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Quantum Information Processing with Ytterbium Ions and a Frequency Comb in a Surface Trap[1] EMILY MOUNT, SO-YOUNG BAEK, DANIEL GAULTNEY, STEPHEN CRAIN, RACHEL NOEK, PETER MAUNZ, JUNGSANG KIM, Fitzpatrick Institute for Photonics, Electrical and Computer Engineering Department, Duke University — Microfabricated surface ion traps are one of the key components for building a trapped ion quantum information processor.These multi-segmented traps are fabricated using existing silicon processing technology and can provide the fields to store a chain of ions and shuttle ions within the trap structure. Using a surface trap microfabricated by Sandia National Laboratories [1] we trap individual Yb-171 ions and demonstrate fundamental quantum information processing primitives. Low light scatter from the trap and the use of photon arrival times during fluorescence state detection enables a state detection fidelity of 98%. High fidelity rotations of the hyperfine clock state qubit have been performed using a resonant microwave field. Furthermore, we have realized single qubit rotations using Raman transitions driven by a repetition-rate stabilized frequency comb, a prerequisite for realizing motional gates with frequency combs [2]. Microelectromechanical systems (MEMS) mirrors will be used to focus Raman laser beams on individual ions in a chain to perform single qubit gates. MEMS beam steering systems can easily be scaled to multiple beams to realize two-ion gates between arbitrary ions in the chain.

[1] D Stick et al., arXiv:1008.0990v2 2010
[2] D Hayes et al., PRL 104(14)2010

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