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Proposed Chromaticity Correction System for RHIC

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RHIC PROJECT

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1. Introduction

This note proposes a modification of the sextupole correction system to correct some apparent inadequacies in the present sextupole correction system in RHIC.

The sextupole correction system has sextupole correctors near QF, which I will call SF correctors, and correctors near QD, which will be called SD correctors. The proposed correction system is to have two families of SF, located at alternating QF and two families of SD, located at alternating QD in every arc. The present sextupole correction system has two families of SF in the inner arc, but only one in the outer arc, and two families of SD in the outer arc but only one family in the inner arc. It will be shown below, that for certain sources of $\Delta p/p$ dependence in ν_x, ν_y, the present correction system may not be able to control the tune variation with $\Delta p/p$.

When the source of the $\Delta p/p$ dependence in ν_x, ν_y does not have the periodicity of 3, the sextupole correctors may have to be excited unequally in the different arcs.

2. Theoretical Considerations

The dependencies of ν_x, ν_y on $\delta = \Delta p/p$ may be written as

$$\nu_x = \nu_{x,0} + c_1\delta + c_2\delta^2 + \cdots$$

$$\nu_y = \nu_{y,0} + d_1\delta + d_2\delta^2 + \cdots$$

The terms which are linear in δ can be controlled with two families of sextupoles, one family of SF, and one family of SD correctors. For the quadratic terms, the dominant harmonics of the sextupole correctors are the harmonics near $2\nu_x$ and $2\nu_y$ or $n \simeq 58$ for RHIC. The harmonics near $2\nu_x$ are generated by having two families of SF correctors at alternating SF and similarly for the QD. However, the correction system should be able to generate the $2\nu_x$ harmonic with the correct phase. In the present correction system, the phase of the $2\nu_x$ harmonic is fixed by the location of the SF, SD, which were chosen to give the correct phase for a lattice with six $\beta^* = 6$ or six $\beta^* = 2$ insertions. By having two families of SF, and two families of SD in all the arcs, one can obtain any arbitrary phase for the $2\nu_x$ and $2\nu_y$ harmonics.

There are two situations where the present correction system may not be able to correct the quadratic terms in ν_x, ν_y because of its inability to obtain an arbitrary phase for the $2\nu_x$ and $2\nu_y$ harmonics:

1) When the $\Delta p/p$ dependence in ν_x, ν_y is caused by a random b_2. This ν spread can be appreciable[1] of the order of $\Delta\nu \simeq 6 \times 10^{-3}$. In this case, the source of the $\Delta p/p$ dependence in ν_x, ν_y has the periodicity of 1 and the sextupole correctors may have to be excited unequally in the different arcs.
2) When the lattice has a mixture of $\beta^* = 2$ and $\beta^* = 6$ insertions with a periodicity less than 3. These cases have not been studied yet. The case of a lattice with one $\beta^* = 2$ and five $\beta^* = 6$ insertions appears correctable with the present sextupole correction system. More complicated mixtures of $\beta^* = 2$ and $\beta^* = 6$ insertions have not been studied.

The above proposed sextupole correction needs to be simulated in a computer study.

Nothing has been said so far about the momentum dependencies of the beta functions. When the momentum dependence of the tune is corrected, the momentum dependence of the beta functions will also be corrected to a fair extent. Correcting the momentum dependence of the tune appears to be more important. The remaining momentum dependence in the beta functions will have to be tolerated, unless one is willing to add even more families of sextupoles.

[1] G. Parzen, ν–Spread due to Random Field Errors, BNL Report AD/RHIC–61 (1990).