Active magnetic-field stabilization system with magnetic sensor array

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A magnetically-quiet environment is important for measuring faint magnetic-field signals. Given that the environmental magnetic field noise is higher at lower frequencies, an active magnetic-field stabilization system is set up outside the magnetic shield. Increasing the number of magnetic sensors can improve the uniformity of the compensated residual magnetic field, which helps to maintain the stability of the magnetization state of the magnetic shield [1]. To theoretically measure the system performance at different positions around the magnetic shield, we develop the model based on single magnetic sensor to magnetic sensor array [2]. From this model, the positions of the magnetic sensor array can be optimized to improve the system performance with a limited number of magnetic sensors. The optimized system suppresses the magnetic-field noise caused by subways (∼100 nT) to within 10 nT. This noise rejection ratio is mainly limited by the system's ability to generate a compensating magnetic field, which can be further improved by designing more complex coils.

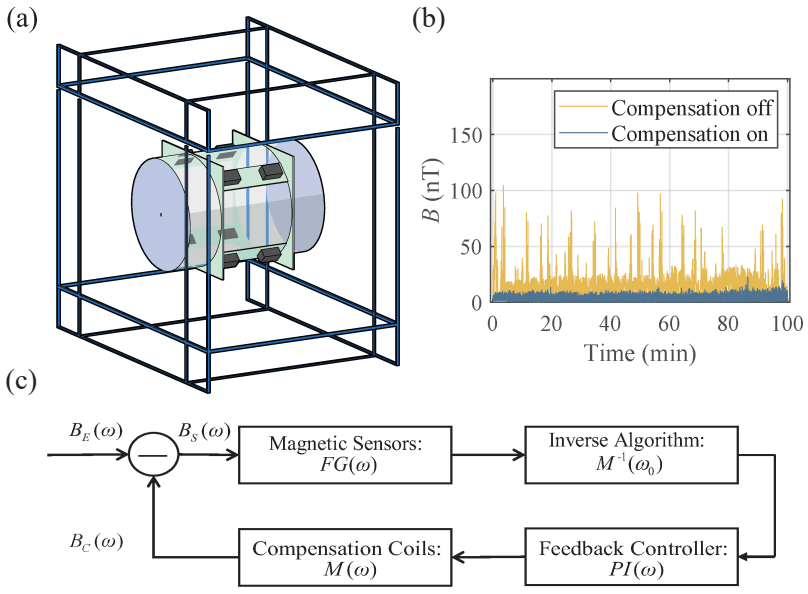

Figure 1. (a) Experimental apparatus. (b) The magnitude of magnetic field measured by the magnetic sensor (not involved in active magnetic-field stabilization) before and after compensation. (c) The block diagram of the active magnetic-field stabilization system.

[1] C. Abel, N.J. Ayres, G. Ban, K. Bodek, V. Bondar, T. Bouillaud, E. Chanel, J. Chen and W. CHen, A large 'Active Magnetic Shield'for a high-precision experiment: nEDM collaboration, The European Physical Journal C **83**, 1061 (2023).
[2] R. Zhang, Y. Ding, Y. Yang, Z. Zheng, J. Chen, X. Peng, T. Wu and H. Guo, Active magnetic-field stabilization with atomic magnetometer, Sensors **20**, 4241 (2020).