Coherent Four-Josephson Junction Flux Qubits For Quantum Annealing

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In this work, we present a capacitively shunted flux qubit made out of four Josephson junctions in a superconducting loop. As part of the European FET Open project AVaQus [1], we designed and characterized a first prototype of low-impedance persistent current qubits [2] suitable for coherent quantum annealing. Here, we consider a circuit topology with four Josephson junctions in a loop to avoid unde- sired stray junctions by design. Based on progress made in the field [3], we shunt the smaller a junction with a capacitor C_{sh} = 8 to 13 fF, making the charging energy E_C more reproducible and thus the qubit gap ω_{01} more controllable, which is targeted to be between 1 to 2 GHz. Aiming at application in quantum annealing, the persistent current is designed to be small enough (I_p around ~ 100 nA) to remain high coherence while allowing for an inductive coupling between qubits in future designs [4].

Within the framework of the AVaQus project, this first generation device was fabricated by our collaborators at the University of Glasgow using a subtractive junction fabrication process [5] while the characterization of the device is carried out at IFAE.

References

1. https://www.avaqus.eu
2. J. E. Mooij et al., Science 285, 5430 (1999)
3. F. Yan et al., Nat Commun. 7, 12964 (2016)
4. S. J. Weber et al., Phys. Rev. Applied 8, 014004 (2017)
5. A. Stehli et al., Appl. Phys. Lett. 117, 124005 (2020)

Figures

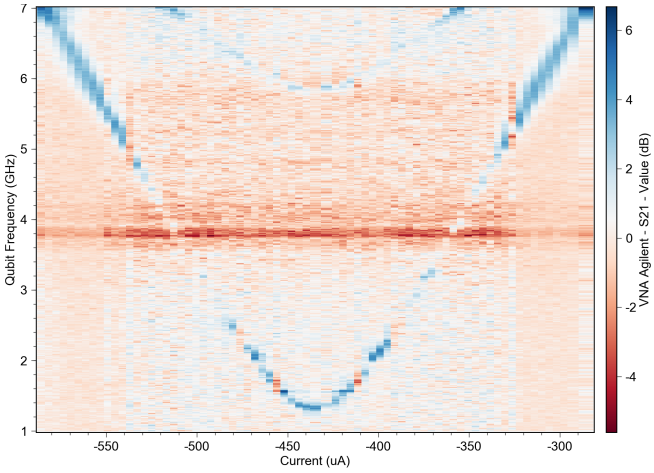

Figure 1: Measured qubit spectrum.

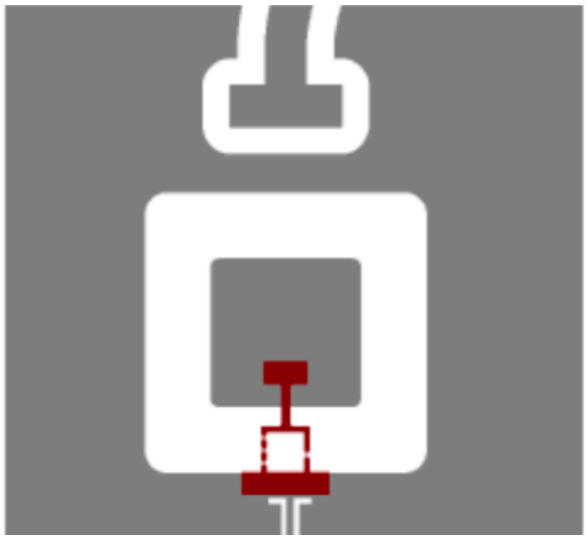

Figure 2: Grounded qubit design.