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Trapped-ion Quantum Information Processing using Scalable Techniques[1] RYAN BOWLER, JOHN GAEBLER, YIHENG LIN, TING REI TAN, National Institute of Standards and Technology, DAVID HANNEKE, Amherst College, JOHN JOST, National Institute of Standards and Technology, JONATHAN HOME, ETH Zurich, ADAM MEIER, EMANUEL KNILL, DIETRICH LEIBFRIED, DAVID WINELAND, National Institute of Standards and Technology — We report progress towards combining all the building blocks required for scalable quantum information processing using trapped atomic ions. Included elements are qubits with long coherence times, a laser-induced universal gate, motional state initialization using a second ion species, and information transport. We currently explore techniques to efficiently measure gate fidelity in a scalable way involving multiple qubits and randomized benchmarking. For this, we perform sets of quantum information sequences involving as many as 16 two-qubit entanglement gates and 50 single-qubit gates. We have also developed an arbitrary waveform generator with an update rate far above the ions' motional frequencies which is capable of rapidly bringing together and separating the qubit ions each time a two-qubit gate is performed.

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