Comparison of moving average and exponential moving average filters on LNGS SiPM output

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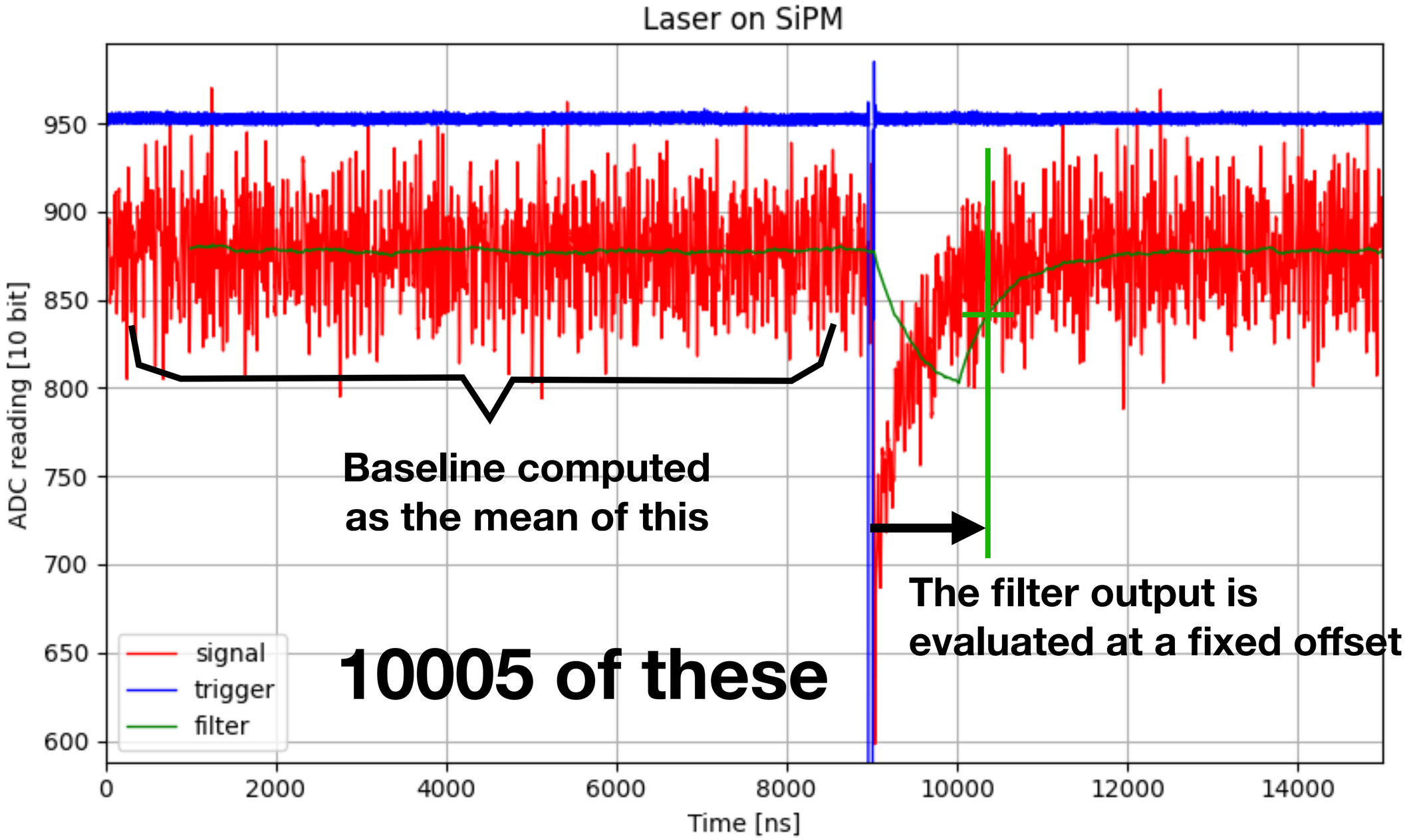
Summary

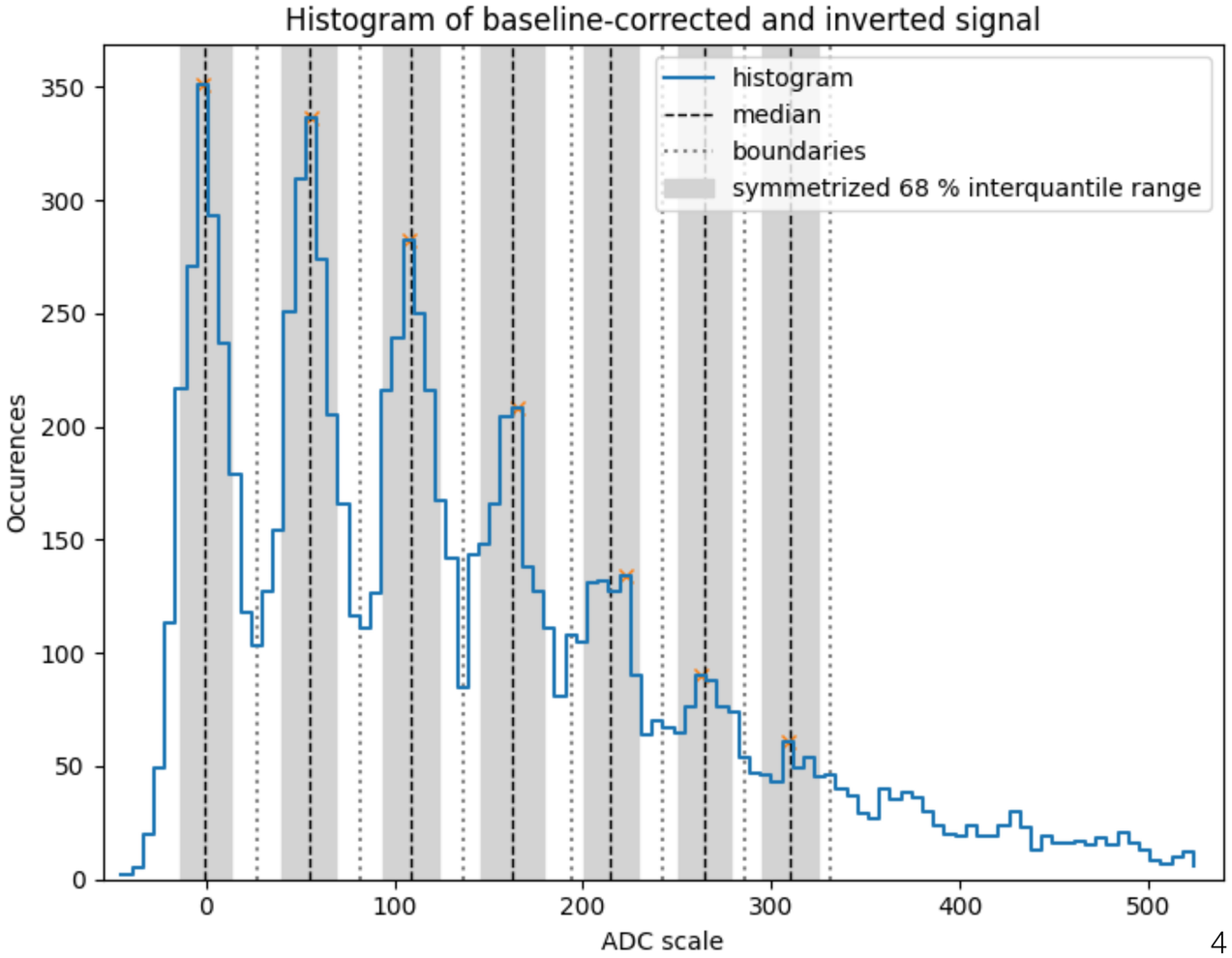
- Filter LNGS laser data in liquid nitrogen with moving average and exponential moving average
- Subtract per-signal baseline
- Compute the SNR (position of 1 photoelectron peak over width of 0 photoelectrons peak)
- See how the SNR changes varying the filter parameters
- Check how the precision of the baseline estimation affects the SNR
- Comparison of noise spectra from LNGS and Proto0

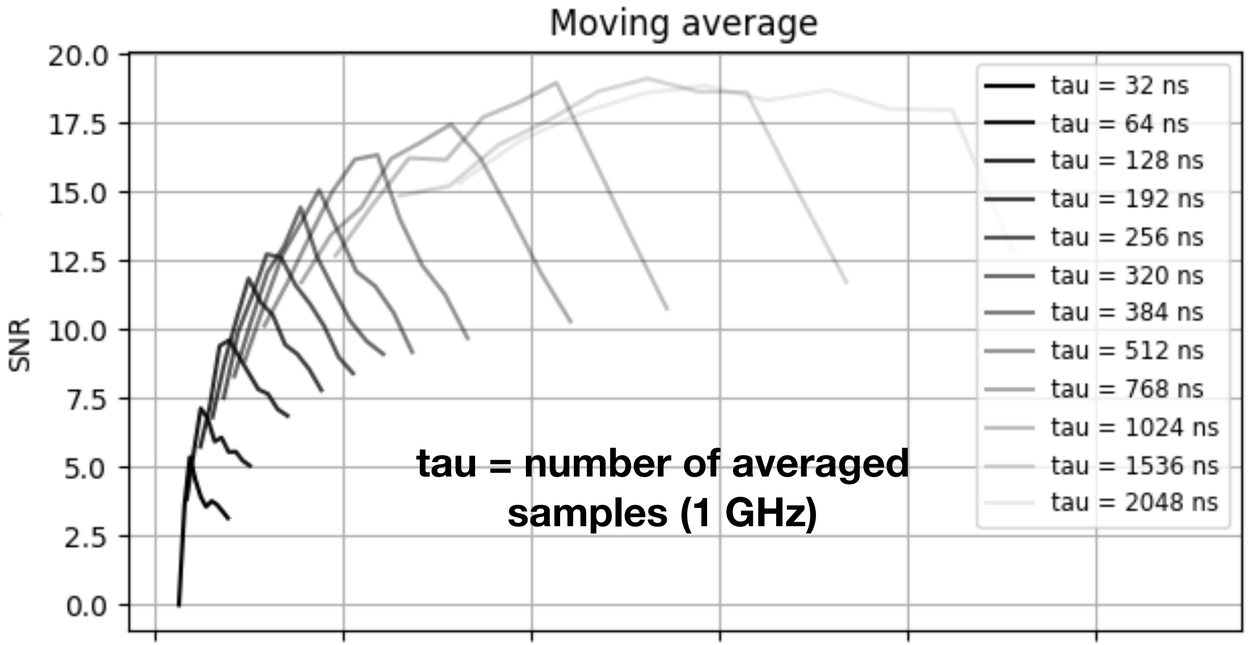
Code: https://bitbucket.org/Gattocrucco/sipmfilter/src/master/
Data: http://ds50tb.lngs.infn.it:2180/SiPM/Tiles/FBK/NUV/MB2-LF-3x/NUV-LF_3x_57/nuvhd_lf_3x_tile57_77K_64V_6VoV_1.wav

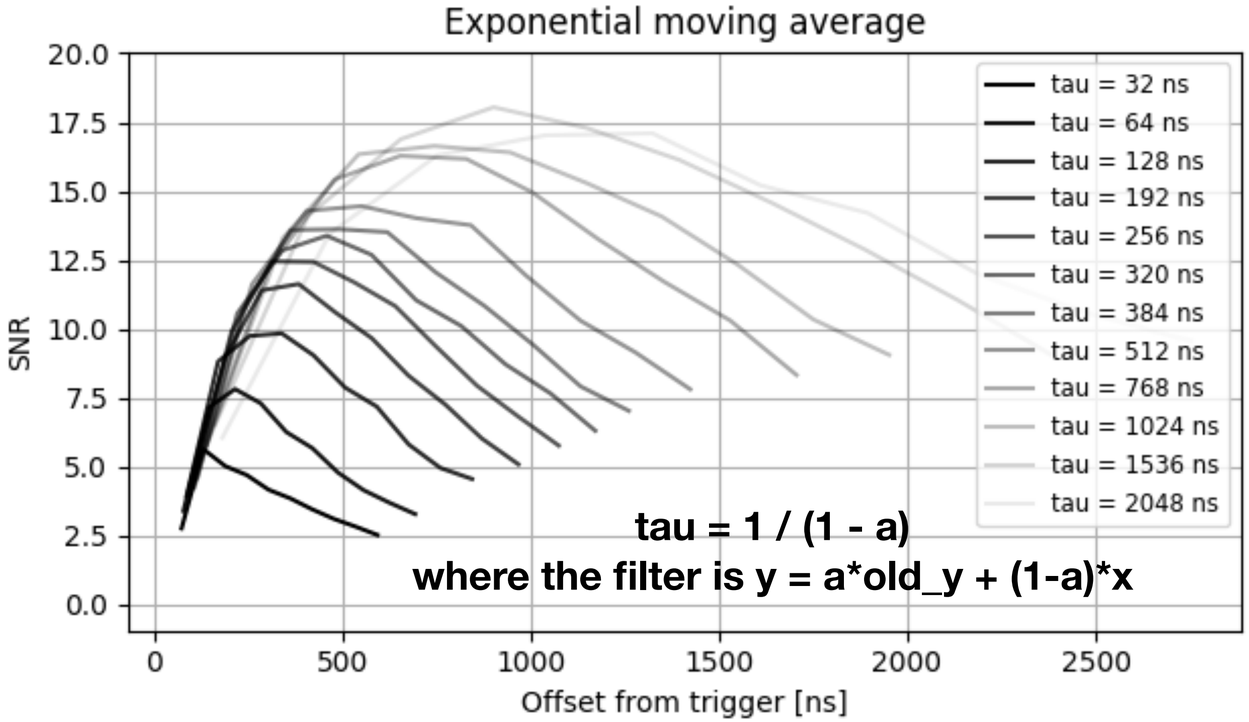


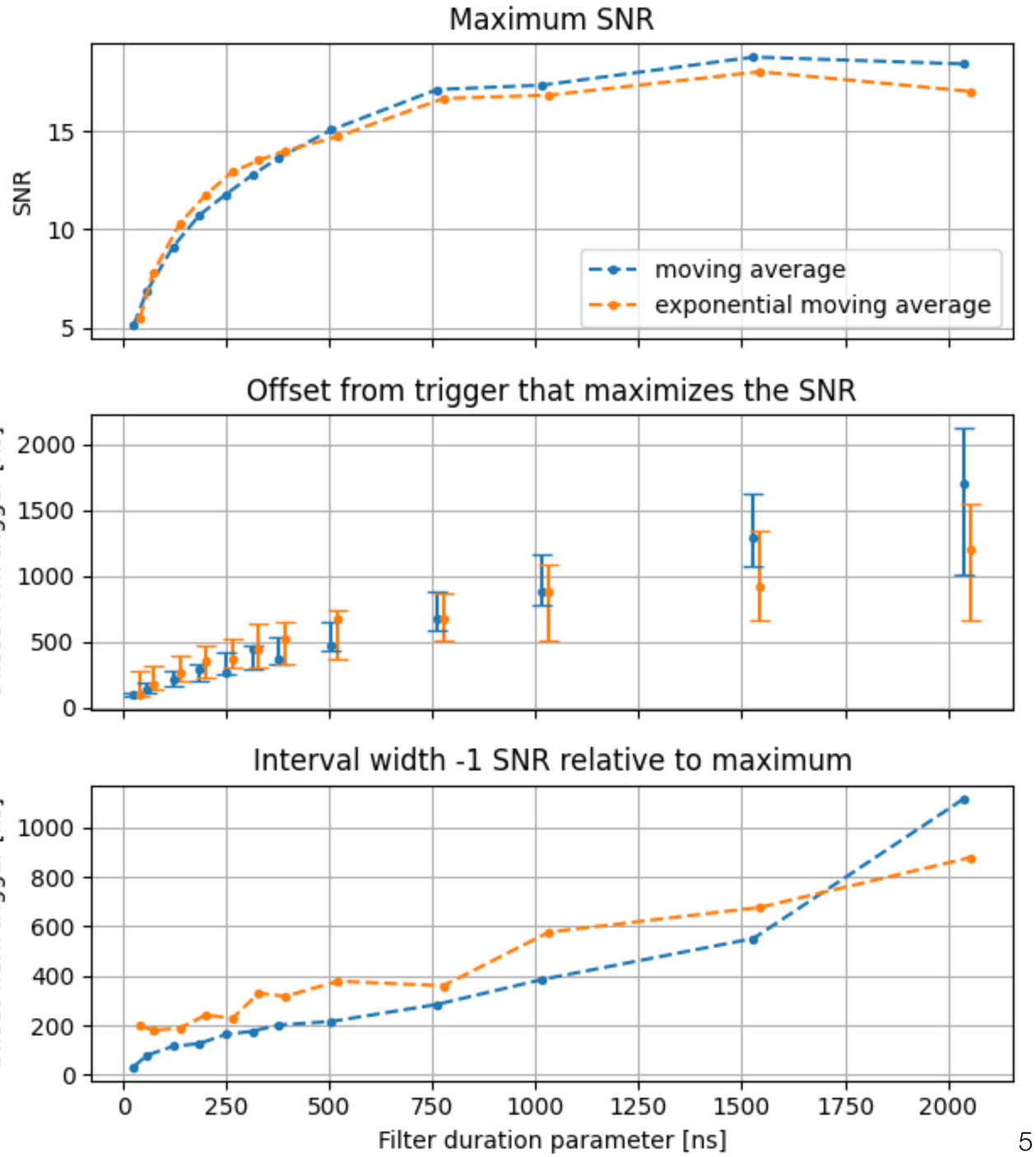
There were 72/10005 cases with a spurious signal, they were removed.

We find the peaks in the distribution of the collected filter outputs and compute the **signal-to-noise ratio as the median of the second peak** (1 photoelectron) **over the half centered 68 % interquantile range of the first peak** (no photoelectrons).
The example below is a 32 ns moving average.



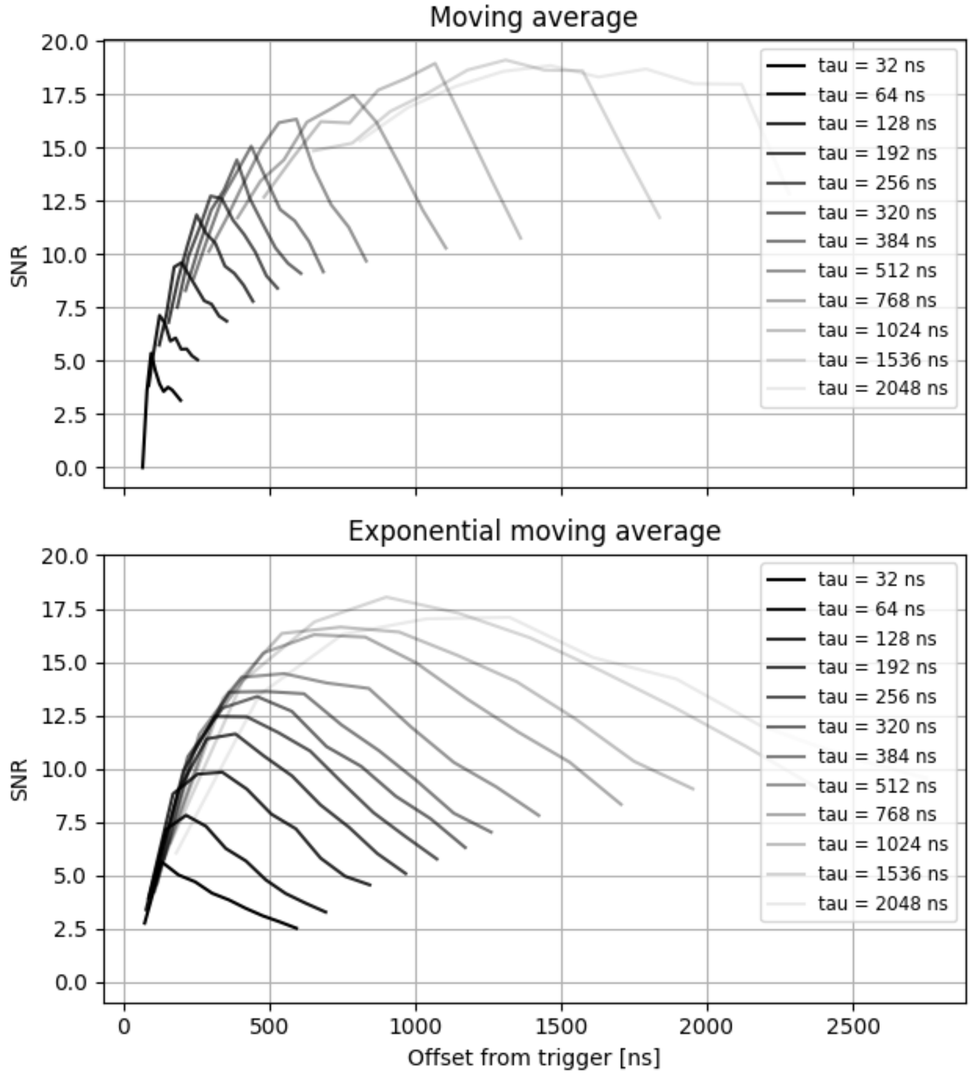




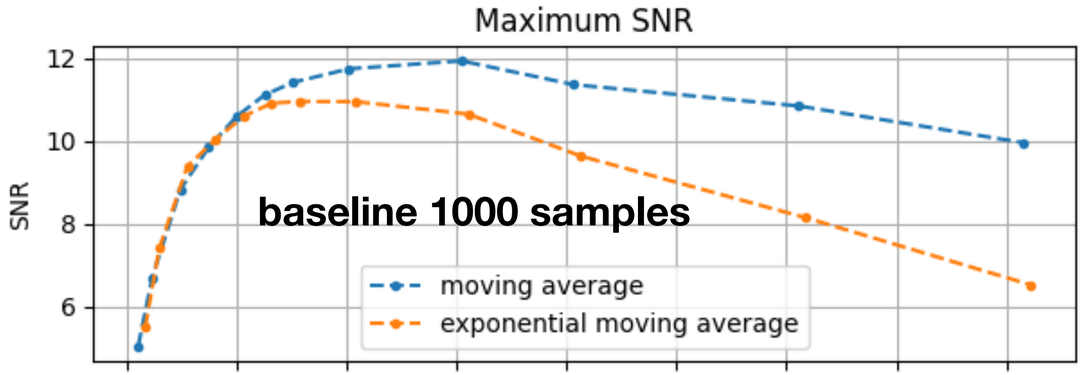


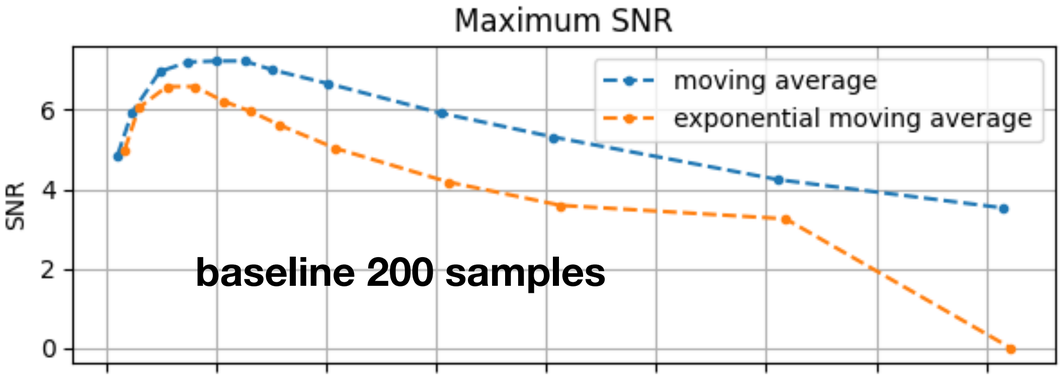
The plot on the left is a summary of the plot below, showing the height and width of maxima of SNR(offset), as a function of tau.

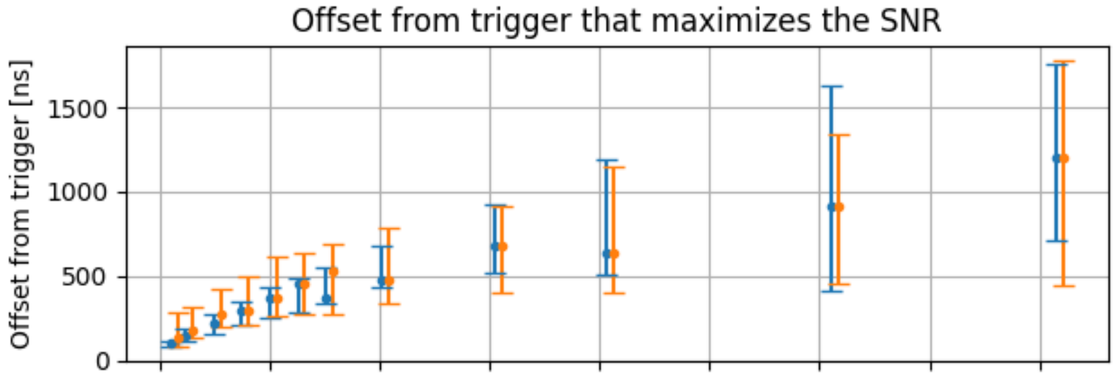
The width is related (guess) to the time localization resolution of the signals.

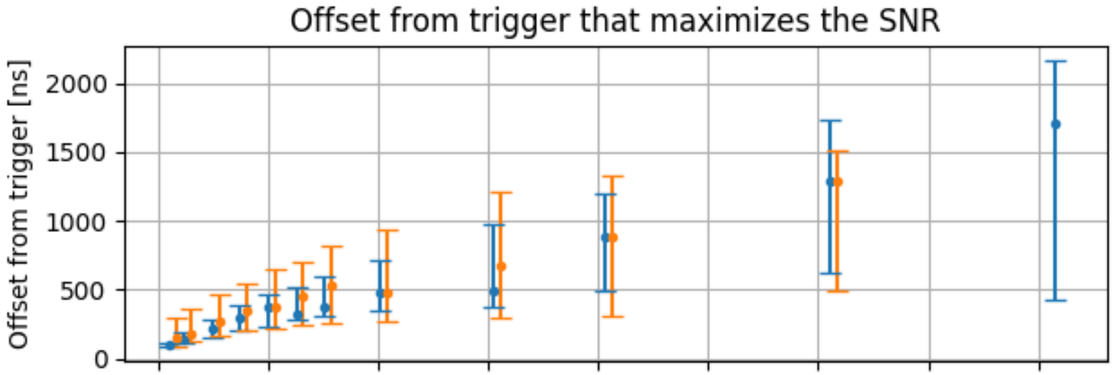


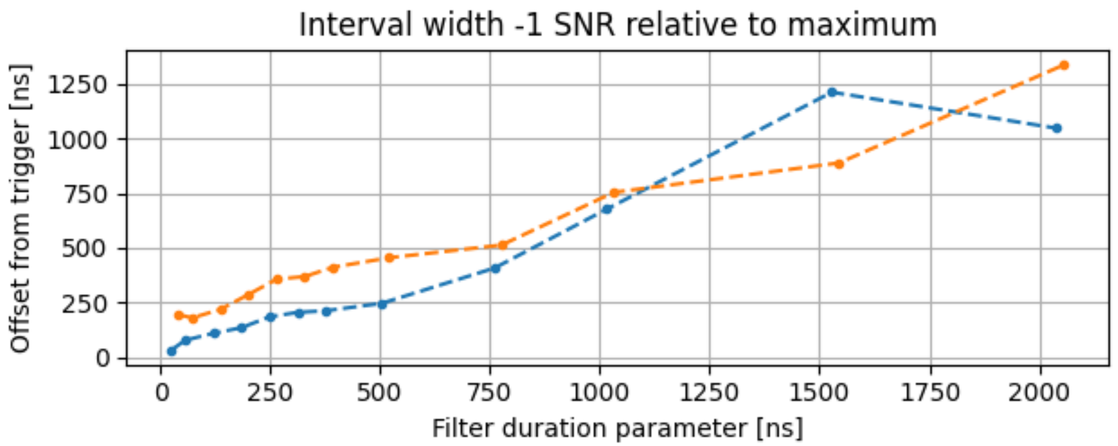
The baseline was computed with 8000 samples, now we try 1000 and 200. The maximum SNR was about 18.5 with 8000.

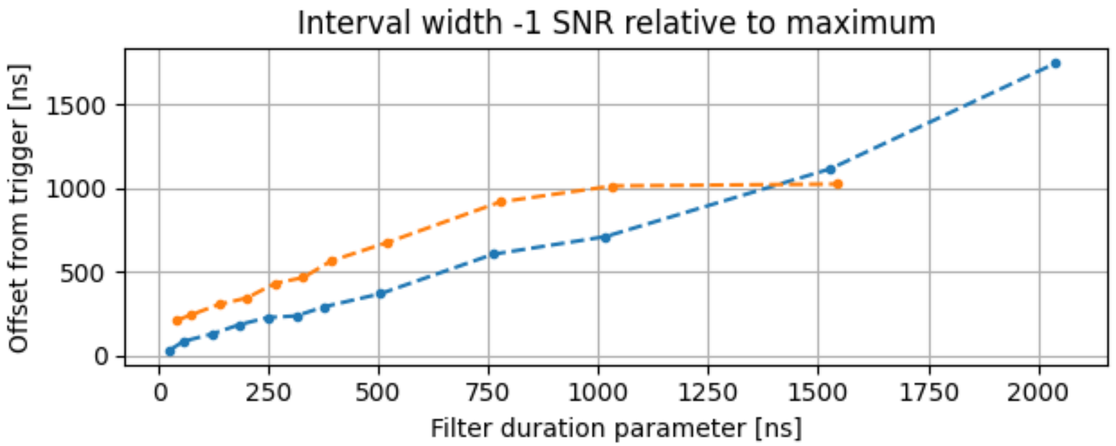


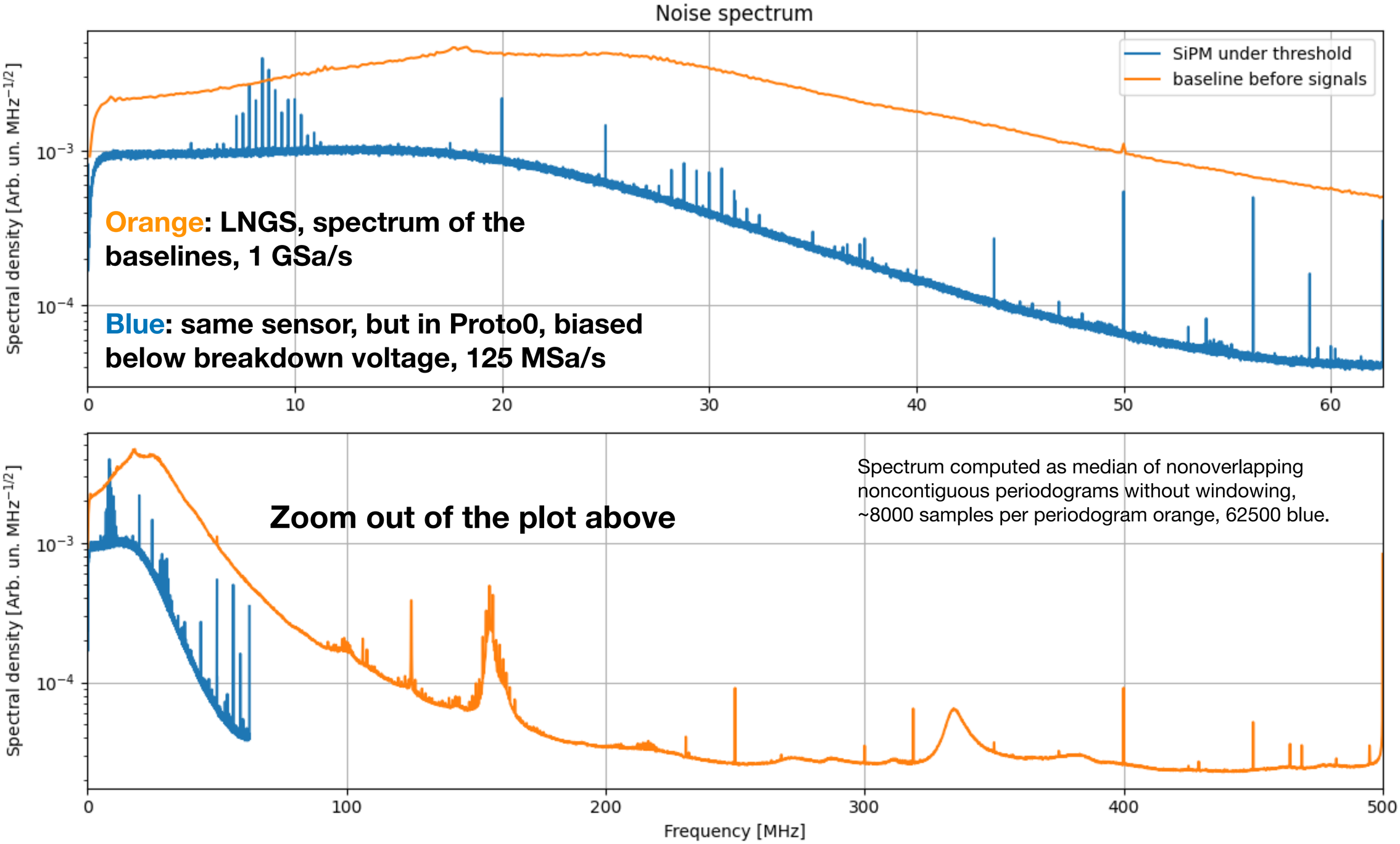











Noise spectrum
SiPM under threshold
baseline before signals
Spectral density [Arb. un. MHz$^{-1/2}$]
10^{-3}
10^{-4}
0
10
20
30
40
50
60
Orange: LNGS, spectrum of the baselines, 1 GSa/s
Blue: same sensor, but in Proto0, biased below breakdown voltage, 125 MSa/s
Zoom out of the plot above
Spectrum computed as median of nonoverlapping noncontiguous periodograms without windowing, ~8000 samples per periodogram orange, 62500 blue.
100
200
300
400
500
Frequency [MHz]