Calibration and bad channels with new protoDUNE data

ProtoDUNE SP operations

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BNL

December 6, 2019

Updated 12:15 EST

Introduction

I have been looking at the recent cosmic runs

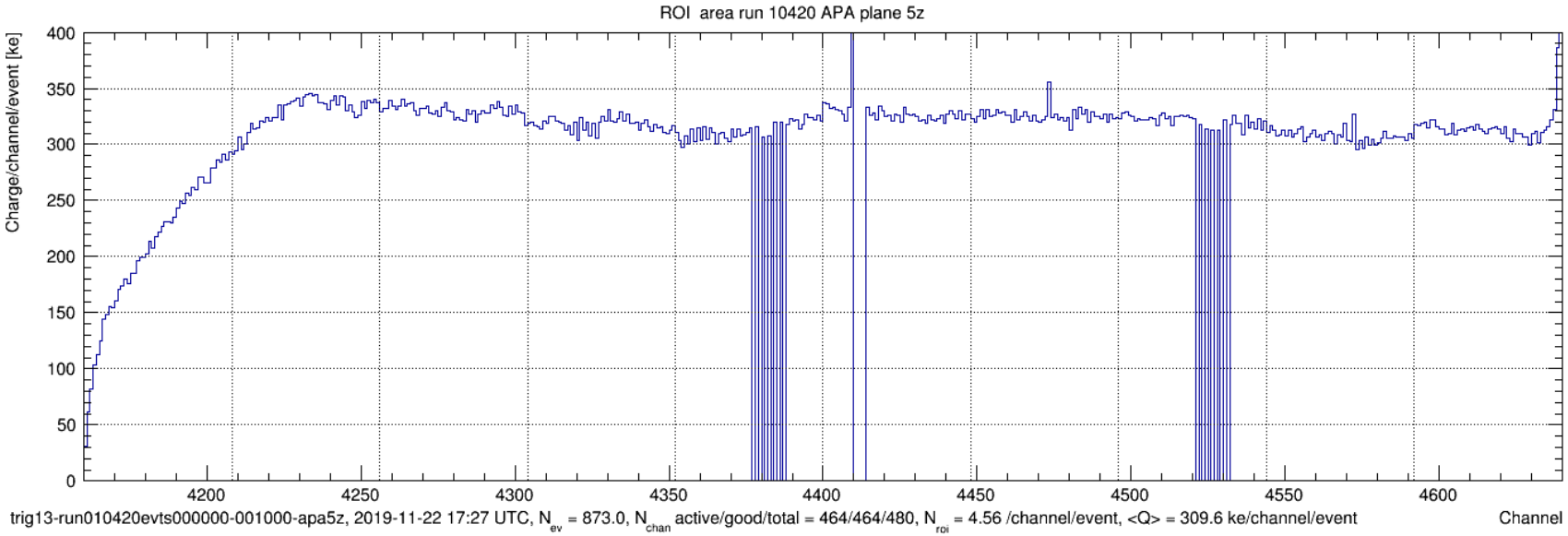
- Initially only CRT trigger
  - To capture horizontal muons
- Now CRT plus 1 Hz random
  - Latter provide unbiased monitor of detector performance

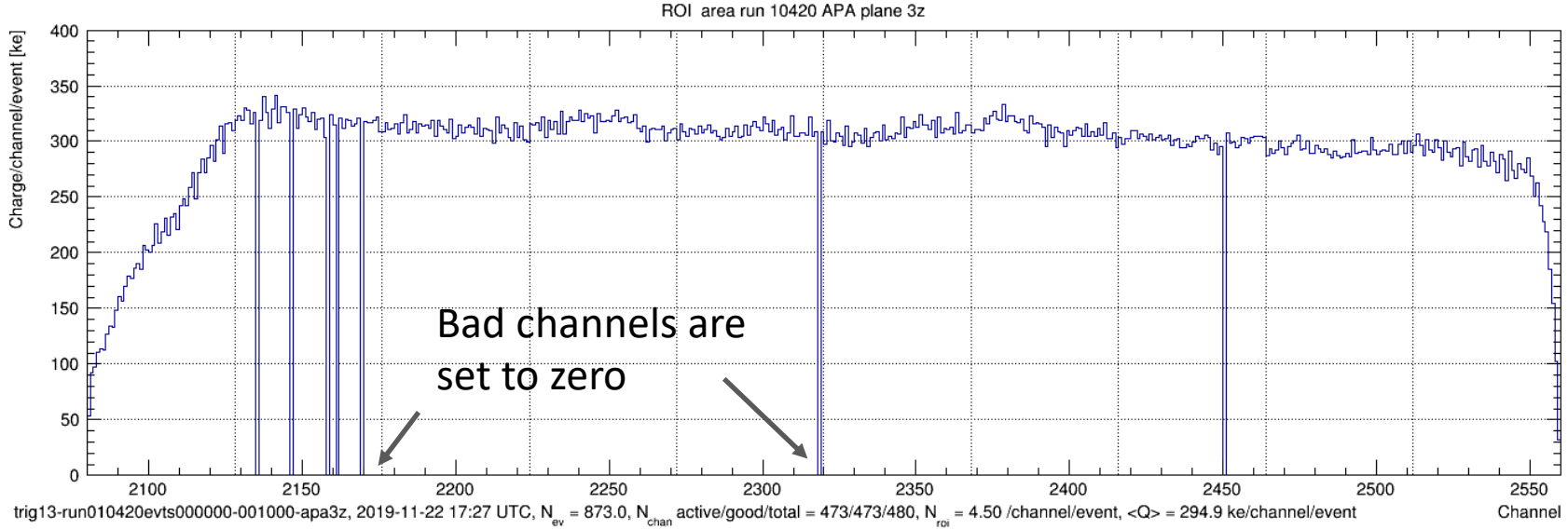
Studies

- Signal strength
  - See DRA talk Nov 27
  - Updated summary plot here
    - Recent data plus some old data to fill in gaps
    - New normalization: ke/ms
    - https://internal.dunescience.org/people/dladams/protodune/monitoring/roiChargeLogVsAllTime.png
- Pulser calibration
- New bad channels

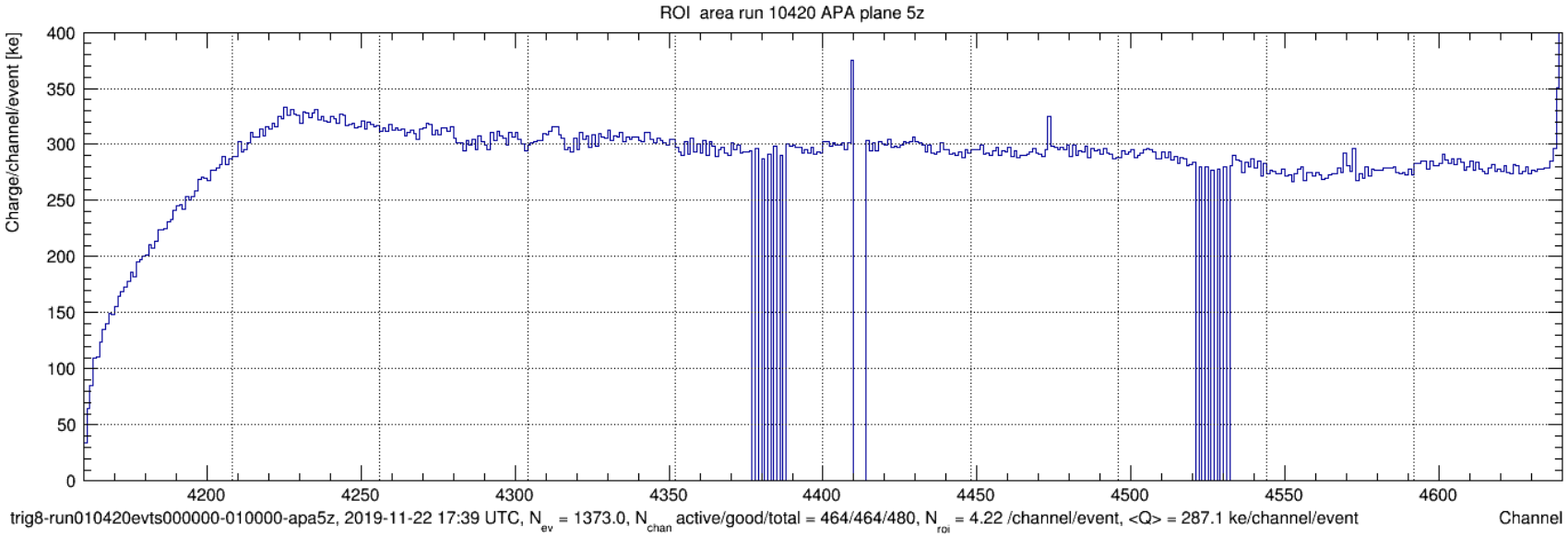
Signal strength

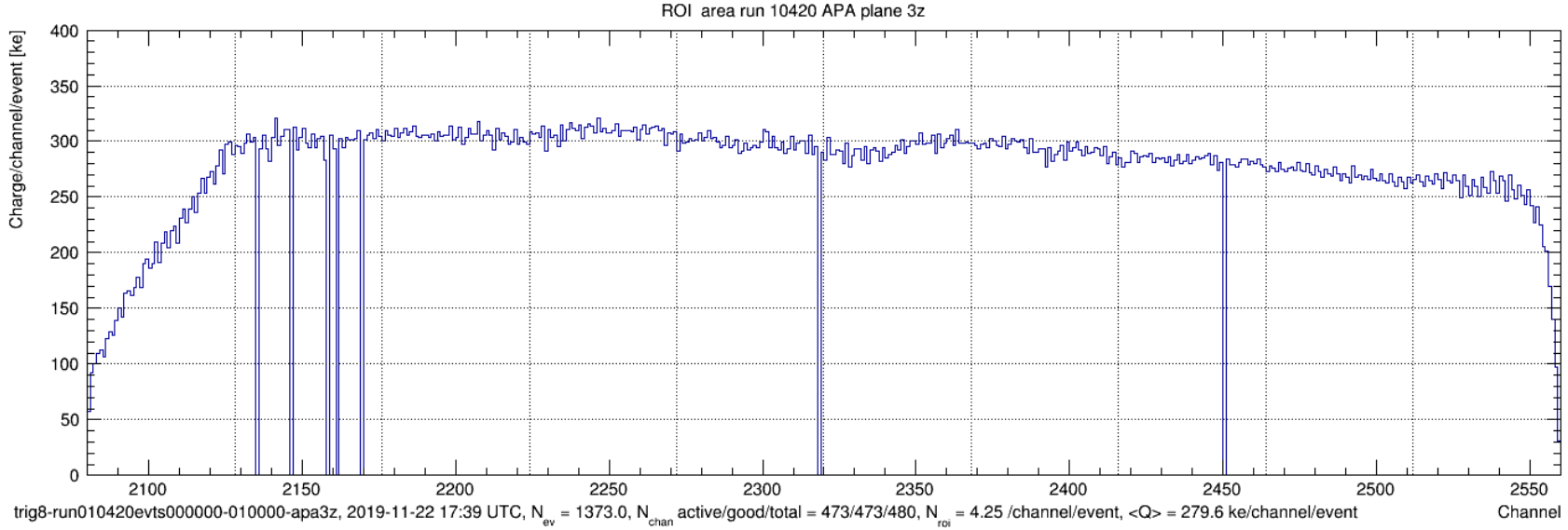
Front APAs with CRT trigger



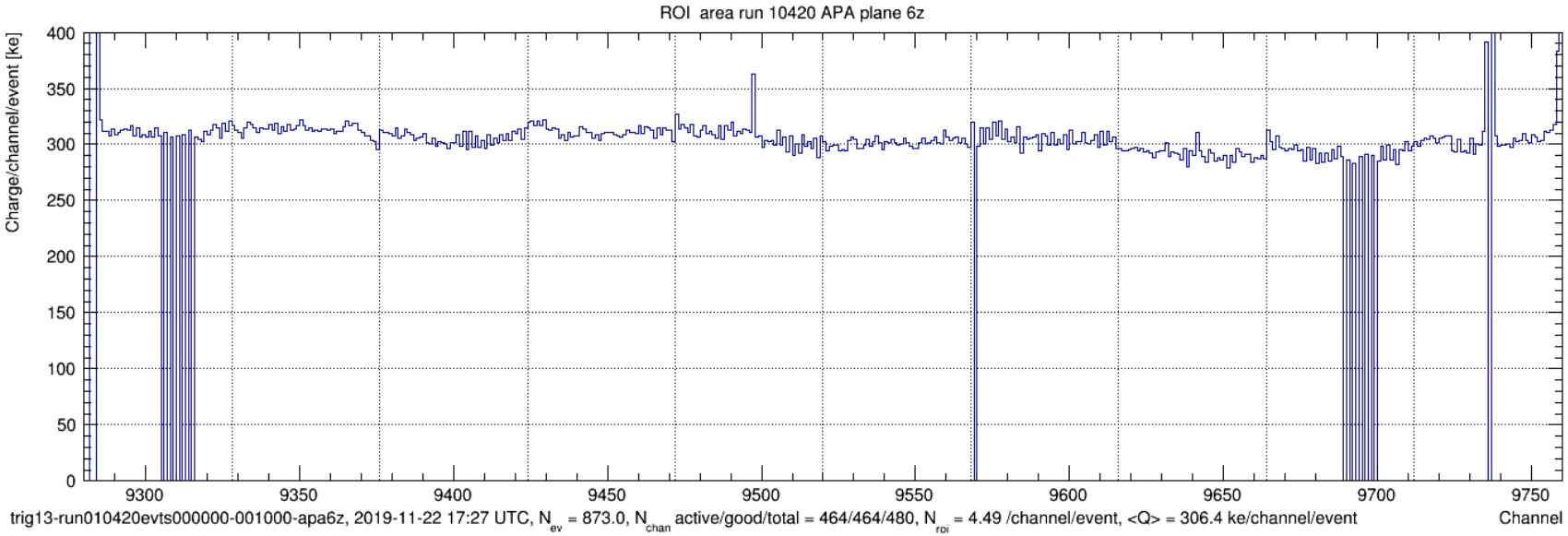


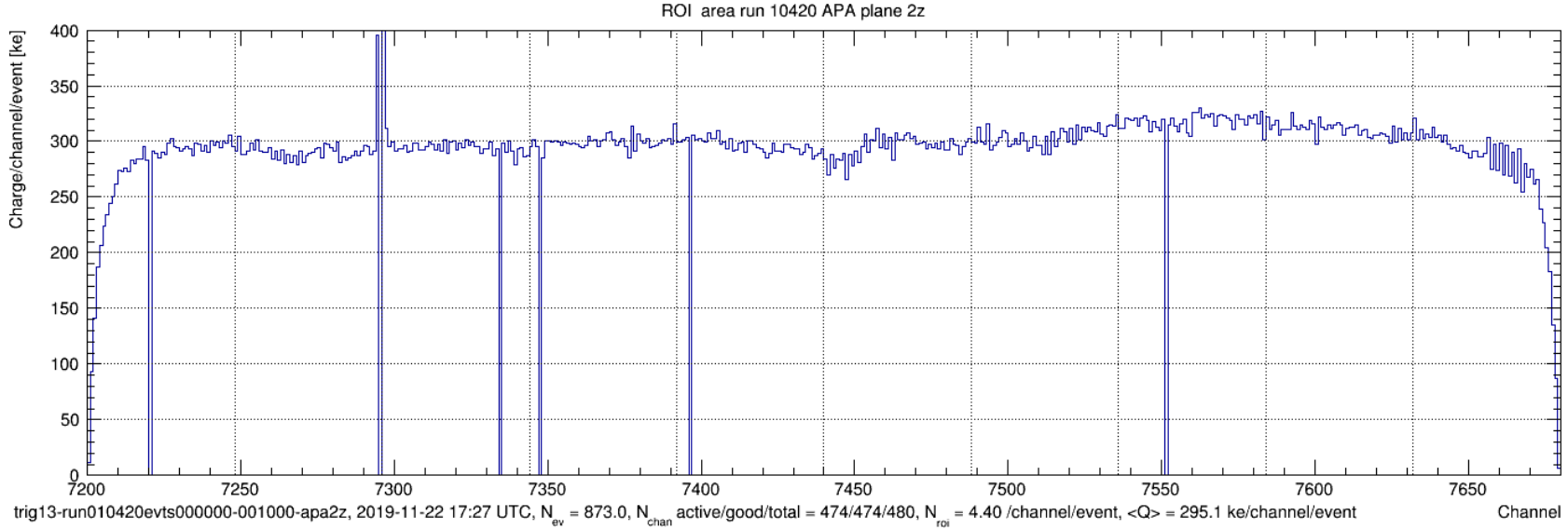
Front APAs with random trigger



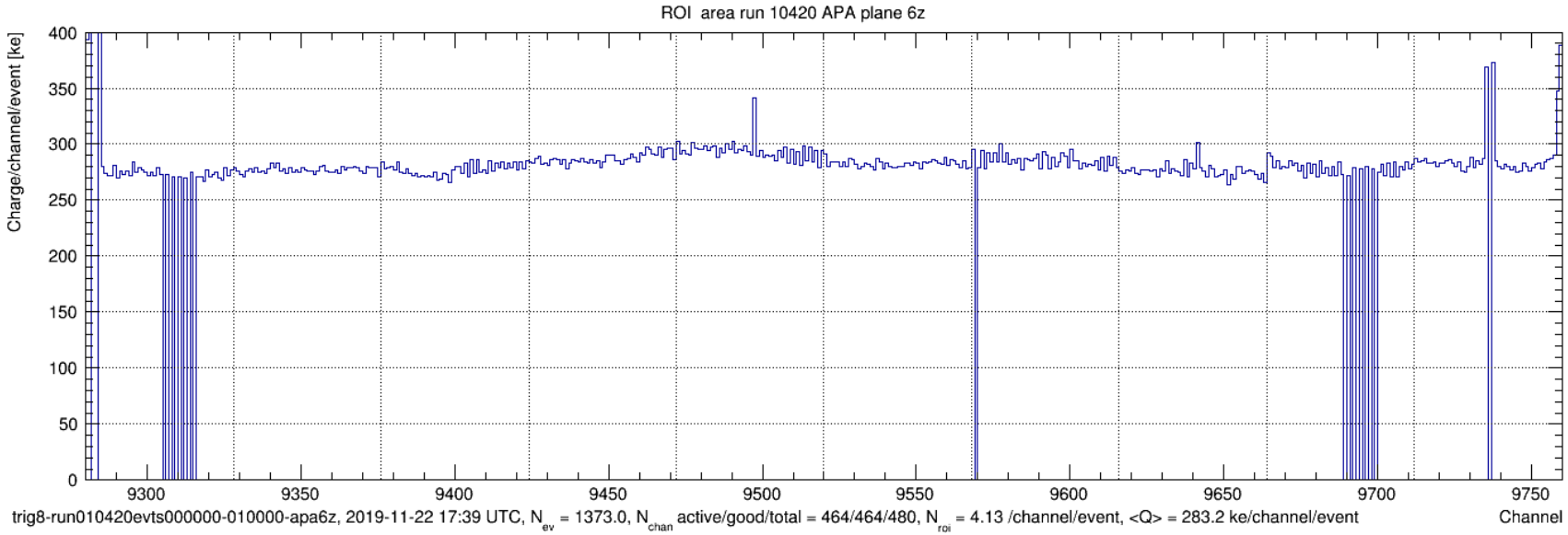


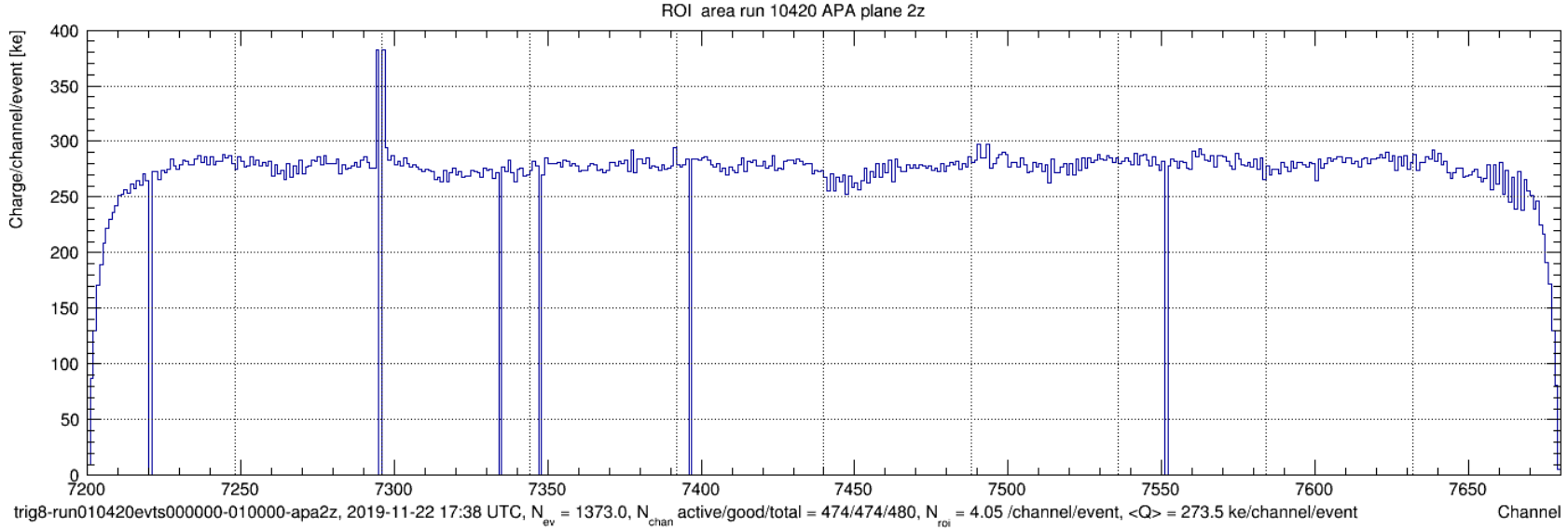
Middle APAs with CRT trigger



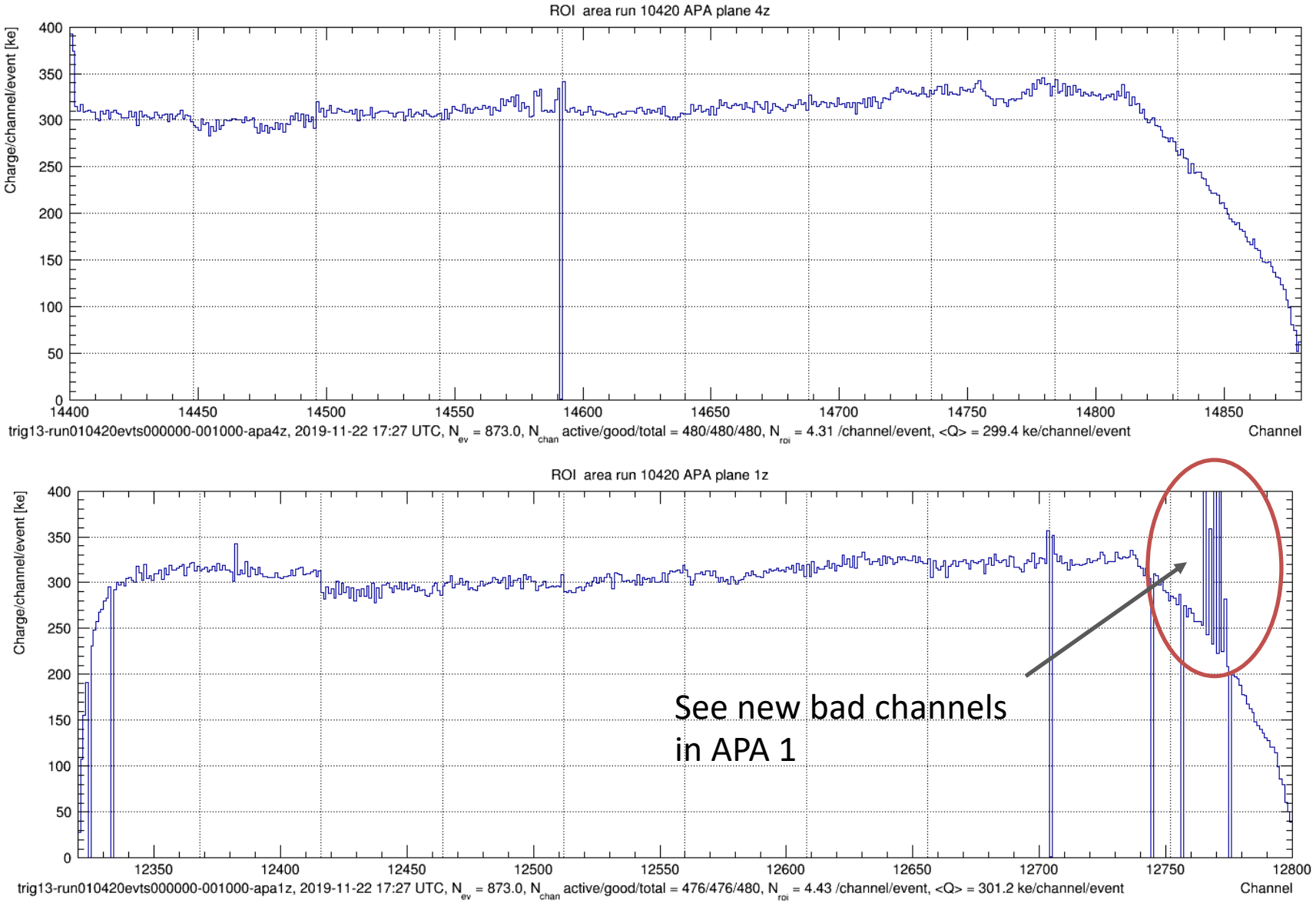


Middle APAs with random trigger

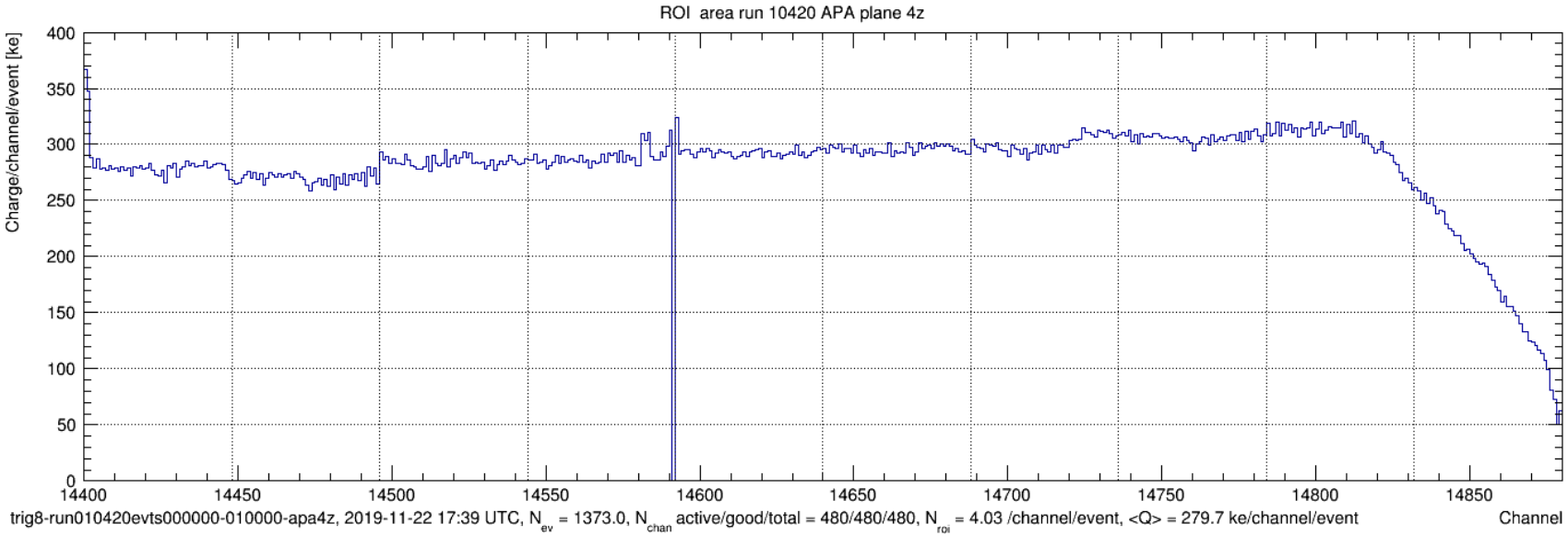


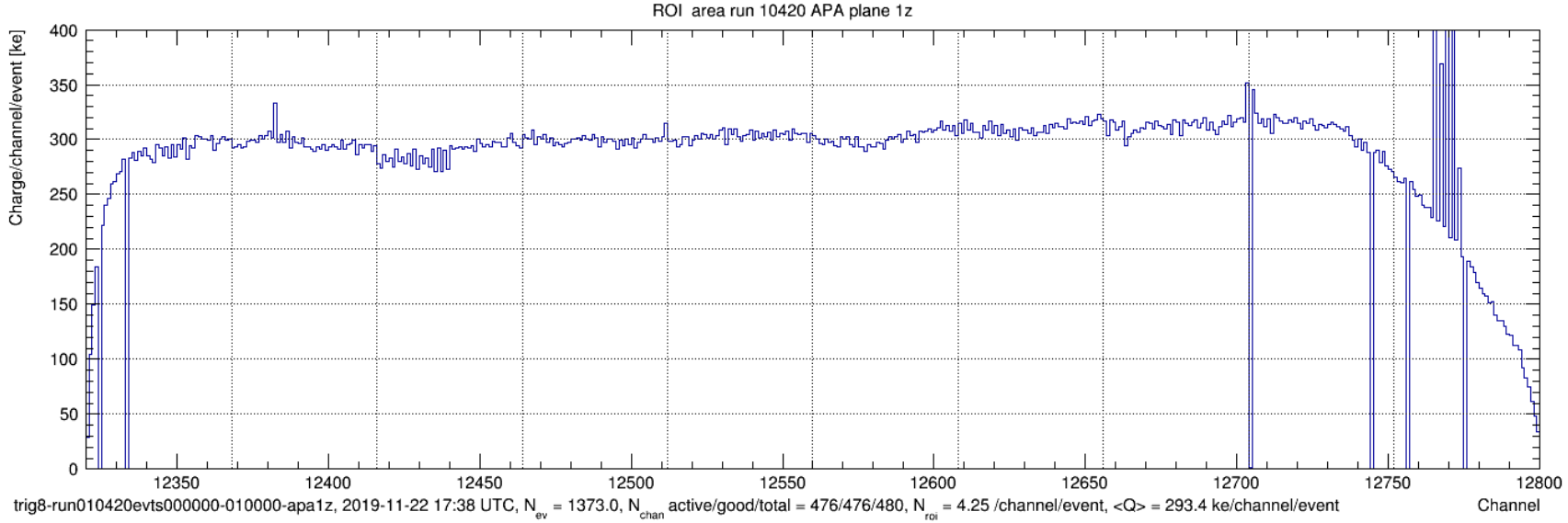


Back APAs with CRT trigger

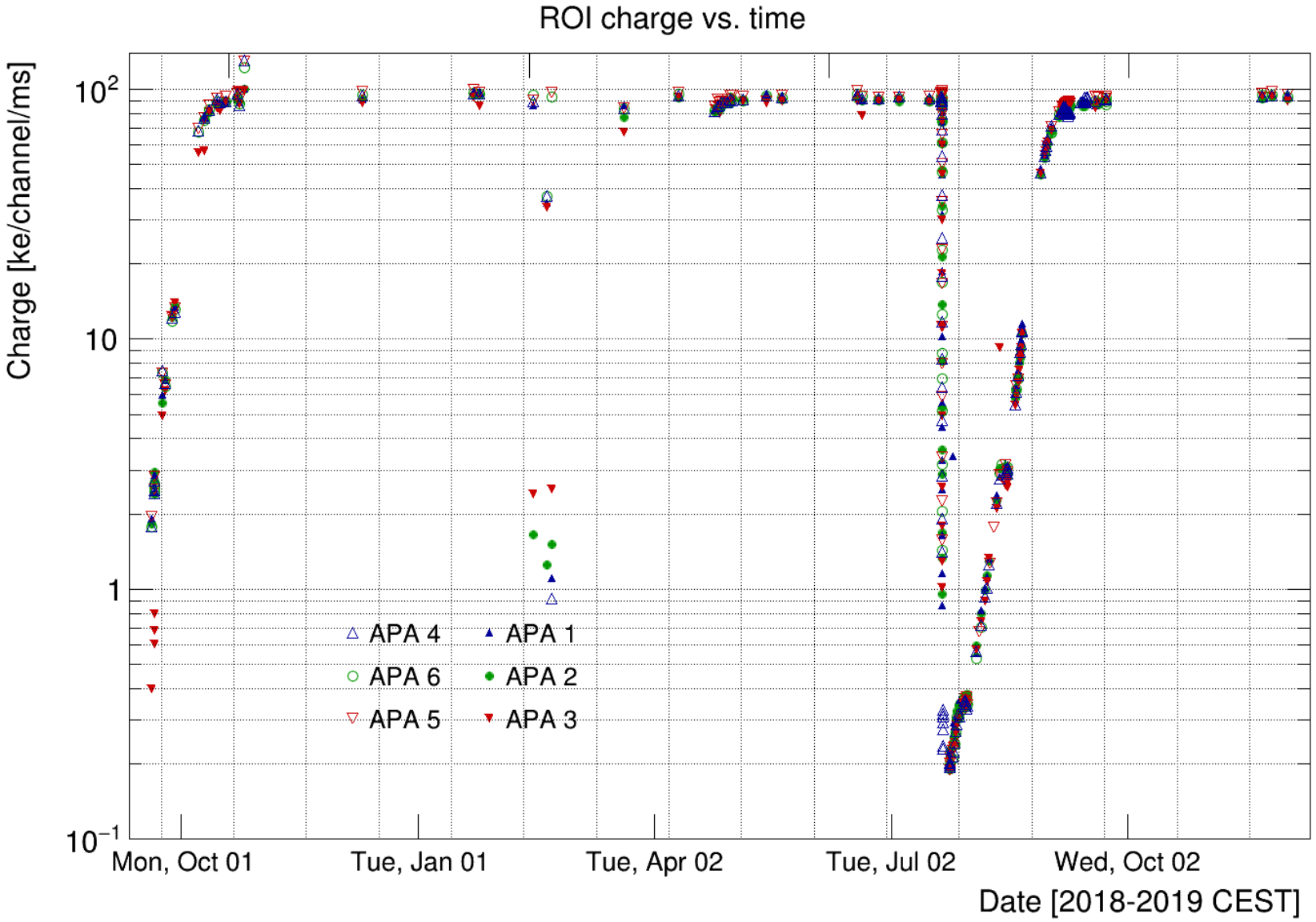


Back APAs with random trigger

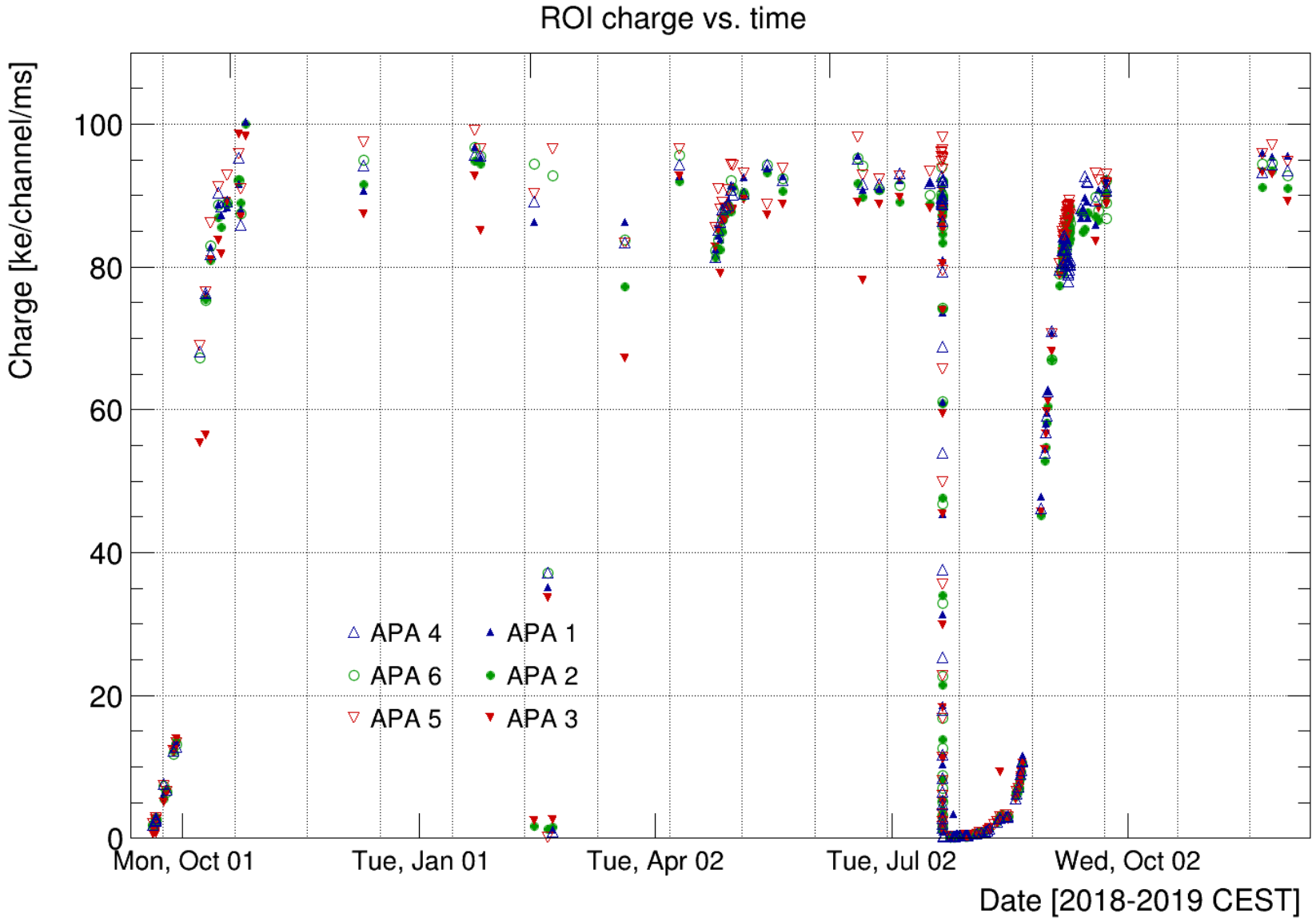




Signal strength summary (log scale)



Signal strength summary (linear scale)



New calibration

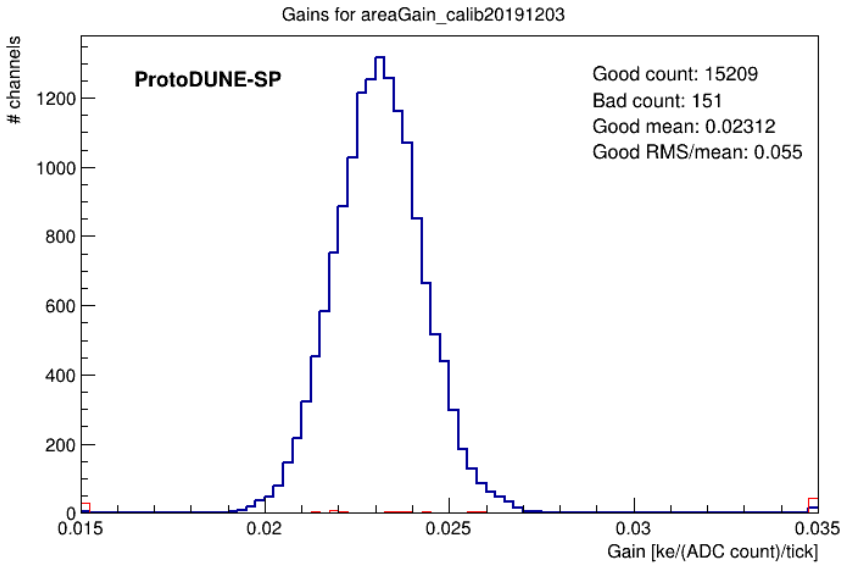
New calibration

Calibration data

- External pulser data taken Nov 28

Calibration

- I processed this as for the Dec 2018 data
  - See DUNE-doc-15523 for the old calibration
- New gains are 1% lower
- new/old channel-by-channel RMS is 0.7% (including low tail)



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Calibration data

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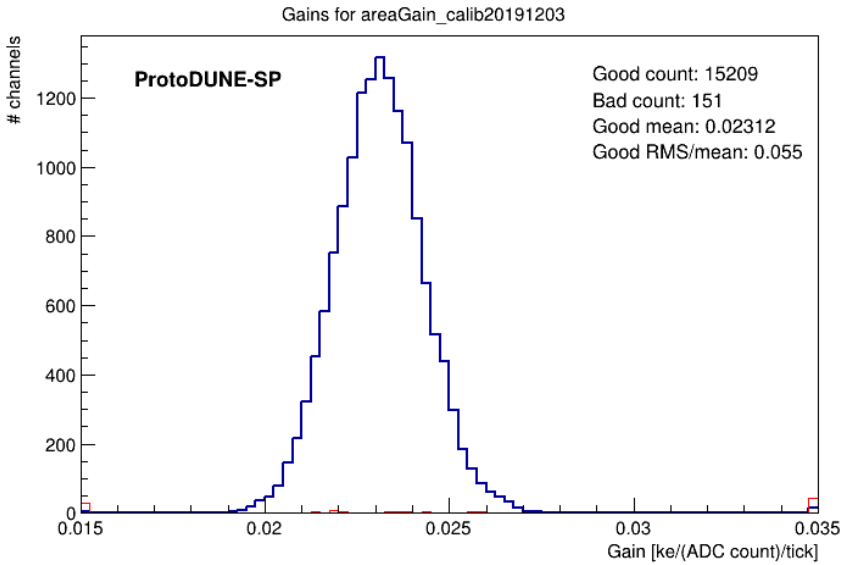
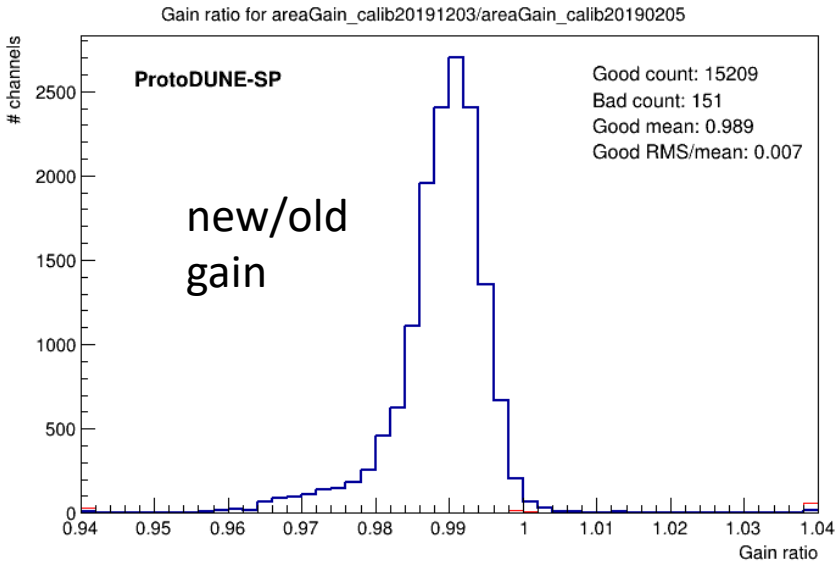
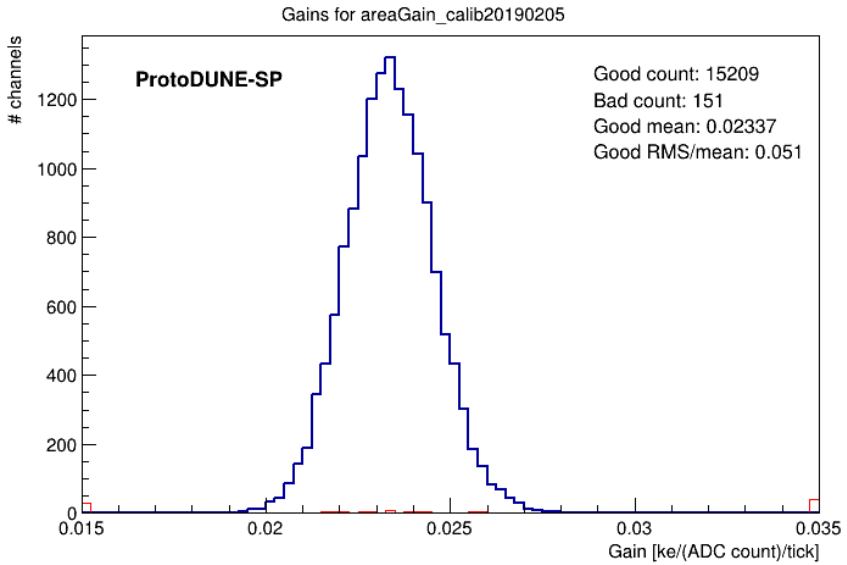




Old calibration

Old calibration

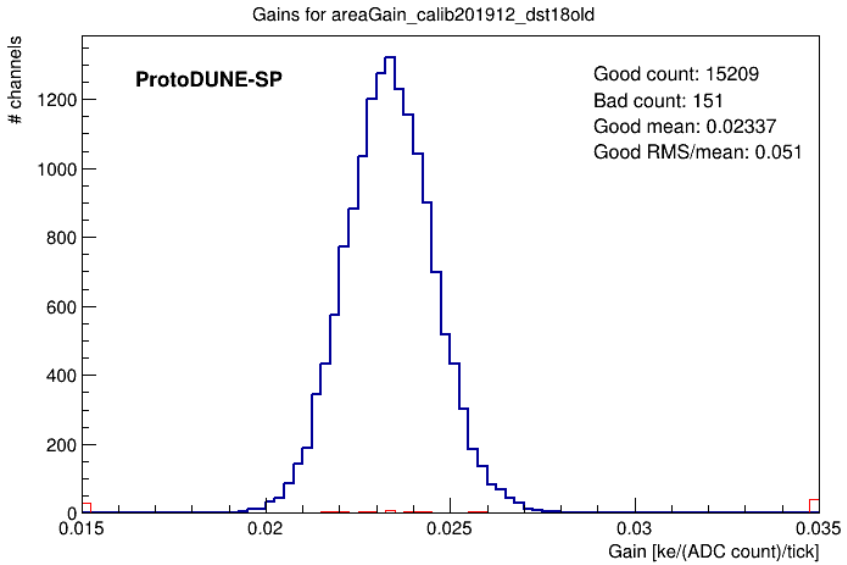
- Dec 2018 data
- February evaluation of mean are for each channel and signed pulser setting
- Gain distribution below

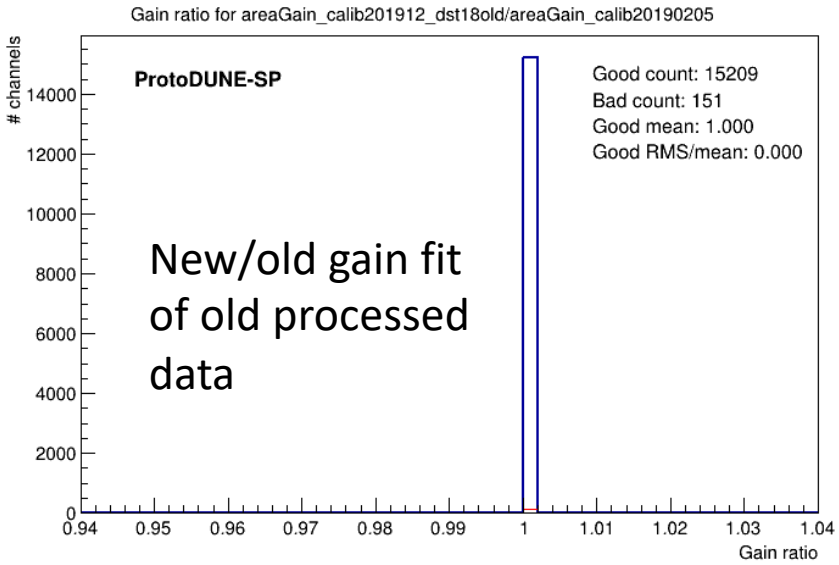


New calibration with old processed data

New with old processed data

- December 2018 data
- Area measurements from February 2019
- New fit to get gains
- Looks identical to the old calibration

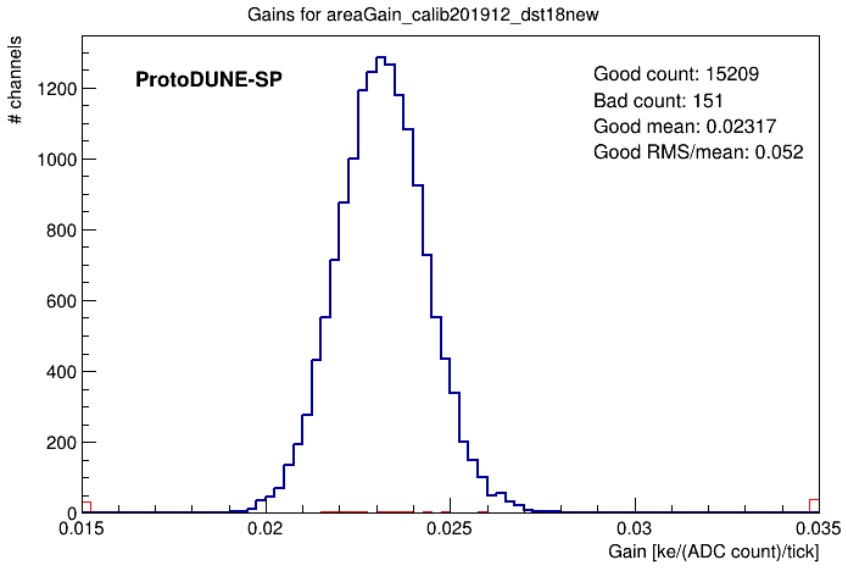


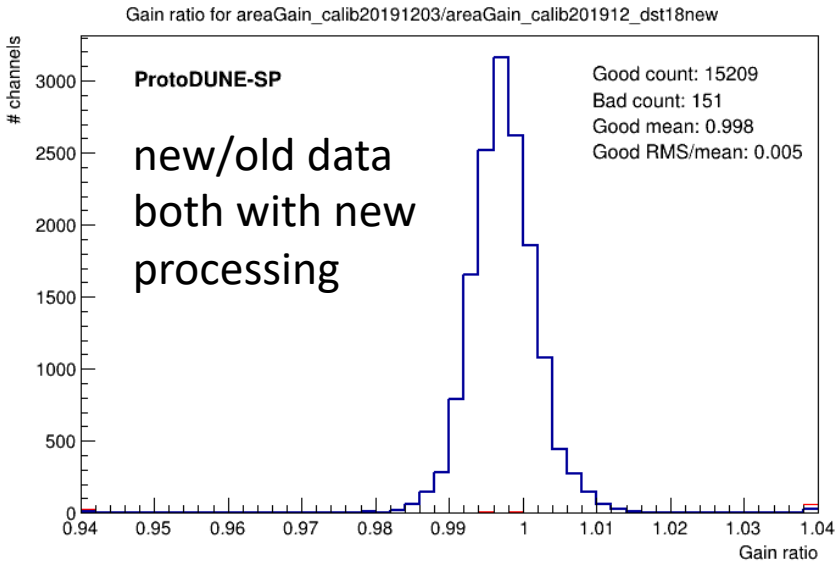


New processing and calibration old raw data

Ne with old raw data

- December 2018 data
- Reevaluate area measurements
  - ROI finding, area evaluation, mean evaluation
- Fit to get gains
- Added after presentation of slides





Bad channels

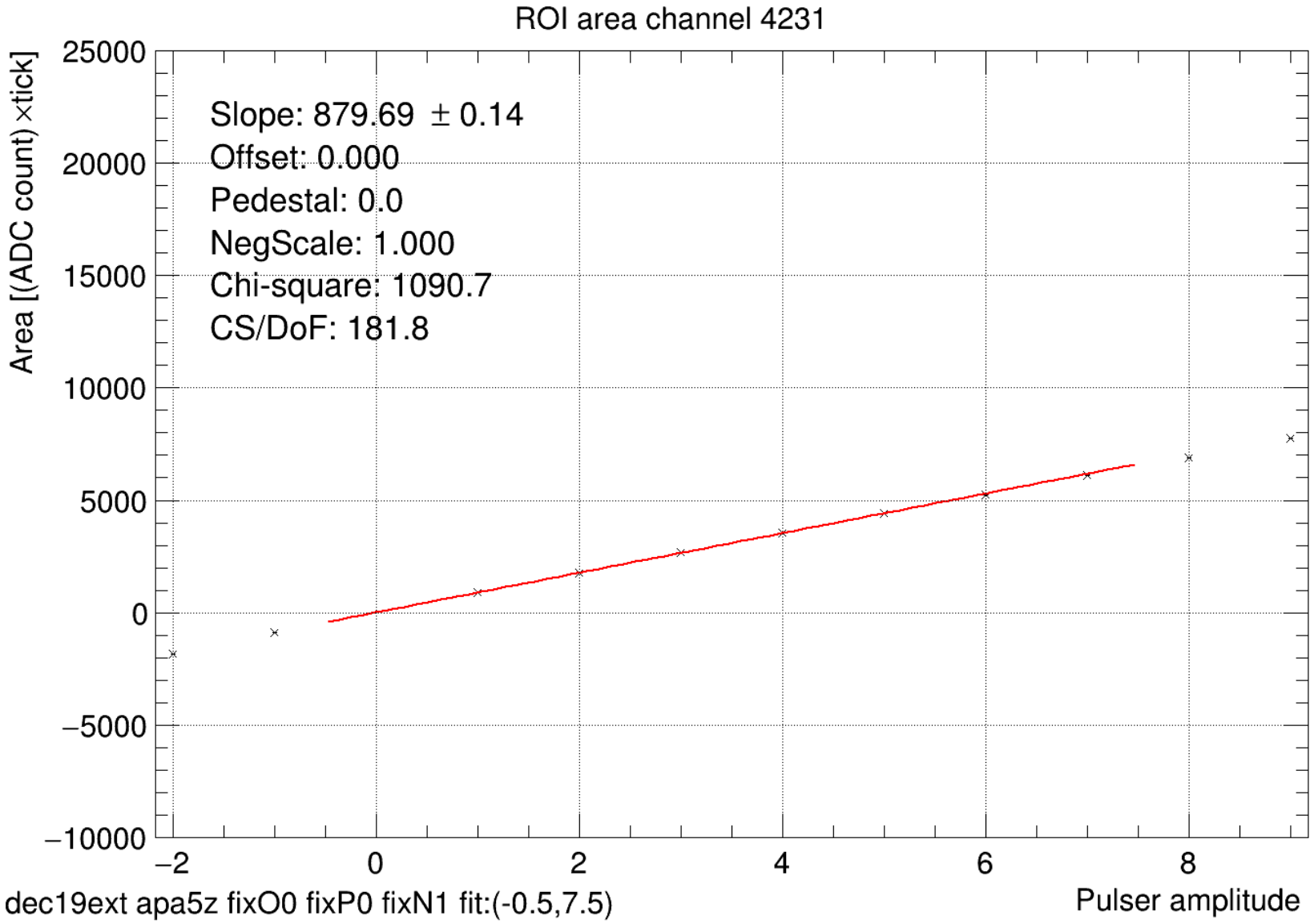
Bad channel observations

- 17+7 more bad channels (not bad in 2018)
  - 17 were shown in Nov 27 DRA meeting
    - 16 from one ASIC
  - 6 dead, 1 very noisy
- 16 new noisy channels
  - Probably noisy before—didn't look so carefully or critically
  - 2 new (near pedestal) sticky codes
    - Mitigating these might remove noisy flag
- 19 channels with nonlinear response
  - 3 blocks of 6 (ASIC) look shifted
  - 1 channel has jump(s)
  - See following plots
- My notes are on the following page

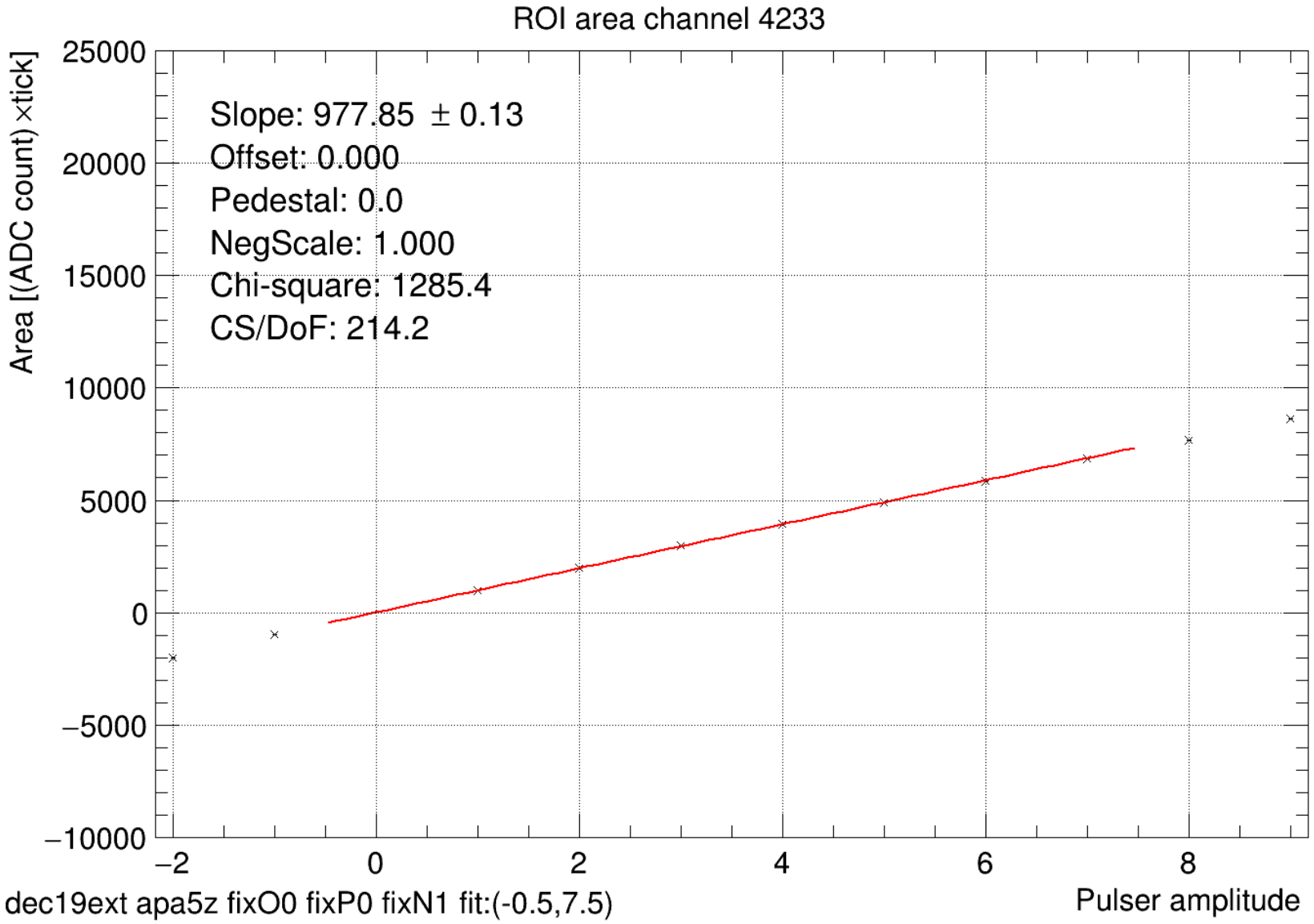
Run 10492 — Runs 5461 and 10527 pedestal WFs
Dec 2, 2019

1u	10573	wide (50-->80), low tail (5%)	WFs look fine	NOISY
1u	10831	wide (95-->134)	Both WFs sticking to pedestal zero	NOISY
1u	11001	low RMS	Good in old run, now dead	BAD
1u	11014	low RMS	Good in old run, now dead	BAD
1u	11018	low RMS	Good in old run, now dead	BAD
1v	11315	wide (55-->99)	WFs look fine	NOISY
1v	11501	low RMS	Good in old run, now dead	BAD
1v	11773	wide (55-->103)	Many SC near pedestal for both	NOISY
1c	12252	very wide (55-->390), bad shape	Pulser mostly stuck on one value for both	NOISY
1z	12382	very wide (43-->370), bad shape	Many SCs. New SC and worse in new run.	NOISY, add SC
3u	426	wide (55-->100), low tail (1%)	Many SC near pedestal. Better now.	NOISY
3v	867	wide (55-->100)	Both pedestals fine.	NOISY
3v	1522	wide (65-->125)	Both sticking near pedestal.	NOISY
3z	2330	wide (41-->72), low tail (1%)	Both pedestals look fine.	NOISY
3z	2333	wide (40-->99), high tail (2%)	New SC. Old is fine.	NOISY, add SC and check
4u	12938	wide (70-->150)	Pedestals look fine.	NOISY
4v	13748	wide (65-->87)	Pedestals look fine.	GOOD
5z	4232	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
5z	4234	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
5z	4236	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4238	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4240	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4242	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4472	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4473	split peak varies with DAC	Nonlinear response.	BAD?
5z	4474	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4476	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4478	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4480	missing	Big pulser offset in new data.	Recalibrate varying offset?
5z	4482	missing	Big pulser offset in new data.	Recalibrate varying offset?
6u	7715	very wide (55-->2300)	Pedestal was fine, now very noisy (amp?)	BAD
6u	8234	wide (50-->100)	Both pedestals sticking.	NOISY
6u	8290	tails (10%)	Both pedestal mostly stuck	NOISY
6c	9941	tails (5%)	SC bad goes to very bad.	NOISY
6c	10033	missing (tail @ ADC < 500)	OK then. Now dead (I think)	BAD
6z	9545	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9547	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9549	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9551	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9553	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9555	low RMS	Big pulser offset in new data.	Recalibrate varying offset?
6z	9641	low tail	Big nonlinearity in pulser response.	BAD

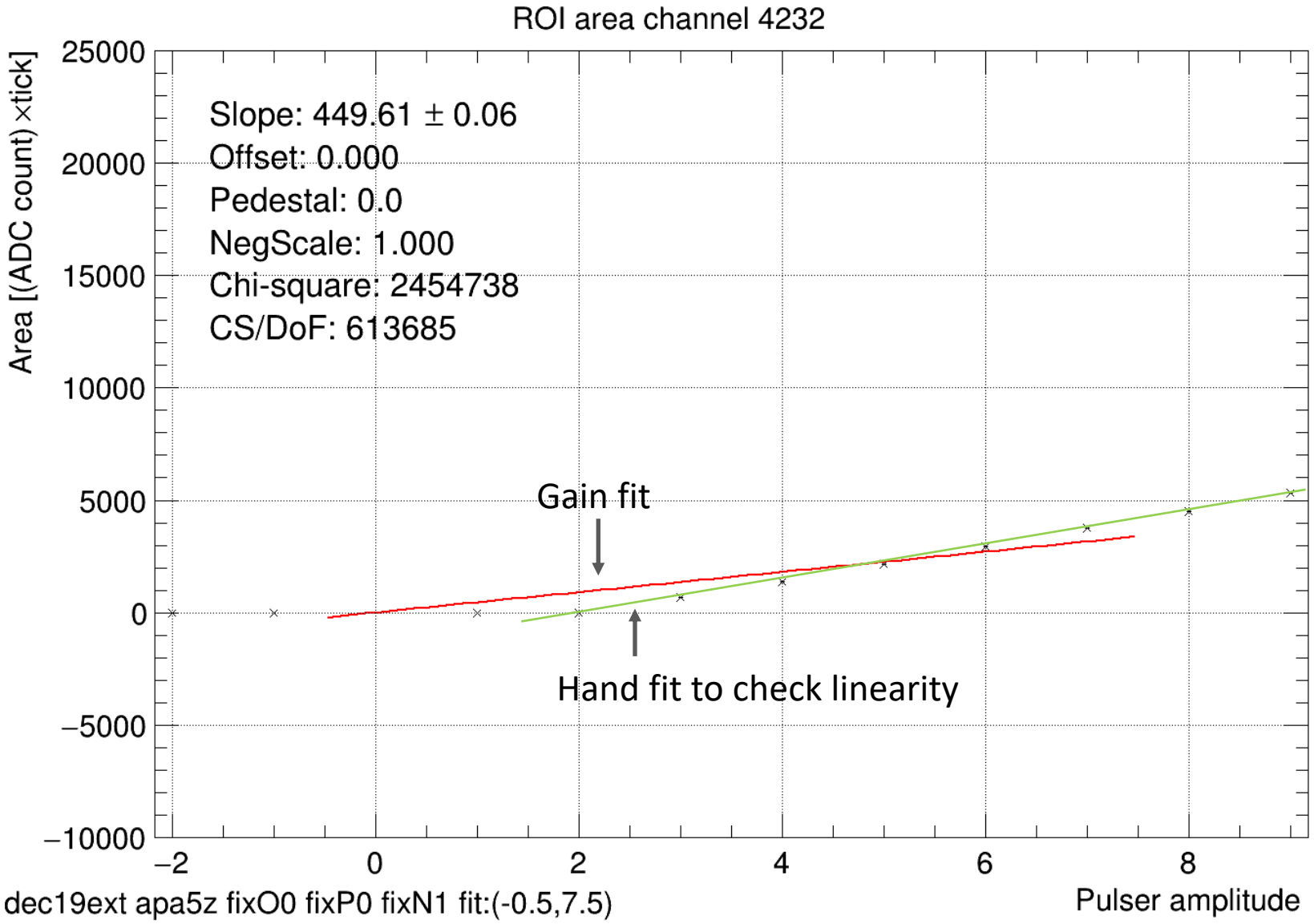
Good channel



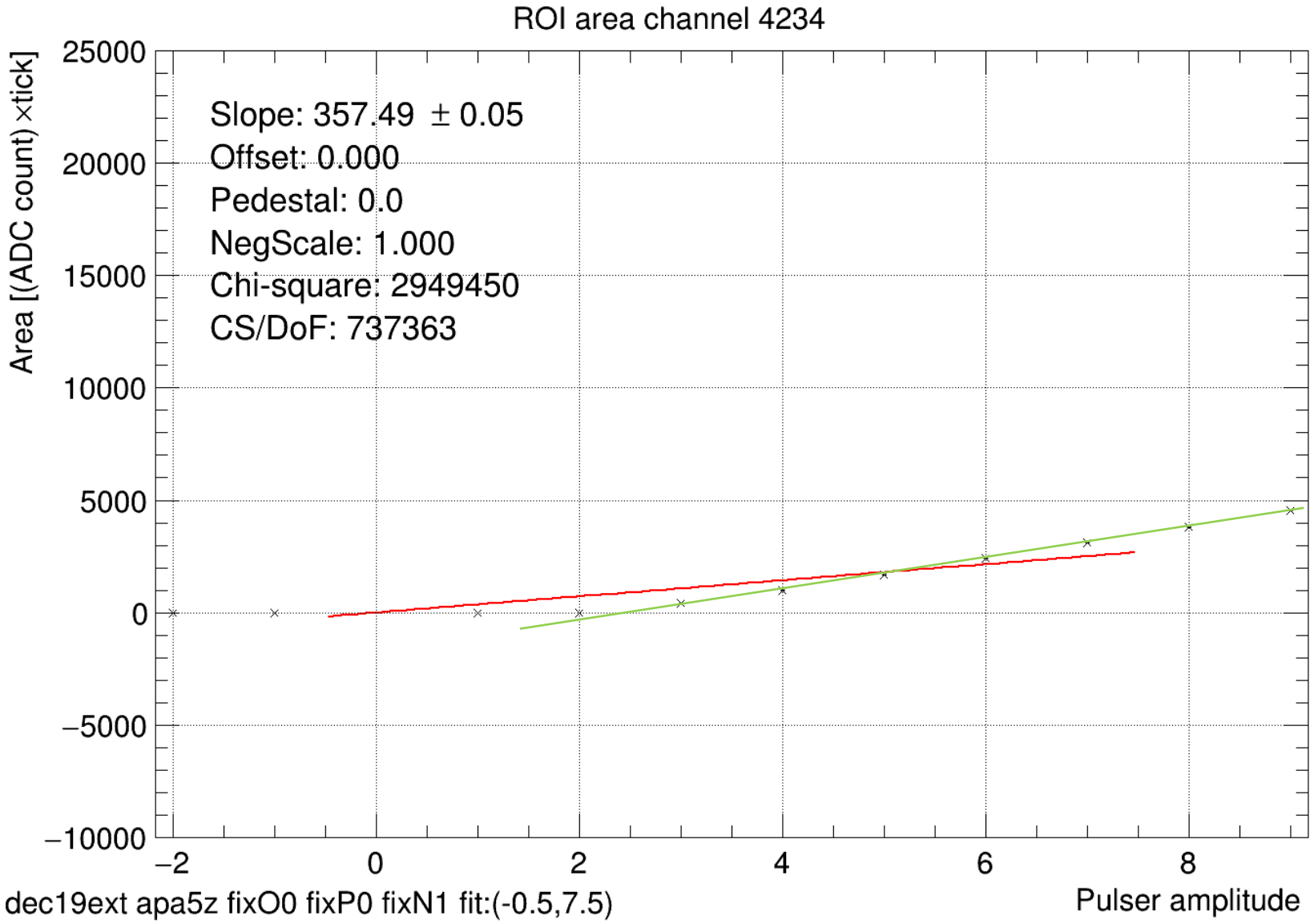
Good channel



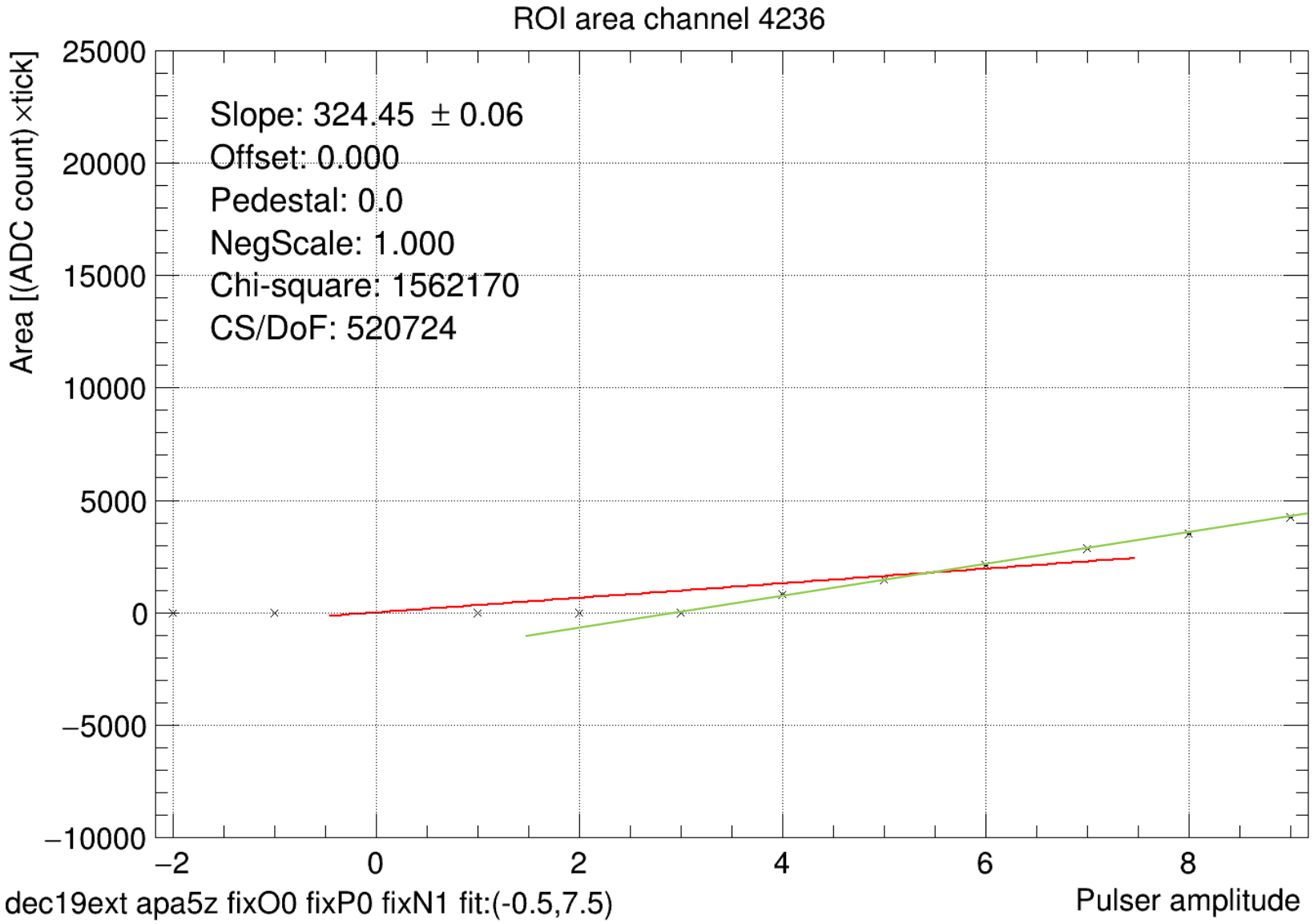
Shift


ROI area channel 4232
Slope: 449.61 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2454738
CS/DoF: 613685
Gain fit
Hand fit to check linearity
Area [(ADC count) ×tick]
Pulser amplitude
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8

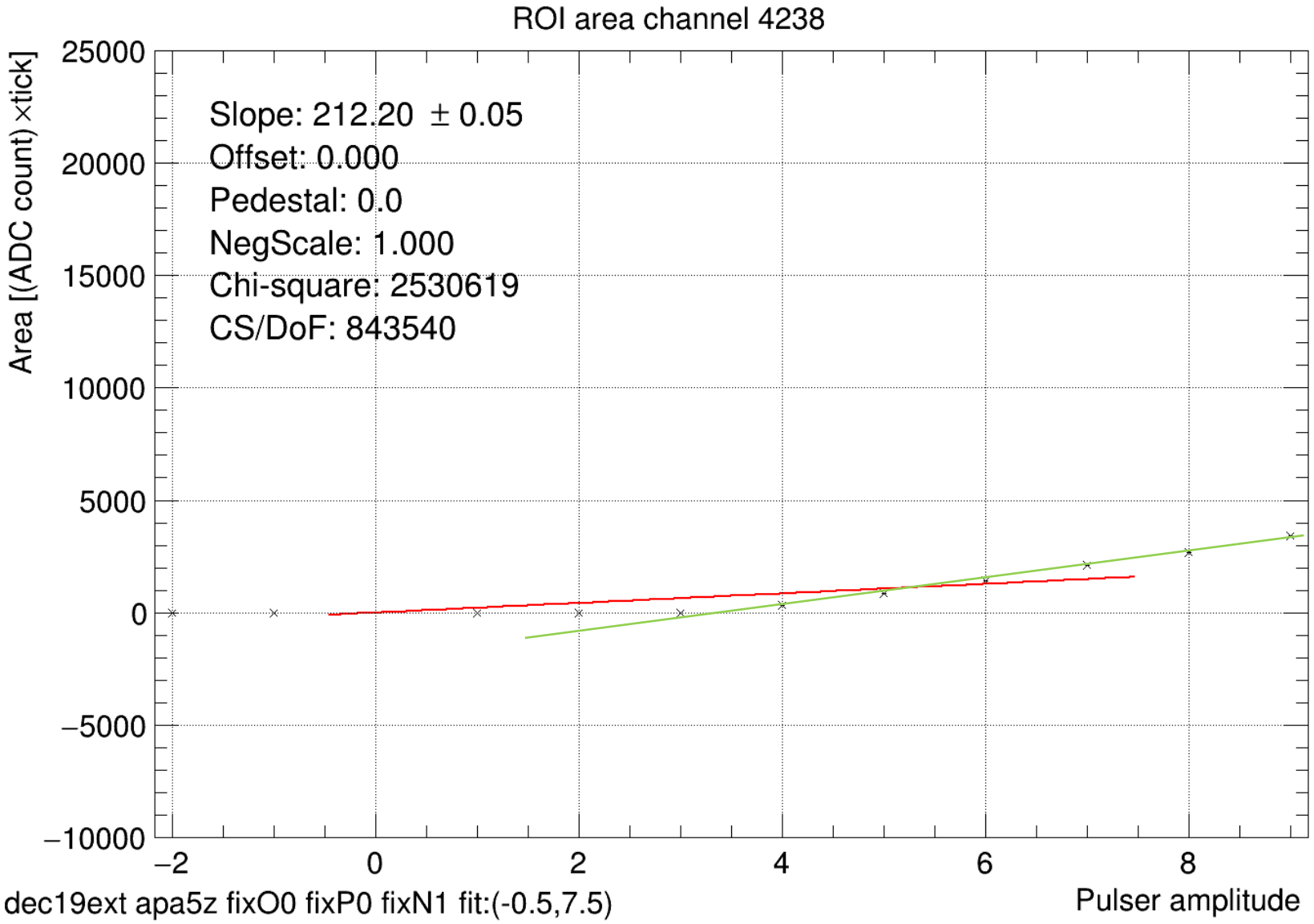
Shift


ROI area channel 4234
Slope: 357.49 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2949450
CS/DoF: 737363
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

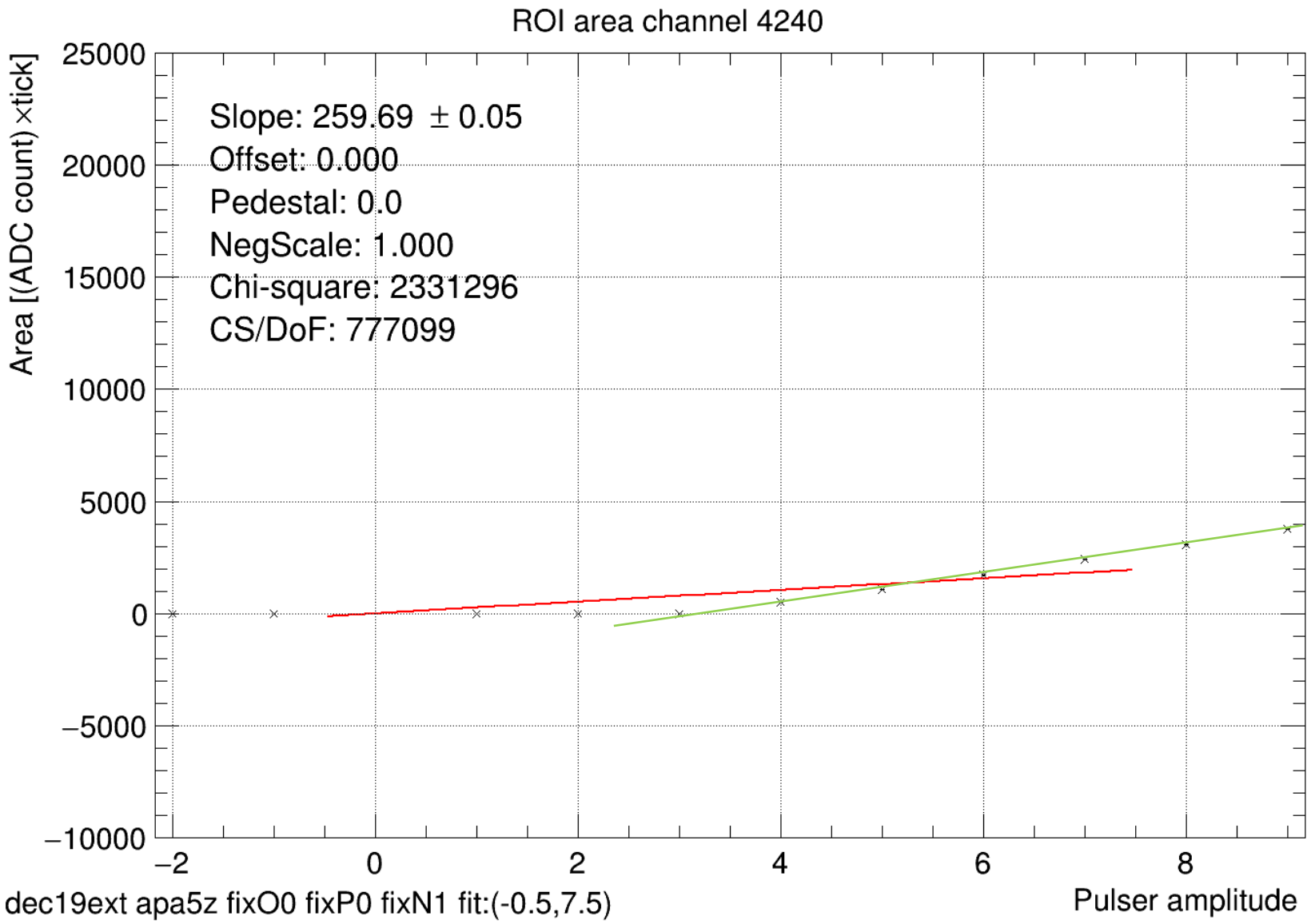
Shift


ROI area channel 4236
Slope: 324.45 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 1562170
CS/DoF: 520724
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

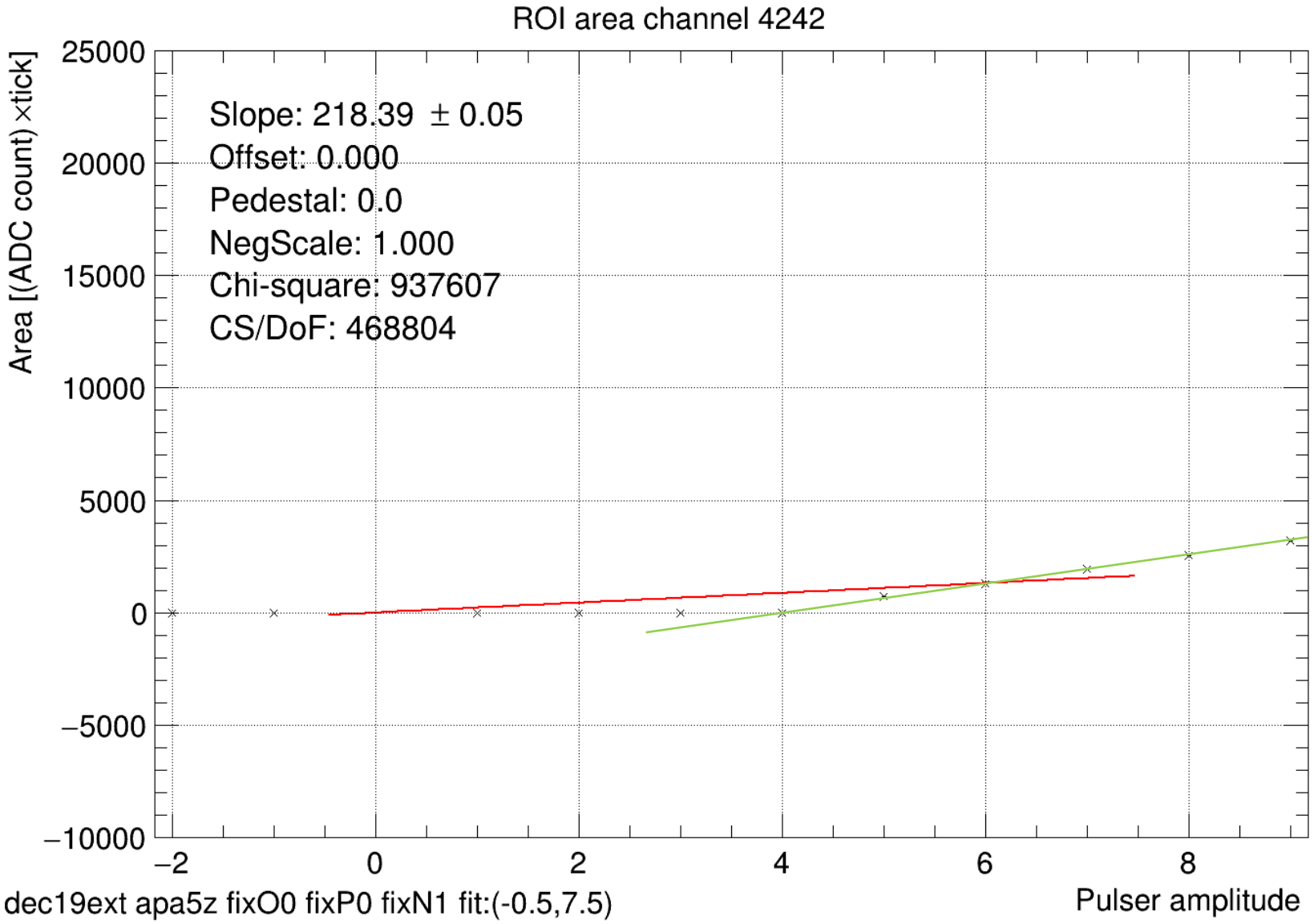
Shift


ROI area channel 4238
Slope: 212.20 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2530619
CS/DoF: 843540
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

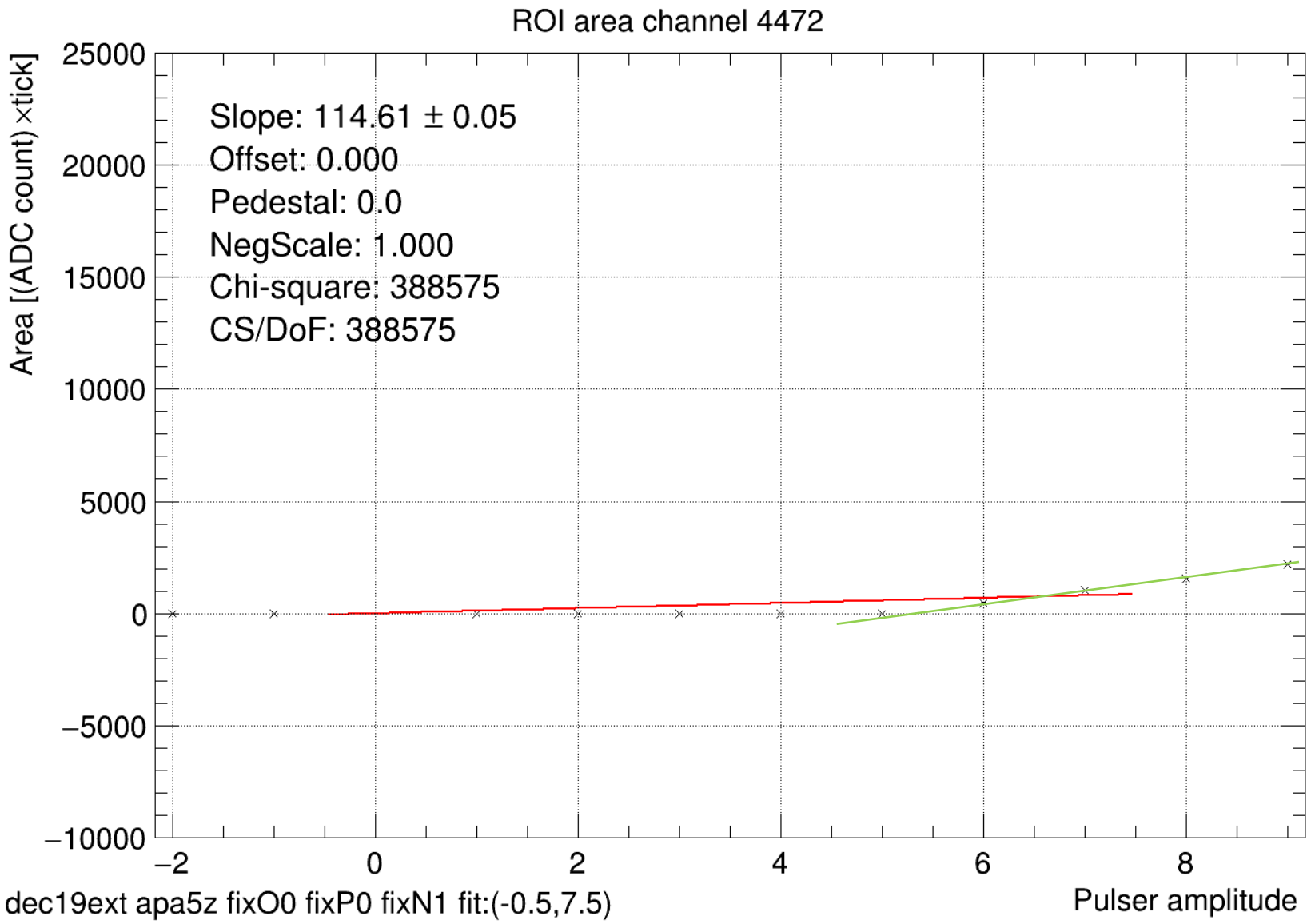
Shift


ROI area channel 4240
Slope: 259.69 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2331296
CS/DoF: 777099
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

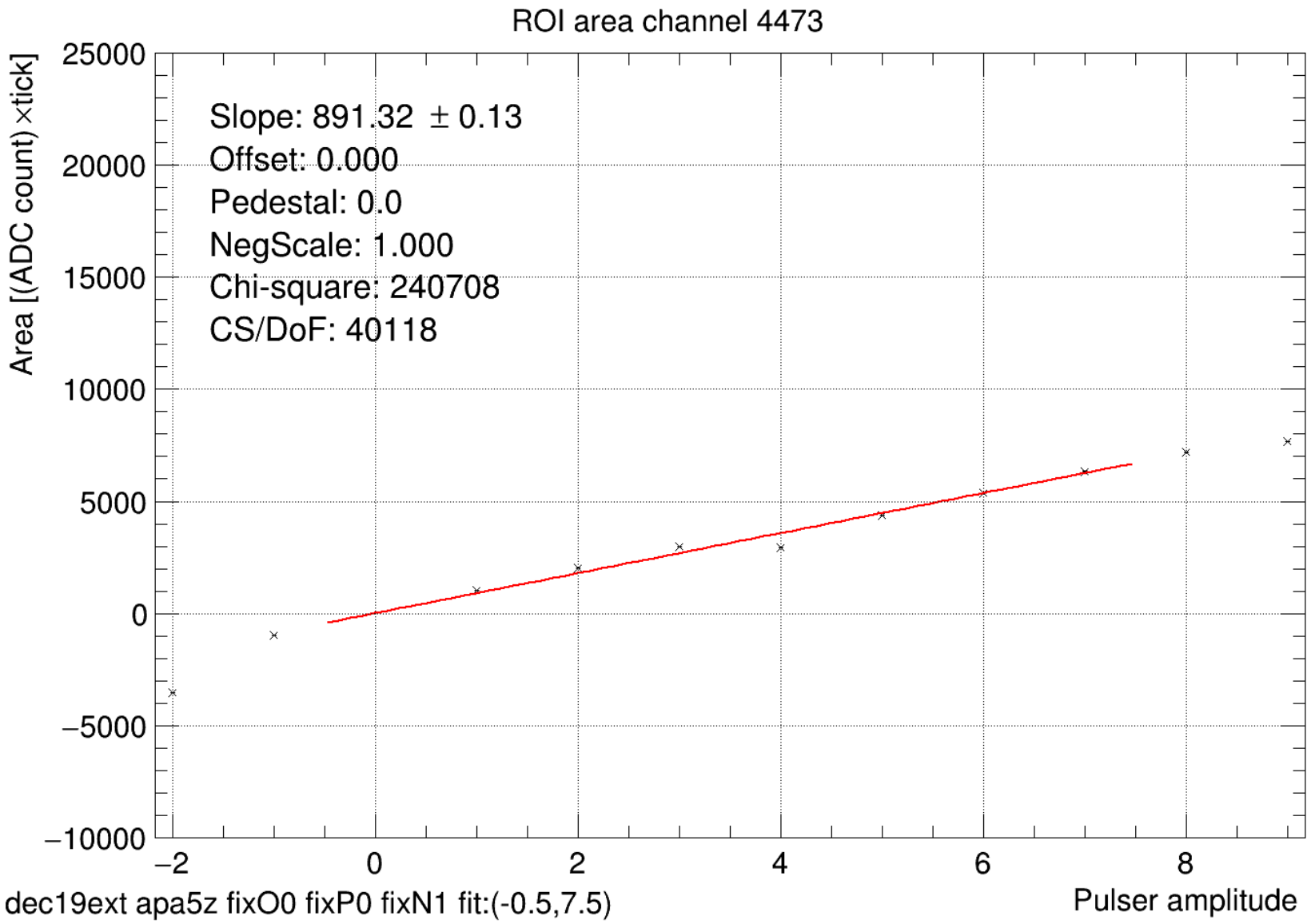
Shift


ROI area channel 4242
Slope: 218.39 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 937607
CS/DoF: 468804
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

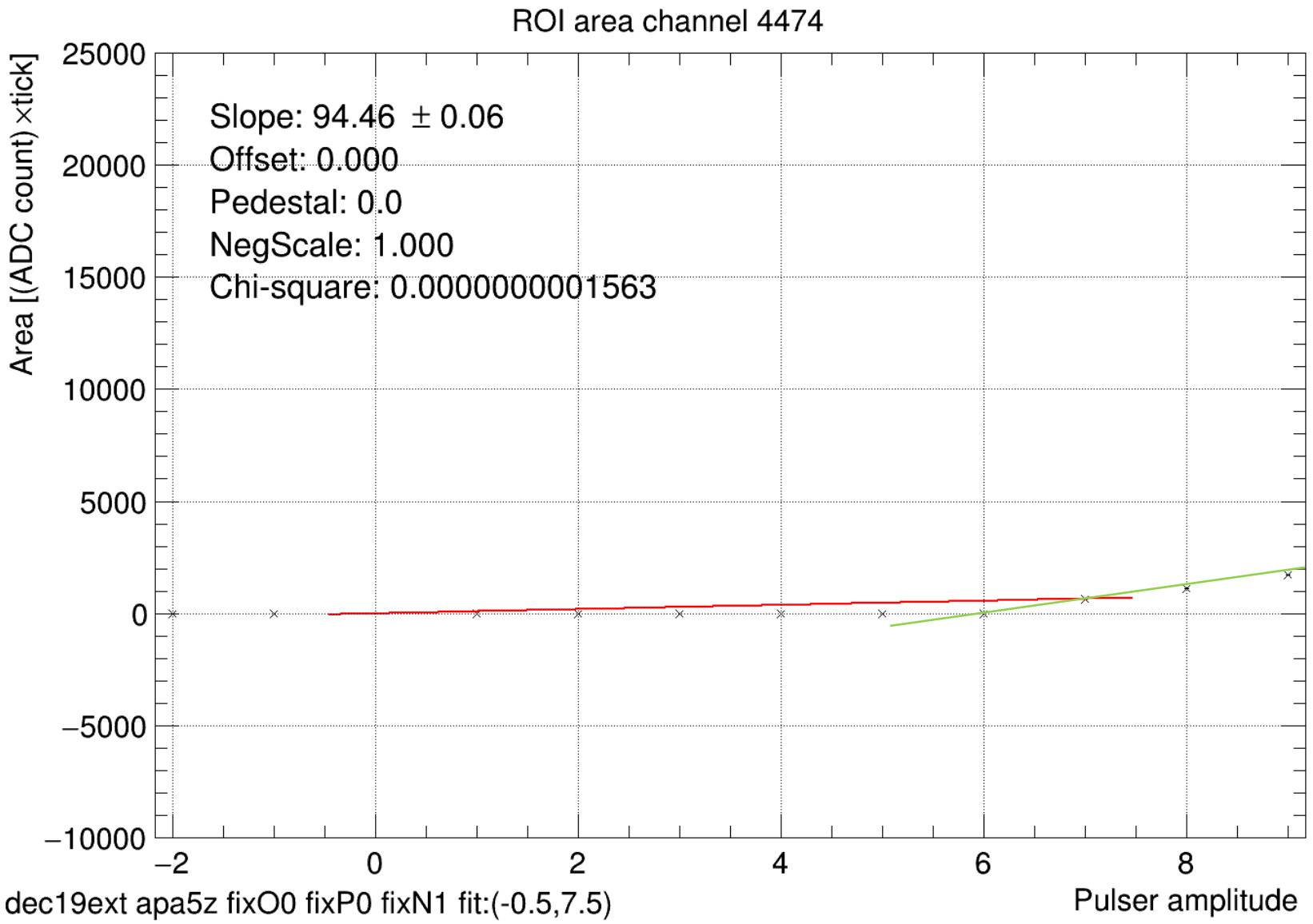
Shift


ROI area channel 4472
Slope: 114.61 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 388575
CS/DoF: 388575
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

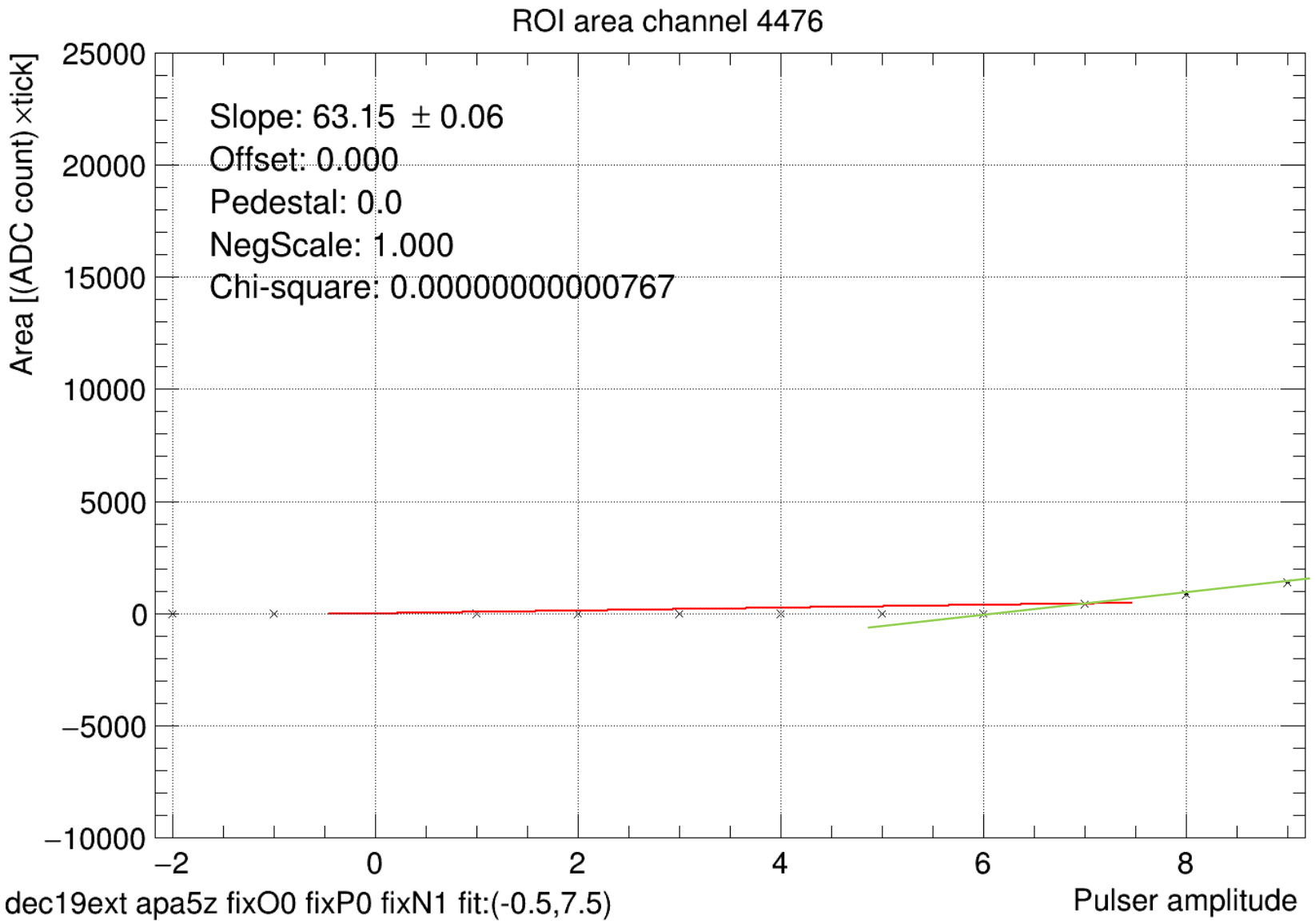
Jump


ROI area channel 4473
Slope: 891.32 ± 0.13
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 240708
CS/DoF: 40118
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

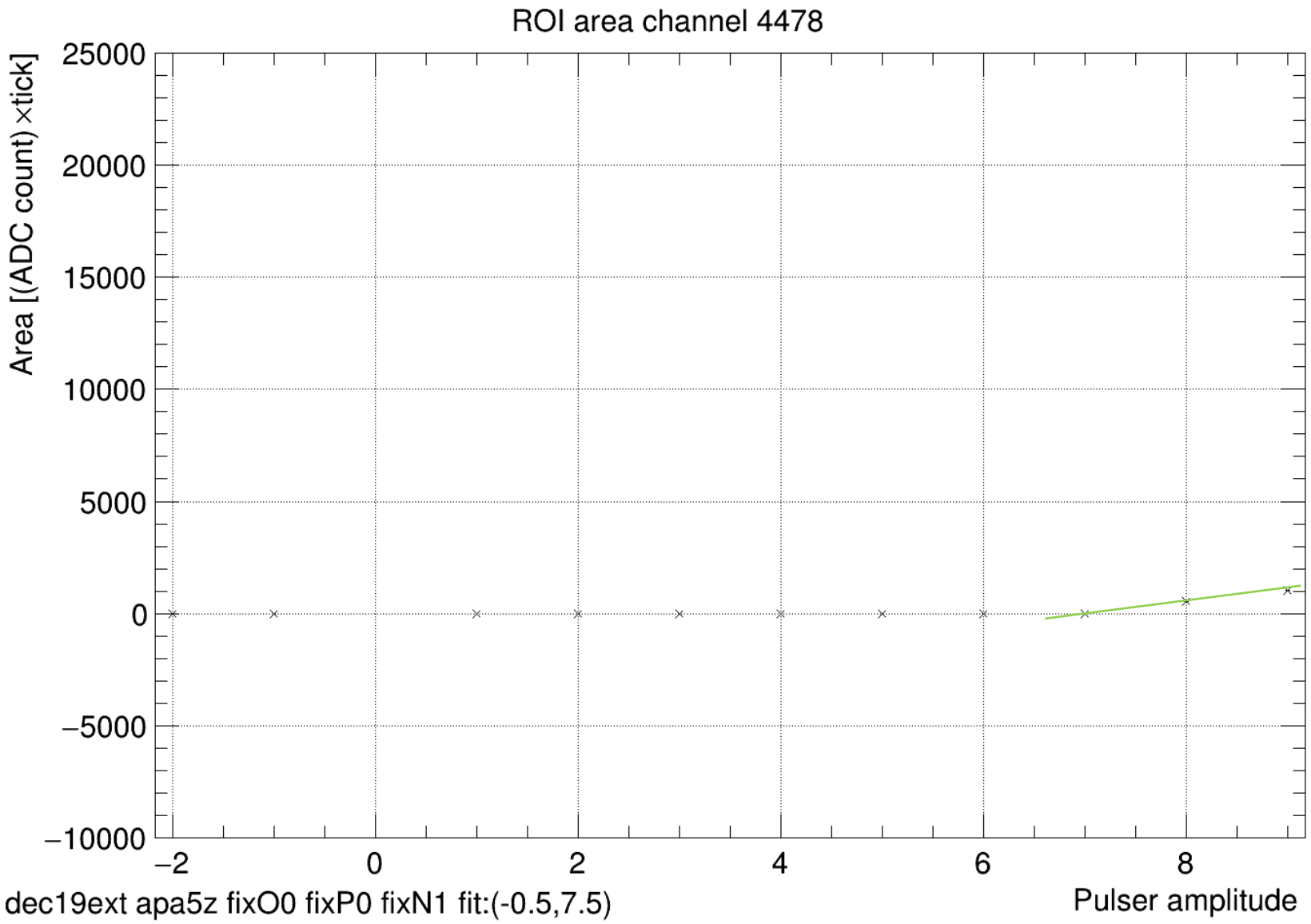
Shift


ROI area channel 4474
Slope: 94.46 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 0.0000000001563
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

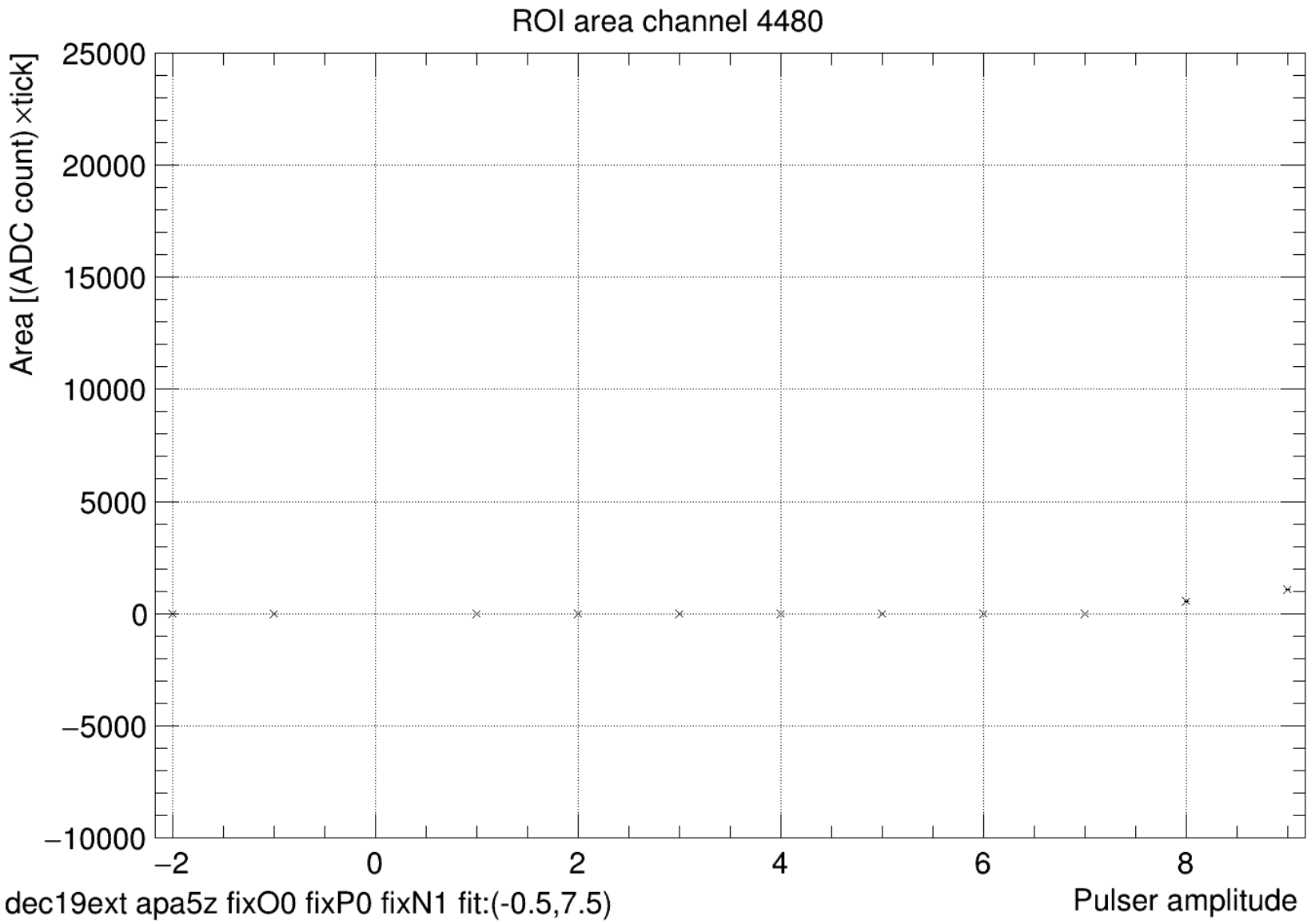
Shift


ROI area channel 4476
Slope: 63.15 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 0.00000000000767
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

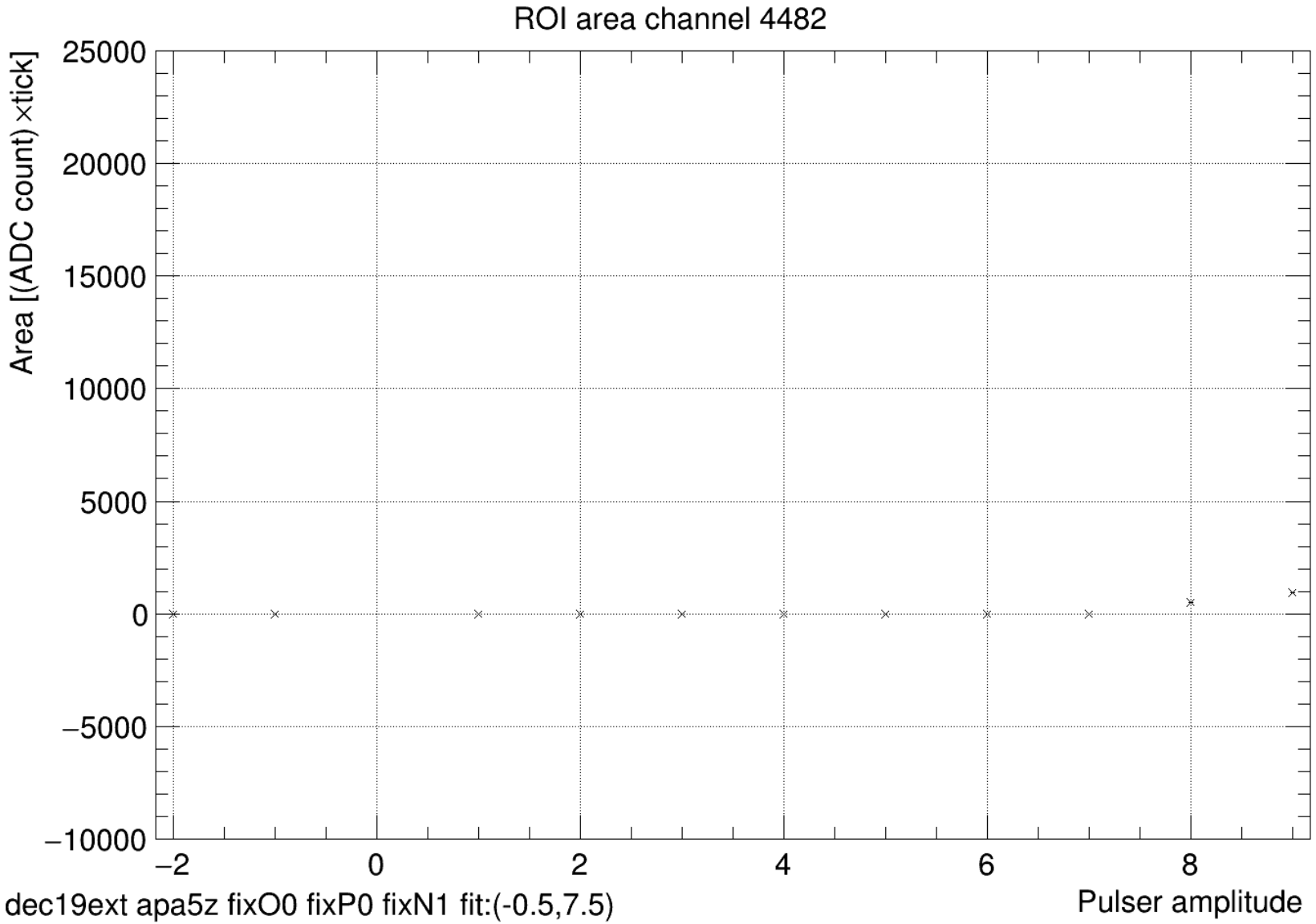
Shift


ROI area channel 4478
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

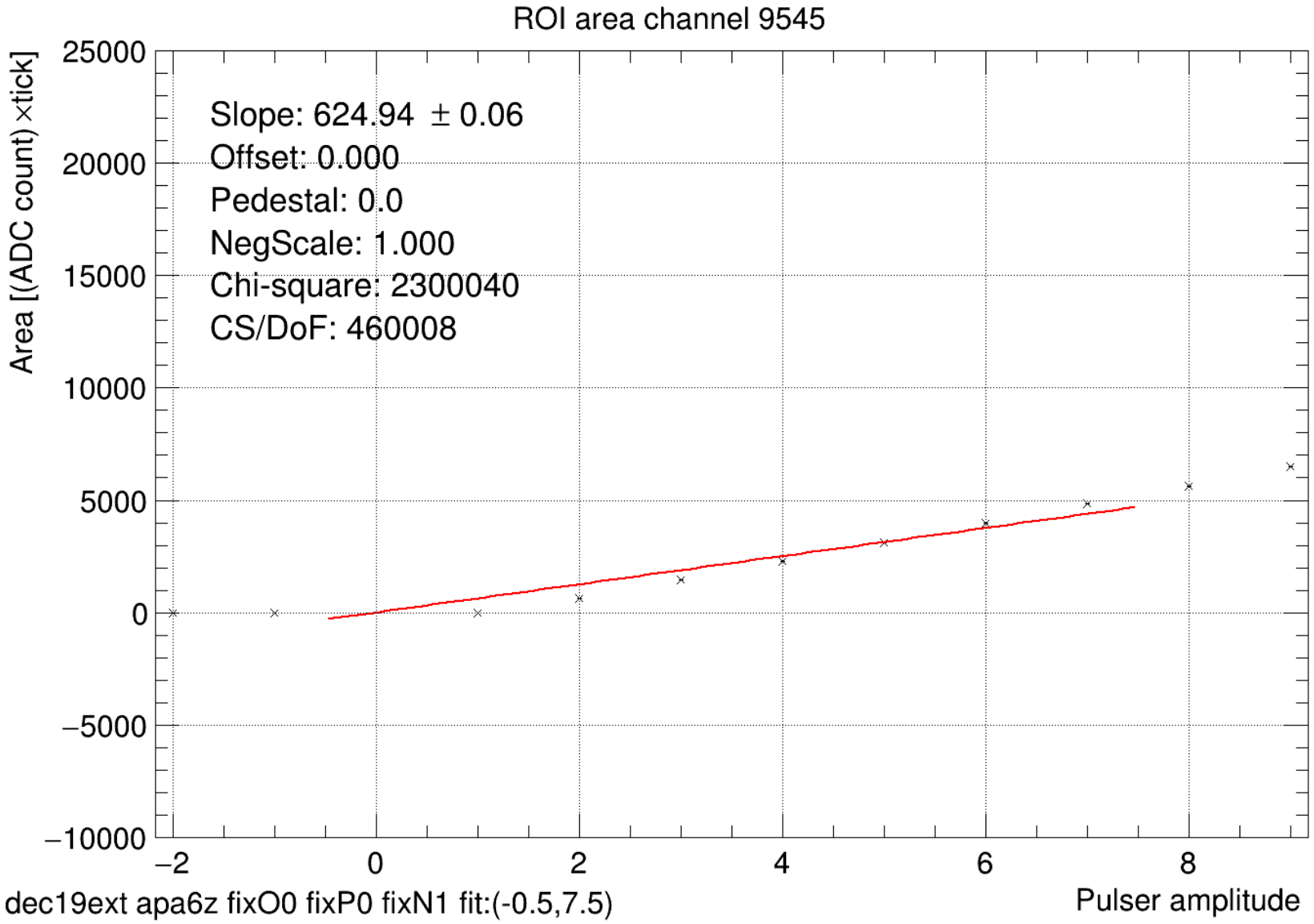
Shift


ROI area channel 4480
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

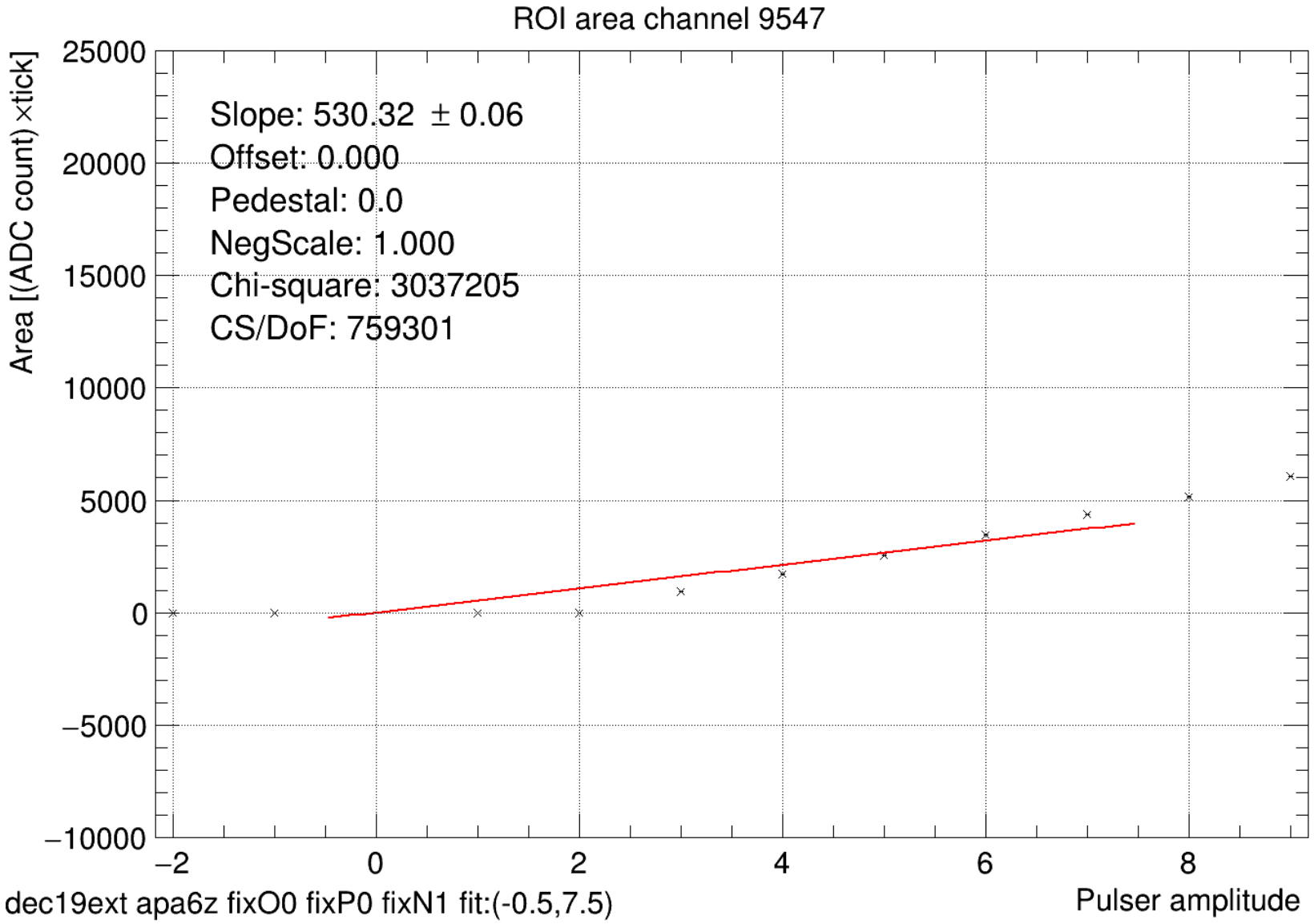
Shift


ROI area channel 4482
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa5z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

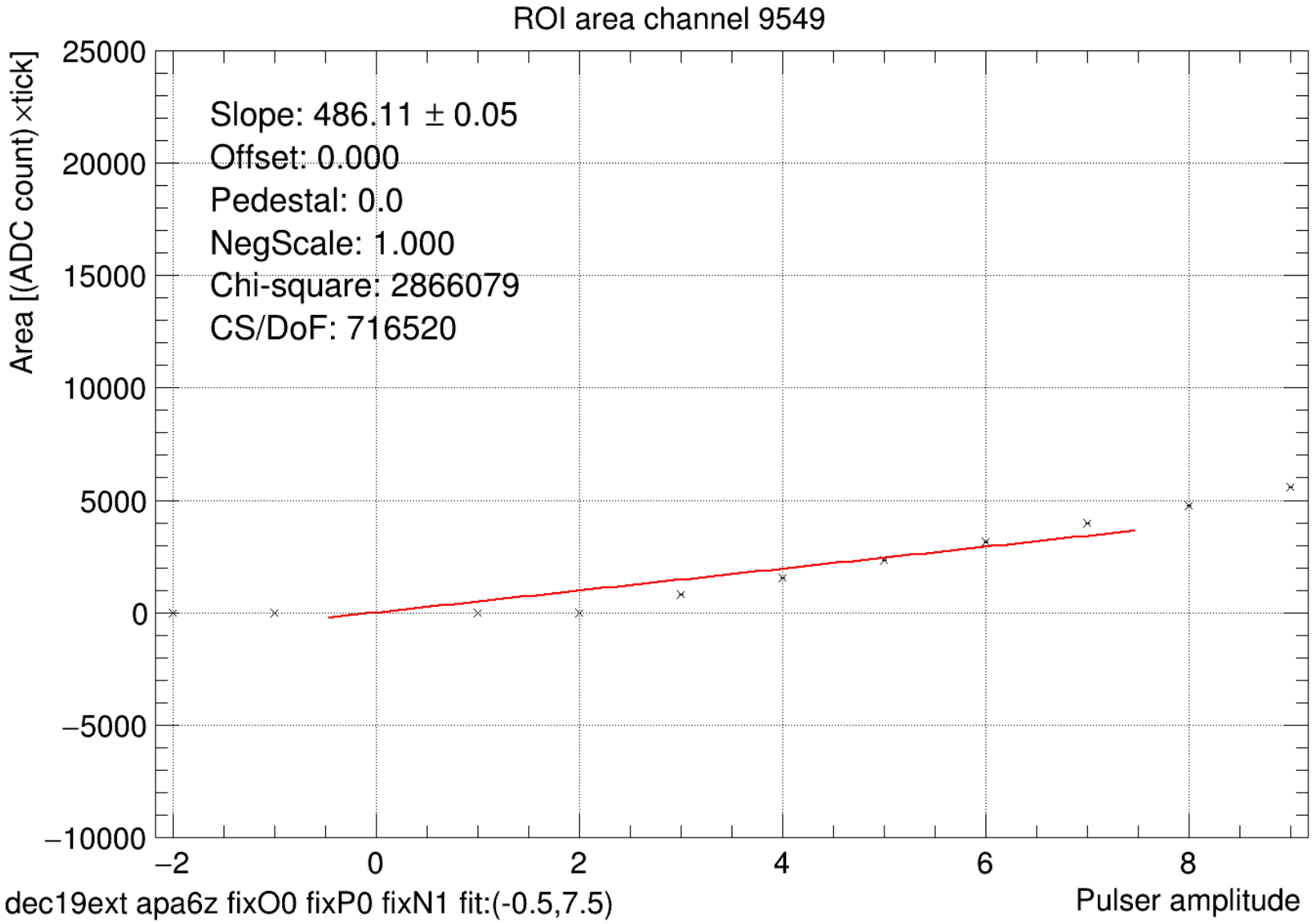
Shift


ROI area channel 9545
Slope: 624.94 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2300040
CS/DoF: 460008
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

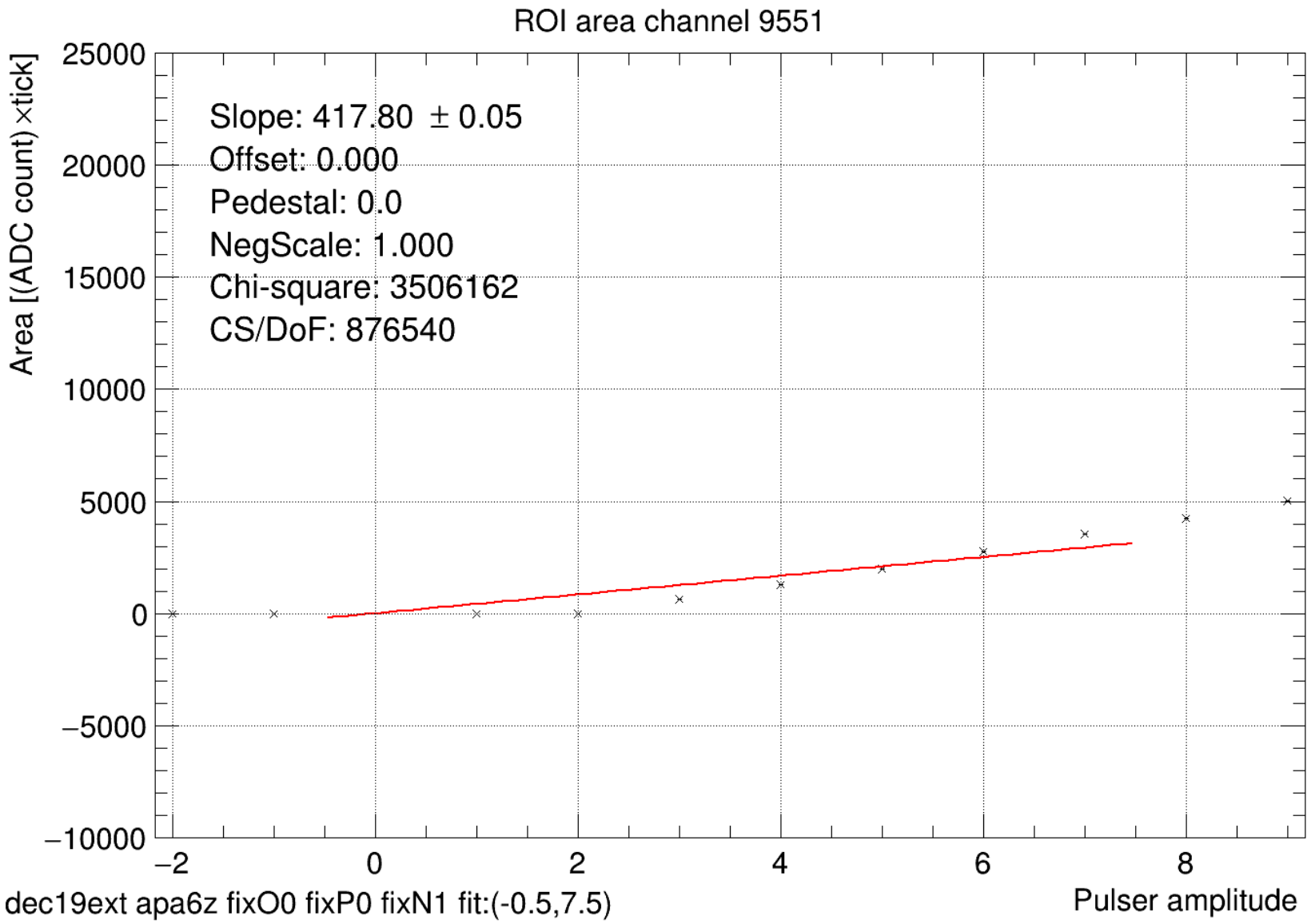
Shift


ROI area channel 9547
Slope: 530.32 ± 0.06
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 3037205
CS/DoF: 759301
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

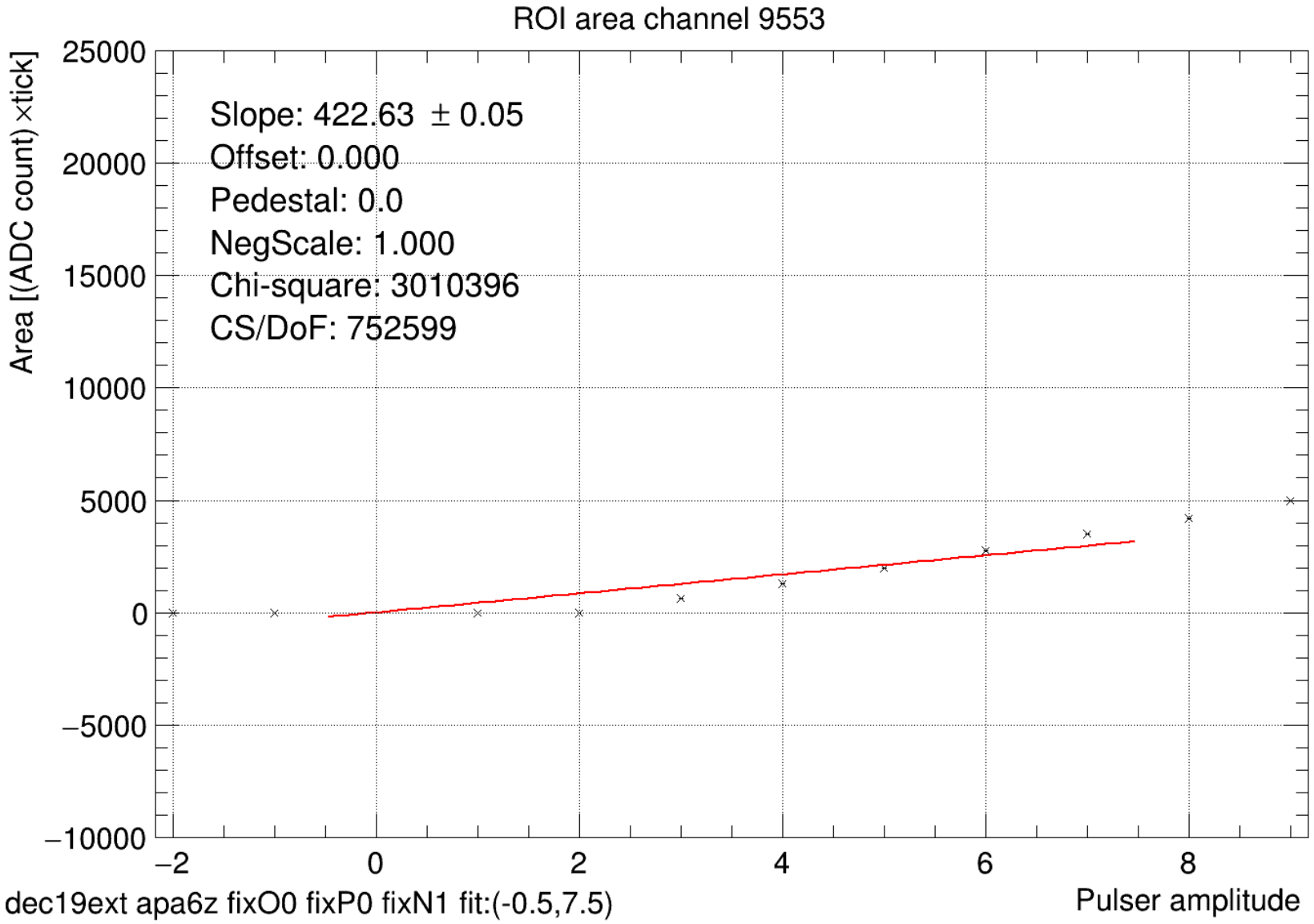
Shift


ROI area channel 9549
Slope: 486.11 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 2866079
CS/DoF: 716520
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

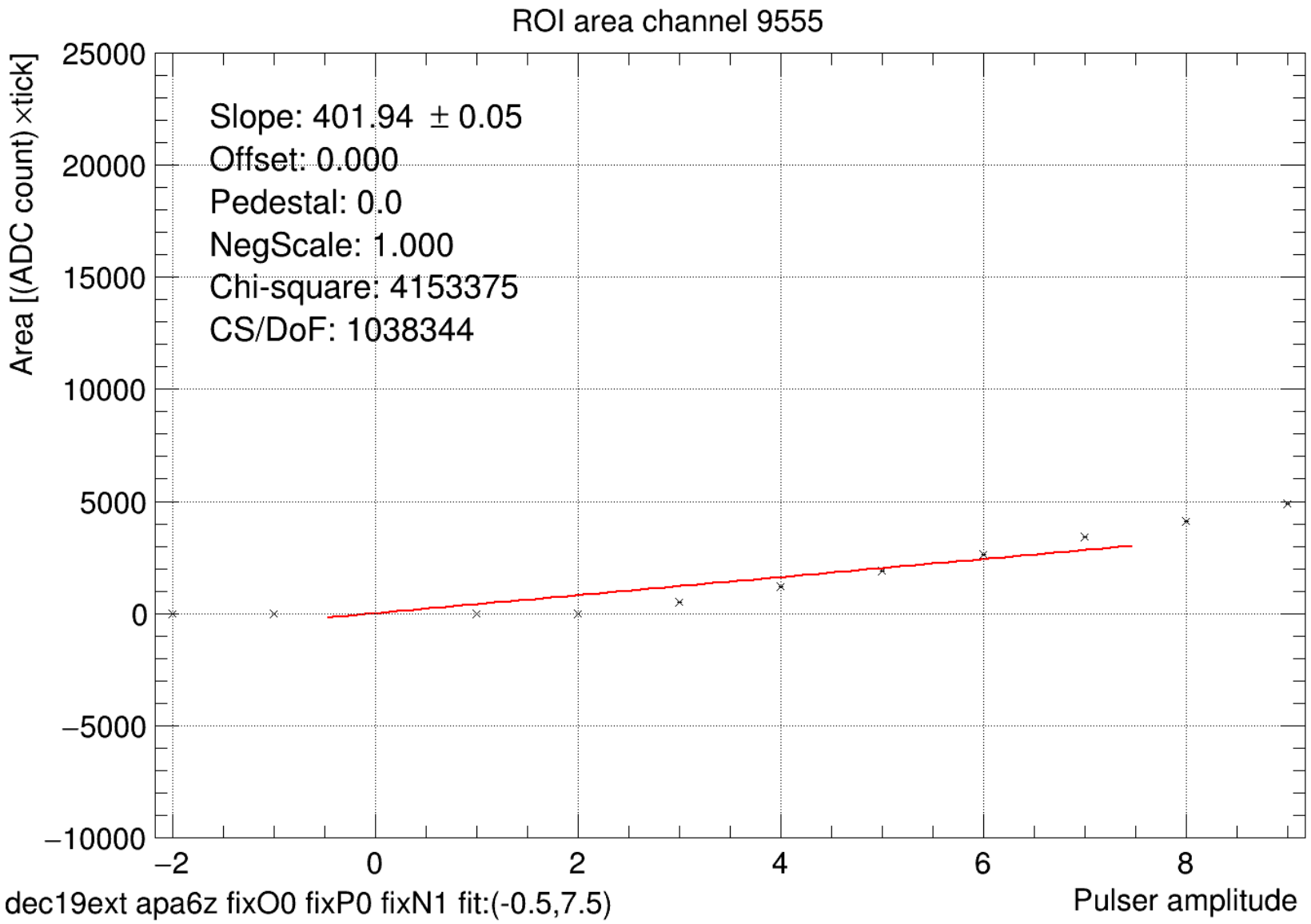
Shift


ROI area channel 9551
Slope: 417.80 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 3506162
CS/DoF: 876540
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

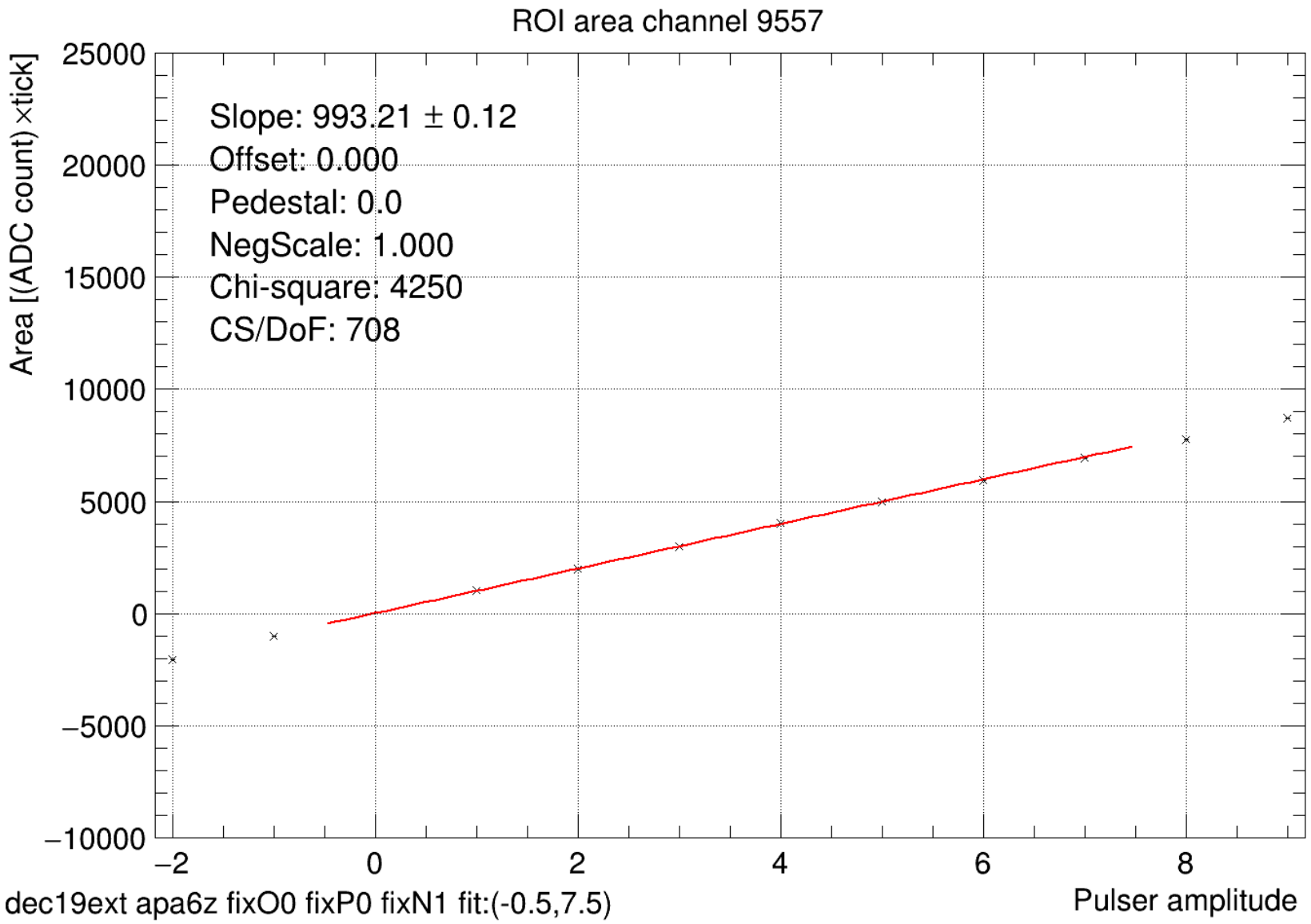
Shift


ROI area channel 9553
Slope: 422.63 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 3010396
CS/DoF: 752599
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

Shift


ROI area channel 9555
Slope: 401.94 ± 0.05
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 4153375
CS/DoF: 1038344
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

Good

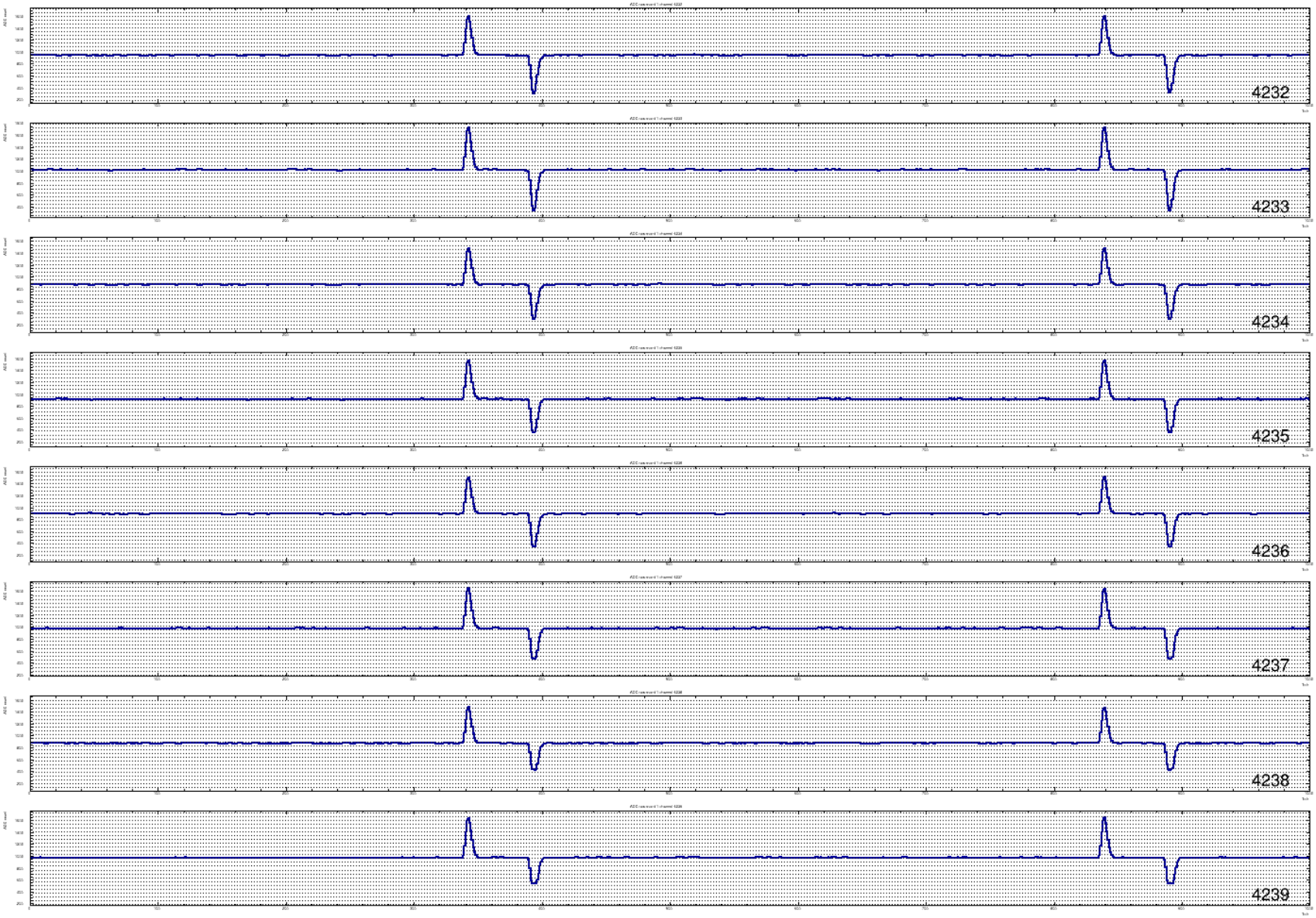

ROI area channel 9557
Slope: 993.21 ± 0.12
Offset: 0.000
Pedestal: 0.0
NegScale: 1.000
Chi-square: 4250
CS/DoF: 708
Area [(ADC count) ×tick]
25000
20000
15000
10000
5000
0
−5000
−10000
−2
0
2
4
6
8
dec19ext apa6z fixO0 fixP0 fixN1 fit:(-0.5,7.5)
Pulser amplitude

Waveforms

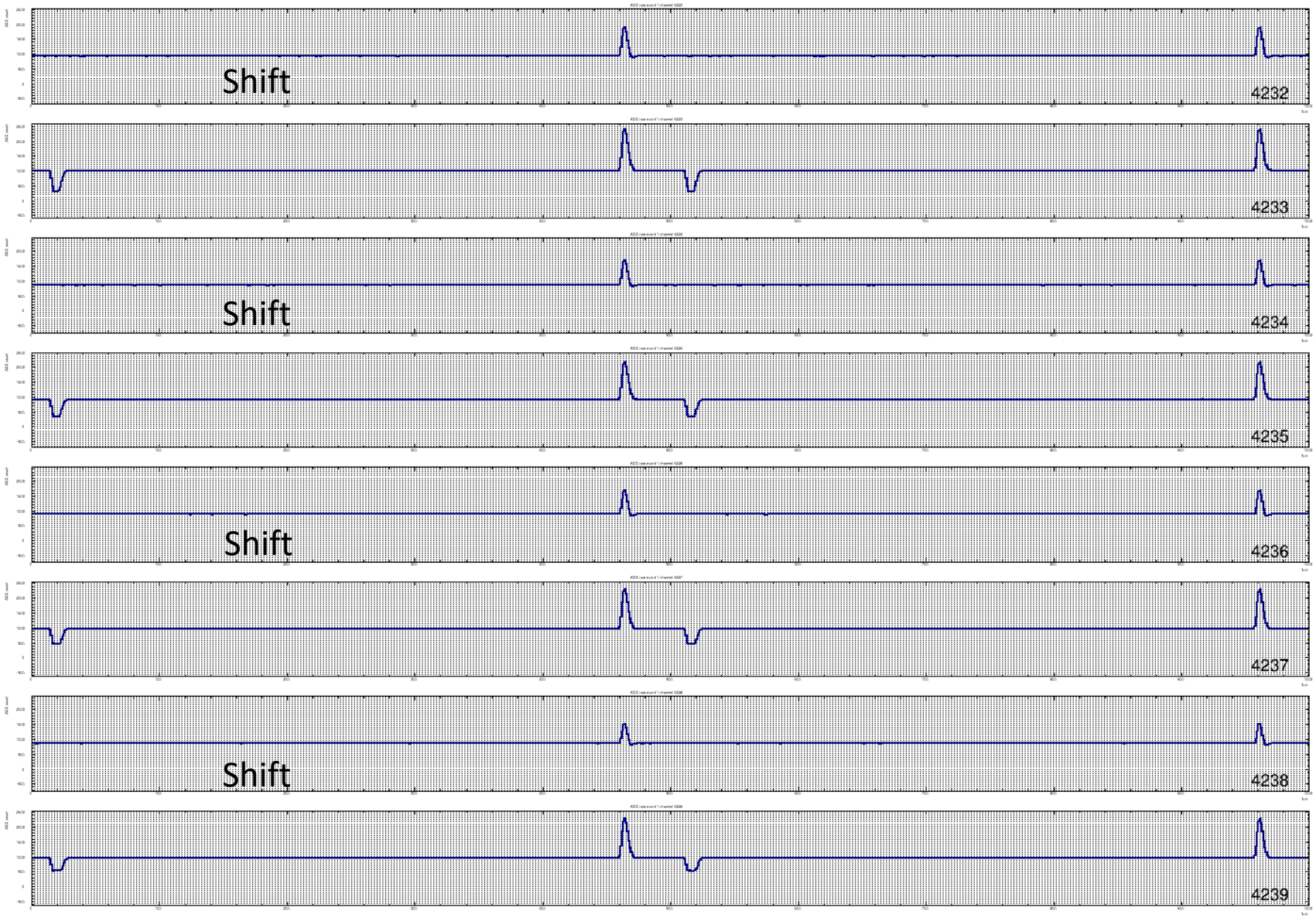
DAC=4


Shift
4232
4233
Shift
4234
4235
Shift
4236
4237
Shift
4238
4239

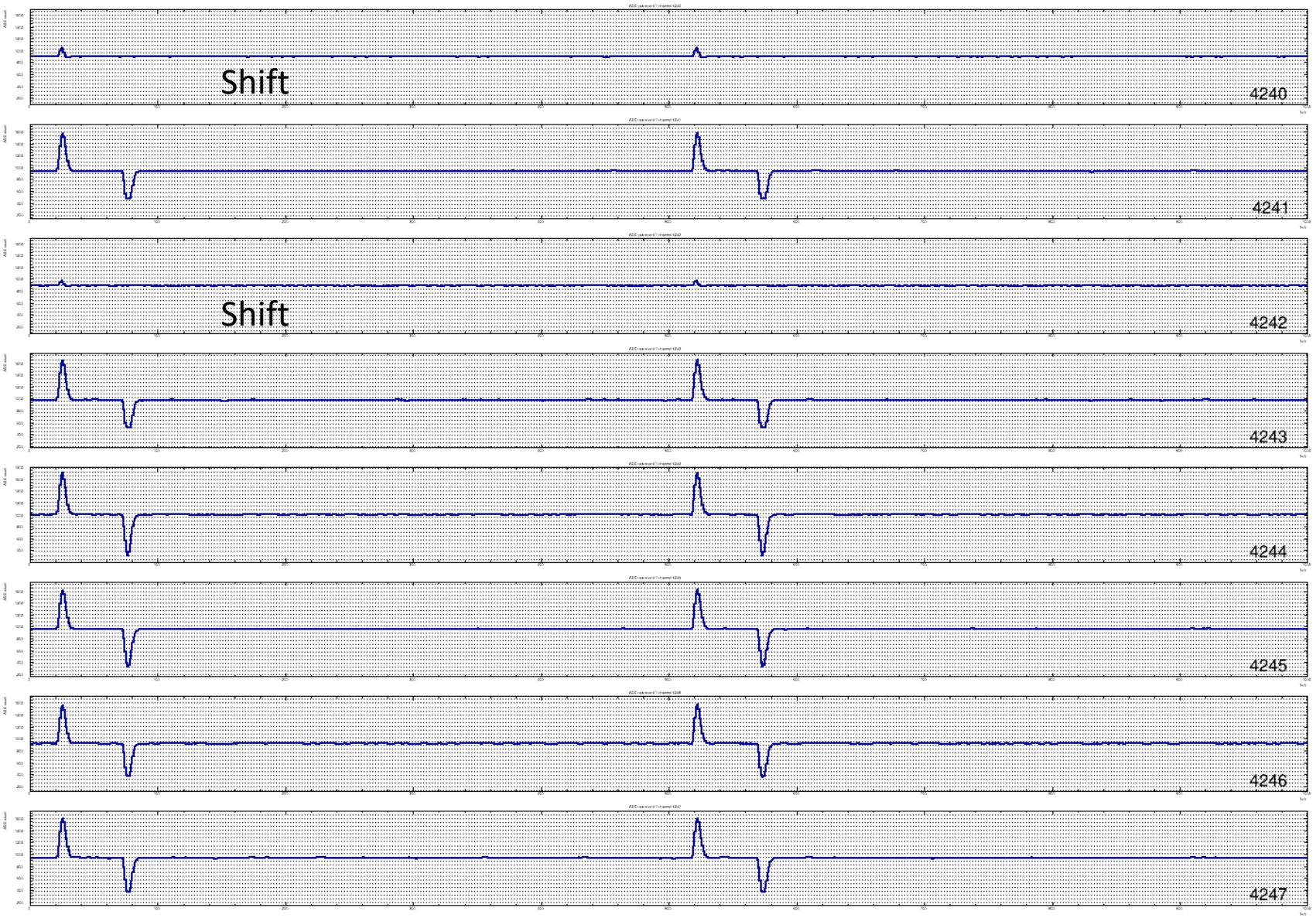
DAC=4 run 10572 (New run)



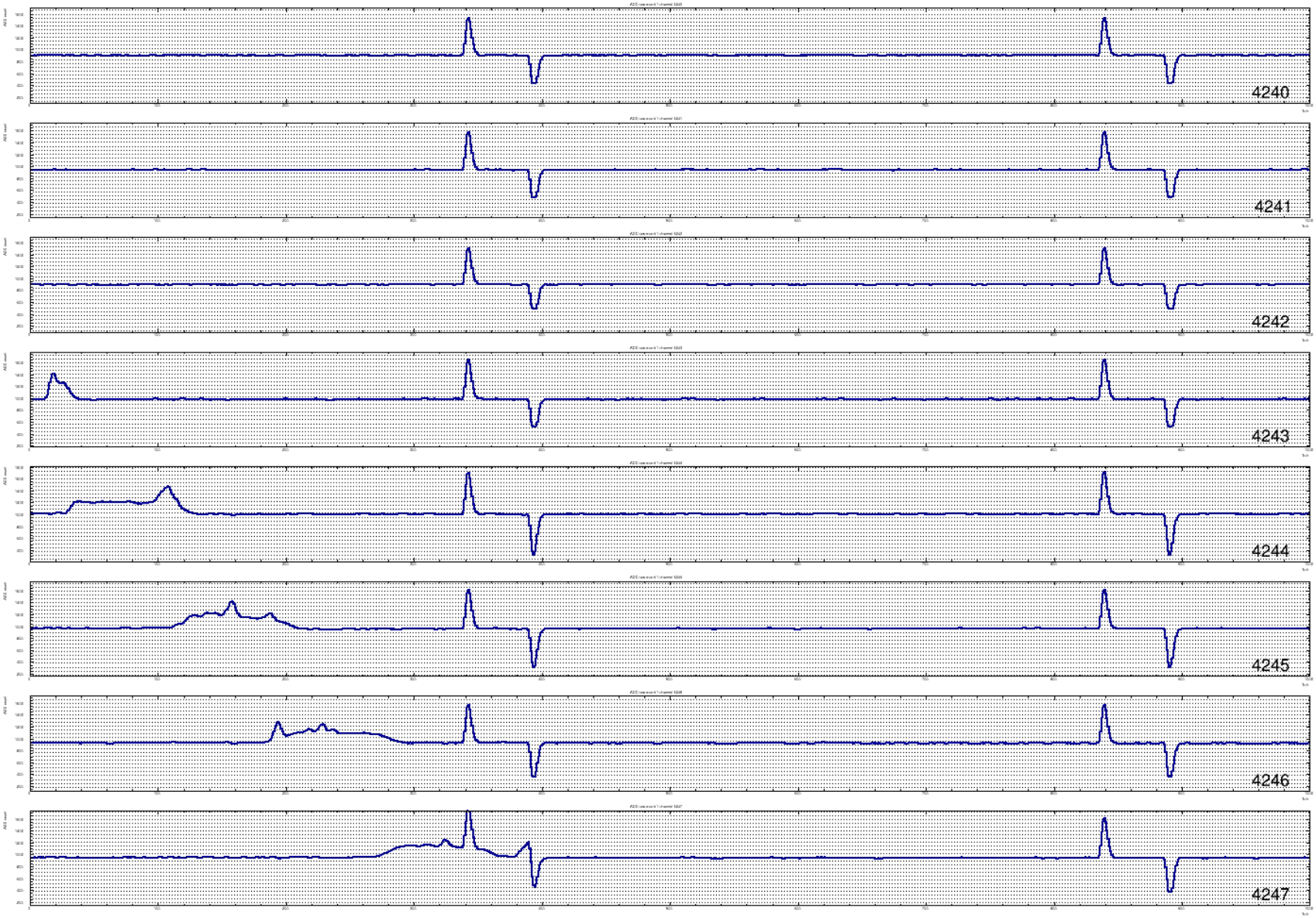
DAC=8


Shift
4232
4233
Shift
4234
4235
Shift
4236
4237
Shift
4238
4239

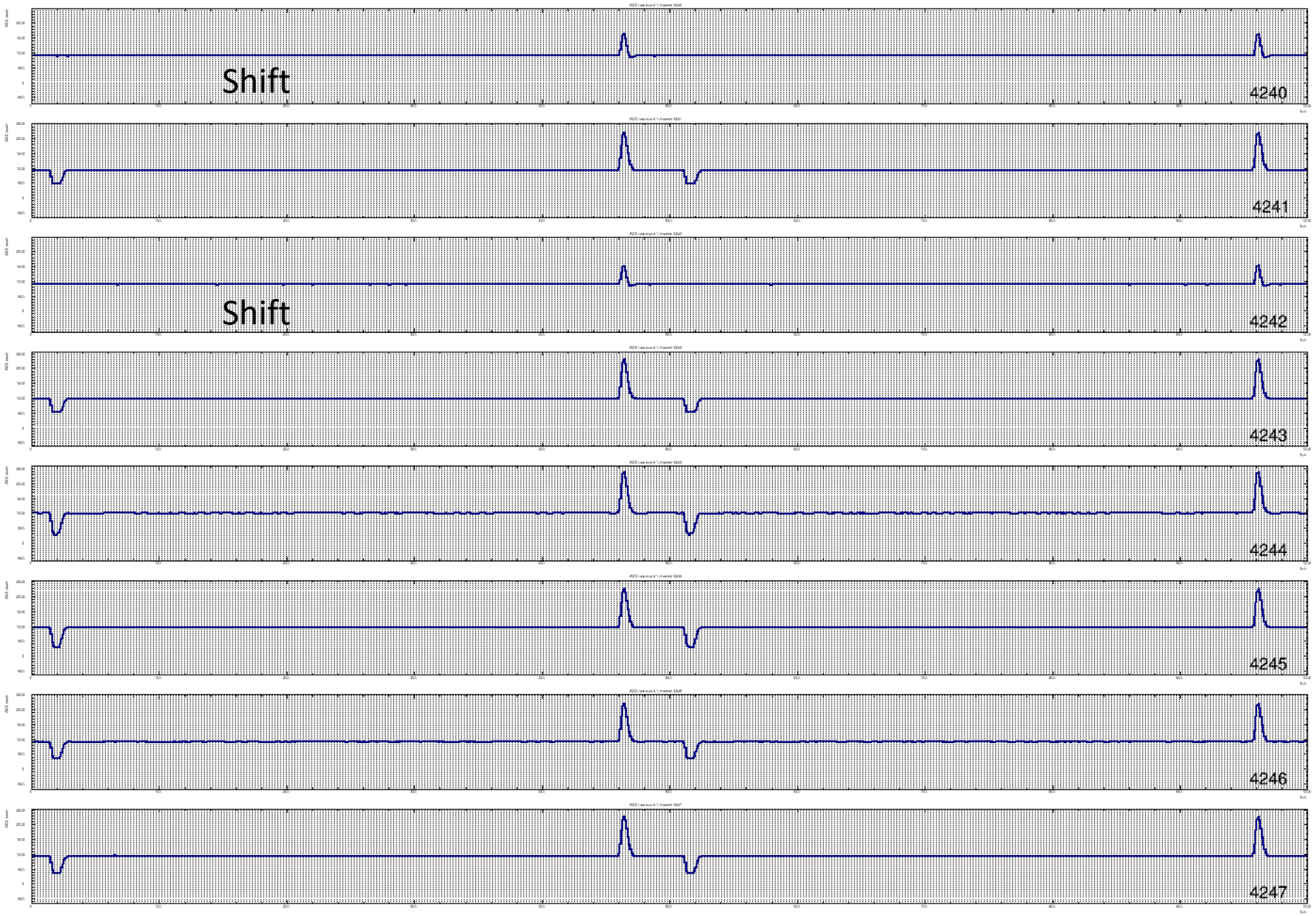
DAC=4



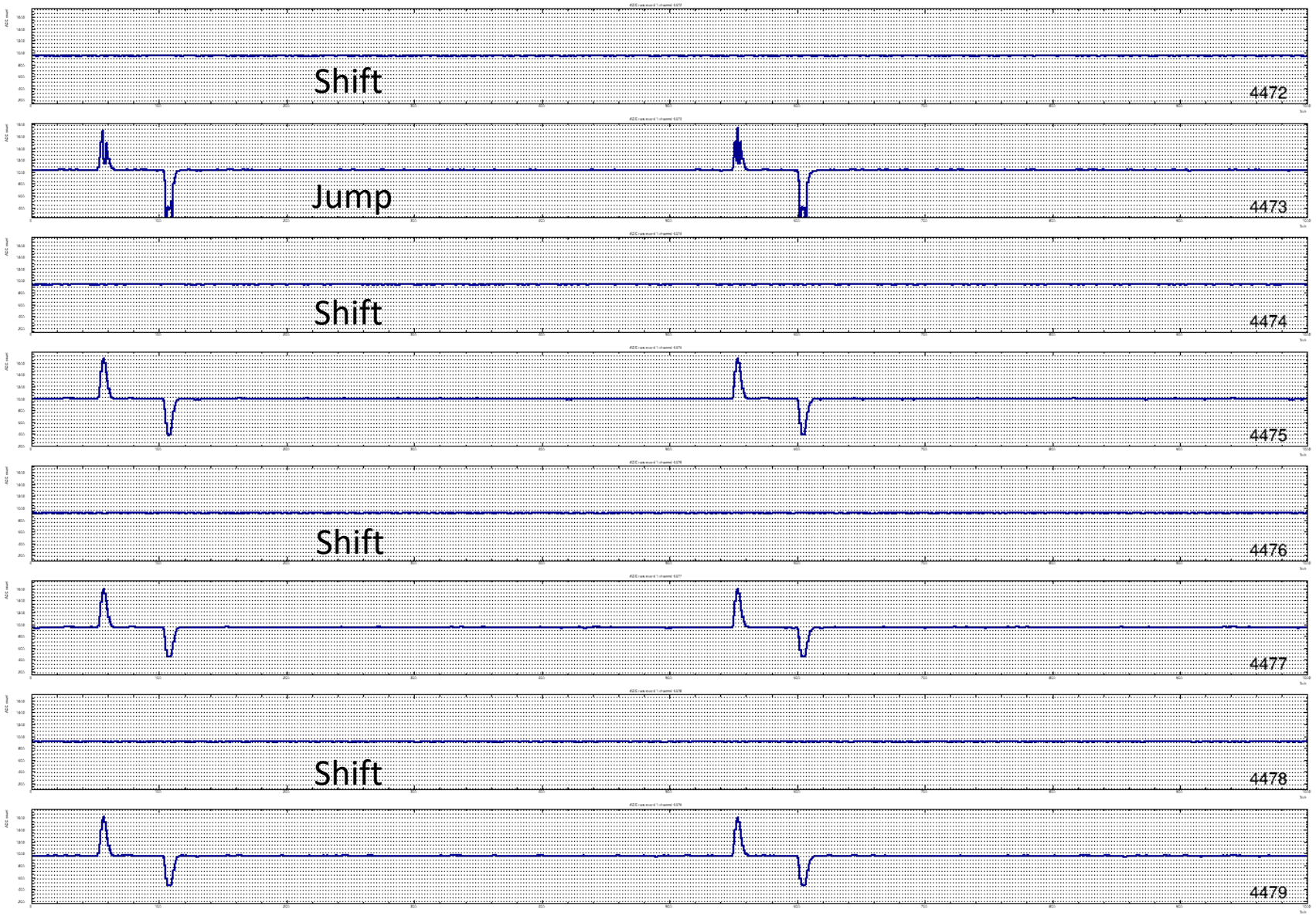
DAC=4 run 10572



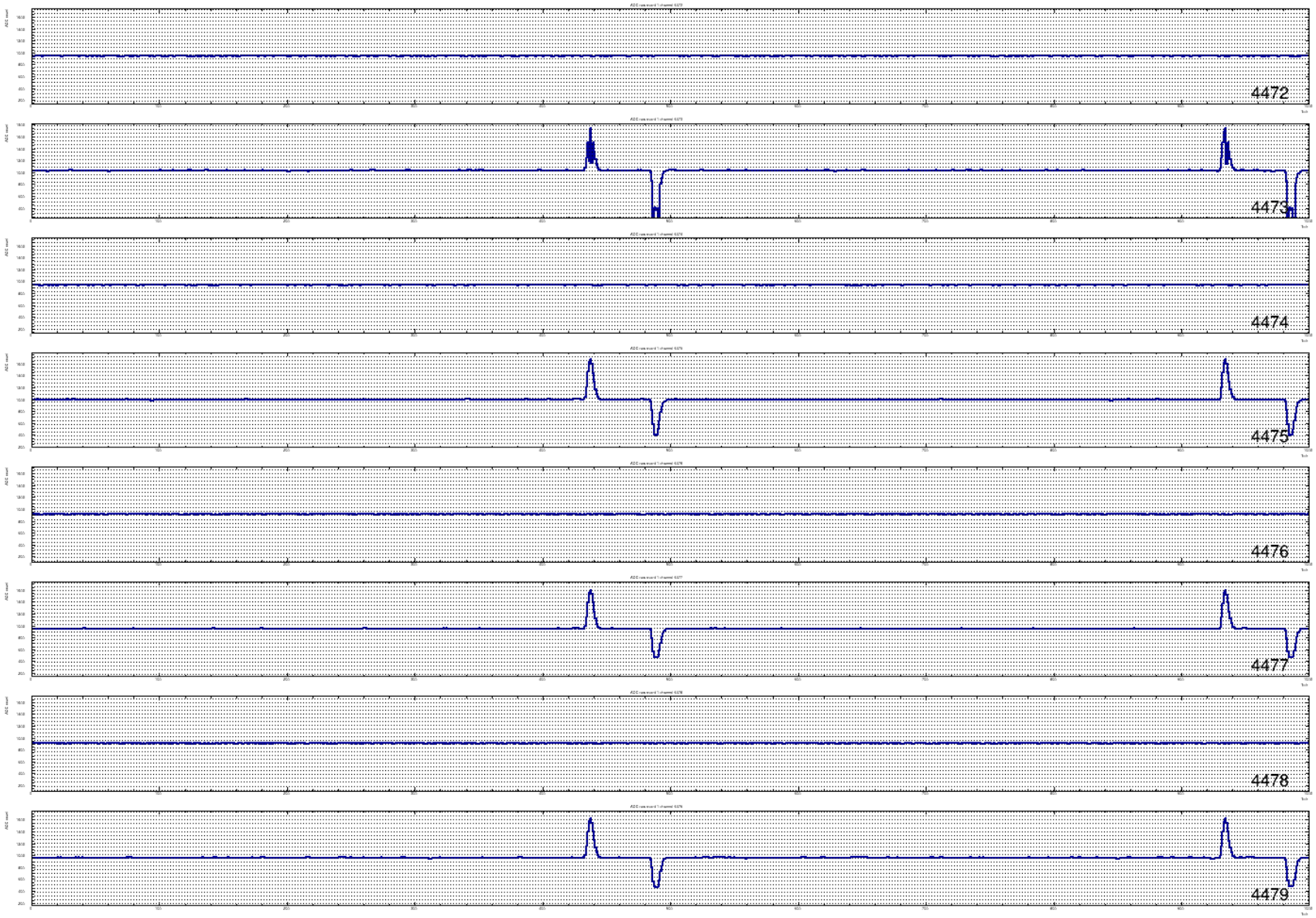
DAC=8



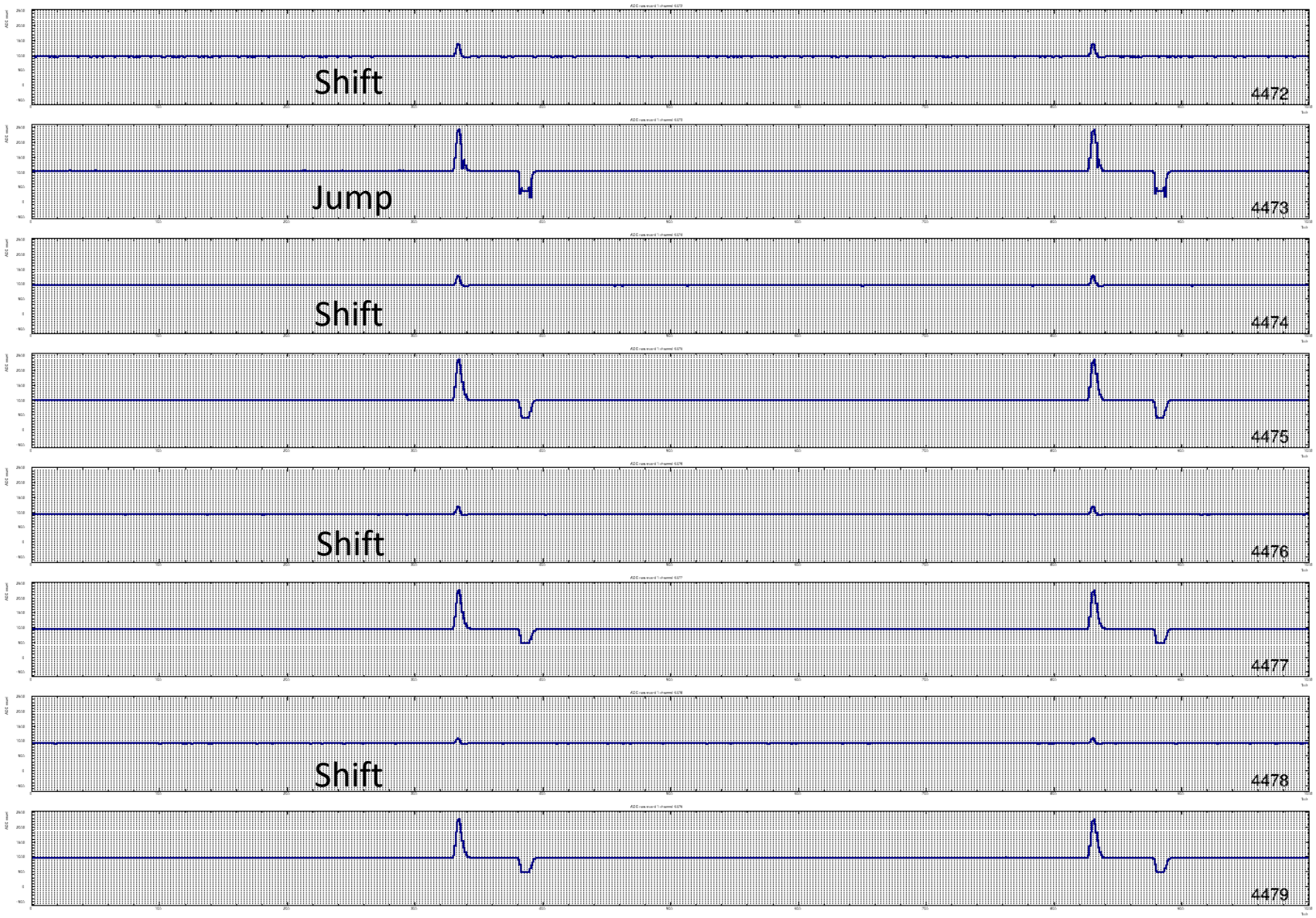
DAC=4


Shift
4472
Jump
4473
Shift
4474
4475
Shift
4476
4477
Shift
4478
4479

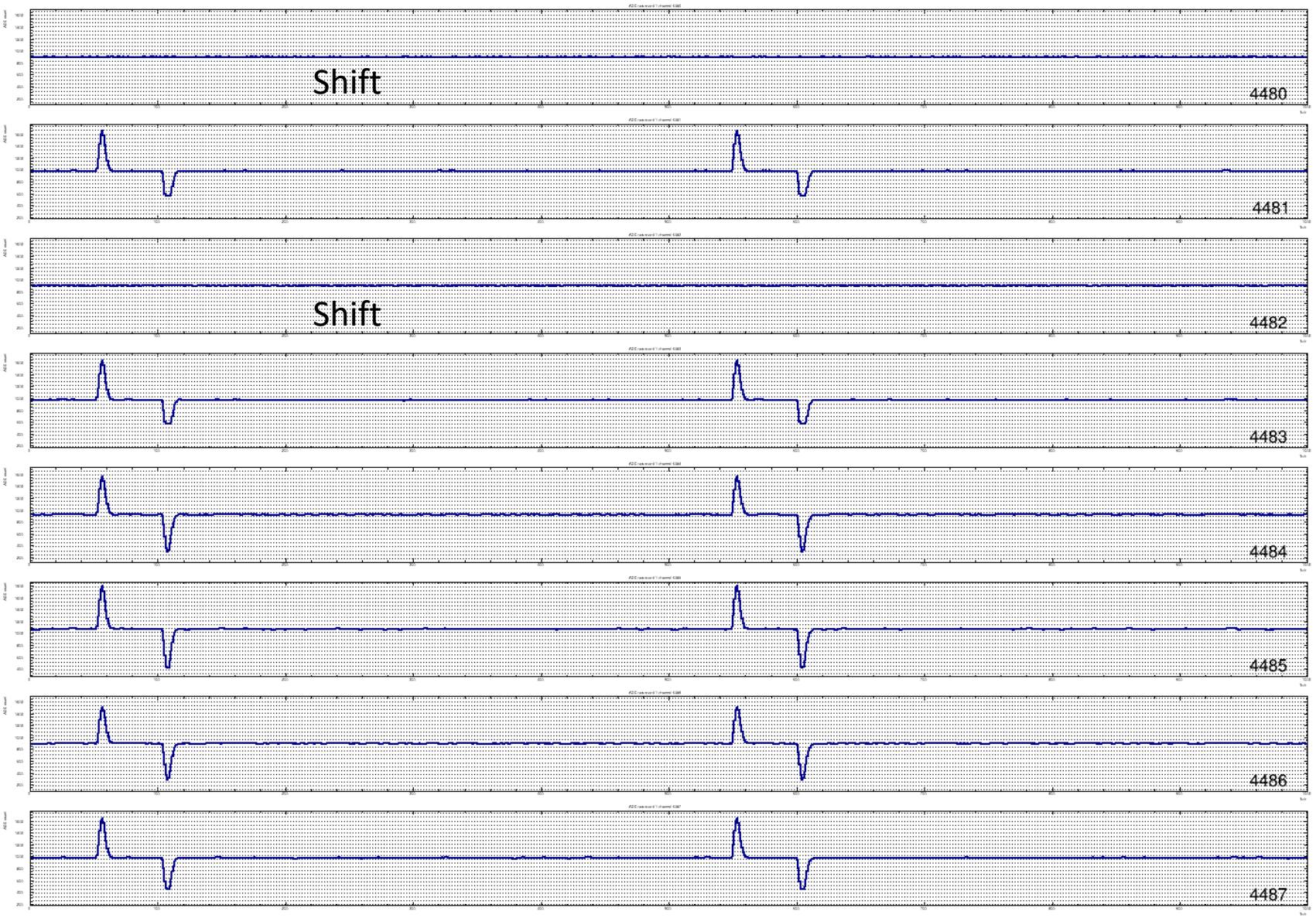
DAC=4 run 10572



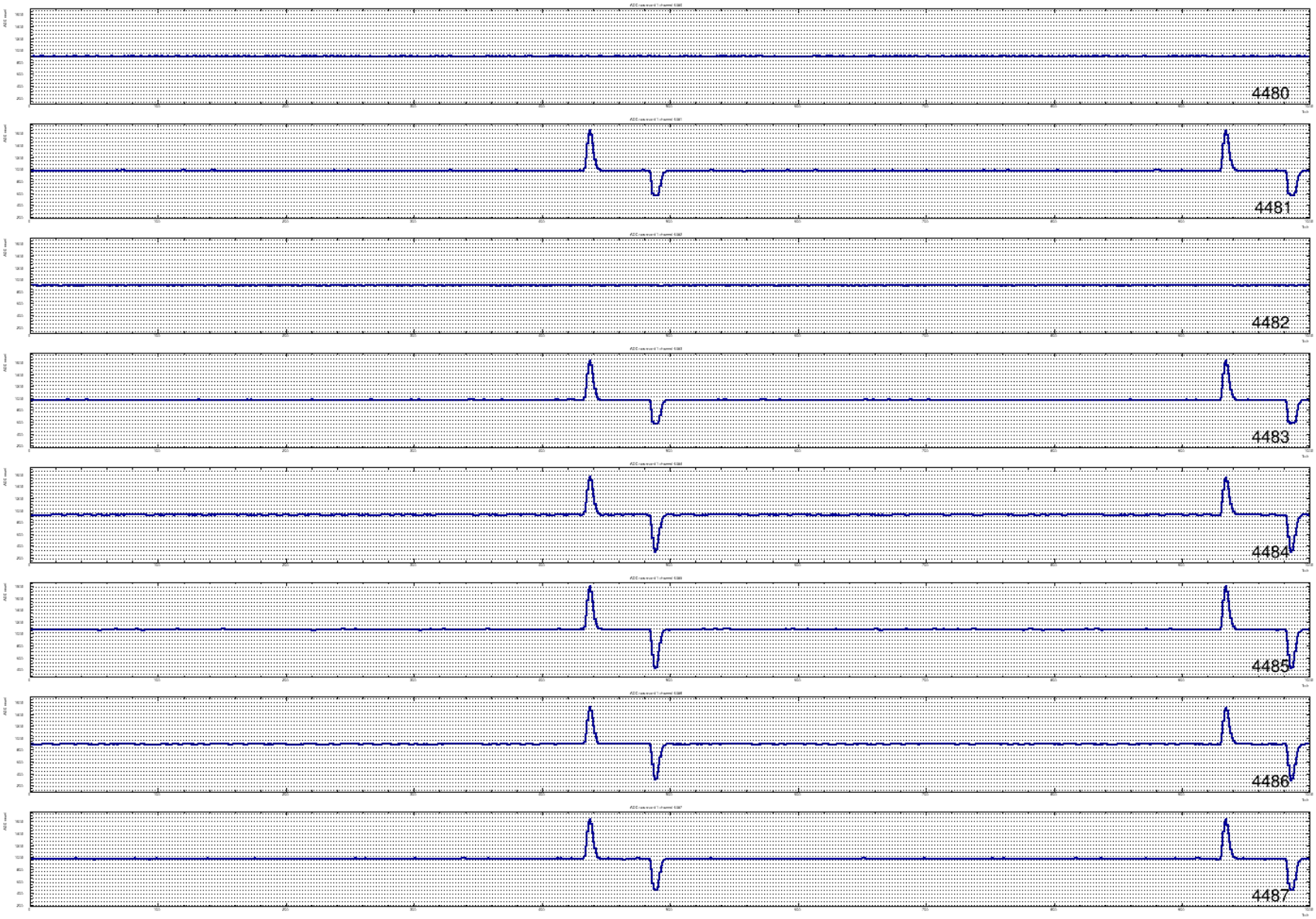
DAC=8


Shift
4472
Jump
4473
Shift
4474
4475
Shift
4476
4477
Shift
4478
4479

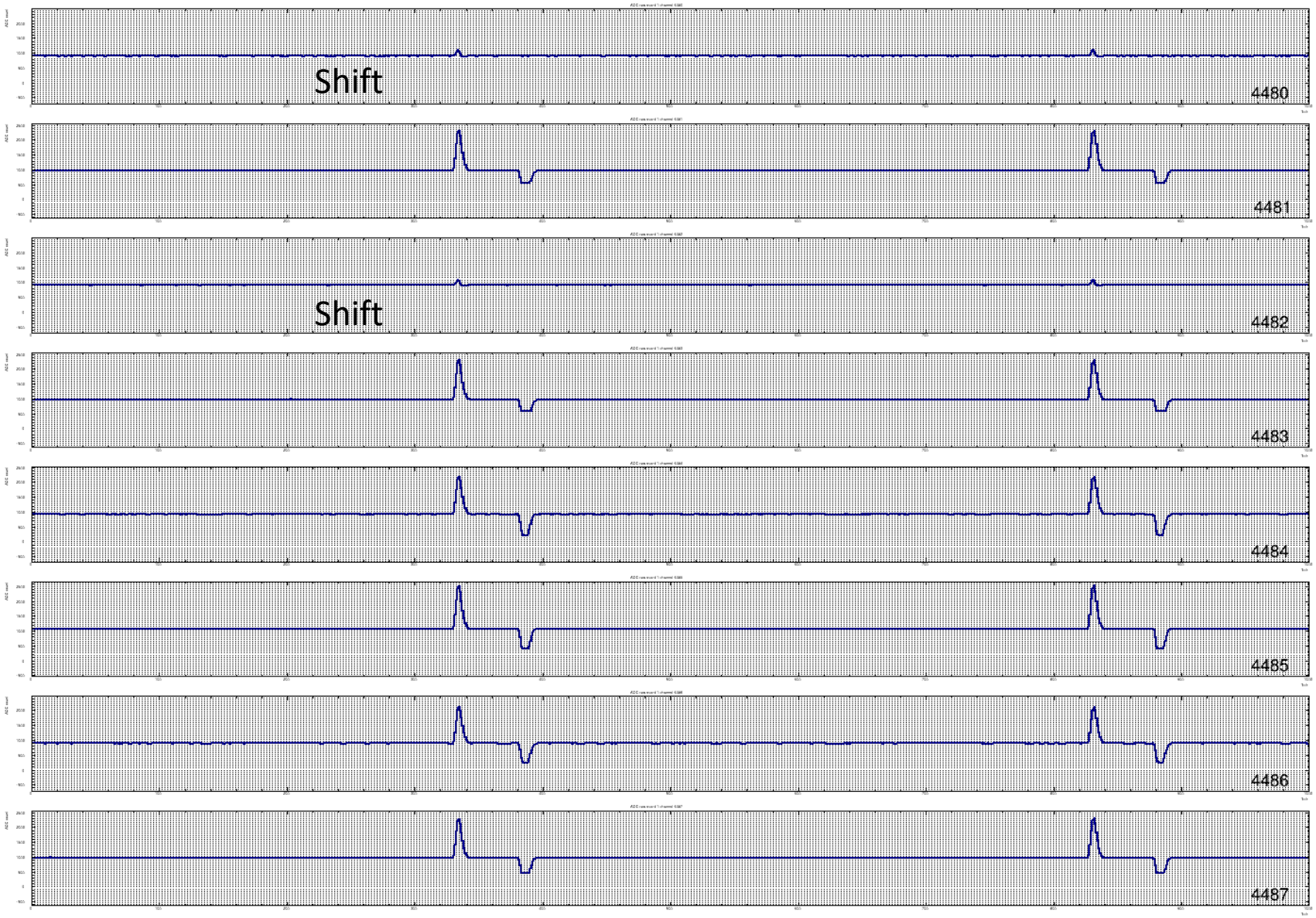
DAC=4



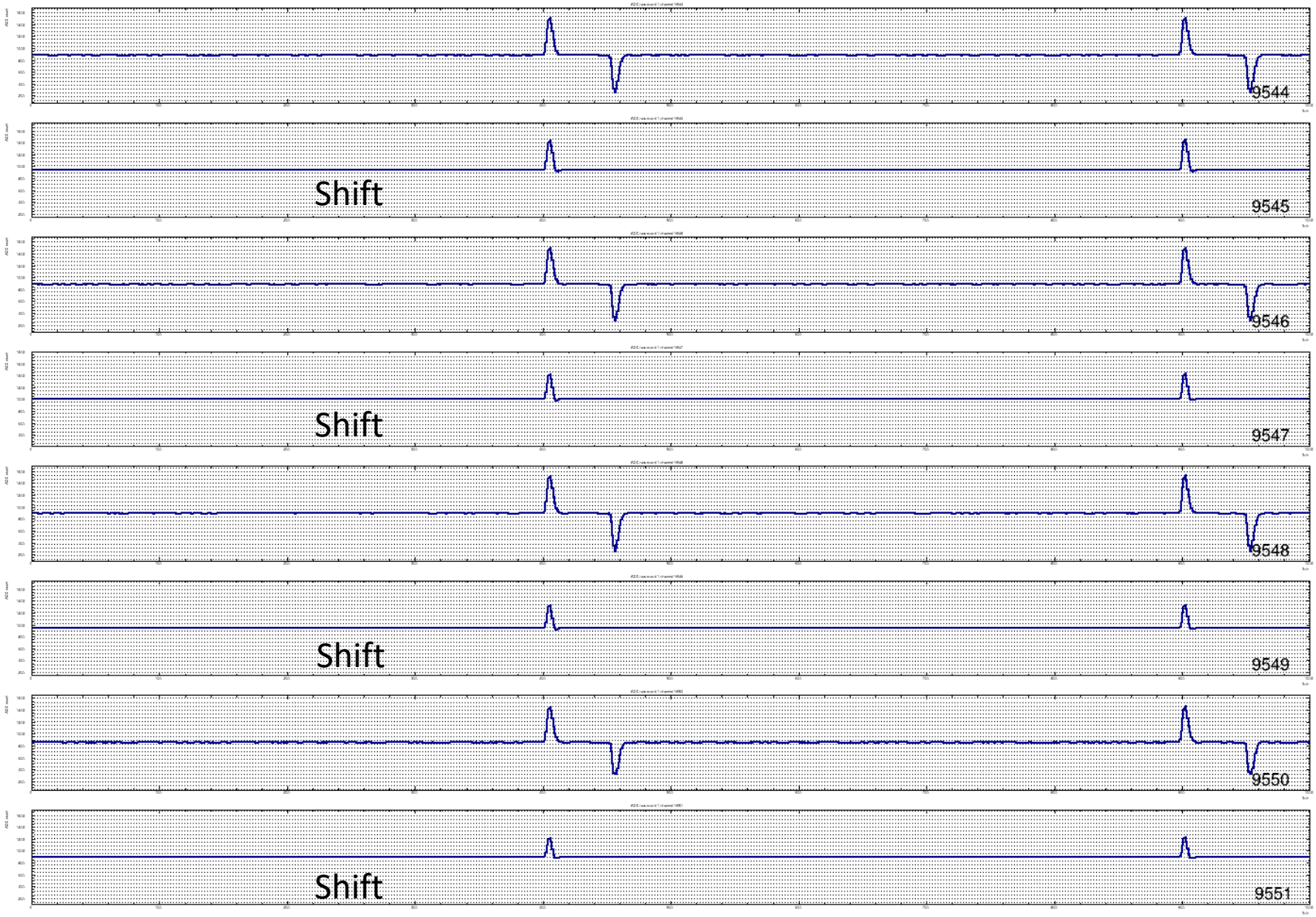
DAC=4 run10572



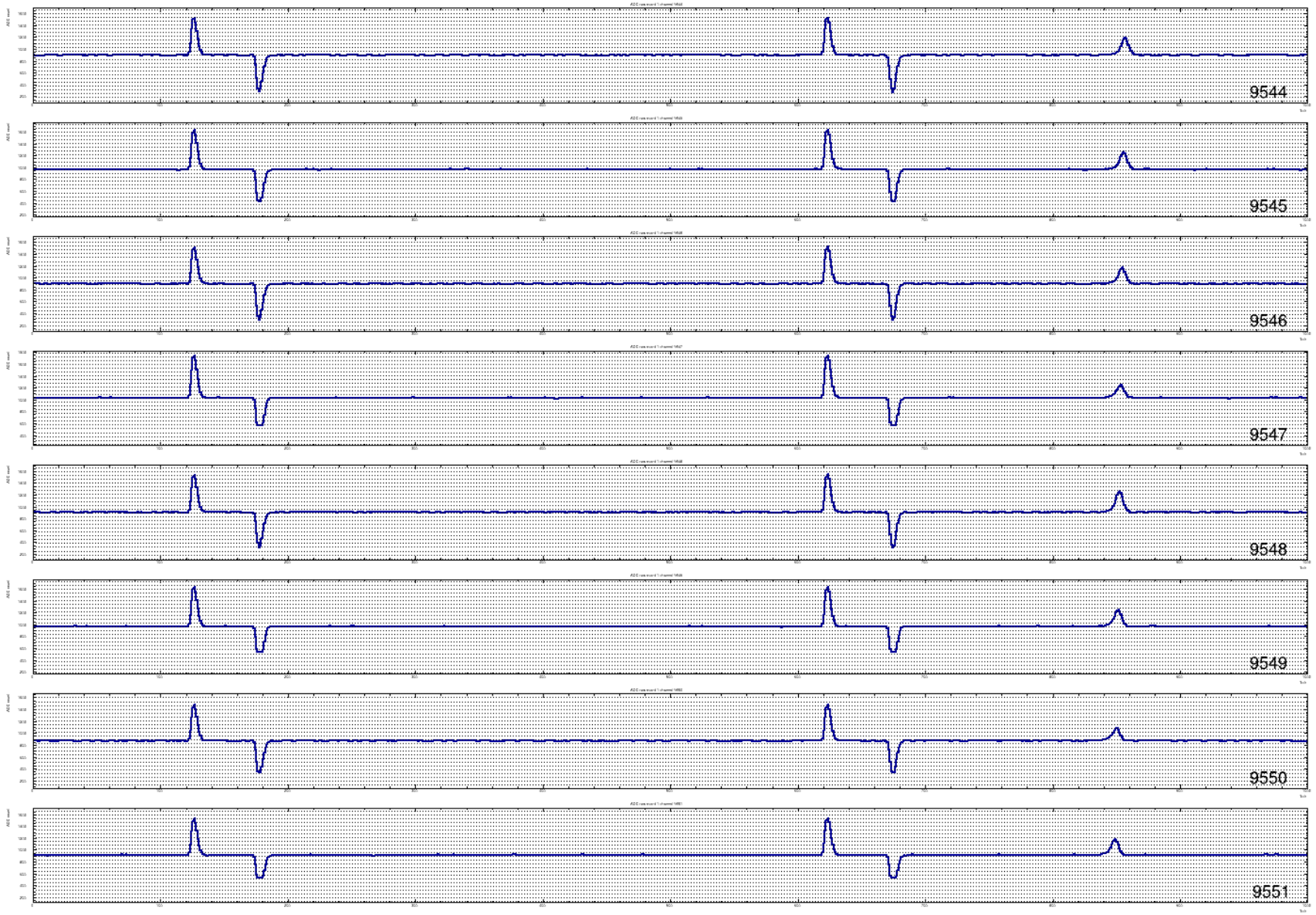
DAC=8



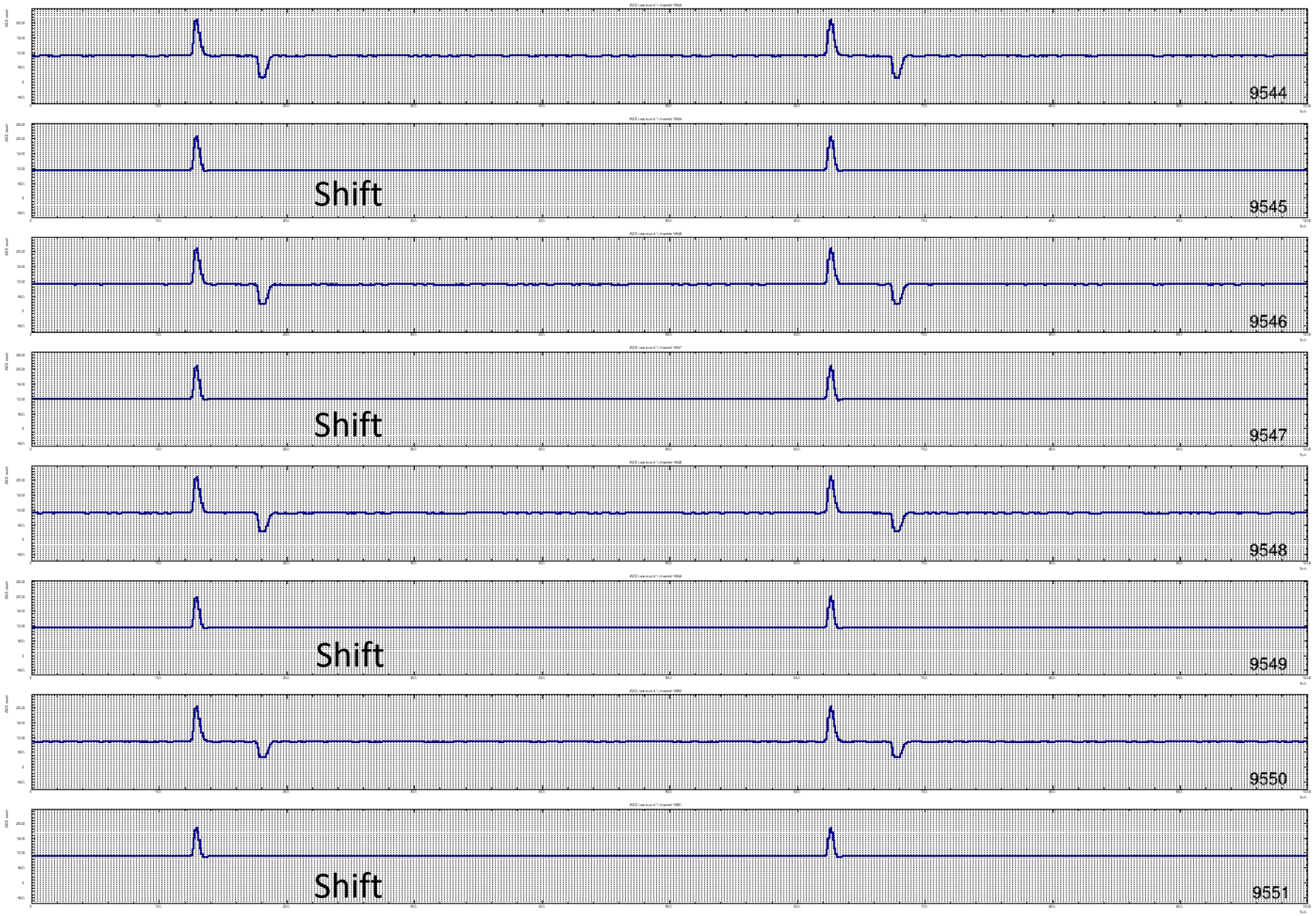
DAC=4


9544
Shift
9545
9546
Shift
9547
9548
Shift
9549
9550
Shift
9551

DAC=4 10572

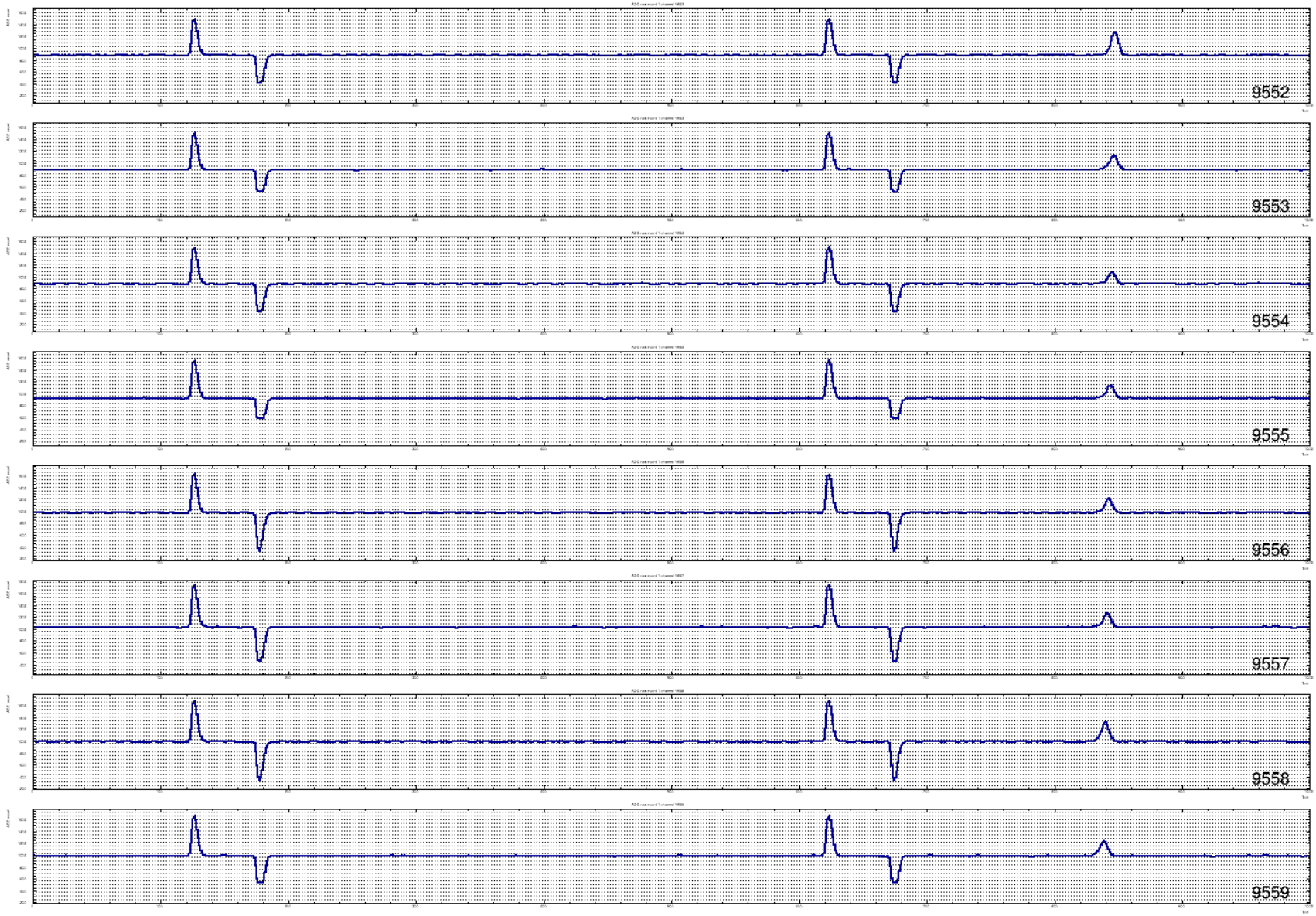


DAC=8

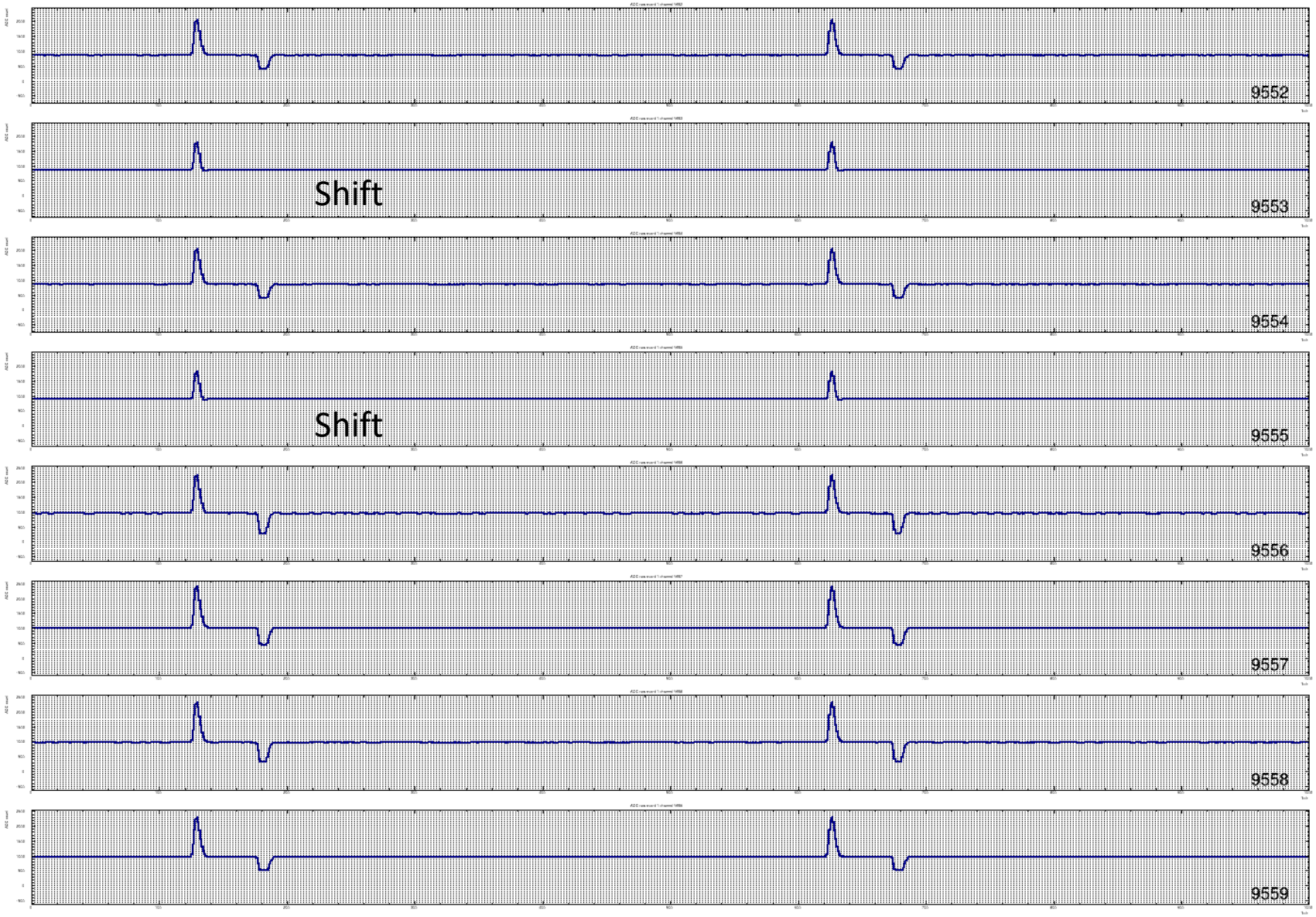

9544
Shift
9545
9546
Shift
9547
9548
Shift
9549
9550
Shift
9551

DAC=4

DAC=4 10572



DAC=8



Comments on waveforms

Initial pulser data showed

- 19 channels with bad waveforms
  - Apparent shifts in all collection channels for 3 ASICs (18 channels)
  - Plus more complicated problem for 1 channel

New data

- Only one pulser setting (DAC=4)
- 12 channels (2 shifted ASICs now look OK)
- 7 channels (FEMB 514) remain bad

Next

- Try again?
- “Reset” the FEMB?
- Then retake calibration data???