

**2001 Mars Odyssey**

**GAMMA RAY SPECTROMETER EDR  
NASA LEVEL 0  
SOFTWARE INTERFACE  
SPECIFICATION**

April 1, 2004

# 2001 Mars Odyssey GAMMA RAY SPECTROMETER EDR NASA LEVEL 0 SOFTWARE INTERFACE SPECIFICATION

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**DOCUMENT CHANGE LOG**

Date	Description	Sections Affected
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12/11/02	Added product versioning information 2.3.4, 2.3.5	Appendix
12/11/02	Revised examples of labels in Appendix	Appendix
5/8/03	Added new CAT2_CNT column in Neutron Spectrometer data	Table 1, Appendix
4/01/04	Re-format due to lost formatting	All
4/01/04	BAD_code, message_log, and eng_data updates.	Section 2.2, Table 1, Appendix

**TBD ITEMS**

Section	Description

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## ACRONYMS

CEB	Common Electronics Box
EDR	Experiment Data Record
GiB	Gigabytes
GRS	Gamma Ray Spectrometer
GSH	Gamma Sensor Head
HEND	High Energy Neutron Detector
IKI	Institute for Space Research
KiB	Kilobytes
LANL	Los Alamos National Laboratory
MiB	Megabytes
NS	Neutron Spectrometer
PDS	Planetary Data System
RDR	Reduced Data Record
SIS	Software Interface Specification
SOPC	Science Operations Planning Computer
TBD	To Be Determined

## GLOSSARY

<b>TERM</b>	<b>DEFINITION</b>
Pixel	Duration of accumulation interval

## 1. INTRODUCTION

### 1.1 Purpose and Scope

The purpose of this Data Product SIS is to provide users of the GRS EDR (NASA Level 0) data product with a detailed description of the product and a description of how it was generated, including data sources and destinations. The EDR product contains uncalibrated gamma spectra from the GRS Gamma Sensor Head, neutron spectra from the High Energy Neutron Detector and neutron counts from the Neutron Spectrometer. Ancillary data, which will be used in calibration of higher-level data products, is also included. This SIS is intended to provide enough information to enable users to read and understand the data product. The users for whom this SIS is intended are the scientists who will analyze the data, including those associated with the 2001 Mars Odyssey Project and those in the general planetary science community.

### 1.2 Contents

This Data Product SIS describes how the EDR data product is acquired by the GRS instrument, and how it is processed, formatted, labeled, and uniquely identified. The document discusses standards used in generating the product and software that may be used to access the product. The data product structure and organization is described in sufficient detail to enable a user to read the product. Finally, an example of a product label is provided.

### 1.3 Applicable Documents and Constraints

This Data Product SIS is responsive to the following 2001 Mars Odyssey documents:

1. Mars Exploration Program Data Management Plan, R. E. Arvidson et al., Rev. 3.0, March 20, 2002.
2. 2001 Mars Odyssey Orbiter Archive Generation, Validation and Transfer Plan, R.E. Arvidson, R. S. Saunders, and S. Slavney, JPL D-20679, May 21, 2001.

This SIS is also consistent with the following Planetary Data System documents:

3. Planetary Data System Data Preparation Workbook, February 1, 1995, Version 3.1, JPL D-7669, Part 1.
4. Planetary Data System Data Standards Reference - Revised, June 15, 2001, Version 3.4, JPL D-7669, Part 2.
5. Planetary Science Data Dictionary Document, July 15, 1996, Planetary Data System, JPL D-7116, Rev. D.

The reader is referred to the following documents for additional information:

6. Boynton et al., The Mars Odyssey Gamma-Ray Spectrometer instrument suite, Space Science Rev., submitted, 2002.

Finally, this SIS is meant to be consistent with the contract negotiated between the 2001 Mars Odyssey Project and the GRS Principal Investigator (PI) in which reduced data records and documentation are explicitly defined as deliverable products.

## 1.4 Relationships with Other Interfaces

The GRS EDR Archive Volume SIS describes how the data products specified by this document will be made available through the PDS.

## 2. DATA PRODUCT CHARACTERISTICS AND ENVIRONMENT

### 2.1 Instrument Overview

The GRS instrument consists of the GRS Gamma Sensor Head (GSH), the Los Alamos Neutron Spectrometer (NS) and the Russian Space Institute High Energy Neutron Detector (HEND). Each detector (GSH, NS and HEND) is interfaced with the 2001 Mars Odyssey Orbiter through a microcomputer called the Common Electronics Box (CEB). Independent parameters for each detector, such as accumulation time (a.k.a. “pixel” duration) may be changed through commands executed on the CEB. In nominal operating mode, each detector collects data for one pixel, sends the data back to the CEB, and repeats the process. In addition, the CEB collects engineering data (temperatures, voltages, currents, etc). Data is sent from the CEB through the spacecraft bus for receipt by the Deep Space Network.

### 2.2 Data Product Overview

The GRS EDR data product contains ten types of data.

GAMMA_SPECTRA	GRS raw gamma ray spectra
PULSER_SPECTRA	Pulser calibration spectra
PROFILE_DATA	High time resolution count rates
NEUTRON_SPECTRA	Neutron spectrometer data
HEND_DATA	High Energy Neutron Detector data
CHAN_DATA	Spacecraft channelized engineering data
ENG_DATA	CEB, GRS, and NS engineering data
COMMAND_LIST	Command execution list
MESSAGE_LOG	CEB system message log
E_KERNEL	Experimenter’s Notebook

GAMMA\_SPECTRA is a time series file of GSH spectra. PULSER\_SPECTRA is a time series file of GSH spectra sampling the pulser (calibration energy source outputting at known fixed energies). PROFILE\_DATA is a series of counts in four energy bands, each item in the series summed for a nominal period of 32 milliseconds.

NEUTRON\_SPECTRA is a time series of LANL Neutron Spectrometer data.

HEND\_SPECTRA is a time series of IKI High Energy Neutron Spectrometer data.

ENG\_DATA is split into 81 files, one per source (e.g. Mounting Ring Temperature A), each a time series. CHAN\_DATA likewise has 109 sources, with a time series for each.

MESSAGE\_LOG is a time series of messages (including errors) output by the CEB.

COMMAND\_LIST provides a time history of commands that have been completed by the CEB. E\_KERNEL has two parts, a binary time series E\_KERNEL\_PEF data and an ASCII plain text stream (experimenter's notebook).

## **2.3 Data Processing**

Data format is described in section 3, Detailed Data Product Specifications. Data volume is a function of collection rate as parameterized by pixel duration. The nominal pixel duration is 19.2 seconds or 4500 records per day per file. However, some data is produced only on command or when triggered (i.e. profile data) or at some lower priority (i.e. engineering data) and will occur less frequently. Also note that the pixel duration can change in the middle of a time series file, which can be determined by noting the difference between record timestamps.

### **2.3.1 Data Processing Level**

The EDR product contains individual raw gamma spectra and associated data corresponding to NASA Processing Level 0, CODMAC Level 2 [see Applicable Document 1].

### **2.3.2 Data Product Generation**

A process termed "ingest" occurs on the GRS Science Operations Planning Computer (SOPC) which queries JPL flight databases and stores this data in relational database tables. The ingest process verifies the consistency of the data. The GRS EDR data product is output by software that maps the stored relational data into the format described by this SIS. Both processes (ingest and output) are rigorously tested. Multiple versions of the data product may be made available if software bugs affecting the output data are uncovered and corrected. In the event of an error whose fix changes released data, it is expected that the data will be reprocessed by the revised software and made available.

### **2.3.3 Data Flow**

The GRS-EDR data product will be made available in sequential data releases at three month intervals as specified in applicable document #2 (Table 5-1, Mars Odyssey Orbiter Archive Delivery Schedule). Releases of the GRS-EDR shall remain available for transfer from the GRS web site.

In the case of gamma spectra we will have approximately 32 KiB per record or 144 MiB per day during nominal mapping. Volume of the EDR data product will be approximately 300 MiB per day. Over the approximately 1000 days of data collection, total data product volume will be 300 GiB.

### **2.3.4 Labeling and Identification**

The data set ID provided by the PDS for the GRS EDR data product is:  
ODY-M-GRS-2-EDR-V1.0

The version number is incremented should the entire EDR data set be revised.

The file naming convention for GRS EDR data files will be the PRODUCT\_TYPE value

followed by an eight-digit date specifier in the format YYYYMMDD, e.g. GAMMA\_SPECTRA\_20010723.DAT. The EDR parts will have a detached PDS label in a separate file of the same name, extension .LBL.

### **2.3.5 Data Product Revisions**

Individual EDR products may be revised during the course of the mission. A product's revision status is recorded in its PDS label using the keyword `PRODUCT_VERSION_ID`. The value of this keyword is "1.0" for the first version of a product. The value is incremented with each product revision. Also, the label keyword `PRODUCT_CREATION_TIME` is updated with each product revision.

The PDS label also includes a `RELEASE_ID` keyword to indicate the number of the data release in which the product was included. The first release of the mission has a `RELEASE_ID` value of "0001"; the second release three months later has a value of "0002", and so on. This keyword is *not* updated for a revised product; it always shows the ID of the release in which the product first appeared.

`PRODUCT_VERSION_ID`, `PRODUCT_CREATION_TIME`, and `RELEASE_ID` appear in the index table for the EDR archive so that the set of revised products can be easily identified.

## **2.4 Standards Used in Generating Data Products**

### **2.4.1 PDS Standards**

The GRS EDR data product complies with Planetary Data System standards for file formats and labels, as specified in the PDS Standards Reference [4].

### **2.4.2 Time Standards**

Time series data in the GRS EDR data product is sorted according to the value of spacecraft clock as measured in ticks. 256 ticks constitute 1 second. Time series records are tagged by `SC_RECV_TIME` (spacecraft received time) and/or `SC_EV_TIME` (spacecraft event time). Received time is the time the spacecraft received the data record. Spacecraft event time is included where the spacecraft tags the actual time that the data record was collected. If the data is collected over a pixel interval, event time is at the middle of the pixel. Where we have event time, it is also included as converted to UTC by the NAIF SPICE toolkit and the appropriate 2001 Mars Odyssey spacecraft clock kernel. In binary files, UTC is stored as the decimal values corresponding to the ASCII character values when the UTC date is formatted in the pattern yyyy-mm-ddThh:mm:ss.sss (four digit year, two digits for month, day, hour, minute and second, and three digits for decimal fractional second). In addition, where appropriate we have included `SC_EV_TIME_FINE`, the fine time portion of `SC_EV_TIME` which is in fractions of a tick (256 per tick). Finally, the CEB contains its own internal clock. Values from this clock are also included, units are in milliseconds since the last CEB clock rollover.

### 2.4.3 Coordinate Systems

GRS EDR provides data using the MARSIAU coordinate system and also a fixed (with respect to the planet) Mars coordinate system. MARSIAU is defined by the Mars Mean Equator and IAU vector of J2000. The IAU-vector at Mars is the point on the mean equator of Mars where the equator ascends through the earth mean equator. This vector is the cross product of Earth mean north with Mars mean north.

In the Mars fixed frame, the Y-axis extends through the North pole of Mars, X extends through longitude zero, and the origin is the center of mass.

Columns SCPOS\_INERT and SCVEL\_INERT give the spacecraft position and velocity in this frame at the time of observation (middle of the pixel interval). In addition, column SCPOS\_MARS gives the spacecraft position in the Mars fixed coordinate system. SUBSC\_MARS gives the sub-spacecraft point in the Mars fixed coordinate system. Columns LATITUDE and LONGITUDE give the sub-instrument position of the observation.

### 2.4.4 Data Storage Conventions

Binary files are all fixed-length, stored in most-significant-byte-first (big-endian) format. In text files each record is terminated with a carriage return followed by a line feed.

## 2.5 Data Validation

GRS EDR products will be validated by the GRS Team for science content and for compliance with PDS archive standards [Applicable Document 4].

## 3. DETAILED DATA PRODUCT SPECIFICATIONS

The EDR data product shall be grouped into directories with one directory per flight day. Flight day is defined to be midnight-to-midnight UTC. Within each directory shall be the ten labels corresponding to the individual parts of the data product. The labels will point to one or more data files, and contain pointers to format labels detailing the column layout of the data files.

### 3.1 Data Product Structure and Organization

In the DATA directory of the EDR archive, data for each flight day will be in a subdirectory named in the format YYYYMMDD, indicating the date at the *end* of the data acquisition period.

### 3.2 Data Format

The ten types of data included in the GRS EDR product are listed in section 2.2. Each product type is stored in a separate file with a detached PDS label. All the product types are stored as binary tables with fixed-length records, except for the message log which is stored as an ASCII text table. Definitions of the columns in the tables are listed in Table 1.

### **3.3 Labels and Headers**

Each data file is described by a PDS label in a separate file with the same name, extension “.LBL”. A label file is stored in the same directory as the data file it describes. In most cases, the PDS label includes a pointer to another file that contains the column definitions, in order to avoid repeating the lengthy definitions in every label. These column definition files have the extension “.FMT” and are stored in the LABEL directory of the EDR archive.

The data files themselves do not contain any embedded headers.

Examples of GRS EDR labels are found in an Appendix to this document.

## **4. APPLICABLE SOFTWARE**

A library of source code to parse the EDR data product files is included. This library will allow a programmer to easily build tools that display or manipulate the EDR data. This source is written in the Java language, and requires version 1.3 (or higher) of the Java 2 Runtime Environment (JRE) or Java 2 Software Development Kit (SDK).

### **4.1 Utility Programs**

None at this time. May be included in future revisions.

### **4.2 Applicable PDS Software Tools**

PDS-labeled images and tables can be viewed with the program NASAView, developed by the PDS and available for a variety of computer platforms from the PDS web site <http://pdsproto.jpl.nasa.gov/Distribution/license.html>. There is no charge for NASAView.

### **4.3 Software Distribution and Update Procedures**

Any software will be distributed with the archive on the GRS web site. Version numbers and a CHANGELOG document will describe updates.

**Table 1. GRS EDR Data Columns**

This table lists the columns in all GRS EDR data files in alphabetical order. The format of each type of data file, including column positions, sizes, data types, units, and full descriptions, can be found in the format files (\*.FMT) in the LABEL directory.

<b>Column Name</b>	<b>Data Type</b>	<b>Length</b>	<b>Description</b>	<b>Appears In</b>
ANTICOINCIDENCE_CODE	MSB_UNSIGNED_INTEGER	1 byte	Anticoincidence code.	HEND_SPECTRA
BAD_CODE	MSB_UNSIGNED_INTEGER	4 bytes	If non-zero, the data has been flagged bad. Definitions in BAD_CODE.TXT.	GAMMA_SPECTRA HEND_SPECTRA, NEUTRON_SPECTRA PULSER PROFILE
CAT1_1_HIST	MSB_UNSIGNED_INTEGER	128 bytes	Category 1 histogram 1.	NEUTRON_SPECTRA
CAT1_2_HIST	MSB_UNSIGNED_INTEGER	128 bytes	Category 1 histogram 2.	NEUTRON_SPECTRA
CAT1_3_HIST	MSB_UNSIGNED_INTEGER	128 bytes	Category 1 histogram 3.	NEUTRON_SPECTRA
CAT1_3SEG_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Category 1, 3 prism event count.	NEUTRON_SPECTRA
CAT1_4_HIST	MSB_UNSIGNED_INTEGER	128 bytes	Category 1 histogram 4.	NEUTRON_SPECTRA
CAT1_4SEG_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Category 1, 4 prism event count.	NEUTRON_SPECTRA
CAT1_SUM_HIST	MSB_UNSIGNED_INTEGER	128 bytes	Category 1 summation histogram.	NEUTRON_SPECTRA
CAT2_3SEG_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Category 2, 3 prism event count.	NEUTRON_SPECTRA
CAT2_4SEG_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Category 2, 4 prism event count.	NEUTRON_SPECTRA
CAT2_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Category 2 event count.	NEUTRON_SPECTRA
CAT2_EARLY_1_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 early time histogram 1.	NEUTRON_SPECTRA
CAT2_EARLY_2_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 early time histogram 2.	NEUTRON_SPECTRA
CAT2_EARLY_3_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 early time histogram 3.	NEUTRON_SPECTRA

Column Name	Data Type	Length	Description	Appears In
CAT2_EARLY_4_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 early time histogram 4.	NEUTRON_SPECTRA
CAT2_EARLY_SUM_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 early time summation histogram.	NEUTRON_SPECTRA
CAT2_LATE_1_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 late time histogram 1.	NEUTRON_SPECTRA
CAT2_LATE_2_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 late time histogram 2.	NEUTRON_SPECTRA
CAT2_LATE_3_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 late time histogram 3.	NEUTRON_SPECTRA
CAT2_LATE_4_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 late time histogram 4.	NEUTRON_SPECTRA
CAT2_LATE_SUM_HIST	MSB_UNSIGNED_INTEGER	32 bytes	Category 2 late time summation histogram.	NEUTRON_SPECTRA
CEB_TIME	MSB_UNSIGNED_INTEGER	8 bytes	Clock count from the GRS Common Electronics Box at the beginning of the Collection interval (pixel).	GAMMA_SPECTRA, HEND_SPECTRA, NEUTRON_SPECTRA, PROFILE, PULSER_SPECTRA, ENG_DATA
CHECKSUM	MSB_UNSIGNED_INTEGER	2 bytes	An XOR checksum of the packet from title through temps, put on the data by the HEND instrument.	HEND_SPECTRA
CMD_ID	MSB_UNSIGNED_INTEGER	2 bytes	ID of the command that was sent to the FIS.	COMMAND_LIST, E_KERNEL
CMD1	MSB_UNSIGNED_INTEGER	6 bytes	Most recent command received by the HEND instrument.	HEND_SPECTRA
CMD2	MSB_UNSIGNED_INTEGER	6 bytes	2nd most recent command received by the HEND instrument.	HEND_SPECTRA
CMD3	MSB_UNSIGNED_INTEGER	6 bytes	3rd most recent command received by the HEND instrument.	HEND_SPECTRA
CMD4	MSB_UNSIGNED_INTEGER	6 bytes	4th most recent command received by the HEND instrument.	HEND_SPECTRA
CMD5	MSB_UNSIGNED_INTEGER	6 bytes	5th most recent command received by the HEND instrument.	HEND_SPECTRA
CMD6	MSB_UNSIGNED_INTEGER	6 bytes	6th most recent command received by the HEND instrument.	HEND_SPECTRA
COMMAND_COUNT	MSB_UNSIGNED_INTEGER	2 bytes	Number of commands in array	E_KERNEL
COUNTER	MSB_UNSIGNED_INTEGER	4 bytes	A spectrum can come down in up to 8 packets. Each packet has its own counter. This counter is the combination of all eight possible counters, four bits for each.	GAMMA_SPECTRA, PROFILE

Column Name	Data Type	Length	Description	Appears In
COUNTER	MSB_UNSIGNED_INTEGER	1 byte	The packet counter from the message packet, values from 0 to 15.	MESSAGE_LOG HEND_SPECTRA PULSER_SPECTRA NEUTRON_SPECTRA
DAY_INDEX	MSB_UNSIGNED_INTEGER	2 bytes	Day of Martian year.	GAMMA_SPECTRA, HEND_SPECTRA, NEUTRON_SPECTRA
DEAD_CNT	MSB_UNSIGNED_INTEGER	8 bytes	Dead count.	NEUTRON_SPECTRA
DELAY	MSB_UNSIGNED_INTEGER	1 byte	Delayed interaction pulse height.	NEUTRON_SPECTRA
DELAY_FLAG	BOOLEAN	1 byte	If non-zero, this a delayed command.	COMMAND_LIST
DELAY_HITS	MSB_UNSIGNED_INTEGER	1 byte	Delayed segment id, 0 if a single-prism event, 1 for multiple-prism event.	NEUTRON_SPECTRA
DELTA_ANGLE	IEEE_REAL	8 bytes	Difference between GSH +y direction and true north.	GAMMA_SPECTRA, HEND_SPECTRA, NEUTRON_SPECTRA
EARLY_2ND_PULSE_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Early time to second pulse count.	NEUTRON_SPECTRA
EARLY_TIME	MSB_UNSIGNED_INTEGER	2 bytes	Early time register.	NEUTRON_SPECTRA
ENG_VAL	IEEE_REAL	8 bytes	Raw value transformed to a physical unit.	ENG_DATA
EXEC_CODE	MSB_INTEGER	2 bytes	Completion code for command.	COMMAND_LIST
FIRST_CHAN	MSB_UNSIGNED_INTEGER	2 bytes	First valid channel in the spectrum.	GAMMA_SPECTRA
FIRST_CHAN	MSB_UNSIGNED_INTEGER	2 bytes	Starting channel of the first 500-channel wide pulser spectrum.	PULSER_SPECTRA
FIS_CMD_TYPE	MSB_UNSIGNED_INTEGER	1 byte	Flags whether command is interactive or not.	COMMAND_LIST
FIS_SEND_TIME	CHARACTER	23 bytes	UTC time when the command was sent to the FIS, stored as yyyy-mmddThh: mm:ss.sss.	COMMAND_LIST, E_KERNEL
FRAME_NUMBER	MSB_UNSIGNED_INTEGER	2 bytes	HEND data frame number, aka packet counter.	HEND_SPECTRA
FRAME_TYPE	MSB_UNSIGNED_INTEGER	1 byte	Type of frame, (status=0, spectra=2, profile=3).	HEND_SPECTRA
GCR_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Galactic cosmic ray count.	NEUTRON_SPECTRA

Column Name	Data Type	Length	Description	Appears In
GRS_COMPRESSED	MSB_UNSIGNED_INTEGER	1 byte	Indicates if Gamma compression algorithm was used on this data	NEUTRON_SPECTRA
GRS_EXEC_TIME	MSB_UNSIGNED_INTEGER	8 bytes	CEB time when command was executed.	COMMAND_LIST
GRS_ORBIT_NUMBER	MSB_UNSIGNED_INTEGER	4 bytes	Sequential counter of orbits from GRS CEB boot.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER MESSAGE_LOG
GRS_PIXEL_NUMBER	MSB_UNSIGNED_INTEGER	4 bytes	Sequential counter of accumulation intervals. Starts with one as GRS orbit begins. Special case on reboot when the CEB is in orbit 0, pixel 0.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER MESSAGE_LOG
HV1_LVL	MSB_UNSIGNED_INTEGER	1 byte	High Voltage #1 (SD) level.	HEND_SPECTRA
HV2_LVL	MSB_UNSIGNED_INTEGER	1 byte	High Voltage #2 (MD) level.	HEND_SPECTRA
HV3_LVL	MSB_UNSIGNED_INTEGER	1 byte	High Voltage #3 (LD) level.	HEND_SPECTRA
HV4_LVL	MSB_UNSIGNED_INTEGER	1 byte	High Voltage #4 (Inner) level.	HEND_SPECTRA
HV5_LVL	MSB_UNSIGNED_INTEGER	1 byte	High Voltage #5 (Outer) level.	HEND_SPECTRA
IN_CONTROL	MSB_UNSIGNED_INTEGER	2 bytes	The state of the In control discretizes between the CEB and HEND.	HEND_SPECTRA
IN_DISCRIMINATOR	MSB_UNSIGNED_INTEGER	1 byte	Inner discriminator level.	HEND_SPECTRA
IN_PROFILE	MSB_UNSIGNED_INTEGER	60 bytes	Inner scintillator profile data.	HEND_SPECTRA
IN_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Inner scintillator spectrum.	HEND_SPECTRA
INSTR_BORESIGHT_MARS	IEEE_REAL	24 bytes	Sub instrument boresight (x,y,z) in Mars fixed coordinates.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
INTERSECTING	BOOLEAN	1 byte	True if intersection data was available.	GAMMA_SPECTRA, HEND_SPECTRA, NEUTRON_SPECTRA

Column Name	Data Type	Length	Description	Appears In
K1	MSB_UNSIGNED_INTEGER	1 byte	Bitmask for total number of permitted triggering, 0=arbitrary, N=N successive triggers are permitted.	HEND_SPECTRA
L1_CNTR	MSB_UNSIGNED_INTEGER	2 bytes	Total number of gamma events within the L1 energy range.	GAMMA_SPECTRA
L1_L2	MSB_INTEGER	4 bytes	Counts in the L1 to L2 energy range.	PROFILE
L2_CNTR	MSB_UNSIGNED_INTEGER	2 bytes	Total number of gamma events within the L2 energy range.	GAMMA_SPECTRA
L2_L3	MSB_INTEGER	4 bytes	Counts in the L2 to L3 energy range.	PROFILE
L3_CNTR	MSB_UNSIGNED_INTEGER	2 bytes	Total number of gamma events within the L3 energy range.	GAMMA_SPECTRA
LAST_CHAN	MSB_UNSIGNED_INTEGER	2 bytes	Last valid channel in the spectrum.	GAMMA_SPECTRA,
LAST_CHAN	MSB_UNSIGNED_INTEGER	2 bytes	Starting channel of the third 500-channel wide pulser spectrum.	PULSER_SPECTRA,
LATE_TIME	MSB_UNSIGNED_INTEGER	2 bytes	Late time register.	NEUTRON_SPECTRA
LATITUDE	IEEE_REAL	8 bytes	Sub-spacecraft latitude in Mars fixed coordinates at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
LD_DISCRIMINATOR	MSB_UNSIGNED_INTEGER	1 byte	Large detector discriminator level	HEND_SPECTRA
LD_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Large detector spectrum.	HEND_SPECTRA
LLD	MSB_INTEGER	4 bytes	All counts above the LLD energy.	PROFILE
LLD_CNTR	MSB_UNSIGNED_INTEGER	2 bytes	Lower level discriminator count.	GAMMA_SPECTRA
LLD_L1	MSB_INTEGER	4 bytes	Counts in the LLD to L1 energy range.	PROFILE
LOCAL_HOUR	MSB_UNSIGNED_INTEGER	1 byte	Local Sun Hour at the sub-spacecraft point.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
LOCAL_MIN	MSB_UNSIGNED_INTEGER	1 byte	Local Sun Minute at the sub-spacecraft point.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
LONGITUDE	IEEE_REAL	8 bytes	Sub-spacecraft longitude in Mars fixed coordinates at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA

Column Name	Data Type	Length	Description	Appears In
MARS_SOL	IEEE_REAL	8 bytes	Longitude of the Sun at 0 hours UT on the date of the record.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
MARSPOS_INSTR	IEEE_REAL	24 bytes	The (x,y,z) position of the sub-spacecraft point as seen from the spacecraft in the instrument frame. If no spacecraft orientation data was available from the loaded CK files for the request time, then all elements of are set to zero.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
MARSVEL_INSTR	IEEE_REAL	24 bytes	Contains the inertial spacecraft velocity direction (x,y,z) rotated to the instrument frame. If no spacecraft orientation data was available for the request time, then all elements are set to zero.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
MD_DISCRIMINATOR	MSB_UNSIGNED_INTEGER	1 byte	Medium detector discriminator level.	HEND_SPECTRA
MD_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Medium detector spectrum.	HEND_SPECTRA
MESSAGE_TEXT	CHARACTER	128 bytes	More verbose description of message.	MESSAGE_LOG
MID_CHAN	MSB_UNSIGNED_INTEGER	2 bytes	Starting channel of second 500-channel wide spectrum.	PULSER_SPECTRA
MSG_ID	MSB_UNSIGNED_INTEGER	2 bytes	Identifies type of message. See Label for details.	MESSAGE_LOG
NEUTRON_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Neutron spectrum.	HEND_SPECTRA
NS_COMPRESSED	MSB_UNSIGNED_INTEGER	1 byte	Indicates if LANL compression algorithm was used on this data.	NEUTRON_SPECTRA
NS_INSTRUMENT_MEMORY_SIDE	MSB_UNSIGNED_INTEGER	2 bytes	Memory side data is coming from.	NEUTRON_SPECTRA
ODY_ORBIT_NUMBER	MSB_UNSIGNED_INTEGER	4 bytes	Orbit number common to all instruments aboard Odyssey. This orbit number is incremented by one as the spacecraft passes through the orbital descending node.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER_SPECTRA MESSAGE_LOG
OPCODE	MSB_UNSIGNED_INTEGER	2 bytes	Opcode of the command. See Label for values.	COMMAND_LIST, E_KERNEL
ORIGIN	MSB_UNSIGNED_INTEGER	1 byte	Origin of execution (loader or flight software).	MESSAGE_LOG
OUT_DISCRIMINATOR	MSB_UNSIGNED_INTEGER	1 byte	Outer discriminator level.	HEND_SPECTRA
OUT_PROFILE	MSB_UNSIGNED_INTEGER	240 bytes	Outer scintillator profile data.	HEND_SPECTRA

Column Name	Data Type	Length	Description	Appears In
OUT_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Outer scintillator spectrum.	HEND_SPECTRA
OUT_STATUS	MSB_UNSIGNED_INTEGER	2 bytes	The state of the Out status discretes between the CEB and the HEND.	HEND_SPECTRA
PARM1	MSB_INTEGER	2 bytes	First command argument.	COMMAND_LIST
PARM2	MSB_INTEGER	2 bytes	Second command argument.	COMMAND_LIST
PARM3	MSB_INTEGER	2 bytes	Third command argument.	COMMAND_LIST
PHA_CNTR	MSB_UNSIGNED_INTEGER	4 bytes	Pulse Height Analyzer counter.	GAMMA_SPECTRA
PHA_TIMER	MSB_UNSIGNED_INTEGER	8 bytes	Pulse Height Analyzer timer.	GAMMA_SPECTRA
POINTING	BOOLEAN	1 byte	True if pointing data was available.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
PRISM_ID	MSB_UNSIGNED_INTEGER	1 byte	1 = prism segment 1 only, 2 = prism segment 2 only, 3 = prism segment 3 only, 4 = prism segment 4 only, 5 = multiple prism event.	NEUTRON_SPECTRA
PROCESSED_VAL	IEEE_REAL	4 bytes	Processed engineering value of reading.	CHAN_DATA
PROFILE_COUNT	MSB_UNSIGNED_INTEGER	2 bytes	Number of 4-scalar element sets that are in the profile array.	PROFILE
PROMPT	MSB_UNSIGNED_INTEGER	4 bytes	Prompt interaction pulse height.	NEUTRON_SPECTRA
RAW_SPECTRUM	MSB_UNSIGNED_INTEGER	32768 bytes	Raw uncompressed gamma spectrum.	GAMMA_SPECTRA
RAW_VAL	INTEGER	2 bytes	The raw digital value of the reading as output from the analog-to-digital converter in the CEB.	ENG_DATA
SC_EV_TIME	MSB_UNSIGNED_INTEGER	8 bytes	Spacecraft time at the middle of the pixel, in ticks.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER_SPECTRA, ENG_DATA MESSAGE_LOG
SC_EV_TIME_FINE	MSB_UNSIGNED_INTEGER	2 bytes	Fine time portion of spacecraft time when this engineering reading was taken, units of 65536ths of a second.	ENG_DATA, PROFILE

Column Name	Data Type	Length	Description	Appears In
SC_RECV_TIME	MSB_UNSIGNED_INTEGER	8 bytes	The time this packet was received by the spacecraft, in ticks (256 per second).	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER_SPECTRA, CHAN_DATA
SC_SENT_TIME	CHARACTER	23 bytes	Approximate time command was sent to the spacecraft, stored as yyyy-mmddThh:mm:ss.sss.	COMMAND_LIST
SCALT	IEEE_REAL	8 bytes	Areocentric altitude of the sub-spacecraft point in Mars-fixed rotating frame at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
SCPOS_INERT	IEEE_REAL	24 bytes	The geometric position (x,y,z) of the spacecraft with respect to Mars in the 'MARSIAU' inertial frame at the input epoch 'et' at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
SCPOS_MARS	IEEE_REAL	24 bytes	Spacecraft position (x,y,z) in Mars fixed coordinates at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
SCVEL_INERT	IEEE_REAL	24 bytes	The geometric velocity (x,y,z) of the spacecraft with respect to Mars in the 'MARSIAU' inertial frame at the input epoch 'et' at the middle of the pixel.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA
SD_DISCRIMINATOR	MSB_UNSIGNED_INTEGER	1 byte	Small detector discriminator level.	HEND_SPECTRA
SD_SPECTRUM	MSB_UNSIGNED_INTEGER	32 bytes	Small detector spectrum.	HEND_SPECTRA
SPECTRUM	MSB_UNSIGNED_INTEGER	1500 bytes	Pulser Spectrum.	PULSER_SPECTRA
SUB_SCPOS_MARS	IEEE_REAL	24 bytes	Sub spacecraft vector (x,y,z) in mars fixed coordinates.	GAMMA_SPECTRA, HEND_SPECTRA, NEUTRON_SPECTRA
T1	MSB_UNSIGNED_INTEGER	4 bytes	Time of previous SYNC signal/start of accumulation.	HEND_SPECTRA
T1_T4_TEMP	MSB_UNSIGNED_INTEGER	2 bytes	Temperature 1 if even frame, Temperature 4 if odd.	HEND_SPECTRA
T2	MSB_UNSIGNED_INTEGER	4 bytes	Time of last trigger as a 16 bit value.	HEND_SPECTRA
T2_T5_TEMP	MSB_UNSIGNED_INTEGER	2 bytes	Temperature 2 if even frame, Temperature 5 if odd.	HEND_SPECTRA

Column Name	Data Type	Length	Description	Appears In
T3_T6_TEMP	MSB_UNSIGNED_INTEGER	2 bytes	Temperature 3 if even frame, Temperature 6 if odd.	HEND_SPECTRA
TIME_ORBIT	MSB_UNSIGNED_INTEGER	8 bytes	The time or orbit/pixel at which the command should be executed.	COMMAND_LIST
TIME_ORBIT_FLAG	MSB_UNSIGNED_INTEGER	1 byte	True if the command to be executed by time or orbit/pixel.	COMMAND_LIST
TITLE	MSB_INTEGER	4 bytes	Title field in the HEND packet.	HEND_SPECTRA
TRIG_LOGIC	MSB_UNSIGNED_INTEGER	1 byte	Triggering logic, (0=AND, 1=OR).	HEND_SPECTRA
TRIGGER_CNT	MSB_UNSIGNED_INTEGER	2 bytes	Count of triggers seen.	HEND_SPECTRA
TRIGGER_LVL_C1	MSB_UNSIGNED_INTEGER	1 byte	Criteria code for profile 1 (inner scintillator).	HEND_SPECTRA
TRIGGER_LVL_C2	MSB_UNSIGNED_INTEGER	1 byte	Criteria code for profile 2 (outer scintillator).	HEND_SPECTRA
TRIGGER_PERM_C1	BOOLEAN	1 byte	Trigger permission on/off for profile1.	HEND_SPECTRA
TRIGGER_PERM_C2	BOOLEAN	1 byte	Trigger permission on/off for profile2.	HEND_SPECTRA
TTSP	MSB_UNSIGNED_INTEGER	2 bytes	Time to second pulse.	NEUTRON_SPECTRA
ULD_CNTR	MSB_UNSIGNED_INTEGER	2 bytes	Upper level discriminator count.	GAMMA_SPECTRA
UTC	CHARACTER	23 bytes	SC_EV_TIME converted to UTC, stored as yyyy-mm-ddThh:mm:ss.sss.	GAMMA_SPECTRA, NEUTRON_SPECTRA, HEND_SPECTRA, PROFILE, PULSER_SPECTRA, CHAN_DATA, ENG_DATA, MESSAGE_LOG