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LBID-509

LAWRENCE BERKELEY LABORATORY – UNIVERSITY OF CALIFORNIA ENGINEERING NOTE		CODE BW7892	SERIAL M5655A and MT 294	PAGE 1 OF 11
AUTHOR Egon Hoyer/Don Nelson	DEPARTMENT	LOCATION LBL	DATE January 28, 1981	

PROGRAM – PROJECT – JOB
Bevatron Vacuum Improvement

IHM7 Inflection Magnet

TITLE
11/80 Magnetic Measurements

A Revision 3/19/81

SUMMARY

Magnetic Measurements were carried out to determine if IHM7 could be operated from 1000-1500 Amps and still have acceptable fringe fields in the Bevatron aperture, which IHM7 is adjacent to, without modifying the magnetic shield.

Per John Staples, the maximum acceptable fringe field integrals are:

220 Gauss - cm - Dipole
86 Gauss - cm/cm - Quadrupole

Magnet measurements were made in the east tangent tank during November 1980, and show that the fringe fields are acceptable, ∿≤100 Gauss - cm Dipole and ∿ ≤10 Gauss - cm/cm Quadrupole in the 1450-1500 ampere range. However, in order to achieve these acceptable fields, 300-400 Amperes is required in the IHM7 compensating coil.

For the record, IHM7 main coil cooling circuits must be modified for reliable operation at 1500 Amperes.

Measurements

The results of the magnetic measurements are displayed graphically on Figures 1-5. Errors, accuracy of measurements, and the data acquisition system used are spelled out in Don Nelson's Memo of December 9, 1980, which is attached to this note.

Figure 1 shows the background field integral of IHM7, without excitation, in the east tangent tank as a function of distance from the shield, which is the same as from the edge of the Bevatron Aperture inward. These background field integral measurements were used in the subsequent data reduction to determine the effects of the main coil and the compensation coil on IHM7 fringe fields in the Bevatron aperture.

Figure 2 shows midplane isoremenant field lines in the east tangent tank of the Bevatron with IHM7 not energized. Note how IHM7 effects the tangent tank field.

Figure 3 shows IHM7 fringe field integrals in the Bevatron aperture due only to compensating coil excitation. As expected increasing the compensating coil current increases the magnitude of the fringe field.

Figure 4 shows IHM7 fringe field integrals with 1450 Amps of main coil excitation and various values of compensating coil current. 300-400 Amps in the compensating coil appears to cancel the fringe field produced by IHM7's main coil in the Bevatron aperture.

Figure 5 shows similar information as in Figure 4 but the main coil excitation is 1500 Amps. With 300 Amps excitation, good fringe field cancellation is obtained.

The field integral measurements were made with a 213 cm long coil. Isoremenant points were obtained with a Hall probe. Magnetic Measurements Data are saved in Magnetic Measurements Engineering Data Book (MME Book No. 546).

DISTRIBUTION:

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Magnetic Measurement Engineering (5)

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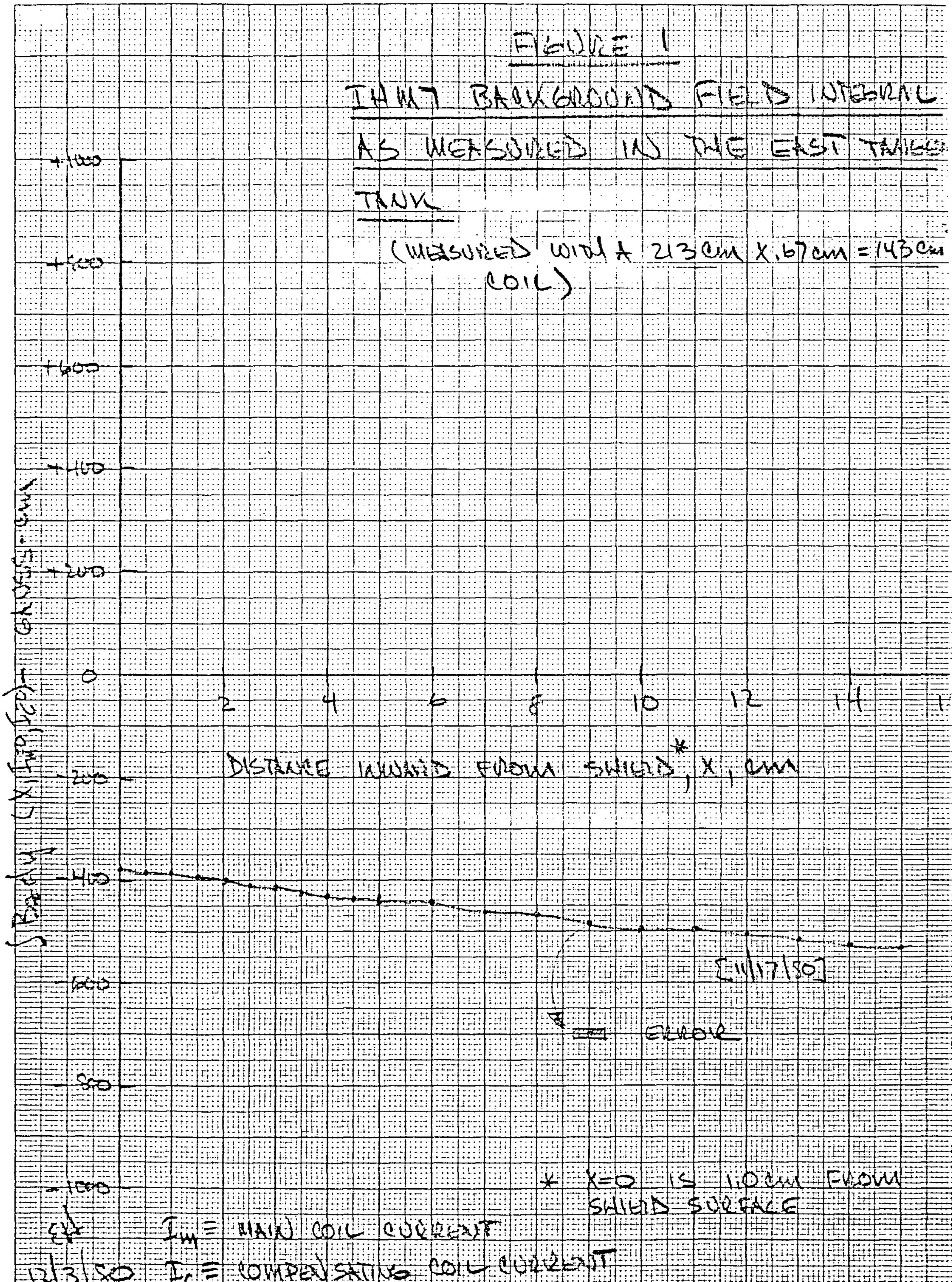


FIGURE 1
TANK
COIL)
+1000
+800
+600
+400
+200
0
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
DISTANCE INWARD FROM SHIELD*, X, cm
[11/17/80]
ERROR
* X=0 IS 1.0cm FROM SHIELD SURFACE
I_M = MAIN COIL CURRENT
12/3/80 I_C = COMPENSATING COIL CURRENT

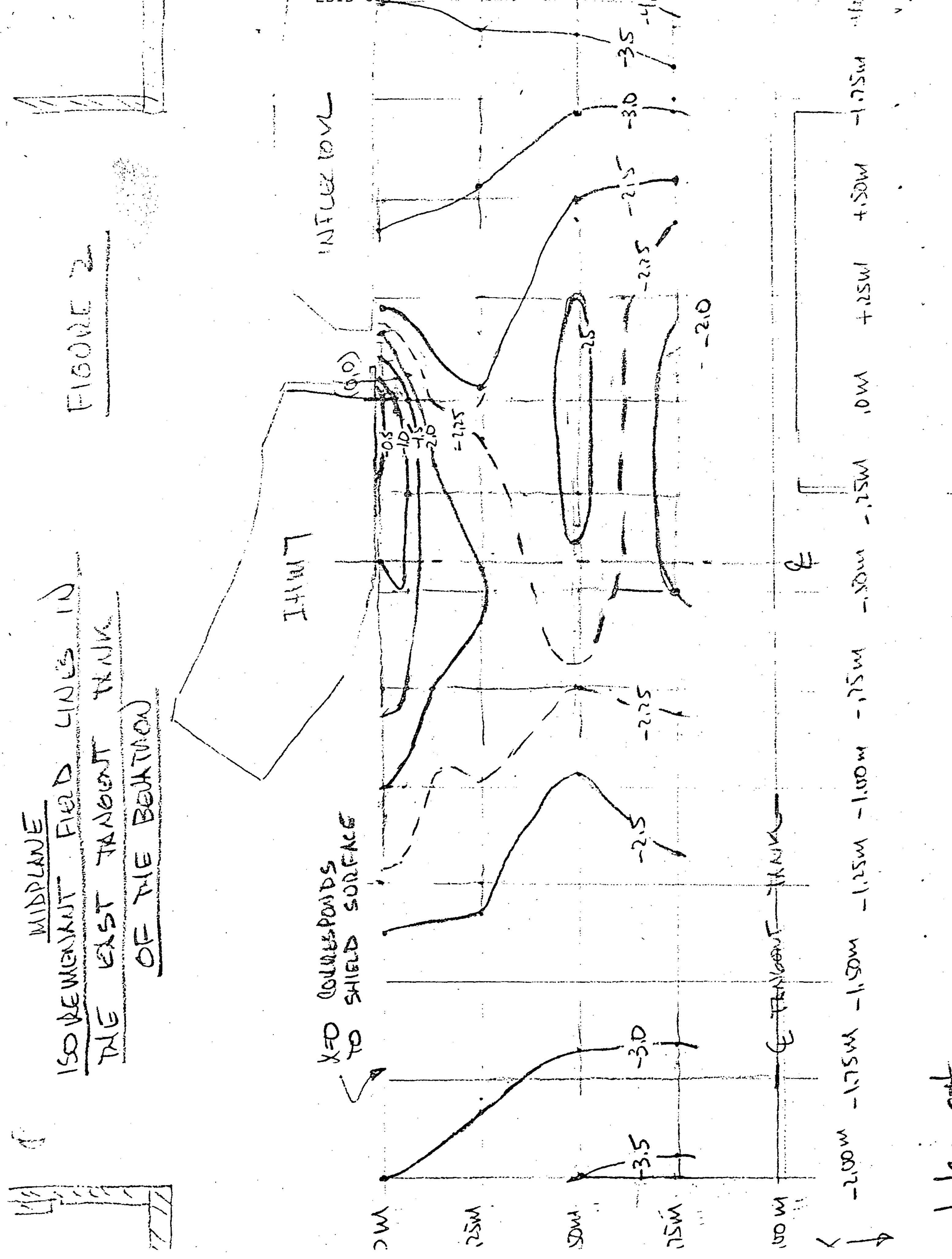


FIGURE 2
MIDPLANE
FIELD LINES IN
THE EAST TANGENT TANK
OF THE BEVATRON
INFLECTION
LIMIT
X=0 CORRESPONDS TO SHIELD SURFACE
℄ TANGENT TANK
(0,0)
-2.00M -1.75M -1.50M -1.25M -1.00M -.75M -.50M -.25M .0M +.25M +.50M +.75M

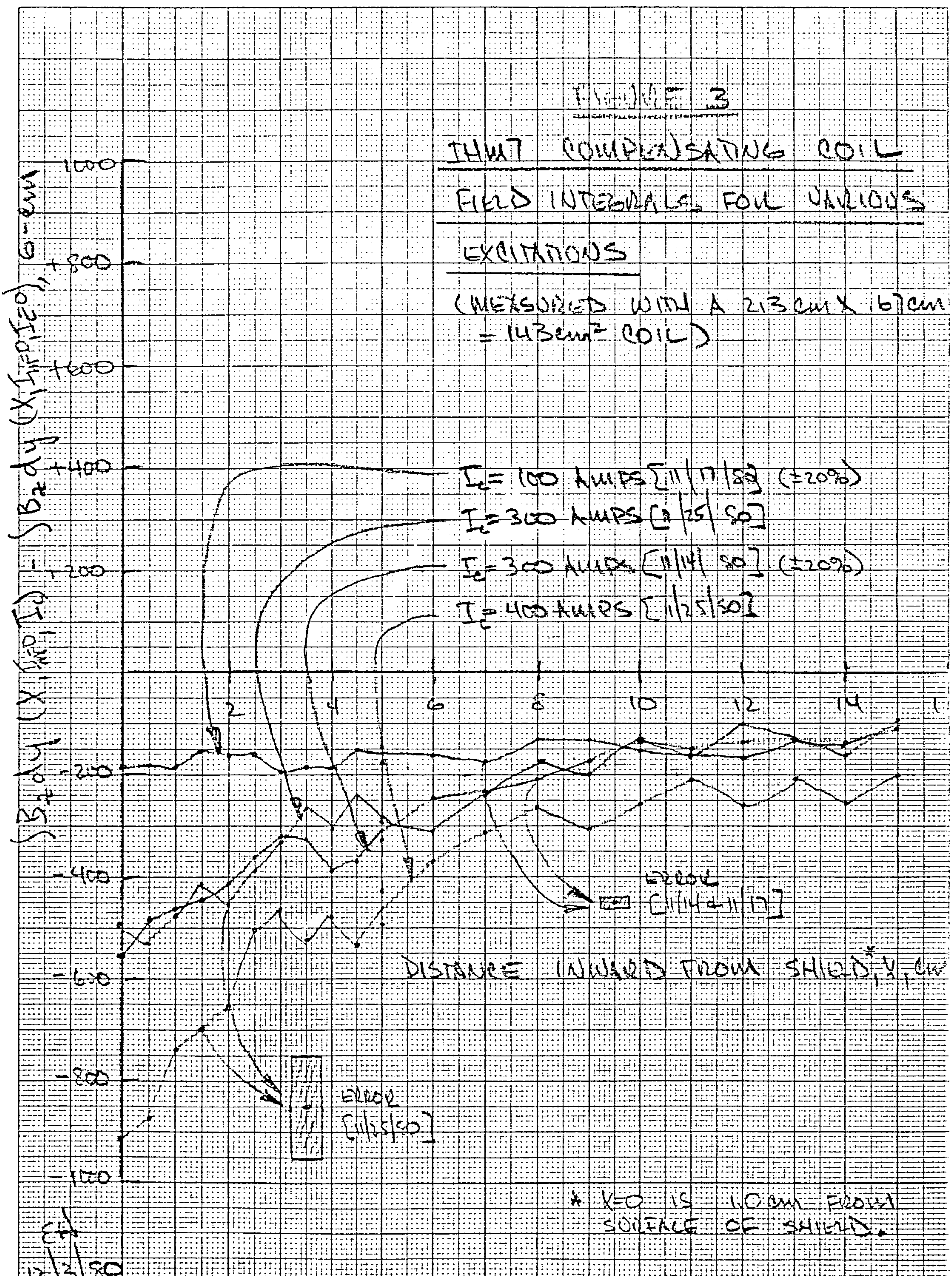


FIGURE 3
IHM7 COMPENSATING COIL
FIELD INTEGRALS FOR VARIOUS EXCITATIONS
(MEASURED WITH A 21.3 cm X 6.7 cm = 143 cm² COIL)
I_c = 100 AMPS [11/17/80] (±20%)
I_c = 300 AMPS [11/25/80]
I_c = 300 AMPS [11/14/80] (±20%)
I_c = 400 AMPS [11/25/80]
ERROR [11/14 & 11/17]
ERROR [11/25/80]
DISTANCE INWARD FROM SHIELD*, Y, cm
* Y=0 IS 1.0 cm FROM SURFACE OF SHIELD.
1000
+800
+600
+400
+200
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
12/3/80

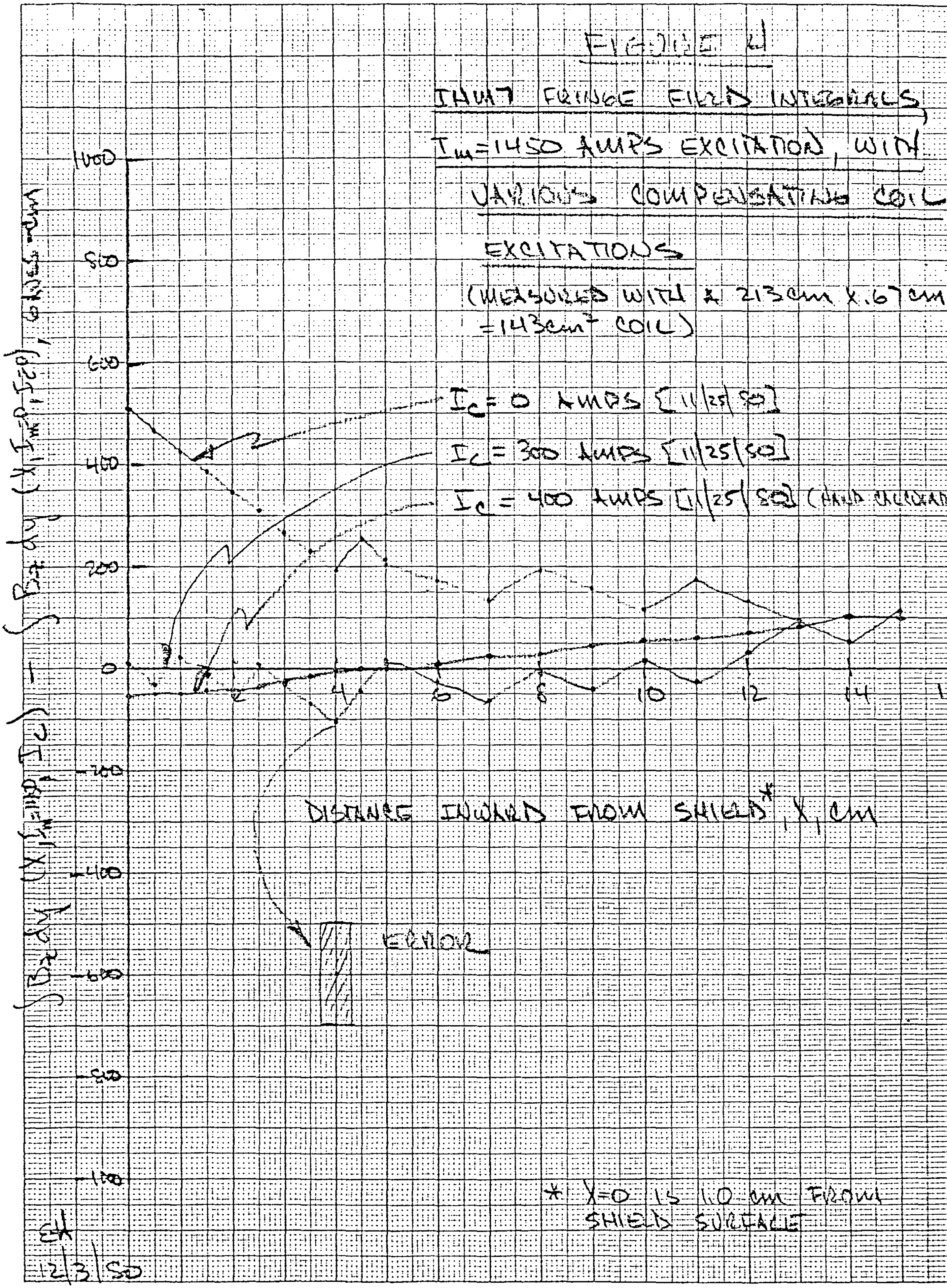


FIGURE 4
THM7 FRINGE FIELD INTEGRALS,
IM=1450 AMPS EXCITATION, WITH
VARIOUS COMPENSATING COIL
EXCITATIONS
(MEASURED WITH A 213cm X .67cm
=143cm² COIL)
IC = 0 AMPS [11/25/80]
IC = 300 AMPS [11/25/80]
IC = 400 AMPS [11/25/80]
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
2
4
6
8
10
12
14
DISTANCE INWARD FROM SHIELD*, X, cm
ERROR
* X=0 IS 1.0 cm FROM
SHIELD SURFACE
12/3/80

LBID-509

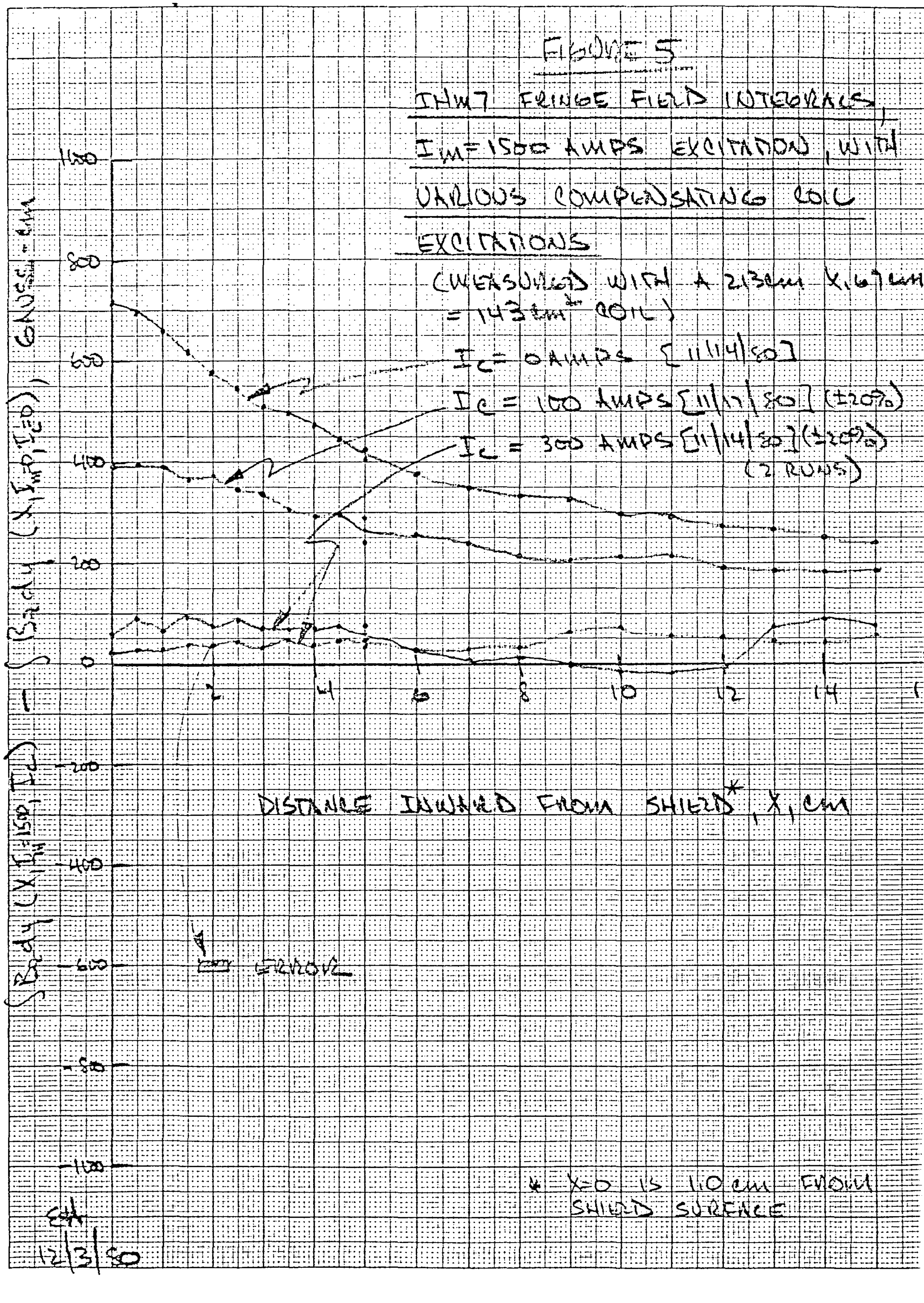


FIGURE 5
IHW7 FRINGE FIELD INTEGRALS, IM=1500 AMPS EXCITATION, WITH VARIOUS COMPENSATING COIL EXCITATIONS
(MEASURED WITH A 2.13cm X 6.7cm = 14.3cm² COIL)
IC = 0 AMPS [11/14/80]
IC = 100 AMPS [11/17/80] (±20%)
IC = 300 AMPS [11/14/80] (±20%) (2 RUNS)
DISTANCE INWARD FROM SHIELD*, X, cm
* X=0 IS 1.0 cm FROM SHIELD SURFACE
ERROR
0
2
4
6
8
10
12
14
1000
800
600
400
200
-200
-400
-600
-800
-1000
12/3/80

LAWRENCE BERKELEY LABORATORY
Bldg.: 25A Room: 124 Ext.: 5378

December 9, 1980

M E M O R A N D U M

To: Egon Hoyer

From: Don Nelson *DN*

Subject: Accuracy of Measurements of IHM7 Stray Fields

1. On October 8th, John Staples told me he would like us to measure $\int Bd\ell$ with a resolution of 0.1 Gm = 100 Gauss cm.

2. On October 15th, you defined (from your notes of an October 6th meeting with J. Staples)

   acceptable dipole: 86 Gin = 219 Gcm

   acceptable quadrupole: 86 Gm/m = 86 Gcm/cm.

3. Absolute accuracy is limited to $\pm$0.5% due primarily to uncertainty in the sensitivity of coil L-34.

4. For all measurements except the November 25th measurements resolution of the tabulated data was $\pm$0.001 V or 10 Gcm. (The data stored on tape has more resolution, but with the scatter I observed I judged that more significance was not important.) The accuracy in terms of acceptable dipole (219 Gcm) was therefore $\sim\pm$5% of acceptable dipole.

5. For the November 25th measurements, the DVM range switch was inadvertantly set to 1000 V full scale, limiting our resolution to 0.01 V or 100 Gcm ($\pm$50% of acceptable dipole).

6. Positioning Accuracy

   a. x = 0 is 1.8 cm $\pm$ 0.3 cm from magnet iron (see sketch)

   b. Coil L-34 was parallel to the "circulating beam" (according to fiducials provided by Glen White) within $\pm$3 cm over a length of $\sim$200 cm = > 1.5 m radians.

   c. Coil tilt error (deviation from vertical $\pm$ 60 m radians) introducing a "cosine error" of 0 to -0.2% $\int B_z dy$.

   d. Relative positioning accuracy (in the x direction) was $\pm$0.02 cm.

7. Attachments:

   a. Figure showing test equipment and location of coil L-34 @ x = 0.

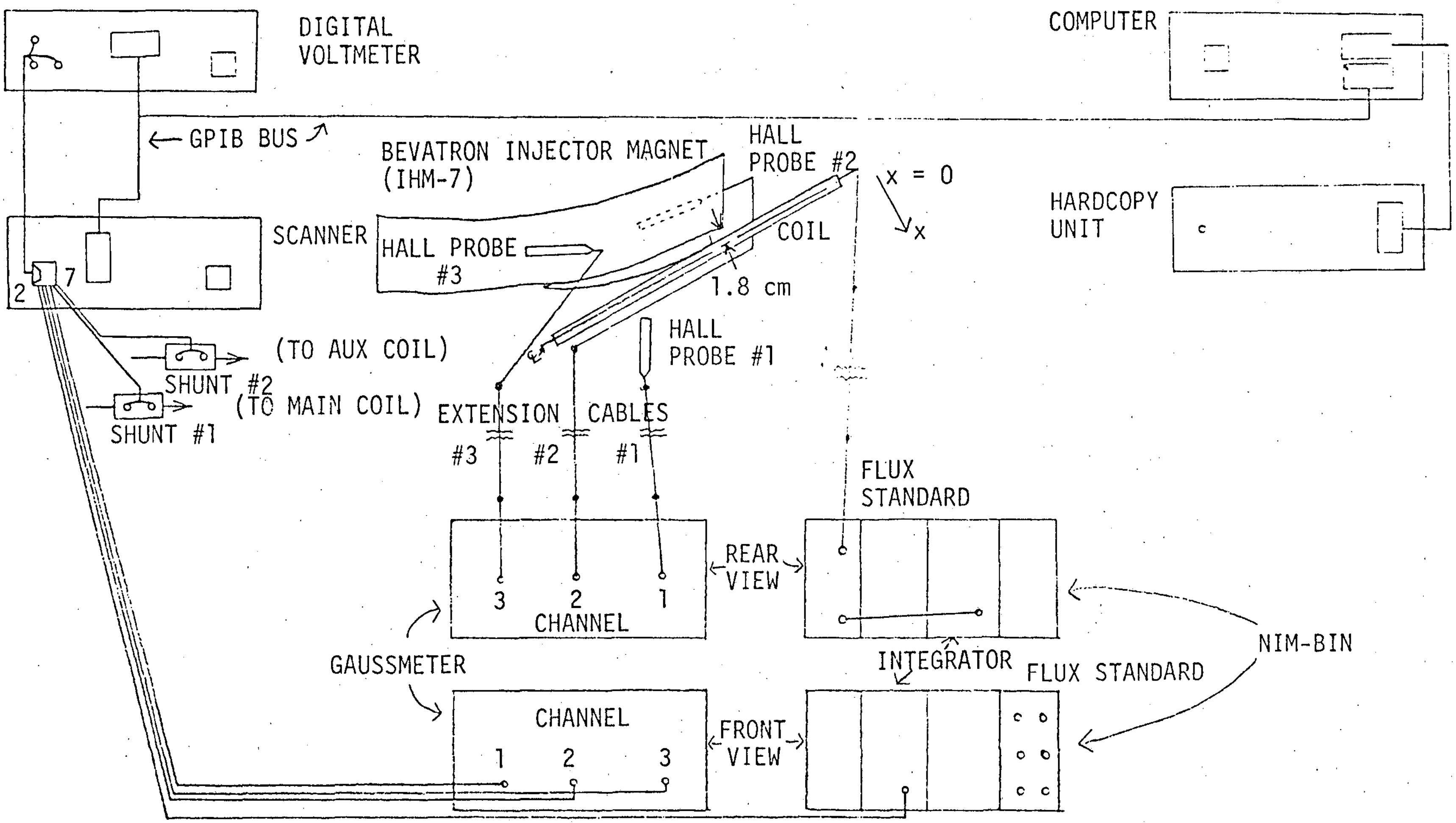
   b. Table of equipment used for tests.

DHN:cw

cc: W.H. Deuser
    M.I. Green

DATA LOGGER - IHM-7 DATA ACQUISITION SYSTEM

(Drawn December 2, 1980, EAC)



BW7892; M5655A and MT294

EQUIPMENT	MANUFACTURER	MODEL NUMBER	S/N	DOE/LBL	REMARKS
Computer	Tektronix	4051	B051568	504556	
Hard Copy Unit	Tektronix	4631	B094611	504505	
Voltmeter	Hewlett Packard	3455A	1622A08417	517459	
Scanner	Hewlett Packard	3495A	1428A06532	--	
Gauss Meter	F.W. Bell	8512	139635	517835	
Probe 1	F.W. Bell	HTB8-0608	127879		Cal. Const. = 7088
Probe 2	F.W. Bell	HTB8-0608	128626		Cal. Const. = 7874
Probe 3	F.W. Bell	HTB8-0608	129087		Cal. Const. = 6356
Extension Cable 1	F.W. Bell	XOVO-0025	139566		Cal. Const. = 7106
Extension Cable 2	F.W. Bell	XOVO-0025	139565		Cal. Const. = 7894
Extension Cable 3	F.W. Bell	XOQ4-0025	99258		Cal. Const. = 6372
Integrator	LBL	71	2		R = 26.1 K C = 0.1 μf Atten = 636
Flux Standard	LBL	SLFS42	42		Ø = 0.02231 (Wb)
Coil	LBL	L-34			nw = 27.32 (turn cm) n = 41 (t) ℓ = 213 (cm)
Shunt #1	?	Bevatron			1500 A/100 mV
Shunt #2	?	Bevatron			500 A/100 mV

DATA LOGGER EQUIPMENT LIST - IHM-7

(November 1980)

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