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Scalable randomized benchmarking of non-Clifford gates[1] ANDREW CROSS, EASWAR MAGESAN, LEV BISHOP, JOHN SMOLIN, JAY GAMBETTA, IBM T J Watson Res Ctr — Randomized benchmarking is a widely used experimental technique to characterize the average error of quantum operations. Benchmarking procedures that scale to enable characterization of n-qubit circuits rely on efficient procedures for manipulating those circuits and, as such, have been limited to subgroups of the Clifford group. However, universal quantum computers require additional, non-Clifford gates to approximate arbitrary unitary transformations. We define a scalable randomized benchmarking procedure over n-qubit unitary matrices that correspond to protected non-Clifford gates for a class of stabilizer codes. We present efficient methods for representing and composing group elements, sampling them uniformly, and synthesizing corresponding poly(n)-sized circuits. The procedure provides experimental access to two independent parameters that together characterize the average gate fidelity of a group element.

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