Tests of a SQUID-based ^{3}He Co-magnetometer Readout for a Neutron EDM Experiment

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Abstract — In a new experimental search for an electric dipole moment of the neutron, polarized ^{3}He will occupy the same volume as the neutrons under study to serve as co-magnetometer, enabling precise corrections for ambient magnetic field drifts that would otherwise severely limit the reach of the experiment. One of the two methods that will be built into the apparatus is to directly detect the ^{3}He magnetization signal using SQUID based gradiometers. In a previous publication (*IEEE Trans. Appl. Supercond*., 23 (2013), 2500104), we proposed a candidate design for a SQUID system consistent with experimental requirements and the planned nEDM apparatus. Because the ^{3}He precession signal is at approximately 100 Hz, signal contamination from low frequency magnetic noise could adversely affect the co-magnetometer readout precision; the addition of reference magnetometer channels to the SQUID system could mitigate this risk. In this paper, we present noise studies of the candidate SQUID system in a test apparatus and demonstrate effective ambient magnetic field noise cancellation with the implementation of reference channels. In addition, we report a demonstration of low-noise SQUID operation while a nearby photomultiplier tube and its high voltage power supply are operating.

Keywords (Index Terms) — EDM, magnetic-resonance, ^{3}He co-magnetometer, SQUID, magnetic field noise, reference channel