Digital Coherent Control of a Superconducting Qubit

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***Abstract*— High-fidelity gate operations are essential to the realization of a fault-tolerant quantum computer. It is critical that any control approach be compatible with scaling to large system sizes. In this talk, we describe a low-footprint control scheme for superconducting qubits based on irradiation of the qubit modes with trains of quantized flux pulses derived from the Single Flux Quantum (SFQ) digital logic family. We describe an experiment in which an SFQ pulse driver is integrated on a single chip with a high quality transmon qubit. We use randomized benchmarking to characterize the fidelity of SFQ-based gates and discuss the impact of quasiparticle poisoning on SFQ gate fidelity. We then present a next-generation design in which the classical control circuit and the qubits are fabricated on separate chips that are integrated in a multichip module (MCM) using indium bump bonds. We show that the MCM architecture leads to a significant reduction in quasiparticle poisoning and describe preliminary work to characterize SFQ-based gate fidelity in these devices.**

***Keywords (Index Terms)* — Superconducting Qubit, SFQ, multichip module.**

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