Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Bottom-up construction of artificial molecules for superconducting quantum processors STEFANO POLETTO, CHAD RIGETTI, JAY M. GAMBETTA, SETH MERKEL, JERRY M. CHOW, ANTONIO D. CORCOLES, JOHN A. SMOLIN, JIM R. ROZEN, GEORGE A. KEEFE, MARY B. ROTHWELL, MARK B. KETCHEN, MATTHIAS STEFFEN, IBM T.J. Watson Research Center — Recent experiments on transmon qubits capacitively coupled to superconducting 3-dimensional cavities have shown coherence times much longer than transmons coupled to more traditional planar resonators. For the implementation of a quantum processor this approach has clear advantages over traditional techniques but it poses the challenge of scalability. We are currently implementing multi-qubits experiments based on a bottom-up scaling approach. First, transmon qubits are fabricated on individual chips and are independently characterized. Second, an artificial molecule is assembled by selecting a particular set of previously characterized single-transmon chips. We present recent data on a two-qubit artificial molecule constructed in this way. The two qubits are chosen to generate a strong Z-Z interaction by matching the 0-1 transition energy of one qubit with the 1-2 transition of the other. Single qubit manipulations and state tomography cannot be done with "traditional" single tone microwave pulses but instead specifically shaped pulses have to be simultaneously applied on both qubits. Coherence times, coupling strength, and optimal pulses for decoupling the two qubits and perform state tomography are presented

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Date submitted: 06 Dec 2011 Electronic form version 1.4