High-Q Magnetic Flux Hose: A Dual-Purpose Approach for Fast Tuning and Readout

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Being able to apply fast flux changes to tune superconducting qubit energy levels or variable couplers is a necessity for scalable quantum processing. The challenge is to realize this tuneability without compromising the coherence time of the circuit. Here we present a design using a solid superconducting structure to transport magnetic field [1] into a superconducting enclosure. Simulation-driven optimization of the design minimizes dielectric and conductive losses. Strategically locating the coil in a microwave field-free region ensures that the flux-hose microwave resonance is of a high internal quality factor. Our approach enhances the tunability by an order of magnitude compared to our previous design [2], improves the internal quality factor of its fundamental microwave mode ($\gg 4 \times 10^4$), and opens the possibility for a dispersive readout using the hose resonance. To date, we have performed proof-of-principle measurements using a SQUID-tunable resonator.

References

[1] Sanchez, A., Bort-Soldevila, N., Journal of Applied Physics, 130(16) (2021)
[2] Gargiulo, O., Oleschko, S., Prat-Camps, J., Zanner, M., Kirchmair, G., Applied Physics Letters, 118(1) (2021)

Figures

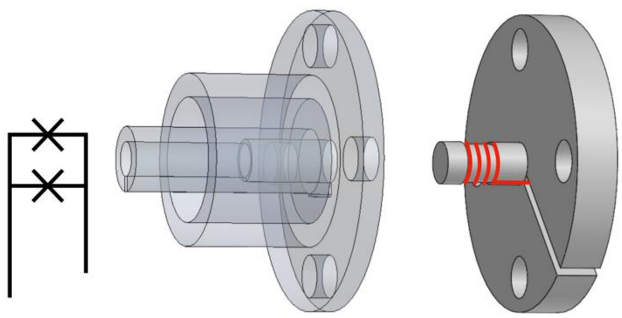

Figure 1: Flux hose design: The superconducting coil (right) is placed inside the flux hose cylinder (centre). The slitted hose transports flux to the SQUID tunable resonator (left).

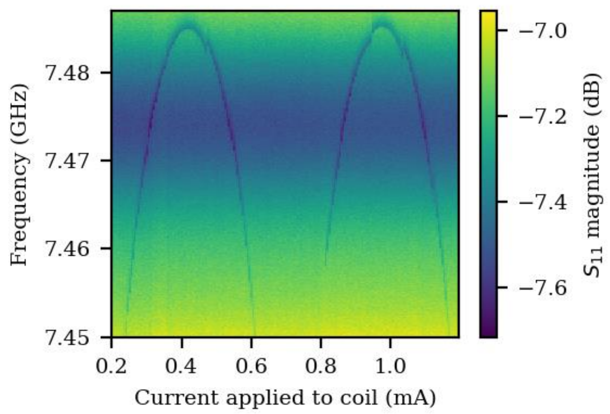

Figure 2: Proof-of-principle flux map: Tuning the mode of the SQUID tunable resonator with applied current. 0.55mA corresponds to 1 flux quantum.