Fast Room-Temperature Phase Gate on a Single Nuclear Spin in Diamond\footnote{Research was supported by the Sloan and Packard Foundations, the National Science Foundation through awards DMR-0819860 and DMR-0846341, and the Army Research Office through PECASE award W911NF-08-1-0189.}

S. SANGTAWESIN, T.O. BRUNDAGE, J.R. PETTA, Department of Physics, Princeton University — Nuclear spins support long lived quantum coherence due to weak coupling to the environment, but are difficult to rapidly control using nuclear magnetic resonance as a result of the small nuclear magnetic moment. We demonstrate a fast \( \sim 500 \text{ ns} \) nuclear spin phase gate on a \(^{14}\text{N}\) nuclear spin qubit intrinsic to a nitrogen-vacancy center in high purity diamond \cite{Sangtawesin2014}. This phase gate is achieved by utilizing electron-nuclear hyperfine interaction. By driving off-resonant Rabi oscillations on the electronic spin, we can generate an arbitrary phase gate on the nuclear spin. We also demonstrate that repeated applications of \( \pi \)-phase gates can bang-bang decouple the nuclear spin from the environment, locking the spin state for up to \( 140 \mu \text{s} \).