TM-854
2750.000

ON THE TOPIC OF SHIELDING ONESELF FROM THE CHARMING MAGNETISM OF THE EGYPTIAN PRINCESS BEKETATEN (A MAGNET)

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The Beketaten (named after the younger sister of King Tutankhaman) is a magnet built by the Research Services Department for use in Exp. 516. Recently, there is a discussion as to whether one should tie the end guard of the magnet to her main body of iron using an iron cross-over bridge or not. (See Fig. 1) The magnetostatic computer program TRIM was used to investigate the problem. Figures 2 and 3 show the mesh set-up and magnetic flux distribution in a typical run. Four different cases: (a) with end guard and a three-inch thick iron bridge, (b) with end guard and an eight-inch thick iron bridge, (c) with an end guard and no iron bridge, and (d) with neither end guard nor an iron bridge; were studied with an operating current of 900A, 1800A and 2700A respectively in the inner coil of the magnet. The outer coil is left non-energied as would be the case in the 1st phase of the experiment. The results are enclosed in Figs 4 to 6 and/or Table I.

TABLE I

Operating Current	B/B_0 on the outer edge of the end guard at x = 38.5" & y = 0			
	3" thick end guard 3" thick bridge	3" thick end guard 8" thick bridge	no end guard no bridge	3" thick end guard no iron bridge
900A	9.5%	9.5%	23.0%	20.5%
1800A	9.5%	9.5%	23.5%	21.0%
2700A	12.5%	10.0% (5" bridge)	24.0%	22.0%

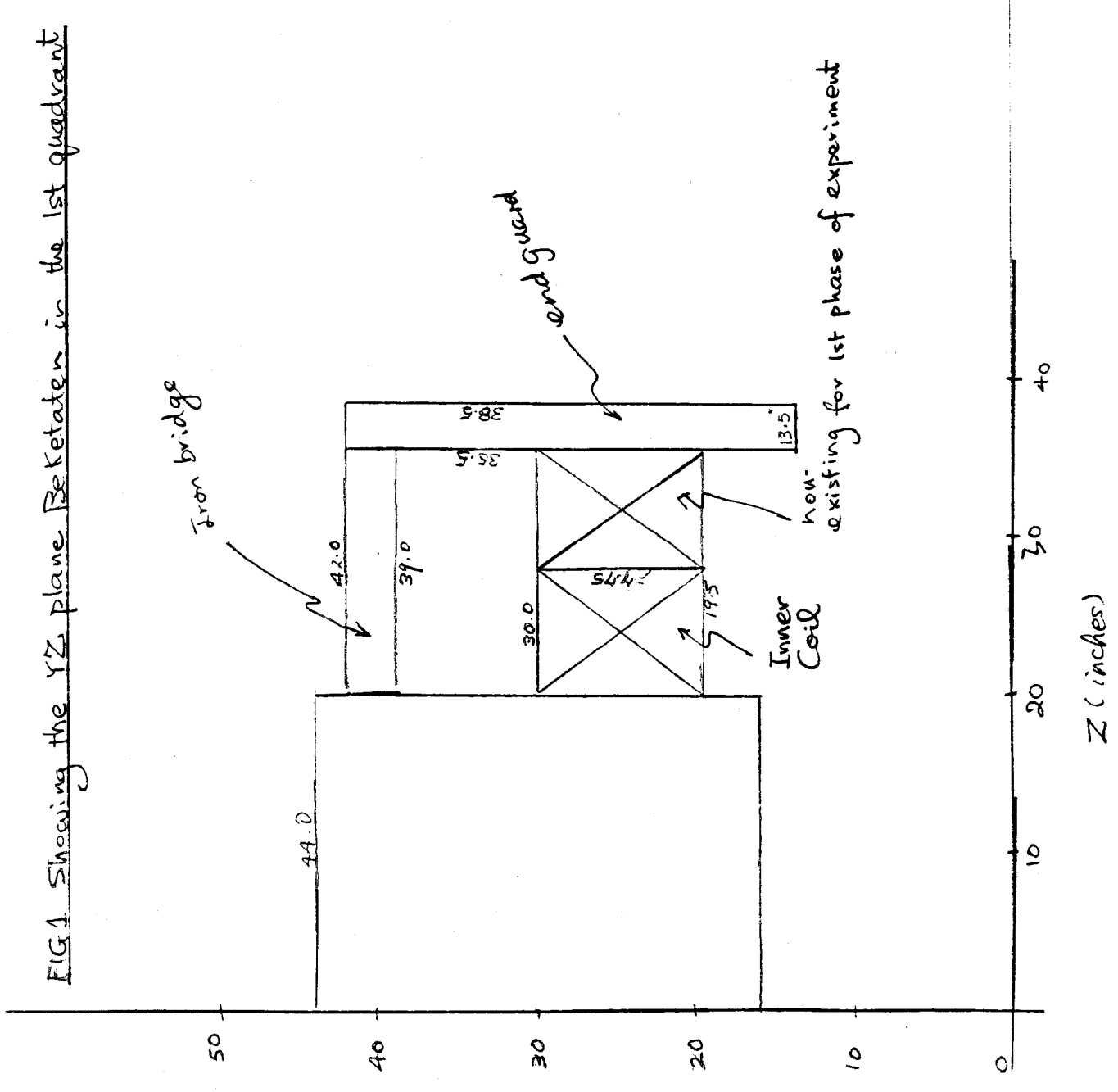
Where B_0 = central field of magnet.

Conclusions

1. An un-grounded end guard (one without an iron bridge) is not very useful. From Table I, it can be seen that it is not too much better than the no end guard case on the mid-plane.
2. Three inches is a sufficient thickness for operating current up to 1800A. For running at max. current, 2700A, one might choose to increase the thickness of the iron bridge.
3. An end guard (with an iron bridge) is rather effective in reducing stray fields on the ends of the magnet, but it also reduces the $\int B \cdot d\ell$ of the magnet. For cases where the magnitude of $\int B \cdot d\ell$ rather than that of the stray field is the determining factor, one might choose to use no end guard.
4. The stray field over central field B_0 ratio anywhere outside the magnet is available from the author if anyone wants them.
5. An iron bridge is also very important if one has to place photomultiplier tubes close to the top or bottom of the end guard plate.

P.S. Also enclosed is a summary sheet of the Akhenaten and Beketaten magnets.

FIG 1 Showing the YZ plane Beketaten in the 1st quadrant



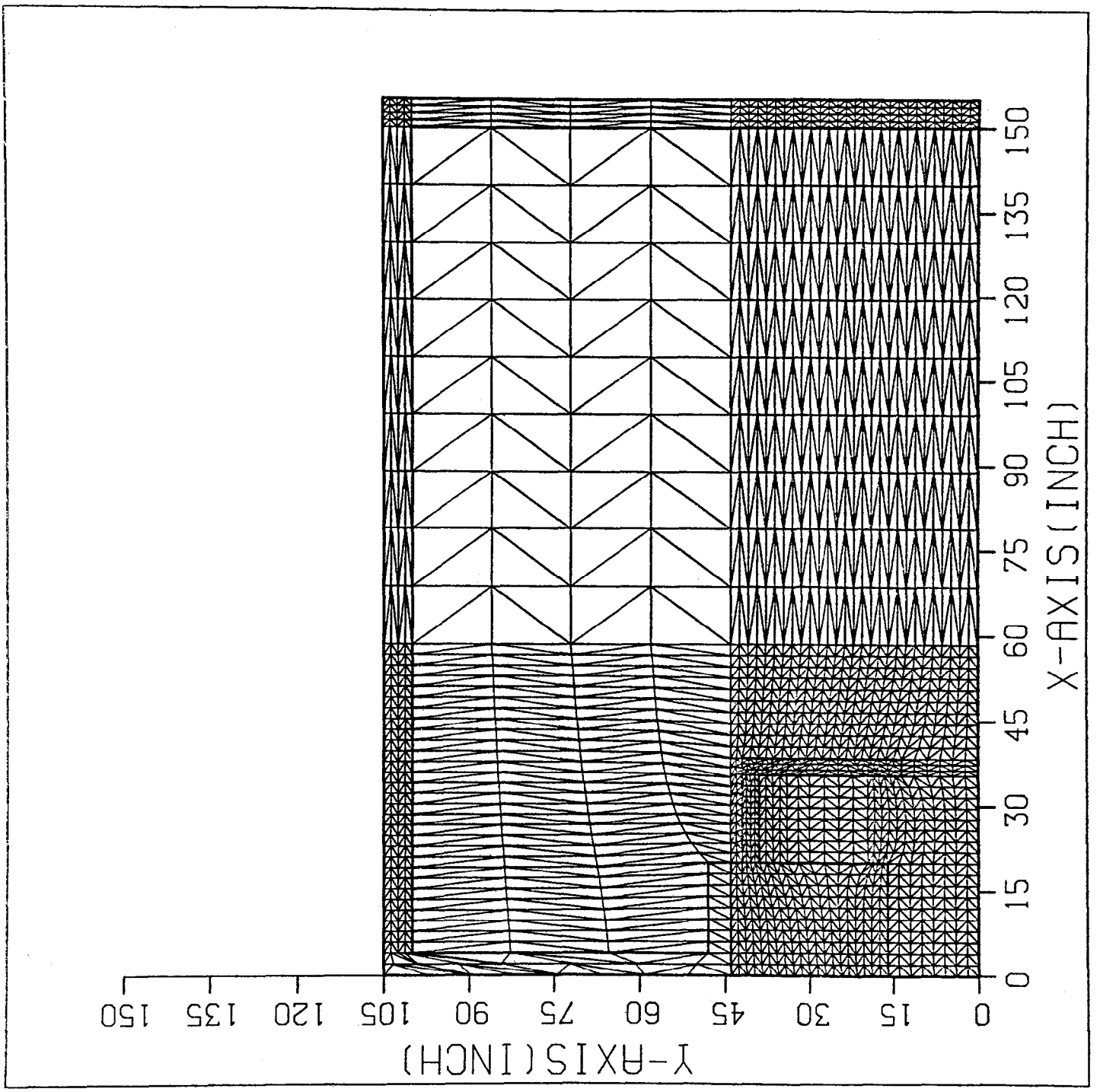
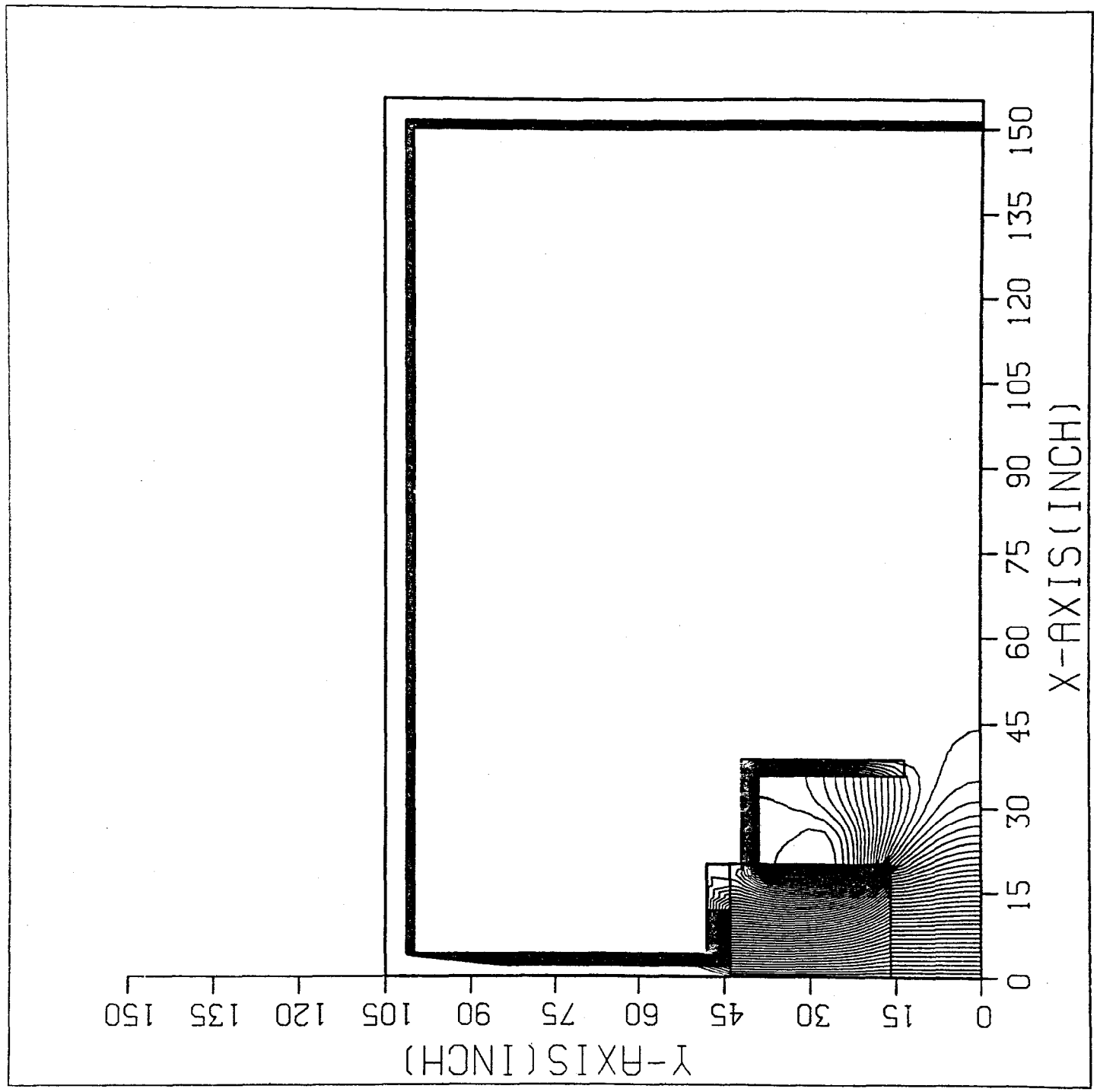

X-AXIS(INCH)
0
15
30
45
60
75
90
105
120
135
150
Y-AXIS(INCH)
0
15
30
45
60
75
90
105
120
135
150

Fig. 2


X-AXIS(INCH)
0
15
30
45
60
75
90
105
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135
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Y-AXIS(INCH)
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15
30
45
60
75
90
105
120
135
150

Fig. 3

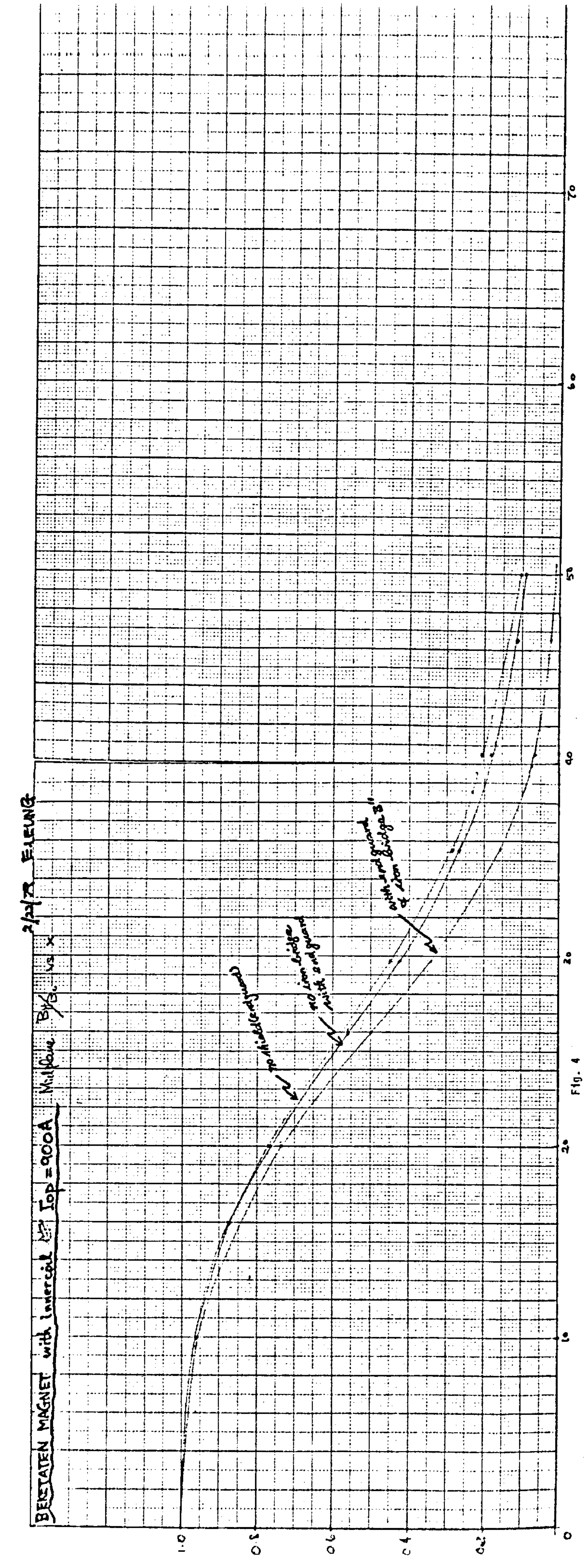


Fig. 4

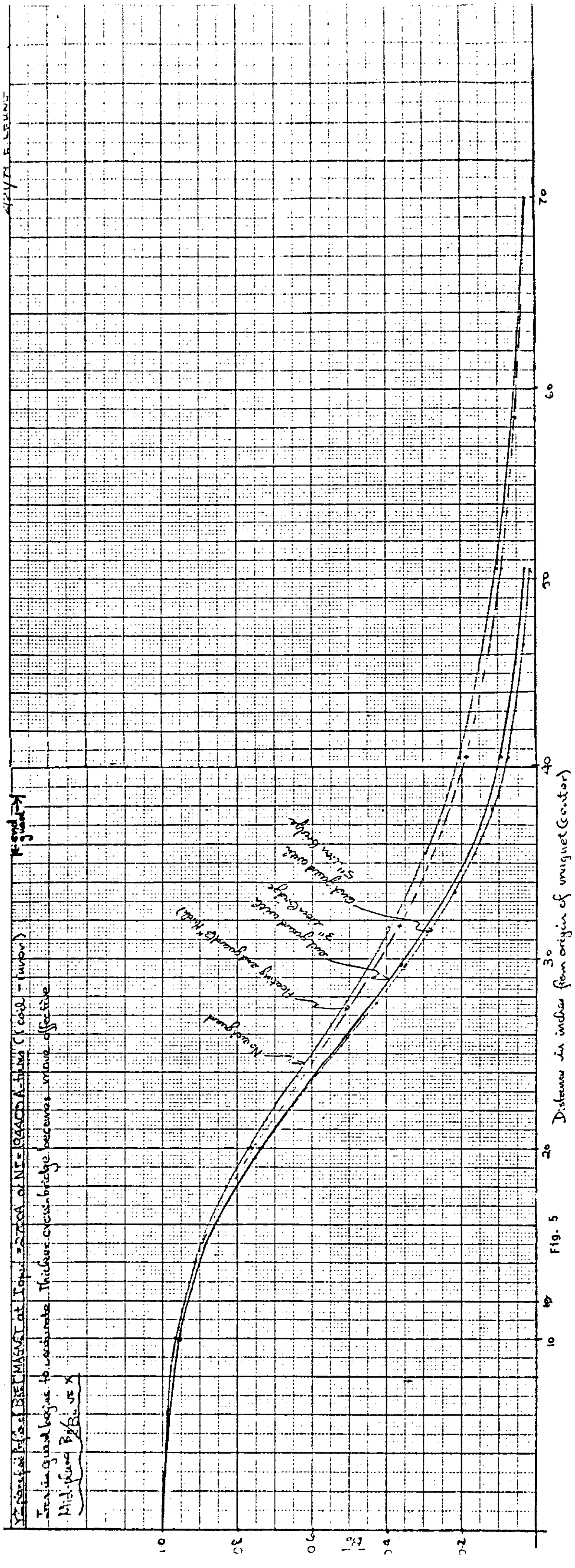

No end guard
Floating end guard (9" thick)
end guard with 3" iron bridge
end guard with 5" iron bridge
Distance in inches (from origin of magnet (center))
10
20
30
40
50
60
70
1.0
.8
.6
.4
.2

Fig. 5

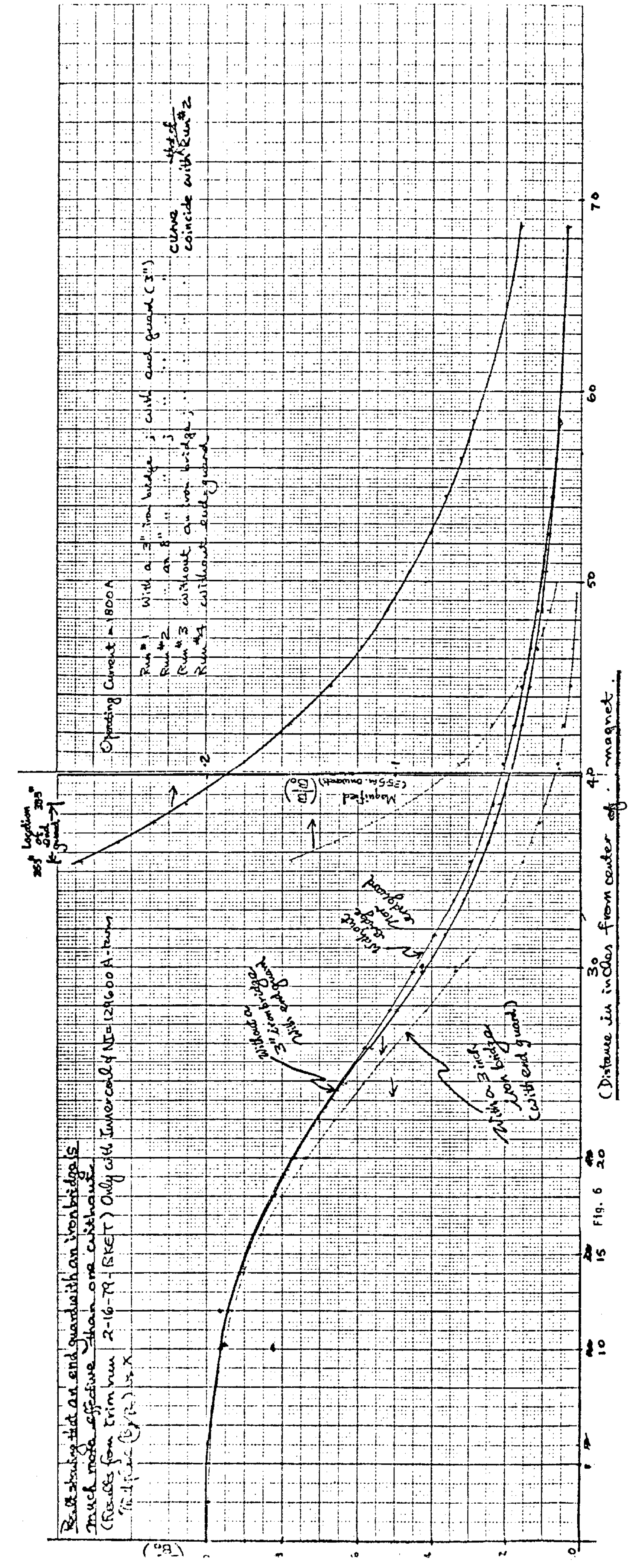

Result showing that an end guard with an iron bridge is much more effective than one without.
(Results from trim run 2-16-79-BKET) Only with Inner coil & NI = 129600 A-turns
Operating Current = 1800 A
Run #1 With a 3" iron bridge ; with end guard (3")
Run #2 an 8"
Run #3 without an iron bridge ;
Run #4 without end guard
curve that of coincide with Run #2
Location of end guard
Without a 3" iron bridge With end guard
Without bridge Nor end guard
With a 3 inch iron bridge (With end guard)
Magnified (355 in. onward)
(Distance in inches from center of magnet.

Fig. 6

FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
Research Services			10

SUBJECT: AKHENATEN and BEKETATEN

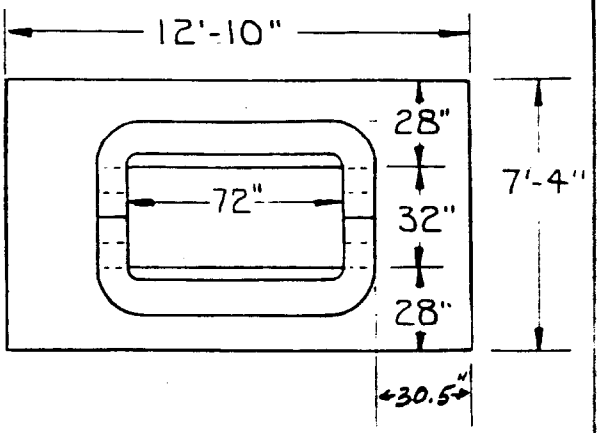
Research Services 32/72/40 Magnet

NAME: E. Leung/W. Bosworth

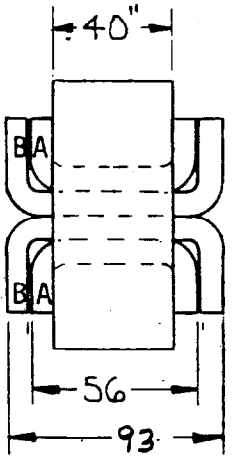
DATE: 09/22/77 | REVISION DATE: 08/30/78

MAGNETIC FIELD

** Half Current	TWO** COILS	TWO COILS	ONE COIL
Central Field	5.2	10.4	5.2 kG
Field Uniformity	≈.5%	≈.5%	>.5%
Integral Field kG-ft.	25.17	50.33	24.2 kG-ft.
Field in Return Leg	≈7.0	14.0	≈7.0 kG
Effective Length = $\frac{\int B \cdot dl}{B_o}$	4.84'	4.84'	4.65'
Effective Length/ Pole Length	1.45	1.45	1.39



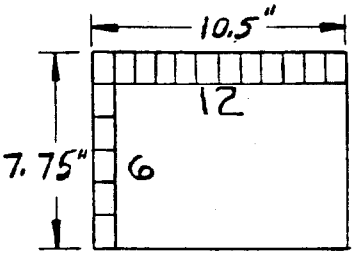
POWER	COILS A Upper	COILS B Lower
DC Power	109	129 kW
Current	2450	2450 A
Voltage	44	52 V
Copper Temp. Average	132	138°F
Resist. @ Above Temp.	18	21.6 mΩ
TOTAL Power (4 Coils)	--	476 kW
TOTAL Voltage (4 Coils)	--	192 V



SCALE 3/16" = 1'-0"

COOLING

Water Temp. Rise	39	50°F
Flow	19	18 gpm
Pressure Drop	200	200 psi
TOTAL Flow	--	74 gpm

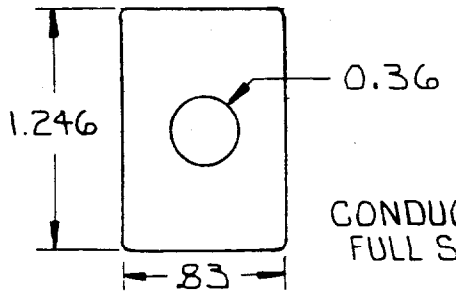


SCALE 1/8" = 1"

COIL CROSS SECTION

COIL DATA

Turns	72	72
Water Paths	6	6
Average Turn Length	293"	361"
Coil Length	1760'	2170'



CONDUCTOR FULL SCALE

WEIGHTS (Est.)

Coil & Insulation	6,490#	7,614#
Core	--	120,000#
TOTAL Magnet Assembly	--	148,000#