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Design and optimization of combined-function quadrupole-sextupole magnets

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A lightweight superconducting (SC) gantry with large momentum acceptance is under development at Huazhong University of Science and Technology (HUST). Three types of combined-function quadrupole-sextupole (QS) magnets are used to suppress the chromatic dispersion for the large momentum acceptance. Moreover, the size and weight of the gantry can be further reduced. This paper introduces the design and optimization of the QS magnets with an adjustable sextupole to quadrupole (S/Q) field ratio. A comparative study on the pole shaping and asymmetric excitation method is performed. Considering the magnetic field quality deterioration caused by the asymmetry of the pole face, the contour of the pole face and the pole end chamfer are optimized to minimize the harmonics of the QS magnets. After several iterations, the maximum harmonics of the QS2 magnet can be reduced to 1E-03. In addition, we investigate different S/Q ratios as well as the magnetic center shift caused by the asymmetric excitation.

Primary author: Mr GENG, Chen (State Key Laboratory of Advanced Electromagnetic Engineering and Technology)

Co-authors: Dr WENJIE, Han (Huazhong University of Science and Technology); Mr RUNXIAO, ZHao (State Key Laboratory of Advanced Electromagnetic Engineering and Technology); Mr YICHENG, Liao (State Key Laboratory of Advanced Electromagnetic Engineering and Technology); Prof. BIN, Qin (State Key Laboratory of Advanced Electromagnetic Engineering and Technology)

Presenter: Mr GENG, Chen (State Key Laboratory of Advanced Electromagnetic Engineering and Technology)

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