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3D modeling of the decapole corrector for the FAIR project

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GSI (Darmstadt) together with a large international scientific community, among the members of which is the Budker Institute of Nuclear Physics, are engaged in the development of equipment and the construction of the CR (Collector Ring), which is part of the FAIR project.
Detailed calculations of CR in the isochronous mode show that the inhomogeneity of magnetic fields in dipole magnets leads to a deviation of the time of flight of particles by almost the same relative value. The quality of the field in CR dipole magnets, at best, can be improved to a level $dB/(B(x))\tilde{}2\cdot10\hat{}(-4)$. In general, there is no need for the field quality of each dipole to reach such a high level, since the field integral must be compensated for over a full revolution in CR.
The most critical are the deflections of particles with different momentum. The effect introduced by different multipole distributions at different heights in a dipole magnet will be averaged by vertical betatron oscillations. But, in the case of a closed dispersion line, purely longitudinal contributions will not be averaged, and therefore they will be the largest. This means that the integral of the multipole component in one complete revolution must be corrected with high accuracy.
The sextupole and octupole correctors are already included in the CR. But the typical field distribution in an H-type magnet is characterized by a strong decapole component. However, the value of this component cannot be calculated in advance with the required accuracy, since it will change when the magnet is turned on. Therefore, a decapole corrector is required in CR. Otherwise, it will not be possible to achieve the required level of isochronism.
It was decided to use free-standing decapole magnets with a gradient integral of 182.33 $T/m\hat{}2$ and an integral decapole harmonic of $-6.75\cdot10\hat{}(-4)$.

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