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Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

Accelerator & Fusion Research Division

A COMPILATION OF OPERATING DATA FOR THE TFTR-PROJECT SOURCE

MFE Neutral Beam Development Group

October 1979

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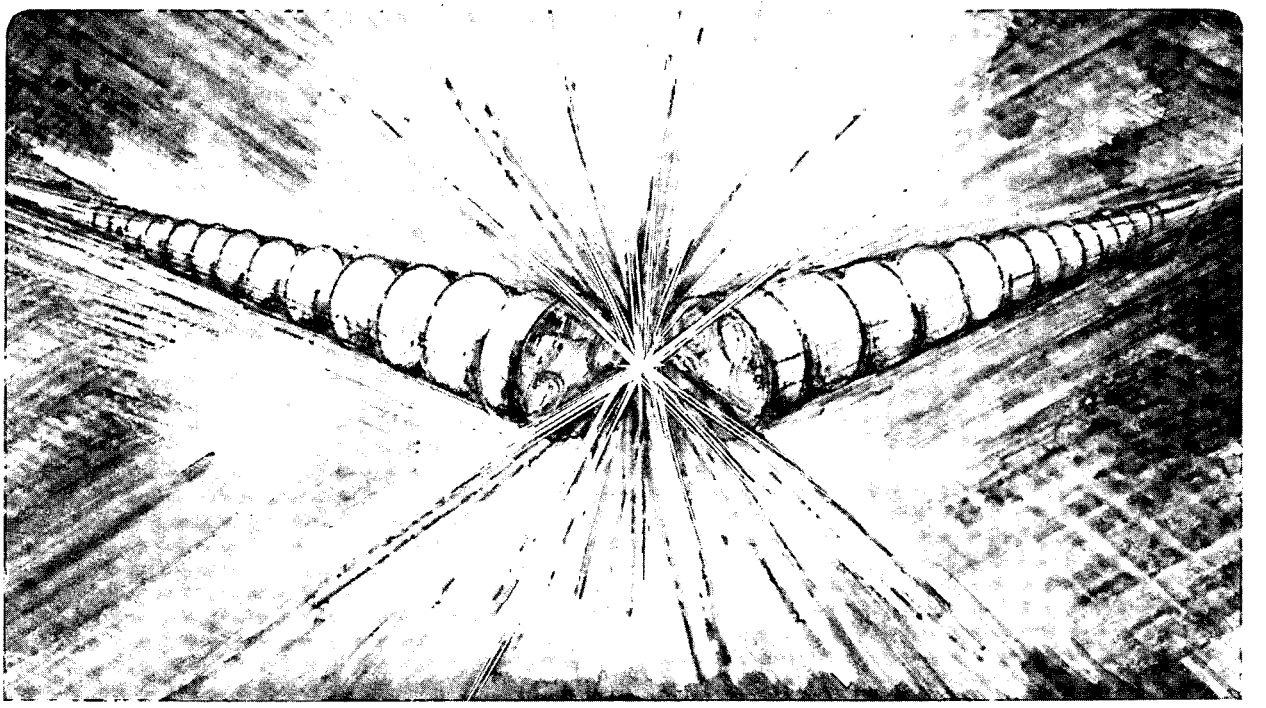

LBID-154 c.1

Prepared for the U.S. Department of Energy under Contract W-7405-ENG-48

A COMPILATION OF OPERATING DATA FOR THE TFTR-PROJECT SOURCE

MFE Neutral Beam Development Group

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

October, 1979

INTRODUCTION

This is a compilation of operating data for the TFTR-Project Source - an ion source and accelerator system which has produced 60 amperes of ions when operated at 120 kV with deuterium, and 80 amperes when operated with hydrogen.

Although the system is designed for 0,5 sec operation, the data presented here is limited to ~ 15 msec pulses by the power supply available on Test Stand IIIB.

Klaus H. Berkner, ext. 5011
Dexter Massoletti,ext. 5314

This work was supported by the U. S. Department of Energy under Contract W-7405-ENG-48.

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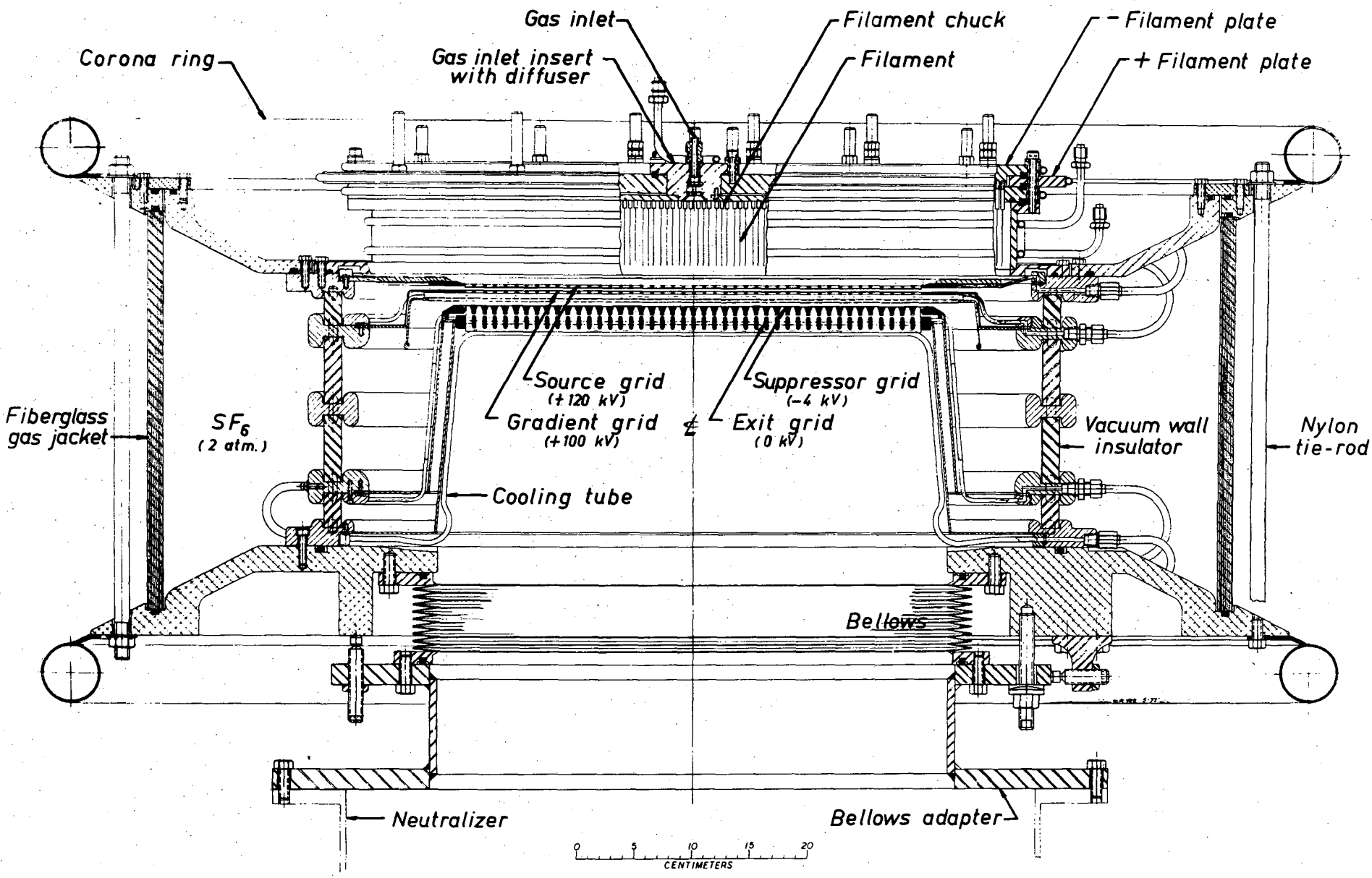
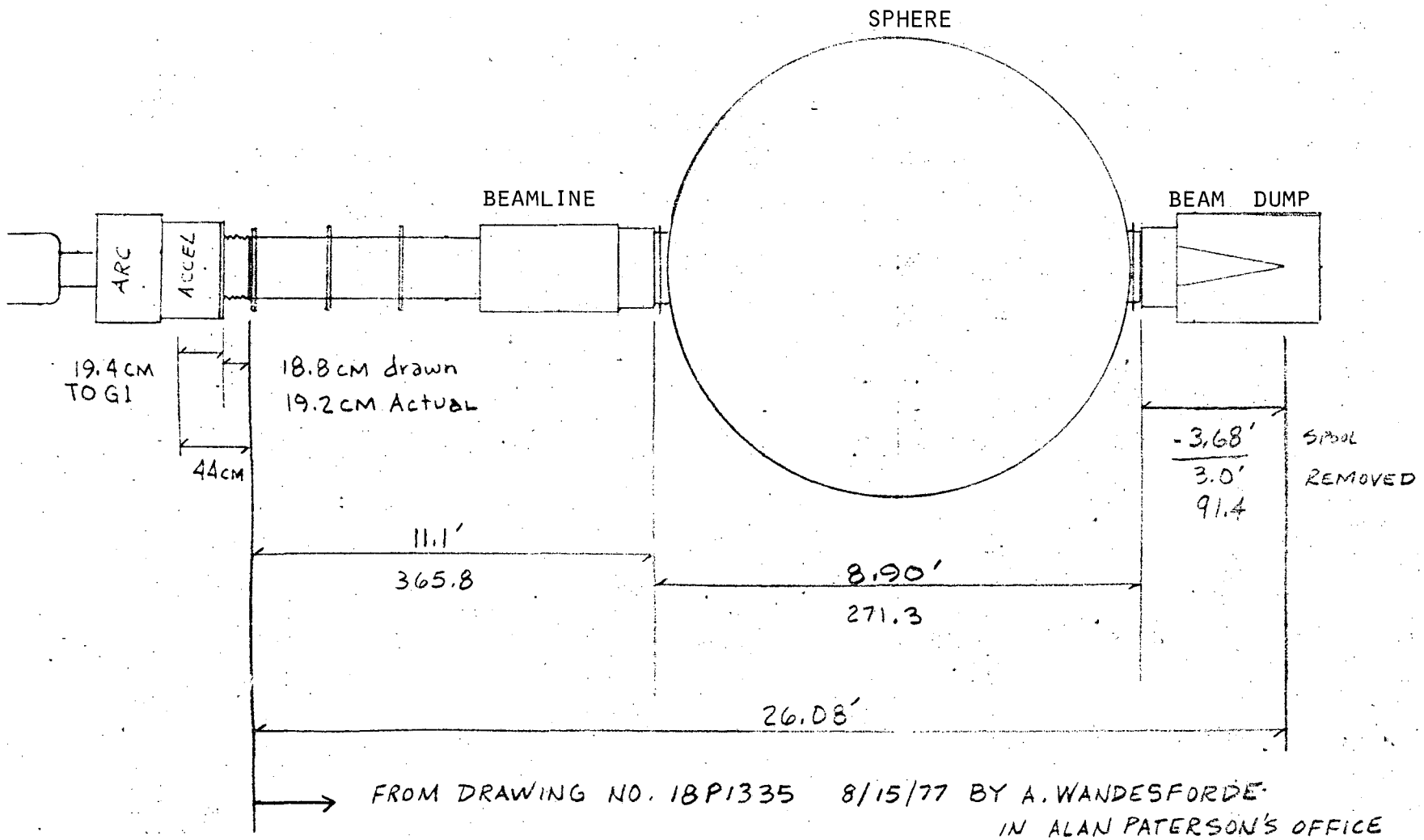
GENERAL INFORMATION



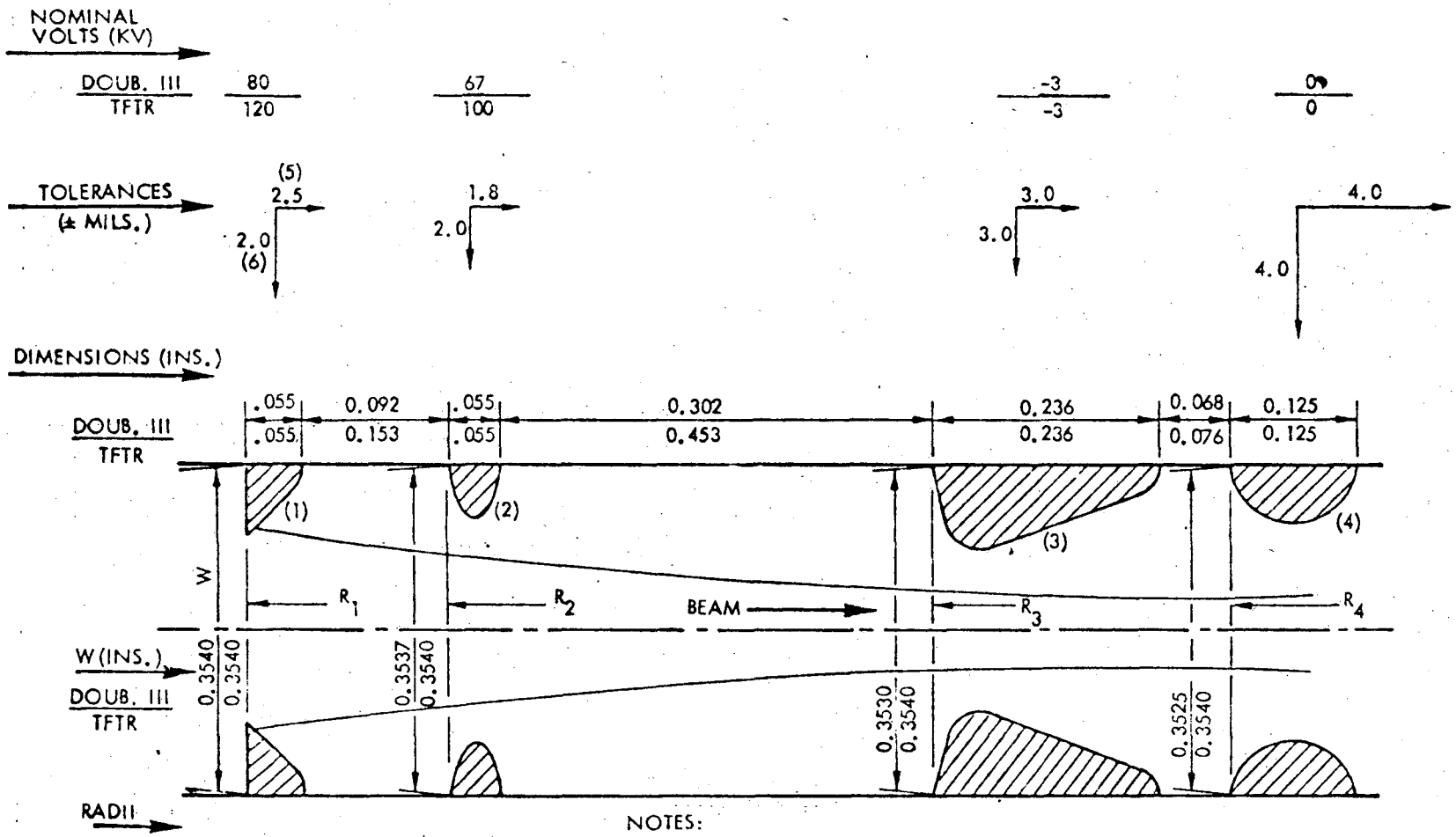
LBL "65-AMP." NEUTRAL BEAM SOURCE MODULE
(65-Amp., 120-keV, 0.5-sec.)

BEAMLINE LAYOUT

GRID #1 TO APEX OF CALORIMETER = 795 CM



FROM DRAWING NO. 18P1335 8/15/77 BY A. WANDESFORDE
IN ALAN PATERSON'S OFFICE



DOUB. III RAIL HOLDER RADII (INS.)

R_1	189.004	REFERENCE ONLY
R_2	188.857	
R_3	188.500	
R_4	188.196	

NOTES:

(1) SOURCE GRID
(2) GRADIENT GRID
(3) SUPPRESSOR GRID
(4) EXIT GRID
(5) HORIZONTAL LOCATION TOLERANCES (± MILS)
(6) VERTICAL LOCATION TOLERANCES (± MILS)

DOUB. III RAIL RADII* (INS.)

r_1	214.594	REFERENCE ONLY
r_2	214.447	
r_3	214.090	
r_4	213.786	

*IN A PLANE PERPENDICULAR TO THE R PLANE.

FIGURE 2 - COMPARISON - DOUBLET III AND TFTR SOURCE GRIDS VOLTAGES, DIMENSIONS AND TOLERANCES

11-7-78

SOURCE SPECIFICATIONS

TEST STAND III B

MK — 10CM X 44 SHOTS DATE 2-16-79

TFTRP

SPACING BETWEEN RAILS:		"ASKED-FOR"
GAP SPACING 1st	.156	.153
2nd	.454	.453
3rd	.113	.076

CURVATURE

#1 FLAT

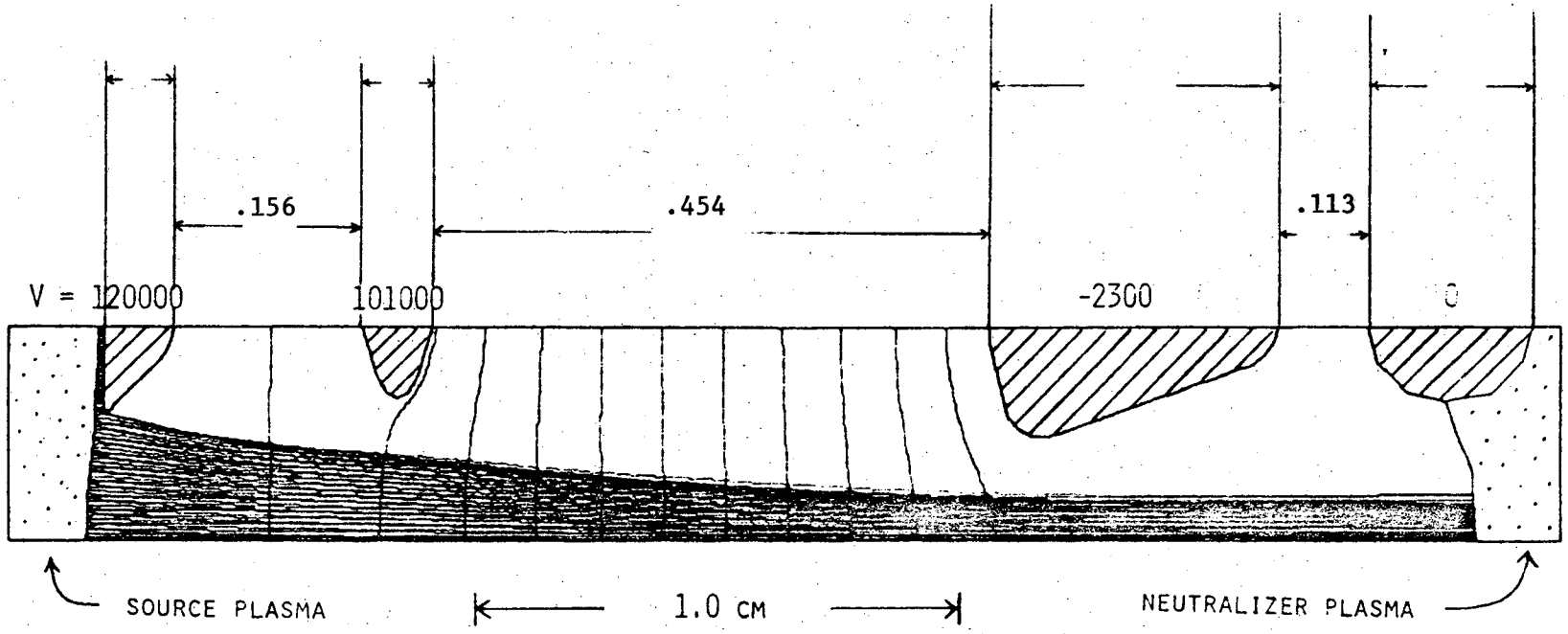
#2 FLAT

MASKING:

SHIELDING:

REMARKS:

2-16-79 ALIGNMENT CHECKED-FOUND TO BE GOOD. GRADIENT GRID FLATNESS CHECKED-FOUND TO BE GOOD. SOURCE GRID REMOVED AND READJUSTED FOR FLATNESS ALL OK! TOTAL SHOTS 10,250 DATE OF REMOVAL

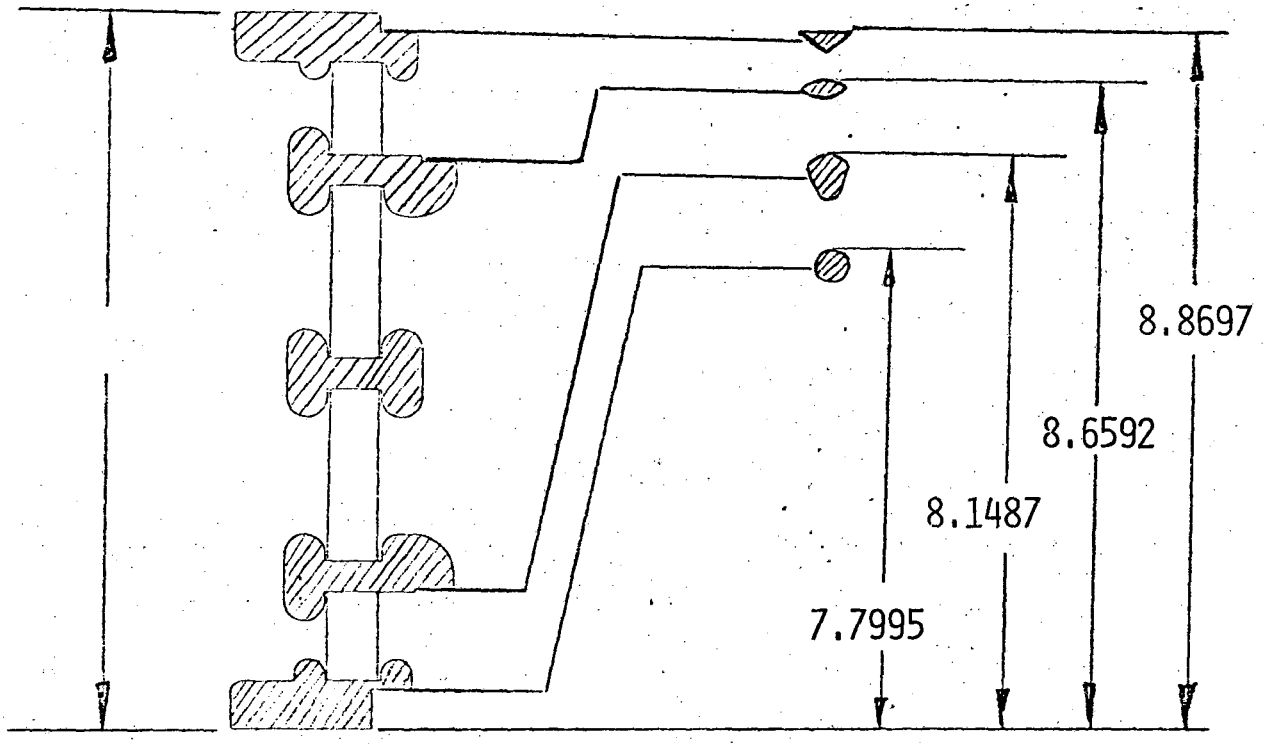


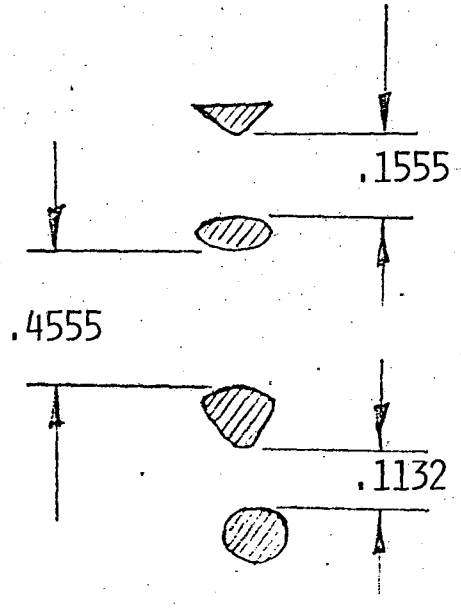
ION CURRENT DENSITY = 0.31 A/CM^2 (D^+)

TRANSPARENCY = 0.6

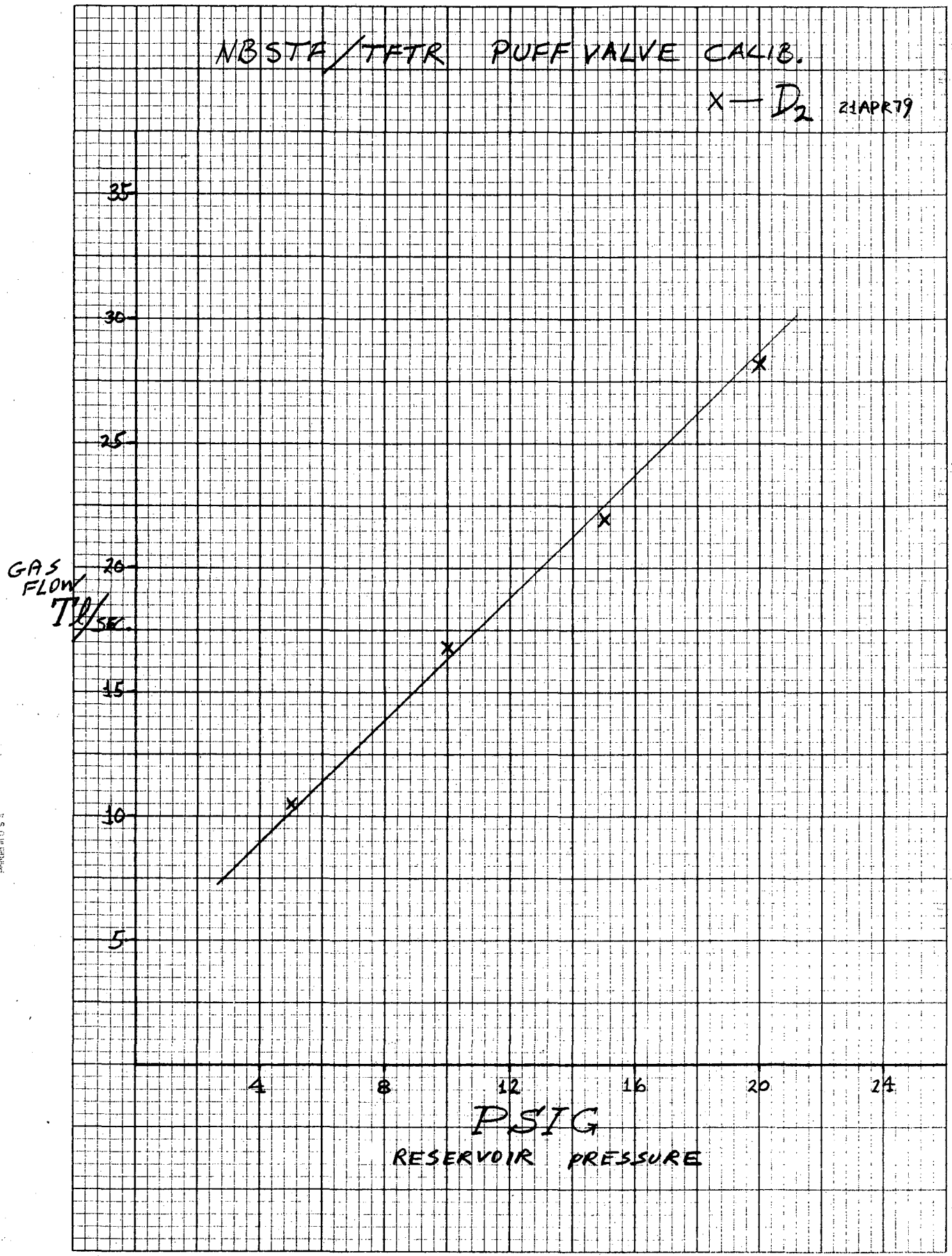
BEAM DIVERGENCE ($\sqrt{2}\,\theta_{RMS}$) = 0.53 DEGREES

#22
Rail





GENERAL OPERATION



SQUARE 5 X 5 TO THE HALF INCH AS-0811i-BD
GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York
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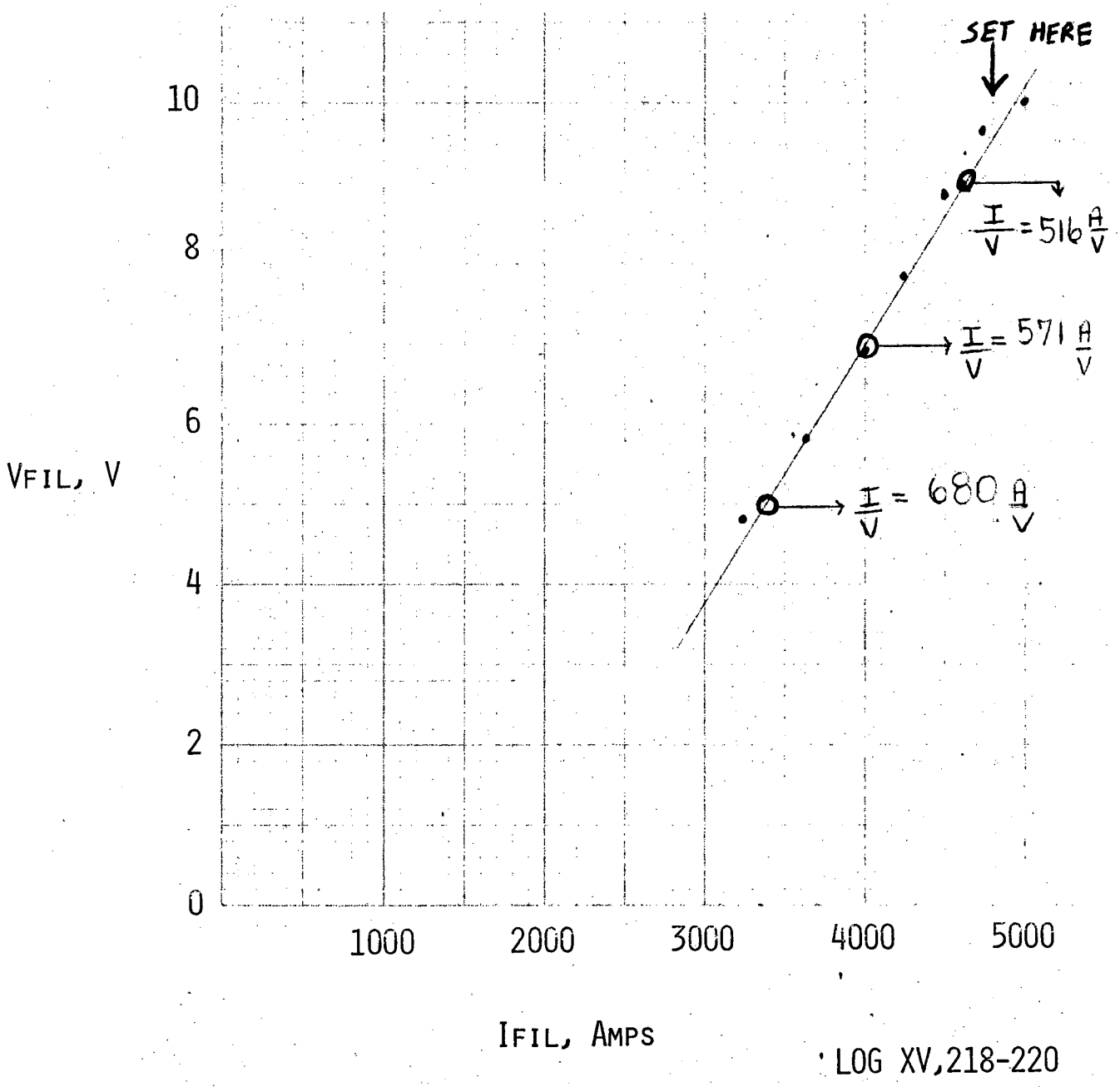
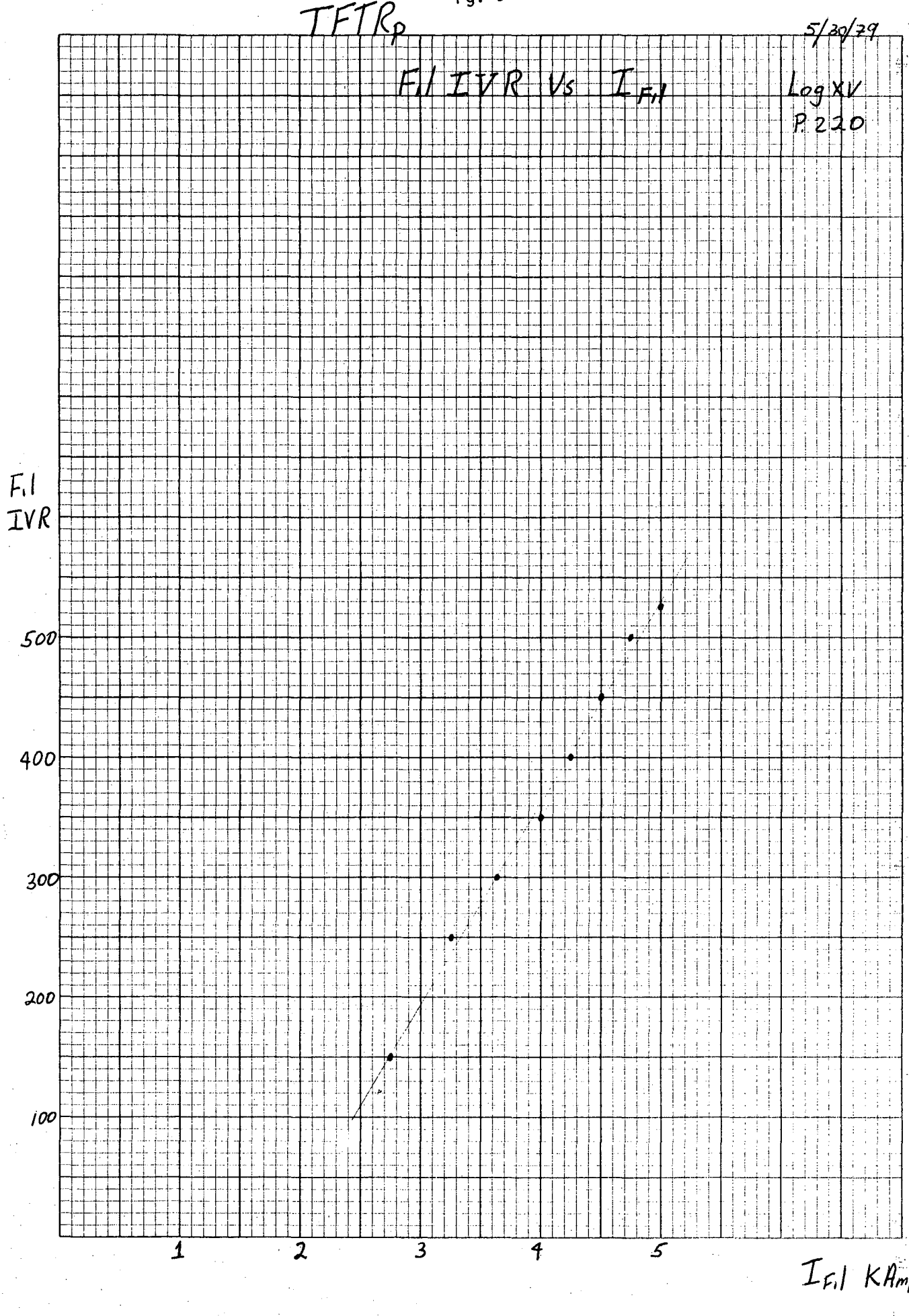
TFTR FILAMENT VOLTS VS. FILAMENT AMPS



LOG XV,218-220

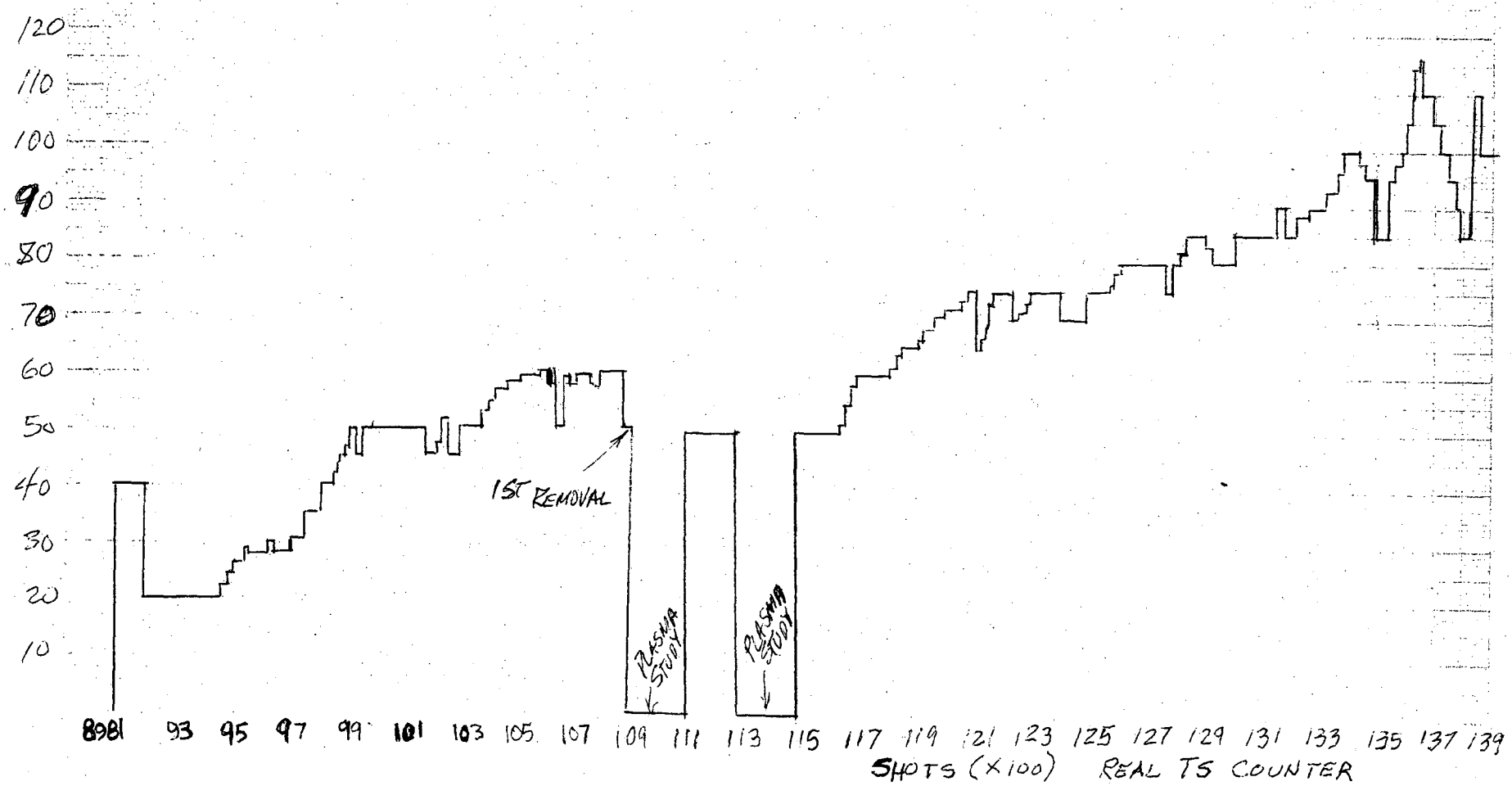
5/30/79


TFTRp
5/30/79
Fil IVR Vs IFil
Log XV
P. 220
Fil IVR
500
400
300
200
100
1
2
3
4
5
IFil KAmps
SQUARE 5 X 5 TO THE HALF INCH AS-08111-60
GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York
Printed in U.S.A.

KV

3/13/79
LOG XVII
P. 183

CONDITIONING TFTRp
KV'S VS # SHOTS
FROM 8981 → 10900 COPIED FROM LOG XVI P.121
4875 REAL SHOTS



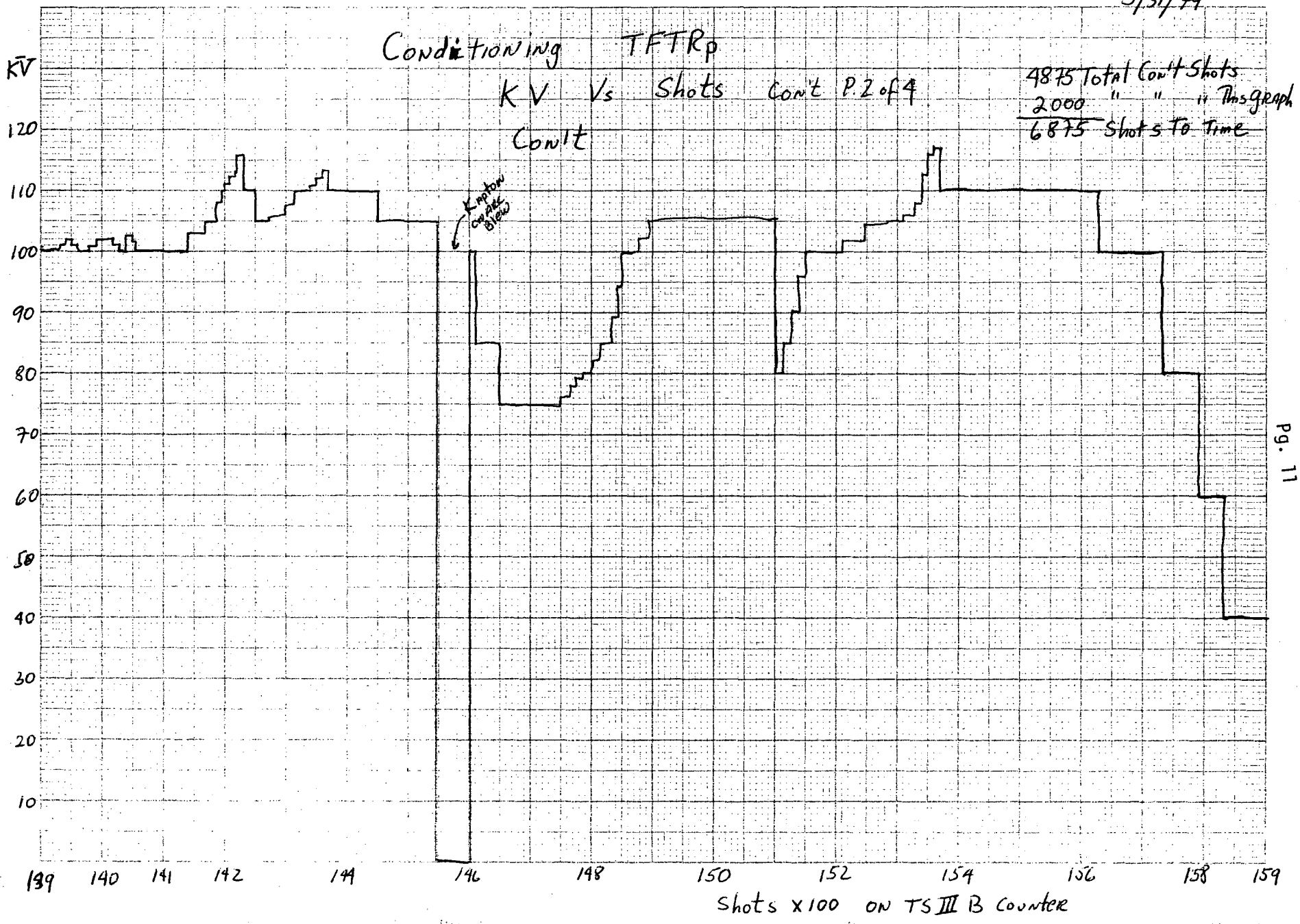
5/31/79

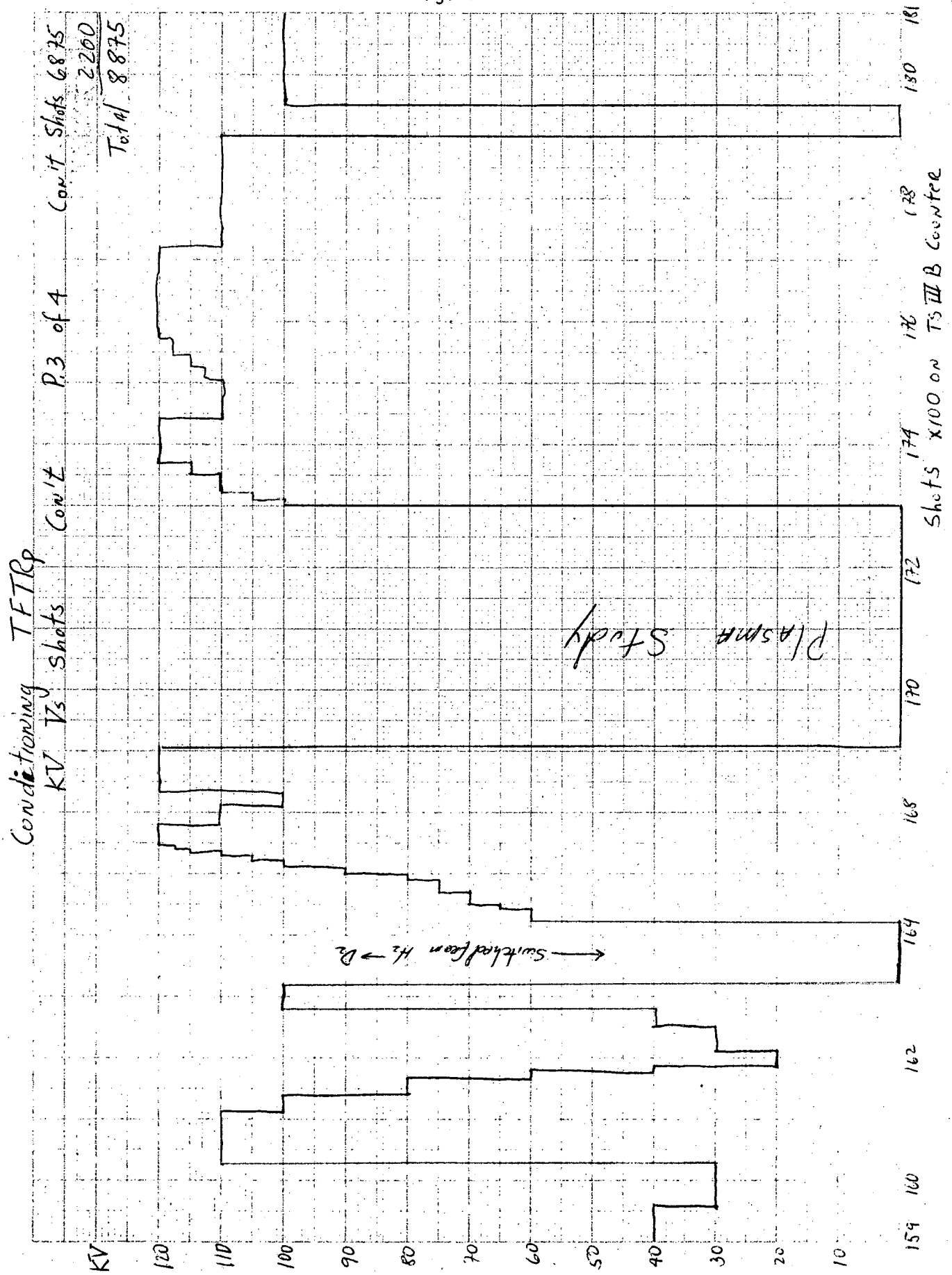
Conditioning TFTRp

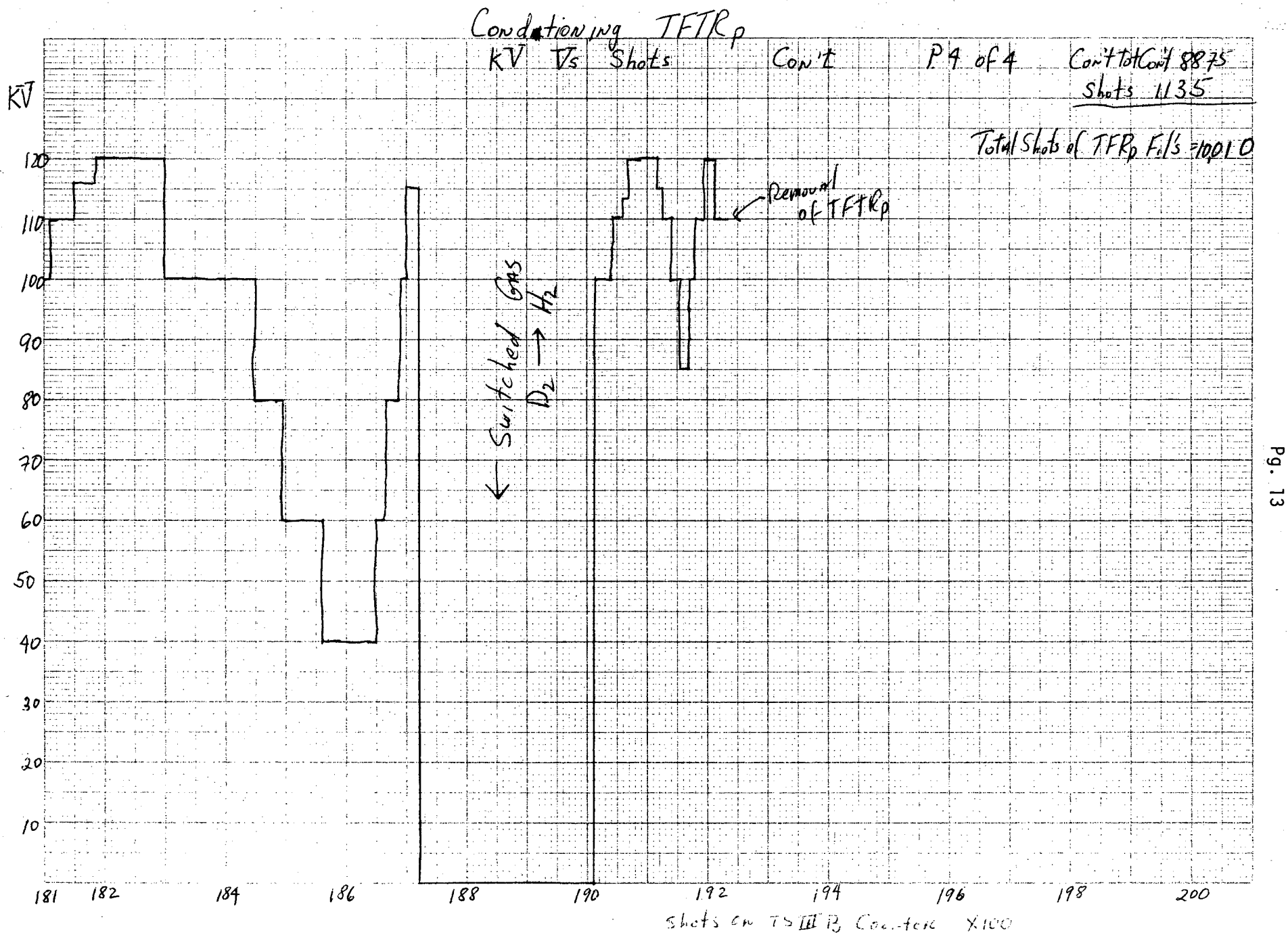
KV Vs Shots Con't P.2 of 4

Con't

4875 Total Con't Shots
2000 " " " This graph
6875 Shots To Time




Conditioning TFTRp
KV Vs Shots Con't P.3 of 4 Con't Shots 6875
2200
Total 8875
Plasma Study
Switched from H2 → D2
KV
120
110
100
90
80
70
60
50
40
30
20
10
159
160
162
164
168
170
172
174
176
178
180
181
Shots X100 on TS III B Counter

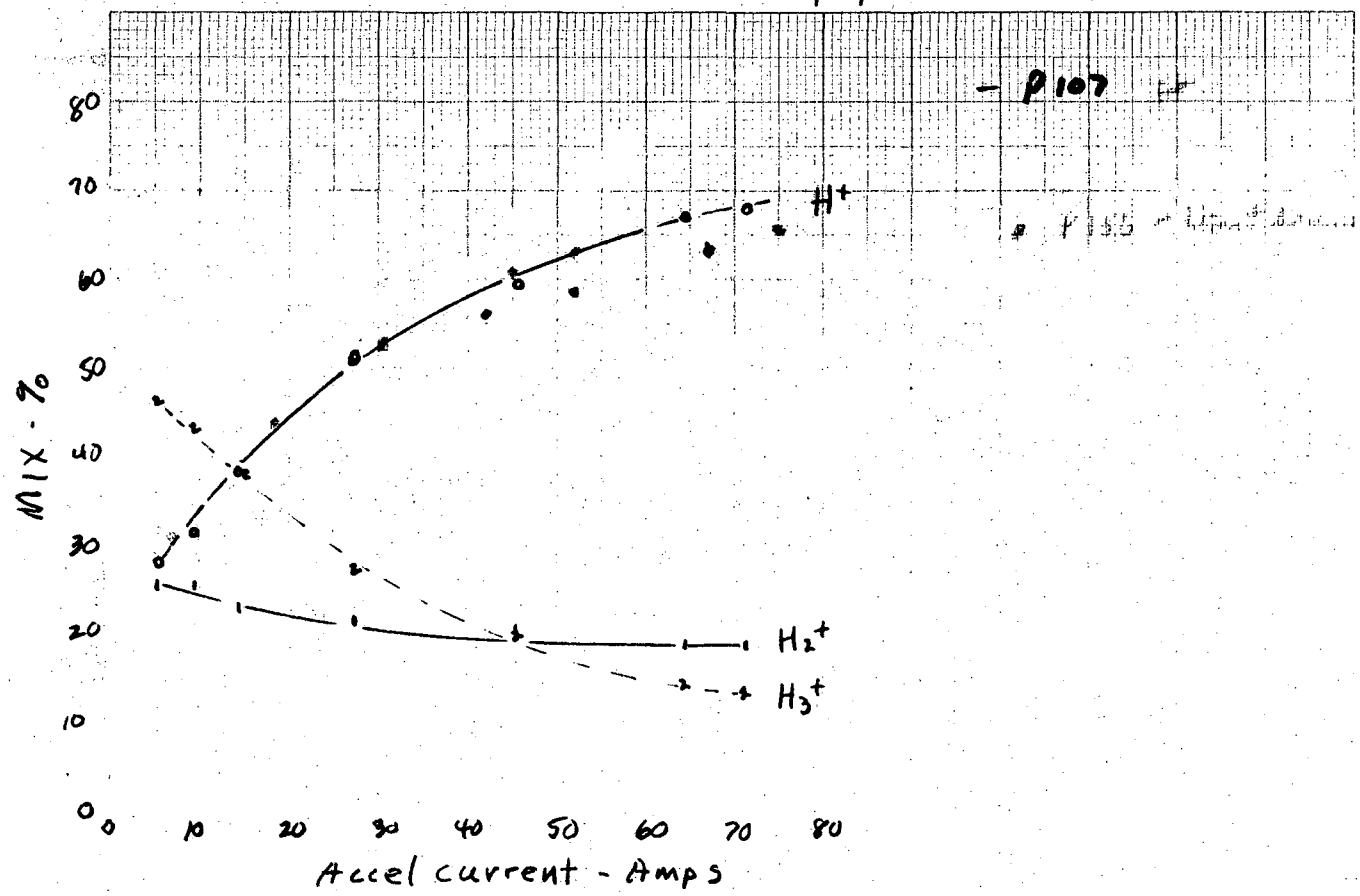

Conditioning TFTRp
KV Vs Shots
Con't
P 4 of 4
Con't Tot Con't 8875
Shots 1135
Total Shots of TFTRp Fils = 10,010
KV
120
110
100
90
80
70
60
50
40
30
20
10
Removal of TFTRp
Switched Gas
D2 → H2
181
182
184
186
188
190
192
194
196
198
200
Shots on TS III B Counter X100

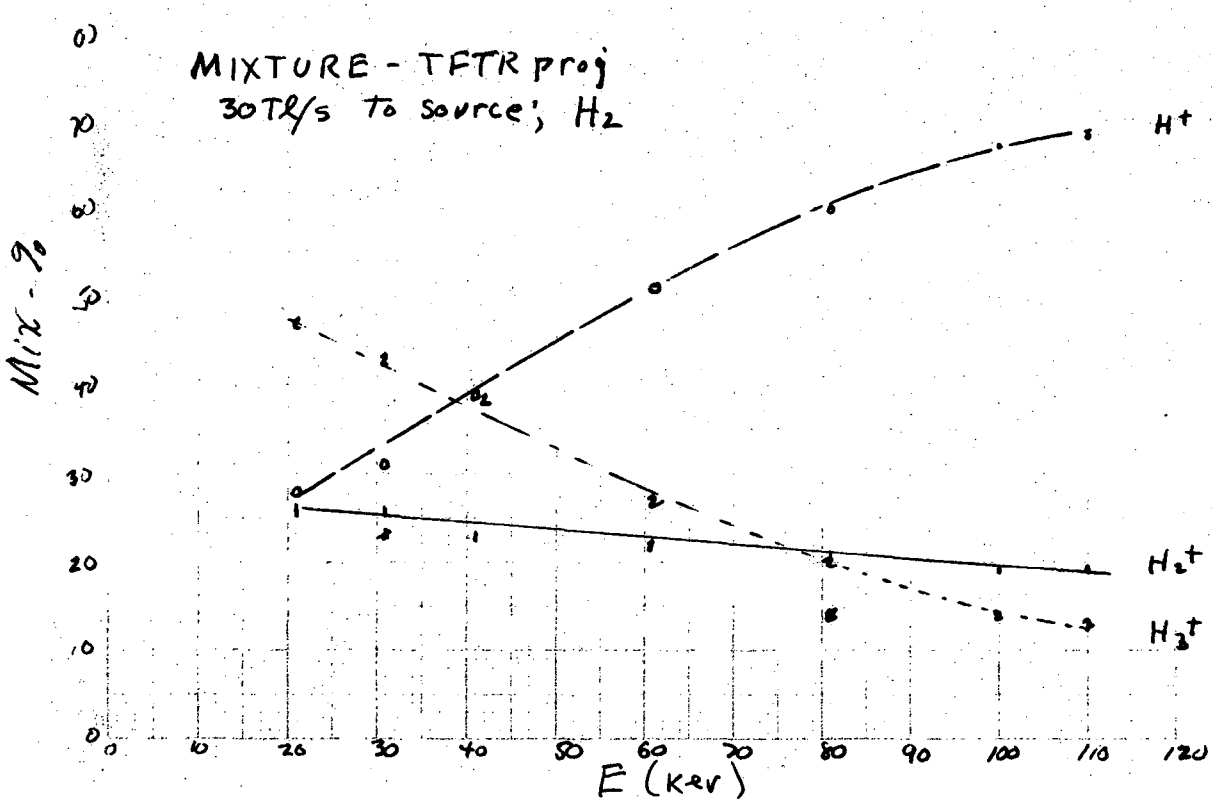
BEAM SPECIES

Spectroscopy Results
April 13, 1979

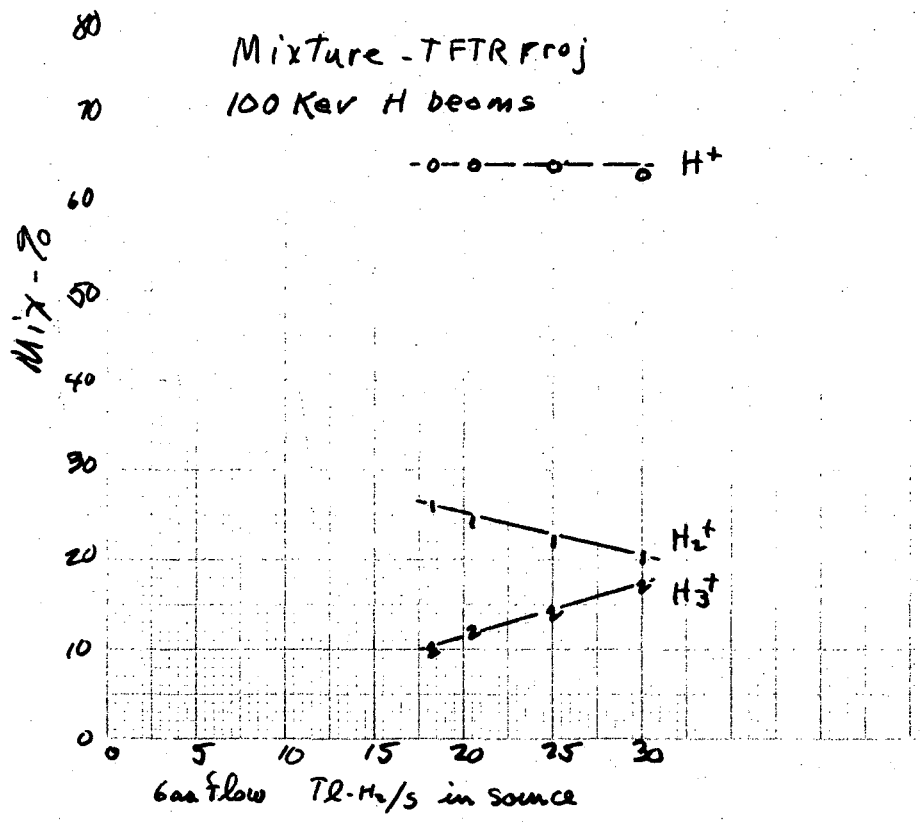
E	I_{accel}	Species		
		D^+	D_2^+	D_3^+
61	18.5	34.9 %	27.3 %	37.8 %
81	30.5	51.5	26.2	22.3
101	44.8	58.8	26.2	15
115	51.8	60.8	26.9	12.3

 3/26/79


- P107
H+
H2+
H3+
MIX - %
Accel current - Amps
0
10
20
30
40
50
60
70
80


MIXTURE - TFTR proj
30Tl/s to source; H2
H+
H2+
H3+
Mix - %
E (kev)
0
10
20
30
40
50
60
70
80
90
100
110
120

3/26/79


Mixture - TFTR proj
100 Kev H beams
H+
H2+
H3+
Mix - %
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Gas flow Tl-H2/s in source

TFTR Project Source - Deuterium Operation
OMA Results on p. 212 Log XIX

Log	Page	Shot	Gas	Flow	I_{arc}	P_{arc}	V_{arc}	V_{Beam}	I/j	D^+	D_2^+	D_3^+
XIX	146	18637	D_2	22	552	16.3	29.6	40	$^{9.4}/_{0.040}$	31.8	23.5	44.7
		18635	"	"	"		"	"	"	31.8	23.1	45.1
										31.8	22.7	45.5
									OMA:			
	148	18651	"	"	985	33.5	34	61	$^{18.5}/_{0.078}$	44.3	28.8	26.9
										44.25	28.9	26.9
		50								44.2	29.0	26.9
	212								OMA:	34.9	27.3	37.8
	150	18662			1522	63.9	42	81	$^{30.5}/_{0.128}$	52.6	26.2	21.2
	212								OMA:	51.5	26.2	22.3
	152	18677			1851	92.6	50	100.8	$^{44.8}/_{0.189}$	61.2	24.8	14.0
		76							"	61.2	25.0	13.8
										61.2	25.2	13.6
	212								OMA:	58.8	26.2	15
	155	18708			1970	102.4	52	116	$^{51.8}/_{0.218}$	63.2	24.1	12.7
								"		63.8	24.0	12.3
										64.3	23.9	11.8
	212								OMA:	60.8	26.9	12.3

44 Slots, Each 10 cm. long x 0.54 cm. wide--

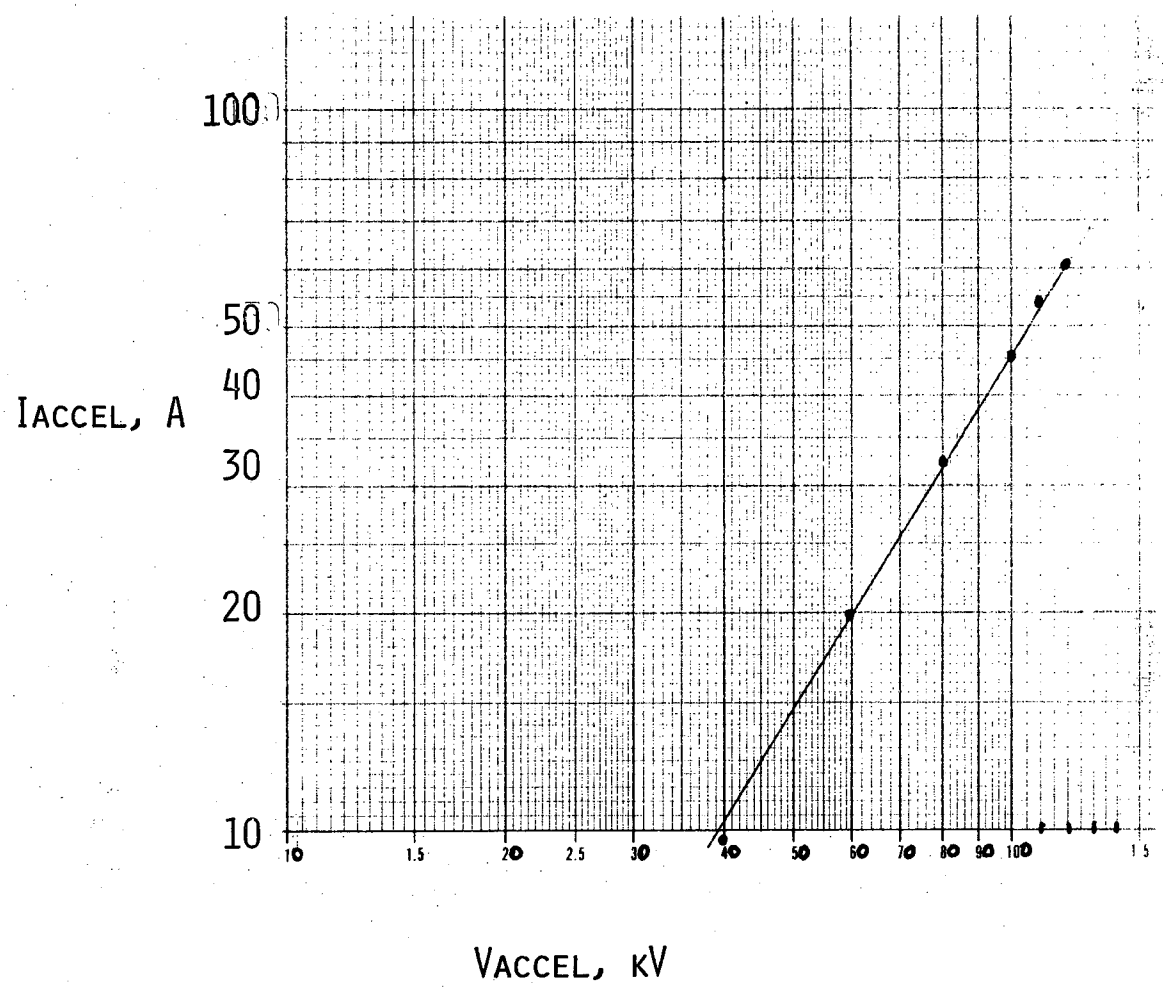
$A_{accelerator} = 44 \times 10 \times 0.54 = 237.6\ cm^2$

5/25/79

D_2 OPERATION

TFTR I_{ACCEL} vs. $V^{3/2}$

D_2 OPERATION

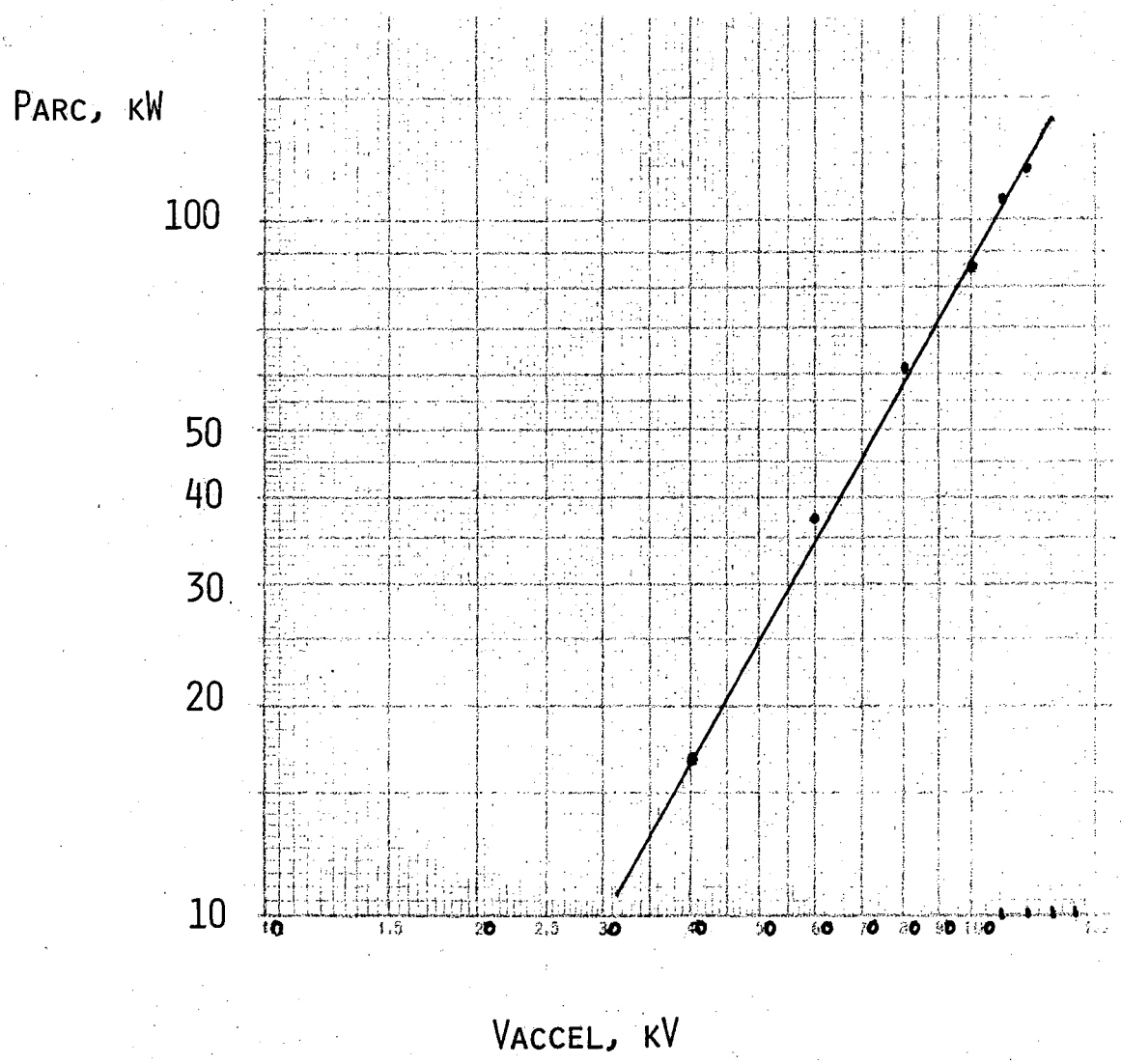


$I_{ACC} = I_{BANK} - I_{DR}$

LOG XIX
p. 300
5/21/79

TFTR VACCEL VS. ARC POWER

22 TL/S D_2 OPERATION

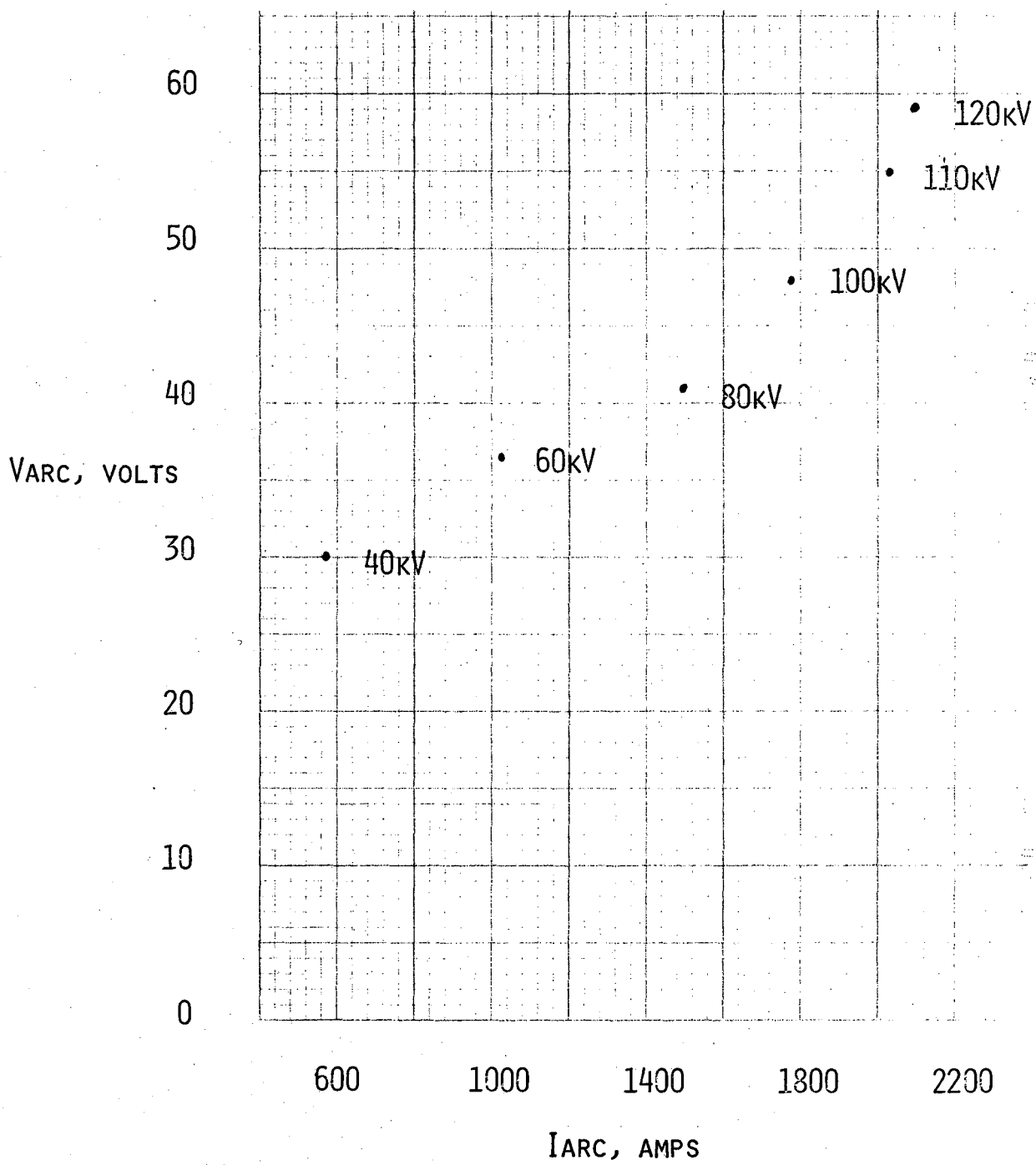


Log XIX
p. 301
5/30/79

TFTR ARC VOLTS VS. ARC AMPS

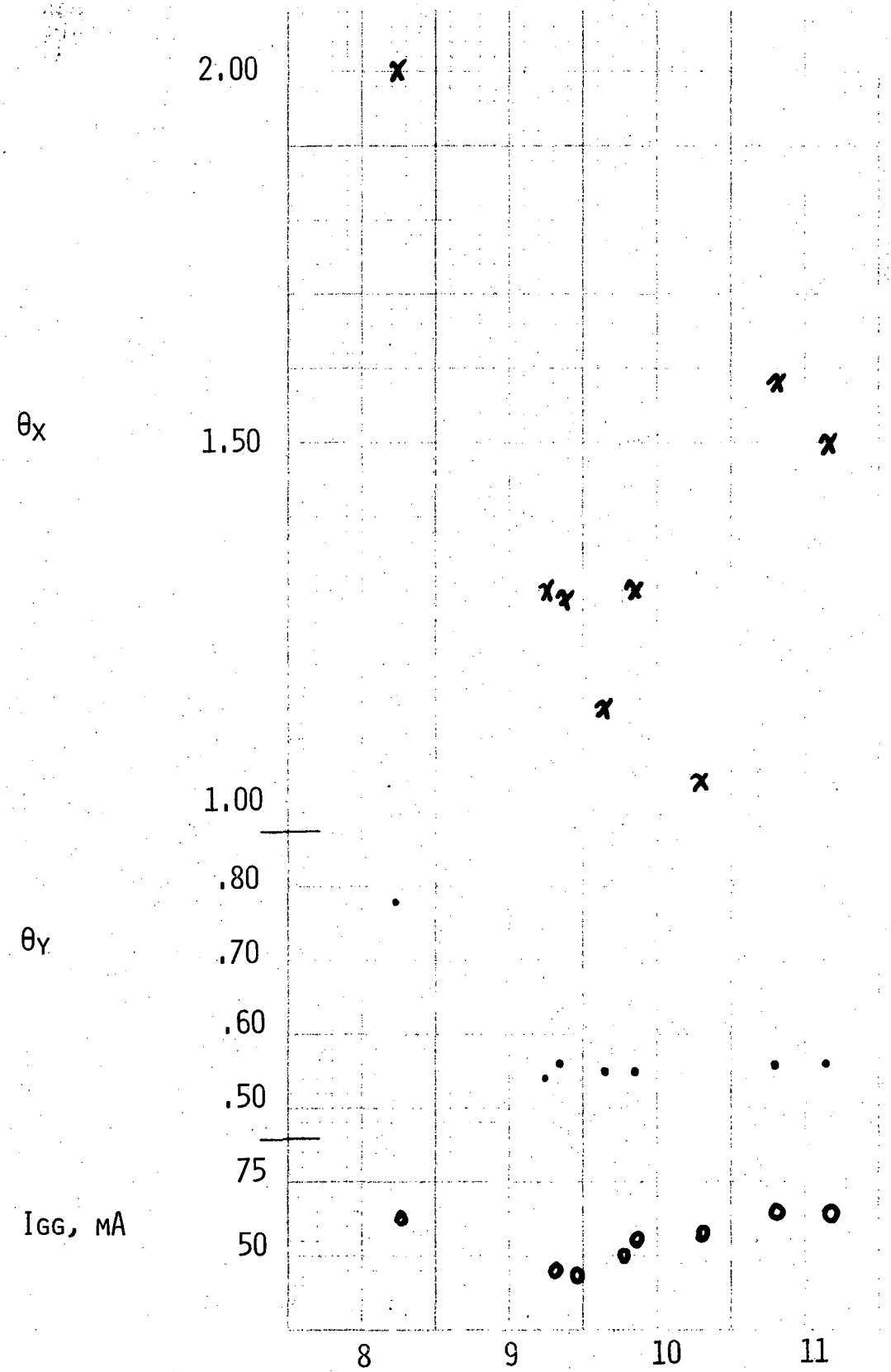
AT OPTIMUN...WITHIN LIMITS OF TELEMETRY INSTABILITIES

22TL/s D_2



LOG XIX
p. 301
5/30/79

TFTR TUNING CURVE FOR 40 kV OPERATION, 22 TL/s D_2

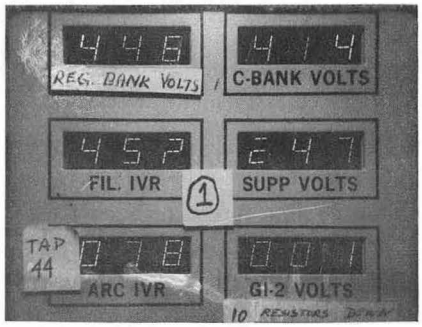


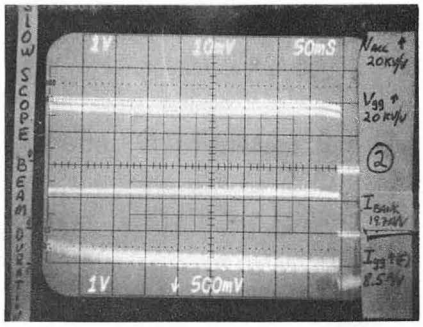
V_{ACC} = 40kV
V_{gg} = 34kV
V_{supp} = 3050V

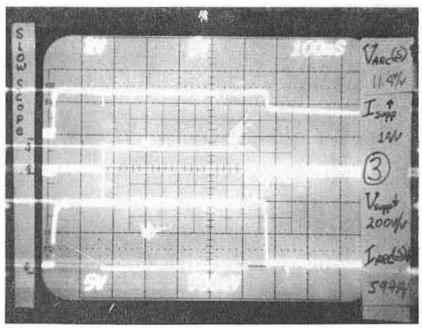
$I_{ACC} = I_{BANK} - I_{DR}$

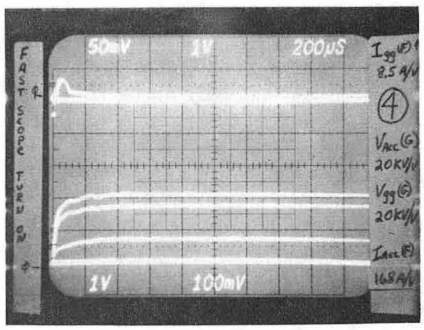
IACCEL, A

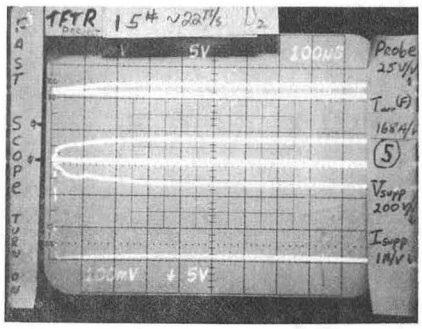
OPTIM JM AT K40 D2

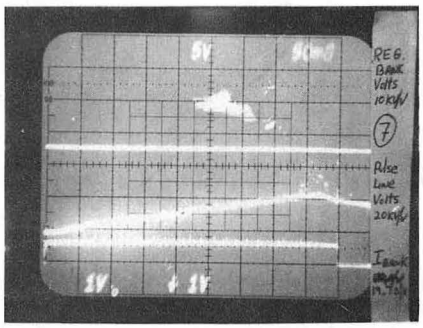


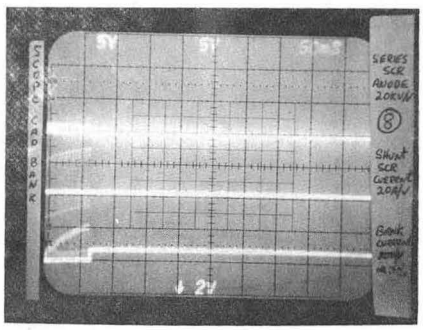


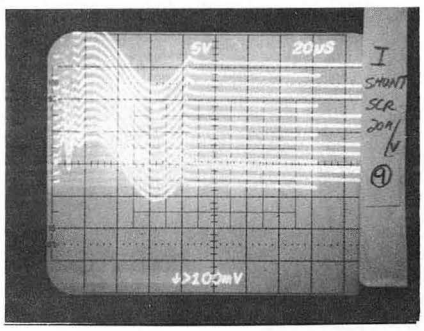


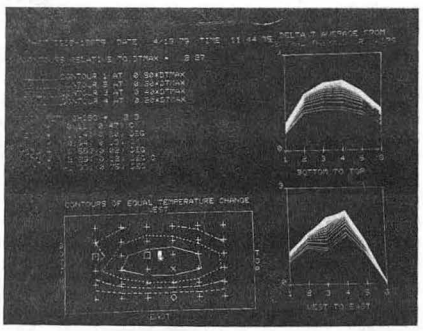


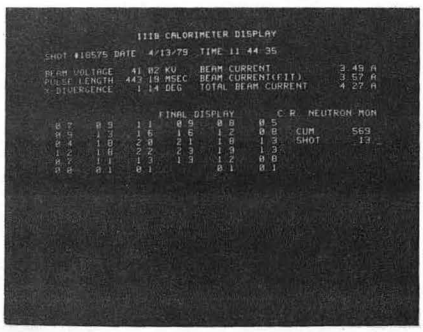












V_{ACC} = 40KV

V_{GG} = 34KV

I_{ACC} = 9.36A

I_{GG} = 50MA

V_{ARC} = 29 6V

I_{ARC} = 597A

P_{ARC} = 17 7KW

V_{SUPP} = 3.0KV

I_{SUPP} = 3A

15# D_2 22 TL/s

I_{DR} = 2.46 A

LOG XIX - III B

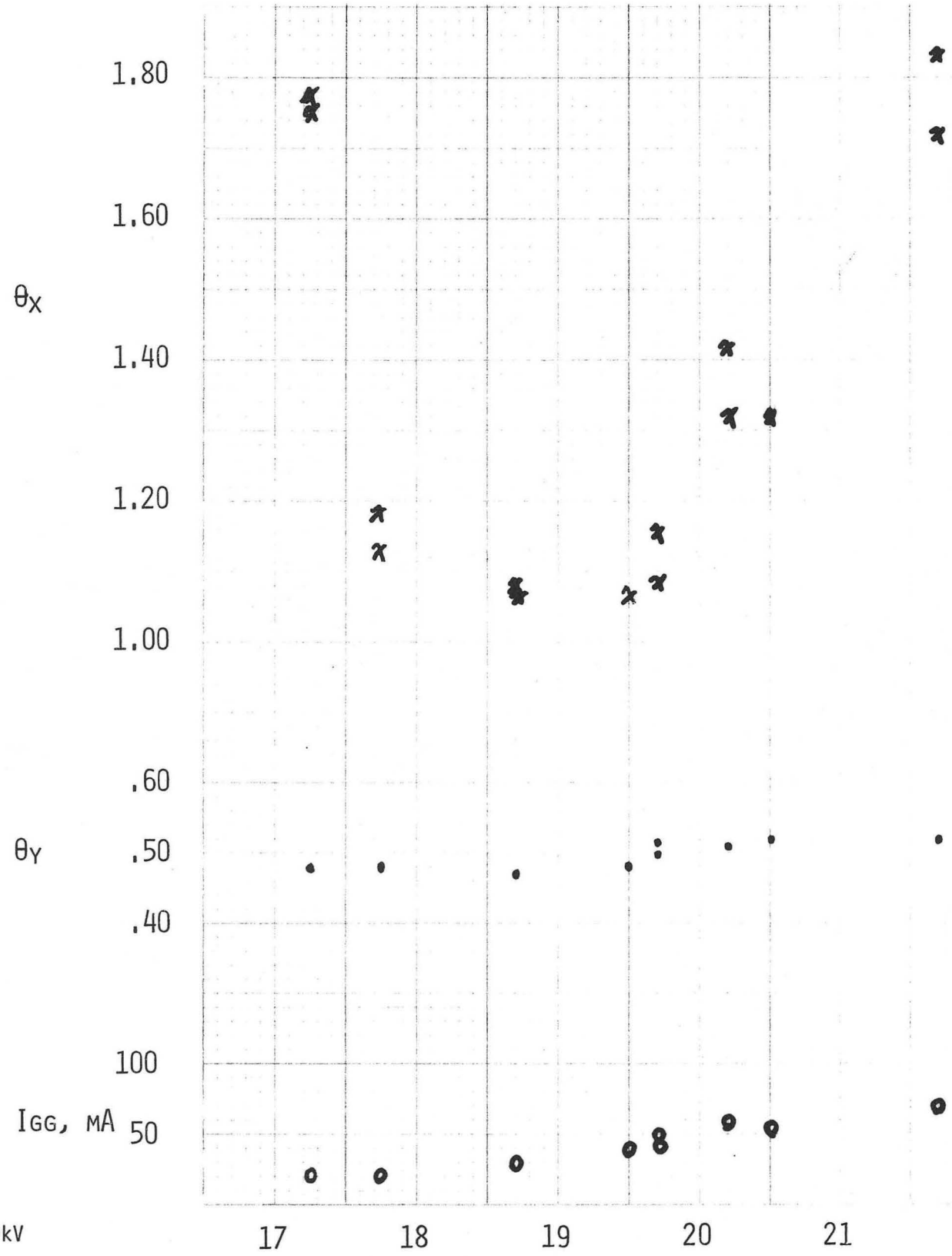
P. 138

NOTE:

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

TFTR TUNING CURVE FOR 60 kV OPERATION, 22 TL/s D_2

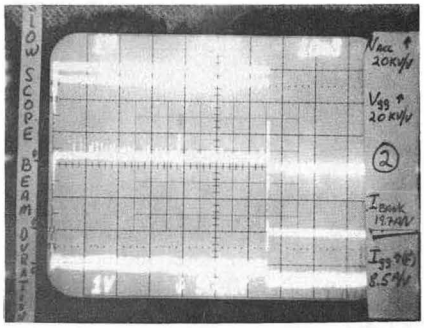


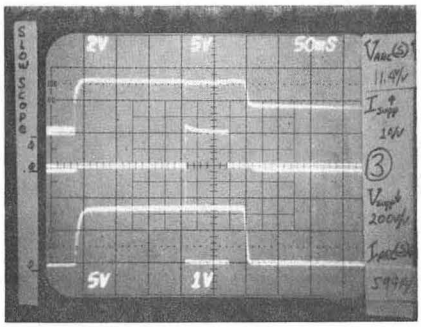
V_{ACC} = 60kV
V_{gg} = 52kV
V_{supp} = 3000V

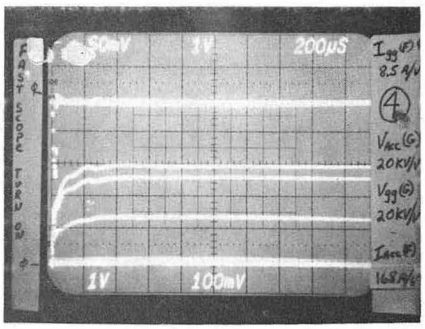
$I_{ACC} = I_{BANK} - I_{DR}$

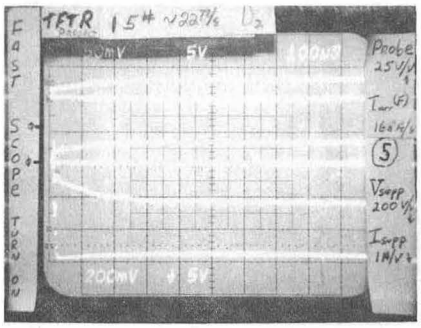
LOG XIX
p. 130

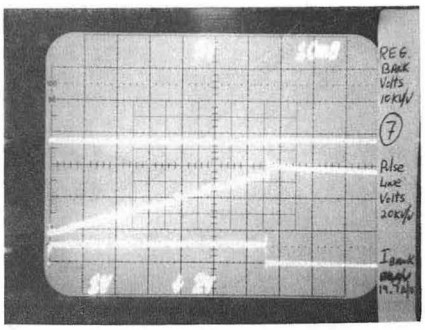
OPTIMUM AT K60 D2

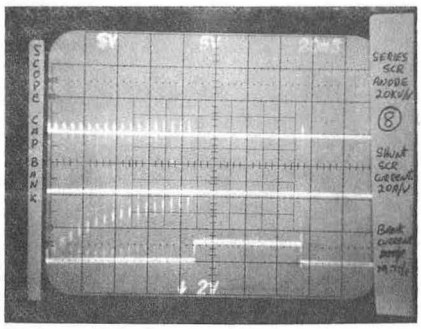


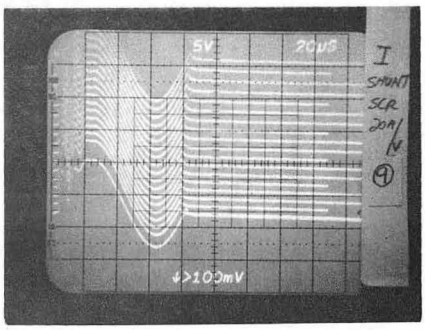


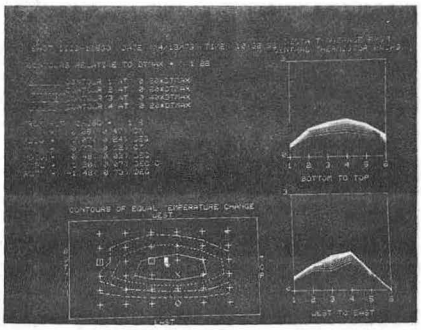


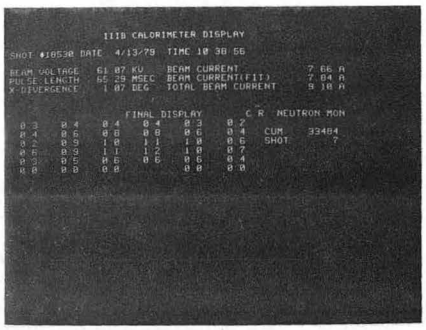












V_{ACC} = 60KV

V_{GG} = 52KV

I_{ACC} = 19 7A

I_{GG} = 42MA

V_{ARC} = 36.5V

I_{ARC} = 1015A

P_{ARC} = 37KW

V_{SUPP} = 3 0KV

I_{SUPP} = 5.5A

15# D_2 22 TL/s

I_{DR} = 3.94 A

LOG XIX - IIIB

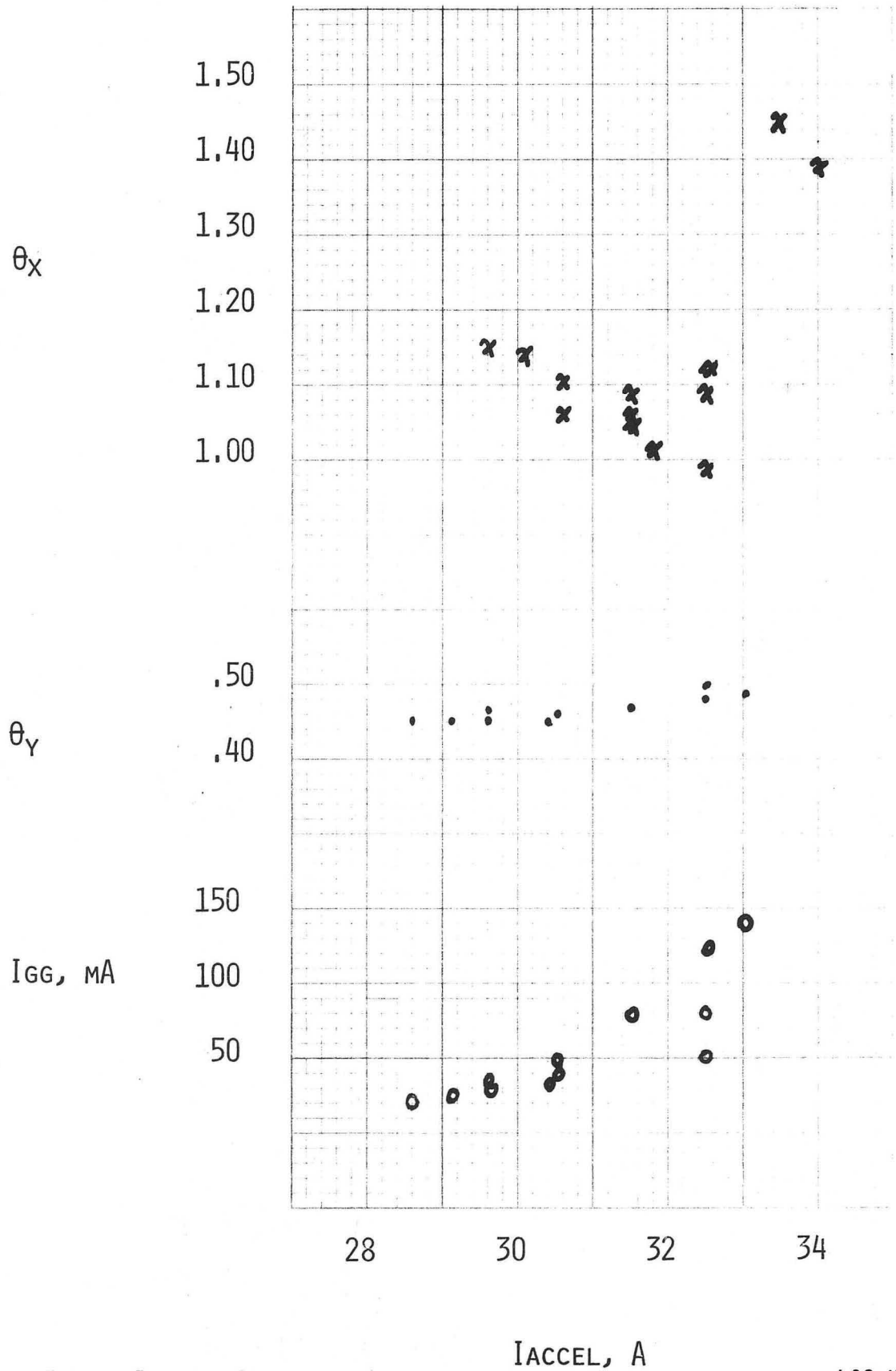
P. 130

NOTE.

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

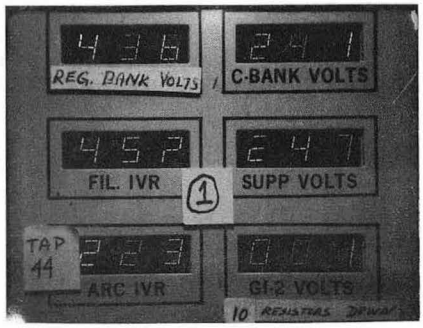
TFTR TUNING CURVE FOR 80 kV OPERATION, 22 TL/s D_2

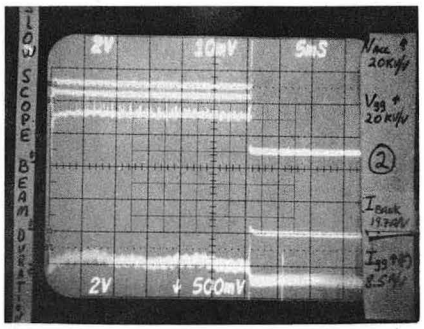


V_{ACC} = 81kV
V_{gg} = 72kV
V_{supp} = 2900V

$I_{ACC} = I_{BANK} - I_{DR}$

OPTIMUM AT K80 D2



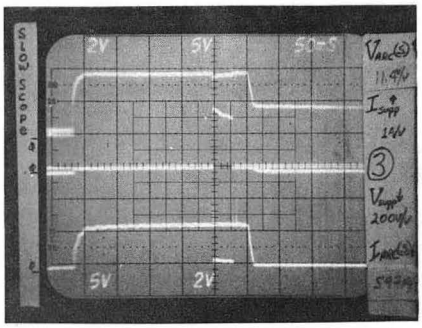


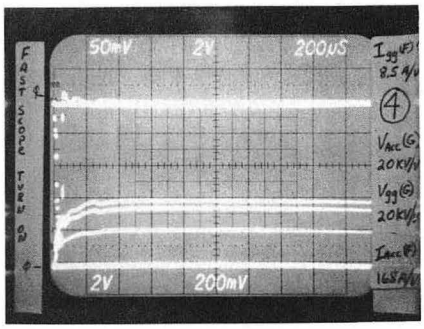
V_{ACC} = 82 KV

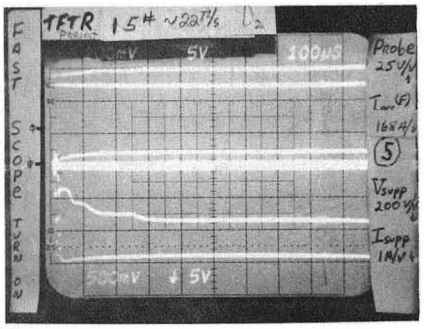
V_{GG} = 68 KV

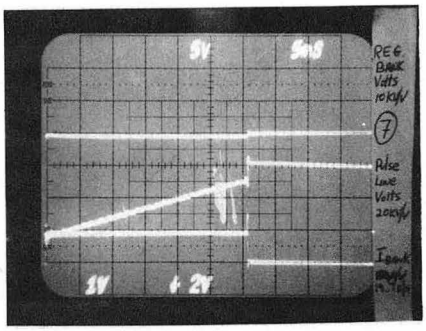
I_{ACC} = 32.5 A

I_{GG} = 50 MA





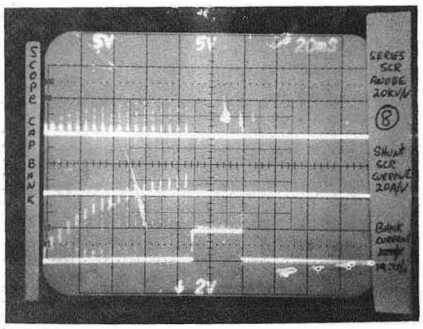


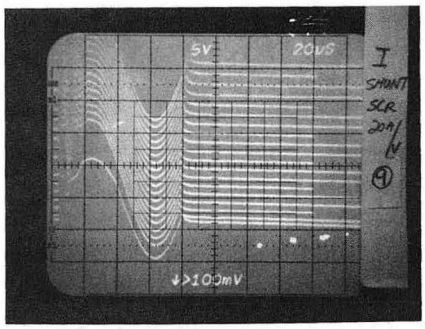


V_{ARC} = 41 V

I_{ARC} = 1552 A

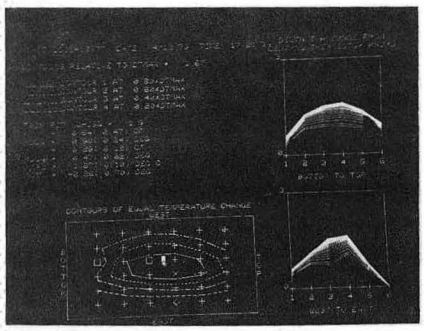
P_{ARC} = 63.6 KW

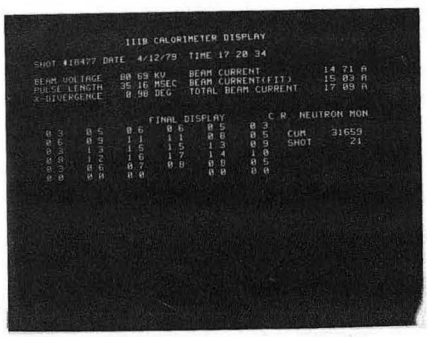




V_{SUPP} = 2950 V

I_{SUPP} = 8 A





15# D_2 22 TL/s

I_{DR} = 4.93 A

LOG XIX - III B

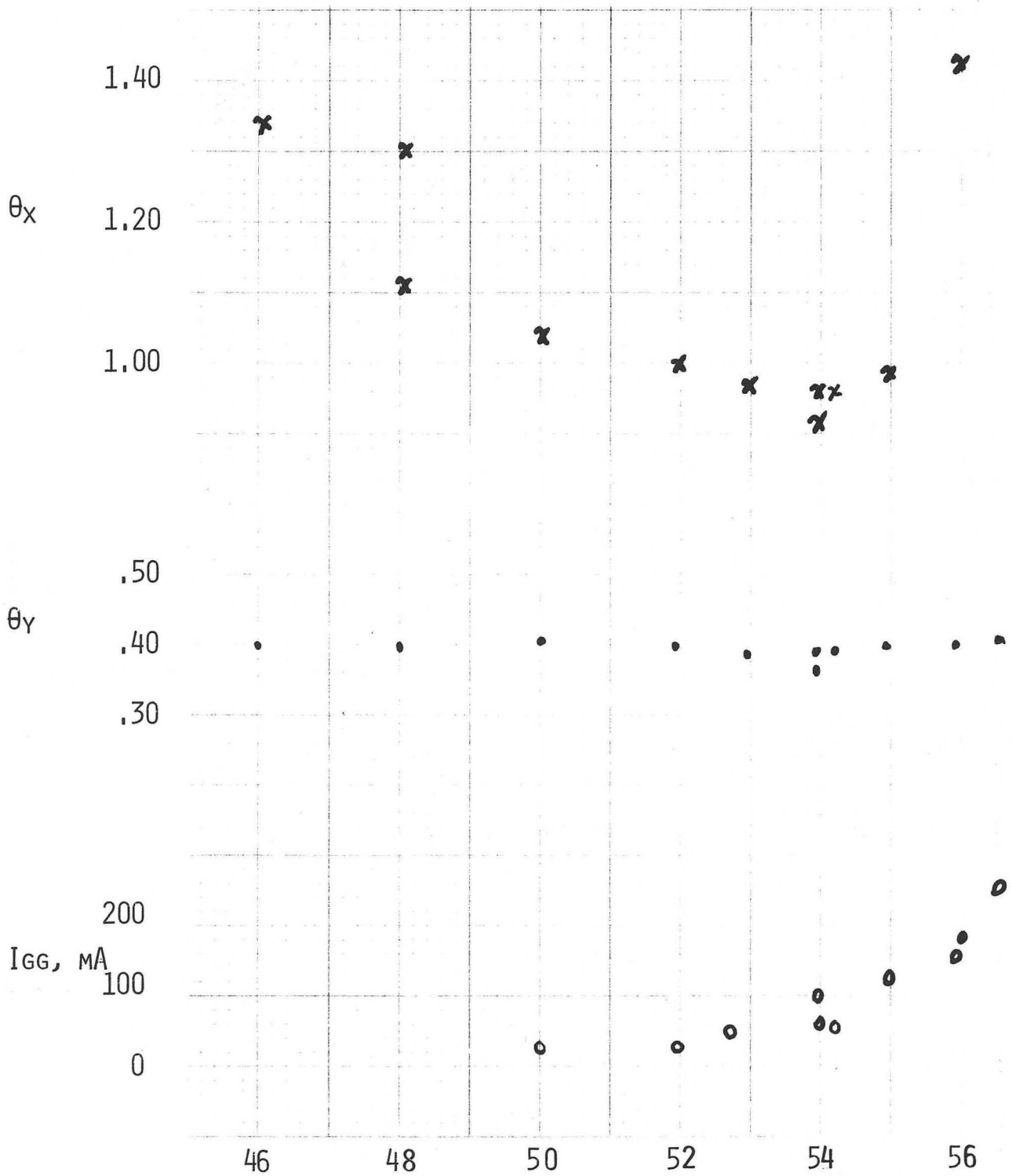
P. 116

NOTE.

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

TFTR TUNING CURVE FOR 110 kV OPERATION, 22 TL/s D_2



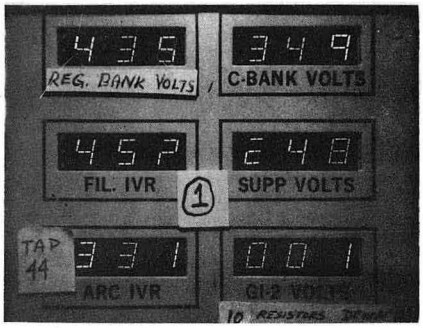
V_{ACC} = 112kV
V_{gg} = 94kV
V_{supp} = 2800V

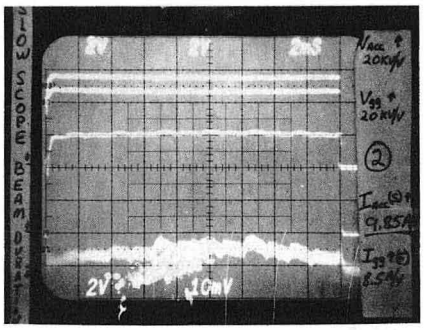
IACCEL, A

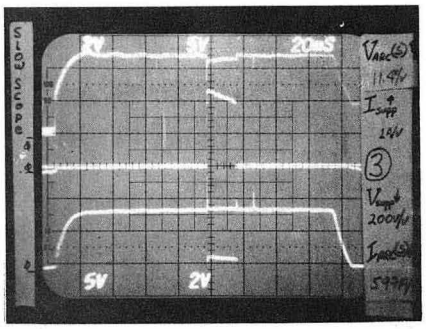
$I_{ACC} = I_{BANK} - I_{DR}$

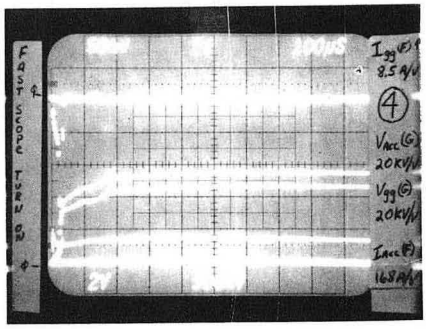
LOG XIX
p. 66
4/11/79

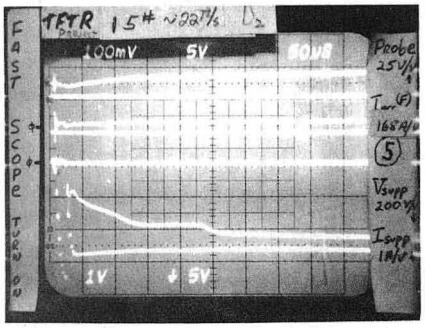
OPTIMUM AT K110 D2

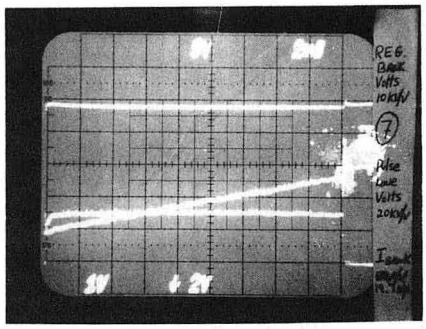


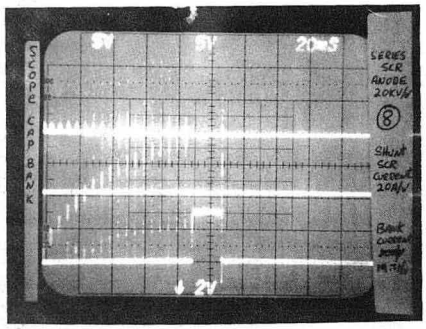


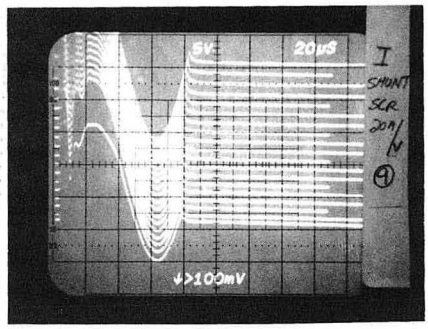


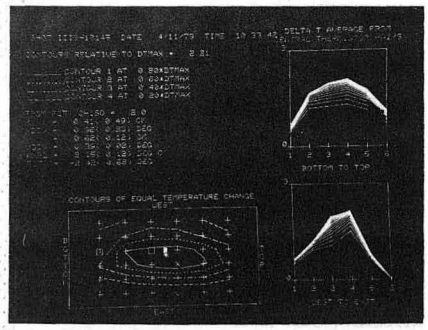


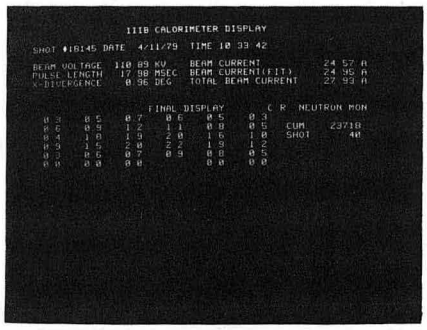












V_{ACC} = 112 KV

V_{GG} = 94 KV

I_{ACC} = 54 2 A

I_{GG} = 50 MA

V_{ARC} = 54 7 V

I_{ARC} = 2030 A

P_{ARC} = 111 KW

V_{SUPP} = 2900 V

I_{SUPP} = 10 5 A

15# D_2 22 TL/s

I_{DR} = 6.9 A

LOG XIX - III B

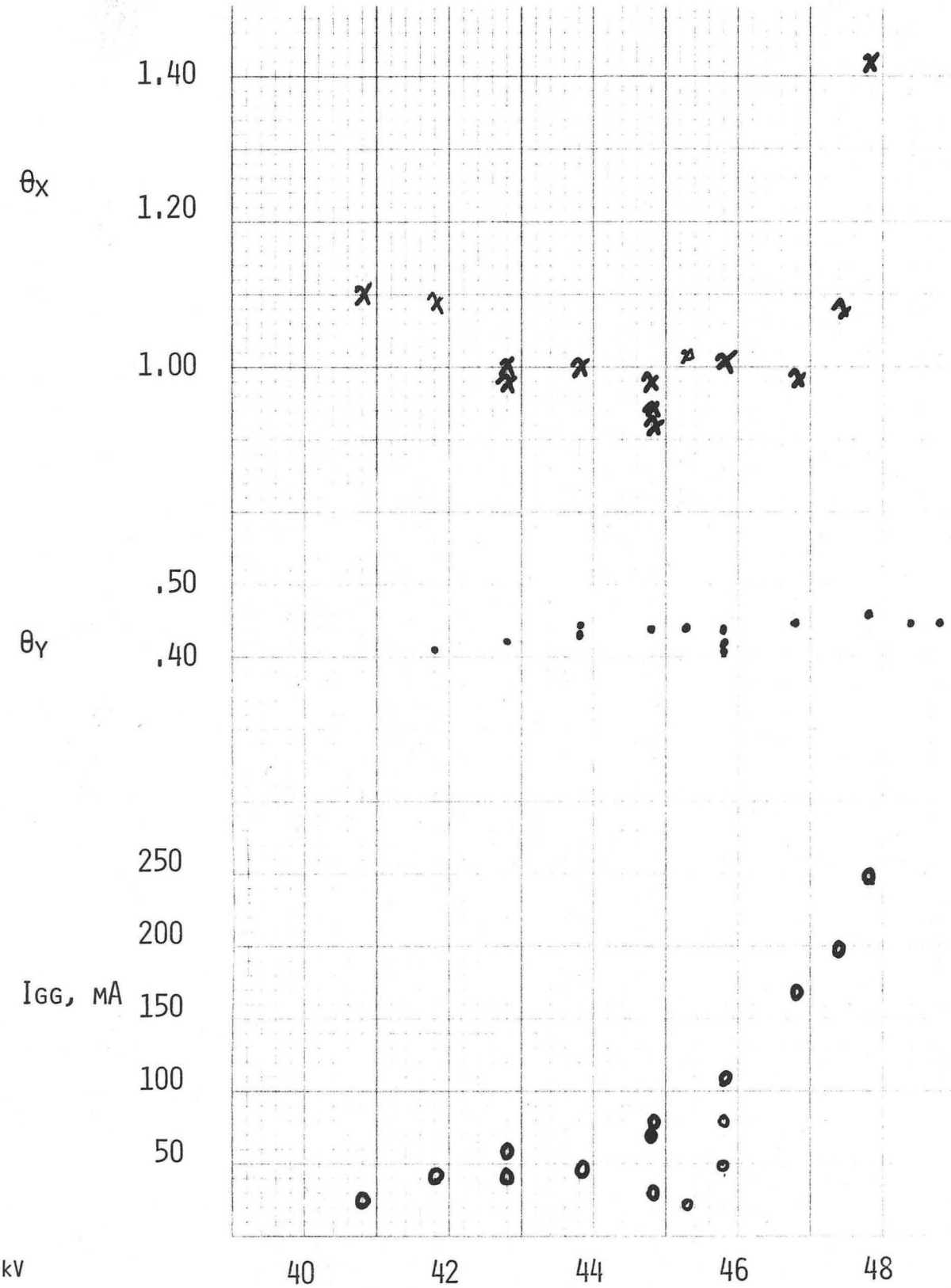
P. 64

NOTE:

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

TFTR TUNING CURVE FOR 100 kV OPERATION, 22 TL/s D_2

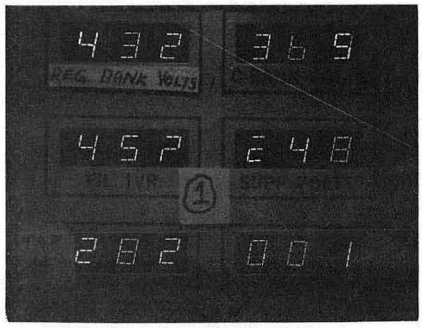


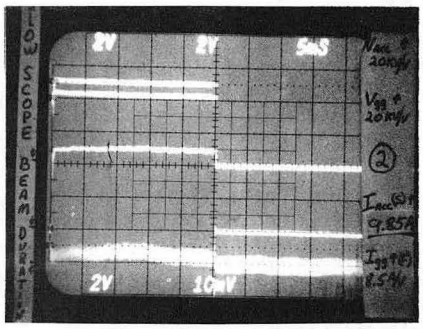
V_{ACC} = 101kV
V_{gg} = 86kV
V_{supp} = 2.9kV

$I_{ACC} = I_{BANK} - I_{Dr}$

LOG XIX
p. 105

OPTIMUM AT K100 D2



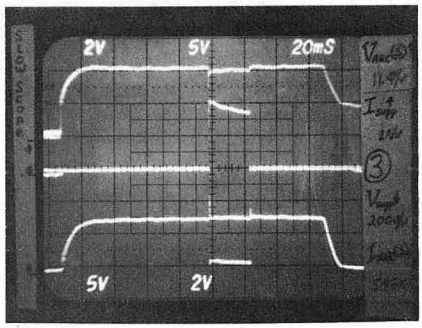


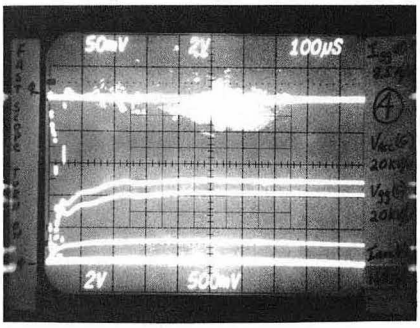
V_{ACC} = 100KV

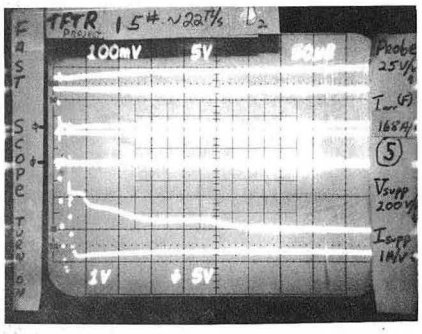
V_{GG} = 84KV

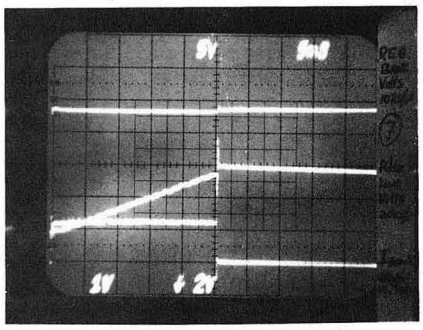
I_{ACC} = 45.3A

I_{GG} = 20MA





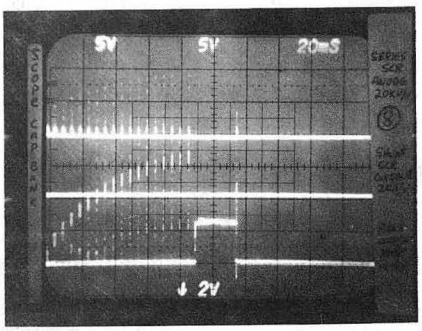


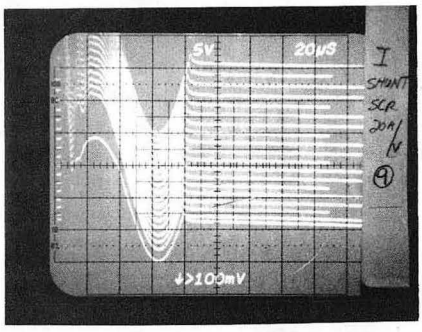


V_{ARC} = 48V

I_{ARC} = 1791A

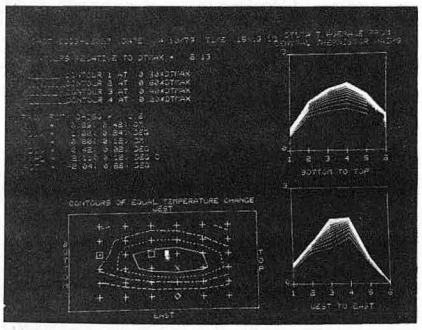
P_{ARC} = 85.9KW

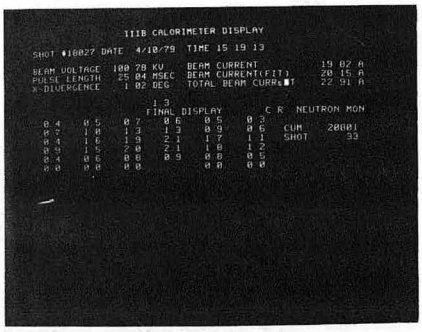




V_{SUPP} = 2950V

I_{SUPP} = 9.5A





15# D_2 22 TL/s

I_{DR} = 5.92 A

LOG XIX - IIIB

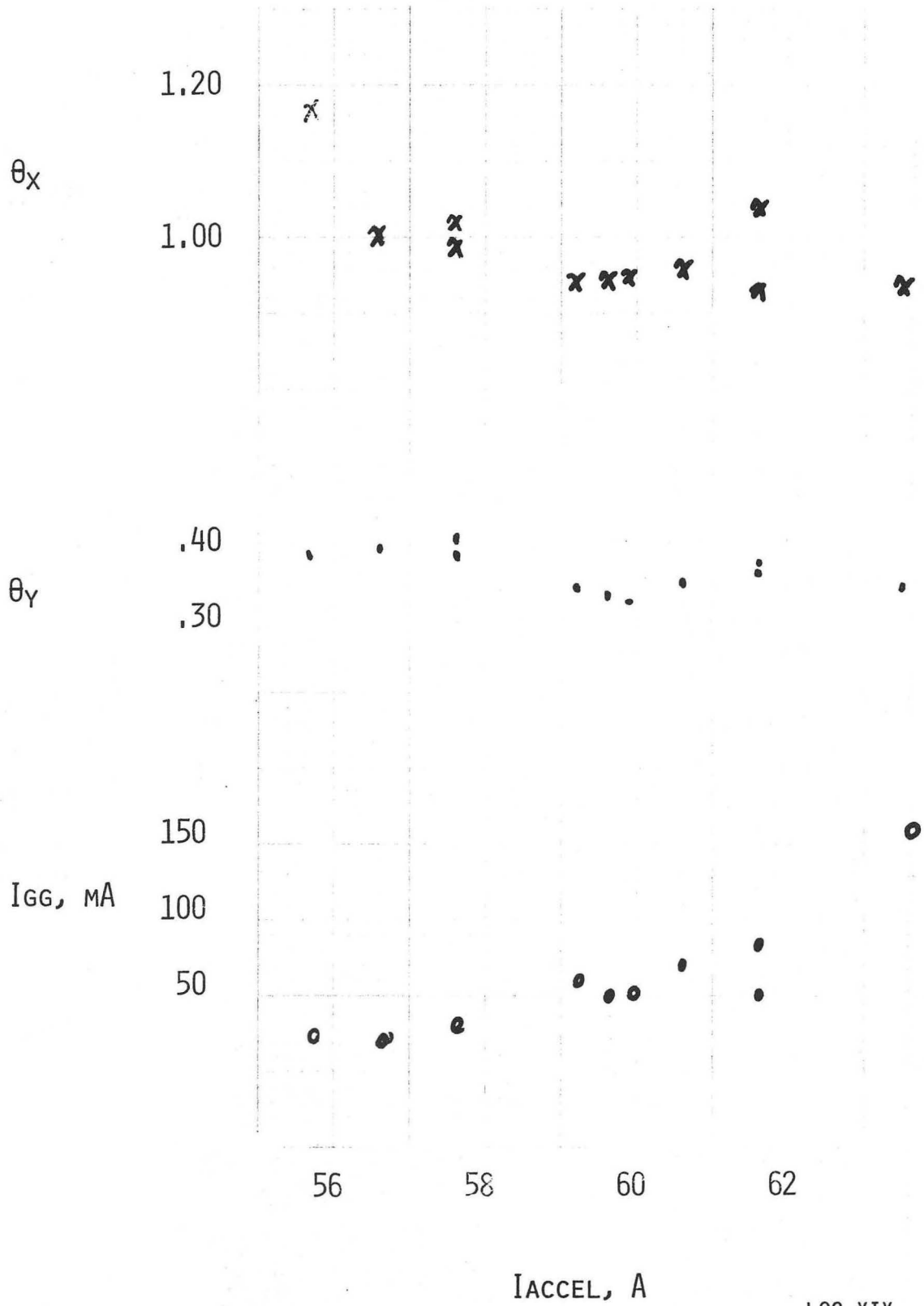
P. 43

NOTE:

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCUIATIONS

TFTR TUNING CURVE FOR 120 kV OPERATION, 22 TL/s D_2

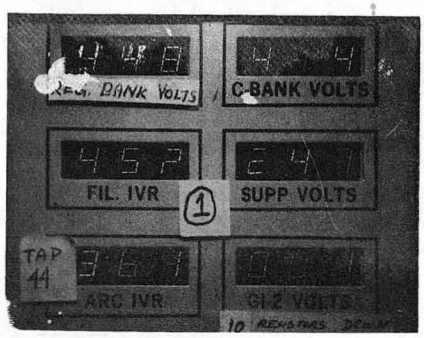


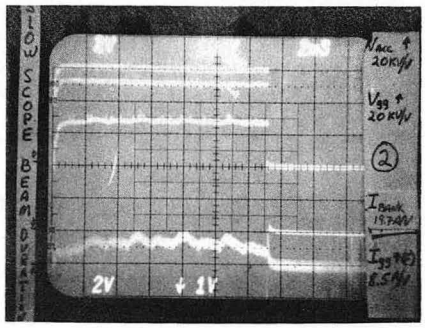
V_{SUPP} = 2800V
V_{ACC} = 121kV
V_{gg} = 104kV

$I_{ACC} = I_{BANK} - I_{DR}$

LOG XIX
p. 94

OPTIMUM AT K120 D2



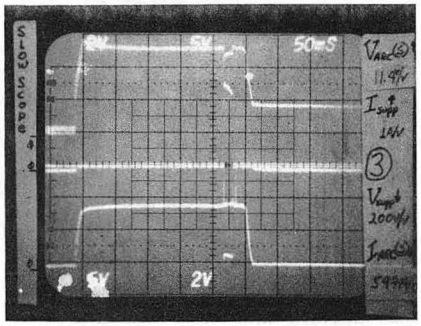


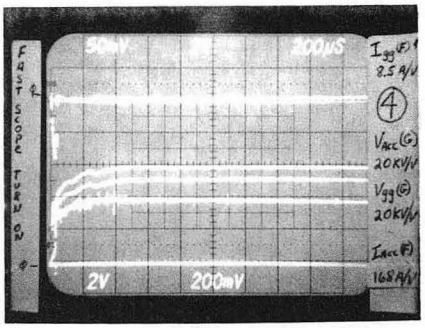
V_{ACC} = 120KV

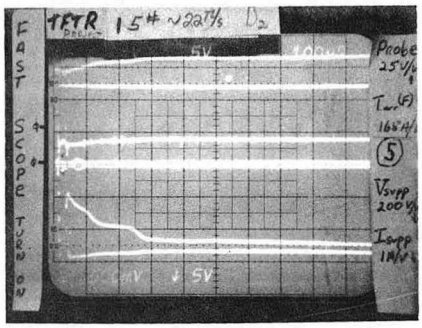
V_{GG} = 104KV

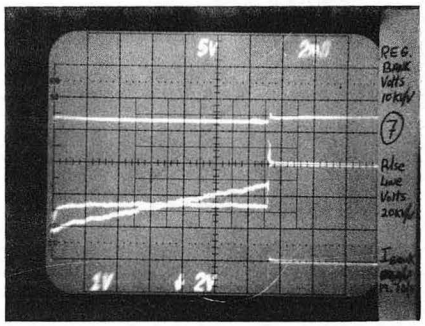
I_{ACC} = 61.5A

I_{GG} = 50 MA





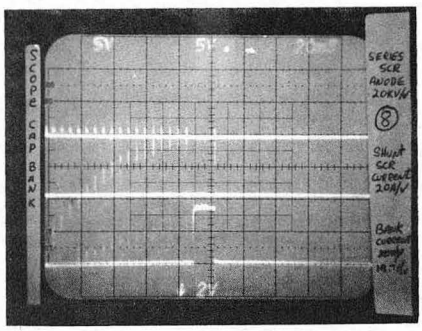


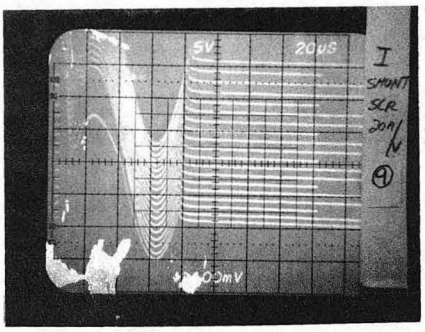


V_{ARC} = 52V

I_{ARC} = 2149A

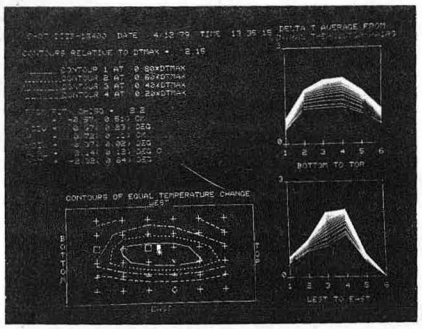
P_{ARC} = 111.7KW

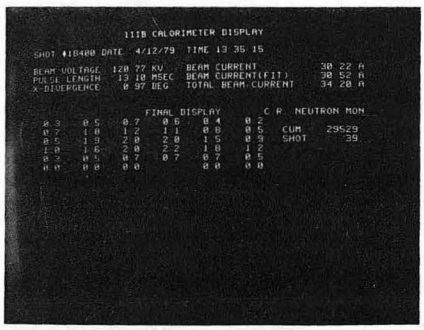




V_{SUPP} = 2900V

I_{SUPP} = 11.5A





15# D_2 22 TL/s

I_{DR} = 7.39 A

LOG XIX - III B

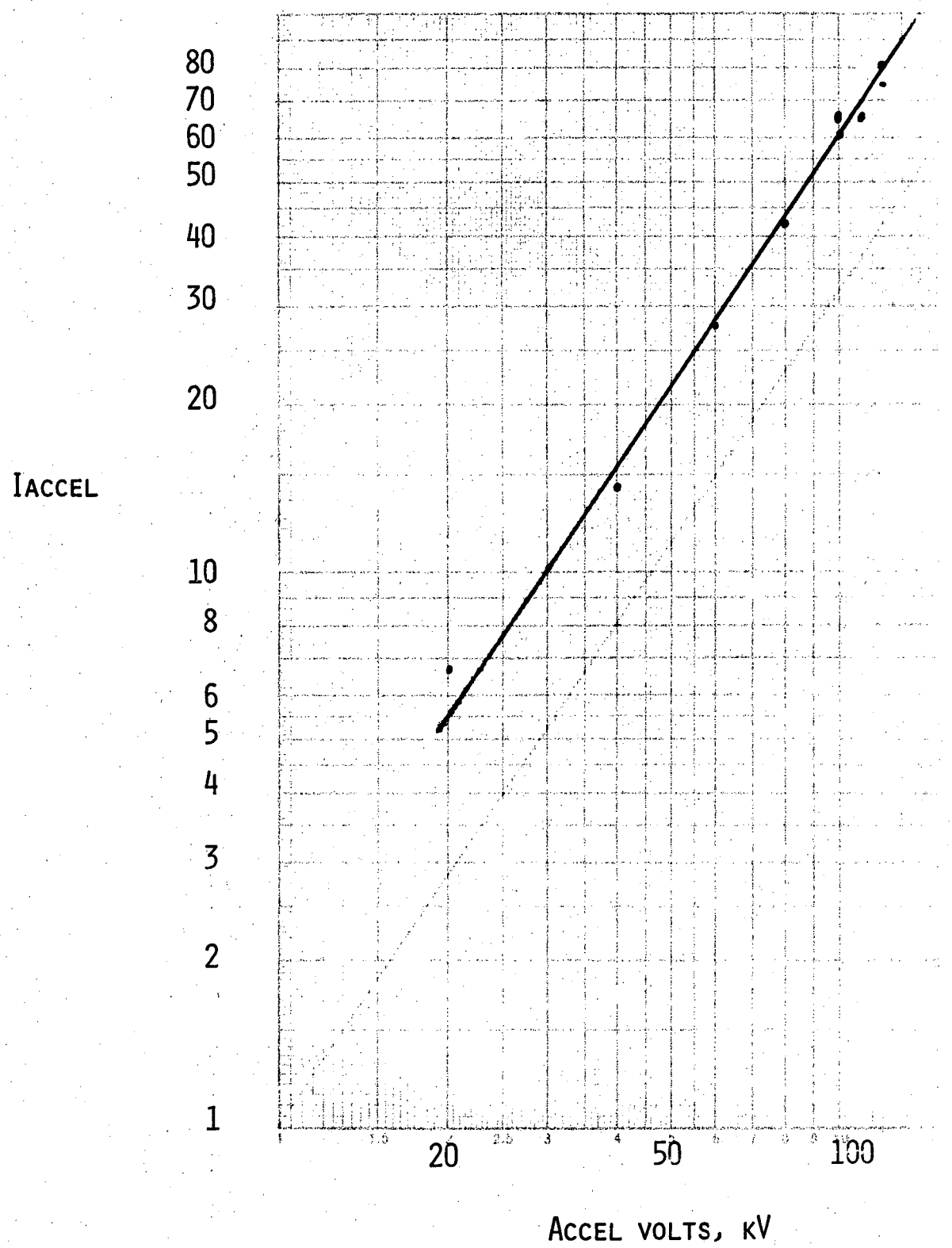
P. 97

NOTE: $I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

H_2 OPERATION

TFTR IACCEL VS. $V^{3/2}$, H_2 OPERATION

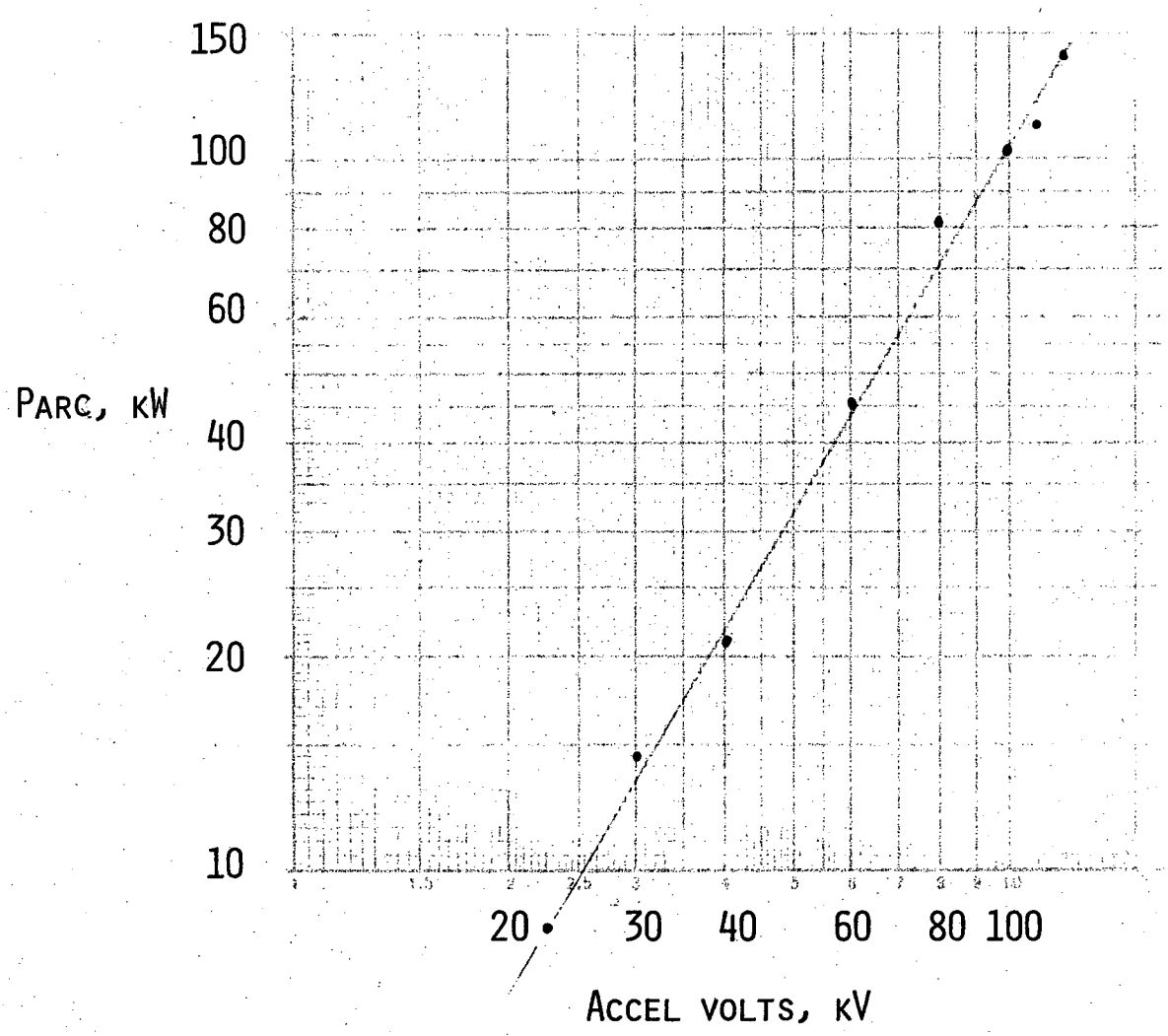


$I_{ACC} = I_{BANK} - I_{DR}$

LOG XIX
p. 300
5/21/79

TFTR ACCEL VOLTS VS. ARC POWER

30 TL/s H_2



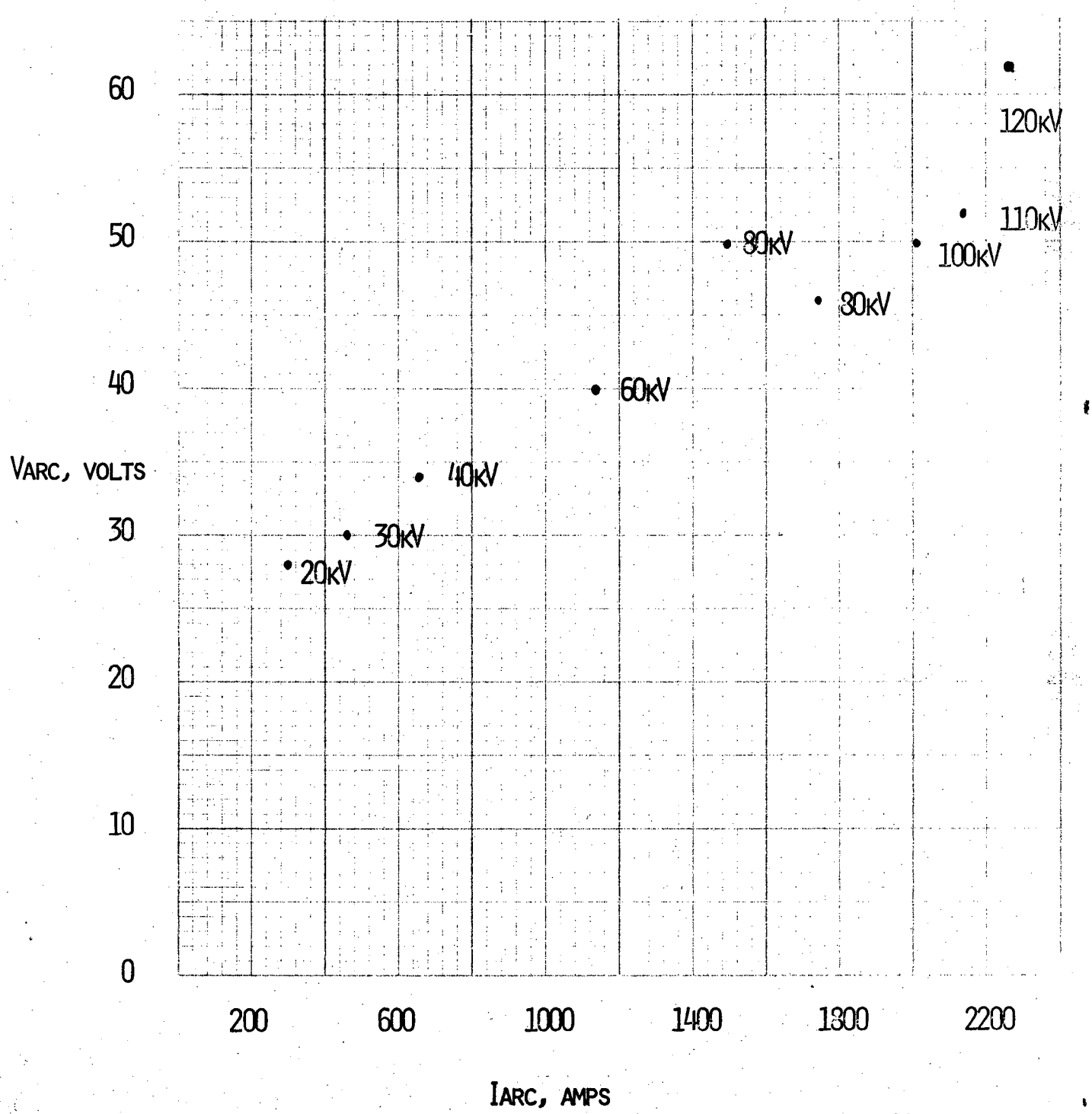
$I_{ACC} = I_{BANK} - I_{DR}$

LOG XIX
p. 301
5/30/79

TFTR ARC VOLTS VS. ARC AMPS

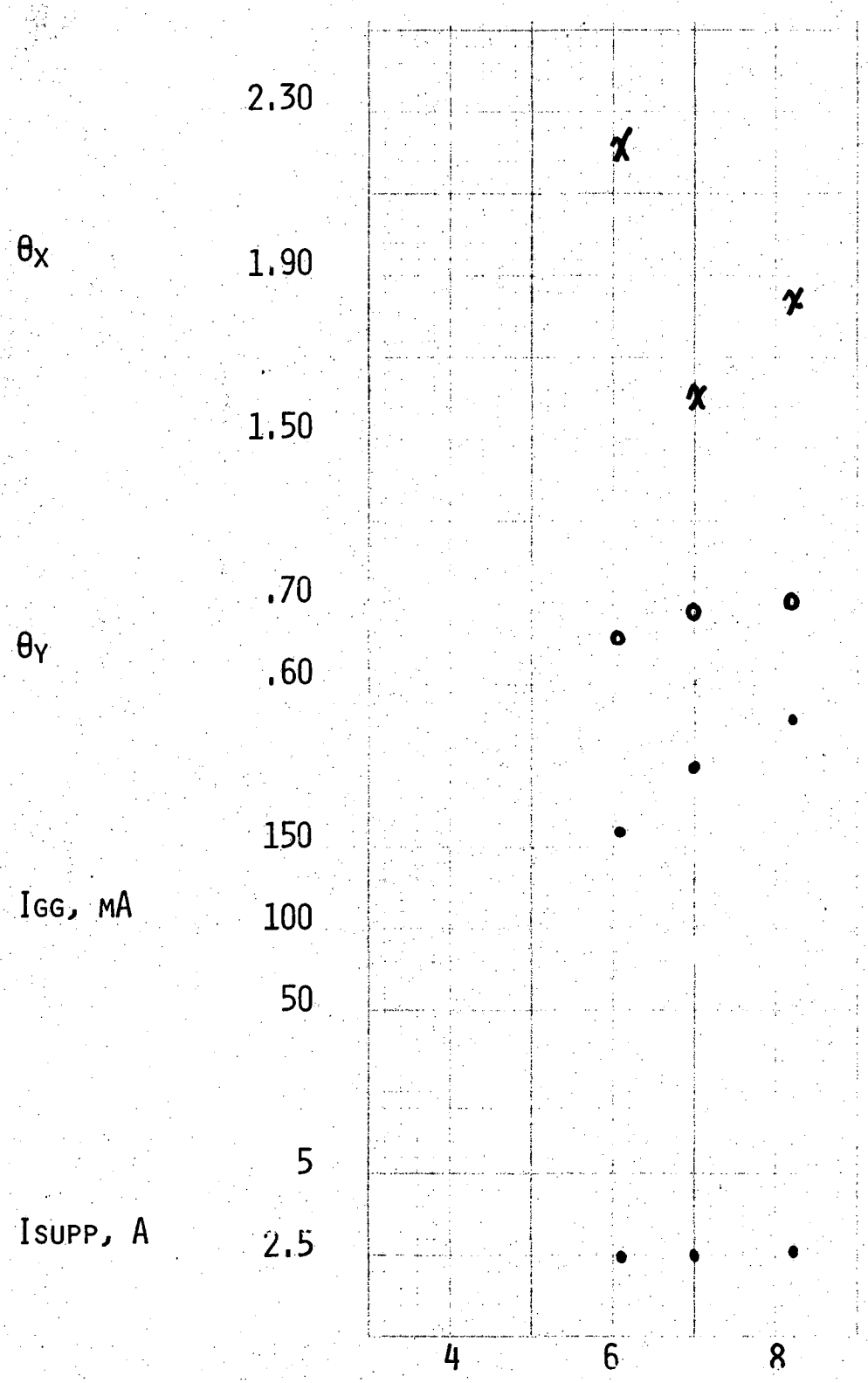
AT OPTIMUM...WITHIN LIMITS OF TELEMETRY INSTABILITIES

30 TL/S H_2



LOG XIX
p. 300
5/30/79

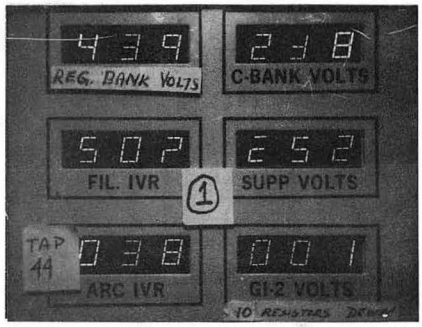
TFTR TUNING CURVE FOR 20 kV OPERATION, 30TL/s H_2

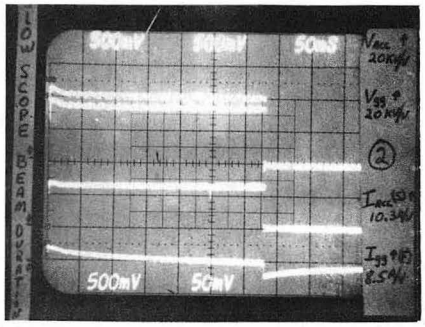


V_{ACC} = 21kV
V_{gg} = 18kV
V_{supp} = 3100V

$I_{ACC} = I_{BANK} - I_{DR}$

OPTIMUM AT K20 H2



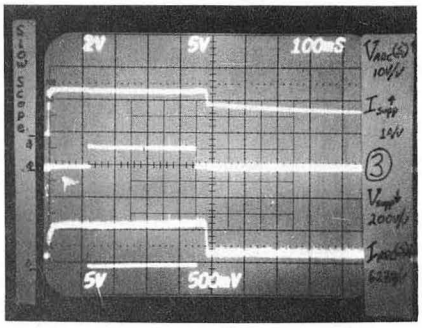


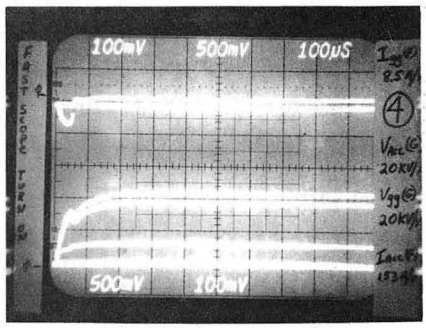
V_{ACC} = 22KV

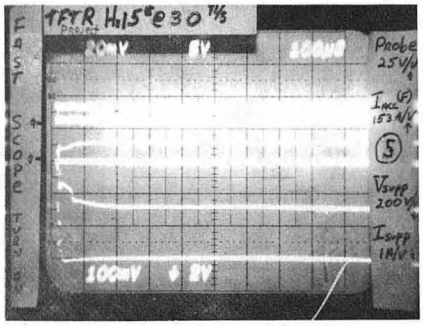
V_{GG} = 17.5KV

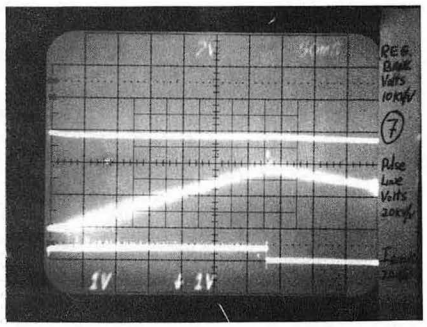
I_{ACC} = 6.8A

I_{GG} = 200MA





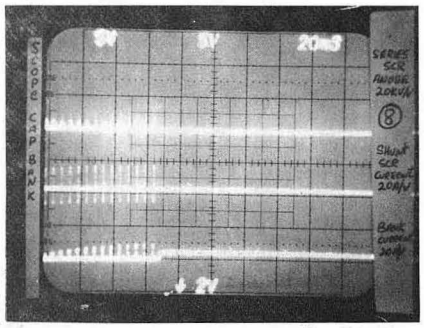


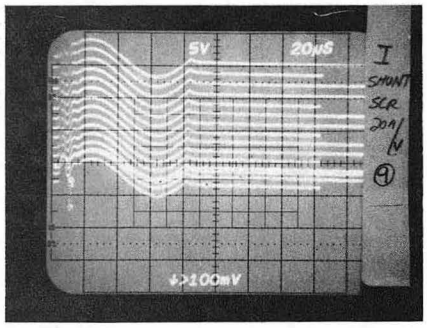


V_{ARC} = 26V

I_{ARC} = 329A

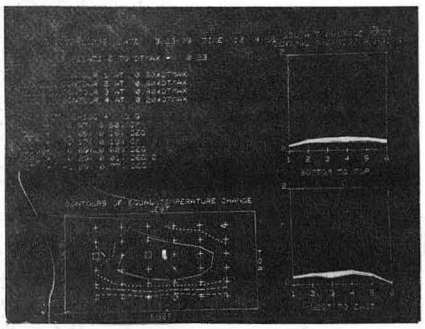
P_{ARC} = 8.5KW

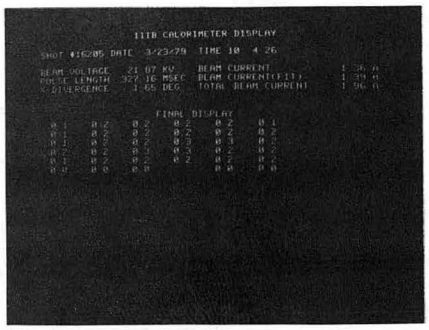




V_{SUPP} = 3100V

I_{SUPP} = 2.5A





15# H_2 30 TL/s

I_{DR} = 1.12 A

LOG XVIII IIIB

P.113

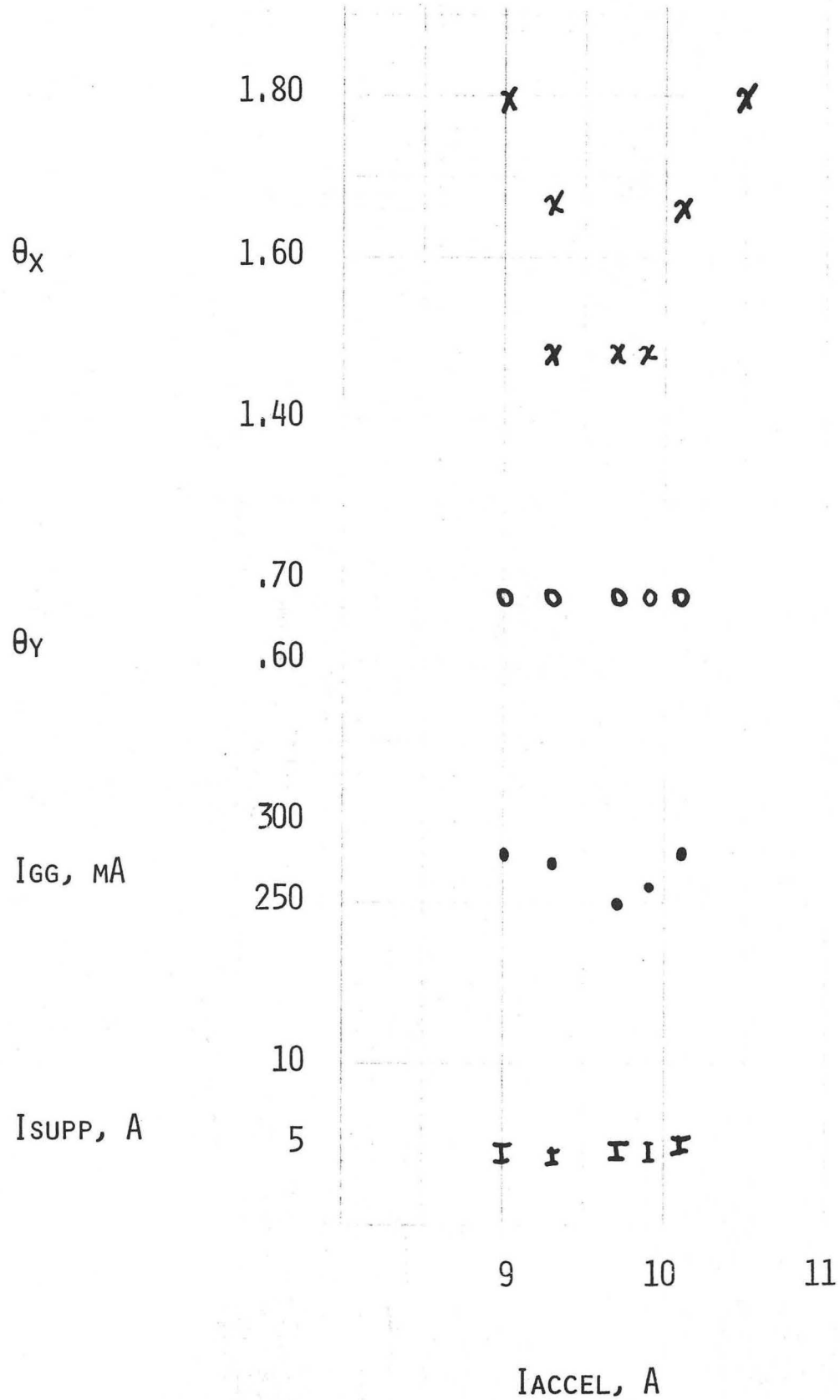
W/O NOTCHEN

NOTE.

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

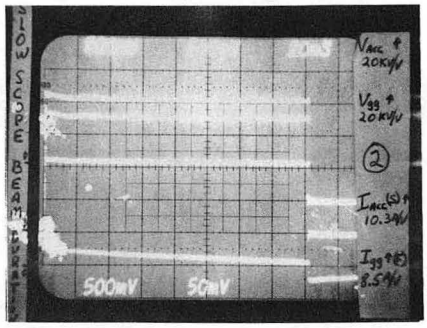
TFTR TUNING CURVE FOR 30 kV OPERATION, 30TL/s H_2



V_{ACC} = 31kV
V_{gg} = 25kV
V_{supp} = 3000V

LOG XVIII
p. 92

OPTIMUM AT K30 H2

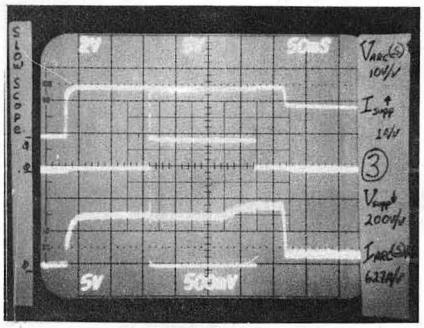


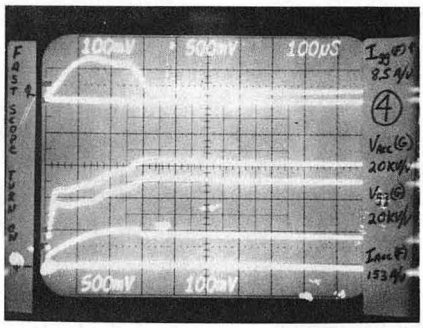
V_{ACC} = 31KV

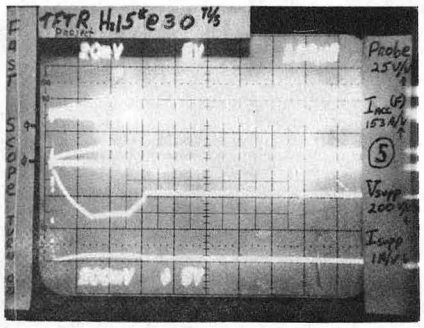
V_{GG} = 25.5KV

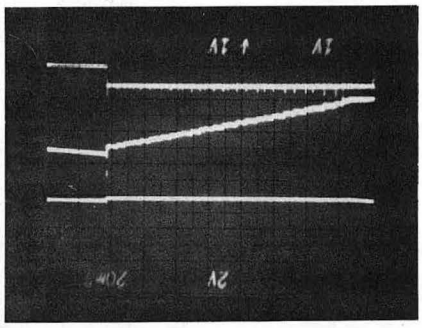
I_{ACC} = 10.33A

I_{GG} = 250MA





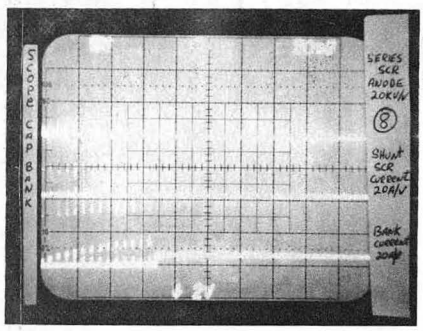


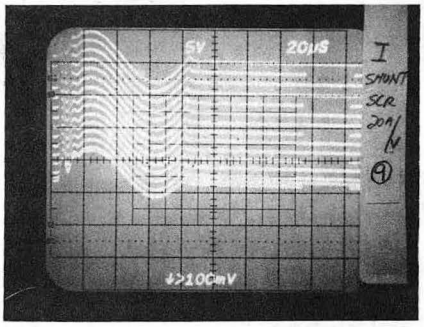


V_{ARC} = 30V

I_{ARC} = 470 A

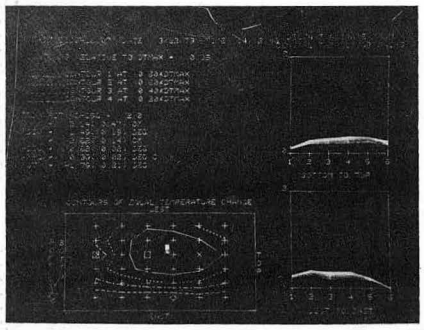
P_{ARC} = 14.1KW

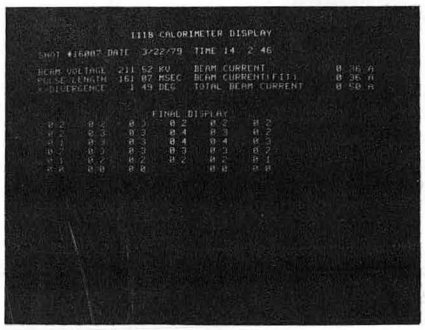




V_{SUPP} = 3000V

I_{SUPP} = 4A





15# H_2 30 TL/s

I_{DR} = 1.67 A

LOG XVIII IIIB

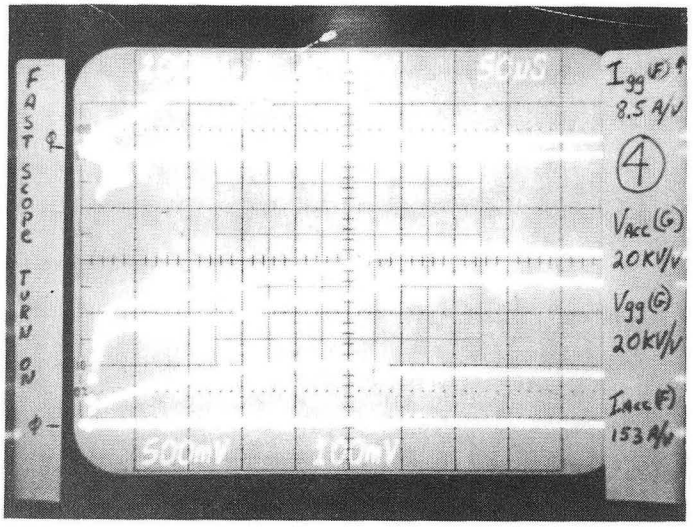
P.90-91

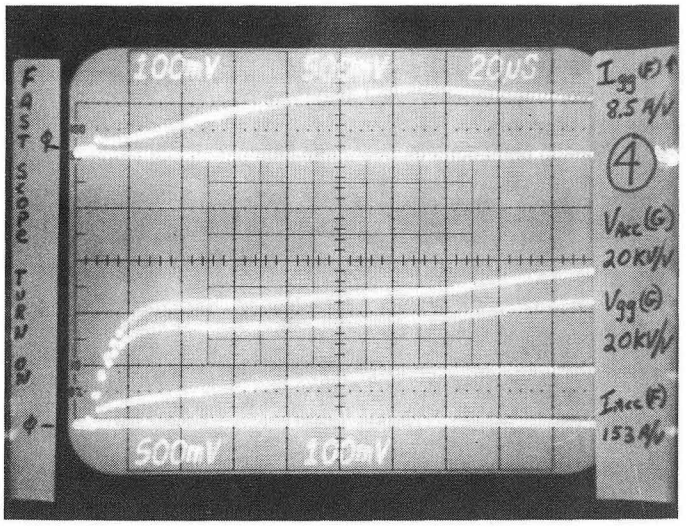
NOTE:

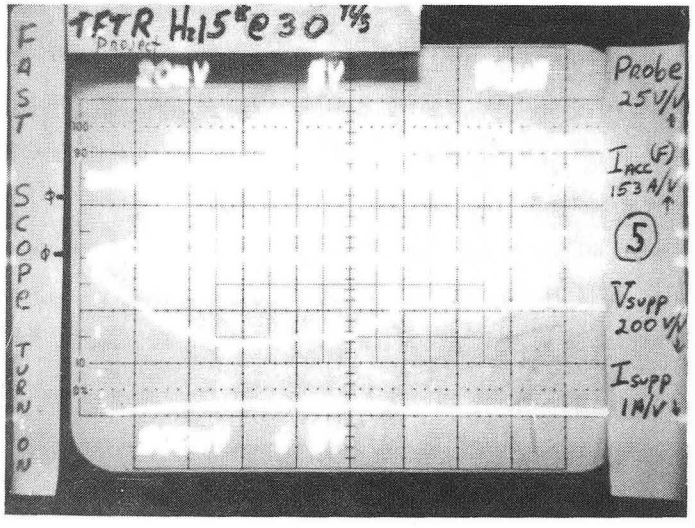
$I_{ACC} = I_{BANK} - I_{DR}$

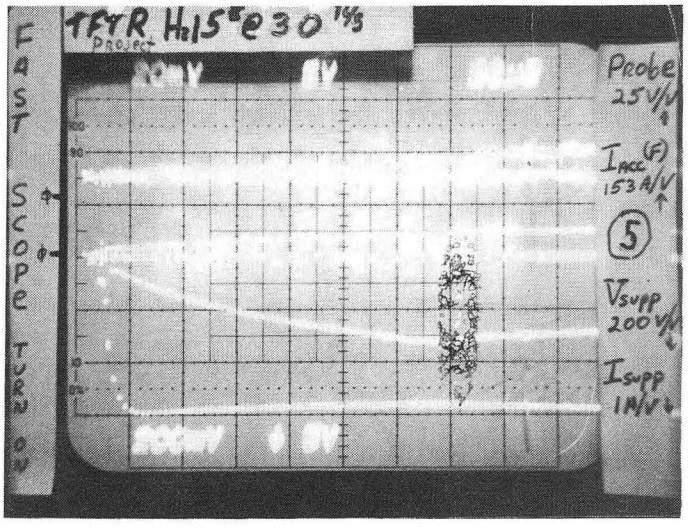
FOR CALCULATIONS

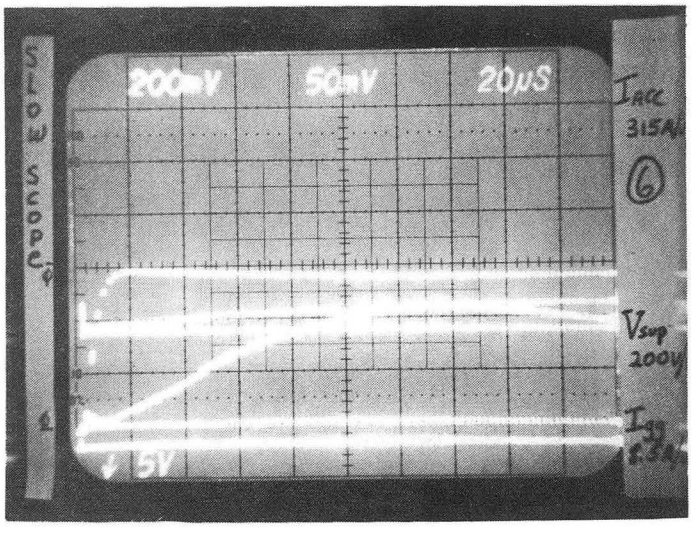
FAST TURN ON AT K30





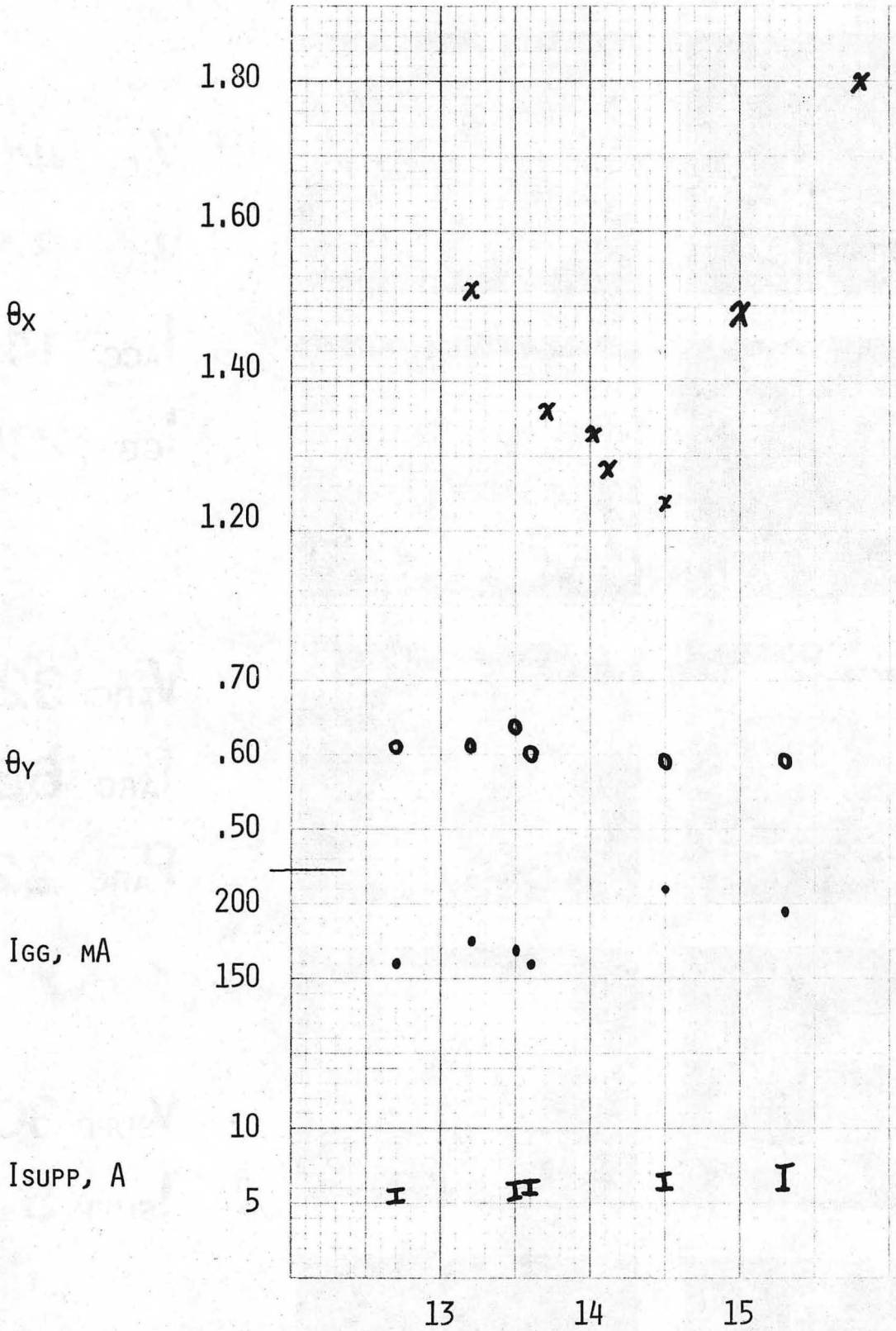






TFTR

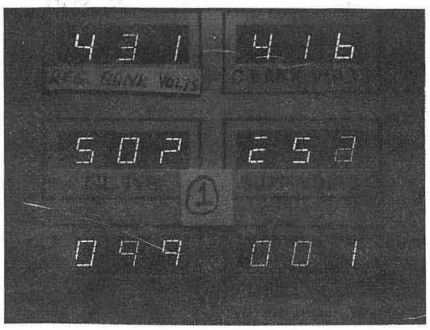
TUNING CURVE FOR 40 kV OPERATION, 30 TL/s H_2

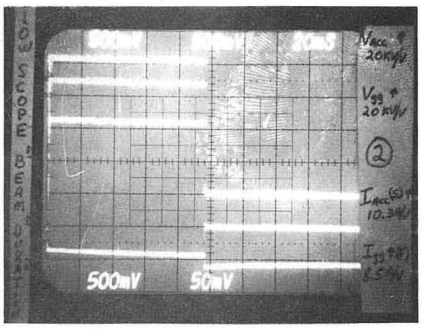


V_{ACC} = 41kV
V_{gg} = 34kV
V_{supp} = 2800V

$I_{ACC} = I_{BANK} - I_{DR}$

OPTIMUM AT K40 H2



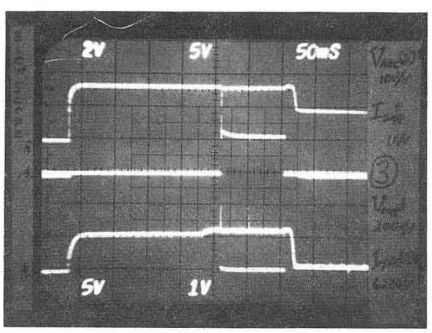


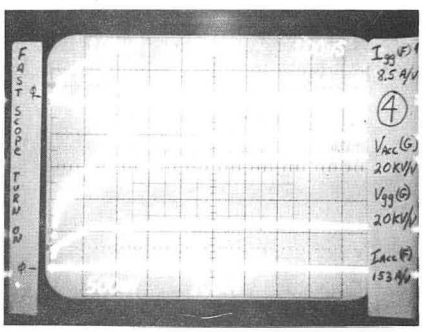
V_{ACC} = 41KV

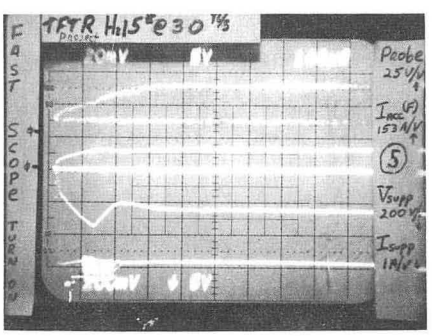
V_{GG} = 34.5KV

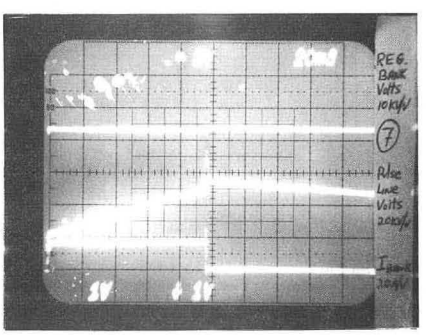
I_{ACC} = 14.5A

I_{GG} = 210MA





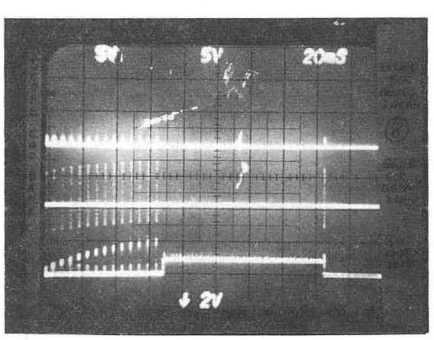


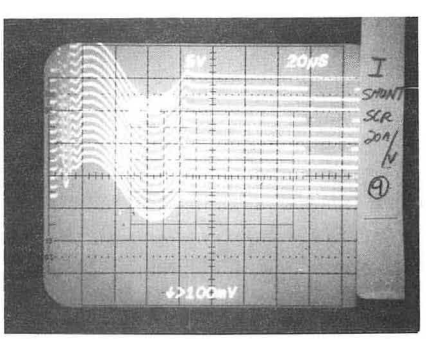


V_{ARC} = 32V

I_{ARC} = 689 A

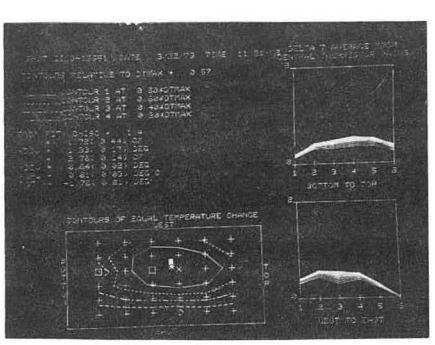
P_{ARC} = 22KW

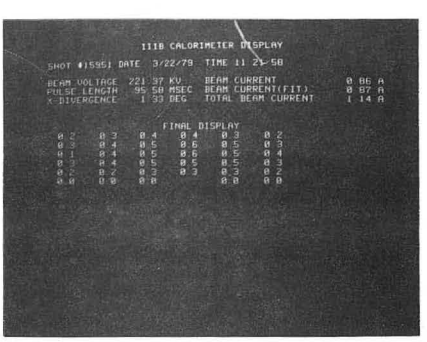




V_{SUPP} = 3000V

I_{SUPP} = 5.5A





15# H_2 30 TL/S

I_{DR} = 2.43 A

LOG XVIII IIIB

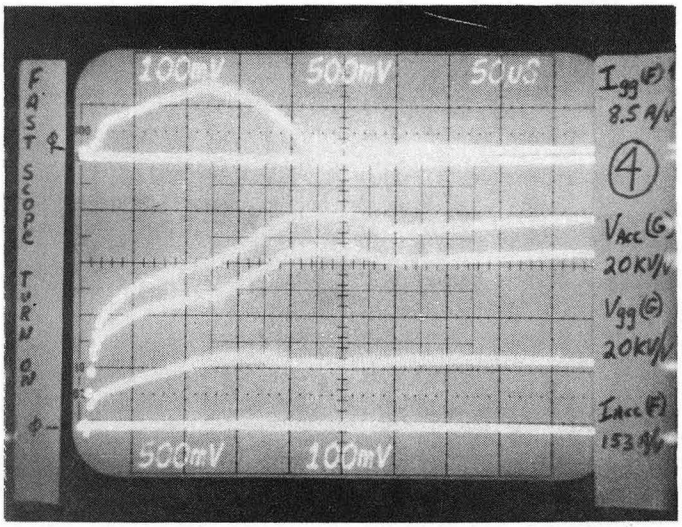
P.80

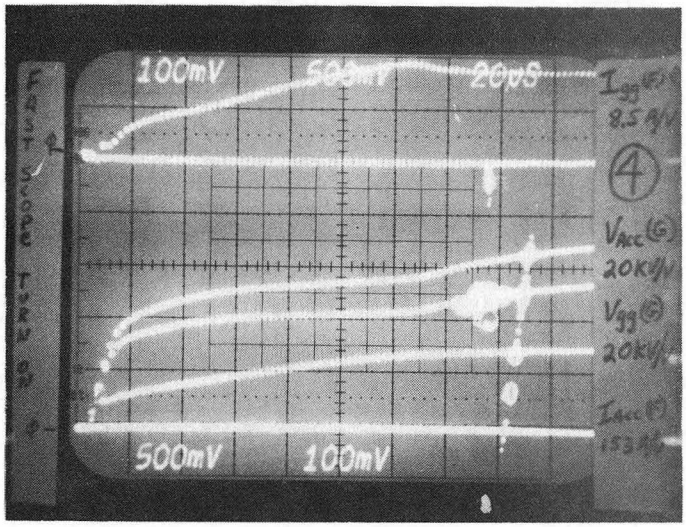
NOTE:

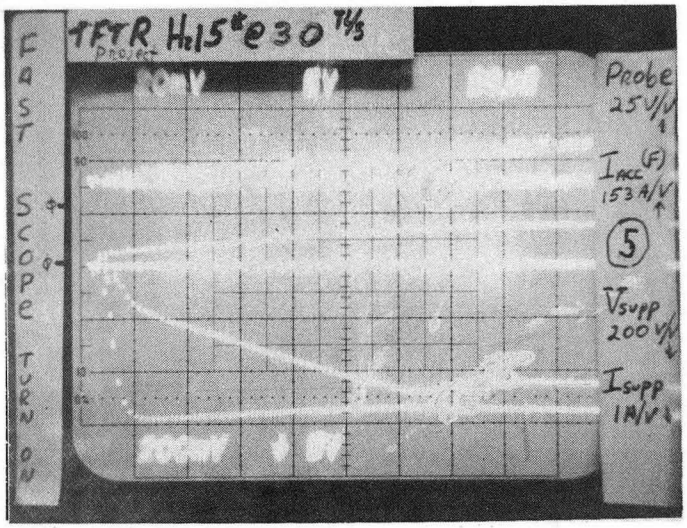
$I_{ACC} = I_{BANK} - I_{DR}$

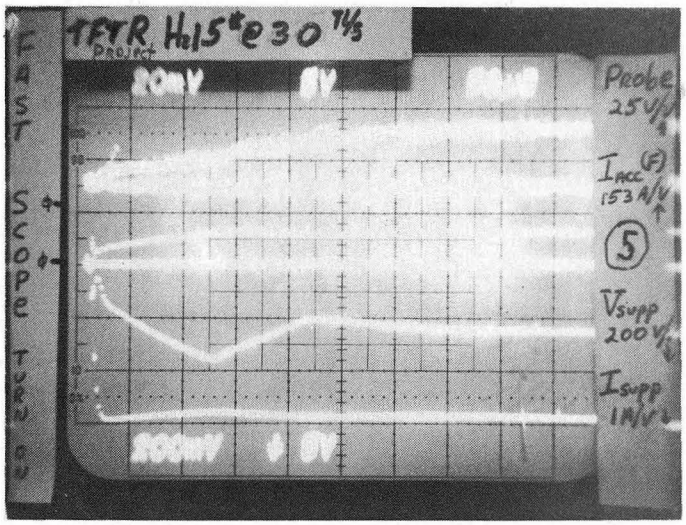
FOR CALCULATIONS

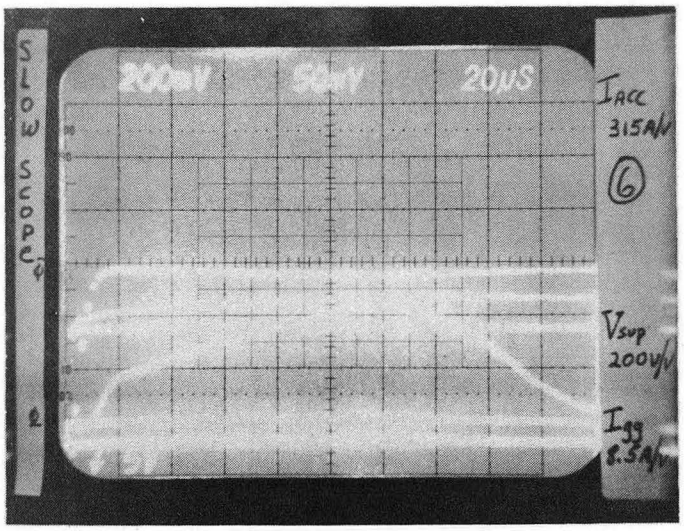
FAST TURN ON AT K40



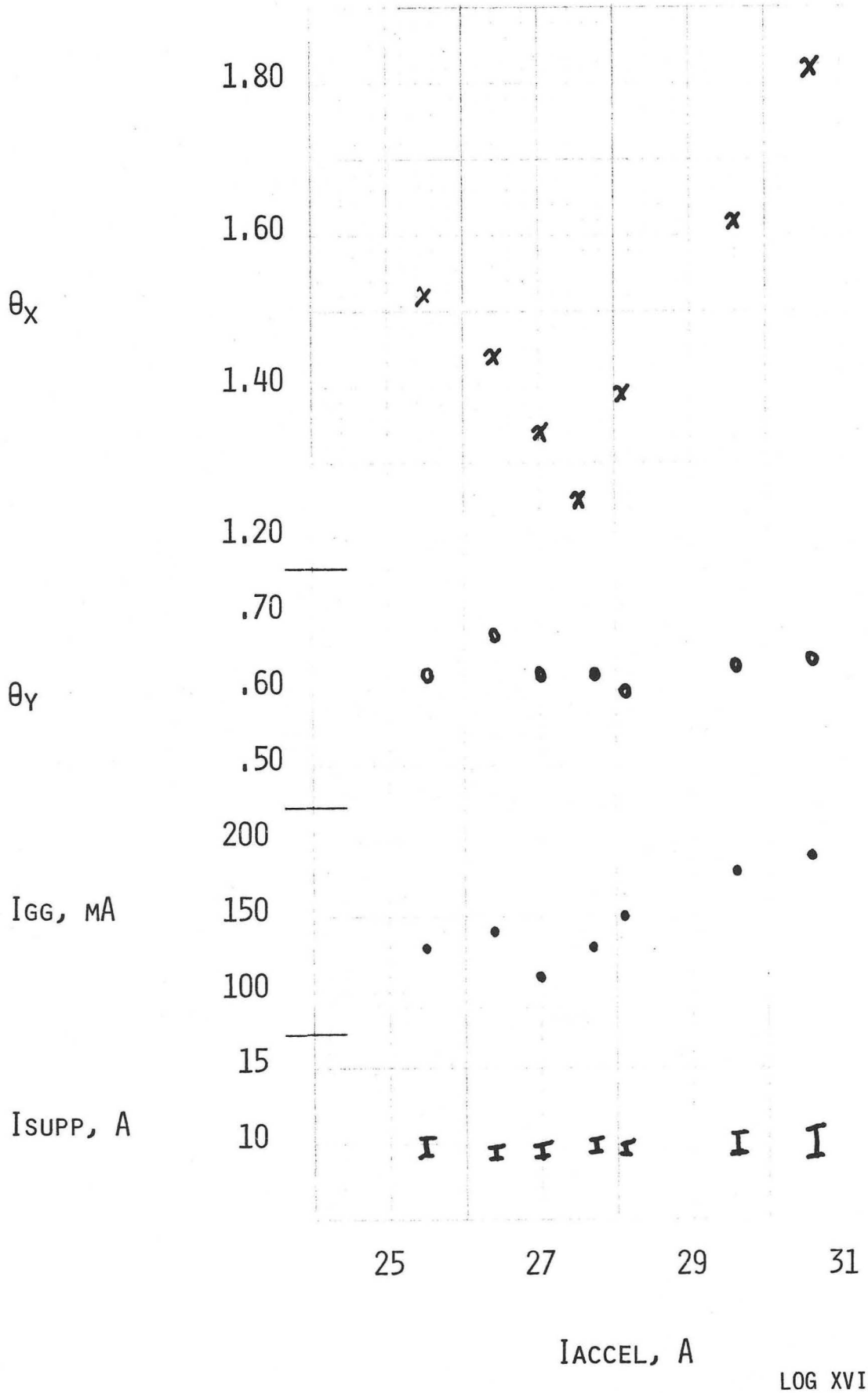






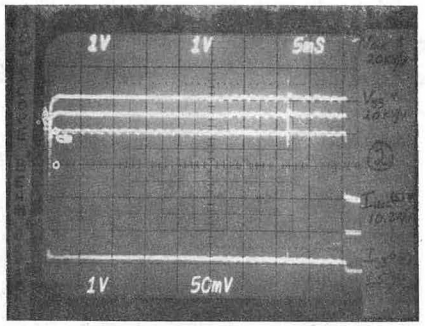


TFTR TUNING CURVE FOR 60 kV OPERATION, 30 TL/s H_2



V_{ACC} = 62kV
V_{gg} = 51kV
V_{supp} = 2600V

OPTIMUM AT K60 H2

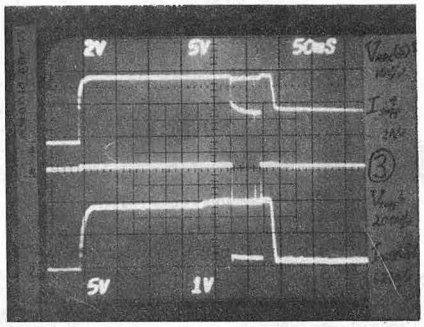


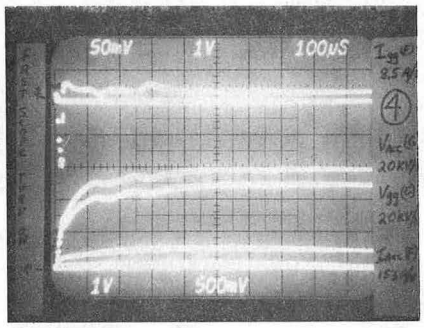
V_{ACC} = 62 KV

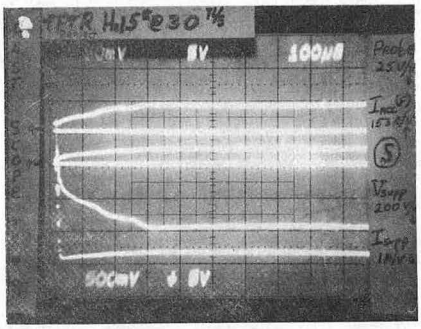
V_{GG} = 50 KV

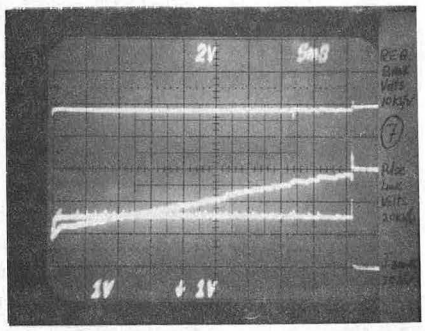
I_{ACC} = 27.5 A

I_{GG} = 125 MA





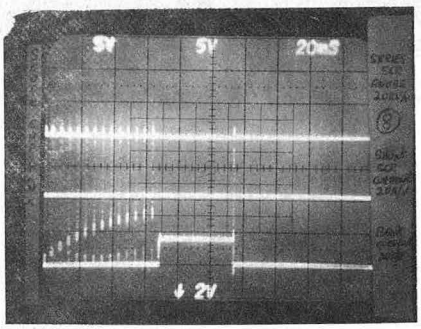


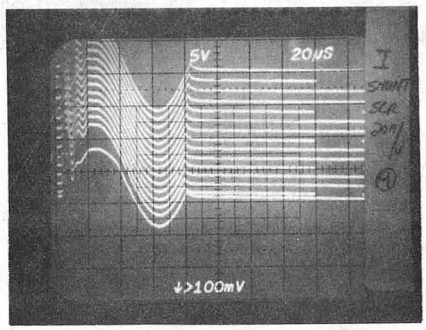


V_{ARC} = 40 V

I_{ARC} = 1128 A

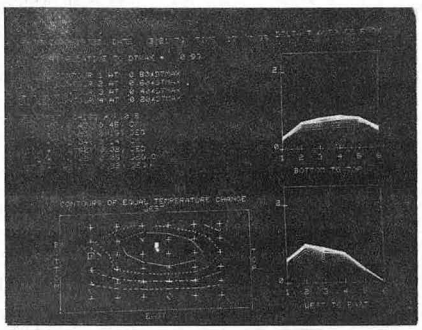
P_{ARC} = 45.1 KW

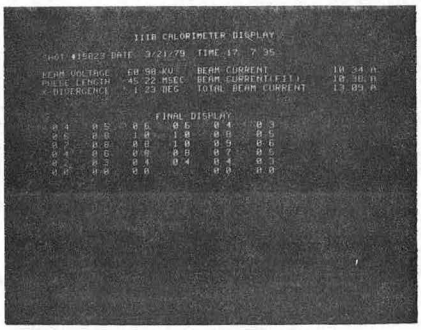




V_{SUPP} = 2800 V

I_{SUPP} = 8.5 A





15# H_2 30 TL/s

I_{DR} = 3.94 A

LOG XVIII - IIIB

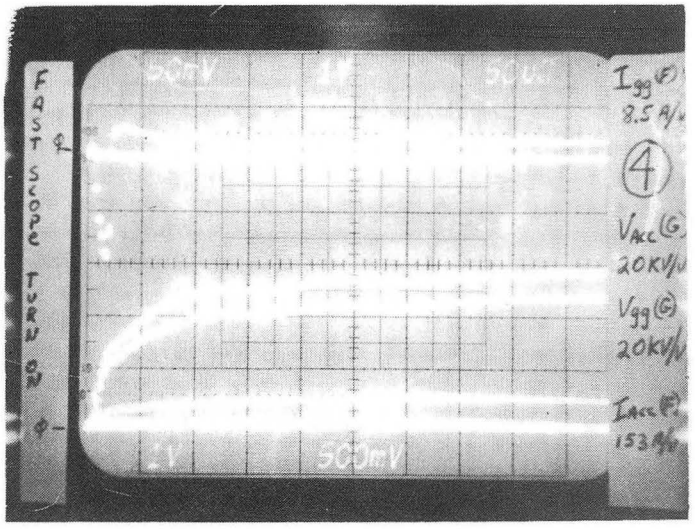
P.66

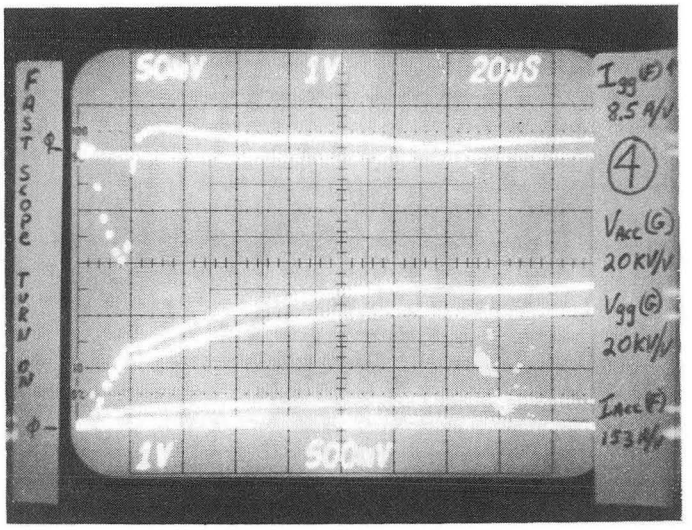
NOTE:

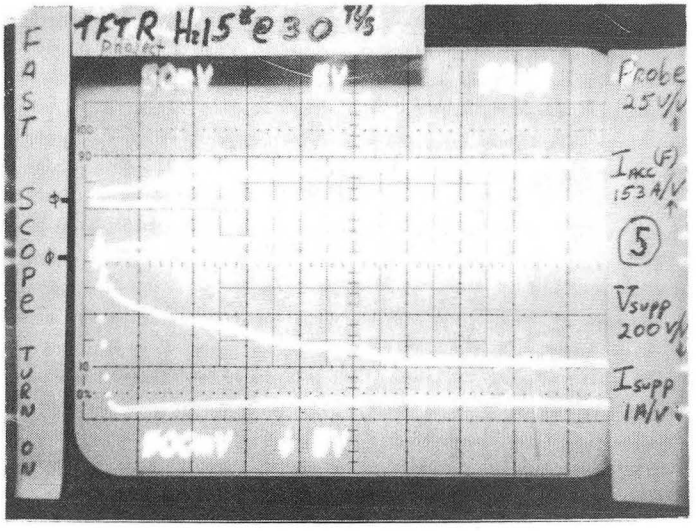
$I_{ACC} = I_{BANK} - I_{DR}$

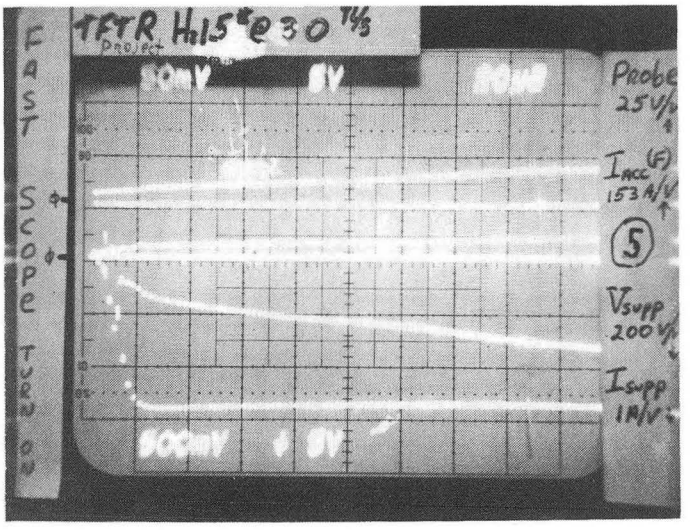
FOR CALCULATIONS

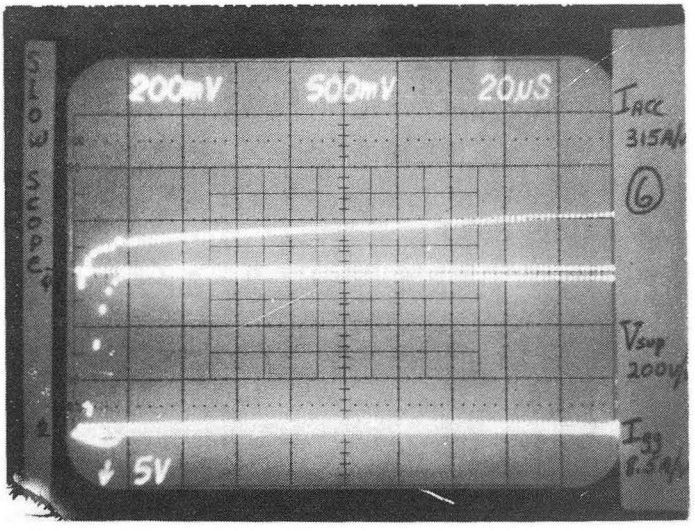
FAST TURN ON AT K60



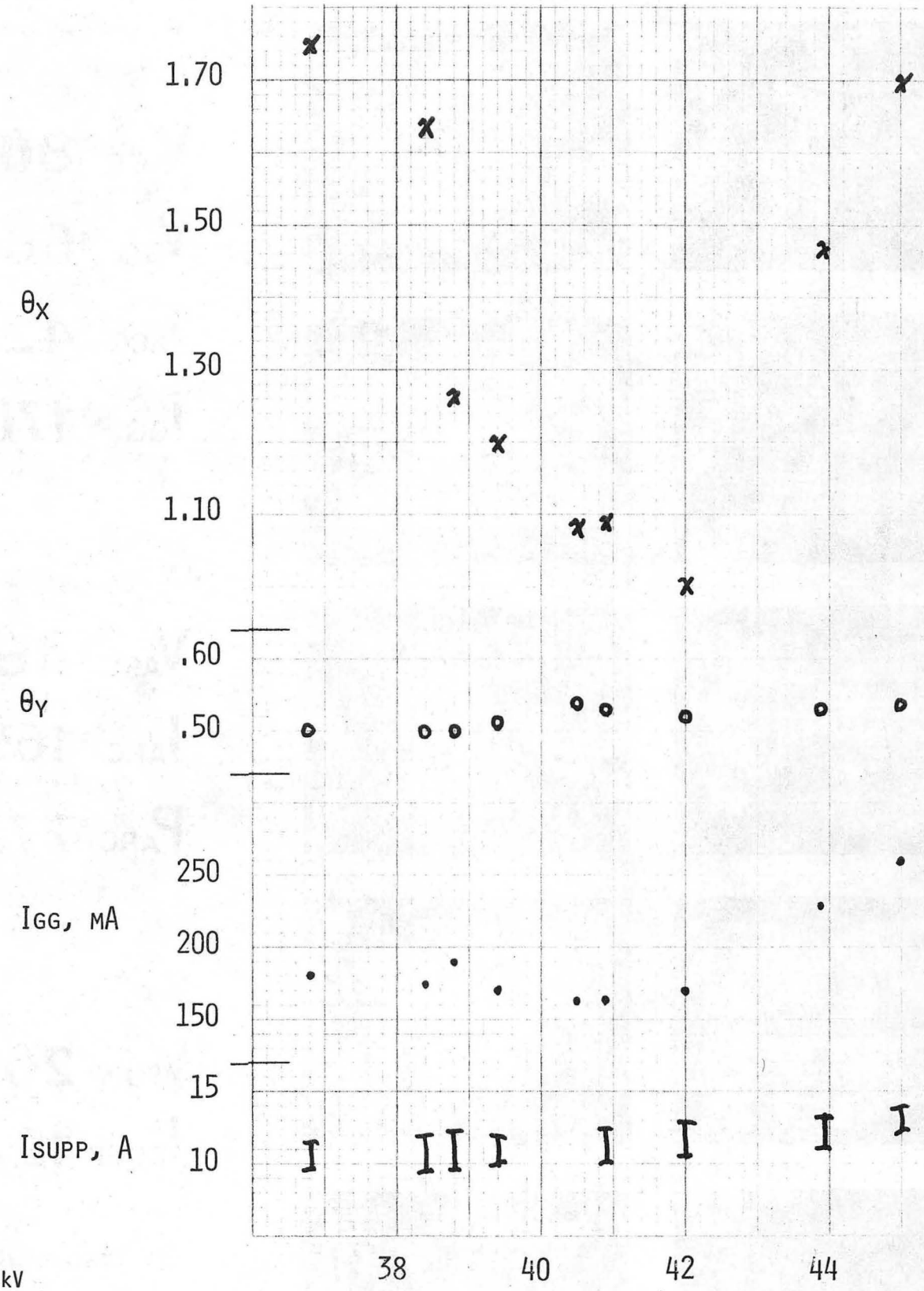








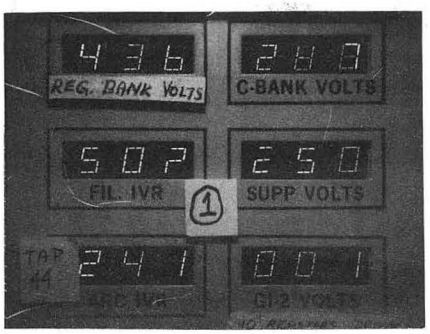
TFTR TUNING CURVE FOR 80 kV OPERATION, 30 TL/s H_2

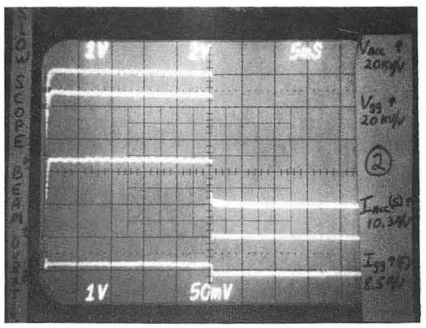


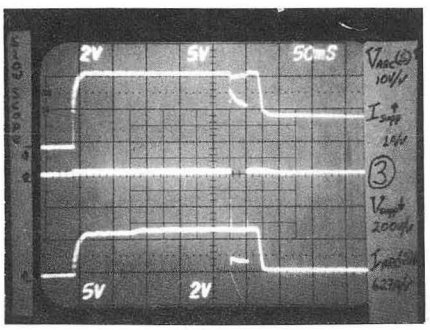
V_{ACC} = 81kV
V_{gg} = 68kV
V_{supp} = 2600V

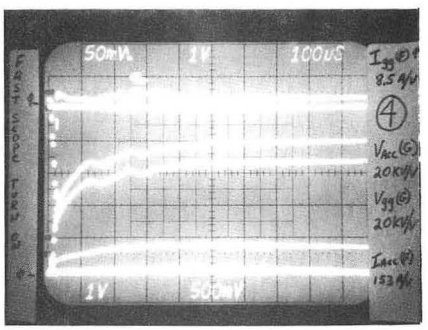
$I_{ACC} = I_{BANK} - I_{DR}$

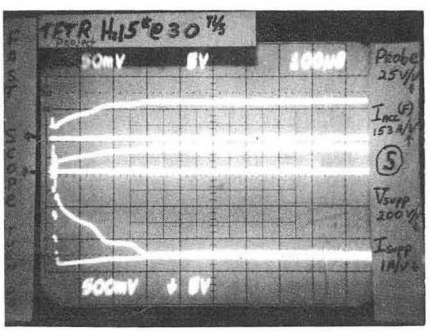
OPTIMUM AT K80 H2

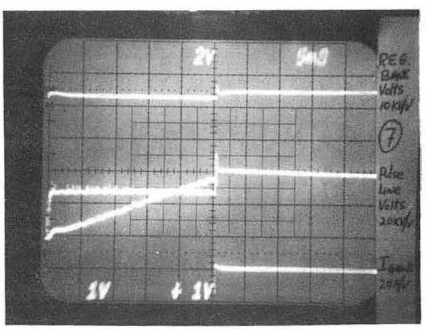


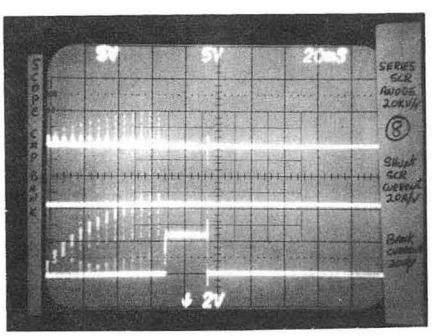


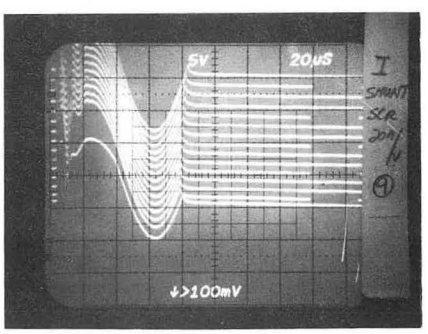


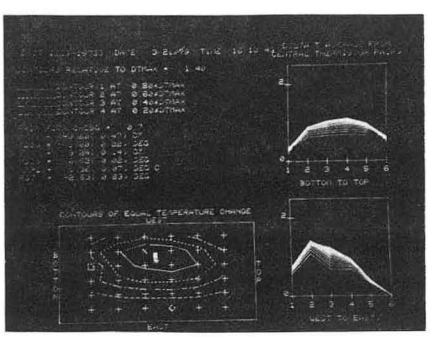


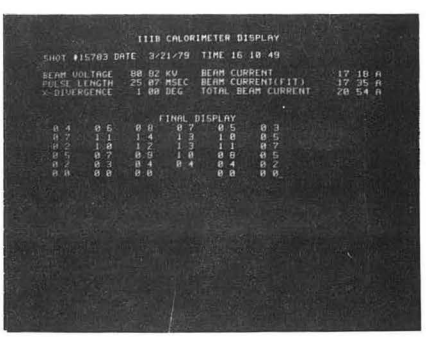












V_{ACC} = 80KV

V_{GG} = 68KV

I_{ACC} = 42.1 A

I_{GG} = 170MA

V_{ARC} = 46V

I_{ARC} = 1693A

P_{ARC} = 77.8KW

V_{SUPP} = 2600V

I_{SUPP} = 12.5A

15# H_2 30 TL/S

I_{DR} = 4.93 A

LOG XVIII - III B

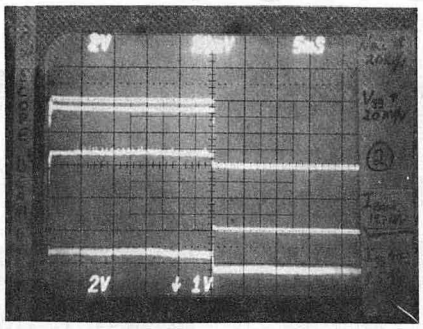
P. 56 - 57

NOTE:

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

OPTIMUM AT K80 H2

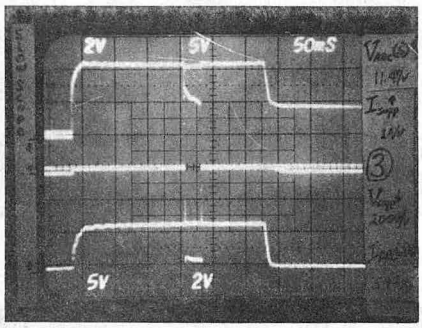


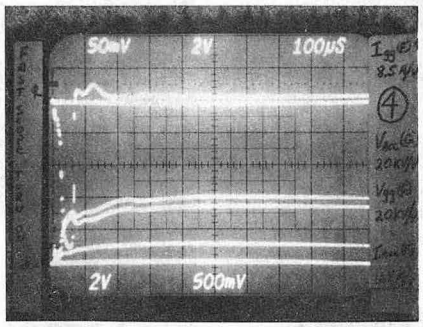
V_{ACC} = 80KV

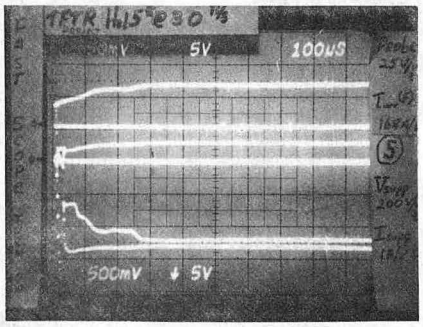
V_{GG} = 68KV

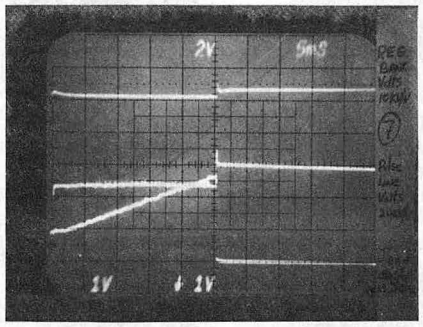
I_{ACC} = 42.4A

I_{GG} = 210MA





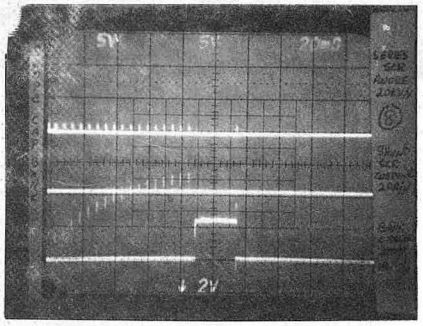


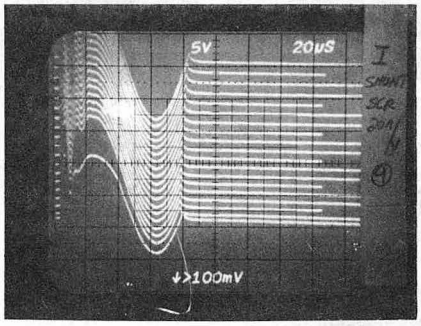


V_{ARC} = 50V

I_{ARC} = 1552A

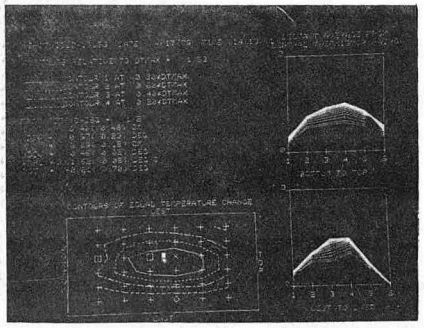
P_{ARC} = 77.6KW

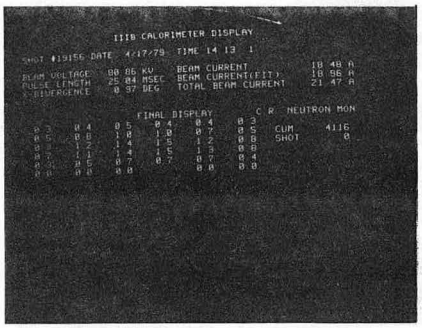




V_{SUPP} = 2900V

I_{SUPP} = 11.5A





15# H_2 30 TL/s

I_{DR} = 4.93 A

LOG XIX - IIIB

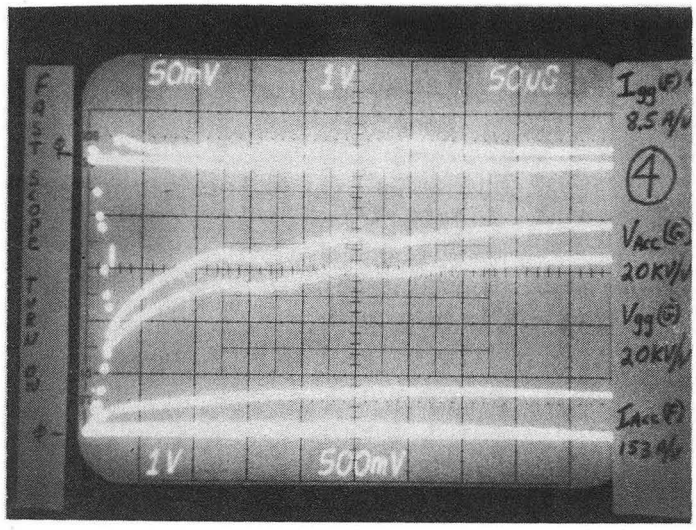
P. 194

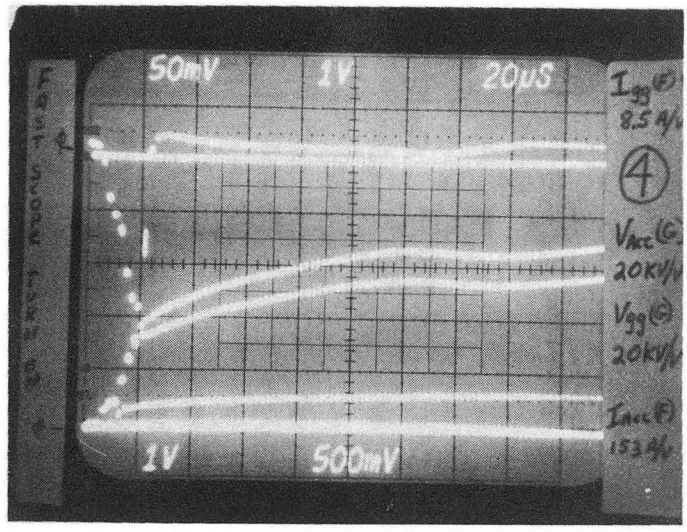
NOTE.

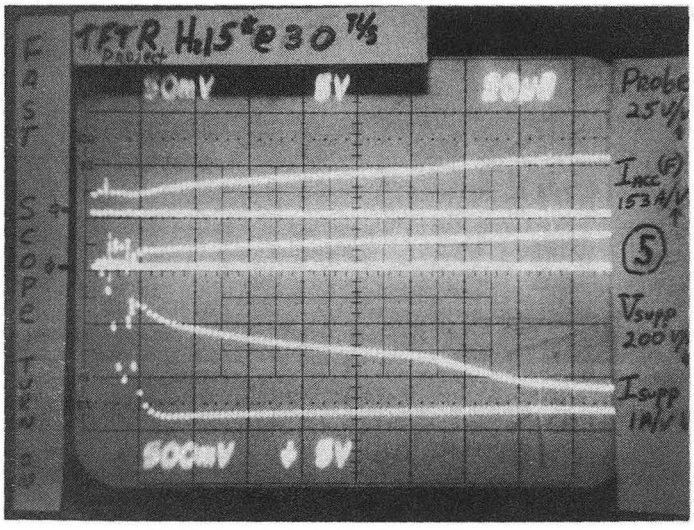
$I_{ACC} = I_{BANK} - I_{DR}$

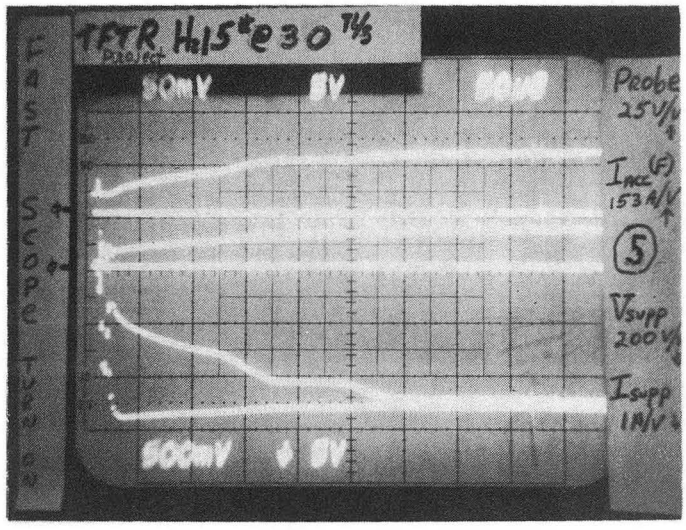
FOR CALCULATIONS

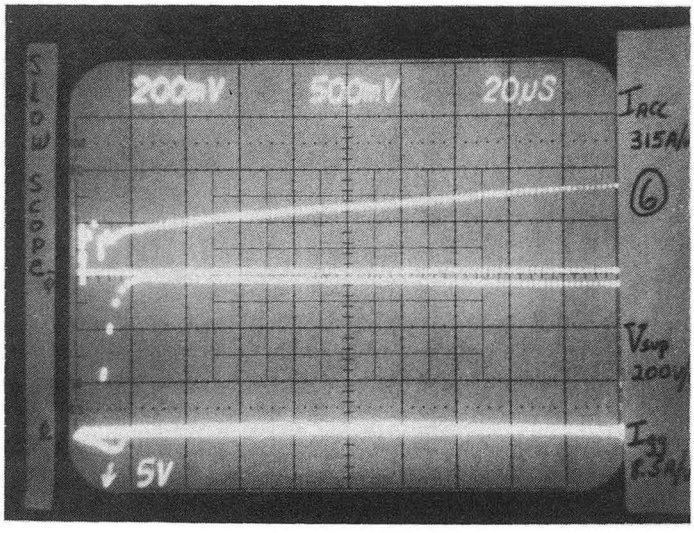
FAST TURN ON AT K80



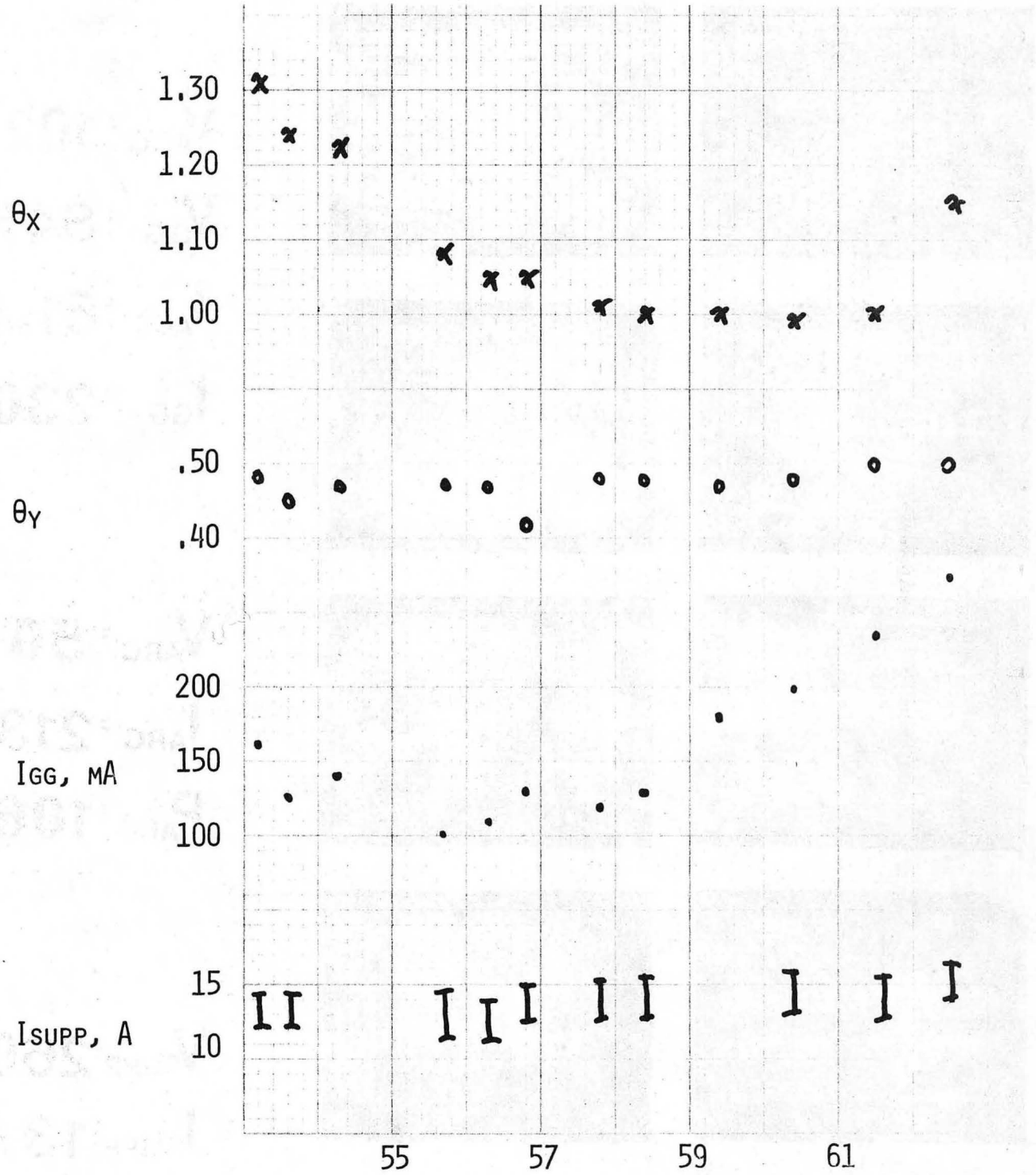








TFTR TUNING CURVE FOR 100 kV OPERATION, 30 TL/s H_2

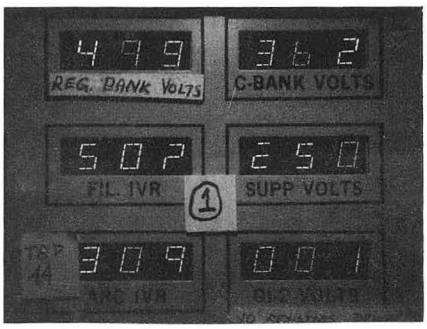


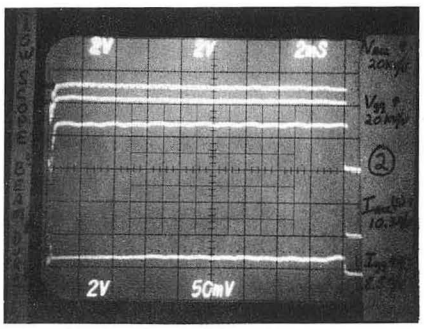
V_{ACC} = 101kV
V_{gg} = 84kV
V_{supp} = 2600V

$I_{ACC} = I_{BANK} - I_{DR}$

LOG XVIII
p. 47

OPTIMUM AT K100 H2



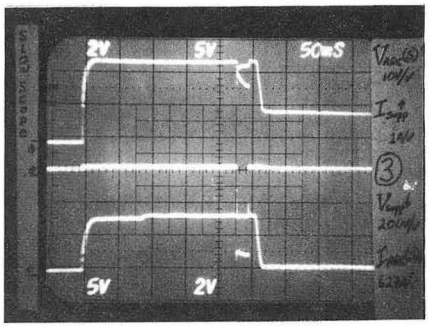


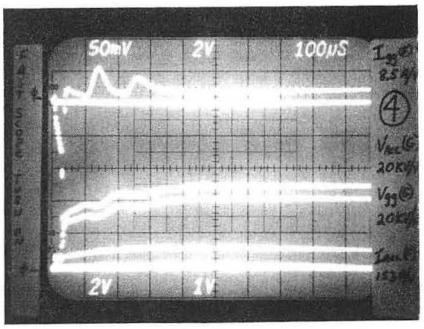
V_{ACC} = 102KV

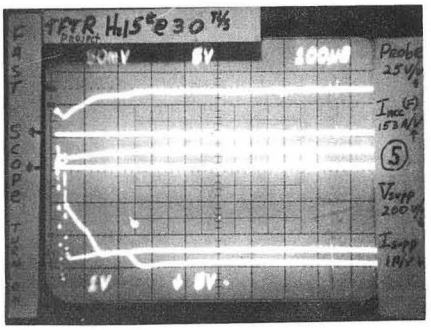
V_{GG} = 84KV

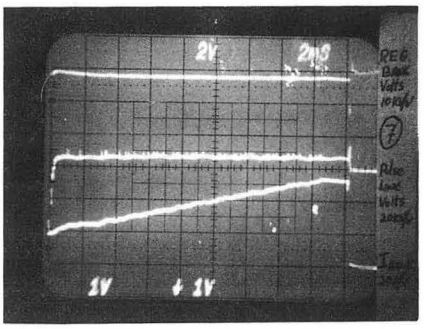
I_{ACC} = 61.1A

I_{GG} = 230MA





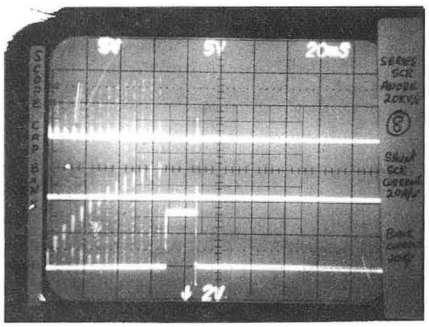


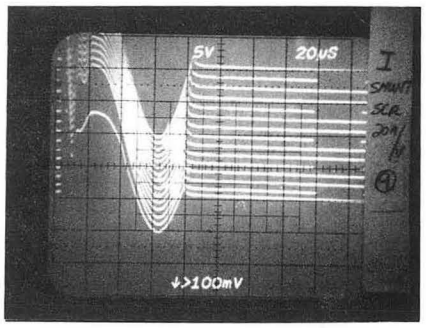


V_{ARC} = 50V

I_{ARC} = 2132A

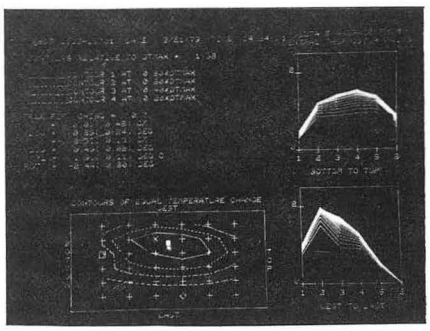
P_{ARC} = 106KW

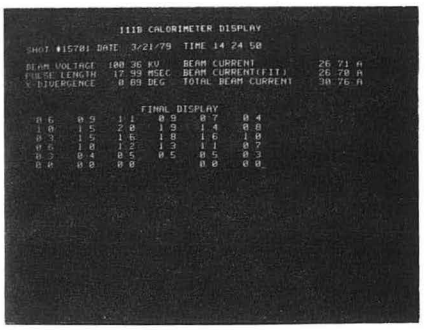




V_{SUPP} = 2600V

I_{SUPP} = 13A





15# H_2 30 TL/s

I_{DR} = 5.92

LOG XVIII - IIIB

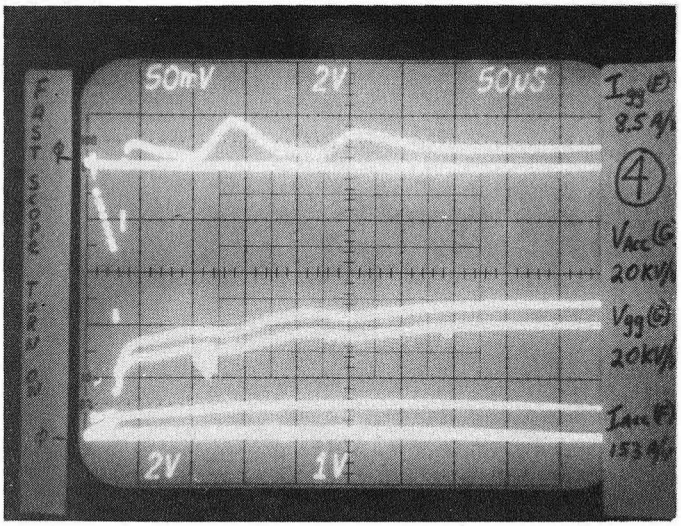
P. 45 - 47

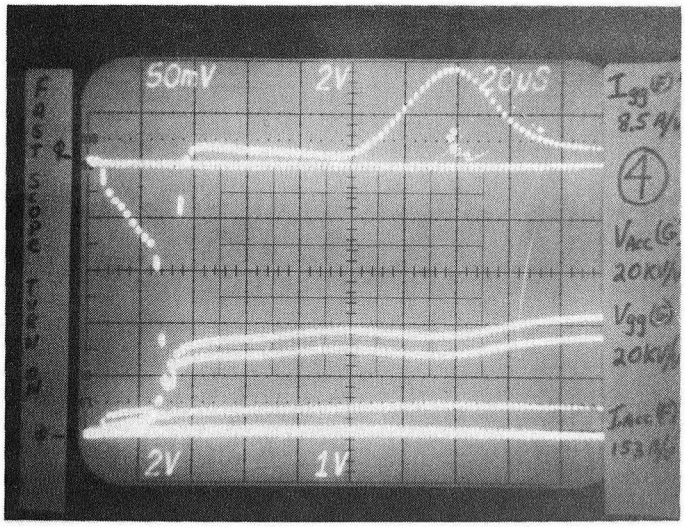
NOTE:

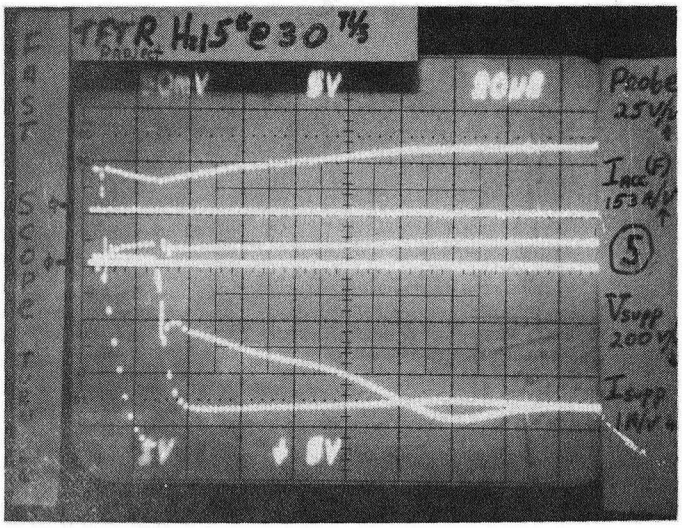
$I_{ACC} = I_{BANK} - I_{DR}$

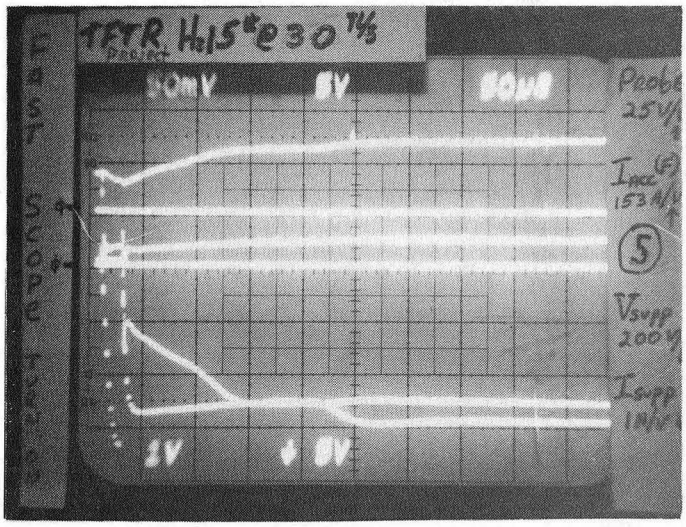
FOR CALCULATIONS

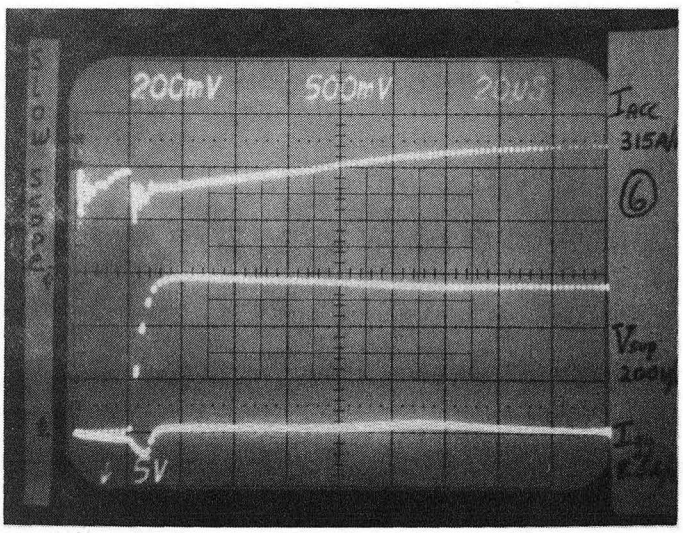
FAST TURN ON AT K100



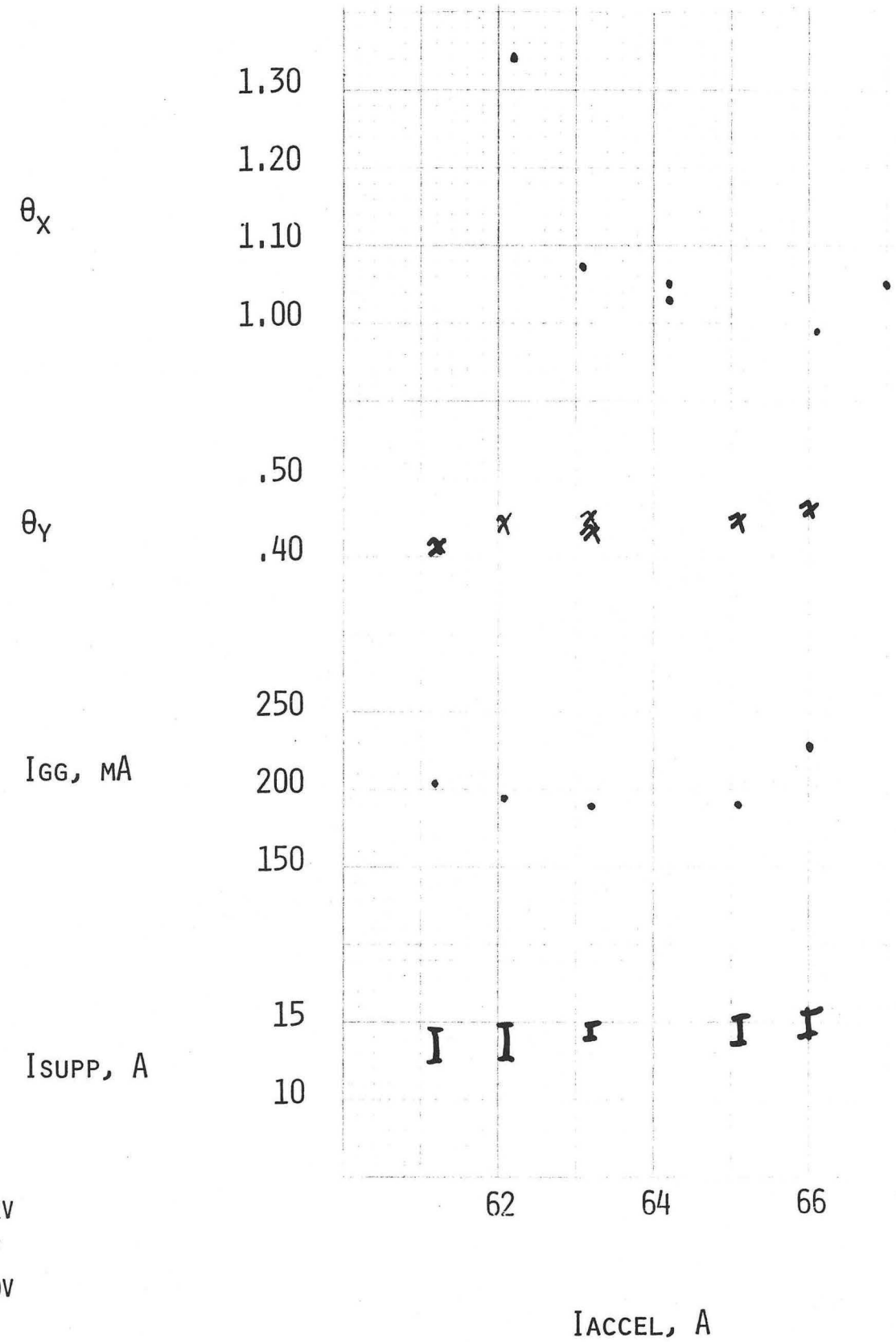








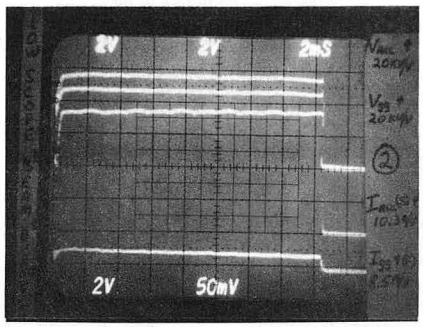
TFTR Tuning Curve For 110 kV Operation, 30 TL/s H_2



V_{ACC} = 112kV
V_{gg} = 94kV
V_{supp} = 2500V

$I_{ACC} = I_{BANK} - I_{DR}$

OPTIMUM AT K110 H2

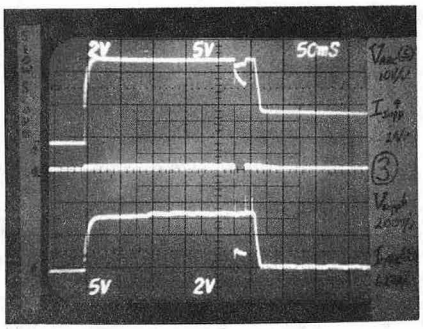


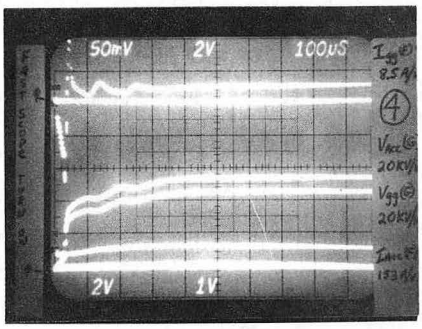
V_{ACC} = 112 KV

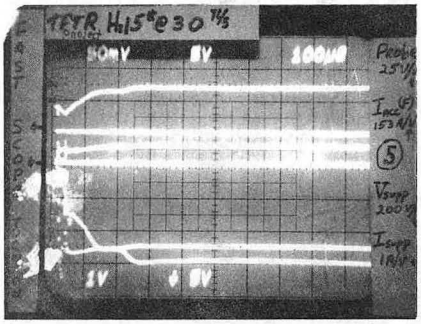
V_{GG} = 94 KV

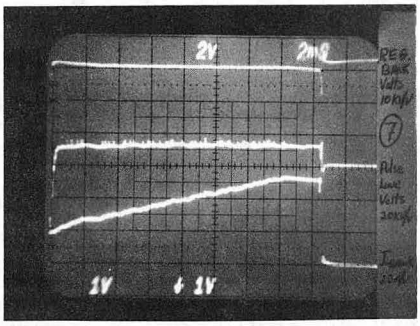
I_{ACC} = 66.1 A

I_{GG} = 210 MA





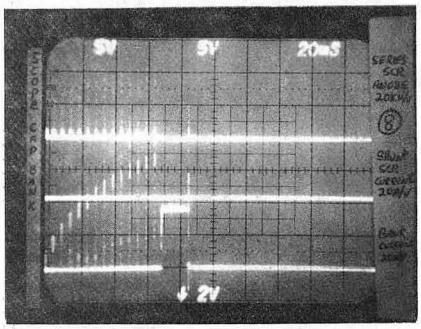


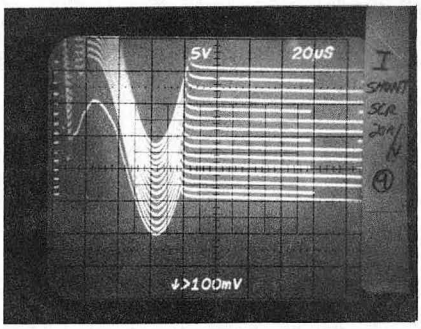


V_{ARC} = 52 V

I_{ARC} = 2132 A

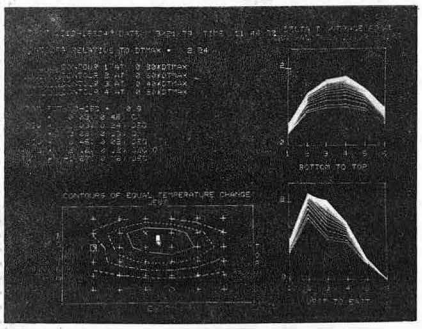
P_{ARC} = 111.1 KW

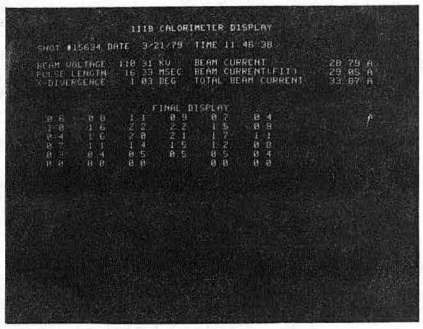




V_{SUPP} = 2600 V

I_{SUPP} = 14.5 A





15# H_S 30 TL/S

I_{DR} = 6.9 A

LOG XVIII - IIIB

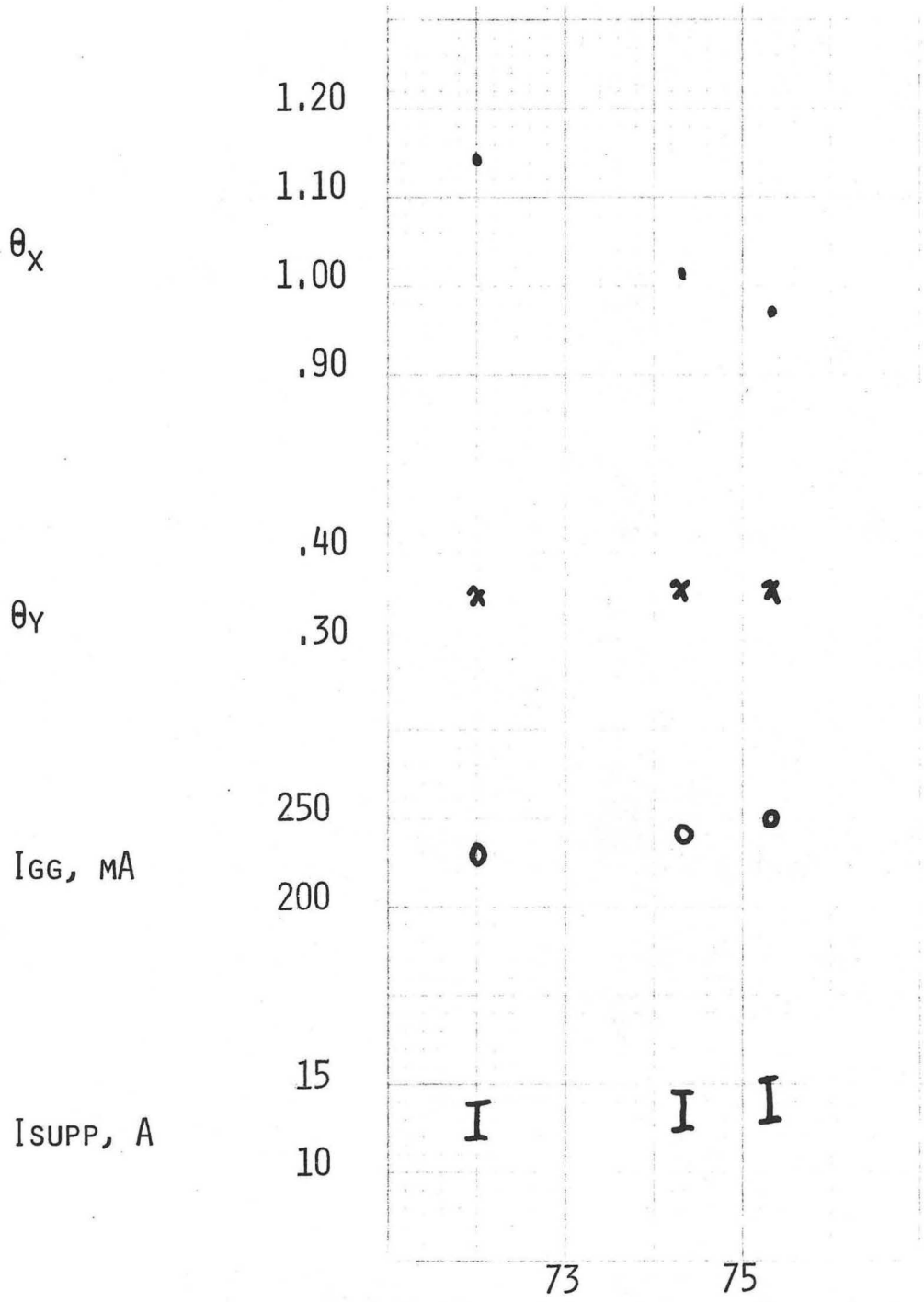
P. 32 - 33

NOTE:

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

TFTR TUNING CURVE FOR 120 kV OPERATION, 30 TL/s H_2



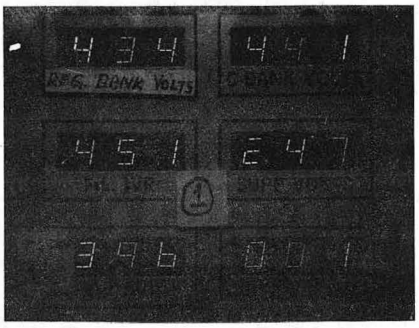
V_{ACC} = 120kV
V_{gg} = 104kV
V_{supp} = 2700V

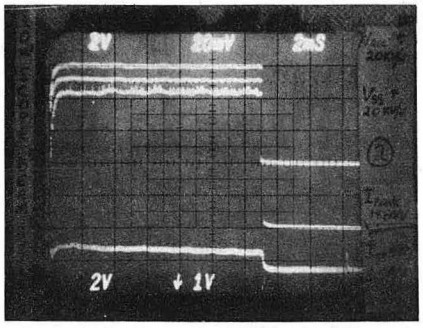
IACCEL, A

LOG XIX
p. 206

$I_{ACC} = I_{BANK} - I_{DR}$

OPTIMUM AT K120 H2



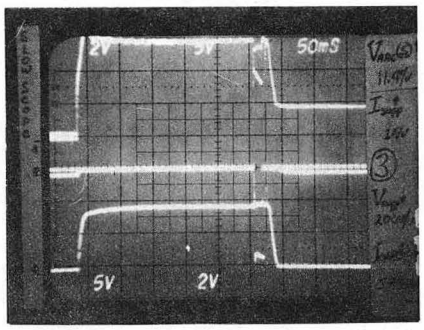


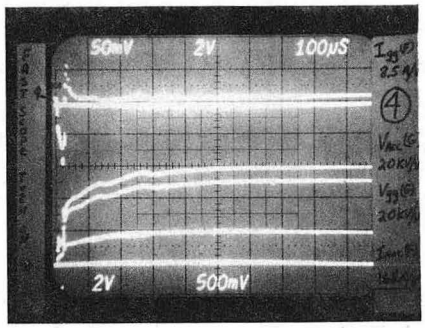
V_{ACC} = 120 KV

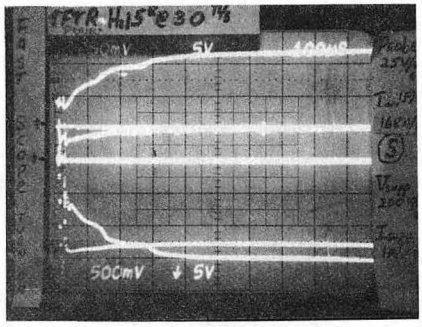
V_{GG} = 102 KV

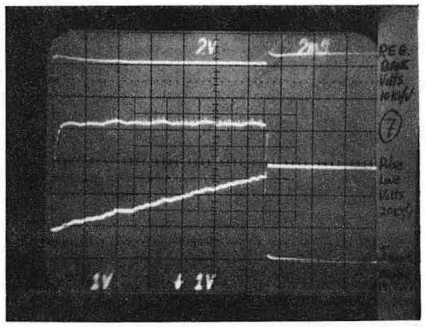
I_{ACC} = 75.3 A

I_{GG} = 255 MA





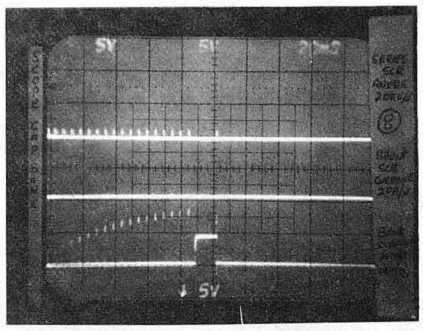


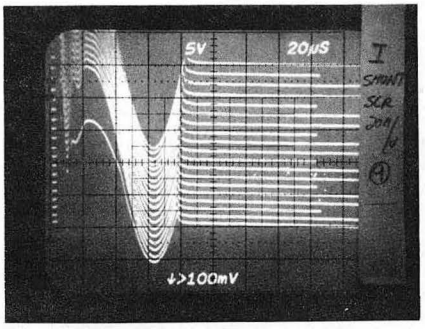


V_{ARC} = 66 V

I_{ARC} = 2269 A

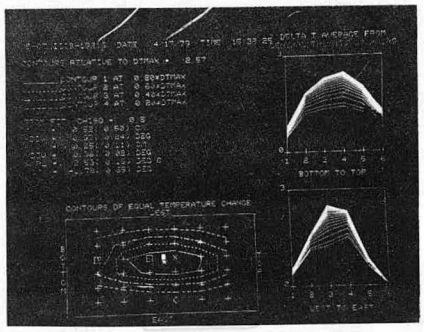
P_{ARC} = 149 KW

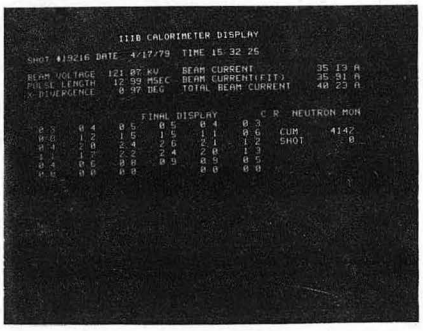




V_{SUPP} = 2800 V

I_{SUPP} = 13.5 A





15# H_2 3- TL/s

I_{DR} = 7.49 A

LOG XIX - IIIB

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NOTE.

$I_{ACC} = I_{BANK} - I_{DR}$

FOR CALCULATIONS

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