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Robust Quantum Information Processing with Trapped Ions in a Surface Trap EMILY MOUNT, STEPHEN CRAIN, SO-YOUNG BAEK, DANIEL GAULTNEY, Duke University, PETER MAUNZ, Sandia National Laboratories, JUNGSANG KIM, Duke University — Microfabricated surface ion traps provide a scalable platform for building a trapped ion quantum information processor. These multi-segmented traps are fabricated using existing silicon processing technology and can provide the capability to store a chain of ions and shuttle parts of the chain to various locations within the trap structure. Utilizing micro-mirrors fabricated using microelectromechanical systems (MEMS) technology, we focus and shift Raman laser beams to individual ions in the chain to perform quantum logic gates on them. Using a microfabricated surface trap made by Sandia National Laboratories we demonstrate individually addressed single qubit gates on a chain of ions driven by a repetition-rate-stabilized frequency comb. Compensating pulse sequences were utilized to mitigate the effect of the intensity fluctuations of the Raman beams. Our MEMS-based individual addressing system requires around 5 μs to switch between different ions in the chain with crosstalk to neighboring qubits on the order of 10^{-5} characterized by the intensity spillover of the addressing beams. Here we present full state tomography results on un-compensated and compensated single qubit gates, single qubit gate fidelities measured by randomized benchmarking techniques, and progress towards entangling gates and their characterization.

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