VDCB Tests with CRP6 in April 2024 at NP04

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On behalf of the DUNE TPG/Trigger Group

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Preliminary Checks

/eos/experiment/neutplatform/protodune/dune/vd-coldbox

- Timestamp continuity
- 2048 ticks - difference between consecutive WIBEth-frame timestamps in a readout system fragment
- Files checked - no discontinuity found in:

  106 TB = 105941 GB

  25275 raw HDF5 files (Trigger Records)

  4.19 GB per HDF5 file

  Runs: 23351–25157 / 837 runs

  np02vdcoldbox_raw_run0<>_???_dataflow0_datawriter_0

TPG / Trigger runs

Trigger Records data

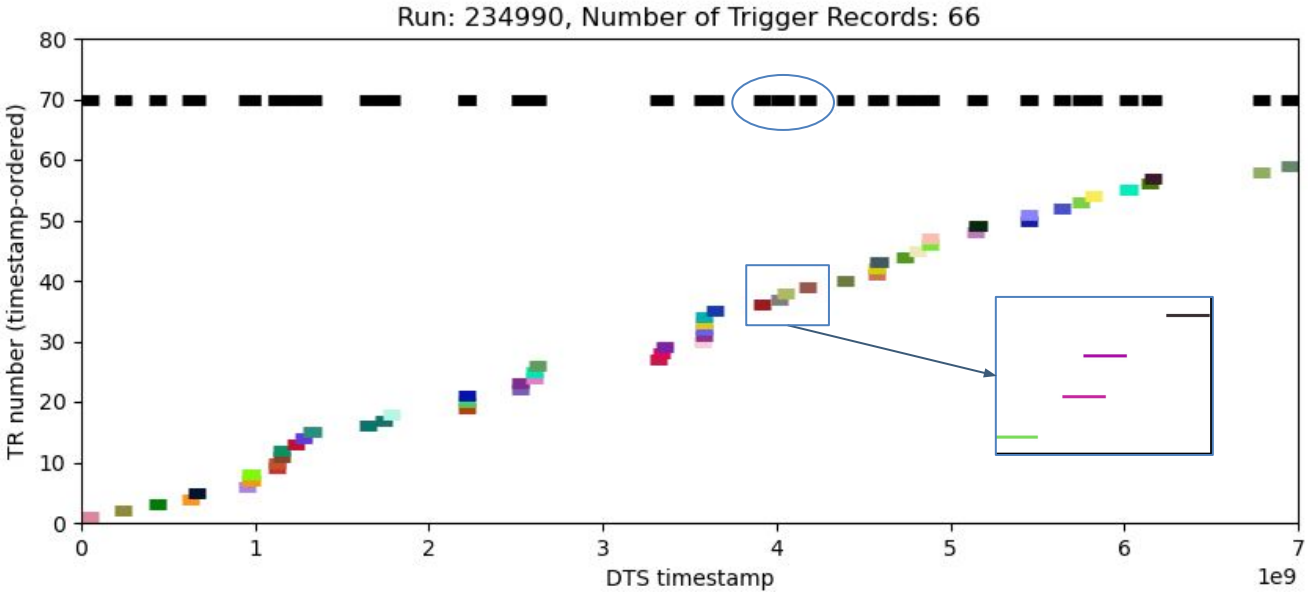
1.7 TB = 1710 GB
438 raw HDF5 files
3.9 GB per HDF5 file
Runs: 24732 – 24999 / 70 runs

TPStream data

485 GB
164 TPStream files
2.96 GB per TPStream file (averaged)

TriggerRecord Writing

- TriggerRecord start/duration based on **`window_begin`** and **`window_end`** TR header info
- TRs not time-ordered, some TRs can overlap in time -> few same TPs found in up to 4 TRs



Noisy Channels

- From TPStream data - e.g. spikes in the number of TPs per channel distribution

  [209, 975, 1041, 1186, 1931, 1941, 1957, 1959, 1967, 1974, 1989, 2200, 2980, 2993, 3056]

- From TriggerRecord data - e.g. RMS noise of channel significantly larger than those of neighbour channels

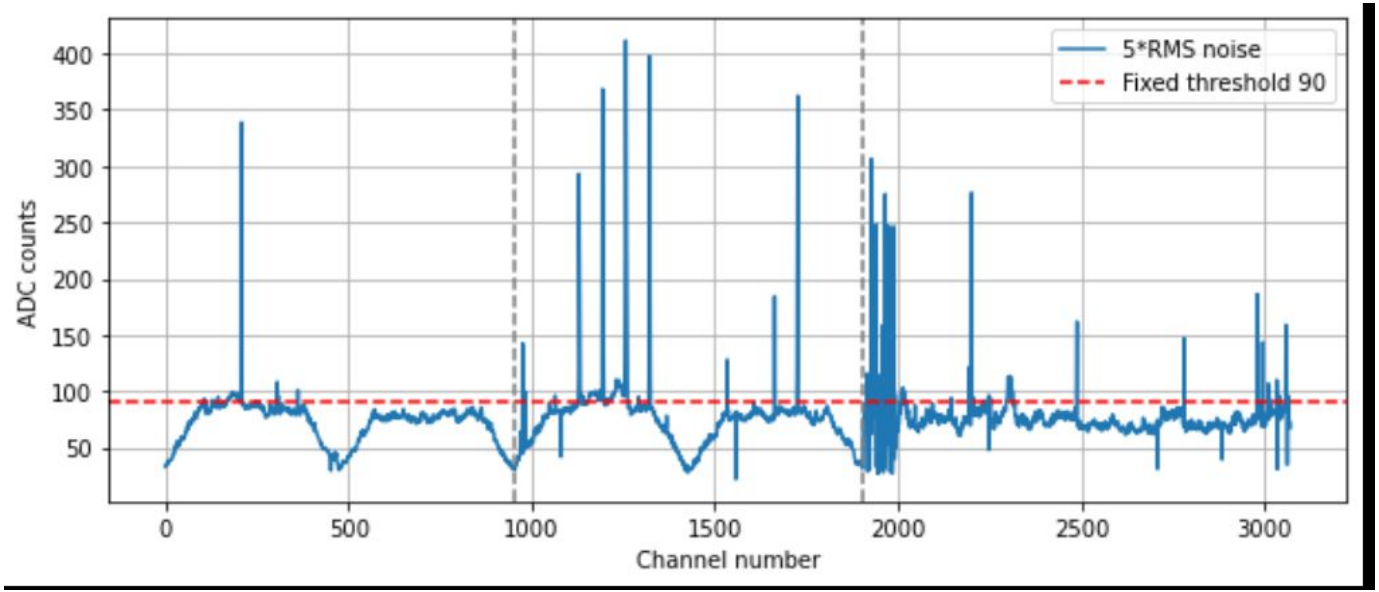
tighter cut [208, 975, 1129, 1193, 1257, 1321, 1663, 1726, 1927, 1940, 1965, 1974, 1988, 2200, 2980,]

looser cut [208, 975, 983, 1129, 1130, 1193, 1194, 1257, 1258, 1321, 1322, 1534, 1663, 1725, 1726, 1915, 1927, 1940, 1949, 1957, 1958, 1965, 1974, 1980, 1988, 2200, 2488, 2780, 2980, 2995, 3058,]

- Features not entirely understood - is there an underlying reason or analysis bug
  - Few channels match
  - More channels are direct neighbours or the next-to-next neighbour
  - Few channels are more than 2 apart

Noise Distribution

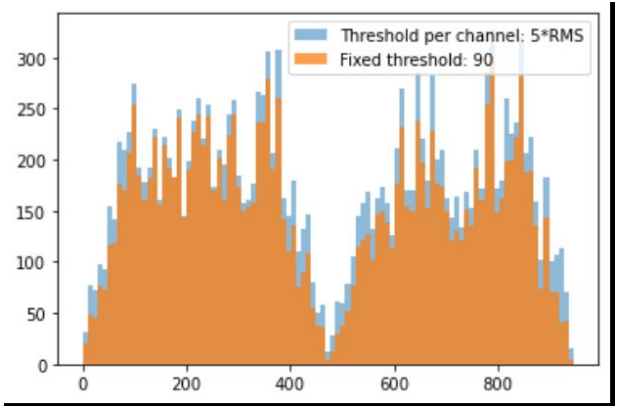
- Desirable to configure different ADC threshold values per plane: 1 collection + 2 induction
- The other extremes - fixed threshold for all planes vs different thresholds per channel



TPG Threshold Experience

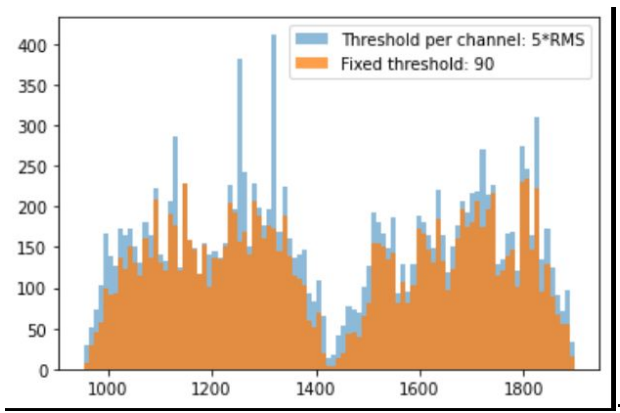
- Desirable to configure different ADC threshold values per plane: 1 collection + 2 induction
- The other extremes - fixed threshold for all planes vs different thresholds per channel

U-plane



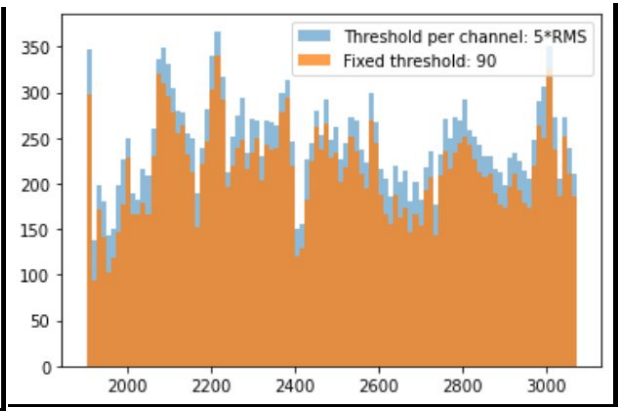
#TPs = 17265, Δ = 14%

V-plane



#TPs = 15451, Δ = 19%

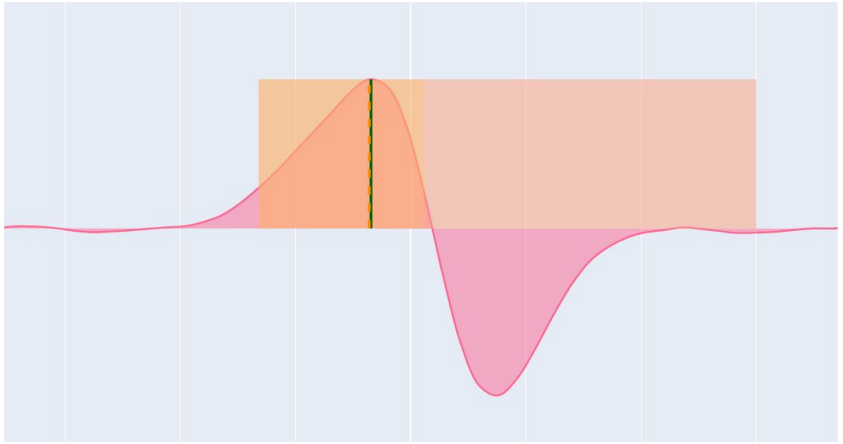
X-plane



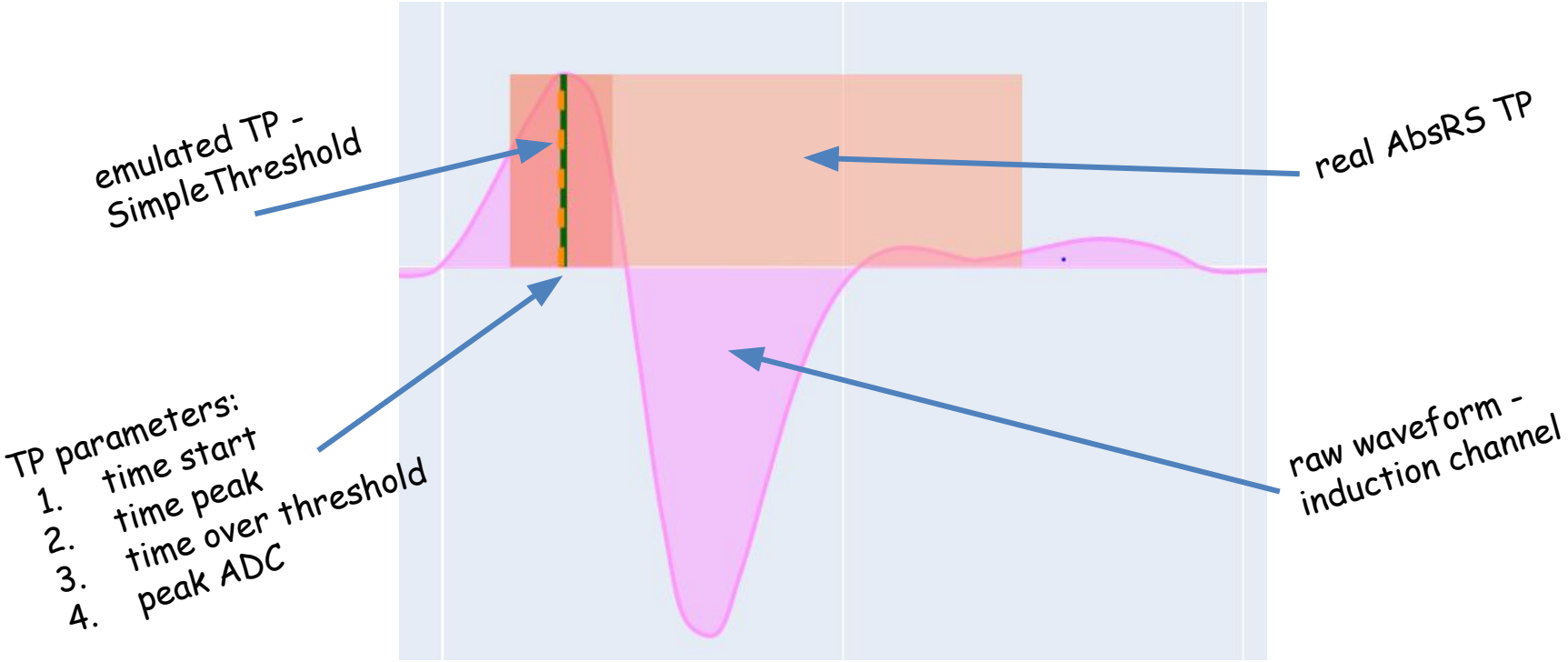
#TPs = 24205, Δ = 12%

TPG Algorithm Experience - AbsRS

- Excellent match between raw waveforms and overlaid real AbsRS TPs parameters - peak time and peak ADC
- However, AbsRS TP parameters not as expected from equation that uses AbsRS samples



TPG Algorithm Experience - AbsRS



AbsoluteRS vs StandardRS AVX2 Implementation

- Absolute Running Sum Algorithm
- Standard Running Sum Algorithm

*RS_adcs used for hit finding, raw_adcs used for TP parameter calculation

```
AbsRS_adcs[]
I_RS = 0
R = 0.8
s = 2.0
for adc in pedsub_adcs:
    I_RS = R*I_RS + abs(adc/s)
    AbsRS_adcs.append(I_RS)
```

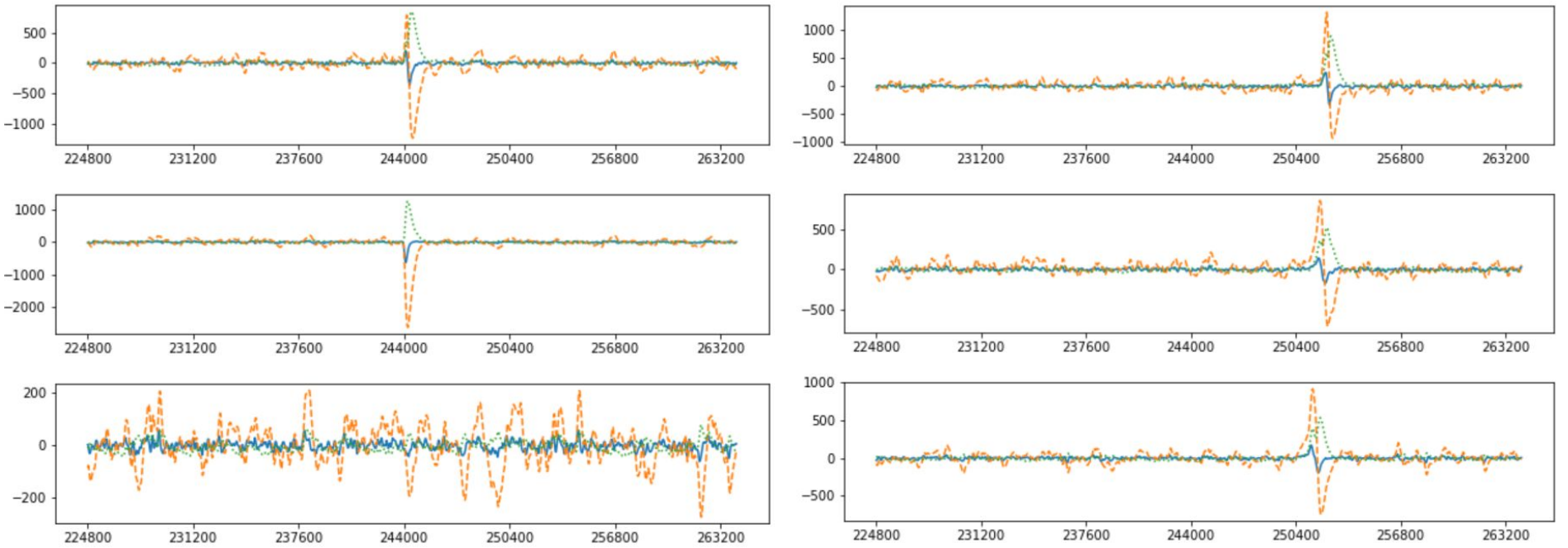
algorithm configurable parameters

```
StdRS_adcs[]
I_RS = 0
R = 0.9
s = 1.0
for adc in pedsub_adcs:
    I_RS = R*I_RS + adc
    StdRS_adcs.append(I_RS)
```

Both algorithms implement second pedestal subtraction on *RS_adcs

TPG Algorithm Emulator

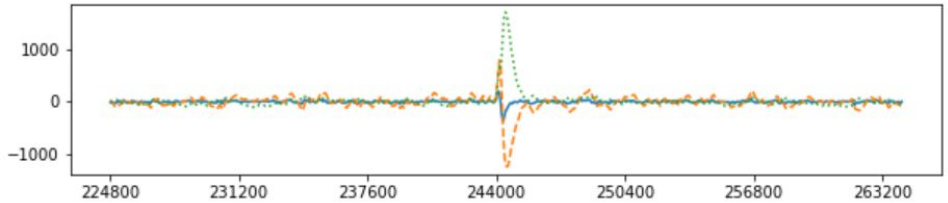
- s-value impacts peak ADC (re-scale parameter)

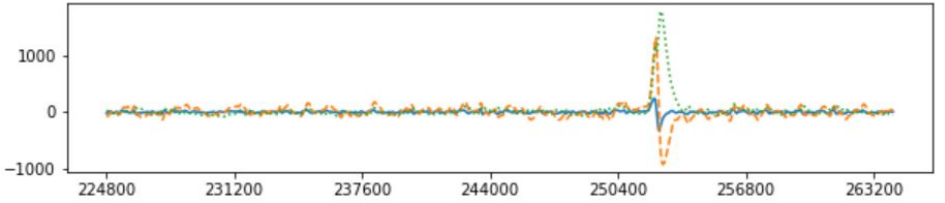


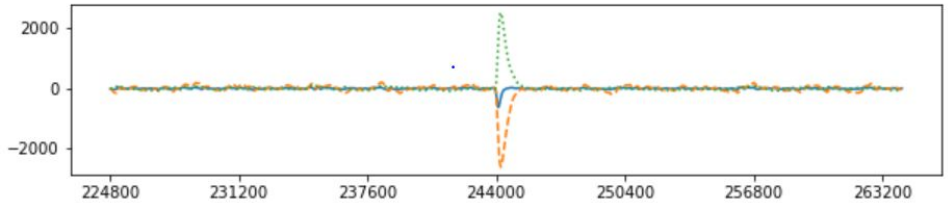
TPG Algorithm Emulator

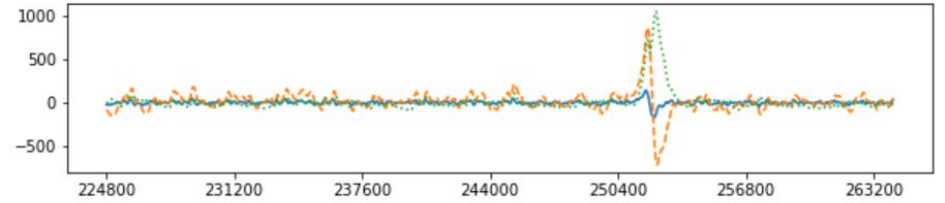
- Comparison at equal s- and R-values

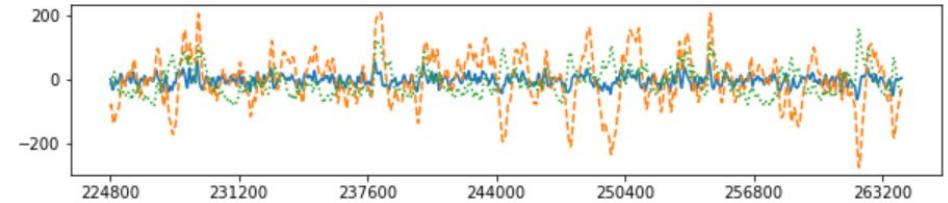
Raw waveform
Standard RS s = 1.0
Absolute RS s = 1.0

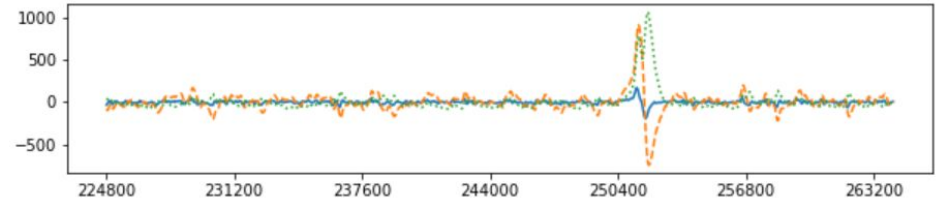








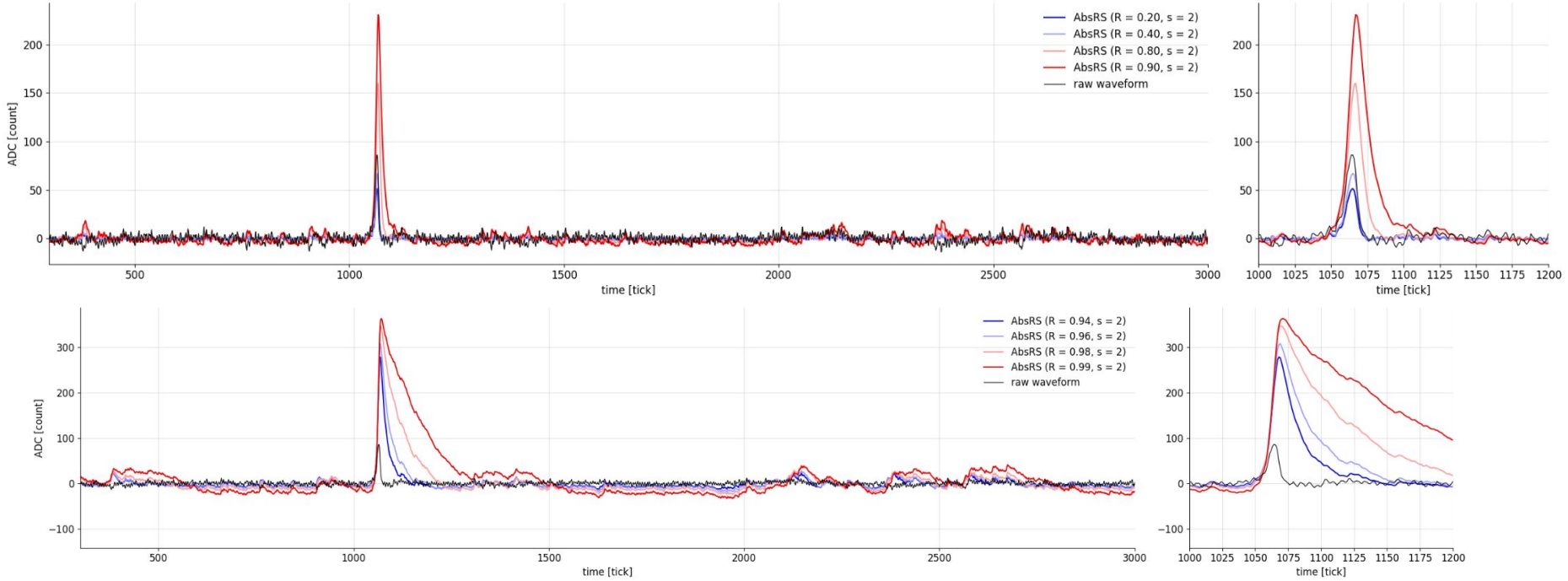




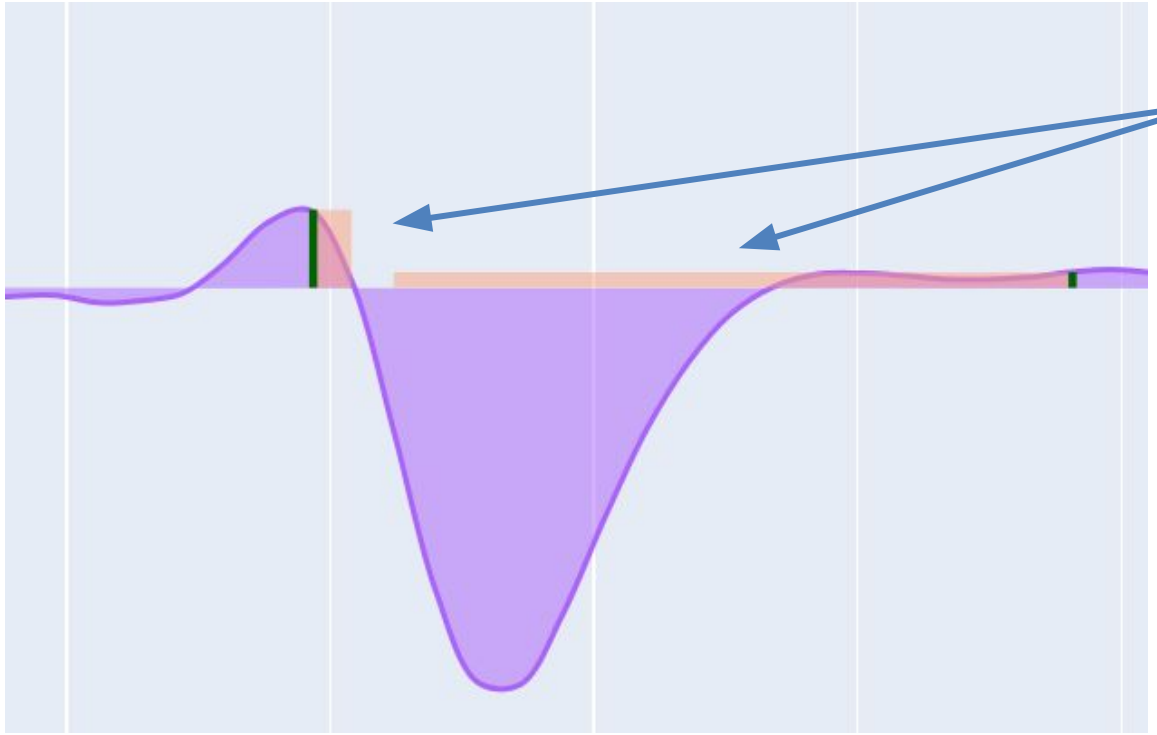
Science and Technology Facilities Council

AbsRS R-Parameter Scan

- R-value impacts time-over-threshold (peak width)



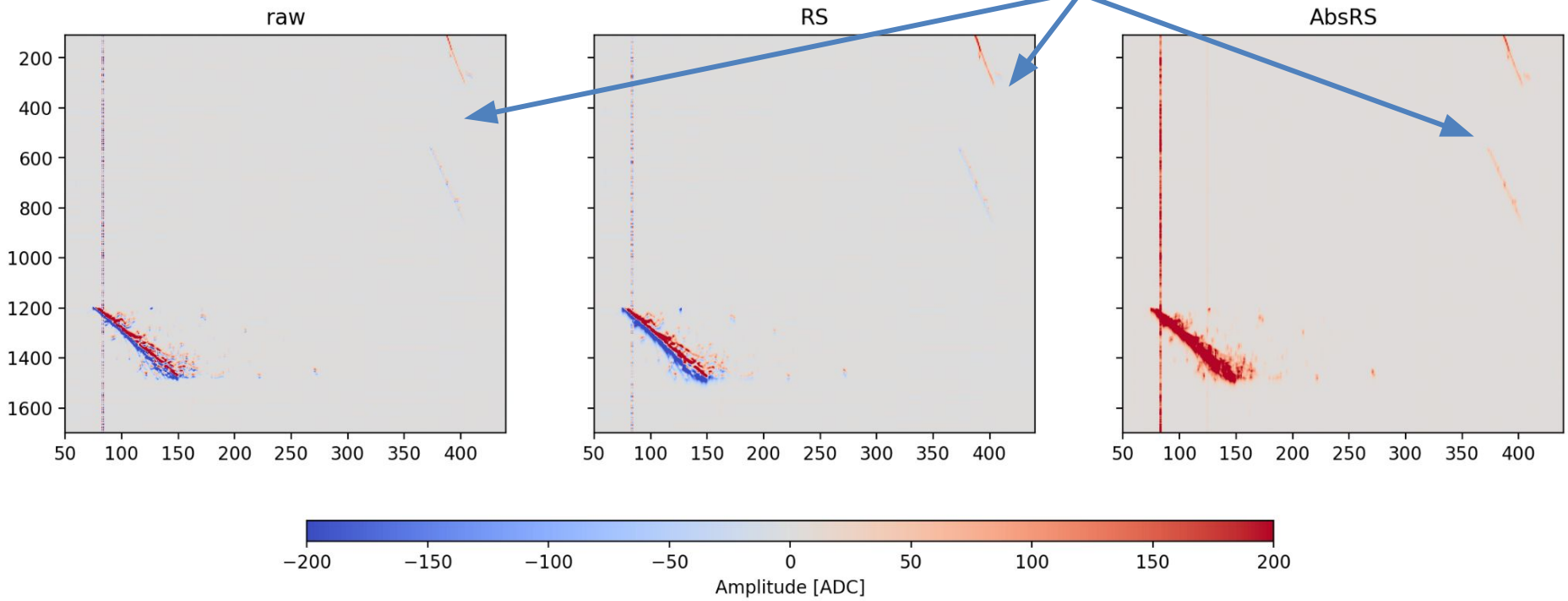
AbsRS R-Parameter Optimisation



2 real AbsRS TPs - R-parameter supposed to fix this feature

AbsRS Faint Track Enhancement

Two faint background tracks (along with an energetic shower)



Comments & Discussion

- "Problem statement" based on the latest VDCB real-time experience (April 2024)
  - AbsRS TPG algorithm was noisy and had poor stability
    - This was surprising and opposite to expectation
    - s = 1.0=2.0. R = 0.8-0.95 – why not fix s to 1.0 (or as default)
  - StandardRS was tested for the first time in a coldbox
    - It performed really well
    - s = 1.0 (fixed). R = 0.8-0.95
  - The issuei s that currently we see no obvious factor causing the AbsRS to perform differently in the real system

- Arguably in the absence of energetic showers, AbsRS helps to keep the lower-energy tracks
- Working on better quantifying the performance of the two algorithms from the VDCB high-statistics data samples (e.g. parameters and threshold scans)
- There is no necessarily a problem but more understanding/insight is desired

Summary & Conclusion

- We presented update on ongoing studies of TPG/Trigger algorithms for ProtoDUNEs and DUNE. AbsoluteRS and StandardRS are being investigated in the context of detector feasibility and physics goals
- These two fundamental motivations are being considered
- We predominantly need induction TPs for low energy searches, and any ROI trigger algorithm should be aware of what modulated TP output to expect from different algorithms, and how to maximise triggering efficiency on those TPs.
- A complementary view that hit parameters should reflect raw waveform parameters as much as possible