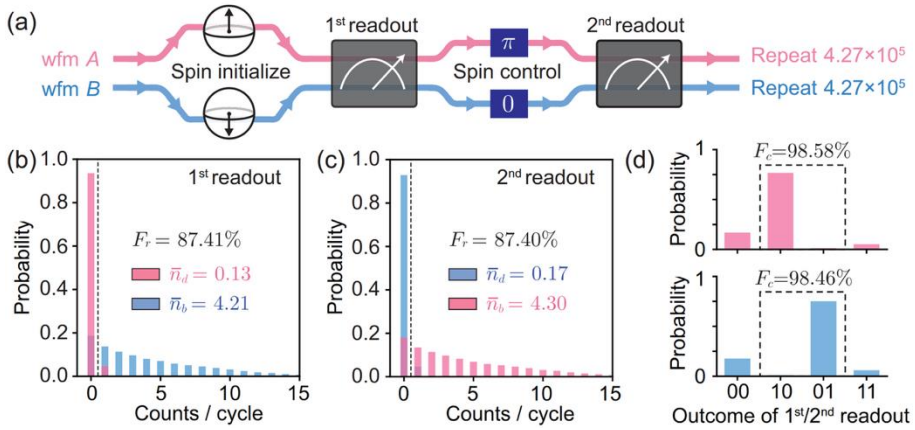
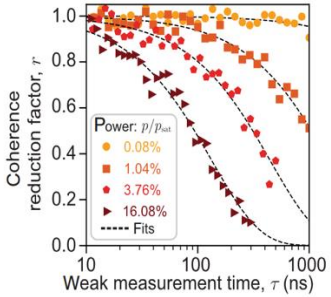
Single-Shot Readout and Weak Measurement of a Tin-Vacancy Qubit in Diamond

Scientific Achievement

We show that high-fidelity readout is compatible with rapid microwave spin control, demonstrating a favorable parameter regime for use of the SnV− center as a high-quality spin-photon interface



Single-shot readout of a single electron spin. (a) Readout sequence repeated for 4.27×10^5 cycles. (b,c) Count distribution of 1st and 2nd readouts showing single-shot readout fidelity of 87.4%. (d) Conditional fidelity of a 2-shot readout sequence of 98.5%.



Measurement of the ratio of remaining to initial coherence, $r = |\hat{\rho}'_{\uparrow\downarrow}|/|\hat{\rho}_{\uparrow\downarrow}|$ where $|\hat{\rho}^{(\prime)}_{\uparrow\downarrow}|$ is the off-diagonal density matrix element before (after) measurement.

Significance and Impact

Color-center qubits have been recognized as an advantageous platform for the realization of quantum technologies, and, in particular, quantum networks. Today, state-of-the-art quantum networks consist of three nodes with single nitrogen-vacancy center (NV^-) in diamond as nodes. However, the NV^- is not the optimal qubit for future quantum networks because of its low entanglement generation rate. Tin-vacancies (SnV^-) are a favorable alternative due to its large ground state splitting of 820 GHz, allowing for coherent spin control at several Kelvin.

Research Details

- SnV^- were created by ion implantation followed by high-temperature annealing in ultra-high vacuum.
- Demonstrated measurement of a single SnV−electronic spin with a single-shot readout fidelity of 87.4%, which can be further improved to 98.5% by conditioning on multiple readouts.

Rosenthal, E. I.; Biswas, S.; Scuri, G.; Lee, H.; Stein, A. J.; Kleidermacher, H. C.; Grzesik, J.; Rugar, A. E.; Aghaeimeibodi, S.; Riedel, D.; Titze, M.; Bielejec, E. S.; Choi, J.; Anderson, C. P.; Vučković, J. Single-Shot Readout and Weak Measurement of a Tin-Vacancy Qubit in Diamond. *Physical Review X* **2024**, *14* (4).

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