BROOKHAVEN NATIONAL LABORATORY

MAGNET DIVISION NOTES

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Title: Adjusting Midplane Gap to Control Field Harmonics in RHIC Production Dipoles

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In the present arc dipole design, the coil midplane half gap between the top and bottom halves of the coil is $0.004''(3+1)$. (It consists of 3 mil of kapton cap and 1 mil of adhesive). If the thickness of the midplane gap is changed it will also change the values of field harmonics. This could be used as a simple but powerful tool to control a deviation in field harmonics in the production dipoles without changing the wedges or pole angle. This approach has been successfully tested in the rebuild magnet DRS009.

We recommend that the value of this half gap be changed from the present $0.004''(3+1)$ to a nominal $0.006''(5+1)$ to provide ± 2 mil adjustability in the midplane half gap. Therefore, the nominal size of the kapton cap (including adhesive) will be made $0.006''(5+1)$ with additional sizes of $0.004''(3+1)$ and $0.008''(7+1)$. The $0.008''$ thickness can also be achieved with two $0.004''(3+1)$ caps.

In table 1, we list the change in harmonics due to an increased 2 mil midplane half gap. There is a good agreement between the calculations and measurements[1] in the magnet DRS009. DRS009 was originally built with a $0.004''(3+1)$ midplane half gap. It was later rebuilt with an extra kapton cap between the upper and lower coils to obtain a $0.006''$ midplane half gap.

Table 1: Change in field harmonics due to an increase in coil midplane half gap by $0.002''$. There is a good agreement between the calculations and measurements in DRS009.

δb_2	δb_4	δb_6	δb_8	δb_{10}
-3.3	-1.1	-0.31	-0.10	-0.03

In table 2, we list the expected harmonics with $0.004''$ and $0.006''$ midplane half gap in Grumman built dipoles. This estimate is based on the measurements in DRS009 and DRS010 and on the correction for the incorrect size of the wedges used in these magnets.

One may note that the change in the design value of midplane gap is expected to improve the nominal values of expected field harmonics.

Table 2: Expected harmonics in the production dipole based on the cross section used in DRS009 and DRS010 magnets. A 0.006" midplane half gap means that the (5+1) kapton cap will be used both on the upper and lower coils,or a total of three (3+1) caps will be used to make the FULL gap =0.012"

Midplane Gap	b_2	b_4	b_6	b_8	b_{10}
0.004"	2.4	0.6	0.3	0.24	-0.47
0.006"	-0.9	-0.5	0.0	0.14	-0.50

The following is a conceptual scheme for implementing the concept. After a statistically significant number(5-10) of dipoles have been built and measured, the midplane half gap is adjusted from the nominal 0.006"(5+1) to the value that will minimize the b_4' in subsequent magnets. This gives adjustment steps of ± 1.1 unit in b_4'. This effectively increases the acceptance band for b_4' harmonic. To achieve efficiency with this scheme the following steps are important:

- Warm Measurement of harmonics as soon as possible after collaring.
- A stock of caps for insertion in subsequent magnets.
- Reliable QA to insure both that the correct size caps are used and after construction tracking is possible.

The emphasis is on b_4'. The chromaticity sextupoles have capacities in excess of an order of magnet larger than the 3.3 b_2' changes generated by these midplane adjustments.

References :

Magnet Division Note on the magnetic measurements in DRS009, to be published by the Magnet Test Group.