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Effect on temperature dependence for long-term stable control of the magnetic field at sub-ppm using superconducting magnet for MRI

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In MuSEUM experiment at J-PARC, we are working on precise measurements of the muon hyperfine structure in the ground state. We are currently developing a device for experiments in a high magnetic field (1.7 T) in order to achieve higher precision than the previous experiments. For high-precision measurement of muon hyperfine structure, it is essential to improve the magnetic field accuracy in the muon capturing region (200 mm-300 mm area inside the rotating ellipse). In this experiment, it is required to keep the long-term stability of the magnetic field at 0.2 ppm peak-to-peak (hereinafter referred to as pp) during the experiment period while the spatial homogeneity is controlled below 0.2 ppm pp by adjusting the magnetic field using magnetic materials.

Long-term measurements of the magnetic field showed that the field changed with temperature. The factors that cause the magnetic field to change with temperature are considered to be the thermal expansion of the jig and the temperature dependence of the magnetization. Therefore, the magnetic field was measured while the jig was heated. From this result, we evaluate the temperature dependence of the magnetic field. In addition, we were able to separate the two factors of the temperature dependence of the magnetic field, which was concluded experimentally, from the simulation. From the above study, we discuss guidelines for improving the current system to achieve long-term stability of 0.2 ppm p-p for MUSEUM experiment.

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