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Towards measurement-based blind quantum computing with trapped ions

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In the framework of blind quantum computing, quantum computations can be delegated to an untrusted server while ensuring privacy and verifying their correctness [1]. For an experimental demonstration, we consider the practical case of measurement-based blind quantum computation (MBBQC) on a continuously rebuilding cluster state. This protocol involves sequential measurements and remote state preparation, necessitating real-time feedback from the client.
We present progress towards implementing MBBQC protocols in our trapped-ion quantum network [2]. In this network, 88Sr+ is entangled with a spontaneously emitted photon whose polarisation can be manipulated and measured by the client, thus implementing remote state preparation. By adding mixed-species operations using additional 43Ca+, we can create a continuously rebuilding cluster state with sufficient coherence time, as required for MBBQC.

[1] Private quantum computation: an introduction to blind quantum computing and related protocols, J. F. Fitzsimons, npj Quantum Information 3.1 (2017)
[2] High-Rate, High-Fidelity Entanglement of Qubits Across an Elementary Quantum Network, L. J. Stephenson, Physical Review Letters 124.11 (2020)

Authors: NICHOL, Bethan (University of Oxford); NADLINGER, David; DRMOTA, Peter (University of Oxford); BALLANCE, Chris (University of Oxford); LUCAS, David (University of Oxford); MAIN, Dougal (University of Oxford); ARANEDA, Gabriel; SRINIVAS, Raghavendra (University of Oxford)

Presenter: DRMOTA, Peter (University of Oxford)

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