Optimiszation of the signal to noise ratio in haloscope detectors

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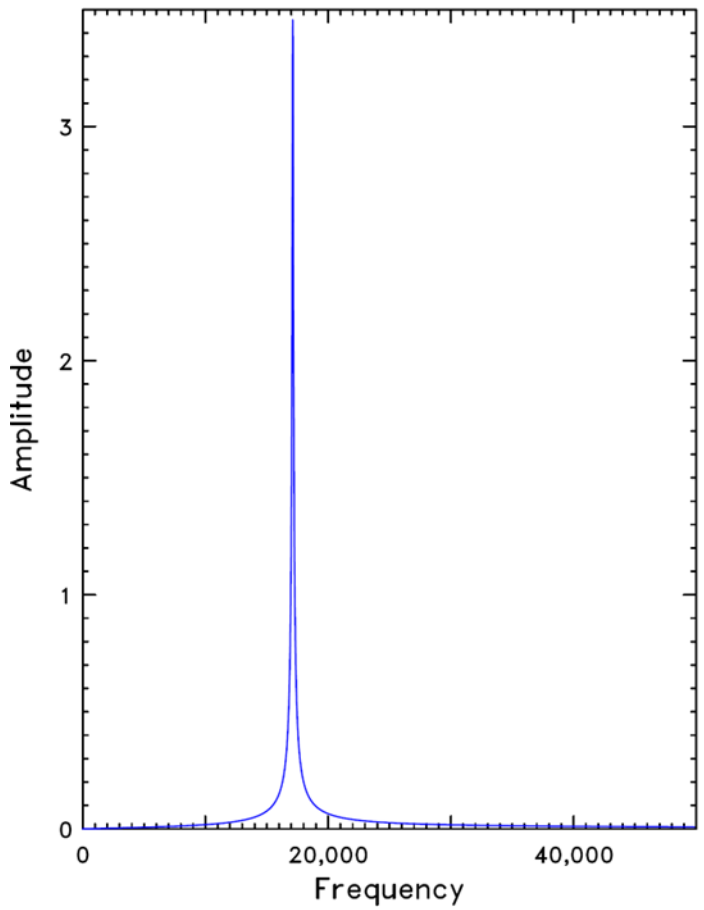
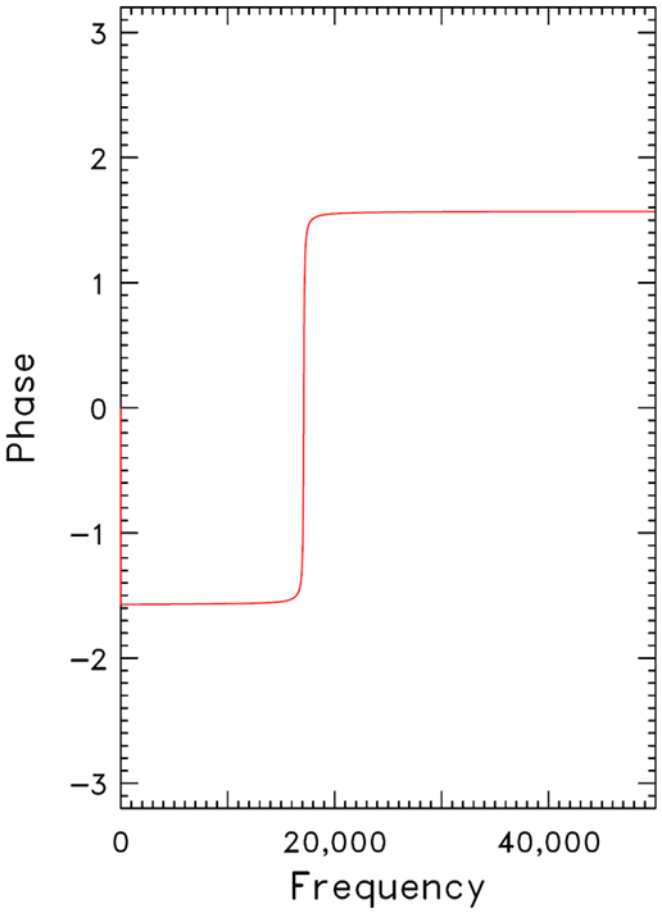
- Halo axions have a ratio of kinetic to rest-mass energy of $K/mc^2 \sim 10^{-6}$.
- At 1 GHz, the signal has a spectral width of 1 kHz.
- Takes 1 ms to resolve 1 kHz.
- SNR improved by measuring longer; ADMX measures for 100 sec.
- The 100 sec time series should be Fourier analyzed in 1 ms chunks.
- Signal just barely resolved spectrally
- Then, the large number ($N = 10^5$) of spectra should be averaged.

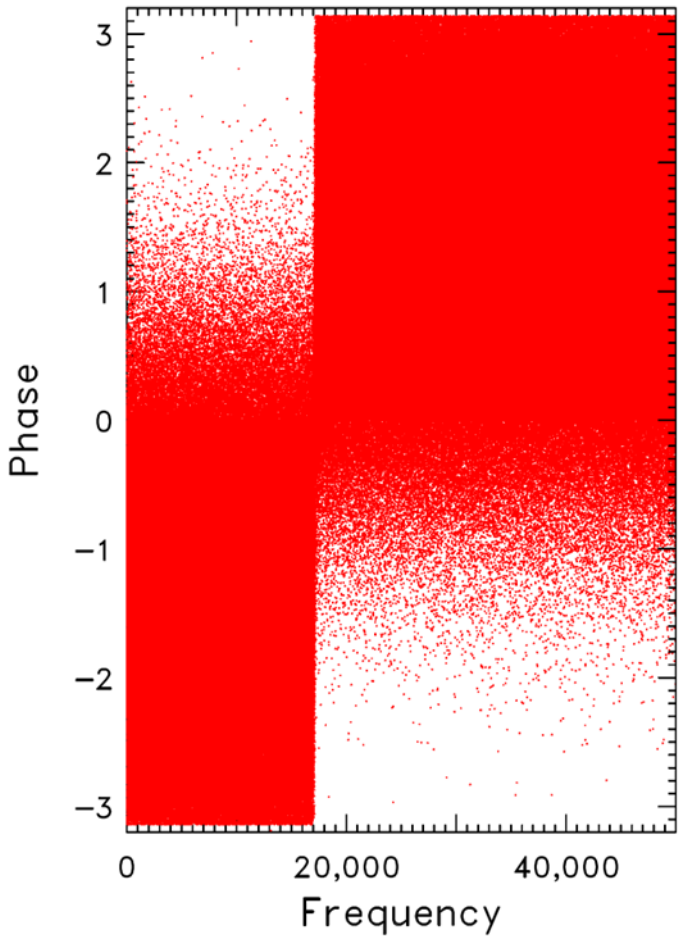
- Poster shows two simulations.
- This talk contains only the second, done for 10 sec, 100 Hz wide signal

Lorentzian signal at 17 kHz in 50 kHz wide spectrum, 1,000,000 points

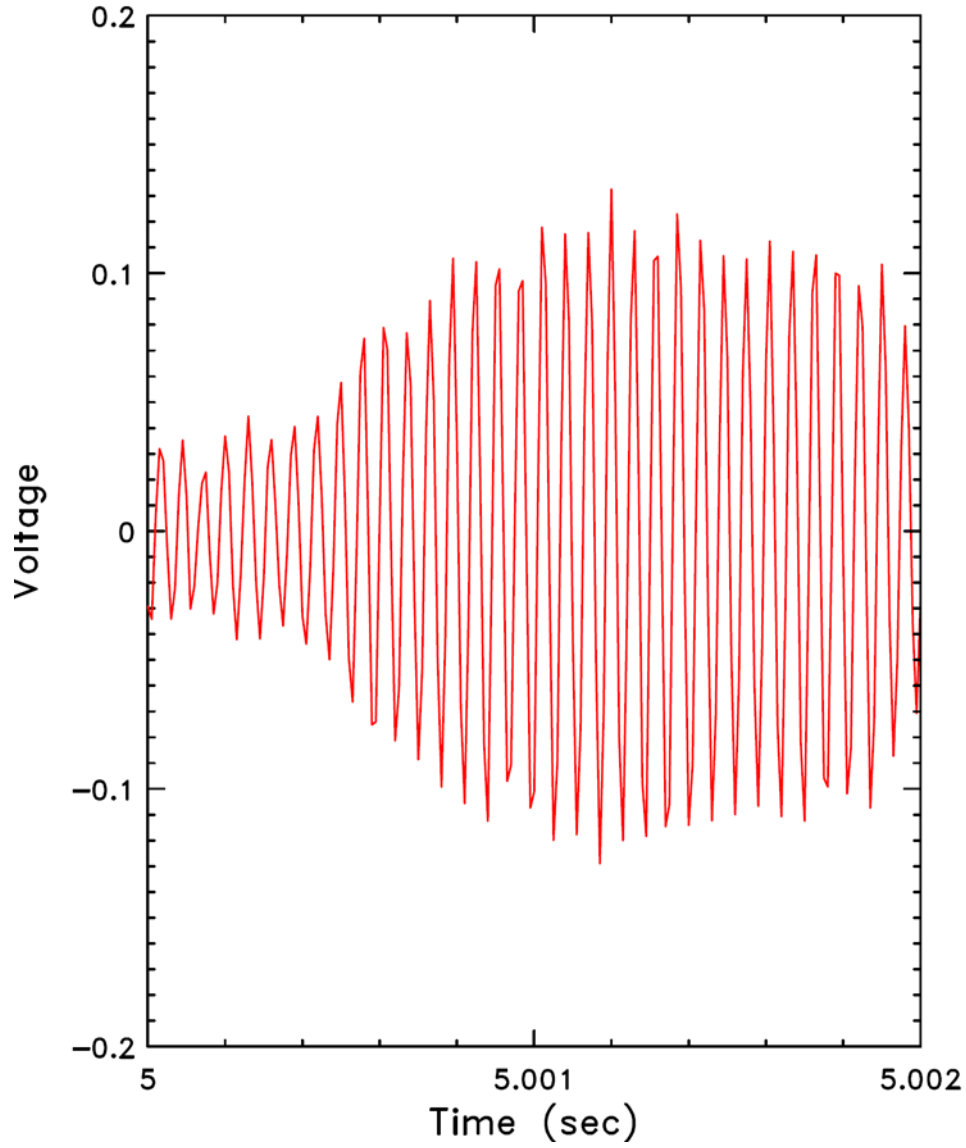




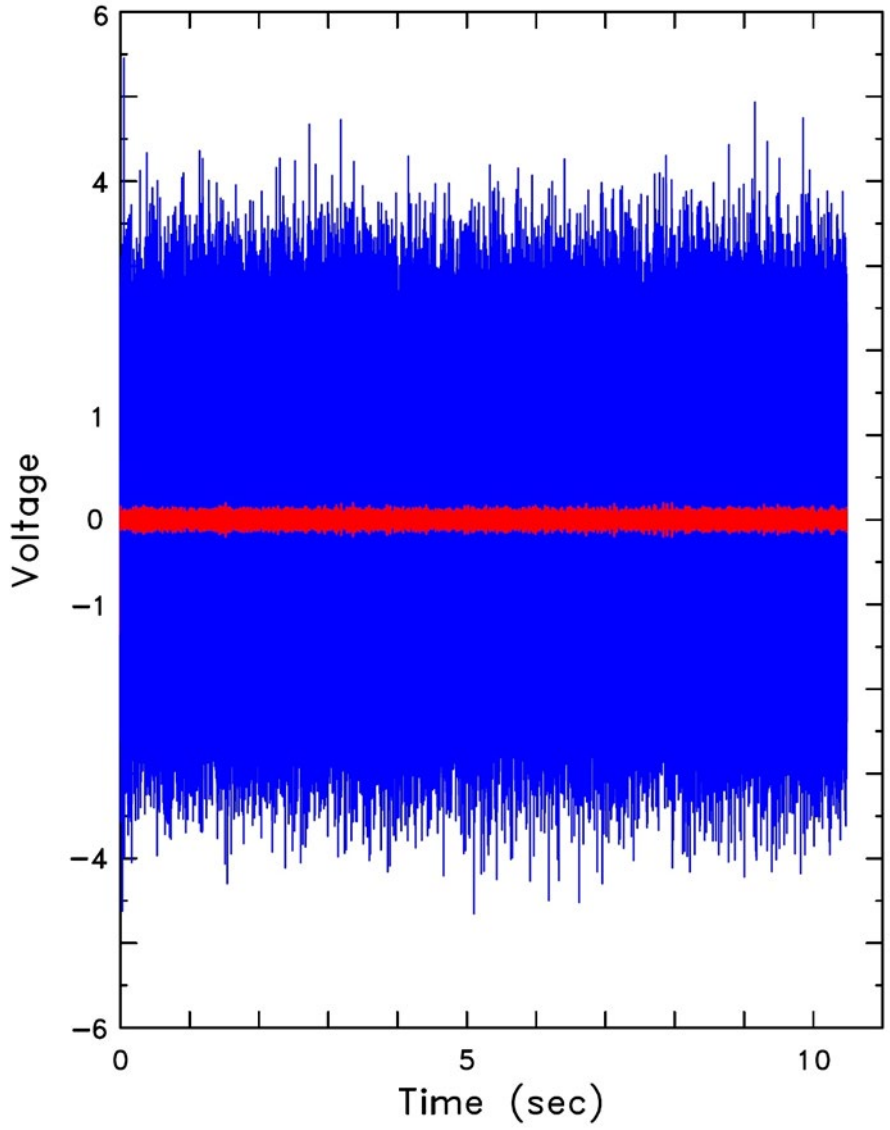
- Inverse FT lasts only ~0.03 sec of the 10.5 sec time.
- Add random number to the phase.
- Amplitude unchanged.



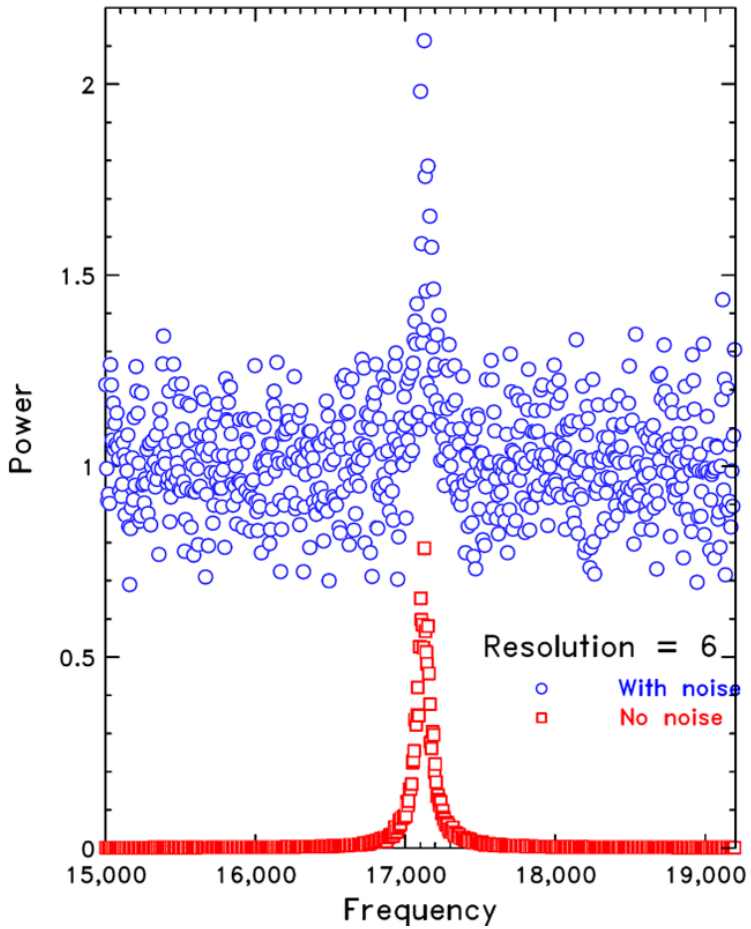
Inverse FT (red) now has amplitude over many seconds.

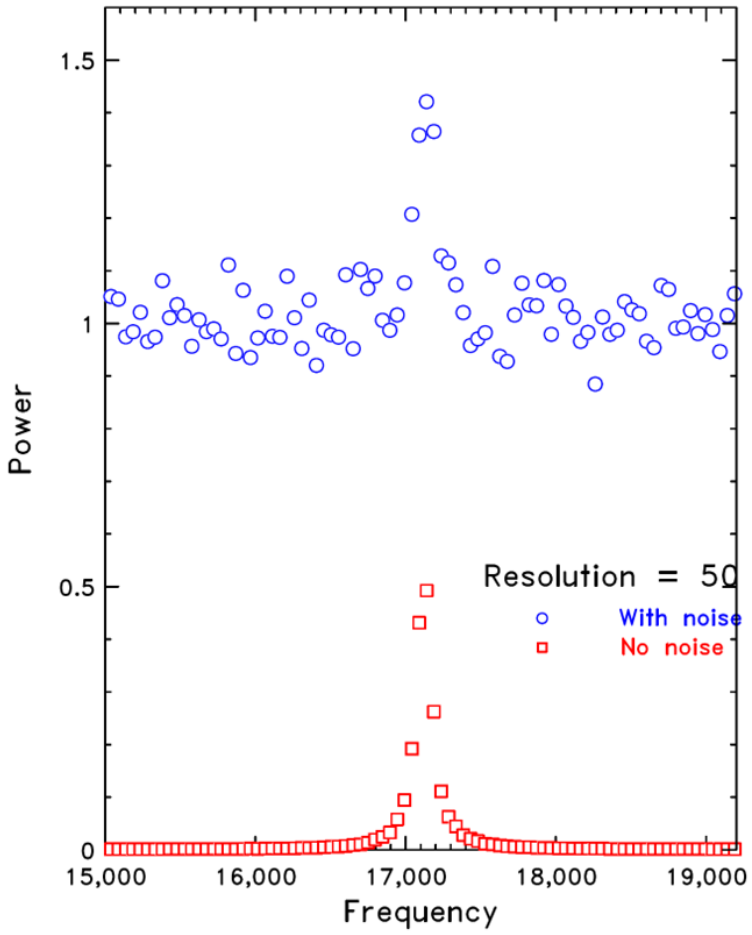


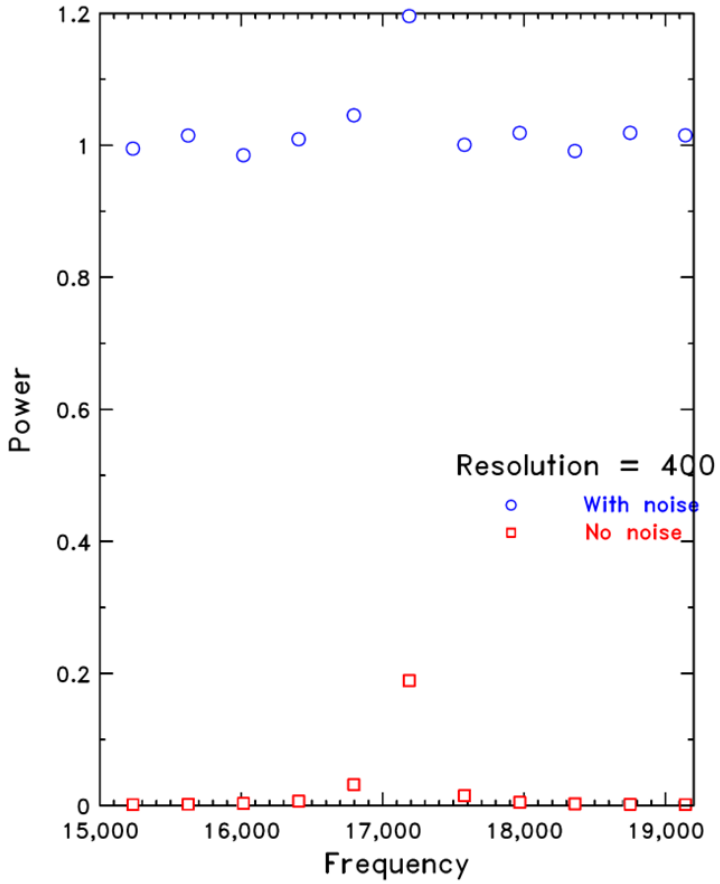
- Add noise (blue) with pk-pk amplitude 33x of inverse transform.



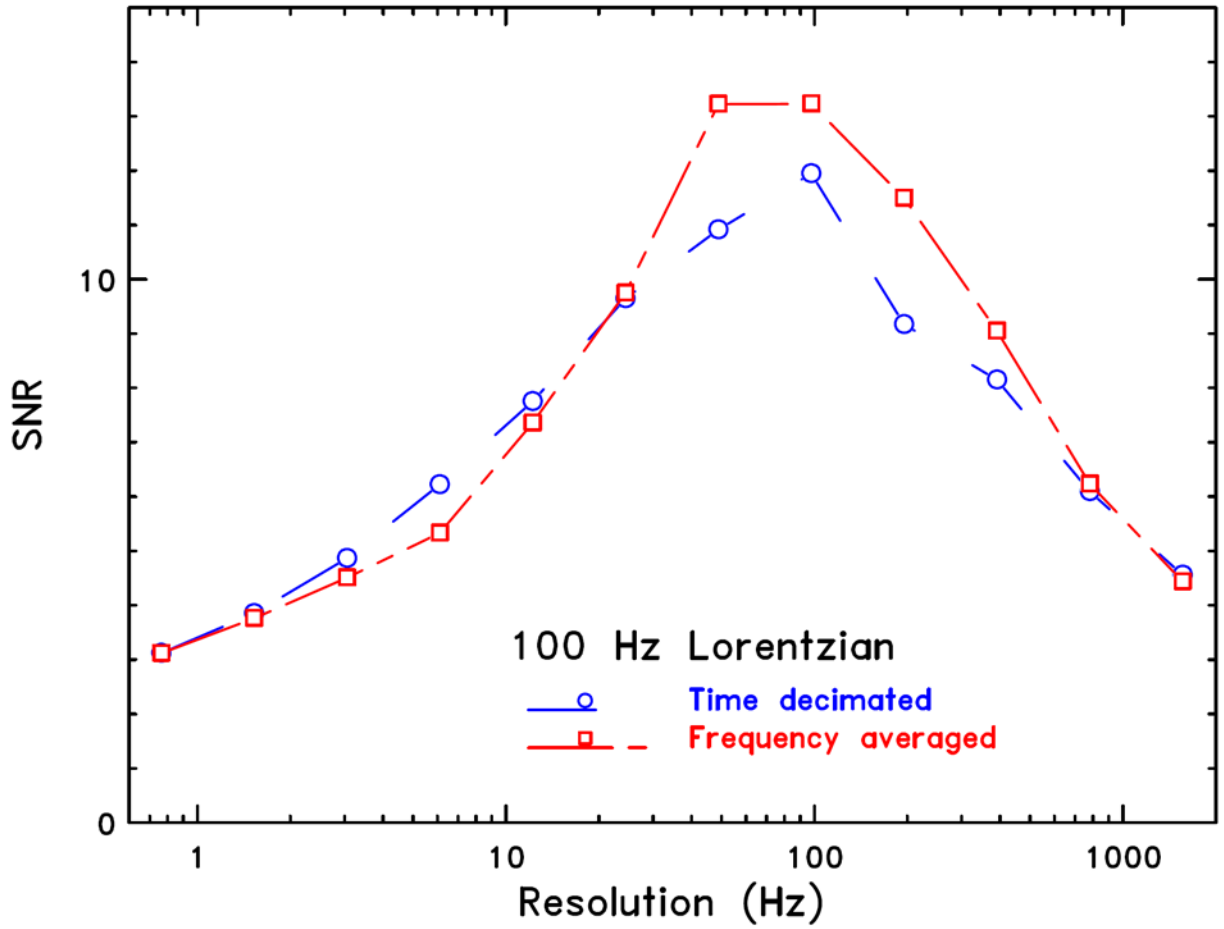
FT *N* time segments, *N* = 1–16,382 in powers of 2 (16 cases)







Frequency resolution should be matched to the spectral width.



Is there an axion in this spectrum?