RMS VARIATIONS IN MULTIPOLE STRENGTHS FOR SEVERAL DIPOLE COIL DIAMETERS

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Introduction

In order to assess the linear and dynamic aperture obtainable for a range of dipole-coil diameters and cell lengths, the random errors appropriate to each coil size are needed. This report lists the estimated rms variations in the regular and skew multipoles, b_n and a_n, from n=1 to n=10 for SSC cosine-theta-type dipole magnets with inside-coil-diameters of 3.5, 4.0, 4.5, and 5.0 cm. They are scaled from the 4-cm-I.D. case (D-4) in SSC-7 in the same manner as was used to derive those estimates from the Tevatron and CBA data.

Method

The scaling equation

$$\sigma(a_n) \text{ and } \sigma(b_n) \propto r_e^{-(n+\frac{1}{2})}, \qquad n \geq 2$$

was developed in SSC-7 and is used here. The index n corresponds to the 2(n+1) multipole. The effective coil radius r_e is taken as the average radius. We assume that the total coil thickness in each case in 2 cm, so that $r_e = \frac{\text{I.D.}}{2} + 1$ cm.

For n = 1 (quadrupole), the ½ in the exponent is dropped, because in this case the multipole strength is determined not by random placement errors but by accuracy in positioning the coil assembly in the iron yoke so as to "zero" the quadrupole component. For this case the absolute positional error was taken to be the same for all four coil sizes. Thus, $\sigma(a_1)$ and $\sigma(b_1) \propto r_e^{-1}$.

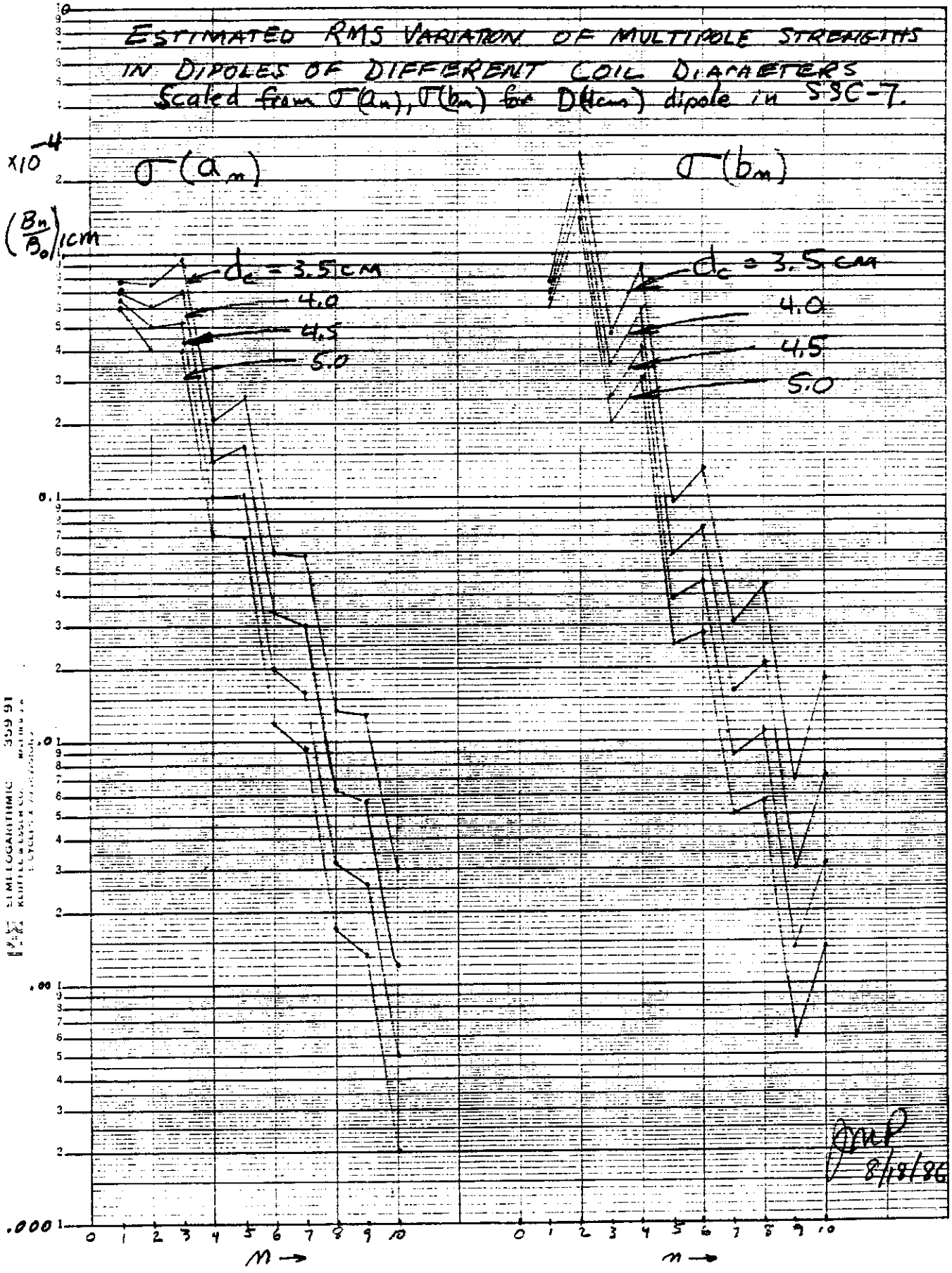
Results

The resulting estimates of the rms variations in the multipole strengths to be expected in the dipoles with coil inner diameters (d_c) of 3.5, 4.0, 4.5, and 5.0 cm are listed in the following table. The estimates for the 4.0-cm case are, of course, simply those listed in SSC-7.

These data are displayed also in the accompanying figure.

Table of Estimated RMS Variations in the Random Mutipole Strengths Anticipated for SC Dipoles Having Coil IDs of 3.5, 4.0, 4.5, and 5.0 cm. Units are 10^{-4} of the dipole field at 1.0 cm.

Multipole	d_c=3.5 cm	d_c=4.0 cm	d_c=4.5 cm	d_c=5.0 cm
a_1	0.76	0.70	0.65	0.60
b_1	0.76	0.70	0.65	0.60
a_2	0.76	0.61	0.50	0.41
b_2	2.50	2.01	1.65	1.37
a_3	0.94	0.69	0.52	0.40
b_3	0.47	0.35	0.26	0.20
a_4	0.21	0.14	0.10	0.070
b_4	0.87	0.59	0.41	0.30
a_5	0.26	0.16	0.10	0.069
b_5	0.095	0.059	0.038	0.025
a_6	0.060	0.034	0.020	0.012
b_6	0.13	0.075	0.045	0.028
a_7	0.058	0.030	0.016	0.0094
b_7	0.031	0.016	0.0088	0.0050
a_8	0.0134	0.0064	0.0032	0.0017
b_8	0.044	0.021	0.011	0.0057
a_9	0.0128	0.0056	0.0026	0.0013
b_9	0.0069	0.0030	0.0014	0.0007
a_{10}	0.0030	0.0012	0.0005	0.0002
b_{10}	0.018	0.0071	0.0031	0.0014


ESTIMATED RMS VARIATION OF MULTIPOLE STRENGTHS
IN DIPOLES OF DIFFERENT COIL DIAMETERS
Scaled from σ(a_n), σ(b_n) for D(4cm) dipole in SSC-7.
x10^-4
σ(a_n)
σ(b_n)
(B_n/B_0) 1cm
d_c = 3.5 cm
4.0
4.5
5.0
n →
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