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Title: The Effect of $\mu \neq 1$ Collar on the SSC 50 mm Dipole

The Effect of $\mu \neq 1$ Collar on the SSC 50 mm Dipole

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In most of the early design work it is presumed that as in air the permeability (μ) of the stainless steel collar material is one. This means that the collar would not be a part of the magnetic circuit. However, in reality the μ of the collar, though close to one, is not exactly one. For "Nitronic 40" steel it is 1.0025 and for "304N" steel it is 1.008. These values are considered[1] to be independent of field.

In this note we examine the influence of $\mu \neq 1$ collar on the field harmonics of the SSC 50 mm Dipole[2] DSX201/W6733. The collar is situated between the coil and the iron. We have done these calculations with the computer code POISSON using the same basic method as used in the SSC 4 cm magnet[3]. The results are shown in the table 1. The calculation of the change in transfer function is limited by the accuracy of such programs and will not be listed here. An analytic procedure should be used for this purpose. However, we estimated the change in transfer function to be less than few part in ten thousand.

The change in field harmonics due to the collar material is independent of the field, as expected from μ not being a function of the field. Moreover, the change in harmonics, at least to first order, is a linear function of the change in μ of the collar material. In the last column of the table 1, we have listed the average change in harmonics for $\delta\mu = 0.001$.

Table 1: The effect of the stainless steel collar material on the field properties of SSC 50 mm dipole DSX201/W6733. These calculations are at I = 5 kA but the results are basically independent of current.

Collar Description (μ and material)	b_2' 10^{-4}	b_4' 10^{-4}	b_6' 10^{-4}	b_8' 10^{-4}
$\mu = 1$, Assumed in Design	0.255	-0.063	0.001	0.047
$\mu = 1.0025$ Nitronic 40	-0.362	0.007	-0.007	0.048
$\mu = 1.008$ 304N Steel	-1.702	0.160	-0.026	0.050
$\delta\mu = 0.001$ Effect	-0.25	0.03	-0.003	0.0004

References

1. Arup Ghosh, "Private communication".

2. R.C. Gupta, S.A. Kahn and G.H. Morgan, "DSX201/W6733 -Coil and Iron Design for SSC 50 mm Dipole Magnet with Wider Cables", SSC Technical Note No. 88 (SSCL-N-699), June 28, 1990.

3. R.C. Gupta, "Effect of the Steel Collar on the Magnetic Properties of SSC Dipole", Magnet Division Note No. 153-1 (SSC-MD-116), Aug 5, 1985.