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Impacts of strongly curved magnetic multipoles on compact synchrotron dynamics

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Superconducting curved magnets are able to reduce accelerator footprints by producing strong fields (>3T) for applications such as carbon ion therapy, however the effect of strongly curved magnetic multipoles and fringe fields on accelerator beam dynamics is not fully understood. This is especially important in compact synchrotrons, where fringe fields can significantly affect beam quality and long-term beam stability. To establish tolerances on these higher order harmonic errors, an electromagnetic model of a superconducting, strongly curved canted-cosine-theta (CCT) combined-function dipole is analysed. The CCT magnet is studied as a potential option for the main dipole of a 27m circumference carbon ion therapy synchrotron within the Next Ion Medical Machine Study (NIMMS) at CERN and the European project HITRIplus. Curved magnetic multipoles are modelled in MAD-X and PTC; results are presented and compared with particle tracking through the magnet's 3D fieldmap in Zgoubi for additional investigation of non-linear effects. Preliminary assessment of the performance of the synchrotron subject to the tolerances on the harmonic errors is given with discussion for the suitability of the synchrotron for clinical applications.

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Footnotes

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