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Universal Quantum‛s Fully Integrated Trapped-Ion Quantum Computer

Scaling ion trap QC to millions of qubits face challenges due to the large number of components required to control the ion and the associated high cost and power consumption. Miniaturization and integration of components in integrated Quantum Processing Units (iQPUs) through microfabrication is a realistic route towards large-scale quantum computing, thanks to the dramatic reduction in size, weight, power and cost (SWaPC) required per qubit.

Our architecture consists of independent iQPUs, in which ions are trapped in microfabricated surface traps, allowing individual control of qubits and arbitrary reconfiguration of qubit registers (strings). Magnetic-gradient-induced multi-qubit gates allow the optical system to be greatly simplified, as the quantum gates are laser-free and performed using long-wavelength microwave radiation that can be delivered on-chip. The remaining functional blocks that rely on optical fields, such as ion cooling, state preparation and readout, are much less demanding to integrate.

Using standard silicon foundry technology, multiple electronic components can be integrated into the iQPU with in-house developed cryogenic Application-Specific-Integrated-Circuits, reducing the I/O of the iQPU and the overall SWaPC.

Another key enabling technology is the high-fidelity transport of quantum information between different iQPUs by direct shuttling of qubits across the module. This overcomes the speed and fidelity limitations of optical interconnects and enables scaling to millions of qubits by connecting a large number of standardised iQPUs.

Compared to other quantum computing platforms, the long coherence time, high gate fidelity and all-to-all connectivity offered by ions means fewer physical qubits per logical qubit, further reducing the size of the machine for a given computational power.

Theme

Theme 1. Energy advantage and cost of quantum technology

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