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A Study on Temporal Stabilization of Magnetic Flux Focused by a Superconducting Magnetic Lens

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Superconducting magnets are required to be smaller and to use less electrical energy to generate higher magnetic fields for many applications. As a solution, Zhang et al. [1] suggested a magnetic lens using high-temperature superconducting bulks. However, the focused magnetic field kept decreasing at a rate of about 1.3%/hour even if the current flowing in the outer superconducting coil kept constant for 20 minutes. This study examines to study a method for stabilizing the focused magnetic fields. A magnetic lens was fabricated with three GdBCO bulks. The magnetic lens was inserted in to a bore of MgB2 superconducting coil with an inner diameter of 220 mm. The MgB2 coil and the magnetic lens were cooled down. The MgB2 coil was energized up to 300 A. The current was kept constant afterward. The temperatures of the three bulks were controlled using heaters, and the temperatures were reduced at the same time when energization currents reached a value of an ignition current, which were used as a parameter and set from 200 A to 285 A. The magnetic fields were measured during the operation. At the constant current of 300 A for 20 minutes, the minimum reduction rate of the magnetic field was 237 ppm/hour for the ignition current of 285 A. In addition, a combination of the temperature-reduction method and current reversal sweep method [2] from 300 A to 285 A was tested. The combination method decreased the reduction rate of the magnetic field at a constant current to 30 ppm/hour. The methods effectively provided higher stability of the magnetic fields. Further studies on operation and design methods for a magnetic lens can realize higher stability of the magnetic fields.
[1] Z. Y. Zhang et al., SUST, 26, (2013) 045001
[2] Y. Yanagisawa et al., Physica C, 469, 22, 1996-1999

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