NEP Space Test Program Objective

The Objective Of The NEP Space Test Program Is To Launch A NEP Satellite Powered By A Russian Topaz II Reactor By December 1995

Space Technology Research Vehicle

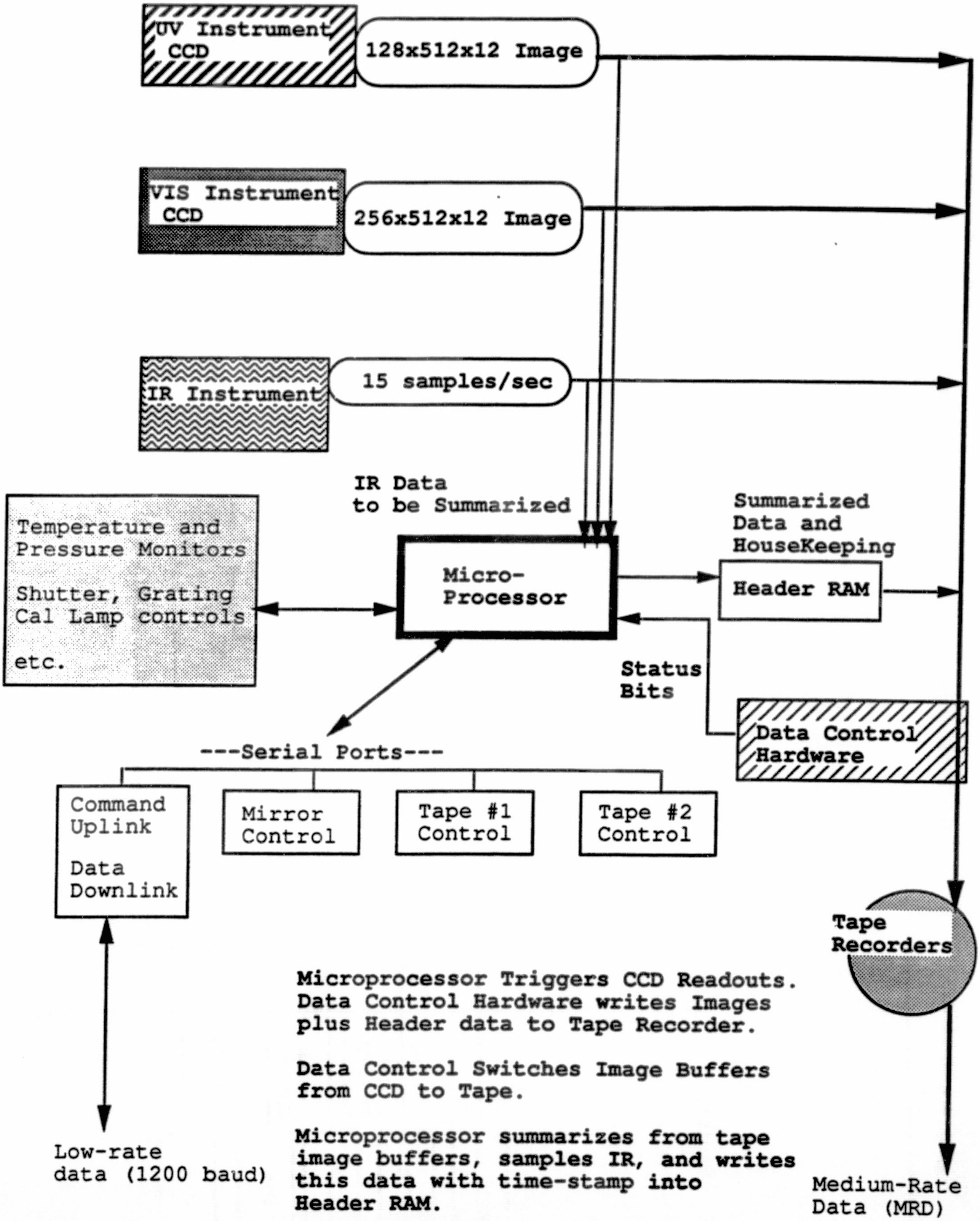
Anticipated Benefits

- Experiments
  - Flight testing of recent advances in the PV area
  - Helpful "industry survey" for PL/VTPC
  - Increase cooperation with NASA LeRC and DRA

- Power Panels
  - Useful "space hardware" experience
    - Procurement
    - Testing & flight qualification
  - Excellent test of MANTECH GaAs solar cell technology
    - Demonstration of the MANTECH cells in a hostile environment
    - Laydown by an outside contractor

- Ground testing
  - Confirmation of space data and other ground testing
  - Participation in the joint US-ESA calibration effort

EISG Data Flow



Microprocessor Triggers CCD Readouts. Data Control Hardware writes Images plus Header data to Tape Recorder.

Data Control Switches Image Buffers from CCD to Tape.

Microprocessor summarizes from tape image buffers, samples IR, and writes this data with time-stamp into Header RAM.

[redacted]

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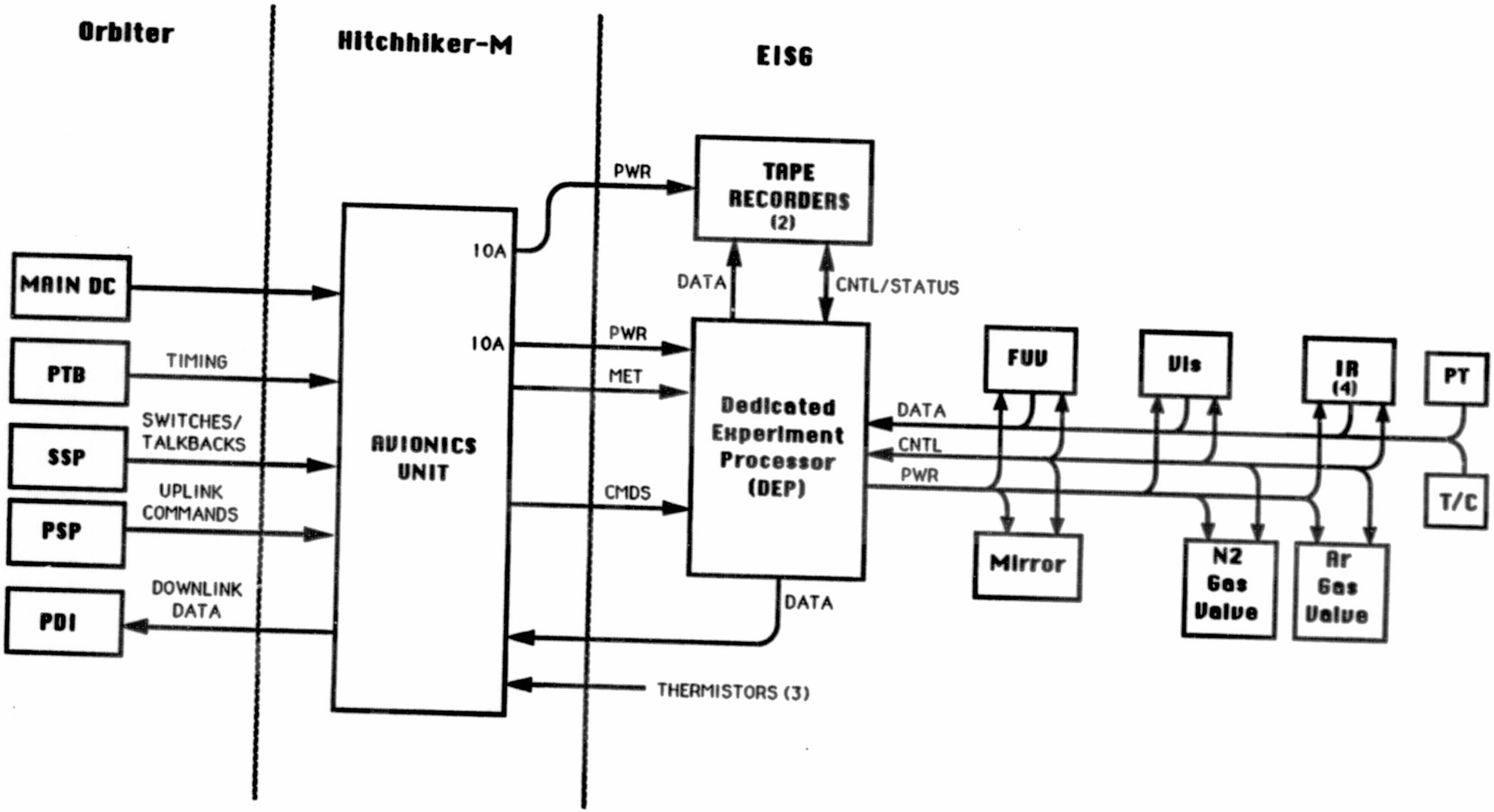
		Alan Epperson	3-5-91

Avionics Block Diagram



IMPORTANCE OF COMBINING SKIRT WITH EISG (con't)

- SKIRT will allow EISG to measure other contributors to the infrared glow: OH, NO^+, NO_2, ...

- SKIRT will obtain data during both day and night sides of orbits, thereby enhancing EISG night-only data.

- Comparing SKIRT data from STS-39 and STS-62 will show the dependence of the glow on phase in the solar activity cycle.

- EISG/SKIRT will expand and enhance the technology base pertaining to shuttle glow.

IMPORTANCE OF COMBINING SKIRT WITH EISG

- Only by including SKIRT as part of EISG will it be possible to investigate all aspects of the glow process. SKIRT gives IR spectroscopic coverage to EISG.

- The elliptical orbits planned for STS-62 will provide a unique opportunity to measure the IR, visible, and UV glow as a function of altitude. Altitude information was not obtained by SKIRT on STS-39.

- EISG nitrogen gas releases will provide the first combined IR, visible and UV test of the role nitrogen plays in the glow chemistry.

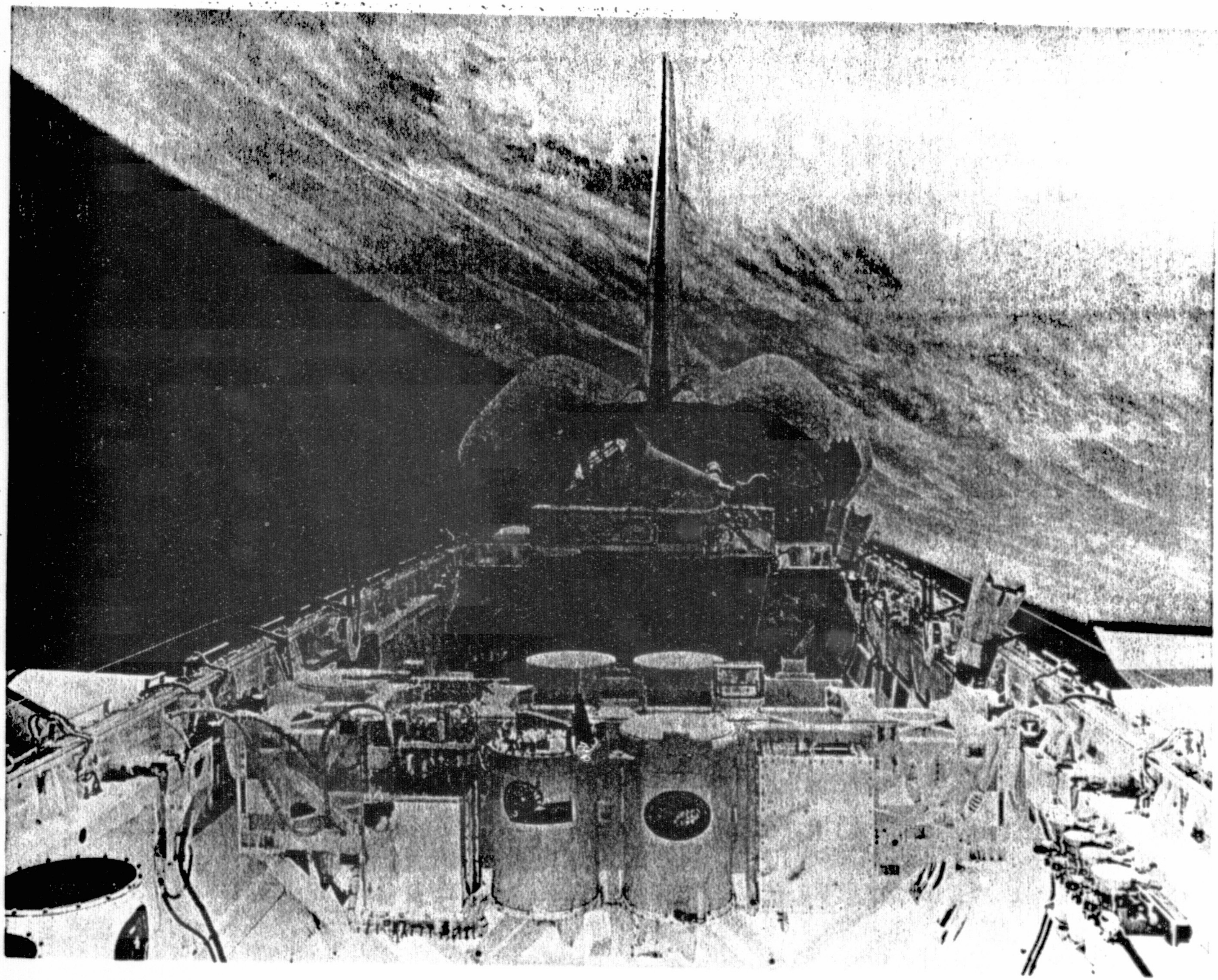
THE ROLE OF INFRARED SPECTRA IN INVESTIGATING THE GLOW PROCESS

- Spacecraft-atmospheric interaction involves three reactions:
  1) $N_2 + O \rightarrow NO + N$
  2) $NO_{surface} + O \rightarrow NO_2^*$
  3) $N_{surface} + N \rightarrow N_2^*$

- Reaction 1) is monitored by observing NO spectral emission in the infrared. (This was first demonstrated by SKIRT on STS-39.)

- Reactions 2) and 3) are monitored by observing NO_2^* and N_2^* spectral emissions in the visible and ultraviolet, respectively.

- Only by observing spectra in all three regimes - IR, visible, and UV - can the entire glow process be studied.



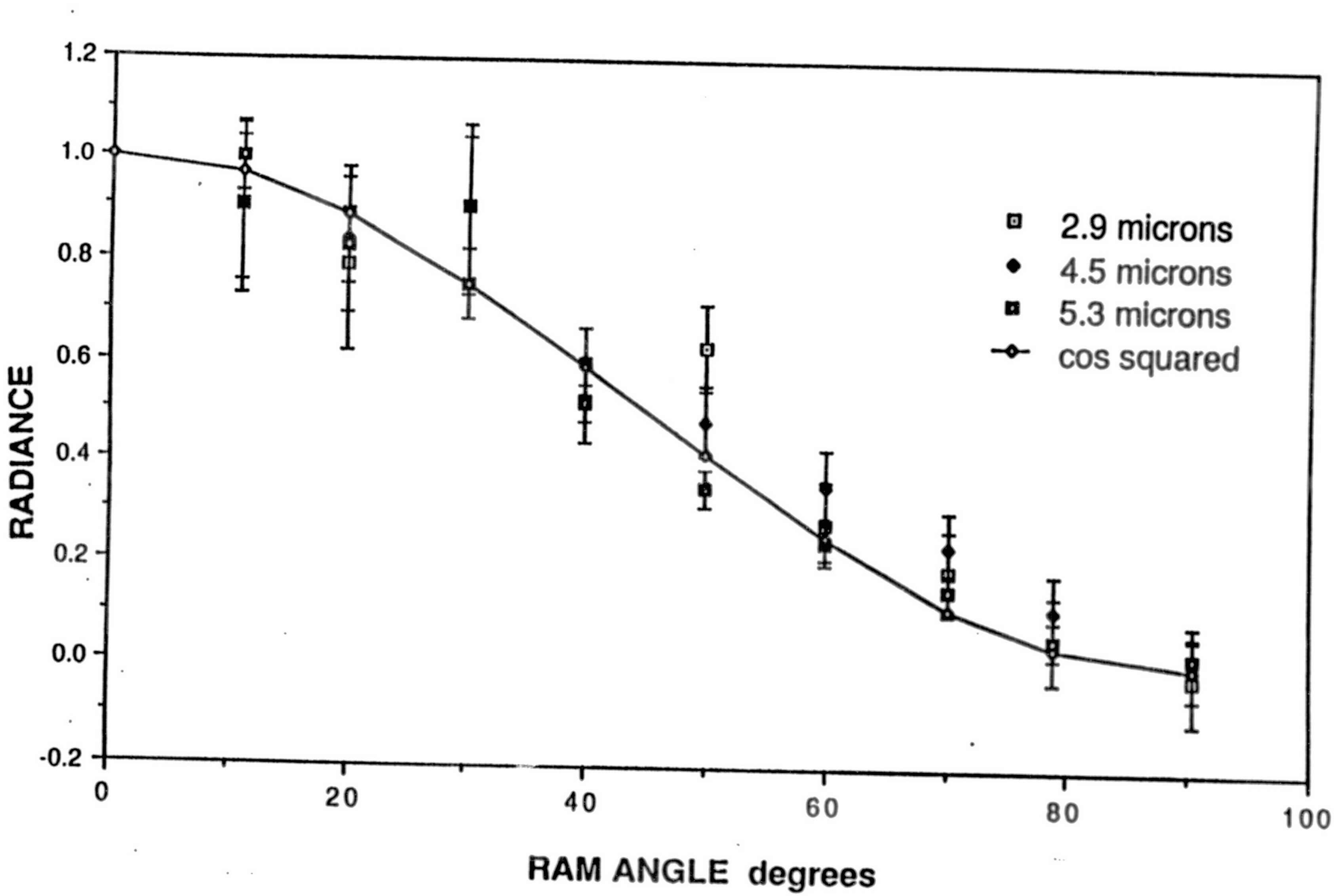
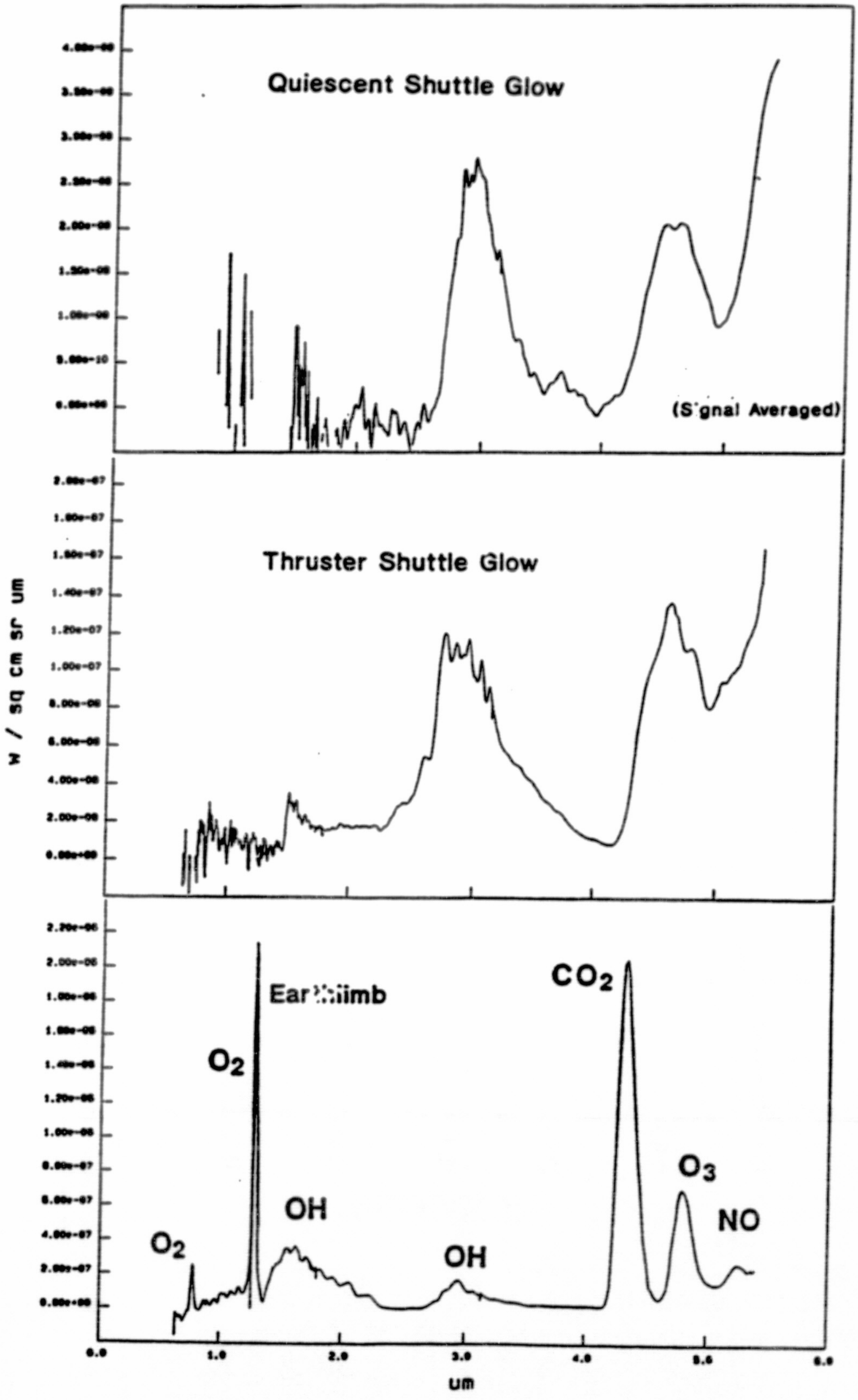
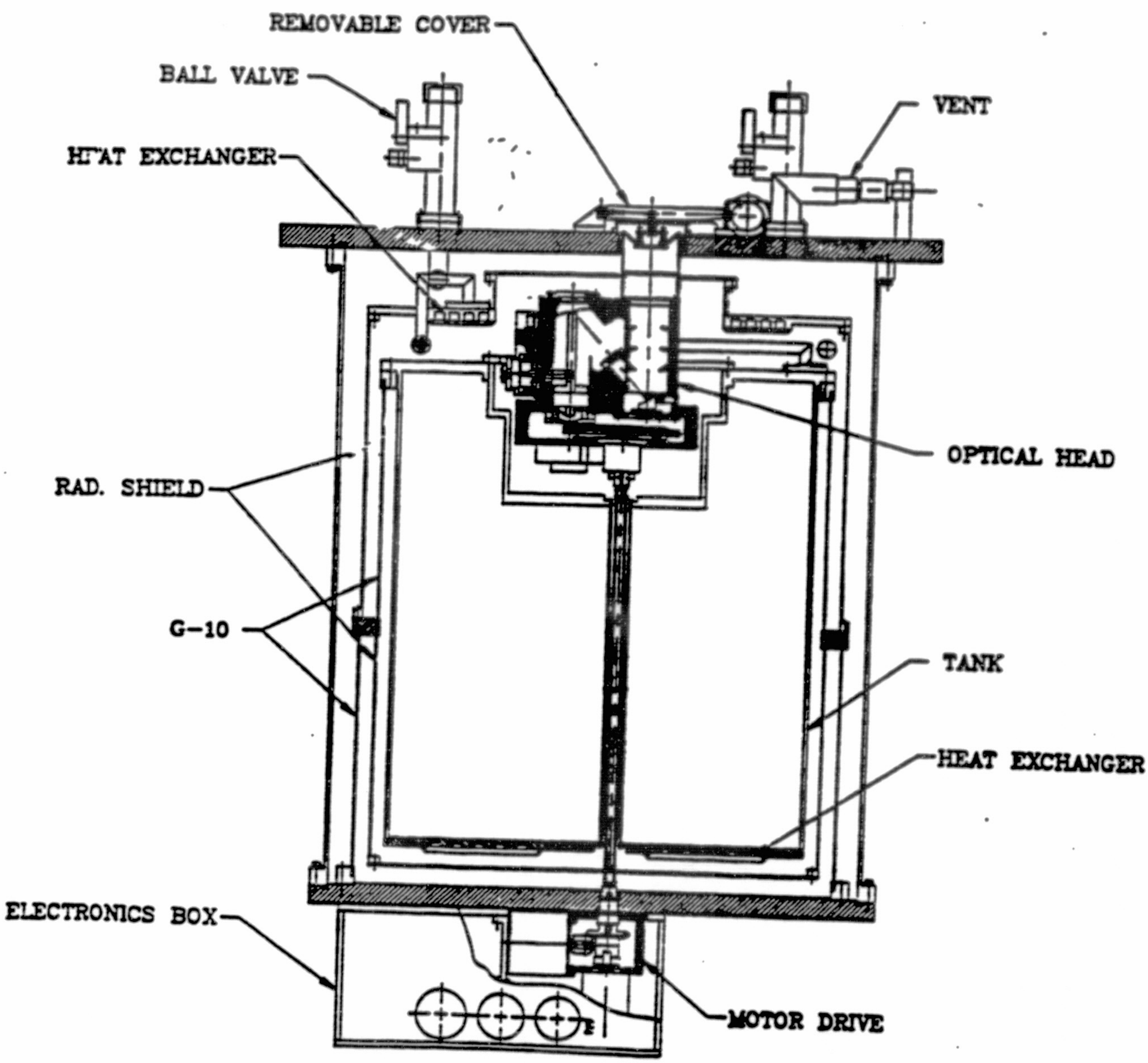


Figure 36. 2.9 μm, 4.5μm, and 5.5 μm Glow Intensities vs Ram Angle.[25]



Quiescent Shuttle Glow
(Signal Averaged)
Thruster Shuttle Glow
Earthlimb
O2
O2
OH
OH
CO2
O3
NO
w / sq cm sr um
um



SKIRT CVF payload configuration. This assembly fits into a NASA Get Away Special (GAS) can modified for a Hitchhiker mechanical and electrical interface.

Instruments - Optical Properties

VISIBLE IMAGING SPECTROMETER (VIS)

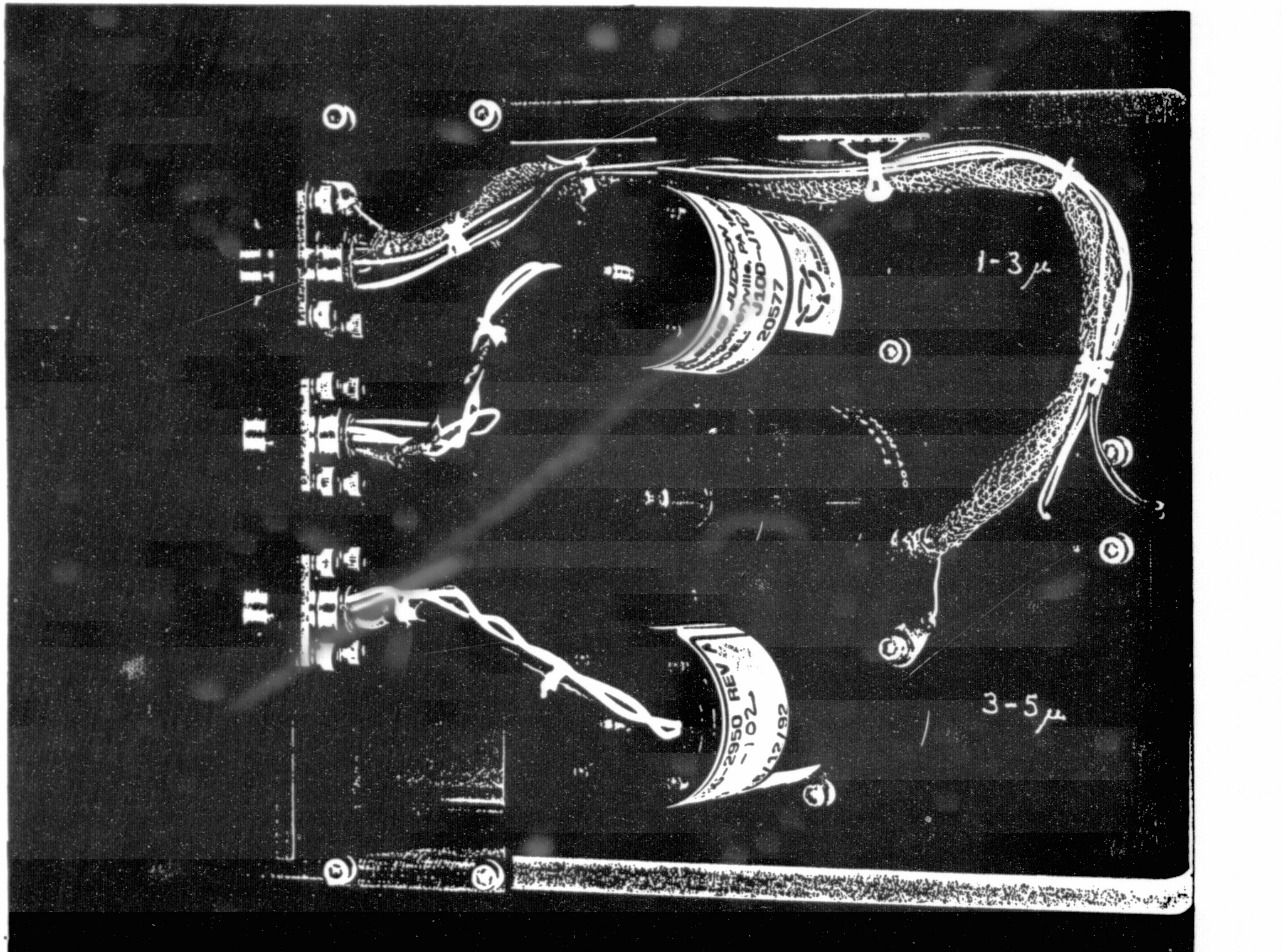
Optics:	Field of view	60°
	Transmission Grating	600 lp/mm
	Throughput	f/1.8
	Spectral range	4500-8400Å
	Spectral Resolution	15Å
Image plane:	X axis - spatial	60° FOV
	Y axis - spectral	4500-8400Å
Detector:	ICCD camera with S20 R photocathode intensifier	
	Integration time	1/60-180 s

FAR ULTRAVIOLET IMAGING SPECTROMETER (FUV)

Optics	Field of View	20°
	Transmission Grating	1800 lp/mm
	Throughput	f/4.8
	Spectral range	1100-2000 and 1900-3000Å [2 step grating cam]
	Spectral resolution	15Å
Image plane:	X axis - spatial	20°
	Y axis - spectral	15Å
Detector:	ICCD camera with RbTe photocathode intensifier	
	Integration time	1/60-180 s

INFRA RED DETECTORS (2 each Sample)

Optics:	Field of view [Cold shield sets field stop, without lenses]	60°
	Filters	1-3 micron (#1)
		3-5.4 microns (#2)
Detectors:	InSb, Joule-Thomson cooled to 84 K with Argon cryostat. Supply bottle at 3000 PSI, flows at .5 liter per minute, STP, while active.	
	Sample rate is 15 Hz for each channel	


1-3 μ
3-5 μ
JUDSON
20577
2950 REV
-102

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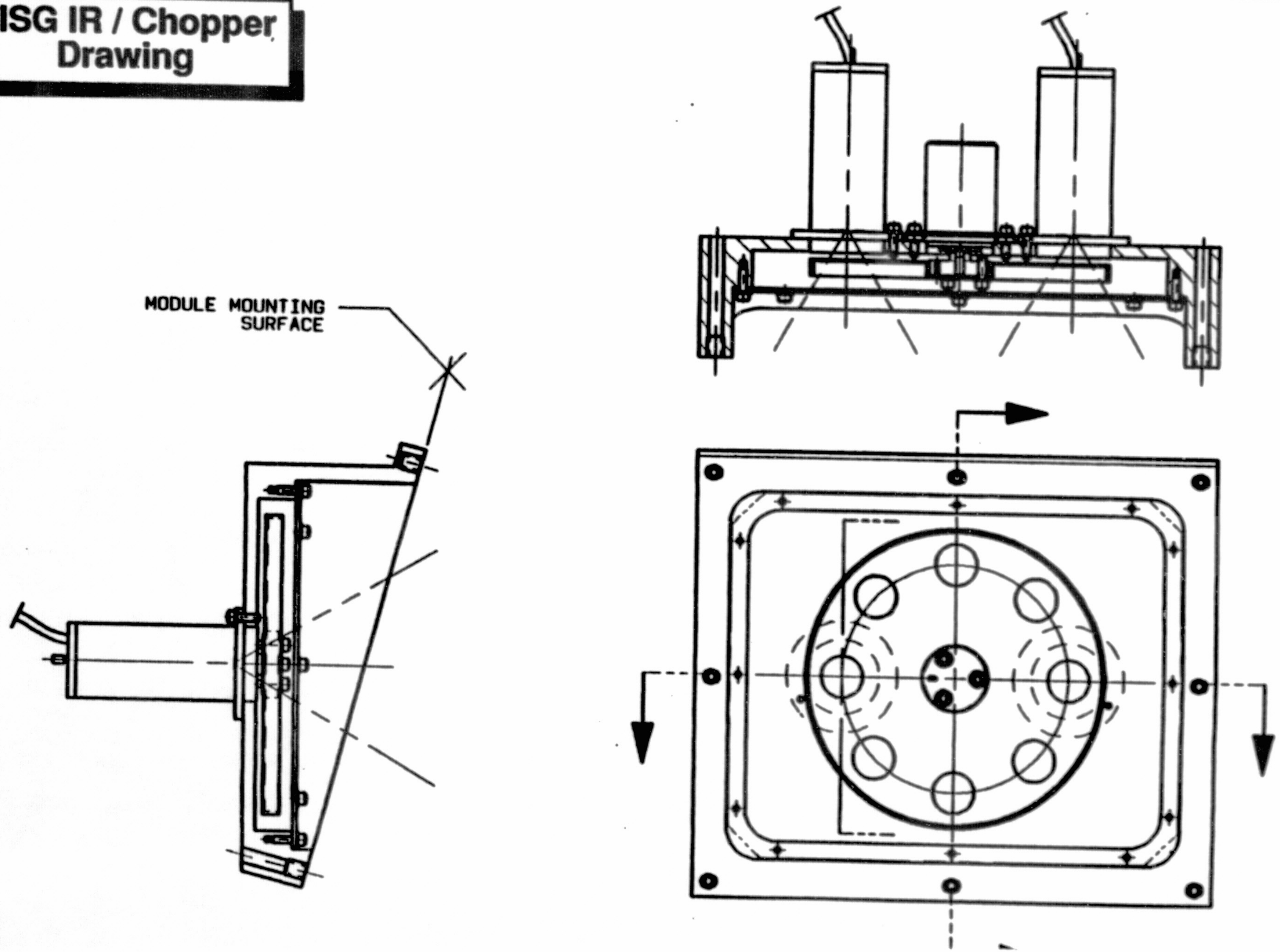
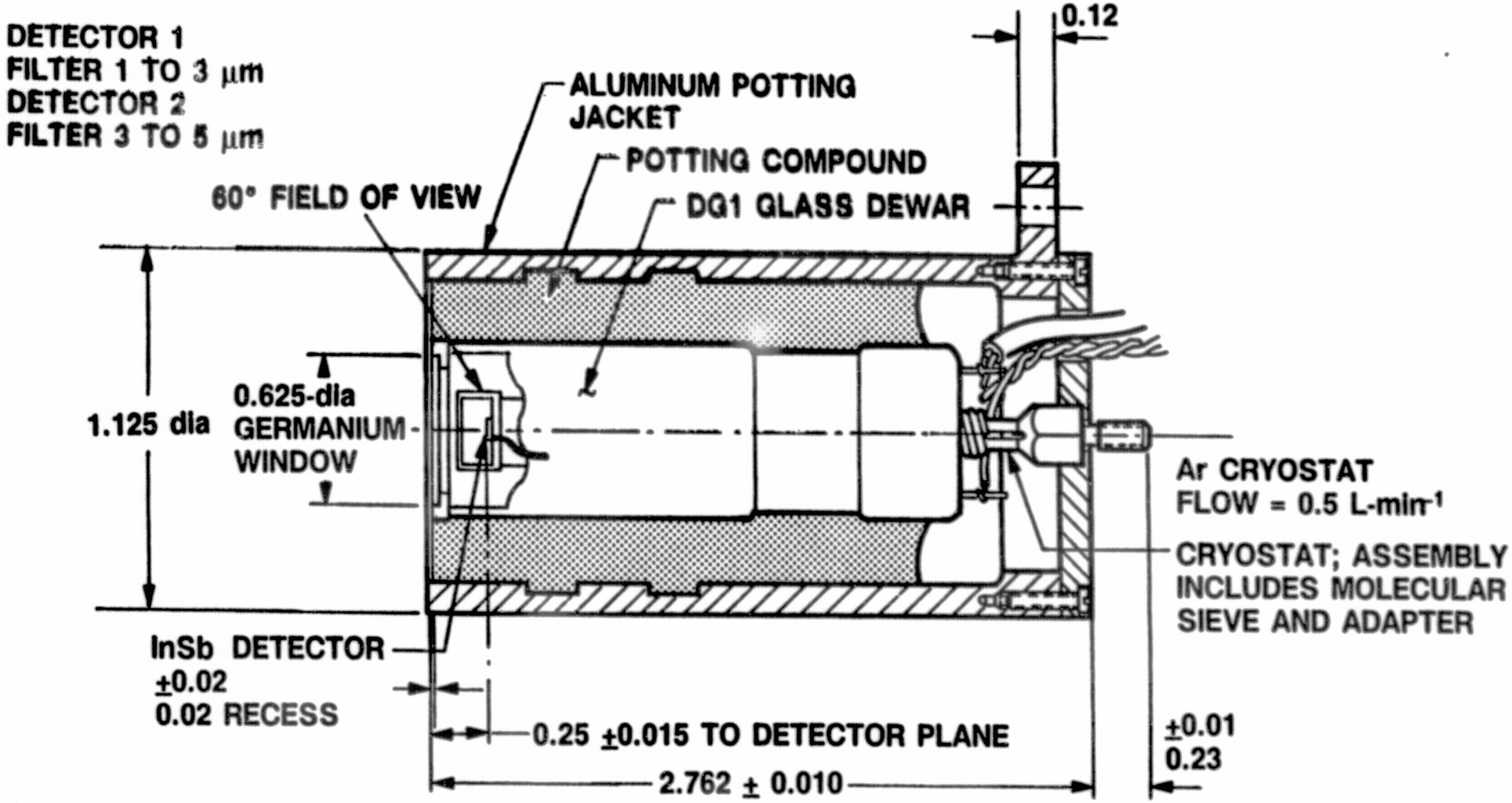
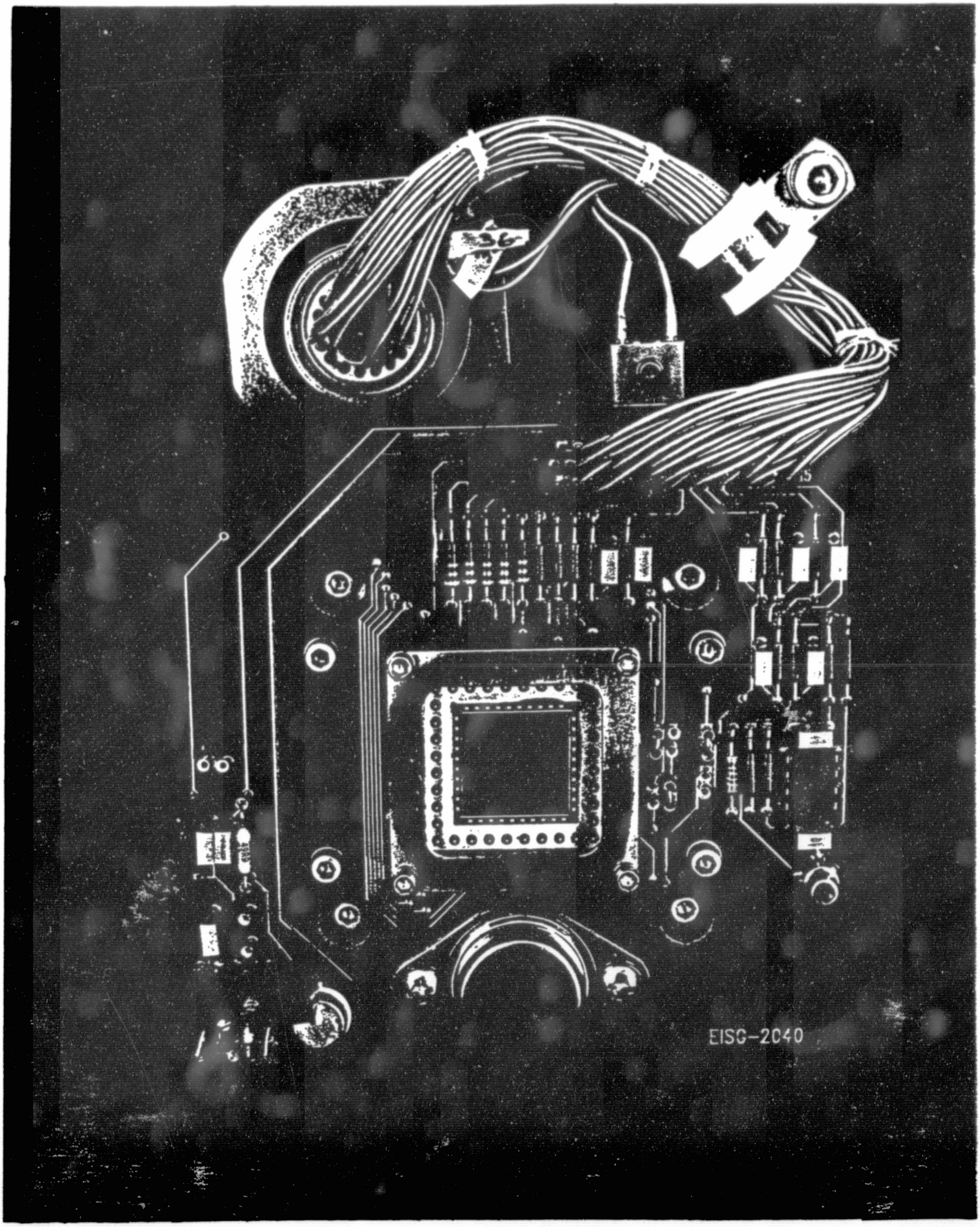
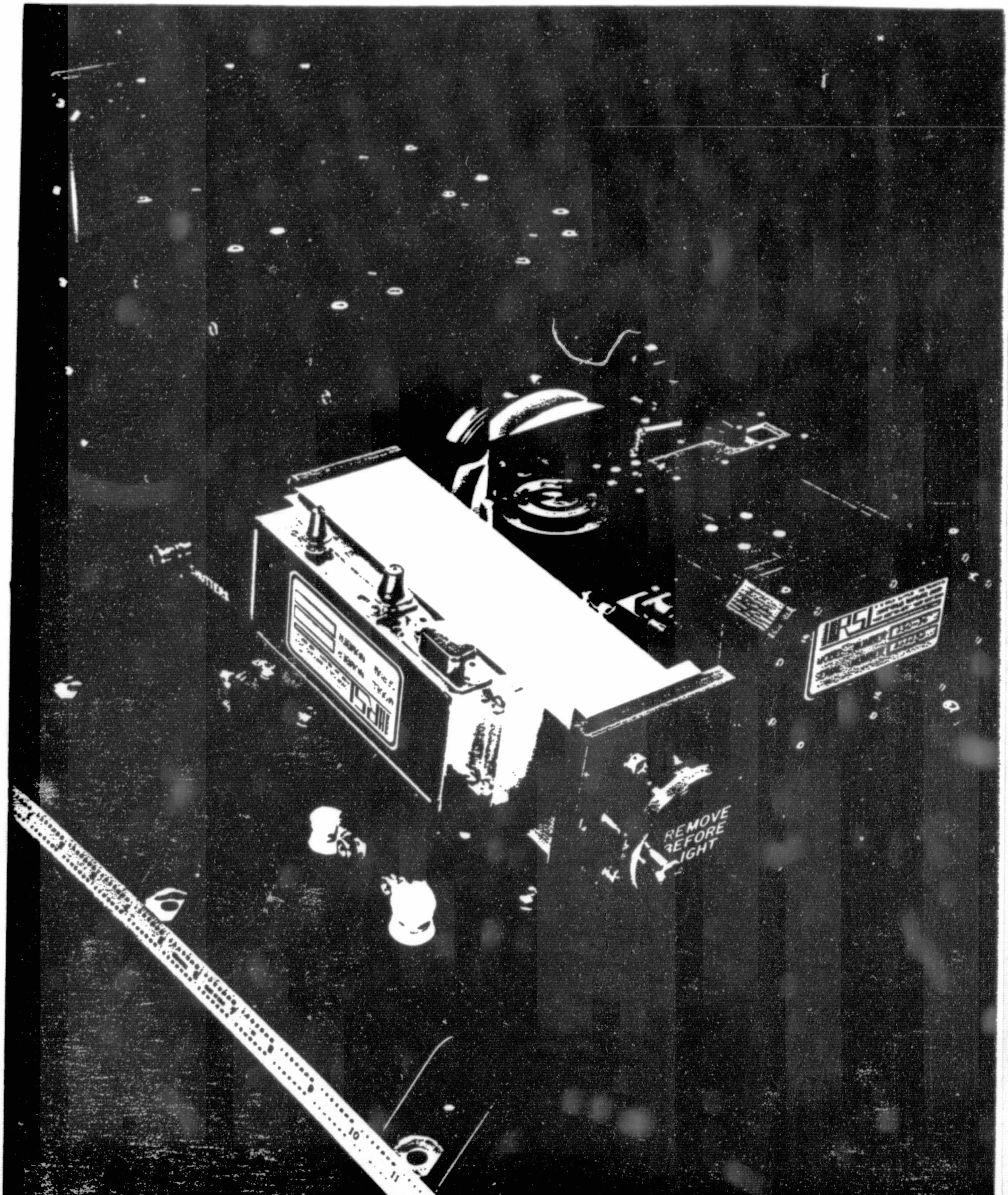
EISG IR / Chopper Drawing



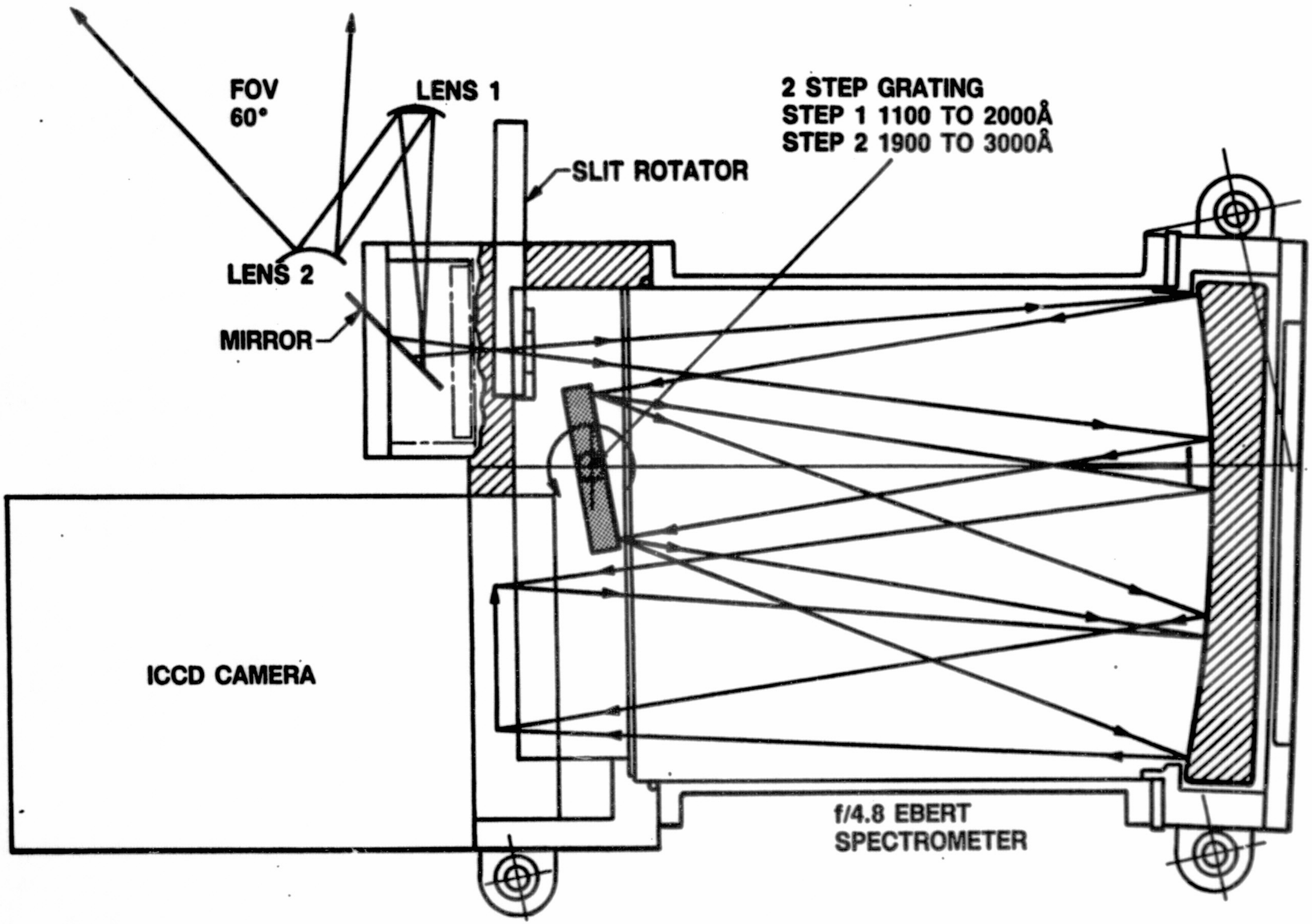
IR DETECTOR (2)

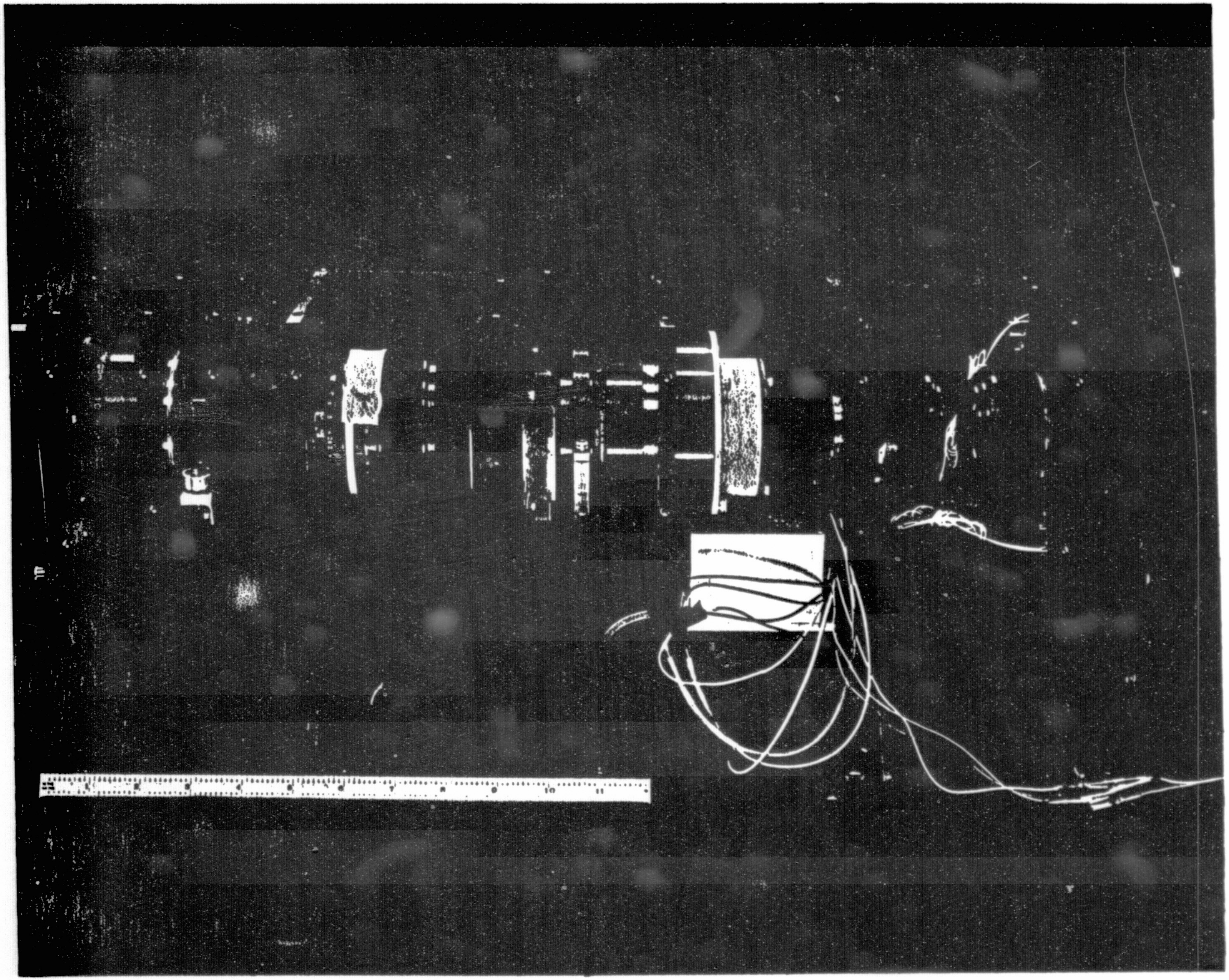


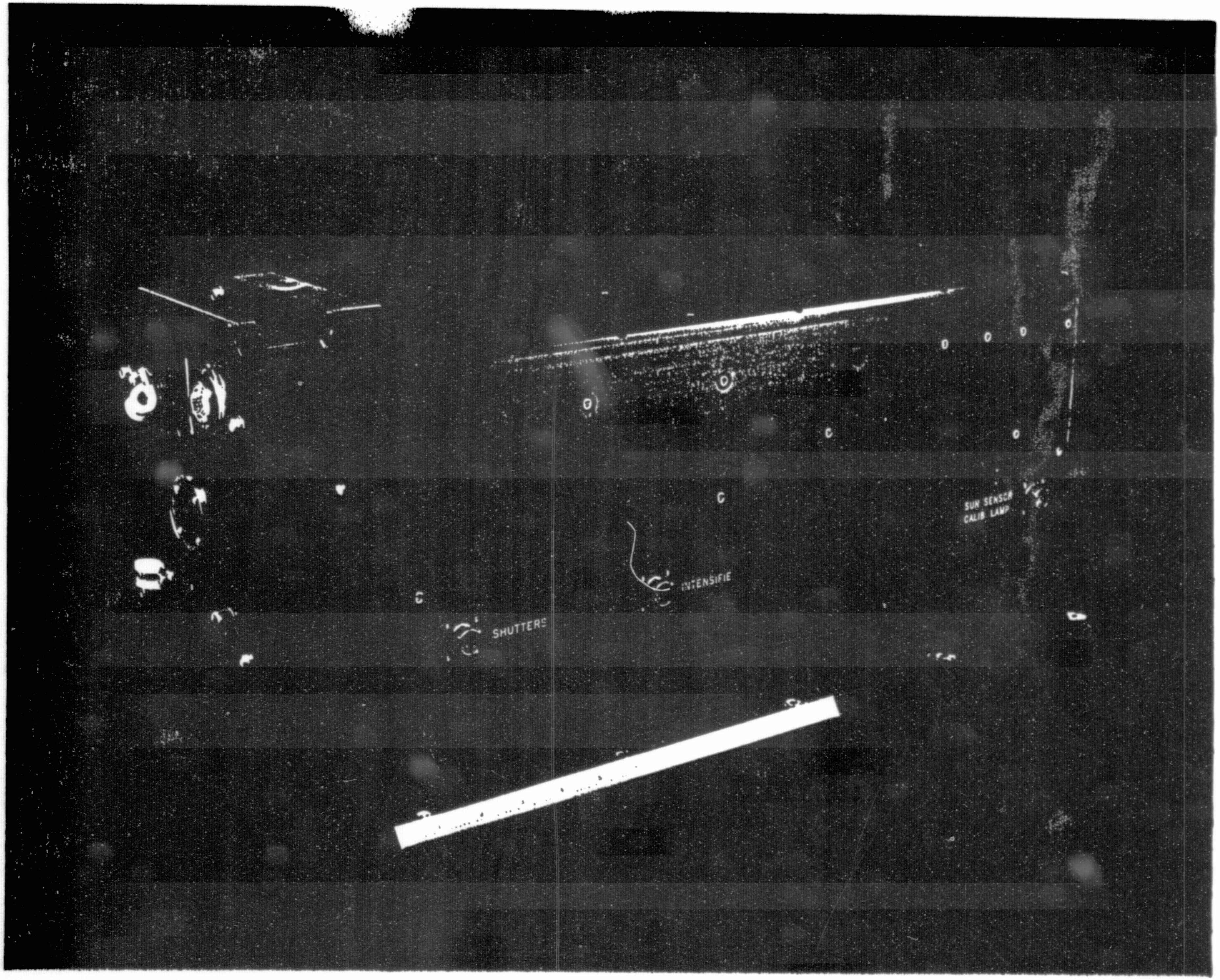

EISG-2040


REMOVE

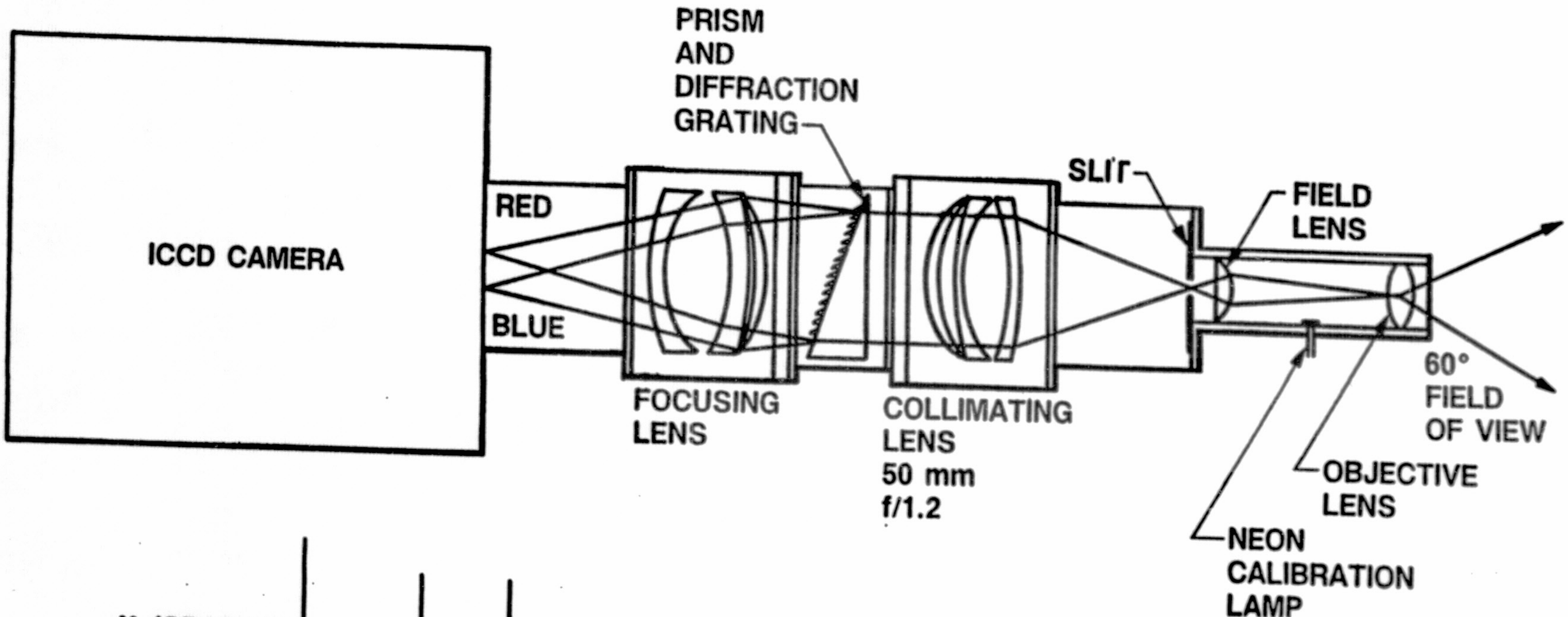
FUV IMAGING SPECTROMETER

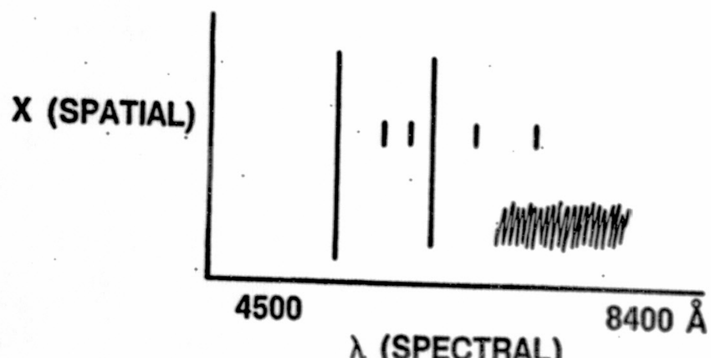




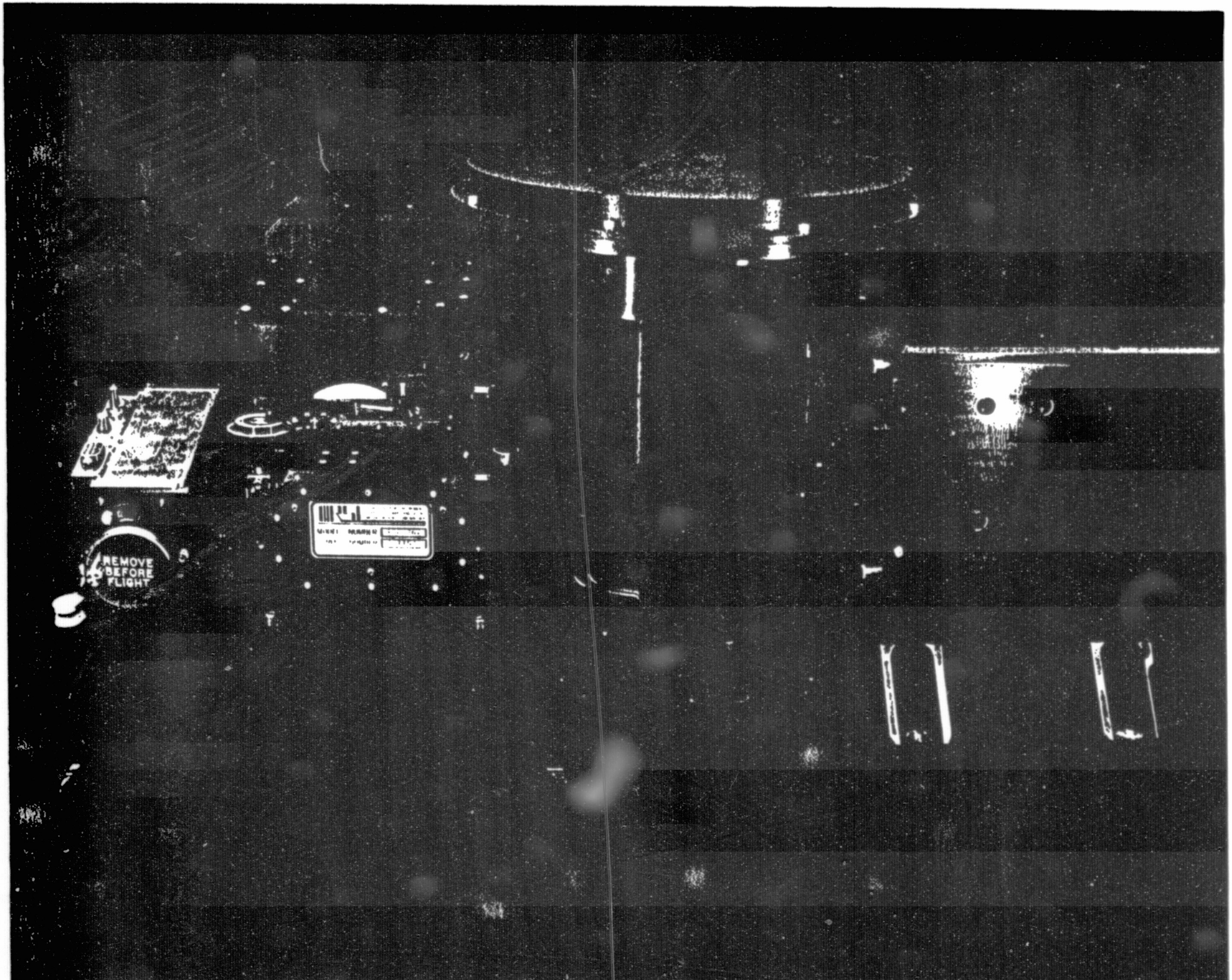

SUN SENSOR
CALIB LAMP
INTENSIFIE
SHUTTERS

VISIBLE IMAGING SPECTROMETER





INTEGRATION
1/60 TO 180 s


REMOVE
BEFORE
FLIGHT

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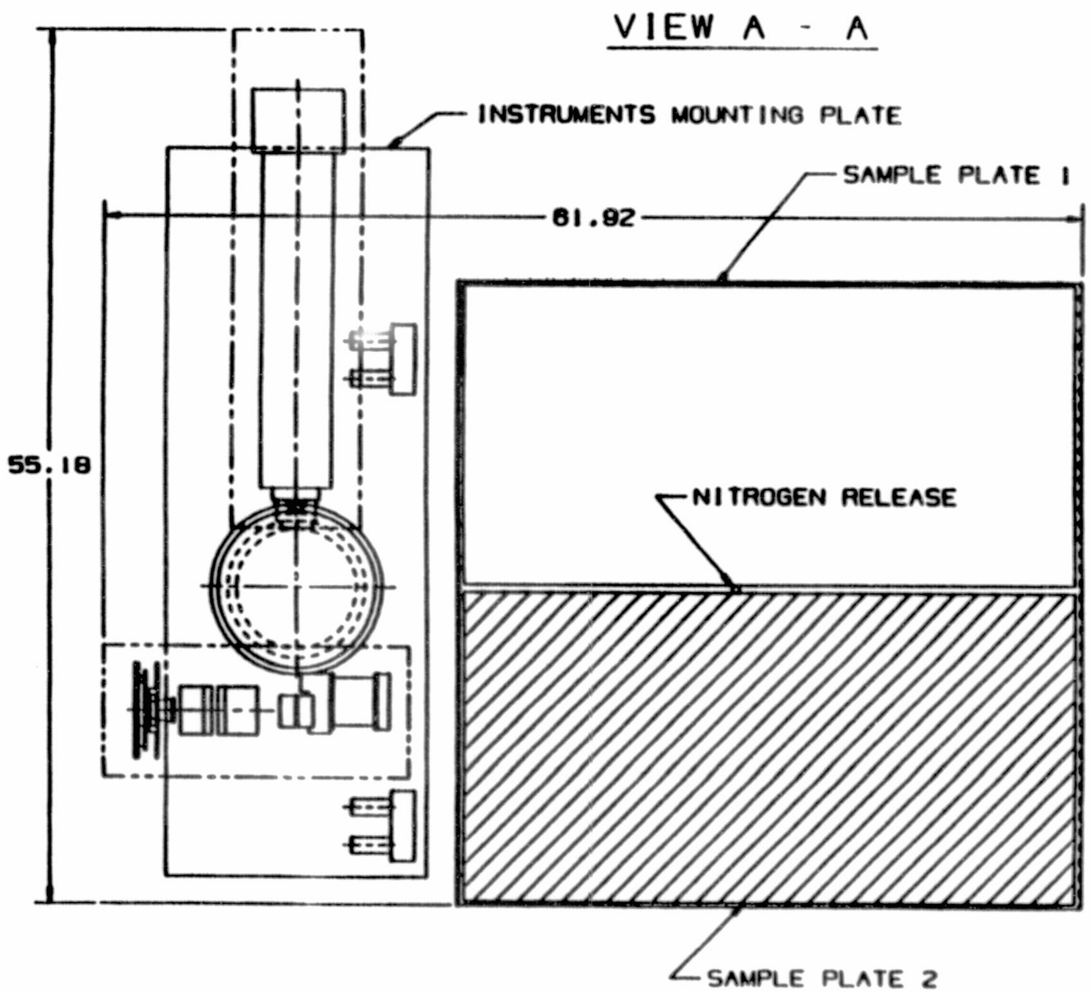

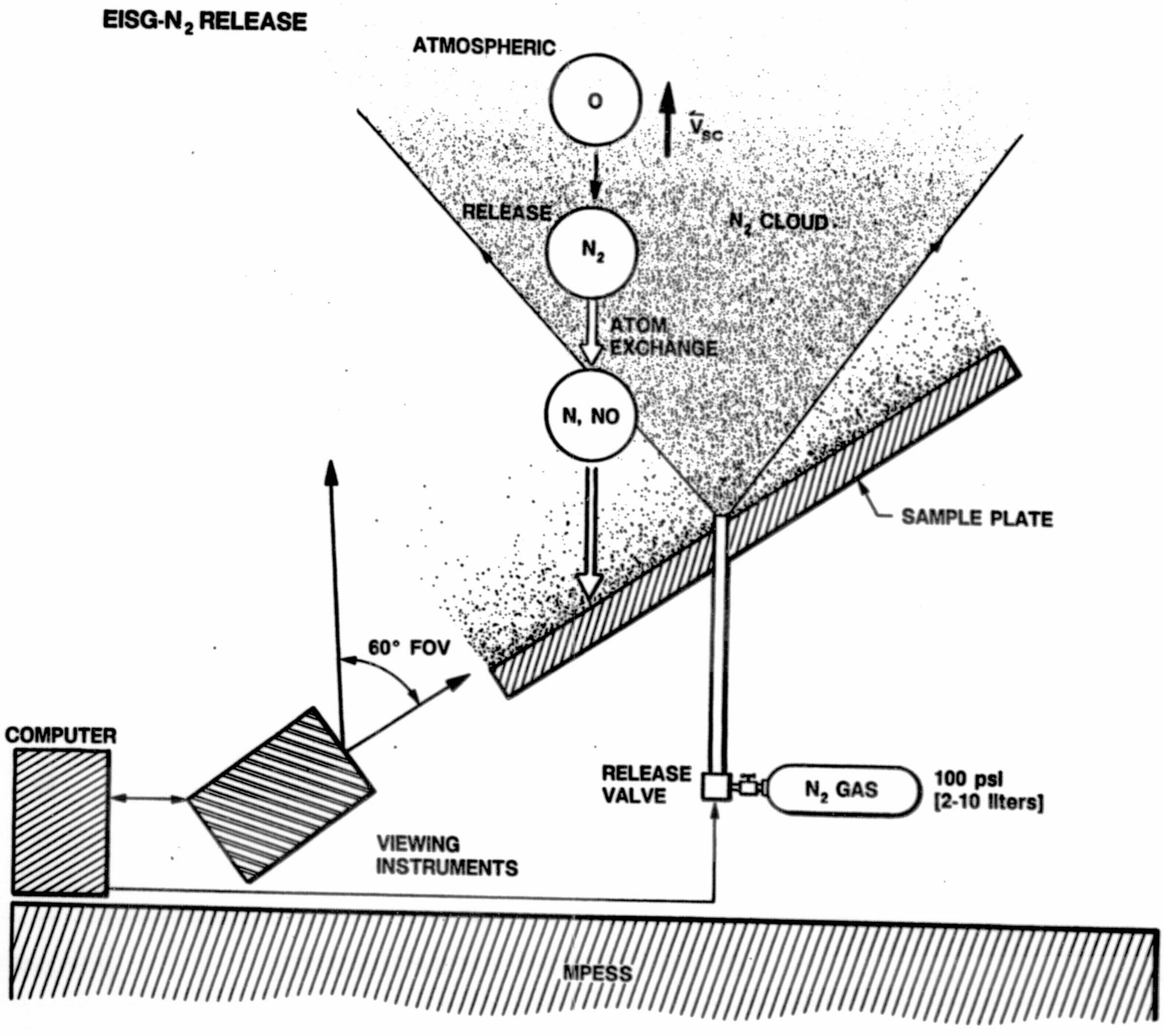

EISG-N_2 RELEASE
ATMOSPHERIC
O
$\vec{V}_{SC}$
RELEASE
N_2
N_2 CLOUD
ATOM
EXCHANGE
N, NO
SAMPLE PLATE
60° FOV
COMPUTER
RELEASE
VALVE
N_2 GAS
100 psi
[2-10 liters]
VIEWING
INSTRUMENTS
MPESS

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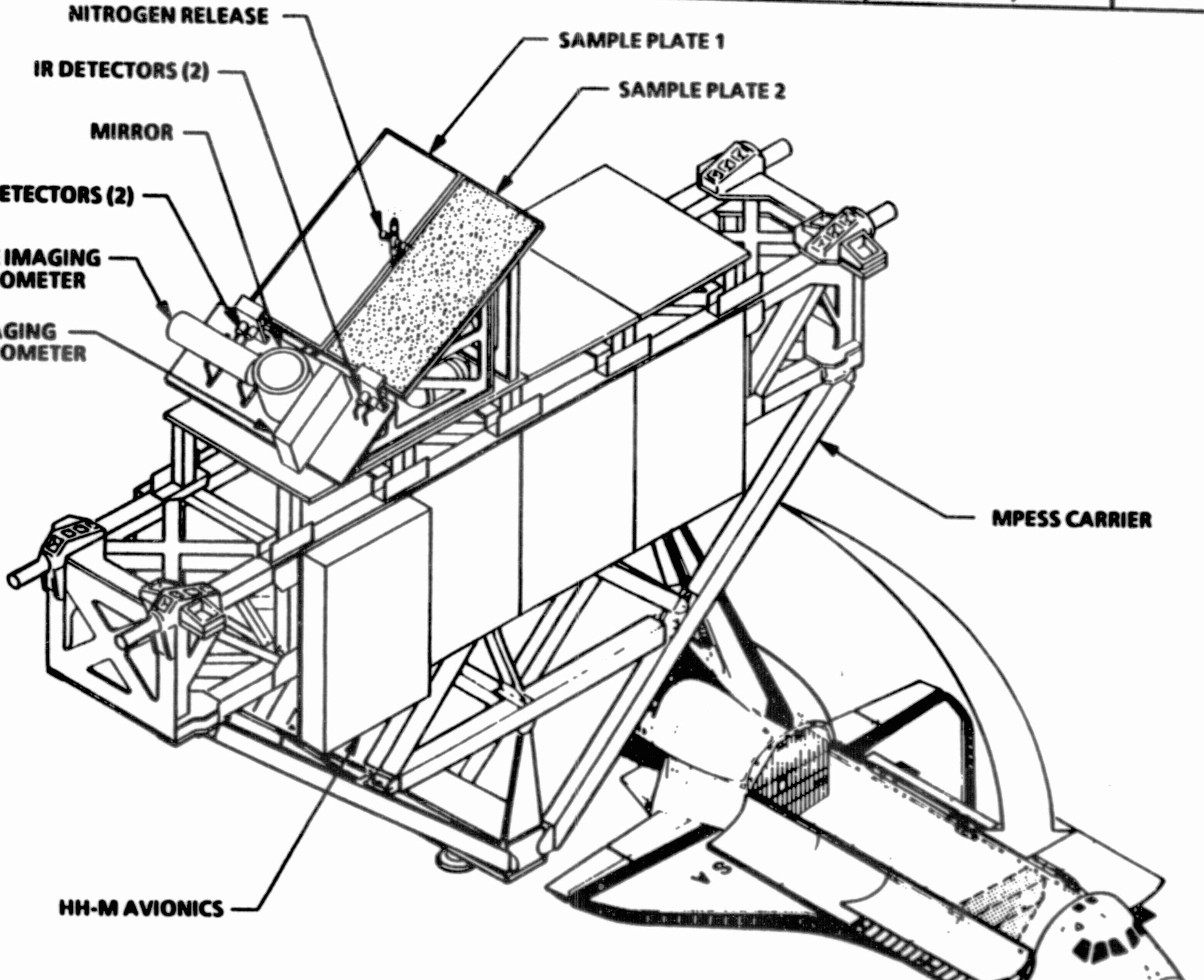
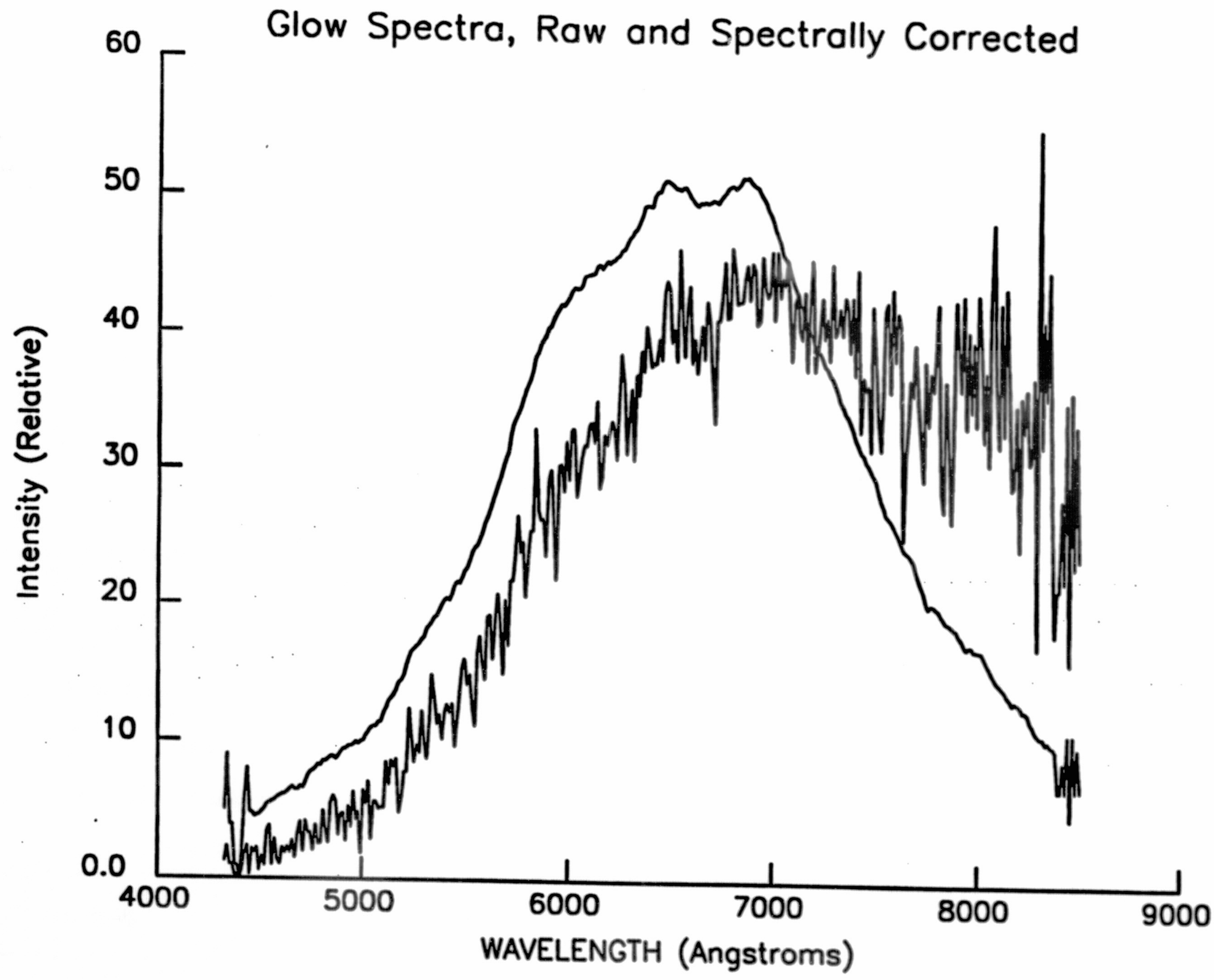
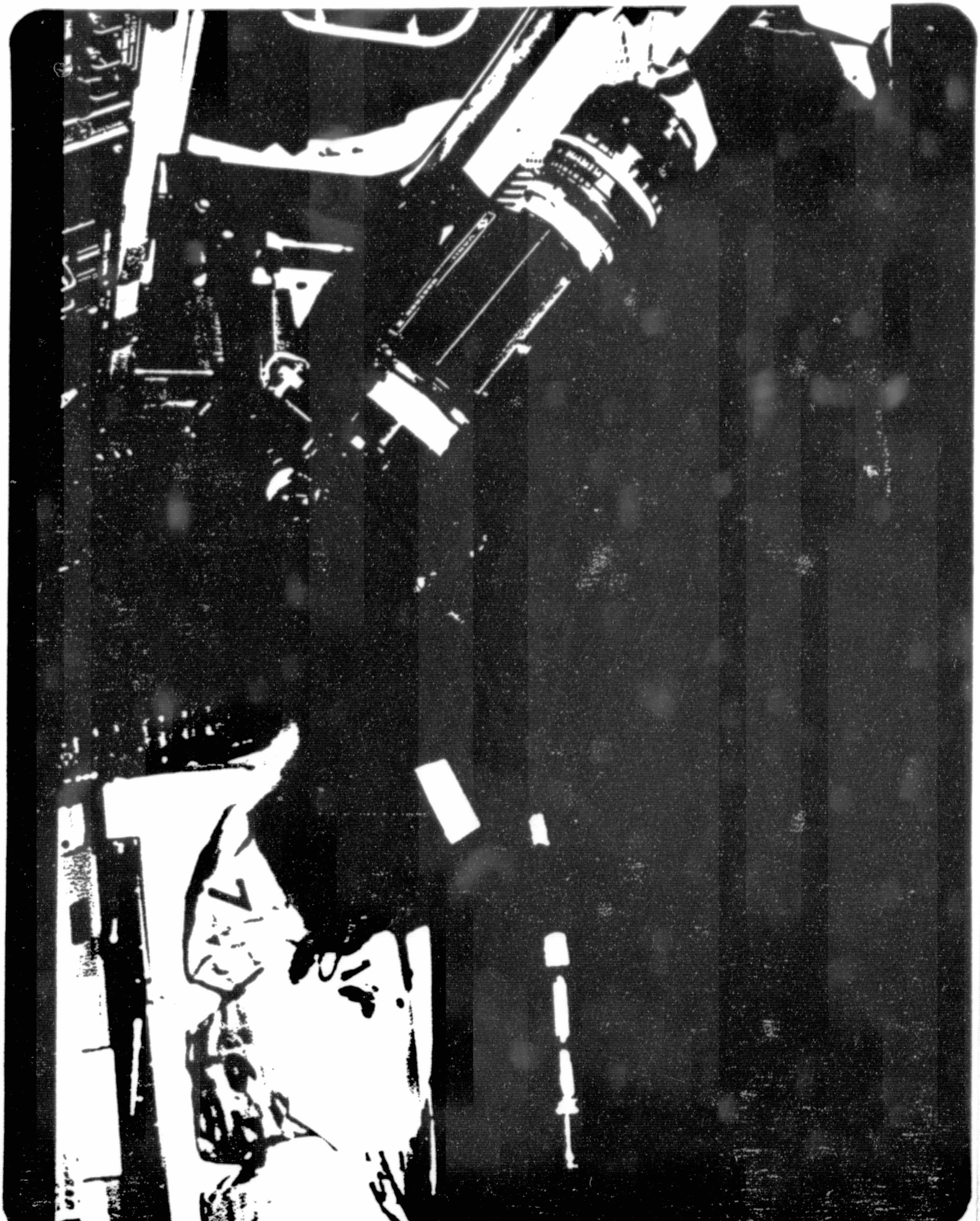


NOTE: 2 TAPE RECORDERS AND ELECTRONICS BOX ARE MOUNTED ON SIDE PLATE IN AFT POSITION.


Glow Spectra, Raw and Spectrally Corrected
Intensity (Relative)
60
50
40
30
20
10
0.0
4000
5000
6000
7000
8000
9000
WAVELENGTH (Angstroms)



ORIGINAL PAGE IS
OF POOR QUALITY

RECENT GLOW DEVELOPMENTS

(GRS, 4/23/92)

1. FLIGHT DATA-STS 39!

   -NO RELEASES CONFIRM GLOW BRIGHTNESS RELATED TO NO SURFACE DOPING.

   -NEW AND INTERESTING IR DATA (INCLUDING SKIRT EXPERIMENT).

2. LABORATORY EXPERIMENTS!

   -CONFIRM N_2 + O ATOM EXCHANGE CROSS SECTION IS LARGE!

3. STUDIES!

   -DAYTIME 1-3 MICRON INTENSITIES FROM SPACELAB 2, IRT EXPERIMENT SUGGEST DAYTIME ANAMOLIES.

Experiment Objective

Develop understanding of the physical processes leading to spacecraft glow phenomena, with emphasis on surface temperature and altitude effects. This development can be used to:

- Characterize optical instrument backgrounds
- Provide guidelines for thermal insulations
- Characterize material selection for flight optics and associated spacecraft
- Affect flight-operation altitude selection for relevant missions

CURRENT (MAJOR) GLOW MYSTERIES

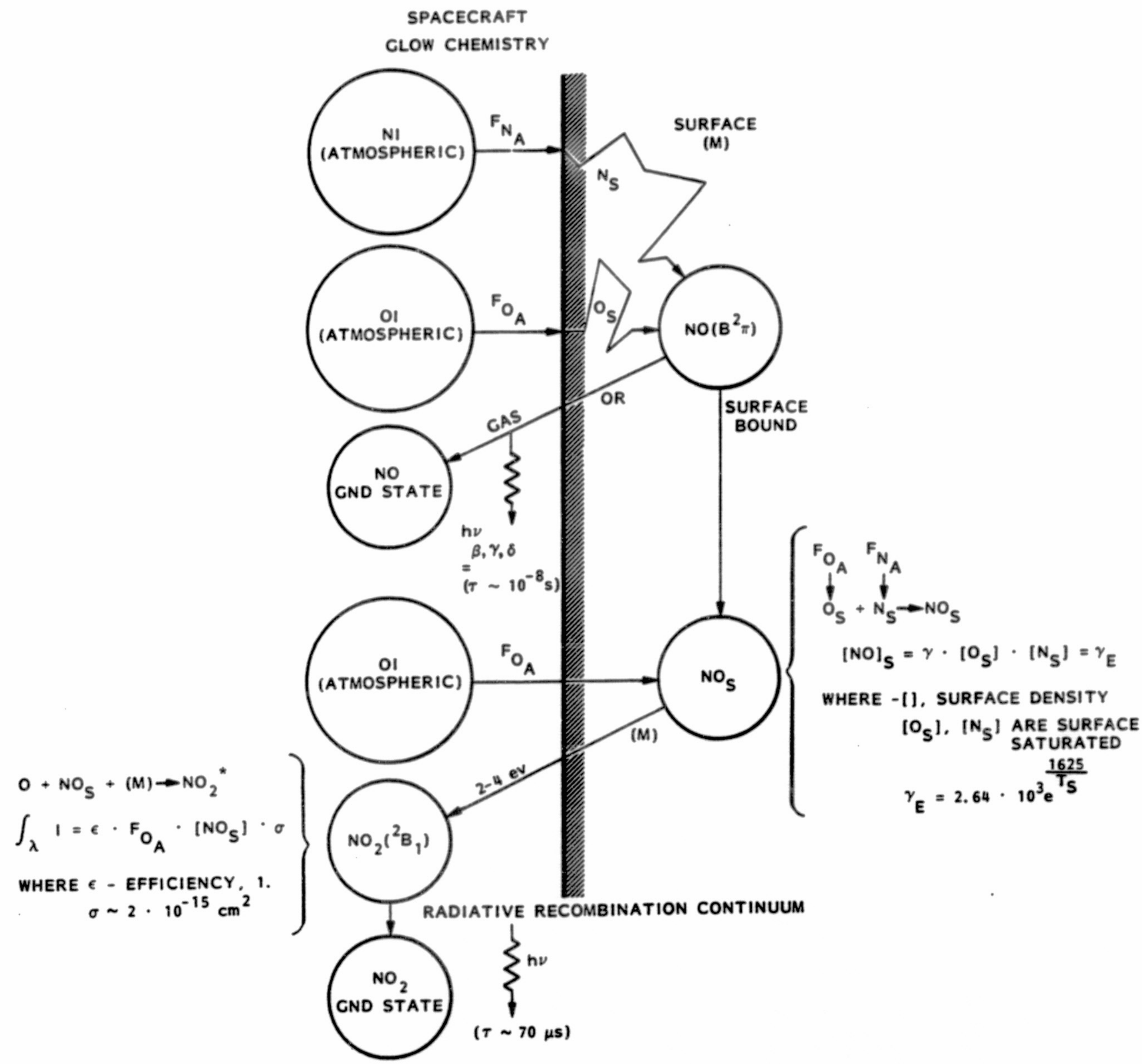
SPECTRAL REGION	MYSTERY
VISIBLE (4000-8000 Å)	-WHAT IS THE SOURCE OF NO? ATMOSPHERIC? ATOM EXCHANGE? I.E. $O + N_2 \rightarrow NO + N$
UV - FUV (1100-4000 Å)	-WHAT IS THE SOURCE OF N? ATMOSPHERIC? ATOM EXCHANGE? I.E. $O + N_2 \rightarrow NO + N$
IR (.8-20 MICRONS)	- H_2O IS A BIG PLAYER, IS ODD N ALSO? -WHY IS DAYTIME SO BRIGHT AT 3.0 MICRONS?

GLOW TECHNOLOGY ISSUES

IDENTIFICATION OF THE PHYSICAL PROCESS

HETEROGENEOUS GLOWS (I.E. THOSE STIMULATED BY SURFACES)
- -SURFACE MATERIAL
- -SURFACE TEMPERATURE
- -CONSTITUENTS INVOLVED
  - (I.E. RAM ATMOSPHERE (ALTITUDE), THRUSTERS, PLOW CLOUD INTERACTIONS (VEHICLE SIZE), OUT/OFF GAS)
- -CONSTITUENT ENERGY (VELOCITY)

HOMOGENEOUS GLOWS (I.E. THOSE INVOLVING GAS-GAS PROCESSES)
- -CONSTITUENTS INVOLVED
  - (I.E. RAM ATMOSPHERE (ALTITUDE), THRUSTERS, PLOW CLOUD INTERACTIONS (VEHICLE SIZE), OUT/OFF GAS)
- -CONSTITUENT ENERGY (VELOCITY)



SPACECRAFT
GLOW CHEMISTRY
NI (ATMOSPHERIC)
F_{N_A}
SURFACE (M)
N_S
OI (ATMOSPHERIC)
F_{O_A}
O_S
$NO(B^2\pi)$
OR
GAS
SURFACE BOUND
NO GND STATE
$h\nu$
β, γ, δ
$(\tau \sim 10^{-8}s)$
F_{O_A} F_{N_A}
$O_S + N_S \rightarrow NO_S$
$[NO]_S = \gamma \cdot [O_S] \cdot [N_S] = \gamma_E$
WHERE -[], SURFACE DENSITY
$[O_S]$, $[N_S]$ ARE SURFACE SATURATED
$\gamma_E = 2.64 \cdot 10^3 e^{\frac{1625}{T_S}}$
OI (ATMOSPHERIC)
F_{O_A}
NO_S
(M)
2-4 ev
$O + NO_S + (M) \rightarrow NO_2^*$
$\int_\lambda I = \epsilon \cdot F_{O_A} \cdot [NO_S] \cdot \sigma$
WHERE ϵ - EFFICIENCY, 1.
$\sigma \sim 2 \cdot 10^{-15}$ cm^2
$NO_2(^2B_1)$
RADIATIVE RECOMBINATION CONTINUUM
$h\nu$
NO_2 GND STATE
$(\tau \sim 70\ \mu s)$

GLOW CONTAMINATIONS (MAJOR KNOWN)

SPECTRAL REGION	CONTAMINANT (MAJOR)
VISIBLE (4000-8000 Å)	-NO_2 FROM SURFACE RECOMBINATION I.E. $NO + O \rightarrow NO_2^*$ (4000-8000 Å)
UV - FUV (1100-4000 Å)	-N_2 FROM SURFACE RECOMBINATION I.E. $N + N \rightarrow N_2^*$ (1400-1800 Å)
	-NO (1900-2200 Å) ??
	-N_2 (2600-3400 Å) ?? 2P OR GH BANDS?
	-O_2 FROM SURFACE RECOMINATION I.E. $O + O \rightarrow O_2^*$ (2800-3800 Å)
IR (.8-20 MICRONS)	-H_2O FROM COLLISIONAL EXCITATION I.E. $H_2O + O \rightarrow H_2O^* + O$ (2.8 - 15 MICRONS)
	-NO, $NO^{\pm}$ EMISSIONS?? (4-5.4 MICRONS)
	-$H_2O^{\pm}$ EMISSIONS FROM CHARGE EXCHANGE?? I.E. $H_2O + O^+ \rightarrow H_2O^{+*} + O$ (2.6-3.3 MICRONS)
	-OH EMISSIONS?? (1.4-3 MICRONS)

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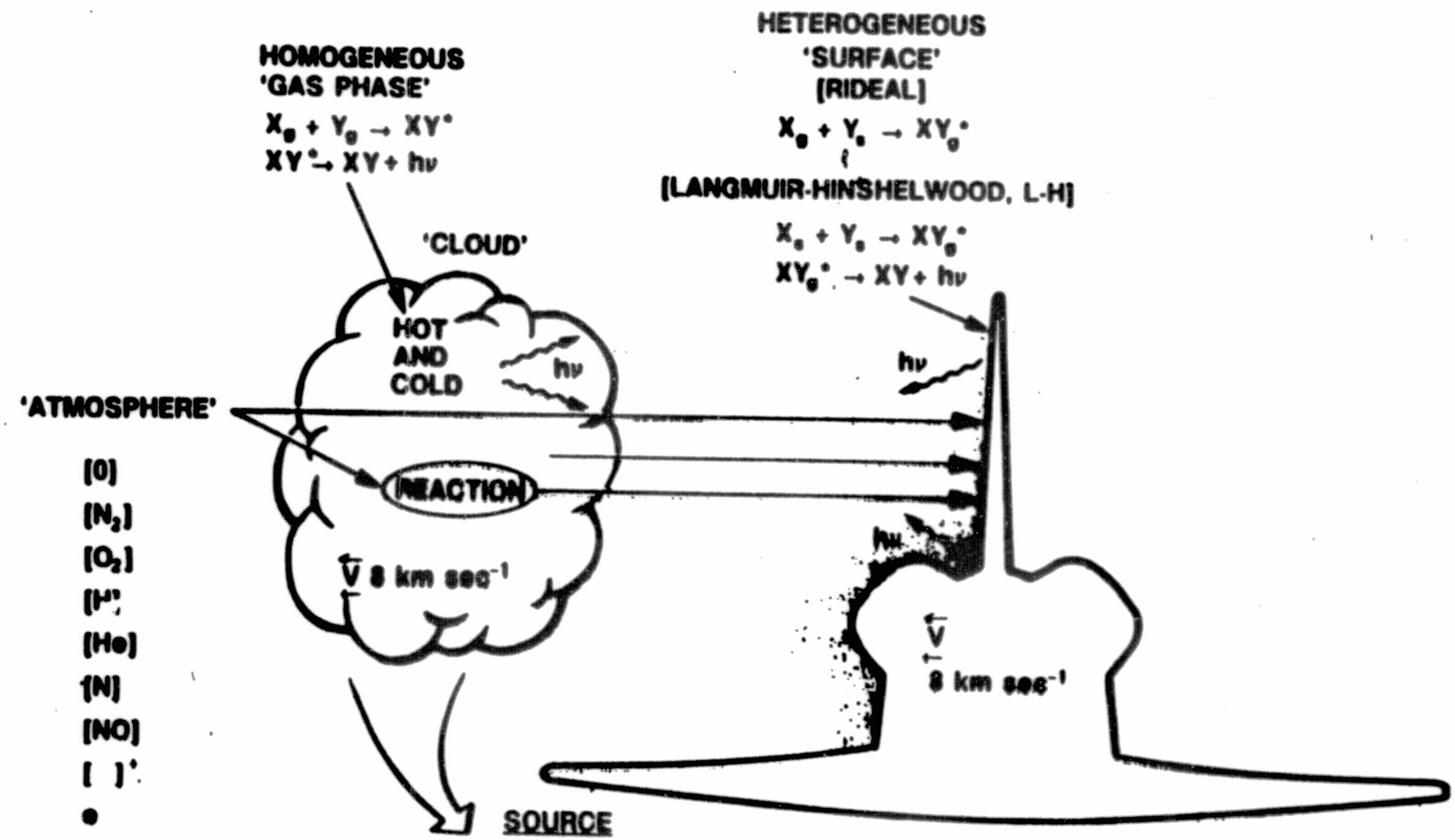
		Gary Swenson — 3-5-91

CHEMICAL PROCESSES



SOURCE

PLOW CLOUD, [ ]$_{CD}$ ~ 30 · LT · [ ]

SURFACE OUTGASSING

LIFE SUPPORT LEAKS; N_2, O_2

DUMPS; H_2O --

CRYOGENS; N_2, He ---

VENTING

THRUSTERS; HYDRAZINE ---

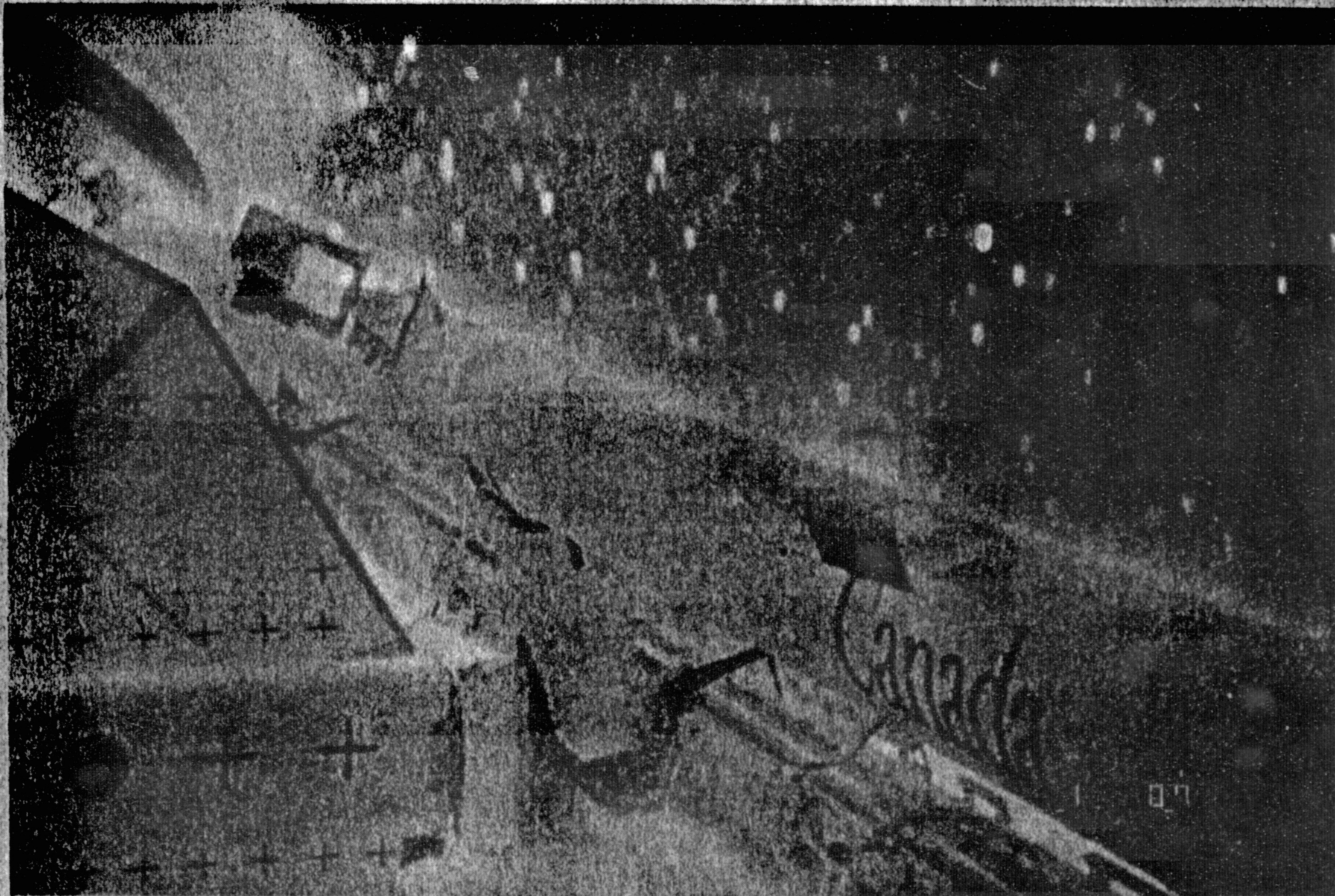
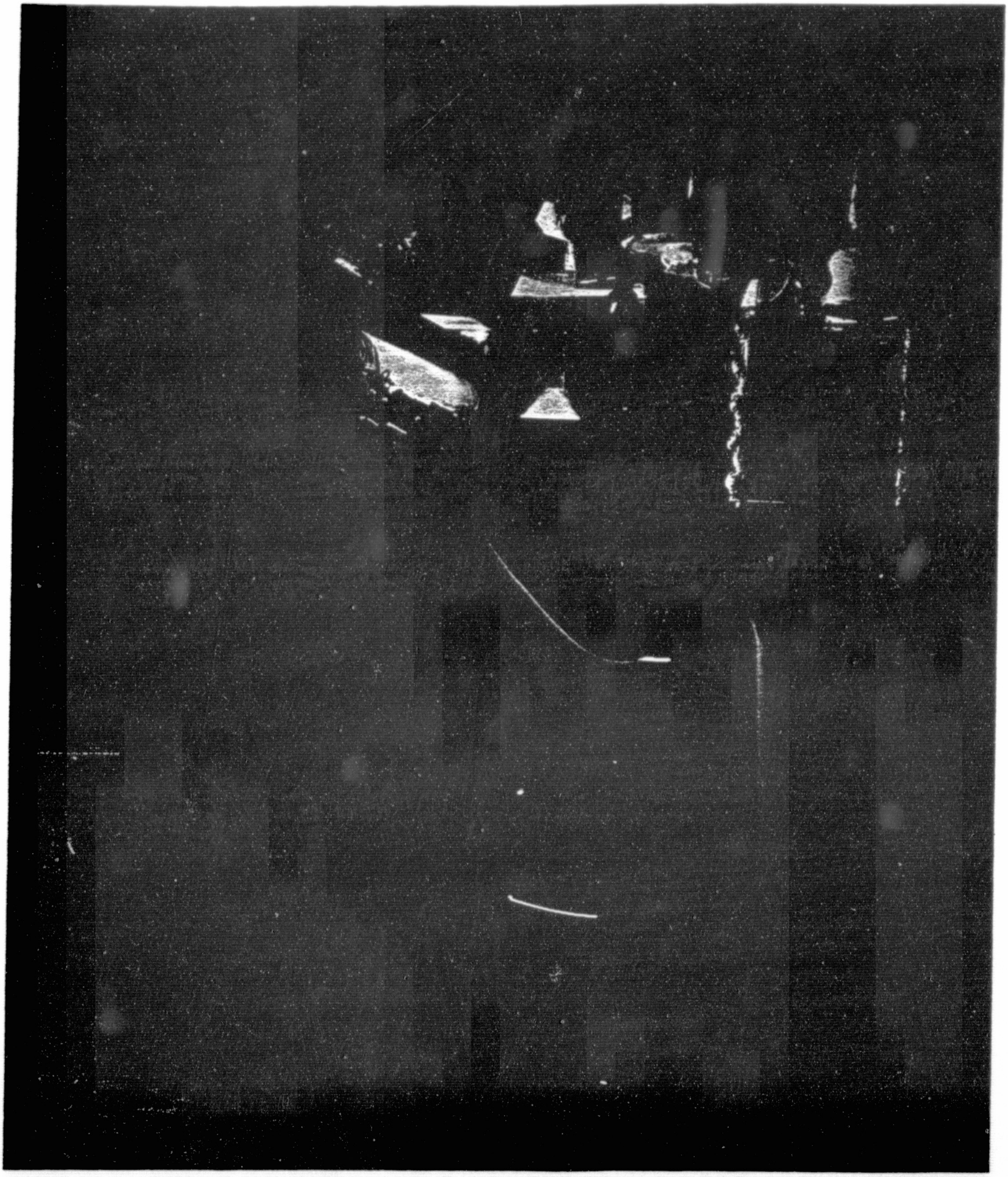
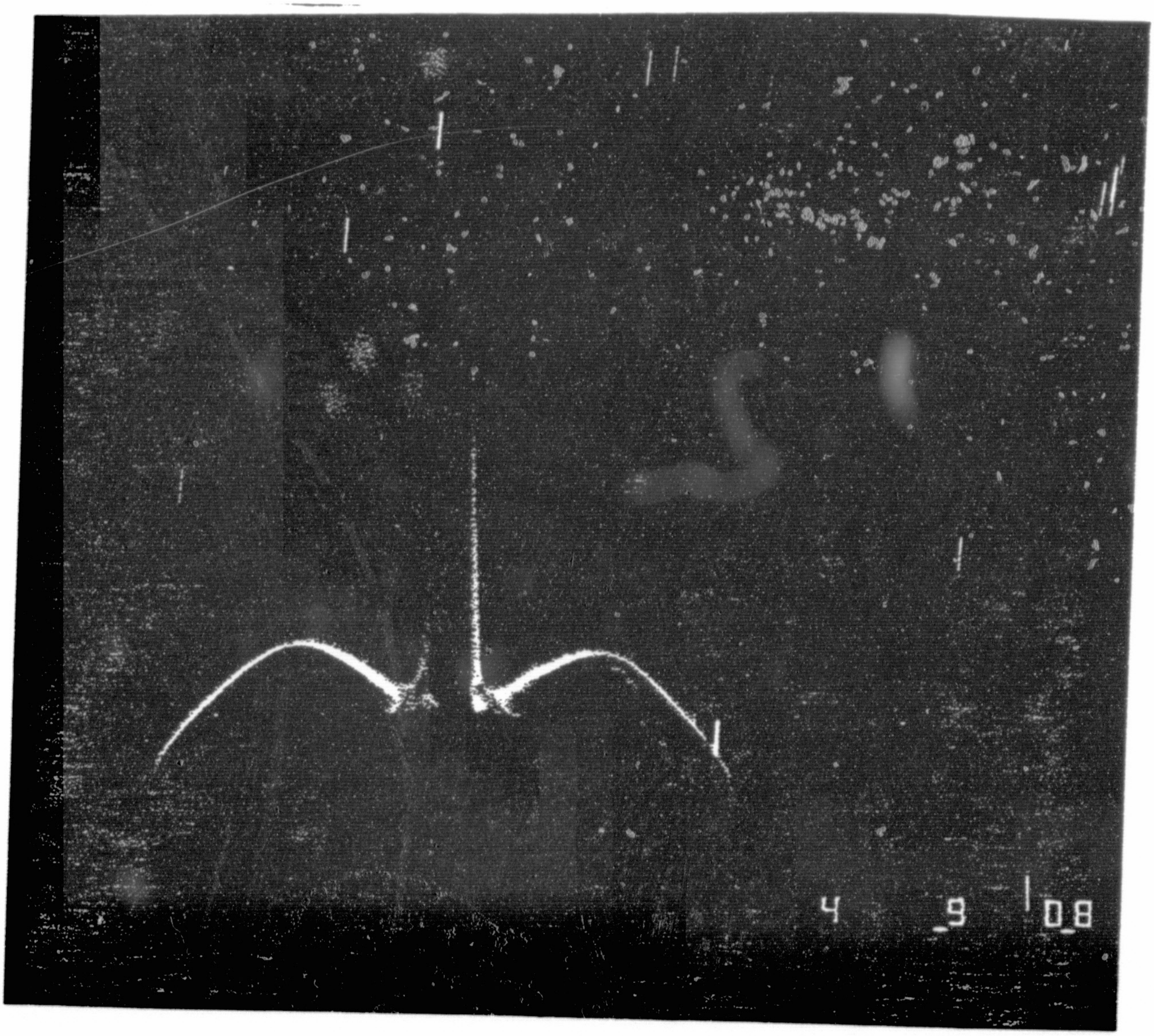


Figure 2. In order to investigate the dependence of the glow intensity on the properties of the spacecraft surface materials samples were mounted on the remote manipulator system (RMS) arm. The samples are in the following sequence: Kapton, Aluminum, Black chem-glaz, Aluminum, Kapton. The image shows a much brighter glow above the chem-glaz than the other two materials. (See Mende et al., 1985)




4 9 08