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Integrated superconducting photon detectors for ion trap quantum information processing[1] D.H. SLICHTER, V.B. VERMA, S.W. NAM, D. LEIBFRIED, D.J. WINELAND, NIST — Quantum state measurement of trapped ions relies on detecting fluorescence photons from a laser-driven atomic transition. Typically, the ion fluorescence is collected by high-numerical-aperture (NA) optics and detected using a camera or photomultiplier tube. However, the quantum efficiency of these detectors is below 40% at the wavelengths of interest for many ion species (generally in the UV). Furthermore, the collection optics are bulky and have a limited field of view, making it difficult to scale this method up to simultaneous detection in multiple locations. These issues can be addressed by integrating high-NA photon detectors into the ion trap structure. Superconducting nanowire single-photon detectors (SNSPDs) have demonstrated quantum efficiencies above 90% and have collection areas large enough to give the desired NA. SNSPDs use simple, compact bias and readout electronics and could be multiplexed to allow simultaneous independent readout from many individual trap zones. We report progress on integrating an SNSPD into a surface-electrode RF ion trap, including measurements of quantum efficiency and performance in the presence of RF trapping potentials.

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Daniel Slichter
NIST

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