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Benchmarking of Quantum Control in ESR GUANRU FENG, KYUNGDEOCK PARK, FRANKLIN H CHO, BRANDON BUONACORSI, ROBABEH RAHIMI, JONATHAN BAUGH, RAYMOND LAFLAMME, Institute for Quantum Computing, University of Waterloo — Quantum error correction is essential for realizing scalable quantum computation. Key ingredients for quantum error correction are highly polarized ancilla qubits and high-fidelity quantum control. While NMR quantum processors have demonstrated high control fidelity, the requirement to prepare highly polarized spin qubits on demand is a major challenge. Electron-nuclear hyperfine coupled spin systems provide a possible solution: electrons can be fully polarized at accessible fields and temperatures, and their polarization is typically reset much faster than nuclei by spin relaxation. This makes open system cooling methods, such as heat bath algorithm cooling, possible. In this talk, I will describe our recent efforts to improve the precision of microwave control in a custom electron spin resonance spectrometer. In particular, we use randomized benchmarking of quantum gates to quantify control errors, and carefully take into account the resonator transfer function in correcting pulses. Moreover, we implement a protocol that distinguishes coherent and incoherent errors, which gives deeper insight into the nature of the remaining control imperfections and how to address them.

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