Novel 3D circuit QED architecture for quantum information processing

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Superconducting circuits based on 3D architectures offer a way for hardware-efficient quantum information processing. Combined with nonlinearity, a single bosonic mode can replace a multi-qubit register, thus significantly reducing the required control electronics. Compared to their purely planar counterpart, 3D circuits possess longer lifetimes and a straightforward design that eases engineering the interactions in composite systems.
In this work, a superconducting coaxial cavity[1] is coupled to a fluxonium qubit[2] via a readout resonator. The tunability of the qubit, provided by a magnetic flux hose[3], is used to adjust the cavity-qubit interaction in situ. Combined with an element for two-photon dissipation, this setup could be utilized as an improved building block for a fully protected logical qubit.

References

[1] P. Heidler, C. Schneider et al, *Phys. Rev. Applied 16* (2021) 034024
[2] D. Gusenkova, M. Spiecker et al, *Phys. Rev. Appl. 15* (2021) 064030
[3] O. Gargiulo, S. Oleschko et al, *Appl. Phys. Lett.* 118 (2021) 012601
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Figures

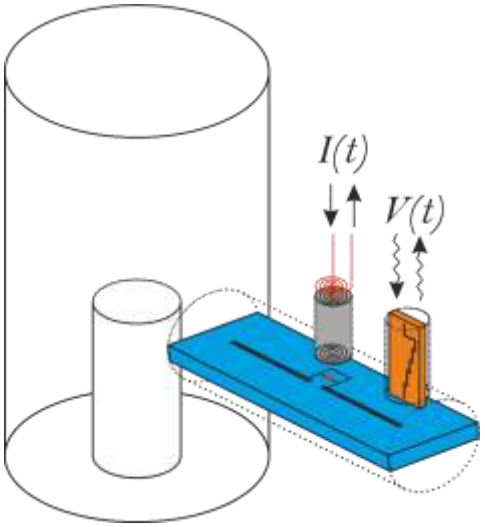

Figure 1: Setup schematic. The system consists of a coaxial cavity (white), fluxonium chip (blue), magnetic flux hose[4] (grey) and a Purcell filter[5] (orange).

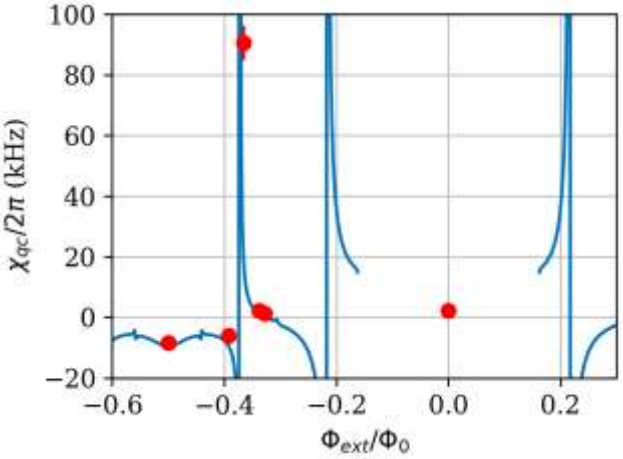

Figure 2: Simulated[4] dispersive shift between the cavity and the qubit as a function of the normalised trapped flux (blue) together with the measured datapoints (red).