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Effect of Sextupole Fields on the Dynamic Aperture

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Introduction

Third order resonances are generated by the random b_2 and a_2 field errors, and by the systematic b_2 due to Chromaticity Correcting Sextupoles iron Saturation at high field levels in the dipoles, and the superconductor magnetization effect at low field levels.

Do these third order resonances need Correction?

Systematic resonances occur at $\nu = 28$, $\nu = 29$. Imperfection resonances occur at $\nu = 28.6667$, 28.3333.

Systematic b_2 effects

Chromaticity Sextupoles

For earlier lattices, when just two families of sextupoles were used, early tracking by F. Dell and G. Parzen found the stability limit due to sextupoles when no other field errors were present of $A_{SL} = 53$ mm at QF (for $\varepsilon_x = \varepsilon_y$)

When 4 families of sextupoles was introduced, A_{SL} decreased to $A_{SL} = 34$ mm.

Both these results are large compared to the overall $A_{SL} \simeq 17$ mm due to all field errors.

Recent tracking studies for the present Lattices gives
$A_{SL} = 61$ mm for $\beta^* = 6$, and
$A_{SL} = 31$ mm for $\beta^* = 2$, which is to be compared with the overall A_{SL} of
$A_{SL} = 15.5$ mm for $\beta^* = 6$, $A_{SL} = 7.5$ mm for $\beta^* = 2$.

Saturation Sextupoles

A saturation sextupole of $b_2' = 6 \times 10^{-4}$ in the dipoles does not reduce the A_{SL} from its present value, $A_{SL} = 15.5$ mm, for the $\beta^* = 6$ lattice.

Random a_2, b_2 effects

The Random a_2, b_2, all by themselves (no other random errors present) gives an $A_{sL} = 25$ mm compared to the overall A_{sL} of $A_{sL} = 15.5$ mm due to all random errors for the present $\beta^* = 6$ lattice

If the random a_2, b_2 is omitted, keeping all the remaining random errors, A_{sL} is not changed from $A_{sL} = 15.5$ mm for the $\beta^* = 6$ lattice.

Tentative Conclusion

Not much is to be gained by correcting third order resonances.