BROOKHAVEN NATIONAL LABORATORY

MAGNET DIVISION NOTES

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Title: Asymmetric Midplane Gap to reduce b_3 in RHIC Quadrupoles

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List Revised 3/93

Asymmetric Midplane Gap to reduce b_3 in RHIC Quadrupoles

Ramesh Gupta

A large b_3 has been observed in the 80 mm aperture RHIC arc quadrupoles. The average value of this harmonic has been observed to be 7.3 unit at 3 kAmp (up ramp) in magnets QRB005 thru QRB012. The minimum was 6.5 unit in QRB012 and the maximum 8 unit in QRB008. We propose the following modification to reduce this harmonic to the level 1 unit. The scheme has been successfully tested with the warm magnetic measurements in the quadrupole magnet QRB012.

In the present arc quadrupole design, the coil midplane half gap between any two coils is $0.004''$(3+1). (It consists of 3 mil of kapton cap and 1 mil of adhesive). We propose that it is increased to $0.008''$ at 0° and at 180° and it is kept to the original value of $0.004''$ at 90° and 270°. In practice this means that instead of one, two standard kapton caps will be used in the coils where the two yoke halves meet.

A quick experimental test of this technique was done with the warm measurements in magnet the QRB012. The magnet was initially built with all midplane half gaps being $0.004''$. In the rebuild magnet the half gap was increased at the required places as per the proposal discussed in the last paragraph. The results of this test on the magnet QRB012 are shown in table 1 (compiled by A. Jain). The harmonic b_3 (Octupole) in the rebuild magnet has come down from 6.54 unit to -0.95 unit (a change of -7.5 unit). As one can see there is a large improvement in this harmonic and the new value is well within the original target of 3 units in arc quadrupoles. Moreover, this harmonic was the lowest in this magnet. The scheme would have brought the average value of this harmonic down to -0.2 unit from the average of 7.3 unit in magnets QRB005-QRB012. It may be mentioned that this observation is based on the warm measurements in a magnet that had no shell on it. However, we do not expect a major change in this harmonic when the magnet is tested cold with shell put on it.

As can be seen from table 1, the scheme will also change other harmonics. The change in b_5 (dodecapole) would be accommodated in the cross section iteration, presently underway.

The change of -0.76 unit in b_7 (16-pole) is the natural consequence of reducing b_3. This, however, is within acceptable range. The changes in other harmonics are either small or not relevant to this experiment.

Table 1: Change in field harmonics due to an increase in coil midplane half gap by 0.004" at 0° and 180°.

Harmonics in QRB012 Before and After Rebuild
Straight Section Measurements

Harmonic	Normal Terms			Skew Terms		
	Before Rebuild (units)	After Rebuild (units)	Change in Harm. (units)	Before Rebuild (units)	After Rebuild (units)	Change in Harm. (units)
Sextupole	-0.963	-0.671	0.292	-0.266	1.288	1.553
Octupole	6.537	-0.950	-7.486	-1.158	-1.221	-0.063
Decapole	-0.224	-0.314	-0.091	-0.021	0.097	0.118
Dodecapole	-8.234	-11.212	-2.978	0.261	0.255	-0.006
14-Pole	-0.067	-0.185	-0.117	-0.030	0.082	0.112
16-Pole	0.054	-0.706	-0.760	-0.191	-0.116	0.075
18-Pole	0.089	0.021	-0.067	-0.012	0.042	0.054
20-Pole	-1.723	-1.838	-0.115	0.025	0.131	0.106
22-Pole	0.009	0.020	0.012	0.006	0.023	0.017
24-Pole	0.033	-0.023	-0.056	-0.005	0.009	0.014
26-Pole	0.008	-0.013	-0.021	0.000	0.068	0.068
28-Pole	1.569	1.572	0.003	-0.087	-0.036	0.051

Notes:

Before Rebuild Values are Averages over 2kA-4kA

After Rebuild values are at 10A