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Portable Magnetic Field Mapping Measurement System based on Large-Scale Dipole Magnets

Hall probe measurement technology is a universally applied technology for the magnetic field mapping measurement of magnets. Traditional Hall probe measurement technology relies on a massive three-dimensional measurement platform, coupled with a three-dimensional adjustable magnet support frame, offering great universality and high positional accuracy in measuring medium and small magnets. However, the traditional point measurement platform faces limitations such as magnet volume, measurement environment, and the range of good field regions in the measurement of large dipole magnets, especially huge superconducting dipole magnets, leading to poor operability, low measurement efficiency, and significant errors in secondary positioning accuracy.
The High-Intensity Heavy-Ion Accelerator Facility (HIAF) is a significant national science and technology infrastructure project constructed by the Institute of Modern Physics, Chinese Academy of Sciences. To achieve high beam intensities, large aperture, high-precision dipole magnets are extensively utilised in HIAF, including the Booster Ring dipole magnets, high-precision Spectrometer Ring dipole magnets, and HIAF Fragment Separator (HFRS) dipole magnets. Consequently, an efficient, high-precision and movable magnetic field measurement system is crucial for magnetic field measurements and project construction.
Based on traditional Hall probe measurements. The new system introduces ultrasonic motors capable of operating under strong magnetic fields (<7T) to design and construct a new magnetic field measurement system. The new measurement system primarily includes a rail base, a moving platform, and a rotating shaft. For the first time in the magnetic field measurement system, a motion mode combining translational and rotational movements was adopted, replacing the traditional movement method based on Cartesian coordinate positioning. The new system has a translational stroke of 4300 mm and a rotating shaft length of 280 mm (replaceable), enabling high-precision and rapid measurement of large dipole magnet fields.
After system debugging, a magnetic field measurement of an SRing dipole magnet was conducted, and the testing accuracy and efficiency of the test system were verified through comparison and analysis with traditional Hall probe measurement systems. On this basis, magnetic field distribution and integral excitation curve measurements of an HFRS warm iron superconducting dipole magnet were carried out and completed, achieving the testing objectives for the warm iron superconducting dipole magnet.

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