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Backtracking quantum trajectories with analog feedback[1] G. DE LANGE*, D. RISTÈ*, M.J. TIGGELMAN, Kavli Institute of Nanoscience, Delft University of Technology, C. EICHLER, Department of Physics, ETH Zürich, L. TORNBERG, G. JOHANSSON, Department of Microtechnology and Nanoscience, Chalmers University of Technology, A. WALLRAFF, Department of Physics, ETH Zürich, R.N. SCHOUTEN, L. DICARLO, Kavli Institute of Nanoscience, Delft University of Technology — Circuit quantum electrodynamics offers a nearly ideal platform for the fundamental study of continuous quantum measurement. A non-demolition measurement of a superconducting qubit can be performed via homodyne detection of microwave transmission through a dispersively coupled cavity. By boosting the homodyne signal with a nearly noiseless phase-sensitive parametric amplifier, we experimentally show that a form of measurement backaction, consisting of stochastic quantum phase kicks on the measured qubit, is highly correlated with the fluctuations in the continuous homodyne record. We demonstrate a real-time analog feedback scheme that counteracts these phase kicks and thereby reduces measurement-induced dephasing. We develop a numerical optimization technique to overcome the bandwidth limitations of the amplification chain and provide a theoretical model for the optimization result. A quantum efficiency of 50% is extracted for the complete analog feedback loop. Finally, we discuss the integration of this analog feedback technique to improve performance in our recent demonstration [1] of entanglement by dispersive parity measurement. *equal contribution. [1] D. Ristè *et al.*, Nature 502, 350 (2013).

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