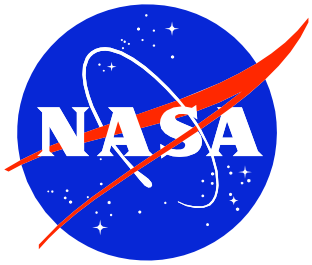
GLAST-GS-DOC-0001

Gamma-Ray Large Area Space Telescope (GLAST) Project

GLAST Science Support Center (GSSC)
Instrument Operations Centers (IOCs)

Science Data Products
File Format Document

December 14, 2006



GODDARD SPACE FLIGHT CENTER

Gamma-Ray Large Area
Space Telescope
(GLAST)
Project

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Science Data Products File Format Document

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ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Original	3/28/06	All	Created
Revisions based on OGIP FITS WG comments	4/11/06	All	GS-104 converted to current RSPII concept 'TUNIT' values revised to conform to standards 'PRIMTYPE' keyword removed 'AUTHOR' keyword removed 'HDU…' keywords removed from primary HDUs that do not contain images Filenames changed to lower case Appendix with acronyms added Overview section added File convention section revised TIME_OBS and TIME_END removed Time convention updated (TT with non-integer MJDREF) Version numbers start with '00'
Document split	4/11/06	All	Document split into ICD and File Format Document (FFD) Text in §1 rewritten LS-003 removed from FFD

Revisions based on OGIP FITS WG comments	4/27/06	All	Additional examples of filenames added to §4.4 Data Product Delivery subsection deleted Subsection on GLAST-specific keywords added Version numbers start with 00 CVSx times are UTC START and STOP replaced by TIME and ENDTIME in spectrum extension of CTIME and CSPEC files. Various errors and inconsistencies corrected
Further revisions	6/29/06	All	Document assigned ID number TRIGDAT file (GS-107) renamed and revised; one extension removed GBM filenames all have detector number or 'all' GS-007 files have been renamed Standard set of keywords inserted into all extensions
Update LS-002 and LS-005. Revise text about GBM and LAT pointing histories	8/2/06	§4.3, GS-006, LS-002 and LS-005	Update LS-002 (currently the same as FT1). Update LS-005. §4.3, GS-006 and LS-005 to reflect different LAT and GBM position, orientation and velocity systems.
Checksum for LUT data need for identification	11/15/06	GS-007	Add GBMCKSUM to primary header

Updates resulting from GSSC issues	12/14/06	§4.4, §4.6, §5.2, §5.3, §6.13, §6.15-§6.25	Limit on 31 character filenames removed from §4.3. FILETYPE keyword table formatted and augmented in §4.6. §5.2 and §5.3 modified to reflect origin of photons. Extension names listed in §6.13. SS-001 is converted into LS-002 because the GSSC will receive the photons from the LISOC and will not extract them from LS-001, which is now the event file; §6.15-§6.25 reordered

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1. Introduction

The purpose of this document is to define the file formats of the science data products that will be exchanged between the GLAST Instrument Operations Centers (IOCs)—the GBM IOC (GIOC) and the LAT Instrument Science and Operations Center (ISOC)—and the GLAST Science Support Center (GSSC).

This document is based on the final report of the GLAST Data Products Working Group (DPWG), which was convened by the GLAST Project Office. The DPWG consisted of representatives from the GSSC (D. Band, J. Bonnell, C. Meetre, and J. Norris), the LAT (S. Digel, E. do Couto e Silva, P. Nolan, T. Schalk, and S. Williams), the GBM (C. Meegan, W. Paciesas, and R. Preece) and the ground system (D. Small). In this report (25 February 2002 – GLAST00203-1), the data products were specified in terms of their contents, naming conventions, expected data volumes, and delivery method and frequency. The contents of the data products were described using FITS keywords.

The documents that are relevant to this document are listed in §2, while §3 provides relevant background information. The conventions regarding the data products are described in §4. In §5, the data products are tabulated by originating data center and delivery schedule. In §6, the data products are defined in as much detail as is practical at present. Appendix A provides a list of acronyms.

2. References

Documents with identifiers 433-XXXX-#### are GLAST project documents that can be found at http://glast.gsfc.nasa.gov/project/cm/mcdl/ (passwords are required). Documents with identifiers GSSC-#### are GSSC documents that can be found at http://glast.gsfc.nasa.gov/ssc/dev/current_documents/ (latest draft) and http://glast.gsfc.nasa.gov/ssc/dev/baselined_documents/ (most recently baselined draft).

Project Data Management Plan (PDMP—433-PLAN-009)

Science Data Products Interface Control Document (GLAST-GS-ICD-0006)

GSSC Ingest System Detailed Design Document (GSSC-0009)

GLAST Operations Concept Document (433-OPS-0001)

GBM AO response, http://f64.nsstc.nasa.gov/gbm/publications/proposal

GLAST Large Area Telescope Flight Investigation, Response to NASA AO 99-OSS-03, http://www-glast.stanford.edu/pubfiles/proposals/bigprop

Large Area Telescope Instrument - Spacecraft Interface Requirements Document (433-IRD-0001)

GLAST Spacecraft Performance Specification (433-SPEC-0003)

1553B Bus Protocol Interface Control Document (1196 EI-S46310-000 Rev)

Definition of the Flexible Image Transport System (NOST 100-2.0), http://fits.gsfc.nasa.gov

OGIP FITS & CALDB specifications, http://heasarc/docs/heasarc/ofwg/ofwg_recomm.html

Seaman, R. L., & Pence, W. D. 1995, FITS Checksum Proposal, http://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/docs/general/checksum/checksum.html

3. Background Information

3.1. GLAST Spacecraft

Figure 1 shows the GLAST spacecraft with the coordinate convention. The Large Area Telescope (LAT) is on top of the spacecraft, and points along the +z axis. Although the spacecraft can point in nearly any direction, in general it will point the LAT away from the Earth, but non necessarily towards the zenith. Thus the Earth will usually be in the –z direction. The y axis is along the solar panels while the x axis is perpendicular to the solar panels. The GLAST Burst Monitor (GBM) consists of 12 NaI and 2 BGO detectors that protrude from the spacecraft bus.

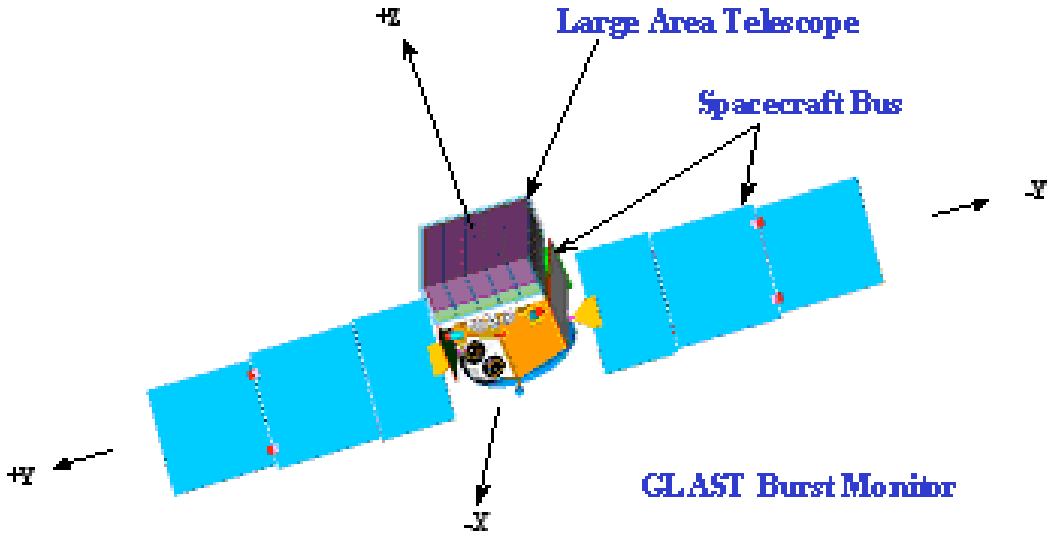

Figure 1—Simplified drawing of the GLAST observatory showing the coordinate convention.

3.2. Data Levels

3.2.1. Raw Data

Raw data are provided by the spacecraft telemetry to the ground and are processed by the MOC. None of the data in this document fall into this category.

3.2.2. Level 0 Data

Level 0 data will have undergone minimal processing. No information will be lost, but duplicate data packets will be removed, quality checks will be made, and the data packets will be time-ordered. The raw data will be decompressed (if necessary) and separated into spacecraft and instrument packets. Performed at the MOC, Level 0 processing converts the raw data into the Level 0 data. Instrument-specific Level 0 data will be archived at the IOCs. The GSSC will keep the Level 0 data for a year and then archive it at the National Space Science Data Center (NSSDC).

The Operations Data Products ICD deals with Level 0 data; none of the data in this document fall into this category.

3.2.3. Level 1 Data

Level 1 data result from "automatic" pipeline processing of Level 0 data. The resulting Level 1 data are generally the starting point for scientific analyses by the user community and the instrument teams. Level 1 processing of LAT and GBM data will be performed at the ISOC and the GIOC, respectively. The instrument teams will access the resulting Level 1 data at their respective IOCs while the general scientific community will extract the Level 1 data from databases at the GSSC.

In LAT Level 1 processing, the Level 0 data describing the interactions within the LAT will be analyzed to identify and characterize the interacting particle (e.g., photons, electrons, protons, etc.). The Level 1 data for an event will include at least the event arrival time, apparent energy and apparent origin on the sky. Other LAT Level 1 data will include histories of the instrument live time and pointing.

GBM Level 1 processing will primarily re-format and reorganize the data. The gains of each detector will be calibrated by monitoring the pulse-height channels of one or more background spectral lines. These gains will then be used to convert the raw detector pulse-height channels to an apparent energy. The Level 1 data will consist of continuous and burst data. Continuous data are the rates in all GBM detectors in different energy bands, regardless of whether a burst has been detected. Burst data are the counts, rates, catalog information (e.g., fluence, duration, peak flux), and ancillary data necessary for analyzing the burst.

A large fraction of the data described in this document is considered Level 1.

3.2.4. Level 2 Data

Level 2 data will result from routine scientific analysis, usually using the science analysis software developed for more focused studies by general scientific community (including GIs) and the instrument teams. For LAT observations these data may include:

exploratory science analyses; quick-look analyses to detect transient sources and to support operations planning; standard analysis of transient sources; refined analyses of on-board GRB and AGN transient alerts; and LAT sky maps accumulated over a variety of time intervals. For GBM observations Level 2 data might include the uniform fitting of GRB spectra with standard spectral models.

3.2.5. Level 3 Data

Level 3 data will consist of catalogs and compendia of Level 2 data. The LAT team will produce a catalog of gamma-ray sources, including (but not limited to) flux histories and tentative source identifications. The first LAT catalog will be based on the first-year sky-survey data; updates are to be released following the 2^{nd} and 5^{th} years of operation, and the end of the mission. The GBM team will release catalogs of GBM burst energy spectra. Both instrument teams will maintain catalogs of transient events.

3.2.6. Ancillary Data

The LAT team will produce, update and make public the diffuse Galactic interstellar and extragalactic emission models used for the analysis resulting in the LAT source catalogs. As a spatially varying background underlying point sources, the diffuse emission must be known to detect point sources. The diffuse Galactic emission is intrinsically interesting because it results from the interaction of cosmic rays with gas and photons in our galaxy.

4. Conventions

4.1. File Types

Unless otherwise specified, files will be formatted as OGIP-compliant FITS files. Where another format is used, all the information included can be mapped into an equivalent FITS file; therefore the definition of the FITS file provided here should be treated as the specification of the information content of the transferred data.

4.2. Representation of Time

The spacecraft will provide GPS (Global Positioning System) time to the instruments (433-IRD-0001, §3.2.6.3.1). GPS time is a uniform-rate time system time referenced to atomic clocks and is not adjusted with leap seconds. The spacecraft and instruments will also use a Mission Elapsed Time (MET) system, the number of seconds since a reference time; thus the MET system is a uniform-rate time system with a constant offset from GPS time. GPS time is also related by a constant offset (13.184 s) to TT (Terrestrial Time), the conventional uniform time system referenced to the center of the earth.

The reference time used for MET is midnight (0h:0m:0s) on January 1, 2001, in Coordinated Universal Time (UTC), another time system. UTC includes occasional leap seconds to keep time to within 0.9 s of UT1 (Universal Time 1), the time system based on the rotation of the earth; UT1 varies as a result of changes in earth's rotation rate.

For timing analyses of celestial sources, TT is preferable to UTC because it does not require accounting for leap seconds. On the other hand, UTC is preferred by the MOC. Therefore, the GLAST ground system has decided that commands and other data products that the MOC will handle will use UTC, while the science data products will use TT. Consequently, TT has been adopted as the time system for the data products described in this document. Time is represented in the data as a double precision offset in seconds—MET—from a fiducial time that is presented in the header. The same fiducial time—a date given by MJDREF keywords—will be used by all science data products for both the GBM and the LAT. The GLAST convention is that MJDREF=51910 (UTC)=51910.0007428703703703703 (TT); the fractional part of MJDREF in the TT system compensates for the use of midnight in the UTC system as the reference time. We break MJDREF into two keywords: MJDREFI=51910, the integer part; and MJDREFF=7.428703703703703D-4, the fractional part. In addition, the SC clock drift for data obtained during periods when the GPS time signal is not available from the SC can also be specified.

The software developed for the analysis of GBM and LAT data should include a tool to transform TT into UTC as needed, by adding leap seconds as appropriate, for

comparison with contemporaneous ground-based observations. This is not likely to be critical, however, for AGN, for which the shortest time scales that the LAT will be able to detect significant changes of flux will be minutes, but will be necessary for comparing observations of GRBs.

We follow the FITS convention whereby the DATE keyword, giving the date a file was created, is in the UTC system, while all other times (e.g., DATE-OBS and DATE-END) are governed by TIMESYS and MJDREF, as applicable. Since we use TIMESYS='TT' throughout, DATE-OBS and DATE-END are in the TT system.

4.3. Representation of Spacecraft Position and Orientation

The LAT and GBM position history files (LS-005 and GS-006, respectively) use different spacecraft position, orientation and velocity systems; see the relevant file definitions.

4.4. File Names

1. Files should have unique, human-readable names; newer versions of a data product should be distinguishable from earlier versions by the file name. The identity of a file may not depend on its position within the directory structure, although a file's name should allow it to be placed into such a system.
2. The allowed characters are the letters a-z, the numbers 0–9, and separators '.' and '_'; note that filenames are lower case. (These limitations are for consistency with ISO 9660 Level 2 specifications.)
3. File names should start with 'gl' and include (in order, as necessary):
   i. The logical instrument: g (GBM), l (LAT), s (spacecraft);
   ii. Identifier for the data type, such as 'tte' for time tagged events;
   iii. GBM detectors are identified by 'n' (NaI) or 'b' (BGO) followed by a single digit—hexadecimal is used for the 12 NaI detectors; if a file applies to all detectors, 'all' is included in the filename;
   iv. Identifier such as burst 'bnyymmddfff', where yymmdd signifies the day and fff the fraction of day;
   v. Identifier for the contact number for that day (c#), for data products that will be produced once per data downlink;
   vi. Version number, such as v03, starting with 00; and
   vii. Three-character format type as file extension, e.g., .fit for FITS file.

An example of a GBM burst filename is glg_tte_n1_bn080109123_v03.fit, the 3rd version of a FITS file with TTE data from the GBM's NaI detector #1 for burst bn080109123.

An example of a daily GBM filename is glg_cspec_n0_070605_v01.pha, the 1st version of a FITS file with CSPEC spectra from the GBM's NaI detector #0 for June 5, 2007. An example of a LAT filename is gll_pt_090615_c3_v01.fit, the 1st version of the FITS file with pointing and time data from the 3rd pass of June 15, 2009.

4.5. FITS Headers

The headers of FITS files provide the metadata necessary for the interpretation of the contents of the files. Every FITS file has a so-called primary header-data unit (HDU) followed by any number of extension header-data units. The FITS standard allows duplication of metadata between primary and extension headers. Originally we planned to minimize repetition between headers to make the files easier to maintain. However, many tools do not read the primary header and use the extension headers exclusively. Therefore the GLAST convention is that primary header will be a complete description identifying the file and how it was created (i.e., including information about processing the data such as the software, processing date, input files, etc.), headers for extensions with the core data (e.g., count rates, events) will have complete information about the data (e.g., time range, source, detectors), while ancillary extensions (e.g., EBOUNDS, GTI) will have stripped down headers.

The following information should be in one of the headers:

1. The name and version number of the software used to produce the data product (CREATOR keyword, HEASARC FITS Working Group Recommendation R7);

2. Sufficient information to identify the mission (TELESCOP keyword) and instrument (INSTRUME keyword).

3. OGIP HDU keywords (HEASARC FITS Working Group Recommendation R8), to the extent practical;

4. The data's maximum (TLMAXx keyword) and minimum (TLMINx keyword) values in definitions of columns in the binary table extensions (HEASARC FITS Working Group Recommendation R6);

5. The units of the quantities (TUNITx keyword) following OGIP recommendations for the units of physical quantities (OGIP Memo OGIP/93-001);

6. The date that the data product was created (DATE keyword) in YYYY-MM-DD format. Multiple representations of the data's time range (e.g., the beginning and end time of the observations in the data product) can be used in the headers (e.g., both as a date and as MET);

7. CHECKSUM and DATASUM keywords for verification of file integrity (Seaman & Pence 1995), in each header. CHECKSUM is the checksum for the entire HDU (i.e., the ASCII header and the data tables) and DATASUM is the checksum just for the data tables.

4.6. GLAST-Specific Keywords and Usages

The following are a number of GLAST-specific keywords or usages.

DATATYPE—GBM keyword based on BATSE usage. This keyword identifies a data class, such as CTIME, CSPEC or TTE.

DETNAM—Not used for the LAT. For the GBM the detector name is either NAI_xx, where xx is 00 to 11, or BGO_xx, where xx is 00 or 01

FILETYPE—GBM keyword based on BATSE usage. This keyword identifies some standard types of files, such as PHA spectrum files. The following are the GLAST-relevant values:

FILETYPE Keyword	**Purpose**
SPECTRAL FITS	RMFIT spectral history; GBM Catalog entry
GBM SPEC HIST	GBM gain and resolution history file
GBM PHOTON LIST	GBM TTE data file
TRIGGER ENTRY	GBM Trigger catalog entry
GBM DRM	GBM-produced RSPII file (file with multiple detector response matrices)
GBM BACK	GBM-produced .bak PHA file (PHA file that can be used as a background)
TRIGDAT	GBM burst alert data file
SPECTRUM	Generic PHA file
PHAII	Generic PHAII file (file with multiple spectra)

INSTRUME—'LAT' or 'GBM'

TELESCOP—'GLAST'

5. Summary of the Data Products and Their Delivery Schedule

The tables below are organized by the sources of the relevant data and their delivery schedule. The data products are identified by 2 letters—the first indicating the ground system element producing the data product, the second the element receiving the data—and then by a number. 'g' denotes the GIOC, 'l' the LISOC and 's' the (G)SSC.

5.1. Data Products Originating in the GIOC

The GIOC will transfer three categories of data products: daily, burst and updates.

The daily data products consist of data that are produced continuously regardless of whether a burst occurred. Thus these products are the count rates from all detectors, the monitoring of the detector calibrations (e.g., the position of the 511 keV line), and the spacecraft position and orientation. The underlying Level 0 data arrive continuously with each Ku band downlink. However, the GIOC will form FITS files of the resulting Level 1 data covering an entire calendar day (UT); these daily files are then sent to the GSSC. Consequently, the data latency is about one day: the first bit from the beginning of a calendar day may arrive a few hours after the day began while the last bit will be processed and added to the data product file a few hours after the day ended. These data products may be sent to the GSSC as they are produced, not necessarily in one package for a given day.

Table 5-1: GIOC Daily Data Products

ICD ID	Product	Description	Number of Files per Day	Latency	Size (bytes)	Level
GS-001	CTIME (daily version)	The counts accumulated every 0.256 s in 8 energy channels for each of the 14 detectors.	14	24 hours after receipt of last input data	230 MB (16 MB /file)	1
GS-002	CSPEC (daily version)	The counts accumulated every 8.192 s in 1288 energy channels for each of the 14 detectors.	14	24 hours after receipt of last input data	290 MB (20.6MB /file)	1
GS-005	GBM gain and energy resolution history	History of the detector gains and energy resolutions; required for calculating DRMs.	14	24 hours after receipt of last input data	42kB (3kB/ file)	1
GS-006	GLAST position and attitude history	History of GLAST's position and attitude, required for calculating DRMs	1	24 hours after receipt of last input data	3MB	1

The burst data products are the files pertaining to a given burst that are produced and sent to the GSSC within a day after the burst. These include lists of counts, binned counts, and the response and background spectra necessary to analyze the burst data. The burst products also include catalog files with summary data resulting from pipeline processing and a file with the TRIGDAT messages sent down over TDRSS immediately after a burst.

Table 5-2: GIOC Burst Data Products

ICD ID	Product	Description	Number of Files per Burst	Latency	Size (bytes)	Level
GS-101	CTIME (burst version)	For each detector, the counts accumulated every 0.256 s in 8 energy channels	14	1 day	16MB (1.15 MB /file)	1
GS-102	CSPEC (burst version)	For each detector, the counts accumulated every 8.192 s in 128 energy channels	14	1 day	16MB (1.15 MB /file)	1
GS-103	GBM TTE	Event data for the burst	14	1 day	40-60MB (3-4.5 MB /file	1
GS-104	GBM DRMs	8 and 128 energy channel DRMs for all 14 detectors	28	1 day	6 MB (0.4 MB /file)	1
GS-105 (non-burst trigger)	GBM Trigger Catalog Entry	Classification of GBM trigger with some characteristics	1	1 day, updated periodically	20 kB	1
GS-106 (burst trigger)	GBM Burst or Spectral Catalog Entry	Values of the quantities describing the burst (e.g., durations, fluences)	1	1 day, updated periodically	100-200 kB	1
GS-107	GBM TRIGDAT	All the GBM's messages downlinked through TDRSS	1	1 day	50-100 kB	1
GS-108	GBM Background Files	Backgrounds for spectral fitting	14	1 day	14kB (1kB /file)	1

The final category of GIOC data products are those that are updated and sent to the GSSC periodically as required by new analysis. These include calibrations that either do not change with time or change slowly. The catalogs—trigger, burst and spectral—are in this category. A preliminary version of the burst catalog file is distributed with the other burst data, while a number of updates will be provided subsequently as the data are reanalyzed, often with human intervention.

Table 5-3: GIOC Data Products Delivered as Updates						
ICD ID	Product	Description	Number of Files	Frequency	Size (bytes)	Level
GS-007	GBM PHA Look-Up Tables	Tables of the correspondence between CTIME and CSPEC energy channels and the photopeak energy for each detector	4	Every ~6 months	4kB (1kB/ file)	1
GS-008	GBM Calibration	Tables of fiducial detector response parameters from which the burst-specific DRMs are calculated	TBD	Every ~6 months	100GB	1
GS-105 (non-burst trigger)	GBM Trigger Catalog Entry	Classification of GBM trigger with some characteristics	1	Updated periodically after initial file	20 kB	2
GS-106 (burst trigger)	GBM Burst or Spectral Catalog Entry	Values of the quantities describing the burst (e.g., durations, fluences)	1	Updated periodically	100-200 kB	2

5.2. Data Products Originating in the LISOC

The LISOC will process the Level 0 data after each Ku band downlink, and send the resulting event and spacecraft position files to the GSSC.

Table 5-4: LISOC Data Products Delivered After Each Pass						
ICD ID	Product	Description	Delivered	Latency	Size (bytes)	Level
LS-001	LAT Events	Subset of merit n-tuple for subset of the events telemetered to the ground	Per Ku downlink (~6-8 per day)	1 day	250 MB	1
LS-002	LAT photons	Selected parameters from the subset of events identified as gamma-ray photons	Per Ku downlink (~6-8 per day)	1 day	25 M	1
LS-005	LAT Pointing and Livetime History	LAT orientation and mode at 30 s intervals; used to calculate exposures	Per Ku downlink (~6-8 per day)	1 day	100 kB	1

Weekly the LISOC will send the GSSC a file describing the state of the LAT such as the number of dead Si strips per TKR tower—to provide the GSSC insight into the performance of the LAT. Note that the LISOC will also provide the GSSC with files necessary for running the Level 1 pipeline. These files are not FITS files and the GSSC

need not have an understanding of their content; consequently, these files are not described here.

Table 5-5: LISOC Data Products Delivered Weekly

ICD ID	Product	Description	Delivered	Latency	Size (bytes)	Level
LS-006	LAT Configuration history	Detailed LAT configuration history, all registers of each subsystem as updated	On update	12 hours	1 M	1

Finally, the LISOC will provide other data products from time to time, as needed. These additional products include new response functions, an updated model of the diffuse emission model and catalogs.

Table 5-6: LISOC Data Products Delivered As Updates

ICD ID	Product	Description	Delivered	Freq.	Size (bytes)	Level
LS-007	LAT Transient Data	Summary information for transient sources (GRBs, solar flares, and AGN flares) derived from LAT event data	Per transient	8 hours	100 kB	2
LS-008	LAT Point Source Catalog	Table of detected gamma-ray sources with derived information	On update	N/A	10 MB	3
LS-009	LAT Burst Catalog	List and characterization of gamma-ray bursts: location, duration, intensity	On update	N/A	TBD	3
LS-010	Interstellar Emission Model	Model for diffuse gamma-ray emission from the Milky Way, input for high-level data analysis; will be refined using GLAST data	On update	N/A	40 MB	Ancillary
LS-011	LAT Energy Redistribution	Constants for parameterization of the LAT's energy redistribution	On update	N/A	12kB (12kB/ file)	1
LS-012	LAT Effective Area	Constants for parameterization of the LAT's effective area	On update	N/A	120kB (~30kB/ file)	1
LS-013	LAT PSF	Constants for parameterization of the LAT's point spread function	On update	N/A	64kB (17kB/ file)	1

5.3. Data Products Originating in the GSSC

The GSSC will collect the ephemerides of the pulsars that might be observable by the LAT; besides maintaining and using the resulting data product, the GSSC will send a copy to the LISOC for use by the LAT team.

Table 5-7: GSSC Data Products

ICD ID	Product	Description	Created	Production Latency	Size
SS-002	Pulsar Ephemerides	Ephemerides of pulsars that may be detectable by the LAT	Periodically	N/A	TBD

6. Detailed Descriptions of the Data Products

Descriptions of the data products are given below. The purpose of each data product is provided along with a summary of salient details. Then the headers for the primary HDU and subsequent extensions are defined; the definitions are followed by an example.

6.1. GS-001 CTIME (Daily Version)

Version: 2.0

Revision date: 4/7/06

Product Description:
The CTIME data type provides the counts accumulated by each detector over 0.256 s (typical) binned into 8 energy channels. This data type is produced and telemetered to the ground continuously regardless whether a burst has occurred. The GIOC bundles these data into one PHAII FITS file per detector per day. Therefore, this file has a standard OGIP PHAII format. The 'Spectrum' extension does NOT include a SPEC_NUM column because the row number is the spectrum number, and including this number would just waste space. Deleting this column will not affect software that uses PHAII files.

Naming Convention	glg_ctime_wz_yymmdd_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 day	
Number of deliveries per day	1	
Number of files per delivery	1 file for each data type for each detector = 14 files per delivery	
Typical size	230 MB for CTIME (16 MB X 14 detectors)	

Product Content

Header		
Extension 1 Name	EBOUNDS	Definition of the channel energy grid
Extension 2 Name	SPECTRUM	The counts spectra
Extension 3 Name	GTI	The time ranges of valid data

GS-001 Primary Header Keywords

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘name’	Software and version creating file
FILETYPE	‘PHAII’	The file format is OGIP PHAII which contains multiple spectra.
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	‘yyyy-mm-ddThh:nn:ss.ss’	Date file was created
ORIGIN	‘GIOC’	Files are created by the GIOC
DATE-OBS	‘yyyy-mm-ddThh:nn:ss.ss’	Time of start of observation, same format as DATE
DATE-END	‘yyyy-mm-ddThh:nn:ss.ss’	Time of end of observation, same format as DATE
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation’s start time relative to MJDREF, double precision
TSTOP		Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
FILENAME	‘glg_ctime_wz_yymmdd_vxx.pha’	Name of this file w = ‘n’ or ‘b’ for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number
INFILE0X	‘name’	File(s) used to create this FITS file X = the file number
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘XXX_YY’	Individual detector name XXX = ‘NAI’ or ‘BGO’ YY = 00 to 11
DATATYPE	‘CTIME’	Name of the primary datatype making up this file
OBSERVER	‘Meegan’	Name of instrument PI
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘GBM_PACKET_HANDLER_V1.0’	Software and version creating file
FILETYPE	‘PHAII’	Name for this type of FITS file (should be unique)

FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	‘2007-06-06T02:25:45’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time relative to MJDREF, double precision
TSTOP	3.455752119D7	Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
FILENAME	‘glg_ctime_n0_07156_v01.pha’	Name of this file
INFILE01	‘pkt_20071552318_vc09_ctime.0’	File(s) used to create this FITS file
INFILE02	‘pkt_20071552313_vc09_ghk.0’	File(s) used to create this FITS file
INFILE03	‘pkt_20071560716_vc09_ctime.0’	File(s) used to create this FITS file
INFILE04	‘pkt_20071561714_vc09_ghk.0’	File(s) used to create this FITS file
INFILE05	‘pkt_20071561605_vc09_ctime.0’	File(s) used to create this FITS file
INFILE06	‘pkt_20071561614_vc09_ghk.0’	File(s) used to create this FITS file
INFILE07	‘pkt_20071562216_vc09_ctime.0’	File(s) used to create this FITS file
INFILE08	‘pkt_20071562214_vc09_ghk.0’	File(s) used to create this FITS file
INFILE09	‘pkt_20071570223_vc09_ctime.0’	File(s) used to create this FITS file
INFILE10	‘pkt_20071570205_vc09_ghk.0’	File(s) used to create this FITS file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
DATATYPE	‘CTIME’	Name of the primary datatype making up this file
OBSERVER	‘Meegan’	Name of instrument PI
END		End of Header

GS-001 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	8	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TELESCOP	'GLAST'	Name of mission / spacecraft
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
INSTRUME	'GBM'	Name of instrument generating data
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	8	CTIME has 8 energy channels
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files
HDUCLAS2	'EBOUNDS'	From CAL/GEN/92-002
TFIELDS	3	Number of fields per row
TFORM1	'1I '	2 byte Integer
TTYPE1	'CHANNEL'	Detector channel number

TUNIT1	‘ ’		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for channel
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for channel
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
END			

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	8	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T10:15:23’	Date file was created
FILTER	‘none‘	Not applicable to GBM
DETNAM	‘NAI_00’	Individual detector name
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘EBOUNDS’	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	‘PHA’	No corrections have been applied
DETCHANS	8	Total number of channels in each rate

HDUCLASS	'OGIP'		
HDUVERS	'1.2.0'		
HDUCLAS1	'RESPONSE'		Typically found in RMF files
HDUCLAS2	'EBOUNDS'		From CAL/GEN/92-002
TFIELDS	3		Number of fields per row
TFORM1	'1I '		2 byte Integer
TTYPE1	'CHANNEL'		Detector channel number
TUNIT1	' '		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	'1E '		Single precision floating point
TTYPE3	'E_MAX'		High energy bound for row
TUNIT3	'keV'		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-001 Extension Header 2

Name: SPECTRUM

Purpose: Provides the counts in each channel for each spectrum.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of rows is the number of spectra
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'SPECTRUM'	XSPEC-compatible PHAII extension that contains spectra
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	No instrument filter used
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Spectra are not linked to a background file
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Spectra are not linked to a correction file
CORRSCAL	1.	Correction scaling file
RESPFILE	'none'	Spectra are not linked to an RMF file
ANCRFILE	'none'	Spectra are not linked to an ARF file
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
GROUPING	0	No special grouping has been applied
HDUCLASS	'OGIP'	

HDUCLAS1	'SPECTRUM'		
HDUCLAS2	'TOTAL'		Indicates source + background
HDUCLAS3	'COUNT'		Indicates PHA data stored as counts
HDUVERS	'1.2.1'		
CHANTYPE	'PHA'		PHA channels from the telemetry
DETCHANS		8	CTIME has 8 energy channels
EXTVER		1	Version of this extension format
TFIELDS		5	Number of fields per row; each row is a new spectrum
TFORM1	'8I '		16 bit integers by channel
TSCAL1	1		To convert from signed to unsigned integers data = COUNTS*TSCAL2+TZERO2
TZERO1	32768		Actual zero of physical data
TTYPE1	'COUNTS'		Counts in the time-energy bin
TUNIT1	'count'		Units of field
TFORM2	'1E'		
TTYPE2	'EXPOSURE'		Total livetime in this time interval
TUNIT2	's'		Seconds
TLMIN2		0.	Exposure is non-negative
TLMAX2		2.e5	2 days
TFORM3	'1I '		
TTYPE3	'QUALITY'		Quality flag for entire spectrum
TFORM4	'1D'		Double precision
TTYPE4	'TIME'		Start time relative to MJDREF
TUNIT4	's'		Seconds
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time relative to MJDREF
TUNIT5	's'		Seconds
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF
END			

Example:

FITS Keyword	Value		Purpose
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel – assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1	(computed value)		Number of bytes per row
NAXIS2		####	Number of spectral accumulation records
PCOUNT		0	No extra bits in table
GCOUNT		1	No multiplier
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	'SPECTRUM'		Corresponds to XSPEC-compatible PHAII

TELESCOP	'GLAST'	Name of telescope generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2007-06-08T01:12:17.06'	Date file was created
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455752119D7	Observation's stop time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Name of corresponding background file (if any)
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Name of corresponding correction file (if any)
CORRSCAL	1.	Correction scaling file
RESPFILE	'none'	Name of corresponding RMF file (if any)
ANCRFILE	'none'	Name of corresponding ARF file (if any)
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
GROUPING	0	No special grouping has been applied
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUVERS	'1.2.1'	
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	8	Total number of channels in each rate
EXTVER	1	Version of this extension format
TFIELDS	5	Number of fields per row
TFORM1	'8I '	16 bit integers by channel
TSCAL1	1	data = COUNTS*TSCAL2+TZERO2
TZERO1	32768	Actual zero of physical data
TTYPE1	'COUNTS'	Counts in the accumulation interval
TUNIT1	'count'	Units of field
TFORM2	'1E'	
TTYPE2	'EXPOSURE'	Total livetime
TUNIT2	's'	Seconds
TLMIN2	0.	Exposure is non-negative
TLMAX2	2.e5	2 days
TFORM3	'1I '	
TTYPE3	'QUALITY'	Quality flag for entire spectrum

TFORM4	'1D'		Double precision
TTYPE4	'TIME'		Start time relative to MJDREF
TUNIT4	's'		Seconds
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time relative to MJDREF
TUNIT5	's'		Seconds
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF

END

GS-001 Extension Header 3

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	XSPEC-compatible PHAII extension providing time range of usable data
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EXTVER	1	Assigned by template parser
TFORM1	'1D'	Double precision
TTYPE1	'START'	Start time of GTI interval relative to MJDREF
TUNIT1	's'	Seconds
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF

TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval relative to MJDREF
TUNIT2	‘s’	Seconds
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘GTI’	Corresponds to XSPEC-compatible PHAII
TELESCOP	‘GLAST’	Name of telescope generating data
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T01:12:23’	Date file was created
HDUCLASS	‘OGIP’	OGIP standard
HDUCLAS1	‘GTI’	Contains Good Time Intervals
HDUVERS	‘1.2.0’	File format version
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	1.23456789011e7	Observation start time relative to MJDREF
TSTOP	1.23456789011e7	Observation stop time relative to MJDREF
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
EXTVER	1	Assigned by template parser
TFORM1	‘1D’	Double precision
TTYPE1	‘START’	Start time of GTI interval relative to MJDREF
TUNIT1	‘s’	Seconds
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval relative to MJDREF

```
TUNIT2          's'                     Seconds
TLMIN2                                  0. MJDREF will be before launch
TLMAX2                                1.5D9 47 years after MJDREF

END
```

6.2. GS-002 CSPEC (Daily Version)

Version: 2.0

Revision date: 4/7/06

Product Description:
The CSPEC data type provides the counts accumulated by each detector over 8.192 s binned into 128 energy channels. This data type is produced and telemetered to the ground continuously regardless whether a burst has occurred. The GIOC bundles these data into one PHAII FITS file per detector per day. Therefore, this file has a standard OGIP PHAII format. The 'Spectrum' extension does NOT include a SPEC_NUM column because the row number is the spectrum number, and including this number would just waste space. Deleting this column will not affect software that uses PHAII files.

Naming Convention	glg_cspec_wz_yymmdd_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 day	
Number of deliveries per day	Average of 1	
Typical size	290 MB per day (20.6 MB X 14 detectors)	

Product Content

Header		
Extension 1 Name	EBOUNDS	Definition of the channel energy grid
Extension 2 Name	SPECTRUM	The counts spectra
Extension 3 Name	GTI	The time ranges of valid data

GS-002 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'name'	Software and version creating file
FILETYPE	'PHAII'	The file format is OGIP PHAII which contains multiple spectra.
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
ORIGIN	'GIOC'	Files are created by the GIOC
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation, same format as DATE
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_cspec_wz_yymmdd_vxx.pha'	Name of this file w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
DATATYPE	'CSPEC'	Name of the primary datatype making up this file
OBSERVER	'Meegan'	Name of instrument PI
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_PACKET_HANDLER_V1.0'	Software and version creating file
FILETYPE	'PHAII'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entireHDU

DATASUM	(computed value)	Checksum for data table
DATE	‘2007-06-06T02:25:05’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-06T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation’s start time relative to MJDREF, double precision
TSTOP		Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
FILENAME	‘glg_cspec_n0_070605_v01.pha’	Name of this file
INFILE01	‘pkt_20071552318_vc09_cspec.0’	File(s) used to create this FITS file
INFILE02	‘pkt_20071552313_vc09_ghk.0’	File(s) used to create this FITS file
INFILE03	‘pkt_20071560716_vc09_cspec.0’	File(s) used to create this FITS file
INFILE04	‘pkt_20071561714_vc09_ghk.0’	File(s) used to create this FITS file
INFILE05	‘pkt_20071561605_vc09_cspec.0’	File(s) used to create this FITS file
INFILE06	‘pkt_20071561614_vc09_ghk.0’	File(s) used to create this FITS file
INFILE07	‘pkt_20071562216_vc09_cspec.0’	File(s) used to create this FITS file
INFILE08	‘pkt_20071562214_vc09_ghk.0’	File(s) used to create this FITS file
INFILE09	‘pkt_20071570223_vc09_cspec.0’	File(s) used to create this FITS file
INFILE10	‘pkt_20071570205_vc09_ghk.0’	File(s) used to create this FITS file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
DATATYPE	‘CSPEC’	Name of the primary datatype making up this file
OBSERVER	‘Meegan’	Name of instrument PI
END		End of Header

GS-002 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	CSPEC has 128 energy channels
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files
HDUCLAS2	'EBOUNDS'	From CAL/GEN/92-002
TFIELDS	3	Number of fields per row
TFORM1	'1I '	2 byte Integer
TTYPE1	'CHANNEL'	Detector channel number
TUNIT1	' '	

TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for channel
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for channel
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
END			

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T02:15:23’	Date file was created
FILTER	‘none‘	Not applicable to GBM
DETNAM	‘NAI_00’	Individual detector name
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘EBOUNDS’	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	‘PHA’	No corrections have been applied
DETCHANS	128	Total number of channels in each rate

HDUCLASS	'OGIP'		
HDUVERS	'1.2.0'		
HDUCLAS1	'RESPONSE'		Typically found in RMF files
HDUCLAS2	'EBOUNDS'		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	'1I '		2 byte Integer
TTYPE1	'CHANNEL'		Detector channel number
TUNIT1	' '		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	'1E '		Single precision floating point
TTYPE3	'E_MAX'		High energy bound for row
TUNIT3	'keV'		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-002 Extension Header 2

Name: SPECTRUM

Purpose: Provides the counts in each channel for each spectrum

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of rows is the number of spectra
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'SPECTRUM'	XSPEC-compatible PHAII extension that contains spectra
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	No instrument filter used
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Spectra are not linked to a background file
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Spectra are not linked to a correction file
CORRSCAL	1.	Correction scaling file
RESPFILE	'none'	Spectra are not linked to an RMF file
ANCRFILE	'none'	Spectra are not linked to an ARF file
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
GROUPING	0	No special grouping has been applied
HDUCLASS	'OGIP'	

HDUCLAS1	'SPECTRUM'		
HDUCLAS2	'TOTAL'		Indicates source + background
HDUCLAS3	'COUNT'		Indicates PHA data stored as counts
HDUVERS	'1.2.1'		
CHANTYPE	'PHA'		PHA channels from the telemetry
DETCHANS		128	CSPEC has 128 energy channels
EXTVER		1	Version of this extension format
TFIELDS		5	Number of fields per row; each row is a new spectrum
TFORM1	'128I '		16 bit integers by channel
TSCAL1	1		To convert from signed to unsigned integers data = COUNTS*TSCAL2+TZERO2
TZERO1	32768		Actual zero of physical data
TTYPE1	'COUNTS'		Counts in the accumulation interval
TUNIT1	'count'		Units of field
TFORM2	'1E'		
TTYPE2	'EXPOSURE'		Total livetime
TUNIT2	's'		Seconds
TLMIN2		0.	Exposure is non-negative
TLMAX2		2.e5	2 days
TFORM3	'1I '		
TTYPE3	'QUALITY'		Quality flag for entire spectrum
TFORM4	'1D'		Double precision
TTYPE4	'TIME'		Start time relative to MJDREF
TUNIT4	's'		Seconds
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time relative to MJDREF
TUNIT5	's'		Seconds
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF
END			

Example:

FITS Keyword	Value		Purpose
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel – assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1	(computed value)		Number of bytes per row
NAXIS2		####	Number of spectral accumulation records
PCOUNT		0	No extra bits in table
GCOUNT		1	No multiplier
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	'SPECTRUM'		Corresponds to XSPEC-compatible PHAII

TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2007-06-08T01:15:23'	Date file was created
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455752119D7	Observation's stop time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Name of corresponding background file (if any)
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Name of corresponding correction file (if any)
CORRSCAL	1.	Correction scaling file
RESPFILE	'none'	Name of corresponding RMF file (if any)
ANCRFILE	'none'	Name of corresponding ARF file (if any)
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
GROUPING	0	No special grouping has been applied
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUVERS	'1.2.1'	
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	Total number of channels in each rate
EXTVER	1	Version of this extension format
TFIELDS	5	Number of fields per row
TFORM1	'128I '	16 bit integers by channel
TSCAL1	1	data = COUNTS*TSCAL2+TZERO2
TZERO1	32768	Actual zero of physical data
TTYPE1	'COUNTS'	Counts in the accumulation interval
TUNIT1	'count'	Units of field
TFORM2	'1E'	
TTYPE2	'EXPOSURE'	Total livetime
TUNIT2	's'	Seconds
TLMIN2	0.	Exposure is non-negative
TLMAX2	2.e5	2 days
TFORM3	'1I '	
TTYPE3	'QUALITY'	Quality flag for entire spectrum

TFORM4	‘1D’		Double precision
TTYPE4	‘TIME’		Start time relative to MJDREF
TUNIT4	‘s’		Seconds
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	‘1D’		Double precision
TTYPE5	‘ENDTIME’		Stop time relative to MJDREF
TUNIT5	‘s’		Seconds
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF

END

GS-002 Extension Header 3

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	XSPEC-compatible PHAII extension providing time range of usable data
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EXTVER	1	Assigned by template parser
TFORM1	'1D'	Double precision
TTYPE1	'START'	Start time of GTI interval
TUNIT1	's'	Seconds
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF

TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval
TUNIT2	‘s’	Seconds
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘GTI’	Corresponds to XSPEC-compatible PHAII
TELESCOP	‘GLAST’	Name of telescope generating data
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T01:15:23’	Date file was created
HDUCLASS	‘OGIP’	OGIP standard
HDUCLAS1	‘GTI’	Contains Good Time Intervals
HDUVERS	‘1.2.0’	File format version
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	1.23456789011e7	Observation start time relative to MJDREF
TSTOP	1.23456789011e7	Observation stop time relative to MJDREF
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
EXTVER	1	Assigned by template parser
TFORM1	‘1D’	Double precision
TTYPE1	‘START’	Start time of GTI interval
TUNIT1	‘s’	Seconds
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval
TUNIT2	‘s’	Seconds
TLMIN2	0.	MJDREF will be before launch

TLMAX2 1.5D9 47 years after MJDREF

END

6.3. GS-005 GBM Gain and Energy Resolution History

Version: 2.0

Revision date: 4/7/06

Product Description:
This file contains the time history of GBM detector calibrations (the gains of the detectors and their energy resolutions) that are required for calculating the DRMs. These time histories are produced daily for each of the 14 detectors

Naming Convention	glg_spechist_wx_yymmdd_vzz.fit	w—N or B, depending on the detector type x—hexadecimal detector number, 0-B yymmdd—date covered by file zz—version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 day	
Number of deliveries per day	1	
Typical size	42 kB (3 kB X 14 detectors)	

Product Content

Header:	
Extension 1 Name	GBM SPEC HIST

GS-005 Primary Header Keywords

Definitions:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_SPECHIST_V1.0'	Software and version creating file
FILETYPE	'GBM SPEC HIST'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation, same format as DATE
FILENAME	'glg_spechist_wx_yymmdd_vzz.fit'	Name of this file: w—n or b, depending on the detector type x—hexadecimal detector number, 0-b yymmdd—date covered by file zz—version number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'DET_GAIN'	Dataset contains the gain of the detector
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CDES0001	'Spectral gain history for NAI_00'	A string giving a brief description of this dataset
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard

BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘GBM_SPECHIST_V1.0’	Software and version creating file
FILETYPE	‘GBM SPEC HIST’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	‘2007-06-07T‘12:02:17.06’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
FILENAME	‘glg_spechist_n0_20042150_v01.fit’	Name of this file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
CCLS0001	‘BCF’	Dataset is a Basic Calibration File
CTTP0001	‘DATA’	Dataset contains calibration data
CCNM0001	‘DET_GAIN’	Dataset contains the gain of the detector
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CDES0001	‘Spectral gain history for NAI_00’	A string giving a brief description of this dataset
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455762919D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
INFILE01	‘PKT_20042150123_VC09_CSPEC.0’	File(s) used to create this FITS file
END		End of Header

GS-005 Extension Header 1

Name: GBM SPEC HIST

Purpose: Provides the history of the gain of a single detector by providing the fit to a calibration line (usually the 511 keV line) and the background spectrum over the time range of the fit.

Definitions:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
LO_CHAN		Beginning channel of background
HI_CHAN		Ending channel of background
LINE_NRG		Energy of fitted line (keV)
DOF		Number of degrees of freedom
TARGET_T		Target accumulation time for spectra (s)
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GBM SPEC HIST'	Unique name for this extension type
EXTVER	1	Version of this extension format
DETCHANS	128	Total number of channels in each rate
ALGORTHM	'GaussFit_v01'	Name and version of line-fitting routine
BKGD_FNC	'a + b x'	Specifies background model used
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'DET_GAIN'	Dataset contains the gain of the detector
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should

			be first used
CVST0001	hh:mm:ss		UTC Time when this calibration data should be first used
CDES0001	‘Spectral gain history for XXX_YY’		A string giving a brief description of this dataset XXX = ‘NAI’ or ‘BGO’ YY = 00 to 11
TFIELDS	11		Number of fields per row
TFORM1	‘1E ‘		Single precision floating point
TTYPE1	‘LINECENT’		Channel number of calibration line centroid
TUNIT1	‘ ’		
TLMIN1		0.	Channel numbers are non-negative
TLMAX1		130.	Beyond maximum number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘LINE_WID’		Width in channels of the calibration line
TUNIT2	‘ ’		
TLMIN2		0.	Channel numbers are non-negative
TLMAX2		130.	Beyond maximum number of channels
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘LINE_AMP’		Amplitude of the calibration line
TUNIT3	‘count’		
TLMIN3		0.	Count numbers are non-negative
TLMAX3		1.e9	
TFORM4	‘1E ‘		Single precision floating point
TTYPE4	‘ERR_CENT’		Uncertainty in the channel number of calibration line centroid
TUNIT4	‘ ’		
TLMIN4		0.	Uncertainties are non-negative
TLMAX4		130.	Beyond maximum number of channels
TFORM5	‘1E ‘		Single precision floating point
TTYPE5	‘ERR_WID’		Uncertainty in the width in channels of the calibration line
TUNIT5	‘ ’		
TLMIN1		0.	Uncertainties are non-negative
TLMAX1		130.	Beyond maximum number of channels
TFORM6	‘1E ‘		Single precision floating point
TTYPE6	‘ERR_AMP’		Uncertainty in the amplitude of the calibration line
TUNIT6	‘count’		
TLMIN6		0.	Uncertainties are non-negative
TLMAX6		1.e9	
TFORM7	‘1D ‘		Double precision floating point
TTYPE7	‘START’		Start time of spectral accumulation relative to MJDREF
TUNIT7	‘s’		Seconds
TLMIN7		0.	MJDREF will be before launch
TLMAX7		1.5D9	47 years after MJDREF

TFORM8	‘1D ‘	Double precision floating point
TTYPE8	‘STOP’	Stop time of spectral accumulation relative to MJDREF
TUNIT8	‘s’	Seconds
TLMIN8	0.	MJDREF will be before launch
TLMAX8	1.5D9	47 years after MJDREF
TFORM9	‘1J ‘	Double precision integer
TTYPE9	‘NUM_REC	Sequence number of beginning record
TUNIT9	‘ ’	
TFORM10	‘1E ‘	Single precision floating point
TTYPE10	‘CHI_SQ’	Goodness of fit
TUNIT10	‘ ’	
TLMIN10	0.	Chi-sq is non-negative
TLMAX10	1.e9	
TFORM11	‘PE(####)’	Variable-length array of single precision floating point
TTYPE11	‘BKGD_MDL	Background Model Parameters
TUNIT11	‘ ‘	

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T02:16:26’	Date file was created
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455851919D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
LO_CHAN	65	Beginning channel of background
HI_CHAN	105	Ending channel of background
LINE_NRG	511.	Energy of fitted line (keV)
DOF	35	Number of degrees of freedom

TARGET_T		3000	Target accumulation time for spectra (s)
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	‘GBM SPEC HIST’		Unique name for this extension type
EXTVER		1	Version of this extension format
DETCHANS	128		Total number of channels in each rate
ALGORTHM	‘GaussFit_v01’		Name and version of line-fitting routine
BKGD_FNC	‘a + b x’		Specifies background model used
CCLS0001	‘BCF’		Dataset is a Basic Calibration File
CTTP0001	‘DATA’		Dataset contains calibration data
CCNM0001	‘DET_GAIN’		Dataset contains the gain of the detector
CVSD0001	yyyy-mm-dd		UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss		UTC Time when this calibration data should be first used
CDES0001	‘Spectral gain history for NAI_00’		A string giving a brief description of this dataset
TFIELDS	11		Number of fields per row
TFORM1	‘1E ‘		Single precision floating point
TTYPE1	‘LINECENT’		Line centroid channel number
TUNIT1	‘ ‘		
TLMIN1		0.	Channel numbers are non-negative
TLMAX1		130.	Beyond maximum number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘LINE_WID’		Line centroid channel width
TUNIT2	‘ ‘		
TLMIN2		0.	Channel numbers are non-negative
TLMAX2		130.	Beyond maximum number of channels
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘LINE_AMP’		Line centroid amplitude
TUNIT3	‘count’		
TLMIN3		0.	Count numbers are non-negative
TLMAX3		1.e9	
TFORM4	‘1E ‘		Single precision floating point
TTYPE4	‘ERR_CENT’		Line centroid channel number error
TUNIT4	‘ ‘		
TLMIN4		0.	Uncertainties are non-negative
TLMAX4		130.	Beyond maximum number of channels
TFORM5	‘1E ‘		Single precision floating point
TTYPE5	‘ERR_WID’		Line centroid channel width error
TUNIT5	‘ ‘		
TLMIN5		0.	Uncertainties are non-negative
TLMAX5		130.	Beyond maximum number of channels
TFORM6	‘1E ‘		Single precision floating point
TTYPE6	‘ERR_AMP’		Line centroid amplitude error
TUNIT6	‘count’		
TLMIN6		0.	Uncertainties are non-negative

TLMAX6	1.e9	
TFORM7	‘1D ‘	Double precision floating point
TTYPE7	‘START’	Start time of spectral accumulation
TUNIT7	‘s’	Seconds
TLMIN7	0.	MJDREF will be before launch
TLMAX7	1.5D9	47 years after MJDREF
TFORM8	‘1D ‘	Double precision floating point
TTYPE8	‘STOP’	Stop time of spectral accumulation
TUNIT8	‘s’	Seconds
TLMIN8	0.	MJDREF will be before launch
TLMAX8	1.5D9	47 years after MJDREF
TFORM9	‘1J ‘	Double precision integer
TTYPE9	‘NUM_REC	Sequence number of beginning record
TUNIT9	‘ ‘	
TFORM10	‘1E ‘	Single precision floating point
TTYPE10	‘CHI_SQ’	Goodness of fit
TUNIT10	‘ ‘	
TLMIN10	0.	Chi-sq is non-negative
TLMAX10	1.e9	
TFORM11	‘PE(####)’	Variable-length array of single precision floating point
TTYPE11	‘BKGD_MDL	Background Model Parameters
TUNIT11	‘ ‘	

END

6.4. GS-006 GLAST Position and Attitude History

Version: 2.1

Revision date: 8/2/06

Product Description:
The position and attitude of GLAST in the format required by the software that calculates the DRMs. This file is produced daily.

The spacecraft position, orientation and velocity are reported as provided by the spacecraft; in particular the orientation is given by quaternions. The relevant definitions are given by the 1553B Bus Protocol Interface Control Document.

Naming Convention	glg_poshist_all_yymmdd_vxx.fit	yymmdd = year, month and day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 day	
Number of deliveries per day	1	
Typical size	3 MB at 2s sampling	

Product Content

Header:	
Extension 1 Name	GLAST POS HIST

GS-006 Primary Header Keywords

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX		Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘name’	Software and version creating file
FILETYPE	‘GLAST POS HIST’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	‘yyyy-mm-ddThh:nn:ss.ss’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘yyyy-mm-ddThh:nn:ss.ss’	Time of start of observation
DATE-END	‘yyyy-mm-ddThh:nn:ss.ss’	Time of end of observation
FILENAME	‘glg_poshist_all_yymmdd_vxx.fit’	Name of this file yymmdd = year, month and day xx = the version number
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘ALL’	All the detectors are included in this file
OBSERVER	‘MEEGAN’	In this case, the PI
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation’s start time relative to MJDREF, double precision
TSTOP		Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
INFILE0X	‘name’	File(s) used to create this FITS file X = the file number
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘GBM_POSHIST_V1.0’	Software and version creating file
FILETYPE	‘GLAST POS HIST’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table

DATE	'2007-06-06T13:28:45.12'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-05T23:57:46.22'	Date of end of observation
FILENAME	'glg_poshist_all_070604_v01.fit'	Name of this file
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'ALL'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455761919D7	Observation's stop time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
INFILE01	'PKT_20042150123_VC01_00701.0'	File(s) used to create this FITS file
END		End of Header

GS-006 Extension Header 1

Name: GLAST POS HIST

Purpose: This extension provides the time history of GLAST's position, orientation and velocity. The relevant definitions are given by the 1553B Bus Protocol Interface Control Document.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	(depends on data)	Number of attitude records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'ALL'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GLAST POS HIST'	Unique name for this extension type
EXTVER	1	Version of this extension format
TFIELDS	15	Number of fields per row
TFORM1	'1D '	Double precision floating point
TTYPE1	'SCLK_UTC'	SC clock: UTC seconds of day
TUNIT1	's'	
TFORM2	'1D '	Double precision floating point
TTYPE2	'QSJ_1'	First component of SC attitude quaternion
TFORM3	'1D '	Double precision floating point
TTYPE3	'QSJ_2'	Second component of SC attitude quaternion

TFORM4	‘1D ‘		Double precision floating point
TTYPE4	‘QSJ_3’		Third component of SC attitude quaternion
TFORM5	‘1D ‘		Double precision floating point
TTYPE5	‘QSJ_4’		Fourth component of SC attitude quaternion
TFORM6	‘1D ‘		Double precision floating point
TTYPE6	‘WSJ_1’		SC X-axis component of ang. vel.
TUNIT6	‘rad /s’		
TFORM7	‘1D ‘		Double precision floating point
TTYPE7	‘WSJ_2’		SC Y-axis component of ang. vel.
TUNIT7	‘rad /s’		
TFORM8	‘1D ‘		Double precision floating point
TTYPE8	‘WSJ_3’		SC Z-axis component of ang. vel.
TUNIT8	‘rad /s’		
TFORM9	‘1E ‘		Single precision floating point
TTYPE9	‘POS_X’		Earth Centered Inertial X position
TUNIT9	‘m’		
TFORM10	‘1E ‘		Single precision floating point
TTYPE10	‘POS_Y’		Earth Centered Inertial Y position
TUNIT10	‘m’		
TFORM11	‘1E ‘		Single precision floating point
TTYPE11	‘POS_Z’		Earth Centered Inertial Z position
TUNIT11	‘m’		
TFORM12	‘1E ‘		Single precision floating point
TTYPE12	‘VEL_X’		Earth Centered Inertial X velocity
TUNIT12	‘m /s’		
TFORM13	‘1E ‘		Single precision floating point
TTYPE13	‘VEL_Y’		Earth Centered Inertial Y velocity
TUNIT13	‘m /s’		
TFORM14	‘1E ‘		Double precision floating point
TTYPE14	‘VEL_Z’		Earth Centered Inertial Z velocity
TUNIT14	‘m /s’		
TFORM15	‘1I ‘		
TTYPE15	‘FLAGS’		SC Flags
TZERO15		32768	Offset for unsigned integers
TSCAL15		1	To convert from signed to unsigned integers data = FLAGS*TSCAL16+TZERO16

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type

BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	(depends on data)	Number of attitude records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘ALL’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T03:14:27’	Date file was created
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455851919D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘GLAST POS HIST’	Unique name for this extension type
EXTVER	1	Version of this extension format
TFIELDS	16	Number of fields per row
TFORM1	‘1D ‘	Double precision floating point
TTYPE1	‘SCLK_UTC’	SC clock: UTC seconds of day
TUNIT1	‘s’	
TFORM2	‘1D ‘	Double precision floating point
TTYPE2	‘QSJ_1’	First component of SC attitude quaternion
TFORM3	‘1D ‘	Double precision floating point
TTYPE3	‘QSJ_2’	Second component of SC attitude quaternion
TFORM4	‘1D ‘	Double precision floating point
TTYPE4	‘QSJ_3’	Third component of SC attitude quaternion
TFORM5	‘1D ‘	Double precision floating point
TTYPE5	‘QSJ_4’	Fourth component of SC attitude quaternion
TFORM6	‘1D ‘	Double precision floating point
TTYPE6	‘WSJ_1’	SC X-axis component of ang. vel.
TUNIT6	‘rad /s’	
TFORM7	‘1D ‘	Double precision floating point
TTYPE7	‘WSJ_2’	SC Y-axis component of ang. vel.
TUNIT7	‘rad /s’	
TFORM8	‘1D ‘	Double precision floating point

TTYPE8	'WSJ_3'		SC Z-axis component of ang. vel.
TUNIT8	'rad /s'		
TFORM9	'1E '		Single precision floating point
TTYPE9	'POS_X'		Earth Centered Inertial X position
TUNIT9	'm'		
TFORM10	'1E '		Single precision floating point
TTYPE10	'POS_Y'		Earth Centered Inertial Y position
TUNIT10	'm'		
TFORM11	'1E '		Single precision floating point
TTYPE11	'POS_Z'		Earth Centered Inertial Z position
TUNIT11	'm'		
TFORM12	'1E '		Single precision floating point
TTYPE12	'VEL_X'		Earth Centered Inertial X velocity
TUNIT12	'm /s'		
TFORM13	'1E '		Single precision floating point
TTYPE13	'VEL_Y'		Earth Centered Inertial Y velocity
TUNIT13	'm /s'		
TFORM14	'1E '		Double precision floating point
TTYPE14	'VEL_Z'		Earth Centered Inertial Z velocity
TUNIT14	'm /s'		
TFORM15	'1I '		
TTYPE15	'FLAGS'		SC Flags
TZERO15		32768	Offset for unsigned integers
TSCAL15		1	Data are not scaled

END

6.5. GS-007 GBM PHA Look-Up Tables

Version: 2.1

Revision date: 11/15/06

Product Description:
These files provide the mapping from the GBM detectors' 4096 PHA channels and the 8 or 128 channels reported by the CTIME or CSPEC data types for each detector, respectively. Each of the 14 detectors has a file for each of the two data types. These files are provided whenever these mappings change, and the file keywords indicate the beginning of the time range for which this mapping is valid (the end is not known when the files are created).

Naming Convention	glg_lutww_zzz_yymmddfff_vxx.fit	ww—datatype to which look up table applies, ct for ctime and cs for cspec zzz—nai or bgo yymmdd—date of start of table validity fff—fraction of day xx—version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	On update	
Typical size	4 kB (1 kB X 4 detector-data type combinations)	

Product Content

Header:	
Extension 1 Name	GBM PHA LUT

GS-007 Primary Header Keywords

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_LUTTABLE_HANDLER_V1.0'	Software and version creating file
FILETYPE	'GBM PHA LUT'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'YYYY-MM-DDTHH:MM:SS.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'YYYY-MM-DDTHH:MM:SS.ss'	Date of start of validity (see CVSD0001)
FILENAME	'glg_lutww_zzz_yymmddfff_vxx.fit'	ww—datatype to which look up table applies, ct for CTIME and cs for CSPEC zzz—nai or bgo yymmdd—date of start of table validity fff—fraction of day xx—version number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
DETNAM	'XXX'	Detector type XXX = 'NAI' or 'BGO'
OBSERVER	'Meegan'	Name of instrument PI
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'DET_BINS'	Physical detector PHA binning (non-standard)
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CDES0001	'GBM PHA LUT'	A string giving a brief description of this dataset
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
GBMCKSUM		GBM FSW checksum performed on the data in EEPROM
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard

BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘GBM_LUTTABLE_HANDLER_V1.0’	Software and version creating file
FILETYPE	‘GBM PHA LUT’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	‘2007-07-12T12:01:25.34’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of validity (see CVSD0001)
FILENAME	‘glg_lutct_n0_2004215123_v01.fit’	Name of this file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI’	Individual detector name
OBSERVER	‘Meegan’	Name of instrument PI
CCLS0001	‘BCF’	Dataset is a Basic Calibration File
CTTP0001	‘DATA’	Dataset contains calibration data
CCNM0001	‘DET_BINS’	Physical detector PHA binning (non-standard)
CVSD0001	‘‘2007-06-04’	UTC Date when this calibration data should be first used
CVST0001	‘23:58:46.12’	UTC Time when this calibration data should be first used
CDES0001	‘GBM PHA LUT’	A string giving a brief description of this dataset
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
GBMCKSUM		GBM FSW checksum performed on the data in EEPROM
INFILE01	‘PKT_20042150123_VC09_GLUTN.0’	File(s) used to create this FITS file
INFILE02	‘PKT_20042150528_VC09_GHK.0’	File(s) used to create this FITS file
END		End of Header

GS-007 Extension Header 1

Name: GBM PHA LUT

Purpose: This extension provides the lookup table mapping the detector's PHA channels into the channels downlinked in the telemetry.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	For CSPEC; CTIME is 8
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DETTYPE	'XXX'	Detector type XXX = 'NAI' or 'BGO'
DATE-OBS	'yy-mm-ddThh:mm:ss.ss'	Date of start of validity
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Time of start of validity
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
DATATYPE	'xxxxx'	Type of lookup table, xxxx=CTIME or CSPEC
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DETCHANS	x	Total number of channels in table, x=8 for CTIME and 128 for CSPEC
EXTNAME	'GBM PHA LUT'	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'DET_BINS'	Physical detector PHA binning (non-standard)
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CDES0001	'GBM PHA LUT'	A string giving a brief description of this dataset
TFIELDS	2	Number of fields per row
TFORM1	'1I '	Single precision Integer
TTYPE1	'CHANNEL'	Datatype channel number
TUNIT1	' '	

TLMIN1	0	Channel numbers are non-negative
TLMAX1	130	Greater than the number of datatype channels
TFORM2	‘1I ‘	Single precision Integer
TTYPE2	‘PHA_CHAN’	Corresponding detector PHA channel number
TUNIT2	‘ ‘	
TLMIN2	0	Channel numbers are non-negative
TLMAX2	4100	Greater than the number of PHA channels

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	For CSPEC; CTIME is 8
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T01:43:26’	Date file was created
DETTYPE	‘NAI’	Individual detector name
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of validity
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
DATATYPE	‘CSPEC’	Type of lookup table
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DETCHANS	128	Total number of channels in table
EXTNAME	‘GBM PHA LUT’	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	‘BCF’	Dataset is a Basic Calibration File
CTTP0001	‘DATA’	Dataset contains calibration data
CCNM0001	‘DET_BINS’	Physical detector PHA binning (non-standard)
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CDES0001	‘GBM PHA LUT’	A string giving a brief description of this dataset
TFIELDS	2	Number of fields per row
TFORM1	‘1I ‘	Single precision Integer
TTYPE1	‘CHANNEL’	Detector channel number

TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	Greater than the number of datatype channels
TFORM2	‘1I ‘		Single precision Integer
TTYPE2	‘PHA_CHAN’		Corresponding internal PHA channel number
TUNIT2	‘ ‘		
TLMIN2		0	Channel numbers are non-negative
TLMAX2		4100	Greater than the number of PHA channels

END

6.6. GS-008 GBM Calibration

Version: 2.0

Revision date: 4/7/06

Product Description:
These files provide the parameters for calculating the detector response. Each file contains the response function for a single detector to a burst at a given direction; this response does not include scattering off the Earth's atmosphere. Thus there is one file per zenith and azimuth direction per detector. New files are created and provided whenever the detector response is updated.

A detector using a scintillating crystal, such as both types of GBM detectors, measures photon energies imperfectly; a distribution of apparent energies results from a given incident photon energy. This distribution is usually a peak (the photopeak) with a finite width with a tail trailing to lower apparent energy. The GBM response functions are modeled as detector response matrices (DRMs) mapping incident photon flux F_i at energy E_i into the measured photon flux F'_j at apparent energies E'j:

$$F'_j = D_{ji} F_i$$

where summation over i is assumed. If the detector were ideal, the matrix would be diagonal, i.e., there would be elements only on the diagonal of the matrix. For a scintillating detector there are elements in a band around the diagonal resulting from the photopeak, and elements in the lower diagonal for the tail of the distribution at apparent energies. This data product provides the data to produce a detector's DRM for a given burst.

Because the gain of the 14 GBM detectors may change, the grid of apparent energies E'_j used provided by this calibration data product has to be mapped into the grid of apparent energies corresponding to the detector channels at a given moment. Since there will always be a mapping between grids of apparent energies, it is more efficient to use a separate apparent energy grid for each incident energy. The GBM team is using grids that are scaled by the photopeak energy. Thus this data product provides f_j, E_i and D'_{ji} where

$$F'(f_j E_i) = D'_{ji} F(E_i)$$

The vector f_j is chosen such that D'ji consists of values that are not zero or negligible.

The ith row of the first extension provides E_i and then 100 values of D'_{ji}. The second extension provides f_j (all values of E_i use the same set of f_j).

Naming Convention	glg_cal_vz_zuu_azyyy_vxx.fit	v—n or b, depending on detector type z—hexadecimal detector number, 0-b uu—zenith angle, in degrees yyy—azimuth angle, in degrees xx—version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	On update	
Typical size	100 GB total, number of files TBD	

Product Content

Header:	
Extension 1 Name	DIRERESP
Extension 2 Name	PHTPEAKE

GS-008 Primary Header Keywords

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'gbmsim_v01'	Software and version creating file
FILETYPE	'GBM RESPONSE'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'YYYY-MM-DDTHH:MM:SS.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'YYYY-MM-DDHH:MM:SS.ss'	Date of start of validity (see CVSD0001)
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703 D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_cal_vz_zuu_azyy y_vxx.fit'	Name of this file: v—n or b, depending on detector type z—hexadecimal detector number, 0-b uu—zenith angle, in degrees yyy—azimuth angle, in degrees xx—version number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
ZENITH	u	Zenith angle for response calculation, in degrees
AZIMUTH	z	Azimuth angle for response calculation, in degrees
OBSERVER	'Meegan'	Name of instrument PI
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'SPECRESP'	'1D ' list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	'DET(XXX_YY)'	XXX = 'NAI' or 'BGO' YY = 00 to 11
CBD20001	'THETA(u1-u2)deg'	Zenith angle boundary for dataset
CBD30001	'PHI(z1-z2)deg'	Azimuth angle boundary for dataset
CDES0001	'GBM DIRECT DRM ELEMENT'	A string giving a brief description of this dataset
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'gbmsim_v01'	Software and version creating file
FILETYPE	'GBM RESPONSE'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'YYYY-MM-DDTHH:MM:SS.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'YYYY-MM-DDHH:MM:SS.ss'	Date of start of validity (see CVSD0001)
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703 D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_cal_n0_z05_az160_v01.fit'	Name of this file
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
ZENITH	5	Zenith angle for response calculation
AZIMUTH	160	Azimuth angle for response calculation
OBSERVER	'Meegan'	Name of instrument PI
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'SPECRESP'	'1D ' list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	'DET(NAI_00)'	Specific detector for dataset
CBD20001	'THETA(0-10)deg'	Zenith angle boundary for dataset
CBD30001	'PHI(140-180)deg'	Azimuth angle boundary for dataset
CDES0001	'GBM DIRECT DRM ELEMENT'	A string giving a brief description of this dataset
END		End of Header

GS-008 Extension Header 1

Name: DIRERESP

Purpose: This extension provides the direct component of the DRM for a standard set of input energies; the same grid of apparent energies is assumed. The DRM generating software uses the direct component to calculate the contributions from scattering off the spacecraft and the Earth's atmosphere.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	150	Number of compressed energy bins
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
ZENITH	u	Zenith angle for response calculation, in degrees
AZIMUTH	z	Azimuth angle for response calculation, in degrees
DATE-OBS	'YYYY-MM-DDHH:MM:SS.ss'	Date of start of validity
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'DIRERESP'	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'SPECRESP'	'1D ' list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	'DET(XXX_YY)'	XXX = 'NAI' or 'BGO' YY = 00 to 11
CBD20001	'THETA(u1-u2)deg'	Zenith angle boundary for dataset
CBD30001	'PHI(z1-z2)deg'	Azimuth angle boundary for dataset

CDES0001	'GBM DIRECT DRM ELEMENT'	A string giving a brief description of this dataset
TFIELDS	2	Number of fields per row
TFORM1	'1E '	Single precision float
TTYPE1	'PHOT_E'	Input Photon Energy
TUNIT1	'keV'	
TLMIN1	0.	Energies are non-negative
TLMAX1	1.e6	
TFORM2	'100D '	Array of 100 Single precision floats
TTYPE2	'DIRERESP'	Direct Response
TUNIT2	'cm**2'	

END

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	150	Number of compressed energy bins
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2007-06-07T23:16:53'	Date file was created
DETNAM	'NAI_00'	Individual detector name
ZENITH	5	Zenith angle for response calculation
AZIMUTH	160	Azimuth angle for response calculation
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of validity
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'DIRERESP'	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'SPECRESP'	'1D ' list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	'DET(NAI_00)'	Specific detector for dataset

CBD20001	‘THETA(0-10)deg’	Zenith angle boundary for dataset
CBD30001	‘PHI(140-180)deg’	Azimuth angle boundary for dataset
CDES0001	‘GBM DIRECT DRM ELEMENT’	A string giving a brief description of this dataset
TFIELDS	2	Number of fields per row
TFORM1	‘1E ‘	Single precision float
TTYPE1	‘PHOT_E’	Input Photon Energy
TUNIT1	‘keV’	
TLMIN1	0.	Energies are non-negative
TLMAX1	1.e6	
TFORM2	‘100D ‘	Array of 100 Single precision floats
TTYPE2	‘DIRERESP’	Direct Response
TUNIT2	‘cm**2’	

END

GS-008 Extension Header 2

Name: PHTPEAKE

Purpose: Energy of the photonpeak.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	100	Number of compressed energy bins
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	'GLAST'	Name of mission / spacecraft
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
ZENITH	u	Zenith angle for response calculation, in degrees
AZIMUTH	z	Azimuth angle for response calculation, in degrees
DATE-OBS	'YYYY-MM-DDHH:MM:SS.ss'	Date of start of validity
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'PHTPEAKE'	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	'BCF'	Dataset is a Basic Calibration File
CTTP0001	'DATA'	Dataset contains calibration data
CCNM0001	'SPECRESP'	'1D ' list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	'DET(XXX_YY)'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CBD20001	'THETA(u1-u2)deg'	Zenith angle boundary for dataset
CBD30001	'PHI(z1-z2)deg'	Azimuth angle boundary for dataset
CDES0001	'GBM DIRECT DRM ELEMENT'	A string giving a brief description of this dataset
TFIELDS	1	Number of fields per row

TFORM1	‘1E ‘	Single precision float
TTYPE1	‘PHT_PK_E’	Measured energy with respect to photopeak energy
TUNIT1	‘ ‘	
TLMIN1	0.	Energies are non-negative
TLMAX1	2.	

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	100	Number of compressed energy bins
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-05T14:27:37’	Date file was created
ZENITH	5	Zenith angle for response calculation
AZIMUTH	160	Azimuth angle for response calculation
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of validity
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	‘PHTPEAKE’	Unique name for this extension type
EXTVER	1	Version of this extension format
CCLS0001	‘BCF’	Dataset is a Basic Calibration File
CTTP0001	‘DATA’	Dataset contains calibration data
CCNM0001	‘SPECRESP’	‘1D ‘ list of detector spectral response
CVSD0001	yyyy-mm-dd	UTC Date when this calibration data should be first used
CVST0001	hh:mm:ss	UTC Time when this calibration data should be first used
CBD10001	‘DET(NAI_00)’	Specific detector for dataset
CBD20001	‘THETA(0-10)deg’	Zenith angle boundary for dataset
CBD30001	‘PHI(140-180)deg’	Azimuth angle boundary for dataset
CDES0001	‘GBM DIRECT DRM ELEMENT’	A string giving a brief description of this dataset
TFIELDS	1	Number of fields per row

TFORM1	‘1E ‘	Single precision float
TTYPE1	‘PHT_PK_E’	Measured energy with respect to photopeak energy
TUNIT1	‘ ‘	
TLMIN1		0. Energies are non-negative
TLMAX1		2.

END

6.7. GS-101 CTIME (Burst Version)

Version: 2.0

Revision date: 4/11/06

Product Description:
The CTIME data type provides the counts accumulated by each detector over 0.256 s binned into 128 energy channels. This data type is produced and telemetered to the ground. The GIOC bundles these data from 4000 s before to 4000 s after a burst into one PHAII FITS file per detector per burst. Therefore, this file has a standard OGIP PHAII format. The 'Spectrum' extension does NOT include a SPEC_NUM column because the row number is the spectrum number, and including this number would just waste space. Deleting this column will not affect software that uses PHAII files.

Naming Convention	glg_ctime_wz_bnyymmddfff_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2	
Number of files per delivery	1 file for each data type for each detector that view burst = 14 files per delivery	
Typical size	~16 MB for CTIME (1.15 MB X 14 detectors)	

Product Content

Header		
Extension 1 Name	EBOUNDS	Definition of the channel energy grid
Extension 2 Name	SPECTRUM	The counts spectra
Extension 3 Name	GTI	The time ranges of valid data

GS-101 Primary Header Keywords

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'name'	Software and version creating file
FILETYPE	'PHAII'	The file format is OGIP PHAII which contains multiple spectra.
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation, same format as DATE
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_ctime_wz_bnyymmddfff_vxx.pha'	Name of this file w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
DATATYPE	'CTIME'	Name of the primary datatype making up this file
OBSERVER	'Meegan'	Name of instrument PI
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
END		End of Header

Example:

FITS Keyword	Value	Purpose

SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_TRIGGER_HANDLER_V1.0'	Software and version creating file
FILETYPE	'PHAII'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entireHDU
DATASUM	(computed value)	Checksum for data table
DATE	'2007-06-06T02:24:43'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_ctime_n0_bn070605401_v01.pha'	Name of this file
INFILE01	'pkt_20071562217_vc09_ctime.0'	File(s) used to create this FITS file
INFILE02	'pkt_20071562214_vc09_ghk.0'	File(s) used to create this FITS file
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_01'	Individual detector name
DATATYPE	'CTIME'	Name of the primary datatype making up this file
OBSERVER	'Meegan'	Name of instrument PI
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ	1	DEC of burst
END		End of Header

GS-101 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	8	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	8	CTIME has 8 energy channels
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files

HDUCLAS2	‘EBOUNDS’	From CAL/GEN/92-002
TFIELDS	3	Number of fields per row
TFORM1	‘1I ‘	2 byte Integer
TTYPE1	‘CHANNEL’	Detector channel number
TUNIT1	‘ ‘	
TLMIN1	0	Channel numbers are non-negative
TLMAX1	130	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	8	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TRIGTIME	3.455751950D7	Trigger time (s) relative to MJDREF
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC’	Origin of file
DATE	‘2007-06-08T12:34:23’	Date file was created

FILTER	‘none‘		Not applicable to GBM
DETNAM	‘NAI_00’		Individual detector name
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
OBJECT	‘GRByymmddfff’		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’		Stellar reference frame
EQUINOX	2000.0		Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
EXTNAME	‘EBOUNDS’		Unique name for this extension type
EXTVER		1	Version of this extension format
CHANTYPE	‘PHA’		No corrections have been applied
DETCHANS		8	Total number of channels in each rate
HDUCLASS	‘OGIP’		
HDUVERS	‘1.2.0’		
HDUCLAS1	‘RESPONSE’		Typically found in RMF files
HDUCLAS2	‘EBOUNDS’		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	‘1I ‘		2 byte Integer
TTYPE1	‘CHANNEL’		Detector channel number
TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for row
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for row
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-101 Extension Header 2

Name: Spectrum

Purpose: Provides the counts in each channel for each spectrum

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
GROUPING	0	No special grouping has been applied
EXTNAME	'SPECTRUM'	XSPEC-compatible PHAII extension that contains spectra
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Spectra are not linked to a background file
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Spectra are not linked to a correction file
CORRSCAL	1.	Correction scaling file
RESPFILE	'glg_ctime_wz_bnyymmddfff_vxx.rsp'	Response file associated with these data w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date

			fff = fraction of day xx = the version number
ANCRFILE	‘none‘		Spectra are not linked to an ARF file
SYS_ERR		0.	No systematic errors
POISSERR		T	Assume Poisson Errors
OBJECT	‘GRByymmddfff’		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’		Stellar reference frame
EQUINOX		2000.0	Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
HDUCLASS	‘OGIP’		
HDUCLAS1	‘SPECTRUM’		
HDUCLAS2	‘TOTAL’		Indicates source + background
HDUCLAS3	‘COUNT’		Indicates PHA data stored as counts
HDUVERS	‘1.2.1’		
CHANTYPE	‘PHA’		PHA channels from the telemetry
DETCHANS		8	CTIME has 8 energy channels
EXTVER		1	Version of this extension format
TFIELDS		5	Number of fields per row; each row is a new spectrum
TFORM1	‘8I ‘		16 bit integers by channel
TSCAL1	1		To convert from signed to unsigned integers data = COUNTS*TSCAL2+TZERO2
TZERO1	32768		Actual zero of physical data
TTYPE1	‘COUNTS’		Counts in the accumulation interval
TUNIT1	‘count’		Units of field
TFORM2	‘1E’		
TTYPE2	‘EXPOSURE’		Total livetime in this time interval
TUNIT2	‘s’		Seconds
TLMIN2		0.	Exposure is non-negative
TLMAX2		2.e5	2 days
TFORM3	‘1I ‘		
TTYPE3	‘QUALITY’		Quality flag for entire spectrum
TFORM4	‘1D’		Double precision
TTYPE4	‘TIME’		Start time
TUNIT4	‘s’		Seconds
TZERO4			Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	‘1D’		Double precision
TTYPE5	‘ENDTIME’		Stop time
TUNIT5	‘s’		Seconds
TZERO5			Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF
END			

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
GROUPING	0	No special grouping has been applied
EXTNAME	'SPECTRUM'	Corresponds to XSPEC-compatible PHAII
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'2007-06-05T17:42:54'	Date file was created
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455752119D7	Observation's stop time
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Name of corresponding background file (if any)
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Name of corresponding correction file (if any)
CORRSCAL	1.	Correction scaling file
RESPFILE	'glg_ctime_n0_bn070605401_v00.rsp'	Response file associated with these data
ANCRFILE	'none'	Name of corresponding ARF file (if any)
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
OBJECT	'GRB070605401'	Object Designation (used for trigger data)
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUVERS	'1.2.1'	

CHANTYPE	'PHA'		No corrections have been applied
DETCHANS		8	Total number of channels in each rate
EXTVER		1	Version of this extension format
TFIELDS		5	Number of fields per row
TFORM1	'8I '		16 bit integers by channel
TSCAL1	1		data = COUNTS*TSCAL2+TZERO2
TZERO1	32768		Actual zero of physical data
TTYPE1	'COUNTS'		Counts in the accumulation interval
TUNIT1	'count'		Units of field
TFORM2	'1E'		
TTYPE2	'EXPOSURE'		Total livetime
TUNIT2	's'		Seconds
TLMIN2		0.	Exposure is non-negative
TLMAX2		2.e5	2 days
TFORM3	'1I '		
TTYPE3	'QUALITY'		Quality flag for entire spectrum
TFORM4	'1D'		Double precision
TTYPE4	'TIME'		Start time
TUNIT4	's'		Seconds
TZERO4		3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time
TUNIT5	's'		Seconds
TZERO5		3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF
END			

GS-101 Extension Header 3

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	XSPEC-compatible PHAII extension providing time range of usable data
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst

EXTVER	1	Assigned by template parser
TFORM1	'1D'	Double precision
TTYPE1	'START'	Start time of GTI interval
TUNIT1	's'	Seconds
TZERO1		Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	Corresponds to XSPEC-compatible PHAII
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC'	Origin of file
DATE	'2007-06-08T05:15:32'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation start time relative to MJDREF
TSTOP	3.455752119D7	Observation stop time relative to MJDREF
TRIGTIME	3.455751920D7	Trigger (s) time relative to MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction

		of the day fff given to 3 decimal places
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
EXTVER	1	Assigned by template parser
TFORM1	‘1D’	Double precision
TTYPE1	‘START’	Start time of GTI interval
TUNIT1	‘s’	Seconds
TZERO1	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval
TUNIT2	‘s’	Seconds
TZERO2	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF

END

6.8. GS-102 CSPEC (Burst Version)

Version: 2.0

Revision date: 5/30/06

Product Description:
The CSPEC data type provides the counts accumulated by each detector over 8.192 s binned into 128 energy channels. This data type is produced and telemetered to the ground. The GIOC bundles these data from 4000 s before to 4000 s after a burst into one PHAII FITS file per detector per burst. Therefore, this file has a standard OGIP PHAII format. The 'Spectrum' extension does NOT include a SPEC_NUM column because the row number is the spectrum number, and including this number would just waste space. Deleting this column will not affect software that uses PHAII files.

Naming Convention	glg_cspec_wz_bnyymmddfff_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2 per day	
Typical size	16 MB (1.15 MB × 14 detectors)	

Product Content

Header		
Extension 1 Name	EBOUNDS	Definition of the channel energy grid
Extension 2 Name	SPECTRUM	The counts spectra
Extension 3 Name	GTI	The time ranges of valid data

GS-102 Primary Header Keywords

Definition:

FITS Keyword	Value—Required or Standard		Definition
SIMPLE	T		Confirms that file conforms to NOST standard
BITPIX		8	Bits used per pixel – depends on production operating system
NAXIS		0	Number of axes in the primary table
EXTEND	T		Extensions are permitted
CREATOR	'name'		Software and version creating file
FILETYPE	'PHAII'		The file format is OGIP PHAII which contains multiple spectra.
FILE-VER	'1.0.0'		Version of the format for this filetype
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'		Date file was created
ORIGIN	'GIOC'		Files are created by the GIOC
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'		Time of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'		Time of end of observation, same format as DATE
MJDREFI	51910.		MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4		MJD date of reference epoch, fractional part
TSTART			Observation's start time relative to MJDREF, double precision
TSTOP			Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'		Time system used in time keywords
TIMEUNIT	's'		Time unit used in TSTART, TSTOP
FILENAME	'glg_cspec_wz_bnyymmddfff_vxx.pha'		Name of this file w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
INFILE0X	'name'		File(s) used to create this FITS file X = the file number
TELESCOP	'GLAST'		Name of mission / spacecraft
INSTRUME	'GBM'		Name of instrument generating data
DETNAM	'XXX_YY'		Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
DATATYPE	'CSPEC'		Name of the primary datatype making up this file
OBSERVER	'Meegan'		Name of instrument PI
OBJECT	'GRByymmddfff'		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'		Stellar reference frame
EQUINOX		2000.0	Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
END			End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard

BITPIX	8	Bits used per pixel – depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	‘GBM_TRIGGER_HANDLER_V1.0’	Software and version creating file
FILETYPE	‘PHAII’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entireHDU
DATASUM	(computed value)	Checksum for data table
DATE	‘2007-06-06T02:25:05’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-05T22:28:24.00’	Date of start of observation
DATE-END	‘2007-06-06T00:45:12.00’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation’s start time relative to MJDREF, double precision
TSTOP		Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
FILENAME	‘glg_cspec_n0_bn070605401_v01.pha’	Name of this file
INFILE01	‘pkt_20071562216_vc09_cspec.0’	File(s) used to create this FITS file
INFILE02	‘pkt_20071562214_vc09_ghk.0’	File(s) used to create this FITS file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
DATATYPE	‘CSPEC’	Name of the primary datatype making up this file
OBSERVER	‘Meegan’	Name of instrument PI
OBJECT	‘GRB070605401’	Object Designation (used for trigger data)
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
END		End of Header

GS-102 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	CSPEC has 128 energy channels
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files

HDUCLAS2	‘EBOUNDS’	From CAL/GEN/92-002
TFIELDS	3	Number of fields per row
TFORM1	‘1I ‘	2 byte Integer
TTYPE1	‘CHANNEL’	Detector channel number
TUNIT1	‘ ‘	
TLMIN1	0	Channel numbers are non-negative
TLMAX1	130	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T05:39:12’	Date file was created

FILTER	‘none‘		Not applicable to GBM
DETNAM	‘NAI_00’		Individual detector name
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
OBJECT	‘GRByymmddfff’		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’		Stellar reference frame
EQUINOX	2000.0		Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
EXTNAME	‘EBOUNDS’		Unique name for this extension type
EXTVER		1	Version of this extension format
CHANTYPE	‘PHA’		No corrections have been applied
DETCHANS		128	Total number of channels in each rate
HDUCLASS	‘OGIP’		
HDUVERS	‘1.2.0’		
HDUCLAS1	‘RESPONSE’		Typically found in RMF files
HDUCLAS2	‘EBOUNDS’		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	‘1I ‘		2 byte Integer
TTYPE1	‘CHANNEL’		Detector channel number
TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for row
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for row
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-102 Extension Header 2

Name: Spectrum

Purpose: Provides the counts in each channel for each spectrum

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'SPECTRUM'	XSPEC-compatible PHAII extension that contains spectra
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Spectra are not linked to a background file
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Spectra are not linked to a correction file
CORRSCAL	1.	Correction scaling file
RESPFILE	'glg_cspec_wz_bnyymmddfff_vxx.rsp'	Response file associated with these data w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day

			xx = the version number
ANCRFILE	‘none‘		Spectra are not linked to an ARF file
SYS_ERR		0.	No systematic errors
POISSERR		T	Assume Poisson Errors
OBJECT	‘GRByymmddfff’		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’		Stellar reference frame
EQUINOX		2000.0	Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
HDUCLASS	‘OGIP’		
HDUCLAS1	‘SPECTRUM’		
HDUCLAS2	‘TOTAL’		Indicates source + background
HDUCLAS3	‘COUNT’		Indicates PHA data stored as counts
HDUVERS	‘1.2.1’		
CHANTYPE	‘PHA’		PHA channels from the telemetry
DETCHANS		128	CSPEC has 128 energy channels
EXTVER		1	Version of this extension format
TFIELDS		5	Number of fields per row; each row is a new spectrum
TFORM1	‘128I ‘		16 bit integers by channel
TSCAL1	1		To convert from signed to unsigned integers data = COUNTS*TSCAL2+TZERO2
TZERO1	32768		Actual zero of physical data
TTYPE1	‘COUNTS’		Counts in the accumulation interval
TUNIT1	‘count’		Units of field
TFORM2	‘1E’		
TTYPE2	‘EXPOSURE’		Total livetime in this time interval
TUNIT2	‘s’		Seconds
TLMIN2		0.	Exposure is non-negative
TLMAX2		2.e5	2 days
TFORM3	‘1I ‘		
TTYPE3	‘QUALITY’		Quality flag for entire burst
TFORM4	‘1D’		Double precision
TTYPE4	‘TIME ’		Start time relative to MJDREF
TUNIT4	‘s’		Seconds
TZERO4			Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN4		0.	MJDREF will be before launch
TLMAX4		1.5D9	47 years after MJDREF
TFORM5	‘1D’		Double precision
TTYPE5	‘ENDTIME’		Stop time relative to MJDREF
TUNIT5	‘s’		Seconds
TZERO5			Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN5		0.	MJDREF will be before launch
TLMAX5		1.5D9	47 years after MJDREF
END			

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'SPECTRUM'	Corresponds to XSPEC-compatible PHAII
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2007-06-05T12:32:45'	Date file was created
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455752019D7	Observation's stop time
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILTER	'none'	Instrument filter used (if any)
AREASCAL	1.	No special scaling of effective area by channel
BACKFILE	'none'	Name of corresponding background file (if any)
BACKSCAL	1.	No scaling of background
CORRFILE	'none'	Name of corresponding correction file (if any)
CORRSCAL	1.	Correction scaling file
RESPFILE	glg_cspec_n0_bn070605401_v00.rsp	Name of associated response file
ANCRFILE	'none'	Name of corresponding ARF file (if any)
SYS_ERR	0.	No systematic errors
POISSERR	T	Assume Poisson Errors
OBJECT	'GRB070605401'	Object Designation (used for trigger data)
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUVERS	'1.2.1'	
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	Total number of channels in each rate

EXTVER	1	Version of this extension format
TFIELDS	5	Number of fields per row
TFORM1	‘128I ‘	16 bit integers by channel
TSCAL1	1	data = COUNTS*TSCAL2+TZERO2
TZERO1	32768	Actual zero of physical data
TTYPE1	‘COUNTS’	Counts in the accumulation interval
TUNIT1	‘count’	Units of field
TFORM2	‘1E’	
TTYPE2	‘EXPOSURE’	Total livetime
TUNIT2	‘s’	Seconds
TLMIN2	0.	Exposure is non-negative
TLMAX2	2.e5	2 days
TFORM3	‘1I ‘	
TTYPE3	‘QUALITY’	Quality flag for entire burst
TFORM4	‘1D’	Double precision
TTYPE4	‘TIME’	Start time relative to MJDREF
TUNIT4	‘s’	Seconds
TZERO4	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN4	0.	MJDREF will be before launch
TLMAX4	1.5D9	47 years after MJDREF
TFORM5	‘1D’	Double precision
TTYPE5	‘ENDTIME’	Stop time relative to MJDREF
TUNIT5	‘s’	Seconds
TZERO5	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN5	0.	MJDREF will be before launch
TLMAX5	1.5D9	47 years after MJDREF

END

GS-102 Extension Header 3

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	XSPEC-compatible PHAII extension providing time range of usable data
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TRIGTIME		Trigger time (s) relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst

EXTVER	1	Assigned by template parser
TFORM1	'1D'	Double precision
TTYPE1	'START'	Start time of GTI interval
TUNIT1	's'	Seconds
TZERO1		Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	####	Number of spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields in each row
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'GTI'	Corresponds to XSPEC-compatible PHAII
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2007-06-08T04:16:36'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'2007-06-04T23:58:46.12'	Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation start time relative to MJDREF
TSTOP	3.455752019D7	Observation stop time relative to MJDREF
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction

		of the day fff given to 3 decimal places
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
EXTVER	1	Assigned by template parser
TFORM1	‘1D’	Double precision
TTYPE1	‘START’	Start time of GTI interval
TUNIT1	‘s’	Seconds
TZERO1	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval
TUNIT2	‘s’	Seconds
TZERO2	3.455751920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN2	0.	MJDREF will be before launch
TLMAX2	1.5D9	47 years after MJDREF

END

6.9. GS-103 GBM TTE

Version: 2.0

Revision date: 4/7/06

Product Description:
These files provide the event list for the counts in one detector for one burst. The counts are characterized by arrival time and one of 128 energy channels. Consequently, one set of these files is provided after each burst.

Naming Convention	glg_tte_wz_bnyymmddfff_vxx.fit	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2	
Typical size	40-60 MB (3-4.5 MB per file)	

Product Content

Header	
Extension 1 Name	EBOUNDS
Extension 2 Name	EVENTS

GS-103 Primary Header Keywords

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_TRIGGER_HANDLER_V1.0'	Software and version creating file
FILETYPE	'GBM PHOTON LIST'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM		Checksum for entireHDU
DATASUM		Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_tte_wz_bnyymmddfff_vxx.fit'	Name of this file: w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
DATATYPE	'TTE'	Name of the primary datatype making up this file
OBSERVER	'Meegan'	Name of instrument PI
OBJECT	'GRByymmddfff'	Object Designation (used for trigger data)
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_TRIGGER_HANDL	Software and version creating file

	ER_V1.0’	
FILETYPE	‘GBM PHOTON LIST’	Name for this type of FITS file (should be unique)
FILE-VER	‘1.0.0’	Version of the format for this filetype
CHECKSUM		Checksum for entireHDU
DATASUM		Checksum for data table
DATE	‘2007-06-06T02:24:15’	Date file was made
ORIGIN	‘GIOC’	Name of organization making file
DATE-OBS	‘2007-06-05T22:28:24.00’	Date of start of observation
DATE-END	‘2007-06-06T00:45:12.00’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation’s start time relative to MJDREF, double precision
TSTOP		Observation’s stop time relative to MJDREF, double precision
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
FILENAME	‘glg_tte_n0_bn070605401_v01.fit’	Name of this file
INFILE01	‘pkt_20071562215_vc09_tte.0’	File(s) used to create this FITS file
INFILE02	‘pkt_20071562214_vc09_ghk.0’	File(s) used to create this FITS file
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
DATATYPE	‘TTE’	Name of the primary datatype making up this file
OBSERVER	‘Meegan’	Name of instrument PI
OBJECT	‘GRB070605401’	Object Designation (used for trigger data)
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
END		End of Header

GS-103 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TRIGTIME		Trigger time (s) relative to MJDREF
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	Total number of channels in each rate
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files

HDUCLAS2	‘EBOUNDS’		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	‘1I ‘		2 byte Integer
TTYPE1	‘CHANNEL’		Detector channel number
TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for row
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for row
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3		2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
END			

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T03:31:54’	Date file was created
FILTER	‘none‘	Not applicable to GBM

DETNAM	'NAI_00'		Individual detector name
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
OBJECT	'GRByymmddfff'		Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'		Stellar reference frame
EQUINOX	2000.0		Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
EXTNAME	'EBOUNDS'		Unique name for this extension type
EXTVER		1	Version of this extension format
CHANTYPE	'PHA'		No corrections have been applied
DETCHANS		128	Total number of channels in each rate
HDUCLASS	'OGIP'		
HDUVERS	'1.2.0'		
HDUCLAS1	'RESPONSE'		Typically found in RMF files
HDUCLAS2	'EBOUNDS'		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	'1I '		2 byte Integer
TTYPE1	'CHANNEL'		Detector channel number
TUNIT1	' '		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	'1E '		Single precision floating point
TTYPE3	'E_MAX'		High energy bound for row
TUNIT3	'keV'		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-103 Extension Header 2

Name: EVENTS

Purpose: This extension provides the event list.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	####	Number of bytes per row
NAXIS2	####	Number of event records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
RESPFILE	'glg_cspec_wz_bnyymmddfff_vxx.rsp'	Response file associated with these data w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = the fraction of day xx = the version number
OBJECT	'GRB070605401'	Object Designation (used for trigger data)
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Time of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TRIGTIME		Trigger time (s) since MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EXTNAME	'EVENTS'	Unique name for this extension type

EXTVER		1	Version of this extension format
TFIELDS		2	Number of fields per row
TFORM1	‘1D ‘		Double precision floating point
TTYPE1	‘TIME’		Arrival time of recorded event
TUNIT1	‘s’		Units of field
TZERO1			Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1		0.	MJDREF will be before launch
TLMAX1		1.5D9	47 years after MJDREF
TFORM2	‘1I ‘		Single precision integer
TTYPE2	‘PHA’		Channel number of recorded event
TUNIT2	‘ ‘		Units of field
TLMIN2		0	Channel numbers are non-negative
TLMAX2		130	More than the number of channels
END			

Example:

FITS Keyword	Value		Purpose
XTENSION	‘BINTABLE’		Extension type
BITPIX		8	Bits per pixel – assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1		####	Number of bytes per row
NAXIS2		####	Number of event records
PCOUNT		0	No extra bits in table
GCOUNT		1	No multiplier
CHECKSUM			Checksum for entire HDU
DATASUM			Checksum for data table
TELESCOP	‘GLAST’		Name of mission / spacecraft
INSTRUME	‘GBM’		Name of instrument generating data
DETNAM	‘NAI_00’		Detector ID of recorded events
OBSERVER	‘MEEGAN’		In this case, the PI
ORIGIN	‘GIOC”		Origin of file
DATE	‘2007-06-08T14:32:46’		Date file was created
RESPFILE	‘glg_cspec_n0_bn070605401_v00.rsp’		Response file associated with these data
OBJECT	‘GRB070605401’		Object Designation (used for trigger data)
RADECSYS	‘FK5’		Stellar reference frame
EQUINOX		2000.0	Equinox for RA and Dec
RA_OBJ		35.6	RA of source (used for trigger data)
DEC_OBJ		165.3	DEC of source (used for trigger data)
DATE-OBS	‘2007-06-04T23:58:46.12’		Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’		Date of end of observation
MJDREFI		51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4		MJD date of reference epoch, fractional part
TSTART	3.455751919D7		Observation’s start time
TSTOP	3.455772019D7		Observation’s end time

TRIGTIME	3.455761920D7	Trigger time (s) since MJDREF
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
EXTNAME	‘EVENTS’	Unique name for this extension type
EXTVER	1	Version of this extension format
TFIELDS	2	Number of fields per row
TFORM1	‘1D ‘	Double precision floating point
TTYPE1	‘TIME’	Arrival time of recorded event
TUNIT1	‘s’	Units of field
TZERO1	3.455761920D7	Offset (s) relative to MJDREF, equal to TRIGTIME
TLMIN1	0.	MJDREF will be before launch
TLMAX1	1.5D9	47 years after MJDREF
TFORM2	‘1I ‘	Single precision integer
TTYPE2	‘PHA’	Channel number of recorded event
TUNIT2	‘ ‘	Units of field
TLMIN2	0	Channel numbers are non-negative
TLMAX2	130	More than the number of channels
END		

6.10. GS-104 GBM DRMs

Version: 2.1

Revision date: 4/7/06

Product Description:
A detector response matrix (DRM) file is provided for each detector for each burst. Because the spacecraft orientation may change significantly during a burst, either because the burst is long or because of an autonomous repoint, multiple DRMs may be included. Consequently, this file has an RSPII format, a new variant of the RSP format. The RSP (short for 'response') format combines both the energy redistribution and the effective area in one file. In the new RSPII format multiple response matrix extensions are provided. One set of files, with a file per detector, is provided after each burst.

A detector using a scintillating crystal, such as both types of GBM detectors, measures photon energies imperfectly; a distribution of apparent energies results from a given incident photon energy. This distribution is usually a peak (the photopeak) with a finite width with a tail trailing to lower apparent energy. The GBM response functions are modeled as a DRM mapping incident photon flux F_i at energy E_i into the measured photon flux F'_j at apparent energies E'j:

$$F'_j = D_{ji} F_i$$

where summation over i is assumed. If the detector were ideal, the matrix would be diagonal, i.e., there would be elements only on the diagonal of the matrix. For a scintillating detector there are elements in a band around the diagonal resulting from the photopeak, and elements in the lower diagonal for the tail of the distribution at apparent energies.

This data product provides DRMs for a given burst for each detector. These DRMs will suffice for most users; however, a tool will be provided so that users can create their own DRMs if they so desire.

Naming Convention	glg_uu_wz_bnyymmddfff_vxx.rsp	uu='cspec' or 'ctime w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	

Product delivered to	GSSC
Delivery Method	FASTCOPY
Input Products Required	Level 0 data, GBM energy calibration file, GBM position history file
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.
Product contains data for	1 trigger
Number of deliveries per day	Average of 1
Typical size	6 MB (~0.4 MB X 14 Detectors)

Product Content

Header	
Extension 1 Name	EBOUNDS
Extension 2:n+1 Name	MATRIX—n extensions for n matrices
Extension n+2 Name	PHT_EDGE

GS-104 Primary Header Keywords

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel - depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_RESPONSE_GENERATOR_V1.0'	Software and version creating file
FILETYPE	'GBM DRM'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entireHDU
DATASUM	(computed value)	Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_uu_wz_bnyymmddfff_vxx.rsp'	Name of this file uu='CSPEC' or 'CTIME w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number
INFILE0X	'name'	File(s) used to create this FITS file X = the file number
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'Meegan'	Name of instrument PI
DRM_NUM		Number of DRMs stored in this file—if more than one, then file is RSPII format
DRM_TYPE	uu	Data type for which DRM is intended: uu='CSPEC' or 'CTIME
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst

DEC_OBJ		DEC of burst
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel - depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_RESPONSE_GENERATOR_V1.0'	Software and version creating file
FILETYPE	'GBM DRM'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.0'	Version of the format for this filetype
CHECKSUM	(computed value)	Checksum for entireHDU
DATASUM	(computed value)	Checksum for data table
DATE	'2007-06-06T02:23:45'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'2007-06-05T23:30:24.00'	Date of start of observation
DATE-END	'2007-06-05T23:45:24.00'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time relative to MJDREF, double precision
TSTOP		Observation's stop time relative to MJDREF, double precision
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
FILENAME	'glg_cspec_n0_bn070605401_v01.rsp'	Name of this file
INFILE01	'glg_spechist_n0_2007156_v01.fit'	File(s) used to create this FITS file
INFILE02	'glg_poshist_2007156_v01.fit'	File(s) used to create this FITS file
INFILE03	'glg_lut_cs_n_2007100_v01.fit'	File(s) used to create this FITS file
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'NAI_00'	Individual detector name
OBSERVER	'Meegan'	Name of instrument PI
DRM_NUM	1	Number of DRMs stored in this file
DRM_TYPE	'CSPEC'	Data type DRM is intended for
OBJECT	'GRB070605401'	Object Designation (used for trigger data)
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
END		End of Header

GS-104 Extension Header 1

Name: EBOUNDS

Purpose: Provides the apparent energy grid E'_j for the spectrum' channels.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TSTOP		Observation's stop time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TRIGTIME		Trigger time (s) relative to MJDREF
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
FILTER	'none'	Not applicable to GBM
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'EBOUNDS'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
DETCHANS	128	Total number of channels in each rate
HDUCLASS	'OGIP'	
HDUVERS	'1.2.0'	
HDUCLAS1	'RESPONSE'	Typically found in RMF files
HDUCLAS2	'EBOUNDS'	From CAL/GEN/92-002

TFIELDS	3	Number of fields per row
TFORM1	‘1I ‘	2 byte Integer
TTYPE1	‘CHANNEL’	Detector channel number
TUNIT1	‘ ‘	
TLMIN1	0	Channel numbers are non-negative
TLMAX1	130	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for row
TUNIT2	‘keV’	
TLMIN2	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX2	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for row
TUNIT3	‘keV’	
TLMIN3	5.	Lowest channel energy, 5 keV for NaI detectors, 150 keV for BGO detectors
TLMAX3	2000.	Highest channel energy, 2000 keV for NaI detectors, 150 keV for BGO detectors

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	128	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TRIGTIME	3.45571920D7	Trigger time (s) relative to MJDREF
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T04:29:47’	Date file was created
OBJECT	‘GRByymmddfff’	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’	Stellar reference frame

EQUINOX	2000.0		Equinox for RA and Dec
RA_OBJ			RA of burst
DEC_OBJ			DEC of burst
FILTER	‘none‘		Not applicable to GBM
DETNAM	‘NAI_00’		Individual detector name
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	‘EBOUNDS’		Unique name for this extension type
EXTVER		1	Version of this extension format
CHANTYPE	‘PHA’		No corrections have been applied
DETCHANS		128	Total number of channels in each rate
HDUCLASS	‘OGIP’		
HDUVERS	‘1.2.0’		
HDUCLAS1	‘RESPONSE’		Typically found in RMF files
HDUCLAS2	‘EBOUNDS’		From CAL/GEN/92-002
TFIELDS		3	Number of fields per row
TFORM1	‘1I ‘		2 byte Integer
TTYPE1	‘CHANNEL’		Detector channel number
TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for row
TUNIT2	‘keV’		
TLMIN2		5.	Lowest channel energy
TLMAX2		2000.	Highest channel energy
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘E_MAX’		High energy bound for row
TUNIT3	‘keV’		
TLMIN3		5.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

GS-104 Extension Header 2:n+1

Name: SPECRESP MATRIX

Purpose: There will be n extensions of this format for the n DRMs that the file provides. Note that each extension is accompanied by information about the detector's orientation to the burst and its time range of applicability.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	1	Number of matrices in file
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'SPECRESP MATRIX'	Unique name for this extension type—no ARF
EXTVER	1	Version of this extension format
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Beginning of the range of applicability
TSTOP		End of the range of applicability
TRIGTIME		Trigger time (s) relative to MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used
SRC_AZ		Azimuth of source in detector coordinates (degrees)
SRC_EL		Elevation of source in detector coordinates (degrees)
GEO_AZ		Azimuth of geocenter in detector coordinates (degrees)
GEO_EL		Elevation of geocenter in detector coordinates (degrees)
FILTER	'none'	The instrument filter in use (if any)

CHANTYPE	'PHA'		Whether the channels in this file have been corrected in any way
NUMEBINS		250	Number of true energy bins of the MATRIX
DETCHANS		128	Number of apparent energy bins of MATRIX
HDUCLASS	'OGIP'		Indicating that this is an OGIP style file
HDUCLAS1	'RESPONSE'		Indicating that this is a response file
HDUCLAS2	'RSP_MATRIX'		Indicating that this is a response matrix
HDUVERS	1.3.0		The version number of the format
TLMIN1		1	The first channel in the response. The '#' is the column number for the F_CHAN column.
TFIELDS	4		Number of fields per row
TFORM1	'250I '		INTEGER array, length is equal to NUMEBINS
TTYPE1	'N_GRP'		The number of 'channel subsets' in the response array per energy channel
TFORM2	'PI(####)'		Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE2	'F_CHAN'		The channel number of the start of each 'channel subset' in the response array
TFORM3	'PI(####)'		Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE3	'N_CHAN'		The number of channels within each 'channel subset' in the response array
TFORM4	'PE(####)'		Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE4	'MATRIX'		The compressed detector response matrix
TUNIT4	'cm**2'		Units of field
END			

Example:

FITS Keyword	Value		Purpose
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel - assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1	(computed value)		Number of bytes per row
NAXIS2		1	Number of matrices in file
PCOUNT		0	No extra bits in table
GCOUNT		1	No multiplier
CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	'SPECRESP MATRIX'		Unique name for this extension type—no ARF
EXTVER		1	Version of this extension format
TELESCOP	'GLAST'		Name of mission / spacecraft
INSTRUME	'GBM'		Name of instrument generating data
DETNAM	'NAI_00'		Individual detector name (if only 1)
OBSERVER	'MEEGAN'		In this case, the PI
ORIGIN	'GIOC"		Origin of file
DATE	'2007-06-08T12:54:03'		Date file was created

OBJECT	‘GRB070605401’	Object Designation (used for trigger data)
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Beginning of the range of applicability
TSTOP	3.455772019D7	End of the range of applicability
TRIGTIME	3.455761920D7	Trigger time (s) relative to MJDREF
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used
SRC_AZ		Azimuth of source in detector coordinates (degrees)
SRC_EL		Elevation of source in detector coordinates (degrees)
GEO_AZ		Azimuth of geocenter in detector coordinates (degrees)
GEO_EL		Elevation of geocenter in detector coordinates (degrees)
FILTER	‘none‘	The instrument filter in use (if any)
CHANTYPE	‘PHA’	Whether the channels in this file have been corrected in any way
NUMEBINS	250	Number of true energy bins of the MATRIX
DETCHANS	128	Number of apparent energy bins of MATRIX
HDUCLASS	‘OGIP’	Indicating that this is an OGIP style file
HDUCLAS1	‘RESPONSE’	Indicating that this is a response file
HDUCLAS2	‘RSP_MATRIX’	Indicating that this is a response matrix
HDUVERS	1.3.0	The version number of the format
TLMIN1	1	The first channel in the response. The ‘#’ is the column number for the F_CHAN column.
TFIELDS	4	Number of fields per row
TFORM1	‘250I ’	INTEGER array, length is equal to NUMEBINS
TTYPE1	‘N_GRP’	The number of ‘channel subsets’ in the response array per energy channel
TFORM2	‘PI(####)’	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE2	‘F_CHAN’	The channel number of the start of each ‘channel subset’ in the response array
TFORM3	‘PI(####)’	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE3	‘N_CHAN’	The number of channels within each ‘channel subset’ in the response array
TFORM4	‘PE(####)’	Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE4	‘MATRIX’	The compressed detector response matrix
TUNIT4	‘cm**2’	Units of field
END		

GS-104 Extension Header n+2

Name: PHT_EDGE

Purpose: This extension provides the grid of input photon energies E_i. This grid will most likely not be the same as the grid of apparent energies in the first extension.

Definition:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	250	Number of true energy bins, equals NEBINS
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TSTOP		Observation's stop time
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TRIGTIME		Trigger time (s) relative to MJDREF
TELESCOP	'GLAST'	Name of mission / spacecraft
INSTRUME	'GBM'	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was created
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
FILTER	'none'	Not applicable to GBM
CHECKSUM	(computed value)	Checksum for entire HDU
DATASUM	(computed value)	Checksum for data table
EXTNAME	'PHT_EDGE'	Unique name for this extension type
EXTVER	1	Version of this extension format
CHANTYPE	'PHA'	No corrections have been applied
NUMEBINS	250	Number of true energy bins of the MATRIX
TFIELDS	3	Number of fields per row
TFORM1	'1I '	2 byte Integer

TTYPE1	‘CHANNEL’	Detector channel number
TUNIT1	‘ ‘	
TLMIN1	0	Channel numbers are non-negative
TLMAX1	130	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘ENERGY_LO’	Low energy bound for true energy bin
TUNIT2	‘keV’	
TLMIN2	0.	Energies are non-negative
TLMAX2	1.e6	
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘ENERGY_HI	High energy bound for true energy bin
TUNIT3	‘keV’	
TLMIN3	0.	Energies are non-negative
TLMAX3	1.e6	
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	(computed value)	Number of bytes per row
NAXIS2	250	Number of true energy bins, equals NEBINS
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
DATE-OBS	‘2007-06-04T23:58:46.12’	Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	Date of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation’s start time
TSTOP	3.455752119D7	Observation’s stop time
TIMESYS	‘TT’	Time system used in time keywords
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP
TRIGTIME	3.455751920D7	Trigger time (s) relative to MJDREF
TELESCOP	‘GLAST’	Name of mission / spacecraft
INSTRUME	‘GBM’	Name of instrument generating data
DETNAM	‘NAI_00’	Individual detector name
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘GIOC”	Origin of file
DATE	‘2007-06-08T03:18:35’	Date file was created
OBJECT	‘GRByymmddfff’	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
FILTER	‘none‘	Not applicable to GBM

CHECKSUM	(computed value)		Checksum for entire HDU
DATASUM	(computed value)		Checksum for data table
EXTNAME	‘PHT_EDGE’		Unique name for this extension type
EXTVER		1	Version of this extension format
CHANTYPE	‘PHA’		No corrections have been applied
NUMEBINS		250	Number of true energy bins of the MATRIX
TFIELDS		3	Number of fields per row
TFORM1	‘1I ‘		2 byte Integer
TTYPE1	‘CHANNEL’		Detector channel number
TUNIT1	‘ ‘		
TLMIN1		0	Channel numbers are non-negative
TLMAX1		130	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘ENERGY_LO’		Low energy bound for true energy bin
TUNIT2	‘keV’		
TLMIN2		0.	Energies are non-negative
TLMAX2		1.e6	
TFORM3	‘1E ‘		Single precision floating point
TTYPE3	‘ENERGY_HI		High energy bound for true energy bin
TUNIT3	‘keV’		
TLMIN3		0.	Energies are non-negative
TLMAX3		1.e6	
END			

6.11. GS-105 GBM Trigger Catalog Entry

Version: 2.0

Revision date: 4/7/06

Product Description:
This file classifies a GBM trigger as a burst, solar flare, transient or noise. The first version is provided when the data are first processed at the GIOC and uses the onboard classification of the trigger. If the burst is reclassified, then new versions will be created and provided to the GSSC.

Naming Convention	glg_tcat_all_bnyymmddfff_vxx.fit	yymmdd—the date of the trigger fff = fraction of day xx—file version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 day; possibly updated if the trigger is reclassified	
Product contains data for	1 trigger	
Number of deliveries per day	Average of 1/3-1/2	
Typical size	25 kB	

Product Content
Header:
No extensions

GS-105 Primary Header

Definition:

```
SIMPLE  =                    T /

BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    F / File does not contain extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'TRIGGER ENTRY'      / Unique FITS file type name
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
ORIGIN  = 'GIOC'               / Name of organization
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / MJD date of reference epoch, int part
MJDREFF = 7.428703703703703D-4 / MJD date of reference epoch, frac part
TSTART  =                      / Observation start time, rel to MJDREF
TSTOP   =                      / Observation end time, rel to MJDREF,
TIMESYS = 'TT'                 / Time system
TIMEUNIT= 's'                  / Time until
OBJECT  =                        / Name of source (e.g., burst name)
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
CLASS   =                      / Classification of trigger.  Options
                                 Include 'Burst', 'Solar Flare',
                                 'Astronomical Source' and 'Noise'
RELIABLT=                      / Reliability of classification, a number
                                 between 0 and 1
FILENAME= 'glg_tcat_all_bnyymmddfff_vxx.fit' / Name of FITS file:
                                          yymmdd—the date of the
                                             trigger
                                          fff—fraction of the day
                                          xx—file version number
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI

END
```

Example:

```
SIMPLE  =                    T /

BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    F / File does not contain extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'TRIGGER ENTRY'      / Unique FITS file type name
CHECKSUM=                      / For entire HDU
```

```
DATASUM =                      / For data table
DATE    = '2007-07-08T03:04:05.67' / Date file was created
ORIGIN  = 'GIOC'               / Name of organization
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-05T00:56:46.12' / Date of end of observation
MJDREFI =              51910. / MJD date of reference epoch, int part
MJDREFF = 7.428703703703703D-4 / MJD date of reference epoch, frac part
TSTART  =                      / Observation start time, rel to MJDREF
TSTOP   =                      / Observation end time, rel to MJDREF,
TIMESYS = 'TT'                 / Time system
TIMEUNIT= 's'                  / Time until
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =               2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of source
DEC_OBJ =                      / DEC of source
CLASS   = 'BURST'              / Classification of trigger
RELIABLT=                  0.9 / Reliability of classification
FILENAME= 'glg_tcat_all_bn070604991_v01.fit' /Name of FITS file
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI

END
```

6.12. GS-106 GBM Burst or Spectral Catalog Entry

Version: 2.0

Revision date: 4/7/06

Product Description:
This file contains data describing a burst. New versions are provided as additional data are added. Thus the early versions might have only basic burst quantities such as duration in the header, while later versions will have spectra in extensions (which are not provided in earlier versions).

Naming Convention	glg_bcat_all_bnyymmddfff_vxx.fit	yymmdd = date fff = fraction of day xx = version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	3 day, but updated periodically	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2	
Typical size	100-200 kB	

Product Content

Header:	
Extension 1 Name	Detector Data
Extension 2 Name	Fit Params

GS-106 Primary Header

Definition:

```
SIMPLE  =                    T /

BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T / File contains extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'SPECTRAL FITS'      / Unique FITS file type name
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
ORIGIN  = 'GIOC'               / Name of organization
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =                51910. / MJD date of reference epoch, int part
MJDREFF = 7.428703703703703D-4 / MJD date of reference epoch, frac part
TSTART  =                      / Observation start time, rel to MJDREF
TSTOP   =                      / Observation end time, rel to MJDREF,
TIMESYS = 'TT'                 / Time system
TIMEUNIT= 's'                  / Time until
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
CLASS   = 'BURST'              / Classification of trigger
RELIABLT=                      / Reliability of classification,
                                    a number between 0 and 1
FLU     =                      / 1-1000 keV fluence (erg/cm^2)
FLU_ERR =                      / Uncertainty on fluence
PFLX    =                      / 50-300 keV peak flux (ph/cm^2/s)
PFLX_ERR=                      / Uncertainty on peak flux
T90     =                      / T90 (s)
T90_ERR =                      / Uncertainty on T90
T50     =                      / T50 (s)
T50_ERR =                      / Uncertainty on T50
FILENAME= 'glg_bcat_all_bnyymmddfff_vxx.fit' / Name of FITS file:
                                          yymmdd = Date
                                          fff = fraction of day
                                          xx = Version number
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI

END
```

Example:

```
SIMPLE  =                    T /
```

```
BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T / File contains extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'SPECTRAL FITS'      / Unique FITS file type name
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
DATE    = '2007-07-08T03:04:05.67' / Date file was created
ORIGIN  = 'GIOC'               / Name of organization
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-05T00:56:46.12' / Date of end of observation
MJDREFI =               51910. / MJD date of reference epoch, int part
MJDREFF = 7.428703703703703D-4 / MJD date of reference epoch, frac part
TSTART  =                      / Observation start time, rel to MJDREF
TSTOP   =                      / Observation end time, rel to MJDREF,
TIMESYS = 'TT'                 / Time system
TIMEUNIT= 's'                  / Time until
OBJECT  = 'GRB070604991'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source
CLASS   = 'BURST'              / Classification of trigger
RELIABLT=                  0.9 / Reliability of classification
FLU     =               5.3e-6 / 1-1000 keV fluence (erg/cm^2)
FLU_ERR =               4.2e-7 / Uncertainty on fluence
PFLX    =                  0.7 / 50-300 keV peak flux (ph/cm^2/s)
PFLX_ERR=                 0.03 / Uncertainty on peak flux
T90     =                130.4 / T90 (s)
T90_ERR =                  5.3 / Uncertainty on T90
T50     =                110.4 / T50 (s)
T50_ERR =                  5.1 / Uncertainty on T50
FILENAME= 'glg_bcat_all_yymmddfff_v01.fit' /Name of FITS file
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI

END
```

GS-106 Extension Header 1

Name: DETECTOR DATA

Purpose: This extension provides deconvolved spectra over the burst.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  244 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                92676 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   12 /Number of columns
EXTNAME = 'DETECTOR DATA'      /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used

TFORM1  = '20A     '           /Character string
TTYPE1  = 'INSTRMNT'           /Instrument name for this detector

TFORM2  = '20A     '           /Character string
TTYPE2  = 'DETECTOR'           /Detector #; if one of several available

TFORM3  = '20A     '           /Character string
TTYPE3  = 'DATATYPE'           /Data type used for this analysis

TFORM4  = '20A     '           /Character string
TTYPE4  = 'DETSTAT '           /Was this detector INCLUDED or OMITTED

TFORM5  = '60A     '           /Character string
TTYPE5  = 'DATAFILE'           /File name for this dataset

TFORM6  = '60A     '           /Character string
TTYPE6  = 'FIT_INT '           /Fit intervals
```

```
TFORM7  = '1J      '           /Integer*4 (long integer)
TTYPE7  = 'CHANNUM '           /# of energy channels for this detector

TFORM8  = '2J      '           /Integer*4 (long integer)
TTYPE8  = 'FITCHAN '           /Channels selected in fitting detector

TFORM9  = '1PE(129)'           /Real*4 (floating point), variable length
TUNIT9  = 'keV     '           /
TTYPE9  = 'E_EDGES '           /Energy edges for each selected detector

TFORM10 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT10 = 'photon /cm**2 /s /keV' /
TTYPE10 = 'PHTCNTS '           /Array of photon counts data

TFORM11 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT11 = 'photon /cm**2 /s /keV' /
TTYPE11 = 'PHTMODL '           /Array of photon model data

TFORM12 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT12 = 'photon /cm**2 /s /keV' /
TTYPE12 = 'PHTERRS '           /Array of errors in photon counts data

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  244 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                92676 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   12 /Number of columns
EXTNAME = 'DETECTOR DATA'      /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = '2007-06-08T02:34:12.61' / Date file was created
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / Date of end of observation
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used

TFORM1  = '20A     '           /Character string
TTYPE1  = 'INSTRMNT'           /Instrument name for this detector
```

```
TFORM2  = '20A     '           /Character string
TTYPE2  = 'DETECTOR'           /Detector #; if one of several available

TFORM3  = '20A     '           /Character string
TTYPE3  = 'DATATYPE'           /Data type used for this analysis

TFORM4  = '20A     '           /Character string
TTYPE4  = 'DETSTAT '           /Was this detector INCLUDED or OMITTED

TFORM5  = '60A     '           /Character string
TTYPE5  = 'DATAFILE'           /File name for this dataset

TFORM6  = '60A     '           /Character string
TTYPE6  = 'FIT_INT '           /Fit intervals

TFORM7  = '1J      '           /Integer*4 (long integer)
TTYPE7  = 'CHANNUM '           /# of energy channels for this detector

TFORM8  = '2J      '           /Integer*4 (long integer)
TTYPE8  = 'FITCHAN '           /Channels selected in fitting detector

TFORM9  = '1PE(129)'           /Real*4 (floating point), variable length
TUNIT9  = 'keV     '           /
TTYPE9  = 'E_EDGES '           /Energy edges for each selected detector

TFORM10 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT10 = 'photon /cm**2 /s /keV' /
TTYPE10 = 'PHTCNTS '           /Array of photon counts data

TFORM11 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT11 = 'photon /cm**2 /s /keV' /
TTYPE11 = 'PHTMODL '           /Array of photon model data

TFORM12 = '1PE(7740)'          /Real*4 (floating point), variable length
TUNIT12 = 'photon /cm**2 /s /keV' /
TTYPE12 = 'PHTERRS '           /Array of errors in photon counts data

END
```

GS-106 Extension Header 2

Name: FIT PARAMETERS

Purpose: This extension provides the spectral parameters resulting from fitting spectra over the burst.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                   94 /Number of bytes per row
NAXIS2  =                   60 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   13 /Number of columns
EXTNAME = 'FIT PARAMS'         /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
MJDREFI =              51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used

FLU_LOW =             25.0000 /E_lo of flux/fluence integ. (keV)
FLU_HIGH=             2000.00 /E_hi of flux/fluence integ. (keV)

TFORM1  = '2E      '           /Real*4 (floating point)
TTYPE1  = 'TIMEBIN '           / Start/stop times rel. to trigger

TFORM2  = '2E      '           /Real*4 (floating point)
TTYPE2  = 'PARAM0  '           /Smoothly Broken PL: Amplitude

TFORM3  = '2E      '           /Real*4 (floating point)
TTYPE3  = 'PARAM1  '           /Smoothly Broken PL: Pivot E =fix

TFORM4  = '2E      '           /Real*4 (floating point)
TTYPE4  = 'PARAM2  '           /Smoothly Broken PL: Index1 < BE

TFORM5  = '2E      '           /Real*4 (floating point)
```

```
TTYPE5  = 'PARAM3  '           /Smoothly Broken PL: Break E

TFORM6  = '2E      '           /Real*4 (floating point)
TTYPE6  = 'PARAM4  '           /Smoothly Broken PL: Break scale

TFORM7  = '2E      '           /Real*4 (floating point)
TTYPE7  = 'PARAM5  '           /Smoothly Broken PL: Index2 > BE

TFORM8  = '2E      '           /Real*4 (floating point)
TTYPE8  = 'PHTFLUX '           /Photon Flux (ph/s-cm^2)

TFORM9  = '2E      '           /Real*4 (floating point)
TTYPE9  = 'PHTFLNC '           /Photon Fluence (ph/cm^2)

TFORM10 = '2E      '           /Real*4 (floating point)
TTYPE10 = 'NRGFLUX '           /Energy Flux (erg/s-cm^2)

TFORM11 = '2E      '           /Real*4 (floating point)
TTYPE11 = 'NRGFLNC '           /Energy Fluence (erg/cm^2)

TFORM12 = '1E      '           /Real*4 (floating point)
TTYPE12 = 'REDCHSQ '           /Reduced Chi-squares

TFORM13 = '1I      '           /Integer*2 (short integer)
TTYPE13 = 'CHSQDOF '           /Degrees of Freedom

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                   94 /Number of bytes per row
NAXIS2  =                   60 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   13 /Number of columns
EXTNAME = 'FIT PARAMS'         /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = '2007-06-08T12:23:42.67' / Date file was created
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / Date of end of observation
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
TRIGTIME=        3.455751920D7 / Trigger time (s) since MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
```

```
TIMEUNIT= 's'                  / Time unit used

FLU_LOW =              25.0000 /E_lo of flux/fluence integ. (keV)
FLU_HIGH=              2000.00 /E_hi of flux/fluence integ. (keV)

TFORM1  = '2E      '           /Real*4 (floating point)
TTYPE1  = 'TIMEBIN '           / Start/stop times rel. to trigger

TFORM2  = '2E      '           /Real*4 (floating point)
TTYPE2  = 'PARAM0  '           /Smoothly Broken PL: Amplitude

TFORM3  = '2E      '           /Real*4 (floating point)
TTYPE3  = 'PARAM1  '           /Smoothly Broken PL: Pivot E =fix

TFORM4  = '2E      '           /Real*4 (floating point)
TTYPE4  = 'PARAM2  '           /Smoothly Broken PL: Index1 < BE

TFORM5  = '2E      '           /Real*4 (floating point)
TTYPE5  = 'PARAM3  '           /Smoothly Broken PL: Break E

TFORM6  = '2E      '           /Real*4 (floating point)
TTYPE6  = 'PARAM4  '           /Smoothly Broken PL: Break scale

TFORM7  = '2E      '           /Real*4 (floating point)
TTYPE7  = 'PARAM5  '           /Smoothly Broken PL: Index2 > BE

TFORM8  = '2E      '           /Real*4 (floating point)
TTYPE8  = 'PHTFLUX '           /Photon Flux (ph/s-cm^2)

TFORM9  = '2E      '           /Real*4 (floating point)
TTYPE9  = 'PHTFLNC '           /Photon Fluence (ph/cm^2)

TFORM10 = '2E      '           /Real*4 (floating point)
TTYPE10 = 'NRGFLUX '           /Energy Flux (erg/s-cm^2)

TFORM11 = '2E      '           /Real*4 (floating point)
TTYPE11 = 'NRGFLNC '           /Energy Fluence (erg/cm^2)

TFORM12 = '1E      '           /Real*4 (floating point)
TTYPE12 = 'REDCHSQ '           /Reduced Chi-squares

TFORM13 = '1I      '           /Integer*2 (short integer)
TTYPE13 = 'CHSQDOF '           /Degrees of Freedom

END
```

6.13. GS-107 GBM TRIGDAT

Version: 2.4

Revision date: 12/14/06

Product Description:
The TRIGDAT messages (the messages the GBM downlinks through TDRSS after each bursts) for each burst are gathered up into a single file, with an extension for each TRIGDAT type. One file is provided after each burst.

Naming Convention	glg_trigdat_all_bnyymmmddfff_vxx.fit	yymmdd = date fff = fraction of day xx = version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 day	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2	
Typical size	50-100 kB	

Product Content

Header:	
Primary	
Extension 1 Name	TRIGRATE
Extension 2 Name	BCKRATES
Extension 3 Name	OB_CALC
Extension 4 Name	MAXRATES
Extension 5 Name	EVNTRATE

GS-107 Primary Header

Definition:

```
SIMPLE  =                    T /

BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T / File contains extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'TRIGDAT'            / Unique FITS file type name
FILE-VER= '1.0.0  '            / Version of this file format
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =                51910. / Reference epoch MJD date,
                                  integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional
                                  part
TSTART  =                      / Start time
TSTOP   =                      / Stop time
DETTYPE = 'BOTH    '           / Detector type—BGO, NAI or both
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or
                                  CSPEC
TRIGTIME=                      / Trigger time (s) relative to
                                     MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                  fff = fraction of day
RADECSYS = 'FK5'               / Stellar reference frame
EQUINOX  =               2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
TRIGSCAL=                  256 / [ms] Triggered timescale
TRIG_ALG=                    3 / Triggered algorithm number
CHAN_LO =                    3 / Trigger channel: low
CHAN_HI =                    4 / Trigger channel: high
ADC_LO  =                  205 / Trigger channel: low (ADC: 0 - 4095)
ADC_HI  =                 1228 / Trigger channel: high (ADC: 0 - 4095)
DET_MASK= '0010000000100000'   / Triggered detectors: (0-11)
INFILE01= '                  ' / Level 0 input data file
FILENAME= 'glg_trigdat_all_bnyymmddfff_vxx.fit' / Name of file:
                                        yymmdd = date
                                        fff = fraction of day
                                        xx = version number
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element

END
```

Example:

```
SIMPLE  =                    T /

BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T / File contains extensions
CREATOR = ' '                  / Software/version creating file
FILETYPE= 'TRIGDAT'            / Unique FITS file type name
FILE-VER= ‘1.0.0  ‘            / Version of this file format
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
DATE    = '2004-07-08T23:14:05.44' / Date file was created
DATE-OBS= ‘2007-06-04T23:58:46.12’ / Start of observation
DATE-END= ‘2007-06-07T13:56:46.12’ / End of observation
MJDREFI =               51910. / Ref. epoch MJD, integer part
MJDREFF = 7.428703703703703D-4 / Ref. epoch MJD, fraction part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
DETTYPE = ‘BOTH    ‘           / Detector type—BGO, NAI or both
DATATYPE= ‘TRIGDAT ‘           / Type of lookup table: CTIME or
                                 CSPEC
TRIGTIME=        3.455751920D7 / Trig. time (s) rel. to MJDREF
TIMESYS = ‘TT’                 / Time system for time keywords
TIMEUNIT= ‘s’                  / Time unit used
OBJECT  = 'GRB070605401'       /
RADECSYS = 'FK5'                / Stellar reference frame
EQUINOX  =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of burst, J2000
DEC_OBJ =                165.3 / DEC of burst, J2000
TRIGSCAL=                  256 / [ms] Triggered timescale
TRIG_ALG=                    3 / Triggered algorithm number
CHAN_LO =                    3 / Trigger channel: low
CHAN_HI =                    4 / Trigger channel: high
ADC_LO  =                  205 / Trigger channel: low (ADC: 0 - 4095)
ADC_HI  =                 1228 / Trigger channel: high (ADC: 0 - 4095)
DET_MASK= '0010000000100000'   / Triggered detectors: (0-11)
INFILE01= 'GLAST_2006093_214150_VC00_GTRIG.0.00' / Level 0 input data
fileTRIGTIME=             8447256 / trigger time (s) relative to
                                    MJDREF
FILENAME= 'glg_trigdat_all_bnyymmddfff_v01.fit'   /Name of FITS
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= ‘MEEGAN’             / Name of observer
ORIGIN  = ‘GIOC’               / Originating ground element

END
```

GS-107 Extension Header 1

Name: TRIGRATE

Purpose: This extension corresponds to the TRIGDAT that provides the spacecraft position when the detectors triggered, and the rates from each detector in each of 8 channels. This extension provides TRIGDAT02

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  492 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'TRIGRATE'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E      '           / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions
```

```
TFORM4  = '3E     '            /Single precision float
TTYPE4  = 'EIC  '              /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '           /Array of single precision floats
TDIM5   = '(16, 8) '           / Array dimensions
TTYPE5  = 'RATE    '           /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  500 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    ? /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'TRIGRATE'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = '2007-06-05T04:23:12.21' / Date file was created
DATE-OBS= '2007-06-04T10:58:46.12' / Date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E     '            / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions
```

```
TFORM4  = '3E     '           /Single precision float
TTYPE4  = 'EIC  '             /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '          /Array of single precision floats
TDIM5   = '(16, 8) '          / Array dimensions
TTYPE5  = 'RATE    '          /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

GS-107 Extension Header 2

Name: BCKRATES

Purpose: The background rates in each of the 14 detectors in 8 channels. This extension provides TRIGDAT03.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  458 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    4 /Number of columns
EXTNAME = 'BCKRATES'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Detector used
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or
CSPECTRIGTIME=                     / Trigger time (s) relative to
MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of background accumulation,
                                 calculated value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '14I     '           / Array of integers
```

```
TTYPE3  = 'QUALITY '           / Quality Flag, one per detector

TFORM4  = '112E    '           /Array of single precision floats
TTYPE4  = 'BCKRATES'           /Background rates, 14 dets, 8 channels
TDIM4   = '(16, 8) '           / Array dimensions
TUNIT4  = 'count /s'

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  458 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    4 /Number of columns
EXTNAME = 'BCKRATES'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Detector used
DATE    = '2007-06-05T04:23:12.21' / Date file was created
DATE-OBS= '2007-06-04T10:58:46.12' / Date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / Date of end of observation
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or
CSPECTRIGTIME=        3.455751920D7 / Trigger time (s) relative to
MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of background accumulation,
                                 calculated value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '14I     '           / Array of integers
TTYPE3  = 'QUALITY '           / Quality Flag, one per detector
```

```
TFORM4  = '112E    '           /Array of single precision floats
TTYPE4  = 'BCKRATES'           /Background rates, 14 dets, 8 channels
TDIM4   = `(16, 8) ’           / Array dimensions
TUNIT4  = 'count /s'

END
```

GS-107 Extension Header 3

Name: OB_CALC

Purpose: This extension provides the calculated position of the triggering source (e.g., a burst) and some spectral information. This information is calculated and telemetered to the ground up to 5 times, resulting in up to 5 rows. This extension provides TRIGDAT04.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                   74 /Number of bytes per row
NAXIS2  =                    2 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   12 /Number of columns
EXTNAME = 'OB_CALC'            /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Individual detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000

TFORM1  = '1D      '           /Double floating point number
TTYPE1  = 'TIME'               /Packet time in TT s
TUNIT1  = 's'

TFORM2  = '1E      '           /Single floating point number
TTYPE2  = 'RA      '           /RA
TUNIT2  = 'deg'

TFORM3  = '1E      '           /Single floating point number
```

```
TTYPE3  = 'DEC     '           /DEC
TUNIT3  = 'deg'

TFORM4  = '1E      '           /Single floating point number
TTYPE4  = 'STATERR '           /Statistical error
TUNIT4  = 'deg'

TFORM5  = '1I      '           /Short integer
TTYPE5  = 'LOCALG  '           /Location algorithm

TFORM6  = '2I      '           / Short integer
TTYPE6  = 'EVTCLASS'           /Event classification & reliability est.

TFORM7  = '2I      '           / Short integer
TTYPE7  = 'RELIABLT'           / reliability estimate

TFORM8  = '2E      '           / Array of floating point
TTYPE8  = 'INTNSITY'           / Peak flux (2 timescales)
TUNIT8  = 'count'

TFORM9  = '1E'                 / Short integer
TTYPE9  = 'HDRATIO '           /

TFORM10 = '1E      '           /
TTYPE10 = 'FLUENCE '           / Fluence
TUNIT10 = 'count'

TFORM11 = '1E      '           / Array of floating point
TTYPE11 = 'SIGMA   '           /

TFORM12 = '12I     '           / data format of field: 2-byte INTEGER
TYPE12  = 'LOCRATES'           /
TUNIT12 = 'count   '           / physical unit of field

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  122 /Number of bytes per row
NAXIS2  =                    5 /Number of rows
PCOUNT  =                    ? /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   12 /Number of columns
EXTNAME = 'OB_CALC'            /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Individual detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = '2007-06-05T04:23:12.21' / Date file was created
DATE-OBS= '2007-06-04T10:58:46.12' / Date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
```

```
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source

TFORM1  = '1D      '           /Double floating point number
TTYPE1  = 'TIME    '           /Packet time in TT s
TUNIT1  = 's'

TFORM2  = '1E      '           /Single floating point number
TTYPE2  = 'RA      '           /RA
TUNIT2  = 'deg'

TFORM3  = '1E      '           /Single floating point number
TTYPE3  = 'DEC     '           /DEC
TUNIT3  = 'deg'

TFORM4  = '1E      '           /Single floating point number
TTYPE4  = 'STATERR '           /Statistical error
TUNIT4  = 'deg'

TFORM5  = '1I      '           /Short integer
TTYPE5  = 'LOCALG  '           /Location algorithm

TFORM6  = '1I      '           / Short integer
TTYPE6  = 'EVTCLASS'           /Event classification & reliability est.

TFORM7  = '2I      '           / Short integer
TTYPE7  = 'RELIABLT'           / reliability estimate

TFORM8  = '2E      '           / Array of floating point
TTYPE8  = 'INTNSITY'           / Peak flux (2 timescales)
TUNIT8  = 'count'

TFORM9  = '1E'                 / Short integer
TTYPE9  = 'HDRATIO '           /

TFORM10 = '1E      '           /
TTYPE10 = 'FLUENCE '           / Fluence
TUNIT10 = 'count'

TFORM11 = '1E      '           / Array of floating point
TTYPE11 = 'SIGMA   '           /

TFORM12 = '12I     '           / data format of field: 2-byte INTEGER
TYPE12  = 'LOCRATES'           /
TUNIT12 = 'count   '           / physical unit of field

END
```

GS-107 Extension Header 4

Name: MAXRATES

Purpose: This extension provides the maximum rate seen in each channel of the 14 detectors up to the time the data are telemetered to the ground. This extension provides TRIGDAT05.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  492 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'MAXRATES'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Individual detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =                2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E      '           / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions
```

```
TFORM4  = '3E     '            /Single precision float
TTYPE4  = 'EIC  '              /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '           /Array of single precision floats
TDIM5   = '(16, 8) '           / Array dimensions
TTYPE5  = 'MAXRATES'           /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  512 /Number of bytes per row
NAXIS2  =                    3 /Number of rows
PCOUNT  =                    ? /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'MAXRATES'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
DETNAM  = 'ALL     '           / Individual detector name
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = '2007-06-05T04:23:12.21' / Date file was created
DATE-OBS= '2007-06-04T10:58:46.12' / Date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =       3.455751919D7 / Start time
TSTOP   =       3.455752019D7 / Stop time
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=       3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =               2000. / Equinox for RA and Dec
RA_OBJ  =                35.6 / RA of source
DEC_OBJ =               165.3 / DEC of source

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E     '            / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions
```

```
TFORM4  = '3E     '           /Single precision float
TTYPE4  = 'EIC  '             /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '          /Array of single precision floats
TDIM5   = '(16, 8) '          / Array dimensions
TTYPE5  = 'MAXRATES'          /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

GS-107 Extension Header 5

Name: EVNTRATE

Purpose: This extension provides the event rate in each channel of each detector. The events are provided at different times relative to the trigger. This extension provides TRIGDAT09.

Definition:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  492 /Number of bytes per row
NAXIS2  =                  154 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'EVNTRATE'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = 'yyyy-mm-ddThh:mm:ss.s' / Date file was created (UTC)
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =               2000. / Equinox for RA and Dec
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E      '           / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions
```

```
TFORM4  = '3E     '            /Single precision float
TTYPE4  = 'EIC  '              /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '           /Array of single precision floats
TDIM5   = '(16, 8) '           / Array dimensions
TTYPE5  = 'RATE    '           /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

Example:

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  500 /Number of bytes per row
NAXIS2  =                  124 /Number of rows
PCOUNT  =                    ? /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                    5 /Number of columns
EXTNAME = 'EVNTRATE'           /Name of this binary table extension
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'MEEGAN'             / Name of observer
ORIGIN  = 'GIOC'               / Originating ground element
DATE    = '2007-06-05T04:23:12.21' / Date file was created
DATE-OBS= '2007-06-04T10:58:46.12' / Date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Start time
TSTOP   =        3.455752019D7 / Stop time
DETTYPE = 'BOTH    '           / Detector type: NAI or BGO
DATATYPE= 'TRIGDAT '           / Type of lookup table: CTIME or CSPEC
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 / Time system for time keywords
TIMEUNIT= 's'                  / Time unit used
OBJECT  = 'GRB070605401'       /
RADECSYS= 'FK5'                / Stellar reference frame
EQUINOX =               2000. / Equinox for RA and Dec
RA_OBJ  =                35.6 / RA of source
DEC_OBJ =               165.3 / DEC of source

TFORM1  = '1D      '           / Double floating point number
TTYPE1  = 'TIME'               / Beginning of accumulation, calculated
                                 value
TUNIT1  = 's'

TFORM2  = '1D      '           / Double floating point number
TTYPE2  = 'ENDTIME'            / End of accumulation, same as PCKTTIME
TUNIT2  = 's'

TFORM3  = '4E     '            / Single precision float
TTYPE3  = 'SCATTITD'           /Spacecraft attitude quaternions

TFORM4  = '3E     '            /Single precision float
```

```
TTYPE4  = 'EIC  '              /Spacecraft position: Earth X, Y, & Z
TUNIT4  = 'km'

TFORM5  = '112E    '           /Array of single precision floats
TDIM5   = '(16, 8) '           / Array dimensions
TTYPE5  = 'RATE    '           /Rates—14 detectors, 8 channels
TUNIT5  = 'count /s'

END
```

6.14. GS-108 GBM Background Files

Version: 2.0

Revision date: 4/7/06

Product Description:
The GIOC provides files with background spectra for each GBM after each burst. Thus one set of files is provided after each burst.

Naming Convention	glg_bck_wz_bnyymmddfff_vxx.bak	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 day	
Product contains data for	1 burst	
Number of deliveries per day	Average of 1/3-1/2	
Typical size	14 kB (1kB x 14 files)	

Product Content		
Header		
Extension 1 Name	EBOUNDS	Definition of the channel energy grid
Extension 2 Name	SPECTRUM	The counts spectra
Extension 3 Name	GTI	The time ranges of valid data

GS-108 Primary Header Keywords

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel - depends on production operating system
NAXIS	0	Number of axes in the primary table
EXTEND	T	Extensions are permitted
CREATOR	GBM_RESPONSE_GENERATOR_V1.0	Software and version creating file
FILETYPE	GBM BACK	Name for this type of FITS file (should be unique)
FILE-VER	1.0.0	Version of the format for this filetype
CHECKSUM		Checksum for entireHDU
DATASUM		Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss.ss'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	Date of end of observation
FILENAME	glg_bck_wz_bnyymmddfff_vxx.bak	Name of this file: w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number
TELESCOP	GLAST	Name of mission / spacecraft
INSTRUME	GBM	Name of instrument generating data
DETNAM	'XXX_YY'	Individual detector name XXX = 'NAI' or 'BGO' YY = 00 to 11
OBSERVER	Meegan	Name of instrument PI
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART		Observation's start time
TSTOP		Observation's end time
TRIGTIME		Trigger time (s) since MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP and TRIGTIME keywords
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ		RA of burst
DEC_OBJ		DEC of burst
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits used per pixel - depends on production operating system
NAXIS	0	Number of axes in the primary table

EXTEND	T	Extensions are permitted
CREATOR	GBM_RESPONSE_GENERATOR_V1.0	Software and version creating file
FILETYPE	GBM BACK	Name for this type of FITS file (should be unique)
FILE-VER	1.0.0	Version of the format for this filetype
CHECKSUM		Checksum for entireHDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'YYYY-MM-DDTHH:MM:SS.ss'	Date of start of observation
DATE-END	'YYYY-MM-DDTHH:MM:SS.ss'	Date of end of observation
FILENAME	glg_bck_n0_bnyymmddfff_v01.bak	Name of this file
TELESCOP	GLAST	Name of mission / spacecraft
INSTRUME	GBM	Name of instrument generating data
DETNAM	NAI_00	Individual detector name (if only 1)
OBSERVER	Meegan	Name of instrument PI
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TSTART	3.455751919D7	Observation's start time
TSTOP	3.455772019D7	Observation's end time
TRIGTIME	3.455761920D7	Trigger time (s) since MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP and TRIGTIME keywords
OBJECT	'GRByymmddfff'	Burst name in standard yymmdd format, with the fraction of the day fff given to 3 decimal places
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
RA_OBJ	35.6	RA of source (used for trigger data)
DEC_OBJ	165.3	DEC of source (used for trigger data)
END		End of Header

GS-108 Extension Header 1

Name: EBOUNDS

Purpose: Provides the energy grid for the spectrum channels

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   10 / width of table in bytes
NAXIS2  =                  128 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    3 / number of fields in each row
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 /
TIMEUNIT= 's'                  /
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
DETNAM  = 'xxx_yy'             / Individual detector name:
                                 xxx = 'NAI' or 'BGO'
                                 yy = 00 to 11
FILTER  = 'none'               / Instrument filter in use (if any)
EXTNAME = 'EBOUNDS '           / Extension name
CHANTYPE= 'PHA     '           / Energy channel type
DETCHANS=                  128 / Number of detector channels available
HDUCLASS= 'OGIP'               /
HDUCLAS1= 'SPECTRUM'           /
HDUCLAS2= 'EBOUNDS'            /
HDUVERS = '1.2.0'              /
EXTVER  =                    1 / auto assigned by template parser

TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
TLMIN1  =                    0 / Channel numbers are non-negative
TLMAX1  =                  130 / Greater than the number of channels

TTYPE2  = 'E_MIN   '           / label for field
```

```
TFORM2  = '1E      '           / format of field
TUNIT2  = 'keV     '           / Unit of this field
TLMIN2  =                   5. / Lowest channel energy, 5 keV for NaI
                               detectors, 150 keV for BGO detectors
TLMAX2  =                2000. / Highest channel energy, 2000 keV for
                               NaI detectors, 150 keV for
                               BGO detectors

TTYPE3  = 'E_MAX   '           / label for field
TFORM3  = '1E      '           / format of field
TUNIT3  = 'keV     '           / Unit of this field
TLMIN3  =                   5. / Lowest channel energy, 5 keV for NaI
                               detectors, 150 keV for BGO detectors
TLMAX3  =                2000. / Highest channel energy, 2000 keV for
                               NaI detectors, 150 keV for
                               BGO detectors
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   10 / width of table in bytes
NAXIS2  =                  128 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    3 / number of fields in each row
DATE-OBS= ‘2007-06-04T23:58:46.12’ / Date of start of observation
DATE-END= ‘2007-06-07T13:56:46.12’ / Date of end of observation
MJDREFI =                51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / mission time of observation start
TSTOP   =        3.455772019D7 / mission time of observation end
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = ‘TT’                 /
TIMEUNIT= ‘s’                  /
TELESCOP= ‘GLAST’              / Name of mission
INSTRUME= ‘GBM’                / Name of instrument
OBSERVER= ‘Meegan’             / Name of instrument PI
DATE    = ‘2007-06-08T03:24:45.6’ / Date file was created
OBJECT  = 'GRByymmddfff'       / Burst name
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
DETNAM  = ‘NAI_00’             / Detector name
FILTER  = ‘none‘               / Instrument filter in use (if any)
EXTNAME = 'EBOUNDS '           / Extension name
CHANTYPE= 'PHA     '           / Energy channel type
DETCHANS=                  128 / Number of detector channels available
HDUCLASS= ‘OGIP’               /
HDUCLAS1= ‘SPECTRUM’           /
HDUCLAS2= ‘EBOUNDS’            /
HDUVERS = ‘1.2.0’              /
EXTVER  =                    1 / auto assigned by template parser
```

```
TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
TLMIN1  =                    0 / Channel numbers are non-negative
TLMAX1  =                  130 / Greater than the number of channels

TTYPE2  = 'E_MIN   '           / label for field
TFORM2  = '1E      '           / format of field
TUNIT2  = 'keV     '           / Unit of this field
TLMIN2  =                   5. / Lowest channel energy
TLMAX2  =                2000. / Highest channel energy

TTYPE3  = 'E_MAX   '           / label for field
TFORM3  = '1E      '           / format of field
TUNIT3  = 'keV     '           / Unit of this field
TLMIN2  =                   5. / Lowest channel energy
TLMAX2  =                2000. / Highest channel energy
```

GS-108 Extension Header 2

Name: Spectrum

Purpose: Provides the background counts in each channel.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION=	'BINTABLE'	/ binary table extension
BITPIX =	8	/ 8-bit bytes
NAXIS =	2	/ 2-dimensional binary table
NAXIS1 =		/ width of table in bytes
NAXIS2 =	128	/ number of rows in table
PCOUNT =	0	/ size of special data area
GCOUNT =	1	/ one data group (required keyword)
TFIELDS =	4	/ number of fields in each row
EXTNAME =	'SPECTRUM'	/ Extension name
TELESCOP=	'GLAST'	/ Name of mission
INSTRUME=	'GBM'	/ Name of instrument
OBSERVER=	'Meegan'	/ Name of instrument PI
DATE =	**'yyyy-mm-ddThh:mm:ss.ss'**	/ Date file was created
DETNAM =	'xxx_yy'	/ Individual detector name: xxx = 'NAI' or 'BGO' yy = 00 to 11
FILTER =	'none '	/ Instrument filter in use (if any)
EXPOSURE=		/ Integration time (s) for the PHA data
BACKFILE=	'none '	/ Background file (none here)
CORRFILE=	'none '	/ Correction file (if any)
CORRSCAL=	1.	/ Correction scaling factor
POISSERR=	F	/ Poissonian errors appropriate?
SYS_ERR =	0	/ Systematic error
QUALITY =	0	/ Quality flag
GROUPING=	0	/ Grouping flag
AREASCAL=	1.	/ Effective area scaling factor
BACKSCAL=	1.	/ Background scaling factor
RESPFILE=	'none '	/ Corresponding response file (if any)
ANCRFILE=	'none '	/ Corresponding ARF file (if any)
HDUCLASS=	'OGIP '	/ Format confirms to OGIP standard
HDUCLAS1=	'SPECTRUM'	/ PHA dataset (OGIP memo OGIP-92-007)
HDUCLAS2=	'BKG '	/ Type of data stored
HDUCLAS3=	'RATE '	/ Further details of type of data stored
HDUCLAS4=	'PHA:I '	/ Single PHA dataset
HDUVERS =	'1.2.1 '	/ Format version number
CHANTYPE=	'PHA '	/ Channels corrected?
DETCHANS=	128	/ Number of available detector channels
DATE-OBS=	**'yyyy-mm-ddThh:mm:ss.ss'**	/ Date of start of observation
DATE-END=	**'yyyy-mm-ddThh:mm:ss.ss'**	/ Date of end of observation
MJDREFI =	51910.	/ Reference epoch MJD date, integer part
MJDREFF =	7.428703703703703D-4	/ Reference epoch MJD, fractional part
TSTART =		/ Start time relative to MJDREF
TSTOP =		/ Stop time relative to MJDREF
TRIGTIME=		/ Trigger time (s) relative to MJDREF, double precision
TIMESYS =	'TT'	/

```
TIMEUNIT= 's'                  /
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
NDSKEYS =                   0 / Number of header data subspace keywords
EXTVER  =                   1 / auto assigned by template parser

TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
TLMIN1  =                   0 / Channel numbers are non-negative
TLMAX1  =                 130 / Greater than the number of channels

TTYPE2  = 'RATE    '           / label for field
TFORM2  = '1E      '           / format of field

TTYPE3  = 'STAT_ERR'           / Statistical error
TFORM3  = '1E      '           / format of field

END
```

Example:

FITS Keyword	Value	Purpose

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                   8 / 8-bit bytes
NAXIS   =                   2 / 2-dimensional binary table
NAXIS1  =                     / width of table in bytes
NAXIS2  =                 128 / number of rows in table
PCOUNT  =                   0 / size of special data area
GCOUNT  =                   1 / one data group (required keyword)
TFIELDS =                   4 / number of fields in each row
EXTNAME = 'SPECTRUM'           / Extension name
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = '2007-06-08T19:27:12.6' / Date file was created
DETNAM  = 'NAI_00'             / Detector name
FILTER  = 'none    '           / Instrument filter in use (if any)
EXPOSURE=   99.674147367477417 / Integration time (s) for the PHA data
BACKFILE= 'none    '           / Background file (none here)
CORRFILE= 'none    '           / Correction file (if any)
CORRSCAL=                  1. / Correction scaling factor
POISSERR=                   F / Poissonian errors appropriate?
SYS_ERR =                   0 / Systematic error
QUALITY =                   0 / Quality flag
GROUPING=                   0 / Grouping flag
AREASCAL=                  1. / Effective area scaling factor
BACKSCAL=                  1. / Background scaling factor
RESPFILE= 'none    '           / Corresponding response file (if any)
ANCRFILE= 'none    '           / Corresponding ARF file (if any)
HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
HDUCLAS1= 'SPECTRUM'           / PHA dataset (OGIP memo OGIP-92-007)
HDUCLAS2= 'BKG     '           / Type of data stored
HDUCLAS3= 'RATE    '           / Further details of type of data stored
HDUCLAS4= 'PHA:I   '           / Single PHA dataset
```

```
HDUVERS = '1.2.1   '           / Format version number
CHANTYPE= 'PHA     '           / Channels corrected?
DETCHANS=                  128 / Number of available detector channels
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / mission time of observation start
TSTOP   =        3.455772019D7 / mission time of observation end
TRIGTIME=        3.455751920D7 / Trigger time relative to MJDREF
TIMESYS = 'TT'                 /
TIMEUNIT= 's'                  /
OBJECT  = 'GRB070605401'       /
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
NDSKEYS =                    0 / Number of header data subspace keywords
EXTVER  =                    1 / auto assigned by template parser

TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
TLMIN1  =                    0 / Channel numbers are non-negative
TLMAX1  =                  130 / Greater than the number of channels

TTYPE2  = 'RATE    '           / label for field
TFORM2  = '1E      '           / format of field

TTYPE3  = 'STAT_ERR'           / Statistical error
TFORM3  = '1E      '           / format of field

END
```

GS-108 Extension Header 3

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    2 / number of fields in each row
EXTNAME = 'GTI     '           / Extension name
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
DETNAM  = 'xxx_yy'             / Individual detector name:
                                 xxx = 'NAI' or 'BGO'
                                 yy = 00 to 11
HDUCLASS= 'OGIP    '           / File format is OGIP standard
HDUCLAS1= 'GTI     '           / Contains Good Time Intervals
HDUVERS = '1.2.0   '           / Version of file format
EXPOSURE=                      / Integration time (s) for the PHA data
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / Date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =                      / Start time relative to MJDREF
TSTOP   =                      / Stop time relative to MJDREF
TRIGTIME=                      / Trigger time (s) relative to MJDREF,
                                 double precision
TIMESYS = 'TT'                 /
TIMEUNIT= 's'                  /
OBJECT  = 'GRByymmddfff'       / Burst name—yymmdd = date,
                                 fff = fraction of day
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
EXTVER  =                    1 / auto assigned by template parser

TTYPE1  = 'START   '           / label for field
TFORM1  = '1D      '           / format of field
TUNIT1  = 's       '           / Unit of this field
TZERO1  =                      / Offset (s) relative to MJDREF, equal to
                                 TRIGTIME

TTYPE2  = 'STOP    '           / label for field
TFORM2  = '1D      '           / format of field
TUNIT2  = 's       '           / Unit of this field
```

```
TZERO2  =                      / Offset (s) relative to MJDREF, equal to
                                 TRIGTIME

END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    2 / number of fields in each row
EXTNAME = 'GTI     '           / Extension name
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = '2007-06-08T12:23:45.7' / Date file was created
DETNAM  = 'NAI_00'             / Detector name
HDUCLASS= 'OGIP    '           / File format is OGIP standard
HDUCLAS1= 'GTI     '           / Contains Good Time Intervals
HDUVERS = '1.2.0   '           / Version of file format
EXPOSURE=   99.674147367477417 / Integration time (s) for the PHA data
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TSTART  =        3.455751919D7 / Time of observation start
TSTOP   =        3.455852019D7 / Time of observation end
TRIGTIME=        3.455751920D7 / Trigger time (s) relative to MJDREF
TIMESYS = 'TT'                 /
TIMEUNIT= 's'                  /
OBJECT  = 'GRByymmddfff'       / Burst name
RA_OBJ  =                      / RA of burst, J2000
DEC_OBJ =                      / DEC of burst, J2000
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
EXTVER  =                    1 / auto assigned by template parser

TTYPE1  = 'START   '           / label for field
TFORM1  = '1D      '           / format of field
TUNIT1  = 's       '           / Unit of this field
TZERO1  =        3.455751920D7 / Offset (s), equal to TRIGTIME

TTYPE2  = 'STOP    '           / label for field
TFORM2  = '1D      '           / format of field
TUNIT2  = 's       '           / Unit of this field
TZERO2  =        3.455751920D7 / Offset (s), equal to TRIGTIME

END
```

GS-108 Extension Header 4

Name: BACKMOD

Purpose: If included, this extension provides a polynomial fit to the background in each channel. The order of the fit is provided.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION=	'BINTABLE'	/ binary table extension
BITPIX =	8	/ 8-bit bytes
NAXIS =	2	/ 2-dimensional binary table
NAXIS1 =		/ width of table in bytes
NAXIS2 =	128	/ number of rows in table
PCOUNT =	0	/ size of special data area
GCOUNT =	1	/ one data group (required keyword)
TFIELDS =	2	/ number of fields in each row
EXTNAME =	'BACKMOD '	/ Extension name
TELESCOP=	'GLAST'	/ Name of mission
INSTRUME=	'GBM'	/ Name of instrument
OBSERVER=	'Meegan'	/ Name of instrument PI
DATE =	'yyyy-mm-ddThh:mm:ss.ss'	/ Date file was created
DETNAM =	'xxx_yy'	/ Individual detector name: xxx = 'NAI' or 'BGO' yy = 00 to 11
FILTER =	'none '	/ Instrument filter in use (if any)
CORRFILE=	'none '	/ Correction file (if any)
CORRSCAL=	1.	/ Correction scaling factor
STAT_ERR=	0.	/ Statistical error
SYS_ERR =	0.	/ Systematic error
POISSERR=	F	/ Poissonian errors appropriate?
QUALITY =	0	/ Quality flag
GROUPING=	0	/ Grouping flag
CHANTYPE=	'PHA '	/ Channels corrected?
DETCHANS=	128	/ Number of available detector channels
DATE-OBS=	'yyyy-mm-ddThh:mm:ss.ss'	/ Date of start of observation
DATE-END=	'yyyy-mm-ddThh:mm:ss.ss'	/ Date of end of observation
NORDER =	3	/ Order of fit
MJDREFI =	51910.	/ Reference epoch MJD date, integer part
MJDREFF =	7.428703703703703D-4	/ Reference epoch MJD, fractional part
TSTART =		/ Start time relative to MJDREF
TSTOP =		/ Stop time relative to MJDREF
TRIGTIME=		/ Trigger time (s) relative to MJDREF, double precision
TIMESYS =	'TT'	/
TIMEUNIT=	's'	/
OBJECT =	'GRByymmddfff'	/ Burst name—yymmdd = date, fff = fraction of day
RA_OBJ =		/ RA of burst, J2000
DEC_OBJ =		/ DEC of burst, J2000
EQUINOX =	2000.	/ Equinox of RA & DEC specifications
RADECSYS=	'FK5 '	/ world coord. system (FK5 or FK4)
NDSKEYS =	0	/ Number of header data subspace keywords
EXTVER =	1	/ auto assigned by template parser

```
TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
TLMIN1  =                    0 / Channel numbers are non-negative
TLMAX1  =                  130 / Greater than the number of channels

TTYPE2  = 'RATECOEF'           / Rate coefficients
TFORM2  = 'PE(####)'           / Array of size NORDER+1
END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                  128 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    2 / number of fields in each row
EXTNAME = 'BACKMOD '           / Extension name
TELESCOP= 'GLAST'              / Name of mission
INSTRUME= 'GBM'                / Name of instrument
OBSERVER= 'Meegan'             / Name of instrument PI
DATE    = '2007-06-08T01:18:53.7' / Date file was created
DETNAM  = 'NAI_00'             / Detector name
FILTER  = 'none    '           / Instrument filter in use (if any)
CORRFILE= 'none    '           / Correction file (if any)
CORRSCAL=                   1. / Correction scaling factor
STAT_ERR=                   0. / Statistical error
SYS_ERR =                   0. / Systematic error
POISSERR=                    F / Poissonian errors appropriate?
QUALITY =                    0 / Quality flag
GROUPING=                    0 / Grouping flag
CHANTYPE= 'PHA     '           / Channels corrected?
DETCHANS=                  128 / Number of available detector channels
DATE-OBS= '2007-06-04T23:58:46.12' / Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / Date of end of observation
MJDREFI =               51910. / Reference epoch MJD date, integer part
MJDREFF = 7.428703703703703D-4 / Reference epoch MJD, fractional part
TRIGTIME=       3.455751920D7 / Trigger time (s) relative to MJDREF
NORDER  =                    3 / Order of fit
TSTART  =       3.455751919D7 / mission time of observation start
TSTOP   =       3.455772019D7 / mission time of observation end
TIMESYS = 'TT'                 /
TIMEUNIT= 's'                  /
OBJECT  = 'GRB070605401'       /
RA_OBJ  =                 35.6 / RA of source
DEC_OBJ =                165.3 / DEC of source
EQUINOX =                2000. / Equinox of RA & DEC specifications
RADECSYS= 'FK5     '           / world coord. system (FK5 or FK4)
NDSKEYS =                    0 / Number of header data subspace keywords
EXTVER  =                    1 / auto assigned by template parser

TTYPE1  = 'CHANNEL '           / label for field
TFORM1  = '1I      '           / format of field
```

```
TLMIN1  =                    0 / Channel numbers are non-negative
TLMAX1  =                  130 / Greater than the number of channels

TTYPE2  = 'RATECOEF'           / Rate coefficients
TFORM2  = 'PE(####)'           / Array of size NORDER+1

END
```

6.15. LS-001 Event Summary Data

Version: 3.2

Revision date: 12/14/06

Product Description:
File containing the event list for a single TDRSS pass. The events included are a subset of all the events telemetered down from the LAT and a superset of the events considered photons (contained in LS-002).

Currently the definition is the same as an FT1 file. In the future a large fraction of the merit n-tuple for each event will be provided provided.

Naming Convention	gll_evsum_yymmdd_cn_vxx.fit	yymmdd = date n = pass number xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 day	
Product contains data for	1 Ku Band Downlink (TBR)	
Number of deliveries per day	6-8	
Typical size	250 Mbyte	

Product Content	
Primary HDU:	Standard GLAST FITS Primary Header
Extension 1	Event list
Extension 2	GTI

LS-001 Primary Header

Definition:

```
SIMPLE  = T                         / file does conform to FITS standard
BITPIX  = 8                         / number of bits per data pixel
NAXIS   = 0                         / number of data axes
EXTEND  = T                         / FITS dataset may contain extensions
CHECKSUM=                           / checksum for entire HDU
TELESCOP= 'GLAST'                   / name of telescope generating data
INSTRUME= 'LAT'                     / name of instrument generating data
EQUINOX = 2000.0                    / equinox for ra and dec
RADECSYS= 'FK5'                     / world coord. system for this file
                                        (FK5 or FK4)
DATE    = 'YYYY-MM-DDThh:mm:ss'     / file creation date (UTC)
DATE-OBS= 'YYYY-MM-DDThh:mm:ss'     / start date/time of the obs. (UTC)
DATE-END= 'YYYY-MM-DDThh:mm:ss'     / end date/time of the obs. (UTC)
TSTART  =                           / mission time of the obs. start
TSTOP   =                           / mission time of the obs. end
TIMEUNIT= 's'                       / units for the time related keywords
TIMESYS = 'TT'                      / type of time system that is used
MJDREFI = 51910.0                   / Int. part of MJD of SC clock start
MJDREFF =     7.428703703703703D-4  / Frac. part of MJD of SC clock start
OBSERVER= 'Peter Michelson'         / LAT PI
FILENAME= 'gll_evsum_yymmdd_cn_vxx.fit' / name of this file:
                                          yymmdd = date
                                          n = pass number
                                          xx = version number
ORIGIN  = 'LISOC'                   / name of organization making file
CREATOR =                           / software and version creating file
VERSION = 1                         / release version of the file
END
```

Example:

```
SIMPLE  = T                         / file does conform to FITS standard
BITPIX  = 8                         / number of bits per data pixel
NAXIS   = 0                         / number of data axes
EXTEND  = T                         / FITS dataset may contain extensions
CHECKSUM=                           / checksum for entire HDU
TELESCOP= 'GLAST'                   / name of telescope generating data
INSTRUME= 'LAT'                     / name of instrument generating data
EQUINOX = 2000.0                    / equinox for ra and dec
RADECSYS= 'FK5'                     / world coord. system (FK5 or FK4)
DATE    = '2009-01-09T23:22:12'     / file creation date (UTC)
DATE-OBS= '2009-01-09T01:02:03'     / start date/time of the obs. (UTC)
DATE-END= '2009-01-09T03:52:10'     / end date/time of the obs. (UTC)
TSTART  =           253155723.184 / mission time of the obs. start
TSTOP   =           253165930.184 / mission time of the obs. end
TIMEUNIT= 's'                       / units for the time related keywords
TIMESYS = 'TT'                      / type of time system that is used
MJDREFI = 51910.0                   / Int. part of MJD of SC clock start
MJDREFF =     7.428703703703703D-4  / Frac. part of MJD of SC clock start
OBSERVER= 'Peter Michelson'         / LAT PI
FILENAME= 'gll_evsum_090109_c1_v00.fit' / name of this file:
ORIGIN  = 'LISOC'                   / name of organization making file
CREATOR =                           / software and version creating file
VERSION = 1                         / release version of the file
END
```

LS-001 Extension Header 1

Name: EVENTS

Purpose: This extension lists provides the event list.

Definition:

```
XTENSION= 'BINTABLE'               / binary table extension
BITPIX  = 8                        / 8-bit bytes
NAXIS   = 2                        / 2-dimensional binary table
NAXIS1  =                          / width of table in bytes
NAXIS2  =                          / number of rows in table
PCOUNT  =                        0 / size of special data area
GCOUNT  = 1                        / one data group (required keyword)
TFIELDS =                       17 / number of fields in each row
CHECKSUM=                          / checksum for entire HDU
DATASUM =                          / checksum for data table
TELESCOP= 'GLAST'                  / name of telescope generating data
INSTRUME= 'LAT'                    / name of instr. generating data
EQUINOX = 2000.0                   / equinox for ra and dec
RADECSYS= 'FK5'                    / world coord. system for this file
                                       (FK5 or FK4)
DATE    = 'YYYY-MM-DDThh:mm:ss'    / file creation date (UTC)
DATE-OBS= 'YYYY-MM-DDThh:mm:ss'    / start date/time of the obs. (UTC)
DATE-END= 'YYYY-MM-DDThh:mm:ss'    / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'        / LAT PI
ORIGIN  = 'LISOC'                  / name of organization making file
EXTNAME = 'EVENTS'                 / name of this binary table extension
HDUCLASS= 'OGIP'                   / format conforms to OGIP standard
HDUCLAS1= 'EVENTS'                 / ext. contains events
HDUCLAS2= 'ALL'                    / ext. contains all events detected
TSTART  =                          / mission time of the obs. start
TSTOP   =                          / mission time of the obs. end
MJDREFI = 51910.0                  / Int. part of MJD of SC clock start
MJDREFF =     7.428703703703703D-4 / Frac. part of MJD of SC clock start
TIMEUNIT= 's'                      / units for the time related keywords
TIMEZERO= 0.0                      / clock correction
TIMESYS = 'TT'                     / type of time system that is used
TIMEREF = 'LOCAL'                  / reference frame used for times
CLOCKAPP=                          / clock drift correction applied?
GPS_OUT =                          / GPS time unavailable at any time
                                       during interval?
NDSKEYS = 0                        / # of data subspace keywords in
                                       header
TTYPE1  = 'ENERGY'                 / energy of event
TFORM1  = 'E'                      / data format of field: 4-byte REAL
TUNIT1  = 'MeV'                    / physical unit of field
TLMIN1  = 0.0                      / minimum value
TLMAX1  = 1.0e+7                   / maximum value
TTYPE2  = 'RA'                     / right ascension (J2000) of event
TFORM2  = 'E'                      / data format of field: 4-byte REAL
TUNIT2  = 'deg'                    / physical unit of field
TLMIN2  = 0.0                      / minimum value
TLMAX2  = 360.0                    / maximum value
TTYPE3  = 'DEC'                    / declination (J2000) of event
TFORM3  = 'E'                      / data format of field: 4-byte REAL
TUNIT3  = 'deg'                    / physical unit of field
TLMIN3  = -90.0                    / minimum value
TLMAX3  = 90.0                     / maximum value
TTYPE4  = 'L'                      / Galactic longitude of event
```

```
TFORM4  = 'E'                   / data format of field: 4-byte REAL
TUNIT4  = 'deg'                 / physical unit of field
TLMIN4  = 0.0                   / minimum value
TLMAX4  = 360.0                 / maximum value
TTYPE5  = 'B'                   / Galactic latitude of event
TFORM5  = 'E'                   / data format of field: 4-byte REAL
TUNIT5  = 'deg'                 / physical unit of field
TLMIN5  = -90.0                 / minimum value
TLMAX5  = 90.0                  / maximum value
TTYPE6  = 'THETA'               / inclination angle of event in
                                    instrument coordinates
TFORM6  = 'E'                   / data format of field: 4-byte REAL
TUNIT6  = 'deg'                 / physical unit of field
TLMIN6  = 0.0                   / minimum value
TLMAX6  = 180.0                 / maximum value
TTYPE7  = 'PHI'                 / azimuthal angle of event in
                                    instrument coordinates
TFORM7  = 'E'                   / data format of field: 4-byte REAL
TUNIT7  = 'deg'                 / physical unit of field
TLMIN7  = 0.0                   / minimum value
TLMAX7  = 360.0                 / maximum value
TTYPE8  = 'ZENITH_ANGLE'        / zenith angle of event
TFORM8  = 'E'                   / data format of field: 4-byte REAL
TUNIT8  = 'deg'                 / physical unit of field
TLMIN8  = 0.0                   / minimum value
TLMAX8  = 180.0                 / maximum value
TTYPE9  = 'EARTH_AZIMUTH_ANGLE' / Earth azimuth (from north to east)
                                    of event
TFORM9  = 'E'                   / data format of field: 4-byte REAL
TUNIT9  = 'deg'                 / physical unit of field
TLMIN9  = 0.0                   / minimum value
TLMAX9  = 360.0                 / maximum value
TTYPE10 = 'TIME'                / Mission Elapsed Time
TFORM10 = 'D'                   / data format of field: 8-byte DOUBLE
TUNIT10 = 's'                   / physical unit of field
TLMIN10 = 0.0                   / minimum value
TLMAX10 = 1.0D+10               / maximum value
TTYPE11 = 'EVENT_ID'            / ID number of original event
TFORM11 = 'J'                   / data format of field: 4-byte signed
                                    INTEGER
TLMIN11 = 0                     / minimum value
TLMAX11 = 2147483647            / maximum value
TTYPE12 = 'RUN_ID'              / Run number of original event
TFORM12 = 'J'                   / data format of field: 4-byte signed
                                    INTEGER
TLMIN12 = 0                     / minimum value
TLMAX12 = 2147483647            / maximum value
TTYPE13 = 'RECON_VERSION'       / version of event reconstruction
                                    software
TFORM13 = 'I'                   / data format of field: 2-byte signed
                                    INTEGER
TLMIN13 = 0                     / minimum value
TLMAX13 = 32767                 / maximum value
TTYPE14 = 'CALIB_VERSION'       / versions of calibration tables for
                                    the ACD, CAL, TKR
TFORM14 = '3I'                  / data format of field: 2-byte signed
                                    INTEGER
TTYPE15 = 'EVENT_CLASS'         / event class: 0=Front converting
                                    class A, 1=Back A, 2=Front B,
                                    3=Back B
TFORM15 = 'I'                   / data format of field: 2-byte signed
                                    INTEGER
TLMIN15 =  0                    / minimum value
TLMAX15 =  32767                / maximum value
```

```
TTYPE16 = 'CONVERSION_TYPE'        / type of conversion: 0=Front converting, 1=Back
TFORM16 = 'I'                      / data format of field: 2-byte signed
                                       INTEGER
TLMIN16 =  0                       / minimum value
TLMAX16 =  32767                   / maximum value
TTYPE17 = 'LIVETIME'               / Accumulated livetime since mission
                                       start
TFORM17 = 'D'                      / data format of field: 8-byte DOUBLE
TUNIT17 = 's'                      / physical unit of field
TLMIN17 = 0.0                      / minimum value
TLMAX17 = 1.0D+10                  / maximum value
END
```

Example:

```
XTENSION= 'BINTABLE'               / binary table extension
BITPIX  = 8                        / 8-bit bytes
NAXIS   = 2                        / 2-dimensional binary table
NAXIS1  =                          / width of table in bytes
NAXIS2  =                          / number of rows in table
PCOUNT  =                        0 / size of special data area
GCOUNT  = 1                        / one data group (required keyword)
TFIELDS =                       17 / number of fields in each row
CHECKSUM=                          / checksum for entire HDU
DATASUM =                          / checksum for data table
TELESCOP= 'GLAST'                  / name of telescope generating data
INSTRUME= 'LAT'                    / name of instr. generating data
EQUINOX = 2000.0                   / equinox for ra and dec
RADECSYS= 'FK5'                / world coord. system for this file (FK5 or FK4)
DATE    = '2009-01-09T23:22:12'    / file creation date (UTC)
DATE-OBS= '2009-01-09T01:02:03'    / start date/time of the obs. (UTC)
DATE-END= '2009-01-09T03:52:10'    / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'        / LAT PI
ORIGIN  = 'LISOC'                  / name of organization making file
EXTNAME = 'EVENTS'                 / name of this binary table extension
HDUCLASS= 'OGIP'                   / format conforms to OGIP standard
HDUCLAS1= 'EVENTS'                 / ext. contains events
HDUCLAS2= 'ALL'                    / ext. contains all events detected
TSTART  =           253155723.184 / mission time of the obs. start
TSTOP   =           253165930.184 / mission time of the obs. end
MJDREFI = 51910.0                  / Int. part of MJD of SC clock start
MJDREFF =     7.428703703703703D-4 / Frac. part of MJD of SC clock start
TIMEUNIT= 's'                      / units for the time related keywords
TIMEZERO= 0.0                      / clock correction
TIMESYS = 'TT'                     / type of time system that is used
TIMEREF = 'LOCAL'                  / reference frame used for times
CLOCKAPP= 'NO'                     / clock drift correction applied?
GPS_OUT = 'NO'               / GPS time unavailable at any time during interval?
NDSKEYS = 0                        / # of data subspace keywords in header
TTYPE1  = 'ENERGY'                 / energy of event
TFORM1  = 'E'                      / data format of field: 4-byte REAL
TUNIT1  = 'MeV'                    / physical unit of field
TLMIN1  = 0.0                      / minimum value
TLMAX1  = 1.0e+7                   / maximum value
TTYPE2  = 'RA'                     / right ascension (J2000) of event
TFORM2  = 'E'                      / data format of field: 4-byte REAL
TUNIT2  = 'deg'                    / physical unit of field
TLMIN2  = 0.0                      / minimum value
TLMAX2  = 360.0                    / maximum value
TTYPE3  = 'DEC'                    / declination (J2000) of event
TFORM3  = 'E'                      / data format of field: 4-byte REAL
TUNIT3  = 'deg'                    / physical unit of field
TLMIN3  = -90.0                    / minimum value
TLMAX3  = 90.0                     / maximum value
```

```
TTYPE4  = 'L'                     / Galactic longitude of event
TFORM4  = 'E'                     / data format of field: 4-byte REAL
TUNIT4  = 'deg'                   / physical unit of field
TLMIN4  = 0.0                     / minimum value
TLMAX4  = 360.0                   / maximum value
TTYPE5  = 'B'                     / Galactic latitude of event
TFORM5  = 'E'                     / data format of field: 4-byte REAL
TUNIT5  = 'deg'                   / physical unit of field
TLMIN5  = -90.0                   / minimum value
TLMAX5  = 90.0                    / maximum value
TTYPE6  = 'THETA'                 / event inclination angle in instr. cood.
TFORM6  = 'E'                     / data format of field: 4-byte REAL
TUNIT6  = 'deg'                   / physical unit of field
TLMIN6  = 0.0                     / minimum value
TLMAX6  = 180.0                   / maximum value
TTYPE7  = 'PHI'                   / event azimuthal angle in instr. cood.
TFORM7  = 'E'                     / data format of field: 4-byte REAL
TUNIT7  = 'deg'                   / physical unit of field
TLMIN7  = 0.0                     / minimum value
TLMAX7  = 360.0                   / maximum value
TTYPE8  = 'ZENITH_ANGLE'          / zenith angle of event
TFORM8  = 'E'                     / data format of field: 4-byte REAL
TUNIT8  = 'deg'                   / physical unit of field
TLMIN8  = 0.0                     / minimum value
TLMAX8  = 180.0                   / maximum value
TTYPE9  = 'EARTH_AZIMUTH_ANGLE'   / Event Earth azimuth (from north to east)
TFORM9  = 'E'                     / data format of field: 4-byte REAL
TUNIT9  = 'deg'                   / physical unit of field
TLMIN9  = 0.0                     / minimum value
TLMAX9  = 360.0                   / maximum value
TTYPE10 = 'TIME'                  / Mission Elapsed Time
TFORM10 = 'D'                     / data format of field: 8-byte DOUBLE
TUNIT10 = 's'                     / physical unit of field
TLMIN10 = 0.0                     / minimum value
TLMAX10 = 1.0D+10                 / maximum value
TTYPE11 = 'EVENT_ID'              / ID number of original event
TFORM11 = 'J'                     / field data format: 4-byte signed INTEGER
TLMIN11 = 0                       / minimum value
TLMAX11 = 2147483647              / maximum value
TTYPE12 = 'RUN_ID'                / Run number of original event
TFORM12 = 'J'                     / field data format: 4-byte signed INTEGER
TLMIN12 = 0                       / minimum value
TLMAX12 = 2147483647              / maximum value
TTYPE13 = 'RECON_VERSION'         / event reconstruction software version
TFORM13 = 'I'                     / field data format: 2-byte signed INTEGER
TLMIN13 = 0                       / minimum value
TLMAX13 = 32767                   / maximum value
TTYPE14 = 'CALIB_VERSION'         / calib. table versions for ACD, CAL, TKR
TFORM14 = '3I'                    / field data format: 2-byte signed INTEGER
TTYPE15 = 'EVENT_CLASS'   / class: 0=Front, A; 1=Back, A; 2=Front B; 3=Back, B
TFORM15 = 'I'                     / field data format: 2-byte signed INTEGER
TLMIN15 =  0                      / minimum value
TLMAX15 =  32767                  / maximum value
TTYPE16 = 'CONVERSION_TYPE'       / conversion type: 0=Front, 1=Back
TFORM16 = 'I'                     / field data format: 2-byte signed INTEGER
TLMIN16 =  0                      / minimum value
TLMAX16 =  32767                  / maximum value
TTYPE17 = 'LIVETIME'              / Accumulated livetime since mission start
TFORM17 = 'D'                     / data format of field: 8-byte DOUBLE
TUNIT17 = 's'                     / physical unit of field
TLMIN17 = 0.0                     / minimum value
TLMAX17 = 1.0D+10                 / maximum value
END
```

LS-001 Extension Header 2

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

```
XTENSION= 'BINTABLE'                / binary table extension
BITPIX  = 8                         / 8-bit bytes
NAXIS   = 2                         / 2-dimensional binary table
NAXIS1  =                           / width of table in bytes
NAXIS2  =                           / number of rows in table
PCOUNT  =                         0 / size of special data area
GCOUNT  = 1                         / one data group (required
                                        keyword)
TFIELDS =                         2 / number of fields in each row
CHECKSUM=                           / checksum for entire HDU
DATASUM =                           / checksum for data table
TELESCOP= 'GLAST'                   / name of telescope generating
                                        data
INSTRUME= 'LAT'                     / name of instrument generating
                                        data
EQUINOX = 2000.0                    / equinox for ra and dec
RADECSYS= 'FK5'                     / world coord. system for this
                                         file (FK5 or FK4)
DATE    = 'YYYY-MM-DDThh:mm:ss'     / file creation date (UTC)
DATE-OBS= 'YYYY-MM-DDThh:mm:ss'    / start date/time of the obs. (UTC)
DATE-END= 'YYYY-MM-DDThh:mm:ss'     / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'       / LAT PI
ORIGIN  = 'LISOC'                 / name of organization making file
EXTNAME = 'GTI'                     / name of this binary table ext.
HDUCLASS= 'OGIP'                    / format conforms to OGIP standard
HDUCLAS1= 'GTI'                    / ext. contains good time intervals
HDUCLAS2= 'ALL'                     / ext. contains all science time
TSTART  =                           / mission time of the obs. start
TSTOP   =                           / mission time of the obs. end
MJDREFI = 51910.0                 / Int. part of MJD of SC clock start
MJDREFF =     7.428703703703703D-4 / Frac. part of MJD of SC clock start
TIMEUNIT= 's'                       / units for time-related keywords
TIMEZERO= 0.0                       / clock correction
TIMESYS = 'TT'                      / type of time system that is used
TIMEREF = 'LOCAL'                   / reference frame used for times
CLOCKAPP=                           / clock drift correction applied?
GPS_OUT =                           / GPS time was unavailable at any
                                        time during this interval?
ONTIME  =                           / sum of GTI lengths
TELAPSE =                           / time between first GTI START and
                                        last GTI STOP
TTYPE1  = 'START'                   / start time of good time
                                        intervals
TFORM1  = 'D'                       / field data format: 8-byte DOUBLE
TUNIT1  = 's'                       / physical unit of field
TLMIN1  = 0.0                       / minimum value
TLMAX1  = 1.0D+10                   / maximum value
TTYPE2  = 'STOP'                    / stop time of good time intervals
TFORM2  = 'D'                       / field data format: 8-byte DOUBLE
TUNIT2  = 's'                       / physical unit of field
TLMIN2  = 0.0                       / minimum value
TLMAX2  = 1.0D+10                   / maximum value
END
```

Example:

```
XTENSION= 'BINTABLE'                  / binary table extension
BITPIX  = 8                           / 8-bit bytes
NAXIS   = 2                           / 2-dimensional binary table
NAXIS1  =                             / width of table in bytes
NAXIS2  =                             / number of rows in table
PCOUNT  =                           0 / size of special data area
GCOUNT  = 1                           / one data group (required keyword)
TFIELDS =                           2 / number of fields in each row
CHECKSUM=                             / checksum for entire HDU
DATASUM =                             / checksum for data table
TELESCOP= 'GLAST'                     / name of telescope generating data
INSTRUME= 'LAT'                       / name of instr. generating data
EQUINOX = 2000.0                      / equinox for ra and dec
RADECSYS= 'FK5'                     / world coord. system for file (FK5 or FK4)
DATE    = '2009-01-09T23:22:12'     / file creation date (UTC)
DATE-OBS= '2009-01-09T01:02:03'     / start date/time of the obs. (UTC)
DATE-END= '2009-01-09T03:52:10'     / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'         / LAT PI
ORIGIN  = 'LISOC'                   / name of organization making file
EXTNAME = 'GTI'                       / name of this binary table ext.
HDUCLASS= 'OGIP'                      / format conforms to OGIP standard
HDUCLAS1= 'GTI'                      / ext. contains good time intervals
HDUCLAS2= 'ALL'                       / ext. contains all science time
TSTART  =           253155723.184 / mission time of the obs. start
TSTOP   =           253165930.184 / mission time of the obs. end
MJDREFI = 51910.0                  / Int. part of MJD of SC clock start
MJDREFF =    7.428703703703703D-4 / Frac. part of MJD of SC clock start
TIMEUNIT= 's'                         / units for time-related keywords
TIMEZERO= 0.0                         / clock correction
TIMESYS = 'TT'                        / type of time system that is used
TIMEREF = 'LOCAL'                     / reference frame used for times
CLOCKAPP= 'NO'                        / clock drift correction applied?
GPS_OUT = 'NO'                    / GPS time was unavailable during interval?
ONTIME  =                  10207.0 / sum of GTI lengths
TELAPSE =            10207.0 / time between first GTI START and last GTI STOP
TTYPE1  = 'START'                     / start time of good time intervals
TFORM1  = 'D'                         / field data format: 8-byte DOUBLE
TUNIT1  = 's'                         / physical unit of field
TLMIN1  = 0.0                         / minimum value
TLMAX1  = 1.0D+10                     / maximum value
TTYPE2  = 'STOP'                      / stop time of good time intervals
TFORM2  = 'D'                         / field data format: 8-byte DOUBLE
TUNIT2  = 's'                         / physical unit of field
TLMIN2  = 0.0                         / minimum value
TLMAX2  = 1.0D+10                     / maximum value
END
```

6.16. LS-002 LAT Photons

Version: 2.0

Revision date: 12/13/06

Product Description:
These event files contain the events considered to be photons detected by the LAT. The data provided per photon is a subset of the data per event in LS-001. The format is FT1. The GSSC will aggregate the photons into progressively longer lists.

Naming Convention	gll_phsum_yymmdd_c#_v##.fit
Originator of Product	LISOC
Product Format	FITS
Production Latency Requirement	1 day
Product contains data for	1 Ku downlink
Number of deliveries per day	6
Typical size	~15 Mbyte

Product Content	
Primary HDU:	
Extension 1	LAT event summary
Extension 2	Good time intervals

LS-001 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
EXTEND	T	Extension(s) present
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'	Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'	End date and time of observation
FILENAME	'gll_evsum_yymmdd_c#_v##.fit'	Name of this file
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
CREATOR	'EVENT_SUMMARY_MAKER_V##'	Software and version creating files
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
EXTEND	T	Extension(s) present
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'2010-12-03T12:34:25.6'	File creation date
DATE-OBS	'2010-12-02T02:31:45.6'	Start date and time of observation
DATE-END	'2010-12-02T05:41:43.6'	End date and time of observation
FILENAME	'gll_evsum_yymmdd_c#_v##.fit'	Name of this file
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
CREATOR	'EVENT_SUMMARY_MAKER_V##'	Software and version creating files
VERSION	#	Release version of the model

SOFTWARE	#	Version of the generating software
END		

LS-002 Extension Header 1

Name: EVENTS

Purpose: This extension provides the event list for events considered to be photons. The columns are a subset of the columns in LS-002.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
GCOUNT	1	No multiplier
TFIELDS	###	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'	Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'	End date and time of observation
EXTNAME	'EVENTS'	Name of the extension
HDUCLASS	'OGIP'	Conforms to OGIP standard
HDUCLAS1	'EVENTS'	Extension contains events
HDUCLAS2	'ALL'	Extensions contains all events detected
TSTART	###	Mission time of the observation start
TSTOP	###	Mission time of the observation end
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'	Units for time
TIMESYS	'TT'	Time system
TIMEREF	'LOCAL'	Reference frame for times
TASSIGN	'SATELLITE'	Location where time assignment performed
CLOCKAPP	T or F	Clock drift correction applied?
GPS_OUT	T or F	Whether GPS time was unavailable at any time
OBS_ID	###	Observation ID number
OBJECT	TBD	Observed object
MC_TRUTH	T or F	MC truth columns included?
NDSKEYS	3	# of data subspace keywords in header
DSTYP1	'POS(RA,DEC)'	Type of data filtering
DSUN1	'deg'	Physical unit of filtering parameters
DSVAL1	'circle(100.0,20.0,15.0)'	Value range of filtering parameters

DSTYP2	'TIME'	Type of data filtering
DSUNI2	's'	Physical unit of filtering parameters
DSVAL2	'10.993700:1000000.0'	Value range of filtering parameters
DSTYP3	'ENERGY'	Type of data filtering
DSUNI3	'GeV'	Physical unit of filtering parameters
DSVAL3	'0.511:100.312'	Value range of filtering parameters
TTYPE1	'ENERGY'	Event energy
TFORM1	'1E '	4-byte REAL
TUNIT1	'MeV'	
TLMIN1	0.0	Minimum value
TLMAX1	1.0e+7	Maximum value
TTYPE2	'RA'	RA (J2000)
TFORM2	'1E '	4-byte REAL
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'DEC'	DEC (J2000)
TFORM3	'1E '	4-byte REAL
TUNIT3	'deg'	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	'THETA	Inclination in instrument coordinates
TFORM4	'1E '	4-byte REAL
TUNIT4	'deg'	
TLMIN4	0.0	Minimum value
TLMAX4	180.0	Maximum value
TTYPE5	'PHI'	Azimuth in instrument coordinates
TFORM5	'1E '	4-byte REAL
TUNIT5	'deg'	
TLMIN5	0.0	Minimum value
TLMAX5	180.0	Maximum value
TTYPE6	'ZENITH_ANGLE'	Zenith angle
TFORM6	'1E '	4-byte REAL
TUNIT6	'deg'	
TLMIN6	0.0	Minimum value
TLMAX6	180.0	Maximum value
TTYPE7	EARTH_AXIMUTH_ANGLE	Earth azimuth (from north to east)
TFORM7	'1E '	4-byte REAL
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	'TIME'	Mission elapsed time
TFORM8	'1D '	8-byte DOUBLE
TUNIT8	's'	
TLMIN8	0.0	Minimum value
TLMAX8	1.0D+10	Maximum value

TTYPE9	'EVENT_ID'	ID of original event
TFORM9	'1J '	4-byte signed INTEGER
TLMIN9	0	Minimum value
TLMAX9	2147483647	Maximum value
TTYPE10	'RECON_VERSION'	
TFORM10	'1I '	2-byte signed INTEGER
TLMIN10	0	Minimum value
TLMAX10	32767	Maximum value
TTYPE11	'CALIB_VERSION'	Versions of calibration tables for the ACD, CAL, TKR
TFORM11	'3I '	2-byte signed INTEGER
TTYPE12	'IMGOODCALPROB'	Classification tree probability that CAL energy is well-measured
TFORM12	'1E '	4-byte REAL
TUNIT12	' '	Dimensionless
TLMIN12	0.0	Minimum value
TLMAX12	1.0	Maximum value
TTYPE13	'IMVERTEXPROB'	Classification tree probability that the vertex gives a better measure of the direction than the best track alone
TFORM13	'1E '	4-byte REAL
TUNIT13	' '	Dimensionless
TLMIN13	0.0	Minimum value
TLMAX13	1.0	Maximum value
TTYPE14	'IMCOREPROB'	Classification tree probability that the event is in the core of the PSF
TFORM14	'1E '	4-byte REAL
TUNIT14	' '	Dimensionless
TLMIN14	0.0	Minimum value
TLMAX14	1.0	Maximum value
TTYPE15	'IMPSFERRPRED'	Classification tree prediction of the PSF for this event, normalized to the 68% point predicted from an analytic model
TFORM15	'1E '	4-byte REAL
TUNIT15	' '	Dimensionless
TLMIN15	0.0	Minimum value
TLMAX15	100.0	Maximum value
TTYPE16	'CALENERGYSUM'	Sum of the raw energies in all the crystals
TFORM16	'1E '	4-byte REAL
TUNIT16	'MeV'	
TLMIN16	0.0	Minimum value
TLMAX16	1.0e+7	Maximum value
TTYPE17	'CALTOTRLN'	Total radiation lengths integrated along trajectory first track
TFORM17	'1E '	4-byte REAL
TUNIT17	' '	Dimensionless
TLMIN17	0.0	Minimum value
TLMAX17	100.0	Maximum value
TTYPE18	'IMGAMMAPROB'	Classification tree probability that the event is

		a gamma ray
TFORM18	‘1E ‘	4-byte REAL
TUNIT18	‘ ’	Dimensionless
TLMIN18	0.0	Minimum value
TLMAX18	1.0	Maximum value
TTYPE19	‘CONVERSION_POINT’	Reconstructed 3-space conversion point in instrument coordinates
TFORM19	‘3E ’	4-byte REAL
TUNIT19	‘m’	
TTYPE20	‘CONVERSION_LAYER’	Conversion layer in TKR, -1 means not in TKR
TFORM20	‘1I ’	2-byte INTEGER
TLMIN20	-1	Minimum value
TLMAX20	18	Maximum value
TTYPE21	‘PULSE_PHASE’	
TFORM21	‘1D ‘	8-byte DOUBLE
TUNIT21	‘ ’	Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value

END

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
GCOUNT	1	No multiplier
TFIELDS	###	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World coord. system for this file (FK5 or FK4)
DATE	'2010-12-03T12:34:25.6'	File creation date
DATE-OBS	'2010-12-02T02:31:45.6'	Start date and time of observation
DATE-END	'2010-12-02T05:41:43.6'	End date and time of observation
EXTNAME	'EVENTS'	Name of the extension
HDUCLASS	‘OGIP’	Conforms to OGIP standard
HDUCLAS1	‘EVENTS’	Extension contains events
HDUCLAS2	‘ALL’	Extensions contains all events detected
TSTART	###	Mission time of the observation start
TSTOP	###	Mission time of the observation end
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part

TIMEUNIT	‘s’	Units for time
TIMESYS	‘TT’	Time system
TIMEREF	‘LOCAL’	Reference frame for times
TASSIGN	‘SATELLITE’	Location where time assignment performed
CLOCKAPP	T or F	Clock drift correction applied?
GPS_OUT	T or F	Whether GPS time was unavailable at any time
OBS_ID	###	Observation ID number
OBJECT	TBD	Observed object
MC_TRUTH	T or F	MC truth columns included?
NDSKEYS	3	# of data subspace keywords in header
DSTYP1	‘POS(RA,DEC)’	Type of data filtering
DSUN1	‘deg’	Physical unit of filtering parameters
DSVAL1	‘circle(100.0,20.0,15.0)’	Value range of filtering parameters
DSTYP2	‘TIME’	Type of data filtering
DSUNI2	‘s’	Physical unit of filtering parameters
DSVAL2	’10.993700:1000000.0’	Value range of filtering parameters
DSTYP3	‘ENERGY’	Type of data filtering
DSUNI3	‘GeV’	Physical unit of filtering parameters
DSVAL3	‘0.511:100.312’	Value range of filtering parameters
TTYPE1	‘ENERGY’	Event energy
TFORM1	‘1E ‘	4-byte REAL
TUNIT1	‘MeV’	
TLMIN1	0.0	Minimum value
TLMAX1	1.0e+7	Maximum value
TTYPE2	‘RA’	RA (J2000)
TFORM2	‘1E ‘	4-byte REAL
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	‘DEC’	DEC (J2000)
TFORM3	‘1E ‘	4-byte REAL
TUNIT3	‘deg’	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	‘THETA	Inclination in instrument coordinates
TFORM4	‘1E ‘	4-byte REAL
TUNIT4	‘deg’	
TLMIN4	0.0	Minimum value
TLMAX4	180.0	Maximum value
TTYPE5	‘PHI’	Azimuth in instrument coordinates
TFORM5	‘1E ‘	4-byte REAL
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	180.0	Maximum value
TTYPE6	‘ZENITH_ANGLE’	Zenith angle
TFORM6	‘1E ‘	4-byte REAL
TUNIT6	‘deg’	
TLMIN6	0.0	Minimum value

TLMAX6	180.0	Maximum value
TTYPE7	EARTH_AXIMUTH_ANGLE	Earth azimuth (from north to east)
TFORM7	‘1E ‘	4-byte REAL
TUNIT7	‘deg’	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	‘TIME’	Mission elapsed time
TFORM8	‘1D ‘	8-byte DOUBLE
TUNIT8	‘s’	
TLMIN8	0.0	Minimum value
TLMAX8	1.0D+10	Maximum value
TTYPE9	‘EVENT_ID’	ID of original event
TFORM9	‘1J ‘	4-byte signed INTEGER
TLMIN9	0	Minimum value
TLMAX9	2147483647	Maximum value
TTYPE10	‘RECON_VERSION’	
TFORM10	‘1I ’	2-byte signed INTEGER
TLMIN10	0	Minimum value
TLMAX10	32767	Maximum value
TTYPE11	‘CALIB_VERSION’	Versions of calibration tables for the ACD, CAL, TKR
TFORM11	‘3I ’	2-byte signed INTEGER
TTYPE12	‘IMGOODCALPROB’	Classification tree probability that CAL energy is well-measured
TFORM12	‘1E ‘	4-byte REAL
TUNIT12	‘ ’	Dimensionless
TLMIN12	0.0	Minimum value
TLMAX12	1.0	Maximum value
TTYPE13	‘IMVERTEXPROB’	Classification tree probability that the vertex gives a better measure of the direction than the best track alone
TFORM13	‘1E ‘	4-byte REAL
TUNIT13	‘ ’	Dimensionless
TLMIN13	0.0	Minimum value
TLMAX13	1.0	Maximum value
TTYPE14	‘IMCOREPROB’	Classification tree probability that the event is in the core of the PSF
TFORM14	‘1E ‘	4-byte REAL
TUNIT14	‘ ’	Dimensionless
TLMIN14	0.0	Minimum value
TLMAX14	1.0	Maximum value
TTYPE15	'IMPSFERRPRED'	Classification tree prediction of the PSF for this event, normalized to the 68% point predicted from an analytic model
TFORM15	‘1E ‘	4-byte REAL
TUNIT15	‘ ’	Dimensionless
TLMIN15	0.0	Minimum value
TLMAX15	100.0	Maximum value

TTYPE16	‘CALENERGYSUM’	Sum of the raw energies in all the crystals
TFORM16	‘1E ‘	4-byte REAL
TUNIT16	‘MeV’	
TLMIN16	0.0	Minimum value
TLMAX16	1.0e+7	Maximum value
TTYPE17	‘CALTOTRLN’	Total radiation lengths integrated along trajectory first track
TFORM17	‘1E ‘	4-byte REAL
TUNIT17	‘ ’	Dimensionless
TLMIN17	0.0	Minimum value
TLMAX17	100.0	Maximum value
TTYPE18	‘IMGAMMAPROB’	Classification tree probability that the event is a gamma ray
TFORM18	‘1E ‘	4-byte REAL
TUNIT18	‘ ’	Dimensionless
TLMIN18	0.0	Minimum value
TLMAX18	1.0	Maximum value
TTYPE19	‘CONVERSION_POINT’	Reconstructed 3-space conversion point in instrument coordinates
TFORM19	‘3E ’	4-byte REAL
TUNIT19	‘m’	
TTYPE20	‘CONVERSION_LAYER’	Conversion layer in TKR, -1 means not in TKR
TFORM20	‘1I ’	2-byte INTEGER
TLMIN20	-1	Minimum value
TLMAX20	18	Maximum value
TTYPE21	‘PULSE_PHASE’	
TFORM21	‘1D ‘	8-byte DOUBLE
TUNIT21	‘ ’	Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value

END

LS-002 Extension Header 2

Name: GTI

Purpose: Provides a list of the time intervals during which there are usable data.

Definition:

FITS Keyword	Value—Required or Standard		Definition
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel - assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1		16	Number of bytes per row
NAXIS2		###	Number of point sources in file (~3e4)
PCOUNT		0	
GCOUNT		1	No multiplier
TFIELDS		2	Number of fields per row
CHECKSUM		###	Checksum for entire HDU
DATASUM		###	Checksum for data table
TELESCOP	'GLAST'		
INSTRUME	'LAT'		Name of instrument generating data
ORIGIN	'GSSC'		Name of organization making file
OBSERVER	'Michelson'		Name of PI
EQUINOX	2000.0		Equinox for RA and DEC
RADECSYS	'FK5'		World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'		File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'		Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'		End date and time of observation
EXTNAME	'GTI'		Name of the extension
HDUCLASS	'OGIP'		Conforms to OGIP standard
HDUCLAS1	'GTT'		Extension contains good time intervals
HDUCLAS2	'ALL'		Extensions contains all events detected
TSTART	###		Mission time of the observation start
TSTOP	###		Mission time of the observation end
MJDREFI		51910.	MJD date of reference epoch, integer part
MJDREFF		7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'		Units for time
TIMESYS	'TT'		Time system
TIMEREF	'LOCAL'		Reference frame for times
TASSIGN	'SATELLITE'		Location where time assignment performed
CLOCKAPP	T or F		Clock drift correction applied?
GPS_OUT	T or F		Whether GPS time was unavailable at any time
ONTIME	###		Sum of GTI lengths
TELAPSE	###		Time between the start of the first GTI and the end of the last GTI
TTYPE1	'START'		Start time of the first GTI
TFORM1	'1D '		8-byte DOUBLE
TUNIT1	's'		
TLMIN1	0.0		Minimum value
TLMAX1	1.0D+10		Maximum value

TTYPE2	‘STOP’	End time of the last GTI
TFORM2	‘1D ‘	8-byte DOUBLE
TUNIT2	‘s’	
TLMIN2	0.0	Minimum value
TLMAX2	1.0D+10	Maximum value
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	16	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World coord. system for this file (FK5 or FK4)
DATE	'2010-12-03T12:34:25.6'	File creation date
DATE-OBS	'2010-12-02T02:31:45.6'	Start date and time of observation
DATE-END	'2010-12-02T05:41:43.6'	End date and time of observation
EXTNAME	'GTI'	Name of the extension
HDUCLASS	‘OGIP’	Conforms to OGIP standard
HDUCLAS1	‘GTT’	Extension contains good time intervals
HDUCLAS2	‘ALL’	Extensions contains all events detected
TSTART	###	Mission time of the observation start
TSTOP	###	Mission time of the observation end
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	‘s’	Units for time
TIMESYS	‘TT’	Time system
TIMEREF	‘LOCAL’	Reference frame for times
TASSIGN	‘SATELLITE’	Location where time assignment performed
CLOCKAPP	T or F	Clock drift correction applied?
GPS_OUT	T or F	Whether GPS time was unavailable at any time
ONTIME	###	Sum of GTI lengths
TELAPSE	###	Time between the start of the first GTI and the end of the last GTI
TTYPE1	‘START’	Start time of the first GTI
TFORM1	‘1D ‘	8-byte DOUBLE
TUNIT1	‘s’	
TLMIN1	0.0	Minimum value
TLMAX1	1.0D+10	Maximum value

TTYPE2	‘STOP’	End time of the last GTI
TFORM2	‘1D ‘	8-byte DOUBLE
TUNIT2	‘s’	
TLMIN2	0.0	Minimum value
TLMAX2	1.0D+10	Maximum value
END		

6.17. LS-005 Pointing and Livetime History

Version: 3.0

Revision date: 8/2/06

Product Description:
This file provides the pointing direction, instrument mode and the livetime time histories for the LAT (i.e., this is an FT2 file). The file is created after each TDRSS downlink, and thus contains the time histories between downlinks.

The spacecraft position is given in inertial coordinates (in m) with respect to the center of the earth. The x-direction in this coordinate system is the J2000 vernal equinox, RA, Dec (0,0), the z-direction is (0, +90°), and the y-direction is consistent with a right-handed coordinate system. The orientation of the spacecraft is defined by the directions of the spacecraft z- and x-axes (in J2000 RA, Dec in deg; see Figure 1 for the spacecraft coordinate system).

Standard OGIP FITS header keywords for the specification of spacecraft orientations and pointings can be found at
http://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/docs/ofwg_recomm/r3.html

Naming Convention	gll_pt_yymmdd_cn_vxx.fit	yymmdd = date n = pass number xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	12 hours	
Product contains data for	1 Ku Band Downlink (TBR)	
Number of deliveries per day	6 (TBR)	
Typical size	~100 kbyte (per 12 hours)	

Product Content	
Primary HDU:	
Extension 1	Contains the pointing and operation history

LS-005 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Number of bits per data pixel
NAXIS	0	No data in primary header
EXTEND	T	Extension(s) present
CHECKSUM	####	Checksum for entire HDU
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and Dec
RADECSYS	'FK5'	World Coord. System for this file (FK5 or FK4)
DATE	'YYYY-MM-DDThh:mm:ss.ssss'	File creation date (UTC)
DATE-OBS	'YYYY-MM-DDThh:mm:ss.ssss'	Observation start date and time (UTC)
DATE-END	'YYYY-MM-DDThh:mm:ss.ssss'	Observation end date and time (UTC)
TSTART		Mission time of the observation start
TSTOP		Mission time of the observation end
MJDREFI	51910.	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703 D-4	Fractional part of the MJD of the SC clock
FILENAME	'gll_pt_yymmdd_cn_vx x.fit'	Name of this file yymmdd = date n = pass number xx = version number
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
CREATOR	'LAT_POINT_HIST_V ##'	Software and version creating file
VERSION	#	Release version of the file
END		

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Number of bits per data pixel
NAXIS	0	No data in primary header
EXTEND	T	Extension(s) present
CHECKSUM	####	Checksum for entire HDU
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and Dec
RADECSYS	'FK5'	World Coord. System for this file (FK5 or FK4)
DATE	'YYYY-MM-DDThh:mm:ss.ssss'	File creation date
DATE-OBS	'2009-06-15T02:03:15.6'	Observation start date and time
DATE-END	'2009-06-15T05:10:23.3'	Observation end date and time
TSTART	253155723.184	Mission time of the observation start
TSTOP	253165723.184	Mission time of the observation end
MJDREFI	51910.	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703	Fractional part of the MJD of the SC clock

	D-4	
FILENAME	‘gll_pt_090615_c3_v01.fit’	Name of this file
ORIGIN	‘LISOC’	Name of organization making file
OBSERVER	‘MICHELSON’	Instrument PI
CREATOR	‘LAT_POINT_HIST_V##’	Software and version creating file
VERSION	#	Release version of the file
END		

LS-005 Extension Header 1

Name: LAT_POINTING_HIST

Purpose: This extension provides the average spacecraft position and orientation averaged over a specified time range, as well as the livetime and deadtime for that time range.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	Size of special data area
GCOUNT	1	No multiplier
TFIELDS	11	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
EQUINOX	2000.0	Equinox for RA and Dec
RADECSYS	'FK5'	World Coord. System for this file (FK5 or FK4)
DATE	'YYYY-MM-DDThh:mm:ss.ssss'	File creation date
DATE-OBS	'YYYY-MM-DDThh:mm:ss.ssss'	Observation start date and time
DATE-END	'YYYY-MM-DDThh:mm:ss.ssss'	Observation end date and time
EXTNAME	'LAT_POINTING_HIST'	Name of the extension
TSTART	###	Mission time of start of observation
TSTOP	###	Mission time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
TIMEZERO		Clock correction
TIMESYS	'TT'	Time system used in time keywords
TIMEREF	'LOCAL'	Reference frame used for times
TASSIGN	'SATELLITE;	Location where time assignment performed
CLOCKAPP	T or F	Whether a clock drift correction has been applied
GPS_OUT	T or F	Whether GPS time was unavailable at any time during this interval
TTYPE1	'START'	Mission Elapsed Time of start of interval
TFORM1	'1D '	8-byte DOUBLE

TUNIT1	‘s’	Seconds
TLMIN1	0.0	Minimum value
TLMAX1	1.0D+10	Maximum value
TTYPE2	‘STOP’	Mission Elapsed Time of end of interval
TFORM2	‘1D ’	8-byte DOUBLE
TUNIT2	‘s’	Seconds
TLMIN2	0.0	Minimum value
TLMAX2	1.0D+10	Maximum value
TTYPE3	‘SC_POSITION	Position of spacecraft in (x,y,z) inertial coordinates
TFORM3	‘3E ’	3 _ 4-byte REAL
TUNIT3	‘m’	
TTYPE4	‘LAT_GEO’	Ground point latitude
TFORM4	‘1E ’	4-byte REAL
TUNIT4	‘deg’	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TTYPE5	‘LON_GEO’	Ground point longitude
TFORM5	‘1E ’	4-byte REAL
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	‘RAD_GEO’	S/C altitude
TFORM6	‘1D ’	8-byte DOUBLE
TUNIT6	‘m’	
TLMIN6	0	Minimum value
TLMAX6	10000.0	Maximum value
TTYPE7	‘RA_ZENITH’	RA of zenith at start
TFORM7	‘1D ’	8-byte DOUBLE
TUNIT7	‘deg’	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	‘DEC_ZENITH’	DEC of zenith at start
TFORM8	‘1E ’	4-byte REAL
TUNIT8	‘deg’	
TLMIN8	-90.0	Minimum value
TLMAX8	90.0	Maximum value
TTYPE9	‘B_MCILWAIN’	McIlwain B parameter, magnetic field
TFORM9	‘1E ’	4-byte REAL
TUNIT9	‘G’	Gauss
TLMIN9	0.0	Minimum value
TLMAX9	100.0	Maximum value
TTYPE10	‘L_MCILWAIN’	McIlwain L parameter, distance
TFORM10	‘1E ’	4-byte REAL
TUNIT10	‘Earth_Radii’	
TLMIN10	0.0	Minimum value
TLMAX10	100.0	Maximum value
TTYPE11	‘IN_SAA’	Whether S/C was in SAA

TFORM11	'1L '	Logical
TTYPE12	'RA_SCZ'	RA of LAT +z axis at start of observation
TFORM12	'1E '	4-byte REAL
TUNIT12	'deg'	
TLMIN12	0.0	Minimum value
TLMAX12	360.0	Maximum value
TTYPE13	'DEC_SCZ'	RA of LAT +z axis at start of observation
TFORM13	'1E '	4-byte REAL
TUNIT13	'deg'	
TLMIN13	-90.0	Minimum value
TLMAX13	90.0	Maximum value
TTYPE14	'RA_SCX'	RA of LAT +x axis at start of observation
TFORM14	'1E '	4-byte REAL
TUNIT14	'deg'	
TLMIN14	0.0	Minimum value
TLMAX14	360.0	Maximum value
TTYPE15	'DEC_SCX'	RA of LAT +x axis at start of observation
TFORM15	'1E '	4-byte REAL
TUNIT15	'deg'	
TLMIN15	-90.0	Minimum value
TLMAX15	90.0	Maximum value
TTYPE16	'LAT_MODE'	LAT operation mode
TFORM16	'1J '	4-byte signed INTEGER
TLMIN16	0	Minimum value
TLMAX16	2147483647	Maximum value
TTYPE17	'LIVETIME'	Livetime
TFORM17	'1D '	8-byte DOUBLE
TUNIT17	's'	
TLMIN17	0.0	Minimum value
TLMAX17	1.0D+10	Maximum value
TTYPE18	'DEADTIME'	Deadtime accumulated since start of mission
TFORM18	'1D '	8-byte DOUBLE
TUNIT18	's'	
TLMIN18	0.0	Minimum value
TLMAX18	1.0D+10	Maximum value

Example:

FITS Keyword	Value	Detail
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	Size of special data area
GCOUNT	1	No multiplier
TFIELDS	11	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	

INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and Dec
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	‘YYYY-MM-DDThh:mm:ss.ssss’	File creation date
DATE-OBS	‘YYYY-MM-DDThh:mm:ss.ssss’	Observation start date and time
DATE-END	‘YYYY-MM-DDThh:mm:ss.ssss’	Observation end date and time
EXTNAME	‘LAT_POINTING_HIST’	Name of the extension
TSTART	###	Mission time of start of observation
TSTOP	###	Mission time of end of observation
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	‘s’	Time unit used in TSTART, TSTOP keywords
TIMEZERO		Clock correction
TIMESYS	‘TT’	Time system used in time keywords
TIMEREF	‘LOCAL’	Reference frame used for times
TASSIGN	‘SATELLITE;	Location where time assignment performed
CLOCKAPP	T or F	Whether a clock drift correction has been applied
GPS_OUT	T or F	Whether GPS time was unavailable at any time during this interval
TTYPE1	‘START’	Mission Elapsed Time of start of interval
TFORM1	‘1D ’	8-byte DOUBLE
TUNIT1	‘s’	Seconds
TLMIN1	0.0	Minimum value
TLMAX1	1.0D+10	Maximum value
TTYPE2	‘STOP’	Mission Elapsed Time of end of interval
TFORM2	‘1D ’	8-byte DOUBLE
TUNIT2	‘s’	Seconds
TLMIN2	0.0	Minimum value
TLMAX2	1.0D+10	Maximum value
TTYPE3	‘SC_POSITION	Position of spacecraft in (x,y,z) inertial coordinates
TFORM3	‘3E ’	3 _ 4-byte REAL
TUNIT3	‘m’	
TTYPE4	‘LAT_GEO’	Ground point latitude
TFORM4	‘1E ’	4-byte REAL
TUNIT4	‘deg’	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TTYPE5	‘LON_GEO’	Ground point longitude
TFORM5	‘1E ’	4-byte REAL
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value

TTYPE6	'RAD_GEO'	S/C altitude
TFORM6	'1D '	8-byte DOUBLE
TUNIT6	'm'	
TLMIN6	0	Minimum value
TLMAX6	10000.0	Maximum value
TTYPE7	'RA_ZENITH'	RA of zenith at start
TFORM7	'1D '	8-byte DOUBLE
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	'DEC_ZENITH'	DEC of zenith at start
TFORM8	'1E '	4-byte REAL
TUNIT8	'deg'	
TLMIN8	-90.0	Minimum value
TLMAX8	90.0	Maximum value
TTYPE9	'B_MCILWAIN'	McIlwain B parameter, magnetic field
TFORM9	'1E '	4-byte REAL
TUNIT9	'G'	Gauss
TLMIN9	0.0	Minimum value
TLMAX9	100.0	Maximum value
TTYPE10	'L_MCILWAIN'	McIlwain L parameter, distance
TFORM10	'1E '	4-byte REAL
TUNIT10	'Earth_Radii'	
TLMIN10	0.0	Minimum value
TLMAX10	100.0	Maximum value
TTYPE11	'IN_SAA'	Whether S/C was in SAA
TFORM11	'1L '	Logical
TTYPE12	'RA_SCZ'	RA of LAT +z axis at start of observation
TFORM12	'1E '	4-byte REAL
TUNIT12	'deg'	
TLMIN12	0.0	Minimum value
TLMAX12	360.0	Maximum value
TTYPE13	'DEC_SCZ'	RA of LAT +z axis at start of observation
TFORM13	'1E '	4-byte REAL
TUNIT13	'deg'	
TLMIN13	-90.0	Minimum value
TLMAX13	90.0	Maximum value
TTYPE14	'RA_SCX'	RA of LAT +x axis at start of observation
TFORM14	'1E '	4-byte REAL
TUNIT14	'deg'	
TLMIN14	0.0	Minimum value
TLMAX14	360.0	Maximum value
TTYPE15	'DEC_SCX'	RA of LAT +x axis at start of observation
TFORM15	'1E '	4-byte REAL
TUNIT15	'deg'	
TLMIN15	-90.0	Minimum value
TLMAX15	90.0	Maximum value
TTYPE16	'LAT_MODE'	LAT operation mode

TFORM16	‘1J ‘	4-byte signed INTEGER
TLMIN16	0	Minimum value
TLMAX16	2147483647	Maximum value
TTYPE17	‘LIVETIME’	Livetime
TFORM17	‘1D ‘	8-byte DOUBLE
TUNIT17	‘s’	
TLMIN17	0.0	Minimum value
TLMAX17	1.0D+10	Maximum value
TTYPE18	‘DEADTIME’	Deadtime accumulated since start of mission
TFORM18	‘1D ‘	8-byte DOUBLE
TUNIT18	‘s’	
TLMIN18	0.0	Minimum value
TLMAX18	1.0D+10	Maximum value

6.18. LS-006 Configuration History

Draft version 0.1, 22 Oct 2001

Fulfills Requirement TBD

Naming Convention lat_config_yymmdd_v01.fit

Originator of Product LISOC

Description of Product

The Configuration history data product contains the configuration, and updates to the configuration, of the LAT. The configuration registers for the ACD, CAL, and TKR subsystems are occasionally read out and sent in their entirety (~800,000 values) in the telemetry stream for the LAT. To reduce the demand on the telemetry bandwidth, in the interim, only changes to the configuration (as a result of commands to the LAT) are sent so that the configuration at any given time can be reconstructed in detail.

Product Format TBD

Product Recipient GSSC

Delivery Method FASTCopy

Production Latency Req. 12 hours

Product Contains Data for 1 Ku Band Downlink (TBR)

Number of deliveries per day N/A, as updated

Typical size TBD

6.19. LS-007 Transient Parameters

Version: 2.0

Revision date: 4/7/06

Product Description:
These files provide the summary information for transient sources detected by the LAT. This data product is meant to serve as an alert produced when a transient is detected; therefore it will contain preliminary parameters and quite likely only partial light curves.

Naming Convention	gll_trans_an####_vxx.fit	xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	8 hours (TBR)	
Product contains data for	time interval N/A	
Number of deliveries per day	As detected	
Typical size	~100 kbyte	

Product Content	
Primary HDU:	
Extension 1	Summary information (nearly identical to LS-008, the Point Source Catalog)

LS-007 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	T	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'gll_trans_an####_vxx .fit'	xx = version number
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
DATE-OBS	'YYYY-MM-DDT HH:MM:SS.ssss'	Date of start of observation
DATE-END	'YYYY-MM-DDT HH:MM:SS.ssss'	Date of end of observation
CREATOR	'TRANS_PARAM_MA KER_V##'	Software and version creating file
VERSION	#	Release version of the catalog
SOFTWARE	#	Version of the analysis software
RESPONSE	#	Version of the IRFs
END		

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	T	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'gll_trans_an####_v# #.fit'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
DATE-OBS	'2008-01-04T13:25:45.'	Date of start of observation
DATE-END	'2008-01-04T14:23:42.'	Date of end of observation)
CREATOR	'TRANS_PARAM_MA KER_V00'	Software and version creating file
VERSION	#	Release version of the catalog
SOFTWARE	#	Version of the analysis software
RESPONSE	#	Version of the IRFs
END		

LS-007 Extension 1

Name: LAT_Transient_Source

Purpose: This extension lists provides a list of sources considered to be transients, along with their position, fluxes and lightcurves.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of entries in file (1?)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	22	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_Transient_Source'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'	Time unit used in TSTART and TSTOP keywords
TSTART	###	Time of start of observation offset from MJDREF in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from MJDREF in units of TIMEUNIT
TTYPE1	'Source_Name'	Source name in standard format
TFORM1	'14A '	Character string
TUNIT1	' '	Units of field
TLMIN1	'GLT J0000-9000'	Minimum value
TLMAX1	'GLT J2359+9000'	Maximum value
TTYPE2	'Right_Ascension'	
TFORM2	'1E '	Floating point
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'Declination'	DEC
TFORM3	'1E '	Floating point
TUNIT3	'deg'	

TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	‘Conf_68_Region’	Semimajor, semiminor axes and position angle, 68% containment confidence region
TFORM4	‘3E ‘	Floating point, 3 values
TUNIT4	‘deg’	
TLMIN4	0.0	Minimum value
TLMAX4	360.0	Maximum value
TTYPE5	‘Conf_95_Region’	Semimajor, semiminor axes and position angle, 95% containment confidence region
TFORM5	‘3E ‘	Floating point, 3 values
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	‘Flux’	Average flux >100 MeV
TFORM6	‘1E ‘	Floating point
TUNIT6	‘photon /cm**2 /s’	
TLMIN6	0.0	Minimum value
TLMAX6	###	Maximum value
TTYPE7	‘Unc_Flux’	Uncertainty (1-sigma) in average flux >100 MeV
TFORM7	‘1E ‘	Floating point
TUNIT7	‘photon /cm**2 /s’	
TLMIN7	0.0	Minimum value
TLMAX7	###	Maximum value
TTYPE8	‘Spectral_Index’	Photon spectral index
TFORM8	‘1E ‘	Floating point
TUNIT8	‘ ’	Dimensionless
TLMIN8	-10.0	Minimum value
TLMAX8	10.0	Maximum value
TTYPE9	‘Variability_Index’	Flux variability index
TFORM9	‘1E ‘	Floating point
TUNIT9	‘ ’	Dimensionless
TLMIN9	###	Minimum value
TLMAX9	###	Maximum value
TTYPE10	‘Signif_Avg’	Detection significance (whole time interval)
TFORM10	‘1E ‘	Floating point
TUNIT10	‘ ’	Dimensionless
TLMIN10	0.0	Minimum value
TLMAX10	###	Maximum value
TTYPE11	‘Signif_Peak’	Detection significance (peak)
TFORM11	‘1E ‘	Floating point
TUNIT11	‘ ’	Dimensionless
TLMIN11	0.0	Minimum value
TLMAX11	###	Maximum value
TTYPE12	‘Flux_Peak’	Peak flux (>100 MeV) for time interval above
TFORM12	‘1E ‘	Floating point
TUNIT12	‘photon /cm**2 /s’	
TLMIN12	0.0	Minimum value

TLMAX12	###	Maximum value
TTYPE13	'Unc_Peak_Flux'	Uncertainty (1-sigma) in peak flux >100 MeV
TFORM13	'1E '	Floating point
TUNIT13	'photon /cm**2 /s'	
TLMIN13	0.0	Minimum value
TLMAX13	###	Maximum value
TTYPE14	'Time_Peak'	Center of time interval of peak significance
TFORM14	'1D '	Double precision
TUNIT14	's'	
TLMIN14	0	Minimum value
TLMAX14	###	Maximum value
TTYPE15	'Peak_Interval'	Duration of time interval of peak significance
TFORM15	'1D '	Double precision
TUNIT15	's'	
TLMIN15	0	Minimum value
TLMAX15	###	Maximum value
TTYPE16	'Flux_History'	Flux (>100 MeV) history
TFORM16	'PE(100) '	Floating point variable-length array
TUNIT16	'photon /cm**2 /s'	
TLMIN16	0	Minimum value
TLMAX16	###	Maximum value
TTYPE17	'Flux_Unc_History'	Flux uncertainty (1-sigma, >100 MeV) history
TFORM17	'PE(100) '	Floating point variable-length array
TUNIT17	'photon /cm**2 /s'	
TLMIN17	0	Minimum value
TLMAX17	###	Maximum value
TTYPE18	'Hist_Start'	Start of time intervals of flux history
TFORM18	'PE(100) '	Floating point variable-length array
TUNIT18	's'	
TLMIN18	0	Minimum value
TLMAX18	###	Maximum value
TTYPE19	'Hist_End'	Ends of time intervals of flux history
TFORM19	'PE(100) '	Floating point variable-length array
TUNIT19	's'	
TLMIN19	0	Minimum value
TLMAX19	###	Maximum value
TTYPE20	'ID_Counterpart'	Source counterparts
TFORM20	'PA(20) '	Character variable-length array
TUNIT20	' '	Dimensionless
TTYPE21	'Conf_Counterpart'	Confidence of association of counterpart with source
TFORM21	'PE(20) '	Floating point variable-length array
TUNIT21	' '	Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value
TTYPE22	'Flags'	Flags (TBD) for catalog entry
TFORM22	'1B '	
TUNIT22	' '	Dimensionless

END

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of entries in file (1?)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	22	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
DATE	'2008-07-11'	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_Transient_Source'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'	Time unit used in TSTART and TSTOP keywords
TSTART	###	Time of start of observation offset from MJDREF in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from MJDREF in units of TIMEUNIT
TTYPE1	'Source_Name'	Source name in standard format
TFORM1	'14A '	Character string
TUNIT1	' '	Units of field
TLMIN1	'GLT J0000-9000'	Minimum value
TLMAX1	'GLT J2359+9000'	Maximum value
TTYPE2	'Right_Ascension'	
TFORM2	'1E '	Floating point
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'Declination'	DEC
TFORM3	'1E '	Floating point
TUNIT3	'deg'	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	'Conf_68_Region'	Semimajor, semiminor axes and position angle, 68% containment confidence region
TFORM4	'3E '	Floating point, 3 values
TUNIT4	'deg'	

TLMIN4	0.0	Minimum value
TLMAX4	360.0	Maximum value
TTYPE5	‘Conf_95_Region’	Semimajor, semiminor axes and position angle, 95% containment confidence region
TFORM5	‘3E ‘	Floating point, 3 values
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	‘Flux’	Average flux >100 MeV
TFORM6	‘1E ‘	Floating point
TUNIT6	‘photon /cm**2 /s’	
TLMIN6	0.0	Minimum value
TLMAX6	###	Maximum value
TTYPE7	‘Unc_Flux’	Uncertainty (1-sigma) in average flux >100 MeV
TFORM7	‘1E ‘	Floating point
TUNIT7	‘photon /cm**2 /s’	
TLMIN7	0.0	Minimum value
TLMAX7	###	Maximum value
TTYPE8	‘Spectral_Index’	Photon spectral index
TFORM8	‘1E ‘	Floating point
TUNIT8	‘ ’	Dimensionless
TLMIN8	-10.0	Minimum value
TLMAX8	10.0	Maximum value
TTYPE9	‘Variability_Index’	Flux variability index
TFORM9	‘1E ‘	Floating point
TUNIT9	‘ ’	Dimensionless
TLMIN9	###	Minimum value
TLMAX9	###	Maximum value
TTYPE10	‘Signif_Avg’	Detection significance (whole time interval)
TFORM10	‘1E ‘	Floating point
TUNIT10	‘ ’	Dimensionless
TLMIN10	0.0	Minimum value
TLMAX10	###	Maximum value
TTYPE11	‘Signif_Peak’	Detection significance (peak)
TFORM11	‘1E ‘	Floating point
TUNIT11	‘ ’	Dimensionless
TLMIN11	0.0	Minimum value
TLMAX11	###	Maximum value
TTYPE12	‘Flux_Peak’	Peak flux (>100 MeV) for time interval above
TFORM12	‘1E ‘	Floating point
TUNIT12	‘photon /cm**2 /s’	
TLMIN12	0.0	Minimum value
TLMAX12	###	Maximum value
TTYPE13	‘Unc_Peak_Flux’	Uncertainty (1-sigma) in peak flux >100 MeV
TFORM13	‘1E ‘	Floating point
TUNIT13	‘photon /cm**2 /s’	
TLMIN13	0.0	Minimum value
TLMAX13	###	Maximum value

TTYPE14	‘Time_Peak’	Center of time interval of peak significance
TFORM14	‘1D ‘	Double precision
TUNIT14	‘s’	
TLMIN14	0	Minimum value
TLMAX14	###	Maximum value
TTYPE15	‘Peak_Interval’	Duration of time interval of peak significance
TFORM15	‘1D ‘	Double precision
TUNIT15	‘s’	
TLMIN15	0	Minimum value
TLMAX15	###	Maximum value
TTYPE16	‘Flux_History’	Flux (>100 MeV) history
TFORM16	‘PE(100) ‘	Floating point variable-length array
TUNIT16	‘photon /cm**2 /s’	
TLMIN16	0	Minimum value
TLMAX16	###	Maximum value
TTYPE17	‘Flux_Unc_History’	Flux uncertainty (1-sigma, >100 MeV) history
TFORM17	‘PE(100) ‘	Floating point variable-length array
TUNIT17	‘photon /cm**2 /s’	
TLMIN17	0	Minimum value
TLMAX17	###	Maximum value
TTYPE18	‘Hist_Start’	Start of time intervals of flux history
TFORM18	‘PE(100) ‘	Floating point variable-length array
TUNIT18	‘s’	
TLMIN18	0	Minimum value
TLMAX18	###	Maximum value
TTYPE19	‘Hist_End’	Ends of time intervals of flux history
TFORM19	‘PE(100) ‘	Floating point variable-length array
TUNIT19	‘s’	
TLMIN19	0	Minimum value
TLMAX19	###	Maximum value
TTYPE20	‘ID_Counterpart’	Source counterparts
TFORM20	‘PA(20) ‘	Character variable-length array
TUNIT20	‘ ’	Dimensionless
TTYPE21	‘Conf_Counterpart’	Confidence of association of counterpart with source
TFORM21	‘PE(20) ‘	Floating point variable-length array
TUNIT21	‘ ’	Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value
TTYPE22	‘Flags’	Flags (TBD) for catalog entry
TFORM22	‘1B ‘	
TUNIT22	‘ ’	Dimensionless

END

6.20. LS-008 Source Catalog

Version: 2.0

Revision date: 4/7/06

Product Description:
This file contains the LAT Point Source Catalog. The catalog will be provided after 1, 2, and 5 years, and at the end of the mission; a preliminary version will be provided after half a year.

Naming Convention	gll_psc_vxx.fit	xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	TBD	
Product contains data for	Intervals TBR, likely years	
Number of deliveries per day	N/A	
Typical size	~10 Mbyte	

Product Content	
Primary HDU:	
Extension 1	Catalog

LS-008 Extension 1

Name: LAT_Point_Source_Catalog

Purpose: This extension provides the actual catalog. Each row is a different source. The source name, position, and fluxes in different energy bands are provided, along with uncertainties where appropriate.

Definition:

FITS Keyword Value—Required or Standard **Definition**

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  = 8                    / 8-bit bytes
NAXIS   = 2                    / 2-dimensional binary table
PCOUNT  = 0                    / size of special data area
GCOUNT  = 1                    / one data group (required keyword)
TFIELDS = 34                   / number of fields in each row
CHECKSUM=                      / checksum for entire HDU
DATASUM =                      / checksum for data table
TELESCOP= 'GLAST'              / name of telescope generating data
INSTRUME= 'LAT'                / name of instrument generating data
OBSERVER= 'Michelson'          / Name of instrument PI
DATE    = 'yyyy-mm-ddThh:mm:ss.ss' / Date file was created
EQUINOX = 2000.0               / equinox for ra and dec
RADECSYS= 'FK5'                / world coord. system for this file (FK5 or FK4)
EXTNAME = 'LAT_Point_Source_Catalog' / name of this binary table extension
HDUCLASS= 'OGIP'               / format conforms to OGIP standard
HDUCLAS1= 'EVENTS'             / extension contains events
HDUCLAS2= 'ALL'                / extension contains all events detected
TSTART  =                      / mission time of the start of the observation
TSTOP   =                      / mission time of the end of the observation
TIMEUNIT= 'd'                  / units for the time related keywords
TIMEZERO= 0.0                  / clock correction
TIMESYS = 'MJD'                / type of time system that is used
TIMEREF = 'LOCAL'              / reference frame used for times
DATE-OBS=                      / start date and time of the observation
DATE-END=                      / end date and time of the observation
NDSKEYS = 0                    / number of data subspace keywords in header

HDUCLASS= 'OGIP  '             / format conforms to OGIP standard
HDUDOC  = '?'                  / document describing the format
HDUVERS= '1.0.0 '      / version of the format
HDUCLAS1= 'SRCLIST'            / an OGIP standard class

TTYPE1  = 'Source_Name'        / e.g., 1GL J123456-012345
TFORM1  = '18A     '    / character string
TUNIT1  = ' '                   / units of field

TTYPE2  = 'RA'                 / right ascension of source
TFORM2  = 'E'                   / floating point
TUNIT2  = 'deg'                / units of field
TLMIN2  = 0.0                   / minimum value
TLMAX2  = 360.0                 / maximum value

TTYPE3  = 'DEC'                 / declination of source
TFORM3  = 'E'                  / floating point
TUNIT3  = 'deg'                / units of field
TLMIN3  = -90.0                / minimum value
TLMAX3  = 90.0                 / maximum value
```

```
TTYPE4  = 'Conf_68_SemiMajor'/ semimajor axis, 68% containment confidence region
TFORM4  = 'E'                / floating point
TUNIT4  = 'deg'              / units of field
TLMIN4  = 0.0                / minimum value
TLMAX4  = 360.0              / maximum value

TTYPE5  = 'Conf_68_SemiMinor'/ semiminor, axis, 68% containment confidence region
TFORM5  = 'E'                / floating point
TUNIT5  = 'deg'              / units of field
TLMIN5  = 0.0                / minimum value
TLMAX5  = 360.0              / maximum value

TTYPE6  = 'Conf_68_PosAng'   / position angle, 68% containment confidence region, E of
N
TFORM6  = 'E'                / floating point
TUNIT6  = 'deg'              / units of field
TLMIN6  = 0.0                / minimum value
TLMAX6  = 360.0              / maximum value

TTYPE7  = 'Conf_95_SemiMajor'/ semimajor axis, 95% containment confidence region
TFORM7  = 'E'                / floating point
TUNIT7  = 'deg'              / units of field
TLMIN7  = 0.0                / minimum value
TLMAX7  = 360.0              / maximum value

TTYPE8  = 'Conf_95_SemiMinor'/ semiminor, axis, 95% containment confidence region
TFORM8  = 'E'                / floating point
TUNIT8  = 'deg'              / units of field
TLMIN8  = 0.0                / minimum value
TLMAX8  = 360.0              / maximum value

TTYPE9  = 'Conf_95_PosAng'   / position angle, 95% containment confidence region, E of
N
TFORM9  = 'E'                / floating point
TUNIT9  = 'deg'              / units of field
TLMIN9  = 0.0                / minimum value
TLMAX9  = 360.0              / maximum value

TTYPE10 = 'Flux100'          / average photon flux >100 MeV
TFORM10 = 'E'                / floating point
TUNIT10 = 'photon /cm**2 /s' / units of field
TLMIN10 = 0.0                / minimum value
TLMAX10 = 1.0                / maximum value

TTYPE11 = 'Unc_Flux100'      / uncertainty (1-sigma) in average flux >100 MeV
TFORM11 = 'E'                / floating point
TUNIT11 = 'photon /cm**2 /s' / units of field
TLMIN11 = 0.0                / minimum value
TLMAX11 = 1.0                / maximum value

TTYPE12 = 'Flux30_100'       / average photon flux 30-100 MeV
TFORM12 = 'E'                / floating point
TUNIT12 = 'photon /cm**2 /s' / units of field
TLMIN12 = 0.0                / minimum value
TLMAX12 = 1.0                / maximum value

TTYPE13 = 'Unc_Flux30_100'   / uncertainty (1-sigma) in average flux 30-100 MeV
TFORM13 = 'E'                / floating point
TUNIT13 = 'photon /cm**2 /s' / units of field
TLMIN13 = 0.0                / minimum value
TLMAX13 = 1.0                / maximum value

TTYPE14 = 'Flux100_300'      / average photon flux 100-300 MeV
TFORM14 = 'E'                / floating point
```

```
TUNIT14 = 'photon /cm**2 /s' / units of field
TLMIN14 = 0.0                / minimum value
TLMAX14 = 1.0                / maximum value

TTYPE15 = 'Unc_Flux100_300'  / uncertainty (1-sigma) in average flux 100-300 MeV
TFORM15 = 'E'                / floating point
TUNIT15 = 'photon /cm**2 /s' / units of field
TLMIN15 = 0.0                / minimum value
TLMAX15 = 1.0                / maximum value

TTYPE16 = 'Flux300_1000'     / average photon flux 300-1000 MeV
TFORM16 = 'E'                / floating point
TUNIT16 = 'photon /cm**2 /s' / units of field
TLMIN16 = 0.0                / minimum value
TLMAX16 = 1.0                / maximum value

TTYPE17 = 'Unc_Flux300_1000' / uncertainty (1-sigma) in average flux 300-1000 MeV
TFORM17 = 'E'                / floating point
TUNIT17 = 'photon /cm**2 /s' / units of field
TLMIN17 = 0.0                / minimum value
TLMAX17 = 1.0                / maximum value

TTYPE18 = 'Flux3000'         / average photon flux >3000 MeV
TFORM18 = 'E'                / floating point
TUNIT18 = 'photon /cm**2 /s' / units of field
TLMIN18 = 0.0                / minimum value
TLMAX18 = 1.0                / maximum value

TTYPE19 = 'Unc_Flux3000'     / uncertainty (1-sigma) in average flux >3000 MeV
TFORM19 = 'E'                / floating point
TUNIT19 = 'photon /cm**2 /s' / units of field
TLMIN19 = 0.0                / minimum value
TLMAX19 = 1.0                / maximum value

TTYPE20 = 'Spectral_Index'   / photon spectral index, >100 MeV
TFORM20 = 'E'                / floating point
TUNIT20 = ' '             / dimensionless
TLMIN20 = -10.0              / minimum value
TLMAX20 = 10.0               / maximum value

TTYPE21 = 'Unc_Spectral_Index' / 1-sigma uncertainty, photon spectral index
TFORM21 = 'E'                / floating point
TUNIT21 = ' '             / dimensionless
TLMIN21 = 0.0                / minimum value
TLMAX21 = 10.0               / maximum value

TTYPE22 = 'Variability_Index'/ flux variability index (TBD)
TFORM22 = 'E'                / floating point
TUNIT22 = ' '                / dimensionless
TLMIN22 = ###                / minimum value (TBD)
TLMAX22 = ###                / maximum value (TBD)

TTYPE23 ='Signif_Avg'        / detection significance (whole time interval)
TFORM23 = 'E'                / floating point
TUNIT23 = ' '                / dimensionless (sigmas)
TLMIN23 = 0.0                / minimum value
TLMAX23 = 1.0E9              / maximum value

TTYPE24 = 'Signif_Peak'      / detection significance (peak)
TFORM24 = 'E'                / floating point
TUNIT24 = ' '                / dimensionless (sigmas)
TLMIN24 = 0.0                / minimum value
TLMAX24 = 1.0E9              / maximum value
```

```
TTYPE25 = 'Flux_Peak'        / peak flux (>100 MeV) for time interval above
TFORM25 = 'E'                / floating point
TUNIT25 = 'photon /cm**2 /s' / units of field
TLMIN25 = 0.0                / minimum value
TLMAX25 = 1.0                / maximum value

TTYPE26 = 'Unc_Peak_Flux'    / uncertainty (1-sigma) in peak flux >100 MeV
TFORM26 = 'E'                / floating point
TUNIT26 = 'photon /cm**2 /s' / units of field
TLMIN26 = 0.0                / minimum value
TLMAX26 = 1.0                / maximum value

TTYPE27 = 'Time_Peak'        / center of time interval of peak significance
TFORM27 = 'D'                / double precision
TUNIT27 = 'd'                / units of field
TLMIN27 = 0.0                / minimum value
TLMAX27 = 1.0D5              / maximum value

TTYPE28 = 'Peak_Interval'    / duration of time interval of peak significance
TFORM28 = 'D'                / double precision
TUNIT28 = 's'                / units of field
TLMIN28 = 0.0                / minimum value
TLMAX28 = 3.0D7              / maximum value

TTYPE29 = 'Flux_History'     / flux (>100 MeV) history (monthly)
TFORM29 = '12E'              / floating point array, 12 months (number TBR)
TUNIT29 = 'photon /cm**2 /s' / units of field
TLMIN29 = 0.0                / minimum value
TLMAX29 = 1.0                / maximum value

TTYPE30 = 'Flux_Unc_History' / flux uncertainty (1-sigma, >100 MeV) history
TFORM30 = '12E'              / floating point array, 12 months (number TBR)
TUNIT30 = 'photon /cm**2 /s' / units of field
TLMIN30 = 0.0                / minimum value
TLMAX30 = 1.0                / maximum value

TTYPE31 = 'Hist_Start'       / start of time intervals of flux history
TFORM31 = '12E'              / floating point array, 12 months (number TBR)
TUNIT31 = 'd'                / units of field
TLMIN31 = 0.0                / minimum value
TLMAX31 = 1.0D5              / maximum value

TTYPE32 = 'ID_Counterpart'   / source counterpart (if any)
TFORM32 = '20A'              / character string
TUNIT32 = ' '                / dimensionless

TTYPE33 = 'Conf_Counterpart' / confidence of association of counterpart with source
TFORM33 = 'I'                / index, 1 = Figure of Merit, 2 = Correlated variability
TUNIT33 = ' '                / dimensionless
TLMIN33 = 0                  / minimum value
TLMAX33 = 2                  / maximum value

TTYPE34 = 'Flags'            / flags (TBD) for catalog entry
TFORM34 = 'I'                / integer
TUNIT34 = ' '                / dimensionless

END
```

Example:

```
XTENSION= 'BINTABLE'         / binary table extension
BITPIX  = 8                  / 8-bit bytes
NAXIS   = 2                  / 2-dimensional binary table
```

```
PCOUNT  = 0                  / size of special data area
GCOUNT  = 1                  / one data group (required keyword)
TFIELDS = 34                 / number of fields in each row
CHECKSUM=                    / checksum for entire HDU
DATASUM =                    / checksum for data table
TELESCOP= 'GLAST'            / name of telescope generating data
INSTRUME= 'LAT'              / name of instrument generating data
OBSERVER= 'Michelson'        / Name of instrument PI
DATE    = '2008-12-23T03:16:34.6' / Date file was created
EQUINOX = 2000.0             / equinox for ra and dec
RADECSYS= 'FK5'              / world coord. system for this file (FK5 or FK4)
EXTNAME = 'LAT_Point_Source_Catalog' / name of this binary table extension
HDUCLASS= 'OGIP'             / format conforms to OGIP standard
HDUCLAS1= 'EVENTS'           / extension contains events
HDUCLAS2= 'ALL'              / extension contains all events detected
TSTART  =                    / mission time of the start of the observation
TSTOP   =                    / mission time of the end of the observation
TIMEUNIT= 'd'                / units for the time related keywords
TIMEZERO= 0.0                / clock correction
TIMESYS = 'MJD'              / type of time system that is used
TIMEREF = 'LOCAL'            / reference frame used for times
DATE-OBS=                    / start date and time of the observation
DATE-END=                    / end date and time of the observation
NDSKEYS = 0                  / number of data subspace keywords in header

HDUCLASS= 'OGIP  '           / format conforms to OGIP standard
HDUDOC  = '?'                / document describing the format
HDUVERS= '1.0.0 '      / version of the format
HDUCLAS1= 'SRCLIST'          / an OGIP standard class

TTYPE1  = 'Source_Name'      / e.g., 1GL J123456-012345
TFORM1  = '18A     '    / character string
TUNIT1  = ' '                / units of field

TTYPE2  = 'RA'               / right ascension of source
TFORM2  = 'E'                  / floating point
TUNIT2  = 'deg'              / units of field
TLMIN2  = 0.0                  / minimum value
TLMAX2  = 360.0                / maximum value

TTYPE3  = 'DEC'                / declination of source
TFORM3  = 'E'                / floating point
TUNIT3  = 'deg'              / units of field
TLMIN3  = -90.0              / minimum value
TLMAX3  = 90.0               / maximum value

TTYPE4  = 'Conf_68_SemiMajor'/ semimajor axis, 68% containment confidence region
TFORM4  = 'E'                / floating point
TUNIT4  = 'deg'              / units of field
TLMIN4  = 0.0                / minimum value
TLMAX4  = 360.0              / maximum value

TTYPE5  = 'Conf_68_SemiMinor'/ semiminor, axis, 68% containment confidence region
TFORM5  = 'E'                / floating point
TUNIT5  = 'deg'              / units of field
TLMIN5  = 0.0                / minimum value
TLMAX5  = 360.0              / maximum value

TTYPE6  = 'Conf_68_PosAng'   / position angle, 68% containment confidence region, E of
N
TFORM6  = 'E'                / floating point
TUNIT6  = 'deg'              / units of field
TLMIN6  = 0.0                / minimum value
TLMAX6  = 360.0              / maximum value
```

```
TTYPE7  = 'Conf_95_SemiMajor'/ semimajor axis, 95% containment confidence region
TFORM7  = 'E'                / floating point
TUNIT7  = 'deg'              / units of field
TLMIN7  = 0.0                / minimum value
TLMAX7  = 360.0              / maximum value

TTYPE8  = 'Conf_95_SemiMinor'/ semiminor, axis, 95% containment confidence region
TFORM8  = 'E'                / floating point
TUNIT8  = 'deg'              / units of field
TLMIN8  = 0.0                / minimum value
TLMAX8  = 360.0              / maximum value

TTYPE9  = 'Conf_95_PosAng'   / position angle, 95% containment confidence region, E of
N
TFORM9  = 'E'                / floating point
TUNIT9  = 'deg'              / units of field
TLMIN9  = 0.0                / minimum value
TLMAX9  = 360.0              / maximum value

TTYPE10 = 'Flux100'          / average photon flux >100 MeV
TFORM10 = 'E'                / floating point
TUNIT10 = 'photon /cm**2 /s' / units of field
TLMIN10 = 0.0                / minimum value
TLMAX10 = 1.0                / maximum value

TTYPE11 = 'Unc_Flux100'      / uncertainty (1-sigma) in average flux >100 MeV
TFORM11 = 'E'                / floating point
TUNIT11 = 'photon /cm**2 /s' / units of field
TLMIN11 = 0.0                / minimum value
TLMAX11 = 1.0                / maximum value

TTYPE12 = 'Flux30_100'       / average photon flux 30-100 MeV
TFORM12 = 'E'                / floating point
TUNIT12 = 'photon /cm**2 /s' / units of field
TLMIN12 = 0.0                / minimum value
TLMAX12 = 1.0                / maximum value

TTYPE13 = 'Unc_Flux30_100'   / uncertainty (1-sigma) in average flux 30-100 MeV
TFORM13 = 'E'                / floating point
TUNIT13 = 'photon /cm**2 /s' / units of field
TLMIN13 = 0.0                / minimum value
TLMAX13 = 1.0                / maximum value

TTYPE14 = 'Flux100_300'      / average photon flux 100-300 MeV
TFORM14 = 'E'                / floating point
TUNIT14 = 'photon /cm**2 /s' / units of field
TLMIN14 = 0.0                / minimum value
TLMAX14 = 1.0                / maximum value

TTYPE15 = 'Unc_Flux100_300'  / uncertainty (1-sigma) in average flux 100-300 MeV
TFORM15 = 'E'                / floating point
TUNIT15 = 'photon /cm**2 /s' / units of field
TLMIN15 = 0.0                / minimum value
TLMAX15 = 1.0                / maximum value

TTYPE16 = 'Flux300_1000'     / average photon flux 300-1000 MeV
TFORM16 = 'E'                / floating point
TUNIT16 = 'photon /cm**2 /s' / units of field
TLMIN16 = 0.0                / minimum value
TLMAX16 = 1.0                / maximum value

TTYPE17 = 'Unc_Flux300_1000' / uncertainty (1-sigma) in average flux 300-1000 MeV
TFORM17 = 'E'                / floating point
```

```
TUNIT17 = 'photon /cm**2 /s' / units of field
TLMIN17 = 0.0                / minimum value
TLMAX17 = 1.0                / maximum value

TTYPE18 = 'Flux3000'         / average photon flux >3000 MeV
TFORM18 = 'E'                / floating point
TUNIT18 = 'photon /cm**2 /s' / units of field
TLMIN18 = 0.0                / minimum value
TLMAX18 = 1.0                / maximum value

TTYPE19 = 'Unc_Flux3000'     / uncertainty (1-sigma) in average flux >3000 MeV
TFORM19 = 'E'                / floating point
TUNIT19 = 'photon /cm**2 /s' / units of field
TLMIN19 = 0.0                / minimum value
TLMAX19 = 1.0                / maximum value

TTYPE20 = 'Spectral_Index'   / photon spectral index, >100 MeV
TFORM20 = 'E'                / floating point
TUNIT20 = ' '                / dimensionless
TLMIN20 = -10.0              / minimum value
TLMAX20 = 10.0               / maximum value

TTYPE21 = 'Unc_Spectral_Index' / 1-sigma uncertainty, photon spectral index
TFORM21 = 'E'                / floating point
TUNIT21 = ' '                / dimensionless
TLMIN21 = 0.0                / minimum value
TLMAX21 = 10.0               / maximum value

TTYPE22 = 'Variability_Index'/ flux variability index (TBD)
TFORM22 = 'E'                / floating point
TUNIT22 = ' '                / dimensionless
TLMIN22 = ###                / minimum value (TBD)
TLMAX22 = ###                / maximum value (TBD)

TTYPE23 ='Signif_Avg'        / detection significance (whole time interval)
TFORM23 = 'E'                / floating point
TUNIT23 = ' '                / dimensionless (sigmas)
TLMIN23 = 0.0                / minimum value
TLMAX23 = 1.0E9              / maximum value

TTYPE24 = 'Signif_Peak'      / detection significance (peak)
TFORM24 = 'E'                / floating point
TUNIT24 = ' '                / dimensionless (sigmas)
TLMIN24 = 0.0                / minimum value
TLMAX24 = 1.0E9              / maximum value

TTYPE25 = 'Flux_Peak'        / peak flux (>100 MeV) for time interval above
TFORM25 = 'E'                / floating point
TUNIT25 = 'photon /cm**2 /s' / units of field
TLMIN25 = 0.0                / minimum value
TLMAX25 = 1.0                / maximum value

TTYPE26 = 'Unc_Peak_Flux'    / uncertainty (1-sigma) in peak flux >100 MeV
TFORM26 = 'E'                / floating point
TUNIT26 = 'photon /cm**2 /s' / units of field
TLMIN26 = 0.0                / minimum value
TLMAX26 = 1.0                / maximum value

TTYPE27 = 'Time_Peak'        / center of time interval of peak significance
TFORM27 = 'D'                / double precision
TUNIT27 = 'd'                / units of field
TLMIN27 = 0.0                / minimum value
TLMAX27 = 1.0D5              / maximum value
```

```
TTYPE28 = 'Peak_Interval'    / duration of time interval of peak significance
TFORM28 = 'D'                / double precision
TUNIT28 = 's'                / units of field
TLMIN28 = 0.0                / minimum value
TLMAX28 = 3.0D7              / maximum value

TTYPE29 = 'Flux_History'     / flux (>100 MeV) history (monthly)
TFORM29 = '12E'              / floating point array, 12 months (number TBR)
TUNIT29 = 'photon /cm**2 /s' / units of field
TLMIN29 = 0.0                / minimum value
TLMAX29 = 1.0                / maximum value

TTYPE30 = 'Flux_Unc_History' / flux uncertainty (1-sigma, >100 MeV) history
TFORM30 = '12E'              / floating point array, 12 months (number TBR)
TUNIT30 = 'photon /cm**2 /s' / units of field
TLMIN30 = 0.0                / minimum value
TLMAX30 = 1.0                / maximum value

TTYPE31 = 'Hist_Start'       / start of time intervals of flux history
TFORM31 = '12E'              / floating point array, 12 months (number TBR)
TUNIT31 = 'd'                / units of field
TLMIN31 = 0.0                / minimum value
TLMAX31 = 1.0D5              / maximum value

TTYPE32 = 'ID_Counterpart'   / source counterpart (if any)
TFORM32 = '20A'              / character string
TUNIT32 = ' '                / dimensionless

TTYPE33 = 'Conf_Counterpart' / confidence of association of counterpart with source
TFORM33 = 'I'                / index, 1 = Figure of Merit, 2 = Correlated variability
TUNIT33 = ' '                / dimensionless
TLMIN33 = 0                  / minimum value
TLMAX33 = 2                  / maximum value

TTYPE34 = 'Flags'            / flags (TBD) for catalog entry
TFORM34 = 'I'                / integer
TUNIT34 = ' '                / dimensionless

END
```

6.21. LS-009 Burst Catalog

Version: 2.0

Revision date: 4/7/06

Product Description:
This file contains the LAT catalog of GRBs. The file is updated when the bursts are reprocessed or new bursts are added to the catalog.

Naming Convention	gll_grbc_vxx.fit	xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCOPY (TBR)	
Production Latency Requirement	TBD	
Product contains data for	Intervals TBR, likely years	
Number of deliveries per day	< 1/day	
Typical size	1 MB	

Product Content	
Primary HDU:	Standard GLAST FITS Primary Header
Extension 1	Catalog

LS-009 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	T	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'yyyy-mm-dd'	Date file was made in YYYY-MM-DD
FILENAME	'gll_grbc_vxx.fit'	File name: xx = version number
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
DATE-OBS	'yyyy-mm-ddT hh:mm:ss.ssss'	Date of start of observation
DATE-END	'yyyy-mm-ddT hh:mm:ss.ssss'	Date of end of observation
CREATOR		Software and version creating file
VERSION		Release version of this catalog
SOFTWARE		Version of the analysis software
RESPONSE		Version of the IRFs
END		End of Header

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	T	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'2008-01-05'	Date file was made in YYYY-MM-DD
FILENAME	'gll_grbc_v##.fit'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'MICHELSON'	Instrument PI
DATE-OBS	'2008-01-04T12:32:33'	Date of start of observation
DATE-END	'2008-01-04T14:22:53'	Date of end of observation
CREATOR	'LAT_BURSTCAT_V04'	Software and version creating file
VERSION	#	Release version of this catalog
SOFTWARE	#	Version of the analysis software
RESPONSE	#	Version of the IRFs
END		End of Header

LS-009 Extension Header 1

Name: LAT_GRB_Catalog

Purpose: This extension provides the catalog of the bursts that the LAT detected. The time of the burst, position and various measures of the burst intensity and spectrum are provided.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	31	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_GRB_Catalog'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREFI	51910.	MJD date of reference epoch, integer part
MJDREFF	7.428703703703703D-4	MJD date of reference epoch, fractional part
TIMEUNIT	's'	Time unit used in TSTART and TSTOP keywords
TSTART		Time of start of observation offset from MJDREF in units of TIMEUNIT
TSTOP		Time of end of observation offset from MJDREF in units of TIMEUNIT
TTYPE1	'GCN_NAME'	GCN name of burst (without GRB prefix): yymmdd + 'A', 'B' if needed (e.g., 050525A)
TFORM1	'9A '	Character string
TUNIT1	' '	Units of field
TTYPE2	'LAT_GRB_ID'	A sequence number that includes only GRBs detected by the LAT
TFORM2	'1I '	Integer
TUNIT2	' '	Units of field
TLMIN2	1	Minimum value
TLMAX2	10000	Maximum value
TTYPE3	'LAT_Alert_Time'	LAT alert time wrt MJDREF
TFORM3	'1D '	Double precision
TUNIT3	's'	

TLMIN3	-1	Minimum value (no LAT alert)
TLMAX3	####	Maximum value
TTYPE4	'GBM_GRB_ID'	GBM identifier (without GRB or BN prefix): yymmdd+fff where fff is the fraction of the day. Entry is blank if GBM did not detect the burst
TFORM4	'9A '	Character string
TUNIT4	' '	
TTYPE5	'Right_Ascension'	Right ascension, J2000
TFORM5	'1E '	Floating point
TUNIT5	'deg'	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	'Declination'	DEClination, J2000
TFORM6	'1E '	Floating point
TUNIT6	'deg'	
TLMIN6	-90.0	Minimum value
TLMAX6	90.0	Maximum value
TTYPE7	'Conf_90_Region'	Radius of 90% confidence region
TFORM7	'1E '	Floating point
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	'GCAT_FLAGS'	Flags for catalog entry indicating whether data provided is for the prompt phase or an afterglow
TFORM8	'1B '	
TUNIT8	' '	Dimensionless
TTYPE9	'Peak_30_Flux'	Peak flux >30 MeV on (TBD)binned timescale
TFORM9	'1E '	Floating point
TUNIT9	'photon /cm**2 /s'	
TLMIN9	0.0	Minimum value
TLMAX9	####	Maximum value
TTYPE10	'Unc_30_Peak_Flux'	Uncertainty (1-sigma) in peak flux >30 MeV
TFORM10	'1E '	Floating point
TUNIT10	'photon /cm**2 /s'	
TLMIN10	0.0	Minimum value
TLMAX10	####	Maximum value
TTYPE11	'Time_30_Peak_Flux'	time of peak flux >30 MeV wrt MJDREF
TFORM11	'1D '	Double precision
TUNIT11	's'	
TLMIN11	-1	Minimum value
TLMAX11	####	Maximum value
TTYPE12	'Max_Energy'	maximum photon energy in burst
TFORM12	'1E '	Floating point
TUNIT12	'GeV'	
TLMIN12	0.0	Minimum value
TLMAX12	10000.0	Maximum value

TTYPE13	'Unc_Max_Energy'	Uncertainty (1-sigma) in maximum energy
TFORM13	'1E '	Floating point
TUNIT13	'GeV'	
TLMIN13	0.0	Minimum value
TLMAX13	10000.0	Maximum value
TTYPE14	'Time_Max_Energy'	time of maximum energy photon wrt MJDREF
TFORM14	'1D '	Double precision
TUNIT14	's'	
TLMIN14	0	Minimum value
TLMAX14	####	Maximum value
TTYPE15	'Duration'	burst duration measure
TFORM15	'1E '	floating point
TUNIT15	's'	
TLMIN15	0	Minimum value
TLMAX15	####	Maximum value
TTYPE16	'Unc_Duration'	1 sigma uncertainty for burst duration measure
TFORM16	'1E '	floating point
TUNIT16	's'	
TLMIN16	0	Minimum value
TLMAX16	####	Maximum value
TTYPE17	Start_Duration'	duration measure start time wrt MJDREF
TFORM17	'1D '	Double precision
TUNIT17	's'	
TLMIN17	0	Minimum value
TLMAX17	####	Maximum value
TTYPE18	'Avg_30_Energy'	average photon energy in burst > 30 MeV
TFORM18	'1E '	Floating point
TUNIT18	'GeV'	
TLMIN18	0.0	Minimum value
TLMAX18	10000.0	Maximum value
TTYPE19	'Unc_30_Avg_Energy'	1 sigma uncertainty in avg photon energy > 30 MeV
TFORM19	'1E	Floating point
TUNIT19	'GeV'	
TLMIN19	0.0	Minimum value
TLMAX19	10000.0	Maximum value
TTYPE20	'Fluence30'	fluence > 30 MeV (number fluence?)
TFORM20	'1E '	floating point
TUNIT20	'erg /cm**2'	
TLMIN20	0.0	Minimum value
TLMAX20	####	Maximum value
TTYPE21	'Unc_Flu30'	1 sigma uncertainty in fluence > 30 MeV
TFORM21	'1E '	Floating point
TUNIT21	'erg /cm**2'	
TLMIN21	0.0	Minimum value
TLMAX21	####	Maximum value
TTYPE22	'Avg_100_Energy'	average photon energy in burst > 100 MeV
TFORM22	'1E '	Floating point

TUNIT22	'GeV'	
TLMIN22	0.1	Minimum value
TLMAX22	10000.0	Maximum value
TTYPE23	'Unc_100_Avg_Energy'	1 sigma uncertainty in avg photon energy > 100MeV
TFORM23	'1E '	Floating point
TUNIT23	'GeV'	
TLMIN23	0.0	Minimum value
TLMAX23	10000.0	Maximum value
TTYPE24	'Fluence100'	fluence > 100 MeV (number fluence?)
TFORM24	'1E '	floating point
TUNIT24	'erg /cm**2'	
TLMIN24	0.0	Minimum value
TLMAX24	####	Maximum value
TTYPE25	'Unc_Flu100'	1 sigma uncertainty in fluence > 100 MeV
TFORM25	'1E '	Floating point
TUNIT25	'erg /cm**2'	
TLMIN25	0.0	Minimum value
TLMAX25	####	Maximum value
TTYPE26	'Rate_Hist'	rate history for grb
TFORM26	'PE(100) '	Floating point variable-length array
TUNIT26	'count /s'	
TLMIN26	0	Minimum value
TLMAX26	####	Maximum value
TTYPE27	'Unc_Rate_Hist'	1-sigma rate history uncertainty for grb
TFORM27	'PE(100) '	Floating point variable-length array
TUNIT27	'count /s'	
TLMIN27	0	Minimum value
TLMAX27	####	Maximum value
TTYPE28	'Start_Hist_Bin'	start time for each rate history bin wrt MJDREF
TFORM28	'PE(100) '	Floating point variable-length array
TUNIT28	's'	
TLMIN28	0	Minimum value
TLMAX28	####	Maximum value
TTYPE29	'Stop_Hist_Bin'	stop time for each rate history bin wrt MJDREF
TFORM29	'PE(100) '	Floating point variable-length array
TUNIT29	's'	
TLMIN29	0	Minimum value
TLMAX29	####	Maximum value
TTYPE30	'Avg_Phot_Ind'	average photon spectral index
TFORM30	'1E '	Floating point
TUNIT30	' '	dimensionless
TLMIN30	-999	Minimum value
TLMAX30	999	Maximum value
TTYPE31	'Unc_Avg_Phot_Ind'	1-sigma uncertainty for average photon spec index
TFORM31	'1E '	Floating point variable-length array
TUNIT31	' '	dimensionless
TLMIN31	0	Minimum value

TLMAX31	999	Maximum value

6.22. LS-010 Interstellar Emission Model

Version: 2.0

Revision date: 4/7/06

Product Description:
This file contains the LAT team's best model of the diffuse emission underlying the point and extended sources. Here it is assumed that the sky is divided into pixels by some hierarchical scheme (e.g., COBE spherical cube or HEALpix), and the model is tabulated for these directions (~500,000). New versions will be provided when this model is updated.

Naming Convention	gll_iem_vxx.fit	xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCopy	
Production Latency Requirement	Initial model will be refined based on analysis of sky survey data	
Product contains data for	Intervals TBR, likely updated once or twice during mission	
Number of deliveries per day	N/A	
Typical size	~15 Mbyte	

Product Content	
Primary HDU:	
Extension 1	Contains the specification of intensity spectrum for each pixel
Extension 2	Contains the mapping of pixel number to ra,dec for completeness
Extension 3	Contains the energies for which the intensities are defined in the first extension

LS-010 Primary Header

Definition:

FITS Keyword	Value—Required or Standard	Definition
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
NAXIS1		
NAXIS2		
NAXIS3		
EXTEND	T	Extension(s) present
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'yyyy-mm-dd'	Date file was made in YYYY-MM-DD
FILENAME	'gll_iem_vxx.fit'	File name: xx = version number
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘MICHELSON’	Instrument PI
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
NAXIS1		
NAXIS2		
NAXIS3		
EXTEND	T	Extension(s) present
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'2008-12-25'	Date file was made in YYYY-MM-DD
FILENAME	'gll_iem_v04.fit'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘MICHELSON’	Instrument PI
VERSION	4	Release version of the model
SOFTWARE	#	Version of the generating software
END		

LS-010 Extension Header 1

Name: LAT_IEM_INTENSITIES

Purpose: This extension provides the intensity and spectrum of the diffuse emission. Each row corresponds to a different pixel on the sky.

Definition:

FITS Keyword	Value—Required or Standard		Definition
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel - assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1		###	Number of bytes per row
NAXIS2		###	Number of point sources in file (~3e4)
PCOUNT		###	
THEAP		###	
GCOUNT		1	No multiplier
TFIELDS		3	Number of fields per row
CHECKSUM			Checksum for entire HDU
DATASUM			Checksum for data table
TELESCOP	'GLAST'		
INSTRUME	'LAT'		Name of instrument generating data
ORIGIN	'LISOC'		Name of organization making file
OBSERVER	'Michelson'		Name of PI
DATE	'YYYY-MM-DD'		Date file was made in YYYY-MM-DD
EXTNAME	'LAT_IEM_INTENSITIES'		Name of the extension
TTYPE1	'Pixel_Number'		Pixel number for sky tessellation (prob. same as row #)
TFORM1	'1J '		Long integer
TUNIT1	' '		Units of field
TLMIN1	0		Minimum value
TLMAX1	###		Maximum value
TTYPE2	'Intensity'		Model gamma-ray intensity
TFORM2	'20E '		Floating point, 20 values
TUNIT2	'photon /cm**2 /s /sr /GeV'		
TLMIN2	0.0		Minimum value
TLMAX2	###		Maximum value
TTYPE3	'Intensity'		Model gamma-ray intensity 1-sigma uncertainty
TFORM3	'20E '		Floating point, 20 values
TUNIT3	' photon /cm**2 /s /sr /GeV'		
TLMIN3	0.0		Minimum value
TLMAX3	###		Maximum value

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
DATE	‘2008-12-27’	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_IEM_INTENSITIES'	Name of the extension
TTYPE1	'Pixel_Number'	Pixel number for sky tessellation (prob. same as row #)
TFORM1	‘1J ‘	Long integer
TUNIT1	‘ ‘	Units of field
TLMIN1	0	Minimum value
TLMAX1	###	Maximum value
TTYPE2	'Intensity'	Model gamma-ray intensity
TFORM2	'20E '	Floating point, 20 values
TUNIT2	' photon /cm**2 /s /sr /GeV'	
TLMIN2	0.0	Minimum value
TLMAX2	###	Maximum value
TTYPE3	'Intensity'	Model gamma-ray intensity 1-sigma uncertainty
TFORM3	'20E '	Floating point, 20 values
TUNIT3	' photon /cm**2 /s /sr /GeV'	
TLMIN3	0.0	Minimum value
TLMAX3	###	Maximum value

LS-010 Extension Header 2

Name: LAT_IEM_PIXELS

Purpose: This extension defines the pixels on the sky.

Definition

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_IEM_PIXELS'	Name of the extension
TTYPE1	'Pixel_Number'	Pixel number for sky tessellation (prob. same as row #)
TFORM1	'1J '	Long integer
TUNIT1	' '	Units of field
TLMIN1	0	Minimum value
TLMAX1	###	Maximum value
TTYPE2	'Right_Ascension'	Right ascension (J2000)
TFORM2	'1E '	Floating point
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'Declination'	Declination (J2000)
TFORM3	'1E '	Floating point
TUNIT3	'deg'	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row

NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	3	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
DATE	‘2008-12-27’	Date file was made in YYYY-MM-DD
EXTNAME	‘LAT_IEM_PIXELS’	Name of the extension

TTYPE1	‘Pixel_Number’	Pixel number for sky tessellation (prob. same as row #)
TFORM1	‘1J ‘	Long integer
TUNIT1	‘ ’	Units of field
TLMIN1	0	Minimum value
TLMAX1	###	Maximum value
TTYPE2	‘Right_Ascension’	Right ascension (J2000)
TFORM2	‘1E ‘	Floating point
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	‘Declination’	Declination (J2000)
TFORM3	‘1E ‘	Floating point
TUNIT3	‘deg’	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value

LS-010 Extension Header 3

Name: LAT_IEM_ENERGIES

Purpose: This extension provides the grid of energies on which the diffuse emission is provided.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	1	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
DATE	‘YYYY-MM-DD’	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_IEM_ENERGIES '	Name of the extension
TTYPE1	'Energy'	Energies for which the intensities are defined
TFORM1	'20E '	Floating point, 20 values
TUNIT1	'GeV'	Units of field
TLMIN1	20?	Minimum value
TLMAX1	3E5?	Maximum value

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	1	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LISOC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI

DATE	‘2008-12-27’	Date file was made in YYYY-MM-DD
EXTNAME	'LAT_IEM_ENERGIES '	Name of the extension
TTYPE1	'Energy'	Energies for which the intensities are defined
TFORM1	'20E '	Floating point, 20 values
TUNIT1	'GeV'	Units of field
TLMIN1	20?	Minimum value
TLMAX1	3E5?	Maximum value

6.23. LS-011 LAT Energy Redistribution

Version: 1.3

Revision date: 4/7/06

Product Description:
This FITS file contains the constants for the parameterization of the energy distribution function. Currently one function suffices for both the back and front of the LAT and Class A and B photons.

Naming Convention	gll_edisp_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCopy	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	N/A	
Typical size	12 Kbyte	

Product Content	
Primary HDU:	
Extension 1	ENERGY REDISTRIBUTION—Contains the constants for the parameterization of the energy redistribution function

LS-011 Primary Header

Definition/Example:

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                    8 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in
'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode:
2001A&A...376..359H
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
HDUCLASS= 'OGIP    '           /
HDUDOC  = '        '           /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EDISP   '           /
HDUVERS = '1.0.0   '           /
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
FILENAME= 'gll_edisp_cwz_yymmdd_vwz.fits' / Name of this file:
                                          w—photon class identifier,
                                             e.g., A or B
                                          z—'F' for front, 'B' for
                                             back
                                          yymmdd—date the file
                                             becomes applicable
                                          xx—version number
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                   X = Class, such as 'A' or 'B'
                                   Y = 'F' for front, 'B' for back

END
```

LS-011 Extension Header 1

Name: ENERGY REDISTRIBUTION

Purpose: This extension contains the constants for the parameterization of the energy distribution function. Note that the keyword order may differ from an implementation of the format.
The redistribution function from actual photon energy E to apparent photon energy E' is parameterized as:

$$dN/dx = (1+x)^{p1}/(1+\exp(x/p2)) \text{ where } x=(E'-E)/E$$

Column 5, LTAIL, gives p2 while column 6, RWIDTH, gives p1. These values are valid in an energy-cos(inclination angle) bin.

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                      / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
EXTNAME = 'ENERGY REDISTRIBUTION' / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                     X = Class, such as 'A' or 'B'
                                     Y = 'F' for front, 'B' for back

The following HDU keywords identify the extension as following a
standard type

HDUCLASS= 'OGIP    '           /
HDUDOC  = '        '           /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EDISP   '           /
HDUVERS = '1.0.0   '           /

The following keywords, most of which start with 'C', identify the file
for CALDB.  See http://heasarc.gsfc.nasa.gov/docs/heasarc/caldb/
docs/memos/cal_gen_92_019/cal_gen_92_019.html

EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'EDISP   '           / OGIP codename
CBD10001= 'ENERG(xx-yy)MeV'    / Energy goes from xx to yy MeV
```

```
CBD20001= 'THETA(0-90)deg'     / Inclination angle goes from 0 to 90 deg
CBD30001= 'PHI(0-360)deg'      / Azimuthal angle goes from 0 to 360 deg
CVSD0001= 'yyyy-mm-dd'         / Start date of validity (UTC)
CVST0001= 'hh:mm:ss'           / Start time (within date) of validity
                                 (UTC)
CDES0001= '        '           / Descriptive name of calibration dataset

End of CALDB keywords

EMIN    =                      / [MeV] Minimum energy
EMAX    =                      / [MeV] Maximum energy
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    6 / number of fields in each row

TTYPE1  = 'ENERG_LO'           / Low end of energy range
TFORM1  = '16E     '           / format of field
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           / High end of energy range
TFORM2  = '16E     '           / format of field
TUNIT2  = 'MeV     '           /

TTYPE3  = 'COSTH_LO'           / Low end of cos(inclination) range
TFORM3  = '6E      '           / format of field
TUNIT3  = 'rad     '           /

TTYPE4  = 'COSTH_HI'           / High end of cos(inclination) range
TFORM4  = '6E      '           / format of field
TUNIT4  = 'rad     '           /

TTYPE5  = 'LTAIL   '           / label for field
TFORM5  = '96E     '           / format of field, total number of array
                                 elements
TDIM5   = '(16, 6) '           / Gives dimensions of array
1CTYP5  = 'ENERGY  '           / First dimension is energy
2CTYP5  = 'COSTHETA'           / Second dimension is cos(inclination)
CREF5   = '(ENERG_LO:ENERG_HI,COSTH_LO,COSTH_HI)' / Column referencing

TTYPE6  = 'RWIDTH  '           / label for field
TFORM6  = '96E     '           / format of field, total number of array
                                 elements
TDIM6   = '(16, 6) '           / Gives dimensions of array
1CTYP6  = 'ENERGY  '           / First dimension is energy
2CTYP6  = 'COSTHETA'           / Second dimension is cos(inclination)
CREF6   = '(ENERG_LO:ENERG_HI,COSTH_LO,COSTH_HI)' / Column referencing

END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  944 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM= 'ZCVleBTjZBTjdBTj'   / HDU checksum updated 2006-02-
14T17:44:16
```

```
DATASUM = '4069136297'         / data unit checksum updated 2006-02-
14T17:44:16
DATE    = ‘2006-03-15T10:08:54’ / Date file was created
DATE-OBS= ‘2006-03-01T00:00:00’ / Date file becomes applicable
EXTNAME = 'ENERGY REDISTRIBUTION' / name of this binary table extension
ORIGIN  = ‘LISOC’              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= ‘Michelson’          / Instrument PI
LATCLASS= 'AF      '           / Class A, Front
HDUCLASS= 'OGIP    '           /
HDUDOC  = '        '           /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EDISP   '           /
HDUVERS = '1.0.0   '           /
EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'EDISP   '           / OGIP codename
CBD10001= 'ENERG(18-18808)MeV' / Energy goes from 18 MeV to ~19 GeV
CBD20001= 'THETA(0-90)deg'     / Inclination angle goes from 0 to 90 deg
CBD30001= 'PHI(0-360)deg'      / Azimuthal angle goes from 0 to 360 deg
CVSD0001= '2006-03-01'         / Start date of validity (UTC)
CVST0001= '00:00:00'           / Start time (within date) of validity
CDES0001= 'GLAST LAT energy redistribution function for Data Challenge
2'
EMIN    =                   18 / [MeV] Minimum energy
EMAX    =                18808. / [MeV] Maximum energy
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    6 / number of fields in each row

TTYPE1  = 'ENERG_LO'           / label for field
TFORM1  = '16E     '           / format of field
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           / label for field
TFORM2  = '16E     '           / format of field
TUNIT2  = 'MeV     '           /

TTYPE3  = 'COSTH_LO'           / label for field
TFORM3  = '6E      '           / format of field
TUNIT3  = 'rad     '           /

TTYPE4  = 'COSTH_HI'           / label for field
TFORM4  = '6E      '           / format of field
TUNIT4  = 'rad     '           /

TTYPE5  = 'LTAIL   '           / label for field
TFORM5  = '96E     '           / format of field
TUNIT5  = '        '           /
TDIM5   = '(16, 6) '           /
1CTYP5  = 'ENERGY  '           / Always use log(ENERGY) for
interpolation
2CTYP5  = 'COSTHETA'           / Always use cos(THETA) for interpolation
CREF5   = '(ENERG_LO:ENERG_HI,COSTH_LO,COSTH_HI)'

TTYPE6  = 'RWIDTH  '           / label for field
```

```
TFORM6  = '96E     '           / format of field
TUNIT6  = '        '
TDIM6   = '(16, 6) '
1CTYP6  = 'ENERGY  '           / Always use log(ENERGY) for
interpolation
2CTYP6  = 'COSTHETA'           / Always use cos(THETA) for interpolation
CREF6   = '(ENERG_LO:ENERG_HI,COSTH_LO,COSTH_HI)'

HISTORY File modified by user 'ddavis' with fv  on 2006-02-14T12:37:07
END
```

6.24. LS-012 LAT Effective Area

Version: 1.3

Revision date: 4/7/06

Product Description:
This data product provides the effective area as a function of energy and inclination angle.

Naming Convention	gll_earea_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCopy	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	N/A	
Typical size	120 kbytes (4 files, ~30 kbytes/file)	

Product Content	
Primary HDU:	
Extension 1	EFFECTIVE AREA—Contains the effective area

LS-012 Primary Header

Definition/Example:

```
SIMPLE  =                    T /Dummy Created by MWRFITS v1.4a
BITPIX  =                    8 /Dummy primary header created by MWRFITS
NAXIS   =                    0 /No data is associated with this header
EXTEND  =                    T /Extensions may (will!) be present
COMMENT   FITS (Flexible Image Transport System) format is defined in
'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode:
2001A&A...376..359H
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
FILENAME= 'gll_earea_cwz_yymmdd_vwz.fits' / Name of this file:
                                          w—photon class identifier,
                                             e.g., A or B
                                          z—'F' for front, 'B' for
                                             back
                                          yymmdd—date the file
                                             becomes applicable
                                          xx—version number
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                    X = Class, such as 'A' or 'B'
                                    Y = 'F' for front, 'B' for back

END
```

LS-012 Extension Header 1

Name: EFFECTIVE AREA

Purpose: This extension provides the effective area as a function of energy and inclination angle. Note that the keyword order may differ from an implementation of the format.

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                    1 / number of rows in table
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
EXTNAME = 'EFFECTIVE AREA'     / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                    X = Class, such as 'A' or 'B'
                                    Y = 'F' for front, 'B' for back

The following HDU keywords identify the extension as following a
standard type

HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EFF_AREA'           /
HDUVERS = '1.0.0   '           /

The following keywords, most of which start with 'C', identify the file
for CALDB.  See http://heasarc.gsfc.nasa.gov/docs/heasarc/caldb/
docs/memos/cal_gen_92_019/cal_gen_92_019.html

EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'EFF_AREA'           / OGIP codename
CBD10001= 'ENERG(xx-yy)MeV'    / Energy goes from xx to yy MeV
CBD20001= 'THETA(0-90)deg'     / Inclination angle goes from 0 to 90 deg
CBD30001= 'PHI(0-360)deg'      / Azimuthal angle goes from 0 to 360 deg
CVSD0001= 'yyyy-mm-dd'         / Start date of validity (UTC)
CVST0001= 'hh:mm:ss'           / Start time (within date) of validity
                                    (UTC)
CDES0001= '        '           / Descriptive name of calibration dataset
```

```
End of CALDB keywords

EXTVER  =                    1 / auto assigned by template parser
EMIN    =                      / [MeV] Minimum energy
EMAX    =                      / [MeV] Maximum energy
GAMMA   =                      / Spectral slope
CTMIN   =                      / Minimum cos(THETA)
CTMAX   =                      / Maximum cos(THETA)
TFIELDS =                    6 / number of fields in each row

TTYPE1  = 'ENERG_LO '          / Low end of energy range
TFORM1  = '35E     '           /
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI '          / High end of energy range
TFORM2  = '35E     '           /
TUNIT2  = 'MeV     '           /

TTYPE3  = 'THETA   '           / Inclination angle
TFORM3  = '51E     '           /
TUNIT3  = 'rad     '           /

TTYPE4  = 'EFFAREA '           / Effective area
TFORM4  = '1785E   '           /
TUNIT4  = 'm**2    '           /
TDIM4   = '( 35, 51)'          / Gives dimensions of array
1CTYP4  = 'ENERGY  '           / First dimension is energy
2CTYP4  = 'THETA   '           / Second dimension is inclination angle
CREF4   = '(ENERG_LO:ENERG_HI,THETA)' / Column referencing

TTYPE5  = 'STAT_MIN '          /
TFORM5  = '1785E   '           /
TDIM5   = '( 35, 51)'          / Gives dimensions of array
TUNIT5  = 'm**2     '           /

TTYPE6  = 'STAT_MAX '          /
TFORM6  = '1785E   '           /
TDIM6   = '( 35, 51)'          / Gives dimensions of array
TUNIT6  = 'm**2     '           /

END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                21904 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
CHECKSUM= 'Y9KSZ9ISY9ISY9IS'   / HDU checksum updated 2006-02-
09T07:15:30
DATASUM = '409863926'          / data unit checksum updated 2006-02-
09T07:15:30
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
DATE    = '2006-03-15T15:54:30' / Date file was created
DATE-OBS= '2006-03-01T00:00:00' / Date file becomes applicable
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
```

```
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'AF      '           / Photon classification
HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EFF_AREA'           /
HDUVERS = '1.0.0   '           /
EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'EFF_AREA'           / OGIP codename
CBD10001= 'ENERG(18-17800)MeV' /
CBD20001= 'THETA(0-90)deg'     /
CBD30001= 'PHI(0-360)deg'      /
CVSD0001= '2006-03-01'         / Start date of validity (UTC)
CVST0001= '00:00:00'           / Start time (within date) of validity
CDES0001= 'GLAST LAT effective area for Data Challenge 2' /
EXTVER  =                    1 / auto assigned by template parser
EMIN    =                17.78 / [MeV] Minimum energy
EMAX    =             177800.0 / [MeV] Maximum energy
GAMMA   =                  1.0 / Spectral slope
CTMIN   =                  0.0 / Minimum cos(THETA)
CTMAX   =                  1.0 / Maximum cos(THETA)
TFIELDS =                    6 / number of fields in each row

TTYPE1  = 'ENERG_LO '          /
TFORM1  = '35E     '           /
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI '          /
TFORM2  = '35E     '           /
TUNIT2  = 'MeV     '           /

TTYPE3  = 'THETA   '           /
TFORM3  = '51E     '           /
TUNIT3  = 'rad     '           /

TTYPE4  = 'EFFAREA '           /
TFORM4  = '1785E   '           /
TDIM4   = '( 35, 51)'          /
1CTYP4  = 'ENERGY  '           / First dimension is energy
2CTYP4  = 'THETA   '           / Second dimension is inclination angle
CREF4   = '(ENERG_LO:ENERG_HI,THETA)' /
TUNIT4  = 'm**2    '           /

TTYPE5  = 'STAT_MIN '          /
TFORM5  = '1785E   '           /
TDIM5   = '( 35, 51)'          /
TUNIT5  = 'm**2    '           /

TTYPE6  = 'STAT_MAX '          /
TFORM6  = '1785E   '           /
TDIM6   = '( 35, 51)'          /
TUNIT6  = 'm**2    '           /

HISTORY Input merit file: allGamma-rep-GR-v7r3p4_concat_CTnew.root
```

```
HISTORY Filter string:
HISTORY CFITSIO used the following filtering expression to create this
table:
HISTORY allGamma-rep-GR-v7r3p4_concat_CTnew.fits[EVENTS][col McEnergy;
McLogEner
HISTORY gy; McXDir; McYDir; McZDir; McDirErr; Tkr1FirstLayer;
CTBBestXDir; CTBBe
HISTORY stYDir; CTBBestZDir; CTBBestEnergy; CTBBestEnergyProb; CTBCORE;
CTBGAM][
HISTORY CTBGAM > 0.35 && CTBBestEnergyProb > 0.3]
HISTORY TASK: FSELECT on FILENAME: allGamma.fits
HISTORY fselect4.4 at 2006-03-03T10:11:01
HISTORY Expression: Tkr1FirstLayer < 6
HISTORY TASK: FSELECT on FILENAME: allGamma-BACK.fits
HISTORY fselect4.4 at 2006-03-03T10:11:04
HISTORY Expression: CTBGAM > 0.50 && CTBCORE > 0.35 && CTBBestEnergyProb
> 0.35
HISTORY File modified by user 'jchiang' with fv  on 2006-03-03T09:34:14

END
```

6.25. LS-013 LAT PSF

Version: 1.3

Revision date: 4/7/06

Product Description:
This data product contains the constants for the parameterization of the point spread function (PSF).

Naming Convention	gll_psf_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	GSSC	
Delivery Method	FASTCopy	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	N/A	
Typical size	68 kbytes (4 files, 17 kbytes/file)	

Product Content	
Primary HDU:	
Extension 1	POINT SPREAD FUNCTION—Contains the constants for the parameterization of the PSF after energy scaling
Extension 2	PSF_SCALING_PARAMS—Energy scaling of the PSF

LS-013 Primary Header

Definition/Example:

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                    8 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in
'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode:
2001A&A...376..359H
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
FILENAME= 'gll_psf_cwz_yymmdd_vwz.fits' / Name of this file:
                                          w—photon class identifier,
                                             e.g., A or B
                                          z—'F' for front, 'B' for
                                             back
                                          yymmdd—date the file
                                             becomes applicable
                                          xx—version number
ORIGIN  = 'LISOC'            / Organization creating file
TELESCOP= 'GLAST   '         /
INSTRUME= 'LAT     '         /
OBSERVER= 'Michelson'        / Instrument PI
LATCLASS= 'XY      '         / Photon classification:
                                  X = Class, such as 'A' or 'B'
                                  Y = 'F' for front, 'B' for back

END
```

LS-013 Extension Header 1

Name: POINT SPREAD FUNCTION

Purpose: This extension contains the constants for the parameterization of the point spread function (PSF) after energy scaling.
If the angle between the actual and apparent positions θ is scaled as δ=θ/θ', where the energy scaled angle θ' is given in the next extension, then the PSF is parameterized as

$$dlnN/d\delta = (\delta/\sigma^2)(1-1/\gamma)(1+(\delta/\sigma)^2/2\gamma)^{-\gamma}$$

Column 4, SIGMA, provides σ, while column 5, GAMMA, provides γ. A given set of parameter values is valid over an energy range at a specific angle.

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                    1 / number of rows in table
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
EXTNAME = 'POINT SPREAD FUNCTION' / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                    X = Class, such as 'A' or 'B'
                                    Y = 'F' for front, 'B' for back

The following HDU keywords identify the extension as following a
standard type

HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
HDUDOC  = '        '           /
HDUCLAS1= 'RESPONSE'           / Extension contains response data
HDUCLAS2= 'PSF     '           /
HDUVERS = '1.0.0   '           /

The following keywords, most of which start with 'C', identify the file
for CALDB.  See http://heasarc.gsfc.nasa.gov/docs/heasarc/caldb/
docs/memos/cal_gen_92_019/cal_gen_92_019.html

EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'PSF     '           / OGIP codename
CBD10001= 'ENERG(xx-yy)MeV'    / Energy goes from xx to yy MeV
CBD20001= 'THETA(0-90)deg'     / Inclination angle goes from 0 to 90 deg
```

```
CBD30001= 'PHI(0-360)deg'      / Azimuthal angle goes from 0 to 360 deg
CVSD0001= 'yyyy-mm-dd'         / Start date of validity (UTC)
CVST0001= 'hh:mm:ss'           / Start time (within date) of validity
CDES0001= '        '           / Descriptive name of calibration dataset

End of CALDB keywords

EXTVER  =                    1 / auto assigned by template parser
EMIN    =                      / [MeV] Minimum energy
EMAX    =                      / [MeV] Maximum energy
TFIELDS =                    5 / number of fields in each row

TTYPE1  = 'ENERG_LO'           / Low end of energy range
TFORM1  = '8E      '           / format of field
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           / High end of energy range
TFORM2  = '8E      '           / format of field
TUNIT2  = 'MeV     '           /

TTYPE3  = 'THETA   '           / Inclination angle
TFORM3  = '8E      '           / format of field
TUNIT3  = 'rad     '           /

TTYPE4  = 'SIGMA   '           / label for field
TFORM4  = '64E     '           / format of field
TDIM4   = '( 8, 8) '           / Gives dimensions of array
1CTYP4  = 'ENERGY  '           / First dimension is energy
2CTYP4  = 'THETA   '           / Second dimension is inclination angle
CREF4   = '(ENERG_LO:ENERG_HI,THETA)' / Column referencing

TTYPE5  = 'GAMMA   '           / label for field
TFORM5  = '64E     '           / format of field
TDIM5   = '( 8, 8) '           / Gives dimensions of array
1CTYP5  = 'ENERGY  '           / First dimension is energy
2CTYP5  = 'THETA   '           / Second dimension is inclination angle
CREF5   = '(ENERG_LO:ENERG_HI,THETA)' / Column referencing

END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  608 / width of table in bytes
NAXIS2  =                    1 / number of rows in table
CHECKSUM= '8WcYAUcX2UcX8UcX'   / HDU checksum
DATASUM = '4129632526'         / data unit checksum
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
DATE    = '2006-03-15T15:54:30' / Date file was created
DATE-OBS= '2006-03-01T00:00:00' / Date file becomes applicable
EXTNAME = 'POINT SPREAD FUNCTION' / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'AF      '           / Photon classification
```

```
HDUCLASS= 'OGIP    '           /
HDUDOC  = '        '           /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'PSF     '           /
HDUVERS = '1.0.0   '           /
EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           / Coordinate system
CCLS0001= 'BCF     '           / OGIP class of calibration file
CDTP0001= 'DATA    '           / OGIP class of data type
CCNM0001= 'PSF     '           / OGIP codename
CBD10001= 'ENERG(18-177800)MeV' /
CBD20001= 'THETA(0-90)deg'     /
CBD30001= 'PHI(0-360)deg'      /
CVSD0001= '2006-03-01'         /
CVST0001= '00:00:00'           /
CDES0001= 'GLAST LAT point spread function for Data Challenge 2' /
EXTVER  =                    1 / auto assigned by template parser
EMIN    =                17.78 / [MeV] Minimum energy
EMAX    =               177800. / [MeV] Maximum energy
TFIELDS =                    5 / number of fields in each row

TTYPE1  = 'ENERG_LO'           / label for field
TFORM1  = '8E      '           / format of field
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           / label for field
TFORM2  = '8E      '           / format of field
TUNIT2  = 'MeV     '           /

TTYPE3  = 'THETA   '           / label for field
TFORM3  = '8E      '           / format of field
TUNIT3  = 'rad     '           /

TTYPE4  = 'SIGMA   '           / label for field
TFORM4  = '64E     '           / format of field
TUNIT4  = '        '           /
TDIM4   = '( 8, 8) '           /
1CTYP4  = 'ENERGY  '           / First dimension is energy
2CTYP4  = 'THETA   '           / Second dimension is inclination angle
CREF4   = '(ENERG_LO:ENERG_HI,THETA)' /

TTYPE5  = 'GAMMA   '           / label for field
TFORM5  = '64E     '           / format of field
TUNIT5  = '        '           /
TDIM5   = '( 8, 8) '           /
1CTYP5  = 'ENERGY  '           / First dimension is energy
2CTYP5  = 'THETA   '           / Second dimension is inclination angle
CREF5   = '(ENERG_LO:ENERG_HI,THETA)' /

END
```

LS-013 Extension Header 2

Name: PSF_SCALING_PARAMS

Purpose: This extension provides the parameters for the energy scaling angle θ' (see Extension 1). Only the 8th (p_1) and 9th (p_2) elements of the parameter array are used. The formula is

$$\theta' = \mathrm{sqrt}[(p_1(E/100\ \mathrm{MeV})^{-0.8})^2 + p_2^2]$$

Definition:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                      / width of table in bytes
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM=                      / HDU checksum
DATASUM =                      / data unit checksum
DATE    = 'yyyy-mm-ddThh:nn:ss.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:nn:ss.ss' / Date file becomes applicable
EXTNAME = 'PSF_SCALING_PARAMS' / Extension name
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'XY      '           / Photon classification:
                                    X = Class, such as 'A' or 'B'
                                    Y = 'F' for front, 'B' for back
FILTER  =                      / Instrument filter

The following HDU keywords identify the extension as following a
standard type

HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
HDUCLAS1= 'RESPONSE'           / Extension contains response data
HDUCLAS2= 'PSFPARAMS'          / Extension contains response matrix
HDUVERS = '1.2.0   '           / Version number of the format
CREATOR =                      / Software and version creating file
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    1 / number of fields in each row

TTYPE1  = 'PSFSCALE'           / PSF energy scaling parameters
TFORM1  = '13E     '           / format of field

END
```

Example:

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   52 / width of table in bytes
```

```
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM= '9iHkGh9j9hGjGh9j'   / HDU checksum
DATASUM = '774449715'          / data unit checksum
DATE    = '2006-03-15T15:15:45' / Date file was created
DATE-OBS= '2006-03-01T00:00:00' / Date file becomes applicable
EXTNAME = 'PSF_SCALING_PARAMS' / Extension name
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
LATCLASS= 'AF      '           / Photon Class A, Front
FILTER  = 'DC2 cuts'           / Instrument filter in use (if any)
HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
HDUCLAS1= 'RESPONSE'           / Extension contains response data
HDUCLAS2= 'PSFPARAMS'          / Extension contains response matrix
HDUVERS = '1.2.0   '           / Version number of the format
CREATOR = 'convertPsf v0'      / Software and version creating file
HISTORY  $Id: psf.tpl,v 1.4 2006/02/14 23:06:53 jchiang Exp $
EXTVER  =                    1 / auto assigned by template parser

TFIELDS =                    1 / number of fields in each row
TTYPE1  = 'PSFSCALE'           / label for field
TFORM1  = '13E     '           / format of field

END
```

6.26. SS-002 Pulsar Ephemerides

Version: 2.0

Revision date: 2/15/06

Product Description:
This file contains the ephemerides of pulsars that may be detectable by the LAT.

Naming Convention	gll_psreph_yymmdd_vxx.fit	yymmdd = date file was created xx = version number
Originator of Product	GSSC	
Product Format	FITS	
Delivery frequency	On update	
Typical size	~15 Mbyte	

Product Content

Primary HDU:	
Extension 1	Pulsar spin parameters
Extension 2	Pulsar orbital parameter
Extension 3	Observer information
Extension 4	Pulsar alternative name

SS-002 Primary Header

Definition:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
EXTEND	T	Extension(s) present
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
EQUINOX	2000.0	Equinox for ra and dec
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	Date file was made in YYYY-MM-DD
FILENAME	'gll_psreph_yymmdd_vxx.fit'	Name of file: yymmdd = date file was created xx = version number
ORIGIN	'GSSC'	Name of organization making file
CREATOR		Software and version creating file
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Example:

FITS Keyword	Value	Purpose
SIMPLE	T	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
EXTEND	T	Extension(s) present
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	'Michelson'	Name of PI
EQUINOX	2000.0	Equinox for ra and dec
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'2008-12-25T12:11:55.111'	Date file was made in YYYY-MM-DD
FILENAME	'gll_psreph_081225_v01.fit'	Name of file
ORIGIN	'GSSC'	Name of organization making file
CREATOR	'PULSAR_EPHEMERIDES_EXTRACTOR_V##'	Software and version creating file
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

SS-002 Extension Header 1

Name: SPIN_PARAMETERS

Purpose: This extension provides the pulsar spin ephemerides.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	8 bit bytes
NAXIS	2	2-D binary table
NAXIS1	###	Width of table in bytes
NAXIS2	###	Number of rows in table
PCOUNT	###	Size of special data area
GCOUNT	1	One data group
TFIELDS	###	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	‘yyyy-mm-ddThh:mm:ss.ssss’	File creation date
EXTNAME	'SPIN_PARAMETERS'	Name of the extension
TTYPE1	‘PSRNAME’	Pulsar name in PSR Jxxxx+xx[xx[aa]] format whenever available, or in any format otherwise
TFORM1	‘32A ’	Character
TTYPE2	‘RA’	RA (J2000) of pulsar
TFORM2	‘1D ‘	8 byte DOUBLE
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.	Maximum value
TTYPE3	‘DEC’	Model gamma-ray intensity 1-sigma uncertainty
TFORM3	‘1D ‘	8 byte DOUBLE
TUNIT3	‘deg’	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	‘VALID_SINCE’	First date for valid timing parameters
TFORM4	‘1J ‘	4-byte signed INTEGER
TUNIT4	‘d‘	Units of field
TTYPE5	‘VALID_UNTIL’	Last date for valid timing parameters
TFORM5	‘1J ‘	4-byte signed INTEGER
TUNIT5	‘d‘	Units of field

TTYPE6	‘EPOCH_INT’	Integer part of barycentric epoch of RA, DEC, F0, F1, and F2 in MJD
TFORM6	‘1J ‘	4-byte signed INTEGER
TUNIT6	‘d‘	
TTYPE7	‘EPOCH_FRAC’	Fractional part of barycentric epoch of RA, DEC, F0, F1, and F2 in MJD
TFORM7	‘1D ‘	8 byte DOUBLE
TUNIT7	‘d‘	Units of field
TLMIN7	0.0	Minimum value
TLMAX7	1.0	Maximum value
TTYPE8	‘TOAGEO_INT’	Integer part of infinite-frequency geocentric pulse arrival time (TT) in MJD
TFORM8	‘1J ‘	4-byte signed INTEGER
TUNIT8	‘d‘	
TTYPE9	‘TOAGEO_FRAC’	Fractional part of infinite-frequency geocentric pulse arrival time (TT) in MJD
TFORM9	‘1D ‘	8 byte DOUBLE
TUNIT9	‘d‘	
TLMIN9	0.0	Minimum value
TLMAX9	1.1	Maximum value
TTYPE10	‘TOABARY_INT’	Integer part of infinite-frequency barycentric pulse arrival time (TDB) in MJD
TFORM10	‘1J ‘	Data format of field: 4-byte signed INTEGER
TUNIT10	‘d‘	
TTYPE11	‘TOABARY_FRAC’	Fractional part of infinite-frequency barycentric pulse arrival time (TDBT) in MJD
TFORM11	‘1D ‘	Data format of field: 8-byte DOUBLE
TUNIT11	‘d‘	
TLMIN11	0.0	Minimum value
TLMAX11	1.0	Maximum value
TTYPE12	‘F0’	Pulsar rotation frequency
TFORM12	‘1D ‘	8 byte DOUBLE
TUNIT12	‘/s’	Units of field
TTYPE13	‘F1’	First derivative of pulsar rotation frequency
TFORM13	‘1D ‘	8 byte DOUBLE s
TUNIT13	‘/s**2’	
TTYPE14	‘F2’	Second derivative of pulsar rotation frequency
TFORM14	‘1D ‘	8 byte DOUBLE
TUNIT14	‘/s**3’	
TTYPE15	‘RMS’	Root-mean-square radio timing residual in milli-periods
TFORM15	‘1E ‘	
TUNIT15	‘ ’	
TLMIN15	0.0	Minimum value
TLMAX15	100000.0	Maximum value
TTYPE16	‘OBSERVER_CODE	Source of timing information
TFORM16	‘4A ’	Character

TTYPE17	‘BINARY_FLAG’	True for binary pulsars, false for single pulsars
TFORM17	‘1L ’	Logical
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	8 bit bytes
NAXIS	2	2-D binary table
NAXIS1	###	Width of table in bytes
NAXIS2	###	Number of rows in table
PCOUNT	###	Size of special data area
GCOUNT	1	One data group
TFIELDS	###	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	'2008-12-25T12:11:55.111'	File creation date
EXTNAME	'SPIN_PARAMETERS'	Name of the extension
TTYPE1	‘PSRNAME’	Pulsar name in PSR Jxxxx+xx[xx[aa]] format whenever available, or in any format otherwise
TFORM1	‘32A ’	Character
TTYPE2	‘RA’	RA (J2000) of pulsar
TFORM2	‘1D ‘	8 byte DOUBLE
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.	Maximum value
TTYPE3	‘DEC’	Model gamma-ray intensity 1-sigma uncertainty
TFORM3	‘1D ‘	8 byte DOUBLE
TUNIT3	‘deg’	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	‘VALID_SINCE’	First date for valid timing parameters
TFORM4	‘1J ‘	4-byte signed INTEGER
TUNIT4	‘d‘	Units of field
TTYPE5	‘VALID_UNTIL’	Last date for valid timing parameters
TFORM5	‘1J ‘	4-byte signed INTEGER
TUNIT5	‘d‘	Units of field
TTYPE6	‘EPOCH_INT’	Integer part of barycentric epoch of RA, DEC, F0, F1, and F2 in MJD
TFORM6	‘1J ‘	4-byte signed INTEGER
TUNIT6	‘d‘	

TTYPE7	'EPOCH_FRAC'	Fractional part of barycentric epoch of RA, DEC, F0, F1, and F2 in MJD
TFORM7	'1D '	8 byte DOUBLE
TUNIT7	'd'	Units of field
TLMIN7	0.0	Minimum value
TLMAX7	1.0	Maximum value
TTYPE8	'TOAGEO_INT'	Integer part of infinite-frequency geocentric pulse arrival time (TT) in MJD
TFORM8	'1J '	4-byte signed INTEGER
TUNIT8	'd'	
TTYPE9	'TOAGEO_FRAC'	Fractional part of infinite-frequency geocentric pulse arrival time (TT) in MJD
TFORM9	'1D '	8 byte DOUBLE
TUNIT9	'd'	
TLMIN9	0.0	Minimum value
TLMAX9	1.1	Maximum value
TTYPE10	'TOABARY_INT'	Integer part of infinite-frequency barycentric pulse arrival time (TDB) in MJD
TFORM10	'1J '	Data format of field: 4-byte signed INTEGER
TUNIT10	'd'	
TTYPE11	'TOABARY_FRAC'	Fractional part of infinite-frequency barycentric pulse arrival time (TDBT) in MJD
TFORM11	'1D '	Data format of field: 8-byte DOUBLE
TUNIT11	'd'	
TLMIN11	0.0	Minimum value
TLMAX11	1.0	Maximum value
TTYPE12	'F0'	Pulsar rotation frequency
TFORM12	'1D '	8 byte DOUBLE
TUNIT12	'/s'	Units of field
TTYPE13	'F1'	First derivative of pulsar rotation frequency
TFORM13	'1D '	8 byte DOUBLE s
TUNIT13	'/s**2'	
TTYPE14	'F2'	Second derivative of pulsar rotation frequency
TFORM14	'1D '	8 byte DOUBLE
TUNIT14	'/s**3'	
TTYPE15	'RMS'	Root-mean-square radio timing residual in milli-periods
TFORM15	'1E '	
TUNIT15	' '	
TLMIN15	0.0	Minimum value
TLMAX15	100000.0	Maximum value
TTYPE16	'OBSERVER_CODE	Source of timing information
TFORM16	'4A '	Character
TTYPE17	'BINARY_FLAG'	True for binary pulsars, false for single pulsars
TFORM17	'1L '	Logical
END		

SS-002 Extension Header 2

Name: ORBITAL_PARAMETERS

Purpose: This extension provides the orbital parameters of pulsars that are in binaries.

Definition:

FITS Keyword	Value—Required or Standard		Definition
XTENSION	'BINTABLE'		Extension type
BITPIX		8	Bits per pixel – assume single precision floating point
NAXIS		2	# of axes=2
NAXIS1		###	Number of bytes per row
NAXIS2		###	Number of point sources in file (~3e4)
PCOUNT		0	
GCOUNT		1	No multiplier
TFIELDS		2	Number of fields per row
CHECKSUM			Checksum for entire HDU
DATASUM			Checksum for data table
TELESCOP	'GLAST'		
INSTRUME	'LAT'		Name of instrument generating data
ORIGIN	'GSSC'		Name of organization making file
OBSERVER	'Michelson'		Name of PI
EQUINOX	2000.0		Equinox for RA and DEC
RADECSYS	'FK5'		World Coord. System for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.sss'		File creation date
EXTNAME	ORBITAL_PARAMETERS'		Name of the extension
TTYPE1	'PSRNAME'		Pulsar name in PSR Jxxxx+xx[xx[aa]] format (w/o 'PSR J')
TFORM1	'32A '		Character
TTYPE2	'PB'		Orbital period
TFORM2	'1D '		8-byte DOUBLE
TUNIT2	's'		
TTYPE3	'PBDOT'		First derivative of orbital period
TFORM3	'1D '		8-byte DOUBLE
TUNIT3	' '		
TTYPE4	'A1'		Projected semi-major axis in light seconds (light travel time)
TFORM4	'1D '		8-byte DOUBLE
TUNIT4	'lt-s'		Units of field
TTYPE5	'XDOT'		First time derivative of A1 (projected semi-major axis)
TFORM5	'1D '		8-byte DOUBLE
TUNIT5	'lt-s / s'		
TTYPE6	'ECC'		Orbital eccentricity

TFORM6	‘1D ‘	8-byte DOUBLE
TUNIT6	‘ ’	
TTYPE7	‘ECCDOT’	First derivative of orbital eccentricity
TFORM7	‘1D ‘	8-byte DOUBLE
TUNIT7	'/s'	Units of field
TTYPE8	‘OM’	Longitude of periastron
TFORM8	‘1D ‘	8-byte DOUBLE
TUNIT8	‘deg’	
TLMIN8	0.0	
TLMAX8	360.0	
TTYPE9	‘OMDOT’	First derivative of periastron longitude (degrees per Julian year)
TFORM9	‘1D ‘	8-byte DOUBLE
TUNIT9	‘deg /yr’	Units of field
TTYPE10	‘T0’	Barycentric time of periastron in MJD
TFORM10	‘1D ‘	8-byte DOUBLE
TUNIT10	‘d‘	
TTYPE11	‘GAMMA’	Time-dilation and gravitational redshift parameter
TFORM11	‘1D ‘	8-byte DOUBLE
TUNIT11	‘ ’	
TTYPE12	‘SHAPIRO_R’	Range parameter of Shapiro delay in binary system
TFORM12	‘1D ‘	8-byte DOUBLE
TUNIT12	‘us’	
TTYPE13	‘SHAPIRO_S’	Shape parameter of Shapiro delay in binary system
TFORM13	‘1D ‘	8-byte DOUBLE
TUNIT13	‘ ’	Units of field
TTYPE14	‘OBSERVER_CODE’	Source of orbital parameters
TFORM14	‘4A ’	Character
TTYPE15	'SOLAR_SYSTEM_EPHEMERIS'	Name of solar system ephemeris used for barycentric quantities ("JPL DE200" or "JPL DE405")
TFORM15	'32A '	Data format of field: character

END

Example:

FITS Keyword	Value	Purpose
XTENSION	‘BINTABLE’	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier

TFIELDS	2	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	'2008-12-25T12:11:55.111'	File creation date
EXTNAME	ORBITAL_PARAMETERS’	Name of the extension
TTYPE1	‘PSRNAME’	Pulsar name in PSR Jxxxx+xx[xx[aa]] format (w/o 'PSR J')
TFORM1	‘32A ’	Character
TTYPE2	‘PB’	Orbital period
TFORM2	‘1D ‘	8-byte DOUBLE
TUNIT2	‘s’	
TTYPE3	‘PBDOT’	First derivative of orbital period
TFORM3	‘1D ‘	8-byte DOUBLE
TUNIT3	‘ ’	
TTYPE4	‘A1’	Projected semi-major axis in light seconds (light travel time)
TFORM4	‘1D ‘	8-byte DOUBLE
TUNIT4	‘lt-s’	Units of field
TTYPE5	‘XDOT’	First time derivative of A1 (projected semi-major axis)
TFORM5	‘1D ‘	8-byte DOUBLE
TUNIT5	‘lt-s /s’	
TTYPE6	‘ECC’	Orbital eccentricity
TFORM6	‘1D ‘	8-byte DOUBLE
TUNIT6	‘ ‘	
TTYPE7	‘ECCDOT’	First derivative of orbital eccentricity
TFORM7	‘1D ‘	8-byte DOUBLE
TUNIT7	'/s'	Units of field
TTYPE8	‘OM’	Longitude of periastron
TFORM8	‘1D ‘	8-byte DOUBLE
TUNIT8	‘deg’	
TLMIN8	0.0	
TLMAX8	360.0	
TTYPE9	‘OMDOT’	First derivative of periastron longitude (degrees per Julian year)
TFORM9	‘1D ‘	8-byte DOUBLE
TUNIT9	‘deg /yr’	Units of field
TTYPE10	‘T0’	Barycentric time of periastron in MJD
TFORM10	‘1D ‘	8-byte DOUBLE

TUNIT10	‘d‘	
TTYPE11	‘GAMMA’	Time-dilation and gravitational redshift parameter
TFORM11	‘1D ‘	8-byte DOUBLE
TUNIT11	‘ ’	
TTYPE12	‘SHAPIRO_R’	Range parameter of Shapiro delay in binary system
TFORM12	‘1D ‘	8-byte DOUBLE
TUNIT12	‘us’	
TTYPE13	‘SHAPIRO_S’	Shape parameter of Shapiro delay in binary system
TFORM13	‘1D ‘	8-byte DOUBLE
TUNIT13	‘ ’	Units of field
TTYPE14	‘OBSERVER_CODE’	Source of orbital parameters
TFORM14	‘4A ’	Character
TTYPE15	'SOLAR_SYSTEM_EPHEMERIS'	Name of solar system ephemeris used for barycentric quantities ("JPL DE200" or "JPL DE405")
TFORM15	'32A '	Data format of field: character

END

SS-002 Extension Header 3

Name: OBSERVERS

Purpose: This extension lists the observers who provided the data.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	‘yyyy-mm-ddThh:mm:ss.ssss’	File creation date
EXTNAME	‘OBSERVERS’	Name of the extension
TTYPE1	‘OBSERVER_CODE	Observer code
TFORM1	‘4A ’	Character
TTYPE2	‘OBSERVATORY’	Name of observatory
TFORM2	‘128A ’	Character
TTYPE3	‘CONTACT_PERSON’	Name of contact person
TFORM3	‘128A ’	Character
TTYPE4	‘REFERENCE’	Reference for Publications
TFORM4	‘1024A ’	Character
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row

CHECKSUM		### Checksum for entire HDU
DATASUM		### Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	'2008-12-25T12:11:55.111'	File creation date
EXTNAME	‘OBSERVERS’	Name of the extension
TTYPE1	‘OBSERVER_CODE	Observer code
TFORM1	‘4A ’	Character
TTYPE2	‘OBSERVATORY’	Name of observatory
TFORM2	‘128A ’	Character
TTYPE3	‘CONTACT_PERSON’	Name of contact person
TFORM3	‘128A ’	Character
TTYPE4	‘REFERENCE’	Reference for Publications
TFORM4	‘1024A ’	Character
END		

SS-002 Extension Header 4

Name: ALTERNATIVE_NAMES

Purpose: This extension lists the multiple names by which a pulsar might be known.

Definition:

FITS Keyword	Value—Required or Standard	Definition
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
DATE	‘yyyy-mm-ddThh:mm:ss.ssss’	File creation date
EXTNAME	'ALTERNATIVE_NAMES'	Name of the extension
TTYPE1	'ALTNAME'	Alternative name for pulsar
TFORM1	'32A '	Character
TTYPE2	‘PSRNAME’	Pulsar name that appears in other extension
TFORM2	‘32A ’	Character
END		

Example:

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data

ORIGIN	'GSSC'	Name of organization making file
OBSERVER	‘Michelson’	Name of PI
DATE	‘YYYY-MM-DD’	Date file was made in YYYY-MM-DD
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World Coord. System for this file (FK5 or FK4)
EXTNAME	'ALTERNATIVE_NAMES'	Name of the extension
TTYPE1	'ALTNAME'	Alternative name for pulsar
TFORM1	'32A '	Character
TTYPE2	‘PSRNAME’	Pulsar name that appears in other extension
TFORM2	‘32A ’	Character

END

Appendix A. Acronyms

ACD	Anti-Coincidence Detector (part of LAT)
CAL	Calorimeter (part of LAT)
CALDB	Calibration Data Base
DRM	Detector Response Matrix
FITS	Flexible Image Transport System
GBM	GLAST Burst Monitor
GIOC	GBM Instrument Operations Center
GLAST	Gamma-ray Large Area Space Telescope
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
GSSC	GLAST Science Support Center
GRB	Gamma-Ray Burst
GTI	Good Time Interval
HDU	header-data unit
HEASARC	High Energy Astrophysics Science Archive Research Center
kB	kilobyte
LAT	Large Area Telescope
LISOC	LAT Instrument and Science Operations Center
PSF	Point Source Function
MB	megabyte
MET	Mission Elapsed Time
MOC	Mission Operations Center
NSSDC	National Space Science Data Center
OGIP	Office of General Investigator Programs
TDRS	Tracking and Data Relay Satellite

TDRSS	Tracking and Data Relay Satellite System
TKR	Tracker (part of LAT)
TRIGDAT	Trigger Data
TT	Terrestrial Time
UTC	Coordinated Universal Time