1.0 General

1.1 Spacecraft Configuration - For the purposes of this document, the Galileo Orbiter can be considered a two part spacecraft, one section, the "despun" portion, is held fixed with respect to inertial space, while the other section rotates about a spacecraft axis at a nominal rate of 3 RPM. The EUV instrument is mounted on the spun section and rotates with it, thereby observing a circular section of the universe once every 20 seconds.

1.2 Instrument General Description - The Extreme Ultraviolet (EUV) channel instrument consists of a spectrometer with its processing electronics, and a logic module consisting of a microprocessor-based controller and the required interface electronics (Fig. 1). Ultraviolet energy having wavelengths in the range of 400 to 1200 Angstroms is collected, measured, digitized and stored. At appropriate intervals, groups of processed data are made available to the spacecraft telemetry system for transmission back to earth.

1.3 Mission Objectives - The principal objective of the EUV experiment is to observe the torus defined by the orbit of the Jovian moon IO, and to measure the intensity of the radiation emanating from the torus in the extreme ultra-violet portion of the spectrum. At other times, the instrument will be used to conduct full sky scans or to observe targets of opportunity as the need arises.

2.0 Spacecraft Interfaces

2.1 Spacecraft (Mission) Timekeeping - Timekeeping on board the spacecraft is accomplished by downcounting a 120 Hz clock signal and providing the output of various intermediate stages of the counter for synchronizing purposes. A conceptual view of the timing chain is given in Fig. 2. A full cycle of the divide-by-ten MOD10 counter defines what is referred to as a Minor Frame. Each minor frame is subdivided into ten equal intervals of 66 2/3 milliseconds duration called RTI-0 through RTI-9. A Real Time Interrupt (RTI) pulse coincident with the active edge of the clock input of the MOD10 counter defines the beginning of each RTI interval.

The output of the MOD10 counter serves as the input for the MOD91 counter. A full cycle of the MOD91 counter requires 60 2/3 seconds and defines what is known as a Major Frame. The output of the MOD91 counter, in turn, serves as the input to a 24-bit RIM (Realtime IMage) counter. Each of these quantities, RIM (3 bytes), MOD91 and MOD10 (1 byte each) are made available every 2/3 second to any on board experiment requiring them.

Mission documentation has decreed that certain activities will occur during specific RTI intervals. In particular, in the case of the EUV instrument, spacecraft information will be provided during RTI-8, data to be telemetered to earth will be retrieved during RTI-1, and external (uplinked) commands will be relayed to the instrument during RTI-4. Instrument software will anticipate these events and execute appropriate actions, when required.

2.2 Spacecraft Spatial Orientation - As mentioned earlier, the section of the spacecraft on which the EUV instrument is mounted is continuously rotating. It is desirable to collect data from the spectrometer only when a target of interest is within the field of view of the instrument. This requires that the instantaneous position of the instrument, relative to some reference, be known or deducible.

```
 ________________________            ____________________________________
|SPECTRO|PROCESS|<------>| FDS      |   uP    |  BUS      |           |   ________
|METER  |ELECTR |        | SIM      |_________|ADAPTOR    |<--------->|
|_______|_______|        |--------- |         |-----------|           |
                |------->|ANA MUX   |   RAM   |PWR SUP    |<----------|   S/C
                         |__________|_________|___________|           |
                              |                                       |
                              |-------------------------------------->|
                                                                      |   ________
```

Figure 1

```
                                                              MOD 8
 ___ ___ ___            _____           _____           _____
|   |   |   |          |     |         |     |         |     |
| R | I | M |<---------|MOD91|<--------|MOD10|<--------| 1/8 |<----120 Hz
|___|___|___|          |_____|         |_____|         |_____|

             |_____|          |_____|          |_____|
             60 2/3             2/3            66 2/3
              SEC               SEC             MSEC


|<-------------------------  60 2/3 sec  ------------------------->|
|                                                                  |
| 0   1   2   3                  91 - MOD91s           88  89  90  |
|___|___|___|___|____________________,,_______________|___|___|___|
          /     \
         /       \
        /         \
       /           \
  |<----- 2/3 SEC ----->|
  |                     |
  | 0  1  2     7  8 (9)|------- MOD 10 * 10 =          mf = .666 sec
  |__|__|__|_,,_|__|__|_|     ONE MINOR FRAME
               /     \                                  RTI = .0666 sec
              /       \
             /         \
            |            |          8 * MOD 8 =
            |- 66 2/3 MILLISEC-|    ONE RTI INTERVAL = .0666 sec
            | 0 | 1 | 2 | 3 | 4 | 5 | 6 |(7)|
            |___|___|___|___|___|___|___|___|
```

Figure 2

1 Scan = 20.8 msec = 0.0208 sec

$\therefore \sim \frac{.0666}{.0208} \cong 3.20$ scans/RTI

$\cong 32.02$ scans/mf

During RTI-8, the spacecraft makes available a 16-bit number representing the angle between the -X axis of the spacecraft and the projection of the north ecliptic pole vector on the spin plane. This number is a prediction of the value of the angle at the beginning of the next minor frame. Also provided is a 16-bit number representing the time rate of change of this angle (angular change during 8 1/3 milliseconds). EUV instrument software uses this information to determine when it is time to initiate a data taking session.

Potentially, there is some possibility of semantic confusion with regard to angular data. Mission documentation generally refers to angle and rate of change of angle collectively as Sector Data. Unfortunately, EUV documentation also utilizes the terminology "sector" but with quite a different conotation, specifically, the observed target field is time-divided into variable width segments which are also called sectors. Both meanings are used in this document; however, when "sector" refers to spin position angle, this usage will be literally emphasized.

an integral number of instrument scan periods * *See §3.3*

2.3 Shared HIC Interface - Exigencies of the telemetry system have mandated that the EUV share the telemetry channel with another instrument, the Heavy Ion Counter (HIC). Actually this requirement has minimal effect on either instrument. The EUV is an extremely sensitive instrument which will yield corrupted data when operated too close to the planet; HIC must operate in close proximity to the planet in order to obtain meaningful data. In this context, distances are conveniently expressed in terms of Jovian radii (Rj). EUV operation, then, is confined to the (approximate) range 40-25 Rj.

? (note that HIC power may be on when EUV on but EUV power must be OFF when HIC uses the TM stream.)

2.4 Direct Memory Access - The methodology employed for communication between the spacecraft Command and Data System (CDS) and the on board experiments is a technique called Direct Memory Access (DMA). The architecture of the microprocessors (RCA 1802) generally used on this vehicle readily supports this approach. In brief, information from the CDS is written into a predefined location in the instrument memory and collected by the instrument microprocessor at some later time. To send data to the CDS, the microprocessor stores the data at a (different) predefined location and the CDS will retrieve it later. Successful transfers require that storage of data in memory be completed before a retrieval is attempted, no other collaboration is necessary.

Same process for mem load & verify?

2.5 Time/Sector Broadcasts - Spacecraft (mission) time, and sector (spacecraft spin position angle and rate of change) information are transferred by DMA from the CDS to the instrument at some time during each RTI-8 interval. To preclude any conflict, the instrument waits until RTI-9 to retrieve these data.

2.6 Telemetry - Science (or housekeeping) data which are to be relayed back to earth are placed in a specific area of instrument memory where they will be collected by the CDS, again by DMA, during RTI-1. To insure that a data block is collected intact, the instrument stores the return data during RTI-0. A data block, regardless of content, is always 12 bytes long. Since 12 bytes are transferred every 2/3 second, the effective data rate is 18 bytes/second.

*?? * maybe we could add Sandel's sky map showing observed plane w/ "sector" indicated as a time-specific value ??*

See 3.3.3. ← See p5. ?? conflict

3.0 Instrument Specifics

3.1 Spectrometer/Electronics - The spectrometer contains a concave objective grating and a detector array consisting of 128 spatially distributed elements, called pixels, which are sensitive to radiation in the 400 to 1200 Angstrom range. Radiation entering the instrument through an aperture, passes through a mechanical collimator and is reflected by the grating onto the detector array. Dispersion causes specific pixels to be illuminated as a function of the wavelengths of the incoming radiation. When a photon enters the detector, it will cause a flood of electrons which will be collected and stored by one or more (adjacent) pixels.

The outputs of the pixels are electrically segregated into two groups, the even-numbered elements (0, 2,...,126) and the odd-numbered elements (1, 3,...,127). On the detector, the individual elements may be considered as members of two 64 bit serial shift registers. From this point, even and odd data are processed separately in identical channels. Pixel contents are shifted out in pairs, one even and one odd, at the rate of one pair every 5 microseconds. The charge level acquired by each pixel is integrated and the resulting voltage applied to a level detector. If the threshold is exceeded, a sixteen bit counter is incremented and saved. A period of 320 microseconds is required to sample all of the 64 pixel pairs before the cycle repeats.

Do we need to know how the level is set? Is this the HV levels which are selectable? ?? - See 3.3.1

The 128 sixteen bit counters are stored in a bank of 32 sixty-four bit shift registers. These registers can be sequentially accessed by a pair of sixteen bit parallel-in, serial-out shift registers which provide the means for transferring data to the logic module. Upon receipt of a start command, even and odd data are loaded into the output registers, in pairs, and serially transmitted to the FDS simulator.

It requires 325 microseconds to transfer a pair of data words to the logic module. Therefore, the operation of transferring all 128 data words, called a scan, requires 20.8 milliseconds. Since each pixel is sampled once every 320 microseconds, but is shifted out at most once every 20.8 milliseconds, it is conceivable that the count associated with a particular pixel could be as high as 64. However, it is considered unlikely that the count will ever exceed 5 or so. For this reason, only the lower eight bits of each data word are preserved in the FDS simulator.

It should be noted the spectrometer electronics provide two methods of processing the data from the sensing elements, namely, the pulse counting mode (mode 1), described above, and the pulse integration mode (mode 0). The principal difference between the two methods is that in mode 0, the level detector referred to above is configured as a three bit analog to digital converter to transform the pulse amplitude into a digital value. It is not anticipated that this mode will be used on Galileo.

any implications on rest of system if this was used? In part, buffer overflow due to every value being present?

3.2 Logic Module - The logic module contains an 1802A microprocessor, utilizing 4096 bytes of random access memory, a spacecraft interface called a bus adaptor and an interface to the spectrometer electronics called the Flight Data System (FDS) simulator. The microprocessor controls the flow of data from the spectrometer, processes the data received and presents it to the spacecraft telemetry system for downlinking.

Should we note a round number of how much the current load takes? ✓ See 3.2.1

3.2.1 Microprocessor Functional Overview - The software which governs the operation of the EUV instrument is contained in a program, roughly one kilobyte long, which is interrupt driven. An interrupt may be generated for one or more of three reasons: a) Timing (RTI interrupt), b) Data (a pair of data bytes is available for retrieval), and c) Sector (a scan of the spectrometer data registers has been completed). When not servicing interrupts, the program causes data already received, if any, to be processed and various housekeeping tasks to be performed. The remaining three kilobytes of memory are devoted almost entirely to various buffers required to hold processed data until it can be collected by the telemetry system. A detailed description of the program can be found elsewhere; the following paragraphs describe the handling of those tasks which are germane to later discussions.

As noted earlier, the spacecraft supplies information related to the current spin position angle (theta) and rate of change of that angle (delta theta). During RTI-9 the program collects these data and immediately multiplies delta theta by 8 to produce the rate of change in spin angle in 66 2/3 milliseconds, that is, one RTI interval. During each succeeding interval, the value of theta at the beginning of the next interval can be predicted by successively adding this modified value to theta. This technique is used to determine when a data taking session should be initiated.

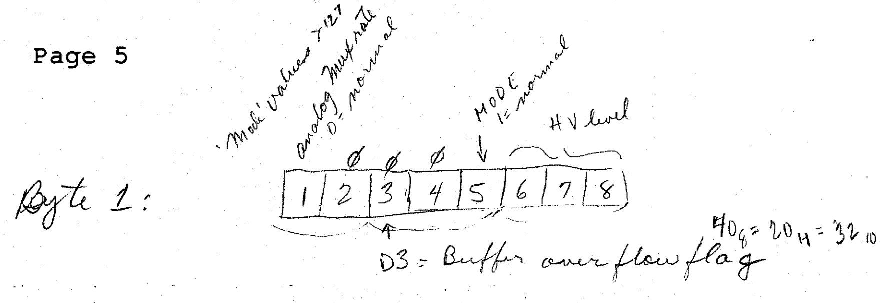
3.3 Commands - Control over the data taking operation is accomplished by uplinking a command consisting of four bytes, in the following order:

1. Mode/High Voltage
2. Starting Angle
3. Number of Scans per Sector
4. Number of Sectors

The following paragraphs discuss the function of each of these commands in detail. (Also see 7(x) Spec document 3- .)

3.3.1 Mode/HV - The sensitivity of the spectrometer to the incident radiation is dependent upon the level of the high voltage applied to the instrument. Seven levels (plus zero) of high voltage are commandable by setting the least significant three bits of the Mode/HV byte to the appropriate binary value. The next most significant bit, D5, controls the mode of operation of the analog channels within the spectrometer. (Note: Bit numbering nomenclature is defined in GLL-3-290 and specifies MSB = bit1 and LSB = bit8). For the Galileo mission, the only anticipated mode has D5 = 1, the pulse counting mode. The most significant bit, D1, when set to 1, causes the analog multiplexer to output data at much higher rate (approximately 16 channels/40 seconds). This feature is included primarily for preflight testing and is expected to be used only for diagnostic purposes after launch. The remaining bits are unused and should be set to zero when creating a Mode/HV command word.

3.3.2 Starting Angle - As mentioned in paragraph 2.5, the spacecraft supplies information in the form of a two byte word which predicts the spacecraft's orientation with respect to the ecliptic north pole at the beginning of the next minor frame. It is the responsibility of ground analysts to determine, from a knowledge of spacecraft position and orientation with respect to the IO torus, what the value of this angle should be at the time a data taking session is to be initiated. Data taking should begin and end with the field of view of the spectrometer sufficiently outside the boundaries of the target area such that uncertainties in spacecraft positioning will not result in a loss of data.



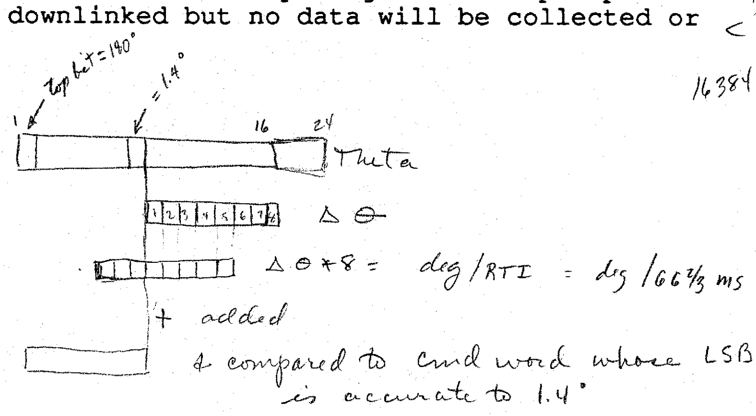
When the value of the start angle has been determined, it is multiplied by the scale factor 256/360 (binary counts/degree) since a full revolution must be described by a single 8-bit byte. Clearly, this introduces a granularity of slightly more than 1.4 degrees in the actual start position of a data taking session. The decimal number thus obtained is truncated, converted to its binary equivalent and inserted into the second byte of the command word.

The strategy utilized during each RTI interval except RTI-9 is to add the most significant byte of delta theta (which has previously been shifted left three places to yield the rate of change of angle in 66 2/3 milliseconds) to the two byte word representing the current value of theta. The resulting MSByte of theta is compared to the uplinked starting angle. (During RTI-9, the most recently received value of theta is used directly.) If a match is found, starting commands are issued to prepare the spectrometer to begin returning data at the beginning of the next RTI interval. The implied resolution of starting angle is 360/256 or 1.4 degrees.

3.3.3 Sectors - The term "sector", as it pertains to the EUV instrument, refers to a technique of dividing the target area into a series of smaller areas or sectors. This is accomplished by defining a sector as the time required to complete one or more "scans" of the storage registers in the spectrometer electronics. When a scan of all 128 registers is completed, the FDS simulator produces an identifiable interrupt which is used by the software to maintain appropriate counters which, in turn, define the sector boundaries.

A target, then, may be divided into two or more sectors (127 maximum) and each sector may be one or more scans in duration (again, 127 maximum). It is evident that a given target area may be sectored in a variety of ways. For instance, consider a target that subtends an arc of 9 degrees. Since a scan of the spectrometer registers requires 20.8 milliseconds and the nominal spacecraft rotation rate is 18 deg/sec, one scan is equivalent to 0.3744 degrees. Nine degrees, then, could be programmed (approximately) as one sector having a duration of 24 register scans, or two sectors requiring 12 scans/sector, four sectors with 6 scans/sector, etc. From the instrument standpoint there is no preferred method of disecting the target area; this is purely a data processing consideration.

When the sectoring scheme has been decided upon, the decimal numbers describing the number of sectors and the number of scans/sector are converted to their binary equivalents and inserted into the command word. It should be noted that zero is always an illegal value for the number of scans per sector. A command of zero sectors, however, will cause the prologue for a spin packet (see section 4) to be generated and downlinked but no data will be collected or transmitted.



4.0 Data Analysis - Because of the extremely low data rate provided by the spacecraft telemetry system, a great deal of effort has been expended in manipulating the data to be downlinked in order to maximize the information return. The following paragraphs describe the formatting and protocol used.

4.1 Spin Packet - A spin packet is defined as a complete record of the data collected during a single data taking period. Before describing the protocol of the spin packet in detail, it will be helpful to discuss the data compression algorithm utilized. The form of the data received from the spectrometer for each pixel is a digital count, the magnitude of which is a measure of the intensity of the radiation seen by that pixel. This information will be transmitted as the pixel number, repeated as many times as the digital count dictates.

There are 128 pixels numbered from 0 through 127. Seven bits are sufficient to cover this range, implying that the eighth (most significant) bit is available to be used for other purposes.

Data will be downlinked in the order in which they were collected, that is, data collected in sector one, if any, will be sent first, data from sector two, if any, next, etc. For those sectors within which no data were seen, a hexidecimal 7F will be sent to so indicate. The unassigned most significant bit in the science data bytes is used to delineate the transition from one sector to the next. When the bit is zero, it indicates that the associated datum was the first to be collected during the current sector; all other data collected during the same sector will have the most significant bit set high.

With these preliminaries out of the way, the complete spin packet protocol can be described as:

Byte 0:	start-of-packet marker (hex FE)
Bytes 1 & 2:	Wavelength Integration Buffer (WIB) data
Byte 3:	MOD91 counter
Byte 4:	MOD10 counter
Bytes 5 - n:	science data (or fillers)

It is quite likely that numerous hex FF bytes will be found scattered throughout the data, either singly or in groups. Whenever there are less than 12 bytes waiting to telemetered, the software transfers those data which are available, and then fills out the remainder of the telemetry buffer with FFs. Whenever encountered, then, (other than in bytes 1 through 4) FFs may be ignored.

Wavelength integration buffers are discussed in detail in the next section. At this point it is sufficient to note that 128 sixteen bit registers are maintained by the software and inserted sequentially at the beginning of each spin packet created. The register is inserted least significant byte first (byte 1).

It was noted earlier that the software performs a test during each RTI interval to determine whether a data taking session should begin at the next RTI interrupt. When such is the case, the software retrieves the current value of the MOD91 and MOD10 counters and inserts them into the spin packet. This information, in conjunction with the RIM count which will be downlinked as part of the housekeeping data, and mission profile data, which will relate space-

Find out how uniform it is expected to be

craft location and angular position correlated to mission time, will provide a positive identification of precisely when the data taking began.

Bytes 0 through 4 constitute a prologue for data collected during each data taking session. As mentioned earlier, this will be the only data telemetered if the number of sectors commanded is equal to zero.

4.2 Integration Buffers - In addition to formatting and storing pixel data as described earlier, the software also maintains two buffers called the Sector Integration Buffer (SIB) and the Wavelength Integration Buffer (WIB). Each buffer contains 128 sixteen bit registers. Within the SIB, the software assigns one register to each sector called for in the command set. When a pixel event is recorded, the register associated with the current sector is incremented. If multiple events are recorded for the same pixel, the sector register is incremented by that amount. The data in the SIB registers are returned by including the contents of each register, sequentially, in the housekeeping packet, described in the next section.

In the WIB, a register is maintained for each of the 128 pixels in the spectrometer. A register is incremented one or more times whenever its associated pixel is determined to have recorded one or more events. As previously noted, the register contents are included, individually, as part of the spin packets. Identification of the specific registers is covered in the next section.

All of the registers within the integration buffers are modulo 65536 counters. They are initialized to zero at power up or whenever the microprocessor is stopped and then restarted.

4.3 Housekeeping - Approximately once per minute, at the beginning of each major frame (MOD91 = 0), the stream of science data is interrupted to permit the transmission of 12 bytes of housekeeping data. The protocol of the housekeeping packet is:

Bytes 0 & 1:	7E - identifies start of housekeeping data
Byte 2:	Mode/HV command
Bytes 3 - 5:	RIM count
Byte 6:	Number of scans/sector
Byte 7:	Number of sectors
Byte 8:	SIB register number for next two bytes
Bytes 9 & 10:	SIB register contents (MSByte first)
Byte 11:	Number of WIB register in next spin packet

HERE: 2 LSB of RIM + RTI of last integ.

The data in bytes 6 and 7 are simply a replica of equivalent data included in the command set (with the most significant bit of each set low). The most significant and the four least significant bits of byte 2 also replicate the uplinked command bits. However, bits 2 - 4 when set equal to 1 indicate the occurrence of certain conditions in accordance with the following table:

Bit 2:	Pixel 126 activity has been recorded
Bit 3:	Pixel data buffer is full
Bit 4:	Pixel 127 activity has been recorded

* Since buffers are never zeroed, if # sectors change then CMD word will have to be used to decide what size sectors these cnts represent.
* Also true if table changes what pixels are masked out

It is characteristic of the detector used that pixels 126 and 127 will be active almost continuously. Therefore, bits 2 and 4 serve as an indicator of the health of the instrument; no 126/127 activity would suggest a problem with either the spectrometer or the logic module. Bit 3, when set, indicates that the incoming data rate is so great that the processing routines cannot keep up, causing the input buffer to fill and, quite probably, reject some of the received data.

The RIM count will be that which is valid during the remainder of the current major frame. SIB data represents the next register in sequence (modulo number-of-sectors).

not that given in Byte 8 ?

Usually, the number contained in byte 11 will indicate the pixel number to be associated with the WIB data included in the next spin packet. However, it should be noted that there is no temporal relationship between the transmission of housekeeping data and science data. Housekeeping data are inserted into the data stream independent of and asynchronous to the science data. Therefore, there will be occasions when rigidly interpreting byte 11 as the number of the next WIB register will be erroneous. Prior and subsequent housekeeping packets will correctly identify the next WIB register permitting a cross checking algorithm to recognize and reject the misleading information.

4.4 Data Analysis - Appendix A displays a sample of data collected during the testing phase of the logic module. The first six bytes in each row are artifacts of the test equipment and should be ignored. The remainder of the data sample is a realistic representation of what may be expected from an actual observation.

The line labeled 1 in the sample shows the beginning of a spin packet. This can be deduced by the leading FE. Preceding this packet is a collection of FFs suggesting that the buffers had been empty of data prior to the start of the data taking session under evaluation. (Some caution is required here, since, had the buffers overflowed, the FFs could be misinterpreted. This is discussed in greater detail in section 4.5.) From a consideration of spacecraft timelines, it is known that each line of data represents a time interval of 2/3 second; therefore, the output buffer was empty for at least 1 1/3 seconds.

Following the FE, the next two bytes (the next WIB contents) indicate that some pixel has accumulated 14 (decimal) events up to this time. Exactly which pixel is being referred to would have to be deduced from earlier housekeeping data and a ground maintained pixel number counter. Following these two bytes is the value of the MOD91 counter (minor frame 41 hex, 65 decimal) at the time it was determined that data taking should begin at the next RTI. Next comes the MOD10 counter with the value of the interval (RTI-2) just prior to the start of data taking.

X wrong, it is MOD10 value

The remainder of the entries through line 29, with one exception, comprise simulated science data. The exception is line 26 which is housekeeping data and will be discussed later. The data are interpreted as follows: in sector one, pixel number 0A recorded one event. It is clear that this is sector one since no other science data preceded it. If, for example, sector one had been void of data, a 7F would have been the first entry. The next byte, 94, is a hex 14 with the most significant bit set high. This means

with # scans/sector = 1

? Discuss time resolution of SIB + WIB + whether either can "overtake" tm data? Note also overflow case where SIB + WIB not incremented.

Tell Casual Observer not to look at EB thru 0B !

that pixel 14 also recorded an event in sector one. Continuing in this vein, pixels 1E, 28, 32, 37, 3C, 46, 50, 52, 64, 6E and 78 all recorded a single event in sector one. The next datum, 01, has the most significant byte low indicating the start of a new sector. This must be sector two since no intervening vacant sectors (i.e. no 7Fs) have been seen. Therefore, pixel one was the first to record activity in sector two and it was followed by 13 more bytes in the same sector.

The evaluation proceeds in this way (ignoring line 26) through line 29, where the trailing FF indicates that insufficient data were available to fill the telemetry buffer causing a filler (FF) to be added to the data stream. The last valid data byte then, is FC which represents pixel number 7C.

Line 26 can be recognized as a housekeeping packet by the two leading 7E bytes. The interpretation of this line follows the protocol outlined above. Byte 3 is a reproduction of the Mode/HV command which is part of the current command set. In this case, it indicates that the high voltage is set to zero, the spectrometer electronics is operating in mode 1, the pulse counting mode (see section 3.1), and accelerated multiplexer operation is turned off. The next three bytes, all identical, simulate the RIM count. The test equipment used does not support an actual RIM counter; three identical but changing bytes are used to simulate the function. The timing is such that the RIM count is incremented prior to being placed in the telemetry buffer, hence, the least significant byte is one greater than the others. The next two bytes, also replicated from the command set, provide the information that there will be 19 (hex, 25 decimal) sectors and the duration of each sector will be defined by a single scan of the spectrometer registers (20.8 msec).

The next three bytes indicate that sector 3 has accumulated 68 hex (104 decimal) events since microprocessor operation was initiated. Finally, the last byte shows that the WIB register associated with pixel 8 will be inserted in the next spin packet.

It is worth noting that since each line (12 byte group) is separated in time by 2/3 second, 30 lines represent a time span of 20 seconds. At 3 RPM, this is about all the time available for returning data before a new data taking session begins. This implies that the quantity of data shown in this data sample is close to the maximum that can be handled without loss (due to overflow). Also, note that the number of sectors can be cross checked against the number called for in the housekeeping data. This is accomplished by counting the data bytes having the most significant bit set low (including the 7Fs, if any). In the sample shown, one such byte occurs on every line except 6, 18 and 29 for a total of 25 sectors, as required.

4.5 Buffer Overflow - In order to handle the varying data rates expected, a buffering scheme has been implemented using two 1K, circular buffers. The circular nature of the buffers implies that for sufficiently high incoming data rates, either or both of these buffers may overwrite valid data before it can be removed by the telemetry system. The dynamics of buffer overflow and methods of dealing with the condition have been covered in a separate paper (see Appendix B). This section simply repeats the results of that analysis and discusses an example of data corrupted by buffer overflow.

Briefly, data coming from the spectrometer are formatted into four-byte packets and stored in the input or pixel data buffer. Each packet contains

Really "detector events" ∴ includes Bkg

information associated with two adjacent pixels and the buffer is capable of storing 255 of these packets. Later, this information is removed, reformatted and stored in the output or spin packet buffer, which is capable of holding 1024 data bytes less a few required fiducials.

Analysis has shown that for [incoming count rates] greater than 9.4 counts/pixel/second, it can be expected that the input buffer will become full. When this occurs, logic within the software will prevent further additions to the buffer until sufficient room exists. Any data received from the spectrometer while the buffer is full will be lost.* It will not be evident from the returned data that such a condition has occurred; however, a software flag will be set and downlinked with the next housekeeping transmission. Specifically, the flag is returned as D3 of the Mode/HV byte. When this bit is equal to 1, it indicates that a special interpretation is required for the data received since the last housekeeping transmission. After inclusion in the data stream, the flag is reset.

For incoming data rates within the range 5.4 to 9.4 counts/pixel/second, it is likely that data in the output buffer may be overwritten. This condition is not detected by the onboard software but can be deduced from a careful study of the returned data. In fact, it is possible to determine how much of the data are usable (Appendix B).

For data rates below 5.4 counts/pixel/second, all data will be valid. Note that all of the data rates discussed in this section are average values and are for reference only. Short bursts of high data rates could induce an overflow/overwrite condition even though the average was within the bounds outlined.

(Mem. R.O.)

* If this occurs in "cruise mode", would not see it since HK is not returned.

* also, since do not use pixel info, only SIB + WIB (+? some other buffer), would want to inhibit "overflow" situation of not putting values in these buffers.