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Tracking Quantum Jumps of Light with Repeated Single-Shot Parity Measurements LUYAN SUN[1], ANDREI PETRENKO , ZAKI LEGHTAS , BRIAN VLASTAKIS , GERHARD KIRCHMAIR , KATRINA SLIWA, ANIRUDH NARLA , MICHAEL HATRIDGE , SHYAM SHANKAR , JACOB BLUMOFF , LUIGI FRUNZIO, MAZYAR MIRRAHIMI , MICHEL DEVORET , ROBERT SCHOELKOPF , Departments of Applied Physics and Physics, Yale University — Quantum error correction (QEC) is required for a practical quantum computer because of the fragile nature of quantum information. A measurement-based QEC requires the measurement of error syndromes in a quantum non-demolition way and at a rate which is faster than errors occur. In a 3D circuit quantum electrodynamics architecture, we realize a parity measurement of a microwave field with about 90% fidelity by mapping its parity onto an ancilla qubit. The projective nature of the parity measurement onto a degenerate parity eigenspace, the cat states, is confirmed by Wigner tomography after a single parity measurement, showing 84% fidelity to ideal cats. The parity can therefore serve as an error syndrome for a recently proposed QEC scheme [Leghtas et.al. PRL (2013)]. We then demonstrate a tracking of quantum jumps of this error syndrome by repeated parity measurements. We will also discuss a quantum filter developed to mitigate the imperfections during the parity measurement for a best estimate of the photon state parity. The demonstrated extraction of error syndromes without perturbing the encoded information is essential for QEC.

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