

## Demonstration of 2D connectivity for a two-dimensional ion trap architecture

*Tuesday 9 July 2024 17:24 (2 minutes)*

We investigate scalable ion trap architectures for quantum computing and simulation, where independent ion strings are located in distinct lattice sites (or potential wells) in a 2D array of RF traps. Distinct ion strings are coupled via their dipole-dipole interaction. Full 2D connectivity is achieved tuning the distance between adjacent potential wells along two orthogonal directions: One direction (axial) is achieved controlling DC voltages, and the other (radial) controlling RF fields. In this work we demonstrate the building blocks of such an architecture using two surface ion traps. With the first, we demonstrate DC shuttling-based well-to-well coupling rates up to 40 kHz between ion-registers of up to 6 ions each, and phonon exchange between ion strings at the quantum level. With the second, we characterize RF transport of ions along the radial direction, and measure well-to-well coupling rates up to 15 kHz. These results provide an important insight into the implementation of fully controllable 2D ion trap lattices, and pave the way to the realization of 2D logical encoding of qubits.

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**Session Classification:** Poster session