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Efficient ion-photon coupling with phase Fresnel lenses ERIK STREED, BENJAMIN NORTON, TILL WEINHOLD, DAVID KIELPINSKI, Griffith University — Efficient ion-photon coupling is an important component for large-scale ion-trap quantum computing. We propose that arrays of phase Fresnel lenses (PFLs) are a favorable optical coupling technology to match with multi-zone ion traps. Both are scalable technologies based on conventional micro-fabrication techniques. The large numerical apertures (NAs) possible with PFLs can reduce the readout time for ion qubits. PFLs also provide good coherent ion-photon coupling by matching a large fraction of an ion's emission pattern to a single optical propagation mode (TEM_{00}). We report on progress towards experimentally integrating a large numerical aperture PFL (NA=0.64) with Yb^+ ions held in a needle style Paul trap. The PFL is designed for use with the 369.5 nm cycling transition in Yb^+ and was fabricated by a e-beam lithography a two level pattern on a fused silica substrate. The trap electrode spacing is adjustable and will allow us to measure the effect of the patterned dielectric PFL surface on the trap stability. The PFL was previously optically characterized to have a diffraction-limited spot w_0=350+/-15 nm ($1/e^2$ waist) with mode quality M^2= 1.08+/-0.05.

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