Abstract Submitted
for the DAMOP13 Meeting of
The American Physical Society

Quantum Information Processing Primitives in a Microfabricated Surface Ion Trap[1] EMILY MOUNT, SO-YOUNG BAEK, DANIEL GAULTNEY, STEPHEN CRAIN, RACHEL NOEK, Duke University, PETER MAUNZ, Sandia National Laboratories, JUNGSANG KIM, Duke University — Microfabricated surface ion traps provide a scalable option for building a trapped ion quantum information processor. These multi-segmented traps are fabricated using existing silicon processing technology and can provide the necessary electric fields to store a chain of ions and shuttle ions within the trap structure. Using a microfabricated surface trap made by Sandia National Laboratories [1] we trap individual $^{171}Yb^{+}$ ions and demonstrate fundamental quantum information processing primitives. Trap lifetimes of over 10 hours with cooling and 20 minutes without have been observed. High fidelity single qubit rotations of the hyperfine clock state qubit have been performed using a resonant microwave field. A single $\pi/2$ gate fidelity of 99.95% has been observed using a randomized benchmarking scheme. Single qubit rotations using Raman transitions were realized, driven by a repetition-rate stabilized frequency comb. The addressing of ion motion using frequency combs has allowed for cooling the ion from the Doppler level ($\bar{n} = 8$ quanta) to less than one average quanta ($\bar{n} = 0.8$ quanta). Heating rates as low as 0.8 quanta/ms have been observed in this trap making it a good platform for motional gates.

[1] D Stick, et al., arXiv:1008.0990v2, 2010.

[1]This work was supported by IARPA/ARO.

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Date submitted: 29 Jan 2013 Electronic form version 1.4