Abstract Submitted
for the DAMOP13 Meeting of
The American Physical Society

Enabling Technologies for Scalable Trapped Ion Quantum Computing[1] STEPHEN CRAIN, DANIEL GAULTNEY, EMILY MOUNT, Duke University, CALEB KNOERNSCHILD, Raytheon Company, SOYOUNG BAEK, Duke University, PETER MAUNZ, Sandia National Laboratories, JUNGSANG KIM, Duke University — Scalability is one of the main challenges of trapped ion based quantum computation, mainly limited by the lack of enabling technologies needed to trap, manipulate and process the increasing number of qubits. Microelectromechanical systems (MEMS) technology allows one to design movable micromirrors to focus laser beams on individual ions in a chain and steer the focal point in two dimensions. Our current MEMS system is designed to steer 355 nm pulsed laser beams to carry out logic gates on a chain of Yb ions with a waist of 1.5 μm across a 20 μm range. In order to read the state of the qubit chain we developed a 32-channel PMT with a custom read-out circuit operating near the thermal noise limit of the readout amplifier which increases state detection fidelity. We also developed a set of digital to analog converters (DACs) used to supply analog DC voltages to the electrodes of an ion trap. We designed asynchronous DACs to avoid added noise injection at the update rate commonly found in synchronous DACs. Effective noise filtering is expected to reduce the heating rate of a surface trap, thus improving multi-qubit logic gate fidelities. Our DAC system features 96 channels and an integrated FPGA that allows the system to be controlled in real time.

[1]This work was supported by IARPA/ARO

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Date submitted: 28 Jan 2013 Electronic form version 1.4