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High-fidelity gates in Josephson phase qubits ERIK LUCERO, University of California at Santa Barbara, MARKUS ANSMANN, RADOSLAW BIALCZAK, MAX HOFHEINZ, NADAV KATZ, The Hebrew University of Jerusalem, MATTTHEW NEELEY, AARON O'CONNELL, HAOHUA WANG, ANDREW CLELAND, JOHN MARTINIS — Complex algorithms for a quantum computer will require error correction, which calls for logic gates with fidelity below a fault tolerant threshold. We present significant progress towards this goal with our detailed measurements of gate fidelity. We carefully separate out gate and measurement error and construct a complete error budget to demonstrate single qubit gate fidelities of 0.98, limited by energy relaxation. We introduce a new metrology tool 'a Ramsey interference error filter' that can measure the excited two-state population down to 10^{-4}, a magnitude near the fault tolerant threshold. This measurement demonstrates that our quantum system remains in the two-state qubit manifold during our single qubit operations. This precision and accuracy is made possible by custom control electronics that can create arbitrarily shaped microwave pulses.

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