

Quantum metrology enhanced by repetitive quantum error correction

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The accumulation of quantum phase in response to a signal is the central mechanism of quantum sensing, as such, loss of phase information presents a fundamental limitation. For this reason approaches to extend quantum coherence in the presence of noise are actively being explored. Here we experimentally protect a room-temperature hybrid spin register against environmental decoherence by performing repeated quantum error correction whilst maintaining sensitivity to signal fields. We use a long-lived nuclear spin to correct multiple phase errors on a sensitive electron spin in diamond and realize magnetic field sensing beyond the timescales set by natural decoherence. The universal extension of sensing time, robust to noise at any frequency, demonstrates the definitive advantage entangled multi-qubit systems provide for quantum sensing and offers an important complement to quantum control techniques. In particular, our work opens the door for detecting minute signals in the presence of high frequency noise, where standard protocols reach their limits.

- [41.95.+m Quantum magnetometry](#) [3]
- [Result](#) [4]
- [SIQS](#) [5]
- [16.10.Ns Nuclear spins](#) [6]
- [13.70.+f Quantum feedback/filtering and control](#) [7]
- [16.20.Dc Defect centers in diamonds](#) [8]

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[4] <http://qurope.eu/category/attribute/result>

[5] <http://qurope.eu/category/projects/ips/siqs>

[6] <http://qurope.eu/category/qics/10-quantum-computation/16-implementations-condensed-matter/1610ns-nuclear-spins>

[7] <http://qurope.eu/category/qics/10-quantum-computation/13-defeating-errors/1370f-quantum-feedback-filtering-and-control>

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