

Effect of window length on temporal localization

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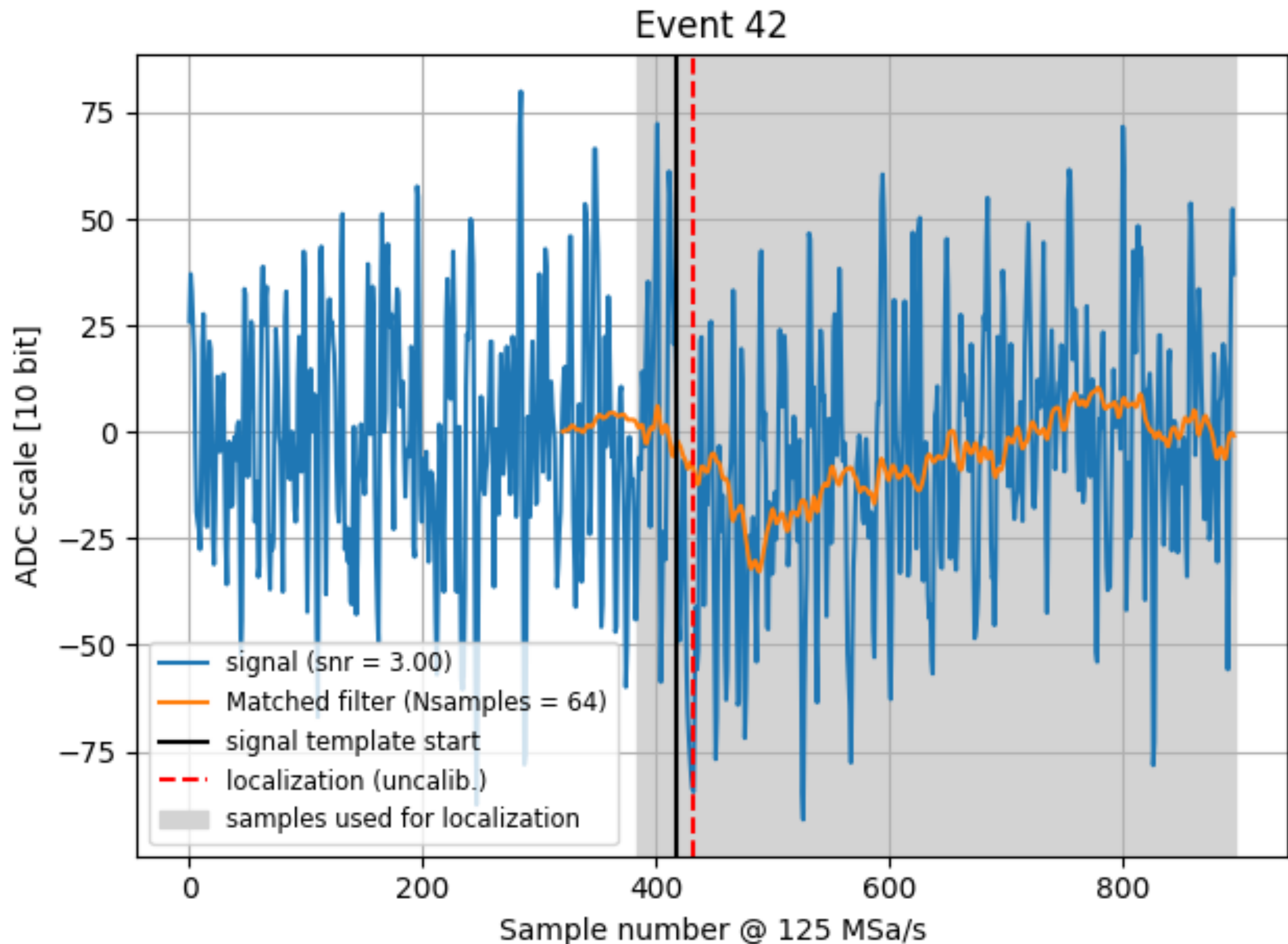
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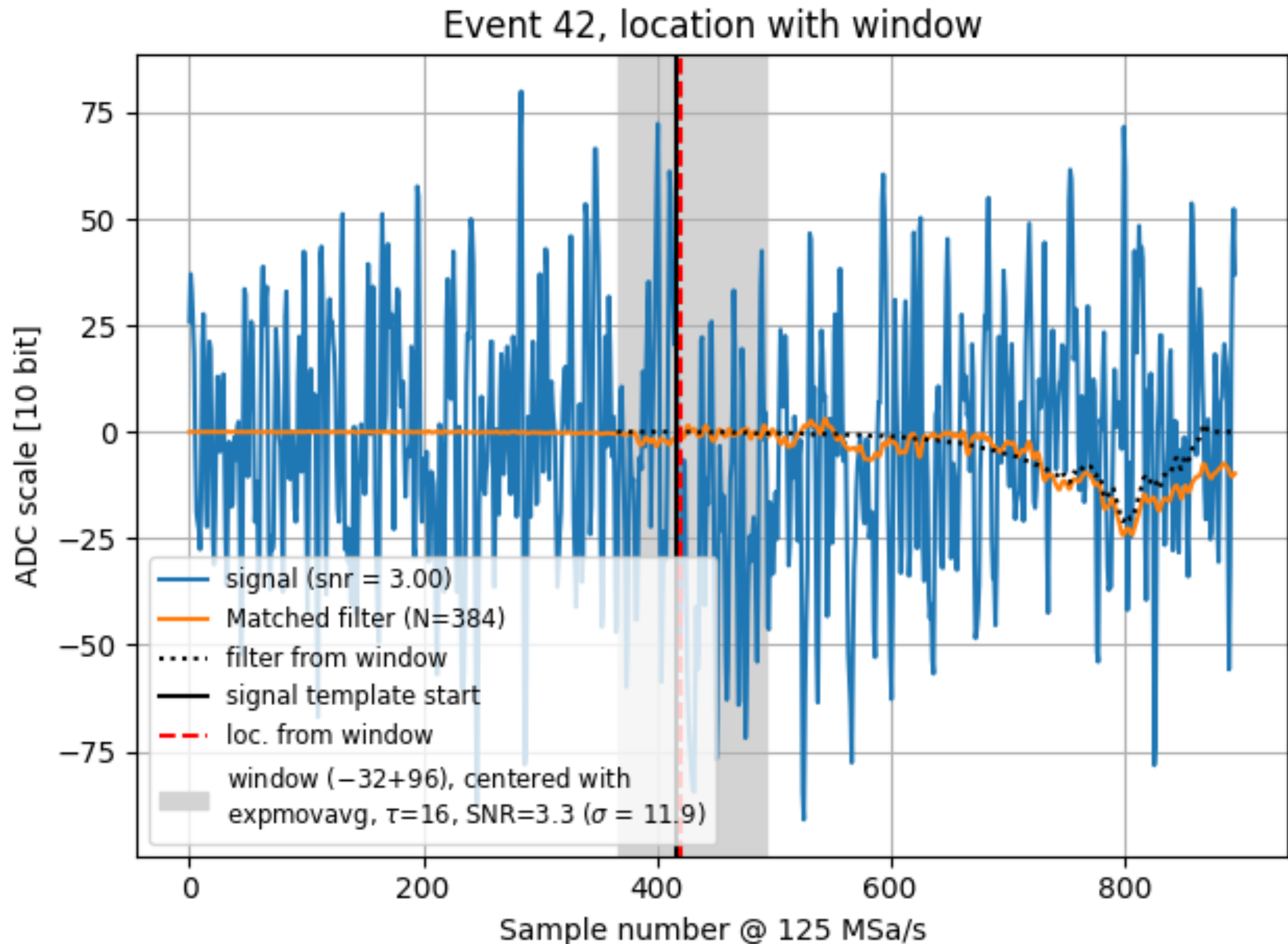
Summary

- Simulate temporal localization of signals with filters that are feasible online.
- Use the localization to extract a window of samples around the signal.
- Redo the localization on the window with an untruncated matched filter.

Example localization

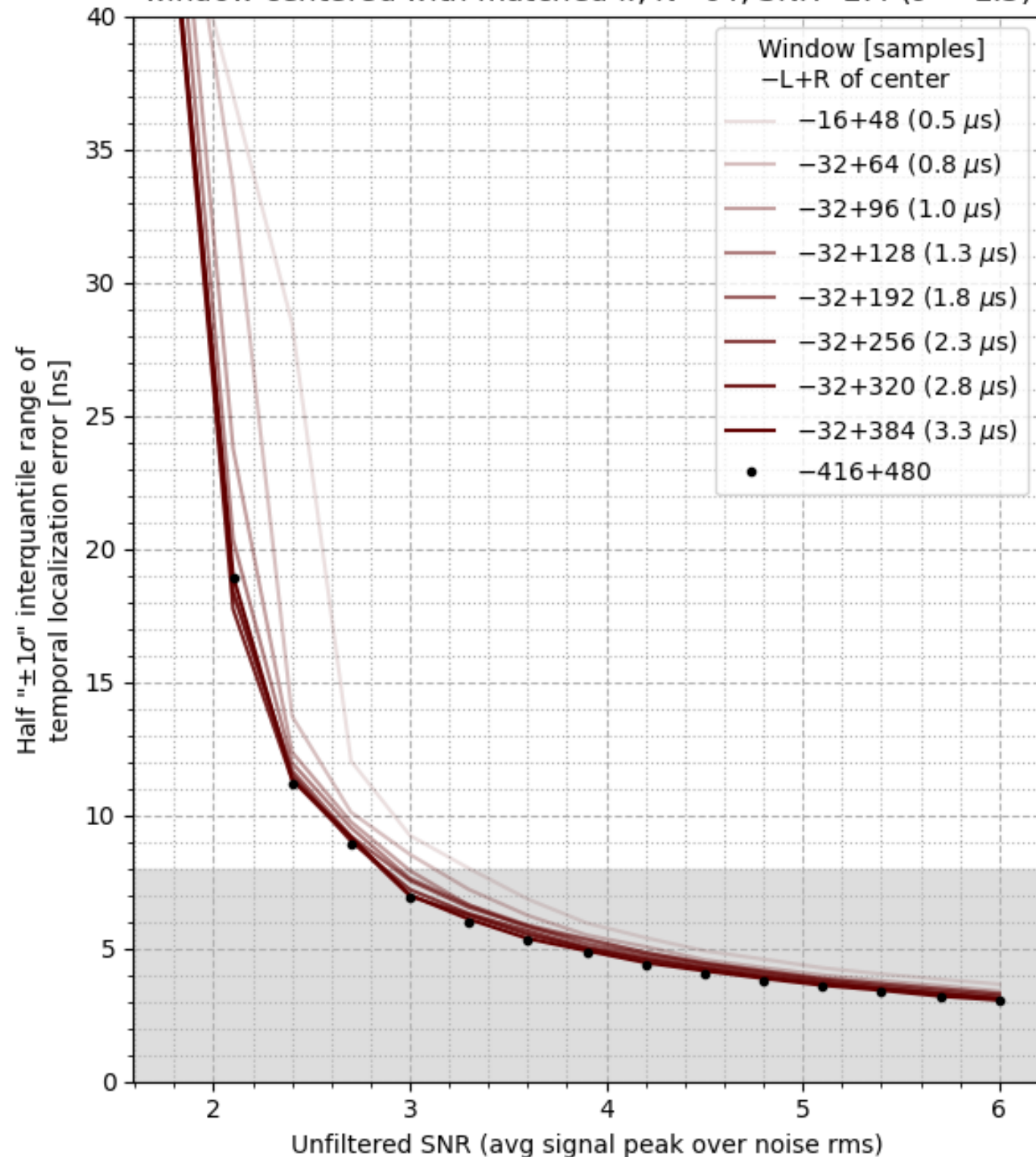


Example localization in window

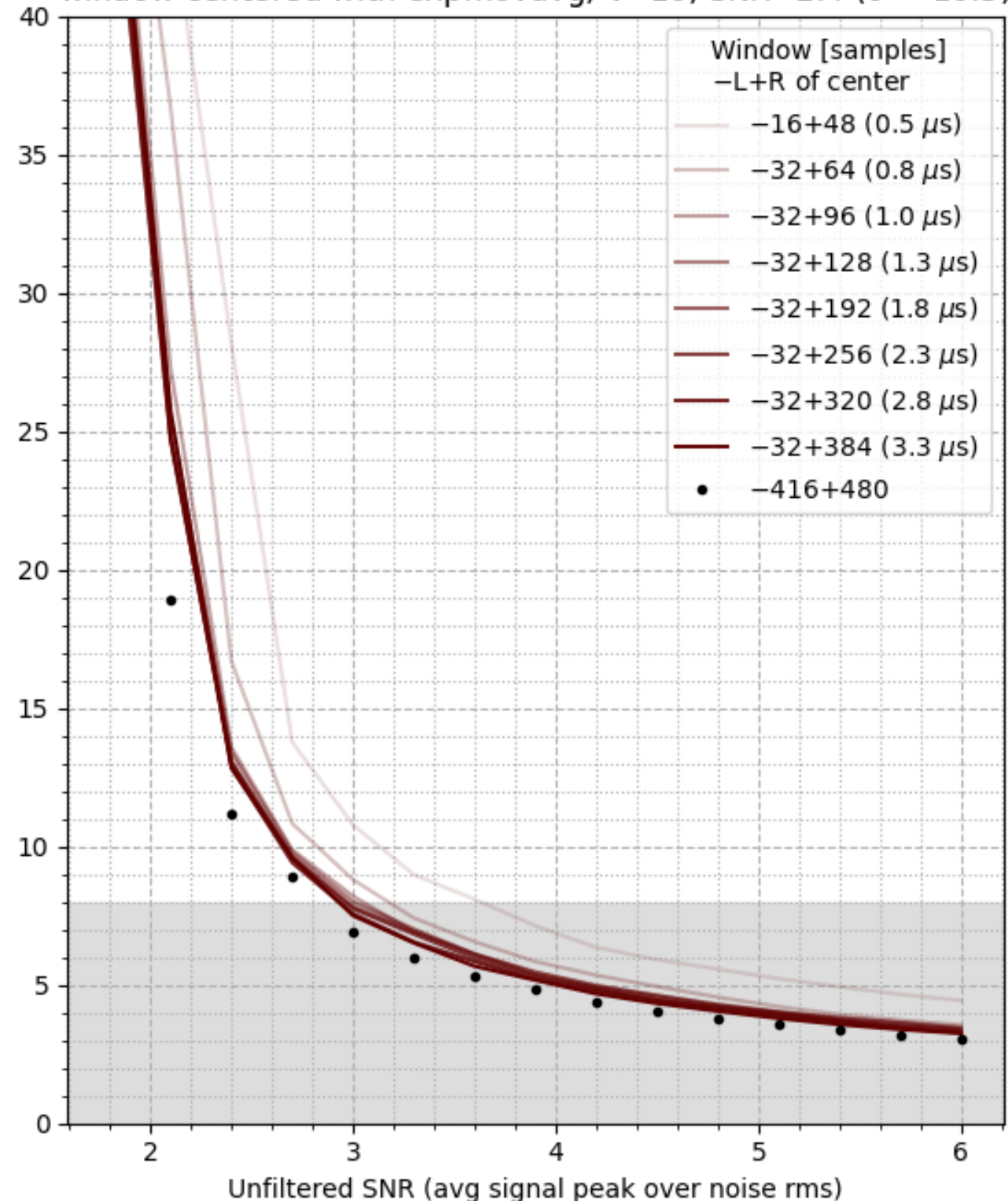


Temp. loc. resolution, proto0 noise

Matched filter on window (Nsamples=384 @ 125 MSa/s),
window centered with matched f., N=64, SNR=2.4 ($\sigma = 2.3$)

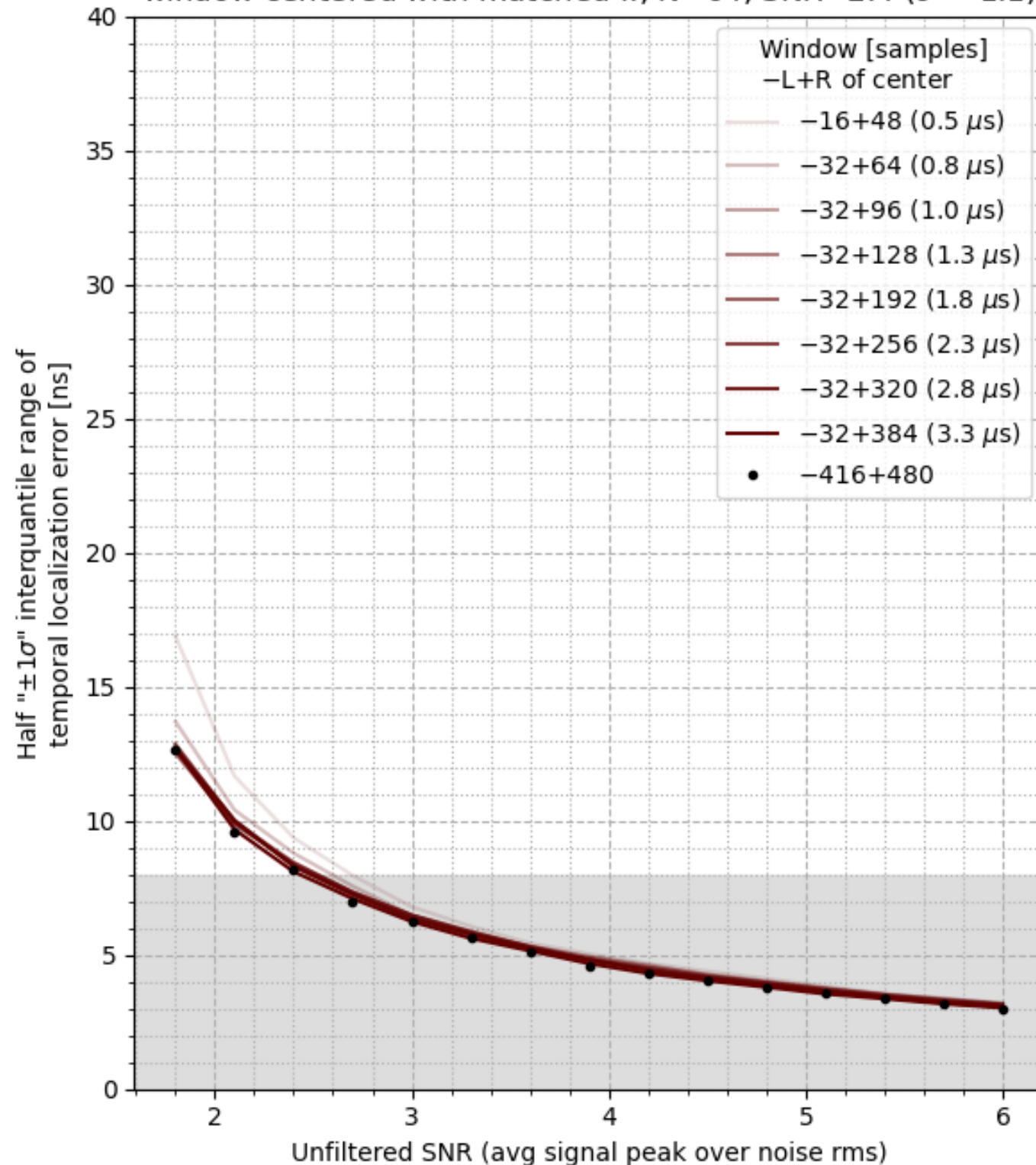


Matched filter on window (Nsamples=384 @ 125 MSa/s),
window centered with expmovavg, $\tau=16$, SNR=2.4 ($\sigma = 16.3$)

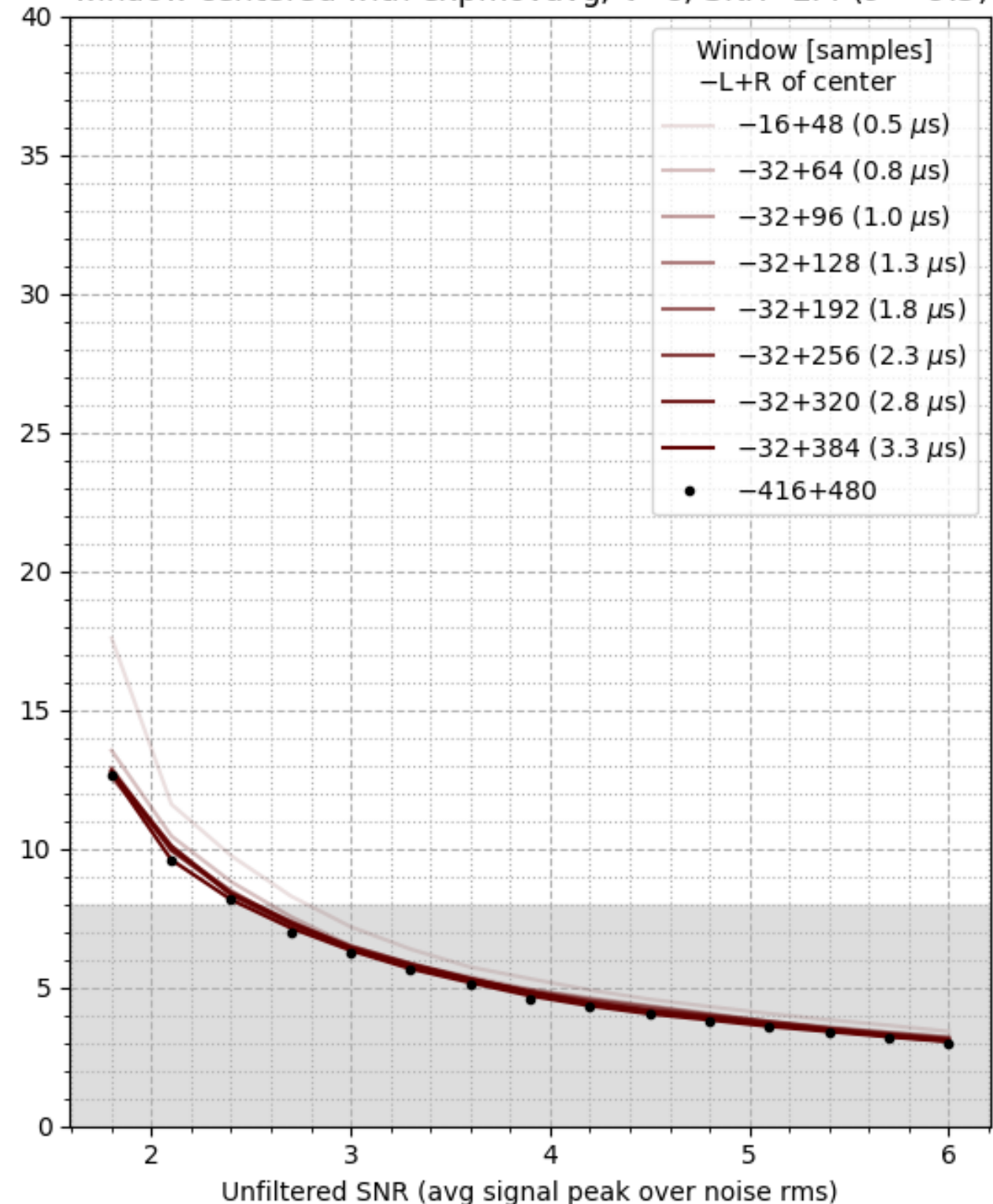


Temp. loc. resolution, LNGS noise

Matched filter on window (Nsamples=384 @ 125 MSa/s),
window centered with matched f., N=64, SNR=2.4 ($\sigma = 1.1$)



Matched filter on window (Nsamples=384 @ 125 MSa/s),
window centered with expmovavg, $\tau=8$, SNR=2.4 ($\sigma = 9.5$)



Some details

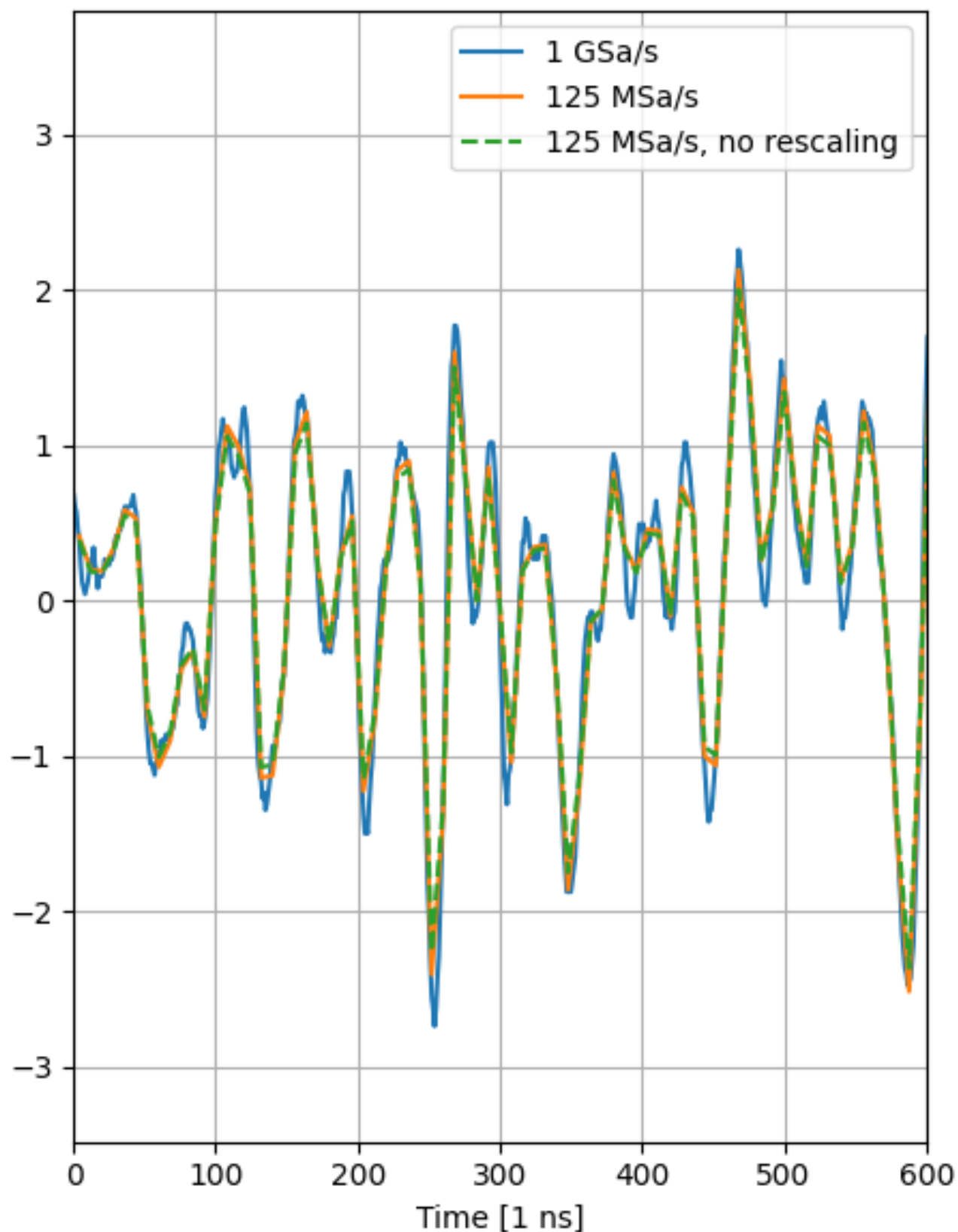
- The LNGS noise @ 125 MSa/s is obtained by downsampling noise at 1 GSa/s averaging samples in groups of 8. The SNR on the x-axis is referred to the LNGS noise after downsampling.
- The matched filter is not really matched, it's a cross-correlation filter, so this is conservative since we can expect better resolution by matching the noise spectrum.
- The windows are centered using localization made at SNR=2.4 (low), this is conservative since at higher SNR the online localization would be better.
- I've not optimized the left/right balance of the window, so this is conservative too. Probably left side should be wider.

Conclusions

- For what concerns the temporal localization, a 1 μs window is already fine.
- The offline peak-finding algorithm may need to be changed for short windows.
- The signals are 2.5 μs long, so 2.5 μs is probably a good choice.
- 0.5 μs (64 samples) to the left for good measure.
- For the baseline: double (at least) the window, or compute it on the digitizers.

Appendix: 1 GSa/s vs 125 MSa/s

LNGS noise



Temporal localization resolution
Matched filter, $\tau=2048$ ns, LNGS noise

