NP04 Status Update

People at CERN this week: Renan, Julio, Anna, Anselmo, Michaela and Manuel

04/07/2024

TASK LIST

NP04 PDS data taking plan

- Data taking optimization → General DAQ JSON ..... ✅
- Take data with all subsystems (during beam time) ..... ✅
- DAQ duplication problem solved (daq trigger set max to 20Hz) ..... ✅
- WAFFLES first release ..... 🟠

- SPE Calibration of all channels ..... 🟠
  - Analyse the runs and fine-tune the last parameters..... ✅
  - Ad-hoc trigger in APA1 for LED tuning ..... ✅
  - Full-streaming channels calibration ..... ✅
  - Take calibration runs with final configuration (3 OV) ..... 🟠
  - SPE template for 160 channels (once gain is equalized)..... 🟠
- Data Deconvolution ..... 🟠
- Trigger rate ..... ✅

OUTPUT FOR RECO TEAM

Summary

During the last couple of weeks we encountered multiple problems:

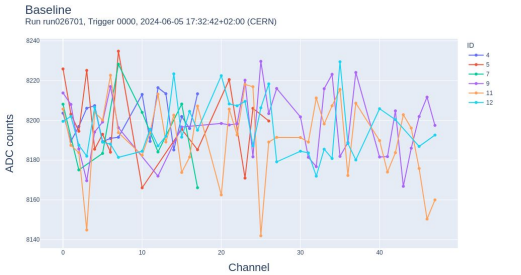
- Specific values for **Threshold** configuration were freezing DAPHNE
- Readout and trigger Performance was below expectations
- We saw significative differences in the **gain** of different modules
- We didn't had the tools to track specific events in the data and correlate with other systems.

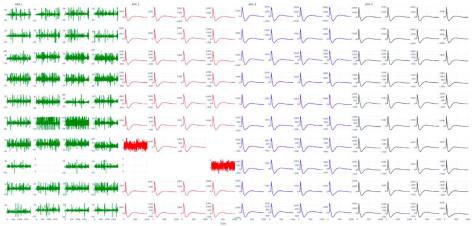
➔ We understood and we improved/solved all of them.
➔ We are able to trigger at **2PE** without errors at the DAQ level.
➔ We have increased the amount of healthy paquets bringing the **errors to cero**.
➔ The **multilink** for the self trigger is still an option, but less critical than before.

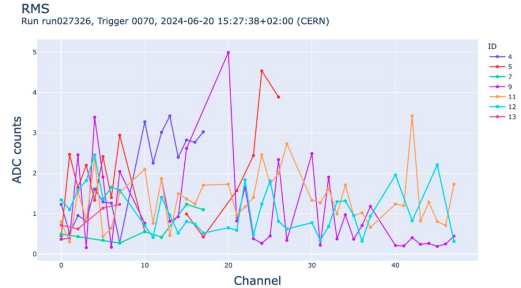
Online monitoring

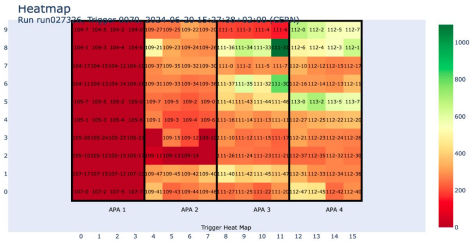
Tool for check that the data we are acquiring is ok → DQM plots + Shifter checking list (Thanks Renan!)

DQM Plots used during the first beam week:



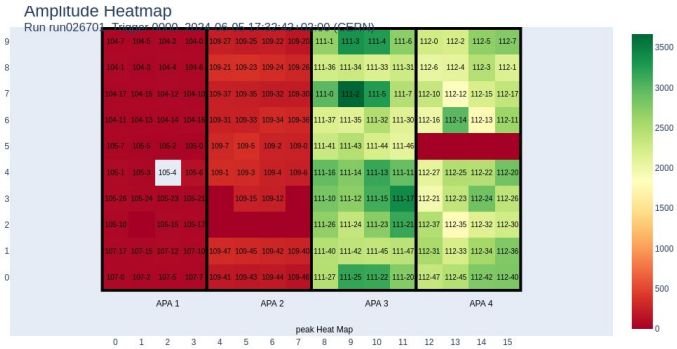






Updates for the next beam:

- Problematic channels were removed;
- Implementation of another heat map, to monitor the maximum amplitude of the mean waveform in each channel:



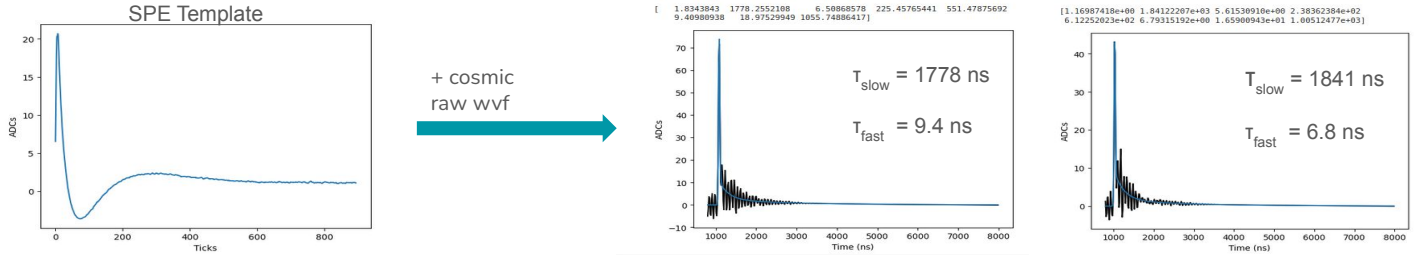
Deconvolution

- **Method:**

1. Compute one template per channel → Average waveform of multiple p.e on the s.p.e scale;
2. Deconvolution: ratio between the ffts of the signal and the template;
3. Application of the gaussian filter for a better result and computation of the inverse fft;
4. Fit model (under testing):

$$fit = \frac{A_S}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_S}} \mathrm{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_S}\right) e^{\frac{t-t_0}{\tau_S}} + \frac{A_I}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_I}} \mathrm{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_I}\right) e^{\frac{t-t_0}{\tau_I}} + \frac{A_F}{\sqrt{2}} e^{\frac{\sigma^2}{2\tau_F}} \mathrm{Erfc}\left(\frac{t-t_0}{\sigma} + \frac{\sigma}{\tau_F}\right) e^{\frac{t-t_0}{\tau_F}}$$

- Example: 2 records of run 026071: endpoint 111 and channel 45 → Cosmics



** Black: result from the deconvolution process; blue: fitting

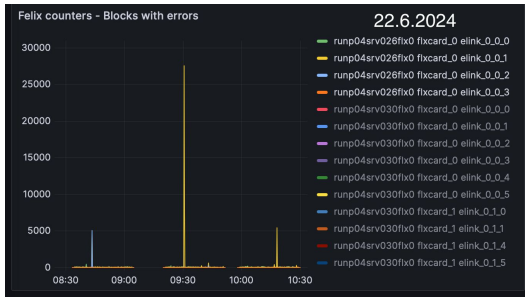
- **Next steps:**

1. Define the template of each channel;
2. Finish the method validation;
3. Implement the method on WAFFLES

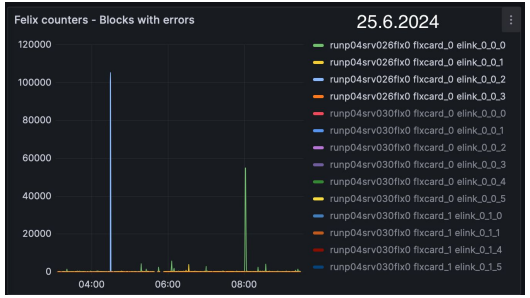
Thanks Renan!

Trigger rate

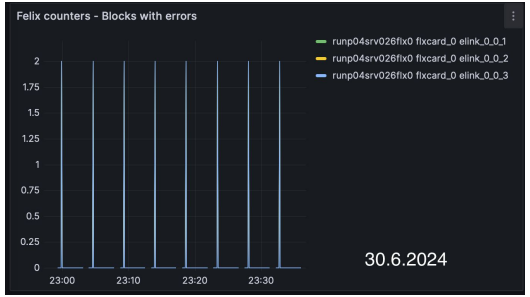
- Beam run 27373 (22. 06. 2024) :
  - APA1 - 3.69 GBps
  - APA2 - 0.43 GBps
  - APA3 - 0.80 GBps
  - APA4 - 0.75 GBps
- Beam run 27412 (25.06. 2024):
  - APA1 - 3.69 GBps
  - APA2 - 0.44 GBps (↑ 0.01 GBps)
  - APA3 - 0.82 GBps (↑ 0.02 GBps)
  - APA4 - 0.77 GBps (↑ 0.02 GBps)
- NON-beam run 27568 (30.06. 2024):
  - APA2 - 1.69 GBps (↑ 1.25 GBps)
  - APA3 - 1.69 GBps (↑ 0.87 GBps)
  - APA4 - 1.69 GBps (↑ 0.92 GBps)



max #errors ~ 27 000



max #errors ~ 100 000



max #errors ~ 2

Thanks Michaela!

SPE Calibration

Details on how to turn the LEDs for calibrating → here

Based on the results which were presented on 20/06 NP04 PDS operation meeting, the following runs were taken for APAs 3 and 4

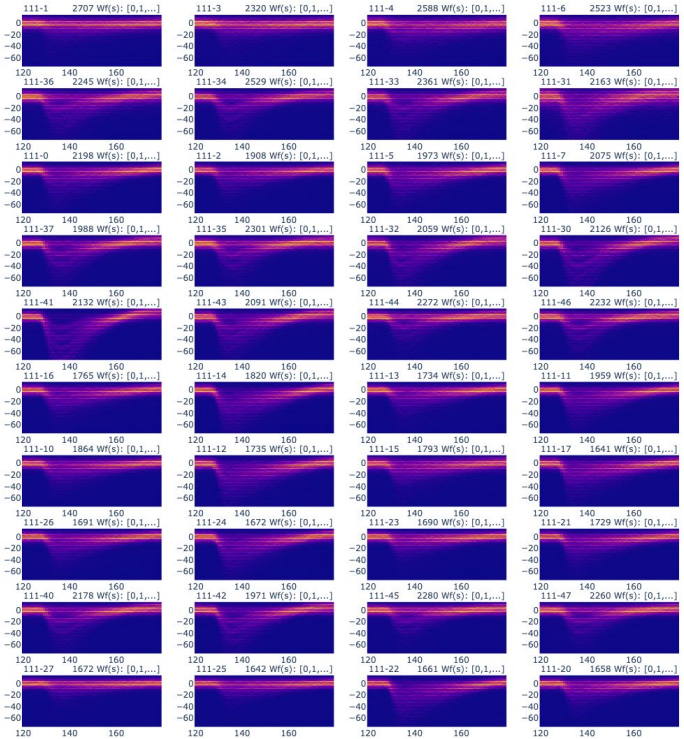
	Calibration Runs for APAs 3, 4							
27562	30/06/2024		120s	marroyav		111,112,113	LED	Calibration Run. Bias DCS:30V. Tests 270nm: SSP_config. pulse_mode:single, mask_channel:1, ticks_width:1, Pulse_bias_percent_270nm:1400. Trigger_ad-hoc 0x7:6250Hz. 20Hz daq triger_rate.
27563	30/06/2024		120s	marroyav		111,112,113	LED	1600
27564	30/06/2024		120s	marroyav		111,112,113	LED	1800
27565	30/06/2024		120s	marroyav		111,112,113	LED	2000
27566	30/06/2024		120s	marroyav		111,112,113	LED	1400 Mask 12
27567	30/06/2024		120s	marroyav		111,112,113	LED	1600 mask 12
27568	30/06/2024		120s	marroyav		111,112,113	LED	1800 mask 12
27569	30/06/2024		120s	marroyav		111,112,113	LED	2000 mask 12

Thanks Julio!

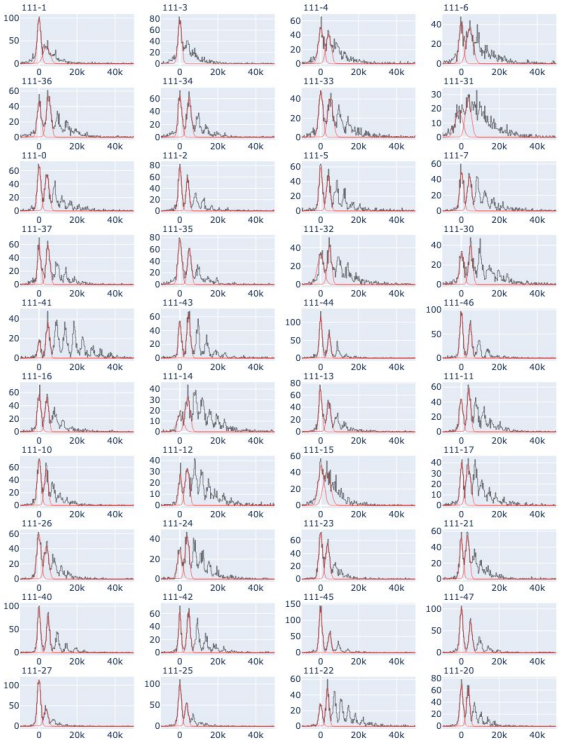
SPE Calibration: APA 3

- PERSISTENCE PLOTS
- CHARGE HISTOGRAMS + FIT

APA 3 - Runs 27562-27565, 27567, 27569



APA 3 - Runs 27562-27565, 27567, 27569



PRELIMINARY

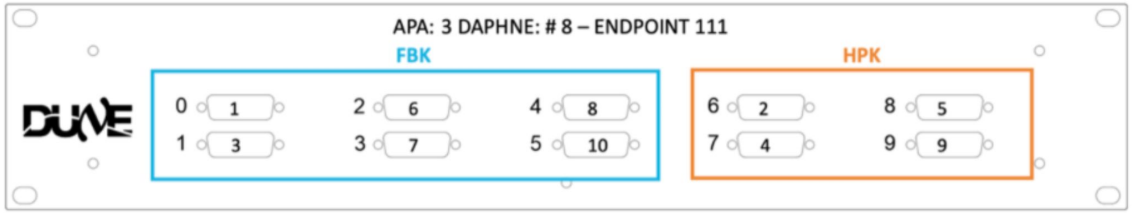
Thanks Julio!

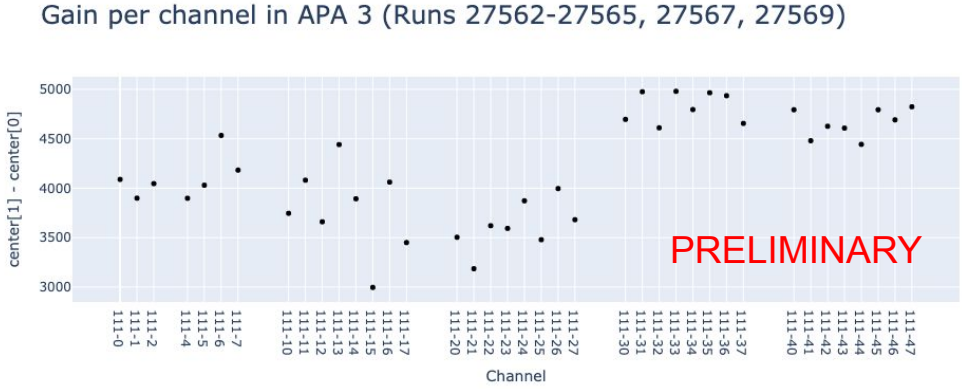
SPE Calibration: APA 3

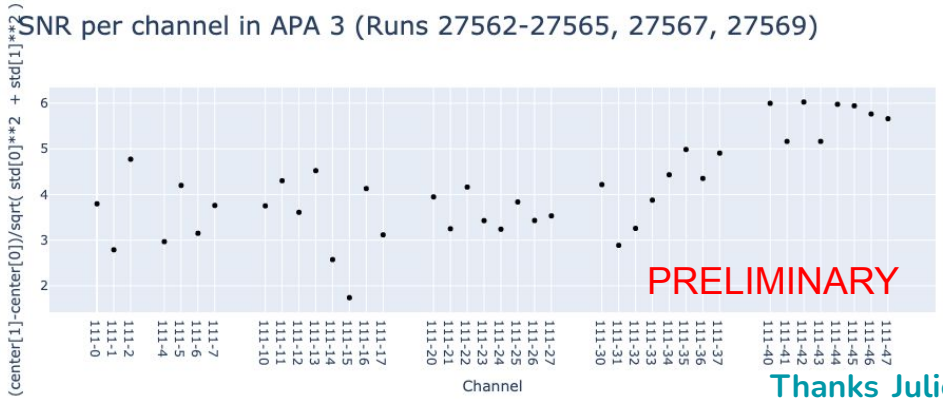
Gain = $\mu_1 - \mu_0$

$$SN_C = \frac{\text{Gain}}{\sqrt{\sigma_0^2 + \sigma_{1st}^2}}$$

CHARACTERIZATION FROM FIT RESULTS (PER CHANNEL)

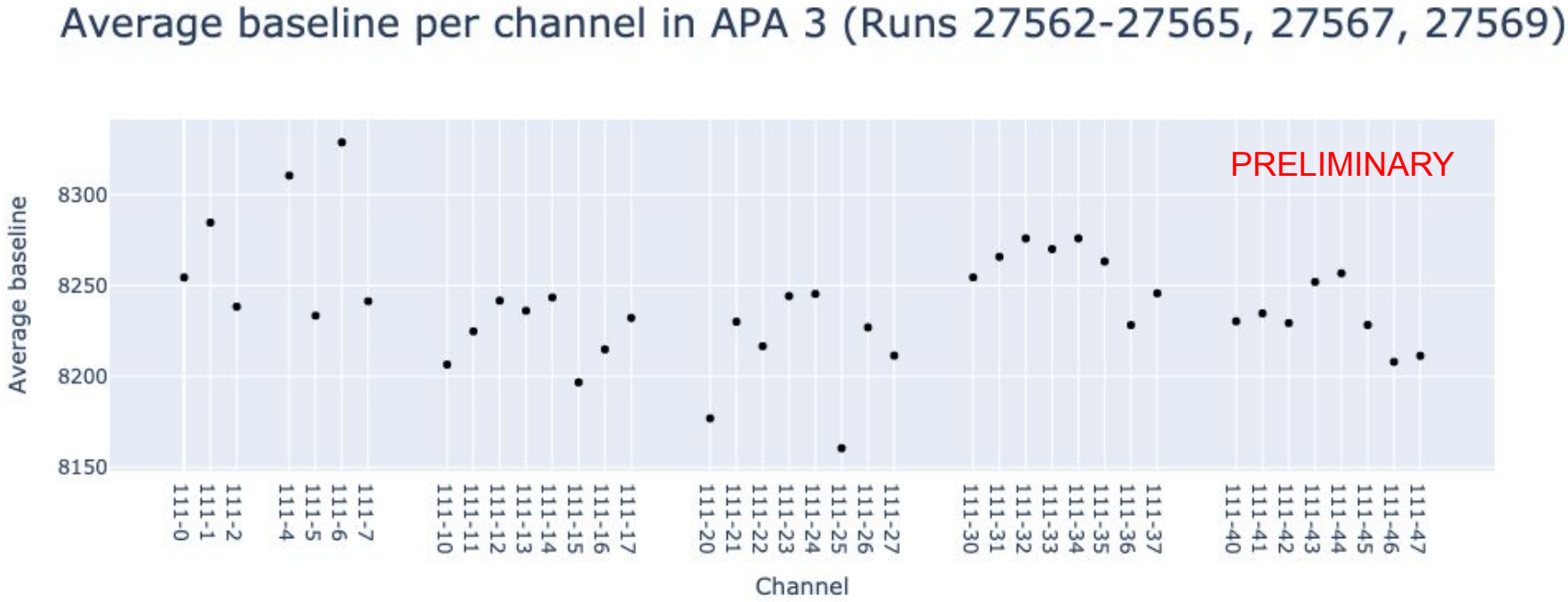






Thanks Julio!

SPE Calibration: APA 3

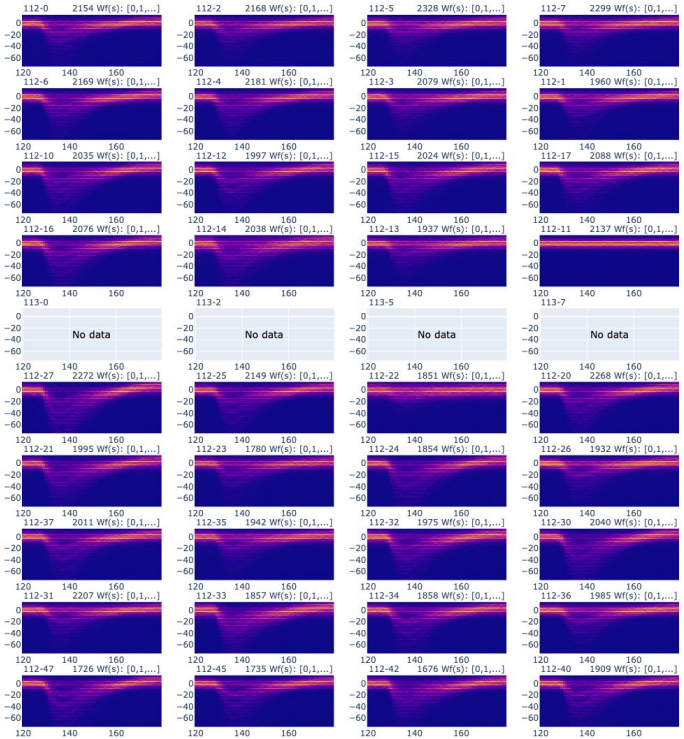


Thanks Julio!

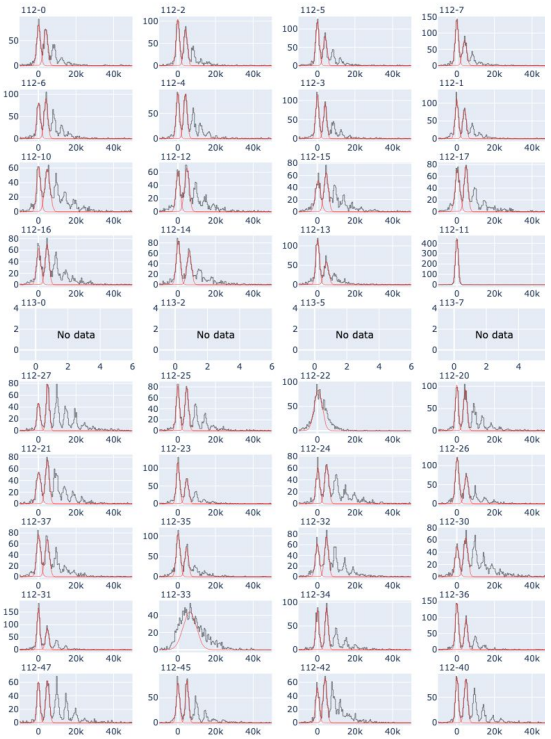
SPE Calibration: APA 4

- PERSISTENCE PLOTS
- CHARGE HISTOGRAMS + FIT

APA 4 - Runs 27562-27565



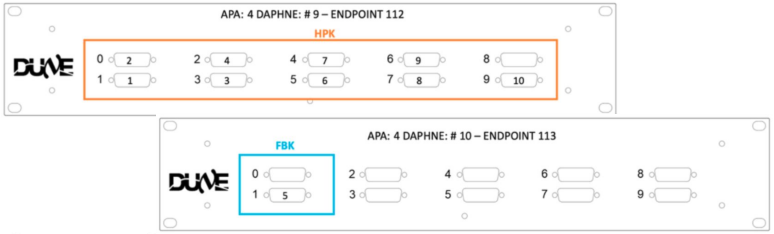
APA 4 - Runs 27562-27565



PRELIMINARY

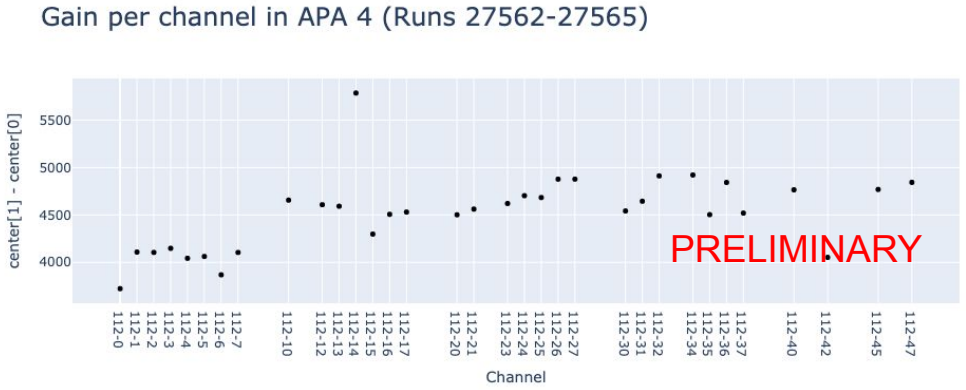
Thanks Julio!

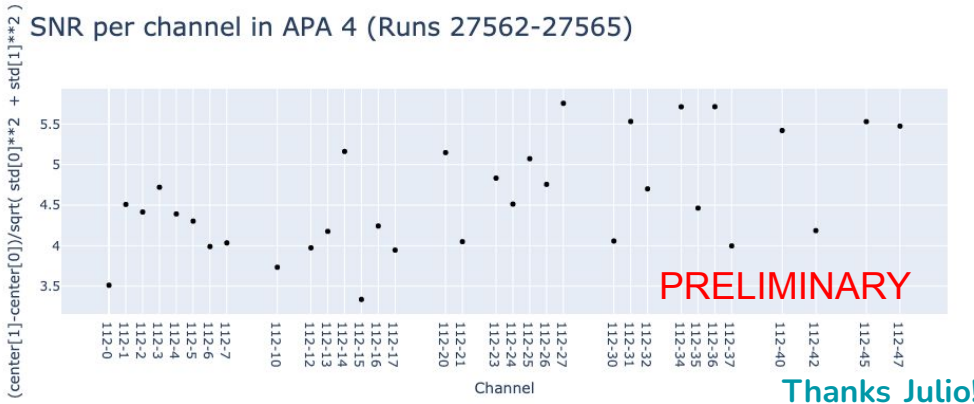
SPE Calibration: APA 4



Gain = $\mu_1 - \mu_0$

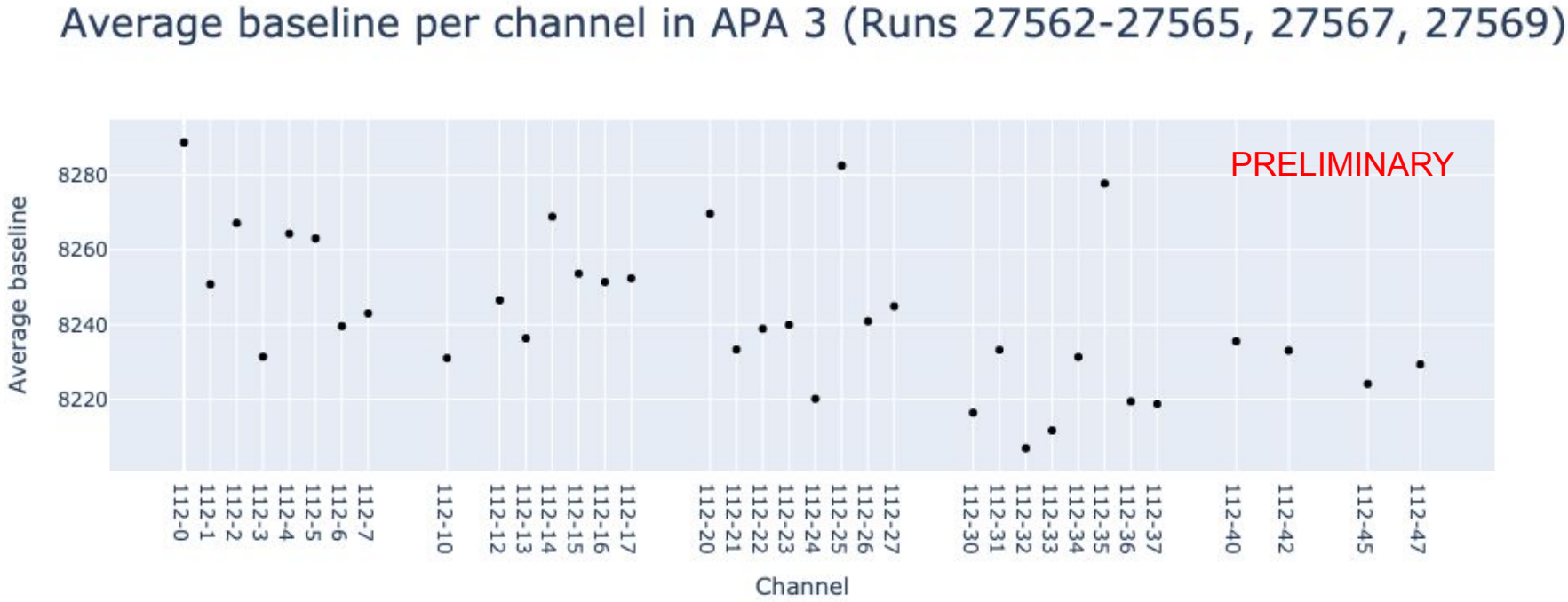
$$SN_C = \frac{\text{Gain}}{\sqrt{\sigma_0^2 + \sigma_{1st}^2}}$$





Thanks Julio!

SPE Calibration: APA 4



Thanks Julio!

SPE Calibration

The format of the entries for these tables is (channel_mask, pulse_bias_percent_270nm). Channels which have a 'N-' are noisy channels. Some of them include a guess of what light intensity would allow a calibration in case they were not noisy.

APA1			
Ongoing work			
APA3			
> (12, 2000)	> (12, 2000)	> (12, 2000)	(12, 2000)
(12, 1600)	(1, 2000)	(1, 2000)	N - (1, 2000)
(1, 2000)	(1, 1800)	(1, 1800)	(1, 1800)
(1, 1800)	(1, 1600)	(1, 1600)	(1, 1600)
(1, 1800)	(1, 1600)	(1, 1400)	(1, 1400)
(1, 1600)	(1, 1600)	(1, 1400)	(1, 1400)
(1, 1600)	(1, 1600)	N - (1, 1400)	(1, 1400)
(1, 1600)	(1, 1600)	(1, 1400)	(1, 1400)
(1, 1600)	(1, 1600)	(1, 1400)	(1, 1400)
(1, 1800)	(1, 1800)	(1, 1800)	(1, 1600)

APA2			
Ongoing work			
APA4			
(1, 2000)	(1, 2000)	(1, 2000)	(1, 2000)
(1, 2000)	(1, 2000)	(1, 2000)	(1, 2000)
(1, 1800)	(1, 1800)	(1, 2000)	(1, 2000)
(1, 1600)	(1, 1800)	(1, 1800)	(1, 2000)
N	N	N	N
(1, 1400)	(1, 1400)	N - (1, 1400)	(1, 1600)
(1, 1400)	(1, 1400)	(1, 1600)	(1, 1800)
(1, 1400)	(1, 1400)	(1, 1600)	(1, 1800)
(12, 1400) - (1, 1400)	N - (1, 1400)	(1, 1600)	(1, 1800)
(1, 1600)	(1, 1600)	(1, 1800)	(1, 1800)

Thanks Julio!

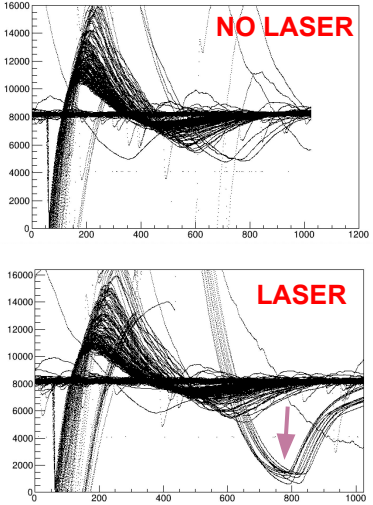
Laser tests

- There is a plan to use Ionization laser for PDS calibration purposes: i.e. light yield map
  - 1064 nm class4 laser with main harmonics at 532 and 266 nm.
    - 266 nm light is the one used to create an artificial ionization track
    - 1064 nm light is minimized with proper band pass filters.
    - 532 nm is kept with a dual band pass filter since a class three green laser is used for alignment purposes
- Yesterday the first tests were done (many thanks to David, Jose and Wallison)
  - Class4 laser at minimum intensity pulsed at 10 Hz
  - Class3 green laser to understand effect of 532 harmonic

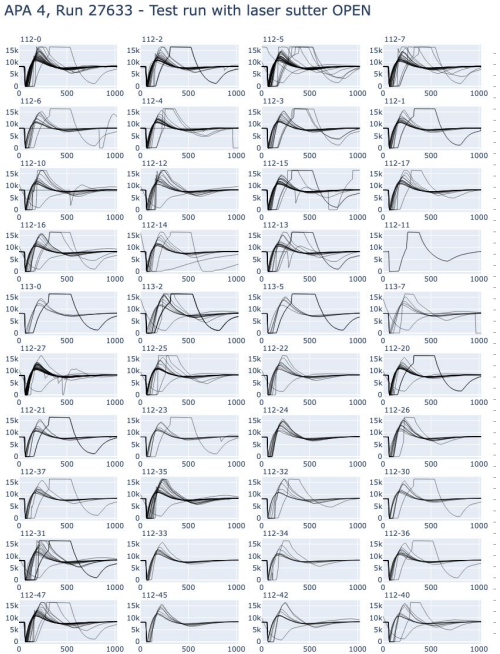
Thanks David!

Class 4 laser waveforms

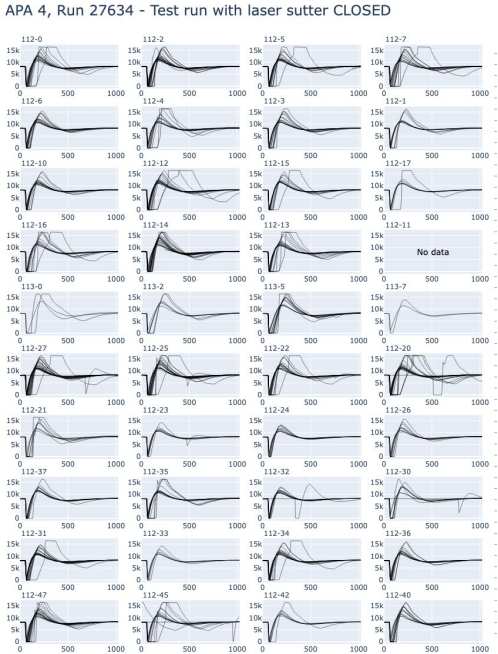
all channels



individual channels in APA4



LASER

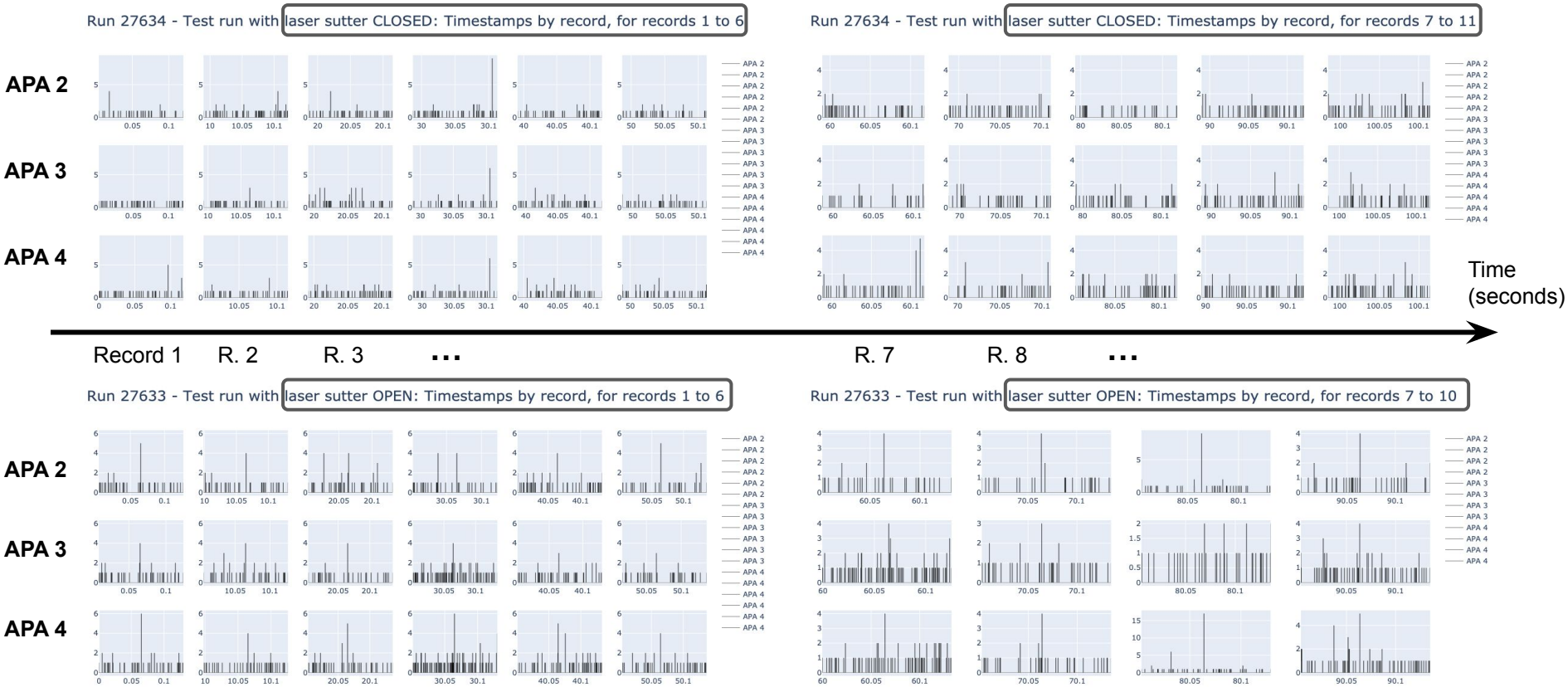


NO LASER

- Too much light even at minimum intensity
- This is expected to be due to scattering of the initial laser light, NOT scintillation light
  - Which harmonic is producing that PDS signal: 266 or 532 ? → Are we sensitive to 532 light → Test it with green laser

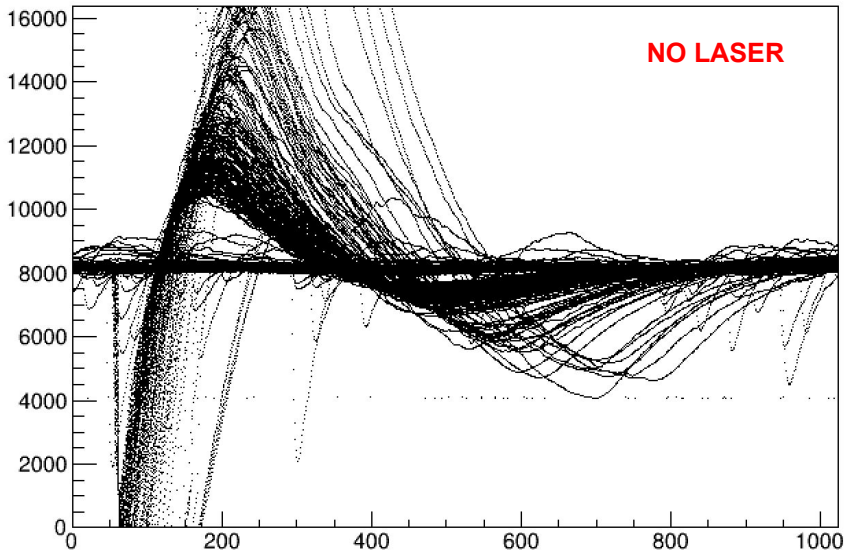
Thanks Julio!

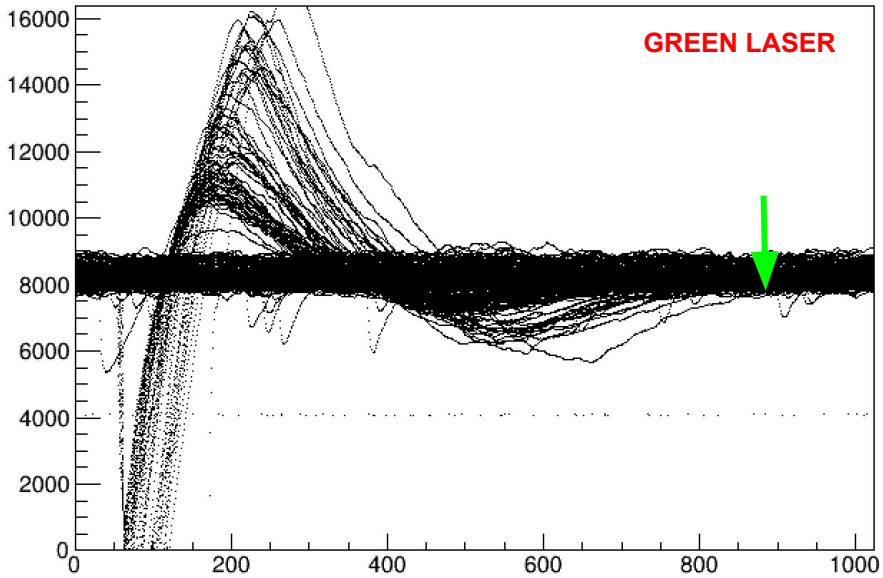
Class 4 laser coincidences



Thanks Julio!

Class 3 laser waveforms





- Continues (no pulsed) light with much lower intensity
- PDS sees that light
- Next step will be to filter out the green light with the proper band pass filter
- Not obvious we can use IoL for the PDS but will keep trying !!!!!

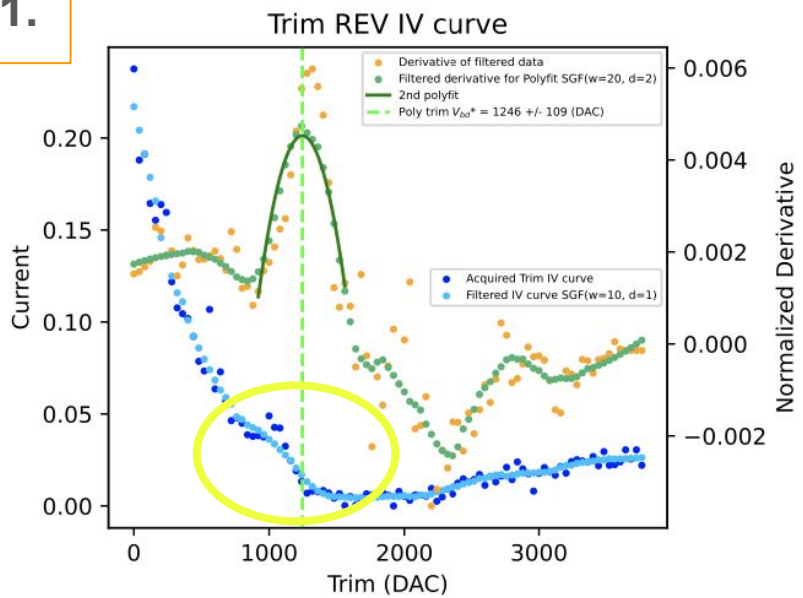
Thanks David!

IV Status

Last data from Jul-02-2024

We noticed some strange behaviour in many channels :

1.



ENDPOINT:105 APA:1 AFE:0 Config_CH:0 DAQ_CH:0 SiPM:FBK

Bump in the region where we're searching for Vbd

↓

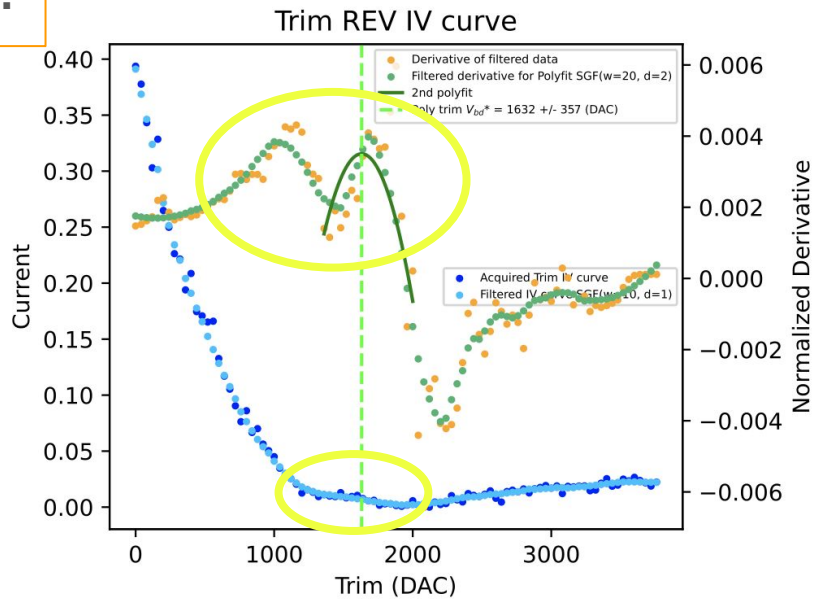
Impossible to find the right Vbd

IV Status

Last data from Jul-02-2024

We noticed two strange behaviour in many channels :

2.



ENDPOINT:111 APA:3 AFE:4 Config_CH:33 DAQ_CH:41 SiPM:HPK

Double peak!

↓

The algorithm selects the second peak by looking at the maximum of the derivative (green) and computes Vbd, but it is wrong (underestimated)

↓

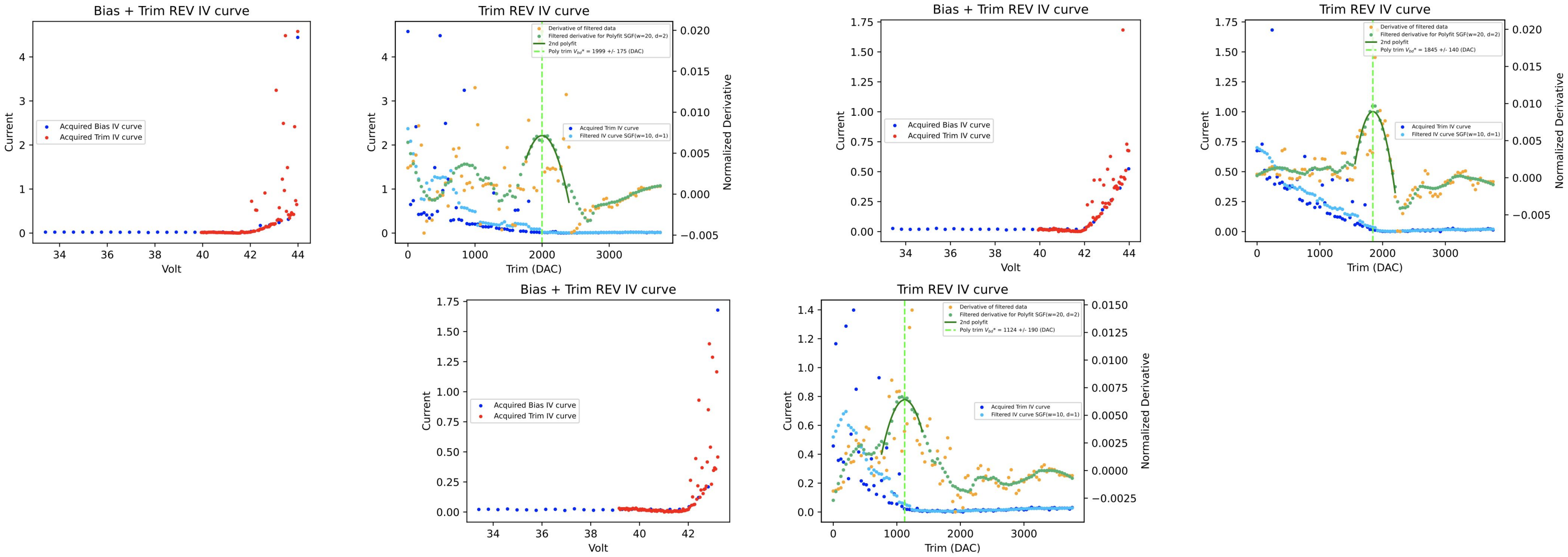
This can be solved adding a condition, by looking at the IV curve slope (*do you have other idea?*)

IV Status

Last data from Jul-02-2024

We noticed some strange behaviour in many channels :

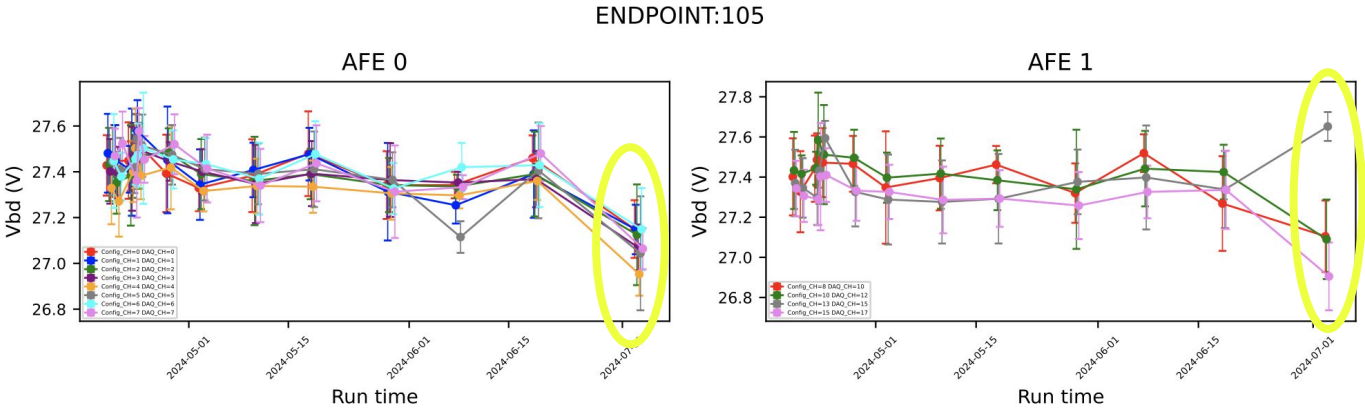
3. Extremely noisy IV curve → Vbd can't be determined



IV Status

This results in un under/over estimation of the breakdown!!

For example:



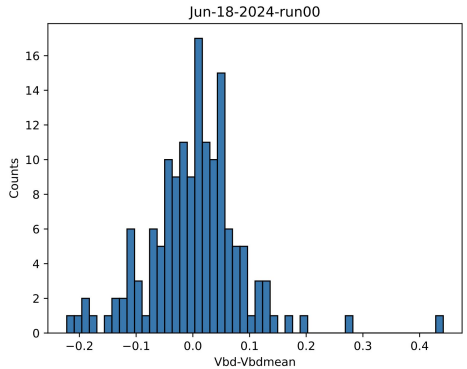
It is extremely important to check IV plots and compare results of different runs, to establish if a run is good or not!

IV Status

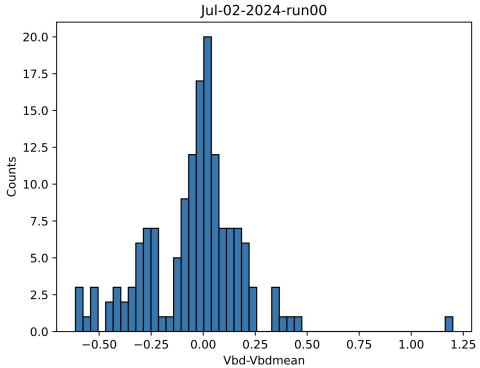
To help to do this, I created a new script **Vbd_quality.py**.
It compares Vbd of a given run with the previous good runs results and it returns a list of comments about the data. For example :

- if a channel is always NaN
- if a channel was always NaN but now has a value and viceversa
- if a channel sometimes was NaN
- if the absolute difference between the current Vbd value and the mean value of previous runs is larger than a certain threshold (for example 250mV)

It also creates an histogram of the difference between Vbd and the mean value!



Good run → small spread



Bad run → huge spread

IV Status

Next steps:

- Vbd comparison with CACTUS data *(Alessandro is working on it ?)*
- Define when change Vop configuration
- (Maybe) create a map with Vop taking into account Vbd mean value (of good runs), since Vbd is fluctuation by some hundreds of mV

Plans until next wednesday

- Next wednesday beam is resumed
- Few details in the firmware to be debugged:
  - Counters for daq statistics were added (Carlos) and there are problems in some of them. New version being tested NOW (Marco Roda)
  - Those counters will be used to understand why we have half bandwidth in self trigger APAs
- Need to take again the APA1 and APA2 calibration runs (tomorrow)
- Apart of this, focus on the analysis:
  - Look at previous beam data (although very inhomogeneous gain)
  - Gain calibrations
  - Redo tau slow analysis with newer runs
  - Start with Bi source analysis

BACKUP

Duplications

Duplication problem solved by DAQ team in the new environment release (we do not see more repeated waveforms from ~10 June)