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Neutral Atoms in an Optical Lattice for Quantum Information Processing CHAD FERTIG, JOHNNY HUCKANS, IAN SPIELMAN, JENNIFER SEBBY-STRABLEY, MARCO ANDERLINI, STEVEN ROLSTON, WILLIAM PHILLIPS, JAMES PORTO, NIST — We experimentally study Bose-Einstein Condensates in optical lattices as a promising candidate for scalable quantum information processing. We study the superfluid-to-Mott-insulator transition as a means of initializing a quantum register of singly occupied lattice sites. The fidelity of the Mott state can be assessed using vibrational spectroscopy. Single q-bit operations can be realized using a 3-photon stimulated Raman coupling field. We conduct experiments to realize 2-qubit operations in a 3D lattice of double-well potentials, where the strength of the barrier is tunable in real-time.

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