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Qubit dephasing due to photon shot noise from coherent and thermal sources[1] S. GUSTAVSSON, F. YAN, A. KAMAL, T. P. ORLANDO, W. D. OLIVER, MIT, J. BIRENBAUM, A. SEARS, D. HOVER, T. GUDMUNDSEN, J. YODER, MIT Lincoln Laboratory — We investigate qubit dephasing due to photon shot noise in a superconducting flux qubit transversally coupled to a coplanar microwave resonator. Due to the AC Stark effect, photon fluctuations in the resonator cause frequency shifts of the qubit, which in turn lead to dephasing. While this is universally understood, we have made the first quantitative spectroscopy of this noise for both thermal (i.e., residual photons from higher temperature stages) and coherent photons (residual photons from the readout and control pulses). We find that the bandwidth of the shot noise from thermal and coherent photons differ by approximately a factor of two, which we attribute to differences in the correlation time for the two noise sources. By comparing the results with noise spectra measured without any externally applied photons, we conclude that the qubit coherence times in our setup were limited by photon shot noise from thermal radiation, with an average resonator photon population of 0.006. Equipped with this knowledge, we improved the filtering for thermal noise and thereby improved the qubit coherence times by more than a factor of two, with T2 echo times approaching 100 us. From the measured T2 decay, we determine an upper bound on the residual photon population of 0.0004.

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