MAGNET DIVISION NOTES

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Task Force: Coil Geometry

Title: Expected Performance of DSS015 with Elliptical Aperture

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Expected Performance of DSS015 with Elliptical Aperture

R. Gupta and G. Morgan

In our earlier note[1], we discussed the benefits of using the elliptical aperture instead of the conventional circular one. The elliptical aperture gives a higher transfer function due to a close-in aperture; the excessive swing in harmonics due to the close-in aperture is minimized by properly modifying (optimizing) the elliptical shape of the iron.

These computer predictions will be compared to measurements in the short dipole DSS015. This dipole will have the iron aperture contoured as in the case of SSCEL36 (Please see Ref. 1). However, the coil configuration will not be the one proposed there. To minimize new construction the coil of C358D will be used. Because of this compromise in construction, there will be a large low field offset, especially in b_2. The saturation swing in harmonics is also expected to be somewhat different. The gain in transfer function, both at low and at high field, should be observable quite clearly. To make verification independent of the details of computer model and to some extent of the magnet construction, the following method is proposed.

We do computations and measurements for both (a) standard circular aperture and (b) for the contoured iron inserted in this aperture (it is presumed that the insert has the same magnetic properties, i.e. permeability table, as that of the iron yoke). Then we study the relative change in the field harmonics. That is, we plot the [(b)-(a)] variation for field harmonics as a function of the magnetic field. This relative variation is the effect of the contoured insert and if the two (calculations and measurements) agree with each other, the computer method for the "elliptical aperture design" can be relied upon. We make a similar plot for the transfer function as well.

In Fig 1, we show the POISSON model for standard circular aperture and in Table 1 the results of the field computations. These results are plotted in Fig 2. In Fig 3, we show the POISSON model with the contoured insert and in Table 2 the results of the field computations. These results are plotted in Fig 4. The shift in b_2 due to saturation of about 1.8 units from the peak at 5.8 Tesla to the value at 6.6 Tesla is greater than the shift of 1.3 units computed using the matched coil SSCEL36. It may be pointed out that the pole notch of case (a) was moved to the midplane in case (b). The engineering design of this magnet is shown in Fig 5. In Fig 6 we plot the relative variation of field harmonics, as discussed in the above paragraph. In Table 3, we list these values.

Table 1: POISSON Run for Circular Aperture with Pole Notch

B_o 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
0.06163	0.059	1.04461	-1.919	-0.588	0.059	0.032	0.086
3.08100	2.950	1.04441	-1.906	-0.588	0.059	0.032	0.086
4.92040	4.720	1.04246	-1.442	-0.607	0.059	0.032	0.087
5.22010	5.015	1.04090	-1.270	-0.615	0.060	0.032	0.087
5.80530	5.605	1.03574	-0.821	-0.628	0.059	0.029	0.085
6.09050	5.900	1.03229	-0.690	-0.613	0.059	0.032	0.087
6.37000	6.195	1.02825	-0.620	-0.603	0.060	0.033	0.088
6.64050	6.490	1.02319	-0.717	-0.594	0.060	0.033	0.088
6.90220	6.785	1.01727	-0.989	-0.587	0.060	0.033	0.089

Table 2: POISSON Run for Elliptical Aperture with Midplane Notch

B_o 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
0.06137	0.05546	1.1066	22.911	0.0184	0.0611	0.0297	0.0816
3.08490	2.78834	1.1064	22.887	0.0184	0.0615	0.0298	0.0816
4.91760	4.45509	1.1038	23.119	0.0281	0.0603	0.0299	0.0818
5.21990	4.73947	1.1014	23.303	0.0343	0.0595	0.0300	0.0820
5.80450	5.31177	1.0928	23.375	0.0599	0.0601	0.0302	0.0826
6.08900	5.60028	1.0873	23.086	0.0670	0.0610	0.0304	0.0830
6.36730	5.88997	1.0810	22.513	0.0635	0.0616	0.0307	0.0835
6.63490	6.17789	1.0740	21.614	0.0460	0.0619	0.0309	0.0840
6.89120	6.46522	1.0659	20.333	0.0137	0.0620	0.0312	0.0847

Table 3: Values of Transfer Function and Field Harmonics in the Elliptical aperture relative to those in the Circular aperture

B_o Tesla	$\delta(T.F.)$ T/kA	$\delta b_2'$ 10^4	$\delta b_4'$ 10^4	$\delta b_6'$ 10^4	$\delta b_8'$ 10^4	$\delta b_{10}'$ 10^4
0.06	0.06199	24.83	0.61	0.00	0.00	0.00
3.08	0.06199	24.79	0.61	0.00	0.00	0.00
4.92	0.06134	24.56	0.64	0.00	0.00	-0.01
5.22	0.06050	24.57	0.65	0.00	0.00	0.00
5.80	0.05706	24.20	0.69	0.00	0.00	0.00
6.09	0.05501	23.78	0.68	0.00	0.00	0.00
6.37	0.05275	23.13	0.67	0.00	0.00	0.00
6.64	0.05081	22.33	0.64	0.00	0.00	0.00
6.90	0.04863	21.32	0.60	0.00	0.00	0.00

References

1. R. Gupta and G. Morgan, "Collarless, Close-in, Elliptical Aperture Design for the SSC Dipole", Magnet Division Note No. 290-1 (SSC-MD-201), July 14, 1988.

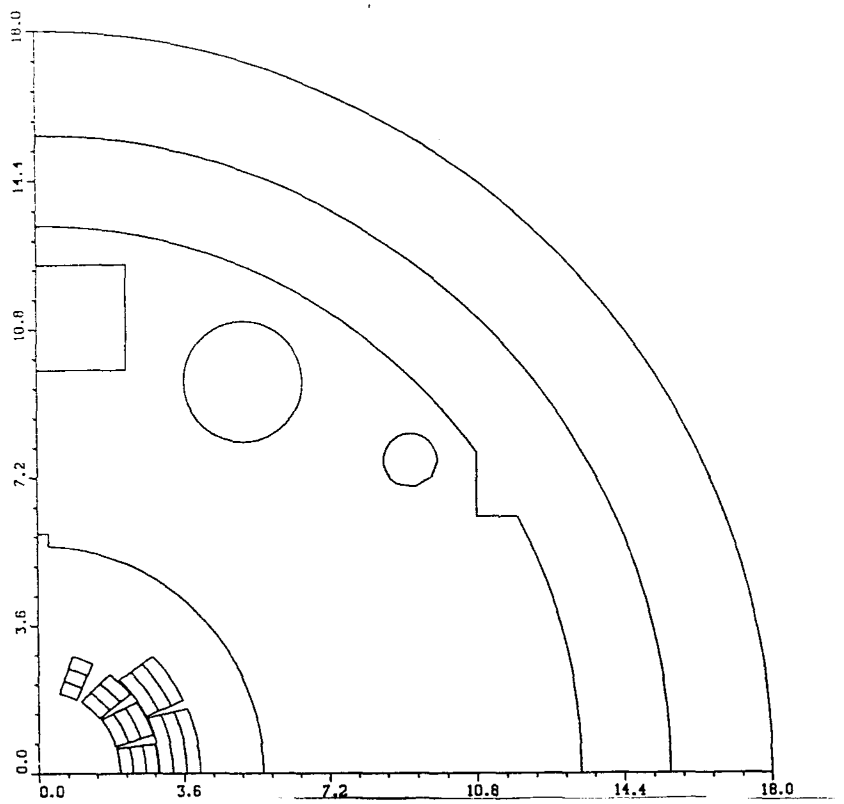

Fig 1. POISSON Model for Circular Aperture.

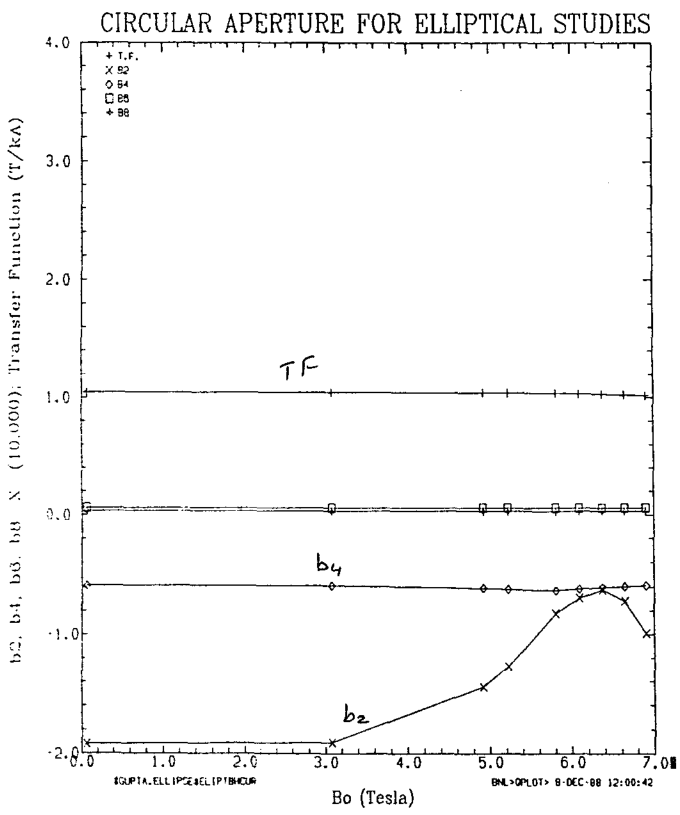

Fig 2. POISSON Results for Circular Aperture.

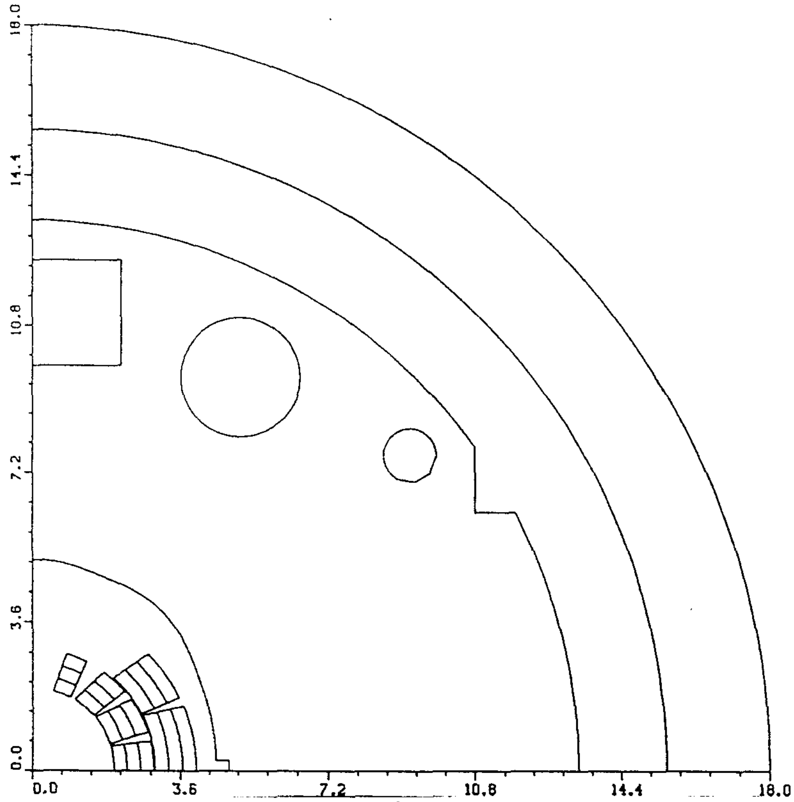

Fig 3. POISSON Model for Elliptical Aperture.

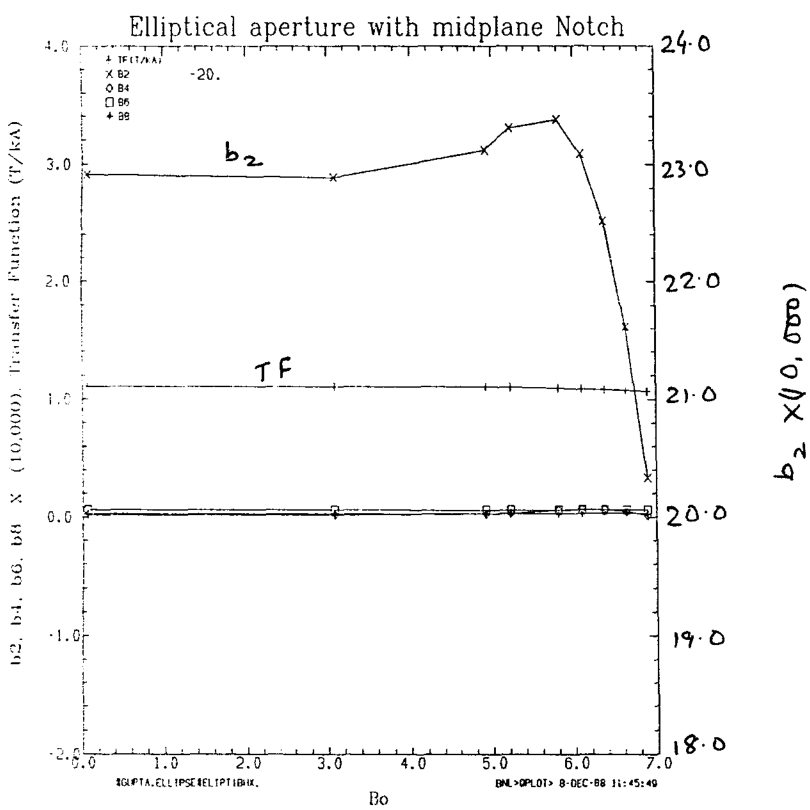

Fig 4. POISSON Results for Elliptical Aperture.

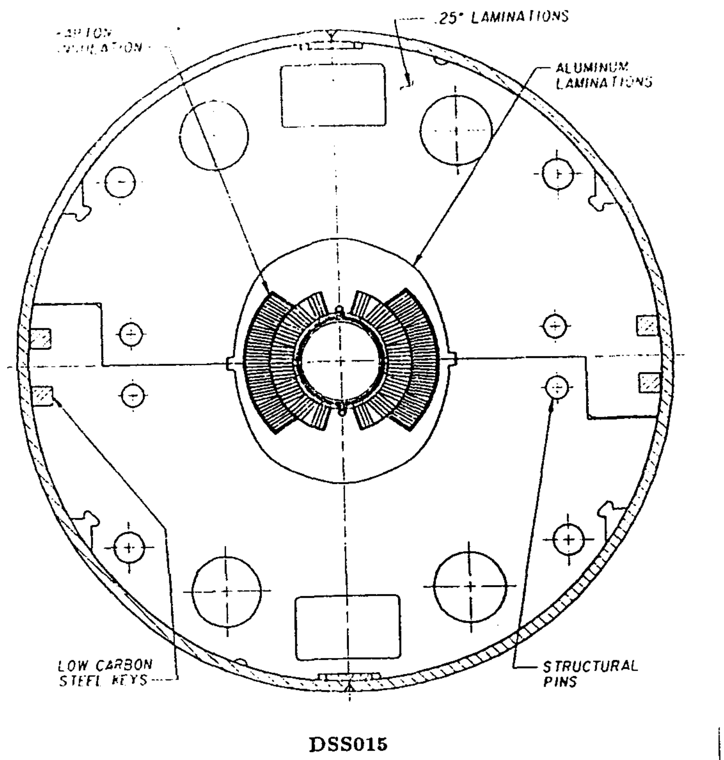

Fig 5. Engineering Design of the magnet DSS015.

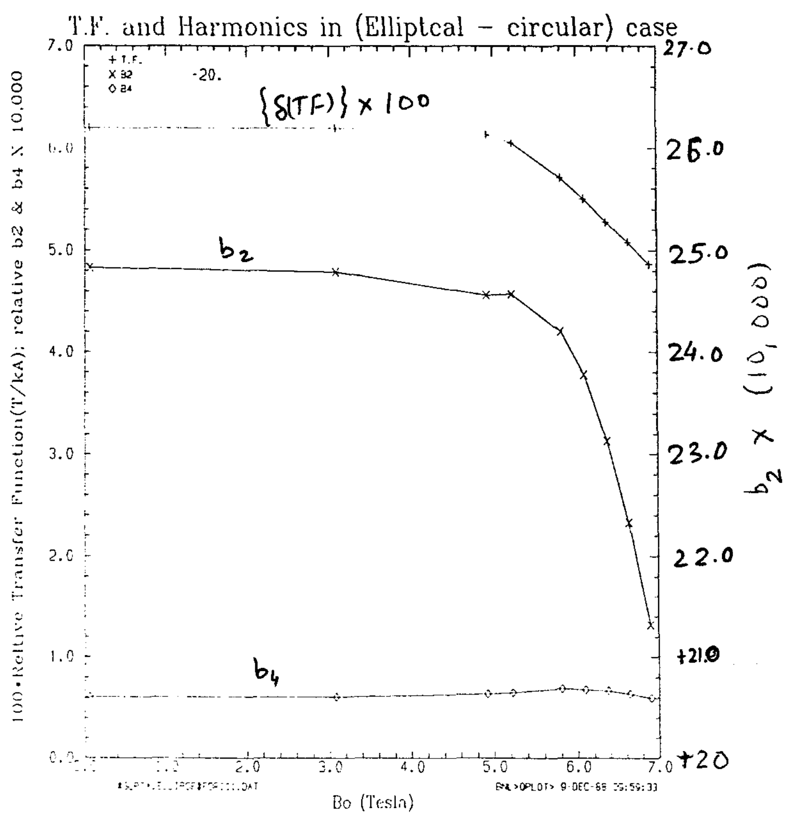

Fig 6. Relative variation of Field Harmonics and Transfer Function (Elliptical relative to Circular).