hit_adc1221
h_hit_adc1221
Entries 427
Mean 331.8
RMS 431.6
Beam: 900 +-1 (MeV)
Average ADC: 336

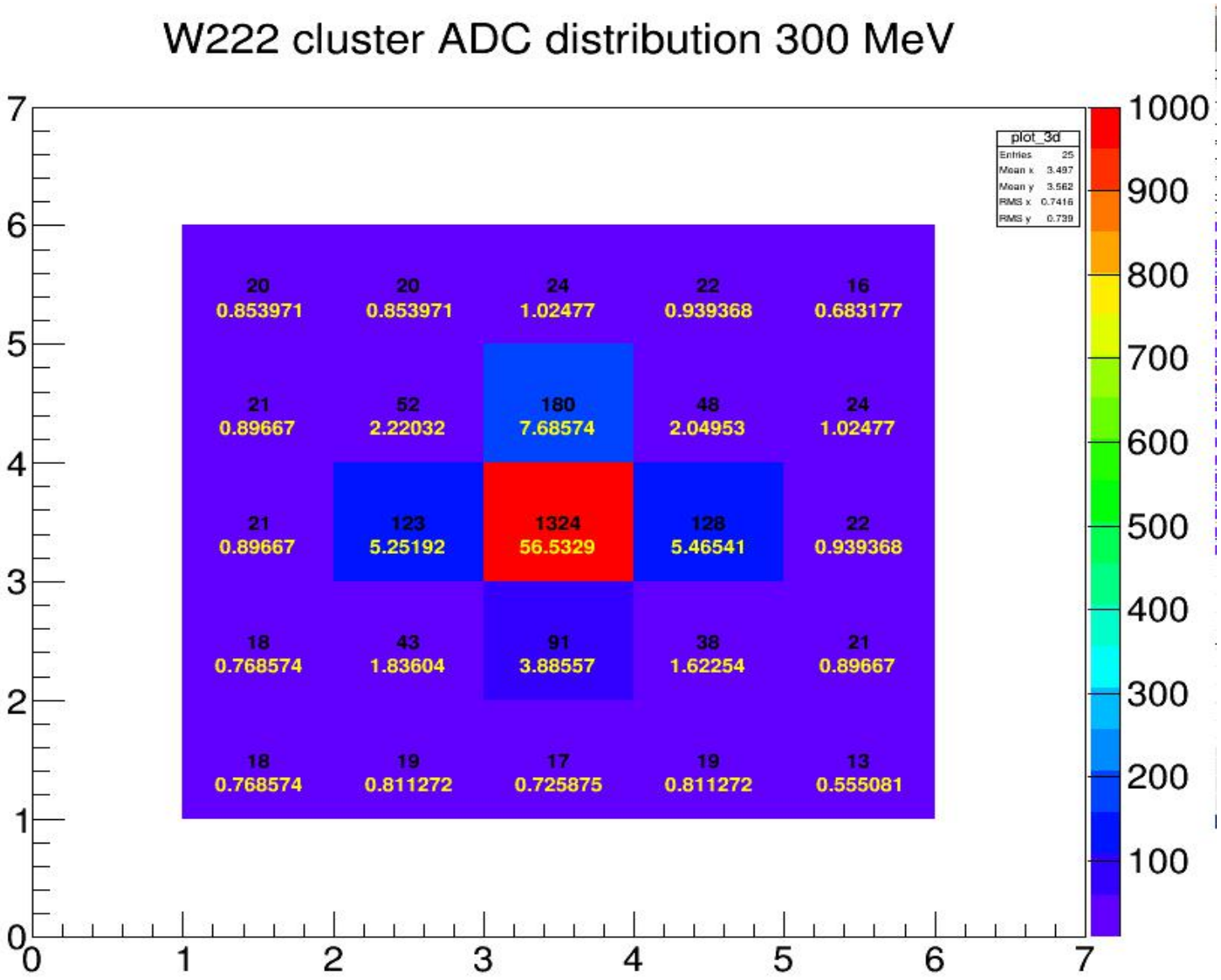

hit_adc1222
h_hit_adc1222
Entries 430
Mean 3925
RMS 731.5
Beam: 900 +-1 (MeV)
Average ADC: 3924


hit_adc1223
h_hit_adc1223
Entries 423
Mean 350.2
RMS 439.7
Beam: 900 +-1 (MeV)
Average ADC: 350


hit_adc1255
h_hit_adc1255
Entries 411
Mean 105.9
RMS 131.4
Beam: 900 +-1 (MeV)
Average ADC: 105

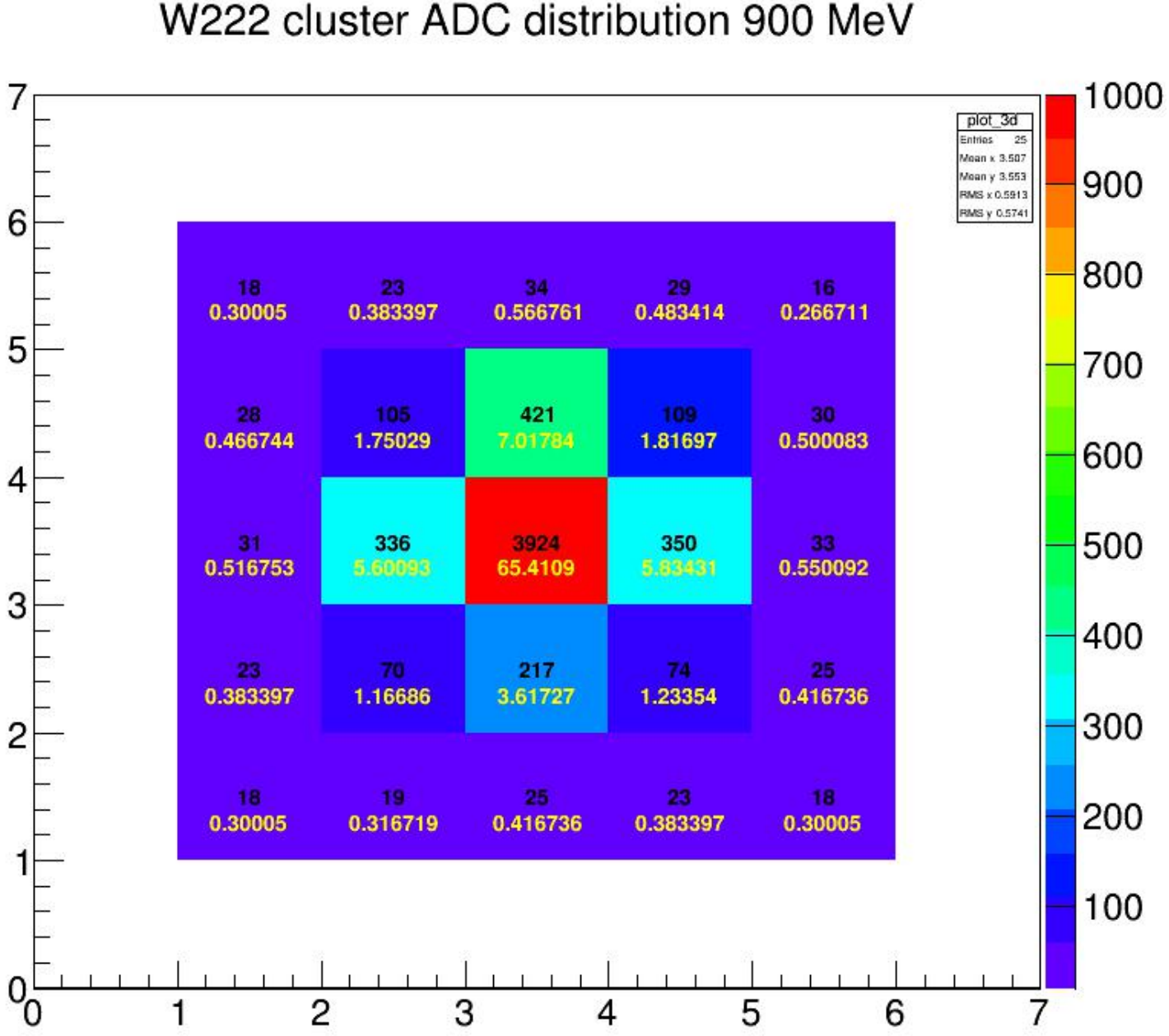

hit_adc1256
h_hit_adc1256
Entries 429
Mean 421.2
RMS 432
Beam: 900 +-1 (MeV)
Average ADC: 421


hit_adc1257
h_hit_adc1257
Entries 413
Mean 110
RMS 147.2
Beam: 900 +-1 (MeV)
Average ADC: 109



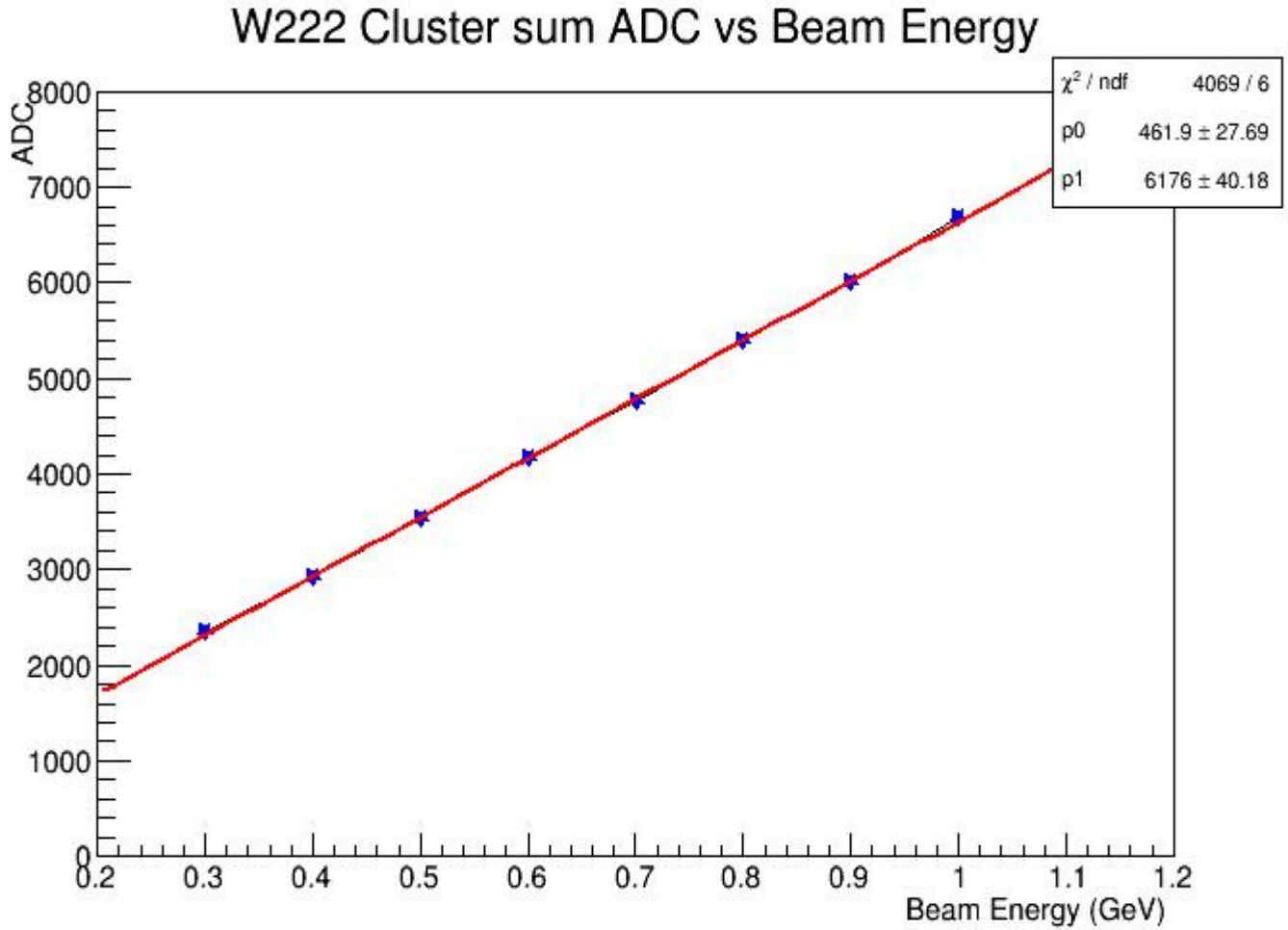
black No: ADC value on this module

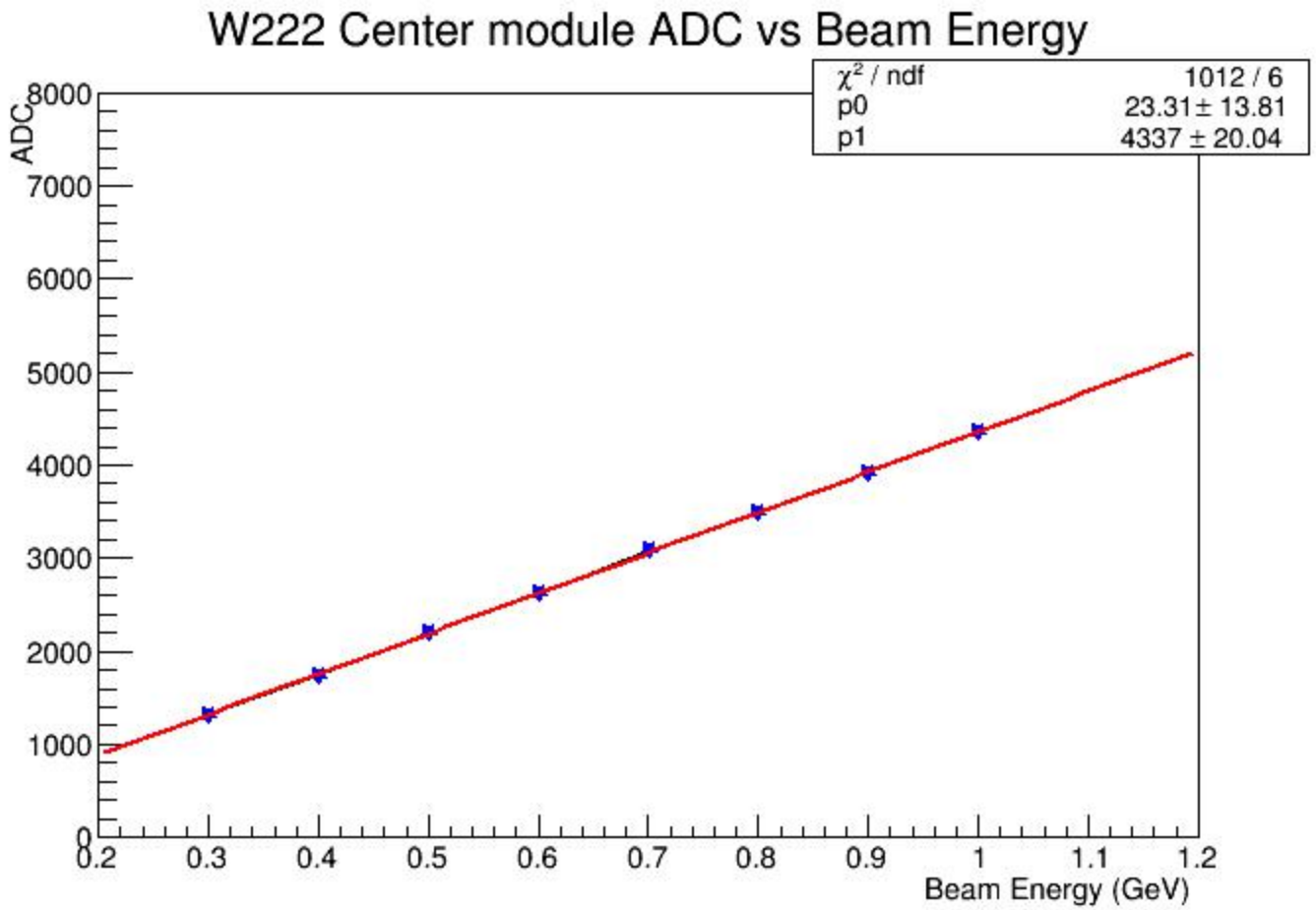
Yellow No: ADC_module / ADC_sum

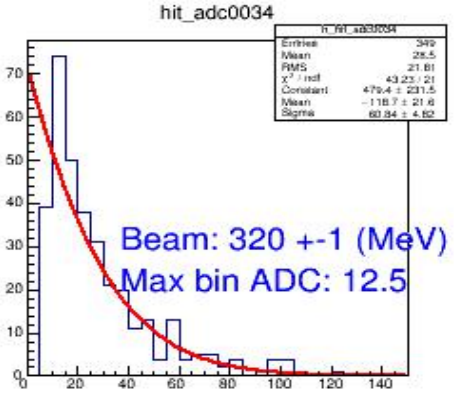

W222 cluster ADC distribution 900 MeV
plot_3d
Entries 25
Mean x 3.507
Mean y 3.553
RMS x 0.5913
RMS y 0.5741
18 0.30005
23 0.383397
34 0.566761
29 0.483414
16 0.266711
28 0.466744
105 1.75029
421 7.01784
109 1.81697
30 0.500083
31 0.516753
336 5.60093
3924 65.4109
350 5.83431
33 0.550092
23 0.383397
70 1.16686
217 3.61727
74 1.23354
25 0.416736
18 0.30005
19 0.316719
25 0.416736
23 0.383397
18 0.30005
0 1 2 3 4 5 6 7
100 200 300 400 500 600 700 800 900 1000

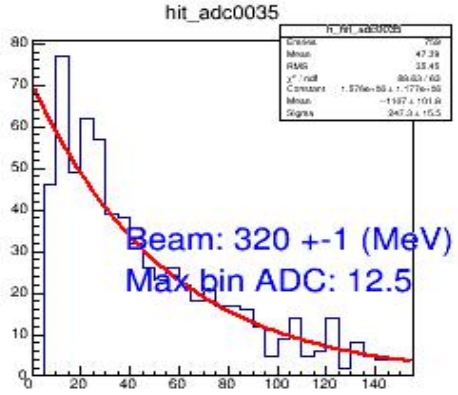
Sum 5 by 5 modules ADC get ADC_sum for different energies

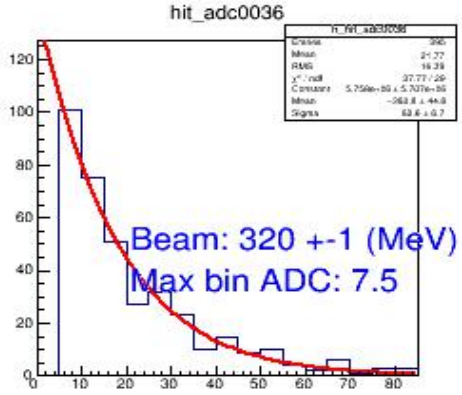
pol1 is well fitting

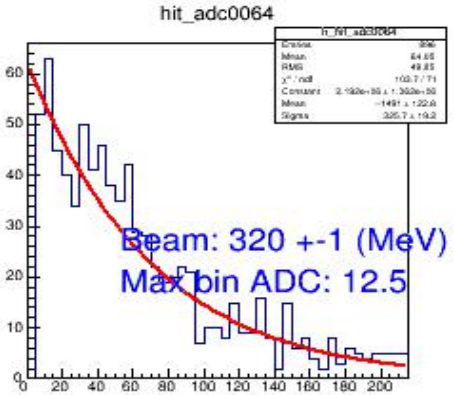


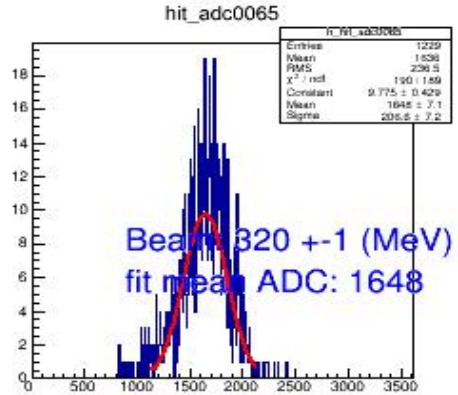

W222 Center module ADC vs Beam Energy
χ² / ndf 1012 / 6
p0 23.31 ± 13.81
p1 4337 ± 20.04
ADC
8000
7000
6000
5000
4000
3000
2000
1000
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
Beam Energy (GeV)

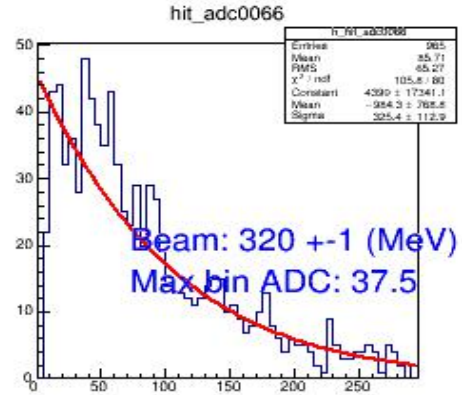

hit_adc0034
Beam: 320 +-1 (MeV)
Max bin ADC: 12.5

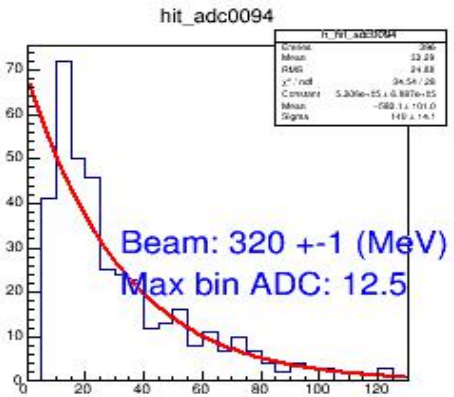

hit_adc0035
Beam: 320 +-1 (MeV)
Max bin ADC: 12.5

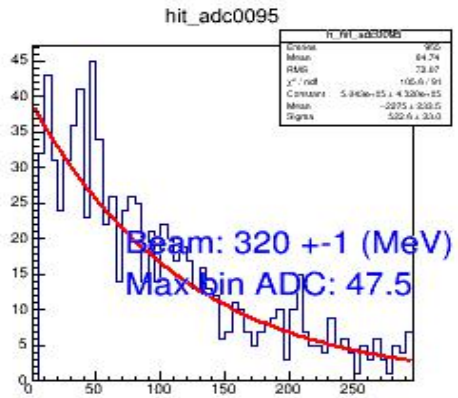

hit_adc0036
Beam: 320 +-1 (MeV)
Max bin ADC: 7.5

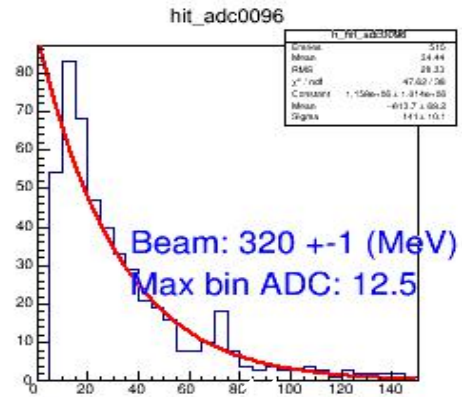

hit_adc0064
Beam: 320 +-1 (MeV)
Max bin ADC: 12.5

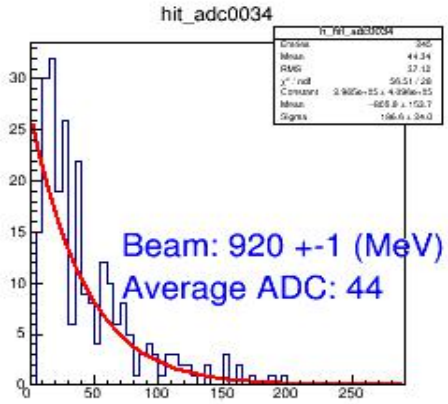

hit_adc0065
Beam: 320 +-1 (MeV)
fit mean ADC: 1648

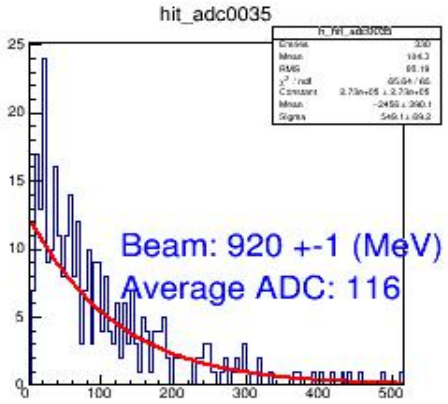

hit_adc0066
Beam: 320 +-1 (MeV)
Max bin ADC: 37.5

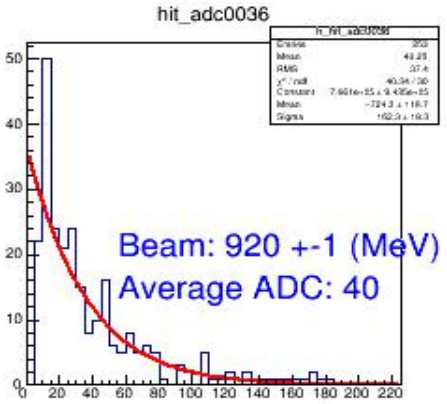

hit_adc0094
Beam: 320 +-1 (MeV)
Max bin ADC: 12.5

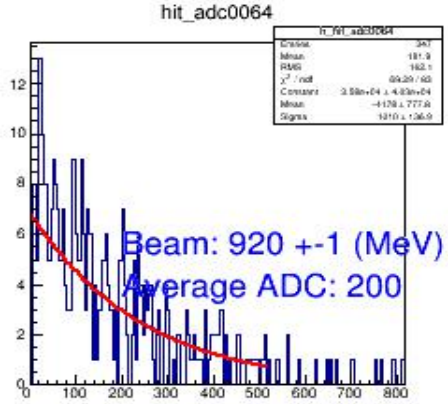

hit_adc0095
Beam: 320 +-1 (MeV)
Max bin ADC: 47.5

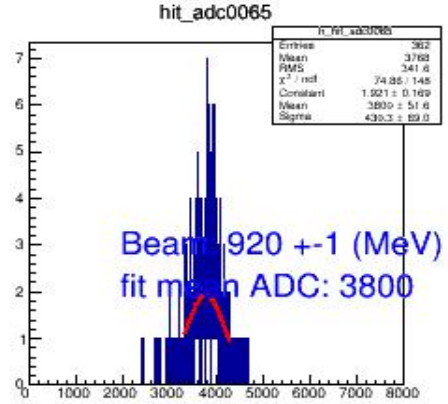

hit_adc0096
Beam: 320 +-1 (MeV)
Max bin ADC: 12.5

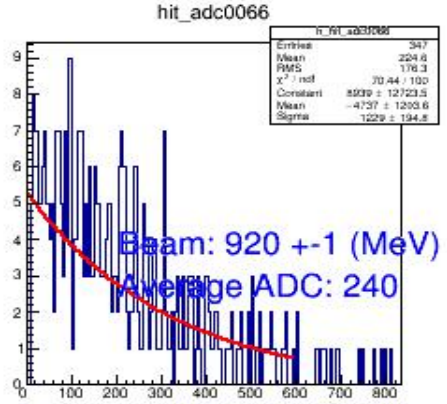

hit_adc0034
Beam: 920 +-1 (MeV)
Average ADC: 44

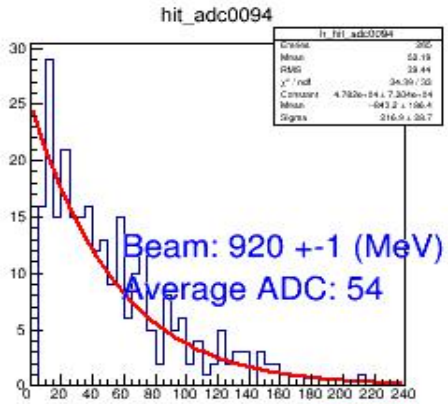

hit_adc0035
Beam: 920 +-1 (MeV)
Average ADC: 116

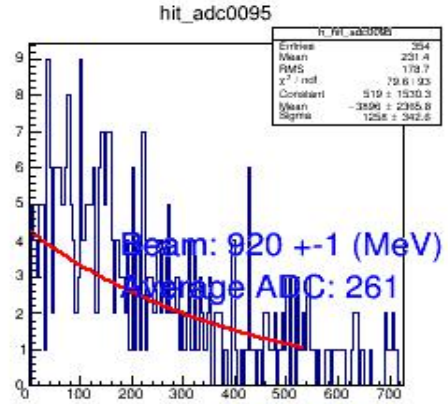

hit_adc0036
Beam: 920 +-1 (MeV)
Average ADC: 40

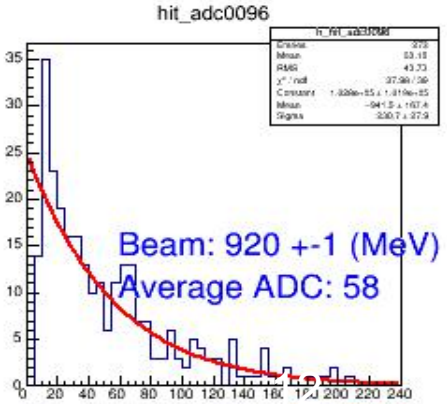

hit_adc0064
Beam: 920 +-1 (MeV)
Average ADC: 200


hit_adc0065
Beam: 920 +-1 (MeV)
fit mean ADC: 3800

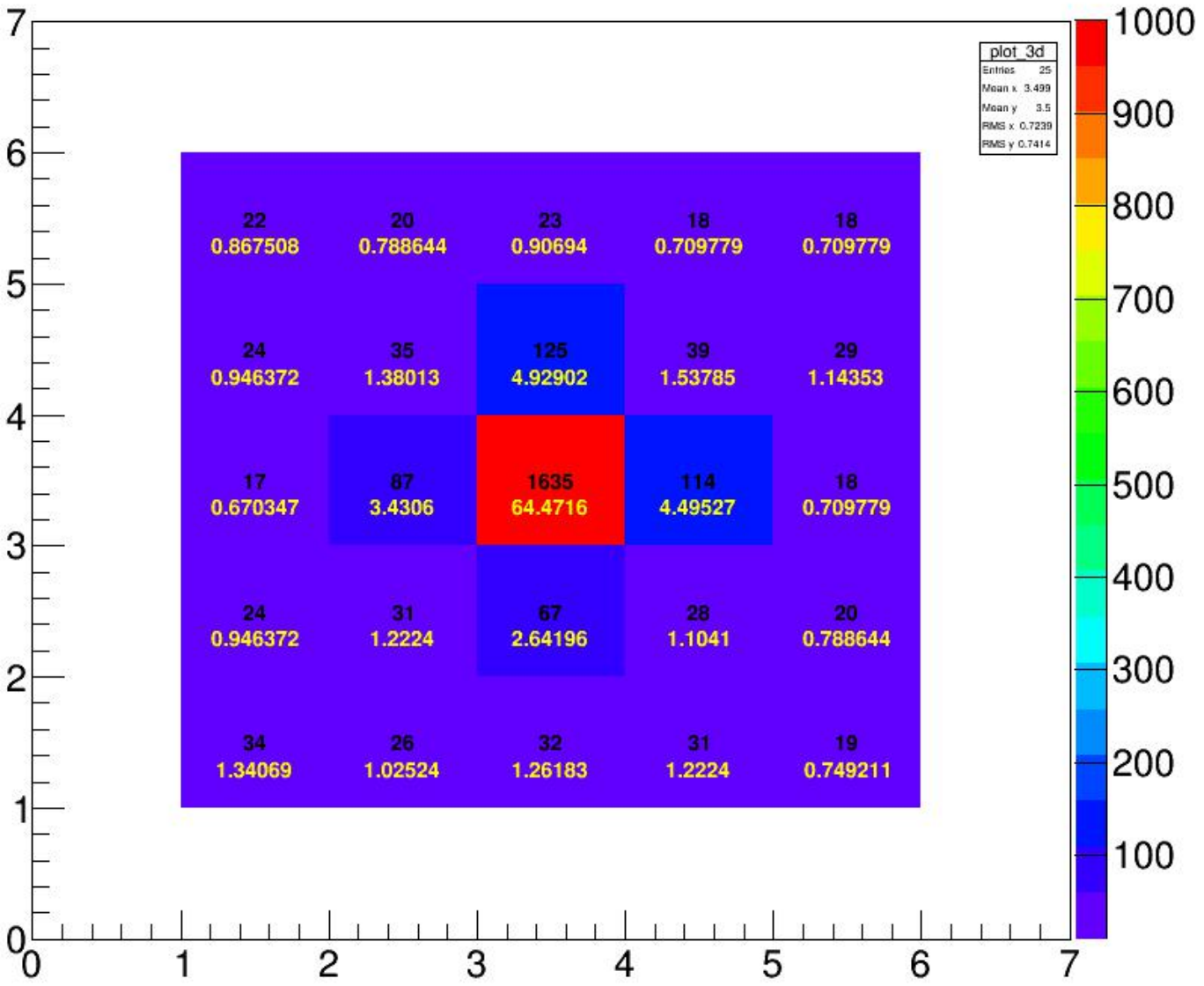

hit_adc0066
Beam: 920 +-1 (MeV)
Average ADC: 240

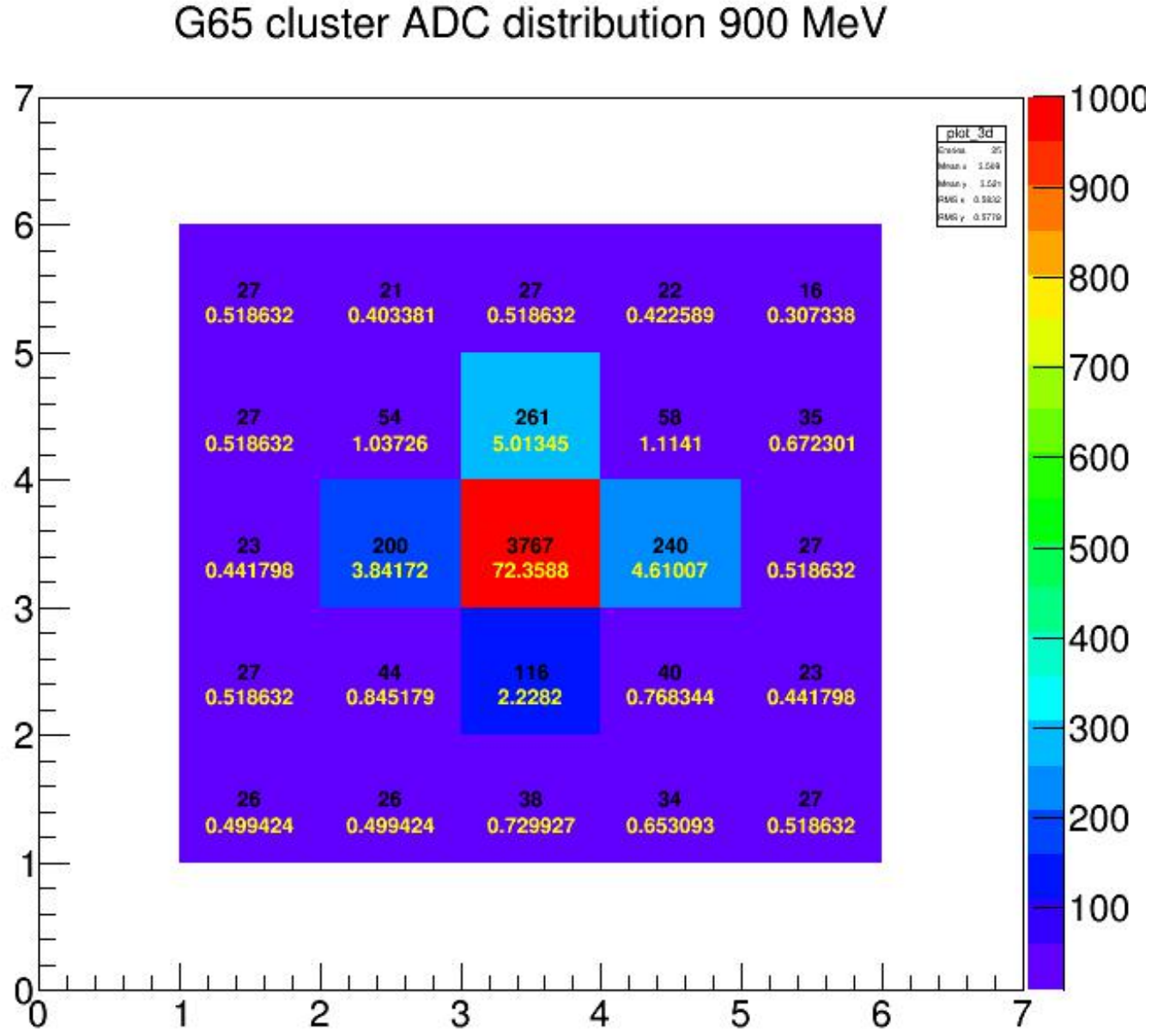

hit_adc0094
Beam: 920 +-1 (MeV)
Average ADC: 54


hit_adc0095
Beam: 920 +-1 (MeV)
Average ADC: 261

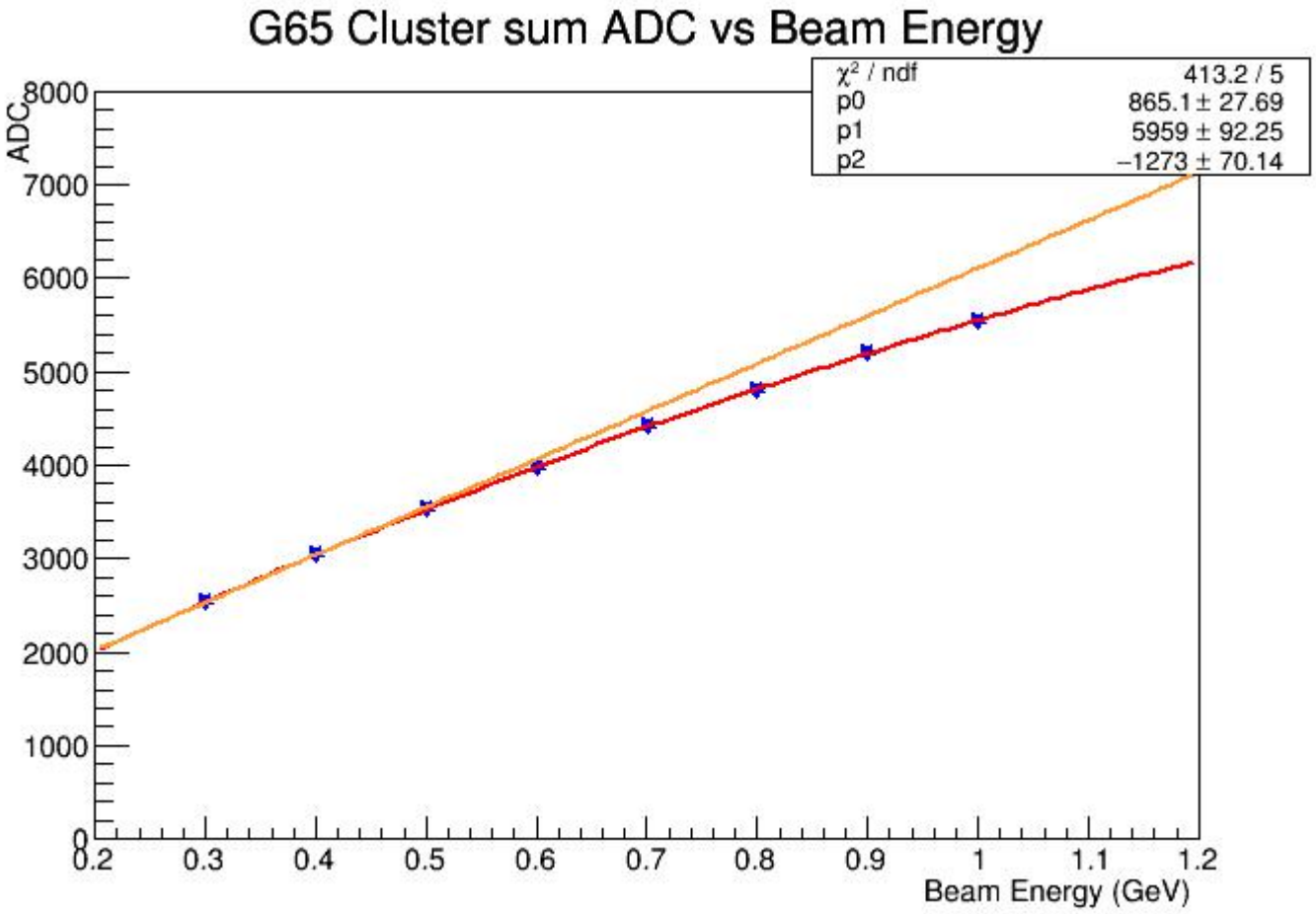

hit_adc0096
Beam: 920 +-1 (MeV)
Average ADC: 58

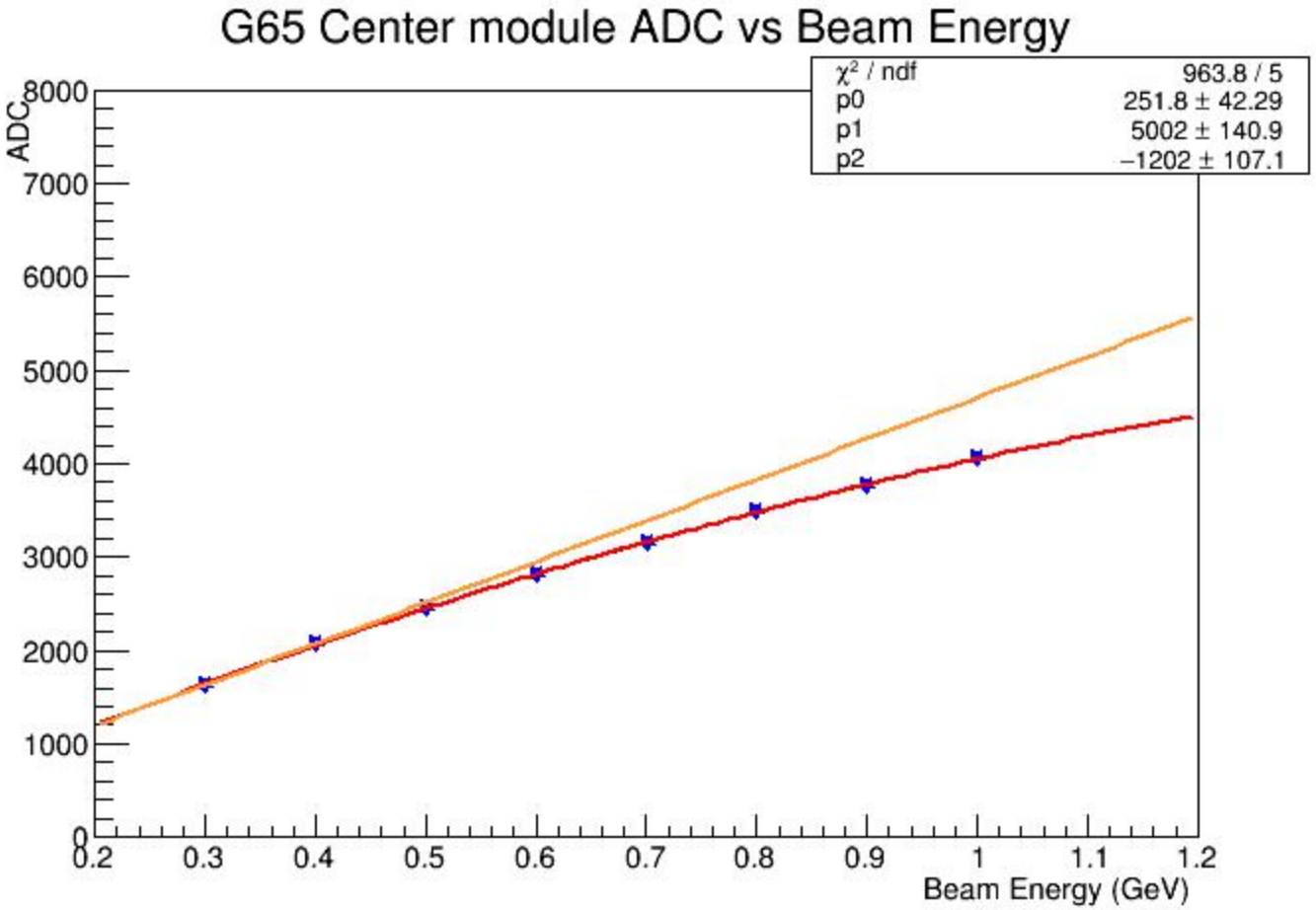
G65 cluster ADC distribution 300 MeV




G65 cluster ADC distribution 900 MeV
plot_3d
27
0.518632
21
0.403381
27
0.518632
22
0.422589
16
0.307338
27
0.518632
54
1.03726
261
5.01345
58
1.1141
35
0.672301
23
0.441798
200
3.84172
3767
72.3588
240
4.61007
27
0.518632
27
0.518632
44
0.845179
116
2.2282
40
0.768344
23
0.441798
26
0.499424
26
0.499424
38
0.729927
34
0.653093
27
0.518632
0
1
2
3
4
5
6
7
100
200
300
400
500
600
700
800
900
1000

Orange line: pol1 line
Red line: pol2 fitting




G65 Center module ADC vs Beam Energy
χ² / ndf 963.8 / 5
p0 251.8 ± 42.29
p1 5002 ± 140.9
p2 −1202 ± 107.1
ADC
8000
7000
6000
5000
4000
3000
2000
1000
0
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
Beam Energy (GeV)

For W channels :

center module energy deposit

from 56.5% (300MeV) ~65.4% (900MeV)

For G channels :

center module energy deposit

from 64.5% (300MeV) ~72.4% (900MeV)

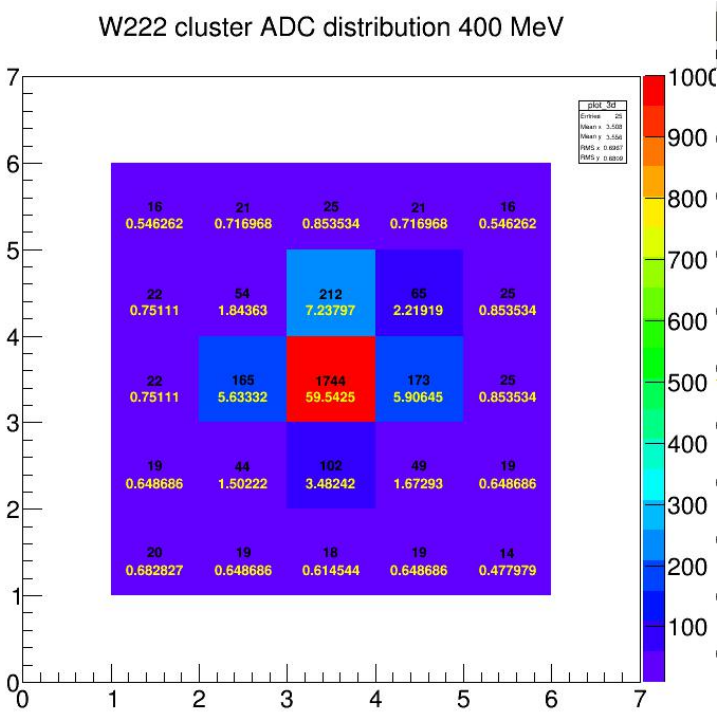
cluster shape and distribution looks 'normal' as W channels

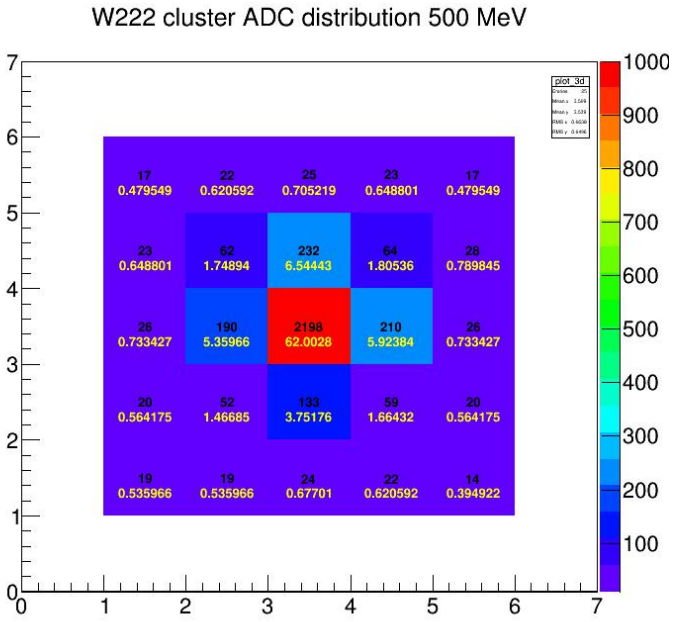
non-linear come from light collection efficiency

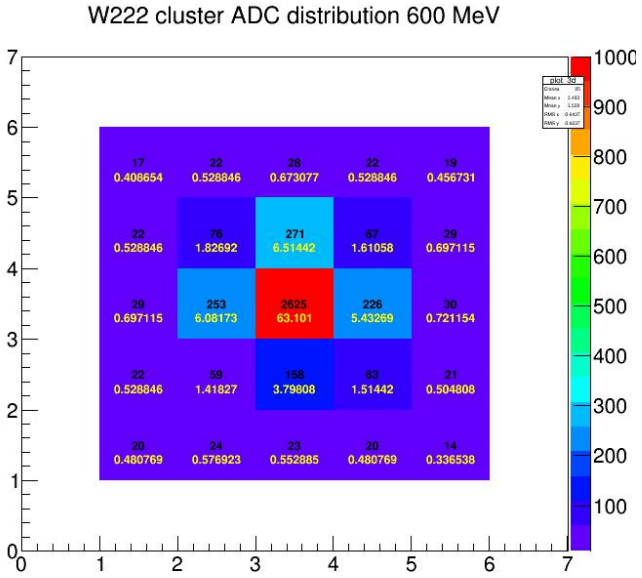
(bad reflection layer ?)

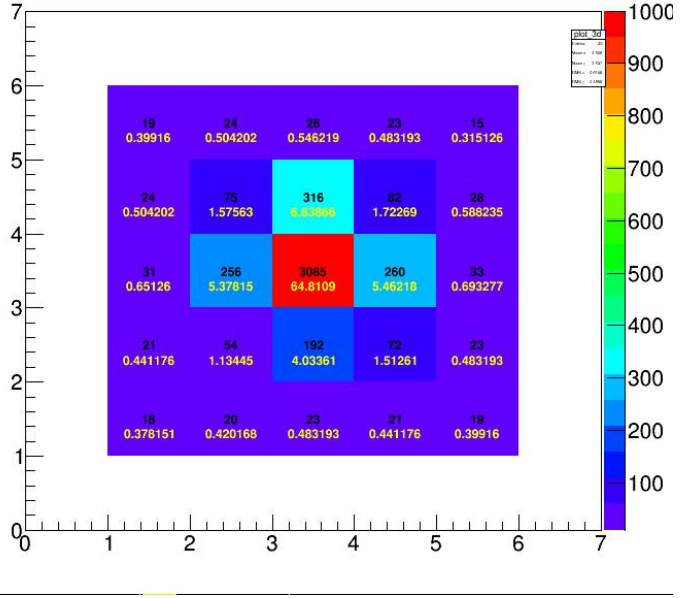
Conclusion

- PbWO4 channels have linear relation between ADC value and beam energy,which indicate that gain factor should be constant
- Lead Glass channels have non-linear behavior which come from the hardware but not the cluster reconstruction Algorithm


W222 cluster ADC distribution 400 MeV
16 0.546262
21 0.716968
25 0.853534
21 0.716968
16 0.546262
22 0.75111
54 1.84363
212 7.23797
65 2.21919
25 0.853534
22 0.75111
165 5.63332
1744 59.5425
173 5.90645
25 0.853534
19 0.648686
44 1.50222
102 3.48242
49 1.67293
19 0.648686
20 0.682827
19 0.648686
18 0.614544
19 0.648686
14 0.477979


W222 cluster ADC distribution 500 MeV
17 0.479549
22 0.620592
25 0.705219
23 0.648801
17 0.479549
23 0.648801
62 1.74894
232 6.54443
64 1.80536
28 0.789845
26 0.733427
190 5.35966
2198 62.0028
210 5.92384
26 0.733427
20 0.564175
52 1.46685
133 3.75176
59 1.66432
20 0.564175
19 0.535966
19 0.535966
24 0.67701
22 0.620592
14 0.394922


W222 cluster ADC distribution 600 MeV
17 0.408654
22 0.528846
28 0.673077
22 0.528846
19 0.456731
22 0.528846
76 1.82692
271 6.51442
67 1.61058
29 0.697115
29 0.697115
253 6.08173
2625 63.101
226 5.43269
30 0.721154
22 0.528846
59 1.41827
158 3.79808
63 1.51442
21 0.504808
20 0.480769
24 0.576923
23 0.552885
20 0.480769
14 0.336538


W222 cluster ADC distribution 700 MeV
19 0.39916
24 0.504202
26 0.546219
23 0.483193
15 0.315126
24 0.504202
75 1.57563
316 6.63866
82 1.72269
26 0.588235
31 0.65126
256 5.37815
3085 64.8109
260 5.46218
33 0.693277
21 0.441176
54 1.13445
192 4.03361
72 1.51261
23 0.483193
18 0.378151
20 0.420168
23 0.483193
21 0.441176
19 0.39916