MAGNET DIVISION NOTE

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Task Force: Coil Geometry Analysis

Title: A Non-Dogboned SSC End Design

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A Non-dogboned SSC End Design

R. C. Fernow

We have examined the magnetic consequences of using a non-dogboned, 1-in-1 end geometry for the 40 mm SSC dipole design (SSC-C5). The geometry assumed for this study is shown in Figure 1. The abscissa is the distance along the magnet axis, with Z = 0 corresponding to the end of the straight section. It is assumed that the iron ends at Z = 0. The ordinates on the figure show the arclength from the post. The upper half of the figure is for the outer coil, and the lower half is for the inner coil We assume the straight section wedges taper to a point over a distance of 3 cm. At that point the post size is maximal. The outer turns then begin their saddle shape over the post. The inner turns extend an additional 6 cm before beginning their saddle shape in order to provide access and to reduce the peak field.

The peak field as a function of distance is shown in Figure 2. We have assumed that the effects of the magnet edge extend about ± 1 coil diameter along Z. It is apparent that the magnet performance should be limited by the peak field in the straight section.

The end multipoles at 2 kA are given in Table 1. Recall that these are defined as

$$b_n = (1\text{cm})^n \frac{2}{B_o L} \int_{end} B_n \, dZ$$

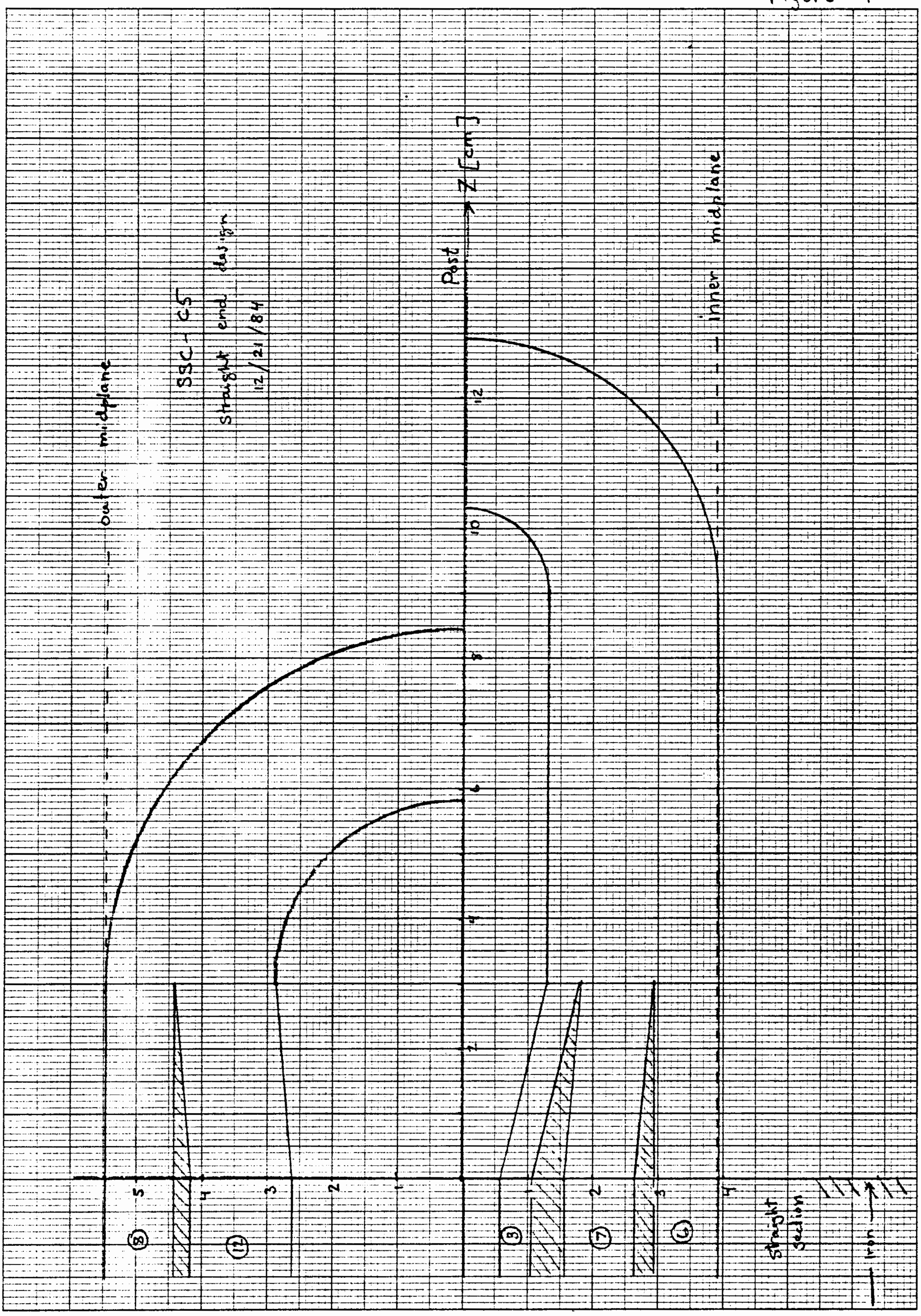
where B_n is the multipole transfer function with dimensions G/cm^n, B_o = 21.4 kG at 2 kA, and L = 16.6 m. We also show in Table 1 the multipoles for the 32 mm SSC prototypes (SSC-P11) and for the dogbone version of SSC-C5. It can be seen that the end design proposed here has very small end multipoles. There are three reasons why this design is as good or better than CBA designs which used spacers to control the multipoles: (1) the normalization length is 16.6 m instead of 4.4 m, (2) the smaller diameter and number of turns allows a much shorter end region, (3) the turns are brought to the midplane and this partially compensates for the intrinsic negative sextupoles of the saddle region. One should should note however, that the higher harmonics have been ignored in this analysis because there is no evidence that they can be accurately calculated, and because the computer code can only approximate the true end shape.

Finally, we show in Figure 3 the field on the axis. The effective length of the magnet can be determined from this figure, depending on the assumptions made about the field near the iron edge.

Table 1 End Multipoles $b_n \times 10^4$ @ 1 cm, 2kA

Design	b_1	b_2	b_3	b_4
SSC-P11	2.7	6.8	0.0	-0.2
SSC-C5 (dogbone, 2-1)	1.9	4.3	0.0	-0.1
SSC-C5 (this design)	0	-0.5	0	-0.3

Figure 1



outer midplane
SSC - C5
straight end design
12/21/84
Post
Z [cm]
inner midplane
straight section
iron
8
12
3
7
6
2
4
6
8
10
12
5
4
3
2
1
1
2
3
4

Figure 2

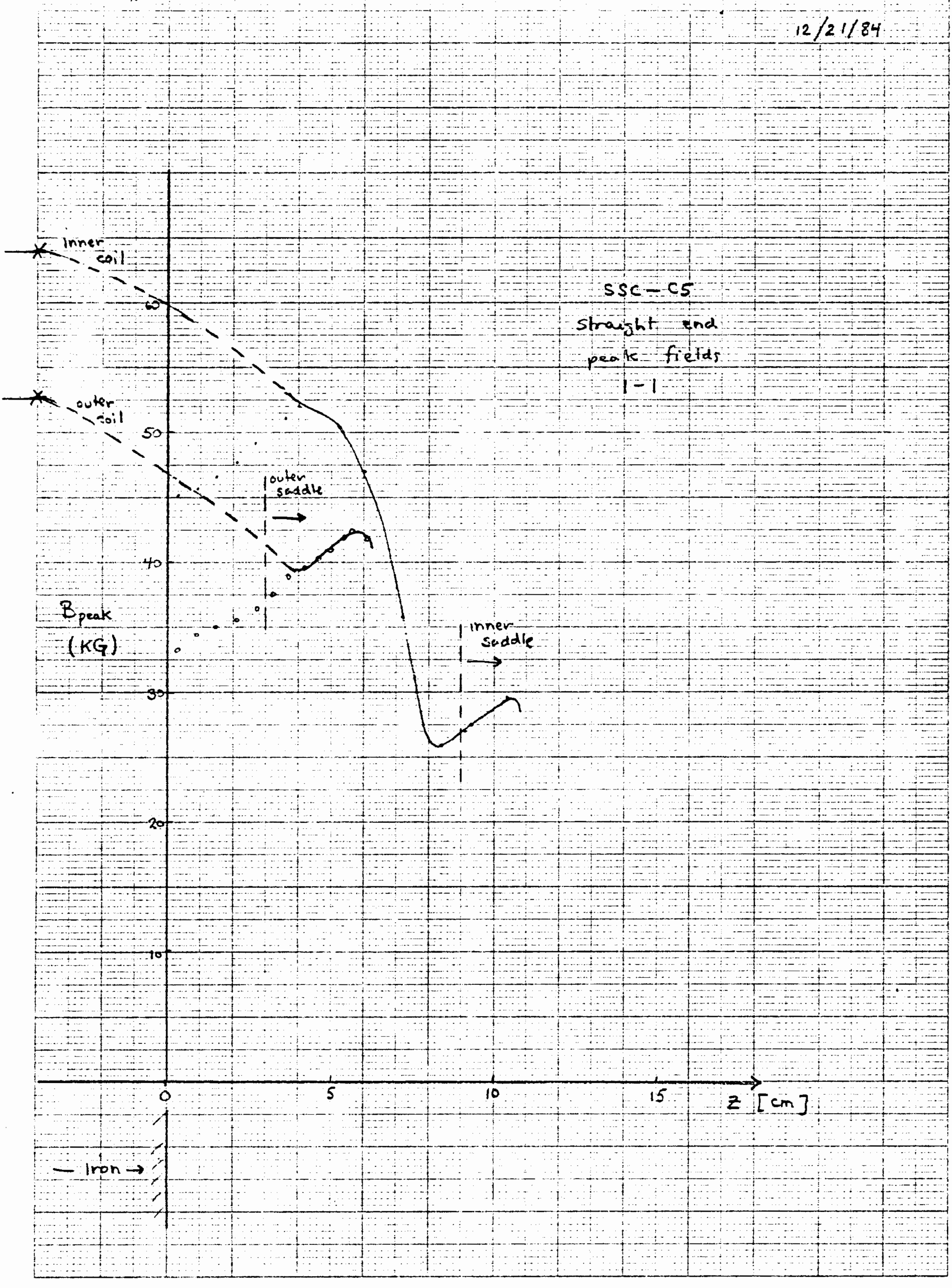

12/21/84
SSC — C5
Straight end
peak fields
1-1
inner coil
outer coil
outer saddle
inner saddle
Bpeak (KG)
60
50
40
30
20
10
0
5
10
15
z [cm]
Iron

Figure 3

12/21/84