ProtoDUNE TPC data: Tail removal and pedestal variation

ProtoDUNE sim/reco

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Introduction

Contents

- Pedestal requirement
- New tool for tail removal
- Start to look at pedestal variation

Pedestal requirement

Pedestal requirement

Calibration was done with default preamp settings

- I.e. gain = 14 mV/fC, shaping = 2.0 µs
- Result: average (area) response is 40 (ADC count)/ke
- ➔ 25 e/(ADC count)
- Consistent with back-of-the-envelope calculation:
  - 1/6 (3 (ADC count)/mV) (14 mV/fC) (6.2 ke/fC)

Effect of pedestal shift on charge measurement

- To get charge integrate over ~40 ticks
- Pedestal shift of 1 ADC count → ΔQ = 1000 e
- Pulser studies showed charge resolution is about 1000 e
  - And included noise from pulser
- We would like to know pedestal to much better than 1 ADC count
  - I.e. much better than 25 e
  - This requirement is for collection planes

New tool for tail removal

ExpTailRemover

New tool: ExpTailRemover

- Same goal as existing tool UndershootCorr
- Assume signals are followed by tails with 1 ms decay
- Fit each channel in event to find pedestal offset and initial charge
  - Fit uses ticks that are not part of “signals”
- Subtract tail from data

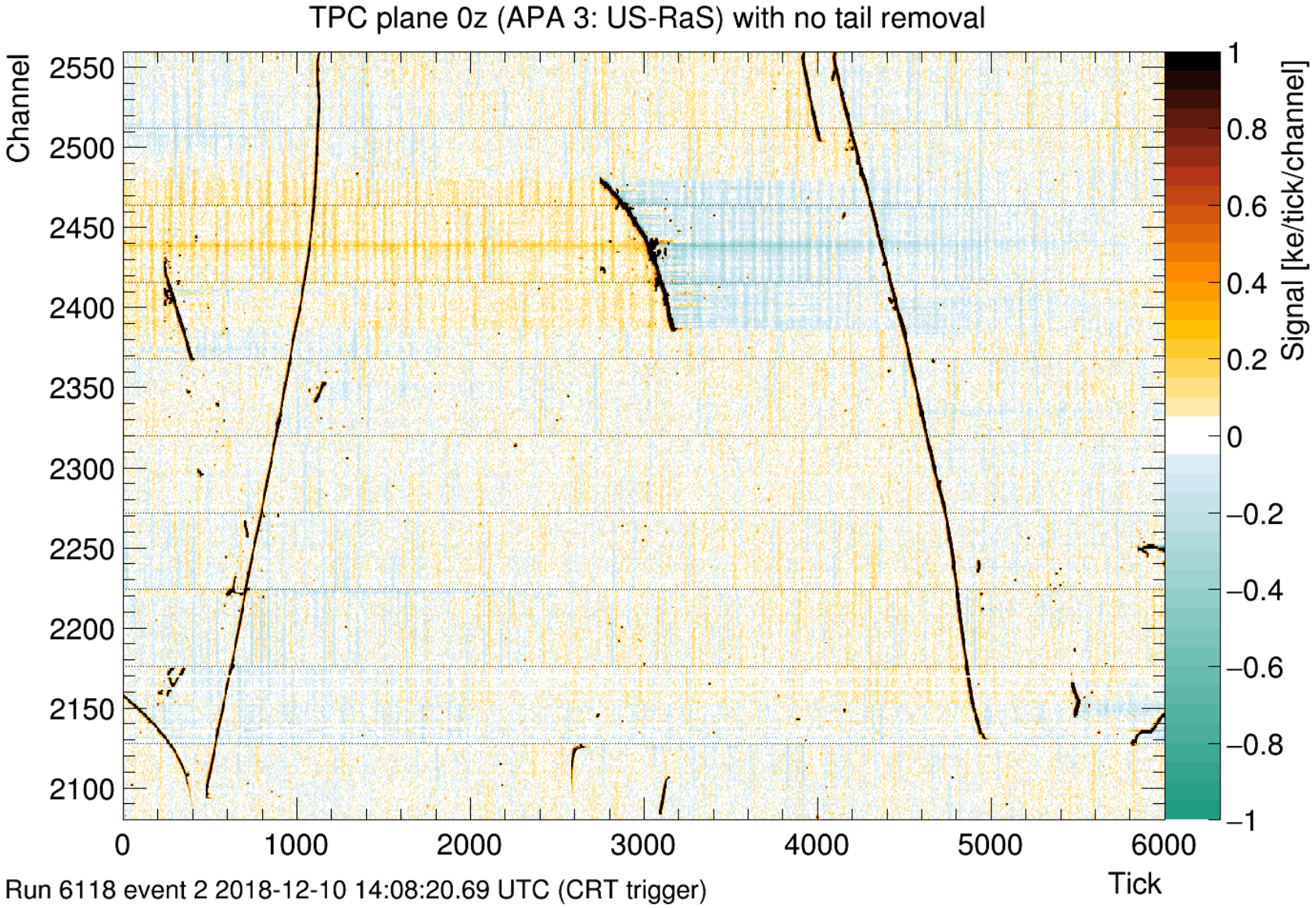
Differences in the new tool

- Can change the decay time without retuning fit params
- Signal identified with tool instead of simple threshold
  - In practice, also cut out (-10, +20) channels around above threshold
- Tail in new tool cancels the signal (area)
  - Old has a param whose chosen value is close to doing that
- New tool has flags for all four planes instead of {u, v, coll}

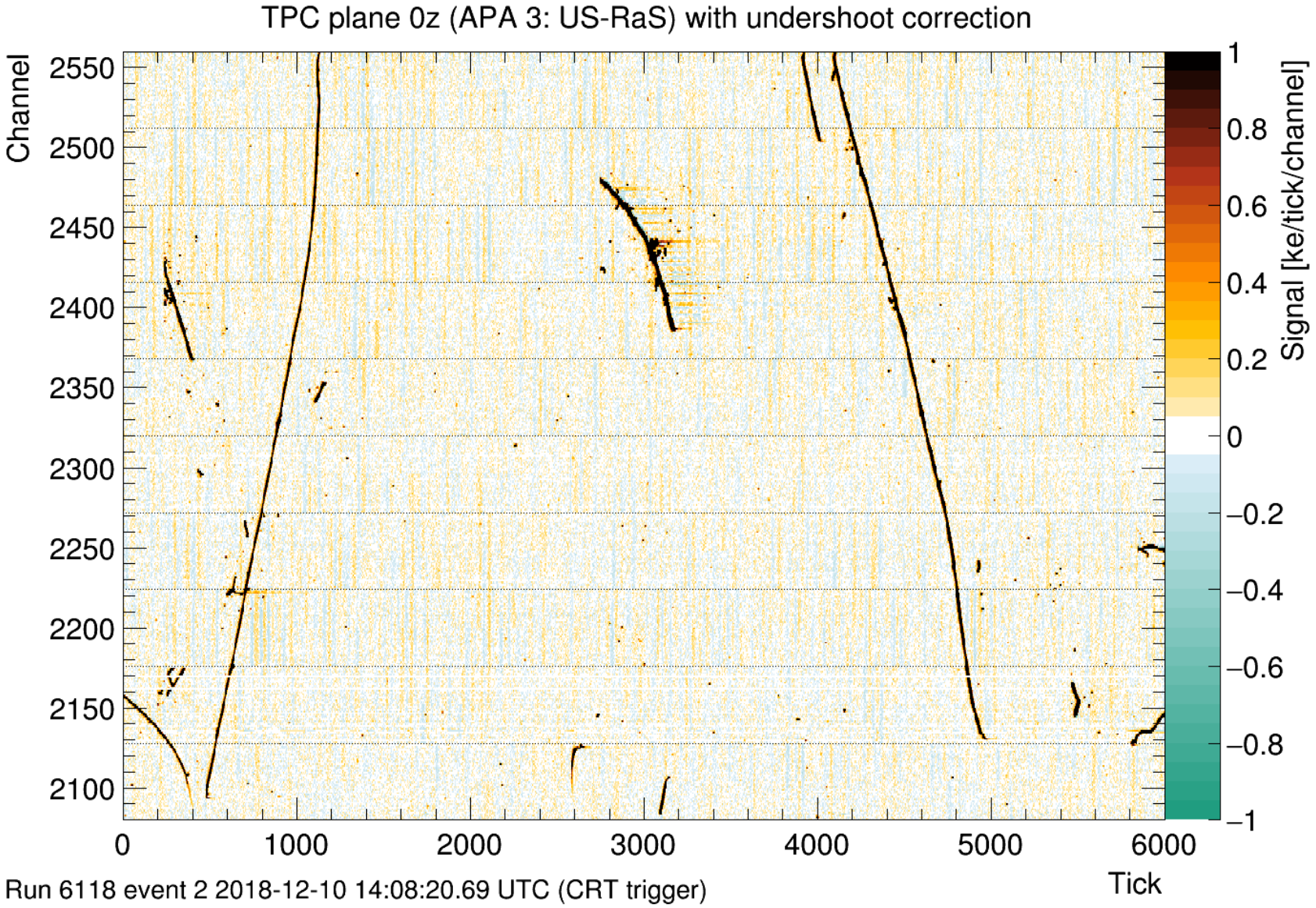
Described in DUNE-doc-14203

- Figures from that note follow

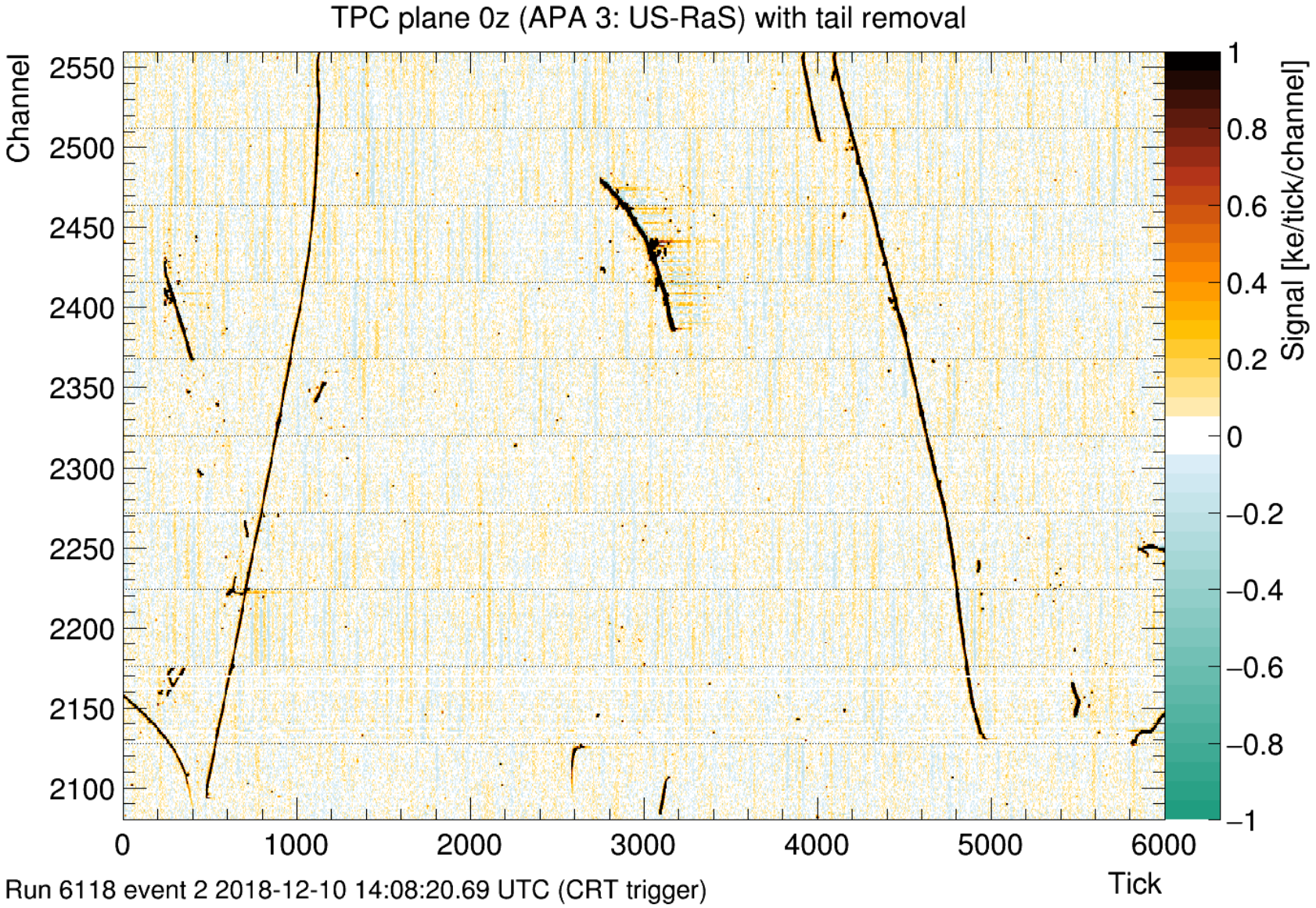
Uncorrected



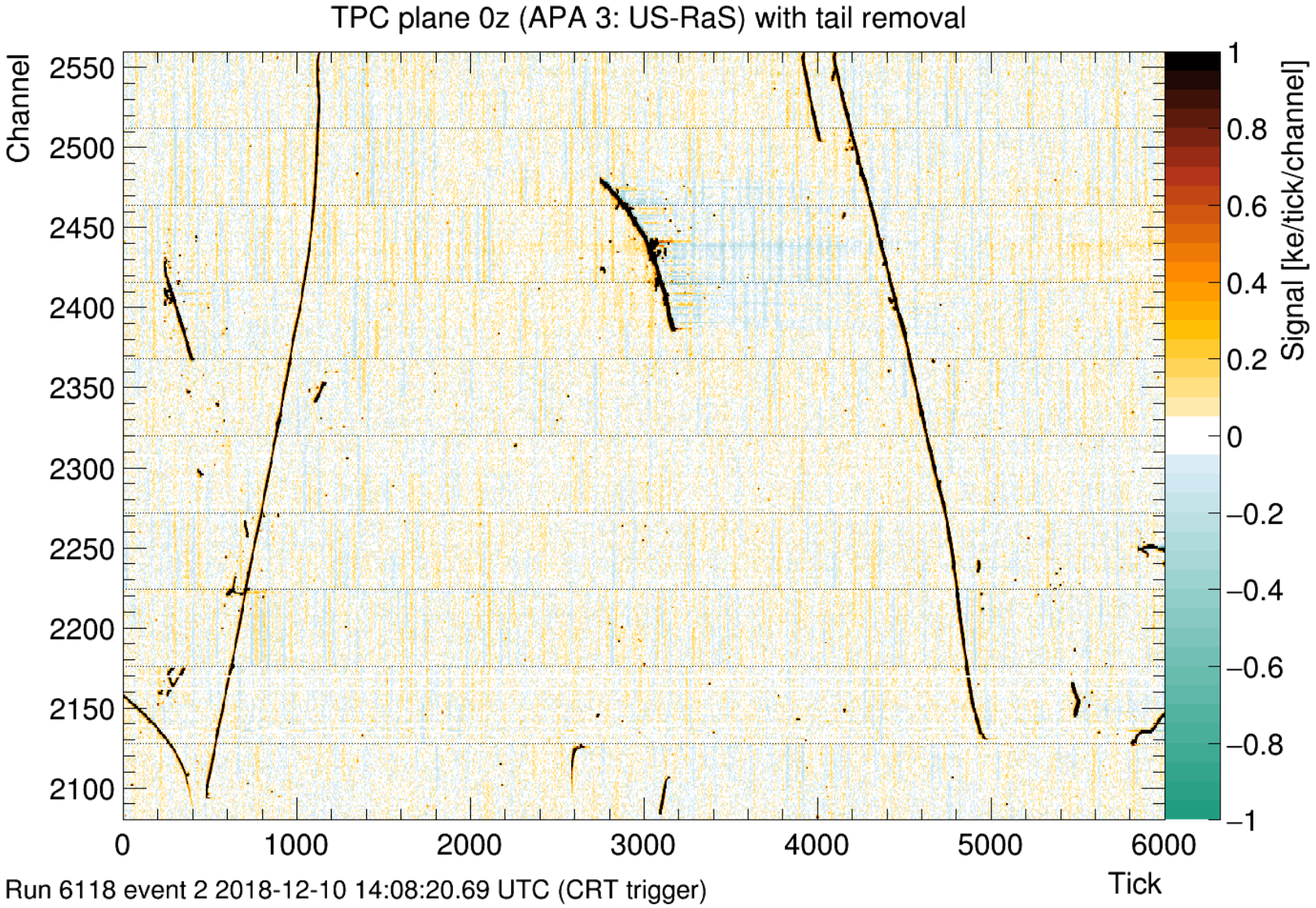
Old correction



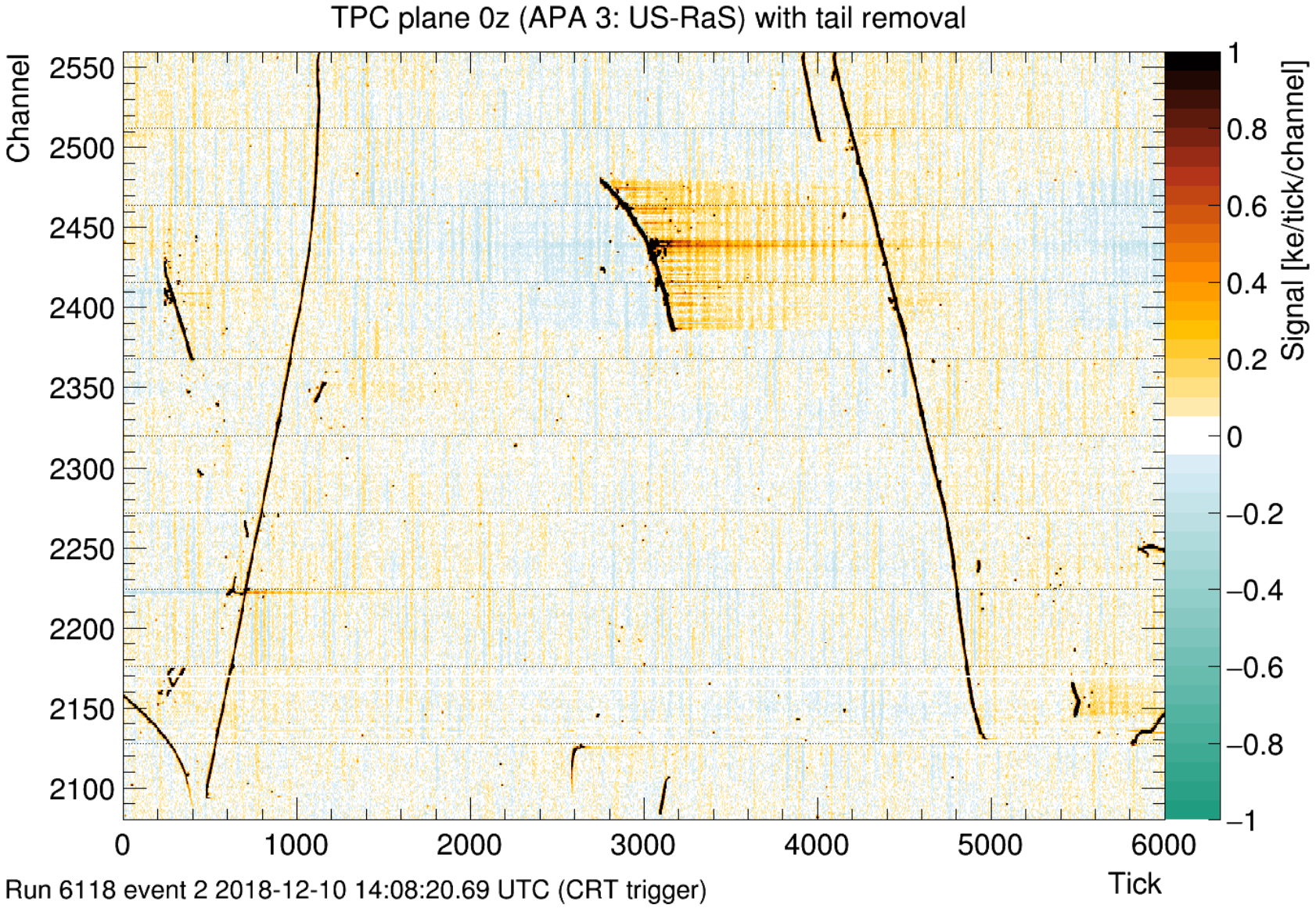
New correction (1 ms decay time)



New correction with 2 ms decay time



New correction with 0.5 ms correction



Comment on tail remover

New tool looks good

- Performance similar to existing tool for 1 ms decay time
- Adds possibility to study other decay times
- Adds signal identification tool and more
- See following for more performance comparison
- Should we switch reco to this tool?

Tool-based dataprep (advertisement)

- Some of the motivations for the tool-based dataprep
  - Easy to try out new code without touching old code
  - Easy to swap out and compare tools that have similar functionality
  - Final fcl configuration does not carry extra complexity of unused tools
  - Hierarchical configuration is easier to comprehend
- Development of the tail remover benefitted from these

Pedestal variation

Pedestal

Reco needs a pedestal for each channel each event

We have a few ways to evaluate pedestals

- Decoder uses the median value
  - Recently updated to have precision better than one ADC count
- AdcPedestalFitter
  - Described in detail at earlier meetings
  - Gaussian fit of pedestal peak after removing possible sticky-code spike
- Tail removal tools include fit of offset to input pedestal
- Might remove DC component in deconvolution

Current reco

- Decoder value is replaced with pedestal from AdcPedestalFitter
- Tail removal effectively offsets that value (after calibration)

Future reco

- How best to evaluate pedestal for reco?
- Could/should we use a fixed (or run) value for each channel?

Pedestal variation

Metric for pedestal event-to-event variation

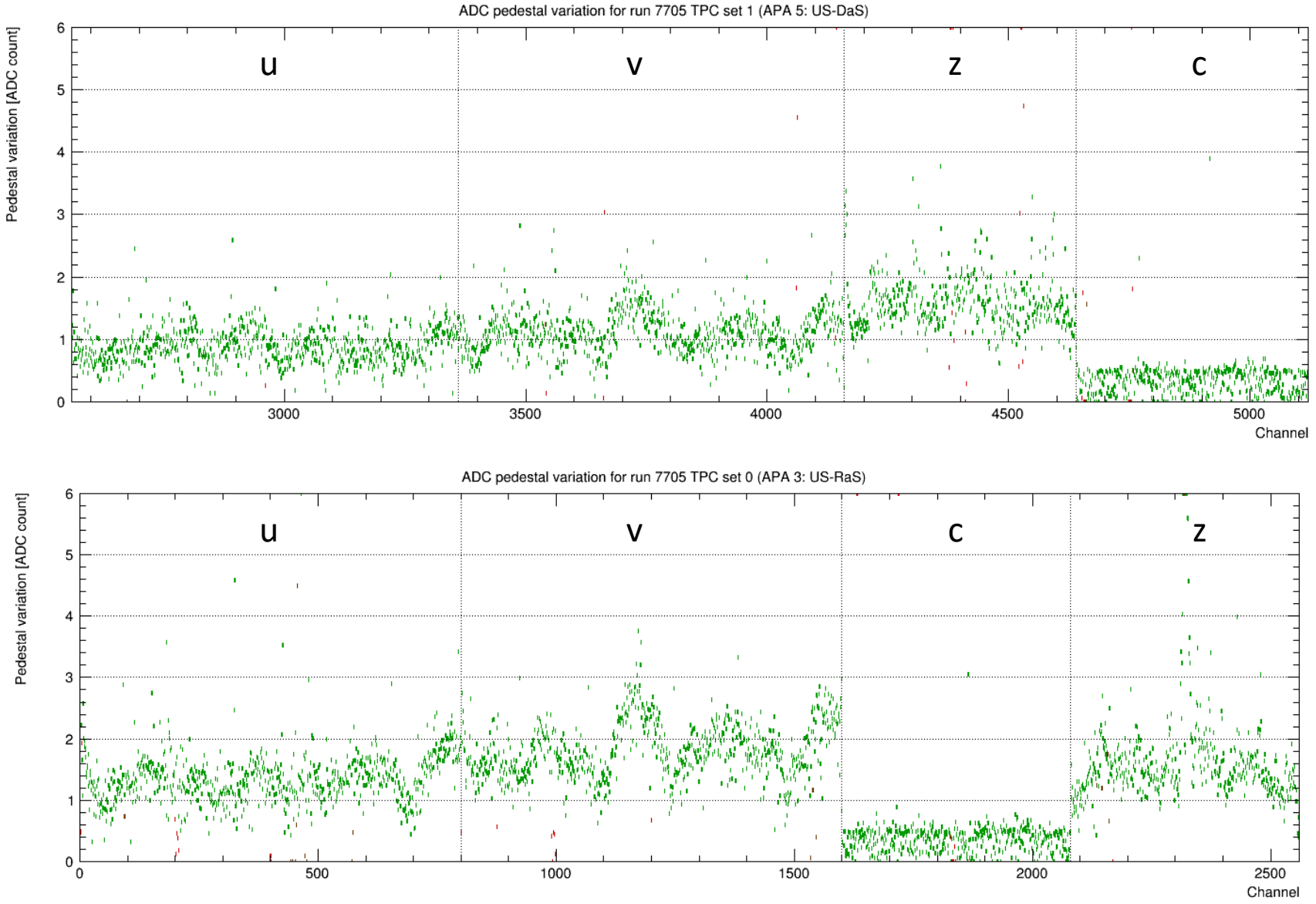
- RMS of the evaluated pedestal for N (e.g. 200) events
- If this is small (and the true variation), we can use a fixed pedestal
- If not, there is a problem with the pedestal evaluation or the pedestal is really changing from event to event
- Note: Each channel has its own pedestal and its own variation

Plots

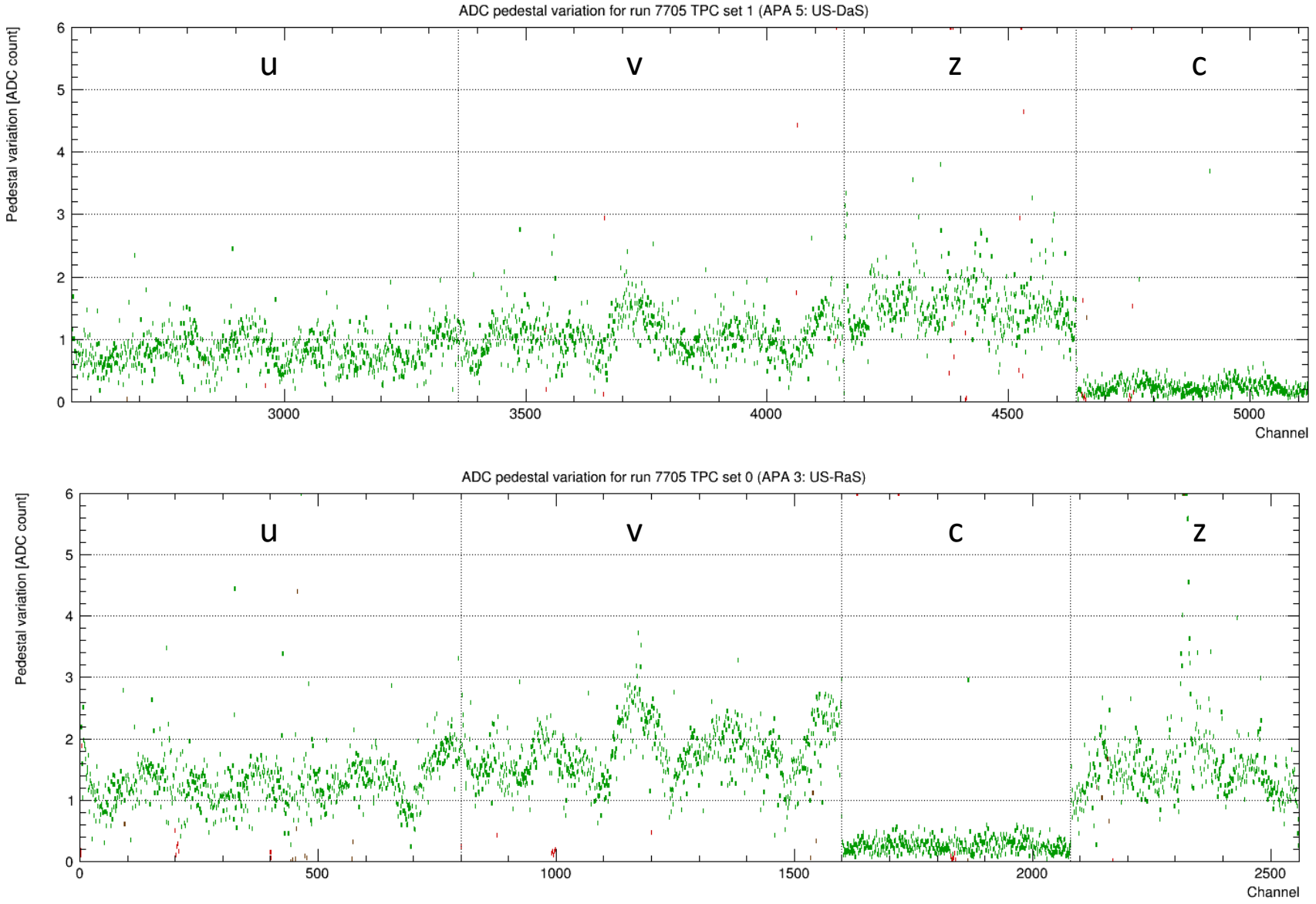
- Following pages show pedestal variation vs. channel
  - Two APAs on a page (top = beam left, bottom = right)
- For various pedestal evaluation algorithms
  - DAQ = median value returned by the decoder
  - Fit = Value from AdcPedestalFitter
  - USC = Value from the UndershootCorr tool
  - ETR = Value from ExpTailRemover

Front APAs

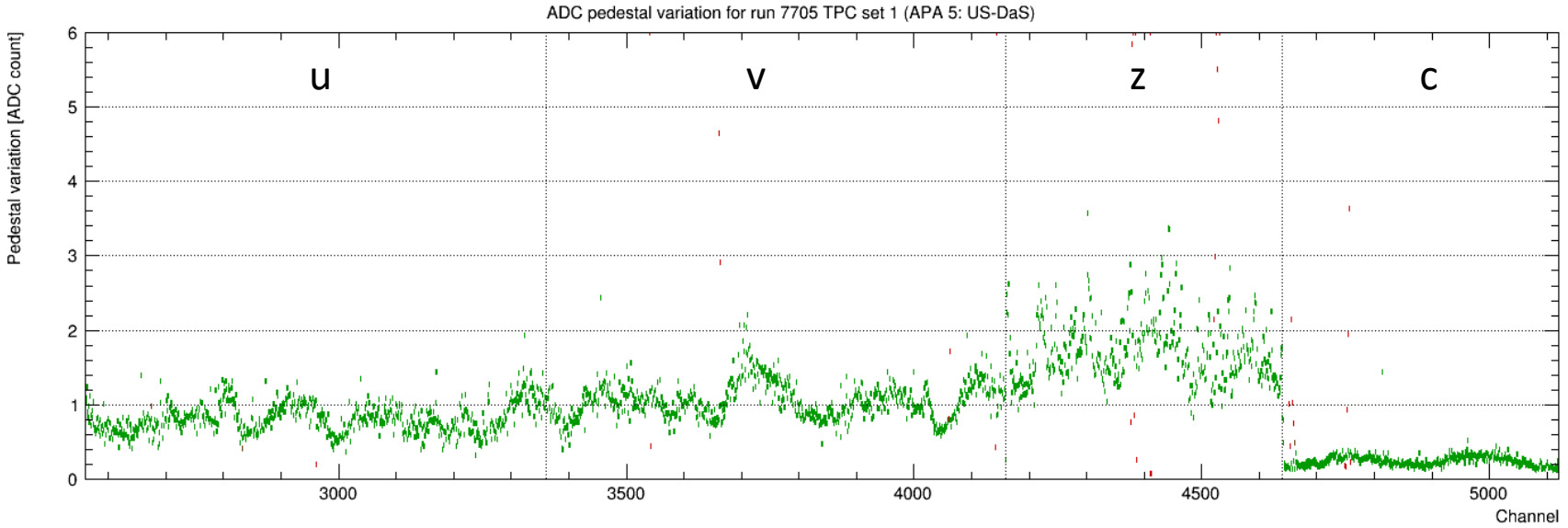
Old DAQ pedestal variation front 200s000

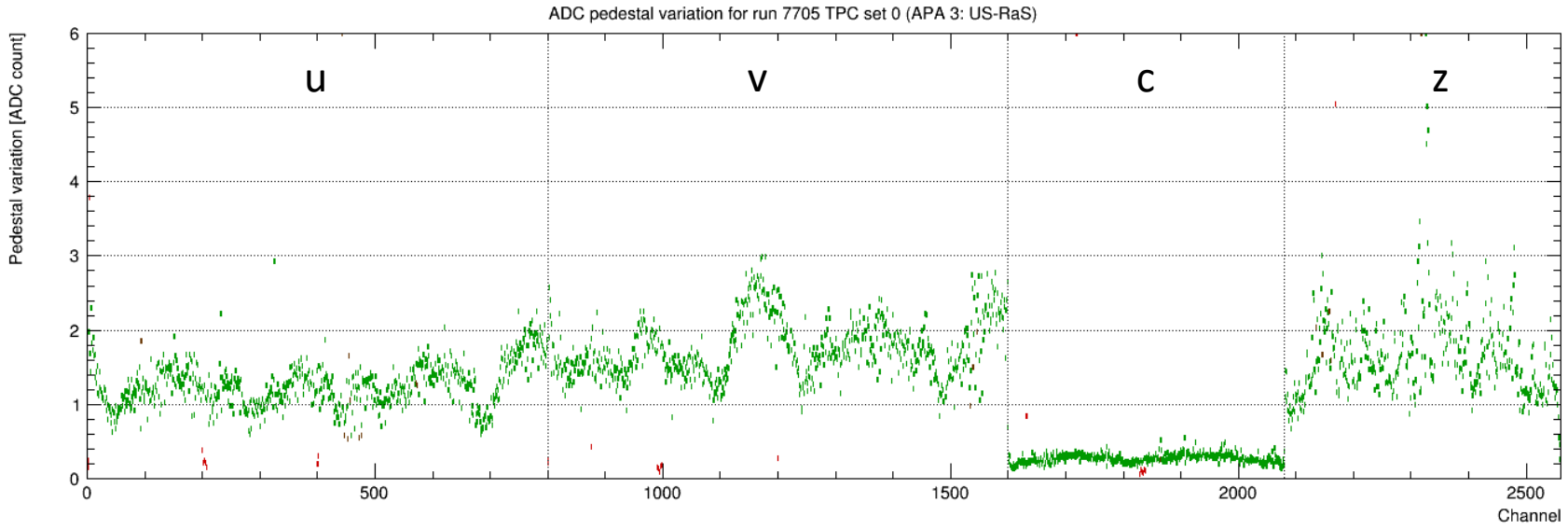


New DAQ pedestal variation front 200s000

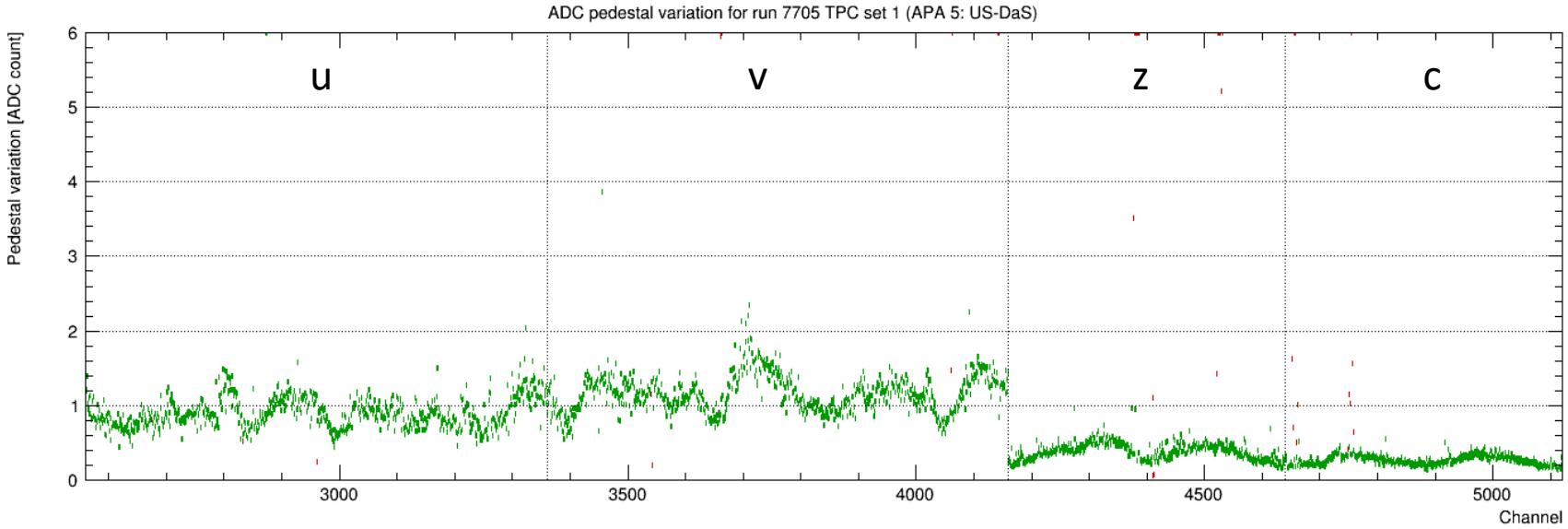


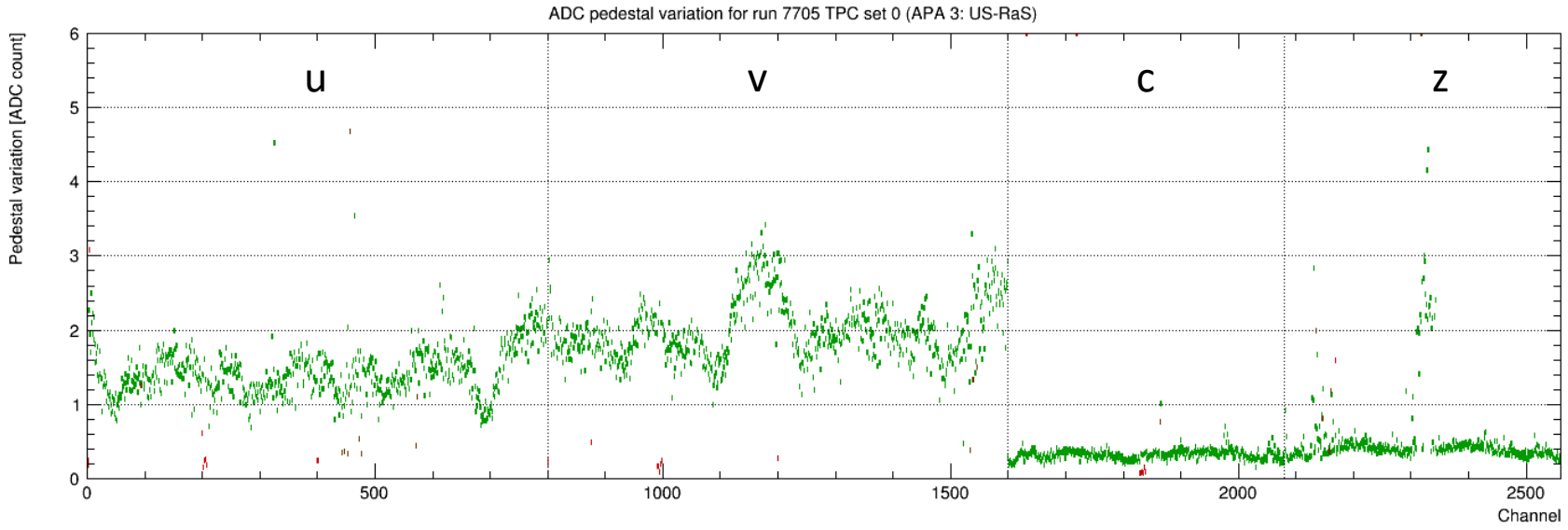
Fit pedestal variation front 200s000



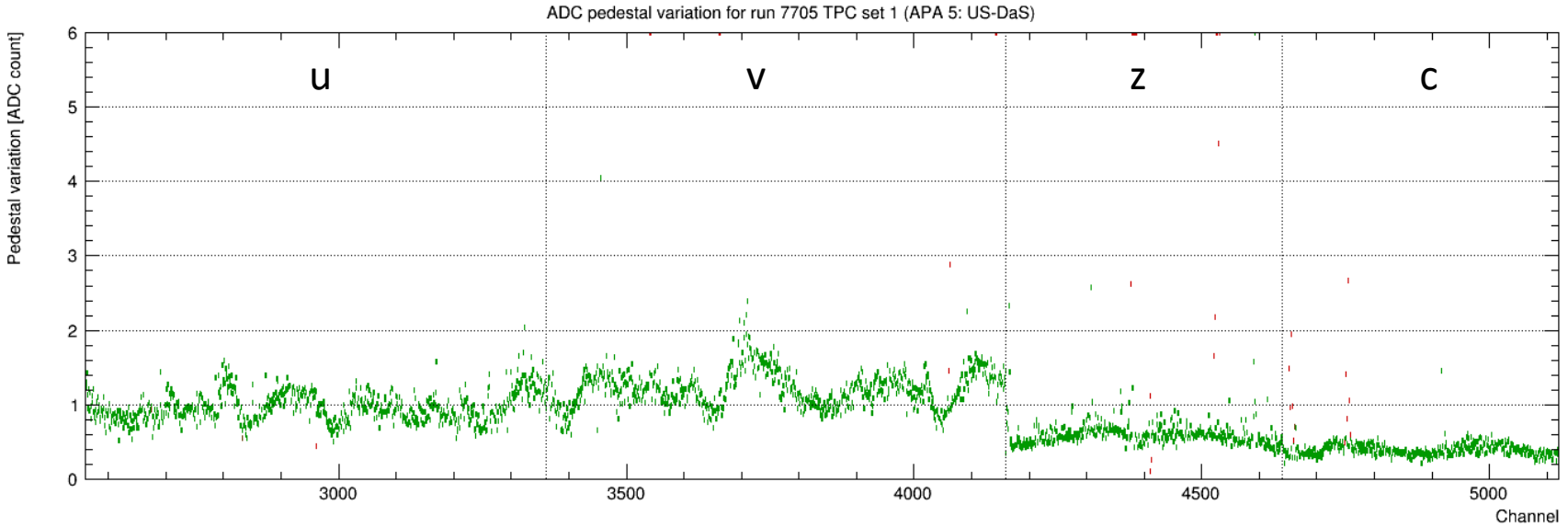


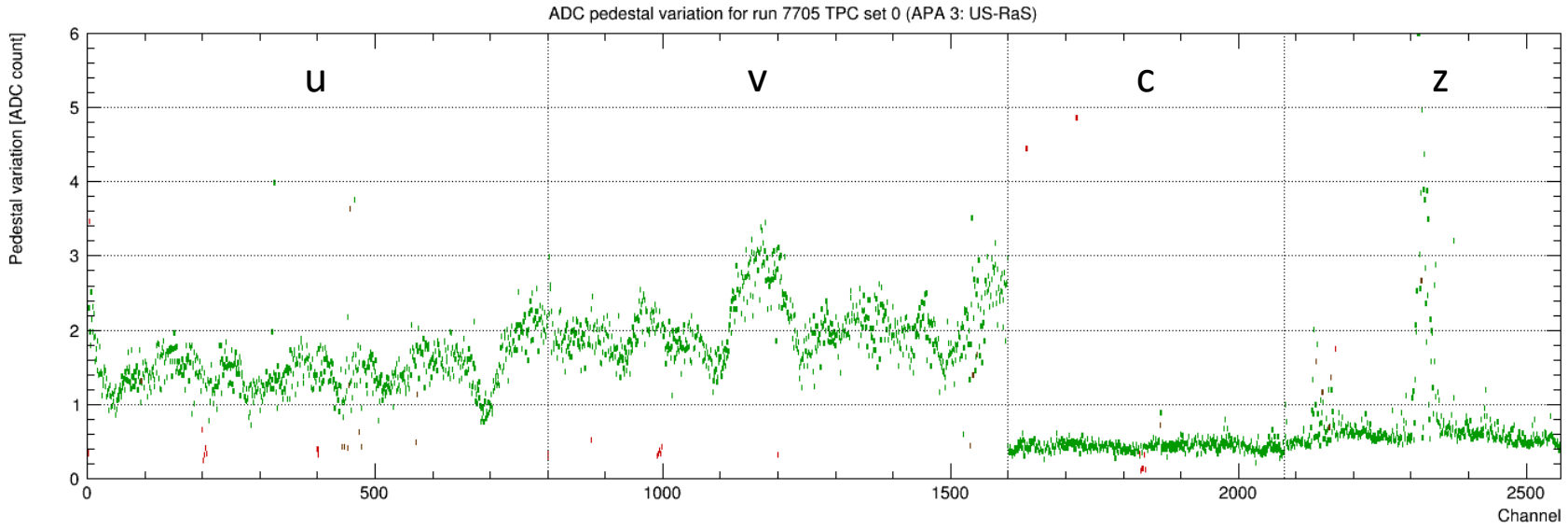
ETR pedestal variation front 200s000





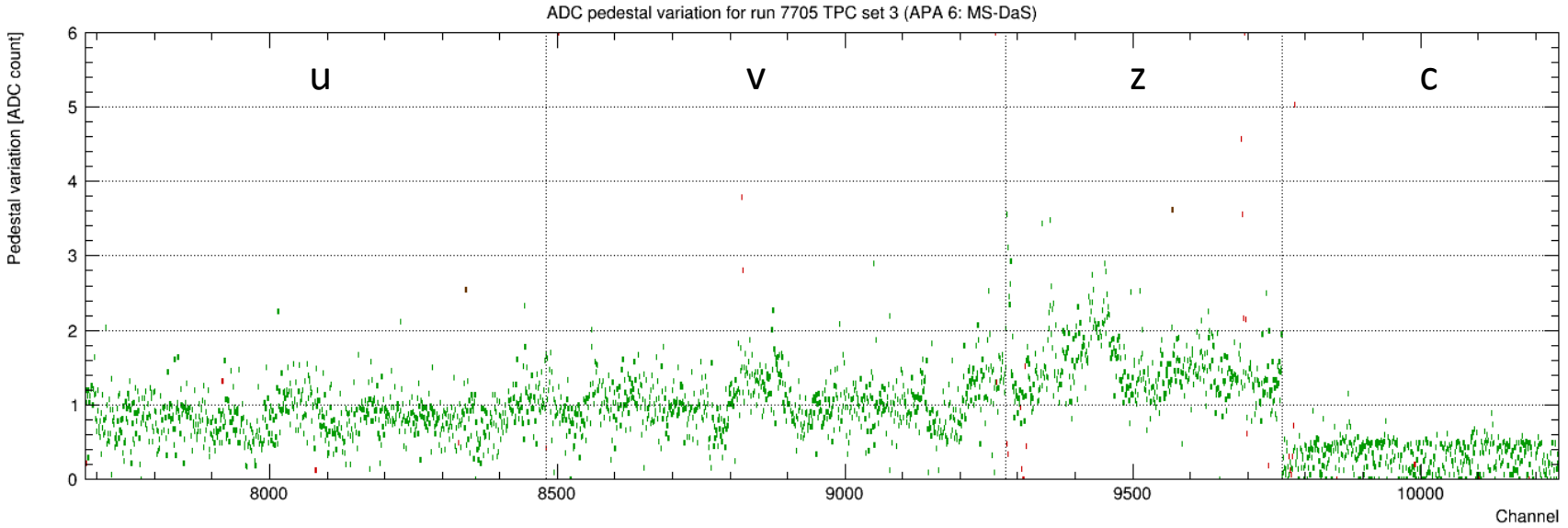
USC pedestal variation front 200s000

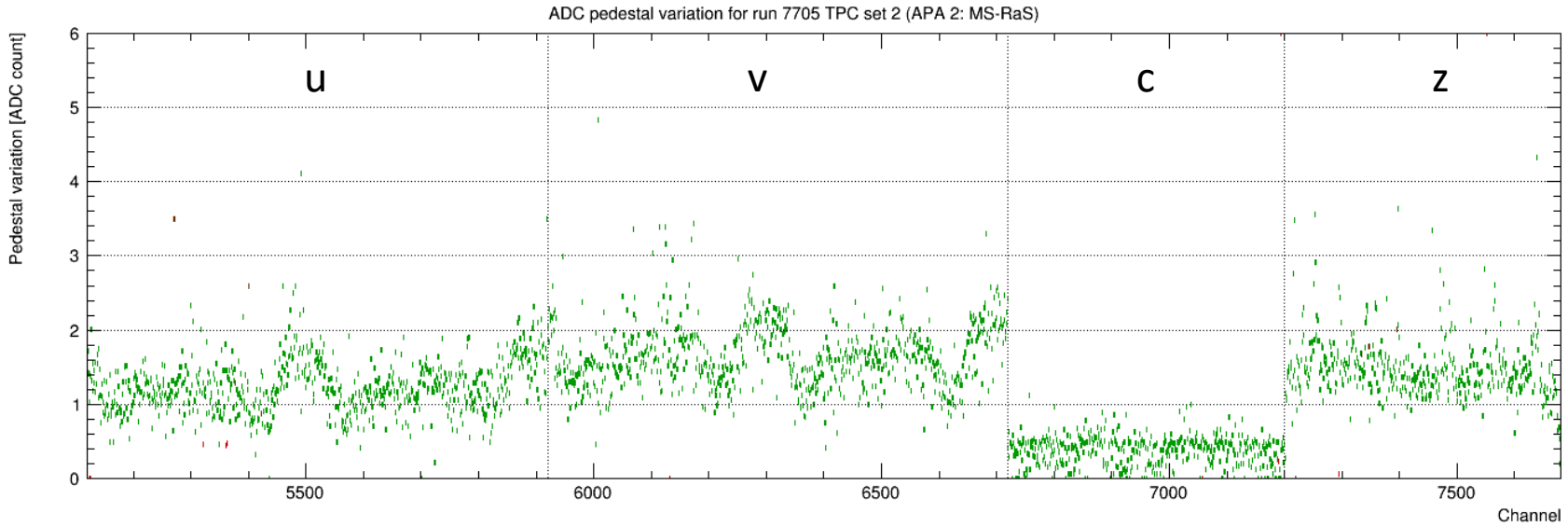




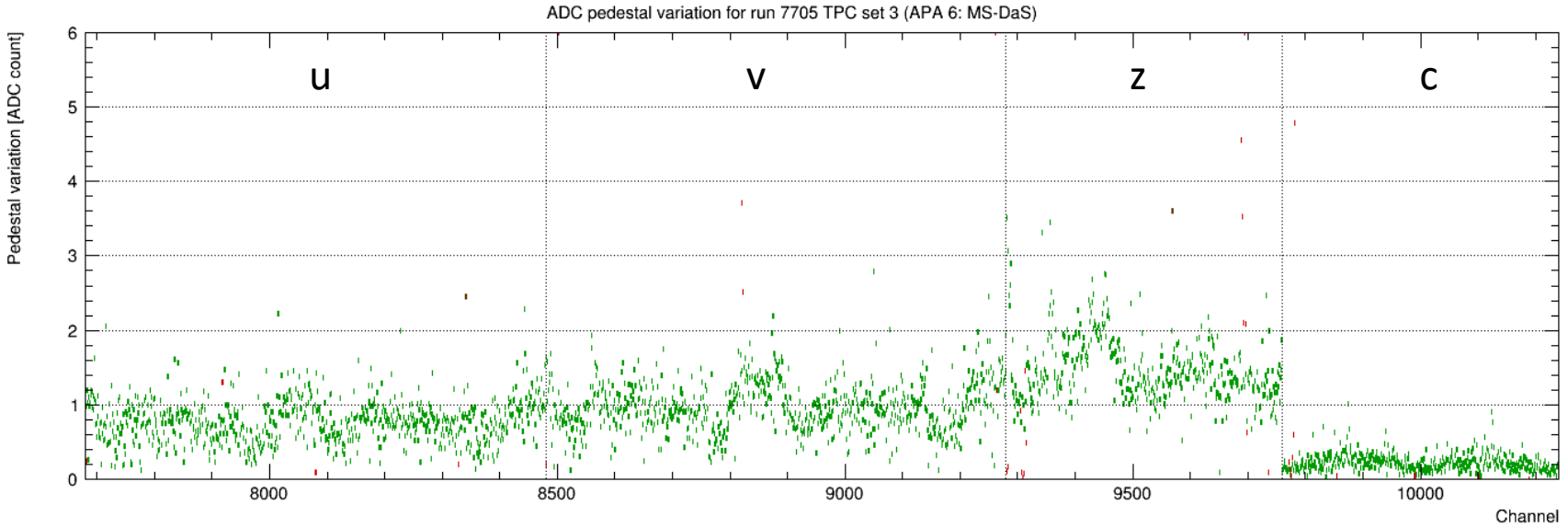
Middle APAs

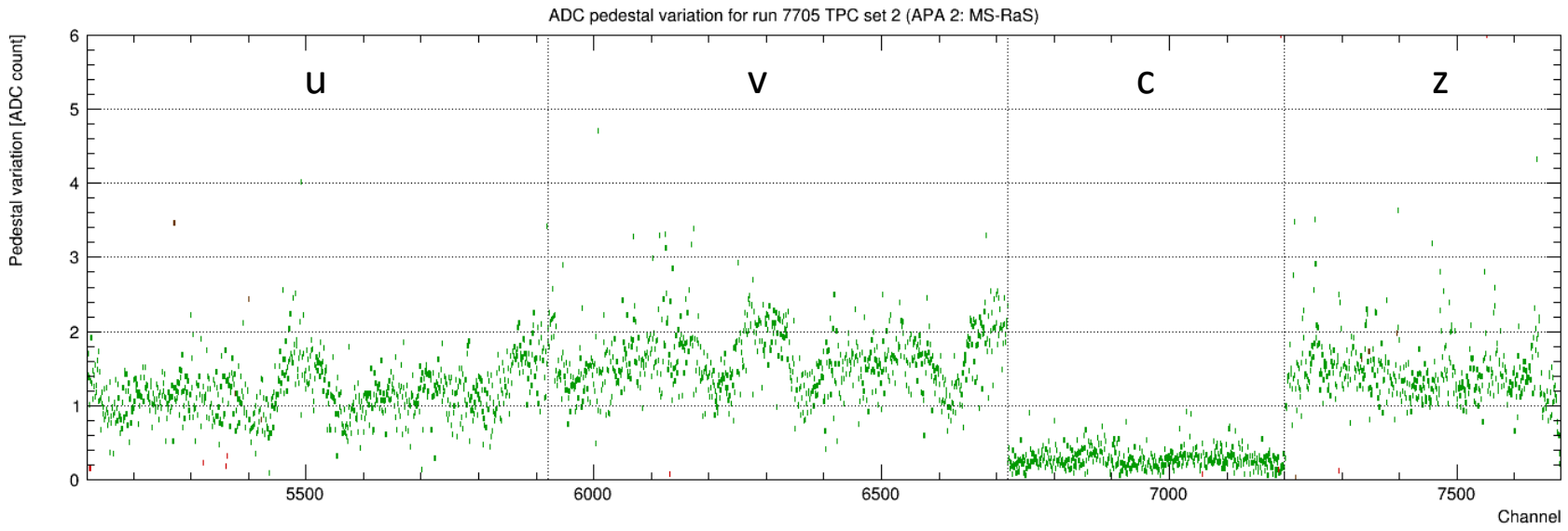
Old DAQ pedestal variation middle 200s000



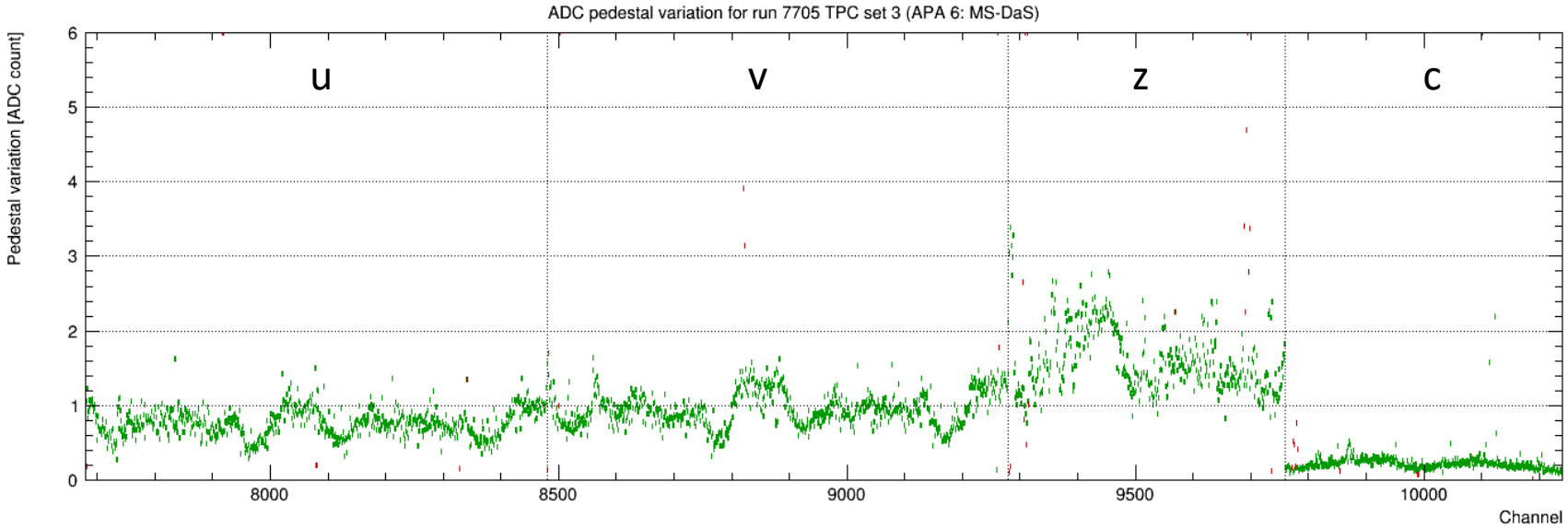


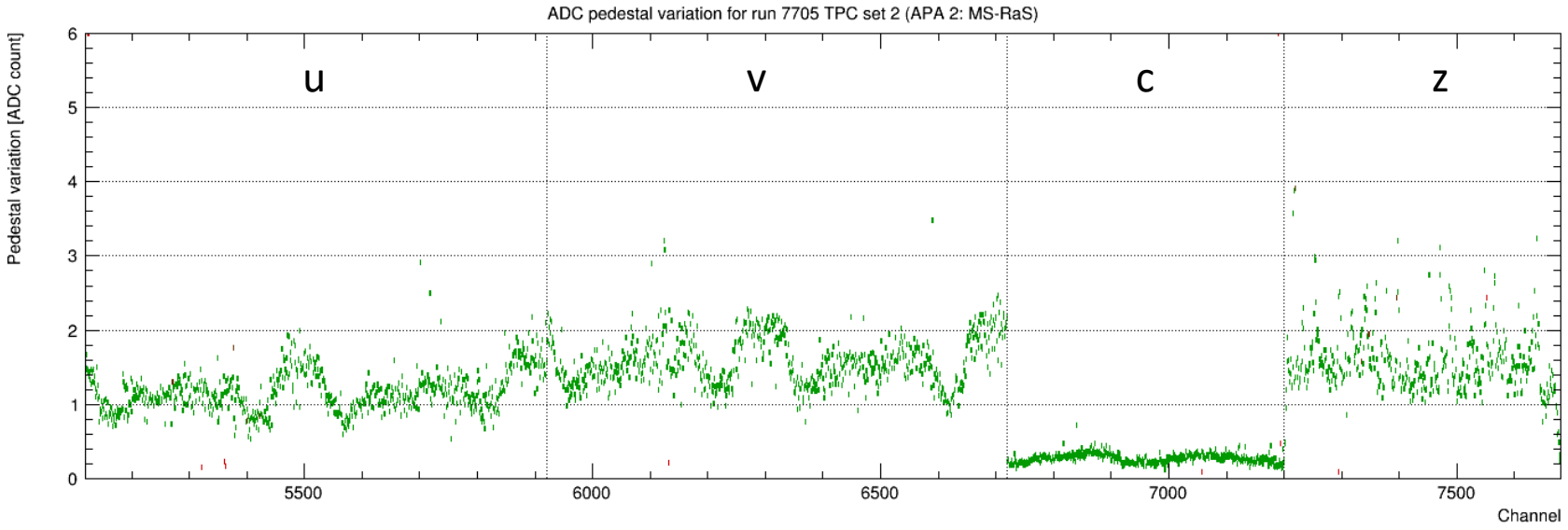
New DAQ pedestal variation middle 200s000



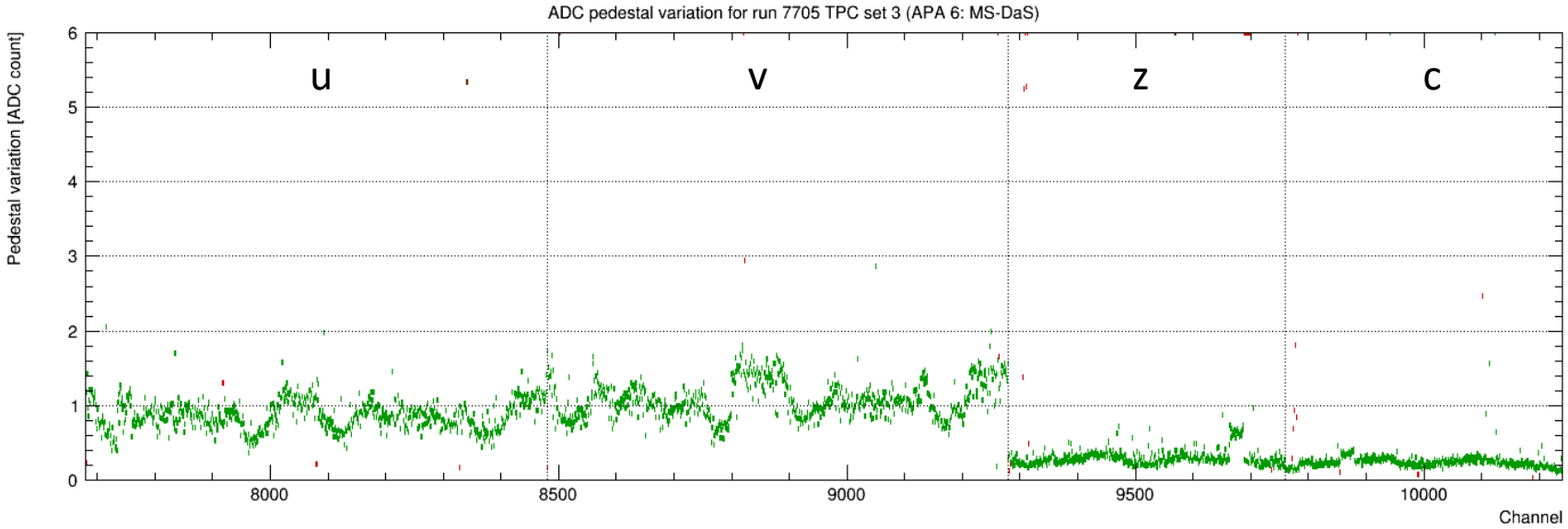


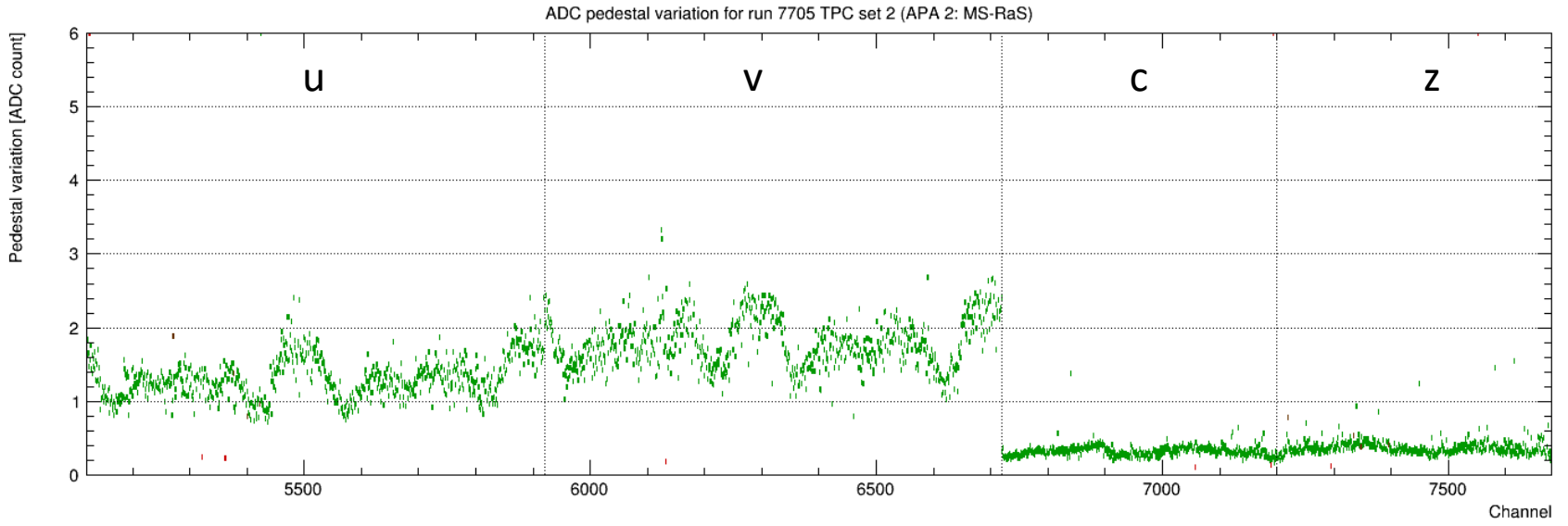
Fit pedestal variation middle 200s000



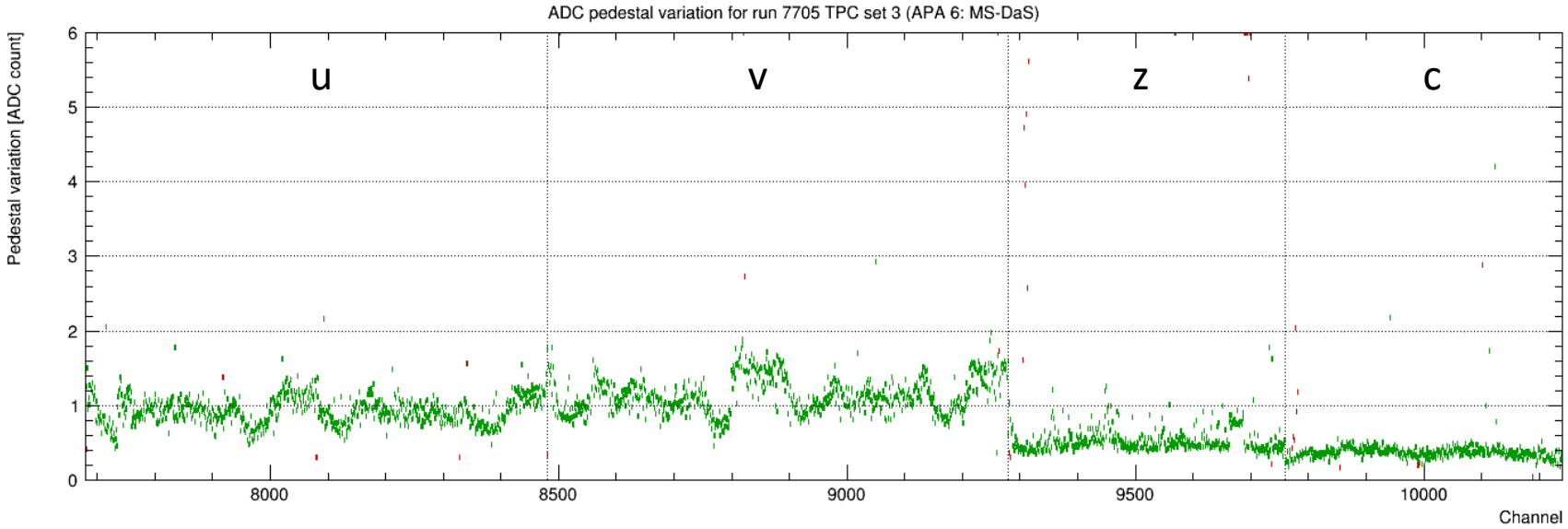


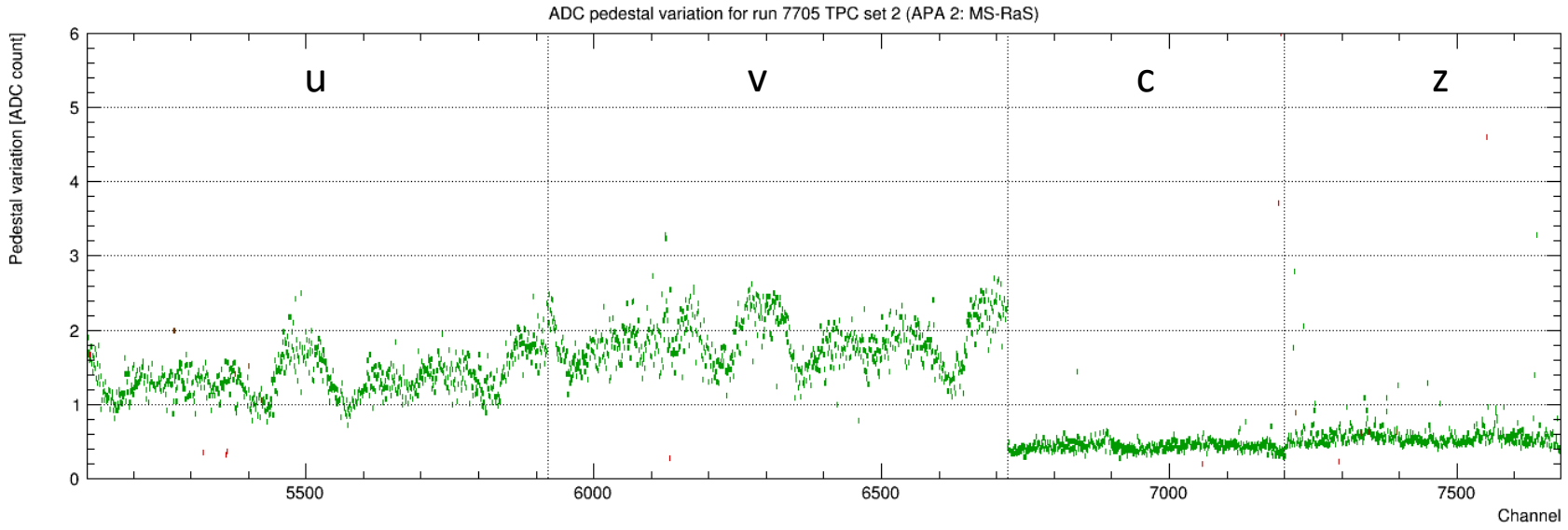
ETR pedestal variation middle 200s000





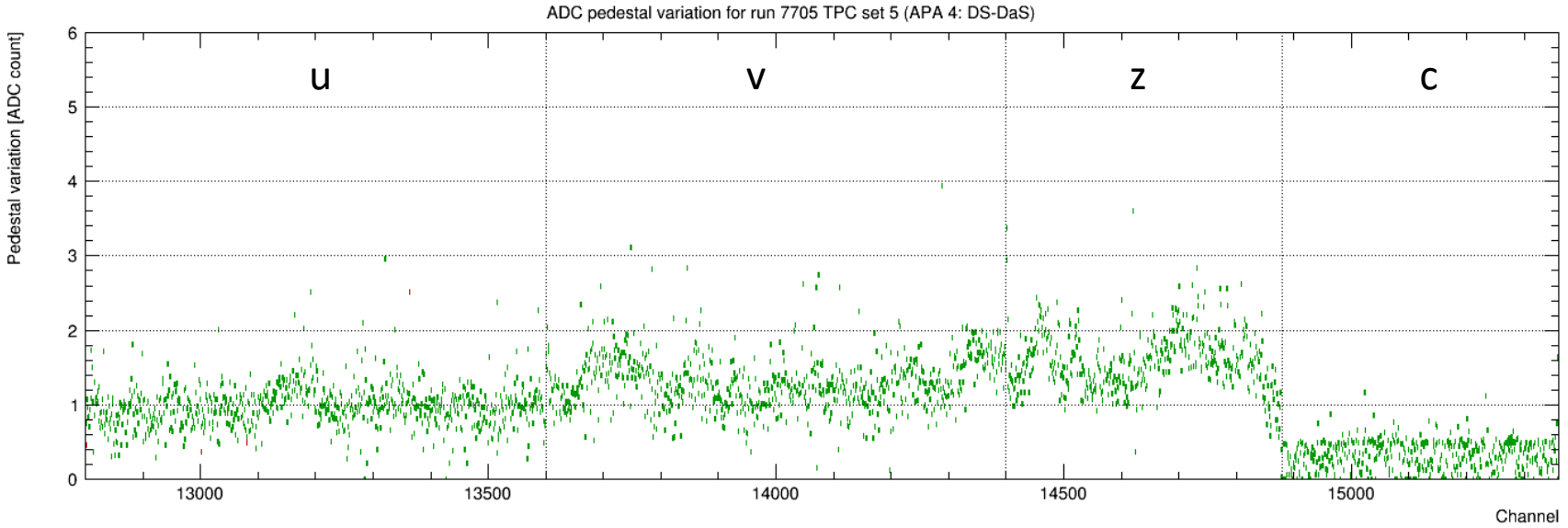
USC pedestal variation middle 200s000

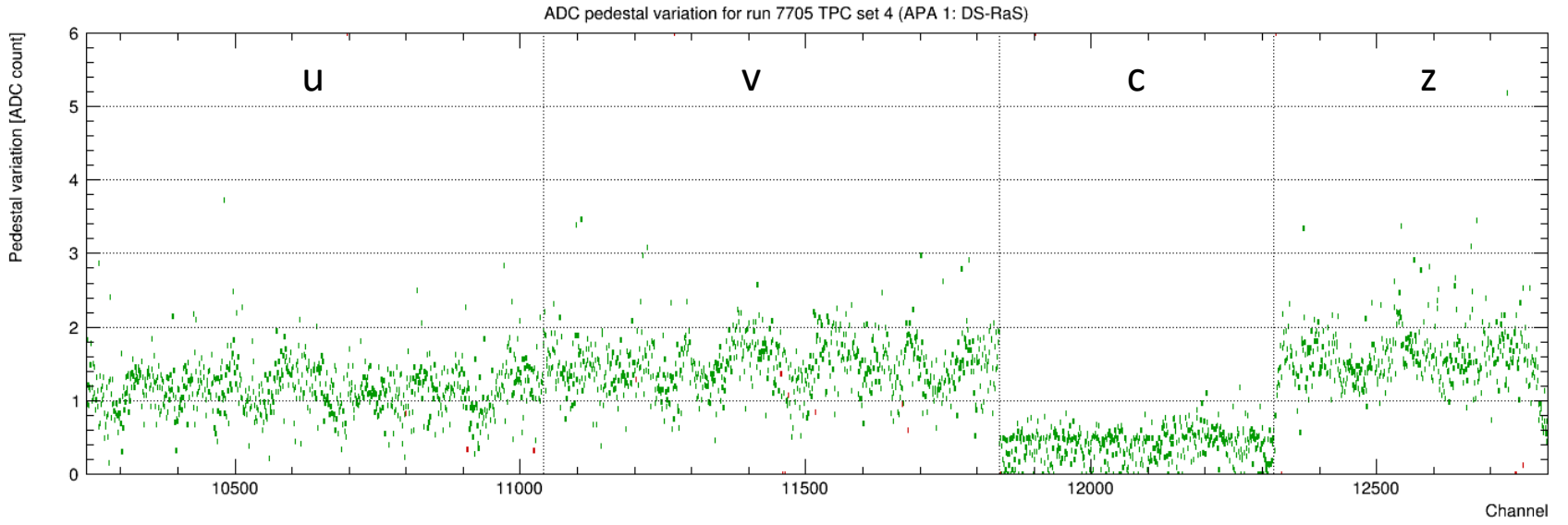




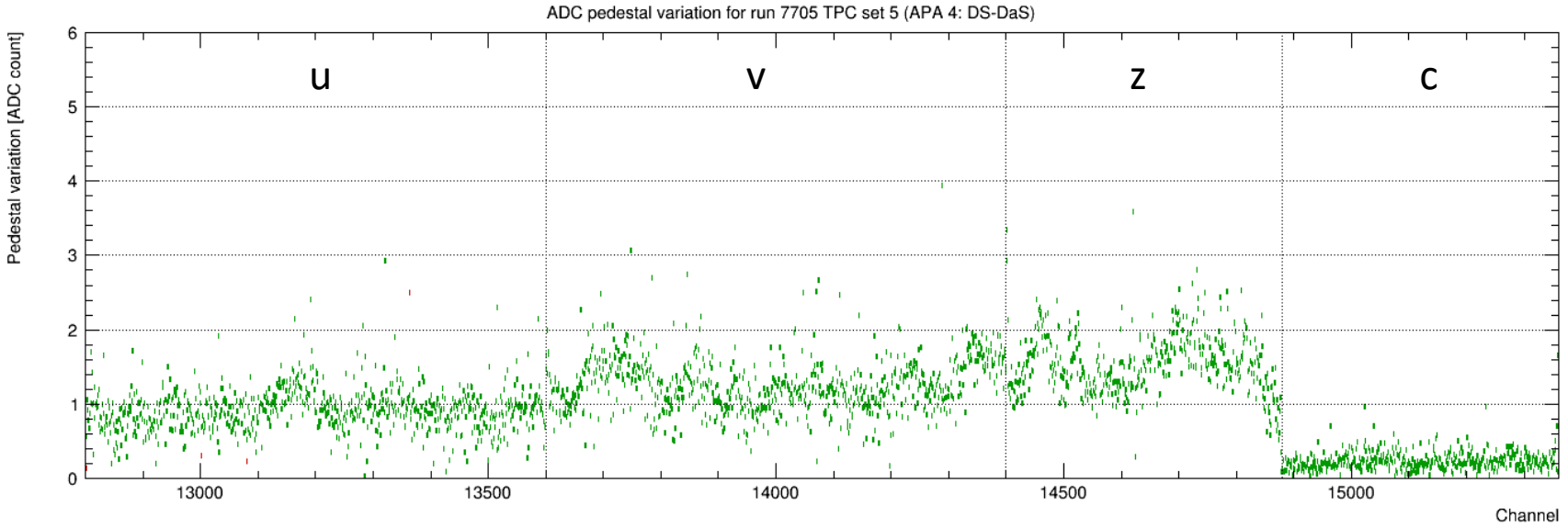
Back APAs

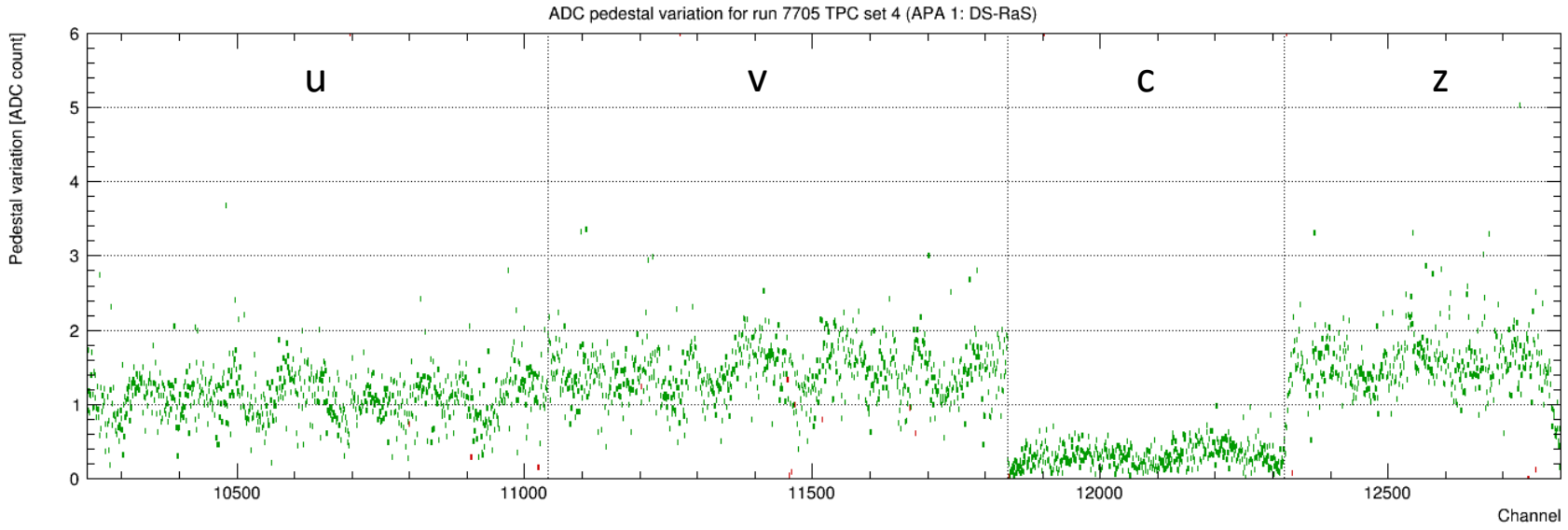
Old DAQ pedestal variation back 200s000



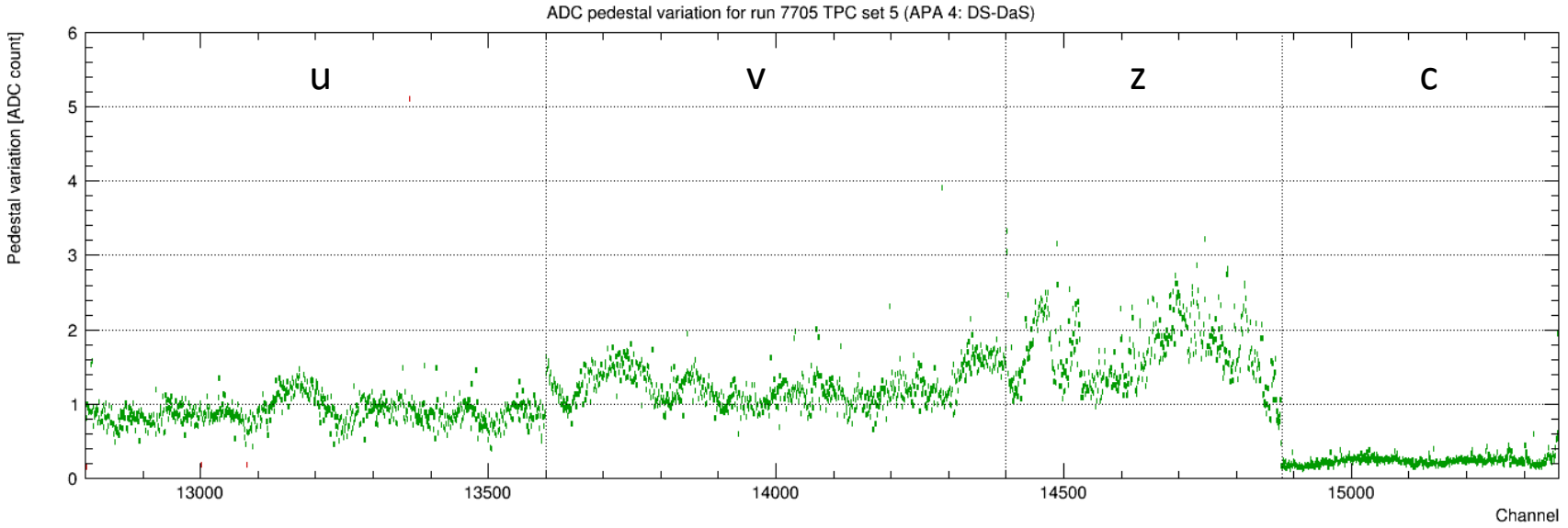


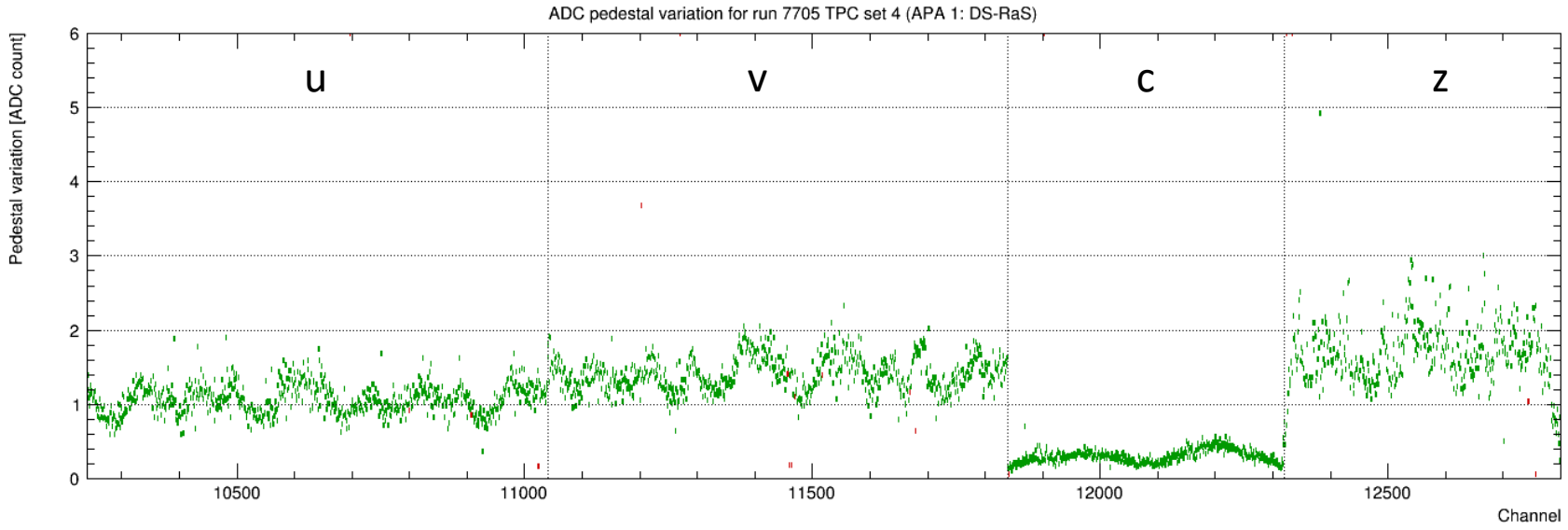
New DAQ pedestal variation back 200s000



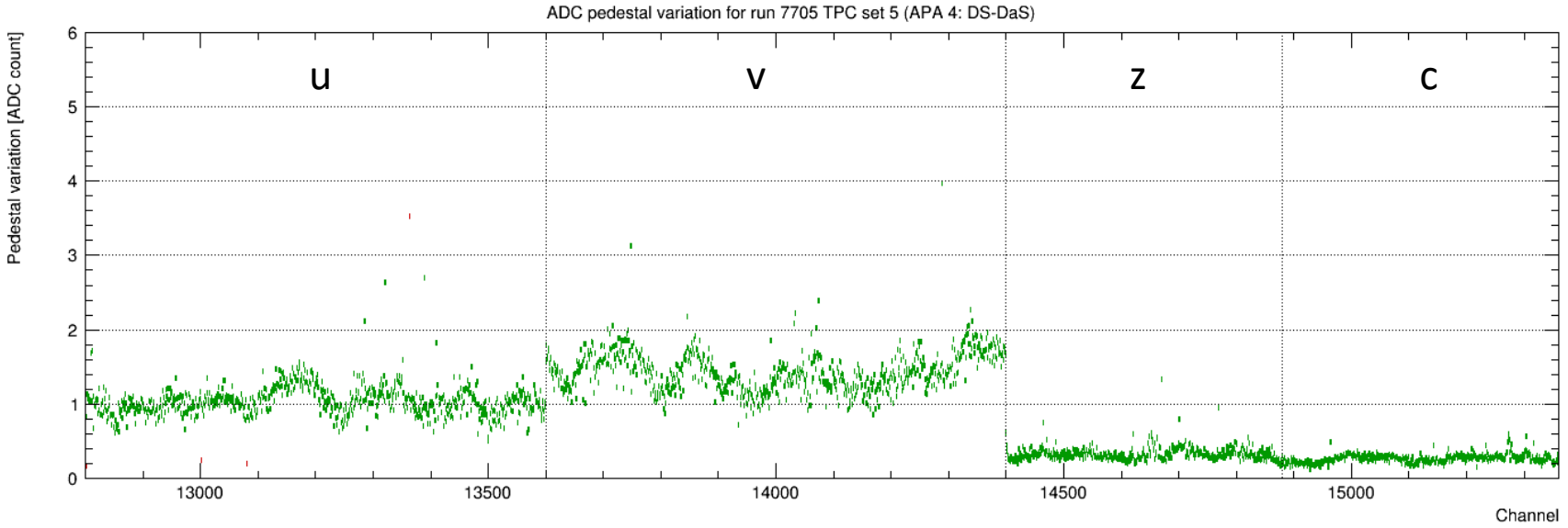


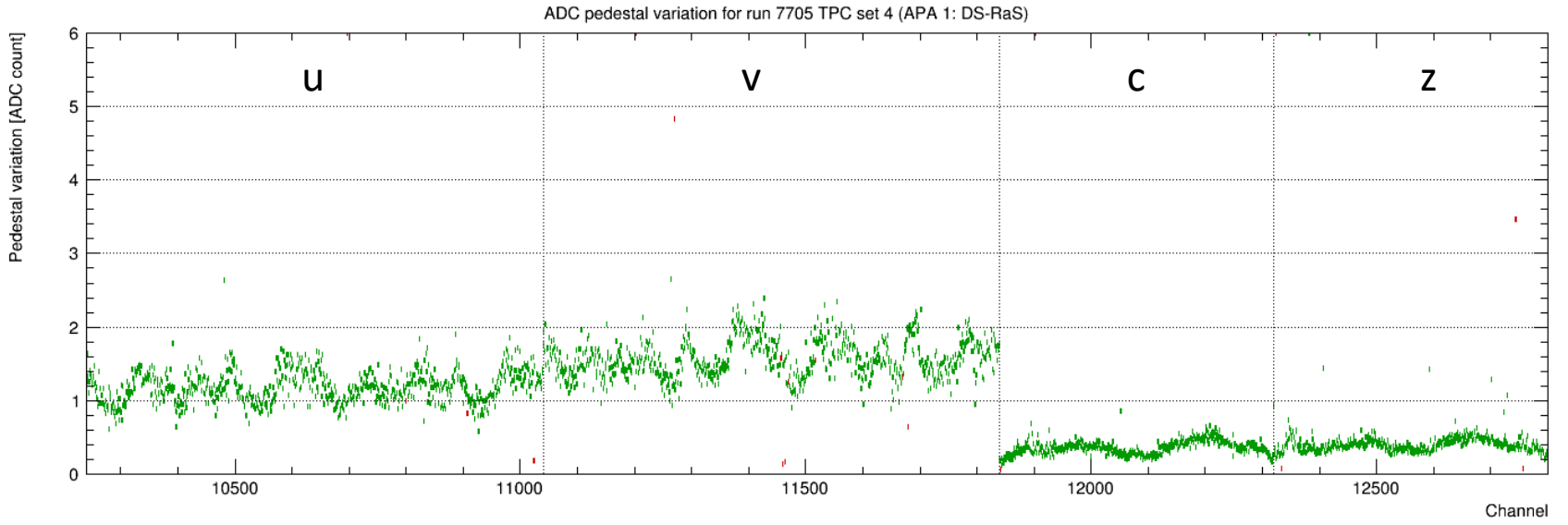
Fit pedestal variation back 200s000



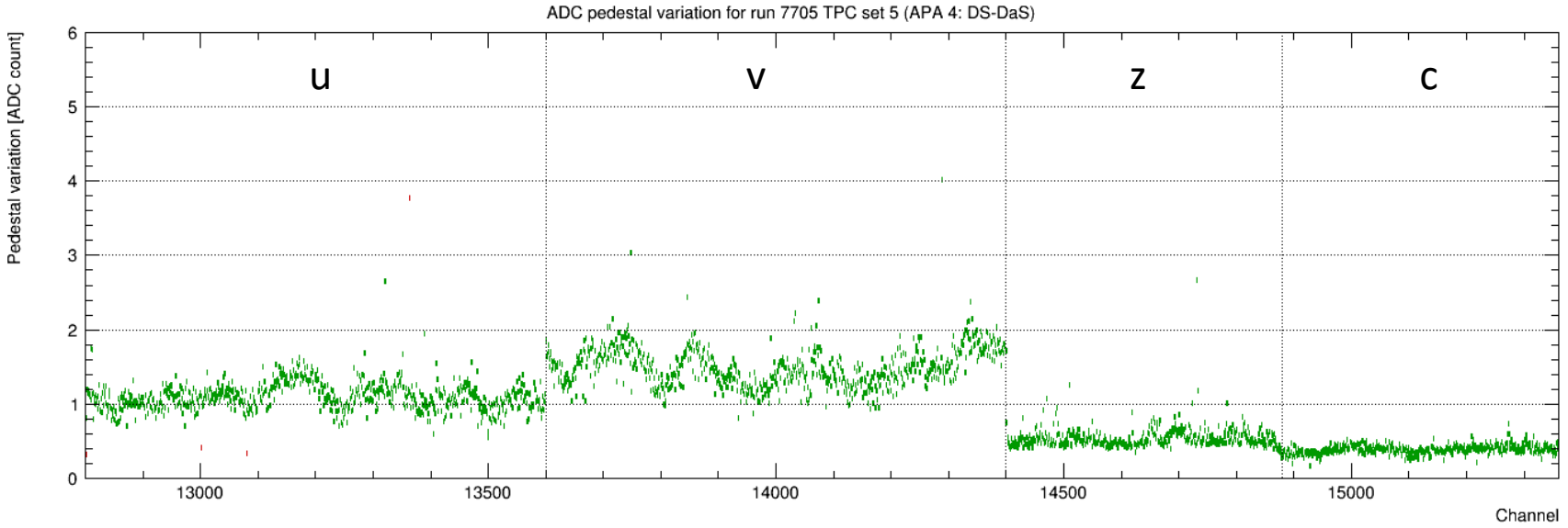


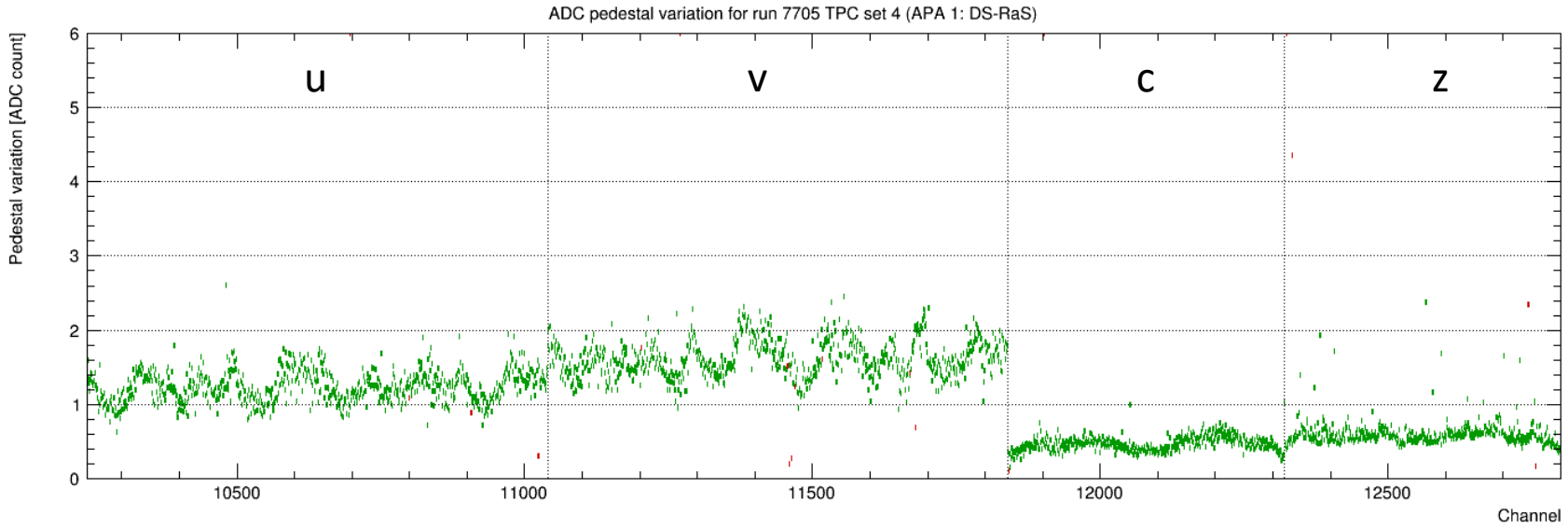
ETR pedestal variation back 200s000





USC pedestal variation back 200s000





Comments

New decoder mean is an improvement

- Small but significant decrease in pedestal variation

Fit pedestal vs. mean pedestal from decoder

- Fit looks better for u, v, c (cryo-side collection)
  - Much less channel-to-channel scatter
- Mean has a little less variation for z (TPC-side collection)

New tail remover (adding offset to input pedestal)

- Dramatic improvement for z-planes—look very much like the c-planes
  - Variation (RMS) is around 0.3 ADC count
- Very small degradation of c-planes
- Small degradation of induction planes

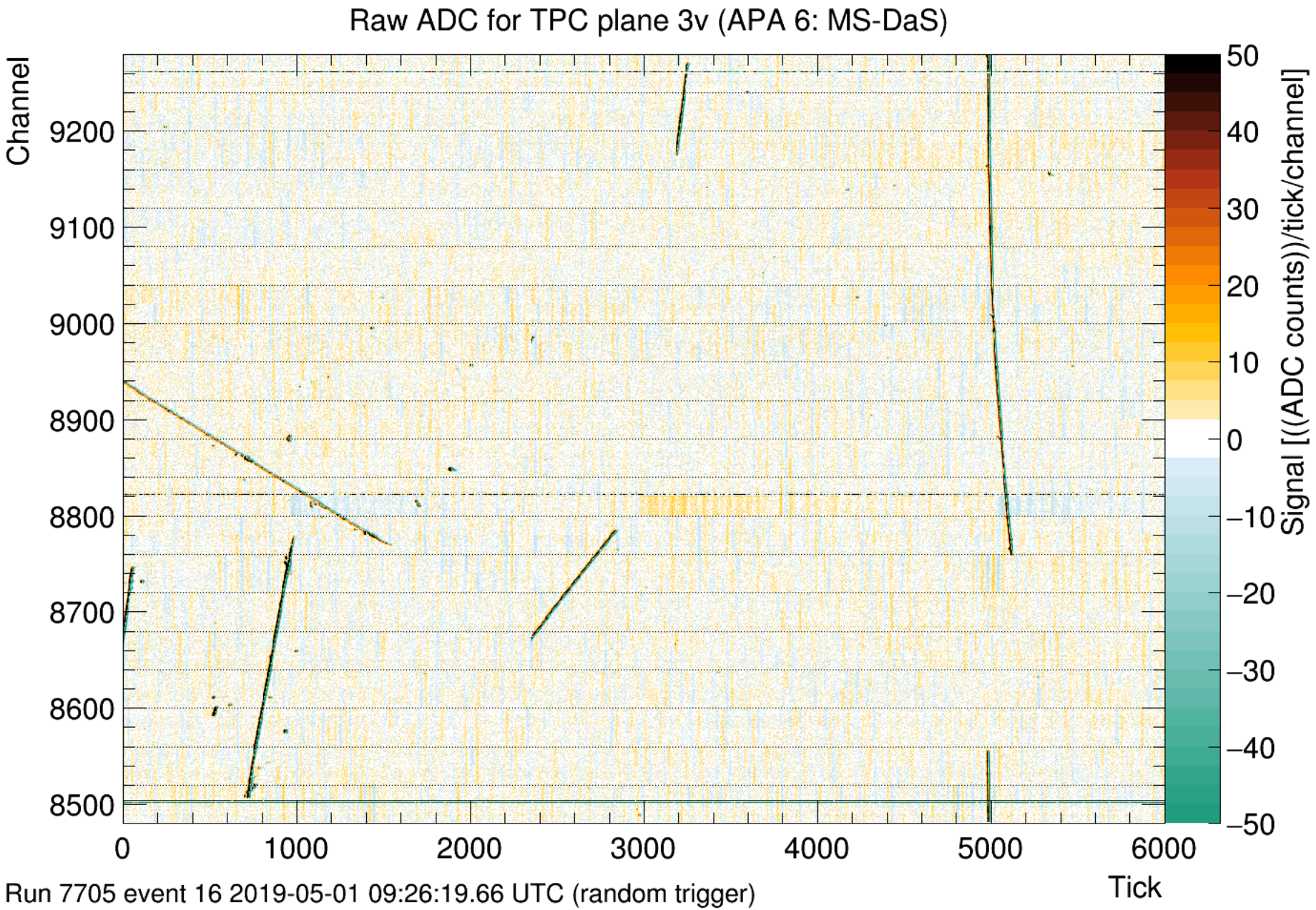
Old tail remover

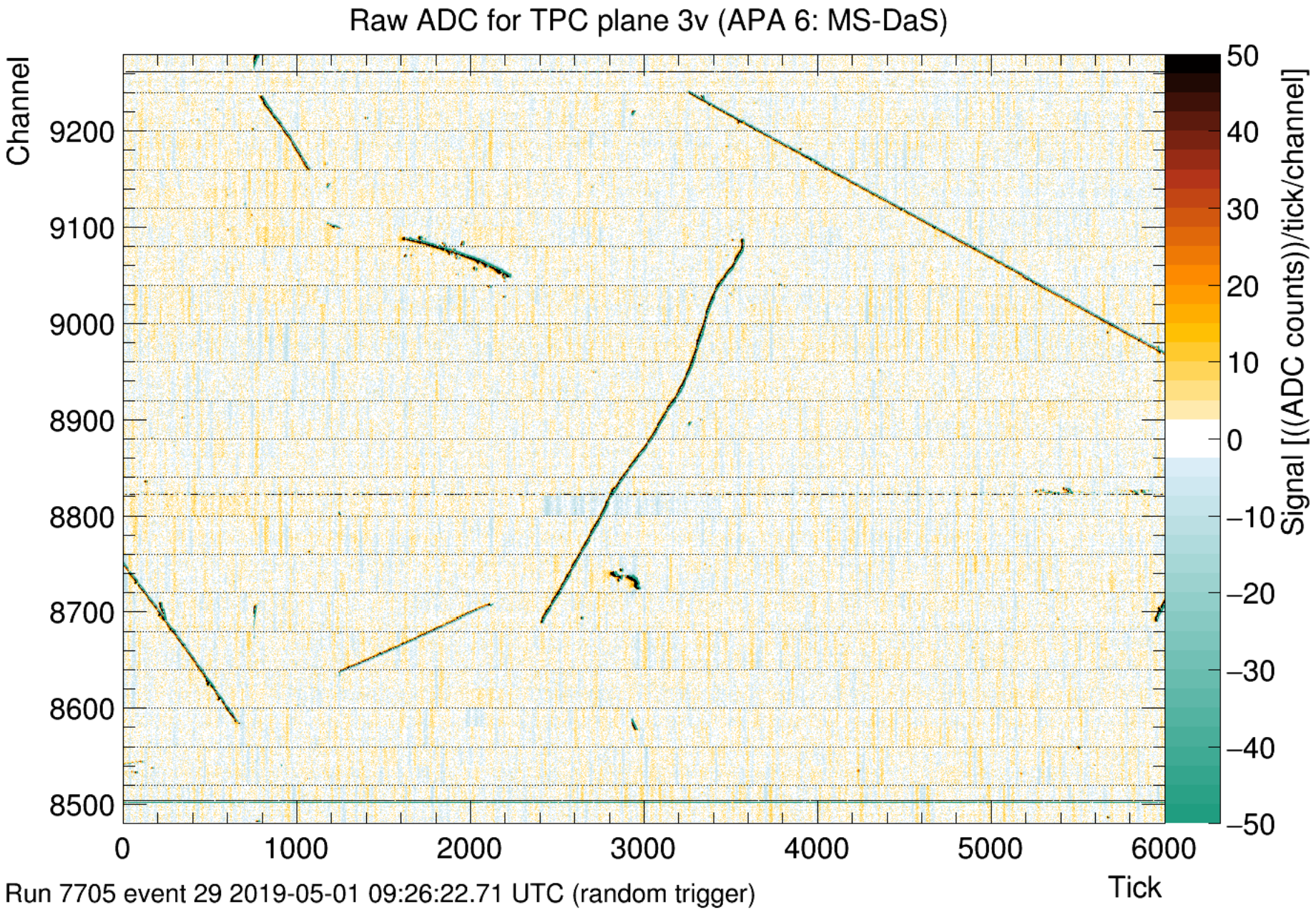
- Similar to new but pedestal variation is a bit larger (due to signal ID?)

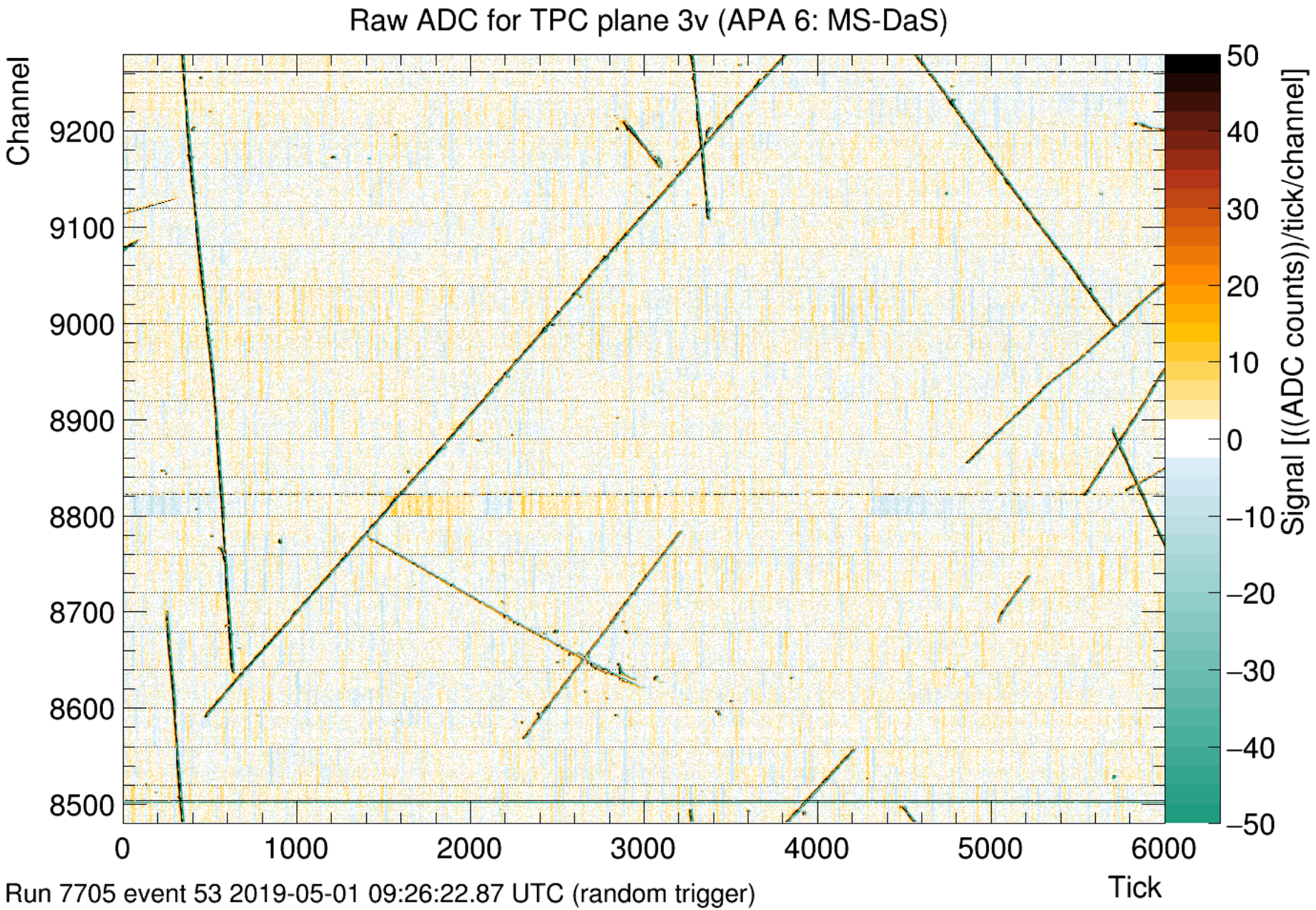
Not able to reduce the variation on the induction planes

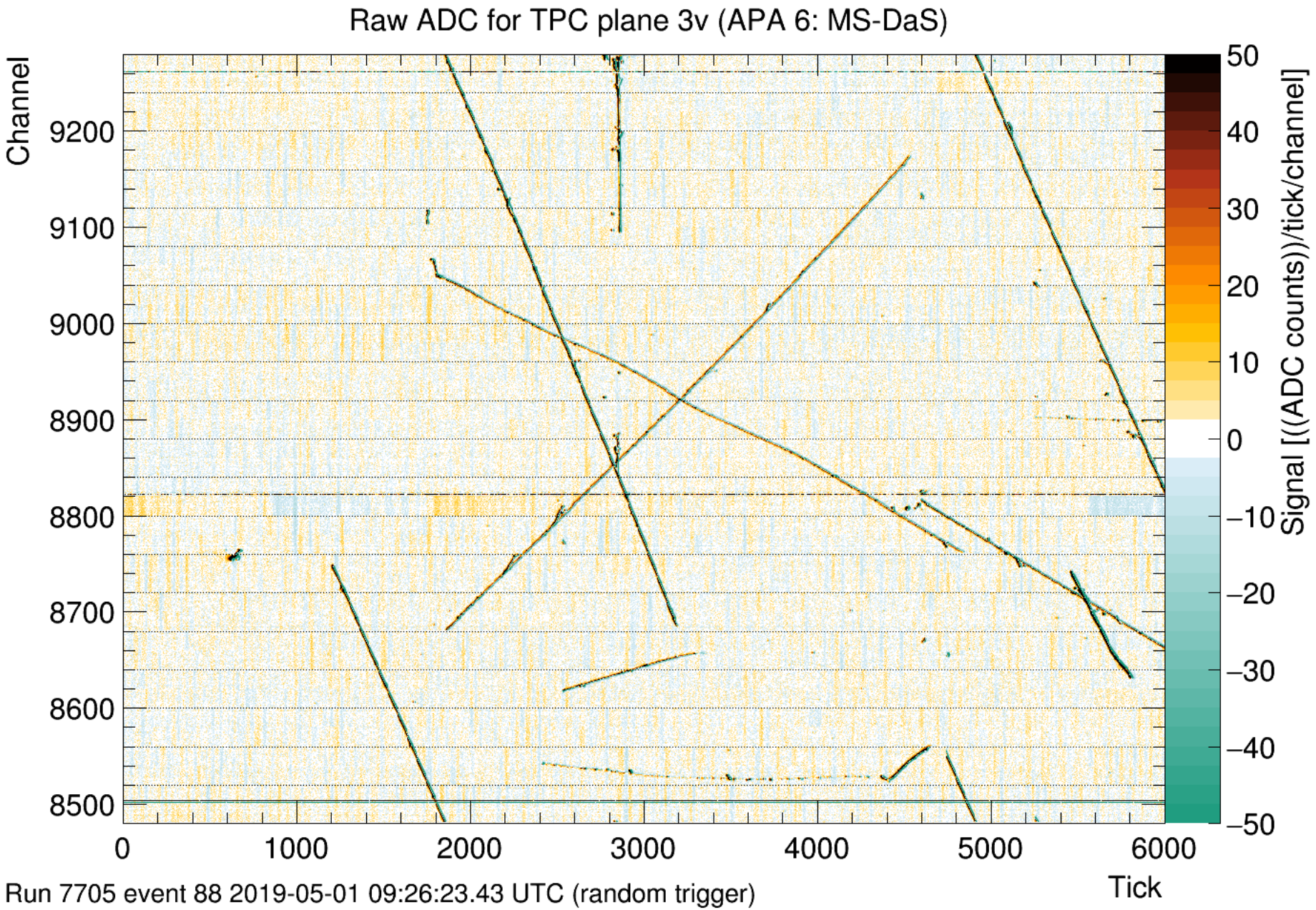
- RMS remains at 1-2 ADC count
- Is this real noise with period much longer than 3 ms readout?
  - A few plots follow

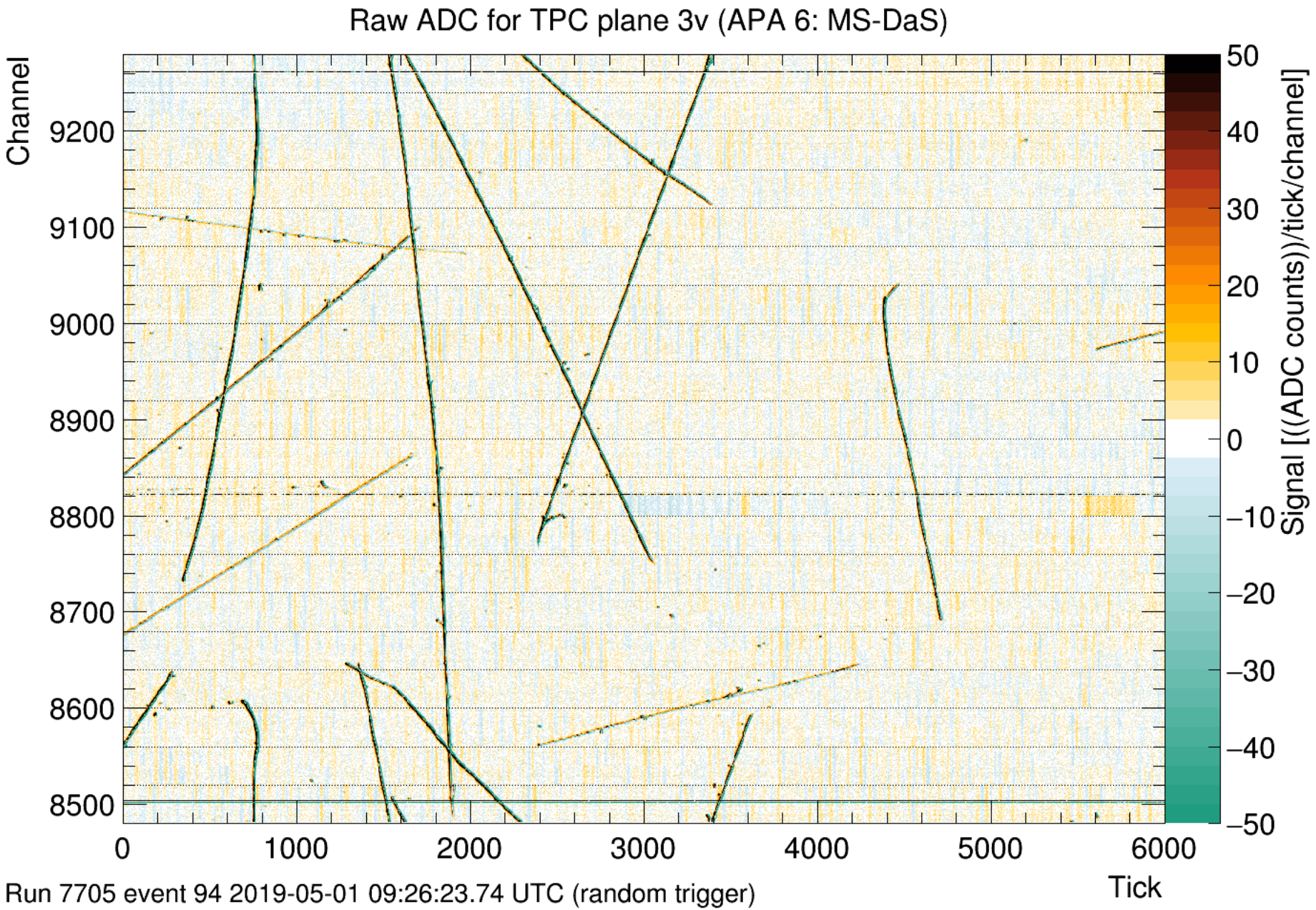
APA3v displays

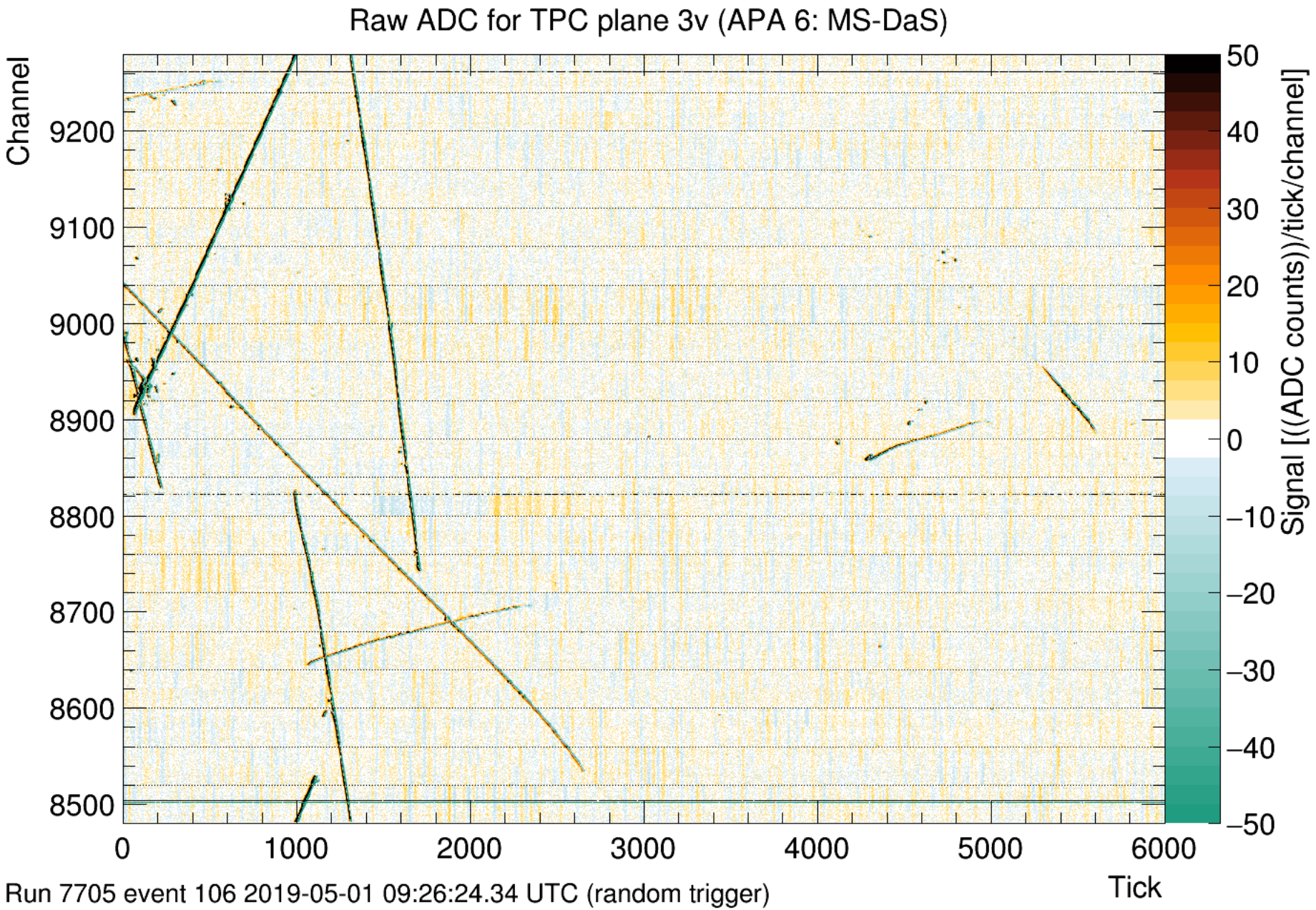

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 16 2019-05-01 09:26:19.66 UTC (random trigger)

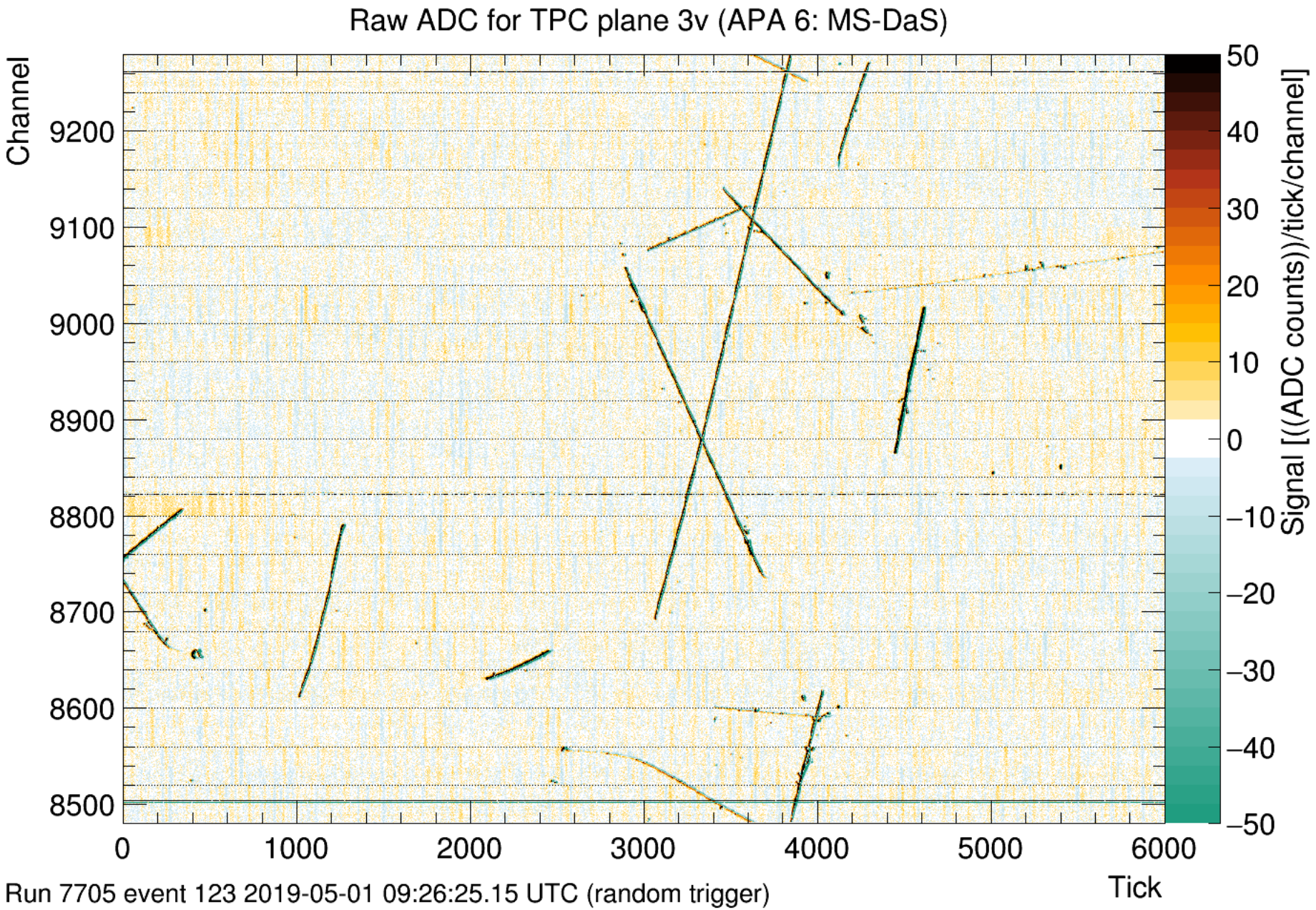

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 29 2019-05-01 09:26:22.71 UTC (random trigger)

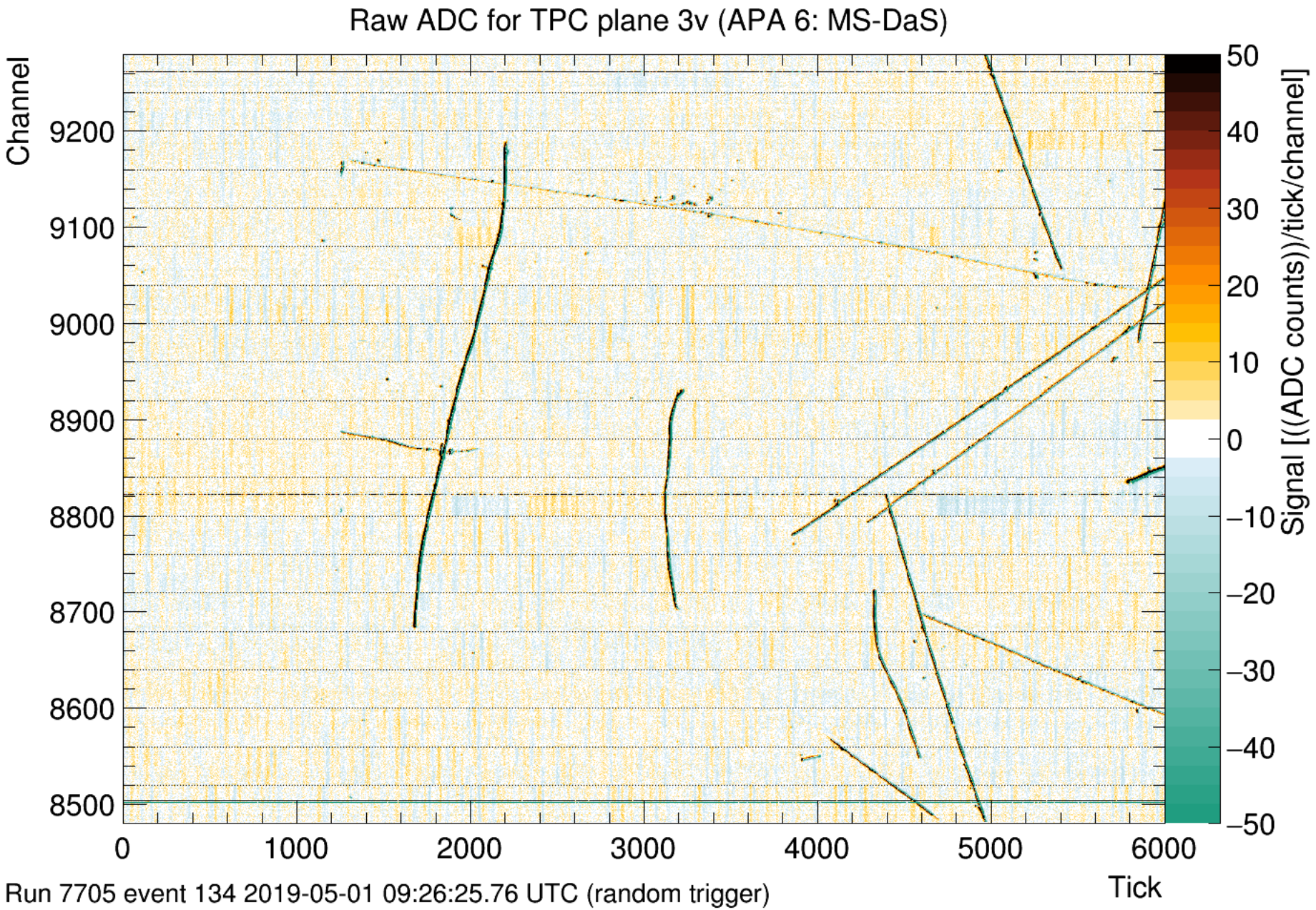

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 53 2019-05-01 09:26:22.87 UTC (random trigger)

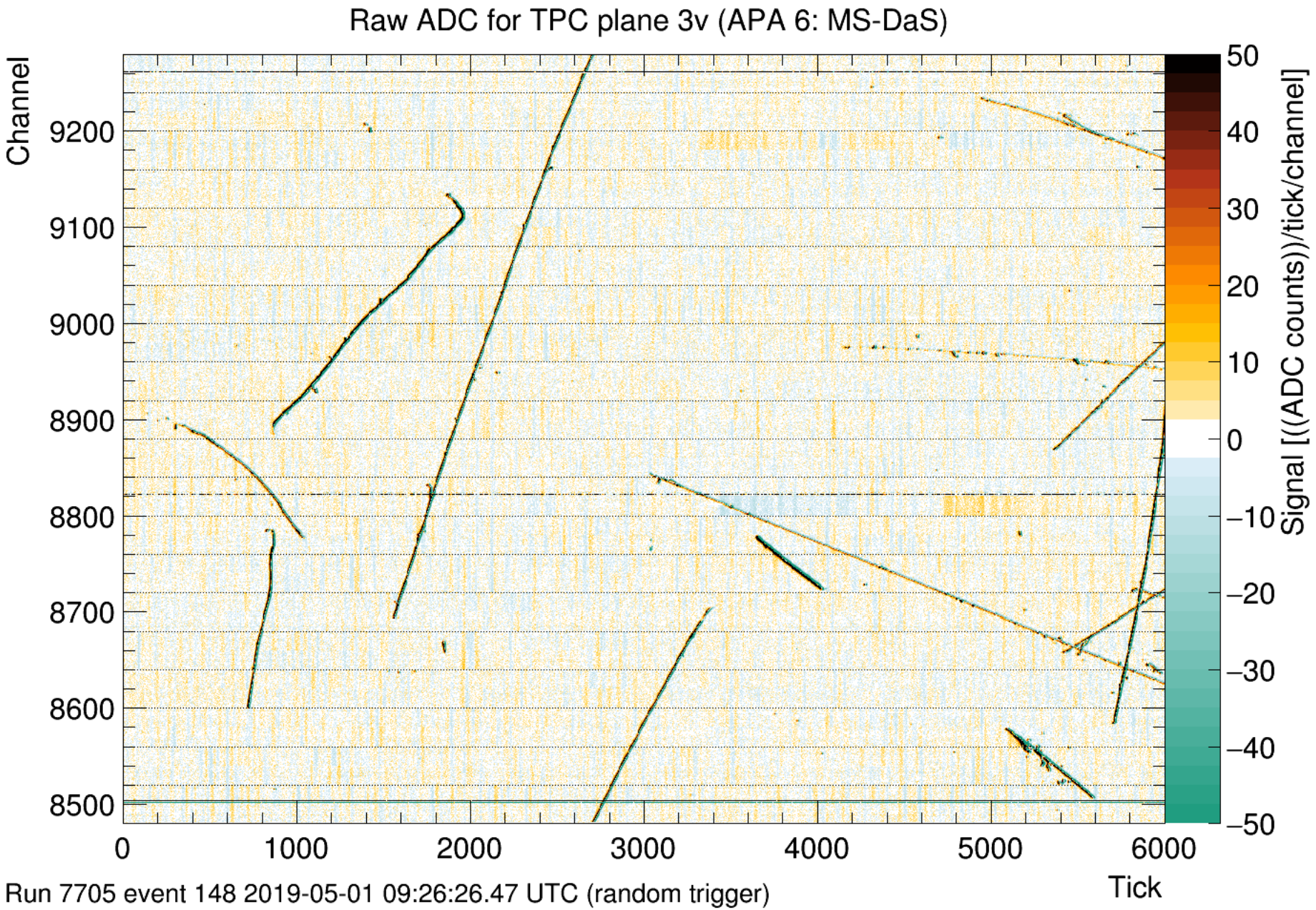

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 88 2019-05-01 09:26:23.43 UTC (random trigger)

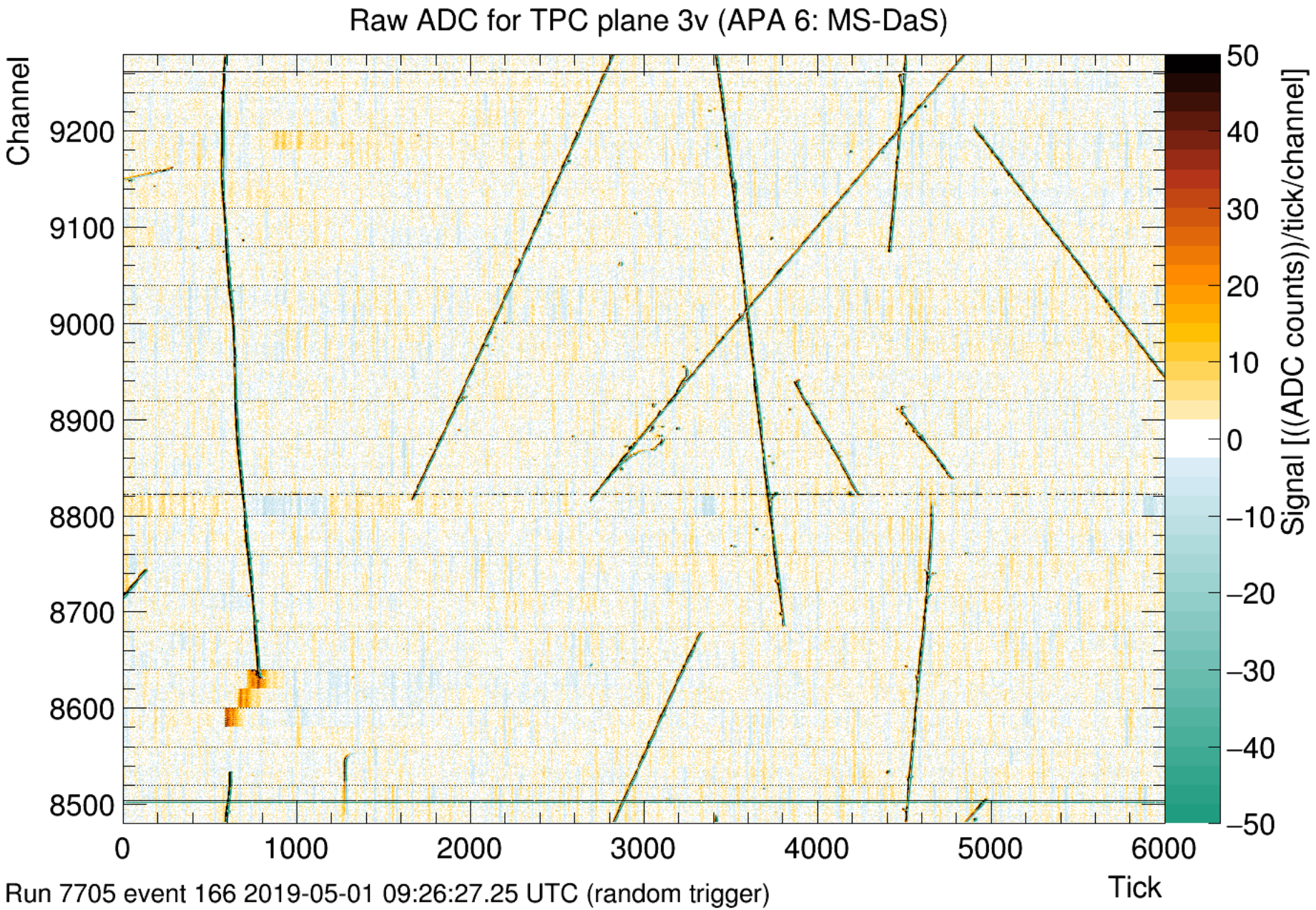

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 94 2019-05-01 09:26:23.74 UTC (random trigger)


Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 106 2019-05-01 09:26:24.34 UTC (random trigger)


Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 123 2019-05-01 09:26:25.15 UTC (random trigger)

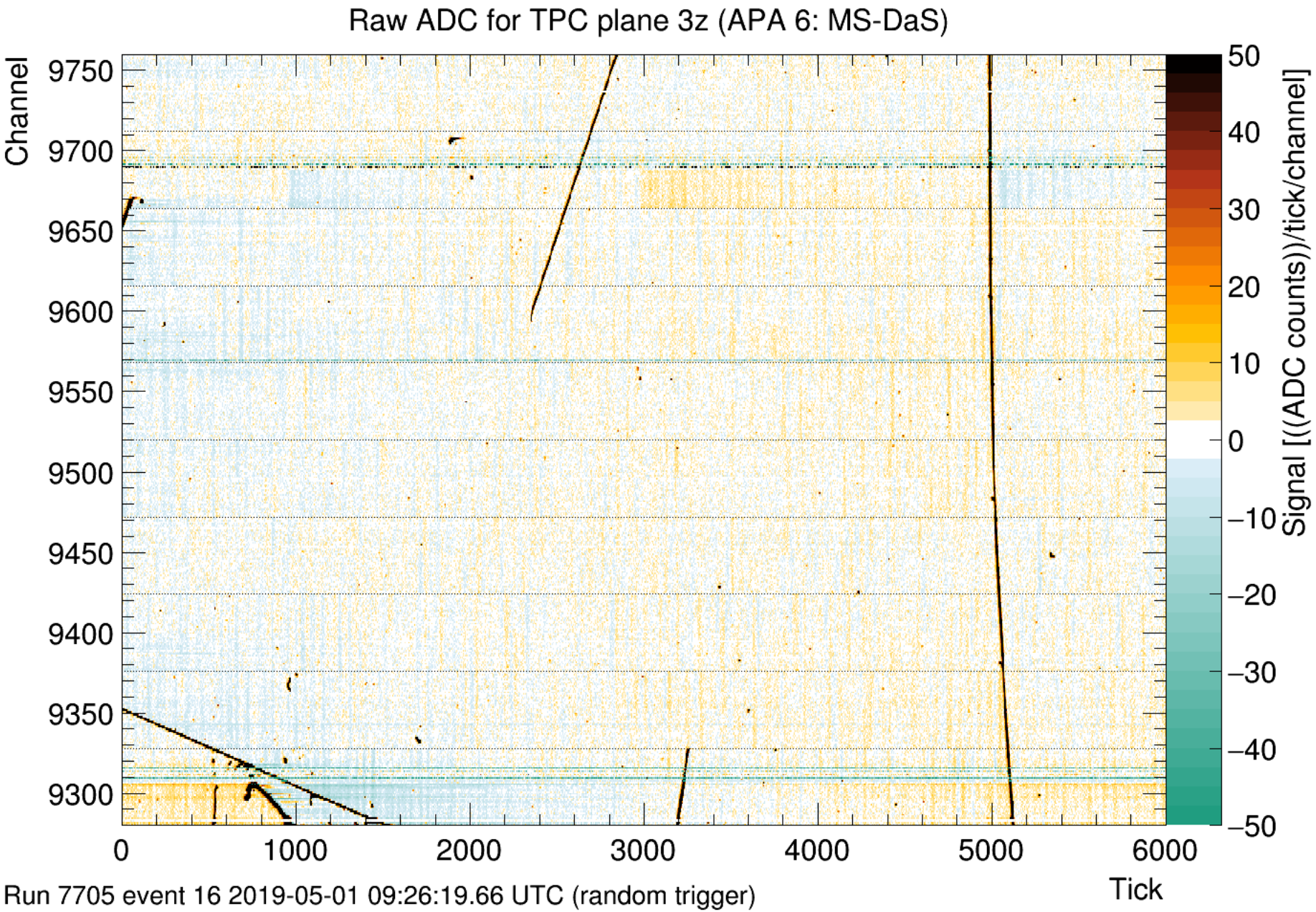

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 134 2019-05-01 09:26:25.76 UTC (random trigger)

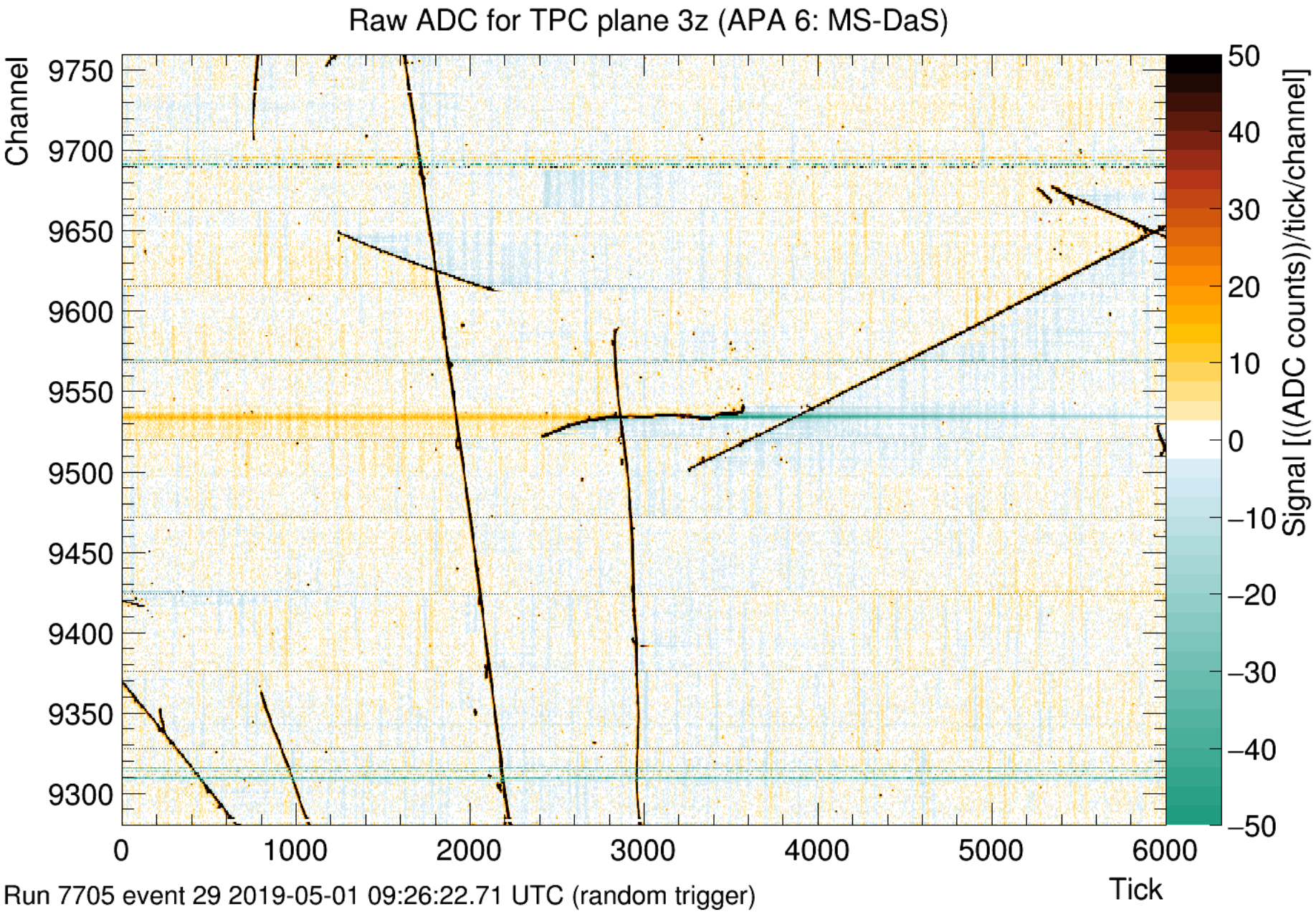

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 148 2019-05-01 09:26:26.47 UTC (random trigger)

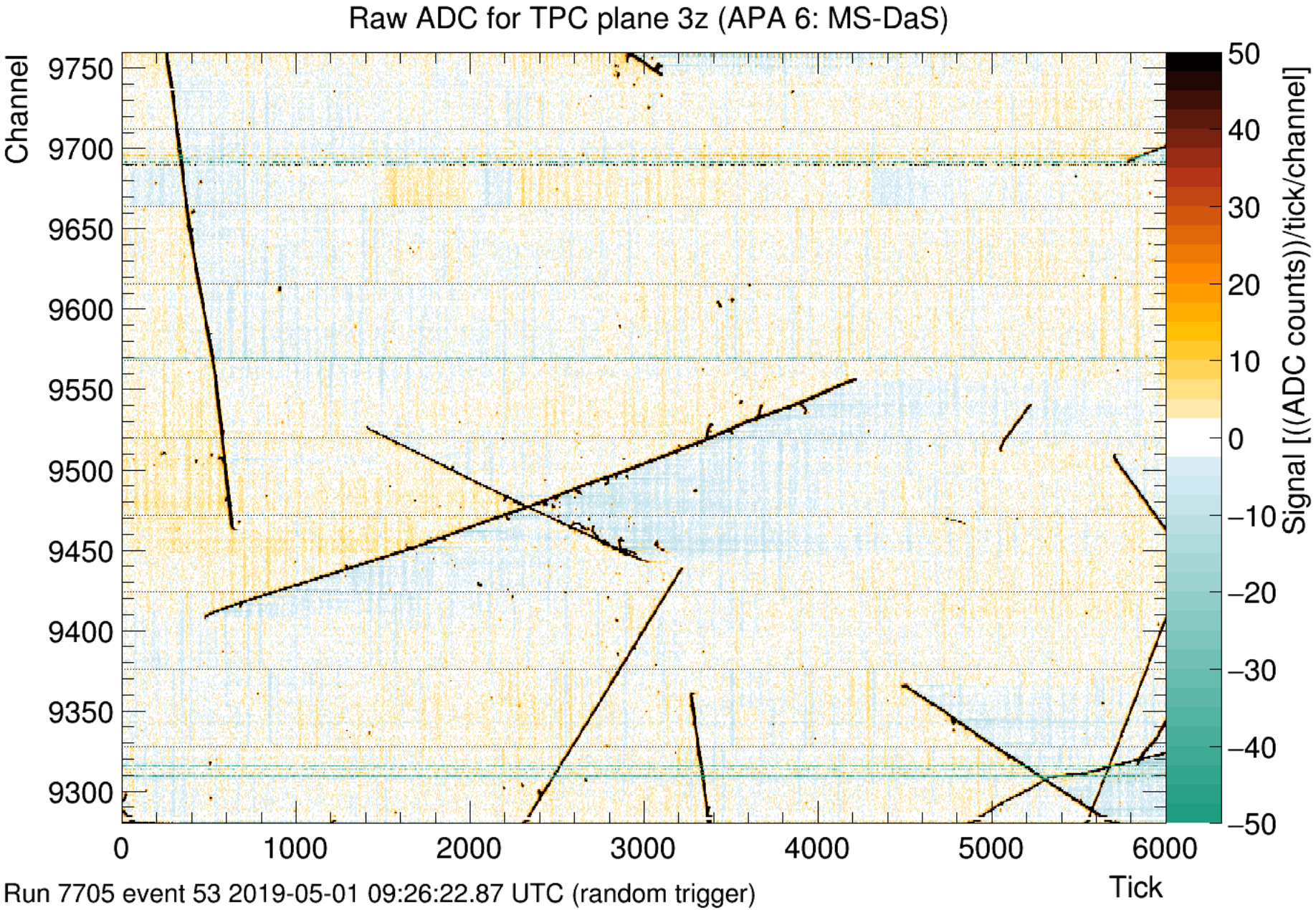

Raw ADC for TPC plane 3v (APA 6: MS-DaS)
Channel
9200
9100
9000
8900
8800
8700
8600
8500
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 166 2019-05-01 09:26:27.25 UTC (random trigger)

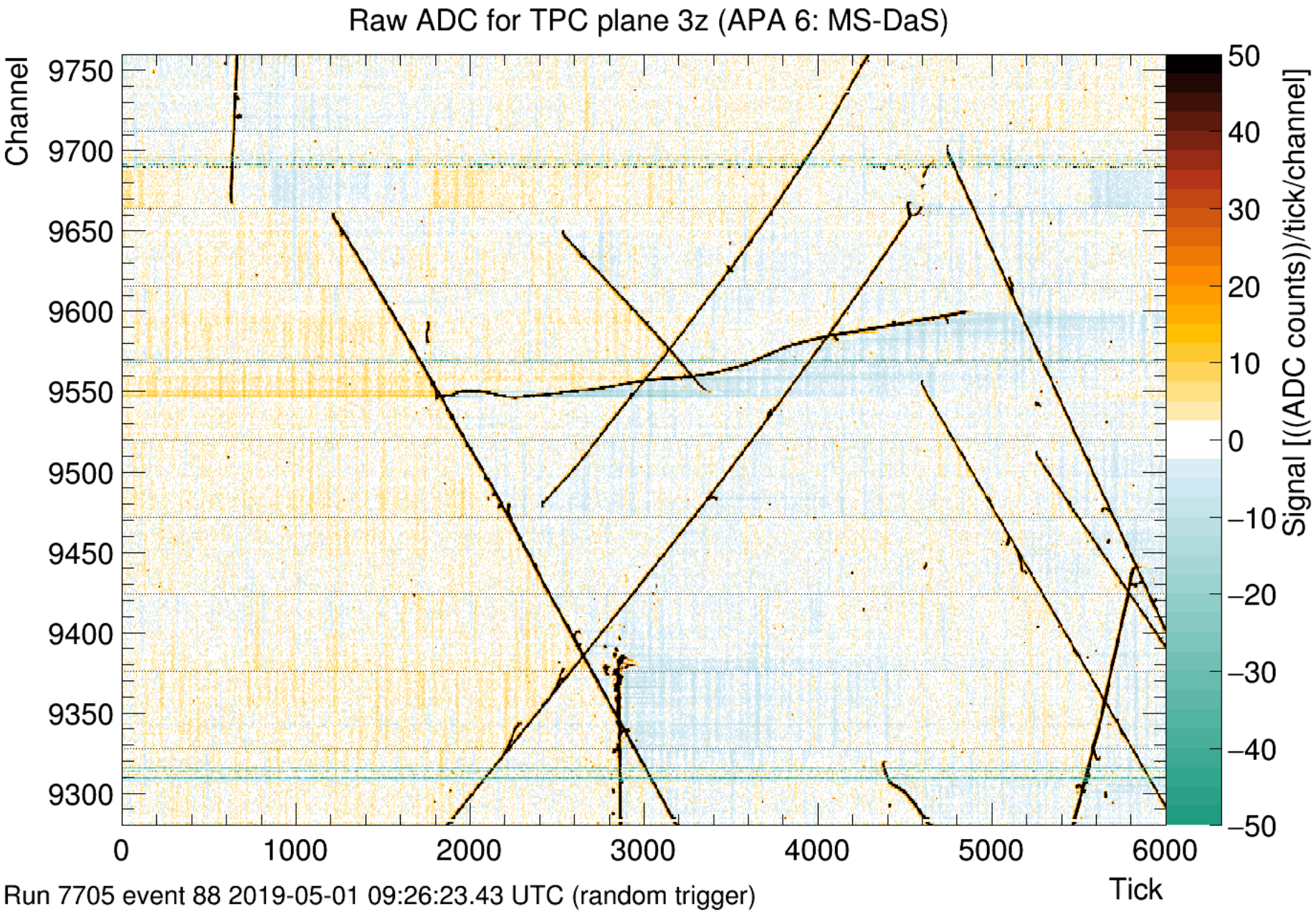
Extras

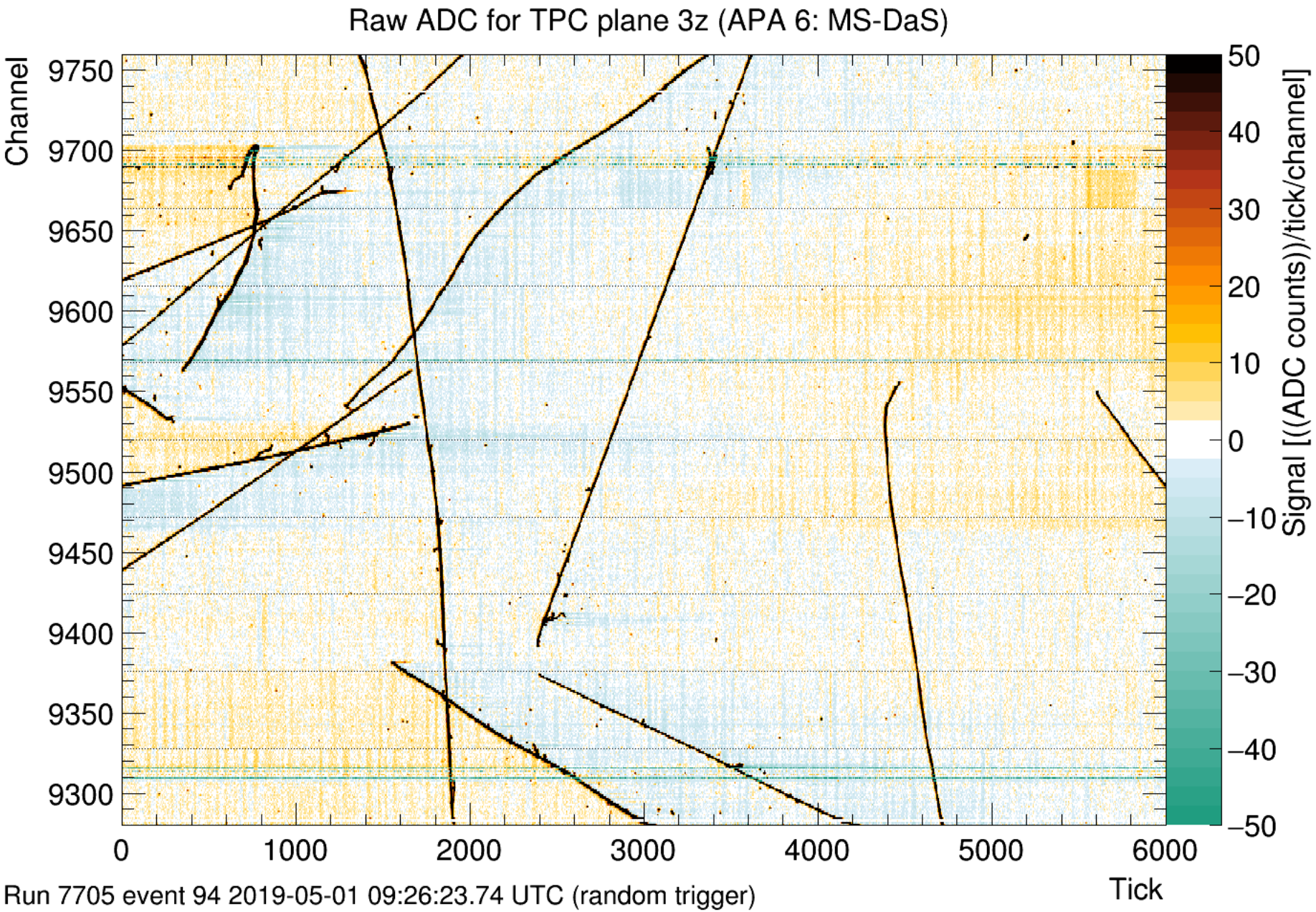
APA3z displays

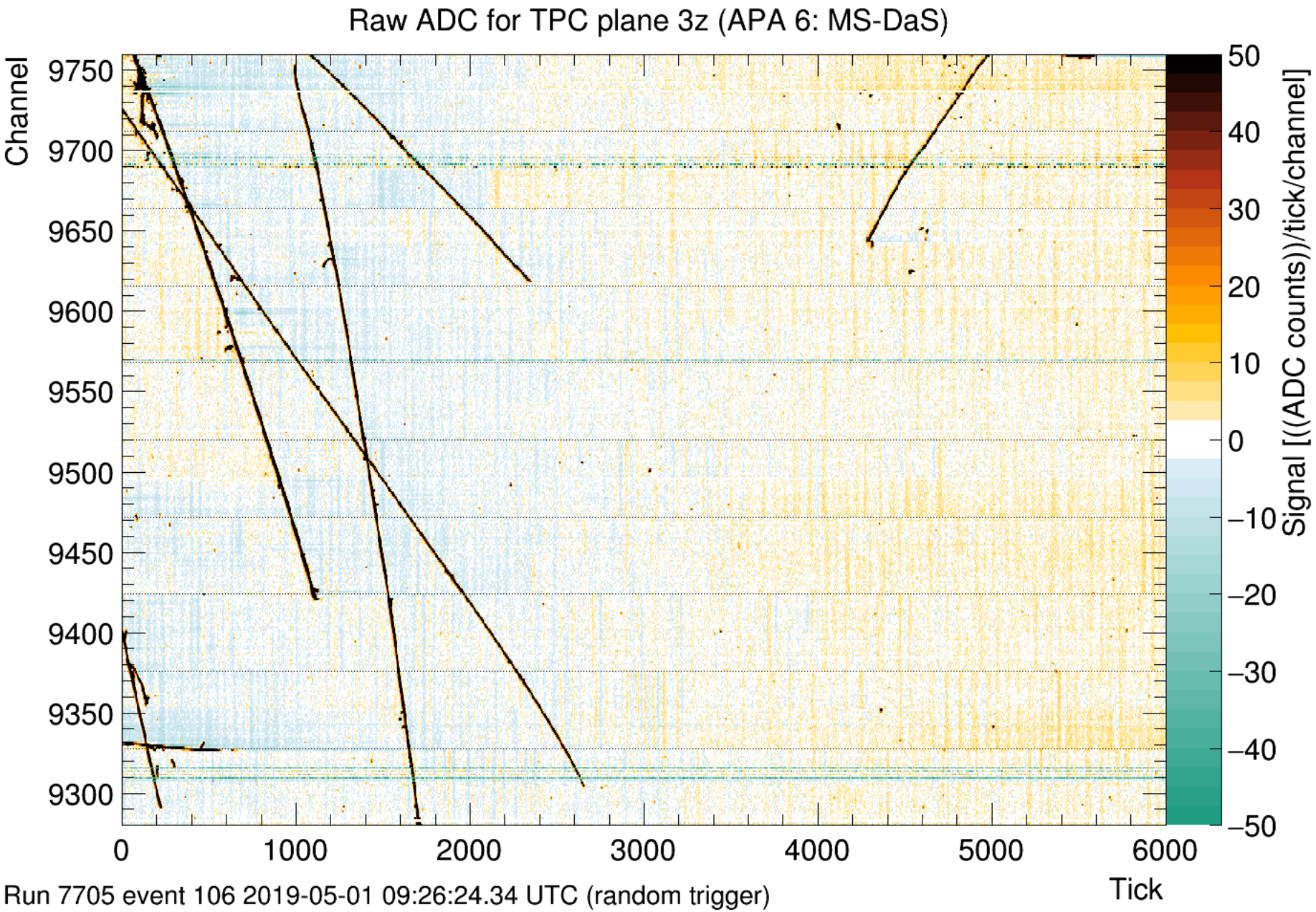

Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 16 2019-05-01 09:26:19.66 UTC (random trigger)

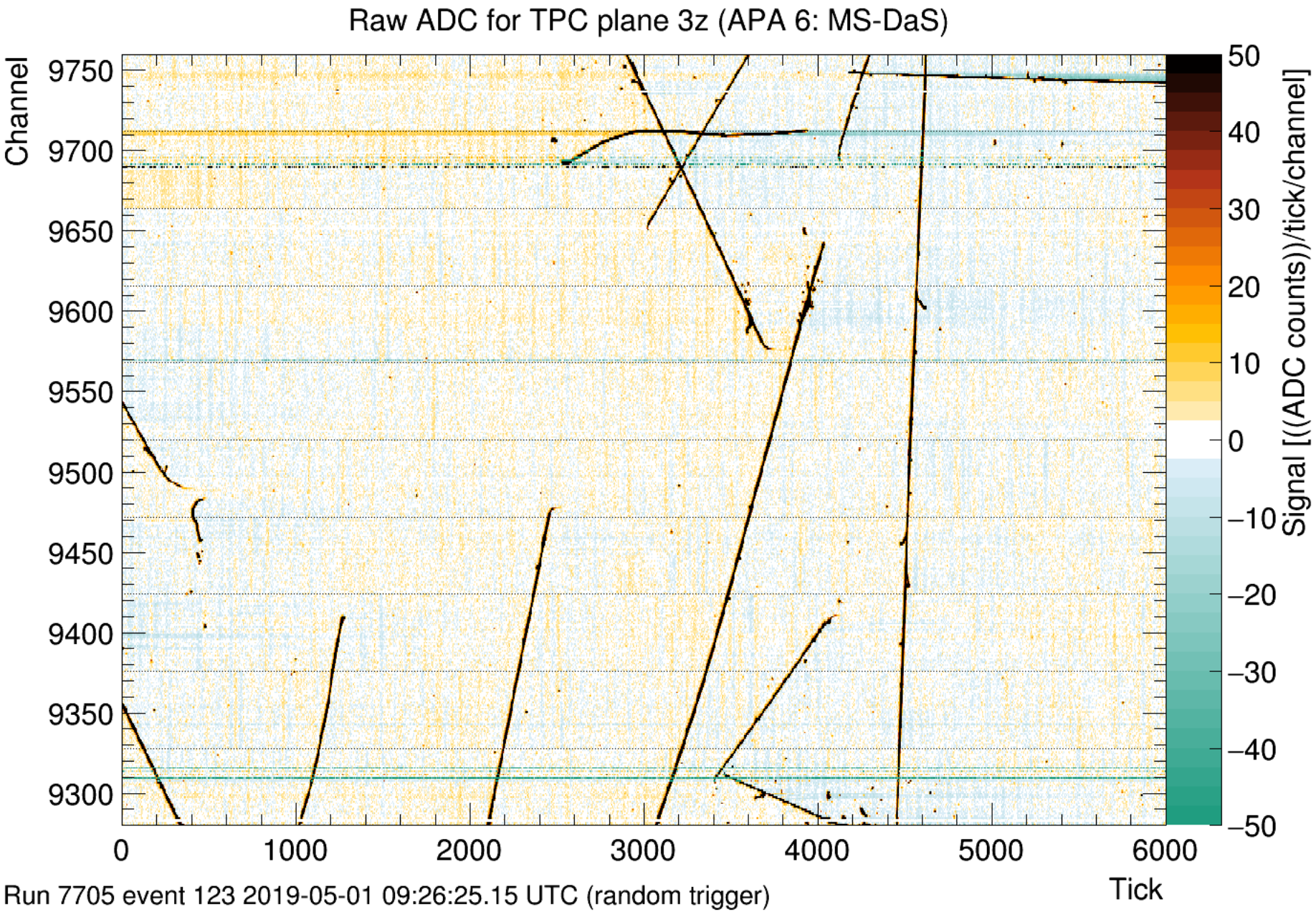

Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 29 2019-05-01 09:26:22.71 UTC (random trigger)

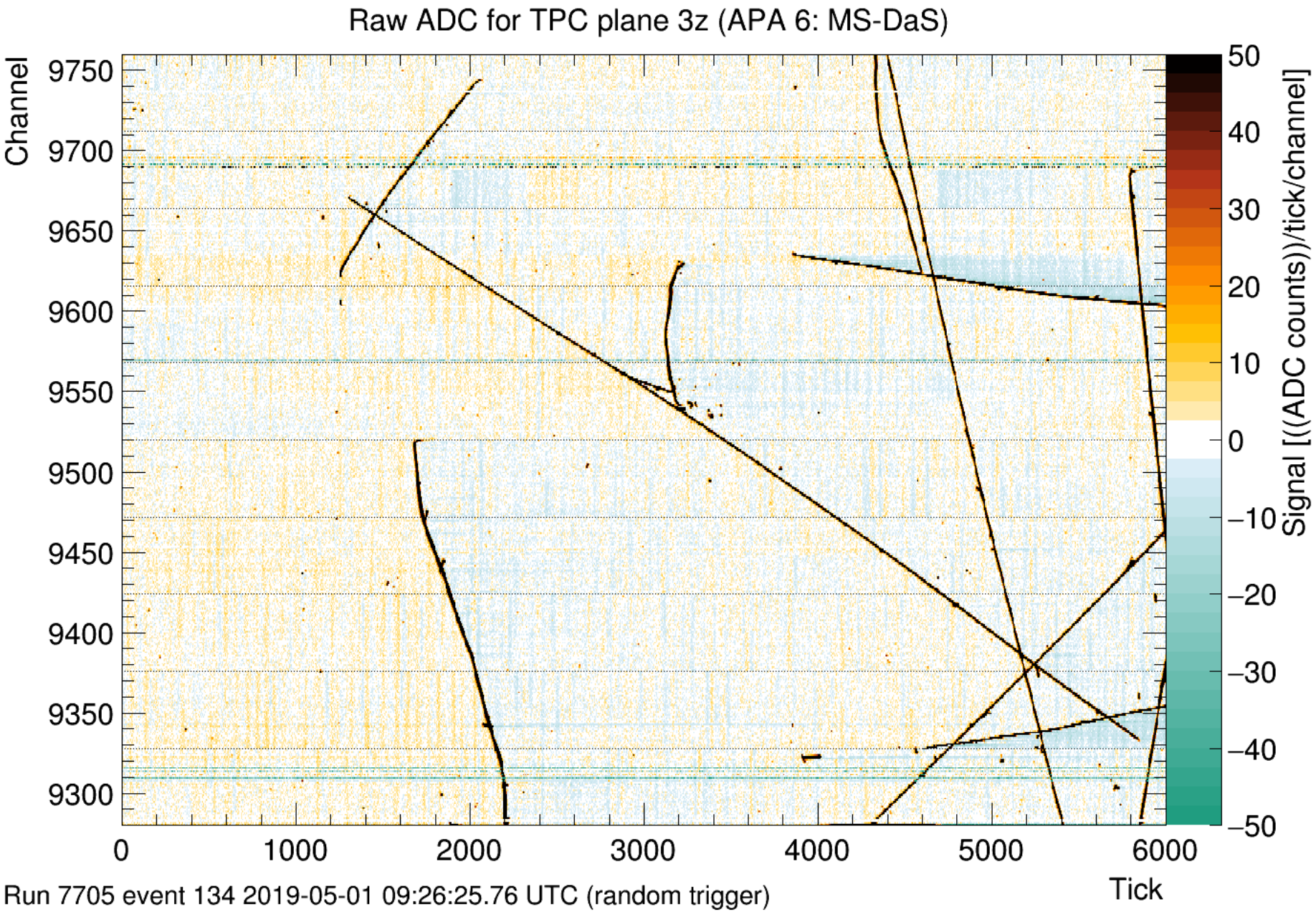

Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 53 2019-05-01 09:26:22.87 UTC (random trigger)

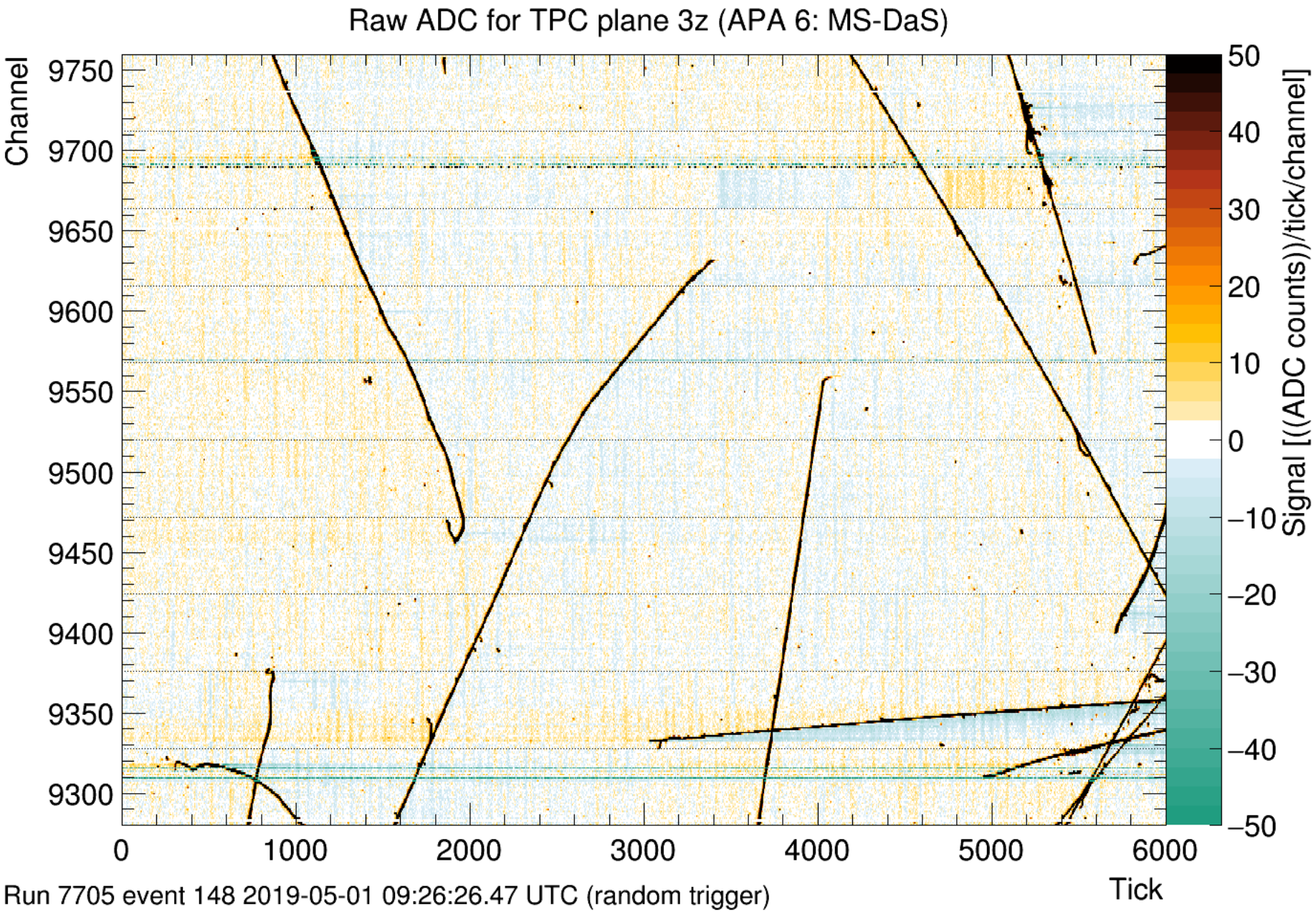

Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 88 2019-05-01 09:26:23.43 UTC (random trigger)

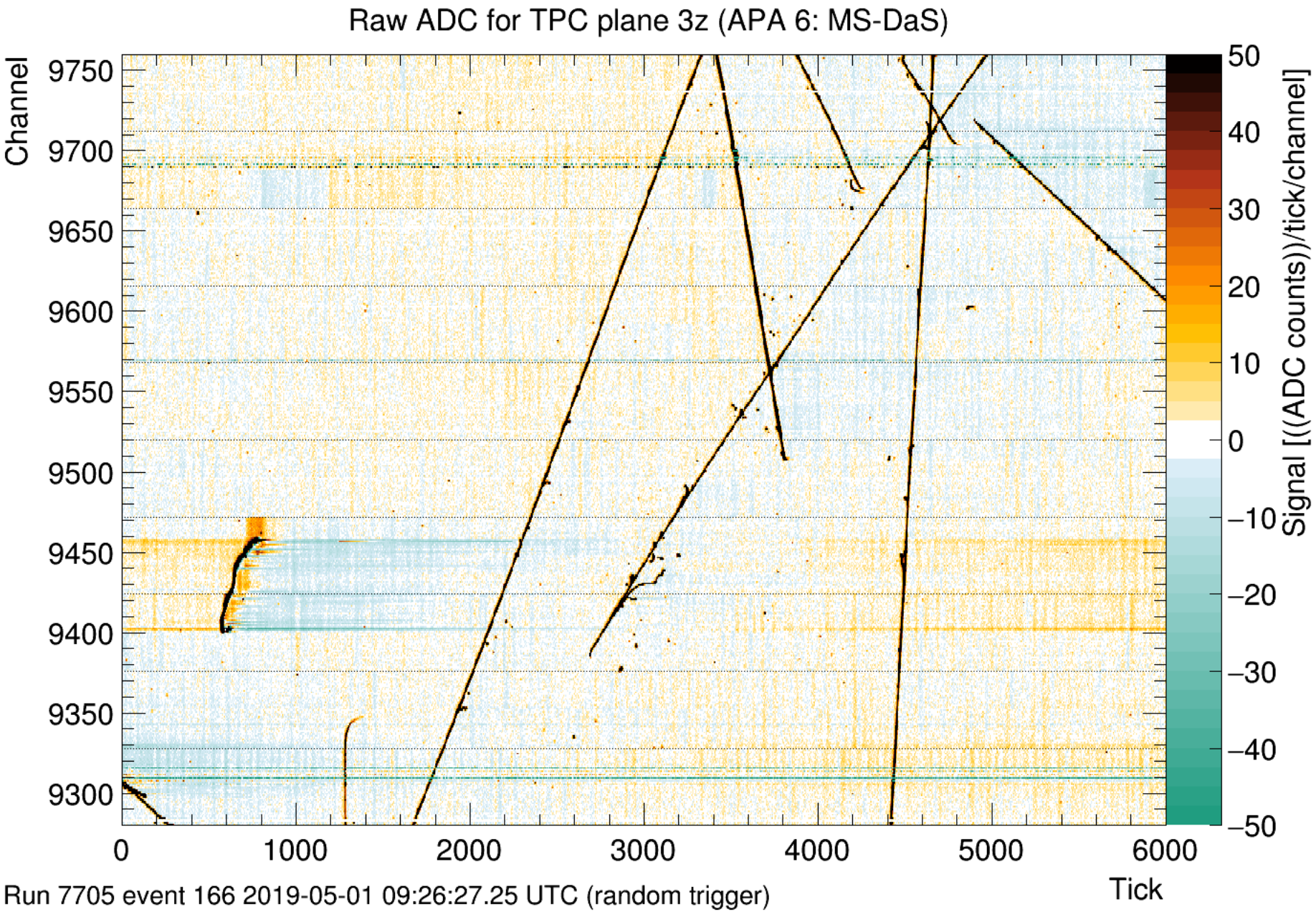

Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 94 2019-05-01 09:26:23.74 UTC (random trigger)


Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 106 2019-05-01 09:26:24.34 UTC (random trigger)


Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 123 2019-05-01 09:26:25.15 UTC (random trigger)


Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 134 2019-05-01 09:26:25.76 UTC (random trigger)


Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 148 2019-05-01 09:26:26.47 UTC (random trigger)


Raw ADC for TPC plane 3z (APA 6: MS-DaS)
Channel
9750
9700
9650
9600
9550
9500
9450
9400
9350
9300
0
1000
2000
3000
4000
5000
6000
Tick
50
40
30
20
10
0
−10
−20
−30
−40
−50
Signal [((ADC counts))/tick/channel]
Run 7705 event 166 2019-05-01 09:26:27.25 UTC (random trigger)