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Optimization of the Radiation Resistant Quadrupole Magnets for the SIS-100 Accelerator of the FAIR Project

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The SIS-100 is a charge particle accelerator developed as a part of the challenging international project Facility for Anti-proton and Ion Research (FAIR) taking place in Darmstadt, Germany. The ion optics of the SIS-100 accelerator includes superconducting and normal conducting quadrupole magnets. To fulfill the requirements of the field quality in the magnet aperture it is necessary to find an optimal pole tip shape as well as an optimal configuration of the coil system. Requirements for radiation resistant magnets installed near the entrance of the SIS-100 accelerator combine high quality of the field distribution, maximum field intensity at the pole tip of more than 1.3 T, and a wide range of the flux density variation. We used a specially developed optimization procedure for designing the magnet cross section. The pole border line is described by a superposition of hyperbolic functions corresponding to different Fourier components of the magnetic field expansion. Strong correlation between amplitudes of the pole shape and field harmonics enables high performance of the optimization algorithms. The developed procedures have been used for designing a quadrupole magnet with especially wide range of the flux density variation. Integral 3D properties of the developed quadrupoles were ensured by optimization of the magnet end chamfers.

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