Direct characterization of noise processes in superconducting microresonators

T. Lindstrom[a, b], J. Burnett[a, b], M. Oxborrow[a], Y. Harada[c], Y. Sekine[c], and A. Ya. Tzalenchuk[a]

[a]National Physical Laboratory , UK
[b]Royal Holloway, University of London, UK
[c]NTT Basic Research Laboratories, Japan

We have studied the frequency noise of superconducting on-chip microresonators using techniques borrowed from precision frequency metrology. By using a so-called Pound locking technique we are able to track the shift in the centre frequency of the resonator which is caused by interaction with the environment. We analyze the data in the time and frequency domain. We demonstrate how the Allen deviation (ADEV) provides valuable additional information about the noise processes present in the resonator, as well as the timescales over which they act.
We have used this technique to study lumped element resonators made from Niobium, with and without an extra dielectric layer deposited over the capacitor, in the temperature range 30-800 mK and at low powers. We show that flicker frequency noise dominates at short and long timescales, but that random walk noise is important over intermediate timescales.
Our results provide insights into the processes that for example affect the noise level in kinetic inductance detectors, as well as limiting the coherence time in solid state quatum information processing.