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Efficient Collection of Single Photons Emitted from a Trapped Ion into a Single Mode Fiber for Scalable Quantum Information Processing ANDRE VAN RYNBACH, RACHEL NOEK, TAEHYUN KIM, PETER MAUNZ, JUNGSANG KIM, Fitzpatrick Institute for Photonics, Electrical and Computer Engineering Department, Duke University — Interference and coincidence detection of two photons emitted by two remote ions can lead to an entangled state between the ions, which is a critical resource for scalable quantum information processing [1]. The success probability of entanglement generation in current experimental realizations is mainly limited by the low coupling efficiency of a photon emitted by an ion into a single mode fiber. Here we consider two strategies to enhance the collection probability and entanglement generation rate of photons emitted from trapped Yb^+ ions. The first method uses high numerical aperture optics to enhance light collection, where a practical collection probability of over 10% is possible with proper control of aberration. The second method uses a hemispherical optical cavity created between a flat mirror containing a surface trap and a spherical mirror to enhance the spontaneous emission into the cavity mode. We show that fiber coupling efficiency of over 30% is possible using this approach, leading to an improvement in the entanglement generation rate of over four orders of magnitude. We also report on experimental progress towards realizing these two light collection schemes using surface trapped Yb^+ ions.

[1] P. Maunz et al. Phys. Rev. Lett. 102, 250502-4 (2009).

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