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Advanced Multipoles for Accelerator Magnets

Theoretical Analysis and Their Measurement

Springer

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Contents

Abstract

Studying the transversal beam dynamic of accelerators requires a sound description of the magnetic field homogeneity. Cylindrical circular multipoles, typically used, have shortcomings if the beam aperture is elliptical or the curvature of the particle path has to be taken into account.

Within this treatise, advanced multipoles are described besides their application on numerical data and measurements. These multipoles allow describing the field consistently for elliptical and toroidal reference volumes and estimating the artefacts of the field deterioration. The higher precision of the field description gives better estimates of the beam dynamics and permits one to better estimate the effects of field inhomogeneity than was available before. Thus, the presentation itself does not create spurious artefacts; the margin normally reserved for these artefacts can be reduced due to the better understanding. This research was first necessitated by the R&D for developing the SIS100 magnets for FAIR, then used for describing the field homogeneity of the magnets next to developing appropriate measurement methods.

These findings are then further elaborated demonstrating their usefulness for describing the field of real magnets and their advantages over the cylindrical circular ones. Furthermore, measurement methods for obtaining the coefficients of these advanced multipoles have been developed and are described within this treatise. All these developments provided a basis for the field measurements of the first SIS100 model and first of series dipole magnets. The research results are then complemented with data obtained on the first SIS100 model and first of series dipole magnets.