

Downsampling vs Narrowing Window

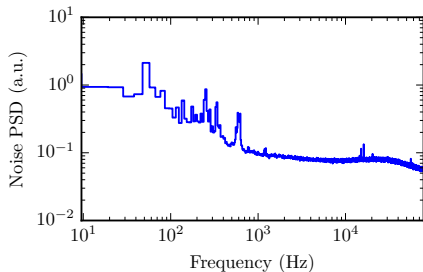
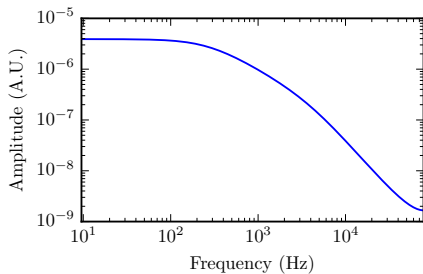
J.S. Wilson

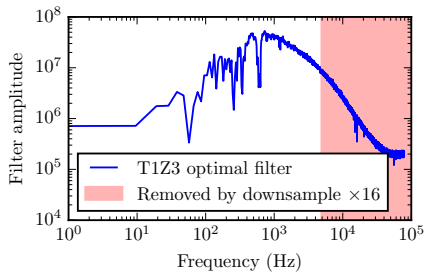
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- ▶ The trace length of 52 ms times 625 kHz gives us 32000 samples per trace
- ▶ We cannot do four FIR filters with 32000 taps each in the DCRC FPGA for level 1 triggering
- ▶ So, how should we reduce the number of taps needed?
- ▶ Either downsample, or else use a shorter filter window
- ▶ Downsampling affects high frequencies only
- ▶ Narrowing the window reduces the spacing between frequencies

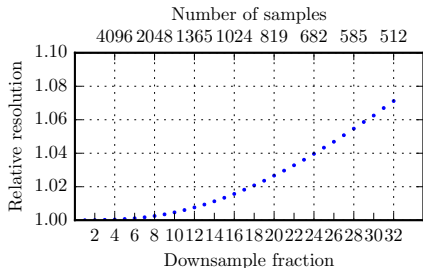
- ▶ Where does our signal lie?
- ▶ Showing pulse template in frequency domain
- ▶ low frequencies have large amplitude, falling quickly as frequency rises
- ▶ Where does our noise lie?
- ▶ Noise also has largest amplitude at low frequencies
- ▶ Falls more quickly than pulse template
- ▶ Also have some spikes to deal with





- ▶ What does an optimal filter (OF) look like?
- ▶ Ratio of pulse to noise PSD in frequency domain
- ▶ Most important frequencies are not quite the lowest frequencies, but still pretty low
- ▶ So, we can downsample by a LOT without cutting out any important bits
- ▶ Shown here is the effect of downsampling pretty aggressively, by factor of 16

- ▶ What effect does downsampling have on the OF resolution?
- ▶ The more aggressively you downsample, the worse the resolution gets (of course)
- ▶ Showing resolution as ratio to resolution without downsampling
- ▶ For most detectors, at $\times 16$ only 1% to 2% worse
- ▶ Corresponds to an FIR with 1024 taps, very reasonable
- ▶ Maybe downsampling by 8 or 4 is safer



This is with Soudan sampling parameters – will be different by a factor of 2 (I think) at SNOLAB.

- ▶ What about detectors with more low-frequency noise?
- ▶ Can't downsample those as aggressively
- ▶ LF noise kills the LF components in the OF
- ▶ Need more of the midrange to get good resolution
- ▶ So maybe downsampling by 8 or even 4 is safer than 16.

- ▶ What about narrowing the window?
- ▶ This hurts the resolution FAST
- ▶ Every step of narrowing takes away some low frequencies
- ▶ Narrowing the window by half, which doesn't gain us enough in the number of FIR taps, makes the resolution 15 % to 20 % worse
- ▶ Conclusion: Clearly better to downsample. Can probably go with about a 4k tap filter.