Single Photo-Electron characterization and noisy channels

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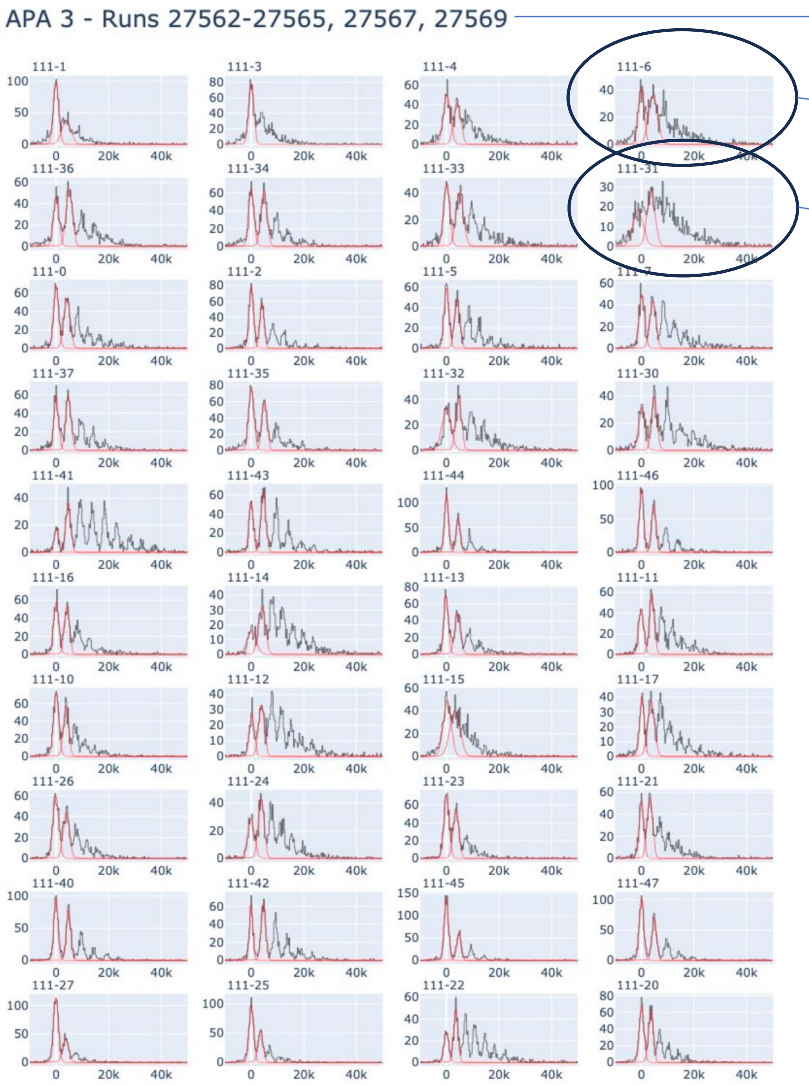
Calibration process

Plotting the charge histogram with Waffles



Multiple runs with different LED intensisies and “masks” to ensure (at least) a good dataset to calibrate

Compute the SNR by fitting the charge histogram

In case of poor SNR we proceeded with further investigations… Do we have a small signal or a large noise?

- Check whether the channel shows some IV problems
- Try to apply a matched filter to resolve the peaks
- Look at the noise FFT

If the IV isn’t reliable and we can perform a Gain vs Overvoltage linear regression, we use this method to estimate the V breakdown

We bias the SiPMs to ensure the that the PDE is as uniform as possible among all the channels

This implies non-uniformities in terms of gain and spe amplitude (especially when comparing FBK and HPK) → We can mitigate this by tuning DAPHNE’s gain

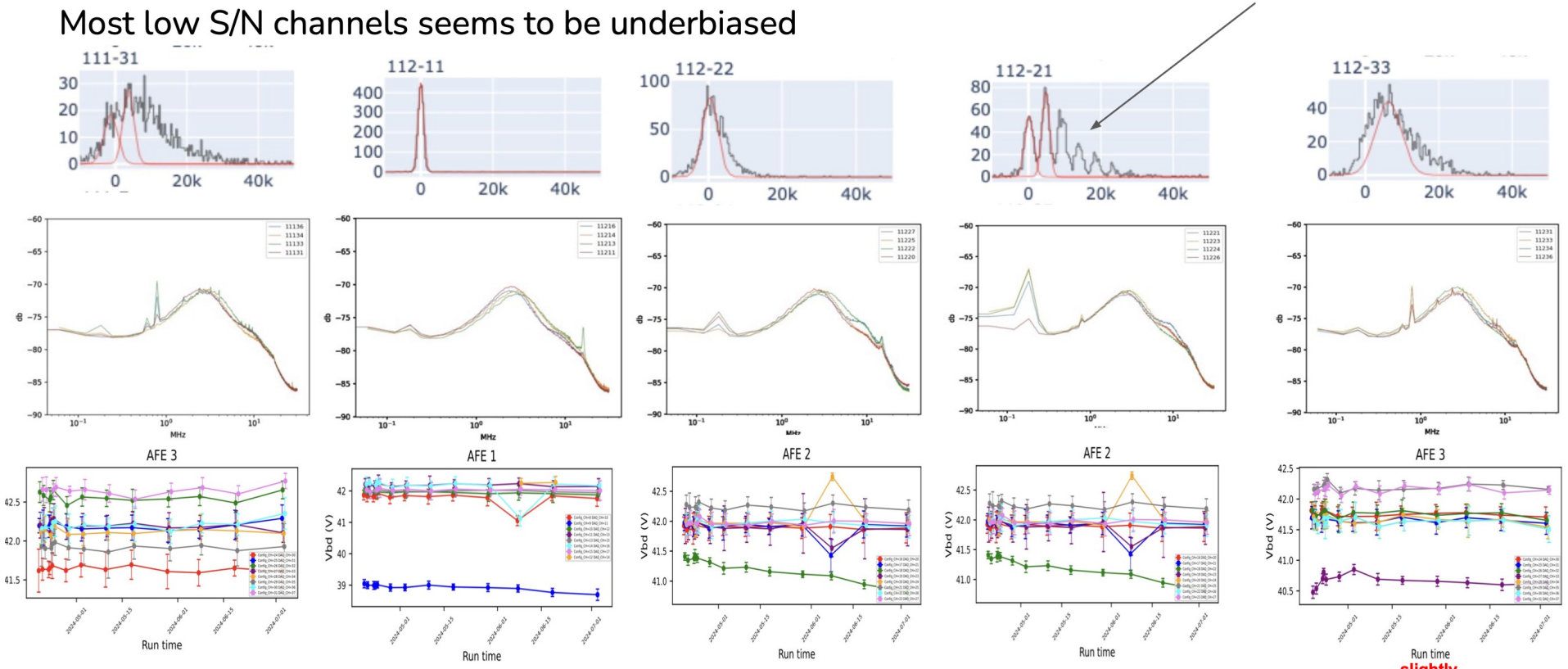
Already presented…

Slide from https://indico.fnal.gov/event/65655/

“Noisy” channels

Electronic noise OK in most channels, except 112-21/23/24/26 at 170 KHz, but does not affect S/N

Most low S/N channels seems to be underbiased

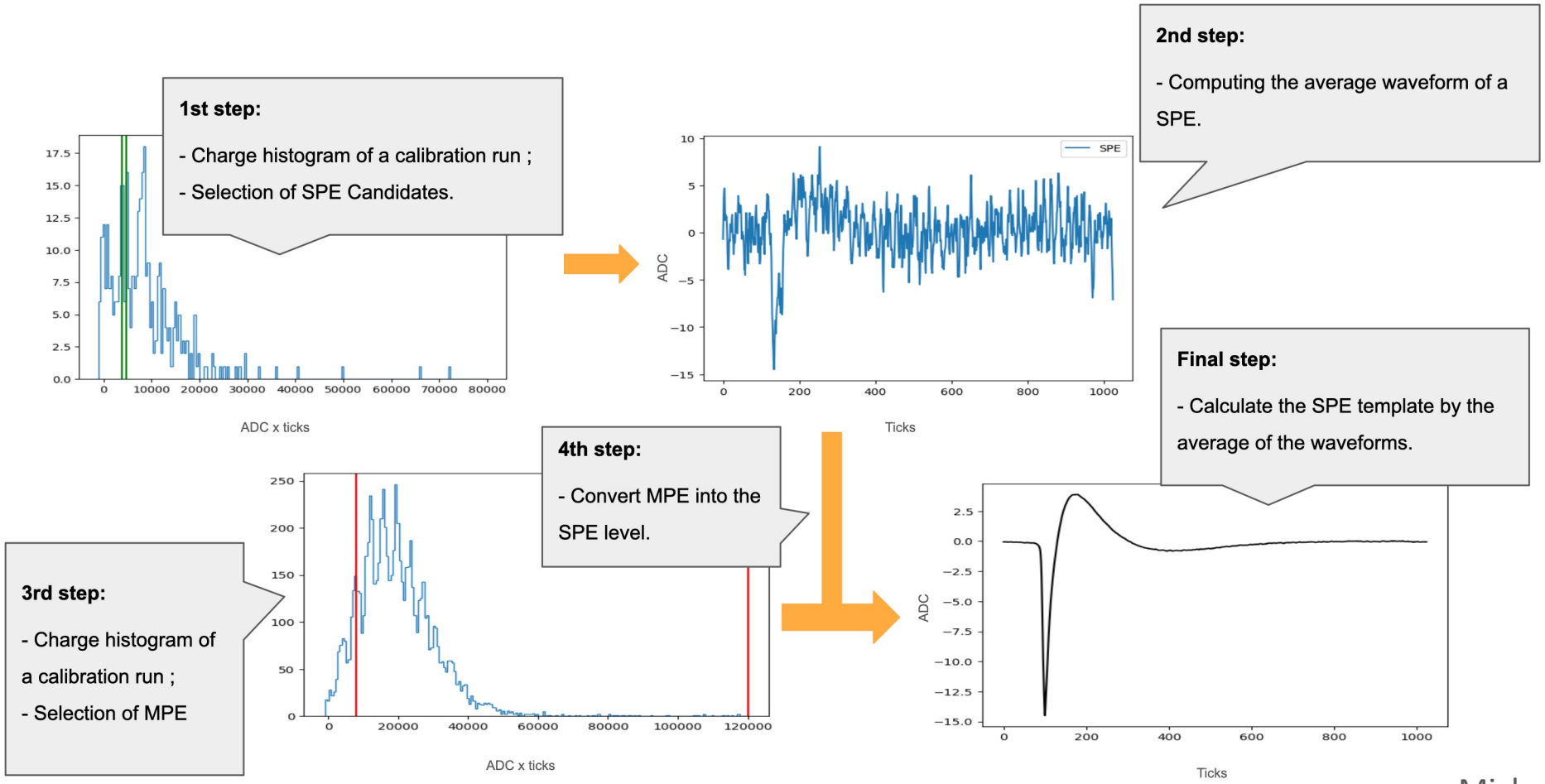


Thanks Federico!

SPE templates

How we build them

Spreadsheet with finished templates:
https://docs.google.com/spreadsheets/d/1ISNXYPVNRvq4KcvvaymYkQCSiIx2SwSuHoQa8itAeds/edit?gid=0#gid=0



Michaela and Renan

The mask problem

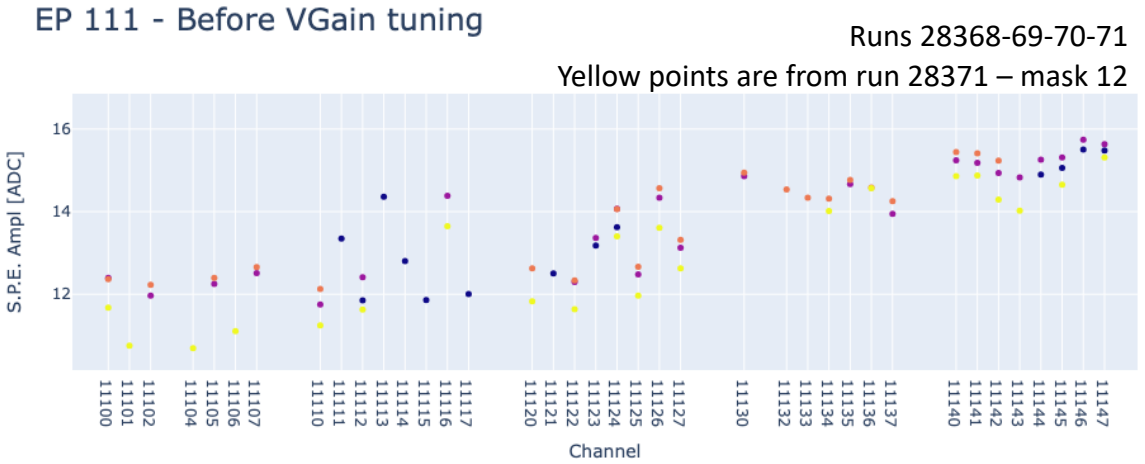
How masks can affect the spe characterisation

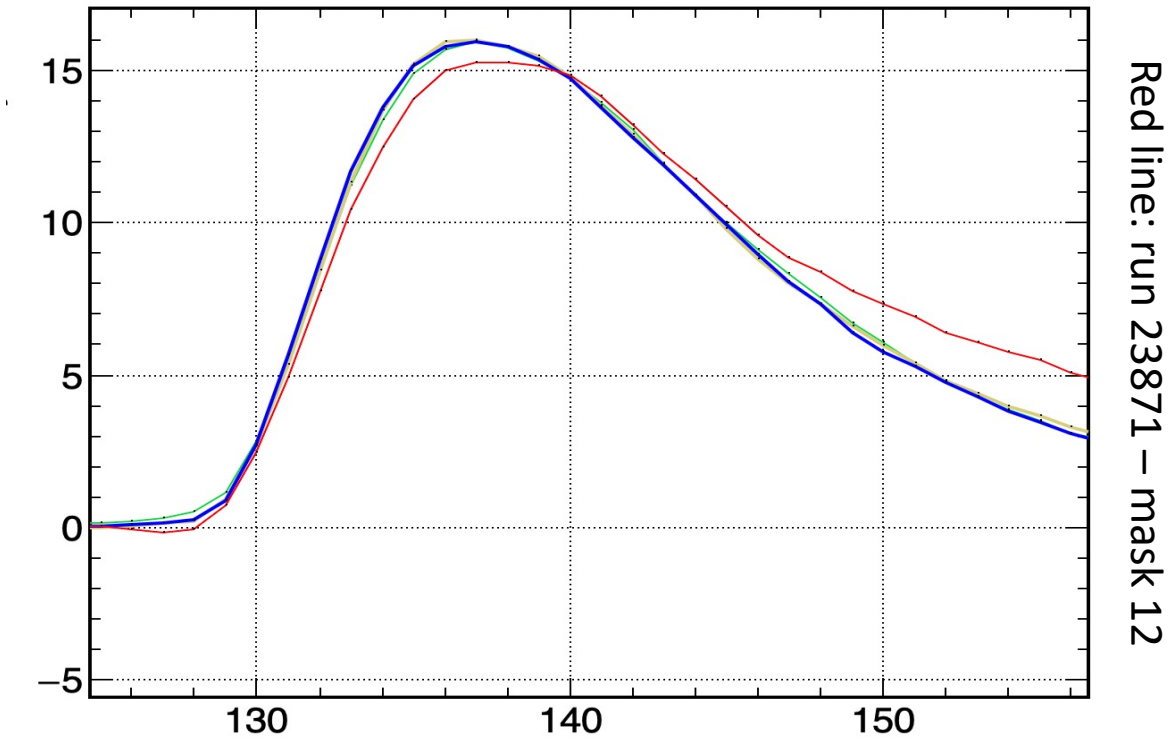
We sistematically observed lower and broader average-SPE candidates when using mask 12

Apparently, this configuration give a larger spread in time

This affects the dynamic range estimation and could and the spe templates

+ Dynamic range: since we are operating DAPHNE with ”integrators on” the baseline is about 8’000 ADC (out of ~16’000); so we estimate the DR as 8’000/spe amplitude



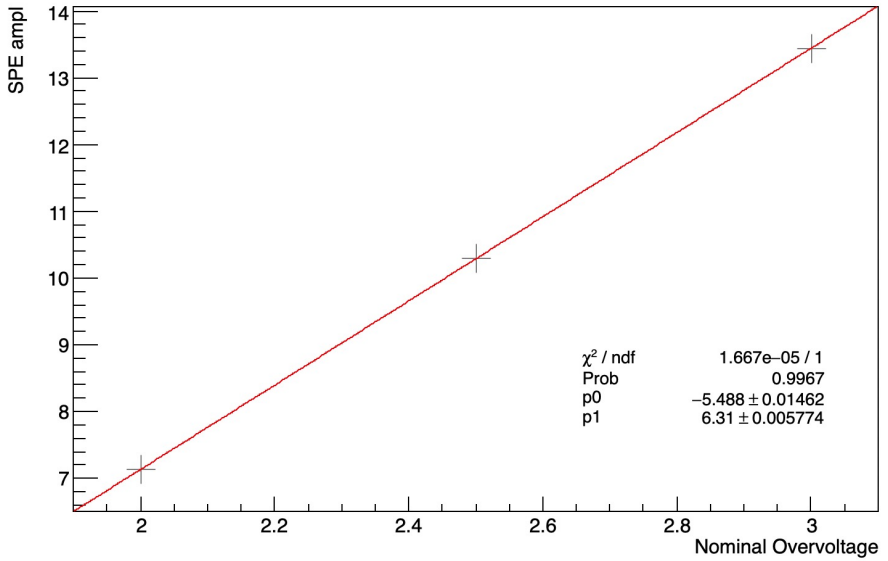


Matched filter

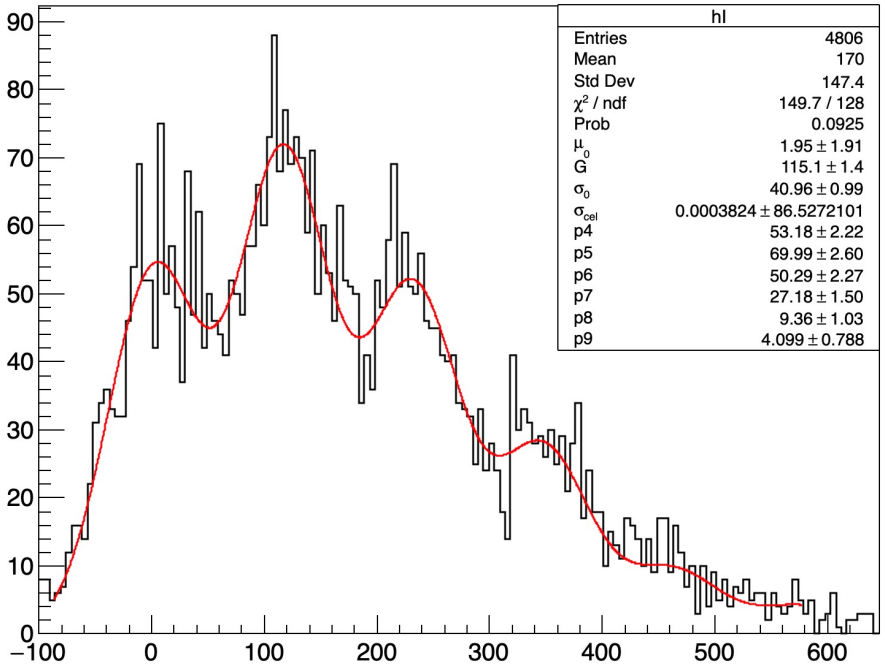
Our best ally for poor SNR

We used the matched filter for the channels showing poor SNRs in the Overvoltage scan in order to improve the spe candidates selection and build more reliable Gain (or spe ampl.) vs Overvoltage plots

Example: run 27918 – channel 112-22

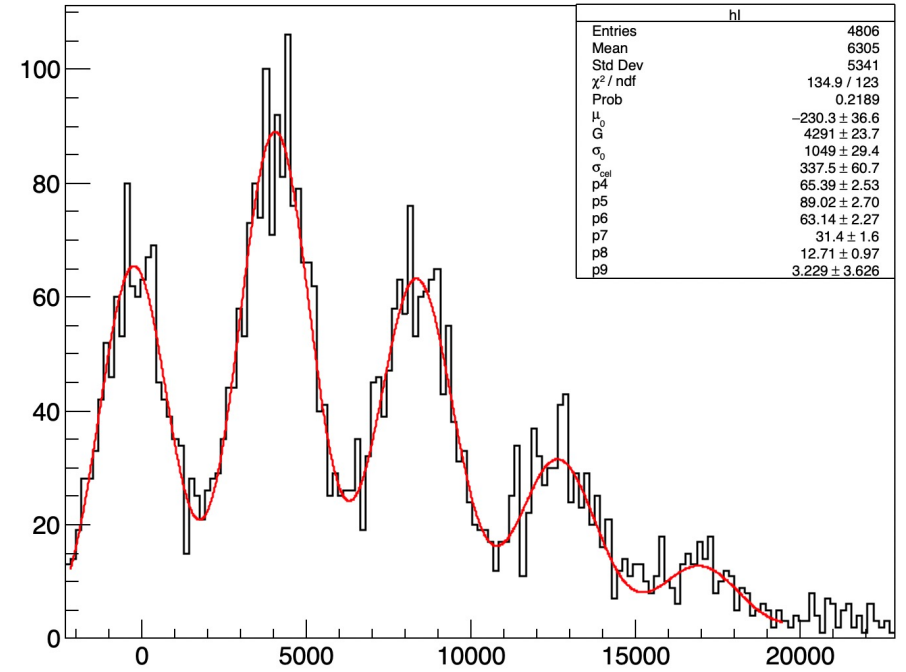


SNR 2.8



Matched filter:
Auto-correlation of the wavwforms with the spe template

SNR 4.1



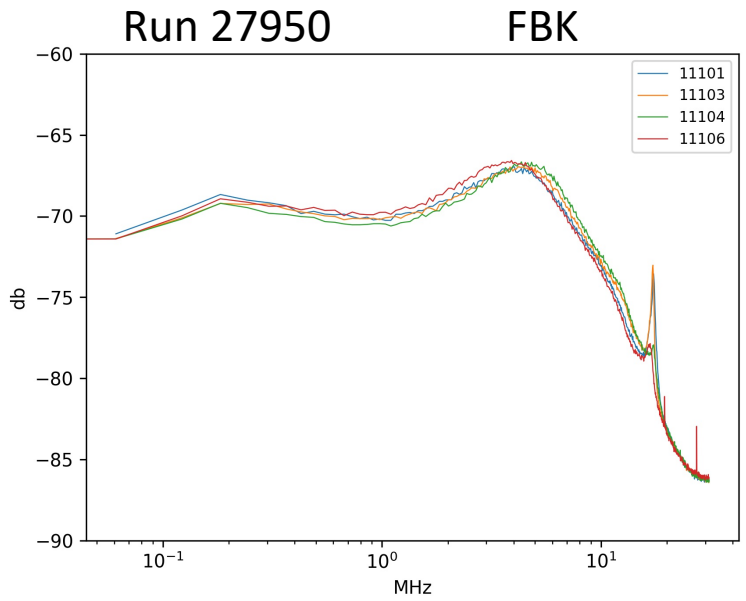
Noise

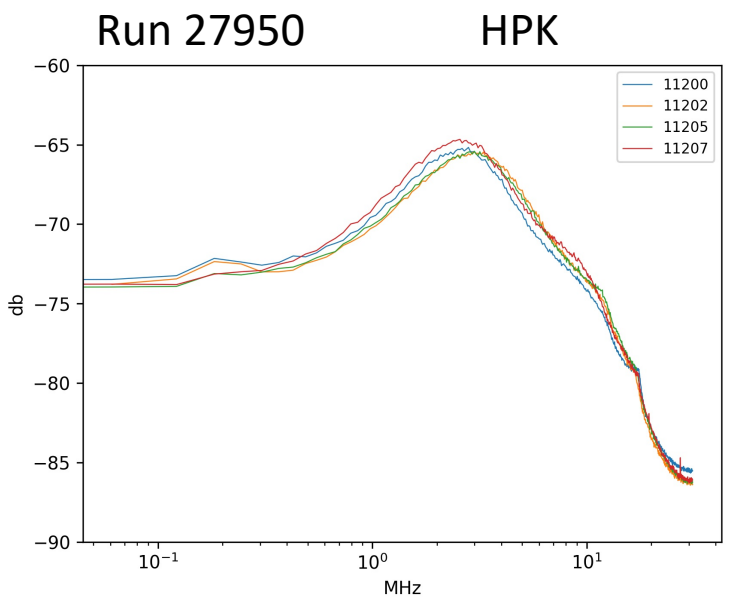
FFT from dedicated runs

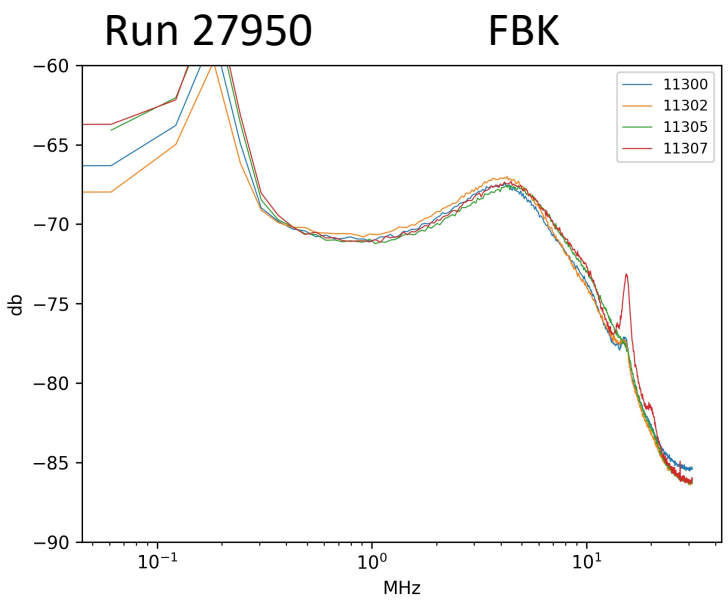
Noise studies consists in plotting the FFTs of data acquired with SiPM's bias slighlty below the breakdown

We appreciate a difference in shape between FBK and HPK channels (probably due to the different capacitance)

Many channels present spikes around 180 kHz and 14 MHz. Channels of endpoint 113 (FBK – APA4) are the most noisy at low frequencies. (All the plots on indico)





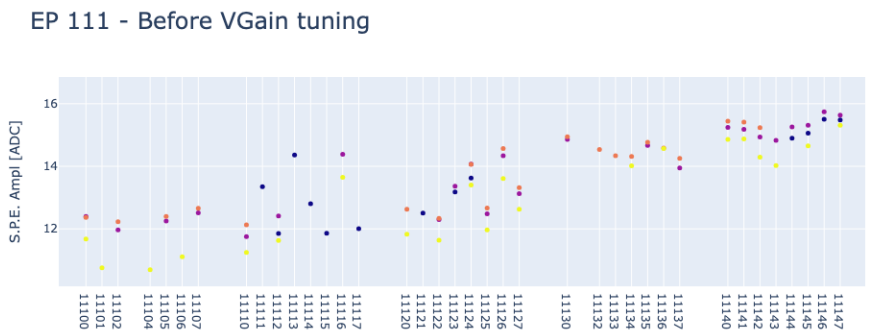


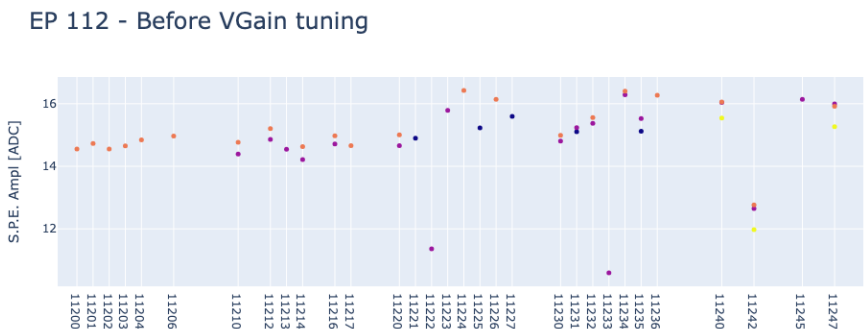
Vgain tuning

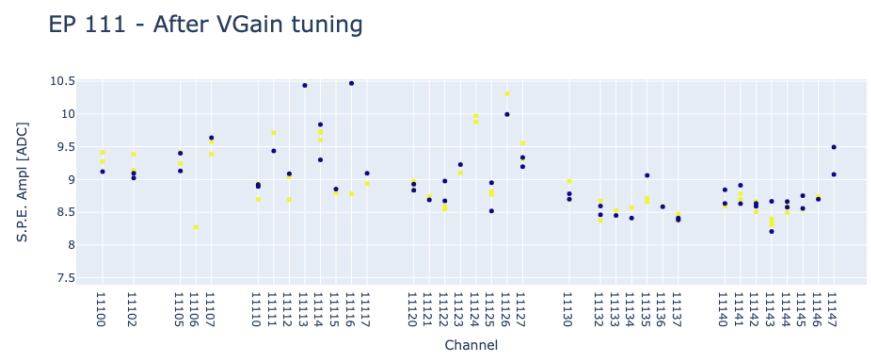
Attempt to equalize the spe amplitudes

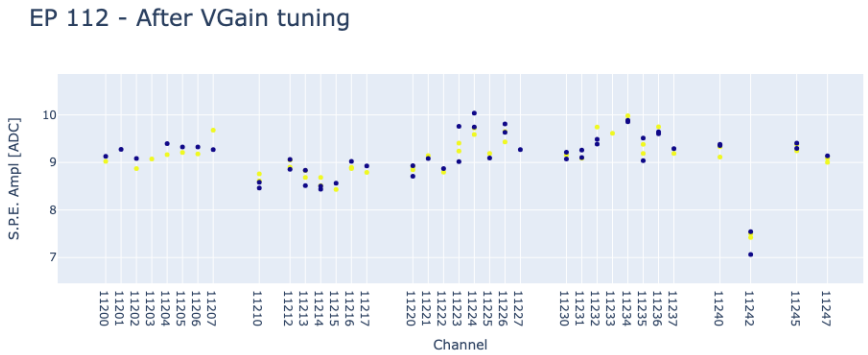
DAPHNE's AFEs have two amplification stages and an attenuator → We can tune the attenuation level AFE by AFE (2 PD modules – 8 channels). Note that this changes both the signal and the noise levels!

We tuned the attenuation level in order to have spe 10 ADC. Unfortunately, for a typo, I overestimated the attenuation to set and we obtained spe aroun 9 ADC (which might be a good piece of news because this gives a larger dynamic range)









Note that the changes in V_bd for ch. 112-22 and 112-33 alligned them to the others ☺

Blue: 28622-23-24 (13 July)
Yellow: 28991-92-93 (28 Aug)

Conclusions

…and todos

- We have the tools to build the spe templates and tune daphne's gain
- We have enough calibration and noise runs
- Most of the poor SNRs were due to low overvoltages
- …

- Study the noise with different attenuation levels
- Try to switch off the integrators and maximize the dynamic range (after the beam?)
- Decide how to deal with the «mask problem»
- …