

ProtoDUNE analysis: Search for sticky codes

ProtoDUNE sim/reco

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BNL

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Introduction

Dataprep status

- The default list of dataprep tools is given below
 - Find names in tools block of fcl (e.g. with fcldump) to get the tool class name and parameter values
 - Class header has documentation
- Sticky codes are recorded for the front four APAs
 - Mostly from one event in run 5308 (taken Oct 15)
- Timing mitigation is done for FEMB 302 only
- New is undershoot correction—see recent talks from Tom

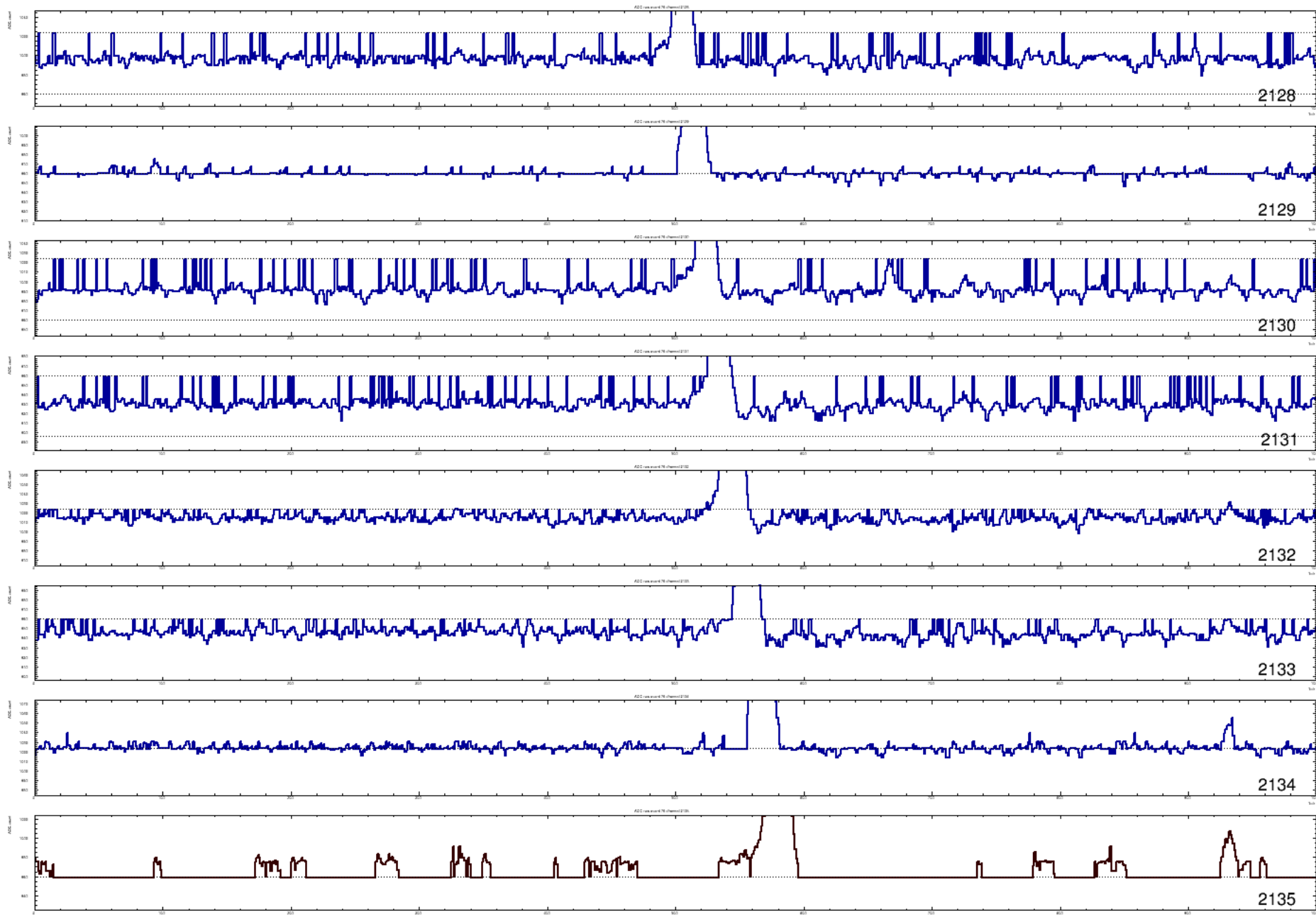
```
services.RawDigitPrepService.AdcChannelToolNames: [  
  "digitReader",           # Read RawDigit  
  "pd_adcPedestalFit",    # Find pedestal  
  "adcSampleFiller",     # Subtract pedestal, trivial calibration  
  "pdsp_sticky_codes_ped", # Flag sticky codes ← Calibrated  
  "pdsp_adcMitigate",     # Mitigate sticky codes  
  "pdsp_timingMitigate",  # Mitigate FEMB302 timing ← Mitigated  
  "adcCorrectUndershoot", # Correct undershoot ← Corrected  
  "adcVintageDeconvoluter", # Deconvolute  
  "adcThresholdSignalFinder" # Build ROIs  
]
```

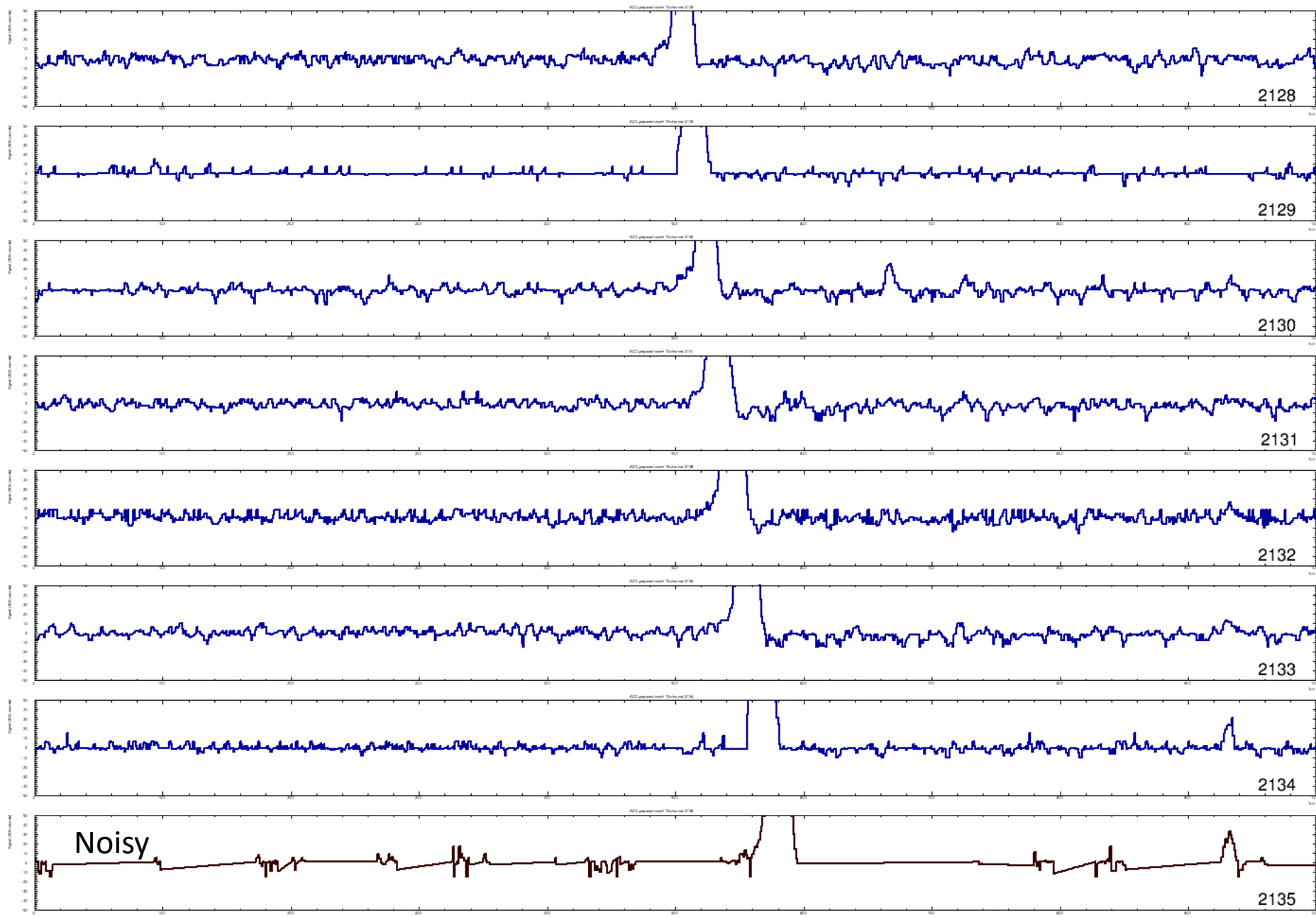
Search for sticky codes

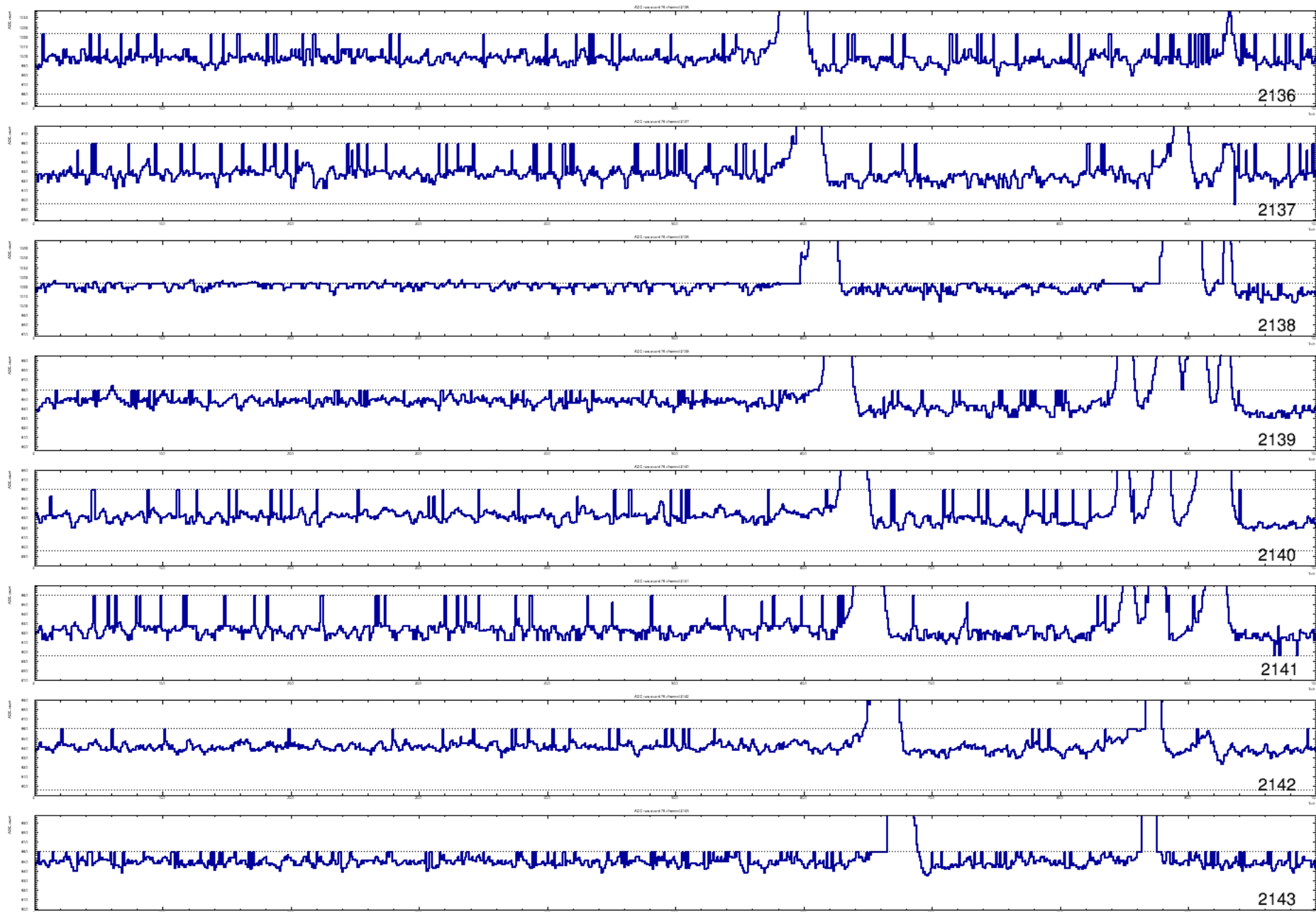
Hand scan

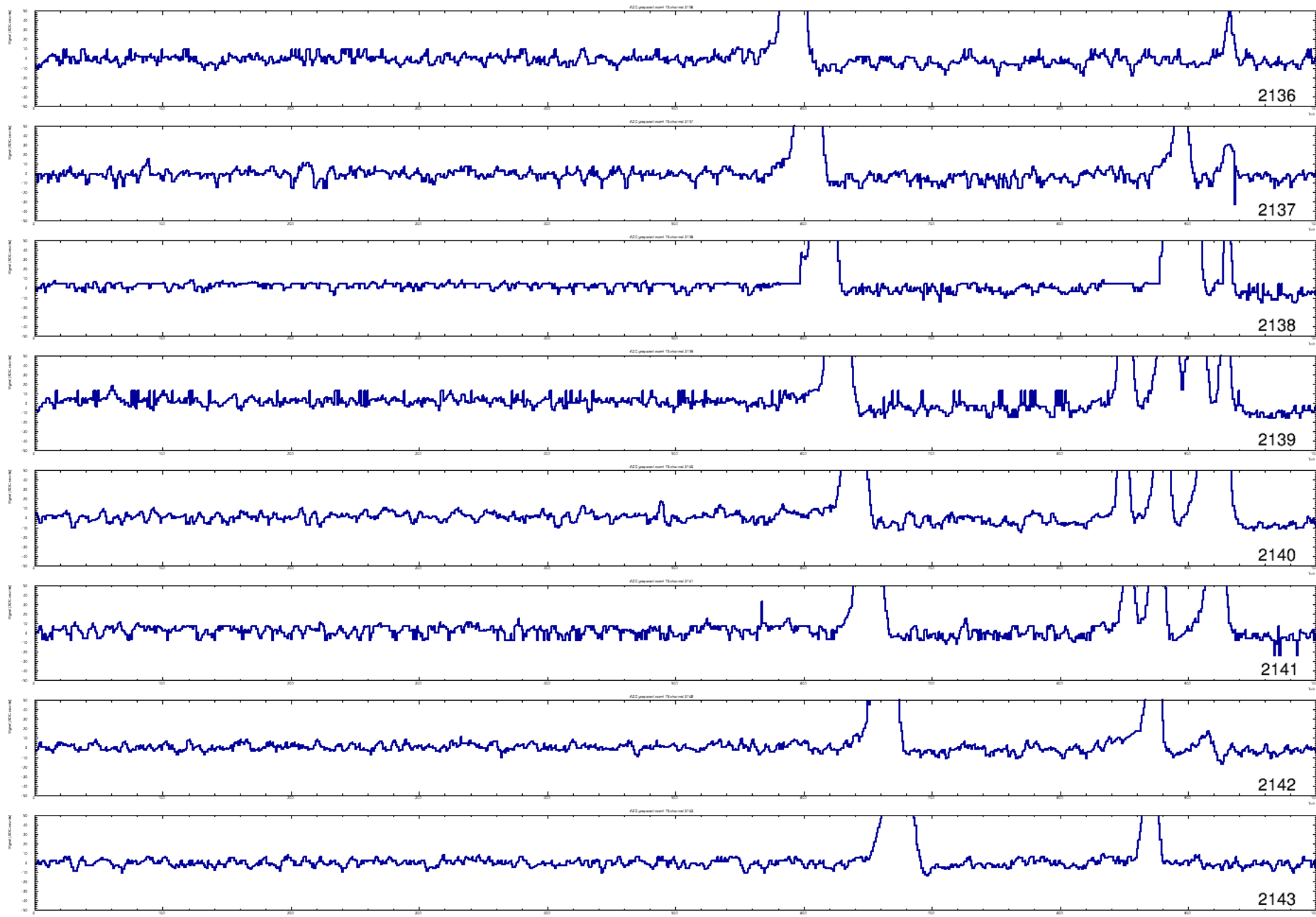
- I have been looking at waveform for each channel
- Using run 5308 usually event 76 (1st in file)
- Where sticky code appears it can be mitigated, I add to list
 - Obvious sticky code especially if far from pedestal
- If problem is severe, channel is flagged as bad or noisy
- I have looked at all channels (APA 1-6)
 - 133 bad channels (0.9%)
 - 37 noisy (0.2%)
 - Mostly sticky channels—this list will likely grow
 - 311 with sticky codes (2.1%)
 - Total of 497 sticky codes

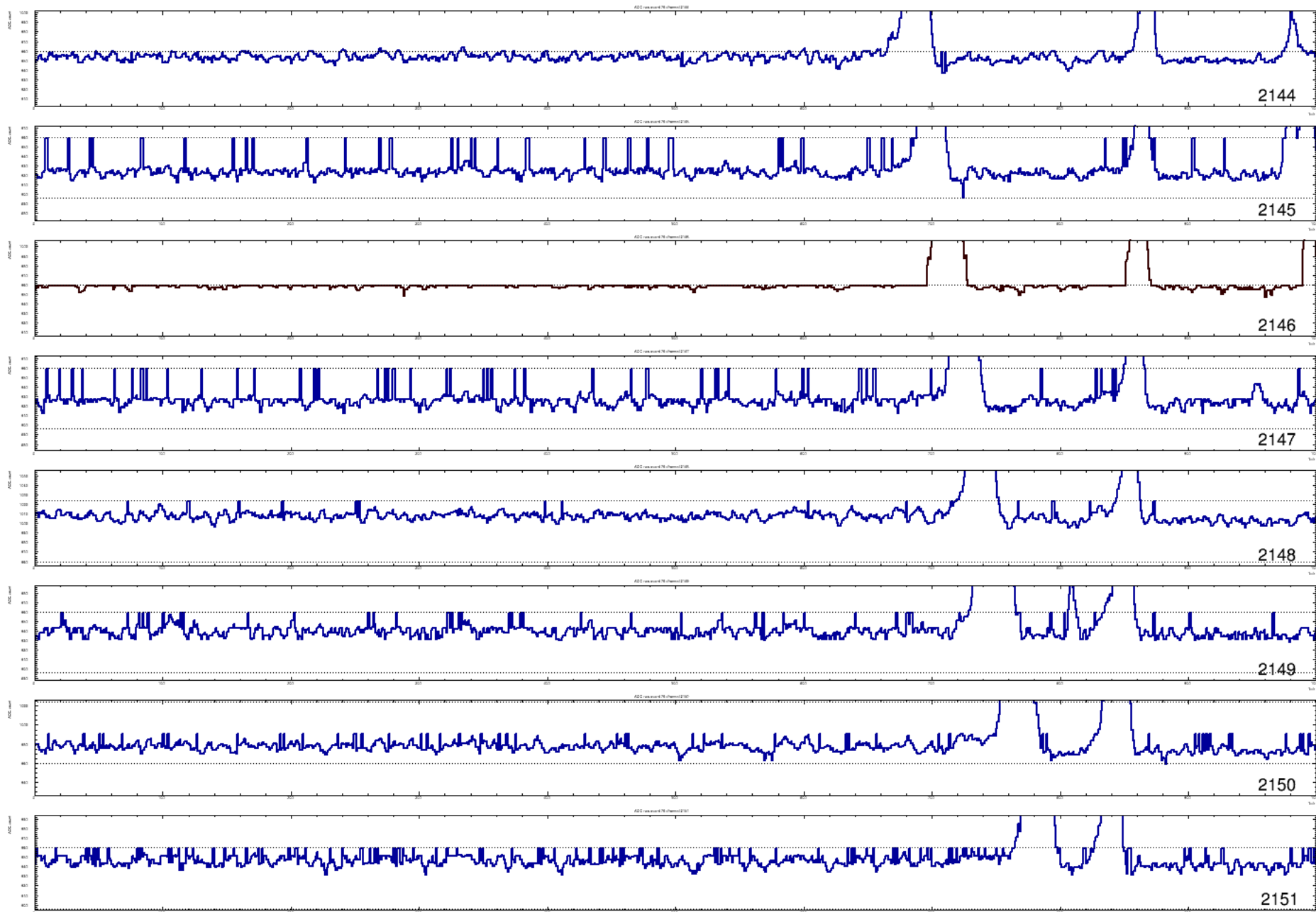
Example mitigated waveforms (FEMB 302x)

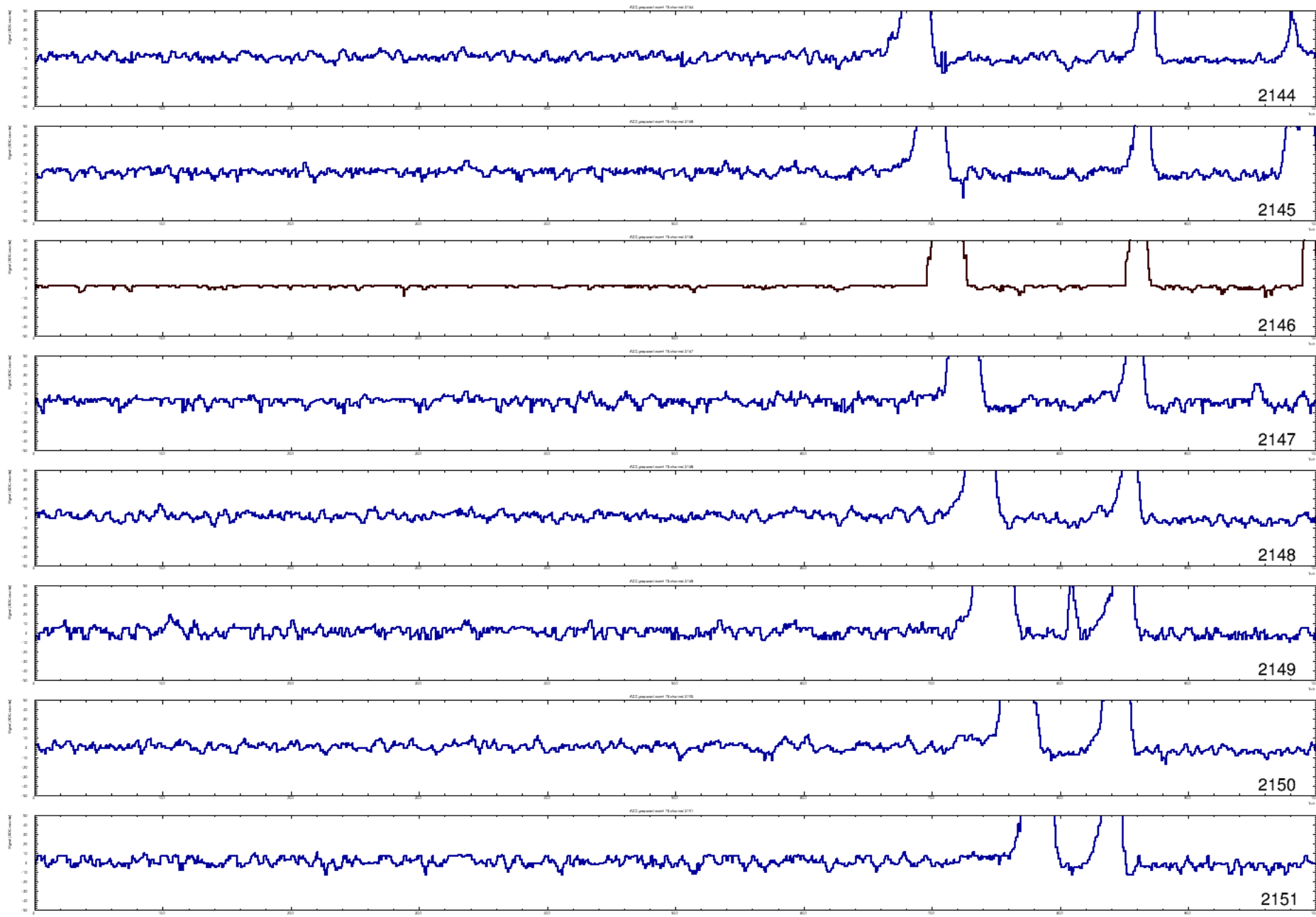


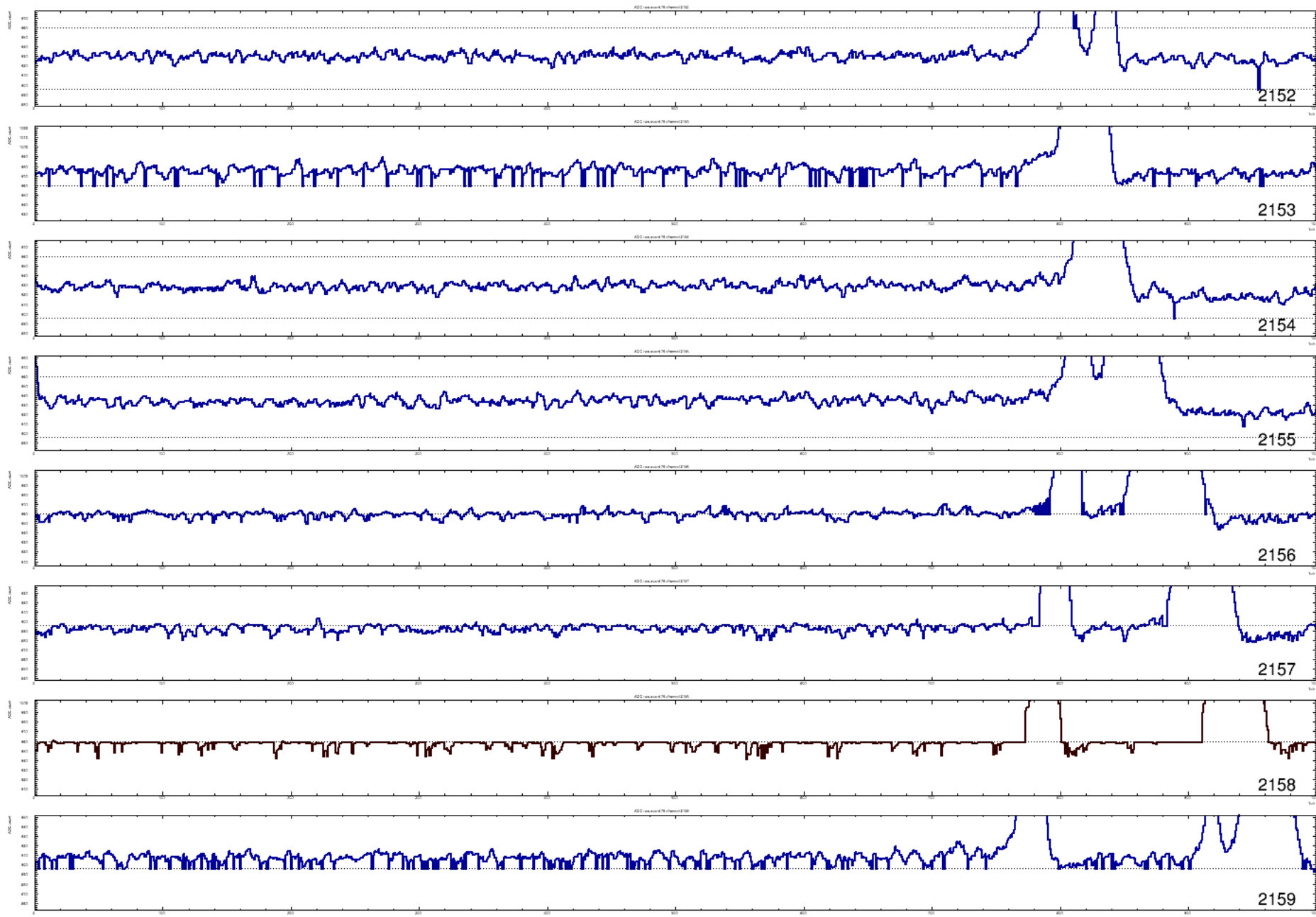


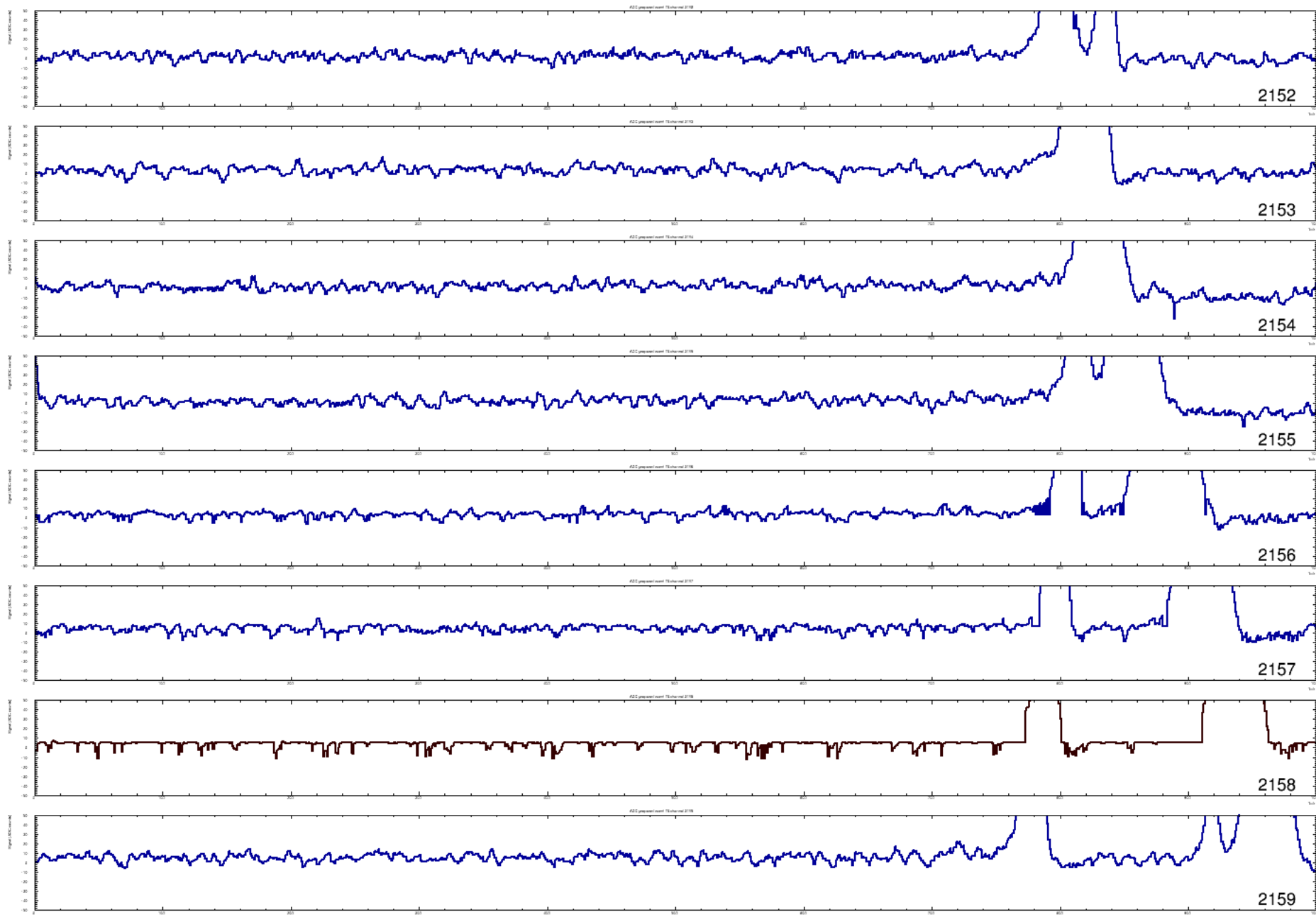


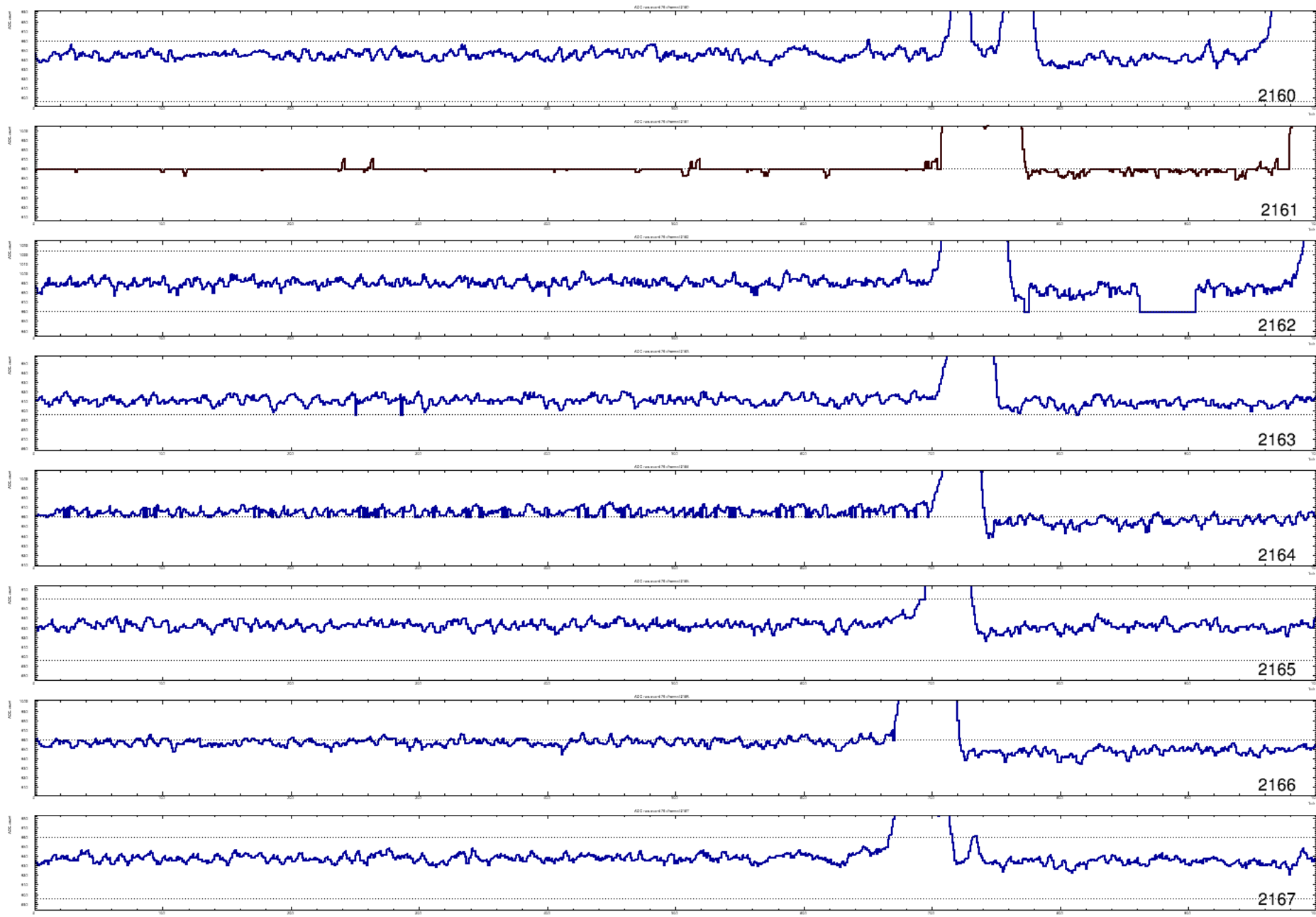


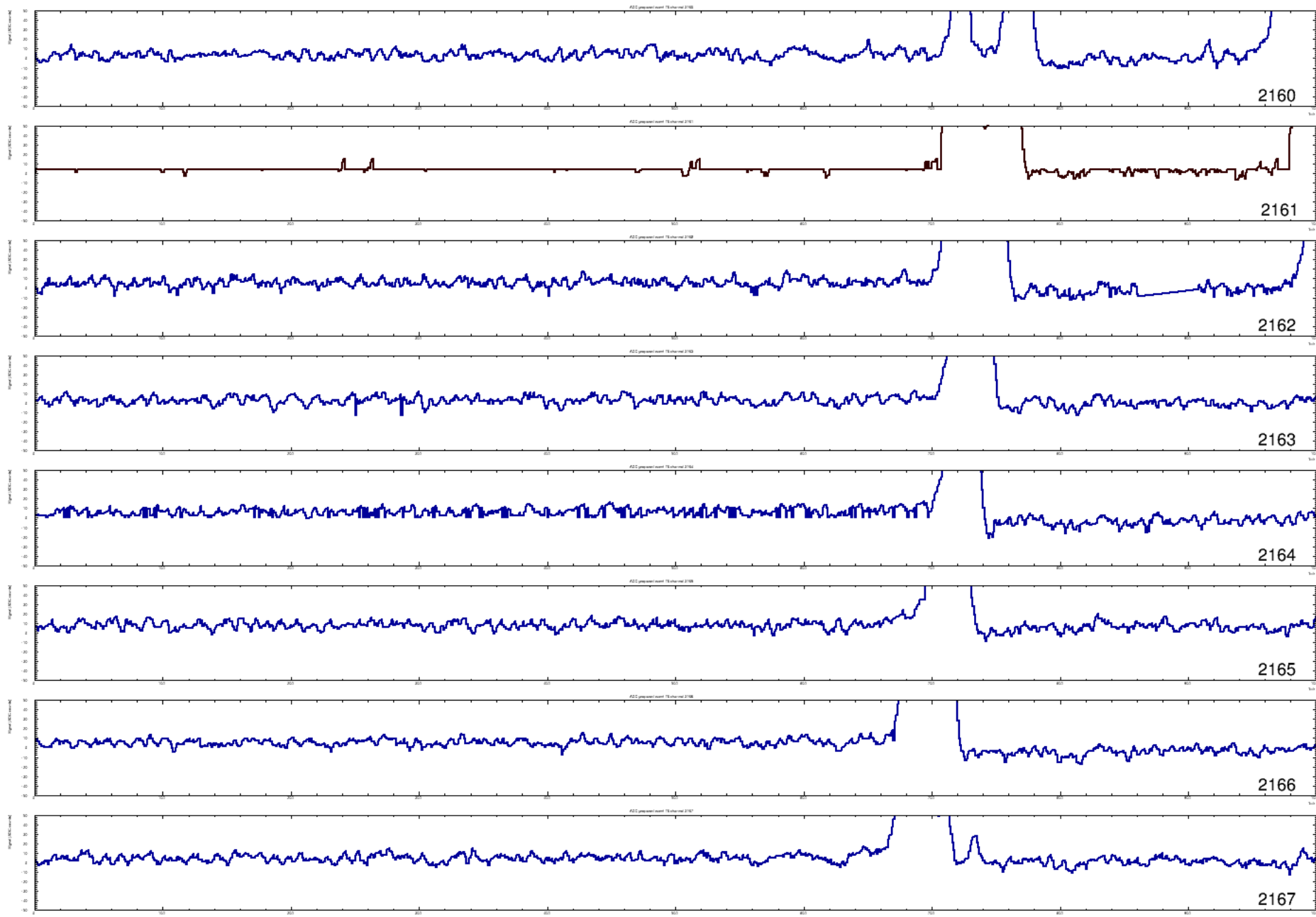


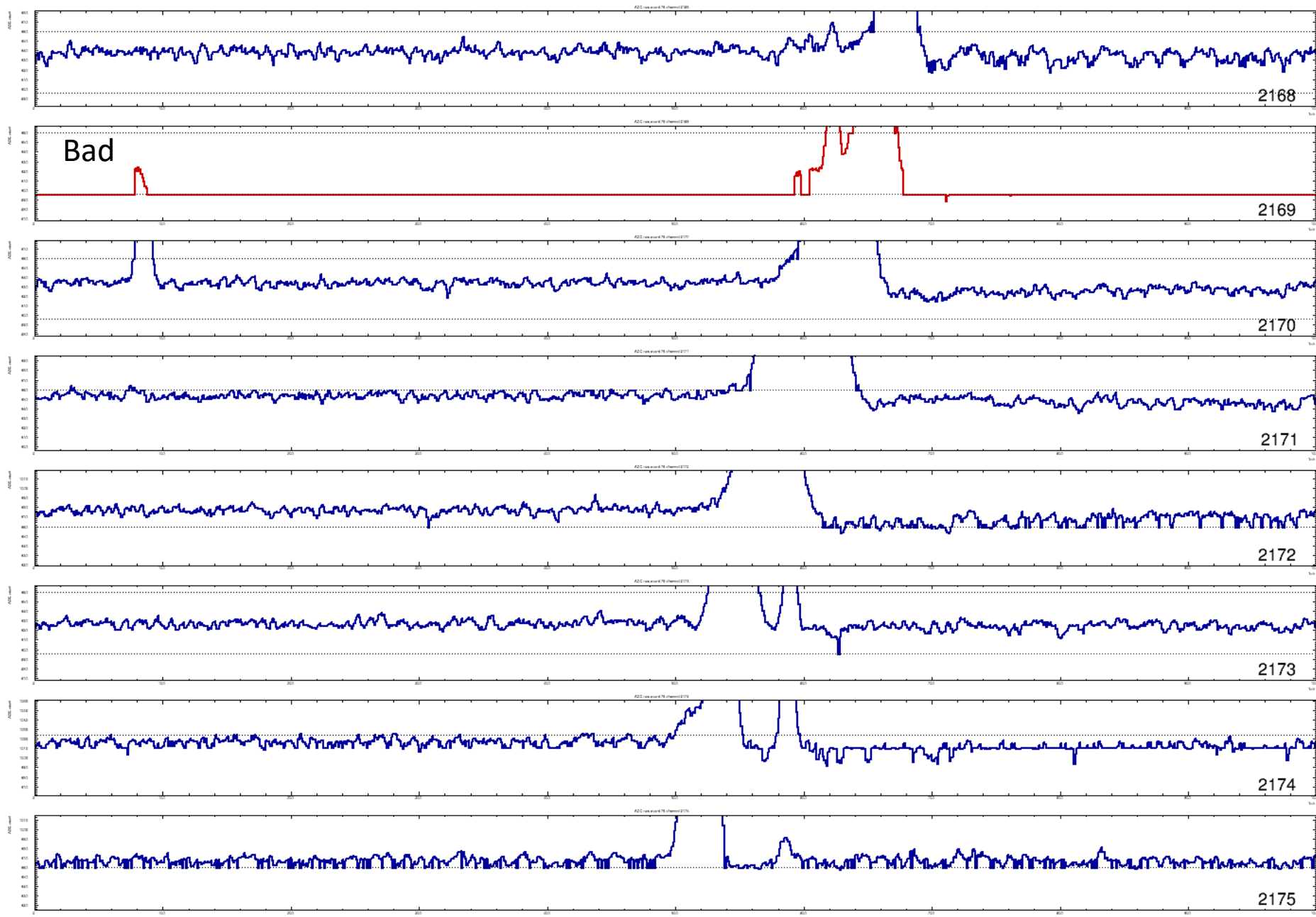


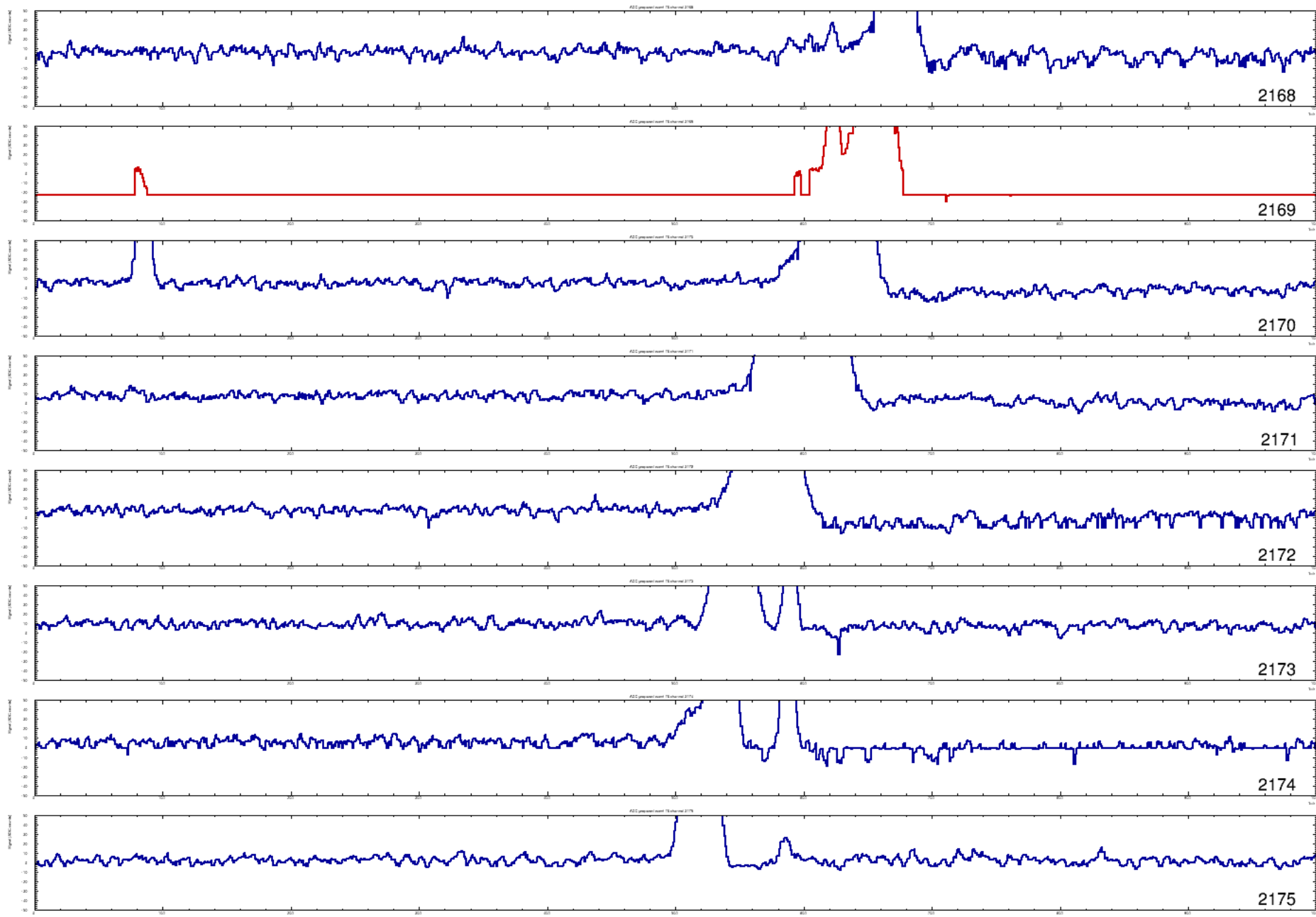












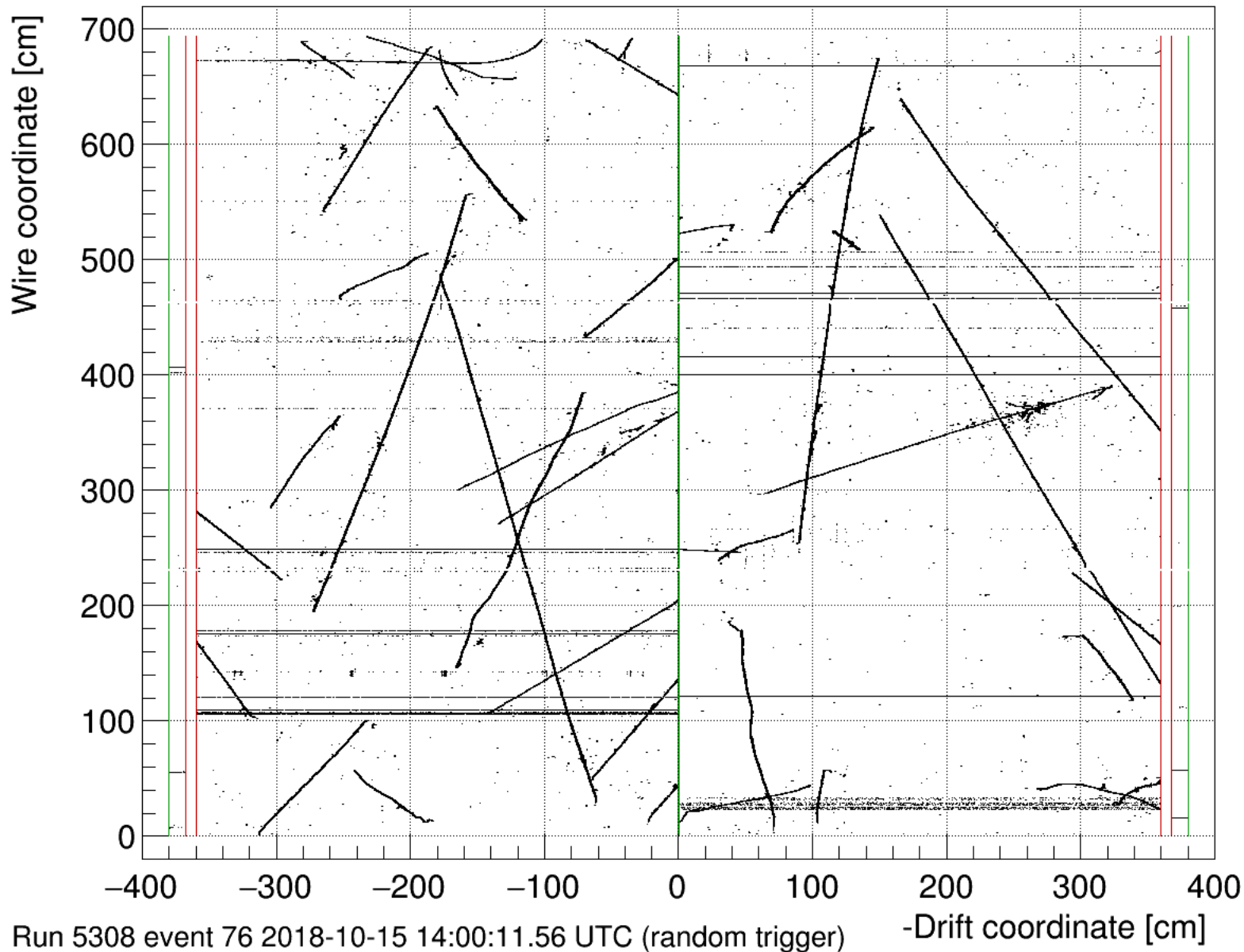
Event displays

Following slides show

- Detector displays
 - Threshold is 20 ADC counts (5X noise)
- Channel-tick displays
 - All APA 3 planes
 - All TPC-side collection planes
 - Plots here show all 6k ticks averaging over 5 bins
- Both for the different stages of data prep

Detector display: collection view

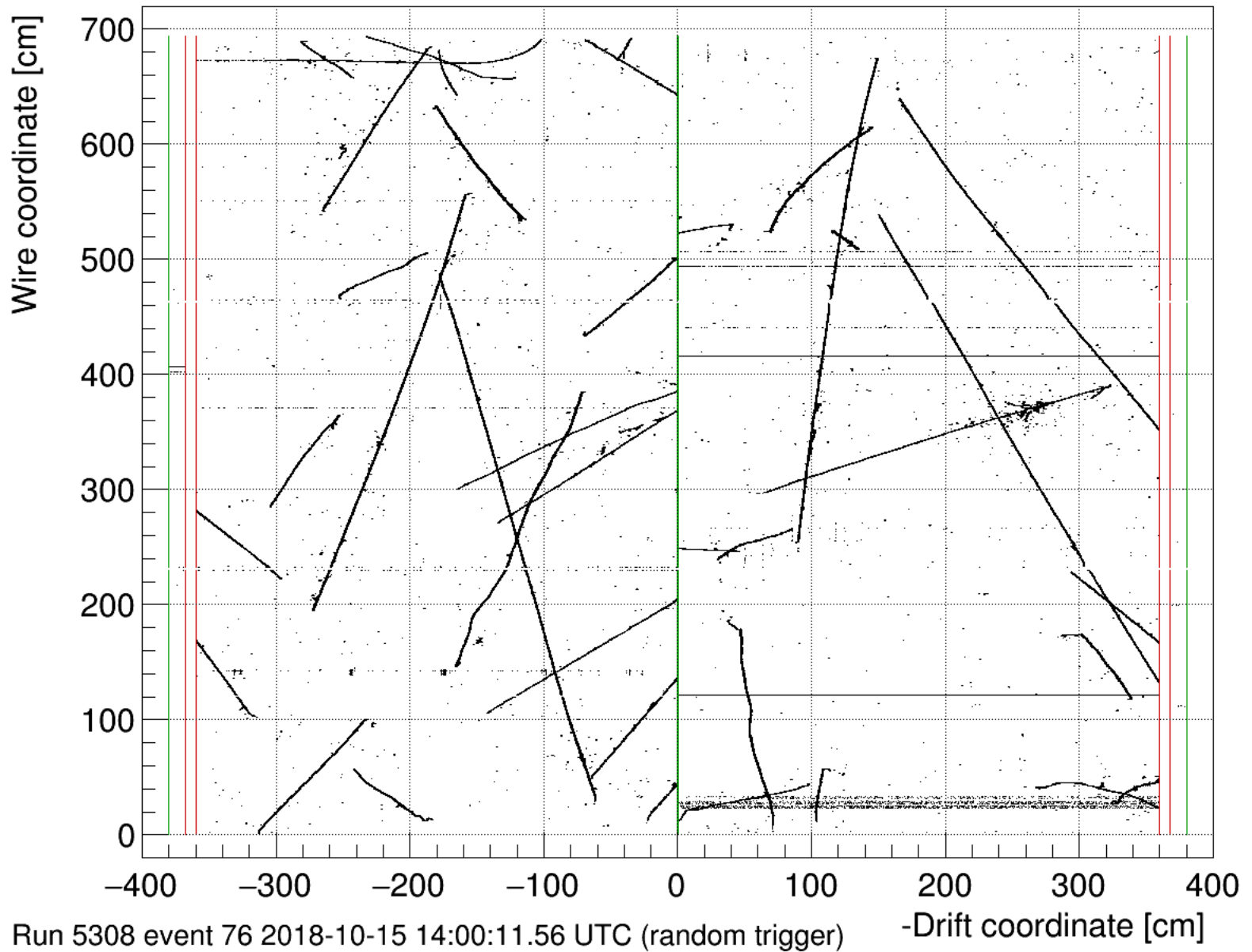
Raw ADC collection view (pedestal subtracted)



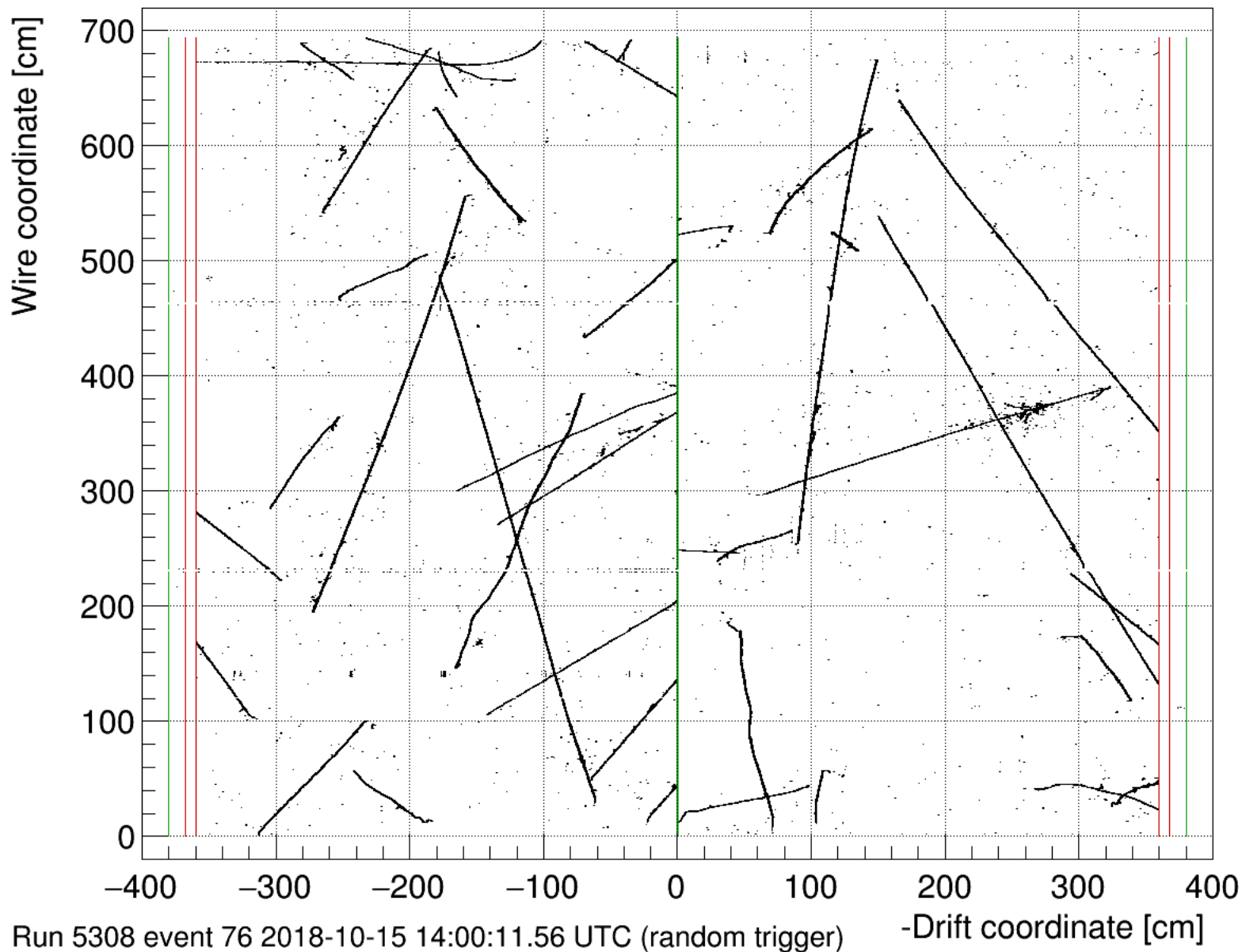
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

-Drift coordinate [cm]

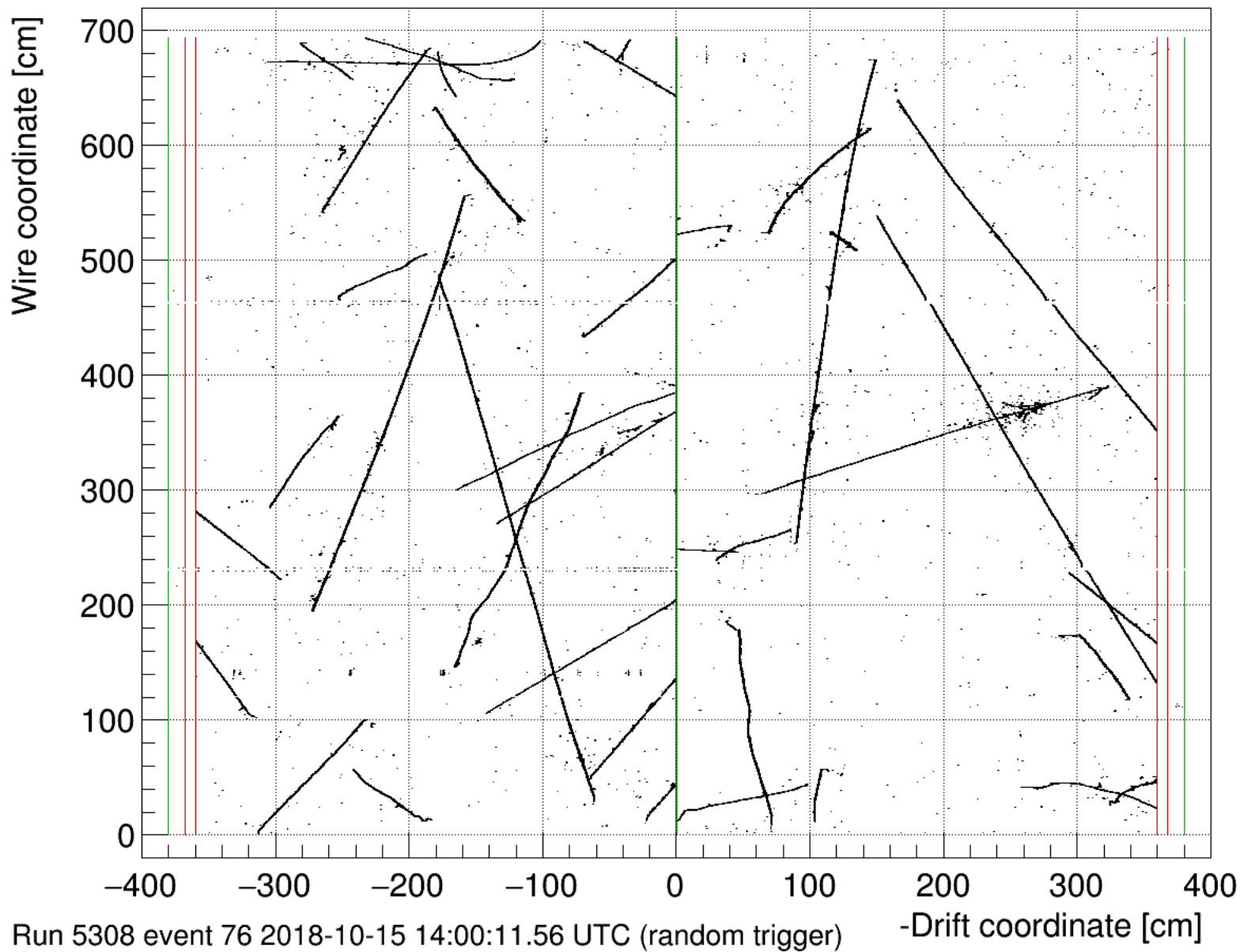
Calibrated ADC collection view (bad channels removed)



Mitigated ADC collection view (sticky code and timing mit.)

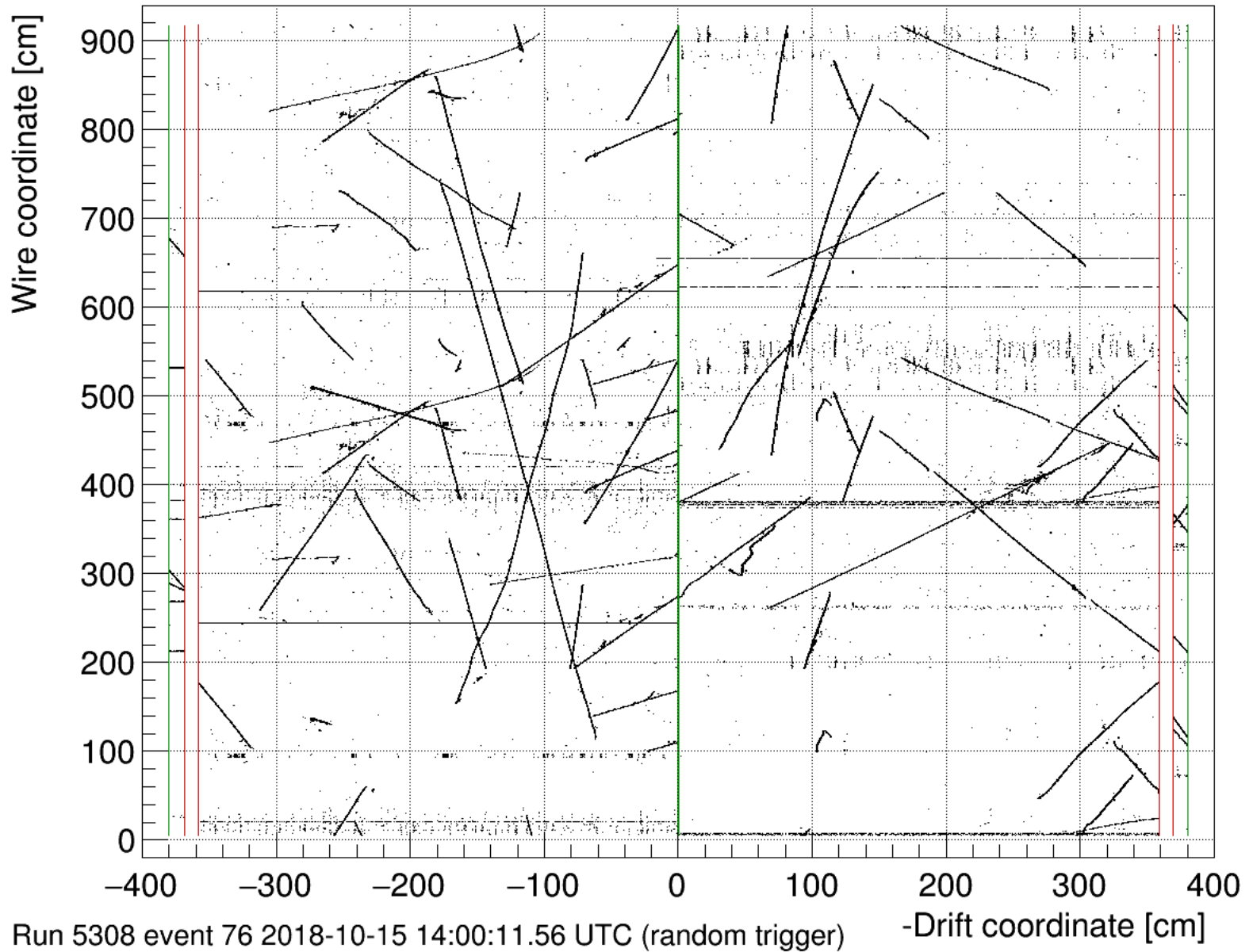


Corrected ADC collection view (tail correction applied)



Detector display: induction view 1

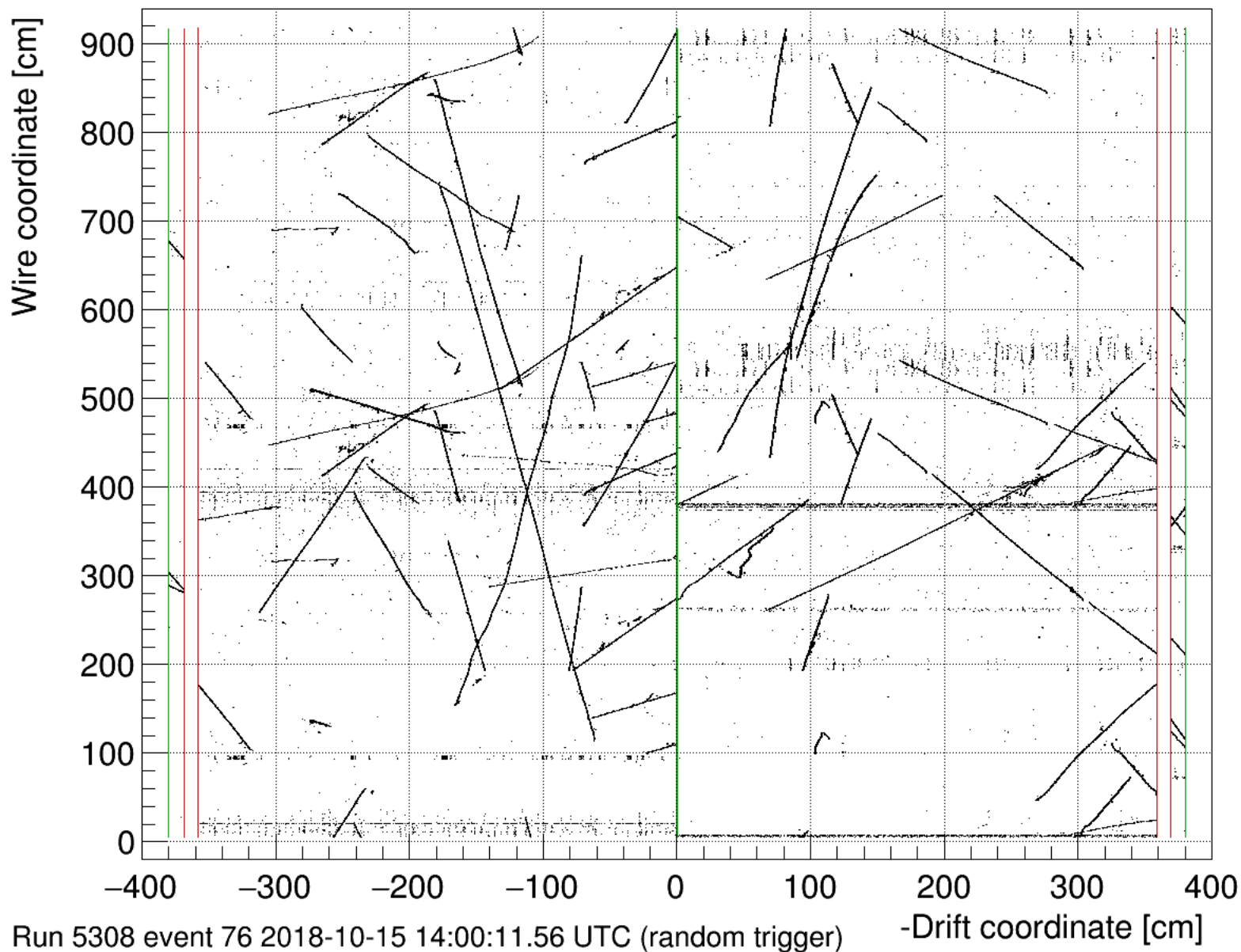
Raw ADC induction view 1



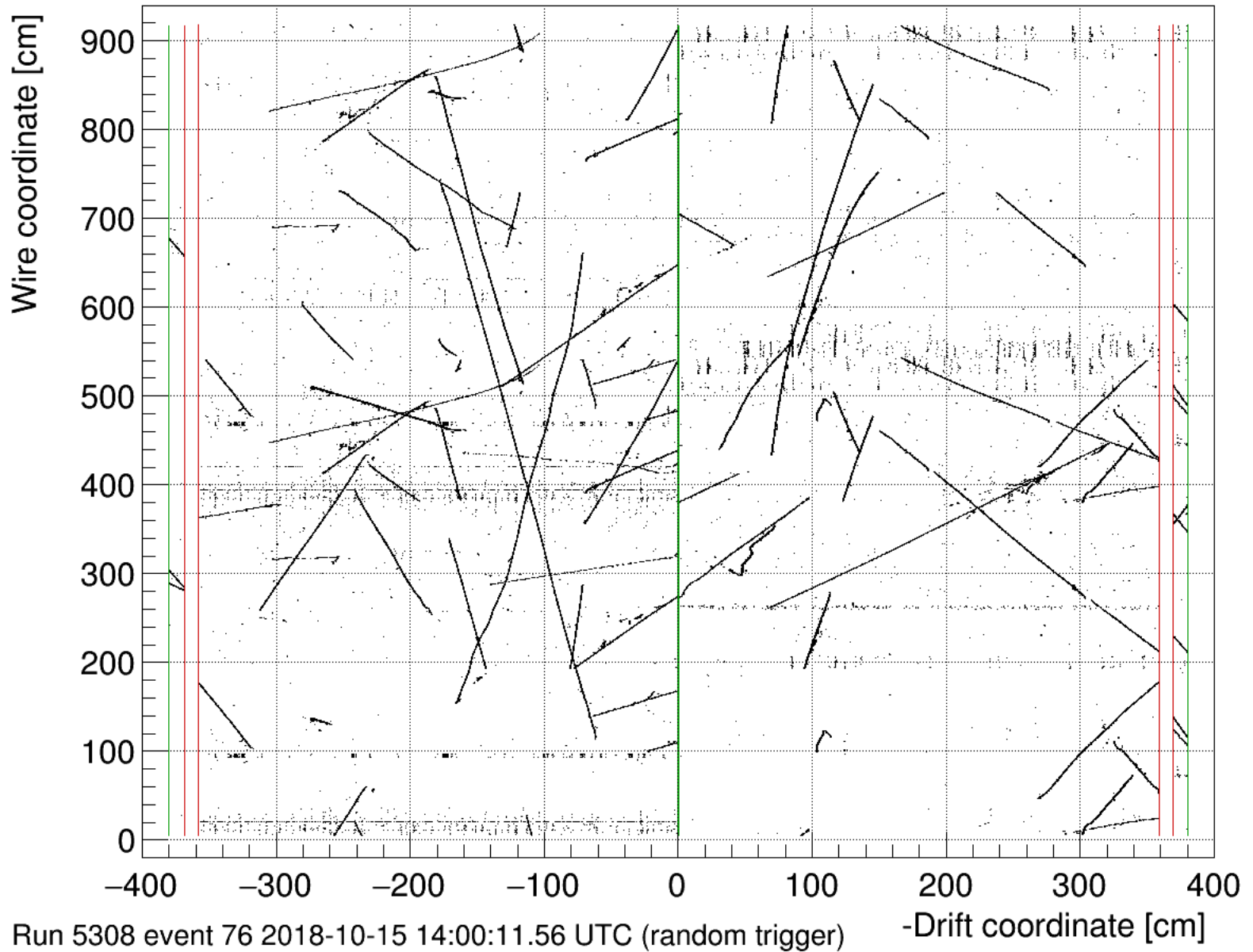
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

-Drift coordinate [cm]

Calibrated ADC induction view 2

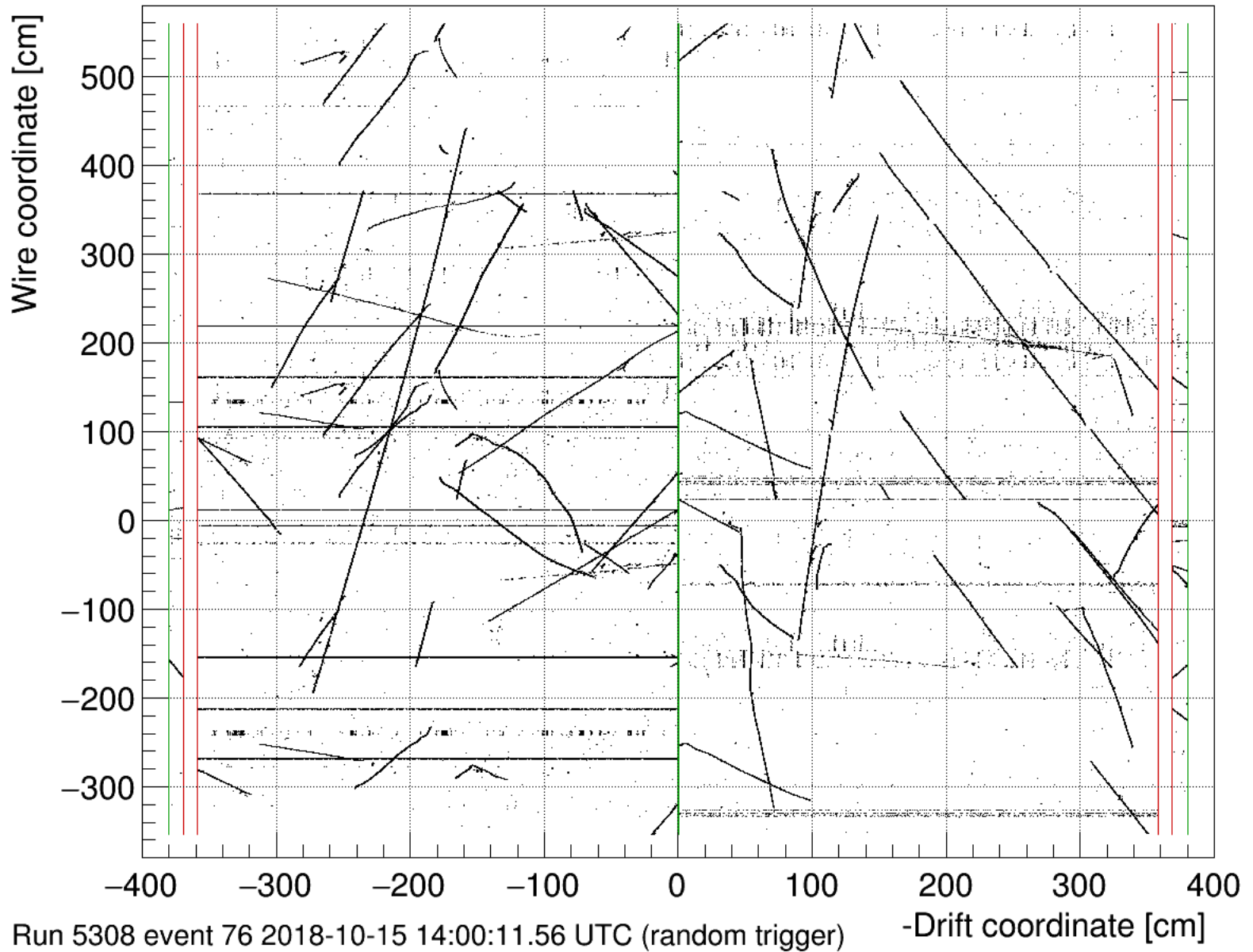


Mitigated ADC induction view 1

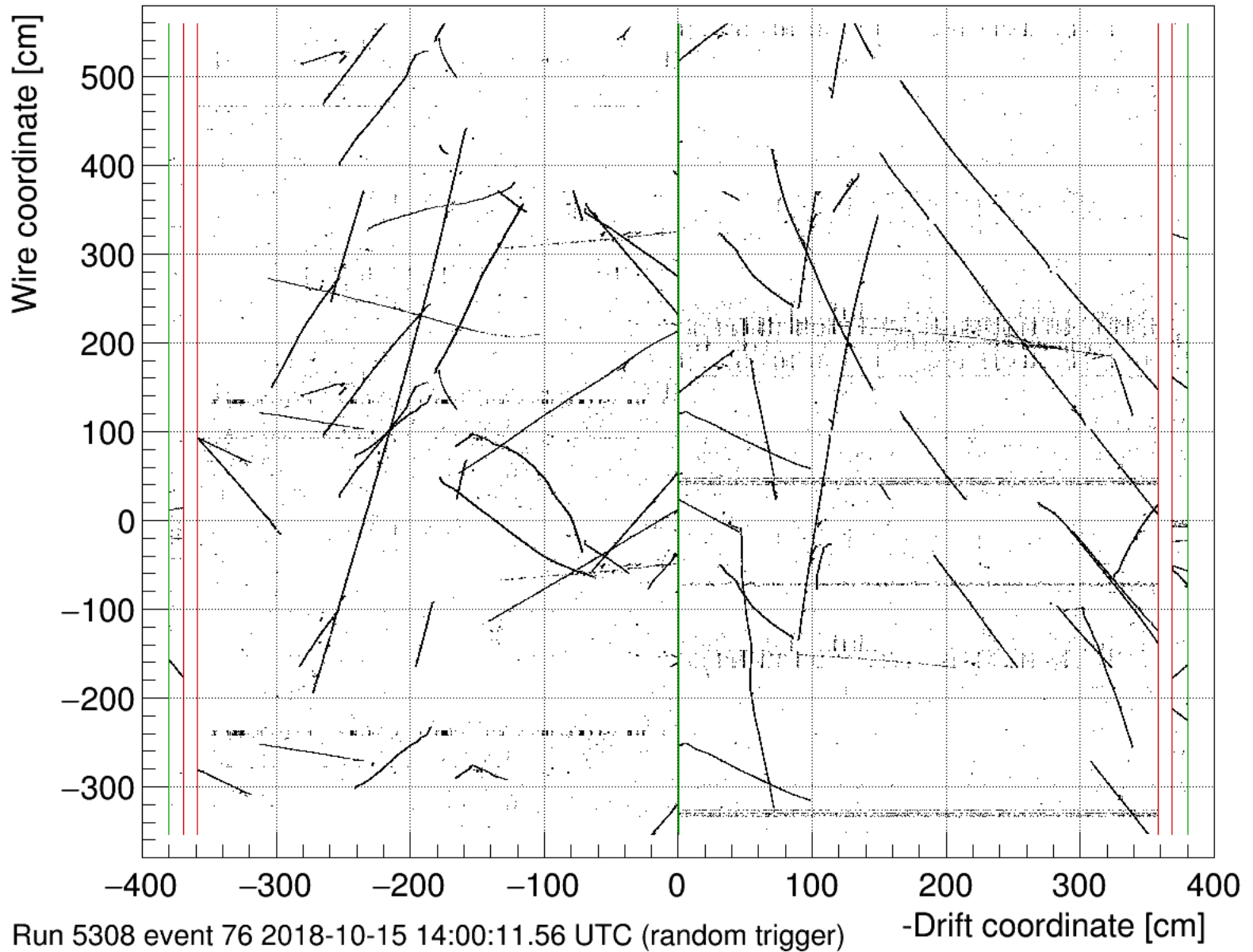


Detector display: induction view 2

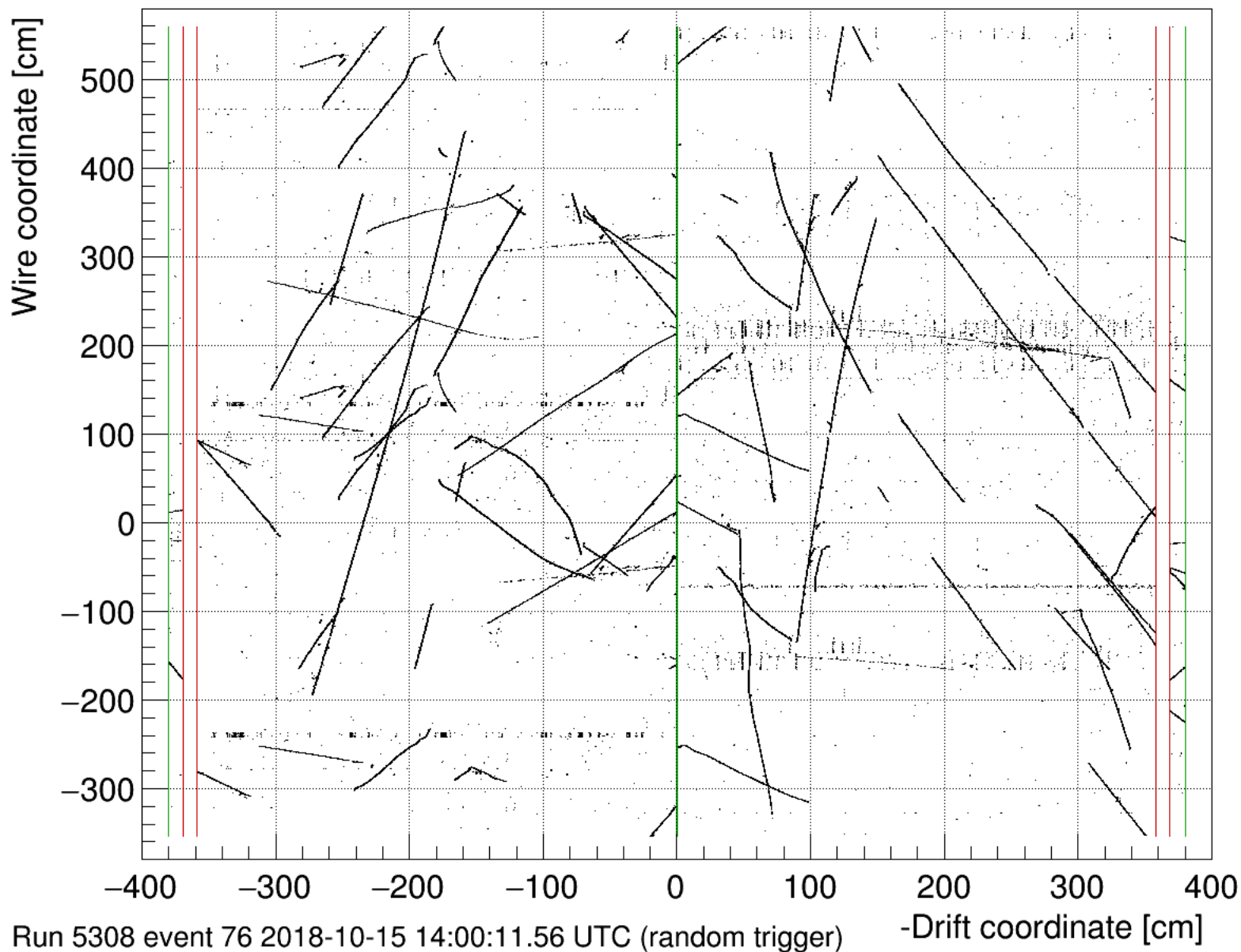
Raw ADC induction view 2



Calibrated ADC induction view 2

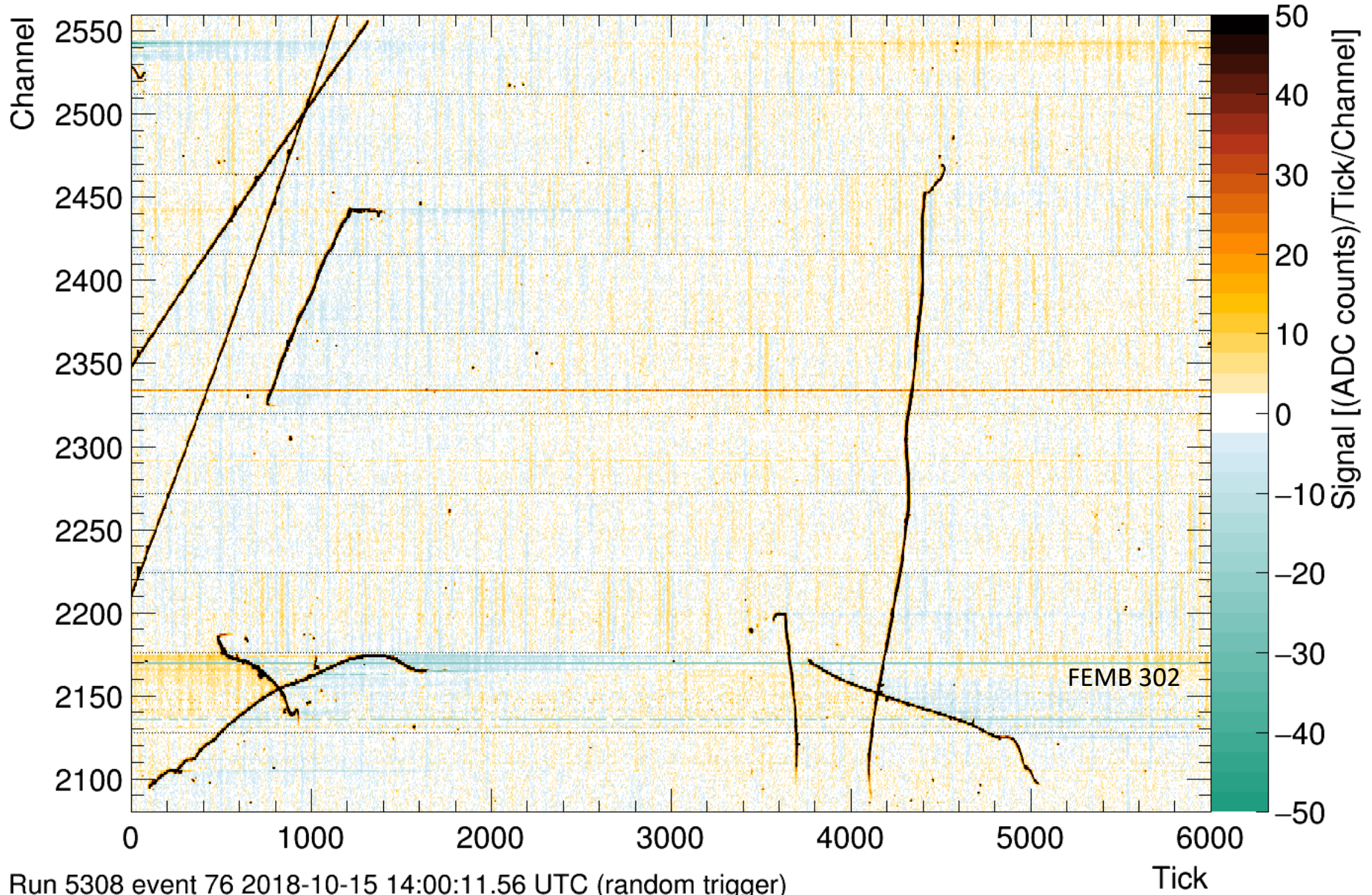


Mitigated ADC induction view 2



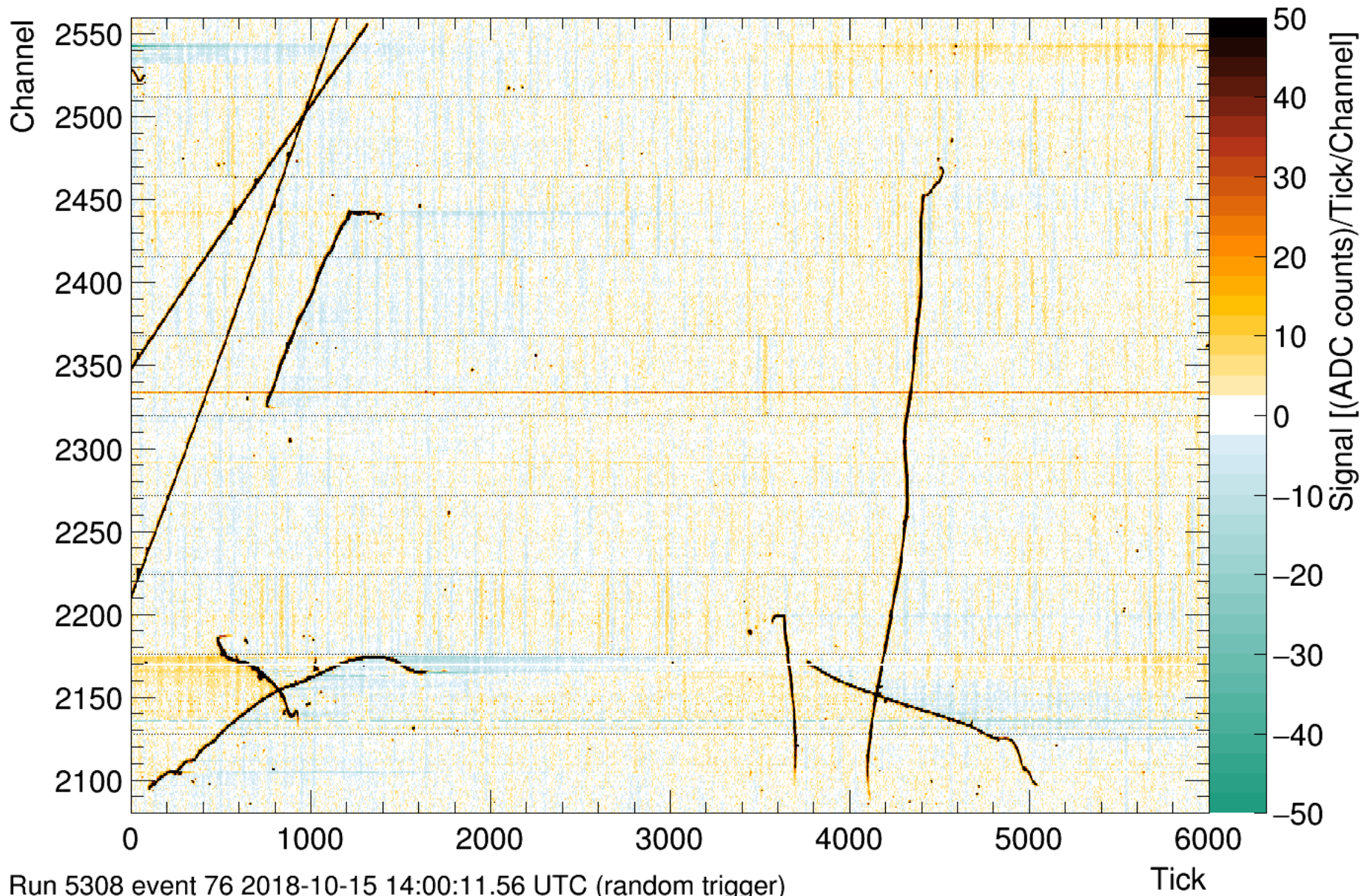
APA 3 collection

Raw ADC for TPC plane 0z (APA 3: US-RaS)



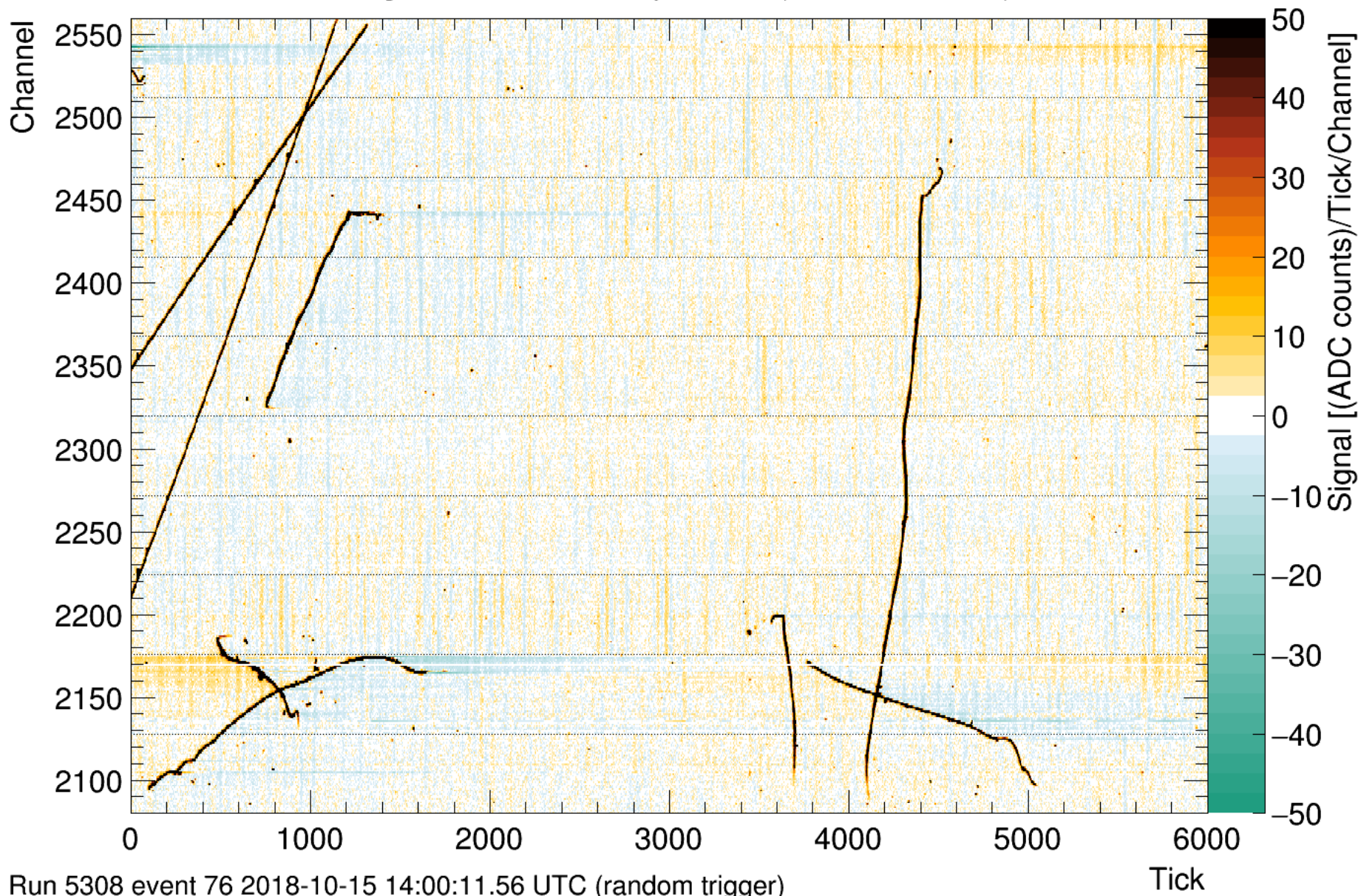
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 0z (APA 3: US-RaS)



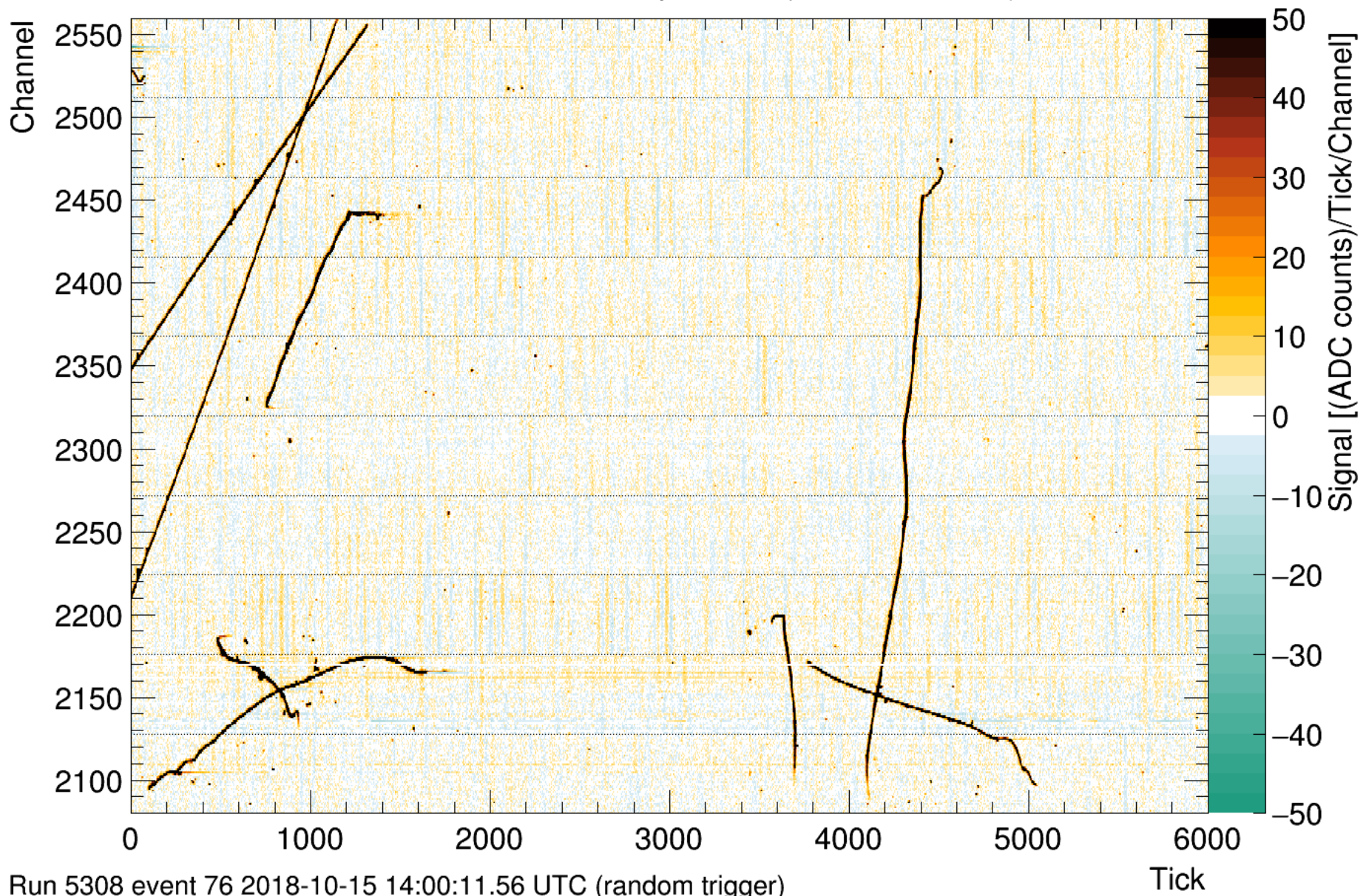
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 0z (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

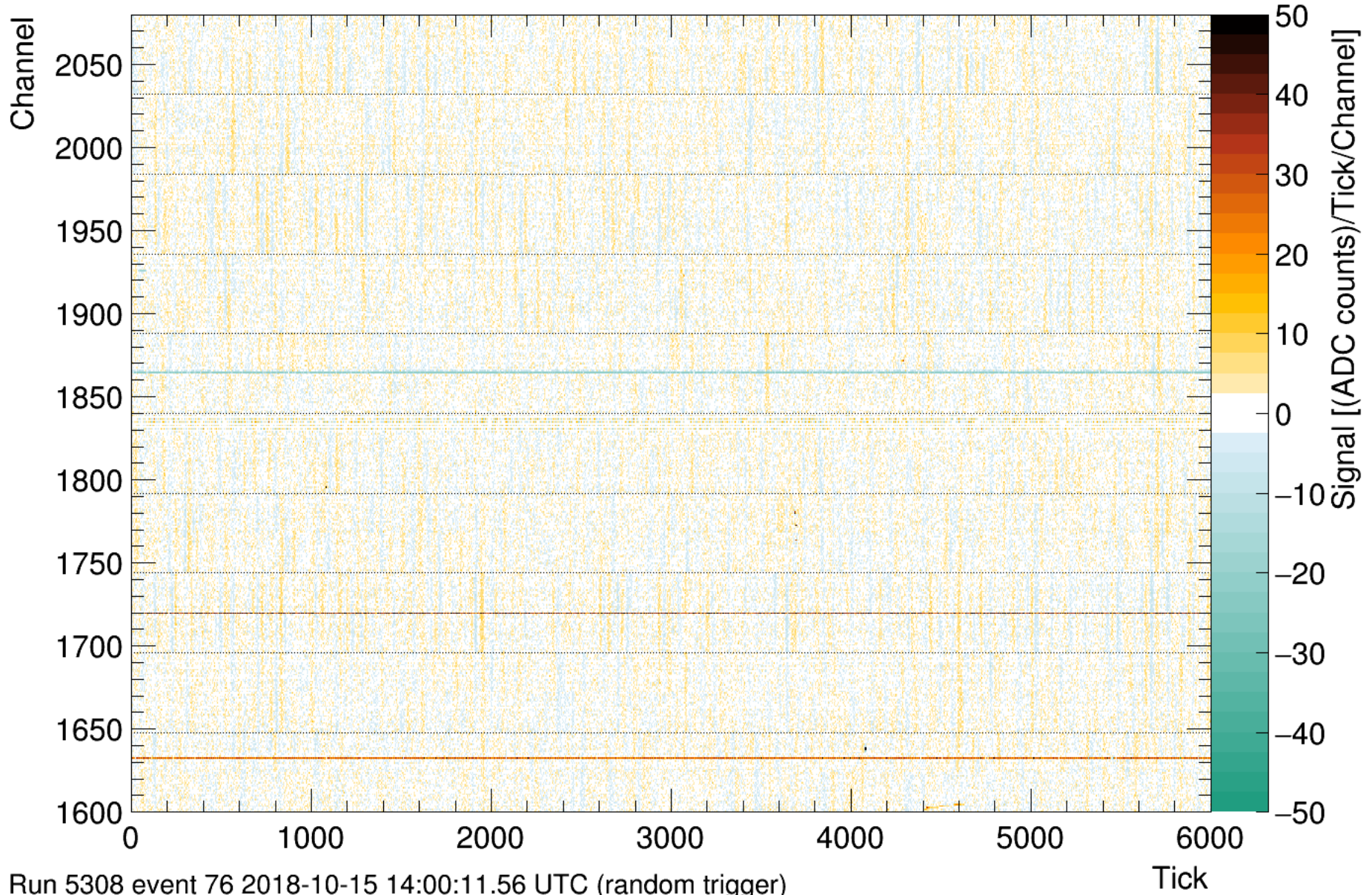
Corrected ADC for TPC plane 0z (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

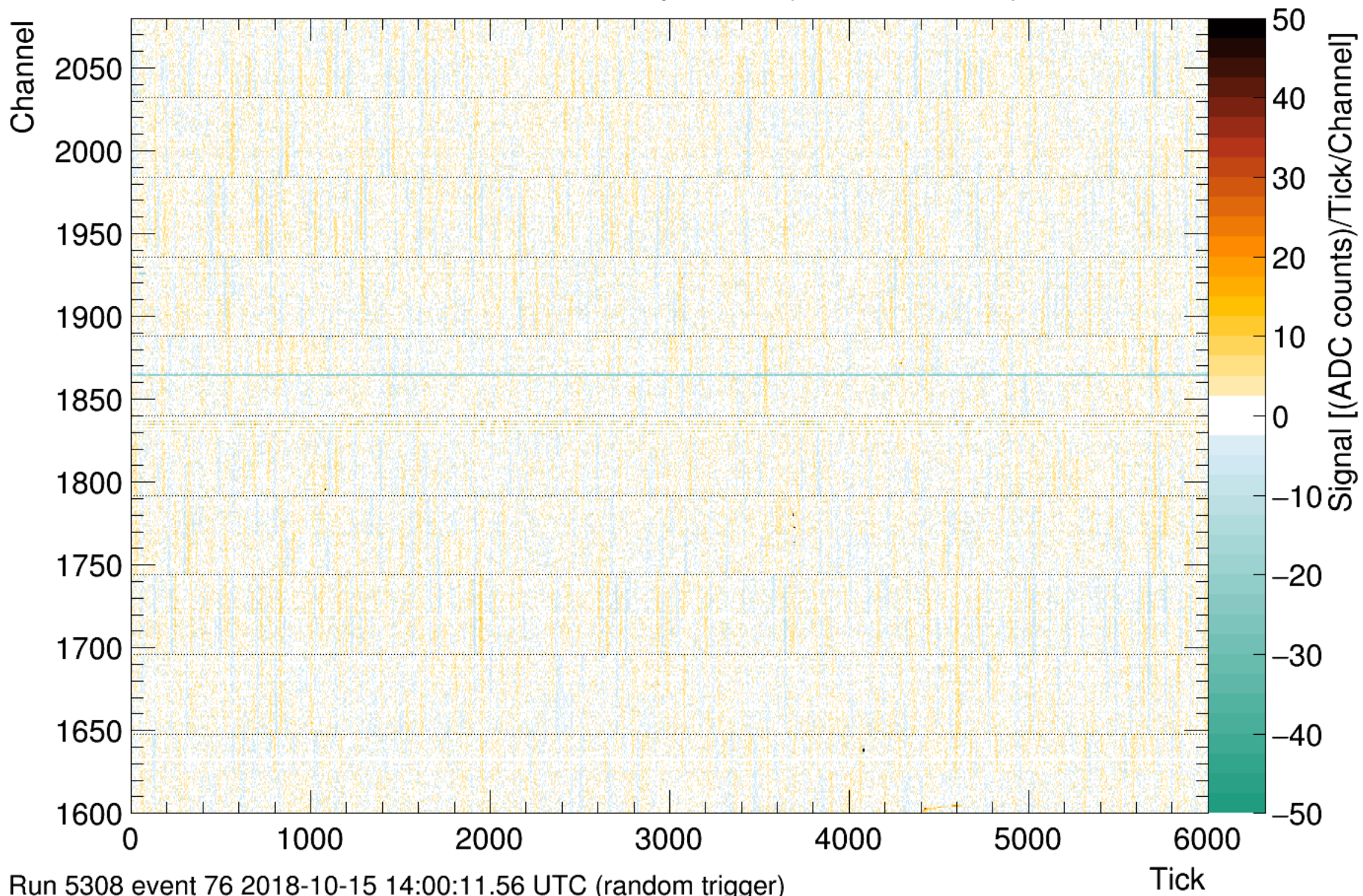
APA 3 cryo-side collection

Raw ADC for TPC plane 0c (APA 3: US-RaS)



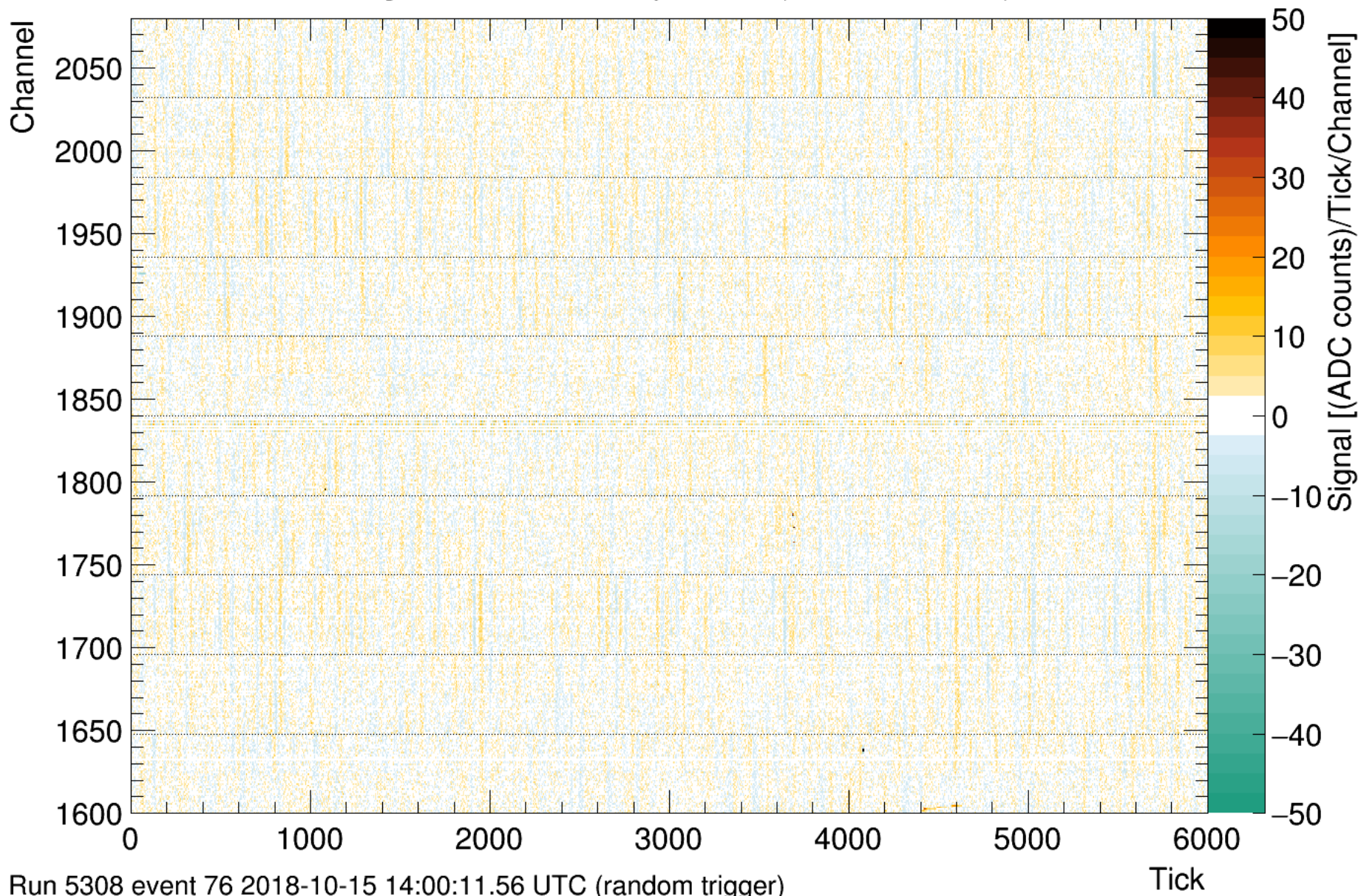
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 0c (APA 3: US-RaS)



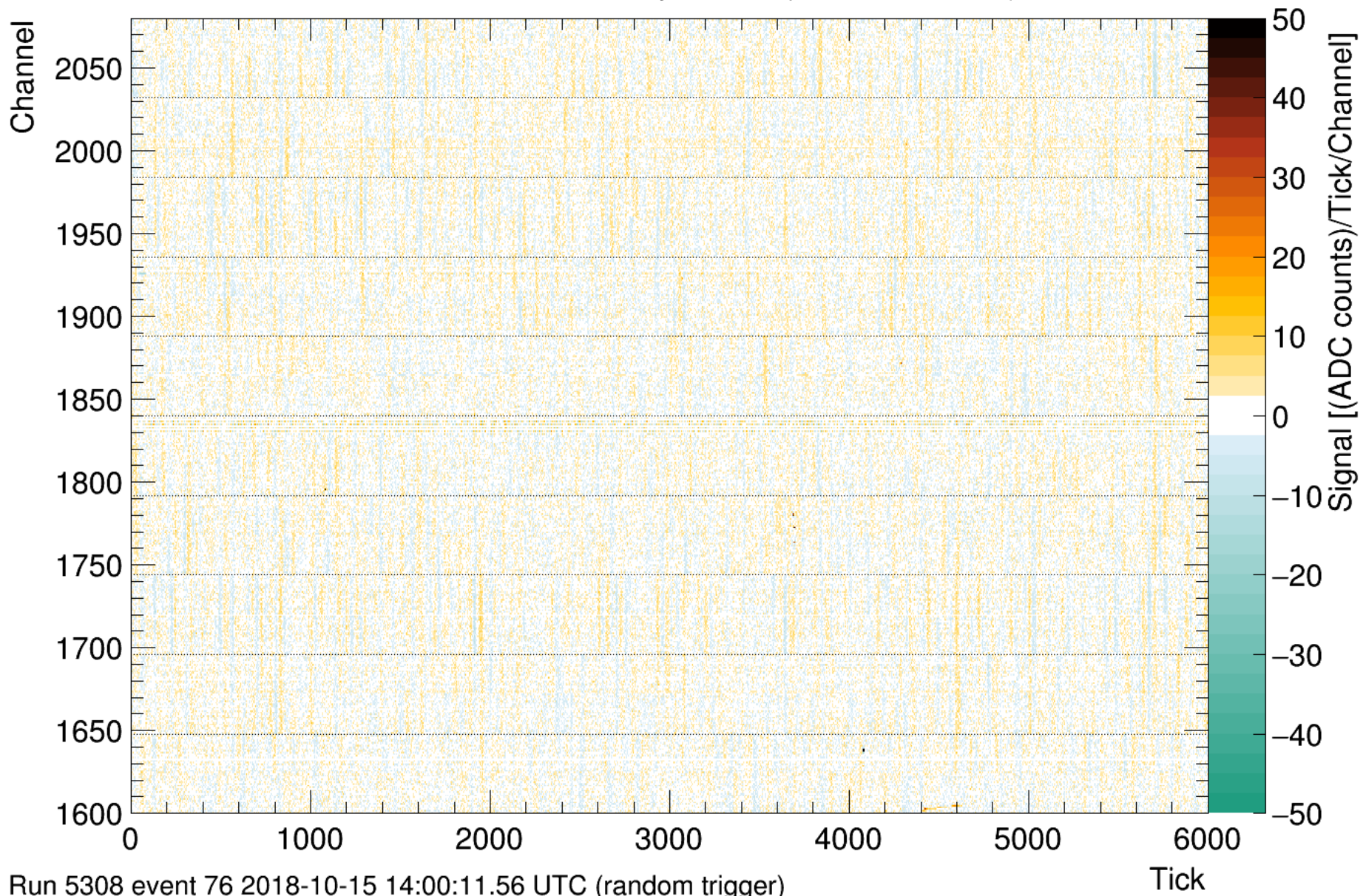
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 0c (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

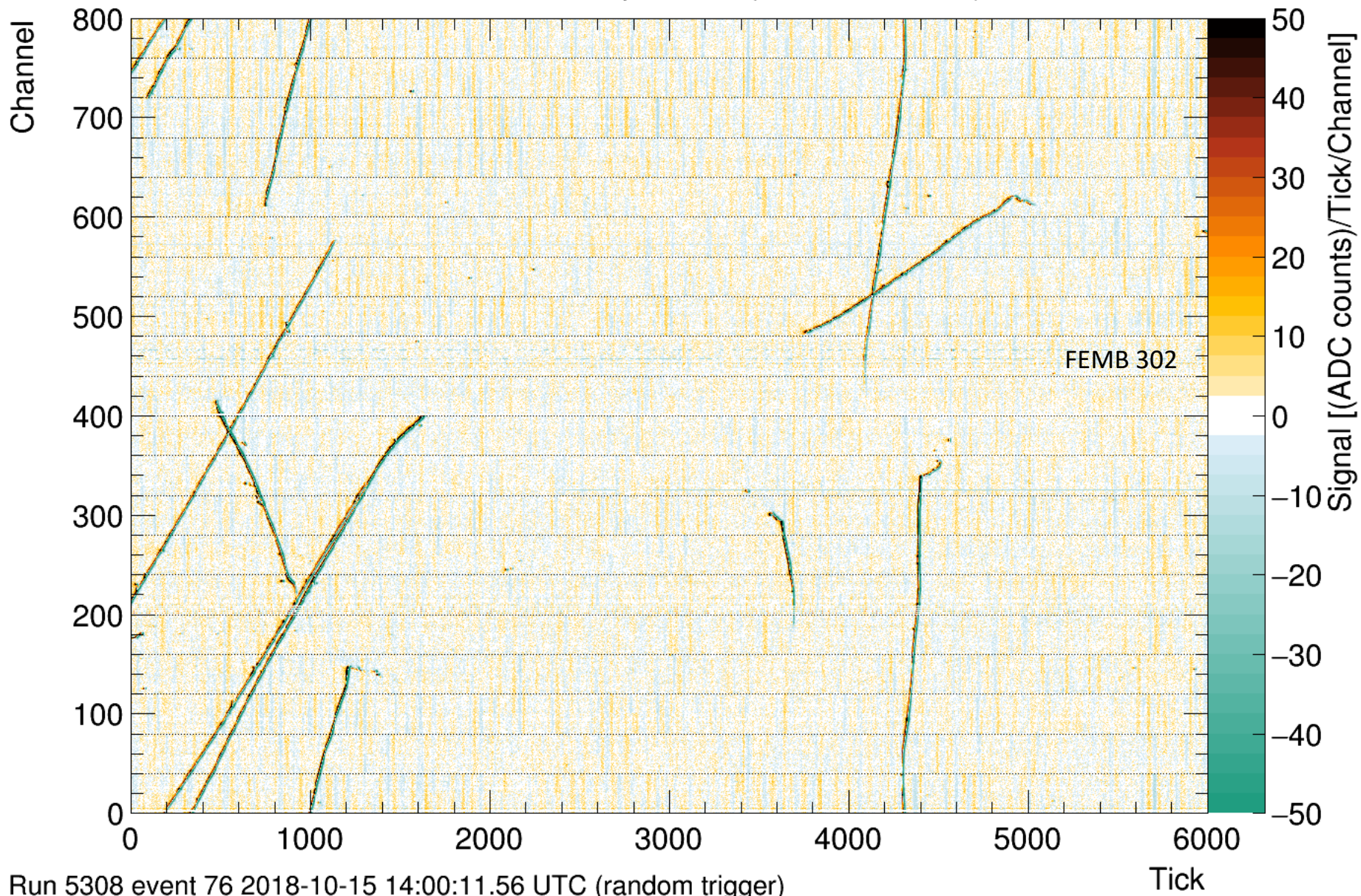
Corrected ADC for TPC plane 0c (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

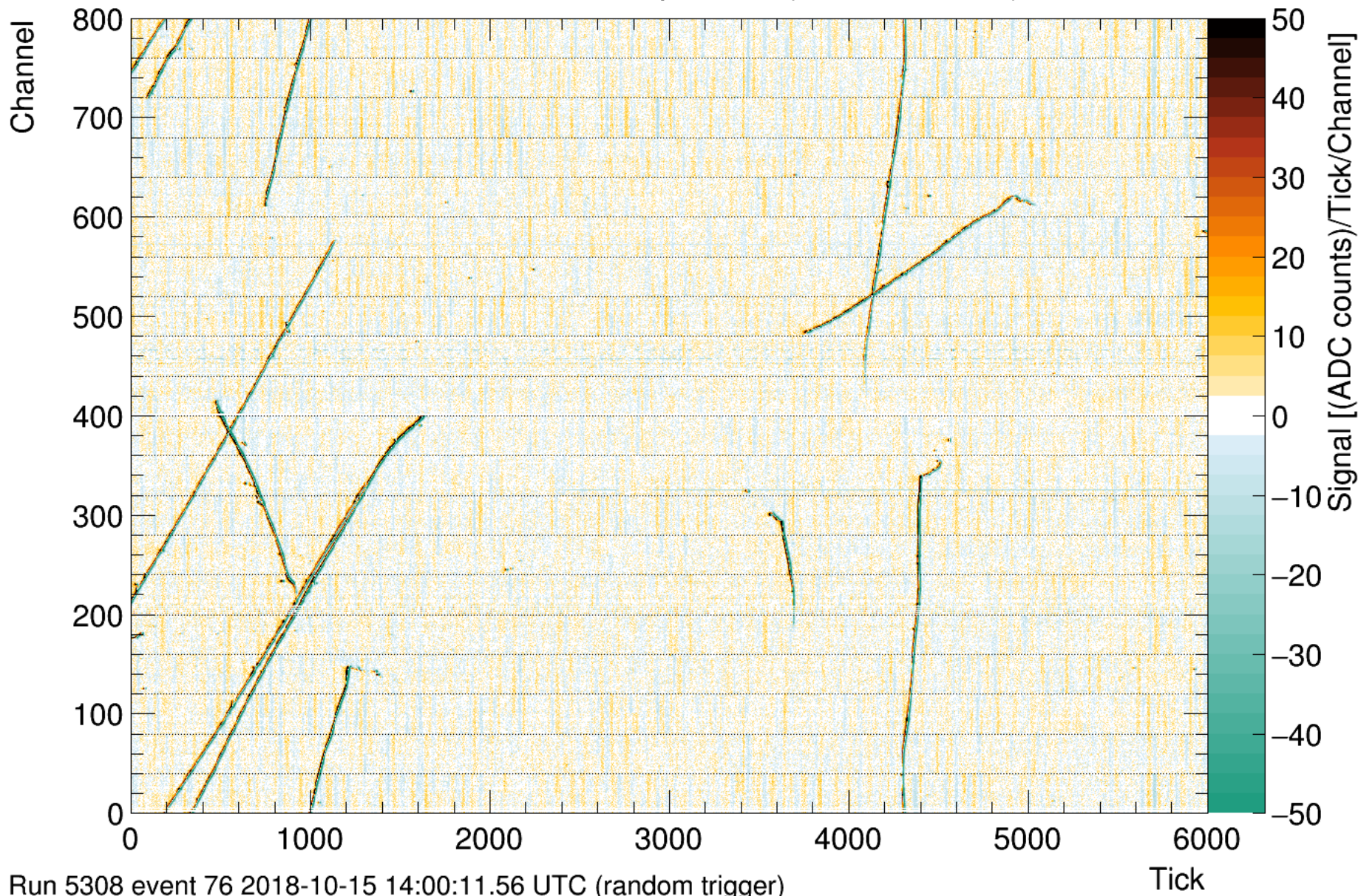
APA 3 induction u

Raw ADC for TPC plane 0u (APA 3: US-RaS)



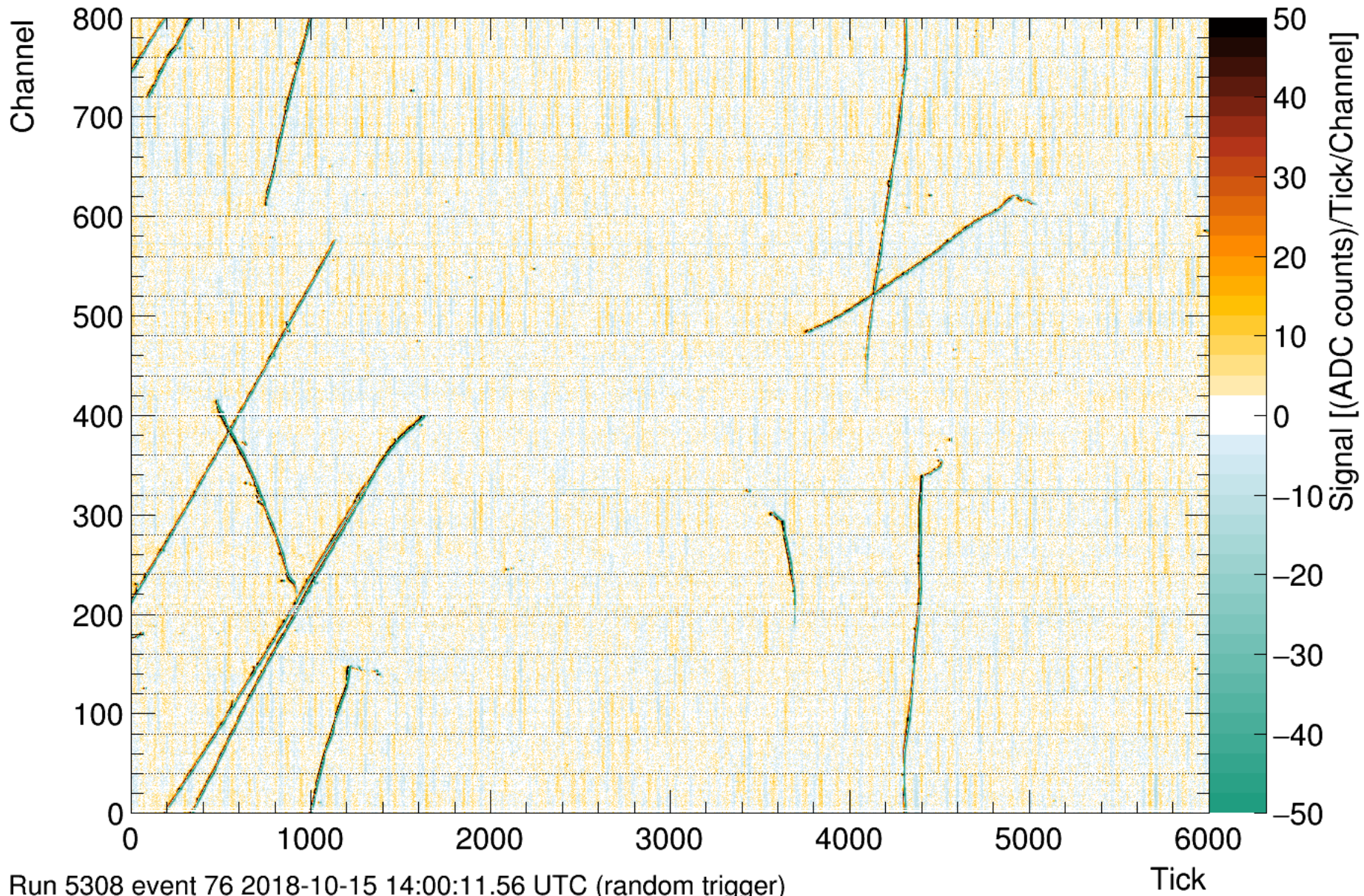
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 0u (APA 3: US-RaS)



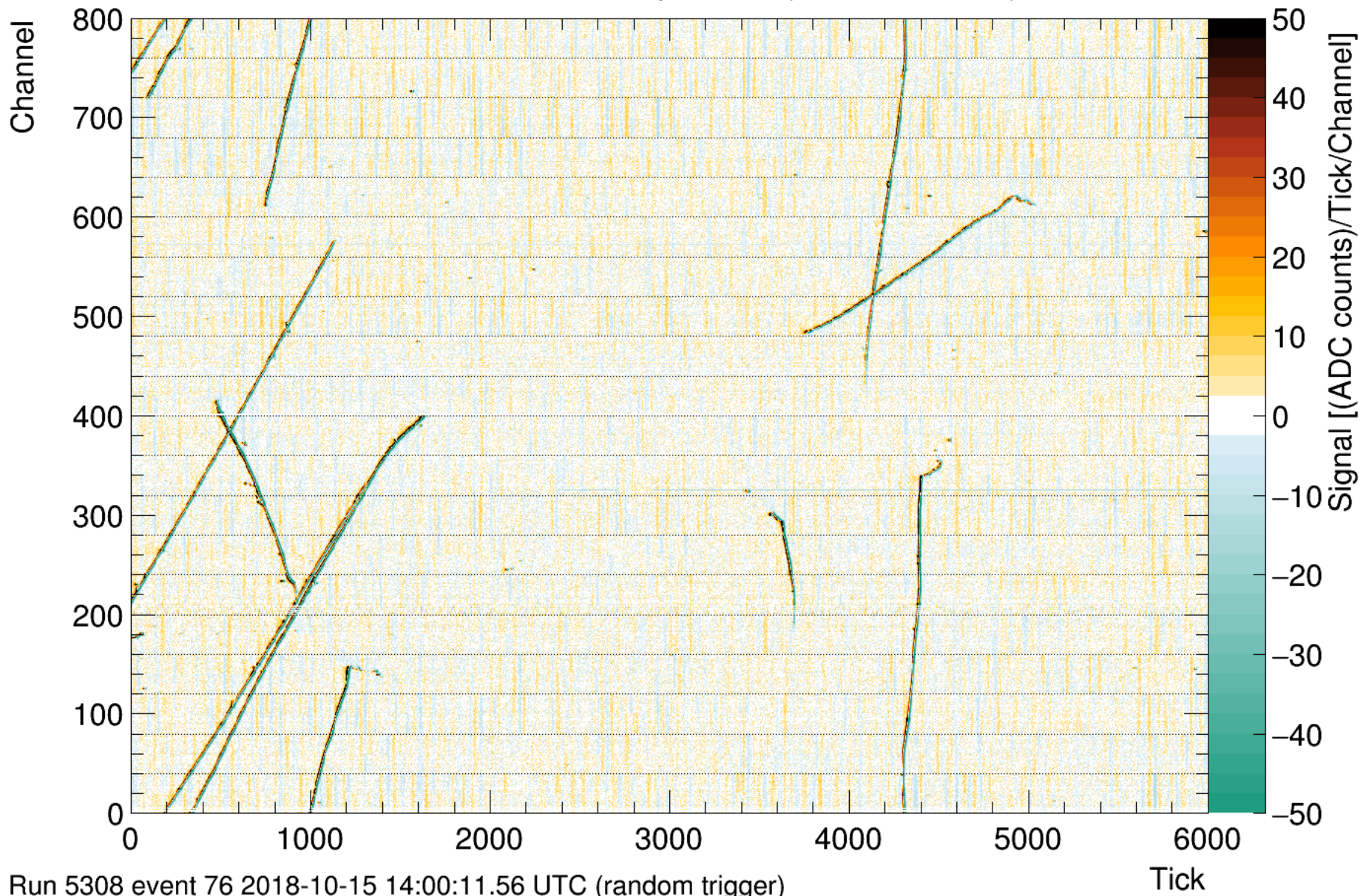
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 0u (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

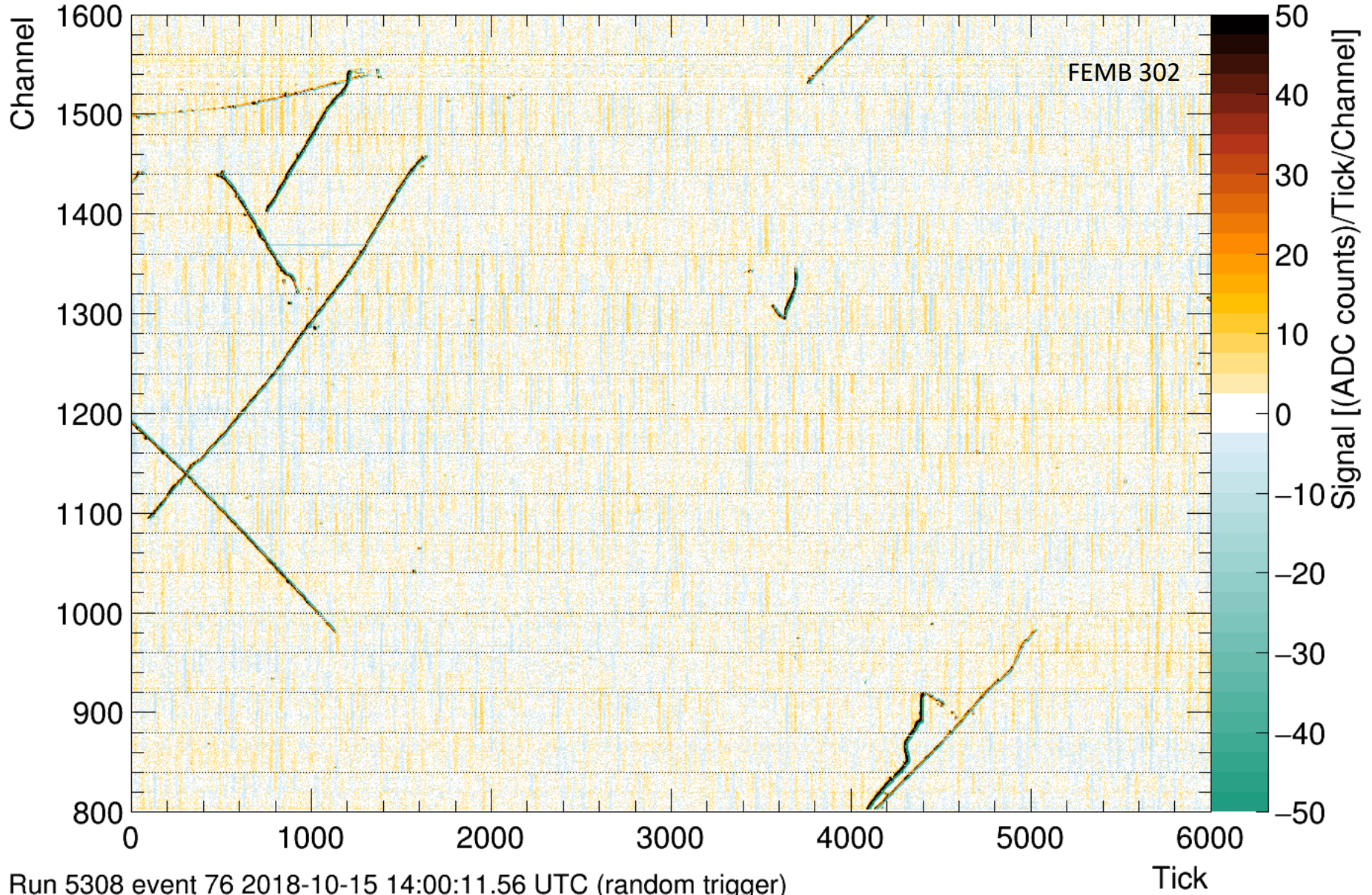
Corrected ADC for TPC plane 0u (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

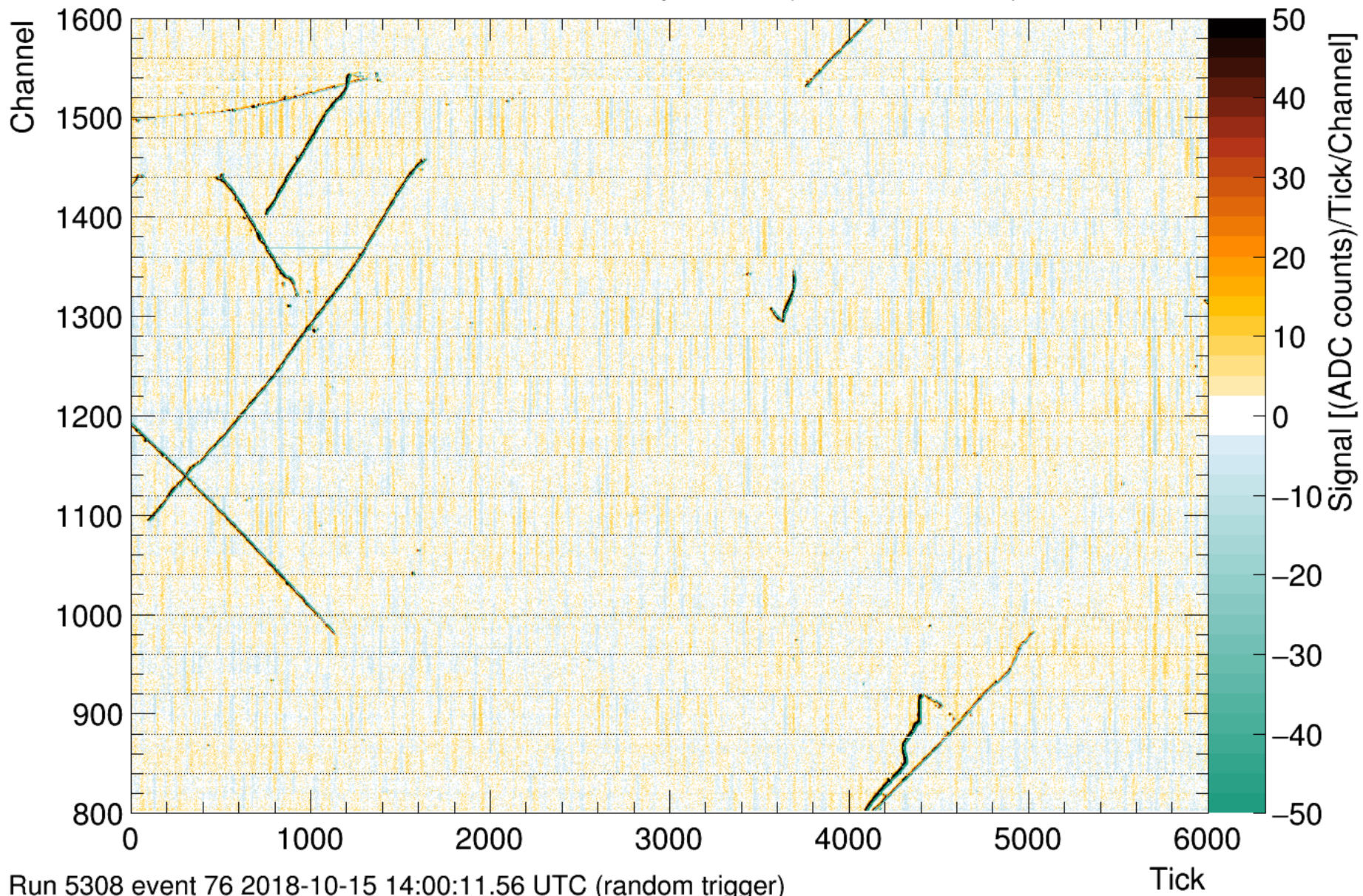
APA 3 induction v

Raw ADC for TPC plane 0v (APA 3: US-RaS)



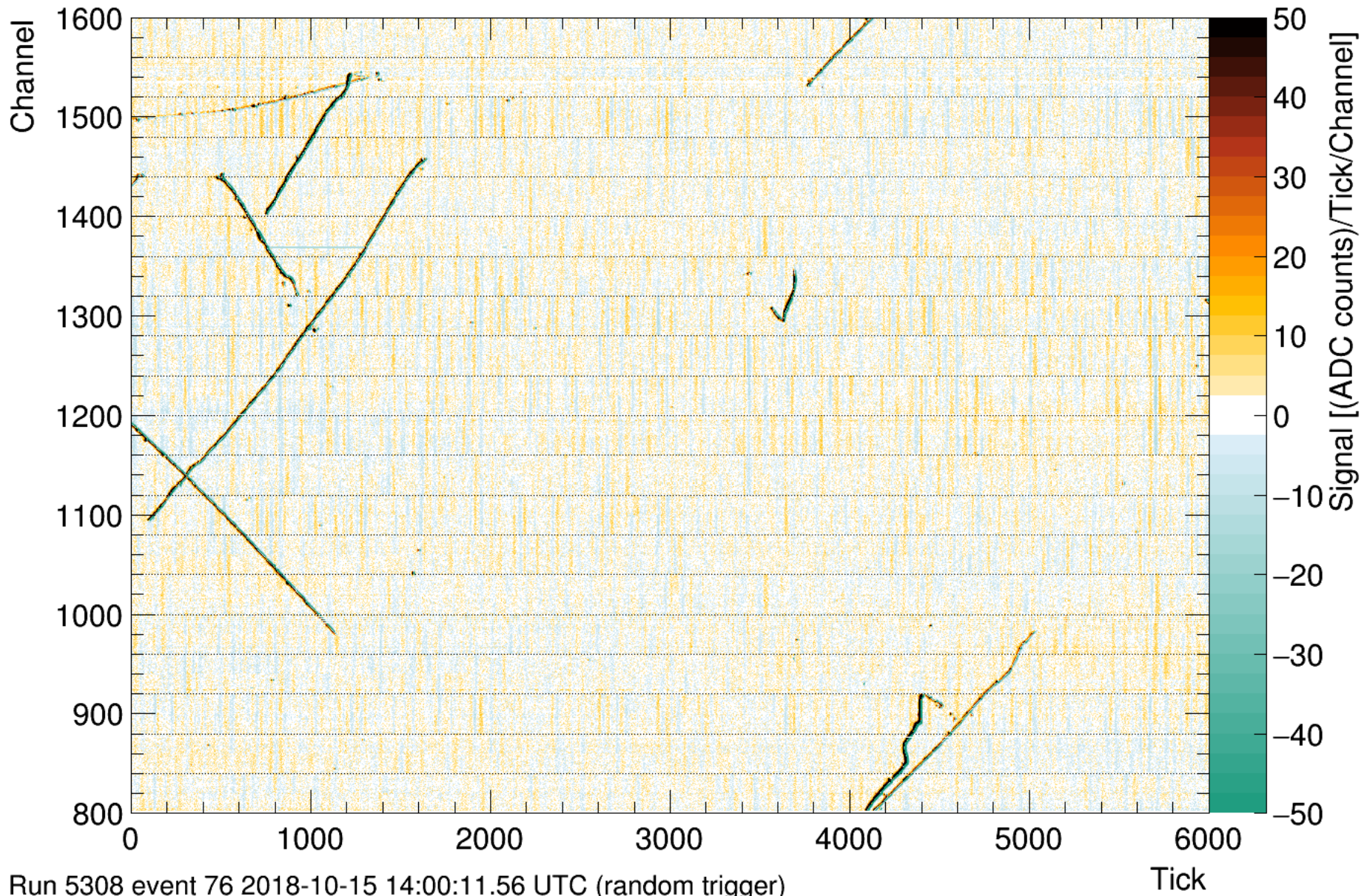
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 0v (APA 3: US-RaS)



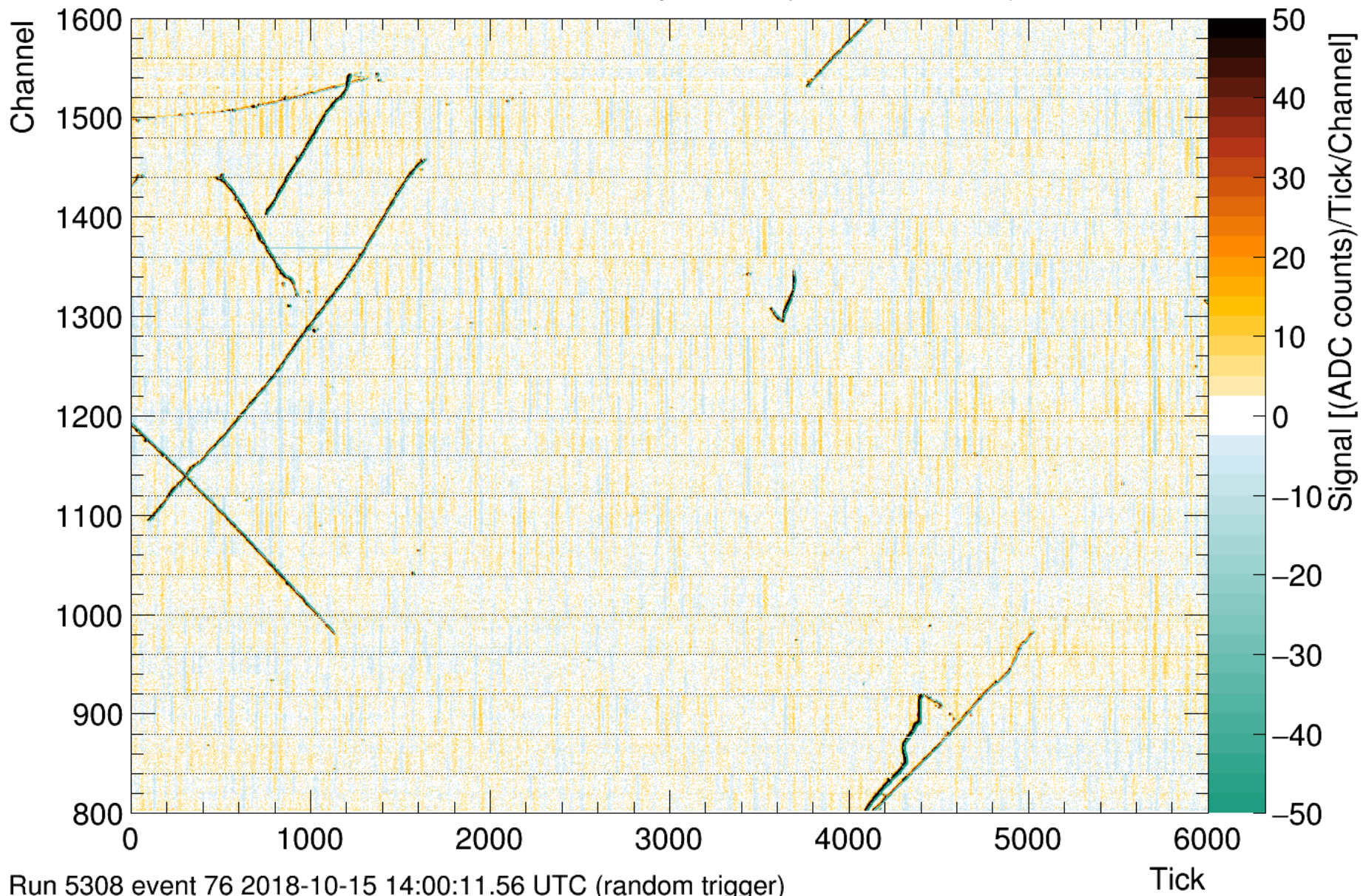
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 0v (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

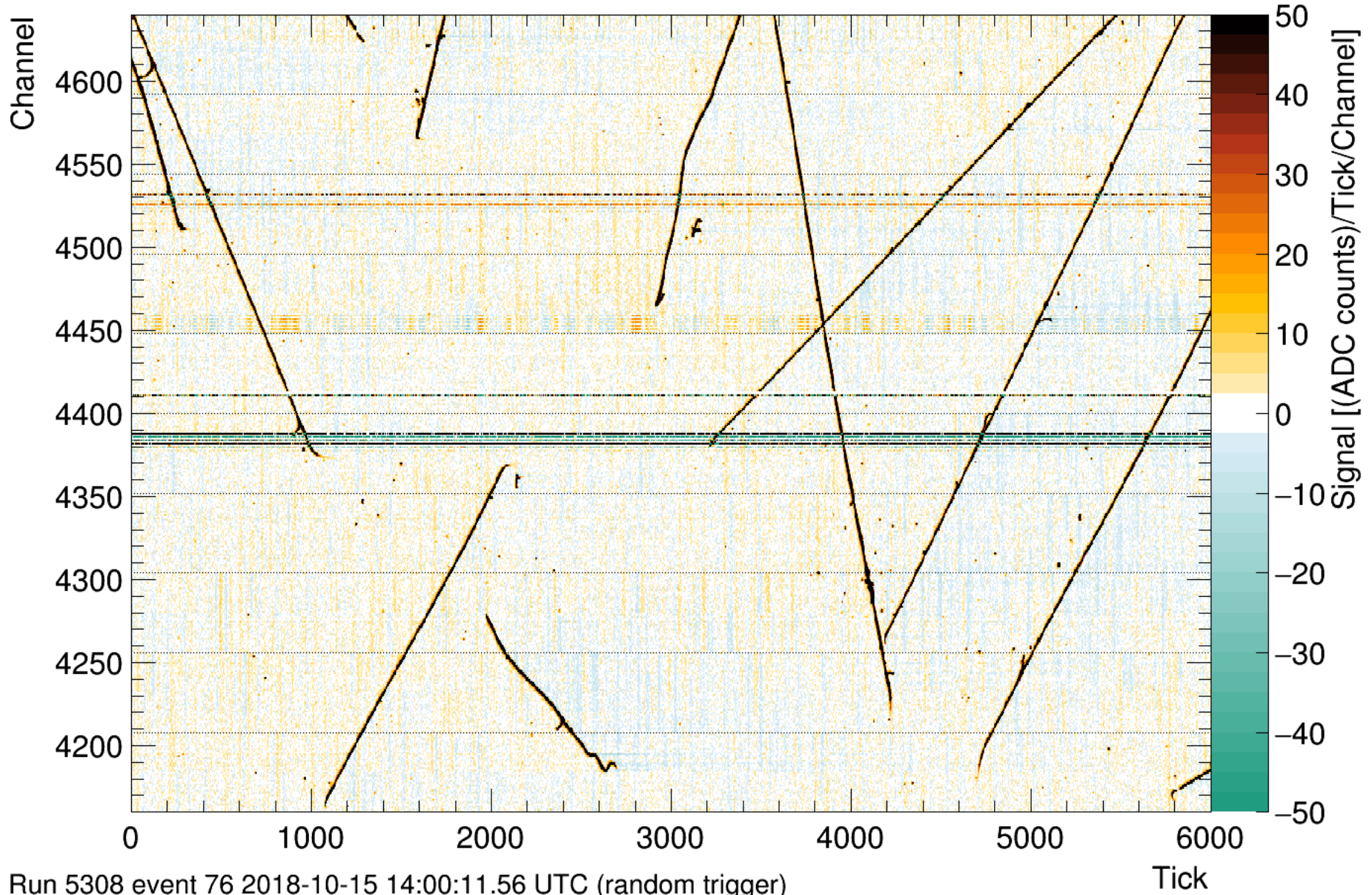
Corrected ADC for TPC plane 0v (APA 3: US-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

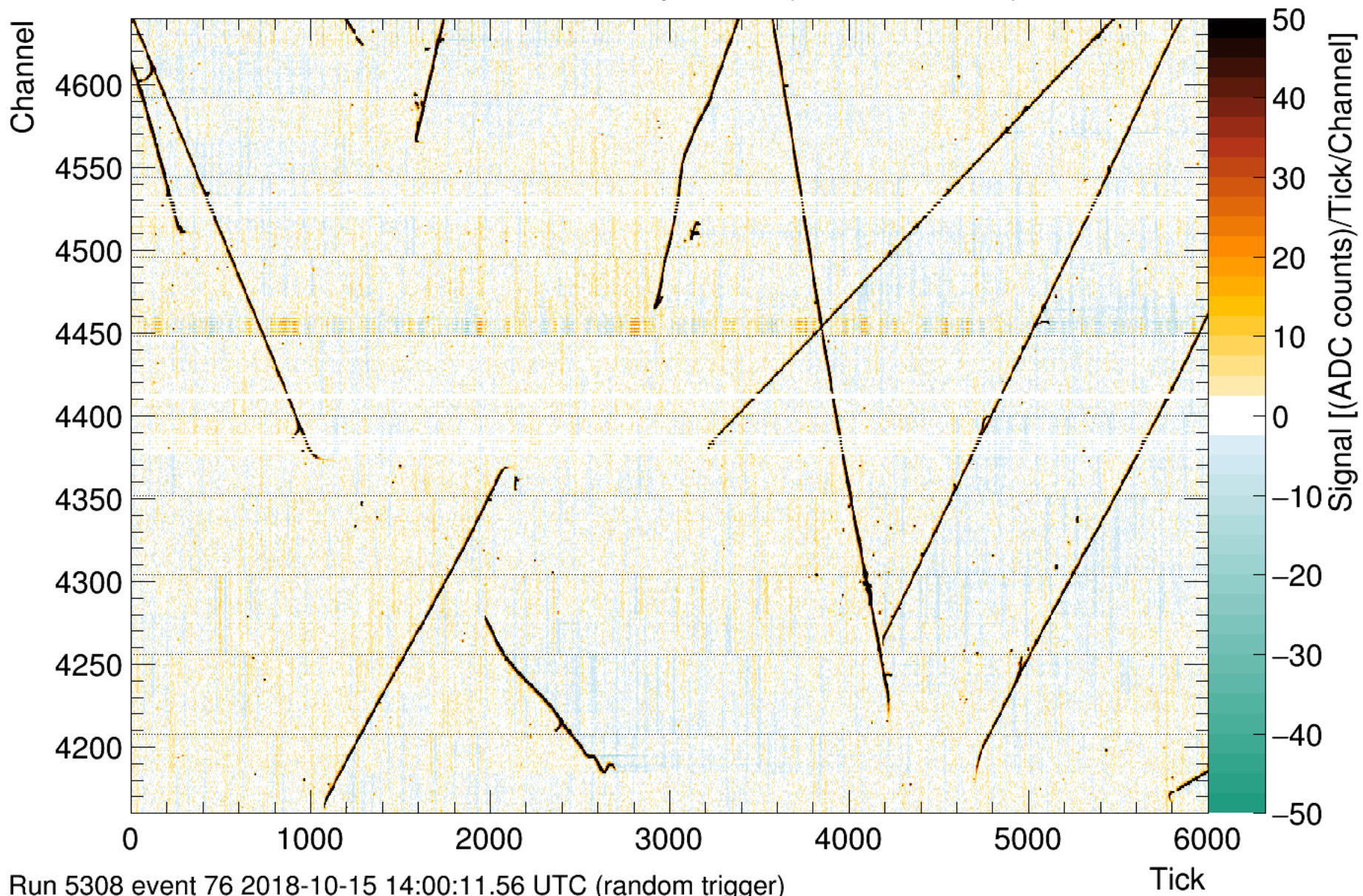
APA 5 collection

Raw ADC for TPC plane 1z (APA 5: US-DaS)



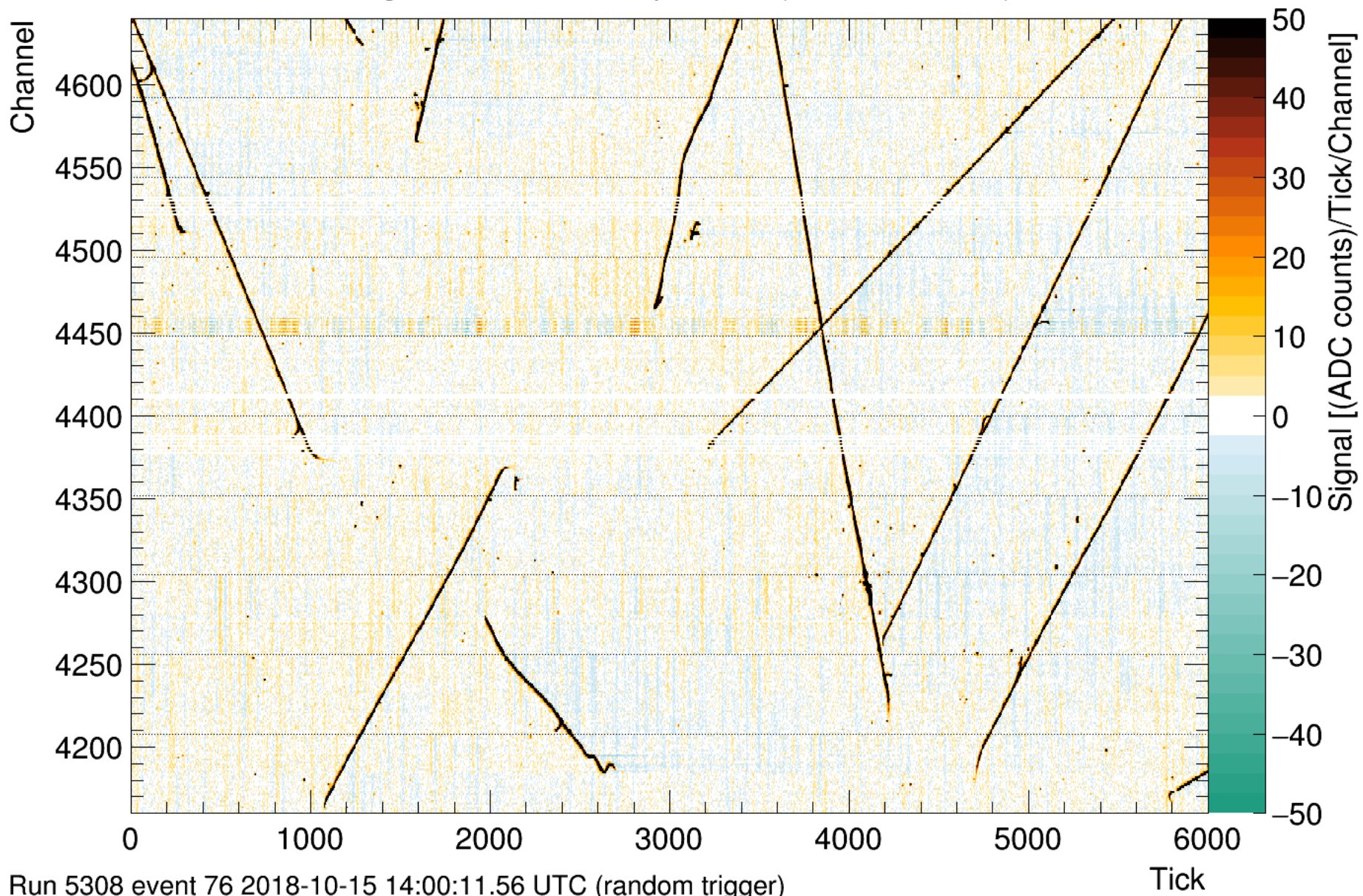
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 1z (APA 5: US-DaS)



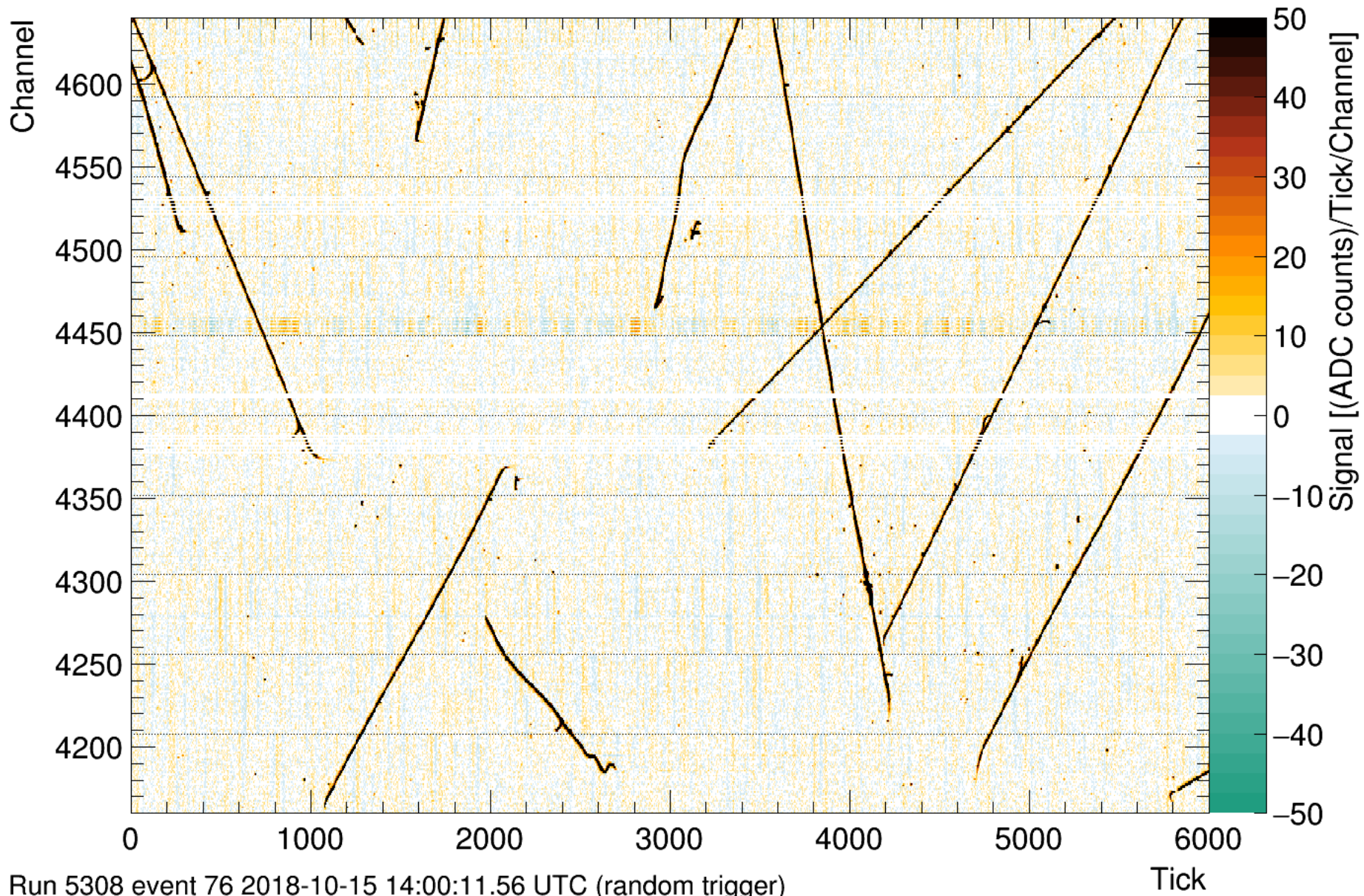
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 1z (APA 5: US-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

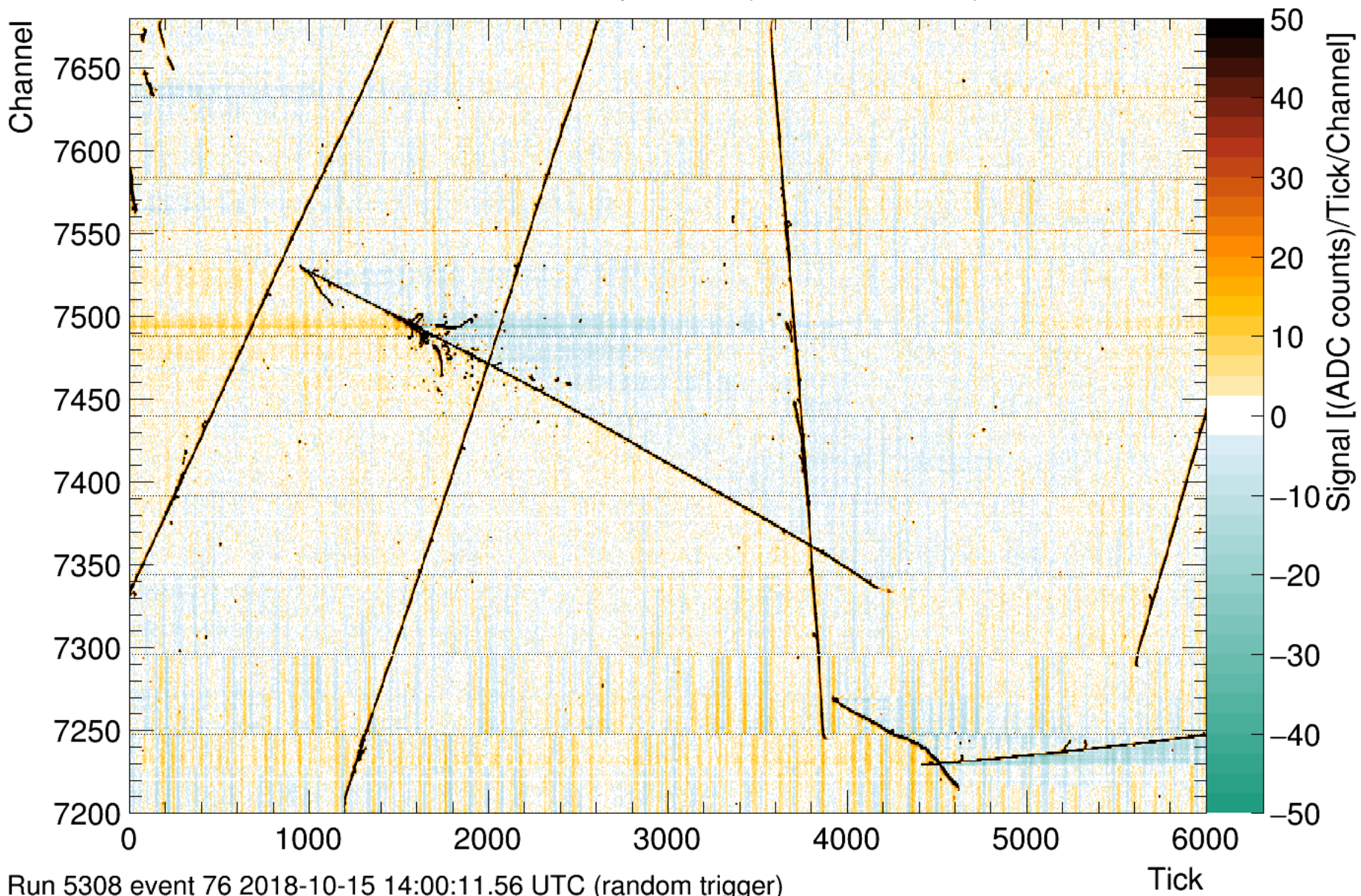
Corrected ADC for TPC plane 1z (APA 5: US-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

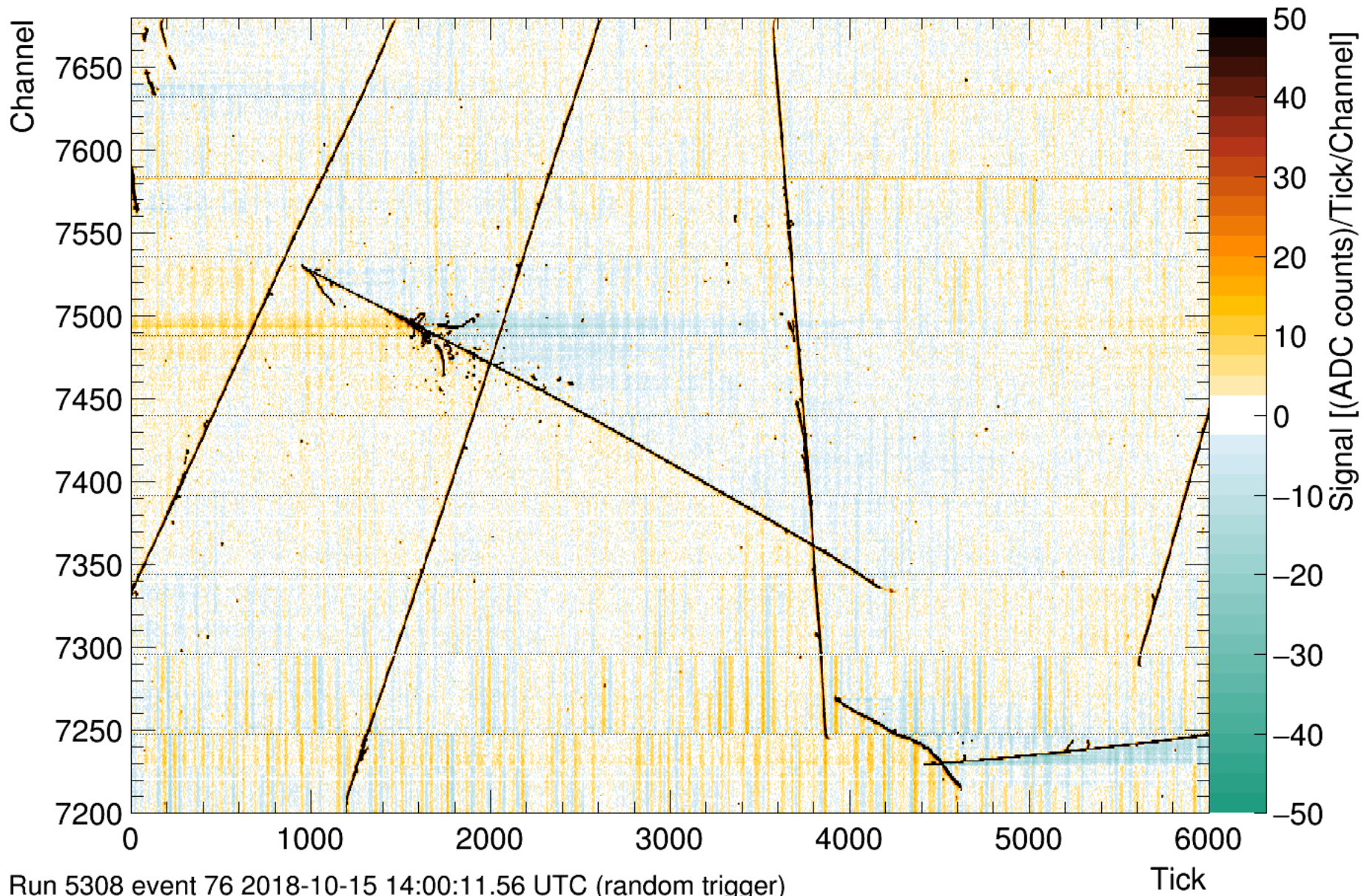
APA 2 collection

Raw ADC for TPC plane 2z (APA 2: MS-RaS)



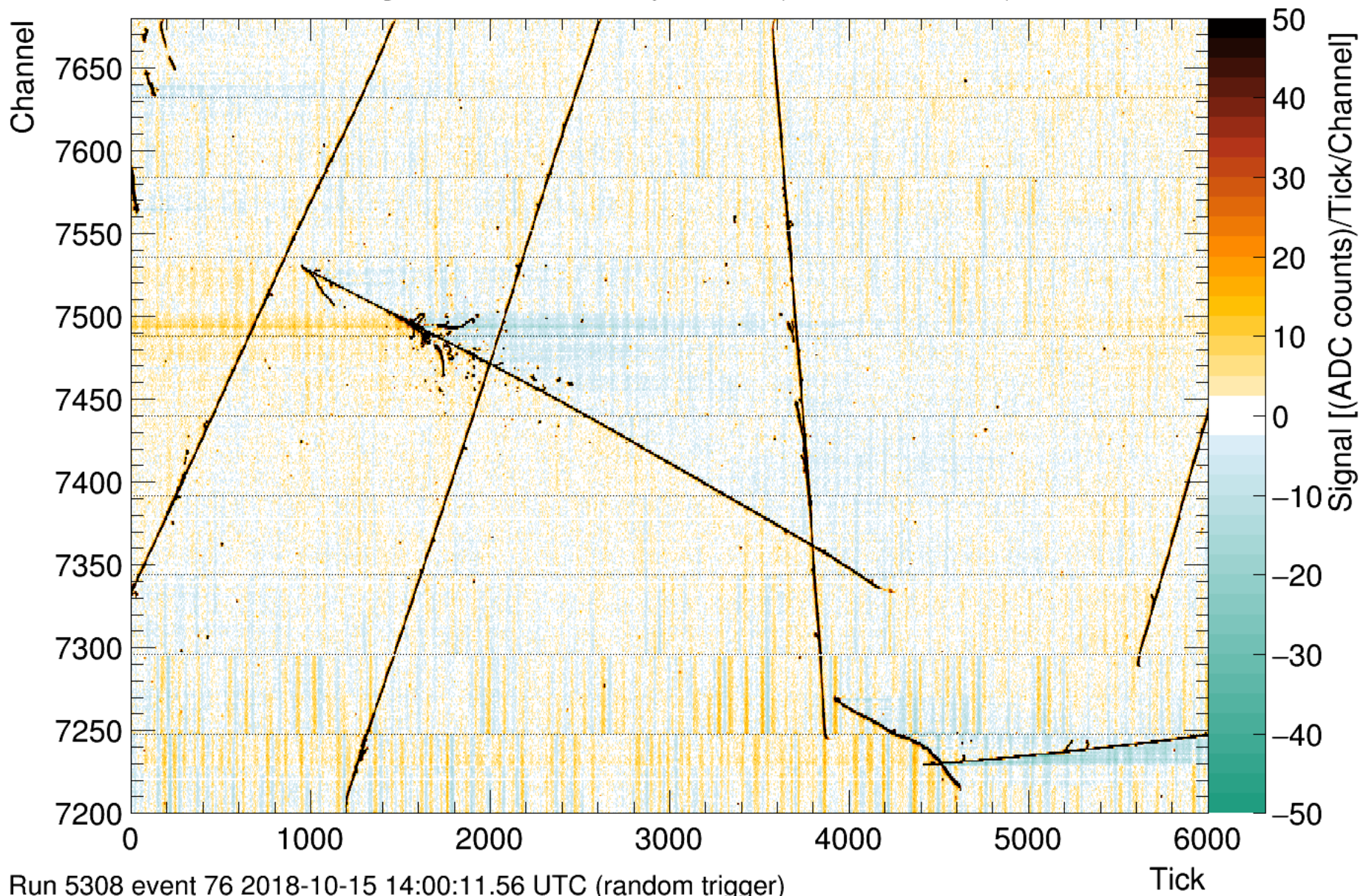
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 2z (APA 2: MS-RaS)



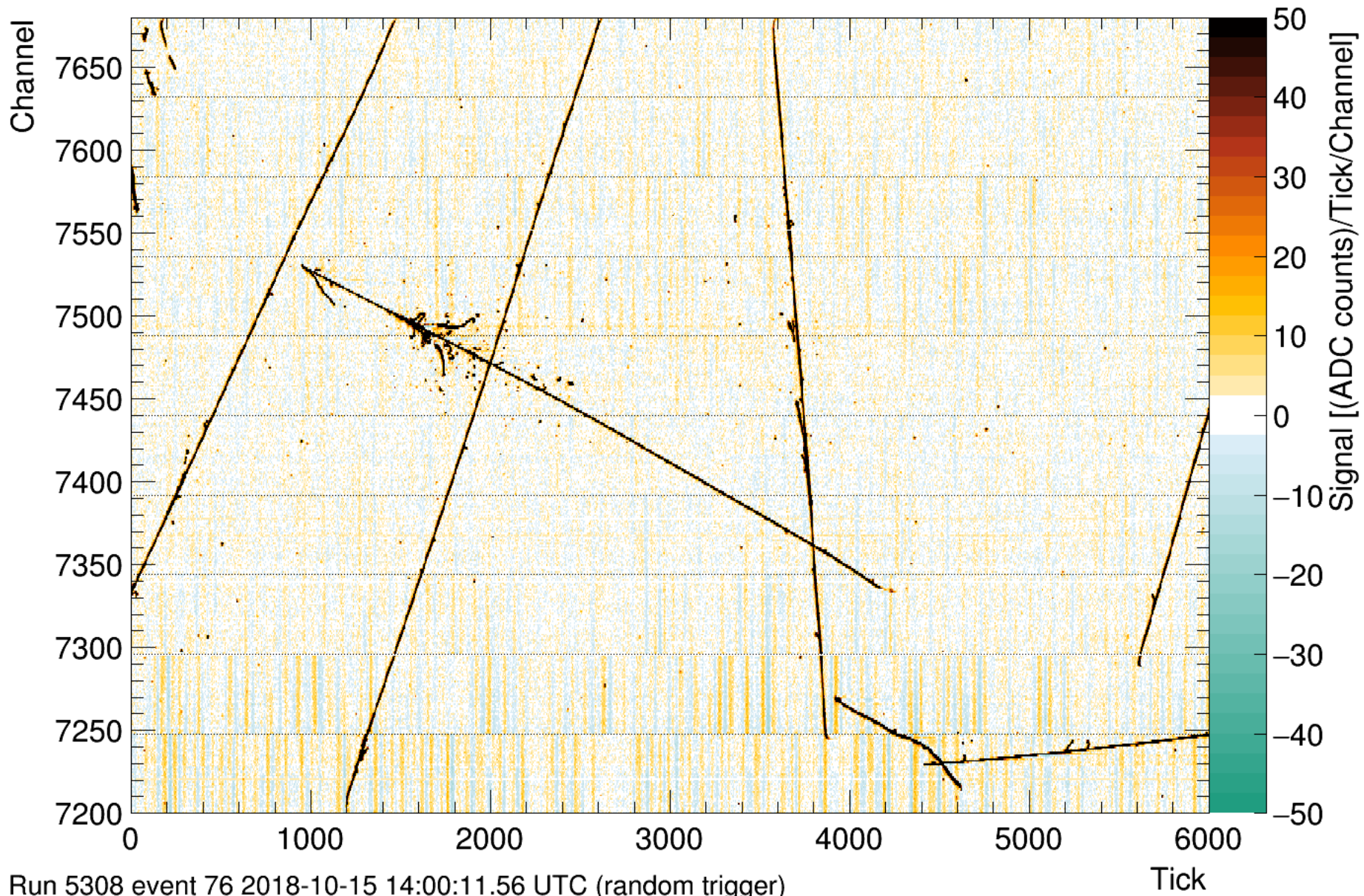
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 2z (APA 2: MS-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

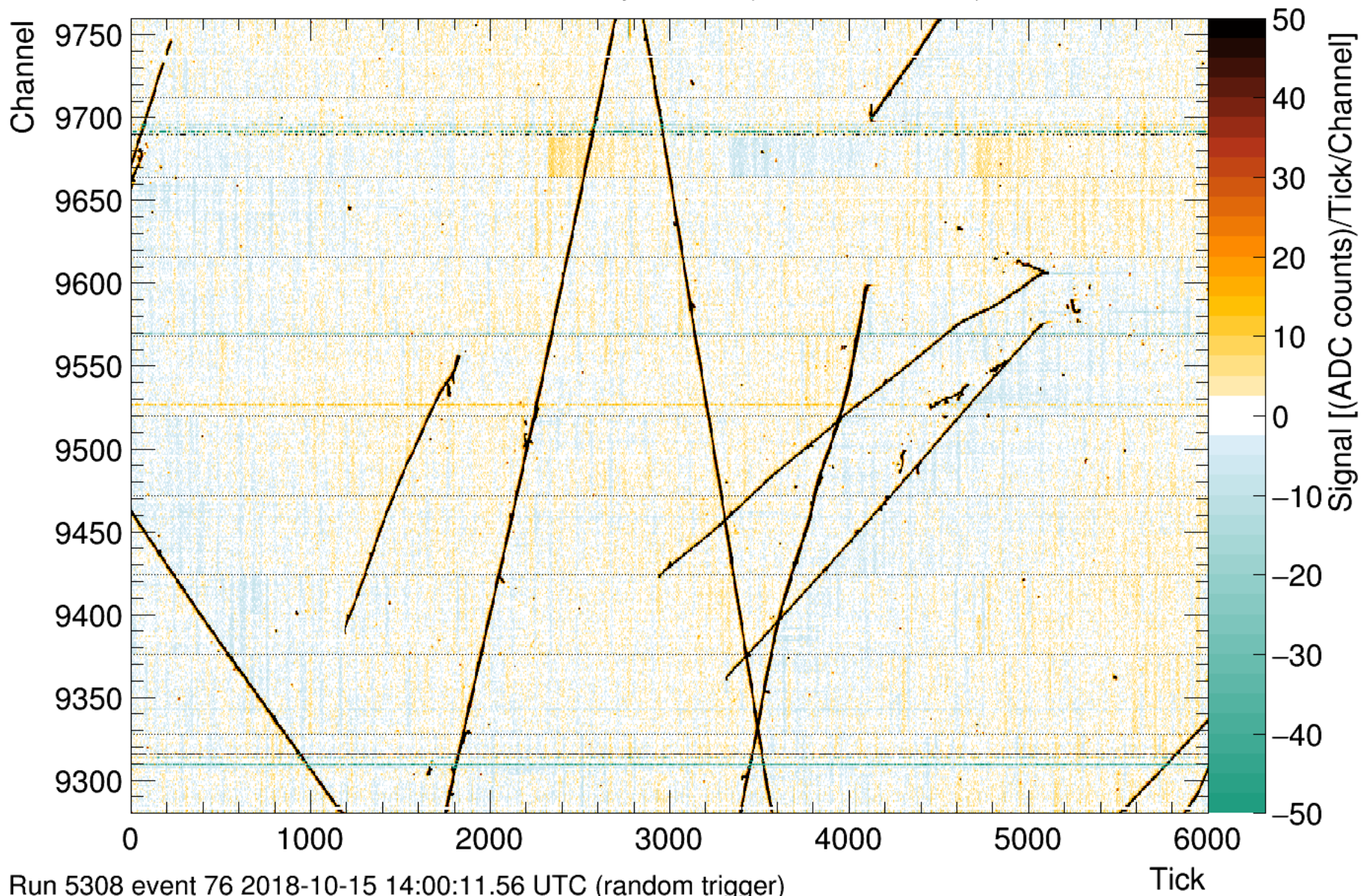
Corrected ADC for TPC plane 2z (APA 2: MS-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

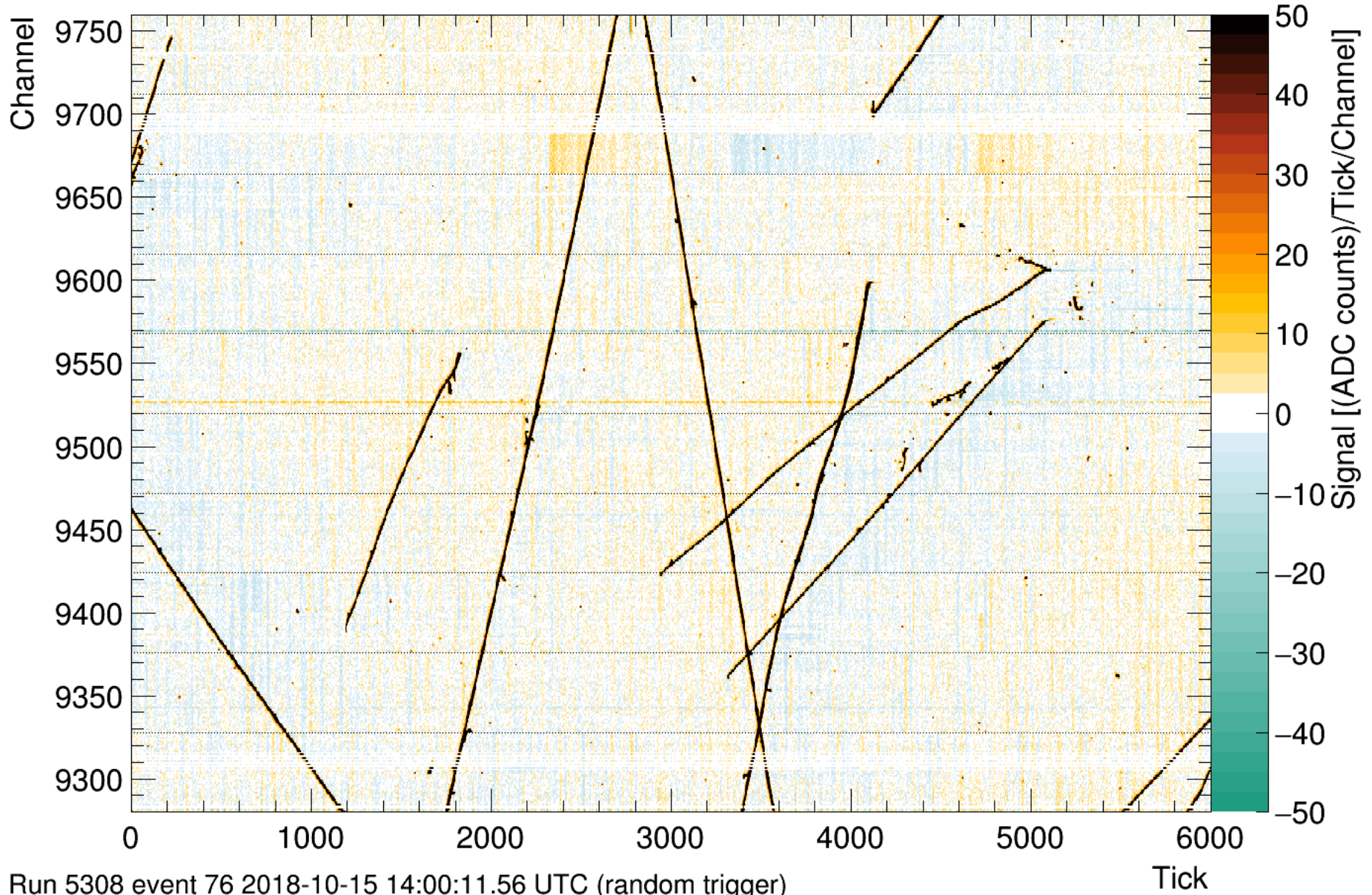
APA 6 collection

Raw ADC for TPC plane 3z (APA 6: MS-DaS)



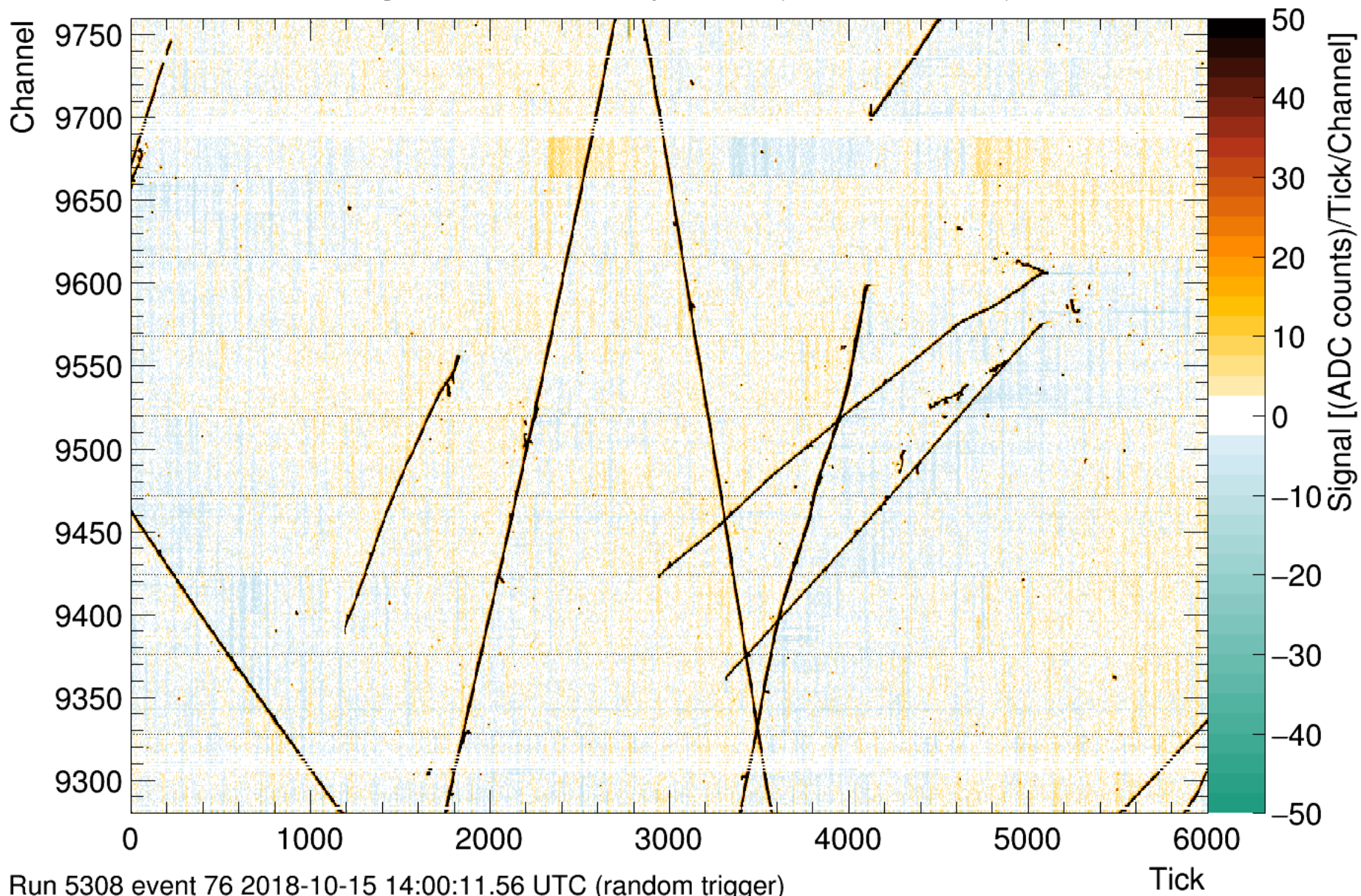
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 3z (APA 6: MS-DaS)



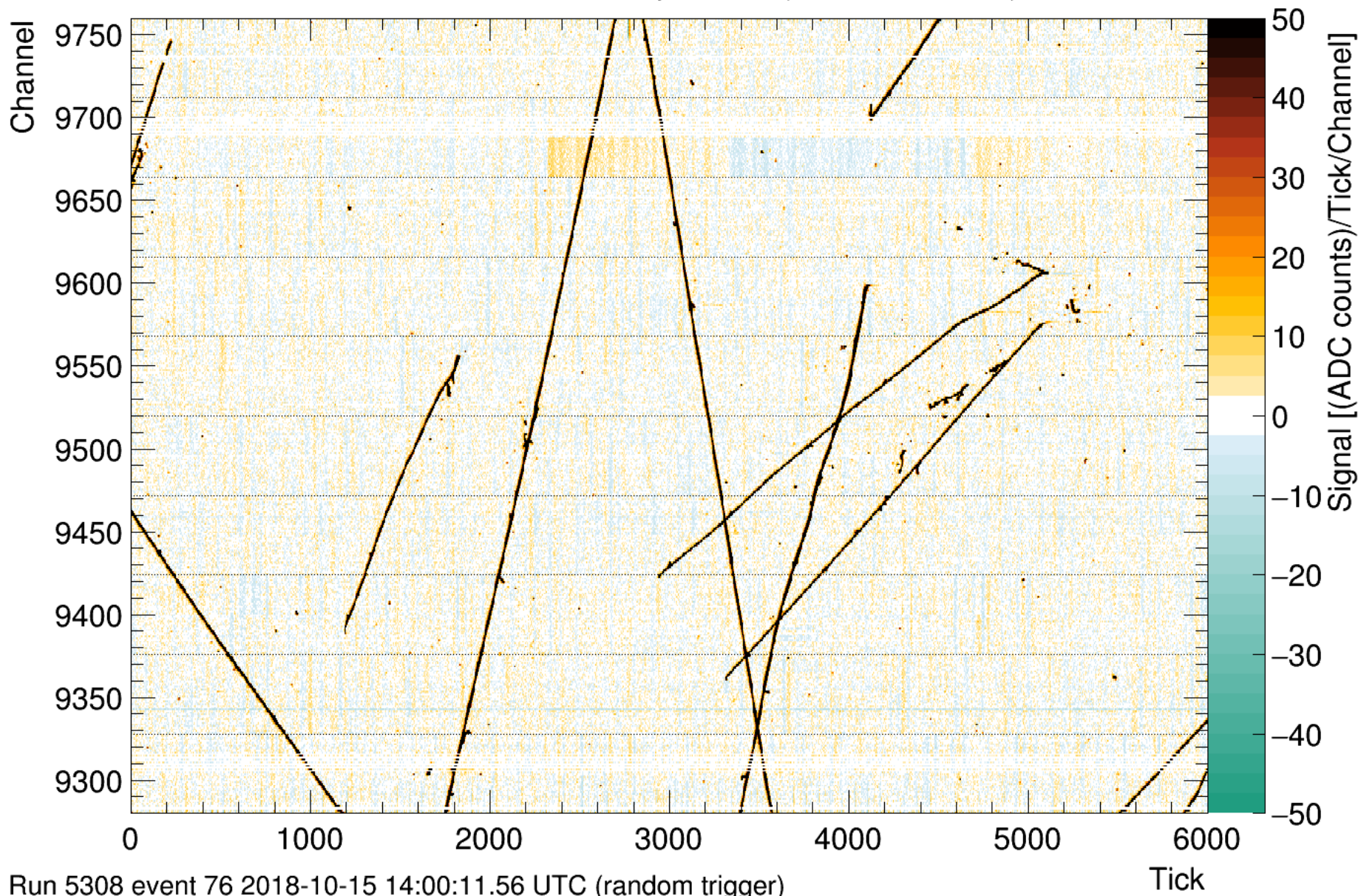
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 3z (APA 6: MS-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

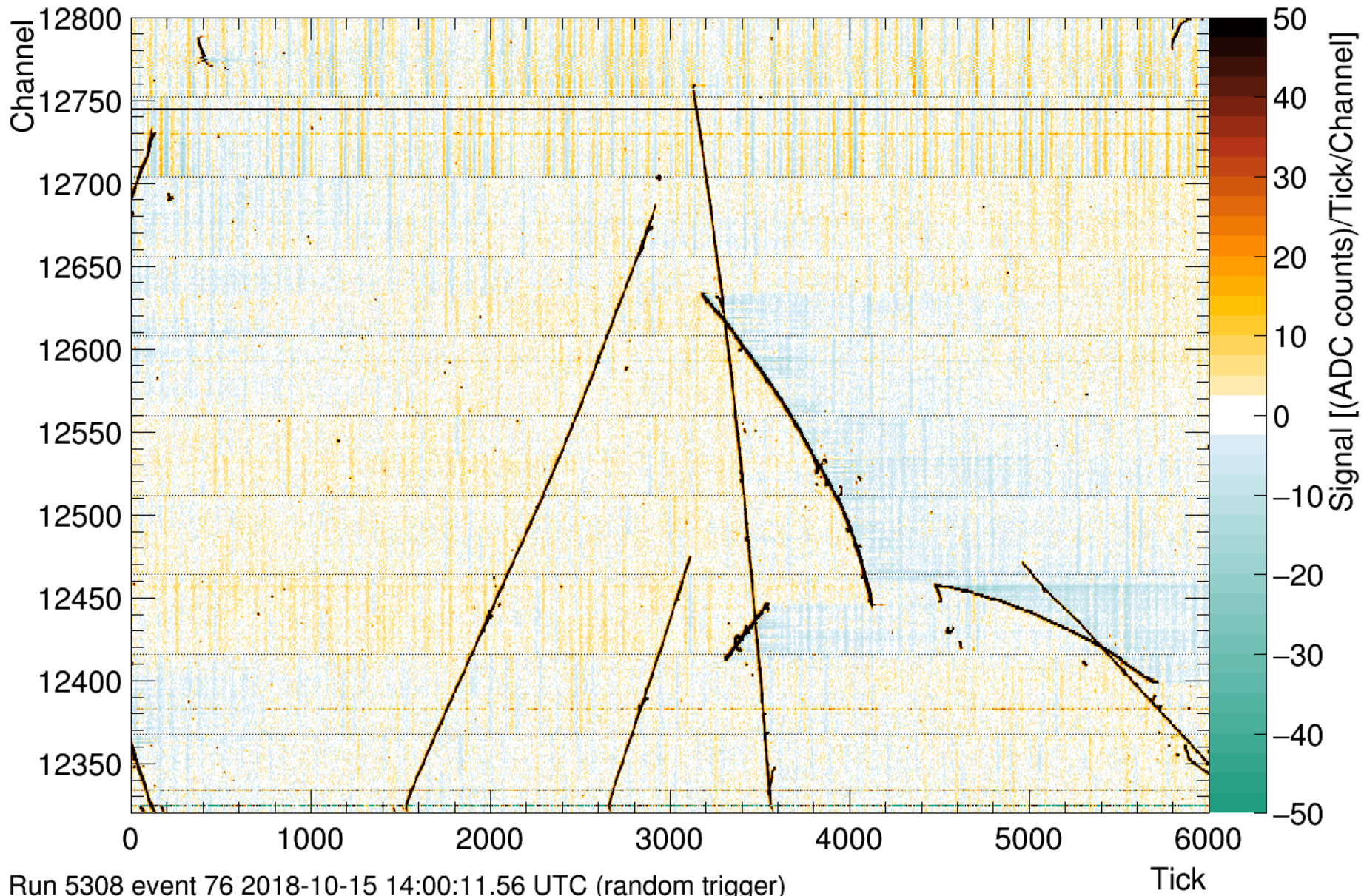
Corrected ADC for TPC plane 3z (APA 6: MS-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

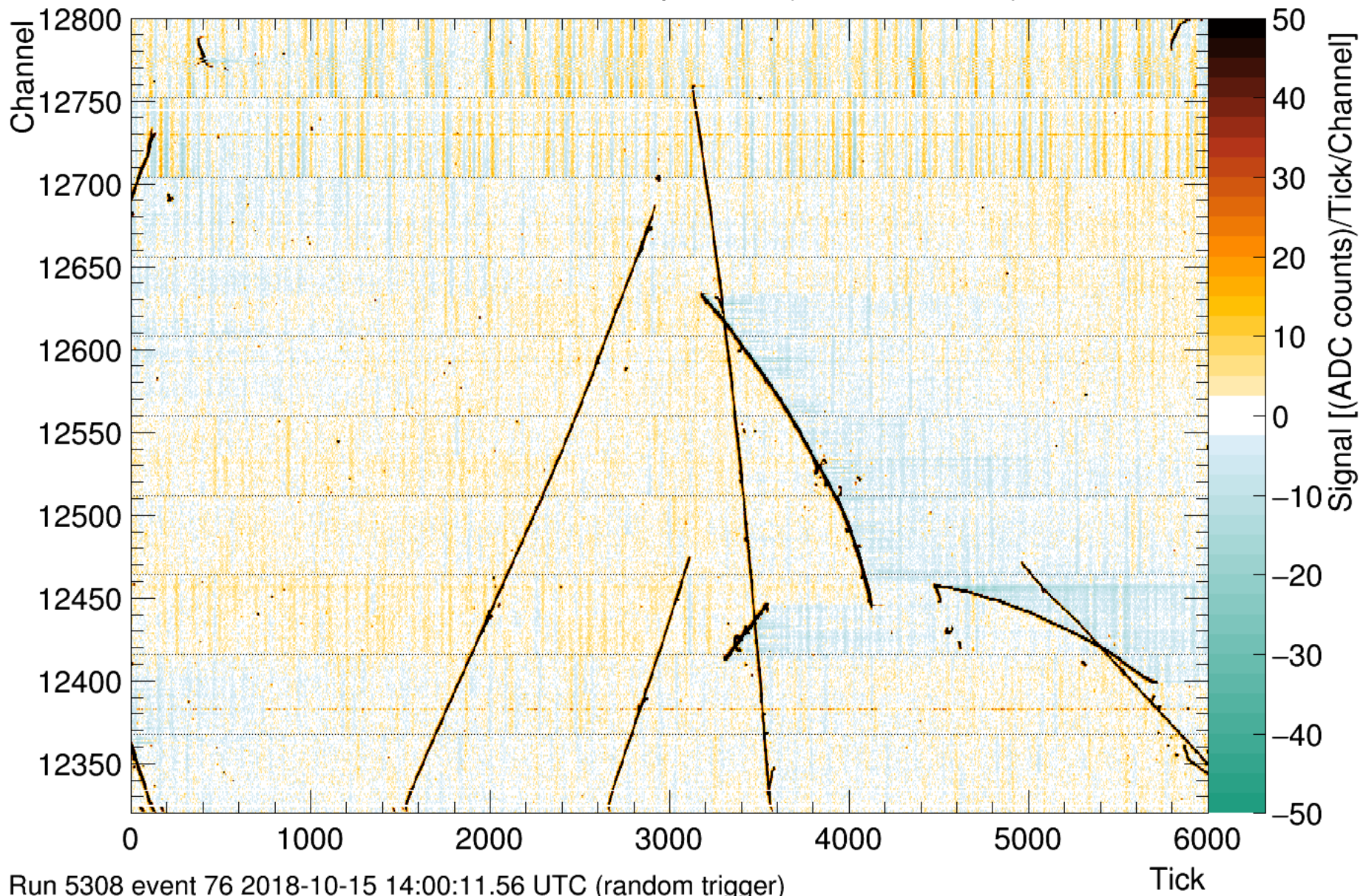
APA 1 collection

Raw ADC for TPC plane 4z (APA 1: DS-RaS)



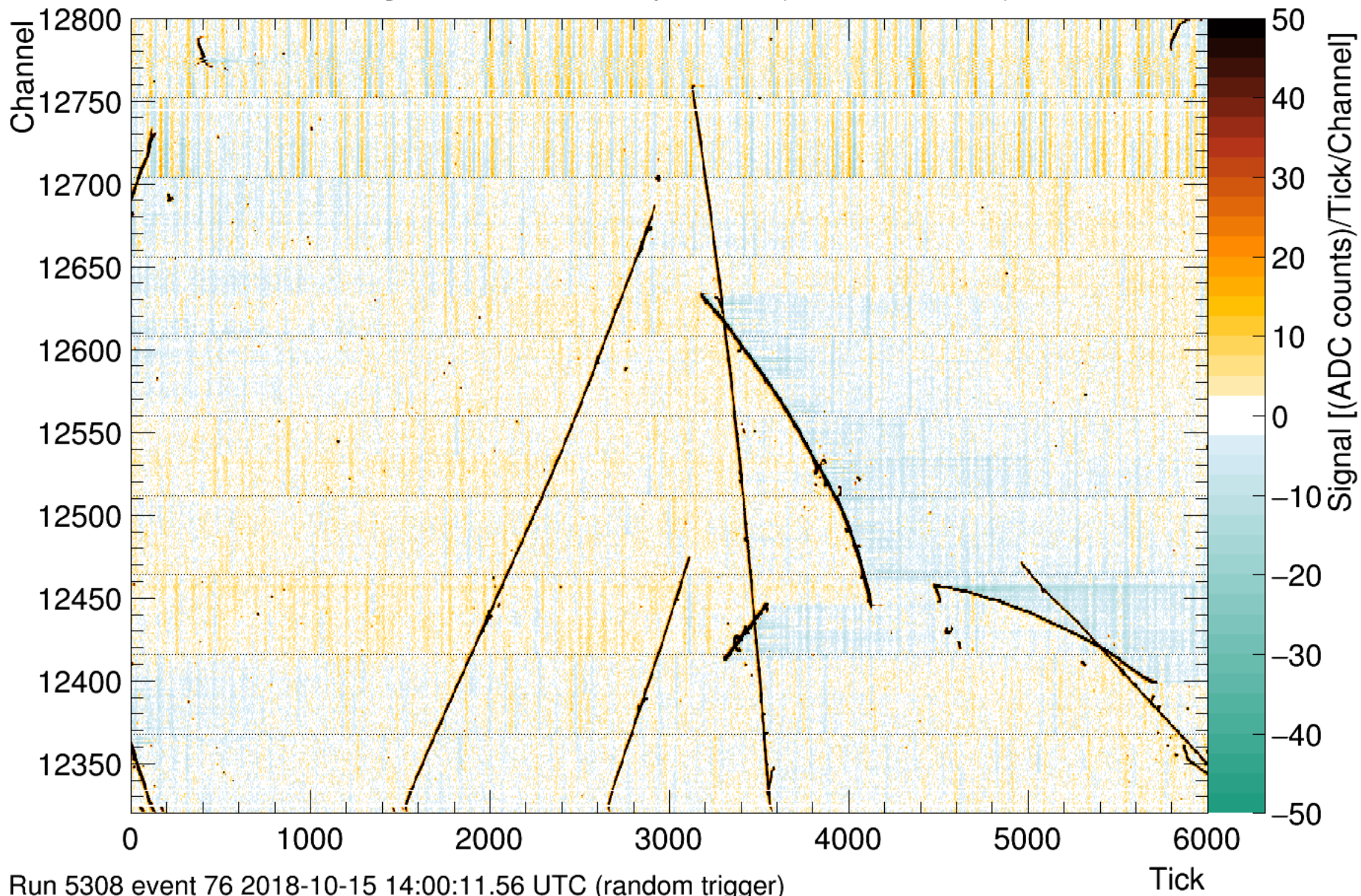
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 4z (APA 1: DS-RaS)



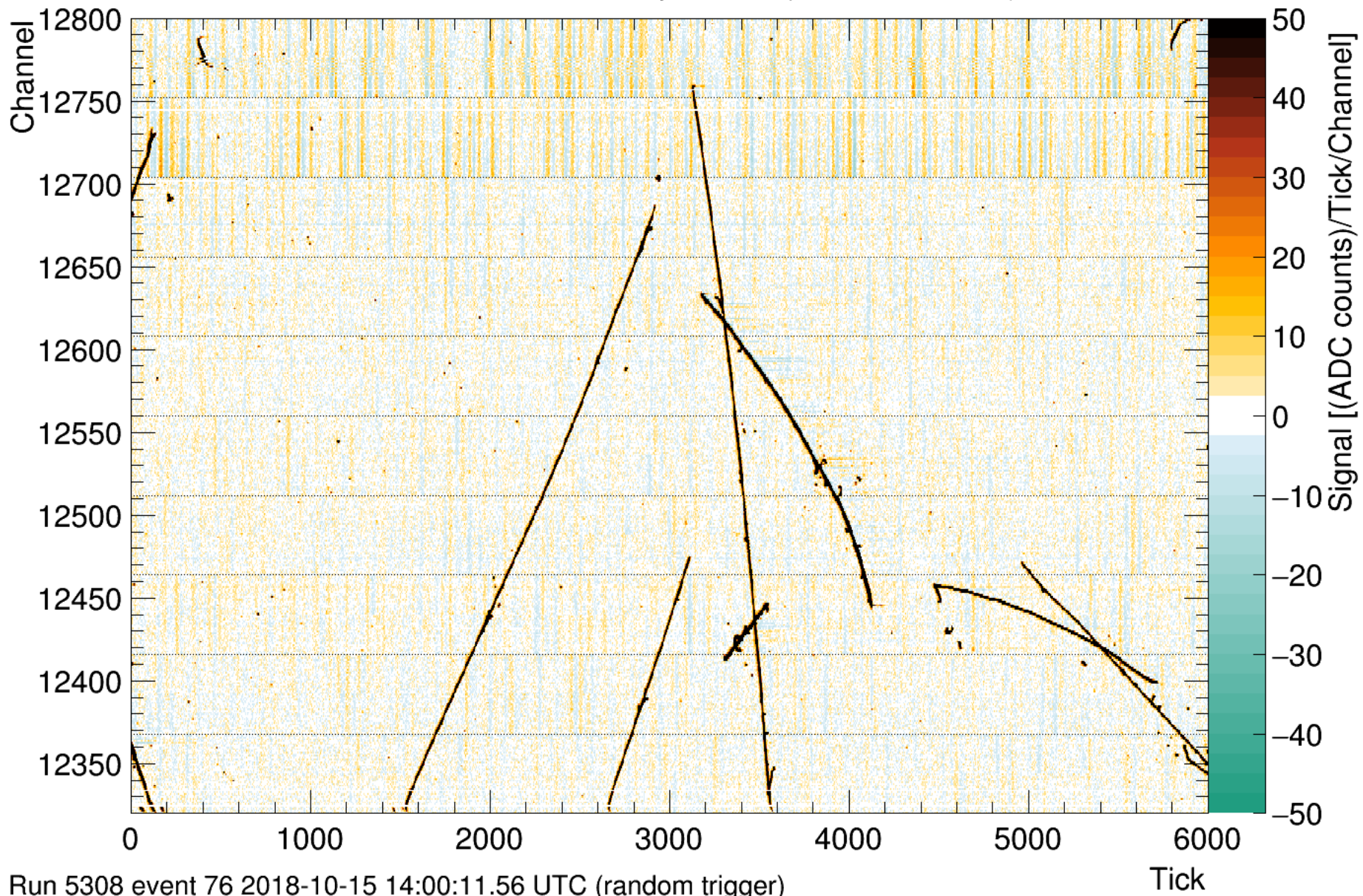
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 4z (APA 1: DS-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

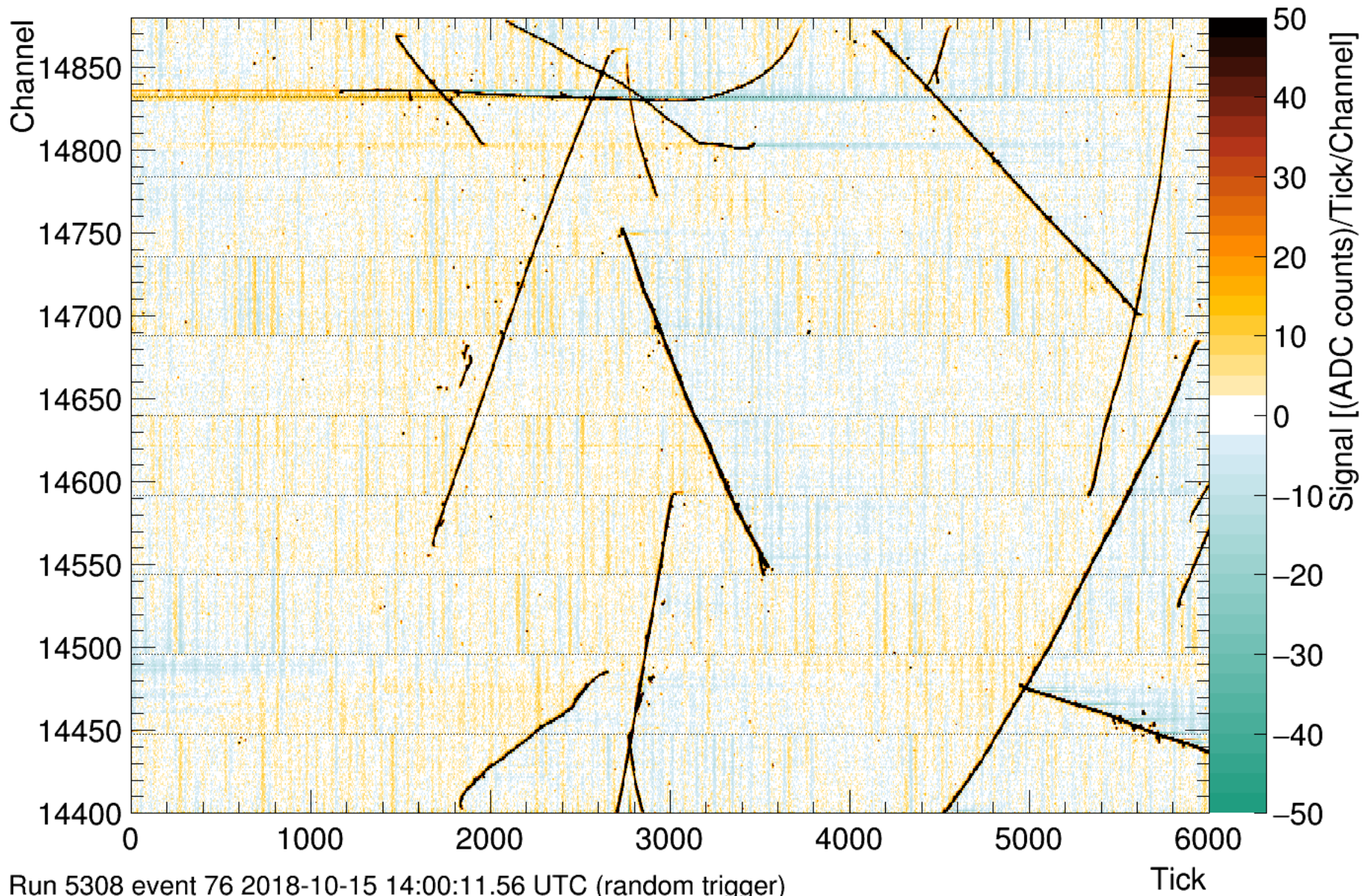
Corrected ADC for TPC plane 4z (APA 1: DS-RaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

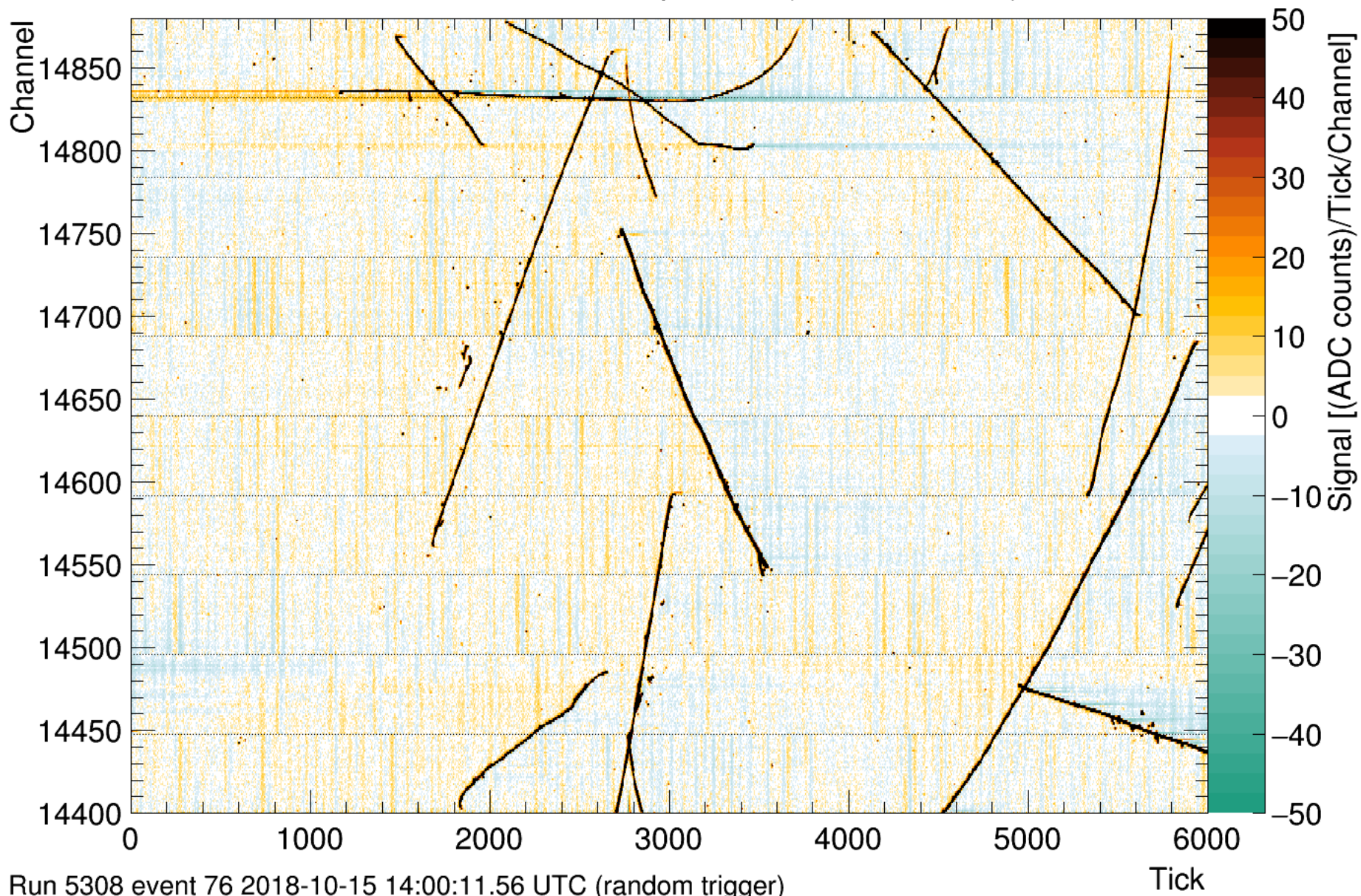
APA 6 collection

Raw ADC for TPC plane 5z (APA 4: DS-DaS)



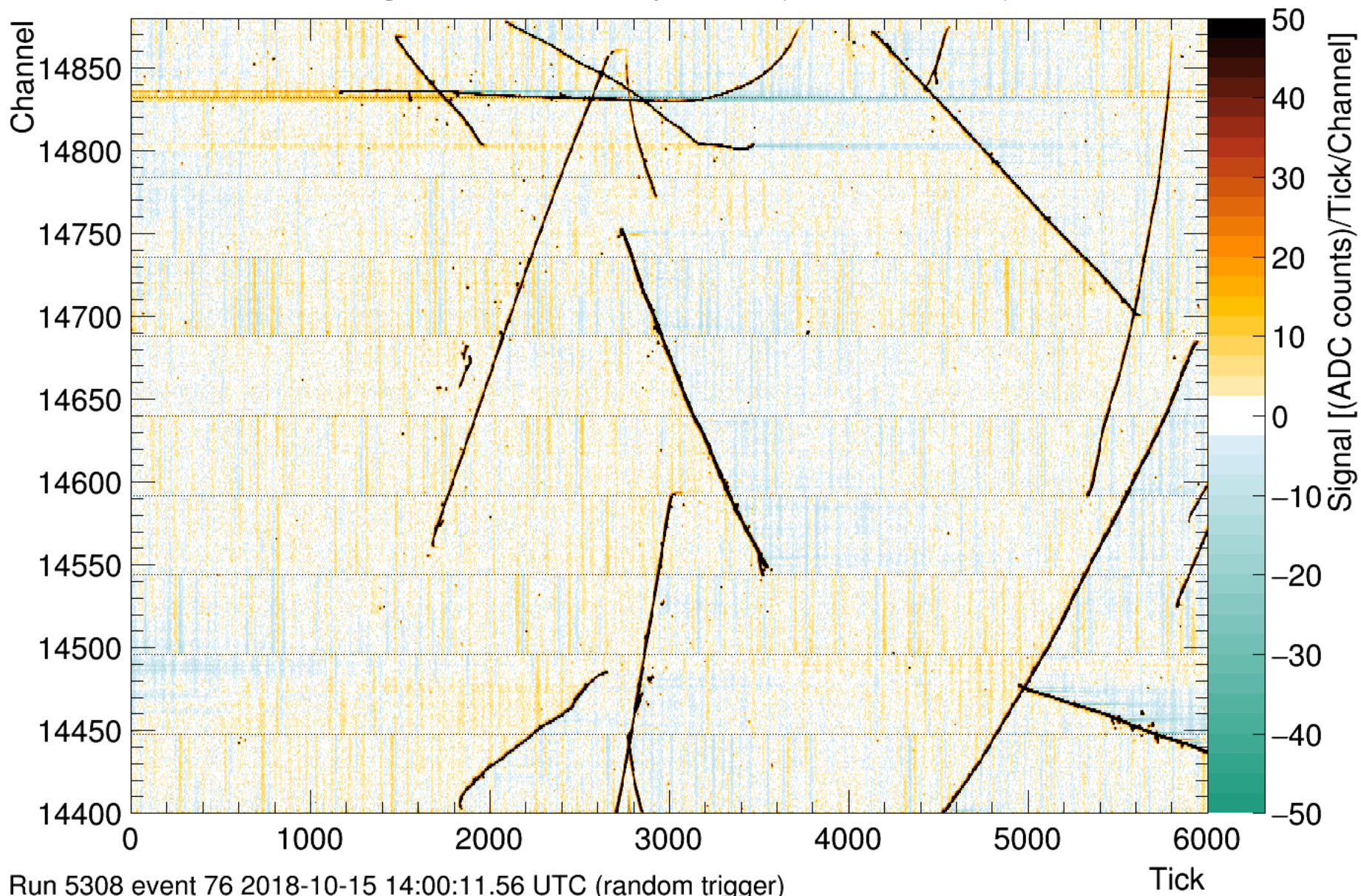
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Calibrated ADC for TPC plane 5z (APA 4: DS-DaS)



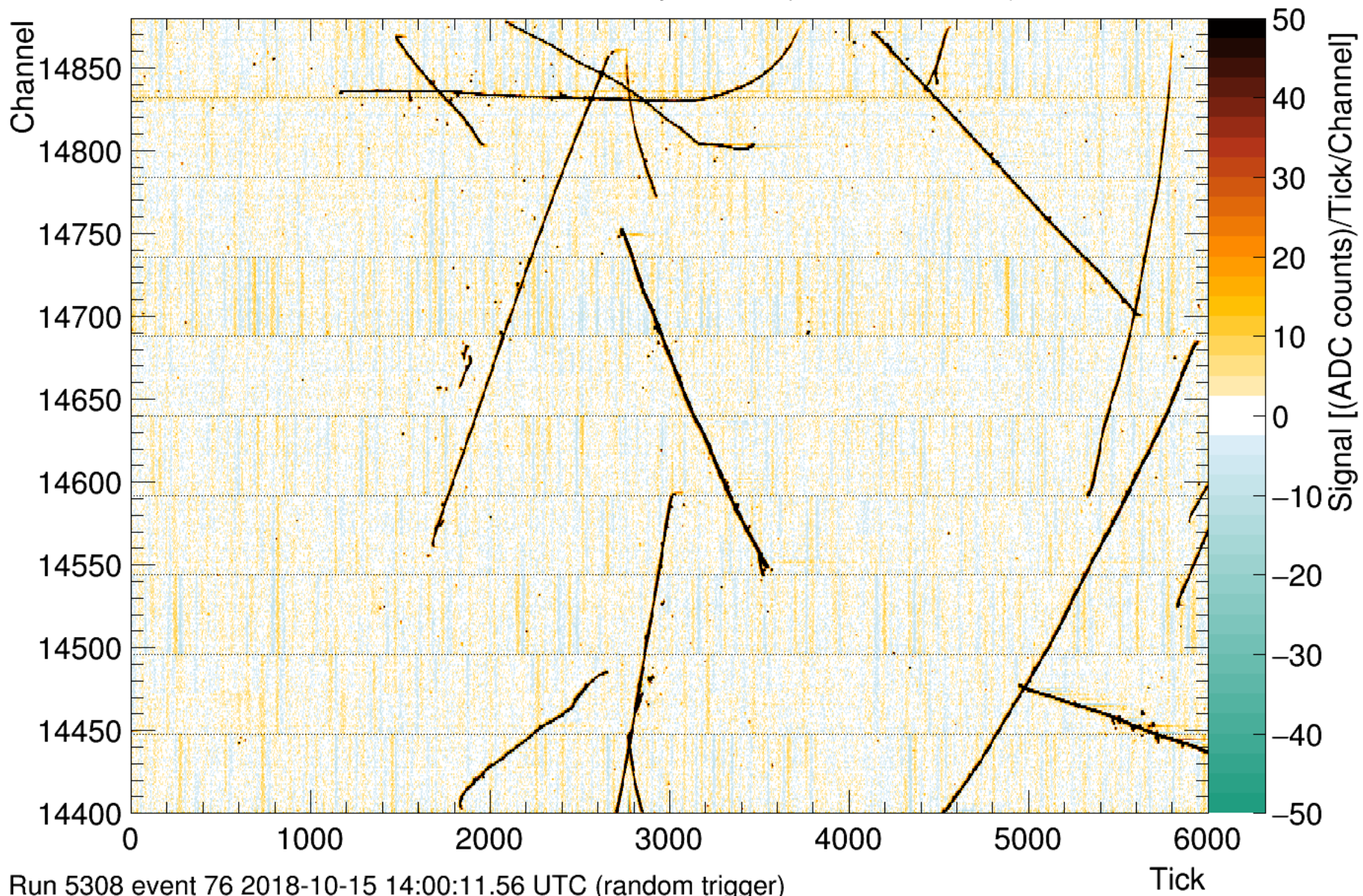
Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Mitigated ADC for TPC plane 5z (APA 4: DS-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Corrected ADC for TPC plane 5z (APA 4: DS-DaS)



Run 5308 event 76 2018-10-15 14:00:11.56 UTC (random trigger)

Pedestal metrics

Pedestal metrics deduced from pedestal spectra

- Tool AdcPedestalFitter
- Histogram ADC count for each channel each event
 - 100 bins roughly centered around the peak
 - **OORF** = out of range fraction is the fraction of counts outside the range
 - May indicate population of a distant sticky code
 - Or track or pulser signals
- For fitting, exclude peak bin if it holds $> 20\%$ and $< 99\%$ of entries
 - Peak bin fraction = fraction entries in that bin
 - Sensitive to sticky codes
- Fit with Gaussian
 - **Mean** is the pedestal position
 - **Sigma** provides measure of the noise (aka RMS)
- **Peak bin excess**
 - Fraction in peak bin after subtracting fit value
 - Better estimate of sticky code contribution
- **Raw tail**
 - Fraction of samples more than $3 \times$ noise away from the pedestal

Pedestal plots

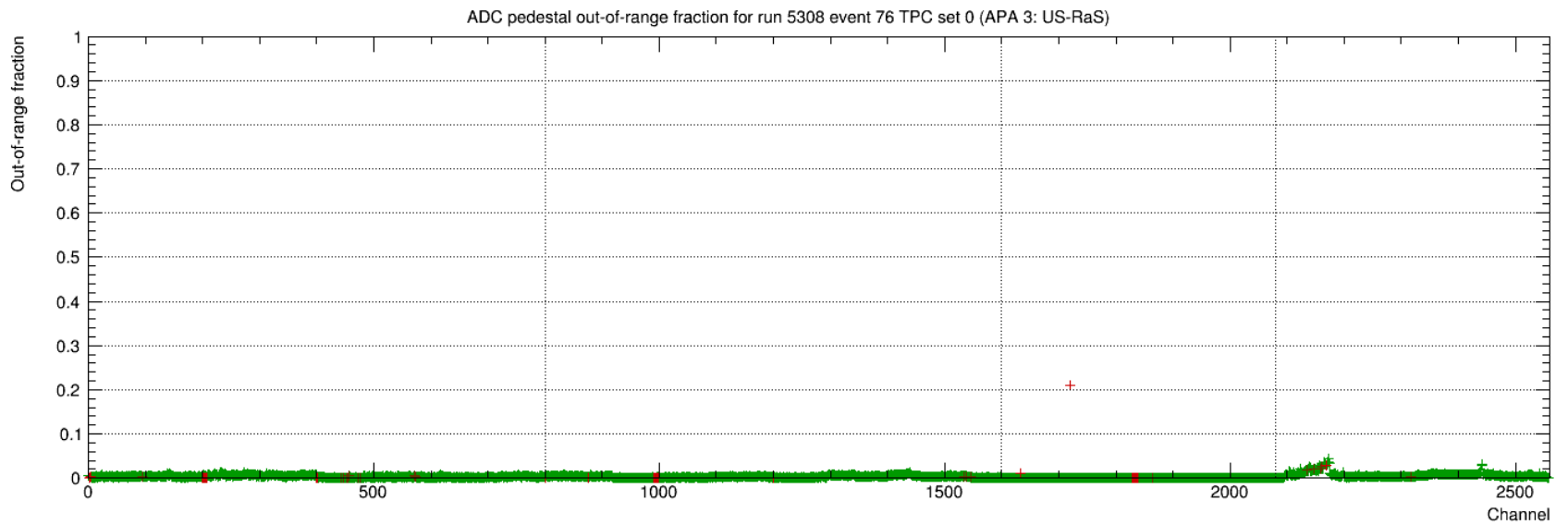
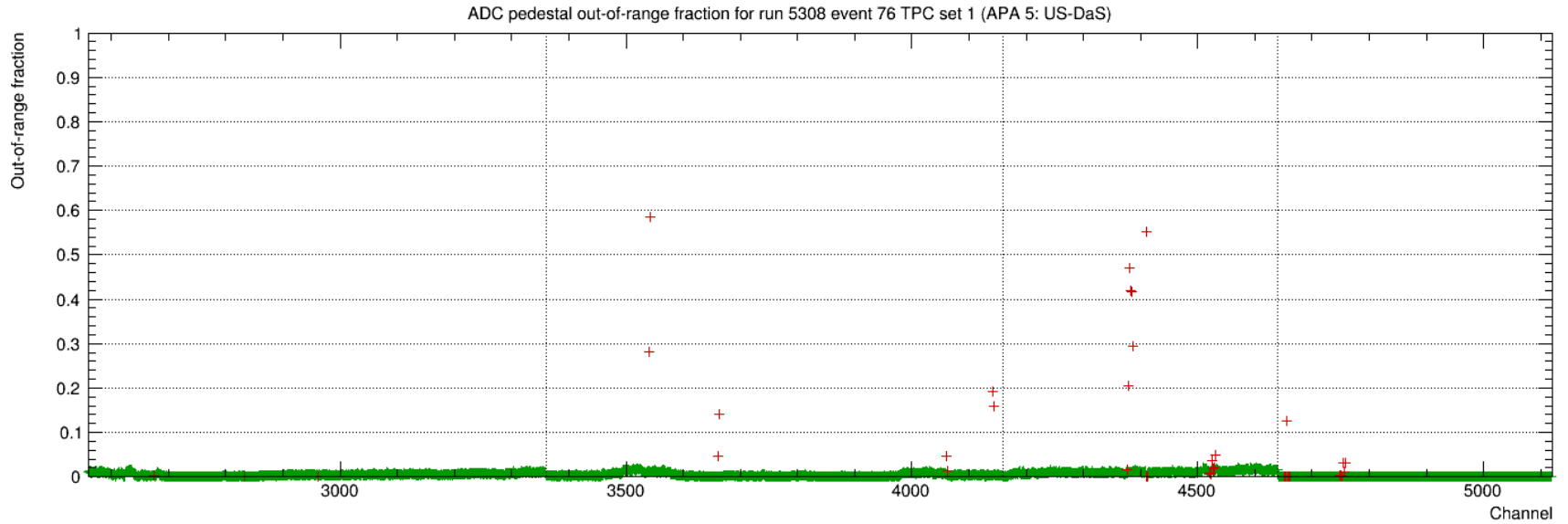
Many pedestal plots are now color coded

- Green = good
- Red = bad
- Brown = noisy

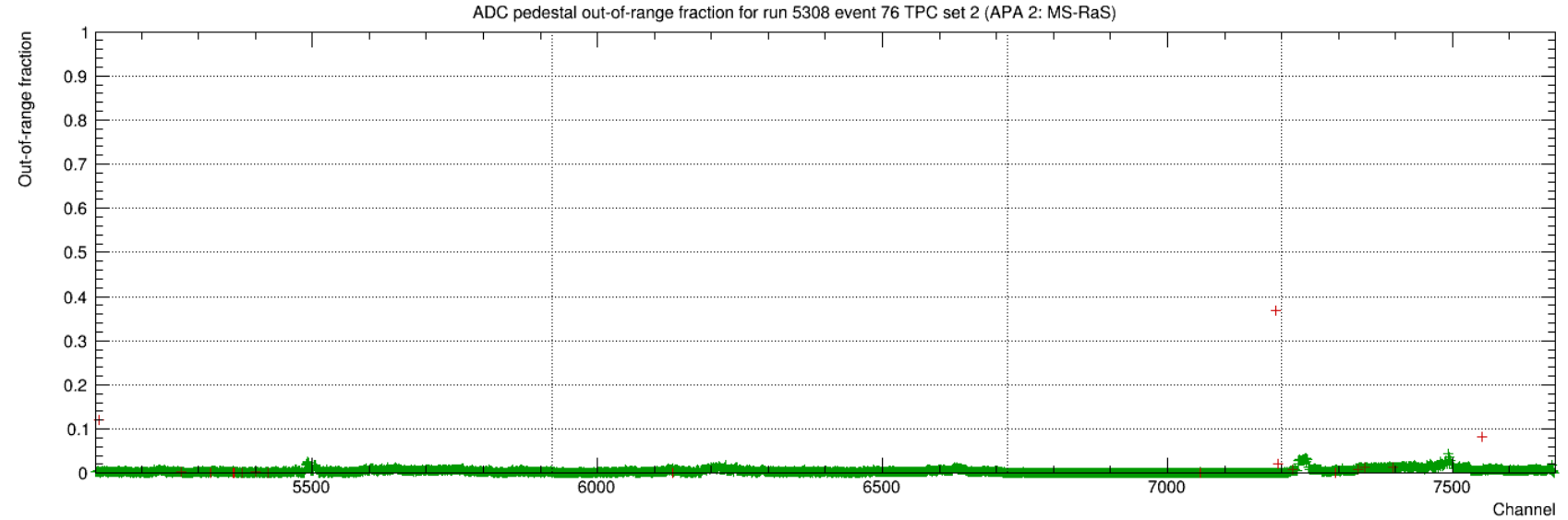
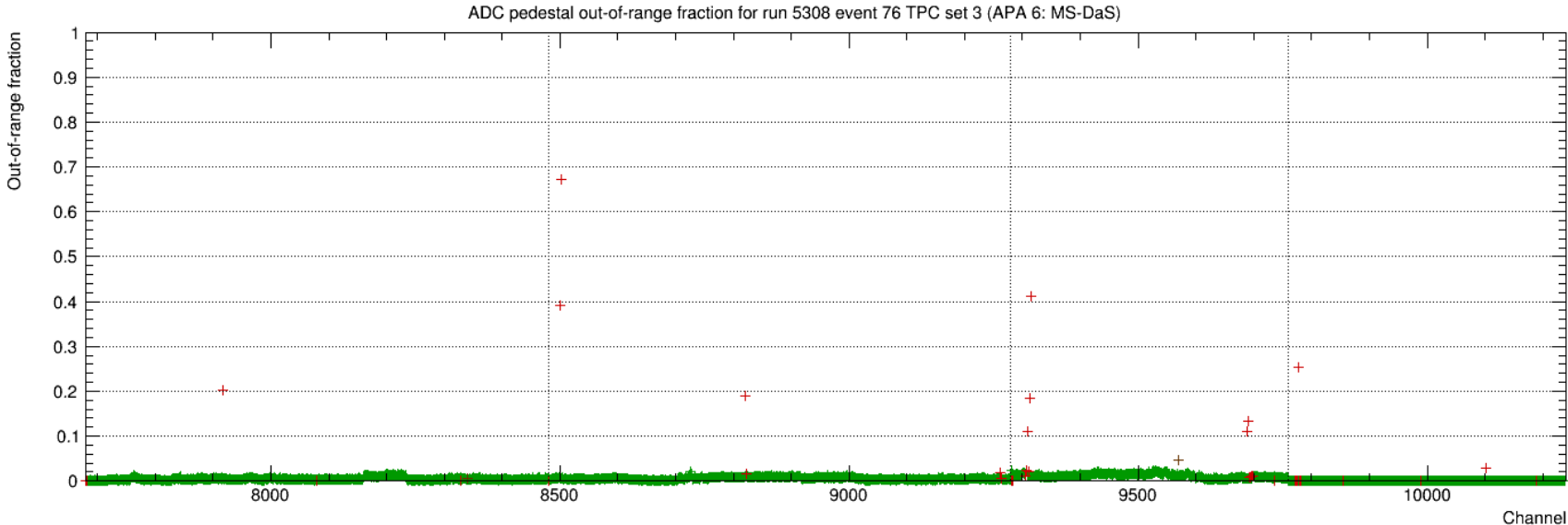
Good correlation with deduced status

- Where not, we should investigate more

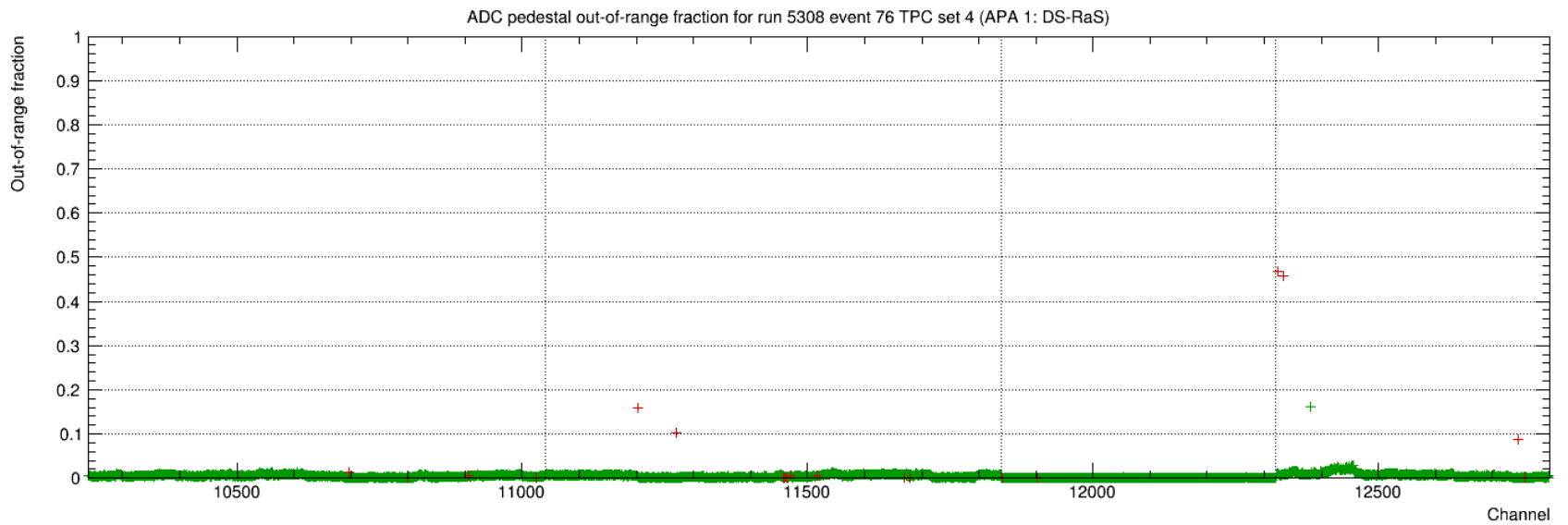
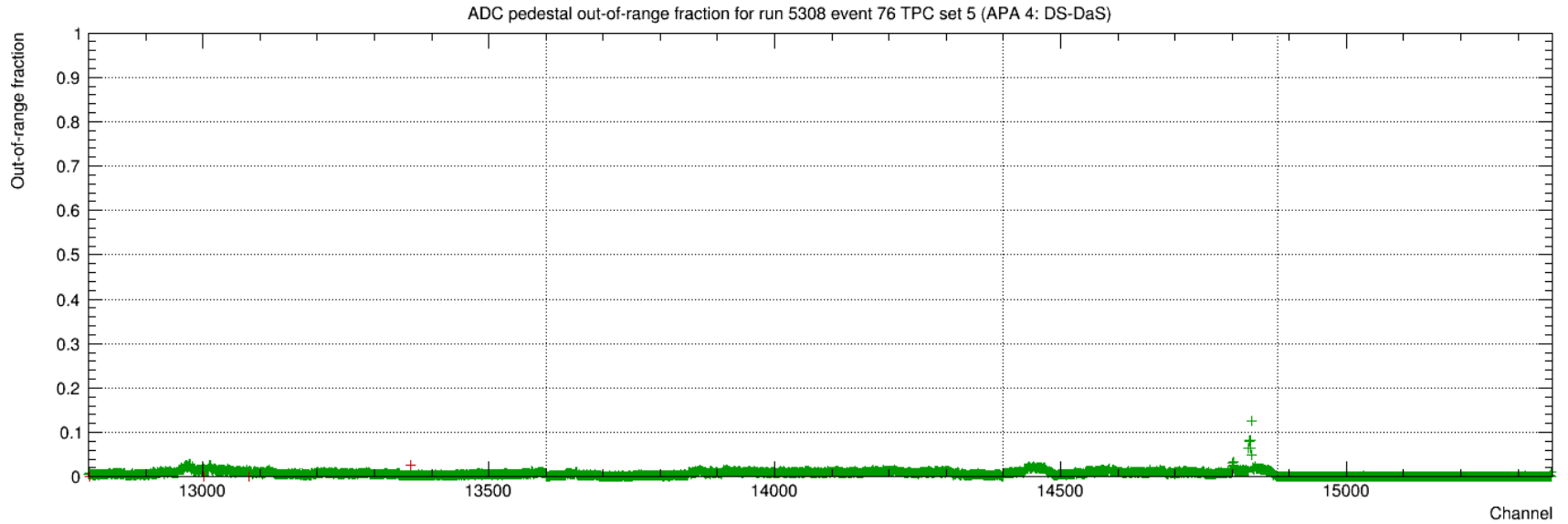
US OORF



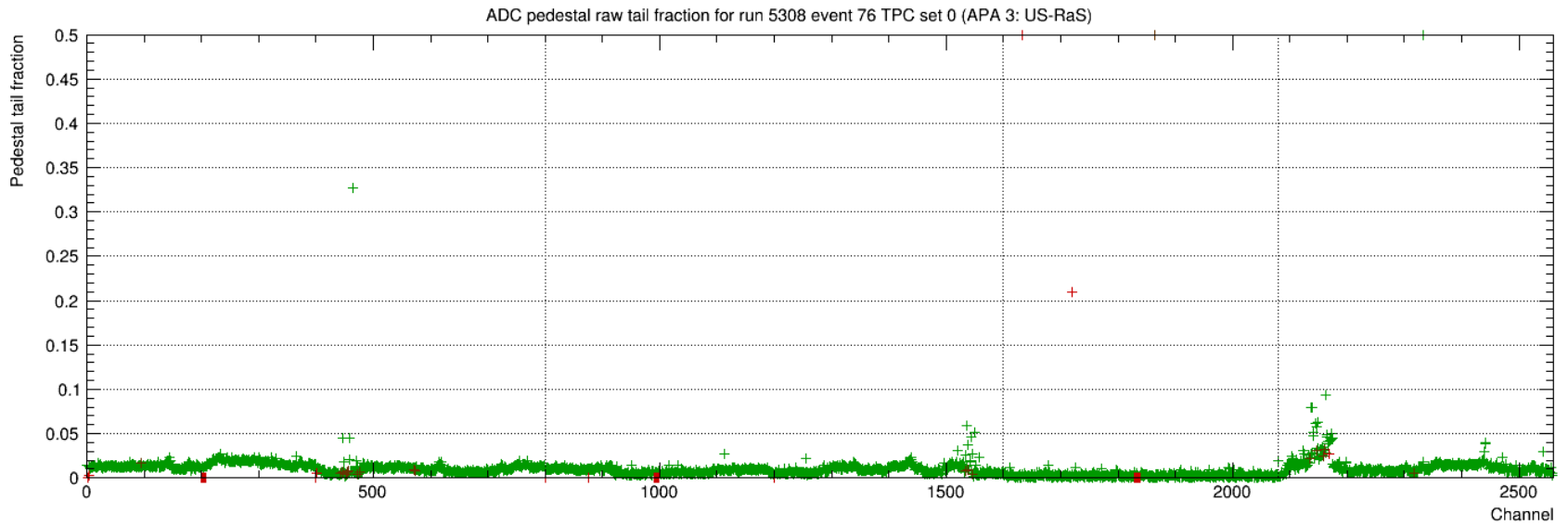
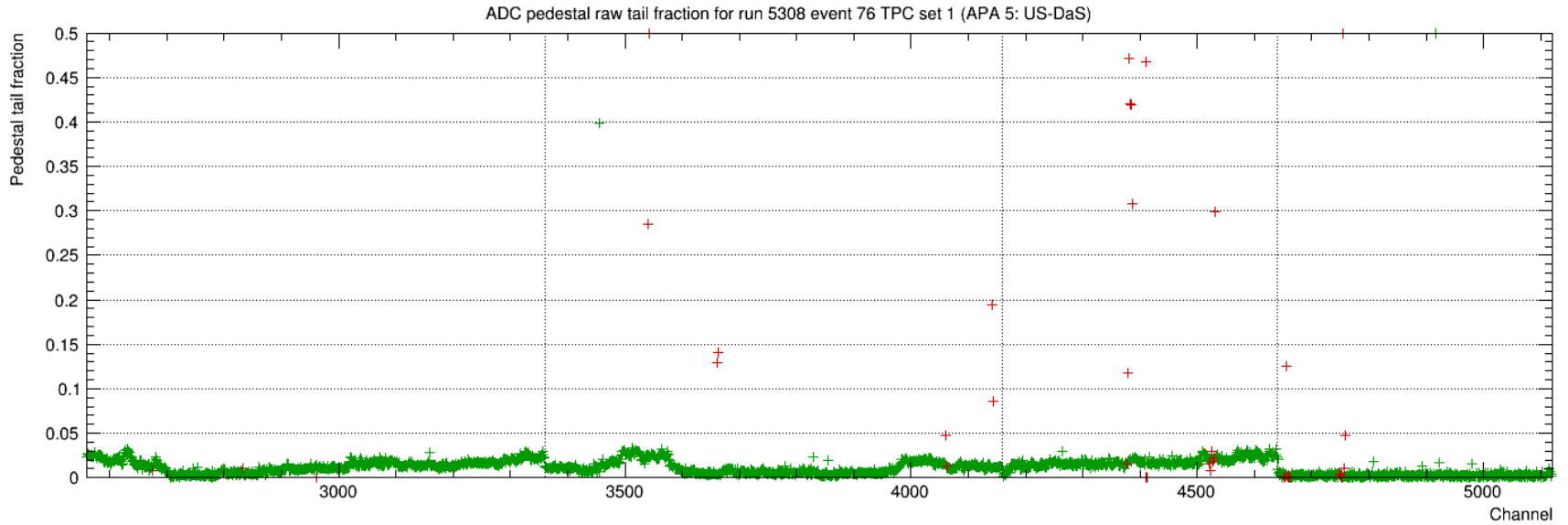
MS OORF



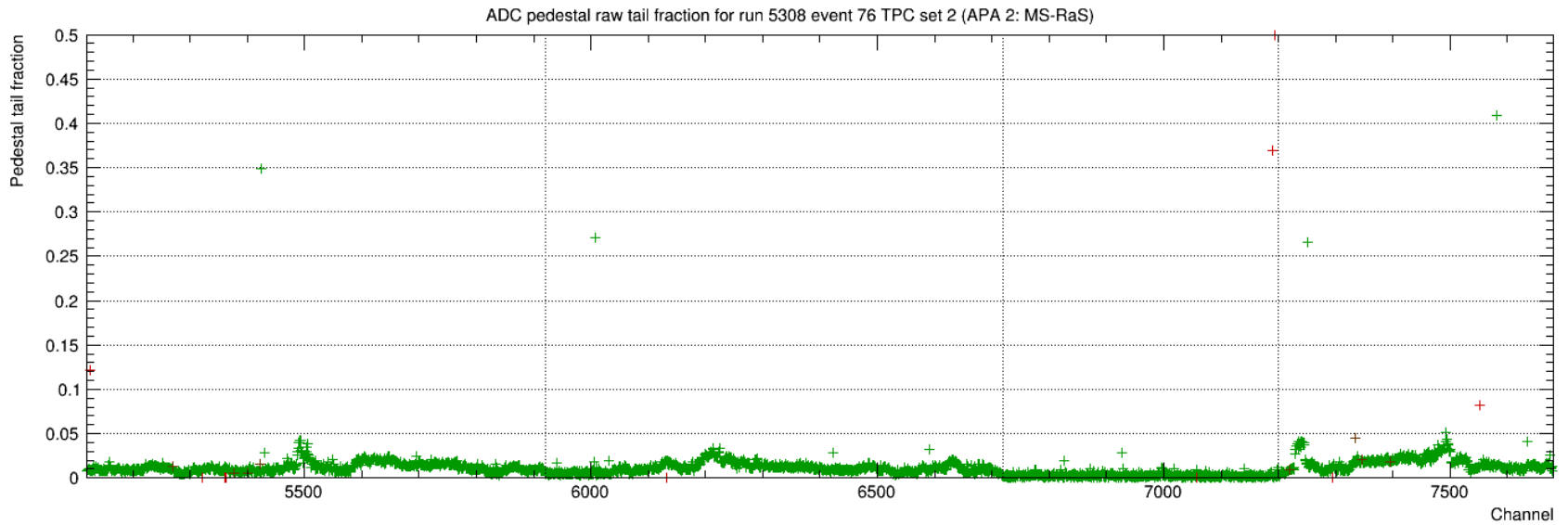
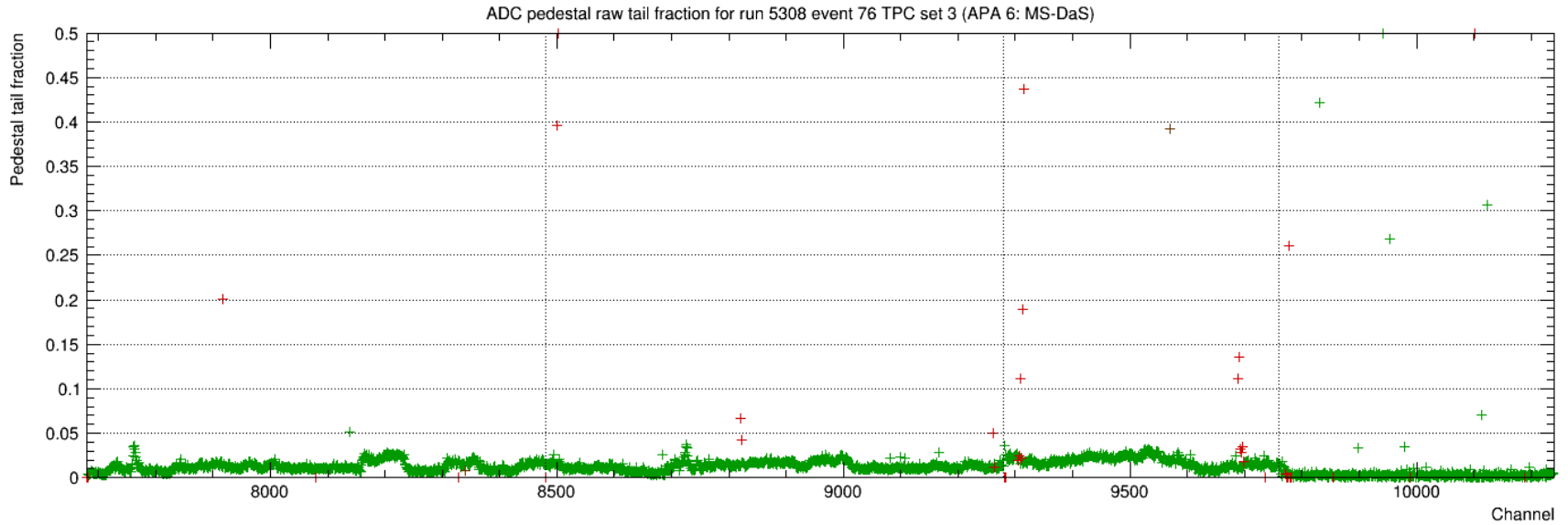
DS OORF



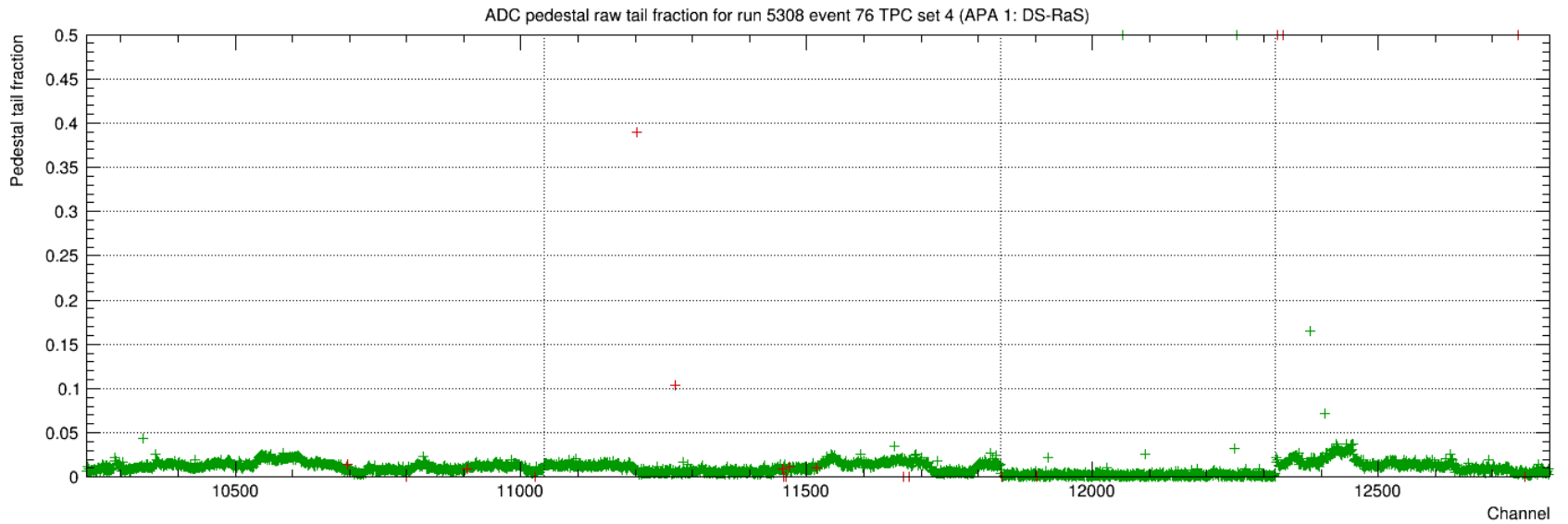
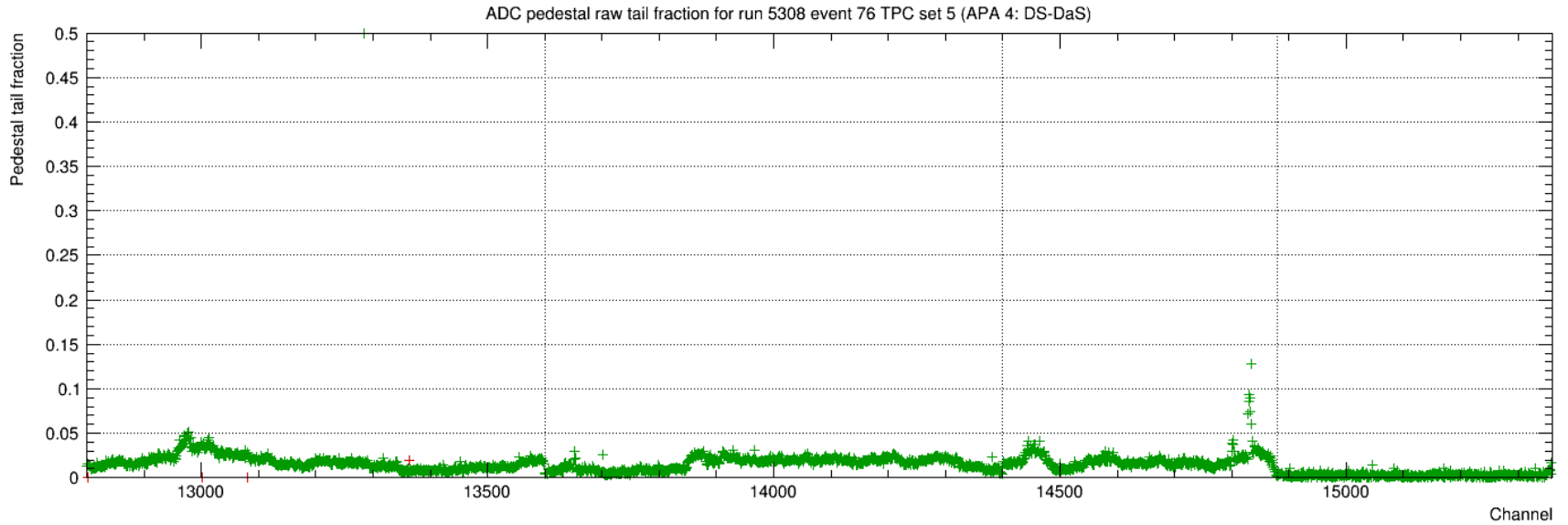
US tail fraction



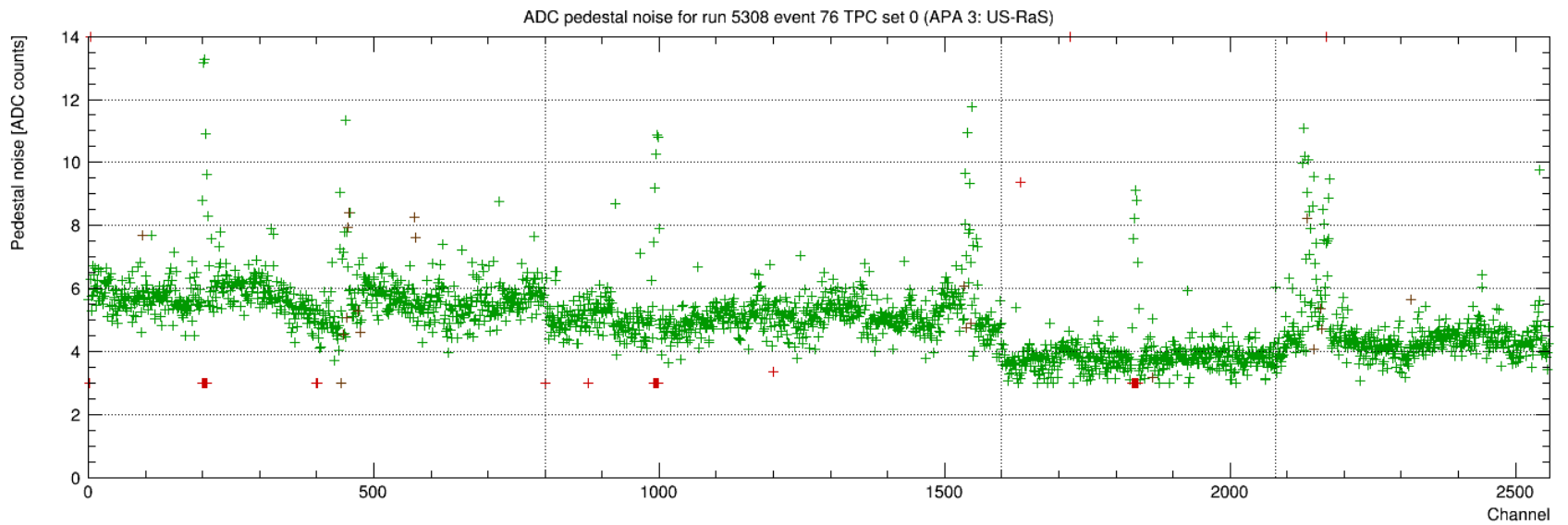
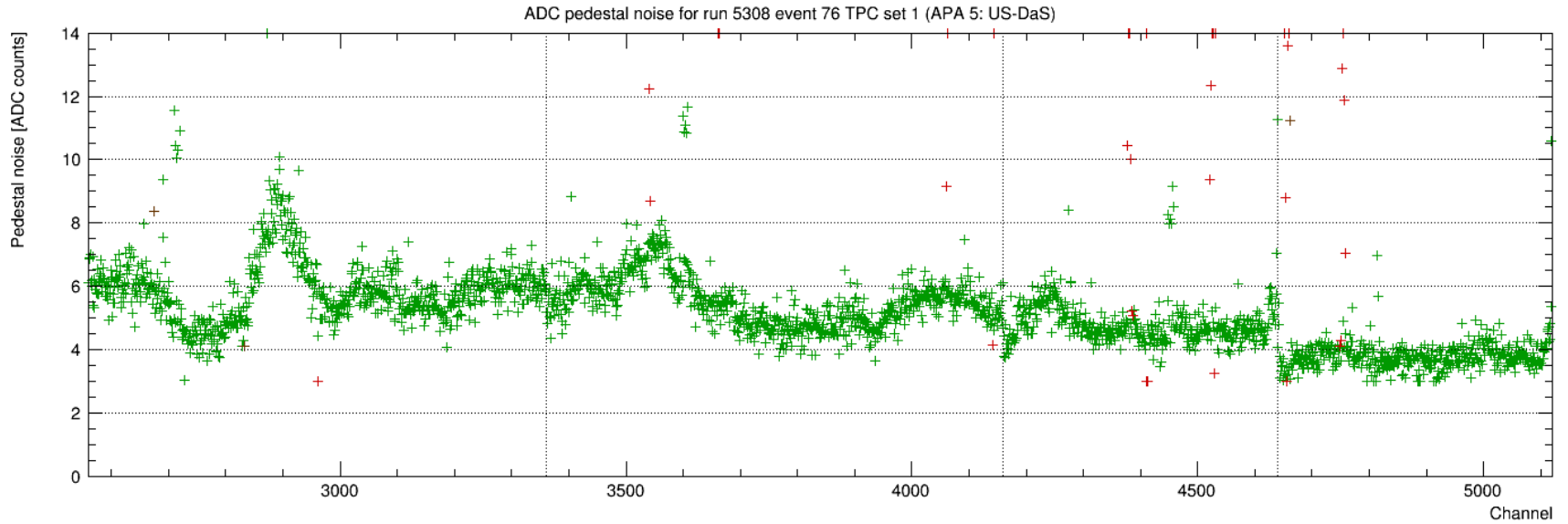
MS tail fraction



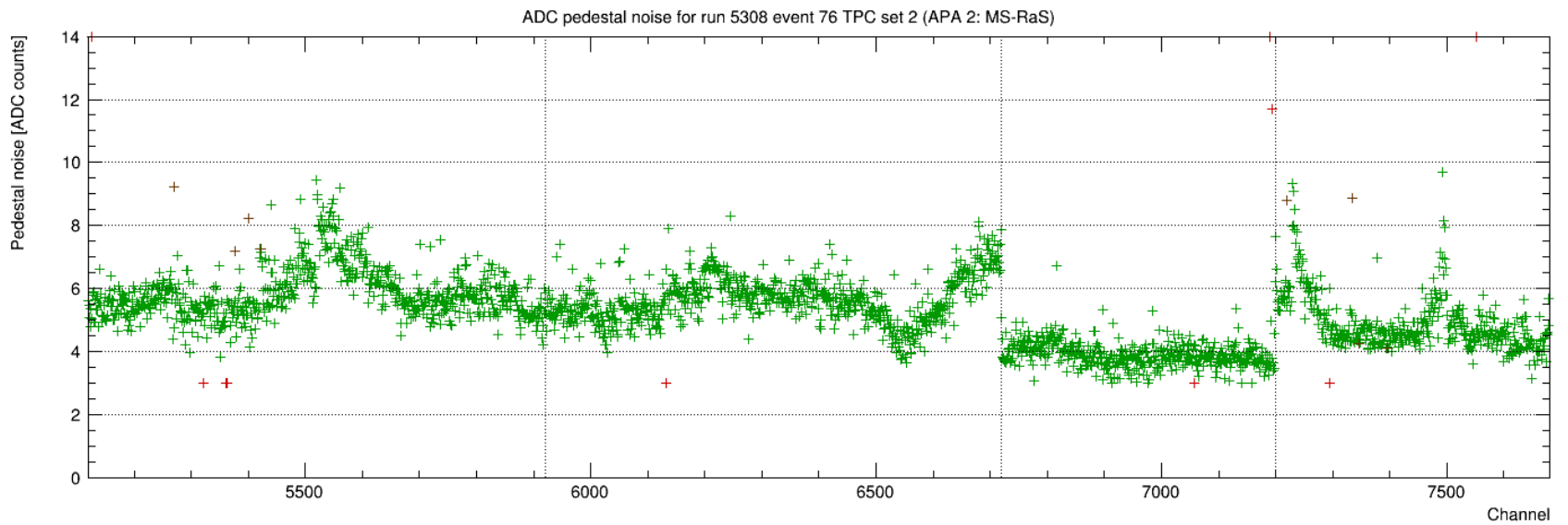
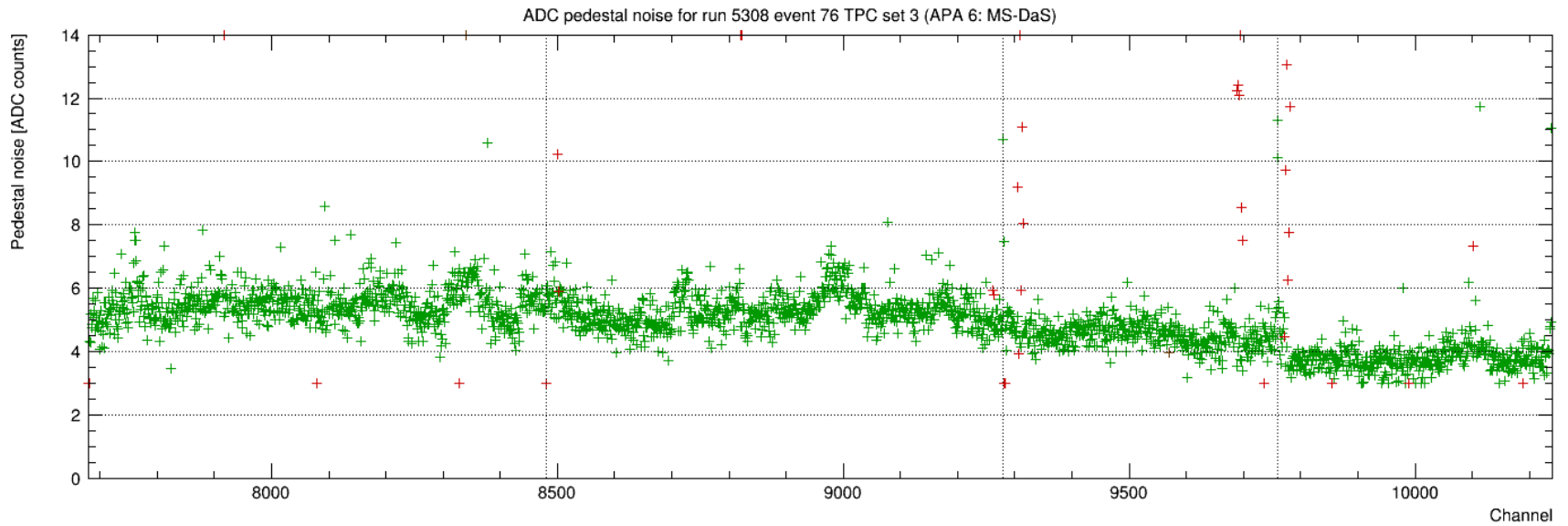
DS tail fraction



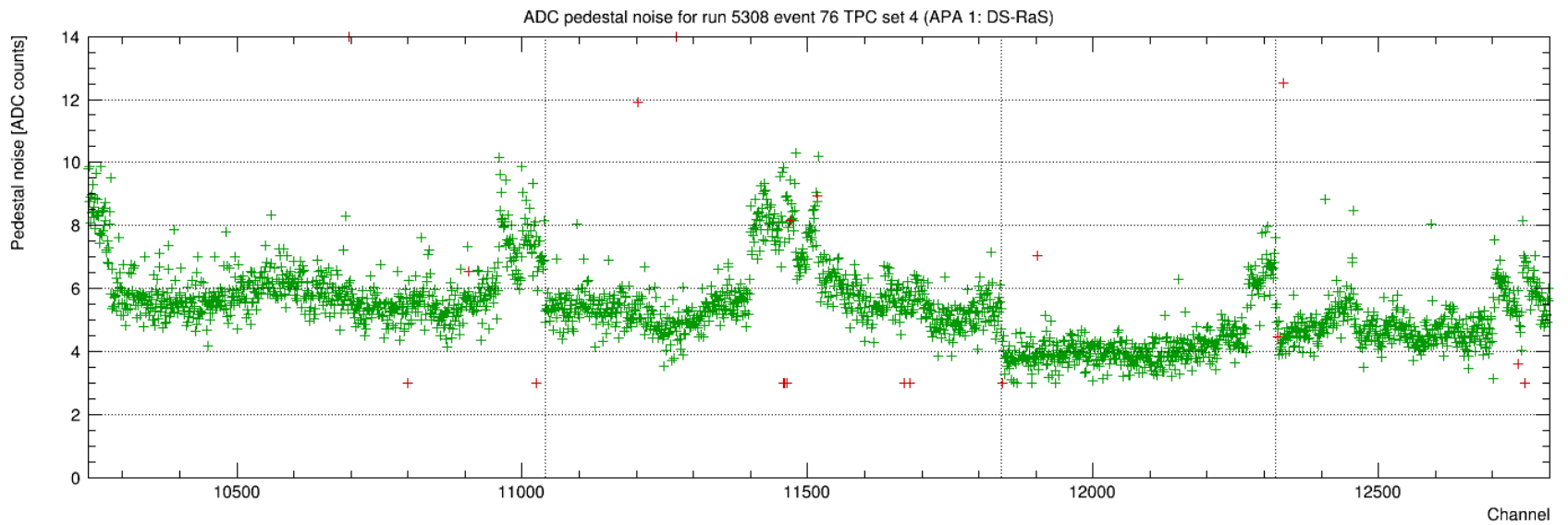
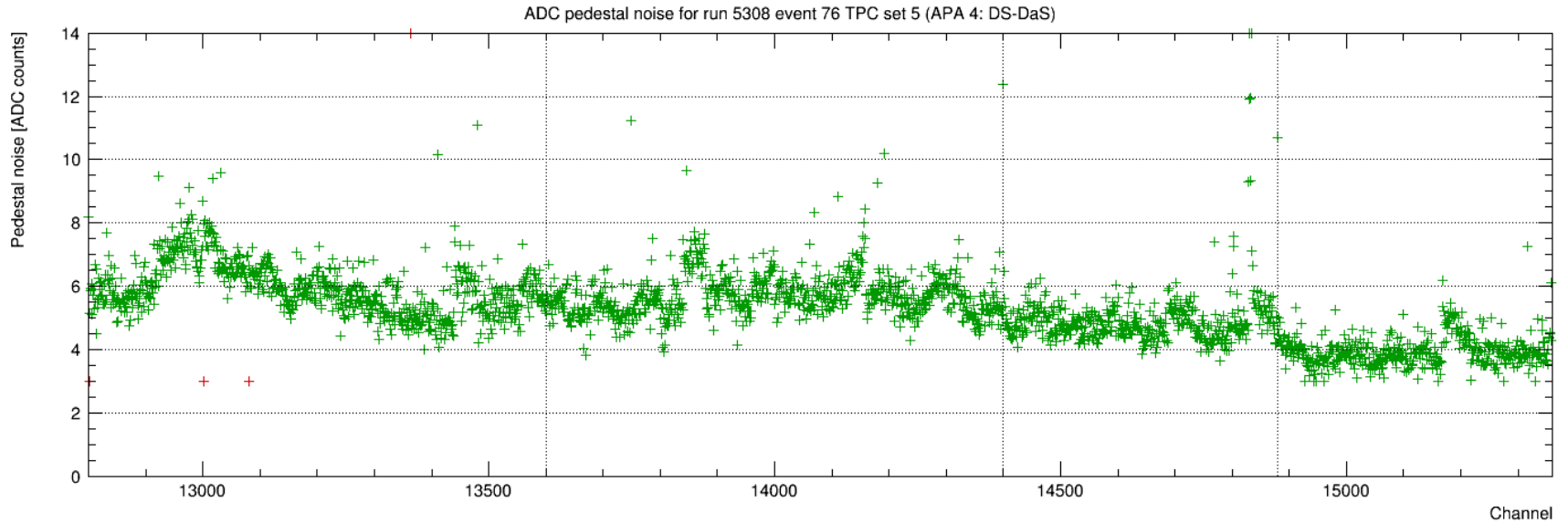
US noise



MS noise



DS noise



Comments

First pass at sticky code identification complete

- All channels
- But mostly just 1k ticks in one event (5308-76)
 - Quick looks suggest this covers most for other events
 - Should do a more systematic study
- Only looked for sticky codes in the pedestal region
 - Use cosmics to look for sticky codes in other regions
 - But difficult to tell if codes are far from true value
 - And difficult to see low rate problems
 - Use pulser to address these issues
 - Like more pulser data to get the FEMBs missed in the last set
 - Add phase offset to improve coverage of ADC range