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High-speed linear optics quantum computing via active feed-forward ROBERT PREVEDEL, PHILIP WALTHER, FELIX TIEFENBACHER, PASCAL BOEHI, RAINER KALTENBAEK, THOMAS JENNEWEIN, ANTON ZEILINGER, Institute for Experimental Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria — Quantum computers promise to be more efficient and powerful than their classical counterparts. In the one-way quantum computer model, a sequence of measurements processes qubits, which are initially prepared in a highly entangled cluster state. The key advantage of this scheme over the standard network approach of quantum computing is that inherent, randomly induced measurement errors can classically be fed-forward and corrected by adapting the basis of subsequent measurements. Active feed-forward is therefore crucial to achieve deterministic quantum computing once a cluster state is prepared. We have experimentally realized such a deterministic one-way quantum computation scheme by employing up to three active-switching Electro-Optical Modulators (EOM) in a four-qubit cluster state encoded into the polarization state of four photons. Using these switches we demonstrate deterministic one- and two-qubit gate operations as well as Grover's quantum search algorithm. A major advantage of optical quantum computation is the very short time for one computational step achievable by using these ultra-fast switches. With present technology this feed-forward step can be performed in less than 150 nanoseconds.

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