Novel Micron-Scale Ion Traps

S. Olmschenk*, L. Deslauriers*, D. Stick*, W.K. Hensinger*†, M.J. Madsen*, J. Sterk*, K. Schwab‡, and C. Monroe*
*FOCUS Center and Deparment of Physics, University of Michigan, Ann Arbor, Michigan 48109
†Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom
‡Laboratory for Physical Sciences, College Park, Maryland 20740
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Two of the major hurdles in realization of an ion trap quantum computer are scalability of ion trap structures and anomalous heating of the trapped atoms. Novel ion trap designs have allowed us to investigate these obstacles. First, we report the successful operation of an integrated radiofrequency trap etched from a doped gallium-arsenide heterostructure. The use of semiconductor micro-electromechanical systems (MEMS) technology in the fabrication process eliminates the need for manual assembly and alignment, making such structures suitable for miniaturization and scaling. Second, the employment of a double needle quadrapole trap has allowed for a precise study of the anomalous heating that plagues ion traps. Here, the variable spacing of the needle electrodes and the ability to cool the electrodes via a liquid nitrogen reservior has lead to characterization and suppression of this heating.