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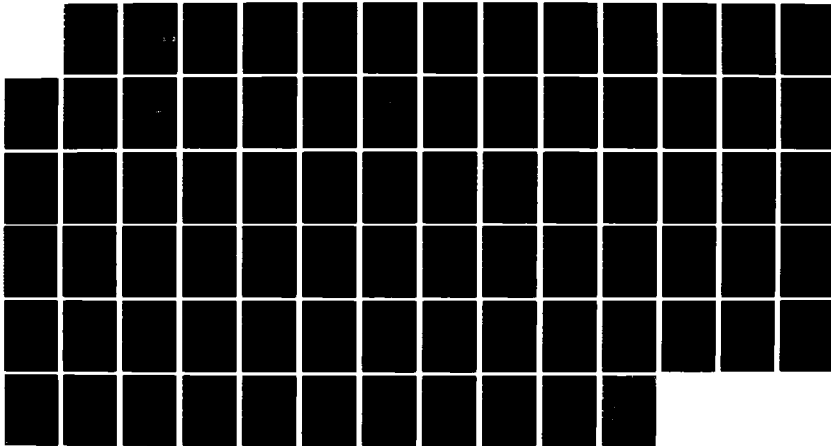
PULSED CHEMICAL LASER TECHNOLOGY DEVELOPMENT CRITICAL
DESIGN REVIEW(U) AVCO EVERETT RESEARCH LAB INC EVERETT
MA 05 MAR 84 DAAH01-83-C-0282

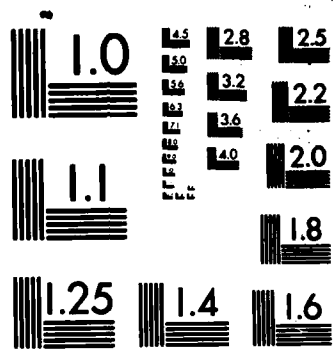
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A166 204

DTIC ACCESSION NUMBER

PHOTOGRAPH THIS SHEET

PULSED CHEMICAL LASER
TECHNOLOGY DEVELOPMENT

1

LEVEL

INVENTORY

CRITICAL DESIGN REVIEW

DOCUMENT IDENTIFICATION

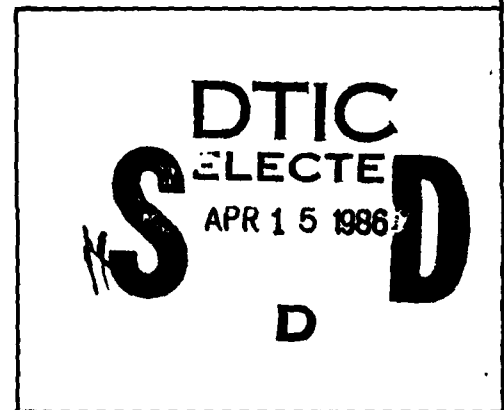
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Wm. A. Duncan
Micom

AD-A166 204

PULSED CHEMICAL LASER TECHNOLOGY DEVELOPMENT
CRITICAL DESIGN REVIEW

Contract No. DAAH01-83-C-0282

3/5/84

Prepared For

Department of the Army
U.S. Army Missile Command
Redstone Arsenal, Alabama

Prepared By

Avco Everett Research Laboratory
Everett, Massachusetts

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MICOM - PCL - CRITICAL DESIGN REVIEW

AGENDA

- | | |
|-----------------------------------|-------------|
| PROGRAM REQUIREMENTS / OBJECTIVES | 9:15-9:30 |
| J. MORAN | |
| STATUS OF SYSTEM MODIFICATIONS | 9:30-10:00 |
| J. MORAN | |
| SPECIAL PERFORMANCE DIAGNOSTICS | 10:00-10:45 |
| B. VU | |
| DATA ACQUISITION | 10:45-11:00 |
| N. ORDECO | |
| LABORATORY TOUR | 11:00-12:00 |
| LUNCH | 12:00-12:30 |
| REPETITIVE PULSE POWER DESIGN | 12:30-1:15 |
| C. PIKE | |
| PULSE POWER IMPLEMENTATION | 1:15-1:45 |
| V. N. MARTIN | |
| TEST PLAN | 2:00-3:00 |
| J. MORAN | |

REQUIREMENTS FOR ARMY APPLICATIONS

CLOSED SYSTEM:

BLOW DOWN: CHEMICAL PUMP (Lithium)

RECIRCULATING: LITHIUM SCRUBBER (Li, F or NaF)

SOLID GRAIN GAS GENERATORS:

F_2 (FROM NF_4 B F_4)

D_2 (FROM ND_3 B D_3)

N_2 (FROM N_A N_3)

TWO COLOR OPERATION:

DF 3.8 μM

DF \rightarrow CO_2 10.6 μM (9.6 μM)

SCOPE OF TECHNOLOGY DEVELOPMENT

TASK I: ANALYSIS

- KINETICS AND LASER PHYSICS
- MEDIUM QUALITY
- FLOW SYSTEM ANALYSIS
- SCALING ANALYSIS

TASK II: SELECTION DESIGN AND FABRICATION

- CONFIGURATION CHARACTERIZATION
- CONFIGURATION DEFINITION
- PERFORMANCE DIAGNOSTICS

Today {

- TEST PLAN
- PDR - CDR
- FABRICATION AND ASSEMBLY

TASK III: DIAGNOSTICS AND PERFORMANCE TESTING

- SINGLE PULSE TESTING
- REPETITIVELY PULSED TESTING
- DATA ANALYSIS AND CORRELATION

TASK IV: SCALABILITY DESIGN/ANALYSIS

- CONCEPTUAL DESIGN

TEST CONFIGURATION REQUIREMENTS

	REQUIRED	PROPOSED
(FUEL VOLUMETRIC EFFICIENCY e_v (j/l))	20-50 j/l	≤ 34 j/l
PULSE LENGTH τ_p	1-10 μ sec	1-10 μ sec
PULSE RATE ν	25 pps	0-30 pps
RUN DURATION	1-5 sec	0-1.6 sec <i>* Limited by F₂ on-line Capability</i>
CAVITY VOLUME	≥ 20 l	** 22.5 l
CAVITY PRESSURE	≤ 1.0 atm	150-760 torr Jet Pump (N ₂ Driven)

CONFIGURATION ELEMENTS

GAS VALVING AND MIXER SYSTEM

LASER CAVITY

INITIATION SYSTEM (REP. PULSE)

OPTICS

ACOUSTIC SUPPRESSOR

DIAGNOSTICS

* Typically will run ~ 18 pulses
or ~ 0.6 sec

** 22.5 liters for RP
30 " " single pulse

TEST MATRIX PARAMETERS

CAVITY PRESSURE

DF AND DF → CO₂ MODES

DILUENTS: HE, N₂, AR, NF₃, SF₆

STABILIZER: O₂

GENERATOR PRODUCTS: NF₃, CF₄, N₂

SEEDANTS: SF₆, NF₃

INITIATION LEVEL

DIAGNOSTICS TO DETERMINE

ENERGY PER PULSE

PULSE SHAPE

→ TIME DEPENDENT SPECTRA

INITIATION SYSTEM CHARACTERISTICS

→ F₂ DISSOCIATION LEVEL

TIME DEPENDENT PRESSURE AND TEMPERATURE

MEDIUM HOMOGENEITY

⇒ TIME DEPENDENT GAIN

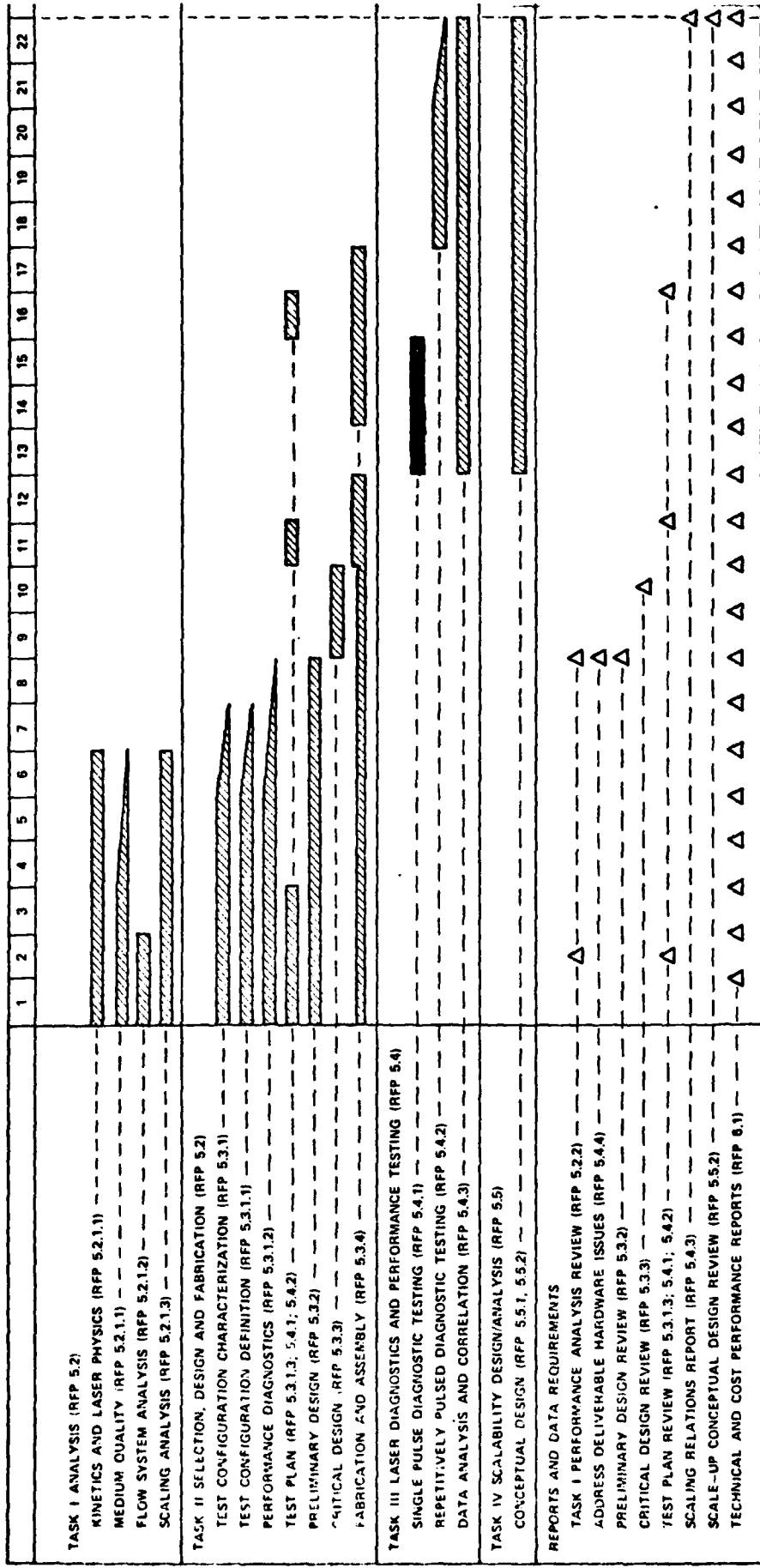
MODELING IS REQUIRED TO SUPPORT THE ABOVE

KINETICS (P.S.I./AERL)

E-BEAM DEPOSITION (AERL)

ACOUSTIC RECOVERY (AERL)

MICOM-PCL PROGRAM SCHEDULE



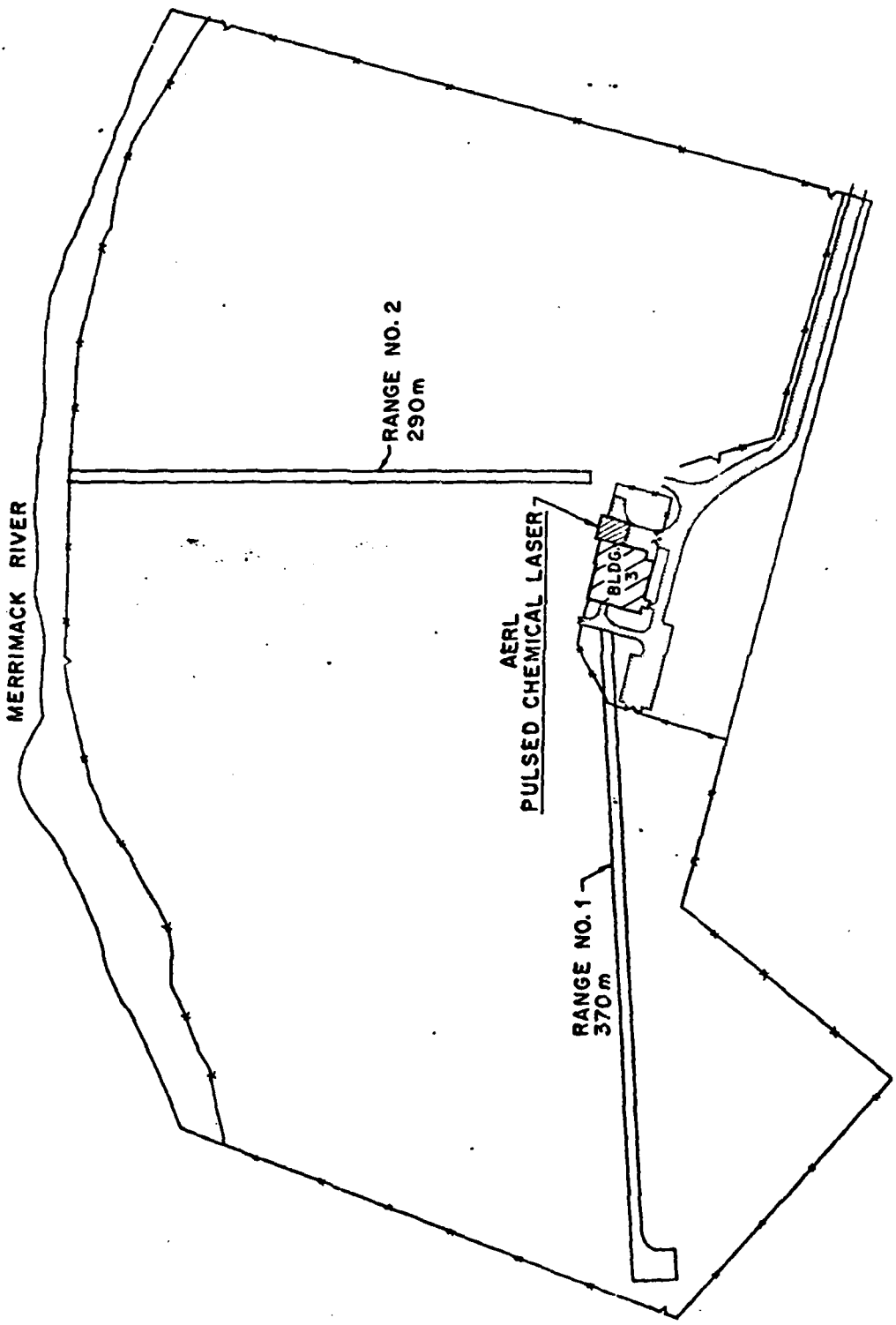
AERL-PCL FACILITY

ELEMENT	MODIFICATIONS IN MICOM PROGRAM	
	SINGLE PULSE	REP PULSE
FLUIDIC VALVING	YES	NO
GAS MIXER	NO	NO
LASER CAVITY	NO	NO
ACOUSTIC SUPPRESSOR	NO	NO
FLOW CHANNEL STRUCTURE	YES	NO
JET PUMP	YES	NO
GAS SCRUBBER	NO	NO
E-BEAM FOIL AND SUPPORT	NO	YES
CATHODE	YES	NO
PULSE FORMING NETWORK	N.A.	YES
MODULATOR	N.A.	YES
FACILITIES	NO	NO
OPTICS TRAIN STRUCTURE	YES	NO
* OUTPUT WINDOW	NO	NO
DIAGNOSTICS AND CONTROLS	YES	YES

* For CO₂ operation, will put calorimeter inside optics box & use small ZnSe window to remove small portion of beam for diagnostics

for DF operation will use large CaF₂ window to transmit beam from the cavity.

AVCO EVERETT RESEARCH LABORATORY HAVERHILL FACILITY



AVCO EVERETT

J8349

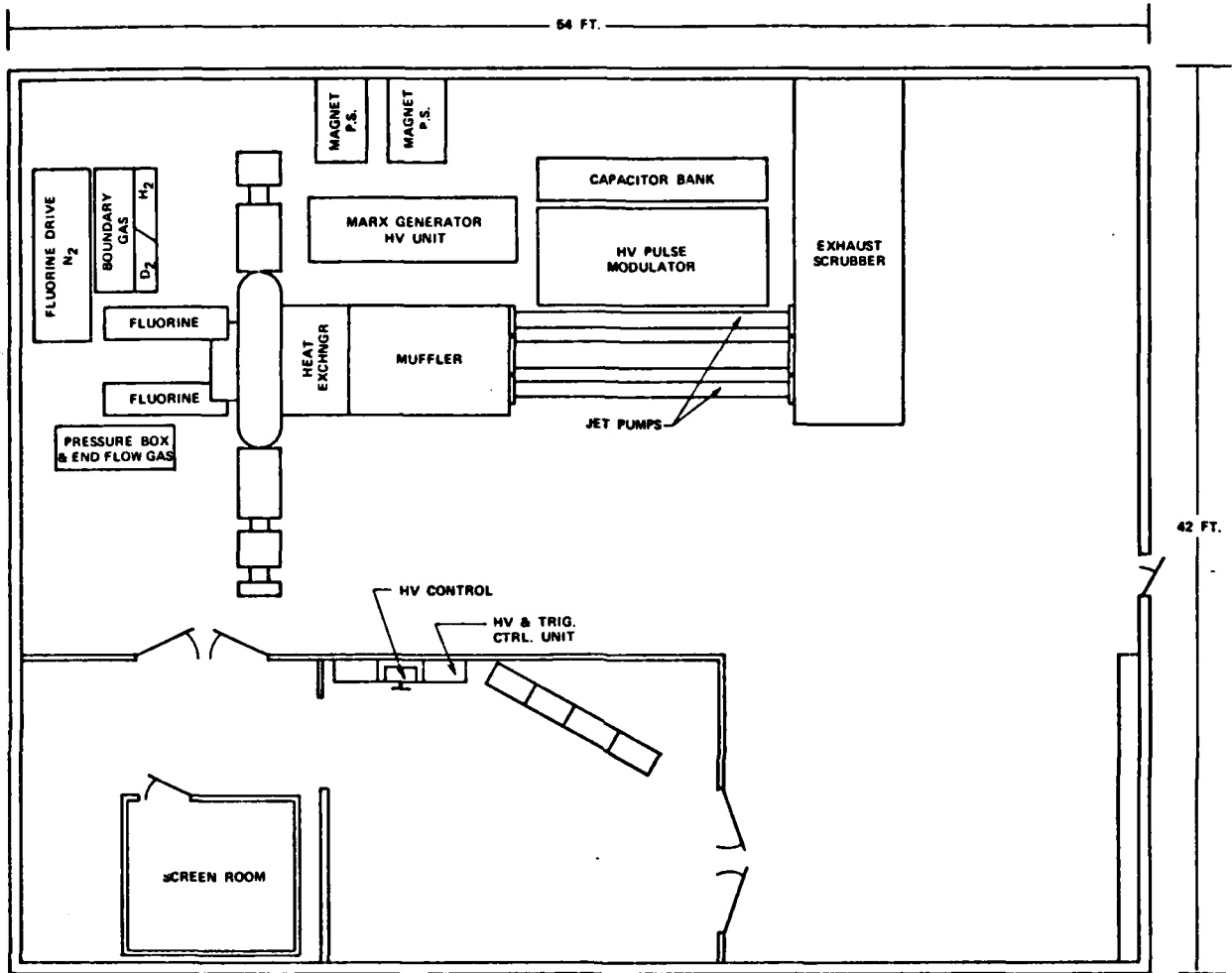
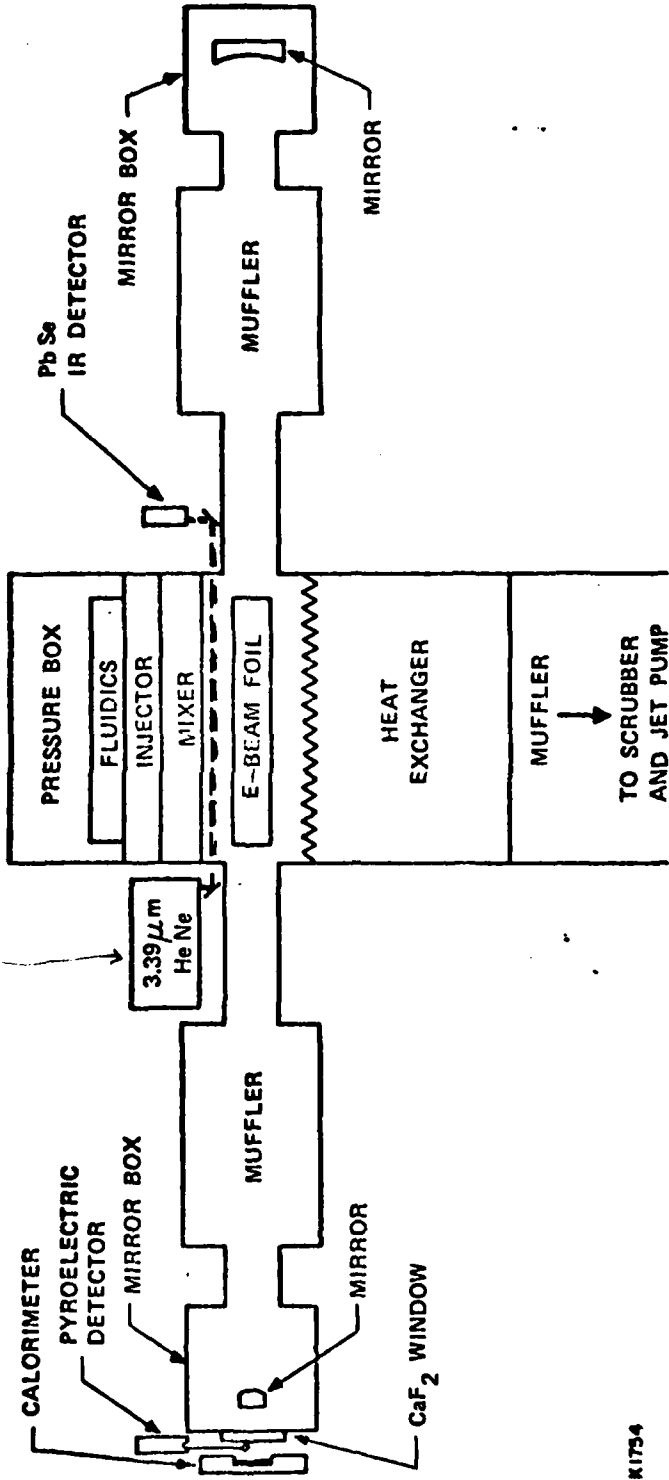


Figure 2.3.2 AERL-PCL Facility Floor Plan

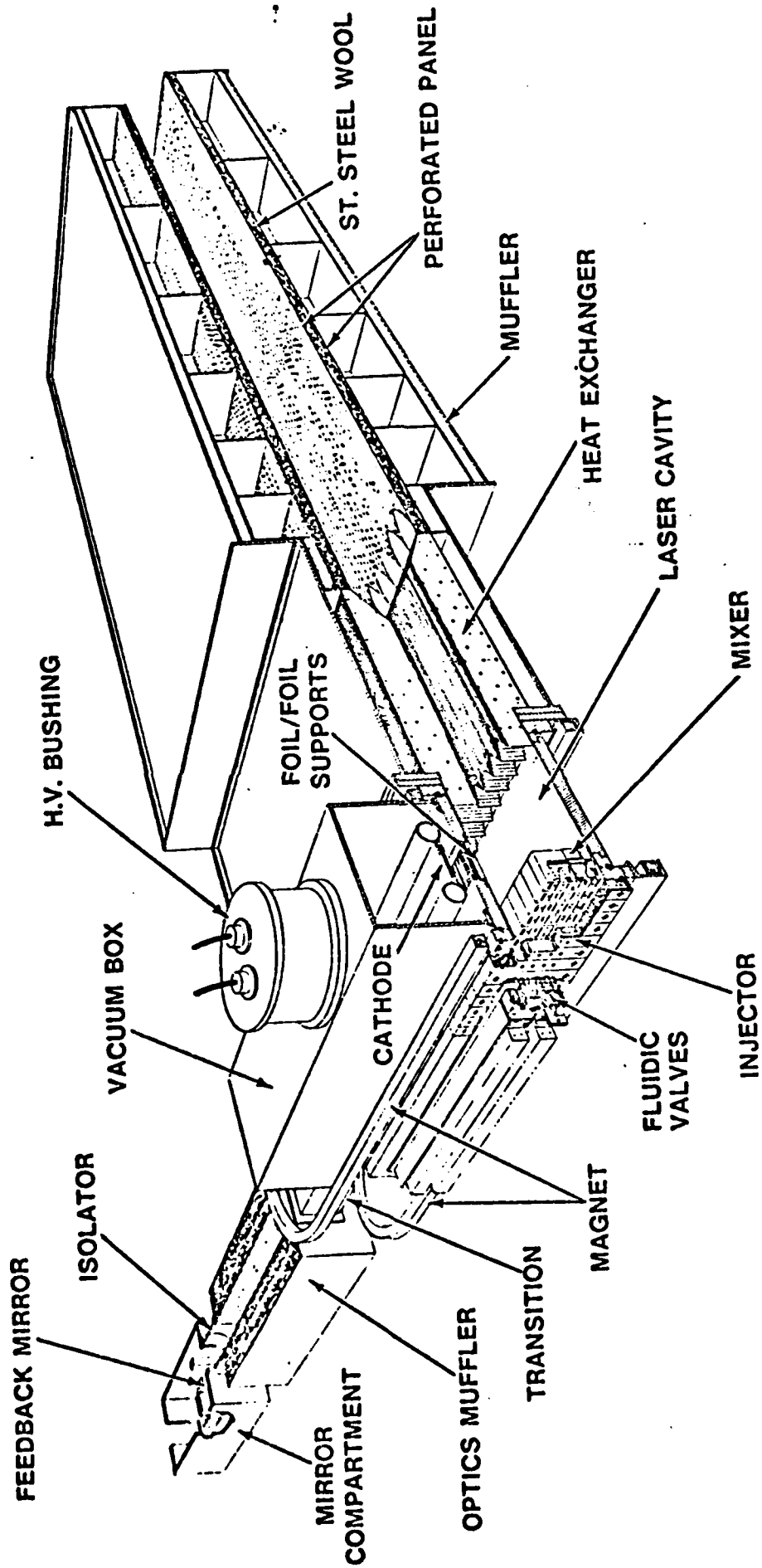
SYSTEM COMPONENTS - PLAN VIEW

Flow thru cavity is TOP to BOTTOM

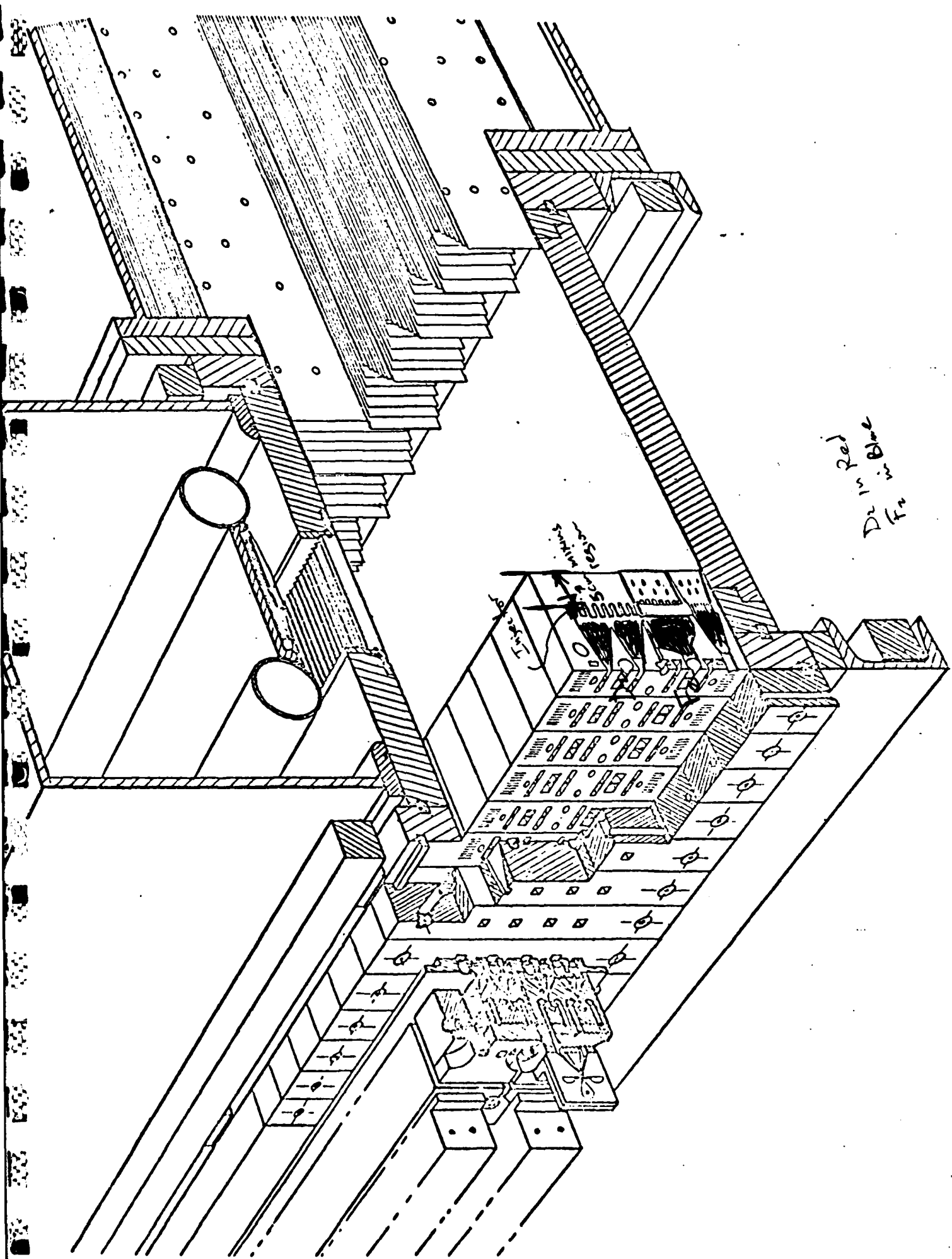
*De diagnostic
cell c₁₀ to Dr. c₁₄ absorber
3.39 μ radiation*



K1754

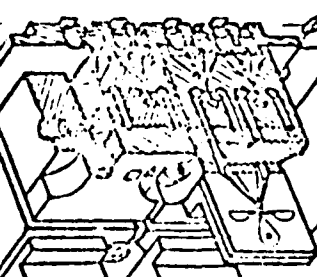


K8074



Dr in Red
Fr in Blue

Top of
Spline
Spline



STATUS OF SYSTEM MODIFICATIONS
ELEMENTS INITIATED AT START OF PROGRAM.

VALVE ASSEMBLY UPGRADE (AERL P-699-SECT 4.3.1.1.1)

TASK COMPLETED.

FLOW TESTING IN PROGRESS.

CATHODE MODIFICATIONS (P-699-SECT 4.3.1.1.3.1)

FABRICATION COMPLETED

INSTALL AND TEST 3/19/84

After 1st single pulse testing.
Will baseline w/ old cathode
for comparison w/ previous data.

ELECTRON GUN MODIFICATIONS (P-699-SECT 4.3.1.1.3.3)

FOIL SUPPORT DESIGN COMPLETED for RP testing

FABRICATE BY 4/9/84

BUSHING MODIFICATIONS COMPLETED ~~for~~ 4 prong receptacle for RP testing

CABLE TERMINATIONS FABRICATION IN PROGRESS

CRYOPUMP AND ADAPTER FLANGES IN HOUSE to increase pumping speed for RP operation

FOIL DESIGN (P-699-SECT 4.3.1.1.2.4) for RP operation

3 MIL KAPTON 1/2 MIL AL FOIL IS IN HOUSE. 1/4" center support. Plan to try 3/8"

4 MIL KAPTON 1.0 MIL AL FOIL TO BE ORDERED. Backup if thinner foils fail
(Takes ~ 2 hrs to replace foil)

OPTICS AND EXHAUST FLOW SYSTEMS MODS (4.3.1.1.4.1-4.3.1.1.5.1)

MODIFICATIONS ARE COMPLETED

FLOW TESTING IS COMPLETED.

OPTICS TESTING - WEEK OF 3/5/84

STATUS OF FLOW TESTING

NO CAVITY GAS FLOW :

AT 1000 PSI JET PUMP DRIVE PRESSURE
CAVITY PRESSURE \leq 180 TORR

FULL CAVITY GAS FLOW :

AT 1200 PSI JET PUMP DRIVE PRESSURE
CAVITY PRESSURE \leq 250 TORR

GOAL OF (.20 ATM F_2 , .06 O_2 , .02 O_2) = 2.13 TORR

CAN BE MET.

may require more O_2 for
stability @ low diluent

CAVITY PRESSURE IS CONSTANT TO $\pm 7\%$

THROUGH THE RUN.

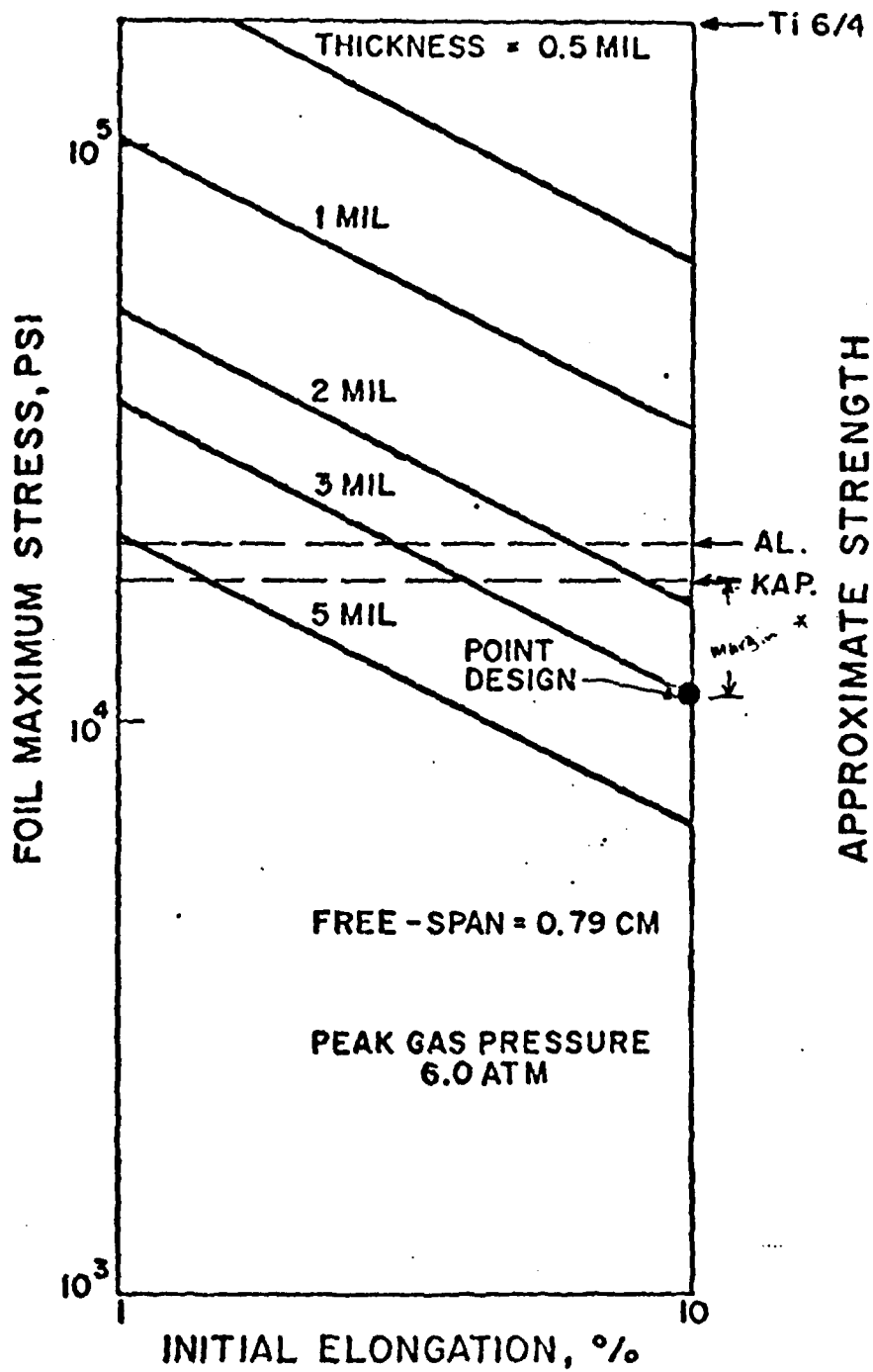
ALL GAS SYSTEMS ARE OPERATING

FLOW CONTROL SYSTEM IS OPERATING.

SPECIAL DIAGNOSTICS GAS HANDLING IS INSTALLED.
HCl & HF sendant flows for diagnostics are installed

FLUIDIC VALVE SWITCHING TESTS 3/5/84 week of

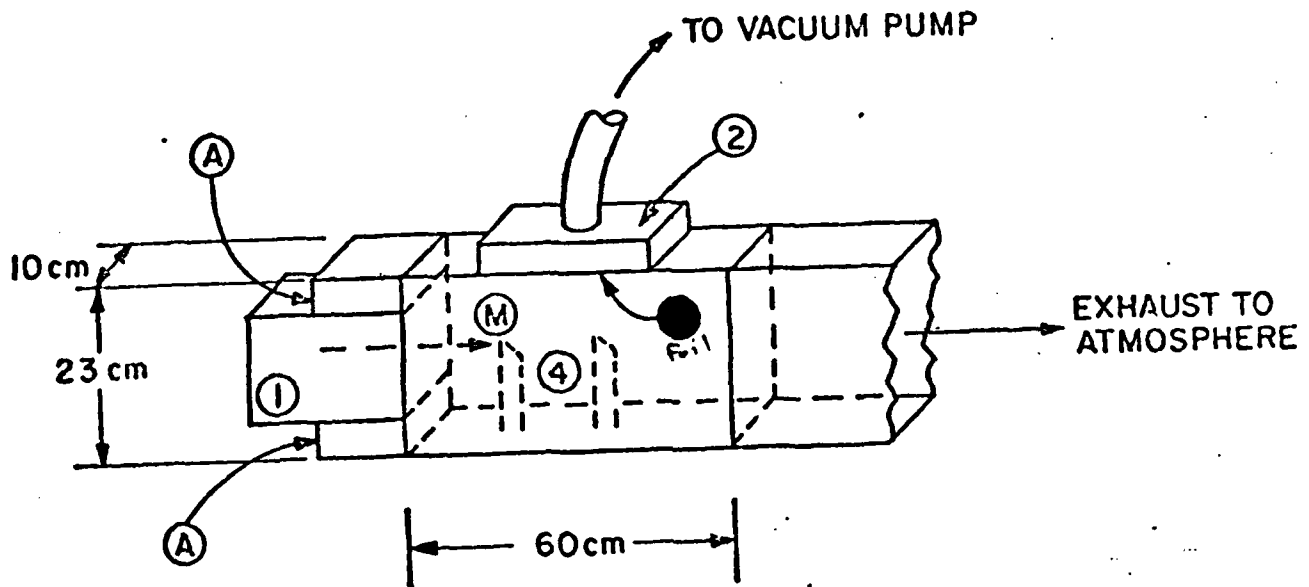
FLUORINE FLOW TESTS 3/5/84 "



K8457

Figure 2.5.1 Stresses in Performed Foils

* Does not include heating.
 If temp goes to 300°C, may
 have to go to 4-mil foil.



L2721

Figure 2.5.2 Sketch of Foil Fatigue Test Set-Up

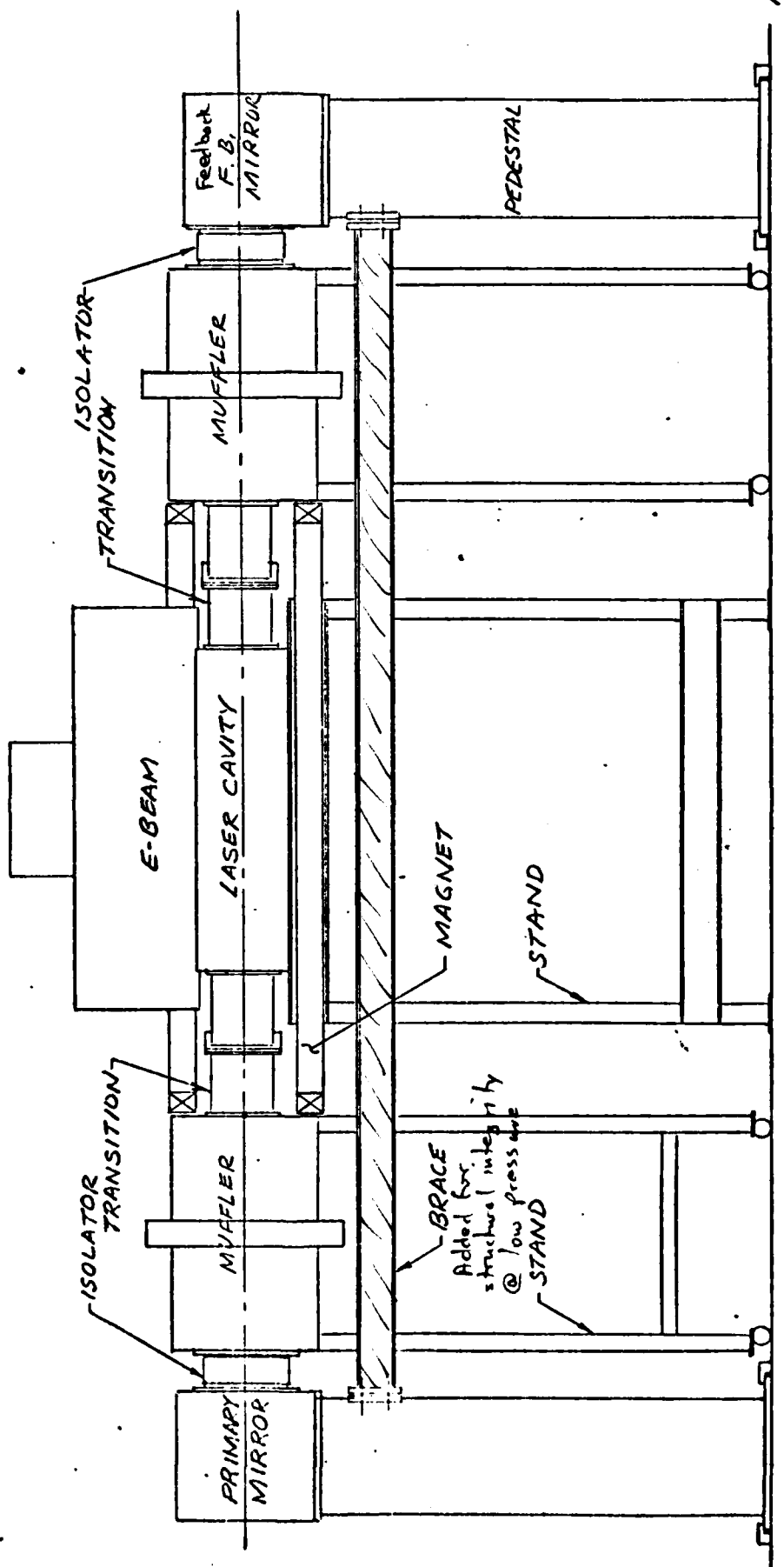
- A : Air Boundary Flow
- M : H₂/Air Mixture Flow
- 1 : Valve and Mixer System
- 2 : Foil Holder and Foil Support Structure
- 3 : 10 x 30 cm Foil
- 4 : Spark Plugs

IR&D Task - Foil Testing

simulates both stress & thermal environments

Goal of 2.5×10^7 pulses @ 25 Hz
(1000 sec @ 25 Hz)

PULSED CHEMICAL LASER
OPTICS TRAIN
SIDE ELEVATION



SPECIAL PERFORMANCE DIAGNOSTICS

Vu

- F₂ (NF₃) DISSOCIATION LEVEL
- LASER SPECTRA
 - < Time integrated
 - < Time Resolved
- TIME DEPENDENT GAIN.

F₂ (NF₃) DISSOCIATION LEVEL

OBJECTIVE: RELATE E-BEAM INITIATION CHARACTERISTICS AND GAS COMPOSITION TO F-ATOM FORMATION.

$$\left(\frac{[F]}{[F_2]} \sim 5 \times 10^{-3} \right)$$

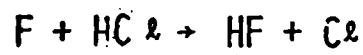
$$0.2 \rightarrow 0.5\%$$

MOTIVATION:

- COUPLE LASER CODE TO EXPERIMENTS.
- DEVELOP SCALING RELATIONS.

APPROACH:

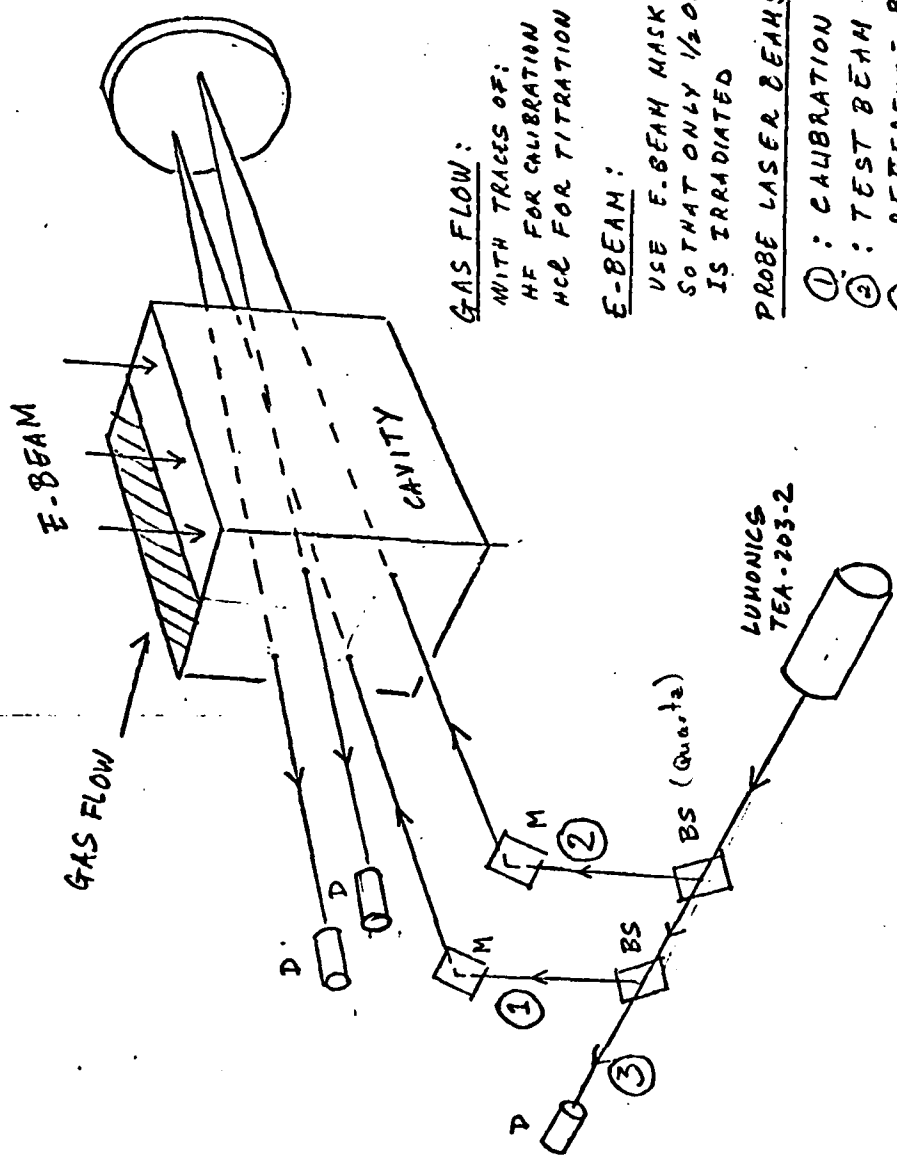
USE SINGLE LINE ($v = 1 \rightarrow 0$) PULSED HF-PROBE LASER TO MEASURE PRODUCT CONCENTRATION IN TITRATION REACTION:



TASKS:

- SELECT HF PROBE LASER (LUMONICS TEA 203).
- SELECT DETECTORS (MOLECTRON PYRCELECTRIC P3-01).
- IMPLEMENT HF CLEAN-UP OF F₂ SUPPLY. (NaF scrubber)
- IMPLEMENT HC₂ INJECTION SYSTEM.
- IMPLEMENT HF CALIBRATION GAS FLOW SYSTEMS.
- IMPLEMENT DIAGNOSTIC OPTICS.
- TEST.

SCHEMATIC FOR F-ATOM MEASUREMENT



GAS FLOW:
 WITH TRACES OF:
 HF FOR CALIBRATION
 HCl FOR TITRATION

E-BEAM:
 USE E-BEAM MASK
 SO THAT ONLY 1/2 OF CAVITY
 IS IRRADIATED

PROBE LASER BEAMS

- ① : CALIBRATION BEAM
- ② : TEST BEAM
- ③ : REFERENCE BEAM

NOMENCLATURE

- D : PYROELECTRIC DETECTOR
- M : MIRROR
- BS : QUARTZ BEAM SPLITTER

F₂ (NF₃) DISSOCIATION MEASUREMENT:

DESIGN CONSIDERATIONS

ABSORPTION LINE

- USE HF 1P8 LINE (2,783 μ) INSTEAD OF 1P4 LINE.
- TOTAL CAVITY LENGTH CAN BE USED AS ABSORPTION PATH.
If 1P4 line is used, ~2cm will absorb 90% of rad
1P8 is 100 times less sensitive.

PROBE LASER

- LUMONICS TEA-203, SINGLE LINE OPERATION
 $I \leq 50\text{KW}/\text{CM}^2$, $\tau = 0.5\mu\text{s}$
- TEST AND CALIBRATION BEAM INTENSITIES
 $I \ll I_S$: AVOID HF BLEACHING

$$I: \text{ BEAM INTENSITY} \approx 0.1\text{KW}/\text{CM}^2$$

$$I_S: \text{ SATURATION INTENSITY} \approx 1.7\text{KW}/\text{CM}^2$$

DETECTORS

- PYROELECTRIC (MOLECTRON P3-01, $\tau_R = 50\text{NS}$,
 $V/I = 3\text{mV}/(\text{KW}/\text{CM}^2)$)
- FILTERS AND FOCUSING LENSES ON DETECTORS.

CALIBRATION

- INTRA-CAVITY CALIBRATION
- CALIBRATION MEASUREMENT SIMULTANEOUS WITH DISSOCIATION MEASUREMENT

LASER SPECTRAL MEASUREMENT

OBJECTIVE:

RELATE DF AND CO₂ TIME-DEPENDENT AND TIME-INTEGRATED SPECTRA,
TO CAVITY AND INITIATION CONDITIONS.

MOTIVATION:

- ADDRESS MODE FORMATION
- TAYLOR SPECTRA TO REMOVE LONG WAVELENGTHS ($74.1 \mu\text{m}$)
- PROVIDE DATA BASE FOR MODELING AND SCALING

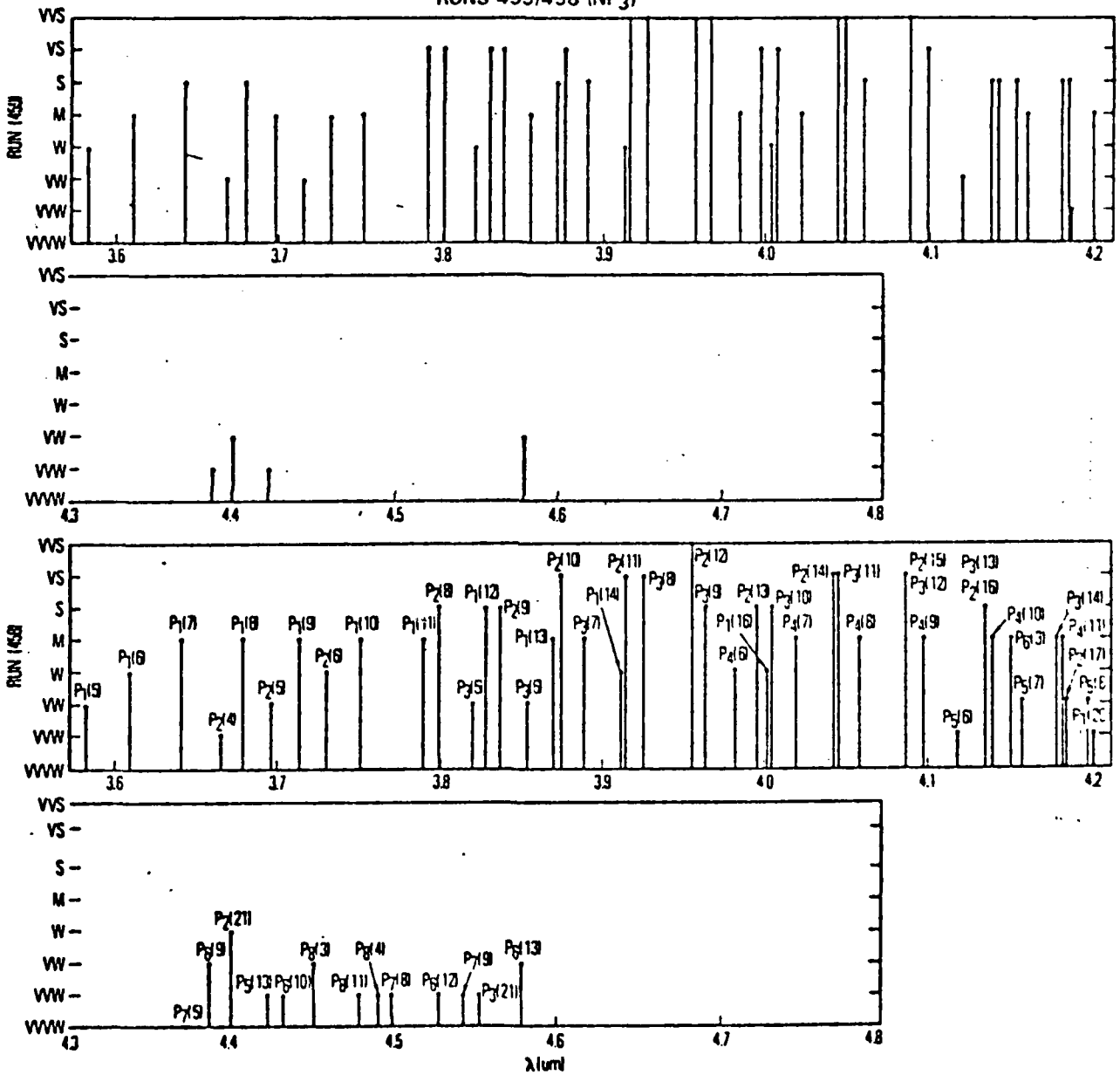
APPROACH:

- GRATING SPECTROMETRY USING EBERT-FASTIE CONFIGURATION
- IR PHOTOGRAPHY FOR TIME-INTEGRATED SPECTRA
- PYROELECTRIC DETECTORS FOR TIME-RESOLVED SPECTRA;
DIGITAL DATA ACQUISITION
Have capability to look @ 10 lines simultaneously

TASKS:

- IMPLEMENT SPECTROMETER OPTICS
- SELECT AND CALIBRATE GRATINGS
- IMPLEMENT IR CAMERA
- IMPLEMENT DETECTOR ARRAYS (10)
- IMPLEMENT DATA ACQUISITION
- TIME-INTEGRATED MEASUREMENT
- TIME RESOLVED MEASUREMENT

DF SPECTRA
RUNS 459/458 (NF₃)

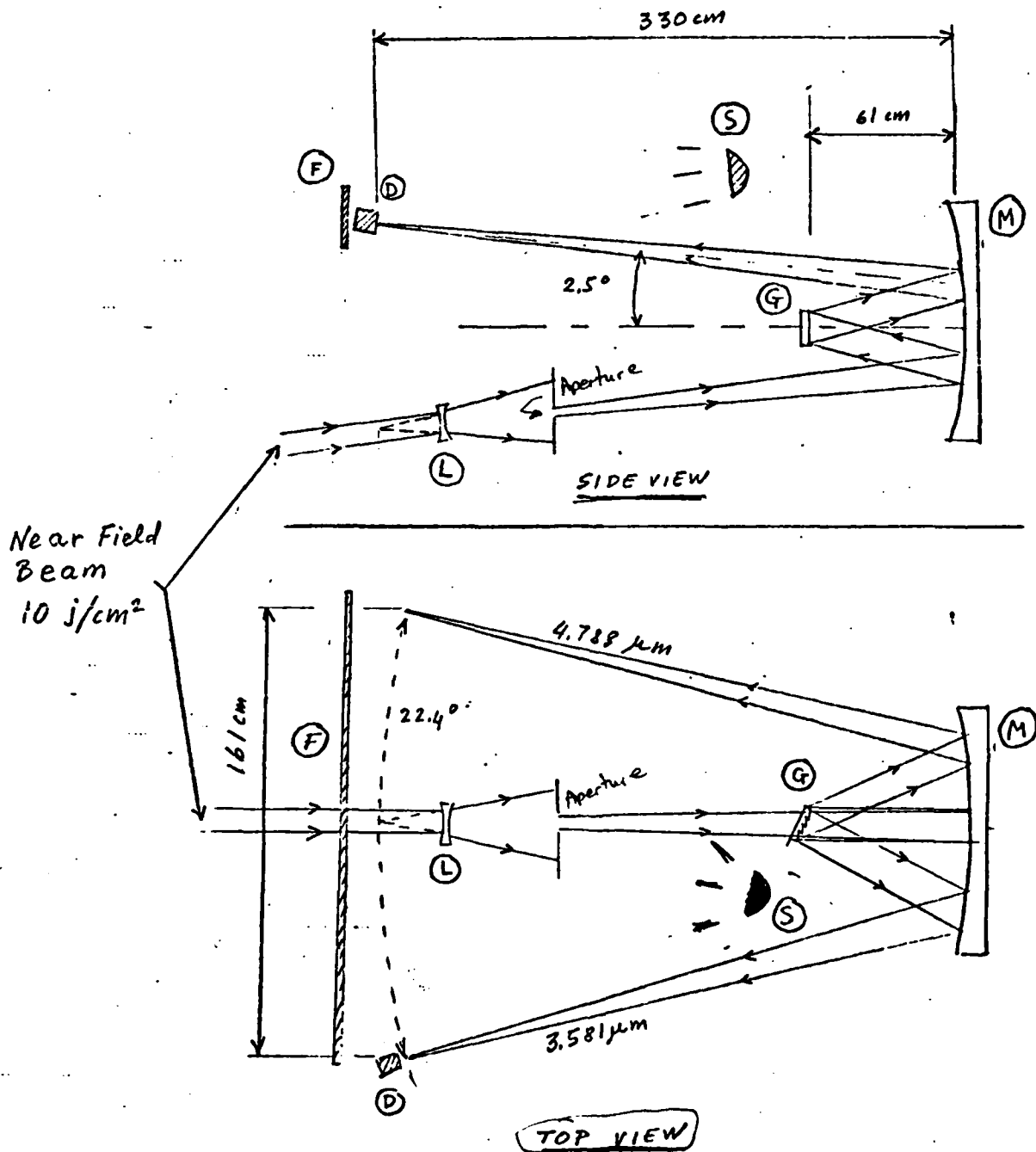


35 F₂ : 18 D₂ : 35 NF₃ : 120₂

458 200 torr

459 400 torr

SPECTROMETER



(L): Diverging Lense,
CaF₂, $f = -10\text{cm}$

(M): Spherical Mirror,
 $f = 330\text{cm}$

(G): Blazed Grating, (5x5cm)
300 l/mm for DF Spectra
150 l/mm for DF/CO₂ Spectra

(D) Pyroelectric Detector
Moletron PI-61
(1 of 10 shown)

(F): Film Plane,
35mm Kodak 5367.No.1

(S): Stoboscope Flash
Gen Rad 1531AB

SPECTRAL MEASUREMENT: DESIGN CONSIDERATIONS

DF SPECTRAL RANGE

- 69 LINES BETWEEN $3.581\mu\text{M}$ AND $4.788\mu\text{M}$
- SMALLEST LINE SEPARATION: $0.003\mu\text{M}$

Expect to have 8 data channels available for tests.

GRATING SPECTROMETER

- EBERT-FASTIE CONFIGURATION
- MAXIMUM REVOLVING POWER: $0.00026\mu\text{M}$
- LINE SEPARATION CAPABILITY:
 $\Delta s/\Delta\lambda = 1.3\text{cm}/0.01\mu\text{M}$
- TOLERANCE TO INCIDENT BEAM JITTER:
 $\Delta\theta_i = \leq \pm 2.5\text{M RAD}$
- N_2 FLUSH TO AVOID ABSORPTION BY CO_2 .

TIME-INTEGRATED MEASUREMENT: IR PHOTOGRAPHY

- PRINCIPLE: HEATING OF FILM BY LASER LINES CHANGES FILM SENSITIVITY.
- LINEAR RESPONSE FOR $J \leq 500 \text{ mJ}/\text{cm}^2$ (SILVER HALIDE EMULSION).
- QUANTITATIVE MEASUREMENT FOR ALL LASING LINES.

TIME-RESOLVED MEASUREMENT: PYROELECTRIC DETECTORS

- 10 STRONGEST LINES ($3.8\mu\text{M} < \lambda < 4.2\mu\text{M}$) MEASURED BY MOLECTRON P1-61 PYROELECTRIC DETECTORS.
- WORKING INTENSITY RANGE $0.04\text{kW}/\text{mm}^2 < I < 4\text{kW}/\text{mm}^2$
- DIGITAL DATA ACQUISITION.

TIME DEPENDENT GAIN

OBJECTIVE:

MEASURE LASER GAIN AT SELECTED WAVELENGTHS

MOTIVATION:

PROVIDE DATA BASE FOR SYSTEM DESIGN,
MODELING AND SCALING

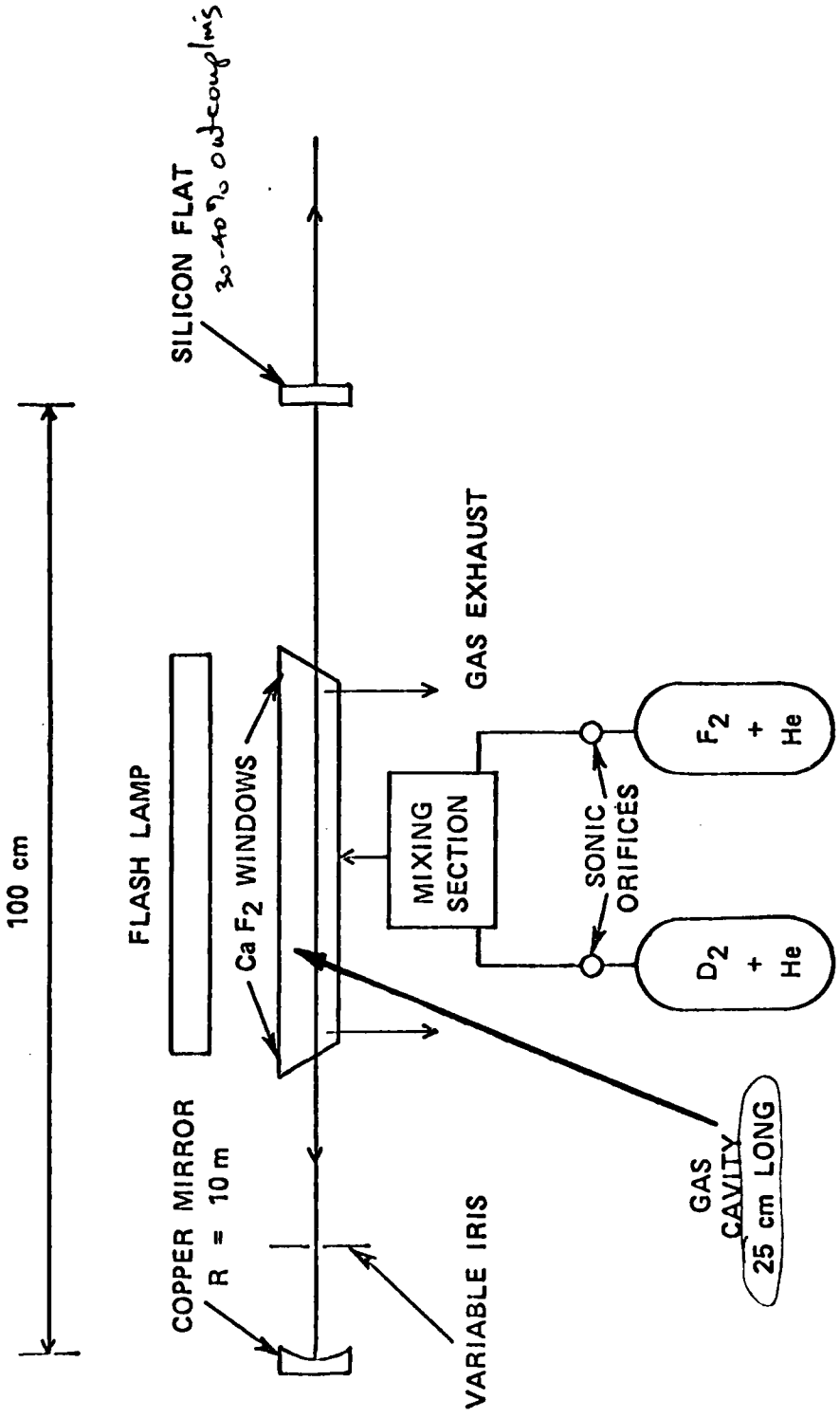
APPROACH:

- FABRICATE PROBE DF LASER WITH 4 μ SEC PULSE TO MEASURE TIME-RESOLVED GAIN
- LINE SELECTION BY 300 λ /MM GRATING

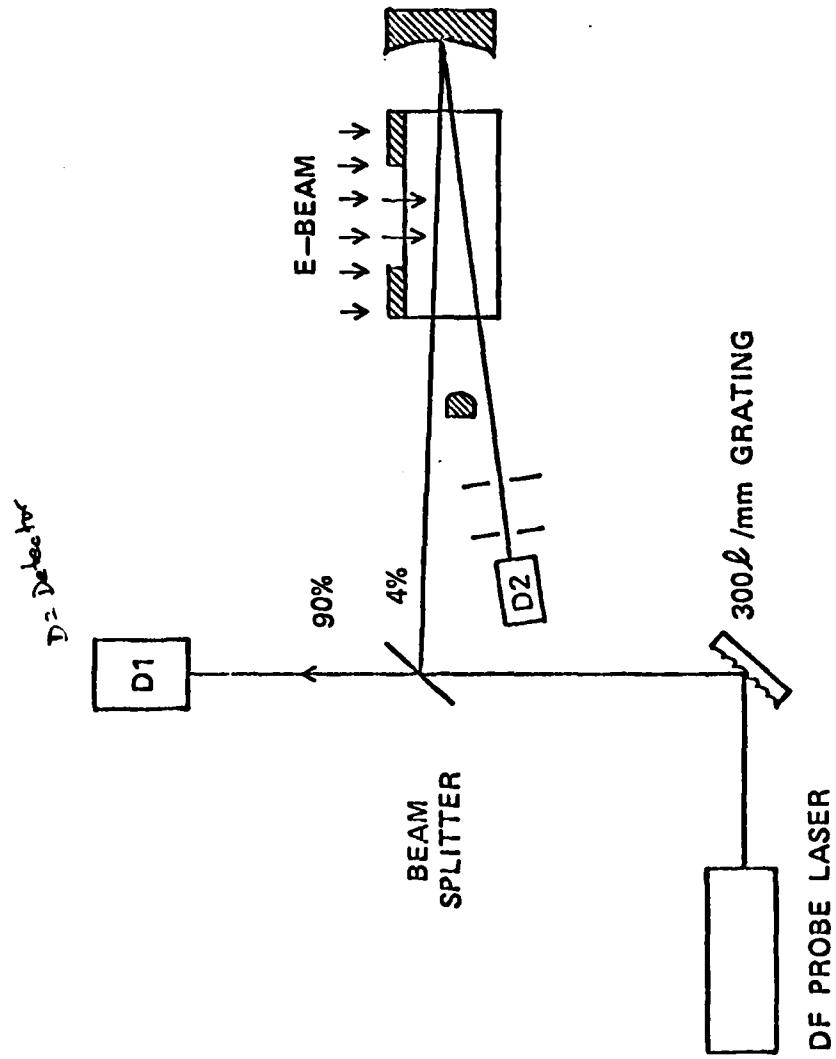
TASKS:

- FABRICATE FLASHLAMP INITIATED DF PROBE LASER
- IMPLEMENT OPTICS AND DETECTOR ARRAY
- GAIN MEASUREMENT

DF PROBE LASER



SCHMATIC FOR TIME RESOLVED GAIN MEASUREMENT



K9546

TIME DEPENDENT GAIN: DESIGN CONSIDERATIONS

DF PROBE LASER

- FLASHLAMP INITIATED
- LASER PULSE:
 - $\tau = 4 \mu\text{s}$ (FWHM)
 - $I = 200 \text{ W/cm}^2$ PER LINE
- GAIN MEASUREMENT: $\pm 15\%$ UNCERTAINTY WITH 100 CM LONG OPTICAL CAVITY OF PROBE LASER

EXPERIMENTAL CONDITIONS

- TEST BEAM INTENSITY:

$$I_T \ll I_S$$

I_T : TEST BEAM INTENSITY (10 W/cm²)

I_S : SATURATION INTENSITY (600 kW/cm²)

- LENGTH OF E-BEAM APERTURE:
REDUCED TO 25 CM TO AVOID AMPLIFIED SPONTANEOUS
EMISSION (ASE)

SPECIAL PERFORMANCE DIAGNOSTICS:
STATUS

F₂ (NF₃) DISSOCIATION MEASUREMENT

- DIAGNOSTIC SYSTEM READY FOR SHAKEDOWN AND TESTING.

SPECTRAL MEASUREMENT

- ASSEMBLY IN PROGRESS
- TIME INTEGRATED MEASUREMENT:
 - SPECTROMETER READY FOR TESTING 3/26/84.
- TIME RESOLVED MEASUREMENT:
 - PYROELECTRIC DETECTORS DELIVERED 3/12/84.
 - INSTALL 1 DATA CHANNEL 3/19-3/26/84. ←
 - IMPLEMENT DETECTOR ARRAY AND DATA ACQUISITION SYSTEM 3/26-4/27/84.
 - READY FOR TESTING 4/30/84. ←

TIME DEPENDENT GAIN MEASUREMENT

- TEST OPTICS COMPLETED
- PROBE LASER READY FOR SHAKEDOWN AND TESTING.
- TESTING 5/7/84 (TENTATIVE).

DATA ACQUISITION REQUIREMENTS

Nelson Drozco

EXPERIMENTS TO BE DONE

CHANNELS AVAILABLE

: F-ATOM FORMATION

- GUN CURRENT
- GUN VOLTAGE
- PROBE LASER PULSE SHAPE
- ABSORPTION REF. PATH
- ABSORPTION TEST PATH
- CAVITY PULSE OVERPRESSURE

: TIME RESOLVED LASER SPECTRA

- GUN CURRENT
- GUN VOLTAGE
- CAVITY PULSE OVERPRESSURE
- LASER PULSE SHAPE
- SPECTRA MEASUREMENTS

Oscillo- SCOPE		* DATA	** LECROY
<u> </u>		<u>PRECISION</u>	<u> </u>
(4)		(4)	(8)
	1	1	
	1	1	
	1	1	
	1	1	
	1		
		1	
		1	
		1	
		1	
			8

* Each unit has 2 channels. Only one in house now. Other on order

** Lecroy Inst. will be ordered this week

DATA ACQUISITION REQUIREMENTS

SCOPE	DATA	LECROY
<u> </u>	<u>PRECISION</u>	<u> </u>
(4)	(4)	(8)

: TIME RESOLVED LASER GAIN MEASUREMENTS

GUN CURRENT

GUN VOLTAGE

CAVITY PULSE OVERPRESSURE

LASER PULSE SHAPE

GAIN MEASUREMENTS

1
1
1
1

2

DATA ACQUISITION REQUIREMENTS

- TIMING & SAMPLING

PULSE WIDTH - 0.5 μ S - 5 μ S

RESOLUTION - 50 NS

PULSE SAMPLING RATE - > 20 MHz

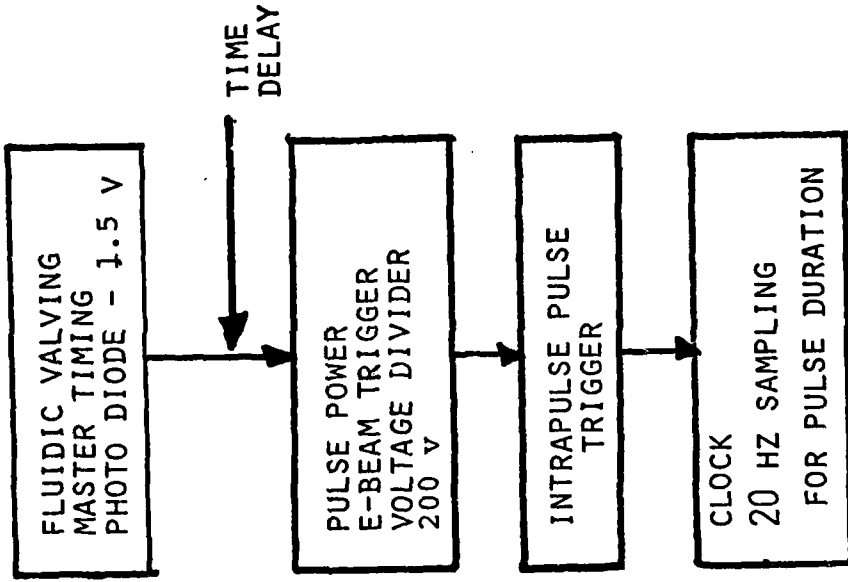
PULSE REPETITION RATE - 10 HZ \rightarrow 30 HZ

No. PULSE EVENTS - 18 MAX.

- No. CHANNELS - 12

DATA ACQUISITION REQUIREMENTS

● TIMING & CONTROL LOGIC



DATA ACQUISITION REQUIREMENTS

- SYSTEM HARDWARE REQUIREMENTS FOR SINGLE PULSE
 - 2 - DATA PRECISION DATA 6000 WAVEFORM ANALYZER
(1 IN HOUSE)
 - 2 - DATA PRECISION MODEL 620 , 100 MHZ DIGITIZING MODULE
8 BIT RESOLUTION, 2 CHANNELS
 - 4 - DATA PRECISION MODEL 694-B PROBES
 - 2 - DATA PRECISION FIRMWARE 682-30
RS232C INTERFACE AND IEEE-4888
GPIB INTERFACE
 - 1 - LECROY 3500SA32 MULTICHANNEL ANALYZER
 - 2 - LECROY NIM MODEL 612AM 6-CHANNEL PHOTOMULTIPLIER AMPLIFIER
 - 6 - LECROY MODEL TR8837F 32 MEGASAMPLE/SEC. TRANSIENT RECORDER
 - 6 - LECROY MODEL 4501A NIM TO CAMAC ADAPTERS
 - 1 - LECROY MODEL 1434 CAMAC CRATE
 - 1 - LECROY MODEL 3501 CRATE CONTROLLER
 - 1 - LECROY 3500-38-488 INTERFACE

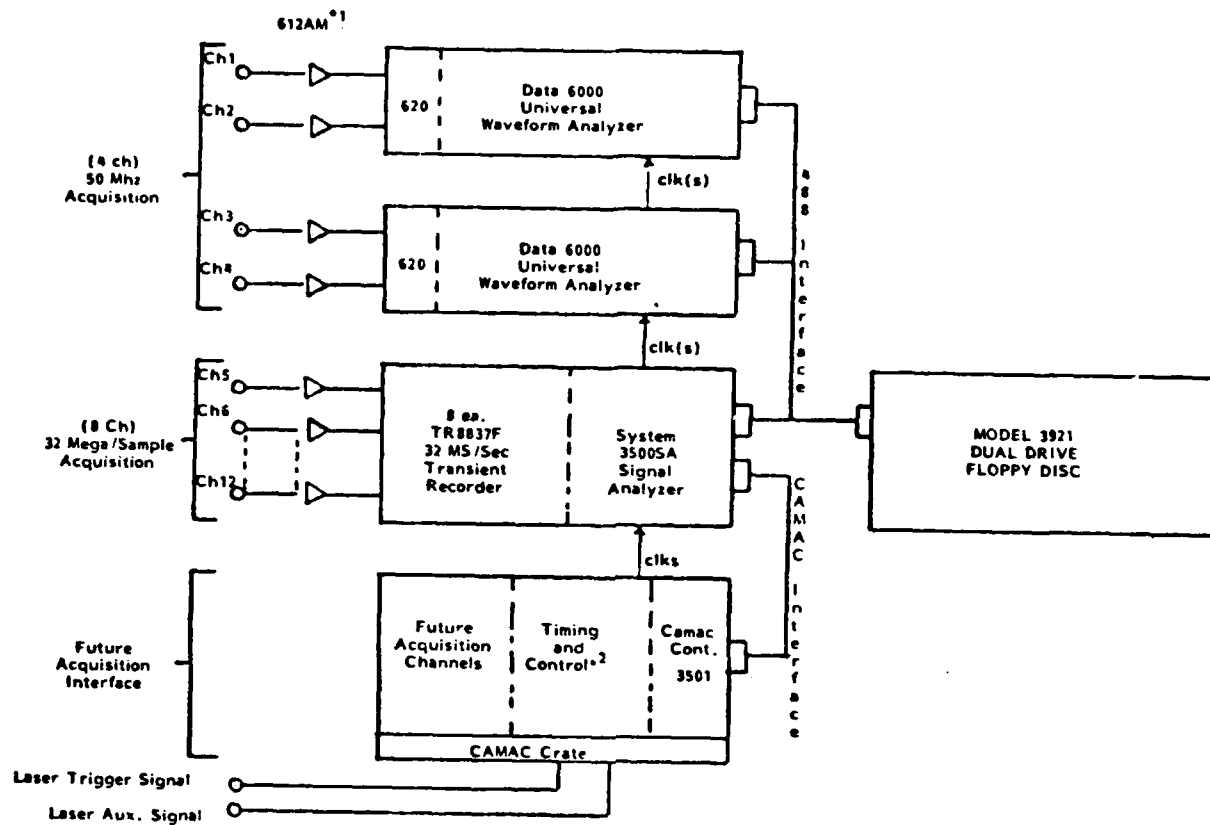
Completed by [unclear] 4-1-80

DATA ACQUISITION REQUIREMENTS

- SYSTEM HARDWARE REQUIREMENTS FOR REP. PULSE

- SAME REQUIREMENTS FOR SINGLE PULSE

- 1 - LECROY NIM MODEL 222/222N DUAL GATE & DELAY GENERATORS
 - 1 - LECROY NIM MODEL 428F (430) QUAD LINEAR FAN IN/FAN OUT
 - 1 - LECROY NIM MODEL 620D 8-CHANNEL DISCRIMINATOR
 - 1 - LECROY NIM MODEL 688AL LEVEL ADAPTER



NOTES:

*1 SW612AM NIM 6-Channel Photomultiplier Amplifier (2 ea) will be contained in CAMAC Crate using NIM to CAMAC adaptors.

*2 The Timing and Control Modules Include

- Lecroy 222 Dual Gate/Delay Generator
- Lecroy 620D - 8 Channel Discriminator
- Lecroy 828F - Quad Linear Fan In/Fan-Out
- Lecroy 688AL - Level Adapter

L2875

Figure 2.8.5 Data Acquisition System Schematic

~1 week behind schedule. No catch-up capability. Slips on 1/1 ratio

TABLE I: TEST PLAN: TASK III - SINGLE PULSE TESTING (Continued)

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

- F. FLUORINE ATOM PRODUCTION MEASUREMENTS
- F1 FABRICATE F-ATOM REFERENCE AND TEST LEGS
- F2 SHAKE DOWN LUMONICS OF LASER
- F3 INSTALL F-ATOM CONVEYANCE OPTICS
- F4 SHAKE DOWN F-ATOM DETECTORS
- F5 MEASURE F-ATOM FORMATION

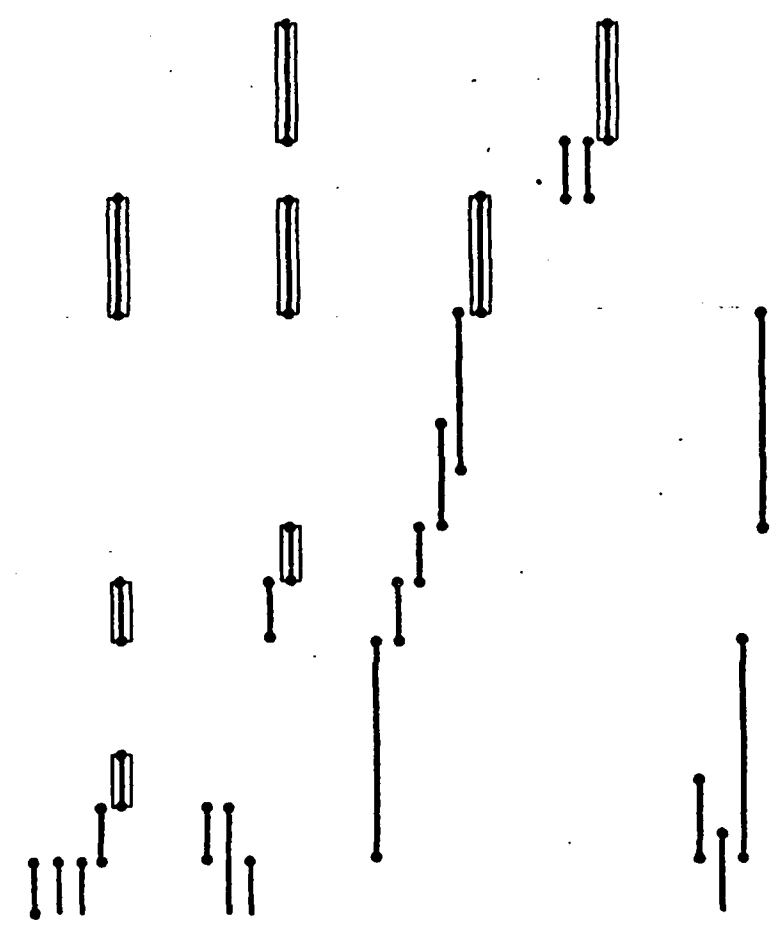
- G. TIME INTEGRATED LASER SPECTRAL MEASUREMENTS, DF
- G1 INSTALL SPECTROMETER
- G2 FABRICATE FILM HOLDER
- G3 INSTALL FLASH LAMP
- G4 IMPLEMENT LASER/SPECTROMETER ALIGNMENT
- G5 MEASURE LASER f_{DF} (A,0) at

- H. TIME RESOLVED LASER SPECTRAL MEASUREMENTS, DF
- H1 OBTAIN DF (A,0), CO₂ (A,0) DETECTORS (10)
- H2 INSTALL ONE COMPLETE DF (A,0) DATA CHANNEL
- H3 SHAKE DOWN ONE DF (A,0) CHANNEL
- H4 INSTALL DF (A,0) DETECTOR ARRAY
- H5 INTEGRATE DF (A,0) WITH DATA ACQUISITION
- H6 MEASURE DF (A,0) - TIME RESOLVED SPECTRA

- I. TIME RESOLVED LASER SPECTRAL MEASUREMENTS, CO₂
- I1 MODIFY CALORIMETER AND WINDOW FOR CO₂ (A,0)
- I2 MODIFY SPECTROMETER FOR CO₂ (A,0)
- I3 MEASURE CO₂ (A,0) - TIME RESOLVED SPECTRA

- J. DATA ACQUISITION SYSTEM
- J1 IMPLEMENT 2-CHANNEL A/D DATA ACQUISITION
- J2 FINALIZE SELECTION OF DATA ACQUISITION SYSTEM
- J3 OBTAIN DATA ACQUISITION SYSTEM
- J4 IMPLEMENT DATA ACQUISITION SYSTEM

LEWIS



PULSED CHEMICAL LASER

PULSE POWER SYSTEM DESIGN

CHARLES PIKE

AVCO EVERETT

TECHNICAL APPROACH FOR REPETITIVE PULSE POWER SYSTEM

- REQUIREMENTS/SPECIFICATION
- IN-HOUSE AVAILABILITY OF SUBSYSTEMS
 - HV LOW CURRENT POWER SUPPLY
 - DOUBLE-ENDED CERAMIC THYRATRONS
 - OIL TANK
 - HV ENERGY STORAGE CAPACITORS
- DESIGN CONSIDERATIONS VS. TRADE-OFFS Modified S³ Device
- SIMPLE SKETCHES
- LAYOUT
 - SUBSYSTEM
 - COMPONENTS
 - INTERFACES



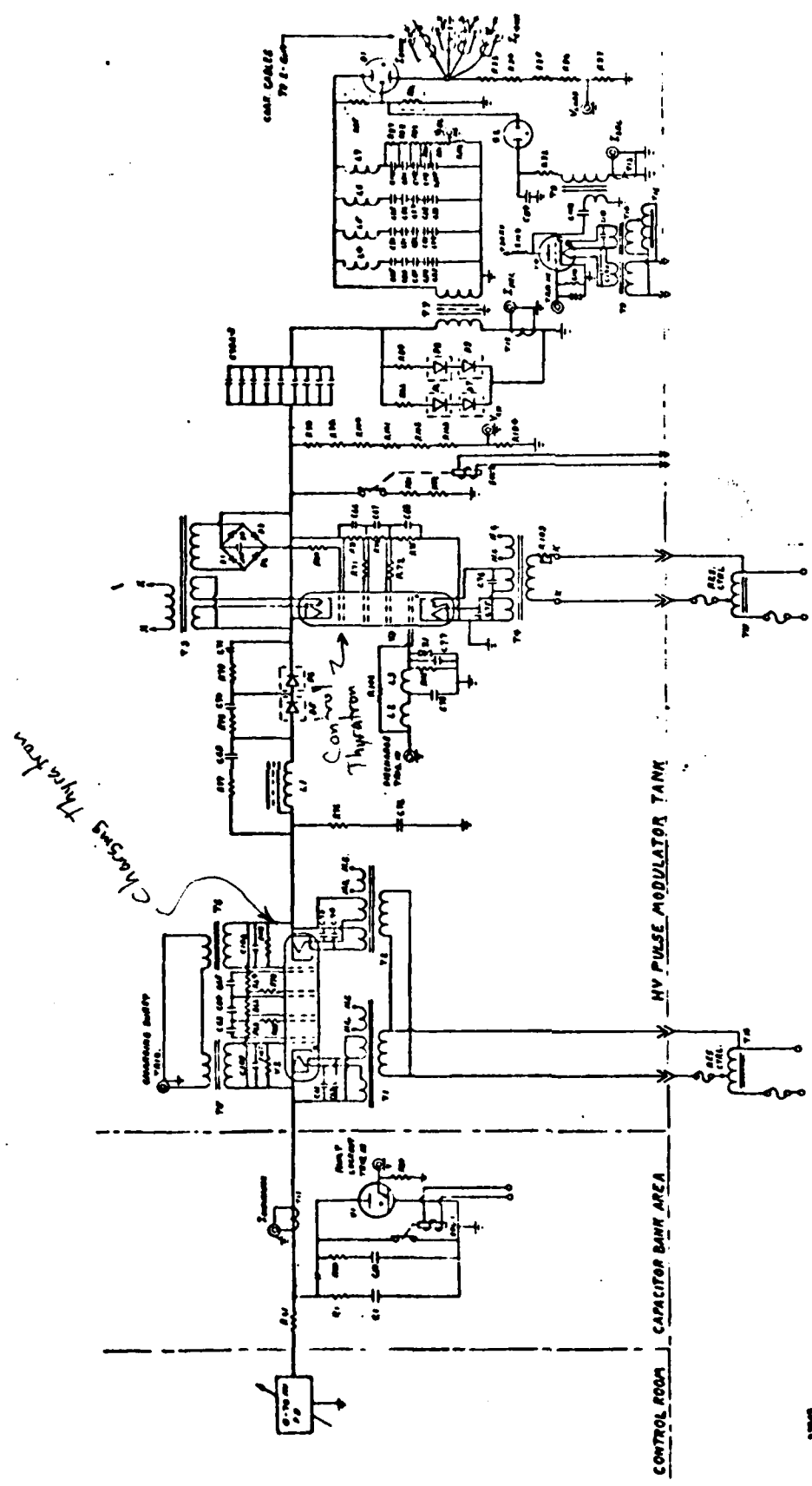
ELECTRON GUN SPECIFICATIONS

- VOLTAGE 230 KV MAX. ● PULSE RATE 30 HZ
- CURRENT DENSITY 11.3A/CM² ● RESISTANCE 12.2 Ω (INITIAL)
- PULSE LENGTH 0.5 μ SEC ● AV. ELCTRODE SPACING 4.3 CM
- ENERGY 1640 J/PULSE ● CLOSURE VELOCITY 1.0 CM/ μ SEC
- AREA 1450 CM² ● RISE TIME 150 N SEC. MAX.
- CURRENT 16.4KA



REPETITIVE PULSE POWER SYSTEM: OPERATING PARAMETERS

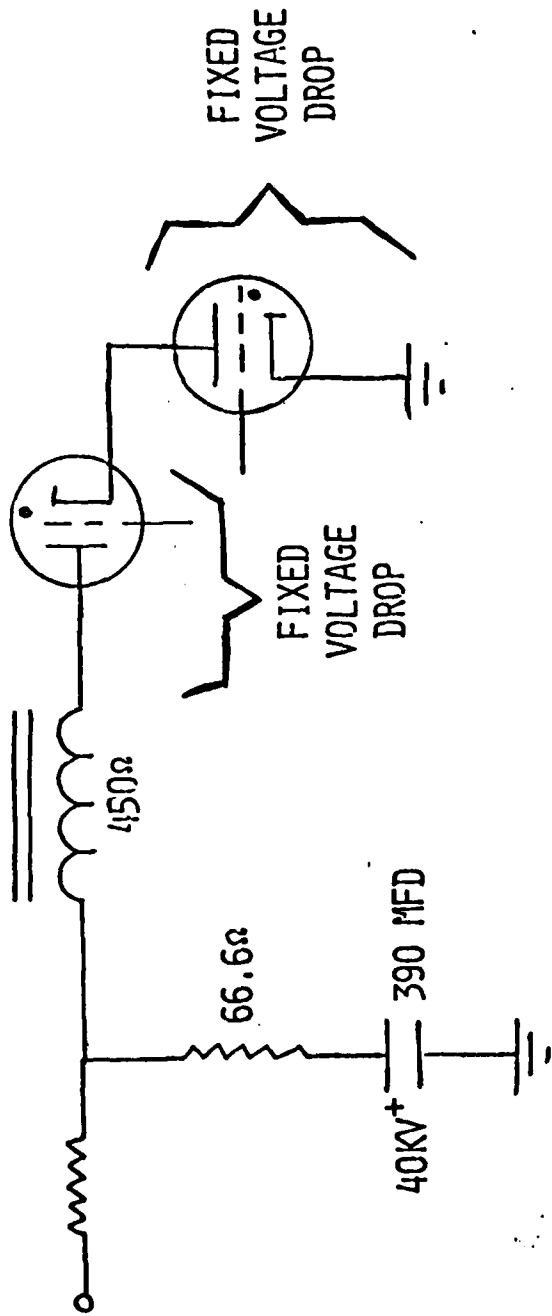
- POWER SUPPLY 0-70 KV AT 50 MA DC
- PRIMARY STORAGE CAPACITY 390 MFD AT 40 KV
- THYRATRON CHARGING STOP/START CHARGE
- INTERMEDIATE CAPACITY 1.0 MFD AT 80 KV
- INTERMEDIATE REGULATION ZENOX UNITS
- INTERMEDIATE SWITCH 105 KV CERAMIC THYRATRON
- MODULATOR OUTPUT SWITCH 460 KV SPARK GAP (Identical to one in S³)



"Master Schematic of E-Gun HV Pulse Modulator System"

AVCO EVERETT

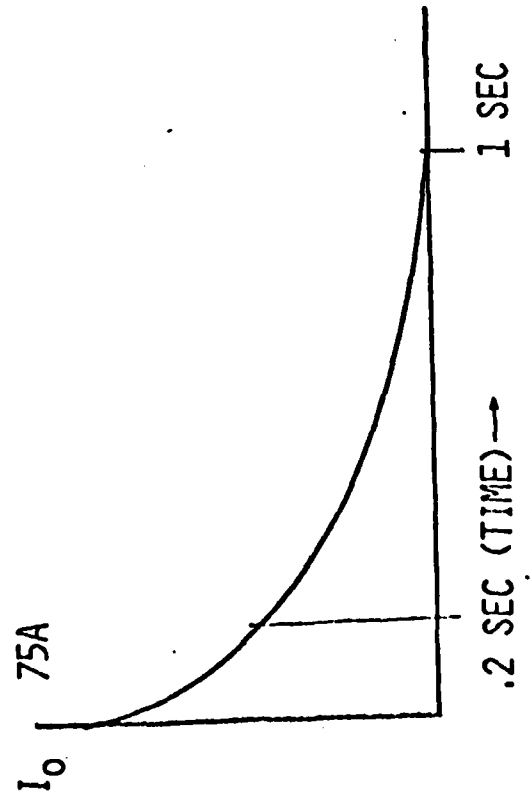
PEAK CAPACITOR BANK FAULT CURRENT



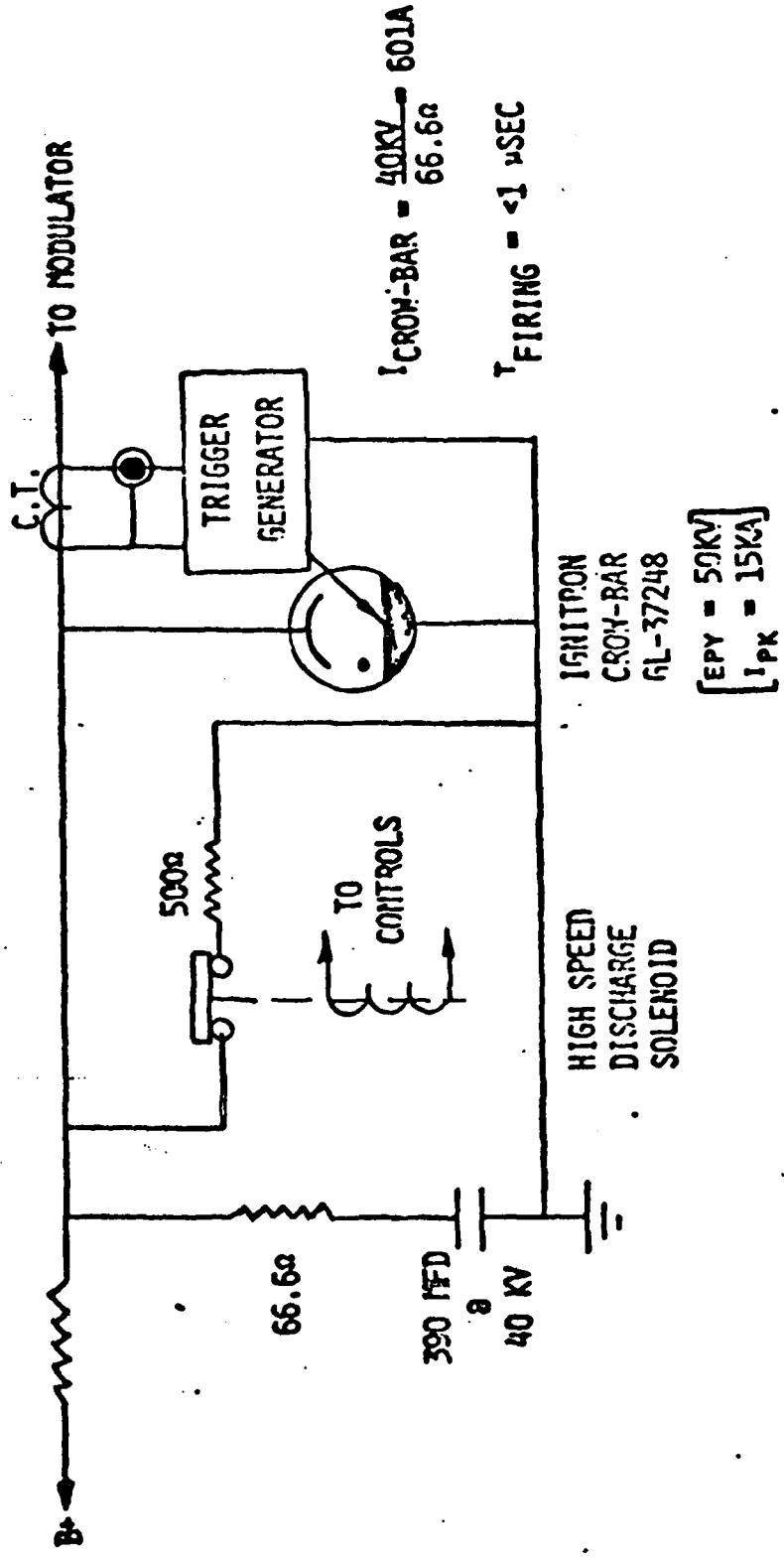
$$I_0 = \frac{40 KV - 2 (TUBE DROP)}{66.6 + 450} = 75 \text{ AMPS}$$

$$RC = 390 \times 10^{-6} \times 516.6 = 0.2 \text{ SEC}$$

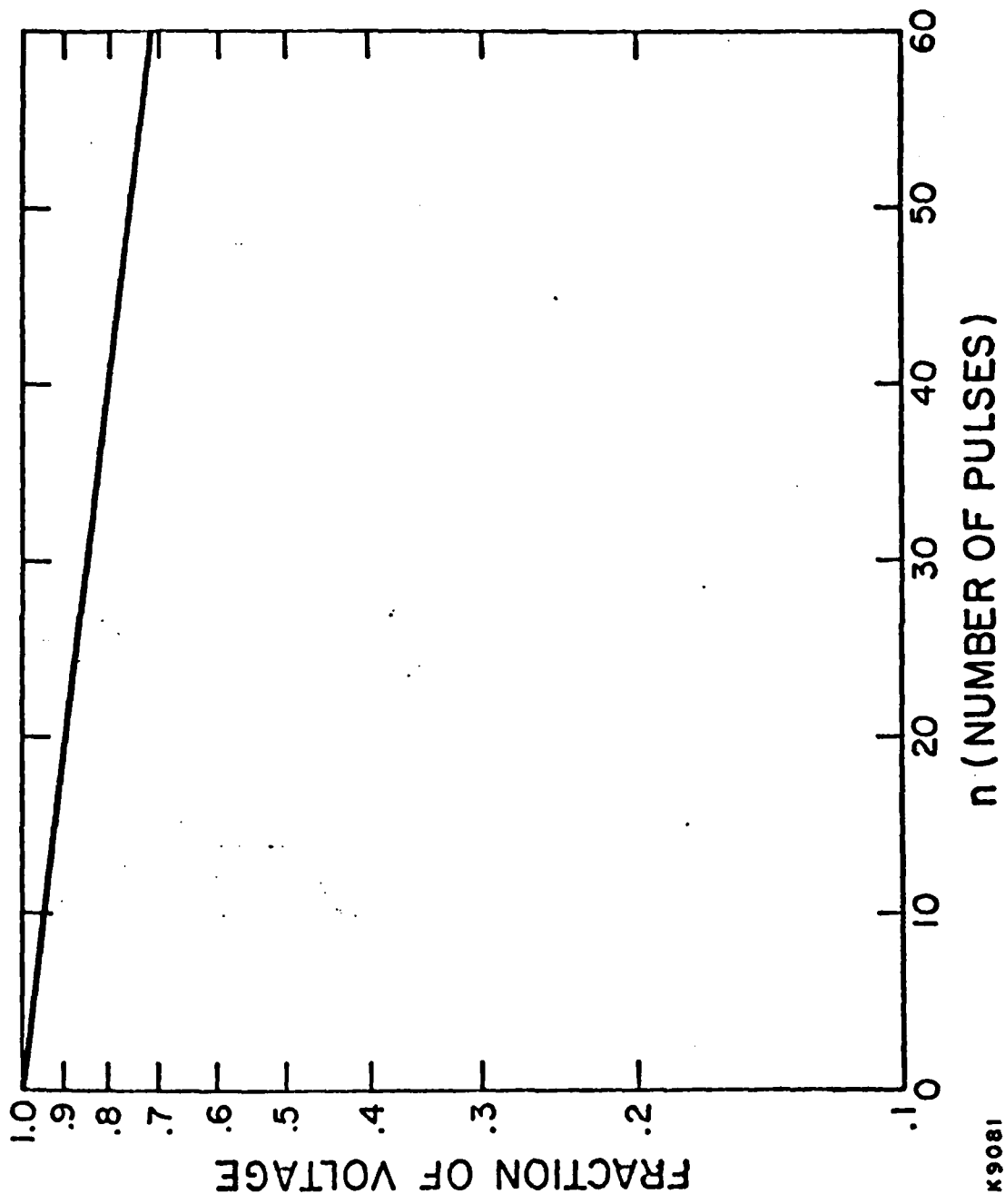
$$5RC = 1 \text{ SEC}$$



PROTECTIVE CROM-BAR DESIGN



AVCO EVERETT

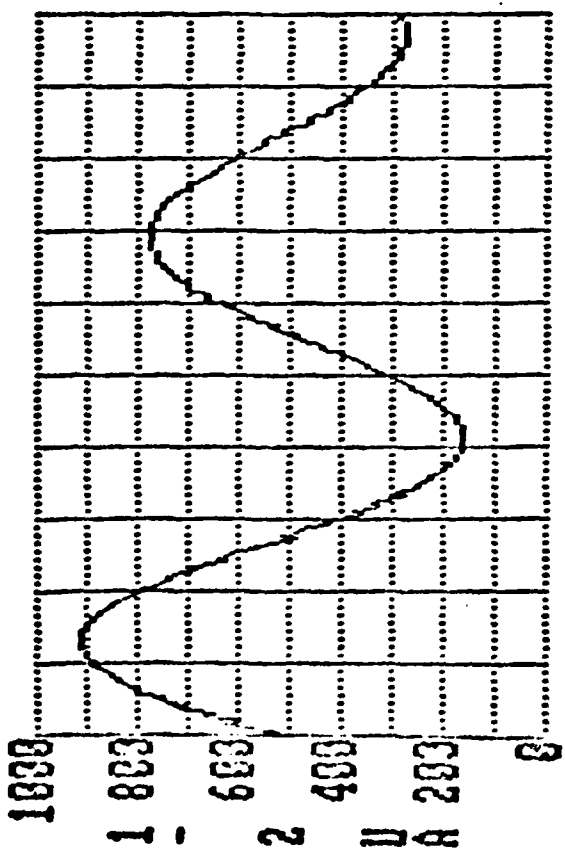


K9081

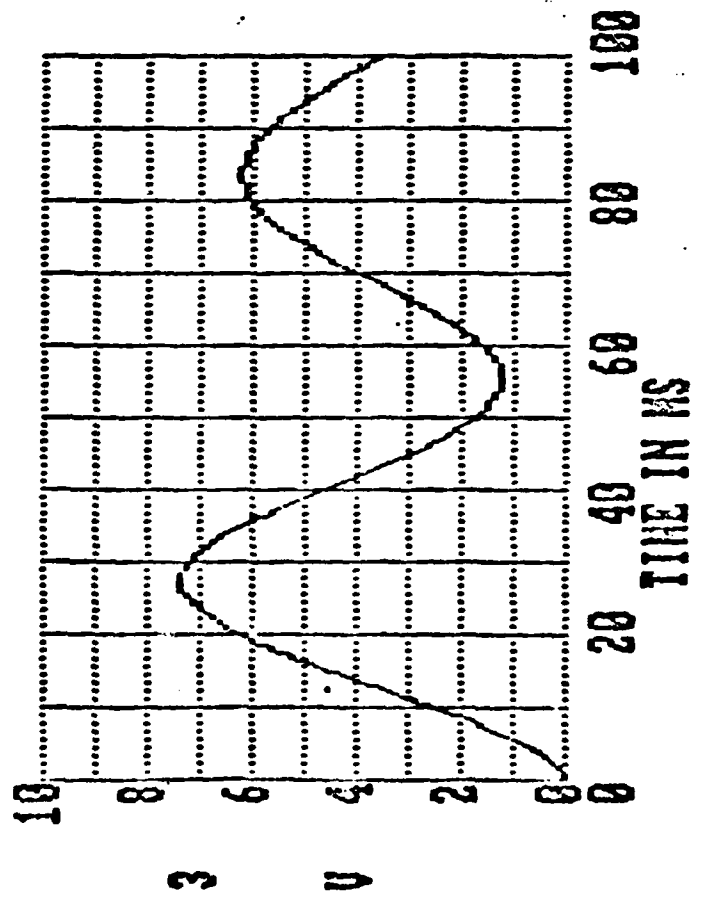
AVCO EVERETT



CHARGE1

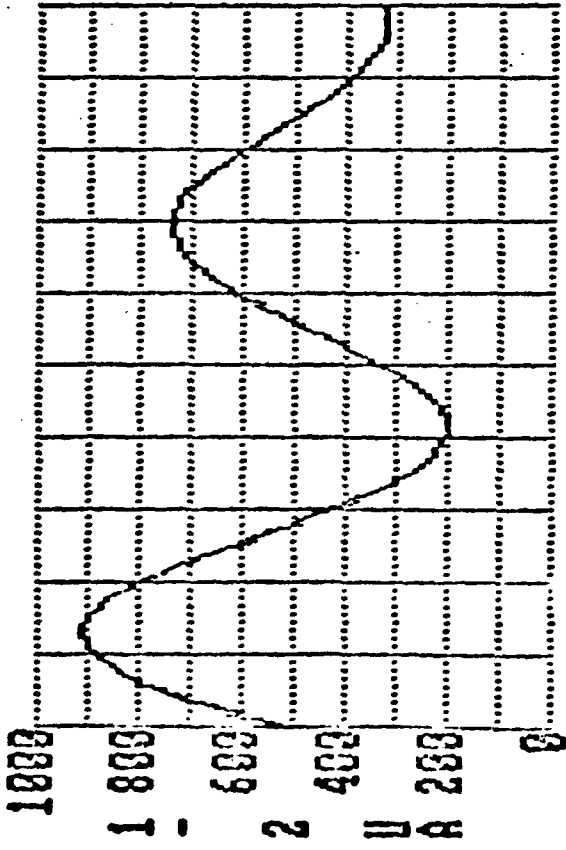


	NODE OFFSET	VALUE	TIME-MS
UPPER	1	.0005	100.000
LOWER	3	0	100.000

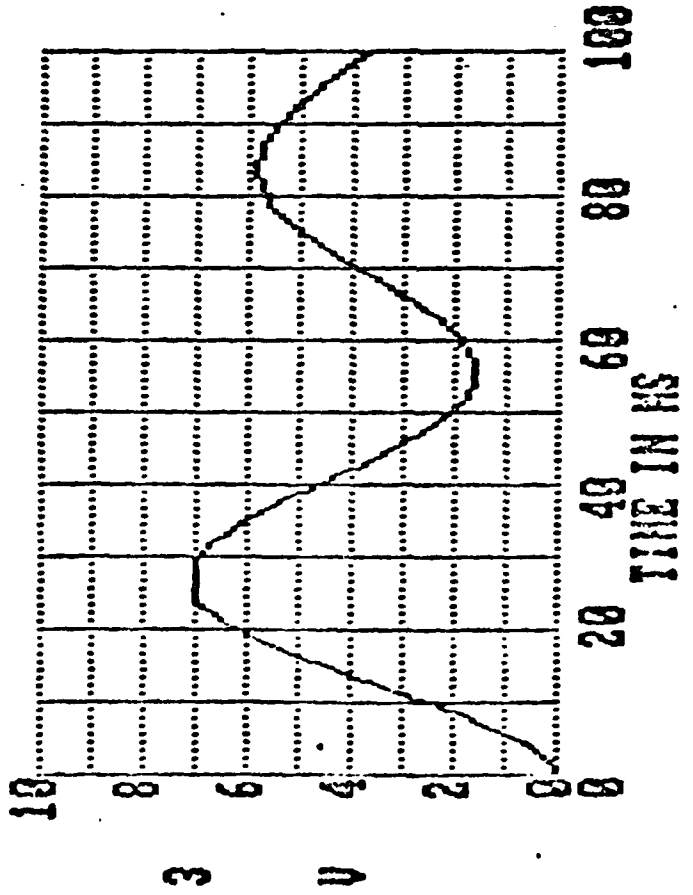


NO DIODE
R = 400Ω

CHARGE1

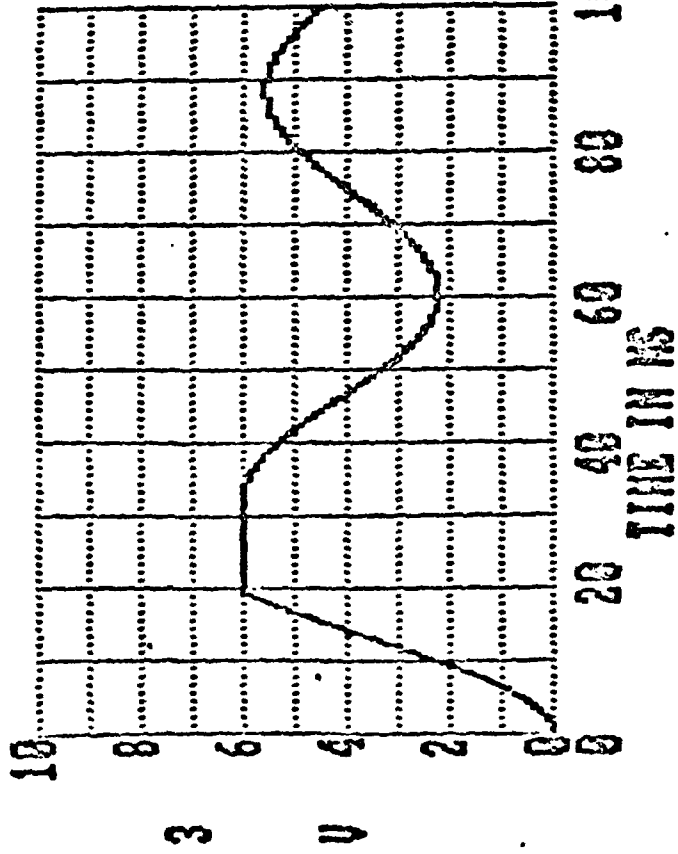
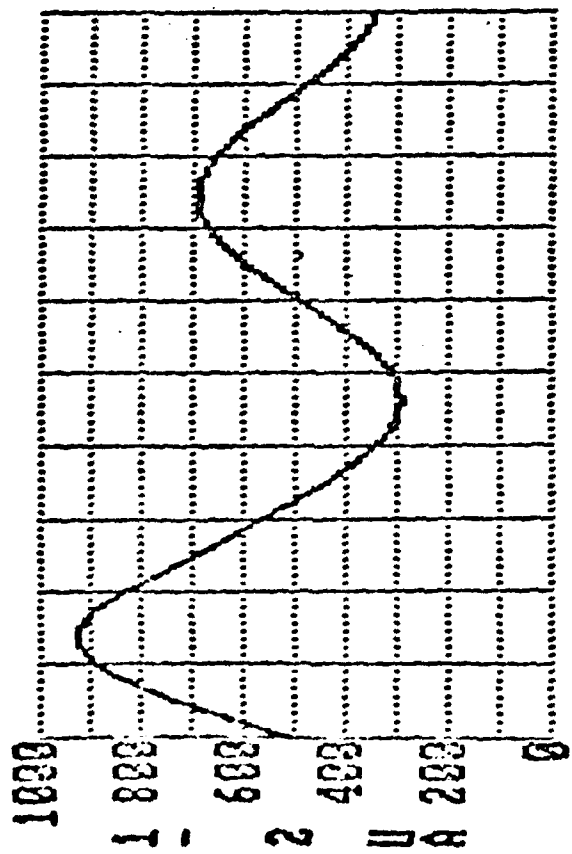


	NODE	OFFSET	VALUE	TIME-NS
UPPER	1	.0005	-0.000	100.000
LOWER	3	0	3.742	100.000



7V ZENER

CHARGE1



	NODE OFFSET	VALUE	TIME-NS
UPPER 1	.8885	-0.8889	103.003
LOWER 3	0	4.475	103.003

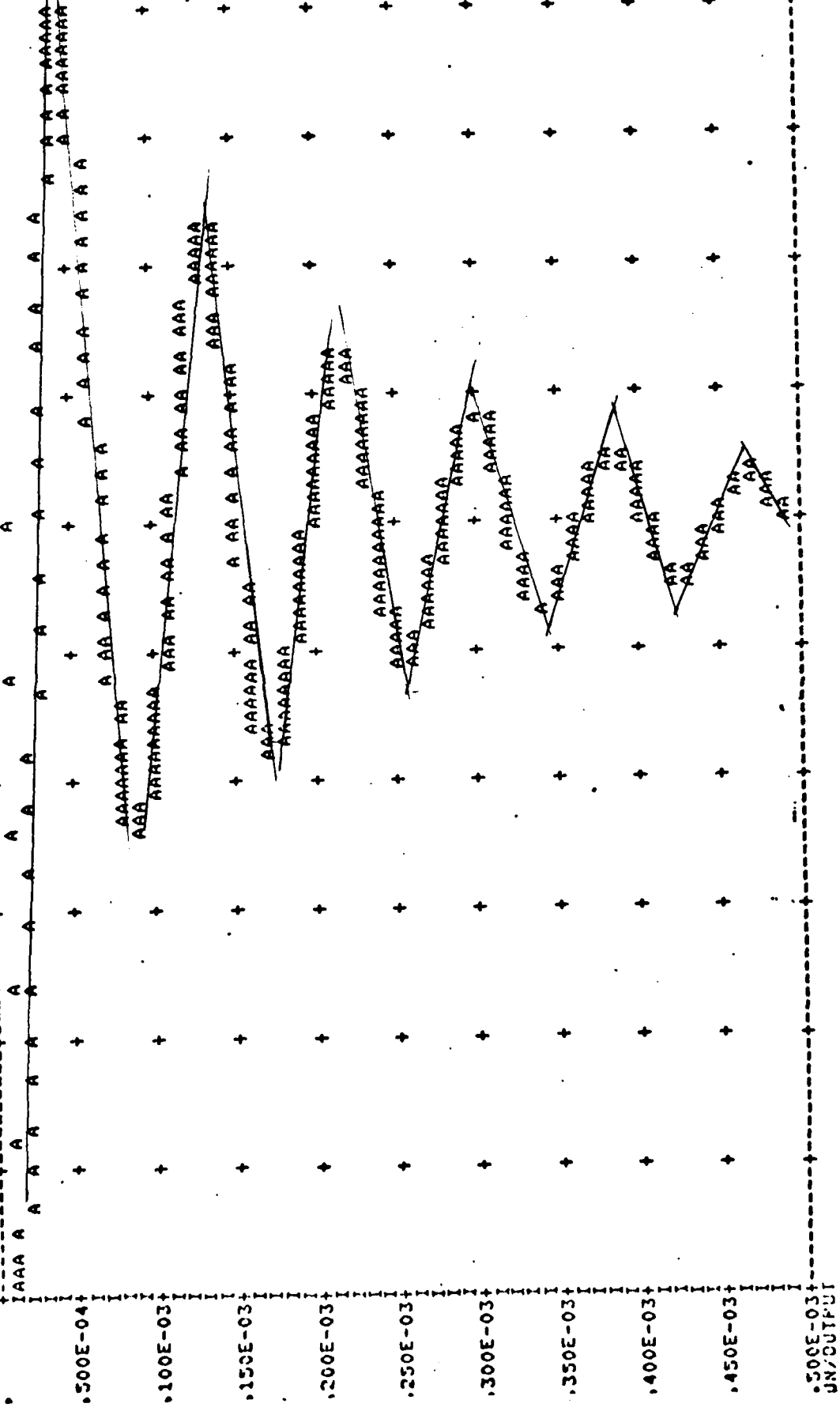
EV ZEPHER

COMPARISON OF THYRATRON BURST MODE OPERATION

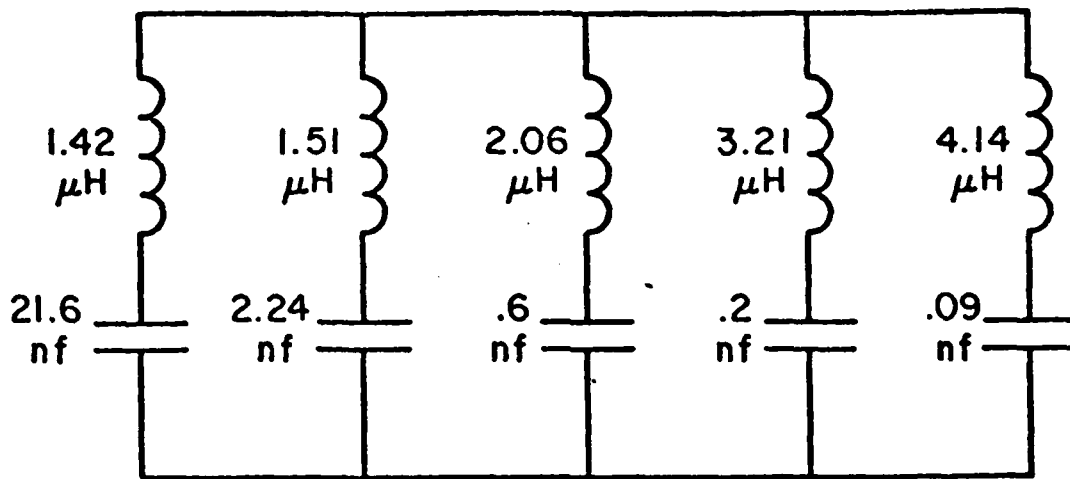
	MARCONI <u>BURST MODE</u>	AVCO <u>BURST MODE</u>
DOUBLE-ENDED	CX1199B	CX1171B
CERAMIC THYRATRON	(3" DIA.)	(3" DIA.)
PULSED STORED ENERGY	6KJ	2.6 KJ, MAX.
PULSE LENGTH	30 μSEC	30 μSEC
PRF	67 PPS	30 PPS
PFN VOLTAGE	105 KV	80KV
PULSE DISCHARGE CURRENT	4800 A	3200 A
BURST ENERGY	400 KJ FOR 1 SEC	49.2 KJ FOR 1 SEC

L,100,S0=NODE2
NODE

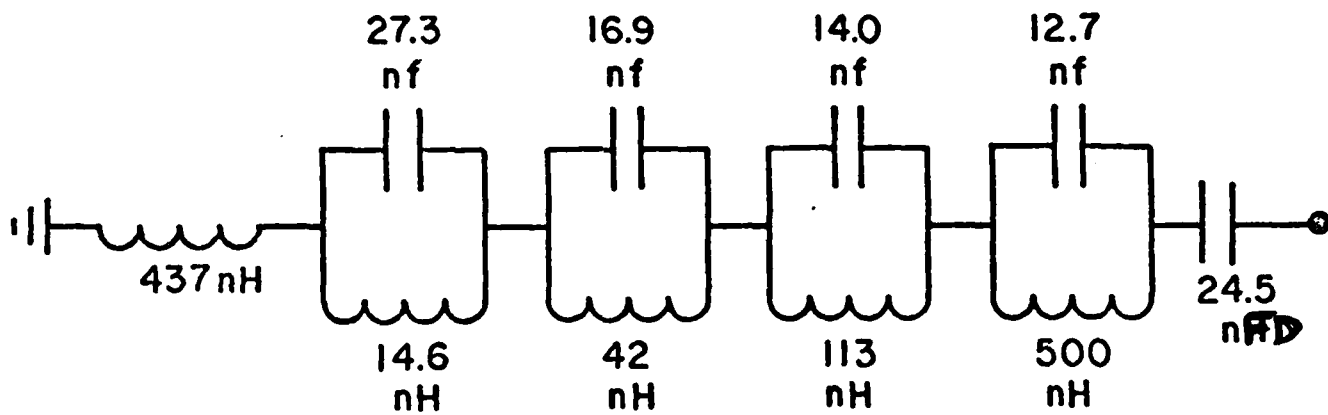
2
-.900E+02 -.665E+02 -.530E+02 -.395E+02 -.260E+02 -.125E+02 .100E+01 .145E+02 .280E+02 .415E+02
250E+02



ESTART FILE? (Y/N)
Y.
O.F1(0.015
CAP(DIODE)
CS THIS BRACE



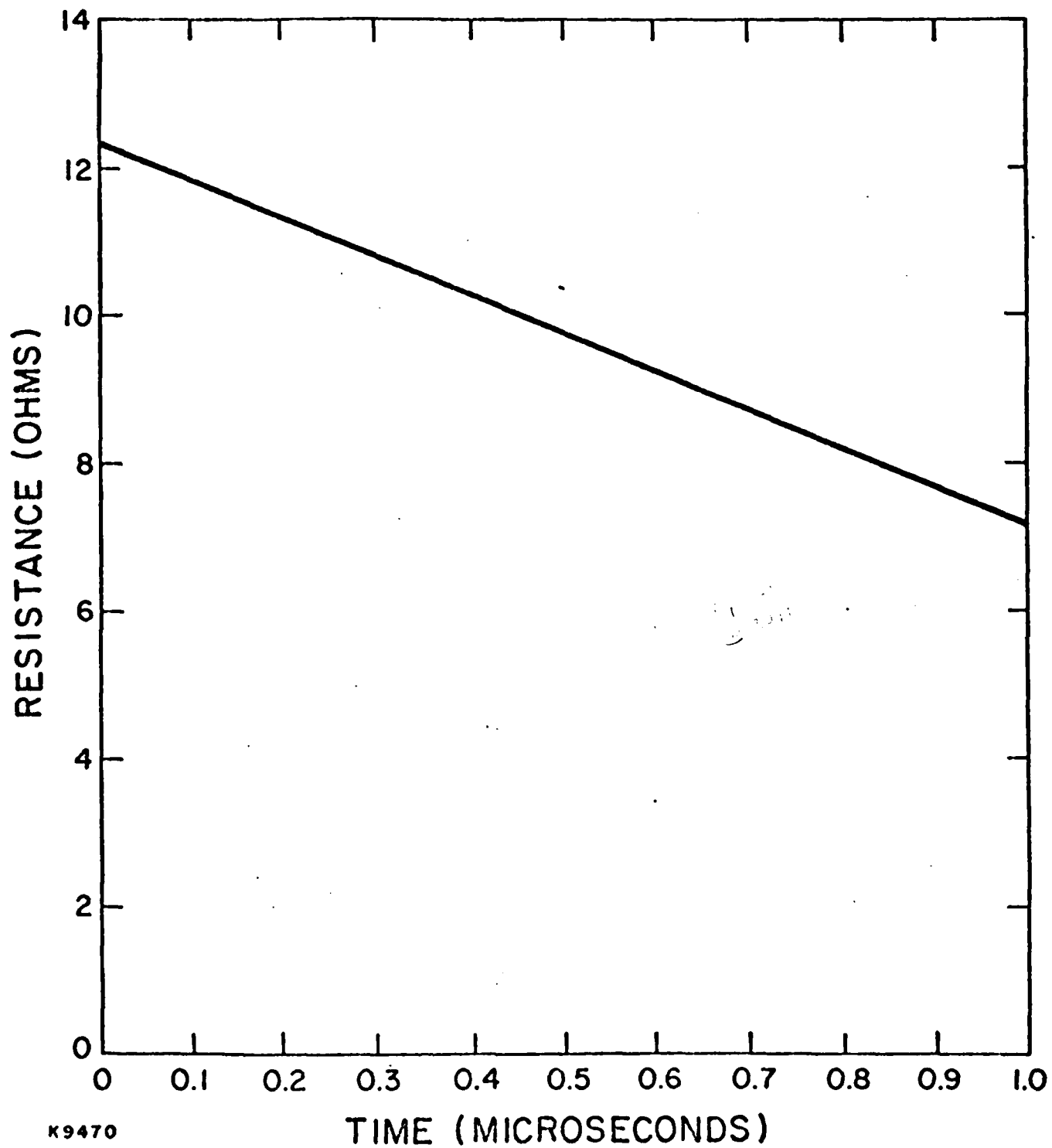
C NETWORK



A NETWORK

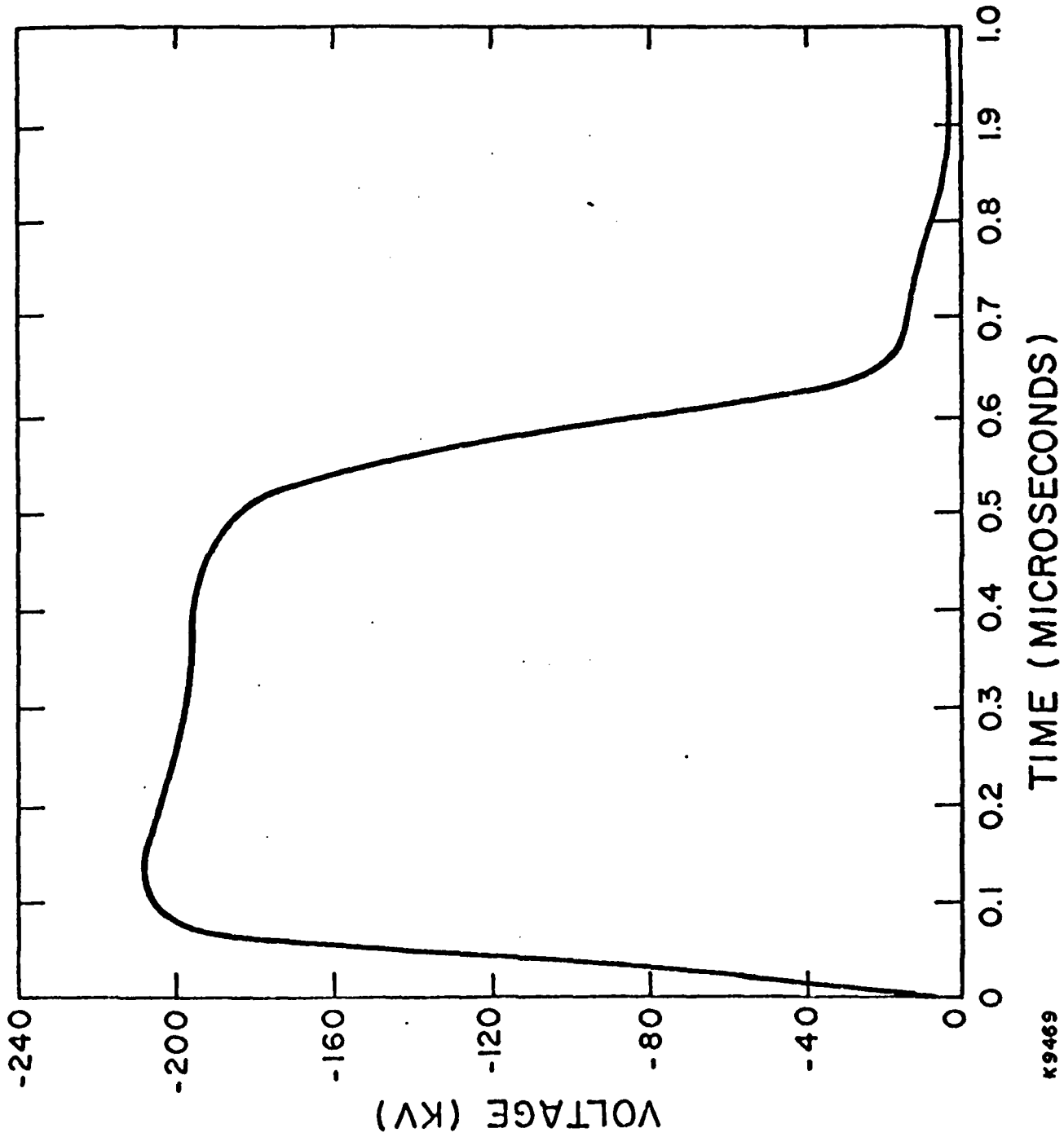
K 9083

AVCO EVERETT



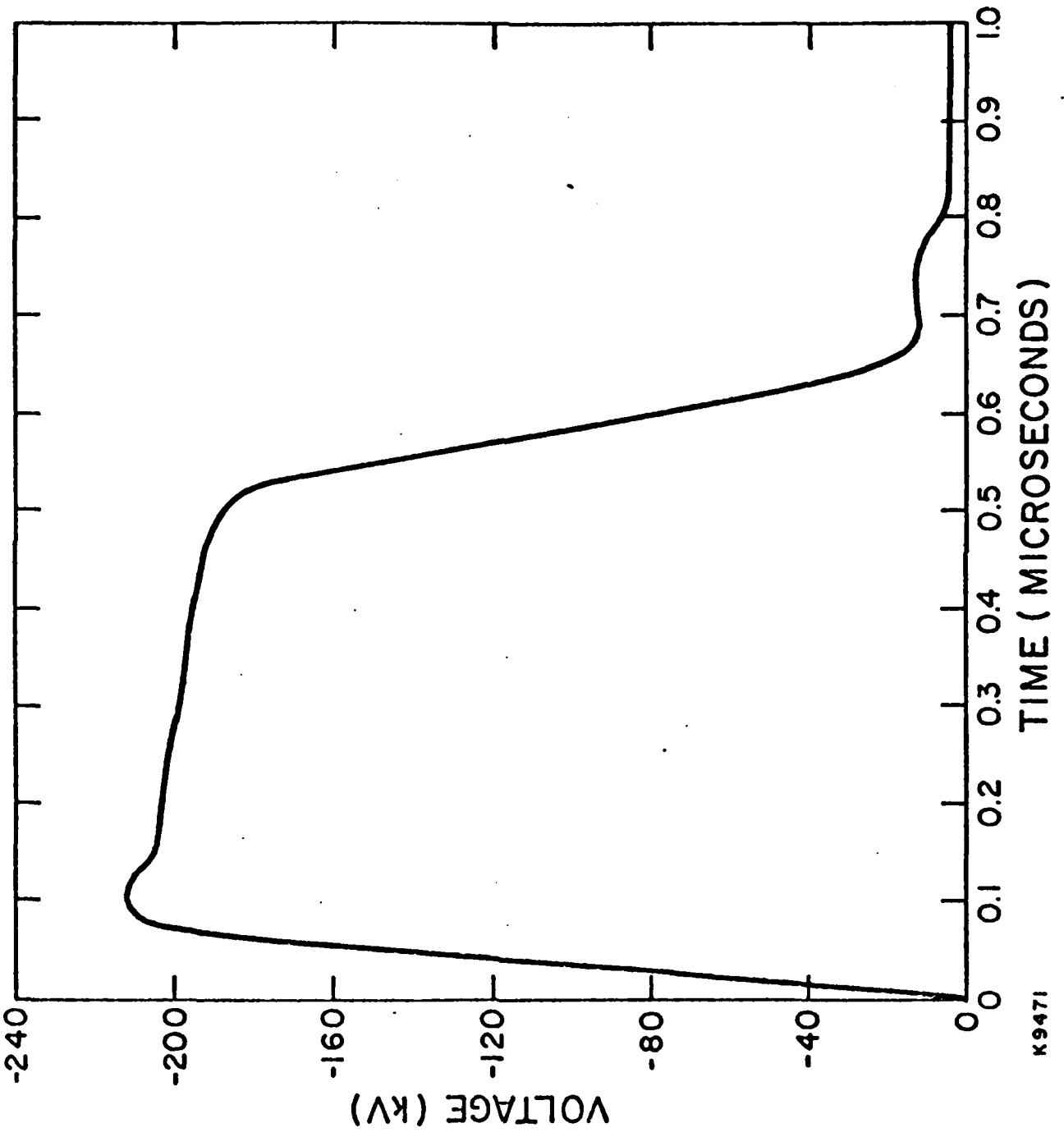
K9470

AVCO EVERETT



K9469

AVCO EVERETT



K9471

AVCO EVERETT



PFN/SWITCH REQUIREMENTS

- VOLTAGE HOLD-OFF: 500 KV
- ENERGY 1640/J PULSE @ 30 PPS (1.5 SEC)
- PULSE CHARGING TIME: 30 μ S
- PULSE DISCHARGE TIME: 0.5 μ SEC

REPETITIVE PULSE POWER SYSTEM

● CONSTRUCTION DETAILS

● STATUS

● SCHEDULE

V. N. MARTIN

STATUS 0% 3/5/84

COMPLETE

- ELECTRICAL DESIGN 95
- LAYOUTS + MECHANICAL DETAILS 95
- MAJOR HV COMPONENTS 85
- SUBASSEMBLIES 90
- TANK INSTALLATION 50

STATUS: COMPLETED SUBASSEMBLIES

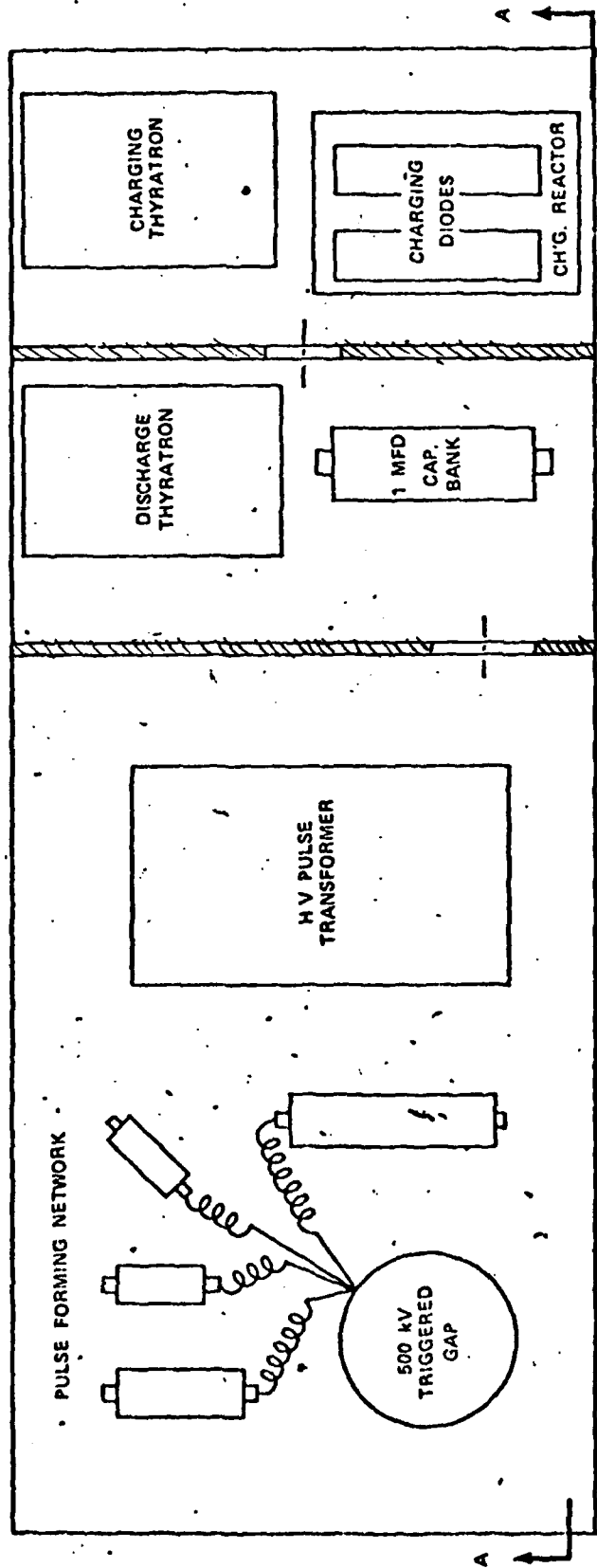
multiple
● T.I.G. HV TRIGGER DRIVE CHASSIS

● CHARGING THYRATRON MODULE

● INTERMEDIATE CAPACITOR ASSEMBLY (10-11 mf capacitors)

● PFN CAPACITORS

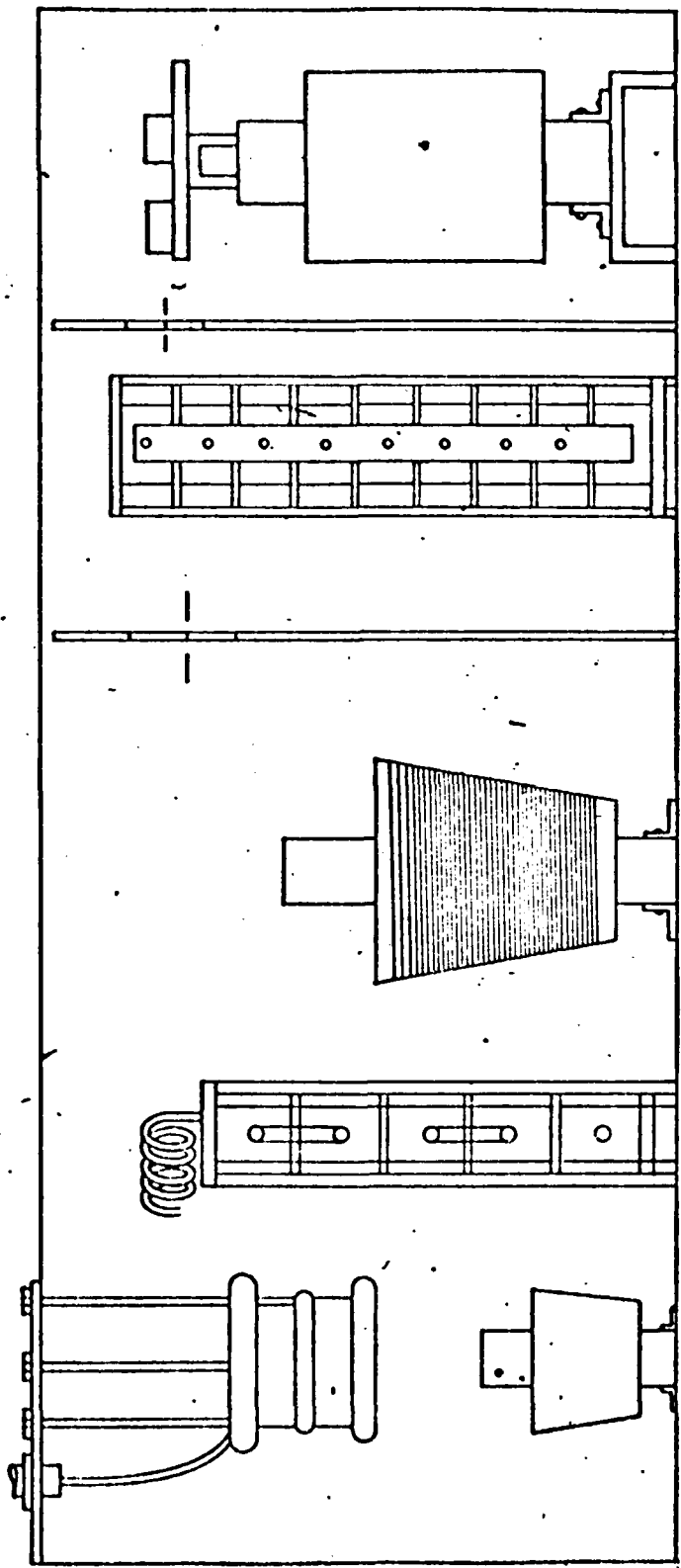
● T.I.G. SUPPORT STRUCTURE



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K9487

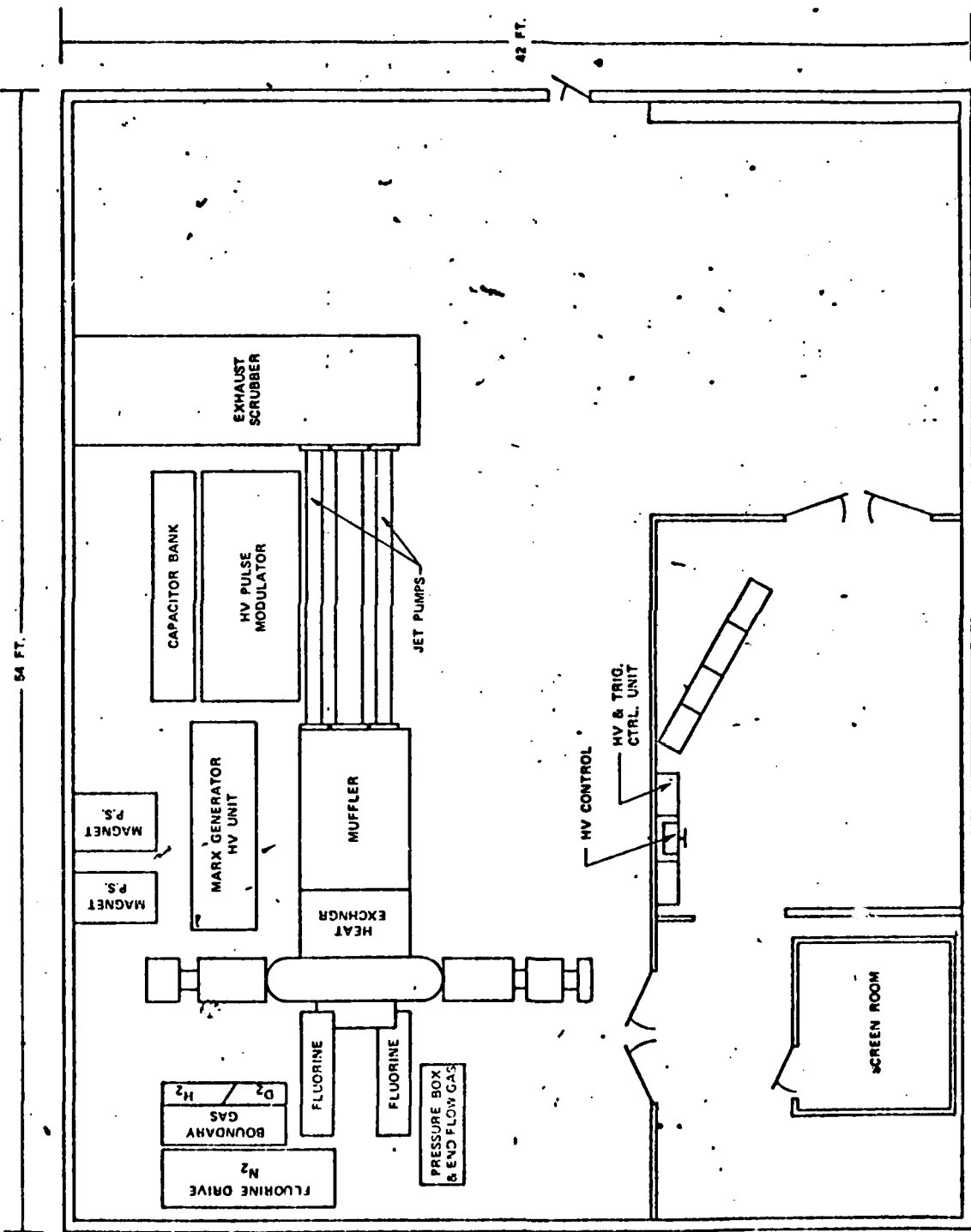




K9466

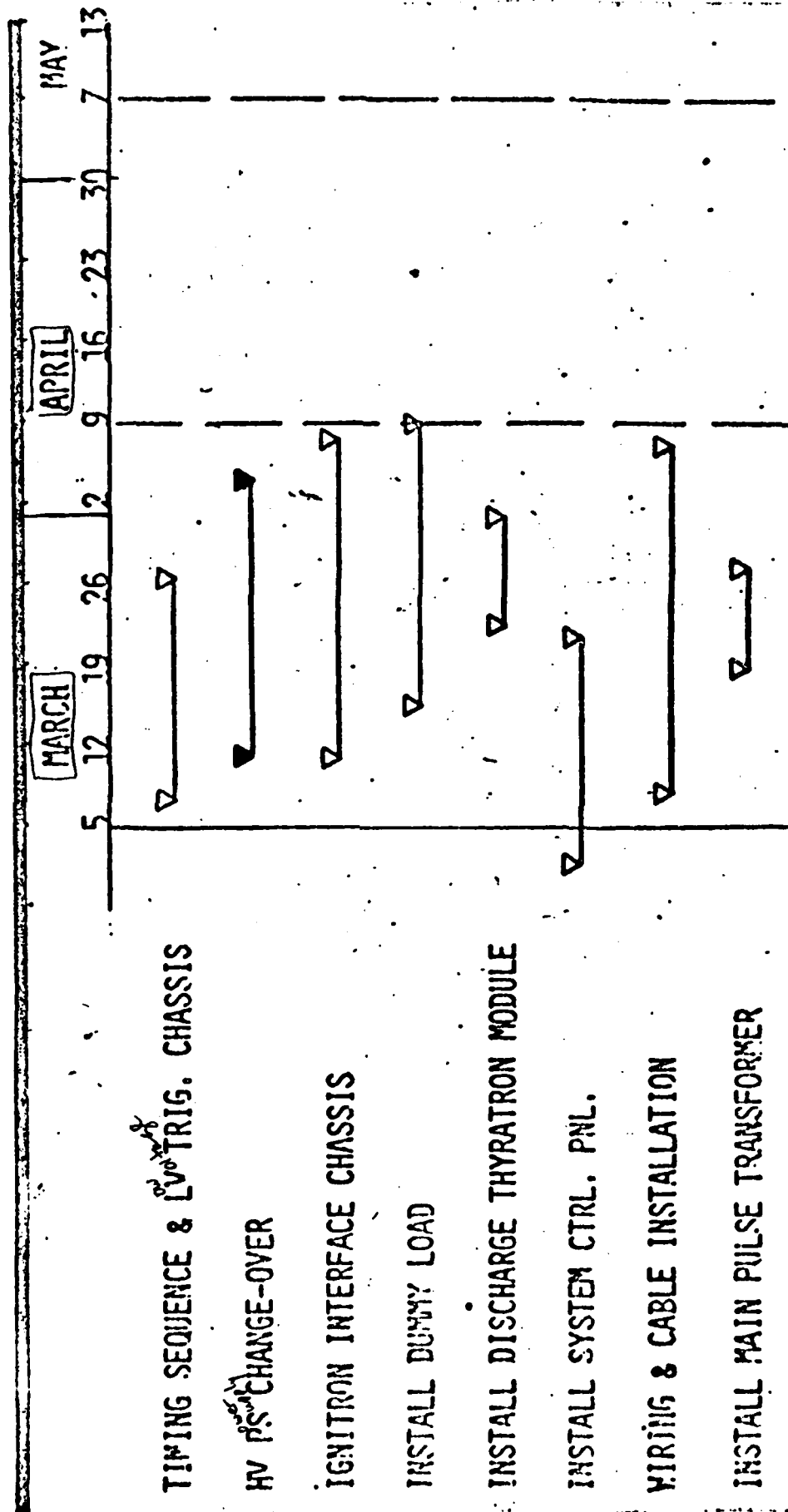


AVCO EVERETT



49488

EQUIPMENT SCHEDULE TO COMPLETION



SYSTEM INTEGRATION AND TESTING --

APRIL MAY JUNE
2 9 16 23 30 7 14 21 28 4 11 18 25 30

ASSEMBLE GAS FLOW

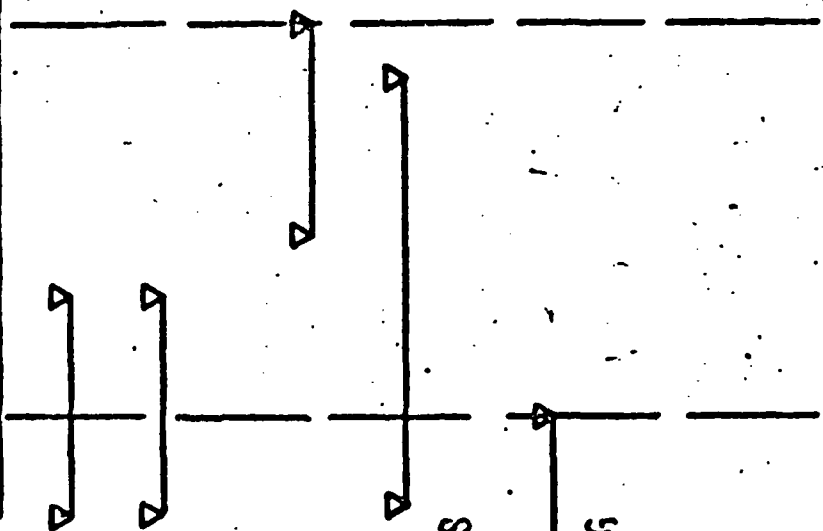
SYSTEM INTEGRATION AND TESTING

DUMMY LOAD TESTING

INTEGRATE PPS CONTROLS WITH LASER SYSTEM CONTROLS

INSTALL COAXIAL CABLE COUPLING TO E-BEAM BUSHING

LASER PERFORMANCE TESTS



PULSED CHEMICAL LASER TECHNOLOGY DEVELOPMENT

TEST PLAN

SINGLE PULSE DIAGNOSTIC TESTING

Contract No. DAAHC1-83-C-0282

Prepared For

Department of the Army
U.S. Army Missile Command
Redstone Arsenal, Alabama

Prepared By

James P. Moran
Avco Everett Research Laboratory
Everett, Mass.

TABLE 1: TEST PLAN: TASK III - SINGLE PULSE TESTING
 Shift Date Scale One week to left

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

A. GAS HANDLING

- A1 TEST JET PUMP WITH CAVITY FLOW
- A2 INSTALL SINGLE PULSE FLUIDIC VALVE DRIVE
- A3 TEST FLUIDICS. PC = 1.0 ATM
- A4 TEST FULL FLOW. PC = 1.0 ATM. 0.5 ATM

Have plot Done!



B. FLUORINE GAS HANDLING

- B1 INSTALL F2 SUPPLY GAS CLEANUP
- B2 INSTALL HF HCl PLUMBING
- B3 SHAKE DOWN F2 GAS HANDLING



C. MAIN LASER OPTICS

- C1 INSTALL LASER OPTICS AND CALORIMETER
- C2 INSTALL LASER PULSE SHAPE DETECTOR
- C3 SHAKE DOWN CALORIMETER DIAGNOSTICS
- C4 SHAKE DOWN LASER ALIGNMENT OPTICS



D. SINGLE PULSE ELECTRON BEAM

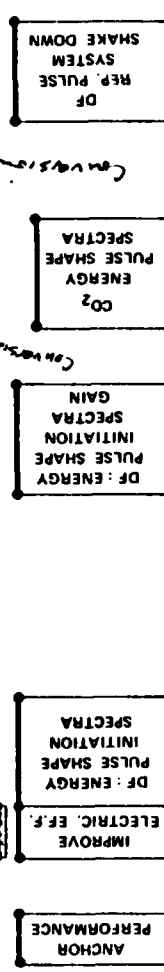
- D1 PUT CARBON FELT ON NEW CATHODE
- D2 TEST TRANSMISSION OF OLD CATHODE. 1/2-IN. FOIL BAR SPACING
- D3 INSTALL NEW CATHODE
- D4 TEST NEW CATHODE TRANSMISSION. 1/2-IN. FOIL BAR SPACING
- D5 TEST NEW CATHODE FOIL BARS REMOVED



E. LASER PERFORMANCE MEASUREMENTS

- E1 TEST DF LASER 1.0 ATM 20 F2, 6 D2, 1 O2, 73 He Baseline Data
- E2 TEST DF LASER 0.5 ATM, 1.0 ATM, 20 F2, 6 D2, 1 O2, 73 He
- E3 DF LASER PERFORMANCE MEASUREMENTS, COMPOSITE
- E4 CO2 LASER PERFORMANCE MEASUREMENTS

Baseline Data



LEW

TABLE I: TEST PLAN: TASK III - SINGLE PULSE TESTING (Continued)

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

F. FLUORINE ATOM PRODUCTION MEASUREMENTS

- F1 FABRICATE F-ATOM REFERENCE AND TEST LEGS
- F2 SHAKE DOWN LUMONICS OF LASER
- F3 INSTALL F-ATOM CONVEYANCE OPTICS
- F4 SHAKE DOWN F-ATOM DETECTORS
- F5 MEASURE F-ATOM FORMATION

G. TIME INTEGRATED LASER SPECTRAL MEASUREMENTS, DF

- G1 INSTALL SPECTROMETER
- G2 FABRICATE FILM HOLDER
- G3 INSTALL FLASH LAMP
- G4 IMPLEMENT LASER/SPECTROMETER ALIGNMENT
- G5 MEASURE LASER $f_{DF}(\lambda, t)$

H. TIME RESOLVED LASER SPECTRAL MEASUREMENTS, DF

- H1 OBTAIN DF (λ, t) , CO₂ (λ, t) DETECTORS (10)
- H2 INSTALL ONE COMPLETE DF (λ, t) DATA CHANNEL
- H3 SHAKE DOWN ONE DF (λ, t) CHANNEL
- H4 INSTALL DF (λ, t) DETECTOR ARRAY
- H5 INTEGRATE DF (λ, t) WITH DATA ACQUISITION
- H6 MEASURE DF (λ, t) - TIME RESOLVED SPECTRA

I. TIME RESOLVED LASER SPECTRAL MEASUREMENTS, CO₂

- I1 MODIFY CALORIMETER AND WINDOW FOR CO₂ (λ, t)
- I2 MODIFY SPECTROMETER FOR CO₂ (λ, t)
- I3 MEASURE CO₂ (λ, t) - TIME RESOLVED SPECTRA

J. DATA ACQUISITION SYSTEM

- J1 IMPLEMENT 2-CHANNEL A/D DATA ACQUISITION
- J2 FINALIZE SELECTION OF DATA ACQUISITION SYSTEM
- J3 OBTAIN DATA ACQUISITION SYSTEM
- J4 IMPLEMENT DATA ACQUISITION SYSTEM

TABLE I: TEST PLAN: TASK III - SINGLE PULSE TESTING (Continued)

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

- X TIME DEPENDENT GAIN MEASUREMENTS DE
- K1 INSTALL PROBE LASER GAS SUPPLIES
 - K2 OBTAIN PROBE LASER LINE SELECTIVE OPTICS
 - K3 ASSEMBLE LASER OPTICS
 - K4 SHAKE DOWN FLASHLAMPS
 - K5 INSTALL PROBE LASER CONVEYANCE OPTICS
 - K6 SHAKE DOWN GAIN MEASUREMENT DETECTORS
 - K7 MEASURE GAIN DF (A.I)

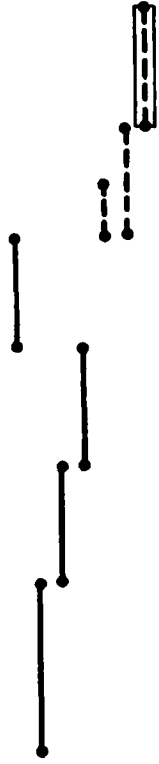


TABLE II: TEST PLAN: TASK III - REPETITIVELY PULSED TESTING

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

E-BEAM FOIL REPETITIVE PULSE OPERATION

- L1 MODIFY FOIL SUPPORT STRUCTURE FRAME
- L2 FABRICATE FOIL SUPPORT BARS
- L3 OBTAIN BACKUP 4 MIL KAPTON/10 MIL A FOIL
- L4 TEST NEW FOIL STRUCTURE TRANSMISSION, 3/8-IN. FOIL BAR SPACING
- L5 TEST NEW FOIL STRUCTURE BURST MODE REP PULSE

REPETITIVE PULSE POWER SYSTEM

- M1 COUPLE DC POWER SUPPLY TO ENERGY STORAGE CAPACITORS
- M2 ASSEMBLE CHARGING THYRATRON MODULE
- M3 ASSEMBLE CHARGING REACTOR SYSTEM
- M4 ASSEMBLE DISCHARGE THYRATRON MODULE
- M5 ASSEMBLE INTERMEDIATE STORAGE CAPACITOR SYSTEM
- M6 INSTALL HV PULSE TRANSFORMER AND TRIGGER TRANSFORMER
- M7 ASSEMBLE PULSE FORMING NETWORK
- M8 INSTALL MAIN SPARK GAP AND TRIGGER ISOLATION GAP
- M9 INSTALL DUMMY LOAD
- M10 COMPONENT CHECKOUT
- M11 ASSEMBLE GAS FLOW CONTROL
- M12 ASSEMBLE SYSTEM CONTROLS AND TIMING AND DIAGNOSTICS
- M13 SYSTEM INTEGRATION
- M14 TEST TO DUMMY LOAD
- M15 INTEGRATE PPS CONTROLS WITH LASER SYSTEM CONTROLS
- M16 INSTALL COAXIAL CABLE COUPLING TO E-BEAM BUSHING

LASER PERFORMANCE MEASUREMENTS, REPETITIVE PULSE TESTS START 6/20/84

- N1 DF LASER PERFORMANCE
- N2 CO₂ LASER PERFORMANCE

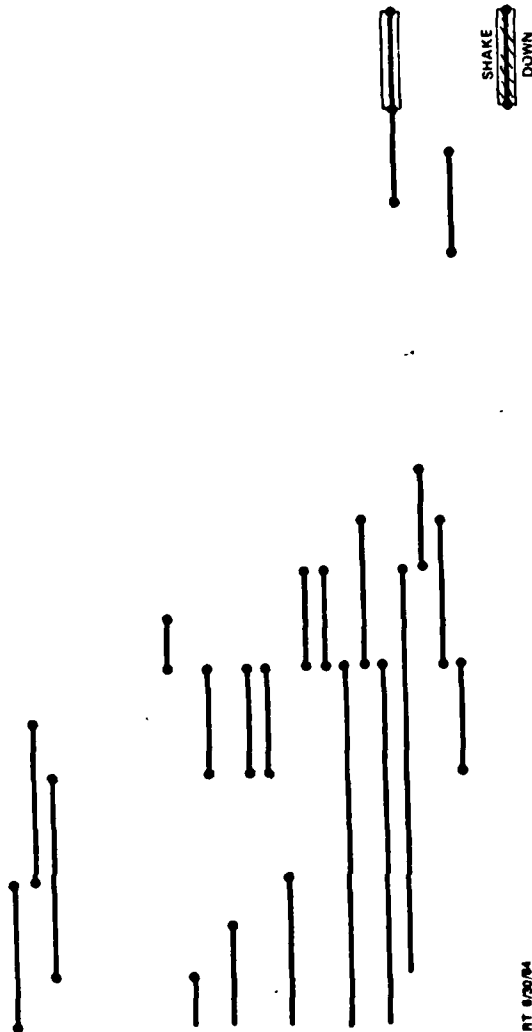


TABLE III: TEST PLAN: AERL-IRAD: REPETITIVELY PULSED TESTING

2/20	2/27	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25	7/2
2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	5/4	5/11	5/18	5/25	6/1	6/8	6/15	6/22	6/29	7/6

Q. E-BEAM FOIL ENVIRONMENT SIMULATOR

- Q1 ASSEMBLE FLOW TRAIN
- Q2 ASSEMBLE GAS SUPPLY AND CONTROL PLUMBING
- Q3 BENCH TEST FLUIDIC VALVES
- Q4 ASSEMBLE VALVING AND MIXER
- Q5 ASSEMBLE SPARK PLUGS AND IGNITION CIRCUITRY
- Q6 FABRICATE FOIL SUPPORT STRUCTURE ASSEMBLY
- Q7 INSTALL FLOW AND TEMPERATURE DIAGNOSTICS
- Q8 SYSTEM SHAKE DOWN
- Q9 TEST CANDIDATE REP PULSE FOILS



* P. MECHANICAL D₂ VALVING

- P1 COMPLETE VALVING DESIGN
- P2 DESIGN VALVE DRIVE TRAIN AND TIMING
- P3 FABRICATE VALVES
- P4 OBTAIN AND ASSEMBLE DRIVE TRAIN COMPONENTS
- P5 MODIFY PCL GAS HANDLING TO ACCOMMODATE VALVES
- P6 INSTALL MECHANICAL VALVES
- P7 TEST MECHANICAL VALVE PERFORMANCE



L2000

* Fluidic valving applicable to high rep rate application.
 25 Hz or below may and itself more applicable
 to mechanical valves.

TABLE IV. TASK III SINGLE PULSE TESTING - TEST MATRIX

SERIES DESCRIPTION	PARAMETER	F ₂ % OR ATM.	D ₂ %	O ₂ %	DILUENT %	HF %	CO ₂ %	PRESSURE TORR.	INITIATION STRENGTH μCOUL/CM ²
3/5-3/9 SHAKE DOWN SYSTEM IMPLEMENT F-ATOM DIAGNOSTICS		20	6	1	He 73	MIN. VS. SUPPLIED	0	760	1.5
3/19-3/23 SHAKE DOWN SYSTEM WITH CATHODE MODIFICATIONS		20	6	1	He 73	MIN.	0	200-760	1.5-3.0
3/26-4/6 LASER PARAMETRICS He REMOVAL IMPLEMENT TIME INTEGRATED SPECTRA		0.20	0.06	AS REQUIRED	He-0.73 -0.0	MIN.	0	210-760	3.0
5/7-5/18 LASER PARAMETRICS ALTERNATE DILUENTS IMPLEMENT TIME RESOLVED SPECTRA		0.20	0.06	AS REQUIRED	He-0.73 -0.00	MIN.	0	210-760	3.0
5/28-6/8 LASER PARAMETRICS DF/CO ₂		0.20	0.06	AS REQUIRED	NF ₃ -0.24 -0.00	MIN.	0	210-400	3.0
		0.20	0.06	AS REQUIRED	0	MIN.	0-0.73	210-760	3.0
		0.20	0.06	AS REQUIRED	NF ₃ -0.24 -0.0	MIN.	NOM. 0.2	360-540	

END

DTic

5-86