MAGNET DIVISION NOTES

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Task Force: Coil Geometry Analysis

Title: New Yoke Design for 4 cm SSC Dipole to Reduce b_2 Saturation to < 0.4 Unit

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New Yoke Design for 4 cm SSC Dipole to Reduce b_2 Saturation to < 0.4 unit

Ramesh Gupta

The new SSC specifications require b_2 saturation to be no more than 0.4 unit. In the present C358D design[1], computed b_2 saturation is 0.65 unit and measured is 0.55 unit. C358D design has a midplane notch which must be closed for Forced Cooling (Transverse Cooling) schemes. Unfortunatly, it raises b_2 saturation to one unit.

We have developed several methods to modify the yoke to reduce b_2 saturation to <0.4 unit. However, in this note we outline only the one which will be used in future 4 cm SSC magnets to be built at BNL. The other approaches and their merits will be discussed in a separate note. It may be pointed out that b_2 takes an upward or positive swing due to the pole saturation and downward or negative swing due to the midplane saturation. Our attempt is to balance these two saturations.

In the present C358D magnet, there is a $\frac{1}{2}''$ x $\frac{1}{2}''$ magnetic key at the midplane located at X=3$''$. Please see Drwg 22-503.02-4, Rev A for more details. We propose that this key be made of non-magnetic material (Stainless Steel) and the size be reduced to $\frac{3}{8}''$ x $\frac{3}{8}''$. It should be located a little inward at X=$2\frac{3}{4}''$. The new cross-section will be described in Drwg 22-00.478-5, Rev B. This also has a vertical flat face 0.032$''$ inward at the midplane replacing the notch in the previous lamination design.

We still use the coil configuration of C358D. The model on computer code POISSON is shown in Fig 1. The results of computations are given in table 1 and plotted in Fig 2. This has a maximum positive b_2 saturation of 0.35 unit (at 5.6 Tesla) and a negative b_2 saturation of -0.27 at 6.6 Tesla. Somewhere in between at around 6.25 Tesla, these two saturations are completely balanced, giving a net zero b_2 saturation. The transfer function for this magnet is about the same (0.04% lower) as that for the C358D magnet.

References

1. G. Morgan, "C358D: A Revision of the SSC coil Design C358A", Magnet Division Note No. 255-1 (SSC-MD-183), Jan 29, 1988.

Table 1: Field harmonics with the new iron lamination

B_0 Tesla	I kAmp	T.F. T/kA	b_2' 10^{-4}	b_4' 10^{-4}	b_6' 10^{-4}	b_8' 10^{-4}	b_{10}' 10^{-4}
$\infty\mu$	$\infty\mu$	1.04238	-0.0920	-0.4197	-0.0022	0.0276	0.0852
2.45965	2.36000	1.04222	-0.0928	-0.4181	-0.0020	0.0278	0.0852
3.07442	2.95000	1.04218	-0.0840	-0.4185	-0.0017	0.0278	0.0852
4.30088	4.13000	1.04138	0.0676	-0.4308	-0.0016	0.0277	0.0853
4.60473	4.42500	1.04062	0.0971	-0.4377	-0.0016	0.0278	0.0853
4.90603	4.72000	1.03941	0.1234	-0.4465	-0.0015	0.0278	0.0854
5.20329	5.01500	1.03755	0.1949	-0.4571	-0.0016	0.0278	0.0856
5.34993	5.16250	1.03631	0.2307	-0.4627	-0.0018	0.0278	0.0857
5.49522	5.31000	1.03488	0.2509	-0.4671	-0.0018	0.0278	0.0858
5.63903	5.45750	1.03326	0.2530	-0.4717	-0.0024	0.0279	0.0860
5.78114	5.60500	1.03143	0.2220	-0.4760	-0.0024	0.0279	0.0861
5.92158	5.75250	1.02939	0.1516	-0.4802	-0.0029	0.0280	0.0863
6.06060	5.90000	1.02722	0.0644	-0.4830	-0.0033	0.0280	0.0865
6.33461	6.19500	1.02254	-0.1302	-0.4855	-0.0038	0.0282	0.0869
6.60230	6.49000	1.01730	-0.3612	-0.4837	-0.0042	0.0284	0.0873
6.86389	6.78500	1.01163	-0.6303	-0.4791	-0.0042	0.0285	0.0878

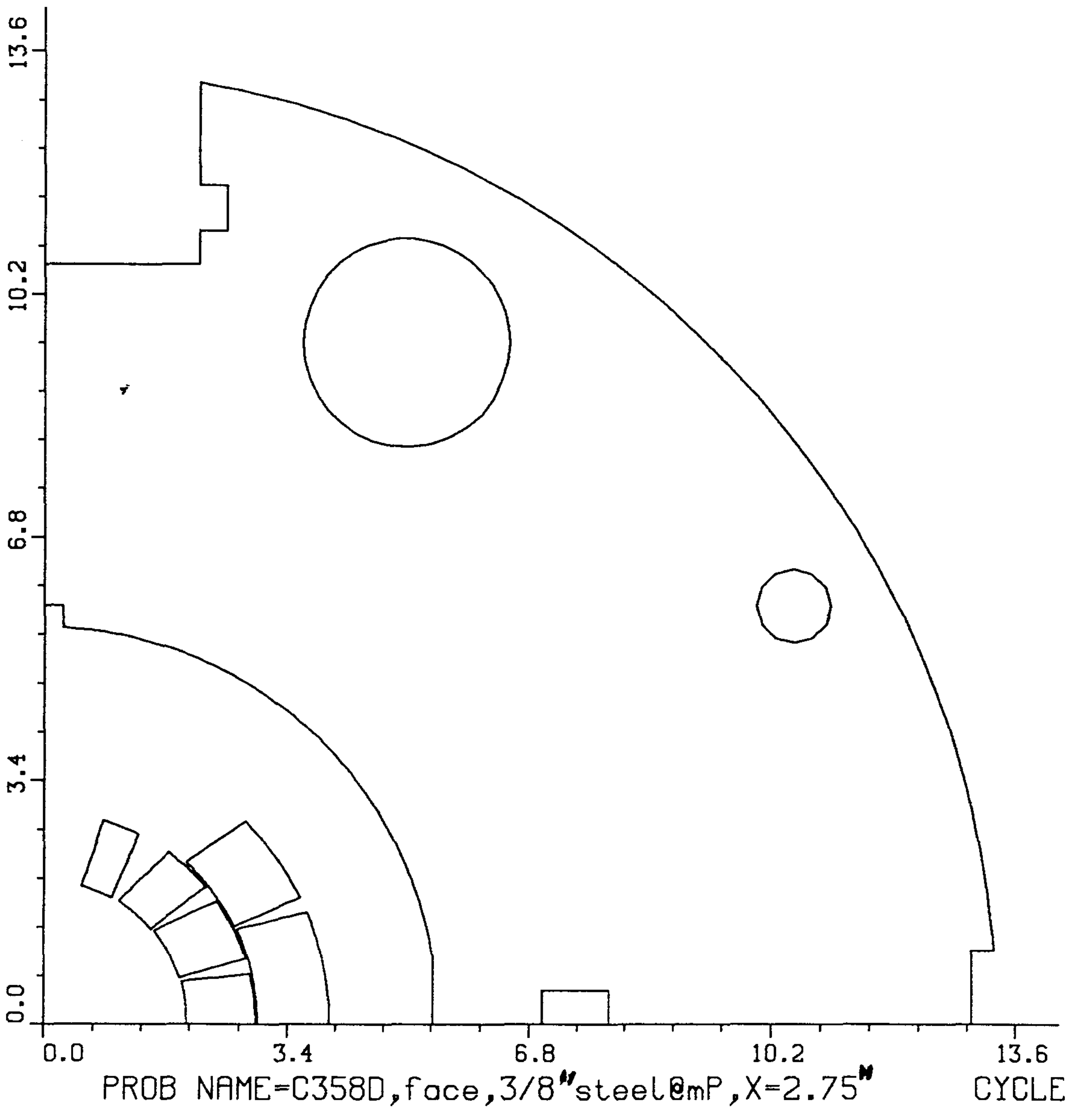

Fig 1. POISSON model for the proposed lamination

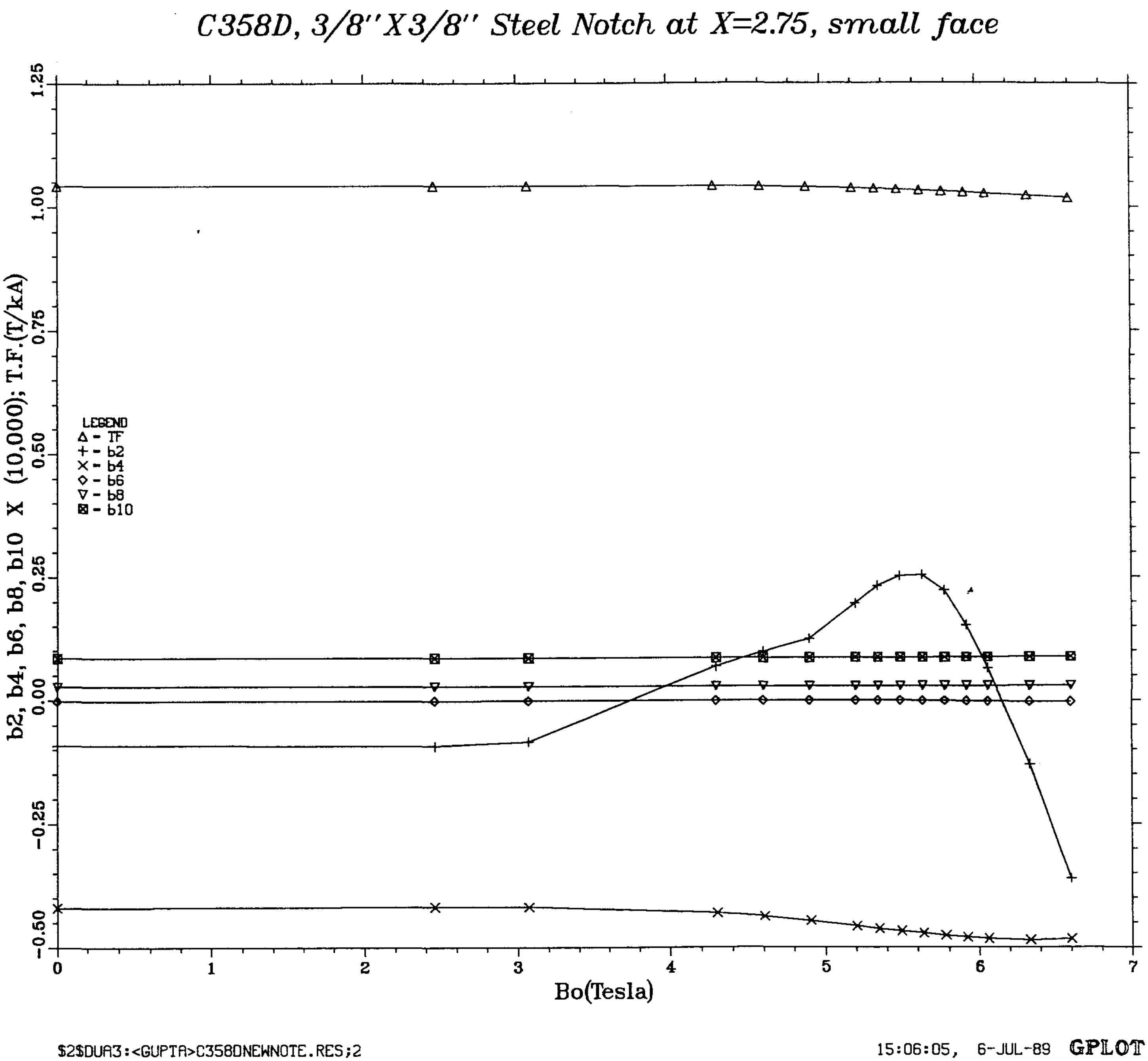

Fig 2. Field harmonics as a function of the central field.