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Trapped ion qubit readout using a trap-integrated superconducting nanowire single photon detector S. L. TODARO, V. B. VERMA, R. P. MIRIN, S. W. NAM, D. J. WINELAND, A. C. WILSON, D. LEIBFRIED, D. H. SLICHTER, National Institute of Standards and Technology Boulder — Readout of the quantum state of a trapped ion qubit is accomplished by driving a state-selective optical cycling transition of the trapped ion and counting the resulting fluorescence photons; the presence or absence of fluorescence indicates the qubit state. These photons are traditionally collected with high-numerical-aperture bulk optics and detected with a camera or photomultiplier tube. By integrating superconducting nanowire single photon detectors (SNSPDs) into microfabricated surface-electrode ion traps, we can realize a scalable architecture for spatially-resolved, high-quantum-efficiency detection of fluorescence photons without the need for collection optics [1]. We report the first readout of a trapped ion qubit with a trap-integrated SNSPD, using a single $^{9}Be^{+}$ ion in a cryogenic surface-electrode trap. Fluorescence photons at 313 nm are detected by the SNSPD, with count rates comparable to those achievable with traditional bulk collection optics, and very low dark counts. We study the impact of the detector on motional heating of the ion, as well as the tolerance of the detector to rf potentials used to trap the ion. This work is supported by IARPA and the NIST Quantum Information Program. [1] D. H. Slichter et al., Opt. Express 25, 8705 (2017).

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