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Multi-zone parallel qubit addressing via multi-wavelength integrated photonics ROBERT NIFFENEGGER, MIT Lincoln Lab, JULES STUART, MIT, COLIN BRUZEWICZ, DAVID REENS, CHERYL SORACE-AGASKAR, DAVE KHARAS, JEREMY SAGE, JOHN CHIAVERINI, MIT Lincoln Lab — The integration of photonics within surface-electrode ion-trap chips could enable the development of larger quantum computers and portable quantum sensors. Here, we demonstrate operation of an ion-trap chip where integrated waveguides and grating couplers deliver all required wavelengths, from the violet to the infrared, necessary to control Sr^+ qubits. Using these integrated photonics, we demonstrate photoionization of neutral Sr, Doppler cooling, electronic-state repumping, sideband cooling, coherent qubit operations, and qubit-state preparation and detection. Laser light is coupled onto the chip via an optical-fiber array, creating an inherently stable optical path that we use to demonstrate qubit coherence resilient to platform vibrations approaching 1g. We also explore using multiple zones of interaction to perform parallel qubit operations on multiple ions using multiple integrated beam paths.

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