sPHENIX INTT -
beam test noise level

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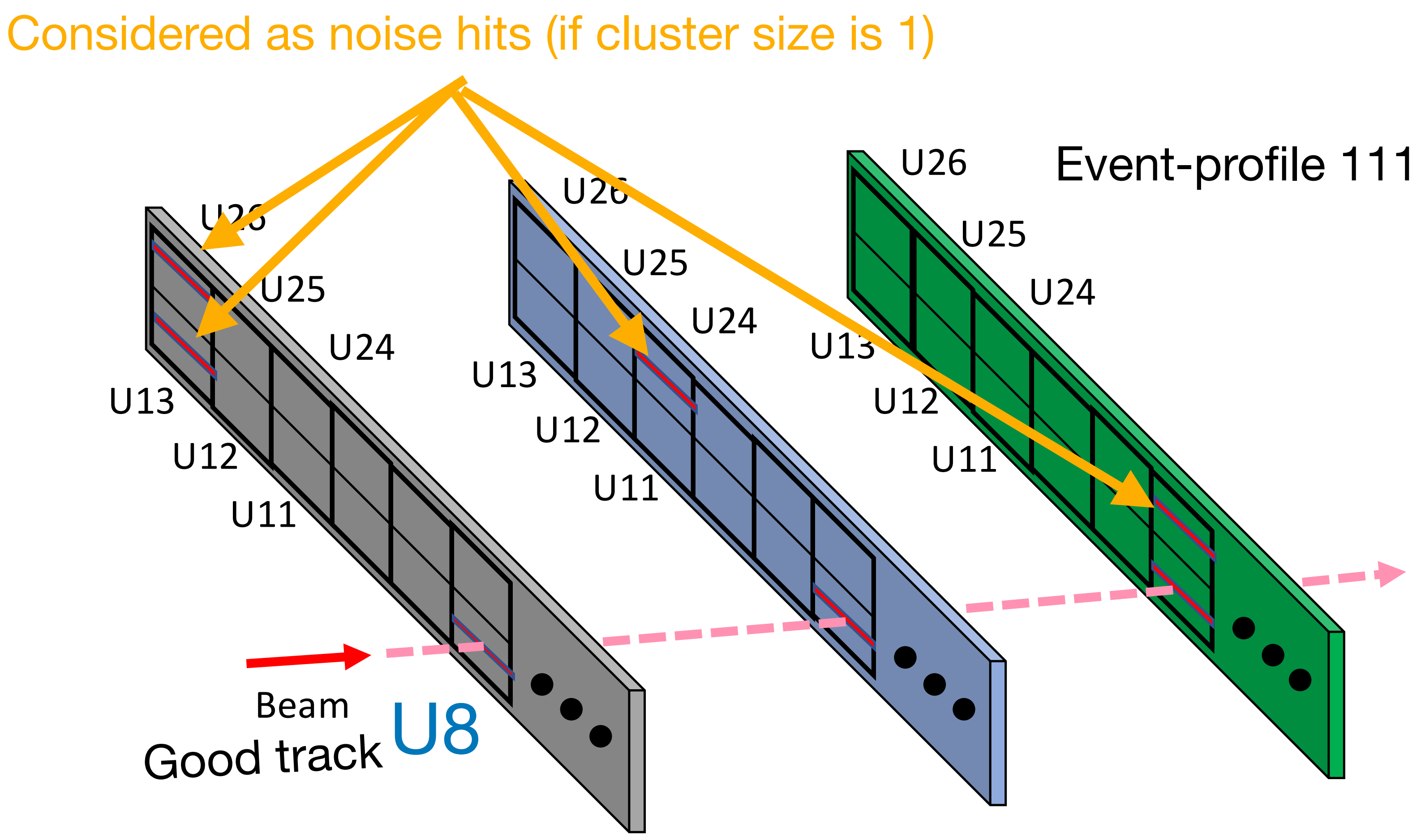
Noise level estimation - Method 1

Try to estimate the noise dist. by data



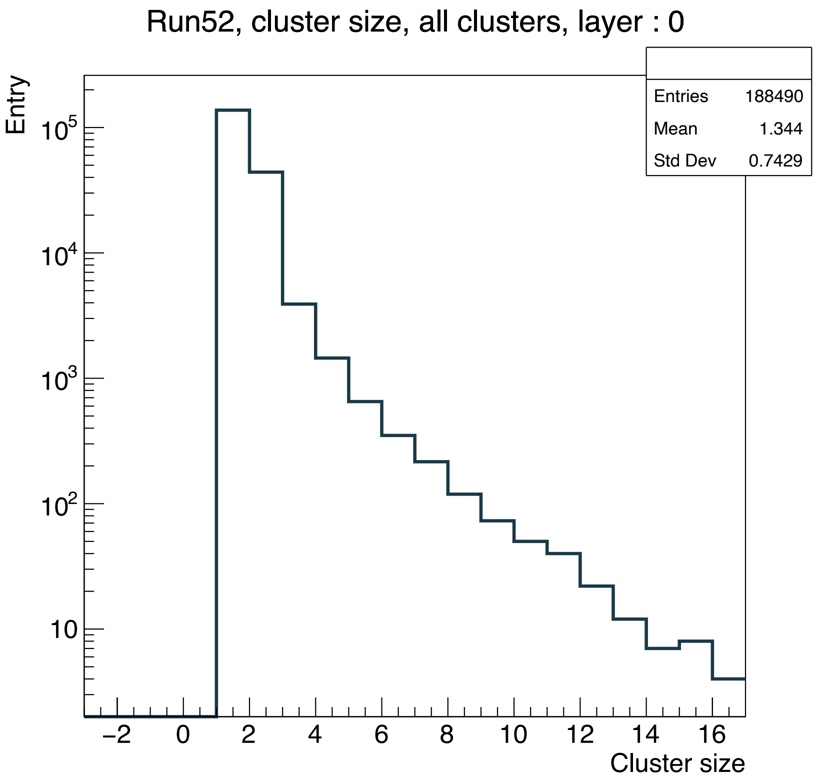
Only check the good track events

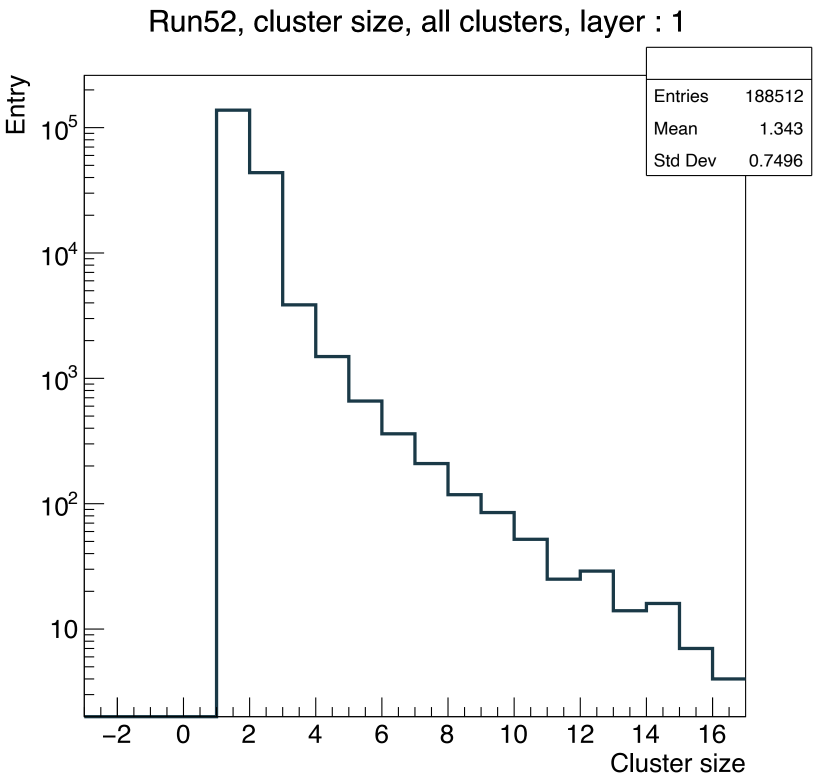
1. Event profile has to be 111 (good track)
2. The size of the cluster has to be 1

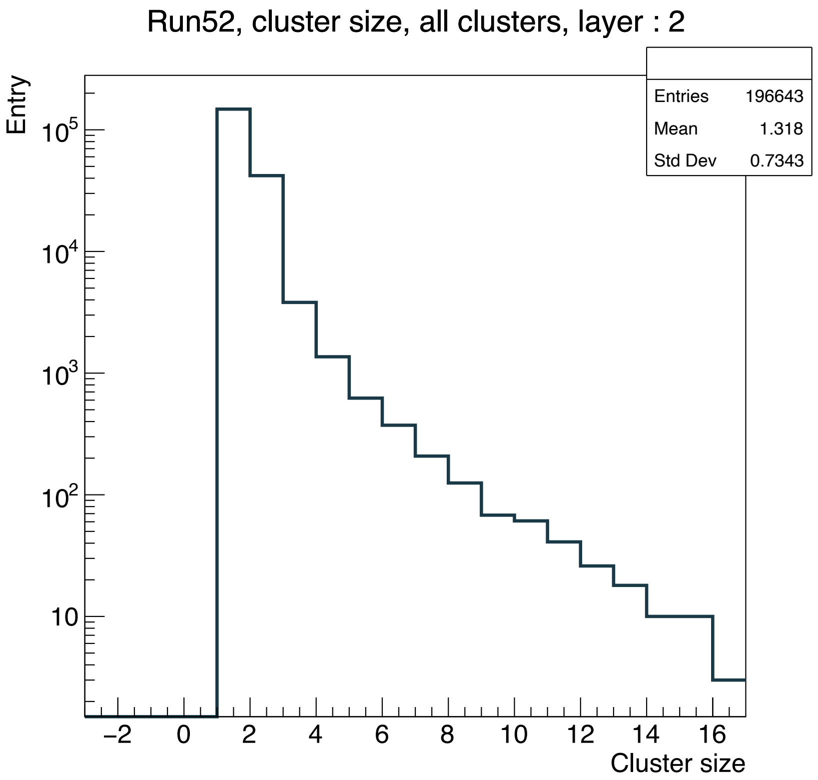
In this example, 4 clusters are considered as noise hits (Assume the 4 clusters are all composed by 1 hit)

Run 52 - cluster size distribution

All clusters

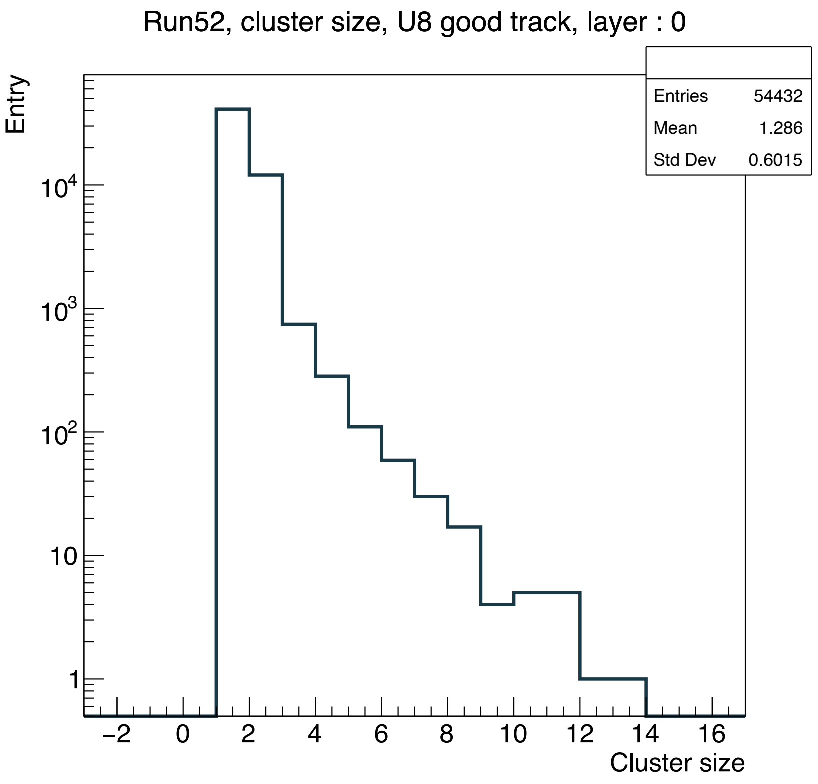

Run52, cluster size, all clusters, layer : 0

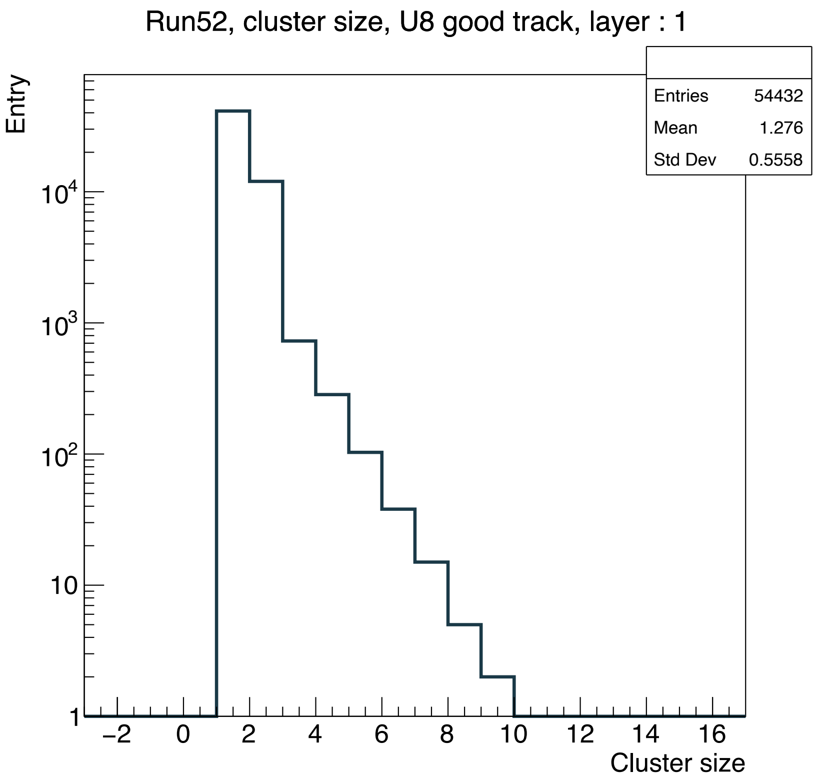

Run52, cluster size, all clusters, layer : 1

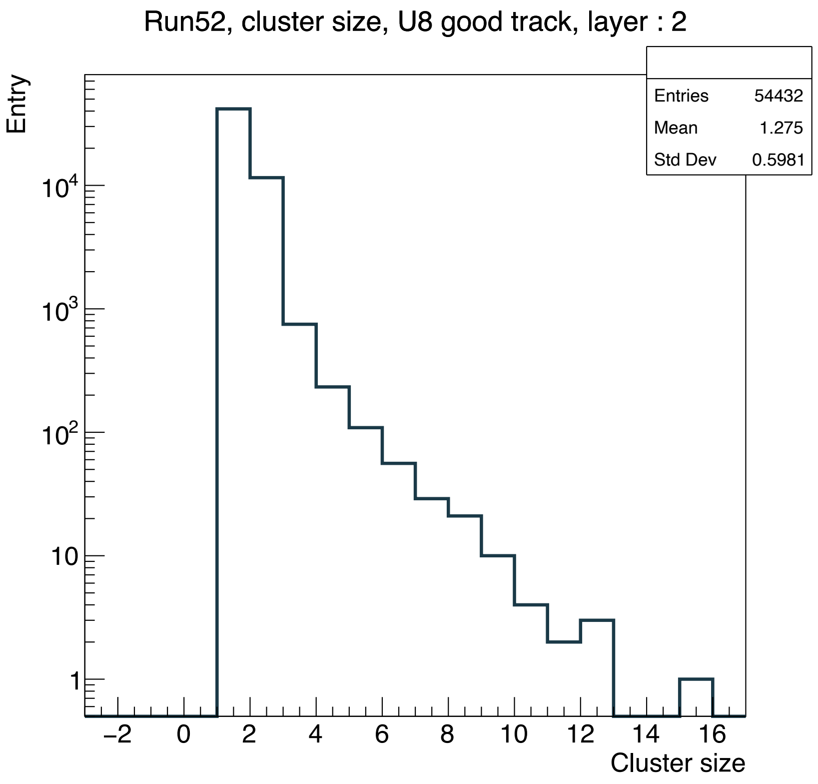

Run52, cluster size, all clusters, layer : 2

Run 52 - cluster size distribution

Only good track at chip 8 or chip 21





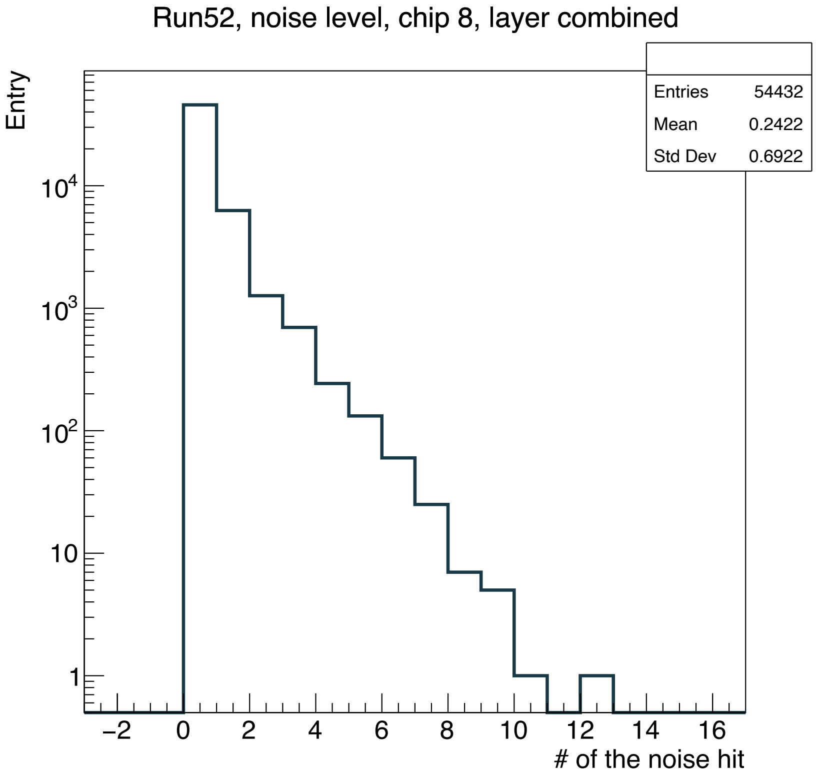


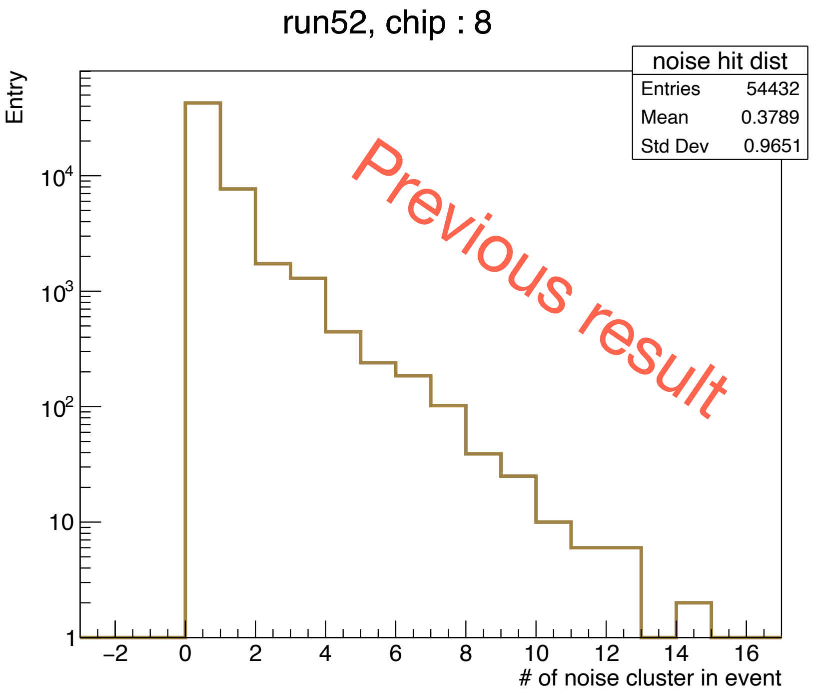
Run 52 - Noise level

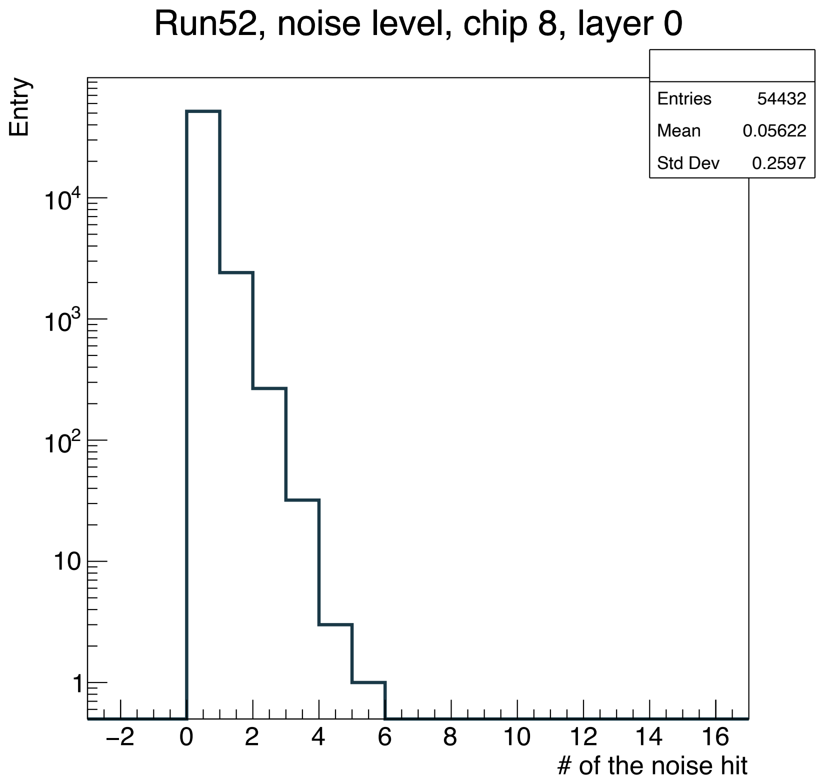
Criteria :

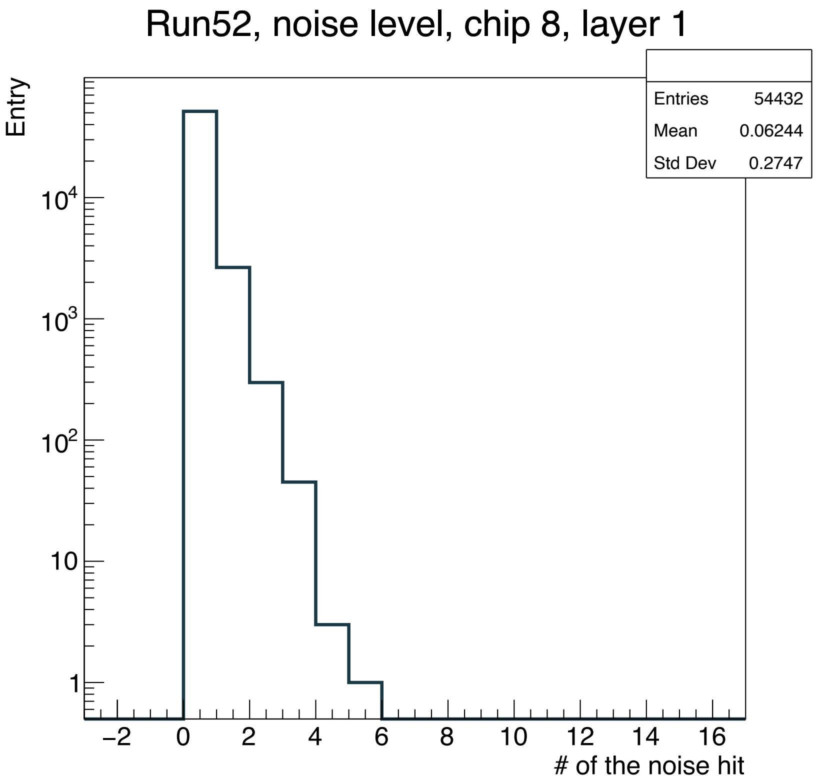
1. One good track at chip 8 or 21
2. Size of the cluster == 1

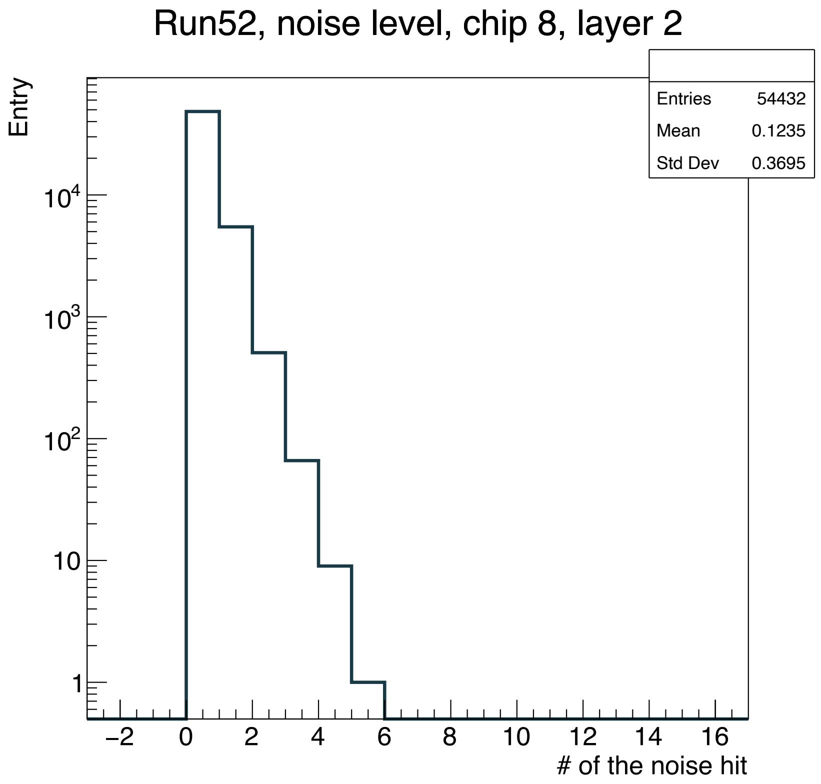
16.0% of the events have at least one additional hit (cluster size == 1) besides the good track.


Run52, noise level, chip 8, layer combined


run52, chip : 8


Run52, noise level, chip 8, layer 0


Run52, noise level, chip 8, layer 1

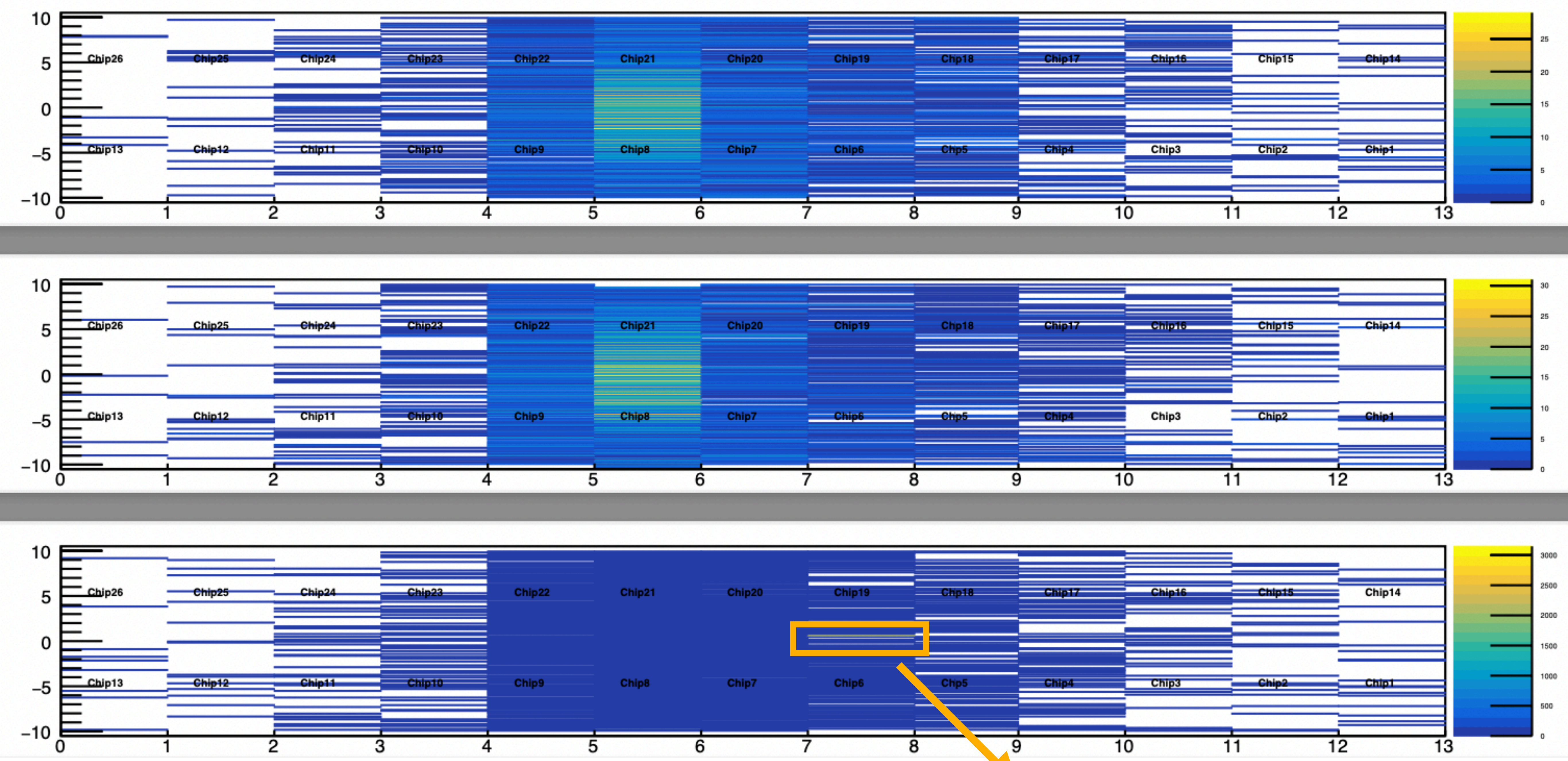

Run52, noise level, chip 8, layer 2

Run 52 - Noise hit map

Criteria :

1. One good track at chip 8 or 21 → Bias
2. Size of the cluster == 1

The distribution is not uniform



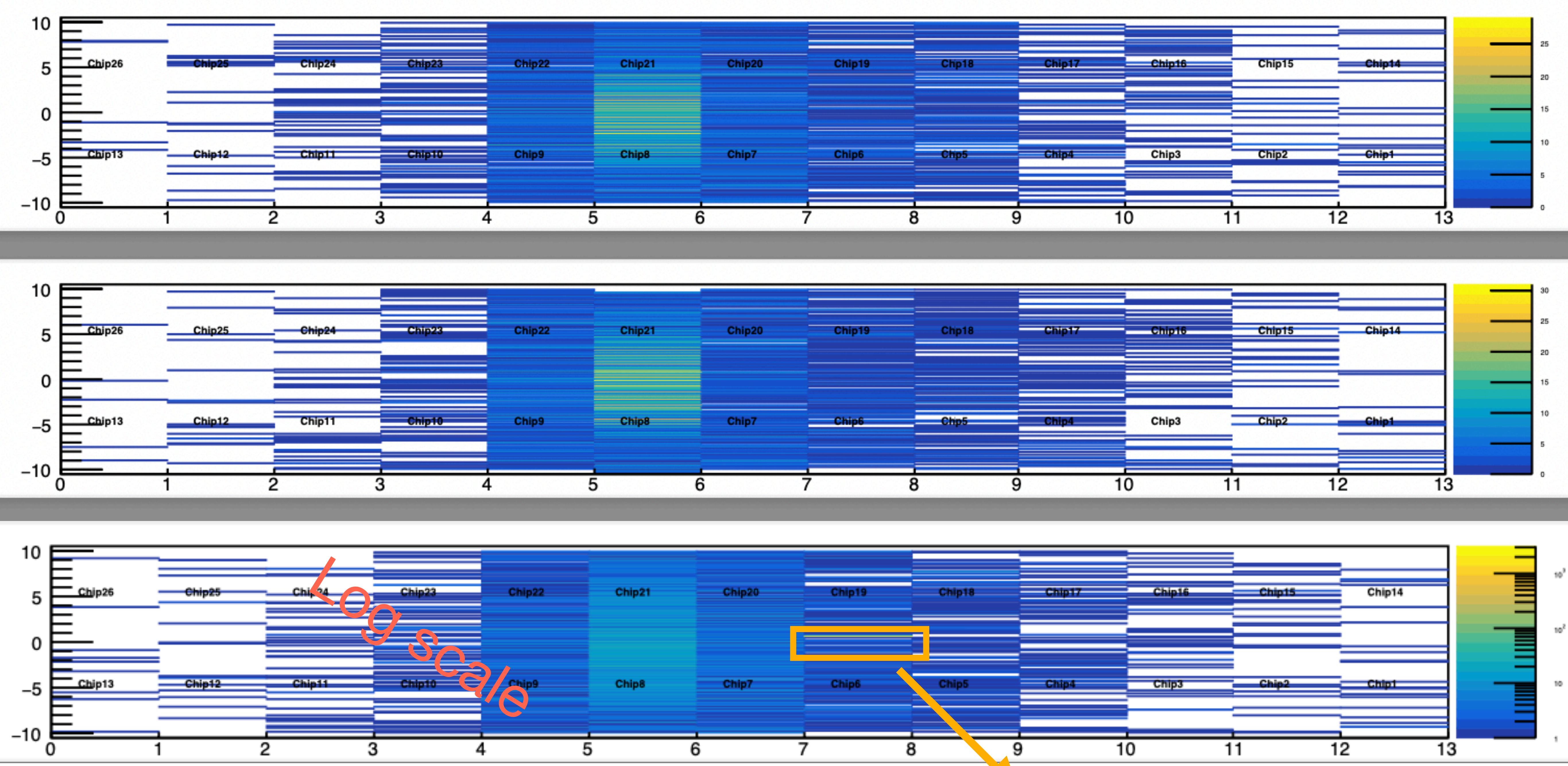
High entry, ~ 3000

Run 52 - Noise hit map

Criteria :

1. One good track at chip 8 or 21 → Bias
2. Size of the cluster == 1

The distribution is not uniform



Log scale

High entry, ~ 3000

Noise level estimation - Method 2, remove multi-tracks

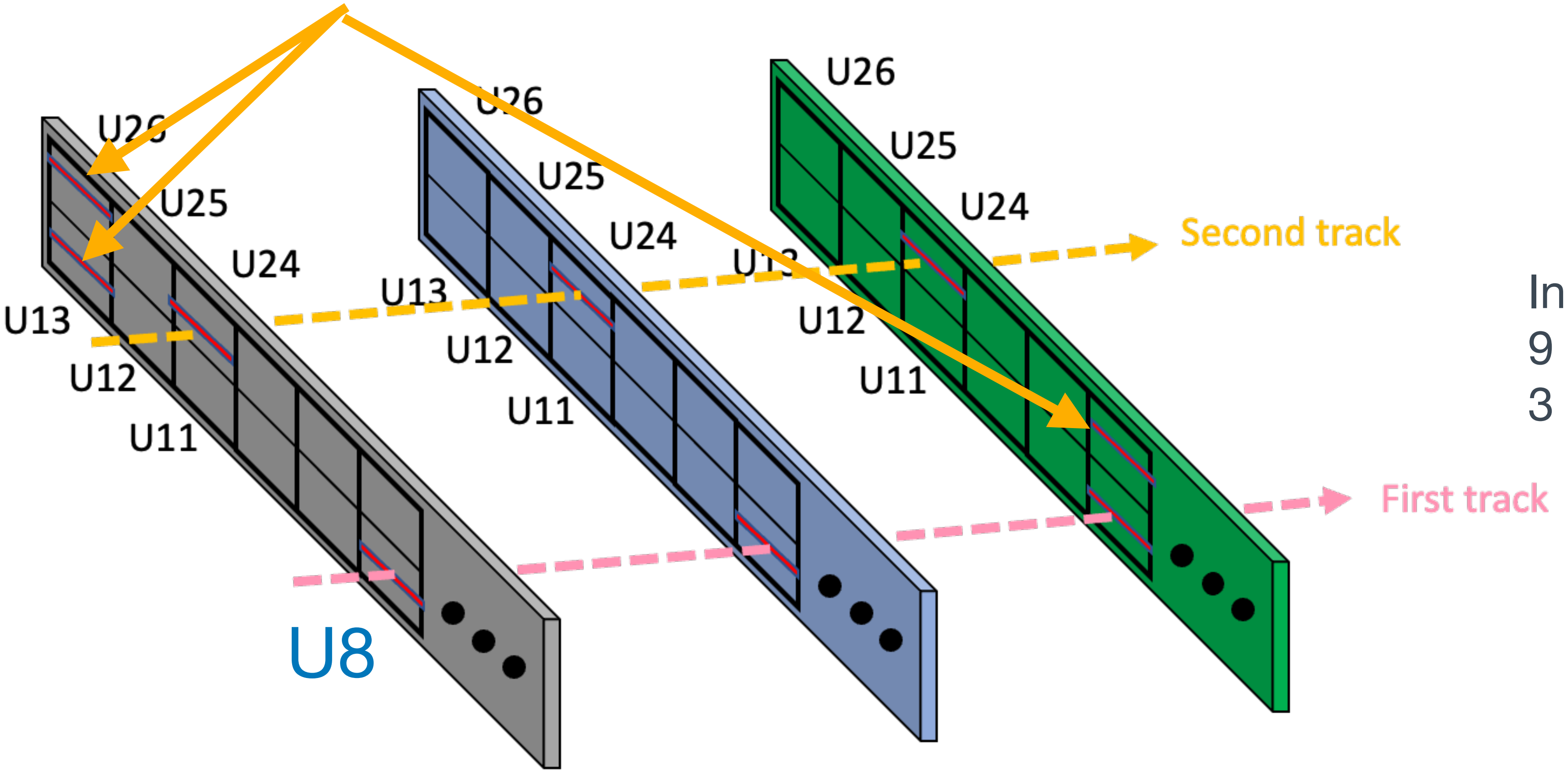
Alignment correction : only chip 8 and 21
Can be more correct

Residual tolerance : same (same as chip 8)

Criteria :

1. One good track at chip 8 or 21
2. Remove rest of good tracks in this event (2nd, 3rd, …)
   - Good track definition : residual < 0.1374 mm (Run 52)
3. For the remaining clusters, the size of the cluster == 1

Considered as noise hits (assume cluster size is 1)

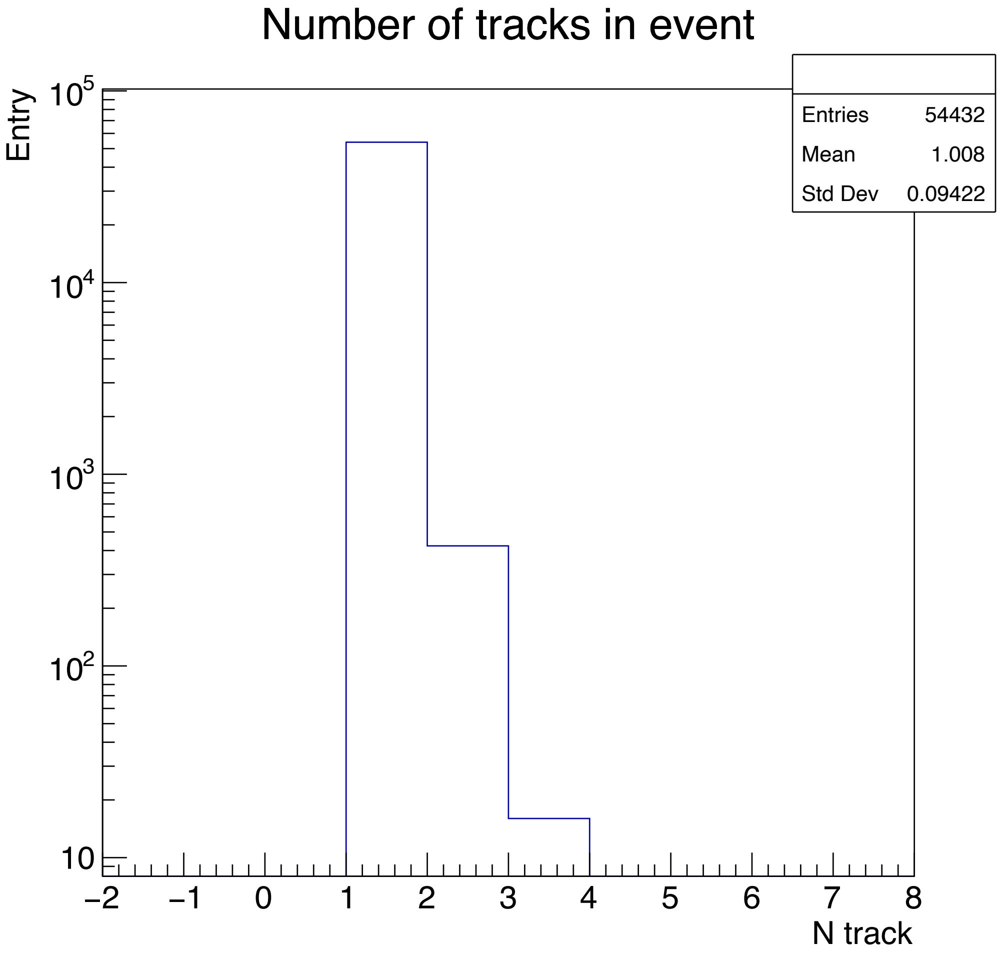


In the example :
9 clusters → 2 good tracks
3 noise hits

Run 52 - remove multi-tracks, N tracks dist.

Alignment correction : only chip 8 and 21
Can be more correct

Have a good track at chip 8, in the first place.

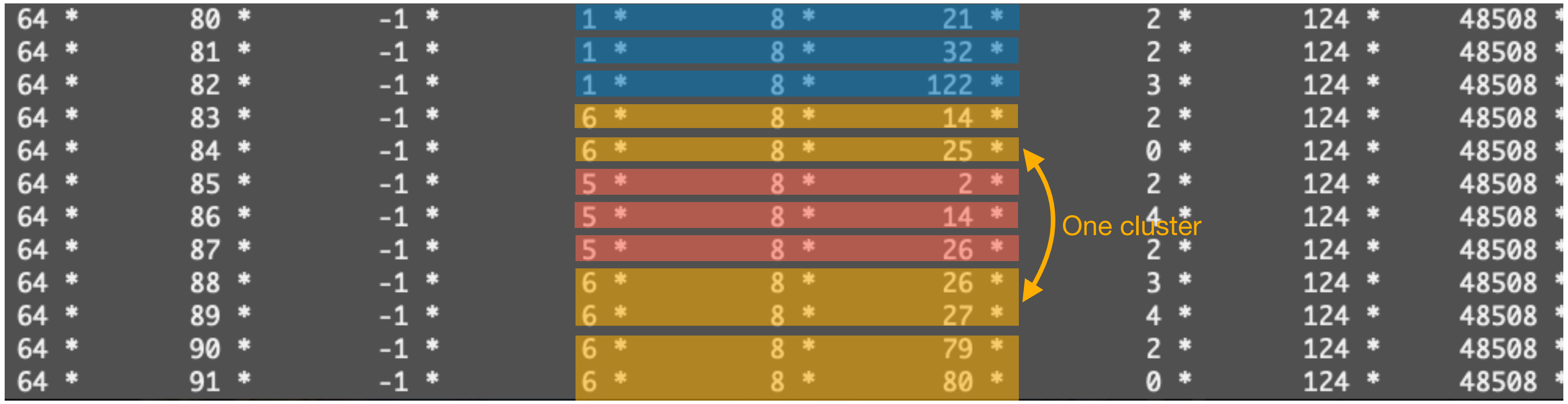


File : run52_no_clone.root

One of the 3-good-tracks event

Layer 0 : 3 clusters
Layer 1 : 3 clusters
Layer 2 : 3 clusters

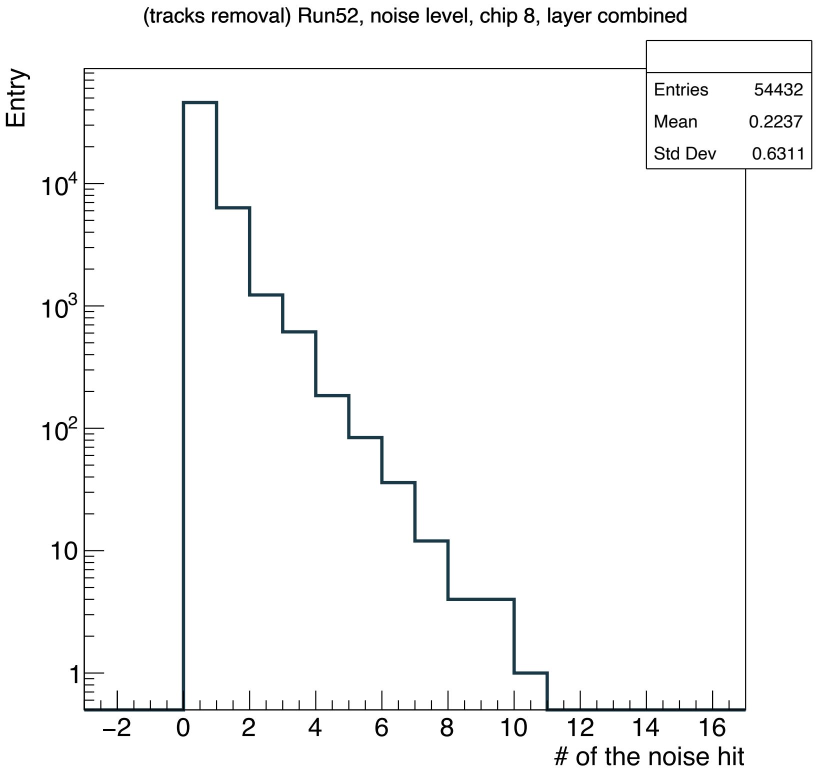
Event ID Layer Chip Channel ADC BCO full

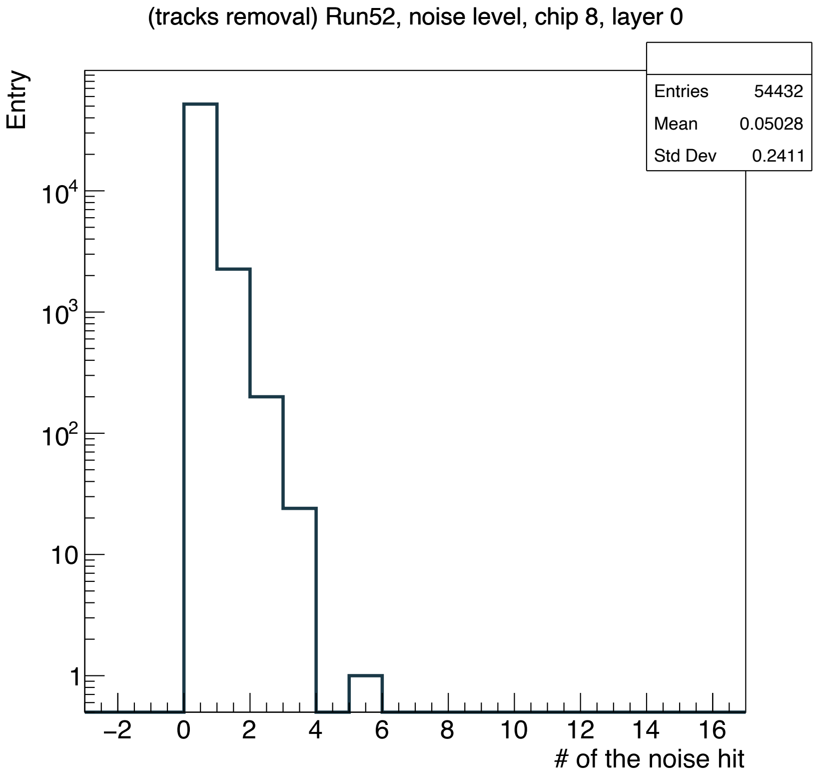


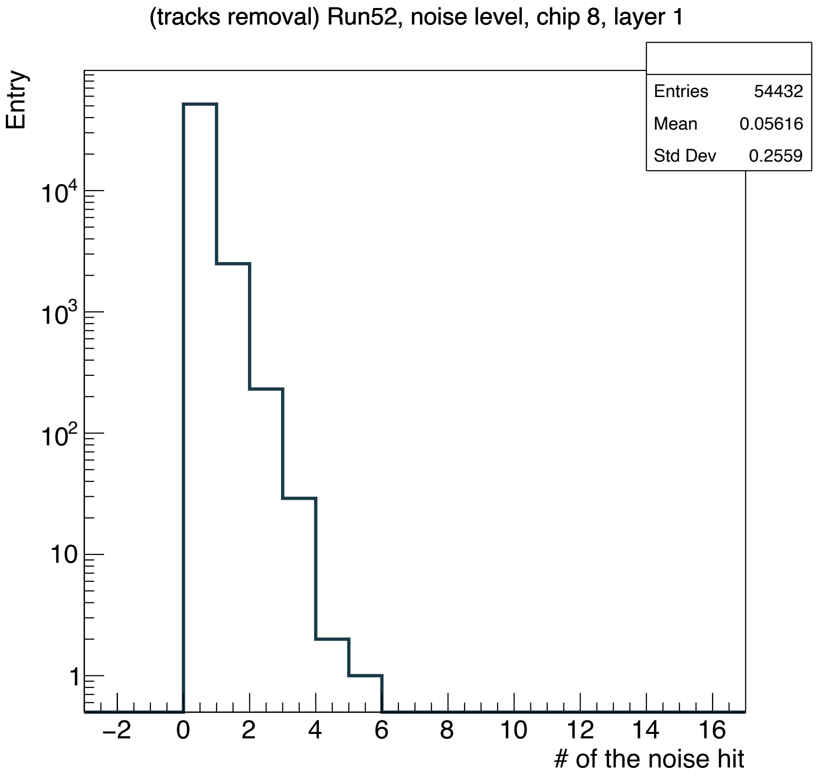
```
64 *  80 *  -1 *  1 *  8 *  21 *  2 *  124 *  48508 *
64 *  81 *  -1 *  1 *  8 *  32 *  2 *  124 *  48508 *
64 *  82 *  -1 *  1 *  8 * 122 *  3 *  124 *  48508 *
64 *  83 *  -1 *  6 *  8 *  14 *  2 *  124 *  48508 *
64 *  84 *  -1 *  6 *  8 *  25 *  0 *  124 *  48508 *
64 *  85 *  -1 *  5 *  8 *   2 *  2 *  124 *  48508 *
64 *  86 *  -1 *  5 *  8 *  14 *  4 *  124 *  48508 *
64 *  87 *  -1 *  5 *  8 *  26 *  2 *  124 *  48508 *
64 *  88 *  -1 *  6 *  8 *  26 *  3 *  124 *  48508 *
64 *  89 *  -1 *  6 *  8 *  27 *  4 *  124 *  48508 *
64 *  90 *  -1 *  6 *  8 *  79 *  2 *  124 *  48508 *
64 *  91 *  -1 *  6 *  8 *  80 *  0 *  124 *  48508 *
```

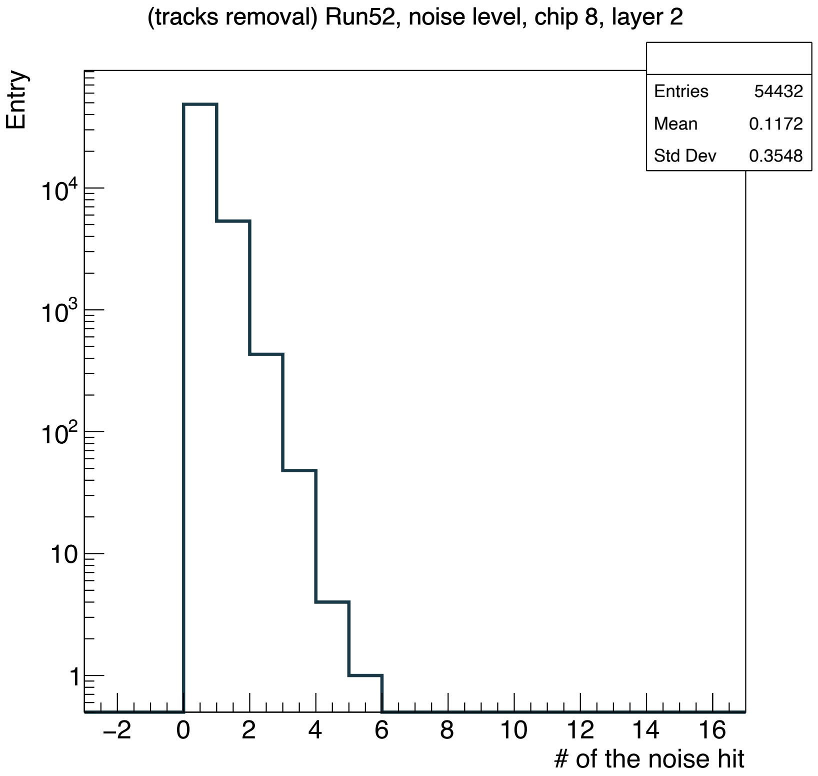
Run 52 - remove multi-tracks, noise level

15.6% of the events have at least one additional hit (cluster size == 1) besides the good track.


(tracks removal) Run52, noise level, chip 8, layer combined


(tracks removal) Run52, noise level, chip 8, layer 0

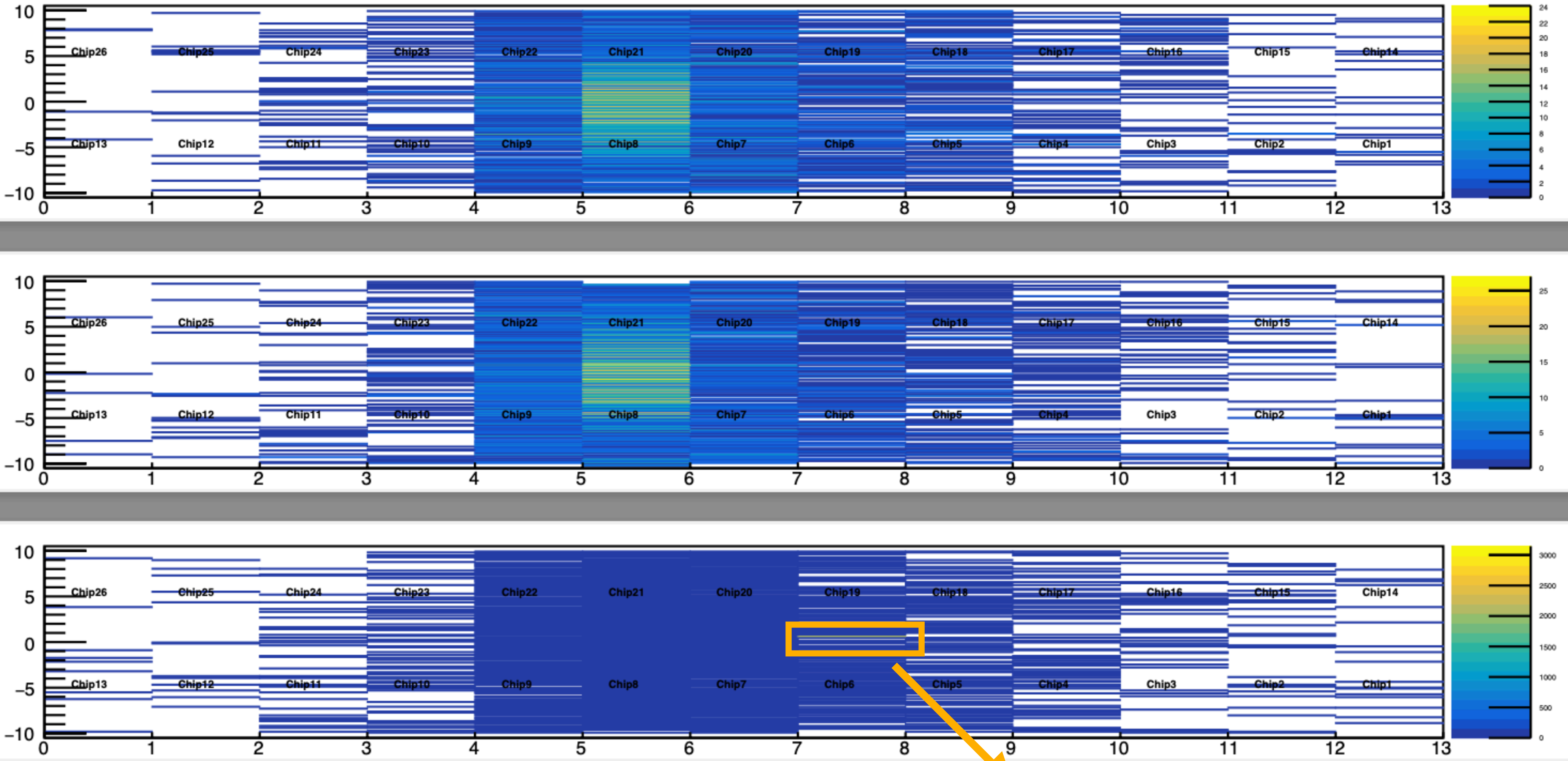

(tracks removal) Run52, noise level, chip 8, layer 1


(tracks removal) Run52, noise level, chip 8, layer 2

Run 52 - remove multi-tracks, noise hit map

Criteria :

1. One good track at chip 8 or 21 → Bias
2. Remove rest of good tracks in this event (2nd, 3rd, …)
    - Good track definition : residual < 0.1374 mm (Run 52)
3. For the remaining clusters, the size of the cluster == 1

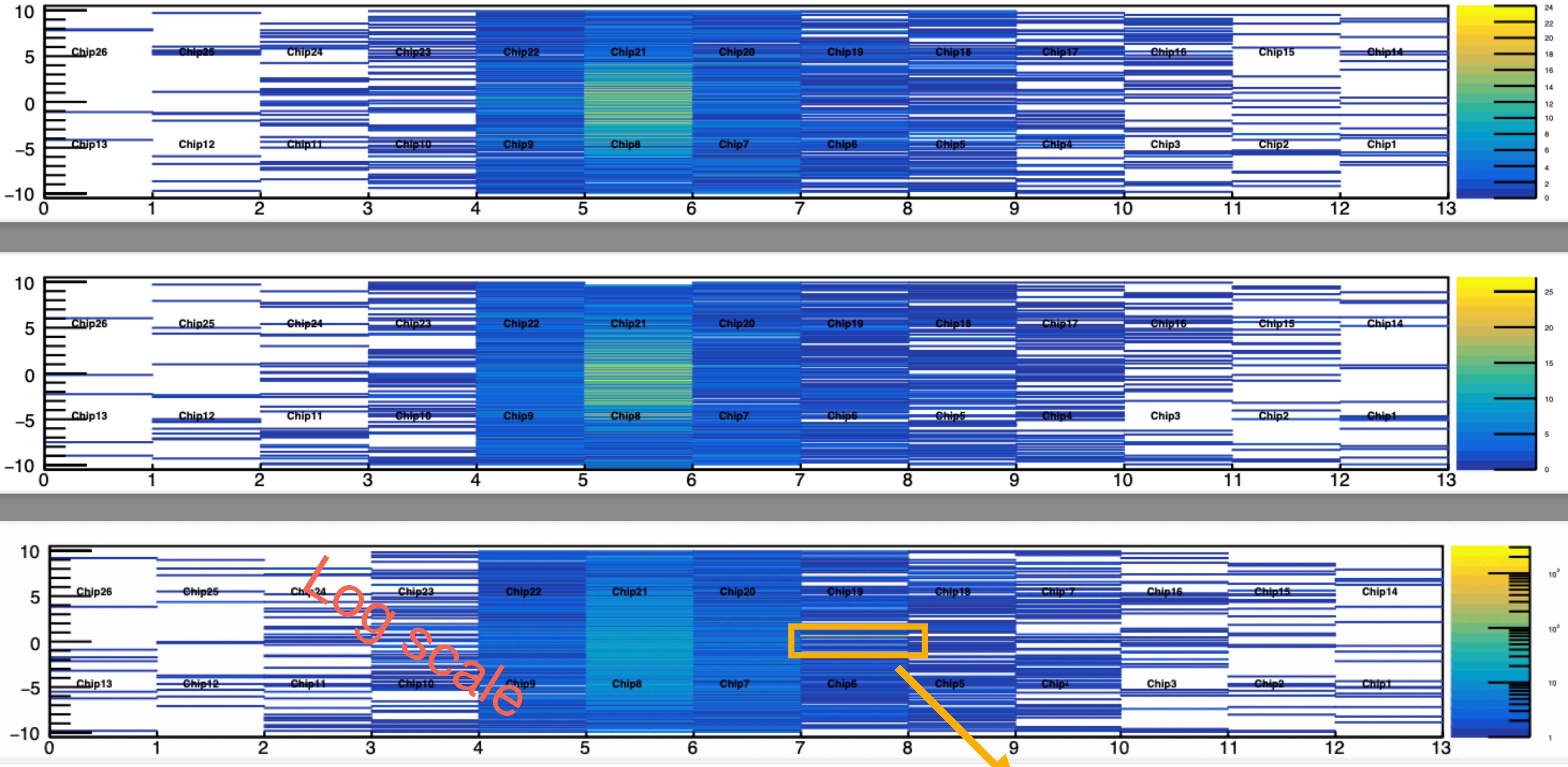


High entry, ~ 3000

Run 52 - remove multi-tracks, noise hit map

Criteria :

1. One good track at chip 8 or 21 → Bias
2. Remove rest of good tracks in this event (2nd, 3rd, …)
   - Good track definition : residual < 0.1374 mm (Run 52)
3. For the remaining clusters, the size of the cluster == 1



Log scale

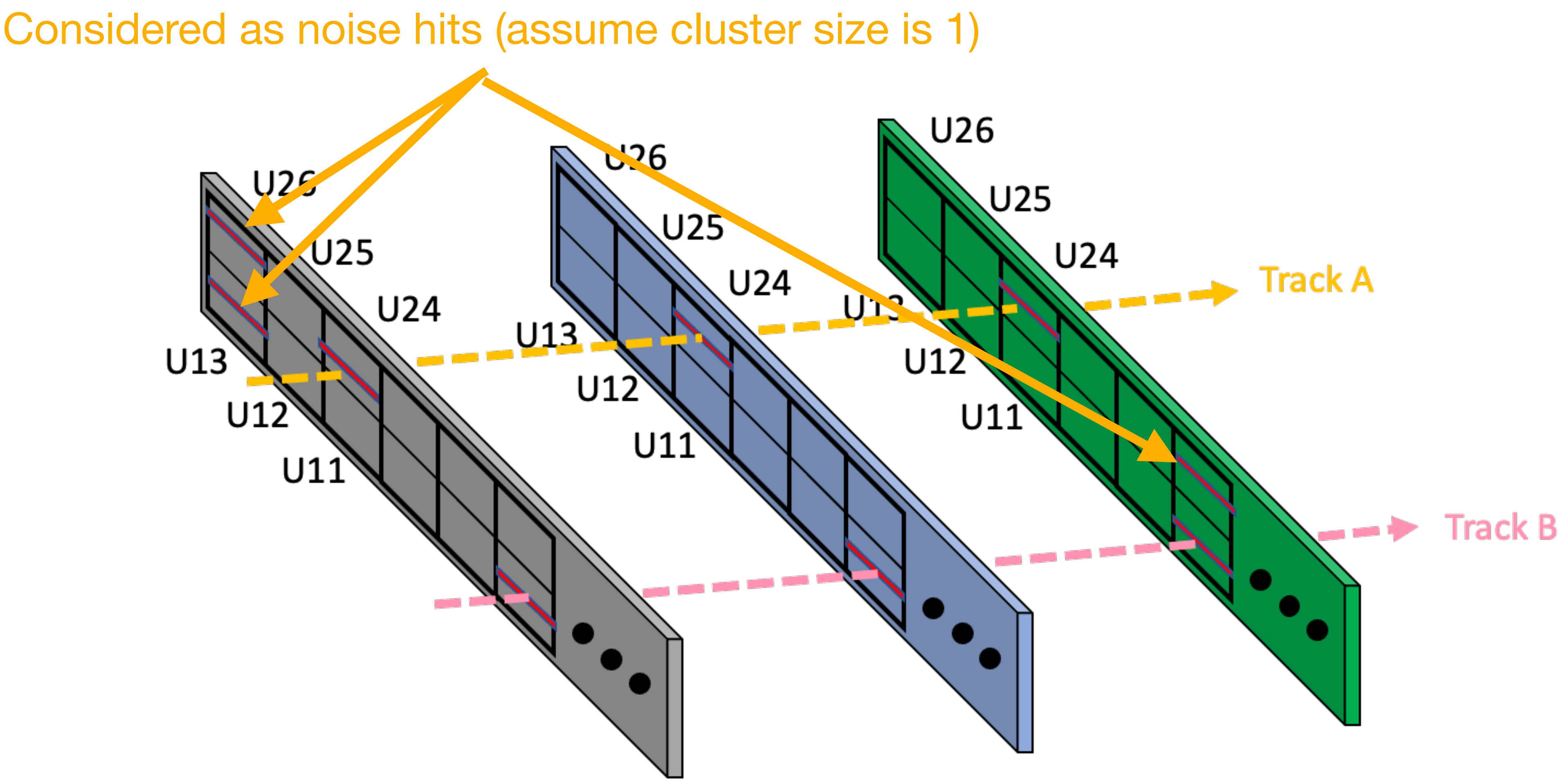
High entry, ~ 3000

Noise level estimation - Method 3, remove multi-tracks

Residual tolerance : same (same as chip 8)

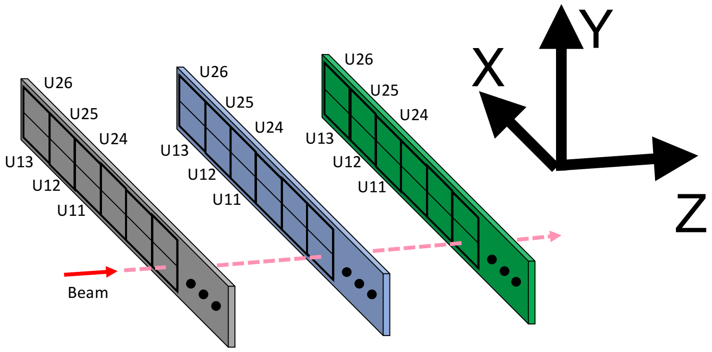
Criteria :

1. Remove all good tracks in this event (1st, 2nd, 3rd, …)
    - Good track definition : residual < 0.1374 mm (Run 52)
2. For the remaining clusters, the size of the cluster == 1

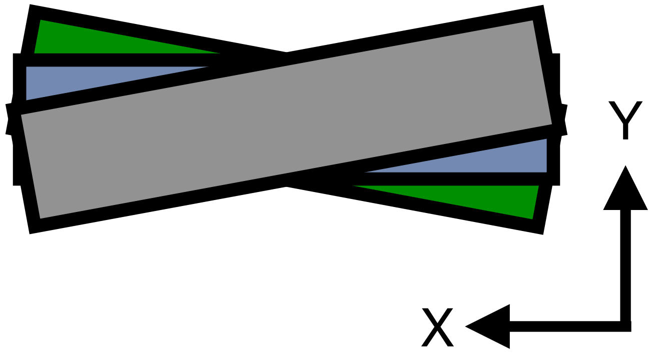


In the example :
9 clusters → 2 good tracks
3 noise hits

Layer-1 alignment, universal correction

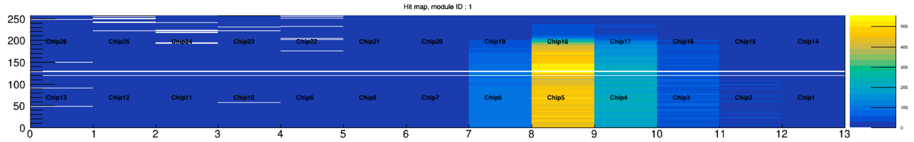


The function of the layer-1 alignment correction
Type A sensor : from Run 52
Type B sensor : from Run 33 (Due to low statistic at sensor B of run 52)

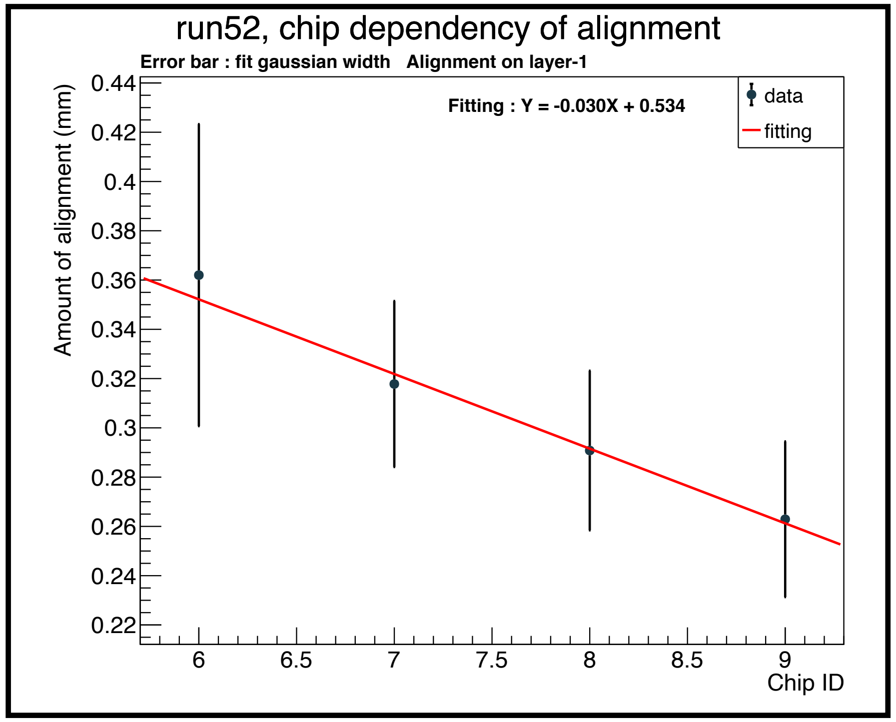


Run 33

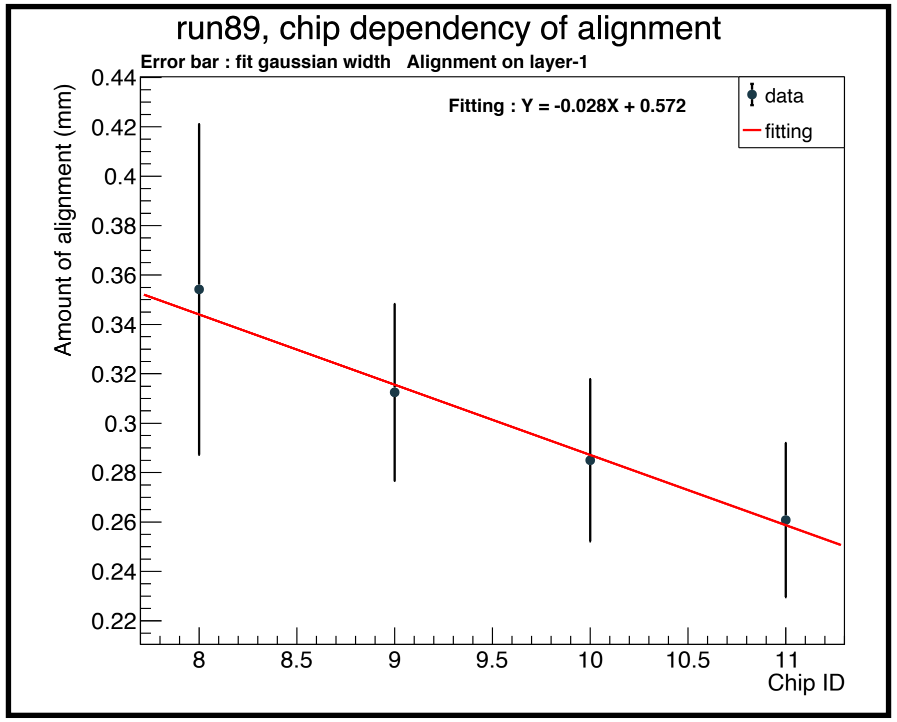
Beam spot is in sensor B

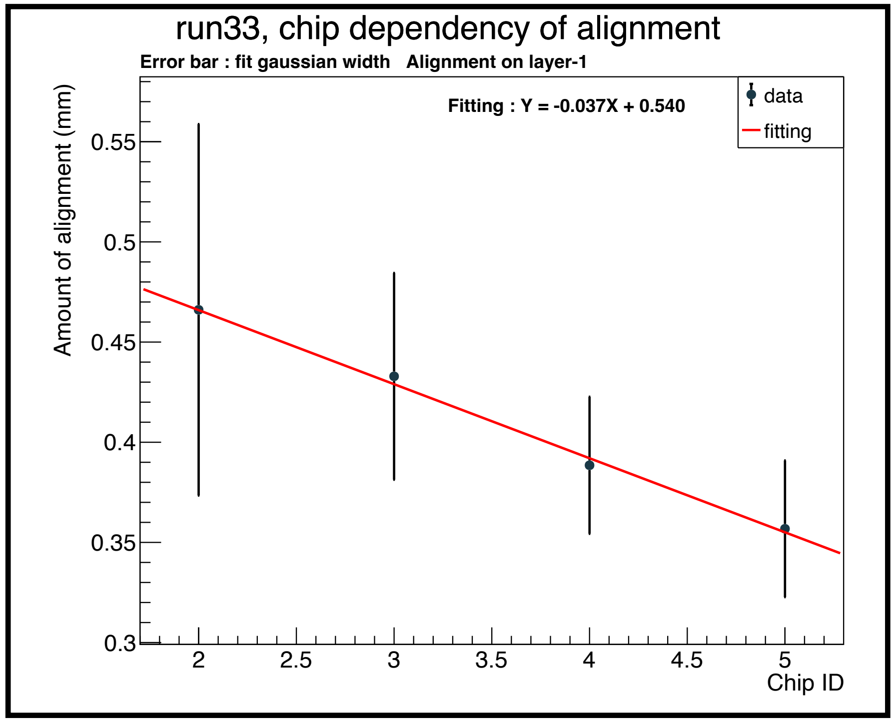


Run 52



Run 89

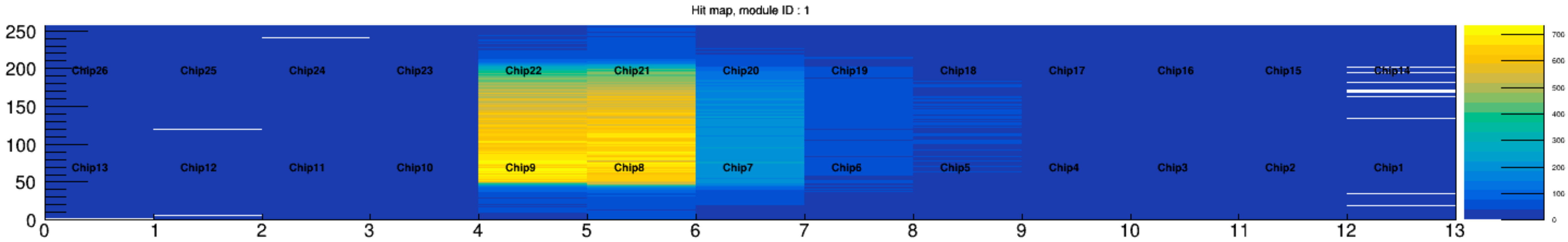


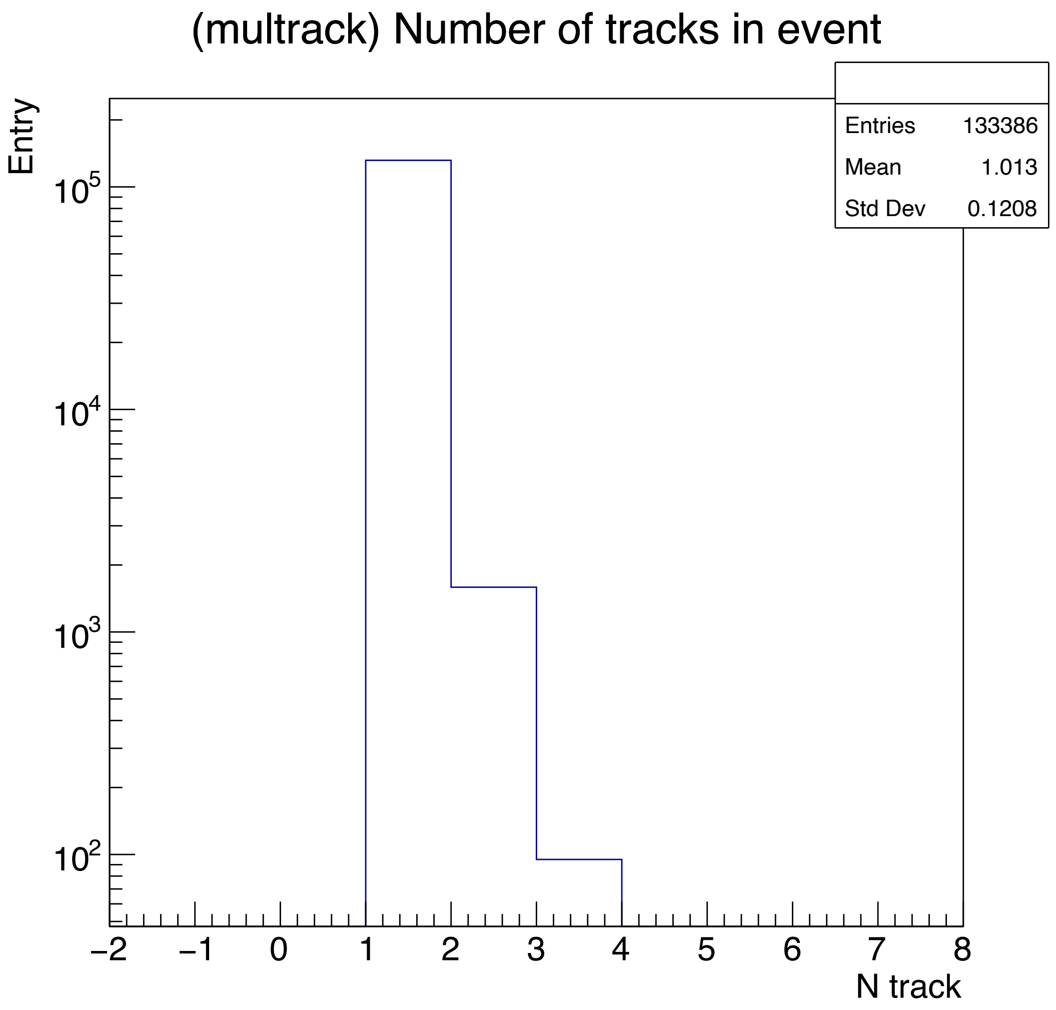


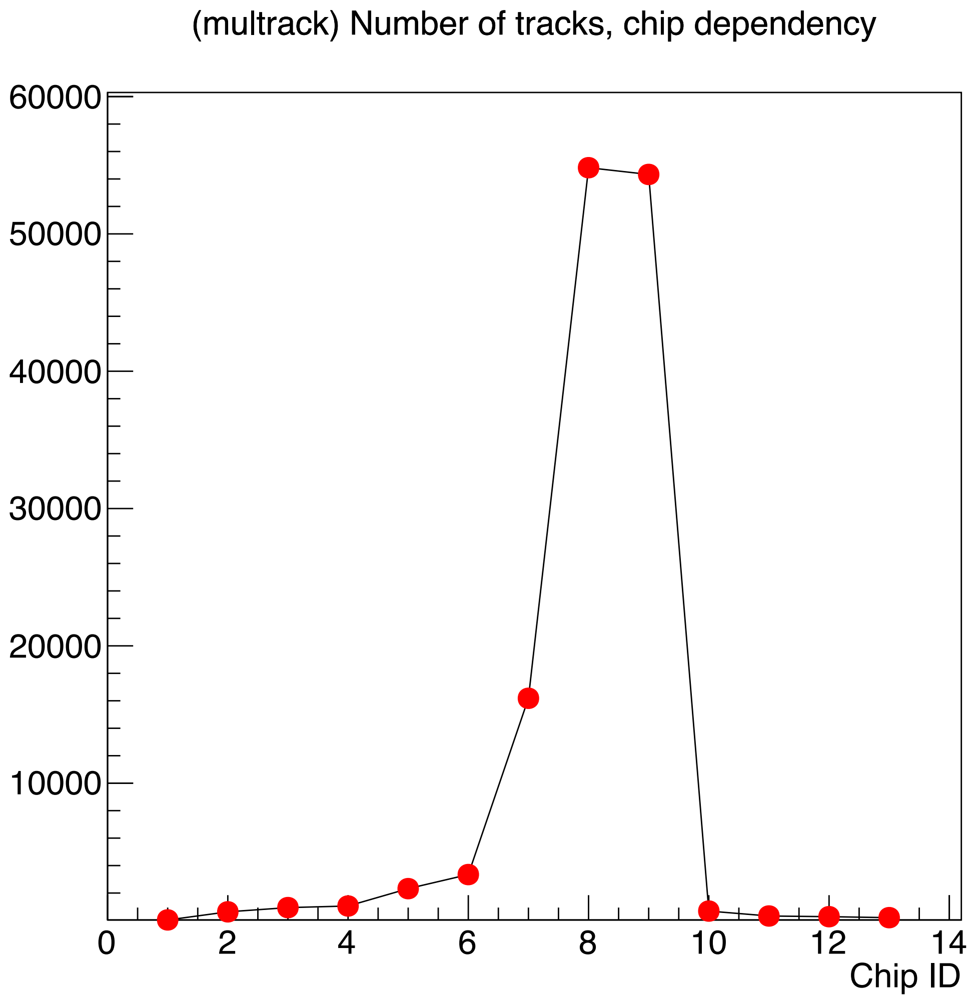
Sensor A

Sensor B

Run 52 - method 3

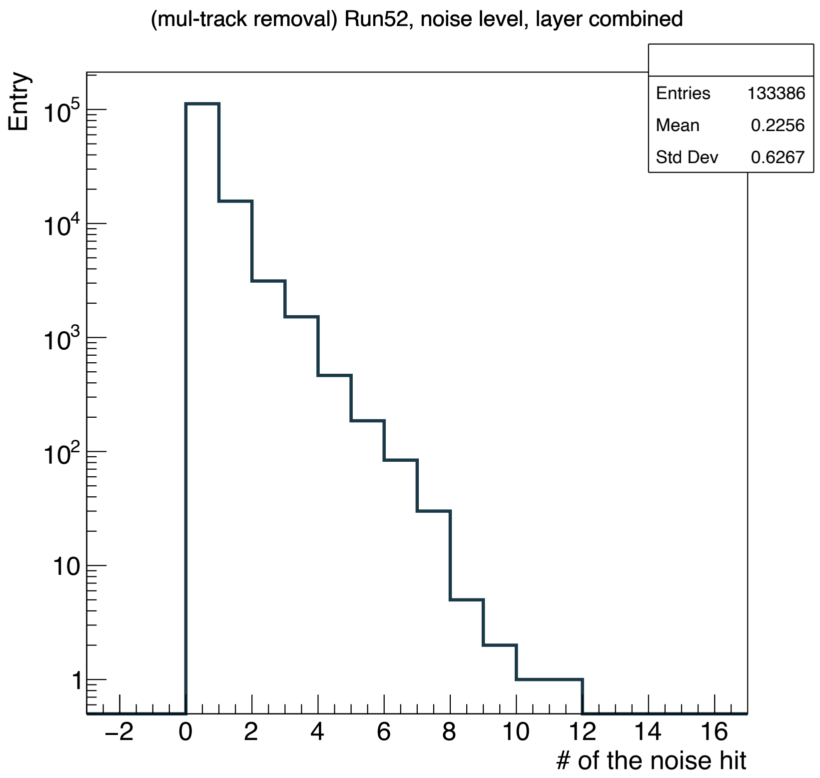


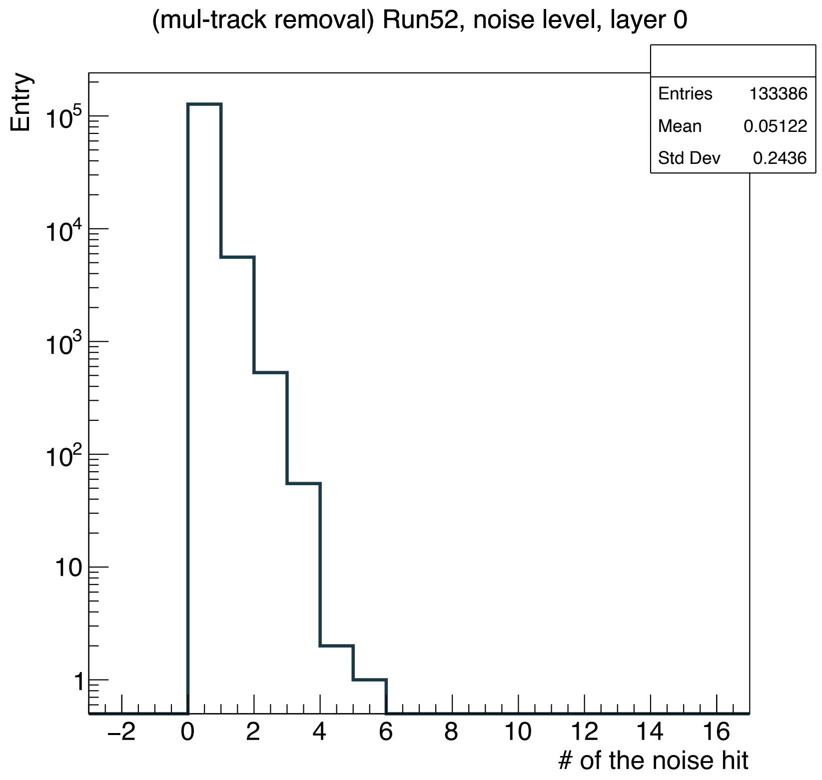


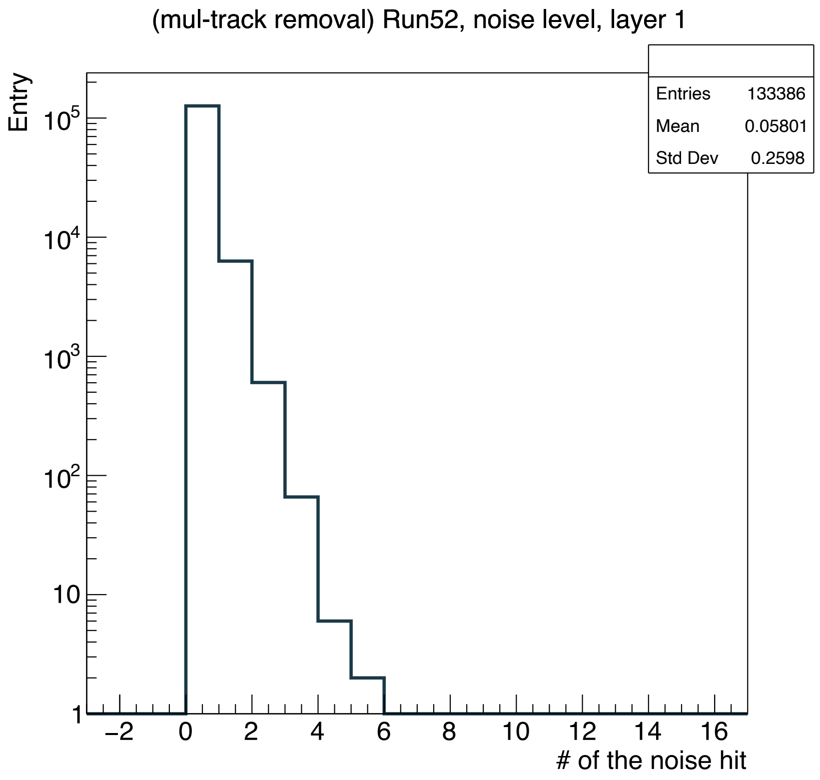


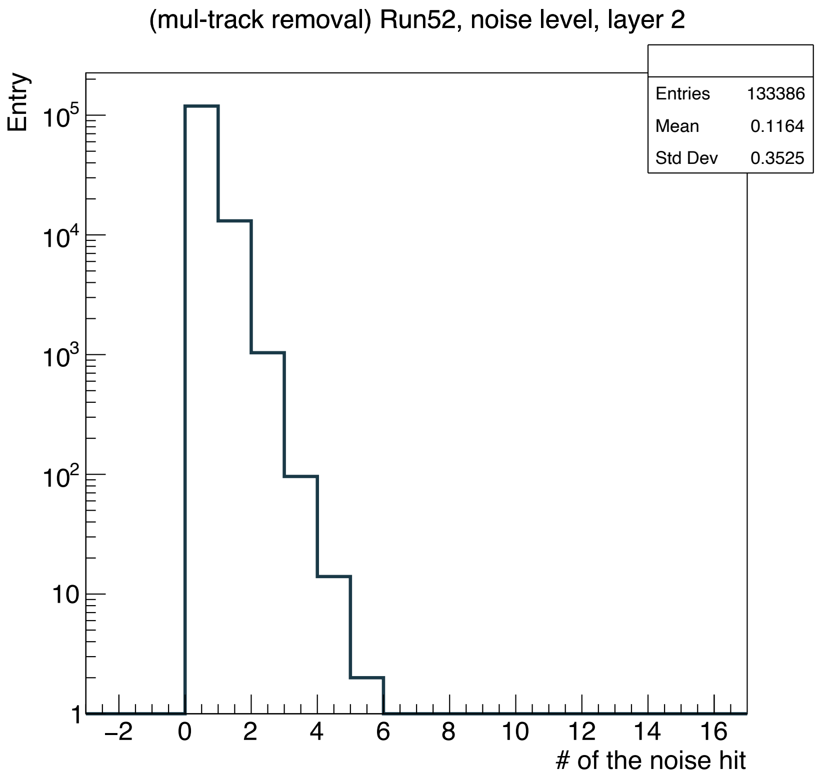
Run 52 - method 3, noise level

15.83% of the events have at least one additional hit (cluster size == 1) besides at least one good track.


(mul-track removal) Run52, noise level, layer combined


(mul-track removal) Run52, noise level, layer 0

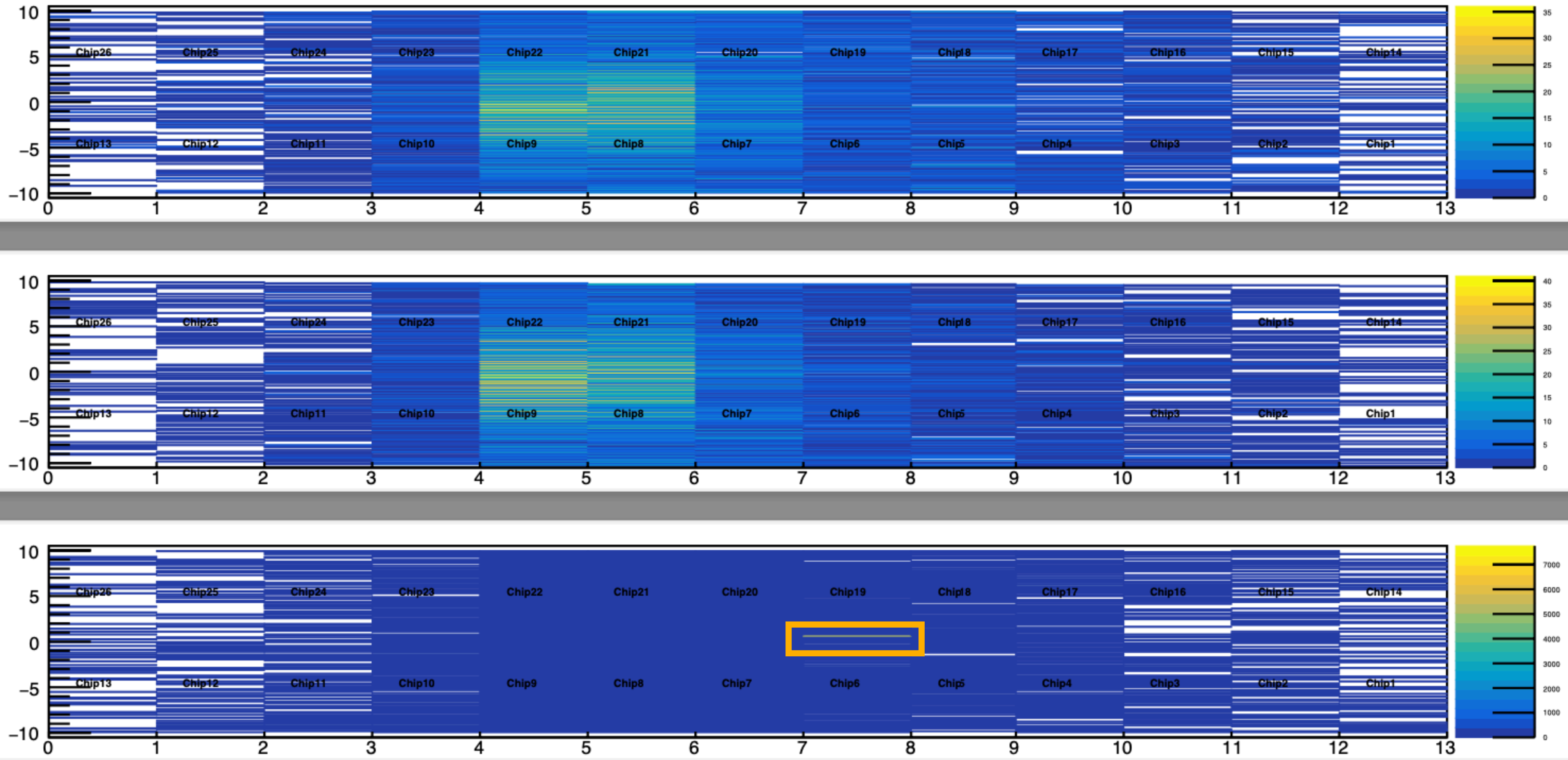

(mul-track removal) Run52, noise level, layer 1


(mul-track removal) Run52, noise level, layer 2

Run 52 - method 3, noise hit map

Based on the distribution (It's not uniform), it seems to be not noise. Delta electron ?

The Noise hit and the delta-ray electrons can not be well separated.



Run 52 - method 3, noise hit map

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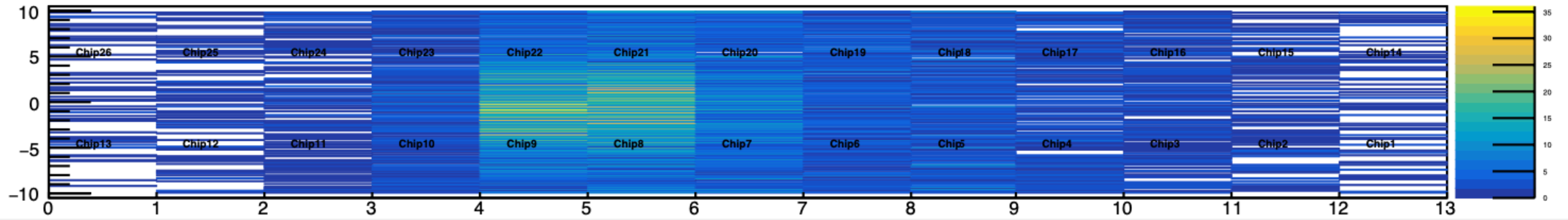
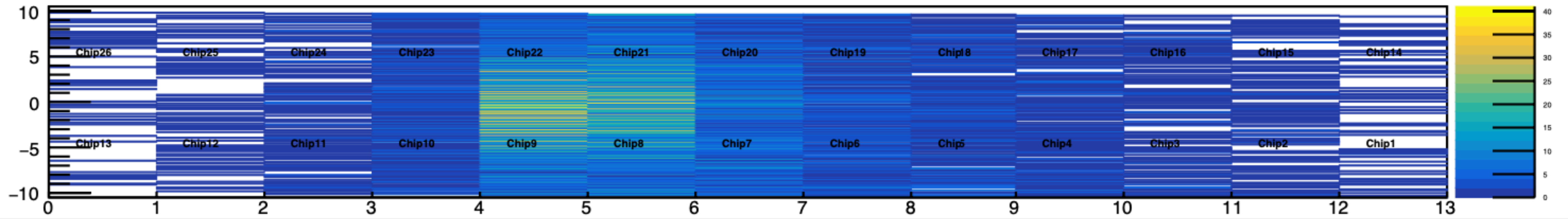
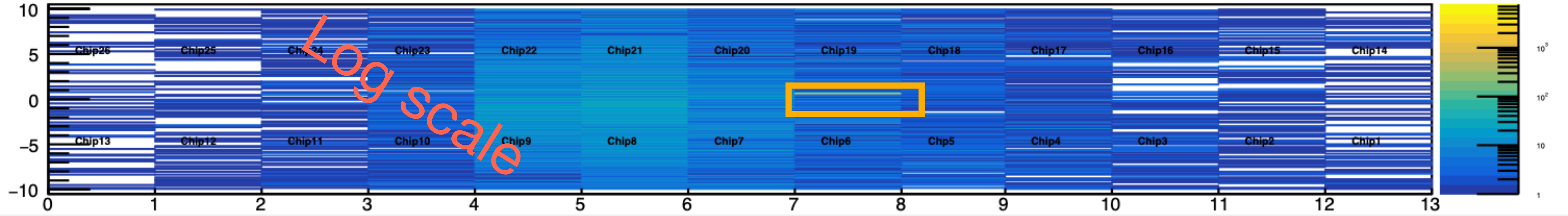
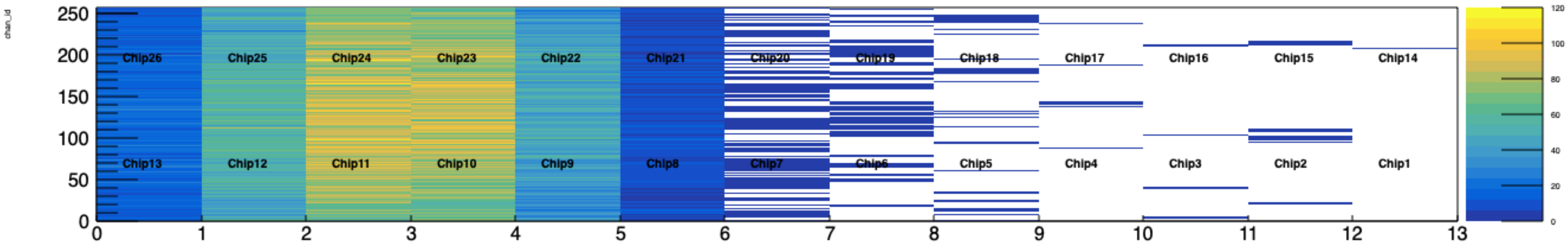




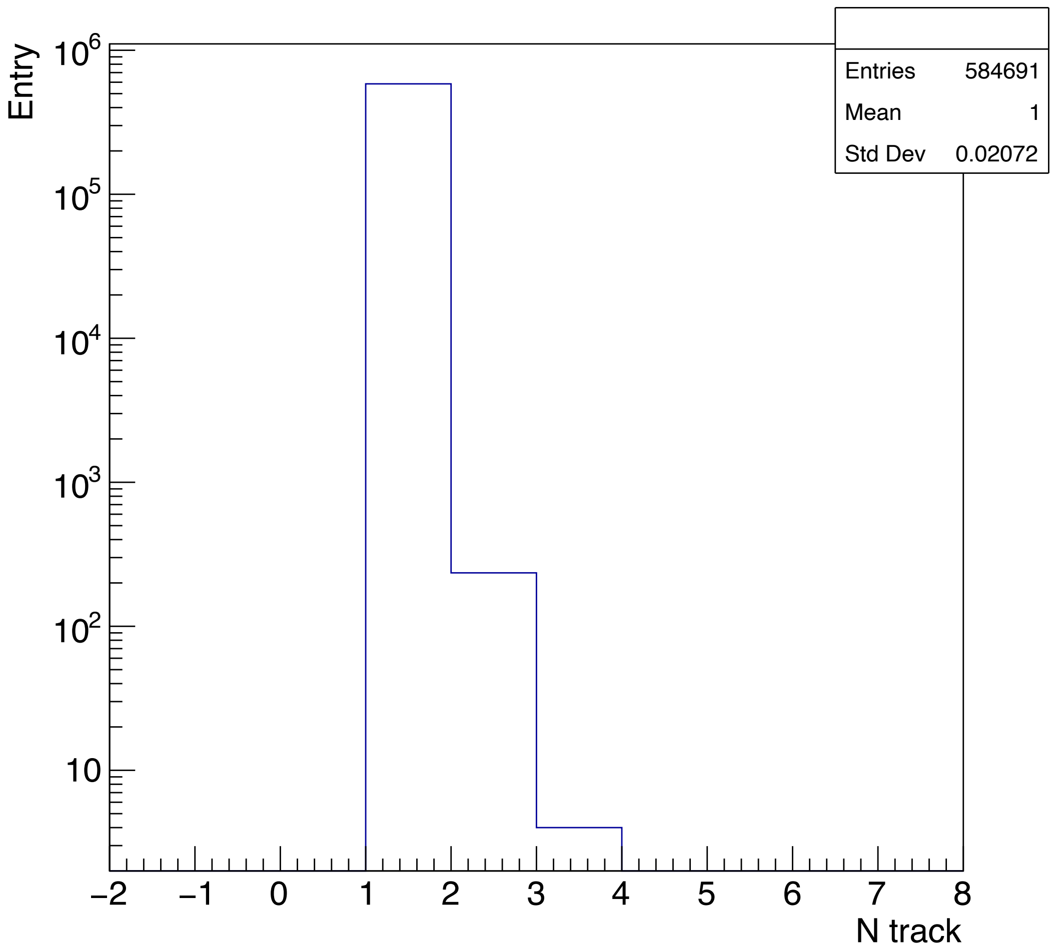


Run 52 MC, method 3

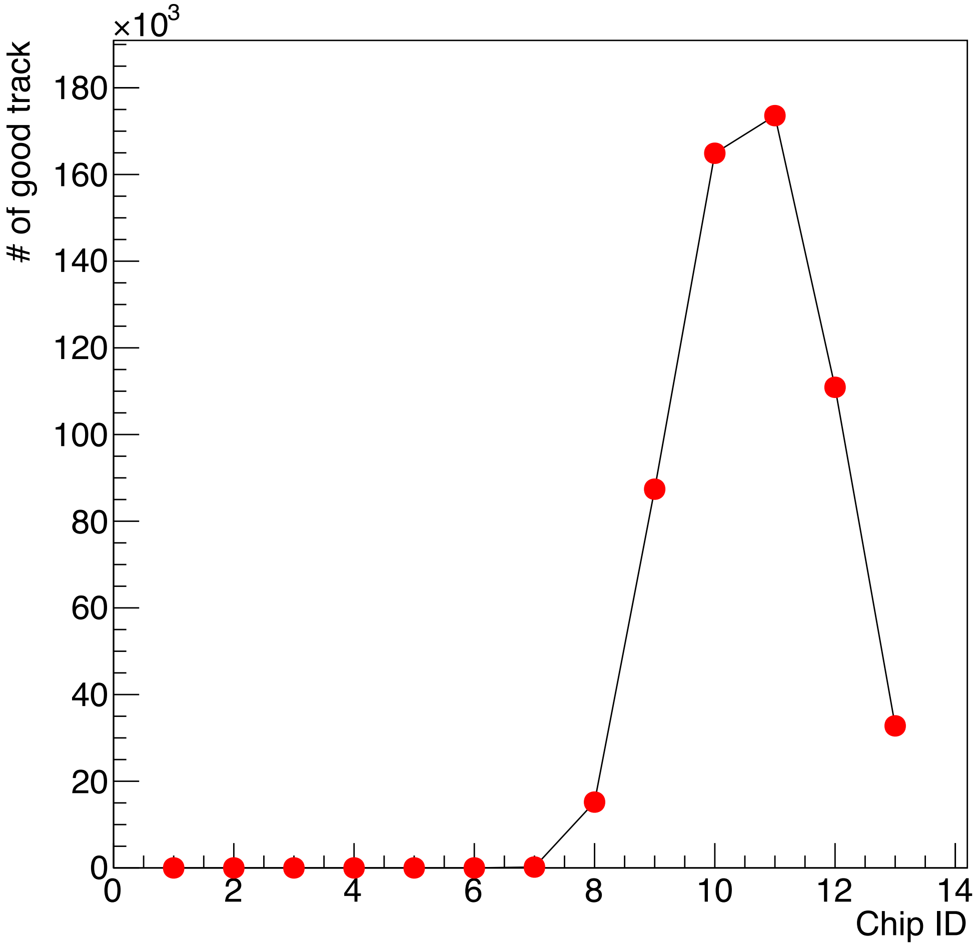
Pure MC, no fake noise hit



(multrack) Number of tracks in event

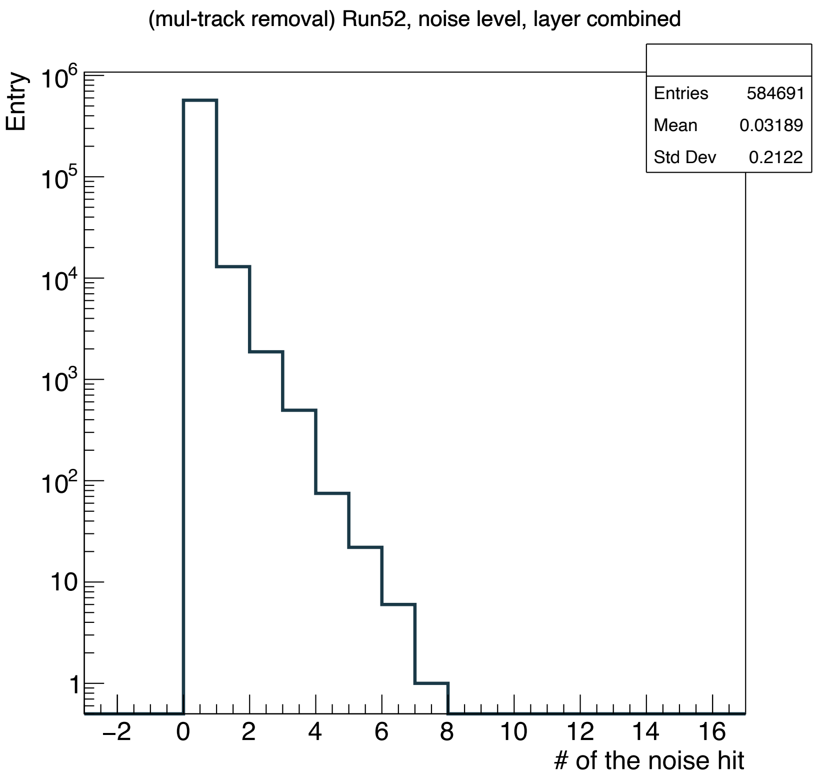


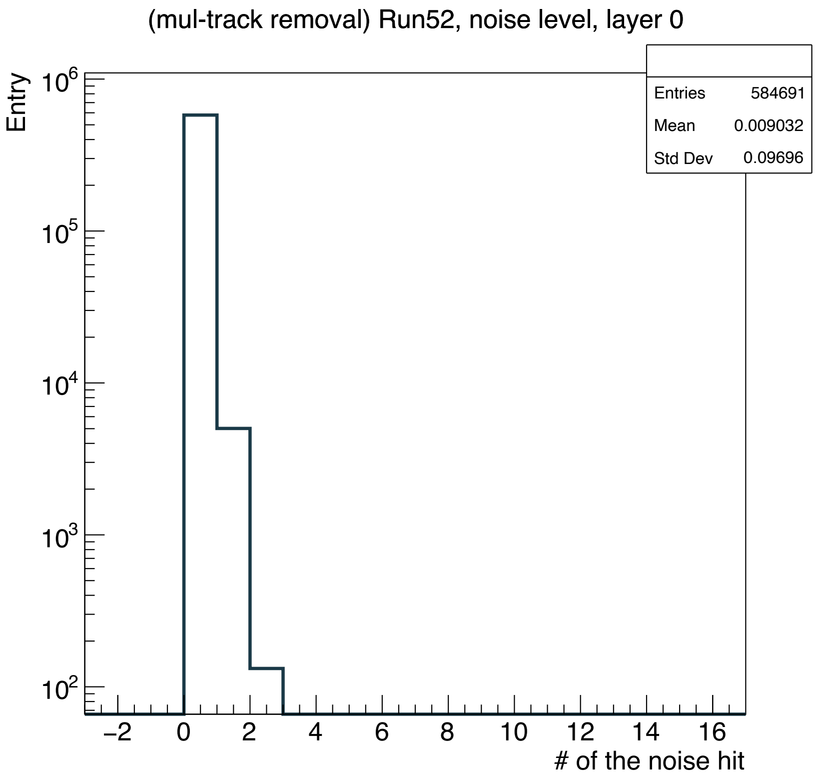
(multrack) Number of tracks, chip dependency

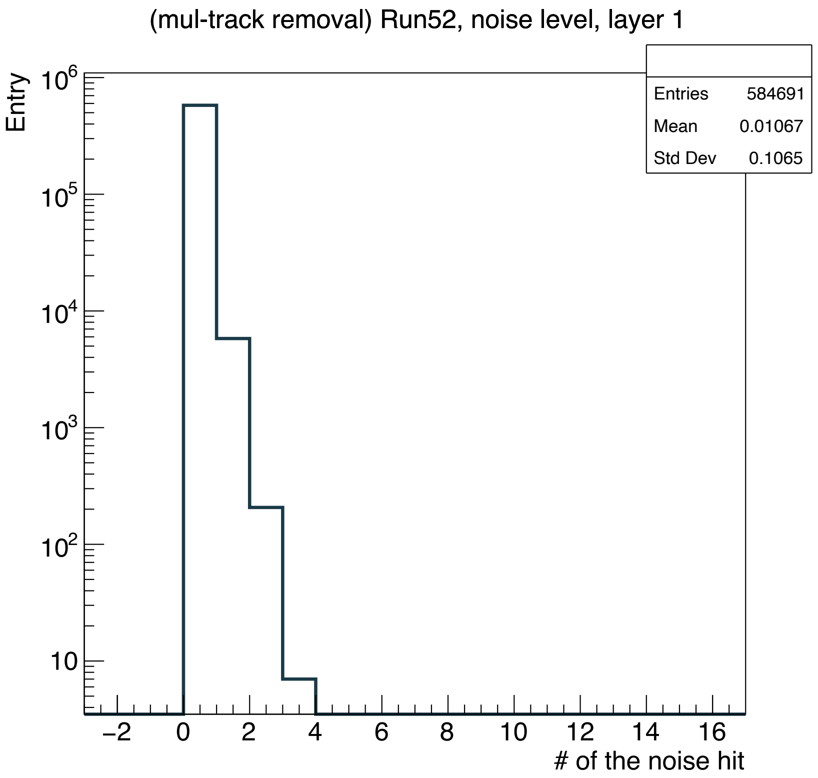


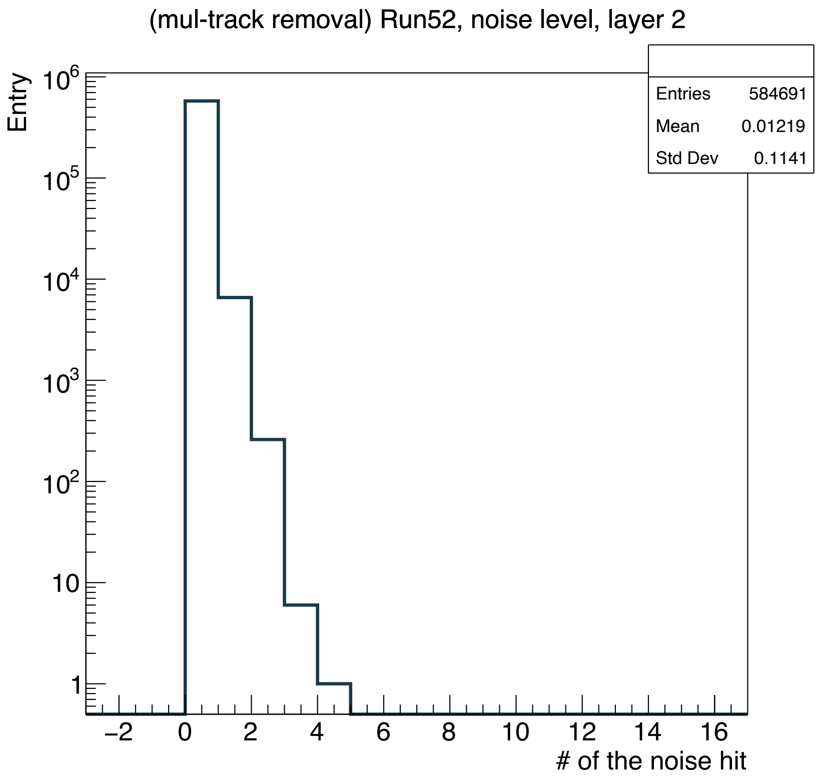
Run 52 MC, method 3

2.6% of the events have at least one additional hit (cluster size == 1) besides at least one good track.


(mul-track removal) Run52, noise level, layer combined

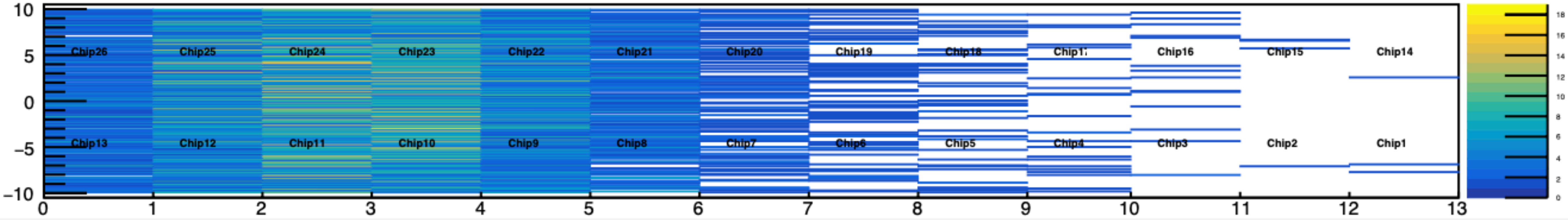

(mul-track removal) Run52, noise level, layer 0

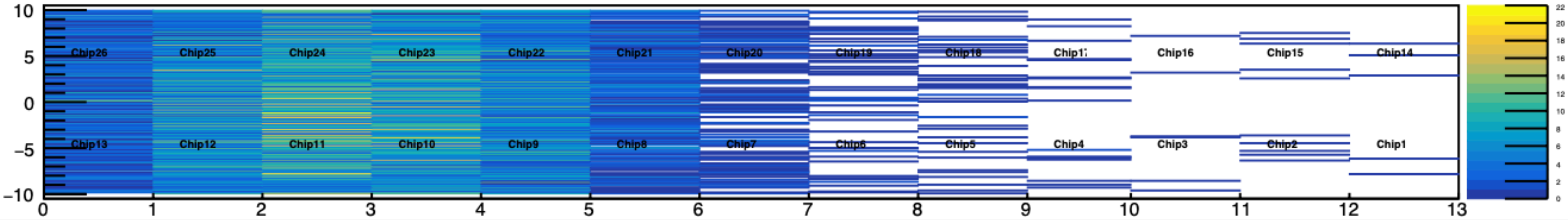

(mul-track removal) Run52, noise level, layer 1

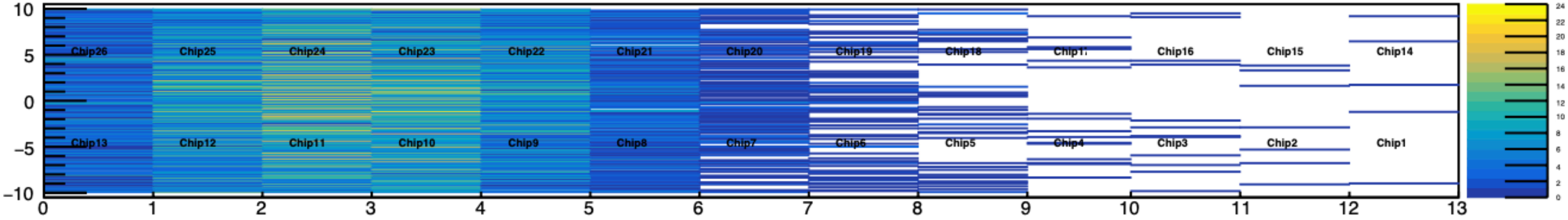

(mul-track removal) Run52, noise level, layer 2

Run 52 MC, method 3

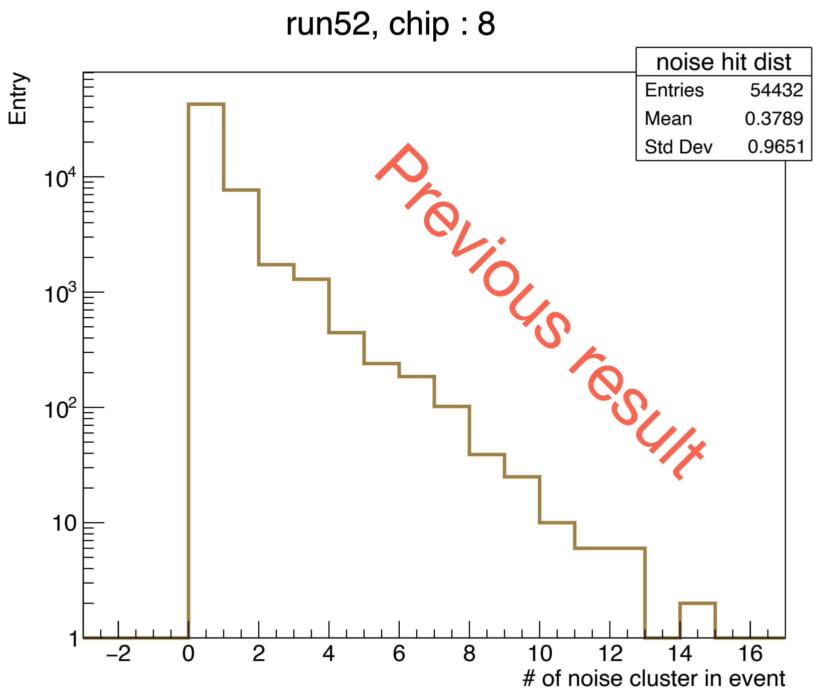
Pure MC, no fake noise hit



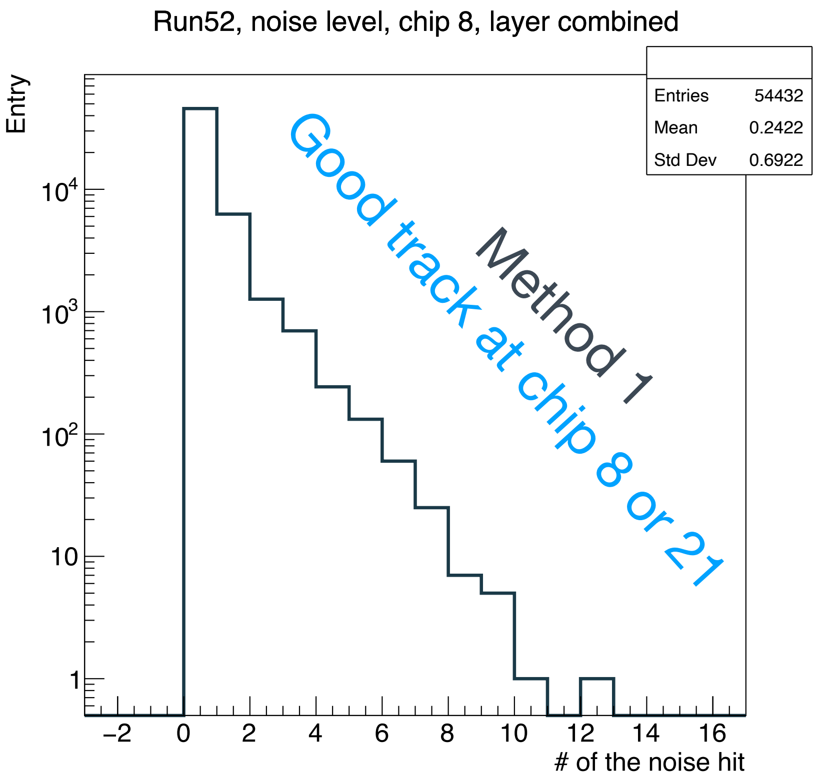




Comparison - run52 noise distribution

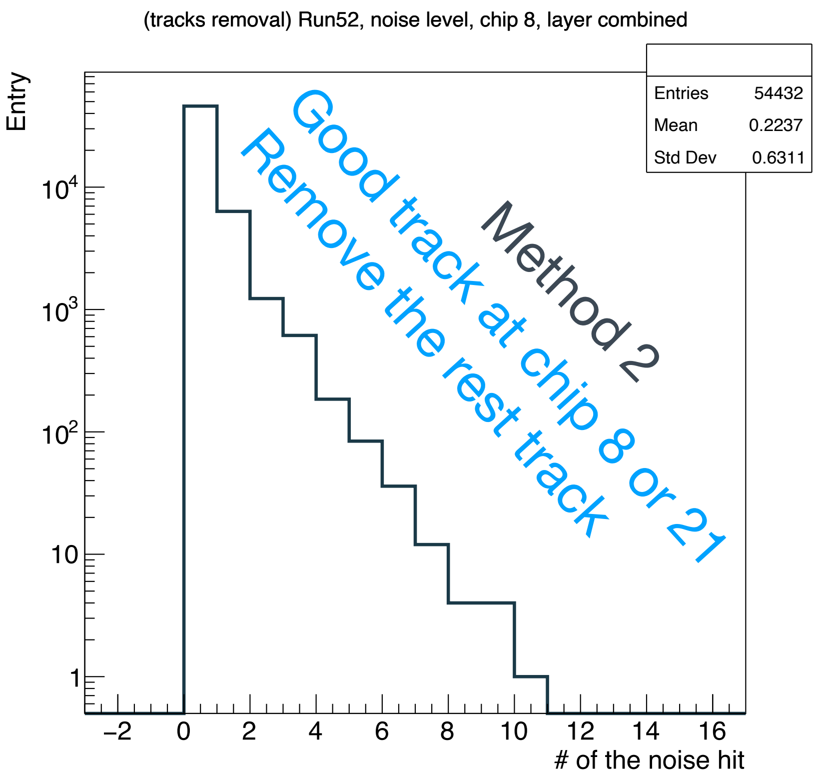


Previous result



Method 1

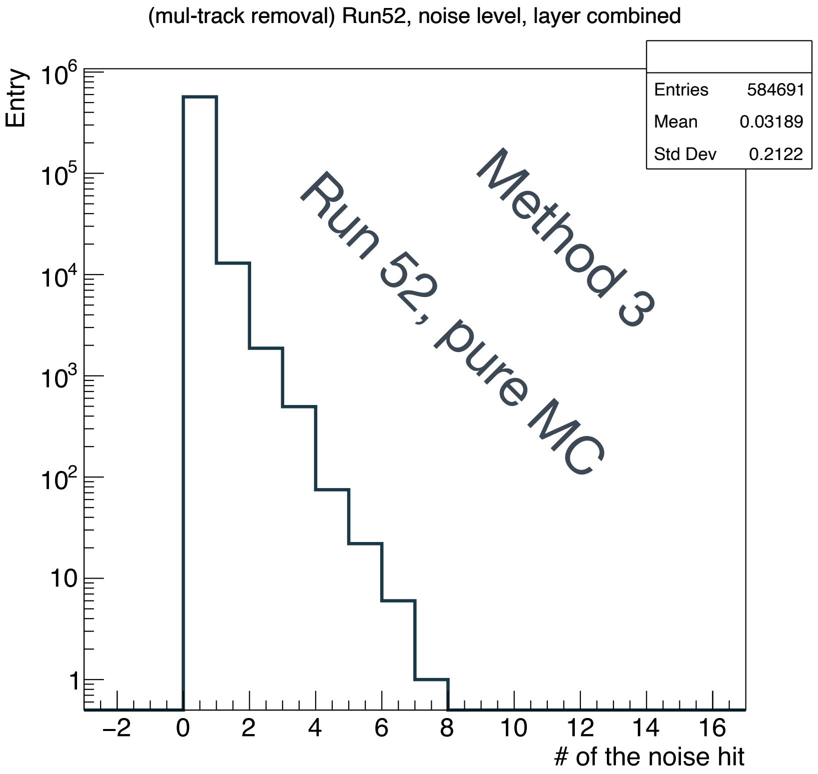
Good track at chip 8 or 21



Method 2

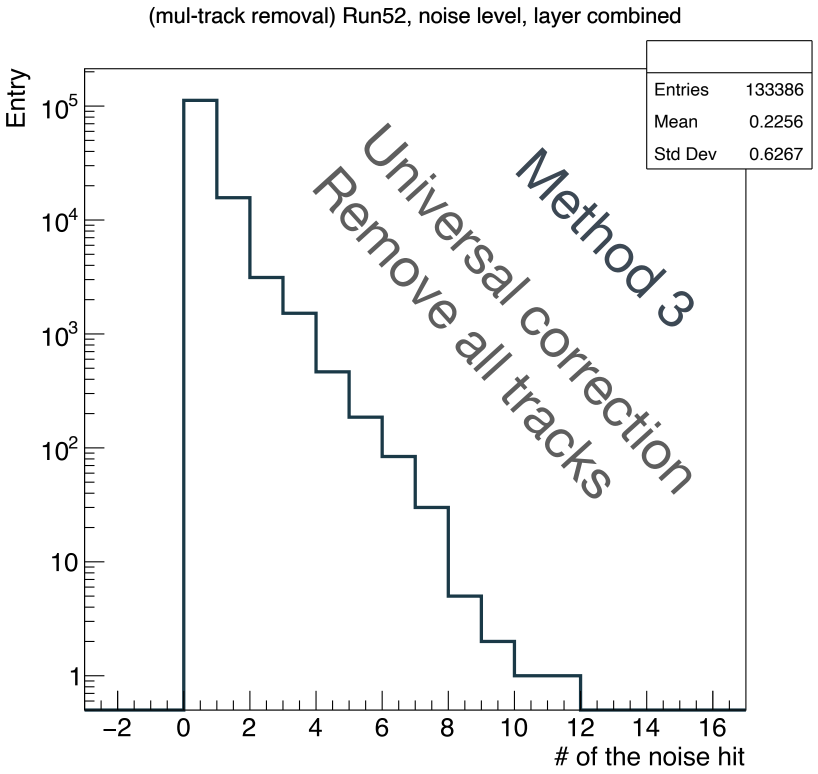
Good track at chip 8 or 21

Remove the rest track



Method 3

Run 52, pure MC



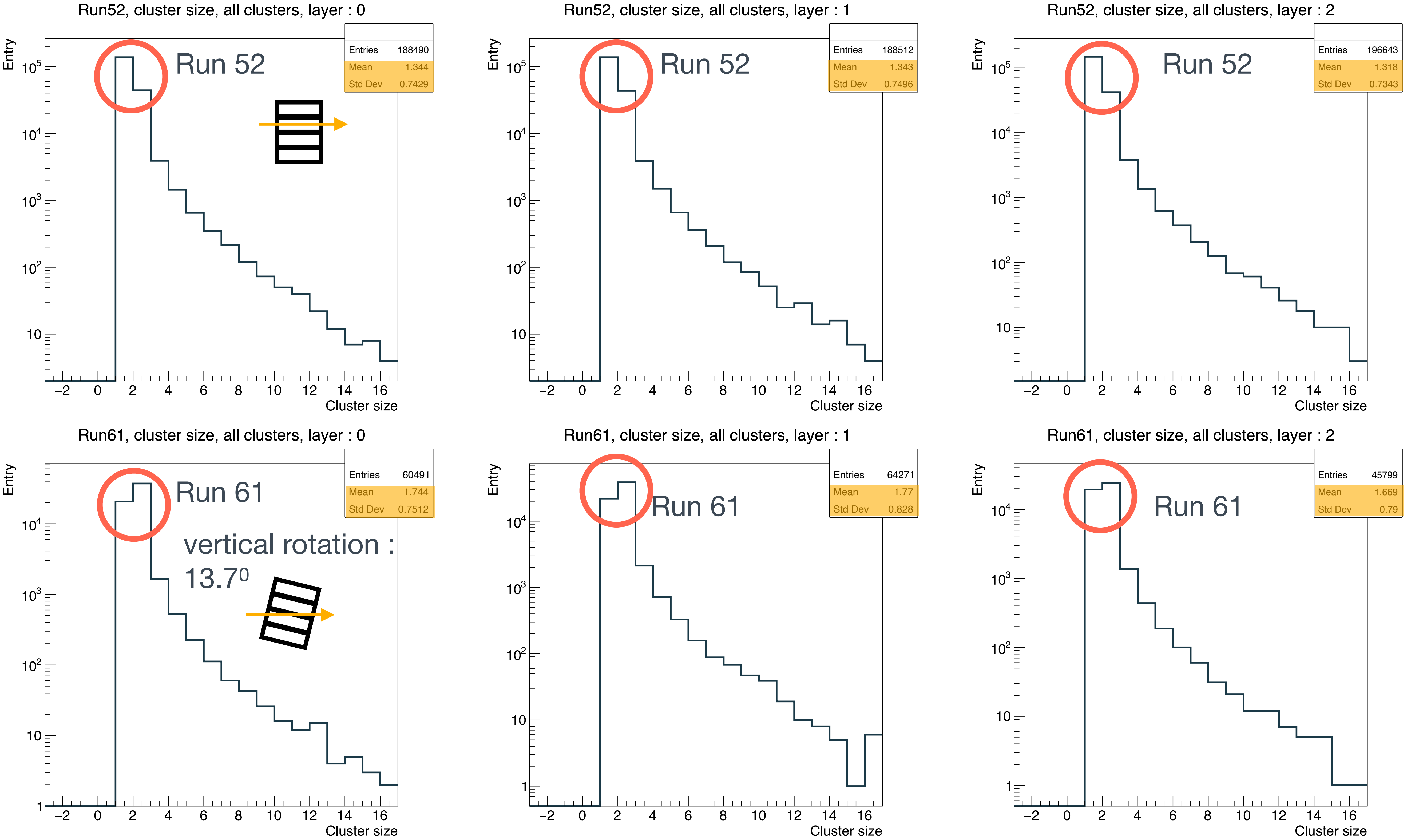
Method 3

Universal correction

Remove all tracks

Comparison - cluster size distribution

All clusters



vertical rotation : 13.7^{0}

Summary

- The 3 new methods of extracting the noise distribution were applied.
  - New added cut : cluster size has to be 1.
  - The noise hit and the delta-ray electron can not be well separated.

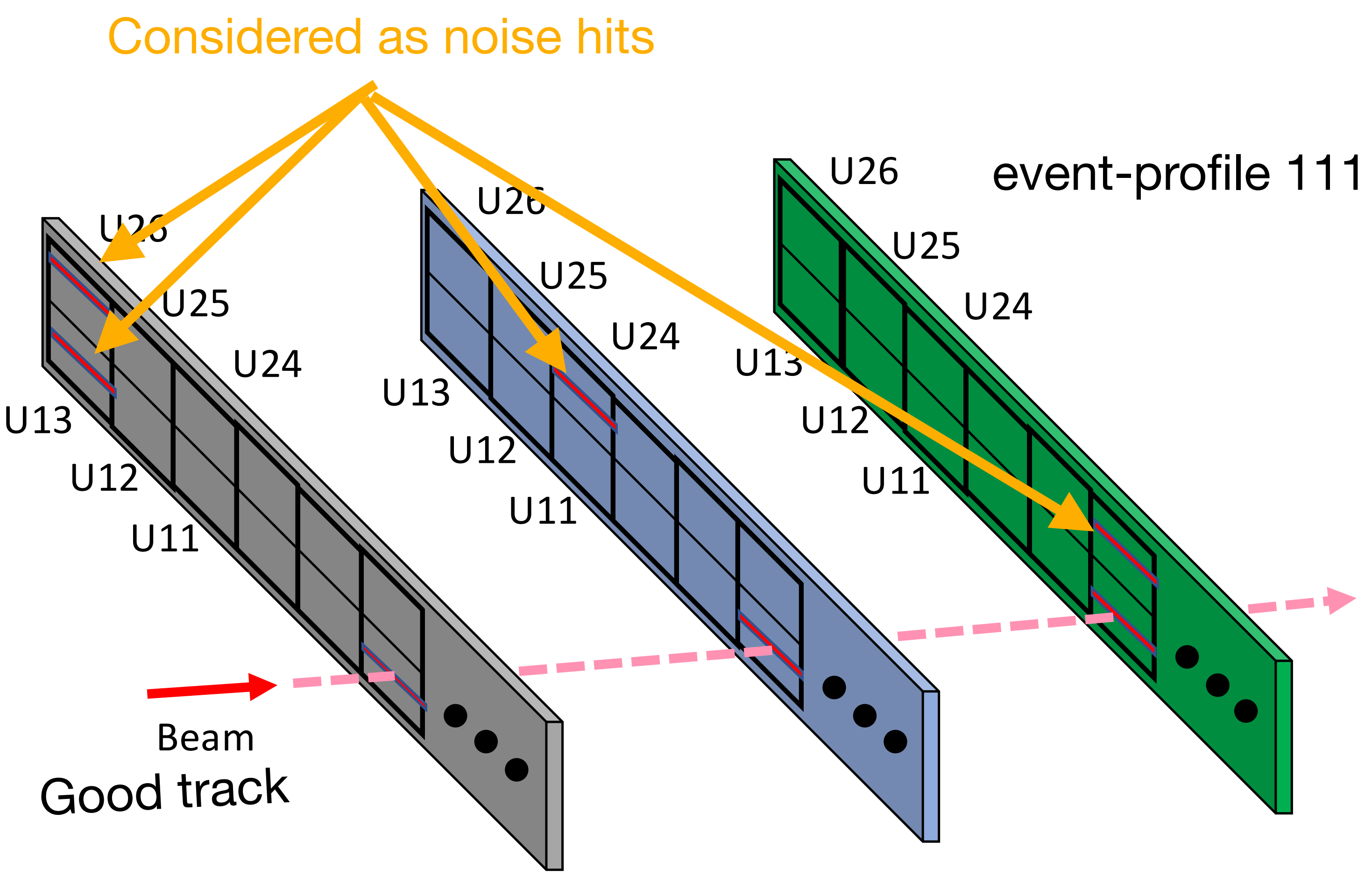
- The cluster size distribution of the tilted run (run 61) is wider than the normal run.

- To do :
  - Take the ADC information into account, trying to have a better suppression on the delta-ray electron.
  - Compare different runs
  - Feed the noise level information to the efficiency calculation.

Back up

Noise level estimation

Try estimate the noise dist. by data



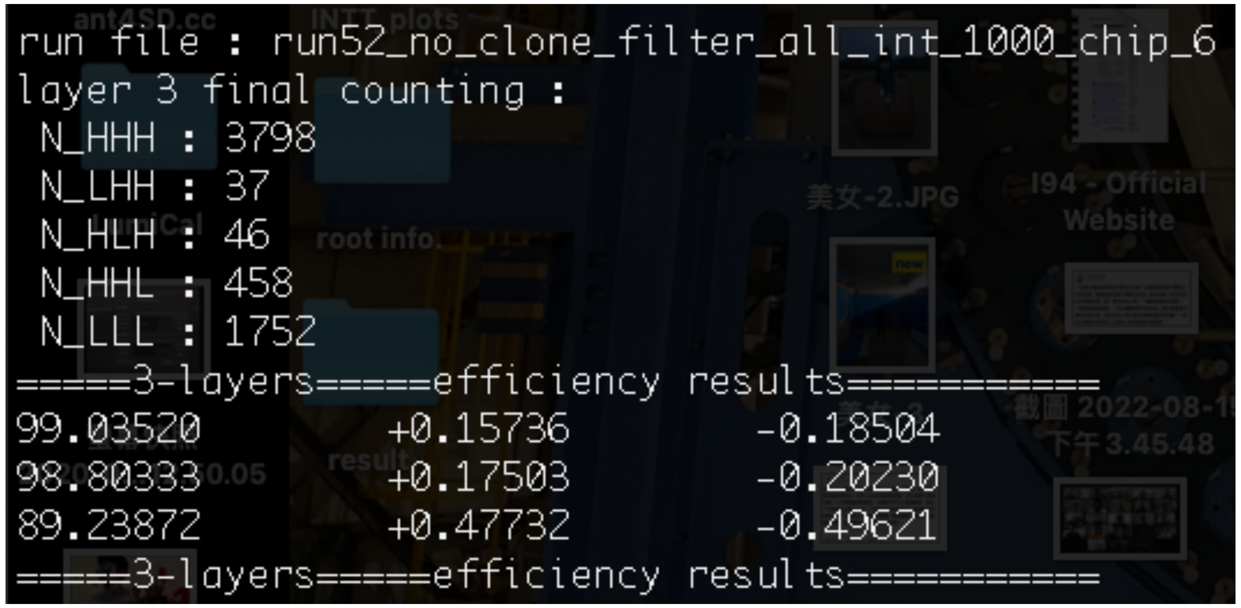
Only check the good track events
In the example, total cluster : 7

Run52, table of run parameters

Run	chip	alignment	alignment layer	window size
Run 52	6	-0.3620	1	0.3304
Run 52	7	-0.3178	1	0.2774
Run 52	8	-0.2908	1	0.1374 ★
Run 52	9	-2.629E-01	1	0.1364

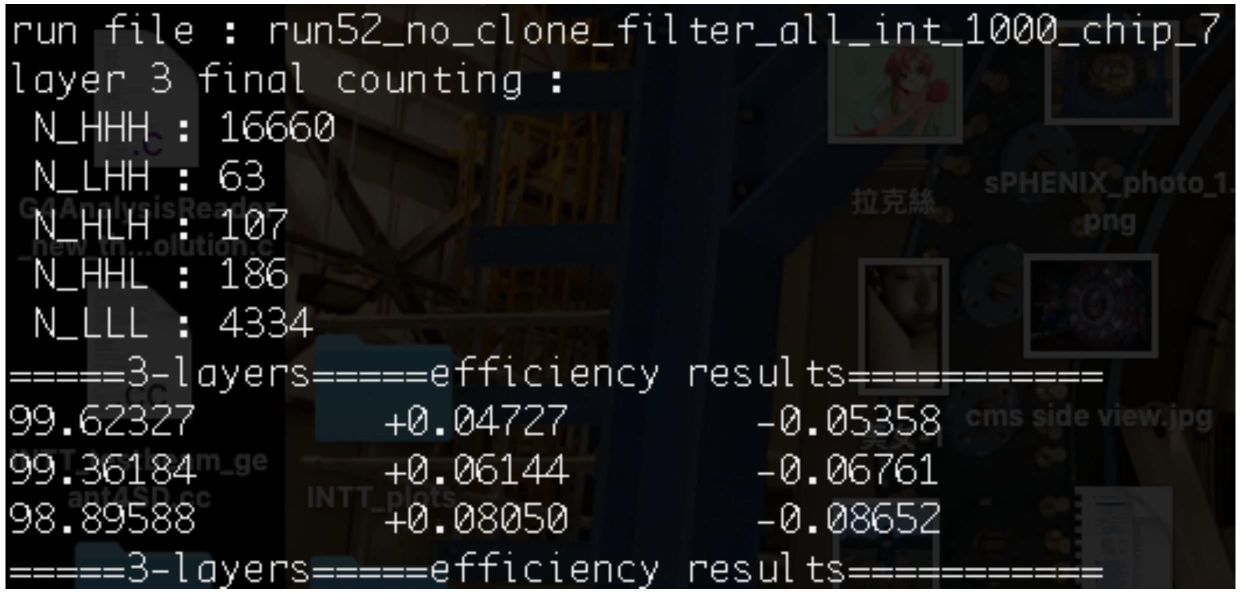
Run52, detection efficiency

Run52 U6



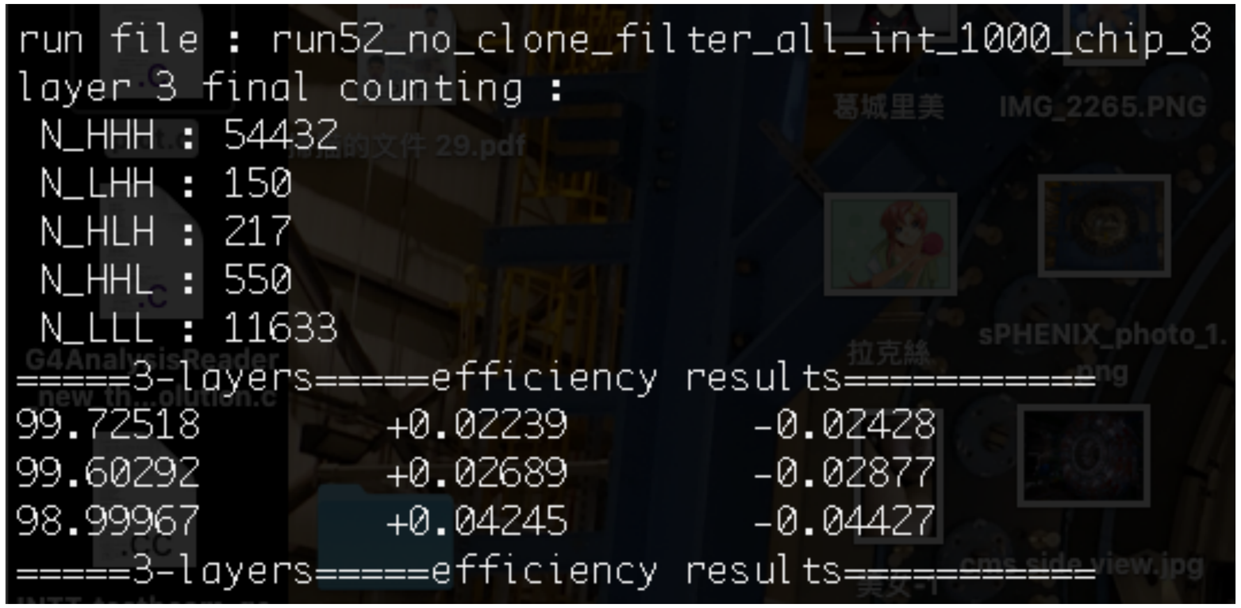
```
run file : run52_no_clone_filter_all_int_1000_chip_6
layer 3 final counting :
 N_HHH : 3798
 N_LHH : 37
 N_HLH : 46
 N_HHL : 458
 N_LLL : 1752
=====3-layers=====efficiency results===========
99.03520         +0.15736        -0.18504
98.80333         +0.17503        -0.20230
89.23872         +0.47732        -0.49621
=====3-layers=====efficiency results===========
```

Run52 U7



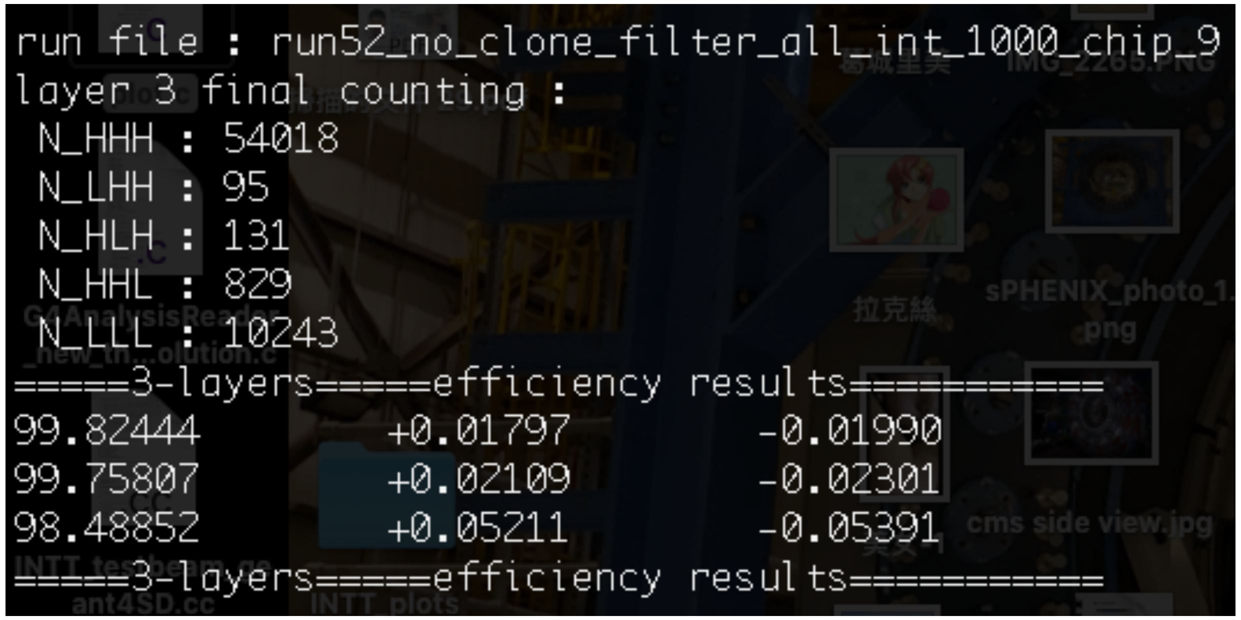
```
run file : run52_no_clone_filter_all_int_1000_chip_7
layer 3 final counting :
 N_HHH : 16660
 N_LHH : 63
 N_HLH : 107
 N_HHL : 186
 N_LLL : 4334
=====3-layers=====efficiency results===========
99.62327         +0.04727        -0.05358
99.36184         +0.06144        -0.06761
98.89588         +0.08050        -0.08652
=====3-layers=====efficiency results===========
```

Run52 U8



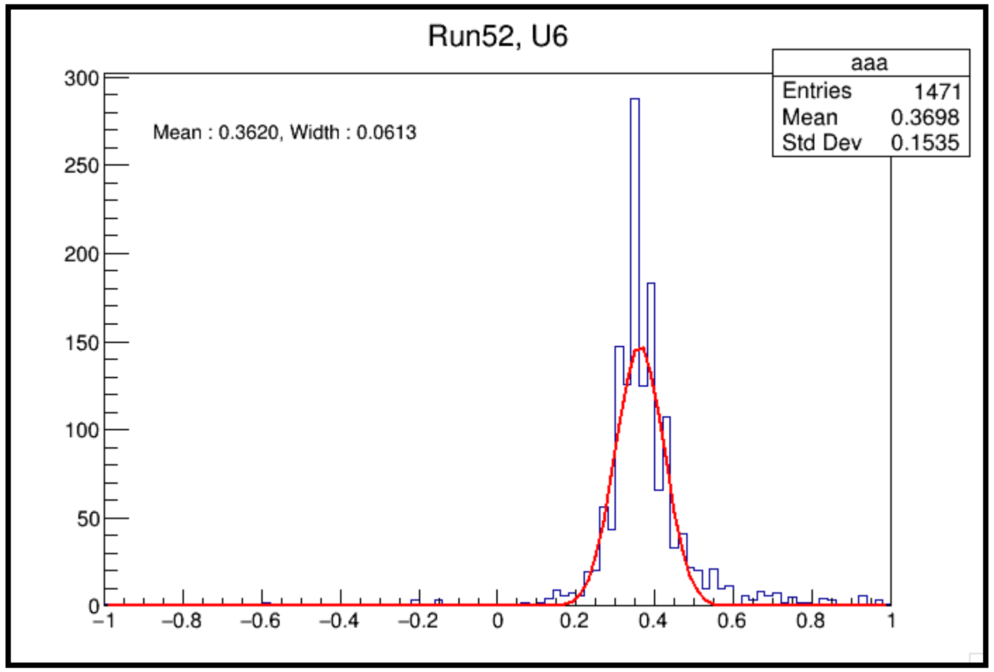
```
run file : run52_no_clone_filter_all_int_1000_chip_8
layer 3 final counting :
 N_HHH : 54432
 N_LHH : 150
 N_HLH : 217
 N_HHL : 550
 N_LLL : 11633
=====3-layers=====efficiency results===========
99.72518         +0.02239        -0.02428
99.60292         +0.02689        -0.02877
98.99967         +0.04245        -0.04427
=====3-layers=====efficiency results===========
```

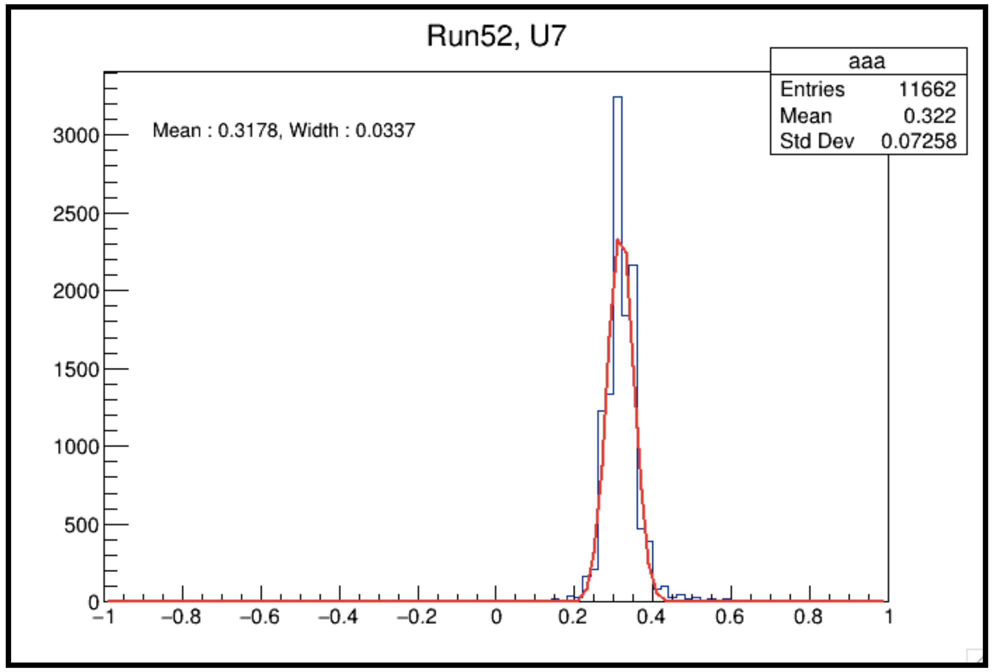
Run52 U9

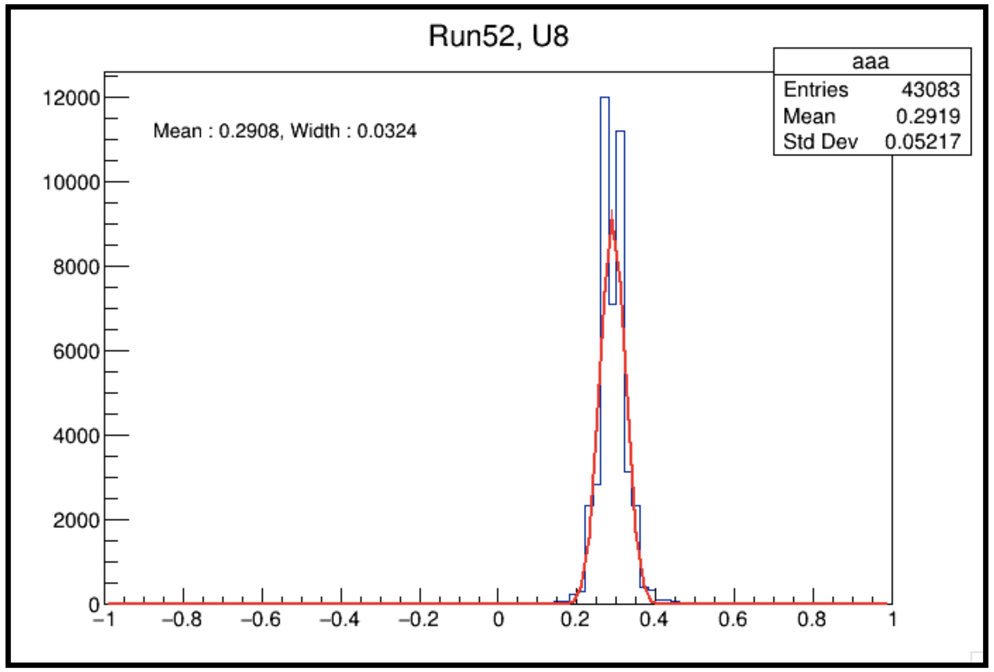


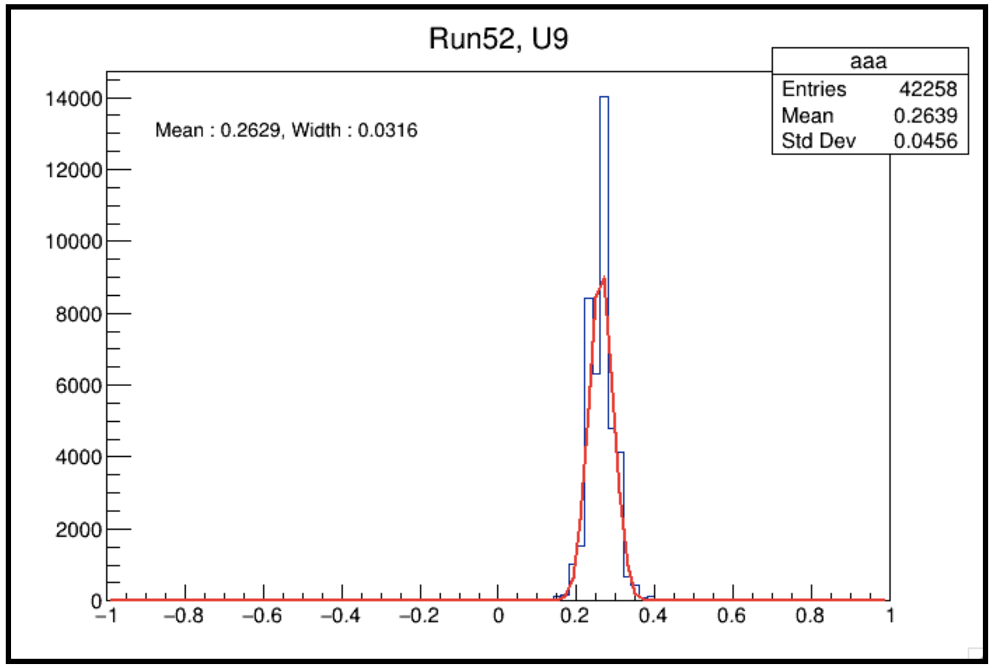
```
run file : run52_no_clone_filter_all_int_1000_chip_9
layer 3 final counting :
 N_HHH : 54018
 N_LHH : 95
 N_HLH : 131
 N_HHL : 829
 N_LLL : 10243
=====3-layers=====efficiency results===========
99.82444         +0.01797        -0.01990
99.75807         +0.02109        -0.02301
98.48852         +0.05211        -0.05391
=====3-layers=====efficiency results===========
```

Run52, alignment distributions of 4 chips

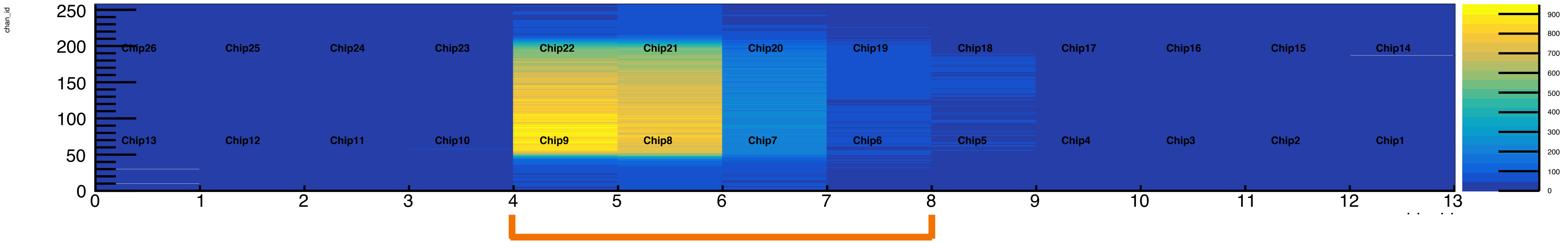




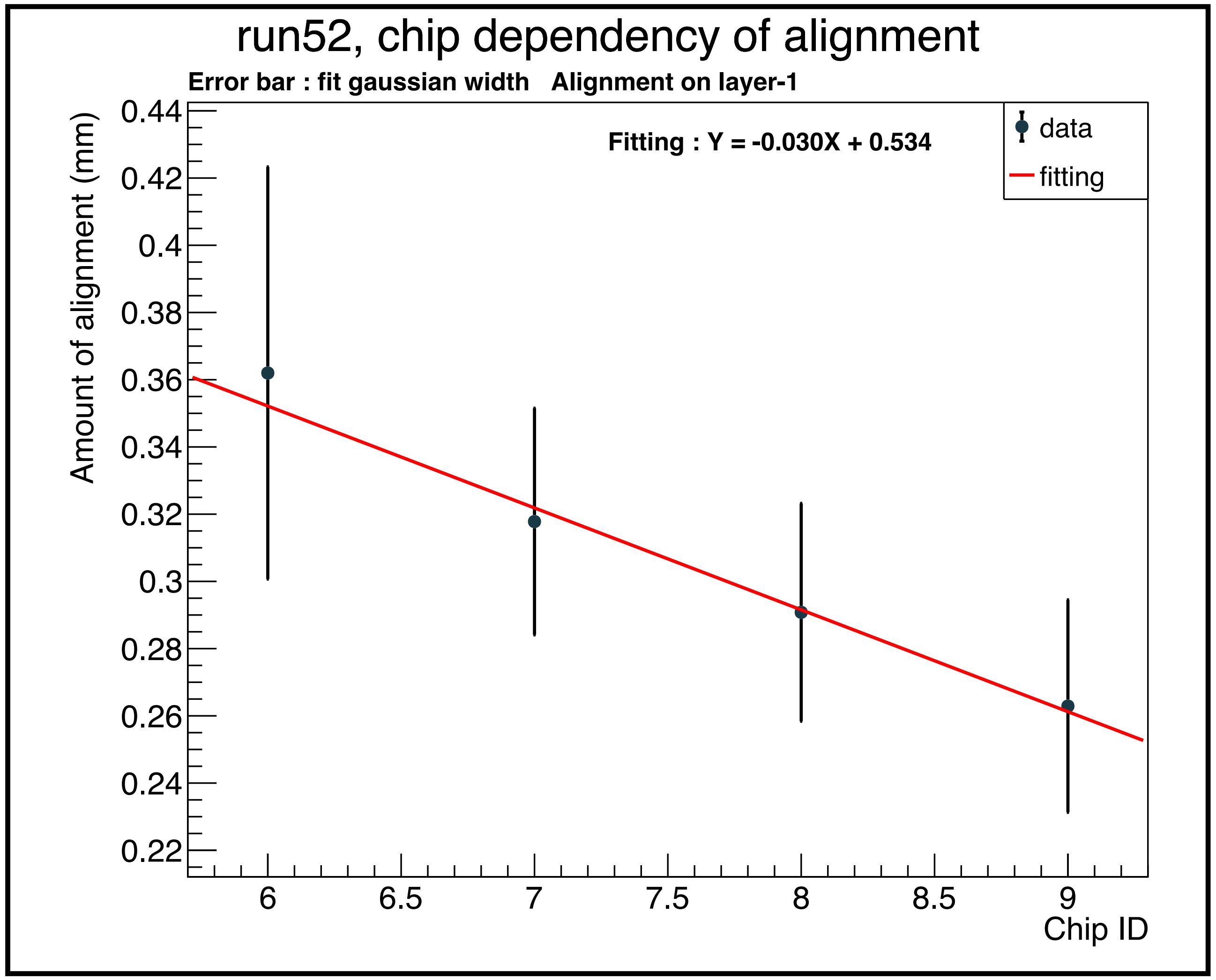




Run 52



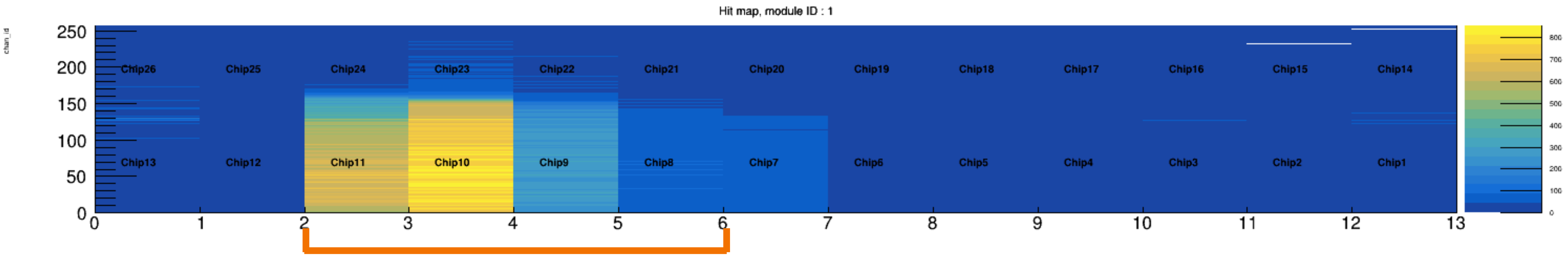
These 4 chips were checked.



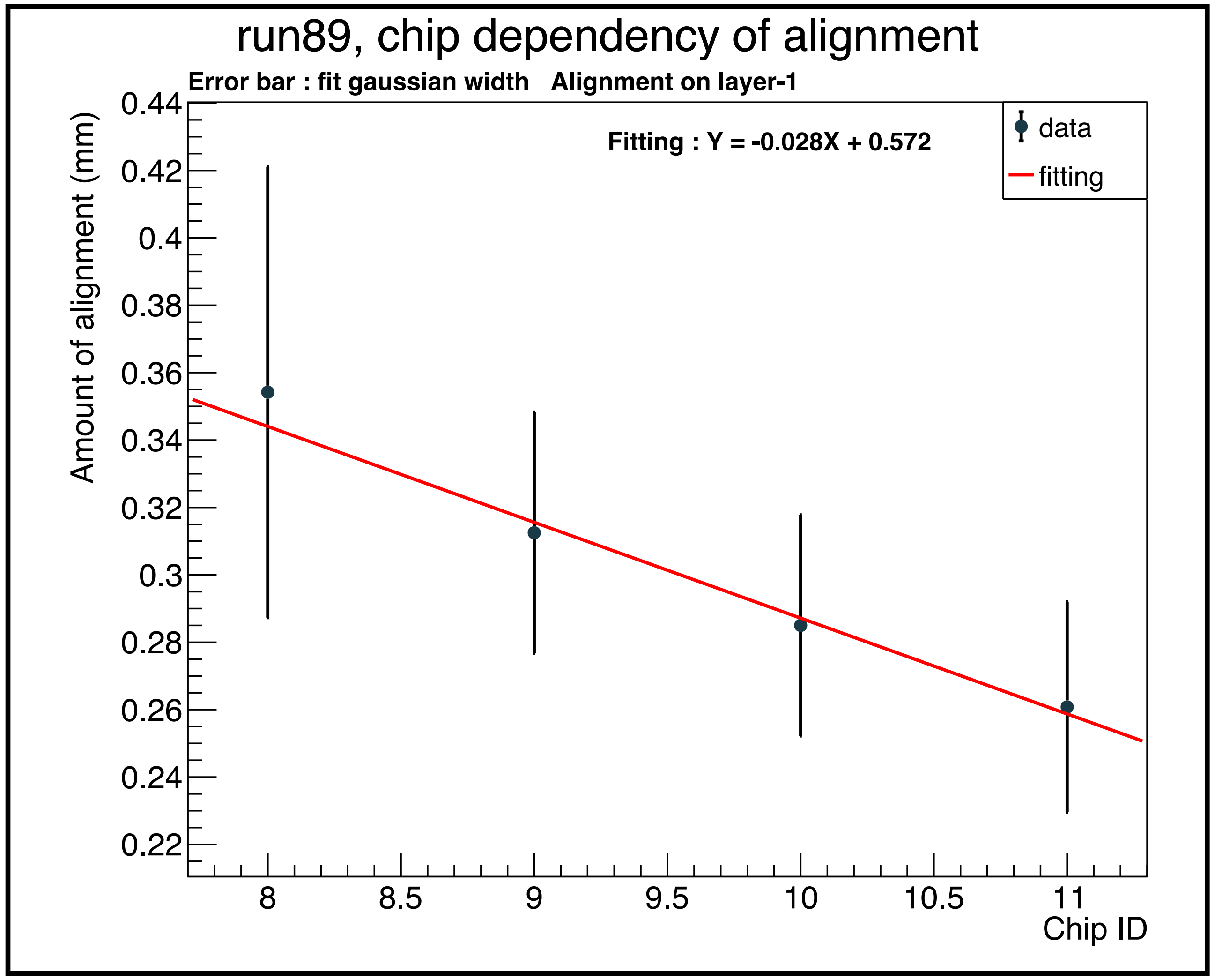
Low statistic

Run ID	effi. L0 (%)	effi. L1 (%)	effi. L2 (%)
52, U6	$99.04^{+0.16}_{-0.19}$	$98.80^{+0.18}_{-0.20}$	$89.24^{+0.48}_{-0.50}$
52, U7	$99.62^{+0.05}_{-0.05}$	$99.36^{+0.06}_{-0.07}$	$98.90^{+0.08}_{-0.09}$
52, U8	$99.73^{+0.02}_{-0.02}$	$99.60^{+0.03}_{-0.03}$	$99.00^{+0.04}_{-0.04}$
52, U9	$99.82^{+0.02}_{-0.02}$	$99.76^{+0.02}_{-0.02}$	$98.49^{+0.05}_{-0.05}$

Run 89



These 4 chips were checked.

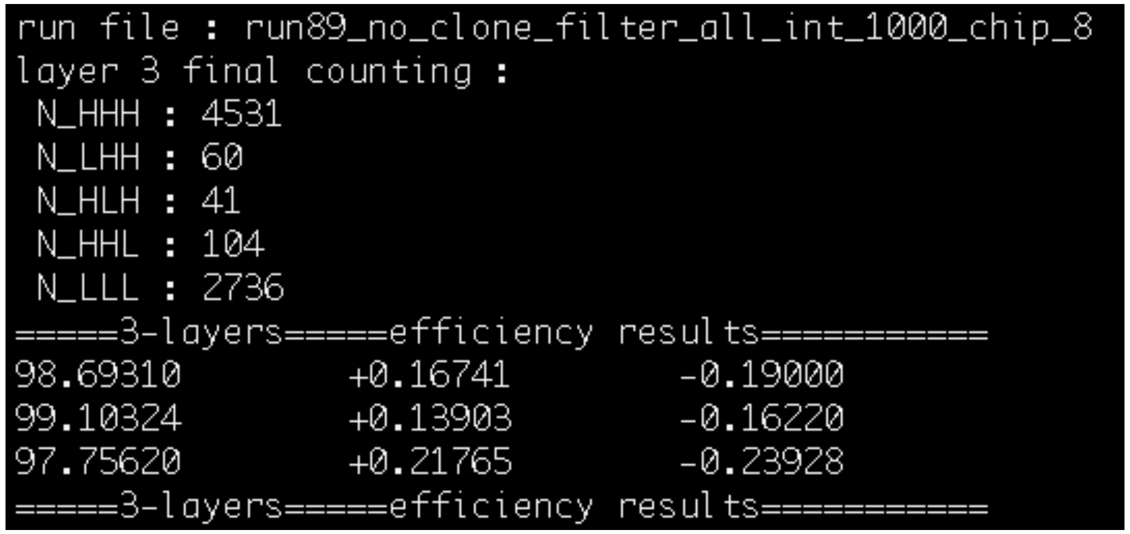


Run ID	effi. L0 (%)	effi. L1 (%)	effi. L2 (%)
89, U8	$98.69^{+0.17}_{-0.19}$	$99.10^{+0.14}_{-0.16}$	$97.76^{+0.22}_{-0.24}$
89, U9	$99.37^{+0.05}_{-0.06}$	$99.57^{+0.05}_{-0.05}$	$98.80^{+0.08}_{-0.08}$
89, U10	$99.62^{+0.02}_{-0.03}$	$99.78^{+0.02}_{-0.02}$	$99.16^{+0.04}_{-0.04}$
89, U11	$99.58^{+0.03}_{-0.03}$	$99.82^{+0.02}_{-0.02}$	$98.91^{+0.05}_{-0.05}$

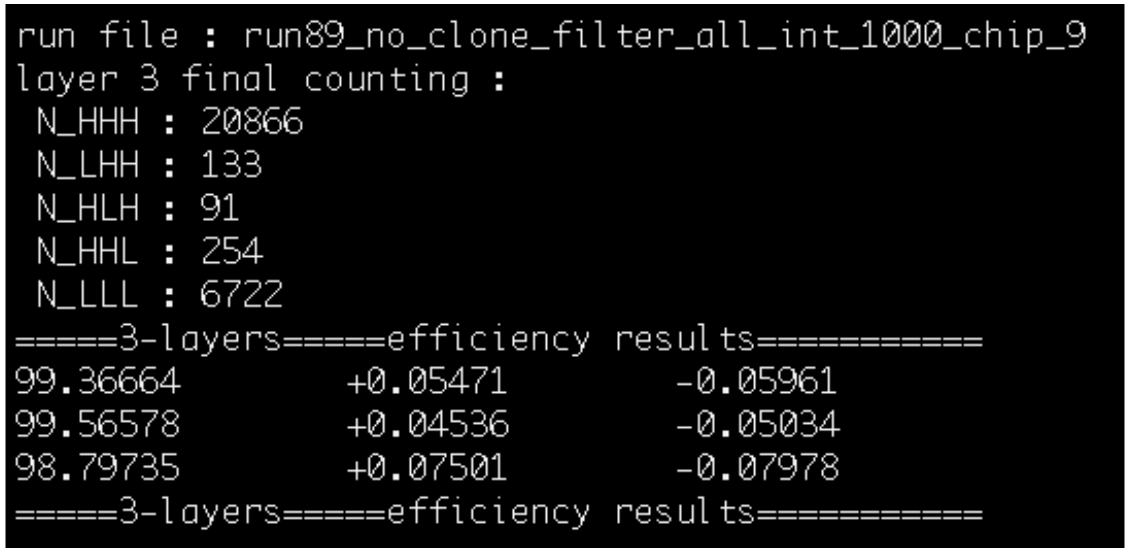
Run89, table of run parameters

Run	chip	alignment	alignment layer	window size
Run 89	8	-0.3542	1	0.3316
Run 89	9	-0.3125	1	0.2824
Run 89	10	-0.2850	1	0.149
Run 89	11	-0.2608	1	0.1444

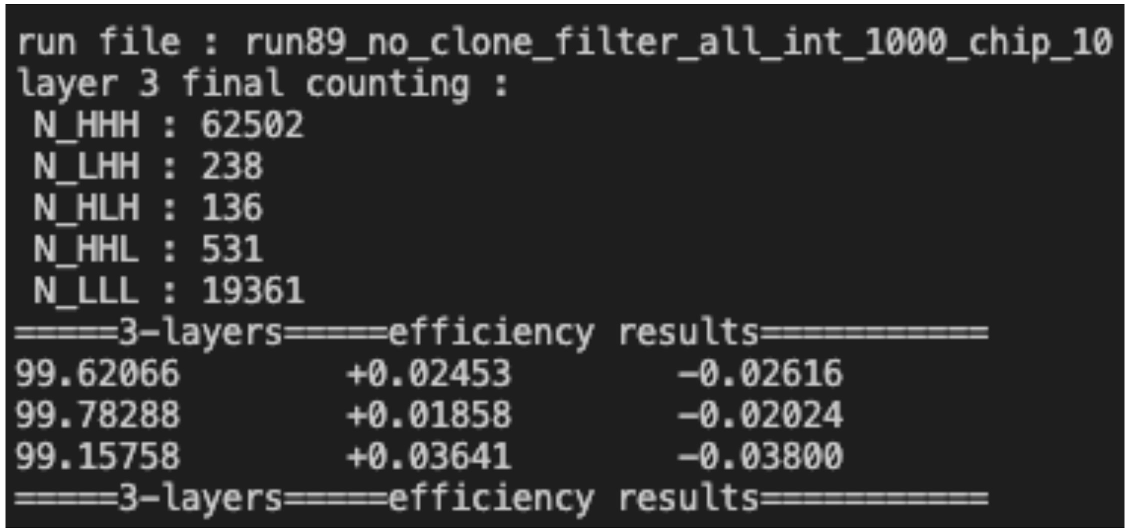
Run89, detection efficiency



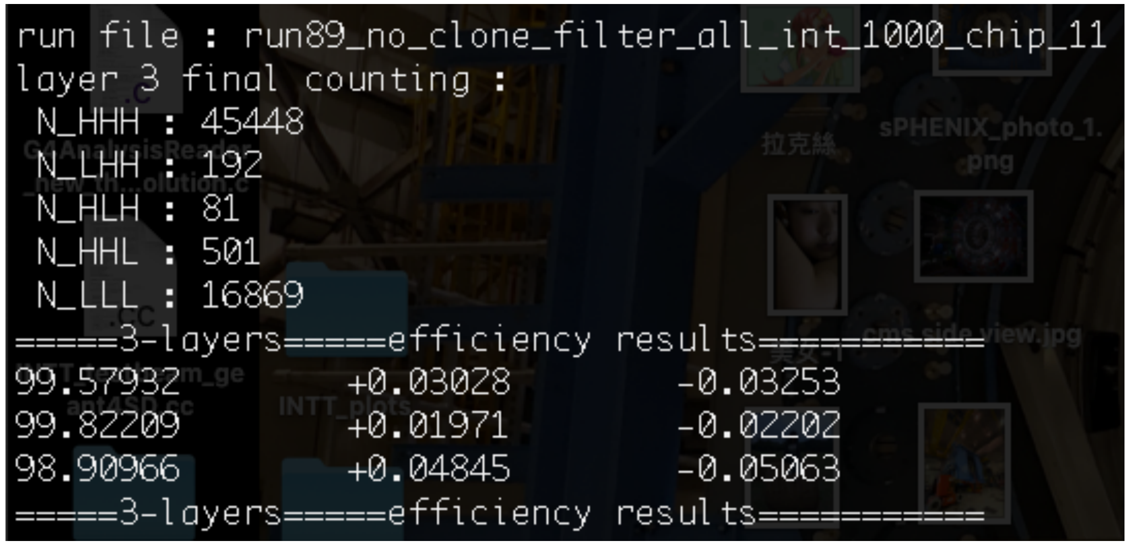
```
run file : run89_no_clone_filter_all_int_1000_chip_8
layer 3 final counting :
 N_HHH : 4531
 N_LHH : 60
 N_HLH : 41
 N_HHL : 104
 N_LLL : 2736
=====3-layers=====efficiency results===========
98.69310        +0.16741        -0.19000
99.10324        +0.13903        -0.16220
97.75620        +0.21765        -0.23928
=====3-layers=====efficiency results===========
```



```
run file : run89_no_clone_filter_all_int_1000_chip_9
layer 3 final counting :
 N_HHH : 20866
 N_LHH : 133
 N_HLH : 91
 N_HHL : 254
 N_LLL : 6722
=====3-layers=====efficiency results===========
99.36664        +0.05471        -0.05961
99.56578        +0.04536        -0.05034
98.79735        +0.07501        -0.07978
=====3-layers=====efficiency results===========
```

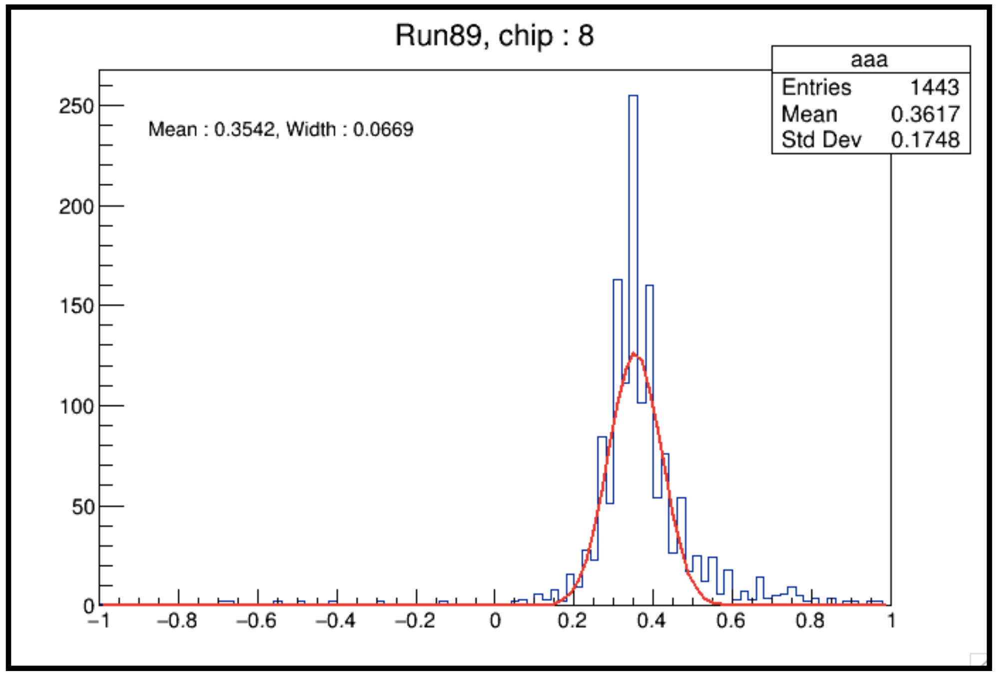


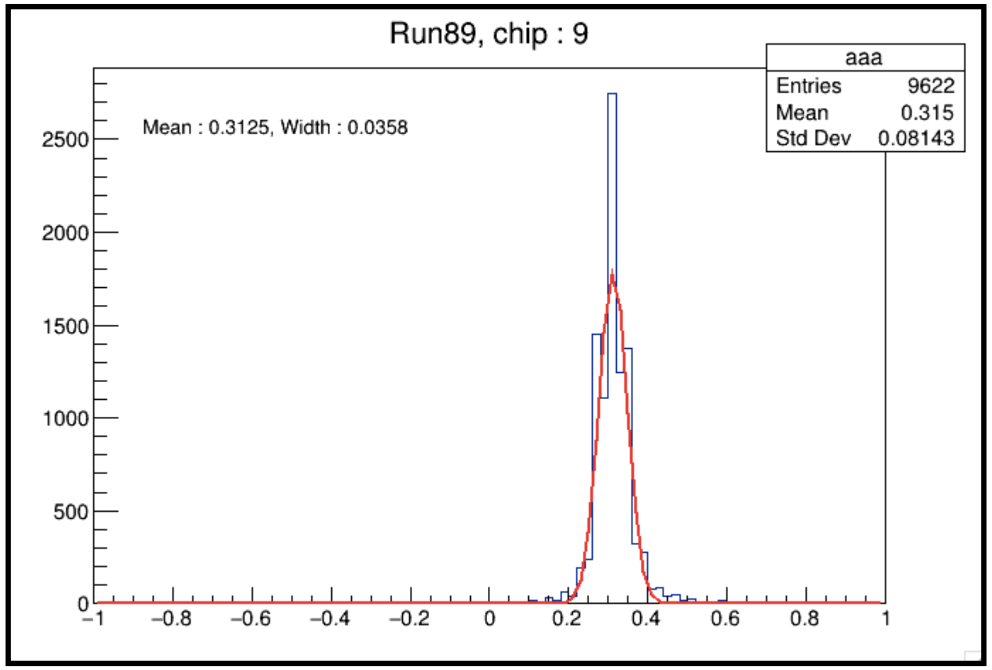
```
run file : run89_no_clone_filter_all_int_1000_chip_10
layer 3 final counting :
 N_HHH : 62502
 N_LHH : 238
 N_HLH : 136
 N_HHL : 531
 N_LLL : 19361
=====3-layers=====efficiency results===========
99.62066        +0.02453        -0.02616
99.78288        +0.01858        -0.02024
99.15758        +0.03641        -0.03800
=====3-layers=====efficiency results===========
```

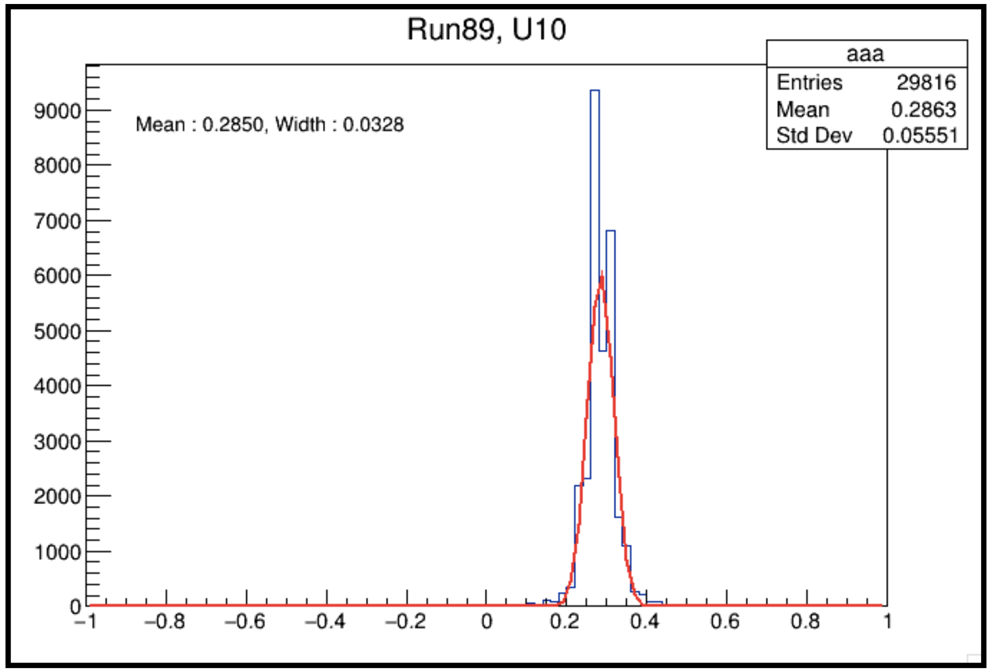


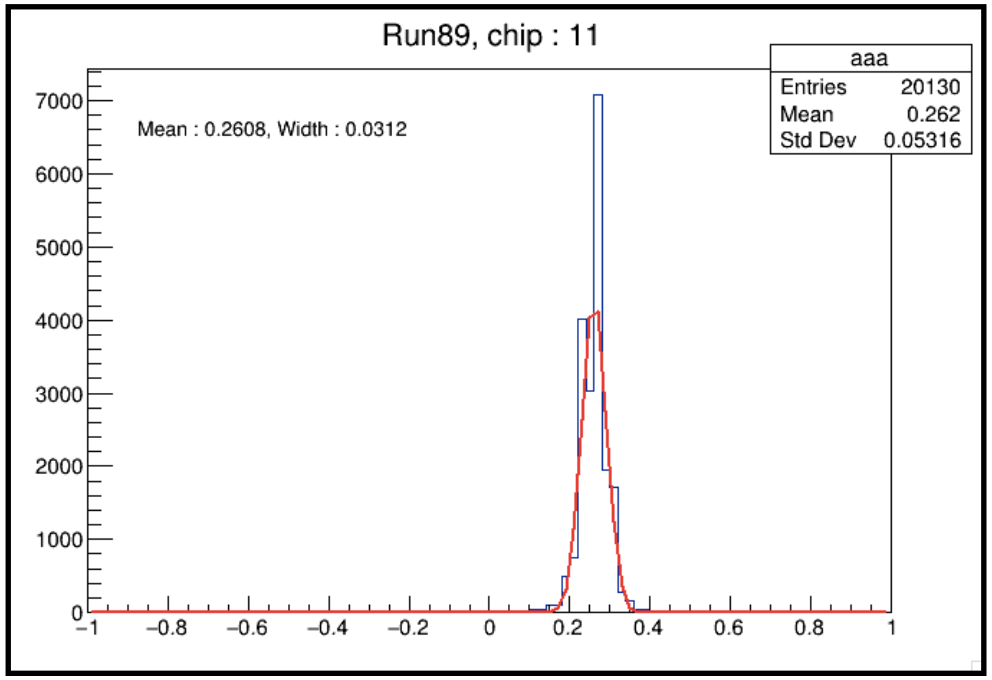
```
run file : run89_no_clone_filter_all_int_1000_chip_11
layer 3 final counting :
 N_HHH : 45448
 N_LHH : 192
 N_HLH : 81
 N_HHL : 501
 N_LLL : 16869
=====3-layers=====efficiency results===========
99.57932        +0.03028        -0.03253
99.82209        +0.01971        -0.02202
98.90966        +0.04845        -0.05063
=====3-layers=====efficiency results===========
```

Run89, alignment distributions of 4 chips

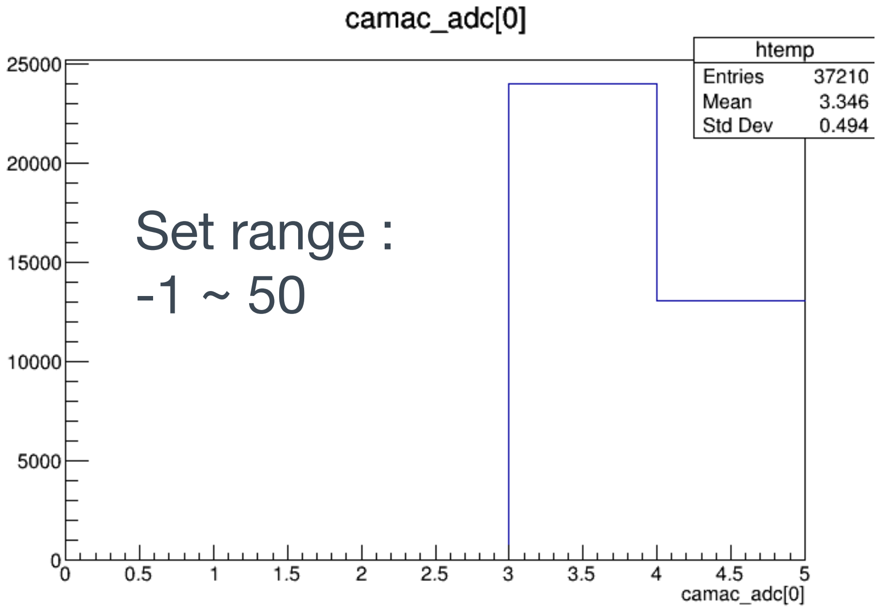




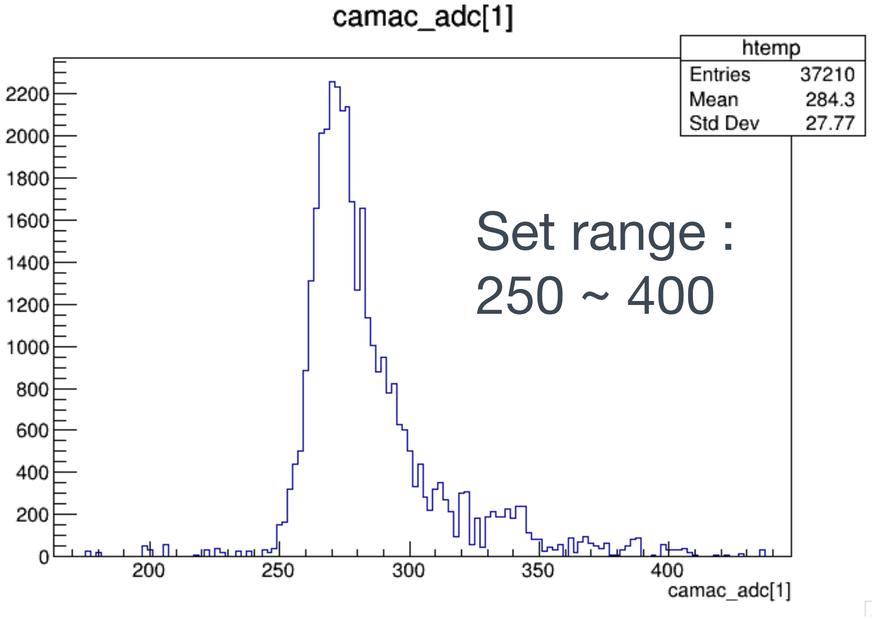




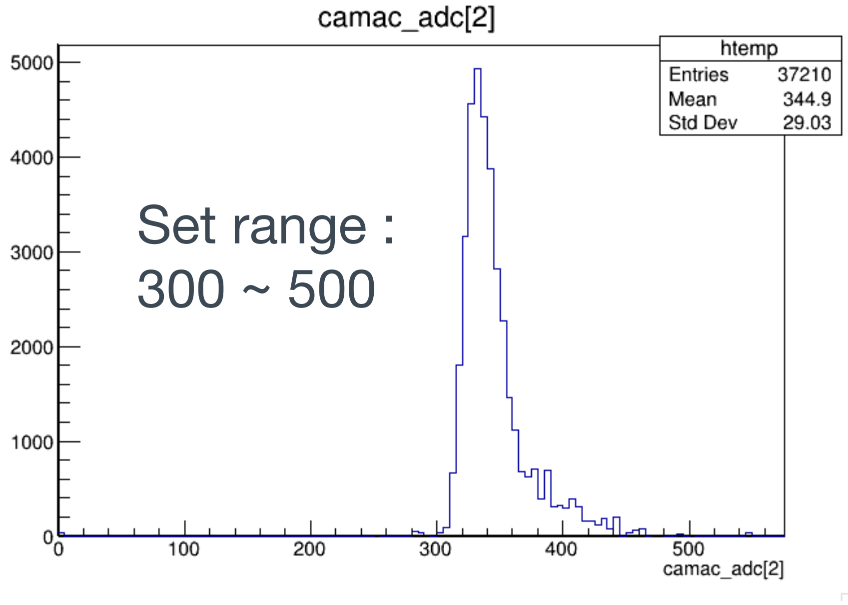
Run 33 check



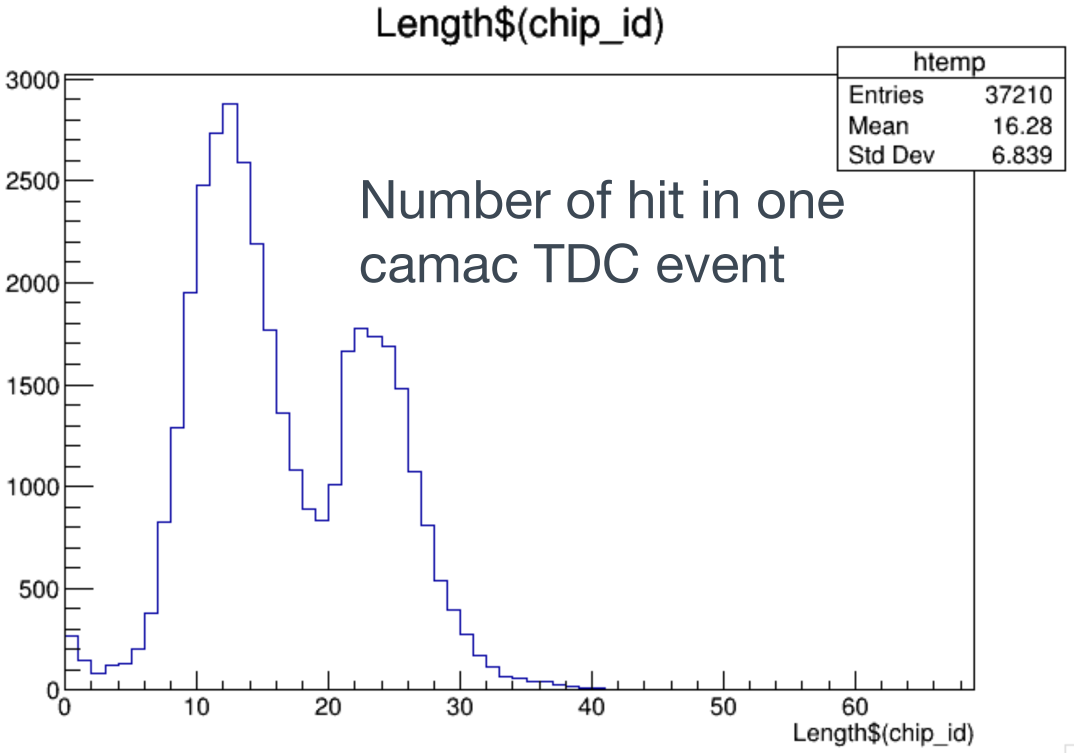
Set range :
-1 ~ 50



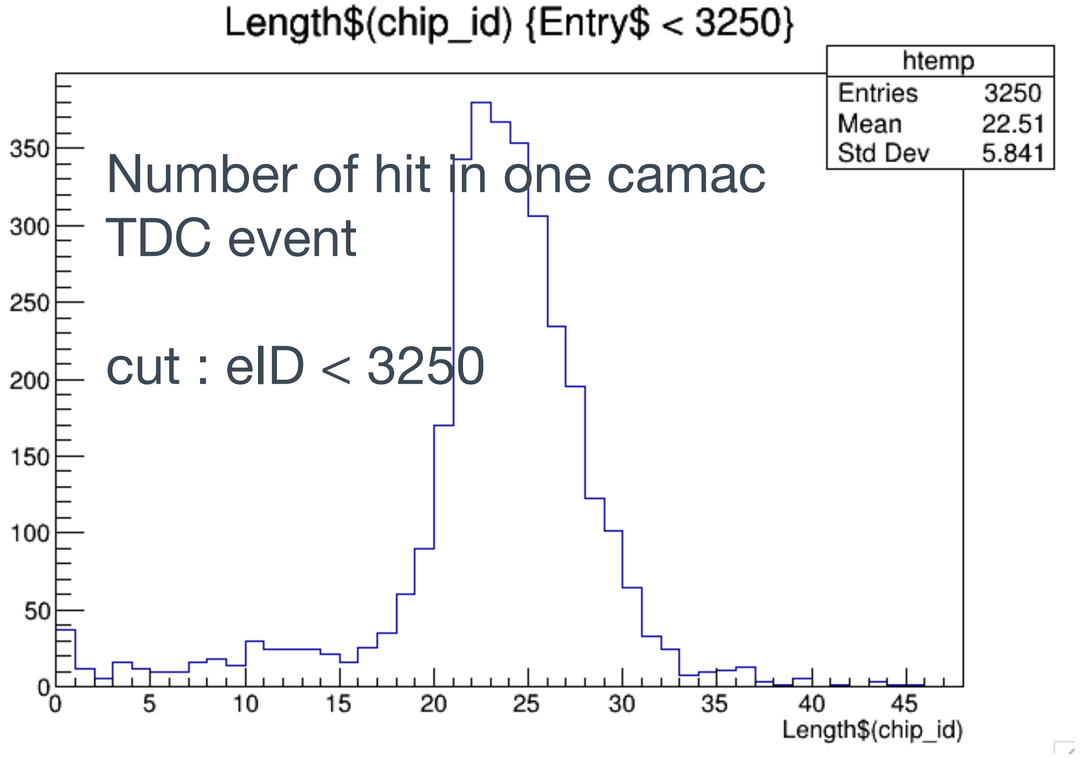
Set range :
250 ~ 400



Set range :
300 ~ 500



Number of hit in one camac TDC event

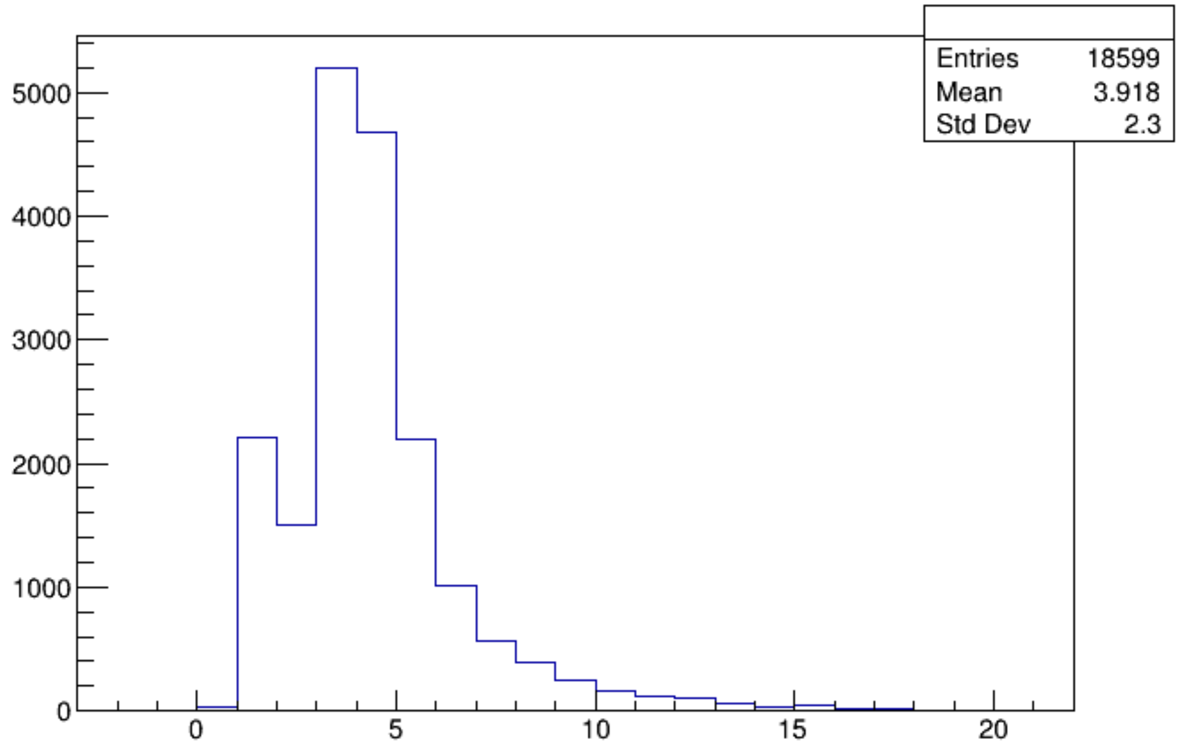


Number of hit in one camac TDC event

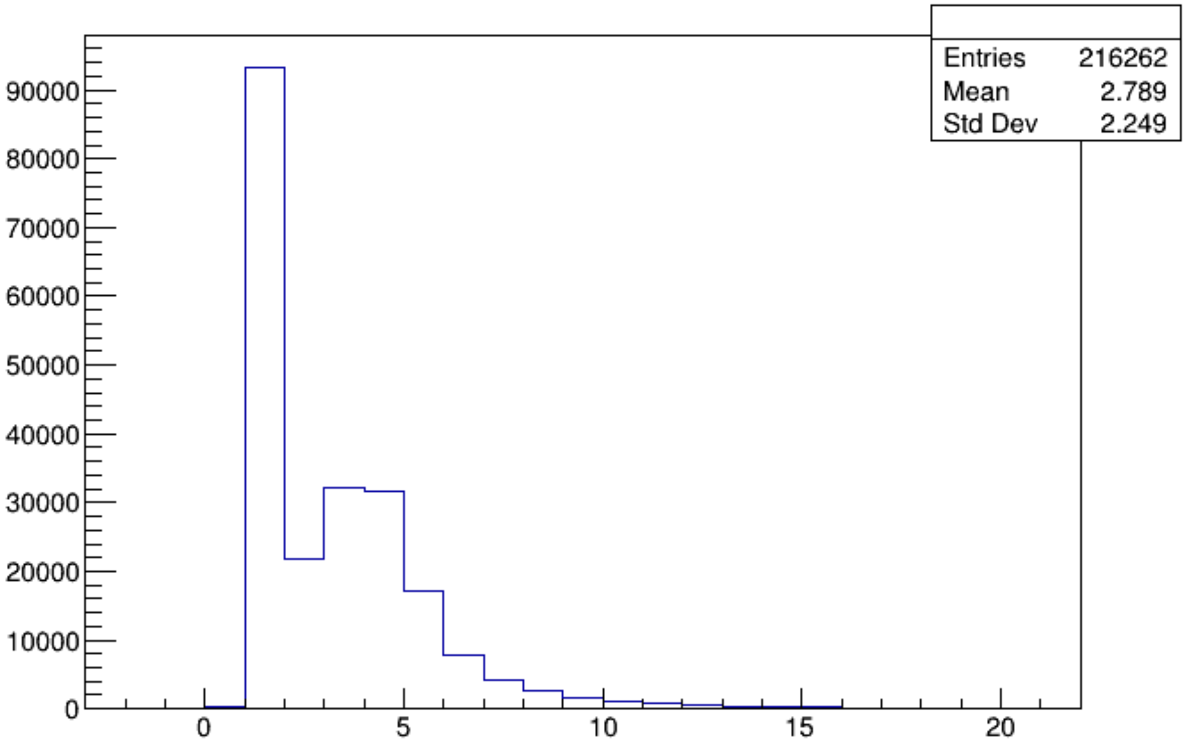
cut : eID < 3250

Run 33 check

of hit of each BCO event
cut : eID < 3250

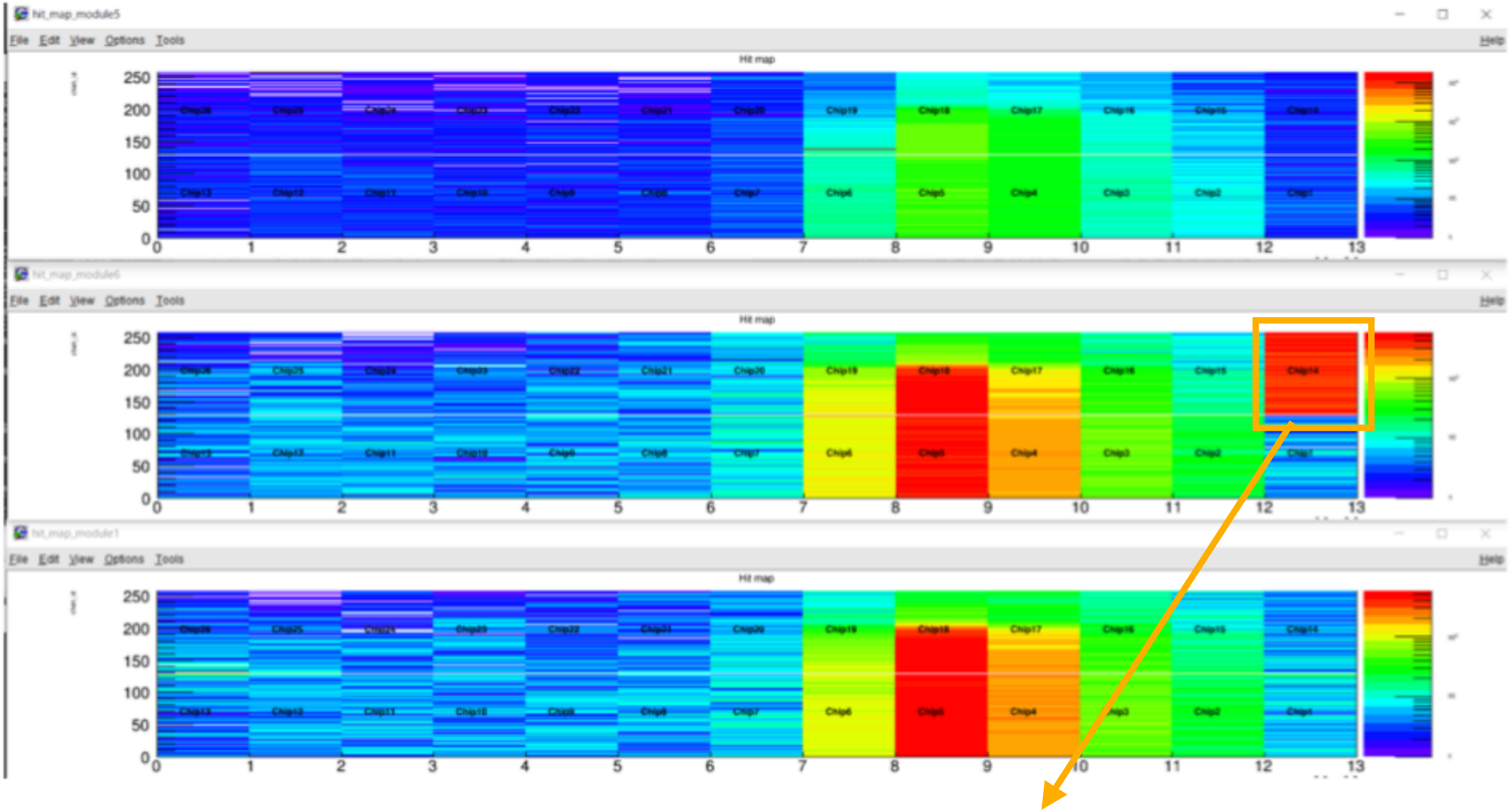


# of hit of each BCO event



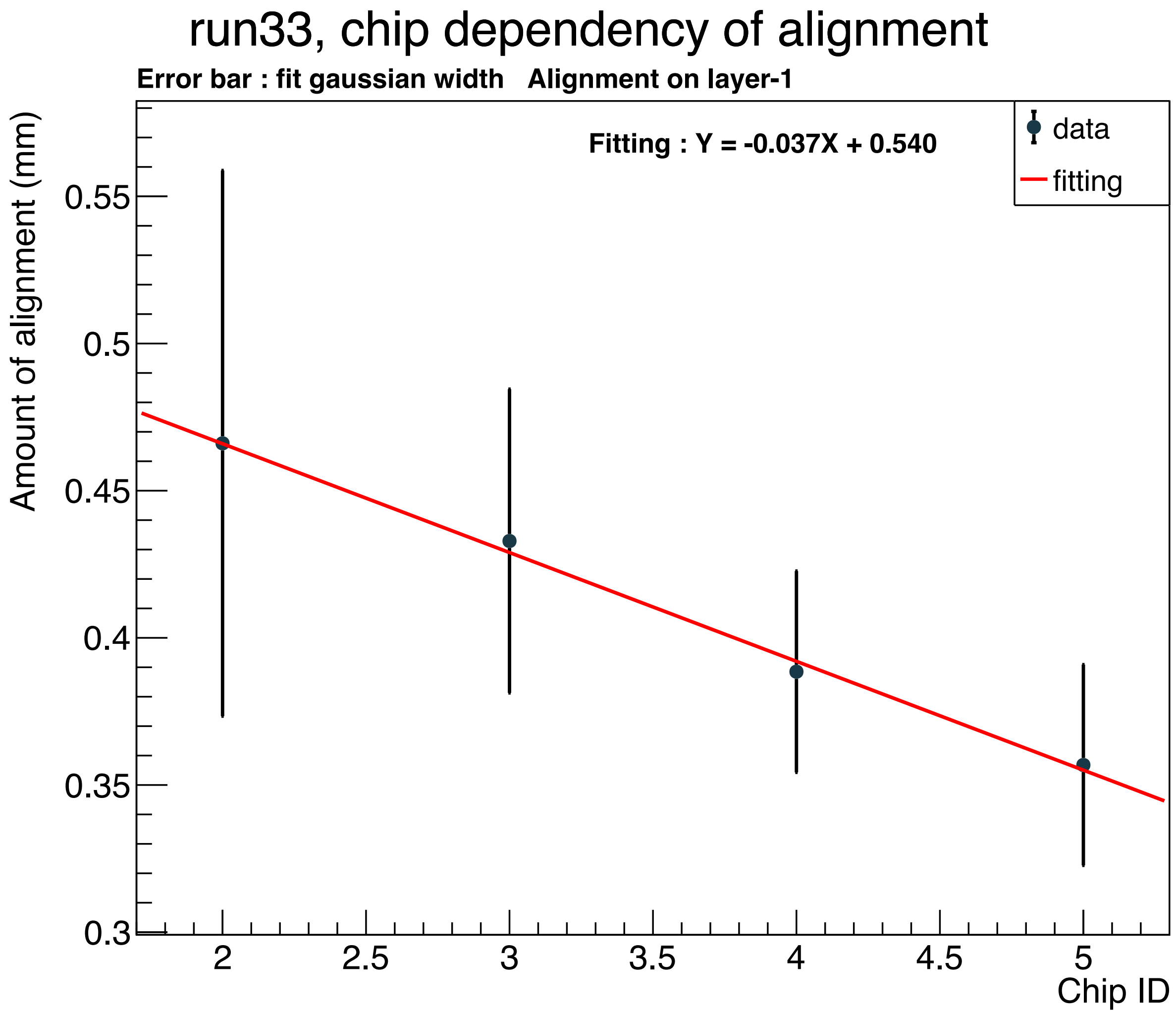
Run 33 check

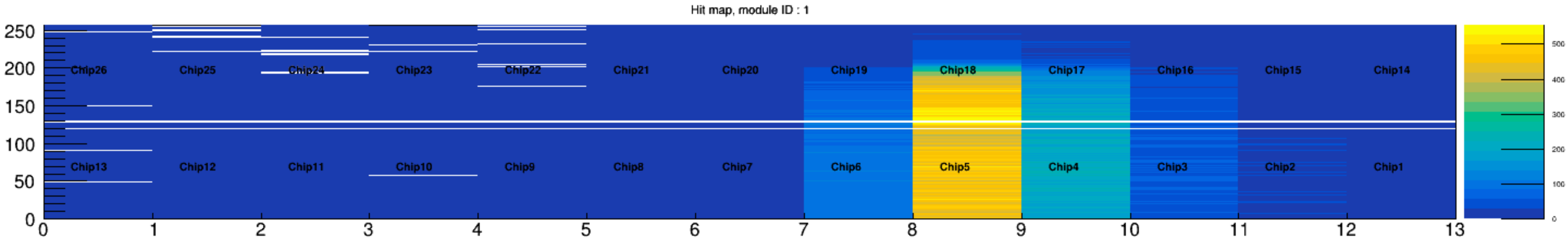
Hit map



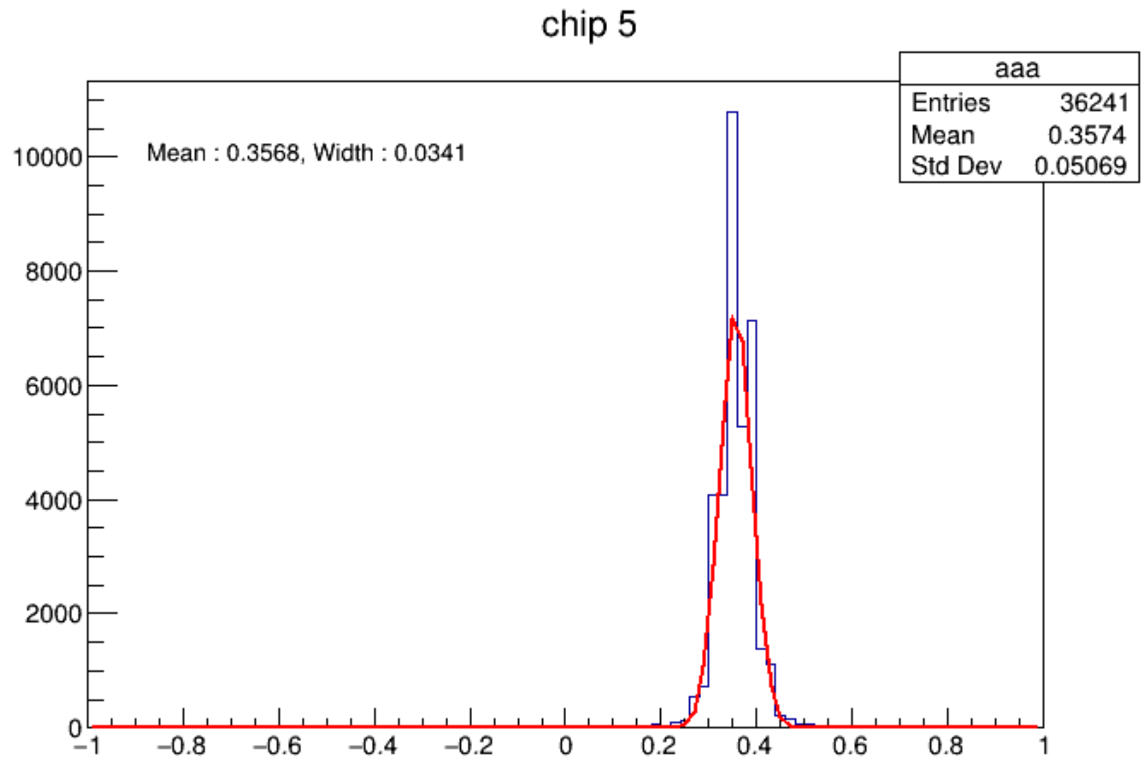
eID > 3250

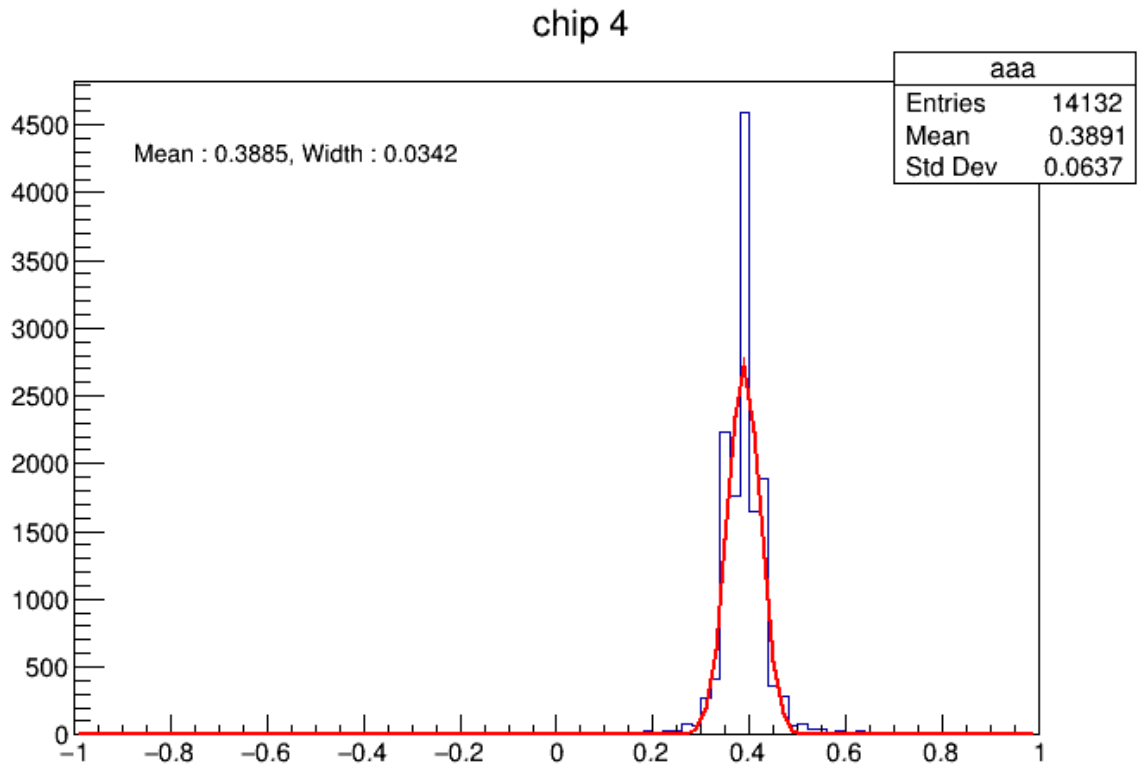
Run 33, alignment dependency

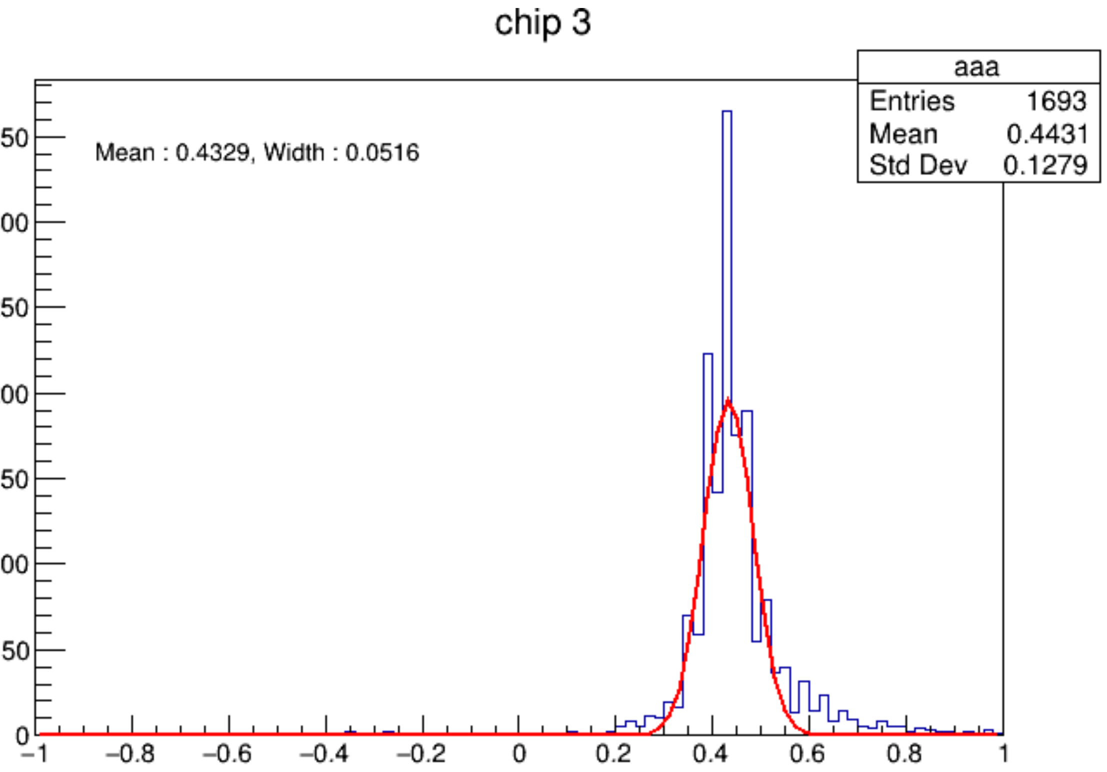


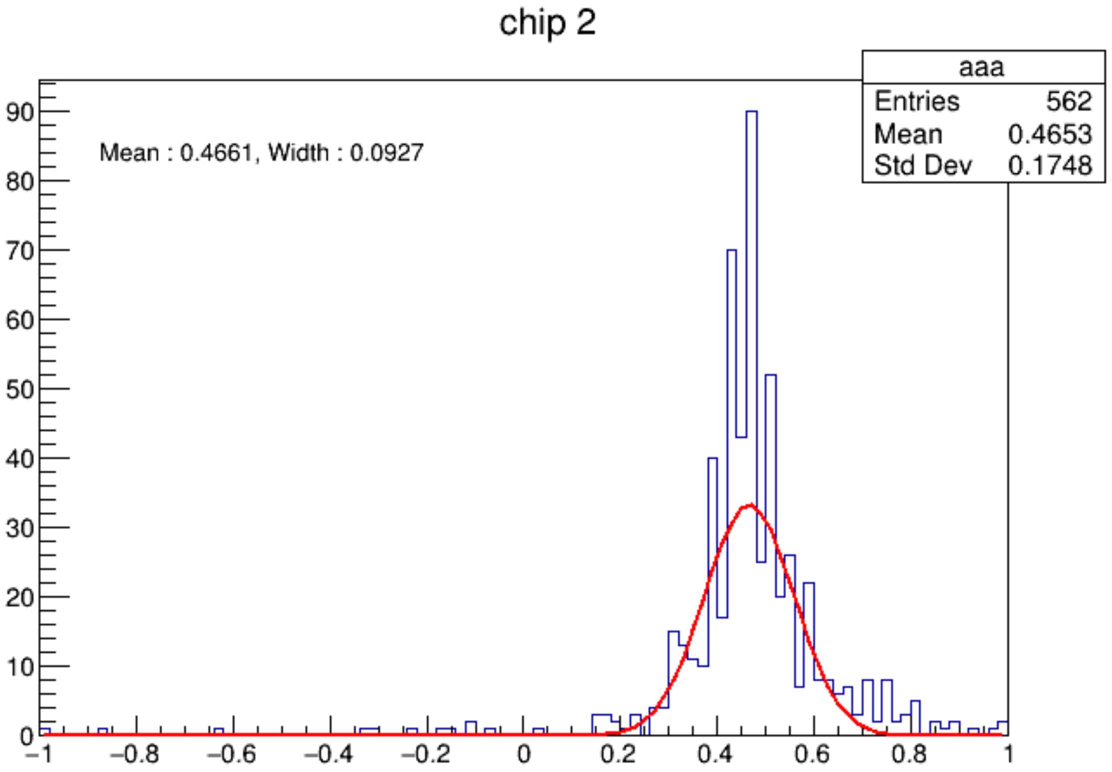


Run 33 - alignment, layer 1

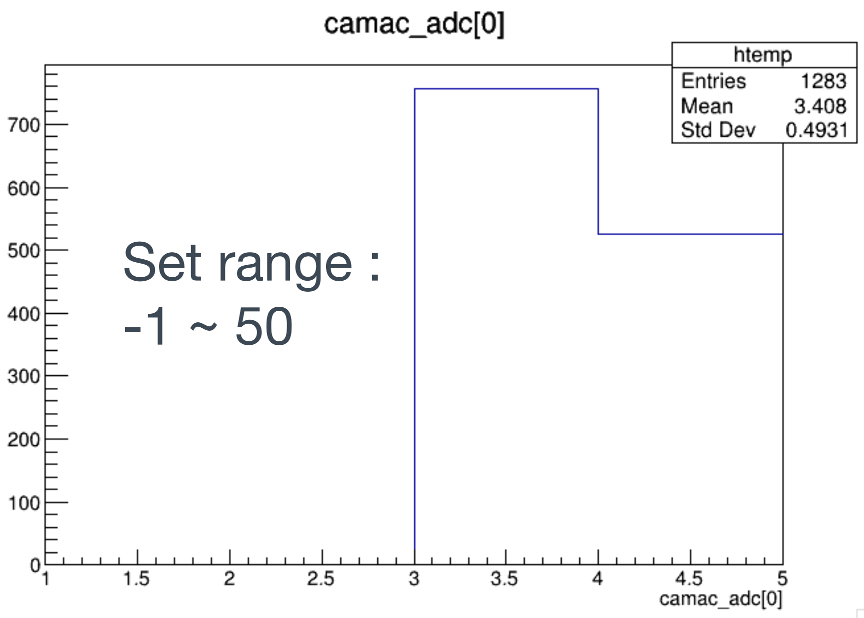




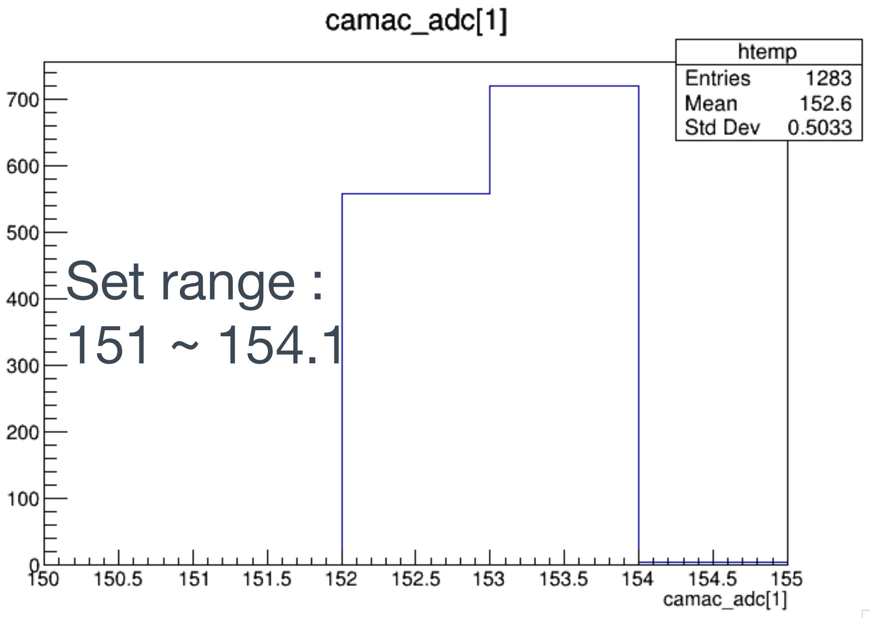




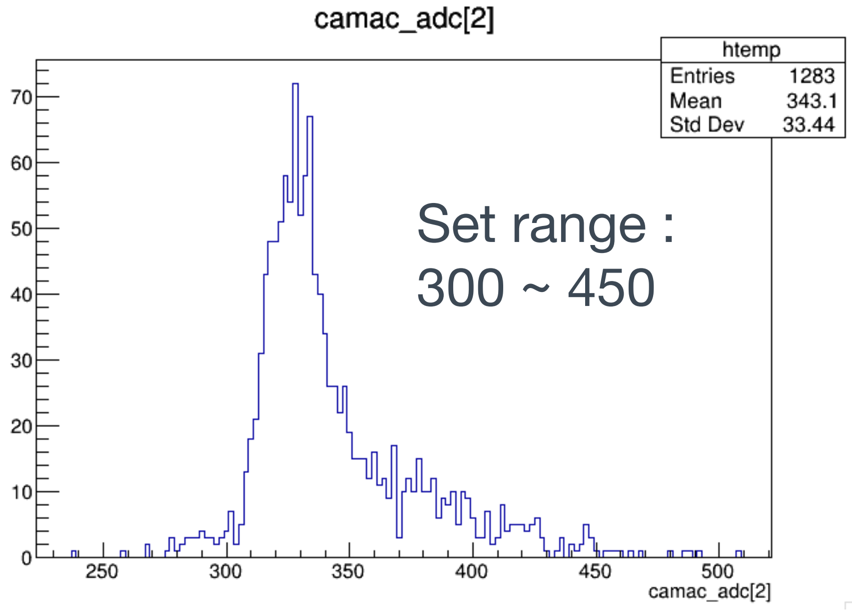
Run 61 check



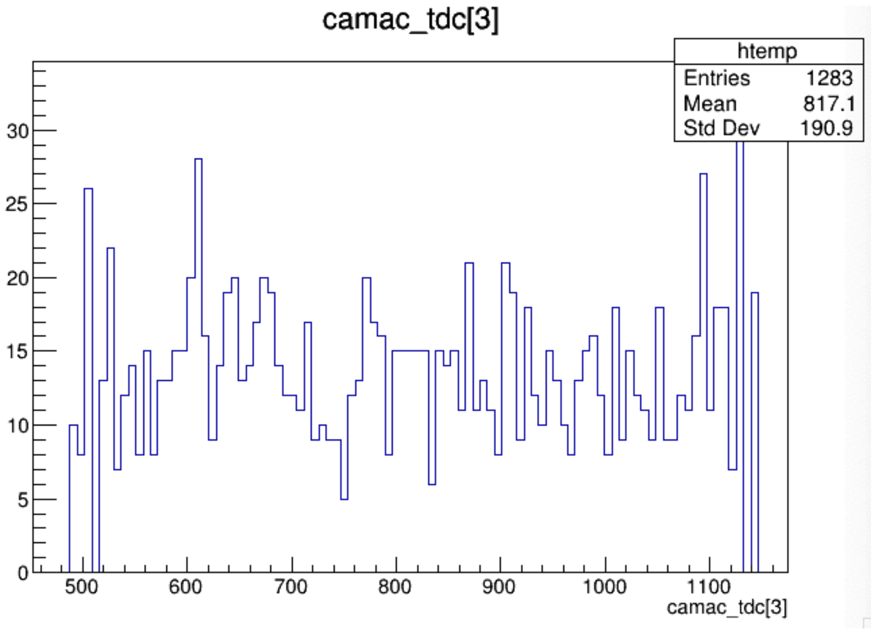
Set range :
-1 ~ 50

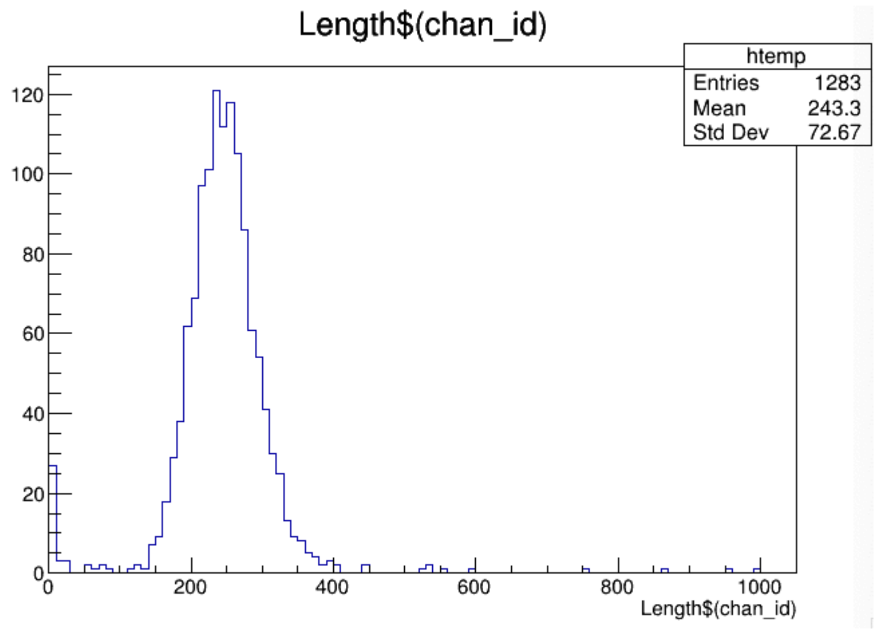


Set range :
151 ~ 154.1

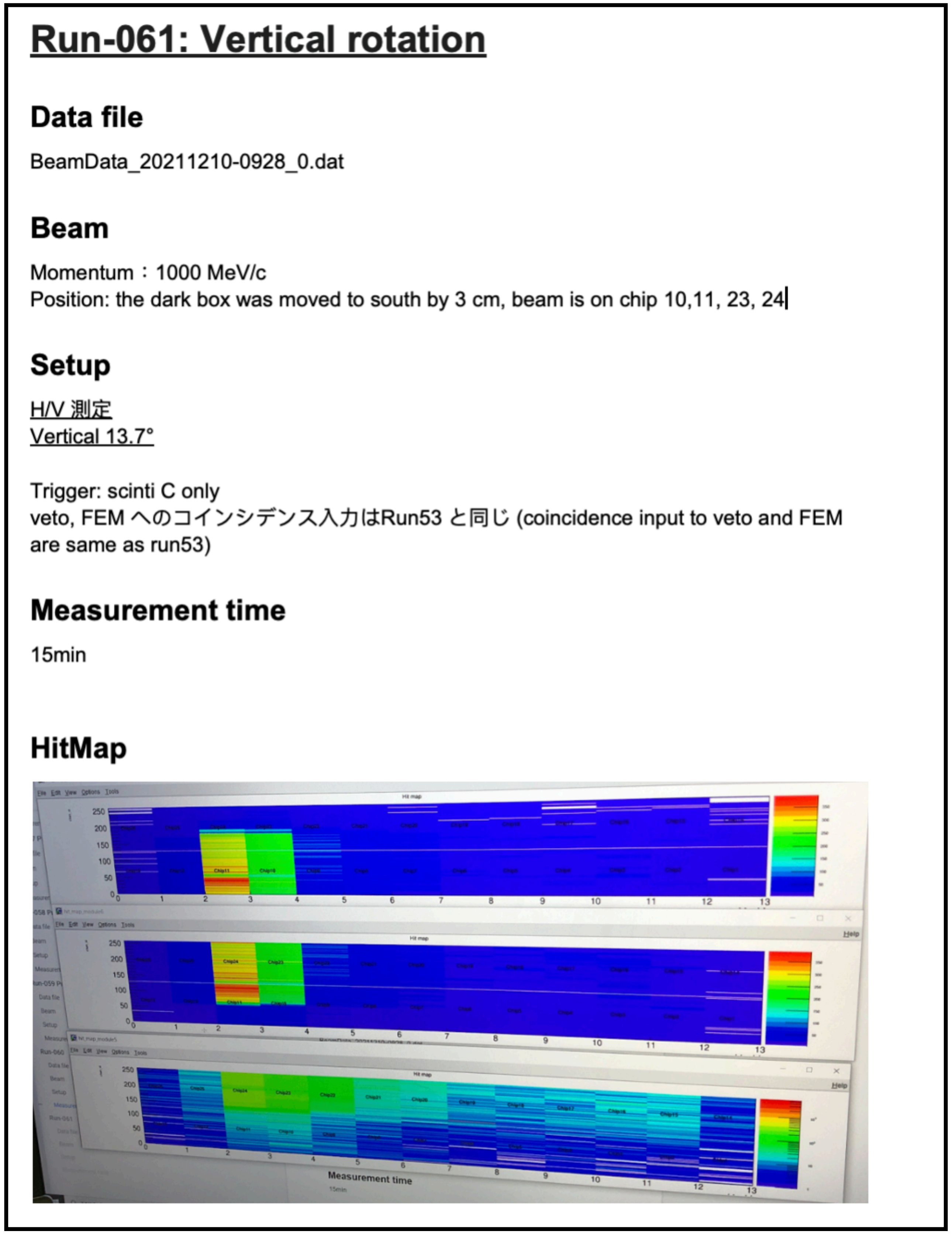


Set range :
300 ~ 450





Run 61 condition



Run-061: Vertical rotation

Data file

BeamData_20211210-0928_0.dat

Beam

Momentum：1000 MeV/c
Position: the dark box was moved to south by 3 cm, beam is on chip 10,11, 23, 24

Setup

H/V 測定
Vertical 13.7°

Trigger: scinti C only
veto, FEM へのコインシデンス入力はRun53 と同じ (coincidence input to veto and FEM are same as run53)

Measurement time

15min

HitMap

run52_MC_1 check

- camac_tdc[5]

- camac_adc[0] : 50 ~ 250
- camac_adc[1] : 50 ~ 250
- camac_adc[2] : 50 ~ 250