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Effects of Position Errors of the Magnetic Center in Dipoles

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Because of the systematic b_2 due to magnetization or iron saturation, random position errors in the magnetic center will generate a random b_1.

The b_2 due to magnetization or saturation in the dipoles is

γ	7	12	100	
b_2'	-10	-3	-6.5	$\times 10^{-4}$

The expected random b_1 in the dipoles is $b_1 = 8.4 \times 10^{-5}$/cm rms. It is hoped to reduce this b_1 by about a factor of 4 by magnet shuffling. In order to preserve this factor of 4, the random magnetic center error should lead to a random b_1 which is smaller than $b_1 = \frac{1}{4}(8.4 \times 10^{-5})$ or $b_1 = 2.1 \times 10^{-5}$/cm rms.

A 0.5 mm rms error in the magnetic center will give a random b_1 of $b_1 = 1.46 \times 10^{-5}$/cm rms.

Assuming a closed orbit error in the dipoles of 0.5 mm rms, then the magnetic center is off the closed orbit by

$$\Delta x = \sqrt{(0.5)^2 + (0.5)^2)} = 0.7 \text{ mm/rms},$$

and

$$b_1 = 2\left(\frac{6.5}{6.25}\right) \times 10^{-4} \times 0.07 = 1.46 \times 10^{-5}\text{/cm rms},$$

using the $b_2' = 6.5$ at $\gamma = 100$.

The average b_1 generated, as described above, can be corrected by horizontal positioning of the dipole during installation, as suggested by H. Hahn. A 0.5 mm rms error in the dipole installation may be considered as a possible tolerance.