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Precision Quantum Control with Trapped $^{171}Yb^+$ Ions ALEXANDER SOARE, DAVID HAYES, JAMES MCLOUGHLIN, Univ of Sydney, XINGLONG ZHEN, Tsinghua University, MICHAEL LEE, M.C. JARRAT, HARRISON BALL, TODD GREEN, MICHAEL BIERCUK, Univ of Sydney, QUANTUM CONTROL LABORATORY TEAM — We present our recent work in developing and characterizing novel methods for quantum error suppression using trapped $^{171}Yb^+$ ions as a model experimental platform. A flexible, robust microwave system allows us to access the 12.6 GHz, hyperfine qubit manifold in trapped $^{171}Yb^+$. The ultra low phase noise characteristics of our source allow the realization of free-evolution coherence times in excess of three seconds, and operational fidelities $F>99.99\%$, characterized by randomized benchmarking. Starting from this baseline, we leverage high-bandwidth vector modulation capabilities to experimentally validate our recent theoretical work developing Walsh-modulated control operations for error-resilient single-qubit control in the presence of synthesized noise. This theory is based on a generalized filter-transfer-function formalism useful for predicting the fidelity of arbitrary operations in the presence of general Gaussian noise. We provide the first experimental validation of this formalism, showing good agreement between experimental measurements and theoretical predictions with no free parameters. These demonstrations support the notion of physical-layer error evasion as an efficient means to realize high-fidelity quantum control across a wide range of quantum technologies.

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