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Development of A Prototype Kicker Magnet for Beam Distribution System of SHINE

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X-ray Free Electron Laser (XFEL) facility based on electron linear accelerator (LINAC) is regarded as one kind of the fourth-generation light source with the characteristics of high intensity, exceptional brightness, ultra-short pulse duration, and spatial coherence. Shanghai high repetition-rate XFEL and extreme light facility (SHINE) is the first hard XFEL based on a superconducting accelerated structure in China, is now under development at the Shanghai Advanced Research Institute, Chinese Academy of Sciences. Beam distribution switchyard is located midway between the endpoint of linear accelerator (LINAC) and the entrance of undulator lines for distributing electron beams within specified mode. The kicker-septum section is used for distributing electron bunches to three different undulator lines. Kicker magnets are the key components to distribute the beam into the different undulator beam lines. For more flexible distribution among the three undulator lines, the kicker should be able to perform bunch-by-bunch kick to the electron beam and, what's more, should also be programmable for arbitrary distribution patterns. In order to reduce power consumption, an inductance-type single-turn coil magnet in a vacuum chamber is adopted for beam distribution. The design considerations of single-turn coil kicker magnet are described. This study presents the design considerations of the single-turn coil kicker magnet. The design considerations of choice for material of iron core, thermal analysis and structure design are described. Simulation results of Opera and Flotherm show that the magnetic field and thermal distribution can meet the requirement. Theoretically analysis and program simulation have verified the feasibility of the kicker magnet basic structure. At the end, relevant experimental results are also presented. The experiment results show that we have developed a kicker magnet mostly satisfying our requirements for the SHINE project.

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