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Entanglement of remote transmon qubits by concurrent measurement using Fock states A. NARLA, M. HATRIDGE, S. SHANKAR, Z. LEGHTAS, K.M. SLIWA, B. VLASTAKIS, E. ZALYS-GELLER, Department of Applied Physics, Yale University, M. MIRRAHIMI, Department of Applied Physics, Yale University and INRIA Paris Rocquencourt, M.H. DEVORET, Department of Applied Physics, Yale University — A requirement of any modular quantum computer is the ability to maintain individual qubits in isolated environments while also being able to entangle arbitrary distant qubits on demand. For superconducting qubits, such a protocol can be realized by first entangling the qubits with flying microwave coherent states which are then concurrently detected by a parametric amplifier. This protocol has a 50% success probability but is vulnerable to losses between the qubits and the amplifier which reduce the entanglement fidelity. An alternative is to use itinerant Fock states, since losses now tend to reduce the success probability of creating an entangled state but not its fidelity. Such single-photon protocols have been implemented in trapped-ion and NV-center experiments. We present such a protocol tailored for entangling two transmon qubits in the circuit QED architecture. Each qubit is entangled with a Fock state of its cavity using sideband pulses. The Fock states leak out of the cavity, interfere on a beam-splitter which erases their which-path information, and are subsequently detected using a novel photo-detector realized by another qubit-cavity system. Simulations suggest that we can realize a high-fidelity entangled state with a success probability as large as 1%.

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