Accelerating resonator spectroscopy using microwave pulses

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The characterization of microwave resonators is an established method to evaluate materials losses [1] to improve the fabrication process for qubit chips. In addition, high quality resonators are essential for reliable qubit readout at low powers. A typical characterization consists of a measurement of the resonator's quality factor as a function of the number of photons and temperature.

Typically, such measurements rely on a vector network analyser (VNA) specifically designed and calibrated to evaluate the scattering matrix parameters of a system. In this article, we explore the potential of employing pulsed instruments as an alternative to speed up resonator characterization. Such instruments can deliver precise microwave pulses with stable timing and phase and are used for the characterization and control of qubits. Despite the intricacies involved in precisely executing the resonator characterization compared to using a VNA, tailoring unique pulses for individual resonators enables us to accelerate the process while maintaining high data quality. We compare the results with those obtained using a VNA and demonstrate that equivalent results can be achieved almost 3 times faster.

Figures

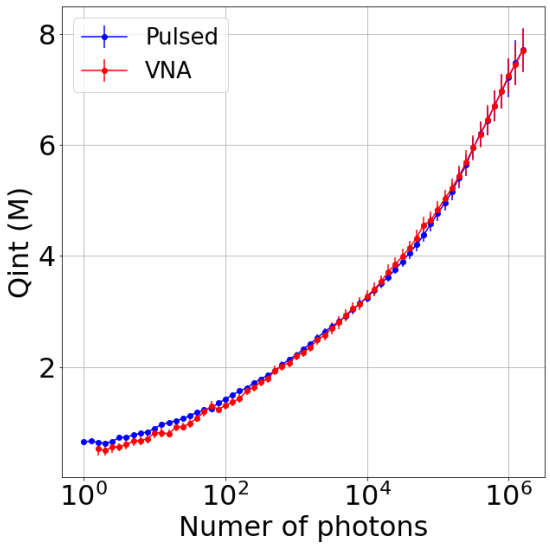

Figure 1: Comparison between a resonator characterization using a pulsed instrument (blue) and a network analyser (red). Q_{int} is extracted using a circle fit routine [2]. Power is converted to photons after calibrating the instruments output powers, cryostat lines and room temperature cables. The measurement was performed at 100 mK using a kiutra L-Type Rapid cryostat.

References

[1] McRae *et al.*, Review of Scientific Instruments, 91, 091101 (2020)
[2] Probst *et al.*, Review of Scientific Instruments, 86, 024706 (2015)