Abstract Submitted
for the DAMOP12 Meeting of
The American Physical Society

Towards experimental realization of a scalable ion chain quantum processor in microfabricated surface trap SO-YOUNG BAEK, EMILY MOUNT, DANIEL GAULTNEY, RACHEL NOEK, STEPHEN CRAIN, ANDRE VAN RYNBACH, PETER MAUNZ, JUNGSANG KIM, Fitzpatrick Institute for Photonics, Electrical and Computer Engineering Department, Duke University — Realization of a practical trapped ion quantum information processor is a major technological challenge that requires development of large-scale integration approaches. The integration technology must include scalable solution for both the qubit datapath and classical controllers necessary to manipulate them. Our approach utilizes linear ion chains in microfabricated surface traps as a platform to store Yb ion qubits and operate quantum logic gates on them. The control signals for qubit manipulation include the abilities to direct precisely tailored laser beams to individual ions, re-arranging the ions in the chains, and parallel detection of multiple qubits. We use a frequency comb generated by an off-resonant picosecond pulsed laser with stabilized repetition rate to drive Raman transitions, realizing single qubit and multiple qubit gates in an inherently scalable way. The laser beams will be delivered to individual ions using a microelectromechanical systems-based beam steering system that can easily be extended to multiple beams, and the parallel state detection will be performed using multi-element photomultiplier tube array. We will describe the experimental progress in implementing basic quantum information processing protocols in this system.

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Date submitted: 30 Jan 2012 Electronic form version 1.4