Wayne Kosk
FNA
6-12-9

Test Results for Magnets DS0308 and DS0309

Fermilab modifications to baseline:

1) Individually Determined Ends

2) All Kapton Coil Insulation with no Collaring Shims c Shoes

3) Collet End Clamp with external inner-outer coil splice.

DS0308

Quench testing at 4.2K

Strain Gage Measurements

Field Measurements

Ramp Rate Study

DS0309

Quench testing at 4.3 and 3

Strain Gage Measurements

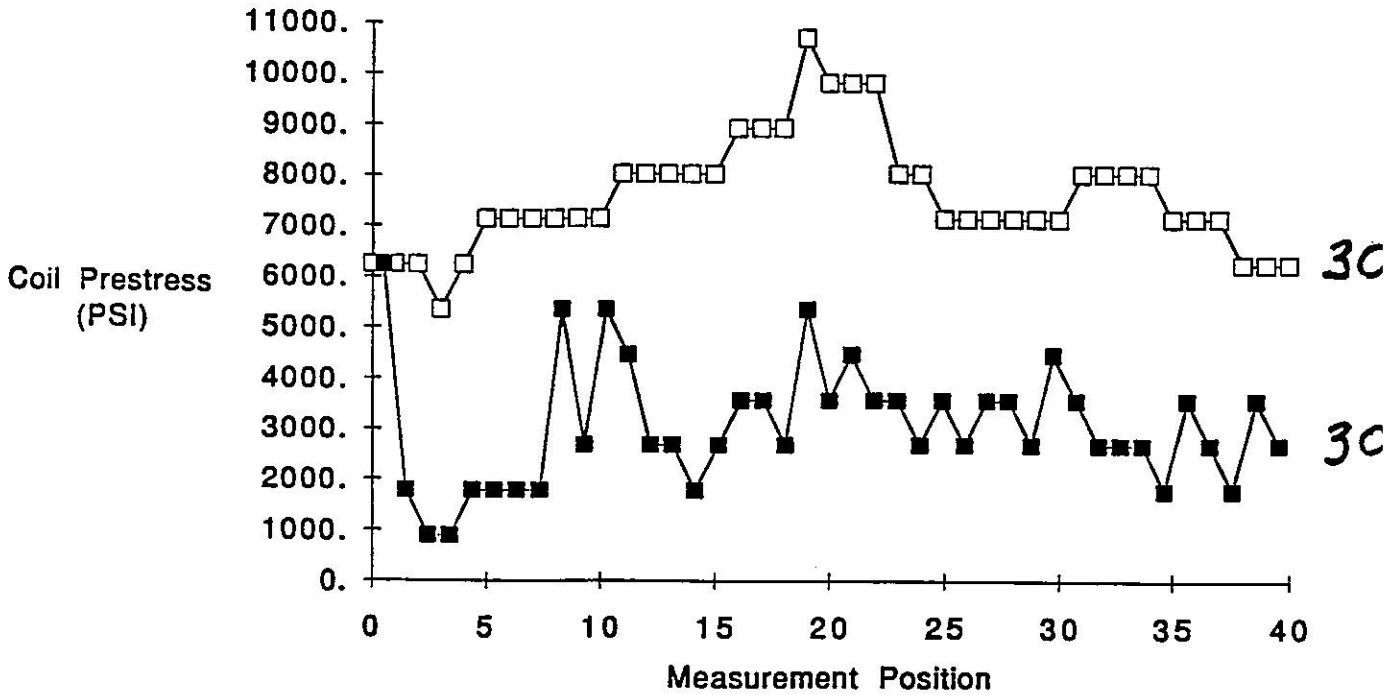
Field Measurements

Ramp Rate Study

Thermal Cycle

Mini-Life Test

Coil Prestress as calculated from Vertical Deflection of Collared Coil

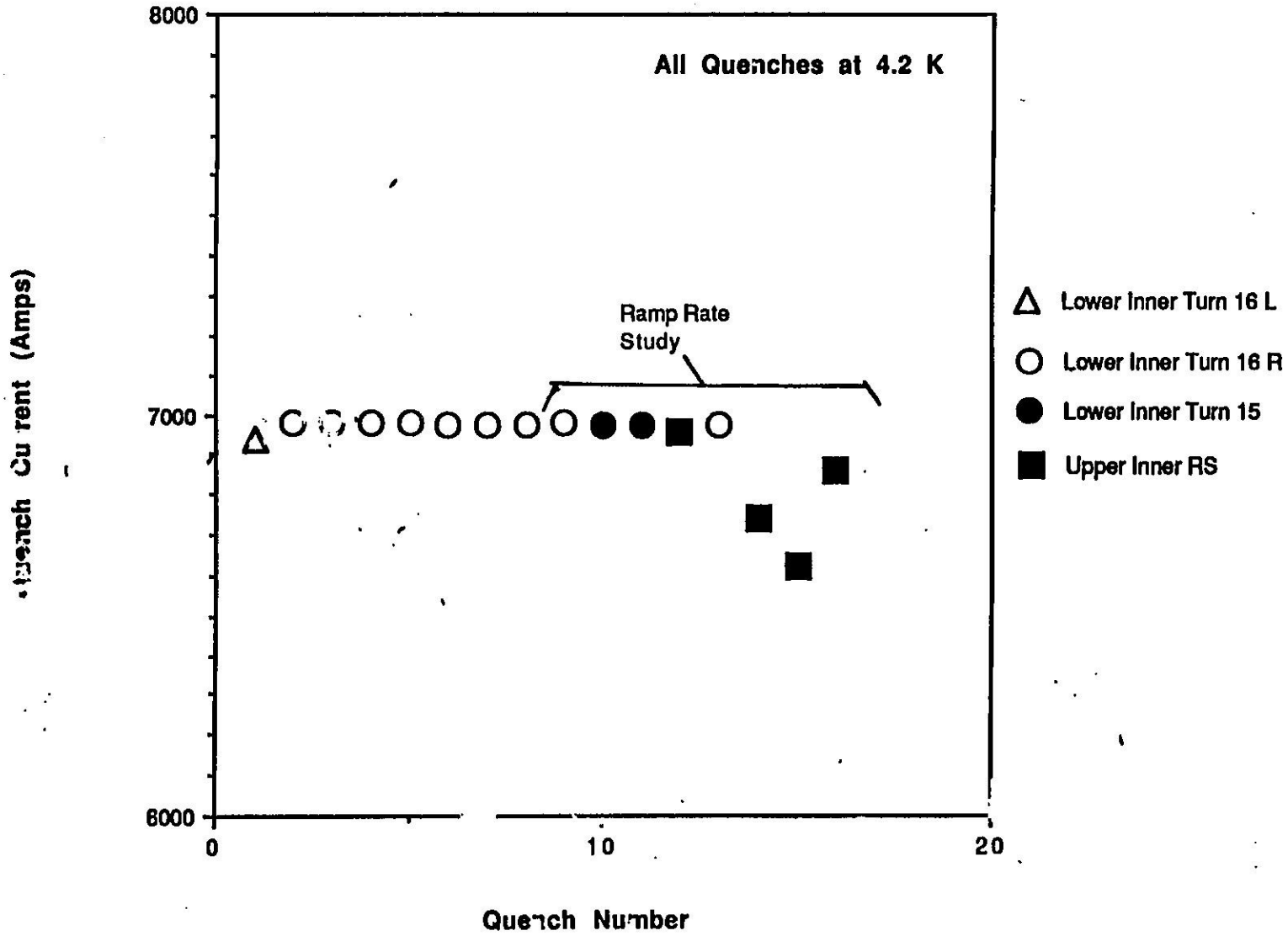


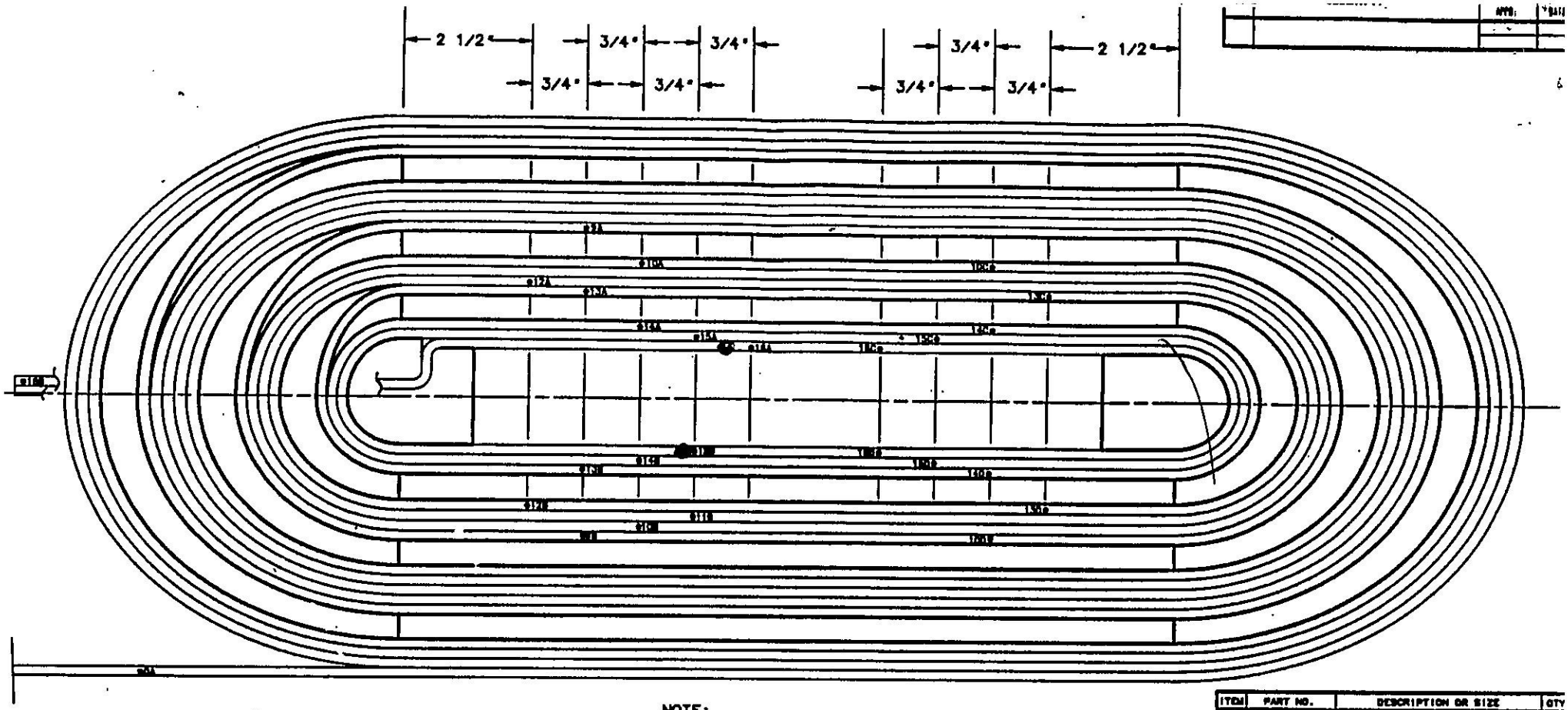
Post Yoking Strain Gage Readings *

	Average Inner	Average Outer
DSØ3Ø8	3700	6200
DSØ3Ø9	5900	8600

*Linear term = 5.7

DS0308 Quench History





NOTE:

1. VOLTAGE TAP WIRES FOR TAPS 0A, 16B, AND THE HALF COIL TAP ARE #22 AWG TEFLON INSULATED.
2. THE REMAINING VOLTAGE TAP WIRES ARE #32 AWG TEFLON INSULATED.
3. TAP WIRES WITH THE SAME NUMBER AT EACH END SHOULD FORM A TWISTED PAIR (A-B AND C-D).
4. VOLTAGE TAP WIRE SHOULD FOLLOW THE CABLE TO WHICH THEY ARE SOLDERED UNTIL THEY MEET AND ARE TWISTED WITH THEIR "MATE".
5. COIL AS VIEWED FROM INSIDE.

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY
PARTS LIST			

UNLESS OTHERWISE SPECIFIED .XX .XXX ANGLES	ORIGINATOR	STRAIT/KOSKA	
	DRAWN	R. DIXON	1/5/8
	CHECKED		
1. BREAK ALL SHARP EDGES .02 MAX. 2. DO NOT SCALE DRAWING. 3. DIMENSIONS BASED UPON ANSI Y14.5M-1982 4. MAX. ALL MACH. SURFACES	APPROVED		
	USED ON		
	MATERIAL		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

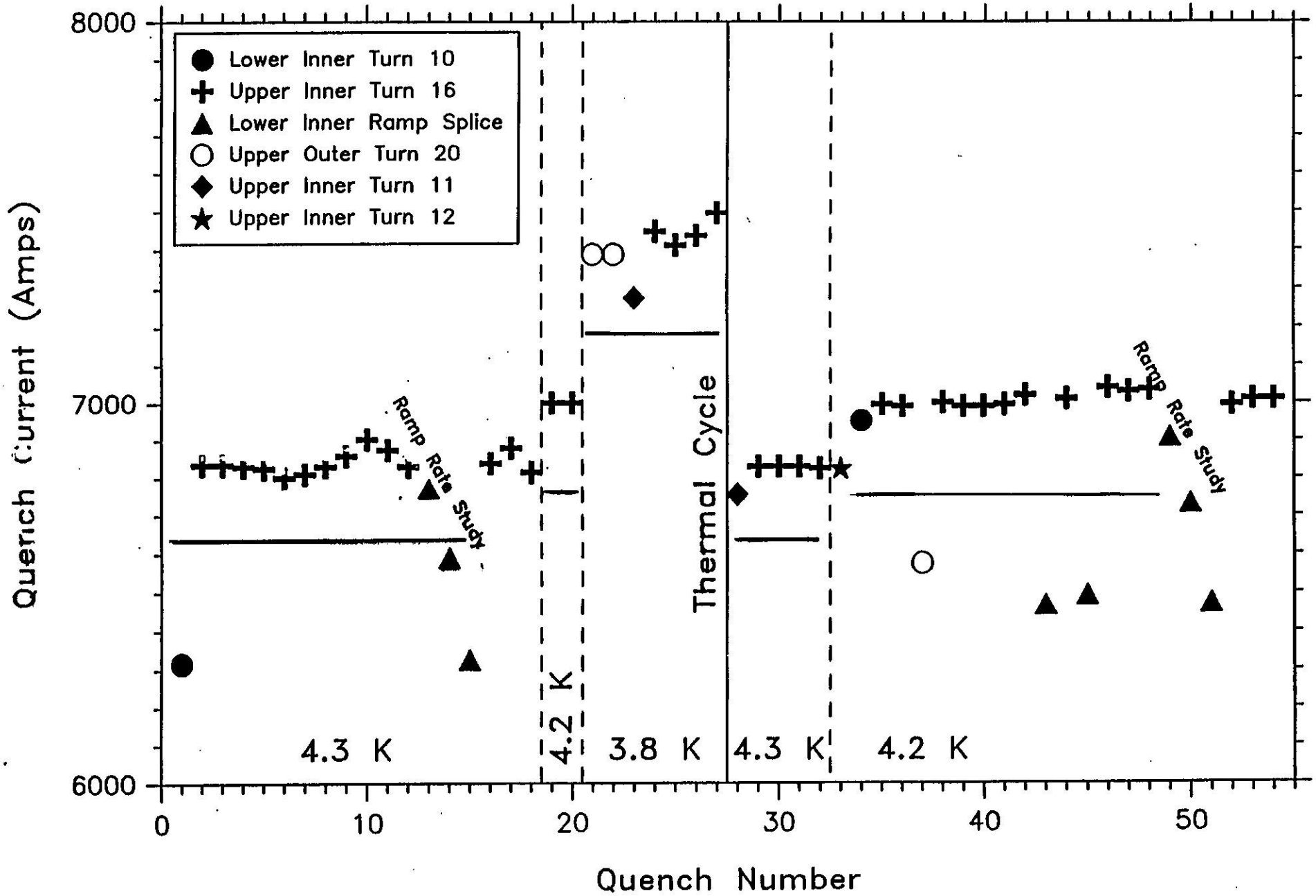
DS0308
VOLTAGE TAPS
INNER COIL

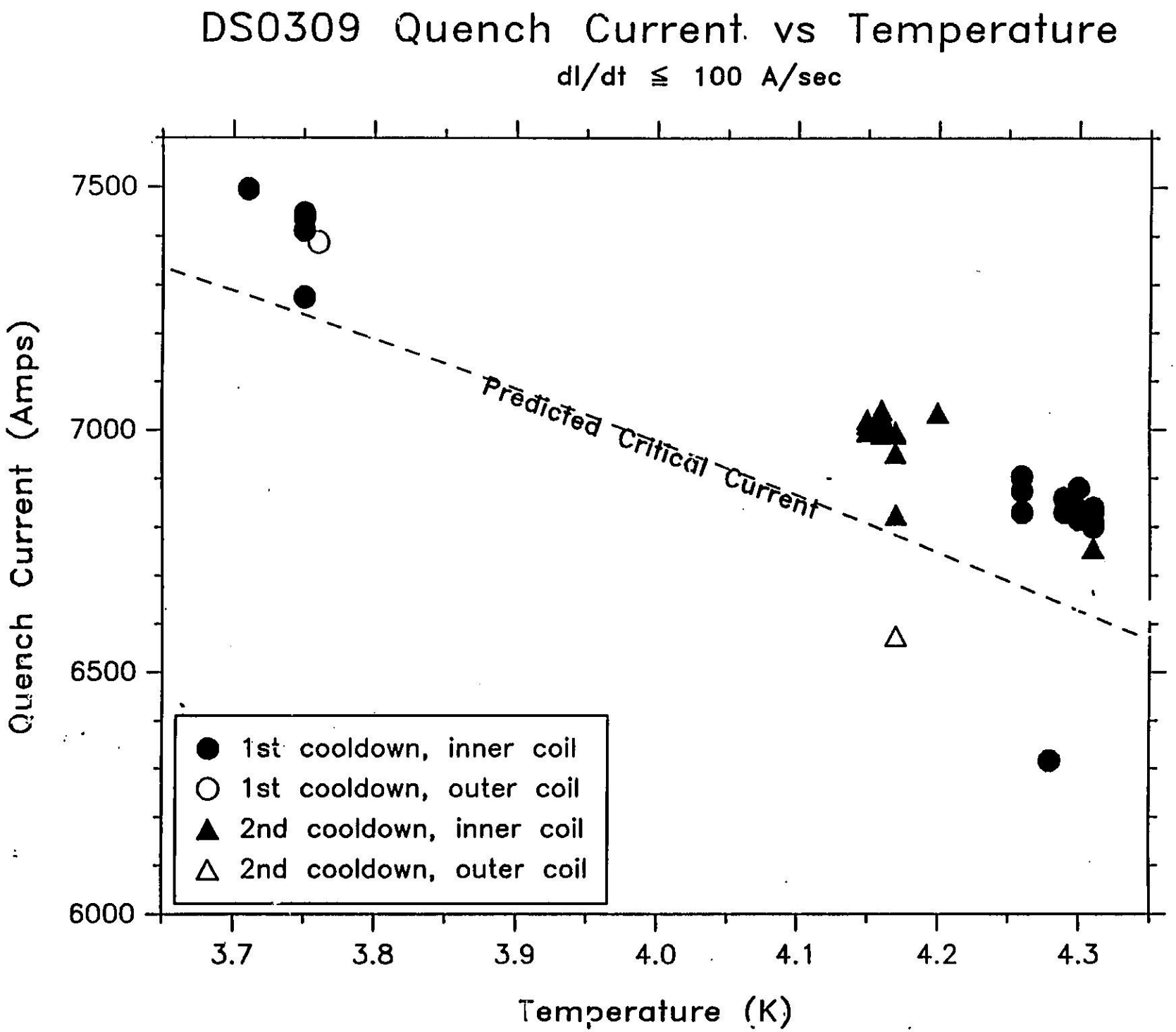
SCALE	FILMED	DRAWING NUMBER	REV.
NONE			

CREATED WITH I-DEAS 4.1 | USER NAME:SPUD

INCHES 0 1 2 3 4 5 6 METRIC 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

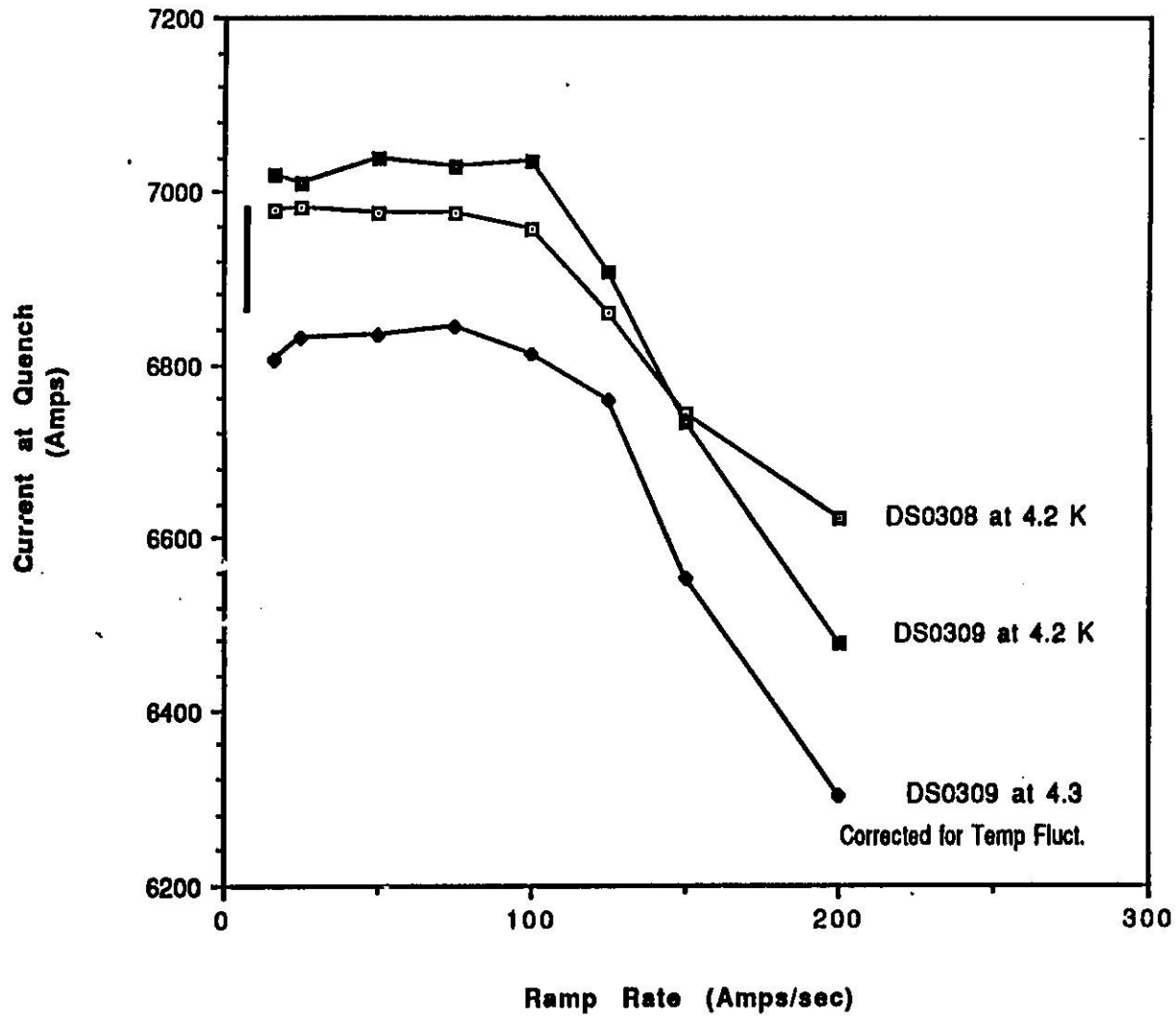
DS0309 Quench History

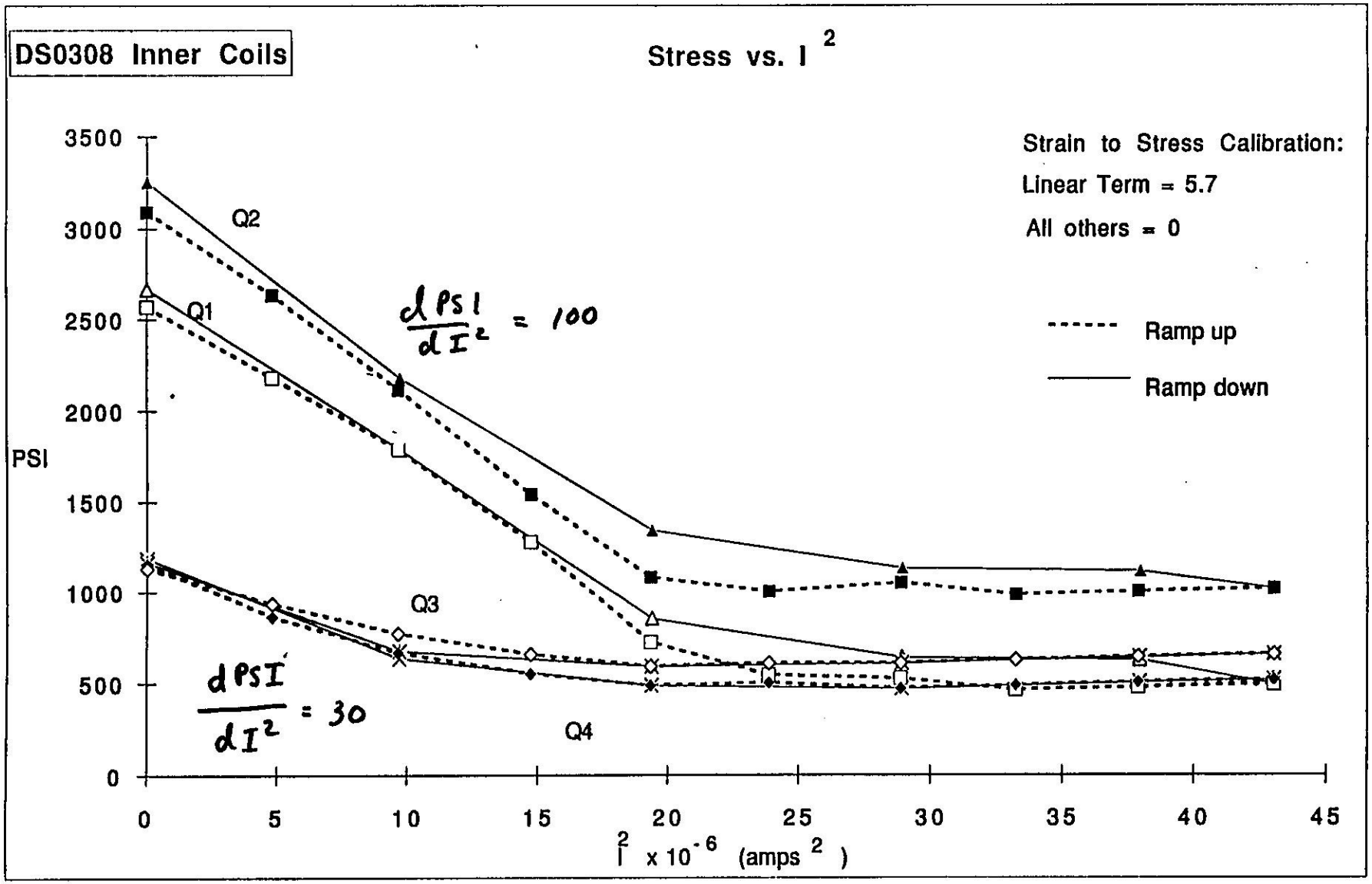


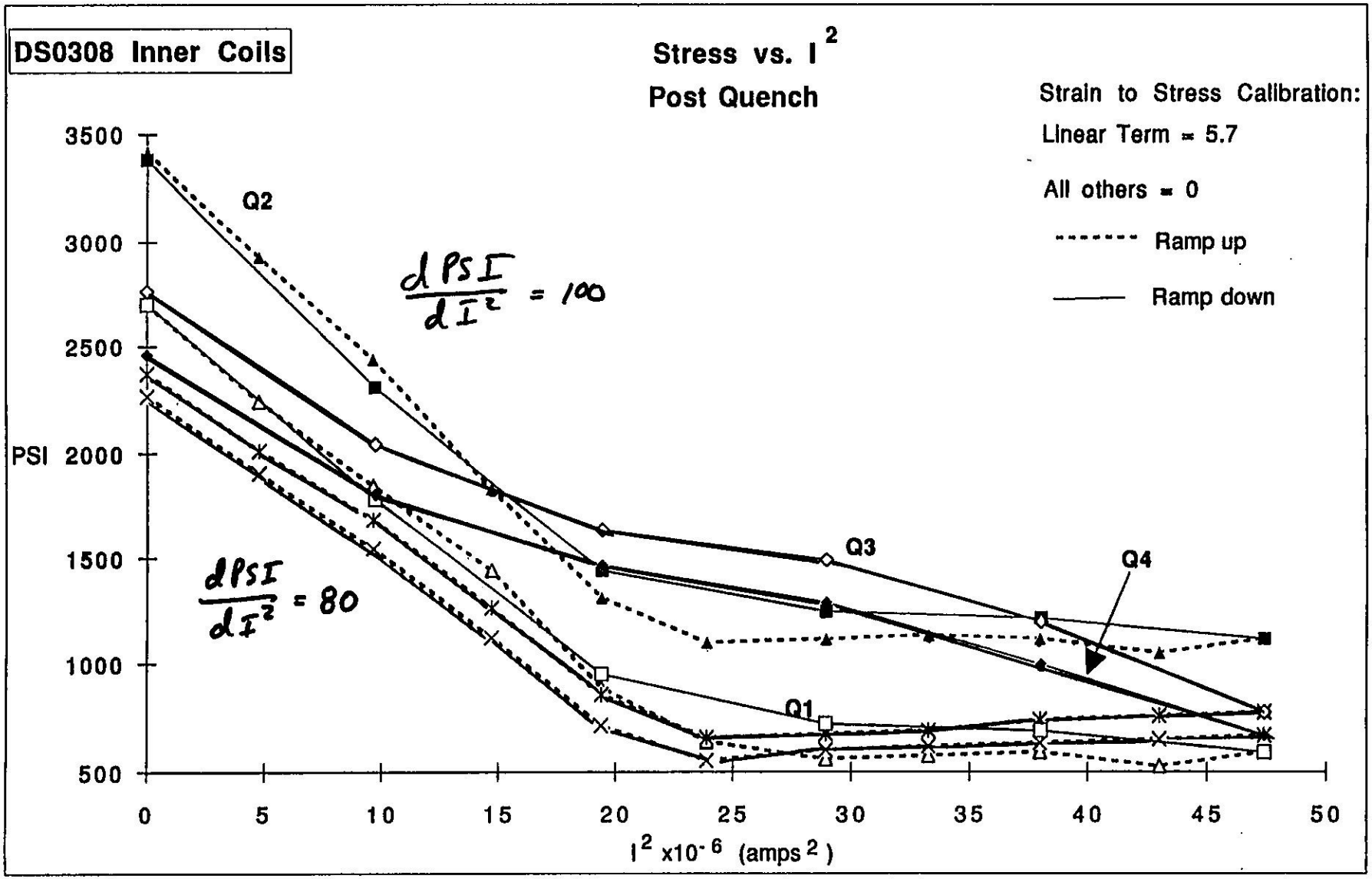

DS0309 Quench Current vs Temperature
dI/dt ≦ 100 A/sec
Quench Current (Amps)
7500
7000
6500
6000
3.7
3.8
3.9
4.0
4.1
4.2
4.3
Temperature (K)
Predicted Critical Current
1st cooldown, inner coil
1st cooldown, outer coil
2nd cooldown, inner coil
2nd cooldown, outer coil

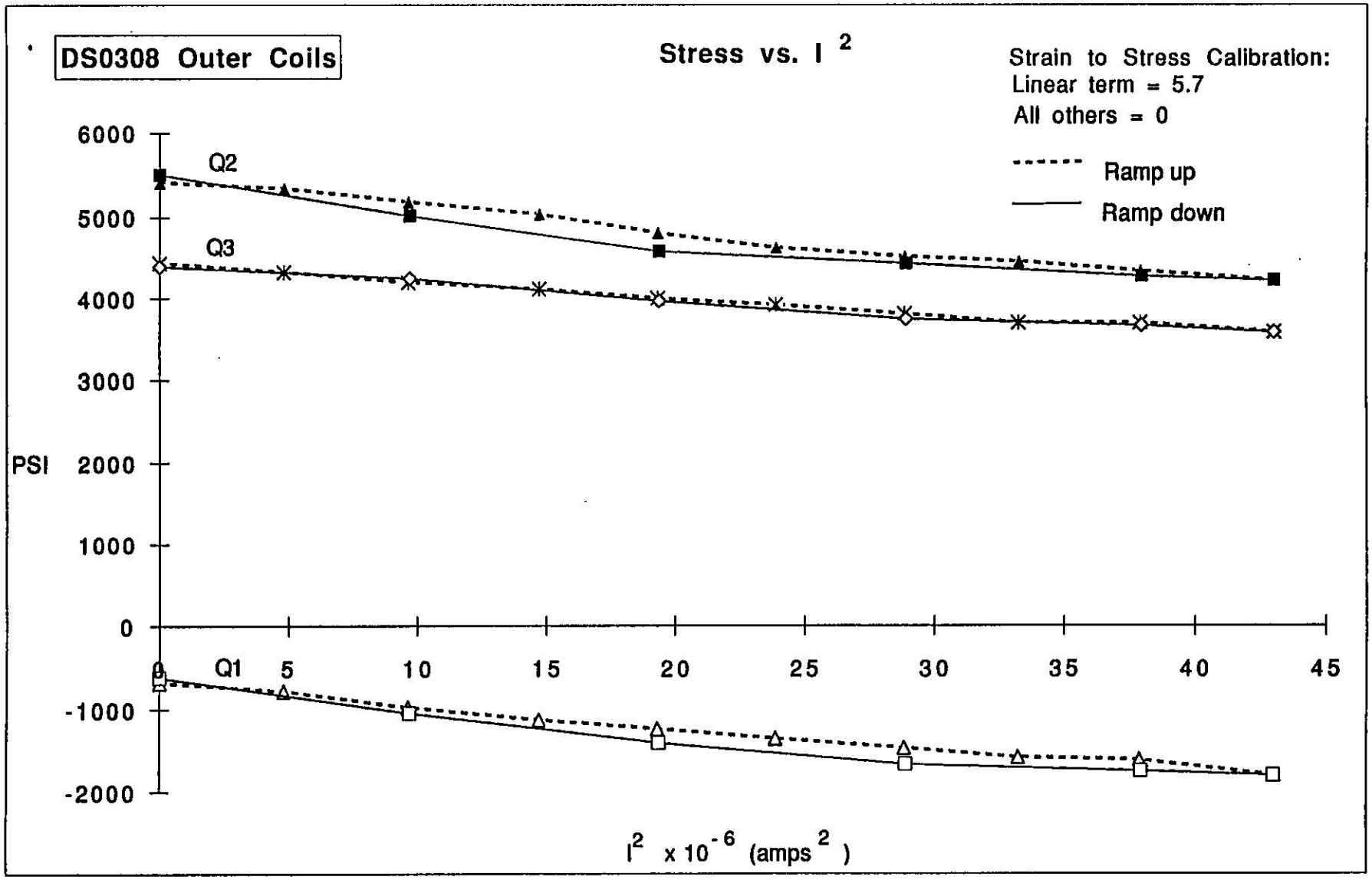
Down Ram
6500 - 4000
400 A/sec

Quench Current vs. Ramp Rate
DS0308 and DS0309

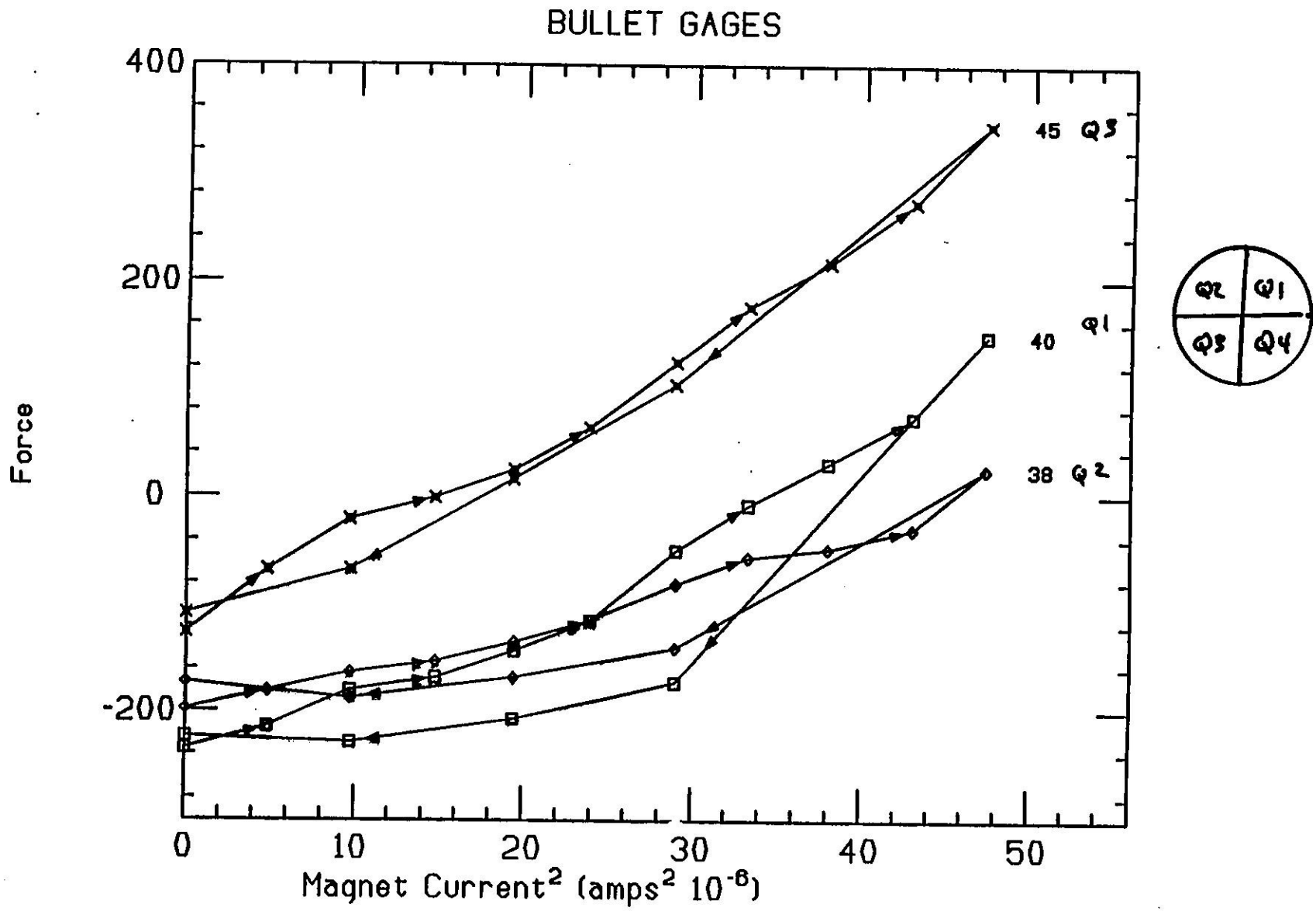



DS0308 Inner Coils
Stress vs. I 2
Strain to Stress Calibration:
Linear Term = 5.7
All others = 0
Ramp up
Ramp down
Q1
Q2
Q3
Q4
dPSI/dI² = 100
dPSI/dI² = 30
PSI
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
40
45
I 2 x 10-6 (amps 2)


DS0308 Inner Coils
Stress vs. I 2
Post Quench
Strain to Stress Calibration:
Linear Term = 5.7
All others = 0
Ramp up
Ramp down
Q1
Q2
Q3
Q4
dPSI/dI² = 100
dPSI/dI² = 80
PSI
3500
3000
2500
2000
1500
1000
500
0
5
10
15
20
25
30
35
40
45
50
I 2 x10- 6 (amps 2)

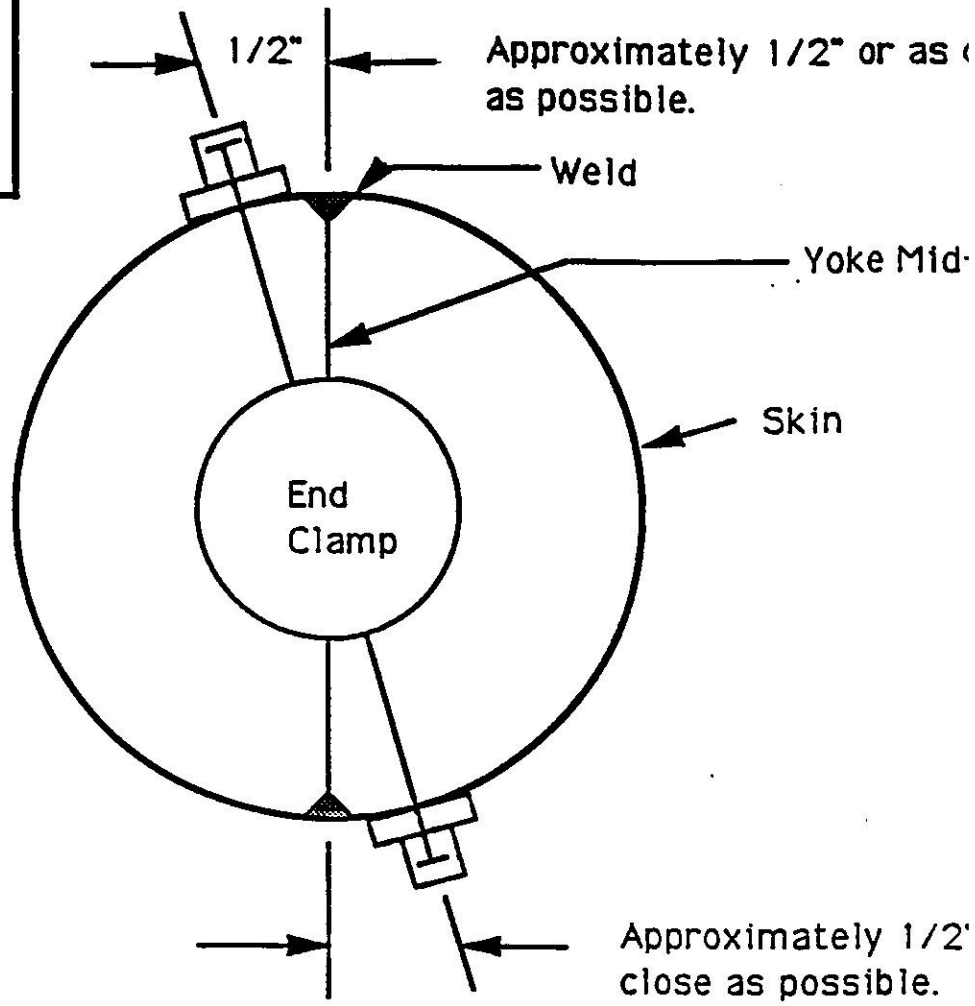

DS0308 Outer Coils
Stress vs. I 2
Strain to Stress Calibration:
Linear term = 5.7
All others = 0
Ramp up
Ramp down
Q2
Q3
Q1
PSI
6000
5000
4000
3000
2000
1000
0
-1000
-2000
0
5
10
15
20
25
30
35
40
45
I2 x 10-6 (amps2)

DSØ3Ø8



DS0308 File: DS0308.CA011 2-MAY-90 16:09:41 3-MAY-90 12:23:27

Sketch for installation of external deflectometers



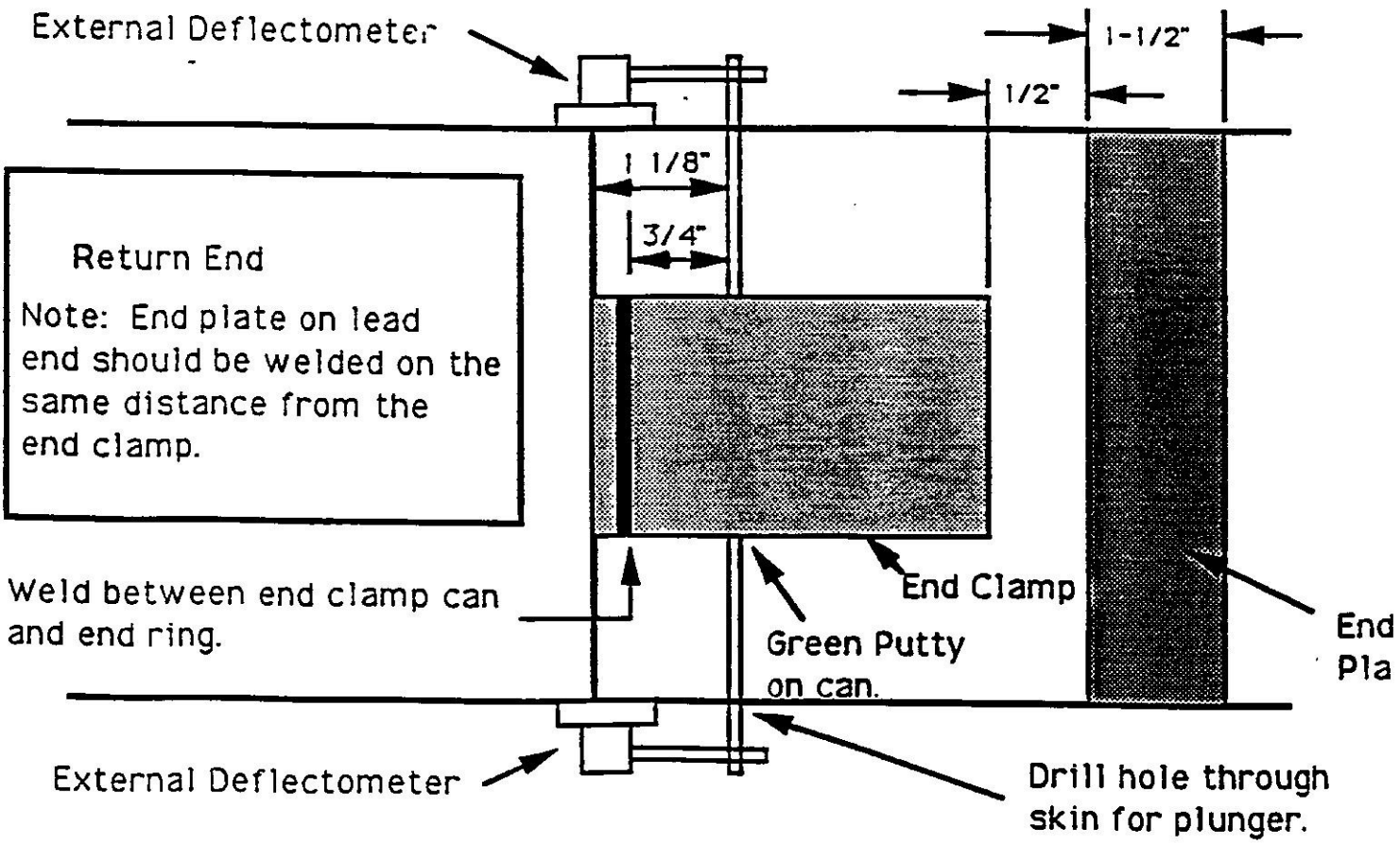
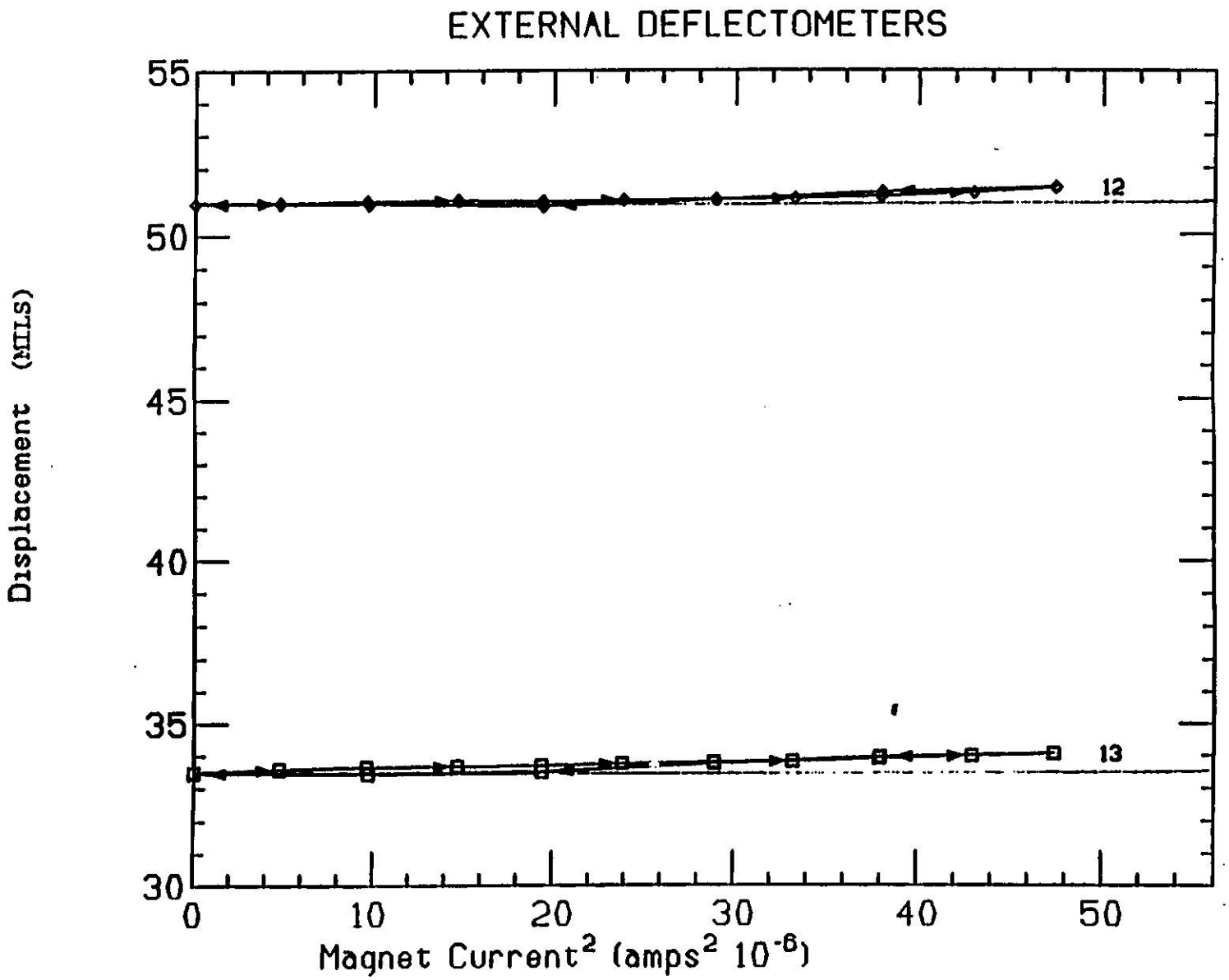
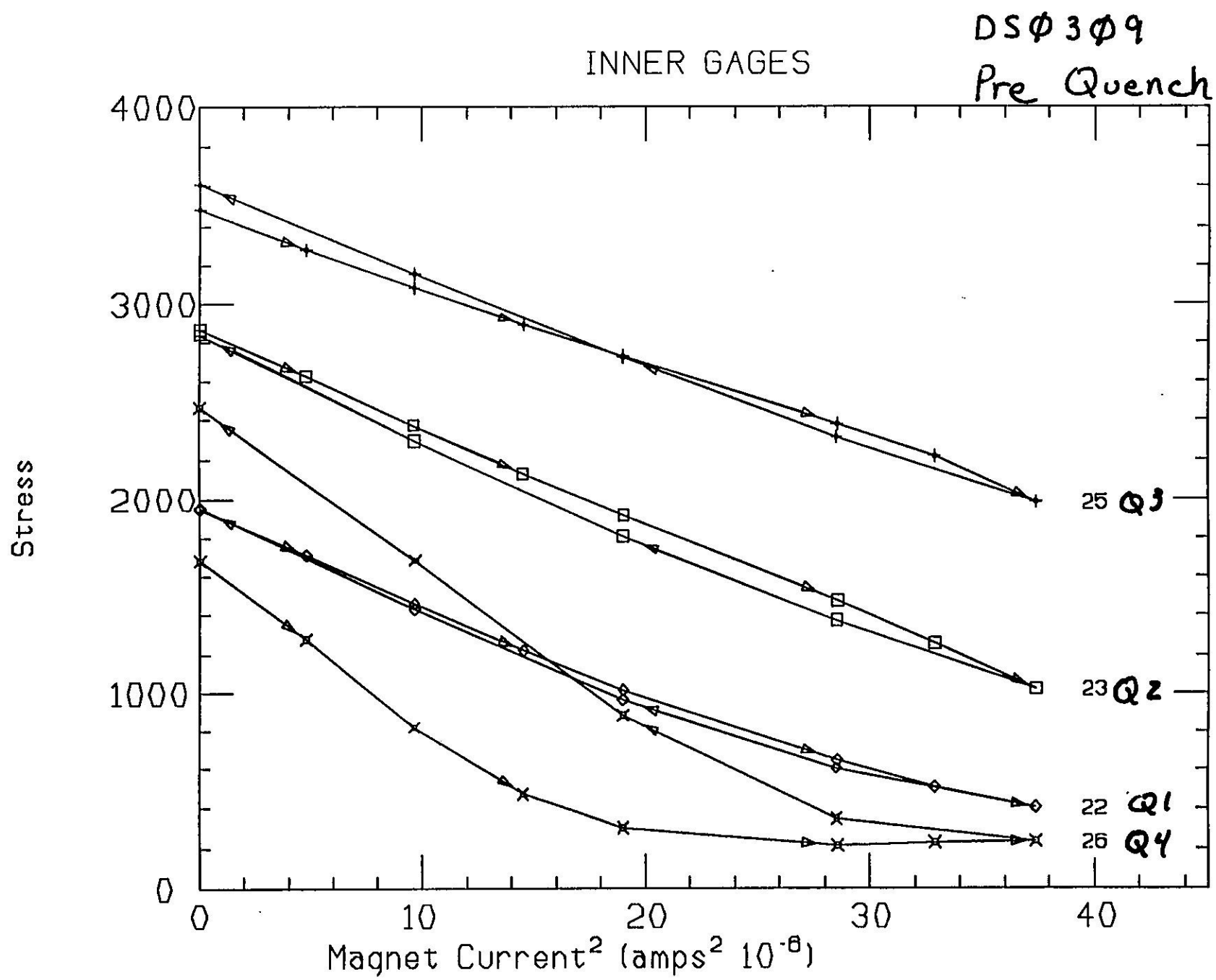


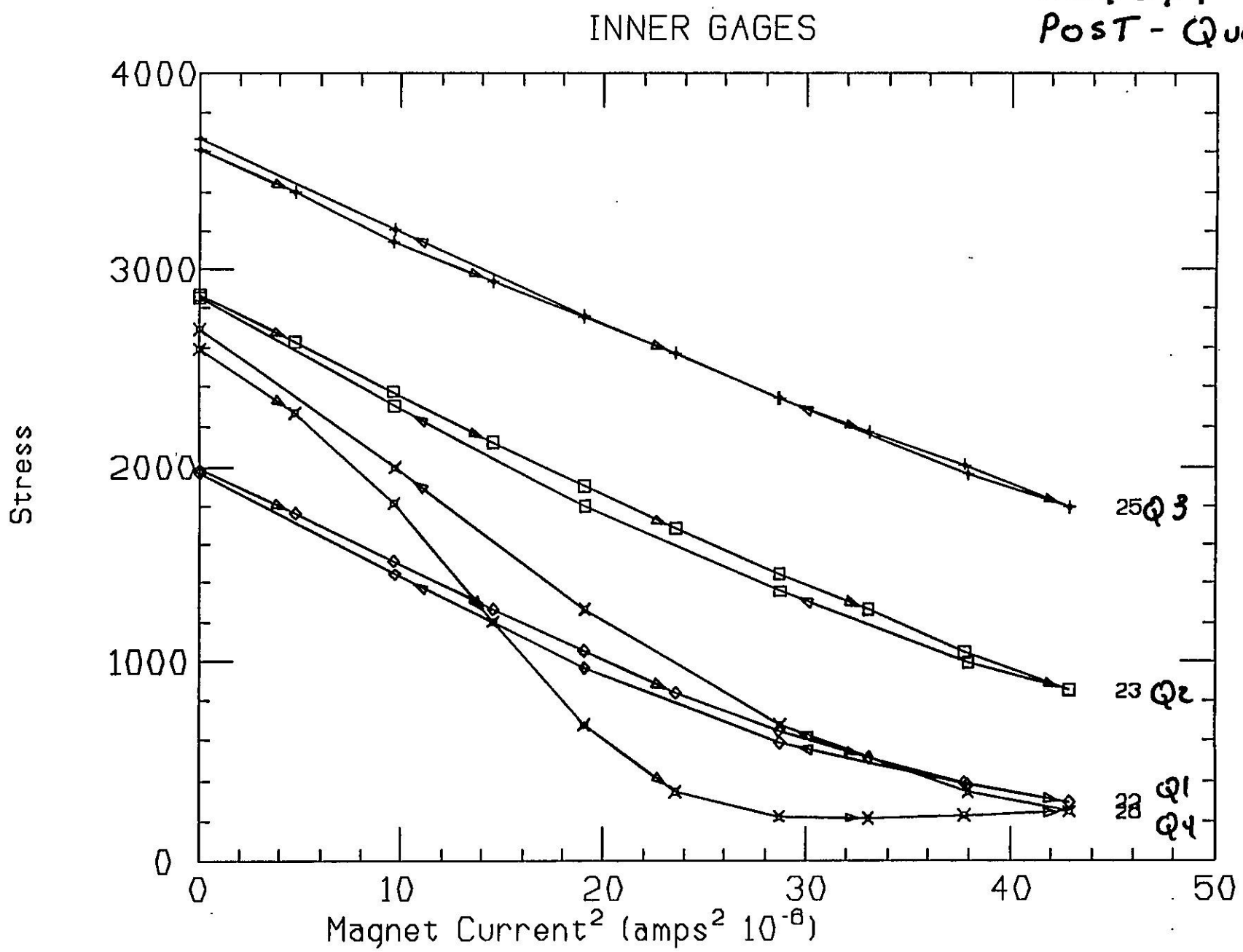
Figure 7


EXTERNAL DEFLECTOMETERS
Displacement (MILS)
55
50
45
40
35
30
0
10
20
30
40
50
Magnet Current^2 (amps^2 10^{-6})
12
13

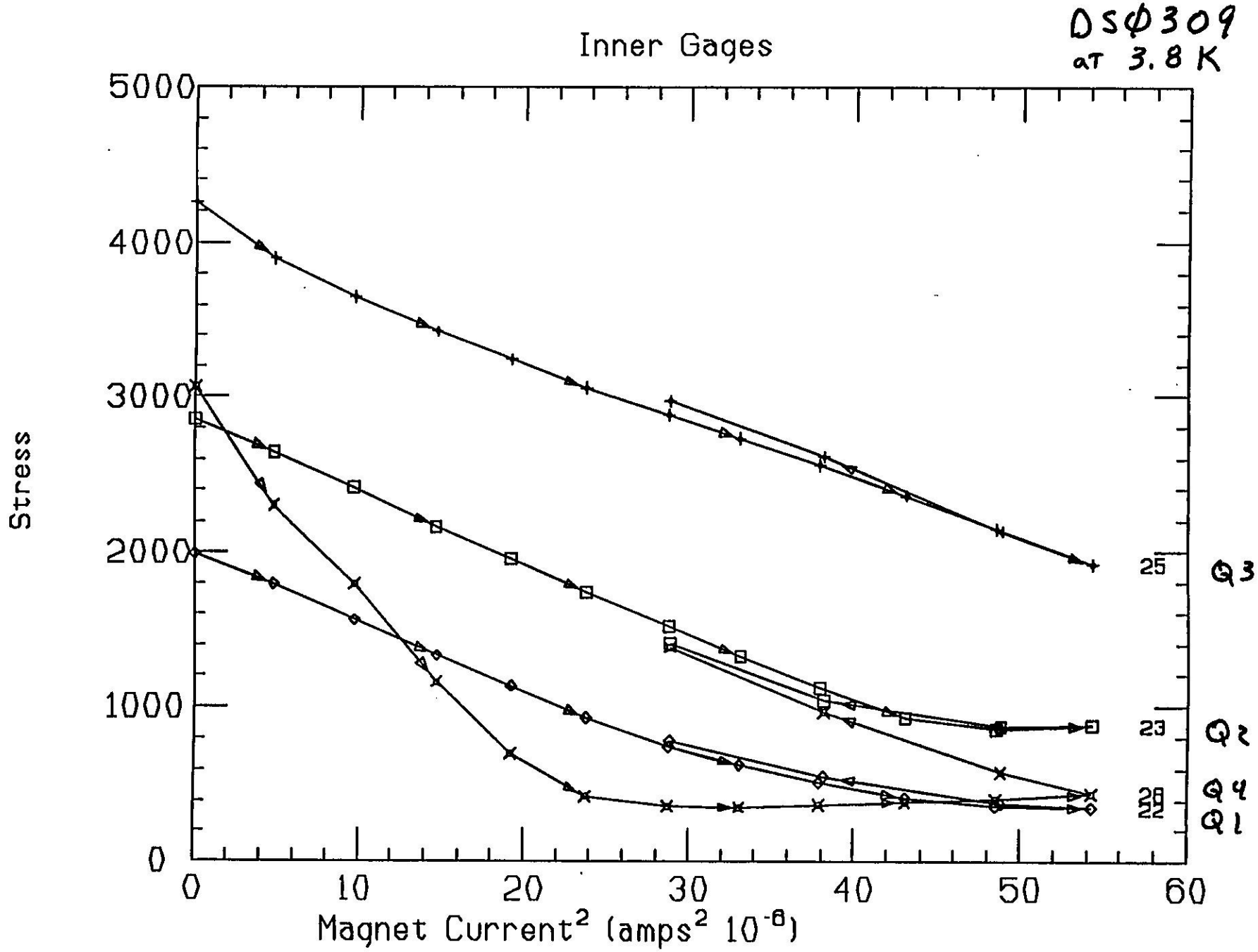


DS0309 File: DS0309.CA002 18-MAY-90 15:22:22 29-MAY-90 13:47:47

DSØ3Ø9
PosT - Quench

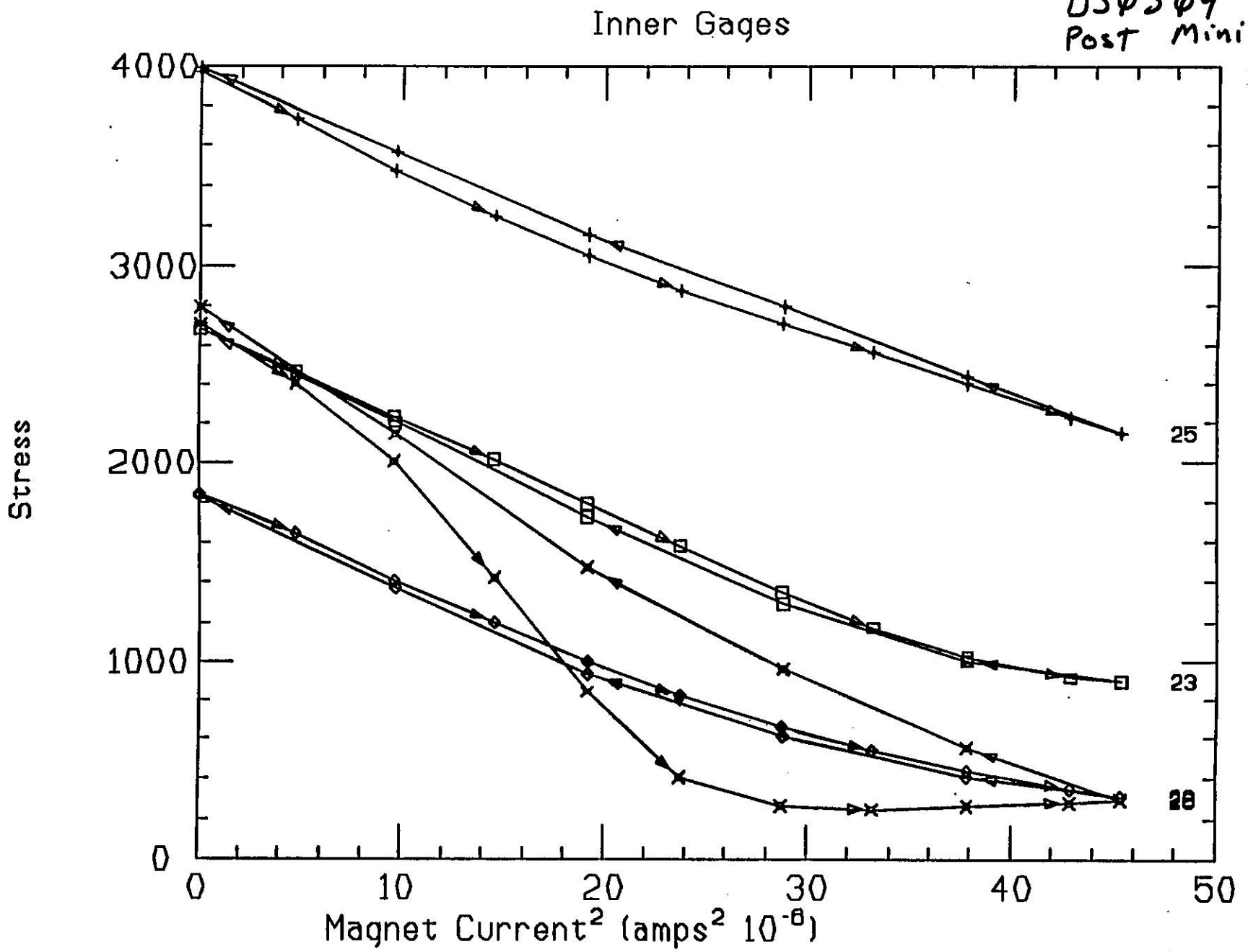


DS0309 File: DS0309.CA005 21-MAY-90 14:17:23 29-MAY-90 16:14:17



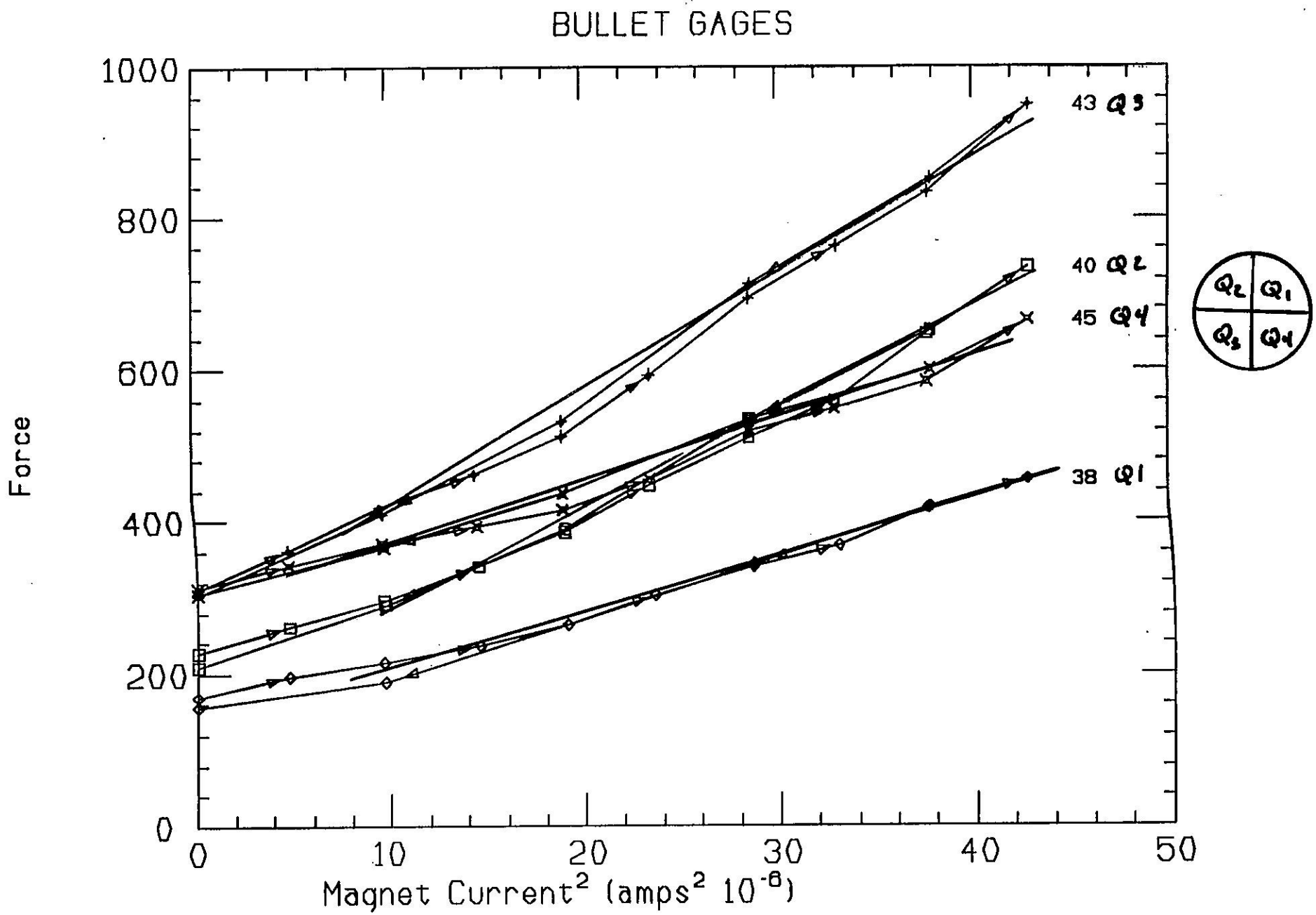
DS0309 File: DS0309.CA00B 24-MAY-90 15:40:23 11-JUN-90 13:10:23

DSØ3Ø9
Post Mini-Life
Test



DS0309 File: DS0309.CA015 5-JUN-90 14:54:38 11-JUN-90 12:35:54

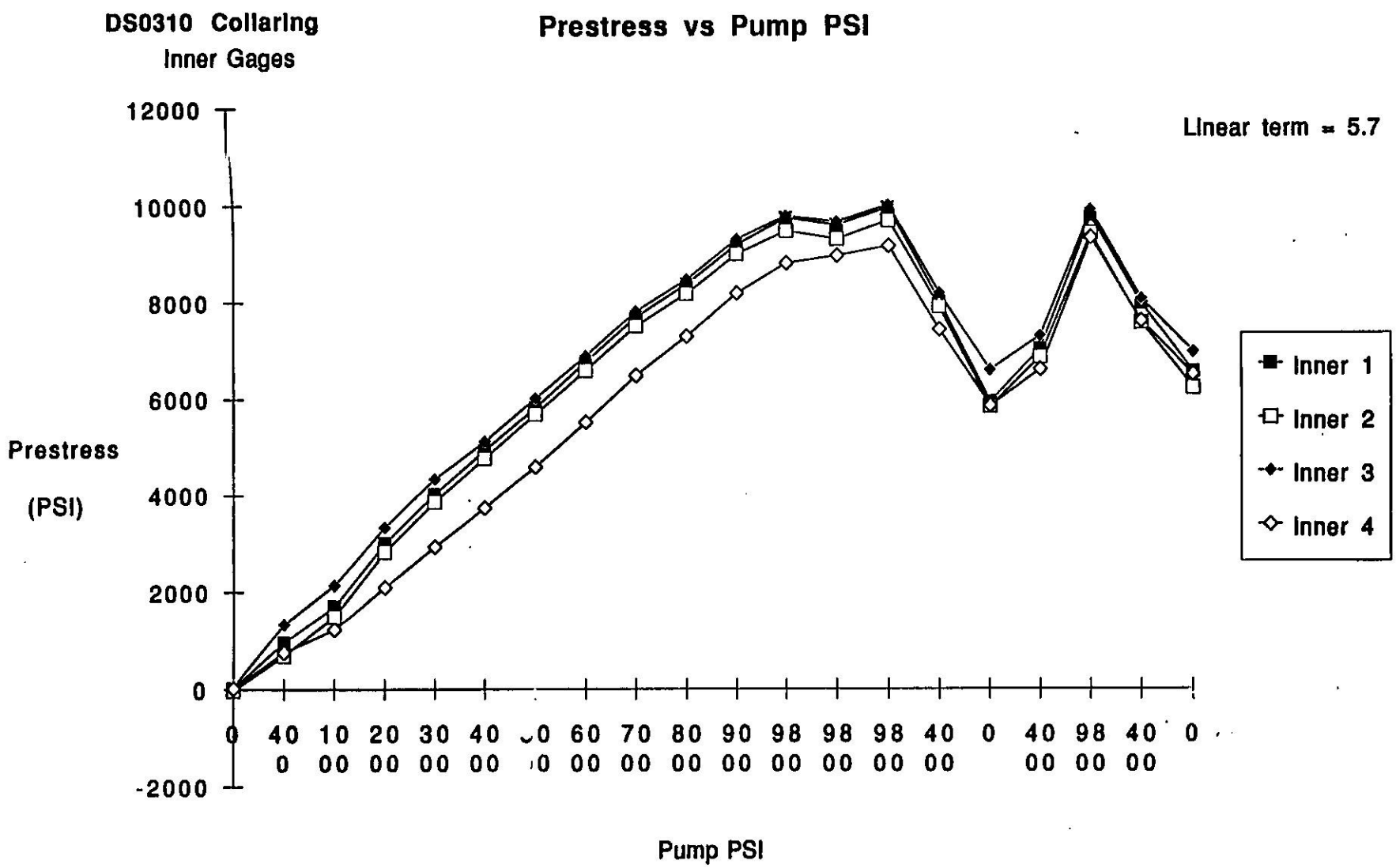
DSØ3Ø9

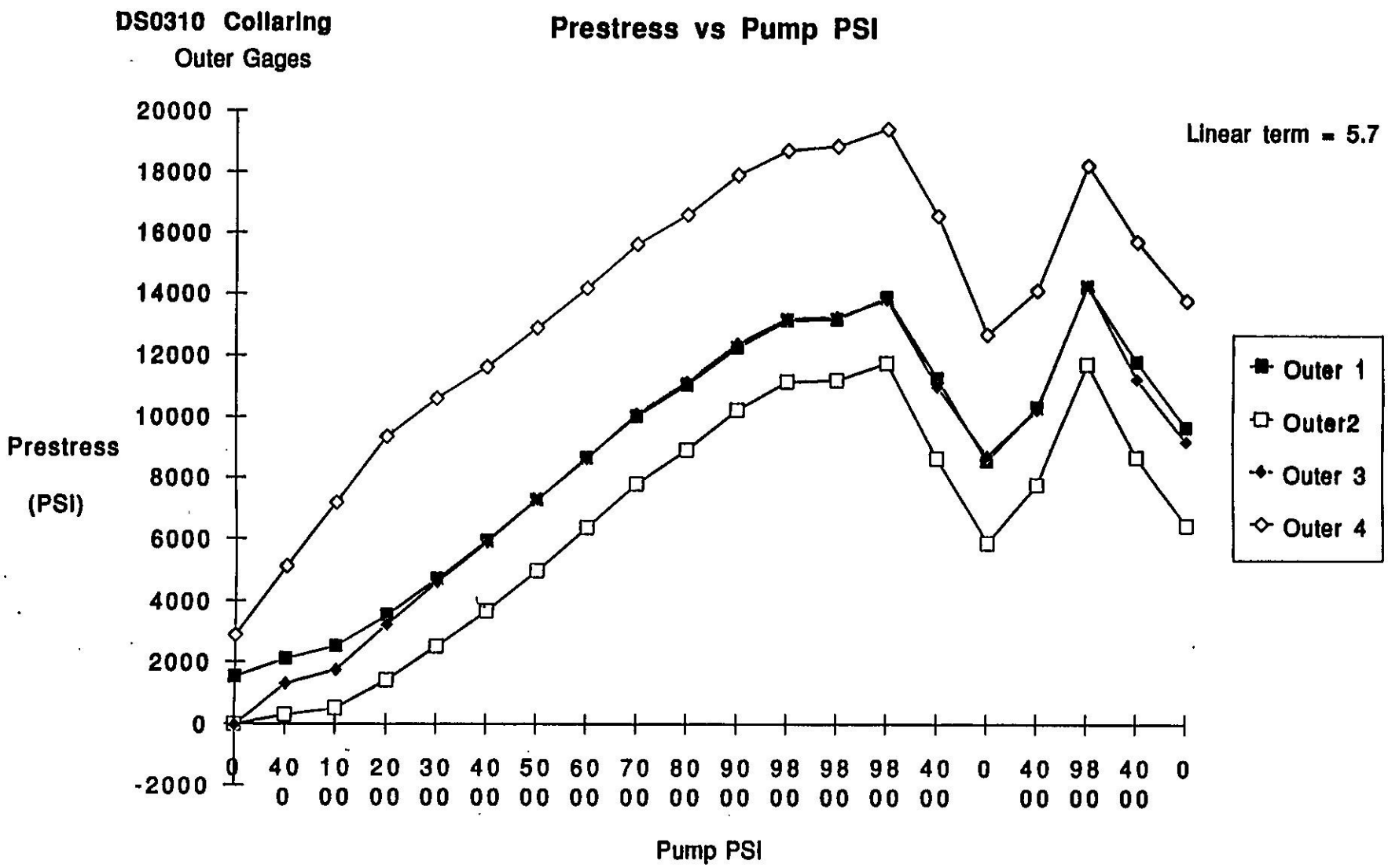


DS0309 File: DS0309.CA005 21-MAY-90 14:17:23 29-MAY-90 16:14:17

40 MM MODEL MAGNET DEVELOPMENT PROGRAM AT FERMILAB

	DS0307[7]	308	309	310	311[8]	312	313	314	315	316	317	318[9]
;ign Features[1]												
'ro-oval collars, horizontally split yoke	X	X	X	X	X	X	X					
lorizontally oval collars, vertically split yoke								X	X	X	X	X
ndividually determined coil ends	X	X	X	X	X							
rouped outer coil ends						X	X	X	X	X	X	X
eflon on coils	X			X	X							
mproved end clamp[2]										X	X	
trumentation[3]												
nd clamp deflection gages		X				X				X	X	
nd clamp strain gages				X		X				X	X	
kin strain gages		X		X		X		X	X	X		
t Plan[4]												
ini-life test[5]			X	X					X			
sts of collaring methods	X				X							
isassemble after cold test			X					X	X			
ot and section	X		X	X		X 10		X	X			
eep tests[6]				X		X						


DS0310 Collaring
Inner Gages
Prestress vs Pump PSI
Linear term = 5.7
Prestress
(PSI)
12000
10000
8000
6000
4000
2000
0
-2000
Pump PSI
Inner 1
Inner 2
Inner 3
Inner 4


DS0310 Collaring
Outer Gages
Prestress vs Pump PSI
Linear term = 5.7
Prestress
(PSI)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
0
40 0
10 00
20 00
30 00
40 00
50 00
60 00
70 00
80 00
90 00
98 00
98 00
98 00
40 00
0
40 00
98 00
40 00
0
Pump PSI
Outer 1
Outer2
Outer 3
Outer 4

```
-------------------------------
r_nominal         =   2.183 inches
rv                = -12.000 mils
rh                =   7.000 mils
skin_stress_300K =  25.000 kpsi
skin_stress       =  45.000 kpsi
contract_collar   =  -0.003
contract_yoke     =  -0.002
-------------------------------
```

							T = 300 K				T = 4 K							
drv/drh	drv/dpr	drh/dpr	prestr	dcool	dh/ds1	dh/ds2	rh	rv	rv_rh0	sk_rh0	rh	rv	rh_rv0	rv_rh0	rh_sk	rv_sk	sk_rv0	sk_rh0
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.03	6.5	-6.4	-2.9	26.4	4.4	-9.8	-13.8	-7.5	0.0	-7.5	-	18.
----- Vary Coil Prestress and Cooldown Loss -----																		
-0.54	0.56	-0.05	13.00	-2.25	-0.25	-0.03	6.3	-4.7	-1.3	25.8	4.3	-8.2	-10.8	-5.9	0.0	-5.9	-	17.
-0.54	0.56	-0.05	7.00	-2.25	-0.25	-0.03	6.6	-8.1	-4.5	27.0	4.6	-11.5	-16.8	-9.1	0.0	-9.1	-	19.
-0.54	0.56	-0.05	10.00	-3.25	-0.25	-0.03	6.5	-6.4	-2.9	26.4	4.5	-10.4	-14.8	-8.0	0.0	-8.0	-	18.
----- Vary dr/d(prestress) -----																		
-0.54	0.44	-0.05	10.00	-2.25	-0.25	-0.03	6.5	-7.6	-4.1	26.4	4.4	-10.8	-15.5	-8.4	0.0	-8.4	-	18.
-0.54	0.56	0.00	10.00	-2.25	-0.25	-0.03	7.0	-6.4	-2.6	28.5	4.8	-9.8	-13.4	-7.2	0.0	-7.2	-	20.
----- Choose values that give a small collared coil -----																		
-0.54	0.44	-0.05	7.00	-3.25	-0.25	-0.03	6.6	-8.9	-5.3	27.0	4.6	-12.5	-18.6	-10.0	0.0	-10.0	-	19.
----- Vary dr/d(skin stress) -----																		
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.03	6.5	-6.4	-2.9	20.3	4.4	-9.8	-13.8	-7.5	0.0	-7.5	-	14.
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.05	6.5	-6.4	-2.9	26.4	4.4	-9.8	-13.8	-7.5	0.0	-7.5	-	18.
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.05	6.5	-6.4	-2.9	20.3	4.4	-9.8	-13.8	-7.5	0.0	-7.5	-	14.
----- Vary drv/drh -----																		
-0.46	0.56	-0.05	10.00	-2.25	-0.25	-0.03	6.5	-6.4	-3.4	26.4	4.4	-9.8	-17.0	-7.8	0.0	-7.8	-	18.
-0.64	0.56	-0.05	10.00	-2.25	-0.25	-0.03	6.5	-6.4	-2.2	26.4	4.4	-9.8	-11.0	-7.0	0.0	-7.0	-	18.

```
--------------------------------
r_nominal         =   2.183 inches
rv                = -12.000 mils
rh                =   5.000 mils
skin_stress_300K  =  25.000 kpsi
skin_stress       =  45.000 kpsi
contract_collar   =  -0.003
contract_yoke     =  -0.002
--------------------------------
```

							T = 300 K				T = 4 K							
drv/drh	drv/dpr	drh/dpr	prestr	dcool	dh/ds1	dh/ds2	rh	rv	rv_rh0	sk_rh0	rh	rv	rh_rv0	rv_rh0	rh_sk	rv_sk	sk_rv0	sk_rh0
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.03	4.5	-6.4	-4.0	18.3	2.4	-9.8	-15.8	-8.5	0.0	-8.5	-	10.
----- Vary Coil Prestress and Cooldown Loss -----																		
-0.54	0.56	-0.05	13.00	-2.25	-0.25	-0.03	4.3	-4.7	-2.4	17.6	2.3	-8.2	-12.8	-6.9	0.0	-6.9	-	9.
-0.54	0.56	-0.05	7.00	-2.25	-0.25	-0.03	4.6	-8.1	-5.6	18.9	2.6	-11.5	-18.8	-10.1	0.0	-10.1	-	10.
-0.54	0.56	-0.05	10.00	-3.25	-0.25	-0.03	4.5	-6.4	-4.0	18.3	2.5	-10.4	-16.8	-9.1	0.0	-9.1	-	10.
----- Vary dr/d(prestress) -----																		
-0.54	0.44	-0.05	10.00	-2.25	-0.25	-0.03	4.5	-7.6	-5.2	18.3	2.4	-10.8	-17.5	-9.5	0.0	-9.5	-	10.
-0.54	0.56	0.00	10.00	-2.25	-0.25	-0.03	5.0	-6.4	-3.7	20.3	2.8	-9.8	-15.4	-8.3	0.0	-8.3	-	11.
----- Choose values that give a small collared coil -----																		
-0.54	0.44	-0.05	7.00	-3.25	-0.25	-0.03	4.6	-8.9	-6.4	18.9	2.6	-12.5	-20.6	-11.1	0.0	-11.1	-	11.
----- Vary dr/d(skin stress) -----																		
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.03	4.5	-6.4	-4.0	14.0	2.4	-9.8	-15.8	-8.5	0.0	-8.5	-	8.
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.05	4.5	-6.4	-4.0	18.3	2.4	-9.8	-15.8	-8.5	0.0	-8.5	-	10.
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.05	4.5	-6.4	-4.0	14.0	2.4	-9.8	-15.8	-8.5	0.0	-8.5	-	8.
----- Vary drv/drh -----																		
-0.46	0.56	-0.05	10.00	-2.25	-0.25	-0.03	4.5	-6.4	-4.3	18.3	2.4	-9.8	-19.0	-8.7	0.0	-8.7	-	10.
-0.64	0.56	-0.05	10.00	-2.25	-0.25	-0.03	4.5	-6.4	-3.5	18.3	2.4	-9.8	-13.0	-8.3	0.0	-8.3	-	10.

```
---------------------------------
r_nominal         =   2.183 inches
rv                = -11.000 mils
rh                =   6.000 mils
skin_stress_300K  =  25.000 kpsi
skin_stress       =  45.000 kpsi
contract_collar   =  -0.003
contract_yoke     =  -0.002
---------------------------------
```

							T = 300 K				T = 4 K							
drv/drh	drv/dpr	drh/dpr	prestr	dcool	dh/ds1	dh/ds2	rh	rv	rv_rh0	sk_rh0	rh	rv	rh_rv0	rv_rh0	rh_sk	rv_sk	sk_rv0	sk_rh0
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.03	5.5	-5.4	-2.4	22.3	3.4	-8.8	-13.0	-7.0	0.0	-7.0	-	14.
----- Vary Coil Prestress and Cooldown Loss -----																		
-0.54	0.56	-0.05	13.00	-2.25	-0.25	-0.03	5.3	-3.7	-0.8	21.7	3.3	-7.2	-10.0	-5.4	0.0	-5.4	-	13.
-0.54	0.56	-0.05	7.00	-2.25	-0.25	-0.03	5.6	-7.1	-4.0	22.9	3.6	-10.5	-15.9	-8.6	0.0	-8.6	-	15.
-0.54	0.56	-0.05	10.00	-3.25	-0.25	-0.03	5.5	-5.4	-2.4	22.3	3.5	-9.4	-13.9	-7.5	0.0	-7.5	-	14.
----- Vary dr/d(prestress) -----																		
-0.54	0.44	-0.05	10.00	-2.25	-0.25	-0.03	5.5	-6.6	-3.6	22.3	3.4	-9.8	-14.7	-7.9	0.0	-7.9	-	14.
-0.54	0.56	0.00	10.00	-2.25	-0.25	-0.03	6.0	-5.4	-2.2	24.4	3.8	-8.8	-12.6	-6.8	0.0	-6.8	-	16.
----- Choose values that give a small collared coil -----																		
-0.54	0.44	-0.05	7.00	-3.25	-0.25	-0.03	5.6	-7.9	-4.9	22.9	3.6	-11.5	-17.7	-9.6	0.0	-9.6	-	15.
----- Vary dr/d(skin stress) -----																		
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.03	5.5	-5.4	-2.4	17.2	3.4	-8.8	-13.0	-7.0	0.0	-7.0	-	11.
-0.54	0.56	-0.05	10.00	-2.25	-0.25	-0.05	5.5	-5.4	-2.4	22.3	3.4	-8.8	-13.0	-7.0	0.0	-7.0	-	14.
-0.54	0.56	-0.05	10.00	-2.25	-0.32	-0.05	5.5	-5.4	-2.4	17.2	3.4	-8.8	-13.0	-7.0	0.0	-7.0	-	11.
----- Vary drv/drh -----																		
-0.46	0.56	-0.05	10.00	-2.25	-0.25	-0.03	5.5	-5.4	-2.9	22.3	3.4	-8.8	-15.8	-7.3	0.0	-7.3	-	14.
-0.64	0.56	-0.05	10.00	-2.25	-0.25	-0.03	5.5	-5.4	-1.9	22.3	3.4	-8.8	-10.4	-6.7	0.0	-6.7	-	14.