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Magnetic-field stability in unshielded Helmholtz coils: Update[1]

DAVID J. MORIN, SHENG ZOU, ZAHRA ARMANFARD, TREVOR FOOTE, JONATHAN MUSCHELL, KATRINA SAAM, BRIAN SAAM, Washington State University — Last year's poster [1] compared several current-stabilization techniques for driving a Helmholtz coil pair, a common setup employed in spin-exchange optical pumping (SEOP) and other table-top experiments. We previously achieved 100-ppm stability on time scales between a few seconds out to an hour by employing an external comparator driving the gate of a FET in series with the coils. We refined this design by (a) adding a cover to reduce ambient temperature fluctuations, (b) attaching a capacitive filter to the output of the comparator to limit the high-frequency response, and (c) placing temperature-sensitive external circuitry (sensing resistors, FET, comparator feedback resistor) onto a water-chilled aluminum block, temperature-controlled at a few degrees below room temperature to 0.1 C. We now achieve 2-ppm current stability on time scales ranging from few seconds out to an hour, which allows us to use a fluxgate magnetometer (max. field 1 G) **outside** the coils to separately correct ambient-magnetic-field shifts and drifts, e.g., from the current-carrying wires powering the building elevator. If we use the magnetometer to correct for these additional ambient fluctuations, the magnetic-field stability approaches the 2-ppm current stability over similar time scales in an unshielded environment. [1] D.J. Morin, et al., Poster Abstract S01 16, Bull. Amer. Phys. Soc. **64**(4), 191 (2019).

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