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Two-Dimensional Control of Trapped Ions in a T-junction Array of Ion Traps D. HUCUL*, W.K. HENSINGER**, S. OLMSCHENK*, D. STICK*, M. YEO*, M. ACTON*, L. DESLAURIERS*, J. RABCHUK***, C. MONROE* — One proposal for a scalable quantum computer involves shuttling trapped atomic ions between interaction zones where ions can be entangled and storage zones where ions can be sent to store quantum information [1]. We have performed a proof of principle experiment where ions were shuttled throughout an array of linear traps arranged to make a T-junction with 11 trapping zones. These experiments were guided by simulations of the electric potential in the ion trap array, where time-varying potentials are efficiently modeled with electrode "basis" functions that exploit the potential of each individual electrode. In order to arbitrarily control trapped ions in two- dimensions, it may be necessary to implement four key shuttling protocols that have all been experimentally demonstrated in the T-junction array [2]: linearly shuttling ions along channels and through junctions, shuttling ions around corners, and separating and recombining two ions that are in the same trapping zone. By combining these protocols, we demonstrated the controllable swapping of the positions of two ions in the same trapping zone. [1]. D. Kielpinski et al, Nature 417, 709 (2002); M. Rowe et al., Quant. Inf. Comp. 2, 257 (2002). [2]. W. K. Hensinger et al. Appl. Phys. Lett. 88, 034101; *University of Michigan,**University of Sussex,***Western Illinois University; Work supported by the DTO and the NSF ITR program.

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