Y92RB1 - HELIOS A
Y92RB2 - HELIOS B

HELIOS MERGE TAPE-HOUR AVERAGES-PLASMA AND MAGNETIC FIELD

JUNE 1981

6250 DEN=4 FB 31828

I) Description of tape - ~~9 TRACK, 800~~ BPI, RECFM = ~~U~~, BLKSIZE = ~~292~~.
Tape is NL

LRECL = 292

II) Tape ~~is written in~~ 360 floating point and integer 32 bit ~~words.~~ There is 1 file, and the tape ~~is~~ not blocked.

CONTENTS OF TAPE

Word	Type	Description
1	I*2	Number of the particular physical record within the sequence of physical records comprising a logical record. 1 in this case.
	I*2	Number of half words contained in the physical record on the sequence minus 2.
2	I*2	Quality indicator. -1 if no mag field data is in record ϕ if mag data is high bit rate. 1 if mag data is low bit rate.
	I*2	SPACECRAFT I.D. A or B.
3	I*2	YEAR.
	I*2	CALENDAR DAY.
4	I*2	Hour.
	I*2	Minute.
5	R*4	Radial distance from sun in AU.
6	R*4	S/C Carrington longitude (Deg.).
7	R*4	S/C latitude Carrington (Deg.).
8	R*4	Proton speed (km/sec) (Vp).
9	R*4	Temperature (proton) (Tp) (1000^{o}K).
10	R*4	Proton density (cm^{-3}) (np).
11	R*4	Elevation flow angle (α^{o}).
12	R*4	Azimuth flow angle (ϕ^{o}).

13	R*4	α-particle speed (Vα) (km/s).
14	R*4	Temperature α (Tα) (1000°K).
15	R*4	Density α (nα) (cm^{-3}).
16	R*4	$\langle np\ Vp \rangle$ $(cm^2/s)^{-1}$.
17	R*4	No data.
18	R*4	No data.
19	R*4	No data.
20	R*4	No data.
21	R*4	No data.
22	R*4	No data.
23	R*4	No data.
24	R*4	ΔV (Standard Deviation)
25	R*4	ΔT (Standard Deviation)
26	R*4	Δn (Standard Deviation)
27	R*4	Δα (Standard Deviation)
28	R*4	Δϕ (Standard Deviation)
29	R*4	ΔVα (Standard Deviation)
30	R*4	ΔTα (Standard Deviation)
31	R*4	Δnα (Standard Deviation)
32	R*4	ΔnV (Standard Deviation)
33	R*4	No data.
34	R*4	No data.
35	R*4	No data.
36	R*4	Number of Carrington Rotations.
37	R*4	X_{SE} Field Component.
38	R*4	Y_{SE} Field Component.
39	R*4	Z_{SE} Field Component.

40	R*4	$(X_{SE}^2 + Y_{SE}^2 + Z_{SE}^2)^{1/2} = \bar{B}$.
41	R*4	Elevation angle at $\underset{\sim}{B}$.
42	R*4	Longitude at $\underset{\sim}{B}$ ($\phi = 0$ toward the sun).
43	R*4	Average of intensities = $\underline{B}$ (No data).
44	I*2	Number of vectors contributing to mag average.
	I*2	No data.
45	R*4	Transversal field = $(X_{SE}^2 + Y_{SE}^2)^{1/2}$.
46	R*4	Standard deviation of $\bar{B}$.
47	R*4	Standard deviation of $\bar{\bar{B}}$.
48	I*2	Flag = 1 when we had hourly averages as input to this tape's mag field data. = 2 when we had to choose between 2 semi-hourly averages.
	I*2	Quality information (0 for good data, 1 for doubtful data).

If there were no data, integer words were filled with -1 and the real words were filled with -1.0000.

DEC 12 1973

HELIOS-A

EDR

ORB/ATT LABEL

FORMAT

ORBIT + Telemetry (below)

This label will preceed all files on the ORB/ATT EDR. The label will consist of 78 characters.

Labels will be written in IBM BCD tape format, odd parity.

1 - 7 + Space	International Code
9 - 11	Tape Type (ORB)
12 - 23	Spaces
24 - 25 + Space	Year of Recording (last 2 digits)
27 - 29 + Space	File Start Time (DAY)
31 - 36 + Space	File Start Time (HHMMSS)
38 - 40 + Space	File Stop Time (DAY)
42 - 47 + Space	File Stop Time (HHMMSS)
49 - 52 + Space	O/A Master Data Tape Number
54 - 55 + Space	O/A Master Data Tape File Number
57 - 62 + Space	Date O/A EDR generated
64 - 66 + Space	O/A EDR Run Number
68 - 69 + Space	O/A EDR File Number
71 - 72 + Space	O/A EDR Reel Number
74 - 76	Experimenter ID
77 - 78	Spares

MAY 30 1974

144.		
145.	First Row (A_{11} A_{12} A_{13}) of the	
146.		
147.		
148.	Second Row (A_{21} A_{22} A_{23}) of the	**Matrix from S/C Spin Axis - Sunline Coordinates to Heliographic Coordinates**
149.		
150.		
151.	Third Row (A_{31} A_{32} A_{33}) of the	
152.		
153.		
154.	First Row (A_{11} A_{12} A_{13}) of the	
155.		
156.		
157.	Second Row (A_{21} A_{22} A_{23}) of the	**Matrix from S/C Spin Axis - Sunline Coordinates to Solar Ecliptic Coordinates**
158.		
159.		
160.	Third Row (A_{31} A_{32} A_{33}) of the	
161.		
162.	Spare	

HELIOS

2.0 Experiment Data Frame

The length of an EDR for Rate Data is 128 rate blocks. The cycle can begin with any rate block readout containing line 1 (ID=1 and A B C and D=0) and ending on line 15 (ID=1 and A, B, C and D=1). During the 128 rate blocks, the unsectored and sectored rate sequence ID bits (DS 2, DS 3, and DS 4) will cycle through all 8 possible positions.

Interspersed between rate blocks are the PHA blocks, identified by a "zero" in bit 48 of each block (ID=0). Although each PHA block contains all the information pertinent to each individual PHA event, a statistical compilation of these events is necessary. Therefore, all PHA blocks contained within the time interval defined by the rate data cycle above should be processed to yield histograms for each PHA quantity.

2.1 Description of Experiment Data Blocks

2.1.1 Rate Data Blocks

The organization of Rate Data Blocks is shown in 2.1.a, and is distinguished from PHA blocks by bit #48 always = 1. Each counter is designated in Fig. 2.1.a by the entries S-XR(1), R1, R2, or SR-1(1), SR-2(1), etc., and are readout in the sequence shown. Each entry specifies a particular counter as follows:

S-XR: These are the sectored x-ray counters. The number in parenthesis indicates the sector number relative to the x-ray axis off-set value. Each x-ray sector is either $\frac{1}{2048}$ or $\frac{1}{1024}$ of a revolution, depending on the SWB

SWB=1 SWB=0

bit, (DS-7, line 5 only).

R1, R2, etc. These specify unsectored rate counters. There are 20 such counters, and each is commutated, or sequenced, between several different rates as shown in Figure 2.1.b. The commutator position for each readout may be designated by the letters a, b, c ... h corresponding to the value of the Unsectored Rate Sequence ID (bits DS 2, 3, and 4 of lines 2, 3, 4, 6, 7, and 8). These bits are shown in Fig. 2.1.b. as A/B, SEQ. 1 and SEQ. 2 respecitvely. For example, R2 which is readout in Rate Word 4 of line 5, is shared between two different rates from the HET or E7a. When the A/B bit, as readout in DS-2 line 2, 3, 4 is zero, Rate Word 4 line 5 contains R2A, which is the number of times the coincidence condition $A_1\bar{A}_2$BCIII was detected. The next following readout of line 5 will specify A/B=1, and Rate Word 4 will contain R2b, or the number of times A_1BK_2CIII was detected.

64

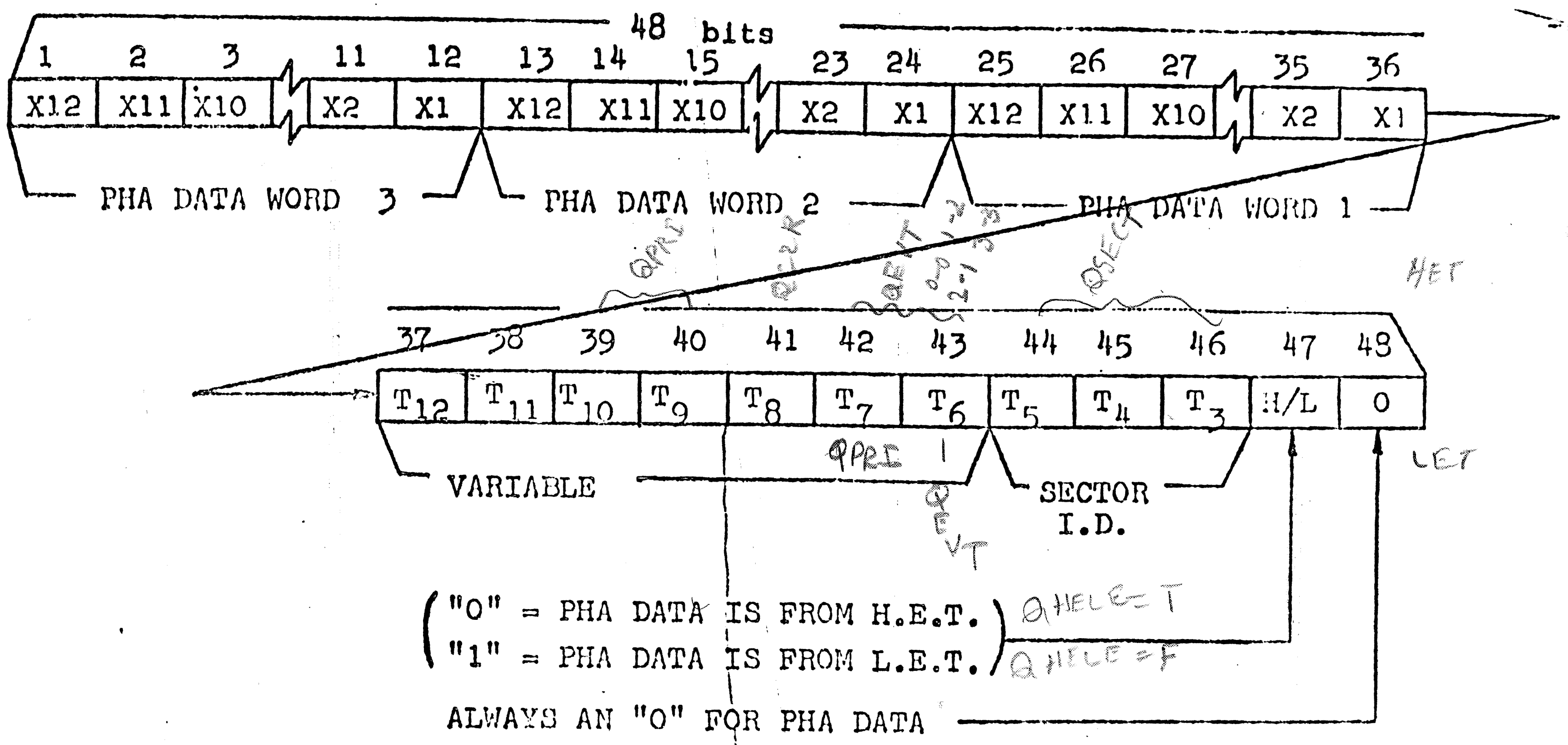
As can be seen from Fig. 2.1.b, there are 56 unsectored rates including R20, the unsectored x-ray rate (USXR). This number may be verified by noting that R1 is used for only one rate, R2-R9 and R11-R13 are each used for 2 rates, R15, 16, 18, and 19 are each used for 4 rates, and R10, R14, and R17 are each used for 8 rates.

Special attention must be given the unsectored rates R1, R9, R14, and R17 since these are not readout in a single line. Each requires 3 consecutive rate blocks to complete its readout since each rate block contains only 4 of the 12 bits necessary. For example, rate block bits 37-40 in lines 2, 3, and 4 contain the 12 bits of R9 and bit 43 (DS-2) identifies whether it is R9a (DS 2=0) or R9b (DS2=1). R14 and R17, which are readout in lines 10-12 and 14-16 respectively, are each shared between eight different

RATE INPUT	RATE	COMMUTATION BITS TO SELECT						DET
		A/B	SEQ. 1	SEQ. 2	SSEQ 1	SSEQ 2	SSEQ 3	
R1	$(A_2K_1 + A_1CI)\,B\,\overline{CIII}$							HET
R2	$A_1\overline{A_2}\,B\,\overline{CIII}$	0						
	$A_1BK_2\overline{CIII}$	1						
R3	$A_2B\overline{CIII}$	0						
	$A_2BK_2\overline{CI}$	1						
R4	$A_2BK_2CI\,\overline{CII}$	0						
	A_1 ☆	1						
R5	$A_2BK_2CI\,CII\,\overline{CIII}$	0						
	A_2 —	1						
R6	$A_1\overline{A_2}\,B\,\overline{CI}$	0						
	$A_1\overline{A_2}\,BCI\,\overline{CII}$	1						
R7	$A_1\overline{A_2}\,BCI\,CII\,\overline{CIII}$	0						
	$A_2BK_1\overline{CI}$	1						
R8	$A_2BK_1CI\,\overline{CII}$	0						
	$A_2BK_1CI\,CII\,\overline{CIII}$	1						
R9	$\overline{SI}\,\overline{SII}\,\overline{SII_a}\,\overline{SIII}$ VLET-1	0						
	$\overline{SI}\,\overline{SII}\,\overline{SII_a}\,\overline{SIII}$ VLET2	1						
R10	DI_1	0	0	0				LET
	⋮	LSB		MSB				
	DI_8	1	1	1				
R11	$DI\,DII\,\overline{F}$	0						
	$DI\,DII\,E\,D\overline{F}$	1						
R12	$DI\,DII\,E_1\overline{F}$	0						
	$DI\,DII\,E\,DE_3\overline{F}$	1						
R13	$DI\,DII\,E_2\overline{F}$	0						
	$DI\,DII\,E\,DE_4\overline{F}$	1						
R14	DI —	0	0					
	DII —	1	0					
	E_1 —	0	1					
	F	1	1					
	B —	0	0	1				HET
	CI —	1	0	1				
	CII —	0	1	1				
	CIII —	1	1	1				
R15	$SI_1\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	0	0					VLET 1
	$SI_2\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	1	0					
	$SI_3\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	0	1					
	$SI_4\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	1	1					
R16	$SI\,SII_1\overline{SII_a}\,\overline{SIII}$	0	0					
	$SI\,SII_2\overline{SII_a}\,\overline{SIII}$	1	0					
	$SI\,SII_3\overline{SII_a}\,\overline{SIII}$	0	1					
	$SI\,SII_4\overline{SII_a}\,\overline{SIII}$	1	1					
R17	SI VLET-1	0	0	0				
	SII VLET-1	1	0	0				
	SII_a VLET-1	0	1	0				
	SIII VLET-1	1	1	0				
	SI VLET-2	0	0	1				VLET 2
	SII VLET-2	1	0	1				
	SII_a VLET-2	0	1	1				
	SIII VLET-2	1	1	1				
R18	$SI_1\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	0	0					
	$SI_2\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	1	0					
	$SI_3\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	0	1					
	$SI_4\overline{SII}\,\overline{SII_a}\,\overline{SIII}$	1	1					
R19	$SI\,SII_1\overline{SII_a}\,\overline{SIII}$	0	0					
	$SI\,SII_2\overline{SII_a}\,\overline{SIII}$	1	0					
	$SI\,SII_3\overline{SII_a}\,\overline{SIII}$	0	1					
	$SI\,SII_4\overline{SII_a}\,\overline{SIII}$	1	1					
R20	USXR							X-RAY
SR1	$A_1\overline{A_2}\,BCI\,\overline{CIII}$				0	0	0	HET
	$A_2BK_1\overline{CIII}$				1	0	0	
	$DI\,DII\,F$				0	1	0	LET
	$DI\,DII\,E_1\overline{F}$				1	1	0	
SR2	$SI_5\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				0	0	0	VLET 1
	$SI_6\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				1	0	0	
	$SI_7\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				0	1	0	
	$SI_8\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				1	1	0	
	$\overline{SI}\,SII_5\overline{SII_a}\,\overline{SIII}$				0	0	1	
	$\overline{SI}\,SII_6\overline{SII_a}\,\overline{SIII}$				1	0	1	
	$\overline{SI}\,SII_7\overline{SII_a}\,\overline{SIII}$				0	1	1	
	$\overline{SI}\,SII_8\overline{SII_a}\,\overline{SIII}$				1	1	1	
SR3	$SI_5\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				0	0	0	VLET 2
	$SI_6\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				1	0	0	
	$SI_7\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				0	1	0	
	$SI_8\overline{SII}\,\overline{SII_a}\,\overline{SIII}$				1	1	0	
	$\overline{SI}\,SII_5\overline{SII_a}\,\overline{SIII}$				0	0	1	
	$\overline{SI}\,SII_6\overline{SII_a}\,\overline{SIII}$				1	0	1	
	$\overline{SI}\,SII_7\overline{SII_a}\,\overline{SIII}$				0	1	1	
	$\overline{SI}\,SII_8\overline{SII_a}\,\overline{SIII}$				1	1	1	

S-XRY Sectored X-RAY

TABLE 2.1.b



+5

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

QEVT = 2 ⇒ 1

Fig. 2.1.c

rates. The unsectored Rate Sequence ID bits in the preceeding line 2 (or 3, 4, 6, 7, or 8) must be used to identify the commutator position. Do not use the sectored rate sequence bits in the same lines as the R10 and R17 data since these bits do not specify the unsectored rate commutator position.

SR1-(1) etc. These specify sectored rate counters and the number in parenthesis specifies the 45° increment during which counting is allowed in each counter relative to the roll index pulse SPØ. Each set of SR counters is commutated among several rates as shown in Fig. 2.1.b, and the commutator position is identified by the Sectored Rate Sequence ID bits in DS2, 3, and 4 of lines 8-16. For example, Rate Word 4 - line 9 contains the number of times a given coincidence condition was detected during the first 45° of revolution following the SPØ pulse. The coincidence condition is determined by Sectroed Rate Sequence ID bits; if these bits are DS4=0, DS3=DS2=1, the commutation position is 3 and the rate is SR1c. Figure 2.1.b shows that this rate is DI DII E_1 $\overline{F}$.

2.1.2 PHA Data Blocks

The PHA data blocks are shown in Figure 2.1.c. Each 12 bit PHA data word represents the digitized amplitude of the pulse from a given detector during a specific instant in time. Incoming charged particles which traverse several detectors in a given telescope may produce a coincident condition which initiates the pulse amplitude analysis. Several additional tag-bits further identify the particle by specifying the look orientation of the telescope at the time of arrival, which of several coincidence conditions initiated the analysis, how far into the stack of detectors the particle penetrated and other non-related housekeeping bits.

The tag bit assignments for HET and LET PHA data blocks is as follows:

DATA CONTENTS

Tag Bit		HET (Bit 47=0)	LET (Bit 47=1)
T3		Sector ID (2^2)	Sector ID (2^2)
T4		Sector ID (2^1)	Sector ID (2^1)
T5		Sector ID (2^0)	Sector ID (2^0)
T6	Note	Event Type Code ($2^{\cancel{1}\,0}$) 1	Event Type Code
T7		Event Type Code ($2^{\cancel{0}}$)	PRIORITY RANK
T8		CII Range	
T9		Priority Rank Bit S1	
T10		Priority Rank Bit S2	
T11			
T12			

Each PHA data word specifies the amplitude of the pulse in a specific detector as indicated below:

PHA Data Word	HET (E7a)	LET (E7c)
Word 1	A when H Tag ~~T6~~ T7 = ~~1~~ CIII " " " = ~~0~~	DI
Word 2	B	DII
Word 3	CI+CII	E

The event type code (2 bits for HET, 1 bit for LET) specifies which of several coincidence conditions initiated the analysis. HET Tag T-6 is essentially an inverted CIII penetration indicator; when HT-6=0, the particle penetrated through the stack to CIII and the associated HET PHA Word 1 contains the amplitude of CIII. If HT-6=1, the particle did not penetrate to CIII (whose output is therefore zero) and PHA Word 1 contains the amplitude of detector A. LET-Tag T-6 is also a penetration indicator, but includes amplitude requirements as well. If LET-Tag T-6=1, the summation DI+DII+1.6E exceeded 0.400 volts. This quantity is designated ΣD and hence the corresponding event coincidence condition is DIDIIΣDF̄.

The priority rank bits S1 and S2 are simply a repeat of the two MSB's of the unsectored rate sequence ID, which are also used in establishing a variable ranked priority system. For each of the four possible combinations of S1 and S2, the coincidence event type which can initiate pulse height analysis are re-ordered so that each event types (for HET) occupies the highest priority position one-fourth of the time.

2.3 Computations Required

2.3.1 Rate Data

The minimum cycle which will readout each rate at least once is 128 rate blocks. During that time, R1 is readout 8 times; R2a and R2b, R3a and R3b, etc. through R13a and R13b are each readout twice; R15a, R15b, R15c, and R15d, etc. through R19 are each readout four times and each eight way commutated rate (R10a, R10b, etc.) is readout once only. Each rate data word must first be converted from its log to linear form and then be added to any previous readouts of the same rate, making sure that each commutated rate position is summed separately (i.e., do not add R9a and R9b together). The accumulation interval may be variable from one test to another, but must always contain an integral number of complete rate sequences (128 rate blocks per sequence). At the end of the accumulation interval, each of the sums should be listed on the printer with the corresponding count rate average. The accumulation time for R1 is essentially the entire accumulation period. The accumulation period for each of the two way commutated rates such as R2a, R2b, R3a, etc. is one-half that for R1, and so on. The period for eight-way commutated rates such as R10a or R14b is one-eighth that for R1.

At the end of each 128 rate block accumulation interval, the largest number will be in R1 since it is not commutated. With internal stimulus turned on and when operating at 4096 bps, format 5, that number should be 1,770,000 or seven decimal digits. If the accumulation interval is longer than 128 blocks, the sum will be correspondingly greater. Hence, summation to ~10^7, or 2^{24} (16,777,216) may well be required. The count rate averages, however, are not expected to exceed 20,000 per second, hence five decimal digits or 2^{16} is considered adequate.

2.3.2 PHA Data

During the accumulation interval, a histogram should be formed for each of the seven pulse height quantities (A, B, CI + CII, DI, DII and E). Since each pulse amplitude word can be as big as 2^{12}=4096, a complete set of histograms should be 7x4096=28,672 core locations wide. This is impossibly large, and for most engineering purposes 7 histograms of 50 channels each are adequate. Hence, for IST's the histogram routine should count the number of times each pulse amplitude word contains a channel numbered from 0 through 50. The routine should also contain one additional channel for each of the seven quantities to count the "overflow" channels, i.e, channel 51 and higher.

Before data is entered into the histogram, a one channel offset should be added. The PHA channel counters in the experiment are reset to all "1"'s, hence a non-event will readout as 4095, a channel one event will add one count to the 4095 causing counter overflow to all zero's, a channel two event will be readout as a 1, etc. Hence, the amplitude readout in each PHA word should be increased by 1 before entering into the histogram.

In addition to the seven histograms, a number of tally registers are required to book-keep the tag bit information. For both HET and LET, one register for each of the eight sectors should be maintained so that a total of the number of HET events in each sector and the number of LET events in each sector may be determined. Also, a total of the number of events of each type (4 for HET, 2 for LET) should be maintained.

Since a maximum of 320 PHA events in HET and LET will occur during each basic cycle of 128 rate blocks, the capacity of each core location for histograms and associated tag bit registers need only be, at most, several thousand counts. If twelve bit counters were assigned to PHA data array storage, each location would have a capacity of 2^{12}=4095 and four decimal digit readout in a printer would suffice. The number of core locations needed is minimumly:

a)	7 parameters, 50 channels ea	350
b)	7 overflow channels	7
c)	sector counters	16
d)	event code counters	6
		379

Upon completion of the accumulation interval, a listing of each of the 7 histograms and the 29 additional registers is required.

3.0 Evaluation of Test Data

A complete verification of the experiment requires the following procedures:

1. Turn on experiment and configure the command status such that CAL A and CAL B are on, S.S. is on, X-Ray H.V. is off, Force B/O is off, and XRSDM is off. This corresponds to the digital subcom word contents of 374

total.

2. Perform a real time block-by-block printout for at least 96 consecutive blocks. Verify that each rate block is followed by the correct number of PHA blocks alternating between HET and LET and the successive rate blocks increase in line number from 0 through 15. The correct number of PHA blocks occurring between rate blocks is 5 at bit rates of 4096 or 2048, 3 at 1024 or 512 FMT 2, and 1 at 512 FMT 1 and all lower bit rates.

3. Perform a data accumulation for a minimum of 128 rate blocks. Print the results and verify that the correct rates are stimulated by the internal calibrators (CAL A and/or CAL B). Also verify that the PHA readouts are in the correct channels and that approximately equal number of events appear in each of the eight PHA sectors.

4. Send one CAL command to turn both CAL A and CAL B off. Verify status (subcom word=314). With all internal stimulus off, the only count rates present are due to background radiation, noise, or interference. Accumulate rate data for at least 10 minutes; the exact period must be an integral number of 128 rate blocks and is, therefore, a function of bit rate and mode. At the end of the accumulation period, print the accumulated rate totals and averages.

5. Send one CAL command to turn on CAL A and repeat step 3.

6. Send one CAL command to turn on CAL B and repeat step 3.

7. Verify x-ray command functions and operation of x-ray off-set circuitry:

a. Load the x-ray command register with the minimum off-set (all "1"'s). This is accomplished by sending 8 pairs of X-Ray Data command followed by X-Ray Clock commands. Verify the command register status by observing all "1"'s in bits DS2 thru DS8 in rate line 1 only. Then execute the new x-ray status by sending at least two consecutive CAL commands, but make sure CAL A is left on. The X-Ray XEQ. Register readout (bits DS2 through DS8 in rate line 5) should now read all "1"'s, and S-XR(1) will show the minimum off-set, or 89 counts. Note also the value of the remaining S-XR(i) counters. This number will be a function of bit rate and S C roll rate.

b. Load the X-Ray Command Register with the maximum off-set by sending six consecutive X-Ray Clock commands followed by X-Ray Data and two additional X-Ray Clock commands. Verify the X-Ray Command Register status by noting all "0"'s in DS2 through DS7 and a "1" in DS8 (XRSDM bit) of rate line 1. Then execute the x-ray status by sending at least two CAL commands but make sure that CAL A is left on. The X-Ray SEQ. Register readout (bits DS2 through DS8 of rate line 5) should now read the same as the command register. Verify that S-XR (1) shows the maximum off-set or 119 counts and that value of the remaining S-XR(i) counters is approximately double the reading found in paragraph a above.

8. Verify the Sector Sync. on/off functions as follows:

a. at 4096 bps with the sector sync. on, those sectored rates (SR's) that are stimulated by the internal CAL are allowed to accumulate for 52 rolls. Assuming the simulated S/C roll rate is exactly 60 RPM, each counter will be on for 1/8 (52) seconds. Since the CAL pulser rate is the bit rate, the number of counts in each SR readout should be approximately 26,624 counts. Note that CAL A and CAL B must be on during this test, and that line by line printout or single-cycle (128 rate blocks) accumulation interval is required to verify this number.

b. At bit rates of 1024, 512, or 256, the SR accumulation interval is 69 rolls. The correct number of counts which should appear in single SR readout can be computed as:

$$X = \frac{1}{8} (69) \text{ Sec. x (bit rate) } \frac{\text{cts}}{\text{sec}}$$

and should be verified in at least one of the bit rates noted above.

c. The remaining stages of the roll counter can be verified only at 8 b[illegible] accumulation internal is 2208 rolls. The number of counts in a SR readout should be approximately 2208 counts. The instrument must be allowed to operate at the 8 bps made for at least two readout sequences (~40 minutes) before beginning the data accumulation interval in the computer.

9. Verify the Force Blackout command by turning Force B/O on (as indicated by the digital subcom word) and verify that no PHA blocks appear in the readout.

10. Verify the X-Ray H.V. on/off command by noting that the corresponding bit in the subcom word responds.

3.2 Test Cycle

The procedural steps outlined above provide a moderately thorough check of the instrument. These steps can be accomplished in any order and may be rearranged to merge with other S/C functions as desired. It is important during the conduct of the test to note any external conditions that can affect the results, such as the presence of radiation sources (type, strength, and location relative to the experiment), S/C activities that may produce electrical noise such as turning TWT's off or on, or radiated RF, S/C simulated roll rate if different from 60 RPM, or similar conditions.

3.3 Mode Table

The experiment cycle times and other parameters of interest as related to S C bit rate and format is shown in Table 3.3. Since the internal calibrators (CAL A and CAL B) are pulsed at the bit rate, the expected number of counts per sectored rate readout can be variable by 8 times number of rolls in the accumulation interval.

4.0 Engineering Data

4.1 Analog Data

Each analog channel, the parameter measured, and its expected analog value is listed in Table 4.1

4.2 Digital Data

Each command status is readout in the subcom word as shown below. Bit number one is the first bit readout after WTC-4 and is thus considered the most significant bit

Bit 1	X-Ray Window Clock
Bit 2	X-Ray Window Data
Bit 3	Internal Calibrator A on/off
Bit 4	Internal Calibrator B on/off
Bit 5	X-Ray H.V. on/off
Bit 6	Sector Synchronizer on/off
Bit 7	Force Blackout mode
Bit 8	XRSDM on/off

BIT Rate	Format	DM	PHA Readouts Rate Readout	#48 BIT Blocks Per Cycle	Cycle Time 128 Rate Blocks Sec.	/ Min.	# Rolls for Sectored Rate Counters	Capacity of Counters at [illegible] Readout ([illegible] RPM)
4096	5	-	5:1	768	432	7.2	52	26,624
2048	1	-	5:1	768	432	7.2	52	13,312
1024	1	-	3:1	512	576	9.6	69	8,832
512	1	-	1:1	256	576	9.6	69	4,416
512	2	-	3:1	512	576	9.6	69	4,416
256	2	-	1:1	256	576	9.6	69	2,208
128	2	-	1:1	256	1152	19.2	138	2,208
64	2/3	-	1:1	256	2304	38.4	276	2,208
32	3	-	1:1	256	4608	76.8	552	2,208
16	3	-	1:1	256	9216	153.6	1104	2,208
8	3	-	1:1	256	18432	307.2	2208	2,208
8	3	B/O	0:1	128	9216	153.6	1104	1,104

TABLE 3.3

BIT Rate	Format	DM	PHA Readouts Rate Readout	#48 BIT Blocks Per Cycle	Cycle Time 128 Rate Blocks Sec.	Cycle Time 128 Rate Blocks Min.	# Rolls for Sectored Rate Counters	Capacity of Counts in SP Readout (640 RPM)
4096	5	-	5:1	768	432	7.2	52	26,624
2048	1	-	5:1	768	432	7.2	52	13,312
1024	1	-	3:1	512	576	9.6	69	8,832
512	1	-	1:1	256	576	9.6	69	4,416
512	2	-	3:1	? 512	576	9.6	69	4,416
256	2	-	1:1	256	576	9.6	69	2,208
128	2	-	1:1	256	1152	19.2	138	2,208
64	2/3	-	1:1	256	2304	38.4	276	2,208
32	3	-	1:1	256	4608	76.8	552	2,208
16	3	-	1:1	256	9216	153.6	1104	2,208
8	3	-	1:1	256	18432	307.2	2208	2,208
8	3	B/O	0:1	128	9216	153.6	1104	1,104

TABLE 3.3

TABLE 4.1

Analog Channel	Connector Pin	Parameter	Estimated Value
ASE 7-1	26	HET Temp	-
2	10	VLET-2 Temp	-
3	27	Det.Mnt.Plate Temp	-
4	11	X-ray det. Temp	-
5	28	TBSP-1 Temp	-
6	12	TBSP-2 Temp	-
7	29	Electronics Temp	-
8	13	Base Plate Temp (Rear)	-
9	30	+12 V. Monitor	~4.4V
10	14	+6 V. Dig. Monitor	~4.4V
11	31	+6 V. Ana. Monitor	~4.4V
12	15	+7.75 V. Monitor	~4.4V
13	32	+4.7V	~4.6V
14	16	Base Plate Temp (Front)	

Expected values for temperature channels vary with ambient conditions and from unit to unit. No operational constraints based on these values will be imposed during testing.

5.1 Line Printer

It is required that data be displayed on the line printer in at least four different formats as described below.

5.1.1 Line-by-Line Display

Each 48 bit block should be printed in chronological order as they appear in telemetry. The component parts of each block should be separated and identified with appropriated legends on the page, and should be converted from binary to decimal or, for rate words, from log to decimal. If the printer page is wide enough (~130 columns) it would be most convenient if the rate data could be on one side of the page and the PHA data on the other side as shown in the suggested format, figure 5.1.1.

Each block results in one line of printout with only the data within that block entered on the page. Proper sequencing of the experiment readout may be easily determined from this format.

This format contains the following entries:

FR No. - frame number from the S/C frame counter in which block was transmitted.

Line No. - same as in figure 2.1.b, rate data block description

S.S. ID - The sectored rate sequence ID contained in DS 2, 3, and 4 of rate data blocks, lines 9-16

U.S.S. ID - The unsectored rate sequence ID from rate data blocks

Rate Word - The contents of the appropriate rate word should be converted from binary log to decimal fixed point form and displayed. Seven columns are required. Each rate word should also be identified by its appropriate symbol as shown in figure 2.1.a.

F.R. No.	Line No.	S.S. ID	U.S.S. ID	Rate Word 4 ID	....	A/CHH/DH	B/DH	CHCHH/E	H/L	ET	F	S
xxxx	xx		x	RIP xxxxxxx	etc.							
xxxx						xxxx	xxxx	xxxx	x	x	x	x
xxxx	xx	x		SRIA(1) xxxxxxx								

16 columns each for rate words 3, 2, and 1

Figure 5.1.1

A/CIII/DI - The contents of PHA word 1 from either HET or LET blocks, converted from binary to decimal and incremented by one.

B/DII - The contents of PHA word 2, as above.

CI+CII/E - The contents of PHA word 3, as above.

H/L - Indicates if the PHA data in that line is from HET or LET as specified by bit 47 of the PHA block.

ET - Event type designator, can be 0, 1, 2, or 3 for HET (tag bits HT6 HT7) or 0,1 for LET (tag bit LT6)

R - The range bit, 0 or 1, located in HT8, applies only to HET blocks.

S - The decimal equivalent of the S1 and S2 bits in either H or L tages.

- - Five additional columns should be reserved for the remaining tag bits and each should be displayed separately.

5.1.2 Accumulated Rate Data Dump

At the end of each rate data accumulation interval in the computer, the processed data should be listed, identifying each rate total and computed average counts/sec by the notation used in 2.1.b (R1A etc.). Also included should be the frame number in which the accumulation interval started and ended, and the total elapsed time in minutes and number of frames. The number of columns required is approximately 5 for the legend, 8 for the total counts, and 5 for the computed average.

5.1.3 Accumulated PHA Data Dump

At the end of each PHA accumulation interval in the computer, the contents of each of the 51 channels for each of seven spectra should be listed. This will require 7x5=35 columns. Each column should of course, be labled at the beginning. The frame number in which the accumulation period started and ended, and the number of frames and elapsed time should also be shown. At the end of the spectra listings, the contents of the book-keeping channels should be listed with appropriate labels.

5.1.4 Engineering Data

Analog Engineering data may be listed by identifying each quantity and then showing the value either in octal or decimal. The digital word should be listed so that the status of each command may be readily determined either bit by bit or in octal. Converting this word to decimal is not desirable.

5.2 Cathode Ray Tube (CRT)

The CRT formats should essentially follows the requirements of 5.1.1 through 5.1.4 above, but the line by line display must be abbreviated significantly. It is suggested that the legends be eliminated, but that the data always be listed beginning with rate line 1 so that the user can, by familiarity, find a specific data word if desired. Frame number could also be detected, but SS ID and US ID must remain.

5.3 Stripchart Recorder (STC)

No requirement.

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3.1 a HOUSEKEEPING DATA

HK TYPE	BIT NUMBER 1 – 12	13 – 24	25 – 36	37	38	39	40	41	42	43	44	45	46	47	48
0	RATE (SLOW)	RATE (MED)	RATE (FAST)	0	0	A	2^0	2^1	2^2	0	0	0	P	0	0
1	THRESHOLD(S)	THRESHOLD(M)	THRESHOLD(F)	0	0	B				1	0	0	P	0	0
2	PWR	CALENDAR TIME (35 BITS)		0	0	AUTO				0	1	0	P	0	0
3	ACCUM. A(18 BITS)	ACCUM. B(18 BITS)		0	0	ROI				1	1	0	P	0	0

- Bit 37: γ-RAY ID
- Bit 38: HK/MEM ID
- Bit 39: MODE
- Bits 40–42: TRIGGER COUNTER
- Bits 43–44: HK TYPE ID
- Bit 45: ~~NOT USED~~ B43
- Bit 46: PARITY
- Bit 47: ~~NOT USED~~ B44
- Bit 48: γ-RAY / PHA ID ≡ 0

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Monolithic Systems
303 770 7400

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3.1 b MEMORY DATA

BIT NO.	1-12	13-24	25-36	37	38	39	40	41	42	43	44	45	46	47	48
	M (SLOW)	M (MED)	M (FAST)	0	1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	P	T	0

- Bits 39–45: MEMORY ADDRESS
- Bit 47: CALENDAR TIME

FIG

Rate Word 4 Bits 1-12	Rate Word 3 Bits 13-24	Rate Word 2 Bits 25-36	37	38	39	40	41 DS 4	42 DS 3	43 DS 2	44 D	45 C	46 B	47 A	48 TD	
S-XR(1)	S-XR(2)	S-XR(3)	(MSB) .... Mode Word Reg. .. (LSB)							0	0	0	0	1	0
S-XR(4)	S-XR(5)	S-XR(6)	X4	X3	X2	X1	(MSB)		(LSB)	1	0	0	0	1	1
S-XR(7)	S-XR(8)	USXR(R20)	R9 a or b				Unsectored Rate Sequence ID			0	1	0	0	1	2
R16	R18	R19	C5	C4	C3	C2				1	1	0	0	1	3
R2	R3	R4	XSDRM	SWB X-Ray	$\overline{16}$ Xeq.	$\overline{8}$ Reg.	$\overline{4}$	$\overline{2}$	$\overline{1}$	0	0	1	0	1	4
R5	R6	R7	X4	X3	X2	X1	(MSB)		(LSB)	1	0	1	0	1	5
R8	R10	R11	R1				Unsectored Rate Sequence ID			0	1	1	0	1	6
R12	R13	R15	C5	C4	C3	C2				1	1	1	0	1	7
SR1-(1)	SR2-(1)	SR3-(1)					(MSB)		(LSB)	0	0	0	1	1	8
SR1-(2)	SR2-(2)	SR3-(2)	X4	X3	X2	X1	Sectored			1	0	0	1	1	9
SR1-(3)	SR2-(3)	SR3-(3)	R14				Rate			0	1	0	1	1	10
SR1-(4)	SR2-(4)	SR3-(4)	C5	C4	C3	C2	Sequence			1	1	0	1	1	11
SR1-(5)	SR2-(5)	SR3-(5)					ID			0	0	1	1	1	12
SR1-(6)	SR2-(6)	SR3-(6)	X4	X3	X2	X1				1	0	1	1	1	13
SR1-(7)	SR2-(7)	SR3-(7)	R17							0	1	1	1	1	14
SR1-(8)	SR2-(8)	SR3-(8)	C5	C4	C3	C2				1	1	1	1	1	15

RATE DATA BLOCKS

HELIOS COSMIC RAY EXPERIMENT (E-7)

DRAFT

SECTION 1 - INTRODUCTION

Helios is a joint scientific effort between the Unites States and Germany to explore the solar plasma close to the Sun. The two spacecrafts, Helios-A (December 1974) and Helios-B (December 1975), contain a series of scientific experiments to investigate different aspects of the solar plasma.

The experiment (No. 7) for which this data processing system is written examines charged particles. It consists of three sensor systems (HET, LET-1, LET-2), plus a gas proportional counter which predominantly responds to X-ray photons in the 2 to 8 KeV energy range. The charged particle detector systems are made up of from four to seven silicon diodes operated with a reverse bias adequate to fully deplete the diodes. If a charged particle passes through a diode, ionization along the path through the detector results in hole-election pairs being formed along this path. The applied electric field causes the charge to be swept up, forming a charge pulse which is then accurately measured by the electronics.

The gas proportional counter ~~really~~ is two independent counters sharing one pressure vessel. The primary X-ray data is obtained through a very narrow collimator. Using on-board electronics, one can accumulate data in eight sections of 0.17° or 0.34° centered on the Sun. Such a system allows as to monitor and locate sources of solar activity. The second aperature is viewed by means of a 53° collimator. Only low energy X-rays are allowed through the foils. This counter monitors detector background as well as low energy solar electrons.

The charged particle (cosmic ray) experiment outputs minor frame data of two basic types, RATE and PHA. RATE data is a 12-bit binary number representing the total number of times per accumulation interval that signals exceeding specific amplitudes from one or more detectors in each telescope occurred in coincidence.

PHA (Pulse Height Analyzer) data represents the digitized amplitude of each of three specified detector signals appearing in coincidence. This amplitude indicates the energy loss of the charged particle in the particular telescope element. The PHA digitizes the amplitude of each pulse into one part in 4096 called a channel corresponding to predetermined energy ranges.

The Helios Data Processing System has been written to parallel Pioneer's Data Processing System as much as possible. Whenever applicable, the Pioneer code was extracted and used in the corresponding Helios routine. This approach has reduced redundant coding considerably. Any programmer who maintains this system and incorporates enhancements into it should investigate making similar enhancements to the corresponding Pioneer logic. Figure 1-1 is an overview of the Helios Data Processing System.

SECTION 2 - DATA REDUCTION PROGRAM

2.1 OVERVIEW

The Data Reduction Program is the initial step in reducing the spacecraft telemetry data into a form that is more reliable and accessible.

The spacecraft telemetry data is received from the Information Processing Division (IPD), where the data pertaining to each individual experiment ~~is~~ are extracted from a master data tape. Once received, the data reduction program takes each minor frame and goes through a series of reliability checks. These include time, continuity, data quality, and blackout mode verification. All data that pass the verification tests are then identified as to the type, RATE or PHA. If minor frames are missing or discarded by the verification logic, a routine (FMSYNC) is called to maintain the extremely important minor frame synchronization. This synchronization is important since RATE and PHA data are transmitted in a definite, pre-determined ratio based upon bit rate and format (see Table 1).

Once the data ~~has~~ have been verified and synchronization guaranteed, ~~it~~ they can then be identified as being either RATE or PHA. Once identified, the data ~~is~~ are then unpacked and the proper series of subroutines called to process that particular type of data.

The data ~~is~~ are temporarily stored in core in ~~a pre-determined~~ location based ~~upon~~ on their ~~its~~ position in the commutation cycle (see Table 2). Whenever an entire cycle (album) of telemetry data has been processed, the accumulated PHA and RATE data are read out to their respective buffers.

The RATE and PHA data bases are time ordered and maintained on single file, 9-track tapes with a density of 1600 BPS. Each logical record contains data accumulated over one album, but never data of differing bit rate or format.

how do we want to change this?

A time history of data processed and options applied is maintained in the DRS tape catalog and the File/Logistics/History catalog. The DRS tape catalog provides pertinent information about the PHA, RATES, and CATALOG tapes previously created and blank tapes currently available to the system. The File/Logistics/History catalog is a permanent disk data set which provides a permanent time-ordered history of all the experimenter data record (EDR) tapes processed by the data reduction system. Four generations of backups are kept of these vital system catalogs. The tapes containing these backups are referred to as CATALOG tapes, and their volume serial numbers and generation are maintained in the DRS catalog.

2.2 SUBROUTINES

2.2.1 <u>HELDRP</u>

2.2.1.1 Functional Description

This routine serves as the executive of the data reduction system. All variable initializations, I/O operations, data unpacking, and data base updating are controlled either directly or indirectly through subroutine calls from this routine.

2.2.1.2 Calling Sequence

This FORTRAN routine serves as the executive of this system and has no calling sequence.

2.2.1.3 Subprogram and COMMON Cross-Reference

Calling Subroutines: Receives control from supervisor

Subroutines Called: HELDRP calls FTIO, EDRSUM, ENDCAT, UPKLBL, DTIME, EORCAT, EXTRCT, GETPUT, RATEND, FMOVE, CNVDAT, DRPMES, EDREND, ENDCAT, FILINT, REMTIM, CNVMJD, DRSRPT, EDRINT, ENDPHA, NEWCAT, NOSTAE, PHAEND

COMMON Blocks Referenced: DATREC, LOGHIS, RECSTA, DRSTAP, TAPLST, LABEL, STATUS, RUNDAT, INTERN, ITEMS, ENGSW

2.2.1.4 Method

Processing begins by setting up the defaults for the system operating options. These defaults can then be overridden by a read from the NAMELIST OPTION. elaborate! A series of option verifications follow, which guarantee that the requested processing can be initiated.

If normal production processing is being performed, a check is then made via a call to REMTIM to assure that enough time is remaining to completely process at least one EDR tape. When insufficient time remains, a message is written indicating the job is being prematurely terminated due to time restraints, performs the necessary end-of-job functions, and terminates the job normally.

If sufficient time remains for further processing, a card is read from the NAMELIST EDRTAP which identifies the volume serial number of the input EDR tape and processing options to be applied when processing the tape. If an input EDR tape is not specified, then the necessary end-of-job functions are performed and the job terminates.

When a valid EDR tape number is supplied to the system, then the tape is mounted and positioned to the first file. The first record of the file is then read and unpacked, which supplies information pertaining to the telemetry data written in that file. The information provided indicates the bit rate, format, and time interval over which the data was recorded.

After the header of the first file has been unpacked and validated, a call is made to EDRCAT to determine if the data on this EDR tape overlaps in time with any data previously processed. If data overlap does occur, the EDR tape is rejected and the program goes on to read another EDR tape volume serial number if one is available.

When the data on an EDR tape has been accepted for further processing, the telemetry data records are read and a call is made to EXTRACT, which controls the extraction of data fields and their validation. When an end-of-file occurs, the program positions to the next file and attempts to read another header record. If instead another end of file occurs, then an end of volume is assumed. Normal processing of the header and data records in each file will continue until the consecutive end-of-file marks are encountered.

When an end-of-volume does occur, a message is written indicating this and the tape is unloaded. A call is then made to EDRSUM to summarize and write all statistics accumulated for the data processed from the tape. A subsequent call to EDREND (an entry point in EDRCAT) will insert the catalog entry created for the EDR tape into its proper time-ordered location in the File/Logistics/History catalog.

After the end-of-volume logic is completed, the program loops back to a call to REMTIM to again verify that enough time remains to process one EDR tape. If sufficient time remains and an EDR tape is available for processing, the entire procedure of validating header records, telemetry data records, file positioning, and end-of-volume processing is repeated. If no additional EDR tapes are to be processed, the routine ENDCAT is invoked to print the File/Logistics/History catalog report and to generate the updated version of the CATALOG tapes. The Current Status Report is then written by the routine DRSRPT; the tape catalog is updated to reflect the data processed; an end-of-job message is written; and the job terminates normally. The above end-of-job procedure differs slightly when Quick-Look processing is requested. In the Quick-Look mode, the DRS tape catalogs and the current File/Logistics/History catalog are not referenced. Additionally, the CATALOG tapes are not updated.

2.2.2 Subroutine ADDFRM (alias COMFRM, MSFRAM)

2.2.2.1 Functional Description

This routine provides necessary time operations needed by the system.

2.2.2.2 Calling Sequences

CALL ADDFRM (MSP1, HDP1, HFRMS, HFM, HBR, MSP2, HDP2)

Symbol	Type	Input/Output	Description
MSP1	I*4	I	milliseconds of day to which increment is added
HDP1	I*2	I	relative modified Julian day to which increment is added
HFRMS	I*2	I	number of minor frames to be incremented
HFM	I*2	I	format of input data
HBR	I*2	I	bit rate of input data
MSP2	I*4	O	milliseconds of day after time increment is added
HDP2	I*2	O	relative modified Julian day after time increment is added

CALL COMFRM (MSP1, HDP1, MSP2, HDP2, MTMDIF)

MSP1	I*4	I	milliseconds of day assisgned to T_1
HDP1	I*2	I	relative modified day assigned to T_1
MSP2	I*4	I	milliseconds of day assigned assigned to T_2
HDP2	I*2	I	relative modified day assigned to T_2
MTMDIF	I*4	O	time difference in milliseconds (T1 - T2)

CALL MSFRAM (HFMT, HBR, MSP1)

Symbol	Type	Input/Output	Description
HFMT	I*2	I	format of input data
HBR	I*2	I	bit rate of input data
MSP1	I*4	O	minor frame accumulation time in milliseconds

2.2.2.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Subroutines Called: This routine calls no subprograms.

COMMON Block Referenced: This routine uses no COMMON blocks.

2.2.2.4 Method

The subroutine ADDFRM is called to increment an input time by a given number of minor frames. The accumulation time for a minor frame is calculated band upon the supplied bit rate and format. This calculated time is used as the time increment.

The entry point COMFRM is used to compare times from two frames. The absolute time difference in milliseconds is returned to the calling program.

The entry point MSFRAM is called to call the minor frame accumulation time at the present bit rate and format.

2.2.3 Subroutine CNVMJD (alias: CNVDAT)

2.2.3.1 Functional Description

This routine provides date conversions.

2.2.3.2 Calling Sequences

CALL CNVMJD (HMOD, HMONTH, HDAY, HYEAR)

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CALL MSFRAM (HFMT, HBR, MSP1)

Symbol	Type	Input/Output	Description
HFMT	I*2	I	format of input data
HBR	I*2	I	bit rate of input data
MSP1	I*4	O	minor frame accumulation time in milliseconds

2.2.2.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Subroutines Called: This routine calls no subprograms.

COMMON Block Referenced: This routine uses no COMMON blocks.

2.2.2.4 Method

The subroutine ADDFRM is called to increment an input time by a given number of minor frames. The accumulation time for a minor frame is calculated band upon the supplied bit rate and format. This calculated time is used as the time increment.

The entry point COMFRM is used to compare times from two frames. The absolute time difference in milliseconds is returned to the calling program.

The entry point MSFRAM is called to call the minor frame accumulation time at the present bit rate and format.

2.2.3 Subroutine CNVMJD (alias: CNVDAT)

2.2.3.1 Functional Description

This routine provides date conversions.

2.2.3.2 Calling Sequences

CALL CNVMJD (HMOD, HMONTH, HDAY, HYEAR)

Symbol	Type	Input/Output	Description
HMOD	I*2	I	relative modified Julian day
HMONTH	I*2	O	month of year
HDAY	I*2	O	day of month
HYEAR	I*2	O	two-digit year

CALL CNVDAT (HMONTH, HDAY, HYEAR, HMOD)

HMONTH	I*2	I	month of year
HDAY	I*2	I	day of month (or day of year if HMONTH=0)
HYEAR	I*2	I	two-digit year
HMOD	I*2	O	relative modified Julian day

2.2.3.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Subroutines Called: This routine calls no subprograms.

COMMON Blocks Referenced: This routine uses no COMMON blocks.

2.2.3.4 Method

The subroutine CNVMJD is called to convert a day count based on day 1 being January 1, 1972 to a date of the form month-day-year. This day count is referred to as the relative modified Julian day.

The entry point CNVDAT is called to perform the reverse function. It converts a date of the form month/day/year to its corresponding relative modified Julian date. Optionally, the month can be set to zero, and the day of the month is assumed to be day of year instead.

2.2.4 Subroutine CONTIM

2.2.4.1 Functional Description

This routine is used to convert a time in milliseconds of day to hours-minutes-seconds.

2.2.4.2 Calling Sequence

CALL CONTIM (MILSEC, HOUR, HMIN, SECOND, TYPE)

Symbol	Type	Input/Output	Description
MILSEC	I*4	I	milliseconds of day
HOUR	I*2	O	derived hours
HMIN	I*2	O	derived minutes
SECOND	R*4 or I*2	O	derived seconds
ITYPE	I*4	I	optional parameter defining the form of SECOND ITYPE=0, floating point ITYPE<0, halfword integers

2.2.4.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: This routine calls no subprograms.

COMMON Blocks Referenced: This routine uses no COMMON blocks.

2.2.4.4 Method

This routine is used to convert milliseconds into hours/minutes/seconds, where seconds may be either floating point or fixed point with thousandths of seconds. The form of the records is determined by the presence of fifth parameter in the call list. If the parameter is negative, the seconds are stored in consecutive halfwords as seconds and thousandths of seconds. Otherwise, seconds are stored in full-word,floating-point format.

2.2.5 Subroutine DRPMES

2.2.5.1 Functional Description

This routine is called for the purpose of message generating. 1

2.2.5.2 Calling Sequence

CALL DRPMES (DPROG, MESCOD, MESAGE)

Symbol	Type	Input/Output	Description
DPROG	R*8	I	name of routine requesting the message generation
MESCOD	I*4	I	message code
MESAGE	I*4	I	array containing information related to the message

2.2.5.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: FTIME, ABEND

COMMON Block References: RUNDAT, INTERN, FERMSG

2.2.5.4 Method

This routine is invoked by various routines in the data processing system for writing informative messages concerning job status.

Each message has been assigned a numeric code which is passed through the argument list along with information needed to properly write the message. Additionally, the message written informs the user of the routine invoking the subroutine call.

2.2.6 Subroutine DRSPT

2.2.6.1 Functional Description

This routine generates the Current Status Report at the end of each production run.

2.2.6.2 Calling Sequence

CALL DRSRPT (NCAT)

Symbol	Type	Input/Output	Description
NCAT	I*4	I	pointer to latest tape catalog

2.2.6.3 Subprograms and COMMON Cross-References

Calling Subroutines:

Called Subroutines: CNVMJD, CONTIM

COMMON Block References: DRSTAP, TAPLST, RUNDAT

2.2.6.4 Method

This routine is invoked at the end of each production run to write the Current Status Report. This report provides information concerning all PHA and RATES tapes generated and/or copied in the current run, the current status of all tapes available to the Data Reduction System, and indicates the latest catalog pointer value.

2.2.7 <u>Subroutine EDRCAT</u> (alias: EDREND, NEWCAT, ENDCAT)

2.2.7.1 Functional Description

This routine handles all data manipulation pertaining to the data reduction system catalogs.

2.2.7.2 Calling Sequences

CALL EDRCAT (*N),
where N is an alternate return taken when the EDR tape is rejected because the data is not in the necessary time-ordered sequence with previously-processed data.

CALL EDREND

CALL NEWCAT

CALL ENDCAT (NCMTAP)

Symbol	Type	Input/Output	Description
NCMTAP	I*4	I	the CATALOG tape sequence number =0, no previous CATALOG tape =1, previous CATALOG tape

2.2.7.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: DAIO, FTIO, DRPMES, FMOVE, CNVMJD, CONTIM, IGET

COMMON Block References: LOGHIS, DRSTAP, RUNDAT, INTERN, LOGCAT

2.2.7.4 Method

The routine EDRCAT is invoked at the beginning of processing an EDR tape to determine if the data contained in the tape is in the proper time order and, if data merging is not specified, that no time overlap occurs. EDRCAT also sets up a pointer to the location where the catalog entry to be created for the EDR tape will be inserted into the File/Logistics/History catalog. ?

When Quick-look processing is specified, EDRCAT does not reference the permanent File/Logistics/History catalog. All catalog entries created for the current Quick-look run are processed on the temporary catalog and discarded at the termination of the run.

When data merging is specified, EDRCAT first determines whether the data to be processed needs to be merged with previously-processed data. If no merge is necessary, then the catalog entries created for the current run are processed in the same manner as when data merging is not specified. That is, all entries are inserted after the last catalog entry contained in the permanent File/Logistics/History catalog and no reference is made to the temporary catalog data set. When the data being processed needs to be merged with previously-processed data, EDRCAT copies the permanent data set onto the temporary data set until the location to insert the new catalog entry is determined. This procedure will continue on each subsequent entry to EDRCAT, and eventually the new updated version of the File/Logistics/History catalog will reside on the temporary catalog data set.

The entry point EDREND is invoked after the processing of an EDR tape. EDREND inserts the catalog entry created for the EDR tape into its proper time-ordered location in the File/Logistics/History catalog. EDREND also saves the absolute file numbers assigned to the first and last catalog entries created in the current run. These absolute file numbers are utilized by the entry point ENDCAT when generating the File/Logistics/History Catalog Report.

The entry point NEWCAT is invoked when the value of the Tape Catalog Pointer is overridden for a particular production run by the value specified for NUMCAT, which is supplied on the OPTION namelist cards. The purpose of this logic is to restore the File/Logistics/History catalog from the appropriate backup CATALOG tape before the processing of EDR tapes begins for the current production run.

The entry point ENDCAT is invoked after the processing of EDR tapes has been completed. ENDCAT first determines if the last catalog entry processed by EDREND was inserted with previously-processed data. If so, it proceeds to finish the copying of the permanent catalog data set onto the temporary data set. If the generation of the CATALOG tapes is specified, EDREND mounts the appropriate CATALOG tapes and writes the first file of information on them. Next, the new updated version of the File/Logistics/History catalog is read and the corresponding catalog report is generated. If the new version of the catalog resides on the temporary data set, it is copied onto the permanent data set, provided Quick-look processing was not requested.

The catalog entries created when Quick-look processing is specified are discarded. Also, the new version of the catalog is written onto the CATALOG tapes.

2.2.8 Subroutine EDRCHK

2.2.8.1 Functional Description

This routine provides logic to verify the integrity of the incoming telemetry data.

2.2.8.2 Calling Sequence

```
CALL EDRCHK (KPAD, HRATIO, $N)
```

SECTION 1 - INTRODUCTION

Helios is a joint scientific effort between the Unites States and Germany to explore the solar plasma close to the sun. The two spacecrafts, Helios-A (December 1974) and Helios-B (December 1975), contain a series of scientific experiments to investigate different aspects of the solar plasma.

The experiment (No. 7) for which this data processing system is written examines charged particles. It consists of three sensor systems (HET, LET-1, LET-2), plus a gas proportional counter which predominantly responds to X-ray photons in the 2 to 8 KeV energy range. The charged particle detector systems are made up of from four to seven silicon diodes operated with a reverse bias adequate to fully deplete the diodes. If a charged particle passes through a diode, ionization along the path through the detector results in hole-election pairs being formed along this path. The applied electric field causes the charge to be swept up, forming a charge pulse which is then accurately measured by the electronics.

The gas proportional counter really is two independent counters sharing one pressure vessel. The primary X-ray data is obtained through a very narrow collimator. Using on-board electronics, one can accumulate data in eight sections of 0.17° or 0.34° centered onthe sun. Such a system allows ? as to monitor and locate sources of solar activity. The second aperature is viewed by means of a 53° collimator. Only low energy X-rays are allowed through the foils. This counter monitors detector background as well as low energy solar electrons.

The charged particle (cosmic ray) experiment outputs minor frame data of two basic types, RATE and PHA. RATE data is a 12-bit binary number representing the total number of times per accumulation interval that signals exceeding specific amplitudes from one or more detectors in each telescope occurred in coincidence.

PHA (Pulse Height Analyzer) data represents the digitized amplitude of each of three specified detector signals appearing in coincidence. This amplitude indicates the energy loss of the charged particle in the particular telescope element. The PHA digitizes the amplitude of each pulse into one part in 4096 called a channel corresponding to predetermined energy ranges.

gamma ray β

The Helios Data Processing System has been written to parallel Pioneer's Data Processing System as much as possible. Whenever applicable, the Pioneer code was extracted and used in the corresponding Helios routine. This approach has reduced redundant coding considerably. Any programmer who maintains this system and incorporates enhancements into it should investigate making similar enhancements to the corresponding Pioneer logic. Figure 1-1 is an overview of the Helios Data Processing System.

DRAFT

SECTION 2 - DATA REDUCTION PROGRAM

2.1 OVERVIEW

The Data Reduction Program is the initial step in reducing the spacecraft telemetry data into a form that is more reliable and accessible.

The spacecraft telemetry data is are received from the Information Processing Division (IPD), where the data pertaining to each individual experiment ~~is~~ are extracted from a master data tape. Once received, the data reduction program takes each minor frame and goes through a series of reliability checks. These include time continuity, data quality, and blackout mode verification. All data that pass the verification tests are then identified as to the type, RATE or PHA. If minor frames are missing or discarded by the verification logic, a routine (FMSYNC) is called to maintain the extremely important minor frame synchronization. This synchronization is important since RATE and PHA data are transmitted in a definite, pre-determined ratio based upon bit rate and format (see Table).

Once the data has have been verified and synchronization guaranteed, it can then be identified as being either RATE or PHA. Once identified, the data is are then unpacked and the proper series of subroutines called to process that particular type of data.

The data is are temporarily stored in core in a pre-determined location based upon its position in the commutation cycle (see Table). Whenever an entire cycle (album) of telemetry data has been processed, the accumulated PHA and RATE data are read out to their respective buffers.

The RATE and PHA data bases are time ordered and maintained on single file, 9-track tapes with a density of 1600 BPS. Each logical record contains data accumulated over one album, but never data of differing bit rate or format.

A time history of data processed and options applied is maintained in the DRS tape catalog and the File/Logistics/History catalog. The DRS tape catalog provides pertinent information about the PHA, RATES, and CATALOG tapes previously created and blank tapes currently available to the system. The File/Logistics/History catalog is a permanent disk data set which provides a permanent time-ordered history of all the experimenter data record (EDR) tapes processed by the data reduction system. Four generations of backups are kept of these vital system catalogs. The tapes containing these backups are referred to as CATALOG tapes, and their volume serial numbers and generation are maintained in the DRS catalog.

2.2 SUBROUTINES

2.2.1 HELDRP

2.2.1.1 Functional Description

This routine serves as the executive of the data reduction system. All variable initializations, I/O operations, data unpacking, and data base updating are controlled either directly or indirectly through subroutine calls from this routine.

2.2.1.2 Calling Sequence

This FORTRAN routine serves as the executive of this system and has no calling sequence.

2.2.1.3 Subprogram and COMMON Cross-~~R~~eference

Calling Subroutines: Receives control from supervisor

Subroutines Called: HELDRP calls FTIO, EDRSUM, ENDCAT, UPKLBL, DTIME, EORCAT, EXTRCT, GETPUT, RATEND, FMOVE, CNVDAT, DRPMES, EDREND, ENDCAT, FILINT, REMTIM, CNVMJD, DRSRPT, EDRINT, ENDPHA, NEWCAT, NOSTAE, PHAEND

COMMON Blocks Referenced: DATREC, LOGHIS, RECSTA, DRSTAP, TAPLST, LABEL, STATUS, RUNDAT, INTERN, ITEMS, ENGSW

2.2.1.4 Method

Processing begins by setting up the defaults for the system operating options. These defaults can then be overridden by a read from the NAMELIST OPTION. A series of option verifications follow which guarantee that the requested processing can be initiated.

If normal production processing is being performed, a check is then made via a call to REMTIM to assure that enough time is remaining to completely process at least one EDR tape. When insufficient time remains, a message is written indicating the job is being prematurely terminated due to time restraints, performs the necessary end-of-job functions, and terminates the job normally.

If sufficient time remains for further processing, a card is read from the NAMELIST EDRTAP which identifies the volume serial number of the input EDR tape and processing options to be applied when processing the tape. If an input EDR tape is not specified, then the necessary end-of-job functions are performed and the job terminates.

When a valid EDR tape number is supplied to the system, then the tape is mounted and positioned to the first file. The first record of the file is then read and unpacked, which supplies information pertaining to the telemetry data written in that file. The information provided indicates the bit rate, format, and time interval over which the data was recorded.

After the header of the first file has been unpacked and validated, a call is made to EDRCAT to determine if the data on this EDR tape overlaps in time with any data previously processed. If data overlap does occur, the EDR tape is rejected and the program goes on to read another EDR tape volume serial number if one is available.

When the data on an EDR tape has been accepted for further processing, the telemetry data records are read and a call is made to EXTRACT, which controls the extraction of data fields and their validation. When an end-of-file occurs, the program positions to the next file and attempts to read another header record. If instead another end of file occurs, then an end of volume is assumed. Normal processing of the header and data records in each file will continue until the consecutive end-of-file marks are encountered.

When an end-of-volume does occur, a message is written indicating this and the tape is unloaded. A call is then made to EDRSUM to summarize and write all statistics accumulated for the data processed from the tape. A subsequent call to EDREND (an entry point in EDRCAT) will insert the catalog entry created for the EDR tape into its proper time-ordered location in the File/Logistics/History catalog.

After the end-of-volume logic is completed, the program loops back to a call to REMTIM to again verify that enough time remains to process one EDR tape. If sufficient time remains and an EDR tape is available for processing the entire procedure of validating header records, telemetry data records, file positioning, and end-of-volume processing is repeated. If no additional EDR tapes are to be processed, the routine ENDCAT is invoked to print the File/Logistics/History catalog report and to generate the updated version of the CATALOG tapes. The Current Status Report is then written by the routine DRSRPT, the tape catalog is updated to reflect the data processed, an end-of-job message is written and the job terminates normally. The above end-of-job procedure differs slightly when Quick-Look processing is requested. In the Quick-Look mode, the DRS tape catalogs and the current File/Logistics/History catalog are not referenced. Additionally, the CATALOG tapes are not updated.

2.2.2 Subroutine FRM (a COMFRM, MSFR

2.2.2.1 Functic)escript

This routine processes necessary time operations needed by the system.

2.2.2.2 Calling Sequences

CALL ADDFRM (MSP1, HDP1, HFRMS, HFM, HBR, MSP2, HDP2)

Symbol	Type	put/Output	D ption
MSP1	I*4	I	milliseconds of day to which increment is added
HDP1	I*2	I	relative modified Julian day to which increment is added
HFRMS	I*2	I	number of minor frames to be incremented
HFM	I*2	I	format of input data
HBR	I*2	I	bit rate of input data
MSP	I*4	O	milliseconds of day after time increment is added
HDI	I*2	O	relative modified Julian day after time increment is added

CAI COMFRM (MSP1, HDP1, MSP2, HDP2, MTMDIF)

MSP1	I*4	I	milliseconds of day assisgned to T_1
HDP1	I*2	I	relative modified day assigned to T_1
MSP2	I*4	I	milliseconds of day assigned assigned to T_2
HDP2	I*2	I	relative modified day assigned to T_2
MTMDIF	I*4	O	time difference in milliseconds (T1 - T2)

CALL MSFRAM (HFMT, HBR, MSP1)

Symbol	Type	Input/Output	Description
HFMT	I*2	I	format of input data
HBR	I*2	I	bit rate of input data
MSP1	I*4	O	minor frame accumulation time in milliseconds

2.2.2.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Subroutines Called: This routine calls no subprograms.

COMMON Block Referenced: This routine uses no COMMON blocks.

2.2.2.4 Method

The subroutine ADDFRM is called to increment an input time by a given number of minor frames. The accumulation time for a minor frame is calculated band upon the supplied bit rate and format. This calculated time is used as the time increment.

The entry point COMFRM is used to compare times from two frames. The absolute time difference in milliseconds is returned to the calling program.

The entry point MSFRAM is called to call the minor frame accumulation time at the present bit rate and format.

2.2.3 Subroutine CNVMJD (alias: CNVDAT)

2.2.3.1 Functional Description

This routine provides date conversions.

2.2.3.2 Calling Sequences

CALL CNVMJD (HMOD, HMONTH, HDAY, HYEAR)

Symbol	Type	Input/Output	Description
HMOD	I*2	I	relative modified Julian day
HMONTH	I*2	O	month of year
HDAY	I*2	O	day of month
HYEAR	I*2	O	two digit year

CALL CNVDAT (HMONTH, HDAY, HYEAR, HMOD)

HMONTH	I*2	I	month of year
HDAY	I*2	I	day of month (or day of year if HMONTH=0)
HYEAR	I*2	I	two digit year
HMOD	I*2	O	relative modified Julian day

2.2.3.3 Subprogram and ~~Common~~ COMMON Cross-~~Reference~~ reference

Calling Subroutines:

Subroutines Called: This routine calls no subprograms.

COMMON Blocks Referenced: This routine uses no COMMON blocks.

2.2.3.4 Method

The subroutine CNVMJD is called to convert a day count based on day 1 being January 1, 1972 to a date of the form month-day-year. This day count is referred to as the relative modified Julian day.

The entry point CNVDAT is called to perform the reverse function. It converts a date of the form month/day/year to its corresponding relative modified Julian date. Optionally, the month can be set to zero, and the day of the month is assumed to be day of year instead.

2.2.4 Subroutine CONTIM

2.2.4.1 Functional Description

This routine is used to convert a time in milliseconds of day to hours-minutes-seconds.

2.2.4.2 Calling Sequence

CALL CONTIM (MILSEC, HOUR, HMIN, SECOND, TYPE)

Symbol	Type	Input/Output	Description
MILSEC	I*4	I	milliseconds of day
HOUR	I*2	O	derived hours
HMIN	I*2	O	derived minutes
SECOND	R*4 or I*2	O	derived seconds
ITYPE	I*4	I	optional parameter defining the form of SECOND ITYPE=0, floating point ITYPE<0, halfword integers

2.2.4.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: This routine calls no subprograms

COMMON Blocks Referenced: This routine uses no COMMON blocks.

2.2.4.4 Method

This routine is used to convert milliseconds into hours/minutes/seconds, where seconds may be either floating point or fixed point with thousandths of seconds. The form of the records is determined by the presence of fifth parameter in the call list. If the parameter is negative, the seconds are stored in consecutive halfwords as seconds and thousandths of seconds. Otherwise, seconds are stored in full word floating point format.

2.2.5 <u>Subroutine DRPMES</u>

2.2.5.1 Functional Description

This routine is called for the purpose of message generating.

2.2.5.2 Calling Sequence

CALL DRPMES (DPROG, MESCOD, MESAGE)

Symbol	Type	Input/Output	Description
DPROG	R*8	I	name of routine requesting the message generation
MESCOD	I*4	I	message code
MESAGE	I*4	I	array containing information related to the message

2.2.5.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: FTIME, ABEND

COMMON Block References: RUNDAT, INTERN, FERMSG

2.2.5.4 Method

This routine is invoked by various routines in the data processing system for writing informative messages concerning job status.

Each message has been assigned a numeric code which is passed through the argument list along with information needed to properly write the message. Additionally, the message written informs the user of the routine invoking the subroutine call.

2.2.6 Subroutine DRSPT

2.2.6.1 Functional Description

This routine generates the Current Status Report at the end of each production run.

2.2.6.2 Calling Sequence

CALL DRSRPT (NCAT)

Symbol	Type	Input/Output	Description
NCAT	I*4	I	pointer to latest tape catalog

2.2.6.3 Subprograms and COMMON Cross-References

Calling Subroutines:

Called Subroutines: CNVMJD, CONTIM

COMMON Block References: DRSTAP, TAPLST, RUNDAT

2.2.6.4 Method

This routine is invoked at the end of each production run to write the Current Status Report. This report provides information concerning all PHA and RATES tapes generated and/or copied in the current run, the current status of all tapes available to the Data Reduction System, and indicates the latest catalog pointer value.

2.2.7 <u>Subroutine EDRCAT</u> (alias: EDREND, NEWCAT, ENDCAT)

2.2.7.1 Functional Description

This routine handles all data manipulation pertaining to the data reduction system catalogs.

2.2.7.2 Calling Sequences

CALL EDRCAT (&N)

where N is an alternate return taken when the EDR tape is rejected because the data is not in the necessary time-ordered sequence with previously-processed data

CALL EDREND

CALL NEWCAT

CALL ENDCAT (NCMTAP)

Symbol	Type	Input/Output	Description
NCMTAP	I*4	I	the CATALOG tape sequence number =0, no previous CATALOG tape =1, previous CATALOG tape

2.2.7.3 Subprogram and COMMON Cross-Reference

Calling Subroutines:

Called Subroutines: DAIO, FTIO, DRPMES, FMOVE, CNVMJD, CONTIM, IGET

COMMON Block References: LOGHIS, DRSTAP, RUNDAT, INTERN, LOGCAT

2.2.7.4 Method

The routine EDRCAT is invoked at the beginning of processing an EDR tape to determine if the data contained in the tape ~~is~~ are in the proper time order and, if data merging ~~is~~ are not specified, that no time overlap occurs. EDRCAT also sets up a pointer to the location where the catalog entry to be created for the EDR tape will be inserted into the File/Logistics/History catalog.

When Quick-look processing is specified, EDRCAT does not reference the permanent File/Logistics/History catalog. All catalog entries created for the current Quick-look run are processed on the temporary catalog and discarded at the termination of the run.

When data merging ~~is~~ are specified, EDRCAT first determines whether the data to be processed need~~s~~ to be merged with previously-processed data. If no merge is necessary, then the catalog entries created for the current run are processed in the same manner as when data merging is not specified. That is, all entries are inserted after the last catalog entry contained in the permanent File/Logistics/History catalog and no reference is made to the temporary catalog data set. When the data being processed needs to be merged with previously-processed data, EDRCAT copies the permanent data set onto the temporary data set until the location to insert the new catalog entry is determined. This procedure will continue on each subsequent entry to EDRCAT, and eventually the new updated version of the File/Logistics/History catalog will reside on the temporary catalog data set.

The entry point EDREND is invoked after the processing of an EDR tape. EDREND inserts the catalog entry created for the EDR tape into its proper time-ordered location in the File/Logistics/History catalog. EDREND also saves the absolute file numbers assigned to the first and last catalog entries created in the current run. These absolute file numbers are utilized by the entry point ENDCAT when generating the File/Logistics/History Catalog Report.

The entry point NEWCAT is invoked when the value of the Tape Catalog Pointer is overridden for a particular production run by the value specified for NUMCAT, which is supplied on the OPTION namelist cards. The purpose of this logic is to restore the File/Logistics/History catalog from the appropriate backup CATALOG tape before the processing of EDR tapes begins for the current production run.

The entry point ENDCAT is invoked after the processing of EDR tapes has been completed. ENDCAT first determines if the last catalog entry processed by EDREND was inserted with previously-processed data. If so, it proceeds to finish the copying of the permanent catalog data set onto the temporary data set. If the generation of the CATALOG tapes is specified, EDREND mounts the appropriate CATALOG tapes and writes the first file of information on them. Next, the new updated version of the File/Logistics/History catalog is read and the corresponding catalog report is generated. If the new version of the catalog resides on the temporary data set, it is copied onto the permanent data set, provided Quick-look processing was not requested.

The catalog entries created when Quick-look processing is specified are discarded. Also, the new version of the catalog is written onto the CATALOG tapes.

2.2.8 Subroutine EDRCHK

2.2.8.1 Functional Description

This routine provides logic to verify the integrity of the incoming telemetry data.

2.2.8.2 Calling Sequence

CALL EDRCHK (KPAD, HRATIO, ~~F~~$N)

Symbol	Type	Input/Output	Description
KPAD	I*4	O	contains a count of the number of frames that are missing/ padded
HRATIO	I*2	I	number revealing the present PHA to RATES block ratio
N	alternate return	O	taken whenever a minor frame is skipped after integrity testing shows a negative result

2.2.8.3 Subprogram and Common Cross-references

Calling Subroutines: EXTRCT

Called Subroutines: DRPMES, TIMCHK, IGET, UPKSTA

COMMON Block References: DATREC LABEL, RECSTA, ITEMS, STATUS

2.2.8.4 Method

This subroutine is invoked from EXTRCT to guarantee the integrity of the incoming minor frame data. Tests are performed to verify that all pertinent engineering words have been read out from telemetry. If it is shown that the spacecraft appears to be in blackout mode, a test is made to check the present bit rate. If the bit rate is not 8BPS, the data are discarded.

Additional tests are made to verify that all data within the file are of the same bit rate and format.

A call to the subroutine UPKSTA provides EDRCHK with information indicating whether the frame is padded and if the quality of the data is in the acceptable range.

A call is then made to TIMCHK to perform a series of time verification on the data. An alternate return is made to the calling program whenever the minor frame data fail any of the indicated tests. If all tests prove positive, a normal return is made to the calling subroutine.

2.2.9 Subroutine EDRSUM (alias: EDRINT, FILINT)

2.2.9.1 Functional Description

This routine handles variable initialization at the beginning of EDR tape processing and new file processing. Additionally, it is called to generate the Data Quality Summary Report.

2.2.9.2 Calling Sequences

CALL EDRSUM

CALL EDRINT

CALL FILINT

2.2.9.3 Subprogram and COMMON Cross-references

Calling Subroutines: HELDRP

Called Subroutines: CNVMJD, CONTIM, FMOVE

COMMON Block References: DRSTAP, ENGR, SEQID, ERATE, LABEL, RECSTA, LOGHIS, INTERN, RUNDAT, ITEMS

2.2.9.4 Method

The subroutine EDRSUM is invoked for the purpose of generating the Data Quality Summary Report for each EDR tape processed. The necessary totals are computed from the related statistics counters in the COMMON area RECSTA.

The entry point EDRINT is called at the start of processing an EDR tape to initialize the statistics counters to zero.

Additionally, the entry point FILINT is called at the start of each file of the EDR tape to initialize variable pertinent to file processing.

2.2.10 <u>Subroutine ENGDAT</u>

2.2.10.1 Functional Description

This routine handles the extraction of the engineering data from a telemetry minor frame.

2.2.10.2 Calling Sequence

CALL ENGDAT

2.2.10.3 Subprogram and COMMON Cross-references

Calling Subroutines: RHTOUT, PHAOUT

Called Subroutines: IGET, FMOVE, DRPMES

COMMON Block References: DATREC, LABEL, STATUS, ENGR, ENGSW

2.2.10.4 Method

ENGDAT is invoked by calling routines at the end of each page in formats 1, 2, 3, and at the end of each sequence in format 5. The engineering data present at this point on the telemetry output are unpacked and stored in the COMMON area ENGR.

The engineering frame number is monitored to guarantee that the proper words are being extracted and stored in the correct location.

2.2.11 <u>Subroutine EXTRCT</u>

2.2.11.1 Functional Description

This routine serves as the supervisor for all telemetry data extraction and verification.

2.2.11.2 Calling Sequence

CALL EXTRCT (&N),
where N is an alternate return to the calling routine to be taken whenever no acceptable minor frames were found in the input major frame.

2.2.11.3 Subprogram and COMMON Cross-reference

Calling Subroutines: HELDRP

Called Subroutines: PHAOUT, RATUPK, FMSYNC, PHAUPK, UPKXRY, ALOG10, PTHIRD, LOG12, PKBLK, EDRCHK, RATOUT

COMMON Block References: DATREC, LABEL, RUNDAT, RECSTA, STATUS, RBLOCK, PBLOCK, SEQID, ITEMS, PHANEW

2.2.11.4 Method

EXTRCT is invoked by its calling routine to extract, verify, and unpack telemetry minor frame data in the incoming telemetry major frame. The physical record read from the EDR tape is a major frame of data or 72 minor frames of data (see Table).

At the beginning of processing each file on the EDR tape, a series of calculations are performed to generate the necessary object time dimensions needed by the PHA processing routines. These calculations are necessary at the beginning of each file because the values generated are bit rate and format dependent.

The program logic then begins to extract each minor frame and examine it. EDRCHK is called to verify data continuity, data quality, pad, etc. If frame verification from EDRCHK proves negative, the frame is rejected and the next one extracted. If the data format is 5, the routine PKBLK is called to generate the necessary 48-bit scientific data block. If the scientific data block cannot be generated by PKBLK, the next minor frame is extracted and examined. If EDRCHK discoverd a time gap between acceptable minor frames, a value is returned in the variable KPAD, indicating the size of the gap in minor frames. If this value is not zero, then FMSYNC is called to maintain the PHA to RATE block ratio.

Once the data have been verified, they must then be identified as to type, RATES or PHA. RATE data are stored on the EDR tapes as logarithmically-packed data (see Table). A call to the subroutine LOG12 is necessary to unpack the data. Once unpacked, the subroutine RATOUT is called to further process the data and store it in its proper location in the output buffer. Additionally, it is necessary to maintain certain information in COMMON areas, which is vital to the RATOUT routine in determining the output buffer location. This information includes RATES data type (sectored or unsectored), unsectored sequence ID, and line number. These variables are described in more detail in the section on RATOUT.

PHA data are unpacked via a call to PHAUPK. The data are stored in their appropriate output buffer location by the PHAOUT routine. Their output buffer location is determined by the unsectored sequence ID corresponding to the associated RATES block. The number of PHA data blocks interspersed between RATES blocks is a predetermined value (see Table).

If all minor frames in the major frame are rejected, the alternate return is taken to the calling routine. If acceptable minor frames are available, they are all processed before control is returned to the calling routine.

2.2.12 Subroutine FMSYNC

2.2.12.1 Functional Description

This routine maintains the minor frame synchronization wherever data are padded or rejected.

2.2.12.2 Calling Sequence

CALL FMSYNC (HRATIO)

Symbol	Type	Input/Output	Description
HRATIO	I*2	I	ratio of PHA to RATES

2.2.12.3 Subprogram and COMMON Cross-reference

Calling Subroutines: EXTRCT

Called Subroutines: None

COMMON Block References: SEQID, RBLOCK, LABEL

2.2.12.4 Method

This routine is invoked by the calling program to maintain the minor frame synchronization whenever minor frame gaps occur.

The logic determines the type of the missing frame by examining available statistics. The present PHA block count is compared to the PHA to RATES ratio. If the count is less than the ratio, it is assumed to be a PHA block and the count is incremented. If the count is equal to the ratio, the count is set to zero and the last unsectored sequence ID and line number is retrieved. The line number is incremented using a module 16 adder. The unsectored sequence ID is incremented using a module 8 adder only under the following circumstances: (1) the ratio is zero (blackout mode) and the line number is zero; or (2) the ratio is greater than zero and the line number is one.

2.2.13 <u>Subroutine INDEXP</u>

2.2.13.1 Functional Description

This routine calculates the index needed to store the PHA data in its proper location in the output buffer.

2.2.12.2 Calling Sequence

CALL INDEXP (ID5432, ILINE, HPHA, HRATIO)

Symbol	Type	Input/Output	Description
IDSY32	I*4	I	unsectored sequence ID
ILINE	I*4	I	line number
HPHA	I*2	I	PHA block count
HRATIO	I*2	I	PHA to RATES block ratio

2.2.13.3 Subprogram and COMMON Cross-reference

Calling Subroutines: PHAOUT

Called Suproutine: None

COMMON Block Referenced: None

2.2.13.4 Method

This function subroutine is invoked to calculate an index into the PHA record output buffer. If the unsectored sequence ID, line number, PHA block count, and PHA:RATES ratio are known in addition to the fact that there are three halfwords per PHA entry, the following formula is applicable:

INDEX = [(MOD(USEQID, 2))*2+LINE #)* Ratio+PHA count -1] *3 + 1

2.2.14 <u>Subroutine LOGDEC</u> (alias: LOG10, LOG12) (assembler)

2.2.14.1 Functional Description

This routine decompresses the logarithmically-compressed rates.

2.2.14.2 Calling Sequence

CALL LOG10(HIN, IOUT)
CALL LOG12 (HIN, IOUT)

Symbol	Type	Input/Output	Description
HIN	I*2	I	logarithmically-compressed ratio
IOUT	I*4	O	decompressed rate

2.2.14.3 Subprogram and COMMON Cross-reference

Calling Subroutine: RATOUT

Called Subroutine: None

COMMON Block Reference: None

2.2.14.4 Method

The entry point LOG10 is called when the rate is a 10-bit compressed rate (5-bit characteristic and 5-bit mantissa).

The entry point LOG12 is called when the rate is a 12-bit compressed rate (5-bit characteristic and 7-bit mantissa).

The rates are decompressed by placing a 1 in the high order position of the mantissa, left justifying it in a register, and shifting right the number of bits specified in the characteristic. The result is then shifted 8 bits to the right to right justify it in the register. An uncertainty factor is then computed using the following formulae:

$\frac{1}{2}(2^{(18-N)}-1)$ for 10-bit decompression

$\frac{1}{2}(2^{(16-N)}-1)$ for 12-bit decompression,

where N is the 5-bit characteristic.

This uncertainty factor is added to the result, and finally the result is incremented by one.

2.2.15 Subroutine PHACLR

2.2.15.1 Functional Description

This routine clears the COMMON area PHANEW for further processing.

2.2.15.2 Calling Sequence

CALL PHACLR (HFMT, MPNREC, JFDM)

Symbol	Type	Input/Output	Description
HFMT	I*2	I	data format
MPNREC	I*4	I/O	address of the start of the portion of the common area containing the varying length PHA data
JFDM	I*4	I	length (in words) of the PHA page

2.2.15.3 Subprogram and COMMON Cross-reference

Calling Subroutine: PHAOUT

Called Subroutine: FMOVE

COMMON Block Reference: PHANEW

2.2.15.4 Method

This routine is invoked by the calling subprogram to clear the COMMON area PHANEW. The data starting at the location MPNREC (MNULL is the same address as MPNREC) is variable in length, and the number of bytes to be cleared must be calculated from input variable IFDM.

2.2.16 Subroutine PHAOUT (alias: PHAEND) - FORTRAN

2.2.16.1 Functional Description

This routine inserts PHA data and other pertinent information into their proper location in the output buffer.

2.2.16.2 Calling Sequence

CALL PHAOUT (MPNREC, HPNREC, JFDM, JHDM, HRATIO)
CALL PHAEND

Symbol	Type	Input/Output	Description
MPNREC	I*4	I/O	address of the start of the PHA data (full-word alignment)
HPNREC	I*2	I/O	address of the start of the PHA data (half-word alignment)
JFDM	I*4	I	number of fullwords per page
JHDM	I*4	I	number of halfwords per page
HRATIO	I*2	I	PHA to RATES block ratio

Helios Documentation

1.

2. Equivalent for FLXDBG
3. Equivalent for Elgamg, matrix, & Lxplt
4. Equivalent for LIBGEN

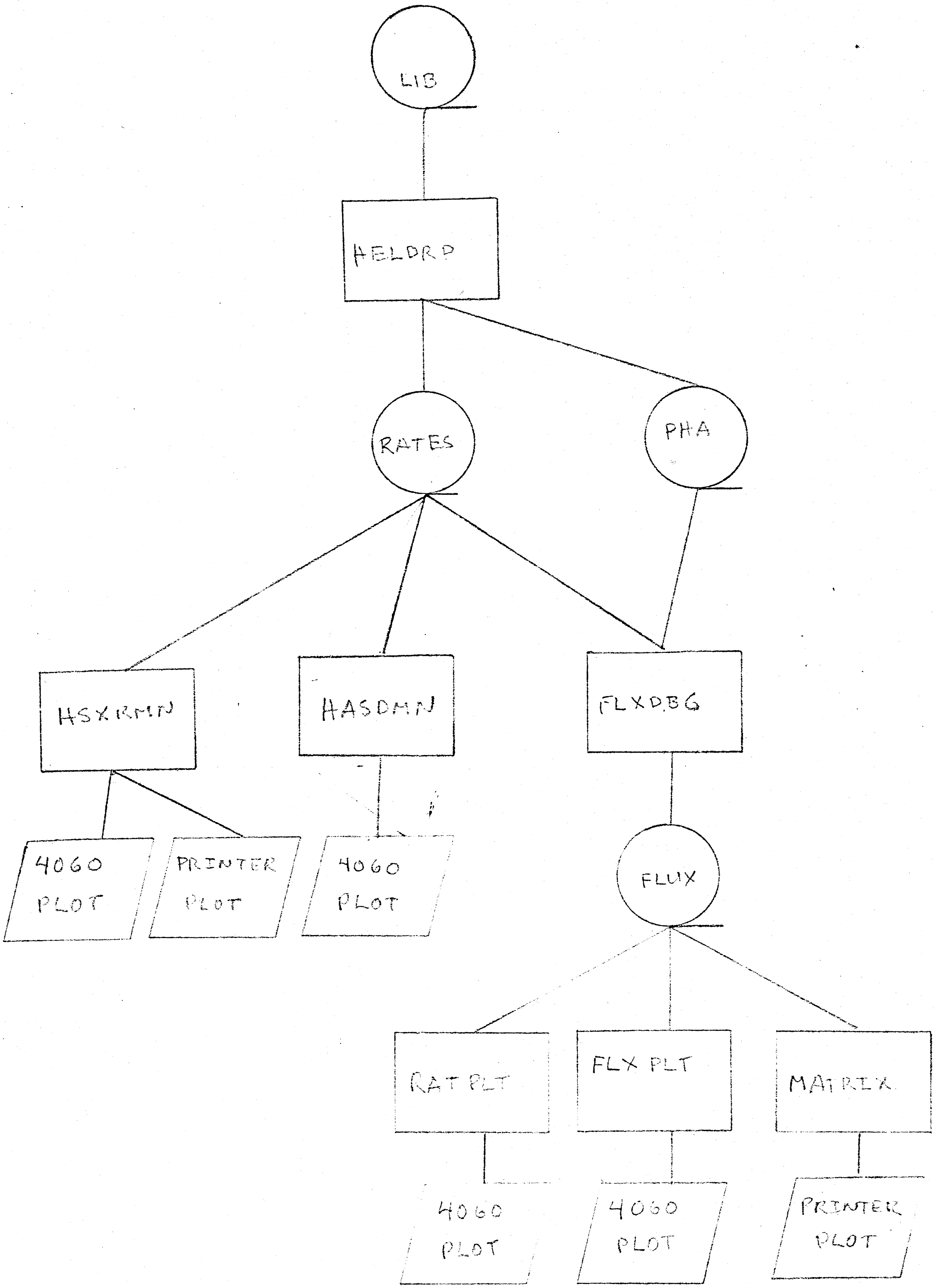

FIG 1
HELIOS NORMAL PRODUCTION FLOW CHART

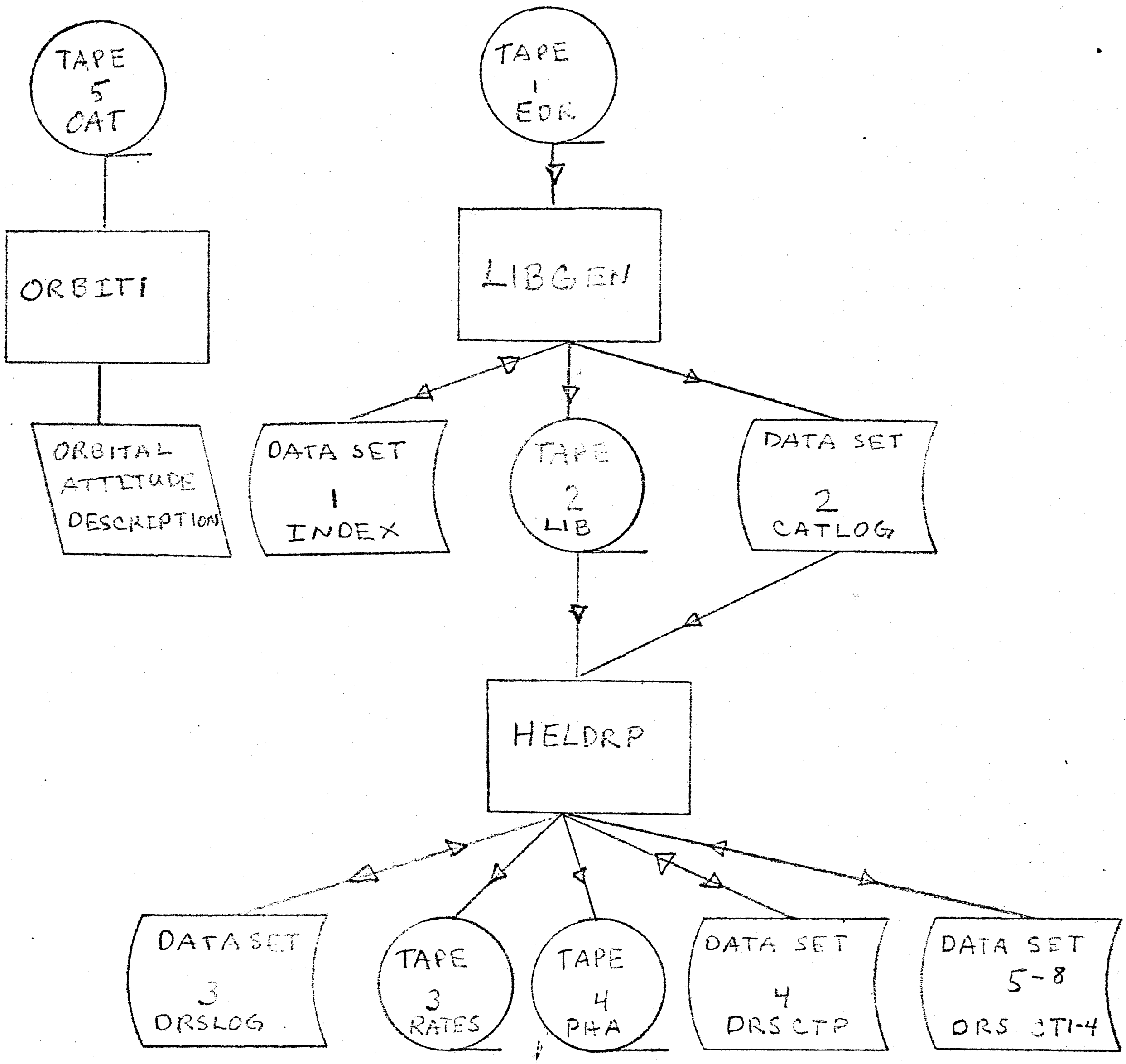

FIG 2

HELDRP DETAILED FLOW CHART
SEE TABLE 1 FOR DISCUSSION

TABLE I

DESCRIPTION OF HELDRP FLOW CHART

TAPE 1: Experimental data record from IPD. The format is outlined in appendix A

TAPE 2: Compressed EDR library tape. The format is the same as TAPE 1.

TAPE 3: Rates output tape. The format is outlined in appendix D.

Tape 4: PHA output tape. The format is outlined in appendix C.

TAPE 5: Orbital attitude tape. the format is outlined in appendix B.

Data SET 1: INDEX of EDR tapes processed. The format is outlined in appendix E.

DATa Set 2: CATLOG of EDR tapes processed. The format is outlined in appendix F.

Data Set 3: DRSLOG of [illegible] logistics and history of each file processed by HELDRP. The format is outlined in appendix G.

Data Set 4: DRSCTP, current catalog number for DRSCT1-4. The format is outlined in appendix H.

Table 1. (cont.)

Data Set 5-8: DRSCT1-4, the four catalogs of file times, quality and production. The format is outlined in appendix 4.

Appendix E

INDEX describes CATLOG for LIBGEN processing. The number of records, last record written, last LIB written EDR tapes to be compressed are written and read by LIBGEN.

There is one record, 7292 bytes, 1823 words.

WORD	BYTE	type	name	Description
1	1	L*1		satellite ID
2		I*4	MAXREC	maximum number of record in CATLOG
3		I*4	OFFSET	record offset of region two in CATLOG
4		I*4	LOCIN	maximum EDR tapes allowed
5		I*4	LOCOUT	Maximum LIB tapes allowed
6		I*4	NEXTREC	Displacement in region two of first available blank record
7		I*4	OUTSER	Serial number of last LIB tape
8		I*4	OUTSEQ	File number of last LIB
9		R*4	FEETOUT	Number of feet used on LIB tape
10		I*4	INSERA	LAST EDR serial number
11		I*4	INSEQA	LAST file number on EDR
14		I*4	LINSER	NOT USED
15		I*4	LINSEQ	NOT USED
51	1-2	I*2	OUTPTR	Start EDR serial number on 1st LIB
	3-4	I*2		start EDR file number on 1st LIB
52	1-2	I*2		start EDR serial number on 2nd LIB
	3-4	I*2		start EDR file number on 2nd LIB
.	.	.		.
.	.	.		.
.	.	.		.
1051	1	L*1	INFLAG	disposition of 1st EDR 11 = allocated 01 = added to library 03 = I/O error
	2			disposition of 2nd EDR
.	.			.
.	.			.
.	.			.

Appendix F

CATLOG contains information on each EDR compressed onto a LIB tape. The CATLOG is used by GETLIB to locate the correct file on the LIB tape given the serial number and file number of the EDR tape. There are 2250 records divided into two regions. Region one contains the first 6 files for every EDR, one EDR per record. Region two contains the overflow files from each EDR. Each file on a LIB tape has a DSN composed of the serial number and file number of the EDR tape. GETLIB uses CATLOG to construct the DSN as well as locate the LIB tape and file.

Appendix F (cont)

The record number corresponds to the EDR serial number.

Single record format

word	byte	length	name	description
1	1-2	I*2	NXTREC	Displacement in record numbers from OFFSET to next record with file history for the EDR serial number given by the record in region one. A displacement of zero means there are no more than six remaining files on that particular EDR
	3-4	I*2		number of files described by record
2	1-2	I*2	OUTSER	LIB serial number of 1st file/EDR
	3-4	I*2	OUTSEQ	LIB file number of 1st file of EDR
3	1-2	I*2		Serial number of next EDR file
	3-4	I*2		file number of next EDR file
4	1-2	I*2	HMRTAP	Serial number of master tape
	3	L*1	HMRFIL	file number of master tape
	4	L*1		hour of start time of 1st file
5	1	L*1		minute of start time of 1st file
	2	L*1		second of start time of 1st file
	3	L*1		hour of end time of 1st file
	4	L*1		minute of end time of 1st file
6	1	L*1		second of end time of 1st file
	2	L*1		year of 1st file
	3-4	I*2		day of start time of 1st file
7	1-2	I*2		day of end time of 1st file
	3-4	I*2		Bit rate of 1st file
8	1-2	I*2		NOT USED
	3-4	I*2	OUTSER	LIB serial number of 2nd file of EDR
⋮	⋮	⋮	⋮	⋮
40	1-2	I*2		Bit rate of 6th file

Appendix G

the DRSLOG keeps track of the history of each file processed by HFLOOK. The absolute file number, times, record count and quality. DRSLOG has 17 tracks and each track has 1823 - 4 byte words which contain the last file number and the history of 182 files. Each file is on one "line"; there are 182 lines per "track."

Single track format

Word	byte	length	name	description
1		I*4	NUMOLD	Number of last line in track
2		I*4		milliseconds of start of file of line
3		I*4		milliseconds of end of file of line
4	1-2	I*2		absolute file number of line 1
	3-4	I*2		modified Julian day of start of file of line 1
5	1-2	I*2		modified Julian day of end of file of line 1
	3-4	I*2		EDR number of line 1
6	1-2	I*2		Modified Julian day EDR was generated
	3-4	I*2		Modified Julian day EDR was processed
7		I*4		Total number of records of line 1
8		I*4		Number of good records of line 1
9	1-2	I*2		Highest quality of line 1
	3-4	I*2		Lowest quality of line 1
10	Bit 1			PHA processed flag (MSB)
	Bit 2			RATES processed flag
11		I*4		milliseconds of start of file of line 2
.	.	.		.
.	.	.		.
.	.	.		.
1811		I*4		milliseconds of start of file of line 18[illegible]
.	.	.		.
.	.	.		.

Appendix H

DRSCTP contains the satellite ID and number of the current catalog. DRSCT1-4 & DRSCT1-4 contains the satellite ID, RATES and PHA tape lists, times, feet written and last absolute file number

DRSCTP

One record, 80 bytes

Word	byte	length	name	description
1	1	I*1	LSTCAT	Number of last DRSCT1-4 catalog
	2	L*1	IDTAP	Satellite ID

DRSCT1-4

Four catalogs, each has one record 5540 bytes long. The current catalog is referenced by DRSCTP. For the format of this catalog see the common block description for the common block DRSTAP.

RATES Tape Logical Record Format

Displacement	Type	Description
∅	I*4	Time of day (MS) for first page contained in record
4	I*4	Time of day (MS) for page which is expected to immediately follow the last page in this record
8	I*2	Day (RMJD) for first page contained in record
1∅	I*2	Day (RMJD) for page which is expected to immediately follow the last page in this record
12	I*4	Round Trip Light Time
16	I*4	Spacecraft Clock
2∅	I*2	Absolute File Number
22	I*2	Time Correction Flag
24	I*2	Ratio of PHA blocks to RATES blocks
26	I*2	Bit Rate (8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096)
28	I*2	Format (1, 2, 3, 5)
3∅	I*2	Frame Counter Correction
32	I*2	Data Type
34	I*2	Data Quality
36		All the subcom data associated with the first page of data contained in the record. Refer to Tables 1 and 2 for a description of the subcom data for the two format groups.
92 (136)	I*4	All the rates data associated with the first page of data contained in record. Each page consists of 4 sets (2 sectored and 2 unsectored) of 32 and 20 rates respectively, which are uniquely identified by the corresponding rate sequence ID's appearing in the associated set of subcom data. The rates data associated with each page appears in 104 consecutive words, as follows: 1 - Sectored Rate (First Set) • • •

RATES Tape Logical Record Format (continued)

Displacement	Type	Description
		32 - Sectored Rate (First Set) 33 - Unsectored Rate (First Set) . . . 52 - Unsectored Rate (First Set) 53 - Sectored Rate (Second Set) . . . 84 - Sectored Rate (Second Set) 85 - Unsectored Rate (Second Set) . . . 1Ø4 - Unsectored Rate (Second Set)
		Refer to Table 3 to determine the rates data associated with each unsectored and sectored rate sequence ID.
564 (652)		All the subcom and Rates data for the second page of data contained in the record.
1036 (1168)		All the subcom and Rates data for the third page of data contained in the record.
1508 (1684)		All the subcom and Rates data for the fourth page of data contained in the record.

Note: The first displacement is for data transmitted in formats 1, 2, or 3. The second displacement is for data transmitted in format 5.

Table 1. RATES Tape

(Subcom data for format group 1 - formats 1, 2, 3)

Displacement	Type	Description
∅	I*2	Spin Rate (in RPM)
2	I*2	HET (E7A) temperature
4	I*2	VLET1 (E7B1) temperature
6	I*2	VLET2 (E7B2) temperature
8	I*2	LET (E7C) temperature
1∅	I*2	detector mounting plate temp.
12	I*2	X-Ray detector temperature
14	I*2	thermal blanket support plate 1 temp.
16	I*2	thermal blanket support plate 2 temp.
18	I*2	electronics temperature
2∅	I*2	base plate temperature
22	I*2	+12 v monitor
24	I*2	+6 v digital monitor
26	I*2	+6 v analog monitor
28	I*2	+7.75 v monitor
3∅	I*2	+4.7 v monitor
32	I*2	base plate temperature (front)
34	I*2	Power status (1=on, ∅=off)
36	L*1	X-Ray Window Clock
37	L*1	X-Ray Window Data
38	L*1	Internal Calibrator A
39	L*1	Internal Calibrator B
4∅	L*1	X-Ray high voltage
41	L*1	Sector synchronizer
42	L*1	Force blackout mode
43	L*1	X-Ray sector data mode
44	I*2	X-Ray command reg.
46	I*2	X-Ray XEQ. reg.
48	I*2	Unsectored Rate Sequence ID (First Set)

Table 1. (continued)

Displacement	Type	Description
5Ø	I*2	Sectored Rate Sequence ID (First Set)
52	I*2	Unsectored Rate Sequence ID (Second Set)
54	I*2	Sectored Rate Sequence ID (Second Set)

(14 words)

Table 2. RATES Tape

(Subcom data for format group 2 - format 5)

Displacement	Type	Description
Ø - 43	(same as Table 1)	(same as Table 1)
44 - 87	(same as Ø - 43)	(same as Ø - 43)
88 - 99	(same as 44 -54)	(same as 44 - 54)
(25 words)		

Table 3. (continued)

Unsectored	Sectored	Rate
xx	1	SR1B - $A_2\ BK_1\ \overline{CIII}$ (1-8)
		SR2B - $SI_6\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SR3B - $SI_6\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SXRY - Sectored X-Ray (1-8)
		R1
1	xx	R2B - $A_1\ BK_2\ \overline{CIII}$
		R3B - $A_2\ BK_2\ \overline{CI}$
		R4B - A_1
		R5B - A_2
		R6B - $A_1\ \overline{A}_2\ BCI\ \overline{CII}$
		R7B - $A_2\ BK_1\ \overline{CI}$
		R8B - $A_2\ BK_1\ CI\ CII\ \overline{CIII}$
		R9B - $SI\ SII\ SII_a\ SIII$
		R1ØB - DI_2
		R11B - $DI\ DII\ \Sigma\ D\ \overline{F}$
		R12B - $DI\ DII\ \Sigma\ DE_3\ \overline{F}$
		R13B - $DI\ DII\ \Sigma\ DE_4\ \overline{F}$
		R14B - DII
		R15B - $SI_2\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R16B - $SI\ SII_2\ \overline{SII}_a\ \overline{SIII}$
		R17B - SII (VLET 1)
		R18B - $SI_2\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R19B - $SI\ SII_2\ \overline{SII}_a\ \overline{SIII}$
		R2Ø

Table 3. RATE Sequence ID

Unsectored	Sectored	Rate
xx	Ø	SR1A $A_1\overline{A}_2BCI\ \overline{CIII}$ (1-8)
		SR2A $SI_5\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SR3A $SI_5\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SXRY Sectored X-Ray (1-8)
Ø	xx	R1 - $(A_2K_1 + A_1CI)\ B\overline{CIII}$
		R2A - $A_1\overline{A}_2BCIII$
		R3A - A_2BCIII
		R4A - $A_2BK_2CI\ \overline{CII}$
		R5A - $A_2BK_2CI\ CII\ \overline{CIII}$
		R6A - $A_1\overline{A}_2B\overline{CI}$
		R7A - $A_1\overline{A}_2BCI\ CII\ \overline{CIII}$
		R8A - $A_2BK_1CI\ \overline{CII}$
		R9A - $SI\ SII\ SII_a\ SIII$
		R1ØA - DI_1
		R11A - $DI\ DII\ \overline{F}$
		R12A - $DI\ DII\ E_1\ \overline{F}$
		R13A - $DI\ DII\ E_2\ \overline{F}$
		R14A - DI
		R15A - $SI_1\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R16A - $SI\ SII\ \overline{SII}_a\ \overline{SIII}$
		R17A - SI (VLET1)
		R18A - $SI_1\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R19A - $SI\ SII_1\ \overline{SII}_a\ \overline{SIII}$
		R2Ø - USXR

Table 3. (continued)

Unsectored	Sectored	Rate
xx	2	SR1C - DI DII $\overline{F}$ (1-8)
		SR2C - $SI_7\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SR3C - $SI_7\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SXRY - Sectored X-Ray (1-8)
2	xx	R1
		R2A - R9A
		R1ØC - DI_3
		R11A - R13A
		R14C - E_1
		R15C - $SI_3\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R16C - $SI\ SII_3\ \overline{SII}_a\ \overline{SIII}$
		R17C - SII_a (VLET 1)
		R18C - $SI_3\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		R19C - $SI\ SII_3\ \overline{SII}_a\ \overline{SIII}$
		R2Ø
xx	3	SR1D - DI DII E_1 F (1-8)
		SR2D - $SI_8\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$ (1-8)
		SR3D - $SI_8\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$
		SXRY - Sectored X-Ray (1-8)
3	xx	R1
		R2B - R9B
		R1ØD - DI_4
		R11B - R13B
		R14D - F
		R15D - $SI_4\ \overline{SII}\ \overline{SII}_a\ \overline{SIII}$

Table 3. (continued)

Unsectored	Sectored	Rate
		R16D - SI SII_4 $\overline{SII}_a$ $\overline{SIII}$
		R17D - SIII (VLET 1)
		R18D - SI_4 $\overline{SII}$ $\overline{SII}_a$ $\overline{SIII}$
		R19D - SI SII_4 $\overline{SII}_a$ $\overline{SIII}$
		R2Ø
xx	4	SR1A (1-8)
		SR2E - $\overline{SI}$ SII_5 $\overline{SII}_a$ $\overline{SIII}$ (1-8)
		SR3E - $\overline{SI}$ SII_5 $\overline{SII}_a$ $\overline{SIII}$ (1-8)
		SXRY - Sectored X-Ray (1-8)
4	xx	R1
		R2A - R9A
		R1ØE - DI_5
		R11A - R13A
		R14E - B
		R15A - R16A
		R17E - SI (VLET 2)
		R18A - R19A
		R2Ø
xx	5	SR1B - (1-8)
		SR2F - $\overline{SI}$ SII_6 $\overline{SII}_a$ $\overline{SIII}$
		SR3F - $\overline{SI}$ SII_6 $\overline{SII}_a$ $\overline{SIII}$
		SXRY - Sectored X-Ray
5	xx	R1
		R2B - R9B
		R1ØF - DI_6
		R11B - R13B
		R14F - CI

Table 3. (continued)

Unsectored	Sectored	Rate
		R15B - R16 B
		R17F - SII (VLET 2)
		R18B - R19B
		R2Ø
xx	6	SR1C (1-8)
		SR2G - $\overline{SI}\ SII_7\ \overline{SII}_a\ \overline{SIII}$
		SR3G - $\overline{SI}\ SII_7\ \overline{SII}_a\ \overline{SIII}$
		SXRY - Sectored X-Ray
6	xx	R1
		R2A - R9A
		R1ØG - DI_7
		R11A - R13A
		R14G - CII
		R15C - R16C
		R17G - SII_a (VLET 2)
		R18C - R19C
		R2Ø
xx	7	SR1D (1-8)
		SR2H - $\overline{SI}\ SII_8\ \overline{SII}_a\ \overline{SIII}$
		SR3H - $\overline{SI}\ SII_8\ \overline{SII}_a\ \overline{SIII}$
		SXRY - Sectored X-Ray
7	xx	R1
		R2B - R9B
		R1ØH - DI_8
		R11B - R13B
		R14H - CIII
		R15D - R16D
		R17H - SIII (VLET 2)
		R18D - R19D
		R2Ø

PHA Tape Logical Record Format

Displacement	Type	Description
Ø	I*4	Time of day (MS) for first page contained in record
4	I*4	Time of day (MS) for page which is expected to immediately follow the last page in this record
8	I*2	Day (RMJD) for first page contained in record
1Ø	I*2	Day (RMJD) for page which is expected to immediately follow the last page in this record
12	I*4	Round Trip Light Time
16	I*4	Spacecraft Clock
2Ø	I*2	Absolute File Number
22	I*2	Time Correction Flag
24	I*2	Ratio of PHA blocks to RATES blocks
26	I*2	Bit Rate (8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096)
28	I*2	Format (1, 2, 3, 5)
3Ø	I*2	Frame Counter Correction
32	I*2	Data Type
34	I*2	Data Quality
36		All the subcom data associated with the first page of data contained in the record. Refer to Tables 1 and 2 for a description of the subcom data for the two format groups.
84 (128)	I*4	All the rates data associated with the first page of data contained in PHA record. The rates data associated with each page appear in eight consecutive words, as follows:

Displacement	Type	Description

(1) HET RATE R1 - (A2K1 + A1CI)B CIII

(2) HET RATE R1 - (A2K1 + A1CI)B CIII

(3) HET RATE R2A - A1 $\overline{\text{A2}}$ B CIII

(4) HET RATE R2B - A1 BK2 $\overline{\text{CIII}}$

(5) HET RATE R3A - A2 B CII

(6) LET RATE R11A - DI DII $\overline{\text{F}}$

(7) LET RATE R11B - DI DII Σ D $\overline{\text{F}}$

(8) Computed HET RATE R1 = (R6B + R7A + R7B + R8A + R8B)

All rates which fail the trend check will be indicated by a negative rate value. Whenever a rate with a value of zero fails the trend check, it will be set to the value -21000000. Padded rates will be indicated by the value -20000000.

I*2 — All the PHA data associated with the first page of data contained in the PHA record. Each PHA entry, comprised of a HET and LET event, has a unique time associated with it and appears in three consecutive words, as follows:

0(MSB)............................	31(LSB)
(1) HET - 1	HET - 2
(2) HET - 3	LET - 1
(3) LET - 2	LET - 3

Padded/missing PHA data is indicated by a negative one in the PHA entry. There is a varying number of PHA readouts per page depending upon the PHA/RATE block ratio: At a ratio of 5:1, there are 160 PHA readouts; at 3:1, there are 96 PHA readouts; and at 1:1, there are 32 PHA readouts. (See Table 3 for the structure of a PHA readout.)

Displacement	Type	Description
D_2 (D_2^1)		All the subcom, Rates, and PHA data for the second page of data contained in the record
D_3(D_3^1)		All the subcom, Rates, and PHA data for the third page of data contained in the record
D_4(D_4^1)		All the subcom, Rates, and PHA data for the fourth page of data contained in the record

Note: The first displacement is for data transmitted in formats 1, 2, or 3. The record displacement is for data transmitted in format 5. Actual displacements for page 2 - 4 are dependent upon bit rate and the PHA/RATES block ratio.

Table 1. PHA Tape

(Subcom data for format group 1 - formats 1, 2, 3)

Displacement	Type	Description
Ø	I*2	Spin Rate (in RPM)
2	I*2	HET (E7A) temperature
4	I*2	VLET1 (E7B1) temperature
6	I*2	VLET2 (E7B2) temperature
8	I*2	LET (E7C) temperature
1Ø	I*2	detector mounting plate temp.
12	I*2	X-Ray detector temperature
14	I*2	thermal blanket support plate 1 temp.
16	I*2	thermal blanket support plate 2 temp.
18	I*2	electronics temperature
2Ø	I*2	base plate temperature
22	I*2	+12 v monitor
24	I*2	+6 v digital monitor
26	I*2	+6 v analog monitor
28	I*2	+7.75 v monitor
3Ø	I*2	+4.7 v monitor
32	I*2	base plate temperature (front)
34	I*2	Power status (1=on, Ø=off)
36	L*1	X-Ray Window Clock
37	L*1	X-Ray Window Data
38	L*1	Internal Calibrator A
39	L*1	Internal Calibrator B
4Ø	L*1	X-Ray high voltage
41	L*1	Sector synchronizer
42	L*1	Force blackout mode
43	L*1	X-Ray sector data mode
44	I*2	X-Ray command reg.
46	I*2	X-Ray XEQ. reg.

(12 words)

Table 2. PHA Tape

(Subcom Data for format group 2 - format 5)

Displacement	Type	Description
0 - 43	same as 0 - 43, Table 1, for sequence 1	
44 - 87	same as 0 - 43, Table 1, for sequence 2	
88 - 91	same as 44 - 47, Table 1	
(23 words)		

Table 3. Helios PHA Events

Halfword 1 METTAAAAAAAAAAAA

Halfword 2 BBBBBBBBBBBBCCCC

Halfword 3 CCCCCCCCRSSQPPN

Where:

M = 0, data is good

= 1, data is missing 1 padded

E = 0, LET event

= 1, HET event

TT = 00, $A1\overline{A2}BCIII$ (HET)/$DIDII\,\Sigma\,D\,\overline{F}$ (LET)

= 01, $A2BCIII$ (HET)/$DIDII\,\overline{F}$ (LET)

= 10, $(A2K1 + A1CI)\,B\overline{CIII}$ (HET)/(No LET)

= 11, $A1BK2\overline{CIII}$ (HET)/(No LET)

R = 0, CII threshhold not exceeded

= 1, CII threshhold is exceeded

HET only

SSS = 0-7, sectors 0-7, respectively

Q = 0, PHA word 1 is the A amplitude

= 1, PHA word 1 is the CIII amplitude

HET only

PP = 0-3 priorities (HET)/0-1 priorities (LET)

N = 0, good event

= 1, null event