TM-1123
1620.00

Fermilab

CALCULATION OF SUPER"Fe" MAGNET PARAMETERS

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INTRODUCTION

The calculations presented in this note were made with the magnet design code "GFUN" written by the Rutherford Lab group of W.Trowbridge. The magnet parameters are those of a "proof of principle" magnet whose performance data are given in TM-1121 and construction details in TM-1122.

RESULTS

The computed load line is given in Figure 1. The "GFUN" computed transfer function in the saturation field region seems to be low or physically the iron is more effective than computed. Figure 2 shows the computed sextupole as a function of current per turn. Given the fact the iron seems more effective than the computation predicts, the saturation part of the sextupole probably does not rise as rapidly as predicted until the field is a little higher. Figure 3 shows a computer graphics plot of the flux at 6.5 kA/turn for the Super "Fe" magnet.

Tables I through VI are the computed Fourier coefficients of the field at 1000 A intervals of transport current.

CONCLUSIONS

The computer calculations agree with the data obtained from the "proof of principle" magnet with the only reservation being that the iron saturation effects may be slightly overestimated.

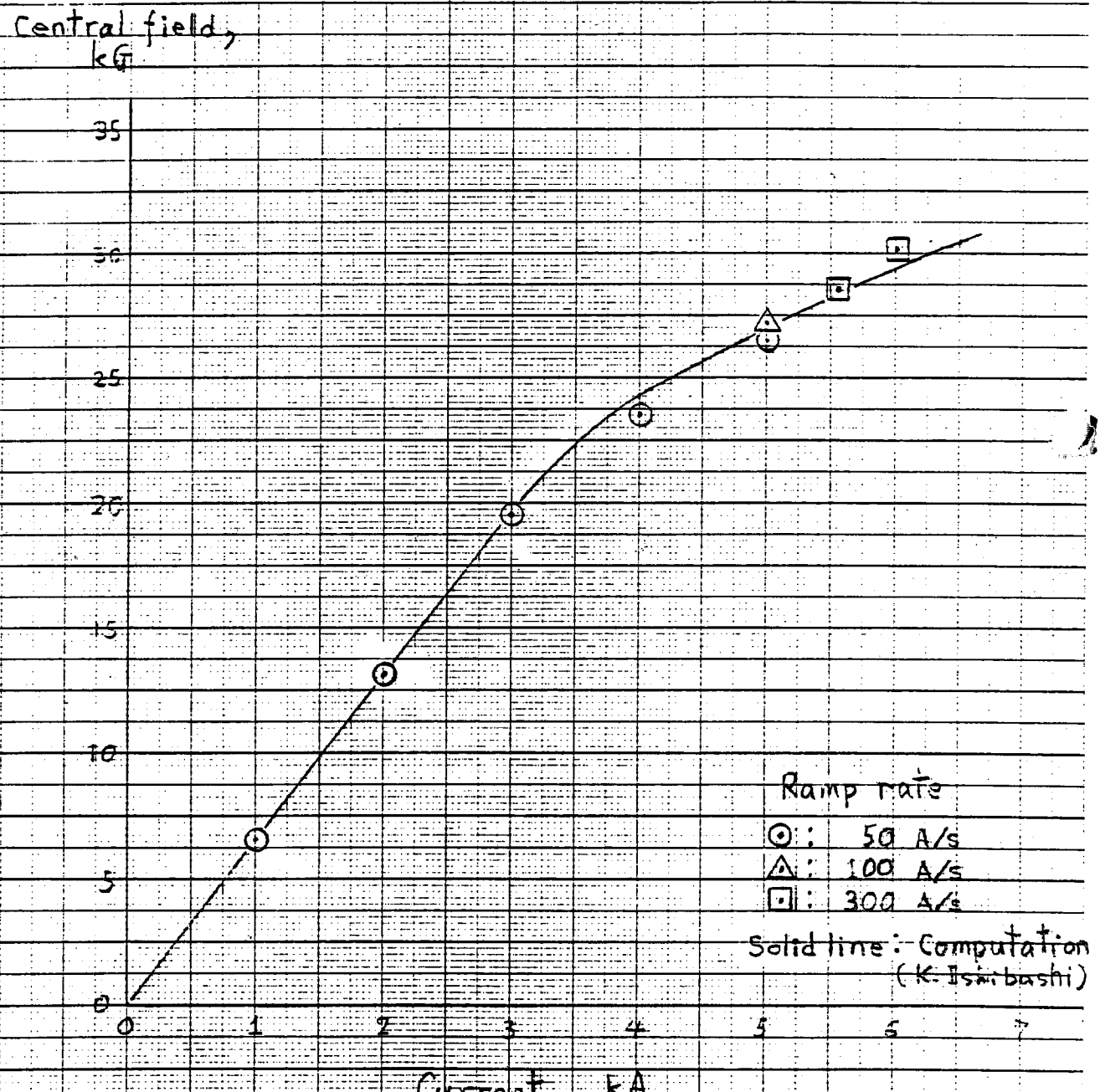
Central field, kG
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
Current, kA
Ramp rate
⊙ : 50 A/s
△ : 100 A/s
⊡ : 300 A/s
Solid line : Computation
(K. Ishibashi)

Figure 1.

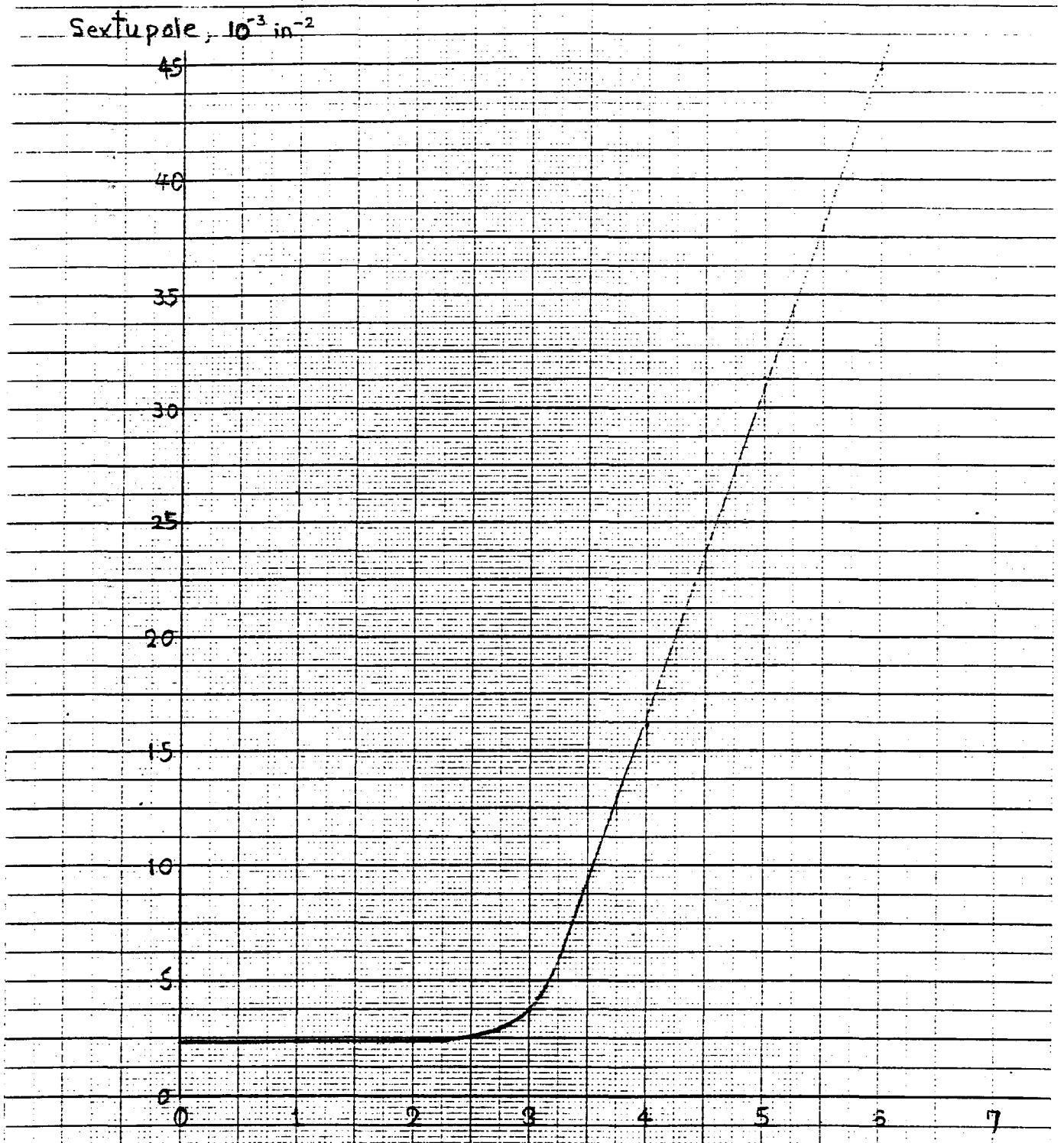
Sextupole, 10^{-3} in^{-2}
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
Current, kA

Figure 2.

Three Kiloampere/turn Magnetic field flux plot. "GFUN"

Computation

Current kA	Central field kG
1.0	6.59
2.0	13.18
3.0	19.57
4.0	24.27
5.0	27.01
6.0	29.35
6.5	30.45

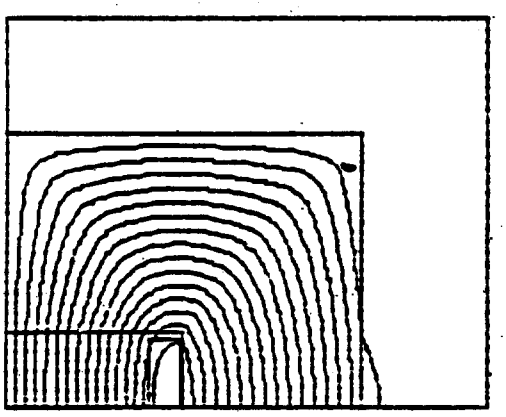

figure 3

I = 2.0kA

TABLE FOR FIELD COEFFICIENTS

NORMALIZATION RADIUS = 2.54000 cm

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)	
1	-6.5921E+03 Gauss	0.	6.5921E+03	
3	-1.5624E+01 Gauss	0.	1.5624E+01	239×10^{-3} in^2
5	-2.0940E+01 Gauss	0.	2.0940E+01	
7	-1.0406E+01 Gauss	0.	1.0406E+01	
9	-1.1736E+00 Gauss	0.	1.1736E+00	

Table I

cf. I = 1.0 kA ($\mu = \infty$)

N		
1	-6.5982 E+3	
3	-1.4793 E+1	2.24×10^{-3} in^{-2}
5	-2.0871 E+1	
7	-1.0440 E+1	
9	-1.4001 E+0	

I = 2.0 kA

TABLE FOR FIELD COEFFICIENTS

NORMALIZATION RADIUS = 2.54000

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)	
1	-1.3180E+04	0.	1.3180E+04	
3	-3.1040E+01	0.	3.1040E+01	2.36×10^{-3} in^2
5	-4.2114E+01	0.	4.2114E+01	
7	-2.0902E+01	0.	2.0902E+01	
9	-2.3677E+00	0.	2.3677E+00	

Table II

TABLE FOR FIELD COEFFICIENTS

I = 3.0 kA

NORMALIZATION RADIUS = 2.54000

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)	
1	-1.9574E+04	0.	1.9574E+04	
3	-7.3633E+01	0.	7.3633E+01	3.76×10^{-3} in^2
5	-6.8642E+01	0.	6.8642E+01	
7	-3.2090E+01	0.	3.2090E+01	
9	-2.9862E+00	0.	2.9862E+00	

TABLE III

TABLE FOR FIELD COEFFICIENTS

I = 4.0 kA

NORMALIZATION RADIUS = 2.54000

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)
1	-2.4266E+04	0.	2.4266E+04
3	-3.9168E+02	0.	3.9168E+02
5	-1.5413E+02	0.	1.5413E+02
7	-4.7645E+01	0.	4.7645E+01
9	3.5989E+00	0.	3.5989E+00

1.61×10^{-2} in^{-2}

Table IV

TABLE FOR FIELD COEFFICIENTS

I = 5.0 kA

NORMALIZATION RADIUS = 2.54000

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)
1	-2.7007E+04	0.	2.7007E+04
3	-8.4558E+02	0.	8.4558E+02
5	-2.6992E+02	0.	2.6992E+02
7	-6.5009E+01	0.	6.5009E+01
9	8.3708E+00	0.	8.3708E+00

3.13×10^{-2} in^{-2}

Table V

TABLE FOR FIELD COEFFICIENTS

I = 6.0 kA

NORMALIZATION RADIUS = 2.54000

(BX - I BY) = I * SUM N*(AN + I BN)/R * (Z/R)**(N-1)

N	N(AN)/R	N(BN)/R	ABS(N(CN)/R)
1	-2.9353E+04	0.	2.9353E+04
3	-1.3108E+03	0.	1.3108E+03
5	-3.9446E+02	0.	3.9446E+02
7	-9.0842E+01	0.	9.0842E+01
9	2.0654E+01	0.	2.0654E+01

4.47×10^{-2} in^{-2}

TABLE VI