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Silicon quantum processor with robust long-distance qubit coupling GUILHERME TOSI, FAHD A. MOHIYADDIN, STEFANIE TENBERG, UNSW Australia, RAJIB RAHMAN, GERHARD KLIMECK, Purdue University, ANDREA MORELLO, UNSW Australia — Recent demonstration of high-fidelity quantum operations using donors in silicon [1] has ignited an urge in scaling up these systems to a multi-qubit device. However, multi-qubit operations and long-distance donor coupling remain a formidable challenge. We will present a novel scalable design for a silicon quantum processor [2] that allows for long-distance fast 2-qubit gates and does not require precise donor placement. Quantum information is encoded into either the nuclear-spin or the flip-flop states of electron and nucleus. It can be manipulated by biasing the electron wavefunction to be shared between donor and interface, in such a way that the hyperfine interaction strongly depends on electric fields. The qubits are spaced by hundreds of nanometers and coupled through direct electric dipole interactions and/or photonic links. All operations are performed at second-order clock transitions, preserving the qubits' outstanding coherence times. A large number of qubits can then be interconnected in a network robust against errors. Prototypical devices are fabricated to demonstrate the processor's basic units. [1] J. T. Muhonen, et.al. Nature Nanotechnol. 9, 986 (2014). [2] G. Tosi, et.al. arXiv:1509.08538 (2015).

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