# SOME SHORT SAMPLE TEST DATA

Nov. 23, 1974

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## Experimental Setup

A superconducting solenoid obtained from Berkeley provides the magnetic field that we use for testing the sample. It is 10" high with a 10" diameter and has a 5" bore. The magnet is powered by an Oxford Instrument power supply and can go up to 57kG at central field. Magnet stability is very good and testing is done at 55kG with no problems. The magnet can be excited to 55kG in only 2 or 3 minutes. The field varies by 6.6 per cent from center to edge of magnet with center a minimum.

The sample is approximately a 40" length of superconductor. It is wound in a bifilar manner on a G-10 cylinder with a 1 5/8" diameter. About 5" of superconductor are soldered onto each power lead using 50-50 solder. Voltage taps are attached below the power leads and a thermocouple has one junction in contact with the sample, as shown in Fig.1. BIPAX epoxy is placed between the sample turns, but not on top of the sample. The sample holder is held in place by a flange at the top of the dewar. A spindle at the bottom end of the sample holder fits into a centering hole. The sample is centered in the magnet both horizontally and vertically and is held rigidly in place. The field of the magnet is along its cylindrical axis and thus is along the cylindrical axis of the sample. The direction of the field is down.

At magnetic fields of 25, 30, 35, 40, 45, 50, and 55kG, the current in the sample is increased until the sample quenches. The current in the sample and the voltage across the sample are constantly monitored and plotted on a chart recorder. A voltage change of 1μv can be detected. A safety circuit cuts off the power supplies as soon as a quench is detected. An automatic ramp turns up the power supplies at the selected ramp rate. The rate can be changed while the current is being ramped.

Data Reduction

Representative I-V curves at each field value are plotted on the same graph. Then resistivities between $10^{-11}$ Ωcm and $10^{-13}$ Ωcm are calculated and the lines are plotted on the same graph as the quench curves. The intersection points give the resistivities at selected fields and currents. Quench and resistivity curves for individual wires are shown in Figures 4 through 9.

The experimental data are listed in Tables I and II, and in Figures 2 and 3. Actual quench current as well as current at effective resistivities of $2 \times 10^{-12}$Ωcm, $10^{-12}$Ωcm, and $5 \times 10^{-13}$Ωcm are given.

One Berkeley wire (IMI), one MCA wire, two Furukawa wires and one 7 strand Supercon wire were measured in October. Their data are shown in Fig. 2, and in Tables I and III.

Recently one MCA and three Supercon samples were tested. Due to the problem with a power supply, we could measure only in the range of

40 to 55kG. Their results are shown in Fig. 3, and in Tables II and IV. For the MCA wire the current difference between resistivity of $5x10^{-13}\Omega cm$ and quench was small, only 5 or 6 per cent. For the Supercon wires these differences varied from 11 to 25 per cent.

Several quenches were run for each sample at each field. For MCA at 50kG all quenches occured within 5 amps of each other. For the 11 strand Supercon (Roll 23), the quench consistence at 50kG was also good. It varied by only 30 amps over half a dozen quenches. The two 7 strand Supercon samples were not as good. Roll 21 showed a variation of 60 amps and the quench value of Roll 22 varied by 90 amps.

The two Supercon 7 strand samples should have given very similar data but the quench currents of these varied by 15 to 25 per cent.

Resistivity Test

Resistivity tests are also made on the superconducting short samples. With the sample in the same configuration as previously described it is suspended in vapor from liquid Helium and gradually cooled from approximately 50K to the transition temperature and then to liquid Helium temperature (4.2K).

A current of 10.0 amperes is periodically passed through the sample. The voltage across the sample is monitored and displayed on a D.V.M., where it can be read to the nearest μv. The voltage is also recorded when there is no current through the sample. The resistance is measured at room temperature and extrapolated to 300K, and measured at liquid Nitrogen temperature.

The resistances at 300K and immediately before the transition temperature are compared to get the resistivity ratio. The ratios have been measured for MCA, Supercon, Furukawa and IMI wires. The IMI with a ratio of 125 was significantly higher than the others. MCA wire with ratios from 85 to 95 was below manufacturers specifications. The Furukawa wires had ratios of 60 and 65. Of the six Supercon wires tested five had ratios of 35 to 45 and the exception, one of the seven stranded cable (Roll 22) was 68. These data and other pertinent data are listed in Tables III and IV. Typical resistance curves are shown in Figures 10 and 11.

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Attach. (15)

SUBJECT Double Helix Sample Holder

NAME

DATE | REVISION DATE

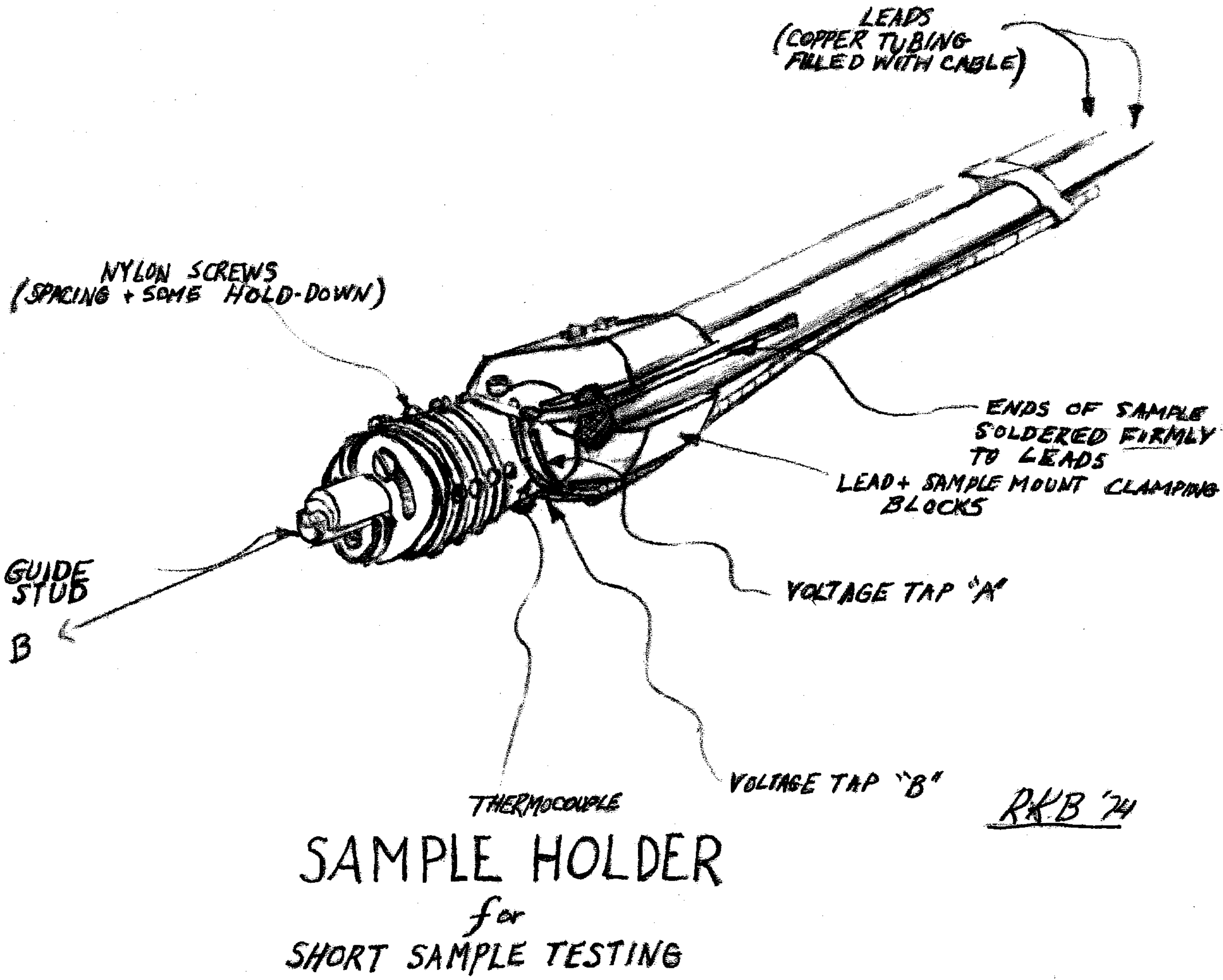



FIGURE 1

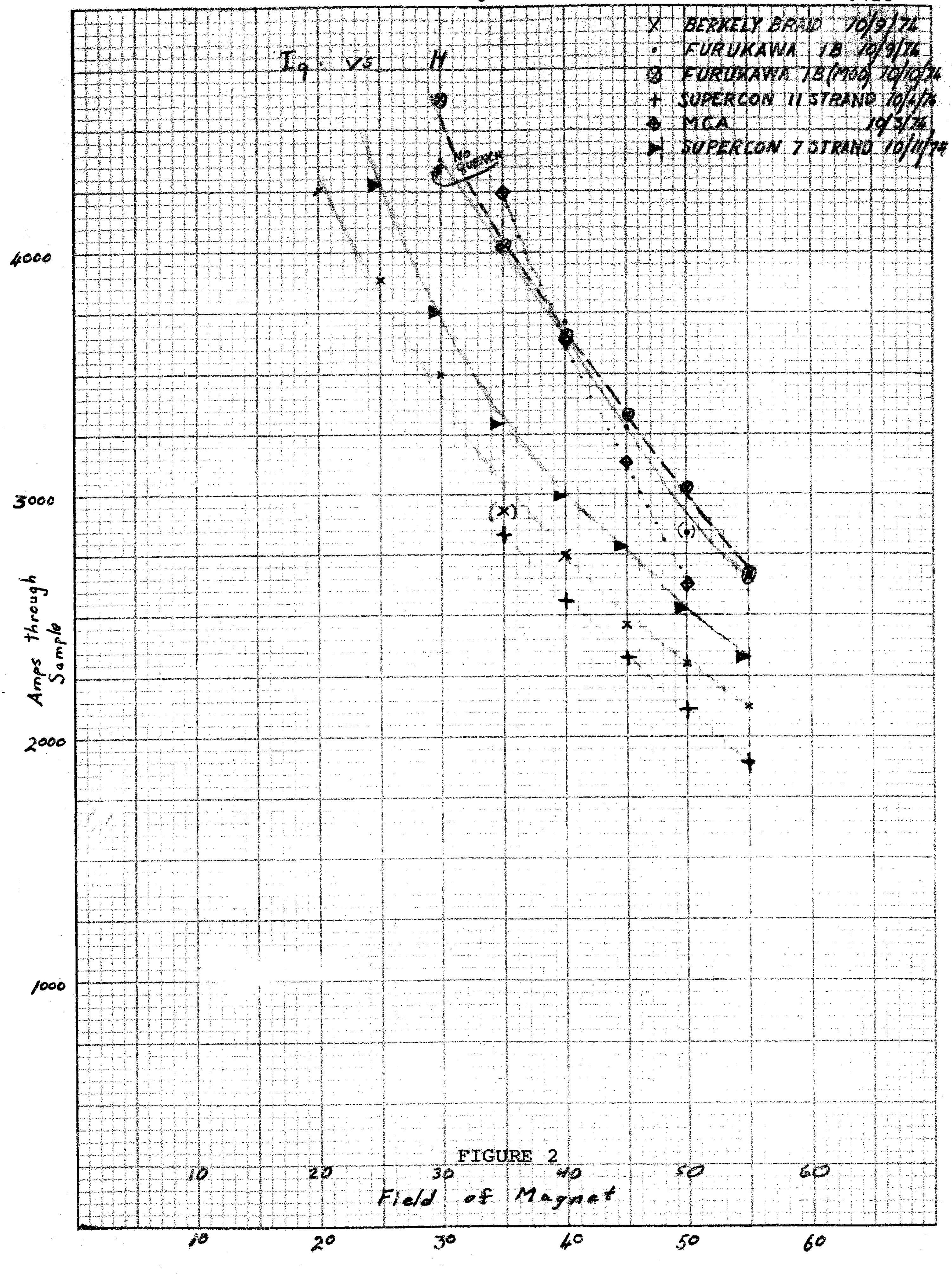

Iq vs H
X BERKELY BRAID 10/9/74
• FURUKAWA 1B 10/9/74
⊗ FURUKAWA 1B(MOD) 10/10/74
+ SUPERCON 11 STRAND 10/4/74
MCA 10/3/74
SUPERCON 7 STRAND 10/11/74
NO QUENCH
4000
3000
2000
1000
Amps through Sample
10
20
30
40
50
60
Field of Magnet

FIGURE 2

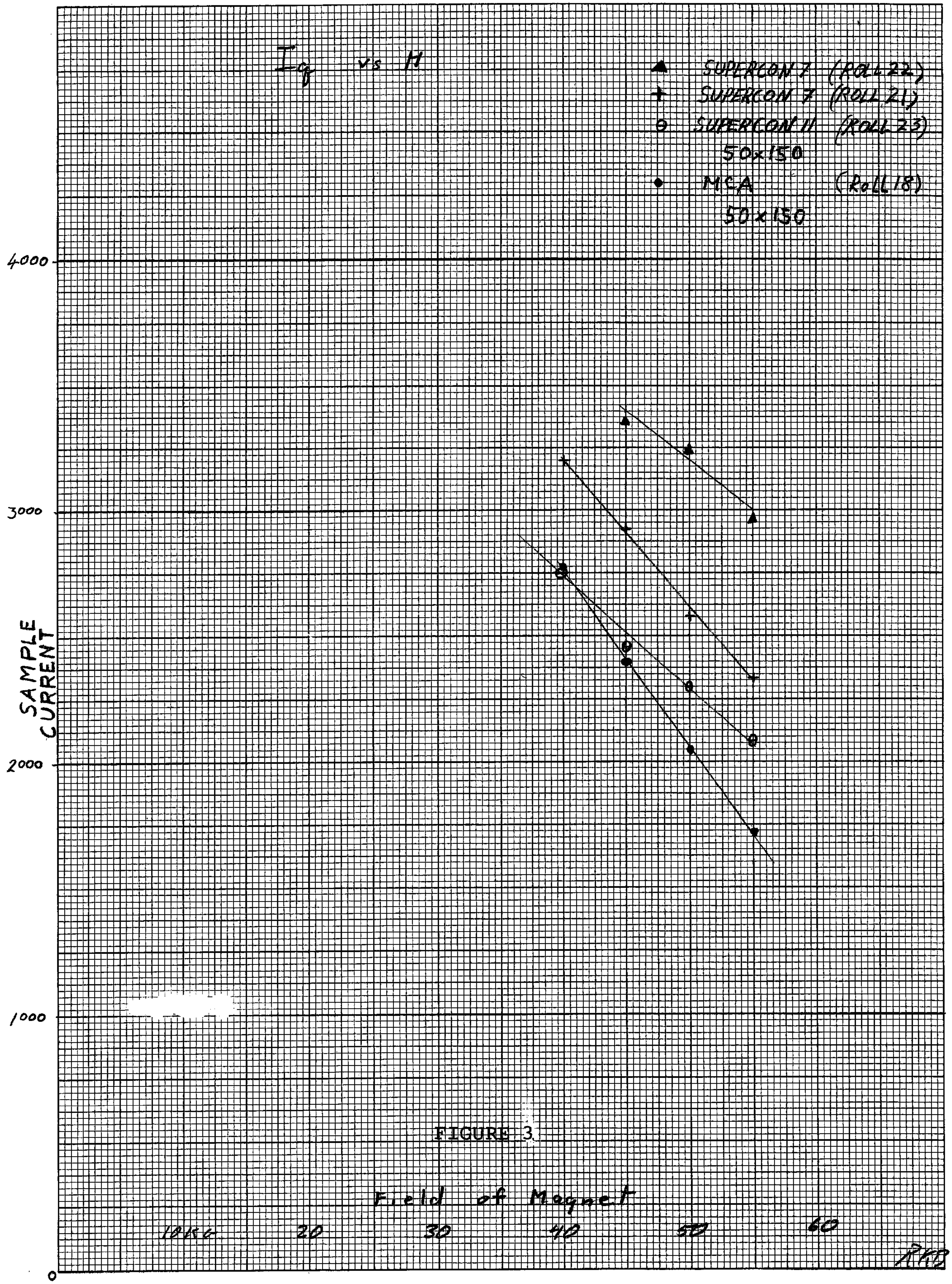

Iq vs H
SUPERCON 7 (ROLL 22)
SUPERCON 7 (ROLL 21)
SUPERCON 11 (ROLL 23)
50x150
MCA (ROLL 18)
50x150
4000
3000
2000
1000
0
SAMPLE CURRENT
Field of Magnet
10KG
20
30
40
50
60
RKD

FIGURE 3

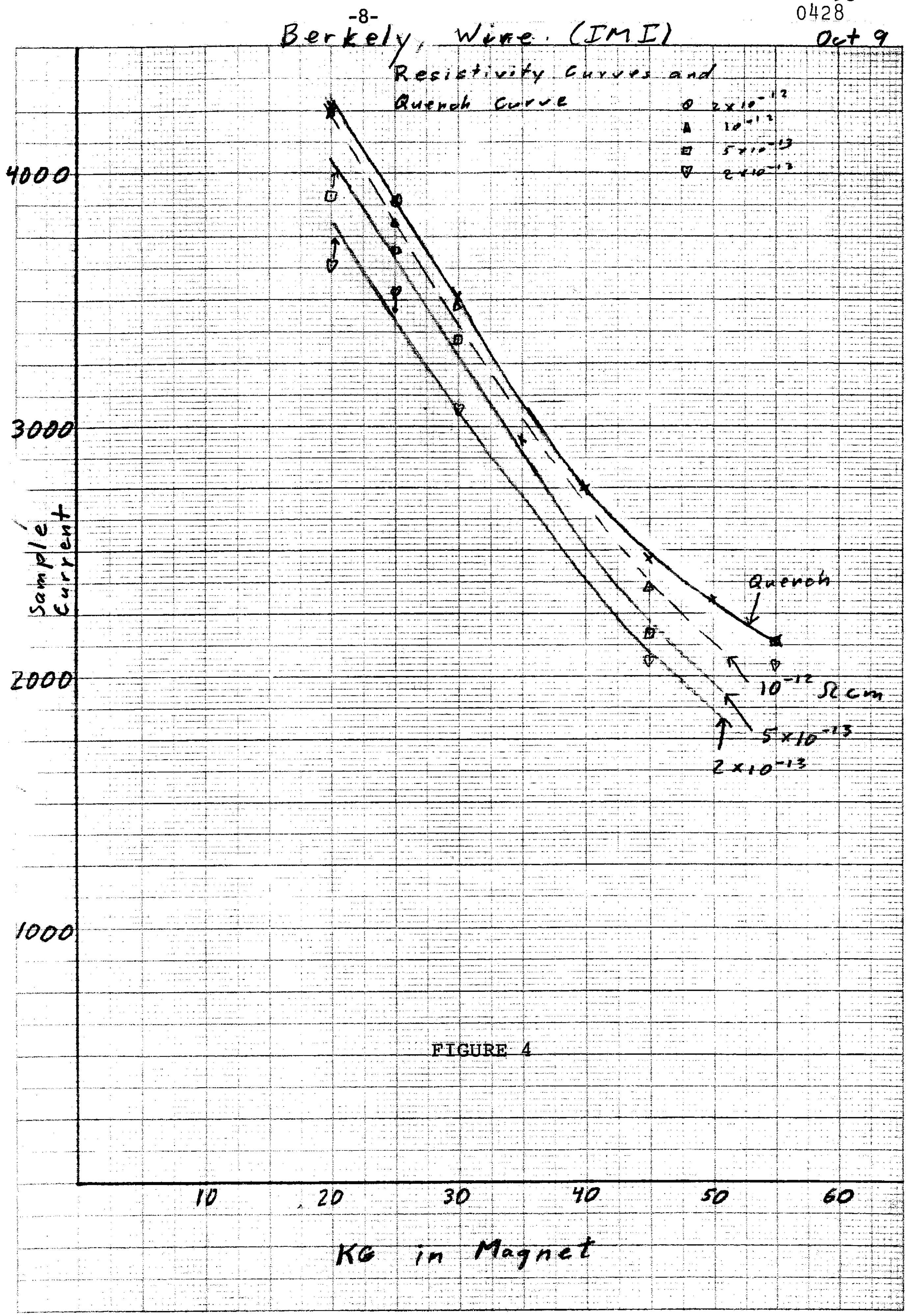

Berkely Wire (IMI)
Oct 9
Resistivity Curves and Quench Curve
2×10⁻¹²
10⁻¹²
5×10⁻¹³
2×10⁻¹³
4000
3000
2000
1000
Sample Current
Quench
10⁻¹² Ω cm
5×10⁻¹³
2×10⁻¹³
10
20
30
40
50
60
KG in Magnet

FIGURE 4

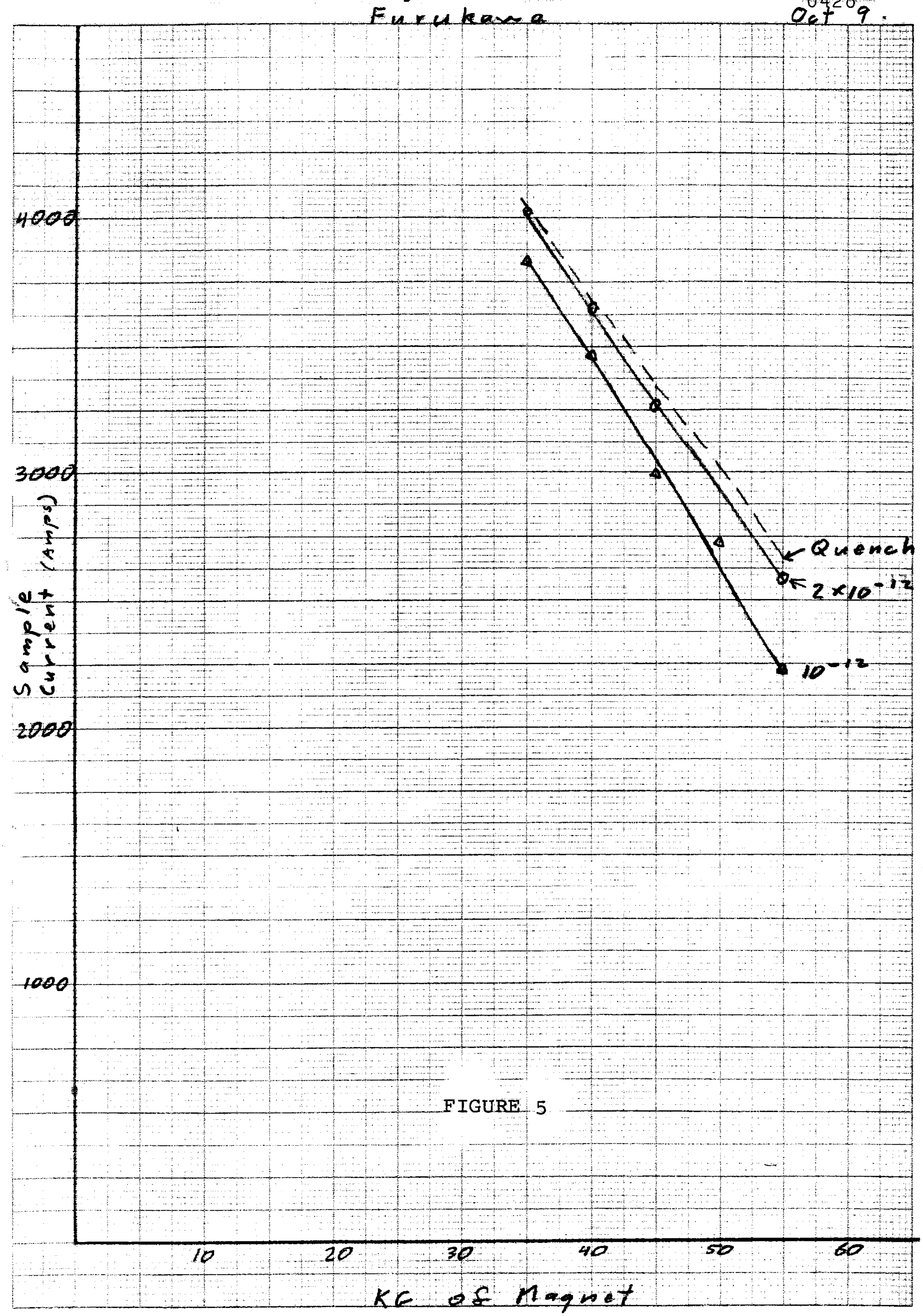

Furukawa
Oct 9.
4000
3000
2000
1000
Sample Current (Amps)
Quench
2×10⁻¹²
10⁻¹²
10
20
30
40
50
60
KG of Magnet

FIGURE 5

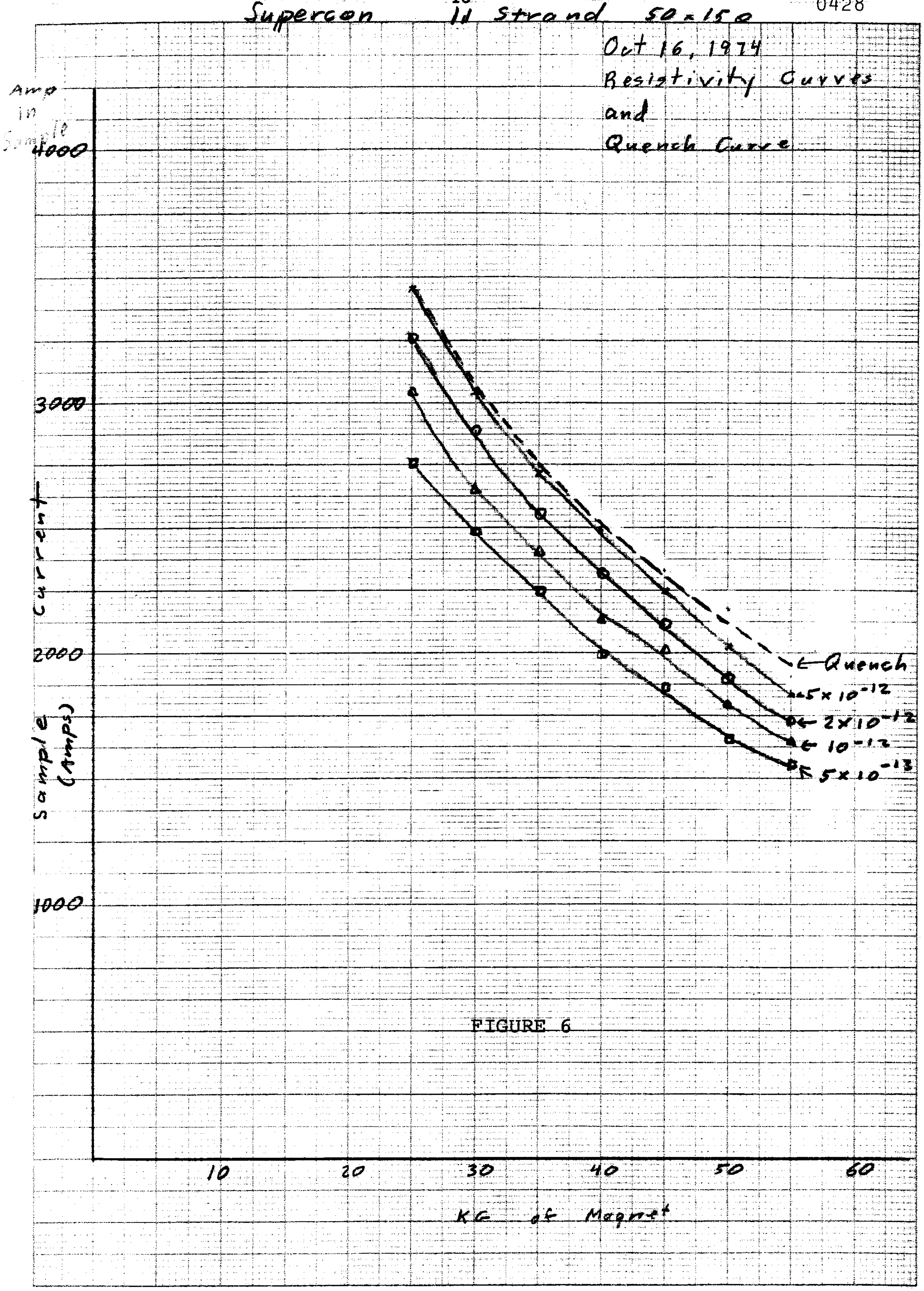

Supercon 11 Strand 50 x 15 a
Oct 16, 1974
Resistivity Curves
and
Quench Curve
Amp in Sample
4000
3000
2000
1000
Sample Current (Amps)
Quench
5x10^-12
2x10^-12
10^-12
5x10^-13
10
20
30
40
50
60
KG of Magnet

FIGURE 6

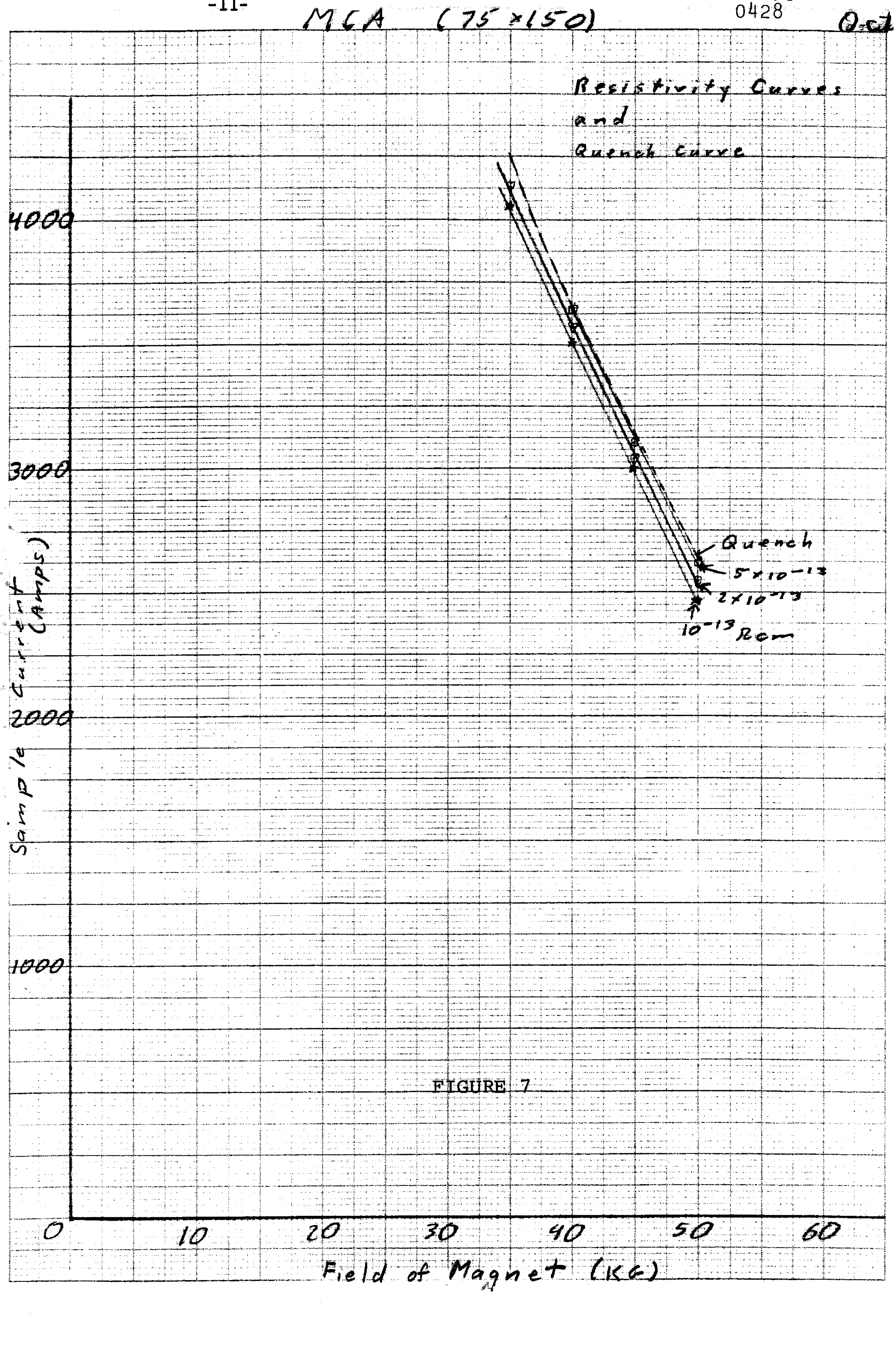

MCA (75 × 150)
Oct
Resistivity Curves
and
Quench Curve
Quench
5 × 10⁻¹³
2 × 10⁻¹³
10⁻¹³ Ωcm
4000
3000
2000
1000
Sample Current (Amps)
0
10
20
30
40
50
60
Field of Magnet (KG)

FIGURE 7

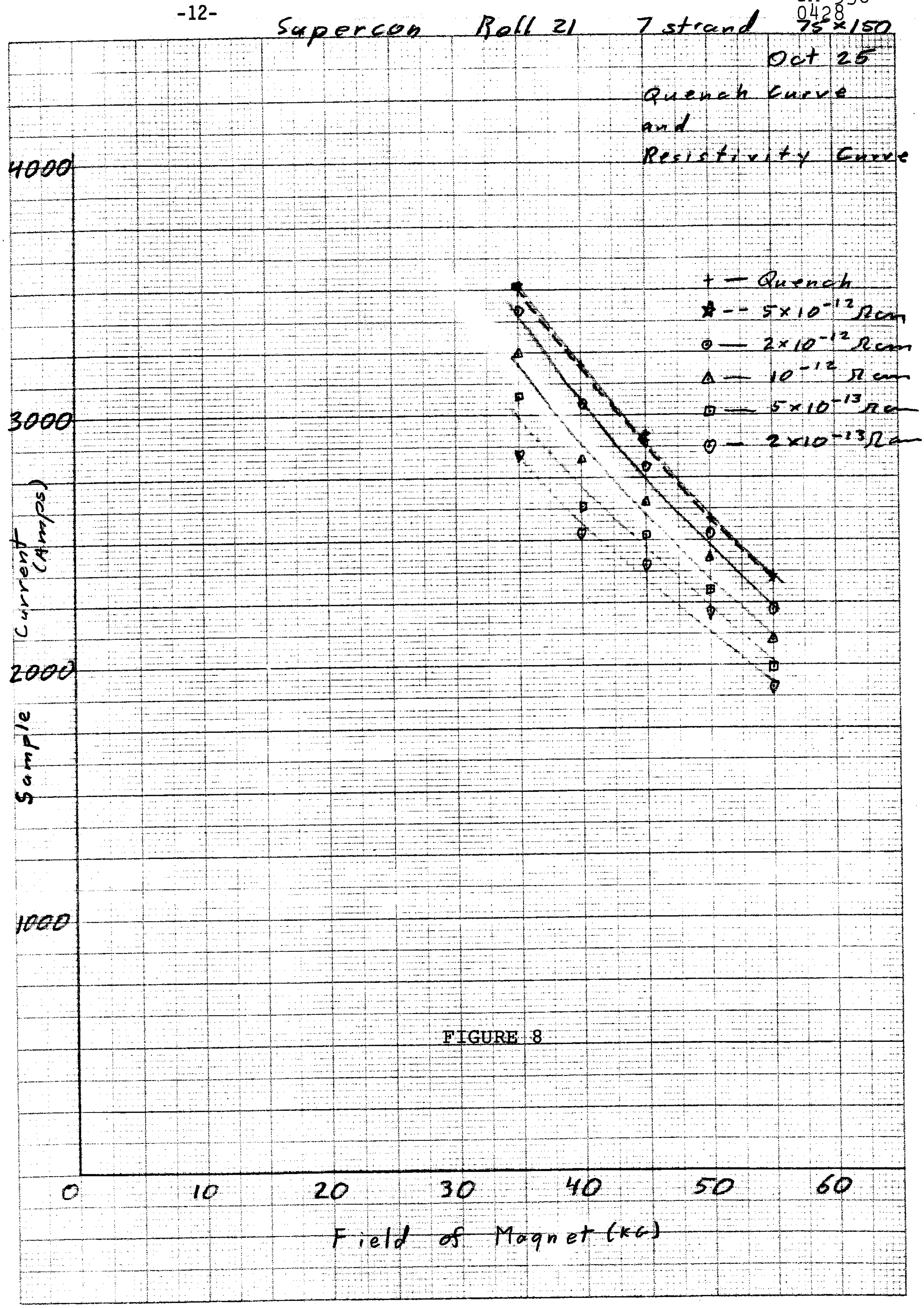

Supercon Roll 21 7 strand 75×150
Oct 25
Quench Curve
and
Resistivity Curve
+ — Quench
✱ -- 5×10^-12 Ωcm
⊙ — 2×10^-12 Ωcm
△ — 10^-12 Ωcm
⊡ — 5×10^-13 Ωcm
▽ — 2×10^-13 Ωcm
4000
3000
2000
1000
Sample Current (Amps)
0
10
20
30
40
50
60
Field of Magnet (kG)

FIGURE 8

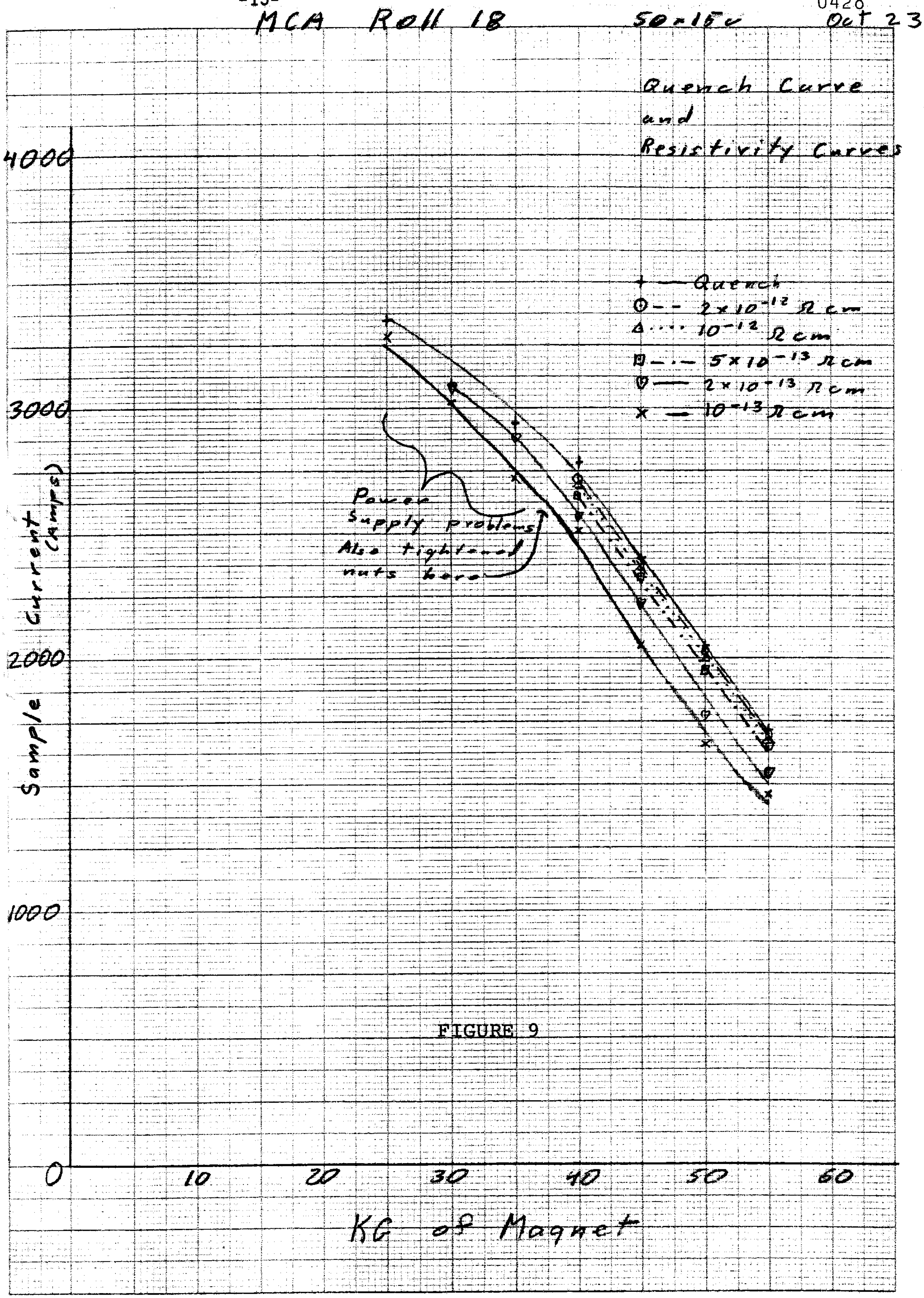
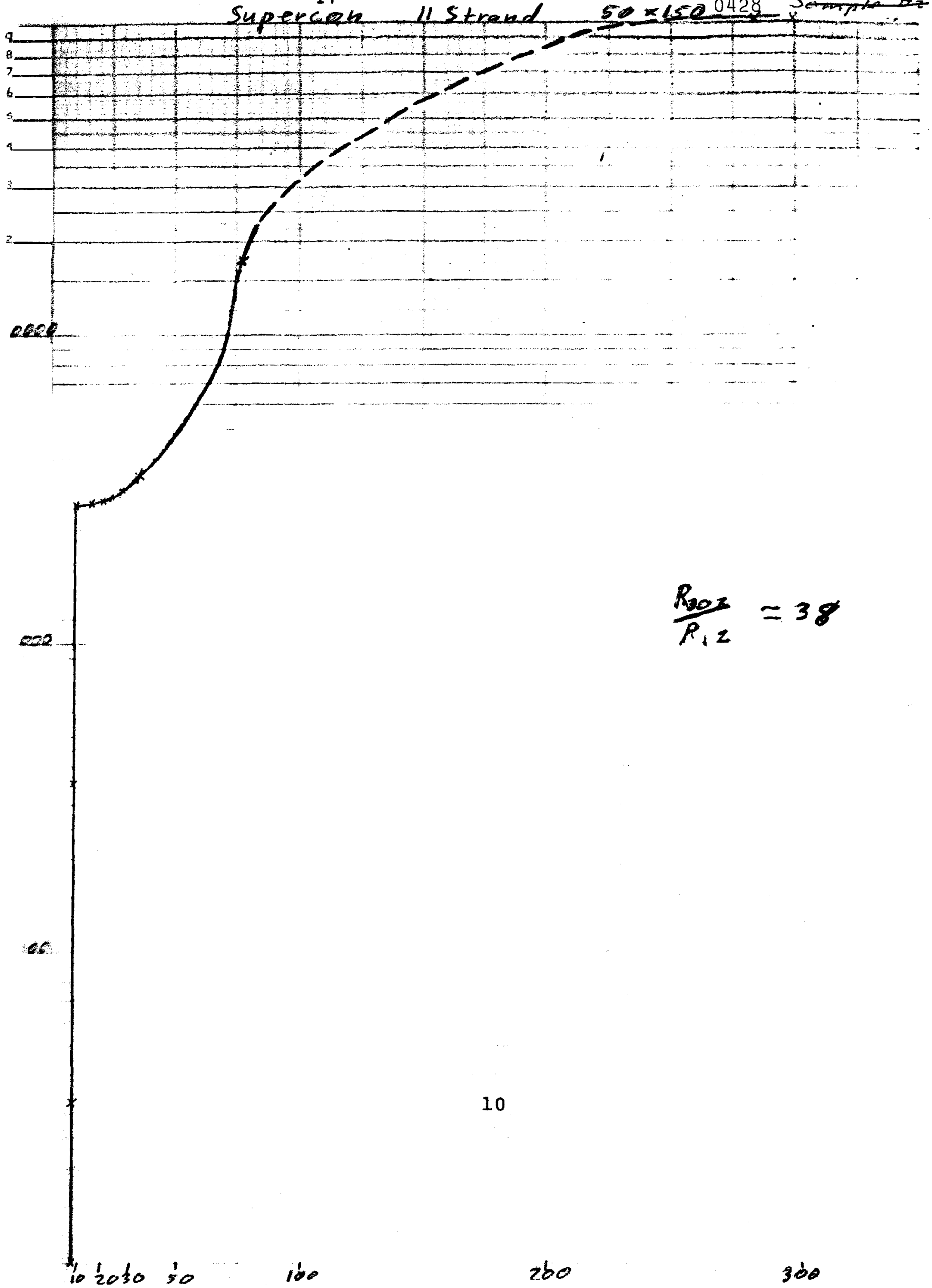

MCA Roll 18
Oct 23
Quench Curve
and
Resistivity Curves
+ — Quench
Power
Supply problems
Also tightened
nuts here
4000
3000
2000
1000
0
10
20
30
40
50
60
Sample Current (Amps)
KG of Magnet

FIGURE 9


Supercon 11 Strand 50×150
Oct 16
$\frac{R_{300}}{R_{12}} \simeq 38$
10 20 30 50 100 200 300

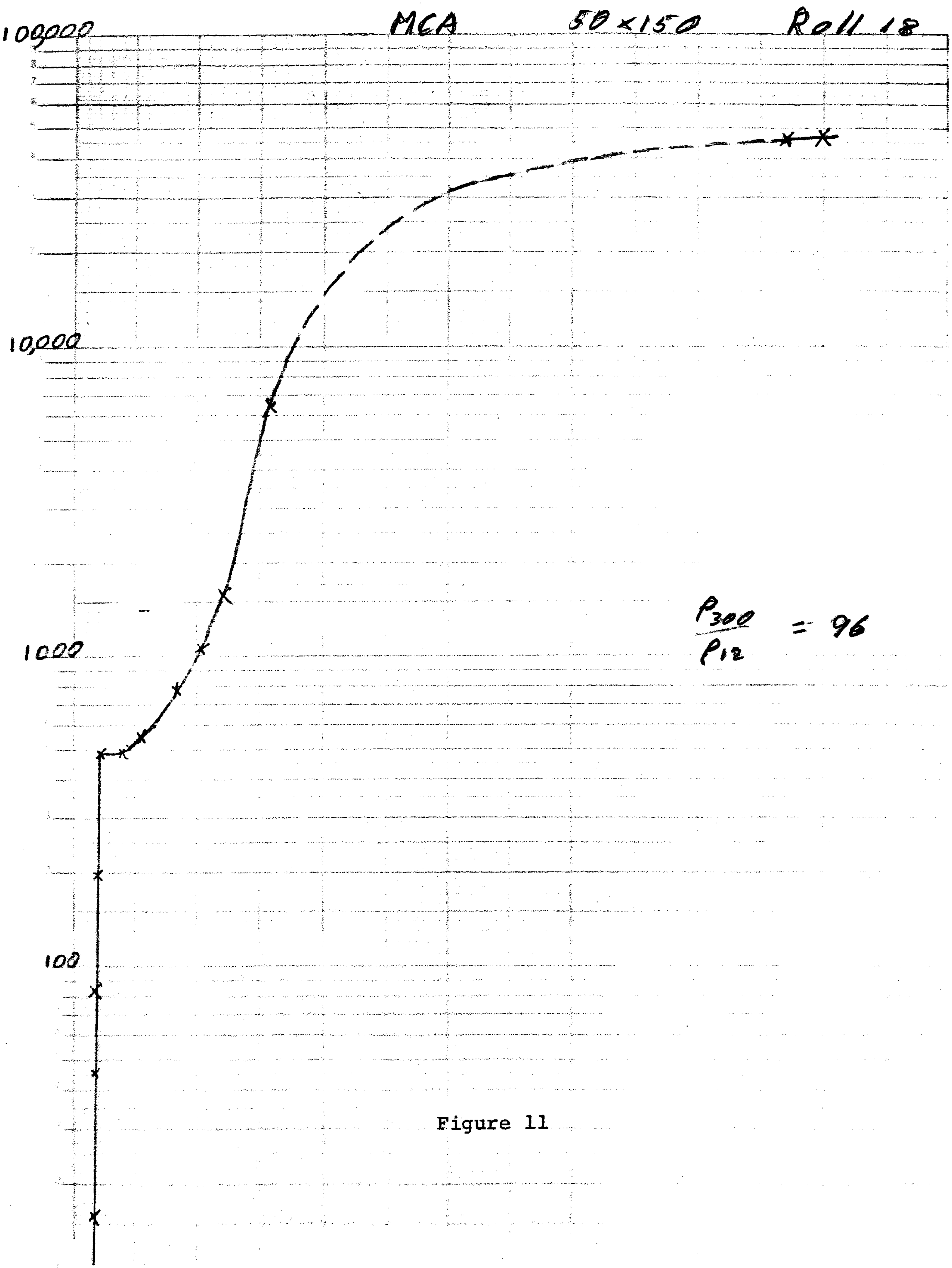



Figure 11

## TABLE I

| TYPE OF WIRE | SIZE | B(kG) | 40 | 45 | 50 | 55 | RESISTANCE WHEN QUENCHES | COMMENT |
|---|---|---|---|---|---|---|---|---|
| Berkeley (IMI) | 58x170 | Quench | 2750 | 2460 | 2300 | 2120 | $10^{-12}$ | Moderately Stable- Improves As Field Increases |
| | | $10^{-12}$ | ____ | 2350 | ____ | ____ | | |
| | | $5x10^{-13}$ | ____ | 2170 | ____ | 2140 | | |
| MCA Oct. 3 | 74x148 | Quench | 3650 | 3130 | 2630 | | $5x10^{-13}$ | Very small current sharing |
| | | $5x10^{-13}$ | 3650 | 3110 | 2620 | | | |
| | | $2x10^{-13}$ | 3580 | 3040 | 2530 | | | |
| Furukawa | 73x146 | Quench | 3710 | 3290 | 2880 | 2660 | $3x10^{-12}$ | Very Unstable Especially At High Field |
| | | $2x10^{-12}$ | 3650 | 3260 | ____ | 2580 | | |
| | | $10^{-12}$ | 3470 | 2990 | 2720 | 2220 | | |
| Furukawa Modified | 139x192 | Quench | 3670 | 3340 | 3010 | 2660 | $3x10^{-12}$ | Much More Stable Than Unmodified Sample |
| | | $2x10^{-12}$ | 3590 | 3260 | 2890 | 2540 | | |
| | | $10^{-12}$ | 3140 | 3010 | 2510 | 2300 | | |
| | | $5x10^{-13}$ | 2500 | 2410 | 1910 | 1820 | | |
| Supercon 7 Strand Oct. 11 | 72x144 | Quench | 2990 | 2770 | 2520 | 2430 | $2x10^{-12}$ | Moderately Stable |
| | | $2x10^{-12}$ | ____ | 2740 | 2470 | 2220 | | |
| | | $10^{-12}$ | 2920 | 2560 | 2340 | 2110 | | |
| | | $5x10^{-13}$ | 2740 | 2380 | 2210 | 1992 | | |
| Supercon 11 Strand Oct. 4 | 46x145 | Quench | 2560 | 2330 | 2110 | 1900 | $7x10^{-12}$ | Very large current sharing |
| | | $6.5x10^{-12}$ | 2480 | 2250 | 2050 | 1820 | | |
| | | $1.5x10^{-12}$ | 2200 | 2040 | 1900 | 1650 | | |
| Supercon 11 Strand Oct .16 | 46x145 | Quench | 2500 | 2330 | 2170 | 1960 | $5x10^{-12}$ | Stable Very large current sharing |
| | | $2x10^{-12}$ | 2310 | 2110 | 1910 | 1730 | | |
| | | $10^{-12}$ | 2170 | 2010 | 1800 | 1650 | | |
| | | $5x10^{-13}$ | 1990 | 1880 | 1670 | 1550 | | |

## TABLE II

| TYPE OF WIRE | SIZE | B(kG) | 40 | 45 | 50 | 55 | RESISTANCE WHEN QUENCHES | COMMENT |
|---|---|---|---|---|---|---|---|---|
| MCA (Roll 18) | 49x148 | Quench | 2780 | 2400 | 2050 | 1710 | $2 \times 10^{-12}$ | Very Consistent data Small current sharing |
| | | $2 \times 10^{-12}$ | 2720 | | 2030 | 1700 | | |
| | | $10^{-12}$ | 2700 | 2370 | 2010 | 1670 | | |
| | | $5 \times 10^{-13}$ | 2660 | 2330 | 1950 | 1640 | | |
| Supercon 7 (Roll 21) | 72x144 | Quench | 3200 | 2920 | 2580 | 2360 | $5 \times 10^{-12}$ | Moderate current sharing |
| | | $2 \times 10^{-12}$ | 3040 | 2800 | 2530 | 2220 | | |
| | | $10^{-12}$ | 2820 | 2650 | 2430 | 2100 | | |
| | | $5 \times 10^{-13}$ | 2630 | 2520 | 2310 | 1990 | | |
| Supercon 7 (Roll 22) | 72x144 | Quench | | 3370 | 3260 | 2980 | $4 \times 10^{-12}$ | This sample will be repeated. Very large current sharing |
| | | $2 \times 10^{-12}$ | | 3320 | 3020 | 2710 | | |
| | | $10^{-12}$ | | 3050 | 2810 | 2450 | | |
| | | $5 \times 10^{-13}$ | | 2680 | 2450 | 2030 | | |
| Supercon 11 (Roll 23) | 46x145 | Quench | 2750 | 2460 | 2300 | 2080 | $10^{-11}$ | Consistent quench currents Large current sharing |
| | | $2 \times 10^{-12}$ | 2450 | 2220 | 2010 | 1870 | | |
| | | $10^{-12}$ | 2280 | 2020 | 1910 | 1780 | | |
| | | $5 \times 10^{-13}$ | 2120 | 1630 | 1810 | 1720 | | |

## TABLE III

| Type of Wire | Size (Mils) | $\rho 300/\rho 12$ | Filament Size ($\mu$) | Number | Area of S.C. ($cm^2$) | Total Area ($cm^2$) | Cu/ S.C. | Area/ S.C. | $I_c$ at 50 kG (amps) | $J_c$ (KA/ $cm^2$) | $I_{eff}$ (KA/ $cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Berkeley (IMI) Oct. 9 | 58x170 | 125 | 11 | 9x2035 | .0174 | .0636 | 1.3/1 | 2.7/1 | 2304 | 132 | 36 |
| MCA Oct. 3 | 74x148 | 85 | 35 | 2300 | .0221 | .0726 | 2.2/1 | 2.3/1 | 2628 | 119 | 36 |
| Furukawa Oct. 9 | 73x146 | 60 | 36 | 2300 | .0234 | .0692 | 1.9/1 | 2/1 | 2880 | 123 | 42 |
| Furukawa Modified Oct. 10 | 139x192 | 65 | 36 | 2300 | .0234 | .1723 | 3/1 | 6.4/1 | 3012 | 129 | 18 |
| Supercon 7 Strand Oct. 11 | 72x144 | 40 | 29<br>21 | 4x520<br>3x1050 | .0246 | .0670 | 1/1 | 1.7/1 | 2520 | 102 | 38 |
| Supercon 11 Strand Oct. 4 | 46x145 | 35 | 19.7<br>13.9 | _x520<br>_x1050 | .0174 | .0431 | 1/1 | 1.5/1 | 2110 | 121 | 49 |
| Supercon 11 Strand Oct. 16 | 46x145 | 38 | 19.7<br>13.9 | _x520<br>_x1050 | .0174 | .0431 | 1/1 | 1.5/1 | 2172 | 125 | 50 |

MP:er

TABLE IV

| Type of Wire | Size (Mils) | $\rho 300/\rho 12$ | Filament Size ($\mu$) | Number | Area of S.C. ($cm^2$) | Total Area ($cm^2$) | Cu/ S.C. | Area/ S.C. | $I_c$ at 50 kG (amps) | $J_c$ (KA/ $cm^2$) | $I_{eff}$ (KA/ $cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MCA<br>(Roll 18)<br>Oct. 24 & 25 | 49x148 | 125 | 28.6 | 2300 | .0148 | .0517 | 2.2/1 | 2.5/1 | 2050 | 139 | 40 |
| Supercon 7<br>(Roll 21)<br>Oct. 25 | 72x144 | 39 | 29<br>21 | 4x520<br>3x1050 | .0246 | .0670 | 1/1 | 1.7/1 | 2580 | 105 | 39 |
| Supercon 7<br>(Roll 22)<br>Oct. 25 | 72x144 | 68 | 29<br>21 | 4x520<br>3x1050 | .0246 | .0670 | 1/1 | 1.7/1 | 3260 | 133 | 49 |
| Supercon 11<br>(Roll 23)<br>Oct. 24 | 46x145 | 45 | 19.7<br>13.9 | _x520<br>_x1050 | .0174 | .0431 | 1/1 | 1.5/1 | 2300 | 132 | 53 |

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