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CRISP 73-2

ACCELERATOR DEPARTMENT
Informal Report

Random Errors in ISA Dipoles

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Abstract

The sensitivity to random positional errors in conductor location was investigated in the case of two dipoles of the $\cos \theta$ type, one of 8-cm aperture and one of 10-cm aperture.

Magnet Geometry

Both dipoles considered contain six blocks of ribbon per quadrant, each ribbon being $3/4$ in. wide and 0.027 in. thick, and are surrounded by an iron shield of infinite μ . The first magnet contains 57 turns arranged in groups of 14, 13, 12, 9, 6 and 3 turns on a radius of 4 cm; this geometry is described in CRISP 72-25 and is that used in the series of 90-cm long dipole magnets currently undergoing tests. The second magnet contains 70 turns arranged in groups of 17, 16, 14, 11, 8 and 4 turns on a radius of 5 cm. Block positions were optimized by small azimuthal displacements to cancel out the leading Fourier coefficients, using the computer program MAGFLD. Field errors due to block displacements from the ideal positions were then obtained by moving all ribbons in a block (and in one quadrant only) a uniform distance, radially or azimuthally. Field errors due to rms errors in all four quadrants are $\sqrt{4}$ times the field errors introduced by errors in one quadrant.

Results

The rms random errors in block positions introduces undesirable multipole components in the field; these are listed in Table I for the case of 2 mil displacements. The effect of random displacements of individual turns within a block are expected to be less severe,¹ and therefore the values listed here may to some extent be regarded as upper limits.

Thanks are due to H. Hahn and G. Parzen for discussions concerning random error effects.

1. G. Parzen, CRISP 72-12 (1972).

TABLE I

Nθ	Multipoles Introduced By 2 x 10 ⁻³ in. rms Displacements	
	8-cm Dipole	10-cm Dipole
1θ	0.384 x 10 ⁻³	0.302 x 10 ⁻³
2θ	0.292 x 10 ⁻³ /in.	0.195 x 10 ⁻³ /in.
3θ	0.226 x 10 ⁻³ /in. ²	0.122 x 10 ⁻³ /in. ²
4θ	0.162 x 10 ⁻³ /in. ³	0.070 x 10 ⁻³ /in. ³
5θ	0.110 x 10 ⁻³ /in. ⁴	0.039 x 10 ⁻³ /in. ⁴
6θ	0.072 x 10 ⁻³ /in. ⁵	0.020 x 10 ⁻³ /in. ⁵
7θ	0.046 x 10 ⁻³ /in. ⁶	0.011 x 10 ⁻³ /in. ⁶
8θ	0.030 x 10 ⁻³ /in. ⁷	0.006 x 10 ⁻³ /in. ⁷
9θ	0.024 x 10 ⁻³ /in. ⁸	0.003 x 10 ⁻³ /in. ⁸
10θ	0.012 x 10 ⁻³ /in. ⁹	
11θ	0.008 x 10 ⁻³ /in. ¹⁰	
12θ	0.006 x 10 ⁻³ /in. ¹¹	
13θ	0.006 x 10 ⁻³ /in. ¹²	