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Implementing small quantum codes with superconducting qubits[1]

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The ability to detect and correct errors is essential to any error correction protocol in quantum systems due to the fragile nature of quantum information. Demonstrating the encoding and decoding of logical states has become an important experimental pursuit. In particular, doing so fault-tolerantly will be critical to test the viability of different quantum error correction protocols. The surface code is particularly amenable to the implementation of error correcting protocols due to its use of nearest-neighbor interactions and relatively high error threshold. As a first step towards larger fault-tolerant circuits, we can study small codes with an accessible number of qubits in the current state-of-the art technology. The smallest code that detects a general error requires four data qubits. With one additional qubit as a syndrome qubit, we can study the [[4,2,2]] code and prepare one of its logical qubits fault-tolerantly. The device consists of five superconducting qubits arranged in a sublattice of the surface code, where a central syndrome qubit is coupled to four data qubits via bus resonators. I will present how these logical states are prepared and compare their lifetimes with each data qubit.

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