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Multiqubit Decoherence in Ion-trap Quantum Computation THOMAS MONZ, PHILIPP SCHINDLER, JULIO T. BARREIRO, MICHAEL CHWALLA, University of Innsbruck, Institute of Experimental Physics, BILL COISH, University of Waterloo, Institute for Quantum Computing, MARKUS T. HENNRICH, RAINER BLATT, University of Innsbruck, Institute of Experimental Physics — We will report on the realisation of high-fidelity Schroedinger- Cat states with more than six qubits in a string of $^{40}Ca^{+}$ ions stored in a linear ion trap. We achieved fidelities with the target states exceeding 95% for up to four ions and 88% for six ions. These high fidelities allow to investigate decoherence of highly entangled quantum states in the presence of collective dephasing, the predominant source of decoherence in ion-trap based and other physical realizations of quantum computation. Assuming the noise to be Gaussian and stationary, we derive and experimentally confirm a model that predicts an exponential decay of the state fidelity that scales as N^2 where N is the number of qubits. Such a scaling behaviour has severe effects on quantum computation and related fields, such as metrology.

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