MI0199

# Effect of the Measured Sextupole Moment of the Recycler Magnets on the Chromaticity and the Dynamic Aperture

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December 11, 1996

## Introduction

A recent MI note (MI0196)[1] gives the value of 17.2 Fermilab units for the measured sextupole multipole component of the long focussing recycler magnets. The value for the long defocusing magnets is -29.96 units. These values are different from those given in the MAD description of the lattice RRv9. This short note attempts to quantify the effect the measured values would have on the calculated performance of the lattice.

## Chromaticity

With the measured value of $b_2$ the chromaticity, as calculated using Tevlat, would be $\xi_x = +27, \xi_y = +28$. These should be compared with the nominal values calculated using the MAD values for the strengths (b2f= units,b2d= units) of $\xi_x = -3, \xi_y = -2$.

[1]MI-0196 Translating Measured Multipoles onto the Reference Orbit in Recycler Combined Function Magnets. S.D. Holmes December 5,1996

## Dynamic Aperture

An *estimate* of the dynamic aperture based on tracking for $10^4$ turns with no high order multipoles and $\epsilon_x = \epsilon_y$, yields a value of $\approx 180\pi mmmr$. Using the measured value of $b_2$ the calculated value of the dynamic aperture would be less then $60\pi mmmr$

## Conclusion

The performance of the Recycler Ring with the measured values of $b_2$ would be much worse than the nominal lattice described in the MAD file.

## Appendix- Conversion from $k_2$ in MAD to $b_2$

The sextupole strength of a magnet in MAD is given by the parameter

$$k_2 = (1/[B\rho]) \cdot (\partial^2 B_y/\partial x^2)$$

and (when y=0)

$$B_y = \sum B_n \cdot x^n/n!$$

The corresponding expression used at Fermilab is

$$B_y = B_0 \sum b_n \cdot x^n$$

For a bend magnet

$$B_0 \cdot l/[B\rho] = \theta$$

where $\theta$ is the bend angle and $l$ is the length of the magnet.

$$(\partial^2 B_y/\partial x^2) = B_2 = 2 \cdot B_0 \cdot b_2$$

for x=0.

$$k_2 = (1/[B\rho]) \cdot 2 \cdot B_0 \cdot b_2$$

Solving for $b_2$ we find:

$$b_2 = 0.5 \cdot (k_2 \cdot l)/\theta$$

For

$k_2 = 1.302937 \cdot 10^{-2}/m^3$

$l = 4.2672m$

$\theta = 20.851282mr$

We find

$$b_2 = 1.33/m^2 = 8.60 \cdot 10^{-4}/in^2$$

This is half the value reported in MI0196.