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Implementation of a Robust Tomography Toolbox COLM RYAN, BLAKE JOHNSON, MARCUS DA SILVA, Raytheon BBN Technologies, SHELBY KIMMEL, Massachusetts Institute of Technology, THOMAS OHKI, Raytheon BBN Technologies, IBM MQCO TEAM — Recent advances in coherence times and control techniques have dramatically improved gate fidelities in superconducting qubits. Already, estimates of these small errors are dominated by errors in the state preparation and measurment pulses of quantum process tomography. Randomized benchmarking (RB) provides a way to isolate gate errors, but only for estimating the fidelity of Clifford operations. Here we implement several extensions to RB that provide more detailed information about specific gates while maintaining the key RB advantage of being robust to state and measurement errors. We will show: interleaved benchmarking results to characterize the average fidelity of specific gates; simultaneous benchmarking to characterize addressabilty errors with multiple qubits; and robust tomography results that show a full unital characterization of a trace preserving operation. Taken together these provide a full suite of characterization tools useful to any quantum experimentalist.

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