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Freely Scalable Quantum Technologies using Cells of 5-to-50 Qubits with Very Lossy and Noisy Photonic Links NAOMI NICKERSON, Imperial College London, JOSEPH FITZSIMONS, Center for Quantum Technologies, National University of Singapore, SIMON BENJAMIN, Oxford University —
Exquisite quantum control has now been achieved in small ion traps, in nitrogen-vacancy centres and in superconducting qubit clusters. We can regard such a system as a universal cell with diverse technological uses from communication to large-scale computing, provided that the cell is able to network with others and overcome any noise in the interlinks. We show that loss-tolerant entanglement purification makes quantum computing feasible with the noisy and lossy links that are realistic today: With a modestly complex cell design, and using a surface code protocol with a network noise threshold of 13.3%, we find that interlinks which attempt entanglement at a rate of 2 MHz but suffer 98% photon loss can result in kilohertz computer clock speeds (i.e. rate of high fidelity stabilizer measurements). Improved links would dramatically increase the clock speed. Our simulations employed local gates of a fidelity already achieved in ion trap devices.

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