



#454

HEAO-1

PULSE HEIGHT 77-075A-02A

DISCOVERY SCALER 77-075A-02B

STATUS INFORMATION 77-075A-02C

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP's).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC
INFORMATION SYSTEM:

<http://nssdc.gsfc.nasa.gov/nmc/>

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

- a. Associated Documents To find associated documents you will need to know the document ID number and then click here.
<http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/>

- b. Core Catalog Materials

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PULSE HEIGHT DATA ON MAGNETIC TAPE

77-075A-02A ASXR-00028

This data set has been restored. There were originally 11 9-track, 1600 BPI tapes written in Binary. There are three restored tapes. The DR tapes are 3480 cartridges and the DS tapes are 9-track, 6250 BPI. The tapes were created on a 360 computer. The DR and DS numbers along with the corresponding D numbers and the time spans are as follows:

DR#	DS#	DD#	FILES	TIME SPAN
DR03888	DS03888	D35342	1-35	09/14/77 - 10/19/77
		D35343	36-64	10/15/77 - 12/21/77
		D35341	65-84	10/21/77 - 11/13/77
DR03889	DS03889	D35344	1-38	12/21/77 - 02/09/78
		D35345	39-68	02/09/78 - 03/19/78
		D35346	69-87	03/19/78 - 04/11/78
DR03890	DS03890	D35347	1-8	04/12/78 - 04/20/78
		D35348	9-33	04/21/78 - 05/15/78
		D35349	34-42	05/16/78 - 10/21/78
		D35350	43	08/17/78 - 08/25/78
		D35351	44-56	08/25/78 - 09/07/78

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LOW ENERGY DETECTOR

PULSE HEIGHT DATA FORMAT

77-075A-02A

<u>WORD</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
1- 2	Time (Day-Fraction) since Jan 1, '77	R*8
3- 98	Z-Axis Readout (3,32)	R*4
99-194	Y-Axis Readout (3,32)	R*4
195-834	PHA or Temporal Data (640,2)	I*2

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77-075A-02A

77-075A-02B

77-075A-02C

These data sets consist of 11 Pulse Height data tapes, 6 Discovery Scaler data tapes and 1 Status Information data tape. These tapes are 1600 BPI, Binary, 9 track and are multifiled. The tapes were created on an IBM 360 computer.

Time spans are as follows:

PULSE HEIGHT 77-075A-02A

<u>D#</u>	<u>C#</u>	<u>FILES</u>	<u>TIME SPAN</u>
D-35341	C-20935	20	10/21/77 - 11/13/77
D-35342	C-20936	35	9/14/77 - 10/19/77
D-35343	C-20937	29	10/15/77 - 12/21/77
D-35344	C-20938	38	12/21/77 - 2/09/78
D-35345	C-20939	30	2/09/78 - 3/19/78
D-35346	C-20940	19	3/19/78 - 4/11/78
D-35347	C-20941	8	4/12/78 - 4/20/78
D-35348	C-20942	25	4/21/78 - 5/15/78
D-35349	C-20943	9	5/16/78 - 10/04/78
D-35350	C-20944	1	8/17/78 - 8/25/78
D-35351	C-20945	13	8/25/78 - 9/07/78

DISCOVERY SCALER DATA 77-075A-02B

<u>D#</u>	<u>C#</u>	<u>FILES</u>	<u>TIME SPAN</u>
D-35357	C-20946	14	8/17/77 - 9/07/77
D-35352	C-20947	56	9/14/77 - 11/12/77
D-35353	C-20948	63	11/15/77 - 2/04/78
D-35354	C-20949	53	2/05/78 - 4/11/78
D-35355	C-20950	31	4/12/78 - 5/13/78
D-35356	C-20951	8	5/14/78 - 1/04/79

STATUS INFORMATION DATA 77-075A-02C

<u>D#</u>	<u>C#</u>	<u>FILES</u>	<u>TIME SPAN</u>
D-35358	C-20952	227	8/17/77 - 2/17/78

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DISCOVERY SCALER ON MAGNETIC TAPE

77-075A-02B ASXR-00008

This data set has been restored. There were originally six 9-track, 1600 BPI tapes written in Binary. The data was lost on D035357. There are two restored tapes. The DR tapes are 3480 cartridges and the DS tapes are 9-track, 6250 BPI. The original tapes were created on an IBM 360 computer and were restored on an IBM 9021 computer. The DR and DS numbers along with the corresponding D numbers and the time spans are as follows:

DR#	DS#	DD#	FILES	TIME SPAN
DR003891	DS003891	D035352	1-56	09/14/77 - 11/13/77
		D035353	57-119	11/15/77 - 02/04/78
DR003892	DS003892	D035354	1-53	02/05/78 - 04/11/78
		D035355	54-84	04/12/78 - 05/13/78
		D035356	85-92	05/14/78 - 01/04/79

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LOW ENERGY DETECTOR

DISCOVERY SCALER DATA FORMAT

77-075A-02B

<u>WORD</u>	<u>DISCRIPTION</u>	<u>FORMAT</u>
1- 2	Time (Day-Fraction) Since Jan 1, '77	R*8
3- 98	Z-Axis Readouts (3,32)	R*4
99-194	Y-Axis Readouts (3,32)	R*4
195-514	Discovery Scaler Readouts (40,8,2)	I*2

HEAD 1

STATUS INFORMATION DATA ON TAPE

77-075A-02C **ASXR-00054**

THIS DATA SET HAS BEEN RESTORED. ORIGINALLY THERE WAS ONE 9-TRACK, 1600 BPI TAPE WRITTEN IN BINARY. THERE IS ONE RESTORED TAPE. THE DR TAPE IS A 3480 CARTRIDGE AND THE DS TAPE IS 9-TRACK, 6250 BPI. THE TAPE WAS CREATED ON AN IBM 370 COMPUTER. THE DR AND DS NUMBERS ALONG WITH THE CORRESPONDING D NUMBER IS AS FOLLOWS:

DR#	DS#	D#	FILES	TIME SPAN
DR03671	DS03671	D35358	227	08/17/77 - 02/01/78

LOW ENERGY DETECTOR
STATUS INFORMATION TAPE FORMAT

77-075A-02C

<u>WORD</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
1- 2	Time (Day-Fraction) Since Jan. 1, '77	R*8
3	Rom Number	I*2
3	Ram Number	I*2
4	Mode of Discovery Scalers (2)	I*2
5	Mode of Discovery Scalers (2)	I*2
6- 7	PHA Windows L1 and L2 (2,2)	I*2
8- 9	TPG Status (2)	I*4
10	Calrod Flags (2)	I*2
11	Z-Axis Right Ascension	R*4
12	Z-Axis Declination	R*4
13	Y-Axis Right Ascension (1st good readout)	R*4
14	Y-Axis Declination (1st good readout)	R*4
15	Y-Axis Right Ascension (last good readout)	R*4
16	Y-Axis Declination (last good readout)	R*4
17	Number of 1st good readout	I*2
17	Number of last good readout	I*2
18	Position of Earth in Spacecraft	R*4
19	Polar Co-ordinates (PHI/Theta)	R*4
20	Angle to Sun	R*4
21	Sun Horizon Angle	R*4
22	Position of Spacecraft	R*4
23	Geodetic Co-ordinates (Lon./Lat.)	R*4
24	Sun/Anomaly Flag	I*2
24	Orbit Number	I*2

<u>WORD</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
25	Altitude of Spacecraft	R*4
26-28	Unit Vector to Sun (3)	R*4
29-31	Vector to Moon (km) (3)	R*4
32	Electron Contamination Flag (2)	I*2
33	High Voltage Step (2)	I*2
34	High Voltage Flag (2)	I*2
35	Magnetic Field Flag (2)	I*2
36-38	Mag. Field Di rection (S/C Coord.) (3)	R*4
39	Magnetic Field Strength	R*4
40	Angle to Magnetic Field	R*4
41	Break Down Flag (2)	I*2
42-46	Housekeeping Rates (10,2)	I*2
47	Electron Rate (2)	I*2
48	High Voltage Stability (2)	I*2
49	Backplate Temp. (2)	I*2
50	Front Plate Temp. (2)	I*2
51	Major Frame Error Flag	I*2
52-60	Blank	

CALIFORNIA INSTITUTE OF TECHNOLOGY

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March 26, 1980

Mr. Ralph Post
GSFC
Code 601
Greenbelt, MD 20771

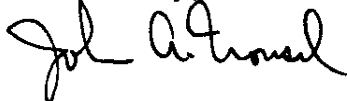
Dear Mr. Post:

Enclosed is a copy of the description of the HEAO-1 A-2 LED science data tapes which we included with the tapes. The description specifies the tape density and record sizes.

To leave no doubt - all tapes are written on nine track 2400' long tapes at 1600 bpi. Each category of tape is formatted differently. The status tapes, labeled STAXXX, have logical records of 240 bytes and blocks of 3600 bytes. Discovery scaler tapes, labeled DATXXX, have logical records of 2056 bytes and blocks of 10280 bytes. The pulse height types, labeled PHAXXX, have unblocked logical records of 3336 bytes.

I hope this is sufficiently clear to enable you to read the tapes.

Sincerely,



John A Nousek

JAN:cm
Encl.

213 795-6811
2622

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CALTECH CONDENSED HEAO-1 A2 LED DATA TAPES

X-ray data for the entire HEAO-1 A2 LED experiment has been condensed onto 27 tapes. These tapes cover the interval from day 229 of 1977, when the experiment first reached its operational configuration, to day 136 of 1978 when the experiment was shut down for lack of gas.

To fit this length of time (during which we received approximately two production tapes per day) onto only 27 tapes we had to compress the data. We did this by discarding all times when the experiment was off, by restricting the X-ray data to the LED detectors and by simplifying the aspect information.

The remaining data was sorted into three categories, and written onto three sets of tapes. These categories are status information, discovery scaler data and pulse height data. Each category of data was written onto a tape in a unique format. Thus a category may be recognized on the basis of record length, even without labeling.

Data was time structured across categories. Thus a given time occurs on the corresponding tape in each category. Selection of a tape indicates both a time range and a category. The following table is a guide to the ordering.

The tapes were written at an IBM installation using a 370/3032 system. The tapes are standard 9-track 2400' length, written at 6250 bpi, without time labels.

Each category was formatted differently. The status tapes are written in logical records of 240 bytes in blocks of 3600 bytes. The discovery scaler tapes are written in 2056 byte logical records and 1280 byte blocks. The pulse height tapes have unblocked records of length 3336 bytes.

Table 1
Tape Data Organization

<u>Time (Day of 1977)</u>	<u>Status</u>	<u>Data Category</u>	
		<u>Discovery Scaler</u>	<u>Pulse Height</u>
229-236	STA201	DAT201	PHA201
237-249	STA202	DAT202	PHA202
257-295	STA203	DAT203	PHA203
296-329	STA204	DAT204	PHA204
330-377	STA205	DAT205	PHA205
378-425	STA206	DAT206	PHA206
426-467	STA207	DAT207	PHA207
468-495	STA208	DAT208	PHA208
496-516	STA209	DAT209	PHA209

The actual tape writing was done by the assembly language routine FWRITE provided by Goddard Space Flight Center. We include listings of the computer code for FWRITE and the FORTRAN listing for FRONTEND. FRONTEND organized the data into the three categories and contains comment cards describing the meaning of the various labels.

Our technique of using the tapes is based on the organization into categories. The only data present on all three category tapes is the time of the observation. Our program GTIMES compares the status data to a desired set of data selection criteria. If the status data falls within the selection criteria the time is stored for later use. Thus the status tape is used only to select useful times.

These useful times are applied to select data on the discovery scaler or pulse height tapes. (For an explanation of the experiment data see the HEAO-1 experiment description, NASA TM-79574, Rothschild et al.) This data can be used as the experimenter wishes.

The low energy data are contained on three sets of tapes, each covering a different aspect of the data: the Status tapes containing satellite status information, attitude and ephemeris information, and data quality information; the Data tapes containing discovery scaler information; and the PHA tapes containing pulse height analysis data.

Variable names follow standard FORTRAN defaults (names beginning with I-N 4-byte integers, all others 4-byte reals) with these exceptions: variable names starting with D indicate double precision (8-byte) reals, and names starting with H indicate 2-byte integers. In listing flag bits, the least significant bit will always be denoted by bit 0.

***** STATUS Tape -- 240-byte records *****

** Satellite status information **

DAY Time, in DAY.FRACTION format, of beginning of major frame (record) of data.

HROMN Flag indicating which, if any, of the two read only memories was controlling the telemetry format:
1 = ROM1, 2 = ROM2, 3 = RAM in use and -3 indicates a gap in the data.

HRAMN Number indicating which, if any, of the random access memory formats was controlling the telemetry format. The only RAMs useful for LED data are RAM1 and RAM10; these will be described with HTEM below.

HSCL56(2) Window selection mode of discovery scalers 5 and 6 for detectors LED1 and LED2 (see HPHAWD below for window descriptions):

Bit	Meaning
0	W1D (1 => open)
1	W1C (1 => open)
2	W1B (1 => open)
3	W1A (0 => open)

Discovery scaler 5 contains Left counts and scaler 6 contains Right counts.

HSCL78(2) Window selection mode of discovery scalers 7 and 8 for detectors LED1 and LED2:

Bit	Meaning
0	W2B (1 => open)
1	W1D (1 => open)
2	W1C (1 => open)
3	W2B Veto layer (0 => open)

Discovery scaler 7 contains Left counts and scaler 8 contains Right counts.

HMAGFL(2) Magnetic field flags for detectors LED1 and LED2. These flags are set when the detector is either almost parallel or almost perpendicular to the magnetic field. The angular tolerances are unknown.

BFIELD(3) Magnetic field direction in satellite rectangular coordinates.

BGAUSS Magnetic field strength in gauss.

ANGMAG Angle between magnetic field and Y-axis in radians.

HBREAK(2) Detector breakdown flags for detectors LED1 and LED2.
0 => Detector OK.
1 => Detector arcing (breakdown)

HOUS(10,2) Housekeeping scalars for LED1 and LED2 (see satellite description).

HNE(2) Estimated number of electrons impinging on detector for LED1 and LED2. Rate is estimated from housekeeping scalars 8 and 10, and estimation formula changed during mission, so this number is not very reliable.
HV level 9: LED1: $3.2 * HOUS(10) - HOUS(8)$
LED2: $3.1 * HOUS(10) - HOUS(8)$
HV level 11: LED1: $2.2 * HOUS(10) - HOUS(8)$
LED2: $2.12 * HOUS(10) - HOUS(8)$

HVSTB(2) High voltage stability flags for LED1 and LED2
0 => High voltage stable
1 => High voltage unstable

HBPTMP(2) Temperature of back side of detectors LED1 and LED2. These temperatures are of mysterious origin and are never right.

HFPTMP(2) Temperature of front side of detectors LED1 and LED2. These temperatures are of mysterious origin, and are never right

HMFERR Major frame data error flag:
Bit 0 set => Block encoder error
Bit 1 set => IPD bit error flag set
Bit 2 set => IPD fill data flag set
(IPD stands for the Information Processing Division of Goddard Flight Center which produced the source tapes for all HEAO-A-2 data.)

HPHAWD(2,2)

Pulse height analysis windows for LED1 and LED2
(first index is layer number, second is detector):

Layer 1:

Bit Meaning

--- -----
0 W1D = 2 002-3.000 keV for LED1
 1.908-3.000 keV for LED2
1 W1C = 0.741-2.002 keV for LED1
 0.720-1.908 keV for LED2
2 W1B = 0.431-0.741 keV for LED1
 0.422-0.720 keV for LED2
3 W1A = 0.152-0.431 keV for LED1
 0.150-0.422 keV for LED2

Layer 2:

Bit Meaning

--- -----
0 W2B = 0.806-3.000 keV for LED1
 0.834-3 000 keV for LED2
1 W2A = 0.157-0.806 keV for LED1
 0.173-0.422 keV for LED2

(0 => open 1 => closed)

ITPG(2)

Test pulse generator flags for LED1 and LED2:

Bit Meaning

--- -----
0 TPG Abort (0 => running, 1 => aborted)
1 Layer 1 left output
2 Layer 1 right output
3 Layer 2 left output
4 Layer 2 right output
5 Veto layer 1 output
6 Veto layer 2 output
7 Alpha output
8 TPG enable == program bug: always 0
9 Layer 2 right selected
10 Layer 2 left selected
11 Layer 1 right selected
12 Layer 1 left selected
13 TPG mode (0 => auto, 1 => manual)
14 Alpha selected
15 Veto layer 2 selected
16 Veto layer 1 selected
17 TPG power (0 => off, 1 => on)

HCALIB(2)

Radioactive calibration rod flags for LED1 and LED2.

0 = rod out (inactive)
1 = rod in (active)

** Attitude information ***

ZRA, ZDEC

Right ascension and declination of Z-axis (rotation axis) of satellite.

YRAS, YDECS

RA and Dec of Y-axis (view direction) at center of first good minor frame in major frame. (Note: LED2 is offset 6 degrees toward the X-axis, and so trails LED1 scanning.)

YRAE, YDECE RA and Dec of Y-axis at center of last good minor frame in major frame.

HATTS Position number (1-32) of first good minor frame in major frame.

HATTE Position number (1-32) of last good minor frame in major frame.

** Ephemeris information **

PHI, THETA Position of earth in satellite coordinates. PHI is the angle from the Z-axis (0° to 2π) and THETA is the angle from the Y-axis (NOT the angle from the X-axis) in the positive direction (0° to 2π).

SUNANG Angle from Y-axis to sun in radians

SUNHOR Angle from the sun to earth's center from the satellite's viewpoint in radians.

EARLON, EARLAT Longitude and latitude of satellite over earth in decimal degrees.

HSUNAN Sunlight/Anomaly flag:
 Bit 0 set => satellite in either the South Atlantic or North Pacific magnetic anomaly.
 Bit 1 set => detector sunlit.

HONUM Orbit number

ALTUDE Altitude of satellite over earth in kilometers.

UVSUN(3) Unit vector in the direction of the sun in rectangular celestial coordinates.

VMOON(3) Vector from earth to moon in rectangular celestial coordinates and in kilometers.

** Data quality information **

HELCON(2) Electron contamination flags for detectors LED1 and LED2:
 0 => rate < 2 standard deviations above zero.
 1 => rate < 3 standard deviations above zero.
 3 => rate < 4 standard deviations above zero.
 4 => rate >= 4 standard deviations above zero.
 (This flag is not very reliable since it uses HNE.)

HVSTP(2) High voltage steps for detectors LED1 and LED2:
 0-15 indicating which of 16 high voltage levels was selected. The voltage levels are in ascending order (0 = minimum).

HVFLAG(2) High voltage flags for detectors LED1 and LED2.
 0 => High voltage on (normal).
 1 => High voltage off (abnormal).

***** DATA Tape -- 2056-byte records *****

** Scaler information **

DDAY Time in DAY.FRACTION format, of beginning of major
 frame (record) of data.

ZVECTR(3,32) Unit vector in the direction of the satellite Z-axis
 in rectangular celestial coordinates at the center of
 each minor frame.

YVECTR(3,32) Unit vector in the direction of the satellite Y-axis
 in rectangular celestial coordinates at the center of
 each minor frame.

HDATA(40,8,2) Scaler count data for detectors LED1 and LED2, each
 with 8 scalers. Minor frame counts come 4 at a time
 (overflows rolled over), followed by a total of the
 four frames (with overflows added). Thus the data are
 arranged: minor frame, minor frame, minor frame, minor
 frame, total, etc.
 Discovery scalers 5 through 8 count according to
 HSCL56 and HSCL78 as above Scalers 1 through 4 count
 as follows:

Scaler Counts

- 1 Layer 1 left within entire window W1
- 2 Layer 1 right within entire window W1
- 3 Layer 2 left within entire window W2
- 4 Layer 2 right within entire window W2

***** PHA Tape -- 3336-byte records *****

** Pulse height analysis and temporal information **

DDDAY Time, in DAY.FRACTION format of beginning of major
 frame (record) of data.

ZVEC(3,32) Unit vector in the direction of the satellite Z-axis
 in rectangular celestial coordinates at the center of
 each minor frame.

YVEC(3,32) Unit vector in the direction of the satellite Y-axis
 in rectangular celestial coordinates at the center of
 each minor frame.

HTEM(640,2) Pusle height analysis or temporal data for detectors
 LED1 and LED2 depending on which memory is in use:
 ROM1 => PHA(4,32,5,2).
 ROM2 => TEMPORAL(40,16,2).
 RAM1 => TEMPORAL(32,16,2), PHA(4,32,2).
 RAM10 => ROM1 format for LED1, RAM1 format for
 LED2.
 For the temporal array formats see the HEAO-A
 technical manual. The PHA array dimensions represent:
 Dimension Meaning
 ----- -
 4 Detector outputs R2,R1,L2,L1 in that
 order
 32 PHA channel number
 5 1-4 are 10.24 second totals , and
 the fifth is the total over the
 major frame (40.96 seconds).
 2 Detector number
 For the PHA array in the RAM1 format all totals are
 over the entire major frame.



Technical Memorandum 79574

**The Cosmic X-Ray Experiment
Aboard HEAO-I**

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S. Holt, P. Serlemitsos,
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June 1978

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The Cosmic X-Ray Experiment Aboard HEAO-1

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ABSTRACT

The Cosmic X-Ray Experiment aboard the HEAO-1 observatory is described. The instrument consists of six gas proportional counters of three types nominally covering the energy ranges of 0.15-3 keV, 1.2-20 keV, and 2.5-60 keV. The two low energy detectors have about 400 cm² open area each while the four others have about 800 cm² each. A novel feature of this experiment is the dual field of view collimators that allow the unambiguous determination of instrument internal background and diffuse x-ray brightness. Instrument characteristics and early performance will be discussed.

I. INTRODUCTION

The HEAO Cosmic X-Ray Experiment (also known as the A-2 experiment) is designed to study the large scale structure of the Galaxy and the Universe at X-ray energies. Within the Galaxy, supernovae and stellar winds contribute to a million or so degree hot gas that fills a substantial fraction of the region between the stars. The presence of this hot gas is important for the dynamics of the cooler gas which is related to the rate of star formation. The A-2 experiment is providing a greatly improved map of the local distribution of this hot component. At higher X-ray energies, a non-thermal component of galactic emission should appear. Cosmic ray electrons, for example, are capable of producing a hard spectrum of X-rays, and mapping the hard X-ray emission will produce new information on galactic magnetic fields and the cosmic ray electron distribution.

On a vaster scale, aggregates of galaxies are filled with a more tenuous but much hotter gas. The study of this hot gas (plasma) may reveal new information about the early phases of galaxy formation, generation of the elements in stars, and cluster formation and evolution in the early history of the Universe.

Extragalactic compact sources, such as Seyfert Galaxies, bright radio galaxies, and quasi-stellar radio sources are being studied over a broad energy range of spectral emission. Most of these objects are the seat of strong nonthermal processes which are poorly understood

at present. The improved sensitivity and increased spectral coverage available to us from the HEAO A-2 experiment can provide new information on the physical setting and parameters of the energy sources, i.e., the spectral shapes and matter content along the line of sight to these objects.

When viewed over angular scales exceeding a few degrees the extragalactic X-ray sky is generally dominated by an isotropic flux of hard radiation, the origin(s) of which is a major puzzle being addressed by the A-2 experiment. A precision measurement of its spectrum will allow detailed comparisons with known extragalactic sources (e.g. clusters of galaxies). By a systematic survey of the entire sky, a small gradual deviation in isotropy such as would arise from our own (observers) velocity should be detectable, thereby defining the proper reference frame(s) for this extensive diffuse emission. A study of the small-scale fluctuations in the isotropy for this apparently "diffuse" flux will characterize the contributions of very distant discrete sources that are otherwise not readily resolvable, especially at higher energies.

X-ray astronomy has also provided us with some simple isolated systems in our own galaxy of the type physicists are looking for when investigating previously unexplored regimes of nature. For example, the behavior of matter and radiation in an astrophysical environment of extremely intense magnetic and gravitational fields may now be modeled quite precisely by measuring the X-ray pulsar emission of a compact rotating object in a binary stellar system; several such cases

are already known. We are now beginning to understand that the key observational requirement is for temporally coherent information over the complete X-ray spectrum from the softest X-rays characteristic of thermal emission through the hardest X-rays indicative of non-thermal processes. The A-2 experiment is particularly well suited for such studies in that the spectral band is remarkably complete for such sources, since the low energy absorption due to the intervening interstellar matter and the characteristic high energy cut-offs in emission are both typically well included. In the very soft X-ray band an order of magnitude improvement in sensitivity over previous surveys enables us to search for hot white dwarf stars, cataclysmic variables and old novae, which appear to be present at the lowest energies transmitted by the interstellar gas.

II. EXPERIMENT DESCRIPTION

One of the primary goals of the A-2 experiment is to study the diffuse component of the X-ray sky over a broad energy band. At energies above the 2 keV the sky is remarkably isotropic. In order to search for structure in this background radiation it is necessary to have the systematic effects associated with the local environment of the experiment reduced to a minimum and any residual effect must be understood to a high degree.

The Cosmic X-Ray Experiment consists of three types of multi-anode, multi-layer, collimated, gas proportional counters and their associated electronics. The detectors are designated HED (high energy detector) for

the xenon-filled counters covering the energy range 2.5-60 keV, MED (medium energy detector) for the argon-filled counter covering the band 1.2-20 keV, and LED (low energy detector) for the thin window, propane-filled, flow counters covering the range 0.15-3 keV. The configuration of the six detectors within the HEAO-1 observatory is shown in Figure 1. These choices allow a reasonable dynamic range to be covered without introducing nonlinearities into any of the elements. Many precautions have been taken to reduce extraneous background, and some novel features have been incorporated which permit the unambiguous extraction of the flux of sky X-rays from the total signal.

The multiwire detectors allow separate readout of alternating cells of the detectors (See Figs. 2 and 3). The mechanical collimator in front of each detector has been carefully designed to exploit this alternating feature in that the left cells (Fig. 3, L1,L2) are covered by one field of view and the right cells (Fig. 3, R1,R2) are covered by a field of view about a factor of two different, but coaligned. Since the right and left cells are identical and their signals pass through a common amplifier, the difference between the left and right cells is a direct measure of what is entering through the aperture.

An important consideration for the detector is the choice of field of view. The field of view should not be so small that the detector internal background dominates the incoming signal. On the other hand, too large a field of view forces the background studies to cover rather large solid angle elements of the sky and makes discrete source studies difficult in crowded regions of the galactic plane. Based on rocket

flight data using the detector design, a field of view of $3^\circ \times 3^\circ$ would provide a diffuse flux signal greater than the internal background signal up to about 40 keV. In order to provide better source positions and higher resolution angular maps at the lower energies where the signal to background expected is very good, a $1\frac{1}{2}^\circ \times 3^\circ$ field of view (FOV) was included. On the offset detectors, a $6^\circ \times 3^\circ$ FOV was incorporated to give a better signal to internal background spectrum during pointing. The field of view of a typical A-2 detector is shown in Fig. 4.

Since the intensity of the diffuse X-ray flux is proportional to the solid angle exposed, the detector counting rate due to the diffuse component viewed by the larger field of view section will be about twice that viewed by the smaller section. Since the internal background is independent of collimator field of view, the count rate due to the diffuse background and due to internal background can be determined simultaneously.

The one medium energy detector, one high energy detector, and the two low energy detectors do not have front layer anticoincidence, since these layers would be too strongly absorptive of the X-rays under study. Penetrating particles will be rejected by the fact that they pass through more than one layer of detection. Soft particle fluxes can be detected by the following consideration. The rate of events in the V2 layer of the detector adjacent to the counter side walls is only a function of penetrating radiation, since these cells do not view space through the collimator. The layers denoted M1, M2, and V1 all view through the collimator, and may be used to measure the soft

component that enters the detector. The low energy detectors have magnets in their collimators that raise the electron threshold energy for electrons entering the detector to about 40 keV as determined by laboratory measurements.

A final design feature included was more important for discrete source identification and study, but is also valuable for background measurements when sharp contrast is present. Four detectors (LED 1, HED 2, MED, and HED 3) are aligned to view along the +Y spacecraft axis, while the remaining two (LED 2 and HED 1) are offset 6° towards the +X spacecraft axis in the X-Y plane (see Figure 1). When a source transits the "deck" detectors it is followed six degrees later by a transit of the offset detectors. Transient bursts of electrons will appear at the same time in both detectors in general since they appear to cover a wide range of pitch angles to the Earth's magnetic field. Another important feature of the offset detectors is that when the "deck" detectors are pointed toward a faint source, the offset detectors provide a continuous measure of the background just six degrees away in the sky for background subtraction.

During normal scanning operations HEAO-1 rotates clockwise about the sunpointed +Z axis with a nominal 33 minute period. Hence, the four deck-mounted detectors view a given point on the sky about 30 seconds before the two offset ones. The spin axis is stepped $1/2^\circ$ every 12 hours in order to remain pointed at the sun. Each observatory rotation provides a scan of a great circle 3° (FWHM) wide on the sky through the ecliptic poles.

The experiment associated electronics include the data director, analog and digital submultiplexer, interfact controller, command decoder, low voltage power supply, and gas control system. A complete set of detector electronics is mounted on each of the six independent detectors and consists of the front-end electronics (preamplifier plus post amplifier and shaping network, high voltage distributions, and test pulse generator input section), source encoder, data processing unit, test pulse generator, detector command decoder, detector programmer, low voltage converter, and high voltage converter. The Cosmic X-Ray Experiment is allotted 1200 bps of telemetry and 23 watts of 28 volt DC power.

DETECTORS

The proportional counters consist of a detector housing, a collimator, four layers of wire grids, a grid cover, a thin window, and the filling gas. Table 1 lists various parameters of the detectors. The detector housing, used in conjunction with the window-collimator assembly are relied upon to maintain a near constant gas pressure inside each detector, and to maintain, with a high degree of accuracy, the structural integrity of the sensitive gas volume under varying amounts of differential pressure across the window. The housing is fitted with a pumping/filling port for evacuation while outgassing all surfaces in contact with the counting gas and for filling the detector. The two-gas HEDs (HED 1 and HED 3) have a second port for evacuating and filling

the propane veto layer, and a second thin window that separates the propane veto layer from the main detector section. After assembly all detectors are heated to 80° C for one week while connected to a pumping system. This is to remove the trapped gases that might degrade detector performance with time. Figures 2a, b, c show cross sectional views of the three types of detectors employed. In order to reduce the X-ray flux entering the detector through the housing (primarily Compton X-rays from the diffuse X-ray flux), the HEDs and MED have shielding epoxied to the housing and sides of the collimator. In the case of the MED the shielding is 0.051 cm of copper and for the HEDs it is 0.152 cm of tin on top of 0.051 cm of copper. The LEDs are shielded only by the 0.234 cm of the aluminum housing itself.

The wire grids are aluminum frames 1.22 cm thick supporting arrays of 0.168 cm OD, 0.018 cm ID BeCu tubes which in turn support the stretched wire cathodes. Kel-F insulators, spaced every 1.22 cm on the frame support the anodes. Both the cathode and anode wires are made of 0.0051 cm stainless steel wire, silver plated and drawn to size. All wires are mounted while supporting a 50 gram mass. Spring loading of the wires allows them to survive both the vibration stress of launch and the distortions due to varying thermal environment. The only grid that is constructed differently is the top grid (nearest the collimator) of the two-gas HEDs, where vertical ground wire boundaries are replaced by stiff aluminum walls, that are used to support the inner window of those detectors, as well as to serve as ground planes.

The grid cover consists of copper laminated onto aluminum for the HEDs and aluminum only for the LEDs and MED. It is mounted on back of the last grid, serving as a ground plane for the last row of anodes. In addition, this cover shields the sensitive gas volume from the unused gas in the counter, the latter being a source of characteristic X-rays which would add to the detector's internal background. For the HEDs the grid cover also supports the Am^{241} calibration source assembly.

Within each detector cell-to-cell interconnections define seven outputs (see Figure 3) denoted L1, L2, R1, R2, V1, V2, and ALPHA. The LEDs and MED use the V2 output as both V2 and ALPHA since these detectors have no internal Am^{241} source. The sets of left and right anodes in data layer one and two form outputs L1, L2, R1, R2. These are appropriately combined in the test pulse generator input section of the front end electronics (see Figure 5a and b) to form outputs M1 and M2 which indicate which data layer triggered and carries the pulse height information. Two other sets of anodes V1 and V2 form an anticoincidence cup around the data layer set of anodes and are used to reject charged particles that penetrate the gas volume. For the two-gas HEDs V1 is comprised of the end cells of each grid of data layers 1 and 2 and the entire rear grid, while V2 is the propane veto layer. In the other detectors V1 includes all but the end cells of the rear grid, while V2 is formed from the end cells of all grids. The ALPHA output comes from the two anodes on either side of the Am^{241} source in the HEDs and is used to route calibration data.

COLLIMATORS

Directional sensitivity is accomplished by the use of a dual field of view collimator which provides the detector with two co-aligned sections having different width field of view in the scan direction. The two components of the collimator are configured to expose alternative sets of anodes (denoted left [L] and right [R] in the counter volume. Each scan across a point in the sky results in two independent exposures. This collimator design allows the unambiguous simultaneous measurement of both the diffuse X-ray flux and detector internal background. The systematic errors are drastically reduced since the measurements utilize the same gas volume, same analog electronics, the same pulse height analyzer, and the same high voltage supply on a given detector.

All collimator sections view 3° (FWHM) normal to the scan plane, and one of the dual field of view sections on each views 3° (FWHM) along the scan plane. The other section views either $1\ 1/2^\circ$ or 6° along the scan plane, nominally. Table 2 gives the solid angles subtended by the various collimator sections on each detector.

The HED collimators are fabricated from hundreds of rectangular cross section copper tubes epoxied together to form a single unit that also supports the 0.0025 cm mylar window. The window is aluminized on both sides with $750\ \text{\AA}$ of aluminum in order to prevent static charge build-up on the window, to form a ground plane for the first grid layer, and to attenuate ultra violet flux entering the detector. HED 1 and 3

have a second 0.0025 cm aluminized mylar window to separate the propane veto layer from the xenon main volume. The MED collimator is similarly constructed from aluminum tubes, and supports the single piece 0.0076 cm Be window. Both MED and HED collimators are covered by 0.008 cm kapton heat shields, aluminized on the inboard side to improve the thermal balance.

The LED collimators are of a more complex design. Starting near the detector gas volume, the LED collimator consists of an egg-crate window support constructed from aluminum slats. A window support mesh is located between the window support and the 1 1/2 micron polypropylene window that is carbon coated to reduce ultraviolet transmission. This yields a total equivalent polypropylene window of $125 \mu\text{g}/\text{cm}^2$ for a nominal LED window. The main collimator consists of a stack of BeCu etched-grid meshes with greater than 90% transmission. A plastic, egg-crate thermal precollimator above the main collimator acts as a thermal baffle which a) minimizes heat loss into space, b) minimizes temperature gradients within the detector gas volume, and c) avoids the X-ray transmission loss which accompanies thin film thermal shields. Each of the three parts of each collimator was partitioned into three panels in order to increase strength and improve the ease of assembly.

Because of heat loss all detector operational heaters are controlled individually and those on the LEDs are supplemented by heaters in the collimator structure to minimize temperature gradients. The LED collimator structures also house Cobalt Samarium permanent magnets

to act as magnetic brooms. They prevent low energy electrons from entering the gas volume which would raise the internal background. Testing of the flight units shows the magnetic brooms to be greater than 90% efficient in rejecting electrons below 40 keV.

The LEDs have movable acoustic covers which are closed during launch to protect the thin windows from severe acoustics and possible damage from small particles. Each cover is spring loaded for opening upon command and can be driven closed by a motor on command.

FRONT END ELECTRONICS

The front end electronics consists of the preamplifiers with their shaping networks, the high voltage distribution system and the test pulse generator input network. Figures 5a and b show the latter two sections combined. Each anode set is connected to the high voltage source through 250 M Ω to insure that the current drawn in the case of a direct short to ground is not high enough to reduce the voltage on other anode sections and to minimize damage if arcing occurs. The charge collected on an anode for a given event charges the .001 μ f coupling capacitor which in turn is the input to the charge sensitive preamplifier.

The test pulse generator input section is a capacitive tee network that provides the input for test signals at the front of the charge sensitive preamplifier without significantly increasing the input capacitance seen by the amplifier. Thus the low level noise is determined by the capacitance of the detector itself. This section also contains

the pulse transformers used to merge the left and right anode section signals to form the M1 and M2 outputs. The amplifier section contains the charge sensitive preamplifier, filter network, and bi-polar amplifier. The voltage pulses are shaped to reduce microphonics and minimize dead time. The outputs of the nine amplifiers are then input to the source encoder for analysis.

SOURCE ENCODER

The source encoder is the heart of a detector's data analysis system. It serves three basic functions. The first is to apply the logic conditions dictated by its command state to the nine signal inputs to determine if an acceptable (i.e., X-ray) event has occurred; to determine which anode sections collected the charge; and to indicate whether or not it was a calibration event. Some of the logic criteria can be relaxed by command, but this is only used to analyze the performance of the detector and is not a normal data taking mode. The second function is to pulse height analyze acceptable events. Due to the limited telemetry available, a compression of the PHA address must occur. The initial 128 equal width pulse-height channels are compressed pseudo-logarithmically into 64 channels. The identification of the anode set that triggered (either L1, R1, L2 or R2 or M1, M2, V1 or V2 depending upon command) is included with the PHA channel number. The third function is to shape and output the data to the data processing unit (DPU) for subsequent analysis. The rate of acceptable events from various anode sets are sent to the discovery scalers, and the raw rates

of the discriminators are output to the housekeeping scalers in the DPU. A commandable combination of the acceptable events from the two main data layers (M1 and M2) are output as the Multiscaler rate for further analysis by the fast timing section of the DPU.

Each of the nine inputs from the detector feeds into its associated threshold detector pulser. All threshold detector pulsers (L1, M1, R1, L2, M2, R2, V1, V2 and Alpha) yield output logic pulses when the commanded thresholds are exceeded by the input signal. M1 may be set at one of three separate thresholds in addition to being turned off by command, while the other pulsers have two separate thresholds along with "OFF". The M1 analog signal is also tested for being above a set upper threshold. Such large signals veto acceptable events.

The M1, M2, V1 and V2 pulses are fed into the anticoincidence logic. An equal to or greater than 2, (≥ 2), output is obtained whenever any two or more of these input pulses occur simultaneously. Thus, in general, the occurrence of a ≥ 2 output indicates the event triggering the detector system is not an X-ray. This ≥ 2 pulse is used to inhibit subsequent processing of events.

The M1 event logic is used to select layer 1 events for pulse height analysis. Three modes are possible by command. Nominally an acceptable event is one for which only the left or right anode set triggers, only layer 1, and the event is not above the upper level threshold. The left-right-only requirement can be eliminated by command as can the only-layer-1 criterion. However, if the most stringent

requirements are relaxed by all, the interpretation of pulse height data will be less straightforward. The M2 event logic is independent of M1 event logic and similar to it.

The M1, M2, V1 and V2 and Alpha analog signals are fed through their associated delay lines (6.0 μ s delay) into linear gates. The linear gates will not pass these signals unless opened (for approximately 5.5 μ s) by the PHA event logic. The delay is provided to allow sufficient time for the PHA event logic to determine whether or not it is a bona fide event. The outputs of the five linear gates are fed into a pulse height to pulse width converter. The analog pulse passed by the opened linear gate charges a capacitor in this circuit to its peak voltage (proportional to the event energy). This capacitor is allowed to discharge linearly and a pulse is generated at its output during the discharge. Thus, the output pulse width during discharge is proportional to the event energy. This pulse is fed to an output gate. Also fed to the output gate is the 500 kHz crystal controlled square wave. After a minimum delay of 5.0 μ s, to assure complete charging of the capacitor in the height to width converter, and at the next leading edge of an oscillator square wave an enable pulse is generated to start discharge of the capacitor and also start the output pulse train. Thus, the output pulse train will always start at the same place in the square wave and the capacitor discharge starts at the same time. This assures no jitter in the output train, thereby yielding an accurate digital reading. Hence, the signal

emerging from the output gate is a 500 kHz square wave pulse train, with the number of pulses proportional to the event energy.

The output pulses are counted and the output count is indicated by digital bits A, B, C, D, E, and F, where A is the LSB and F is the MSB. However, the counting is not linear, and yields a compressed output. The first 31 pulses are counted directly, pulses 32 to 63 are counted two at a time and pulses 64 to 127 are counted four at a time. It should be noted that, normally, for pulse trains with total pulses greater than 127, the output count will be limited to 63. However, when the readout mode is commanded such that it will not include the most significant bit (F), the output will be limited to 31. That is, pulse trains with total pulses greater than 31 will indicate 31.

Some time is required for conversion of the input signal peak amplitude into an output digital word during pulse height analysis. This time is $2.0 \mu\text{s}$ per linear channel (500 kHz oscillator). Thus, this conversion time varies from $2.0 \mu\text{s}$ for Channel 1 to $2.0 \times 127 = 254 \mu\text{s}$ for linear channel 127. This conversion time contributes to the pulse height analysis dead time, that is, the time during which a subsequent event cannot be pulse height analyzed. Provision is made for selection of a fixed or variable dead time by command. The fixed dead time is $322 \mu\text{s}$, assuring conversion and readout to the DPU of the largest acceptable input signal. The variable dead time is the minimum delay possible and is equal to $(2 \times \text{Linear Channel} + 52) \mu\text{s}$. The fixed $52 \mu\text{s}$ is due to the readout pulse, readout delay, reset delay and the reset pulse.

The range of pulse heights from the first data layer (M1) is divided into four preset contiguous windows. Provision is made for selection, by command, of events with energies falling into any combination of these windows. Similarly data layer two (M2) is divided into two windows. Table 3 shows the channel boundaries of these windows measured before launch and in terms of 128 linear channels covering the entire range. The energy range of these windows depends upon the gain of the detector. Only those windows selected by command will be present in the pulse height histograms and in the first four discovery scalers. Thus the proper normalization of the spectra is accomplished using these discovery scalers.

The discovery scalers are the event counters for the X-ray detectors. Discovery scalers 1-4 give the counts in layer one left and right, layer two left and right respectively that are pulse height analyzed. Discovery scalers 5-8 give the counts in various combinations of layers and windows as selected by command. Eight microsecond pulses drive the discovery scaler counters. The housekeeping rates go directly to the DPU for accumulation and readout. Any combination of the first four discovery scalers chosen by command forms the Multi-scaler rate. This rate is fed to the fast time section (Δt computer) in the DPU for temporal analysis. Finally the M1 discriminator rate is sent to the DPU's ratemeter. If this rate is ever greater than 10^6 in a major frame (40.96 s) the high voltage to that detector will be automatically shut off. This protects the counters from excessive

rates at all times. The detector must be commanded back on after such an event, since the high voltage does not automatically return.

DATA PROCESSING UNIT

This experiment contains six identical DPUs (one per detector) that receive the outputs of the source encoders in order to compute and format into buffer storage:

- 1) Pulses in eight 16 bit discovery scalers
- 2) Pulses in ten 24 bit housekeeping scalers
- 3) Events in one hundred twenty-eight 16 bit histogram channels
- 4) Fast Timing information about X-ray events (Δt computer)

The purpose of the DPU is to process the data from the source encoder under control of seven commands and spacecraft timing signals. It then formats this processed data into eight different output buffer shift registers (called port 0 through 7). The following is a description of each port and its function.

Port 0:

Direct Read Out of X-Ray Event PHA. This is an eight bit shift register that is read out serially. The eight bits were transferred from the source encoder in coincidence with a Histogram Read Out pulse, signifying a non-calibration event. This event is loaded into the shift register any time it is not being read out. Thus the data in the shift register is that of the latest event. No 6-bit to 5-bit compression occurs for this port.

Port 1:

Direct Read-Out of Calibration Events. This port is identical to port 0, with the exception that the pulse height data enters the shift register in coincidence with the Calibration Read-Out pulse.

Port 2:

Housekeeping Scalars Read Out. This is a 256 bit shift register that contains ten 24 bit words containing the housekeeping total count for the previous major frame, plus seven bits of DPU command status and nine zeros. The major frame pulse initiates transfer of data from accumulators to the shift register.

Port 3:

Δt Computer Read Out. The Δt computer receives a single input (Multiscaler Rate) from the source encoder. The Δt computer asks one of three questions (mode I, II, or III) depending upon command status:

- I) Any event(s) in Δt : $\Delta t = 1.25, 2.5, 5.0, \text{ or } 10 \text{ ms?}$
- II) How many events in Δt : $\Delta t = 10, 20, 40, \text{ or } 80 \text{ ms?}$
- III) Time to the first eight events in Δt ?

$\Delta t = 80 \text{ ms, Resolution} = 39.0625 \text{ } \mu\text{s or}$

$\Delta t = 160 \text{ ms, Resolution} = 78.125 \text{ } \mu\text{s.}$

The answers to the above questions are put into a 16, 24, or 64 bit shift register depending upon mode for read-out.

When in mode I the contents of a flip-flop are transferred to the appropriate bit of a 16 bit shift register at the beginning of a Δt interval. It is a "one" if one or more events were input to the DPU

on the Multiscaler line during the previous Δt interval. It is "zero" otherwise. The flip-flop is then reset to "zero", and is ready for the next Δt interval. In mode II the accumulator (which has been counting Multiscaler pulses during Δt) is locked and contents transferred to the output shift register at the end of the interval. The accumulator is also zeroed during this time. In mode III the Multiscaler pulse advances a three bit address counter. At each address a counter counts clock pulses until the next Multiscaler pulse changes the address counter. After 8 pulses are received in the Δt interval all counters are inhibited causing a dead time until the process repeats at the next interval. At the beginning of an interval the first address clock starts so that the next pulse received stops the first clock and starts the second. This continues until the time bin ends or the eighth pulse stops the eighth clock. Special cases are as follows:

- a) clock pulses = 0 indicates that more than one event occurred within one clock pulse.
- b) clock pulses = 253, 254, or 255 indicates that no pulses came in within 253-255 clock pulses or that one occurred in the last pulse.

Port 4:

8 LSB Read-Out of Discovery Scaler Rates. This port contains the eight least significant bits of the 16 bit discovery scalers.

This information is transferred to the output buffer every 1.28 s.

Port 5:

8 MSB Bit Read-Out of Discovery Scaler Rates. This port contains the eight most significant bits of the 16 bit discovery scalers. These rates are transferred to the output buffer every 5.12 or 1.28 s, depending upon command.

Port 6:

Read-Out of 8-bit LSB of PHA Histogram Contents. This contains bits 1-8 of the contents of the 16-bit deep, 128 channel science PHA histogram. The accumulation time for port 6 is either 10.24 or 40.96 s as controlled by command. The dead time for the accumulations is 20 μ s in the DPU, but is greater in the source encoder, which drives this input.

Port 7:

Read-Out of 8-bit MSB of PHA Histogram Contents. This contains bits 9-16 of the contents of the 16-bit deep, 128 channel science PHA histogram. The accumulation time is either 10.24 or 40.96 s as controlled by command. Dead times are the same for port 6.

Table 4 summarizes the function of the eight DPU ports along with the telemetry needed for a complete read-out of the data.

TEST PULSE GENERATOR

The purpose of the TPG is to provide a versatile tail pulse generator capable of performing amplitude sweep and coincidence testing of each detector. The TPG produced pulses (at 1.28 kHz) enter

the front-end of selected preamps via the TPG input section. Starting at the beginning of a major frame the pulse amplitude increases linearly with time from zero until $(2)^{15}$ pulses occur (25.6s). The maximum amplitude is such that the final preamp outputs are above channel 124 but below channel 126 (the upper level threshold is set at a voltage equivalent to greater than channel 128 to insure the counting of all $(2)^{15}$ TPG pulses). This maximum TPG ramp voltage is presented to the analog housekeeping and read to a precision of 1/256. Selection of preamps to be stimulated is controlled either by command (manual mode) or by a hard-wired 24 position program (automatic mode). The TPG is inoperative when power is first applied, and remains so until the ABORT command is set to zero and a start pulse is received. Once started in the automatic mode, the TPG runs through the entire program in 15.7 minutes and then aborts itself. The TPG may be stopped at any time with an ABORT or TPG power-off command. In the manual mode the TPG runs through the one commanded combination of preamps repeatedly, with each start synched to the major frame pulse, until either ABORT is sent or power is removed.

HIGH VOLTAGE

Each supply is manually programmed to operate at an expected nominal voltage which is a function of the detector (HED, MED, LED) Four bit binary coded commands select the actual operating voltage output. Each binary command will change the output voltage 33 V. The supply will operate at any selected voltage with a stability of $\pm 0.2\%$

over all line, load, and temperature variations for the top eight voltage steps. The stability is $\pm 0.4\%$ over these conditions for the lower eight voltage steps.

In the event that the control loop opens, a second, passive loop prevents the output voltage from exceeding a voltage no greater than 600 V above the nominal setting. The telemetry readout provides a 0 to 5 volt output (proportional to the high voltage value) that applies over the upper eight and the lower eight settings independently. This provides a telemetry resolution of greater than 20 MV/V. The output ripple is less than 1 mV (peak-to-peak). Transient response to worst case step commands causes no overshoot greater than 4% and with a time duration of less than 100 ms.

There are two "high voltage on" commands for each detector. One is simply "high voltage on", no questions asked. The other is "high voltage on" if propane gas pressure is above some threshold value. The latter is the preferred command. If the propane pressure drops, the electronic edge generated by the pressure flag going from high to low digitally turns off the high voltage. If the preferred "high voltage on" command is then sent, nothing will happen since the flag is low. If the other command is sent the high voltage will come on and not be automatically turned off since the edge and not the level is responsible for turn off. The HEDs turn off at 4.2 psi and the LEDs at 1.8 psi. The HED pressure must rise above about 5 psi to reset the flag, whereas the LEDs re-arm at about 3 psi.

DATA DIRECTOR AND ALLIED EXPERIMENT ELECTRONICS

The Data Director is part of the Data Collection System which gathers, schedules, selects and commutates the data from the six detector DPUs and two housekeeping submultiplexers into a single output through the Interface Controller to the spacecraft telemetry transmission system. The Digital Sub-Multiplexer provides the timing whereby digital housekeeping data from eight data sources are transmitted to the Data Director. Data channels are selected in a pre-programmed sequence. The Analog Sub-Multiplexer contains an analog-to-digital converter to transform analog voltage samples into eight-bit digital words. Data are then read out through the Data Director. The Interface Controller comprises the junction between incoming timing and command signals to the systems and outgoing data transmission from the experiment. Separate from, but associated with, the Data System is the Command System (Experiment Command Decoder and Detector Command Decoder) for reception and execution of ground commands, and the Experiment Programmer (power control and distribution) and Converter system (28 Vdc spacecraft supply to various circuit voltages).

The Data Director generates the control and timing signals necessary to create the telemetry format for the Cosmic X-Ray Experiment. The format information is stored in three banks of memory located in the Data Director. Two of these memories are fixed-format Read Only Memories (ROM). The third is a variable-format Sequential Access Memory (RAM).

The telemetry word frame (20 milliseconds) contains 16 slots for spacecraft telemetry words, each word is eight bits. Three of these words are allocated to the Cosmic X-Ray Experiment. Every sequence, or 1.28 seconds (four minor frames), the experiment must transmit 192 words to the spacecraft telemetry system. A major frame takes 40.96 seconds and consists of 32 sequences.

The ROMs contain 384 words of format information with each word being accessed once every two sequences. The RAM contains 192 words with each word being accessed every sequence. The RAM is programmed by ground command, and can be dumped to check its contents through the Digital Sub-Multiplexer housekeeping words. The six Data Processing Units plus the Analog Sub-Multiplexer and the Digital Sub-Multiplexer are the eight channels of data to be selected. This user selection information is coded using three bits of memory.

Any of the three banks of memories (ROM I, ROM II, RAM) can be selected by a two-bit code from the Experiment Command Decoder. The selected memory becomes effective at the beginning of the next major frame after receipt of the memory select command.

The Digital Sub-Multiplexer commutates eight channels of digital housekeeping data, including the Data Director. During the normal mode of operation the Data Director transfers 12 digital housekeeping words to the Digital Sub-Multiplexer every major frame. Eight of these words are words from the current ROM or RAM in use. A major frame counter is used to determine which memory words are transmitted.

Since a total of 384 ROM words must be sent, it will take 48 major frames (32.768 minutes) to complete this operation. The RAM is read out in 24 major frames or 16.384 minutes.

Two other modes can co-exist within the Data Director. The RAM can be loaded with new format information sequentially through a serial command data line and the contents of the RAM can be dumped through the Digital Sub-Multiplexer housekeeping words. The RAM cannot be loaded or dumped while it is the operating memory. Likewise, the RAM cannot be the memory selected for normal operation while it is in the load or dump mode. The RAM cannot be loaded and dumped at the same time.

Since the dump command is asynchronous, RAM readout will not begin until the next major frame after receipt of this command. However, data requests can occur before the next major frame pulse is received. As an indication that the dump command was detected, the Data Director will send back to the Digital Sub-Multiplexer only "ones" until the next major frame pulse occurs. It then takes three major frames, or 2.048 minutes, to complete the dump via the Digital Sub-Multiplexer.

CALIBRATION SOURCES

All A-2 detectors contain internal Fe^{55} radioactive sources that shine into the end cells (V2 and also V1 for the two gas HEDs). The counting rate in the veto layer is low so as not to affect the layer's ability to reject charged particles. Upon command, the data collection

mode can be changed to include pulse height analysis of the veto layers V1 and V2. The position of the line, and thus detector gain, can be measured. In the HEDs and the MED, this is the 5.96 keV Mn $K_{\alpha\beta}$ line and in the LEDs it is the 1.74 keV $K_{\alpha\beta}$ line of the silicon which is fluoresced by the Fe^{55} source. A further use of this source is to measure the X-ray absorption of the propane veto layer (V2) in the two gas HEDs. By comparing the rates in V1 and V2, changes in absorption can be noted (for instance, due to xenon leaking into the propane layer).

The LEDs and the MED also have a commandable, rotatable, calibration source, that is mounted in the collimator. This consists of a radioactive source inside a hollow rod with a hole opposite the source. This rod is mounted on the shaft of a pulsed motor enabling it to be rotated $\pm 90^\circ$. In the exposed position, the source radiates through the hole in the rod into the detector, while in the unexposed position it is rotated 90° so that the detector is shielded from the X-rays by the rod wall. Surrounding the source rod is another hollow tube (called the source shield) with a hole in one side. This is mounted on the shaft of another pulsed motor. In the event the source rod sticks in the exposed configuration, the shield can be rotated such that it blocks the X-rays entering the detector. Future calibrations can then be made by rotating the shield.

The radioactive source for the MED source rod is Fe^{55} which has a half life of 2.7 years. The LED rods contain Cm^{244} , and alpha

emitter with a 17.9 year half-life. The alphas are shielded from the detectors and fluoresce targets of carbon, teflon, and aluminum whose $K_{\alpha\beta}$ X-rays can enter the detector. There are higher energy X-rays associated with Cm^{244} and they necessitate a graded shield on both the source rod and source shield.

The HEDs contain an internal Am^{241} source that emits an alpha particle coincidently with Np X-rays. The source is situated between the two anodes designated ALPHA (see Figure 2c). When an alpha particle is detected by these anodes, any X-ray event happening simultaneously is tagged as a calibration event. This is a very weak source so that it does not affect the science data dead times or spectra.

GAS CONTROL SYSTEM

Since the propane diffuses through the thin LED windows, it must be replaced to maintain detector pressure. Also, since there is a chance that the propane layer of the two gas HEDs may become contaminated (e.g. with xenon), a method is needed to exhaust and refill this layer. This indicates the need for an active gas replenishment system for the propane. Figure 6 shows the gas system with valves, pressure transducers, and regulation systems.

Propane is stored as a liquid in the reservoir whose pressure is monitored by an absolute transducer. The propane then travels to the two redundant (only one "on" at a time) regulator arms where the liquid is incrementally fed to a heat exchanger coil which vaporizes the propane.

The incremental feed is achieved by a digital regulator which consists of a solenoid valve commanded open or closed by a pressure transducer at the valve outlet. A pneumatic pressure regulator then reduces the pressure of the propane gas emerging from the heat exchanger to 17 psi for distribution to the various detectors.

At the outlet of the heat exchanger is a pressure switch which in the event that the pressure exceeds 50 psi disables the prime digital regulator, closes the arm's latching solenoid valve and starts up the other arm of the system. This prevents large quantities of liquid propane from entering the heat exchanger (and eventually the pressure regulator) if the digital regulator solenoid valve should fail open. If the second arm then fails the entire system shuts down and does not reactivate until commanded to do so.

It is desirable that the LEDs maintain a constant density (and thereby, constant gain). This is achieved by sensing the differential pressure between the detector volume and the reference volume, which is filled to the desired propane density before launch. Each LED has its own gas control loop which opens the fill solenoid for underpressure and opens the exhaust solenoid for overpressure. The pressure bandwidth is 1% of nominal pressure. The detector absolute pressure is also monitored. In the case of a failure of a detector gas loop, the loop can be disabled, the LED interconnect latching solenoid valve can be opened and the remaining gas loop can control both detectors.

The LEDs can, also, be purged using this system. In the purge

mode both the fill and exhaust valves are opened and the regulation bandwidth is widened to 50% of normal pressure. Eight to twelve minutes after receipt of the purge command the exhaust valve closes and the system returns to the regulate mode with its narrow bandwidth.

Protection in the gas loops is provided by the purge fault and valve fault detection circuitry. Valve fault detection integrates separately the time the fill valve and the exhaust valve are open each major frame. If the fill is open greater than 16 seconds or the exhaust is open greater than 8 seconds in a major frame, that LED's gas loop is shut down. Purge fault detection is a parallel timing circuit associated with the purge cycle. Normally the purge ends about a minute before this circuit and returns the gas loop to the regulate mode. If the protect circuit times out first, that LED's gas loop is shut down.

The LEDs also have pop-off valves on the exhaust lines. This not only is in-flight over-pressure protection but also bleeds the detector pressure down during the ascent portion of launch. The pop-offs are set at 0.5 psi.

In the event of a contaminated HED propane layer the gas can be vented and then the layer refilled to ~7 psi. To vent the propane layer of a given two-gas HED, the passive gas control system is enabled and the appropriate exhaust valve opened. Once the layer is evacuated the exhaust valve is closed and the HED main latching solenoid valve is opened. Filling is accomplished by a series of commands to the fill

solenoid valve. For each command received the valve opens once for ~700 ms. This corresponds to about 0.3 psi per pulse. By monitoring the propane layer pressure after each pulse, the proper pressure can be attained.

III. EXPERIMENT PERFORMANCE

HEAO-1 was launched at 6:29 UT on August 12, 1977, into a circular orbit with an apogee of 445 kilometers and an inclination of 22.75 degrees. The orbital period is 93 minutes, with a nominal observatory revolution period of 33 minutes. Within a week after launch all A-2 detectors were turned on and functioning nominally.

The LED detector background is very low relative to the flux of X-rays observed from the sky. As part of the LED turn-on procedure during the first week in orbit, several orbits of data were taken with the protective covers closed. These covers are mainly low atomic number plastic material plus a thin aluminum foil covering. Figure 7 shows the pulse height histogram for detected X-rays from a bright region of the sky in Hercules, a typical sky region, viewing the dark Earth, and with the protective covers closed. As can be seen in this figure, the cover closed data lies somewhat below the flux observed when viewing the dark Earth. Sunlit Earth is very bright below 1 keV due to fluorescence of atmospheric oxygen and nitrogen produced by the illumination of the earth by solar X-rays. The dark Earth flux may be due in part to scattering of the cosmic background X-rays and in part by precipitation of trapped electrons into the upper atmosphere with subsequent bremsstrahlung.

In order to evaluate the effectiveness of the LED anticoincidence system against charged particle events, the rate of Earth events was monitored as a function of the charged particle flux over different geomagnetic latitudes. Figure 8 shows the count rates for the large and small fields of view for LED 1 as a function of cosmic ray rate (anticoincidence rate). There is no noticeable trend in Earth flux versus charged particle rate.

Occasionally, while the LED detectors were scanning across the dark Earth, an increase in the X-ray counting rate was observed which peaked while the collimators were perpendicular to the local magnetic field vector. This effect is much more prominent when viewing the dark Earth, since the Earth flux is so low. Using the V2 rates discussed earlier, it was found that charged particles were in fact present at this time. Figure 9 shows a plot of the "X-ray" flux from the Earth as a function of the charged particle flux for the two different fields of view of the detector in the 1/4 keV channel (0.15 - 0.30 keV). The low energy charged particles seem to be present everywhere in the HEAO-1 orbit. The distribution of particle arrival directions is fairly sharply peaked perpendicular to the magnetic field as can be seen from the plot in Figure 10. This figure shows the rate of "electrons" in LED 1 as a function of angle between the magnetic field vector and the detector look angle. The contribution of these particles to the X-ray signal in the 1/4 keV channel is relatively small, but the possibility of spectral variations in this component

could change the slope of the correlation. This possibility is still under investigation.

One final effect was uncovered by noting the sky intensity as the detectors scanned toward the Earth's horizon. This was the appearance of a horizon brightening even when the spacecraft was on the opposite side of the Earth from the sun. The origin of this brightening is not understood, but is clearly seen in Figure 11. This figure displays the 1/4 keV counting rate as a function of the angle to the center of the Earth for the two fields of view on LED 1. The data was taken during a point at SS Cygni while the Earth slowly occulted the source as a result of HEAO-1's orbital motion. The possible contamination of sky data by this effect limits the useful viewing angles to those greater than 90° from the center of the Earth.

The charged particle monitoring capability of the detectors using the side veto layers and the elimination of data which is too near the Earth's horizon make it possible to construct diffuse X-ray maps of the sky which should be free of systematic or locally produced effects down to a level of better than about 10% of the diffuse sky flux in the 1/4 keV channel. Near 1 keV, the middle layers of the LED detectors are very insensitive to contamination and we may hope to detect anisotropies down to a few percent of the 1 keV diffuse sky signal.

The in-orbit performance of a HED detector is exhibited in Figure 12, where the effectiveness of the dual collimation scheme is quite evident. These histograms are based on data accumulated over many scan cycles regardless of what was in the field of view, be it the Earth or

celestial sources. The telemetry frames selected were those for which there were not bit errors and where the flux of ambient electrons ($\gtrsim 100$ keV) entering the collimator was less than $\sim 5 \text{ (cm}^2 \text{ sec sr)}^{-1}$

The histogram for each of the fields of view exhibits two clearly separated peaks, the high one attributed to exposures dominated by the sky and the one with lower counts attributed to exposures dominated by the Earth. If there were no extraneous sources of background the two histograms would scale as the ratio of solid angles (i.e., both the Earth and the sky represent essentially isotropic sources). In fact, the Earth is a relatively weak X-ray source, even in the hard X-ray band ($\sim 3\text{-}60$ keV) considered here, and most of the signal when the Earth fills the field of view arises from background internal to the detector (e.g. Compton collisions of gamma rays). More extensive data bear out the qualitative indication in Figure 12 that the internal background to be associated with the two fields of view are equal. Furthermore, a comparison of the internal background derived from the two peaks associated with the diffuse sky has been shown to be the same as that derived from the two peaks associated with the diffuse Earth, both in magnitude and spectral shape. As shown in Figure 12 by a dashed line, the internal background for HED 1 represents an average contamination of $\sim 14\%$ for the large field of view ($3^\circ \times 6^\circ$) and a $\sim 25\%$ for the small ($3^\circ \times 3^\circ$) when the full energy bandwidth is included.

Figure 13 displays the accumulated counting rate in $1/2$ bins versus satellite scan angle for 1977 August 21 using non-Earth occulted data

with minimal charged particle contamination. The data are from the $3^\circ \times 3^\circ$ sections of the three types of detectors and show how the diffuse sky flux varies in broad energy ranges. The strongest source in the field of view was 4U0305 + 41 (Perseus Cluster) at scan angle of 158° which exhibits little, if any, $1/4$ keV emission while being easily detected in the 8-70 keV band.

The complex of sources in the Large Magellanic Clouds contributes to the enhancement near 270° scan angle, while the galactic plane crossing is near 320° . The anisotropic $1/4$ keV diffuse background signal is evident as a function of scan angle while at higher energies the anisotropies diminish significantly.

Figure 14 shows count rates referred to scan angle on the sky from the $3^\circ \times 3^\circ$ section of HED 1. As demonstrated here for the data superposed from many scans, the internal background has the effect of a constant offset and that the signal from a relatively weak source such as AM Her is clearly well above any sort of noise. An Abell cluster (A2256) was at the edge of the field of view at scan angle $\sim 103^\circ$ during this time.

The HED propane veto layer has proven to be remarkably effective in reducing electron contamination. As already indicated for the data in Figures 12 and 14, we restricted ourselves to samples of relatively low electron flux; this eliminated $\sim 30\%$ of the data. At this level, we have determined that less than 3% of the internal detector background arises from electrons.

IV. ACKNOWLEDGEMENTS

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TABLE 1 DETECTOR PARAMETERS

	LED 1	LED 2	HED 1	HED 2	MED	HED 3
DETECTOR NUMBER	0	1	2	3	4	5
ENERGY RANGE (keV)	.15-3	.15-3	2-60	2-60	1.5-20	2-60
DETECTION GAS	PROPANE	PROPANE	XENON ⁺	XENON ⁺	ARGON ⁺	XENON ⁺
GAS PRESSURE (TORR)	200 (0°C)	200 (0°C)	760 (20°C)	760 (20°C)	760 (20°C)	760 (20°C)
COLLIMATION LEFT	1.55 x 2.95	4.15 x 2.80	2.91 x 2.81	2.91 x 2.81	2.94 x 2.90	2.91 x 2.81
(DEG. FWHM) RIGHT	2.80 x 2.55	2.70 x 2.75	5.92 x 2.81	5.92 x 2.81	1.40 x 2.90	1.44 x 2.81
OPEN AREA LEFT	176.5	228***	418.0	418.0	390.7	413.0
(CM ²) RIGHT	205.4	205***	425.9	425.9	363.0	402.4
TOTAL OPEN AREA (CM ²)	381.9	433***	843.9	843.9	820.4	820.4
POSITION	DECK	OFFSET	OFFSET	DECK	DECK	DECK
WINDOW MATERIAL	POLYPROPYLENE	POLYPROPYLENE	MYLAR*	MYLAR**	BERYLLIUM	MYLAR*
WINDOW THICKNESS (CM)	1.4 x 10 ⁻⁴	1.4 x 10 ⁻⁴	5.1 x 10 ⁻³	5.1 x 10 ⁻³	7.6 x 10 ⁻³	5.1 x 10 ⁻³
LAYER DEPTH (CM)						
M1	1.372	1.372	1.372	1.372	1.372	1.372
M2	2.438	2.438	1.219	1.219	2.438	1.219
V1	1.372	1.372	1.372	1.372	1.372	1.372
V2	-	-	1.219	-	-	1.219

+ plus 85 torr methane (20°C)

* plus 1.219 cm veto layer containing 380 torr propane (20°C) and 445 torr Neon (20°C) and 1500 Å aluminizing.

** plus 1500 Å aluminizing.

*** preliminary

TABLE 2 COLLIMATOR SOLID ANGLES

<u>DETECTOR</u>	<u>COLLIMATOR</u>	<u>SOLID ANGLE</u>	
		deg ²	msr
LED	3x3	8.11	2.47
	3x1½	4.70	1.43
	3x6	13.44	4.10
HED	3x3	8.18	2.49
	3x1½	4.05	1.23
	3x6	16.64	5.07
MED	3x3	8.53	2.60
	3x1½	4.06	1.24

TABLE 3 DETECTOR WINDOW AND THRESHOLD SETTINGS

	LED 1		LED 2		HED 1		HED 2		MED		HED 3	
	CH	keV*	CH	keV*	CH	keV†	CH	keV†	CH	keV†	CH	keV†
M1 LOW	6.5	.152	6.4	.150	3.2	1.0	3.0	1.0	7.7	1.0	3.3	1.0
M1 MID	9.0	.211	9.0	.211	5.1	2.0	4.9	2.0	10.7	1.5	5.2	2.0
M1 HIGH	11.3	.265	11.8	.277	7.1	3.1	6.9	3.1	17.2	2.5	7.2	3.1
L1 HIGH	10.1	.237	9.9	.232	7.1	3.1	6.8	3.1	12.9	2.0	7.2	3.1
R1 HIGH	10.0	.234	10.3	.241	7.0	3.1	6.9	3.1	12.8	2.0	7.2	3.1
W1A/W1B	18.4	.431	18.0	.422	12.7	6.0	12.4	6.0	38.9	6.0	13.0	6.0
W1B/W1C	31.6	.741	30.7	.720	15.5	7.5	15.1	7.5	48.3	7.5	15.9	7.5
W1C/W1D	85.4	2.002	81.4	1.908	65.0	31.9	63.4	31.9	63.5	10.0	66.3	31.9
M2 LOW	6.7	.157	7.4	.173	3.2	1.0	3.2	1.0	7.5	1.0	3.3	1.0
M2 HIGH	12.5	.293	14.5	.340	5.0	2.0	5.0	2.0	12.7	2.0	5.2	2.0
L2 HIGH	11.2	.263	12.0	.281	7.1	3.1	7.1	3.1	12.5	2.0	7.2	3.1
R2 HIGH	11.1	.260	12.2	.286	7.0	3.1	7.1	3.1	12.5	2.0	7.3	3.1
W2A/W2B	34.4	.806	35.6	.834	68.0	31.9	65.2	31.9	24.7	3.9	67.3	31.9
V1 LOW	7.0	.164	8.8	.206	3.1	1.0	3.2	1.0	7.6	1.0	3.3	1.0
V1 HIGH	11.0	.258			5.2	2.0	5.3	2.0	14.0	2.0	5.3	2.0
V2 LOW	7.1	.166	5.8	.136	3.2	1.0	3.2	1.0	7.6	1.0	3.8	1.0
V2 HIGH	11.0	.258			5.3	2.0	5.4	2.0	14.1	2.0	7.7	2.0

† Assumes Nominal High Voltage Setting (i.e. Nominal Gain)

* Assumes 3,000 keV = 128 ch, No Offset

Table 4

DPU PORT TELEMETRY RATES PER DETECTOR SUMMARY

<u>PORT</u>	<u>SAMPLE TIME</u>	<u>RATE (bps)</u>
0	Depends upon sample period. Example: 2.56s	3.125
1	Depends upon sample period. Example: 2.56s	3.125
2	40.96s	6.250
3	Mode I $\Delta t = 1.25\text{ms}$ $= 2.50\text{ms}$ $= 5.00\text{ms}$ $= 10.00\text{ms}$	800 400 200 100
	Mode II $\Delta t = 10\text{ms}$ 8 bit 12 bit $= 20\text{ms}$ 8 bit 12 bit $= 40\text{ms}$ 8 bit 12 bit $= 80\text{ms}$ 8 bit 12 bit	800 1200 400 600 200 300 100 150
	Mode III $\Delta t = 80\text{ms}$ $= 160\text{ms}$	800 400
4	1.28s	50
5	1.28s 5.12s	50 12.50
6	10.24s 40.96s	100 25
7	10.24s 40.96s	100 25

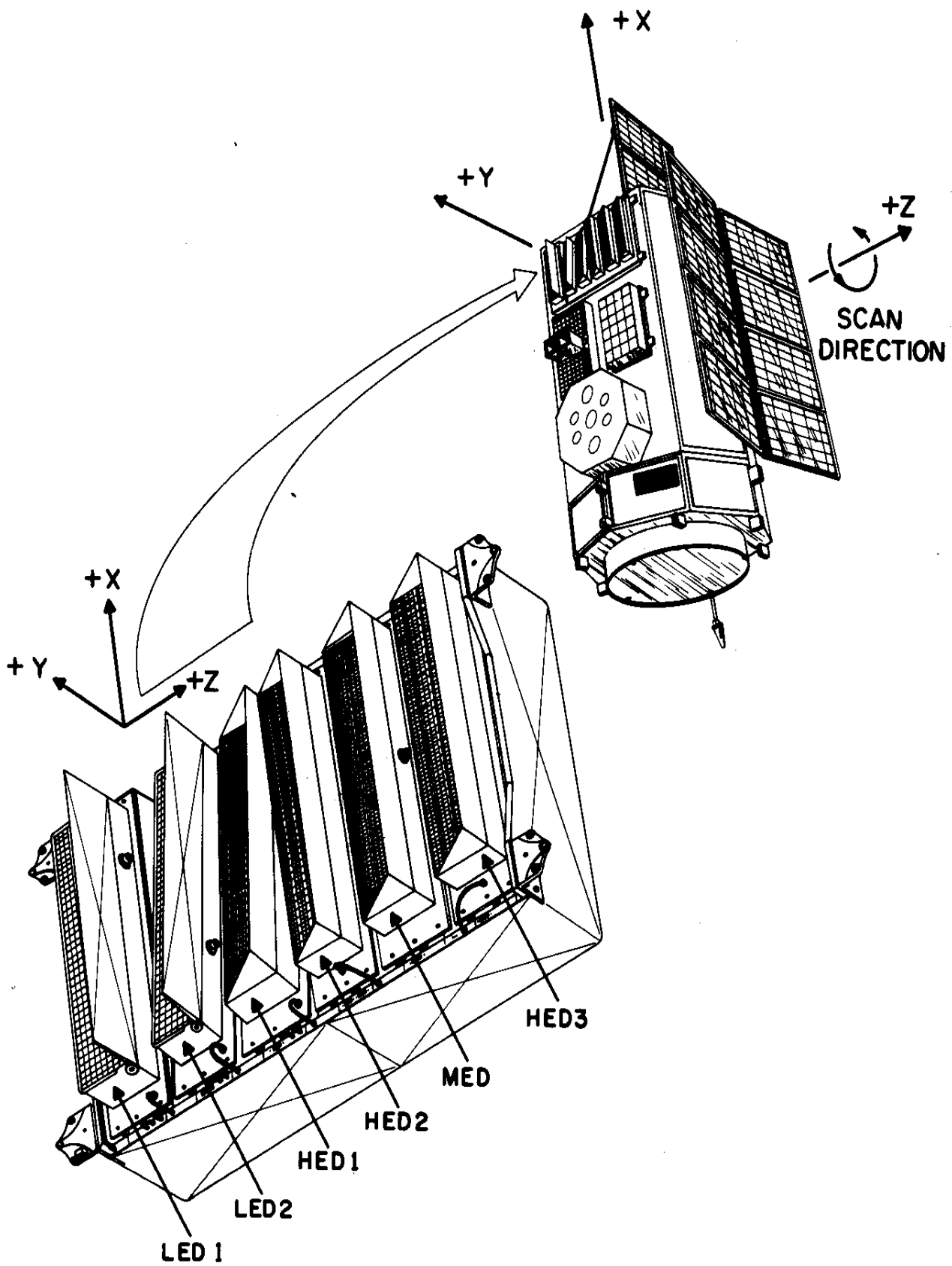
FIGURE CAPTIONS

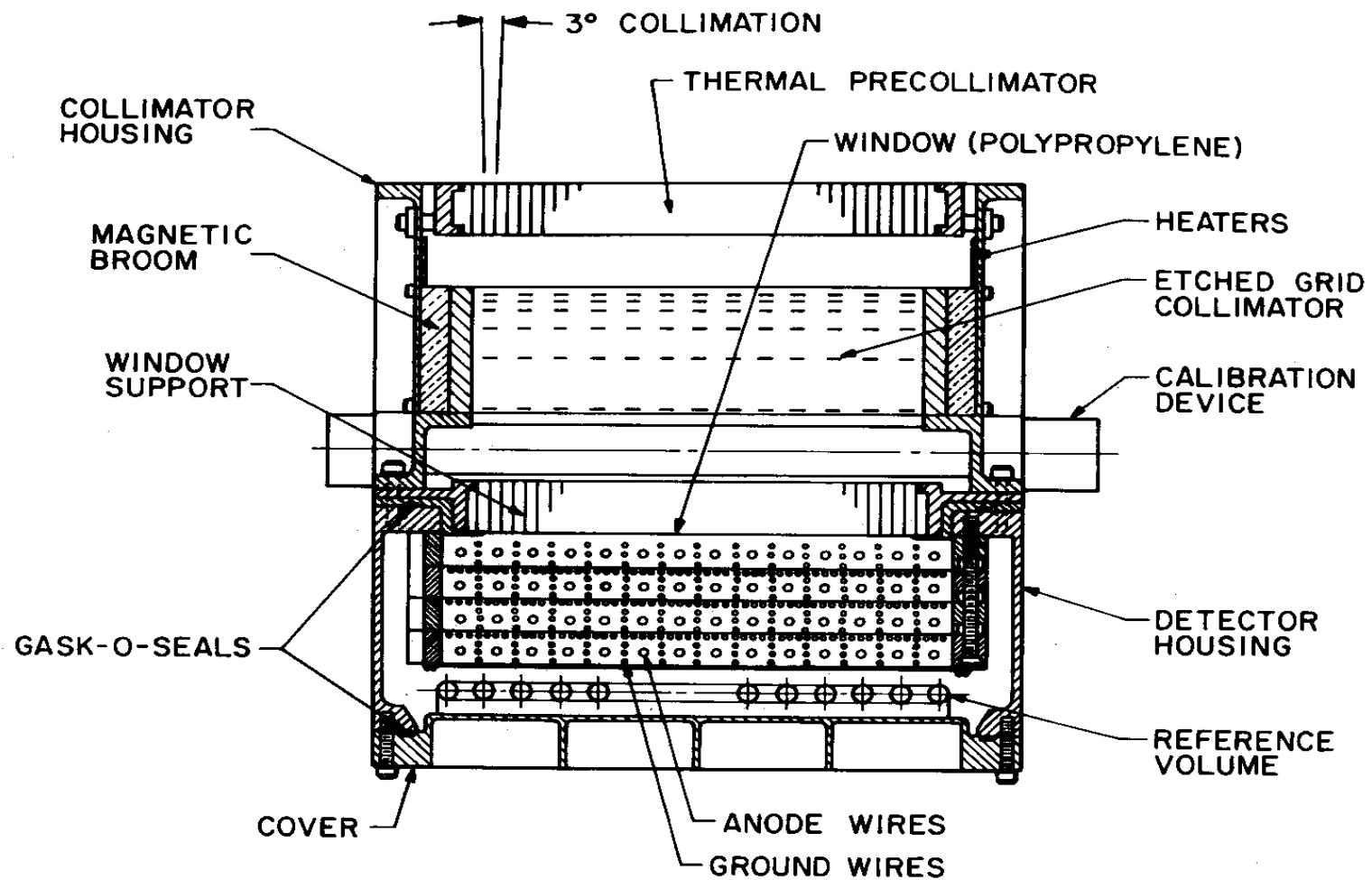
- Figure 1 Configuration of the six detectors within the Cosmic X-Ray (A-2) Experiment and its position in the HEAO-1 observatory. The three axes of the spacecraft are labeled and the sense of the rotation is shown.
- Figure 2 a) Cross-sectional view of an LED.
b) Cross-sectional view of the MED and HED 2. HED 2 also has an AM^{241} calibration unit mounted on the rear of the last set of grids as is on the other HEDs.
c) Cross-sectional view of HED 1 and 3.
- Figure 3 Detector grid connections. Cell-to-cell anode interconnections are labeled.
- Figure 4 Schematic illustration of typical collimator fields of view. All collimators have 3° FWHM fields of view normal to scan path. Parallel to the scan path are 3° FWHM and either $1\ 1/2^\circ$ or 6° FWHM fields of view. Hence $\theta = 1\ 1/2^\circ$ or 3° FWHM, depending upon the detector (see Table 1 for the fields of view of given detectors).
- Figure 5 a) High voltage distribution and test pulse generator input section for LEDs and MED.
b) High voltage distribution and test pulse generator input sections for HEDs.
- Figure 6 Gas control system.

- Figure 7 Pulse height distribution for X-rays entering LED 1 from a bright region in Hercules($\square$), a typical sky region (o), the dark Earth (Δ), and with the protective covers closed (x). Error bars shown are 1σ statistical uncertainties only.
- Figure 8 Counting rates for $3^\circ \times 3^\circ$ and $1\ 1/2^\circ \times 3^\circ$ fields of view LED 1 while viewing the Earth as a function of the anti-coincidence rate.
- Figure 9 Counting rate for $3^\circ \times 3^\circ$ and $1\ 1/2^\circ \times 3^\circ$ fields of view on LED 1 in the 0.15 - 0.30 keV range while viewing the dark Earth as a function of charged particle counting rate (Ne).
- Figure 10 Counting rate of charged particles versus angle between the magnetic field vector and the detector viewing axis. for LED 1. This includes data taken approaching the normal to the magnetic field (x) and receding from the normal ($\cdot$).
- Figure 11 X-ray counting rate (1/4 keV channel) LED 1 versus angle of detector viewing axis to the center of the Earth. The $3^\circ \times 3^\circ$ section is represented by the solid lines, while the $1\ 1/2^\circ \times 3^\circ$ section is denoted by the dotted lines. Data was taken while pointing at SS Cygni as the Earth slowly occulted the source.
- Figure 12 Histograms of observed counting rate samples sorted according to X-ray counting rate for LED 1 for the large and small fields of view.

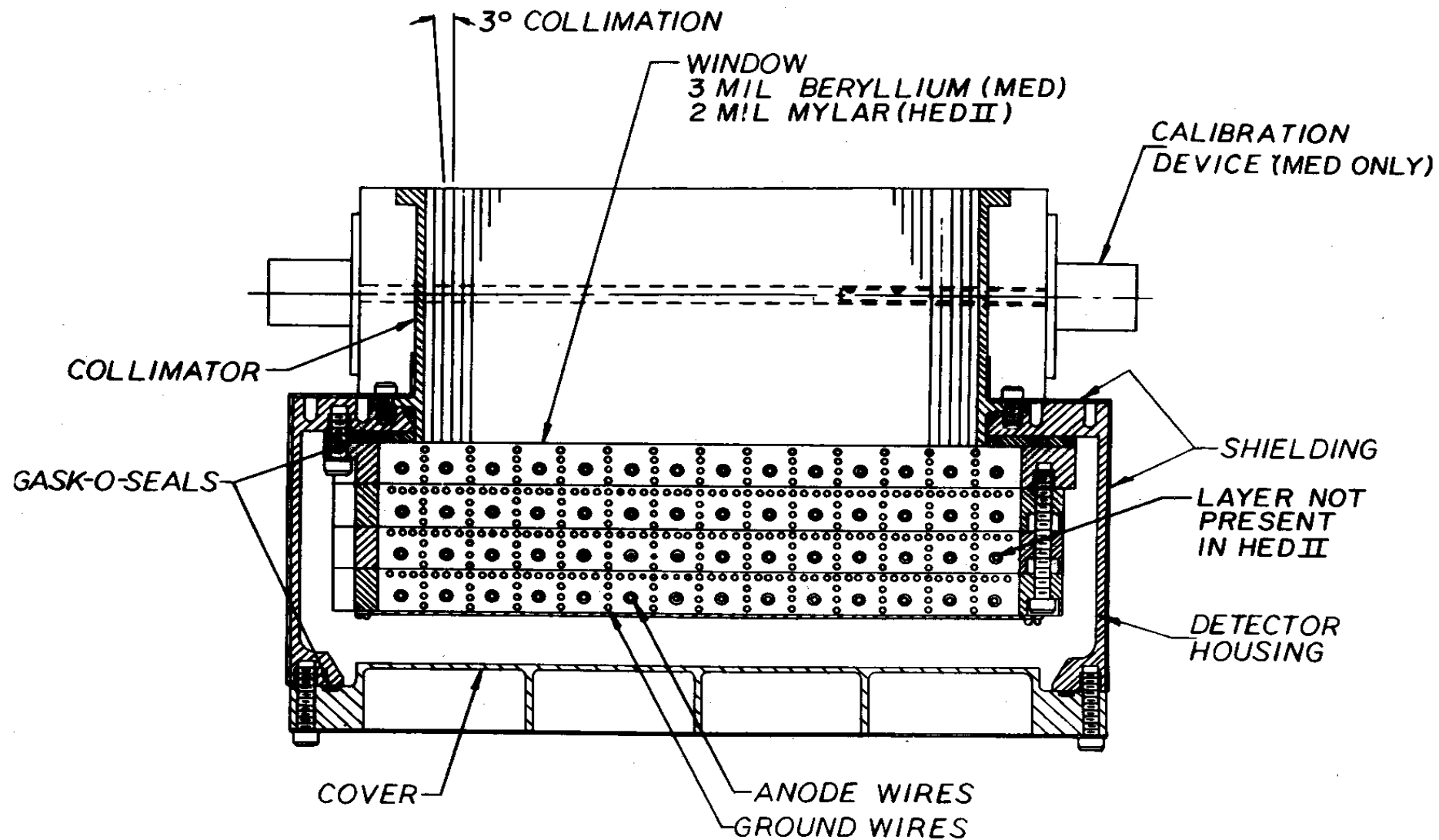
Figure 13 Superposed count rate versus scan angle for August 21, 1977 binned into 1/2 degree bins. The scan angle approximates ecliptic latitude with the origin at the northward crossing of the ecliptic plane. All data are from the $3^\circ \times 3^\circ$ field of view collimator sections. The energy ranges and detectors are noted beside each trace.

Figure 14 Superposed count rate versus scan angle on the sky for the $3^\circ \times 3^\circ$ field of view on HED 1. The peak at a scan angle of $\sim 73^\circ$ is attributed to AM HER. DQ HER is excluded. An Abell cluster (A2256) was at the edge of the scan path.

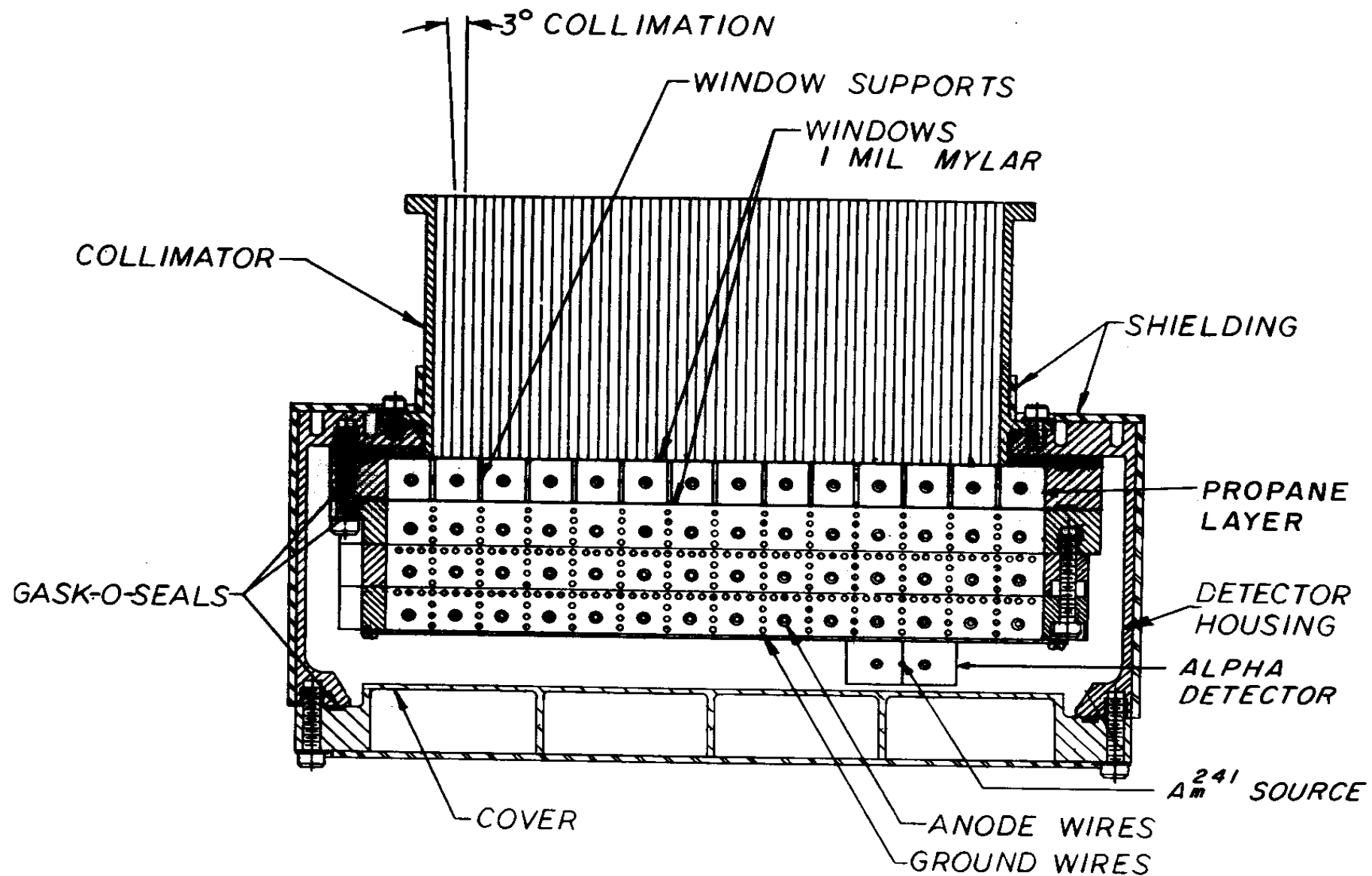




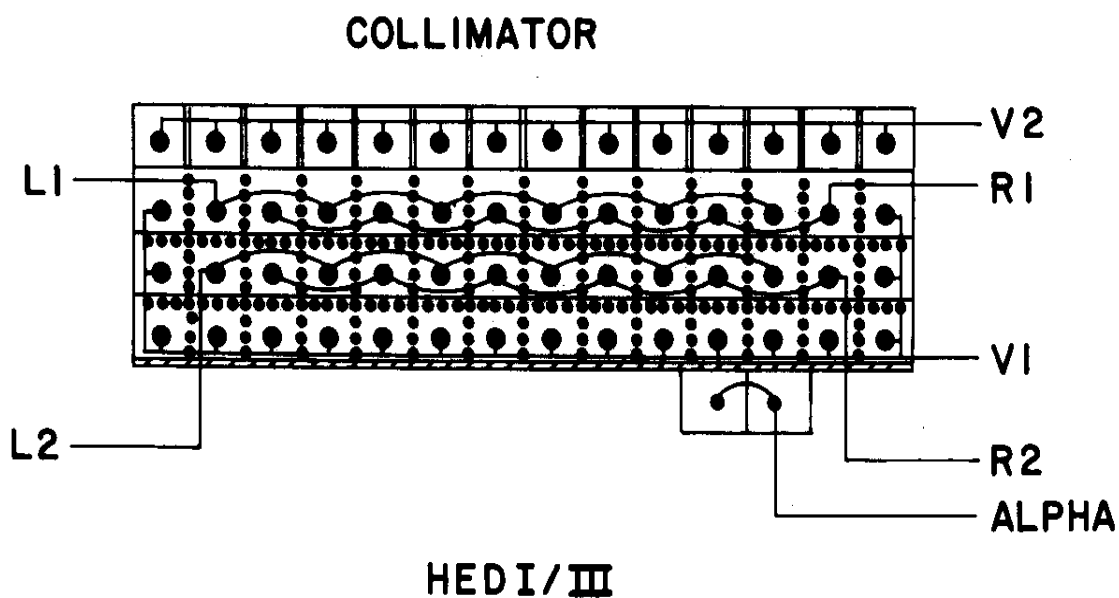
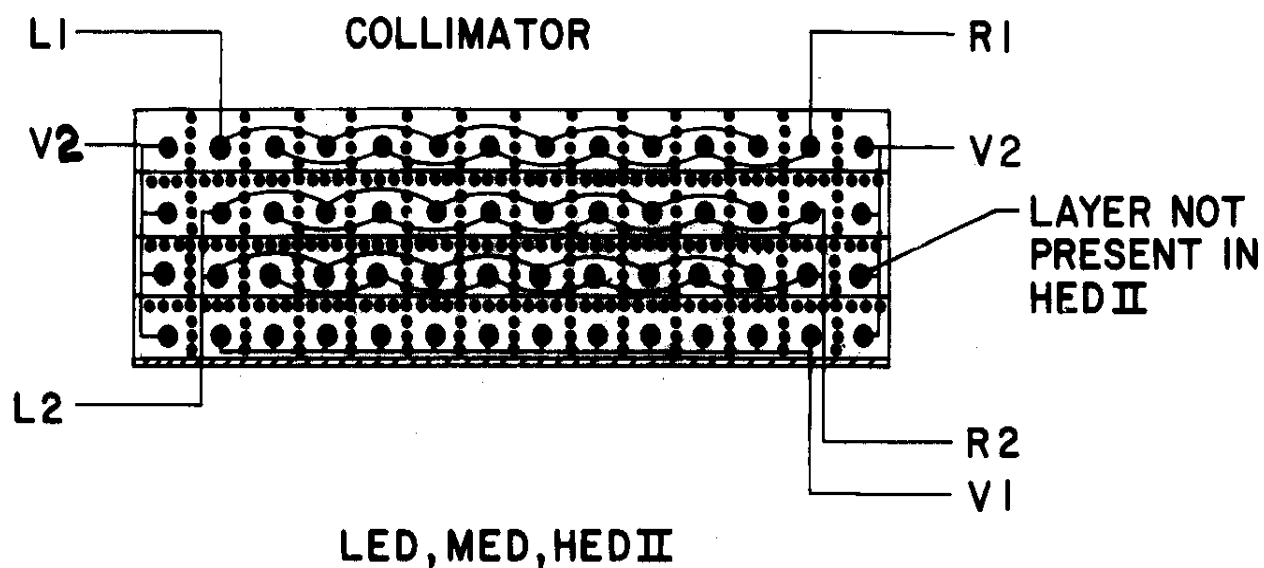
LED CROSSECTION



MED / HED II CROSSECTION

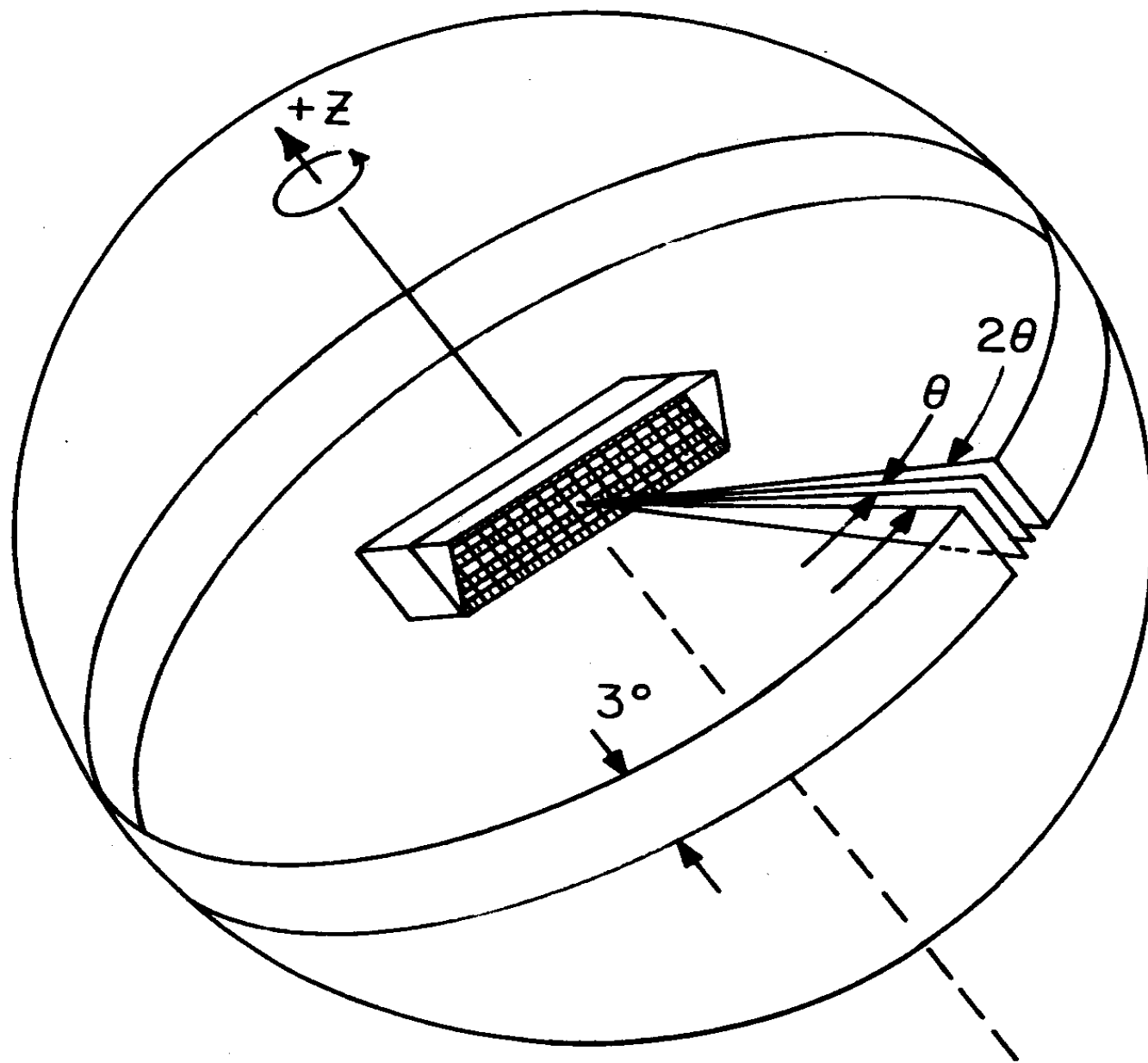


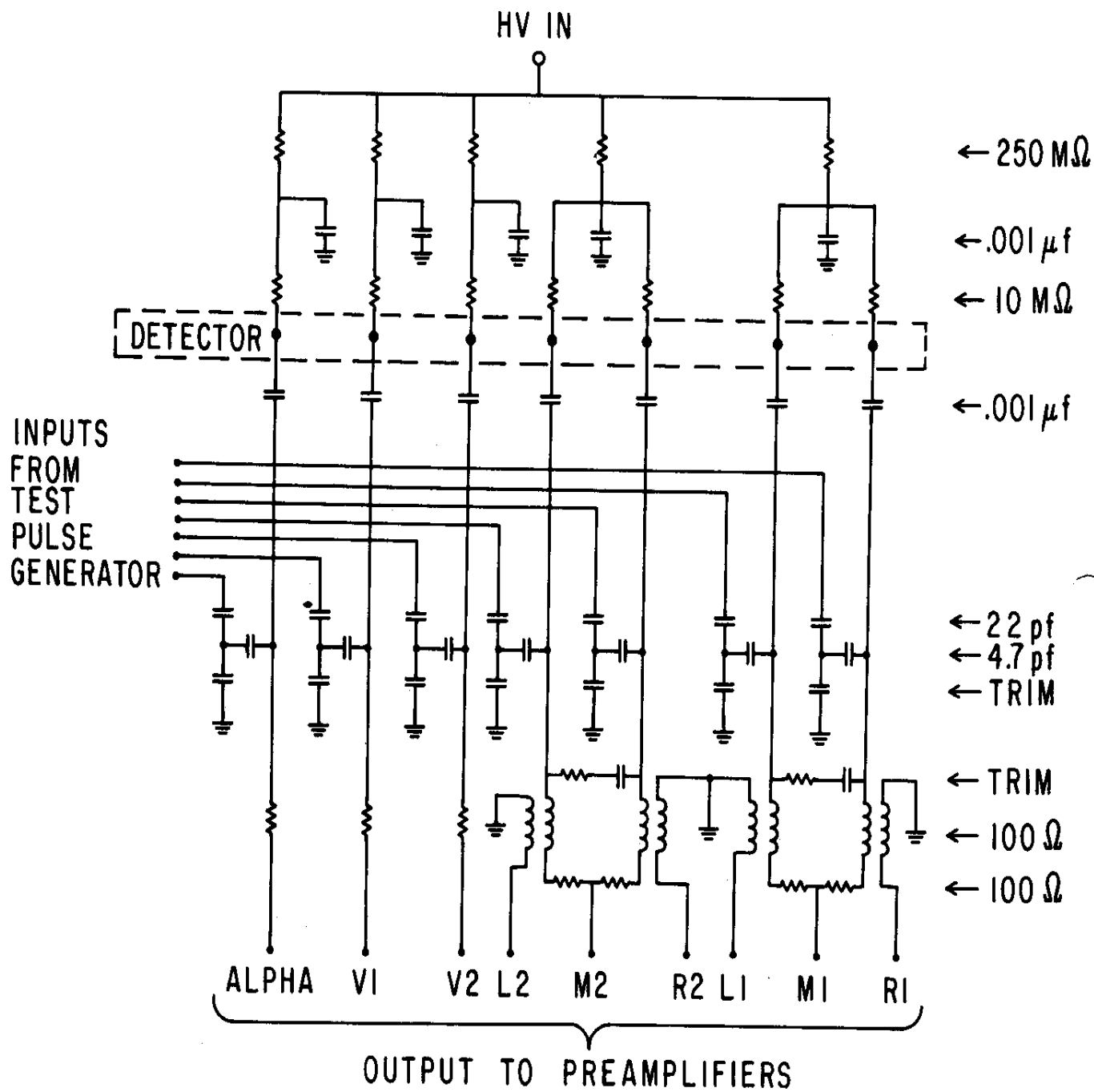
HED CROSS SECTION



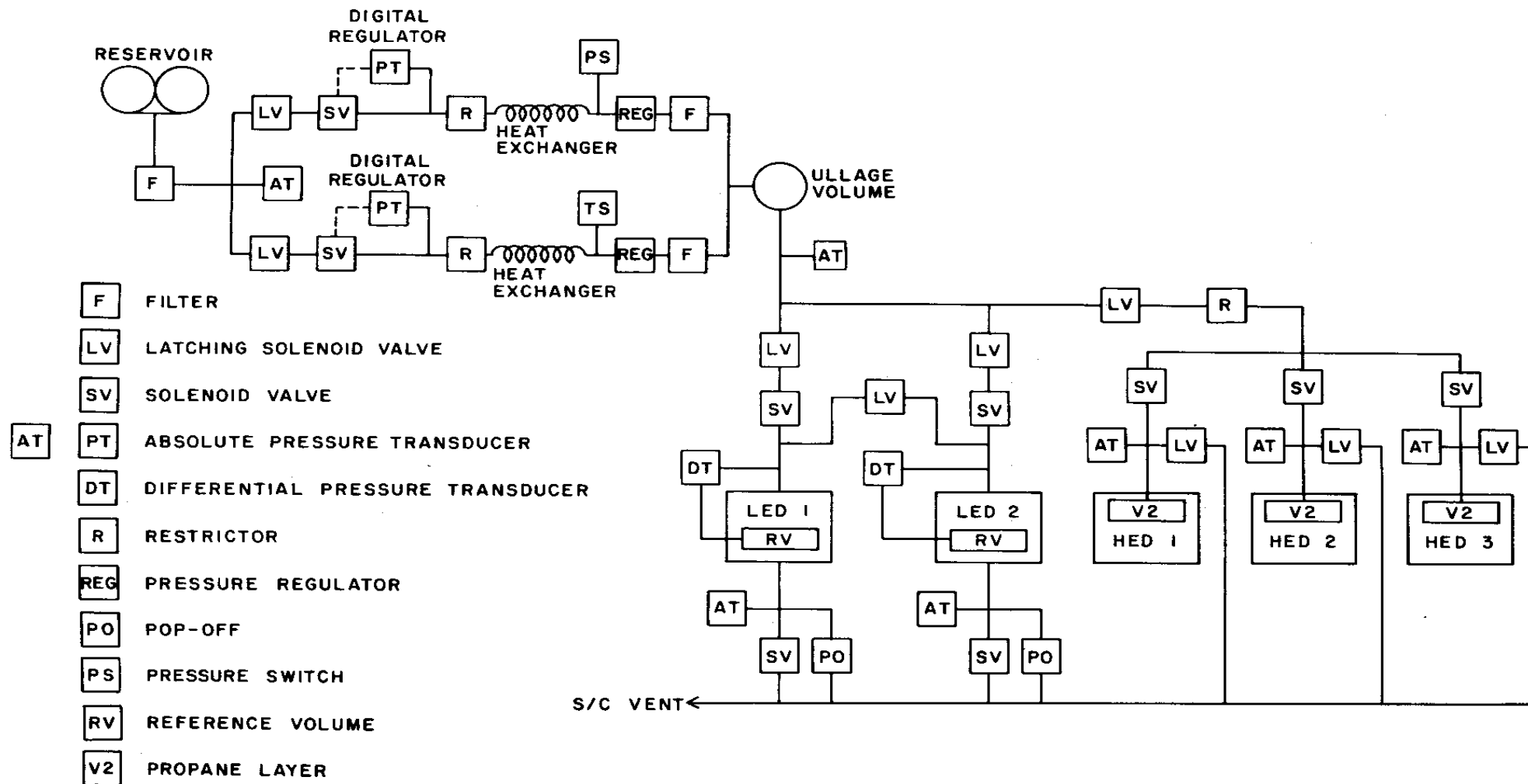
DETECTOR GRID CONNECTIONS

Figure 3





HIGH ENERGY DETECTOR FRONT END SECTION



HEAO A-2 GAS CONTROL SYSTEM

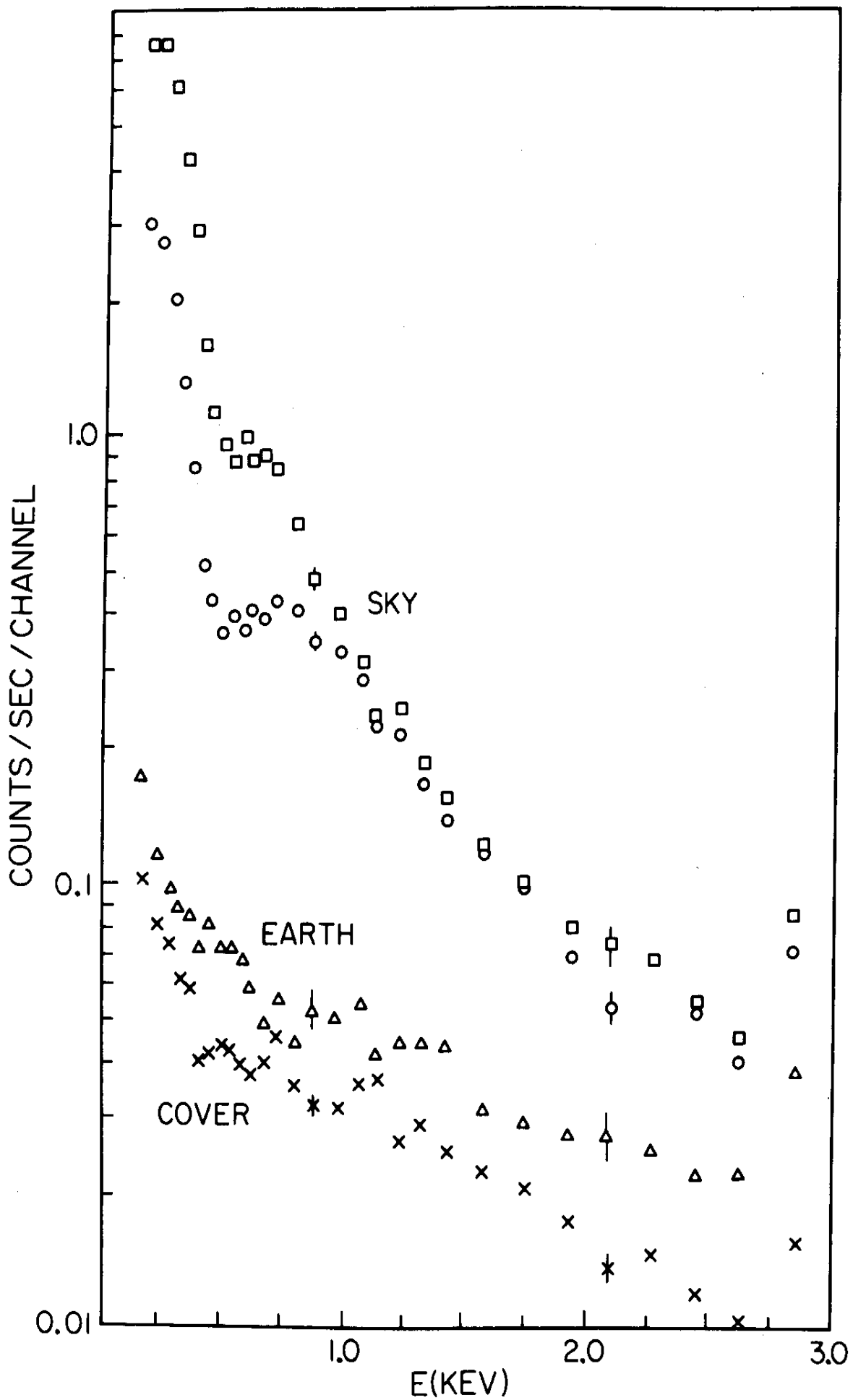


Fig. 7

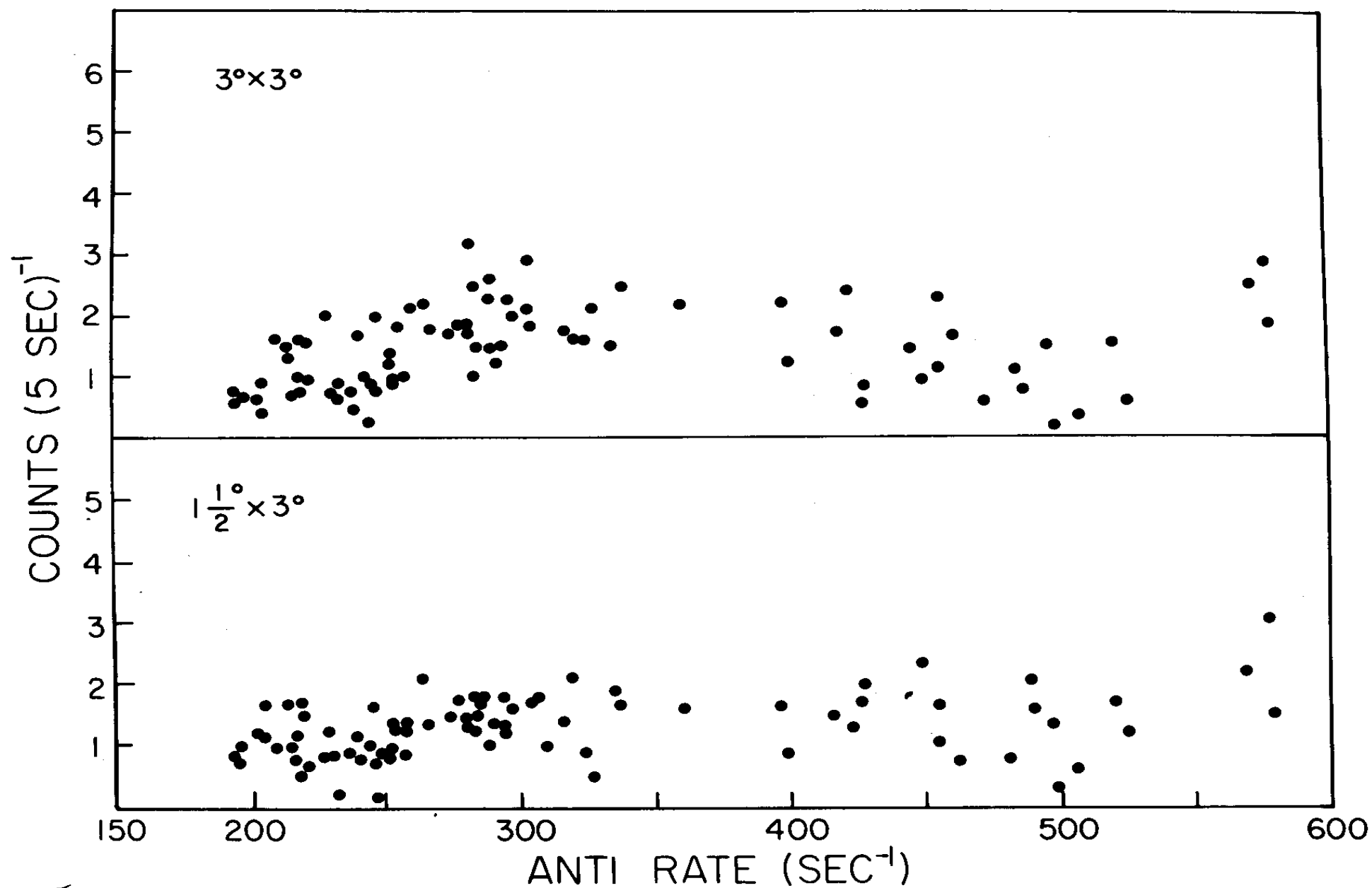


Fig. 8

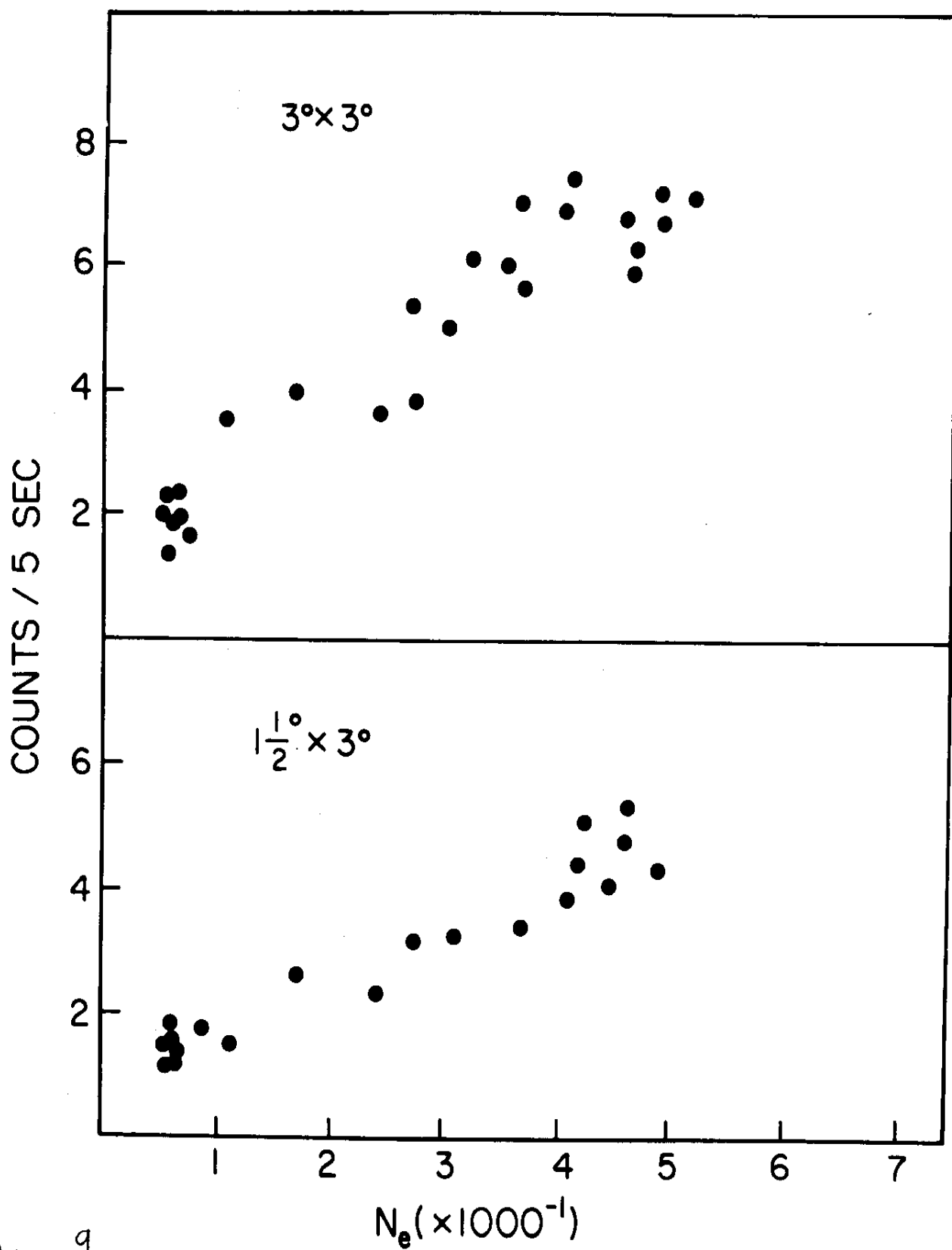


Fig. 9

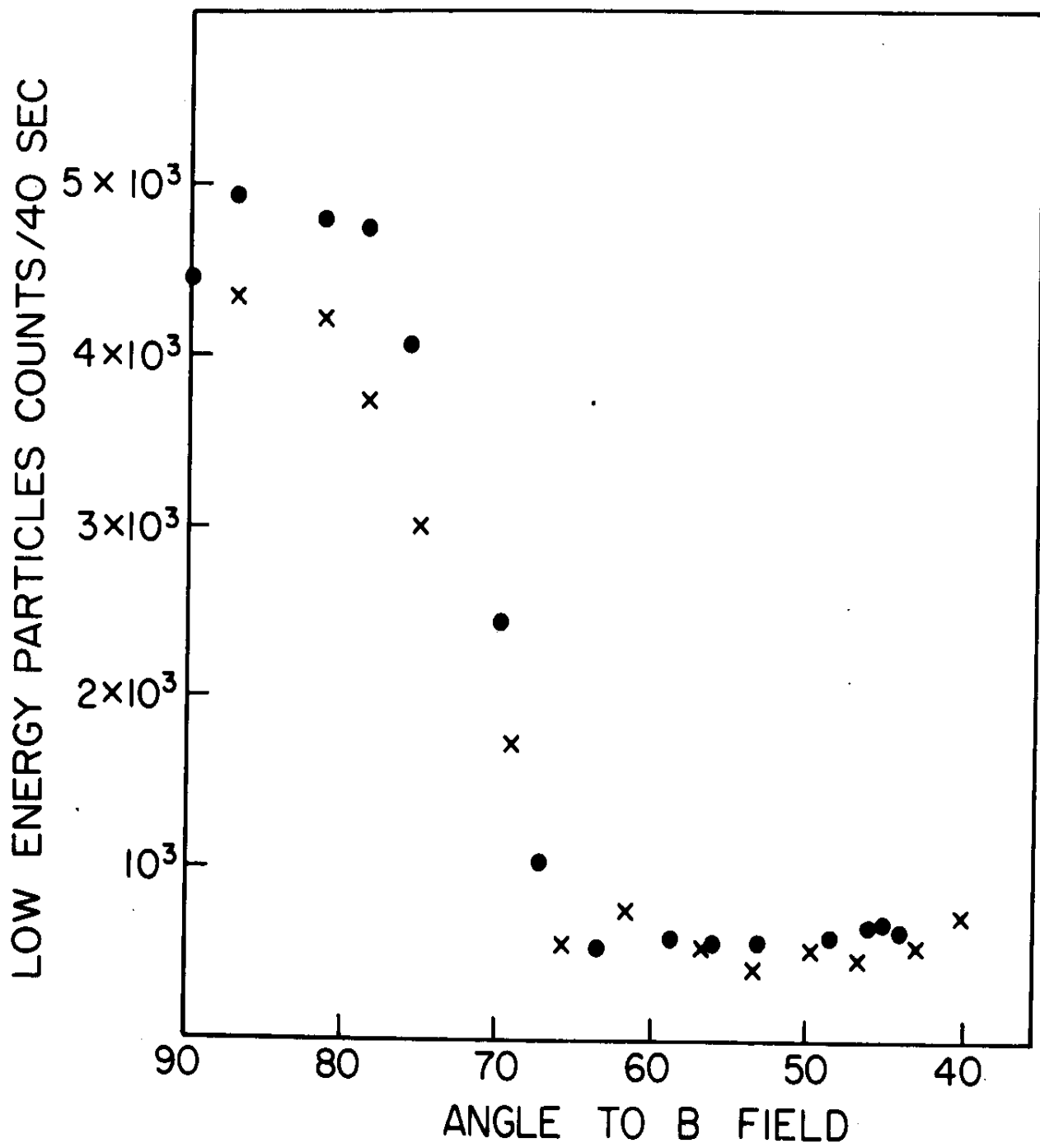


Fig. 10

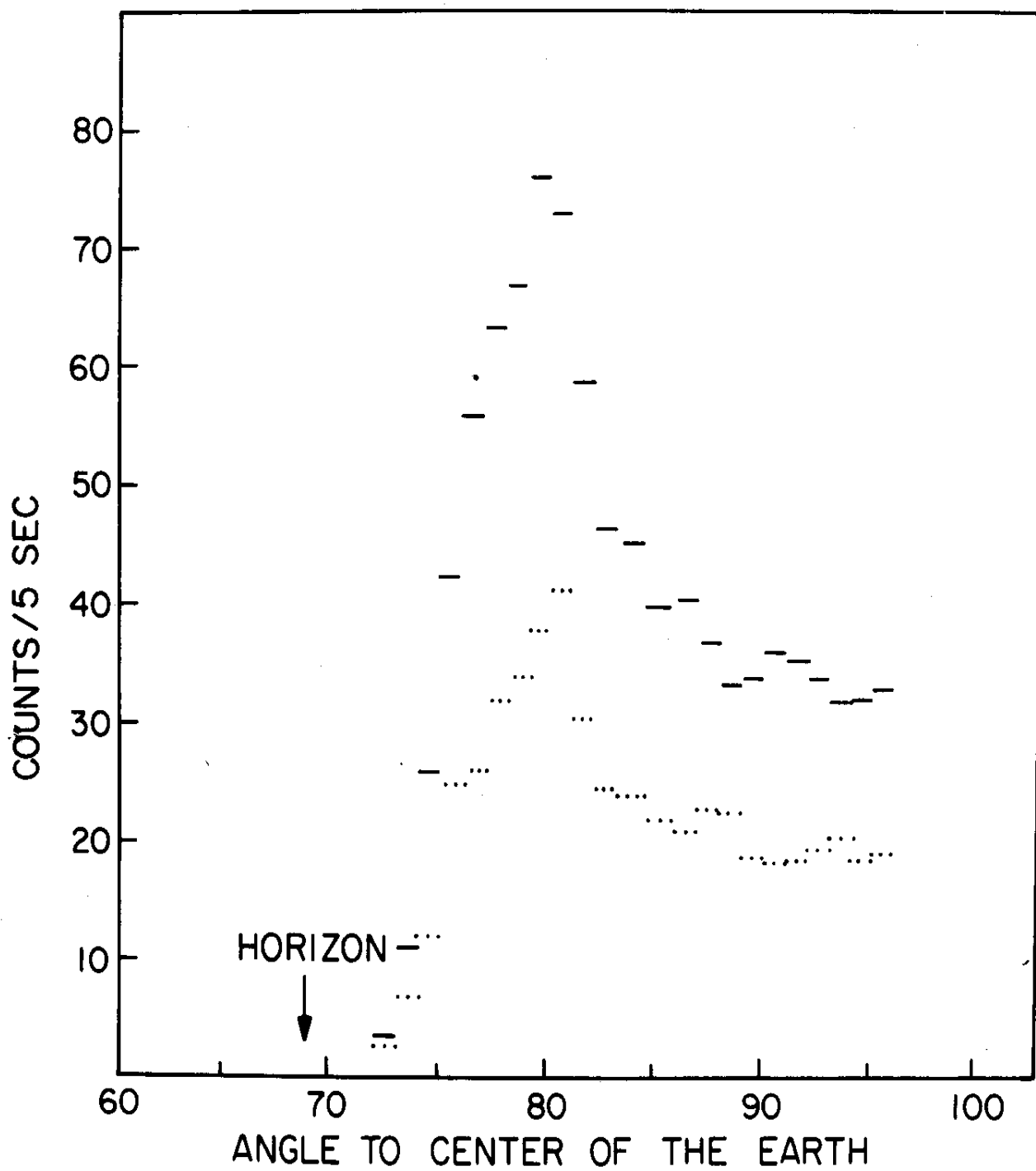


Fig. 11

NUMBER (N) OF SAMPLES OBSERVED:
DISTRIBUTED ACCORDING TO COUNT RATE (HEDI)

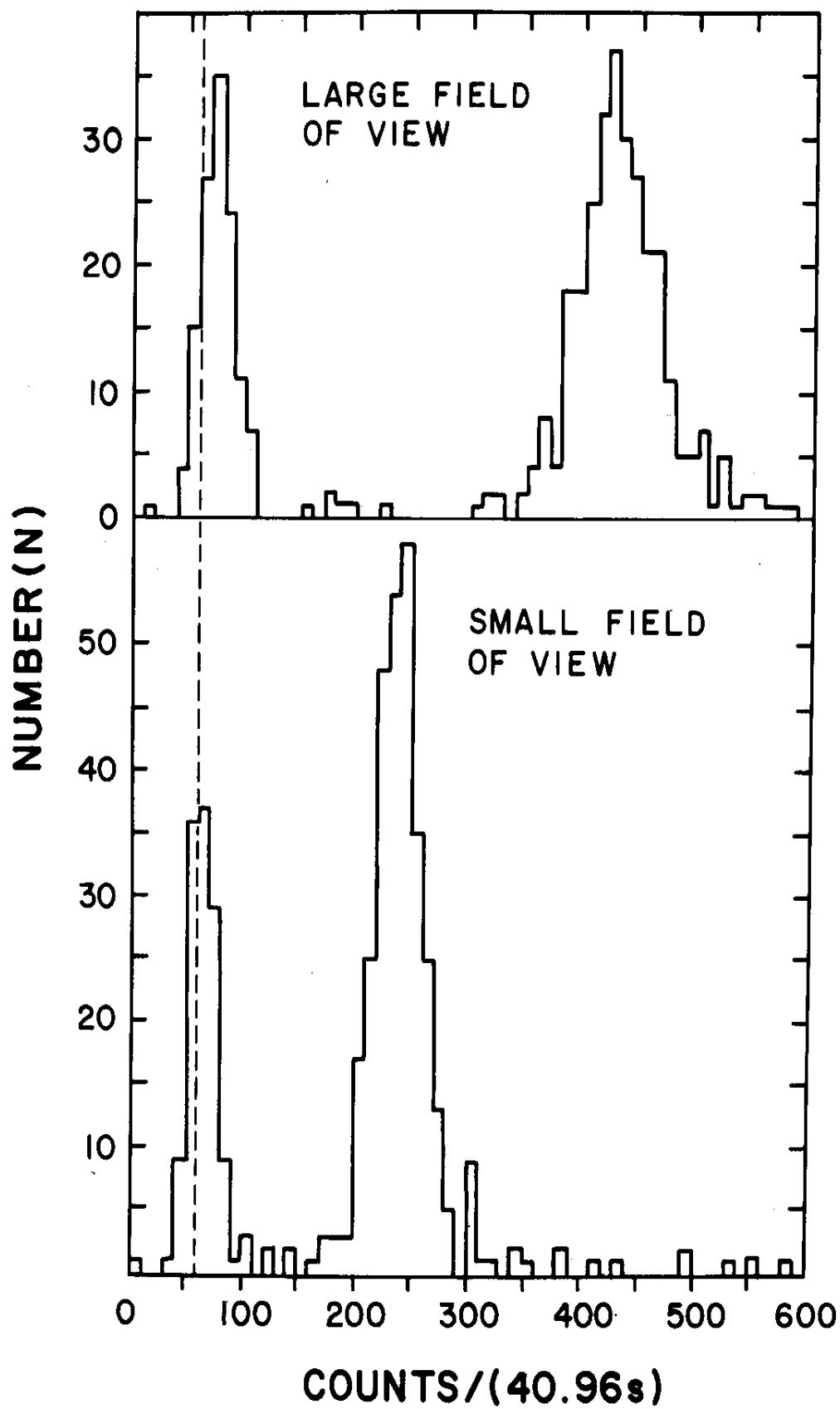


Fig. 12

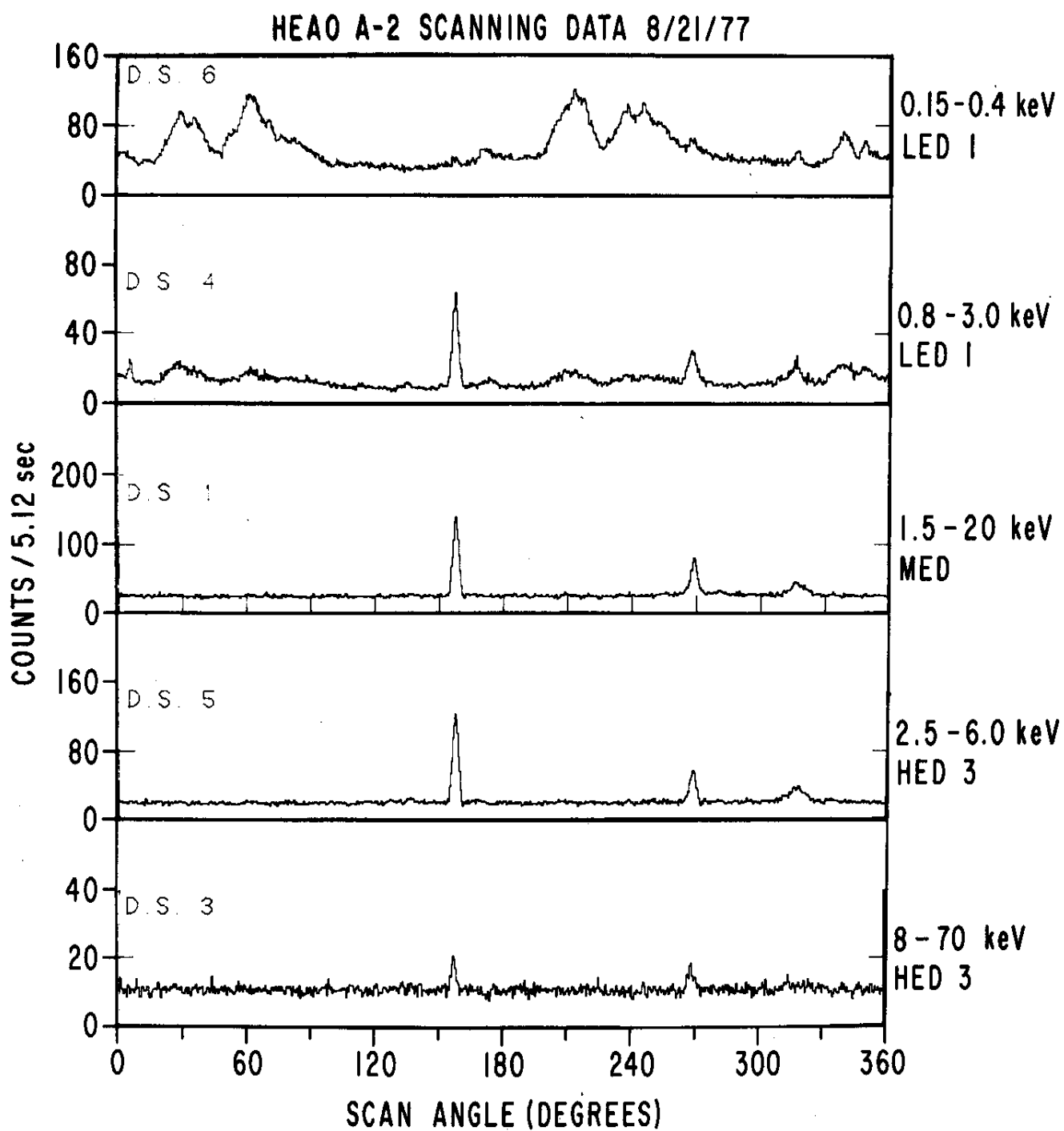


Fig. 13

HEAO SUMMED RATES
DS 1 DET 3 156 SCANS

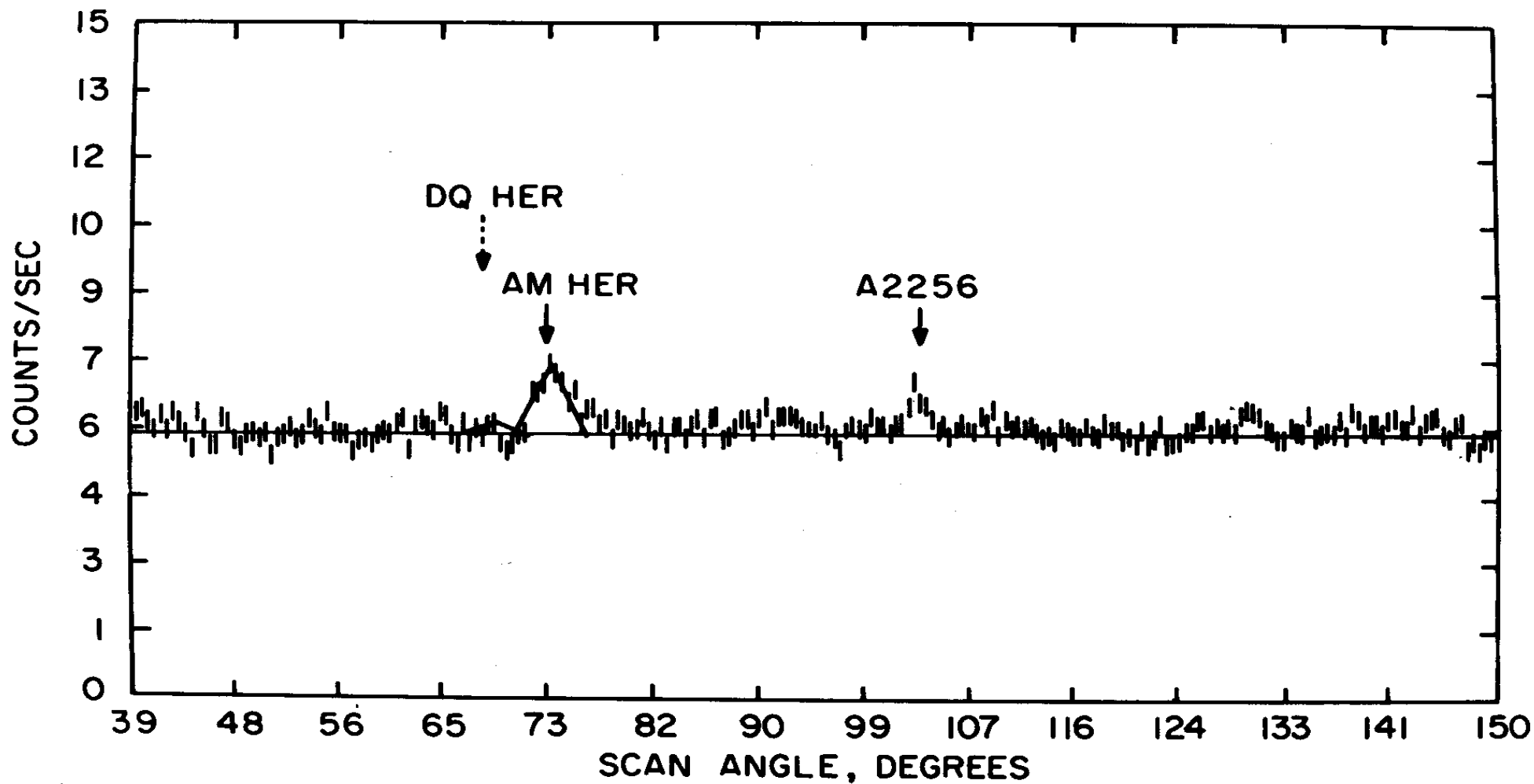


Fig. 14

BIBLIOGRAPHIC DATA SHEET

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
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		6. Performing Organization Code 661	
7. Author(s) R. Rothschild (UCSD), E. Boldt, S. Holt, P. Serlemitsos		8. Performing Organization Report No.	
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15. Supplementary Notes			
16. Abstract The Cosmic X-ray Experiment aboard the HEAO-1 observatory is described. The instrument consists of six gas proportional counters of three types nominally covering the energy ranges of 0.15 - 3 keV, 1.2 - 20 keV, and 2.5 - 60 keV. The two low energy detectors have about 400 cm² open area each while the four others have about 800 cm² each. A novel feature of this experiment is the dual field of view collimators that allow the unambiguous determination of instrument internal background and diffuse X-ray brightness. Instrument characteristics and early performance will be discussed.			
17. Key Words (Selected by Author(s))		18. Distribution Statement	
19. Security Classif. (of this report) U	20. Security Classif. (of this page) U	21. No. of Pages 62	22. Price*

FWRITE PACKAGE

```

*****
* THIS SET OF ROUTINES WAS WRITTEN TO CUT DOWN ON CPU TIME
* REQUIRED TO DO I/O FROM A FORTRAN PROGRAM.
* IT CAN BE USED IF THE FOLLOWING CONDITIONS ARE SATISFIED:
*
*   1) NON FORMATTED I/O IS WANTED
*   2) ALL DATA FOR A RECORD IS CONTIGUOUS IN CORE
*   3) THE LOGICAL RECORD SIZE IS NEVER GREATER THAN
*       THE PHYSICAL RECORD SIZE.
*
* QSAM LOCATE MODE IS USED FOR ALL I/O OPERATIONS IN THESE ROUTINES.
*
* ENTRY POINTS:
*
*   FREAD(A,N,L,&END,&ERR)  READS A RECORD OF LENGTH L FROM
*                           LOGICAL UNIT N INTO CONTIGUOUS CORE
*                           LOCATIONS STARTING AT A.  TRANSFER
*                           TO STATEMENT 'END' ON EOF, AND
*                           'ERR' ON I/O ERROR.
*
*   FREADB(A,N,L,&END,&ERR) SAME AS FREAD EXCEPT RECORD IS
*                           READ BACKWARDS.
*
*   FWRITE(A,N,L)          WRITES A RECORD OF LENGTH L ONTO
*                           LOGICAL UNIT N FROM CONTIGUOUS CORE
*                           LOCATIONS STARTING AT A.
*
*   REWIND(N)              REWINDS LOGICAL UNIT N.
*
*   UNLOAD(N)              DISMOUNTS LOGICAL UNIT N AND FREES
*                           WORK SPACE.
*
*   POSN(IO,N,NFILE)       POSITIONS LOGICAL UNIT N TO FILE
*                           NFILE.  IO = 1 FOR INPUT
*                           IO = 2 FOR OUTPUT
*                           IO = 3 FOR RDBACK
*
*   LEAVE(N)               CLOSSES DCB FOR LOGICAL UNIT N WITH
*                           THE LEAVE OPTION SPECIFIED.
*
*   MOUNT(IO,N,DTAPE)      MOUNTS TAPE SPECIFIED IN DTAPE ON
*                           LOGICAL UNIT N.
*                           IO = 1 FOR INPUT
*                           IO = 2 FOR OUTPUT
*                           IO = 3 FOR RDBACK
*
*   MEMBER(IO,N,DNAME)     POSITIONS TO SPECIFIED MEMBER IN
*                           A PARTITIONED DATA SET.
*                           IO = 1 FOR INPUT
*                           IO = 2 FOR OUTPUT
*                           IO = 3 FOR RDBACK

```


*	0- STORAGE FOR DCB NOT ACQUIRED	* 000113
*		* 000114
*	1- DCB IS OPEN FOR INPUT	* 000115
*		* 000116
*	2- DCB IS OPEN FOR OUTPUT	* 000117
*		* 000118
*	3- DCB IS OPEN FOR READING BACKWARDS	* 000119
*		* 000120
*	4- DCB IS CLOSED	* 000121
*		* 000122
*		* 000123
*		* 000124
*****	CONTROL BLOCK ITEMS USED *****	* 000125
*		* 000126
*	DCB +82 = LRECL	* 000127
*	DCB +62 = BLKSIZE	* 000128
*	DCB +36 = RECFM (BITS 0 AND 1) 10=F,01=V,11=U	* 000129
*	JFCB+44 = MEMBER NAME (FOR PDS PROCESSING)	* 000129
*	JFCB+68 = FILE SEQUENCE NUMBER	* 000130
*	JFCB+117 = NUMBER OF VOLUME SERIAL NUMBERS	* 000131
*	JFCB+118 = FIRST VOLUME SERIAL NUMBER	* 000132
*		* 000133

***** MACRO DEFINITIONS *****		
	MACRO	000001
&LAB	RET &CODE	000002
&LAB	L 13,SVAR+4	000004
	AIF ('&CODE' EQ 'F').FUNC	000004
	AIF ('&CODE' NE '').CODE	000005
	RETURN (14,12),T	000006
	MEXIT	000007
.CODE	RETURN (14,12),T,RC=&CODE	000008
	MEXIT	000009
.FUNC	ANOP	000010
	LM 14,15,12(13) RESTORE 14 AND 15	000011
	LM 1,12,24(13) RESTORE 1 THROUGH 12	000012
	MVI 12(13),X'FF' SET RETURN INDICATOR	000013
	BR 14	000014
	MEND	000015
	MACRO	RENC00
&ENTRY	INIT	RENC00
	GBLC &LABL,&LAB	
	AIF ('&ENTRY' NE '').LABOK	
	AIF ('&LABL' NE '').ERR	
&LAB	SETC '&SYSECT'	
	SAVE (2,12),T,&LAB	
	AGO .NOLAB	
.ERR	MNOTE 'BLANK LABEL FIELD ILLEGAL EXCEPT ON FIRST INIT'	
	MEXIT	
.LABOK	ENTRY &ENTRY	
&ENTRY	SAVE (2,12),T,*	RENC00
&LAB	SETC '&ENTRY'	
.NOLAB	AIF ('&LABL' NE '').NFST	
	LR 12,15	RENC00
	USING &LAB,12	
	CNOP 0,4	RENC00
	BAL 4,I&SYSNDX	RENC00

	BNE	RDCBIN	BRANCH IF YES	000146
	BAL	10,GETDCB	CREATE DCB	000147
RDCBIN	CLI	0(3),4	IS DCB CLOSED?	000148
	BE	ROPEN	BRANCH IF YES	000149
	CLOSE	((7),REREAD)	CLOSE DCB	000150
ROPEN	OPEN	((7),INPUT)		000151
	MVI	0(3),1		000152
READ	GET	(7)	GET NEXT RECORD	000153
	TM	36(7),X'80'	TEST FOR VARIABLE RECORDS	000154
	BO	NOTV	BRANCH IF NOT	000155
	MVC	WORK(2),0(1)	MOVE TO HALF WORD BOUNDARY	000156
	LH	8,WORK	LOAD LRECL	000157
	SH	8,=H'4'	COMPUTE LENGTH OF DATA	000158
	LA	1,4(1)	POINT 1 TO BEGINNING OF DATA	000159
	B	STLRECL		000160
NOTV	LH	8,82(7)	GET LRECL FROM DCB	000161
STLRECL	ST	8,0(6)	STORE IN RETURN PARAMETER	000162
	MOVE	(8),(4),(1)	MOVE DATA TO USERS AREA	000163
	CLI	ERRSW,0		000164
	BE	ROK		000165
	MVI	ERRSW,0		000166
	RET	8		000167
ROK	RET	0		000168
	EJECT			000169
**** ADDRESS READ MODE ONLY ***** 3-15-1977 J D MANNAN **				
FREADA	INIT			
	LM	4,6,0(1)	LOAD 3 PARAMETER POINTERS	000141
	BAL	10,UNCK	SETS GR3+7	000142
	CLI	0(3),1	IS DCB OPEN FOR INPUT?	000143
	BE	READJ	BRANCH IF YES	000144
	CLI	0(3),0	HAS DCB BEEN CREATED?	000145
	BNE	RDCBINJ	BRANCH IF YES	000146
	BAL	10,GETDCB	CREATE DCB	000147
RDCBINJ	CLI	0(3),4	IS DCB CLOSED?	000148
	BE	ROPENJ	BRANCH IF YES	000149
	CLOSE	((7),REREAD)	CLOSE DCB	000150
ROPENJ	OPEN	((7),INPUT)		000151
	MVI	0(3),1		000152
READJ	GET	(7)	GET NEXT RECORD	000153
	TM	36(7),X'80'	TEST FOR VARIABLE RECORDS	000154
	BO	NOTVJ	BRANCH IF NOT	000155
	MVC	WORK(2),0(1)	MOVE TO HALF WORD BOUNDARY	000156
	LH	8,WORK	LOAD LRECL	000157
	SH	8,=H'4'	COMPUTE LENGTH OF DATA	000158
	LA	1,4(1)	POINT 1 TO BEGINNING OF DATA	000159
	B	STLRECLJ		000160
NOTVJ	LH	8,82(7)	GET LRECL FROM DCB	000161
STLRECLJ	ST	8,0(6)	STORE IN RETURN PARAMETER	000162
	ST	1,0(4)	PUT BUFFER ADDRESS INTO A	
	CLI	ERRSW,0		000163
	BE	ROKJ		000164
	MVI	ERRSW,0		000165
	RET	8		000166
ROKJ	RET	0		000167
	EJECT			000168
***** READ RECORD IN BACKWARDS MODE *****				
FREADB	INIT			000170

	LM	4,6,0(1)	LOAD 3 PARAMETER POINTERS	00017
	BAL	10,UNCK	SETS GR3+7	00017
	CLI	0(3),3	IS DCB OPEN FOR RDBACK?	00017
	BE	READ	GO READ IF YES	00017
	CLI	0(3),0	HAS DCB BEEN CREATED?	00017
	BNE	RBDCCBIN	BRANCH IF YES	00017
	BAL	10,GETDCB	CREATE DCB	00017
RBDCCBIN	CLI	0(3),4	DCB CLOSED?	00018
	BE	RBOPEN	BRANCH IF YES	00018
	CLOSE	((7),LEAVE)	CLOSE DCB	00018
	FREEPOOL	(7)		
RBOPEN	OPEN	((7),RDBACK)	OPEN DCB FOR RDBACK	00018
	MVI	0(3),3	SET CODE	00018
	B	READ	GO AND READ	00018
	EJECT			00018

***** WRITE RECORD *****				
FWRITE	INIT			00018
	LM	4,6,0(1)		00019
	BAL	10,UNCK		00019
	CLI	0(3),2		00019
	BE	WRITE		00019
	CLI	0(3),0		00019
	BNE	WDCBIN		00019
	BAL	10,GETDCB		00019
WDCBIN	CLI	0(3),4		00019
	BE	WOPEN		00019
	CLOSE	((7),LEAVE)	CLOSE DCB	00019
WOPEN	OPEN	((7),OUTPUT)		00020
	MVI	0(3),2		00020
WRITE	TM	36(7),X'80'	TEST FOR VARIABLE RECORDS	00020
	BO	NOTVV	BRANCH IF NOT	00020
*				
* VARIABLE LENGTH RECORDS				
*				
	L	8,0(6)	LOAD DATA LENGTH PASSED	00020
	LA	9,4(8)	ADD 4 TO INCLUDE CONTROL WORD	00020
	STH	9,82(7)	STORE IN DCBLRECL	00020
	PUT	(7)	GET NEXT BUFFER	00021
	MVC	0(2,1),82(7)	MOVE LRECL TO DATA RECORD	00021
	MVC	2(2,1),=X'0000'	ZERO REMAINDER OF CONTROL WD	00021
	LA	10,4(1)	BEGINNING OF DATA IN RECORD	00021
	MOVE	(8),(10),(4)	MOVE DATA TO BUFFER	00021
	RET	0		00021
*				
* U OR F RECORDS				
*				
NOTVV	TM	36(7),X'40'	TEST FOR FIXED	00021
	BZ	FIXED	BRANCH IF FIXED	00022
	L	8,0(6)	LOAD LRECL PASSED	00022
	STH	8,82(7)	STORE IN DCBLRECL	00022
FIXED	PUT	(7)	GET NEXT BUFFER	00022
	LH	8,82(7)	GET LENGTH OF RECORD	00022
	LR	10,1		00022
	MOVE	(8),(10),(4)	MOVE DATA TO BUFFER	00022
	RET	0		00022
	EJECT			00022

SVAR	DS	18F		RENC00
I&SYSNDX	ST	13,SVAR+4		RENC00
.STD	ST	4,8(13)		RENC00
	LR	13,4		RENC00
	AIF	('&LABL' NE '').END		RENC00
&LABL	SETC	'&LAB'		
.END	MEXIT			RENC00
.NFST	USING	&LAB,15		
	L	12,=A(&LABL)		RENC00
	DROP	15		RENC00
	LA	4,SVAR		RENC00
	ST	13,SVAR+4		RENC00
	AGO	.STD		RENC00
	MEND			RENC00
	MACRO			000000
&HERE	MOVE	&LEN,&TO,&FROM		000000
	LCLC	&T1,&T2,&T3		000000
&HERE	LA	14,255	MAX LENGTH FOR MVC INSTRUCTION	000000
&T2	SETC	'A'		000000
&T3	SETC	'A'		000000
	AIF	('&LEN'(1,1) NE '()).FIRST		000000
&T1	SETC	'R'		000000
	AIF	('&LEN' EQ '(0)').SKIP1		000000
.FIRST	L&T1	0,&LEN(1)	LOAD REG 0 WITH LENGTH	000000
.SKIP1	AIF	('&TO'(1,1) NE '()).SECOND		000000
&T2	SETC	'R'		000000
	AIF	('&TO' EQ '(15)').SKIP2		000000
.SECOND	L&T2	15,&TO(1)	LOAD REG 15 WITH TO ADDRESS	000000
.SKIP2	AIF	('&FROM'(1,1) NE '()).THIRD		000000
&T3	SETC	'R'		000000
	AIF	('&FROM' EQ '(1)').SKIP3		000000
.THIRD	L&T3	1,&FROM(1)	LOAD REG 1 WITH FROM ADDRESS	000000
.SKIP3	ANOP			000000
	S	0,=F'256'	NO. OF BYTES REMAINING TO BE MOVED	000000
	BNM	*+6	IF .GE. 256,BRANCH TO EX INSTRUCTION	000000
	AR	14,0	SET REG 14 TO REMAINING BYTES	000000
	EX	14,*+22	EXECUTE THE MVC INSTRUCTION	000000
	LA	1,1(14,1)	INCREMENT THE FROM ADDRESS	000000
	LA	15,1(14,15)	INCREMENT THE TO ADDRESS	000000
	LTR	0,0	ARE THERE ANY MORE BYTES TO BE MOVED	000000
	BP	*-24	YES. BRANCH TO S 0,=F'256'	000000
	B	*+10	NO. BRANCH AROUND MVC INSTRUCTION	000000
	MVC	0(1,15),0(1)		000000
	MEND			000000
***** END MACRO DEFINITIONS *****				

*				
	EJECT			000135
*****				000136
***** READ RECORD *****				000137
FREAD	START	0		000138
NUMENTS	EQU	50	MAXIMUM NUMBER OF ENTRIES IN UNIT TABLE	000139
	INIT			000140
	LM	4,6,0(1)	LOAD 3 PARAMETER POINTERS	000141
	BAL	10,UNCK	SETS GR3+7	000142
	CLI	0(3),1	IS DCB OPEN FOR INPUT?	000143
	BE	READ	BRANCH IF YES	000144
	CLI	0(3),0	HAS DCB BEEN CREATED?	000145

```

***** REWIND UNIT *****
REWIND INIT
L 5,0(1)
BAL 10,UNCK
TM 0(3),3
BZ CLOSED
CLOSE ((7),REREAD)
MVI 0(3),4
TEST CODE BYTE
BRANCH IF 0 OR 4 (DCB NOT OPEN)
SET CODE TO INDICATE CLOSED
CLOSED RET
EJECT
***** CLOSE LEAVE *****
LEAVE INIT
L 5,0(1)
BAL 10,UNCK
TM 0(3),3
BZ CLOSED
CLOSE ((7),LEAVE)
MVI 0(3),4
CLOSEDD RET
EJECT
***** UNLOAD UNIT *****
UNLOAD INIT
L 5,0(1)
BAL 10,UNCK
CLI 0(3),0
BE RET
CLI 0(3),4
BNE CLOSE
OPEN ((7),INPUT)
CLOSE CLOSE ((7))
FREEMAIN E,A=(3),LV=96
MVI 0(3),0
RET RET
EJECT
***** POSITION TO REQUESTED FILE *****
POSN INIT
LM 4,6,0(1)
BAL 10,UNCK
CLI 0(3),0
BNE DCBIN
BAL 10,GETDCB
DCBIN CLI 0(3),4
BE CLSD
CLOSE ((7),LEAVE)
CLSD RDJFCB ((7))
L 6,0(6)
STH 6,JFCB+68
CHECK CLI 3(4),1
BE OPENIN
CLI 3(4),2
BE OUTP
CLI 3(4),3
BE OPENRB
ABEND 210,DUMP
OPENIN OPEN ((7)),TYPE=J

```

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000299
000300

	MVI	0(3),1		000280
	B	OVER		000280
OUTP	OPEN	((7),OUTPUT),TYPE=J		000290
	MVI	0(3),2		000290
	B	OVER		000290
OPENRB	OPEN	((7),RDBACK),TYPE=J		000290
	MVI	0(3),3		000290
OVER	RET	0		000290
	EJECT			000290
***** MOUNT REQUESTED TAPE *****				000290
MOUNT	INIT			000290
	LM	4,6,0(1)	LOAD PARAMETER LIST	000300
	L	2,12(1)	LOAD FOURTH ARG ** OPTIONAL **	
	BAL	10,UNCK	CHECK UNIT NUMBER PASSED	000300
	CLI	0(3),0	IS DCB CREATED?	000300
	BNE	DCBIN1	BRANCH IF YES	000300
	BAL	10,GETDCB	CREATE DCB	000300
DCBIN1	CLI	0(3),4	IS DCB CLOSED?	000300
	BE	CLOSEDD0		000300
	CLOSE	((7))	CLOSE DCB	000300
CLOSEDD0	RDJFCB	((7))	READ JFCB	000300
	LTR	6,6	ARE THERE JUST THREE ARGUMENTS?	
	BM	THREEARG	BRANCH IF SO	
	L	2,0(2)	GET FILE NUMBER	
	STH	2,JFCB+68	AND POSITION THE TAPE	
	B	FINISH	NOW GO SET VOLSER	
THREEARG	LA	0,1	NO FILE NUMBER GIVEN	
	STH	0,JFCB+68	SO POSITION TO THE FIRST FILE	
FINISH	MVI	JFCB+117,1	SET # OF VOLS TO 1	000300
	MVC	JFCB+118(6),0(6)	MOVE TAPE LABEL TO JFCB	000310
	B	CHECK	GO OPEN AND RETURN	
	EJECT			000310
***** POSITION TO REQUESTED MEMBER *****				000310
MEMBER	INIT			000310
	LM	4,6,0(1)	LOAD PARAMETER LIST	000310
	BAL	10,UNCK	CHECK UNIT NUMBER PASSED	000310
	CLI	0(3),0	IS DCB CREATED?	000310
	BNE	DCBIN1	BRANCH IF YES	000310
	BAL	10,GETDCB	CREATE DCB	000310
DCBIN1	CLI	0(3),4	IS DCB CLOSED?	000310
	BE	CLOSEDD1		000310
	CLOSE	((7))	CLOSE DCB	000310
CLOSEDD1	RDJFCB	((7))	READ JFCB	000310
	MVC	JFCB+44(8),0(6)	MOVE MEMBER NAME TO JFCB	000310
	B	CHECK	GO OPEN AND RETURN	000310
	EJECT			000310
***** SET DEFAULT DCB PARAMETERS *****				000310
EXIT	CLC	62(2,1),=X'0000'	HAS BLKSIZE BEEN SUPPLIED?	000310
	BNE	BLKOK	BRANCH IF YES	000310
	MVC	62(2,1),=H'32000'	SET DEFAULT BLKSIZE=32000	000310
BLKOK	TM	36(1),X'C0'	HAS RECFM BEEN SUPPLIED?	000310
	BNZ	RECFMOK	BRANCH IF YES	000310
	OI	36(1),X'C0'	SET DEFAULT RECFM=U	000320
RECFMOK	BR	14	RETURN	000320
	EJECT			000320

```

*****M*****
***** CHECK UNIT NUMBER PASSED *****
***** AND LOAD POINTERS TO TABLE *****
UNCK      L      5,0(5)
          LTR     11,5
          BNP     BAD
          C       5,=A(NUMENTS)      IS UNIT NUMBER > MAXIMUM?
          BNH     GOOD
BAD        ABEND  201,DUMP
GOOD       SLL    5,2
          LA     3, TABLE-4(5)
          L      7,0(3)
          BR     10
          EJECT

*****
***** GET AREA FOR DCB *****
***** AND SET IT UP *****
GETDCB     GETMAIN EU, A=(3), LV=96
          L      7,0(3)
          MVI    0(3), 4
          MVC    0(96,7), DCB
          CVD    11, WORK
          MVN    WORK+7(1), =X'0F'
          UNPK   42(2,7), WORK+6(2)
          BR     10
          EJECT

*****
***** E-O-F READING *****
EOF        RET     4
          SPACE  20

*****
***** I/O ERROR *****
ERR        MVI    ERRSW, 1
          BR     14
          EJECT

*****
WORK       DS      D
LIST       DC      X'05'
          DC      AL3(EXIT)
          DC      X'87'
          DC      AL3(JFCB)
JFCB       DS      176C
TABLE      DC      (NUMENTS)F'0'      UNIT TABLE
ERRSW      DC      X'00'
DCB        DCB     DDNAME=FTXXF001, EODAD=EOF, SYNAD=ERR, DSORG=PS, EROPT=ACC, X00036
          MACRE=(GL, PL), EXLST=LIST
          END

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FRNTND PROGRAM (FRONTEND)

```

/*JOBPARM CCTRL=U
/*JOBPARM IOC=999,TAPES=(0,0,4),LINES=9,REGION=256K,TIME=45
//      EXEC FORTHCL,PARM.FORT='OPT=2',PARM.LKED='LET,NCAL'
//FORT.SYSIN DD *
      CALL FRNTND
      STOP
      END

```

```

C
C      THIS PROGRAM READS MAX TAPES AND WRITES THREE TAPES
C      (1) THE STATUS TAPE CONTAINING A SUMMARY OF EACH MAJOR FRAME
C      (2) THE DATA TAPE CONTAINING DISCOVERY SCALER AND ATTITUDE READOUTS
C      (3) THE PHA TAPE CONTAINING PHA OR TEMPORAL READOUTS

```

```

C      DATA FORMATS USED

```

```

C      COMMON /STATUS/

```

```

C      DAY          R*8  TIME (DAY.FRACTION) SINCE JAN 1 1977
C      HROMN        I*2  ROMNUMBER
C      HRAMN        I*2  RAM NUMBER
C      HSCL56(2)    I*2  MODE OF DISCOVERY SCALERS 5,6
C      HSCL78(2)    I*2  MODE OF DISCOVERY SCALERS 7,8
C      HPHAWD(2,2)  I*2  PHA WINDOWS L1 AND L2
C      ITPG(2)      I*4  TPG STATUS
C      HCALIB(2)    I*2  CALROD FLAGS

```

```

C      *** ATTITUDE SECTION ***

```

```

C      ZRA          R*4  Z-AXIS RA
C      ZDEC         R*4  ZAXIS DEC
C      YRAS         R*4  Y-AXIS RA (FIRST GOOD READOUT)
C      YDECS        R*4  Y-AXIS DEC (FIRST GOOD READOUT)
C      YRAE         R*4  Y-AXIS RA (LAST GOOD READOUT)
C      YDECE        R*4  Y-AXIS DEC (LAST GOOD READOUT)
C      HATTS        I*2  NUMBER OF FIRST GOOD READOUT
C      HATTE        I*2  NUMBER OF LAST GOOD READOUT

```

```

C      *** EPHEMERIS SECTION ***

```

```

C      PHI          R*4  POSITION OF EARTH IN
C      THETA        R*4  SPACECRAFT POLAR COORDINATES
C      SUNANG       R*4  ANGLE TO SUN
C      SUNHOR       R*4  SUN HORIZON ANGLE
C      EARLON       R*4  POSITION OF SPACECRAFT IN
C      EARLAT       R*4  GEODETIC COORDINATES
C      HSUNAN       I*2  SUN/ANOMALLY FLAG
C      HONUM        I*2  ORBIT NUMBER
C      ALTUDE       R*4  ALTITUDE OF SPACECRAFT
C      UVSUN(3)     R*4  UNIT VECTOR TO SUN
C      VMOON(3)     R*4  VECTOR TO MOON (KILOMETERS)

```

```

C      *** DATA QUALITY SECTION ***

```

```

C      HELCON(2)    I*2  ELECTRON CONTAMINATION FLAG
C      HVSTP(2)     I*2  HIGH VOLTAGE STEP
C      HVFLG(2)     I*2  HIGH VOLTAGE FLAG
C      HMAGFL(2)    I*2  MAGNETIC FIELD FLAG
C      BFIELD(3)    R*4  MAGNETIC FIELD DISRECTION (S/C COORDINATES)
C      BGAUSS       R*4  MAGNETIC FIELD STRENGTH

```

```
C      ANGMAG      R*4  ANGLE TO MAGNETIC FIELD
C      HBREAK(2)    I*2  BREAKDOWN FLAG
C      HOUS(10,2)   I*2  HOUSEKEEPING RATES
C      HNE(2)       I*2  ELECTRON RATE
C      HVSTB(2)     I*2  HIGH VOLTAGE STABILITY
C      HBPTMP(2)    I*2  BACKPLATE TEMP
C      HFPTMP(2)    I*2  FRONT PLATE TEMP
C      HMFERR       I*2  MAJOR FRAME ERROR FLAG
```

```
C
C      COMMON /DATA/
C      DDAY         R*8  TIME (DAY,FRACTION)
C      ZVECTR(3,32) R*4  Z-AXIS READOUTS
C      YVECTR(3,32) R*4  Y-AXIS READOUTS
C      HDATA(40,8,2) I*2  DISCOVERY SCALER READOUTS
```

```
C
C      COMMON /PHATMP/
C      DDDAY        R*8  TIME (DAY,FRACTION)
C      ZVEC(3,32)   R*4  Z-AXIS READOUTS
C      YVEC(3,32)   R*4  Y-AXIS READOUTS
C      HTEM(640,2)  I*2  PHA OR TEMPORAL DATA
```

```
C
C      SUBROUTINE FRNTND
C      IMPLICIT REAL*8(D),INTEGER*2(H),LOGICAL*1(Q)
C      COMMON /MAXREC/ MFDAY,MSEC,HMFORM,HRAM,HERRF,HENGF,HEOCC1,HEOCC2,
C      XHECONF,HMAGF,HVFLAG,HSANPF,HJETPS,HVST,ISPARE(4),IMUSEC(2),
C      XHMFcnt,QCSTAT(6),QDSTAT(64),QASTAT(32),QDFORM(128),
C      XGERR1(128),GERR2(128),ICLOCK(128),SPRA(32),SPDEC(32),YRA(32),
C      XYDEC(32),SPLON(32),SPLAT(32),YLON(32),YLAT(32),GYRO(32,3),
C      XZERR(32),YERR(32),ATT(32),HBUS(4),HEAA2,HA2STB,HT1,HT2,QUAT(24),
C      XB(3),PHIFAR,TMEAR,E1,E2,IITYPE,IONUM,ODATA(25),HCAL(32,6),
C      XIHK(10,6),HDSC(40,8,6),HPHTMP(3840)
C      COMMON/STATUS/ DAY,HRMN,HRAMN,HSCL56(2),HSCL78(2),HRHAWD(2,2),
C      *      ITPG(2),HCALIB(2),ZRA,ZDEC,YRAS,YDECS,YRAE,YDECE,
C      *      HATTS,HATTE,PHI,THETA,SUNANG,SUNHOR,EARLON,EARLAT,
C      *      HSUNAN,MONUM,ALTUDE,UVSUN(3),VMOON(3),HELCON(2),HVSTP(2),
C      *      HVFLG(2),HMAGFL(2),BFIELD(3),BGAUSS,ANGMAG,HBREAK(2),
C      *      HOUS(10,2),HNE(2),HVSTB(2),HBPTMP(2),HFPTMP(2),
C      *      HMFERR,QEXTRA(18)
C      COMMON /DATA/ DDAY,ZVECTR(3,32),YVECTR(3,32),HDATA(40,8,2)
C      COMMON/PHATMP/DDDAY,ZVEC(3,32),YVEC(3,32),HTEM(640,2)
C      DIMENSION HPHA(128,5,2)
C      EQUIVALENCE (HTEM(1,1),HPHA(1,1,1))
C      DIMENSION HTRAM1(512,6),HPRAM1(128,6)
C      EQUIVALENCE (HPHTMP(1),HTRAM1(1,1)),(HPHTMP(3073),HPRAM1(1,1))
C      DIMENSION HPROM1(640,6)
C      EQUIVALENCE (HPHTMP(1),HPROM1(1,1))
C      DIMENSION QTEMP(4)
C      EQUIVALENCE (ITEMP,QTEMP(1))
C      DATA INREC,IREJ/0,0/
C      DATA ITAPE/1/,IN/1/,IOUT/2/
C      DIMENSION HPRE56(2),HPRE78(2),HPREW1(2),HPREW2(2),ITPG(2)
C      DIMENSION IVSAV(2,2)
C      DIMENSION IDISC(320)
C      EQUIVALENCE (IDISC(1),HDSC(1,1,1))
C      DATA RATODE/57.2957795/
C      DIMENSION HPVEPT(2),HPVBPT(2),IPREHV(3)
C      DIMENSION IARRAY(5)
C      DATA MSK010/Z00000010/,MSK008/Z00000008/,MSK020/Z00000020/
```

```
DATA MSK00F/Z0000000F/,MSK0F0/Z000000F0/,MSK030/Z00000030/
DATA MSK1FF/Z000001FF/,MSK004/Z00000004/
DIMENSION IDATA(320)
DATA DHV/'HI VOLT '/,DOCC/'OCCULT '/,DBREAK/'BRKDOWN'/
DATA DENG/'ENG FORM'/,DZAXIS/'BADZAXIS'/,DATT/'ATTITUDE'/
DATA TWOPI/6.2831853/,PIBY2/1.570796327/,PI/3.14159265/
DIMENSION ISTB(2),VOLTS(2)
DATA ISTB/8,16/,VOLTS/.965,1.008/
EQUIVALENCE (IDATA(1,1,1),IDATA(1))

C
C   THESE ERRSET COMMANDS AVOID TERMINATION DUE TO OVERFLOWS
C   AND ARC COS OUT OF RANGE
C   SUCH VALUES ARE PRODUCED BY BAD VALUES OF ASPECT INFORMATION
C   JAN, 1/3/79
C
C   CALL ERRSET(257,100,100)
C   CALL ERRSET(207,100,100)
C
C   READ A CARD WITH OUTPUT TAPE NAMES AND FILES
C
C   READ(5,100) DSTATP,DATATP,DPHATP,IDFILE
100  FORMAT(3A8,I3)
C   PRINT 102,DSTATP,DATATP,DPHATP,IDFILE
102  FORMAT(' DATA TO BE OUTPUT TO TAPES ',3A8,/' STARTING ON FILE',
+      I5)
C
C   MOUNT AND POSITION THE TAPES
C
C
C   SEARCH FOR LAST FILE OF TAPE
C
C   IF(IDFILE .NE. 0) GO TO 110
C   CALL MOUNT(IN,20,DSTATP,1)
C   IDFILE = 1
105  CONTINUE
C   CALL POSN(IN ,20,IDFILE)
C   CALL FREAD(DAY,20,LEN,&120,&9000)
C   IDFILE = IDFILE + 1
C   GO TO 105
110  CONTINUE
C   CALL MOUNT(IOUT,20,DSTATP,IDFILE)
C   GO TO 130
120  CALL POSN(IOUT,20,IDFILE)
130  CALL MOUNT(IOUT,30,DATATP,IDFILE)
C   CALL MOUNT(IOUT,40,DPHATP,IDFILE)
C   WRITE(6,150) DSTATP,DATATP,DPHATP,IDFILE
150  FORMAT(58X,'** FRONTEND **',/,' STATUS TAPE = ',A8,
* ' DATA TAPE = ',A8,' PHA TAPE = ',A8,' OUTPUT FILE NUMBER = ',
* I3)
C
C   MOUNT AND POSITION THE INPUT TAPES
C
C
200  CONTINUE
C   READ(5,250,END=9998) DTAPE,IFILE,ITAPE,IENDFL
250  FORMAT(A8,3I3)
C   IF(IFILE .LT. 1) IFILE = 1
C   IF(IENDFL.LT.1) IENDFL=9999
C   WRITE(6,275) DTAPE,IFILE
```

275 FORMAT(' INPUT TAPE = ',A8,' AT FILE ',I3)
IF (ITAPE.LT.0) PRINT 278

278 FORMAT(' WILL CLOSE OUTPUT FILES WITH EOF AT END OF INPUT TAPE'
+)

CALL MOUNT(IN,10,DTAPE,IFILE)

C

READ THE INPUT TAPE

C

C

300

CONTINUE

CALL FREAD(MEDAY,10,LEN,&8000,&9000)

CALL FREAD(HPMTMP,10,LEN,&8000,&9000)

310

CONTINUE

INREC = INREC + 1

C

C

REJECTION SECTION - TEST FOR DATA QUALITY

C

IF(HMFORM.EQ. 3 .AND. HRAM.EQ. 0) GO TO 390

C

ITEMP = 0

IWHICH = HMFCNT

IWHICH = MOD(IWHICH,2)

C

C

CAL RODS

C

QTEMP(4) = QDSTAT(15)

HICALIB(2) = 0

IF(MOD(ITEMP,2).EQ. 1) HICALIB(2) = 1

HICALIB(1) = 0

IF(MOD(ITEMP,8).GE. 4) HICALIB(1) = 1

C

C

IF THIS IS AN ODD FRAME OR ANY ERROR FLAG IS ON
USE THE PREVIOUS STORED VALUES

C

C

DRESO = DHV

IF(IWHICH.EQ. 1) GO TO 380

C

C

LED1 HIGH VOLTAGE

C

QTEMP(4) = QERR1(49)

IF(ITEMP.NE. 0) GO TO 320

QTEMP(4) = QDSTAT(26)

L1HV = IAND(ITEMP,MSK010)

C

C

LED 2 HIGH VOLTAGE

C

320

CONTINUE

QTEMP(4) = QERR1(77)

IF(ITEMP.NE. 0) GO TO 340

QTEMP(4) = QDSTAT(39)

L2HV = IAND(ITEMP,MSK010)

C

C

LED1 TPG ENABLE

C

340

CONTINUE

QTEMP(4) = QERR1(69)

IF(ITEMP.NE. 0) GO TO 360

QTEMP(4) = QDSTAT(35)

L1TPG = IAND(ITEMP,MSK004)

```

C
C   LED2 TPG ENABLE
C
360  CONTINUE
      QTEMP(4) = QERR1(93)
      IF(ITEMP .NE. 0) GO TO 380
      QTEMP(4) = QDSTAT(48)
      L2TPG = IAND(ITEMP,MSK004)
380  CONTINUE
      IF(HERRF .GE. 4) GO TO 475
      IF((L1TPG .NE. 0) .OR. (L2TPG .NE. 0)
* .OR. (HCALIB(1) .NE. 0 .AND. L1HV .NE. 0)
* .OR. (HCALIB(2) .NE. 0 .AND. L2HV .NE. 0) ) GO TO 475
      IF((L1HV .NE. 0) .OR. (L2HV .NE. 0)) GO TO 400
C
C
C   REJECT THE FRAME
C
390  CONTINUE
      WRITE(6,395) MFDAY,MSEC,DRESO
395  FORMAT(I5,I9,' REJECTED BECAUSE OF ',A8)
      IREJ = IREJ + 1
      GO TO 300
C
C   TEST FOR BREAKDOWN OR OCCULTATION
C
400  CONTINUE
      DRESO = DBREAK
      IF(HERRF .GT. 1) GO TO 420
      CALL BRKDN(1,MFDAY,IARRAY)
      L1BRK = IARRAY(5)
      CALL BRKDN(2,MFDAY,IARRAY)
      L2BRK = IARRAY(5)
      IF((L1BRK .GT. 1 .OR. L1HV .EQ. 0) .AND.
* (L2BRK .GT. 1 .OR. L2HV .EQ. 0)) GO TO 390
420  CONTINUE
      DRESO = DOCC
      ITEMP = HEQCC2
      L1OCC = 0
      IF(MOD(ITEMP,2) .EQ. 1) L1OCC = 1
      L2OCC = 0
      ITEMP = ITEMP/2
      IF(MOD(ITEMP,2) .EQ. 1) L2OCC = 1
      IF((L1OCC .NE. 0 .OR. L1HV .EQ. 0) .AND.
* (L2OCC .NE. 0 .OR. L2HV .EQ. 0)) GO TO 390
C
C   TEST IF ANY MINOR FRAME IS IN ENGINEERING FORMAT
C
      DRESO = DENG
      ITEMP = 0
      DO 450 I = 1,128
      QTEMP(4) = QDFORM(I)
      IF(ITEMP .EQ. 0) GO TO 390
450  CONTINUE
C
C   NOW WE HAVE SOME CLEAN DATA
C
C   COMPUTE THE DAY AND FRACTION

```

```

C
475 CONTINUE
DAY = MFDAY + (MSEC/86405)
IF (IONUM .GT. 2190 .AND. DAY .LT. 36400) DAY = DAY + 3.6502

```

```

C
C ROM AND RAM NUMBERS
C

```

```

HROMN = HMFORM
HRAMN = HRAM

```

```

C
C DISCOVERY SCALER MODES
C

```

```

IF (IWHICH .EQ. 1) GO TO 500
QTEMP(4) = QDSTAT(31)
ITEMP = IAND(ITEMP,MSK0F0)
CALL SHIFTR(ITEMP,4)
HPRE56(1) = ITEMP
QTEMP(4) = QDSTAT(44)
ITEMP = IAND(ITEMP,MSK0F0)
CALL SHIFTR(ITEMP,4)
HPRE56(2) = ITEMP

```

```

C
QTEMP(4) = QDSTAT(31)
HPRE78(1) = IAND(ITEMP,MSK00F)
QTEMP(4) = QDSTAT(44)
HPRE78(2) = IAND(ITEMP,MSK00F)

```

```

500 CONTINUE
HSCL56(1) = HPRE56(1)
HSCL56(2) = HPRE56(2)
HSCL78(1) = HPRE78(1)
HSCL78(2) = HPRE78(2)

```

```

C
C PHA WINDOWS
C

```

```

IF (IWHICH .EQ. 1) GO TO 600
QTEMP(4) = QDSTAT(33)
ITEMP = IAND(ITEMP,MSK0F0)
CALL SHIFTR(ITEMP,4)
HPREW1(1) = ITEMP
QTEMP(4) = QDSTAT(46)
ITEMP = IAND(ITEMP,MSK0F0)
CALL SHIFTR(ITEMP,4)
HPREW1(2) = ITEMP
QTEMP(4) = QDSTAT(29)
ITEMP = IAND(ITEMP,MSK030)
CALL SHIFTR(ITEMP,4)
HPREW2(1) = ITEMP
QTEMP(4) = QDSTAT(42)
ITEMP = IAND(ITEMP,MSK030)
CALL SHIFTR(ITEMP,4)
HPREW2(2) = ITEMP

```

```

600 CONTINUE
HPHAWD(1,1) = HPREW1(1)
HPHAWD(2,1) = HPREW2(1)
HPHAWD(1,2) = HPREW1(2)
HPHAWD(2,2) = HPREW2(2)

```

```

C
C TPG STATUS
C

```

1
2
3
4 C BIT 0 IS THE LSB BIT 31 IS THE MSB

5 C

6 C BIT MEANING

7 C 0 TPG ABORT

8 C 1 LAYER 1 LEFT OUTPUT

9 C 2 LAYER 1 RIGHT OUTPUT

10 C 3 LAYER 2 LEFT OUTPUT

11 C 4 LAYER2 RIGHT OUTPUT

12 C 5 VETO LAYER 1 OUTPUT

13 C 6 VETO LAYER 2 OUTPUT

14 C 7 ALPHA OUTPUT

15 C 8 TPG ENABLE

16 C 9 LAYER 2 RIGHT SELECTED

17 C 10 LAYER 2 LEFT SELECTED

18 C 11 LAYER 1 RIGHT SELECTED

19 C 12 LAYER 1 LEFT SELECTED

20 C 13 TPG MODE

21 C 14 ALPHA SELECTED

22 C 15 VETO LAYER 2 SELECTED

23 C 16 VETO LAYER 1 SELECTED

24 C 17 TPG POWER

25 C

26 IF(IWHICH .EQ. 1) GO TO 750

27 QTEMP(4) = QDSTAT(36)

28 QTEMP(3) = QDSTAT(35)

29 IPTPG(1) = IAND(ITEMP,MSK1FF)

30 QTEMP(4) = QDSTAT(49)

31 QTEMP(3) = QDSTAT(48)

32 IPTPG(2) = IAND(ITEMP,MSK1FF)

33 QTEMP(4) = QDSTAT(34)

34 ITEMP = IAND(ITEMP,MSK0F0)

35 CALL SHIFTL(ITEMP,5)

36 IPTPG(1) = IOR(IPTPG(1),ITEMP)

37 QTEMP(4) = QDSTAT(47)

38 ITEMP = IAND(ITEMP,MSK0F0)

39 CALL SHIFTL(ITEMP,5)

40 IPTPG(2) = IAND(IPTPG(2),ITEMP)

41 QTEMP(4) = QDSTAT(29)

42 ITEMP = IAND(ITEMP,MSK00F)

43 CALL SHIFTL(ITEMP,13)

44 IPTPG(1) = IOR(IPTPG(1),ITEMP)

45 QTEMP(4) = QDSTAT(42)

46 ITEMP = IAND(ITEMP,MSK00F)

47 CALL SHIFTL(ITEMP,13)

48 IPTPG(2) = IOR(IPTPG(2),ITEMP)

49 QTEMP(4) = QDSTAT(26)

50 ITEMP = IAND(ITEMP,MSK020)

51 CALL SHIFTL(ITEMP,12)

52 IPTPG(1) = IOR(IPTPG(1),ITEMP)

53 QTEMP(4) = QDSTAT(39)

54 ITEMP = IAND(ITEMP,MSK020)

55 CALL SHIFTL(ITEMP,12)

56 IPTPG(2) = IOR(IPTPG(2),ITEMP)

750 CONTINUE

57 C

58 C MAJOR FRAME ERROR FLAG

59 C

60 HMFERR = HERRE

61

62

63

64

65

C
C ATTITUDE SECTION
C Z-AXIS
C

DO 800 I=1,32
IF(SPRA(I) .LT. 0. .OR. SPRA(I) .GT. TWOPI .OR.
* SPDEC(I) .LT. -PIBY2 .OR. SPDEC(I) .GT. PIBY2) GO TO 800
ZRA = SPRA(I)
ZDEC = SPDEC(I)
GO TO 850
800 CONTINUE

C
C NO GOOD Z-AXIS READOUT
C

DRESON = DZAXIS
GO TO 390

C
C Y-AXIS
C FIRST READOUT
C
850 CONTINUE

DO 900 I=1,32
IF(YRA(I) .LT. 0. .OR. YRA(I) .GT. TWOPI .OR.
* YDEC(I) .LT. -PIBY2 .OR. YDEC(I) .GT. PIBY2) GO TO 900
HATTS = I
YRAS = YRA(I)
YDECS = YDEC(I)
GO TO 950
900 CONTINUE

C
C BAD ATTITUDE
C

DRESON = DATT
GO TO 390

950 CONTINUE
C
C LAST Y-AXIS READOUT
C

DO 1000 I=1,32
J = 33 - I
IF(HATTS .EQ. J) GO TO 975
IF(YRA(J) .LT. 0. .OR. YRA(J) .GT. TWOPI .OR.
* YDEC(J) .LT. -PIBY2 .OR. YDEC(J) .GT. PIBY2) GO TO 1000
975 CONTINUE

HATTE = J
YRAE = YRA(J)
YDECE = YDEC(J)
GO TO 1050

1000 CONTINUE
1050 CONTINUE

C
C ORBITAL SECTION
C

PHI = PHIEAR
THETA = THEAR
HSUNAN = HSANPF

C
C COMPUTE ANGLE TO SUN AND EARTH HORIZON ANGLE

C

$$A = \text{SQRT}(\text{ODATA}(1)**2 + \text{ODATA}(2)**2 + \text{ODATA}(3)**2)$$

C

C

C

FILL BOTH SUNANG AND SUNFOR WITH ZERO IF BAD SUN ANGLE DATA

SUNANG = 0.

SUNHOR = 0.

IF (ODATA(10)+ODATA(11)+ODATA(12).GT.3.0) GOTO 1200

IF (A.GT.1.E-6) GO TO 1150

GO TO 1200

1150 CALL CVXYZ(YRAS,YDECS,X,Y,Z)

SUNANG = ARCCOS(X*ODATA(10)+Y*ODATA(11)+Z*ODATA(12))

SUNHOR = PI - ARCCOS((ODATA(1)*ODATA(10) + ODATA(2)*ODATA(11) * + ODATA(3)*ODATA(12))/A)

C

1200 EARLON = ODATA(7)

EARLAT = ODATA(8)

HONUM = IONUM

ALTUDE = ODATA(9)

UVSUN(1) = ODATA(10)

UVSUN(2) = ODATA(11)

UVSUN(3) = ODATA(12)

VMOON(1) = ODATA(13)

VMOON(2) = ODATA(14)

VMOON(3) = ODATA(15)

C

C

DATA QUALITY SECTION

C

HIGH VOLTAGE STEP

C

IF (IWHICH .EQ. 1) GO TO 2000

CALL HVSTEP(1,MFDAY,IPREHV)

2000 CONTINUE

HVSTP(1) = IPREHV(1)

HVSTP(2) = IPREHV(2)

C

C

ELECTRON CONTAMINATION

C

CALL ELCONT(1,IPREHV(1),MFDAY,NE,LEVEL)

HELCON(1) = LEVEL

HNE(1) = NE

CALL ELCONT(2,IPREHV(2),MFDAY,NE,LEVEL)

HELCON(2) = LEVEL

HNE(2) = NE

C

C

HIGH VOLTAGE FLAG

C

ITEMP = HVFLAG

HVFLG(1) = 0

IF (MOD(ITEMP,2) .EQ. 1) HVFLG(1) = 1

ITEMP = ITEMR / 2

HVFLG(2) = 0

IF (MOD(ITEMP,2) .EQ. 1) HVFLG(2) = 1

C

C

MAGNETIC FIELD

C

ITEMP = HMAGF

HMAGFL(1) = 0

IF (MOD(ITEMP,2) .EQ. 1) HMAGFL(1) = 1

```

1  HMAGFL(2) = 0
2  ITEMP = ITEMP/2
3  IF(MOD(ITEMP,2) .EQ. 1) HMAGFL(2) = 1
4  BFIELD(1) = B(1)
5  BFIELD(2) = B(2)
6  BFIELD(3) = B(3)
7  BGAUSS = ODATA(17)
8  CALL CVXYZ(YRAS,YDECS,X,Y,Z)
9  ANGMAG = ARCOS(B(1)*X+B(2)*Y+B(3)*Z)

```

C
C
C

BREAKDOWN FLAG

```

15 CALL BRKDOWN(1,MFDAY,IARRAY)
16 HBREAK(1) = IARRAY(5)
17 CALL BRKDOWN(2,MFDAY,IARRAY)
18 HBREAK(2) = IARRAY(5)

```

C
C
C

HOUSEKEEPING RATES

```

22 DO 2050 I=1,2
23 DO 2040 J=1,10
24 HOUS(J,I) = IMK(J,I)

```

```

25 2040 CONTINUE
26 2050 CONTINUE

```

C
C
C

HIGH VOLTAGE STABILITY

```

31 DO 2300 I=1,2
32 ITEMP = 0
33 QTEMP(4) = QASTAT(ISTB(I))
34 HVSTB(I) = 0
35 IF((IABS(IVSAV(1,I)-IVSAV(2,I))*VOLTS(I)) .GT. 2.0) GO TO 2100
36 IF((IABS(IVSAV(1,I)-ITEMP)*VOLTS(I)) .GT. 2.0) GO TO 2100

```

```

37 IF((IABS(IVSAV(2,I)-ITEMP)*VOLTS(I)) .LE. 2.0) GO TO 2200
38 2100 CONTINUE

```

```

39 HVSTB(I) = 1

```

```

40 2200 CONTINUE

```

```

41 IVSAV(1,I) = IVSAV(2,I)
42 IVSAV(2,I) = ITEMP

```

```

43 2300 CONTINUE

```

C
C
C

FRONT AND BACK BODY TEMPERATURES

```

47 ITEMP = HMFcnt
48 IF(MOD(ITEMP,8) .NE. 3) GO TO 2400
49 ITEMP = 0
50 QTEMP(4) = QASTAT(2)
51 HPVFT(1) = 2.702*ITEMP - 1028.
52 QTEMP(4) = QASTAT(6)
53 HPVFT(2) = 2.192*ITEMP - 957.
54 QTEMP(4) = QASTAT(1)
55 HPVBT(1) = -54.9*ITEMP + 9600.
56 QTEMP(4) = QASTAT(5)
57 HPVBT(2) = -58.43*ITEMP + 9600.

```

```

58 2400 CONTINUE

```

```

59 HBPTMP(1) = HPVBT(1)
60 HBPTMP(2) = HPVBT(2)

```

HFPTMP(1) = HRVFPT(1)
HFPTMP(2) = HRVFPT(2)

C
C
C
NOW FILL IN THE DATA COMMON BLOCK

DDAY = DAY
DDDAY = DAY

C
C
C
ATTITUDE VECTORS

DO 2500 I=1,32
IF (SPRA(I) .LT. 0. .OR. SPRA(I) .GT. TWOPI .OR.
* SPDEC(I) .LT. -PIBY2 .OR. SPDEC(I) .GT. PIBY2) GO TO 2425
CALL CVXYZ(SPRA(I),SPDEC(I),ZVECTR(1,I),ZVECTR(2,I),ZVECTR(3,I))
GO TO 2450

2425 CONTINUE
ZVECTR(1,I) = -9999.
ZVECTR(2,I) = -9999.
ZVECTR(3,I) = -9999.

2450 CONTINUE
IF (YRA(I) .LT. 0. .OR. YRA(I) .GT. TWOPI .OR.
* YDEC(I) .LT. -PIBY2 .OR. YDEC(I) .GT. PIBY2) GO TO 2475
CALL CVXYZ(YRA(I),YDEC(I),YVECTR(1,I),YVECTR(2,I),YVECTR(3,I))
GO TO 2490

2475 CONTINUE
YVECTR(1,I) = -9999.
YVECTR(2,I) = -9999.
YVECTR(3,I) = -9999.

2490 CONTINUE
ZVEC(1,I) = ZVECTR(1,I)
ZVEC(2,I) = ZVECTR(2,I)
ZVEC(3,I) = ZVECTR(3,I)
YVEC(1,I) = YVECTR(1,I)
YVEC(2,I) = YVECTR(2,I)
YVEC(3,I) = YVECTR(3,I)

2500 CONTINUE

C
C
C
MOVE THE DATA

DO 2600 I=1,320
IDATA(I) = IDISC(I)

2600 CONTINUE

C
C
C
FILL UP THE PHA/TEMPORAL RECORD

IF (HMFORM .EQ. 3 .AND. HRAM .NE. 10) GO TO 2775

C
C
C
ROM OR RAM 10

DO 2750 IDET = 1,2
DO 2700 I=1,640
HTEM(I,IDET) = HPROM1(I,IDET)

2700 CONTINUE

2750 CONTINUE
GO TO 3000

C
2775 CONTINUE

C

```

C      RAM OTHER THAN RAM 10
C
DO 2900 IDET = 1,2
DO 2800 I=1,512
HTEM(I,IDET) = HTRAM1(I,IDET)
2800  CONTINUE
DO 2850 I=1,128
HPHA(I,5,IDET) = HPRAM1(I,IDET)
2850  CONTINUE
2900  CONTINUE
3000  CONTINUE
C
C      WRITE THE STATUS AND DATA RECORDS
C
CALL FWRITE(DAY,20,240)
CALL FWRITE(DDAY,30,2056)
CALL FWRITE(DDDAY,40,3336)
C
GO TO 300
8000  CONTINUE
C
C      END OF FILE ON INPUT TAPE
C
WRITE(6,8100) IFILE,DTAPE,INREC,IREJ
8100  FORMAT(' FOR FILE ',I3,' OF TAPE ',A8,' THERE WERE ',I5,
* ' FRAMES READ AND ',I5,' FRAMES REJECTED')
INREC = 0
IREJ = 0
IFILE = IFILE + 1
IF (IFILE.GT.IENDFL) GOTO 8500
CALL POSN(IN,10,IFILE)
CALL FREAD(MFDAY,10,LEN,&8500,&9000)
CALL FREAD(HPWTMP,10,LEN,&8500,&9000)
GO TO 310
8500  CONTINUE
IF (ITAPE.GE. 0) GO TO 200
ITAPE = 1
IDFILE = IDFILE + 1
CALL POSN(IOUT,20,IDFILE)
CALL POSN(IOUT,30,IDFILE)
CALL POSN(IOUT,40,IDFILE)
PRINT 8505,IDFILE
8505  FORMAT (' EOF WRITTEN, STARTING FILE',I5,' ON OUTPUT TAPE')
GO TO 200
C
C      ERROR ON INPUT TAPE
C
9000  CONTINUE
WRITE(6,9100) DTAPE,IFILE,MSEC
9100  FORMAT(' ERROR ON INPUT TAPE ',A8,' AT FILE ',I4,
* ' LAST TIME = ',I8)
GO TO 200
9998  CONTINUE
WRITE(6,9999)
9999  FORMAT(' END OF RUN')
STOP
END
//LKED,SYSMOD DD UNIT=SYSDA,DISP=OLD,VOL=SER=CITSL2,

```

DIRECTORY MEMBER STATUS

202 # 1754

XXX780	229.121755733796	237.078185065444	1	10140
XXX780	237.088140625000	238.081799907407	2	1347
XXX780	238.085118425926	239.082570289352	3	1313
XXX780	239.083992511574	240.071488831019	4	1265
XXX780	239.083992511574	241.081266631944	5	732
XXX780	241.732170347222	242.040318495370	6	452
XXX780	242.584555543982	242.582185173611	7	1134
XXX780	243.083755555556	244.069829641204	8	674
XXX780	244.090214826389	245.082451886574	9	608
XXX780	245.083400034722	246.082748194445	10	315
XXX780	246.083696342593	246.573888946759	11	161
XXX780	247.343785254630	248.081918611111	12	811
XXX780	248.083340833333	249.081740844907	13	350
XXX780	249.083637141204	250.082985312500	14	625
XXX780	257.182244687500	257.453415065444	15	294
XXX780	258.273089155093	258.355578043981	16	73
XXX780	259.188052129630	259.388111400463	17	145
XXX780	260.093059560185	260.679015127315	18	251
XXX780	261.114215127315	261.526185505259	19	240
XXX780	262.085592928241	263.082096643519	20	162
XXX780	263.085415162037	263.343785532407	21	141
XXX780	264.084289259259	265.080318900463	22	228
XXX780	265.086481863426	266.008555949074	23	119
XXX780	266.111904097222	267.076170787037	24	297
XXX780	267.088970787037	268.077415243056	25	171
XXX780	268.114393020833	269.078659710648	26	120
XXX780	269.053356006544	270.080378240741	27	305
XXX780	270.090807870370	271.029474560185	28	303
XXX780	271.231904189815	272.075756053241	29	164
XXX780	272.083341238426	273.068941261574	30	306
XXX780	273.106393113426	274.062126456333	31	306
XXX780	274.087252384259	275.073800543982	32	350
XXX780	275.108882025463	276.064615381944	33	317
XXX780	276.087845011574	277.081978356481	34	361
XXX780	277.640437627315	278.053830231482	35	255
XXX780	278.101237638889	279.077356168982	36	441
XXX780	279.584141365741	280.040200625000	37	427
XXX780	280.562156192130	280.967489537037	38	273
XXX780	281.590896956019	281.883400659722	39	300
XXX780	282.501593263889	282.995578460648	40	345
XXX780	283.533652534722	284.034748842593	41	251
XXX780	284.503608113426	284.926956261574	42	327
XXX780	285.456022535815	286.866867407407	43	525
XXX780	287.117178518519	288.081445208333	44	329
XXX780	288.391489652778	288.827163738426	45	262
XXX780	289.360971157407	289.808971157407	46	262
XXX780	290.326185983796	290.820171180556	47	272
XXX780	291.122156365741	292.077889722222	48	365
XXX780	292.343371111111	292.749652552553	49	225
XXX780	293.101889733796	294.080378645833	50	321
XXX780	294.285178703704	296.082393449074	51	773
XXX780	296.226986087963	296.766956465507	52	346
XXX780	297.095015740741	297.677178703704	53	328
XXX780	298.234215740741	299.545504629630	54	510
XXX780	300.176971319444	301.550363888889	55	451
XXX780	302.119726875000	304.080971377315	56	764
XXX780	304.126956550926	304.925771111111	57	438
XXX780	305.099282534722	306.082512175526	58	473
XXX780	306.083534358148	307.062423298611	59	507
XXX780	307.112201076385	308.082630729167	60	445

STA 501

STATS

XXX780	308.084527025463	309.062541851852	61	432
XXX780	309.112319625630	310.030601122685	62	438
XXX780	310.085119641204	311.074512256944	63	577
XXX780	311.124290034722	312.045415983796	64	512
XXX780	312.096141909722	313.082216006944	65	576
XXX780	313.124882685185	314.053119745270	66	518
XXX780	314.095786412037	315.082334583333	67	460
XXX780	315.084230879630	316.027638298611	68	438
XXX780	316.102067928241	317.082453136574	69	542
XXX780	317.083875358796	317.245534618056	70	181
XXX780	319.344734652778	320.074808738426	71	687
XXX780	320.249267997685	321.082690231482	72	760
XXX780	321.796171724537	323.079016192130	73	372
XXX780	324.264675370370	325.965179074074	74	399
XXX780	326.206482777778	326.936082407407	75	361
XXX780	327.173594016204	327.970512222222	76	367
XXX780	328.212764421296	284.034748842593	77	368
XXX780	329.179875497685	329.847845370370	78	313
XXX780	330.150779247685	331.920497037037	79	607
XXX780	332.162275543982	333.991253148148	80	682
XXX780	334.169031145833	334.962630555556	81	308
XXX780	335.202986747685	336.020764537037	82	318
XXX780	336.172468252315	336.989771967593	83	306
XXX780	337.207846041667	337.941712719907	84	298
XXX780	338.180646053241	338.978038657407	85	280
XXX780	339.212179409722	340.012468310185	86	327
XXX780	340.248557199074	340.994749803241	87	308
XXX780	341.218986840278	342.019697962963	88	364
XXX780	342.194157233796	343.055075763889	89	203
XXX780	343.160320208333	344.023609108796	90	249
XXX780	344.083816516204	344.940942453704	91	141
XXX780	345.231075798611	346.033209143519	92	148
XXX780	346.206720254630	346.875164710648	93	150
XXX780	347.188053599537	347.446898055556	94	156
XXX780	348.193090659722	350.082749942130	95	344
XXX780	350.086542534722	351.077357361111	96	303
XXX780	351.120498113426	351.330512528241	97	160
XXX780	352.084290717593	353.082690729167	98	338
XXX780	353.131994398148	355.082335185185	99	368
XXX780	355.086601851852	355.984971851852	100	180
XXX780	356.100172222222	357.082453750000	101	331
XXX780	357.083875972222	359.080201898148	102	438
XXX780	359.086364861111	361.040498263889	103	407
XXX780	361.096438981482	362.078246388889	104	135
XXX780	362.766127777778	364.082631631944	105	392
XXX780	367.353257152778	368.055834942130	106	209
XXX780	368.525168287037	368.949938657407	107	233
XXX780	369.493701631944	369.902353483796	108	241
XXX780	370.268812754630	370.940101655093	109	325
XXX780	371.307983136574	371.998235000000	110	265
XXX780	372.604101678241	372.967242418982	111	97
XXX780	373.222723912037	374.072783182870	112	110
XXX780	374.408427627315	374.835094305556	113	126
XXX780	375.473198020833	376.078116550926	114	179
XXX780	376.481553587963	376.908694340278	115	183
XXX780	377.163746192130	377.798057314815	116	237
XXX780	379.299924004630	380.710768472222	117	555
XXX780	381.262590706019	382.523627777778	118	636
XXX780	383.194442604167	383.879005578704	119	322
XXX780	384.248309259259	384.849908518519	120	324
XXX780	385.218264814815	385.562916666667	121	176
XXX780	386.187746307870	386.582175925926	122	196
XXX780	387.158175983796	387.891567962963	123	329

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XXX780	388.133820439815	388.989049629630	124	295
XXX780	389.095716736111	390.082264884259	125	316
XXX780	390.084161180556	391.382650185185	126	351
XXX780	392.133109375000	392.345968703704	127	155
XXX780	393.104013078704	395.067153865741	128	346
XXX780	395.110294606481	397.074383541667	129	314
XXX780	397.115627997685	398.067568750000	130	131
XXX780	398.220220613426	399.079242847222	131	320
XXX780	399.121909513889	400.047776192130	132	214
XXX780	400.094709525463	401.082679907407	133	270
XXX780	401.084576203704	402.054531782407	134	229
XXX780	402.107628078704	402.925879942130	135	103
XXX780	403.317465127315	404.057968842593	136	118
XXX780	404.099687361111	405.082442928241	137	354
XXX780	405.083865150463	405.967539247685	138	210
XXX780	406.350591095537	407.029465185185	139	394
XXX780	407.084457777778	408.067687418581	140	323
XXX780	408.372517060185	409.037642986111	141	334
XXX780	411.590057847222	412.935006006544	142	488
XXX780	413.643746759259	414.935124560185	143	242
XXX780	415.679420740741	416.811983333333	144	341
XXX780	417.424961666667	418.733406111111	145	312
XXX780	419.620872777778	419.827568703704	146	202
XXX780	420.400724629630	420.951598518519	147	165
XXX780	421.361672777778	422.740280185185	148	504
XXX780	423.300161724537	423.919776539352	149	175
XXX780	424.270591365741	425.015835821759	150	183
XXX780	425.305021006944	426.054058055556	151	173
XXX780	426.274976574074	426.891272881544	152	167
XXX780	427.249672893519	427.790117337563	153	75
XXX780	428.213939571759	428.825495138889	154	258
XXX780	429.108043287037	429.905702557870	155	326
XXX780	430.153376631944	431.082561828704	156	446
XXX780	431.083509976852	431.841554432870	157	199
XXX780	432.157761851852	433.029584085648	158	212
XXX780	433.123924826389	433.535895196759	159	219
XXX780	434.090087800926	435.082324849537	160	286
XXX780	435.127361886574	436.051332280093	161	236
XXX780	436.103480428241	436.882858217593	162	176
XXX780	437.797821192130	439.082087870370	163	99
XXX780	439.083510092593	440.065317511574	164	164
XXX780	440.086176782407	441.058502719907	165	227
XXX780	441.104013831019	442.082502731481	166	246
XXX780	442.115687916667	443.082799039352	167	183
XXX780	443.083747175926	444.964398518518	168	439
XXX780	446.106443530093	447.032310208333	169	167
XXX780	447.401613888889	448.001791701389	170	311
XXX780	448.367776851852	449.078888009259	171	295
XXX780	449.203095370370	449.995272592593	172	144
XXX780	450.370265740741	453.039302893519	173	1043
XXX780	453.347451041667	454.006414016204	174	657
XXX780	454.306976979167	455.942532557870	175	1852
XXX780	456.088073298611	456.844695532407	176	322
XXX780	457.211154803241	458.036043703704	177	423
XXX780	458.246532592593	458.912132604167	178	335
XXX780	459.206532604167	459.880191875000	179	467
XXX780	460.172695578704	461.006591886574	180	414
XXX780	461.143599293982	461.968962268519	181	545
XXX780	462.105021539352	462.914265995370	182	494
XXX780	463.280251180556	464.016014155093	183	377
XXX780	464.313732673611	464.913910462563	184	323
XXX780	465.279895659722	466.017554918581	185	405
XXX780	466.247954930556	466.954325312500	186	750

XXX780	467.084695682870	467.915747546256	187	692
XXX780	468.223895694444	468.934058668981	188	1462
XXX780	469.208547557870	469.955480902778	189	1564
XXX780	470.168547581019	471.890858715278	190	2886
XXX780	472.400962418982	472.925288356482	191	1093
XXX780	473.086473541667	473.891925405093	192	659
XXX780	474.083451296296	474.917820925926	193	903
XXX780	475.152962465278	475.892043946759	194	480
XXX780	476.121021712963	476.917465925926	195	748
XXX780	477.089080972222	478.077999502315	196	461
XXX780	478.121614305556	479.044636585648	197	388
XXX780	479.087777326389	480.076695844907	198	289
XXX780	480.087125474537	481.078414363426	199	461
XXX780	481.114918055556	482.081555150463	200	537
XXX780	482.083451446759	483.075688483756	201	425
XXX780	483.111718113426	484.010562581018	202	453
XXX780	484.121021805556	485.042147789352	203	421
XXX780	485.096192187500	486.074207048611	204	358
XXX780	486.127303356481	487.065021886574	205	366
XXX780	487.096784849537	488.082384861111	206	458
XXX780	488.083807083333	488.590592280093	207	268
XXX780	489.052636736111	490.071599710648	208	316
XXX780	490.097673784722	491.056725648148	209	591
XXX780	491.091333055556	491.181407125630	210	75
XXX780	492.112014548611	493.043096041667	211	341
XXX780	493.091451608796	494.008310879630	212	492
XXX780	494.169496064815	495.029466446759	213	214
XXX780	495.090622002315	496.002266458333	214	520
XXX780	496.370622025463	497.080310914352	215	426
XXX780	497.131510914352	498.018029456019	216	474
XXX780	498.369318344907	498.999836875000	217	276
XXX780	499.333585023148	499.945140590278	218	477
XXX780	500.240014664352	500.863422083333	219	497
XXX780	501.201910972222	501.930562835648	220	619
XXX780	502.299392476852	502.942711006544	221	540
XXX780	503.265555451389	504.078118425926	222	271
XXX780	505.253348148148	505.800902962963	223	159
XXX780	512.109407418981	517.028874166667	224	12
XXX780	734.088897326389	734.804275127315	225	614
XXX780	735.110526990741	735.568482557870	226	7
XXX780	445.529969444444	410.936786770833	227	433

ST 4501

DIRECTORY MEMBER DATA

XX1126	229.122273807870	237.078185065444	1	10139
XX1126	237.088614699074	238.081799907407	2	1346
XX1126	238.085592500000	239.082570289352	3	1312
XX1126	239.085681400463	240.071488831019	4	1264
XX1126	239.083992511574	241.081266631544	5	732
XX1126	241.732644421296	242.040318495370	6	451
XX1126	242.585029618056	242.582185173611	7	1133
XX1126	243.084229629630	244.069829641204	8	673
XX1126	244.090688900463	245.082451886574	9	607
XX1126	245.083400034722	246.082748194445	10	314
XX1126	246.083696342593	246.573888946759	11	160
XX1126	247.353740810185	248.081918611111	12	810
XX1126	248.083340833333	249.081740844507	13	349
XX1126	249.085059363426	250.082985312500	14	624
XX1127	257.182718761574	257.453415065444	1	293
XX1127	258.273563229167	258.355578043981	2	72
XX1127	259.185474351852	259.388111400463	3	144
XX1127	260.099222523148	260.679015127315	4	250
XX1127	261.130333645833	261.526185509259	5	235
XX1127	262.087015150463	263.082096643519	6	161
XX1127	263.085889236111	263.343785532407	7	140
XX1127	264.084763333333	265.080318900463	8	227
XX1127	265.091696678241	266.006555949074	9	118
XX1127	266.112378171296	267.076170787037	10	296
XX1127	267.089444861111	268.077415243056	11	170
XX1127	268.114867094907	269.078659710648	12	119
XX1127	269.093830081019	270.080378240741	13	304
XX1127	270.091281944444	271.029474560185	14	302
XX1127	271.232378263889	272.075756053241	15	163
XX1127	272.083815312500	273.068941261574	16	305
XX1127	273.112556076389	274.062126458333	17	305
XX1127	274.087726458333	275.073800543982	18	349
XX1127	275.129741296296	276.064615381944	19	316
XX1127	276.088319085648	277.081978356481	20	360
XX1127	277.640911701389	278.053830231482	21	254
XX1127	278.105978379630	279.077356168982	22	440
XX1127	279.584615439815	280.040200625000	23	436
XX1127	280.562630266204	280.967489537037	24	272
XX1127	281.591371030093	281.883400659722	25	299
XX1127	282.502067337963	282.995578460648	26	344
XX1127	283.534126606796	284.034748842593	27	250
XX1127	284.504082187500	284.926956261574	28	336
XX1127	285.464082199074	286.866867407407	29	524
XX1127	287.135934074074	288.081445208333	30	328
XX1127	288.414245208333	288.827163738426	31	261
XX1127	289.369978564815	289.808971157407	32	261
XX1127	290.326660057870	290.820171180556	33	271
XX1127	291.125000810185	292.077889722222	34	364
XX1127	292.343845185185	292.749652592593	35	224
XX1127	293.121800844907	294.080378645833	36	320
XX1127	294.285652777778	296.082393449074	37	772
XX1127	296.227460162037	296.766956469507	38	345
XX1127	297.095489814815	297.677178703704	39	327
XX1127	298.234689814815	299.545504629630	40	509
XX1127	300.177445393515	301.550363888889	41	450
XX1127	302.120200949074	304.080971377315	42	763
XX1127	304.127430625000	304.925771111111	43	437
XX1127	305.104497349537	306.082512175926	44	472
XX1127	306.084408472222	307.062423298611	45	506
XX1127	307.112675150463	308.082630729167	46	448

DATA 501

DATA 502

DATS03

XX1127	308.085001099537	309.062541851852	47	431
XX1127	309.112793703704	310.030601122685	48	437
XX1127	310.085593715278	311.074512256544	49	576
XX1127	311.124764108796	312.045415983796	50	511
XX1127	312.096615983796	313.082216006544	51	575
XX1127	313.125356759259	314.053119745370	52	517
XX1127	314.096260486111	315.082334583333	53	459
XX1127	315.084704953704	316.027638258611	54	437
XX1127	316.102542002315	317.082453136574	55	542
XX1127	317.084349432870	317.245534618056	56	180
XX1128	319.344734652778	320.074808738426	1	687
XX1128	320.249267997685	321.082690231482	2	760
XX1128	321.796171724537	323.079016192130	3	372
XX1128	324.264675370370	325.965179074074	4	359
XX1128	326.206482777778	326.936082407407	5	361
XX1128	327.173594016204	327.970512222222	6	367
XX1128	328.212764421296	284.034748842593	7	368
XX1128	329.179875497685	329.847845370370	8	313
XX1128	330.150779247685	331.920497037037	9	607
XX1128	332.162275543982	333.991253148148	10	682
XX1128	334.165031145833	334.962630555556	11	308
XX1128	335.202986747685	336.020764537037	12	318
XX1128	336.172468252315	336.989771967593	13	306
XX1128	337.207846041667	337.941712719507	14	298
XX1128	338.180646053241	338.978038657407	15	280
XX1128	339.213179409722	340.012468310185	16	327
XX1128	340.248557199074	340.994749803241	17	308
XX1128	341.218986840278	342.019697962563	18	364
XX1128	342.194157233796	343.055075763889	19	203
XX1128	343.160320208333	344.023609108796	20	245
XX1128	344.083816516204	344.940942453704	21	141
XX1128	345.231075798611	346.033209143519	22	148
XX1128	346.206720254630	346.875164710648	23	150
XX1128	347.188053599537	347.446898055556	24	156
XX1128	348.193090659722	350.082749542130	25	344
XX1128	350.086542534722	351.077357361111	26	303
XX1128	351.120498113426	351.330512928241	27	160
XX1128	352.084290717593	353.082690729167	28	338
XX1128	353.131994398148	355.082335185185	29	368
XX1128	355.086601851852	355.984971851852	30	180
XX1128	356.100172222222	357.082453750000	31	331
XX1128	357.083875972222	359.080201898148	32	438
XX1128	359.086364861111	361.040498263889	33	407
XX1128	361.096438981482	362.078246388889	34	135
XX1128	362.766127777778	364.082631631944	35	392
XX1128	367.353257152778	368.055834942130	36	209
XX1128	368.525168287037	368.949938657407	37	233
XX1128	369.453701631944	369.902353483796	38	241
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XX1128	371.307983136574	371.998235000000	40	265
XX1128	372.604101678241	372.967242418982	41	97
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XX1128	375.473198020833	376.078116550926	44	175
XX1128	376.481553587963	376.908694340278	45	182
XX1128	377.163746192130	377.798057314815	46	237
XX1128	379.299924004630	380.710768472222	47	555
XX1128	381.262590706019	382.523627777778	48	636
XX1128	383.194442604167	383.879005578704	49	323
XX1128	384.248309259259	384.849908518519	50	324
XX1128	385.218264814815	385.562916666667	51	176
XX1128	386.187746307870	386.582175925926	52	196
XX1128	387.158175983796	387.891567962963	53	329

XX1128	388.133820439815	388.989049629630	54	295
XX1128	389.095716736111	390.082264884259	55	316
XX1128	390.084161180556	391.382650185185	56	351
XX1128	392.133109375000	392.345968703704	57	155
XX1128	393.104013078704	395.067153865741	58	346
XX1128	395.110294606481	397.074383541667	59	314
XX1128	397.115627997685	398.067568750000	60	131
XX1128	398.220220613426	399.079242847222	61	320
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XX1128	400.094709525463	401.082679907407	63	270
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XX1129	402.107628078704	402.925879942130	2	103
XX1129	403.317465127315	404.057968842593	3	118
XX1129	404.095687361111	405.082442928241	4	394
XX1129	405.083865150463	405.967539247685	5	210
XX1129	406.350591099537	407.029465185185	6	394
XX1129	407.084457777778	408.067687418581	7	323
XX1129	408.372517060185	409.037642986111	8	334
XX1129	411.590057847222	412.935006006944	9	488
XX1129	413.643746759259	414.935124560185	10	342
XX1129	415.679420740741	416.811983333333	11	341
XX1129	417.424961666667	418.733406111111	12	312
XX1129	419.620872777778	419.827568703704	13	202
XX1129	420.400724629630	420.951598518519	14	165
XX1129	421.361672777778	422.740280185185	15	504
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XX1129	424.270591365741	425.015835821759	17	182
XX1129	425.305021006944	426.054058055556	18	173
XX1129	426.274976574074	426.891272881944	19	167
XX1129	427.249672893519	427.790117337963	20	79
XX1129	428.213939571759	428.825495138889	21	258
XX1129	429.108043287037	429.909702557870	22	326
XX1129	430.153376631944	431.082561828704	23	446
XX1129	431.083509976852	431.841554432870	24	159
XX1129	432.157761851852	433.029584085648	25	212
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XX1129	434.090087800926	435.082324849537	27	286
XX1129	435.127361886574	436.051332280093	28	236
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XX1129	439.083510092593	440.065317511574	31	164
XX1129	440.086176782407	441.058502719907	32	227
XX1129	441.104013831019	442.082502731481	33	246
XX1129	442.115687916667	443.082799035352	34	183
XX1129	443.083747175926	444.964398518518	35	439
XX1129	446.106443530093	447.032310208333	36	167
XX1129	447.401613888889	448.001791701289	37	311
XX1129	448.367776851852	449.078888009259	38	295
XX1129	449.203095370370	449.995272592593	39	144
XX1129	450.370265740741	453.039302893519	40	1043
XX1129	453.347451041667	454.006414016204	41	657
XX1129	454.306976979167	455.942532557870	42	1892
XX1129	456.088073298611	456.844695532407	43	322
XX1129	457.211154803241	458.036043703704	44	423
XX1129	458.246532592593	458.912132604167	45	335
XX1129	459.206532604167	459.880191875000	46	467
XX1129	460.172695578704	461.006591886574	47	414
XX1129	461.143599293982	461.968962268519	48	545
XX1129	462.105021539352	462.914265995370	49	494
XX1129	463.280251180556	464.016014155093	50	377
XX1129	464.313732673611	464.913910462963	51	323
XX1129	465.275895659722	466.017554918581	52	409
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DATA 505
DATA 506

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XX1130	469.208547557870	469.959480902778	3	1564
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XX1130	473.086473541667	473.891925405093	6	659
XX1130	474.083451296296	474.917820925926	7	903
XX1130	475.152962465278	475.892043946759	8	480
XX1130	476.121021712963	476.917465925926	9	748
XX1130	477.089080972222	478.077999502315	10	481
XX1130	478.121614305556	479.044636585648	11	386
XX1130	479.087777326389	480.076695844907	12	289
XX1130	480.087125474537	481.078414363426	13	461
XX1130	481.114918055556	482.081555150463	14	537
XX1130	482.083451446755	483.075688483796	15	425
XX1130	483.111718113426	484.010562581018	16	453
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XX1130	489.092636736111	490.071599710648	22	316
XX1130	490.097673784722	491.056725648148	23	591
XX1130	491.091333055556	491.181407129630	24	75
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XX1130	493.091451608796	494.008310879630	26	492
XX1130	494.169496064815	495.029466446759	27	214
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XX1130	497.131510914352	498.018029456019	30	474
XX1130	498.369318344907	498.999836875000	31	276
XX1130	499.333585023148	499.945140590278	32	477
XX1130	500.240014664352	500.863422083333	33	497
XX1131	501.201910972222	501.930562835648	1	619
XX1131	502.299392476852	502.942711006944	2	540
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XX1131	505.253348148148	505.800902962963	4	159
XX1131	512.109407418981	517.028874166667	5	12
XX1131	734.088897326389	734.804275127315	6	614
XX1131	735.110526990741	735.568482557870	7	7
XX1131	445.529969444444	410.936786770833	8	433

DIRECTORY MEMBER PHA

PHAS01

← PHAS02

PHAS03

← PHAS04

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XX1122	263.085415162037
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XX1122	266.111904097222
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31	262
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PHA 504
PHA 505
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XX1121	311.124290034722	312.045415983796	14	512
XX1121	312.096141909722	313.082216006544	15	576
XX1121	313.124882685185	314.053119745370	16	518
XX1121	314.095786412037	315.082334583333	17	460
XX1121	315.084230879630	316.027638298611	18	438
XX1121	316.102067928241	317.082453136574	19	542
XX1121	317.083875358796	317.245534618056	20	181
XX1120	319.344734652778	320.074808738426	1	687
XX1120	320.249267997685	321.082690231482	2	760
XX1120	321.756171724537	323.079016192130	3	372
XX1120	324.264675370370	325.965179074074	4	399
XX1120	326.206482777778	326.936082407407	5	361
XX1120	327.173594016204	327.970512222222	6	367
XX1120	328.212764421296	284.034748842593	7	368
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XX1120	330.150779247685	331.920497037037	9	607
XX1120	332.162275543982	333.991253148148	10	682
XX1120	334.169031145833	334.962630555556	11	308
XX1120	335.202986747685	336.020764537037	12	318
XX1120	336.172468252315	336.989771567593	13	306
XX1120	337.207846041667	337.941712719507	14	298
XX1120	338.180646053241	338.978038657407	15	280
XX1120	339.213179409722	340.012468310185	16	327
XX1120	340.248557199074	340.994749803241	17	308
XX1120	341.218986840278	342.019697962963	18	364
XX1120	342.154157233796	343.055075763889	19	203
XX1120	343.160320208333	344.023609108796	20	249
XX1120	344.083816516204	344.940942453704	21	141
XX1120	345.231075798611	346.033209143519	22	148
XX1120	346.206720254630	346.875164710648	23	150
XX1120	347.188053599537	347.446898055556	24	156
XX1120	348.193090659722	350.082749942130	25	344
XX1120	350.086542534722	351.077357361111	26	303
XX1120	351.120498113426	351.330512928241	27	160
XX1120	352.084290717593	353.082690729167	28	338
XX1120	353.131994398148	355.082335185185	29	368
XX1119	355.086601851852	355.984971851852	1	180
XX1119	356.100172222222	357.082453750000	2	331
XX1119	357.083875972222	359.080201898148	3	438
XX1119	359.086364861111	361.040498263889	4	407
XX1119	361.096438981482	362.078246388889	5	135
XX1119	362.766127777778	364.082631631544	6	392
XX1119	367.353257152778	368.055834942130	7	209
XX1119	368.525168287037	368.949938657407	8	233
XX1119	369.493701631944	369.902353483756	9	241
XX1119	370.268812754630	370.940101655093	10	325
XX1119	371.307983136574	371.998235000000	11	265
XX1119	372.604101678241	372.967242418582	12	97
XX1119	373.232723912037	374.072783182870	13	110
XX1119	374.408427627315	374.835094305556	14	126
XX1119	375.473198020833	376.078116550526	15	175
XX1119	376.481553587963	376.908694340278	16	183
XX1119	377.163746192130	377.798057314815	17	237
XX1119	379.299924004630	380.710768472222	18	555
XX1119	381.262590706019	382.523627777778	19	636
XX1119	383.194442604167	383.879005578704	20	323
XX1119	384.248309259259	384.849908518519	21	324
XX1119	385.218264814815	385.562916666667	22	176
XX1119	386.187746307870	386.582175925926	23	196
XX1119	387.158175983796	387.891567962963	24	329
XX1119	388.133820439815	388.989049629630	25	295

PHASE 507 7230

PHASE 506 →
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XX11119	389.095716736111	390.082264884259	26	316
XX11119	390.084161180556	391.382650185185	27	351
XX11119	392.133109375000	392.345968703704	28	155
XX11119	393.104013078704	395.067153865741	29	346
XX11119	395.110294606481	397.074383541667	30	314
XX11119	397.115627997685	398.067568750000	31	131
XX11119	398.220220613426	399.079242847222	32	320
XX11119	399.121909513889	400.047776192130	33	214
XX11119	400.094709525463	401.082679907407	34	270
XX11119	401.084576203704	402.054531782407	35	229
XX11119	402.107628078704	402.925879942130	36	103
XX11119	403.317465127315	404.057968842593	37	118
XX11119	404.099687361111	405.082442928241	38	394
XX11118	405.083865150463	405.967539247685	1	210
XX11118	406.350591099537	407.029465185185	2	394
XX11118	407.084457717778	408.067687418981	3	323
XX11118	408.372517060185	409.037642986111	4	334
XX11118	411.590057847222	412.935006006944	5	488
XX11118	413.643746759259	414.935124560185	6	342
XX11118	415.679420740741	416.811983333333	7	341
XX11118	417.424961666667	418.733406111111	8	312
XX11118	419.620872777778	419.827568703704	9	202
XX11118	420.400724629630	420.951598518519	10	165
XX11118	421.361672777778	422.740280185185	11	504
XX11118	423.300161724537	423.919776539352	12	175
XX11118	424.270591365741	425.015835821759	13	183
XX11118	425.305021006944	426.054058055556	14	173
XX11118	426.274976574074	426.891272881944	15	167
XX11118	427.249672893519	427.790117337963	16	79
XX11118	428.213939571759	428.825495138889	17	258
XX11118	429.108043287037	429.909702557870	18	326
XX11118	430.153376631944	431.082561828704	19	446
XX11118	431.083509976852	431.841554432870	20	199
XX11118	432.157761851852	433.029584085648	21	212
XX11118	433.123924826389	433.535895196759	22	219
XX11118	434.090087800926	435.082324849537	23	286
XX11118	435.127361886574	436.051332280093	24	236
XX11118	436.103480428241	436.882858217593	25	176
XX11118	437.797821192130	439.082087870370	26	99
XX11118	439.083510092593	440.065317511574	27	164
XX11118	440.086176782407	441.058502719907	28	227
XX11118	441.104013831019	442.082502731481	29	246
XX11118	442.115687916667	443.082799039352	30	183
XX11115	443.083747175926	444.964398518518	1	439
XX11115	446.106443530093	447.032310208333	2	167
XX11115	447.401613888889	448.001791701389	3	311
XX11115	448.367776851852	449.078888009259	4	295
XX11115	449.203095370370	449.995272592593	5	144
XX11115	450.370265740741	453.039302893519	6	1043
XX11115	453.347451041667	454.006414016204	7	657
XX11115	454.306976979167	455.942532557870	8	1892
XX11115	456.088073258611	456.844695532407	9	322
XX11115	457.211154803241	458.036043703704	10	423
XX11115	458.246532592593	458.912132604167	11	335
XX11115	459.206532604167	459.880191875000	12	467
XX11115	460.172695578704	461.006591886574	13	414
XX11115	461.143599293982	461.968962268519	14	545
XX11115	462.185021539352	462.914265995370	15	494
XX11115	463.280251180556	464.016014155093	16	377
XX11115	464.313732673611	464.913910462563	17	323
XX11115	465.279895659722	466.017554918981	18	409
XX11115	466.247954930556	466.954325312500	19	750
XX11114	467.084695682870	467.915747546296	1	692

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XX1114	468.223895694444	468.934058666681	2	1462
XX1114	469.208547557870	469.959480902778	3	1564
XX1114	470.168547581019	471.850858715278	4	2886
XX1114	472.400962418982	472.925288356482	5	1093
XX1114	473.086473541667	473.891925405093	6	659
XX1114	474.083451296296	474.917820925526	7	903
XX1114	475.152962465278	475.892043946759	8	480
XX1112	476.121021712963	476.917465525526	1	748
XX1112	477.089080972222	478.077999502315	2	481
XX1112	478.121614305556	479.044636585648	3	388
XX1112	479.087777326389	480.076695844507	4	289
XX1112	480.087125474537	481.078414363426	5	461
XX1112	481.114918055556	482.081555150463	6	537
XX1112	482.083451446759	483.075688483796	7	425
XX1112	483.111718113426	484.010562581018	8	453
XX1112	484.121021805556	485.042147789352	9	421
XX1112	485.096192187500	486.074207048611	10	358
XX1112	486.127303356481	487.065021886574	11	366
XX1112	487.096784849537	488.082384861111	12	458
XX1112	488.083807083333	488.590592280093	13	268
XX1112	489.052636736111	490.071599710648	14	316
XX1112	490.097673784722	491.056725648148	15	551
XX1112	491.091333055556	491.181407129630	16	75
XX1112	492.112014548611	493.043096041667	17	341
XX1112	493.091451608796	494.008310879630	18	492
XX1112	494.169496064815	495.029466446759	19	214
XX1112	495.090622002315	496.002266458333	20	520
XX1112	496.370622025463	497.080310914352	21	426
XX1112	497.131510914352	498.018029456019	22	474
XX1112	498.369318344907	498.999836875000	23	276
XX1112	499.333585023148	499.945140590278	24	477
XX1112	500.240014664352	500.863422083333	25	497
XX1111	501.201910972222	501.930562835648	1	619
XX1111	502.299392476852	502.942711006944	2	540
XX1111	503.265555451389	504.078118425526	3	271
XX1111	505.253348148148	505.800902962963	4	159
XX1111	512.109407418981	517.028874166667	5	12
XX1111	734.088897326389	734.804275127315	6	614
XX1111	735.110526990741	735.568482557870	7	7
XX1111	445.529969444444	410.936786770833	8	433
XX1111	293.089563807870	294.080378645833	9	322

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FILE 1 RECORD 1 LENGTH 3336BYTES

(0)	43126493	17865864	C0E293A6	C06D956D	C02E0D2E	C0E2941B	C06D91D3	C02ED368	C0E2947B	C06D8E51
(40)	C02ED90A	C0E294D5	C06D8AD3	C02EE02E	C0E29512	C06D87A4	C02EE68D	C0E29557	C06D845C	C02EECE8
(80)	C0E2958D	C06D8142	C02EF3D1	C0E295B8	C06D7E2D	C02EF99E	C0E295DF	C06D7B10	C02F0003	C0E2959E
(120)	C06D7849	C02F2652	C0E295F6	C06D7573	C02F1CAD	C0E295F2	C06D72B6	C02F1319	C0E295E5	C06D70D5
(160)	C02F199C	C0E295CA	C06D6D84	C02F1FE8	C0E295AB	C06D6AFF	C02F265B	C0E2957F	C06D689A	C02F2CBE
(200)	C0E2954D	C06D664D	C02F331F	C0E295JF	C06D63F4	C02F399F	C0E2948C	C06D61E2	C02F3FF5	C0E29463
(240)	C06D5FD	C02F466F	C0E29431	C06D5DDA	C02F4CCB	C0E29396	C06D5BF2	C02F5336	C0E29321	C06D5A15
(280)	C02F59AF	C0E29299	C06D5866	C02F6028	C0E2920F	C06D56C6	C02F6673	C0E2917F	C06D5523	C02F6CEA
(320)	C0E29DDB	C06D53BD	C02F7333	C0E29432	C06D5242	C02F79BF	C0E28F7A	C06D5107	C02F8007	C0E28EBD
(360)	C06D4FB8	C02F8629	C0E28DF3	C06D4E37	C02F8CC5	C0E28D19	C06D4D7E	C02F937B	40541316	C04BC3C0
(400)	C0E59FBF	40546AFC	C04C9953	C0E538E4	4054C0D6	C04D6E9E	C0E4D11D	40551756	C04E43AF	C0E4686D
(440)	4055606C	C04F182C	C0E3FF01	4055C325	C04EE059	C0E394BB	40561865	C050C030	C0E329AA	40566D81
(480)	C0519392	C0E2BDB8	4056C23B	C0E266C6	C0E250E4	40571685	C053396F	C0E1E354	40576A69	C0540B8A
(520)	C0E17507	4057BE08	C054DD56	C0E175D9	40581165	C055AED6	C0E095C8	4058644E	C0568012	C0E324E4
(560)	4058B6D7	C0575393	C0DFB354	405908FE	C05820C0	C0DF40F0	40595AD4	C058F0C7	C0DECDA3	4059AC5F
(600)	C059C027	C0DE5999	4059FD85	C05A8F5D	C0DD4E4D	405A4E52	C05B5D07	C0DD6F15	405A9EAA	C05C2BED
(640)	C0DCF8BB	405AEECC	C05CFCEB	C0DC8175	40583E8E	C05D073E	C0DC095C	405B8DEC	C05E9423	C0DB9091
(680)	405BDCD7	C05F638E	C0DB170C	405C2B81	C0602CAF	C0DA9CA4	405C79BD	C060F865	C0DA2179	405CC7BD
(720)	C061C394	C0D9A585	405D153E	C0628E69	C0D928CF	405D628A	C06358C4	C0D8AB46	405DAF44	C06422B2
(760)	C062D01E	405DF0C3	C04AEC15	C07ADF2	C0600000	C0600000	C0600000	C0600000	C0600000	C0600000
(800)	C0631019	C062D01C	C043001A	C0610015	C0600017	C0633016	C062D019	C0610010	C062000F	C0620008
(840)	C0630009	C062D005	C041000A	C0600001	C0600008	C0600004	C0600005	C0600005	C060000A	C0600001
(880)	C0600009	C0610004	C0600008	C0610002	C0600008	C0600002	C0600002	C0600004	C0600007	C0600003
(920)	C0600013	C0600002	C0610007	C0600004	C0600005	C0600004	C0600002	C0600003	C0600003	C0600001
(960)	C0600012	C0600001	C0600002	C0600002	C0600001	C0600001	C0600001	C0600001	C0600001	C0600002
(1000)	C0600005	C0600003	C0600002	C0600002	C0600001	C0600001	C0600003	C0600002	C0600000	C0600000
(1040)	C0600003	C0600003	C0600000	C0600000	C0600001	C0600000	C0600001	C0600000	C0600000	C0600000
(1080)	C0600015	C0610008	C0610007	C0600005	C0600006	C0600003	C0600002	C0600003	C0600007	C0600008
(1120)	C0600007	C0600006	C0600003	C0600001	C0600008	C0600007	C0600007	C0600003	C060000C	C0600002
(1160)	C060000C	C0600001	C060000A	C0600002	C0600008	C0600004	C0600005	C0600004	C0600006	C0600004
(1200)	C0610003	C0610002	C0600003	C0610001	C0600003	C0600002	C0600002</			

[illegible]