Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Progress towards a multiplexed, semiconductor ion trap for quantum computation DAVID LEIBRANDT, ROBERT CLARK, JAROSLAW LABAZIEWICZ, KENNETH BROWN, MIT, BERNARD YURKE, RICHART SLUSHER, Lucent Technologies, Bell Labs, ISAAC CHUANG, MIT — Moving forward from current few-qubit ion trap quantum information experiments to large-scale systems with thousands or more qubits will require multiplexed ion traps scalable to large ion density. Suitable designs have at least two problems relative to the three-dimensional, millimeter scale RF Paul traps used in most ion trap experiments: low trap depth and high heating rates. The standard loading method, electron bombardment of an atomic vapor, becomes inefficient at trap depths below about 1 eV because only the low energy tail of the ion energy distribution is captured and because nearby dielectric surfaces are charged by the electrons. We present alternative loading strategies including an experimental demonstration of loading a printed circuit board surface electrode trap using laser ablation of a metal alloy target which works below 0.5 eV. For $^{88}Sr^{+}$ in a particular design of multiplexed ion trap lithographically fabricated on a semiconductor substrate we predict heating rates to be of the order of 10^3 s^{-1} using the results of current experiments and the d^{-4} scaling consistent with patch potentials. We expect a fundamentally limited heating rate of 9 s^{-1} due to resistive thermal fluctuations for this trap.

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Date submitted: 21 Nov 2006 Electronic form version 1.4