Towards on-demand, all-to-all connectivity in a superconducting qubit network using a ring resonator based coupler

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Increased connectivity in a multi-qubit network is beneficial in minimizing gate count when executing any algorithm. However, it is challenging to avoid coherent errors in fixed coupling architectures due to the cross-Kerr effect between all coupled qubits. We recently demonstrated [1] the use of a ring resonator to provide beyond nearest-neighbour connectivity in a planar architecture with fixed coupling between 3D superconducting transmon qubits. We now extend this work by introducing tunable couplers between each qubit and the ring resonator in a 2D planar architecture. This enables on-demand activation of coupling between any of the connected qubits in the network while avoiding the coherent errors due to the cross-Kerr effect as the unused qubits are isolated from the network. The coupler design is a modification of the popular *gmon* coupler [2] with a flux biased Josephson junction. We will present the analysis of this coupler design using finite-element simulations and experimental data to validate its operation.

References

[1] S.Hazra, A.Bhattacharjee, et.al. Phys. Rev. Applied **16**, 02 (2021) 024018.

[2] Y.Chen et.al., Phys. Rev. Lett. **113**, 22(2014) 220502