# Bad channels: RMS

## DUNE 35-ton simulation and reconstruction

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# Introduction

I remain interested in using 35t data to look at signal shapes

- Like to stick to the "good" channels
- Both for direct use in the study and for correlated BG removal

Metrics for identifying bad channels

- Bad channel list in DUNE FCL
- RMS of tick ADC values
- Fraction of ADC values that are "sticky", i.e. 6 LSB are 0 or 1
- Fraction of non-sticky ADC values that repeat in contiguous ticks

Past talks

- See my talk from out last meeting (Dec 21)

Today

- Improve RMS metric
  - Remove sticky codes
  - Remove signal tail
- Look at run dependence of the RMS

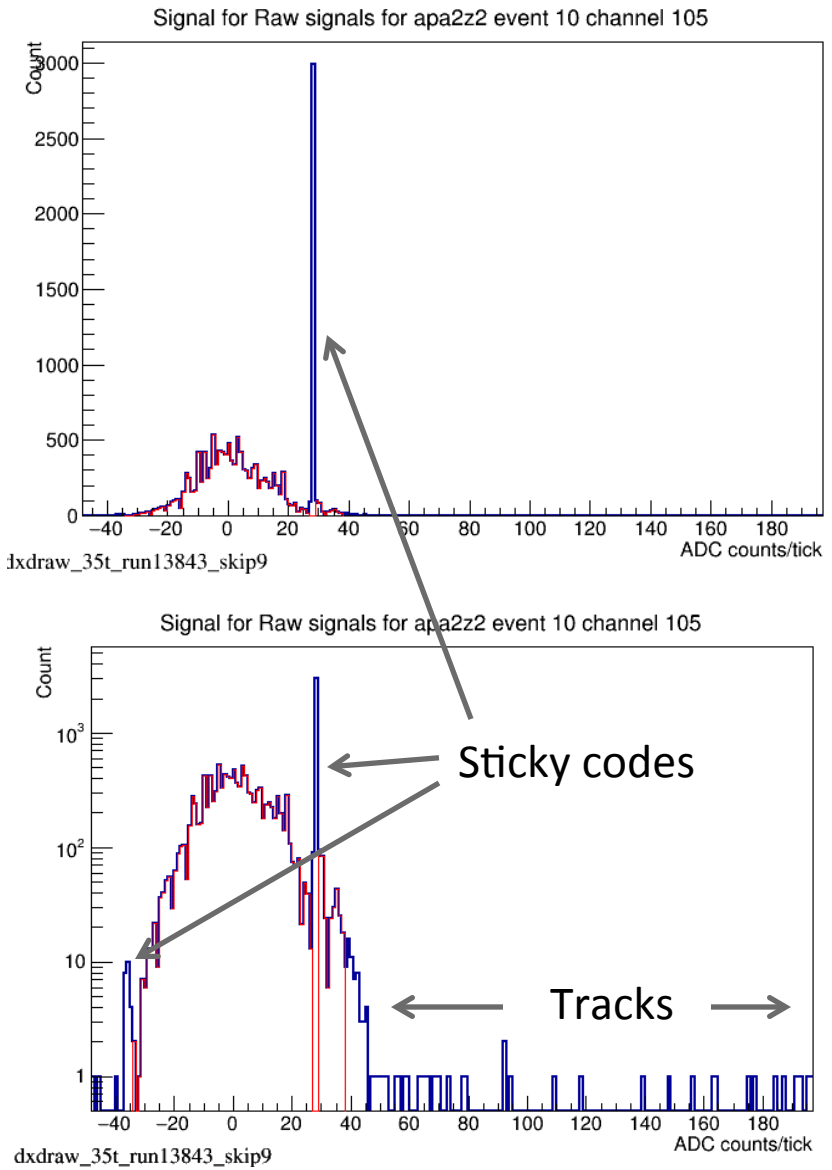
# Fixing the RMS

## Plots show an ADC distribution

- # ticks for each ADC count after subtracting pedestal
- For one “typical” channel and event
- Top is linear, bottom is log
- High side tail due to tracks
- Peaks due to sticky codes

## RMS mitigation

- Sticky values are omitted from the RMS calculation
  - I.e. 0, 63, 64, 127, …, 4095
- Spectrum is iteratively truncated at mean ± 3×RMS
- Blue is the raw spectrum
- Red is mitigated



# RMS and tracks

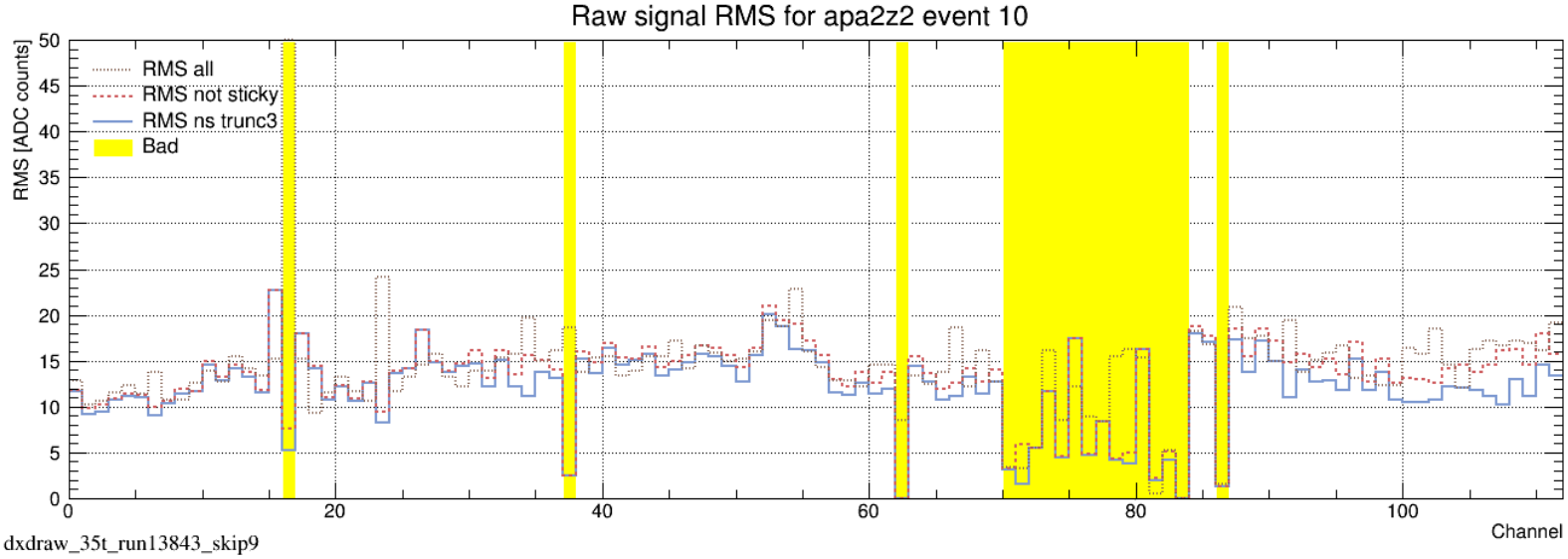
Following pages show RMS for multiple events

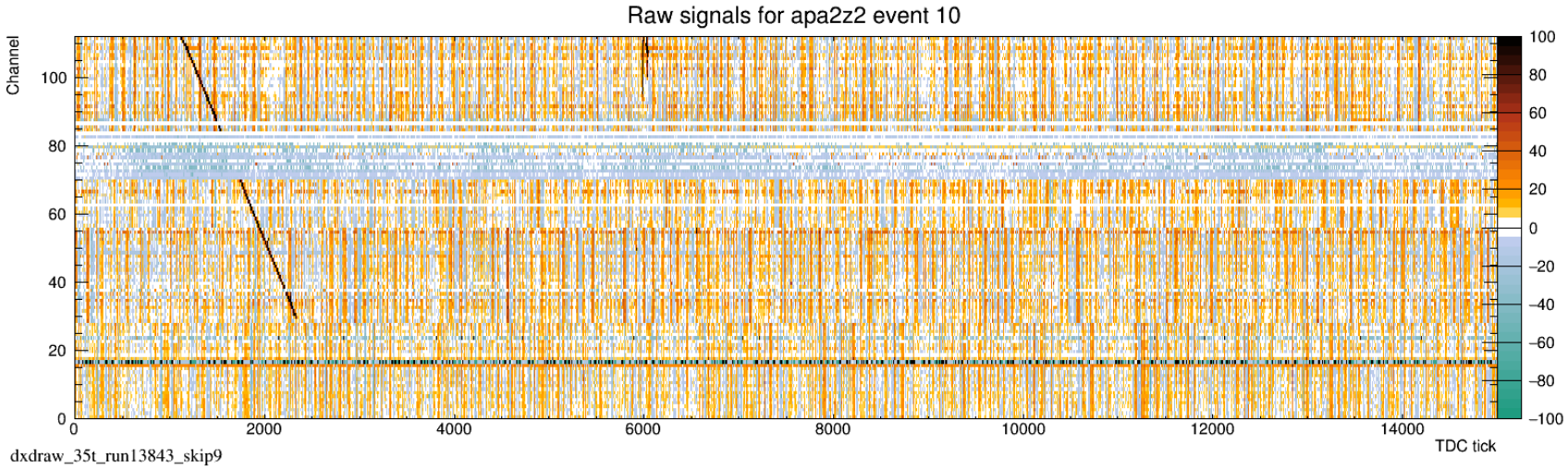
- RMS for each channel in APA 2z2 (top)
- Calculated using all ticks in an event
- For multiple events to show the effect of tracks on distributions
  - Bottom plot shows ADC vs. channel vs. tick to show where tracks are
- Distributions include
  - Raw RMS (dotted brown)
  - RMS without sticky codes (dashed red)
  - RMS without sticky codes and truncated at 3×RMS

Comments

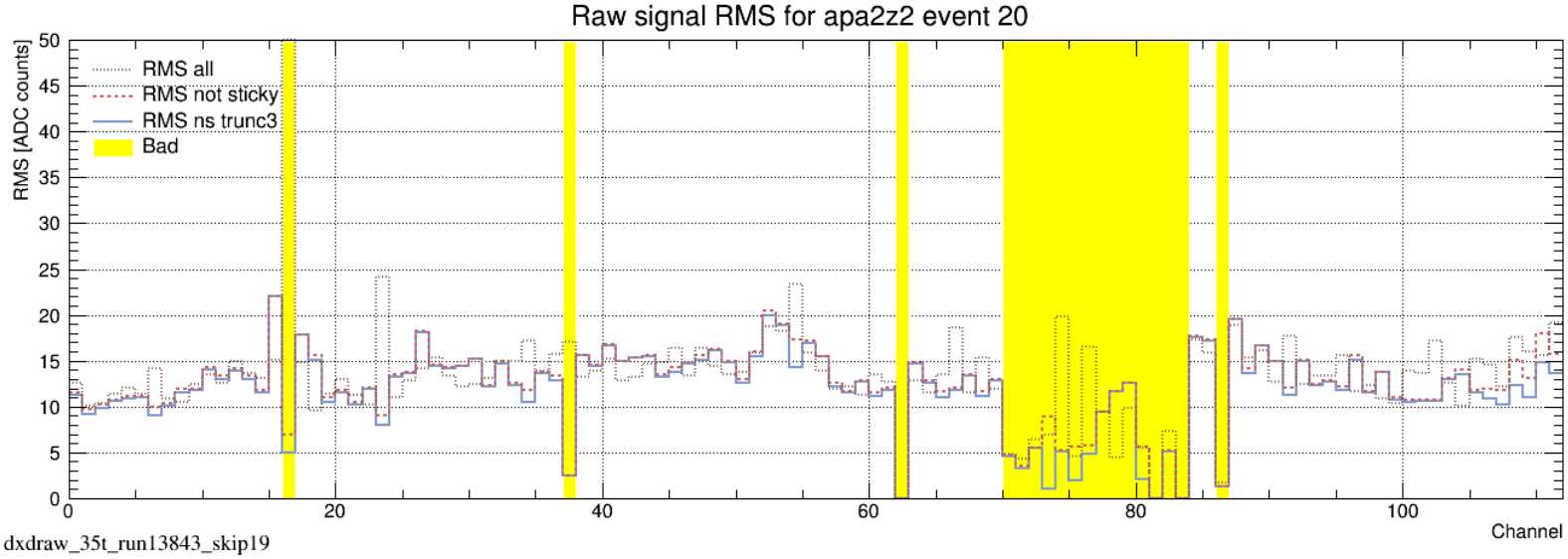
- Without truncation, the RMS increases significantly in channels where tracks have deposited energy
- With truncation, the RMS is much more stable
- RMS vs. tick may be a good way to find signal regions

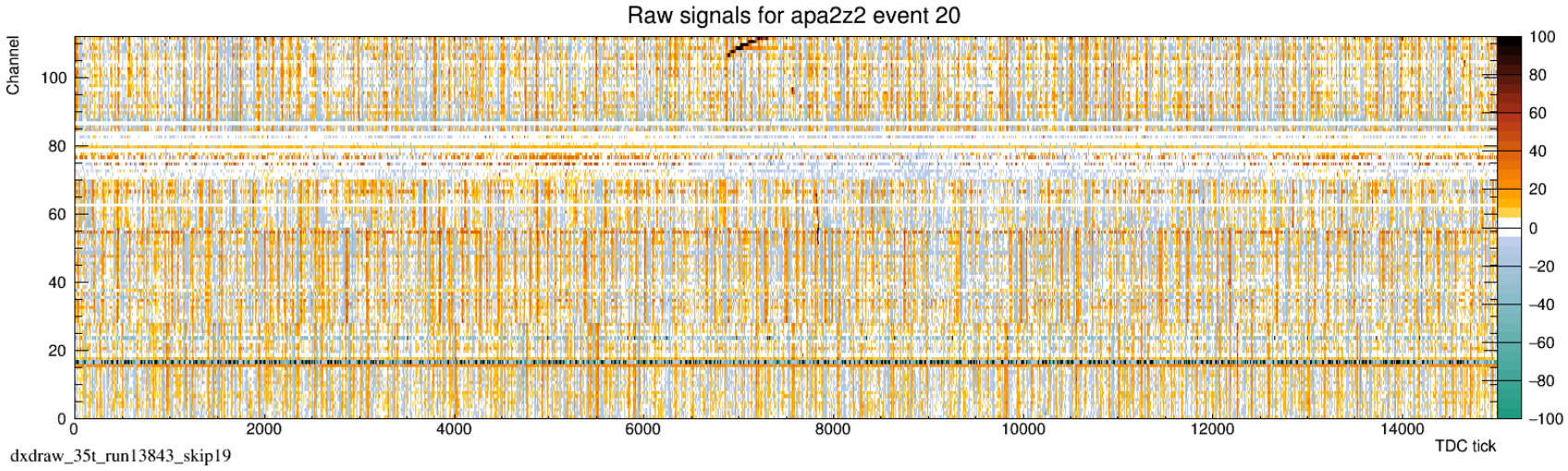
# Event 10


Raw signal RMS for apa2z2 event 10
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip9

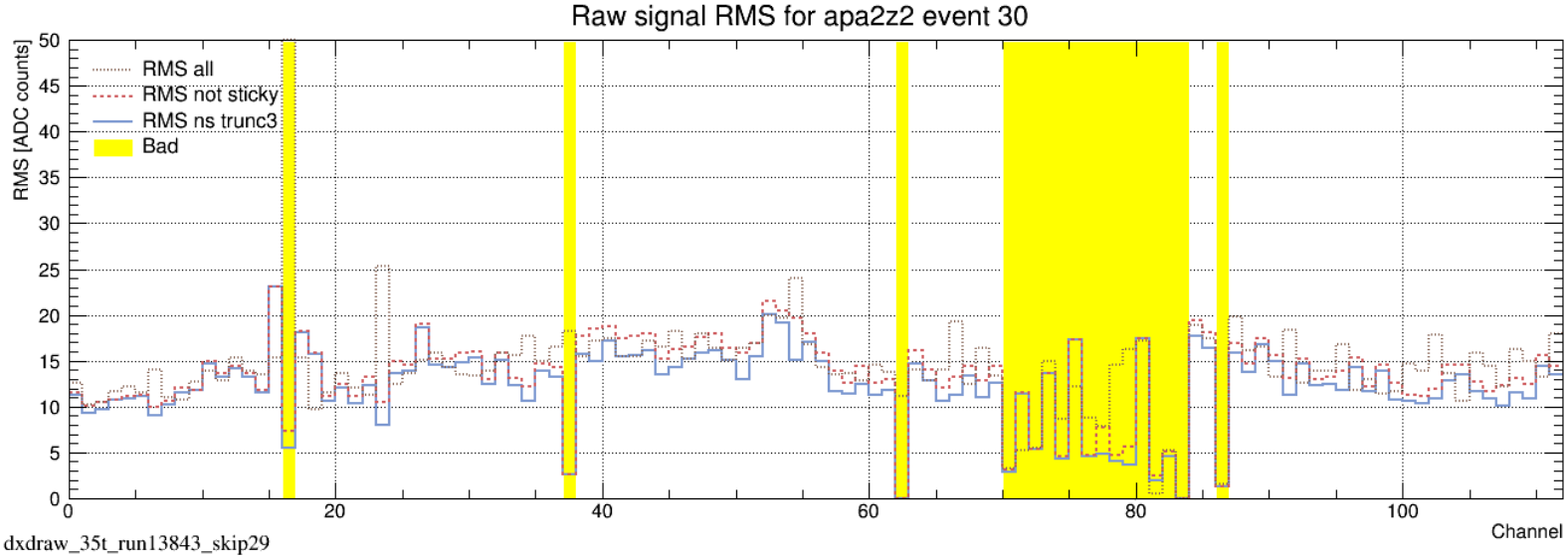

Raw signals for apa2z2 event 10
Channel
TDC tick
dxdraw_35t_run13843_skip9

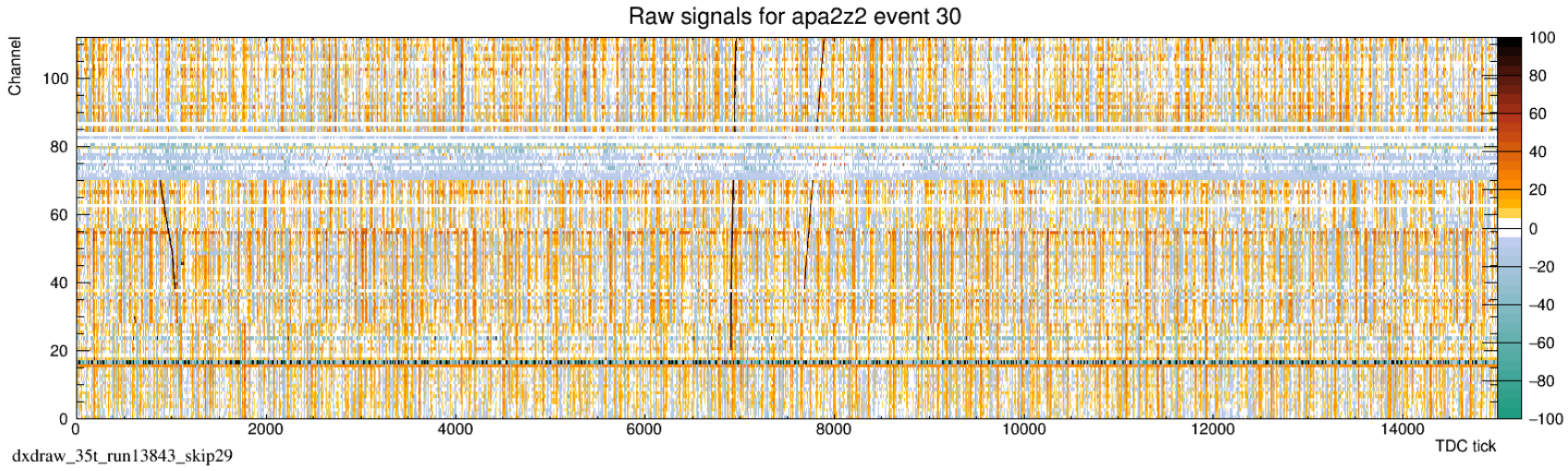
# Event 20


Raw signal RMS for apa2z2 event 20
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip19

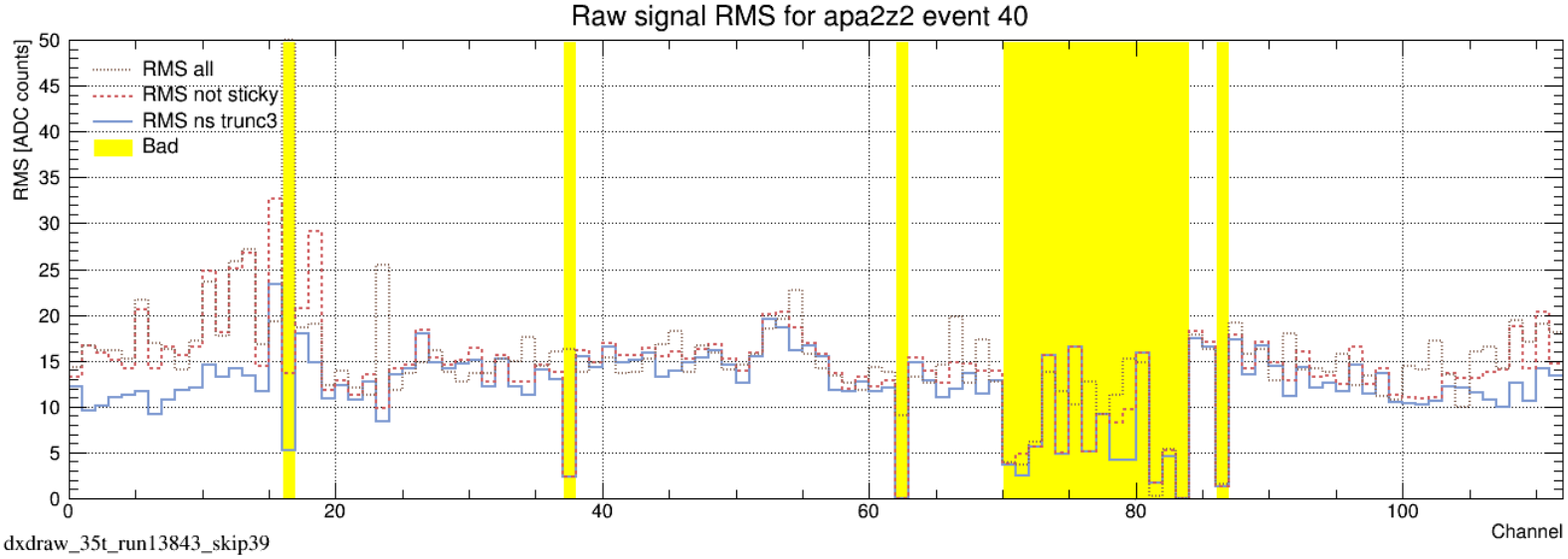

Raw signals for apa2z2 event 20
Channel
TDC tick
dxdraw_35t_run13843_skip19

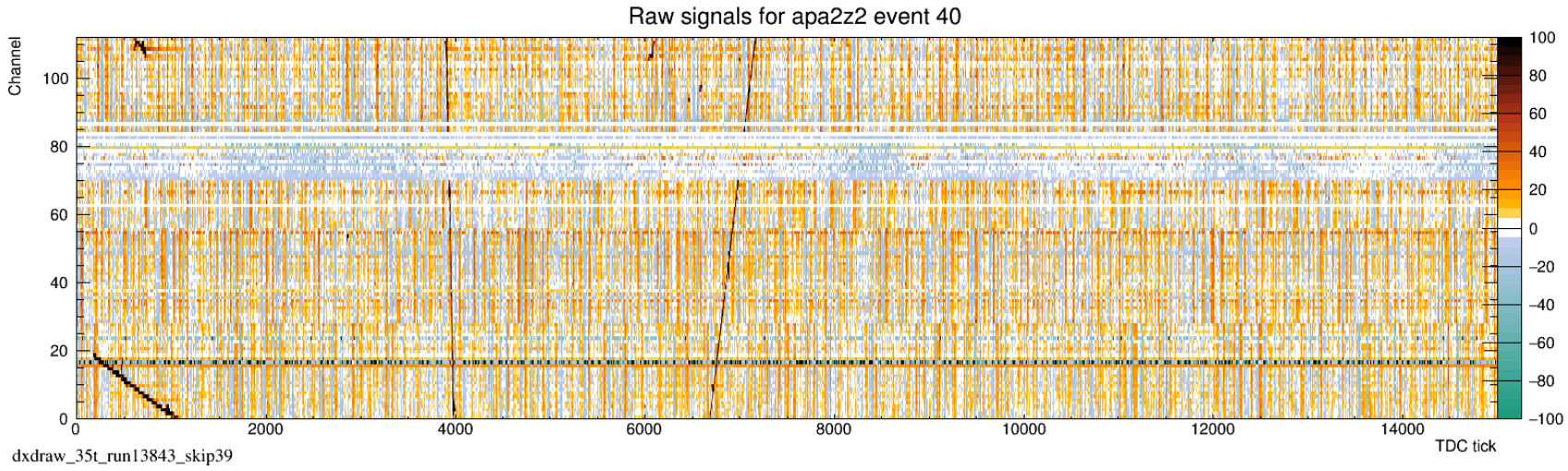
# Event 30


Raw signal RMS for apa2z2 event 30
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip29

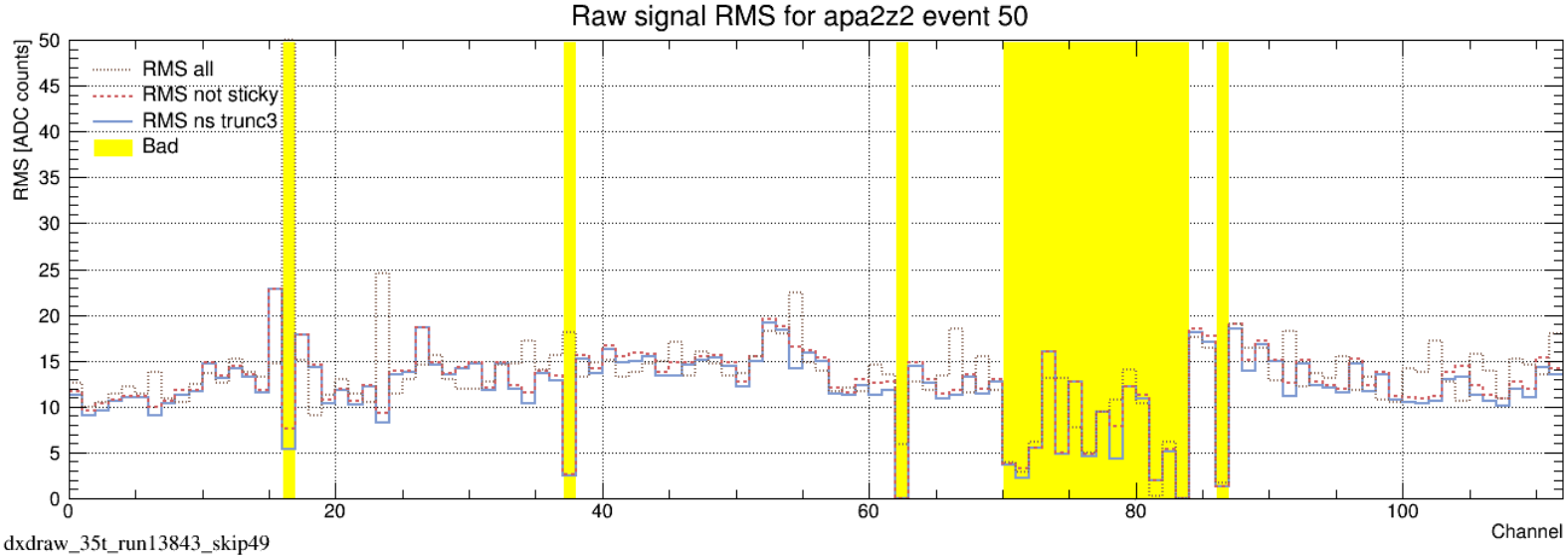

Raw signals for apa2z2 event 30
Channel
TDC tick
dxdraw_35t_run13843_skip29

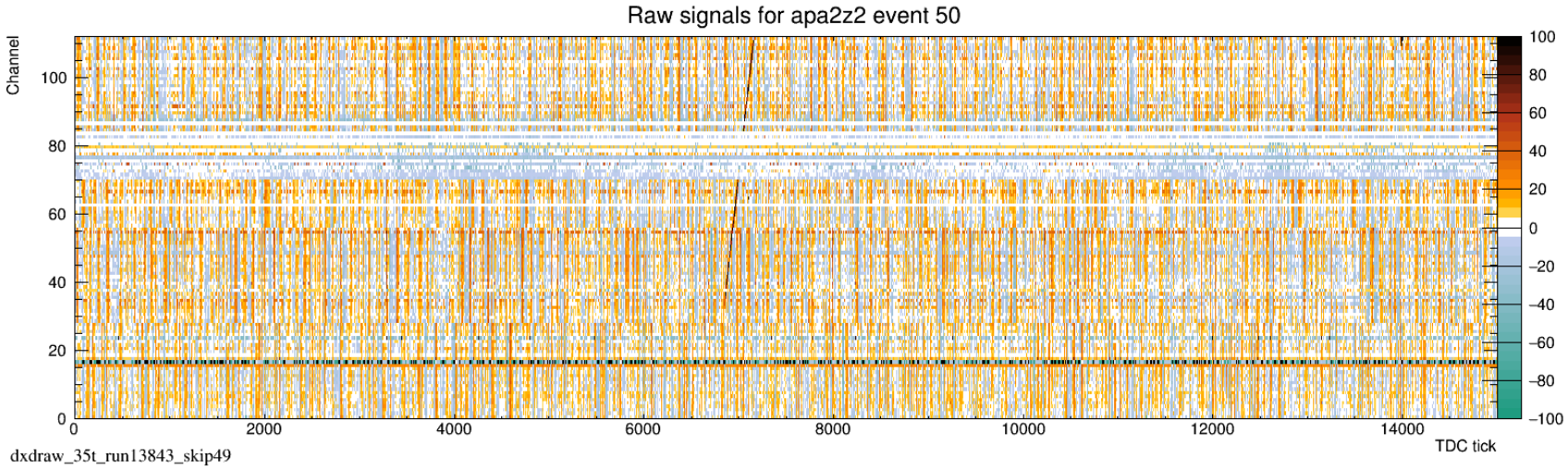
# Event 40


Raw signal RMS for apa2z2 event 40
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip39

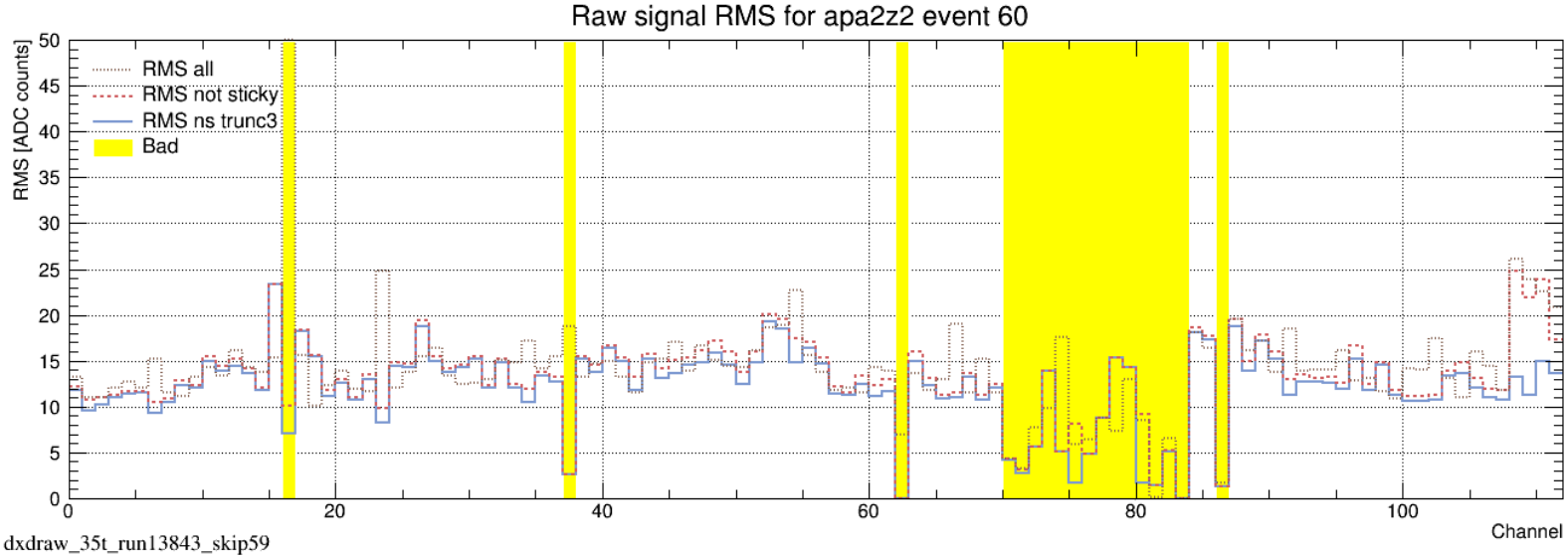

Raw signals for apa2z2 event 40
Channel
TDC tick
dxdraw_35t_run13843_skip39

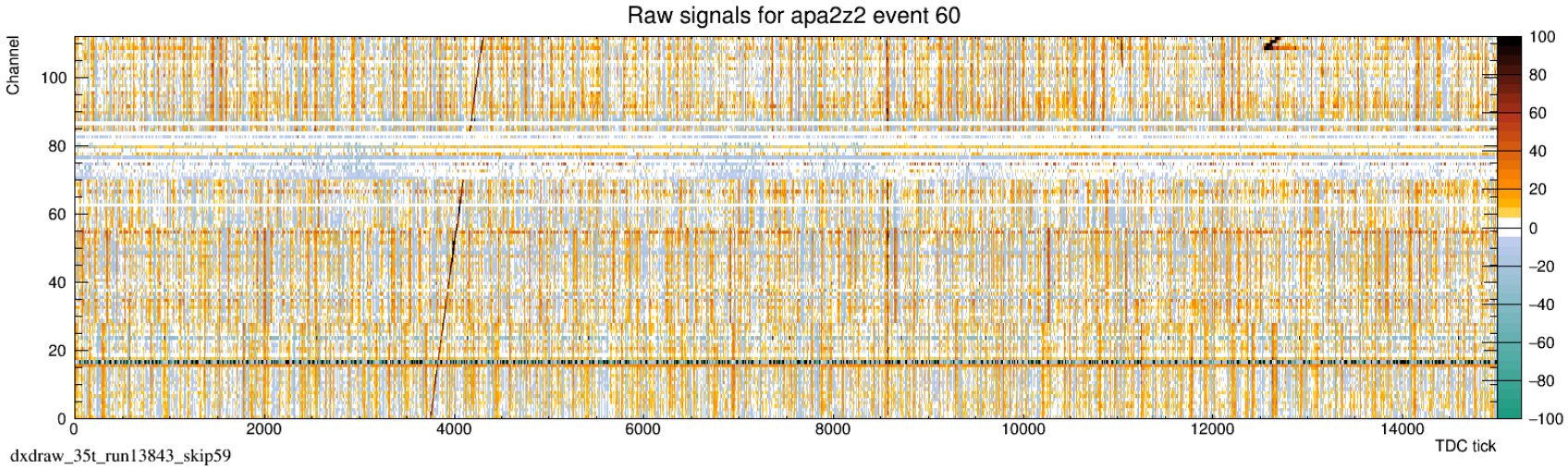
# Event 50


Raw signal RMS for apa2z2 event 50
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip49

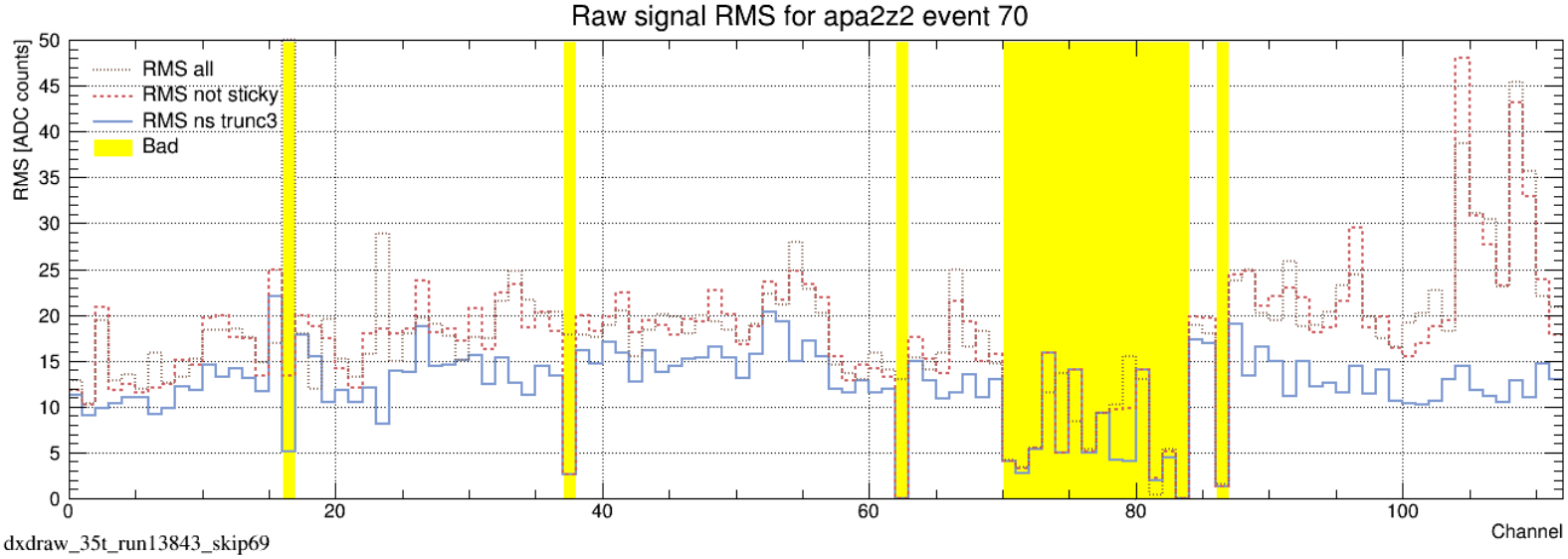

Raw signals for apa2z2 event 50
Channel
TDC tick
dxdraw_35t_run13843_skip49

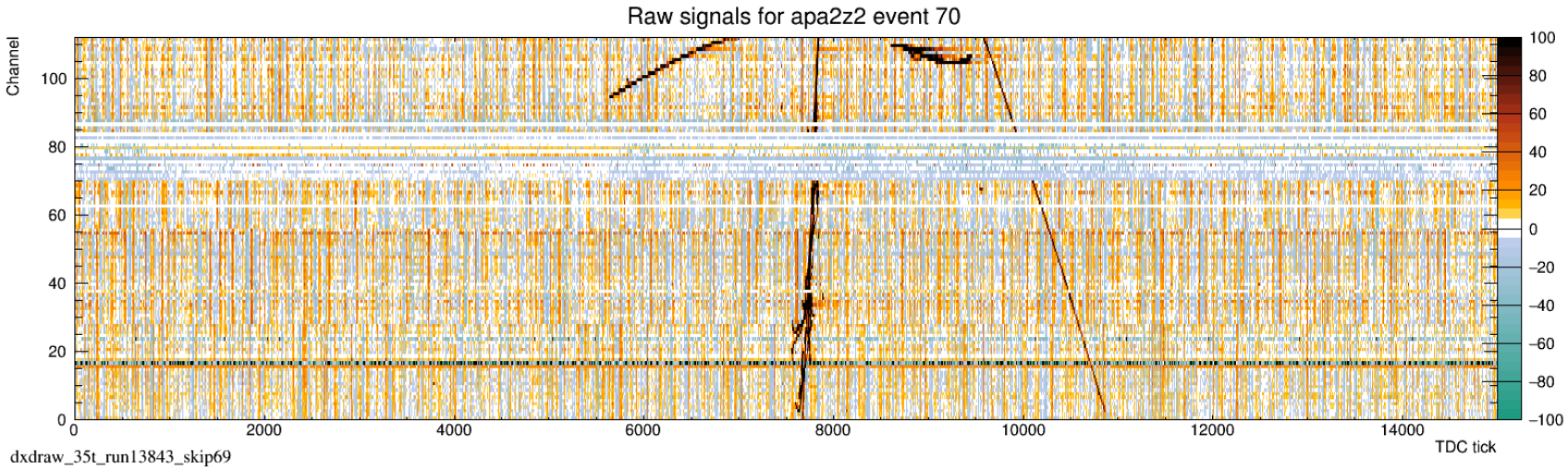
# Event 60


Raw signal RMS for apa2z2 event 60
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip59

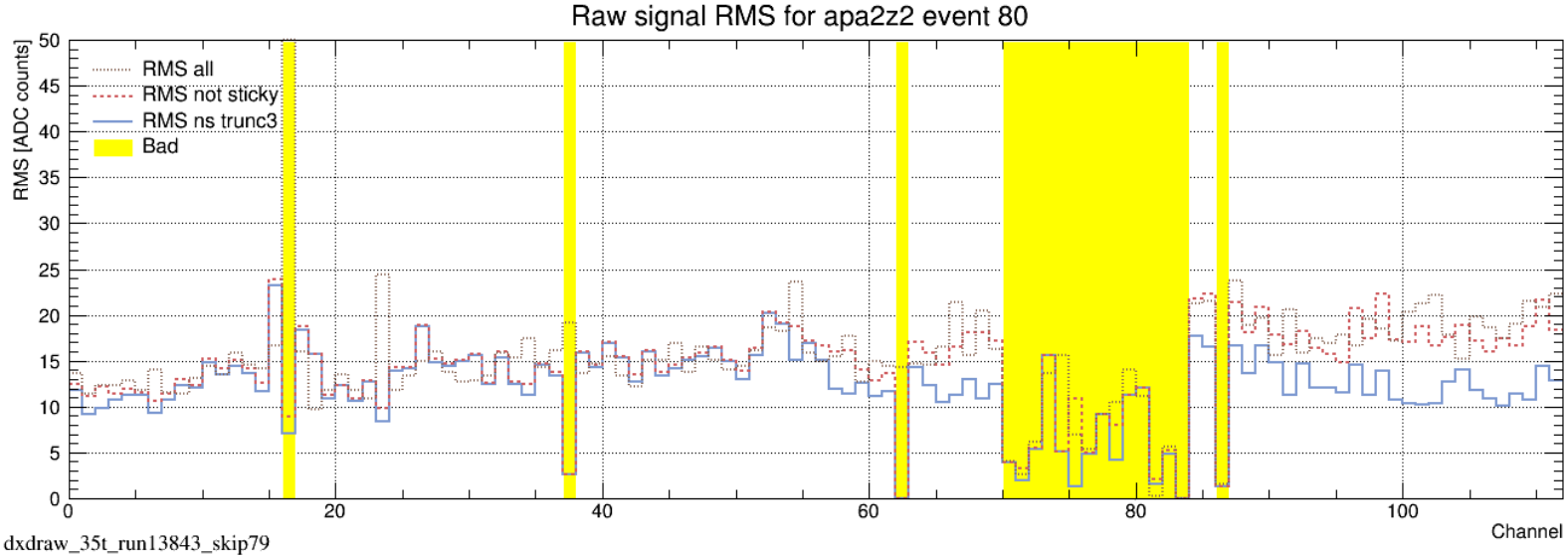

Raw signals for apa2z2 event 60
Channel
TDC tick
dxdraw_35t_run13843_skip59

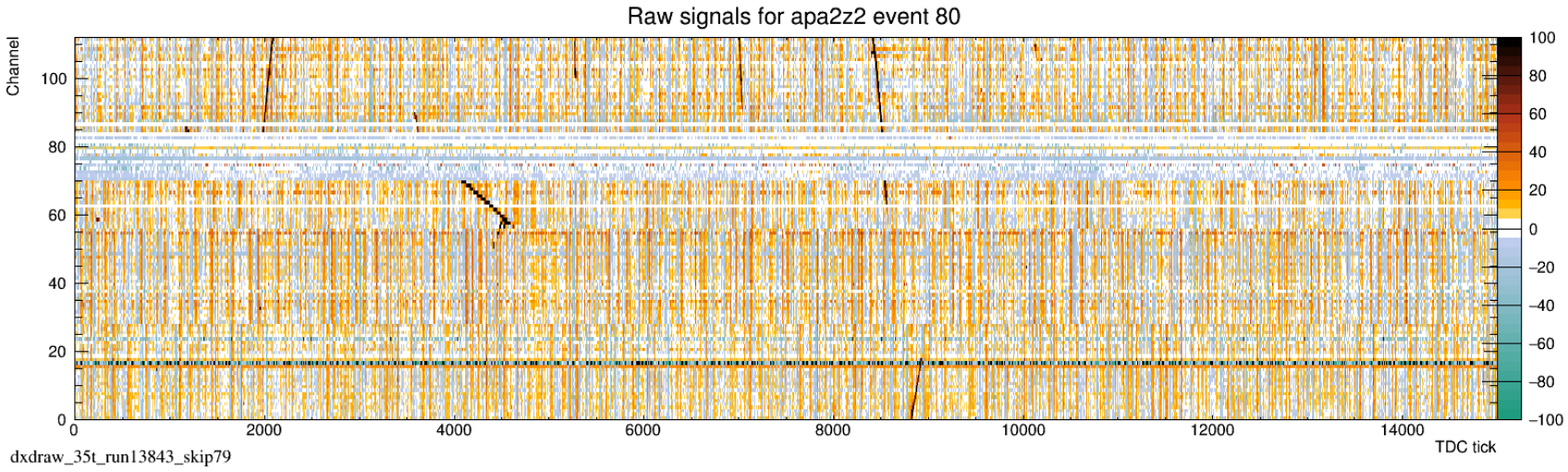
# Event 70


Raw signal RMS for apa2z2 event 70
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip69


Raw signals for apa2z2 event 70
Channel
TDC tick
dxdraw_35t_run13843_skip69

# Event 80


Raw signal RMS for apa2z2 event 80
RMS [ADC counts]
RMS all
RMS not sticky
RMS ns trunc3
Bad
Channel
dxdraw_35t_run13843_skip79


Raw signals for apa2z2 event 80
Channel
TDC tick
dxdraw_35t_run13843_skip79

# RMS vs. run

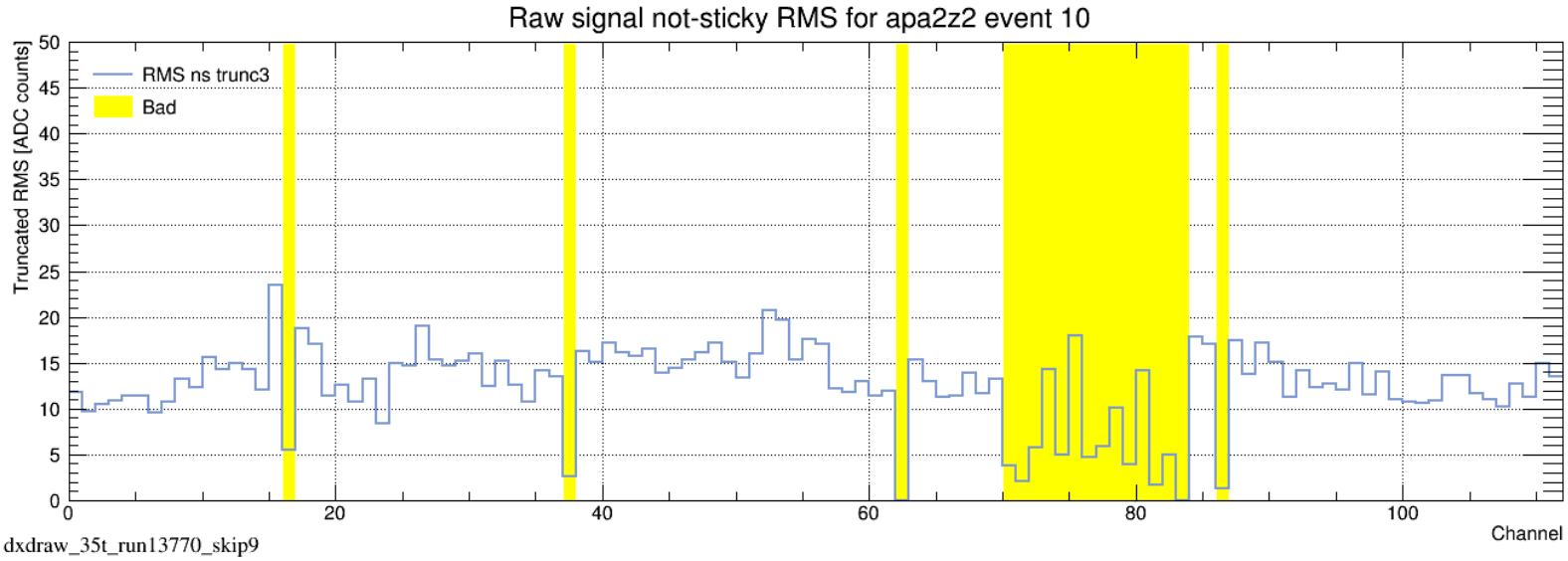
Following pages show RMS for various runs

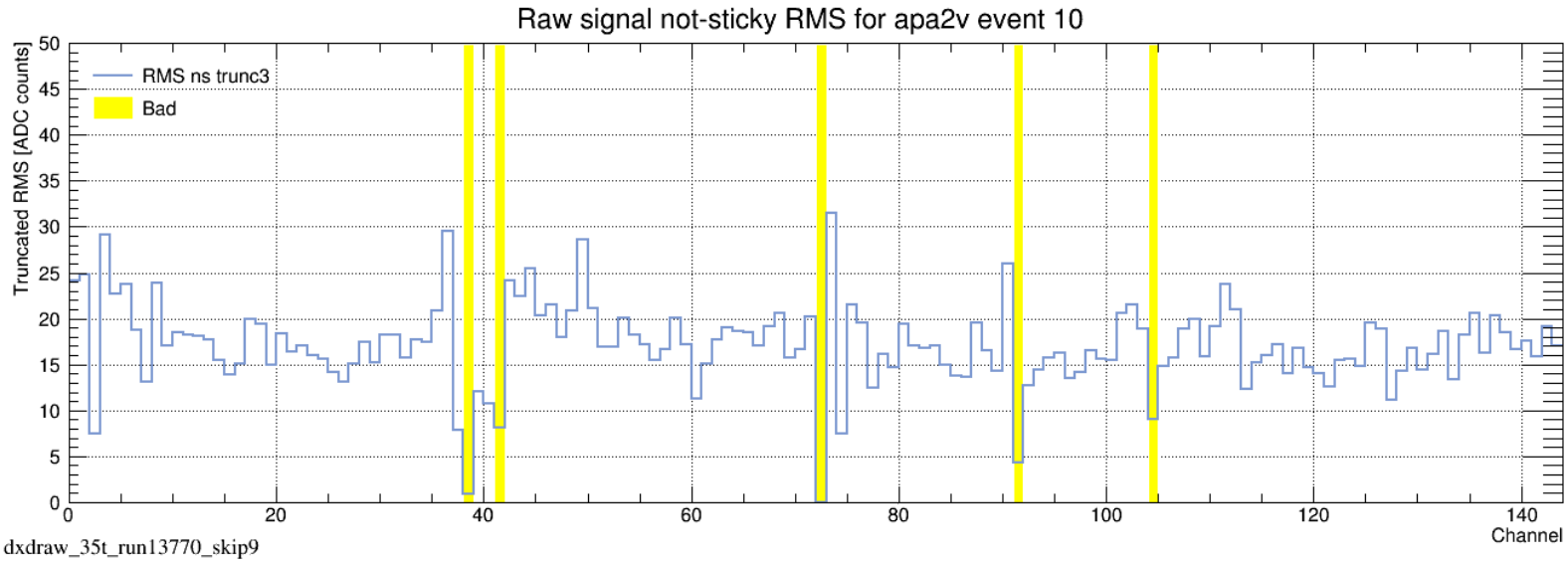
- Using event 10 in the run
- RMS for each channel in APA 2z2 (top) and 2v (bottom)
- This is the mitigated RMS
  - No sticky codes, truncated at 3×RMS

Comments

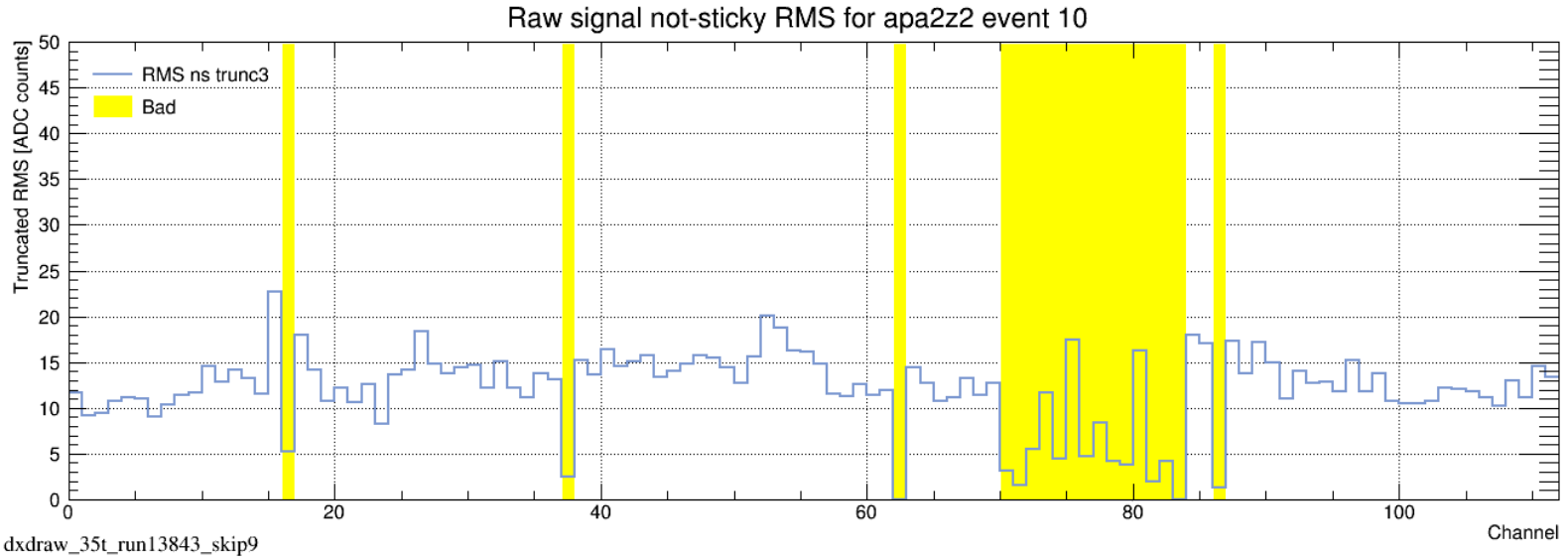
- RMS looks pretty stable over the course of the run
  - Variations with about 5% (by eye) in collection plane
    - Worse (10-20%) for some channels in induction plane
  - Run-to-run average fluctuation also small
  - Pattern vs. channel changes during power failure
    - Average level about the same
- Discovered run 15548 has higher noise
  - Removed it from my good run list

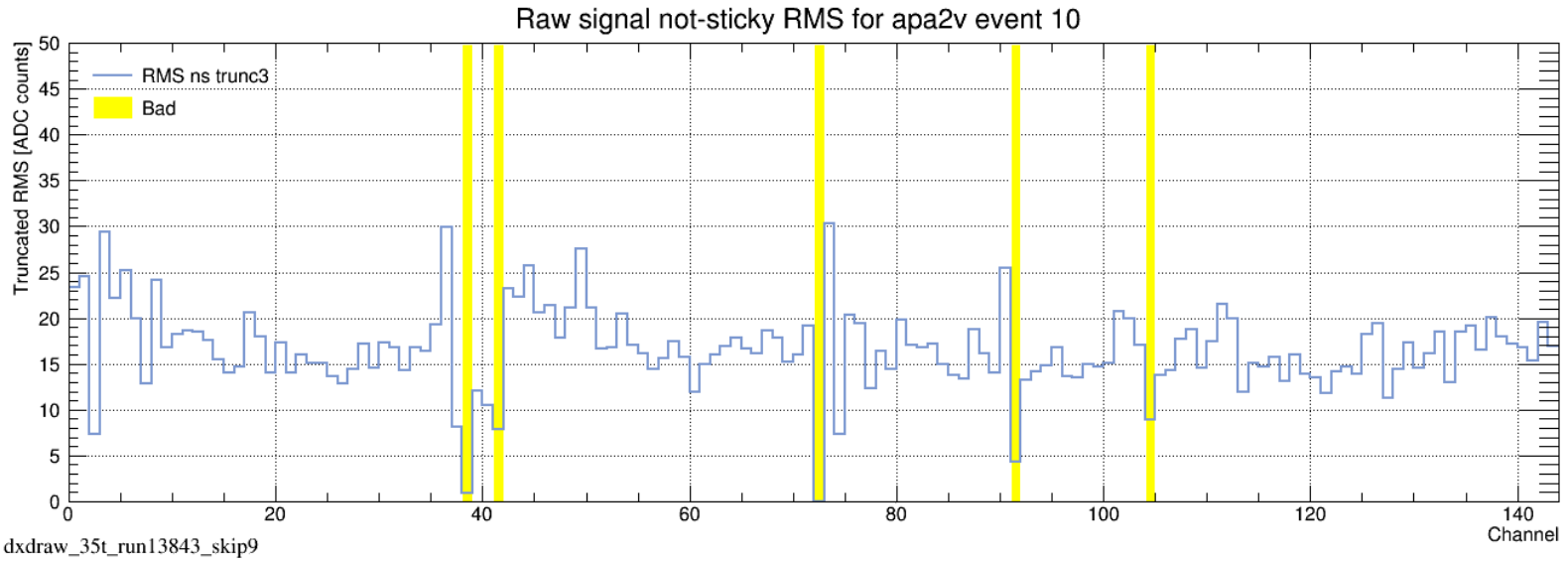
# Run 13770 (first run)



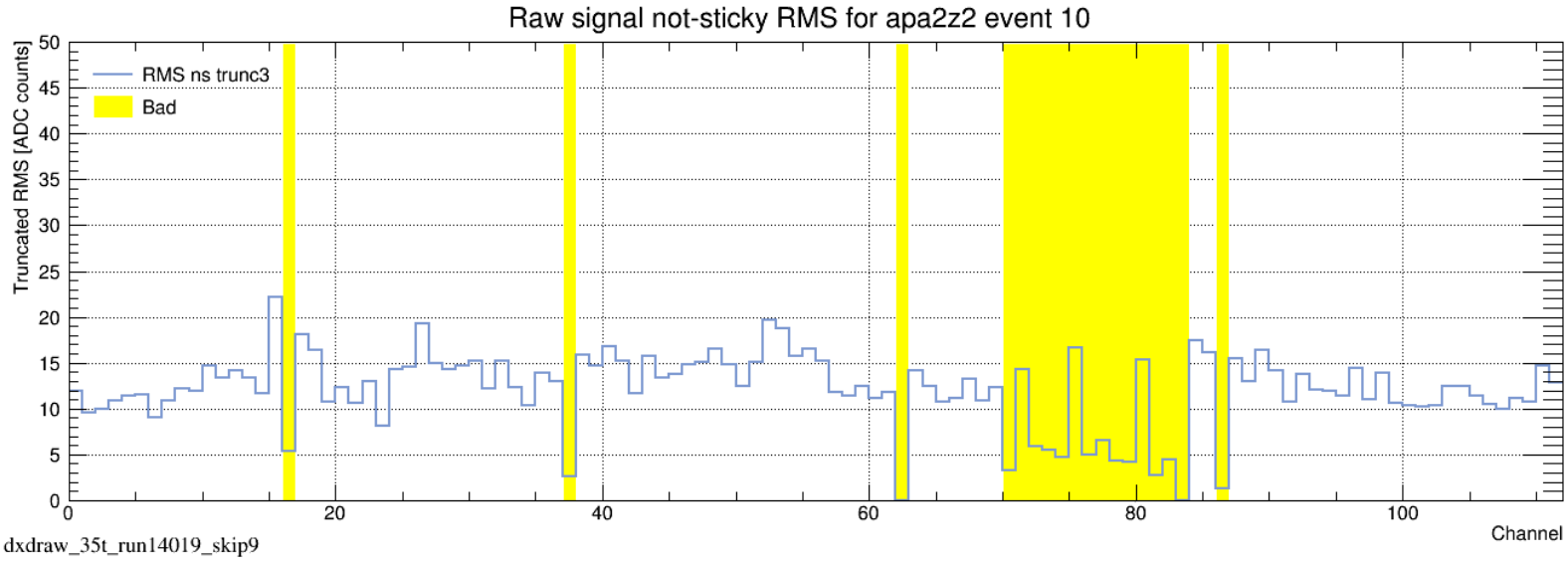



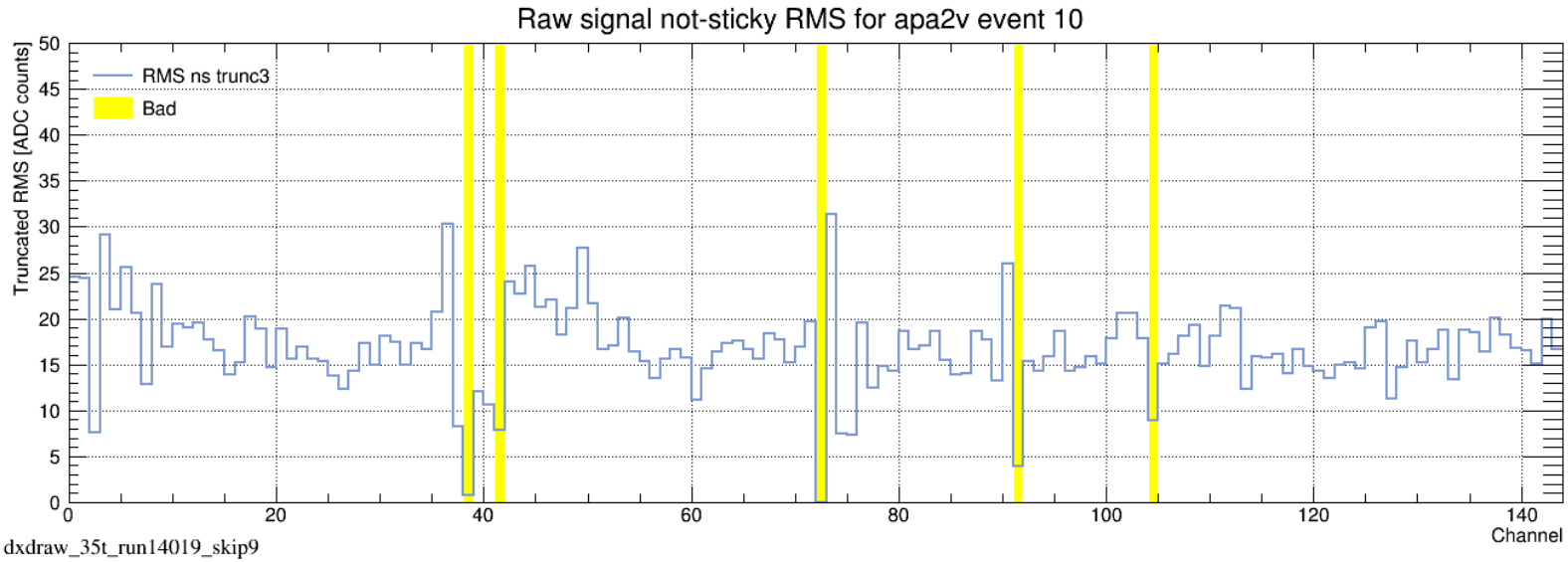
# Run 13843


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run13843_skip9

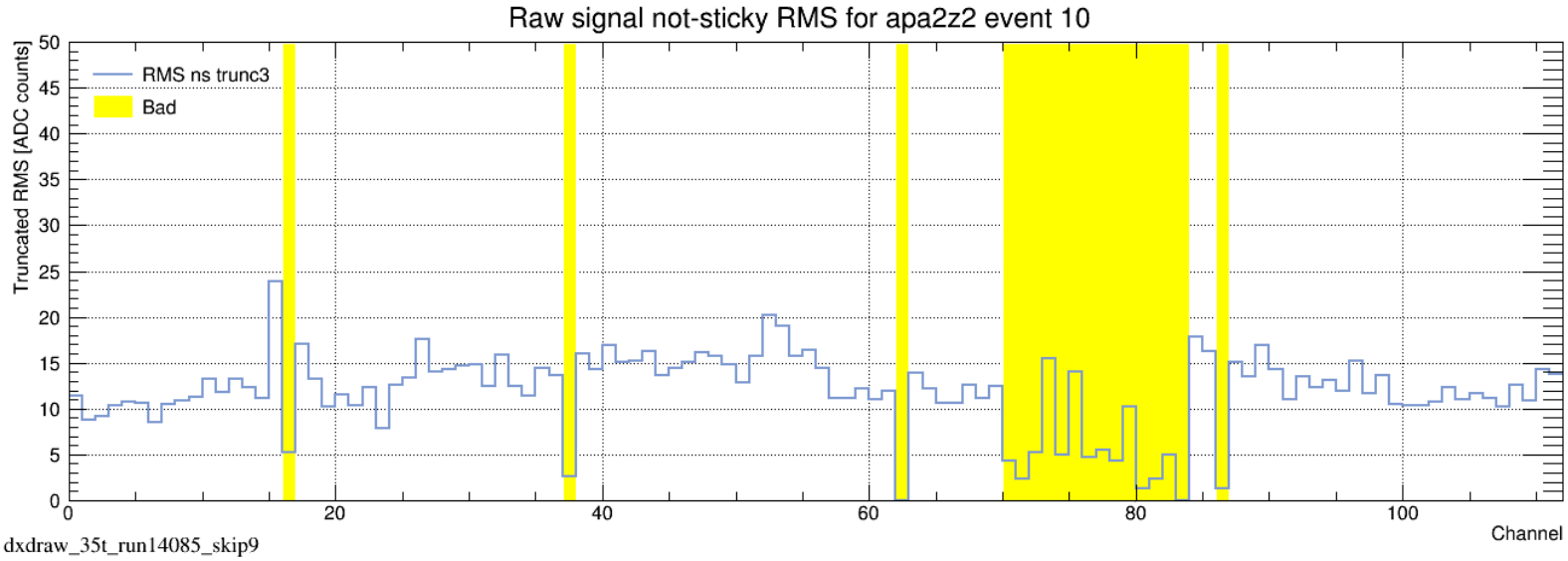

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run13843_skip9

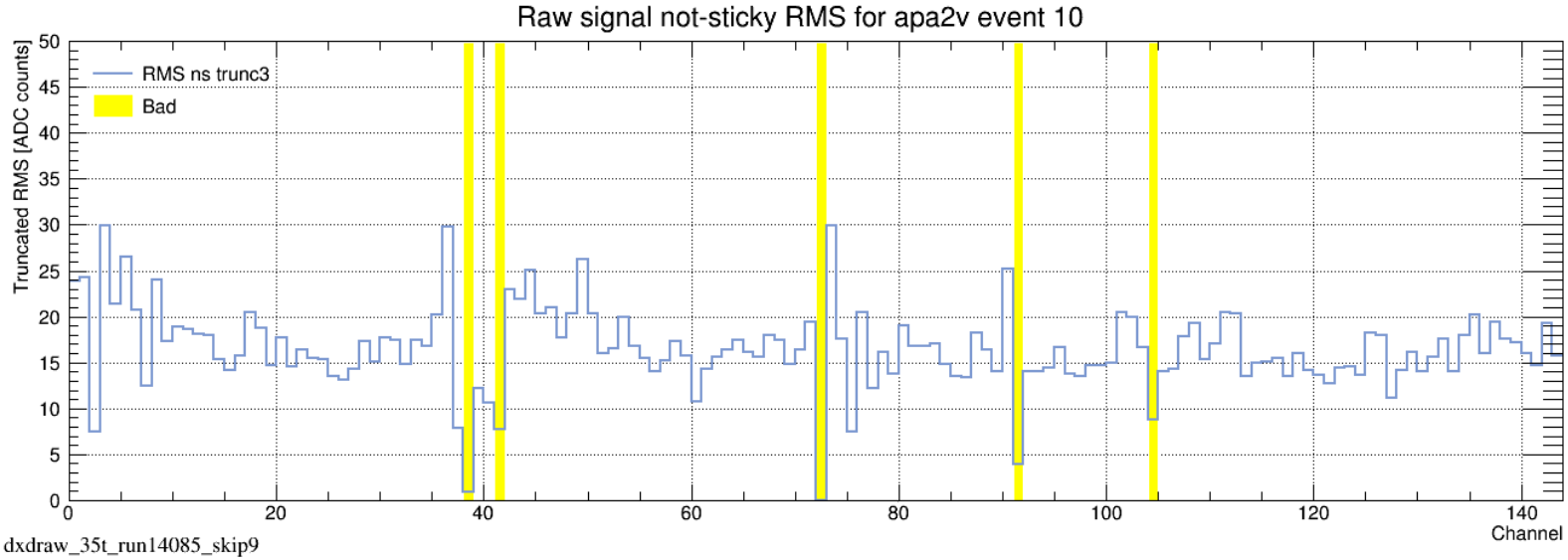
# Run 14019


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14019_skip9

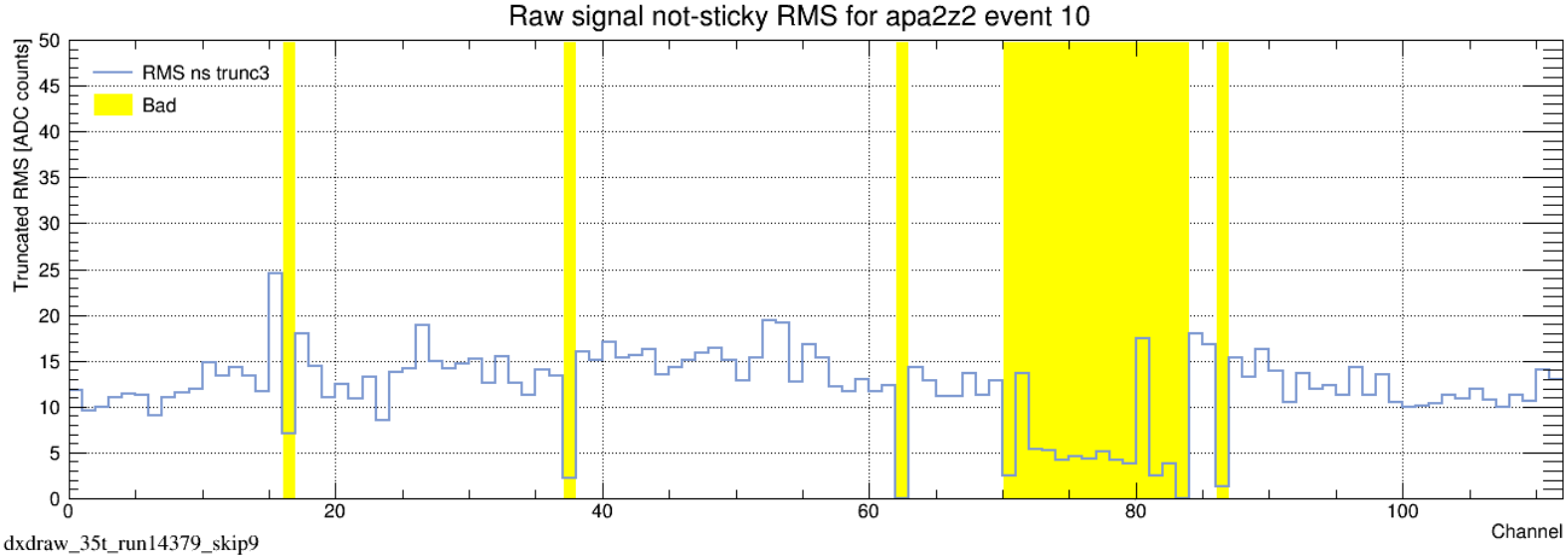

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14019_skip9

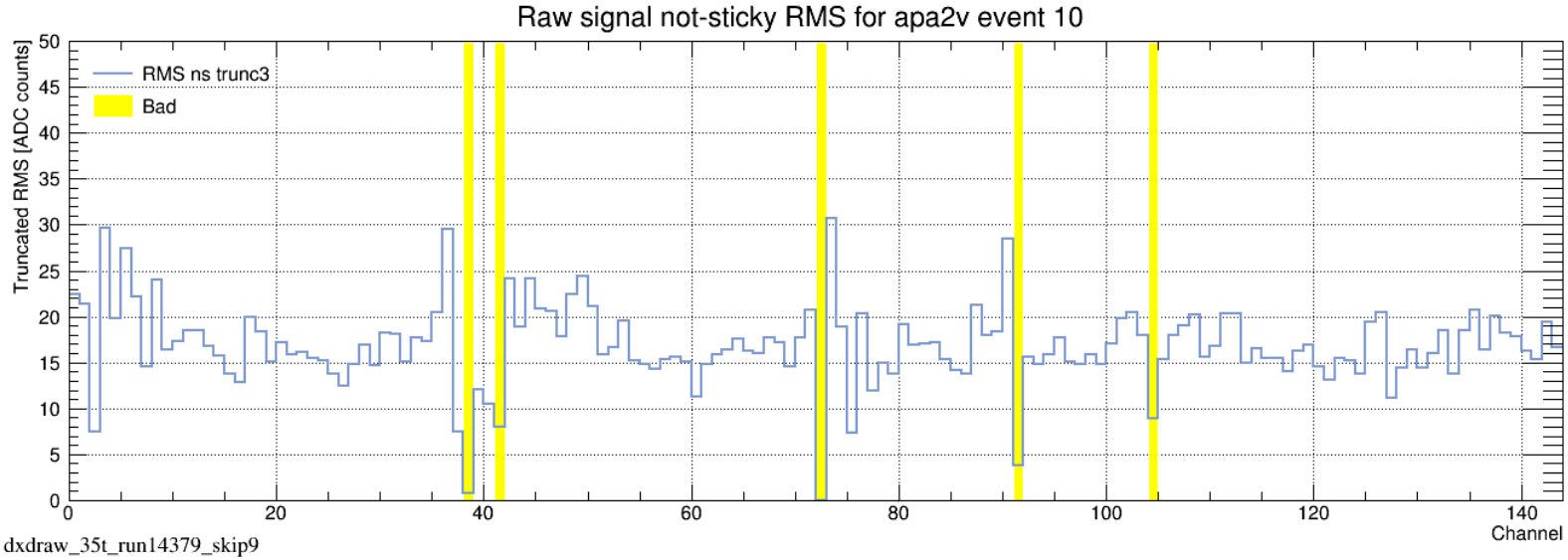
# Run 14085


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14085_skip9

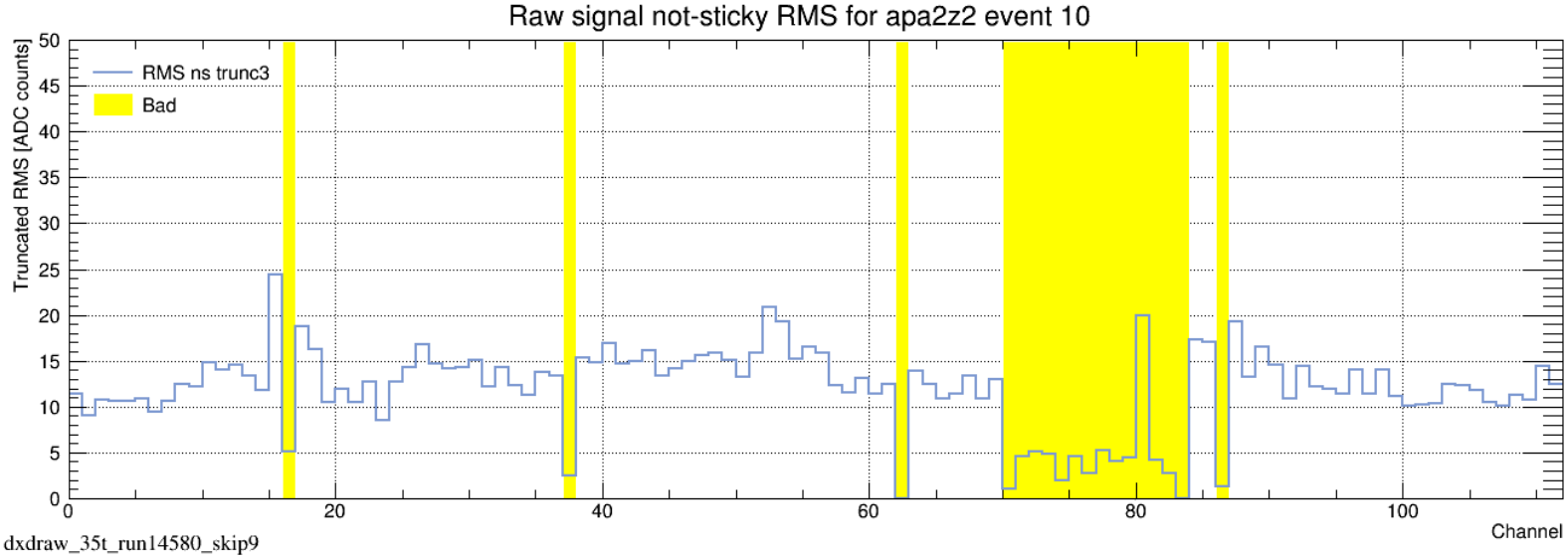

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14085_skip9

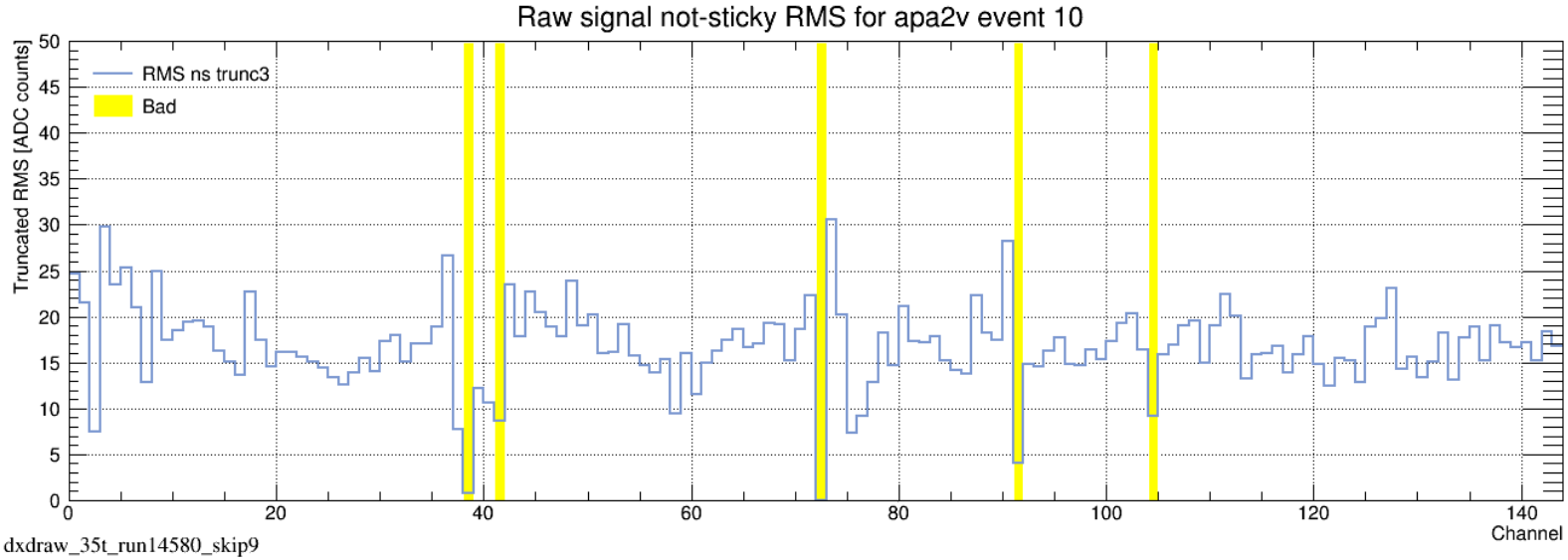
# Run 14379


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14379_skip9

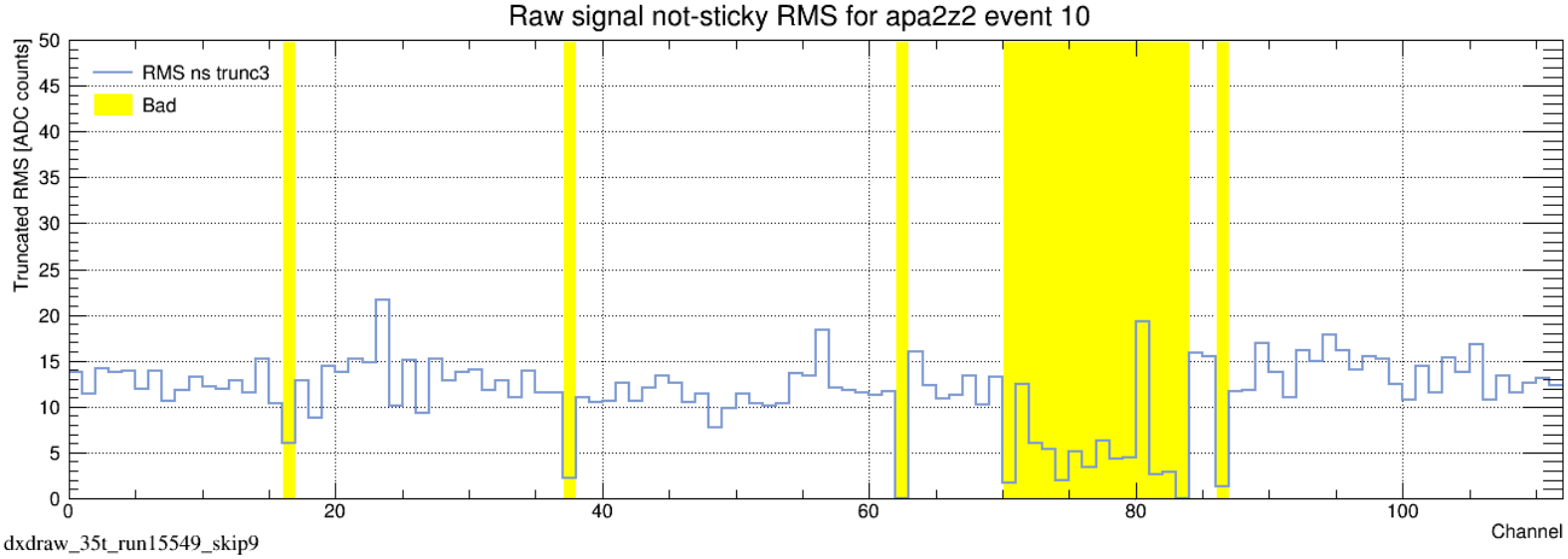

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run14379_skip9

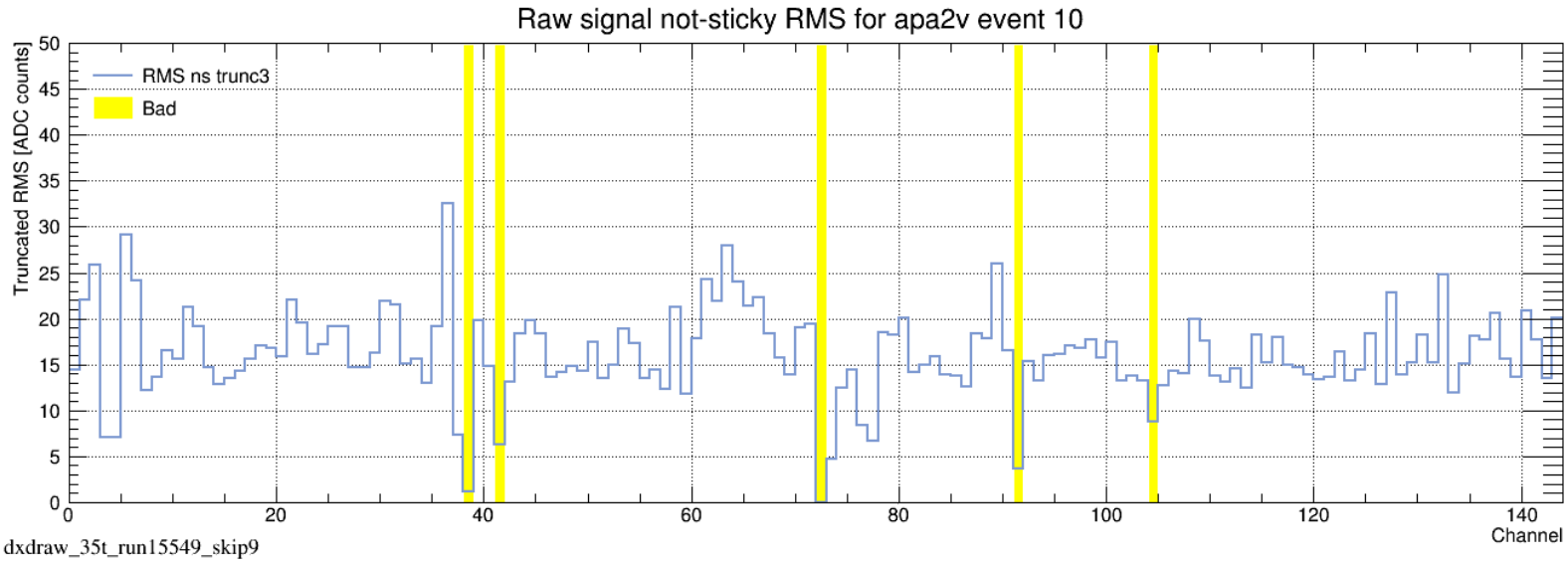
# Run 14580 (last before power failure)



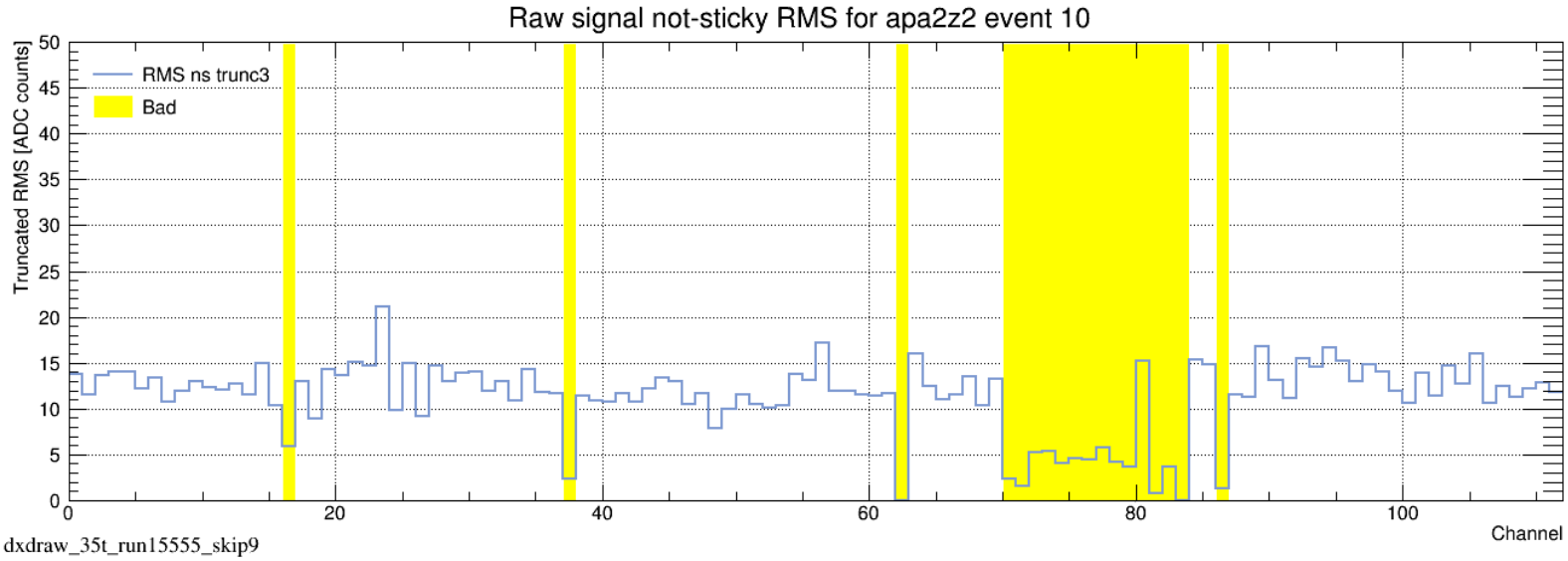



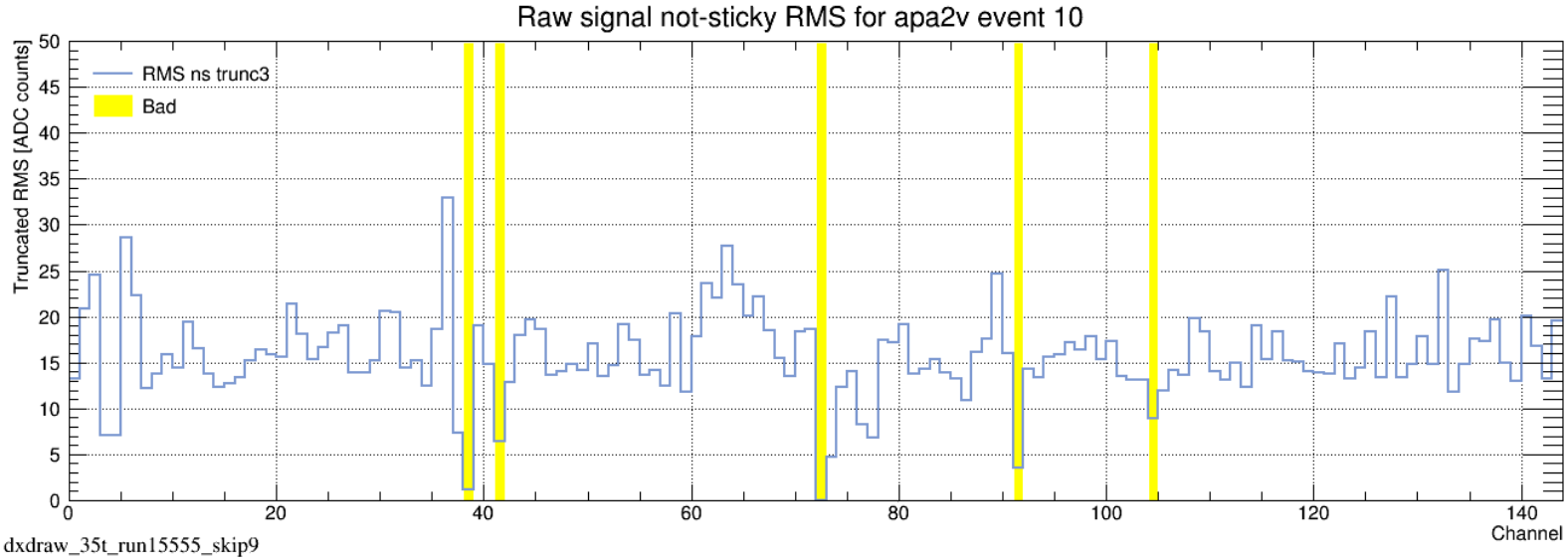
# Run 15549 (first good after power failure)



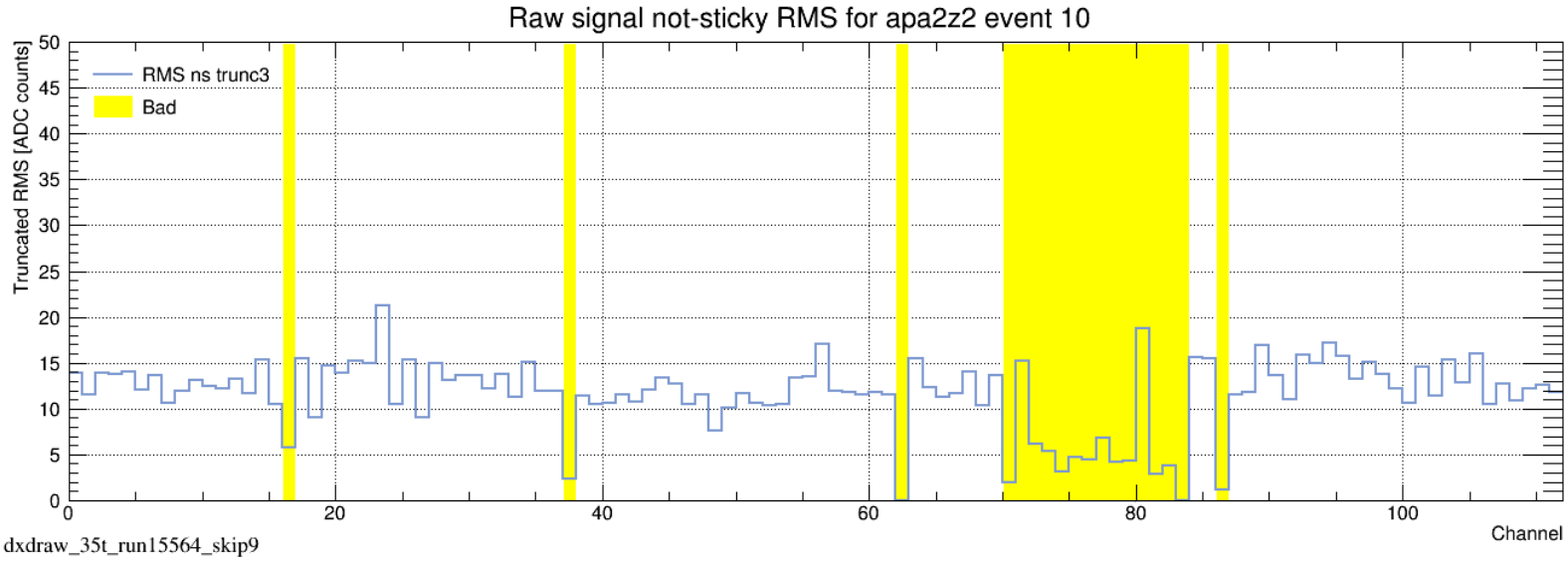



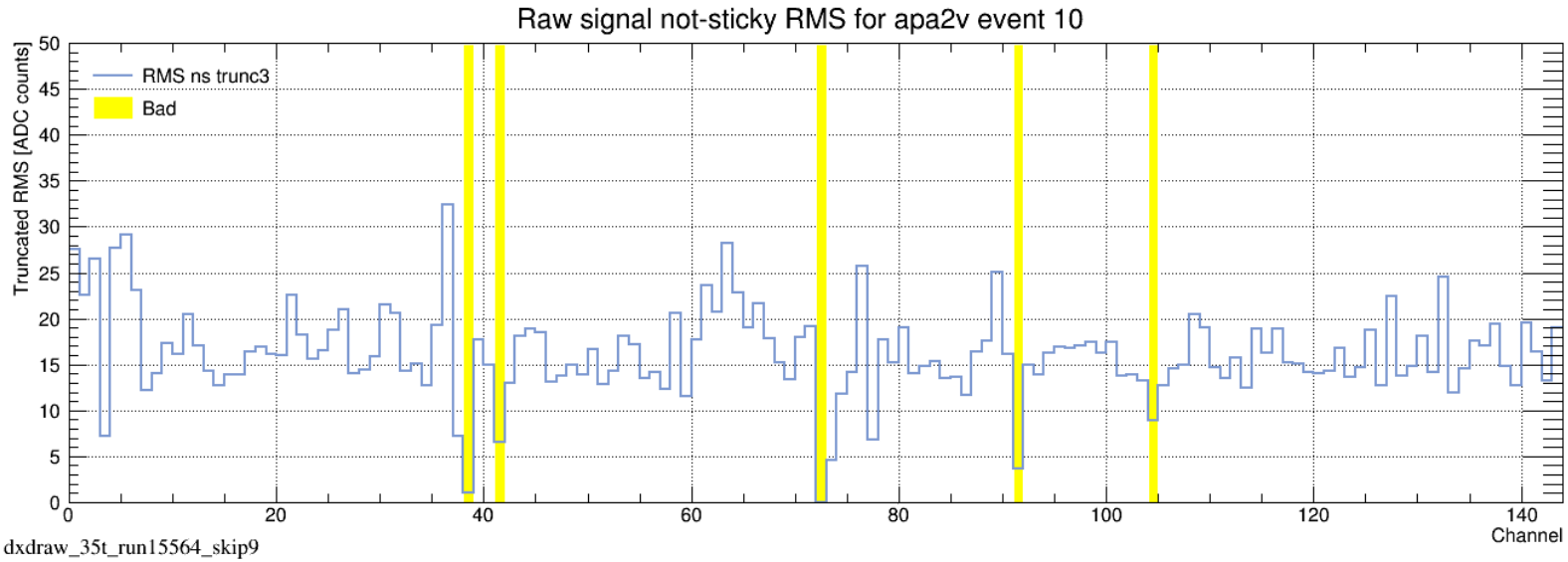
# Run 15555


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15555_skip9

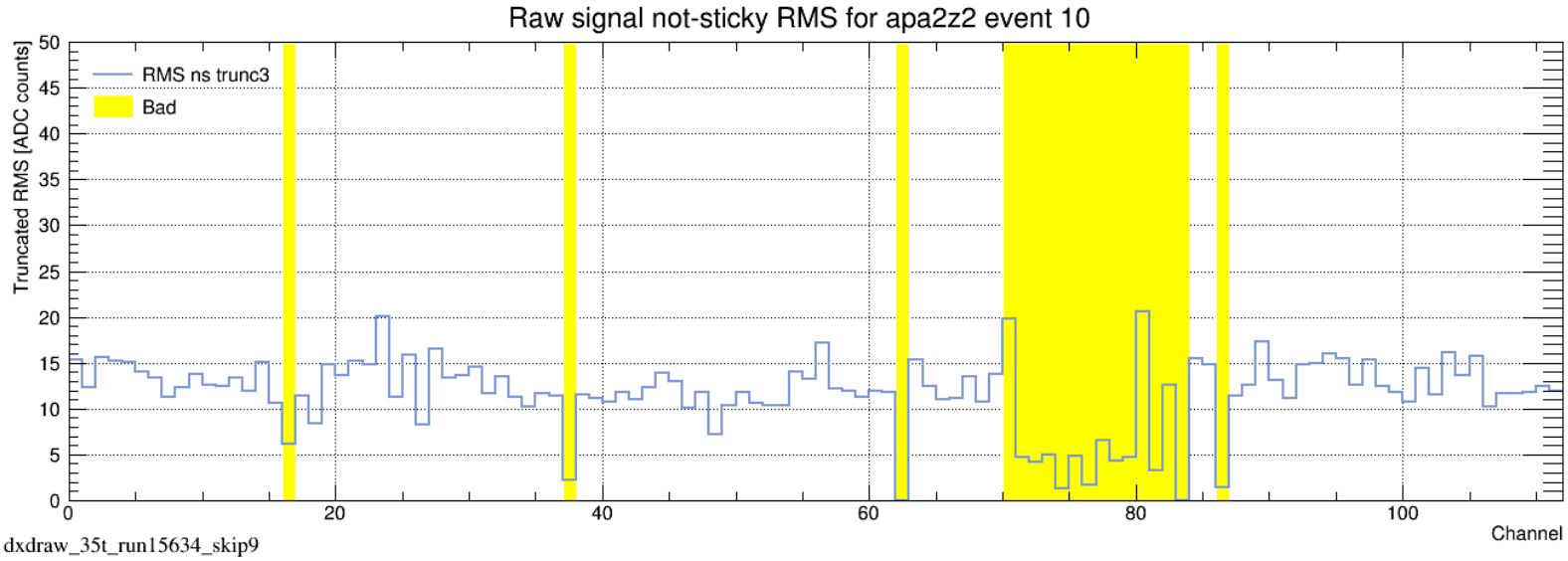

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15555_skip9

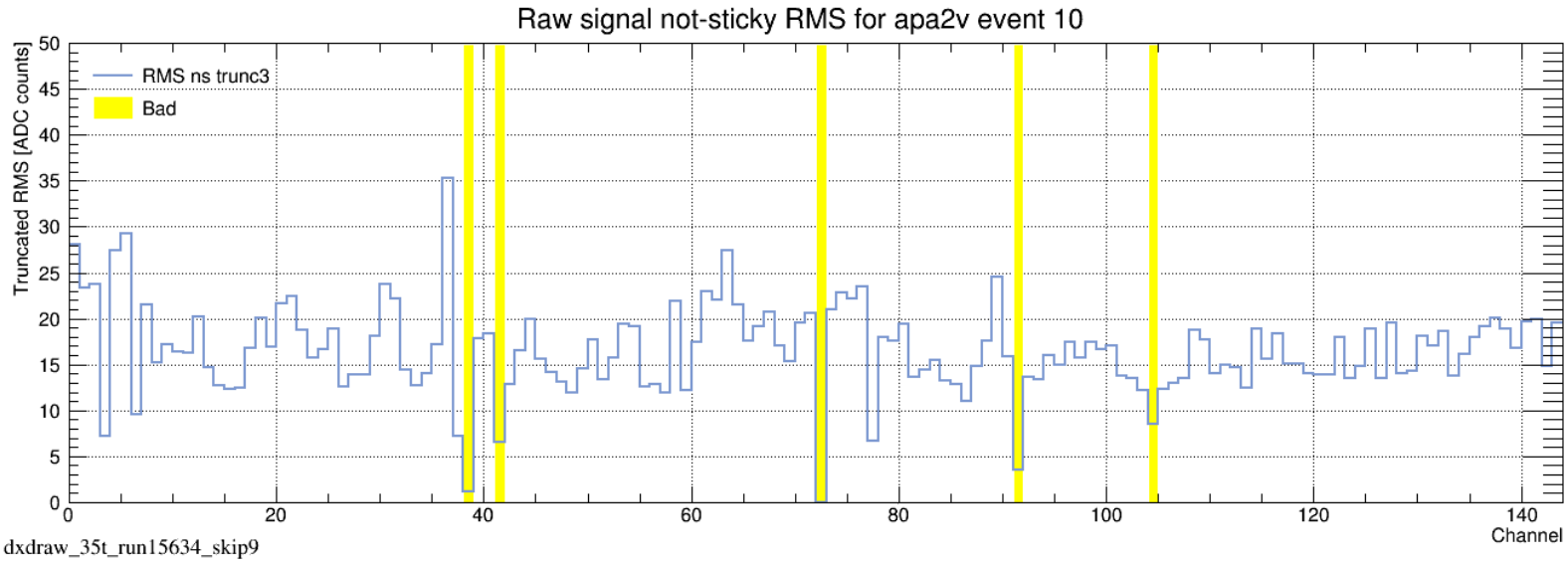
# Run 15564


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15564_skip9

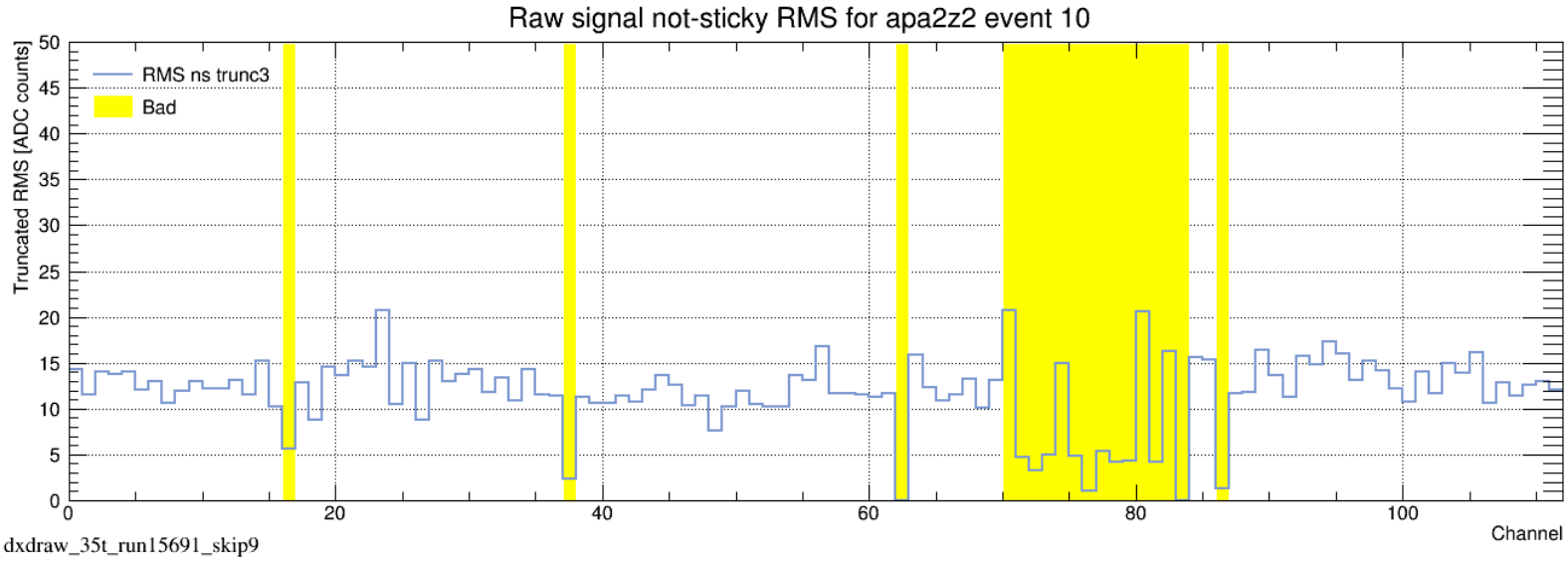

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15564_skip9

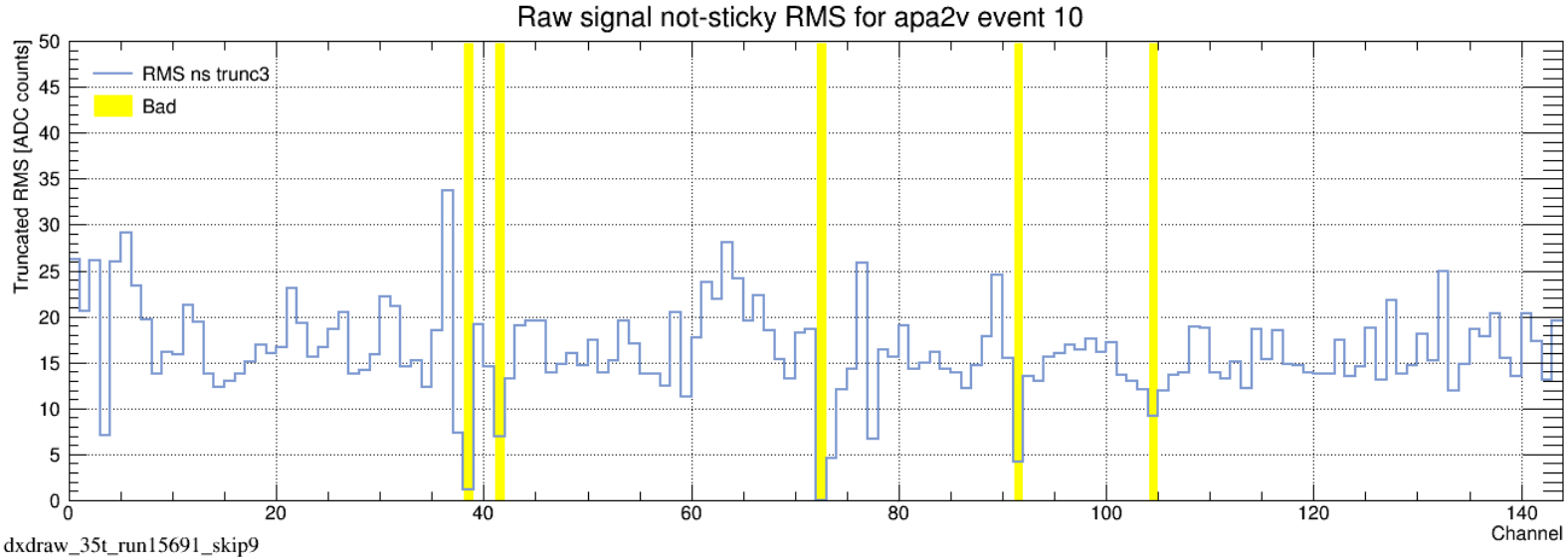
# Run 15634


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15634_skip9

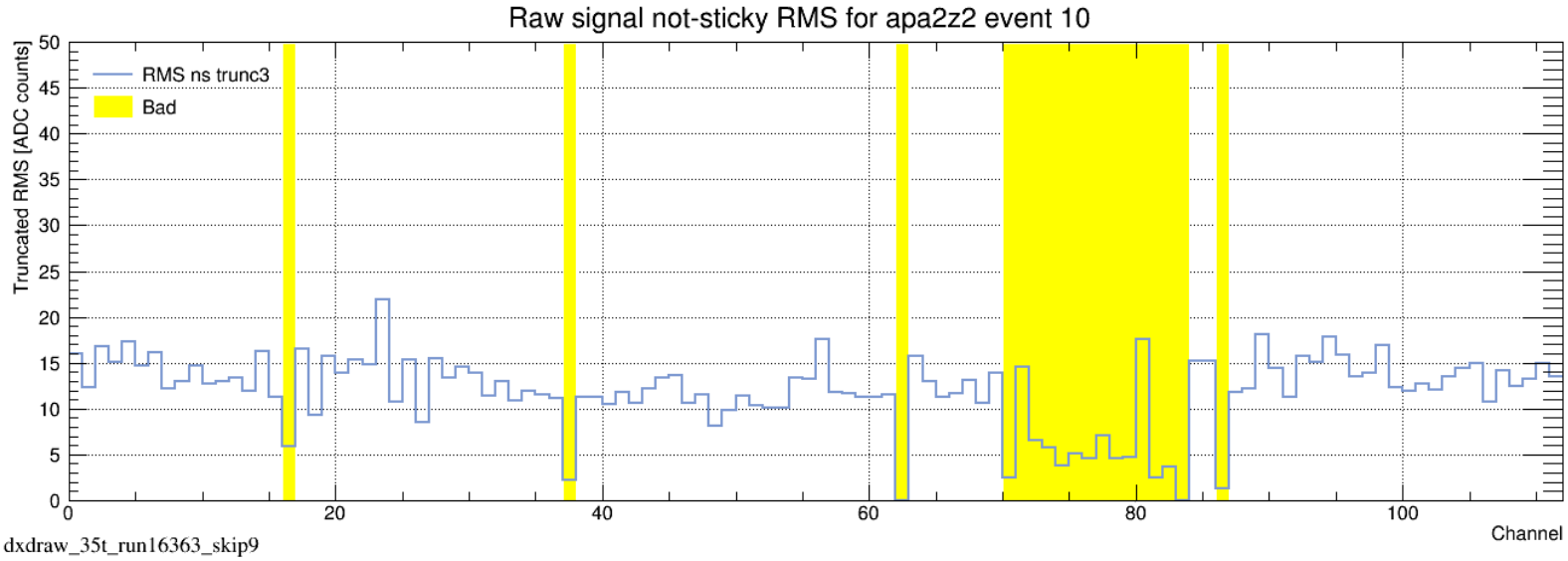

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15634_skip9

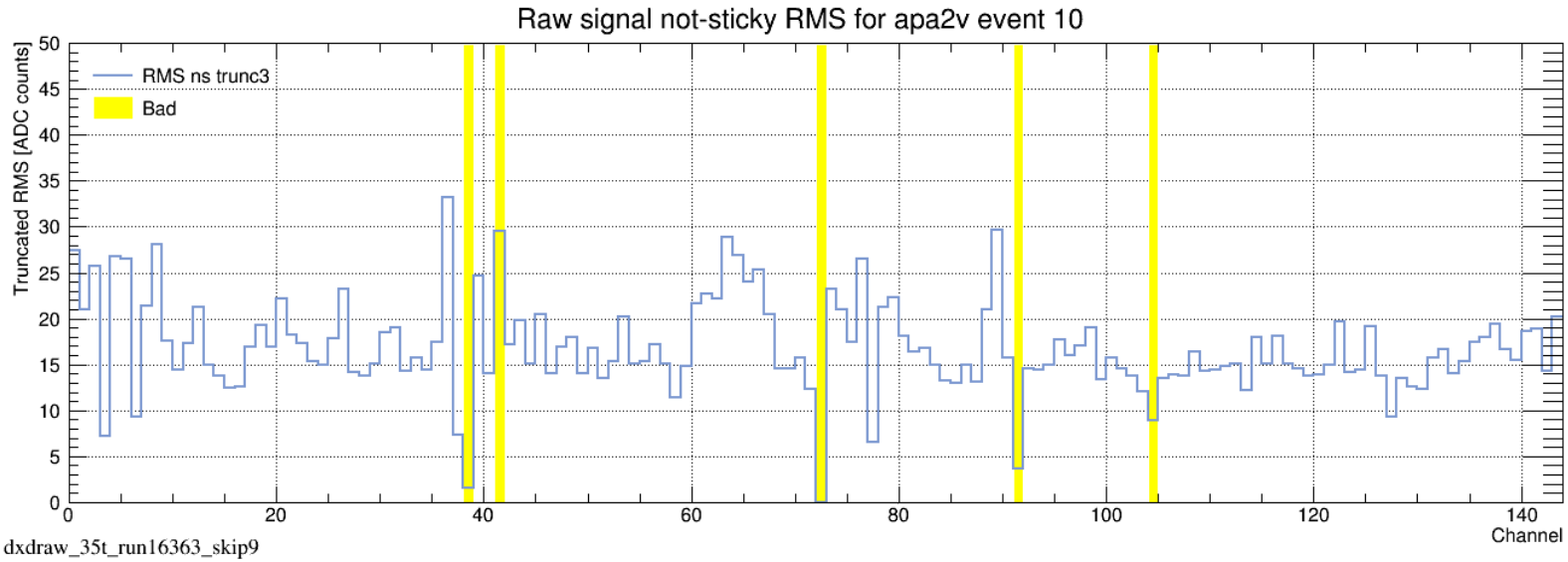
# Run 15691


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15691_skip9

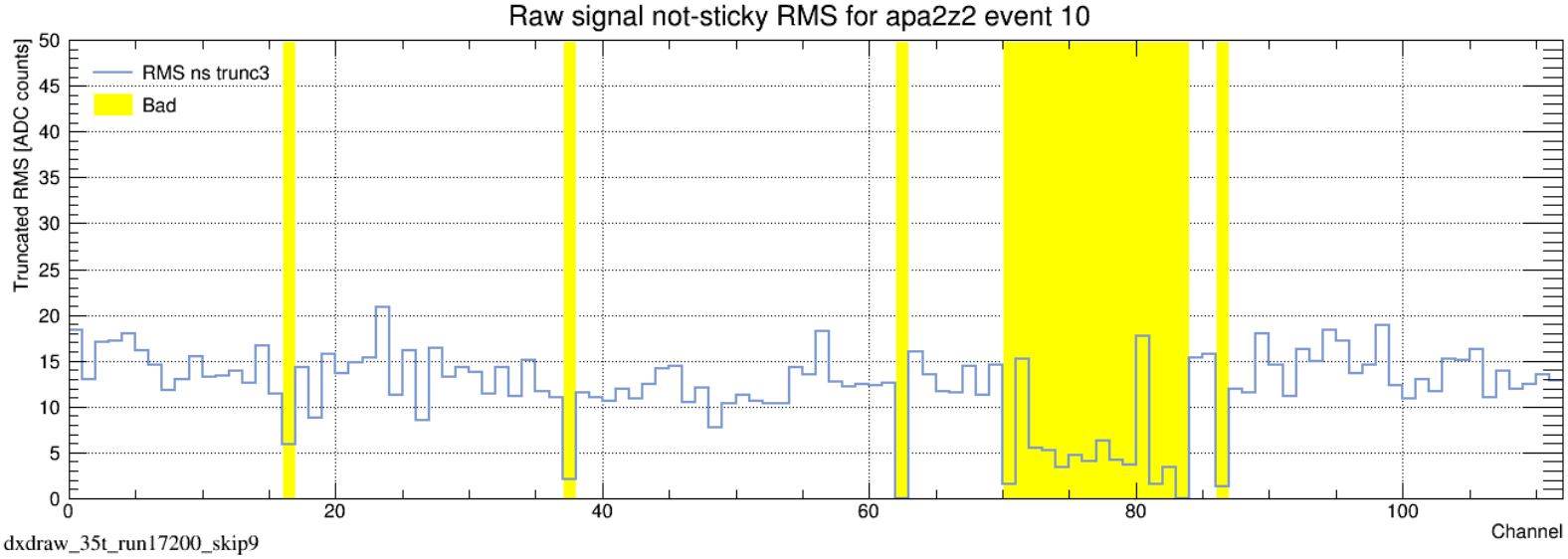

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run15691_skip9

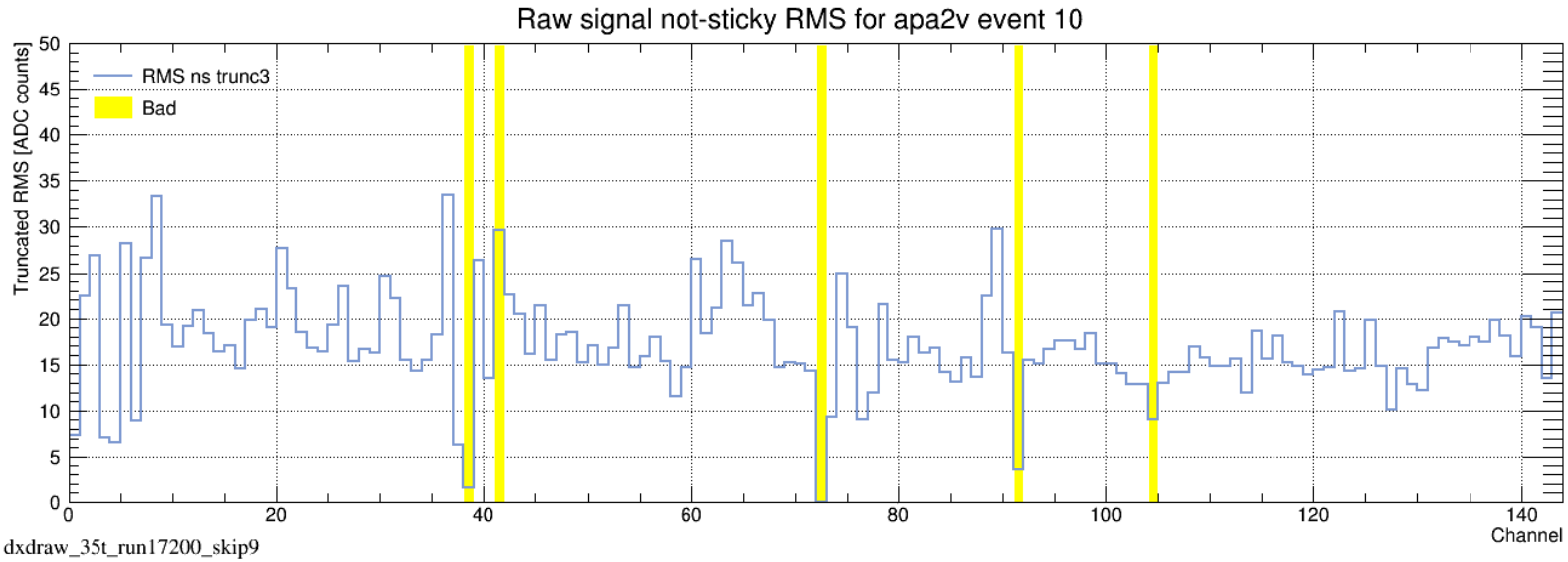
# Run 16363


Raw signal not-sticky RMS for apa2z2 event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run16363_skip9

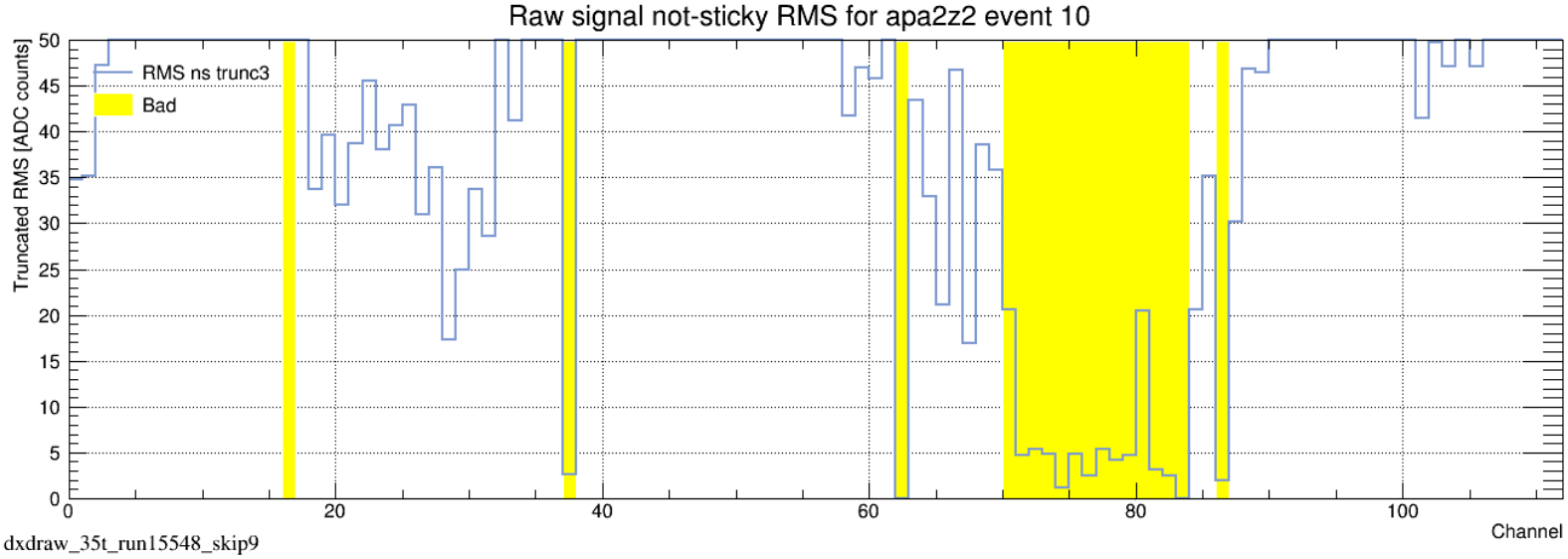

Raw signal not-sticky RMS for apa2v event 10
RMS ns trunc3
Bad
Truncated RMS [ADC counts]
Channel
dxdraw_35t_run16363_skip9

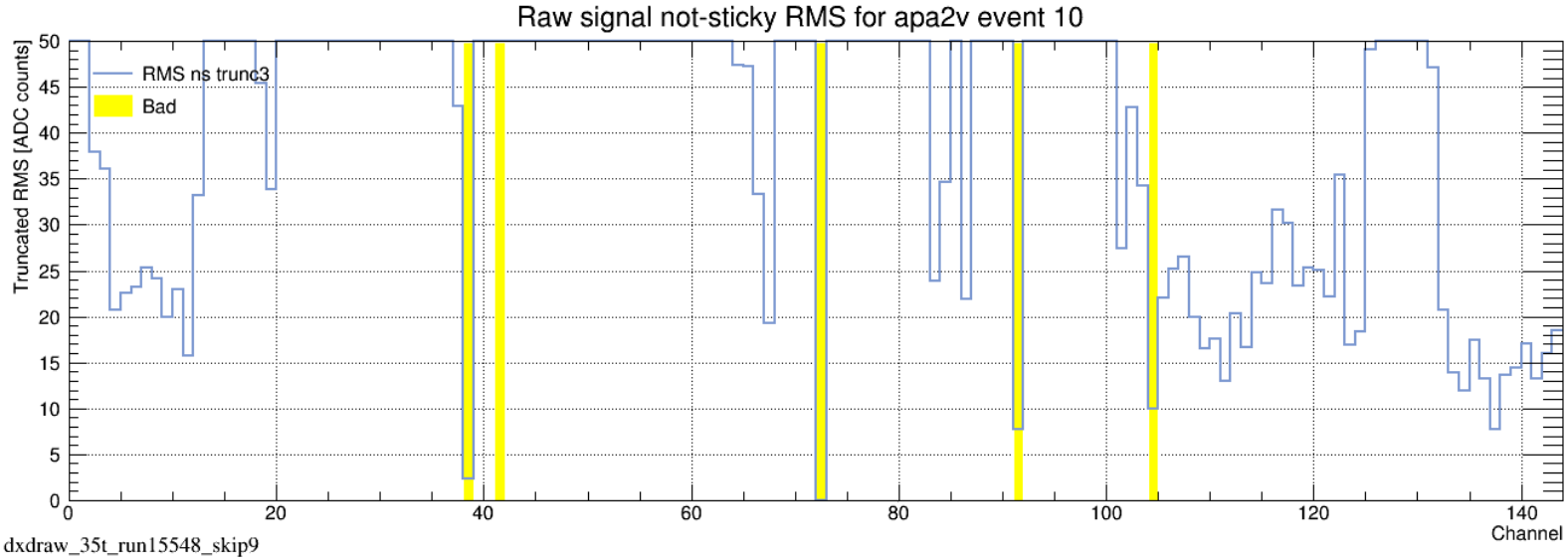
# Run 17200 (last run in sliced prod)



# Run15548 (before first after power failure)



# Sticky fractions vs. run

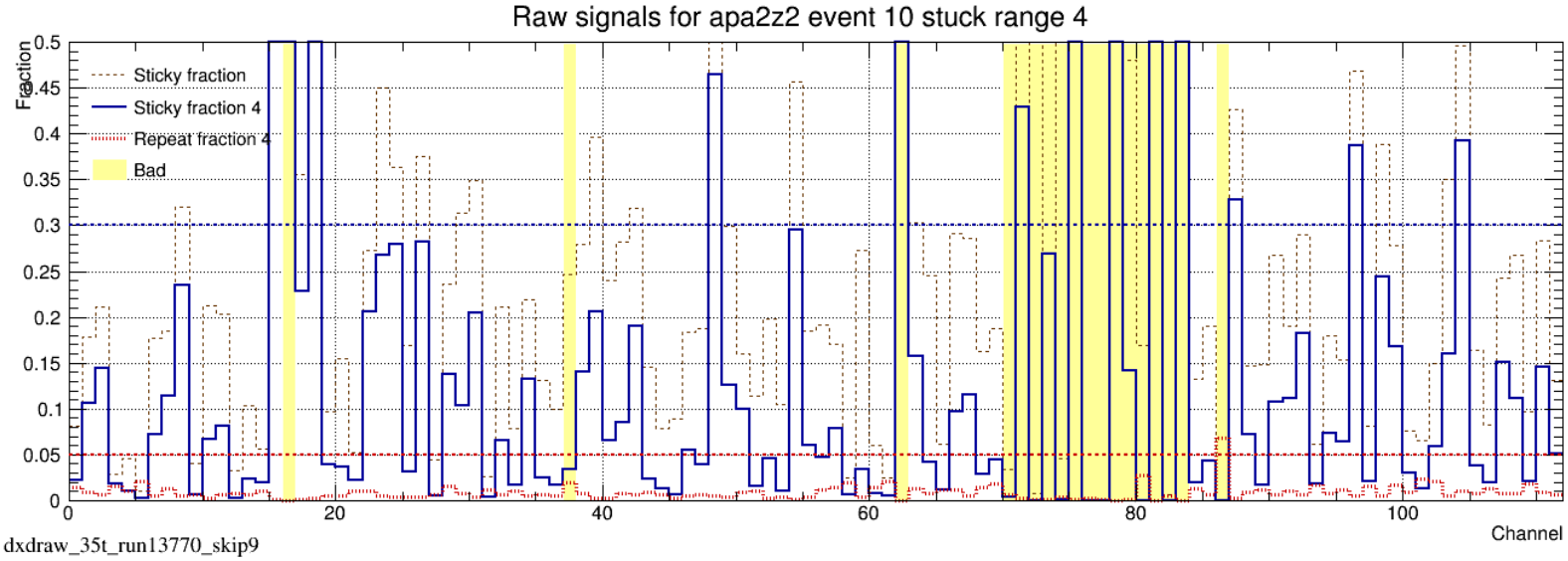
Following pages show sticky fractions for various runs

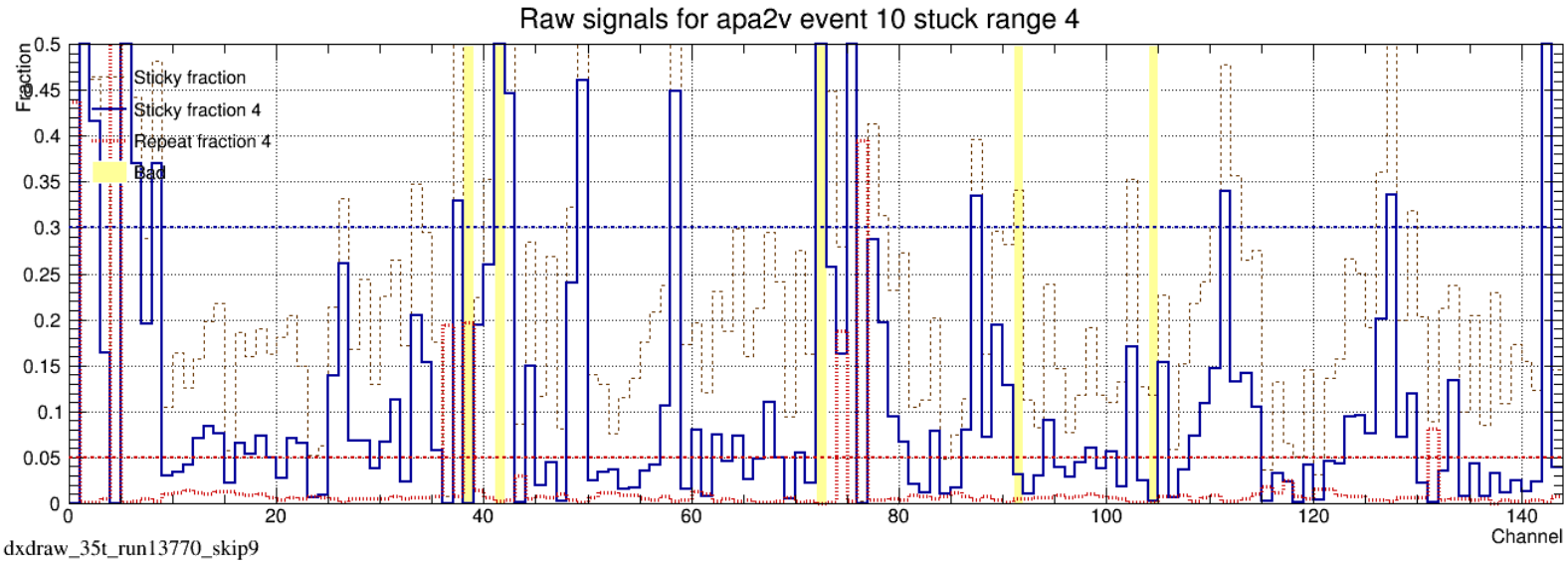
- Using event 10 in the run
- Values for each channel in APA 2z2 (top) and 2v (bottom)
- Displays include
  - Fraction of ticks with sticky codes (brown dotted)
  - Same in a sequence of four more contiguous (blue solid)
  - Fraction non-sticky code repeated four or more contiguous (red dashed)

Comments

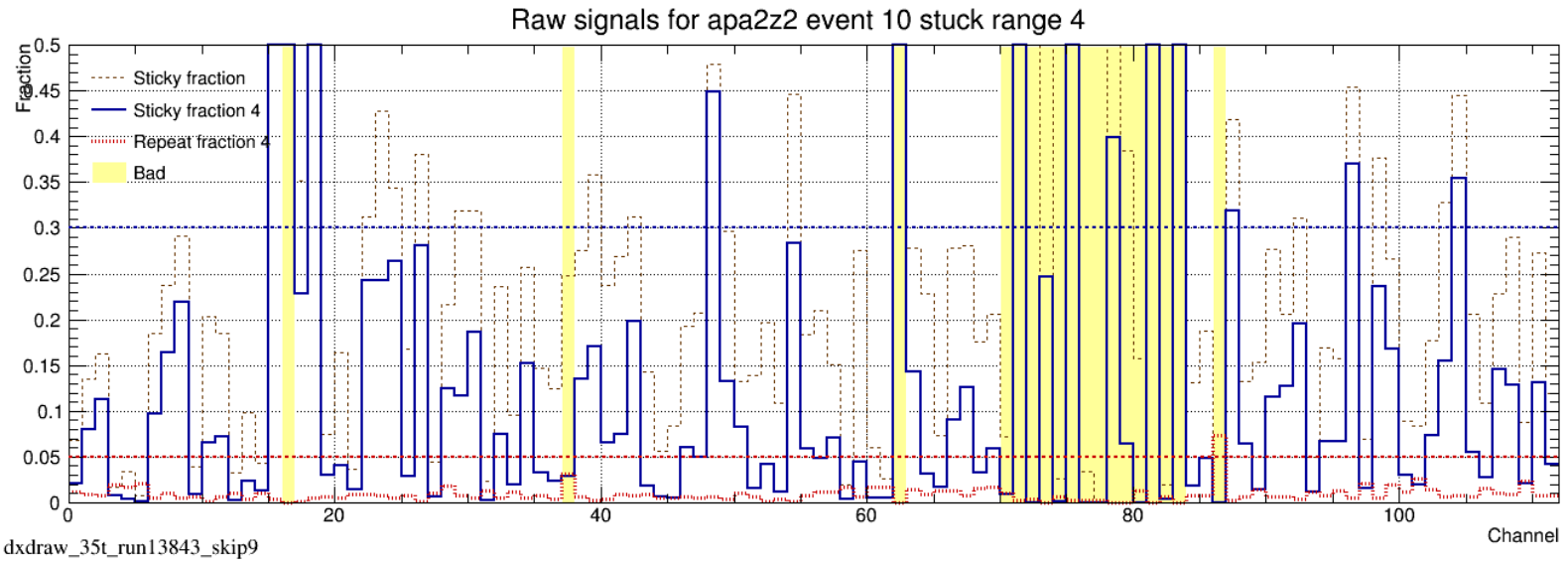
- Bad channels typically stay bad
  - But a few come and go
  - Many changes during power failure
- Proposed threshold for bad channels shown in plots
  - Sticky fraction with four or more contiguous: 30%
  - Repeated non-sticky four or more contiguous: 5%
  - Flag channel bad for either of these in any of the runs?

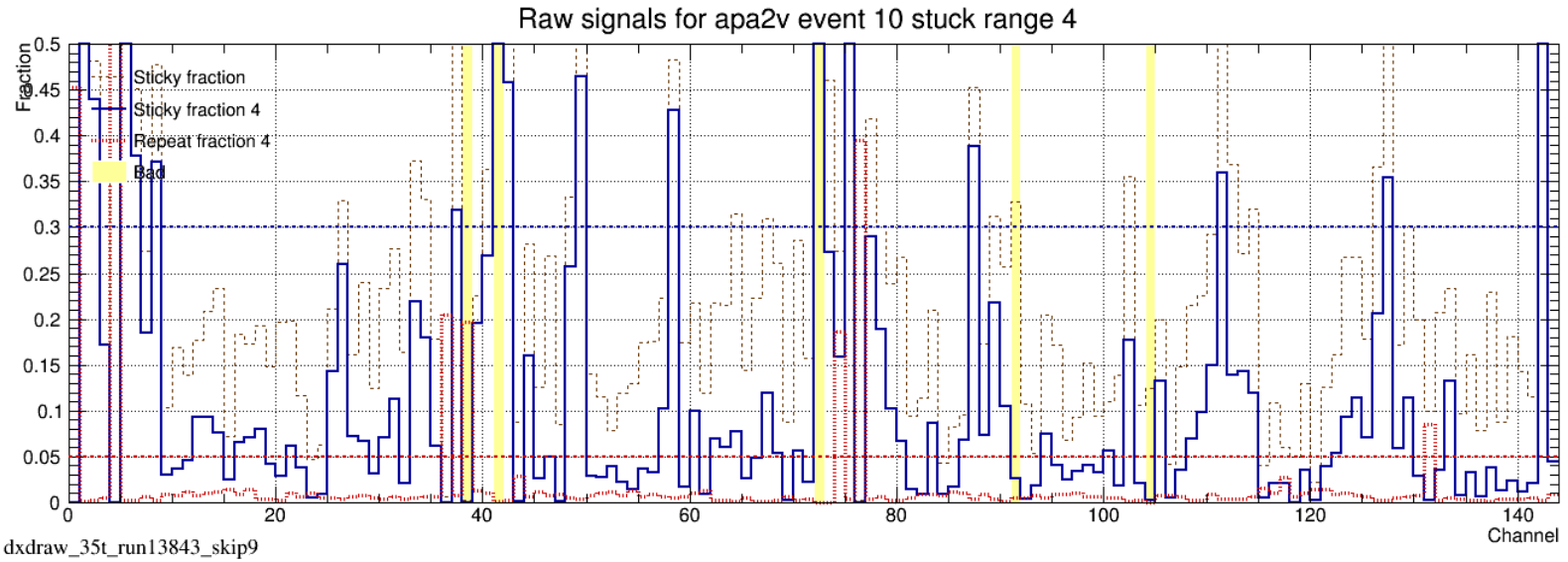
# Run 13770 (first run)



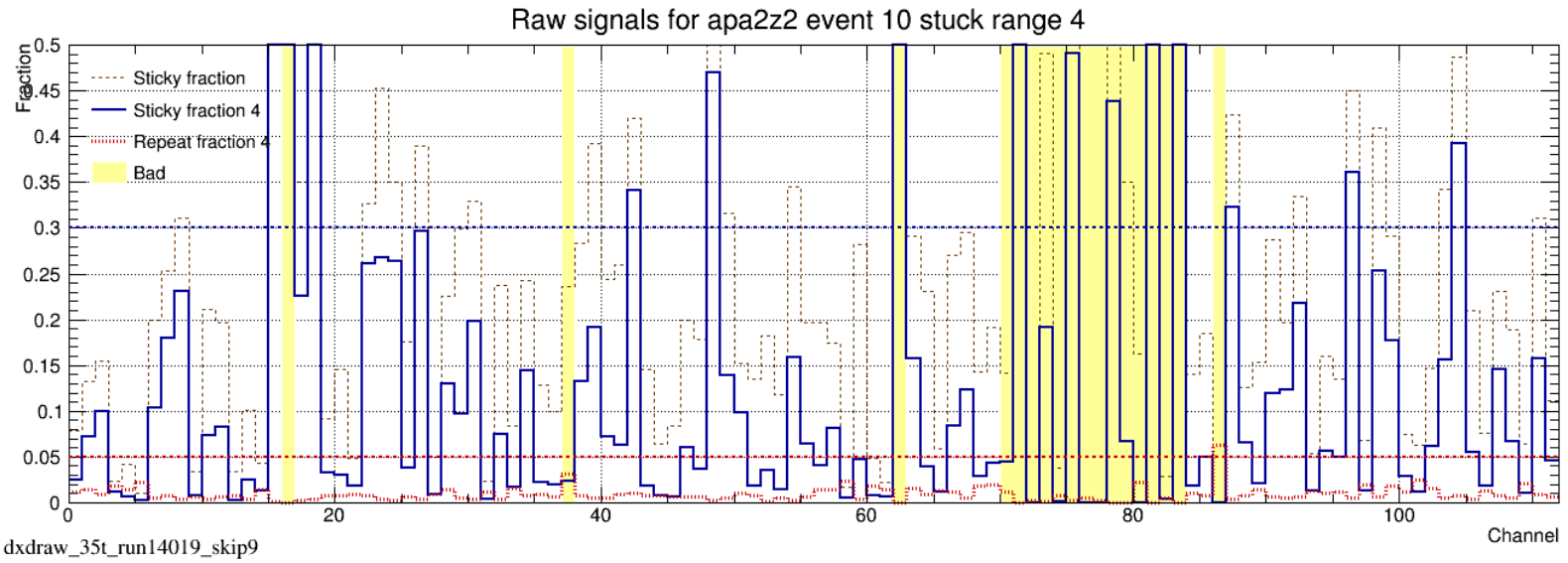



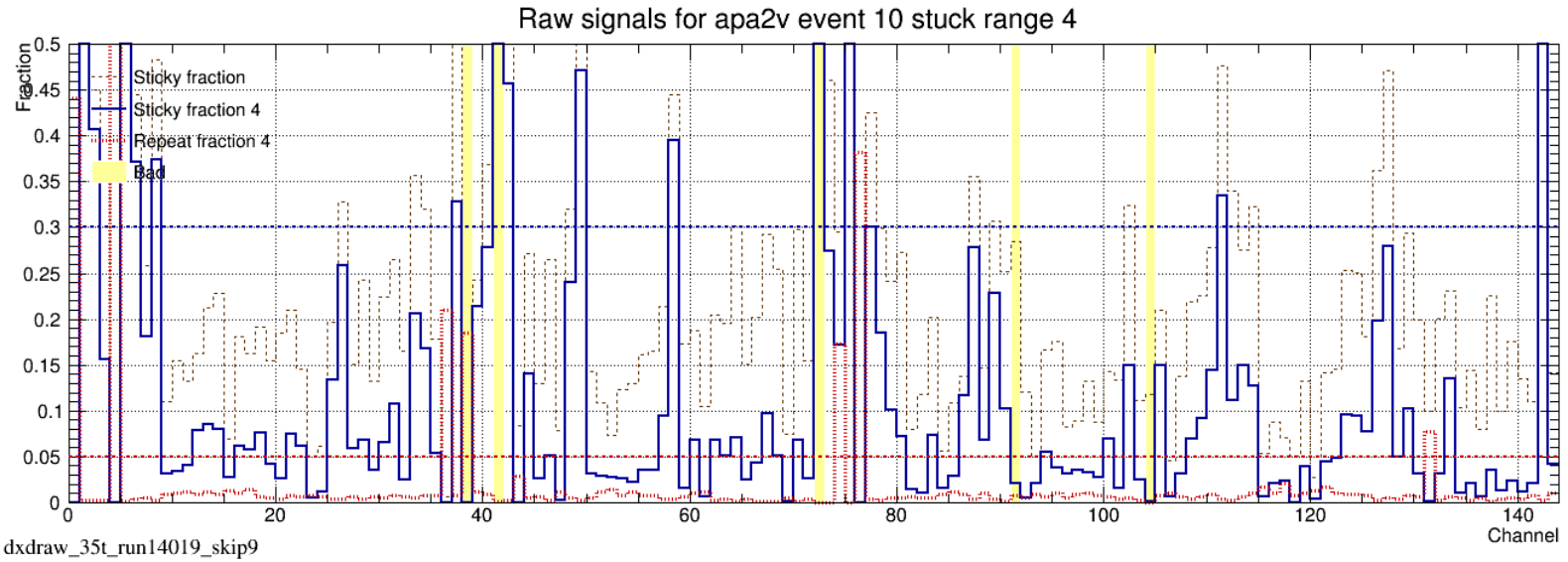
# Run 13843


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Channel
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
dxdraw_35t_run13843_skip9

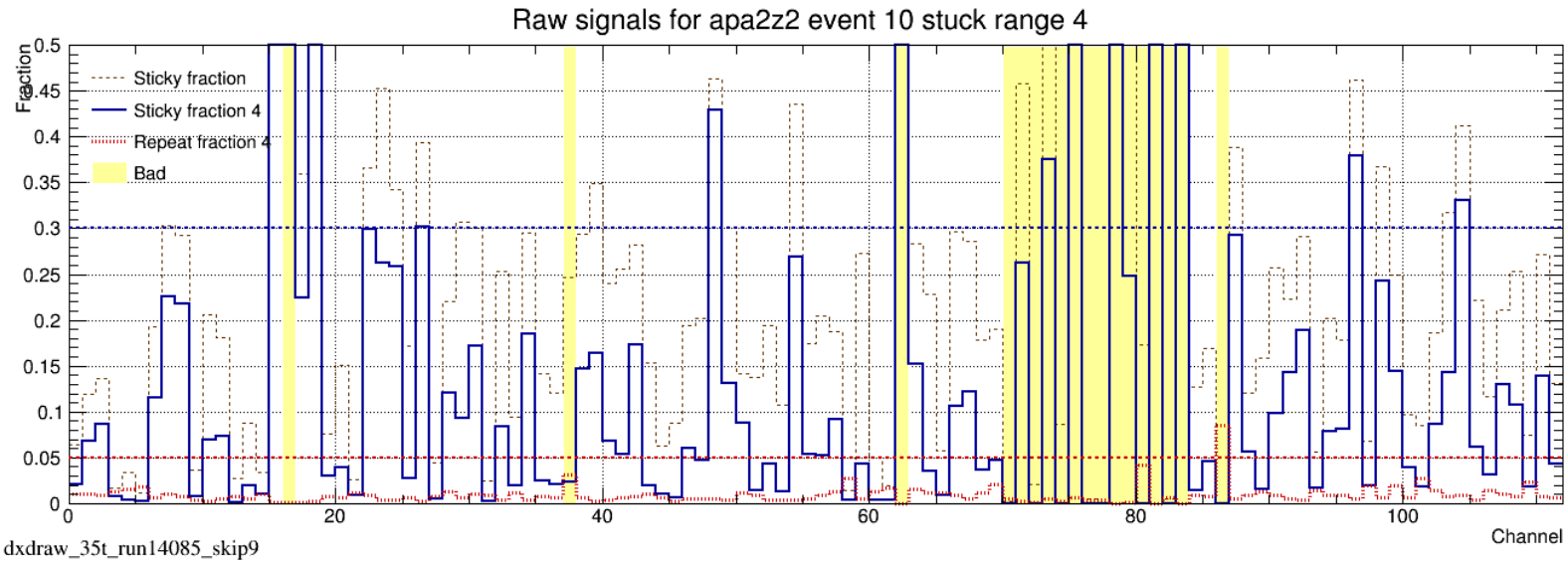

Raw signals for apa2v event 10 stuck range 4
Fraction
Channel
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
dxdraw_35t_run13843_skip9

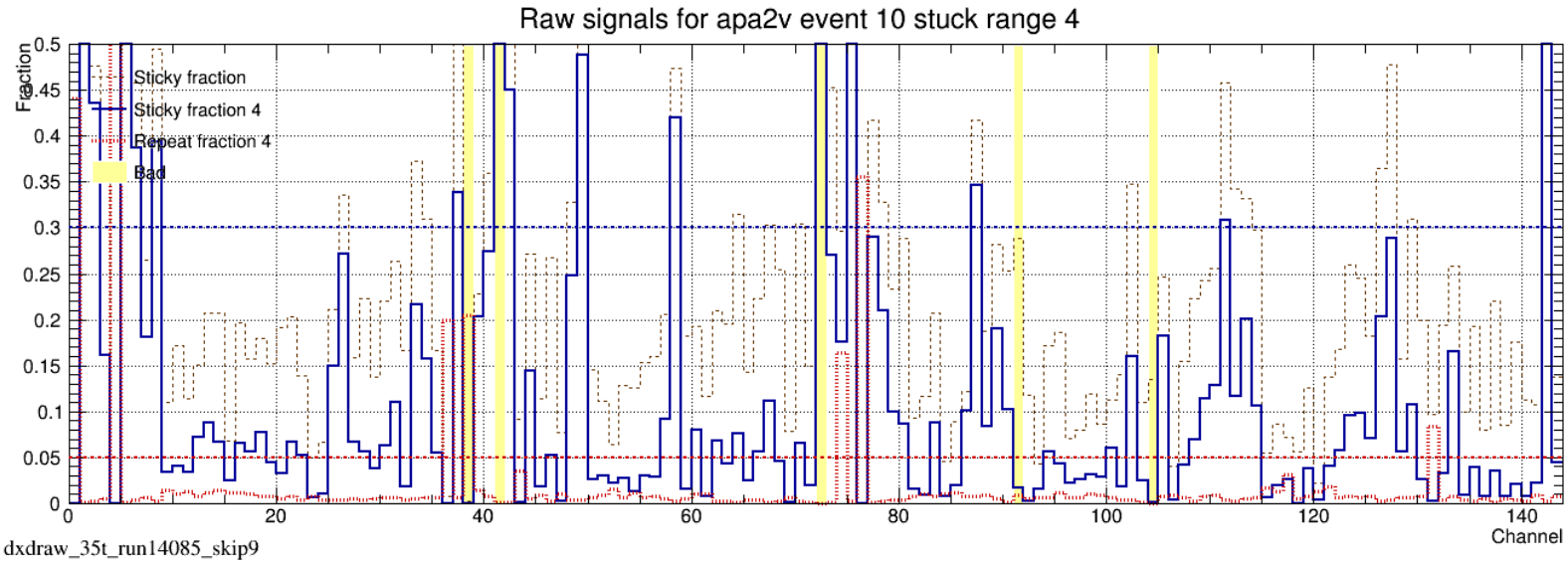
# Run 14019


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Channel
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
dxdraw_35t_run14019_skip9

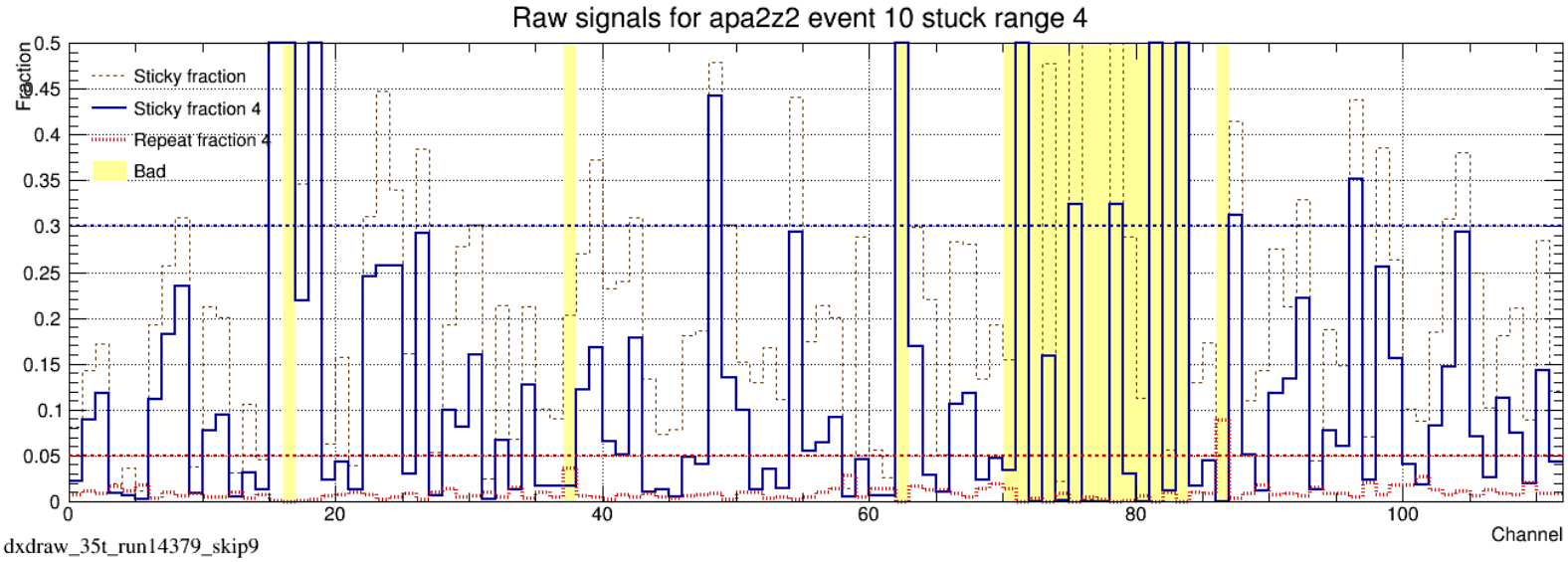

Raw signals for apa2v event 10 stuck range 4
Fraction
Channel
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
dxdraw_35t_run14019_skip9

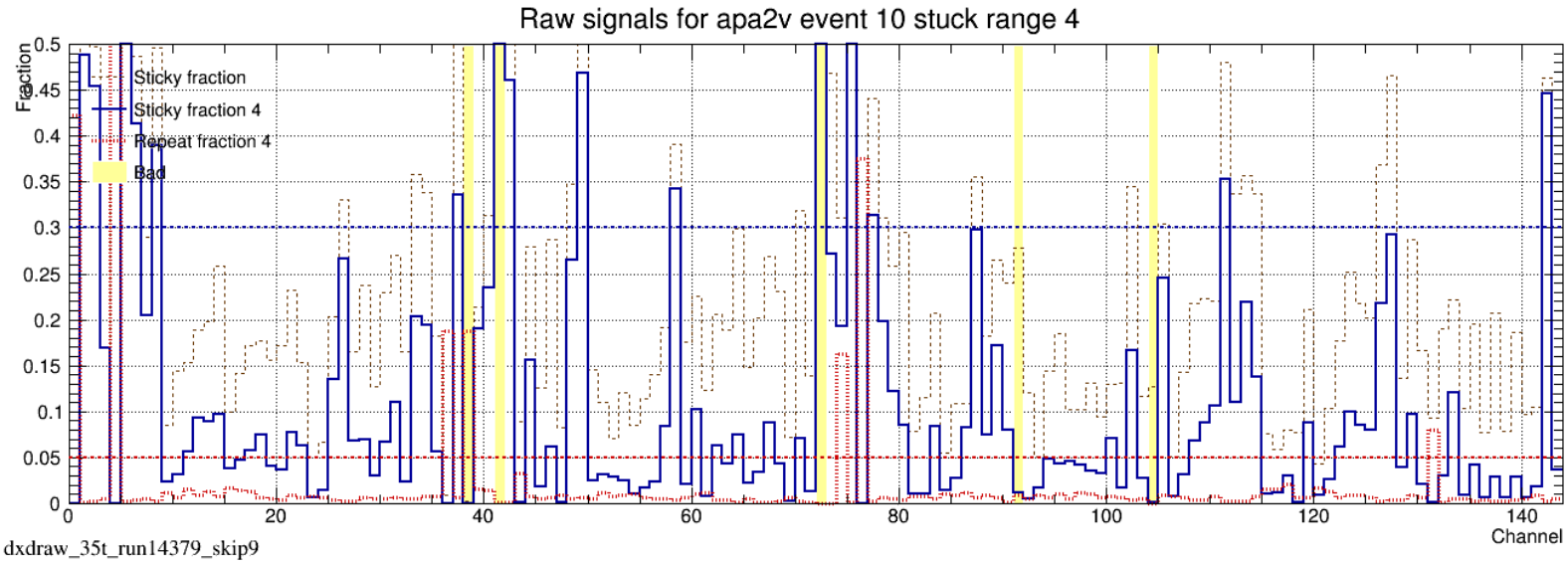
# Run 14085


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run14085_skip9

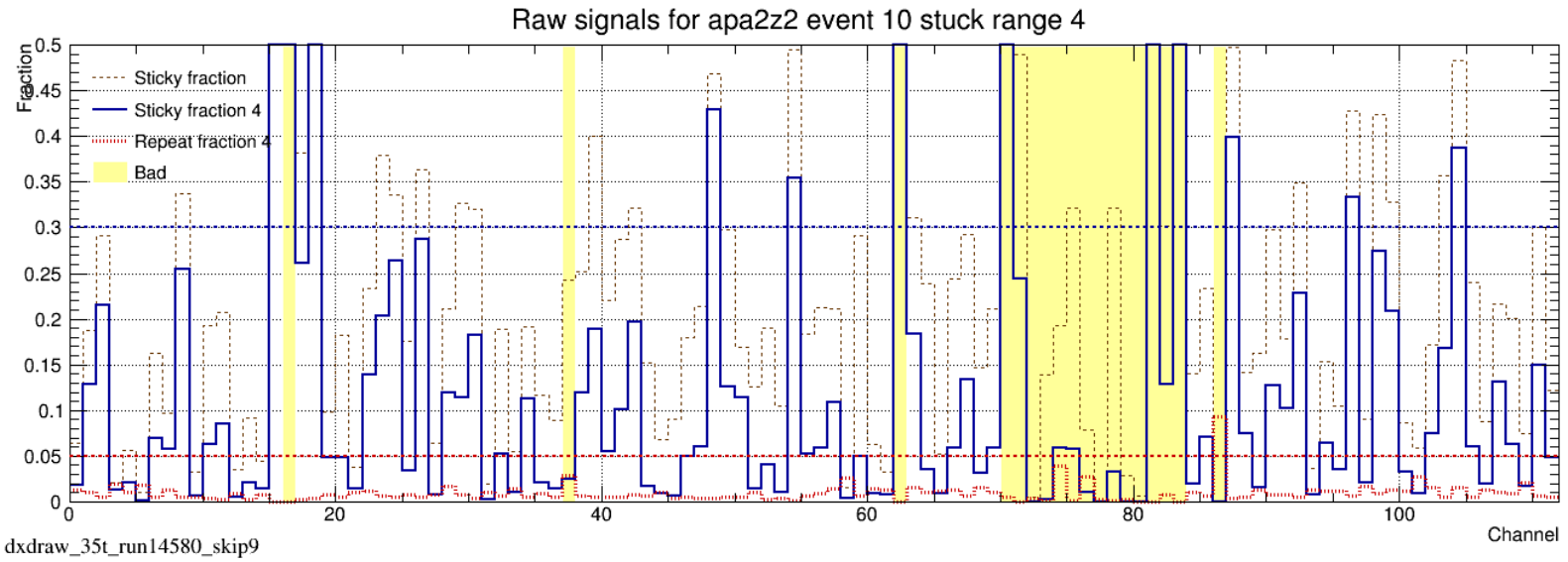

Raw signals for apa2v event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run14085_skip9

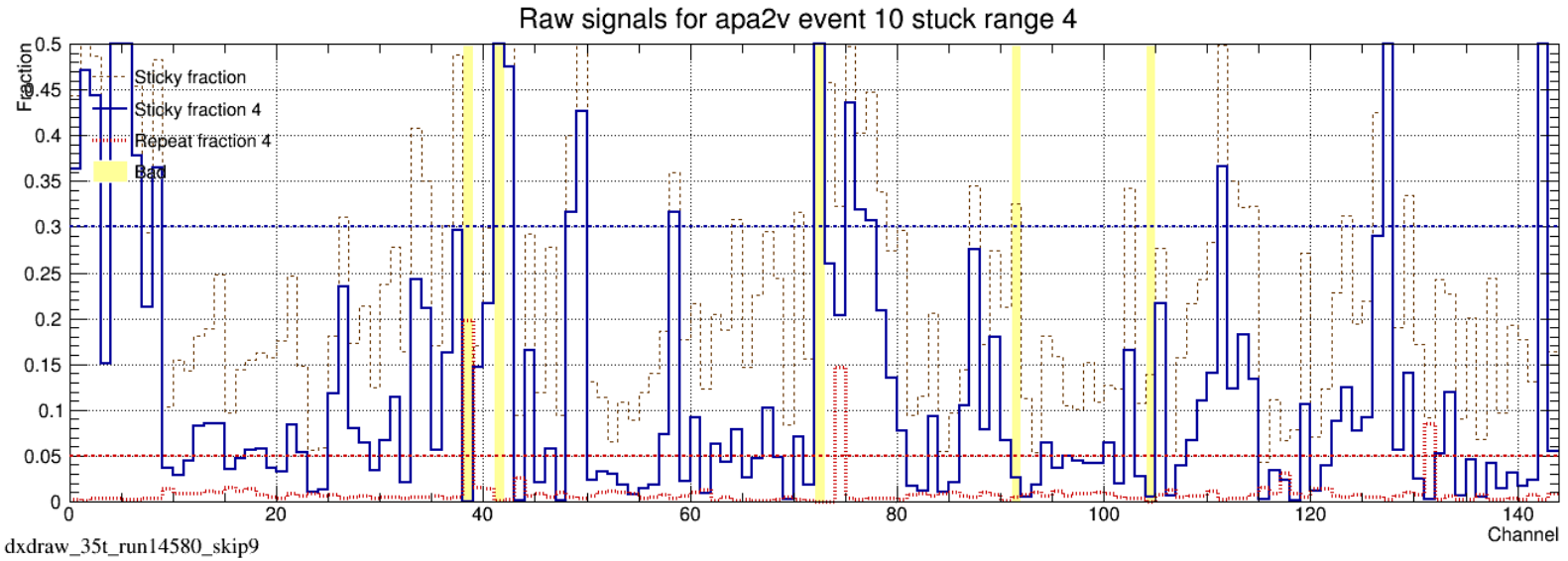
# Run 14379


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run14379_skip9

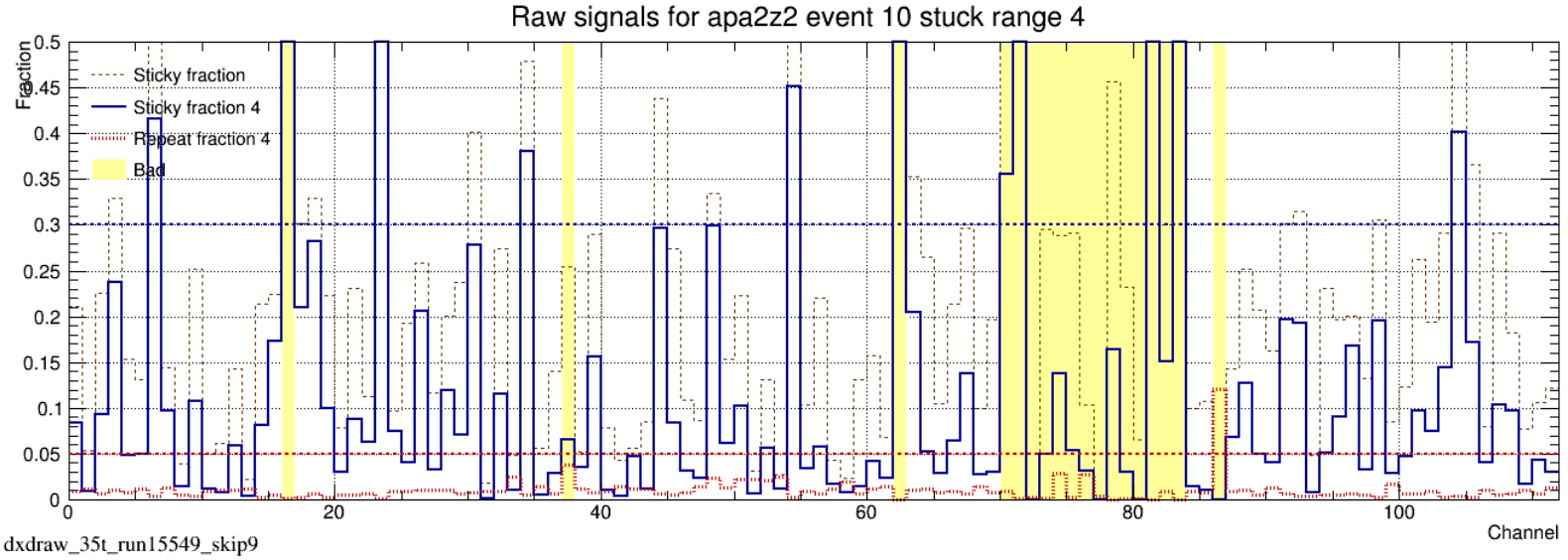

Raw signals for apa2v event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run14379_skip9

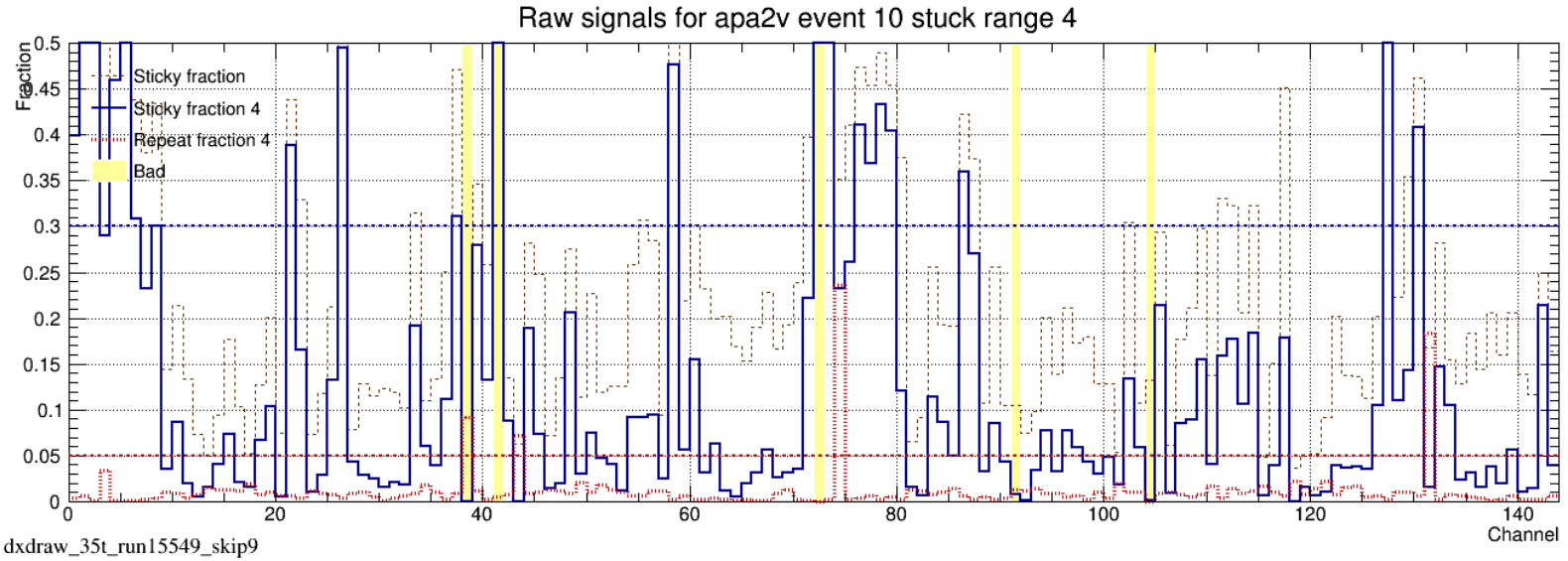
# Run 14580 (last before power failure)



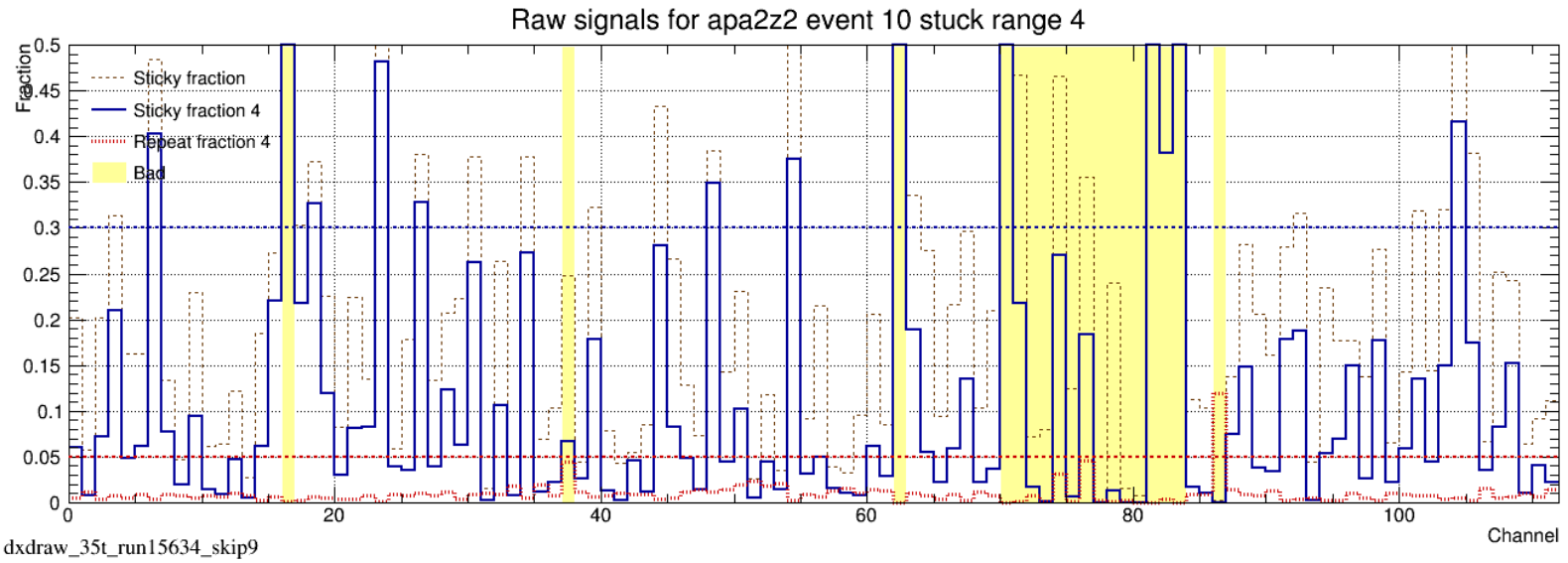



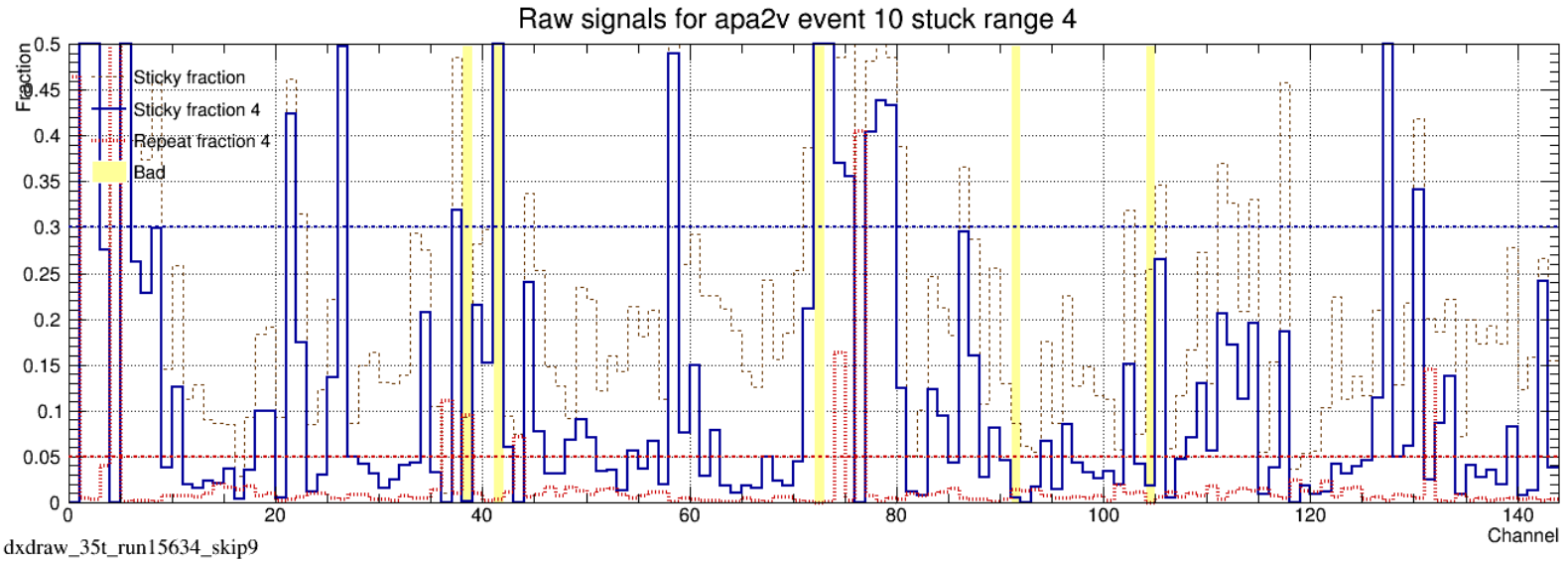
# Run 15549 (first good after power failure)



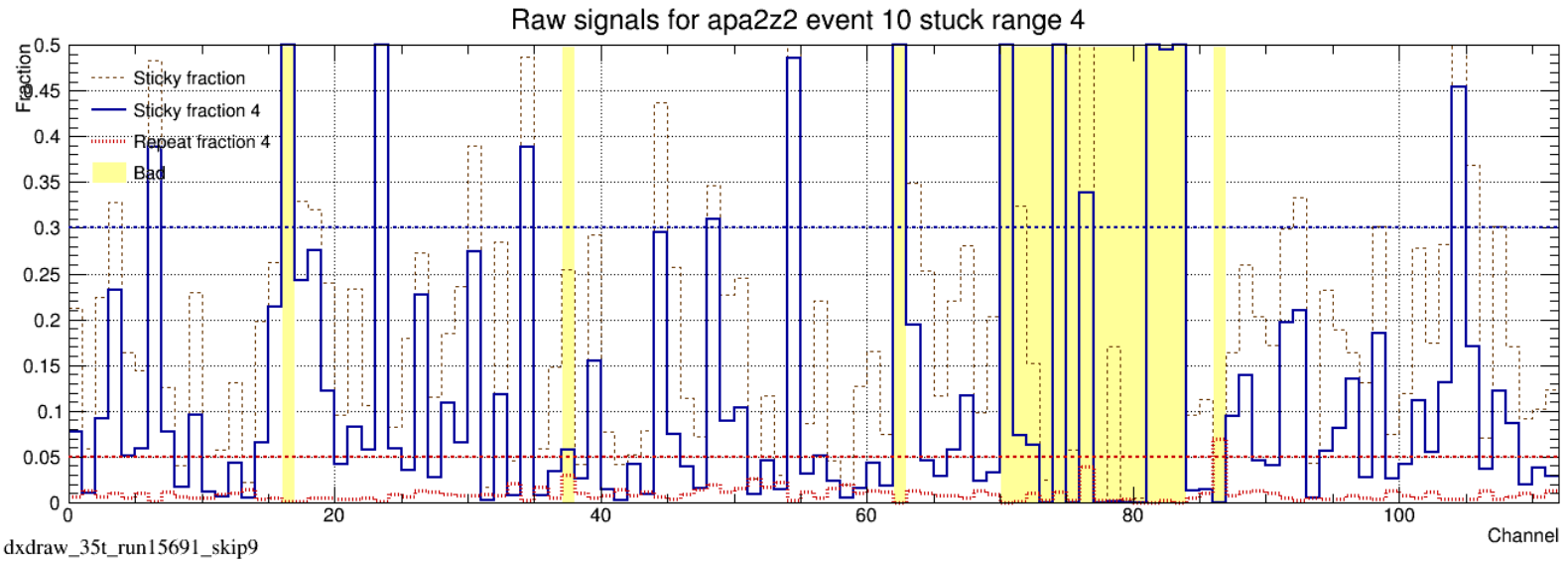



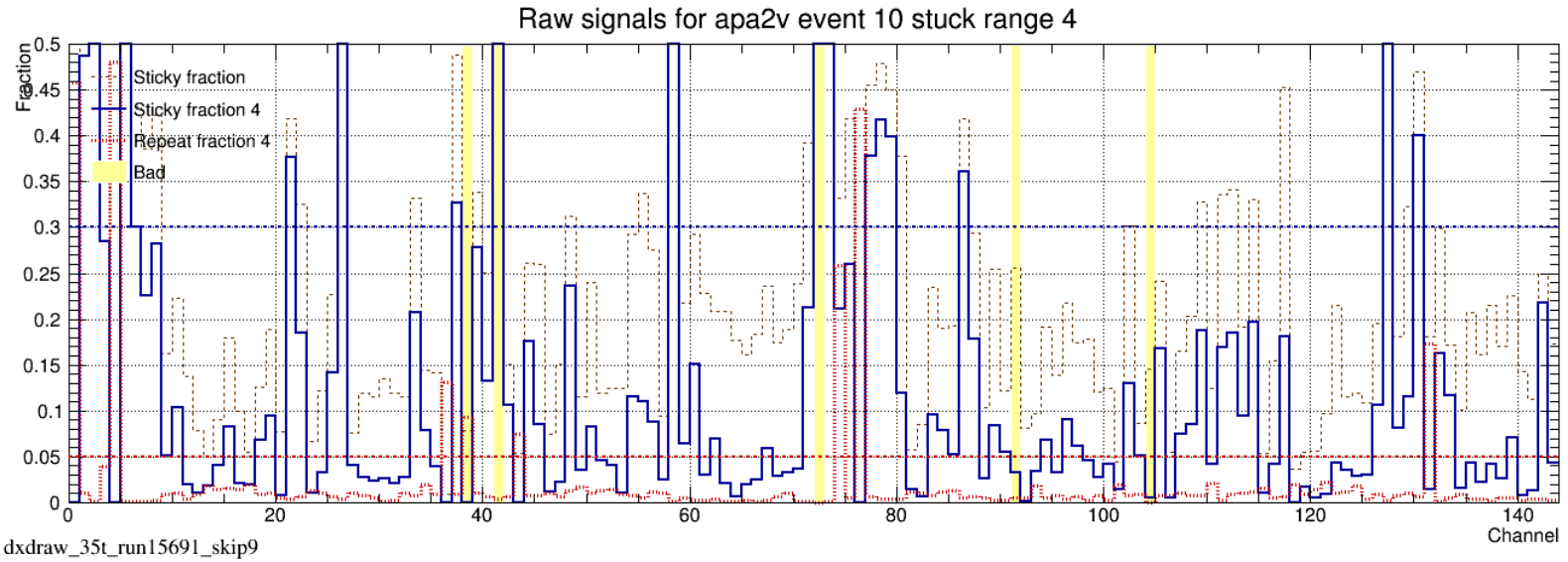
# Run 15634


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run15634_skip9

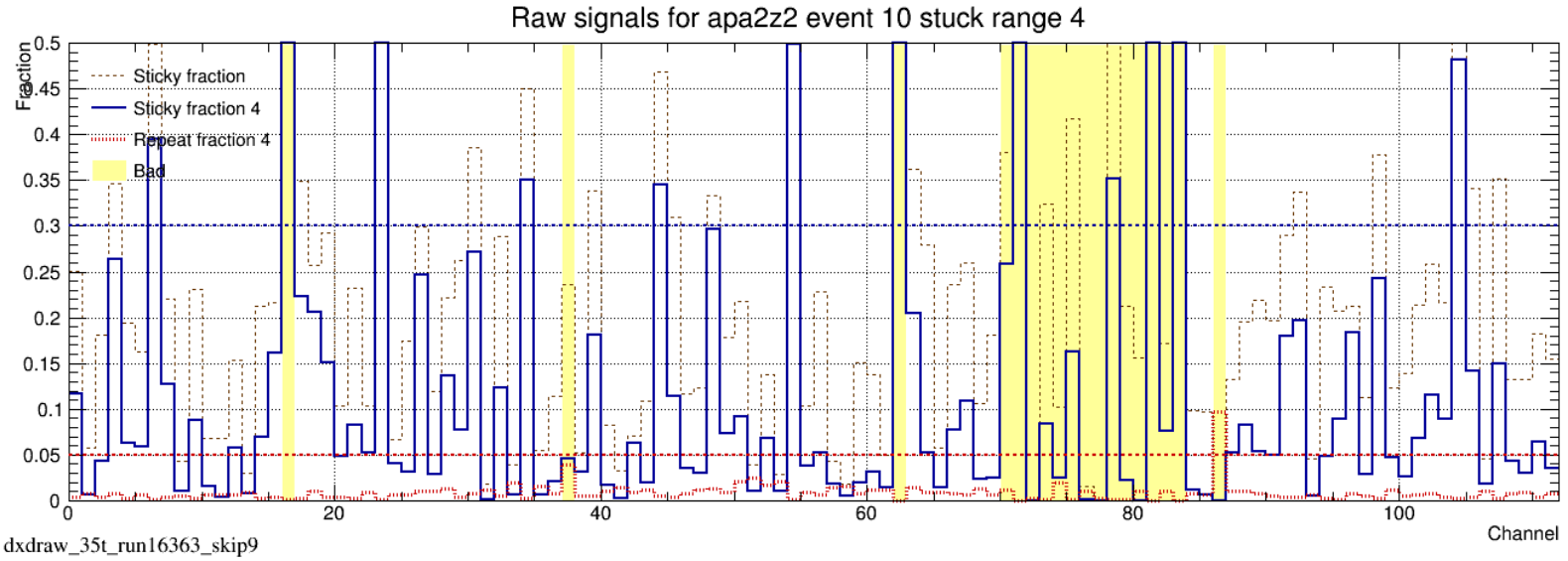

Raw signals for apa2v event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run15634_skip9

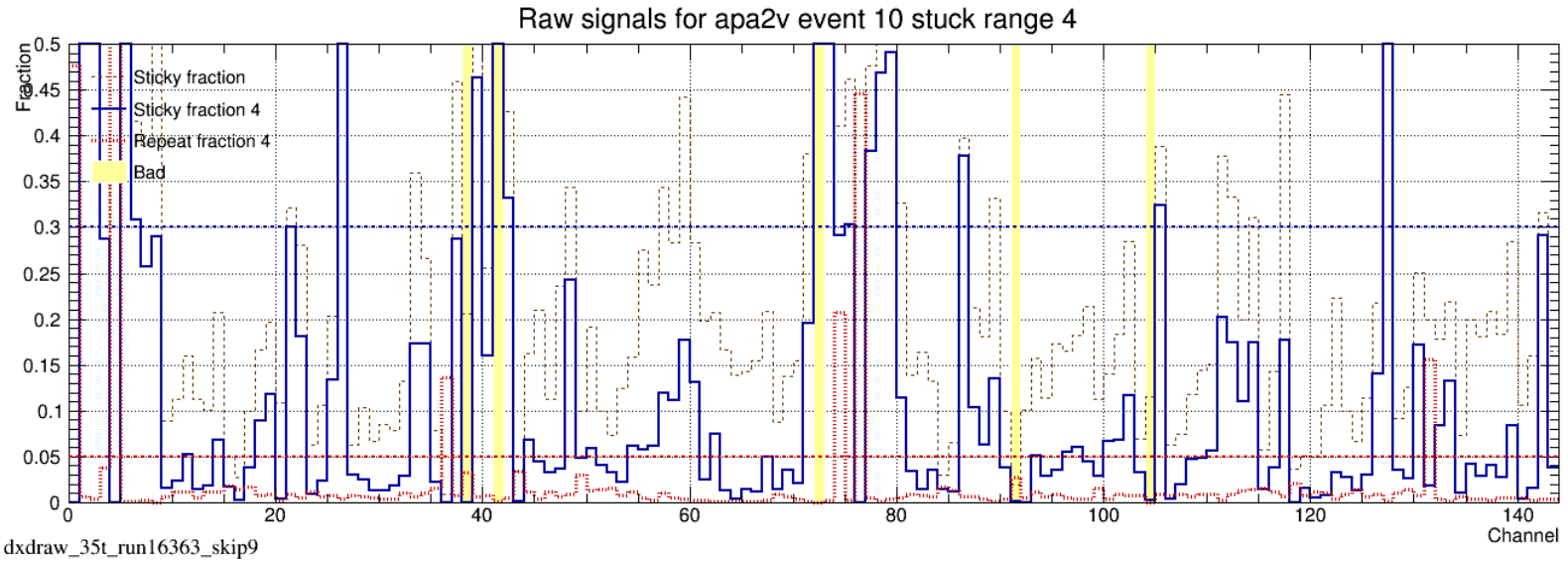
# Run 15691


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run15691_skip9

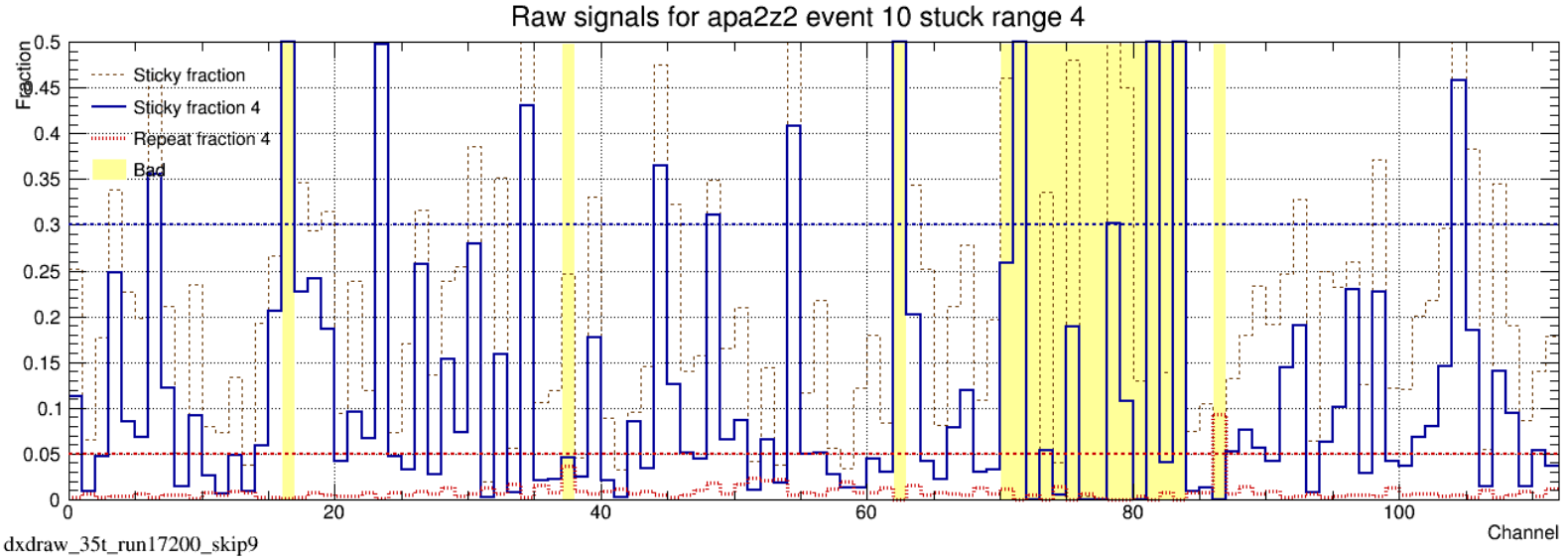

Raw signals for apa2v event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run15691_skip9

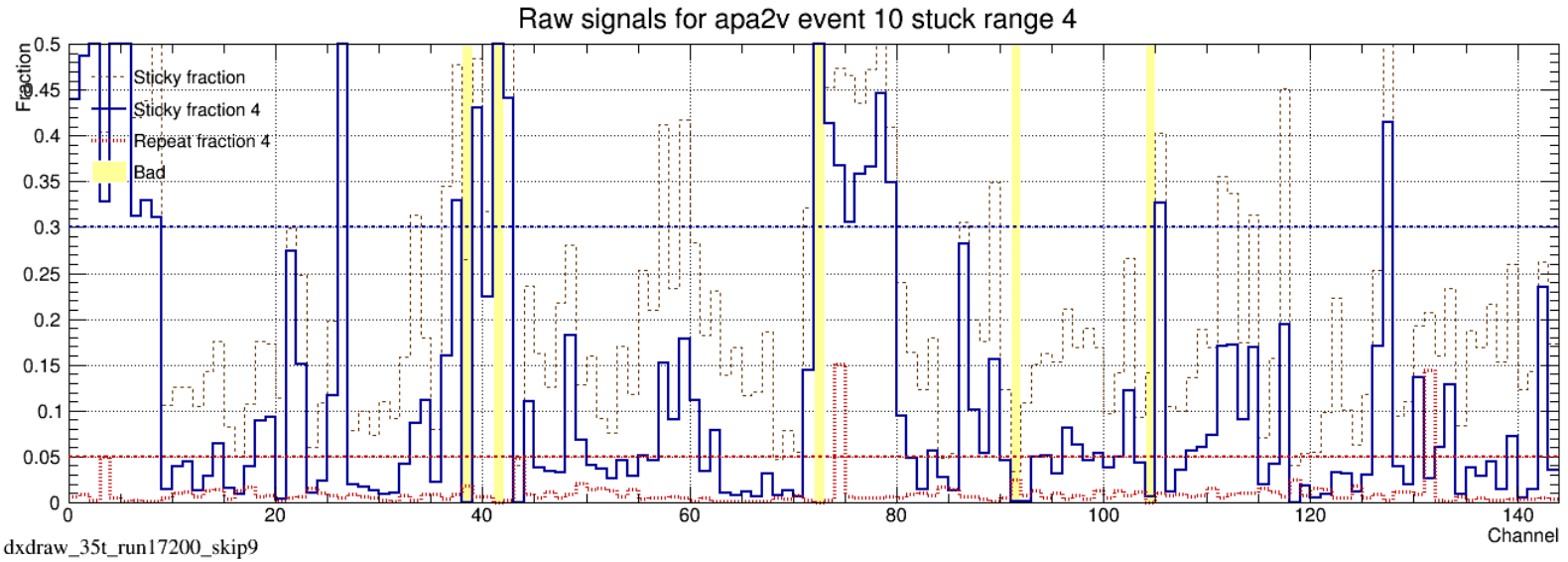
# Run 16363


Raw signals for apa2z2 event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run16363_skip9


Raw signals for apa2v event 10 stuck range 4
Fraction
Sticky fraction
Sticky fraction 4
Repeat fraction 4
Bad
Channel
dxdraw_35t_run16363_skip9

# Run 17200 (last run in sliced prod)



# Summary

Showed variation in RMS and sticky-code fractions

Proposed bad channel thresholds for the latter

# Extras

# Current bad channel list

There is a bad channel list in the reco FCL

- Where did it come from?
- Presumably includes known broken wires and bad electronic channels
- Anything else?
- Do we have documentation for this?
- The bad channels are marked with yellow bars in following plots

# Detector layout (from top)