Psyche Mission
Gamma Ray Neutron Spectrometer Instrument (GRNS)

# GRS Uncalibrated to Calibrated Data Product Software Interface Specification

7506-9074

MO-005-01C

August 1, 2025

Revision: B

Approved by:


Raymond Espiritu
GRNS Science Operations Center Lead

Patrick Peplowski
GRNS Instrument Scientist

Mark LeBlanc
GRNS System Assurance Manager

John Goldsten
GRNS Lead Engineer

David Lawrence
GRNS Instrument Principal Investigator

Michael Cully
GRNS Project Manager

Kathryn Marcotte
GRNS Flight Software Lead

Sam Fix
GRNS DPU Lead


Created under NASA/JPL Psyche Mission Subcontract No. 1569206

## Revision Log

| Rev | By | Description | Date |
|---|---|---|---|
| - | R. Espiritu | Initial Release | 03/04/2022 |
| A | R. Espiritu | Updated based on PDS Preflight Peer Review | 07/20/2022 |
| B | R. Espiritu | Update science goals based on new mission orbits; update Time Standards and usage of SPICE kernels for time conversion and update based on feedback from PDS Pipeline Peer Review | 08/01/2025 |
| | | | |
| | | | |
| | | | |
| | | | |

A Release stamp electronically affixed at bottom of the pages of this document certifies that the above personnel or designated alternates have approved this release. Please refer to the JHU/APL Product Lifecycle Management System (PLM) for record of these approvals.

## Table of Contents

## List of Figures

# 1 Purpose and Scope

This Data Product Software Interface Specification (SIS) describes the format and content of the Psyche Gamma-Ray Spectrometer (GRS) Planetary Data System (PDS) data archive. Note that while the full instrument is known as the Gamma-Ray and Neutron Spectrometer (GRNS), the GRS and Neutron Spectrometer (NS) are archived as two separate bundles. This SIS includes descriptions of the uncalibrated and calibrated data products and associated metadata, the volume archive format, calibration process, and product generation pipeline. The GRNS Science Operations Center (SOC) at the Johns Hopkins University Applied Physics Lab (JHU/APL) produces these data products and distributes them to the Psyche Science Data Center (SDC) at the Arizona State University (ASU) which then distributes them to the Psyche science team and the Planetary Data System.

The document is intended to provide enough information to enable users to read and understand the data products. The users for whom this document is intended are the scientists who will analyze the data, including those associated with the project and those in the general planetary science community.

# 2 Applicable Documents and Constraints

This Data Product SIS is consistent with the following Planetary Data System Documents:

- Planetary Data System Standards Reference, Version 1.22.0, June 4, 2024
- PDS4 Data Dictionary – Abridged – Version 1.22.0.0, June 4, 2024
- PDS4 Information Model Specification, V. 1.22.0.0, June 4, 2024

This Data Product SIS is responsive to the following Psyche documents:

- Psyche Science Data Management Plan, D-100129 – Rev A, Aug 27, 2023

Additional information related to the GRS instrument can be found in the following documents. This GRS SIS is also consistent with these documents.

- Peplowski et al., Radiation Damage and Annealing of the Three Coaxial N-type Germanium Detectors: Preparation for Spaceflight Missions to Asteroid 16 Psyche and Mars' moon Phobos, Nuclear Instruments and Methods in Physics Research, A, Volume 942, article id. 162409 (Oct 2019), doi:10.1016/j.nima.2019.162409
- Placeholder for GRNS instrument paper
- Placeholder for GRNS Calibration paper

# 3 Relationships with Other Interfaces

Changes to the data products described in this SIS effect the following software, products or documents:

| Name | Type |
|---|---|
| Raw/Calibrated GRS HPGe (Low Gain) | Product |
| Raw/Calibrated GRS HPGe (High Gain) | Product |
| Raw/Calibrated GRS HPGe AC (Low Gain) | Product |
| Raw/Calibrated GRS HPGe AC (High Gain) | Product |
| Raw/Calibrated GRS AC Shield (Low Gain) | Product |
| Raw/Calibrated GRS AC Shield (High Gain) | Product |
| Raw/Calibrated AC Shield Fast Neutron Spectra | Product |
| Raw GRS Counts | Product |
| Raw GRS Events | Product |
| Raw Fast Neutron Events | Product |
| Raw/Calibrated Gamma Ray Burst | Product |
| Raw/Calibrated GRS Engineering | Product |
| GRS Engineering Calibration Lookup Table | Product |
| GRS Data Product Pipeline | Software |
| Psyche Science Data Management Plan | JPL Document D-100129 |

# 4 Roles and Responsibilities

The roles and responsibilities of the Project, Working Groups, Instrument Teams, JHU/APL, SDC, and the PDS are defined in the Psyche Science Data Management Plan.

# 5 Data Product Characteristics and Environment

## 5.1 Mission Overview

The Psyche spacecraft was launched on October 13, 2023 and is scheduled to arrive at the Psyche asteroid in August 2029. The science phase is divided into four segments, each in an orbit with a successively smaller semi-major axis; labeled orbits A through D. Each science phase segment has a specific purpose. Between each phase is a period of thrusting that transitions the spacecraft to the next orbit until the final orbit D.

The Psyche mission has the following five science objectives:

1. Determine whether Psyche is a core, or if it is unmelted material
2. Determine the relative ages of regions of Psyche's surface.

3. Determine whether small metal bodies incorporate the same light elements as are expected in the Earth's high-pressure core.
4. Determine whether Psyche was formed under conditions more oxidizing or more reducing than Earth's core.
5. Characterize Psyche's topography.

The Psyche GRS contributes to goals 1, 3, and 4 via measurements that are made during the orbit-B1-to-D transition, throughout orbit D, the orbit D-to-C transfer, and during Orbit C.

## 5.2 Instrument Overview

The Gamma Ray Spectrometer (GRS) instrument aboard the Psyche spacecraft is designed to observe the energy spectrum of gamma rays emitted from Psyche's surface in the energy range from 0.1 MeV to 10 MeV. Gamma rays are produced either directly from radioactive decay (of K, Th, U) or indirectly when activated by galactic cosmic rays. The surface composition of different elements is derived using the number of detected gamma ray events that are measured at the energies linked to each element.

The GRS consists of a high-purity Germanium (HPGe) cylinder surrounded by a shield of borated plastic scintillator (EJ-254) called the anti-coincidence (AC) shield. The HPGe cylinder is suspended within a vented, gold-coated encapsulation that provides thermal isolation for the operation at cyrogenic temperature. The sensor is cooled with a Lockheed Martin pulse-tube microcooler. The sensor requires <100 K temperature to operate, 90 K is typical.

A charge is generated when a gamma ray interacts with the Ge crystal. This electric charge is amplified, measured, and then digitally converted into one of 16,384 channels, or bins on an event-by-event basis. A histogram is produced for each (programmable) accumulation time. The histogram shows the distribution of events (number of strikes) as a function of energy (channel number). Accumulation times of tens of seconds are normal. The Raw science data product is the counts in each of the bins after this accumulation period. This histogram is defined as one gamma-ray spectrum. Two gain modes are provided: a low-gain mode that provides a gamma-ray measurements from 0 to ~10 MeV, and a high-gain mode that provides measurements from 0 to ~3 MeV. The former covers the full range of interest for the Psyche GRNS investigation, the latter focuses on an energy range with many gamma-ray features and provides sampling that takes full advantage of the superior energy resolution of the HPGe sensor.

Anti-coincidence (AC) gamma-ray spectra products are identical to the Raw products described above, except that they are events that occur in the HPGe sensor only. This is determined with the Anti-Coincidence (AC) Shield. The AC Shield is a cup-shaped plastic scintillator with a photomultipler tube readout that registers events from cosmic rays and electronically removes (vetos) them from the AC spectra.

The AC Shield plastic scintillator is composed of borated (EJ-254) plastic scintillator, making it also sensitive to neutrons via the $^{10}B + n \rightarrow {}^{7}Li + \alpha$ reaction. The reaction produces an energy deposition peak at 2.7 MeV that is diagnostic of a neutron capture event. This peak appears in the AC Shield high-gain spectrum, which is sensitive to single-interaction neutron events (energies <100 keV). Additionally, a time-to-second-pulse (TTSP) counter registers events with an initial downscattering (first pulse) and neutron capture (second pulse). These events are fast neutrons with energies >100 keV. These events appear in the AC Shield fast neutron spectra, a 1024-channel-long spectrum that contains four separate 256-channel-long products; the early and late prompt (first pulse) events, and the early and late capture (second pulse) events.

The AC Shield low gain spectrum extends to ~35 MeV, and monitors energy deposition peaks cause by cosmic-ray protons interacting in the plastic scintillator. This minimum-ionizing-particle (MIP) peak provides in-situ monitoring of the local cosmic ray flux. This is important for local background corrections as well as converting HPGe gamma-ray measurements to elemental composition information.

## 5.3 Data Product Overview

This SIS describes the format and structure of science and state of health (engineering) data acquired by the GRS instrument from Raw through Calibrated data processing levels. The ‘Raw’ and ‘Calibrated’ designations refer to the processing level of each product using PDS4 terminology. Data are acquired on a schedule as defined in the Psyche Data Management Plan.

## 5.4 Data Processing Flow

The Psyche Ground Data System (GDS) at JPL receives the GRS data packets and processes them into Data Product (DP) files for ingest by the Science Data Center (SDC) at ASU. The SDC converts (where necessary) all input data into formats specified by the investigation teams. The investigation science leads are responsible for retrieving the original or transformed data from the SDC and processing the data at their home institutions. Each data product generated (raw, calibrated, or derived) is then transferred and stored at the SDC, for use by any member of the Psyche Science Team. Figure 1 shows the overall data flow.

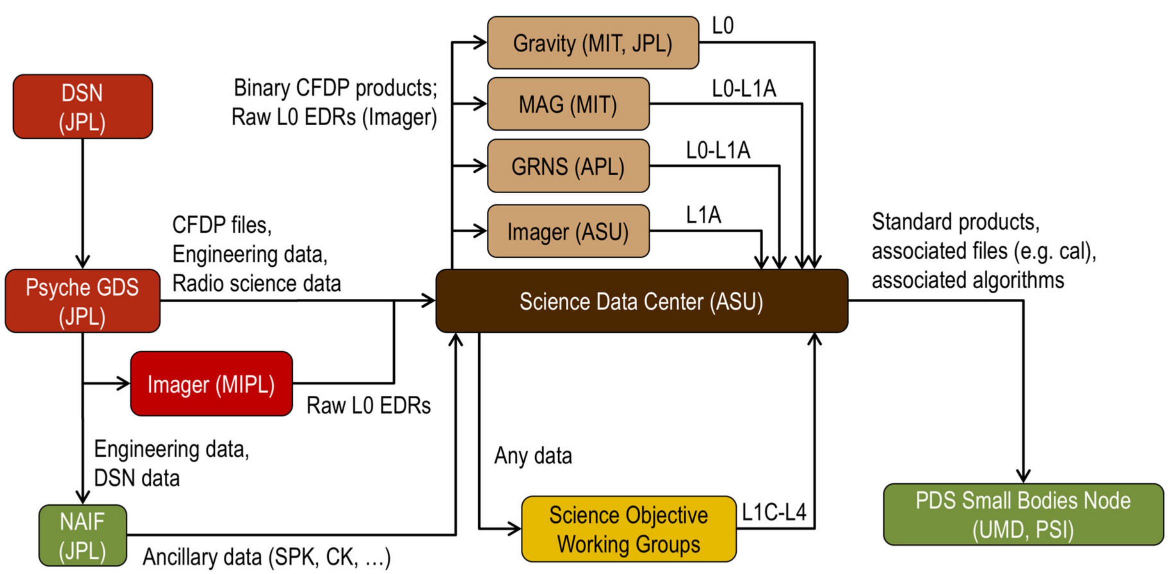


Figure 1. Psyche Data Flow

For the GRS data products, the DP files are retrieved from SDC by the GRNS SOC at APL. After download to the SOC the GRS data processing pipeline converts the DP files into Raw (Level 0) products. The Raw products are in PDS4 format and consist of a binary data file and associated PDS4 XML label. The Raw product is then transferred to the SDC and stored. The Raw product is also stored in a database located at the GRNS SOC to await further processing into Calibrated (L1A) data products, which are also in PDS4 format. The Calibrated data products are then transferred to and stored at the SDC as well as stored in a database at the GRNS SOC to await further processing into Derived (Level 3) data products. Derived data products will be in PDS4 format and also transferred to and stored at the SDC. Specifics of the GRS Derived data products will be covered in the GRS Derived Data Product SIS.

Figure 2 shows the GRS data flow between the SDC and the SOC as well as within the GRS data processing pipeline. The Raw through Derived data products constitute the GRNS standard data products that will be delivered to PDS.

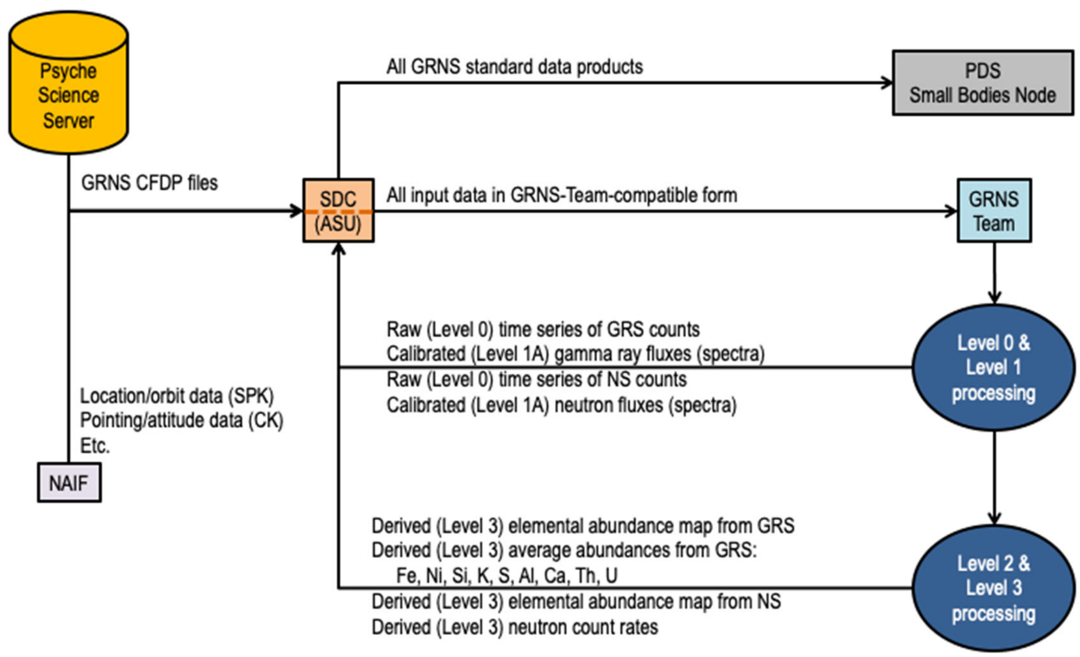


Figure 2. GRS Data Flow

### 5.4.1 Data Processing Level

The following table describes the GRS products in terms of their NASA Product processing levels and the organization of an individual GRS product. Note that the GRS Product name includes the PDS4 Data Processing Level (Raw, Calibrated).

| GRS Product | NASA Product Level | Description |
|---|---|---|
| N/A | Packet data | GRS telemetry |
| Raw GRS HPGe (low gain) | Level 0 | Raw spectra collected from the high purity germanium (HPGe) detector. Covers 0 to 9.2 MeV energy range. |
| Raw GRS HPGe (high gain) | Level 0 | Raw spectra collected from the high purity germanium (HPGe) detector. Covers 0 to 2.8 MeV energy range. |
| Raw GRS HPGe AC (low gain) | Level 0 | Anti-coincidence (AC) spectra collected from the high purity germanium (HPGe) detector. Covers 0 to 9.2 MeV energy range. |
| Raw GRS HPGe AC (high gain) | Level 0 | Anti-coincidence (AC) spectra collected from the high purity germanium (HPGe) detector. Covers 0 to 2.8 MeV energy range. |
| Raw GRS AC Shield (low gain) | Level 0 | Raw AC spectra collected from the shield detector. Used for cosmic-ray proton monitoring. Sensitive to energy deposition events up to ~35 MeV. |
| Raw GRS AC Shield (high gain) | Level 0 | Raw AC spectra collected from the shield detector. Used for neutron science. Sensitive to energy-deposition events up to ~500 keV. |
| Raw AC Shield Fast Neutron | Level 0 | Raw AC Shield spectra capturing double-pulse events, grouped into four separate categories, based on their time to second pulse values. |
| Raw Gamma-Ray Counters | Level 0 | Raw counters of events measured across the integration period. Used for diagnostic purposes. |
| Raw Gamma-Ray Events | Level 0 | Raw events read from the hardware. Includes events not considered valid to be included in a spectrum. Used for diagnostic purposes. |
| Raw Fast Neutron Events | Level 0 | Raw fast neutron events and metadata read from the hardware. Includes events not considered valid to be included in a spectrum. Used for diagnostic purposes. |
| Raw Gamma Ray Burst | Level 0 | Raw spectra of a gamma-ray burst event. |
| Raw GRS Engineering | Level 0 | Raw measurements of the health and status of the GRS instrument. |
| Calibrated GRS HPGe (low gain) | Level 1A | Calibrated from raw HPGe low-gain spectra by applying time-series and gain correction. The binary table also contains attitude information (S/C orientation and position relative to Psyche) at each timestamp; derived from SPICE kernels. |

| GRS Product | NASA Product Level | Description |
|---|---|---|
| Calibrated GRS HPGe (high gain) | Level 1A | Calibrated from raw HPGe high-gain spectra by applying time-series and gain correction. The binary table also contains attitude information (S/C orientation and position relative to Psyche) at each timestamp; derived from SPICE kernels. |
| Calibrated GRS HPGe AC (low gain) | Level 1A | Calibrated from raw HPGe AC low-gain spectra by applying time-series and gain correction. The binary table also contains attitude information (S/C orientation and position relative to Psyche) at each timestamp; derived from SPICE kernels. |
| Calibrated GRS HPGe AC (high gain) | Level 1A | Calibrated from raw HPGe AC high-gain spectra by applying time-series and gain correction. The binary table also contains attitude information (S/C orientation and position relative to Psyche) at each timestamp; derived from SPICE kernels. |
| Calibrated GRS AC Shield (low gain) | Level 1A | Calibrated from raw AC Shield low-gain spectra by applying time-series and gain correction. The binary table also contains attitude information at each timestamp; derived from SPICE kernels. |
| Calibrated GRS AC Shield (high gain) | Level 1A | Calibrated from raw AC Shield high-gain spectra by applying time-series and gain correction. The binary table also contains attitude information at each timestamp; derived from SPICE kernels. |
| Calibrated AC Shield Fast Neutron | Level 1A | Calibrated from raw AC Shield Fast Neutron spectra by applying time-series and gain correction. The binary table also contains attitude information at each timestamp; derived from SPICE kernels. |
| Calibrated Gamma-Ray Bursts | Level 1A | TBR |
| Calibrated GRS Engineering | Level 1A | Converted from raw GRS Engineering DN values into physical units using polynomial coefficients which were derived using instrument calibration |

## 5.5 Data Product Generation

Data Product files are periodically downloaded from the SDC to the GRNS SOC via the ReST API. Requests are sent via the interface for any DP files that have been updated since the previous request. This allows the SOC to automatically download newly created products as well as previously downloaded products that were regenerated by the SDC with new information.

Once downloaded to the GRNS SOC the DP files are used as the basis for the generation of various data products as outlined below.

### 5.5.1 Raw Science and Engineering Data

Processing of the raw science and engineering data products first consists of organizing the DP files by packet type. For example, only DP files associated with the GRS HPGe packet will be used to generate the GRS Raw HPGe product. Data are then reformatted to match acceptable PDS data types and data type lengths, sorted by the timetag associated with each record, and organized into binary table files separated by collection day (Year and Day of Year).

GRS Raw data has no corrections applied. Here data is stored in non-physical units (i.e. voltages and digital numbers) and no calibration is required. One data record is available for each packet generated by the instrument. An associated PDS4 XML label is generated for each binary table file. Raw data products are transferred to the SDC for storage and also stored in the SOC database to serve as the source data for generation of the calibrated products.

### 5.5.2 Calibrated Science Data (TBR)

Calibration begins with the raw, uncalibrated GRS spectra. Each 16,384-channel spectrum will be calibrated using the linear fit (gain and offset) values determined during ground calibration, however second-order corrections informed by in-flight characterization of background gamma rays of known energy (511, 661, 1368, 1809, 2754, and 5617 keV) will be used to provide corrections if/when needed. This is done using an on-board Cs-137 source. [Placeholder reference to GRNS instrument paper]. An additional second-order correction to the calibration accounts for gain shifts resulting from temperature changes, which may induce variations of as much as 20°C in the detector pre-amplifier (preamp) and signal shaper temperatures over the course of the mission. Because these electronic units process raw detector outputs prior to analog-to-digital conversion, they are particularly sensitive to temperature variations, and the result of such a variation is a shift in the gain of the output signals. This effect is removed by applying two empirically derived polynomial corrections (CT) to the energy calibration, one each for the shaper and preamp temperatures. Data collected during Psyche GRNS thermal vacuum (TVAC) test suggests that the corrections are small (<0.1 channel/deg C) and linear.

Additionally, radiation damage and annealing of the HPGe sensor can alter the gamma-ray detection efficiency of the GRS relative to pre-launch science calibration. These changes are tracked in flight by monitoring the ate of 661-keV gamma rays originating from the onboard $^{137}$Cs source. This rate is known from pre-launch, prior to annealing and exposure to space radiation, thus changes are attributed to efficiency loss. Cs-137 was chosen because its single gamma-ray emission does not interfere with science measurements, and its energy is sufficient to sample the response of the entire HPGe crystal.

Details on all energy-calibration and efficiency corrections will be provided in the GRNS calibration paper.

### 5.5.3 Calibrated Engineering Data (TBR)

The GRS Raw Engineering data are converted into physical units (temperature, voltage, current, etc) and the SCLK timetags are converted into UTC time through the use of SPICE kernels.

Polyonimals (up to 6th order) are used to generate calibrated engineering data from several raw engineering data fields. The algorithm used is:

Calibrated Value = $a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6$

where **x** is the value in DN and $a_i$ are the polynomial coefficients.

The coefficients and the fields to which they apply are stored in a GRS coefficient lookup table ASCII file stored in the documents collection.

Conversion of other GRS Engineering fields from DN to voltages is done via the following algorithm:
Calibrated Value = ((int(x)*1e6/1740)*scale)

where int(x) is the integer value of the DN

The scale factor and the fields for which they apply are stored in a GRS scale factor lookup table ASCII file stored in the calibrated data collection.

## 5.6 Product Labeling and Identification

### 5.6.1 File Naming Convention

The naming convention for GRS standard data products from raw through calibrated is as follows (all lower case):

grs_<productType><YYYYDDD><reserved string>_v<version>.<ext>

where

<productType> defines the data as belonging to 'science' or 'state of health (soh)', data product type and processing level:

| productType | Definition |
|---|---|
| scil0hpgelo | Raw HPGE Low Gain science data product |
| scil0hpgehi | Raw HPGE High Gain science data product |
| scil1hpgelo | Calibrated HPGE Low Gain science data product |
| scil1hpgehi | Calibrated HPGE High Gain science data product |
| scil0hpaclo | Raw HPGE AC Low Gain science data product |

| | |
|---|---|
| scil0hpachi | Raw HPGE AC High Gain science data product |
| scil1hpaclo | Calibrated HPGE AC Low Gain science data product |
| scil1hpachi | Calibrated HPGE AC High Gain science data product |
| scil0shaclo | Raw AC Shield Low Gain science data product |
| scil0shachi | Raw AC Shield High Gain science data product |
| scil1shaclo | Calibrated AC Shield Low Gain science data product |
| scil1shachi | Calibrated AC Shield High Gain science data product |
| scil0shacfn | Raw AC Shield Fast Neutron spectra science data product |
| scil1shacfn | Calibrated AC Shield Fast Neutron spectra science data product |
| scil0counts | Raw GRS Counters science data product |
| scil0grsevt | Raw GRS Events science data product |
| scil0fnsevt | Raw Fast Neutron Events science data product |
| scil0gburst | Raw Gamma Ray Bursts science data product |
| scil1gburst | Calibrated Gamma Ray Bursts science data product |
| sohl0grseng | Raw GRS Engineering state of health data product |
| sohl1grseng | Calibrated GRS Engineering state of health data product |

<YYYYDOY> defines the four digit year and three digit day of year corresponding to the timetag associated with each data record in the file.

<reserved string> is a reserved character string use during the course of the mission as needed to define "special" data products. Nominal data products are identified by the "zzz" character string.

<version> is the two digit version number associated with the product file. Version numbering starts at 01 and is incremented when a product that has previously been delivered to PDS needs to be regenerated and redelivered. For example, if a new calibration algorithm that yields better data values is applied retroactively to previously delivered data.

<ext> is the three character file extension. The PDS4 naming convention is used, with 'dat' to denote binary table files, 'tab' for ASCII table files, and 'xml' for PDS XML label files.

## 5.7 Standards Used in Generating Data Products

### 5.7.1 PDS Standards

All data products described in this SIS conform to PDS4 standards as described in the PDS Standards document noted in the Applicable Documents section of this SIS. Prior to public release, all data products will have passed both a data product format PDS peer review and a data product production pipeline PDS peer review to ensure compliance with applicable standards.

All data products are labeled with PDS4 compliant detached XML labels. These labels describe the content and format of the associated data product. Labels and products are associated by filename with the label having the same base filename as the data product but with a .xml extension.

Labels are constructed with the PDS4 Product class, Product Observational sub-class. The Product observational sub-class contains a set of information objects that describe the content of the data product and how the data product file is formatted. Additional information on PDS4 product labels can be found by selecting "How to Approach a PDS4 Data Set" on the PDS Small Bodies Node website at http://sbn.pds.nasa.gov.

### 5.7.2 Time Standards

Time standards used by the Psyche mission conform to PDS time standards. The SCLK field in the GRS data product tables match the spacecraft time in integer seconds that is transmitted to the GRS instrument in a Spacecraft Time Message (STM). This is known as the one pulse per second (1PPS) discrete signal. The SCLK field represents the count of seconds since JPL's J2000 epoch, defined as 01-Jan-2000 12:00:00.00 ET. In addition to the current SCLK value, the GRS processor board maintains a high resolution counter which is referenced to the active edge of the 1PPS pulse. This is reported in the SCLK_Sub field as the count of subsecond ticks since the SCLK value where each tick represents 20 microseconds. The high resolution counter is reset on the active edge of a 1PPS pulse of the most recent valid STM.

Note that the relationship between SCLK and ET or UTC is not accurately described by a linear function. This is a consequence of the fact that the rate at which any spacecraft clock runs varies over time. Thus, accurate conversion from SCLK seconds and subseconds into any other time system should be done using SPICE kernels. SPICE kernels are themselves updated over time, thus the XML labels for each GRS data product contain a listing of the kernels that were used to generate any SPICE derived values, including UTC from SCLK. It is recommended to use the SPICE kernel list in the XML label in order to derive the same SPICE values as the data product.

Additionally, the SPICE Psyche SCLK kernel is defined such that each tick on the subseconds portion of the SCLK time string represents $2^{-16}$ seconds. An extra processing step is required to convert the reported GRNS subsecond values from 20 microsecond ticks to $2^{-16}$ second ticks before passing it to SPICE. The extra processing step is detailed in the pseudocode below.

The pseudocode shown below is an example of how one would use the SPICE toolkit to load SPICE kernels and convert SCLK and SCLK_Sub values to UTC. The pseudocode uses the CSPICE function and argument naming convention; the exact nomenclature may vary depending on the programming language of the SPICE library being used.

1. First load a Psyche SCLK kernel file.

```
furnsh_c ( <name of SCLK kernel file> );
```

2. Next load the leapseconds kernel file.

```
furnsh_c (<name of Leapseconds kernel file>);
```

3. Create the GRNS SCLK string in the form MMMMMMMMM.NNNNN where:

MMMMMMMMM: the whole seconds value parsed from the SCLK field of the GRS data table.

NNNNN: the SCLK_Sub field of the GRS data table after performing the following calculation:

a. Multiply the SCLK_Sub field by 2e^-5 to convert from 20 microsecond ticks to units of seconds.

b. Multiply the result from step a by 65536 to convert from seconds to SPICE subsecond ticks.

c. Round to the nearest integer as the subsecond ticks are integer values.

The subeconds portion of the SCLK string is in the range from 0-65535, hence up to 5 digits is allowed for the subseconds portion of the SCLK string. Ex. GRS SCLK_Sub value of 49999 is converted to 65535 in SPICE subsecond ticks using the steps above. Also note that the GRS SCLK_Sub rollover value of 50000 equates to the SPICE rollover value of 65536 (both equal one second, which results in the SCLK value incrementing by one and the subseconds ticks value rolling over to 0).

4. Convert the SCLK string to a double precision Ephemeris Time (ET) value.

```
scs2e_c (sc, sclkstr, &et);
```

where:
'sc' - NAIF spacecraft ID code. For Psyche it is -255.
'sclkstr'- string containing the SCLK and converted SCLK_sub value as specified in step 3. For example: "685484518.320". The delimiter can either be a '.' or ':' character. Note that the subsecond portion of the string represents the number of subsecond ticks. For example, ".320" represents 320 ticks while ".32000" represents 32000 ticks.

'&et' - pointer to the output in ET

5. Convert the ET to UTC.

```
timout_c (et, pictur, lenout, utc);
```

where:
'et' - ET time output from Step 3.
'pictur' - a string specifying the output format "picture". For example:

```
"MON DD,YYYY  HR:MN:SC.#### (TDB) ::TDB"
```

This specifies the output format as a 3-character month, 2-digit day of month, 4-digit year, hour, minute, second.subseconds in Barycentric Dynamical Time.
'lenout' - maximum allowed length of the output string. If the output string is expected to have N characters, lenout should at least be N+1.
'utc' - output string containing the UTC equivalent to sclkstr from Step 3.

### 5.7.3 Coordinate Systems

All coordinate systems used by the Psyche mission conform to IAU standards. A complete discussion of the coordinate systems and how they are deployed in the mission can be found in future revisions of the Psyche Science Data Management Plan.

#### 5.7.4 Data Storage Conventions

GRS data products are stored as PDS4 binary table data in big-endian (MSB) format. Each GRS data file contains all data observed on a single UTC day as determined by conversion from SCLK time tag to UTC using SPICE kernels. Data formats are explicitly described in Section 6.

# 6 Detailed Product Specification

## 6.1 Data Product Structure and Organization

The Psyche GRS bundle shall consist of data products from Raw through Derived Product processing levels. Data product collections within the bundle are organized by processing level, mission phase, year and day of year. All data products are stored as PDS4 binary tables with detached XML label files.

Note that while the GRS bundle will eventually contain a Derived Product collection with an associated SIS, this will not be present until later in the mission. The following shows the organization of the collections within Psyche GRS bundle.

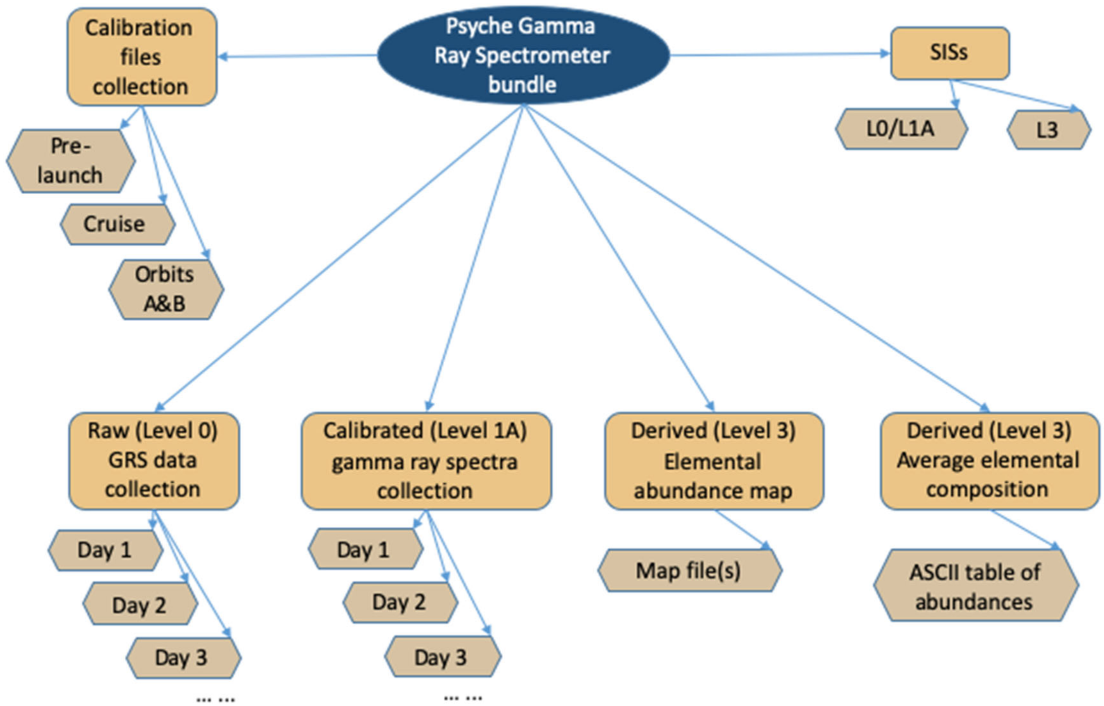


Figure 3. Psyche GRS Bundle Layout

## 6.2 Data Format Descriptions

There are references to channel numbers in some of the following data format descriptions. Below is a lookup table that describes what the channel numbers indicate.

| **Channel** | **Description** |
|---|---|
| channel 0 (ch0) | High-gain HPGe channel |
| channel 1 (ch1) | Low-gain HPGe channel |
| channel 2 (ch2) | High-gain AC shield spectrum |
| channel 3 (ch3) | Low-gain AC shield spectrum |

### 6.2.1 Raw HPGe Low and High Gain

The HPGE Low and High Gain data products contain a 16,384 bin histogram of all pulses recorded in the HPGE detector. The histogram and associated metadata are stored as rows in a fixed-width binary table. The following table shows the format of each row of the binary table.

| **Field Name** | **Length (bytes)** | **Data Type** | **Description** |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Time tag at the start of the histogram integration period in seconds. |

| | | | |
|---|---|---|---|
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6.<br><br>bit 0 would be flagged if the science data product selection were changed in the middle of an integration. This could occur if science histogramming were left on during a mission phase transition (e.g. cruise science to orbit operations). |
| MissingPkts | 2 | Unsigned Integer | Represents a 16-bit flag where each bit indicates whether a given raw telemetry packet was missing when reconstructing the 16,384 bin histogram. Each raw packet contains the values for 1024 bins. The least significant bit corresponds to packet 0 and the most significant bit corresponds to packet 15. A bit value of 1 indicates a missing packet. For example, a value of 0 indicates a complete histogram reconstructed from all 16 packets. A value of 3 indicates that information from the first and second packets are missing and therefore spectral bins 0-2047 should be discounted when analyzing the spectra. |
| HPGE | 4 x 16,384 | Unsigned Integer | 16,384 bin histogram collected by the High Purity Germanium detector. |

### 6.2.2 Raw HPGe Anti-Coincidence Low and High Gain

The HPGE AC Low and High Gain data products contain a 16,384 bin histogram of only those pulses recorded in the HPGE detector that are not time-coincident with an event in the AC Shield. The histogram and associated metadata are stored as rows in a fixed-width binary table. The following table shows the format of each row of the binary table.

| **Field Name** | **Length (bytes)** | **Data Type** | **Description** |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Time tag at the start of the histogram integration period in seconds. |

| | | | |
|---|---|---|---|
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| MissingPkts | 2 | Unsigned Integer | Represents a 16-bit flag where each bit indicates whether a given raw telemetry packet was missing when reconstructing the 16,384 bin histogram. Each raw packet contains the values for 1024 bins. The least significant bit corresponds to packet 0 and the most significant bit corresponds to packet 15. A bit value of 1 indicates a missing packet. For example, a value of 0 indicates a complete histogram reconstructed from all 16 packets. A value of 3 indicates that information from the first and second packets are missing and therefore spectral bins 0-2047 should be discounted when analyzing the spectra. |
| HPGEAC | 4 x 16,384 | Unsigned Integer | 16,384 bin histogram of High Purity Germanium Anti-Coincident data. |

### 6.2.3 Raw Anti-Coincidence Shield Low Gain

The AC Shield Low Gain data product contains a 1024 bin histogram of pulses detected on the low-gain channel of the AC Shield sensor. The histogram and associated metadata are stored as rows in a fixed-width binary table. The following table shows the format of each row of the binary table.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|

| | | | |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Time tag at the start of the histogram integration period in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products<br>bit 1 = Parameters<br>bit 2 = Pulse Processing configuration<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| ACShicldLow | 4 x 1024 | Unsigned Integer | 1024 bin histogram. |

### 6.2.4 Raw Anti-Coincident Shield High Gain

The AC Shield High Gain data product contains a 512-bin histogram of pulses detected on the high-gain channel of the AC Shield detector. The histogram and metadata are stored as rows in a fixed-width binary table. The following table shows the format of each row of the binary table.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag at the start of the histogram integration period in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| ACShieldHigh | 4 x 512 | Unsigned Integer | 512 bin histogram. |

### 6.2.5 Raw Anti-Coincident Shield Fast Neutron

The AC Shield Fast Neutron data product contains four 256 bin histogram pairs. Two histograms bin the energies for the prompt and capture peaks for events that meet the criteria for an "early" capture peak, where the delta-time between the two peaks falls within a parameterized "early" window. The remaining two histograms bin the energies for the prompt and capture peaks for events that meet the criteria of a "late" window. The histograms and metadata are stored in a fixed-width binary table. The following table shows the format of each row of the binary table.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag at the start of the histogram integration period in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| EarlyPrompt | 4 x 256 | Unsigned Integer | 256 bin histogram of early prompt events. |
| EarlyCapture | 4 x 256 | Unsigned Integer | 256 bin histogram of early capture events. |
| LatePrompt | 4 x 256 | Unsigned Integer | 256 bin histogram of late prompt events. |
| LateCapture | 4 x 256 | Unsigned Integer | 256 bin histogram of late capture events. |

### 6.2.6 Raw Gamma-Ray Counters

The Gamma-Ray Counters data product contains counters of events across the integration period and is used for diagnostic purposes. The counters and metadata are stored in a fixed-width binary table. The following table shows the format of each row of the binary table.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag at the start of the histogram integration period in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| AccumPeriod | 2 | Unsigned Integer | Integration period in seconds. |
| ConfigChange | 2 | Unsigned Integer | Indicates whether there was a configuration change during the integration period, which may result in |

| | | | |
|---|---|---|---|
| | | | data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| Ch0_Trigger | 4 | Unsigned Integer | Detected events whose amplitude is over a specified pulse threshold as classified by the FPGA on Channel 0 (HPGE High Gain). Units are number of events per status interval. |
| Ch1_Trigger | 4 | Unsigned Integer | Detected events whose amplitude is over a specified pulse threshold as classified by the FPGA on Channel 1 (HPGE Low Gain). Units are number of events per status interval. |
| Ch2_Trigger | 4 | Unsigned Integer | Detected events whose amplitude is over a specified pulse threshold as classified by the FPGA on Channel 2 (ACS High Gain). Units are number of events per status interval. |
| Ch3_Trigger | 4 | Unsigned Integer | Detected events whose amplitude is over a specified pulse threshold as classified by the FPGA on Channel 3 (ACS Low Gain). Units are number of events per status interval. |
| CR_Short | 4 | Unsigned Integer | Short length charge resets detected |
| CR_Med | 4 | Unsigned Integer | Medium length charge resets detected |
| CR_Long | 4 | Unsigned Integer | Long length charge resets detected |
| FIFO_Write | 4 | Unsigned Integer | Number of events written into hardware FIFO (First-in First-Out) |
| SW_Events | 4 | Unsigned Integer | Number of events software read from hardware FIFO |
| Ch0_Invalid | 4 | Unsigned Integer | Number of Channel 0 events flagged as invalid |
| Ch0_Pileup | 4 | Unsigned Integer | Number of Channel 0 events with pileup detected |
| Ch0_OOR | 4 | Unsigned Integer | Number of Channel 0 events with ADC out of range |
| Ch0_CR | 4 | Unsigned Integer | Number of Channel 0 events with charge reset |
| Ch1_Invalid | 4 | Unsigned Integer | Number of Channel 1 events flagged as invalid |

| | | | |
|---|---|---|---|
| Ch1_Pileup | 4 | Unsigned Integer | Number of Channel 1 events with pileup detected |
| Ch1_OOR | 4 | Unsigned Integer | Number of Channel 1 events with ADC out of range |
| Ch1_CR | 4 | Unsigned Integer | Number of Channel 1 events with charge reset |
| Ch2_Multint | 4 | Unsigned Integer | Number of Channel 2 events with multiple interactions detected |
| Ch2_OOR | 4 | Unsigned Integer | Number of Channel 2 events with ADC out of range |
| Ch2_FN_Present | 4 | Unsigned Integer | Number of Channel 2 events with both prompt and capture pulse (fast neutron event) |
| Ch3_OOR | 4 | Unsigned Integer | Number of Channel 3 events with ADC out of range |
| Ch0_Max_OOR | 4 | Unsigned Integer | Number of Channel 0 events with min-max time out of range |
| Ch0_OOB | 4 | Unsigned Integer | Number of Channel 0 events out of histogram bounds |
| Ch0_Coin | 4 | Unsigned Integer | Number of Channel 0 events with a coincident Anti-Coincident Shield (ACS) event |
| Ch0_Accept | 4 | Unsigned Integer | Number of Channel 0 events with a coincident ACS event that were accepted in the Anti-Coincidence (AC) spectrum (i.e. not vetoed) |
| Ch0_Raw_Spec | 4 | Unsigned Integer | Number of Channel 0 histogrammed raw HPGE events |
| Ch0_AC_Spec | 4 | Unsigned Integer | Number of Channel 0 histogrammed raw HPGE AC events |
| Ch1_Max_OOR | 4 | Unsigned Integer | Number of Channel 1 events with min-max time out of range |
| Ch1_OOB | 4 | Unsigned Integer | Number of Channel 1 events out of histogram bounds |
| Ch1_Coin | 4 | Unsigned Integer | Number of Channel 1 events with a coincident ACS event |
| Ch1_Accept | 4 | Unsigned Integer | Number of Channel 1 events with a coincident ACS event that were accepted in the AC spectrum (i.e., not vetoed) |
| Ch1_Raw_Spec | 4 | Unsigned Integer | Number of Channel 1 histogrammed raw HPGE events |
| Ch1_AC_Spec | 4 | Unsigned Integer | Number of Channel 1 histogrammed raw HPGE AC events |
| Ch2_Shd_OOB | 4 | Unsigned Integer | Number of AC Shield High Gain events out of histogram bounds. |

| | | | |
|---|---|---|---|
| Ch2_ShdHigh_SPEC | 4 | Unsigned Integer | Number of AC Shield High Gain histogrammed events |
| Ch2_FN_Coin_Veto | 4 | Unsigned Integer | Number of Fast Neutron events vetoed by coincident HPGe events |
| Ch2_FN_Not_Valid | 4 | Unsigned Integer | Number of Fast Neutron events rejected because of out of threshold limits |
| Ch2_FN_Valid | 4 | Unsigned Integer | Number of Fast Neutron events that met thresholding requirements |
| Ch2_FN_OOB | 4 | Unsigned Integer | Number of Fast Neutron events out of histogram bounds |
| Ch2_FN_Early | 4 | Unsigned Integer | Number of Fast Neutron events histogrammed into the "early" spectrum |
| Ch2_FN_Late | 4 | Unsigned Integer | Number of Fast Neutron events histogrammed into the "late" spectrum |
| Ch3_OOB | 4 | Unsigned Integer | Number of Channel 3 events out of histogram bounds |
| Ch3_Spec | 4 | Unsigned Integer | Number of histogrammed Galactic Cosmic Ray events |

### 6.2.7 Raw Gamma-Ray Events

The Raw Gamma-Ray Events data product contains up to 50 raw events generated per second when integration is enabled. Note that a single time tag is associated with anywhere from 1-50 events due to the way the data is organized in the downlink telemetry packet. The data are stored in a fixed-width binary table. The following table shows the format of each row of the binary table.

| **Field Name** | **Length (bytes)** | **Data Type** | **Description** |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag of events in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| NumEvents | 2 | Unsigned Integer | The number of events associated with the SCLK time tag; from 1 to 50 events. This value will also indicate how many rows will have the same SCLK time tag. |
| EventValid | 1 | Unsigned Byte | Event word coming out of the file-in file-out (FIFO) is valid. This will always be 1; used by the software to determine if it has read out all the events in the FIFO. |

| | | | |
|---|---|---|---|
| EventDropped | 1 | Unsigned Byte | Unable to write an event into the FIFO. =1 True, =0 False |
| EventErr | 1 | Unsigned Byte | Event has a parity error<br>=1 True, =0 False |
| EventFull | 1 | Unsigned Byte | Event FIFO is currently full<br>=1 True, =0 False |
| Ch0_Present | 1 | Unsigned Byte | Ch0 data is present in the event word. 1=True, 0=False |
| Ch1_Present | 1 | Unsigned Byte | Ch1 data is present in the event word. 1=True, 0=False |
| Ch2_Present | 1 | Unsigned Byte | Ch2 data is present in the event word. 1=True, 0=False |
| Ch3_Present | 1 | Unsigned Byte | Ch3 data is present in the event word. 1=True, 0=False |
| Ch0_Invalid | 1 | Unsigned Byte | Ch0 event is invalid.<br>=1 True, =0 False |
| Ch0_Pileup | 1 | Unsigned Byte | Ch0 event experienced pileup<br>=1 True, =0 False |
| Ch0_ChrgReset | 1 | Unsigned Byte | Ch0 event experienced a charge reset. =1 True, =0 False |
| Ch0_OOR | 1 | Unsigned Byte | Ch0 event experienced an ADC OOR. =1 True, =0 False |
| Ch1_Invalid | 1 | Unsigned Byte | Ch1 event is invalid.<br>=1 True, =0 False |
| Ch1_Pileup | 1 | Unsigned Byte | Ch1 event experienced pileup<br>=1 True, =0 False |
| Ch1_ChrgReset | 1 | Unsigned Byte | Ch1 event experienced a charge reset. =1 True, =0 False |
| Ch1_OOR | 1 | Unsigned Byte | Ch1 event experienced an ADC OOR. =1 True, =0 False |
| Ch2_PromptPresent | 1 | Unsigned Byte | Prompt Pulse present in Ch2 event.<br>=1 True, =0 False |
| Ch2_CapturePresent | 1 | Unsigned Byte | Capture Pulse present in Ch2 event.<br>=1 True, =0 False |
| Ch2_MultInt | 1 | Unsigned Byte | Multiple interactions recorded in Ch2. =1 True, =0 False |
| Ch2_OOR | 1 | Unsigned Byte | Ch2 event experienced an ADC OOR. =1 True, =0 False |
| Ch3_OOR | 1 | Unsigned Byte | Ch3 event experienced an ADC OOR. =1 True, =0 False |
| Coin_Present | 1 | Unsigned Byte | Coincidence detected between HPGE (Ch0 or Ch1) and ACS (Ch2 or Ch3). =1 True, =0 False |
| Ch0_Coin | 2 | Signed Integer | Coincidence timing (in 100ns clock cycles) from Ch0 event and ACS |

| | | | |
|---|---|---|---|
| | | | event. Will be a negative number if HPGe channel triggered first. |
| Ch1_Coin | 2 | Signed Integer | Coincidence timing (in 100ns clock cycles) from Ch1 event and ACS event. Will be a negative number if HPGe channel triggered first. |
| Ch0_MaxVal | 2 | Signed Integer | Maximum amplitude of event in Ch0 |
| Ch0_MaxTime | 2 | Signed Integer | Time of the Ch0 maximum value from trigger in units of 0.1 us |
| Ch0_MinVal | 2 | Signed Integer | Minimum amplitude of event in Ch0 |
| Ch0_MinTime | 2 | Signed Integer | Time of the Ch0 minimum value from trigger in units of 0.1 us |
| Ch0_Lobe | 2 | Signed Integer | Ratio of Ch0 maximum-to-minimum amplitude |
| Ch0_FlatTop | 2 | Signed Integer | Duration of Ch0 flat top shaping time in 0.1 us |
| Ch1_MaxVal | 2 | Signed Integer | Maximum amplitude of event in Ch1 |
| Ch1_MaxTime | 2 | Signed Integer | Time of the Ch1 maximum value from trigger in units of 0.1 us |
| Ch1_MinVal | 2 | Signed Integer | Minimum amplitude of event in Ch1 |
| Ch1_MinTime | 2 | Signed Integer | Time of the Ch1 minimum value from trigger in units of 0.1 us. |
| Ch2_PromptVal | 2 | Unsigned Integer | Amplitude of Ch2 prompt event |
| Ch2_CaptureVal | 2 | Unsigned Integer | Amplitude of Ch2 capture event |
| Ch2_PeaktoPeak | 2 | Unsigned Integer | Absolute magnitude of Ch2 max-to-min values |
| Ch2_TTSP | 2 | Unsigned Integer | Time between Ch2 Prompt and Capture pulses measured in units of 0.1 microseconds |
| Ch3_MaxVal | 2 | Signed Integer | Maximum amplitude of event in Ch3 |
| Ch3_MinVal | 2 | Signed Integer | Minimum amplitude of event in Ch3 |

### 6.2.8 Raw Fast Neutron Events

The Raw Fast Neutron Events data product contains up to 255 raw fast neutron events captured per second when integration is enabled. Note that a single time tag is associated with anywhere from 1-255 events due to the way the data is organized in the downlink telemetry packet. The events are collected even if they are not considered valid to be included in a spectrum. The data are stored in a fixed-width binary table. The following table shows the format of each row of the binary table. Fast neutron event mode data will be collected periodically to very performance of the time-to-second-pulse performance, which guides selection of pulse-processing parameters that optimize fast neutron signal detection and background removal in the fast neutron spectra.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag of events in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| NumEvents | 2 | Unsigned Integer | Number of events up to 255. This value will also indicate how many rows will have the same event timetag. |
| TTSP | 2 | Unsigned Integer | Time-to-second pulse. |
| PromptMax | 2 | Unsigned Integer | Amplitude of first (Prompt) pulse. |
| CaptureMax | 2 | Unsigned Integer | Amplitude of second (Capture) pulse. |

### 6.2.9 Gamma Ray Burst

The Gamma Ray Burst (GRB) data product contains count rates with 1024 samples that capture the detection of a candidate gamma ray burst. The GRS Data Processing Unit (DPU) is continuously monitoring the count rate every 50 ms. When an instantaneous rate above the updateable parameter “GRB Trigger Threshold” is observed, a GRB product is created. The data contains the counts per 50 ms time sample, which includes a pre-trigger period defined by an updatable parameter “GRB precount index”; this pre-trigger period is nominally IDX = 256 samples (12.8 s). Note that some fraction of GRB data products are false positives that are triggered by spurious overload events in the ACS that are caused by galactic cosmic rays.

This data product is intended to be used by the Gamma Ray Burst Interplanetary Network. The Interplanetary Network (IPN) is a system of spacecraft equipped with gamma-ray burst detectors used to locate and study these powerful cosmic events. By observing the same burst from multiple spacecraft at different locations, scientists can triangulate the burst's source, improving the accuracy of localization compared to individual spacecraft.

The IPN will conduct the task of correlating gamma ray burst detection from multiple sensors using gamma ray burst data, hence there is no supplementary data product that shows probable events in this archive. Users are encouraged to go directly to IPN to get definitive information on Psyche GRB data correlated with other space-based GRB assets.

The count rates and metadata are stored in a fixed-width binary table. The following table shows the format of each row of the binary table. The GRS keeps a running buffer of the rate in the AC Shield high-gain (Channel 3). When a valid trigger is detected, the buffer is recorded to the

1024-sample array such that the pre-trigger rate is included. The threshold for triggering the gamma-ray burst mode is a pulse processing parameter that will be optimized in flight.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag when the Gamma Ray Burst was detected. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| IDX | 2 | Unsigned Integer | Pre-trigger index (offset) in sample numbers; nominally IDX=256. |
| Mean | 2 | Unsigned Integer | The mean value of the 64 samples prior to the trigger. For a GRayBurst[1024] array starting with index value of 0, this mean value is mean(GRayBurst[IDX-64 to IDX-1]). |
| NumSamples | 2 | Unsigned Integer | Number of samples in the buffer. Should always be 1024. |
| GRayBurst | 4 x 1024 | Unsigned Integer | 1024-sample count rates |

### 6.2.10 Raw GRS Engineering

The Gamma Ray Spectrometer Engineering data product contains the information about the DPU status, software data, and GRS instrument state. The data are stored in a fixed-width binary table. The following table shows the format of each row of the binary table.

In the descriptions, HVPS1 refers to the High Voltage Power Supply to the HPGe sensor, and HVPS2 refers to High Voltage Power Supply to the AC Shield sensor.

GRS has two internal pulsers. A hardware pulser injects a signal into the HPGe crystal. It was a programmable rate but fixed amplitude. This pulser is useful for diagnosing the performance of the HPGe crystal and the signal chain. A digital pulser with programmable rate and amplitude is also available, it is injected into the signal chain after the HPGe preamplifier, such that it is useful for characterizing the performance of the electronics processing.

| Field Name | Length (bytes) | Data Type | Description |
|---|---|---|---|
| SCLK | 4 | Unsigned Integer | Timetag when the source status packet was generated in seconds. |
| SCLK_Sub | 2 | Unsigned Integer | Subsecond portion of timetag. Units are in subsecond ticks |

| | | | |
|---|---|---|---|
| | | | where each tick is 20 microseconds and values range from 0-49999. |
| SCLK_Last | 4 | Unsigned Integer | Last SCLK time received. |
| SCLK_Last_Sub | 4 | Unsigned Integer | Subsecond portion of last SCLK time received. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| Num_SCLK_Rcvd | 2 | Unsigned Integer | Number of Space Time Messages (STMs) received |
| SCLK_STM_Status | 1 | Unsigned Byte | STM bit flag.<br>Bit 0 = reserved<br>Bit 1 = Pulse per second is late<br>Bit 2 = Pulse per second is early<br>Bit 3 = STM needed<br>Bits 4-7 Unused |
| Cmd_Exec_Count | 2 | Unsigned Integer | Number of commands executed. |
| Last_Cmd_Exec | 4 | Unsigned Integer | SCLK time of last command executed. |
| Last_Cmd_Exec_Sub | 2 | Unsigned Integer | Subsecond portion of time of last command executed. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| Cmd_Rej_Count | 2 | Unsigned Integer | Number of commands rejected. |
| Cmd_Rej_Reason | 1 | Unsigned Byte | Reason code of last command rejected. |
| Last_Cmd_Rej | 4 | Unsigned Integer | SCLK time of last command rejected. |
| Last_Cmd_Rej_Sub | 2 | Unsigned Integer | Subsecond portion of time of last command rejected. Units are in subsecond ticks where each tick is 20 microseconds and values range from 0-49999. |
| Macro_Exec_Count | 2 | Unsigned Integer | Number of macro commands executed. |
| Macro_Rej_Count | 2 | Unsigned Integer | Number of macro commands rejected. |
| Last_Seq_Count | 2 | Unsigned Integer | Last sequence count seen. |
| Queue_Oflow_Count | 1 | Unsigned Byte | Number of queue overflows. |
| Last_Queue_Oflow | 1 | Unsigned Byte | ID of last queue overflow. |
| Mem_Dwell_Addr | 4 | Unsigned Integer | Memory Dwell address (peek) |
| Mem_Dwell_Val | 4 | Unsigned Integer | Memory Dwell value (peek) |
| Counter_Dwell_ID | 1 | Unsigned Byte | Counter Dwell ID (peek) |
| Counter_Dwell_Val | 4 | Unsigned Integer | Counter Dwell value (peek) |

| | | | |
|---|---|---|---|
| Crit_ShVar_Stat | 1 | Unsigned Byte | Status of critical shared variables |
| LEON_Stat | 2 | Unsigned Integer | LEON processor status |
| AHB_Fail_Addr | 4 | Unsigned Integer | AHB Status |
| Local_Osc_Count | 4 | Unsigned Integer | Local oscillator ticks between STM |
| TLM_Bw | 4 | Unsigned Integer | Telemetry bandwidth used this second |
| Bytes_Sent | 4 | Unsigned Integer | Total bytes sent since power on. |
| Time_In_App | 4 | Unsigned Integer | Time spent in application in seconds. |
| Status_Int | 2 | Unsigned Integer | Status packet interval. |
| Sys_TellTales | 4 | Unsigned Integer | System telltales. |
| Last_Alarm_SCLK | 4 | Unsigned Integer | SCLK time of last alarm in seconds. |
| Last_Alarm_ID | 2 | Unsigned Integer | ID of last alarm. |
| Alarm_Count | 1 | Unsigned Byte | Number of alarms. |
| CPU_Idle_Pct | 1 | Unsigned Byte | Processor idle percentage. |
| Macro_Free_Blocks | 2 | Unsigned Integer | Number of free macro blocks. |
| Last_Macro_ID | 2 | Unsigned Integer | Last macro executed. |
| HK_Raw_or_Avg | 1 | Unsigned Byte | Housekeeping data is raw or averaged. |
| LVPS_V_Pri | 2 | Unsigned Integer | LVPS Primary supply voltage. |
| LVPS_T_NS_Plate | 2 | Unsigned Integer | LVPS Plate temperature. |
| LVPS_V_N12 | 2 | Unsigned Integer | LVPS -12V supply voltage. |
| LVPS_T_NS_Preamp1 | 2 | Unsigned Integer | LVPS Preamp 1 Temperature. |
| LVPS_I_N5 | 2 | Unsigned Integer | LVPS -5V supply current. |
| LVPS_I_N12 | 2 | Unsigned Integer | LVPS -12V supply current. |
| LVPS_V_P5 | 2 | Unsigned Integer | LVPS +5V supply voltage. |
| LVPS_V_P6 | 2 | Unsigned Integer | LVPS +6V supply voltage. |
| LVPS_V_N5 | 2 | Unsigned Integer | LVPS -5V supply voltage. |
| LVPS_V_P12 | 2 | Unsigned Integer | LVPS +12V supply voltage. |
| LVPS_V_P33 | 2 | Unsigned Integer | LVPS +3.3V supply voltage. |
| LVPS_T_NS_Preamp2 | 2 | Unsigned Integer | LVPS Preamp 2 temperature. |
| LVPS_I_P5 | 2 | Unsigned Integer | LVPS +5V supply current. |
| LVPS_I_P6 | 2 | Unsigned Integer | LVPS +6V supply current. |
| LVPS_V_N6 | 2 | Unsigned Integer | LVPS -6V supply voltage. |
| LVPS_I_Op_Htr | 2 | Unsigned Integer | LVPS Operational Heater return current. |
| LVPS_Spare1 | 2 | Unsigned Integer | Spare telemetry field to be used in case a future flight software update adds a telemetry parameter. Field names must be unique, hence this is spare field 1. |
| LVPS_T_Brd | 2 | Unsigned Integer | LVPS board temperature. |

| | | | |
|---|---|---|---|
| LVPS_I_Pri | 2 | Unsigned Integer | LVPS Primary supply current. |
| LVPS_I_P12 | 2 | Unsigned Integer | LVPS +12V supply current. |
| LVPS_I_P33 | 2 | Unsigned Integer | LVPS +3.3V supply current. |
| LVPS_T_NS_Preamp3 | 2 | Unsigned Integer | LVPS Preamp 3 temperature |
| LVPS_Spare2 | 2 | Unsigned Integer | Spare telemetry field to be used in case a future flight software update adds a telemetry parameter. Field names must be unique, hence this is spare field 2. |
| LVPS_I_N6 | 2 | Unsigned Integer | LVPS -6V supply current. |
| HVPS_V_Mon1 | 2 | Unsigned Integer | HVPS Monitor 1 voltage. |
| HVPS_I_Mon1 | 2 | Unsigned Integer | HVPS Monitor 1 current. |
| HVPS_V_Mon2 | 2 | Unsigned Integer | HVPS Monitor 2 voltage. |
| HVPS_I_Mon2 | 2 | Unsigned Integer | HVPS Monitor 2 current. |
| HVPS_V_ADC_Cal1 | 2 | Unsigned Integer | HVPS ADC Calibration voltage 1 |
| HVPS_V_ADC_Cal2 | 2 | Unsigned Integer | HVPS ADC Calibration voltage 2 |
| HVPS_T_Brd | 2 | Unsigned Integer | HVPS Board temperature. |
| HVPS_Seq_En | 2 | Unsigned Integer | HVPS Power sequence. |
| PROC_T_Brd | 2 | Unsigned Integer | Processor board temperature. |
| PROC_V_P33 | 2 | Unsigned Integer | Processor +3.3V supply voltage. |
| PROC_V_P25 | 2 | Unsigned Integer | Processor +2.5V supply voltage. |
| PROC_V_P18 | 2 | Unsigned Integer | Processor +1.8V supply voltage. |
| PROC_V_P15 | 2 | Unsigned Integer | Processor +1.5V supply voltage. |
| PROC_I_P25 | 2 | Unsigned Integer | Processor +2.5V supply current. |
| PROC_I_P18 | 2 | Unsigned Integer | Processor +1.8V supply current. |
| PROC_I_P15 | 2 | Unsigned Integer | Processor +1.5V supply current. |
| Op_Htr_State | 1 | Unsigned Byte | Operational Heater 1 Control state.<br>=0 idle<br>=1 heating<br>=2 at temp<br>=3 fault (temperature sensor failure) |
| Op_Htr1_Upper_Limit | 2 | Unsigned Integer | Operational Heater 1 set point upper limit. |
| Op_Htr1_Lower_Limit | 2 | Unsigned Integer | Operational Heater 1 set point lower limit. |
| Op_Htr1_En | 1 | Unsigned Byte | Operational Heater 1 enable. |
| Op_Htr2_State | 1 | Unsigned Byte | Operational Heater 2 Control state.<br>=0 idle<br>=1 heating |

| | | | |
|---|---|---|---|
| | | | =2 at temp<br>=3 fault (temperature sensor failure) |
| Op_Htr2_Upper_Limit | 2 | Unsigned Integer | Operational Heater 2 set point upper limit. |
| Op_Htr2_Lower_Limit | 2 | Unsigned Integer | Operational Heater 2 set point lower limit. |
| Op_Htr2_En | 1 | Unsigned Byte | Operational Heater 2 enabled. |
| HV1_State | 1 | Unsigned Byte | High Voltage Power Supply (HVPS) 1 state<br>=0 disabled<br>=1 off (enabled at 0V)<br>=2 Ramp1<br>=3 Hold1<br>=4 Ramp2<br>=5 Hold2<br>=6 Ramp to Goal<br>=7 Ramp Down<br>=8 At Goal<br>=9 Emergency Shutdown<br>=10 SAFED<br>=11 Fault (temperature sensor failure) |
| HV1_Volt | 2 | Unsigned Integer | HVPS1 Commanded voltage |
| HV1_Goal | 2 | Unsigned Integer | HVPS1 Setpoint goal |
| HV1_Max | 2 | Unsigned Integer | HVPS1 Absolute max allowed voltage. |
| HV1_Fault_State | 1 | Unsigned Byte | HVPS1 Fault condition<br>=0 Nominal<br>=1 Safing level 1<br>=2 Safing level 2 |
| HV2_State | 1 | Unsigned Byte | High Voltage Power Supply (HVPS) 2 state<br>=0 disabled<br>=1 off (enabled at 0V)<br>=2 Ramp1<br>=3 Hold1<br>=4 Ramp2<br>=5 Hold2<br>=6 Ramp to Goal<br>=7 Ramp Down<br>=8 At Gobal<br>=9 Emergency Shutdown<br>=10 SAFED |
| HV2_Volt | 2 | Unsigned Integer | HVPS2 Commanded voltage |

| | | | |
|---|---|---|---|
| HV2_Goal | 2 | Unsigned Integer | HVPS2 Setpoint goal |
| HV2_Max | 2 | Unsigned Integer | HVPS2 Absolute max allowed voltage. |
| HV2_Fault_State | 1 | Unsigned Byte | HVPS2 Fault condition<br>=0 Nominal<br>=1 Safing level 1<br>=2 Safing level 2 |
| CCDB_V_CCBUS | 2 | Unsigned Integer | CCDB Cryocooler Bus voltage. |
| CCDB_I_CCPCB_PRI | 2 | Unsigned Integer | CCDB Cryocooler Power Conditioning Board (CCPCB) Primary current. |
| CCDB_V_P12 | 2 | Unsigned Integer | CCDB +12V supply voltage. |
| CCDB_V_P5 | 2 | Unsigned Integer | CCDB +5V supply voltage. |
| CCDB_T_Brd | 2 | Unsigned Integer | CCDB Board Temperature. |
| CCDB_V_Pri | 2 | Unsigned Integer | CCDB Primary supply voltage. |
| CCDB_V_OutA | 2 | Unsigned Integer | CCDB Output A voltage. |
| CCDB_V_OutB | 2 | Unsigned Integer | CCDB Output B voltage. |
| CCPCB_T_Det | 2 | Unsigned Integer | CCPCB Detector temperature. |
| CCPCB_T_Flange1 | 2 | Unsigned Integer | CCPCB Flange 1 temperature. |
| CCPCB_V_AH1 | 2 | Unsigned Integer | CCPCB Anneal heater 1 voltage. |
| CCPCB_T_Compressor | 2 | Unsigned Integer | CCPCB Compressor temperature. |
| CCPCB_T_Brd | 2 | Unsigned Integer | CCPCB Board temperature. |
| CCPCB_V_Pri | 2 | Unsigned Integer | CCPCB Primary supply voltage. |
| CCPCB_I_Op_Htr | 2 | Unsigned Integer | CCPCB Operational heater current. |
| CCPCB_I_Det_Lkg | 2 | Unsigned Integer | CCPCB Detector leakage current. |
| CCPCB_T_Coldfinger | 2 | Unsigned Integer | CCPCB Coldfinger temperature. |
| CCPCB_T_Flange2 | 2 | Unsigned Integer | CCPCB Flange 2 temperature. |
| CCPCB_V_AH2 | 2 | Unsigned Integer | CCPCB Anneal heater 2 voltage. |
| CCPCB_T_HPGE_Preamp | 2 | Unsigned Integer | CCPCB HPGe preamp temperature. |
| CCPCB_V_P_Preamp | 2 | Unsigned Integer | CCPCB Preamp positive supply voltage. |
| CCPCB_V_N_Preamp | 2 | Unsigned Integer | CCPCB Preamp negative supply voltage. |
| CCPCB_T_ACS_Preamp | 2 | Unsigned Integer | CCPCB ACS Preamp temperature. |
| CCPCB_T_SCUM | 2 | Unsigned Integer | CCPCB Sensor Control Unit Module (SCUM) temperature. |
| Prisec_detector | 1 | Unsigned Byte | Detector temperature active sensor.<br>=0 Primary<br>=1 Secondary |

| | | | |
|---|---|---|---|
| | | | =2 Both invalid |
| Prisec_Flange | 1 | Unsigned Byte | Flange temperature active sensor<br>=0 Primary<br>=1 Secondary<br>=2 Both invalid |
| Prisec_Compressor | 1 | Unsigned Byte | Compressor temperature active sensor<br>=0 Primary<br>=1 Secondary<br>=2 Both invalid |
| GRS_CC_State | 1 | Unsigned Byte | Cryocooler control state<br>=0 Idle<br>=1 PI Control<br>=2 Manual<br>=3 Fault (Temperature sensor failure) |
| GRS_CC_En | 1 | Unsigned Byte | Cryocooler enable. |
| GRS_CC_Pi_En | 1 | Unsigned Byte | Cryocooler PI control loop enable. |
| GRS_CC_CMD_Temp | 2 | Unsigned Integer | Cryocooler commanded temperature. |
| GRS_CC_Max_Pwr | 2 | Unsigned Integer | Cryocooler maximum allowed power. |
| GRS_CC_CMD_Pwr | 2 | Unsigned Integer | Cryocooler commanded power level. |
| CC_Pwm_SD_Status | 1 | Unsigned Byte | Cryocooler PWM shutdown status. |
| CC_Drive_Freq | 4 | Unsigned Integer | Cryocooler drive frequency setting. |
| CC_Carr_Freq | 2 | Unsigned Integer | Cryocooler carrier frequency setting. |
| AH_Pri_State | 1 | Unsigned Byte | Primary Anneal heater state<br>=0 Idle<br>=1 Heating<br>=2 At temp<br>=3 Fault (Temperature sensor failure) |
| AH_Pri_Ctrl | 1 | Unsigned Byte | Primary Anneal heater control enable/disable. |
| AH_Sec_State | 1 | Unsigned Byte | Secondary Anneal heater state<br>=0 Idle<br>=1 Heating<br>=2 At temp<br>=3 Fault (Temperature sensor failure) |

| | | | |
|---|---|---|---|
| AH_Sec_Ctrl | 1 | Unsigned Integer | Secondary Anneal heater control enable/disable. |
| AH_Setpoint | 2 | Unsigned Integer | Anneal heater setpoint. |
| GRS_Pulser_En | 1 | Unsigned Byte | SCUM pulser state. |
| GRS_Pulser_Rate | 1 | Unsigned Byte | SCUM pulser rate.<br>=0 1Hz<br>=1 10 Hz<br>=2 100 Hz<br>=3 1 kHz<br>=4 10 kHz |
| GRS_Pulser_Width | 2 | Unsigned Integer | SCUM pulser width (0.1 microsecond increments). |
| DPulser_Status | 1 | Unsigned Byte | Digital Pulser enable status. Value corresponds to a bitmapped field, where bit=1 indicates channel is enabled, bit=0 indicates channel is disabled.<br>bit 0 (LSB) = Ch0<br>bit 1 = Ch1<br>bit 2 = Ch2<br>bit 3 = Ch3<br>bit 4 = Ch2_CPT, used when conducting Comprehensive Performance Tests (CPT). This is a check of the instrument health and science performance that is performed periodically, i.e. pre/post environmental tests.<br><br>Ex. A value of 9 indicates that Ch3 and Ch0 are enabled. |
| GRS_CRPS | 4 | Unsigned Integer | Charge resets per second. |
| GRS_GE_High_Gain_CPS | 4 | Unsigned Integer | Ge crystal high gain channel counts per second. |
| GRS_GE_Low_Gain_CPS | 4 | Unsigned Integer | Ge crystal low gain channel counts per second. |
| GRS_FN_CPS | 4 | Unsigned Integer | Fast Neutron counts per second. |
| GRS_GCR_CPS | 4 | Unsigned Integer | AC Shield low gain counts per second. |
| PP_Status | 1 | Unsigned Byte | Histogramming status<br>=0 Idle<br>=1 Active<br>=2 Sending histogram; continuing integration. |

| | | | |
|---|---|---|---|
| PP_Data_Product_Mask | 2 | Unsigned Integer | Value corresponds to a bitmapped field, where bit=1 indicates data product is selected to downlink to ground, bit=0 indicates data is not selected for downlink.<br>bit 0 (LSB) = HPGE High Gain<br>bit 1 = HPGE Low Gain<br>bit 2 = HPGE AC High Gain<br>bit 3 = HPGE AC Low Gain<br>bit 4 = AC Shield Fast Neutron<br>bit 5 = AC Shield Low Gain<br>bit 6 = GRS Counters<br>bit 7 = GRS Raw Events<br>bit 8 = AC Shield High Gain<br>bit 9 = Fast Neutron Raw Events<br>bit 10 = Gamma Ray Bursts<br>Ex. A value of 19 indicates the AC Shield Fast Neutron, HPGE High Gain and HPGE Low Gain data products are enabled. |
| PP_Config_Mask | 2 | Unsigned Integer | GRS Pulse Processing configuration. Value corresponds to a bitmapped field, where bit=1 indicates parameter is enabled, bit=0 indicates parameter id disabled.<br>bit 0 (LSB) =Ch0 Data Quality (DQ) Reject<br>bit 1 = Ch1 DQ Reject<br>bit 2 = Ch2 DQ Reject<br>bit 3 = Ch3 DQ Reject<br>bit 4 = HPGE HG Veto<br>bit 5 = Unused<br>bit 6 = HPGE LG Veto<br>bit 7 = Fast Neutron Coin Veto<br>bit 8 = Retriggerable recovery window<br>bit 9-11 = Unused<br>bit 12 = Ch0 Coin Trigger<br>bit 13 = Ch1 Coin Trigger<br>bit 14 = Ch2 Coin Trigger<br>bit 15 = Ch3 Coin Trigger<br>Ex. A value of 19 indicates the HPGE HG Veto, Ch0 DQ Reject, and Ch1 DQ Reject are enabled. |

| | | | |
|---|---|---|---|
| PP_DQ_Mask | 2 | Unsigned Integer | Pulse processing data quality. Indicates whether there was a configuration change during the integration period, which may result in data artifacts. Value corresponds to a bit flag for the following parameters:<br>bit 0 = data products changed.<br>bit 1 = Parameters changed.<br>bit 2 = Pulse Processing configuration changed.<br>For example, if the Parameters and Pulse Processing configuration were changed the value would be 6. |
| PP_Total_Hist_Int_Time | 2 | Unsigned Integer | Histogram integration time in seconds. |
| PP_Current_Hist_Int_Time | 2 | Unsigned Integer | Time into current histogram integration in seconds. |

### 6.2.11 Calibrated GRS HPGe

Calibrated HPGE spectra, where the spectra will be shifted as needed to account for temperature shifts. Will also include channel-to-energy calibration values, ephemeris information, applicable calibrated fields from the GRS Status and GRS counters data products and a measure of data quality.

### 6.2.12 Calibrated GRS HPGe Anti-Coincidence

Calibrated HPGE Anti-Coincidence spectra, where the spectra will be shifted as needed to account for temperature shifts. Will also include channel-to-energy calibration values, ephemeris information, applicable calibrated fields from the GRS Status and GRS counters data products and a measure of data quality.

### 6.2.13 Calibrated GRS Anti-Coincidence Shield

Calibrated Anti-Coincidence Shield spectra, where the spectra will be shifted as needed to account for temperature shifts. Also includes ephemeris information, applicable calibrated fields from the GRS Status and GRS counters data products and a measure of data quality.

### 6.2.14 Calibrated GRS Anti-Coincidence Shield Fast Neutron

Calibrated Anti-Coincidence Shield Fast Neutron spectra, where the spectra will be shifted as needed to account for temperature shifts. Also includes ephemeris information, applicable calibrated fields from the GRS Status and GRS counters data products and a measure of data quality.

### 6.2.15 Calibrated Gamma-Ray Bursts

Calibrated Gamma-Ray Burst spectra, where the spectra will be shifted as needed to account for temperature shifts. Also includes ephemeris information, applicable calibrated fields from the GRS Status and GRS counters data products and a measure of data quality.

### 6.2.16 Calibrated GRS Engineering

Contains the calibrated GRS Engineering fields, transforming the fields from DN to engineering units.

# 7 Applicable Software

No software is provided with this data. The PDS has software utilities that use the PDS4 XML label in order to parse the data file and display its contents to the user.

# 8 Table of Acronyms

| Acronym | Name |
|---|---|
| 1PPS | One Pulse Per Second |
| ACS | Anti-Coincidence Shield |
| ADC | Analog to Digital Converter |
| AH | Anneal Heater |
| AHB | Advanced High Performance Bus |
| ASU | Arizona State University |
| CC | Cryocooler |
| CCBUS | Cryocooler Bus |
| CCDB | Cryocooler Driver Board |
| CCPCB | Cryocooler Power Conditioning Board |
| CCSDS | Consultative Committee for Space Data Systems |
| CFDP | CCSDS File Delivery Protocol |
| CK | C-kernel, one of several SPICE kernel files used to derive geometric information contained in calibrated data products |
| CPS | Counts Per Second |
| CPT | Comprehensive Performance Test |
| CR | Charge Reset |
| CRPS | Charge Resets Per Second |
| DN | Digital Number |
| DP | Data Product |

| | |
|---|---|
| DPU | Data Processing Unit |
| DQ | Data Quality |
| DSN | Deep Space Network |
| EDR | Experimental Data Records (PDS3 terminology; known as ‘Raw’ data in PDS4) |
| ET | Ephemeris Time |
| FIFO | First-in, First-out |
| FN | Fast Neutrons |
| FPGA | Field Programmable Gate Array |
| GCR | Galactic Cosmic Ray; legacy terminology sometimes used when referring to the ACS Low Gain data |
| GDS | Ground Data System |
| GRNS | Gamma-Ray and Neutron Spectrometer instrument |
| GRS | Gamma-Ray Spectrometer |
| HK | Housekeeping |
| HPGe | High Purity Germanium |
| HPGEAC | High Purity Germanium Anti-Coincident data |
| IDX | Index |
| JHU/APL | Johns Hopkins University/Applied Physics Laboratory |
| JPL | Jet Propulsion Laboratory |
| LEON | Designation of the microprocessor used in the DPU |
| LVPS | Low Voltage Power Supply |
| MAG | Magnetometer instrument |
| MIT | Massachusetts Institute of Technology |
| NAIF | Navigation and Ancillary Information Facility |
| NS | Neutron Spectrometer |
| OOB | Out of Bounds (usually refers to histogram bounds) |
| OOR | Out of Range |
| OOR | Out of Range |
| PDS | Planetary Data System |
| PP | Pulse Processing |
| PSI | Planetary Science Institute |
| PWM | Pulse Width Modulation |
| SCLK | Spacecraft Clock |
| SCUM | Sensor Control Unit Module |
| SDC | Science Data Center (for Psyche Mission) |
| SIS | Software Interface Specification |
| SOC | Science Operations Center |
| SPEC | Short for spectra; used to refer to histogram events in engineering data products |
| SPICE | Spacecraft, Planet, Instrument, C-matrix, Events; describes the components of the observation geometry information system used to derive geometric and time information |
| SPK | Spacecraft and Planets Kernel, one of several SPICE kernel files used to derive geometric information contained in calibrated data products |

| | |
|---|---|
| STM | Spacecraft Time Message – digital information sent by the spacecraft to the GRNS instrument containing the SCLK time; used to generate timetags for each GRNS packet |
| SW | Software |
| TLM | Telemetry |
| TTSP | Time to Second Pulse – refers to the time measured between two pulses in the engineering data |
| TVAC | Thermal Vacuum (refers to a type of ground calibration test) |
| UMD | University of Maryland |
| XML | Extensible Markup Language; the format used for PDS4 label files |