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Linear Paul Trap Design for Scalable Quantum Information Processing

In the Ion Trap Quantum Computing group at Oxford we are working towards demonstrating the building blocks of a scalable quantum computer. Using hyperfine states of ^{43}Ca ions confined in a linear Paul trap we have demonstrated state preparation, state readout, single qubit operations, and two-qubit entangling gates, all below the fault-tolerant error threshold. An important ingredient for a freely scalable architecture is a remote entangling link. We plan to implement this by linking together two multi-ion traps using a photonic interconnect.

This poster presents some design details for a macroscopic linear ion trap which will be used to implement this photonic interconnect. The trap has been reduced in size from the previous design by nearly 50% while still maintaining the same ion-electrode distances, requiring careful design choices to minimise manufacturing tolerances. We have also identified some key technical limitations which have contributed to the two-qubit gate error, and optimised the design to further reduce these errors.

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