Quantum Algorithms with Superconducting Qubits coupled to High Q Coaxial Cavities

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Abstract

High Q coaxial cavities have shown high single photon quality factors of 0.5×10^9 [1]. Such a low-loss cavity is especially useful as a common quantum bus for multiple qubits or for encoding quantum information, using it as a bosonic qubit. Here, we present our platform for coupling transmon qubits to a high Q cavity.

We use high purity niobium in a $\lambda/4$ coaxial seamless design [2]. We use electro-discharge machining and buffer chemical polishing for a smooth surface that reduces losses in the cavity.

A flux hose allow us to apply magnetic field inside the superconducting coaxial cavity [3]. The flux hose also allows for fast flux tuning. Our in-house assembled hoses are ideally suited for fast flux bias lines in 3D superconducting architectures.

We are also incorporating a bandpass filter that will act as a modular Purcell filter replacing the readout SMA pin.

By combining these ingredients, we build a platform for interacting mutli-qubit systems for quantum information processing. Additionally, the multi-dimensional Hilbert space of the cavity is a suitable for hardware efficient encoding for quantum error correction.

References

[1] P. Heidler et al., *Phys. Rev. Appl.*, vol. 16, no. 3 (2021) p. 034024
[2] M. Reagor *et al.*, *Phys. Rev. B*, vol. 94, no. 1 (2016) p. 014506
[3] O. Gargiulo et al., *Appl. Phys. Lett.*, vol. 118, no. 1 (2021) p. 012601

Figures

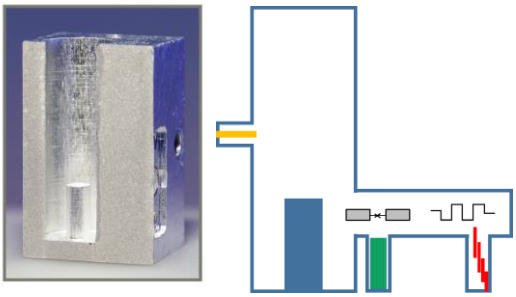

Figure 1: (left) Cut picture of a Coaxial cavity. (right) Schematic representation of the setup. SQUID transmons are capacitively coupled to the High Q Coaxial Niobium cavity. The SQUIDs are tuned with a Flux Hose and protected by a Purcell Filter, which is integrated into the readout pin.

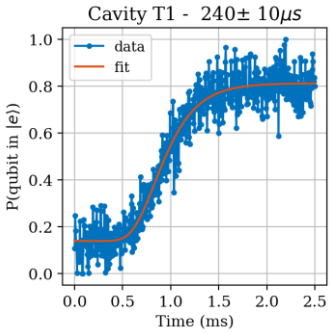

Figure 2: High Q Cavity T1 Measurement – A displacement pulse puts the cavity into a coherent state with high average photon number. The coherent state then decays back to the cavity ground state with characteristic time T_1, which is probed by a selective π pulse on the qubit transition for the cavity ground state.