

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

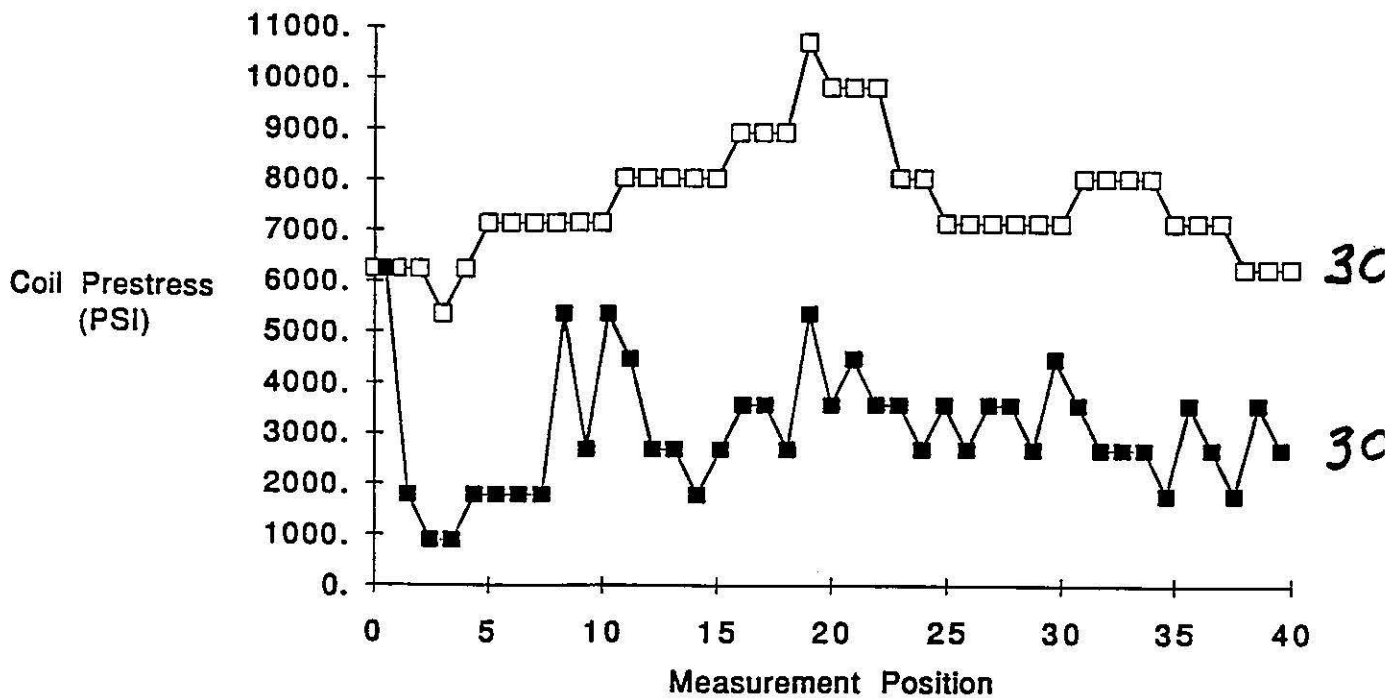
DS0308

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



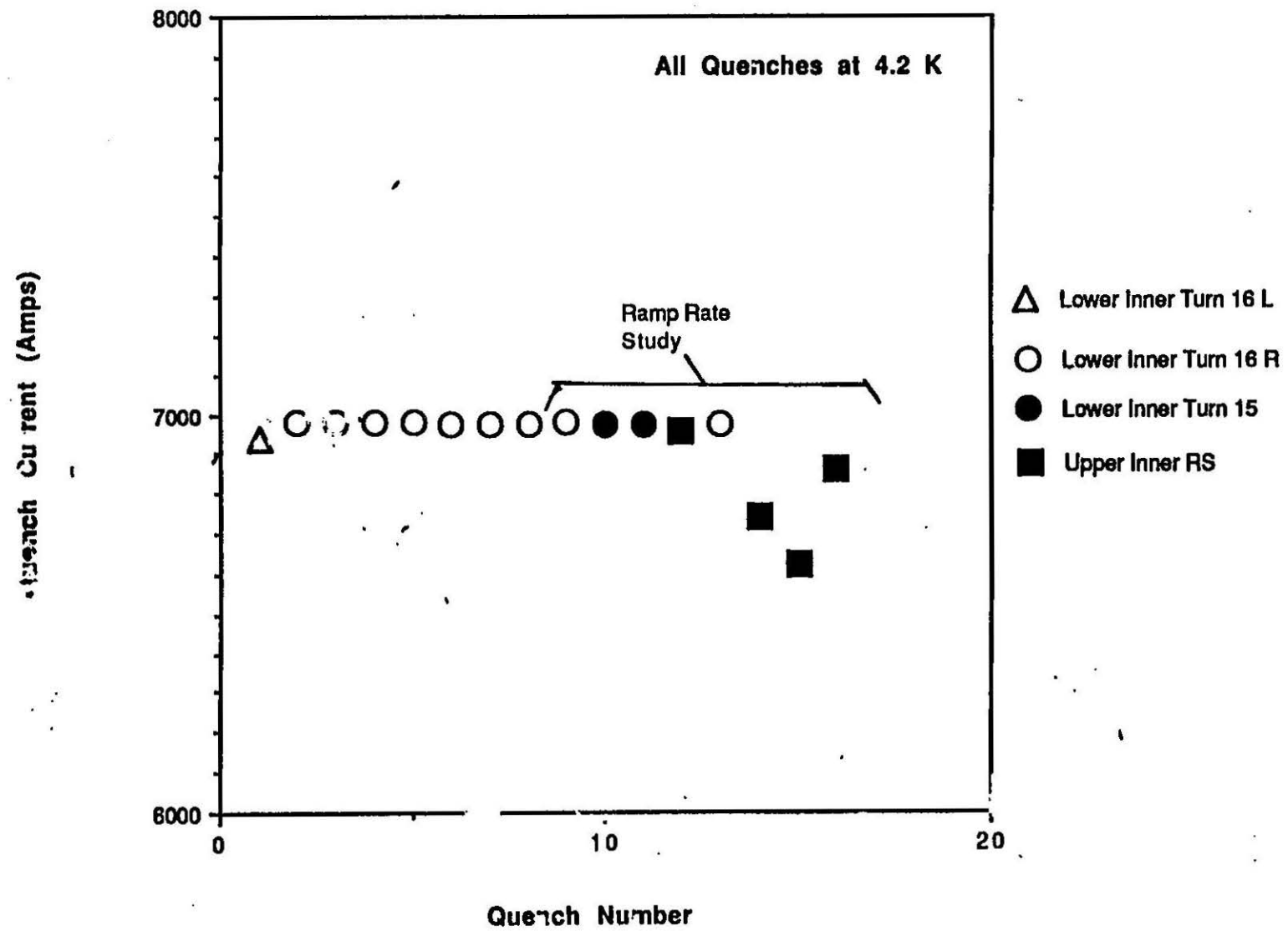
Post Yoking Strain Gage Readings *
 Average Inner Average Outer

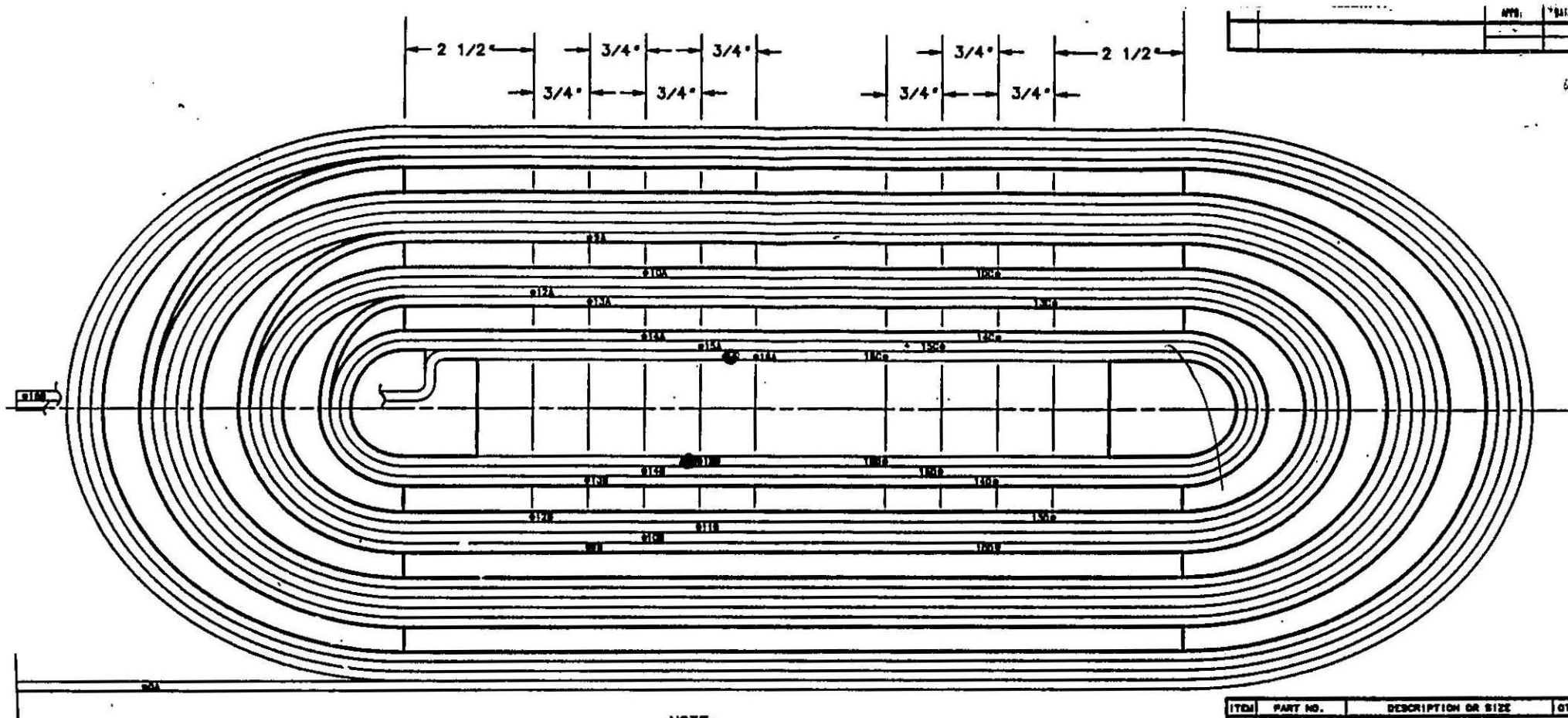
DS ϕ 3 ϕ 8 3700 6200

DS ϕ 3 ϕ 9 5900 8600

* Linear term = 5.7

DS0308 Quench History





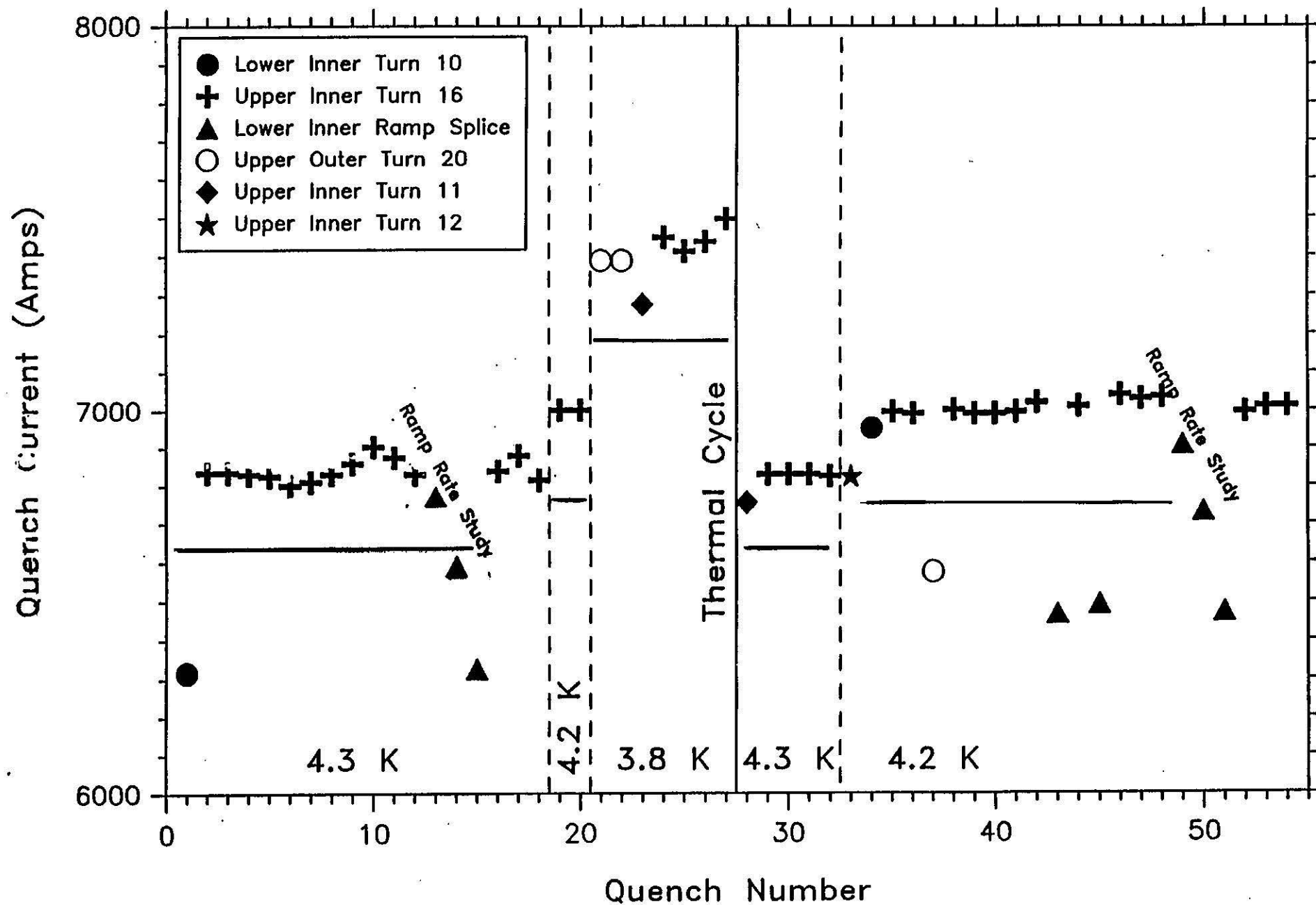
NOTE:

1. VOLTAGE TAP WIRES FOR TAPS OA, 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		ORIGINATOR	STRATY/KOSKA
1. XX	1. XXX	1. XXX	1. XXX
2. XX	2. XXX	2. XXX	2. XXX
1. CHECK ALL SHAPES AND SIZES.		APPROVED	
2. DO NOT SCALE DRAWING.		USED ON	
3. DIMENSIONS SHOWN ON PART FITTED TO PART.		MATERIAL	
4. DIM. ALL DIMS. IN INCHES			
FERMI NATIONAL ACCELERATOR LABORATORY UNITED STATES DEPARTMENT OF ENERGY			
DS0308 VOLTAGE TAPS INNER COIL			
SCALE	FILED	SHOWN CLASS	REV
NONE			
CREATED WITH I-DEAS 4.1		USER NAME: SPLUD	

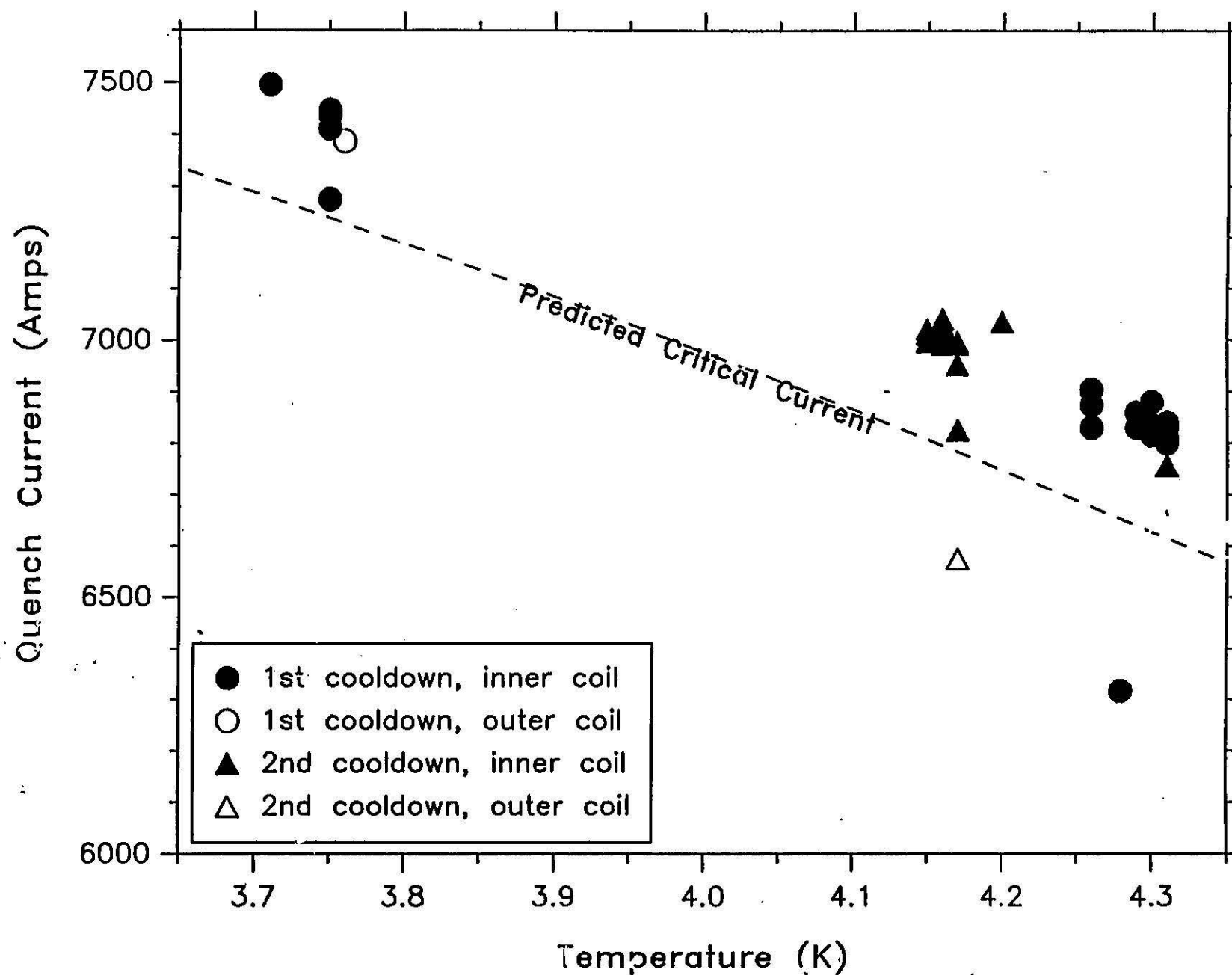
INCHES 0 1 2 3 4 5 6 METRIC 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

DS0309 Quench History



DS0309 Quench Current vs Temperature

$dl/dt \leq 100 \text{ A/sec}$

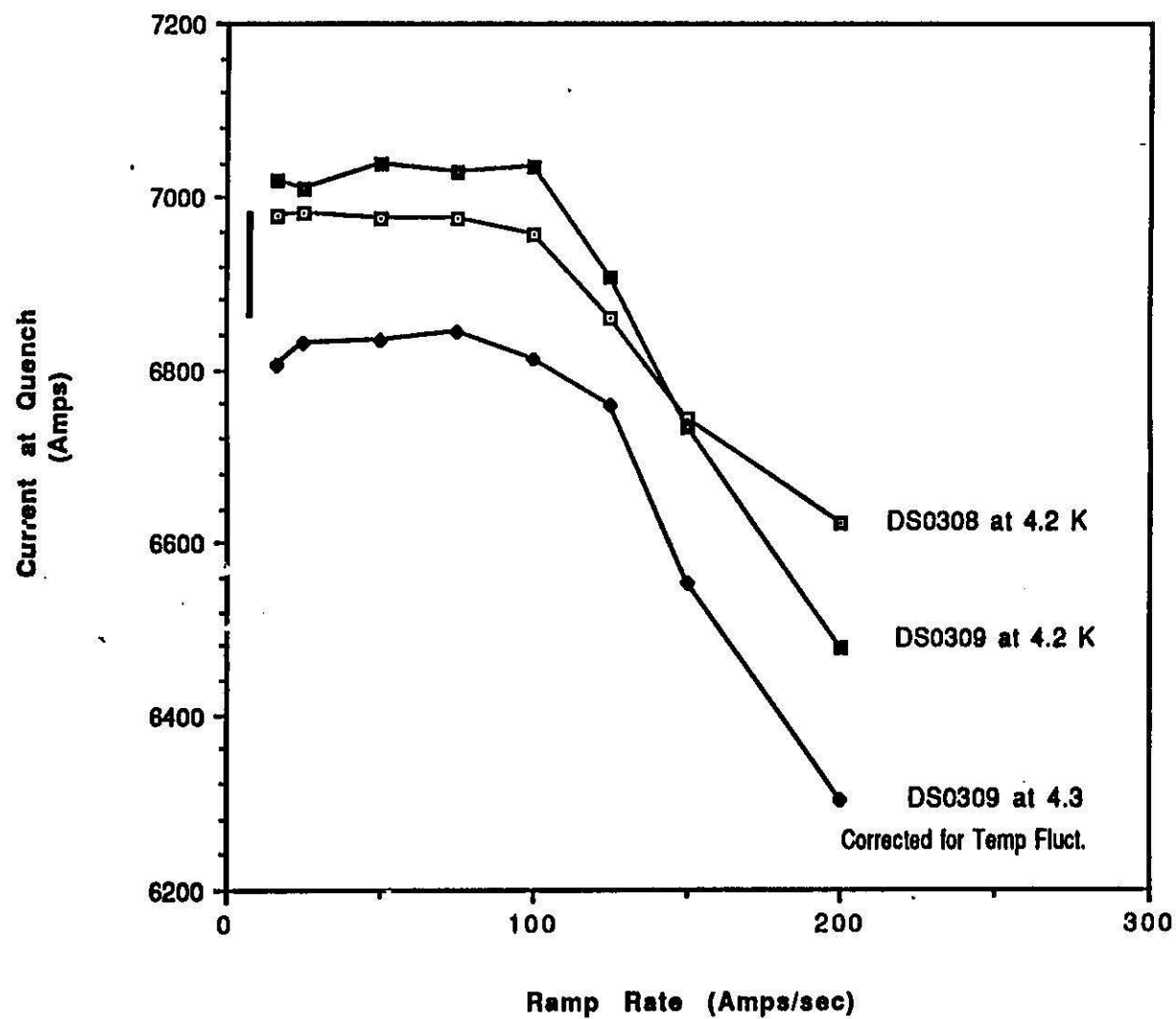


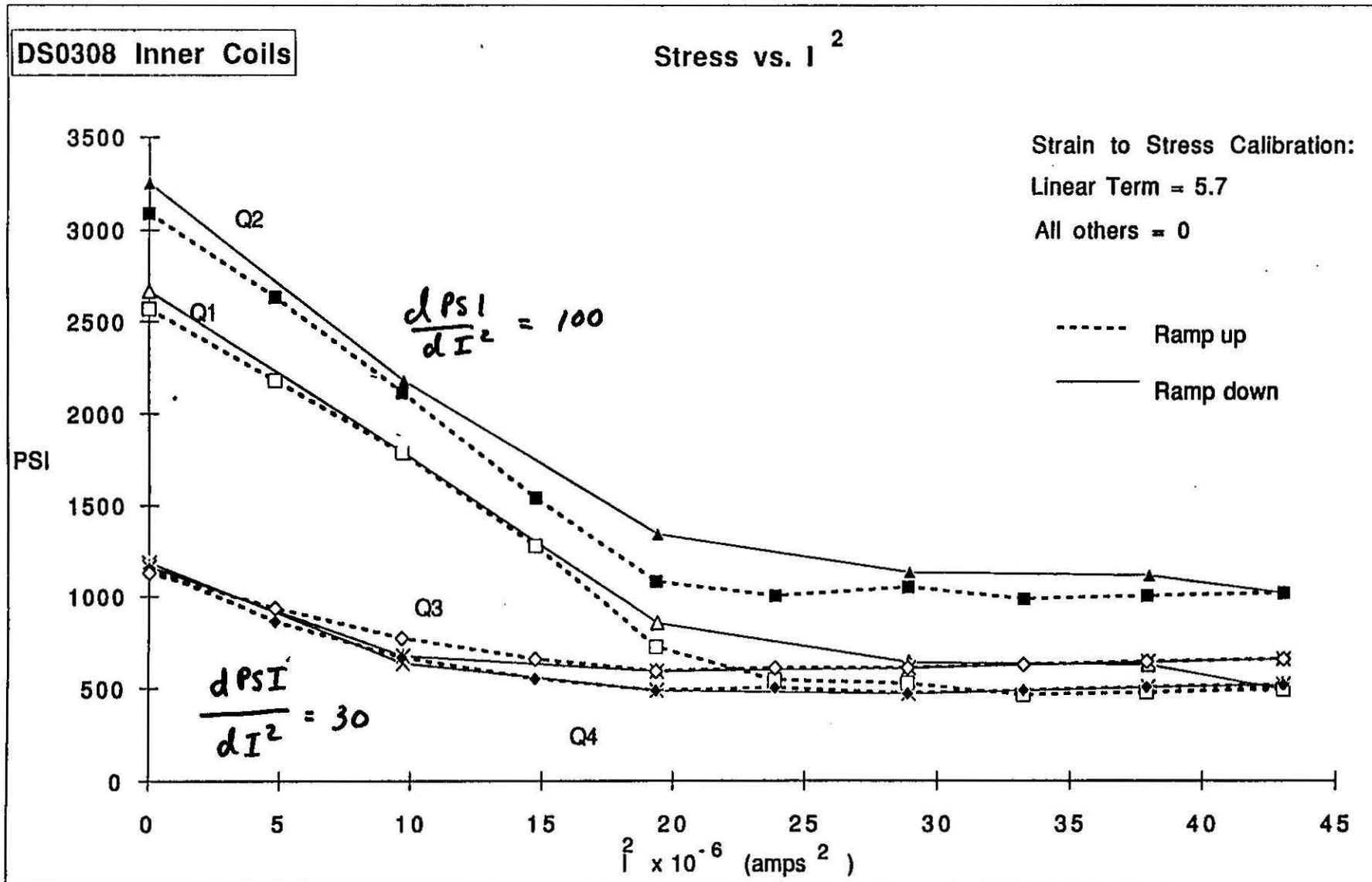
Down Ram

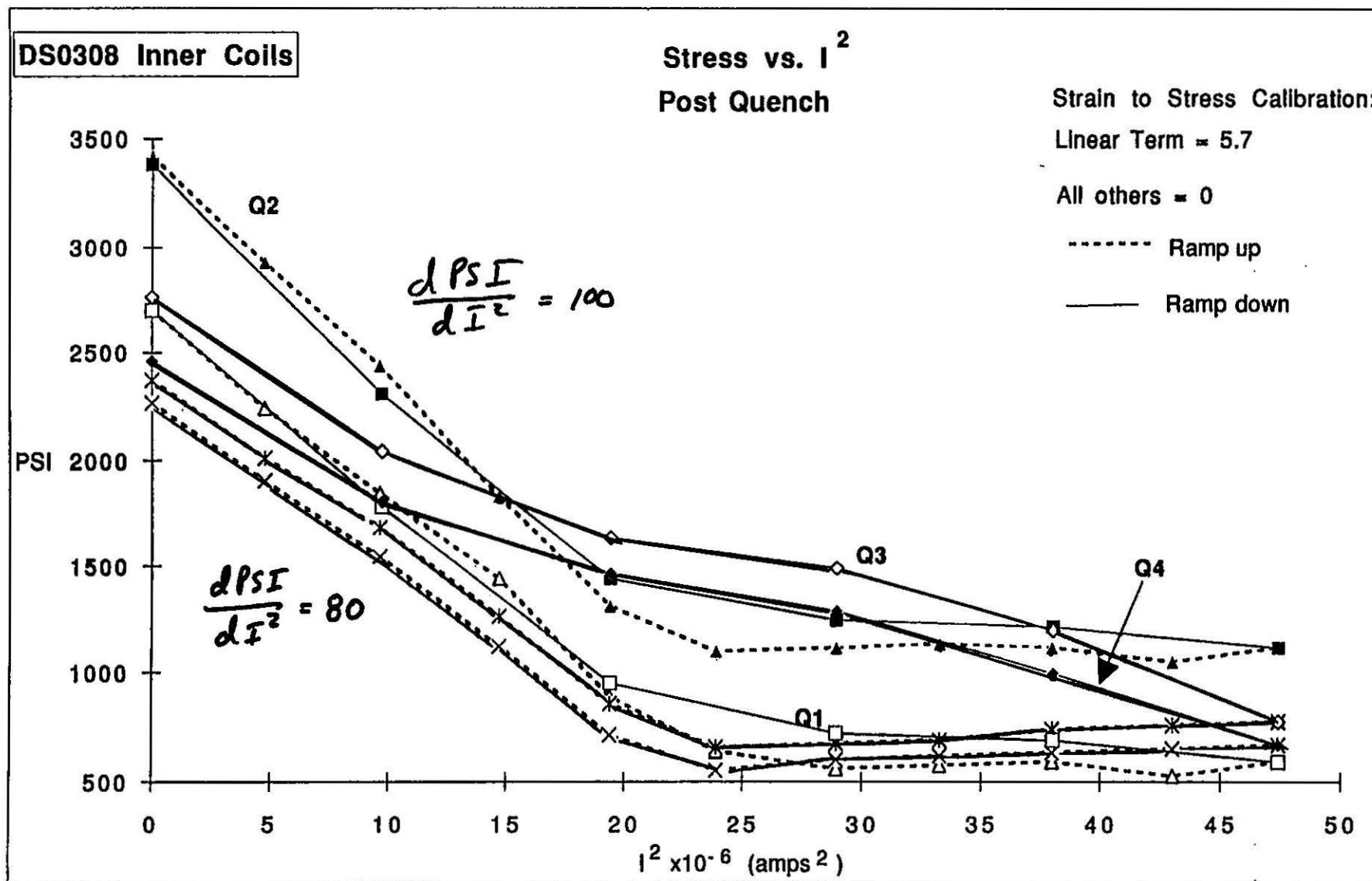
6500 - 4000

400 A/sec

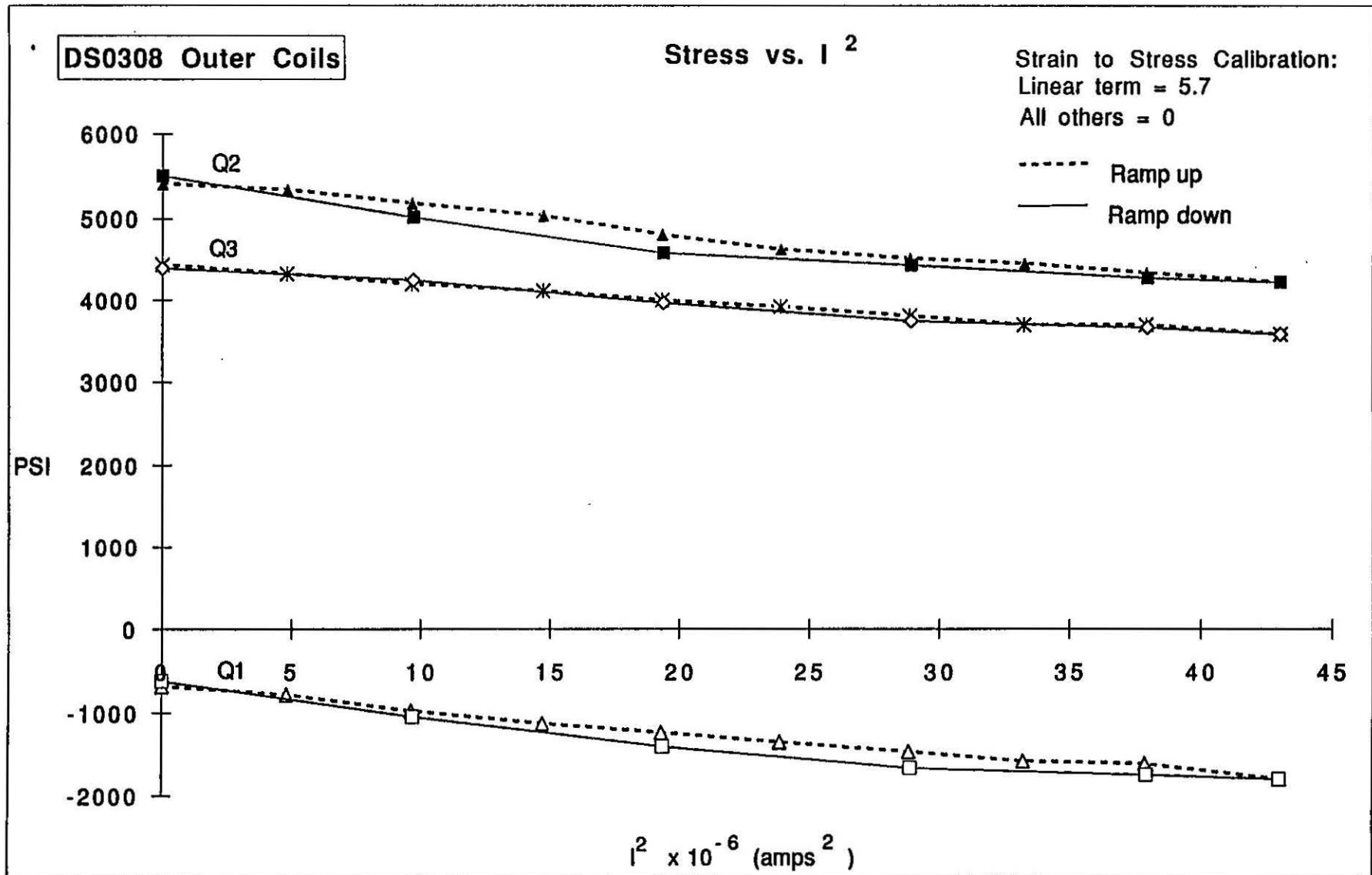
Quench Current vs. Ramp Rate DS0308 and DS0309





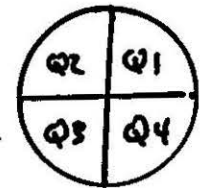
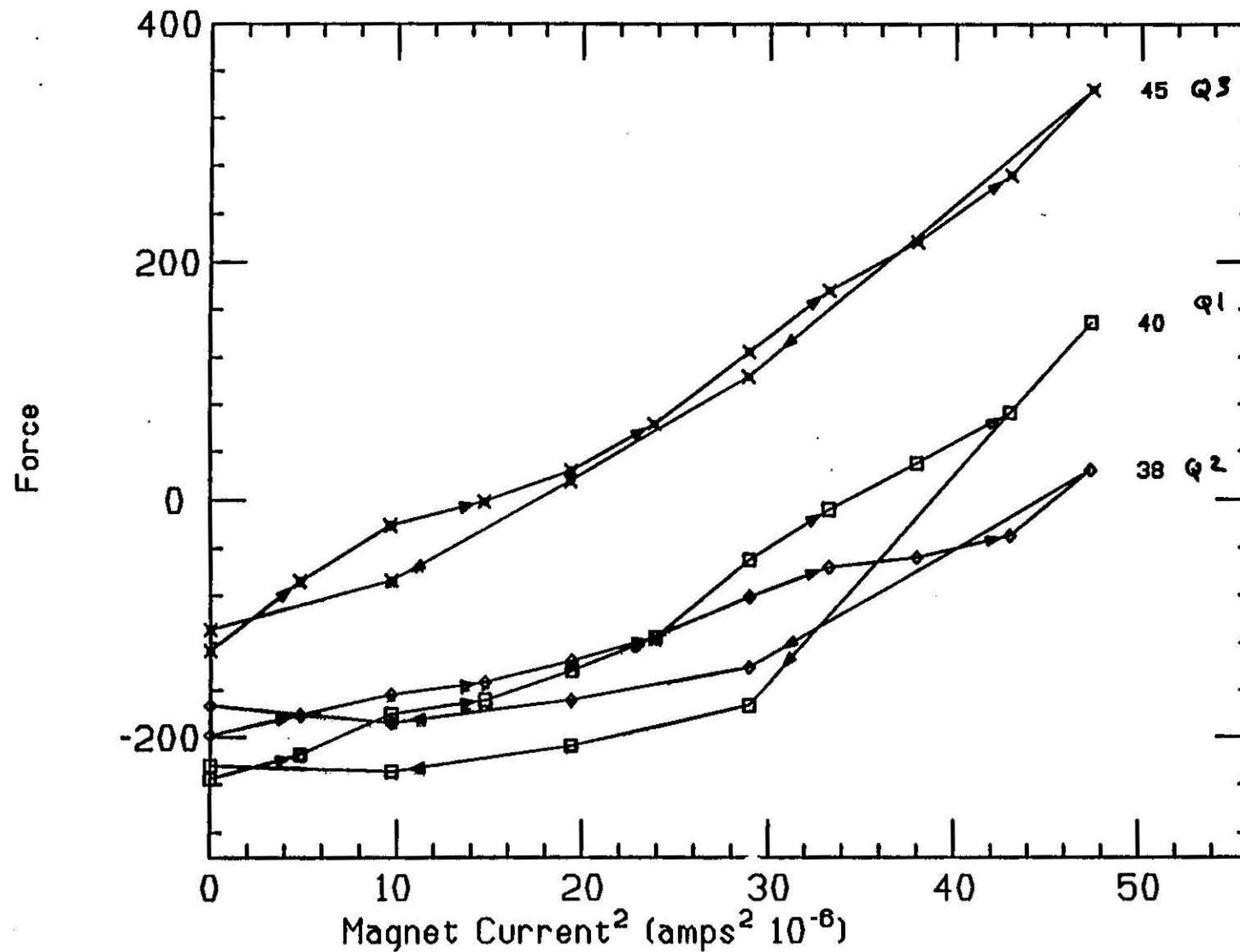


DS0308 Out Coil Stress



DS0308

BULLET GAGES



Sketch for installation
of external
deflectometers

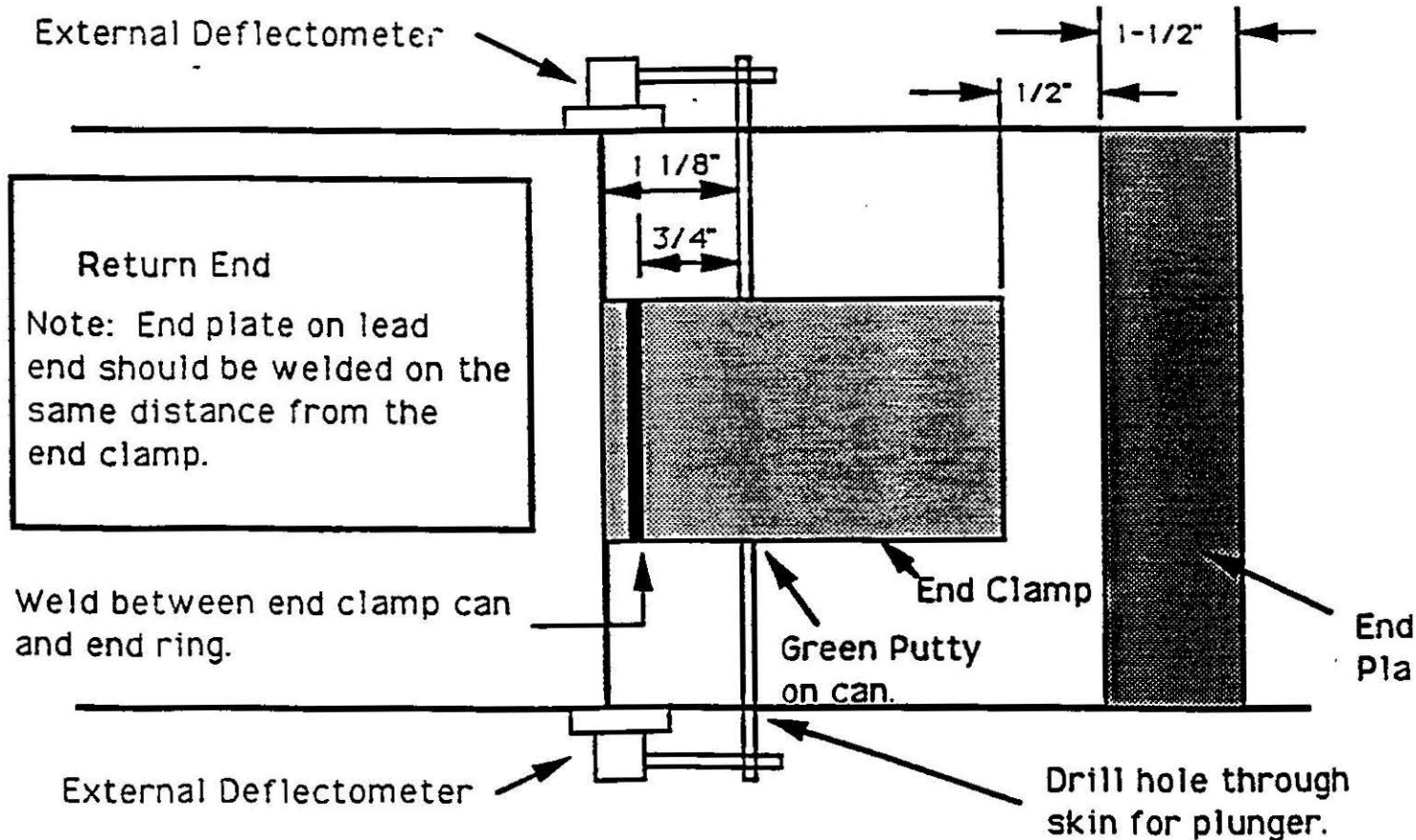
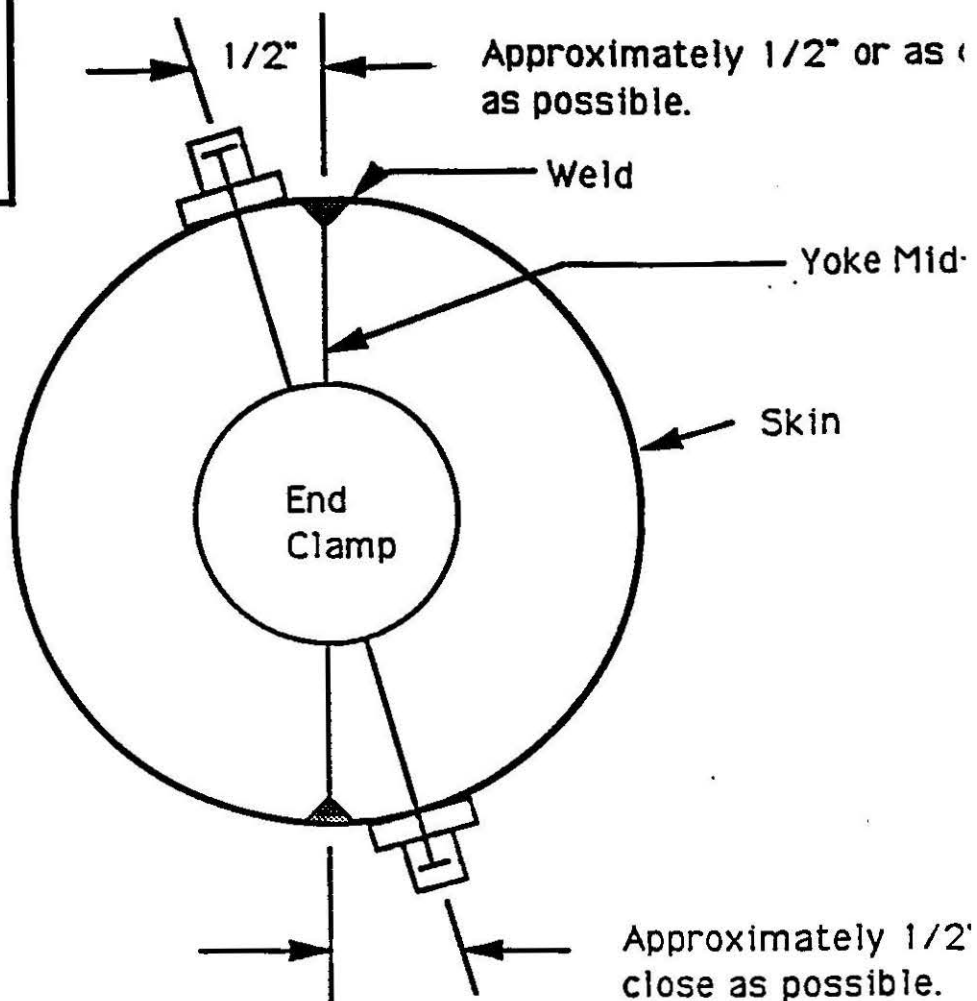
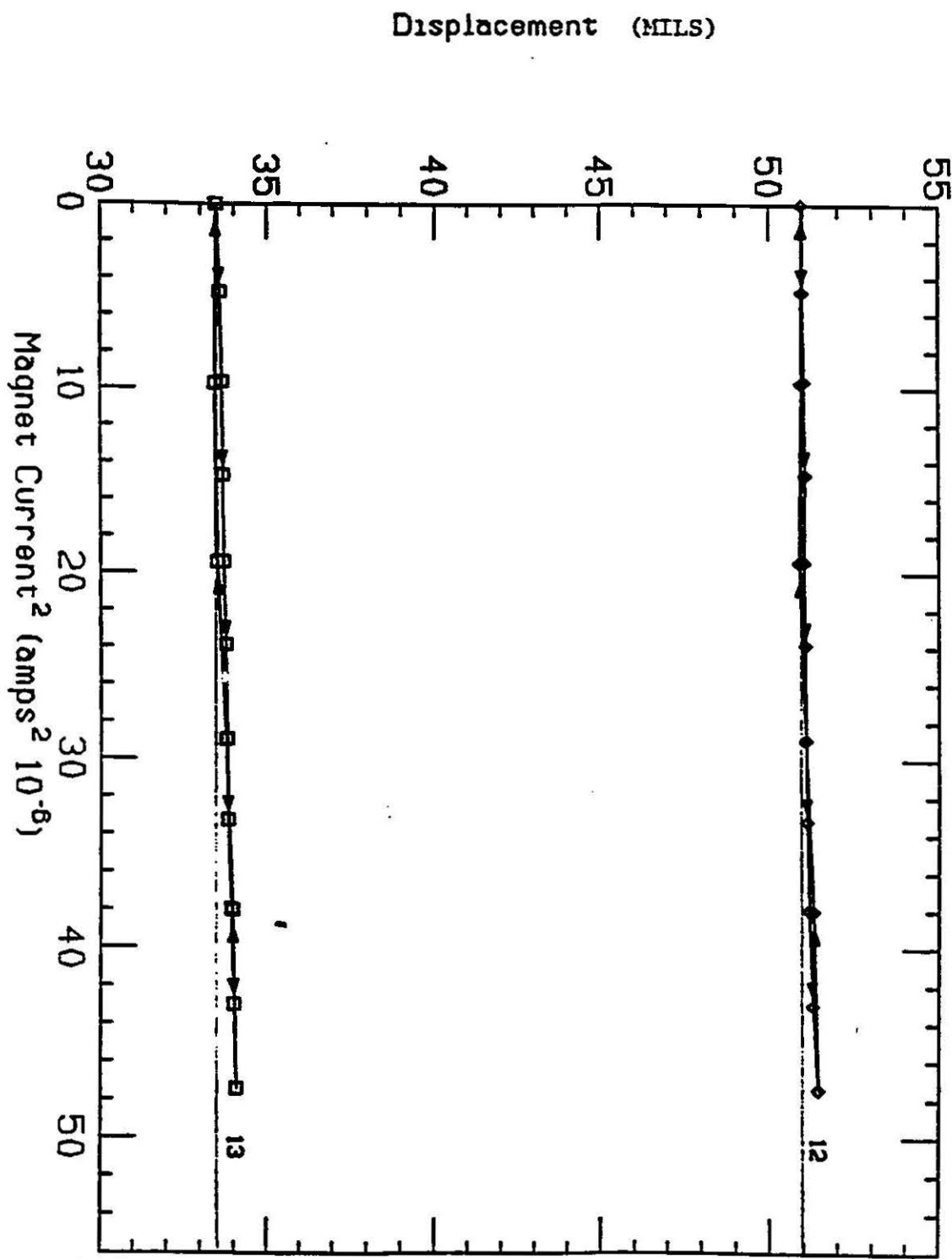


Figure 7

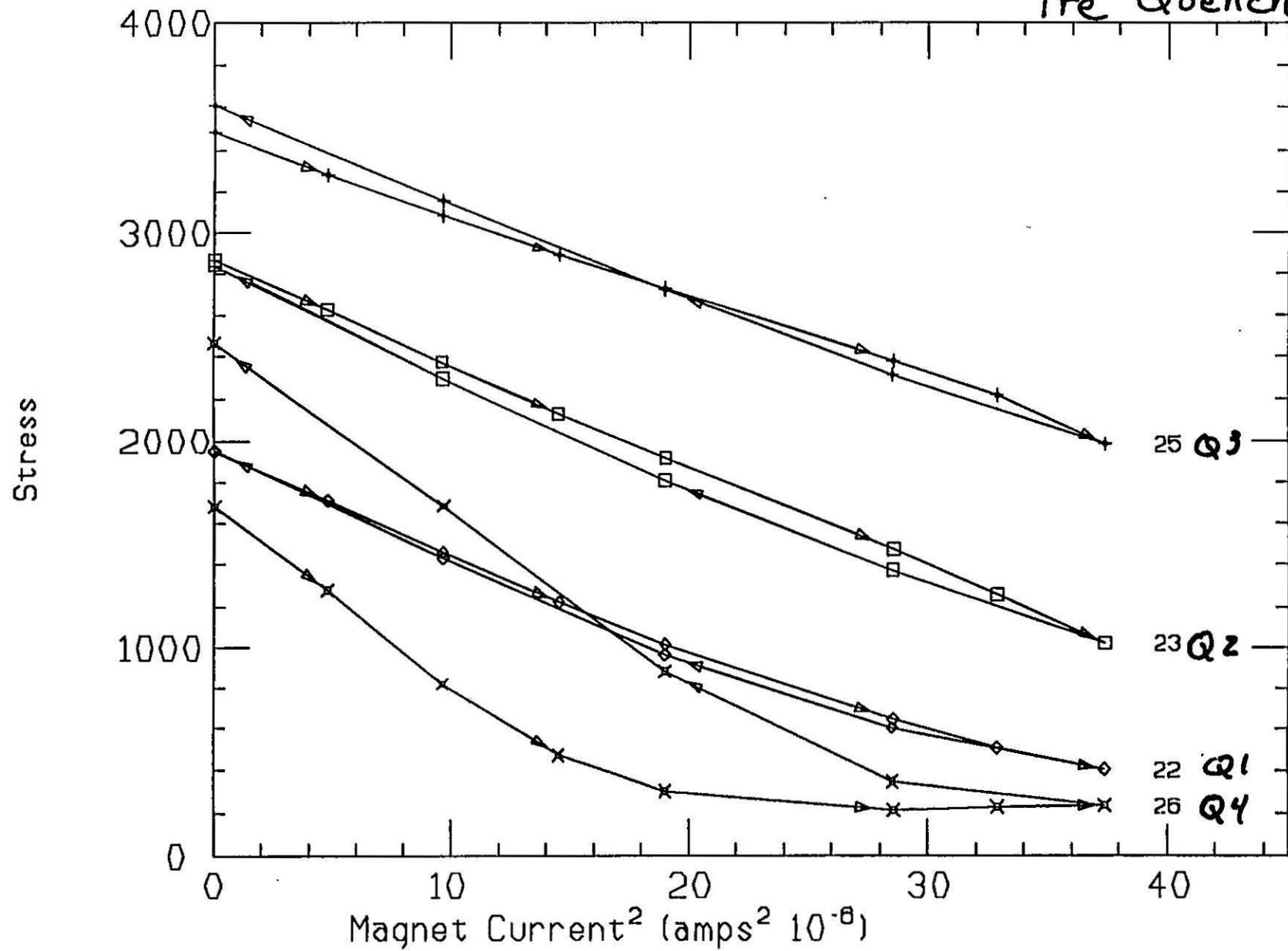
EXTERNAL DEFLECTOMETERS



INNER GAGES

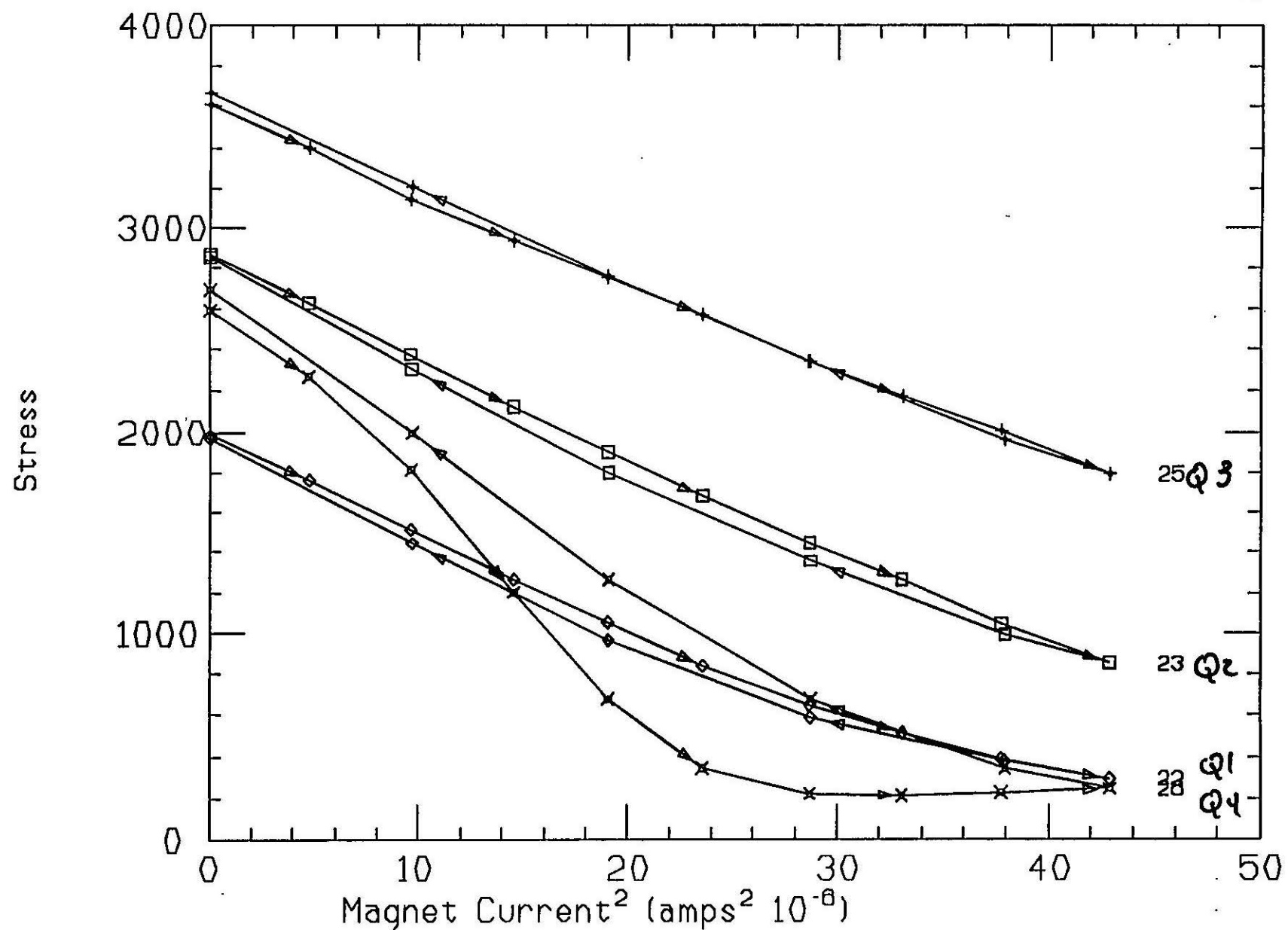
DS0309

Pre Quench



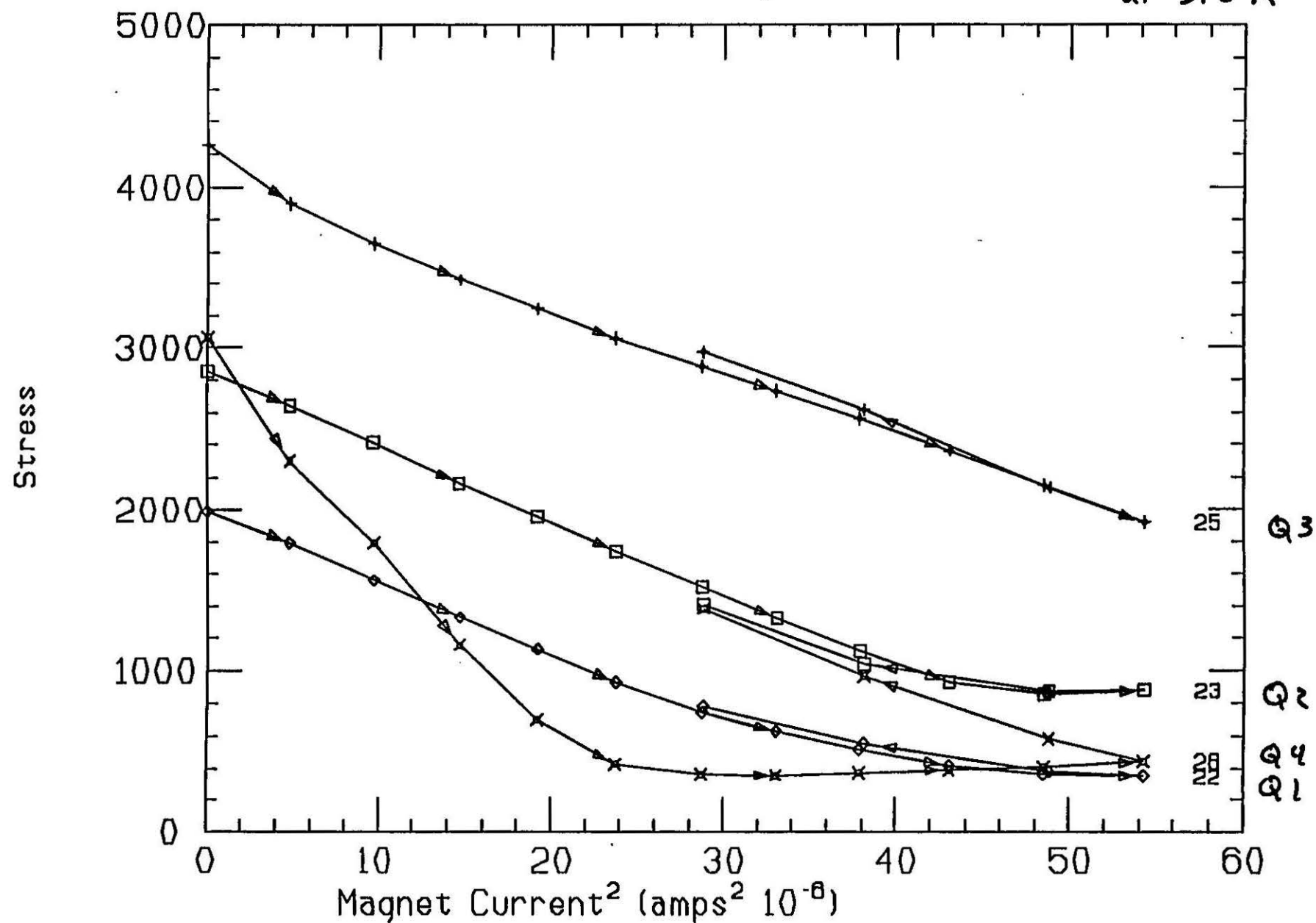
INNER GAGES

DS0309
Post-Quench



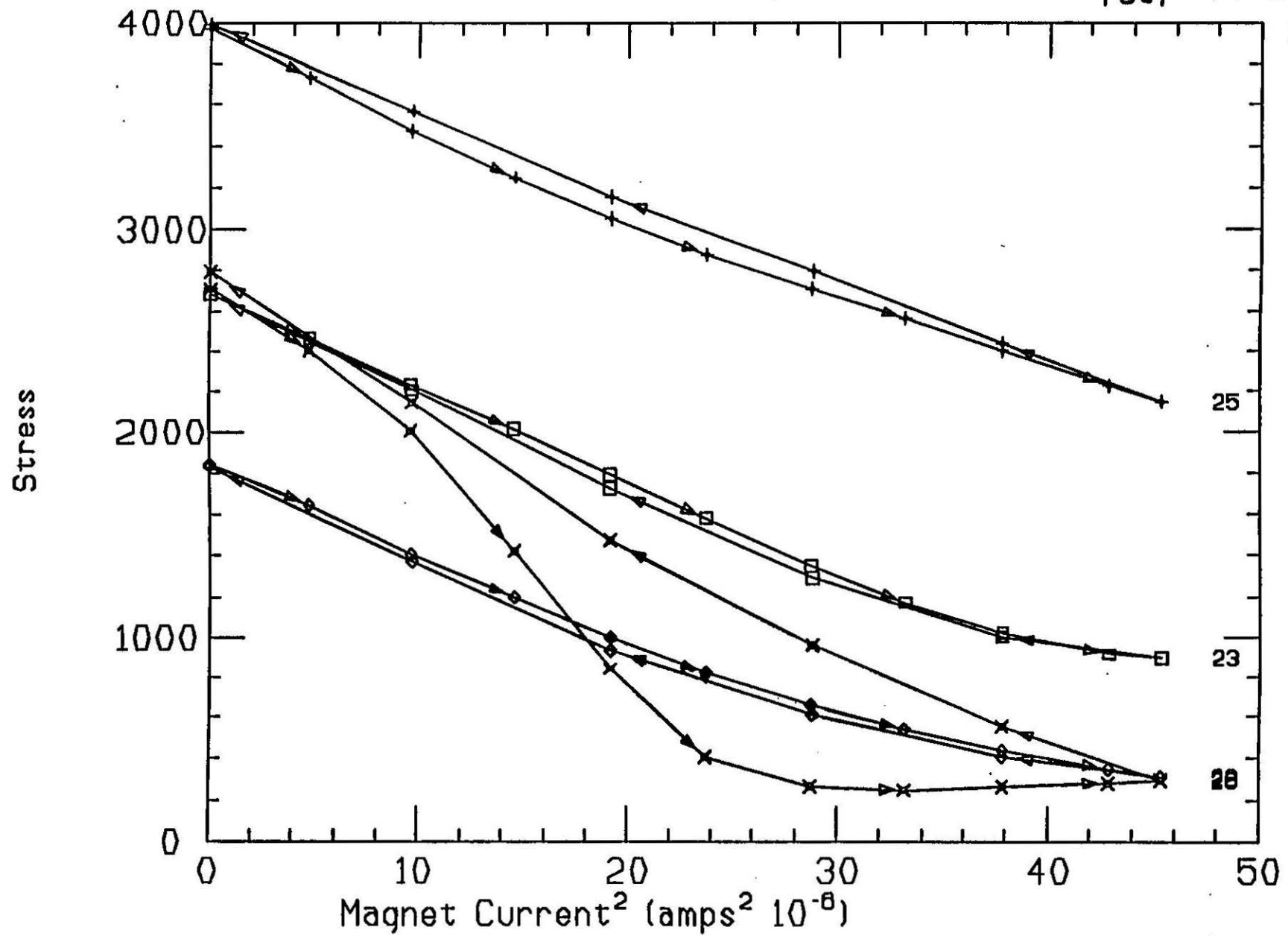
DS0309
at 3.8 K

Inner Gages

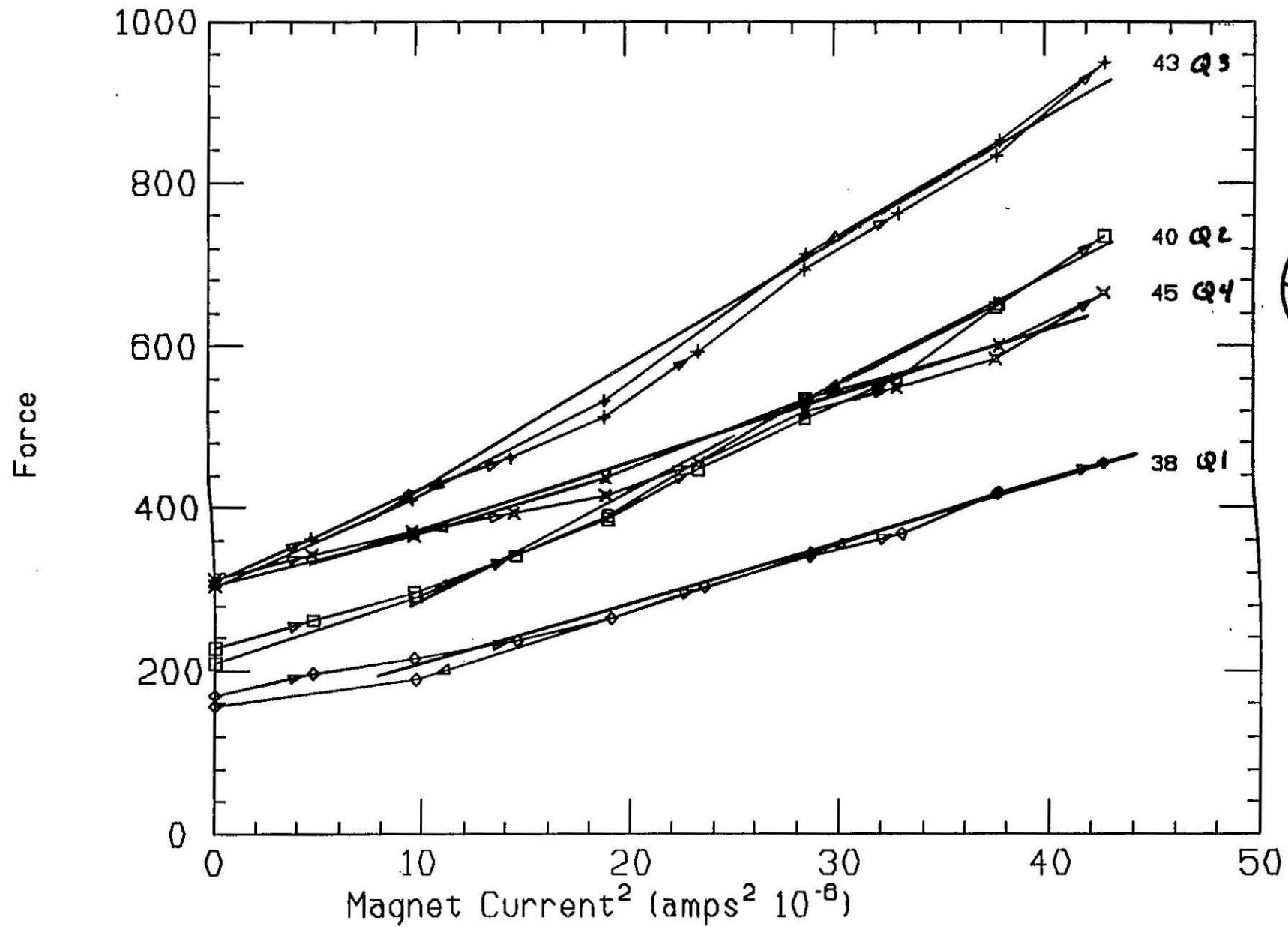


Inner Gages

DS0309
Post Mini-Life
Test



BULLET GAGES

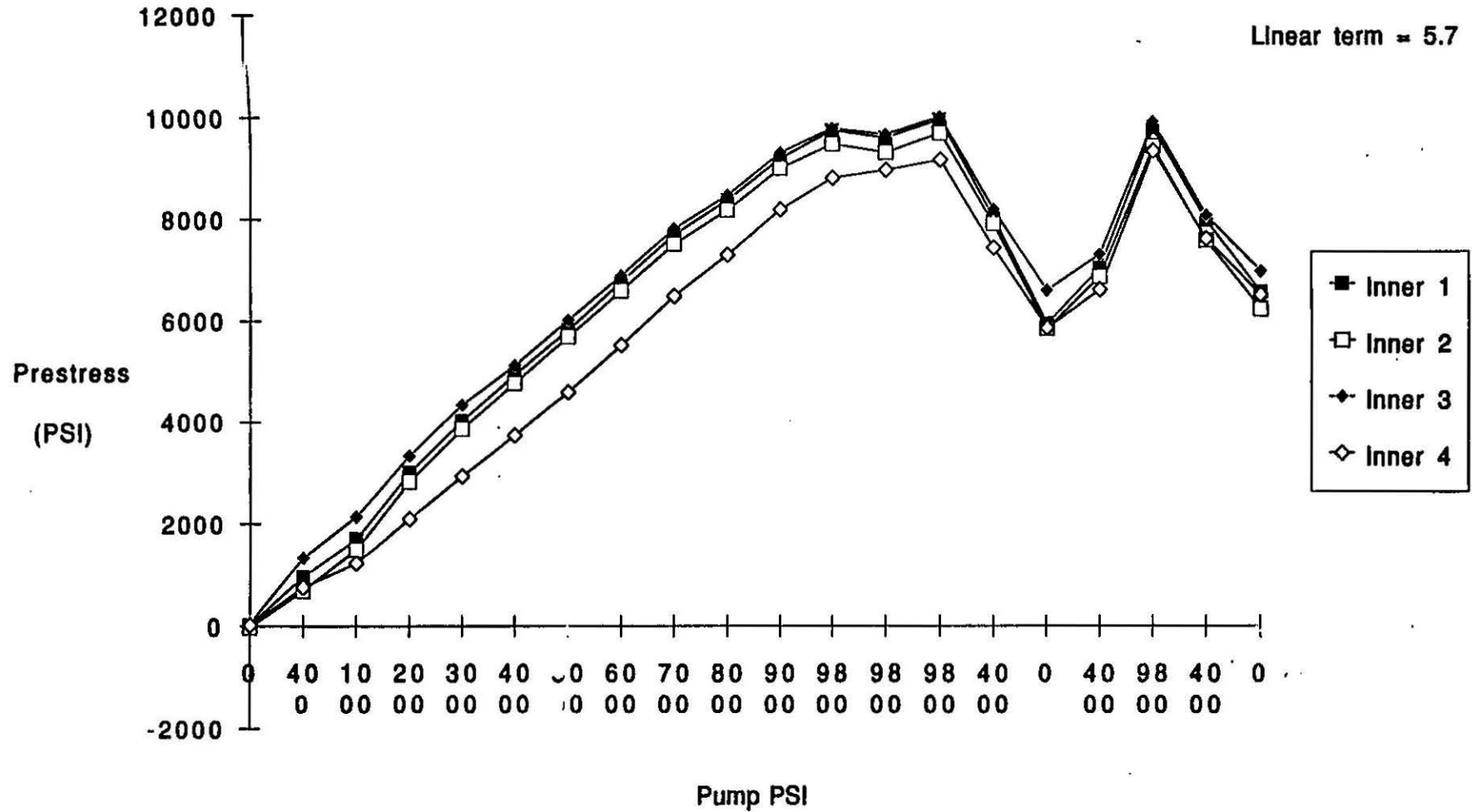


40 MM MODEL MAGNET DEVELOPMENT PROGRAM AT FERMILAB

	DS0307 ⁷	308	309	310	311 ⁸	312	313	314	315	316	317	318 ⁹
Design Features¹												
Pro-oval collars, horizontally split yoke	X	X	X	X	X	X	X					
horizontally oval collars, vertically split yoke								X	X	X	X	X
Individually determined coil ends	X	X	X	X	X							
Grouped outer coil ends						X	X	X	X	X	X	X
Reflexion on coils	X			X	X							
Improved end clamp ²										X	X	
Instrumentation³												
End clamp deflection gages		X				X				X	X	
End clamp strain gages				X		X				X	X	
End clamp strain gages		X		X		X		X	X	X		
Test Plan⁴												
Pre-life test ⁵			X	X					X			
Tests of collaring methods	X				X							
Disassemble after cold test			X					X	X			
Plot and section	X		X	X		X ¹⁰		X	X			
Deep tests ⁶				X		X						

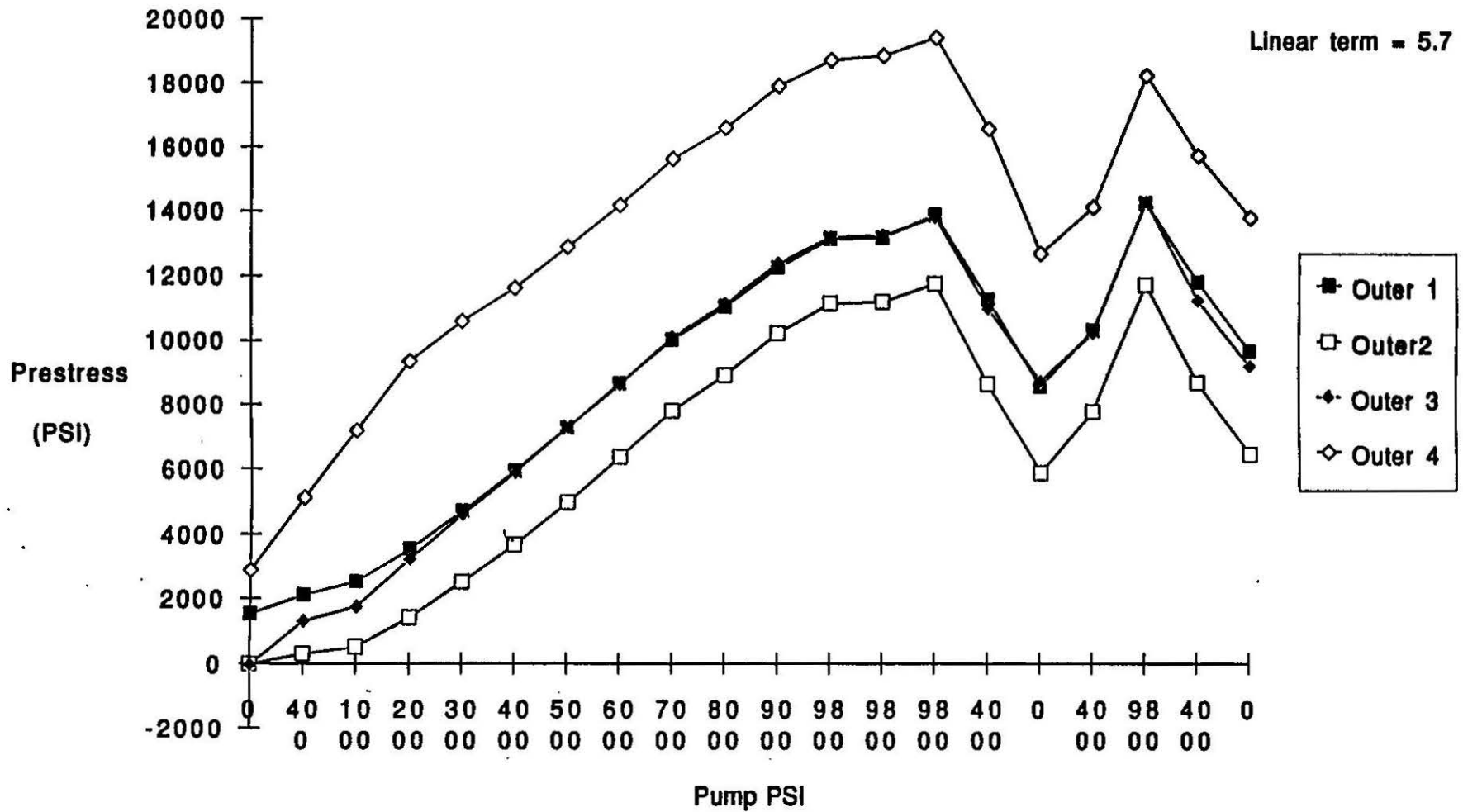
DS0310 Collaring
Inner Gages

Prestress vs Pump PSI



DS0310 Collaring
Outer Gages

Prestress vs Pump PSI



```

-----
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	0.58	-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	0.58	-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	0.58	-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	0.58	-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	0.58	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	0.58	-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	0.58	-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	0.58	-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 -----																		
-0.48	0.58	-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	0.58	-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 -----
drv/drh drv/dpr drh/dpr prestr dcool dh/ds1 dh/ds2 rh rv rv_rh0 sk_rh0 rh rv rh_rh0 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 2.6 -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.

```