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Performance Characterization of a Scalable Trapped Ion Based Quantum Computer STEPHEN CRAIN, CHAO FANG, GEERT VRIJSEN, JAMES JOSEPH, JUNGSANG KIM, Duke University — The rapid progress towards a scalable platform for atomic ion based quantum computing has resulted in a need for a careful characterization of the initial performance of basic qubit functions. This work characterizes the error rate for state readout, measurement crosstalk, and single qubit gates for a $^{171}Yb^{+}$ qubit in a surface trap. Photons scattered from the qubit are coupled into a multimode fiber using a high numerical aperture lens (0.6 NA) and directed towards a superconducting nanowire single photon detector (SNSPD). State dependent fluorescence is used to determine the state of the qubit, with an average state detection time of 12.3 μs and $6.9(5)\times10^{-4}$ detection error. To characterize measurement crosstalk between two qubits, a measurement is performed on one qubit using a focused detection beam, and the coherence of a second qubit is measured as a function of the distance between the two. Gate set tomography is used for the characterization of global single qubit gates driven by a microwave field $(5.(6) \times 10^{-4}$ $R_x(\frac{\pi}{2})$ error). Individual single qubit gates and two qubit gates driven by Raman transitions will be performed and characterized with tightly focused beams steered across the qubits by tilting MEMS mirrors.

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