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# A quantum compiler for small-scale trapped ion quantum processors

Trapped ions are a promising basis for quantum computers. They feature excellent quantum gate fidelities, long coherence times, as well as the ability to shuttle the qubits around the processor, enabling near error-free and arbitrary qubit connectivity. As for any quantum hardware implementation, the physical quantum gate set available with trapped ions is limited - in this case with rotation gates and the Mølmer–Sørensen gate - and most quantum circuits must be decomposed into executable sequences of physical gates before being run. The decomposition should also optimized, with the shortest circuit possible, in order to maximize fidelity [1].

The Ion Quantum Technology group at the University of Sussex is developing technologies enabling the construction of large-scale quantum computers as laid down in a blueprint published in 2017 [2]. Therefore, multiple prototype processors with different ion trap layouts and hardware controls are currently in operation in the same laboratory. The ability to compile generic quantum circuit code, and run it on any targeted prototype will provide flexibility, boost the speed and efficiency of experiments using quantum algorithms, and also provide a solid base for testing quantum error correction algorithms and other large-scale quantum computer software requirements.

We present a full software and hardware stack, which is being implemented to calibrate and run multiple small size quantum computers. It relies on a layer-based compiler architecture as presented in [3], uses already developed software and hardware modules but innovates through the scalability of its architecture, it's resilience to hardware errors and its ergonomic use from the end-user writing quantum circuits to the quantum engineer operating the prototype hardware.

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**Author:** Mr BRETAUD, David (Imperial College London, University of Sussex)

**Co-authors:** Mr VALAHU, Christophe (Imperial College London, University of Sussex); Dr HILE, Sam (University of Sussex); Dr WEIDT, Sebastian (University of Sussex); Prof. HENSINGER, Winfried (University of Sussex)

**Presenter:** Mr BRETAUD, David (Imperial College London, University of Sussex)

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