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Electron shuttling in phosphorus donor qubit systems[1] N. TOBIAS JACOBSON, JOHN KING GAMBLE, ERIK NIELSEN, RICHARD P. MULLER, WAYNE M. WITZEL, INES MONTANO, MALCOLM S. CARROLL, Sandia National Laboratories — Phosphorus donors in silicon are a promising qubit architecture, due in large part to their long nuclear coherence times and the recent development of atomically precise fabrication methods. Here, we investigate issues related to implementing qubits with phosphorus donors in silicon, employing an effective mass theory that non-phenomenologically takes into account inter-valley coupling. We estimate the significant sources of decoherence and control errors in this system to compute the fidelity of primitive gates and gate timescales. We include the effects of valley repopulation during the process of shuttling an electron between a donor and nearby interface or between neighboring donors, evaluating the control requirements for ensuring adiabaticity with respect to the valley sector.

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