Magnetic Field Control for Ultracold Strontium Experiments

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The narrow intercombination line ($^1S_0 \rightarrow {}^3P_1$) of strontium has a linewidth of $2\pi \times 7.5$ kHz and a lifetime of 21 µs. The long lifetime provides us with a platform to experimentally investigate the transient light transmission effects in a cold atomic cloud. For optically thick medium, the forward transmission of a resonant laser can be almost 100% during the transient period when laser is abruptly turned on or off [1]. In experiments where a precise and well controlled detuning of the laser is required, the fluctuations of the magnetic force has to be checked and controlled. We have implemented a feedback control system (see figure 1) that can compensate for the fluctuations of the magnetic field down to the submilligauss level.

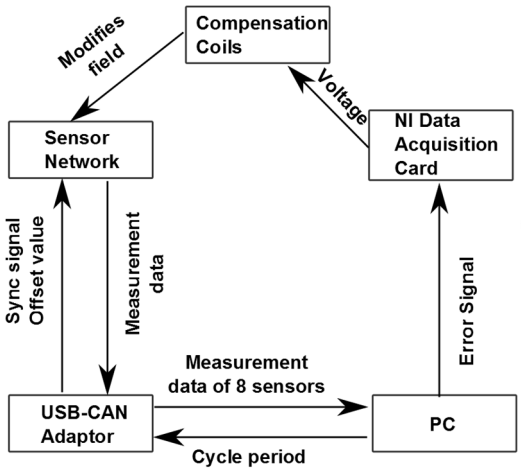

Figure 1 Flowchart of the active magnetic field control system.

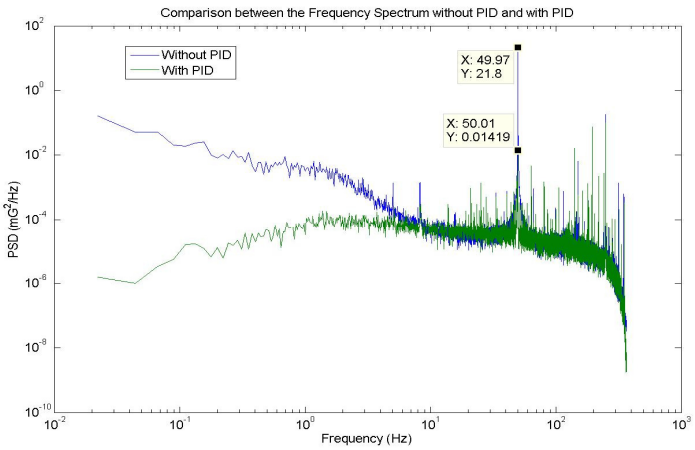

Figure 2 Noise spectral density before and after PID control

A network of 8 sensors is used to measure the magnetic field at the cold atomic cloud. These sensors measure all three components of the field, with a resolution of 40 µG. The system has a sampling rate of 700 Hz; compensation of A.C. 50 Hz and higher harmonics magnetic field disturbances is possible. Figure 2 shows the capability of this system in suppressing the low frequency and 50 Hz magnetic field noise picked up by the sensor array.

References:

[1] M. Chalony, R. Pierrat, D. Delande and D. Wilkowski, Phys. Rev. A **84,** 011401(R) (2011).