Small scale quantum processor with Heavy-Fluxonium Qubit

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Among the various platforms for quantum computation and information processing, superconducting qubits have been a promising candidate for fault-tolerant computation. In the past, multi-qubit processors have only used transmon qubit designs. However, transmon has a fundamental limitation, it sacrifices anharmonicity, a precious quantum resource. Transmon's weak anharmonicity leads to slower two-qubit gates making it prone to decoherence errors. It also limits the scalability of quantum processors, a direct consequence of restricted parameter space of operation, thus motivating to look for alternatives. Recently, fluxonium qubit has emerged as a serious contender for building a superconducting quantum processor. Fluxonium qubits have the potential to excel over transmons due to their inherent advantages of high coherence times and higher anharmonicity [1]. One of the crucial steps in building a fault-tolerant quantum processor is implementing high-fidelity single- and multi-qubit gates. In addition, it is also necessary to have a high-fidelity, quantum non-demolition (QND) readout. Here, we will discuss our implementation of a two-qubit fluxonium gate and experiments to characterize and optimize high-fidelity readout. We will also describe a multi-qubit architecture to build a small-scale quantum processor using fluxonium qubits.

References

[1] Long B. Nguyen, Yen-Hsiang Lin, Aaron Somoroff, Raymond Mencia, Nicholas Grabon, and Vladimir E. Manucharyan, Phys. Rev. X **9**, 4 (2019), 041041.