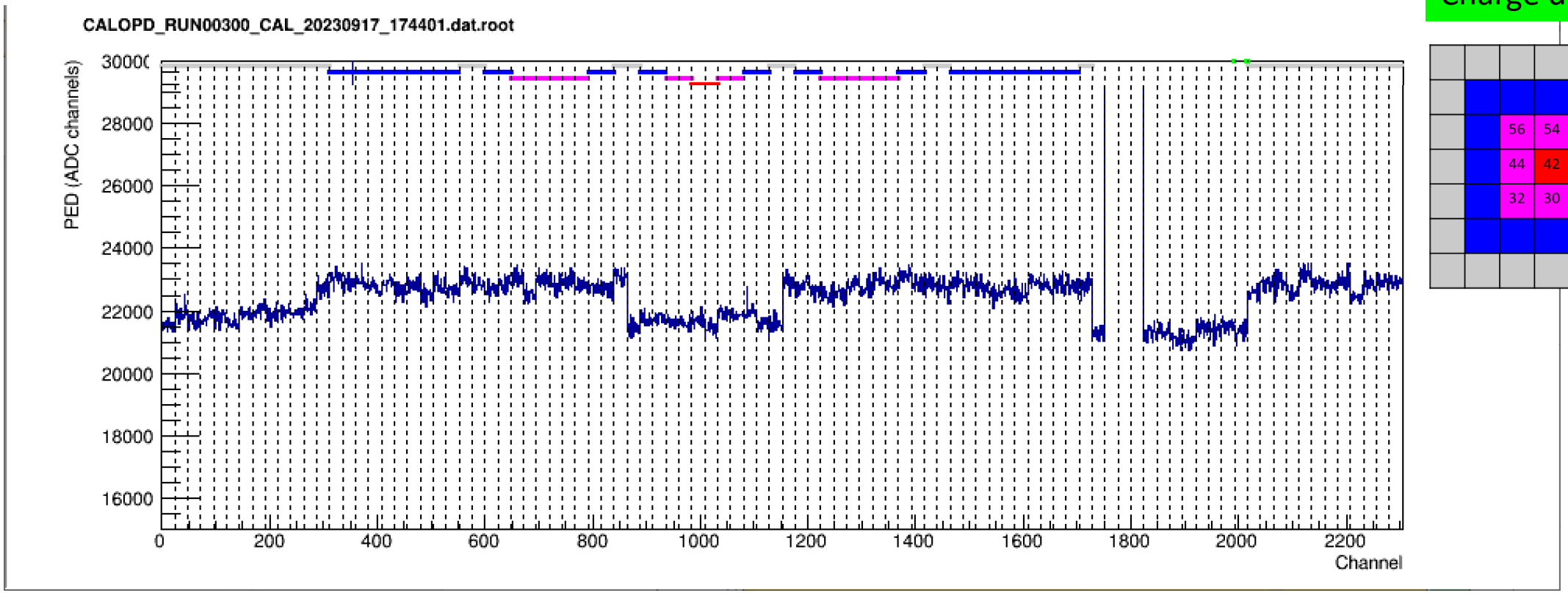
PS/SPS 2023

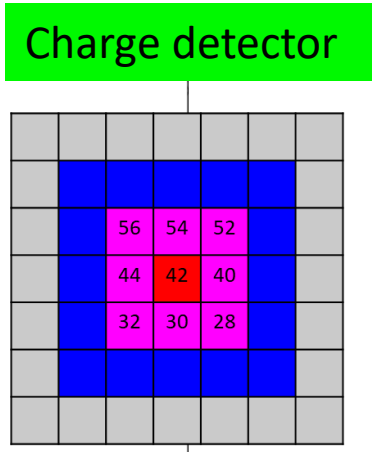
Elettroni

- Ricalibrati utilizzando calibrazione esterna (file CAL o OSCAL)
  - Verificato il metodo di sottrazione del CN → ok fit
- Check dell'effetto di pedestal shift, utilizzando eventi di calibrazione off-spill (file MIX)
  - Effetto ~% → correzione media per ogni file (in corso d'opera…)
- Check di rilasci anomali in prossimita` del cambio di guadagno
  - Particelle che attraversano l'intercapedine e colpiscono i sensori

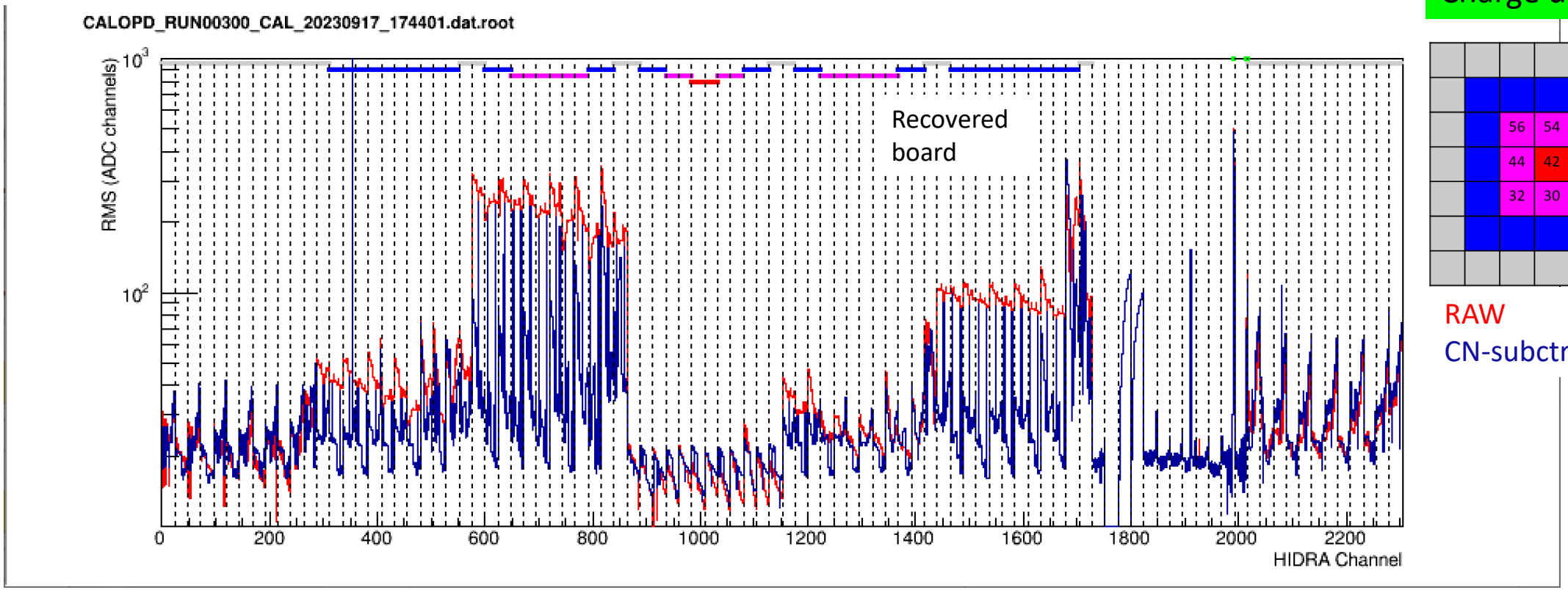
Energy (GeV)	Run	#Pulser	#Trigger	CAL
20	313	20730	100870	300
	333	17361	50152	371
50	~~176~~	~~322~~	~~0~~	
	~~177~~	~~0~~		
	304	1977	101296	300
~~80~~	~~360~~	~~0~~		
100	312	16875	100578	300
149	~~175~~	~~332~~	~~0~~	
	200	174	5753	204
	203	904	24334	204
	303	1576	100685	300
~~178~~	~~361~~	~~0~~		
197	~~182~~	~~0~~		
	305	317	18893	300
	~~306~~	~~0~~		
	307	1138	6924	300
	308	377	1714	300
	309	547	2734	300
	310	10150	47073	300
	311	17554	80840	300
200	334	728	51064	371
243	~~173~~	~~599~~	~~3~~	
	~~174~~	~~342~~	~~2~~	
	199	1354	40981	204
	301	170	9421	300
	302	2317	134038	300

PED

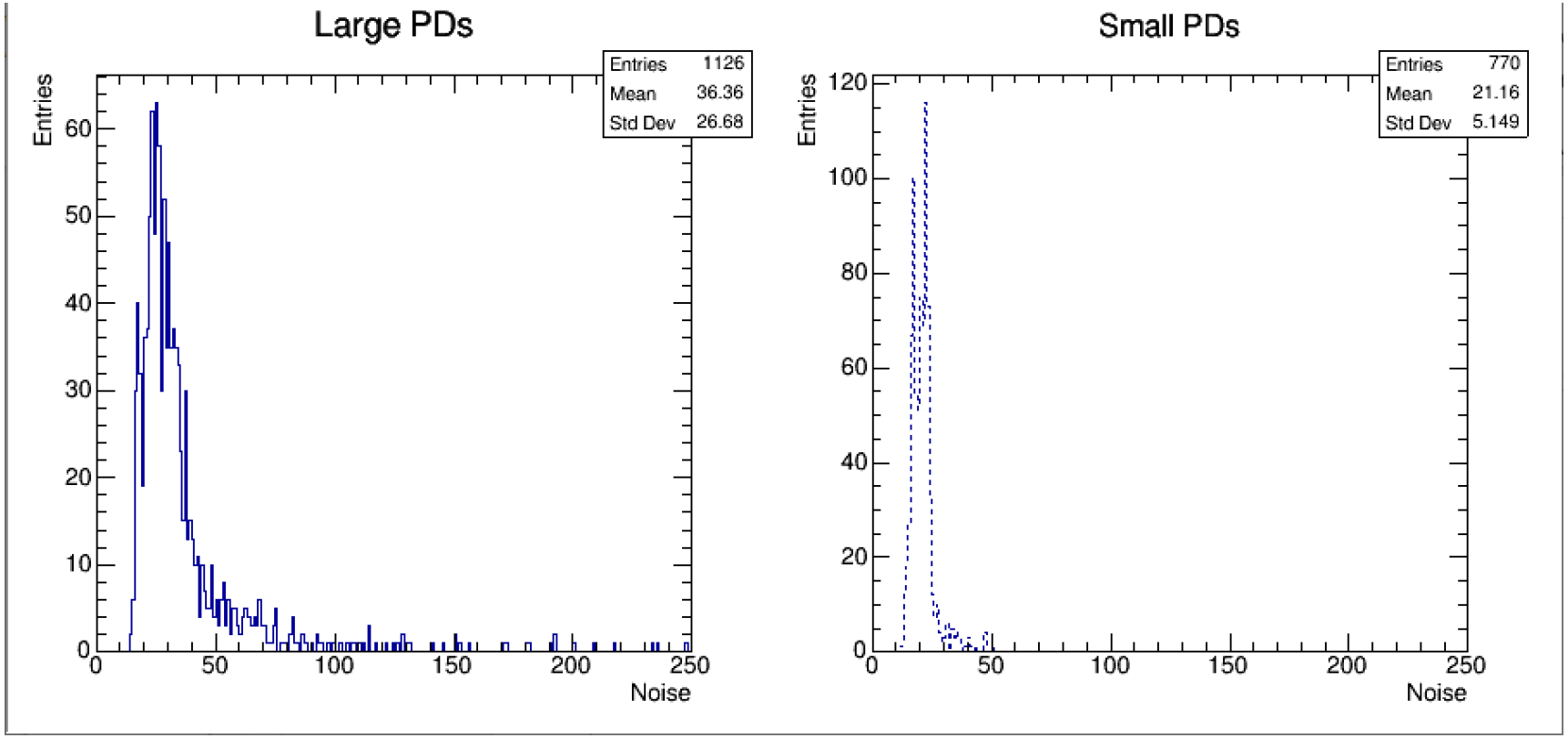

CALOPD_RUN00300_CAL_20230917_174401.dat.root
PED (ADC channels)
30000
28000
26000
24000
22000
20000
18000
16000
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
Channel


Charge detector
56
54
52
44
42
40
32
30
28

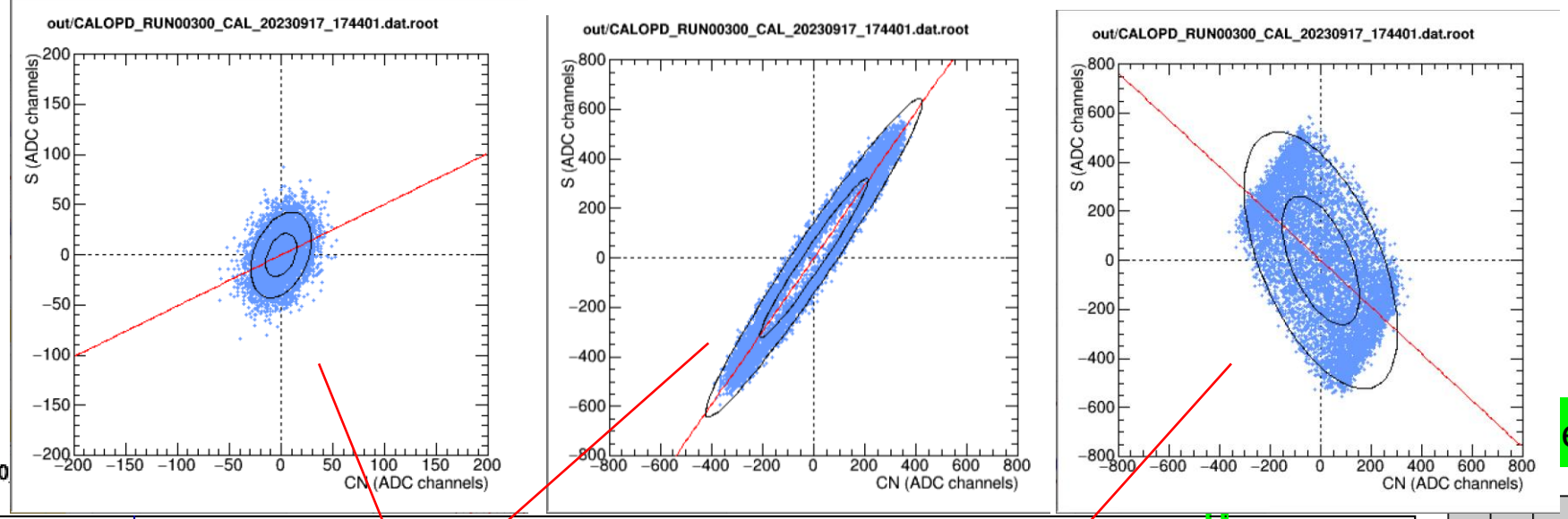
SIG

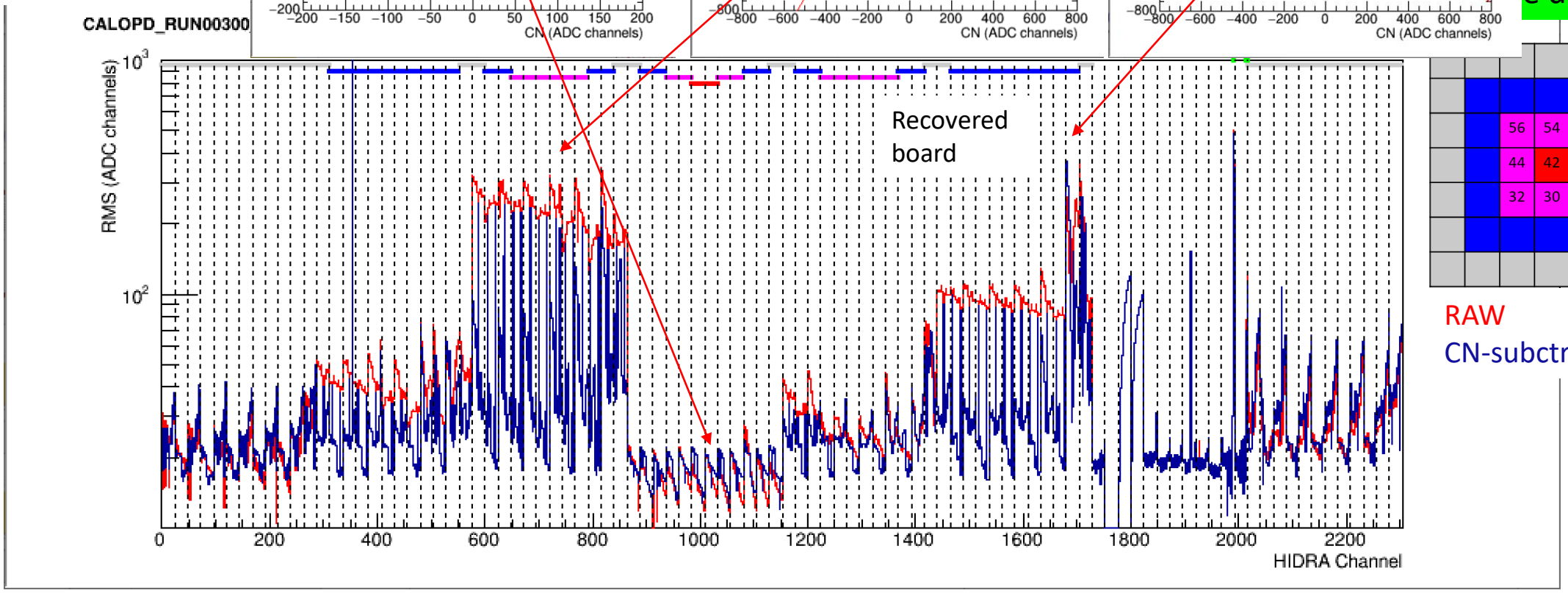

CALOPD_RUN00300_CAL_20230917_174401.dat.root
RMS (ADC channels)
10^3
10^2
Recovered board
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
HIDRA Channel
Charge detector
56
54
52
44
42
40
32
30
28
RAW
CN-subctracted

SIG


Large PDs
Entries 1126
Mean 36.36
Std Dev 26.68
Entries
Noise
Small PDs
Entries 770
Mean 21.16
Std Dev 5.149
Entries
Noise

SIG

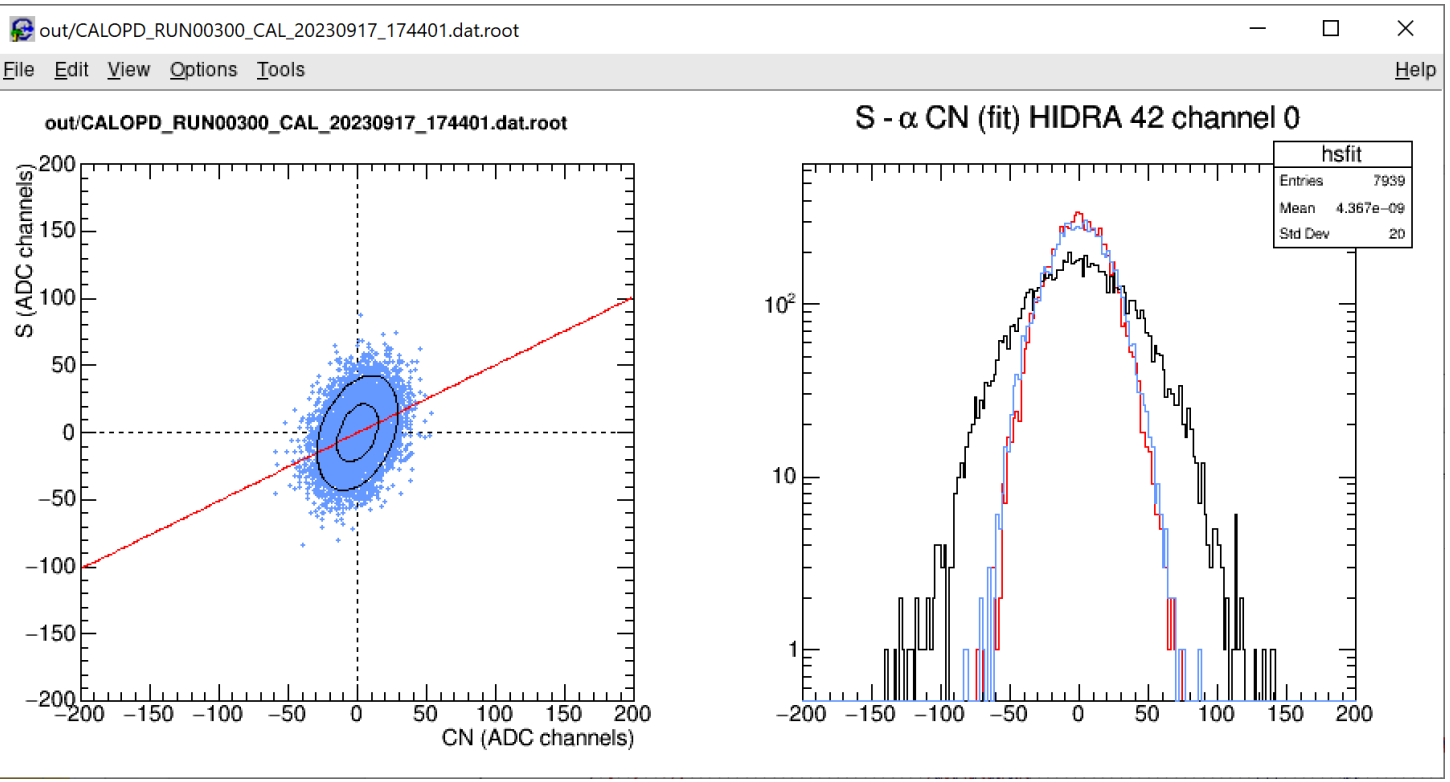




e detector

RAW

CN-subctracted



alpha (fit) 0.507447

eigenvalue 0 498.253 sqrt 22.3216

eigenvalue 1 173.492 sqrt 13.1716

R00 cos(theta) 0.362315 R01 -sin(theta) -0.932056

R10 sin(theta) 0.932056 R11 cos(theta) 0.362315

tg(theta) 2.5725

alpha (matrix) 2.5725

sigma(y) 21.3453

sigma(y - alpha*x) 36.354

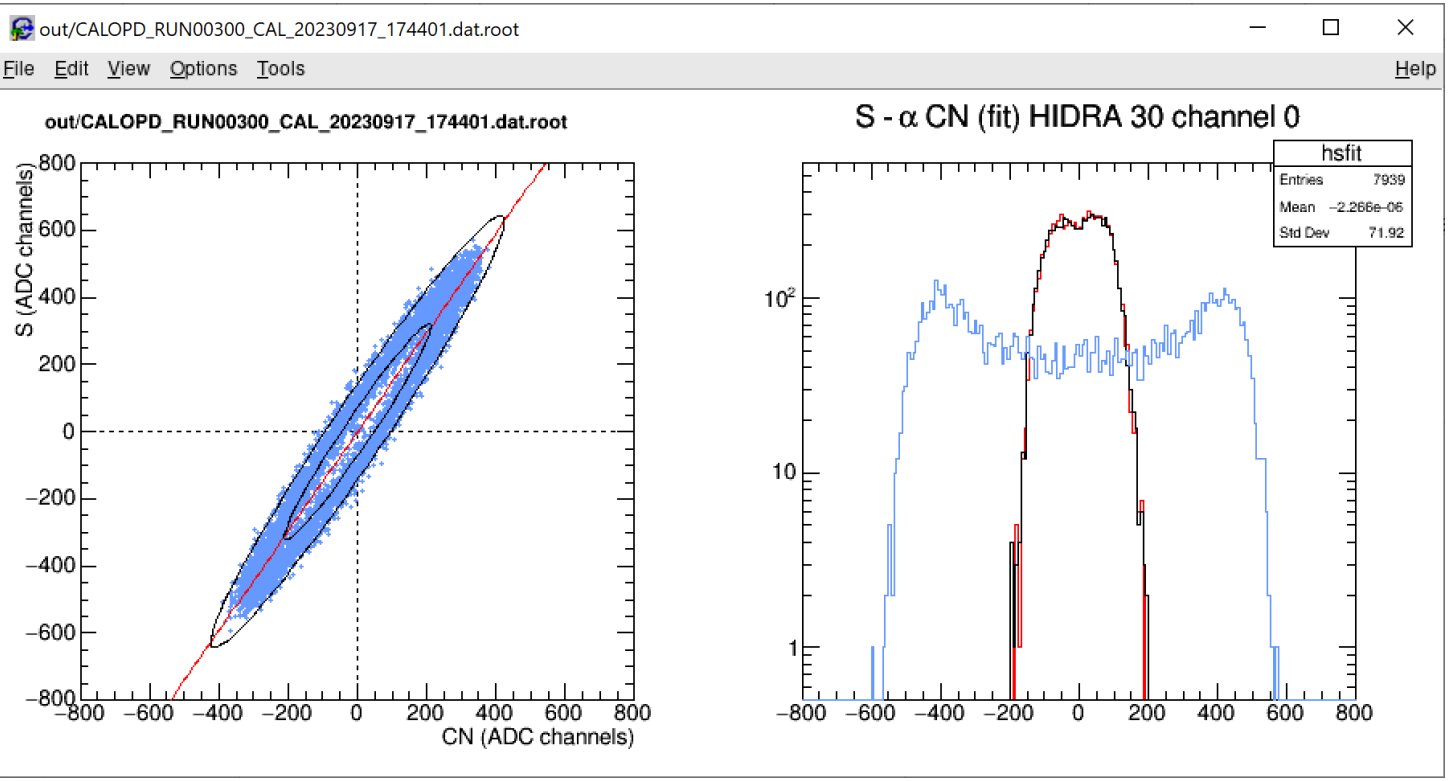
RMS(y) 21.3453

RMS(y - alpha*x) fit 19.9992

RMS(y - alpha*x) matrix 36.354

mean(y - alpha*x) fit 4.36745e-09

mean(y - alpha*x) matrix 1.62746e-08



alpha (fit) 1.47991

eigenvalue 0 146547 sqrt 382.815

eigenvalue 1 1581.46 sqrt 39.7676

R00 cos(theta) 0.546089 R01 -sin(theta) -0.837727

R10 sin(theta) 0.837727 R11 cos(theta) 0.546089

tg(theta) 1.53405

alpha (matrix) 1.53405

sigma(y) 321.429

sigma(y - alpha*x) 72.8226

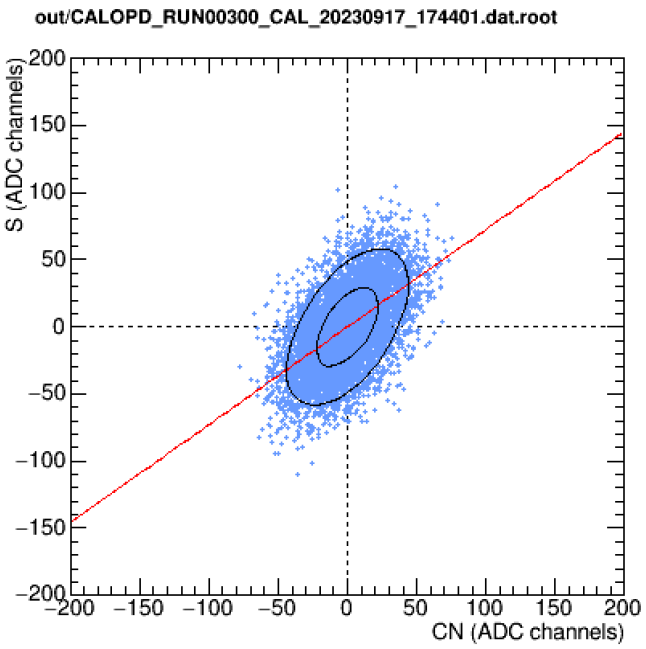
RMS(y) 321.429

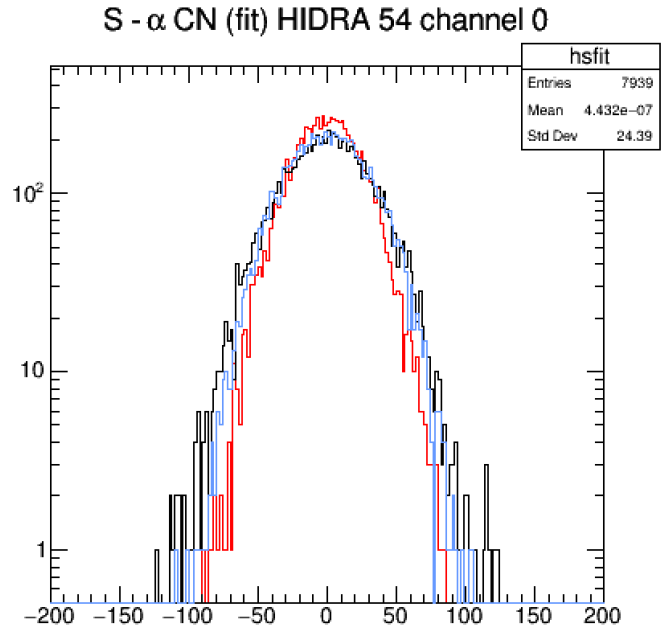
RMS(y - alpha*x) fit 71.9151

RMS(y - alpha*x) matrix 72.8226

mean(y - alpha*x) fit -2.26558e-06

mean(y - alpha*x) matrix -2.04245e-06





alpha (fit) 0.727834

eigenvalue 0 1063.2 sqrt 32.6068

eigenvalue 1 270.087 sqrt 16.4343

R00 cos(theta) 0.517694 R01 -sin(theta) -0.855566

R10 sin(theta) 0.855566 R11 cos(theta) 0.517694

tg(theta) 1.65265

alpha (matrix) 1.65265

sigma(y) 29.1658

sigma(y - alpha*x) 31.7453

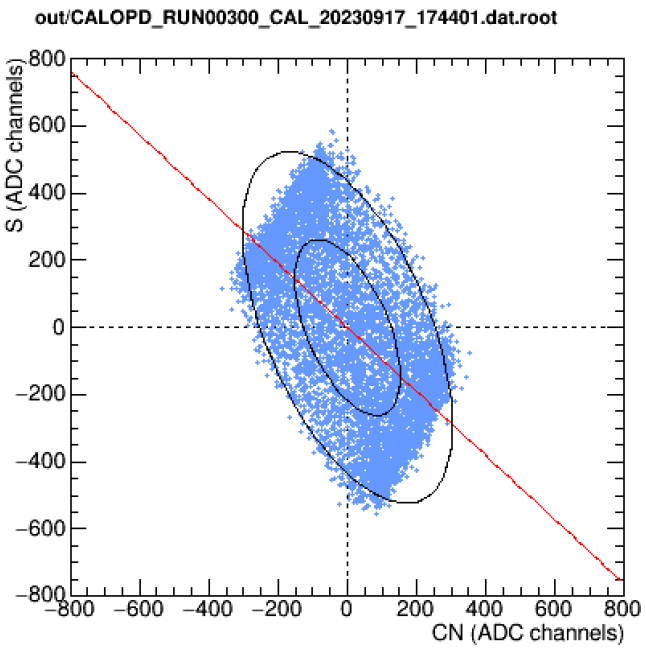
RMS(y) 29.1658

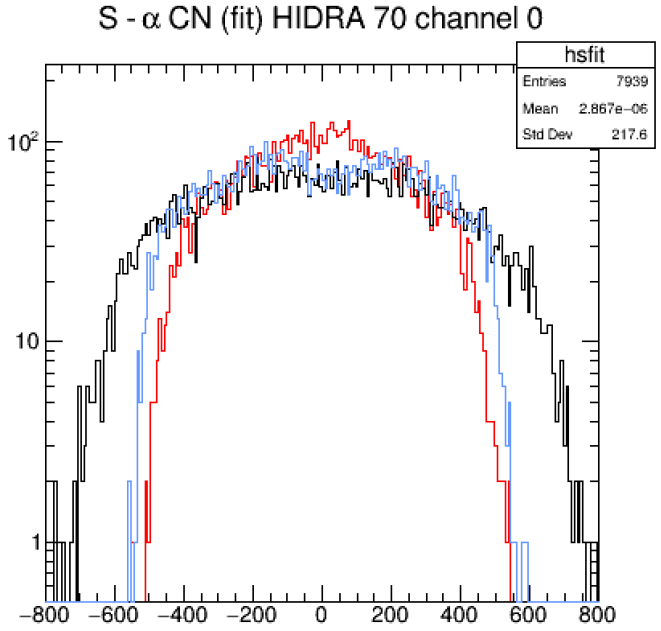
RMS(y - alpha*x) fit 24.3918

RMS(y - alpha*x) matrix 31.7453

mean(y - alpha*x) fit 4.43202e-07

mean(y - alpha*x) matrix 5.87623e-07





alpha (fit) -0.955149

eigenvalue 0 77335.7 sqrt 278.093

eigenvalue 1 14121.9 sqrt 118.836

R00 cos(theta) -0.376109 R01 -sin(theta) -0.926575

R10 sin(theta) 0.926575 R11 cos(theta) -0.376109

tg(theta) -2.46358

alpha (matrix) -2.46358

sigma(y) 261.522

sigma(y - alpha*x) 315.961

RMS(y) 261.522

RMS(y - alpha*x) fit 217.605

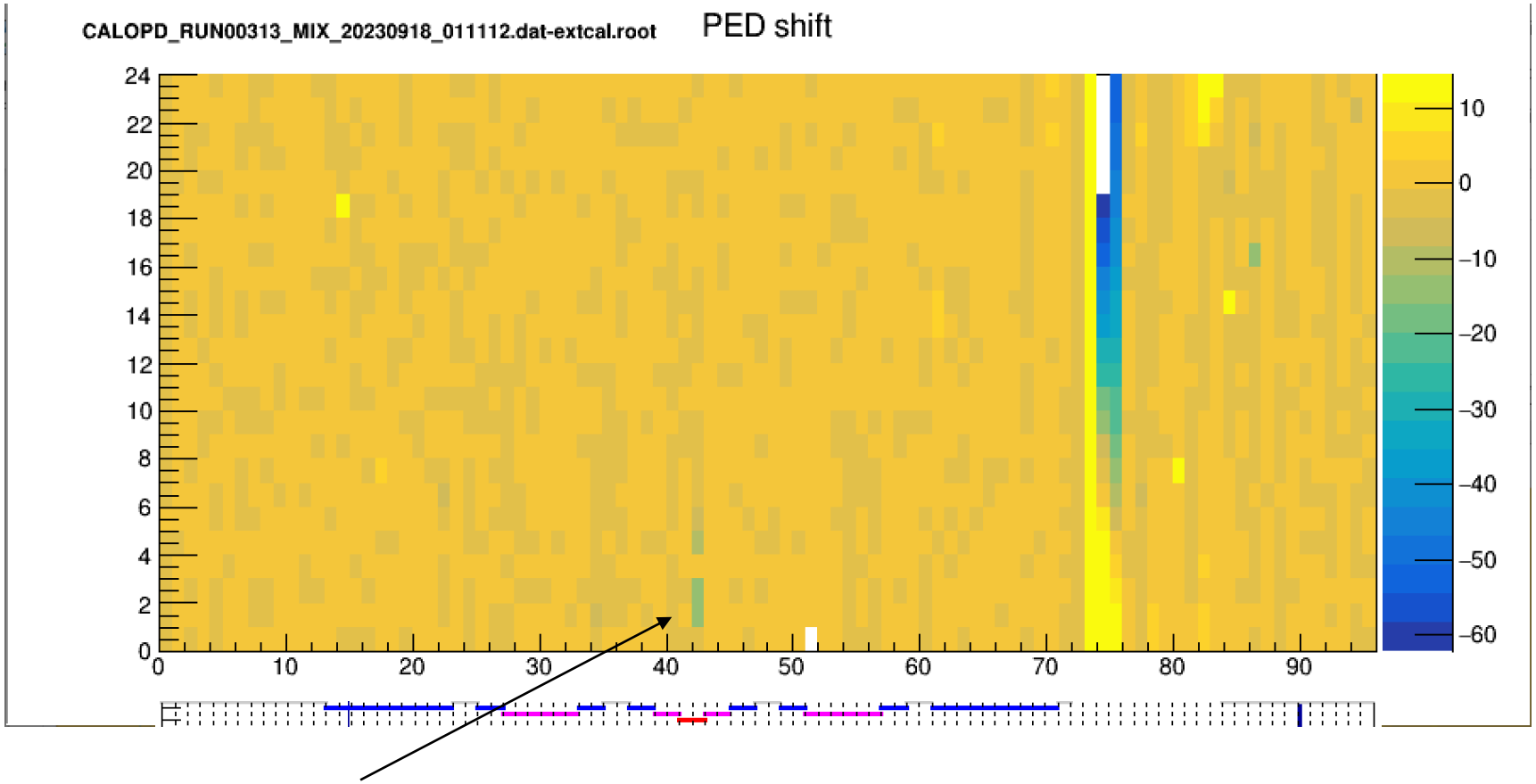
RMS(y - alpha*x) matrix 315.961

mean(y - alpha*x) fit 2.86748e-06

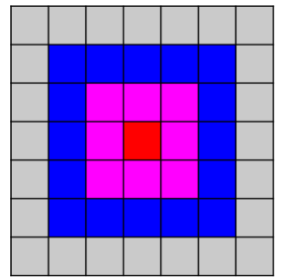
mean(y - alpha*x) matrix 5.11895e-06

Pedestal shift

20 GeV



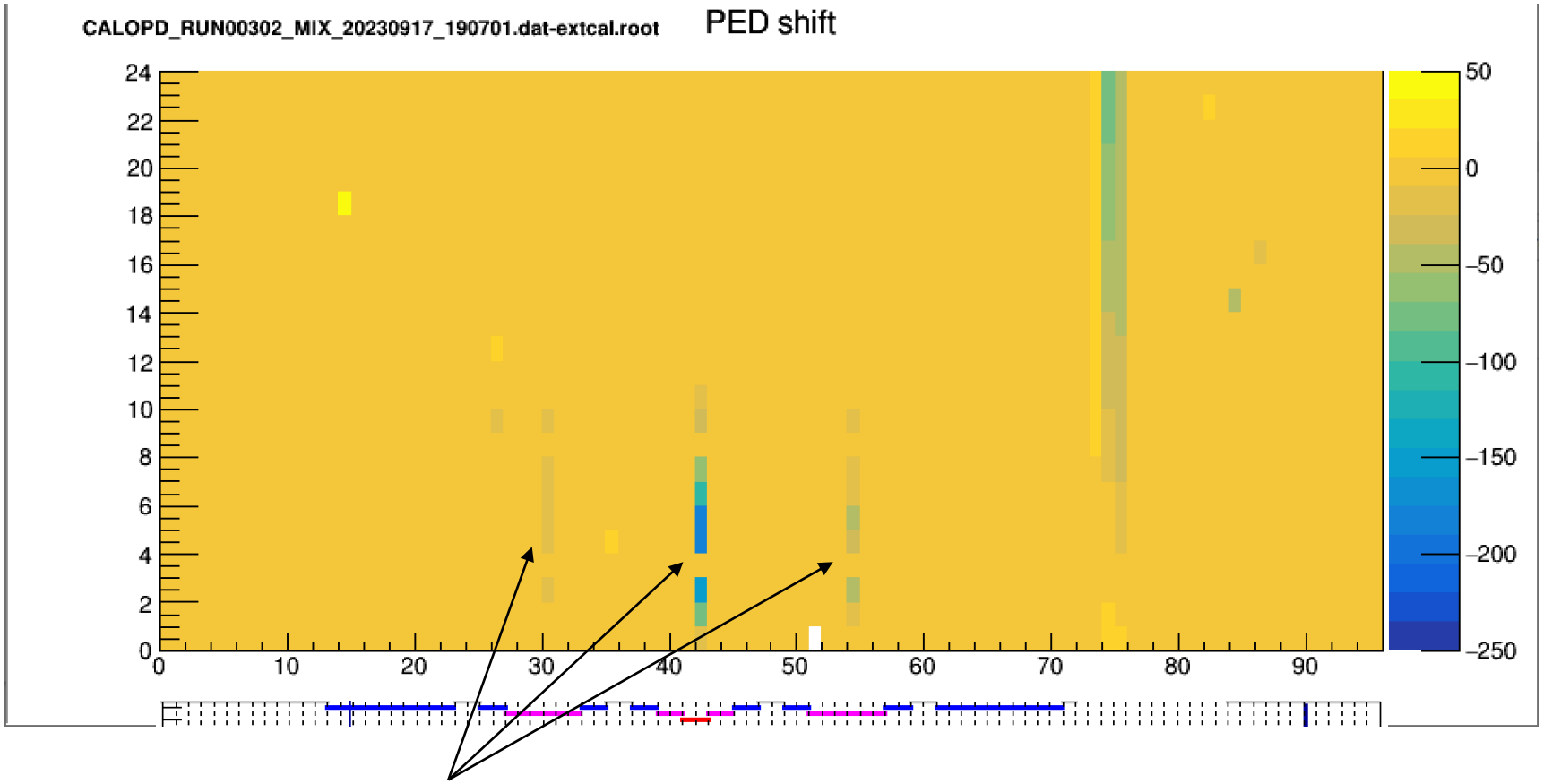
RMS(ADC-PED)



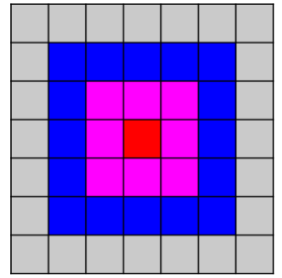
L’effetto e` modesto e limitato alla colonna centrale

Pedestal shift

243 GeV

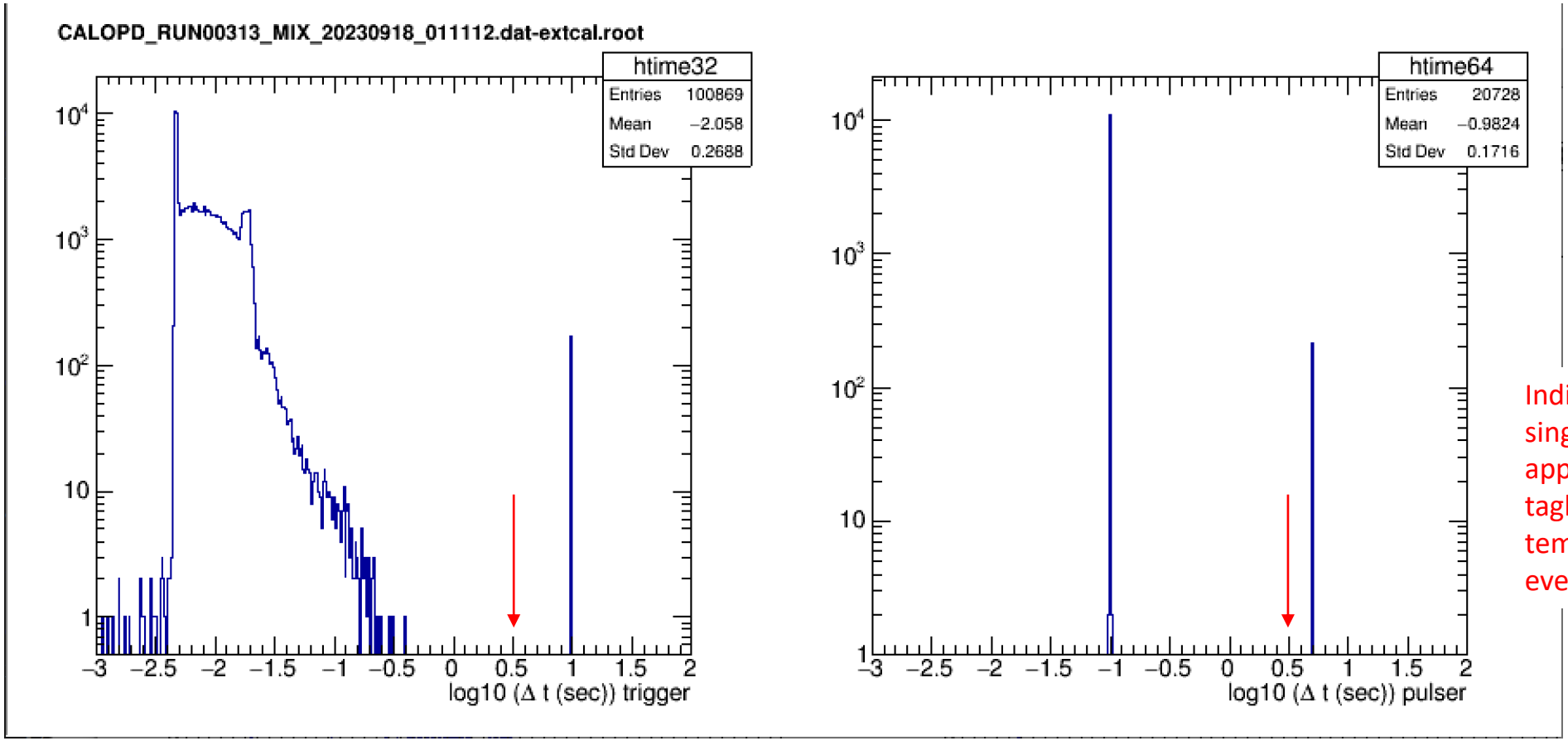


RMS(ADC-PED)



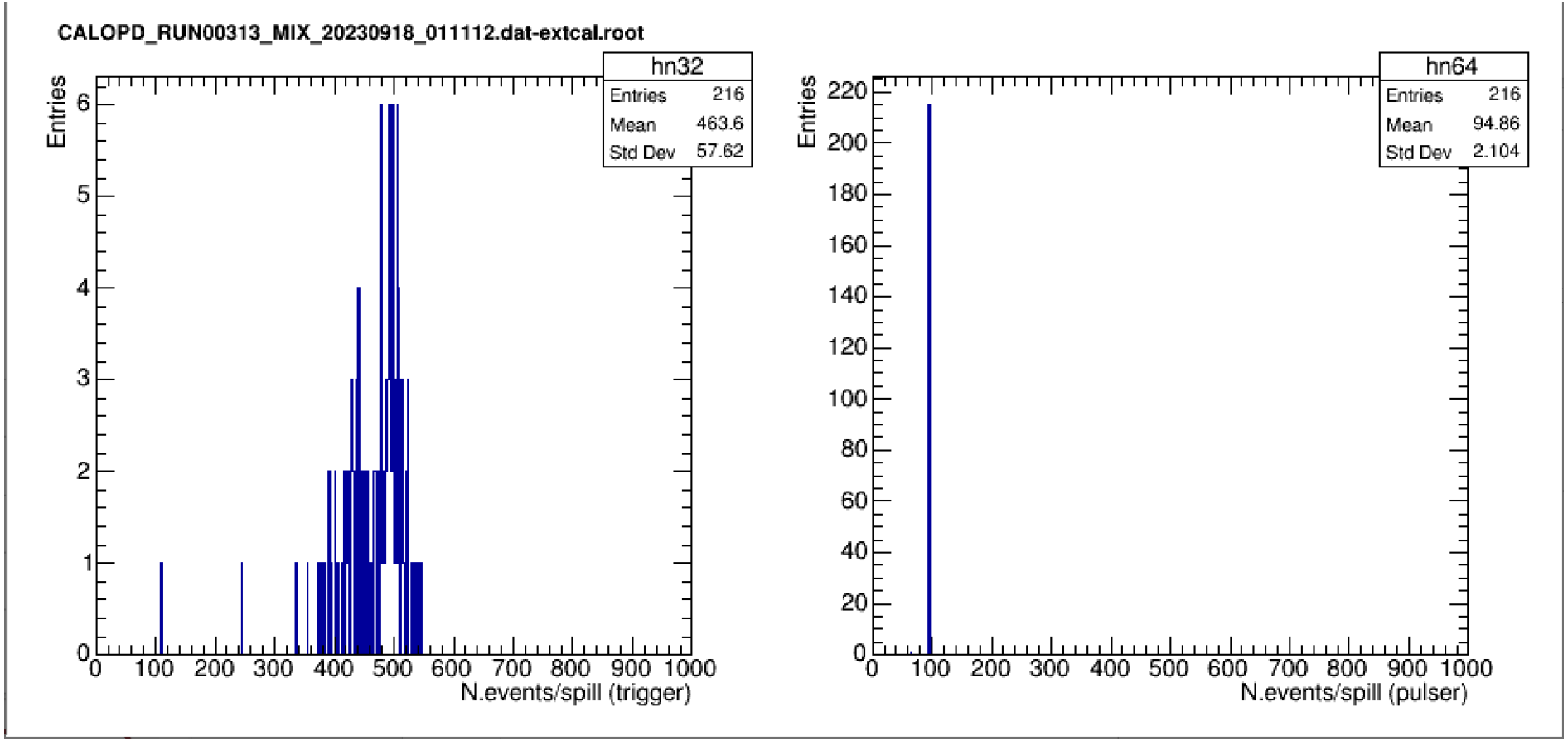
L’effetto e` piu` marcato e visible anche per le colonne laterali

20 GeV

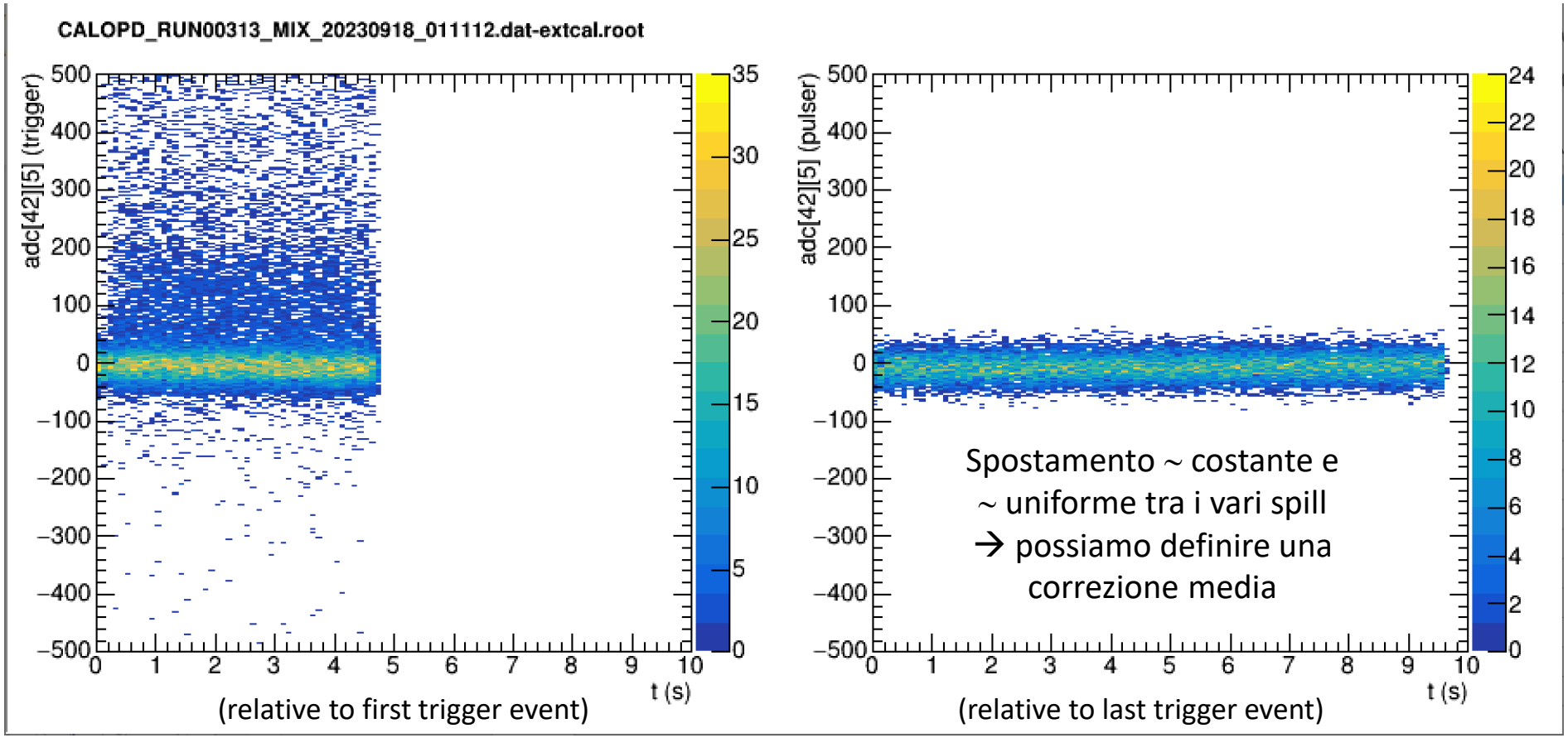


Individuati i singoli spill applicando un taglio alla distanza temporale tra gli eventi

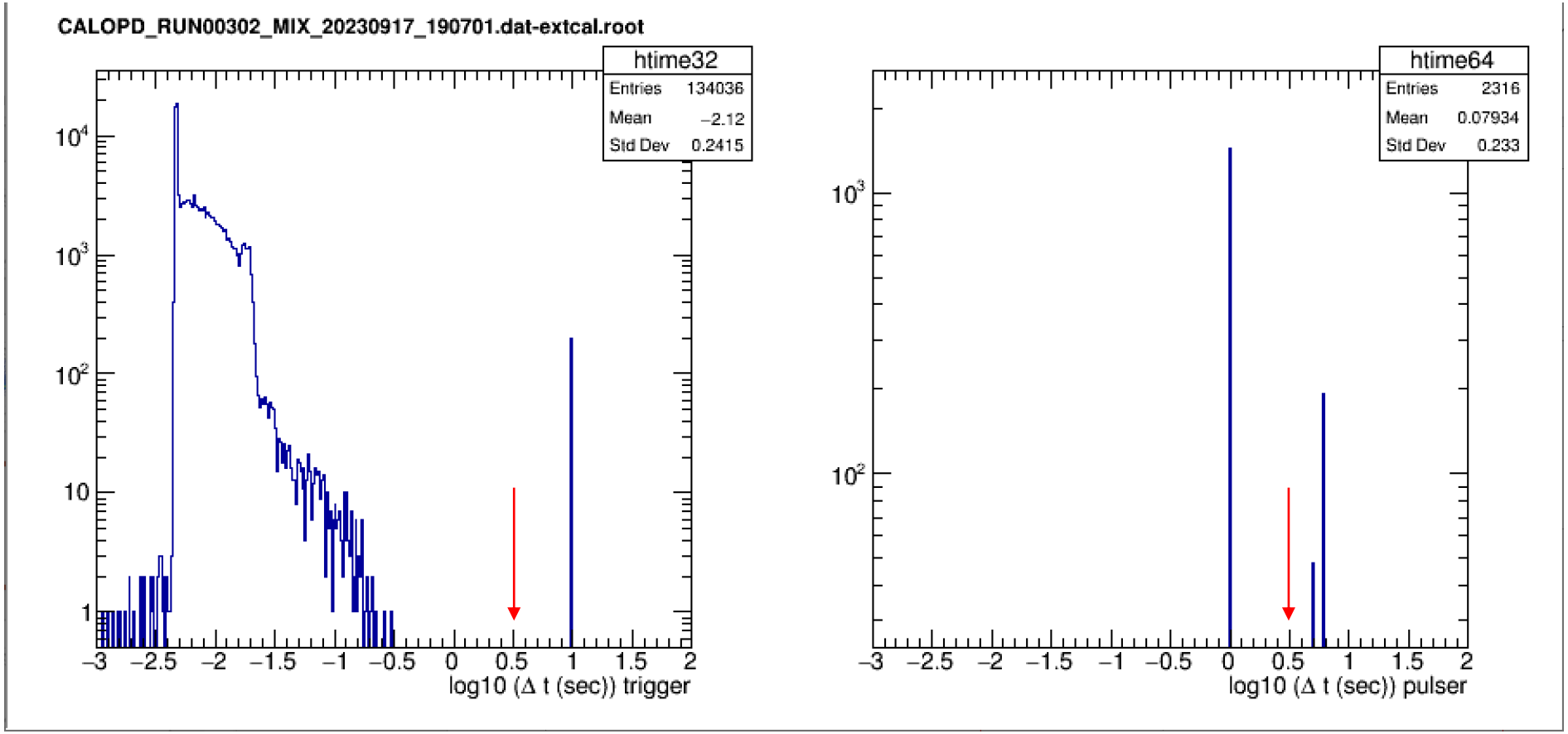
20 GeV


CALOPD_RUN00313_MIX_20230918_011112.dat-extcal.root
hn32
Entries 216
Mean 463.6
Std Dev 57.62
Entries
N.events/spill (trigger)
hn64
Entries 216
Mean 94.86
Std Dev 2.104
Entries
N.events/spill (pulser)

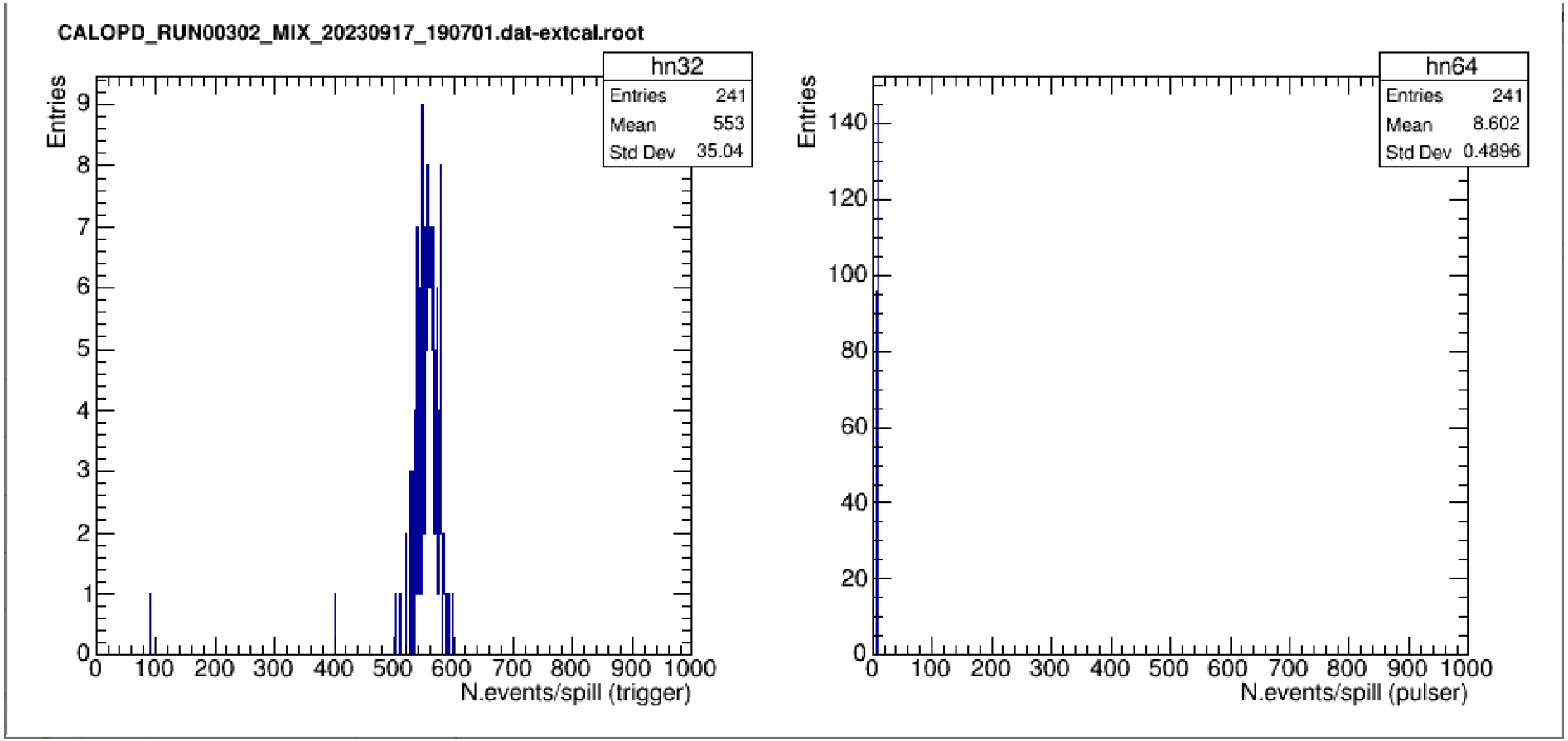
20 GeV


CALOPD_RUN00313_MIX_20230918_011112.dat-extcal.root
adc[42][5] (trigger)
t (s)
(relative to first trigger event)
adc[42][5] (pulser)
t (s)
(relative to last trigger event)
Spostamento ~ costante e
~ uniforme tra i vari spill
→ possiamo definire una
correzione media

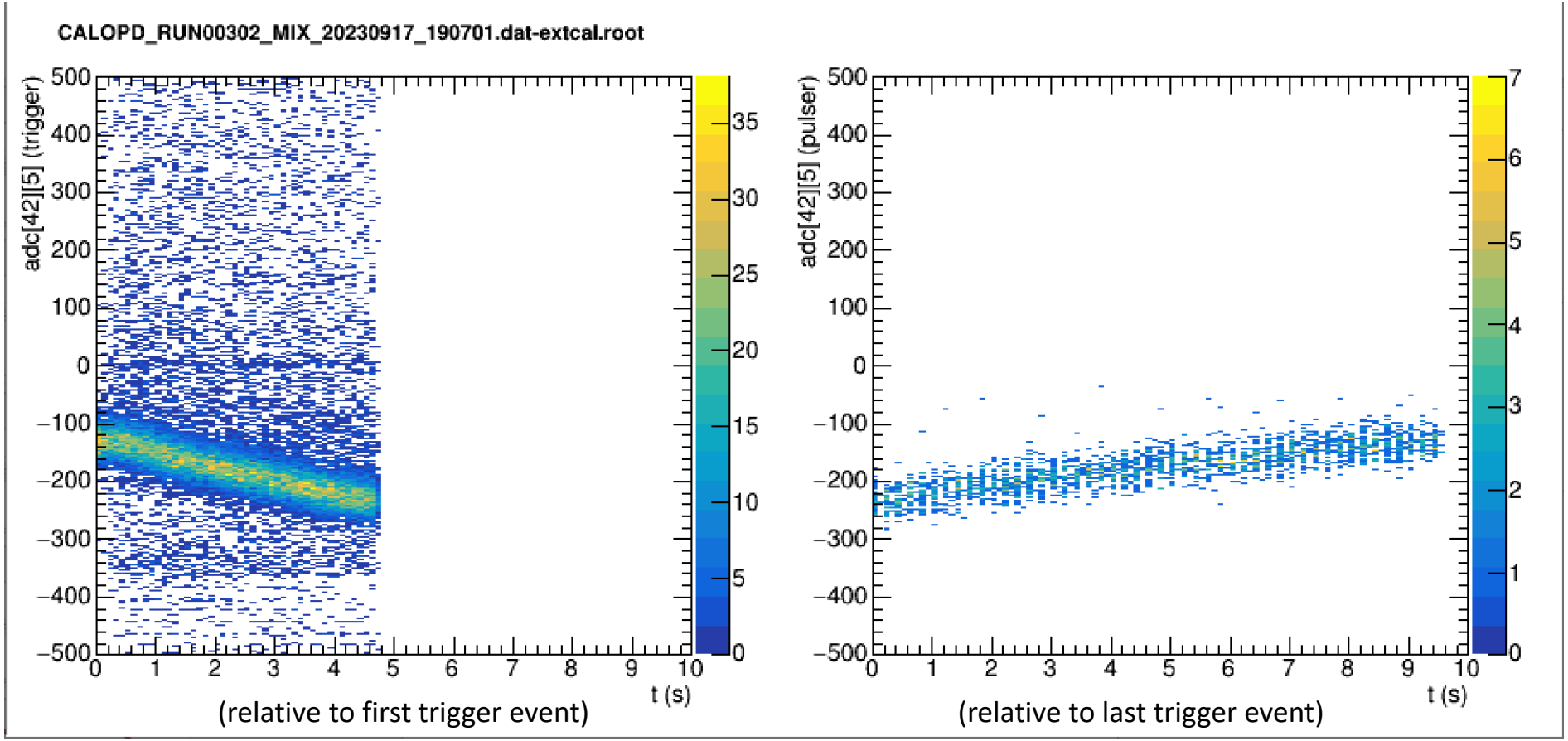
243 GeV


CALOPD_RUN00302_MIX_20230917_190701.dat-extcal.root
htime32
Entries 134036
Mean −2.12
Std Dev 0.2415
log10 (Δ t (sec)) trigger
htime64
Entries 2316
Mean 0.07934
Std Dev 0.233
log10 (Δ t (sec)) pulser

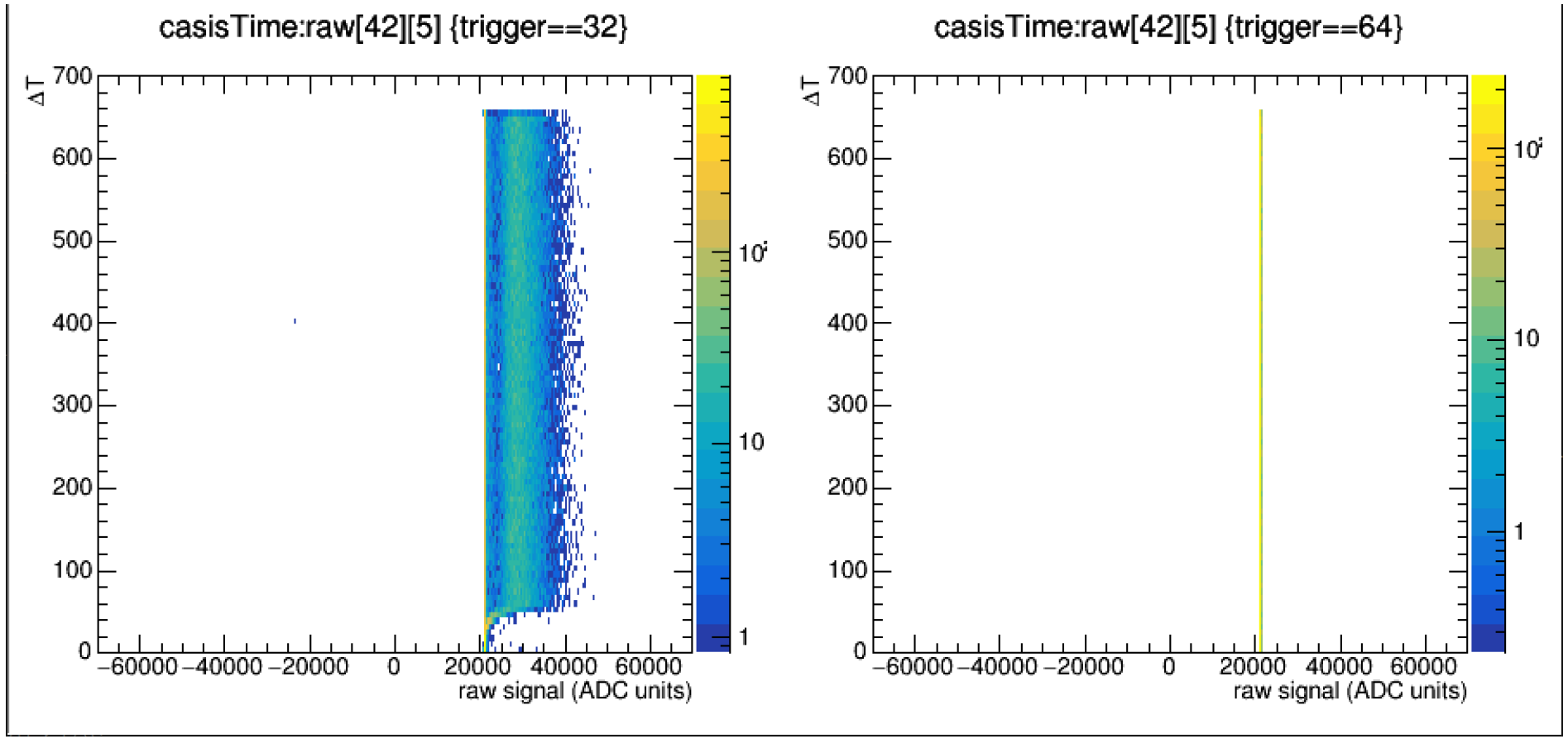
243 GeV


CALOPD_RUN00302_MIX_20230917_190701.dat-extcal.root
hn32
Entries 241
Mean 553
Std Dev 35.04
Entries
N.events/spill (trigger)
hn64
Entries 241
Mean 8.602
Std Dev 0.4896
Entries
N.events/spill (pulser)

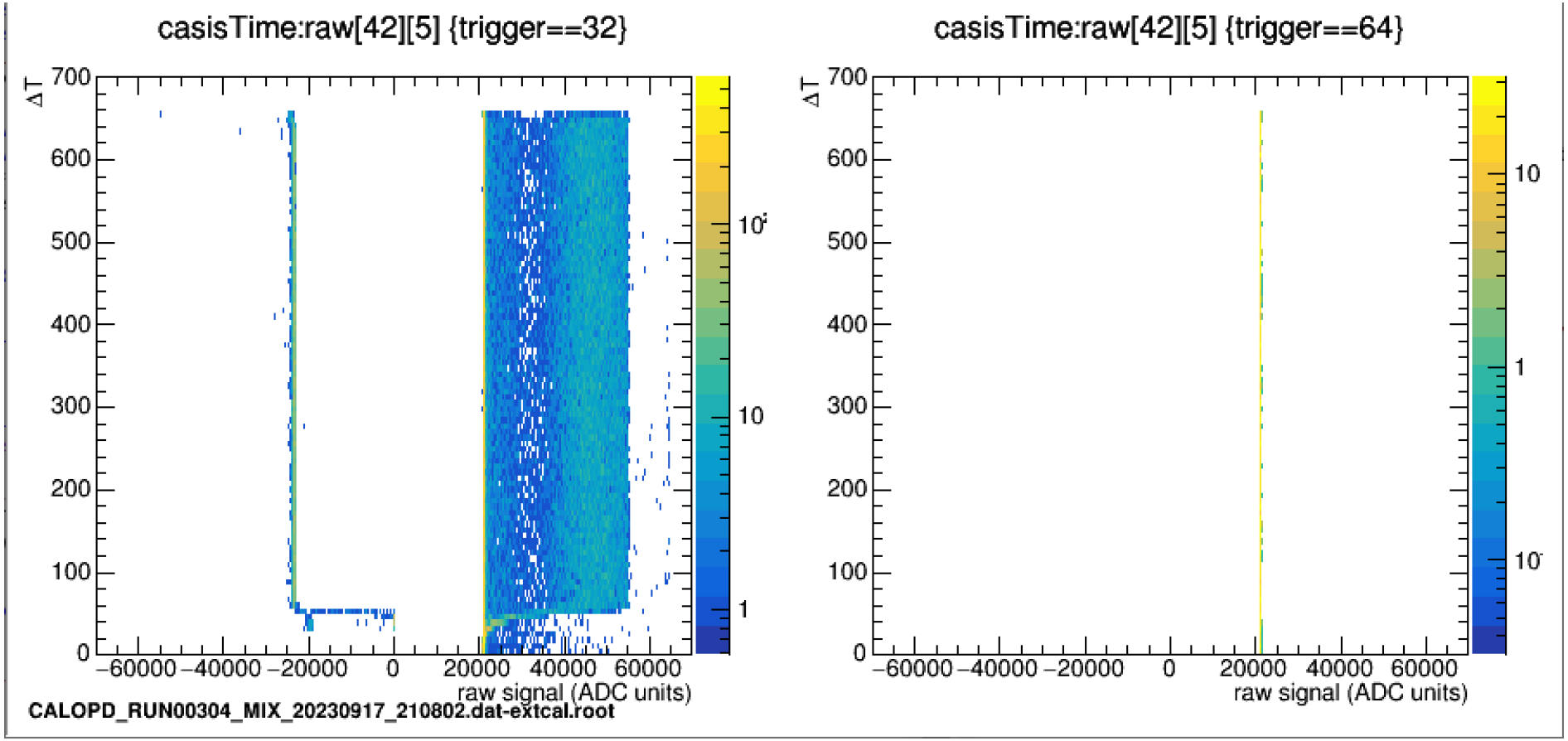
243 GeV


CALOPD_RUN00302_MIX_20230917_190701.dat-extcal.root
adc[42][5] (trigger)
t (s)
(relative to first trigger event)
adc[42][5] (pulser)
t (s)
(relative to last trigger event)

20 GeV


casisTime:raw[42][5] {trigger==32}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10²
10
1
casisTime:raw[42][5] {trigger==64}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10²
10
1

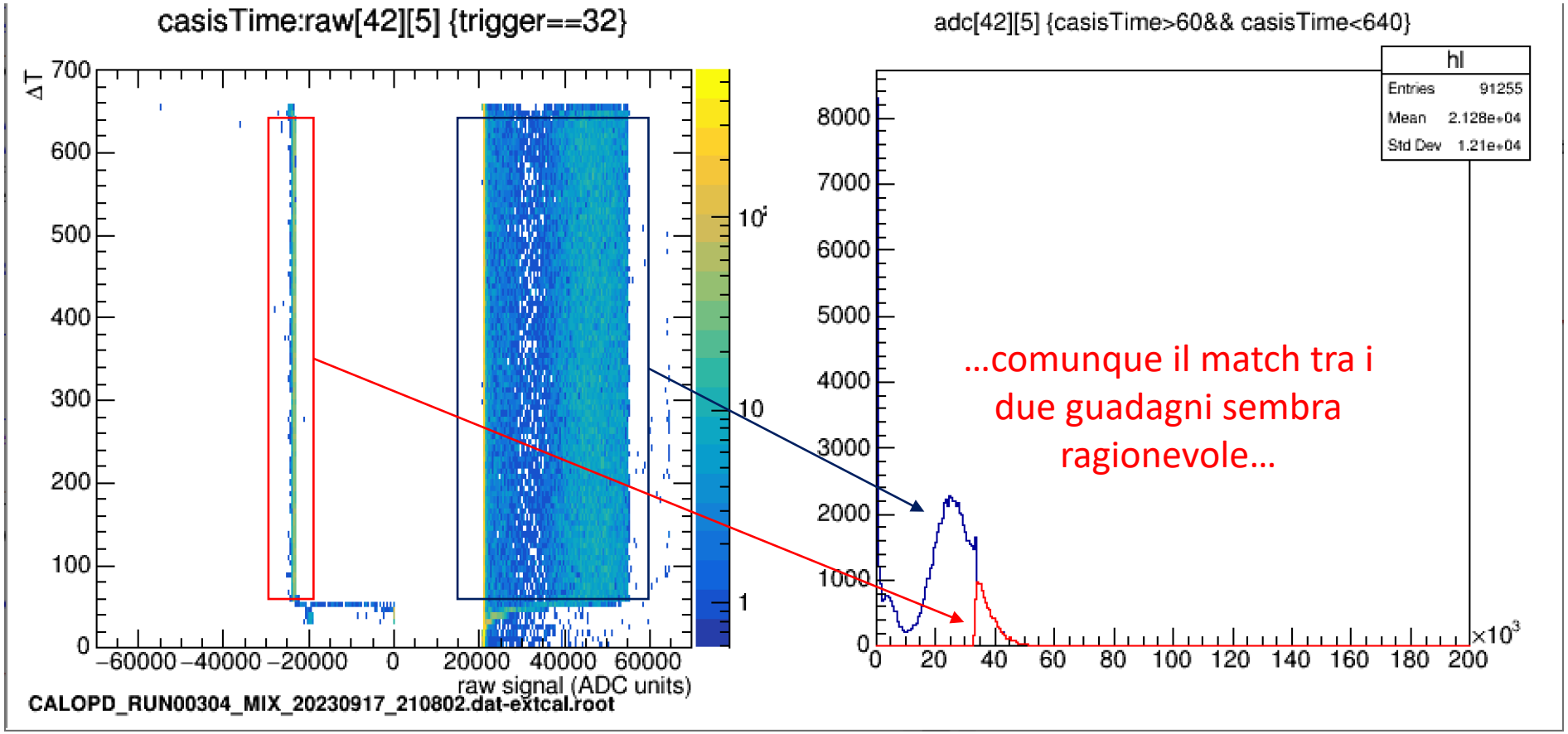
50 GeV


casisTime:raw[42][5] {trigger==32}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10²
10
1
CALOPD_RUN00304_MIX_20230917_210802.dat-extcal.root
casisTime:raw[42][5] {trigger==64}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10
1
10⁻¹

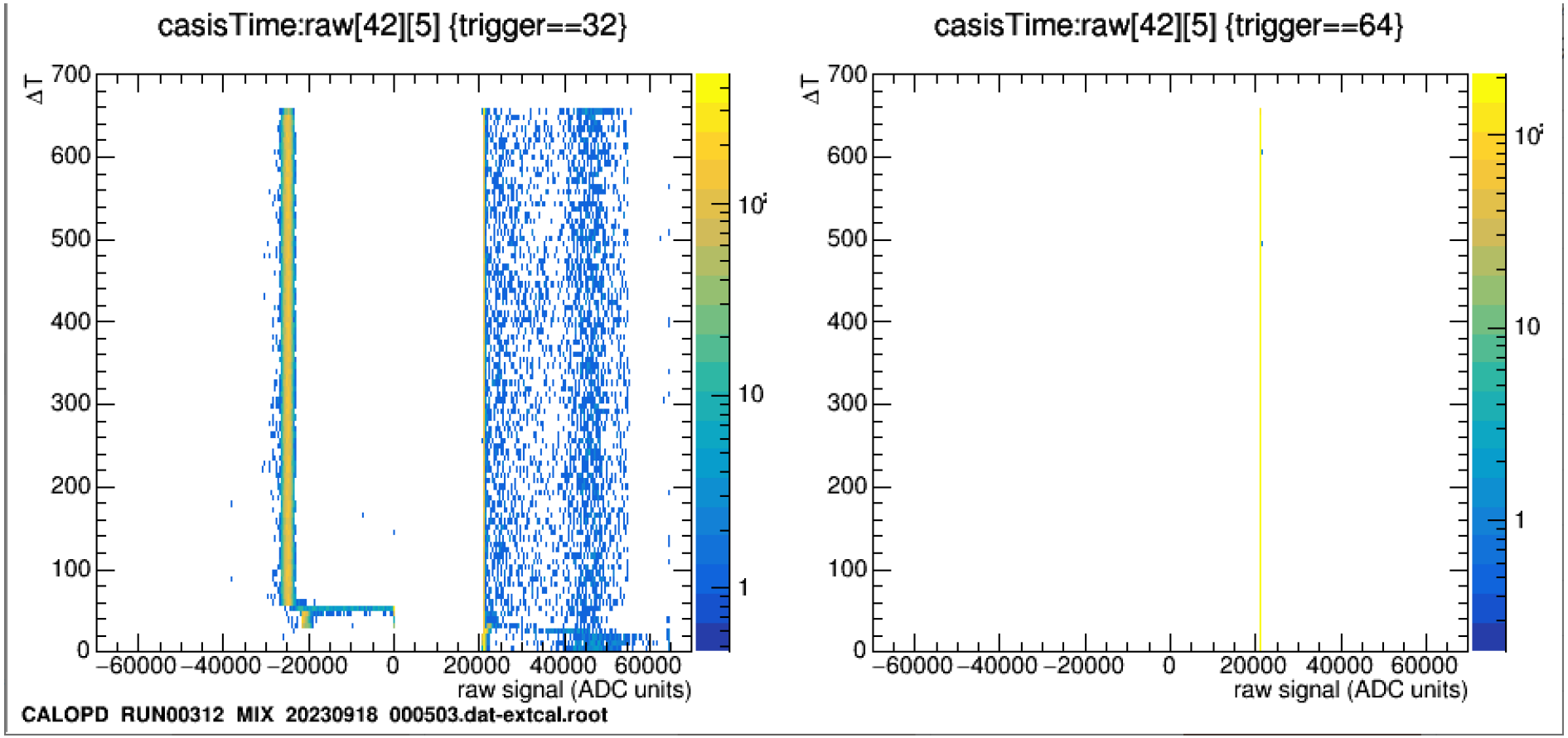
```
const float GAINFACTOR = 20.0488; // ratio between 2 gains
const float GAINJUMP = 1300; // jumps between 2 gains

// --------------------
// guadagno dinamico
// --------------------
signal[iHydra][iHydraChannel] = buf - (float)param->ped[iHydra][iHydraChannel];
if (gain[iHydra][iHydraChannel] == 0)
  signal[iHydra][iHydraChannel] -= (float)cn;
if (gain[iHydra][iHydraChannel] == 1)
  signal[iHydra][iHydraChannel] *= GAINFACTOR; // 20.;
if (gain[iHydra][iHydraChannel] == 1)
  signal[iHydra][iHydraChannel] -= GAINJUMP; // 2000.;
```

Mi sembra dal codice che il CN non venga sottratto in basso Guadagno… perche`?

50 GeV



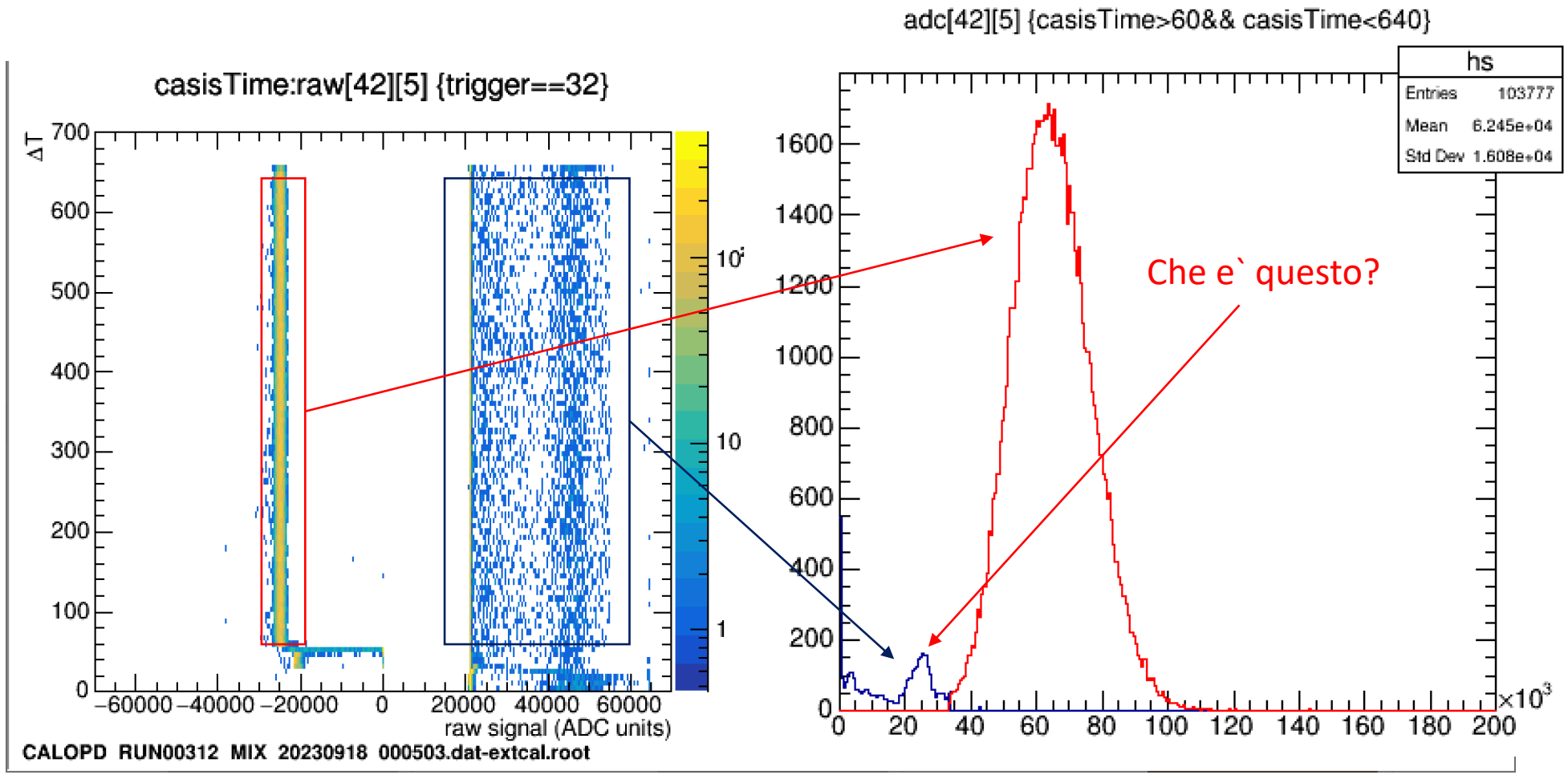
100 GeV


casisTime:raw[42][5] {trigger==32}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10²
10
1
CALOPD RUN00312 MIX 20230918 000503.dat-extcal.root
casisTime:raw[42][5] {trigger==64}
ΔT
700
600
500
400
300
200
100
0
−60000 −40000 −20000 0 20000 40000 60000
raw signal (ADC units)
10²
10
1

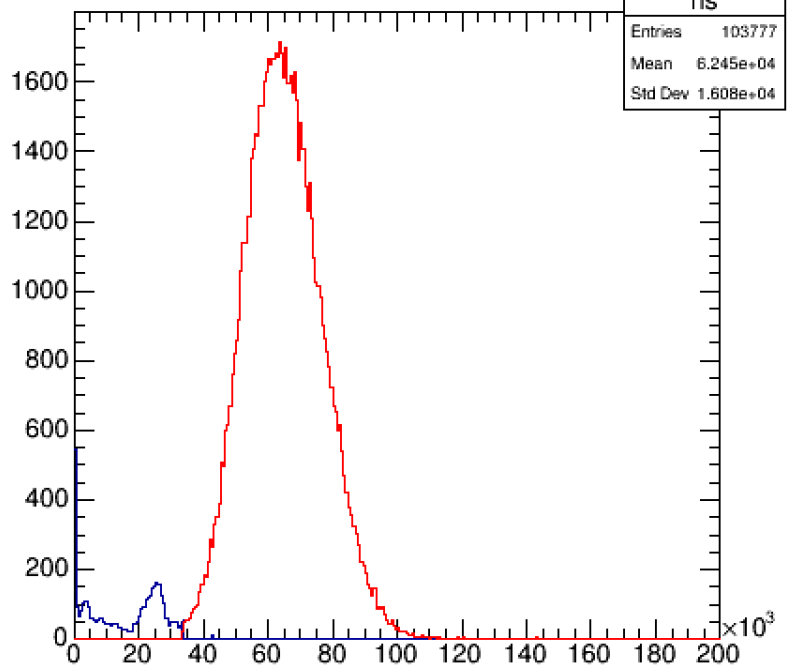
```
const float GAINFACTOR = 20.0488; // ratio between 2 gains
const float GAINJUMP = 1300; // jumps between 2 gains

// --------------------
// guadagno dinamico
// --------------------
signal[iHydra][iHydraChannel] = buf - (float)param->ped[iHydra][iHydraChannel];
if (gain[iHydra][iHydraChannel] == 0)
  signal[iHydra][iHydraChannel] -= (float)cn;
if (gain[iHydra][iHydraChannel] == 1)
  signal[iHydra][iHydraChannel] *= GAINFACTOR; // 20.;
if (gain[iHydra][iHydraChannel] == 1)
  signal[iHydra][iHydraChannel] -= GAINJUMP; // 2000.;
```

Mi sembra che il CN non venga sottratto in basso Guadagno… perche`?

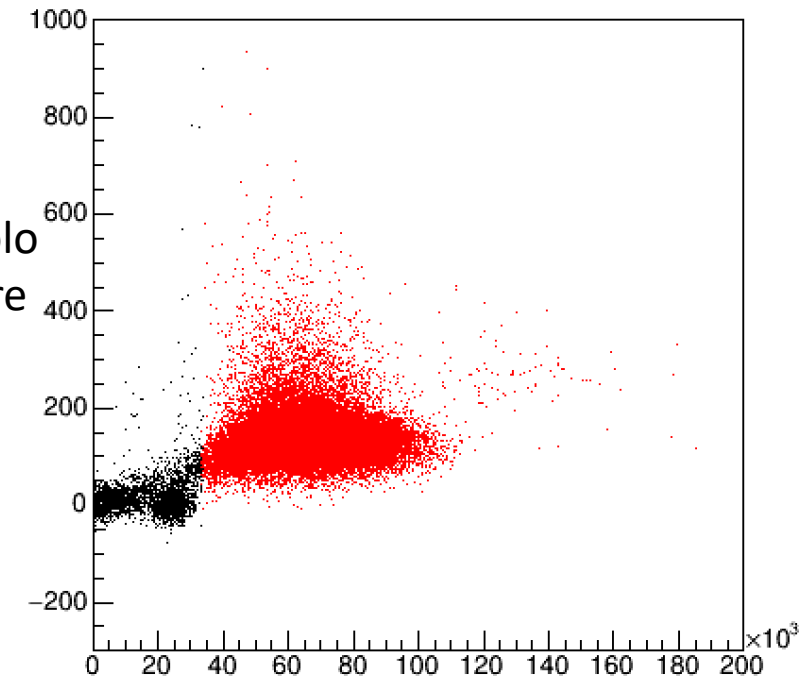
100 GeV

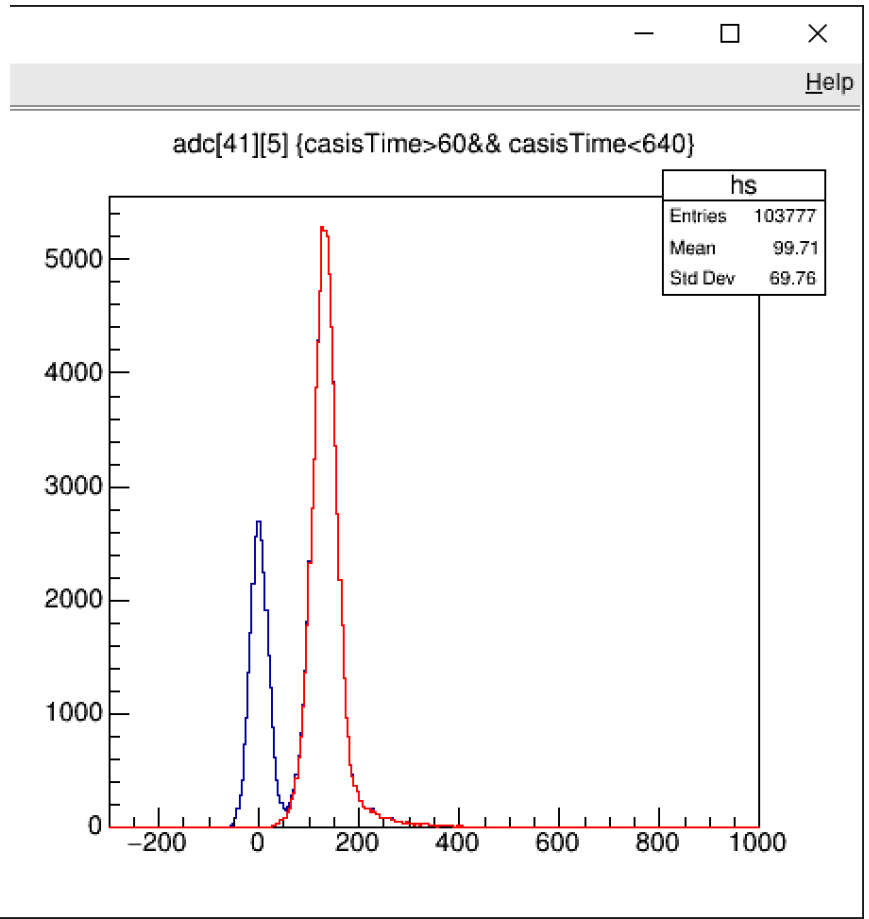


100 GeV

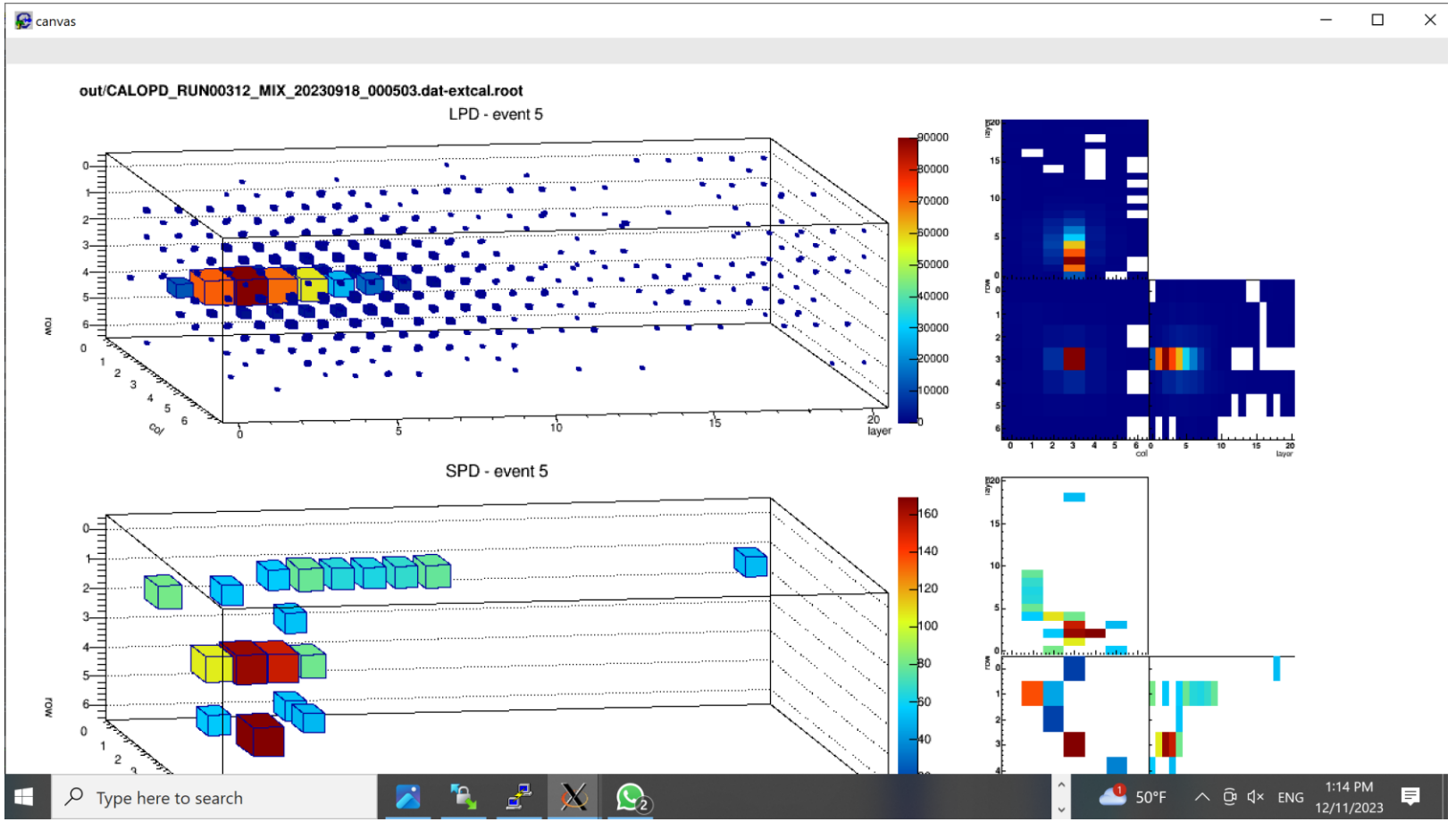


Il blob e` compatibile con solo rumore nel sensore piccolo





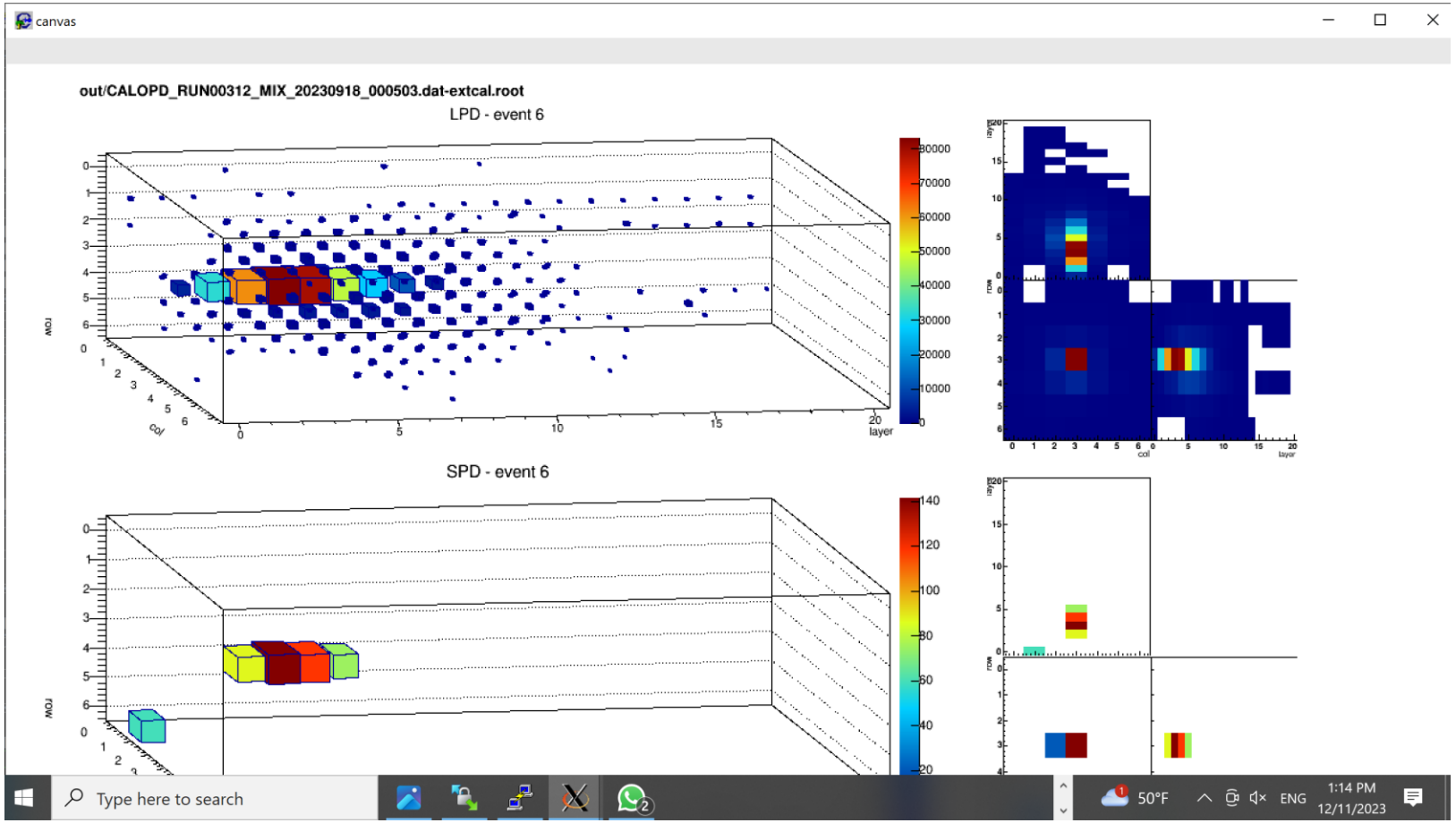
Evento buono



100 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])>300000")

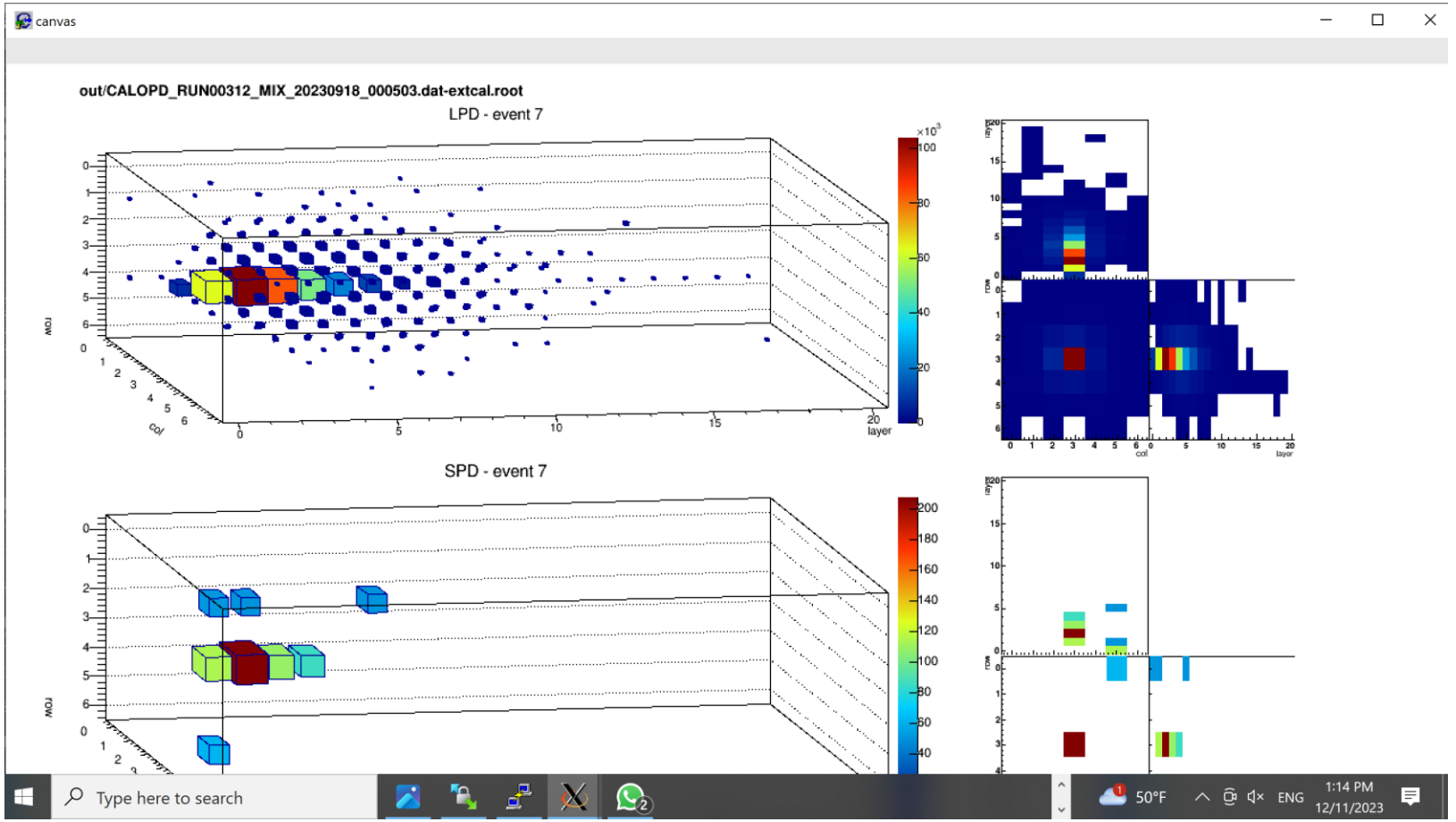
Evento buono



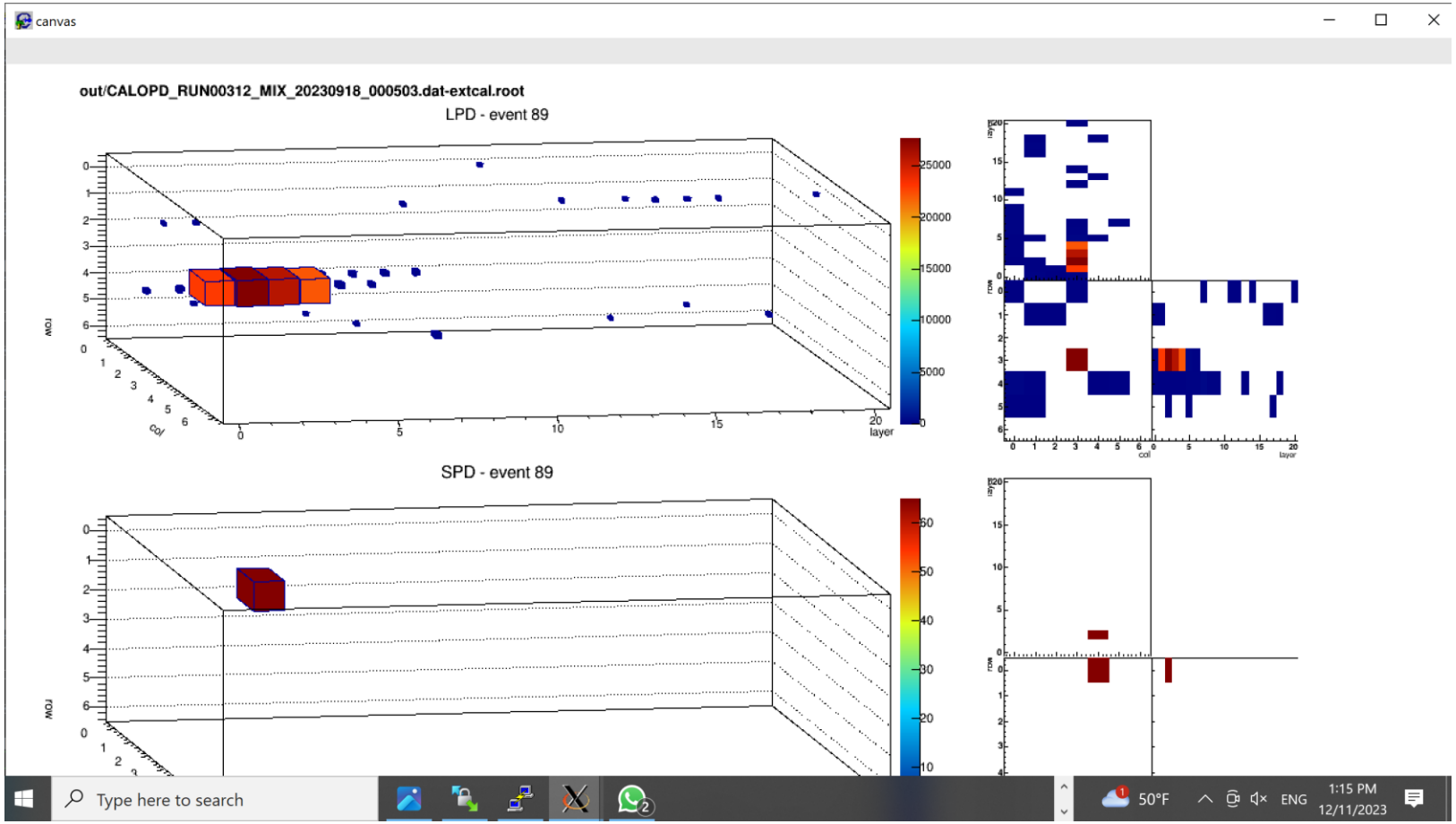
100 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])>300000")

Evento buono



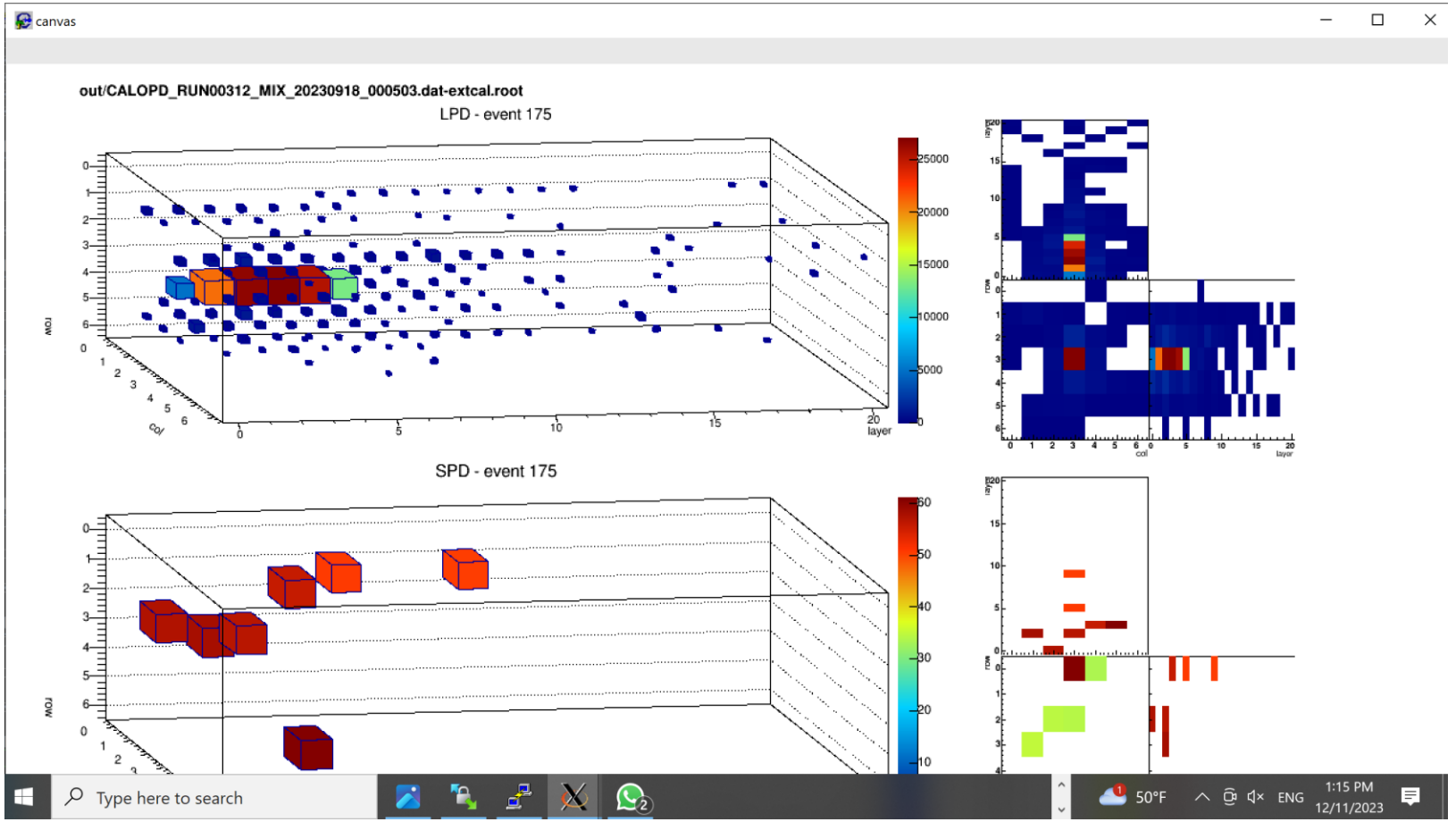
Evento cattivo



100 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<140000&&adc[42][5]>20000")

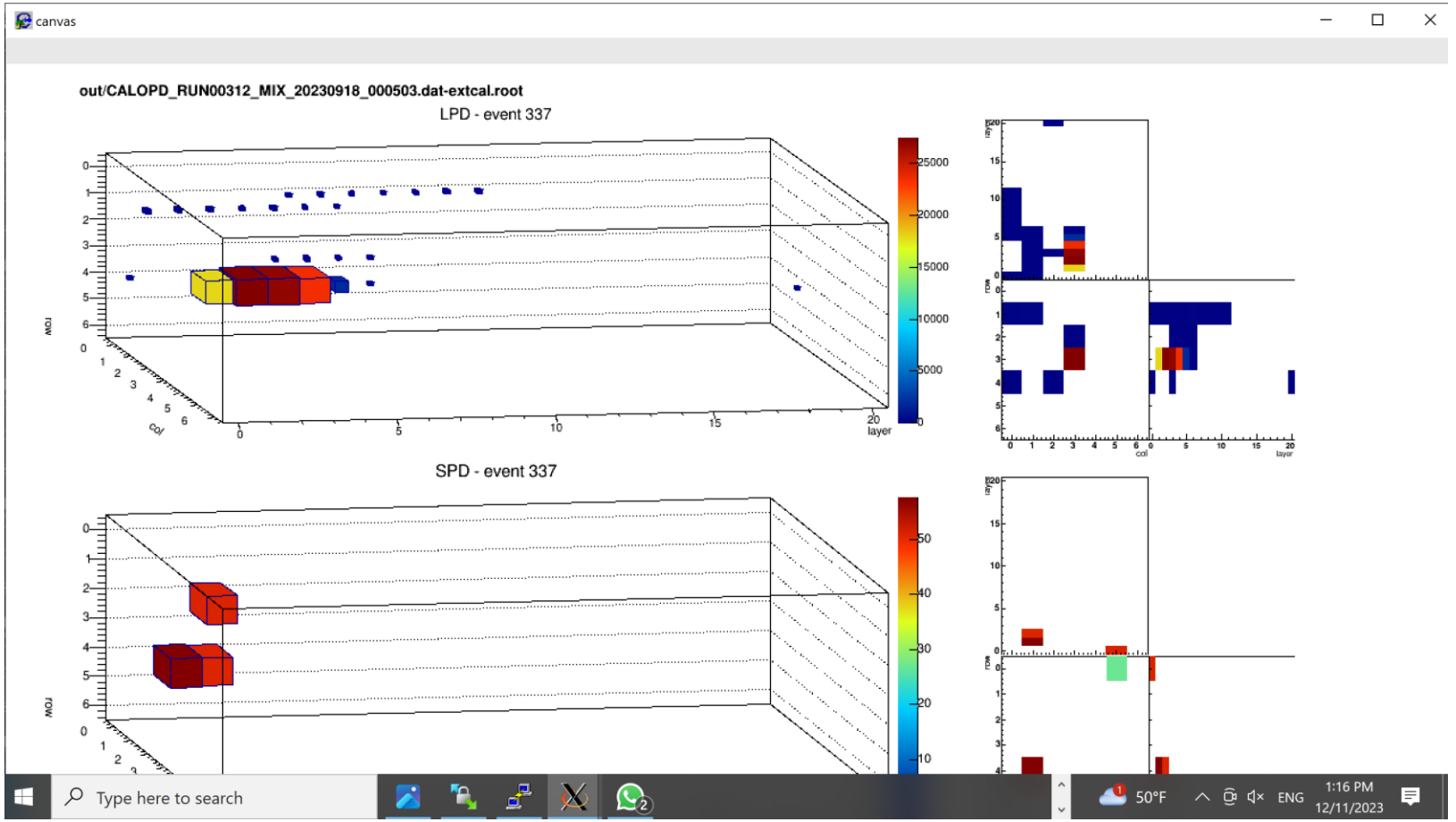
Evento cattivo



100 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<140000&&adc[42][5]>20000")

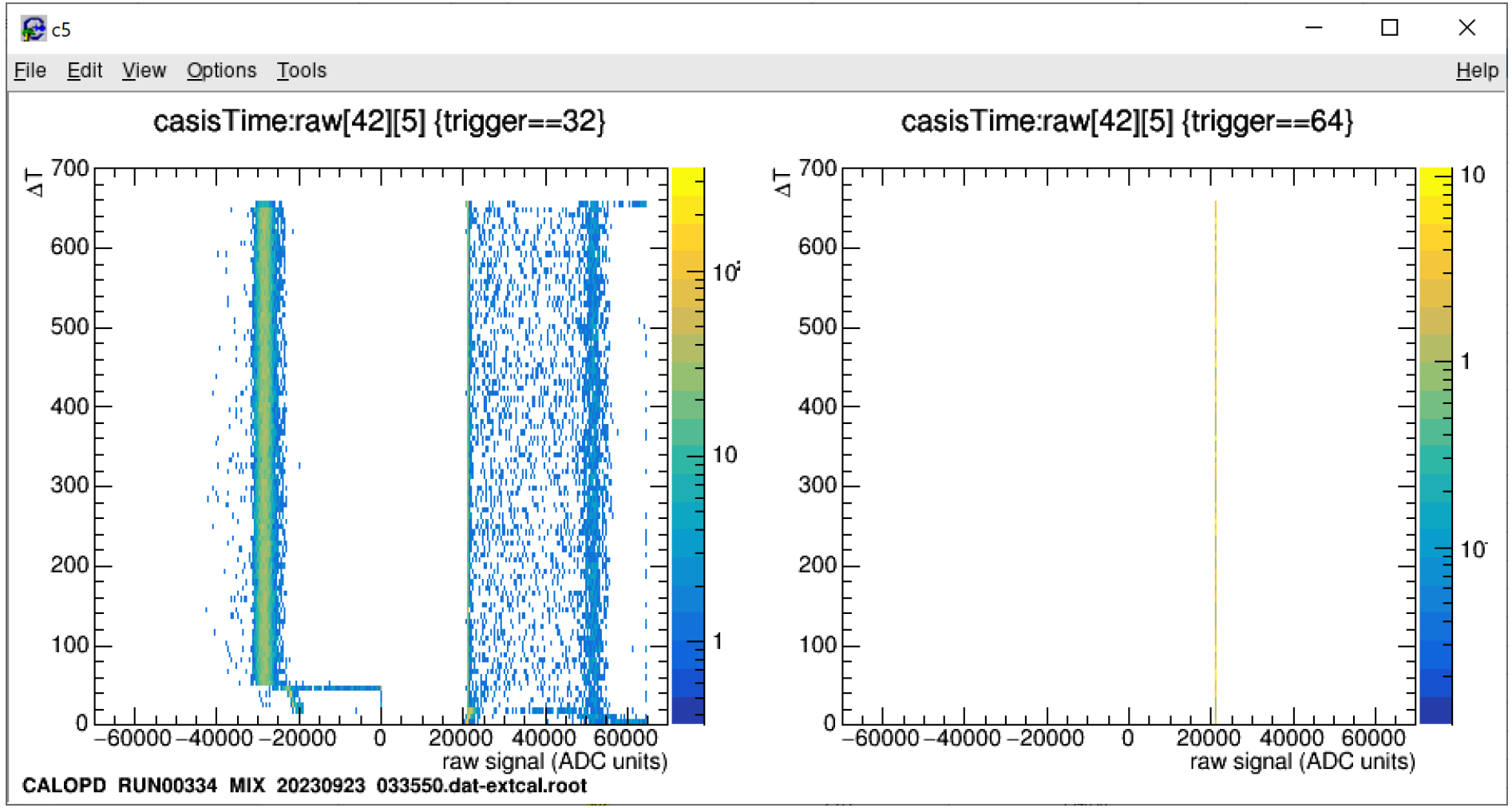
Evento cattivo



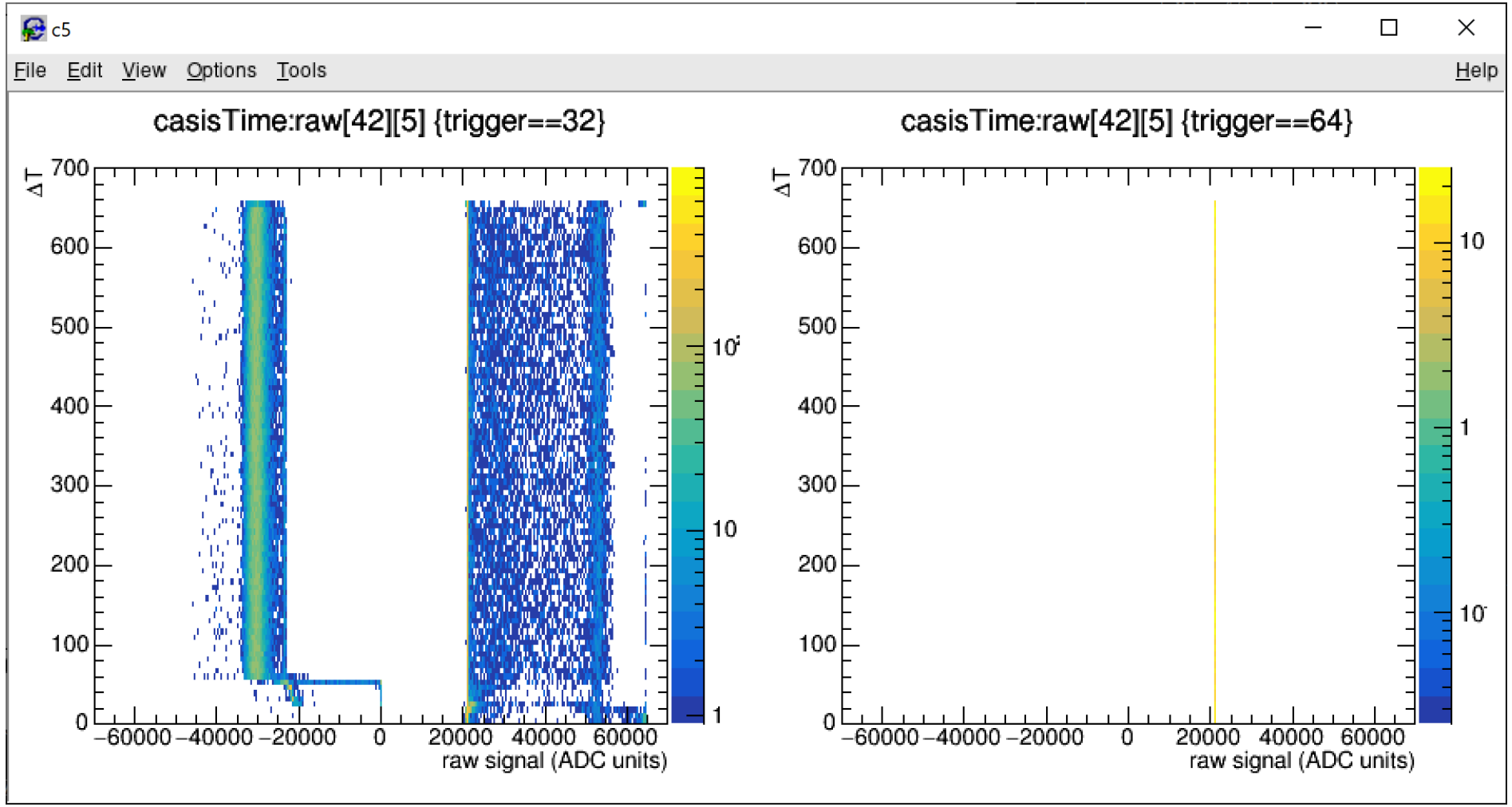
100 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<140000&&adc[42][5]>20000")

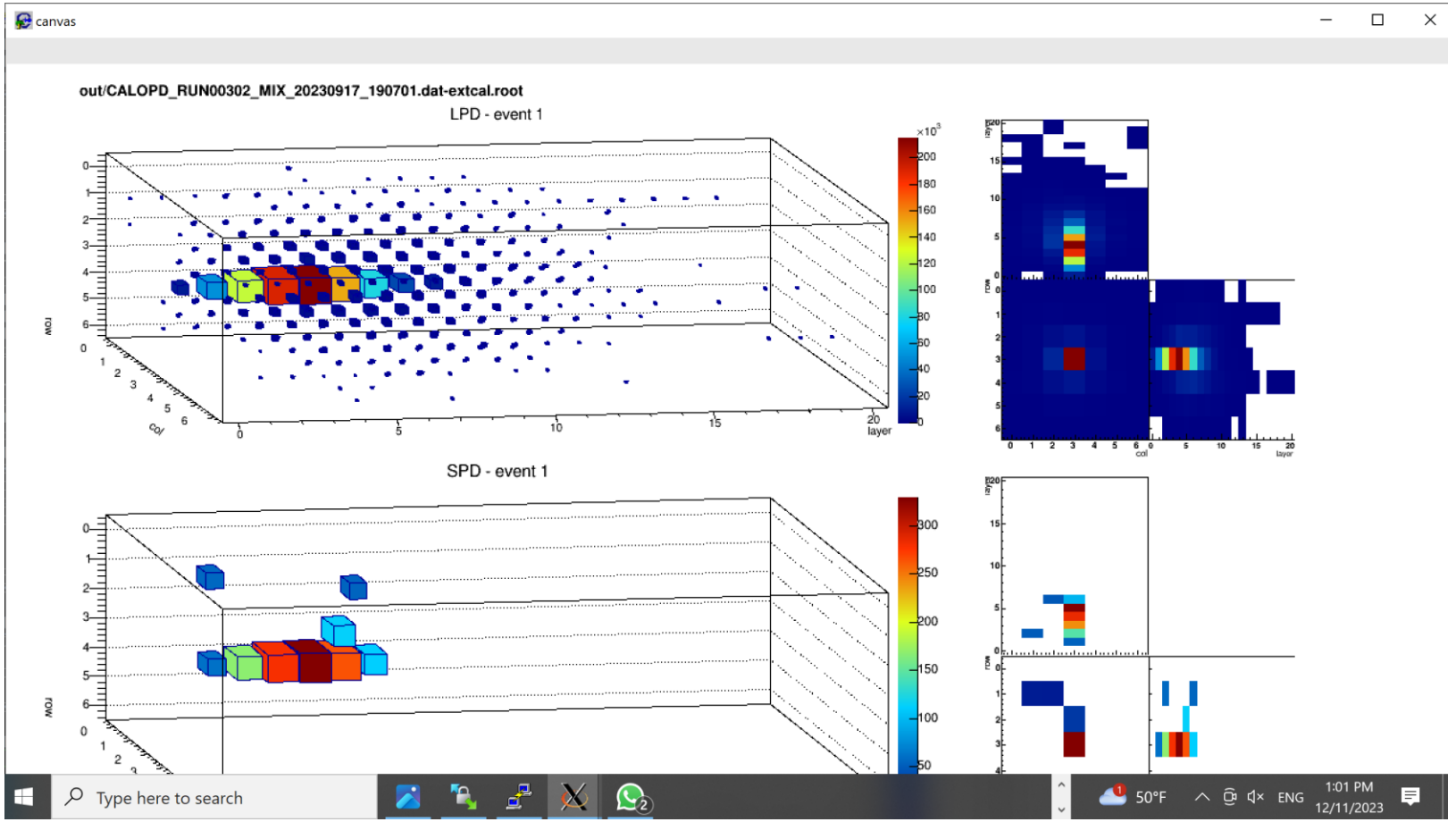
200 GeV


c5
File Edit View Options Tools Help
casisTime:raw[42][5] {trigger==32}
casisTime:raw[42][5] {trigger==64}
ΔT
raw signal (ADC units)
CALOPD RUN00334 MIX 20230923 033550.dat-extcal.root

243 GeV


c5
File Edit View Options Tools Help
casisTime:raw[42][5] {trigger==32}
casisTime:raw[42][5] {trigger==64}
ΔT
raw signal (ADC units)
0 100 200 300 400 500 600 700
−60000 −40000 −20000 0 20000 40000 60000
1 10 10²

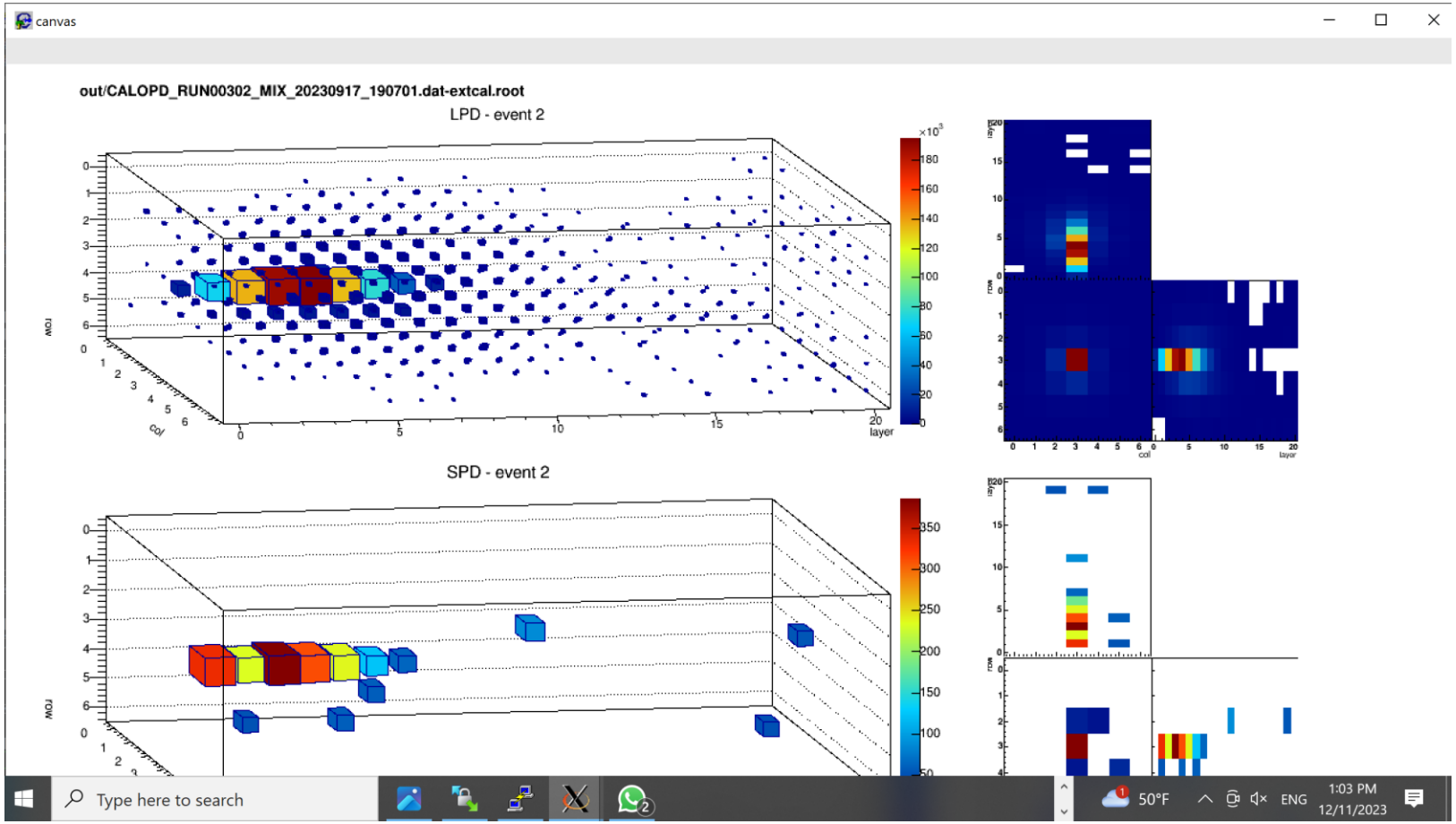
Evento buono



243 GeV

PDtree->Scan("Entry$","adc[42][5]>120000")

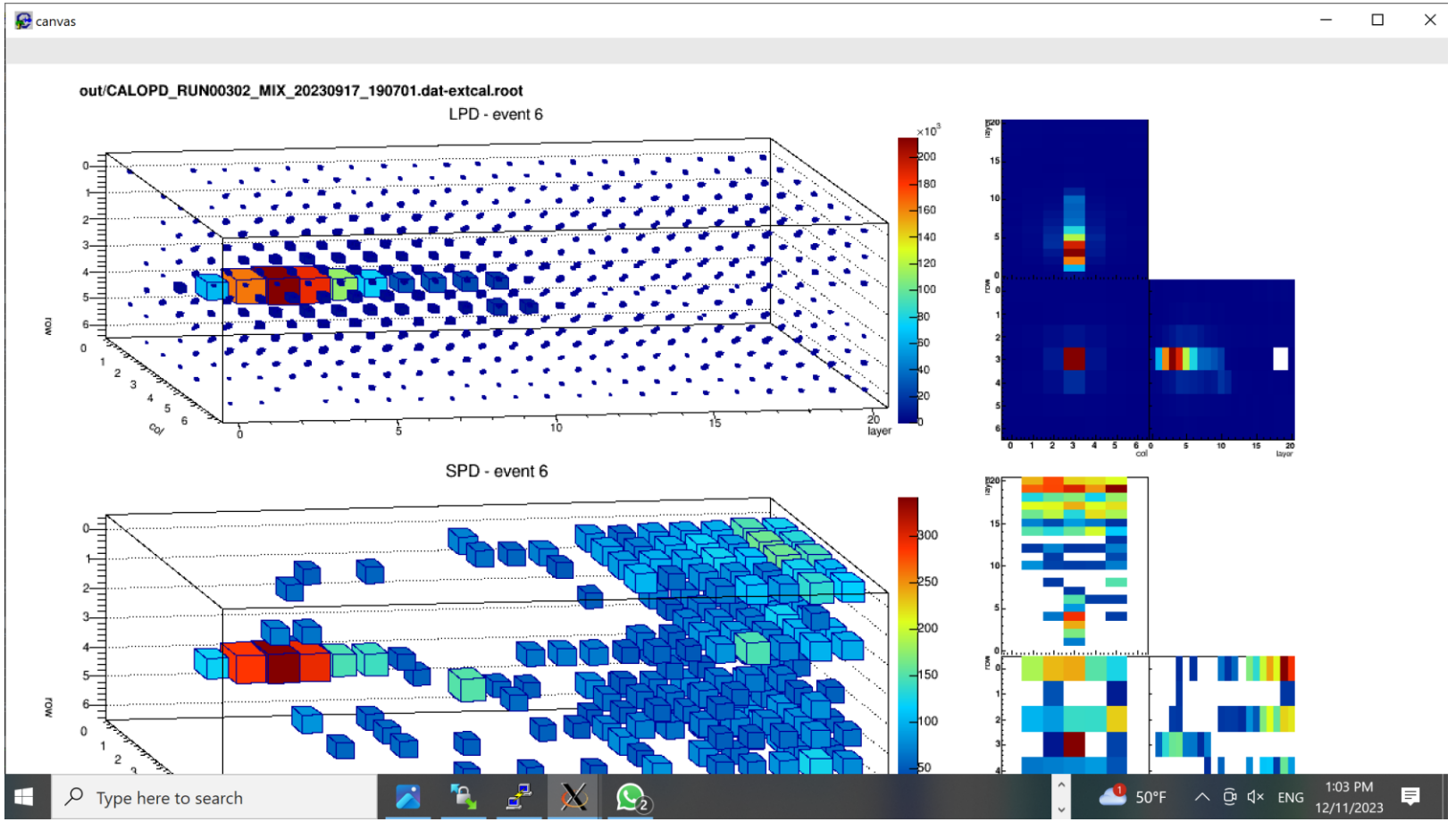
Evento buono



243 GeV

PDtree->Scan("Entry$","adc[42][5]>120000")

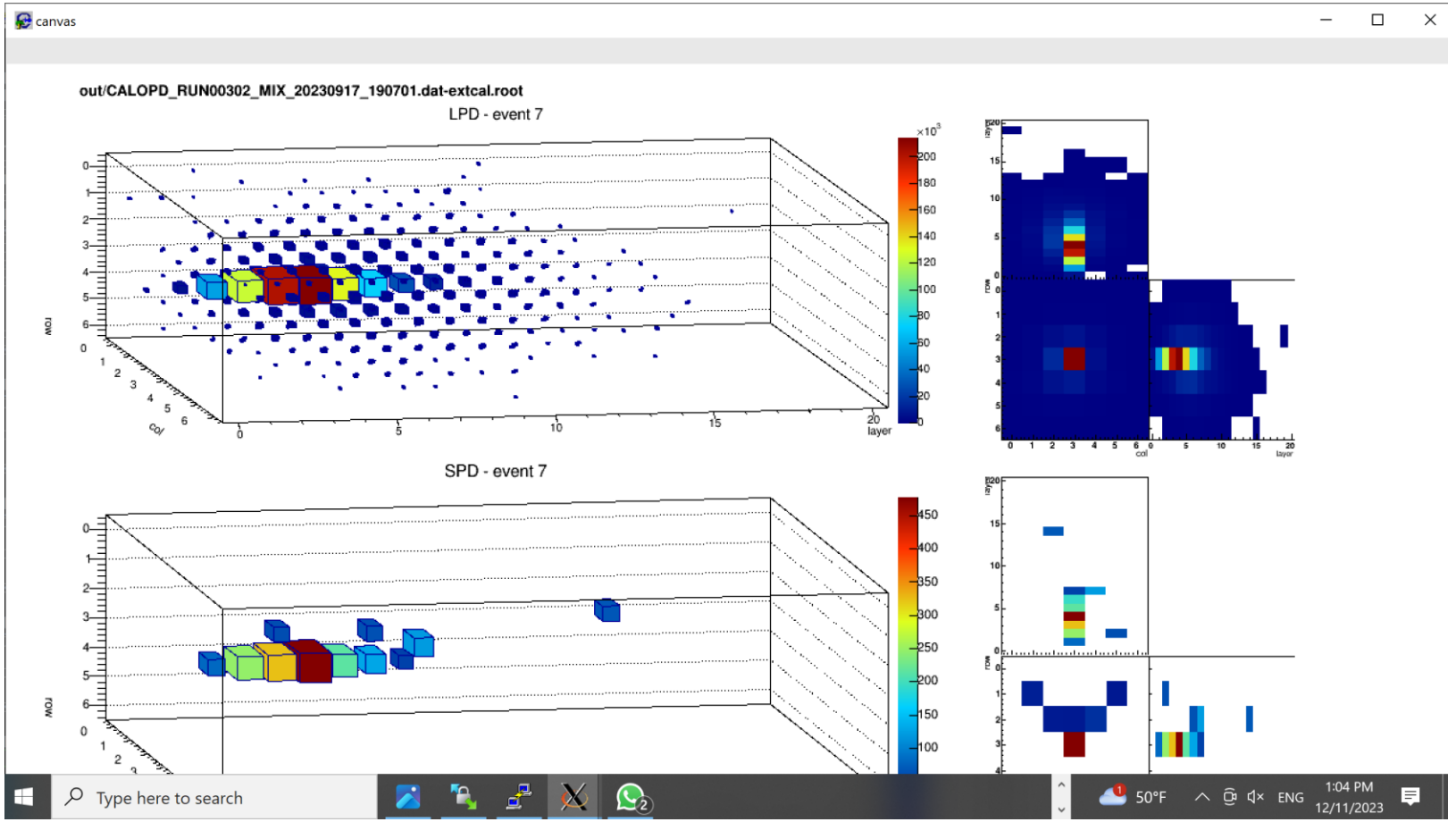
Evento buono



243 GeV

PDtree->Scan("Entry$","adc[42][5]>120000")

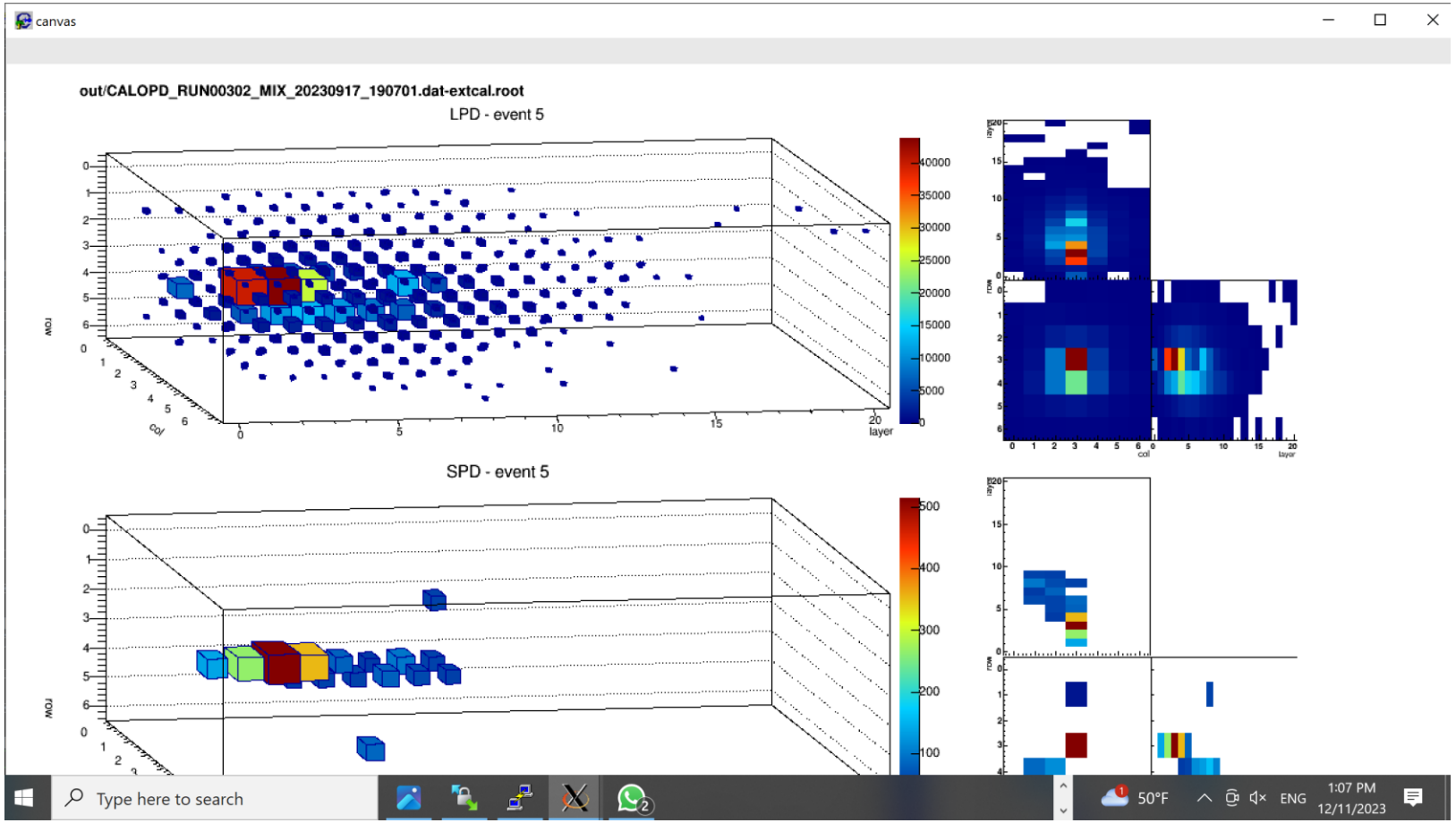
Evento buono



243 GeV

PDtree->Scan("Entry$","adc[42][5]>120000")

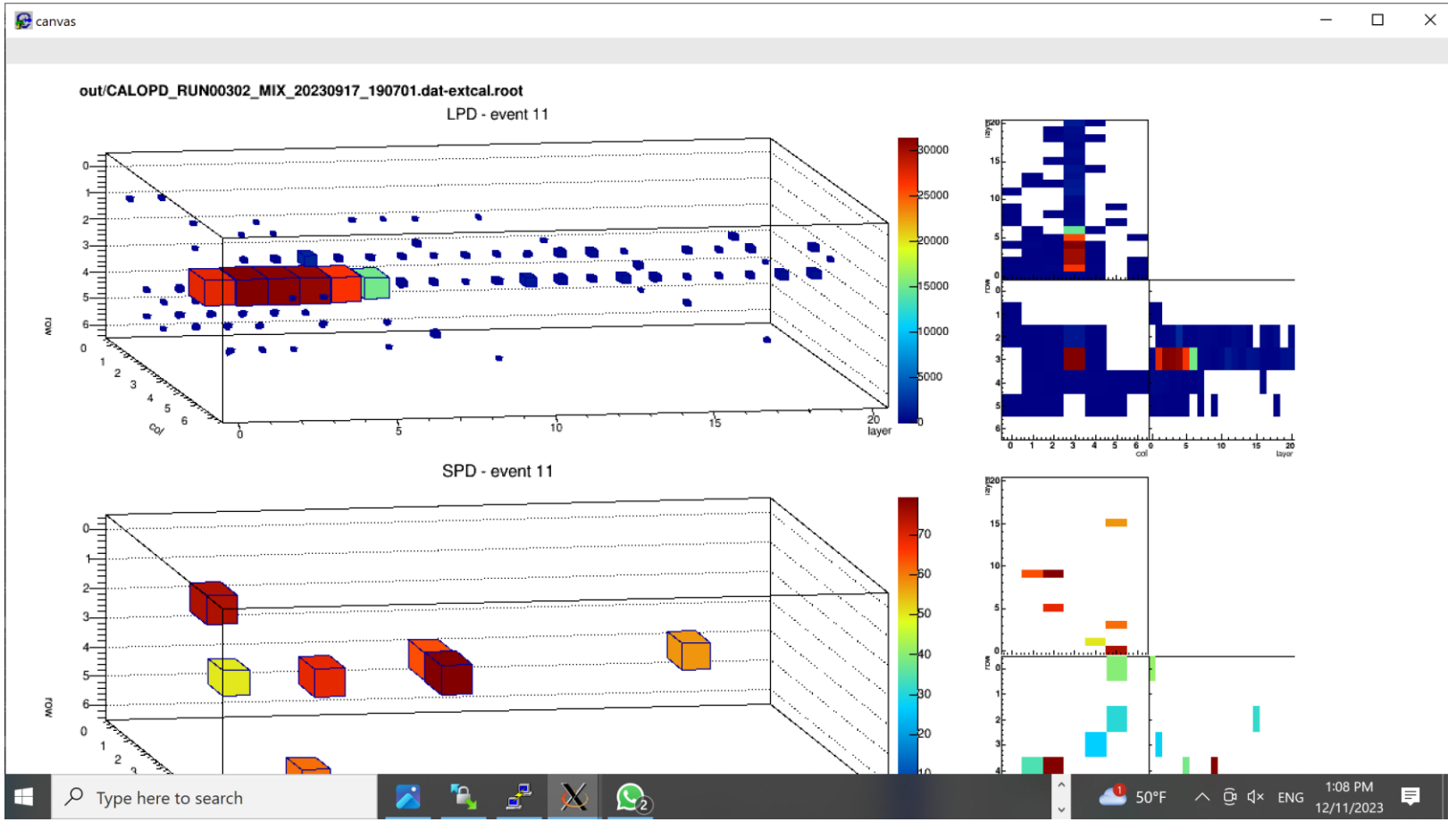
Evento cattivo



243 GeV

PDtree->Scan("Entry$","adc[42][5]>25000&&adc[42][5]<40000")

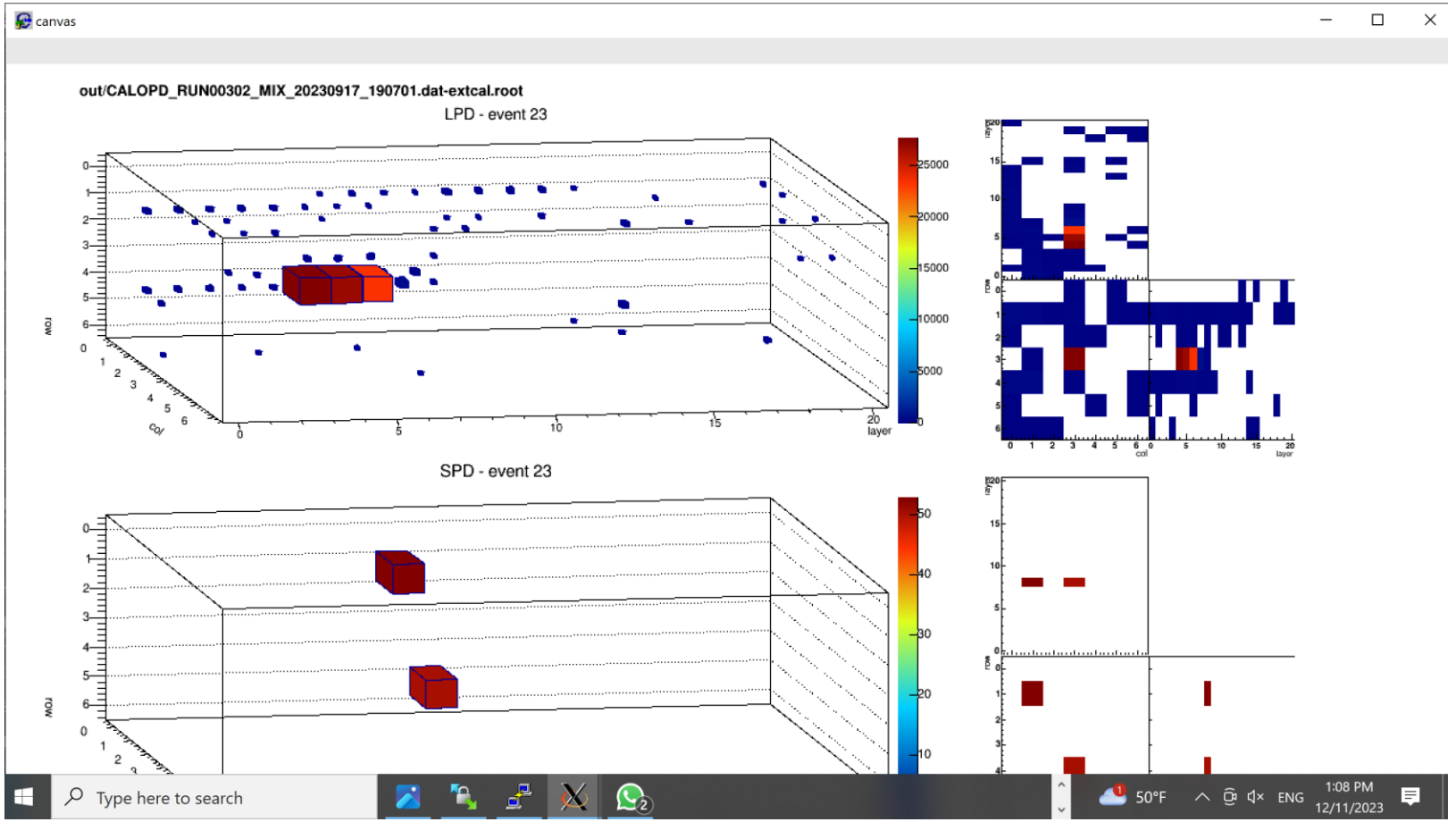
Evento cattivo



243 GeV

PDtree->Scan("Entry$","adc[42][5]>25000&&adc[42][5]<40000")

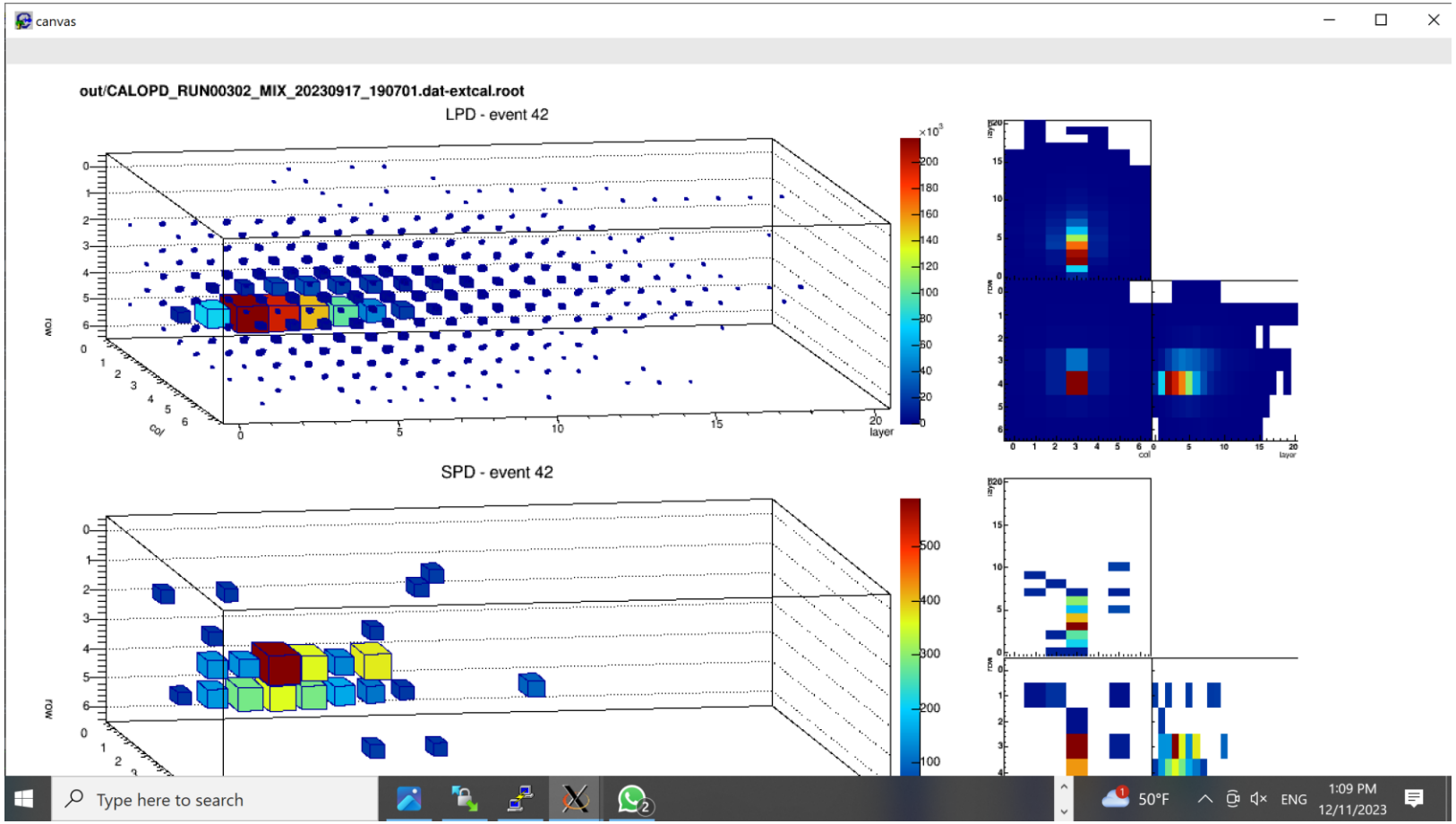
Evento cattivo



243 GeV

PDtree->Scan("Entry$","adc[42][5]>25000&&adc[42][5]<40000")

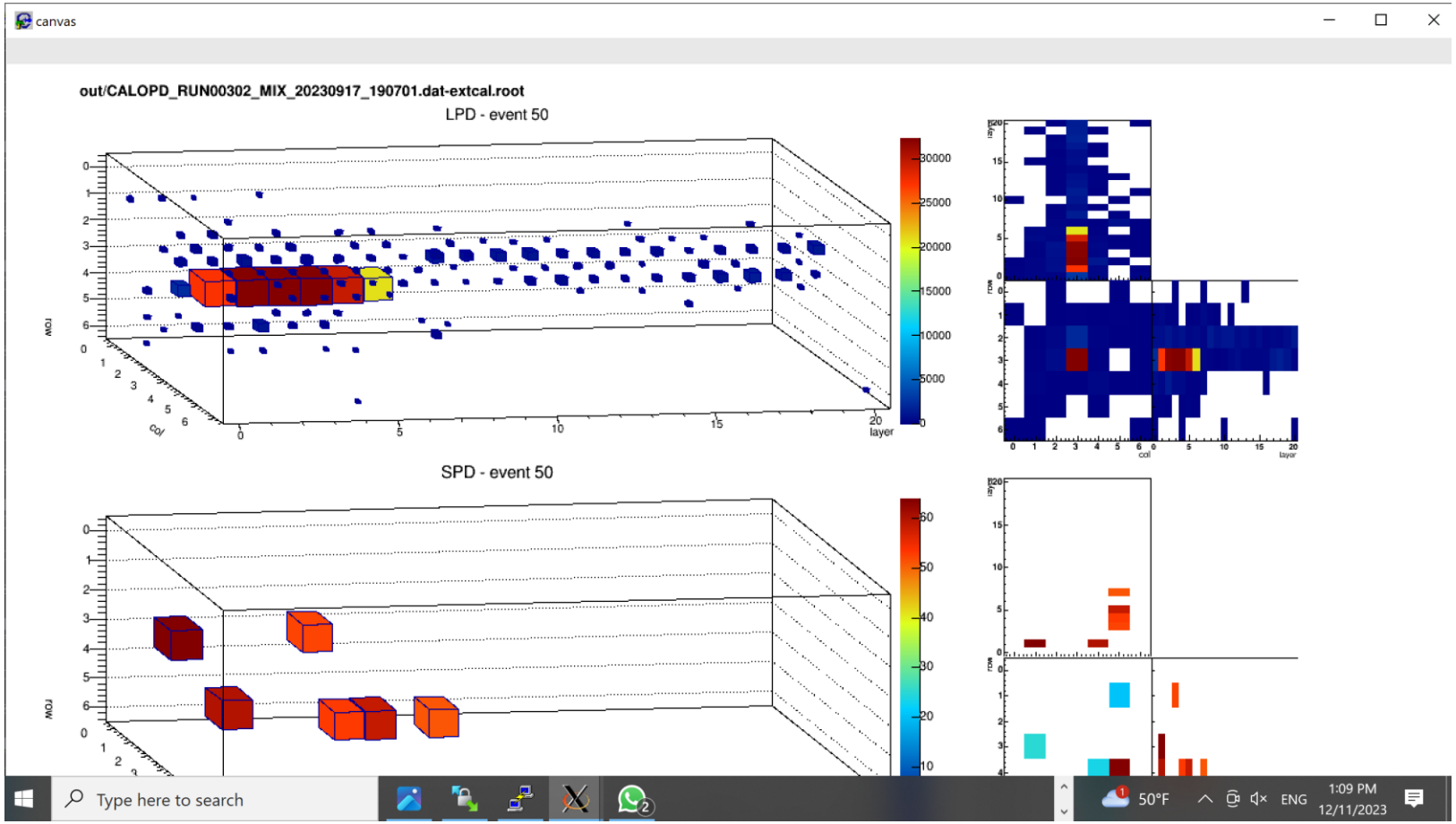
Evento cattivo



243 GeV

PDtree->Scan("Entry$","adc[42][5]>25000&&adc[42][5]<40000")

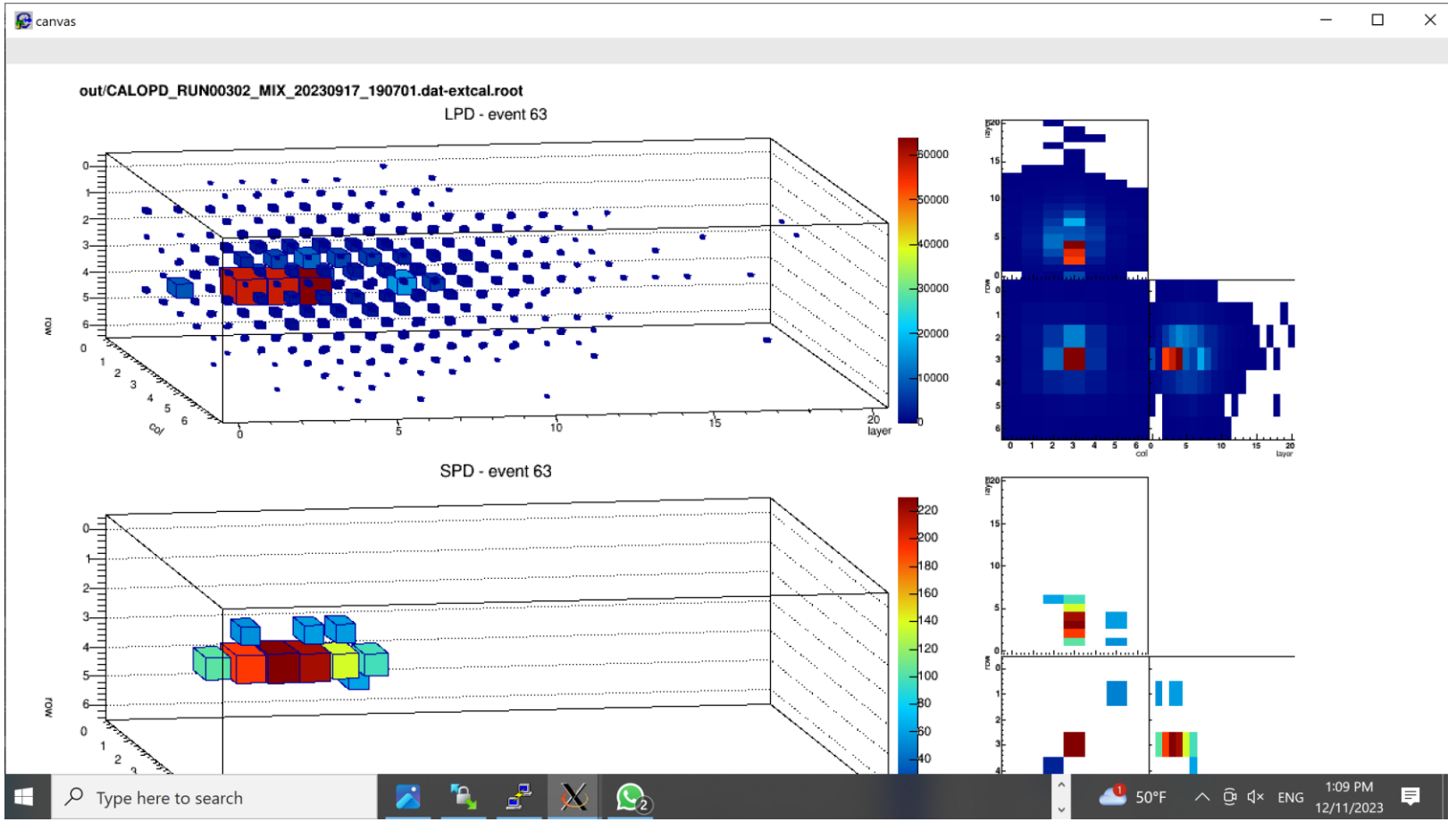
Evento cattivo



243 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<300000&&adc[42][5]>25000")

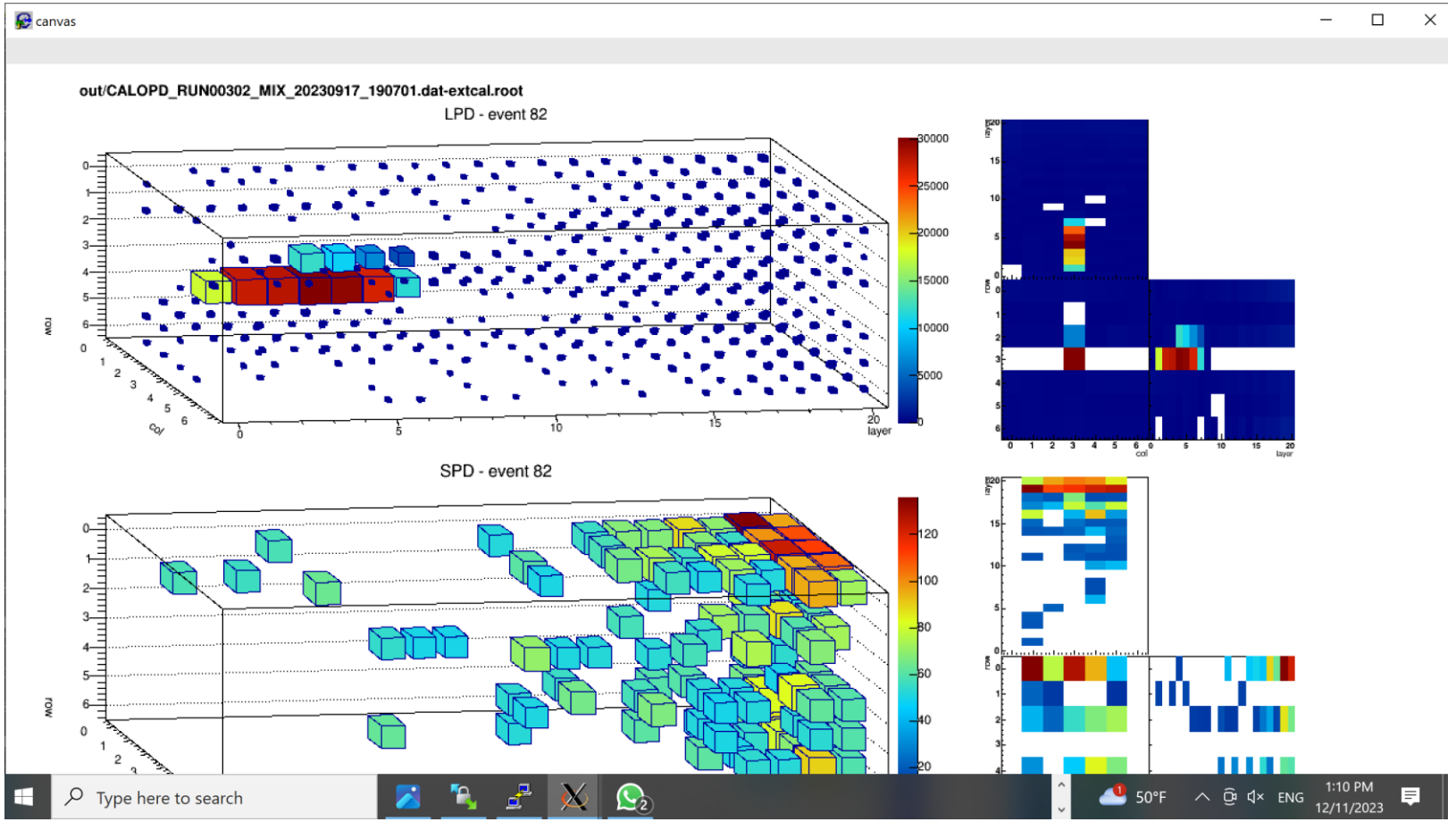
Evento cattivo



243 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<300000&&adc[42][5]>25000")

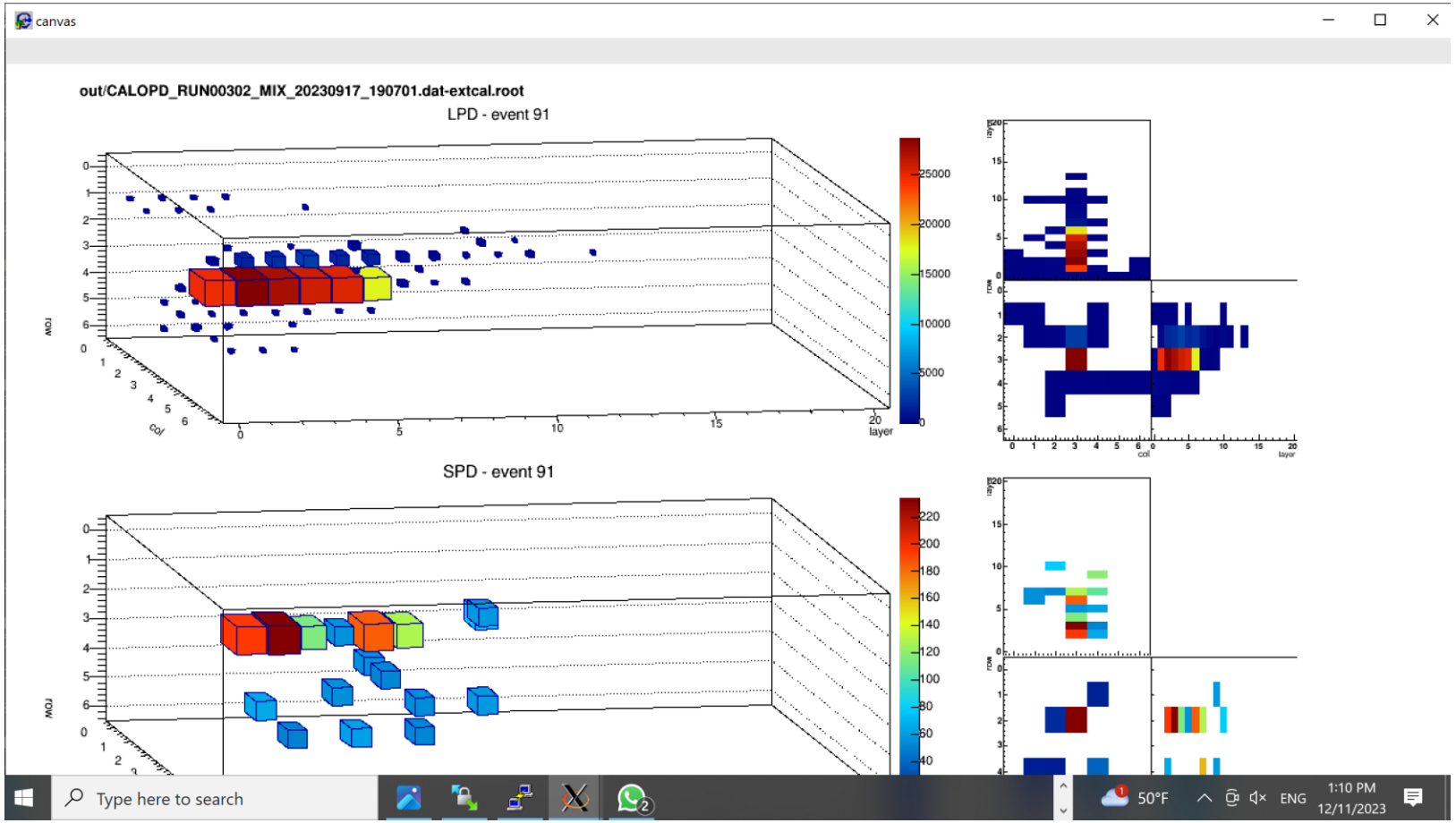
Evento cattivo



243 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<300000&&adc[42][5]>25000")

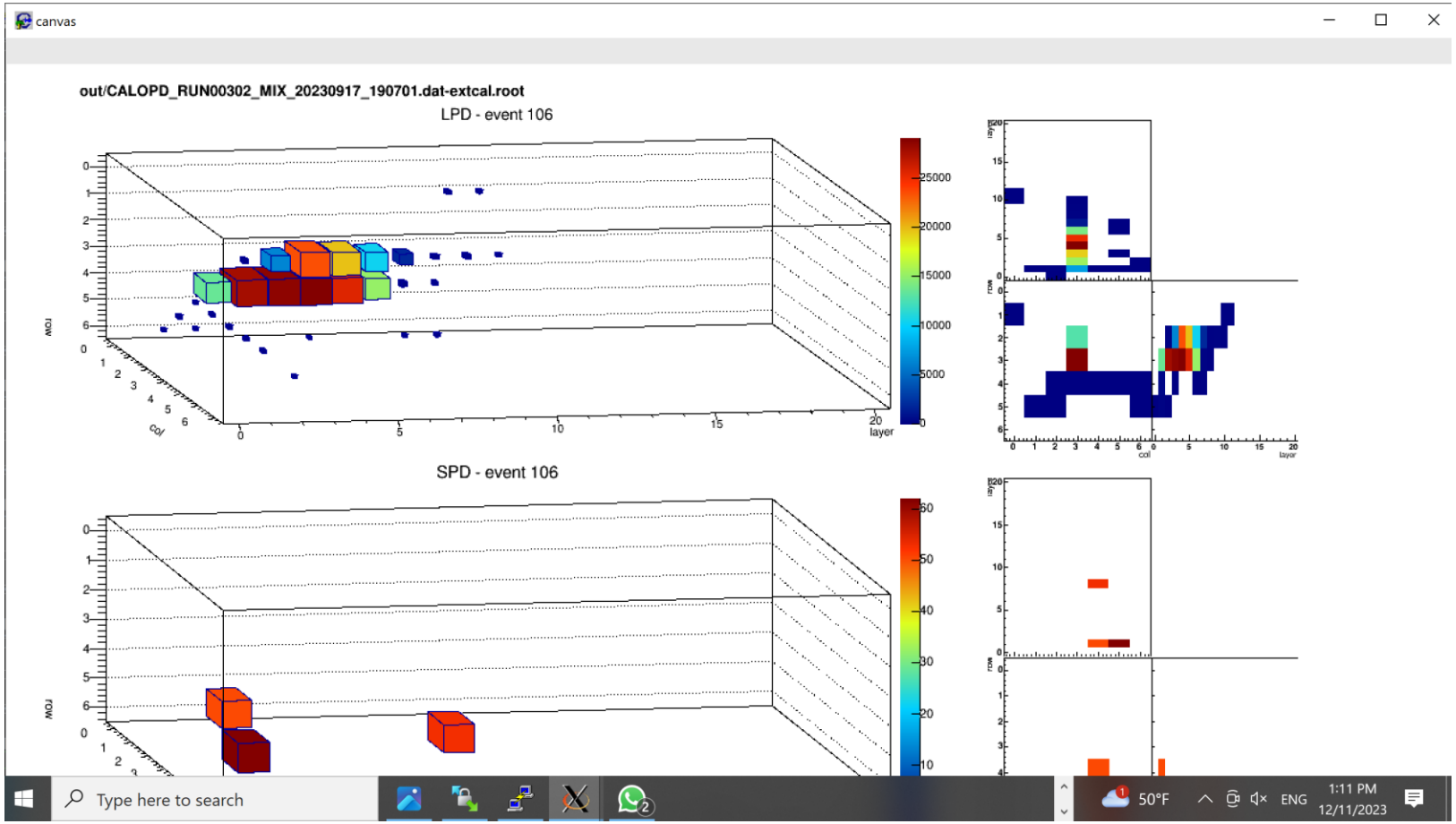
Evento cattivo



243 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<300000&&adc[42][5]>25000")

Evento cattivo



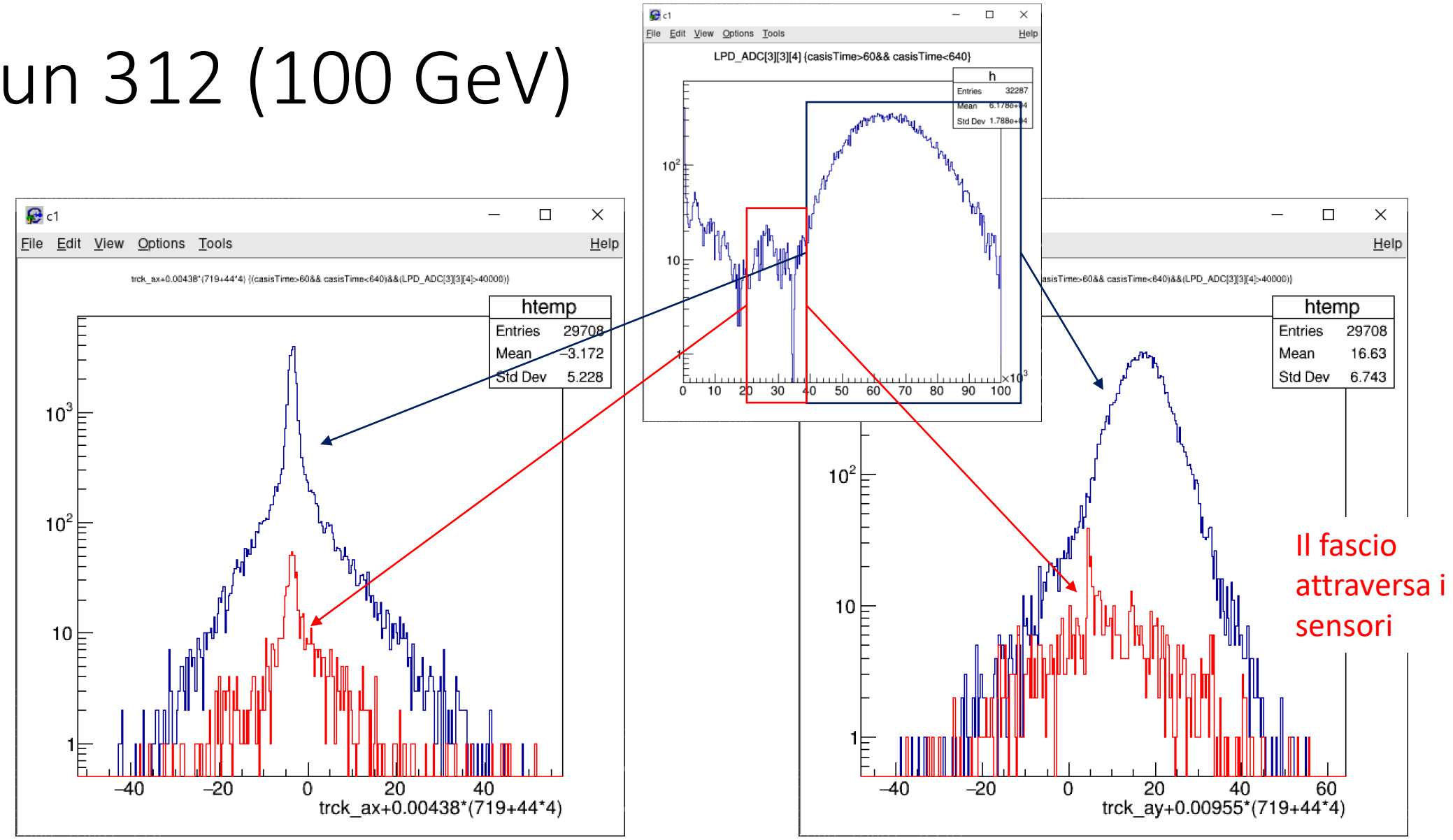
243 GeV

PDtree->Scan("Entry$","Sum$(adc[42][])<300000&&adc[42][5]>25000")

Tracciatore

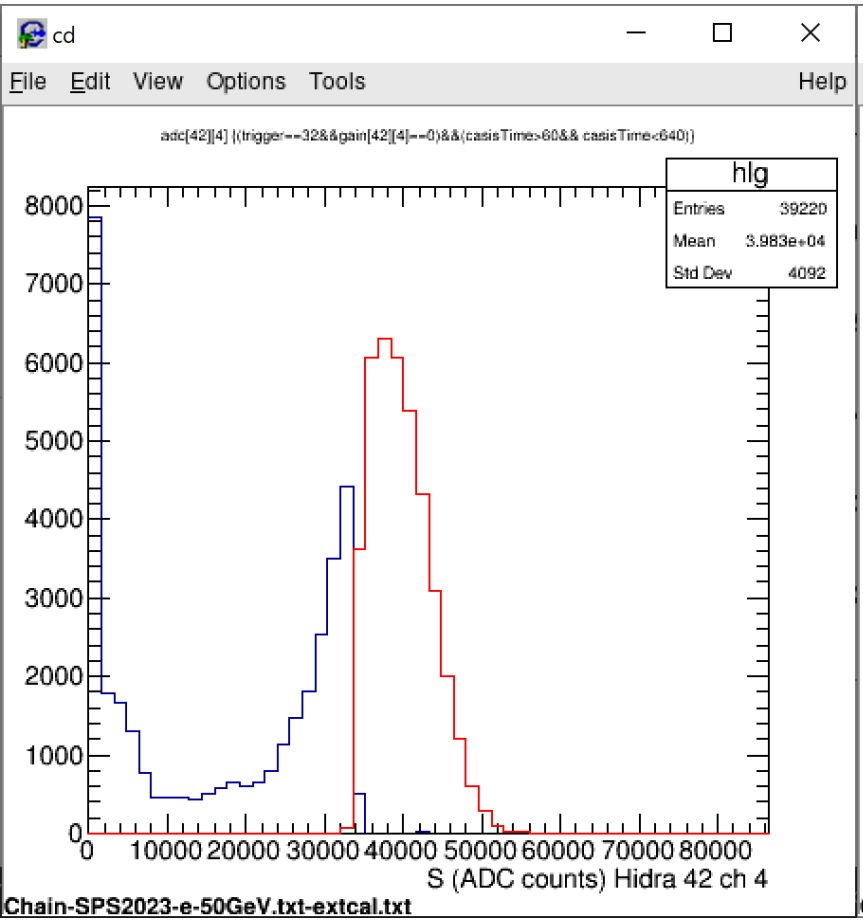
- x(z)=ax+bx*z, y(z)=ay+by*z
  - z è la distanza dal centro del SCD lungo la linea di fascio
- Run elettroni:
  - SCD-CALO faccia frontale ~ 719 mm
  - SCD-CALO ultima faccia ~ 1731 mm

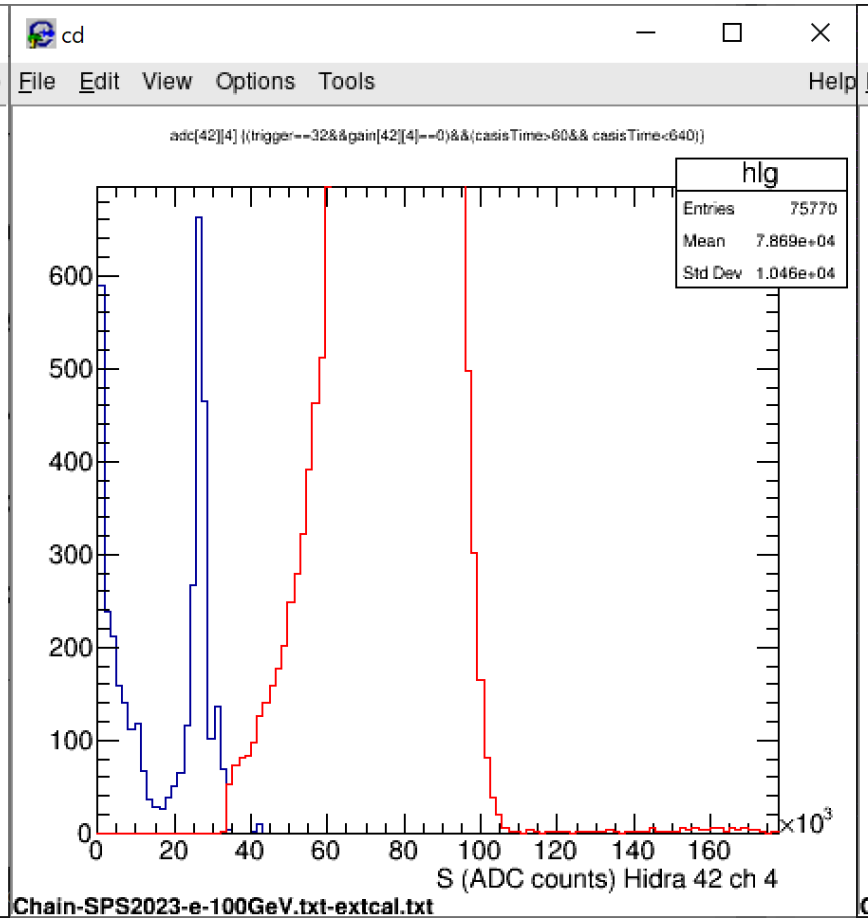
Run 312 (100 GeV)

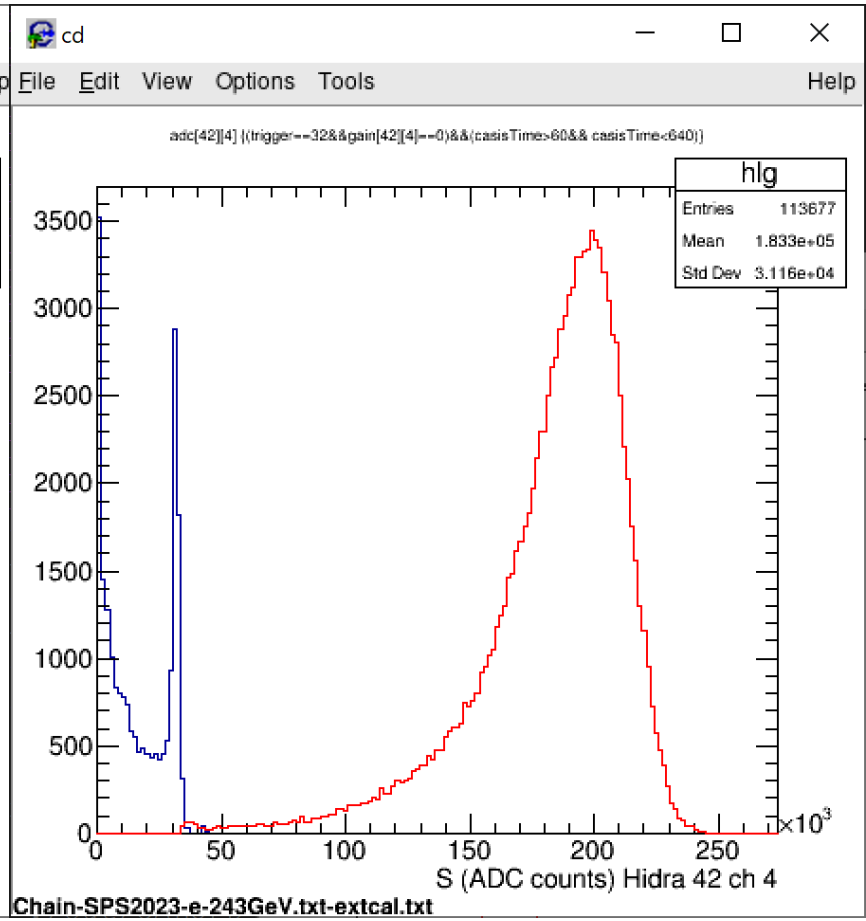


- Osservazioni emerse durante la discussione
  1. Pedestal shift
     - Guardare lo shift anche nelle colonne sopra e sotto e nel canale [42][4] (massimo dello sciame)
     - Valutare la correzione (media) per tutte le colonne 3x3
     - Fare attenzione agli spill vuoti…
  2. Sottrazione CN
     - Valutare se sottrarre il CN anche in basso Guadagno, soprattutto per le schede rumorose
  3. Comportamenti anomali al cambio di guadagno
     - Cercare altre distribuzioni a cavallo del cambio di Guadagno
     - Guardare il segnale degli LPD ciechi

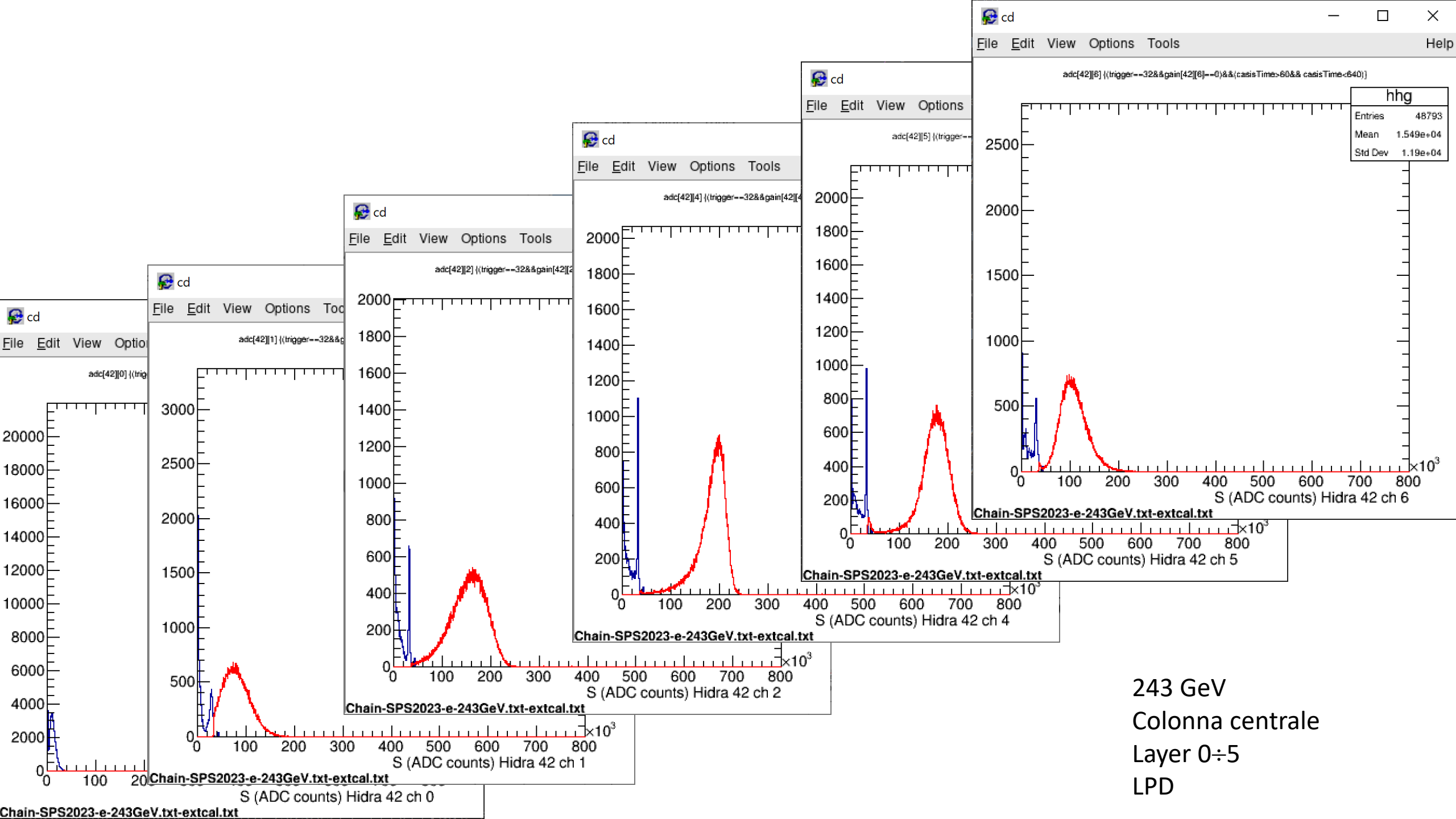
Colonna centrale
layer 3
50-100-243 GeV





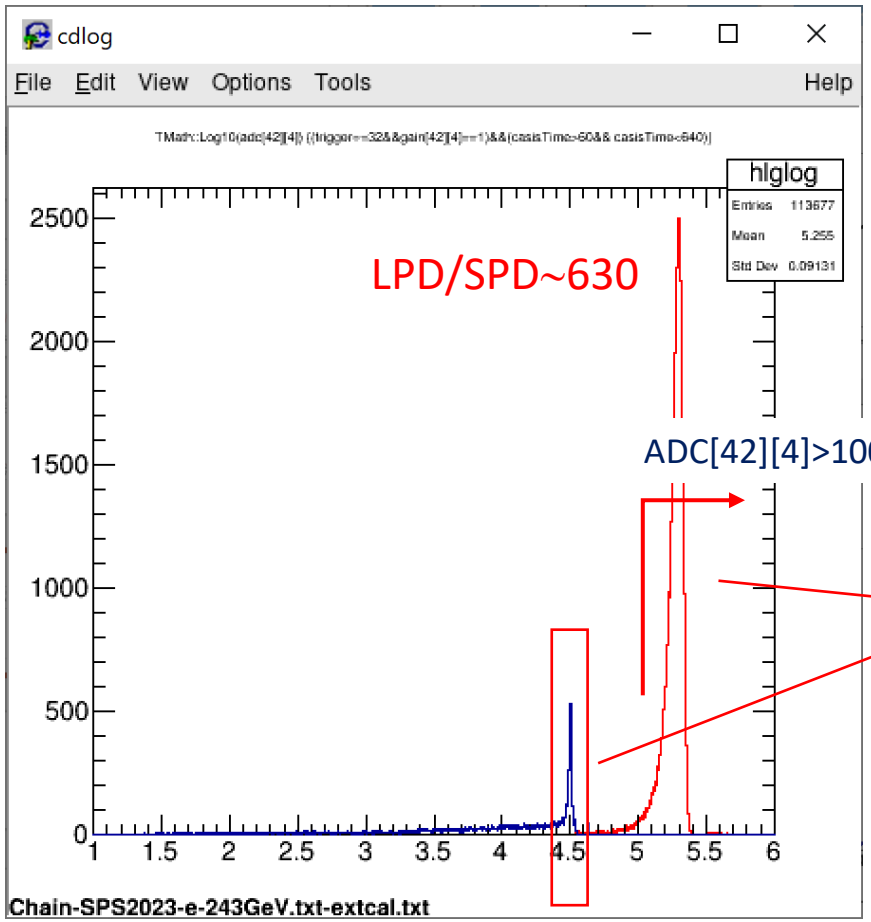


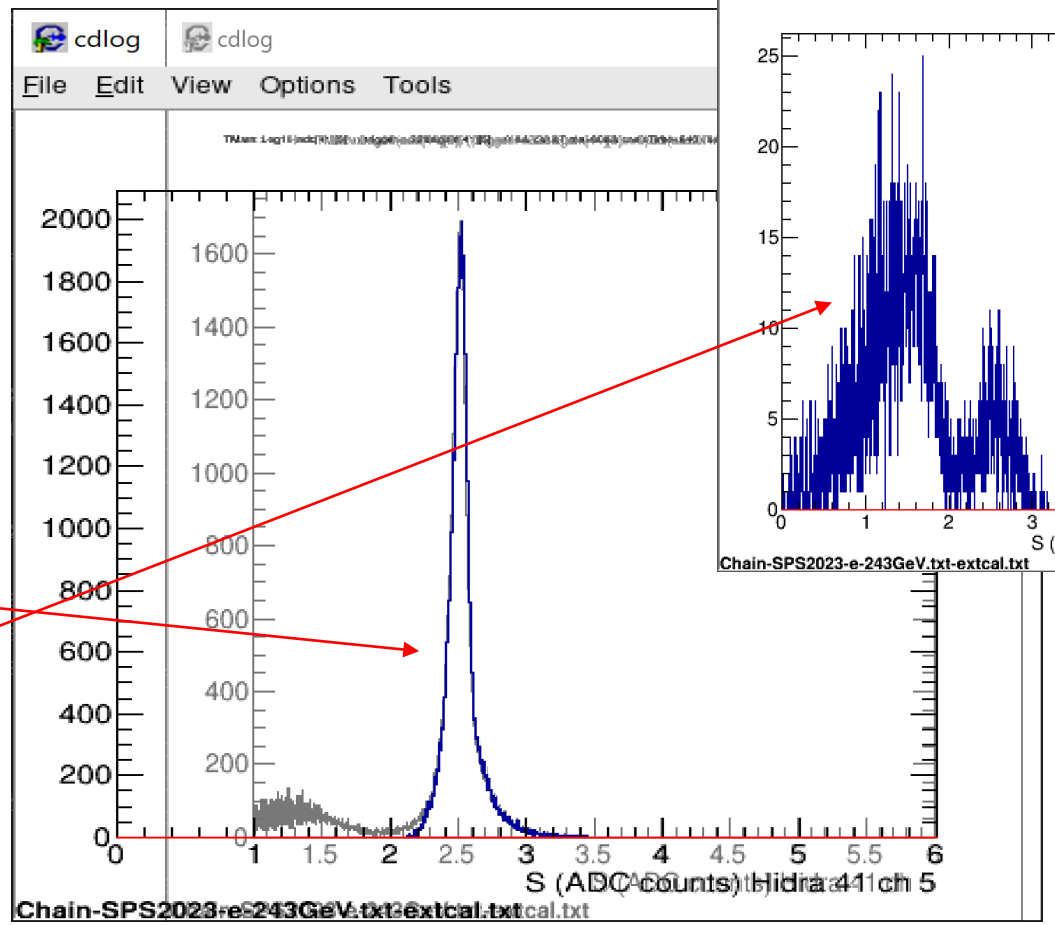
C’e` uno spike vicino al cambio di Guadagno…

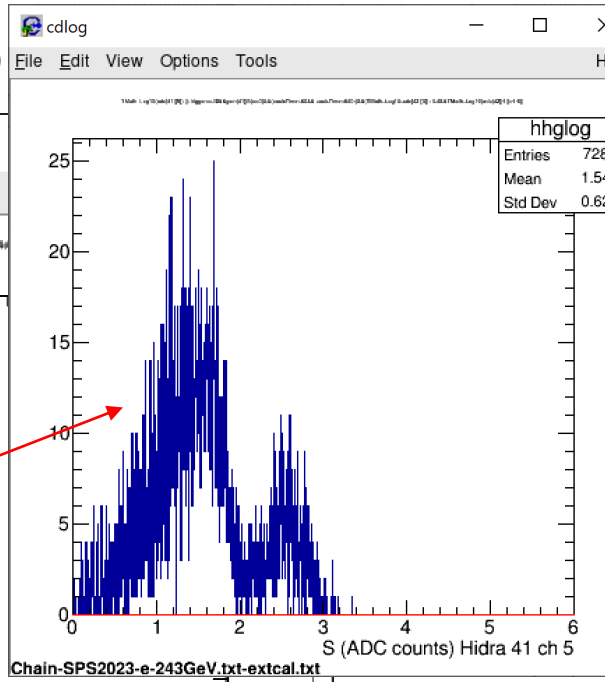


243 GeV
Colonna centrale
Layer 0÷5
LPD

243 GeV
Colonna centrale
Layer 3
LPD-SPD



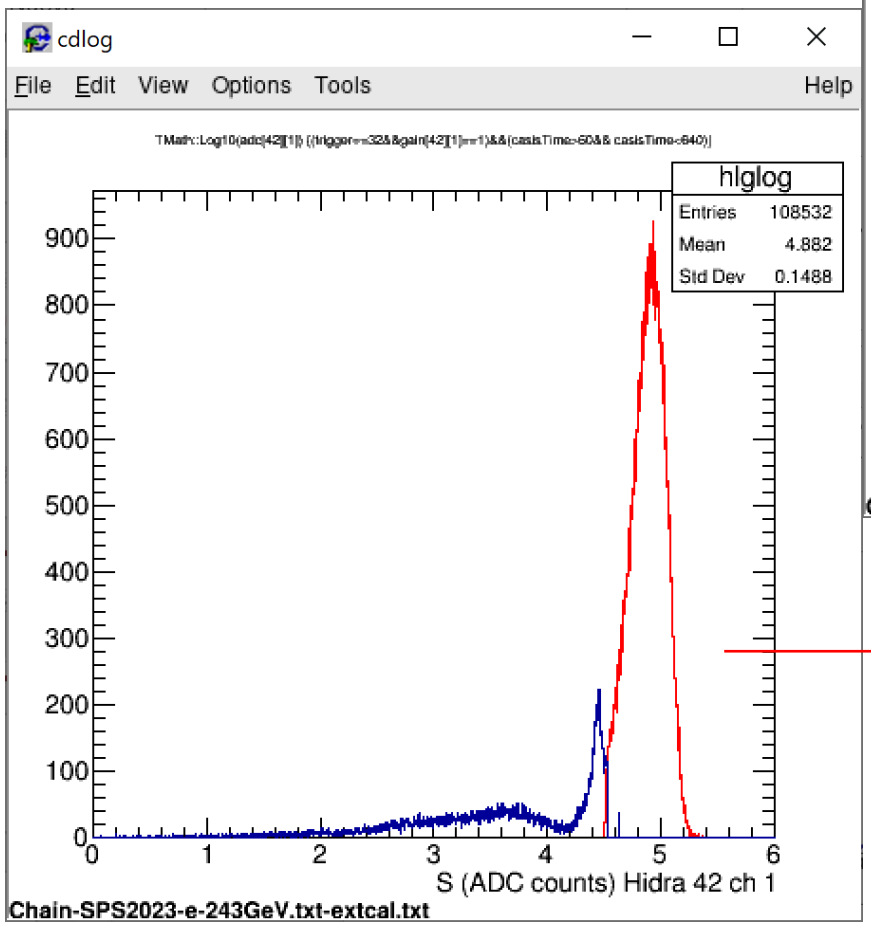


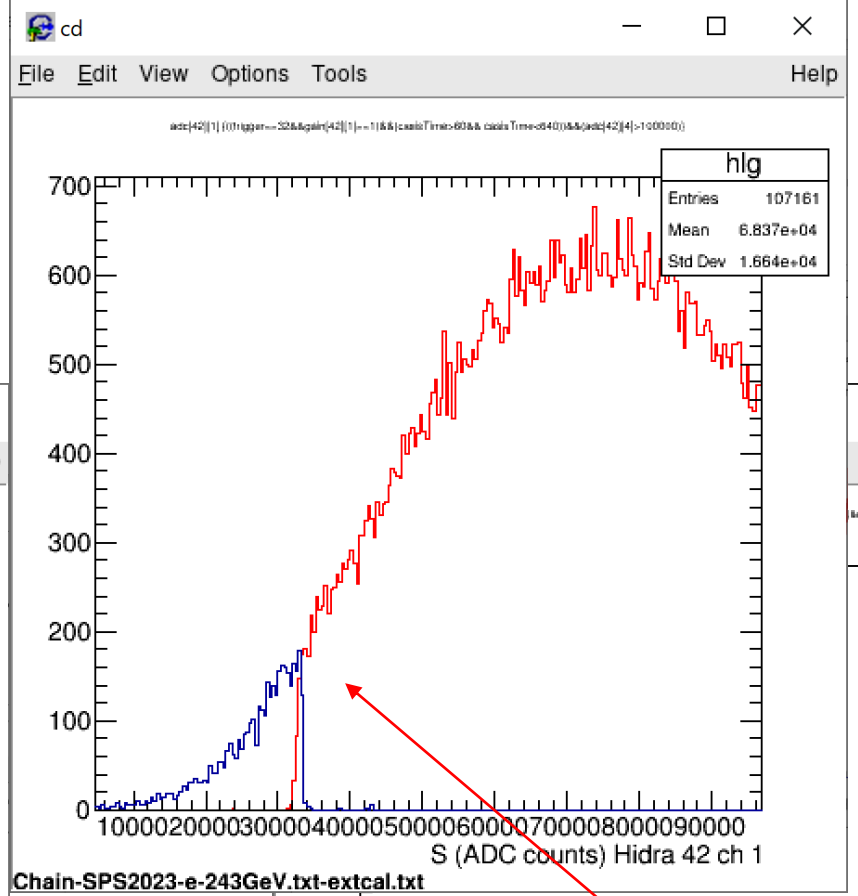


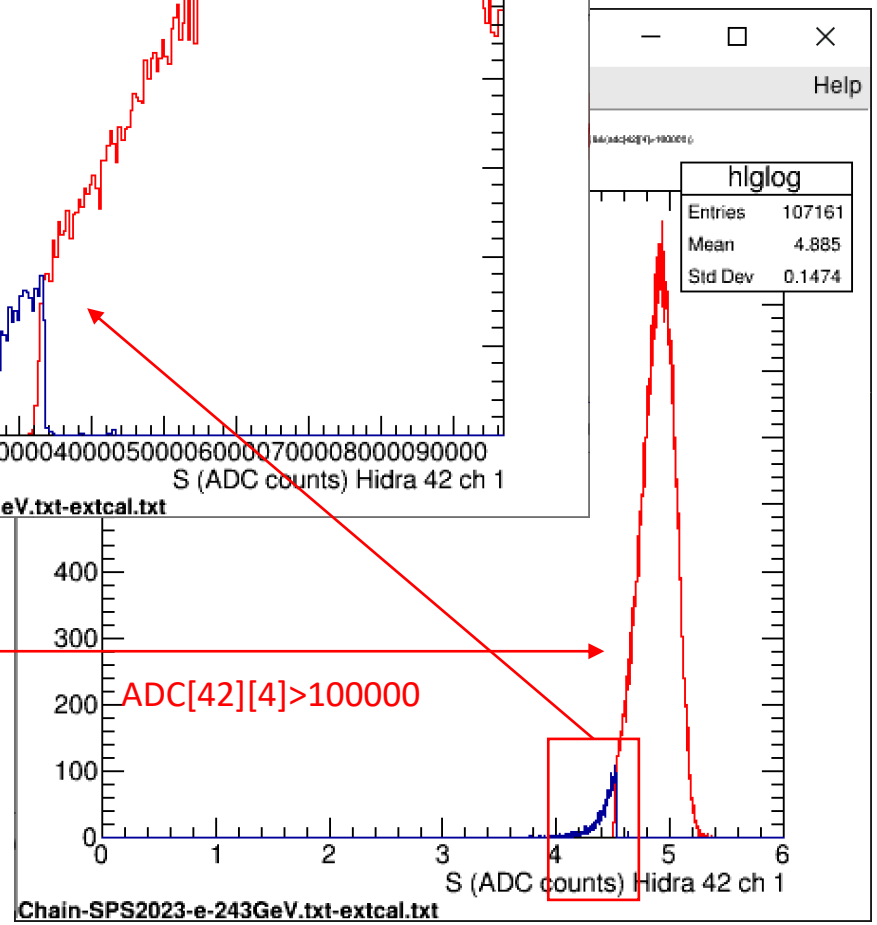
Stesso cubo, fotodiodi diversi

NB scala logaritmica

243 GeV
Colonna centrale
Layer 1
LPD

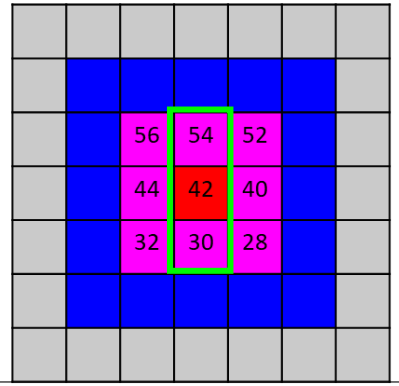




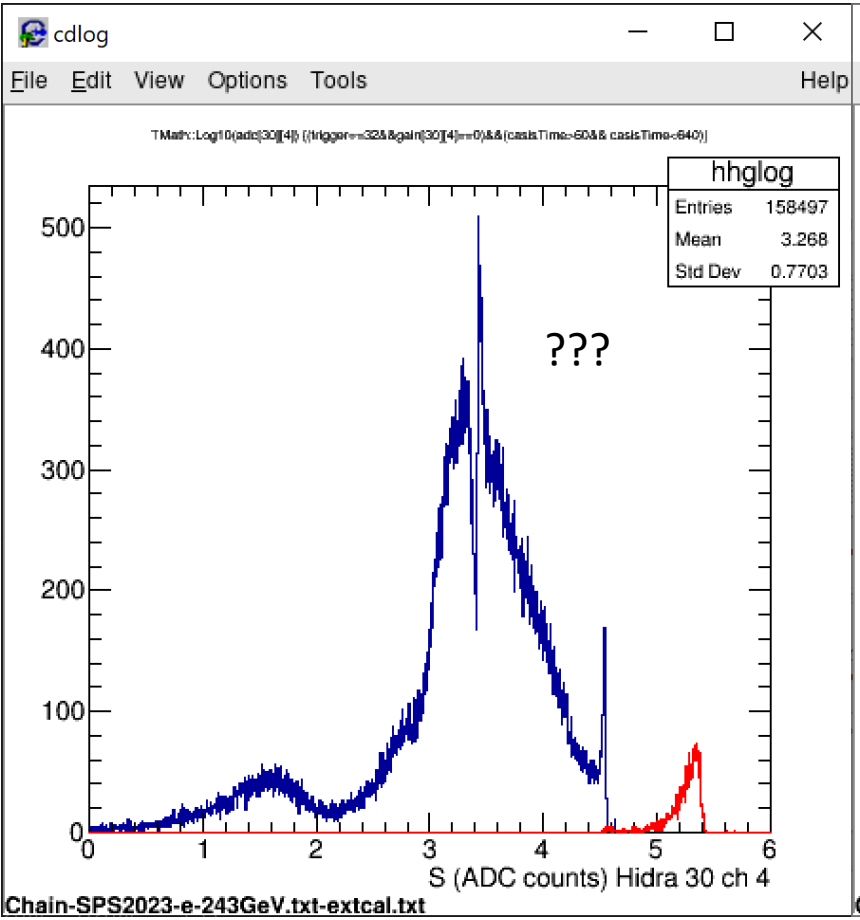


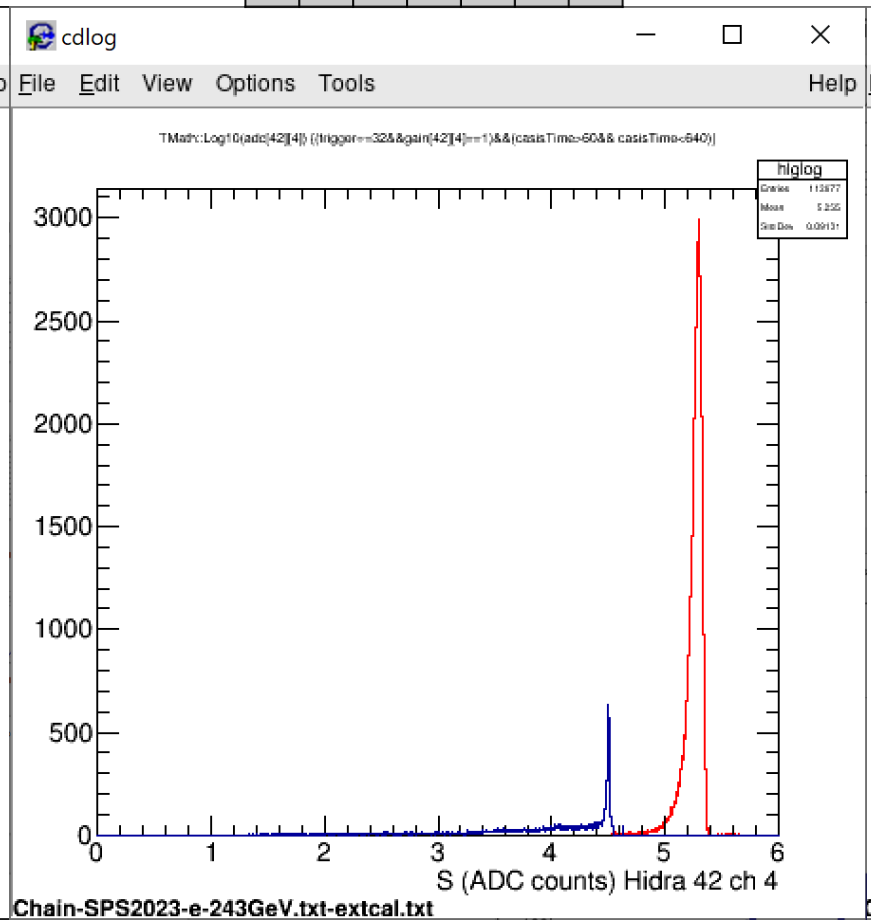
Stessa scolopendra, cubi diversi

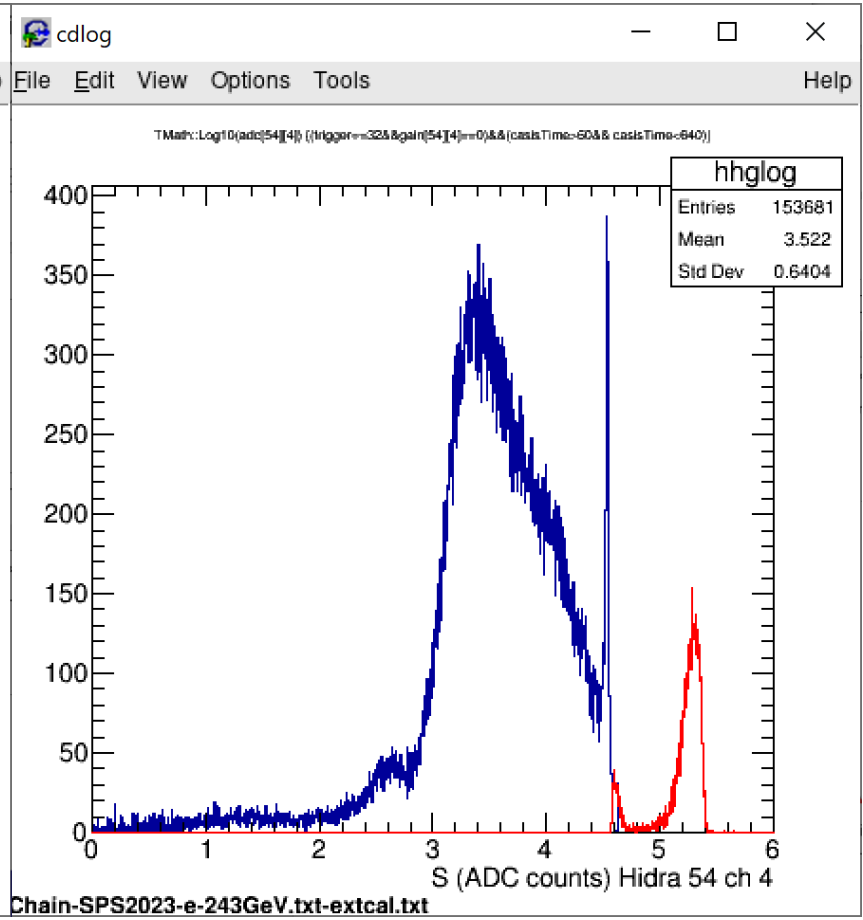
Selezionando un alto rilascio nel layer 3 della Colonna centrale, lo spike sparisce lungo tutta la colonna



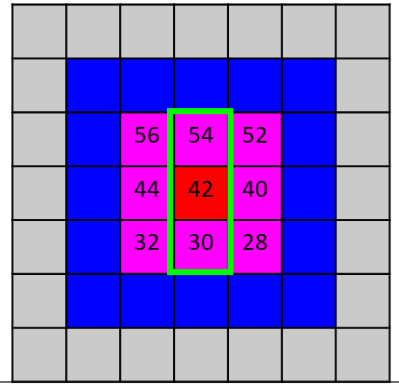
243 GeV
Colonna sott/centrale/sopra
Layer 3
LPD



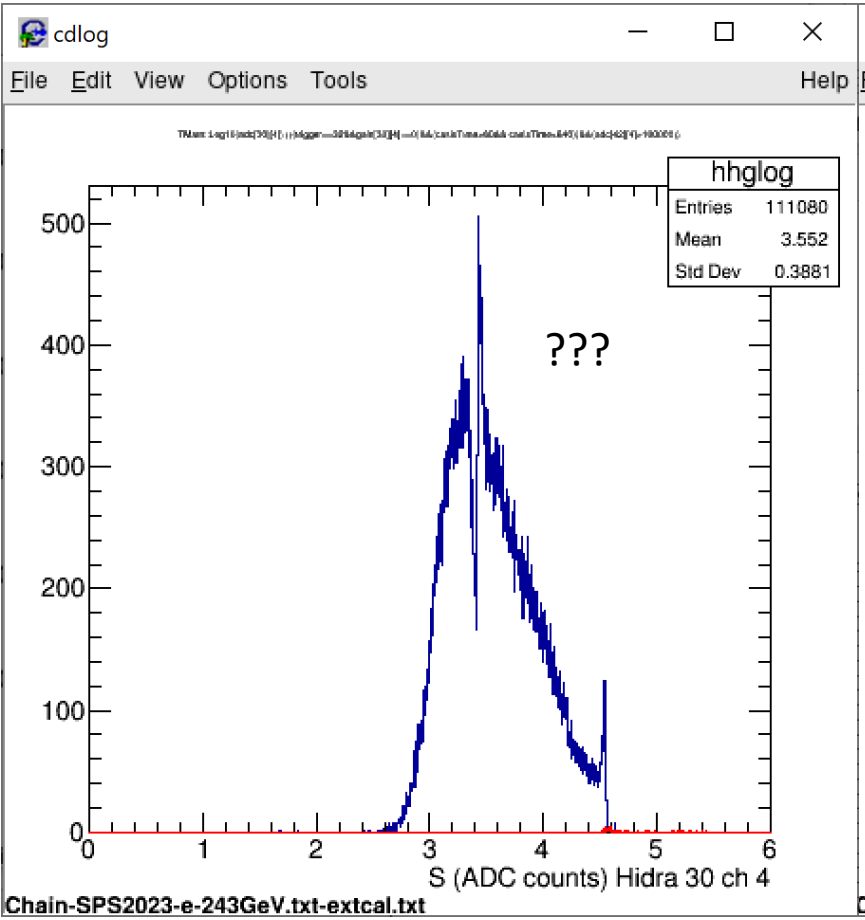


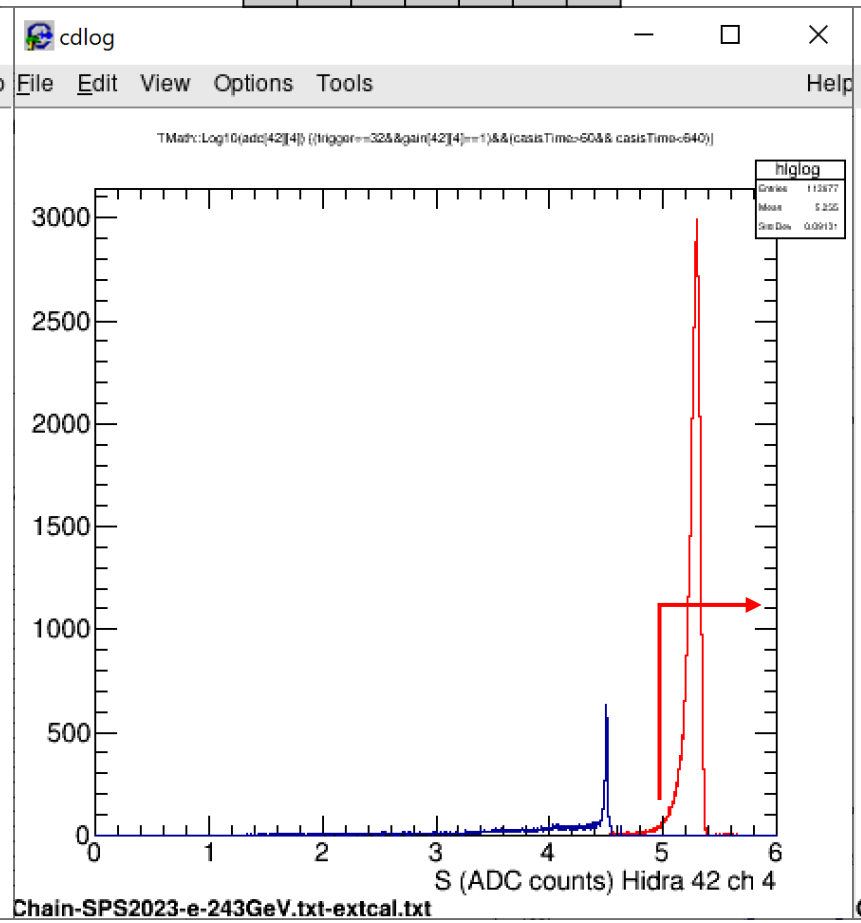


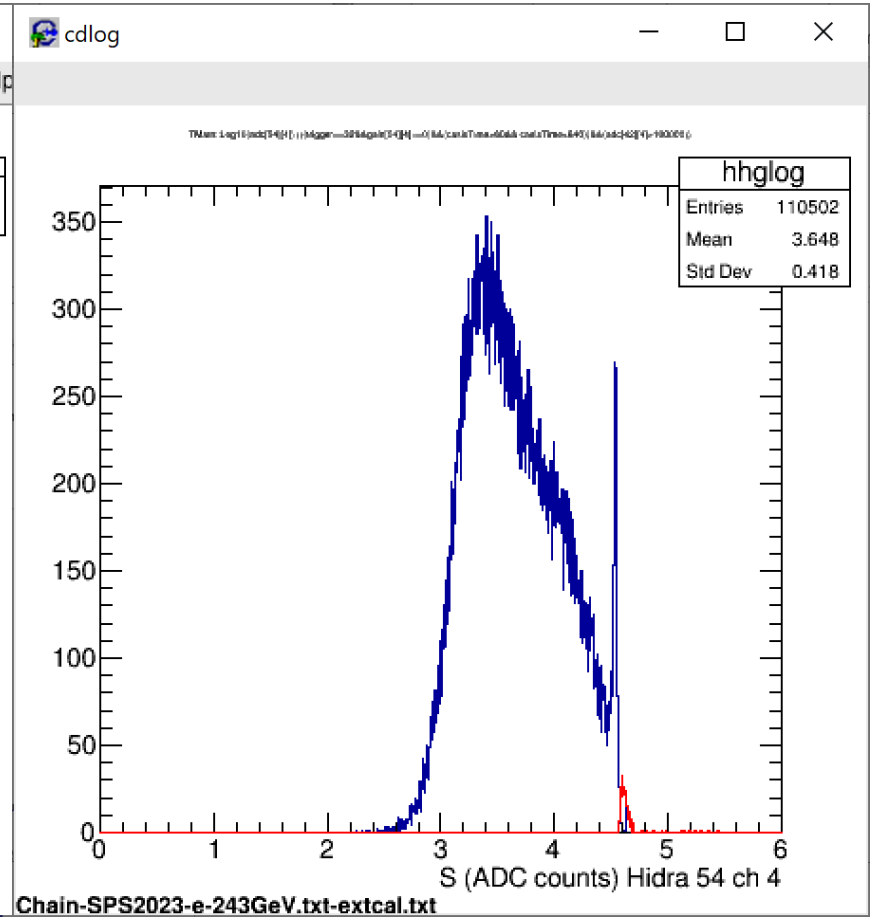
Il fascio si estende in vertical su tre colonne



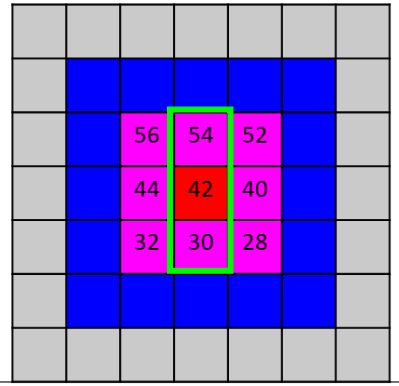
243 GeV
Colonna sott/centrale/sopra
Layer 3
LPD



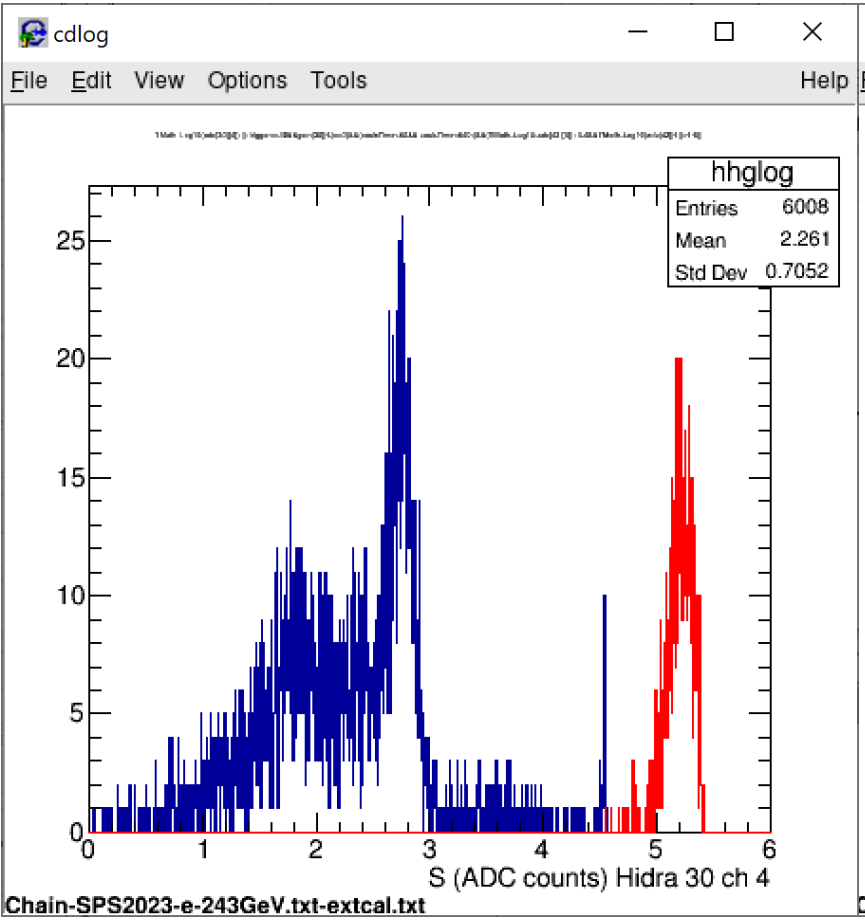


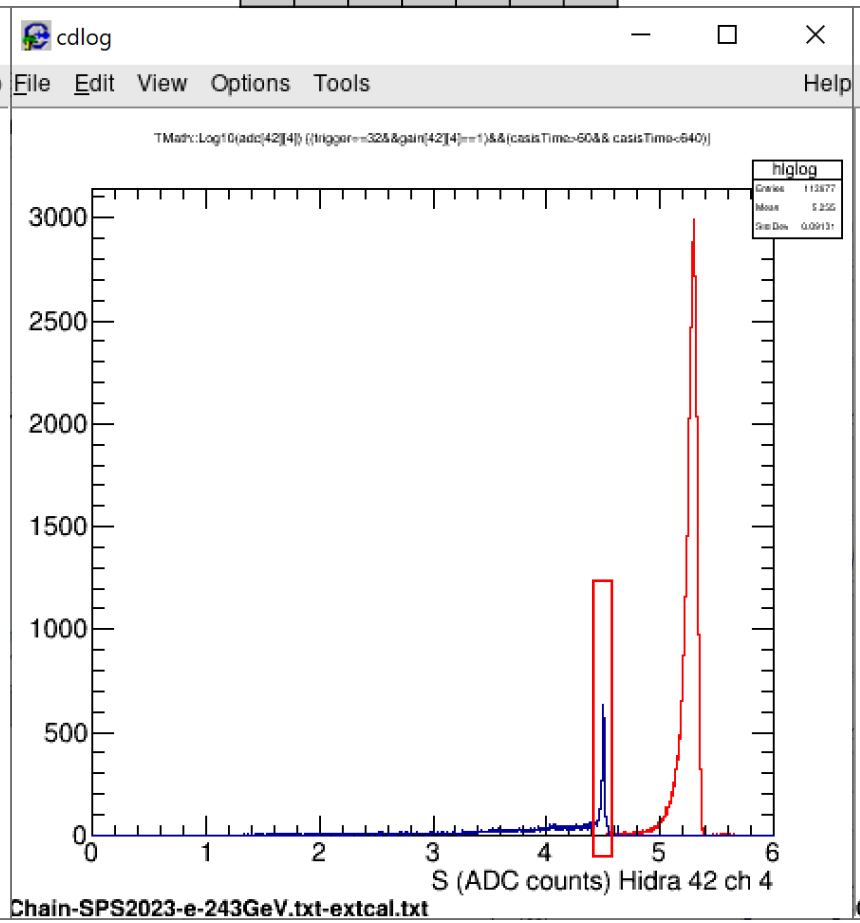


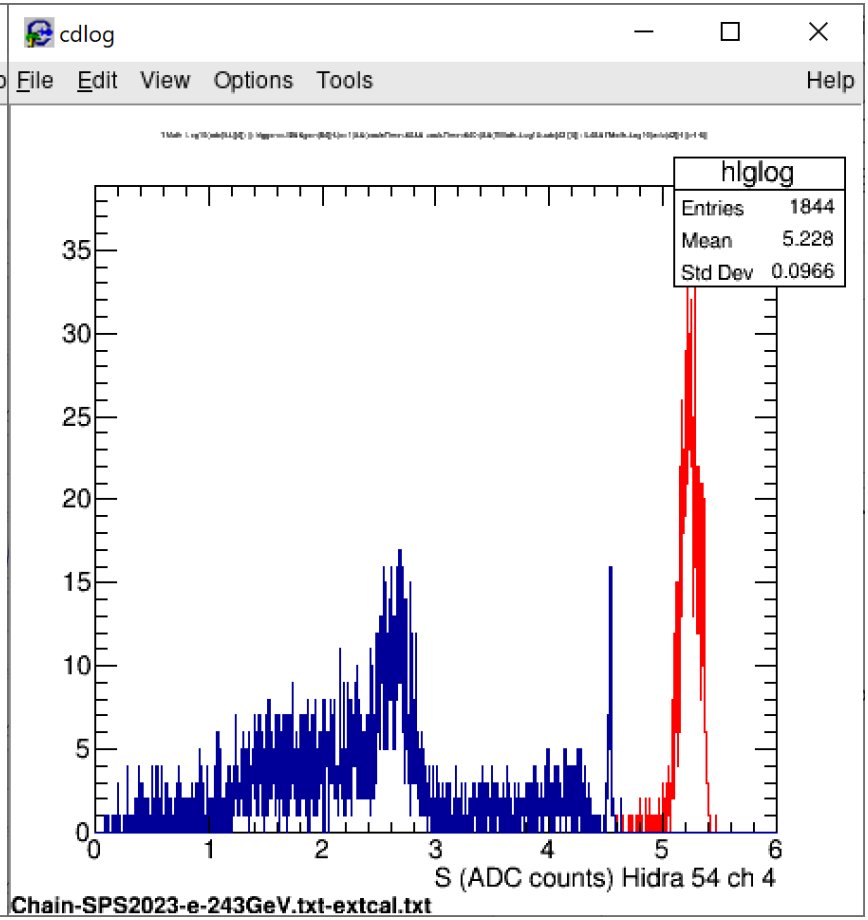
Selezionando un alto rilascio nel layer 3 della Colonna centrale, sparisce il picco relative agli sciami che si sviluppano nelle latre colonne, ma non lo spike malefico…



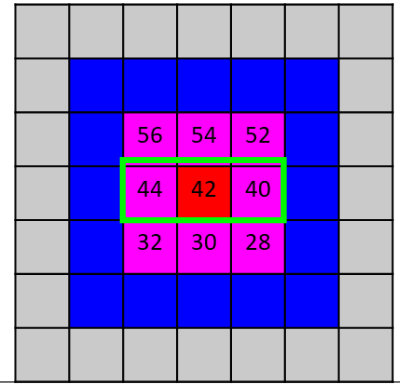
243 GeV
Colonna sott/centrale/sopra
Layer 3
LPD



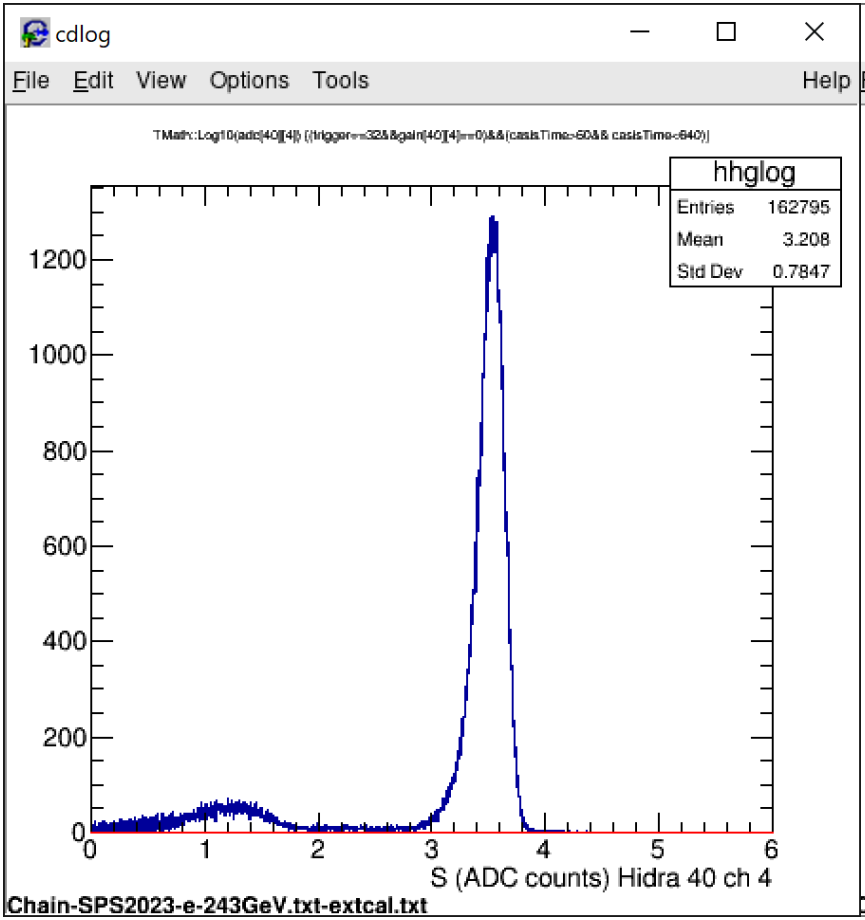


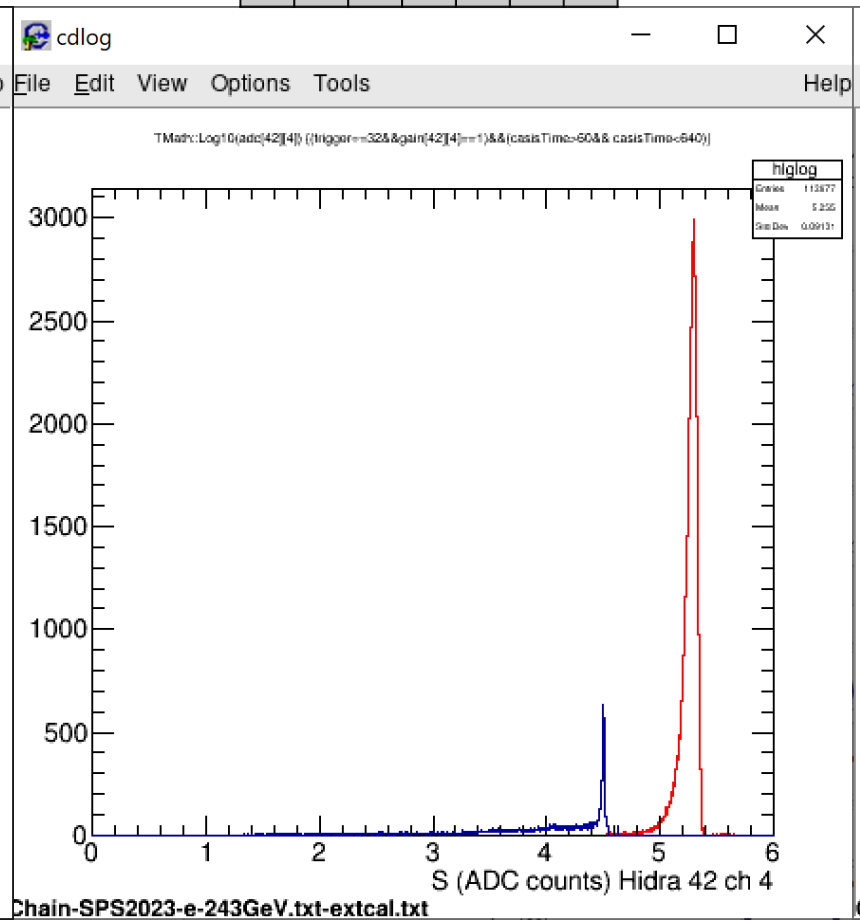


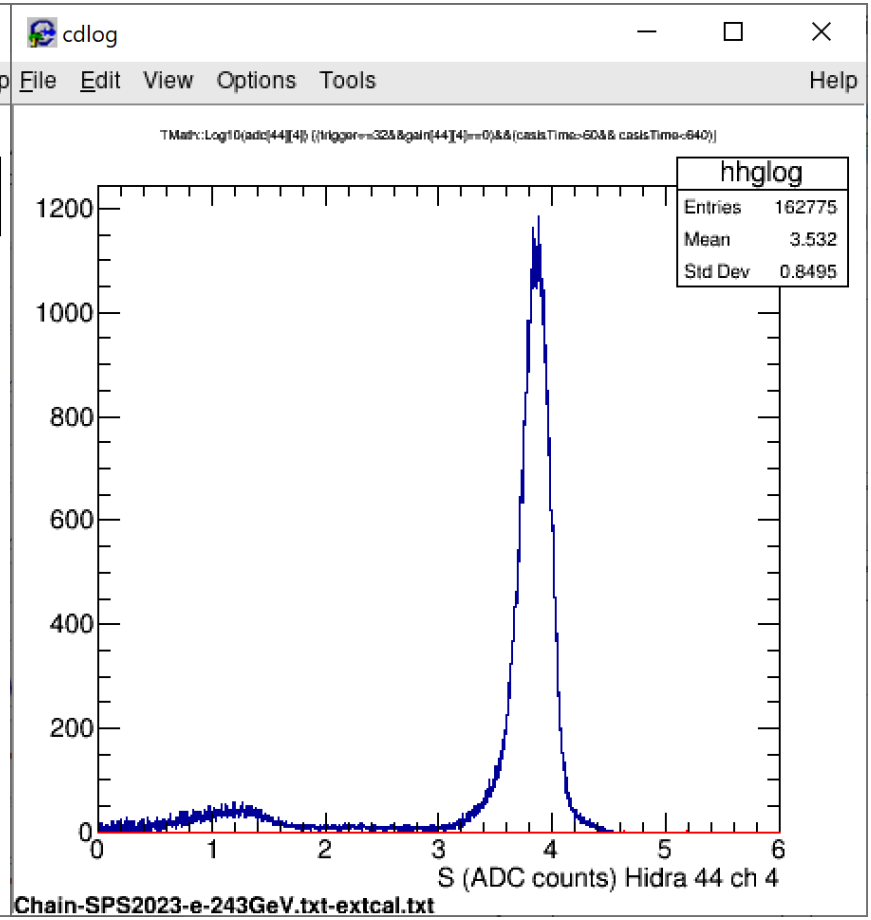
Selezionando lo spike nella olonna centrale, resta comunque lo spike nelle colonne colpite dal fascio, anche se ridotto.
(particelle multiple??)



243 GeV
Colonna sx/centrale/dx
Layer 3
LPD

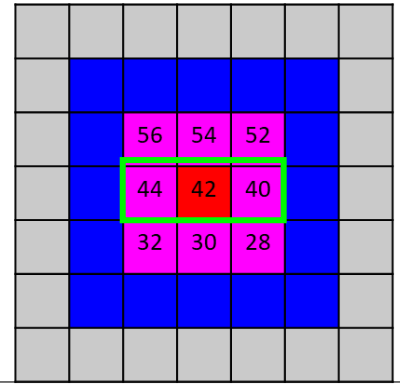




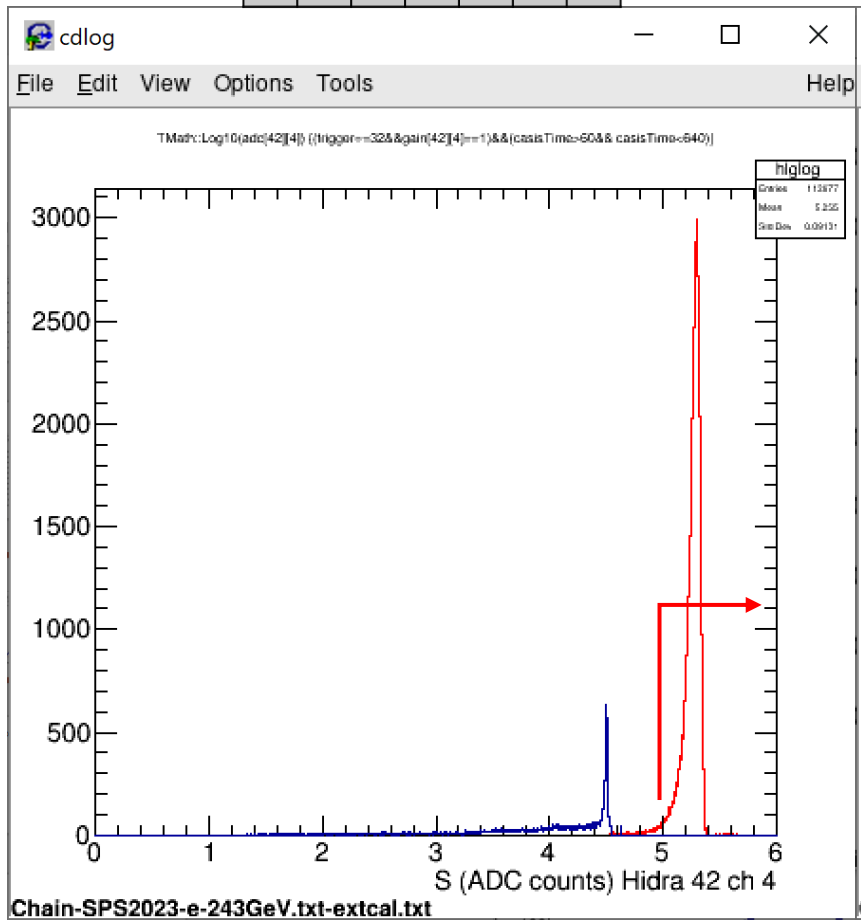


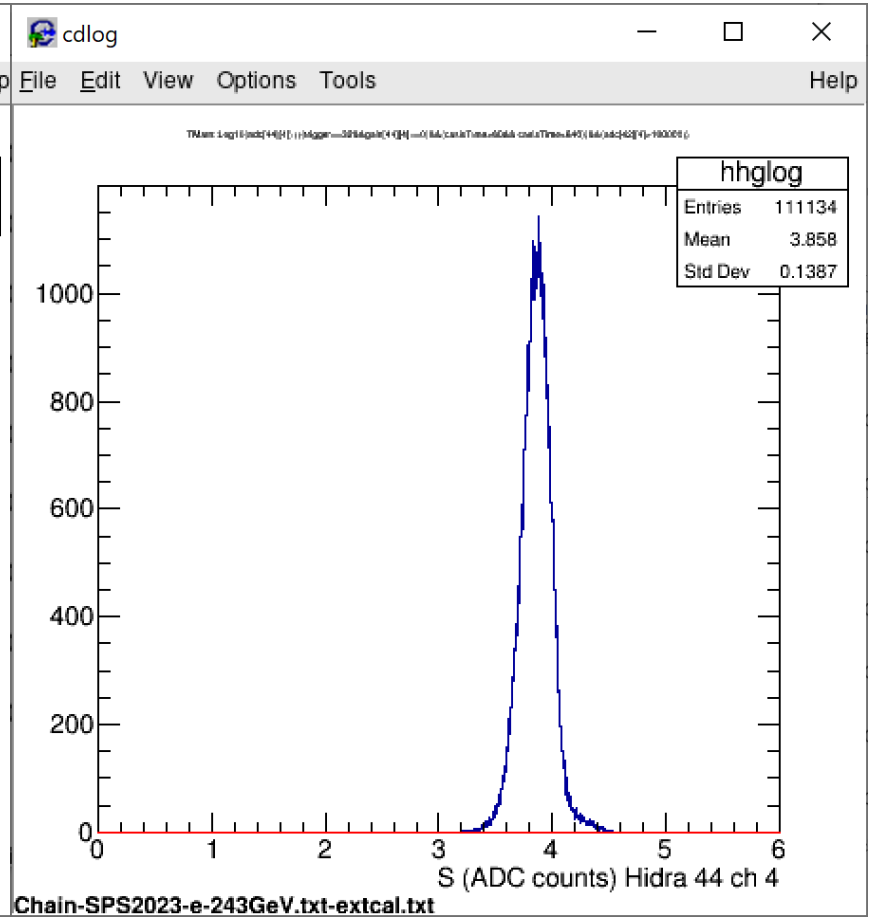
(Scolopendre diverse, stessa scheda)

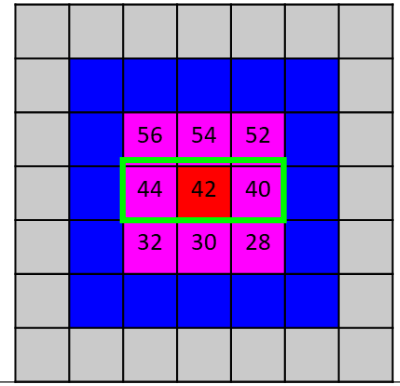
Non si osservano spike sulle colonne laterali



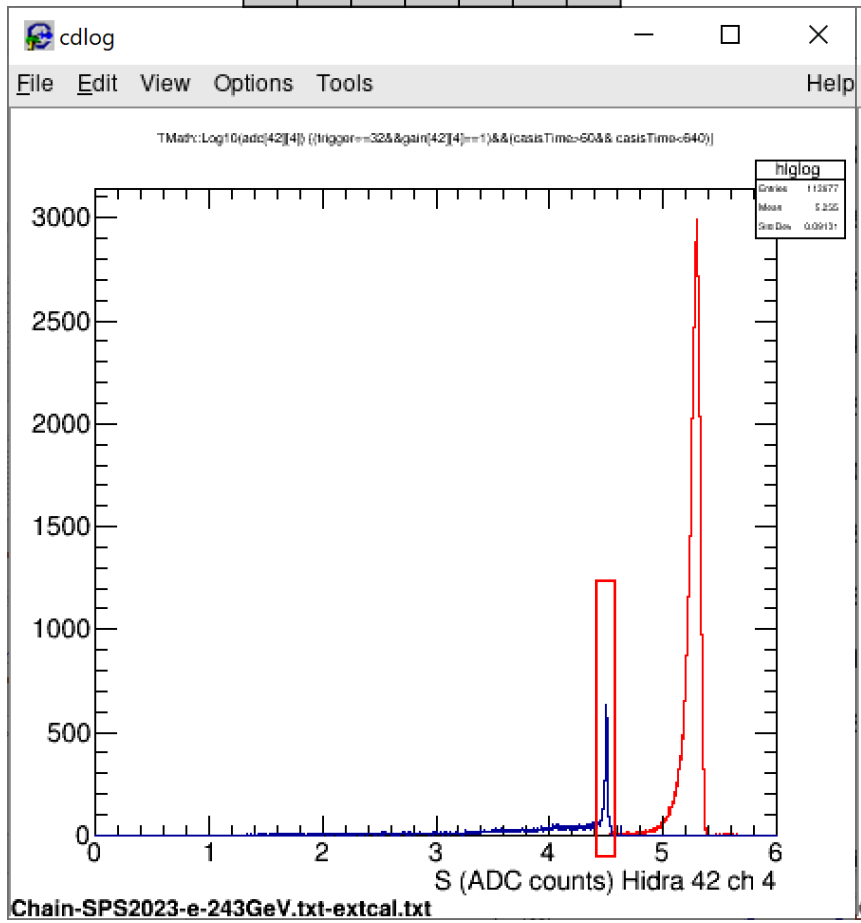
243 GeV
Colonna sx/centrale/dx
Layer 3
LPD

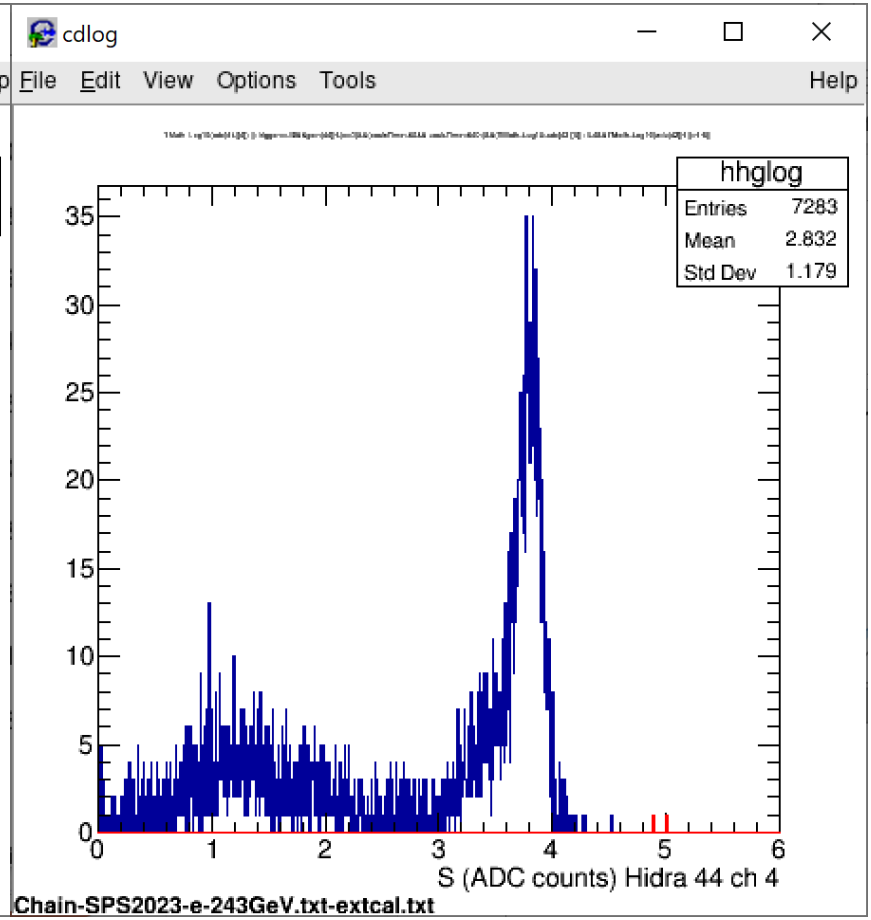






243 GeV
Colonna sx/centrale/dx
Layer 3
LPD

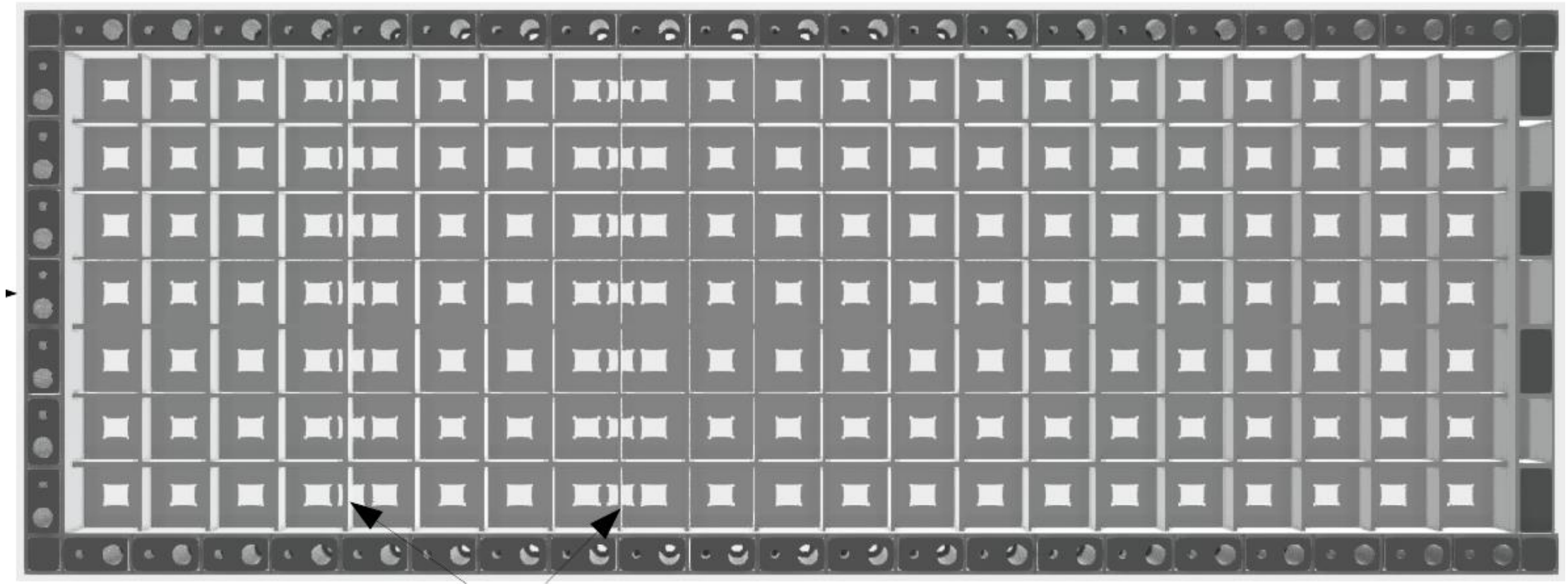




- Il raccordo tra alto e basso guadagno sembra ragionevole, almeno a queste energie (restano da vedere gli ioni)
- Ma, non capisco perche` il picco che si presume sia dovuto al segnale diretto sul sensore si osserva simultaneamente su colonne diverse…
- Guardo i diodi ciechi…

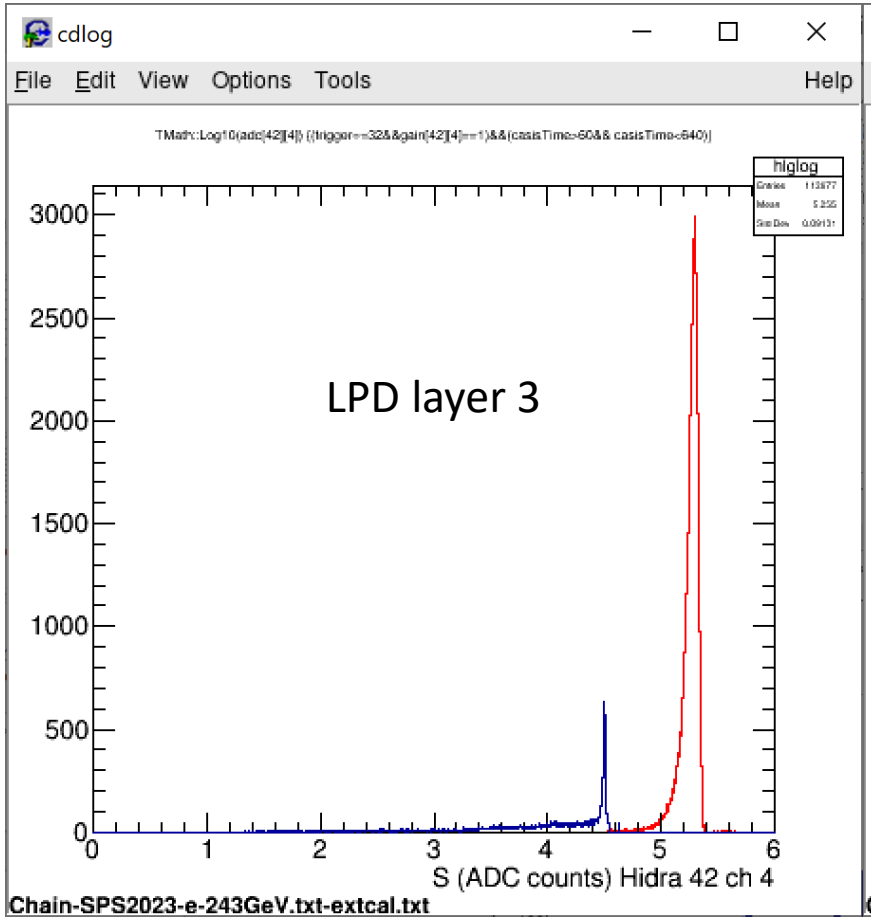
LPD ciechi

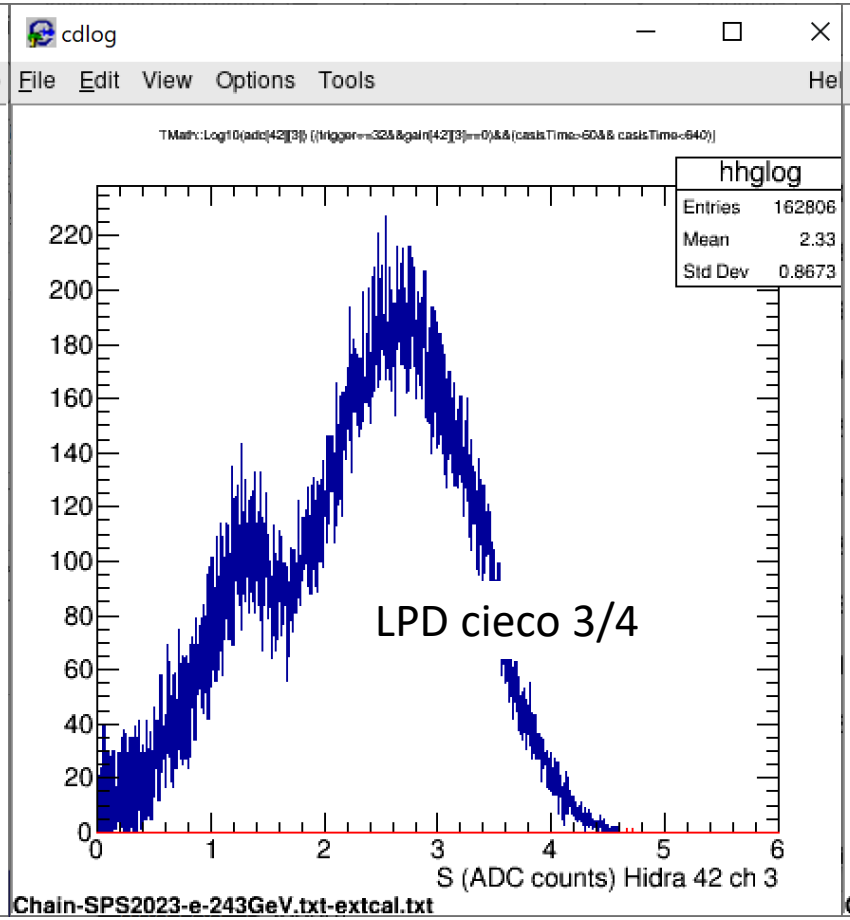
```
root [1] DumpColumn(3,3)

  layer sensor    chip chanel status CN-channel
     21      0      42      3      1         12
     21      1      41      2      1          4
     22      0      42      8      1         12
     22      1      -1     -1      0
```

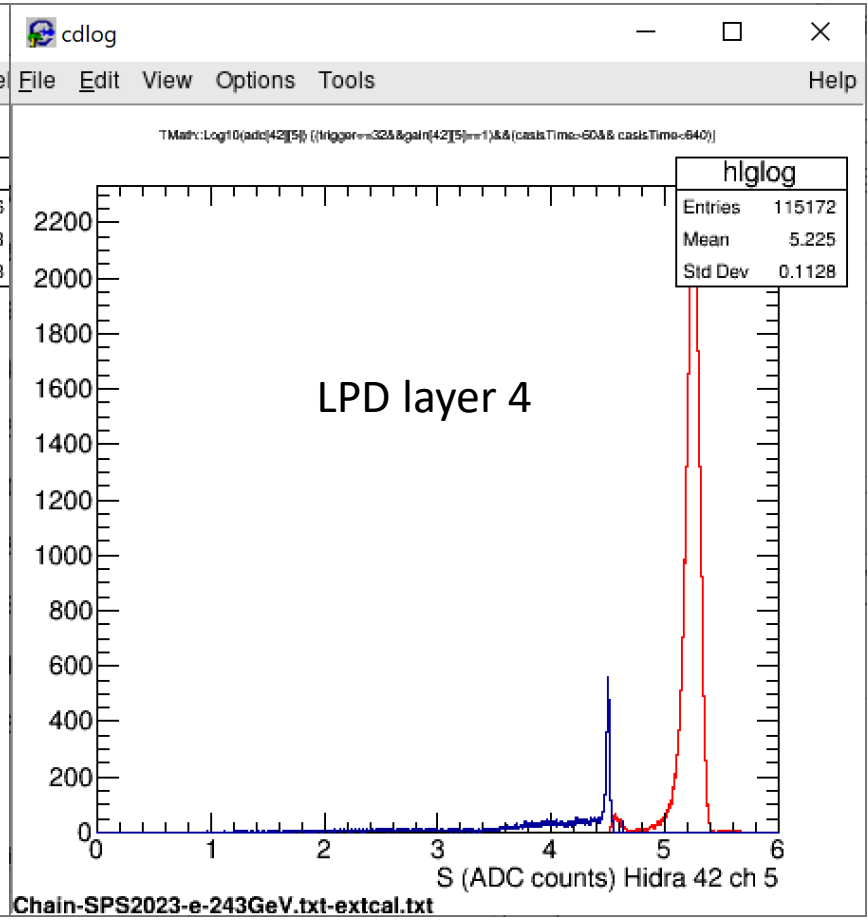


0 1 2 3 4

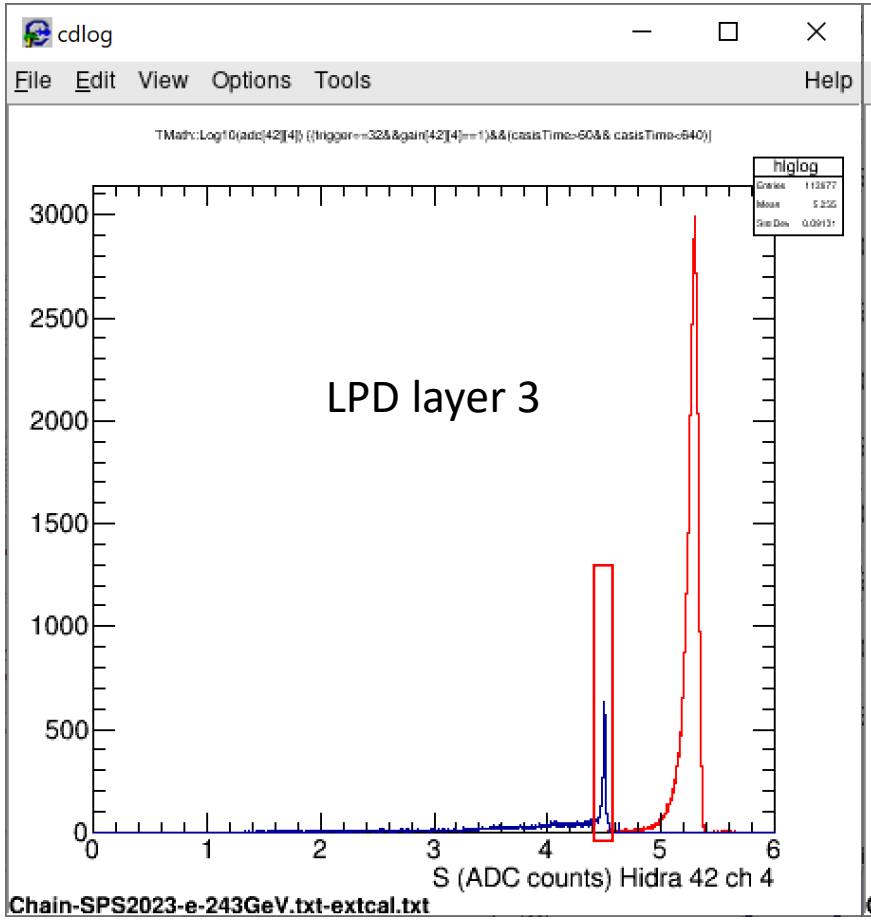
243 GeV
Colonna centrale
Layer 3 (cieco) 4
LPD

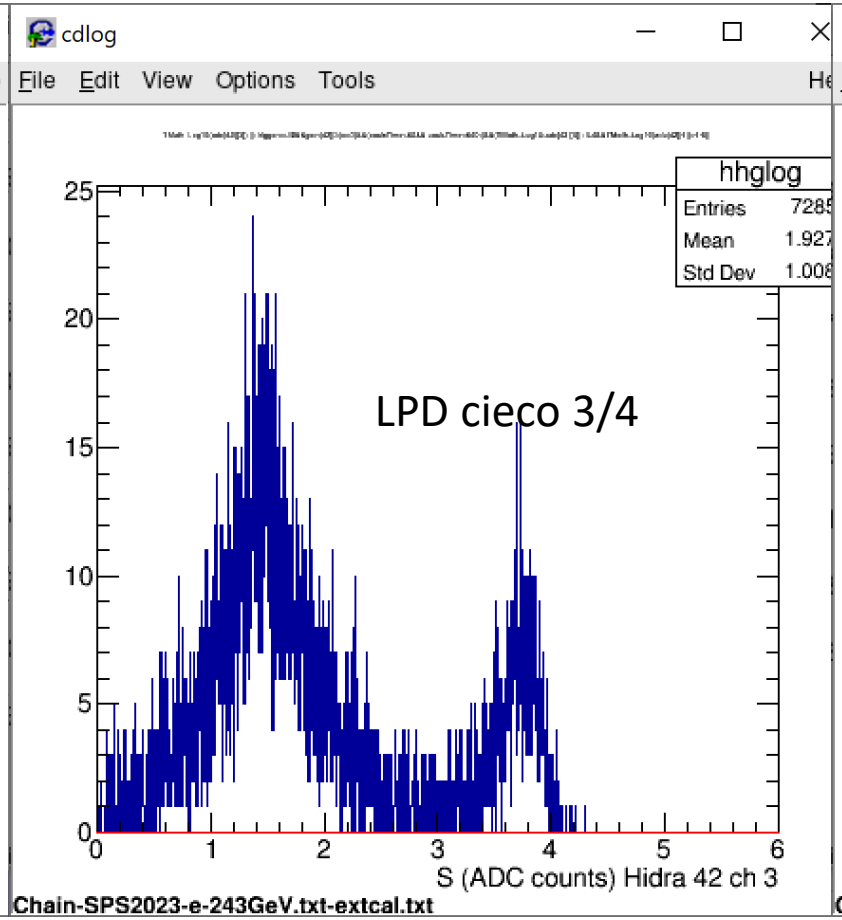


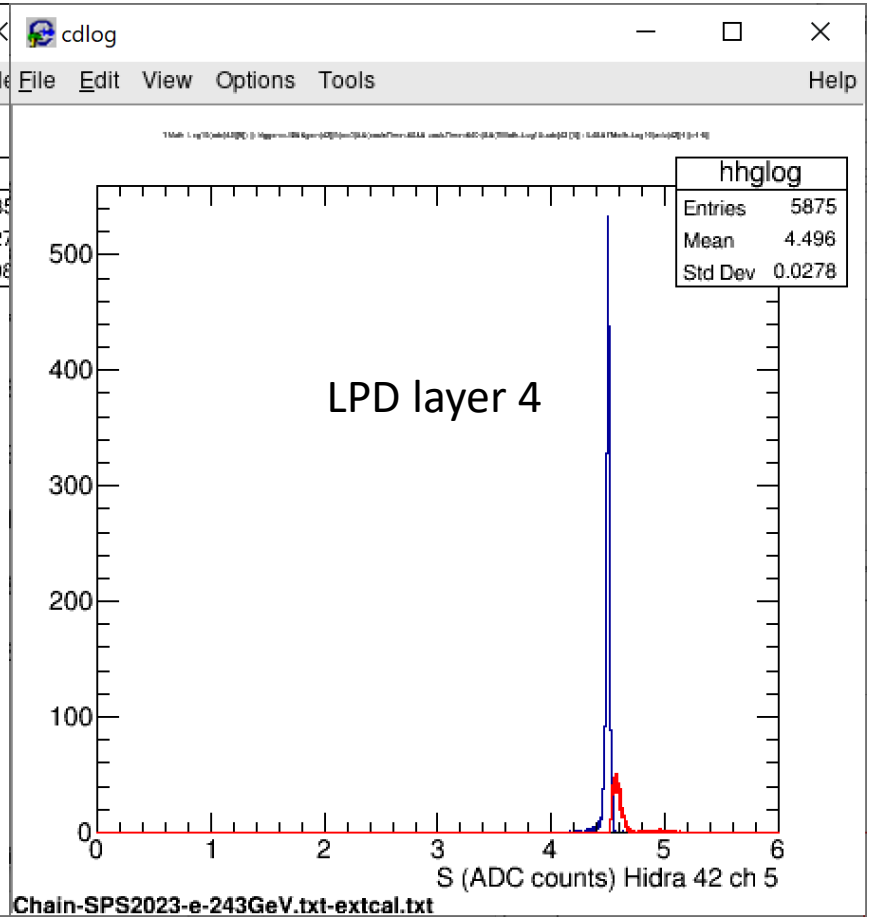




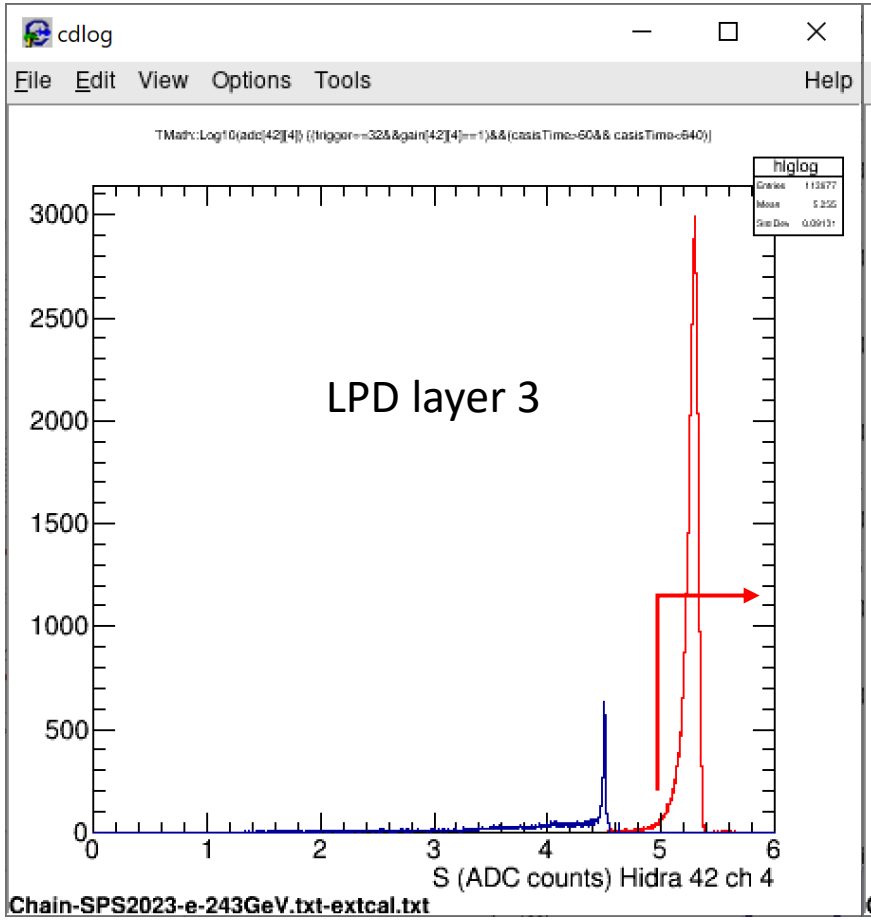
243 GeV
Colonna centrale
Layer 3 (cieco) 4
LPD

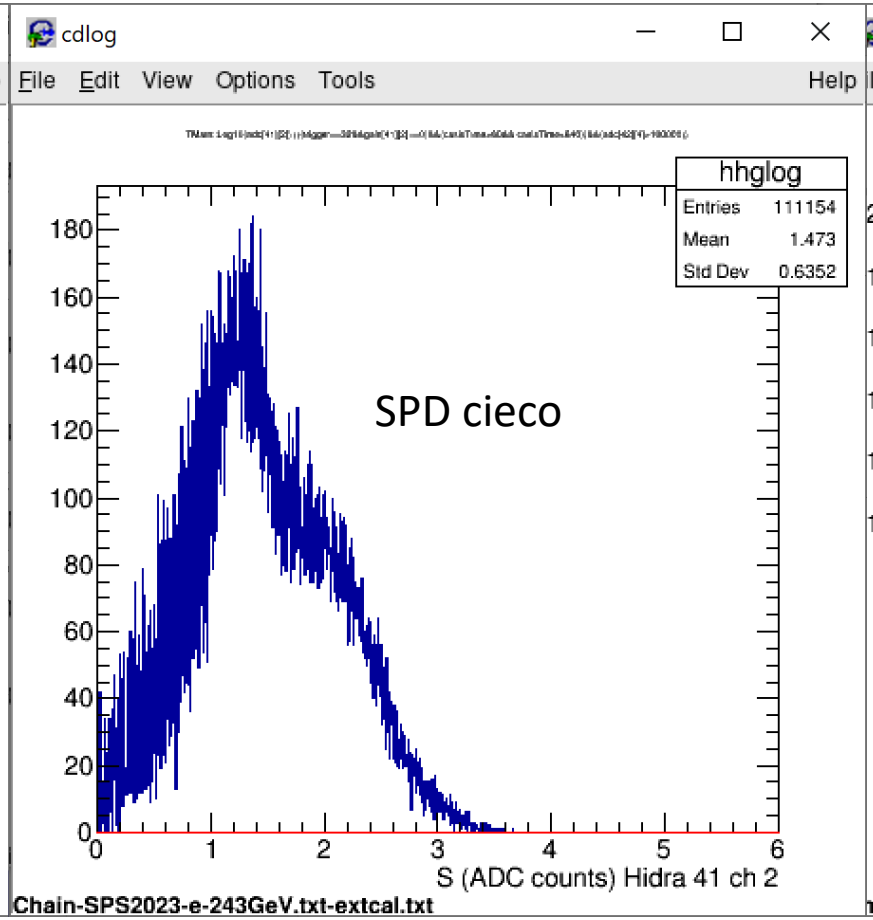


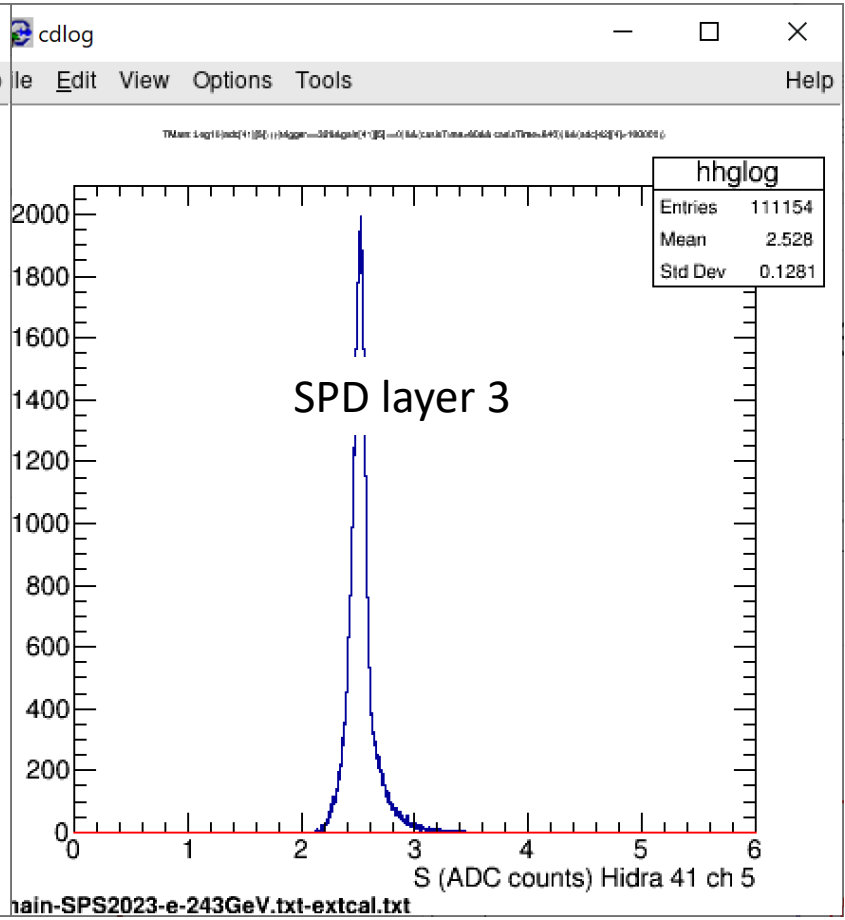




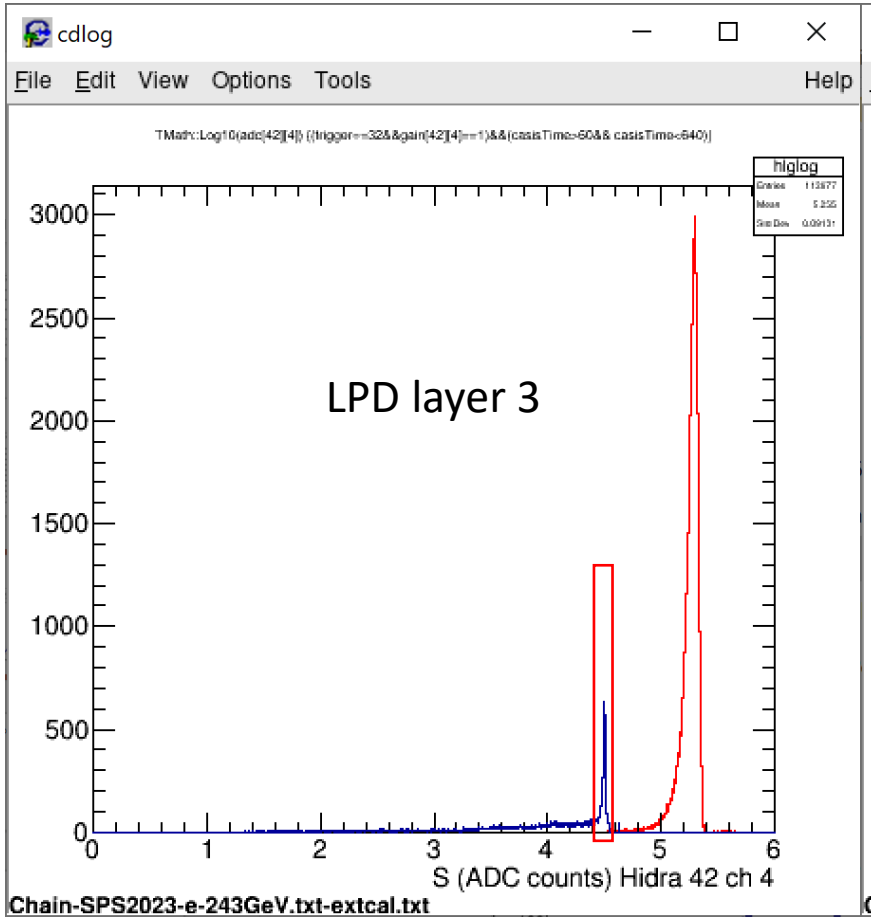
243 GeV
Colonna centrale
Layer 3
LPD SPD

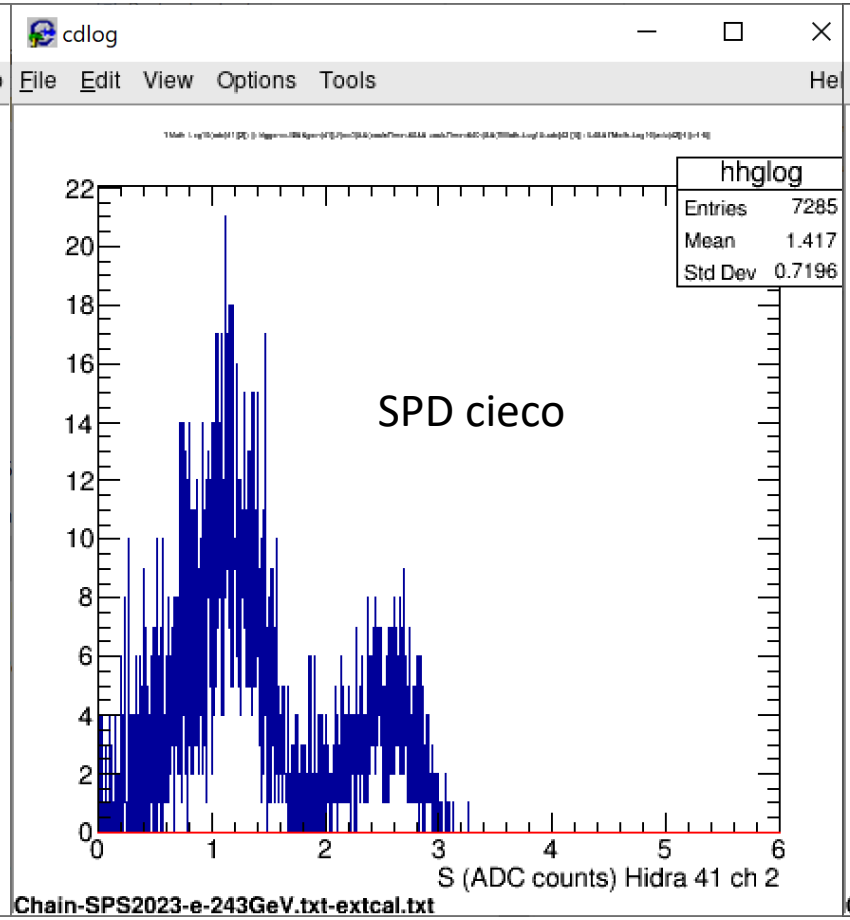


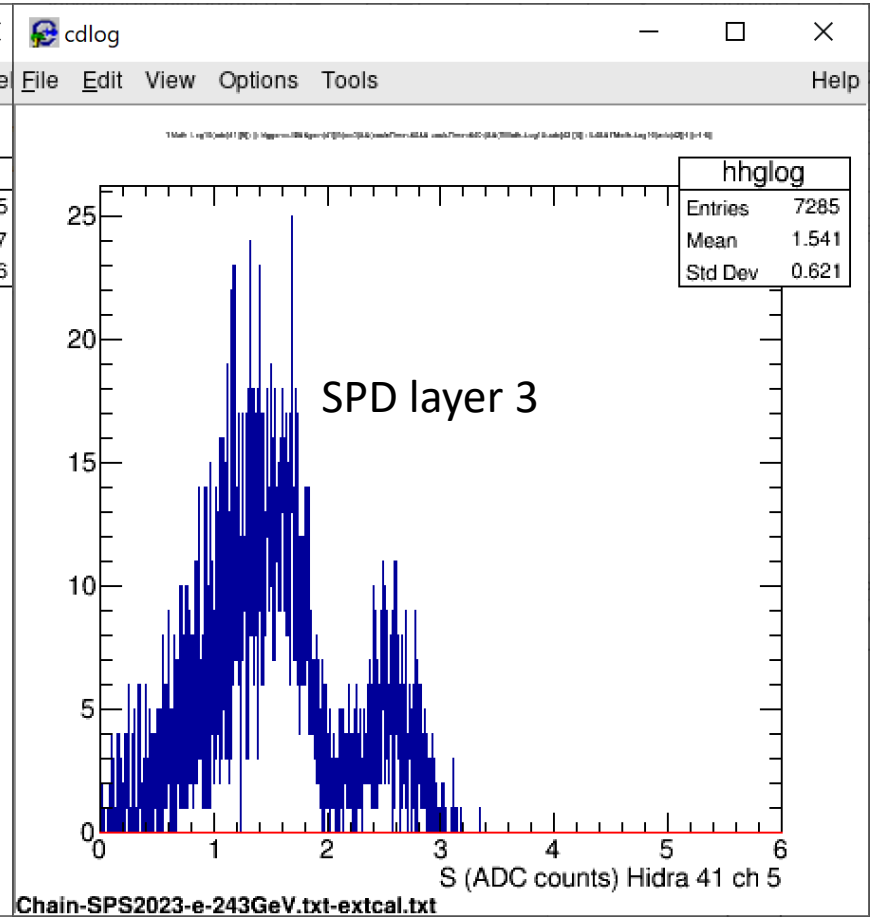




243 GeV
Colonna centrale
Layer 3
LPD SPD



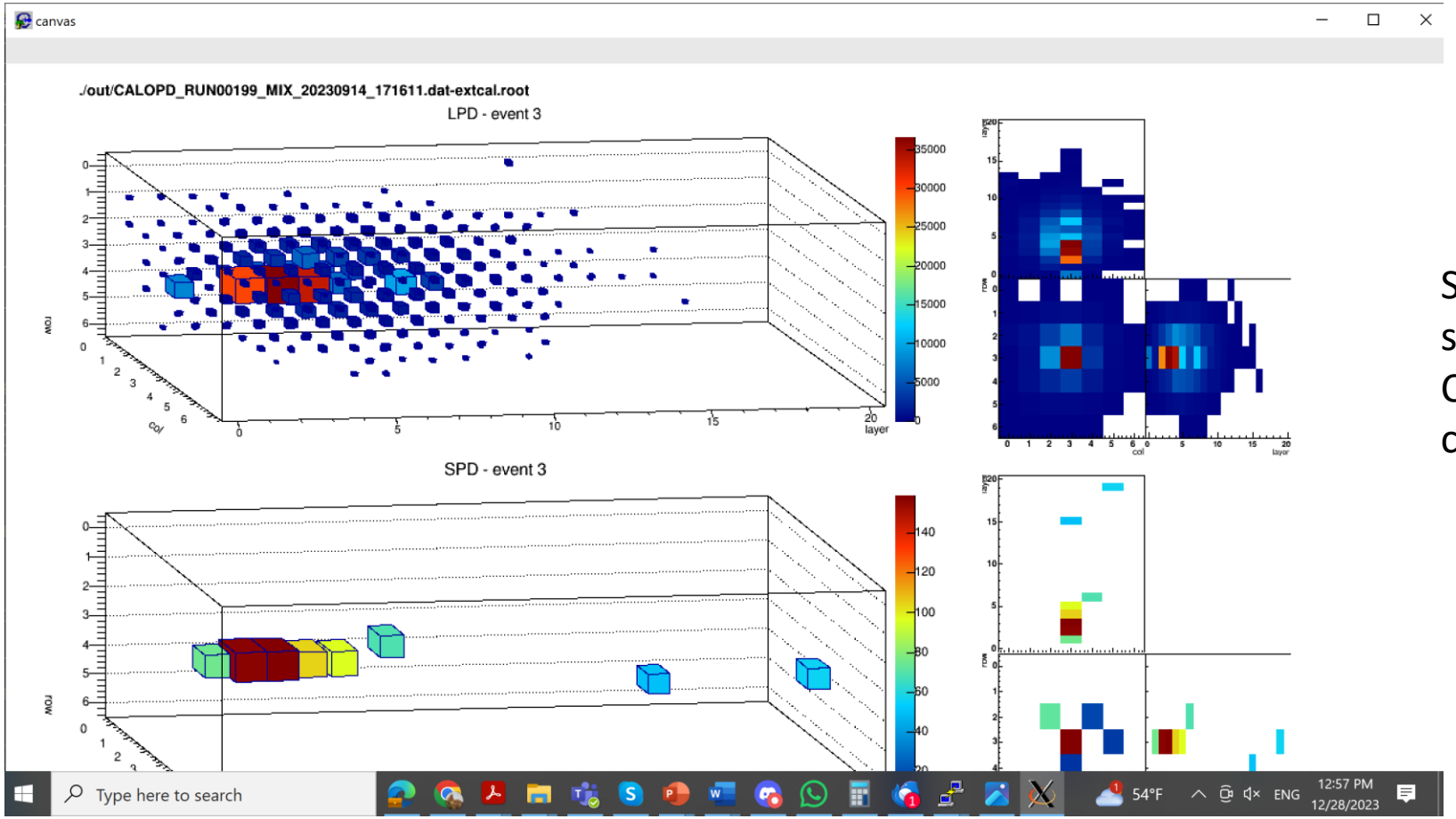




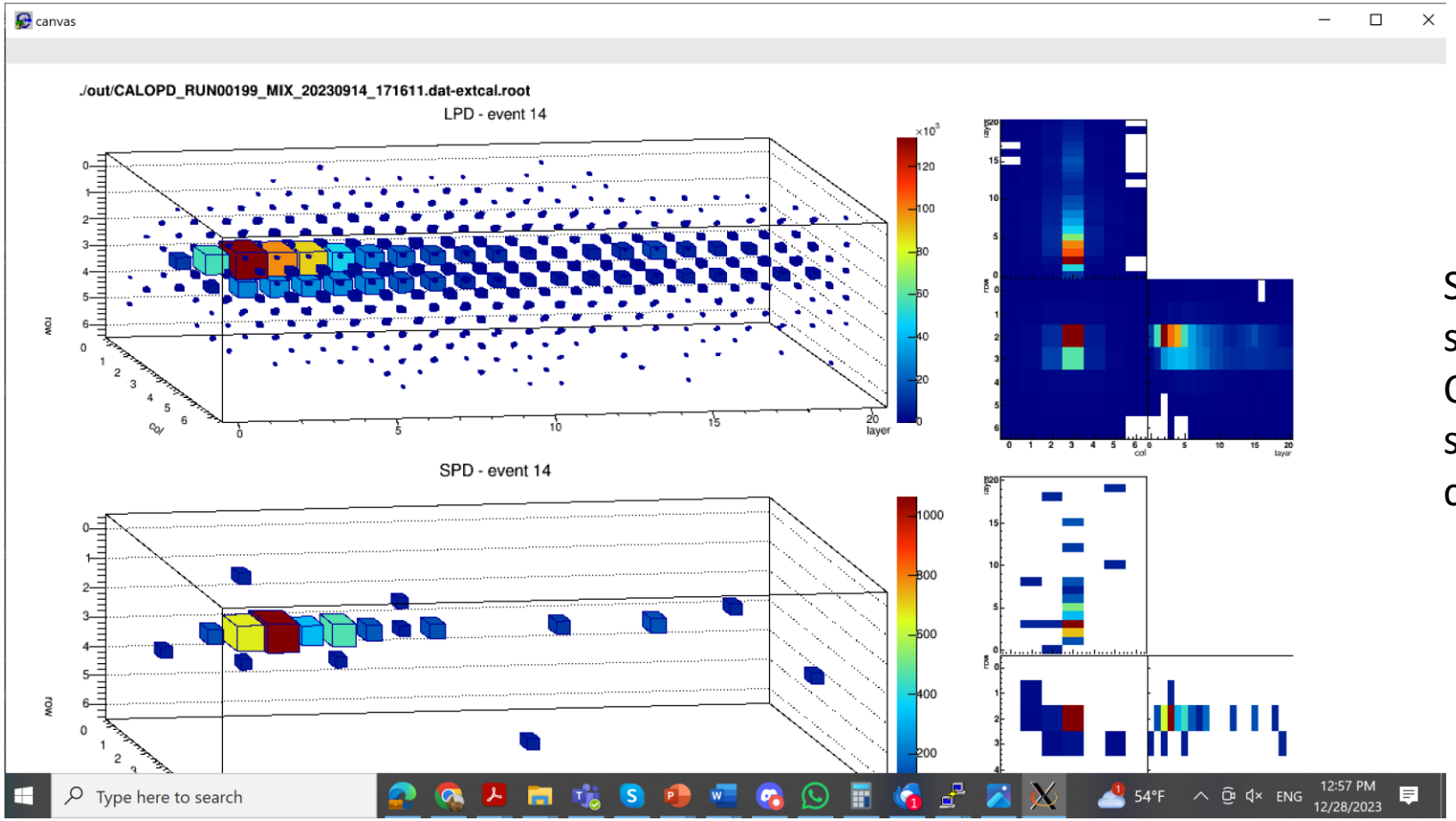
vannucci@farm:~/bombur/HERD/TB2023/Work

```
root (cont'ed, cancel with .@) [13].@
root [14] c->Scan("Entry$:adc[42][4]","TMath::Log10(adc[42][4])>4.4&&TMath::Log10(adc[42][4])<4.6")
***********************************
*    Row   *    Entry$ * adc[42][4 *
***********************************
*        3 *         3 * 36546.652 *
*       14 *        14 * 31064.726 *
*       16 *        16 * 31114.726 *
*       24 *        24 * 35684.554 *
*       42 *        42 * 32536.726 *
*       43 *        43 * 25970.726 *
*       49 *        49 * 31229.726 *
*       76 *        76 * 31784.726 *
*      146 *       146 * 32215.726 *
*      149 *       149 * 30983.726 *
*      159 *       159 * 29657.726 *
*      177 *       177 * 31169.726 *
*      183 *       183 * 31851.726 *
*      190 *       190 * 26404.726 *
*      204 *       204 * 31988.726 *
*      207 *       207 * 35120.726 *
*      210 *       210 * 26741.726 *
*      212 *       212 * 28337.726 *
*      236 *       236 * 25701.726 *
*      249 *       249 * 31075.726 *
*      301 *       301 * 29858.726 *
*      312 *       312 * 36185.773 *
*      321 *       321 * 32166.726 *
*      338 *       338 * 31126.726 *
*      370 *       370 * 31928.726 *
Type <CR> to continue or q to quit ==> q
***********************************
==> 25 selected entries
(long long) 25
root [15] .q
[vannucci@farm Work]$
```

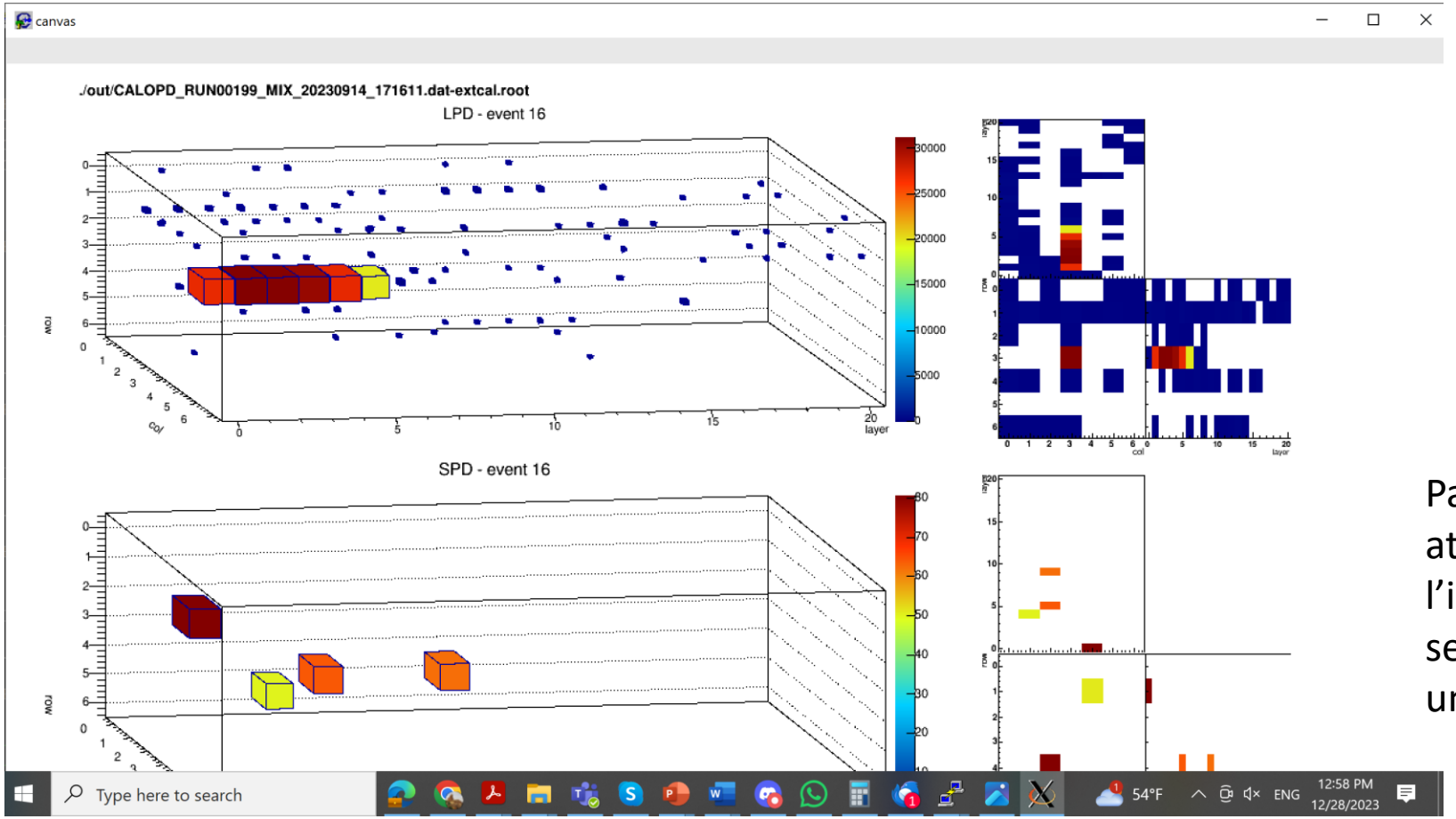
Seleziono lo spike nel cubo centrale del layer 3



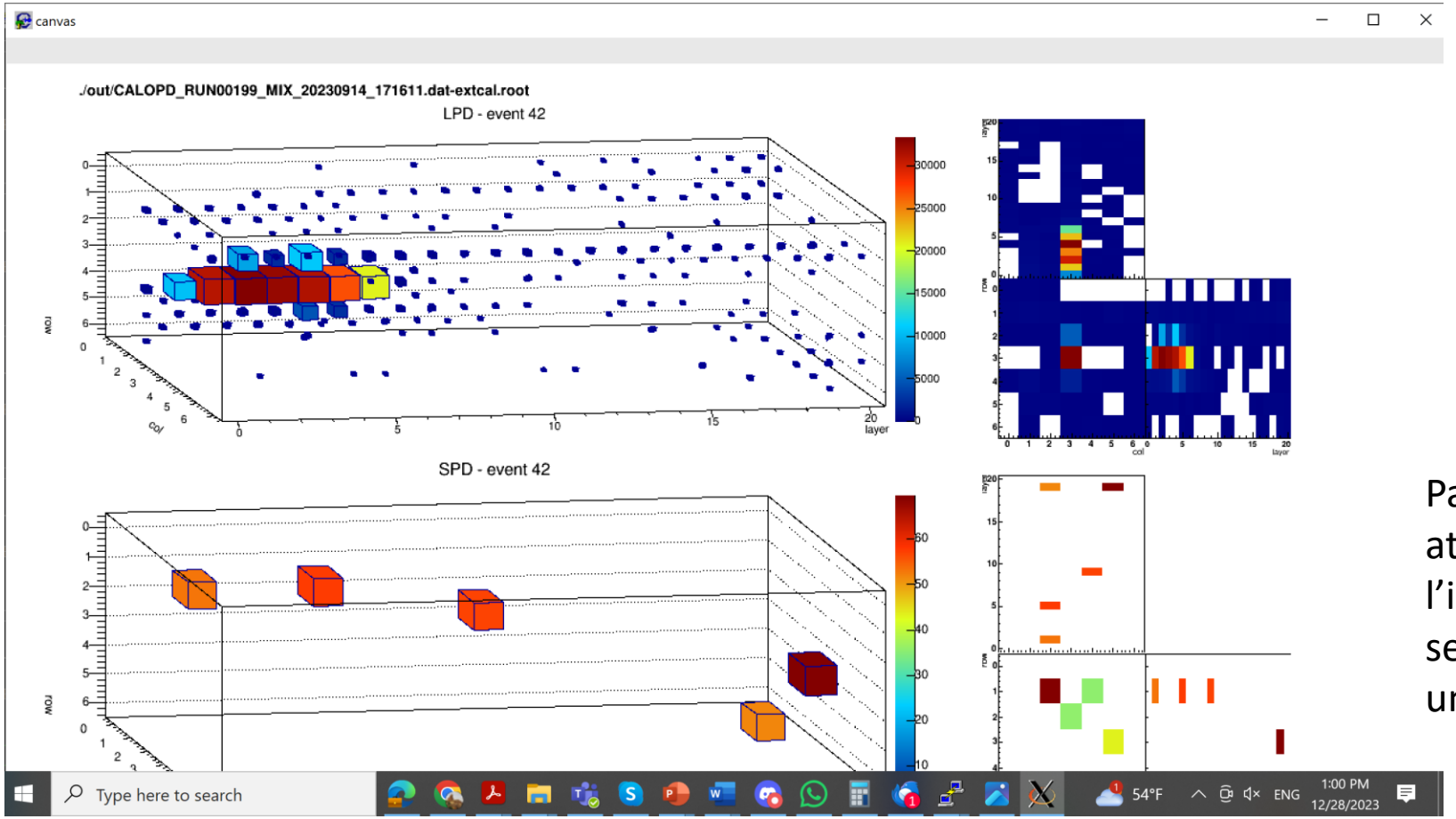
Sciame che si sviluppa nella Colonna centrale



Sciame che si sviluppa nella Colonna sopra a quella centrale



Particella che attravesra l'intercapedine senza generare uno sciame?

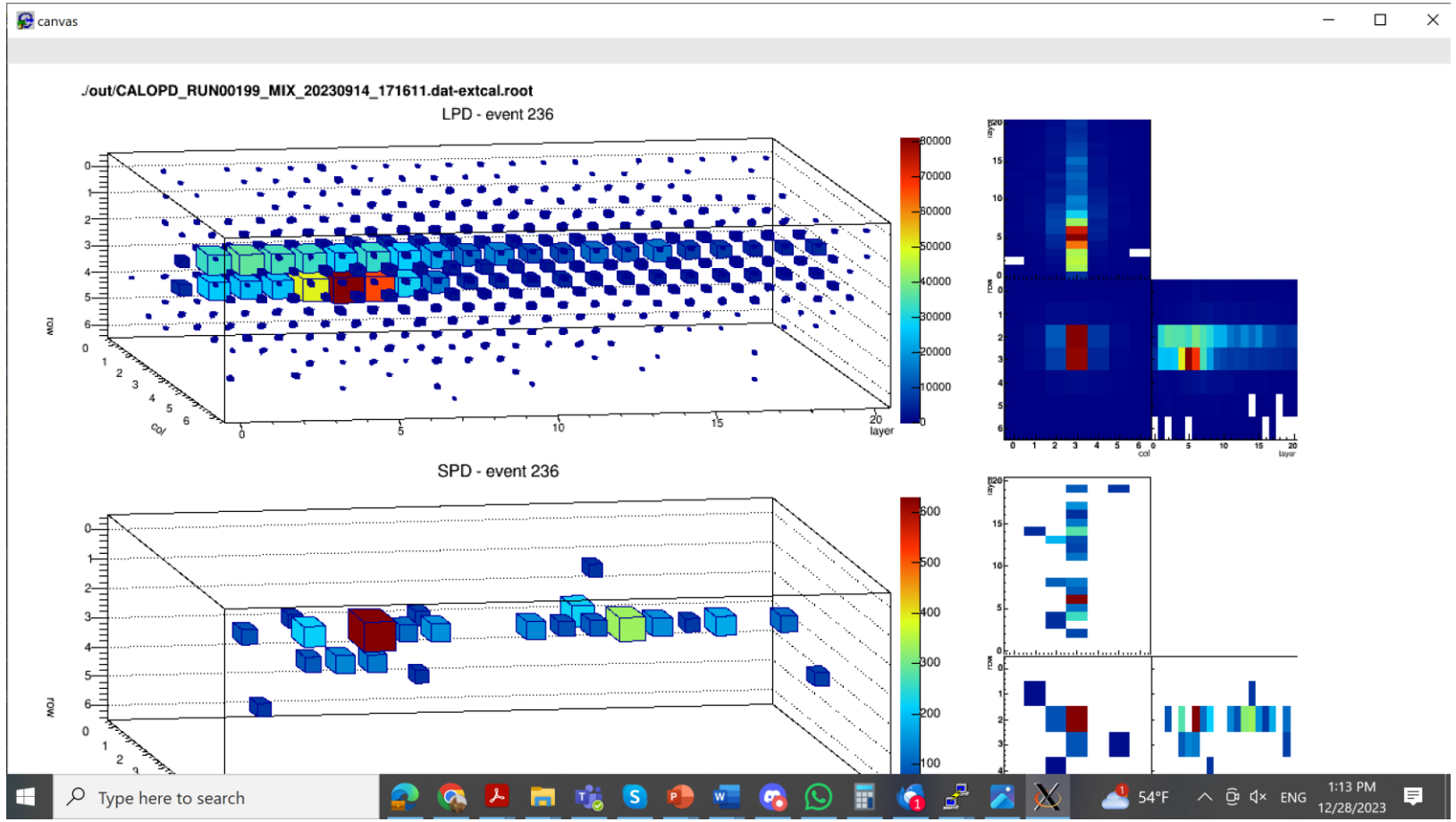


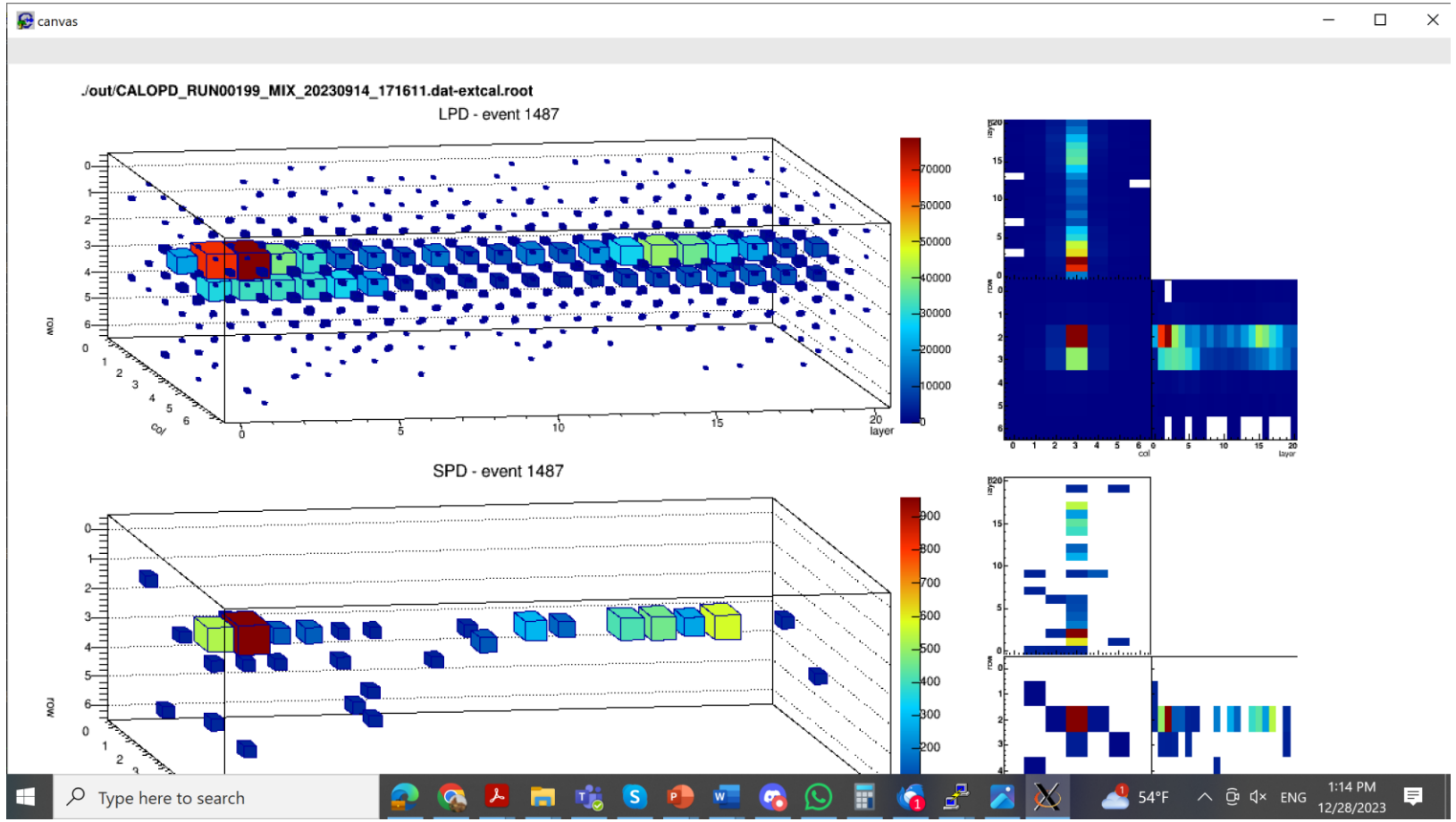
Particella che attravesra l'intercapedine senza generare uno sciame?

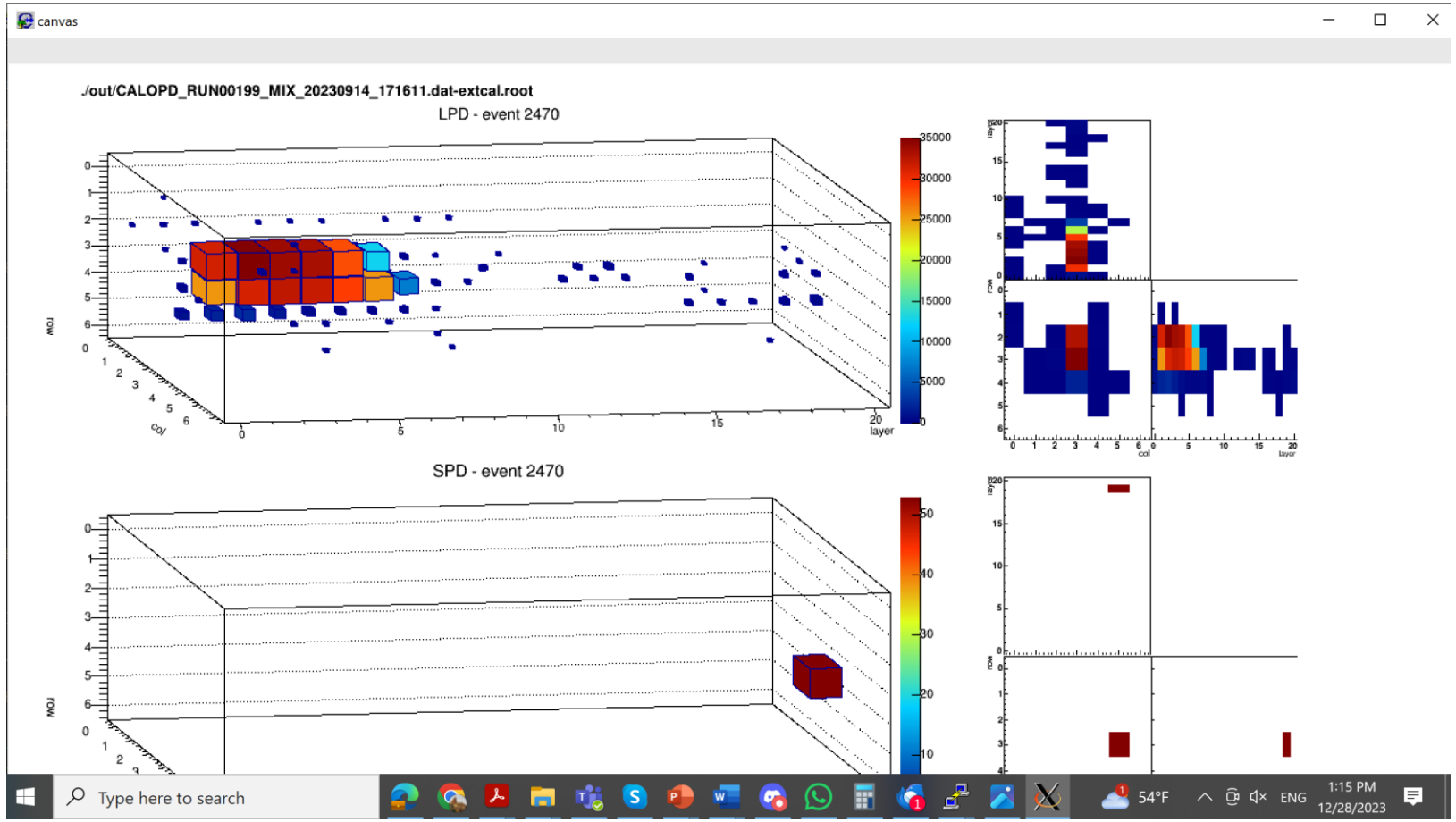
vannucci@farm:~/bombur/HERD/TB2023/Work

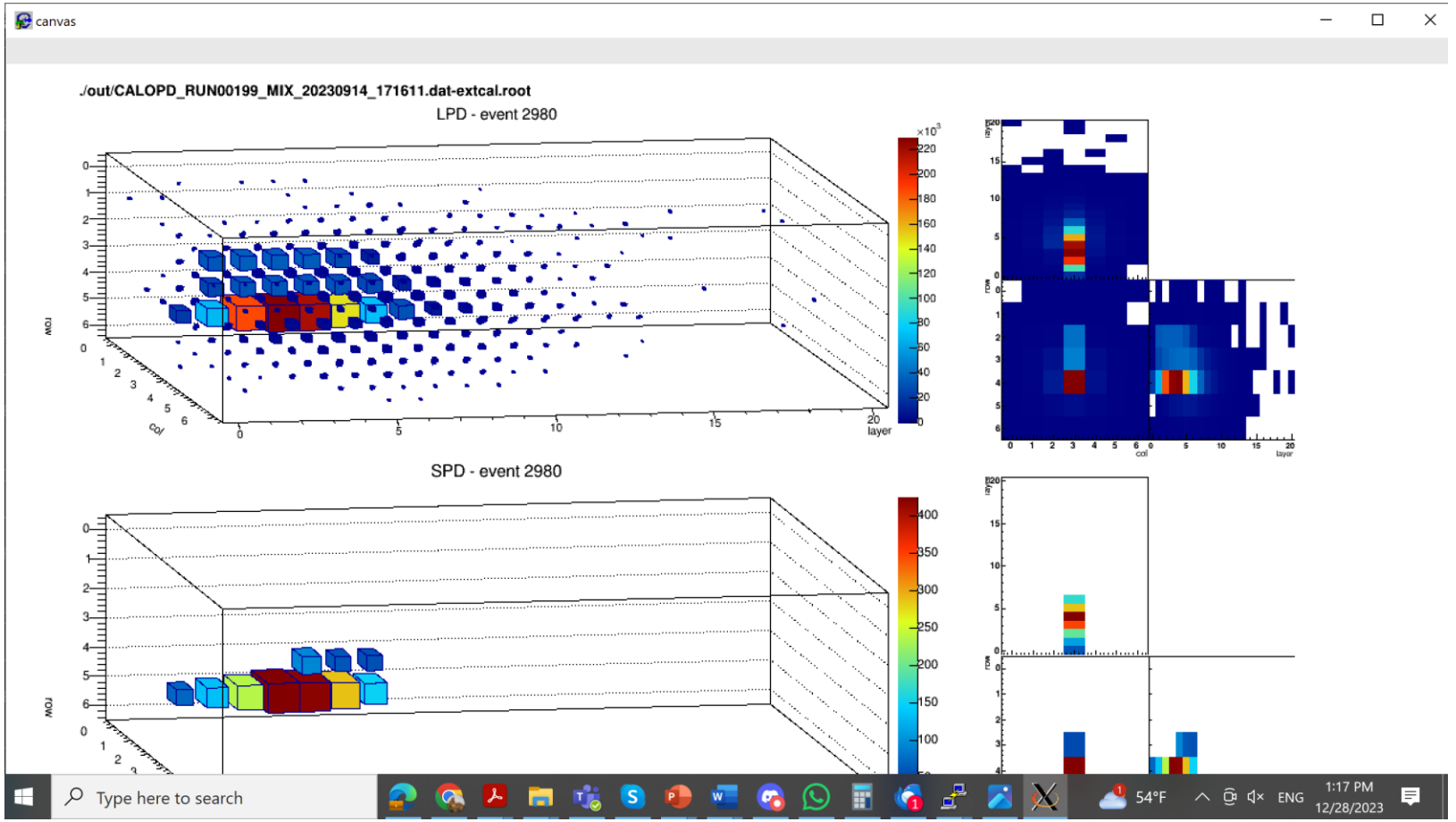
```
*     1439 *      1439 * 34020.503 *
Type <CR> to continue or q to quit ==> q
************************************
==> 25 selected entries
(long long) 25
root [4] c->Scan("Entry$:adc[42][4]","TMath::Log10(adc[42][4])>4.4&&TMath::Log10(adc[42][4])<4.6&&TMath::Log10(adc[54][4])>4.4&&TMath::Log10(adc[54][4])<4.6")
************************************
*    Row   *    Entry$ * adc[42][4 *
************************************
*      236 *       236 * 25701.726 *
*     1487 *      1487 * 32750.726 *
*     2470 *      2470 * 32384.726 *
*     2980 *      2980 * 32625.726 *
*     6029 *      6029 * 29237.726 *
*     6802 *      6802 * 31760.726 *
*     7221 *      7221 * 25410.726 *
*     8319 *      8319 * 29493.726 *
*     9696 *      9696 * 31410.726 *
*    11964 *     11964 * 29512.726 *
*    13675 *     13675 * 30379.726 *
*    14755 *     14755 * 32550.726 *
*    15735 *     15735 * 38591.628 *
*    18035 *     18035 * 31469.726 *
*    18266 *     18266 * 35799.726 *
*    18609 *     18609 * 32830.726 *
*    18824 *     18824 * 31404.726 *
*    21274 *     21274 * 32669.726 *
*    21740 *     21740 * 29794.726 *
*    21966 *     21966 * 31680.726 *
*    24860 *     24860 * 30852.726 *
*    25542 *     25542 * 28569.726 *
*    29750 *     29750 * 30722.726 *
*    31177 *     31177 * 32986.726 *
*    31356 *     31356 * 31654.726 *
Type <CR> to continue or q to quit ==>
```

Seleziono lo spike nel cubo centrale del layer 3 e nel cubo sopra


canvas
./out/CALOPD_RUN00199_MIX_20230914_171611.dat-extcal.root
LPD - event 236
SPD - event 236
row
col
layer
Type here to search
54°F
ENG
1:13 PM
12/28/2023


canvas
./out/CALOPD_RUN00199_MIX_20230914_171611.dat-extcal.root
LPD - event 1487
SPD - event 1487
Type here to search
54°F
ENG
1:14 PM
12/28/2023


canvas
./out/CALOPD_RUN00199_MIX_20230914_171611.dat-extcal.root
LPD - event 2470
row
col
layer
SPD - event 2470
Type here to search
54°F
ENG
1:15 PM
12/28/2023



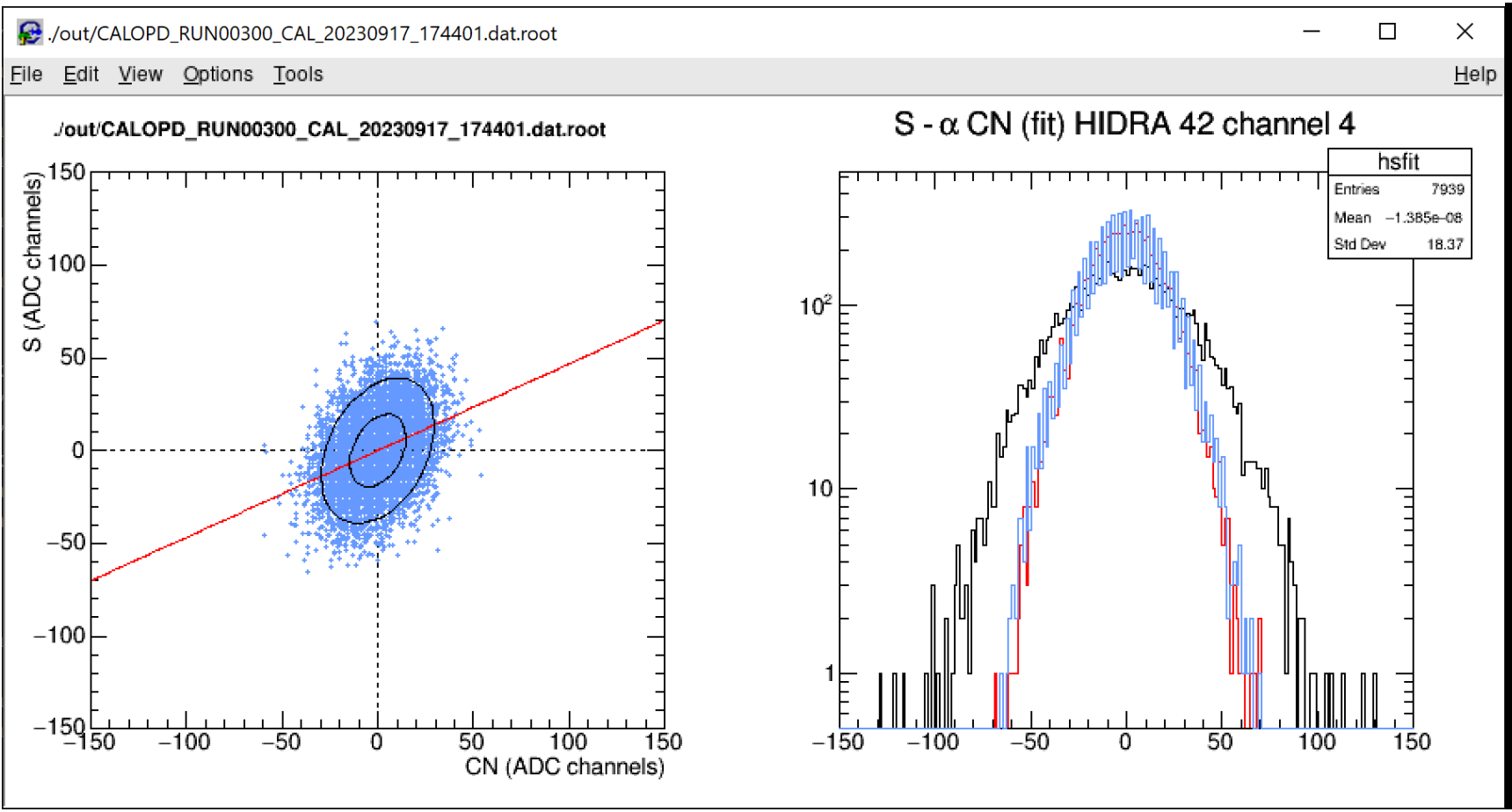
Sciame che si sviluppa nella Colonna sotto a quella centrale

- Il raccordo tra alto e basso guadagno sembra ragionevole, almeno a queste energie (restano da vedere gli ioni)
- Ma, non capisco perche` lo spike che si presume sia dovuto al segnale diretto sul sensore si osserva simultaneamente su colonne diverse…
  - Continuo a non capirlo molto bene… sembrano particelle che attraversano i sensori di taglio, ma non mi e` chiaro perche` dovrebbero farlo su due file contemporaneamente. Particelle multiple? Boh?
- Guardo i diodi ciechi…
  - Non sembrano esssere molto utili
  - Comunque, penso che gli spike siano dovuto ad eventi particolari e non a effetti strumentali. Penso si possano facilmente eliminare con tagli topologici (numero di hit, posizione del massimo, ecc…) + tracciatore

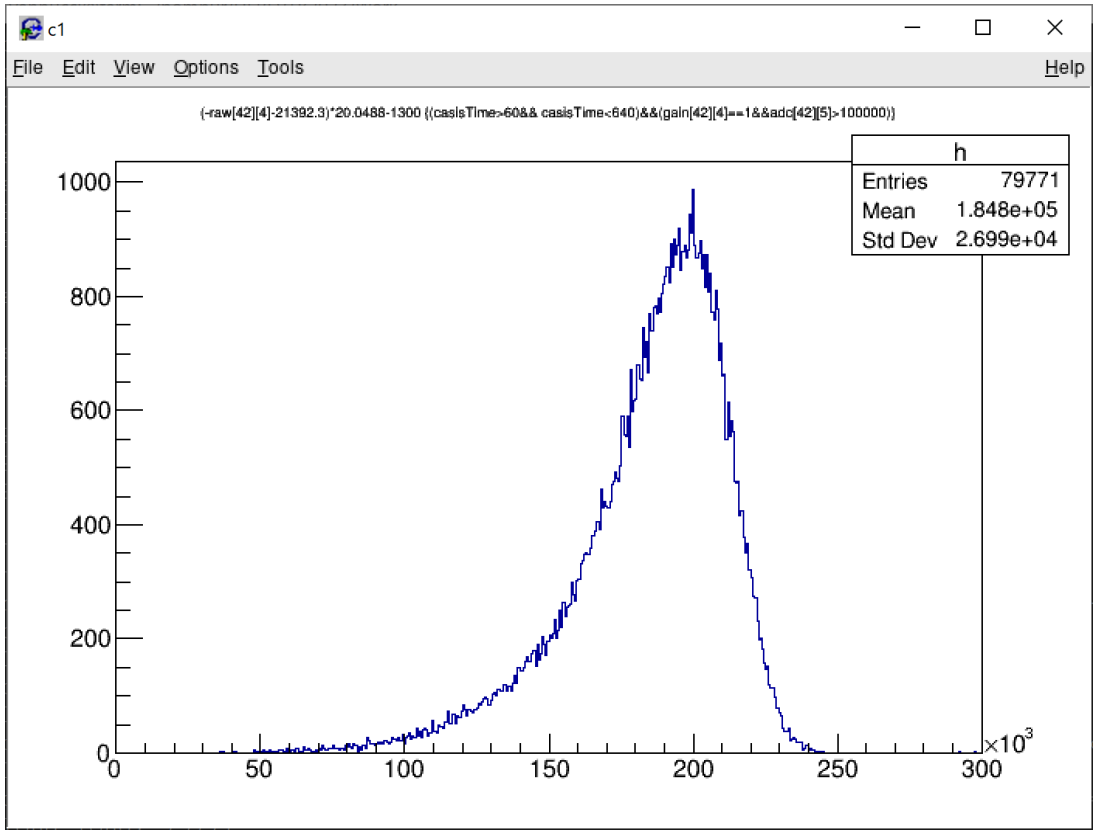
When a signal $R_{i,n}$ is readout in low-gain regime, after pedestal and common noise subtraction, it was scaled according the relation:

$$S_{i,n} = G \cdot (R_{i,n} - PED_i - c \cdot \alpha_i^{a,b} \cdot CN_n^{a,b}) + P \tag{3.2}$$

The parameters in Eq.3.2 represent the ratio (G) between high and low gain of the HIDRA chips, a pedestal offset (P) and a noise scaling factor (c). The scaling parameters were measured in laboratory during the qualification test of the HIDRA board prototypes. The high-to-low gain ratio was found to agree with the nominal value $G = 20$ at the level of less than 0.5%. The pedestal shift P was found to be not negligible and equal to ≈ -2000 ADC units. The factor c accounts for the fact that in low-gain mode the noise is reduced by a factor ≈ 0.07 and ≈ 0.11 for LPD and SPD channels, respectively. All three parameters were assumed to be the same for all the HIDRA boards. The low-gain single-channel response is linear up to a threshold value that depends on the board and is $\gtrapprox 51000$ ADC counts; above this value the signal sharply saturates.




```
iHydra 42 channel 4

 this bin    1013
 sigmaHisto1DRaw(1013)     19.6139
 sigmaHisto1D(1013)        19.9585
 pedHisto1D(1013)        21392.3

gAlpha_42_4   -----> N = 7939

 alpha (fit)    0.468451


cov xx 216.124
cov xy 101.243
cov yy 384.705
cov yx 101.243
 eigenvalue 0 432.153  sqrt  20.7883
 eigenvalue 1 168.676  sqrt  12.9875
 R00  cos(theta)   0.424363 R01 -sin(theta)   -0.905492
 R10  sin(theta)   0.905492 R11  cos(theta)    0.424363
      tg(theta)    2.13377
 alpha (matrix) 2.13377

 sigma( y )            19.6139
 sigma( y - alpha*x ) 30.6047

 RMS( y )                   19.6139
 RMS( y - alpha*x ) fit     18.3651
 RMS( y - alpha*x ) matrix 30.6047

 mean( y - alpha*x ) fit    -1.38462e-08
 mean( y - alpha*x ) matrix -4.24392e-09
```

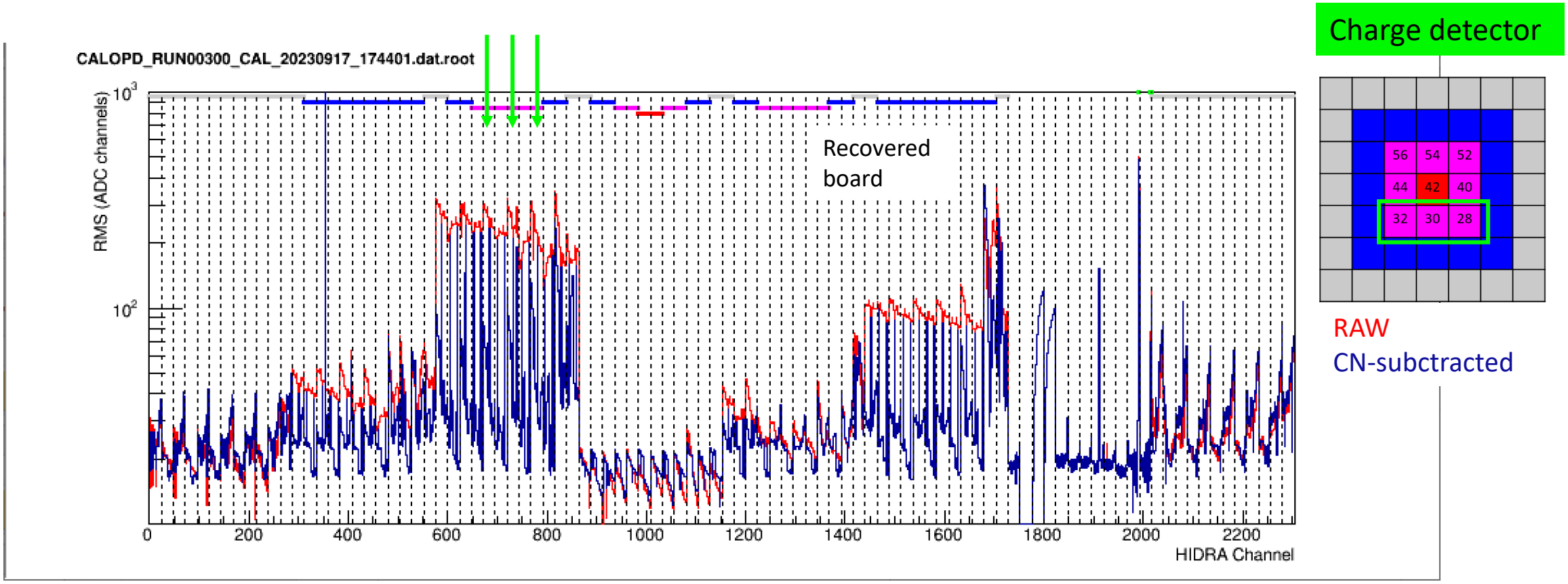


alpha	c	Mean	RMS
0.468451	0	184812.65	26991.616
	0.07	184812.27	26991.729

Nel canale centrale non fa differenza… si sapeva

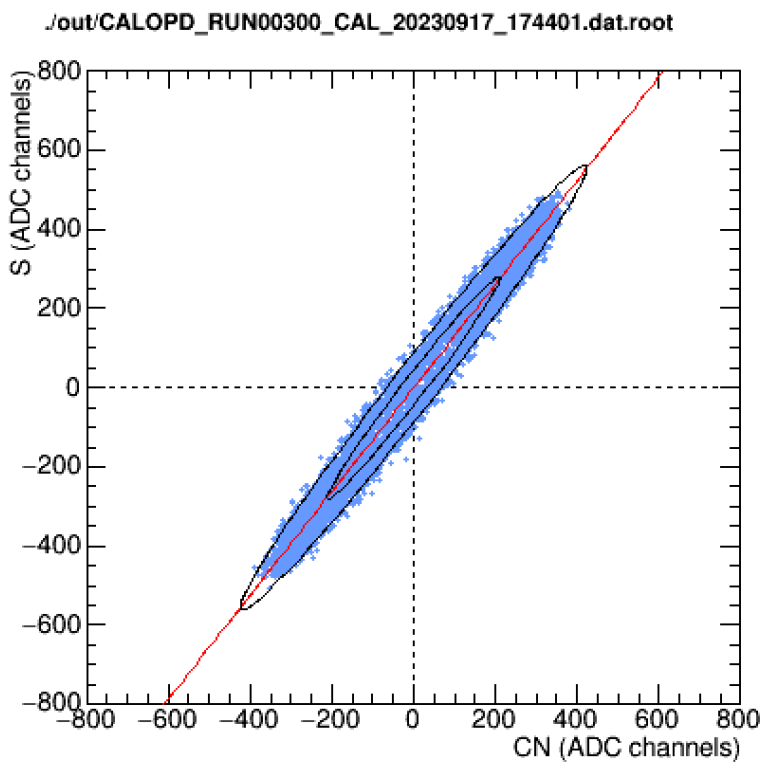
SIG

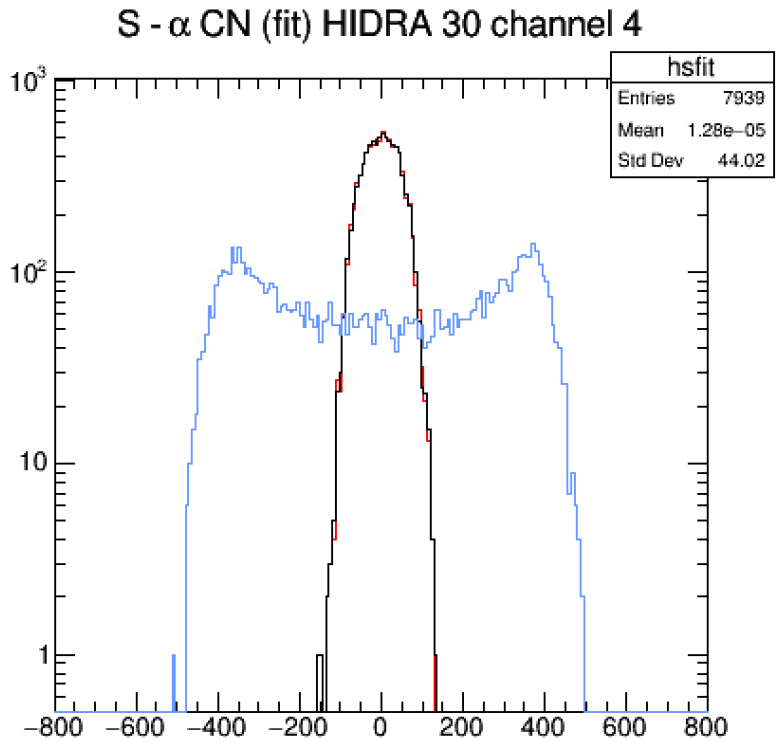
Guardo la scheda rumorosa che legge cubi vicini al core dello sciame



./out/CALOPD_RUN00300_CAL_20230917_174401.dat.root

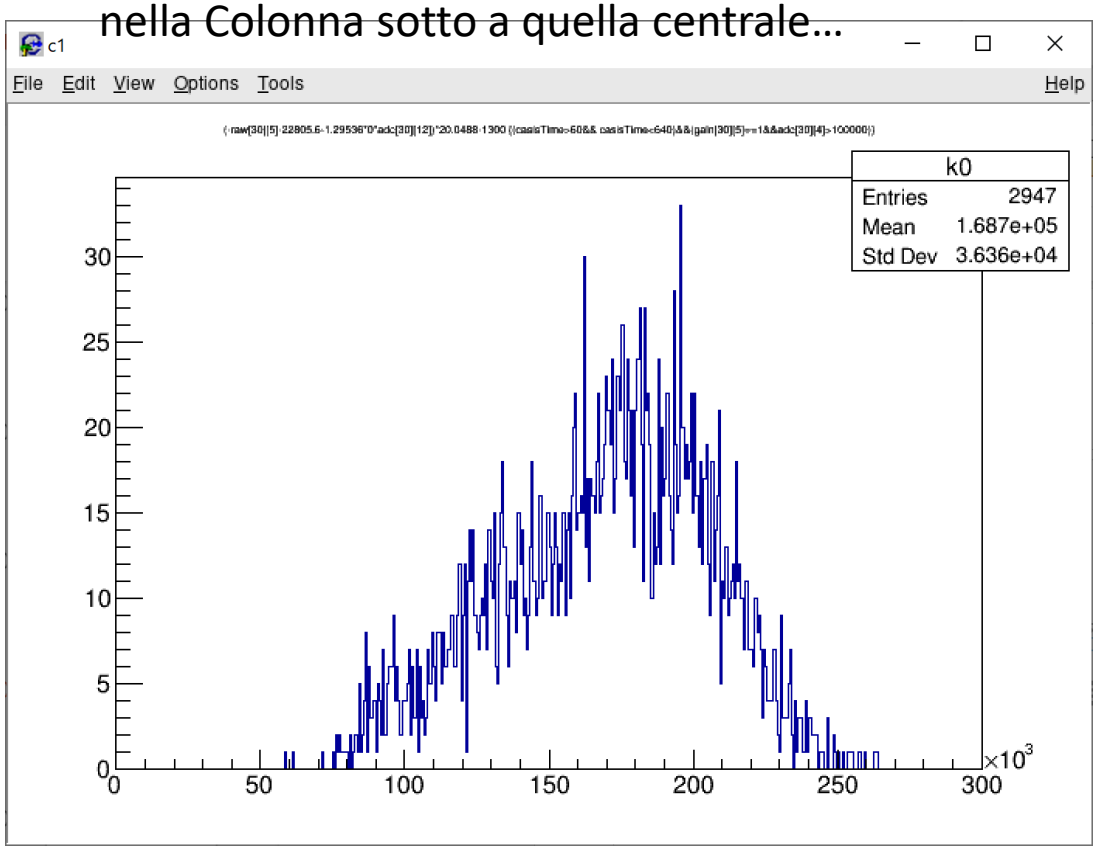
File Edit View Options Tools Help






```
iHydra 30 channel 4

 this bin    725
 sigmaHisto1DRaw(725)    280.766
 sigmaHisto1D(725)       79.0042
 pedHisto1D(725)       22752.9

gAlpha_30_4   -----> N = 7939

 alpha (fit)    1.30991


cov xx 44812.3
cov xy 58700.1
cov yy 78829.6
cov yx 58700.1
 eigenvalue 0 122936  sqrt  350.622
 eigenvalue 1 706.315  sqrt  26.5766
 R00  cos(theta)   0.600705 R01 -sin(theta)  -0.799471
 R10  sin(theta)   0.799471 R11  cos(theta)   0.600705
      tg(theta)    1.33089
 alpha (matrix) 1.33089

 sigma( y )           280.766
 sigma( y - alpha*x ) 44.2423

 RMS( y )                  280.766
 RMS( y - alpha*x ) fit    44.0189
 RMS( y - alpha*x ) matrix 44.2423

 mean( y - alpha*x ) fit    1.28006e-05
 mean( y - alpha*x ) matrix 1.2887e-05
```

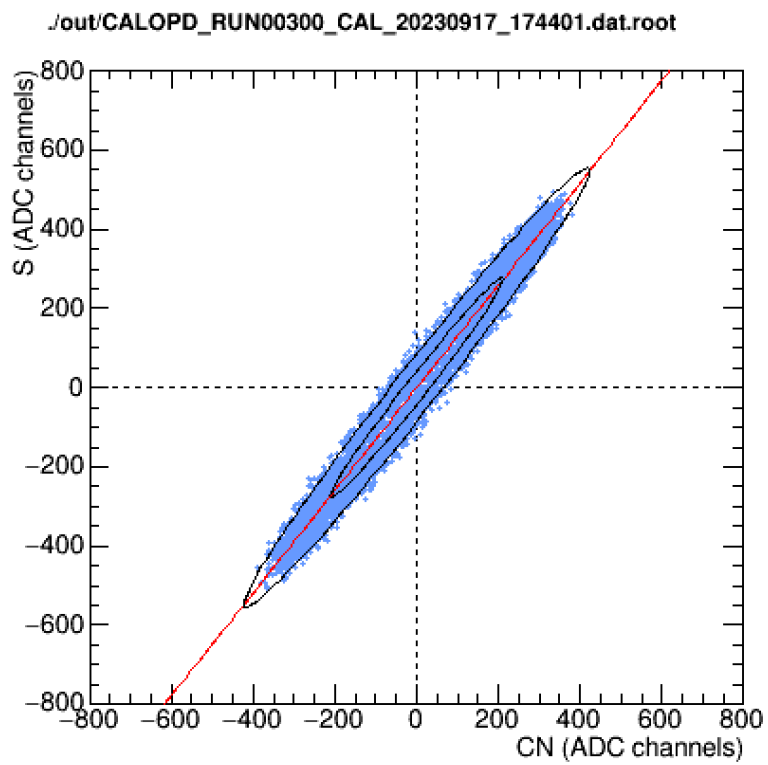
… ma per avere un segnale letto in basso guadagno nel chip 30 devo selezionare sciami off-axis, ovvero che si sviluppano nella Colonna sotto a quella centrale…

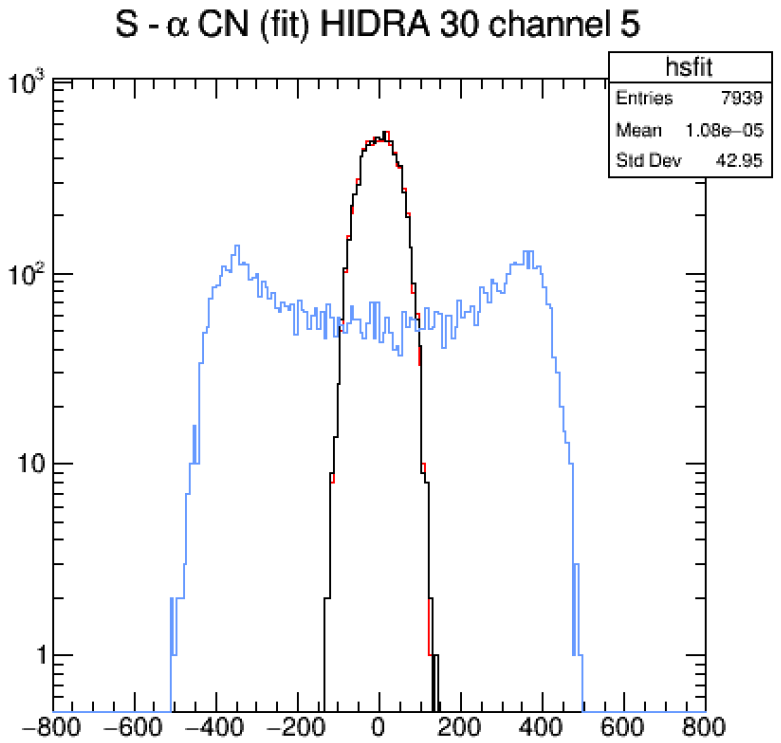


alpha	c	Mean	RMS
1.29536	0		36363.179
	0.01		37135.682
	0.02		37135.470
	0.025		37135.396
	0.027		37135.372
	0.028		37135.362
	0.029		37135.352
	0.03		37135.344
	0.031		37135.336
	0.033		37135.323
	0.034		37135.318
	0.035		37135.313
	0.038		37135.305
	0.039		37135.304
	0.0395		37135.304
	0.04		37135.304
	0.041		37135.305
	0.05		37135.351
	0.06		37135.484
	0.07	193565.09	37135.703
	0.08		37136.009

./out/CALOPD_RUN00300_CAL_20230917_174401.dat.root

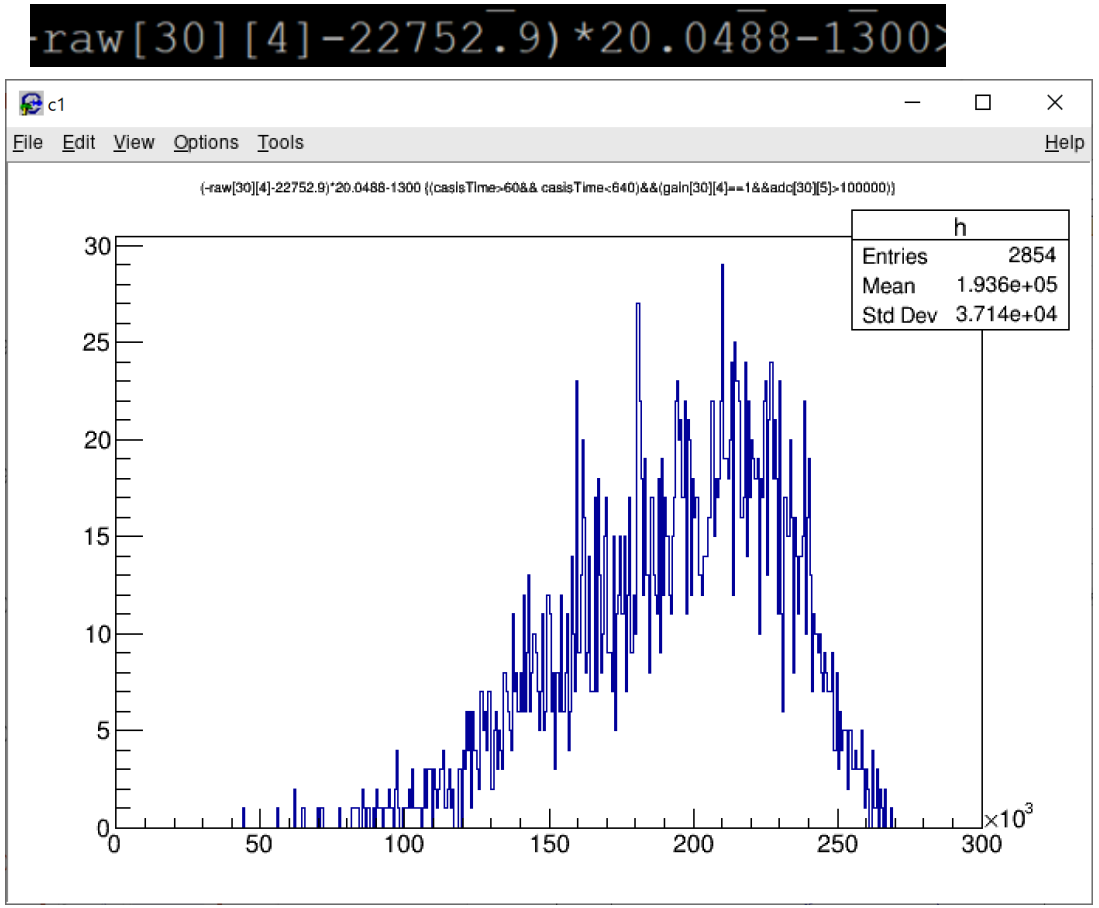
File Edit View Options Tools Help






```
iHydra 30 channel 5

 this bin    726
 sigmaHisto1DRaw(726)    277.557
 sigmaHisto1D(726)       75.857
 pedHisto1D(726)       22805.6

gAlpha_30_5   -----> N = 7939

 alpha (fit)    1.29536


cov xx 44812.3
cov xy 58048
cov yy 77038
cov yx 58048
 eigenvalue 0 121168  sqrt  348.092
 eigenvalue 1 682.346  sqrt  26.1218
 R00  cos(theta)     0.6052 R01 -sin(theta)  -0.796073
 R10  sin(theta)   0.796073 R11  cos(theta)     0.6052
      tg(theta)    1.31539
 alpha (matrix) 1.31539

 sigma( y )           277.557
 sigma( y - alpha*x ) 43.1622

 RMS( y )                   277.557
 RMS( y - alpha*x ) fit     42.9534
 RMS( y - alpha*x ) matrix 43.1622

 mean( y - alpha*x ) fit    1.07985e-05
 mean( y - alpha*x ) matrix 1.0881e-05
```

…il fattore c e` circa 0.04 (invece che 0.07). Ma il metodo e` brutale… e il miglioramento piccolo



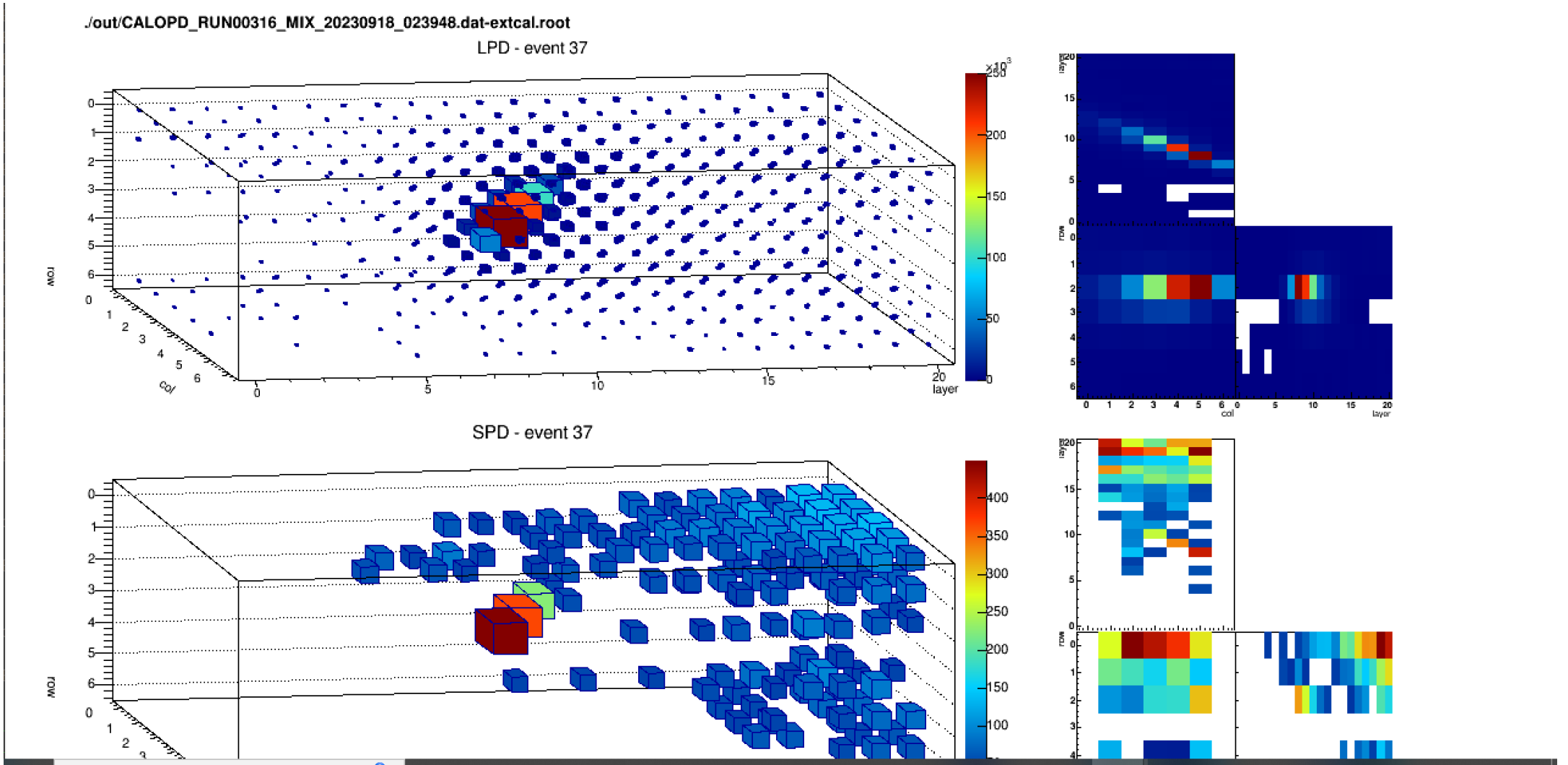
alpha	c	Mean	RMS
1.30991	0		37135.980
	0.01		
	0.02		
	0.025		
	0.027		
	0.028		
	0.029		
	0.03		
	0.031		
	0.033		
	0.034		
	0.035		
	0.038		
	0.039		36361.962
	0.0395		36361.955
	0.04		36361.948
	0.041		36361.935
	0.042		36361.923
	…		…
	0.05		
	0.06		
	0.07		
	0.08		

- Correzione del pedestal shift applicate ai file di elettroni centrali
- Procedo con elettroni inclinati e protoni

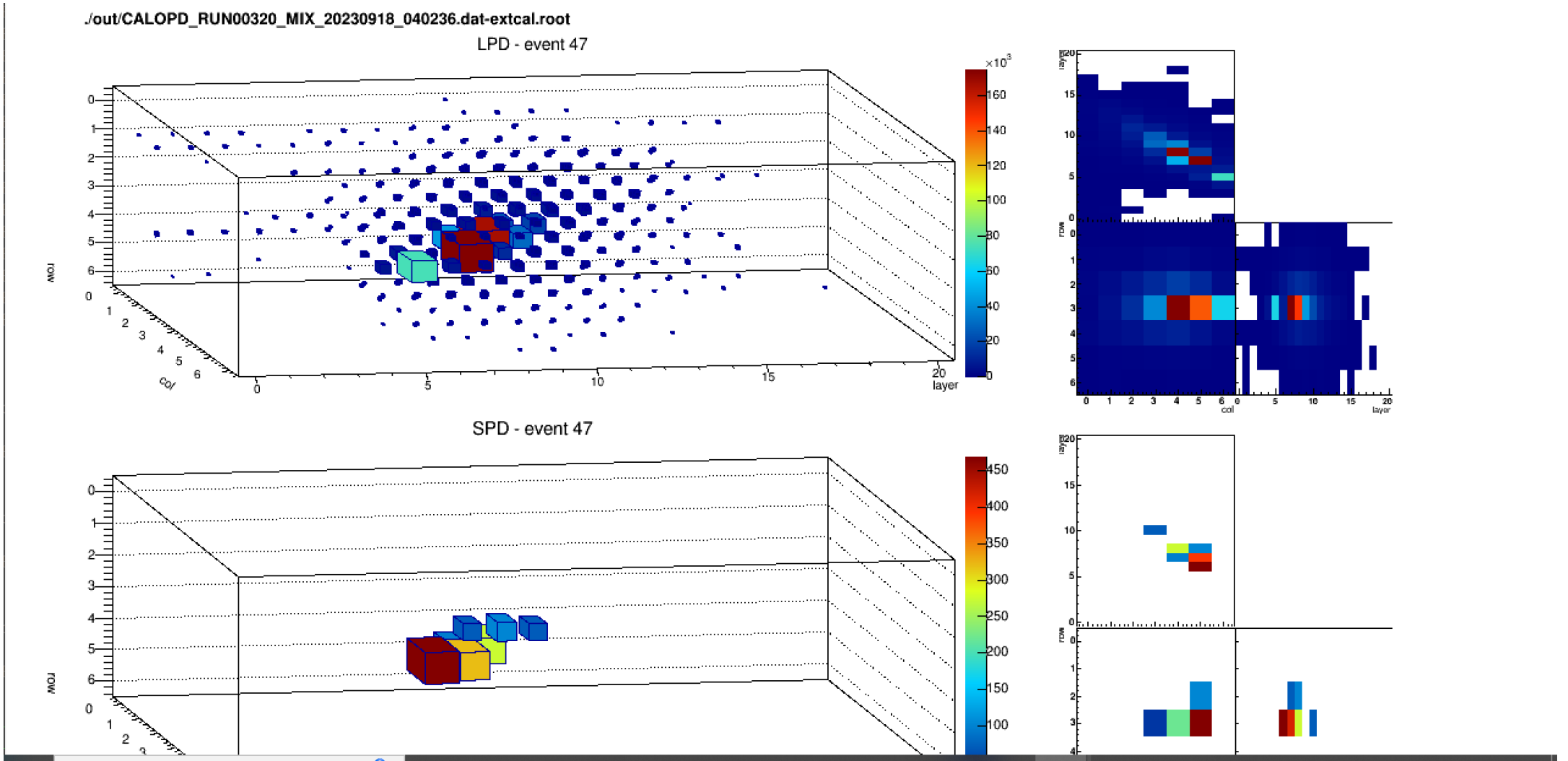
Energy (GeV)	Run	#Pulser	#Trigger	CAL
20	313	20730	100870	300
	333	17361	50152	371
50	~~176~~	~~322~~	~~0~~	
	~~177~~	~~0~~		
	304	1977	101296	300
~~80~~	~~360~~	~~0~~		
100	312	16875	100578	300
149	~~175~~	~~332~~	~~0~~	
	200	174	5753	204
	203	904	24334	204
	303	1576	100685	300
~~178~~	~~361~~	~~0~~		
197	~~182~~	~~0~~		
	305	317	18893	300
	~~306~~	~~0~~		
	307	1138	6924	300
	308	377	1714	300
	309	547	2734	300
	310	10150	47073	300
	311	17554	80840	300
200	334	728	51064	371
243	~~173~~	~~599~~	~~3~~	
	~~174~~	~~342~~	~~2~~	
	199	1354	40981	204
	301	170	9421	300
	302	2317	134038	300

Energy (GeV)	Run	#Pulser	#Trigger	CAL	
197.27	314	6973	38341	300	+45 deg central
	315	194	1067		
	316	154	1093		
	317	119	412		
	318	5548	24627		
	319	17231	60762		
197.27	320	24696	100601		+30 deg central
99.83	321	23326	100645	371	+30 deg central
49.99	322	27010	100251	371	+30 deg central
99.83	388	2288	18291	371	+45 deg central
	389	-2781	20216		
	390	6562	48785		
	~~391~~	-	-	~~371~~	

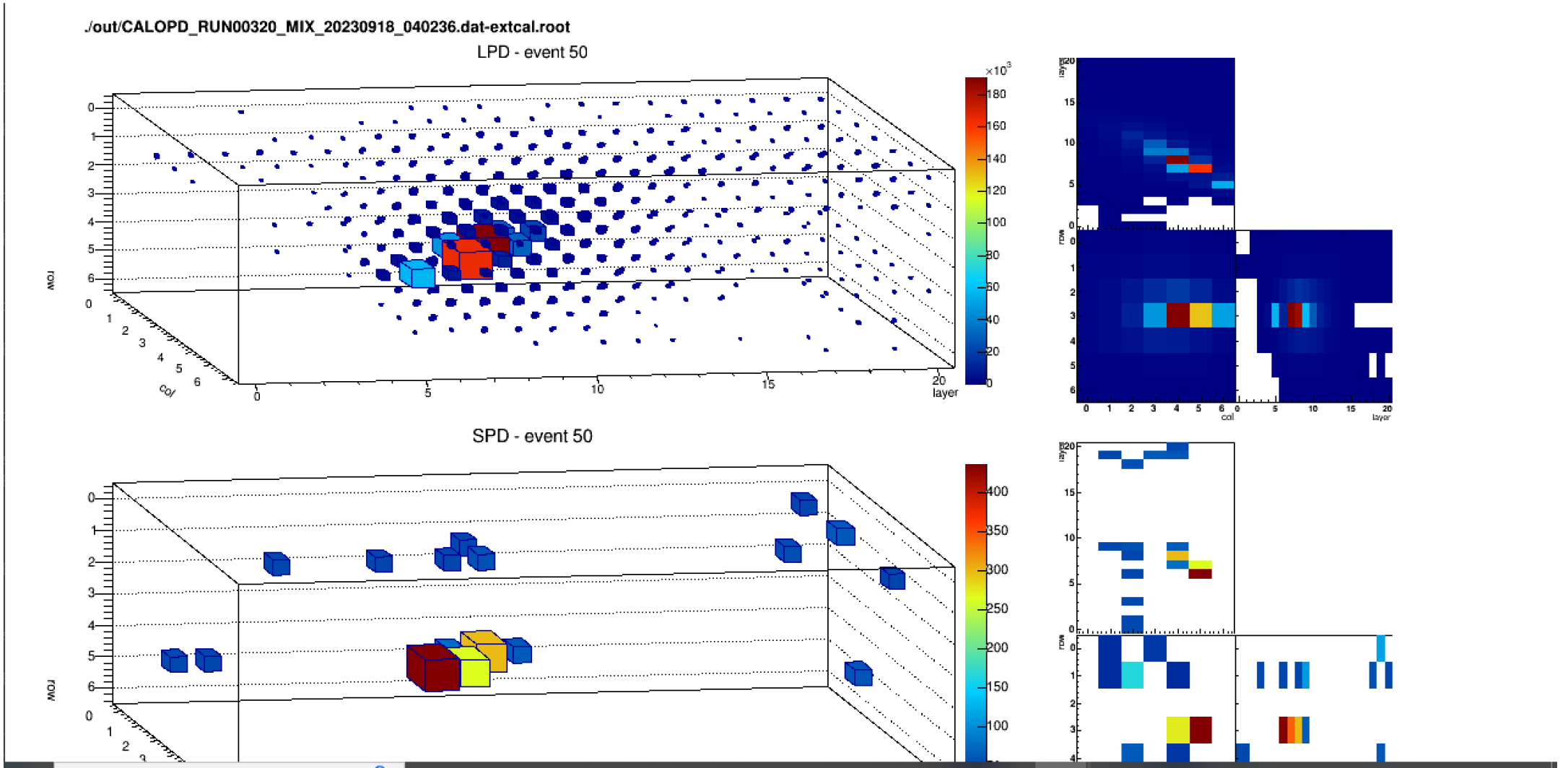
197 GeV 45 deg



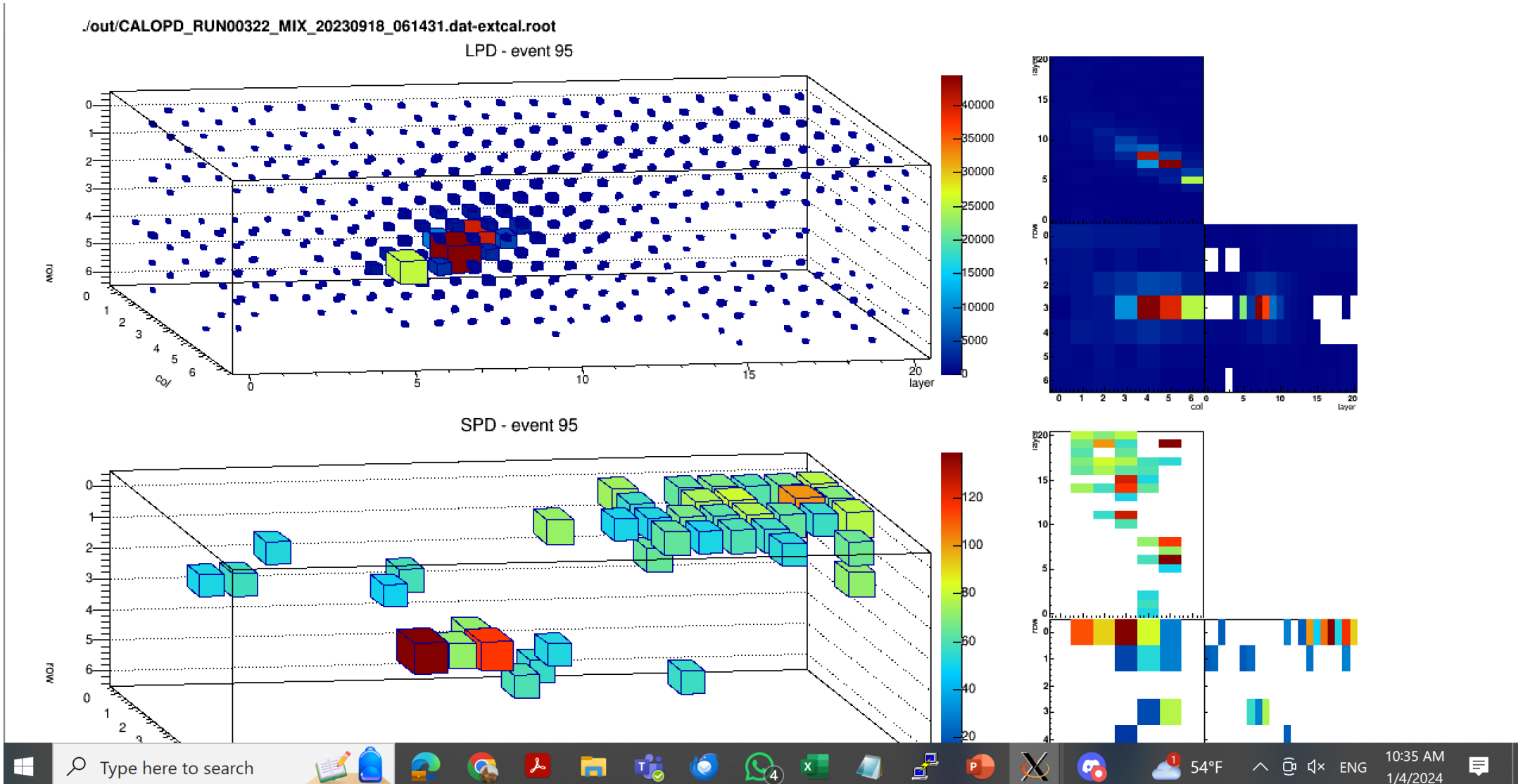
197 GeV 30 deg

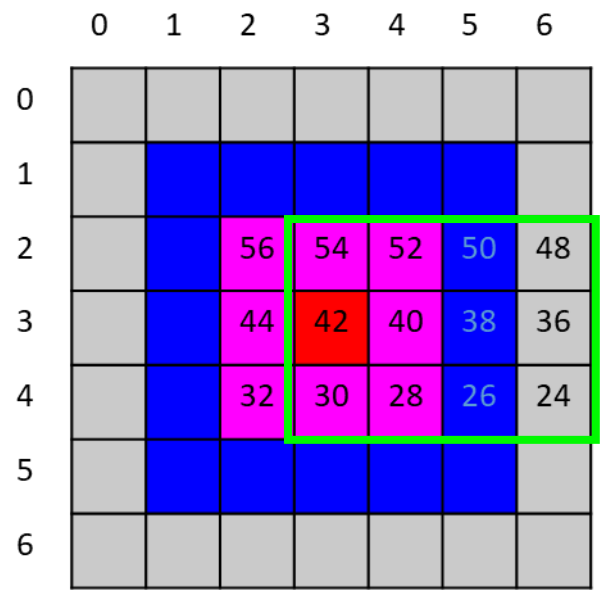


197 GeV 30 deg



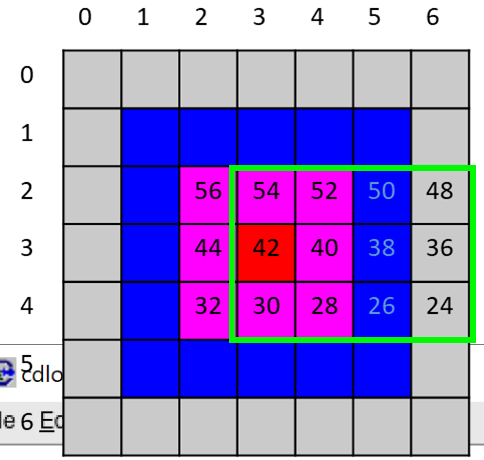
50 GeV 30 deg

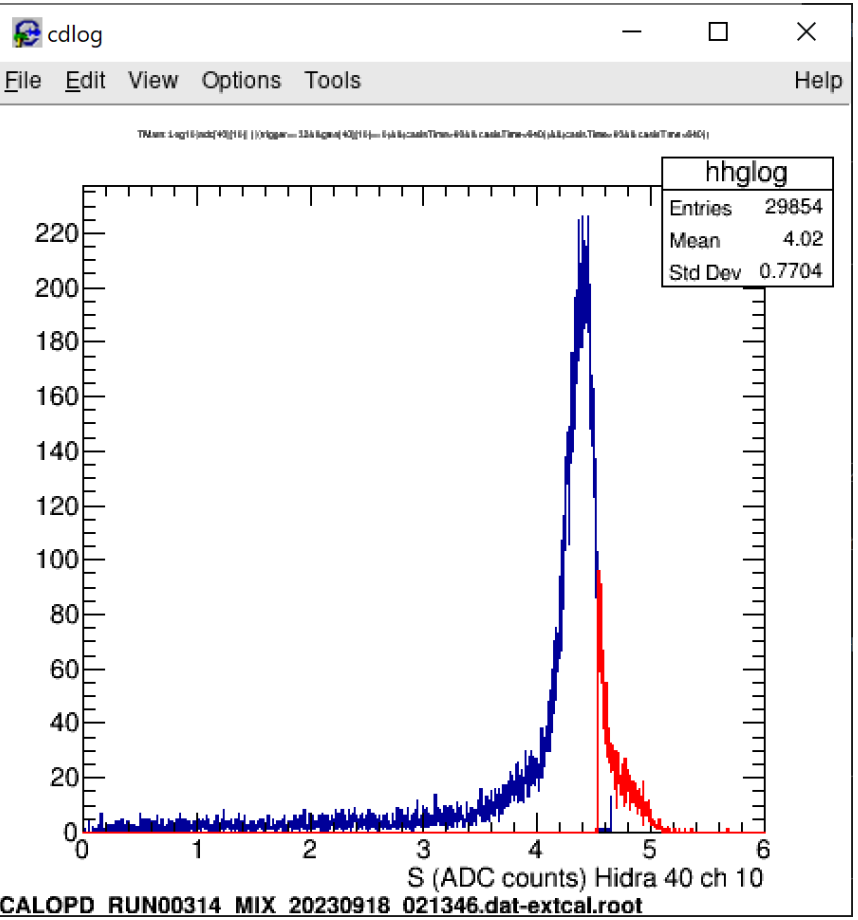

./out/CALOPD_RUN00322_MIX_20230918_061431.dat-extcal.root
LPD - event 95
row
col
layer
SPD - event 95
row
col
layer

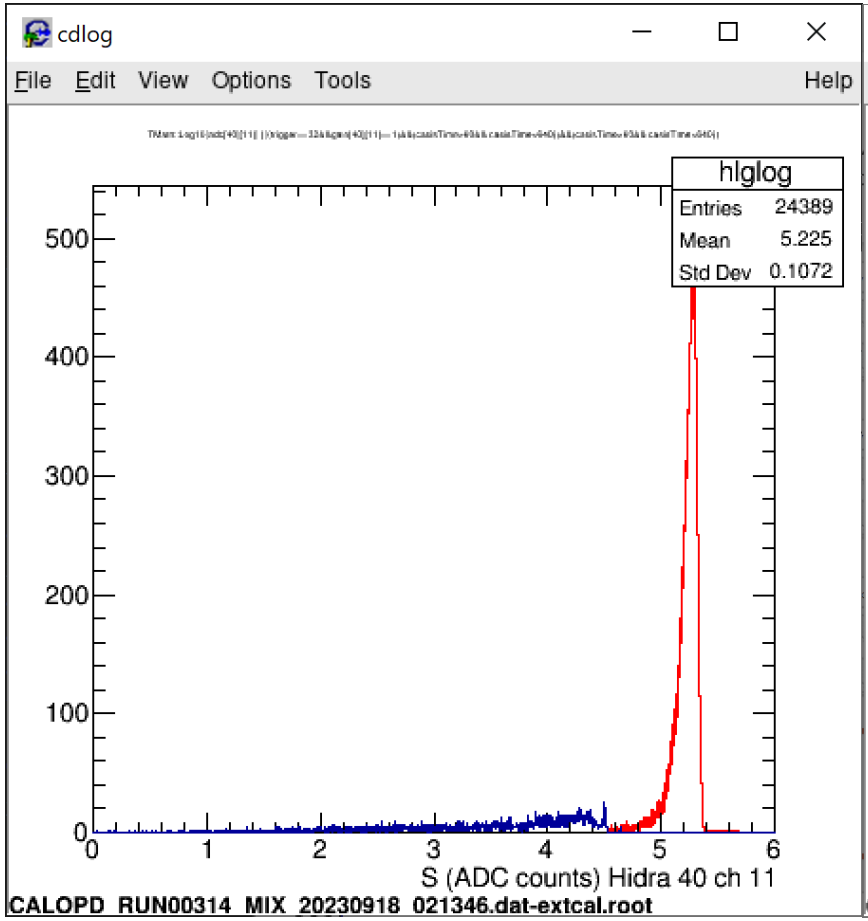


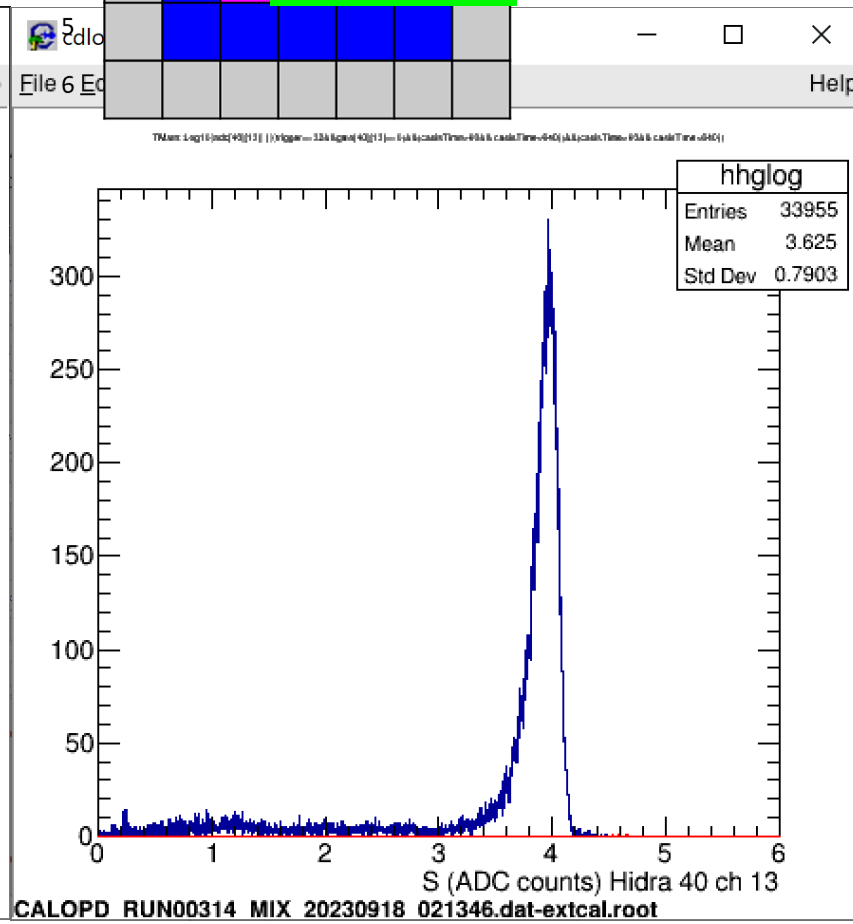
Lo sciame sta nella regione verde. Cerco il massimo

Colonna (3,4)Layer 8-9-10

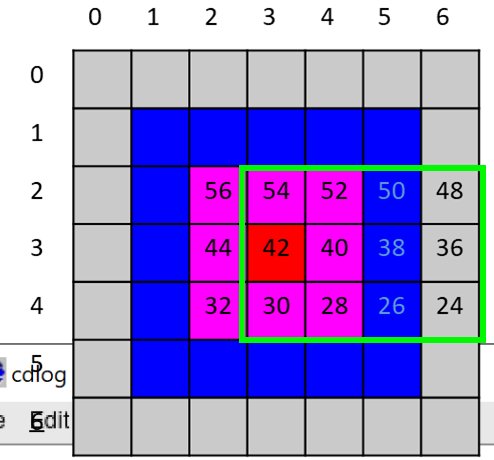


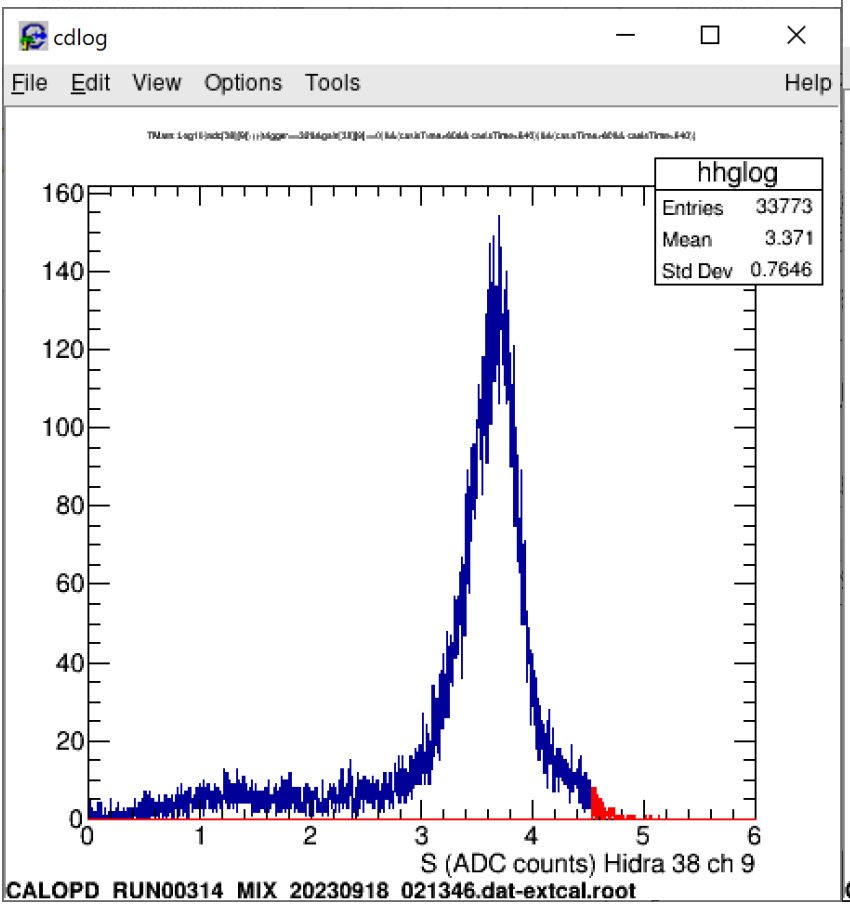


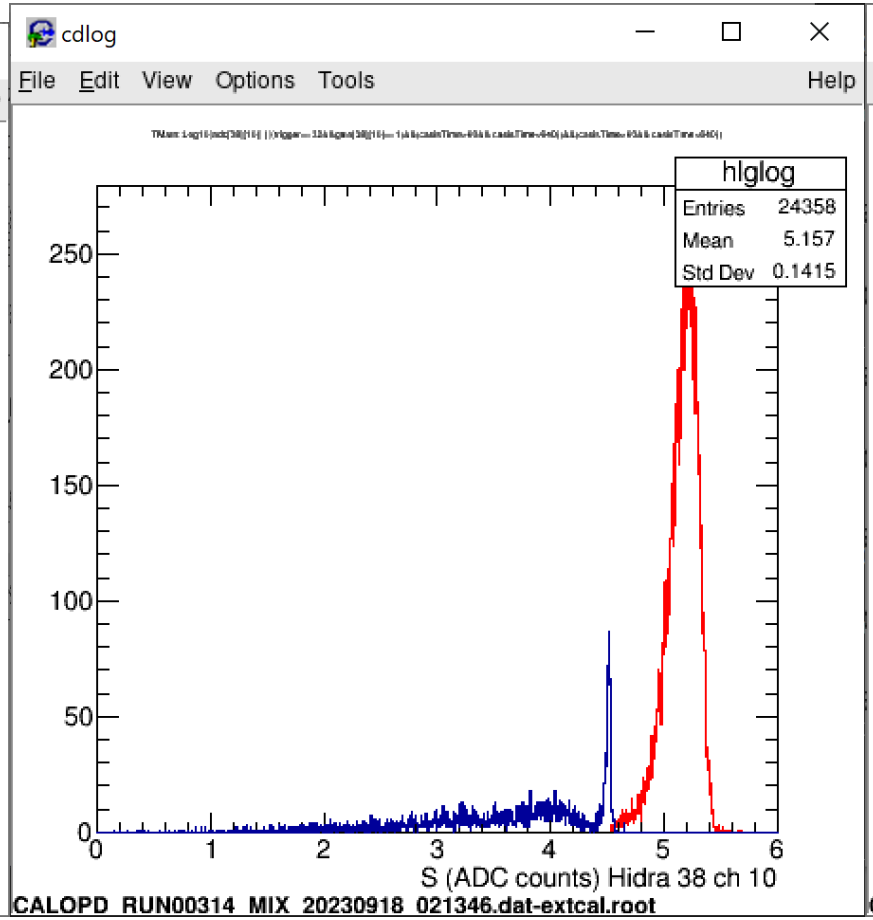


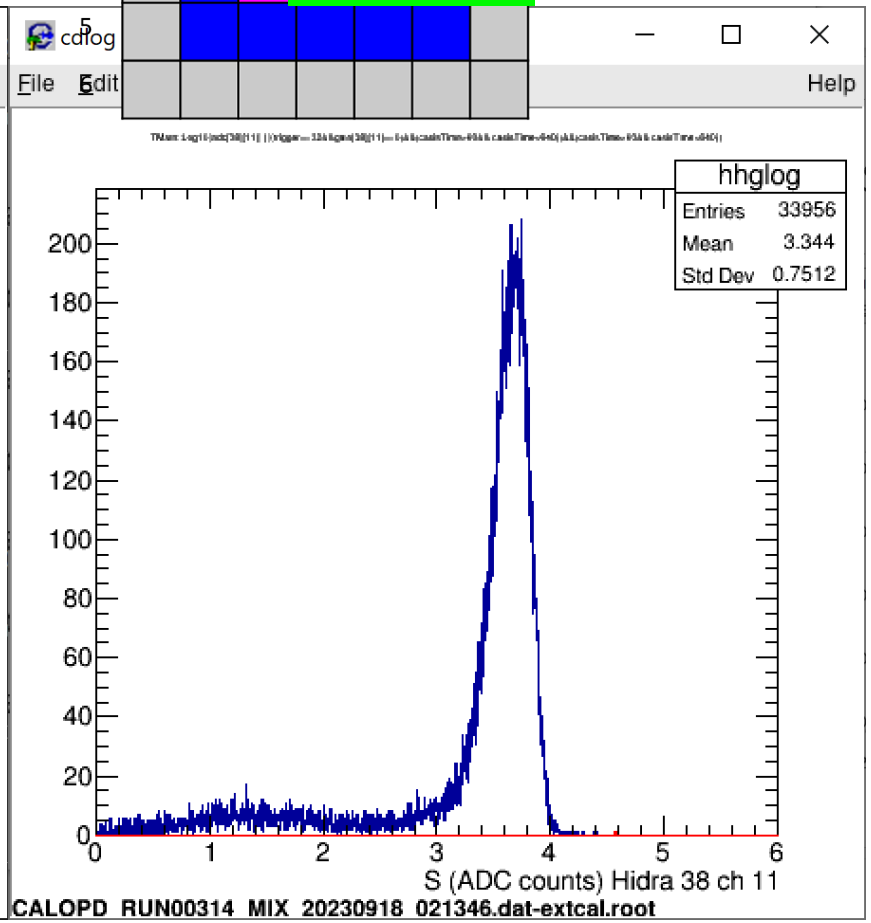


Colonna (3,5) layer 7-8-9

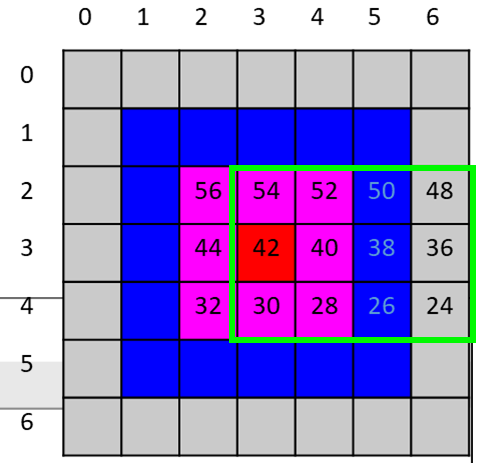


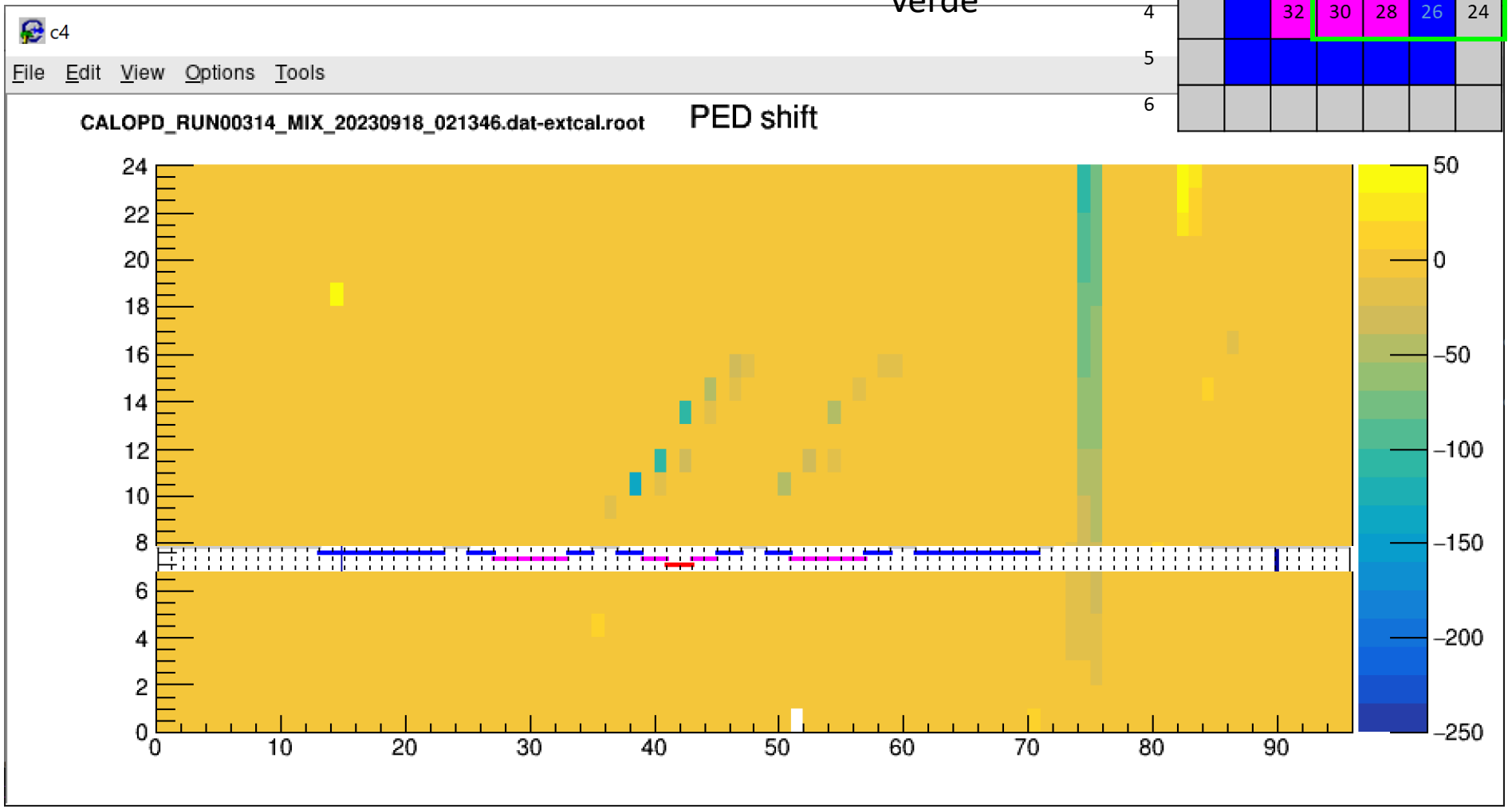




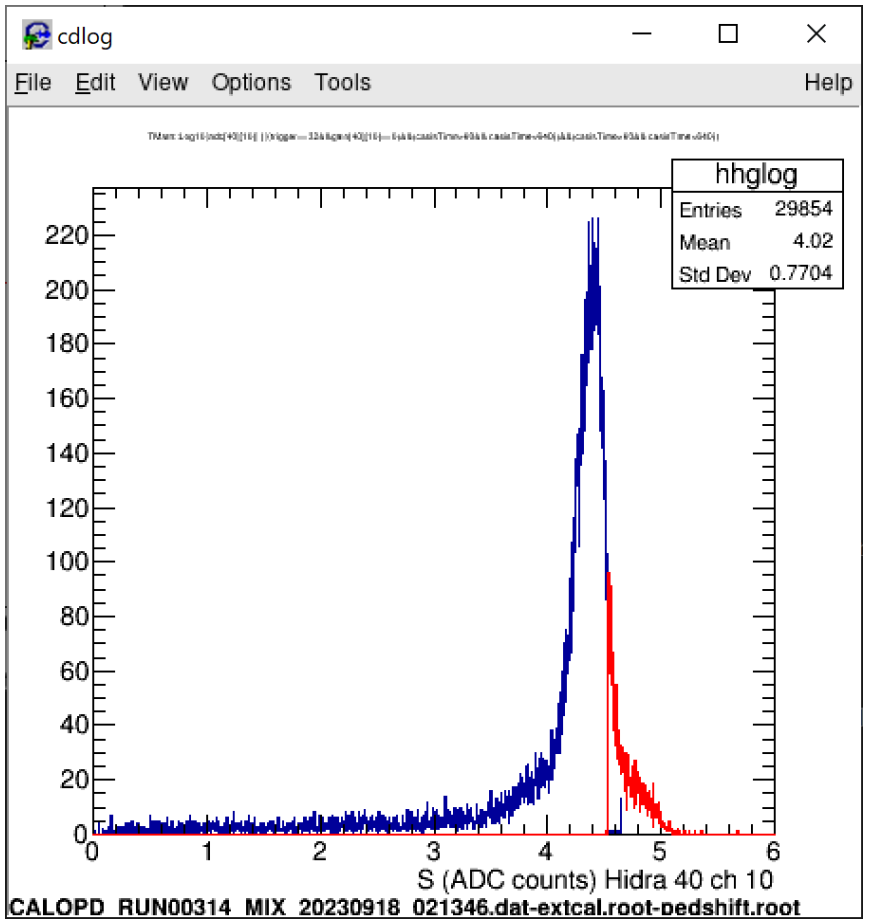


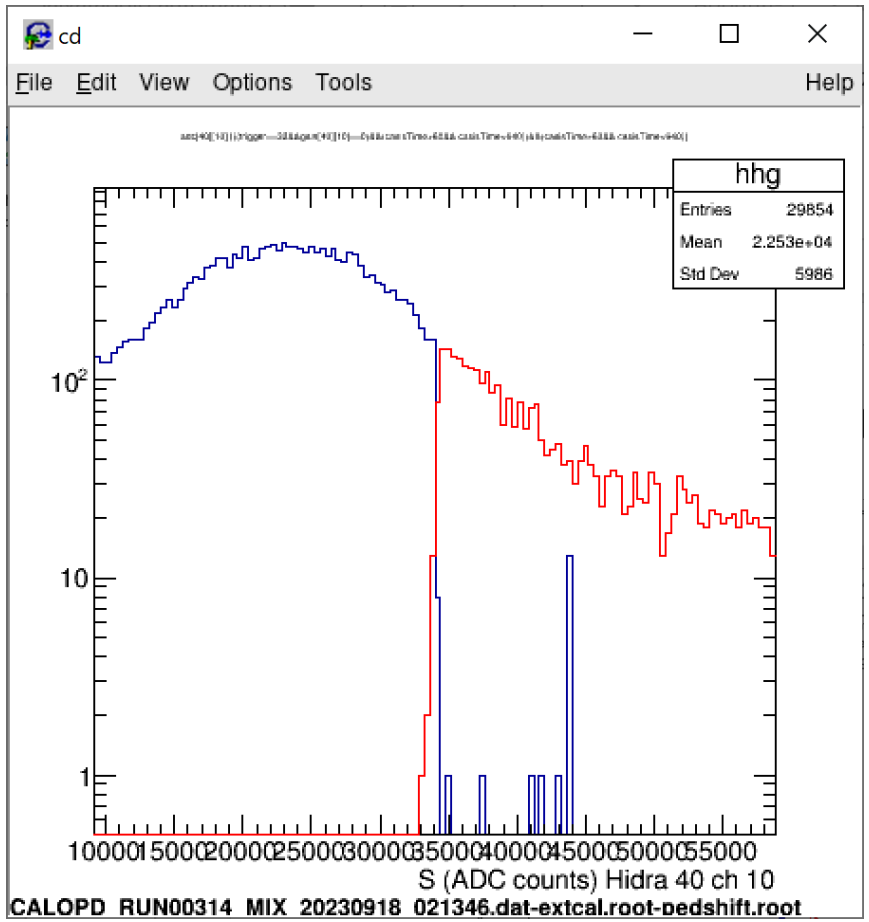
Applico la correzione alle colonne nel riquadro verde



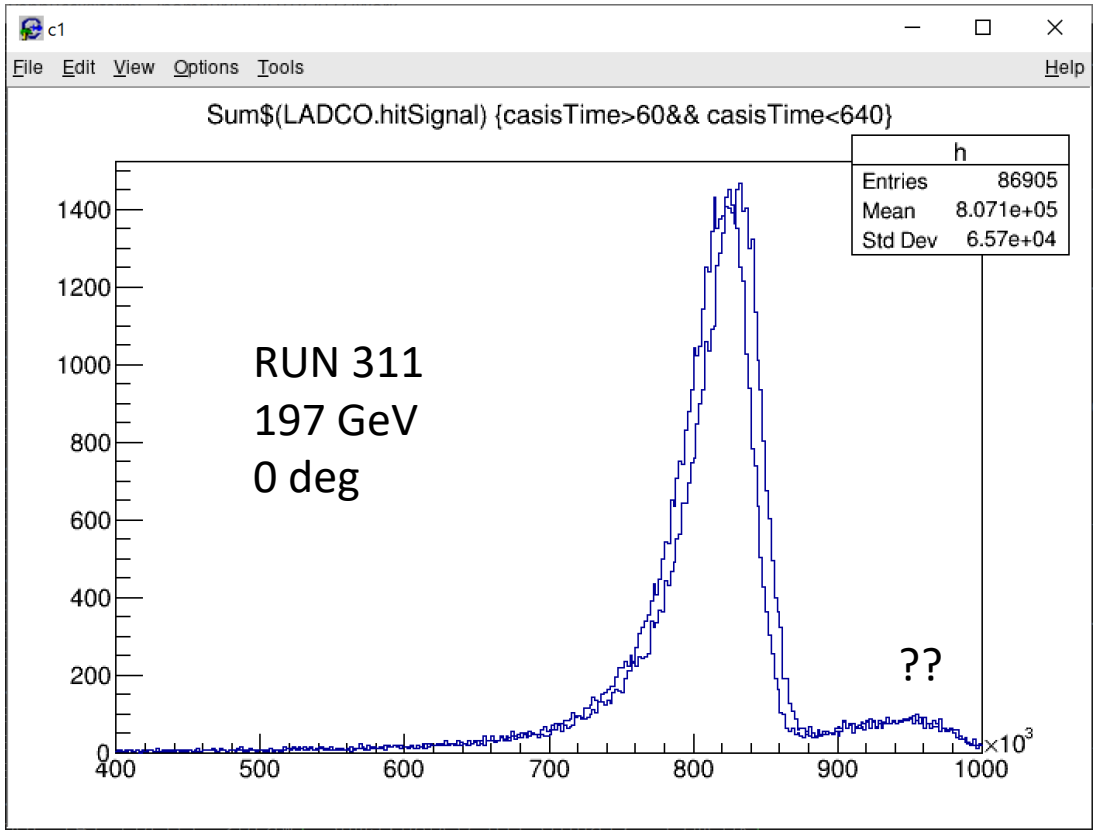


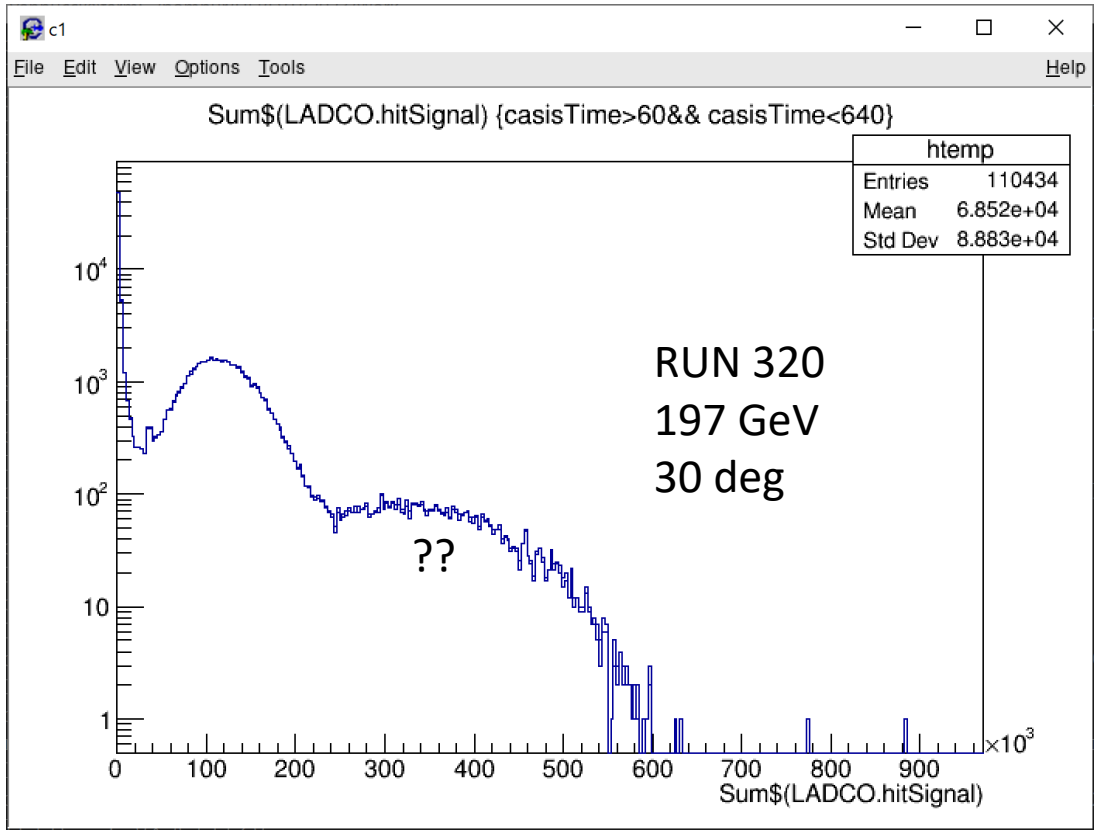
Controllo del raccordo tra alto e basso Guadagno, dopo la correzione per il ped shift





Correzione pedshift

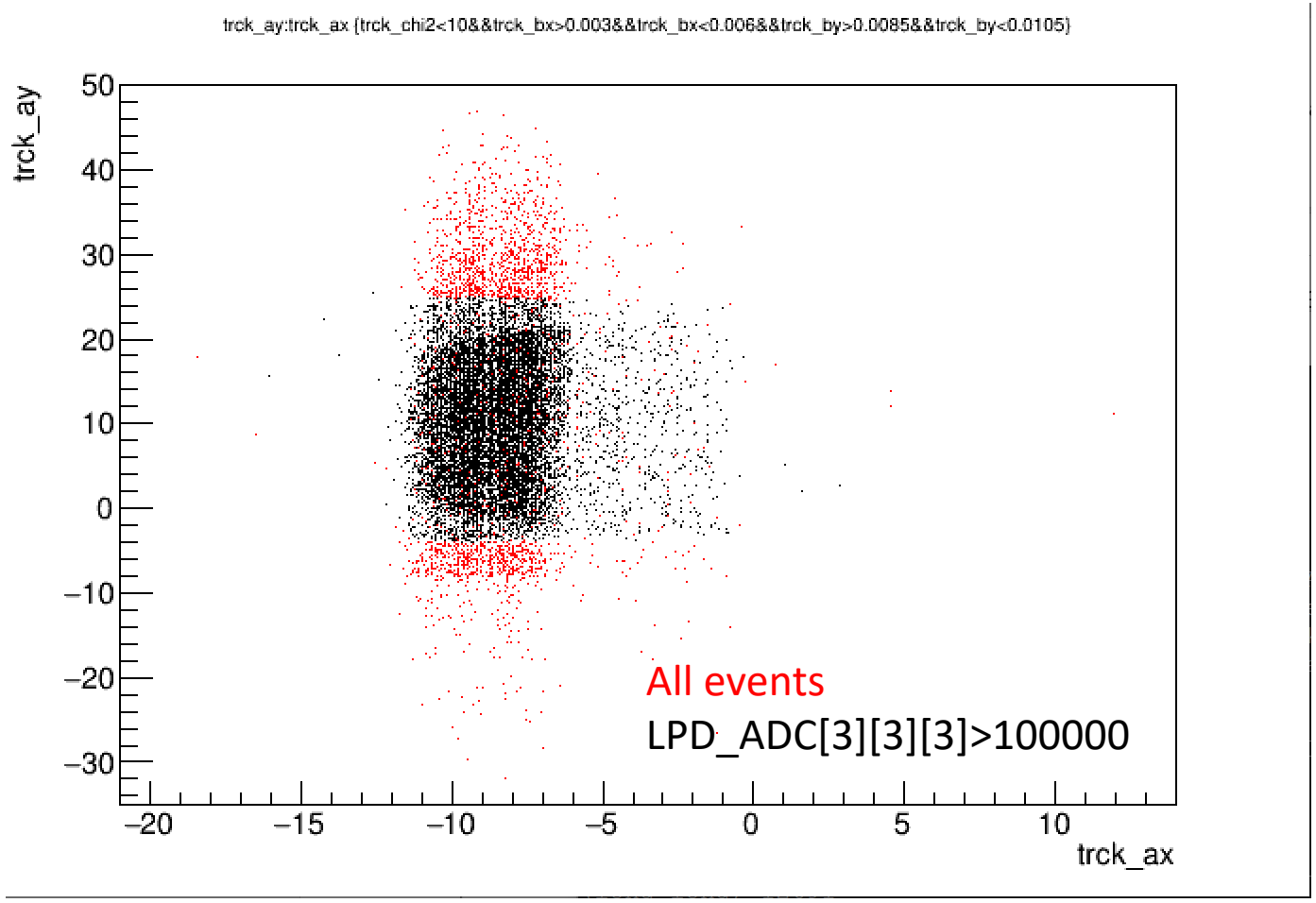


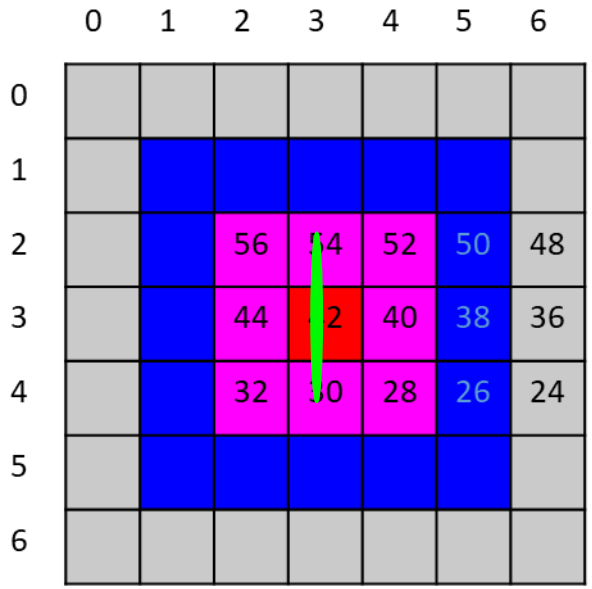


Considerazioni emerse nella riunione del 9/1/2024

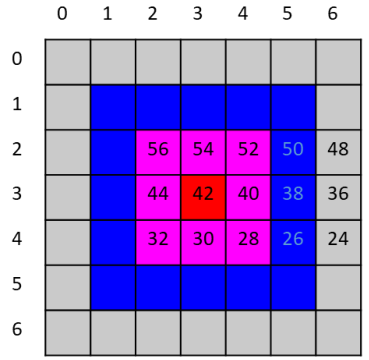
- Capire se lo spike e` legato al timing:
  - casis-time
  - spill-time
  - distanza dall’evento precedente

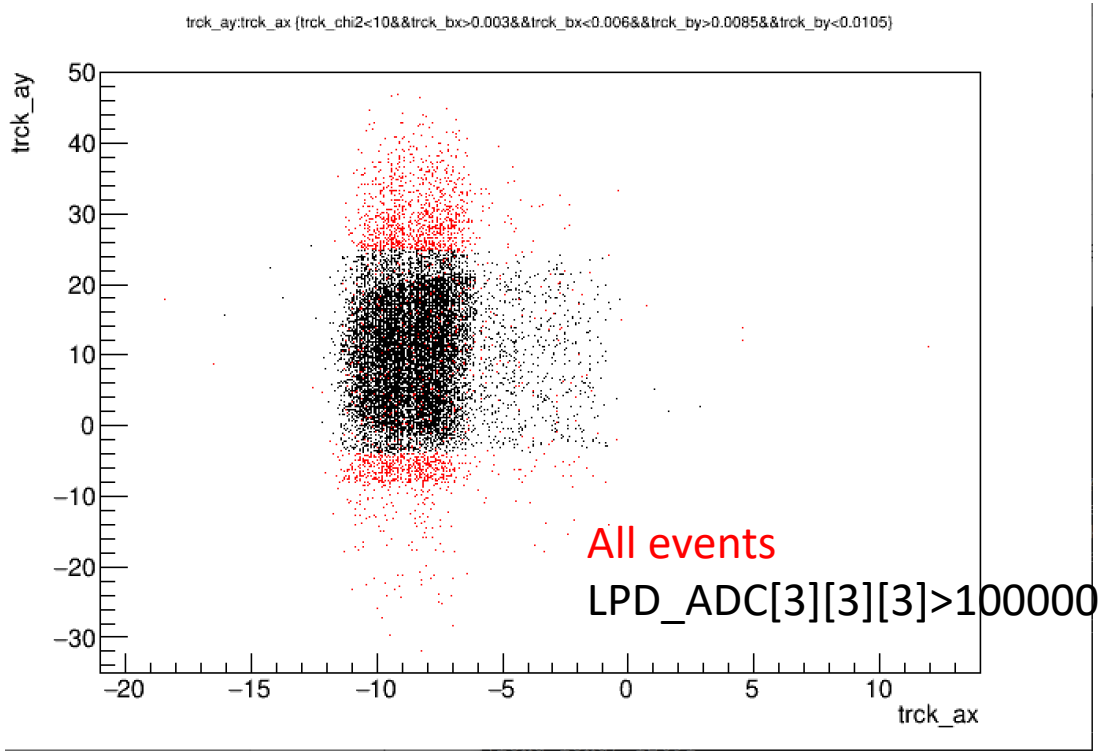
Run 302

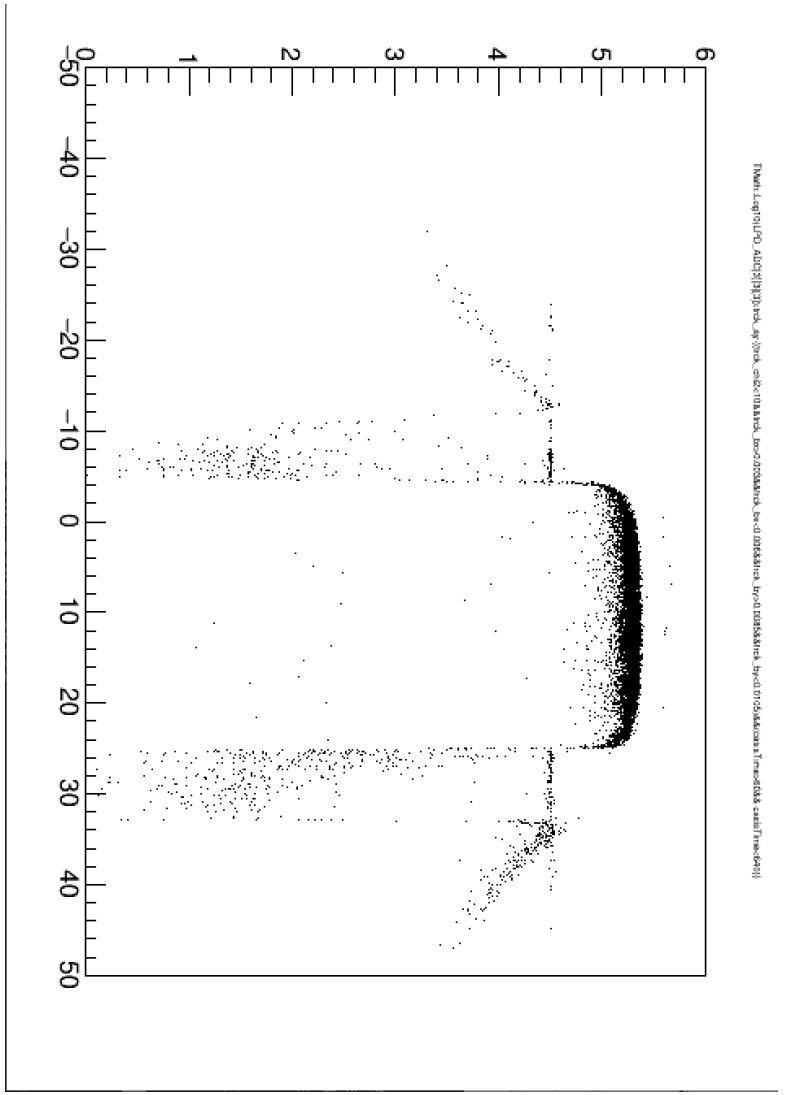

trck_ay:trck_ax (trck_chi2<10&&trck_bx>0.003&&trck_bx<0.006&&trck_by>0.0085&&trck_by<0.0105)
trck_ay
50
40
30
20
10
0
−10
−20
−30
−20
−15
−10
−5
0
5
10
trck_ax
All events
LPD_ADC[3][3][3]>100000


0 1 2 3 4 5 6
0
1
2
3
4
5
6
56
52
50
48
44
40
38
36
32
28
26
24

Run 302

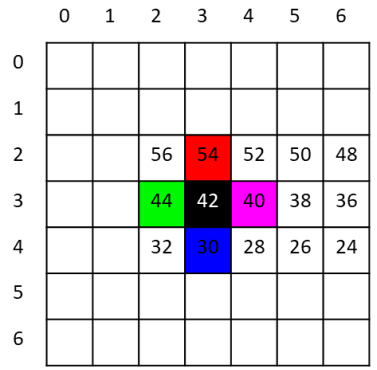






Ay vs Log10(LPD_ADC[3][3][3])

Run 302

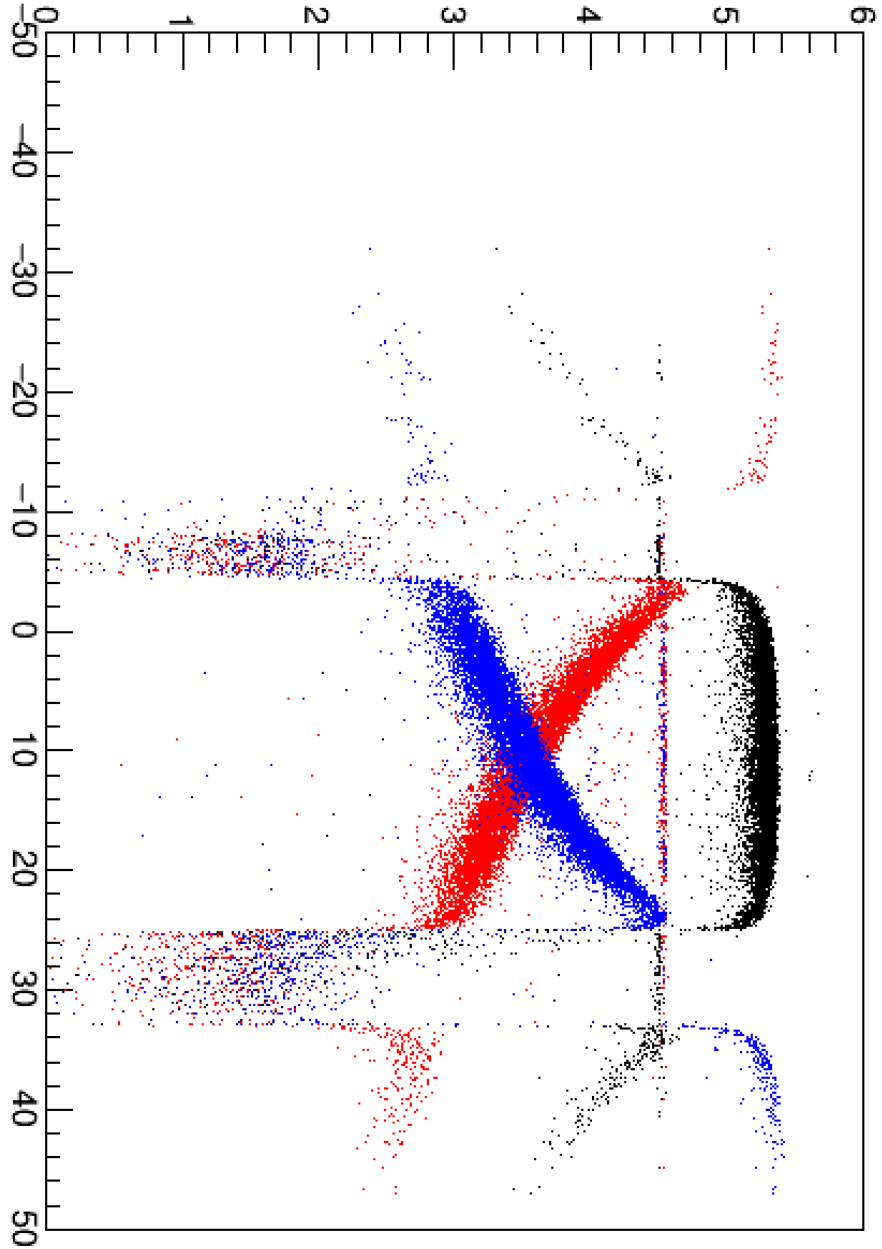


Ay vs Log10(LPD_ADC[2][3][3])

Ay vs Log10(LPD_ADC[3][3][3])

Ay vs Log10(LPD_ADC[4][3][3])

I canali che raccolgono anche segnali alti (in basso guadagno) per eventi in cui il segnale raccolto e` invece basso manifestano in alcuni casi una sorta di effetto di memoria/saturazione dell'alto guadagno.
Cioe`, invece di leggere il segnale basso che ci si aspetterebbe, si legge un valore prossimo alla soglia di cambio guadagno. Come se ci fosse un accumulo di carica (che giustifica il segnale prossimo alla soglia) e una risposta non lineare (che giustifica il fatto che il segnale non e` al valore di saturazione, ma si accumula in prossimita` della soglia di cambio Guadagno, che e` inferior al valore di saturazione).
Forse succede quando l'evento prima era in basso Guadagno? Come se il chip non riuscisse a ripristinare il suo stato?



Run 302

	0	1	2	3	4	5	6
0							
1							
2			56	54	52	50	48
3			44	42	40	38	36
4			32	30	28	26	24
5							
6							

Ay vs Log10(LPD_ADC[2][3][3])

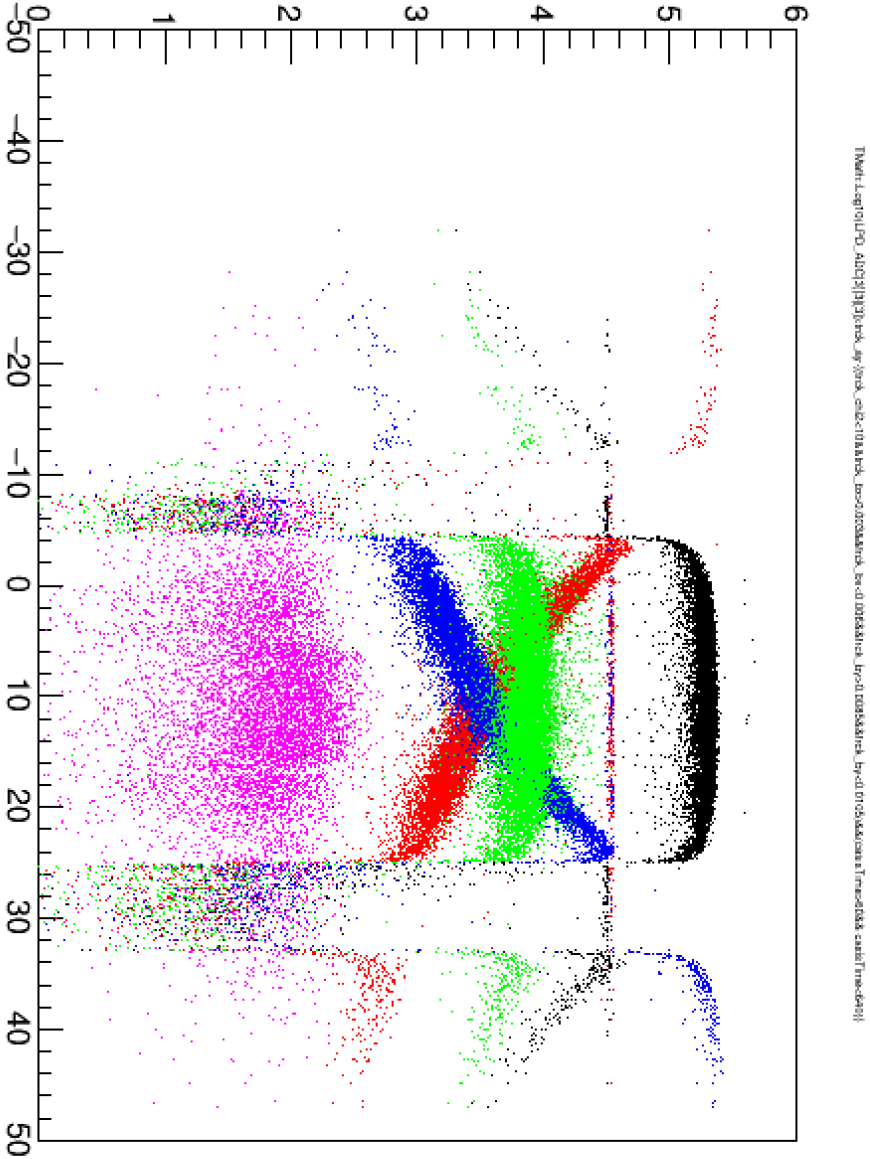
Ay vs Log10(LPD_ADC[3][3][3])

Ay vs Log10(LPD_ADC[4][3][3])

Ay vs Log10(LPD_ADC[3][2][3])

Ay vs Log10(LPD_ADC[3][4][3])

canali che raccolgono



Ay vs Log10(LPD_ADC[3][3][4])

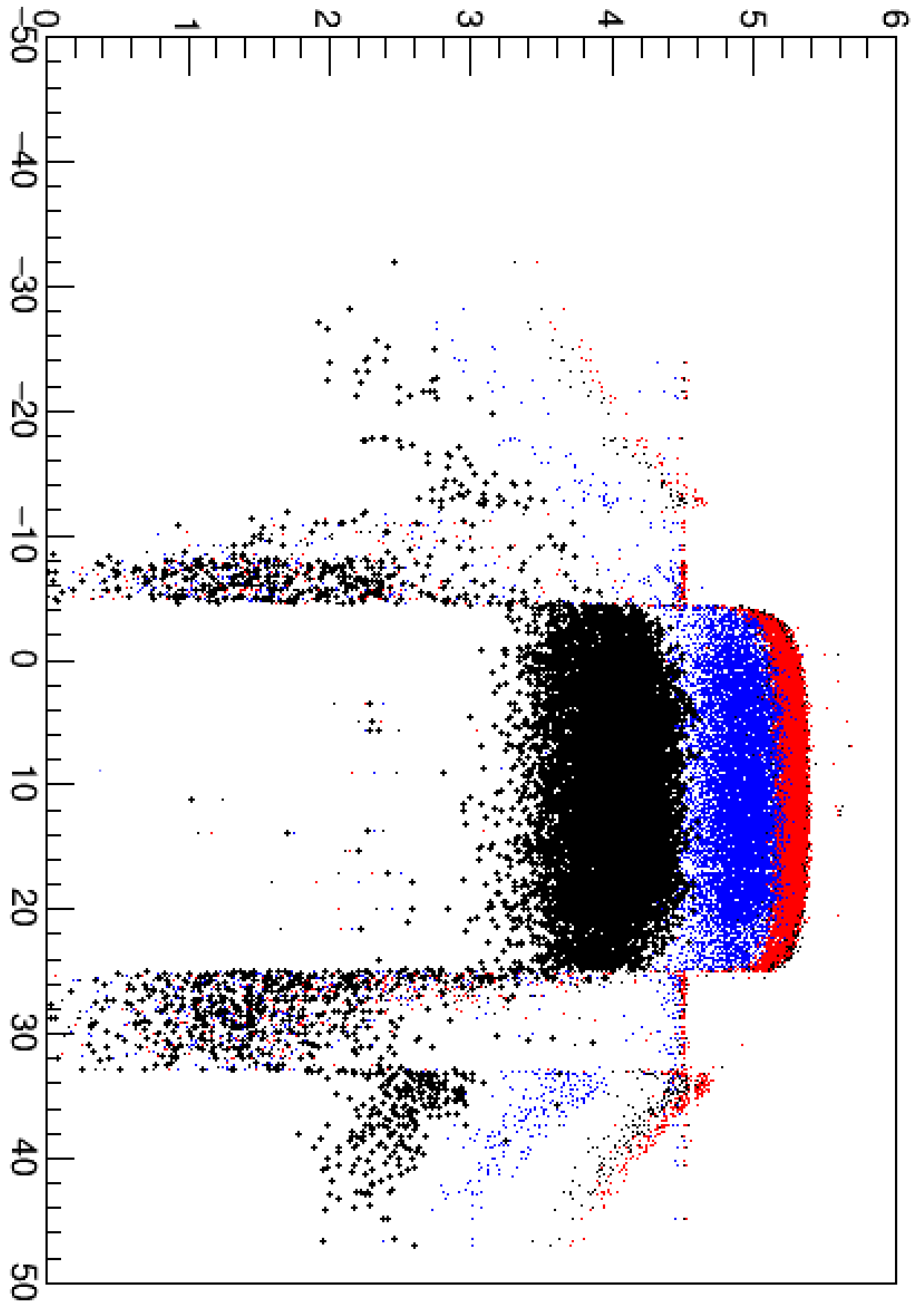
Ay vs Log10(LPD_ADC[3][3][3])

Ay vs Log10(LPD_ADC[3][3][1])

Ay vs Log10(LPD_ADC[3][3]**[0]**)

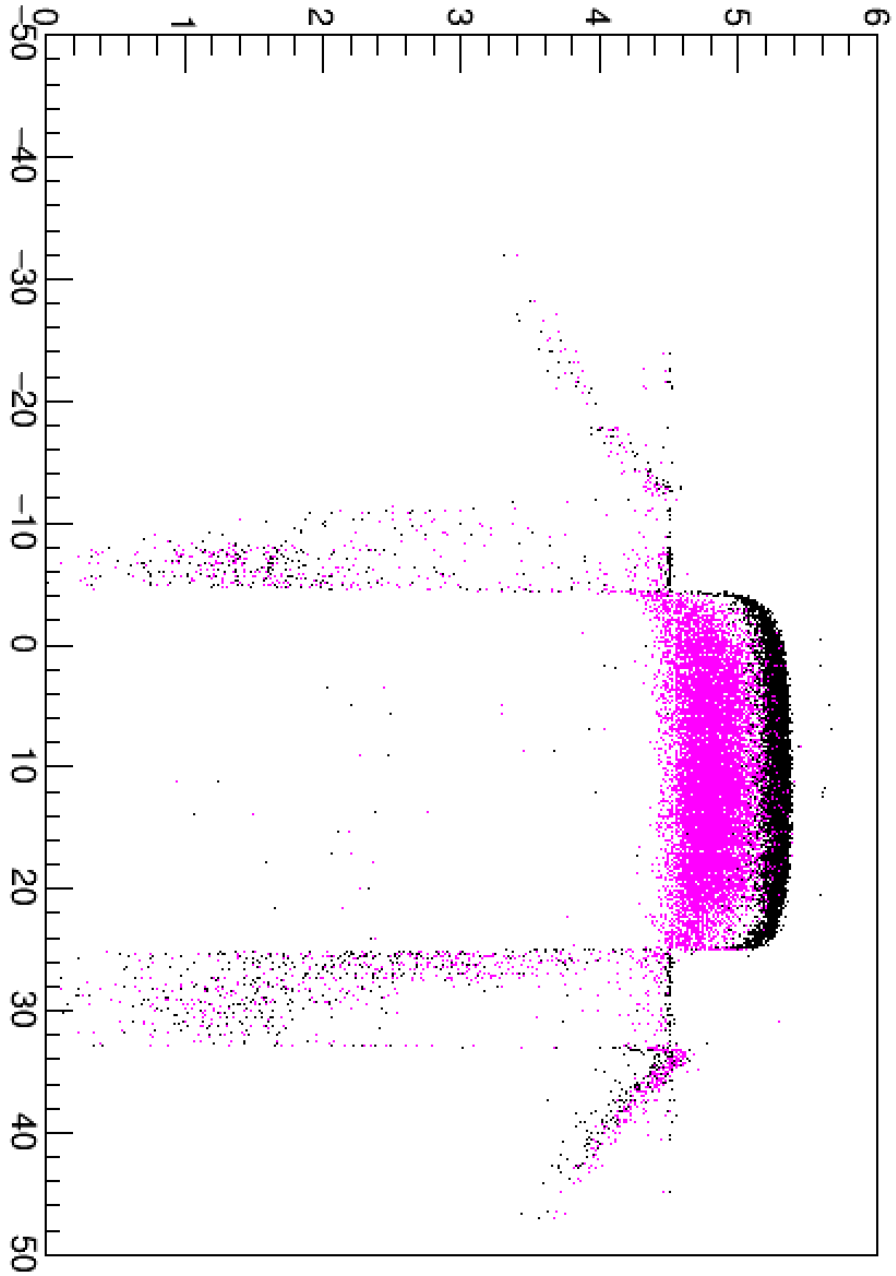
Il problema si manifesta a partire dal layer 1

In questo caso il segnale massimo e` appena sopra soglia.
Lo spike sembra pero` meno marcato



Ay vs Log10(LPD_ADC[3][3][3])

Ay vs Log10(LPD_ADC[3][3][6])



Il problema si manifesta fino al layer 6

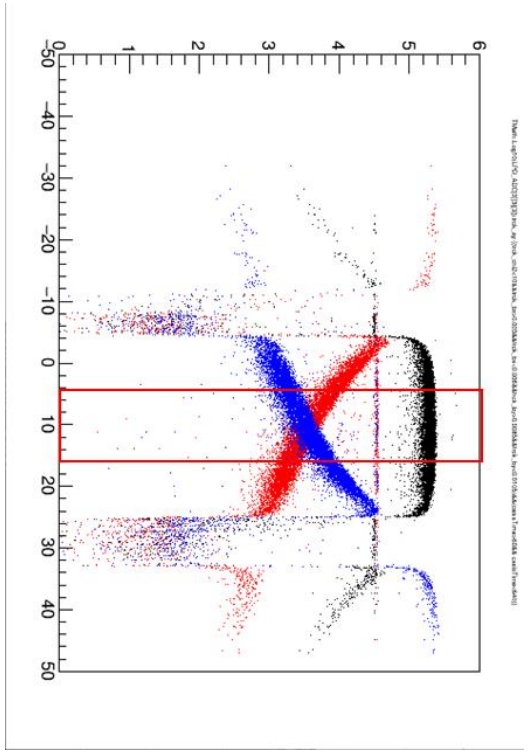
Anche in questo caso il segnale massimo e` appena sopra soglia.
Lo spike sembra meno marcato

	0	1	2	3	4	5	6
0							
1							
2			56	54	52	50	48
3			44	42	40	38	36
4			32	30	28	26	24
5							
6							

Selezionando particelle che colpiscono il centro

LPD_ADC[2][3][3] vs LPD_ADC[2][3][4]

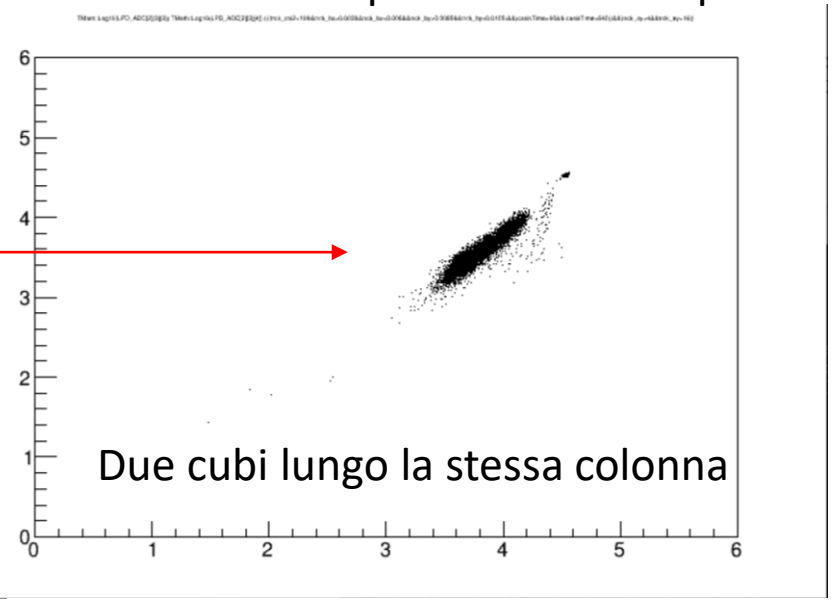
LPD_ADC[2][3][3] vs LPD_ADC[4][3][3]

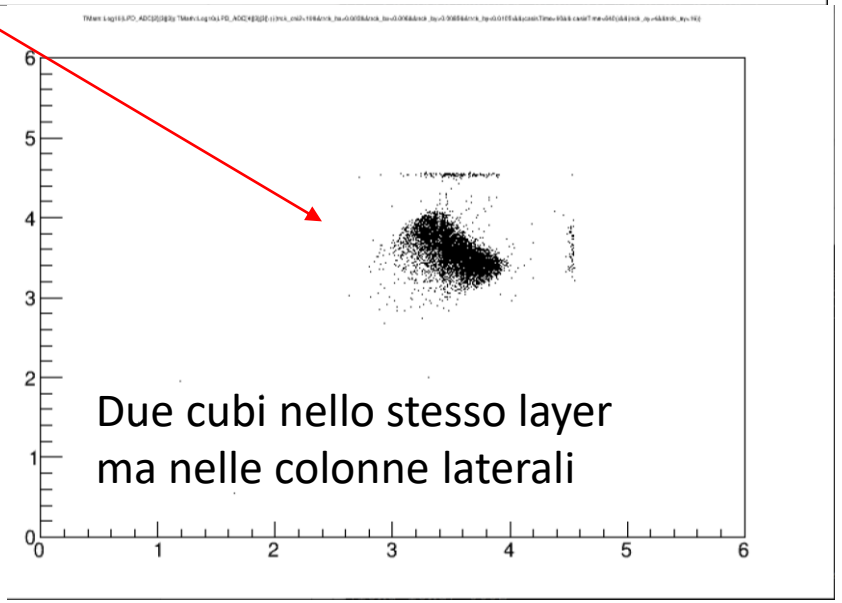


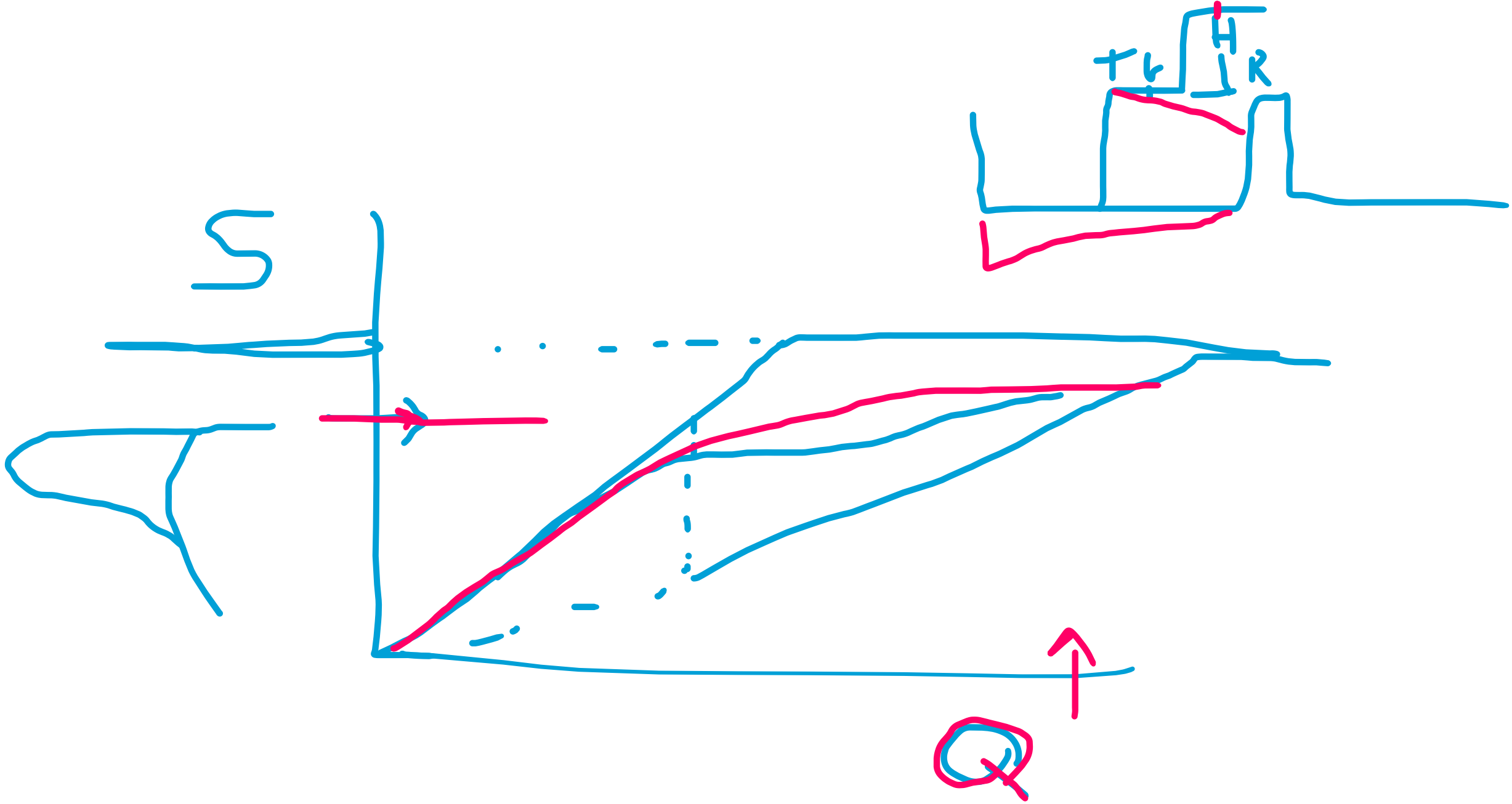
I cubi nella stesa colonna (stesso chip) manifestano lo stesso problema simultaneamente (a parte un “baffo” che non capisco).

I cubi appartenenti a colonne diverse sono completamente scollegati

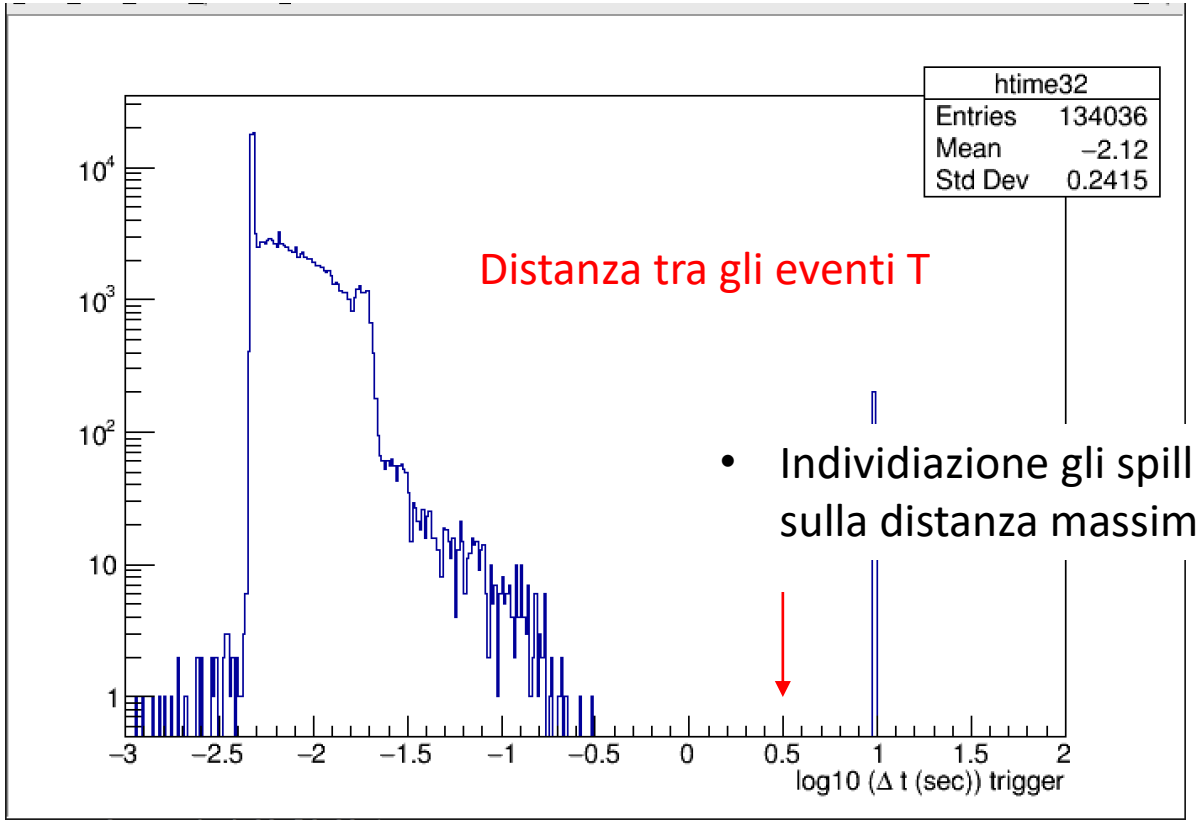
Questo supporta l’ipotesi che sia un problema di ripristino del canale, dopo un evento acquisito in basso guadagno

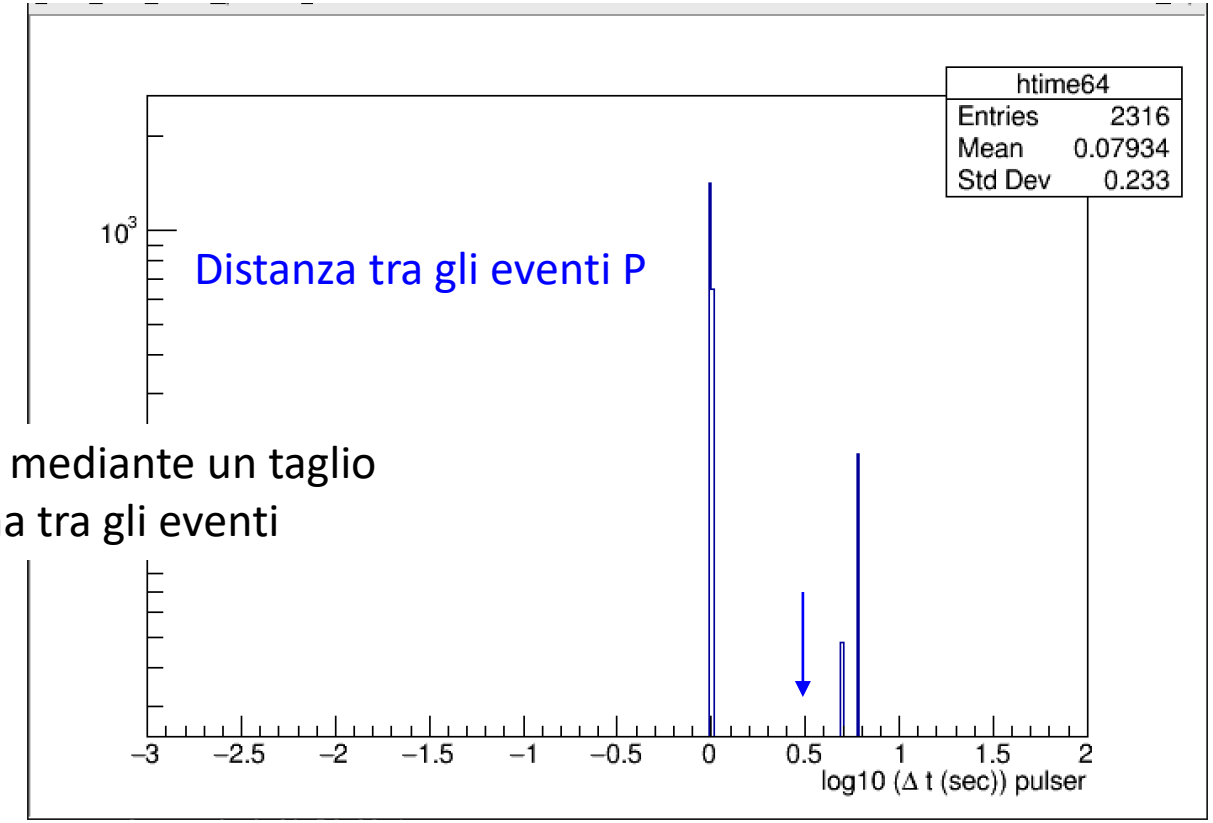




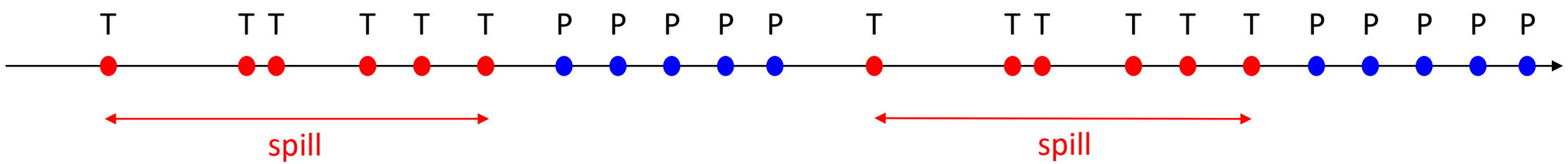

H
R
S
Q

Run 302





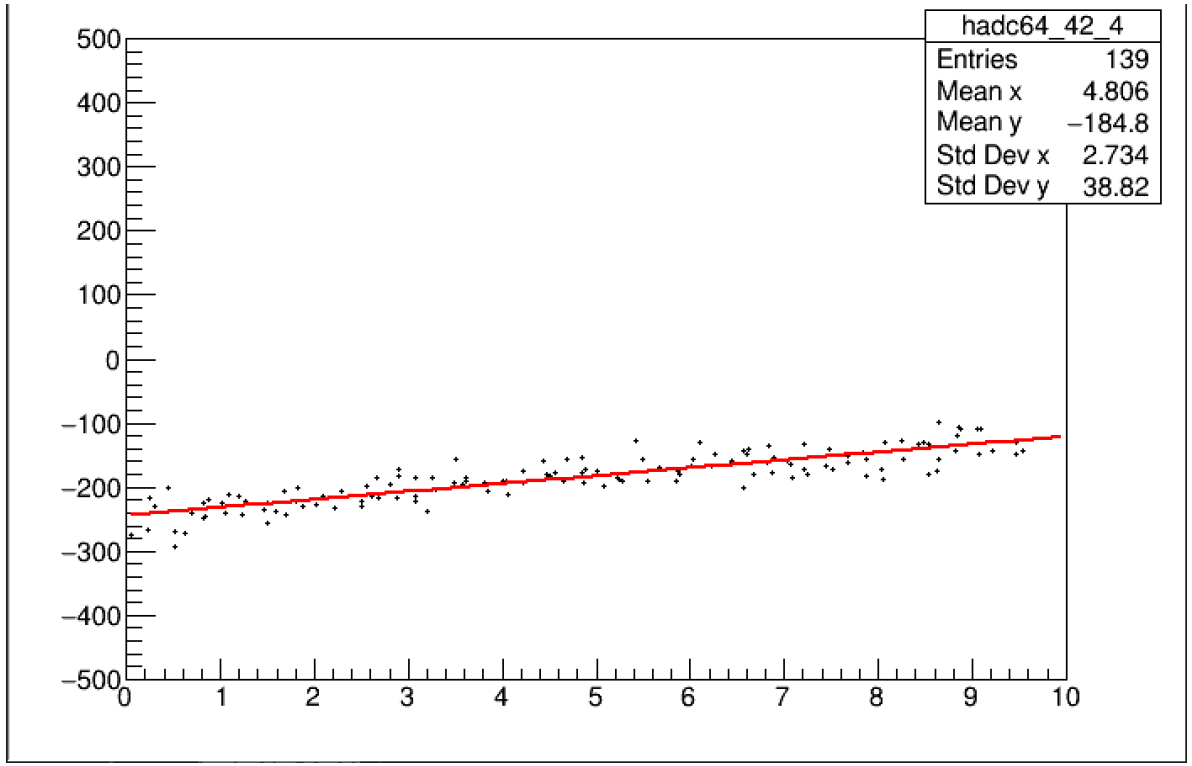
- Individiazione gli spill mediante un taglio sulla distanza massima tra gli eventi

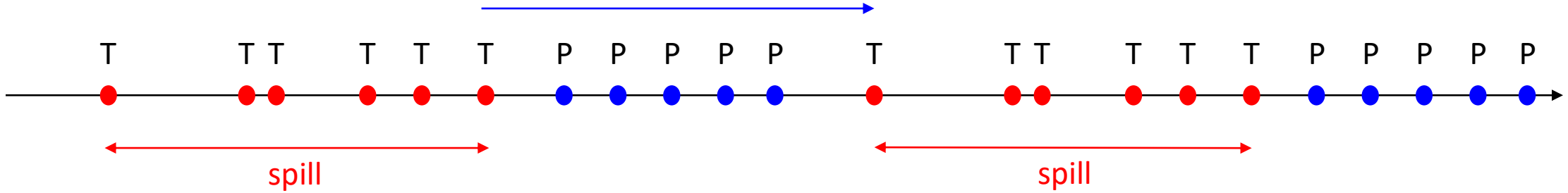


Run 301

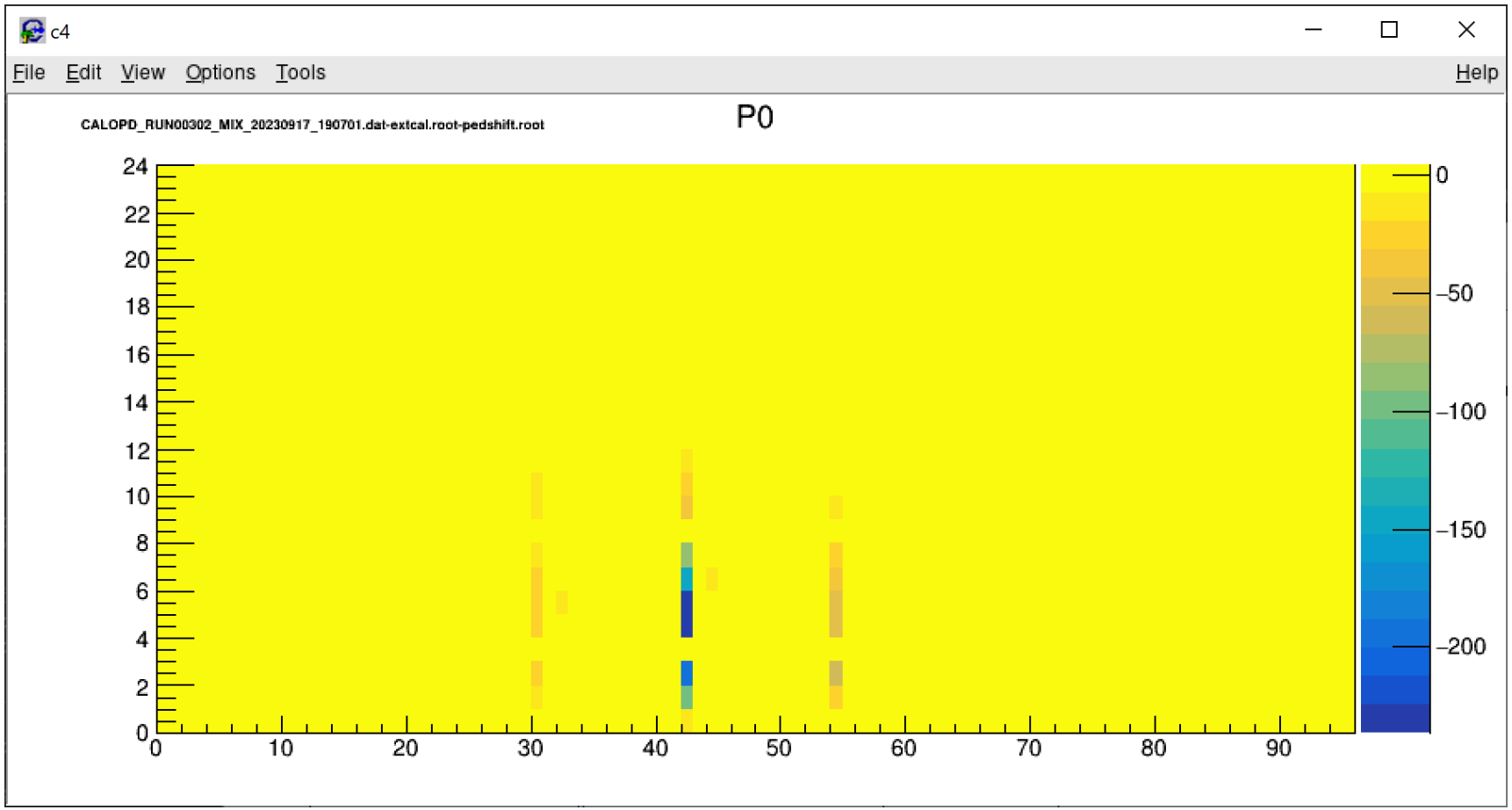
- Fit lineare del piedistallo medio in funzione del tempo calcolato a partire dall'ultimo evento dello spill precedente

$$\Delta_{pulser}(t) = P_0 + P_1 \cdot t_{pulser}$$

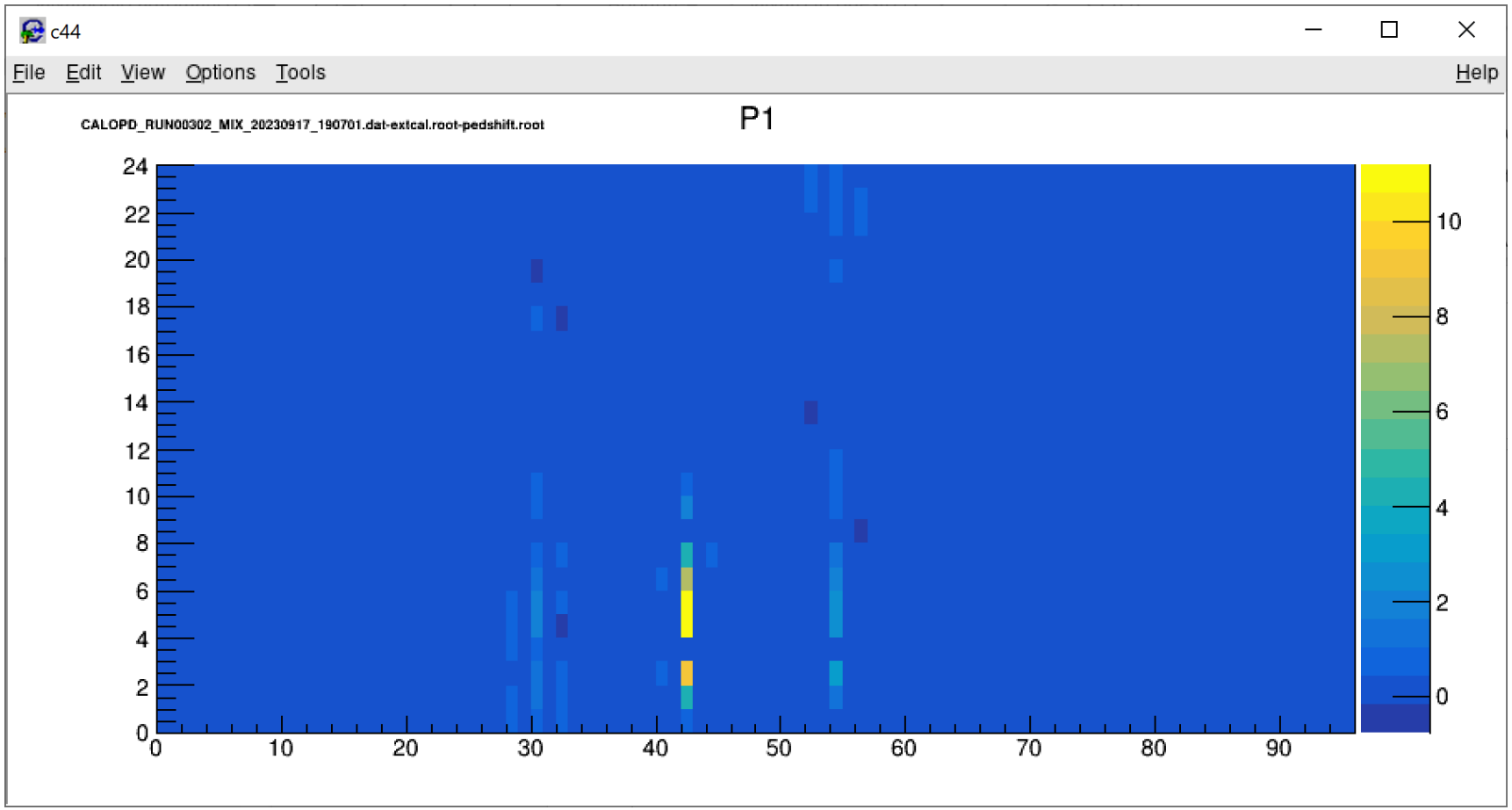




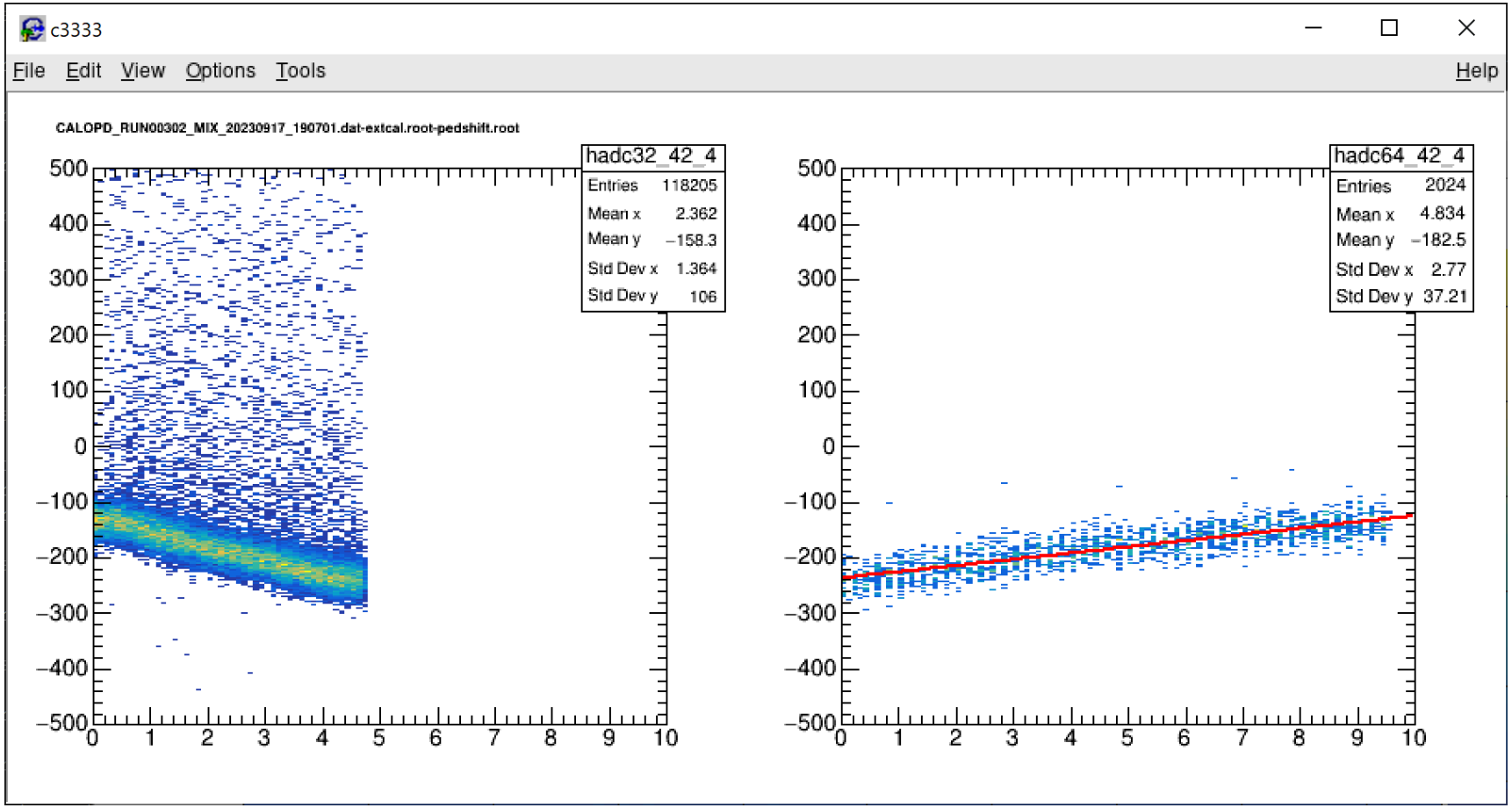
$$\Delta_{pulser}(t) = P_0 + P_1 \cdot t_{pulser}$$



$$\Delta_{pulser}(t) = P_0 + P_1 \cdot t_{pulser}$$



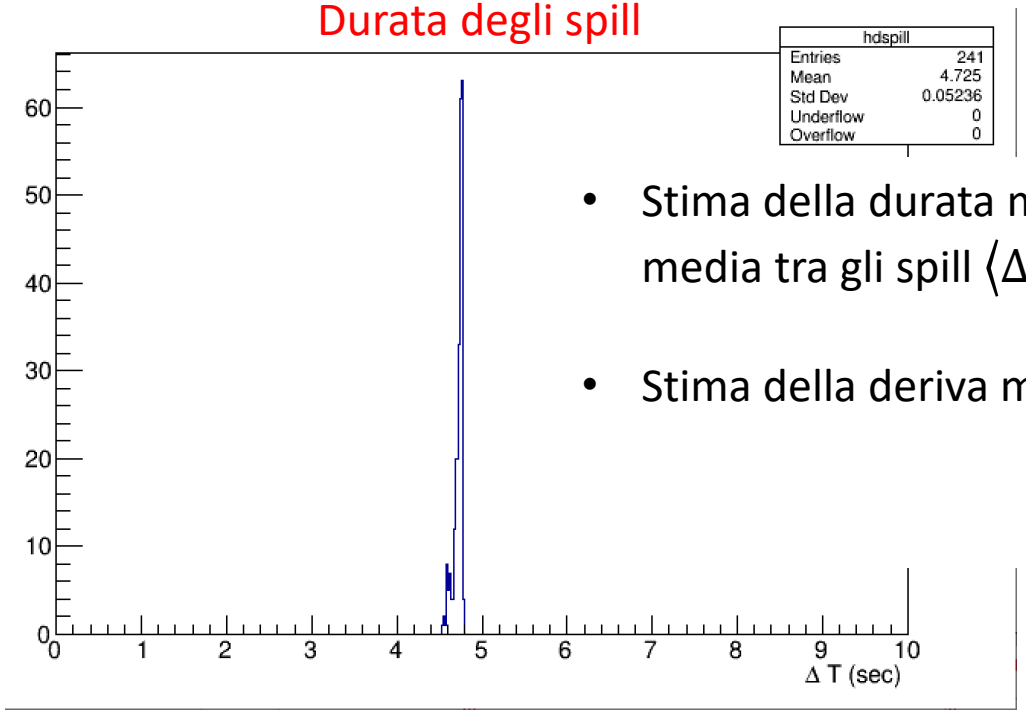
Forse e` opportune mettere un taglio sulla correzione.
Se non e` significativa, non si applica



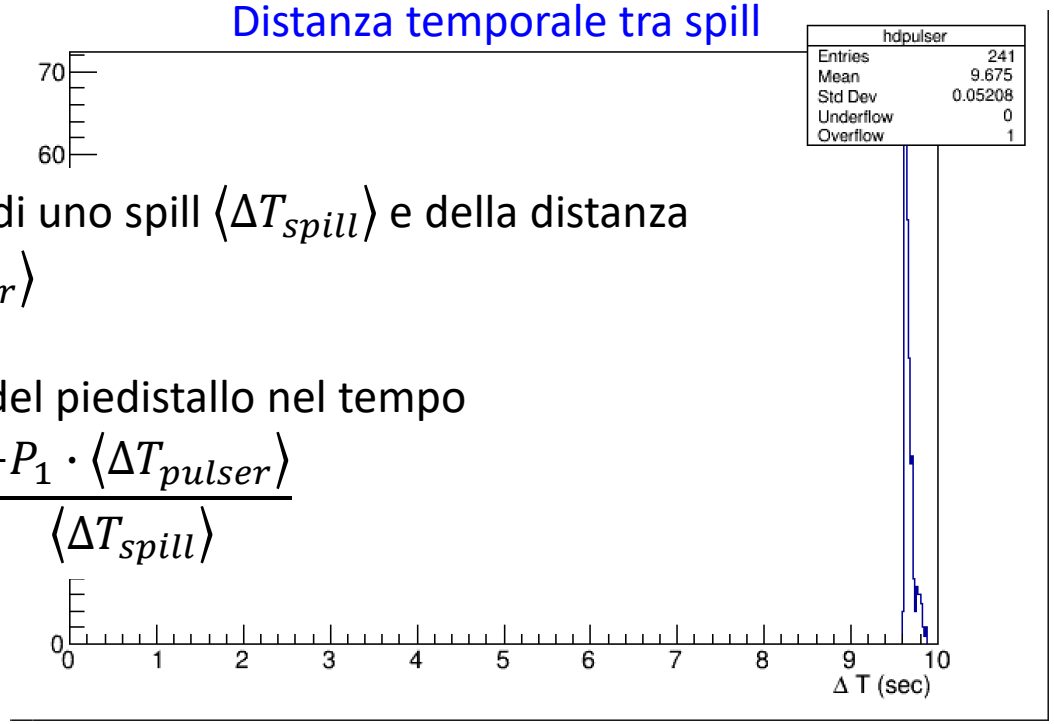
Canale con la correzione massima

Run 302

Durata degli spill

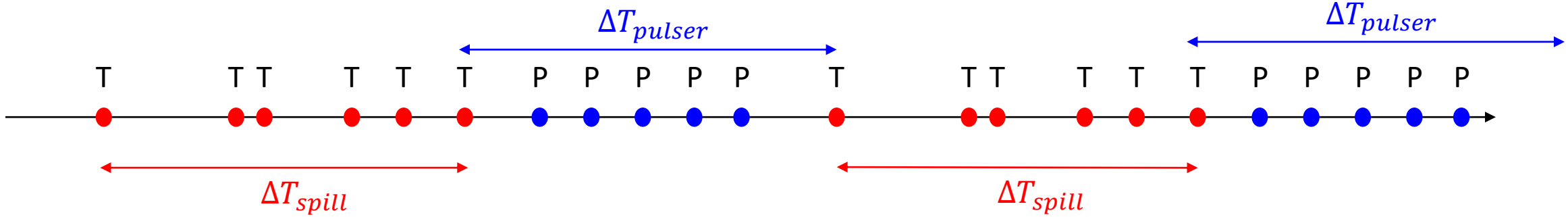


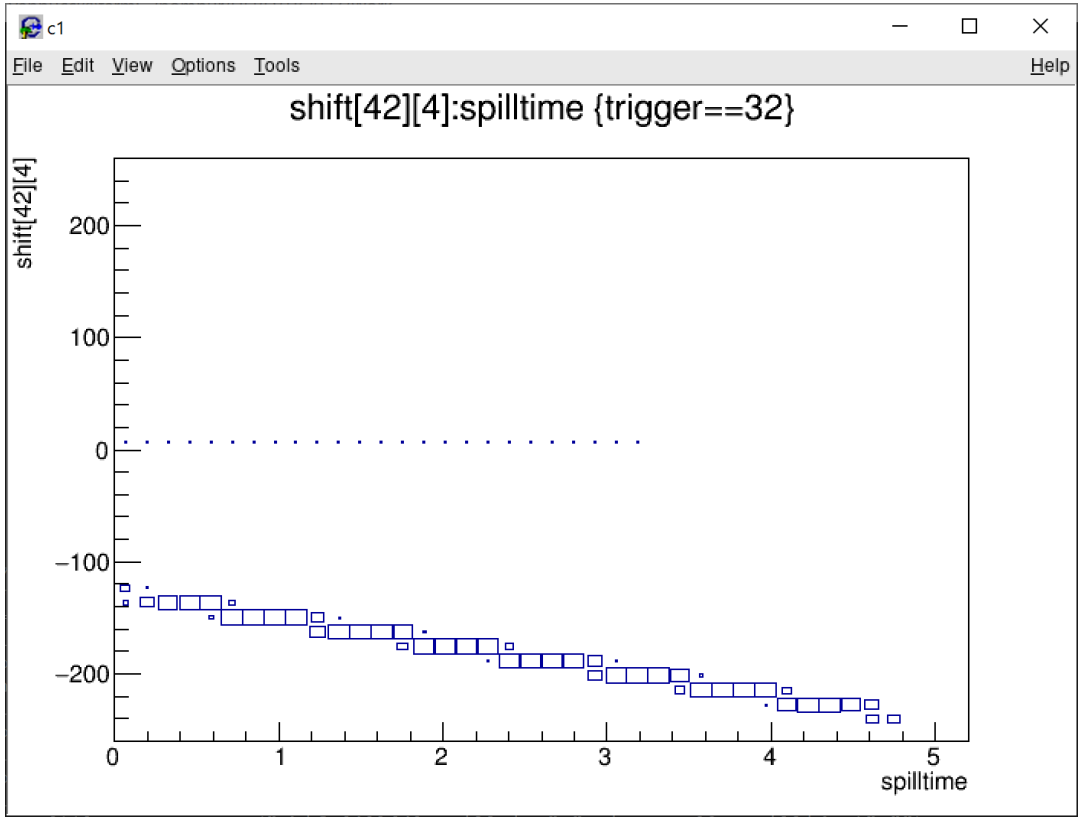
Distanza temporale tra spill



- Stima della durata media di uno spill $\langle \Delta T_{spill} \rangle$ e della distanza media tra gli spill $\langle \Delta T_{pulser} \rangle$
- Stima della deriva media del piedistallo nel tempo

$$P = \frac{-P_1 \cdot \langle \Delta T_{pulser} \rangle}{\langle \Delta T_{spill} \rangle}$$





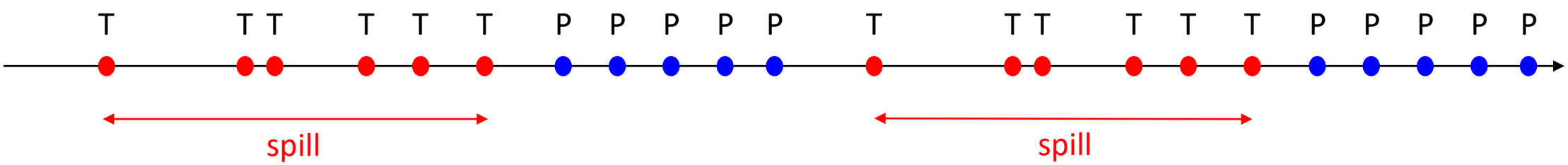
- Per ogni evento nello spill:

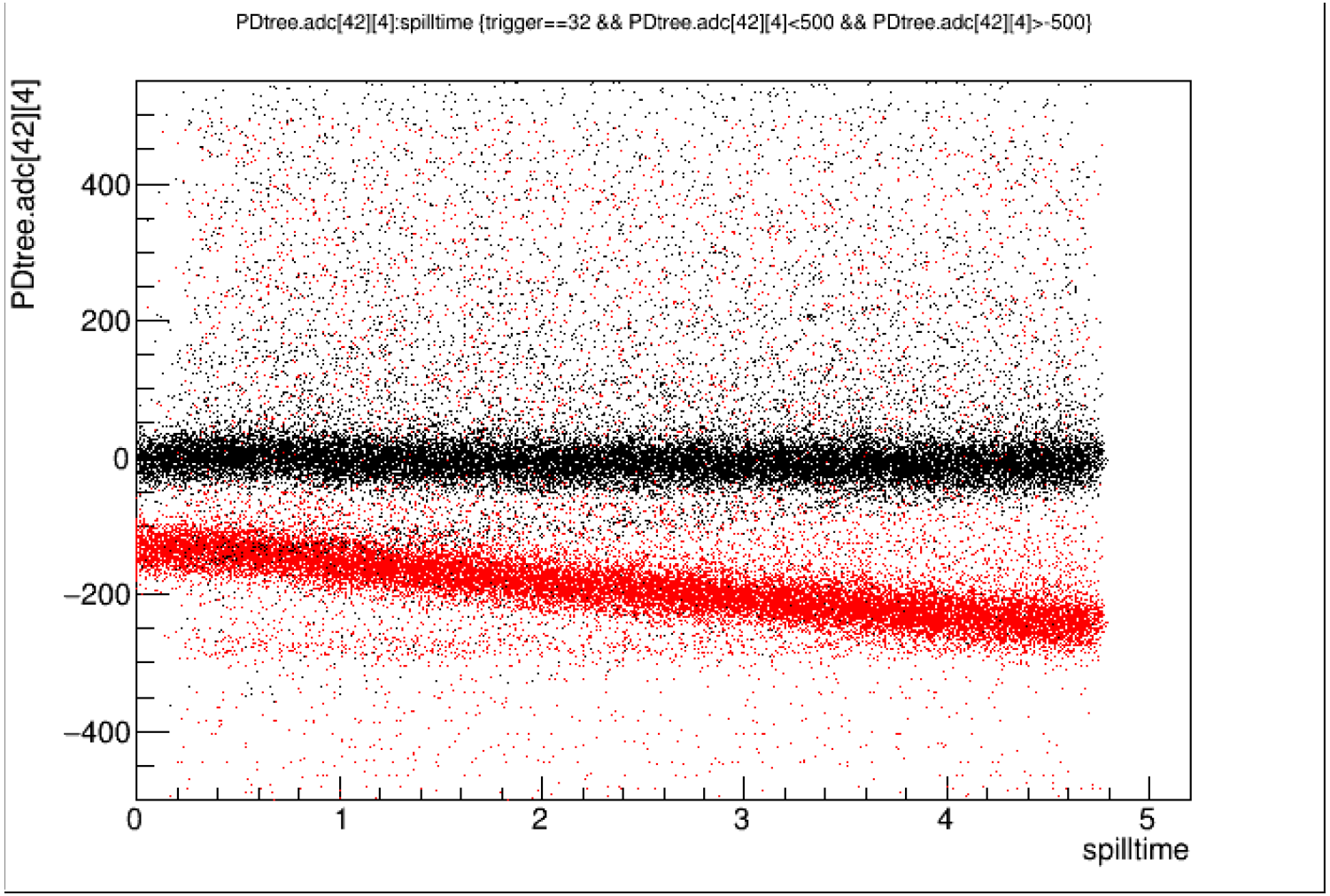
$$\Delta_{spill}\,(t) = \Delta_0 + P \cdot t_{spill}$$

$\Delta_0 = Min\left(P_0 + P_1 \cdot \Delta T_{pulser}\,, 0\right)$ = valore del piedistallo recuperato durante l'intervallo precedente

ΔT_{pulser} = distanza dallo spill precedente

Il primo spill e` escluso

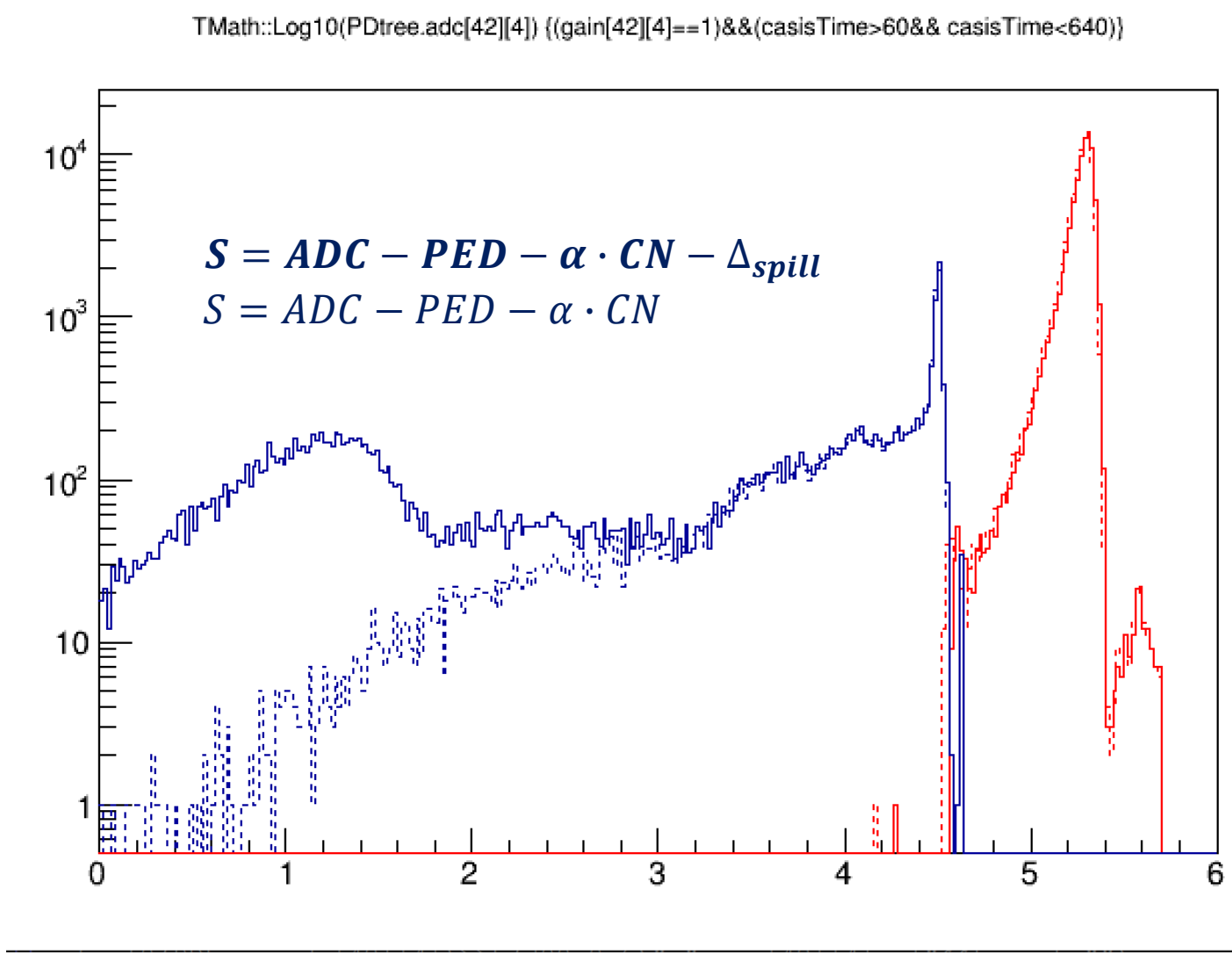




Run 302

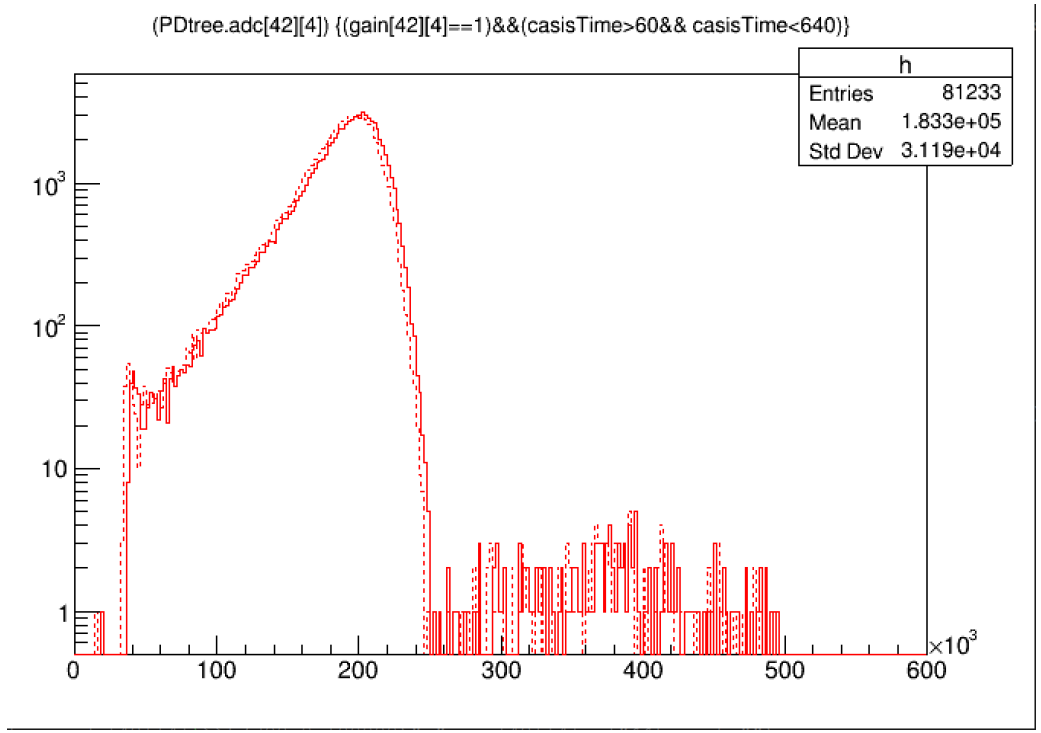
$S = ADC - PED - \Delta_{spill}$

$S = ADC - PED$

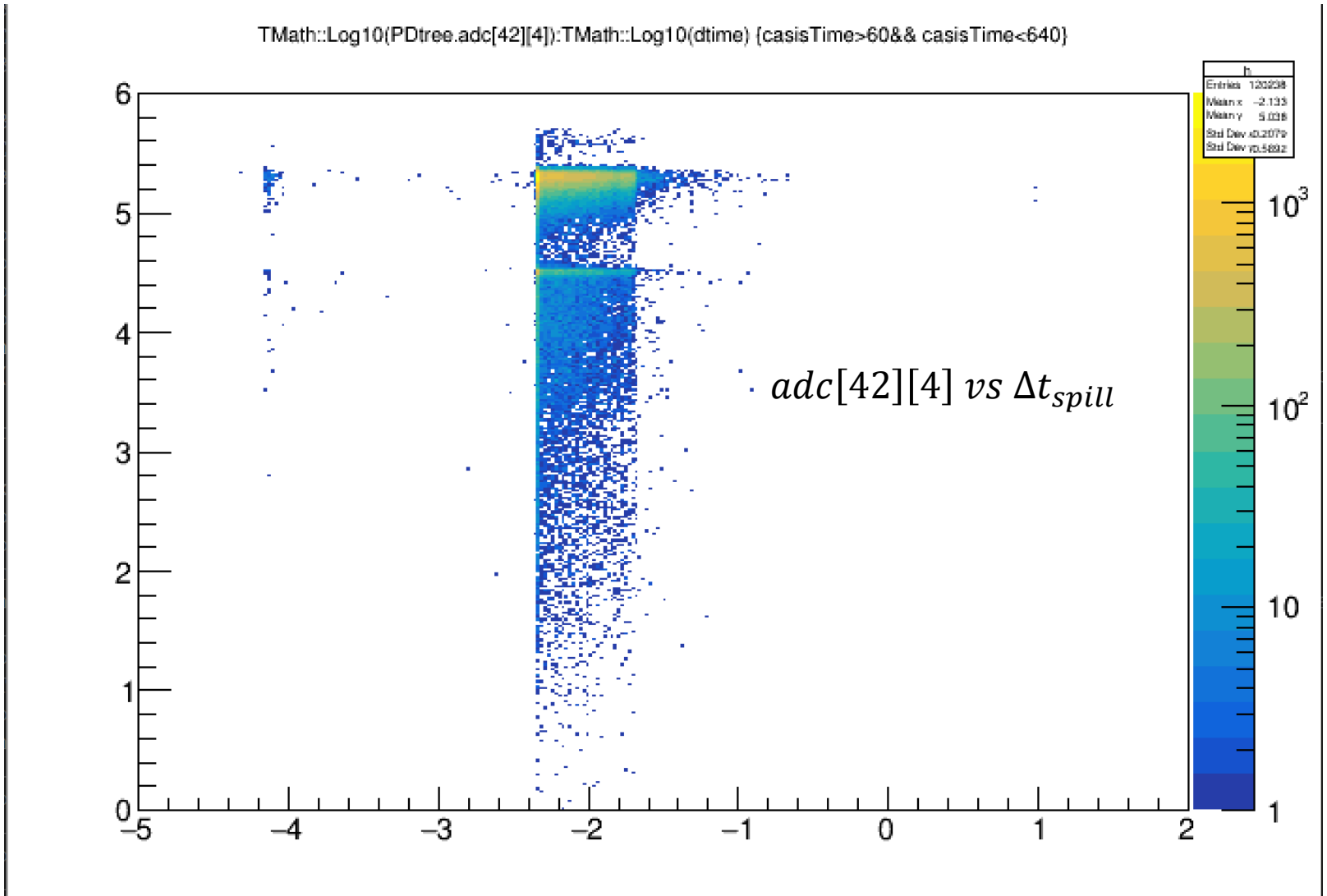


$$S = G \cdot (ADC - PED - \Delta_{spill}) + C$$

$$S = G \cdot (ADC - PED) + C$$



Non c’e` nessuna correlazione con la distanza temporale dall’evento precedente



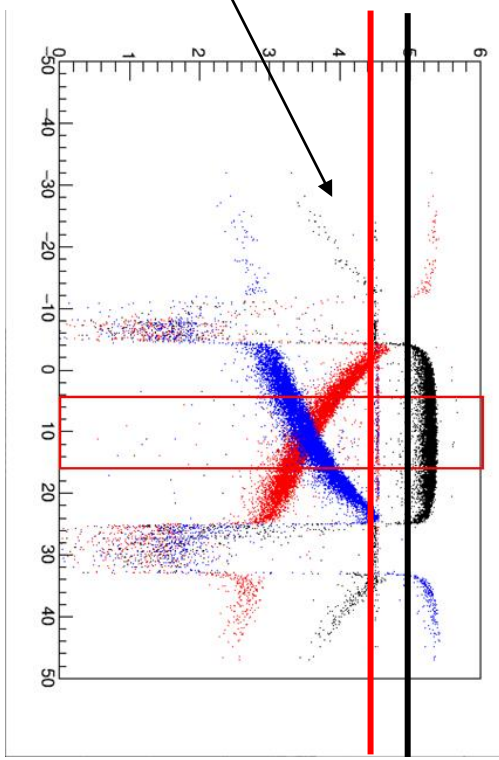
Run 302

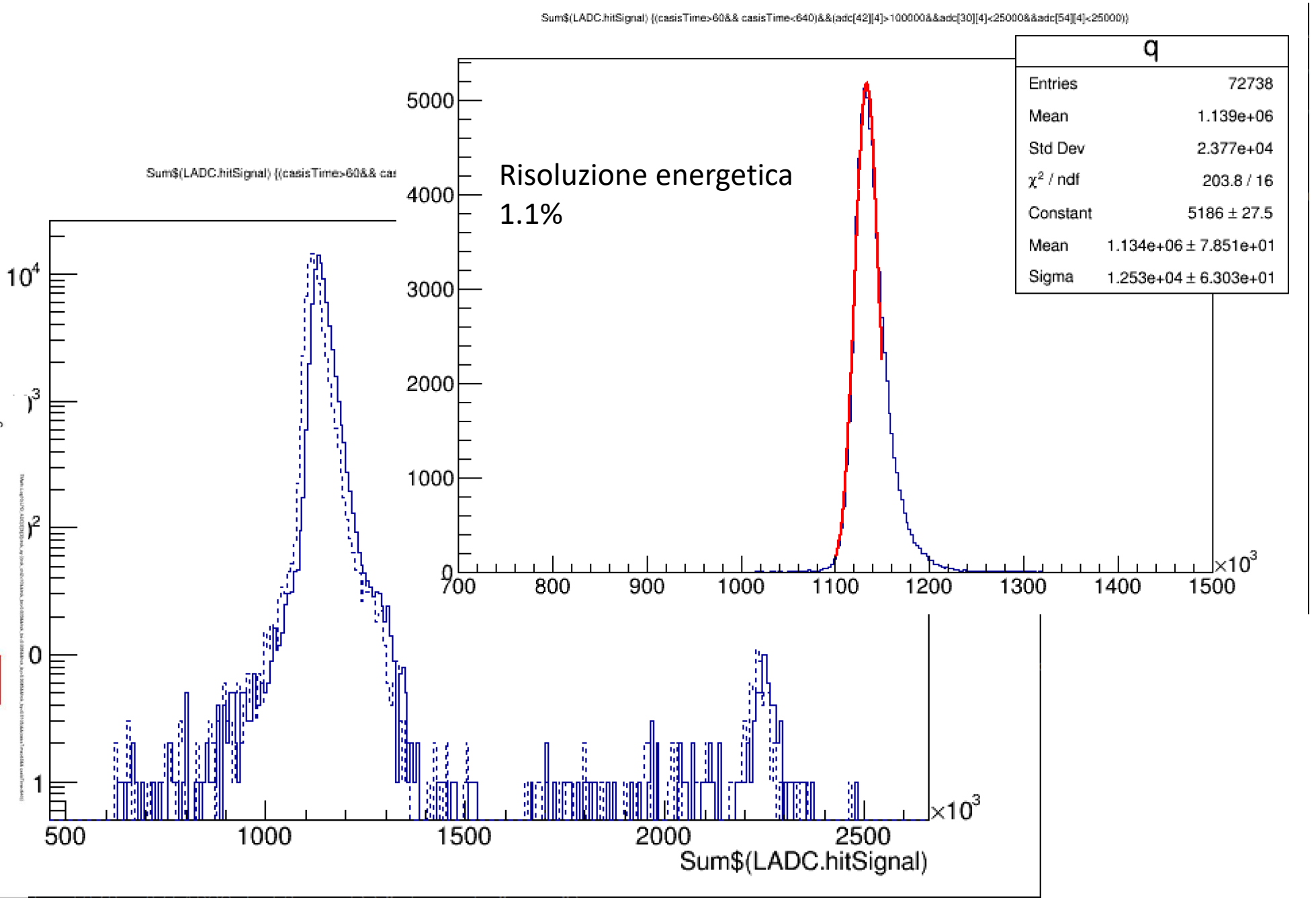
Selezione

adc[42][4]>100000

adc[54][4]<25000

adc[30][4]<25000

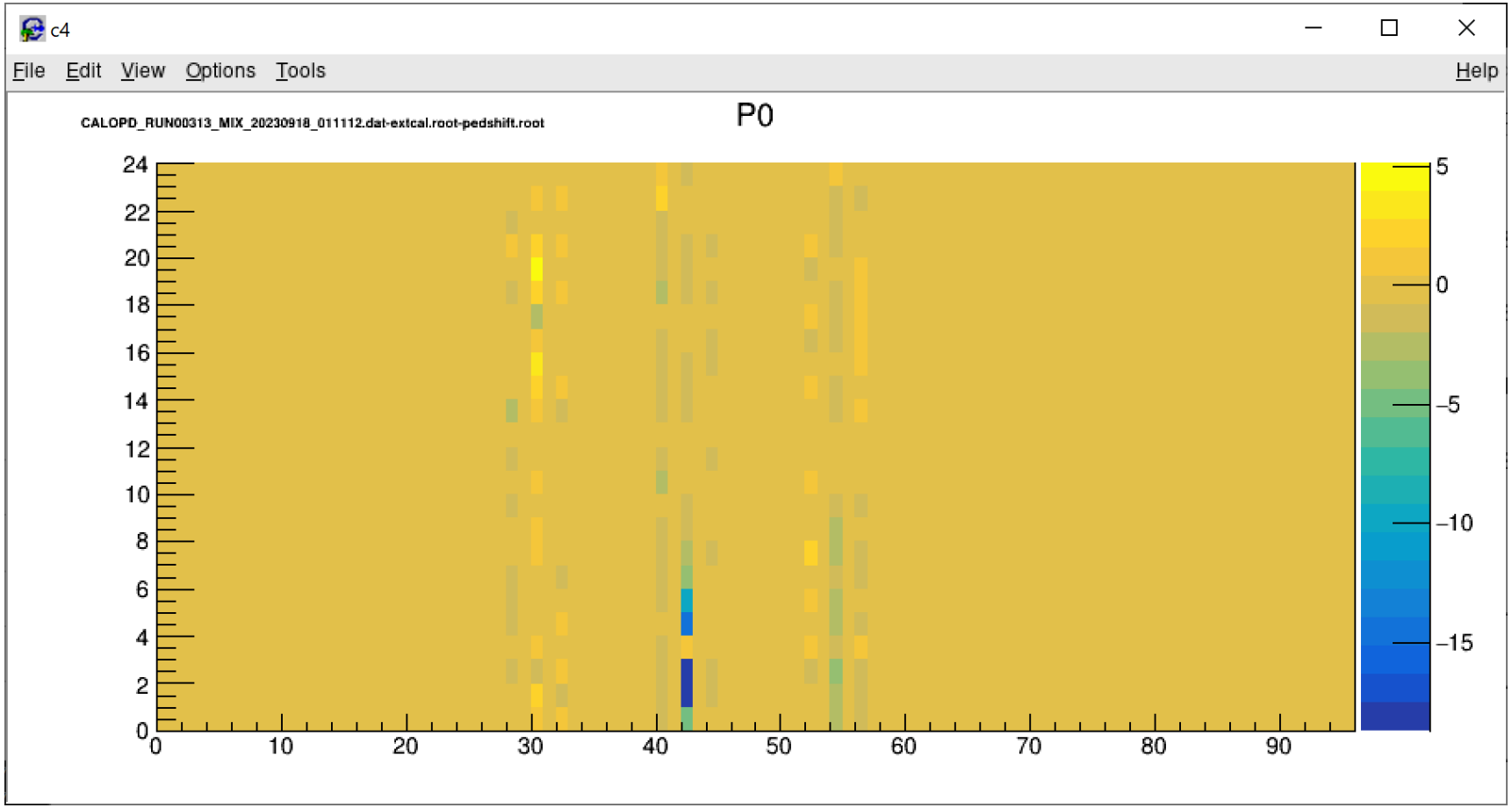




- La correzione e` fatta bene per tutti i file?
  - Ci sono due run dove per alcuni spill la deriva e` diversa. La correzione non e` quindi adeguata per tutti gli eventi
  - I chip rumorosi hanno alcune volte dei parametri anomali
- Ed e` sempre significativa?
  - Non e` sempre significative. Si mette un taglio?

  - Quando la correzione non e` significative, o ha valori anomaly, e` comunque entro il rumore

20 GeV


c4
File Edit View Options Tools Help
CALOPD_RUN00313_MIX_20230918_011112.dat-extcal.root-pedshift.root
P0
24
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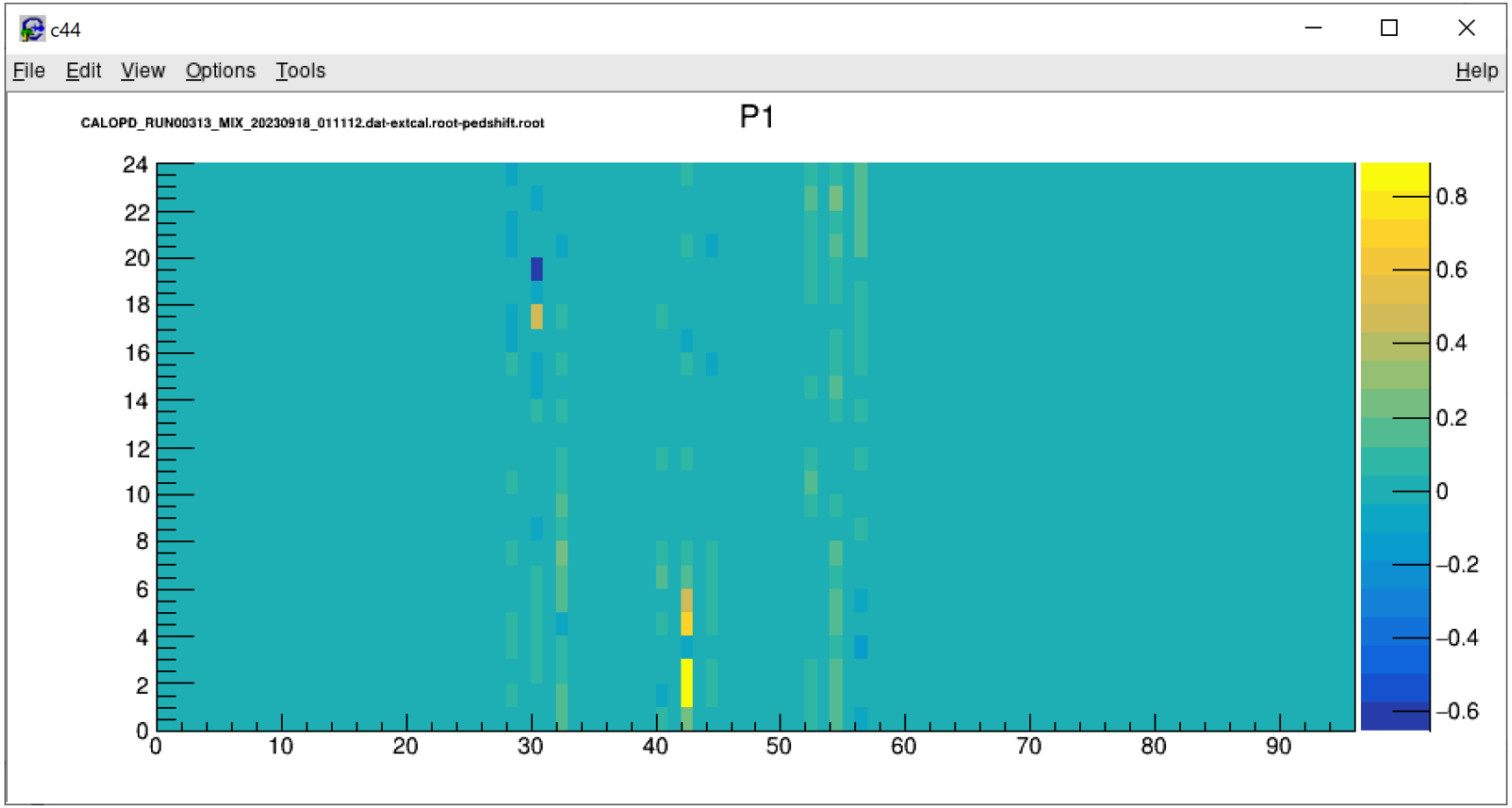
2
0
0 10 20 30 40 50 60 70 80 90
5
0
−5
−10
−15


c44
File Edit View Options Tools Help
CALOPD_RUN00313_MIX_20230918_011112.dat-extcal.root-pedshift.root
P1
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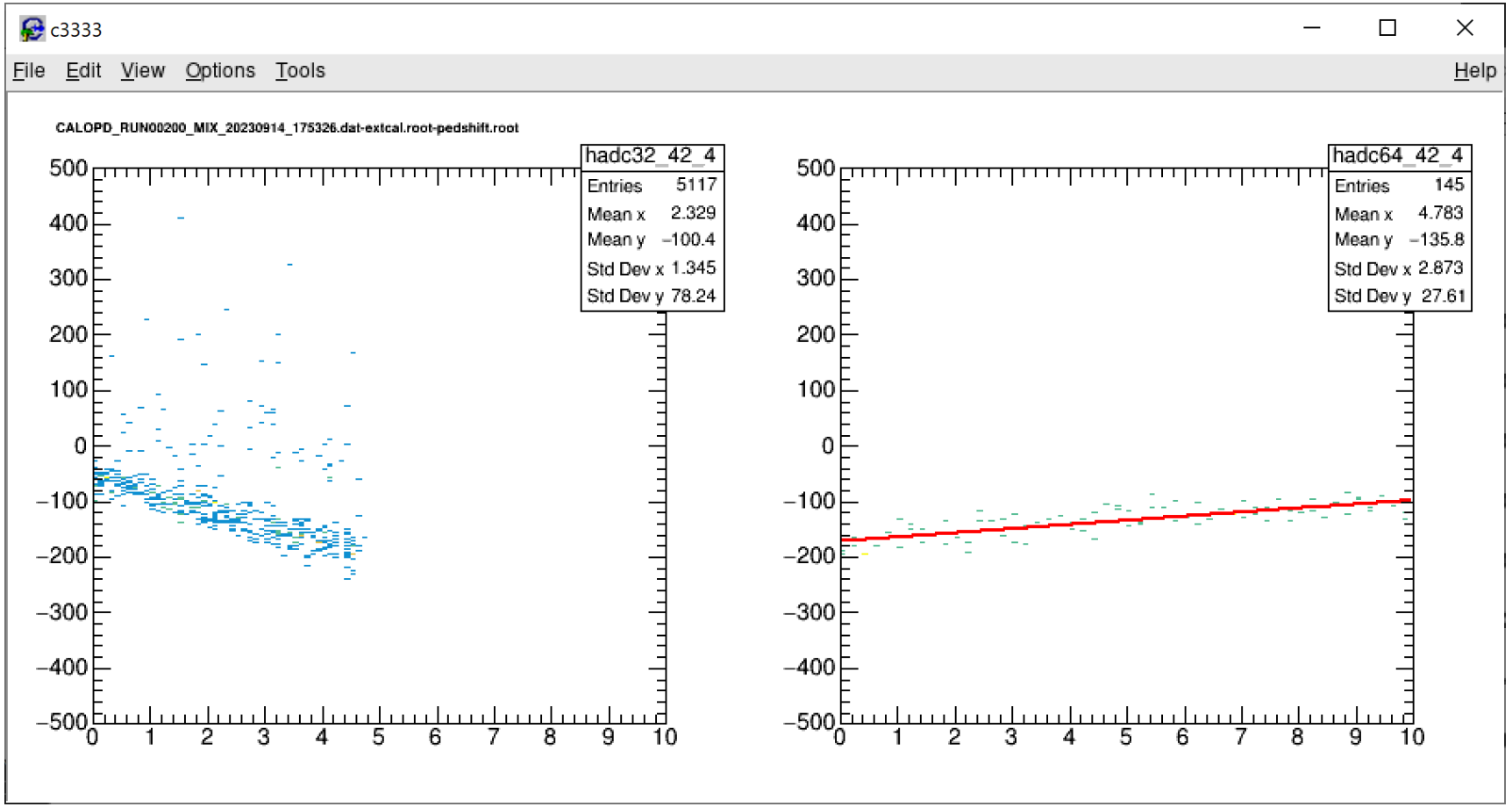
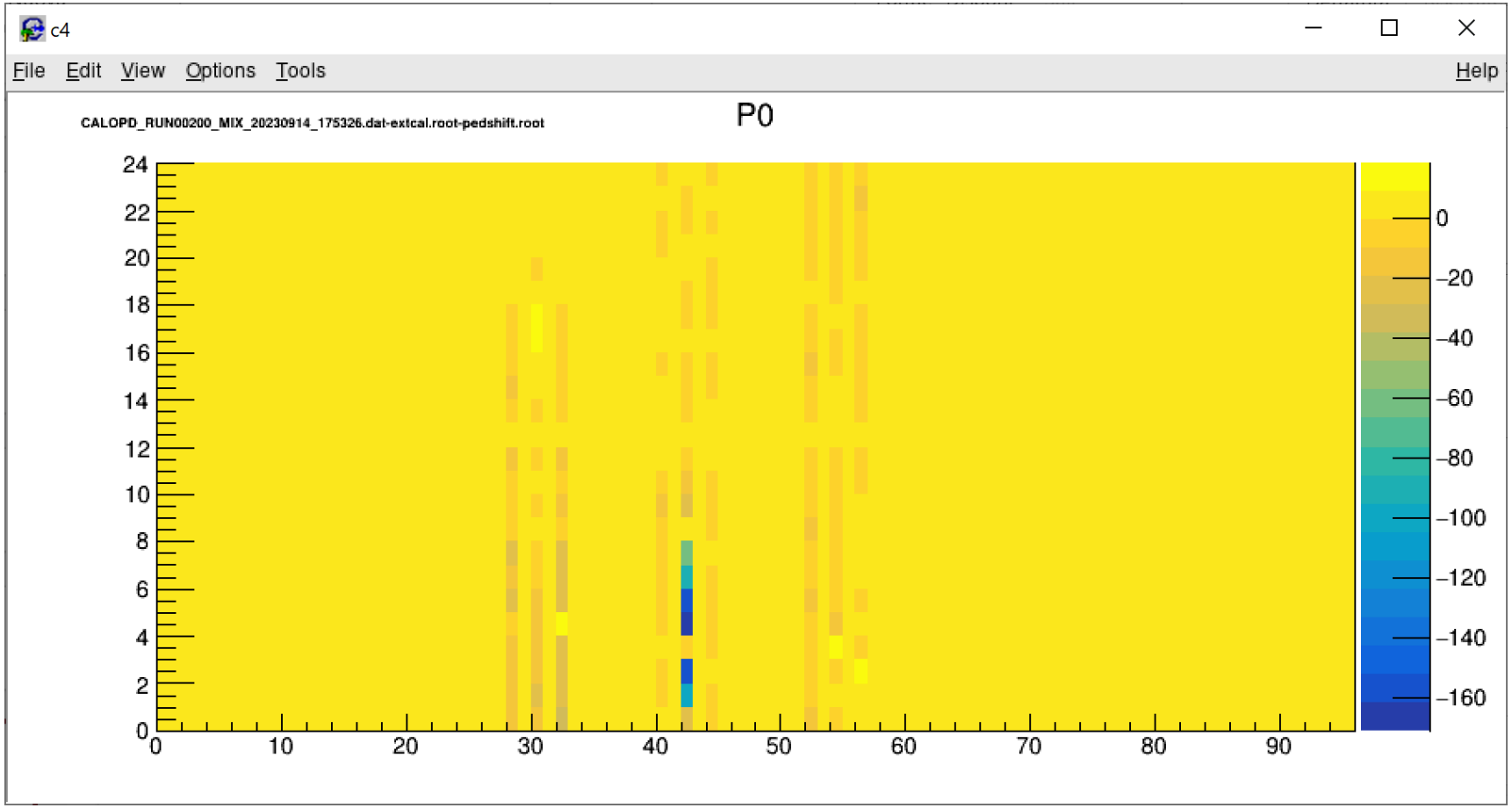
0 10 20 30 40 50 60 70 80 90
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6

149 GeV

In questo caso c'e` poca statistica e molte volte la correzione non e` significativa




c4
File Edit View Options Tools Help
CALOPD_RUN00200_MIX_20230914_175326.dat-extcal.root-pedshift.root
P0
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0 10 20 30 40 50 60 70 80 90
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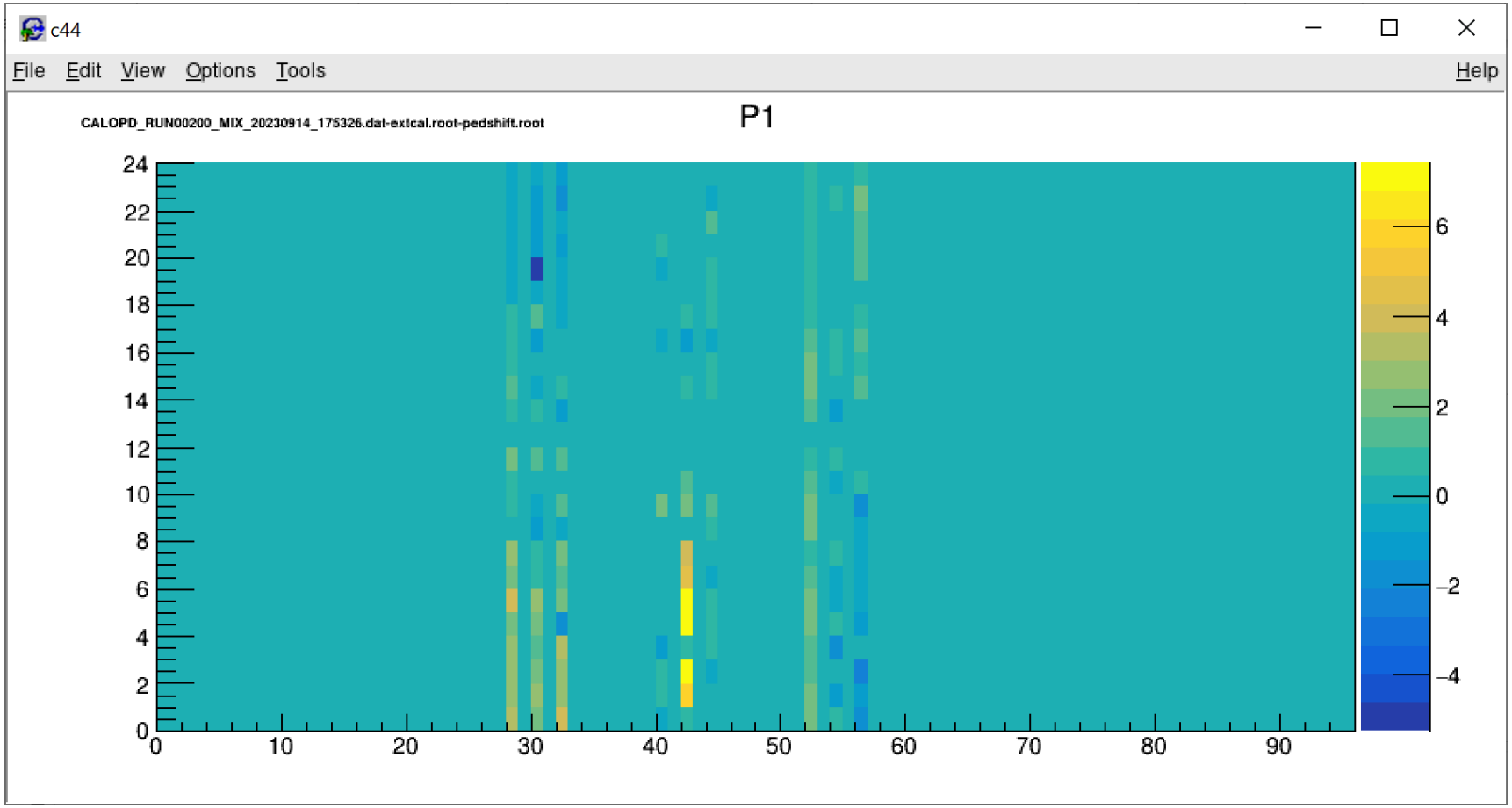
−20
−40
−60
−80
−100
−120
−140
−160


c44
File Edit View Options Tools Help
CALOPD_RUN00200_MIX_20230914_175326.dat-extcal.root-pedshift.root
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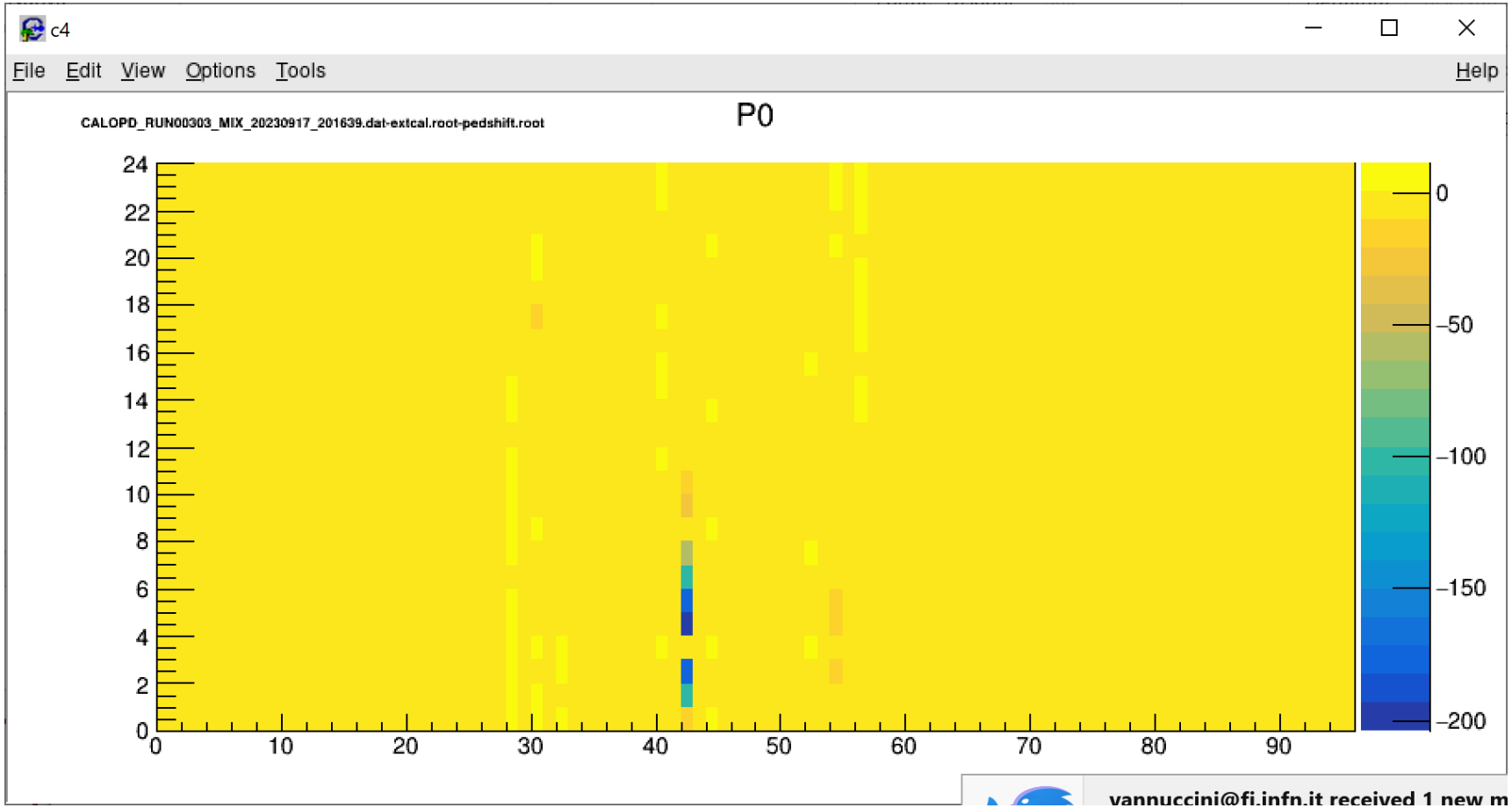
6
4
2
0
−2
−4


c4
File Edit View Options Tools Help
CALOPD_RUN00303_MIX_20230917_201639.dat-extcal.root-pedshift.root
P0
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8
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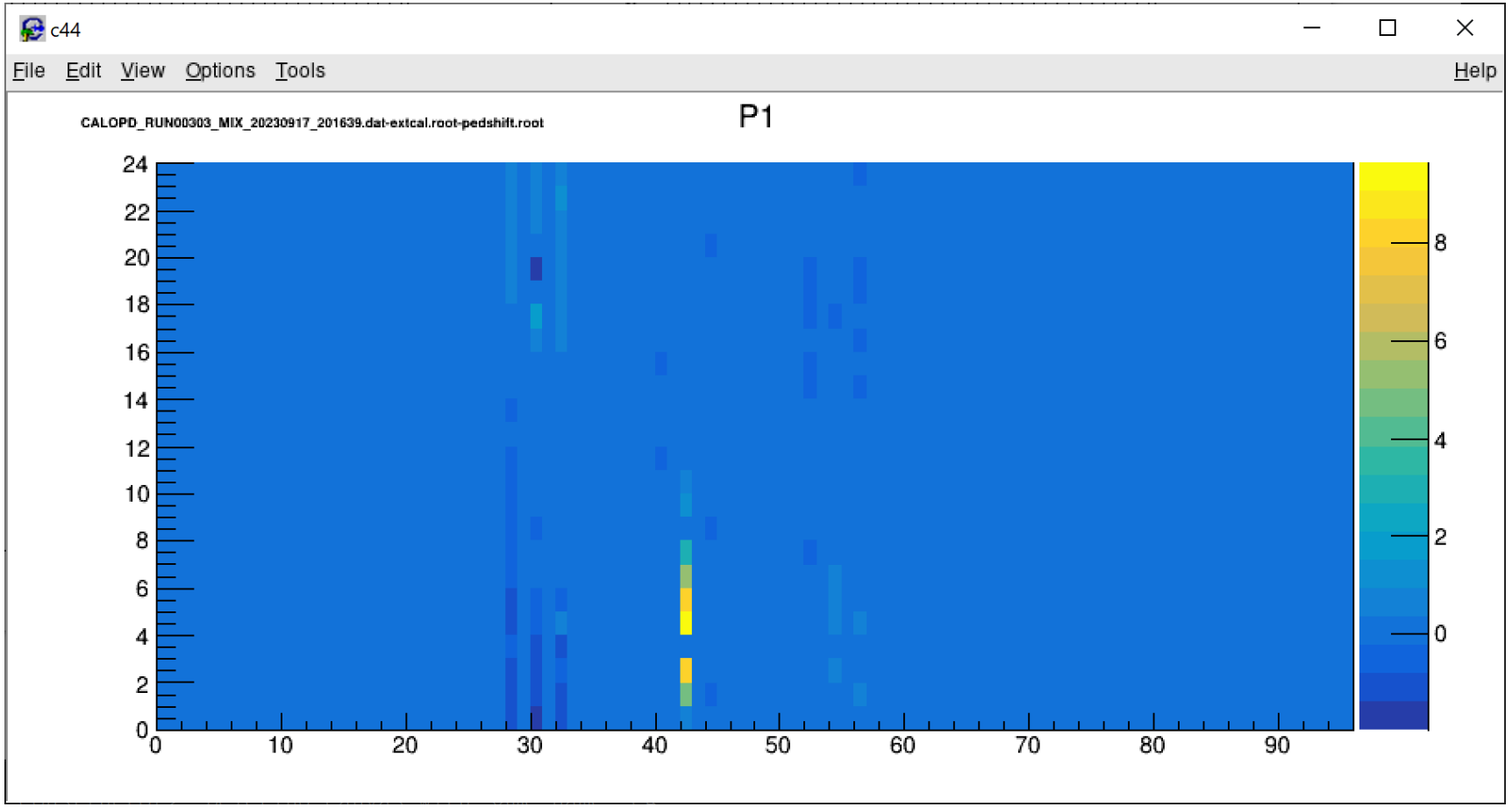
4
2
0
0 10 20 30 40 50 60 70 80 90
0
−50
−100
−150
−200
vannuccini@fi.infn.it received 1 new m

149


c44
File Edit View Options Tools Help
CALOPD_RUN00303_MIX_20230917_201639.dat-extcal.root-pedshift.root
P1
24
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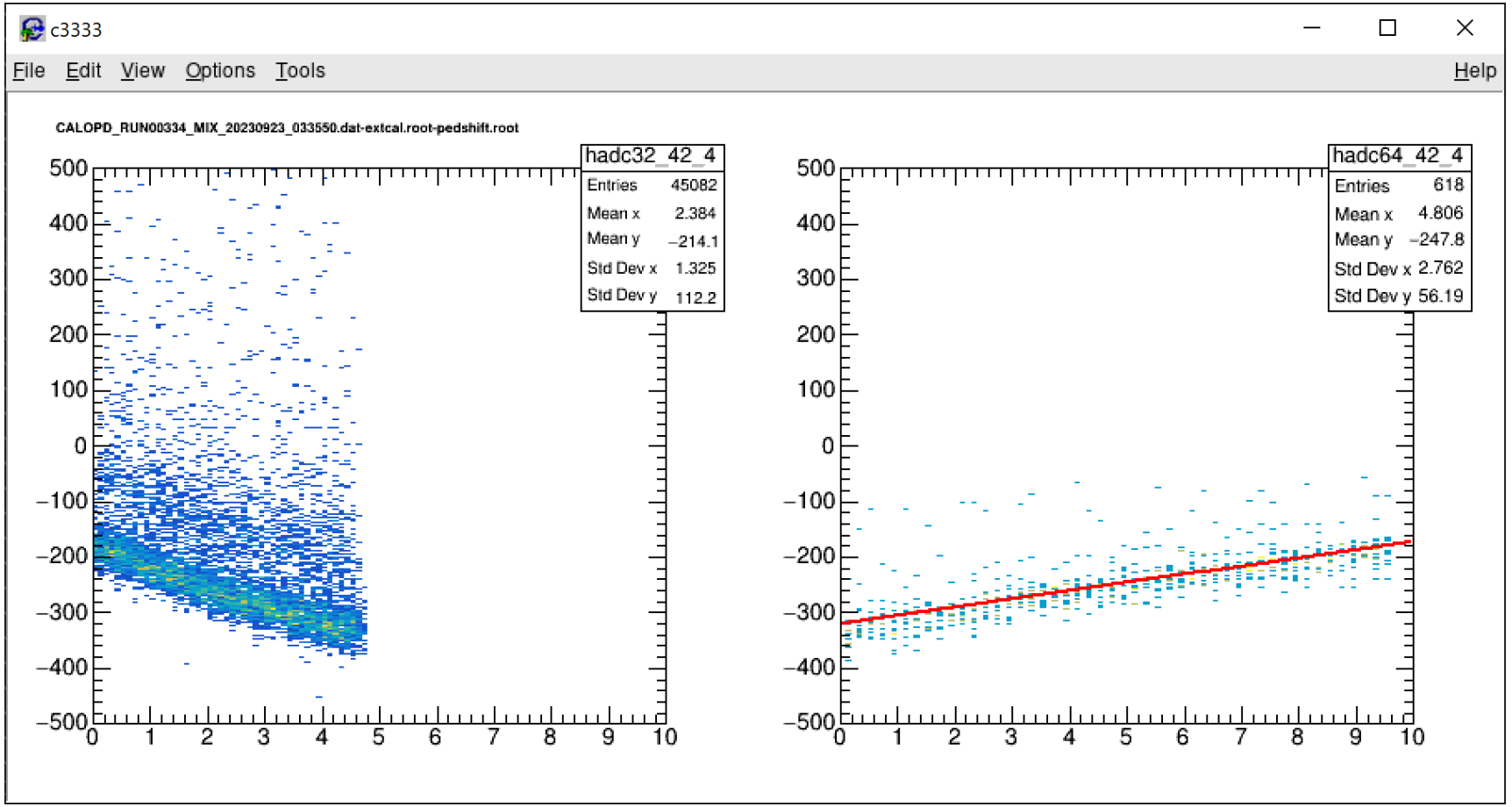
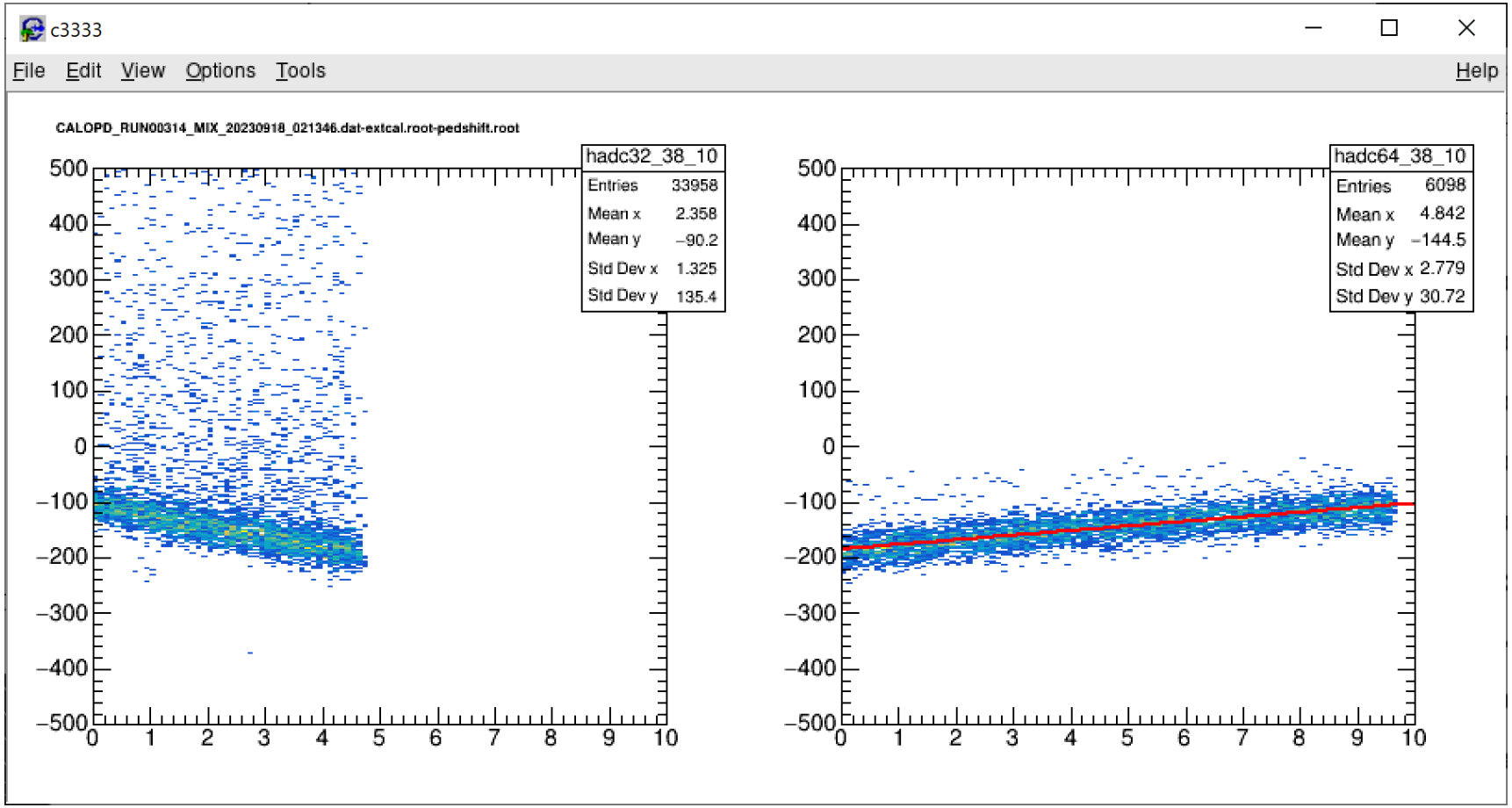
2
0

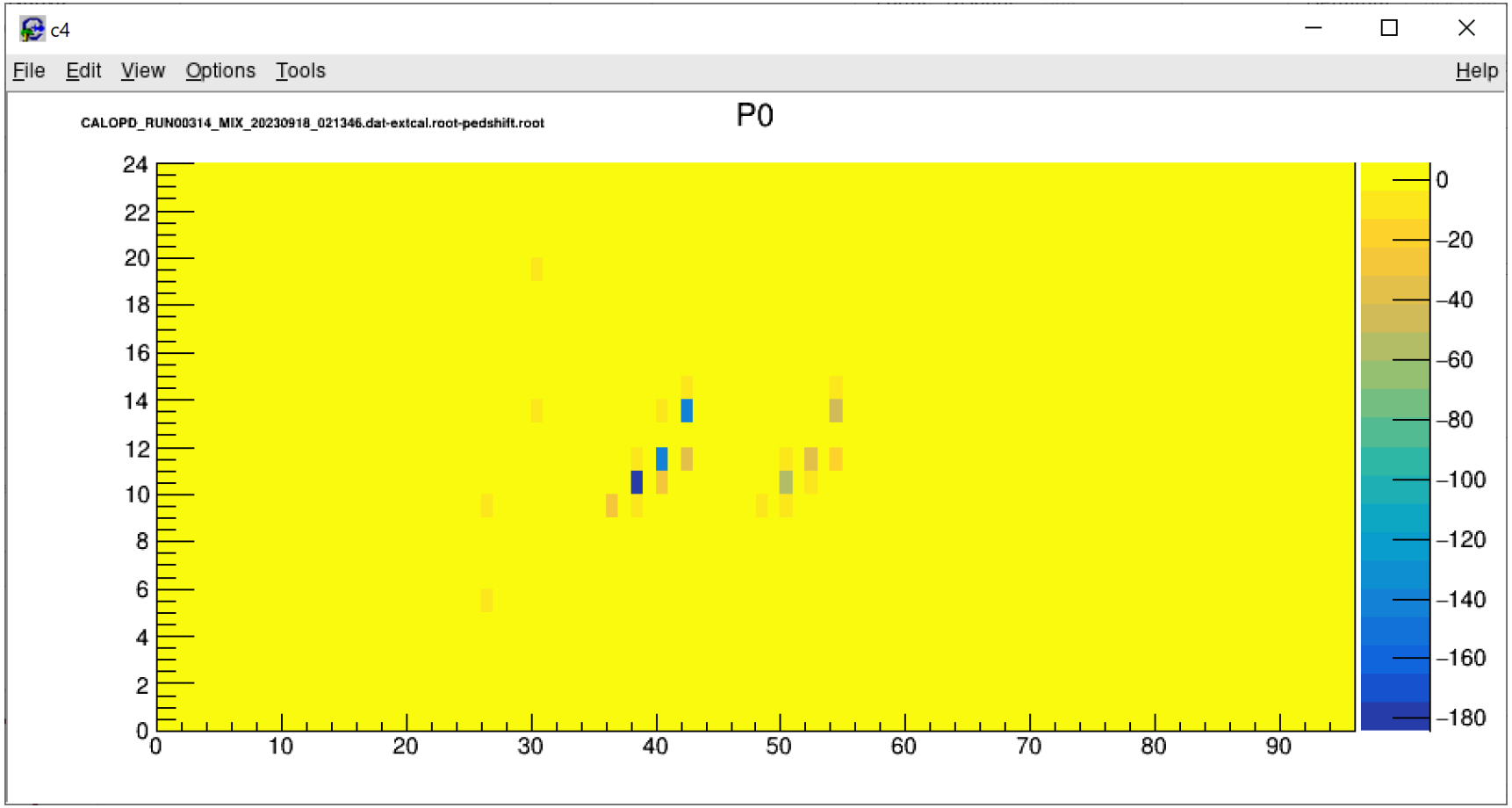


In questo run il fit non e` venuto bene…

Sembra ci siano eventi per i quali il piedistallo e` derivato di meno

45 deg


c3333
File Edit View Options Tools Help
CALOPD_RUN00314_MIX_20230918_021346.dat-extcal.root-pedshift.root
hadc32_38_10
Entries 33958
Mean x 2.358
Mean y −90.2
Std Dev x 1.325
Std Dev y 135.4
hadc64_38_10
Entries 6098
Mean x 4.842
Mean y −144.5
Std Dev x 2.779
Std Dev y 30.72


c4
File Edit View Options Tools Help
CALOPD_RUN00314_MIX_20230918_021346.dat-extcal.root-pedshift.root
P0
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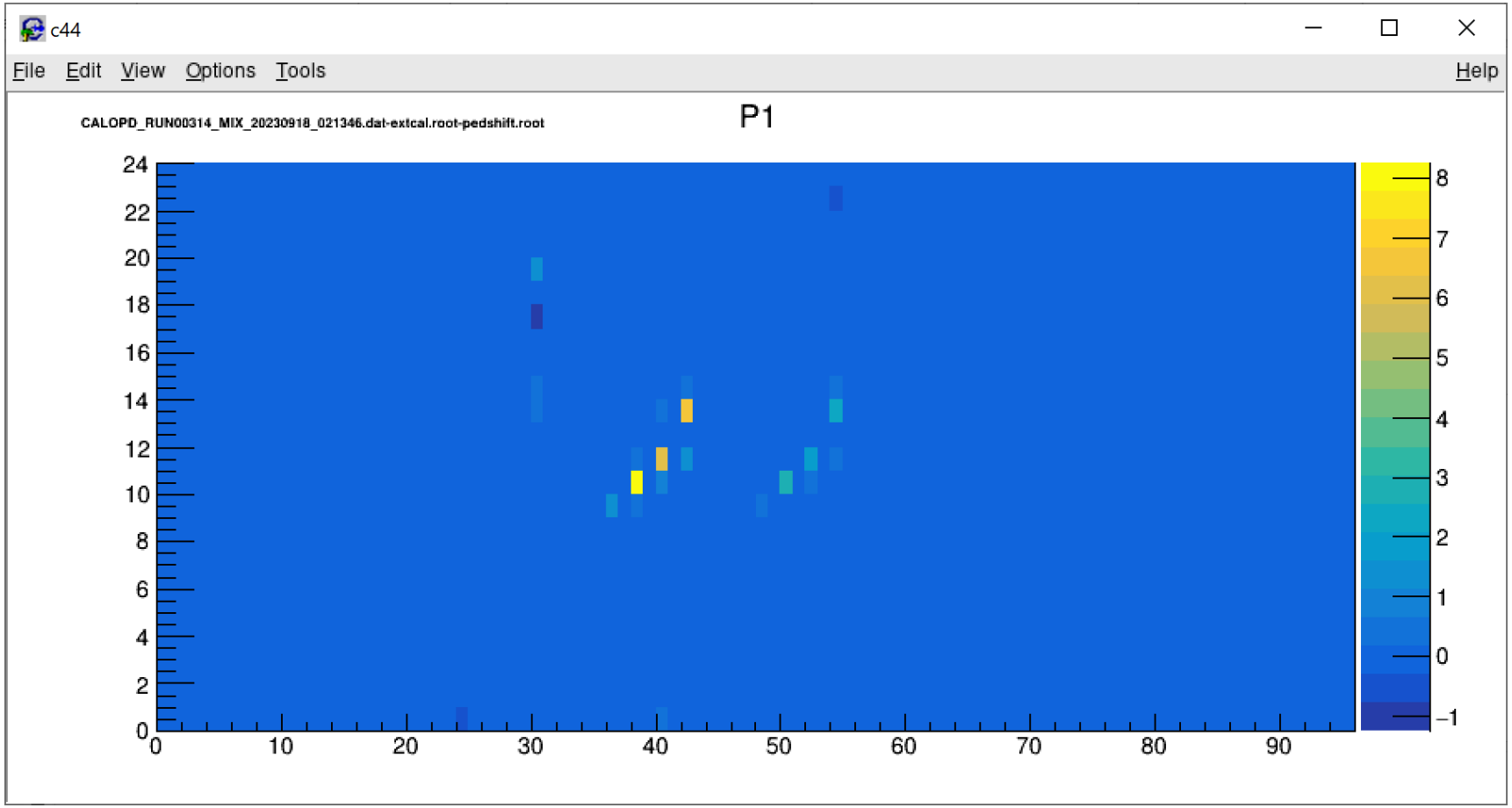
−120
−140
−160
−180


c44
File Edit View Options Tools Help
CALOPD_RUN00314_MIX_20230918_021346.dat-extcal.root-pedshift.root
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0 10 20 30 40 50 60 70 80 90
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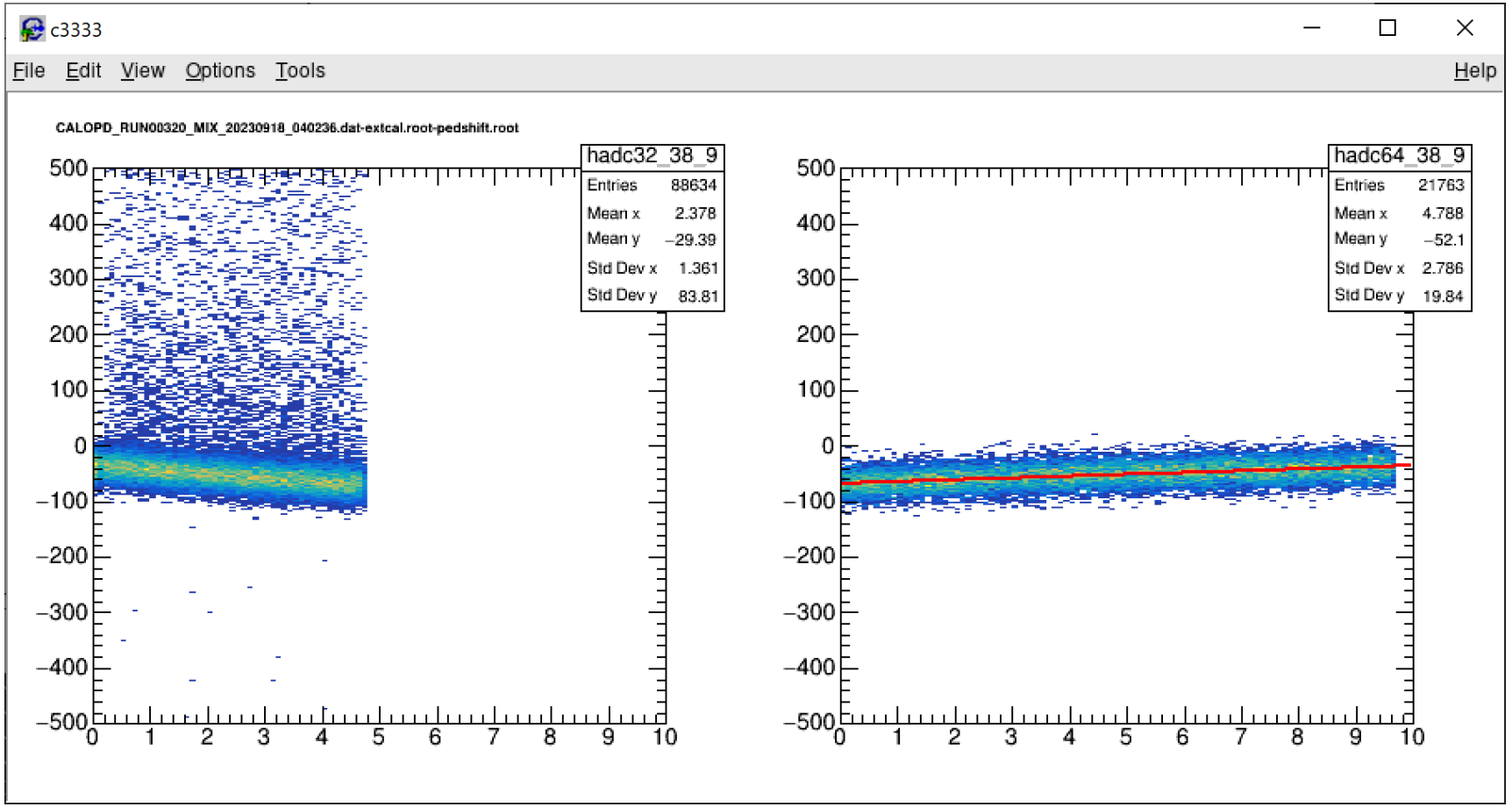
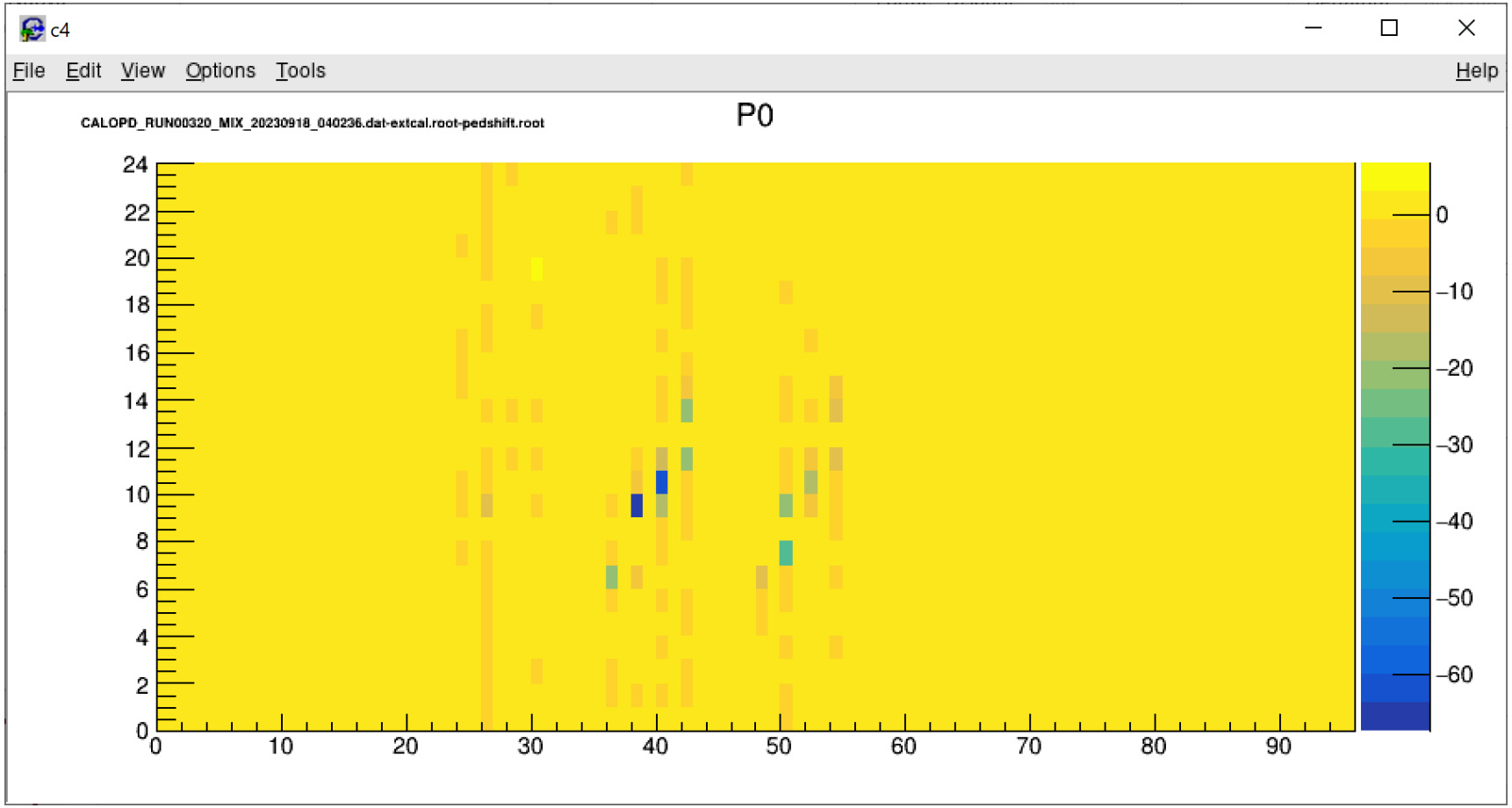
−1

30 deg


c3333
File Edit View Options Tools Help
CALOPD_RUN00320_MIX_20230918_040236.dat-extcal.root-pedshift.root
hadc32_38_9
Entries 88634
Mean x 2.378
Mean y −29.39
Std Dev x 1.361
Std Dev y 83.81
hadc64_38_9
Entries 21763
Mean x 4.788
Mean y −52.1
Std Dev x 2.786
Std Dev y 19.84


c4
File Edit View Options Tools Help
CALOPD_RUN00320_MIX_20230918_040236.dat-extcal.root-pedshift.root
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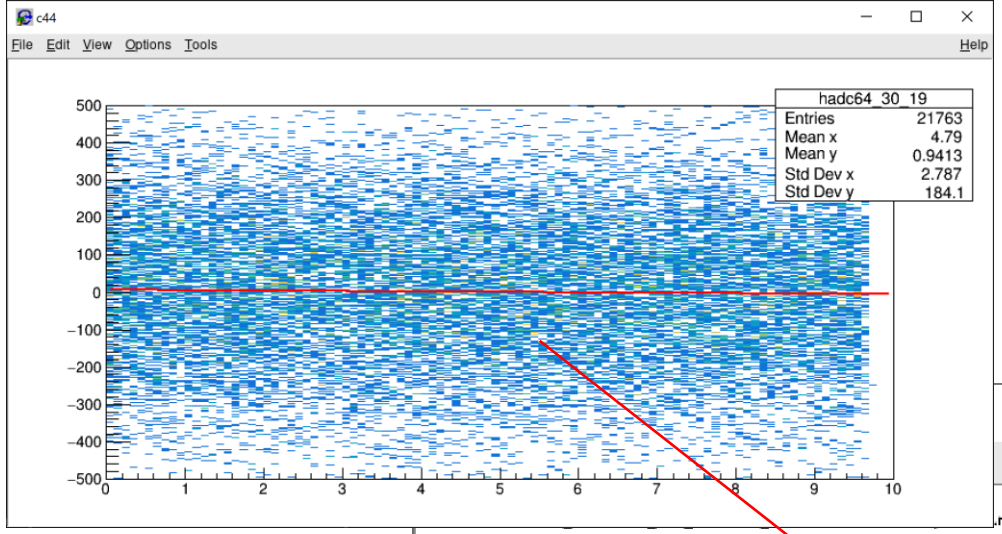
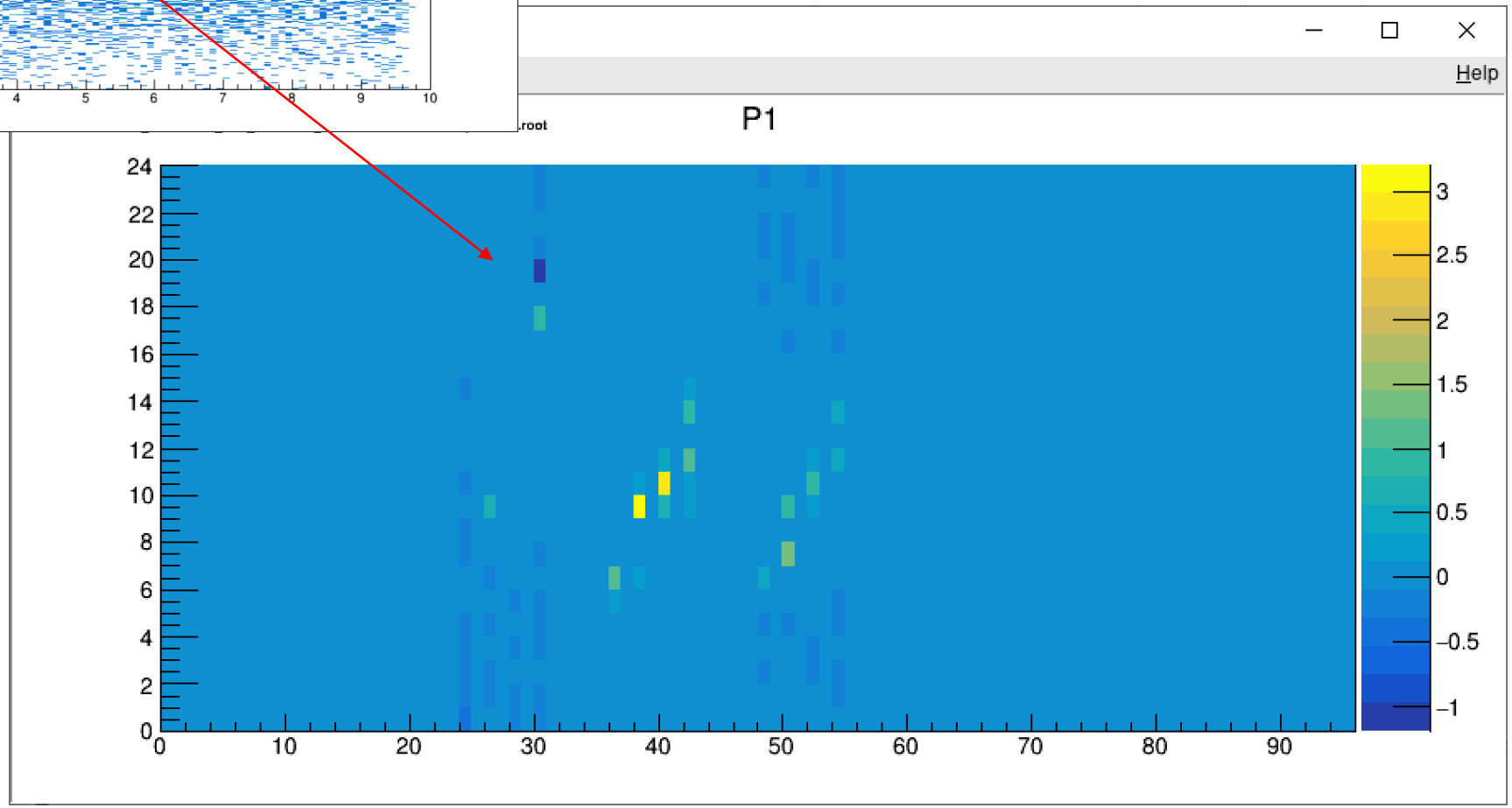
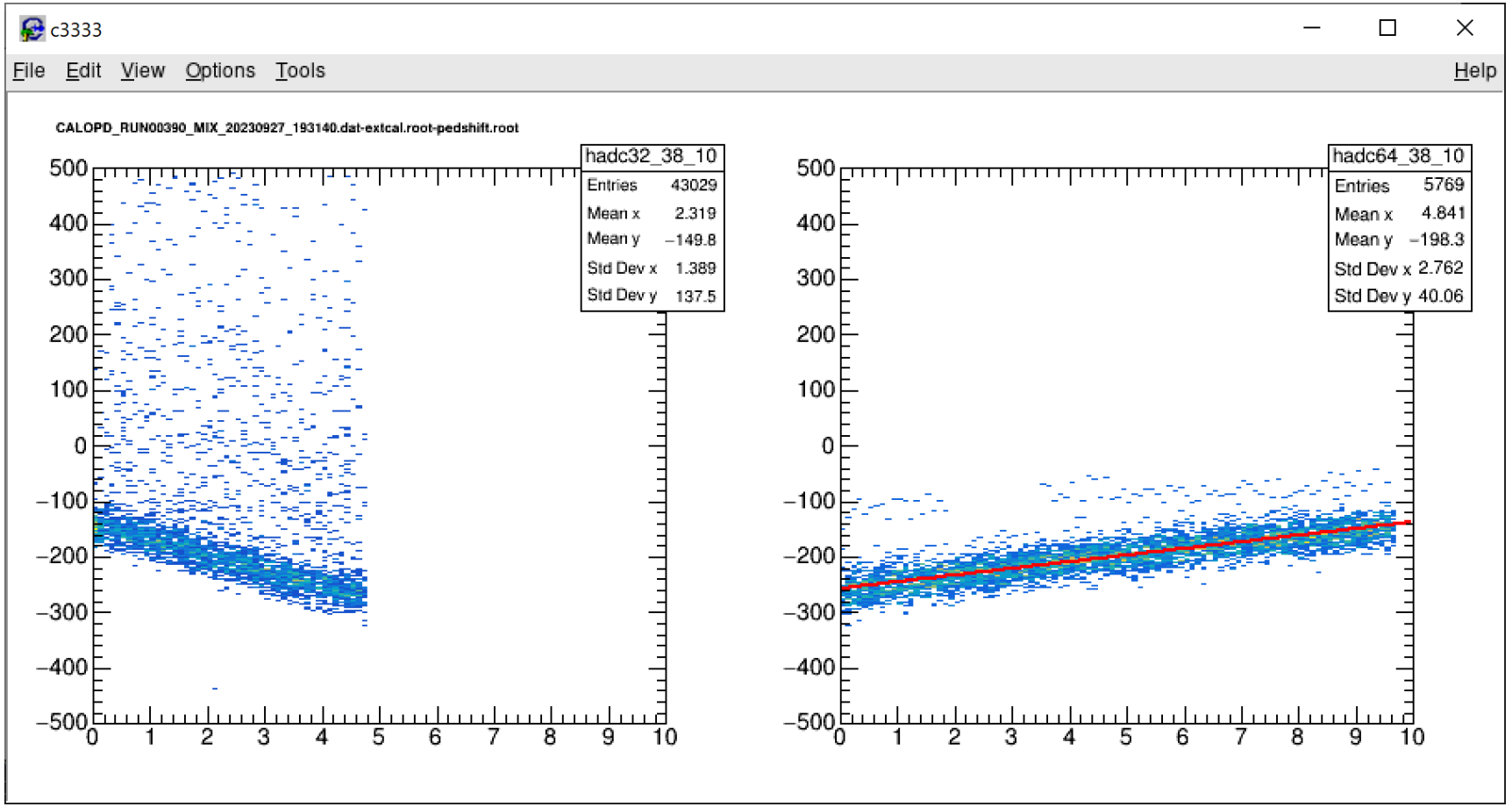
−60

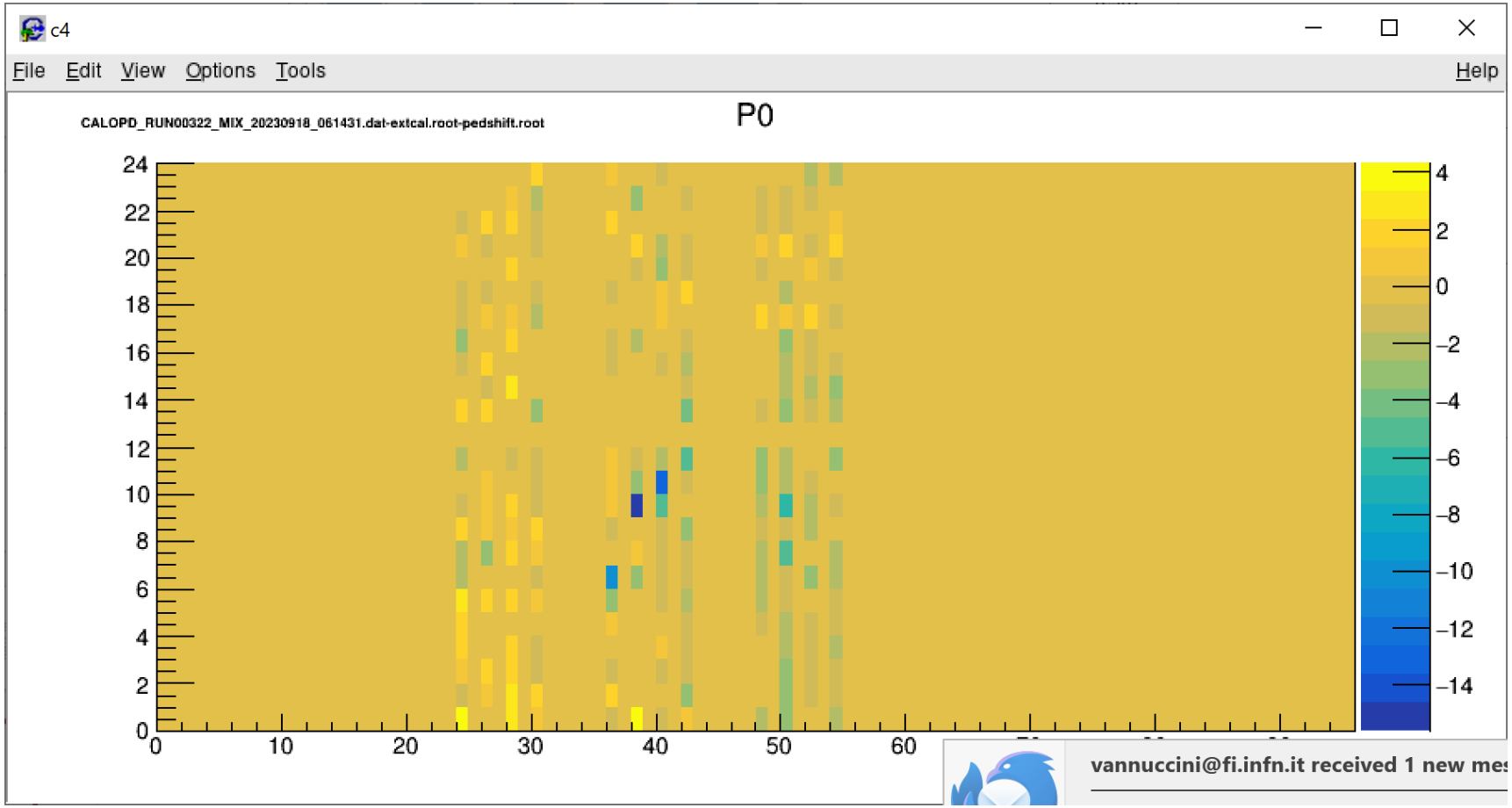

c44
File Edit View Options Tools Help
hadc64_30_19
Entries 21763
Mean x 4.79
Mean y 0.9413
Std Dev x 2.787
Std Dev y 184.1


Help
P1



In questo run il fit non e` venuto bene…

Sembra ci siano eventi per i quali il piedistallo e` derivato di meno


c4
File Edit View Options Tools Help
CALOPD_RUN00322_MIX_20230918_061431.dat-extcal.root-pedshift.root
P0
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−2
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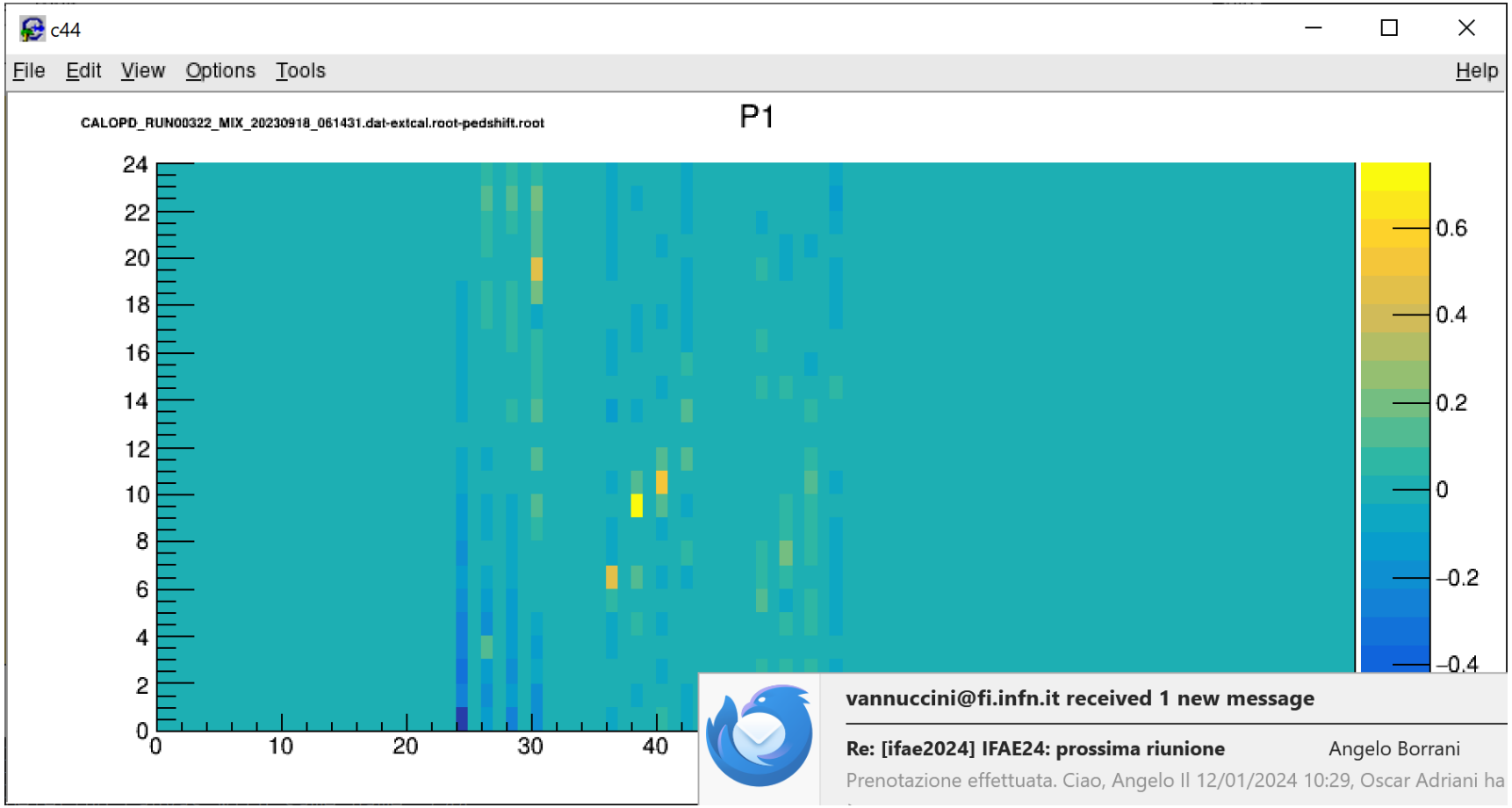
−6
−8
−10
−12
−14
vannuccini@fi.infn.it received 1 new mes


c44
File Edit View Options Tools Help
CALOPD_RUN00322_MIX_20230918_061431.dat-extcal.root-pedshift.root
P1
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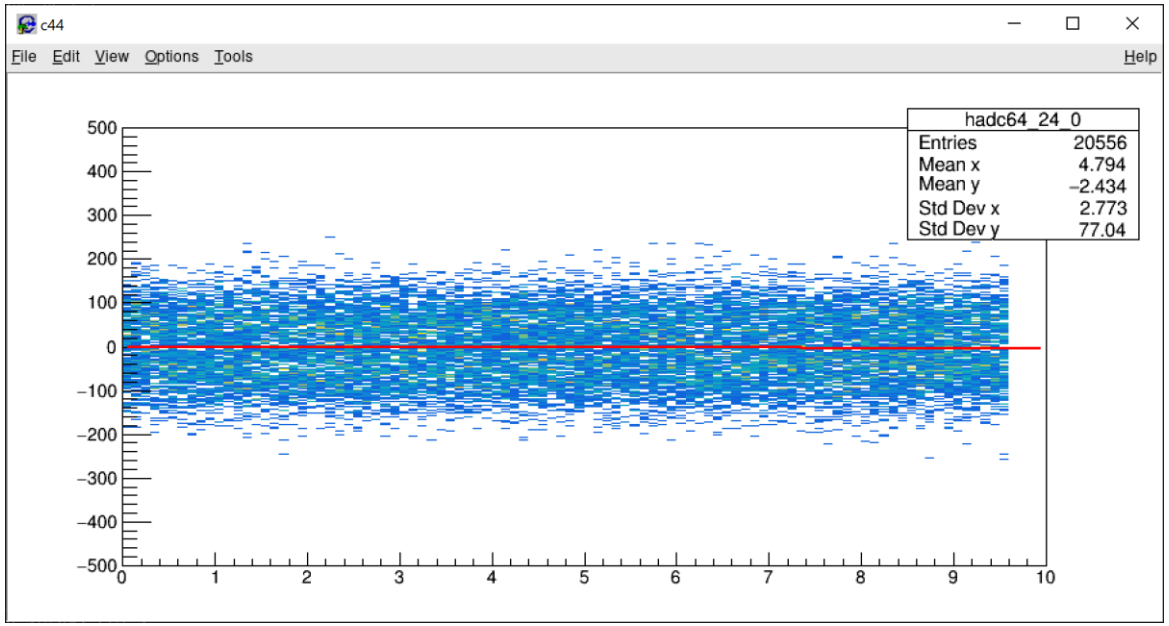
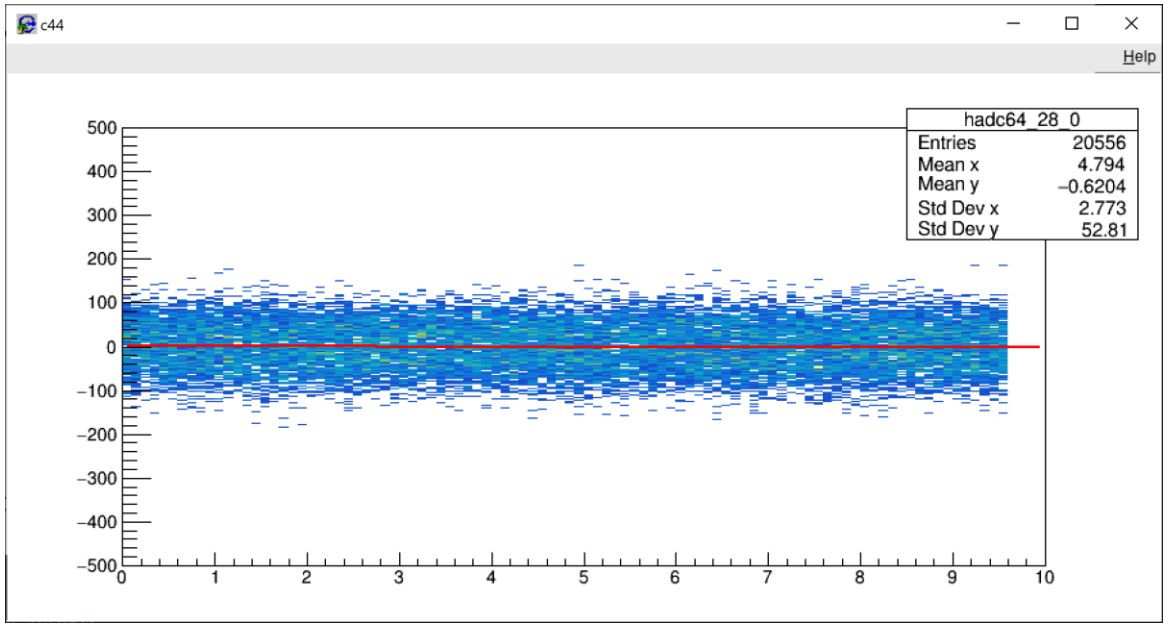
30
40
0.6
0.4
0.2
0
−0.2
−0.4
vannuccini@fi.infn.it received 1 new message
Re: [ifae2024] IFAE24: prossima riunione
Angelo Borrani
Prenotazione effettuata. Ciao, Angelo Il 12/01/2024 10:29, Oscar Adriani ha


c44
File Edit View Options Tools Help
hadc64_24_0
Entries 20556
Mean x 4.794
Mean y −2.434
Std Dev x 2.773
Std Dev y 77.04
500 400 300 200 100 0 −100 −200 −300 −400 −500
0 1 2 3 4 5 6 7 8 9 10


c44
Help
hadc64_28_0
Entries 20556
Mean x 4.794
Mean y −0.6204
Std Dev x 2.773
Std Dev y 52.81
500 400 300 200 100 0 −100 −200 −300 −400 −500
0 1 2 3 4 5 6 7 8 9 10

Energy (GeV)	Run	#Pulser	#Trigger	CAL	
300	327			300	(3,3)
	332				(3,3)
	397			371	(3,3)
	398				(3,3)
300	335			300	(2,3)
	336				(2,3)
	337				(2,3)
	338				(2,2)
	339				(3,2)
	340				(4,2)
	341				(4,3)
	342				(3,4)
	343				(2,4)
	344				(4,4)
300	329				(3,5)
	331				(3,5)
	394			371	(0,5)
	395				(6,5)
	399				(1,3)
	392				+45 deg
	393				+30 deg