Assessment of a Nitrogen-Vacancy Magnetometer for Use in Precision Ultracold Neutron Experiments

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The UCNτ experiment aims to improve current measurements of the mean free neutron lifetime. One innovation of UCNτ is that a large-volume magneto-gravitational trap is used to prevent polarized ultracold neutrons (UCN) from interacting with the walls of the trap, which keeps the UCN from being lost to material interactions. Thus, the UCNτ experiment can count neutrons lost specifically to beta decay without the need for large correction. However, small defects in the magnetic field could still potentially contribute to non-beta decay losses of UCN, so it is important to be able to detect these defects and account for them. The automated Hall probe currently in use for mapping the magnetic field inside the trap has a resolution on the order of 1 mm and requires weeks to measure magnetic field gradients in the large volume of the trap. A possible improvement would be a Nitrogen-Vacancy (NV) fluorescence microscopy setup which could increase the spatial resolution at which field data can be collected while also increasing the speed of data collection. Nitrogen vacancy magnetometers are currently capable of sensitivities exceeding pT/sqrt(Hz) over a wide dynamic range, and with superior spatial resolution. In order to investigate this technology, a typical NV magnetometer was constructed and calibrated using a Halbach element similar to the ones that form the UCNτ trap. Results of this work will be described.