ix. Large Aperture Correctors

Triplets of large bore, i.e. 13 cm, quadrupoles will be antisymmetrically placed on either side of all six intersection points of RHIC. In RHIC collision optics, the triplets at the two experimental detectors are intended to enable the collision beta function to be reduced to the design goal of $\beta^* = 1$ m in both planes, in order to minimize the spot size and maximize the luminosity. This requires running with $\beta_{MAX} \approx 1400$ m in the triplet, where the beams will have their largest size, both absolutely and as a fraction of the available aperture. Hence, the ultimate performance of RHIC rests on achieving the highest possible magnetic field quality in the triplets. The correction of magnetic errors expected in the quadrupole bodies and ends will be attempted by quadrupole body tuning shims, and by lumped correctors.

The large aperture triplet of quadrupoles Q1, Q2 and Q3 on each side of each crossover has associated with them three correctors, for a total of 36 correctors per ring. One, here called C1, is at the crossover end of Q2, a second, C2 is at the crossover end of Q3 and a third, C3 is at the other end of Q3. All have 4 corrector elements in the following combinations, with numbers given for two rings:

Style I: b_0, b_3, b_4, b_5 @ 12 C1 Outer

Style J: a_0, b_3, b_4, b_5 @ 12 C1 Inner

Style K: a_1, a_3, a_2, a_5 @ 24 C2 Inner & Outer

Style L: b_0, b_3, b_2, b_5 @ 12 C3 Inner

Style M: a_0, b_3, b_2, b_5 @ 12 C3 Outer

Table 9-1. Properties of Large Aperture Correctors

Parameter	a_0/b_0	a_1	a_2/b_2	a_3/b_3	b_4	a_5/b_5
Number	48	24	48	72	24	72
Layers	6	2	2	2	2	2
R outer (mm)	97	95	76	82	76	69
R inner (mm)	93	93	73.5	80	73.5	67
Turns/coil/layer	149	79	41	33	23	17
$\int B \bullet ds$ (T·m)*	0.285	44.6×10^{-3}	20.6×10^{-3}	8.64×10^{-3}	5.19×10^{-3}	4.12×10^{-3}
L (mH)	1710	112	30	26	14	8.6

*@ R_{ref} = 40 mm and I = 50 A.

The nominal magnetic length of these correctors is 0.5 m and each element will have a nominal operating current of 50 A. The iron lamination inner diameter is 200 mm; the overall o.d. is 350 mm. These correctors will use the same type of double-layer multiwire coils used in the arc correctors. Table 9-1 shows the winding packages for each corrector element and other salient parameters.

All of the correctors were quench-tested using the same protocol as for the 80 mm correctors. Three coils out of a total of 315 needed to be replaced. Nearly all of the remaining coils reached the test limit of 100 A (70 A for dipoles) without quenching.

The correctors were shimmed based on warm measurements and warm measured a second time to confirm the effect of the shims. The shimming significantly reduced both the field angle and the off-axis distances of the individual layers. The field angles were adjusted to be within ± 1 mrad of nominal. The alignment relative to the center of the yoke was within ± 0.2 mm. A summary of the field quality measurements is given in Table 9-2 .

Table 9-2. Summary of field quality measured at room temperature in all the 130 mm corrector coils.

Coil Type	Integral Transfer Function (T.m/kA at 40 mm)	Std. Dev. of Integral Transfer Function	Harmonics at 40 mm radius
Dipole	5.572	0.15%	< 0.3%
Quadrupole	0.8792	0.09%	< 0.3%
Sextupole	0.4023	0.12%	< 0.7%
Normal Octupole	0.1686	0.17%	< 1.0%
Skew Octupole	0.1678	0.17%	< 0.7%
Decapole	0.1017	0.15%	< 1.2%
Dodecapole	0.0798	0.45%	< 1.0%