

## A single ion as a shot noise limited magnetic field gradient probe

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It is expected that ion trap quantum computing can be made scalable through protocols that make use of transport of ion qubits between sub-regions within the ion trap. In this scenario, any magnetic field inhomogeneity the ion experiences during the transport, may lead to dephasing and loss of fidelity. Here we demonstrate a scalable way to measure the magnetic field gradient inside a segmented ion trap, by transporting a single ion over variable distances. We attain a relative magnetic field sensitivity of  $\Delta B/B_0 = 5 \cdot 10^{-7}$  over a test distance of 140  $\mu\text{m}$ , which can be extended to the mm range, still with sub  $\mu\text{m}$  resolution. A fast experimental sequence is presented, facilitating its use as a magnetic field gradient calibration routine, and it is demonstrated that the main limitation is the quantum shot noise.

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