

Trigger:
the good,
the bad,
and the ugly

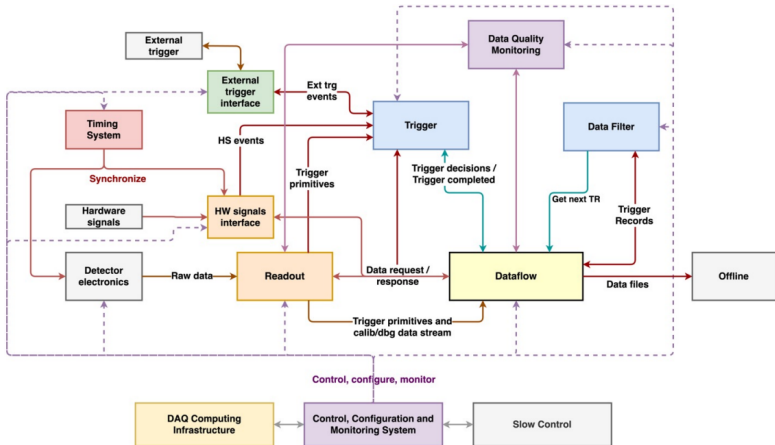
(on behalf of the trigger group)

Michal Rigan
mrigan@sussex.ac.uk

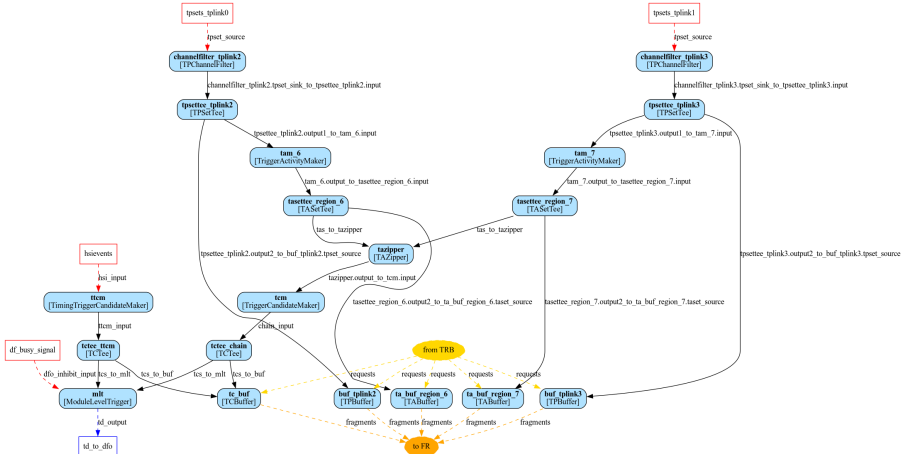
University of Sussex

DAQ General meeting
June 3, 2024





Activity Finder and Decision Maker.



~Defined chain, works with TPs, promotes these based on pre-defined logic.
 Eventually leads to storing data (including raw) to disk.

Trigger menu (algorithms)

Name	AM	CM	Works ?	Used ?
Prescale	X	X	X	X
ADC Simple Window	X	X	X	X
Horizontal Muon	X	X	X	X
Michel Electron	X	X	X (?)	X (?)
Plane Coincidence	X	X	?	-
Channel Adjacency	X	X	X	X
Channel Distance	X	X	X	X
Plane Coincidence	X	X	?	-
DBScan	X	-	-	-
Supernova	X	X X	-	-

X: yes; X: New; X retested, important now; -: nope; ?: ?

Trigger commissioning plan: test algorithms' logic (pick up events we want & not much else) as in CB, efficiency, speed. MLT logic (merging, bitwords). Create configuration for algos we'd like to use during PD with current setup.

How did that go ? ͡_(_ʘ)_/

Few immediate issues:

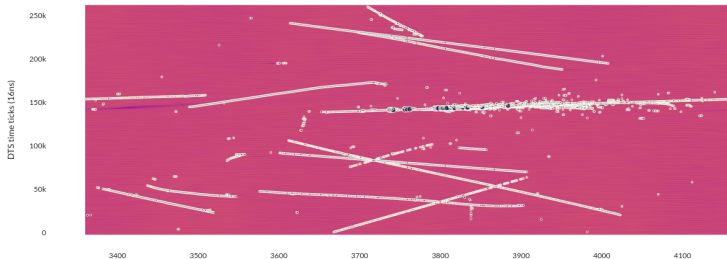
- ▶ Not much time left for trigger commissioning with TPG commissioning, rate issues, other priority tests & requests
- ▶ What types of events do we want to trigger on (and how realistic is that)?

np04hd_raw: Run 26421, Trigger Record 494

Raw Data File: np04hd_raw_run026421_0017_dataflow0_datawriter_0_20240524T184713.hdf5.copied

ADC Counts: V-plane

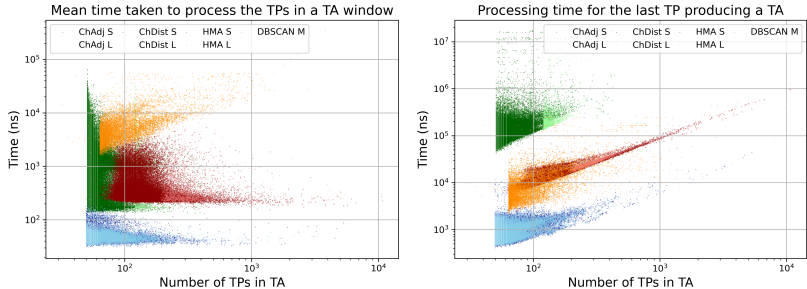
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- ▶ The TPG rates at the tagging efficiency that we'd like are high!
This means, for trigger to keep up, **each TP needs to be processed on $< 1\mu\text{s}$ scale (on average) !!!**

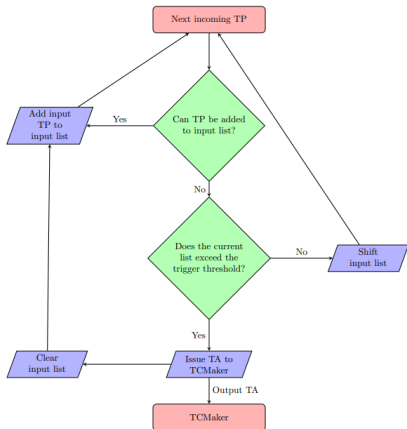


A study was performed *by Artur* (using emulation tools from trgttools [ideal conditions]), evaluating **latency for selection of algos**:

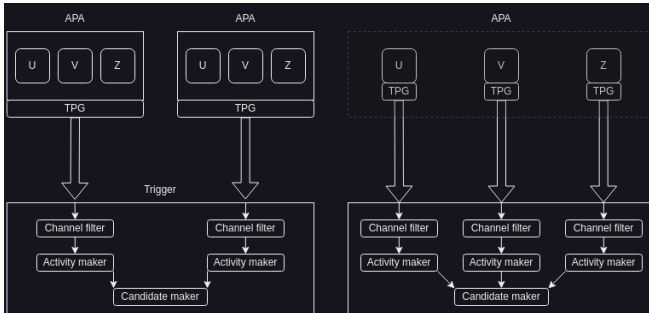


⇒ on the edge, need simple algos and will likely struggle!

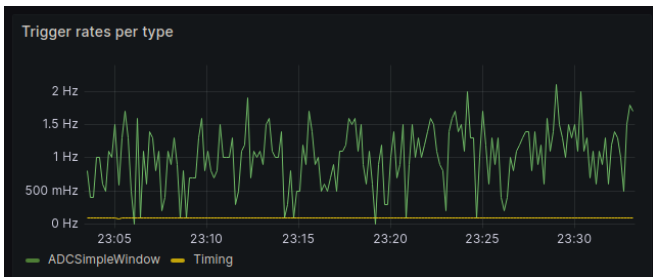
- ▶ uses the typical approach of sliding window, using **TPWindow class**
- ▶ emits **TA** if the sum of ADC integrals of input **TPs** (in the sliding window) is above configurable ADC threshold
- ▶ this was our first candidate, and proved very useful by identifying an ongoing electronics issue! (more on this later)



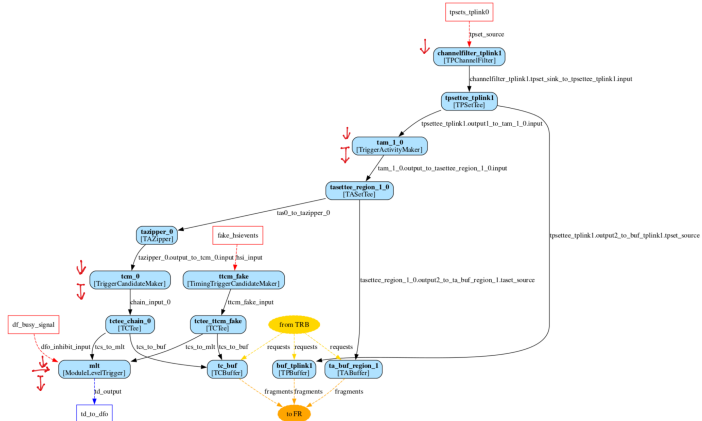
- ▶ **Removal of TP buffers** in trigger: copy of TP buffers from readout, for debugging/dev, issues with rates. *Tested, will be part of next release.*
- ▶ **Per-plane processing** in trigger: instead of one TP link per APA, moving to one link per APA's plane. Make possible to 'withstand' higher rates, doesn't change the 'philosophy' of trigger flow. *Code available (thanks to Giovanna and Alessandro), needs testing.*



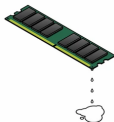
- **Monitoring of Trigger Decision types:** *Ready thanks to Marco.*

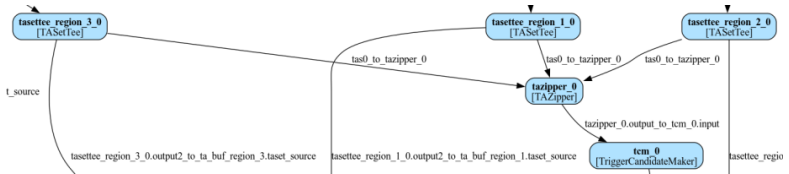


- Online latency monitoring:** Ability to trace data vs system time difference as data passes through the trigger at multiple sampling points. Integration in Generic maker. Configurable. *Hopefully ready by tomorrow. Will then need Grafana integration.*



- ▶ Thanks to many improvements and optimization at the TPG level + purity increase + bigger volume compared to coldboxes => we are now dealing with **very high rates**. Trigger algos need to be able to handle this. Plan/options:
 - ▶ better design/optimization of the algo (Arturs working on potential circular buffer)
 - ▶ core allocation tuning (thread pinning)
 - ▶ implementing the online latency feature
 - ▶ implementing the per-plane processing
- ▶ **memory leak**: It was discovered that there is a memory leak somewhere in the trigger app. It is a 'slow' leak (depends on 'windows' we work with) so it only became apparent after a very long run (12+ hours). Seems to be rate dependent. Was not possible (yet) to replicate with replay.



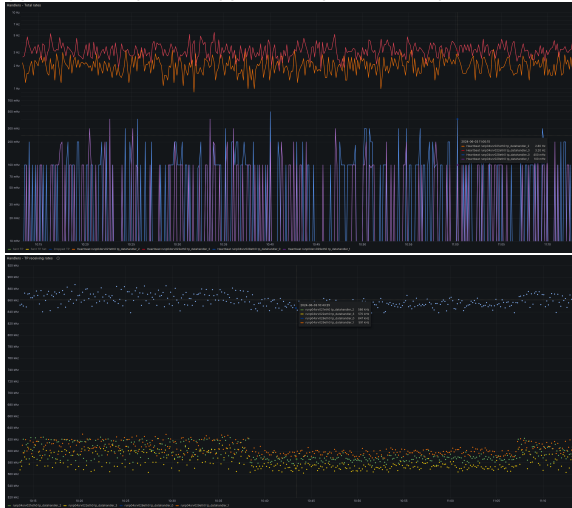


- ▶ Trigger flow is designed to be 'expecting' a steady rate from different TA chains at TA zipper: while TPs (and TPsets) are time ordered coming from one readout source, the sources between themselves are not synchronised (different types of RU, network/processing delays). Zipper then waits to see data from all sources before sending. If not, after a delay it has to proceed. This can result in 'tardy' TPs [completeness and cardinality].

WA... 2024-06-03 10:14:59 trigger Tardy input set from element 3. Set start time 107337655882630000 but last sent time 107337655975980000 DAQModule: tazipper_0

Issues along the way

- ▶ Heartbeats supposed to help with zipper's completeness requirement:





Issues along the way

- ▶ Similar issue for TCs if they are late:

WA...

2024-06-03 10:18:14

trigger

TC of type 6, timestamp 107337668214850251 overlaps with previous TD readout window: [107337668214830251, 107337668214870251] DAQModu

- ▶ (Most importantly) Late requests also an issue:

SourceID[subsystem: Trigger id: 10] Request timed out for trig/seq_num 42684.0, run_num 26587, window begin/end 107337750584387552/107337750584648696, data_destination: fragments_to_dataflow0 -- 16 similar messages suppressed, last occurrence was at 2024-Jun-03 10:40:00.374874

SourceID[subsystem: Detector_Readout id: 405] Trigger Matching result with empty fragment: TS match result for SourceID[subsystem: Detector_Readout id: 405] Trigger/sequence number «42720.0 Oldest stored TS=107337753038743583 Start of window TS=107337752362189515 End of window TS=10733775239228611 Estimated request stored TS=107337753

default... trigger_records: Unable to pop within timeout period (timeout period was 10 milliseconds). Occupancy is 0 / 11 -- 2941 similar messages suppressed, last occurrence was at 2024-Jun-03 11:05:01.896870



Issues along the way

Need better monitoring:

- ▶ latency (emulation, online)
- ▶ adding monitoring for buffers, queues, zipper
- ▶ naming threads properly (to be unique)

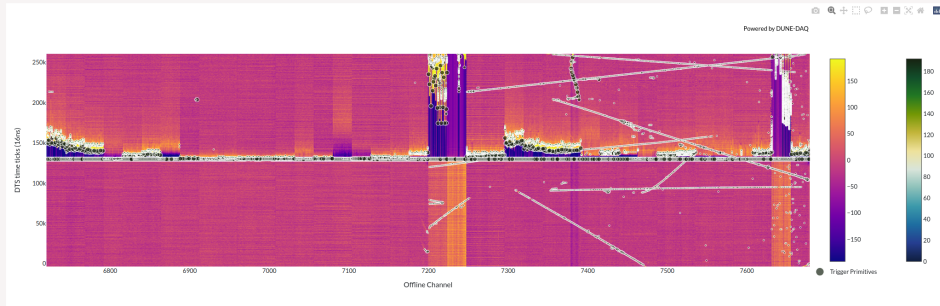
- ▶ we do have many algorithms to choose from, many tested during coldboxes
- ▶ we have simple & fast algo (ADC SW) that already proved useful
- ▶ TPGs in good state (and assuming other issues are fixed) we can focus on trigger commissioning, with access to better features (justintime, latency measurements)
- ▶ throughout last weeks other trigger functionality used and found working: TC merging, custom readout map in MLT, trigger bitwords, TC ignoring...
- ▶ high rates not an issue for FD

- ▶ Throughout the first few days while looking at random triggered events we noticed some anomalous looking events:

np04hd_raw: Run 26372, Trigger Record 20

Raw Data File: np04hd_raw_run026372_0000_dataflow0_datawriter_0_20240522T151839.hdf5.copied

ADC Counts: Z-plane

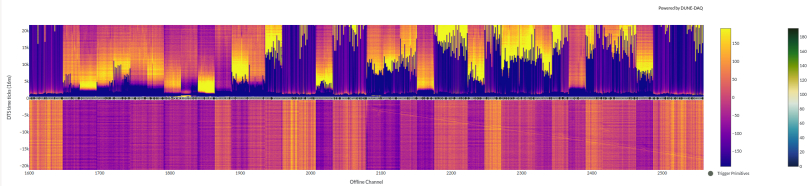


- ▶ We then tuned the ADC SW algo for short windows, incredibly high ADC sum threshold (to trigger on these), and were able to pick (some of) these up!

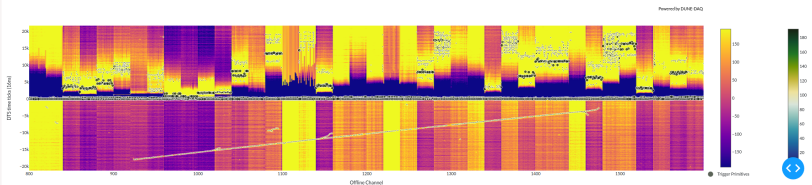
np04hd_raw: Run 26510, Trigger Record 1284

Raw Data File: np04hd_raw_run26510_0006_dataflow0_datawriter_0_20240527T123631.na5.copied

ADC Counts: Z plane



ADC Counts: Y plane





Good but Bad but still Good

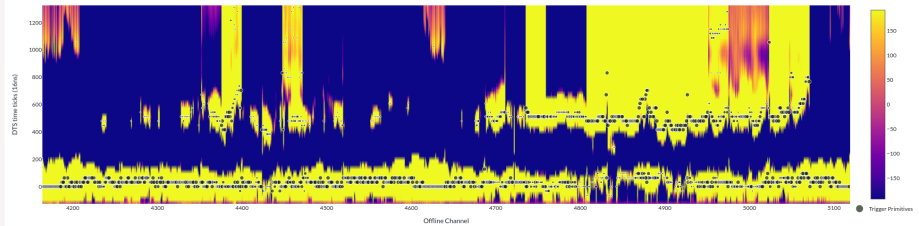
► ZOOM

np04hd_raw: Run 26589, Trigger Record 275

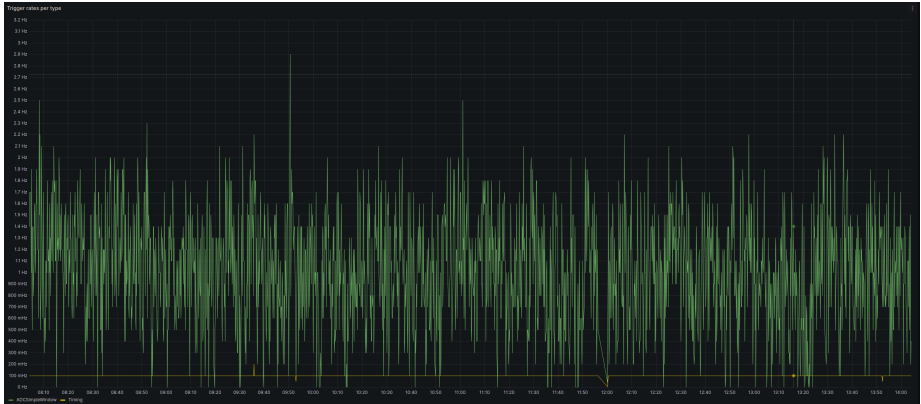
Raw Data File: np04hd_raw_run026589_0002_dataflow0_datawriter_0_20240603T100444.hdf5.copied

ADC Counts: Z-plane

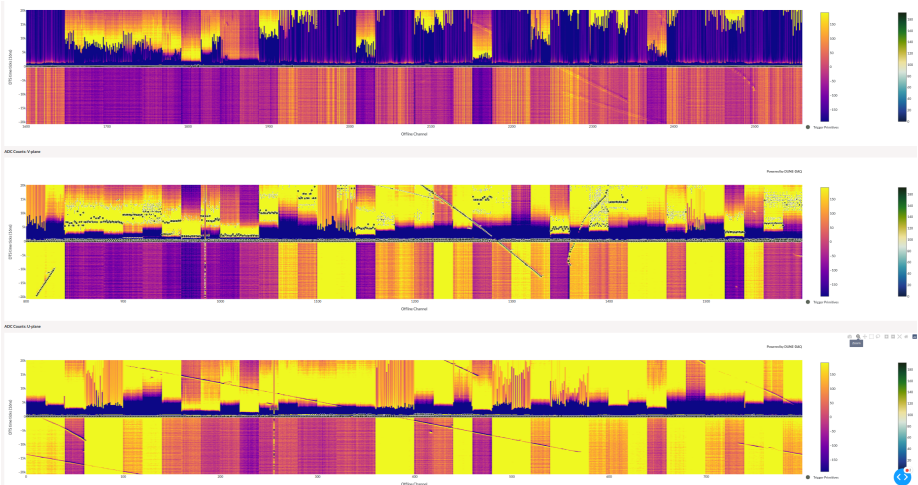
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- ▶ These happen at $>1\text{Hz}$ (this is with very high sum ADC threshold, the rate can be higher than this):



► These happen across all planes, all APAs, at the same time:



- ▶ This has been the focus over the past few days (including "week-start")
- ▶ Many tests performed by the electronics group
- ▶ (not pulser)
- ▶ (not bias)
- ▶ (not PDS)
- ▶ (not cameras/power supplies)
- ▶ disappears when the cathode is 'turned off' (discharged)
- ▶ current best theory is that it is related to grounding (*)



WHAT?!

- ▶ Learned a lot
- ▶ Gotta go fast
- ▶ Gotta monitor all
- ▶ Most infrastructure working well
- ▶ Simple algos can keep up (all we need?)
- ▶ Some ongoing issues, but have good tools and understanding for proper commissionin soon

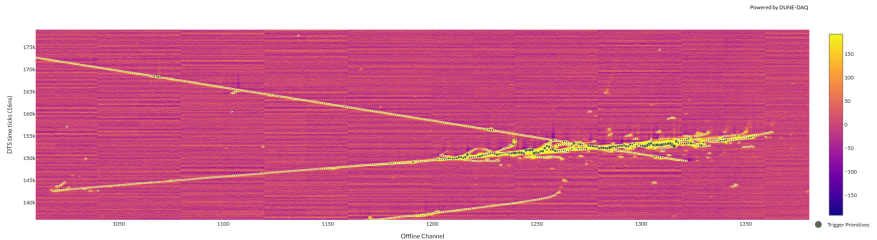


It works

np04hd_raw: Run 26379, Trigger Record 2

Raw Data File: np04hd_raw_run026379_0000_dataflow0_datawriter_0_20240523T111835.MF5.copied

ADC Counts: V-plane





It works

np04hd_raw: Run 26437, Trigger Record 16

Raw Data File: np04hd_raw_run026437_0000_dataflow0_datawriter_0_20240527T120149.h5.cooled

Callback error updating channel_number_ctr1_opt... 14:05:44

ADC Counts: Z plane

