L. Shaw
8/16/73

PIONEER AVERAGE TAPE STRUCTURE

Record Number	Number of Words	Contents
1	20	NDAY, (CR(L), L=1, 6) for first day
2	1200	Minute averages of first 30 minutes of day
3	1200	Second 30 minutes
4	1200	Third 30 minutes
.	.	
.	.	
.	.	
49	1200	Last 30 minutes of day
50	1200	Hour and day averages for first day

Repeat 50 records for each of 7 days.
(We may eventually put 28 days on each average tape.)

The 14 averages are in the following order:

1. $\langle B_R \rangle$
2. $\langle B_T \rangle$
3. $\langle B_N \rangle$
4. $\langle B_R^2 \rangle$
5. $\langle B_R B_T \rangle$
6. $\langle B_R B_N \rangle$
7. $\langle B_T^2 \rangle$
8. $\langle B_T B_N \rangle$
9. $\langle B_N^2 \rangle$
10. $\langle \cos \alpha \rangle = \langle B_R/|B| \rangle$
11. $\langle \cos \beta \rangle = \langle B_T/|B| \rangle$
12. $\langle \cos \gamma \rangle = \langle B_N/|B| \rangle$
13. $\langle |B| \rangle$
14. $\langle |B|^2 \rangle$

The tape is 7-track, 800 BPI, even parity.
(No control words, BCD characters only, FORTRAN readable)

Code to read one day of data:

```
          Dimension CR(6), DTH(24), DTM(60), EVD(14), EVH(14, 24) EVM(14, 60)
          READ (6, 10) NDAY, (CR(L), L=1, 6)
 10       FORMAT (2X, I3, 6E15.7, 25X)
          DO 100 I = 1, 24
          READ (6, 20) (DTM(J), (EVM(K, J), K=1, 14), J=1, 30)
100       READ (6, 20) (DTM(J), (EVM(K, J), K=1, 14), J=31, 60)
 20       FORMAT (30 (8E15.7, 15X, 7E15.7))
          READ (6, 30) (DTH(J), (EVH(K, J), K=1, 14), J=1, 24), DTD,
                (EVD(L), L=1, 14)
 30       FORMAT (25(8E15.7, 15X, 7E15.7), 10(120X))
```

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12/3/80

Plasma Tape Program

A revision of the Plasma Velocity Plot Program was made to allow <u>any</u> plasma tape parameter to be plotted or listed. The new program has been renamed as 'SBPIO.PLASPLT.LOAD', and the updated documentation is enclosed here. The last page contains a list of all possible parameters available from the AMES tapes given to us.

Jenny Jacques

F.B.McDonald

G.A.Muckel

J.H.Broomhall

H.G.Domchick ✓

11/25/80

PIONEER PLASMA PARAMETER PLOT PROGRAM
User's Guide

I. Overview

This program reads PIONEER plasma parameters from tapes supplied by AMES. The first datum from each hour is used to create listings and plots of parameter vs. time.

II. Input Required

A. AMES Plasma Parameter Tape as described in Project 1335-2, Technical Note 6.

B. User namelist INPUT:

Variable	Type	Default	Description
FROM(3)	I*4	0	Year-1900, day of year, and milliseconds of day of start of plot run.
TO(3)	I*4	0	Year-1900, day of year, and milliseconds of day of end of run, inclusive.
INTRVL	I*4	1	Number of hours to average together into one point.
IDENS	I*4	20	Number of intervals per plot frame.
AXMIN,AXMAX	R*4	Supplied by data	Ordinate minimum and maximum values. If not specified, the data minimum and maximum are used.
IDIVS	I*4	8	Number of divisions in the abscissa, used for tic marks and labels.
ZTAPE	A6	blank	Input tape name in EBCDIC.
IDEV	I*4	2	Output plotter device: 1=SD4060, 2=Calcomp 12", 3=Printer plot.
IVAR	A4	blank	Parameter name desired as describwed in the AMES Project 1335-2 Technial Note 6. Example: Free proton bulk velocity: 'PV07'.

Variable	Type	Default	Description
QLABL(16)	A16	blanks	Label associated with IVAR. Example: Free proton bulk velocity: 'PLASMA VELOCITY'.
QDEBUG	L*1	F	T=Print debug statements.
QPLOT	L*1	T	T=create plots
QLIST	L*1	T	T=create data listings

C. Plot tapes (If not printer plots): If making an SD4060 plot, use 7 or 9 track. Calcomp must have 7 track 556 BPI only.

III. Output Generated

A. Data Listing:

The plot number is indicated, then a columnar listing of year, day, hour, and parameter value is listed.

B. Plots:

A choice of SD4060, Calcomp 12", or printer plots is offered. The printer plots are of poor quality and are used usually for debug purposes only.

The plots are linear scale with a tic mark grid and appropriate labels.

IV. Error Handling

The STOP N statement which stops the program with return code N is used for fatal errors.

Return Code	Error Description
1	Input namelist value error. A senstence describing which parameter was in error is printed.
2	"ERROR IN POSITION,START,STOP TIME=" The times read from the plasma tape are inconsistent with user-input times.
3	"ERROR IN READING TAPE IN GETDAT" A tape read error was encountered on the AMES tape.
4	"END OF FILE REACHED IN GETPRM" While positioning to the start of run, an end of file was encountered.
5	"ERROR ON TAPE IN POSITN" While positioning to the start of run, an error was encountered on the input tape.

V. Program Performance and JCL

The program will produce 6 plots for the Calcomp plotter on the 360/75 in $.4^5$ CPU, 1.1^5 I/O. Plots on the printer take slightly more I/O time, and the 360/91 would at least half both times.

The program required 220K core to run, using LOADER. The JCL for a run is held in 'SBPIO.LIB.CNTL(SPLASPLT)'. It links into load module 'SBPIO.PLASPLT.LOAD' as follows:

```
// (JOBCARD)
// EXEC LOADER,REGION=225K,PARM='SIZE=215K,EP=MAIN'
//SYSLIB DD DSN=SPBIO.PLASPLT.LOAD,DISP=SHR
//    DD DSN=SYS2,WOLFPLOT,DISP=SHR
//SYSLIN DD DSN=SBPIO.PLASPLT.LOAD(MAIN),DISP=SHR
//       DD DSN=SBPIO.PLASPLT.LOAD(TIMES),DISP=SHR
//FT09F001 DD DCB=(DEN=2,RECFM=VS,LRECL=4112,BLKSIZE=4116),
//      LABEL=(,NL),UNIT=(800,,DEFER),VOL=SER=DUM09
//*-- THIS CARD NOT NEEDED IF NO CALCOMP PLOTS TO GENERATE
//PLOTTAPE DD DCB=(,DEN=1),LABEL=(,BLP,,OUT),UNIT=(7TRACK,,DEFER),
//    DSN=CALCOMP,VOL=SER=TAPENAME
//*-- THIS CARD NOT NEEDED IF NO SD4060 PLOTS TO GENERATE
//WOLF4060 DD LABEL=(,NL,,OUT),UNIT=(1600,,DEFER),
//    DCB=(BUFNO=1,DEN=3),DSN=NAME,VOL=SER=XXXXX
//* -- THE FOLLOWING IS A COMPLETE LIST OF POSSIBLE INPUT PARAMETERS
//*&INPUT FROM=,TO=,INTRVL=,IDENS=,AXMIN=,AXMAX=,ZTAPE=,IDEV=,
//*      IDIVS=,QDEBUG=,QPLOT=,QLIST=,IVAR=,QLABL=,&END
//*-- EXAMPLE
//DATA5 DD *
 &INPUT FROM=78,125,0,TO=78,131,0,INTRVL=1,IDENS=168,ZTAPE='XXXXX',
      IDIVS=7,QPLOT=T,QLIST=T,IDEV=3,IVAR='PV07',QLABL='PLASMA VELOCITY',&END
// EXEC NOTIFYTS
```

This program uses IBM FORTRANH, WOLFPLOT, and FTIO packages.
The source is archived under 'SEJSS.PLASPLT.SOURCE(PLOT)'

11/25/80

PIONEER PLASMA PARAMETER PLOT PROGRAM
System Documentation

I. Overview

This program reads PIONEER plasma parameters from tapes supplied by AMES. The first datum from each hour is used to create listings and plots of parameter vs. time.

II. Input Required

A. AMES Plasma Parameter Tape as described in Project 1335-2, Technical Note 6.

B. User namelist INPUT:

Variable	Type	Default	Description
FROM(3)	I*4	0	Year-1900, day of year, and milliseconds of day of start of plot run.
TO(3)	I*4	0	Year-1900, day of year, and milliseconds of day of end of run, inclusive.
INTRVL	I*4	1	Number of hours to average together into one point.
IDENS	I*4	20	Number of intervals per plot frame.
AXMIN,AXMAX	R*4	Supplied by data	Ordinate minimum and maximum values. If not specified, the data minimum and maximum are used.
IDIVS	I*4	8	Number of divisions in the abscissa, used for tic marks and labels.
ZTAPE	A6	blank	Input tape name in EBCDIC.
IDEV	I*4	2	Output plotter device: 1=SD4060, 2=Calcomp 12", 3=Printer plot.
IVAR	A4	blank	Parameter name desired as described in the AMES Project 1335-2 Technical Note 6. Example: Free proton bulk velocity: 'PV07'.

Variable	Type	Default	Description
QLABL(16)	16A1	blanks	Label associated with IVAR. Example: Free proton bulk velocity: 'PLASMA VELOCITY'.
QDEBUG	L*1	F	T=Print debug statements.
QPLOT	L*1	T	T=Create plots
QLIST	L*1	T	T=Create data listing

C. Plot tapes (If not printer plots): If making an SD4060 plot, use 9 track, 1600 BPI. Calcomp must have 7 track 556 BPI.

III. Output Generated

A. Data Listing:

The plot number is indicated, then a columnar listing of year, day, hour, and parameter value is listed.

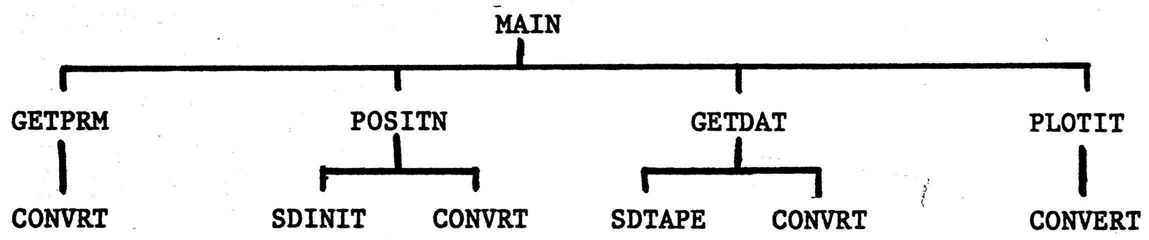
B. Plots:

A choice of SD4060, Calcomp 12", or printer plots is offered. The printer plots are of poor quality and are used usually for debug purposes only.

The plots are linear scale with a tic mark grid and appropriate labels.

IV. Program Structure

A. Block Diagram

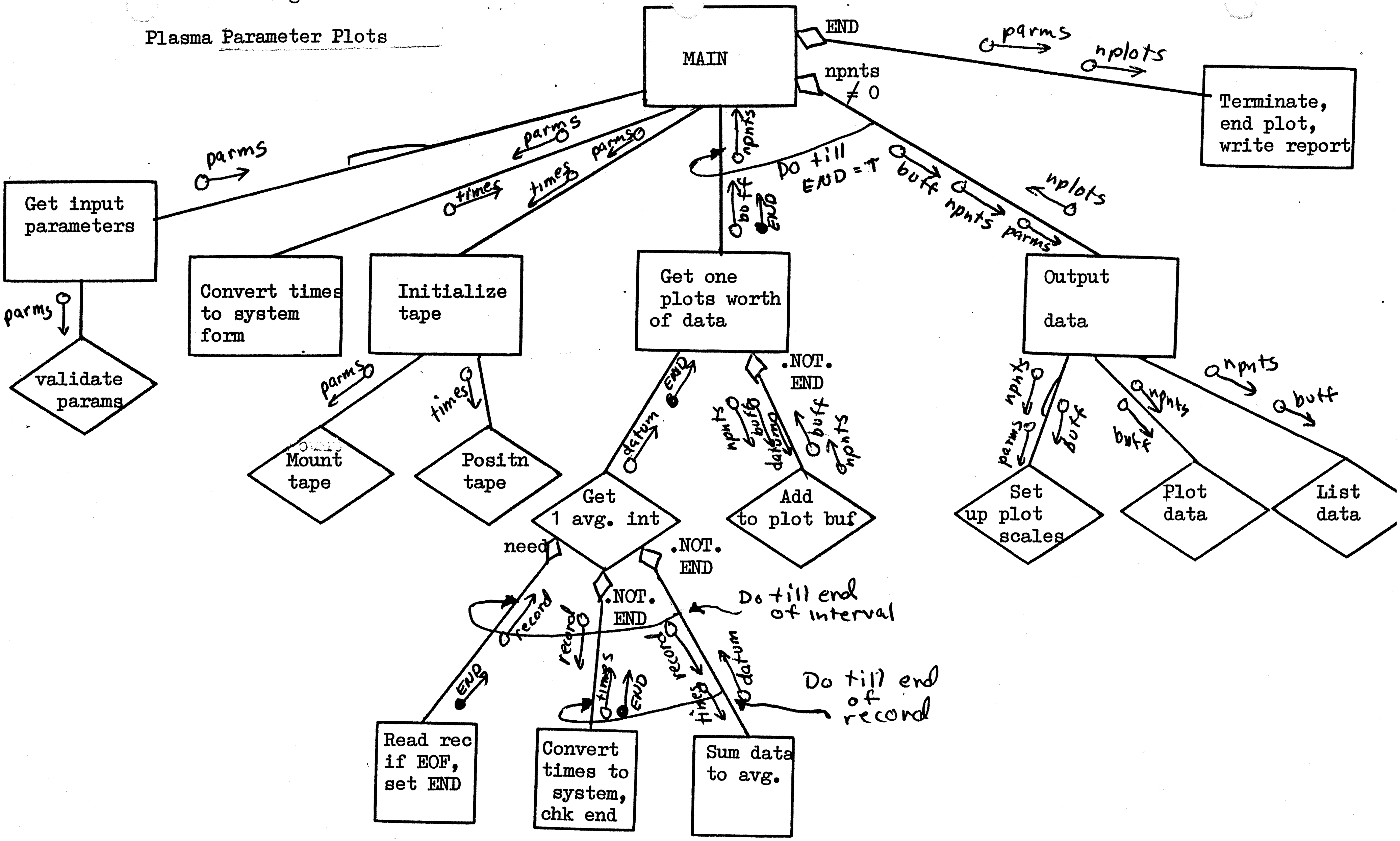


B. Module Definition

1. MAIN - Controls program flow
2. GETPRM - Reads user parameters and validates them
3. POSITN - Positions tape to start time
4. GETDAT - Collects one plot's worth of data
5. PLOTIT - Plots the data
6. CONVRT - Converts to and from system time form

Data Flow Diagram

Plasma Parameter Plots



7. SDTAPE - Supplied by AMES to extract parameter and time from the tape
8. SDINIT - Supplied by AMES to initialize commons for SDTAPE

V. Data Flow Diagram

(See next page)

VI. Error Handling

The STOP N statement which stops the program with return code N is used for fatal errors.

Return Code	Error Description
1	Input namelist value error. A sentence describing which parameter was in error is printed.
2	"ERROR IN POSITION,START,STOP TIME=" The times read from the plasma tape are inconsistent with user-input times.
3	"ERROR IN READING TAPE IN GETDAT" A tape read error was encountered on the AMES tape.
4	"END OF FILE REACHED IN GETPRM" While positioning to the start of run, an end of file was encountered.
5	"ERROR ON TAPE IN POSITN" While positioning to the start of run, an error was encountered on the input tape.

VII. Detail on Coding

A. Timing System: Times are converted to a real number which is intervals (hours) since start of run.

B. Common Blocks:

1. /PARMS/START,STOP,ZTAPE,INTRVL,IDENS,PSTART,PEND,PTOTAL,AXMIN, AXMAX,IDIVS,QDEBUG,QAXIS

   (See Section II.B for details on those variables which are namelist variables. Other are listed below.)

Variable	Type	Description
START,STOP	R*4	System time for start and end of run
PSTART,PEND	R*4	System time for start and end of current plot frame
PTOTAL	R*4	Total intervals per plot
QAXIS	L*1	T=Calculates the ordinate axis minimum and maximum from the plot data

2. See AMES Publications Project 1335-2, Technical Note 7, page 5 for definitions of common variables in SDINFO,SDFLAG,SDATA, SDKEY,SDNEWV.

3. /TIMES/IEPOCH,INTDY,MSINT

Variable	Type	Description
IEPOCH	I*4	Closest leap year-1900 before start time of run
INTDY	I*4	Number of intervals per day
MSINT	I*4	Number of milliseconds per interval

Common Name	Module Occurrence	Input/Output	Function
PARMS	GETDAT GETPRM PLOTIT POSITN	I,O O I I	Holds plotting paramters
TIMES	CONVRT GETPRM	I O	Holds timing information to convert to and from system times
SDATA,SDKEYS SDINFO	POSITN SDTAPE	O I,O	Holds AMES tape reading parameters
SDVAR,SDFLAG, SDNEWV	GETDAT POSITN SDTAPE	I,O O I,O	Holds AMES tape to be returned variables
VARBLS	GETPRM,POSITN, PLOTIT	I O	Holds plasma parameter information.

4. /VARBLS/INPT(4),NUMPRM,QLABL(16)

Variable	Type	Description
INPUT	4A4	The first three are the time parameters 'TI01','TI02', and 'TI06'. The fourth is the user input parameter name.
NUMPRM	I*4	Number of parameters, equal to 4.
QLABL	16A1	Label for parameter input by user.

C. Individual Module Documentation

All modules were designed, coded, and tested by Jenny Jacques, Code 664, September 1980.

1.a. MAIN - Controls program flow

b. Calls: Wolfplot routines, POSITN,GETDAT,GETPRM,PLOTIT

c. No commons used

d. Local Variables:

Name	Type	Description
BUFF(500,2)	R*4	Holds up to 500 plot data, BUFF(N,1)=parameter value BUFF(N,2)=time (system form)

Name	Type	Description
QEND	L*1	T=end of run data
NPNTS	I*4	Number of data to plot
IPLDEV	I*4	Wolfplot plotter device specification
NPLOTS	I*4	Number of plots done
QPLOT	L*1	T=create plots
QLIST	L*1	T=create listing of data

e. Logic:

The user parameters are read in (GETPRM) and plotter and tape are initialized (POSITN,PLOTST,CPRIME). Then the plot loop is done,first filling BUFF with one plot's data (GETDAT), then plotting it (PLOTIT), etc. When QEND=T, stop after plotting any data collected in BUFF.

2.a. CONVRT - Convert to and from year, day, ms of day, and system time form of one real number used for plotting.

b. Calling sequence:
CALL CONVRT(ITIME,SYSTEM,ITYPE)

Variable	Type	Description
ITIME(3)	I*4	Year, day, ms of day
SYSTEM	R*4	System time form of ITIME
ITYPE	I*4	1=Convert to system 2=Convert to ITIME

c. Calls: none
Called by: GETPRM,GETDAT,PLOTIT,POSITN

d. Common blocks:

Common	Variables	I,O
TIMES	IEPOCH,INTDY,MSINT	I

e. Local variables: none

f. Logic:

The algorithm used multiplies the years since epoch leap year by 365.25 and truncates. This adds 1 day every four years. Then the number of intervals per day are added and this becomes the system time form. This process is inverted when converting from system time form.

3.a. GETDAT - Gets the data for one plot

b. Calling sequence:
CALL GETDAT(BUFF,NPNTS,QEND)

See MAIN, Section VII.C.1 for variable explanation.

c. Calls: CONVRT
Called by: MAIN

d. Common blocks:

Common	Variables	I,O
PARMS	START,STOP,PSTART,PEND	I,O
	INTRVL,IDENS,PTOTAL,QDEBUG	I
SDVAR	VARVAL	I,O
SDFLAG	LEOF,LERR	I,O
SDNEWV	LVN	I,O

e. Local variables:

Variable	Type	Description
IHR,IOLDHR	I*4	Holds current and previous hour number of datum.
NUM	I*4	Number of data in SUM
SUM	R*4	Sum of parameters for an average
IODAY	I*4	Previous datum's day numbers

f. Logic:

After variables are initialized, there is a loop collecting one averaging interval of data. This interval is stored and the loop continues until the plot end time is encountered.

3.a. GETPRM - Get user parameters from namelist

b. Calling sequence:

```
CALL GETPRM(IPLDEV,QPLOT,QLIST)
```

See MAIN, Section VII.C.1 for definition of IPLDEV, QPLOT and QLIST.

c. Calls: SDINIT,CONVRT
Called by: MAIN

d. Common blocks:

Common	Variables	I,O
TIMES	All	O
PARMS	All but PEND	O

e. Local variables:

Variable	Type	Description
IHI(7),ILO(7)	I*4	Maximum and minimum input integer allowable values: (1)-(3) → FROM and to (4) → INTRVL, (5) → IDENS, (6) → IDEV, (7) → IDIVS

Variable	Type	Description
ICODE(3)	I*4	Wolfplot plotter code for each allowable output plotter device: (1)=SD4060, (2)=Calcomp 12", (3)=printer

f. Logic:

Read in the INPUT namelist. Validate the parameters. Initialize timing variables and plotting variables.

4.a. PLOTIT - Plots one frame of data

b. Calling sequence:

```
CALL PLOTIT(BUFF,NPNTS,NPLOTS,QPLOT,QLIST)
```

See Section VII.C.1 MAIN for description of variables.

c. Calls: CONVRT, Wolfplot routines
Called by: MAIN

d. Common blocks:

Common	Variables	I,O
PARMS	PSTART,PEND,IDIVS,QDEBUG	I
	QAXIS,AXMIN,AXMAX	I,O

e. Local variables:

Variable	Type	Description
POS	R*4	Used as abscissa position for each tic mark and label
AMAX,AMIN	R*4	Returned ordinate maximum and minimum if to be obtained from the data
INCS	I*4	Same as IDIVS
QDAY(3)	L*1	Holds EBCDIC day number
RINC	R*4	Time increment between tic marks
IOLDY	I*4	Holds previous day number to check for change
ITIME(3)	I*4	Year, day, ms of day for each datum label
QDATE(8)	L*1	Holds EBCDIC run date
QHOUR(2)	L*1	Holds EBCDIC hour for label
QPLTS(11)	L*1	Holds EBCDIC plot number label
QTIME(21)	L*1	Holds EBCDIC start time label

f. Logic:

After intializing variables, the ordinate extreme values are calculated if QAXIS=T. The plot frame is scaled, labels put on, tic marks on upper and left axis drawn, and the time axis labels drawn. Then the data is listed, then plotted and the plot frame is ended.

5.a. POSITN - Positions input tape to correct time

b. Calling sequence:

```
CALL POSITN
```

c. Calls: SDINIT,SDTAPE,FTIO,CONVRT
Called by: MAIN

d. Common blocks:

Common	Variables	I,O
PARMS	START,STOP,ZTAPE	I
SDVAR	IDVAR,VARVAL	I,O
SDINFO	KPRTUN,KTAPUN	O
SDFLAG	LEOF,LERR	I
SDKEYS	IDKEY,KEYVAL	O

e. Local variables:

Variable	Type	Description
TIME	R*4	System time form of the record

f. Logic:

The common blocks are initialized and the input tape is mounted, then rewound to close the DCB for future Fortran reads. A loop follows to read in each record until the start time is reached. This routine returns the first plot data.

6. SDINIT,SDTAPE - AMES supplied these routines to decode their plasma parameters tape. See the document AMES Project 1335-2, Technical Note 7 for explanation of these subroutines.

VIII. Program Performance and JCL

The program will produce 6 plots for the Calcomp plotter on the 360/75 in $.4^5$ CPU, 1.1^5 I/O. Plots on the printer take slightly more I/O time, and the 360/91 would at least half both times.

The program required 220K core to run, using LOADER. The JCL for a run is held in 'SBPIO.LIB.CNTL(SPLASPLT)'. It links into load module 'SBPIO.PLASPLT.LOAD' as follows:

```
// (JOBCARD)
// EXEC LOADER,REGION=225K,PARM='SIZE=215K,EP=MAIN'
//SYSLIB DD DSN=SPBIO.PLASPLT.LOAD,DISP=SHR
//    DD DSN=SYS2,WOLFPLOT,DISP=SHR
//SYSLIN DD DSN=SBPIO.PLASPLT.LOAD(MAIN),DISP=SHR
//       DD DSN=SBPIO.PLASPLT.LOAD(TIMES),DISP=SHR
```

```
//FT09F001 DD DCB=(DEN=2,RECFM=VS,LRECL=4112,BLKSIZE=4116),
//       LABEL=(,NL),UNIT=(800,,DEFER),VOL=SER=DUM09
//*-- THIS CARD NOT NEEDED IF NO CALCOMP PLOTS TO GENERATE
//PLOTTAPE DD DCB=(,DEN=1),LABEL=(,BLP,,OUT),UNIT=(7TRACK,,DEFER),
//     DSN=CALCOMP,VOL=SER=TAPENAME
//*-- THIS CARD NOT NEEDED IF NO SD4060 PLOTS TO GENERATE
//WOLF4060 DD LABEL=(,NL,,OUT),UNIT=(1600,,DEFER),
//     DCB=(BUFNO=1,DEN=3),DSN=NAME,VOL=SER=XXXXX
//* -- THE FOLLOWING IS A COMPLETE LIST OF POSSIBLE INPUT PARAMETERS
//*&INPUT FROM=,TO=,INTRVL=,IDENS=,AXMIN=,AXMAX=,ZTAPE=,IDEV=,
//*       IDIVS=,QDEBUG=,QPLOT=,QLIST=,IVAR=,QLABL=,&END
//*-- EXAMPLE
//DATA5 DD *
 &INPUT FROM=78,125,0,TO=78,131,0,INTRVL=1,IDENS=168,ZTAPE='XXXXX',
     IDIVS=7,QPLOT=T,QLIST=T,IDEV=3,IVAR='PV07',QLABL='PLASMA VELOCITY',&END
// EXEC NOTIFYTS
```

This program uses IBM FORTRANH, WOLFPLOT, and FTIO packages. The source is archived under 'SEJSS.PLASPLT.SOURCE(PLOT)'

Plasma Parameters

The following table describes the parameters available on the AMES plasma tapes. They may be used with the plasma parameter plot program.

Name (IVAR)	Description
CS01	Chi-Square
EP01	Error with free proton temperature (° K)
EP07	Error with free proton bulk velocity (KM/SEC)
EP08	Error with free proton bulk azimuthal angle (degrees)
EP09	Error with free proton bulk polar angle (degrees)
EP10	Error with free proton number density (proton/CC)
PT01	Free proton temperature (° K)
PV07	Free proton bulk velocity (KM/SEC)
PA08	Free proton bulk azimuthal angle (degrees)
PA09	Free proton bulk polar angle (degrees)
PN10	Free proton bulk number density (proton/CC)
** TI01	Year
** TI02	Day of year
** TI06	Milliseconds of day of year
TI91	Year data was generated
TI92	Day of year data was generated

** Included in all listings and plots

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Donnchik

Pioneer 10 and 11
Goddard/U. New Hampshire Cosmic Ray Experiment
Jupiter and Saturn Encounter Data

Instrumentation

This experiment consists of a set of three solid-state telescopes, each designed to complement the others and to cover a broad range in energy, intensity and charge spectra. The three telescopes are shown schematically in the attached figure; they are the high-energy telescope (HET) and two low-energy telescopes (LET-I and LET-II). The HET and LET-I are designed primarily for measuring the relatively low fluxes of cosmic rays in interplanetary space. As such, their geometry factors are relatively large, and they cannot tolerate fluxes $\geq 2 \times 10^4/\text{cm}^2$ s sr. Their usefulness is, therefore, limited to the outer regions of the Jovian magnetosphere (≥ 20 R_J). They are, however, high-resolution double dE/dX vs. E instruments that provide unambiguous particle identification and precise energy spectra, so that their contribution to the overall body of data is quite significant.

The LET-II telescope was designed to measure low-energy solar flare particles in interplanetary space and trapped particles in the Jovian magnetosphere. It has a relatively small geometry factor (1.5×10^{-2} cm^2 sr) and can readily measure fluxes up to $\sim 5 \times 10^5/\text{cm}^2$ s sr. It is surrounded by a colimator and shield which will stop electrons up to ~ 4.5 MeV and protons up to ~ 40 MeV. The telescope employs a two-parameter analysis technique to separate electrons and protons. The front element SI has an electronic threshold that is set so that any electron penetrating to SII is below threshold and any proton penetrating to SII is above threshold. Selected counting rates in all three telescopes are divided into eight angular sectors to measure particle anisotropies.

A major effort has been devoted to understanding the response of all detector systems in the presence of intense particle fluxes. The onset of saturation in the LET and HET systems is abrupt and well defined. Negligible corrections are necessary prior to this saturation point.

There is significant overlap in the response functions of the three telecopes, and it was of great value to observe the consistency between flux measurements made with completely different detector systems. For example, the LET-I and LET-II proton data in the 0.5- to 2-MeV region are in excellent agreement. This finding is especially helpful in the outer Jovian magnetosphere where the nuclear component is small (1-10%) in comparison with electrons of the same energy. A complete description of this instrument has been published in the IEEE Transactions on Nuclear Science (Stilwell et al., 1975). The energy and charge ranges of each telescope are summarized in Table 1.

Since the Goddard/University of New Hampshire experiment was primarily designed as an interplanetary experiment, its telemetry assignment was minimal during the Jupiter and Saturn encounters. Consequently, individual pulse heights were sampled infrequently, and most of the results have to be based on rate data. This leaves some ambiguity about the type of particles responsible for the counts. This problem arises primarily in identifying protons vs. alpha particles and heavier ions. LET-I and LET-II respond differently because of the aluminized mylar foil in front of the LET-I detector. On this basis, it has been concluded (McDonald et al., 1979) that the nominal "proton channels" respond primarily to protons at Jupiter; however, some admixture of heavier ions is clearly present and the amount is time dependent. It is hoped that further analysis can narrow down the uncertainty.

Data have been included only for periods when the detectors operated in this design range. This excludes the inner magnetosphere. At Jupiter, the detectors were heavily saturated in this region, while at Saturn a very penetrating radiation prevented a clear identification of the type and energy of the particles responsible for our counts. Some of the published results from this experiment required extensive corrections for deadtime, accidental coincidences and anticoincidences (Trainor et al., 1974; McDonald and Trainor, 1976; McDonald et al., 1980). These corrections can be applied only on a case-by-case basis after careful study of the environment and many self-consistency checks. They cannot be applied on a systematic basis and we have no computer programs to do so. A special problem arose during the Pioneer 10 out pass from Jupiter. Radiation damage to the digital logics decreased the margins in these circuits. Although most of the data is good, certain bits failed to reset every now and then. For 15-minute averages, this effect can generally be ignored; but the user should be aware that a few points are off due to this problem. If a user is interested in data not included in this submission or has special questions, the experimenters will be glad to consider requests if the desired information can be extracted from the data.

Description of the Data

In the following rate definitions, individual detectors are identified by the same symbols as in the attched figure. Any subscripts refer to different trigger thresholds on that deector (SIIA is an annular guard detector in LET-II which is not labeled in the figure). Several detectors defining a rate are in coincidence unless a bar over the symbol indicates that the detector is in anticoincidence.

(1) $\underline{A_2 \text{ Rate}}$ (Saturn only) gives the counting rate in a 2.5-mm thick Si detector with an area of 3.0 cm^2. Since the threshold is set at 2.01 MeV, it responds primarily to energetic electrons; however, the effective solid angle and detection efficiency are not well known. This rate is given for Saturn because the more desirable coincidence rates suffered from excessive accidentals (note A_2 is identified as A2 on tape).

(2) $\underline{A_1 \overline{A_2} B \overline{CI} \text{ Rate}}$ (Jupiter only) gives the flux of electrons with a range between 2.5 and 5.0 mm of Si which deposit less than 2 MeV in the front detector. The electron energy falls into the range of about 1.8 to 3.2 MeV (on the tape this rate is identified as A1.¬A2.B.¬C1).

(3) $\underline{A_1 \overline{A_2} B\ CI\ \overline{CII} \text{ Rate}}$ (Jupiter only) gives the electron flux with a range of 5 to 10 mm Si; the approximate energy range of 3.2 to 5.1 MeV (the rate ID is
A1.¬A2.B.C1.¬C2).

(4) $\underline{A_1 \overline{A_2} B\ CI\ CII\ \overline{CIII} \text{ Rate}}$ (Jupiter only) gives the electron flux with a range of 10 to 15 mm Si; the approximate electron energies are 5.1 to 8 MeV (the rate ID is A1.¬A2.B.C1.C2.¬C3).

(5) $\underline{\overline{SI}\ SII_5\ \overline{SIIA}\ \overline{SIII} \text{ Rate}}$ gives the flux of electrons in LET-II which do not trigger the 0.145 MeV threshold in the 50 γ front detector and trigger the 50 keV threshold in the 2.5-mm thick second detector. The anticoincidence requirement with the annular guard counter SIIA and rear detector SIII insures that the electrons stop in SII. Our calibrations show that the 50% efficiency points occur at 0.16 and 2.0 MeV. If the electron spectrum is hard, this rate will also respond to bremsstrahlung and electrons penetrating the collimator. The latter effect made the

dominant contribution in the inner Saturnian magnetosphere; otherwise, it is believed to be small but is difficult to evaluate (the rate ID is ¬S1.S2(5).¬S2(A).¬S3).

(6) $\overline{\mathrm{SI}}\ \mathrm{SII}_6\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$ Rate is equivalent to rate (5) but with a 0.35-MeV threshold in SII, corresponding to electron energies from 0.43 to 2.0 MeV (the rate ID is ¬S1.S2(6).¬S2(A).¬S3).

(7) $\overline{\mathrm{SI}}\ \mathrm{SII}_7\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$ Rate is equivalent to rate (5) but with a 0.7 MeV threshold in SII corresponding to electron energies from 0.8 to 2.0 MeV (the rate ID is ¬S1.S2(7).¬S2(A).¬S3).

(8) $\overline{\mathrm{SI}}\ \mathrm{SII}_8\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$ Rate is equivalent to rate (5) but with a 1.0-MeV threshold in SII corresponding to electron energies from 1.1 to 2.0 MeV (the rate ID is ¬S1.S2(8).¬S2(A).¬S3).

(9) DI_4 Rate gives the flux of protons and ions which penetrate a 0.53-mg/cm^2 aluminized mylar foil and deposits at least 0.60 (P-10) or 0.63 (P-11) MeV in detector DI of LET-I. (This rate is not given for the Saturn encounter because of substantial electron contamination.) For protons, this corresponds to energies from 0.84 to 15.1 MeV.

(10) DI_5 Rate is eqivalent to rate (9), but with a threshold in DI of 0.95 MeV corresponding to proton energies between 1.11 and 8.1 MeV.

(11) DI_6 Rate is equivalent to rate (9), but with a threshold in DI of 1.45 MeV corresponding to proton energies from 1.6 to 5.1 MeV.

(12) DI_7 Rate is equivalent to rate (9), but with a threshold energy in DI of 2.20 (P-10) or 2.05 (P-11) MeV corresponding to proton energies from 2.3 to 3.6 MeV and 2.1 to 3.8 MeV, respectively, for P-10 and P-11.

(13) $\mathrm{DI}\ \mathrm{DII}\ \mathrm{E}_2\ \overline{\mathrm{F}}$ Rate from LET-I gives the proton flux between 10.3 and 21 MeV for P-10 and between 11 and 21 MeV for P-11. A small correction has

been made for the contribution from alphas and heavier nuclei in the same energy/nucleus range (the rate ID is D1.D2.E2.¬F - D1.D2.∑ D.E4.¬F).

(14) $\underline{\mathrm{SI_1{\neg}\overline{SII}{\neg}\overline{SIIA}{\neg}\overline{SIII}\ Rate}}$ gives the flux of protons and heavier ions which stop in the 50γ-thick Si detector SI and deposits an energy between 0.16 and 2.6 MeV. This corresponds to proton energies between 0.20 and 2.15 MeV (P-10) or 2.17 MeV (P-11). Detector SI is shielded by only 0.12 mg/cm^2 of Al and is, therefore, relatively sensitive to low-energy ions. At Saturn, the ion contribution is negligible; however, it may be significant at Jupiter (the rate ID is S1(1).¬S2.¬S2)A).¬S3 - S1(4).¬S2.¬S2(A).¬S3).

(15) $\underline{\mathrm{SI_6\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}\ Rate}}$ is equivalent to rate (14) except that the threshold in SI is 0.47 (P-10) or 0.5 (P-11) MeV, this corresponds to proton energies of 0.50 to 2.15 and 0.53-2.17 MeV for P-10 and P-11, respectively (the rate ID is S1(6).¬S2.¬S2(A).¬S3 - S1(4).¬S2.¬S2(A).¬S3).

(16) $\underline{\mathrm{SI_2\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}\ Rate}}$ is equivalent to rate (14) except that the threshold is 0.74 (P-10) an 0.72 (P-11), this corresponds to proton energies of 0.76-2.15 MeV (P-10) and 0.74-2.17 MeV (P-11) (the rate ID is S1(2).¬S2.¬S2(A).¬S3 - S1(4).¬S2.¬S2(A).¬S3).

(17) $\underline{\mathrm{SI_3\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}\ Rate}}$ is equivalent to rate (14) except that the threshold is 1.2 MeV, corresponding to proton energies of 1.24 to 2.15 MeV (1.24-2.17, P-11) (the rate ID is S1(3).¬S2.¬S2(A).¬S3 - S1(4).¬S2.¬S2(A).¬S3).

(18) $\underline{\mathrm{SI\ SII_1\ \overline{SIIA}\ \overline{SIII}\ Rate}}$ gives the flux of protons between 3.13 and 14.8 MeV for Pioneer 10 (3.19-14.9 MeV, P-11) (the rate ID is S1.S2(1).¬S2(A).¬S3 - S1.S2(3).¬S2(A).¬S3).

(19) $\underline{\mathrm{SI}\ \mathrm{SII}_2\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}\ \mathrm{Rate}}$ is equivalent to rate (18) except for a higher threshold and covers protons from 5.65 to 14.8 MeV for P-10 (5.68 to 14.9 MeV for P-11) (The rate ID is S1.S2(2).¬S2(A).¬S3 - S1.S2(3).¬S2(A).¬S3).

Data Format

Time history of Pioneer Cosmic Ray Telescope data described above is being submitted on 9-track tapes recorded at 1600 BPI. Tape marked PIOJUF contains Pioneer-10 data, the one marked PIOJUG contains Pioneer-11 data for Jupiter encounter and tape marked PIOSAG contains Pioneer-11 data for the Saturn encounter. Averaging interval for all data is fifteen minutes.

PIOJUF and PIOJUG each have five files and PIOSAG has four files. Contents of PIOJUF, PIOJUG and PIOSAG are described in Tables 2 to 4, respectively. Each file consists of a number of Flux Time History (FTH) records. An FTH record contains a count of the number of data items (NBIN) whose time-history is included in the record, a count of the number of averaging intervals (NINT) included in the record and definitions of data items included and time-history data. Table 5 defines the structure of an FTH record in detail. These tapes were generated on an IBM System 360 computer; thus, a word consists of 32 bits, half-word 1 is the high order 16-bit field of the word and half-word 2 the low order half (bits 16-31, with the left-most or MSB numbered 0). Characters are represented in 8-bit EBCDIC bytes, real numbers are represented in the IBM single precision floating point format. Length (in words) of an FTH record is given by:

$$200 + (3 + 2 * \mathrm{NBIN}) * \mathrm{NINT}.$$

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TABLE 1: Pioneer 10 and 11 Detectors Used during Planetary Encounters

Detector	Shielding	Energy Range (MeV)	Geometric Factor (cm^2 sr)	Comments
PROTONS:				
o LET I	0.53 mg/cm^2 Mylar			Several channels of protons and ions that exceed threshold in DI. The proton flux from rate agrees with pulse-height analyzed data.
DI only		0.84-15.1	1.13	
DI DII E_2 $\overline{F}$		10.3 -21 (P10) 11.0 -21 (P11)	0.155	
o LET II	0.120 Mg/cm^2 Al			
SI $\overline{\mathrm{SII}}$ $\overline{\mathrm{SIIA}}$ $\overline{\mathrm{SIII}}$		0.2 - 2.15 (P10) 0.2 - 2.17 (P11)	0.015	Several channels of protons and some heavier ion contributions.
SI SII $\overline{\mathrm{SIIA}}$ $\overline{\mathrm{SIII}}$		3.2 -14.8		Protons.
ELECTRONS:				
o HET				
A_1 $\overline{A_2}$ B $\overline{\mathrm{CI}}$	2.5- 5 mm Si	1.8 - 3.2	0.22	Coincidence rates with good background rejection, but accidental coincidence problems at high counting rate.
A_1 $\overline{A_2}$ B CI $\overline{\mathrm{CII}}$	5.0-10 mm Si	3.2 - 5.1		
A_1 $\overline{A_2}$ B CI CII $\overline{\mathrm{CIII}}$	10 -15 mm Si	5.1 - 8		
o LET II				
SI SII $\overline{\mathrm{SIIA}}$ $\overline{\mathrm{SIII}}$		0.16- 2	0.015	Several electron channels. Some contamination from collimator penetration and bremsstrahlung.

Table 2. Contents of PIOJUF

FILE	RATES	TIME PERIOD
1	$A_1\ \overline{A_2}\ B\ \overline{\mathrm{CI}}$	11/26/73 00:00:00-12/01/73 18:00:00 AND
	$A_1\ \overline{A_2}\ B\ \mathrm{CI}\ \overline{\mathrm{CII}}$	12/04/73 22:00:00-12/16/73 00:00:00
	$A_1\ \overline{A_2}\ B\ \mathrm{CI}\ \mathrm{CII}\ \overline{\mathrm{CIII}}$	
2	$\overline{\mathrm{SI}}\ \mathrm{SII}_5\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	11/26/73 00:00:00-12/03/73 08:00:00 AND
	$\overline{\mathrm{SI}}\ \mathrm{SII}_6\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	12/04/73 15:00:00-12/16/73 00:00:00
	$\overline{\mathrm{SI}}\ \mathrm{SII}_7\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
	$\overline{\mathrm{SI}}\ \mathrm{SII}_8\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
3	DI_4	12/26/73 00:00:00-12/03/73 08:00:00 AND
	DI_5	12/04/73 22:00:00-12/16/73 00:00:00
	DI_6	
	DI_7	
	$\mathrm{DI}\ \mathrm{DII}\ E_2\ \overline{F}$	
4	$\mathrm{SI}_1\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	11/26/73 00:00:00-12/03/73 08:00:00 AND
	$\mathrm{SI}_6\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	12/04/73 15:00:00-12/16/73 00:00:00
	$\mathrm{SI}_2\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
5	$\mathrm{SI}_3\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	11/26/73 00:00:00-12/03/73 08:00:00 AND
	$\mathrm{SI}\ \mathrm{SII}_1\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	12/04/73 15:00:00-12/16/73 00:00:00
	$\mathrm{SI}\ \mathrm{SII}_2\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	

Table 3. Contents of PIOJUG

FILE	RATES	TIME PERIOD
1	$A_1\ \overline{A_2}\ B\ \overline{CI}$ $A_1\ \overline{A_2}\ B\ CI\ \overline{CII}$ $A_1\ \overline{A_2}\ B\ CI\ CII\ \overline{CIII}$	11/26/74 00:00:00-12/02/74 16:00:00 AND 12/04/74 22:00:00-12/10/74 00:00:00
2	$\overline{SI}\ SII_5\ \overline{SIIA}\ \overline{SIII}$ $\overline{SI}\ SII_6\ \overline{SIIA}\ \overline{SIII}$ $\overline{SI}\ SII_7\ \overline{SIIA}\ \overline{SIII}$ $\overline{SI}\ SII_8\ \overline{SIIA}\ \overline{SIII}$	11/26/74 00:00:00-12/02/74 18:00:00 AND 12/03/74 09:00:00-12/10/74 00:00:00
3	DI_4 DI_5 DI_6 DI_7 $DI\ DII\ E_2\ \overline{F}$	11/26/74 00:00:00-12/02/74 16:00:00 AND 12/03/74 08:00:00-12/10/74 00:00:00
4	$SI_1\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}$ $SI_6\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}$ $SI_2\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}$	11/26/74 00:00:00-12/02/74 18:00:00 AND 12/03/74 08:00:00-12/10/74 00:00:00
5	$SI_3\ \overline{SII}\ \overline{SIIA}\ \overline{SIII}$ $SI\ SII_1\ \overline{SIIA}\ \overline{SIII}$ $SI\ SII_2\ \overline{SIIA}\ \overline{SIII}$	11/26/74 00:00:00-12/02/74 18:00:00 AND 12/03/74 08:00:00-12/10/74 00:00:00

Table 4. Contents of PIOSAG

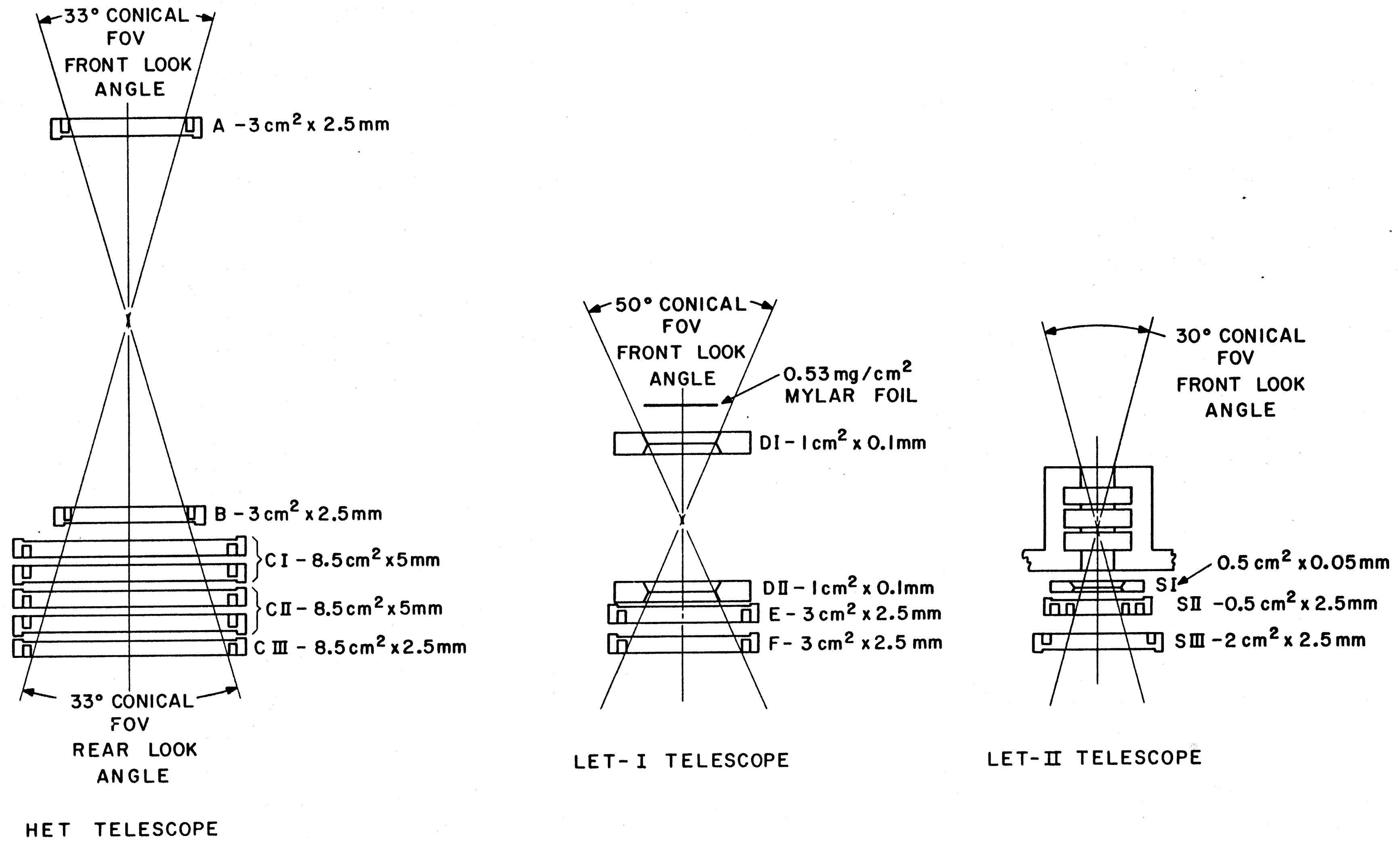
FILE	RATES	TIME PERIOD
1	A_2	8/31/79 00:00:00-9/01/79 13:30:00 AND
	$\overline{\mathrm{SI}}\ \mathrm{SII}_5\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	9/01/70 19:00:00-9/04/79 12:00:00
	$\overline{\mathrm{SI}}\ \mathrm{SII}_6\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
	$\overline{\mathrm{SI}}\ \mathrm{SII}_7\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
	$\overline{\mathrm{SI}}\ \mathrm{SII}_8\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
2	DI_5	8/31/79 00:00:00-9/01/79 13:30:00 AND
	DI_6	9/01/70 19:00:00-9/04/79 12:00:00
	DI_7	
	$\mathrm{DI}\ \mathrm{DII}\ \mathrm{E}_2\ \overline{\mathrm{F}}$	
3	$\mathrm{SI}_1\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	8/31/79 00:00:00-9/01/79 13:30:00 AND
	$\mathrm{SI}_6\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	9/01/79 19:00:00-9/04/79 12:00:00
	$\mathrm{SI}_2\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	
4	$\mathrm{SI}_3\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	8/31/79 00:00:00-9/01/79 13:30:00 AND
	$\mathrm{SI}\ \mathrm{SII}_1\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	9/01/79 19:00:00-9/04/79 12:00:00
	$\mathrm{SI}\ \mathrm{SII}_2\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	

Table 5. STRUCTURE OF FLUX TIME-HISTORY RECORD

WORD	HALFWORD	TYPE	DESCRIPTION
1	1	Integer	Number of data items contained in the record (NBIN).
3-35	2	Integer	Number of averaging intervals (NINT) contained in the record.
3-35		character	132-character title identifies satellite and gives the start time of first averaging interval and last averaging interval in the record.
36-68		character	132-character description of first data item.
69-101		character	132-character description of second data item, if NBIN $\geq$ 2. Otherwise, not used.
102-134		character	132-character description of third data item, if NBIN $\geq$ 3. Otherwise, not used.
135-167		character	132-character description of fourth data item, if NBIN $\geq$ 4. Otherwise, not used.
168-200		character	132-character description of fifth data item, if NBIN $\geq$ 5. Otherwise, not used.
		NBIN $\leq$ 5	
201-			NINT Averaging Interval Entries (AIE). The structure of an AIE is shown in Table 5.
		NBIN = 6	
201-233		character	132-character description of sixth data item.
234-			NINT Averaging Interval Entries.

Table 6. STRUCTURE OF AVERAGING INTERVAL ENTRY

WORD	HALFWORD	TYPE	DESCRIPTION	
1	1	Integer	2-digit year	Start time of averaging interval
	2	Integer	month of year	
2	1	Integer	day of month	
	2	Integer	hour of day	
3	1	Integer	minute of hour	
	2	Integer	second of minute	
4-(3+2*NBIN)		Real	NBIN FLUX entries. Each FLUX entry is two words long. If the second word of the entry is -1.0, data for this item is not available; otherwise the first word is the value of flux and the second word contains the associated statistical error.	



HET TELESCOPE

LET-I TELESCOPE

LET-II TELESCOPE

PIONEER F & G DETECTOR COMPLEMENT
COSMIC RAY ENERGY SPECTRA

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Domchick

The Pioneer 10/11 Cosmic Ray Experiment of Goddard Space Flight Center/University of New Hampshire

The Goddard/University of New Hampshire cosmic-ray experiments on Pioneers 10 and 11 and the Goddard cosmic-ray experiment on Helios-1 and -2 are essentially identical. A schematic drawing of the detector systems is shown in Figure 1 and their parameters are summarized in Table 1. The High-energy Telescope (HET) is used to determine the helium energy spectrum between 20 and 500 MeV per nucleon and the proton spectrum between 20 and 56 MeV and 120 and 300 MeV. The particle trajectory for the HET is defined by the A and B detectors. Stopping particles in this telescope are identified by the additional requirement that there is no signal from the CIII detector. This stopping particle mode covers the range from 20 to 56 MeV per nucleon for both protons and α-particles. For penetrating α-particles and protons with energies greater than 56 MeV per nucleon, the HET becomes a triple dE/dx device. In this case, the energy is determined by the energy loss measured in the 1 cm CI + CII stack of solid-state detectors and the pulse-heights measured in B and CIII are both required to be in an interval that is consistent with a given particle of this energy. This threefold multiparameter analysis reduces the background level of spurious events to a negligible level. It is estimated that the absolute uncertainty in the α flux is ~ 12% at 400 MeV and ~ 7% at energies below 200 MeV. The operation of the LET-I telescope (Fig. 1) is similar to the stopping particle mode of the HET except that the thin 100 μm dE/dx devices (DI and DII; Fig. 1) permit multiparameter measurements to be made from 3.2 to 21.6 MeV per nucleon for protons and helium nuclei. The multiparameter measurements used in this study reduce to a negligible amount any corrections due to the presence of large quantities of radioactive material in the Pioneer 10 and 11 power supplies.

The total radiation damage produced by energetic electrons and protons incident on the Goddard/University of New Hampshire experiment during the passage of Pioneer 10 through the Jovian magnetosphere was sufficiently high that some four electronic failures were induced by radiation damage effects. The most serious of these was the loss of the E detector information from the LET-1 telescope. It was found that the complete 3-21 MeV per nucleon energy range of this detector could be obtained for stopping α-particles by using a two-parameter analysis of DI vs. DII with only a small increase in background ($\leq$ 7%). The other failures occurred at several points in the data system but in such a manner that either redundant information is available or--in one case--a correction factor (which generally was on the order of 3-5%) could be derived from the available data.

ELECTRONICS

Pulses from each detector are amplified and shaped in a preamp/post-amplifier, and applied to one or more pulse-height discriminators which produce logic pulses of uniform amplitude and width for each input pulse exceeding the threshold. These logical pulses are used to form the many coincidence-anticoincidence conditions corresponding to various particle energies and types. Both single detector rates and coincidence rates are counted in 24-bit binary counters. Sixty-one such rates are monitored in the Pioneer instrument and 83 rates are monitored in Helios. The Pioneer rates are shown in Table 2; Helios rate data includes additional LET-II rates and the 2-8-keV X-ray rates. Certain coincidence conditions may initiate pulse-height analysis of selected events. The pulse amplitudes of three selected detector outputs are digitized by three 10-bit analog-to-digital converters (ADC).

Linear Circuits

The pulse-height analyzer and coincidence system electronics for the Pioneer and Helios missions were accomplished using nearly identical designs. The same building blocks contained in Pioneer were used, with only slight modification, in the Helios systems. Each experiment contained three mechanically- and electrically-separate subsystems, one for each telescope. Since Helios contains two identical LET-II's, this subsystem is exactly double its Pioneer counterpart.

The preamps use an FET input in a conventional cascade configuration. After shaping with single integration and differentiation time constants of 0.6 μsec, the pulses are differentially coupled to noise-cancelling linear buffers to eliminate common mode noise pickup. CMRR was measured to be ~ 50 db at the frequencies of interest.

Each of the HET, LET-I and LET-II subsystems operates in a similar fashion. Figure 2 shows the HET system. Each noise-cancelling buffer is followed by another buffer to boost the incoming signal to a level suitable for pulse-height discrimination. The nominal low-level signal to be discriminated corresponds to Channel 1 of the PHA, or 5 millivolts. These low-level discriminators are stable with ± 0.5% total drift from -20°C to +40°C. A lower power version of discriminator is also used where ± 2% stability is tolerable. Three of eight discriminators in HET are of this variety.

Two linear summing amplifiers are used in HET. The first linearly adds the CI and CII buffered inputs. This sum is presented to the PHA for analysis under the proper conditions, and, hence, must exceed the linearity requirements of the PHA. The second summing amplifier adds the signals A and B with a weighted output from the first summing amplifier

(A + B + 1.8 [CI+CII]). This signal is fed into two discriminators for use in the coincidence logic to separate protons from electrons and to separate $Z \geq 2$ particles from protons.

In the HET system there are 15 basic coincidence equations, none of which has less than 5 terms. Six additional singles rates are produced. These are multiplexed into the 10 rate outputs. Four of the coincidence conditions are used in the PHA control logic. Inputs to these equations are both pulse and level. The pulse inputs are derived from the discriminators while the levels are derived from the data system to control commutation of the rates.

To insure that coincidence timing is not affected by "discriminator walk" when two pulse inputs are coincident, an active delay has been incorporated. Since the B input appears in all multi-pulse equations, it is delayed 1.5 microseconds using a monostable circuit. The remaining 7 discriminators are followed by 3.0 microsecond monostables. The delayed edge of the B monostable is fed to an edge-coupled high-speed gate, whose other "anding" inputs are 3.0 microsecond-wide pulses or levels. This method insures that if all inputs are coincident with 1.5 microseconds, the proper equation timing will be fulfilled.

The coincidence system also selects events for pulse-height analysis. There are four coincidence conditions which can initiate analysis; two contain the term CIII (penetrating particles) in which case BI, (CI+CII)and CIII are analyzed. The other two conditions contain $\overline{\text{CIII}}$ (stopping particles) for which A, B and (CI+CII) are analyzed. Priority selection of event types allows higher priority events to be analyzed and stored in place of lower priority events. The relative priority of the four event types is rotated so that each type has highest priority for one-fourth the time. This emphasizes the occurrence of relatively rare events in the data.

The PHA system contains four delay lines and linear gates, three height-to-time converters, a gated current source and a gated clock. When an acceptable event has occurred, "open" signals are sent to the proper linear gates (B, [CI+CII] and A or CIII). The input signals are delayed 3.5 microseconds to compensate for delays in the coincidence and priority logic matrices.

The HTC is of the Wilkinson discharge type, the usual choice for nuclear spectrometers because of its excellent differential linearity characteristics. The gated constant current source remains on between events and is turned off slightly after opening of the linear gate. This minimizes the effect of noise spikes associated with opening of the linear gate, and improves the low-channel resolution and linearity significantly. The PHA's are able to resolve Channel 1 (5 millivolts) and produce a total differential non-linearity of ± 1.5% over the top 99% of full scale (5 volts or Channel 1024). The digitizing clock is 500 kHz, providing a 2-millisecond conversion time for full-scale inputs. The three 1024 channel PHA's used in HET require less than 30 milliwatts of power.

The PHA system outputs three gated pulse trains which are counted in binary counters. Additional tag bits are stored with each three-parameter PHA quantity which identifies the event type, priority, sector ID of spacecraft spin and a CII range indicator to further characterize each event.

The LET-I and -II systems shown in Figures 3 and 4 operate very similarly to HET. The linear buffers, discriminators and coincidence matrix use the same circuits as in HET. LET-I PHA data contains digitized values of the DI, DII and E detector pulses, and tag bits provide sector ID, priority and event type information. A two-level priority system is used, and both event types are allotted equal time as highest priority events. The coincidence rates detected by LET-I and -II are also listed in Table 2.

Data Systems

All rate data is counted in "Mars bugs," a custom PMOS LSI chip developed at GSFC. A single chip contains a 24-bit binary counter, a quasi-log compressor to convert the 24-bit binary number to a 5-bit characteristic and a 7-bit mantissa and a 12-bit storage buffer to hold the data for readout. PHA data are also counted and stored in PMOS IC's. The Pioneer and Helios PMOS data systems are quite similar in design. All spacecraft interface, command processing logic, control of the accumulation intervals and formatting of Rate and PHA data into the available telemetry space is accomplished in a spacecraft-unique Interface Data System (IDS) using low-power T^2L circuits. Discreet components were used where necessary to comply with spacecraft interface impedances and levels.

The telemetry formatting was designed to keep the rate data cycle time between 3 and 7 minutes for as many bit rates and formats as possible which were most likely to be used during a nominal mission, or not more than one-half of the science telemetry available to each experiment. PHA data is inverleaved with rate data and can process up to 3 events per second on available bit rates. PHA telemetry is always equally divided between HET and LET. Because of the wide variation in bit rate (2048/sec to 16/sec) on Pioneer, a complete data cycle for all rates becomes as long as ~ 1.7 hours.

The experiment acquires spin-sectored data. A sectored rate synchronizer generates suitable control signals to insure that the sectored rate accumulators are live for an exact integral number of spacecraft revolutions. The number of revolutions is determined by the bit rate in use and varies from 1 rev/readout to 31 rev/readouts (spin rate $\simeq$ 5 RPM), and between 53 rev/readouts to 2231 rev/readouts on Helios (spin rate ~ 60 RPM). Sectors are 45° wide on both spacecraft.

Commandable features include (a) disabling the sector synchronizers in the event of failure and (b) turning on internally-generated test pulses to stimulate the electronics for pre-flight and in-flight checkout.

This hardware is an example of an extremely lightweight, low-power electronic design for severe environmental conditions. The experiment qualified in vibration at 50 g's and was subjected to almost 5×10^5 rads in Jovian radiation belts. It has already been operating in flight for 9 years, and we expect to be able to receive data from Pioneer 10 until the telemetry signal is lost. Weight was a major problem, especially on Pioneer. The experiment weighed 2.2 kg for the sensor systems, the electronics system consisting of the charge-sensitive preamplifiers, shaping amplifiers, thresholds and logic circuitry, priority control system, six 10-bit pulse-height analyzers, an extensive data system and the low-voltage and detector bias dc-dc converters. Power consumption was 2.4 watts. The Pioneer experiment includes more than 8,000 discrete electronic components per system and more than 40,000 transistors--largely in medium- and large-scale integrated circuits.

Experiment performance has been excellent. Figure 5 shows the LET PHA data for the August 1972 event. This is a plot of the average dE/dx value ([DI + DII]/2) vs. the E value with a consistency check applied to the DI and DII values. The chemical elements are readily identified, and isotopic separation, even for the Magnesium line, is possible.

TIME PERIOD COVERED

The data for the planetary encounters has been excluded from these tapes. The following time periods were, therefore, excluded from the interplanetary data for the spacecraft/encounter indicated:

Pioneer 10/Jupiter: 11/26/73, 00:00, to 12/16/73, 00:00

Pioneer 11/Jupiter:	11/26/74, 00:00, to 12/10/74, 00:00
Pioneer 11/Saturn:	08/31/79, 00:00, to 09/05/79, 00:00

This data will be supplied on their own tapes complete with similar documentation concerning their content.

The time periods included on these tapes are as follows:

Pioneer 10:	03/06/72, 00:00, to 01/01/81, 00:00
Pioneer 11:	04/02/73, 00:00, to 01/01/81, 00:00

Table 3 lists the particles and their energy range to which the different rates are sensitive.

DATA FORMAT

Time-history of Pioneer Cosmic-ray Telescope data described above is being submitted on 9-track tapes recorded at 1600 BPI. The tape marked PIOEPF contains Pioneer 10 data and the one marked PIOEPG contains Pioneer 11 data.

Each tape contains one file of data. The file consists of a number of frames. A frame covers a period of one month or less and consists of eight Flux Time-history (FTH) records. Data items contained in the FTH records in each frame are described in Table 3. An FTH record contains a count of the number of data items (NBIN) whose time-history is included in the record, a count of the number of averaging intervals (NINT) included in the record, definitions of data items included and time-history data. Table 4 defines the structure of an FTH record in detail. These tapes were generated on an IBM System 360 computer; thus, a word consists of 32 bits, half-word 1 is the high order 16-bit field of the word and half-word 2 the low order half (bits 16-31, with the left-most or MSB numbered 0). Characters are represented in 8-bit EBCDIC byte, real numbers are represented in the IBM single precision floating point format. Length (in words) of an FTH record is given by

$200 + (3 + 2 * NBIN) * NINT \qquad NBIN \leq 5$

$233 + (3 + 2 * 6) * NINT \qquad NBIN = 6$

Thus, FTH records have a maximum length of 1812 words (7248 bytes).

Table 1

Summary of the Characteristics of Each
of the Telescopes and Their Component Detectors
(One of Each Carried on Board Pioneer)

TELESCOPE	HET	LET-I	LET-II
Geometrical Factor (cm^2-ster)	.22	.155	.015
Detectors (thickness × area)	A,B: 2.5mm×3cm^2 C's: 2.5mm×8.5cm^2	DI,DII: 100μ×1cm^2 E,F: 2.5mm×3cm^2	SI: 50μ×50mm^2 SII: 2.5mm×50mm^2 SIIA: 2.5mm×50mm^2 SIII: 2.5mm×200mm^2

Table 2

RATE	COINCIDENCE	PARTICLE/ENERGY$^+$
*R1	$(A_2K_1+A_1CI)\overline{BCIII}$	Protons, $Z \geq 2$: 20-56 MeV/nuc Electrons: 2-8 MeV
*R2	$A_1\overline{A_2}B\ CIII$	Protons: >230 MeV
*	$A_1BK_2\overline{CIII}$	$Z \geq 2$: 20-56 MeV/nuc
*R3	$A_2B\ CIII$	Protons, 56-220 MeV; Alphas, >56 MeV
	$A_2BK_2\overline{CI}$	Alphas: 20-30 MeV/nuc
R4	$A_2BK_2CI\overline{CII}$	Alphas: 30-45 MeV/nuc
	A_1	
R5	$A_2BK_2CICII\overline{CIII}$	Alphas: 45-56 MeV/nuc
	A_2	
R6	$A_1\overline{A_2}B\overline{CI}$	Electrons: 2-4 MeV
	$A_1\overline{A_2}BCI\overline{CII}$	Electrons: 4-6 MeV
R7	$A_1\overline{A_2}BCICII\overline{CIII}$	Electrons: 6-8 MeV
	$A_2BK_1\overline{CI}$	Protons, Alphas: 20-30 MeV/nuc
R8	$A_2BK_1CI\overline{CII}$	Protons, Alphas: 30-45 MeV/nuc
	$A_2BK_1CICII\overline{CIII}$	Protons, Alphas: 45-65 MeV/nuc
R9	B	
	CI	
	CII	
	CIII	
R10	DI_1	
	. . .	
	DI_8	
*R11	$DIDII\overline{F}$	Protons, $Z \geq 2$: 3-21 MeV/nuc
*	$DIDII\Sigma D\overline{F}$	$Z \geq 2$: 3-21 MeV/nuc
R12	$DIDIIE_1\overline{F}$	Protons, $Z \geq 2$: 6-21 MeV/nuc
	$DIDII\Sigma DE_3\overline{F}$	$Z \geq 2$: 6-21 MeV/nuc
R13	$DIDIIE_2\overline{F}$	Protons, $Z \geq 2$: 10-21 MeV/nuc
	$DIDII\Sigma DE_4\overline{F}$	$Z \geq 2$: 10-21 MeV/nuc

Table 2, Continued:

RATE	COINCIDENCE	PARTICLE/ENERGY[+]
R14	DI	
	DII	
	E_1	
	F	
	SI	
	SII	
	SIII	
	SIIA	
R15	$\mathrm{SI}_1\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: .15-2.1 MeV
	$\mathrm{SI}_2\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: .72-2.1 MeV
	$\mathrm{SI}_3\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 1.2-2.1 MeV
	$\mathrm{SI}_4\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Alphas: .6-2.1 MeV/nuc
R16	$\mathrm{SI}\ \mathrm{SII}_1\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 2.1-21 MeV
	$\mathrm{SI}\ \mathrm{SII}_2\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 5.7-21 MeV
	$\mathrm{SI}\ \mathrm{SII}_3\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 15.1-21.2 MeV
	$\mathrm{SI}\ \mathrm{SII}_4\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Alphas: 6-21.2 MeV/nuc
SR1	$\mathrm{A}_1\overline{\mathrm{A}_2}\mathrm{B}\ \mathrm{CI}\ \overline{\mathrm{CIII}}$	Electrons: 4-8 MeV
	$\mathrm{A}_2\mathrm{BK}_1\overline{\mathrm{CIII}}$	Protons, $Z \geq 2$: 20-56 MeV/nuc
	$\mathrm{DIDII}\overline{\mathrm{F}}$	Protons, $Z \geq 2$: 3-21 MeV/nuc
	$\mathrm{DIDIIE}_1\overline{\mathrm{F}}$	Protons, $Z \geq 2$: 6-21 MeV/nuc
SR2	$\mathrm{SI}_5\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: .12-2.1 MeV
	$\mathrm{SI}_6\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: .52-2.1 MeV
	$\mathrm{SI}_7\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 1.5-2.1 MeV
	$\mathrm{SI}_8\ \overline{\mathrm{SII}}\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Protons: 1.5-2.1 MeV
	$\overline{\mathrm{SI}}\ \mathrm{SII}_5\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Electrons: .12-2 MeV
	$\overline{\mathrm{SI}}\ \mathrm{SII}_6\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Electrons: .40-2 MeV
	$\overline{\mathrm{SI}}\ \mathrm{SII}_7\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Electrons: .68-2 MeV
	$\overline{\mathrm{SI}}\ \mathrm{SII}_8\ \overline{\mathrm{SIIA}}\ \overline{\mathrm{SIII}}$	Electrons: .97-2 MeV

[+] Design goals, actual parameters for the submitted rates are listed in Table 3.

[*] Designates PHA conditions.

$K = A+B + 1.8(CI+CII)$

$\Sigma D = DI+DII +1.6E$

Table 3. Data Content of a Frame on PIOEPF and PIOEPG

FTH RECORD # WITHIN A FRAME	DATA ITEM	
1	112.0 -400.0 MeV Proton	
	30.0 - 56.0 MeV Proton	
	3.44- 5.2 MeV Proton	
	112.7 -400.0 MeV Alpha	
	30.0 - 56.0 MeV Alpha	
2	10.0 - 21.0 MeV Alpha	
	3.44- 5.2 MeV Alpha	
	2.0 - 6.0 MeV Electron	
	R1	2-8 MeV electrons, 20-56 MeV protons
	R2A	>180 (P-10), >220 (P-11) MeV protons, >8 MeV electrons
3	R2B	All $Z \geq 2$ ions with a range < 1.5 cm in Si
	R3A	56-180 (P-10)-220 (P-11) MeV protons plus > 56 MeV alphas
	R9A	0.22 MeV threshold on Det. B
	R9B	1.0 MeV threshold on Det. CI
	R9C	1.1 MeV threshold on Det. CII
4	R9D	0.23 MeV threshold on Det. CIII
	R10A	0.13 MeV threshold on Det. DI
	R10B	0.60-33 MeV protons, > 0.39 MeV alphas
	R10C	0.72-20 MeV protons, > 0.42 MeV alphas
	R10D	0.84-14.2 (P-10), 0.82-15.1 (P-11) MeV protons > 0.46 MeV alphas
5	R10E	1.1-8.1 MeV protons, > 0.53 MeV alphas
	R10F	1.60-5.1 (P-10), 1.56-5.1 (P-11) MeV protons, > 0.63 MeV alphas
	R10G	2.29-3.8 (P-10), 2.13-3.8 (P-11) MeV protons, > 0.75 MeV alphas
	R10H	> 0.99 MeV alphas with proton contamination
	R11A	3.2-21 MeV protons and alphas
6	R11B	3.2-21 MeV alphas and heavier ions
	R12A	5.6-21 MeV protons and alphas
	R12B	5.6-21 MeV alphas and heavier ions
	R15A	0.20-2.15 (P-10), 0.20-2.17 (P-11) MeV protons, alpha and ion contamination
	R15B	0.74-2.15 (P-10), 0.72-2.17 (P-11) MeV protons, 0.22-2.05 MeV alphas
7	R15C	1.24-2.15 (P-10), -2.17 (P-11) MeV protons, 0.34-2.05 MeV alphas
	R15D	0.69-2.05 (P-10), 0.66-2.05 (P-11) MeV alphas + ions
	R16A	3.2-20.6 MeV protons, plus some alphas
	R16B	5.7-20.6 MeV protons, plus some alphas
	R16C	14.9-20.6 MeV protons, plus some alphas
8	R16D	6.6-20.6 MeV alphas

Table 4. STRUCTURE OF FLUX TIME-HISTORY RECORD

WORD	HALFWORD	TYPE	DESCRIPTION
1	1	Integer	Number of data items contained in the record (NBIN).
3-35	2	Integer	Number of averaging intervals (NINT) contained in the record.
3-35		character	132-character title identifies satellite and gives the start time of first averaging interval and last averaging interval in the record.
36-68		character	132-character description of first data item.
69-101		character	132-character description of second data item, if NBIN $\geq$ 2. Otherwise, not used.
102-134		character	132-character description of third data item, if NBIN $\geq$ 3. Otherwise, not used.
135-167		character	132-character description of fourth data item, if NBIN $\geq$ 4. Otherwise, not used.
168-200		character	132-character description of fifth data item, if NBIN $\geq$ 5. Otherwise, not used.
		NBIN $\leq$ 5	
201-			NINT Averaging Interval Entries (AIE). The structure of an AIE is shown in Table 4.
		NBIN = 6	
201-233		character	132-character description of sixth data item.
234-			NINT Averaging Interval Entries as defined in Table 5.

Table 5. STRUCTURE OF AVERAGING INTERVAL ENTRY

WORD	HALFWORD	TYPE	DESCRIPTION	
1	1	Integer	2-digit year	Start time of averaging interval
	2	Integer	month of year	
2	1	Integer	day of month	
	2	Integer	hour of day	
3	1	Integer	minute of hour	
	2	Integer	second of minute	
4-(3+2*NBIN)		Real	NBIN FLUX entries. Each FLUX entry is two words long. If the second word of the entry is -1.0, data for this item is not available; otherwise the first word is the value of flux and the second word contains the associated statistical error.	

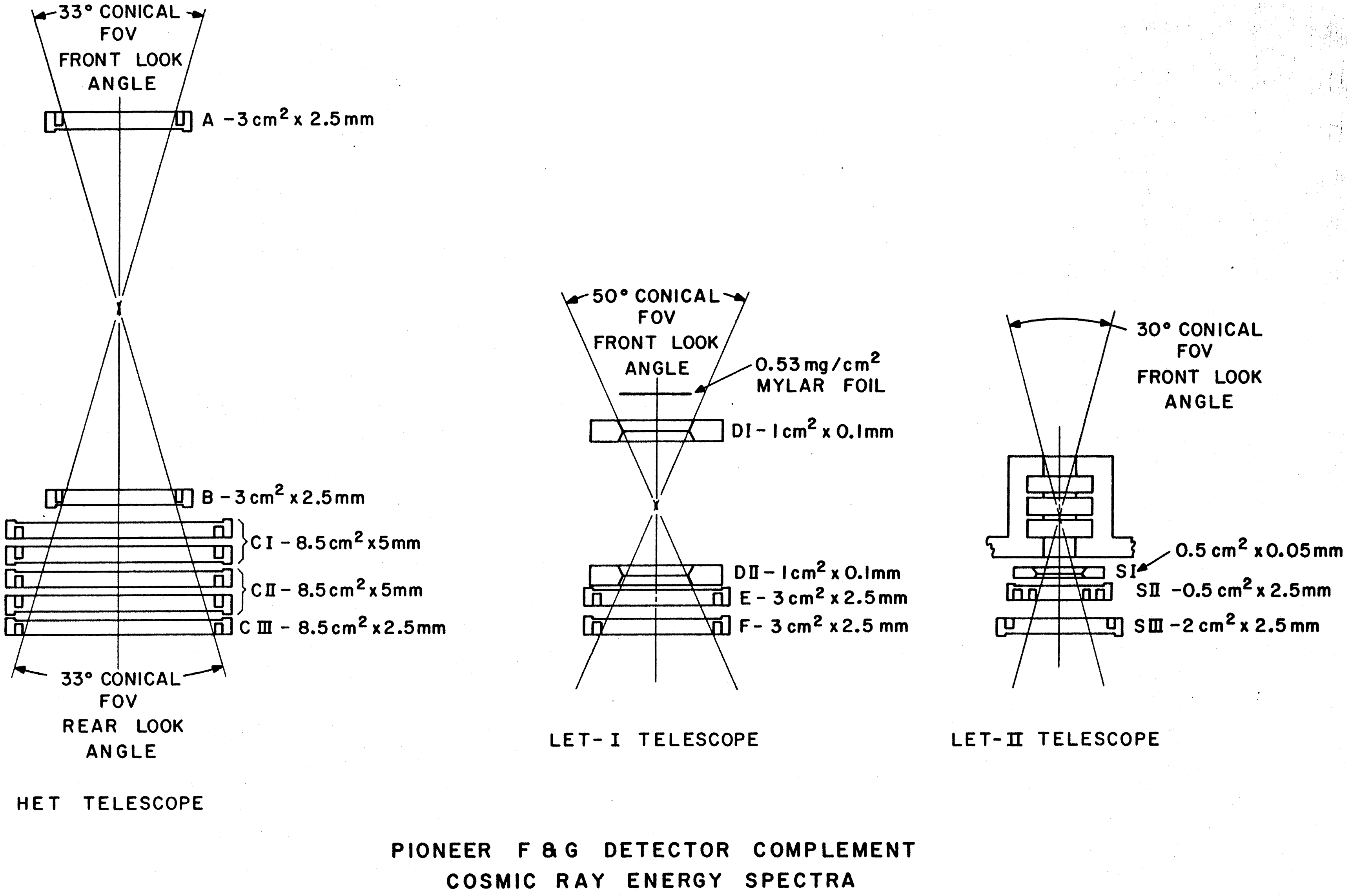

Figure 1. HET, LET-I and LET-II Telescope Assemblies.

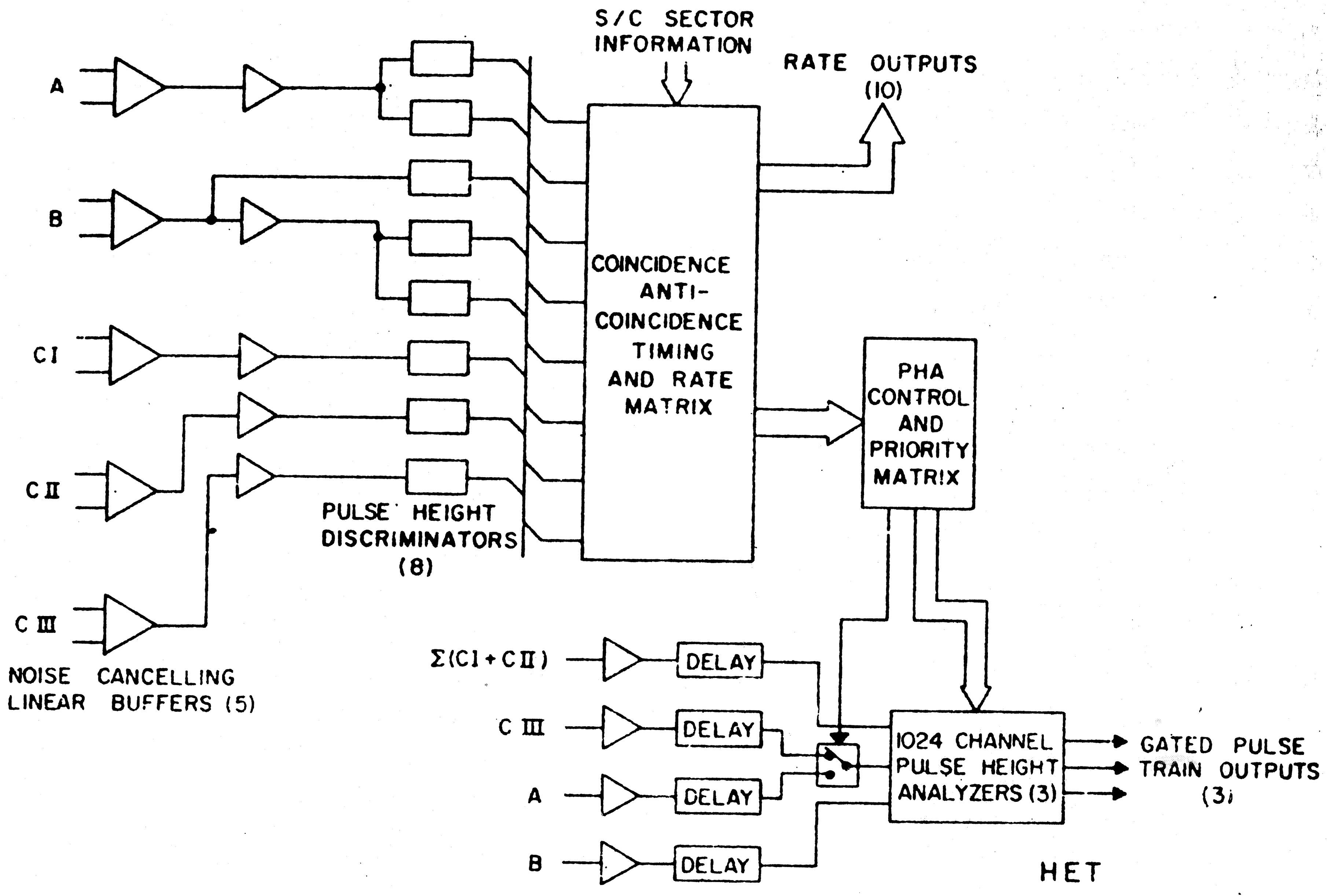

Figure 2. HET Block Diagram.

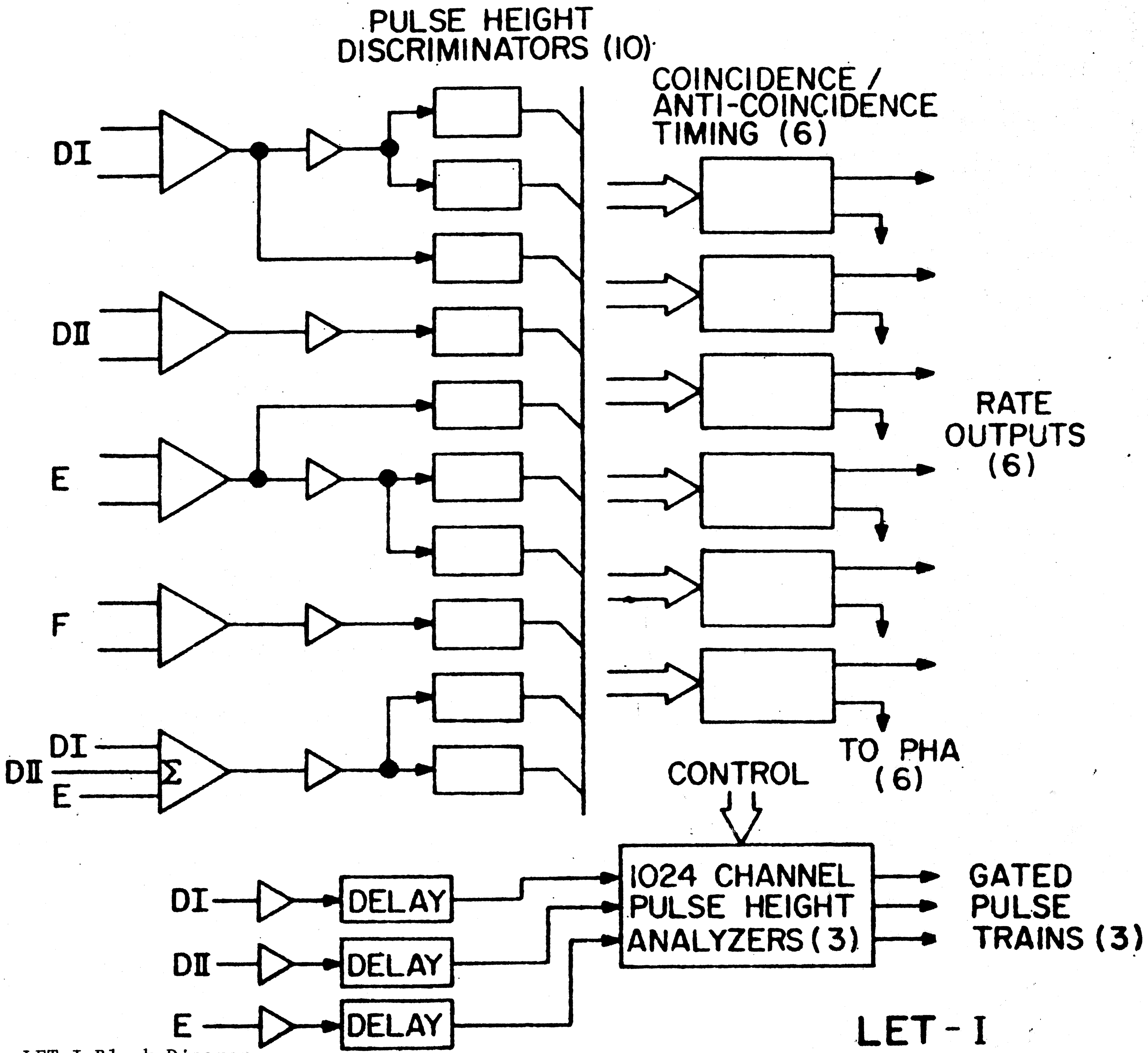

Figure 3. LET-I Block Diagram

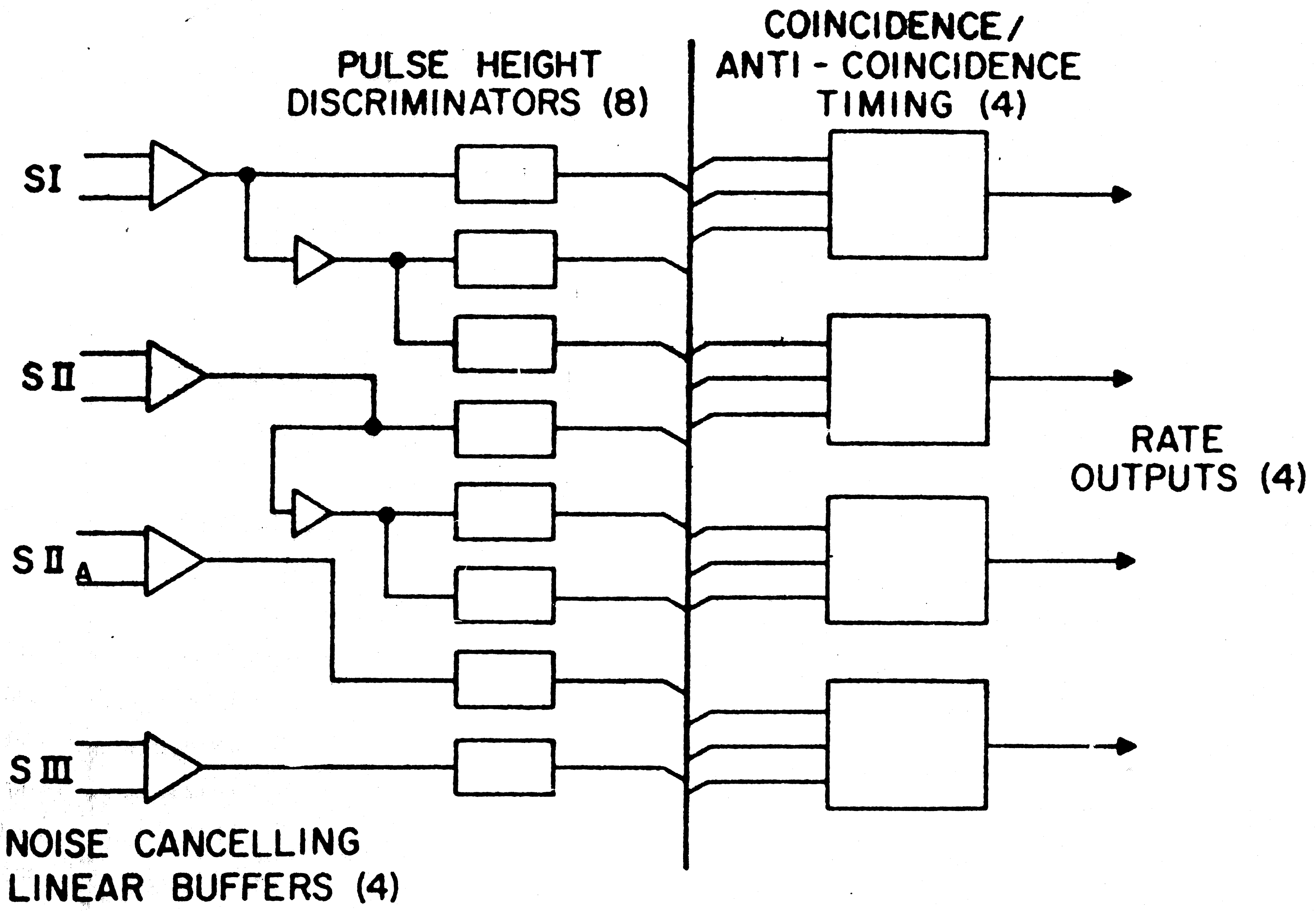

Figure 4. LET-II Block Diagram

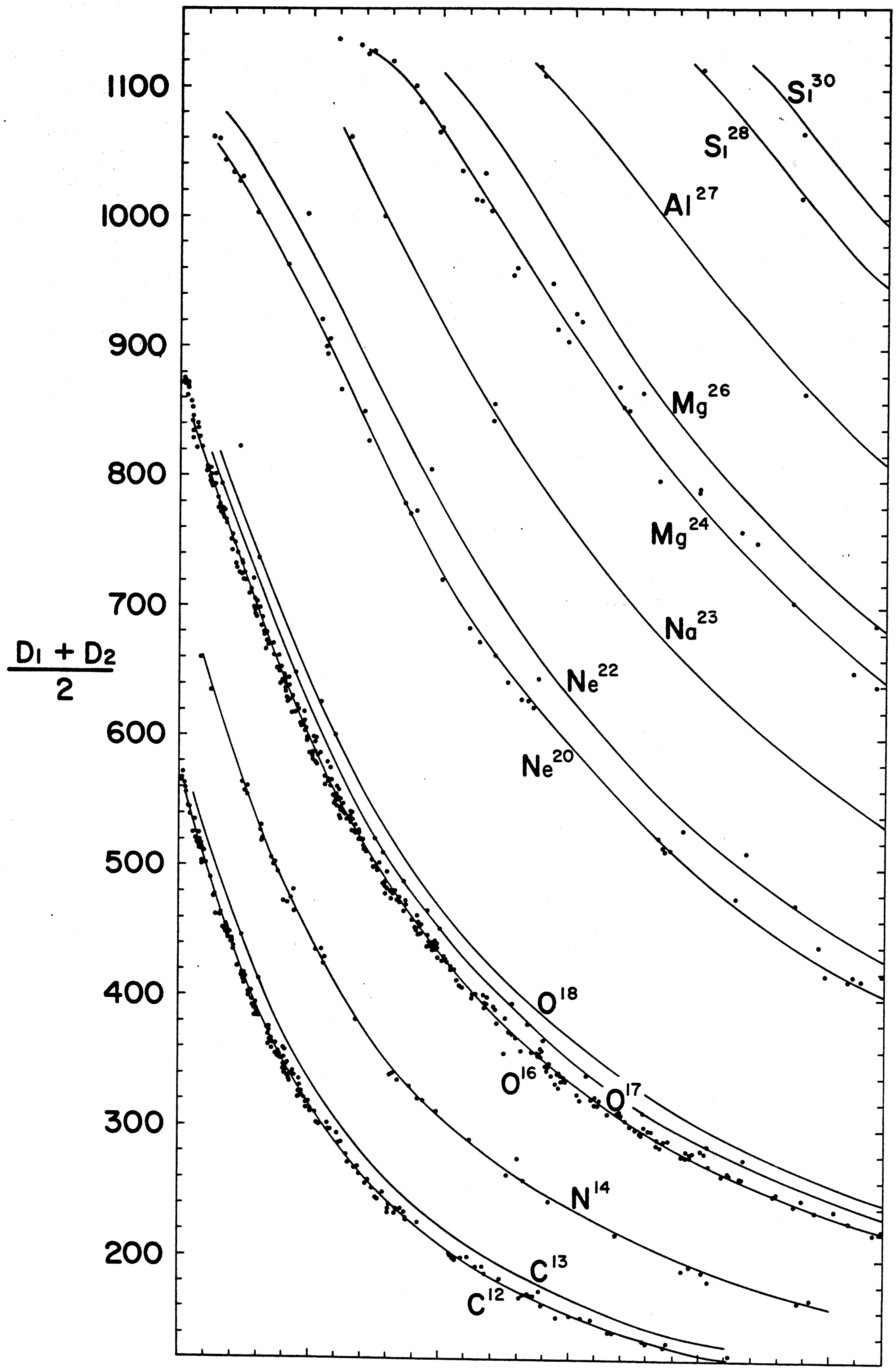

Figure 5.

dE/dx vs. E results from the Pioneer LET-I telescope during the August 1972 solar event. Clear isotopic resolution for elements up to Mg is possible.

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DOCUMENT FOR BIT2ON

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COMPUTER SCIENCES CORPORATION, SYSTEMS SCIENCES

May 1981

Hal,

For your records

INDEX

PIONEER-F BIT2ON PROGRAM

A. PROBLEM:

There is a problem with a number of bits in a Pioneer-F detecter; these bits (usually 2 and 6) intermittently fail to register. Thus, incorrect values are obtained for the rates. Since these values often differ greatly from the general trend of the data, they can cause significant errors in the fluxes.

B. SOLUTION

To correct this problem, the program BIT2ON was written. This program looks for data deviating significantly from the general trend and then tests the effect of turning on these faulty bits. If the resulting value is closer to the trend, the rate is corrected to this value. The program QUICKBIT is a version of BIT2ON which processes only the event type rates (for the specific rates, see the program description in the Programmer's Guide).

PROGRAMMER'S GUIDE

A. PROGRAM DESCRIPTION

1. BIT2ON

When the Pioneer EDR tapes are processed by PIODRP, the PIoneer rates tapes are generated, containing the values of the sectored and unsectored rates (converted to decimal form). For detailed information on the rates tape format, see Appendix B. Because of the bit failures in the satellite (usually 2 and 6), some of the rates on the EDR tapes are incorrect. Thus, there are incorrect rates written to the rates tapes by PIODRP in some cases. In order to deal with this, the BIT2ON program was developed to reprocess the rates tapes, and generate the "BIT2ON corrected" rates tapes.

The initial rates tapes are read by BIT2ON (in PFRBIT). At this point, there are two options to the approach to the reprocessing: TIMESKIP, and TIMECOPY. In the TIMESKIP option, the user can skip forward to a requested time on the input tape, and begin reprocessing from this point directly to the output tape. With the TIMECOPY option, the user may first copy part of a previously reprocessed tape to the output tape, then skip to the desired time on the input tape and start processing to the output tape following the copied data.

For the reprocessing, the program must first identify the format (A or B), and then whether the rate is sectored or unsectored. This is done in BIT2ON. The subroutine BIT2ON will then call BITUS for unsectored rates, or BITSS for sectored rates. These routines will first compare the incoming rate to the known exceptions and zero values. If a match occurs the rate is reset and the routine returns to BIT2ON for the next rate. If the rate does not match an exception or a zero rate, the routine will then move on to the bit turnon.

Before the bit turnon, the rate must be converted from decimal back to the spacecraft log form. This is accomplished with DECLOG. For a complete description of the spacecraft log - decimal conversion, see the HELDRP manual. Once the rate is in log form, the routine uses GETPUT to turn on bit 2. The rate is then converted back to decimal form by LOGDEC. At this point it must be compared to the table of permitted rates (set up in RATTAB). If it is an allowed rate, the new rate is then compared to the trend. Then, if the new rate is closer to the trend than the old rate, it replaces the previous value of the rate. This same procedure is followed for the bit 6 turnon. After the bit turnons, the trend is reset to the current rate value.

2. QUICKBIT

The QUICKBIT version of BIT2ON follows the same procedures as described above, with two exceptions: the bit 6 turn-on is not done, and only events type rates are processed. This means that the following rates are processed: SR1(ABCD), R1, R2(AB), R3A, R4B, R5B, R9(ABCD), R10(ABCDEFGH), R11(AB), R12(AB), R14(ABCD), and R15(AB).

This makes QUICKBIT about twice as fast as BIT2ON.

B. CALLING ORDER OF ROUTINES

```
PFRBIT
   RATTAB
   BIT2ON
      BITSS
         DECLOG
         GETPUT  (BTMNE)
         LOGDEC
      BITUS
         DECLOG
         GETPUT  (BTMNE)
         LOGDEC
```

C. DESCRIPTION OF ROUTINES

PFRBIT : found in SBPIO.RATELIST.SOURCE

This is the BIT2ON control routine. It mounts the tapes and skips to the requested day on the input tape, or copies up to a requested day form a previous BIT2ON tape and then skips to the same day on the input tape.

BIT2ON : found in SBPIO.RATELIST.SOURCE

This subroutine handles both formats A and B. It seperates the rates into sectored and unsectored and and calls the appropriate subroutines (BITSS or BITUS).

BITSS : found in SBPIO.RATELIST.SOURCE

This routine checks for sectored rates exceptions,and zeros, trend checks the data, and calls the bit minipulating routines. It will replace the sectored rate with the calculated (bit turned-on) rate if this new rate is closer to the trend, and reset the trend to the most recent rate.

BITUS : found in SBPIO.RATELIST.SOURCE

This is similar to BITSS, except that it is used to process the unsectored rates.

DECLOG : found in SBPIO.PFRDISP.SOURCE

This routine converts the rates decimal values back into the satellite log value.

GETPUT (**BTMNP**) : found in SDHEL.HELDRP1.SOURCE

This routine turns on the requested bit.

LOGDEC : found in SEPIO.PFRDISP.SOURCE

This routine converts the log back to decimal form.

USER'S GUIDE

A. DESCRIPTION.

The BIT2ON and QUICKBIT programs are designed to do a bit correction and trend check of Pioneer-F rates data. It can process all or part of an input tape; this processing may take place after copying a portion of a previously processed tape.

Only one input tape may be processed per run. The program has two options: TIMESKIP and TIMECOPY. The TIMESKIP option processes an input tape directly to the beginning of an output tape. The input tape may be skipped forward to a requested start time, and will continue to a requested end time. The TIMECOPY option allows a portion of a previously processed tape to be copied to the output tape before new processing begins. In both options an input start and end time determine the records to be processed. If zeros are entered for the start time, processing will begin at the first record of the tape. If zeros are entered for the end time, processing will run to the end of the tape.

If either the input or the output tape is not specified, the request will be ignored. If neither TIMESKIP nor TIMECOPY is entered in the input card, the request will be ignored. An error message is also written if the requested time interval is not found on the specified tapes.

The BIT2ON program processes all of the sectored and unsectored rates, turning on bit 2 and bit 6 in a 12 bit word. Certain rates values which are known to be exceptions (734, 778, 2296, 10208, 12256, 8421376, 16482304, 14254080, 14385152) are changed to pad (-20000000), and values which would be set to zero by turning on bits 2, 6, and 10 (14516224, 14647296) are automatically set to zero. These exceptions and zero values are read into BIT2ON as data, in a namelist (see sample JCL... &EXCEPS...). The sectored and unsectored exceptions are read in seperately (IEXCS and IEXCU). All rates coming in are re-trend checked and failed ony if they are greater than 16 times the last value.

The QUICKBIT program is a version of BIT2ON which has been modified to make it two times as fast. QUICKBIT processes only the event type rates: SR1(ABCD), R1, R2(AB), R3A, R4B, R5B, R9(ABCD), R10(ABCDEFGH), R11(AB), R12(AB), R14(ABCD), and R15(AB). The bit 6 turn-on has also been removed.

B. JCL FOR RATES

The program requires 160K of main storage.

```
//SBPIOBT2 JOB (SB0012356F,T,SA0001,001001),BF3,MSGLEVEL=1
```

```
//* BIT2ON THISDATE
//GO EXEC PGM=BIT2ON,REGION=200K
//STEPLIB  DD  DSN=SDHEL.LIB.LOAD,DISP=SHR
//GO.FT05F001 DD DDNAME=DATA5
//GO.FT06F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=7265)
//GO.FT20F001 DD DUMMY
//GO.FT30F001 DD DUMMY
//GO.FT08F001 DD SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=7265)
//GO.FT09F001 DD DSN=BIORAT,UNIT=(6250,,DEFER),DISP=SHR,
//  VOL=SER=DUMRAT,DCB=DEN=3
//GO.FT10F001 DD DSN=BIORAT,UNIT=(6250,,DEFER),DISP=SHR,
//  DCB=(RECFM=VBS,LRECL=1740,BLKSIZE=8704,BUFNO=1,DEN=3),
//  VOL=SER=DUMOUT,LABEL=(,SL,,OUT)
//GO.SYSUDUMP DD SYSOUT=A
//*DATACARD  DTYPE(1-8),ID(9-10),DTAPE(13-20),DTPOUT(21-28),
//*            DTPCPY(29-36),HTIME:  START:YR(37-38),MN(39-40),DAY(41-42)
//*                                  END:  YR(49-50),MN(51-52),DAY(53-54)
//* DTYPE=TIMESKIP     DTAPE IS MOVED FORWARD TO THE REQUESTED
//*                    START DAY AND PROCESSING IS STARTED AT
//*                    THE BEGINNING OF DTPCPY.
//* DTYPE=TIMECPY      DTPOUT IS COPIED TO DTPCPY UP TO THE
//*                    REQUESTED START TIME, THEN DTAPE IS MOVED
//*                    TO THE REQUESTED TIME AND PROCESSING IS STARTED
//*                    ONTO DTPCPY, UP TO THE REQUESTED END TIME.
//*DATACARD
//*DTAPE ID DTAPE   DTPOUT   DTPCPY   YYMMDD0YYMMDD0
//GO.DATA5  DD *
 &EXCEPS NEXCS=0,IEXCS=100*999999,NEXCU=0,IEXCU=100*999999,NZERO=0,
  IZERO=100*999999,&END
 &EXCEPS NEXCS=09,IEXCS(1)=734,IEXCS(2)=8421376,IEXCS(3)=16482304,
  IEXCS(4)=14254080,IEXCS(5)=14385152,IEXCS(6)=778,IEXCS(7)=2296,
  IEXCS(8)=10208,IEXCS(9)=12256,NEXCU=9,IEXCU(1)=734,
  IEXCU(2)=8421376,IEXCU(3)=16482304,IEXCU(4)=10208,
  IEXCU(5)=12256,IEXCU(6)=14254080,IEXCU(7)=14385152,
  IEXCU(8)=778,IEXCU(9)=2296,
  NZERO=2,IZERO(1)=14516224,IZERO(2)=14647296 &END
 &TRENDS LASTUS=128*0,LASTSS=128*0, &END
 &TRENDS LASTUS(9,1)=0174,LASTUS(4,2)=0186,LASTUS(5,2)=369,
 LASTUS(9,2)=0281,LASTUS(9,3)=0281,LASTUS(14,3)=514,
 LASTUS(14,4)=0192,LASTUS(14,6)=642,LASTUS(14,7)=102,
 LASTUS(14,8)=634,LASTUS(9,4)=0399,&END
TIMESKIP F  B00344  DSD04   DSD04   80090408009070
// EXEC NOTIFYTS
```

QUICKBIT : 0.35 CPU, 0.30 IO for approximately 1500 records (on the IBM 360/91)

BIT2ON : 0.70 CPU, 0.30 IO for approximately 1500 records (on the IBM 360/91)

JCL to run these may be found in SBPIO.LIB.CNTL under the member names : BIT2ON, and BIT2QK.

C. DATA CARDS

The trends, exceptions and zeros are read in through namelist inputs.

trends:

```
&TRENDS LASTSS(I,J)=N,LASTUS(I,J)=N ,&END
```

LASTSS = the table of sectored rates trends
LASTUS = the table of unsectored rates trends

exceptions and zeros:

```
&EXCEPS NEXCS=N1,IEXCS(1)=?,...IEXCS(N1)=?,
 NEXCU=N2,IEXCU(1)=?,......IEXCU(N2)=?,
 NZERO=N3,IZERO(1)=?,......IZERO(N3)=?,&END
```

NEXCS = the number of sectored exceptions
IEXCS = the value of the sectored exception
NEXCU = the number of unsectored exceptions
IEXCU = the value of the unsectored exception
NZERO = the number of zero exceptions
IZERO = the value of the zero exception

For an example of typical values see the JCL FOR RATES section.

Input data for tapes and processing:

card columns	description
1-8	option, must contain word TIMESKIP or TIMECOPY
9-10	HID: should be blank F
11-12	blank
13-20	input tape; data to be processed
21-28	previously processed tape to be copied
29-36	tape to which data will be copied and processed
37-38 ; 49-50	2 digit start year ; 2 digit end year
39-40 ; 51-52	start month ; end month
41-42 ; 53-54	start days ; end days
43-44 ; 55-56	start hour ; end hour
45-46 ; 57-58	start minutes ; end minutes
47-48 ; 59-60	start seconds ; end seconds

D. OUTPUT

Program output for a successful run will list: requested start and end dates, start and end date in modified julian day, the number of records processed, and the tapes involved. The program should produce one output tape of processed data.

E. ABENDS AND ERROR MESSAGES.

The following is a list of program error and information messages with appropriate user response.

1. ***CHECK TAPES FOR PROBLEM: THE NUMBER OF RECORDS COPIED (XXXXX) IS NOT THE SAME AS THE NUMBER OF RECORDS SKIPPED ON THE INPUT TAPE (XXXXX).

cause : in using the TIMECOPY option, the number of records copied from the previously processed tape is not the same as the number of records skipped on the input tape.

user response : the user should check tapes to insure that the proper tapes are being used, since in the TIMECOPY option, the files of the input and the final output tape should correspond.

2. ** UNEXPECTED END OF FILE REACHED, END OF PROCESSING FOOR THIS REQUEST ***

cause : the end of the tape was reached before the requested start time was found.

user response : check input tape and start time entered.

3. *** END OF OUTPUT RECORDS REACHED BEFORE THE REQUESTED TIME INTERVAL WAS FOUND. END PROCESSING FOR THIS REQUEST ***

cause : in the TIMECOPY option, the program copied the entire previously processed tape without reaching the requested start time.

user response : check tape requested to be copied, and the requested start time.

4. *** ERROR DTYPE (XXXXXXXX) NOT THE SAME AS EITHER DTIMES (TIMECOPY) OR DTIMEC (TIMECOPY) SO REQUEST WILL BE IGNORED ***

cause : the option entered did not correspond to either TIMESKIP or TIMECOPY.

user response: check the first eight columns of data card, to make sure the requested option is valid.

5. *** DTAPE OR DTPCPY IS NOT SPECIFIED ***

cause : a tape was not specified for either DTAPE (the input tape) or DTPCPY (the output tape).

user response: check data card (columns 13-20, and 29-36) to make sure that each tape is specified properly, starting in columns 13 and 29.

APPENDIX A: PROLOGUES

```
CH1   ROUTINE PFRBIT
CH
CH2   MAKES BIT2ON CORRECTIONS AFTER SKIPPING TO THE REQUESTED DAY
CH2   ON THE INPUT TAPE, OR AFTER COPYING UP TO THE REQUESTED DAY
CH2   FROM A PREVIOUS BIT2ON TAPE AND SKIPPING TO THE SAME DAY ON
CH2   THE INPUT TAPE.
CH
CH4   CALLS: BIT2ON, DRMJD
CH
CH5   VARIABLES:
CH5   DTYPE        R*8        TIMESKIP: TO SKIP ON THE INPUT TAPE
CH5                                     UP TO THE REQUESTED DAY
CH5                           TIMECOPY: TO COPY FROM DTPOUT TO DTPCPY
CH5                                     AND THEN SKIP FORWARD ON DTAPE
CH5   HID          I*2        PIONEER ID, F OR G
CH5   DTAPE        R*8        INPUT TAPE
CH5   DTPOUT       R*8        OLD OUTPUT TAPE TO BE COPIED
CH5   DTPCPY       R*8        NEW OUTPUT TAPE FOR BIT2ON
CH5   HTIME(12)    I*2        HTIME(1-3):START TIME; YEAR, MONTH, DAY
CH5                           HTIME(7-9):END TIME; YEAR, MONTH, DAY
CH5                           IF HTIME(1) IS 0, THE PROGRAM WILL START
CH5                              AT THE BEGINNING OF THE TAPE.
CH5                           IF HTIME(7) IS 0, THE PROGRAM WILL PROCESS
CH5                              TO THE END OF THE TAPE.
CH
CH7   L CASSWELL FEBRUARY 1980  (MODIFIED FROM PFRBIT OF ED RONISH 1978)
CH
CH9 PFRBIT *************************************************************
CH
```

```
CH1   SUBROUTINE BIT2ON
CH
CH2   THIS SUBROUTINE CYCLES THROUGH THE SECTORED AND UNSECTORED
CH2   RATES, CALLING BITSS AND BITUS TO TEST FOR EXCEPTIONS AND DO
CH2   THE BIT 2 AND 6 TURNON.  THERE ARE SECTIONS FOR BOTH A AND B
CH2   FORMAT.
CH
CH3   CALLED BY : PFBBIT
CH
CH4   CALLS: BITUS, BITSS
CH
CH7   ED RONISH    1978
CH
CH9 BIT2ON ************************************************************
CH
```

```
CH1   SUBROUTINE BITUS      *** FOR UNSECTORED RATES ***
CH
CH2   THIS SUBROUTINE TESTS FOR EXCEPTIONS, AND THEN ATTEMPTS A BIT 2
CH2   OR A BIT 6 TURNON (IF NOT RATES EXCEPTION).  EXCEPTIONS ARE PAD-
CH2   DED, WHILE OTHER RATES ARE COMPARED TO THE TREND (AFTER BIT TURN-
CH2   ON) TO DETERMINE WHETHER OR NOT BIT TURNONS BRING THE RATES CLOSE
CH2   TO THE TREND.  THE RATES MUST BE CONVERTED BACK TO LOGS BEFORE TH
CH2   BIT TURNON, CONVERTED BACK TO DECIMAL FORM, AND THEN TESTED TO EL
CH2   INATE ANY FORBIDDEN LOGS.  THE TREND IS RESET TO THE MOST RECENT
CH2   RATE AT THE END OF THE ROUTINE.
CH
CH3   CALLED BY: BIT2ON
CH
CH4   CALLS: LOGDEC, DECLOG, GETPUT(BTMNP,IGET)
CH
CH5   INPUT VARIABLES:
CH5    IUS - RATE ID SUBSCRIPT
CH5    IRATE - RATE
CH5    L -
CH5    HBTRT - BITRATE
CH5    HFMT - FORMAT
CH
CH7    ED RONISH     1978
CH
CH9BITUS ***********************************************************
CH
```

```
CH1   SUBROUTINE BITSS       *** FOR SECTORED RATES ***
CH
CH    THIS SUBROUTINE TESTS FOR EXCEPTIONS, AND THEN ATTEMPTS A BIT
CH2   2 OR A BIT 6 TURNON (IF NOT RATES EXCEPTION).  EXCEPTIONS ARE
CH2   PADDED, WHILE OTHER RATES ARE COMPARED TO THE TREND (AFTER BIT
CH2   TURN-ON) TO DETERMINE WHETHER OR NOT BIT TURNONS BRING THE RATES
CH2   CLOSER TO THE TREND.  THE RATES MUST BE CONVERTED BACK TO LOGS
CH2   BEFORE THE BIT TURNON, CONVERTED BACK TO DECIMAL FORM, AND THEN
CH2   TESTED TO ELIMINATE ANY FORBIDDEN LOGS.  THE TREND IS RESET TO
CH2   THE MOST RECENT RATE AT THE END OF THE ROUTINE.
CH
CH3   CALLED BY: BIT2ON
CH
CH4   CALLS: LOGDEC, DECLOG, GETPUT(BTMNP,IGET)
CH
CH5   INPUT VARIABLES:
CH5    M -
CH5    IUS - RATE ID SUBSCRIPT
CH5    IRATE - RATE
CH5    L -
CH5    HBTRT - BITRATE
CH5    HFMT - FORMAT
CH
CH7   E RONISH   1978
CH
CH9  BITSS  ***********************************************************
```

APPENDIX B: RATES TAPE FORMAT (TAKEN FROM PIODRP MANUAL)

A DESCRIPTION

The rates tapes are 7-track, 800 bpi tapes with standard OS/360 labels written in the binary mode and odd parity with conversion. They contain variable length, blocked records with a maximum buffer length (BLKSIZE) of 8704 bytes and a maximum logical record length (LRECL) of 1740 bytes. These tapes contain the time-ordered Pioneer GSFC/CRT events per seconds (rates) data and related spacecraft information. Each logical record contains selected spacecraft information and all the rates data for one or more pages (each page represents one fourth of an experiment cycle). All rates which fail the trend check will be indicated by a negative rate value. Whenever a rate with the value of zero fails the trend check, it will be indicated by a negative one (-1). Padded rates data will be indicated by the value -20000000.

B LOGICAL RECORD FORMAT

Mnemonic	Description
MSPAG1	Time of day (milliseconds) for first page contained in record
MSNEXT	Time of day (milliseconds) for page which is expected to immediately follow last page in record
RMJDP1	Day (relative modified Julian day) for first page contained in record
RMJDEX	Day (relative modified Julian day) for page which is expected to immediately follow last page in record
ABFILE	absolute file number
TCFLAG	Time correction flag = 0, no correction = 7, suspect time or corrected time
NPAGES	Number of pages (one-quarter experiment cycle) included in record (maximum of six for format A and five for format B)
BITRAT	Bit rate (1-16, 2-32, 3-64, 4-128, 5-256, 6-512, 7-1024, 8-2048)
FORMAT	Format (1-A, 2-A/D, 3-B, 4-B/D)
MODE	Mode =0 or 1, real time =2 Or 3, memory readout =4 or 5, telemetry store
DSSID	DSS identification

ESCID	Extended frame counter (ESC subcom ID)
RATFLG	RAT flag (roll attitude timer) =0, good value =1, old value =2, missing value =3, corrected value
SPNFLG	ASPNPDC flag (spin period)
SPFFLG	SPF flag (spin flag period)
RIPFLG	ARIPPHEC flag -- pulse/roll index pulse phase error
ROLLAT	Roll attitude timer (RAT)
SPNPDC	Spin period (ASPNPDC)
RIPPEC	Roll pulse/roll index pulse phase error (ARIPPHEC)
SPSGRR	Spin period sector generator (SPSG) roll reference =0, 0 degrees =1, 180 degrees
SPSGMD	Spin period sector generator (SPSG) mode =0, non-spin averaging =1, ACS =2, spin averaging
MSRAT	Roll attitude time (milliseconds of RAT)
DCVOLT	DC bus voltage
DCCURR	DC bus current
SPTEMP	Spacecraft platform temperature
SNR	Signal-to-noise ratio
SPARE1	Spare (currently set to zero)
SPARE2	Spare (currently set to zero)
N1	All subcom data associated with first page of data contained in record. Refer to Tables A-1 and A-2 in the PIODRP manual for a description of formats A and B, respectively. All rates data associated with first page of data contained in record. Each page consists of four sets (two sectored and two unsectored) of 16 rates which are uniquely identified by corresponding rate sequence IDs appearing in associated set of subcom data. Rates data associated with each page appears in 64 consecutive words as follows: 1 - Sectored rate (first set) SR1(1-8) SR2(1-8) 16 - Sectored rate (first set) 17 - Unsectored rate (first set) R1-R8 R9-R16

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	32 - Unsectored rate (first set) 33 - Sectered rate (second set) SR1(1-8) SR2(1-8) 48 - Sectered rate (second set) 49 - Unsectored rate (second set) R1-R8 R9-R16 64 - Unsectored rate (second set) Refer to table A-3 in the PIODRP manual to determine rates data associated with each unsectored and sectored rate sequence ID Note that redundant sectored rates data occurs whenever corresponding sectored rate sequence ID is not updated from previous value =100, format A =112, format B
N2	All subcom and rates data for second page of data contained in record (see description of first page) =356, format A =368, format B
N3	Third page of data =632, format A =656, format B
N4	Fourth page of data =908, format A =944, format B
N5	Fifth page of data =1184, format A =1232, format B
1460	Sixth page of data (format A only)