GLAST-GS-DOC-0001

Fermi Gamma-Ray Space Telescope

Fermi Science Support Center (FSSC)
Instrument Operations Centers (IOCs)

Science Data Products
File Format Document (FFD)

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GODDARD SPACE FLIGHT CENTER
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Fermi Gamma-ray
Space Telescope

Science Data Products
File Format Document

Fermi Gamma-Ray Space
Science Data Products File Format Document

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REVISION STATUS

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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
Revisions resulting from ISOC-GSSC discussions	2/13/07	§5 and §6	Delete LS-006 and LS-007
Complete revision of GS-104	3/2/07	GS-104	Remove PHT EDGE extension and correct SPECRESP MATRIX extension in GS-104
Corrections to GS-104	3/15/07	GS-104	Further small modifications to GS-104.
Modification of GS-103	4/12/07	GS-103	GTI extension added to TTE file, deadtime per event keyword added
Rename GS-108	4/19/07	GS-108	Rename GS-108 files
TRIGTIME added	4/19/07	GS-101, GS-102, GS-103, GS-104, GS-105, GS-106	TRIGTIME keyword added to primary headers of GS-101, GS-102, GS-103, GS-104, GS-105, GS-106
Remove CALDB keywords	4/27/07	GS-005	GS-005 will not be in the GBM CALDB, and therefore CALDB keywords removed
Increase TLMAX	4/27/07	GS-005	In extension 1 of GS-005, TLMAXn for n=1,2,4,5 raised to 4096, the number of GBM channels

Definition of NUM_REC	5/4/07	GS-005	NUM_REC column in extension 1 of GS-005 redefined as ‘Number of records accumulated in the spectrum’
EN_RES column added	5/4/07	GS-005	EN_RES column added to extension 1 of GS-005, columns renumbered
HDUCLAS4 =‘TYPEII’	5/11/07	GS-001, GS-002, GS-101, GS-102	HDUCLAS4=‘TYPEII’ added to SPECTRUM extensions of CTIME and CSPEC
GROUPING =0	5/15/07	GS-102	Spectrum extension was missing the GROUPING keyword
Changes to FT2 file	5/17/07	LS-005	Extension 1 renamed SC_DATA, and in same extension DEADTIME column removed and GEOMAG_LAT column added
Minor changes	6/12/07	GS-103, GS-105, GS-108	HDUCLAS keywords added to EVENTS extension of GS-103 Table with permitted trigger classes added to GS-105 Unnecessary EXTEND keyword deleted from GS-105 primary HDU HDUCLAS1 changed to ‘RESPONSE’ for GS-108 EBOUNDS
Correct TLMIN, TLMAX	6/28/07	GS-001, GS-002, GS-101, GS-102, GS-103, GS-104, GS-108	Current GBM values for TLMIN2, TLMAX2, TLMIN3 and TLMAX3 in EBOUNDS provided
Update of GBM burst catalog file	7/12/07	GS-106	In primary header of GS-106, definition of FLU and PFLX changed, and PFLX_INT, T90START, T50START, LOBCKINT, HIBCKINT, PFLXB and PFLXBERR added

Cleanup	7/20/07	GS-005, GS-007, GS-103, GS-106, GS-107, GS-108	Missing ORIGIN, CHECKSUM and DATASUM keywords added to GS-106, GS-107, and GS-108. FILE-VER in GS-108 is a string. Dimensionless TUNIT keywords dropped from GS-005 CALDB keywords (CCLS0001, CTTP0001, CCNM0001, CVSD0001, CVST0001, CDES0001) dropped from GS-007 DETNAM changed to DETTYPE in primary header of GS-007 DETCHANS added to EVENTS extension of GS-103 DET_MASK added to GS-105 and GS-106 TUNIT2 and TUNIT3 added to SPECTRUM extension of GS-108 DATATYPE added to GS-005, GS-007, GS-108
Misc. GBM items	11/21/07	Table 5-3, GS-003 added GS-104 GS-105 and GS-106	Non-burst version of TTE needed for calibration runs Spurious TLMIN1 in GS-104 removed ADC_HI, ADC_LO, CHAN_HI, CHAN_LO, TRIGSCAL and TRIG_ALG added to GS-105 and GS-106
GS-008	11/26/07	GS-008	New version of GS-008 substituted in; data product renamed
GBM ETE/ DiTL Cleanup	11/26/07	GS-001, GS-002, GS-101, GS-102, GS-103, GS-104, GS-108 LS-005	GBM detector TLMIN energy values in EBOUNDS changed to 5 and 100 keV for NaI and GBM detectors, respectively TIMESYS, TIMEUNIT and GPS_OUT added to primary header, and EXTVER added to SC_DATA header, of LS-005

Event/photon file	12/3/07	LS-001, LS-002	Update LS-002, remove column definitions from LS-001 (these definitions will be provided elsewhere)
Channel TLMIN/ TLMAX; Monotonic time	12/5/07	GS-001, GS-002, GS-008, GS-101, GS-102, GS-104	Correct TLMIN1/TLMAX1 for CHANNEL in EBOUNDS of CTIME and CSPEC and delete in GS-008 and GS-104 Spectrum start time increases monotonically in CTIME and CSPEC
Added LS-003, new filenames for LS-001, LS-002, and LS-005	12/10/07	Tables 5-4, LS-001, LS-002, LS-003, LS-005	Added LS-003 Livetime Cubes, updated table 5-4
Quaternions in LS-005	1/2/08	LS-005	Quaternions added to LS-005
Update LS-003	1/11/08	LS-003	Update of LS-003, primarily addition of CTHETABOUNDS extension
Misc.	1/16/08	Throughout	Added signatures Word changes in §§4 and 5 Tables and data products updated to state 15 LISOC processing runs per day Comment in text introducing GRESS_HISTORY extension of GS-008 that extension is not under configuration control Revised LS-008, LS-010, LS-011, LS-012 and LS-013
Penultimate baseline version	1/18/08	LS-008	All intended columns included in LS-008 LS-011, LS-012 and LS-013 filenames are TBD
Baseline version	1/22/08	GS-101, GS-102, GS-103	Removed TLMIN and TLMAX keywords for time columns that are referenced to the burst trigger

Misc. Revisions	3/18/08	All GBM datatypes GS-003	Minimum energy changed to 0. keV for both detector types EQUINOX, OBJECT, RADECSYS, RESPFILE, TZERO1 & TZERO2 removed from GS-003
Updated LAT Burst Catalog	4/24/08	LS-009	Updated the LAT burst catalog definition
Misc. Revisions	4/25/08	GS-106 LS-005 GS-003, GS-103 GS-003, GS-103 GS-007 GS-108 LS-002 Tables 5-1, 5-2, GS-002, GS-102	Misspelling of PFLXBERR corrected, CLASS changed to GRB TFIELDS corrected to 22 in SC_DATA extension TLMAX for channel numbers changed to 129 from 130 in EBOUNDS extension TLMAX for PHA channel changed to 129 from 130 in EVENTS extension TLMAX for PHA channel changed to 129 from 130 in GBM_PHA_LUT extension TLMAX for channel numbers changed to 9 or 129 from 130 in EBOUNDS, SPECTRUM and BACKMOD extensions EVENTS extension updated CSPEC cadence, number of channels corrected

Misc. Revisions	4/29/08	LS-008 LS-009 LS-011, LS-012, LS-013 LS-012 LS-013	DATASUM added to primary header NAXIS1 and NAXIS 2 added to both extensions Datatype changes for columns 11 and 12, name changes for columns 15 and 16 and CHECKSUM and DATASUM added to LAT_GRB_CATALOG extension Updated naming convention TUNIT5 corrected in EFFECTIVE AREA extension FILTER and CREATOR keywords removed from PSF_SCALING_PARAMS
Update LAT Source Catalog	5/1/08	LS-008	Update catalog file to conform to actually created data product, primarily by adding two columns to LAT_POINT_ SOURCE_CATALOG extension
Update burst data products	5/13/08	GS-101, GS-102, GS-103, GS-104, GS-105, GS-106, GS-107, GS-108 GS-106	Added ERR_RAD to all headers with burst locations Allowed datatypes added to DETECTOR DATA extension
TLMIN keywords removed	5/15/08	LS-002	TLMIN18 and TLMAX18 removed from EVENTS
Update GBM Catalog File	5/21/08	GS-106	NUMFITS keyword and RSPFILE column added to DETECTOR DATA extension. In same extension added TDIM for PHTCNTS, PTHMODL, and PHTERRS
Discrepancy corrections	6/13/08	Section 4.4, bullet 3vi Table 5-4	The version number may have two or three digits. The number of processing runs per day is ~16

TZERO added to GS-001 and GS-002	7/8/08	GS-001 and GS-002	TZERO1 and TZERO2 added to GTI extensions, and TZERO4 and TZERO5 added to SPECTRUM extensions, of GS-001 and GS-002; TLMAX for these columns revised
ASP Source Fluxes	7/8/08	Tables 5-6 and LS-006	ASP Source Fluxes file added as LS-006
Keyword removed from GS-107	7/9/08	GS-107	DETNAM='ALL' removed from TRIGRATE extension
Keywords added to GS-107	8/13/08	GS-107	GEO_LONG, GEO_LAT, RA_SCZ, and DEC_SCZ added to primary header of TRIGDAT
ASP source file updated	8/21/08	LS-006	For LIGHTCURVES extension, fewer flux channels included, EXTNAME added, FILENAME removed
Keywords added to GS burst files	8/21/08	GS-105, GS-106 and GS-107	GEO_LONG, GEO_LAT, RA_SCX, DEC_SCX, RA_SCZ, and DEC_SCZ added to primary header of burst files
CLASS in GS-106	8/21/08	GS-106	CLASS not required to be 'GRB'
Keyword restored to ASP file	8/25/08	LS-006	FILENAME restored to LIGHTCURVES extension
Remove ERR_RAD from RSP file	9/19/08	GS-104	Remove ERR_RAD from all headers
Additions to TRIGDAT	9/22/08	GS-107	Add TRIG_SIG to primary header, and columns TRIG_TS, TR_SCAZ and TR_SCZEN to OB_CALC extension
Update of LS-005	10/29/08	LS-005	SC_DATA extension updated by addition of a number of columns, primarily related to spacecraft orientation
Keywords added to GS-105	10/29/08	GS-105	EXTEND and TRIG_SIG keywords added to TCAT file

Keyword added to GS-105	11/07/08	GS-105	LOC_SRC keyword added
Keyword added to GS-003 & GS-103	04/02/09	GS-003 & GS-103	Added EVTDEDHI to EVENTS header.
TLMAX keyword changed.	04/02/09	GS-001, GS-002, GS-003, GS-007, GS-101, GS-102, GS-103, GS-104, GS-108	TLMAX1 set to 7 or 127 in EBOUNDS.
Update of GS-006	04/16/09	GS-006	Updated GLAST POS HIST extension with additional columns.
Update to GS-105	07/07/09	GS-105	Updated CLASS definition table.
Update LS-002 and LS-003	07/10/09	LS-002 & LS-003	Added columns and keywords to definitions.
Update GS-103	07/31/09	GS-103	Added FIFO_END and PRMT_BEG keywords in EVENTS.
Update LS-003	08/03/09	LS-003	Added WEIGHTED EXPOSURE extension.
Update GS-104	08/14/09	GS-104	Added rsp2 extension for RSPII formatted files.
Update LS-002 & LS-004	9/12/09	LS-002 & LS-005.	Added DIFRSP keywords to LS-002 EVENTS header. Add explanatory text for LAT_MODE and DATA_QUAL in LS-005.
UTC Dates	12/16/09	GBM Files	Modified text and header comments to be clear that DATE-OBS and DATE_END are in UTC for GBM files.
LS-008	1/15/10	LAT Point Source Catalog	Major updated based on release version of catalog.
Formatting	1/20/10	All	Tried to better regularize the formatting and sectioning. Replace GLAST with Fermi where applicable.
GS-106 & GS-109	1/25/10	GS-106 & GS-109	Added GS-109 and major updates to GS-106 definition.

LS-008 Updates	2/1/10	LS-008 LAT_Point_Source_Catalog extension	Added ASSOC_TEV and Unc_FLAG_History columns.
GS-106 & GS-109 updates	2/23/10	GS-1006	Minor updates.
LS-005	4/5/10	LS-005 SC_DATA extension	Change 'LAT' to 'S/C' in FITS header comments for RA_SCX, DEC_SCX, RA,_SCZ, and DEC_SCZ keywords.
GS-106 & GS-109 updates	4/28/10	FIT PARAMETERS extension	Added Covariance Matrix columns.
Updated file names	5/12/10	LS-001, LS-002, LS-003, LS-005	Updated the file name convention to include processing version. Added PROC_VER header keyword.
Added TZERO1 keyword	7/14/10	GS-003 Events header	Added TZERO1 keywords to EVENTS header of GS003 files.
Modified keywords for LS-001 & LS-002	7/23/10	LS-001 & LS-002 Primary and EVENTS headers	Added PASS_VER and modified EVENT_CLASS.
Modified keywords for LS-001 & LS-002	8/19/10	LS-001 & LS-002 Primary and EVENTS headers	Moved PASS_VER from primary to EVENTS header.
Modified definition text for GS-106 & GS-109	9/8/10	GS-106 & GS-109 Primary header	Added text to make it clear that start times (e.g., T90START) are relative to TRIGTIME.
Modified LS-005	2/25/11	LS-005 SC_DATA header	Fixed comments for LAT_CONFIG and DATA_QUAL.
Modified LS-005	4/25/11	LS-005 SC_DATA header	Added RA_SUN and DEC_SUN columns. Changed DATA_QUAL possible values.
Modified GS-106 and GS-109	5/30/11	All	Extensive changes.

Modified GS-106 and GS-109	8/3/11	All	Modified the comment for the PHT* columns in the DETECTOR DATA extension. Changed TIMEBIN to 2D in FITS PARAMETERS extension.
Modified GS-106 and GS-109	8/30/11	GS-106 & GS-109	Added example headers based on test files.
Modified LS-006	9/28/11	LS-006	Increased source name size from 20A to 30A.
Modified GS-106	10/11/11	GS-106	Changed comments on PF64 to correct energy range.
Added GS-009	10/19/11	All	Added new data type: GBM LLT file.
Added LS-014, LS-015, and LS-016	2/23/12	All	Added LAT LLE files.
Modified LS-015 and LS-016	2/27/12	LS-015 & LS-016	Changed CHANTYPE to PI from PHA.
Modified GS-106 and GS-109	4/10/12	GS-106 and GS-109	Added the BCATALOG and SCATALOG keywords.
Modified LS-014 – LS-019	5/4/12	All	Added or updated LAT LLE files.
Modified GS-106	8/23/12	GS-106	Added IDXFIX keyword.
Modified LS-005	10/17/12	LS-005	Added LAMBDA as column 12 in SC_DATA header. Moved existing columns 12-29 back by one.
Modified Table 5.1	3/7/13	Section 5	Added GS-003 to list of daily data products.
Added LS-020	8/2/13	LS-020	Added high resolution pointing and livetime history file (LS-020).
Added GS-110	10/23/13	GS-110	Added GBM localization contour files.
Cleanup	11/22/13	All	General cleanup. Fixed outdated, inconsistent, or wrong information. Fixed typos.

Added GS-111	06/19/14	GS-111	Added GBM localization contour FITS files.
Modified LS-001 & LS-002	1/30/15	LS-001 & LS-02	Updated definitions for Pass 8 data.
Modified LLE files	9/15/15	LS-0014, LS-015, LS-016, LS-017 & LS-018	Minor changes for Pass 8 data.
Added GBM HEALPix file	06/01/17	GS-112 & Table 5-2	Added GBM HEALPix localization FITS files.
Added GS-013	07/24/17	GS-013 & Table 5-1	Added GBM Hourly TTE Data File
Modified GS-112	01/17/18	GS-112	Fixed typos in GBM HEALPix file name convention.
Keyword out of date	01/24/18	GS-112	Description of the OBJECT keyword in the HEALPix extension was out of date.
Modified LS-005	10/10/18	LS-005	Added SC_VELOCITY column.
Modified GS-112	09/10/19	GS-112	Added GEO_RAD to HEALPix definition.

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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 Fermi Instrument Operations Centers (IOCs)—the GBM IOC (GIOC) and the LAT Instrument Science and Operations Center (ISOC)—and the Fermi 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 Fermi 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 Fermi 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. Fermi Spacecraft

Figure 1 shows the Fermi 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 Gamma-Ray Burst Monitor (GBM) consists of 12 NaI and 2 BGO detectors that protrude from the spacecraft bus.

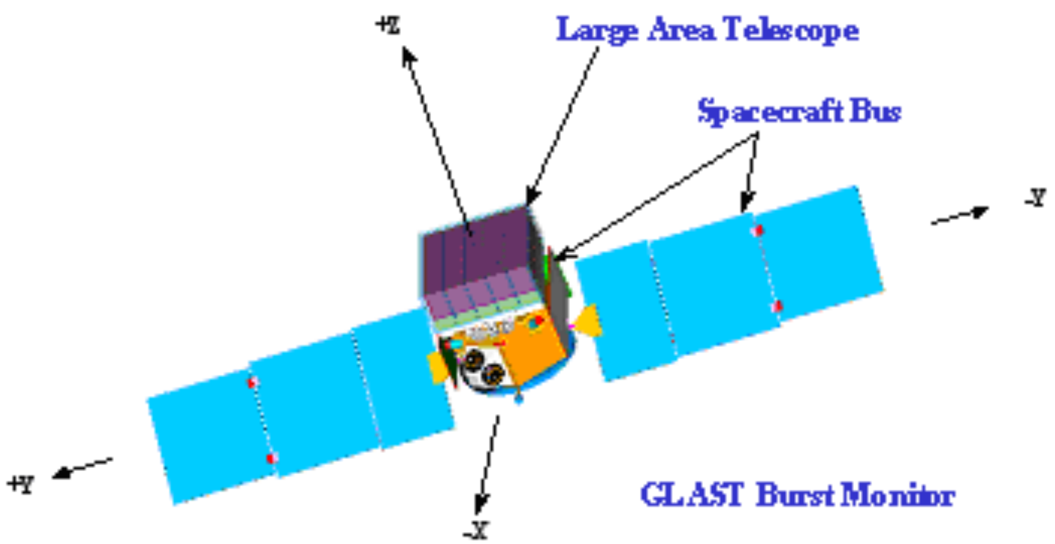

Figure 1—Simplified drawing of the Fermi observatory showing the coordinate convention.

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 FSSC will keep the Level 0 data for 3 months 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 FSSC.

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 2nd and 5th 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.[1] 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 Fermi 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. All science data products will use the same fiducial time, a date given by MJDREF keywords. The Fermi 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

[1] http://heasarc.gsfc.nasa.gov/docs/heasarc/ofwg/ofwg_recomm.html

significant changes of flux will be minutes, but will be necessary for comparing observations of GRBs.

Note that the DATE, DATE-OBS, and DATE-END FITS header keywords are in the UTC system, while all other times are governed by TIMESYS and MJDREF, as applicable.

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 will have unique, human-readable names; newer versions of a data product will 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 will 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 will start with 'gl' and include (in order, as necessary):
    i. The logical instrument: 'g' (GBM) or 'l' (LAT);
    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, while 'all' indicates files that apply to all detectors;
    iv. LAT files may have an additional identifier specifying the processing version, a 'p' followed by three digits. This field was added later in the mission to help distinguish between reprocessing, incompatible formats, etc.;
    v. Identifier such as burst 'bnyymmddfff', where yymmdd signifies the day and fff the fraction of day;
    vi. Identifier such as 'rnnnnnnnnnn' signifies the start time of a LAT run in MET;
    vii. Version number, such as v03 or v003, starting with 00 or 000; and
    viii. 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 4th 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 2nd 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_p130_r0321819587_v01fit, the 2nd version of the

FITS file with pointing and time data from the pass starting at MET 321819587 (March 14, 2011 18:19:45 TUC) for processing version 130.

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 Fermi 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 will 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. Fermi-Specific Keywords and Usages

The following are a number of Fermi-specific keywords or usages:

- DATATYPE—GBM keyword based on BATSE usage. This keyword identifies the data class that is the basis of a data product, 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 Fermi-relevant values:
    - 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' or 'Fermi'

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 FSSC. 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 FSSC file by file as they are produced, not necessarily in one package for a given day.

On 26 November 2012, the GBM flight software was updated to allow operation in a new data-taking mode. In nominal operation mode, the GBM is now continuously recording and sending to the ground time-tagged events (TTE) with 2 μs precision, synchronized to GPS once per second. This continuous TTE mode will be throttled in selected (nominally, sun-facing) detectors at times of high solar activity to avoid telemetry volume problems at the spacecraft and mission operations level.

Table 5-1: GIOC Daily Data Products Descriptions

ICD ID	Product	Description	Latency	Size	Level
GS-001	CTIME (daily version)	The counts accumulated every 0.256 seconds in 8 energy channels for each of the 14 detectors.	24 hours after receipt of last input data	230 MB (16 MB /file)	1
GS-002	CSPEC (daily version)	The counts accumulated every 4.096 seconds in 128 energy channels for each of the 14 detectors.	24 hours after receipt of last input data	290 MB (20.6MB /file)	1
GS-003	TTE (continuous version)	Event data for each detector with a time precise to 2 microseconds, in 128 energy channels.	24 hours after receipt of last input data	~10 GB (66 MB/file)	1

GS-005	GBM gain and energy resolution history	History of the detector gains and energy resolutions; required for calculating DRMs.	24 hours after receipt of last input data	42kB (3kB/ file)	1
GS-006	Fermi position and attitude history	History of Fermi's position and attitude, required for calculating DRMs	24 hours after receipt of last input data	3MB	1
GS-013	TTE (hourly version)	Time tagged events which occurred during the hour including up to the last 120 seconds of events from the previous hour.	24 hours after receipt of last input data	40-60 MB (3-4.5 MB/file)	1

The burst data products are the files pertaining to a given burst that are produced and sent to the FSSC 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.

Note that, although still listed here, the GS-108 GBM Background Files, are not created by the GIOC and were never served to the public

Table 5-2: GIOC Burst Data Products Descriptions

ICD ID	Product	Description	Latency	Size (bytes)	Level
GS-101	CTIME (burst version)	For each detector, the counts accumulated every 0.256 s in 8 energy channels	1 day	16MB (1.15 MB /file)	1
GS-102	CSPEC (burst version)	For each detector, the counts accumulated every 4.096 s or less in 128 energy channels	1 day	16MB (1.15 MB /file)	1
GS-103	GBM TTE	Event data for each detector in 128 energy channels.	1 day	40-60MB (3-4.5 MB /file	1
GS-104	GBM DRMs	8 and 128 energy channel DRMs for all 14 detectors	1 day	6 MB (0.4 MB /file)	1
GS-105	GBM Trigger Catalog Entry (TCAT)	Classification of GBM trigger with some characteristics	1 day, updated periodically	20 kB	1
GS-106 (GRB trigger)	GBM Burst Catalog Entry (BCAT)	Parameters describing the burst (e.g., durations, fluences)	1 day, updated periodically	100-200kB	1
GS-107	GBM TRIGDAT	All the GBM's messages downlinked through TDRSS	1 day	50-100 kB	1
GS-108	GBM Background Files	Backgrounds for spectral fitting	1 day	28kB (1kB /file)	1
GS-109 (GRB trigger)	GBM Spectral Catalog Entry (SCAT)	Parameters describing the burst spectra (e.g., models and fits)	updated periodically	100-200 kB	1

GS-110	GBM Localization	GBM localization contours (text)	1 day	10kB	1
GS-111	GBM Localization	GBM localization contours (FITS)	1 day	2 MB	1
GS-112	GBM HEALPix	GBM HEALPix file	1 day	2 MB	1

The final category of GIOC data products is updated and sent to the FSSC 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 DRM Database Compressed Leaf Files	DRMs on a grid of zenith and azimuth angles	TBD	Every ~6 months	100GB	1
GS-009	GBM Low Level Threshold File	Records periods of non-standard Low Level Threshold (LLT) operation.	1	Updated periodically	4.5K	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 Catalog Entry	Parameters describing the burst (e.g., durations, fluences)	1	Updated periodically	100-200 kB	2
GS-109 (burst trigger)	GBM Spectral Catalog Entry	Parameters describing the burst spectra (e.g., models and fits)	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, breaking the data into time periods spanning an orbit, and send the resulting event and spacecraft position files to the FSSC.

Note that although still listed here, LS-003 Livetime Cubes are no longer created by the LISOC and were never served to the public.

Table 5-4: LISOC Data Products Delivered After Run

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 processing run (~16 per day)	1 day	250 MB	1
LS-002	LAT photons	Selected parameters from the subset of events identified as gamma-ray photons	Per processing run (~16 per day)	1 day	25 M	1
LS-003	LAT Livetime Cubes	LAT livetime as a function of sky position and off axis angle	Per processing run (~16 per day)	1 day		1
LS-005	LAT Pointing and Livetime History	LAT orientation and mode at 30 s intervals; used to calculate exposures	Per processing run (~16 per day)	1 day	100 kB	1
LS-020	LAT Pointing and Livetime History	LAT orientation and mode at 1 s intervals; used to calculate exposures	Per processing run (~16 per day)	1 day	3 MB	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 5-5: LISOC Data Products Delivered As Updates

ICD ID	**Product**	**Description**	**Delivered**	**Freq.**	**Size (bytes)**	**Level**
LS-006	ASP Source Fluxes	Fluxes of sources monitored by ASP	daily			3
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

Table 5-5: LISOC Data Products Delivered As Updates

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 Fermi 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
LS-014	LLE Events	LAT Low Energy Events event file for GRB and Solar Flare	Selected GRB and Solar Flares	On update	1.2 Mbyte	Ancillary
LS-015	LLE CSPEC	LAT Low Energy Events CSPEC files for GRB and Solar Flares	Selected GRB and Solar Flares	On update	< 1Mbyte	Ancillary
LS-016	LLE RSP	LAT Low Energy Events response file for GRB and Solar Flares	Selected GRB and Solar Flares	On update	< 1Mbyte	Ancillary
LS-017	LLE PHA1	LAT Low Energy Events count spectrum (PHA1) files	Selected GRB and Solar Flares	On update	< 1Mbyte	Ancillary
LS-018	LLE Selected	LAT Low Energy Events event file containing only selected events	Selected GRB and Solar Flares	On update	< 1Mbyte	Ancillary
LS-019	LLE PT	LAT Low Energy Events pointing and livetime history file	Selected GRB and Solar Flares	On update	< 1Mbyte	Ancillary

5.3. Data Products Originating in the FSSC

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

Table 5-7: FSSC 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: 2.5
Revision date: 7/8/08

6.1.1. 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	FSSC	
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

6.1.2. 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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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_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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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

6.1.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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	7	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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		7	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		0.	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		0.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

6.1.4. Extension Header 2: SPECTRUM

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
HDUCLAS4	‘TYPEII’	Extension contains multiple spectra
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; must increase monotonically
TUNIT4	‘s’	Seconds
TZERO4		Offset (s) relative to MJDREF, equal to TSTART
TLMIN4	0.	Data start at TSTART
TLMAX4	9e4	Data for little more than a day
TFORM5	‘1D’	Double precision
TTYPE5	‘ENDTIME’	Stop time relative to MJDREF
TUNIT5	‘s’	Seconds
TZERO5		Offset (s) relative to MJDREF, equal to TSTART
TLMIN5	0.	Data start at TSTART
TLMAX5	9e4	Data for little more than a day
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’	[UTC] Date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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
HDUCLAS4	‘TYPEII’	Extension contains multiple spectra
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
TZERO4	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN4	0.	Data start at TSTART
TLMAX4	9e4	Data for little more than a day
TFORM5	'1D'	Double precision
TTYPE5	'ENDTIME'	Stop time relative to MJDREF
TUNIT5	's'	Seconds
TZERO5	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN5	0.	Data start at TSTART
TLMAX5	9e4	Data for little more than a day

END

6.1.5. Extension Header 3: GTI

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
EXTVER	1	Assigned by template parser
TFORM1	'1D'	Double precision
TTYPE1	'START'	Start time of GTI interval relative to MJDREF
TUNIT1	's'	Seconds
TZERO1		Offset (s) relative to MJDREF, equal to TSTART

TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval relative to MJDREF
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TSTART
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
TZERO1	1.23456789011e7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN1	0.	Data start at TSTART
TLMAX1	9e4	Data for little more than a day
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval relative to MJDREF

TUNIT2	‘s’	Seconds
TZERO2	1.23456789011e7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN2	0.	Data start at TSTART
TLMAX2	9e4	Data for little more than a day

END

6.2. GS-002 CSPEC (Daily Version)

Version: 2.4
Revision date: 7/8/08

6.2.1. Product Description

The CSPEC data type provides the counts accumulated by each detector over 4.096 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	FSSC	
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

6.2.2. 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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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_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'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:02:17.06'	[UTC] 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

6.2.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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	127	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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	127	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for row
TUNIT2	‘keV’	
TLMIN2	0.	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	0.	Lowest channel energy
TLMAX3	2000.	Highest channel energy
END		

6.2.4. Extension Header 2: SPECTRUM

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
HDUCLAS4	‘TYPEII’	Extension contains multiple spectra
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; must increase monotonically
TUNIT4	‘s’	Seconds
TZERO4	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN4	0.	Data start at TSTART
TLMAX4	9e4	Data for little more than a day
TFORM5	‘1D’	Double precision
TTYPE5	‘ENDTIME’	Stop time relative to MJDREF
TUNIT5	‘s’	Seconds
TZERO5	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN5	0.	Data start at TSTART
TLMAX5	9e4	Data for little more than a day
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'	[UTC] Date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
HDUCLAS4	'TYPEII'	Extension contains multiple spectra
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
TZERO4	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN4	0.	Data start at TSTART
TLMAX4	9e4	Data for little more than a day
TFORM5	'1D'	Double precision
TTYPE5	'ENDTIME'	Stop time relative to MJDREF
TUNIT5	's'	Seconds
TZERO5	3.455751919D7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN5	0.	Data start at TSTART
TLMAX5	9e4	Data for little more than a day

END

6.2.5. Extension Header 3: GTI

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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 TSTART
TLMIN1	0.	Data start at TSTART

TLMAX1	9e4	Data for little more than a day
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TSTART
TLMIN2	0.	Data start at TSTART
TLMAX2	9e4	Data for little more than a day
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
TZERO1	1.23456789011e7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN1	0.	Data start at TSTART
TLMAX1	9e4	Data for little more than a day

TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2	1.23456789011e7	Offset (s) relative to MJDREF, equal to TSTART
TLMIN2	0.	Data start at TSTART
TLMAX2	9e4	Data for little more than a day

END

6.3. GS-003 Ground Initiated TTE

Version: 1.2
Revision date: 4/25/08

6.3.1. Product Description

These files provide the event list for the counts in one detector. This data product is based on GS-103 (counts from a burst). The counts are characterized by arrival time and one of 128 energy channels. Consequently, one set of these files is provided after each trigger.

Naming Convention	glg_tte_wz_yymmddfff_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	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	1 calibration run	
Number of deliveries per day	Periodic data product	
Typical size	40-60 MB (3-4.5 MB per file)	

Product Content	
Header	
Extension 1 Name	EBOUNDS
Extension 2 Name	EVENTS
Extension 3 Name	GTI

6.3.2. 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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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_wz_yymmddfff_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
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_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	'2007-06-06T02:24:15'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'2007-06-05T22:28:24.00'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:45:12.00'	[UTC] 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
END		End of Header

6.3.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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	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	127	More than the number of channels
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for channel
TUNIT2	'keV'	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	'1E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for channel
TUNIT3	'keV'	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
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		127	More than the number of channels
TFORM2	‘1E ‘		Single precision floating point
TTYPE2	‘E_MIN’		Low energy bound for row
TUNIT2	‘keV’		
TLMIN2		0.	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		0.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

6.3.4. Extension Header 2: EVENTS

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
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
EVT_DEAD		Deadtime per event (s)
EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event
TUNIT2	' '	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	####	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
DATE-OBS	'2007-06-04T23:58:46.12'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EVT_DEAD	2.5e-6	Deadtime per event (s)
EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event
TUNIT2	' '	Units of field

G
END

6.3.5. Extension Header 3: GTI

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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	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	'2007-06-08T03:31:54'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'2007-06-05T22:28:24.00'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:45:12.00'	[UTC] 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
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

6.4. GS-005 GBM Gain and Energy Resolution History

Version: 2.3
Revision date: 7/19/07

6.4.1. 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	FSSC	
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

6.4.2. 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_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’	[UTC] date of start of observation, same format as DATE
DATE-END	‘yyyy-mm-ddThh:nn:ss.ss’	[UTC] date 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
DATATYPE		Name of the primary datatype upon which file is based, either ‘CTIME’ or ‘CSPEC’
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_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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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
DATATYPE	‘CSPEC’	Name of the primary datatype upon which file is based
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	3.455762919D7	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

6.4.3. Extension Header 1: GBM SPEC HIST

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.

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	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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
TFIELDS	12	Number of fields per row
TFORM1	'1E '	Single precision floating point

TTYPE1	'LINECENT'		Linear channel number of calibration line centroid
TLMIN1		0.	Channel numbers are non-negative
TLMAX1		4096.	Beyond maximum number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'LINE_WID'		Width in linear channels of the calibration line
TLMIN2		0.	Channel numbers are non-negative
TLMAX2		4096.	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 linear channel number of calibration line centroid
TLMIN4		0.	Uncertainties are non-negative
TLMAX4		4096.	Beyond maximum number of channels
TFORM5	'1E '		Single precision floating point
TTYPE5	'ERR_WID'		Uncertainty in the linear width in channels of the calibration line
TLMIN5		0.	Uncertainties are non-negative
TLMAX5		4096.	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	'1E '		Single precision floating point
TTYPE7	'EN_RES'		Fractional energy width of the fitted line
TLMIN7		0.	Fraction is non-negative
TLMAX7		2.	
TFORM8	'1D '		Double precision floating point
TTYPE8	'START'		Start 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	'1D '		Double precision floating point
TTYPE9	'STOP'		Stop time of spectral accumulation relative to MJDREF
TUNIT9	's'		Seconds
TLMIN9		0.	MJDREF will be before launch
TLMAX9		1.5D9	47 years after MJDREF

TFORM10	'1J '	Double precision integer
TTYPE10	'NUM_REC	Number of records accumulated in the spectrum
TFORM11	'1E '	Single precision floating point
TTYPE11	'CHI_SQ'	Goodness of fit
TLMIN11	0.	Chi-sq is non-negative
TLMAX11	1.e9	
TFORM12	'2E'	Array of single precision floating point
TTYPE12	'BKGD_MDL	Background Model Parameters
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
TFIELDS	12	Number of fields per row

TFORM1	‘1E ‘	Single precision floating point
TTYPE1	‘LINECENT’	Line centroid linear channel number
TLMIN1	0.	Channel numbers are non-negative
TLMAX1	4096.	Beyond maximum number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘LINE_WID’	Line centroid linear channel width
TLMIN2	0.	Channel numbers are non-negative
TLMAX2	4096.	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 linear channel number error
TLMIN4	0.	Uncertainties are non-negative
TLMAX4	4096.	Beyond maximum number of channels
TFORM5	‘1E ‘	Single precision floating point
TTYPE5	‘ERR_WID’	Line centroid linear channel width error
TLMIN5	0.	Uncertainties are non-negative
TLMAX5	4096.	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	‘1E ‘	Single precision floating point
TTYPE7	‘EN_RES’	Fractional energy width of the fitted line
TLMIN7	0.	Fraction is non-negative
TLMAX7	2.	
TFORM8	‘1D ‘	Double precision floating point
TTYPE8	‘START’	Start time of spectral accumulation
TUNIT8	‘s’	Seconds
TLMIN8	0.	MJDREF will be before launch
TLMAX8	1.5D9	47 years after MJDREF
TFORM9	‘1D ‘	Double precision floating point
TTYPE9	‘STOP’	Stop time of spectral accumulation
TUNIT9	‘s’	Seconds
TLMIN9	0.	MJDREF will be before launch
TLMAX9	1.5D9	47 years after MJDREF
TFORM10	‘1J ‘	Double precision integer
TTYPE10	‘NUM_REC	Number of records accumulated in the spectrum
TFORM11	‘1E ‘	Single precision floating point

TTYPE11	‘CHI_SQ’		Goodness of fit
TLMIN11		0.	Chi-sq is non-negative
TLMAX11		1.e9	
TFORM12	‘2E’		Array of single precision floating point
TTYPE12	‘BKGD_MDL		Background Model Parameters

END

6.5. GS-006 GLAST Position and Attitude History

Version: 2.1
Revision date: 8/2/06

6.5.1. 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	FSSC	
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

6.5.2. 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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date 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'	[UTC] date of start of observation
DATE-END	'2007-06-05T23:57:46.22'	[UTC] 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

6.5.3. Extension Header 1: GLAST POS HIST

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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	19	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	'1E '	Double precision floating point
TTYPE15	'SC_LAT'	Spacecraft latitude over the Earth
TUNIT15	'deg'	
TFORM16	'1E '	Double precision floating point
TTYPE16	'SC_LON'	Spacecraft east longitude over the Earth
TUNIT16	'deg'	
TFORM17	'1E '	Double precision floating point
TTYPE17	'SADA_PY'	Positive Y axis solar array position angle
TUNIT17	'deg'	
TFORM18	'1E '	Double precision floating point

TTYPE18	'SADA_NY'		Negative Y axis solar array position angle
TUNIT18	'deg'		
TFORM19	'1I '		
TTYPE19	'FLAGS'		SC Flags
TZERO19		32768	Offset for unsigned integers
TSCAL19		1	To convert from signed to unsigned integers data = FLAGS*TSCAL16+TZERO16

END

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   90 / width of table in bytes
NAXIS2  =                86392 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   19 / number of fields in each row
TTYPE1  = 'SCLK_UTC'           / label for field   1
TFORM1  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'QSJ_1   '           / label for field   2
TFORM2  = '1D      '           / data format of field: 8-byte DOUBLE
TTYPE3  = 'QSJ_2   '           / label for field   3
TFORM3  = '1D      '           / data format of field: 8-byte DOUBLE
TTYPE4  = 'QSJ_3   '           / label for field   4
TFORM4  = '1D      '           / data format of field: 8-byte DOUBLE
TTYPE5  = 'QSJ_4   '           / label for field   5
TFORM5  = '1D      '           / data format of field: 8-byte DOUBLE
TTYPE6  = 'WSJ_1   '           / label for field   6
TFORM6  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT6  = 'rad/s   '           / physical unit of field
TTYPE7  = 'WSJ_2   '           / label for field   7
TFORM7  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT7  = 'rad/s   '           / physical unit of field
TTYPE8  = 'WSJ_3   '           / label for field   8
TFORM8  = '1D      '           / data format of field: 8-byte DOUBLE
TUNIT8  = 'rad/s   '           / physical unit of field
TTYPE9  = 'POS_X   '           / label for field   9
TFORM9  = '1E      '           / data format of field: 4-byte REAL
TUNIT9  = 'm       '           / physical unit of field
TTYPE10 = 'POS_Y   '           / label for field  10
TFORM10 = '1E      '           / data format of field: 4-byte REAL
TUNIT10 = 'm       '           / physical unit of field
TTYPE11 = 'POS_Z   '           / label for field  11
TFORM11 = '1E      '           / data format of field: 4-byte REAL
TUNIT11 = 'm       '           / physical unit of field
TTYPE12 = 'VEL_X   '           / label for field  12
TFORM12 = '1E      '           / data format of field: 4-byte REAL
TUNIT12 = 'm/s     '           / physical unit of field
TTYPE13 = 'VEL_Y   '           / label for field  13
TFORM13 = '1E      '           / data format of field: 4-byte REAL
```

```
TUNIT13 = 'm/s     '           / physical unit of field
TTYPE14 = 'VEL_Z   '           / label for field  14
TFORM14 = '1E      '           / data format of field: 4-byte REAL
TUNIT14 = 'm/s     '           / physical unit of field
TFORM15 = '1E      '           / Double precision floating point
TTYPE15     = 'SC_LAT  '             / Spacecraft latitude over the
Earth
TUNIT15     = 'deg     '
TFORM16     = '1E      '            /Double precision floating point
TTYPE16     = 'SC_LON  '            /Spacecraft east longitude over the
Earth
TUNIT16     = 'deg     '
TFORM17     = '1E      '            /Double precision floating point
TTYPE17     = 'SADA_PY '            /Positive Y axis solar array
position angle
TUNIT17     = 'deg     '
TFORM18     = '1E      '            /Double precision floating point
TTYPE18     = 'SADA_NY '            /Negative Y axis solar array
position angle
TUNIT18     = 'deg     '
TTYPE19 = 'FLAGS   '           / label for field  15
TFORM19 = '1I      '           / data format of field: 2-byte INTEGER
TZERO19 =                32768 / offset for unsigned integers
TSCAL19 =                    1 / data are not scaled
EXTNAME = 'GLAST POS HIST'     / name of this binary table extension
TELESCOP= 'GLAST   '           / Name of mission/satellite
INSTRUME= 'GBM     '           / Specific instrument used for
observation
DETNAM  = 'ALL     '           / Individual detector name
OBSERVER= 'Meegan  '           / GLAST Burst Monitor P.I.
ORIGIN  = 'GIOC    '           / Name of organization making file
DATE    = '2008-09-09T02:53:47' / file creation date (YYYY-MM-
DDThh:mm:ss UT)
DATE-OBS= '2008-09-08T23:59:59' / [UTC] date of start of observation
DATE-END= '2008-09-10T00:00:00' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time since MJDREF, used in TSTART and
TSTOP
MJDREFI =                51910 / MJD of GLAST reference epoch, integer
part
MJDREFF = 7.428703703703703D-4 / MJD of GLAST reference epoch,
fractional part
TSTART  =     242611199.540070 / [GLAST MET] Observation start time
TSTOP   =     242697600.540068 / [GLAST MET] Observation stop time
EXTVER  =                    1 / Version of this extension format
CHECKSUM= '8UDEAUAC2UAC8UAC'   / HDU checksum updated 2008-09-
10T01:57:58
DATASUM = '1612169577'         / data unit checksum updated 2008-09-
10T01:57:58
END
```

6.6. GS-007 GBM PHA Look-Up Tables

Version: 2.5
Revision date: 4/25/08

6.6.1. 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. Thus there are 4 files for the two types of detectors and for CTIME and CSPEC. 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	FSSC	
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

6.6.2. 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'	Name of instrument PI
DETTYPE	'XXX'	Detector type XXX = 'NAI' or 'BGO'
DATATYPE		Name of the primary datatype upon which file is based, either 'CTIME' or 'CSPEC'
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
DETTYPE	'NAI'	Individual detector name
DATATYPE	'CTIME'	Name of the primary datatype upon which file is based
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
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

6.6.3. Extension Header 1: GBM PHA LUT

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
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	7 or 127	Maximum channel value: 7 for CTIME , 127 for CSPEC
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
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	127	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

6.7. GS-008 GBM DRM Database Compressed Leaf Files

Version: 1.5
Revision date: 1/15/08

6.7.1. Product Description

Detector response matrix (DRM) compressed "leaf" files are use to populate a database of DRMs for different source incidence angles relative to the GLAST spacecraft. These "leaf DRM" files are identical to those specified in GS-104, except that they are generated with a compressed energy scale to aid in subsequent interpolation. The energy compression scheme requires different apparent energy bin definition for each true photon energy. An additional binary table extension GRESS_HISTORY captures data about the data processing history, and a further binary table extension is used to record the 2-D matrix of energy bin definitions. A special Boolean header keyword called "COMPRESS" is used to denote the difference between a compressed leaf file and a normal DRM file.

Naming Convention	glg_leaf_nt_zwwwwww_azyyyyyy_vxx.rsp	n = 'n' or 'b' for detector type t = 0 to b for detector number (hex a and b used) wwwwww—zenith angle, in milli-degrees yyyyyy—azimuth angle, in milli-degrees xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	FSSC	
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 detector at one zenith and angle-azimuth angle	
Number of deliveries per day	Few times per mission	
Typical size	50 kB per detector	

Product Content	
Header	
Extension 1 Name	EBOUNDS
Extension 2 Name	SPECRESP MATRIX
Extension3 Name	GRESS_HISTORY
Extension 4 Name	ECOMPRESS

6.7.2. 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		Software and version creating file
FILETYPE	'GBM DRM'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.1'	Version of the format for this filetype (NOTE: this is a different file than GS-104, so the version number is different)
CHECKSUM	(computed value)	Checksum for entireHDU
DATASUM	(computed value)	Checksum for data table
DATE	'yyyy-mm-ddThh:nn:ss'	Date file was made
ORIGIN	'LANL'	Name of organization making file
OBSERVER	'Meegan'	Name of instrument PI
FILENAME	'glg_leaf_nt_zwwwwww_azyyyyyy_vxx.rsp'	Name of this file n = 'n' or 'b' for detector type t = 0 to b for detector number (hex a and b used) wwwwww —zenith angle, in milli-degrees yyyyyy—azimuth angle, in milli-degrees 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
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
ZENITH	www.www	Zenith angle for response calculation, in degrees
AZIMUTH	yyy.yyy	Azimuth angle for response calculation, in degrees
COMPRESS	T / F	If true, compressed apparent energy scale is used and extra extension ECOMPRESS is present
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	'GRESS_V1.0'	Software and version creating file
FILETYPE	'GBM DRM'	Name for this type of FITS file (should be unique)
FILE-VER	'1.0.1'	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
FILENAME	'glg_leaf_n0_z090000_az037352_v01.rsp'	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'	Name of instrument PI
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
ZENITH	90.000	Zenith angle for response calculation, in degrees
AZIMUTH	37.352	Azimuth angle for response calculation, in degrees
COMPRESS	T	Compressed energy extension ECOMPRESS is present
END		End of Header

6.7.3. Extension Header 1: EBOUNDS

Provides the apparent energy grid E'_j for the spectrum' channels. Note: this is compressed and should be interpreted row-by-row according to the scheme in the ECOMPRESS extension.

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	(computed value)	Number of apparent 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	'LANL'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss'	Date file was created
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
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	(= NAXIS2)	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	' '	
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for row
TUNIT2	'keV'	
TLMIN2	0.	Lowest compressed channel energy
TLMAX2	(computed value)	Highest compressed channel energy
TFORM3	'1E '	Single precision floating point

TTYPE3	'E_MAX'	High energy bound for row
TUNIT3	'keV'	
TLMIN3	(computed value)	Lowest compressed channel energy
TLMAX3	(computed value)	Highest compressed channel energy

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	64	Number of apparent 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	'LANL'	Origin of file
DATE	'2007-06-08T04:29:47'	Date file was created
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
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	64	Total number of apparent 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	' '	
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for row
TUNIT2	'keV'	
TLMIN2	0.	Lowest channel energy
TLMAX2	1.47	Highest channel energy
TFORM3	'1E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for row
TUNIT3	'keV'	
TLMIN3	0.023	Lowest channel energy
TLMAX3	1.5	Highest channel energy

END

6.7.4. Extension Header 2: SPECRESP MATRIX

Contains the compressed detector response matrix.

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		Number of rows in matrix
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'	Date file was created
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
ZENITH	www.www	Zenith angle for response calculation
AZIMUTH	yyy.yyy	Azimuth angle for response calculation
SRC_AZ		Azimuth of source in detector coordinates (degrees)
SRC_EL		Elevation of source 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	(= NAXIS2)	Number of true energy bins of the MATRIX
DETCHANS	(= NAXIS2 of EBOUNDS)	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
TFIELDS	6	Number of fields per row
TFORM1	'1E '	Single precision floating point
TTYPE1	'ENERG_LO'	Upper energy bound of the energy bin
TUNIT1	'keV	
TFORM2	'1E '	Single precision floating point
TTYPE2	'ENERG_HI'	Upper energy bound of the energy bin

TUNIT2	'keV	
TFORM3	'I '	INTEGER scalar
TTYPE3	'N_GRP'	The number of 'channel subsets' in the response array for energy channel
TFORM4	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE4	'F_CHAN'	The channel number of the start of each 'channel subset' in the response array
TFORM5	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE5	'N_CHAN'	The number of channels within each 'channel subset' in the response array
TFORM6	'PE(####)'	Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE6	'MATRIX'	The compressed detector response matrix
TUNIT6	'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	30	Number of rows
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	'LANL'	Origin of file
DATE	'2007-06-08T12:54:03'	Date file was created
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
ZENITH	90.000	Zenith angle for response calculation, in degrees
AZIMUTH	37.352	Azimuth angle for response calculation, in degrees
SRC_AZ	0.0	Azimuth of source in detector coordinates (degrees)
SRC_EL	90.0	Elevation of source 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	30	Number of true energy bins of the MATRIX
DETCHANS	64	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
TFIELDS	6	Number of fields per row
TFORM1	‘1E ‘	Single precision floating point
TTYPE1	‘ENERG_LO’	Upper energy bound of the energy bin
TUNIT1	‘keV	
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘ENERG_HI’	Upper energy bound of the energy bin
TUNIT2	‘keV	
TFORM3	‘I ’	INTEGER scalar
TTYPE3	‘N_GRP’	The number of ‘channel subsets’ in the response array for energy channel
TFORM4	‘PI(####)’	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE4	‘F_CHAN’	The channel number of the start of each ‘channel subset’ in the response array
TFORM5	‘PI(####)’	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE5	‘N_CHAN’	The number of channels within each ‘channel subset’ in the response array
TFORM6	‘PE(####)’	Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE6	‘MATRIX’	The compressed detector response matrix
TUNIT6	‘cm**2’	Units of field
END		

6.7.5. Extension Header 3: GRESS_HISTORY

There will be 1 extension of this format for the file providing a full record of the file's data processing history. This will be ignored by XSPEC, and should not be considered to be under configuration control.

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	(computed value)	Number of rows in matrix
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	'GRESS_HISTORY'	Unique name for this extension type—no ARF
EXTVER	1	Version of this extension format
TFIELDS	1	Number of fields per row
TFORM1	'100A'	Character strings, each 100 characters long
TTYPE1	'HISTORY'	Upper energy bound of the energy bin
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	(computed value)	Number of rows (variable)
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	'GRESS_HISTORY'	Unique name for this extension type—no ARF
EXTVER	1	Version of this extension format
TFIELDS	1	Number of fields per row
TFORM1	'100A'	Single precision floating point
TTYPE1	'HISTORY'	Upper energy bound of the energy bin
END		

6.7.6. Extension Header 4: ECOMPRESS

There will be 1 extension of this format for the file providing the apparent energy bin definitions for each true photon energy.

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	(computed value)	Number of apparent energy bins
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	'ECOMPRESS'	Unique name for this extension type
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	'LANL'	Origin of file
DATE	'yyyy-mm-ddThh:nn:ss'	Date file was created
FILTER	'none'	Not applicable to GBM
RADECSYS	'FK5'	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
DETCHANS	128	Total number of channels in each rate
CHANTYPE	'PHA'	No corrections have been applied
NUMEBINS		Number of true photon energies
DETCHANS		Number of apparent energy channel bins
TFIELDS	3	Number of fields per row
TFORM1	'1I '	2 byte Integer
TTYPE1	'CHANNEL'	Detector channel number
TUNIT1	' '	
TLMIN1		Channel numbers are non-negative
TLMAX1		More than the number of channels
TFORM2	'(NUMEBINS)E '	Single precision floating point array
TTYPE2	'E_MIN'	Low energy bound for row
TUNIT2	' '	
TLMIN2		Lowest E_MIN channel energy in file
TLMAX2		Highest E_MIN channel energy in file
TFORM3	'(NUMEBINS)E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for row

TUNIT3	‘ ’	
TLMIN2		Lowest E_MIN channel energy in file
TLMAX2		Highest E_MIN channel energy in file
END		

Example

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	30	Number of apparent energy bins
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	‘ECOMPRESS’	Unique name for this extension type
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 XXX = ‘NAI’ or ‘BGO’ YY = 00 to 11
OBSERVER	‘MEEGAN’	In this case, the PI
ORIGIN	‘LANL’	Origin of file
DATE	‘yyyy-mm-ddThh:nn:ss’	Date file was created
FILTER	‘none‘	Not applicable to GBM
RADECSYS	‘FK5’	Stellar reference frame
EQUINOX	2000.0	Equinox for RA and Dec
NUMEBINS	30	Number of true photon energies
DETCHANS	64	Total number of channels in each rate
CHANTYPE	‘PHA’	No corrections have been applied
TFIELDS	3	Number of fields per row
TFORM1	‘1I ‘	2 byte Integer
TTYPE1	‘CHANNEL’	Detector channel number
TUNIT1	‘ ‘	
TLMIN1	1	Channel numbers are non-negative
TLMAX1	64	More than the number of channels
TFORM2	‘(NUMEBINS)E ‘	Single precision floating point array
TTYPE2	‘E_MIN’	Low energy bound for row
TUNIT2	‘ ’	
TLMIN2	3.0	Lowest E_MIN channel energy in file
TLMAX2	99999.0	Highest E_MIN channel energy in file
TFORM3	‘(NUMEBINS)E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for row
TUNIT3	‘ ’	
TLMIN2	4.0	Lowest E_MIN channel energy in file

TLMAX2	100000.0 Highest E_MIN channel energy in file

6.8. GS-009 GBM LLT File

Version: 1.0
Revision date: 10/19/11

6.8.1. Product Description

In order to support Fermi pointed observations without loss of data quality or excessive data volume, the GBM team is occasionally adjusting the level of the discriminators for the sun-facing NaI detectors (NaI 0 - 5) so that their energy threshold is higher than in nominal mode. During these periods of non-standard Low Level Threshold (LLT) operation, photons with energies below this threshold are not recorded. Data above this threshold energy are nominal, as are all data from the BGO detectors and from NaI detectors 6-11. The energy thresholds of the affected detectors are between 18 - 30 keV, depending on the nature of the pointing.

The information is transferred via FASTCopy to the FSSC in comma-separated values (CSV) file. It contains a header line followed by rows that show the time spans with non-standard LLT settings.

Naming Convention	glg_llt_yymmdd_vxx.csv	yymmdd—date of start of table validity xx = the version number
Originator of Product	GIOC	
Product Format	CSV	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Input Products Required	NA	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	On update	
Typical size	< 1MB	
Product Content		
Header	Headings for each column, separated by commas	
Data Rows	Values separated by commas	

6.8.2. Definition

Column	Purpose
Column 1	Start time of the LLT setting in YYYY-MM-DD hh:mm:ss (UTC).

Column 2	Start time of the LLT setting in YYYY-DOY hh:mm:ss (day-of-year)
Column 3	Start time of the LLT setting in Fermi Mission Elapsed Time (MET).
Column 4	End time of the LLT setting in YYYY-MM-DD hh:mm:ss (UTC).
Column 5	End time of the LLT setting in YYYY-DOY hh:mm:ss (day-of-year)
Column 6	End time of the LLT setting in Fermi Mission Elapsed Time (MET).
Column 7	Affected NaI detectors
Column 8	LLT setting (lowest usable channel out of 4096 raw channels, which are then grouped for our science data products).
Column 9	Tells the user of CSPEC or TTE data the lowest channel which is safe to use with these settings. This is a number between 1 and 128.
Column 10	Tells the user of CTIME data the lowest channel which is safe to use with these settings. This is a number between 1 and 8.
Column 11	Approximate energy threshold of this LLT setting. This varies slightly over the orbit and from one detector to another.
Column 12	Reason for the non-standard LLT setting.

6.8.3. Example

```
UT Date1,UT1,MET1,UT Date2,UT2,MET2,NaI Det. Range  (0-11),LLT,Lowest Useable CSpec Channel
(1-128),Lowest Useable CTime Channel (1-8),Approx. Energy Threshold (keV)
,Purpose
2011-09-08 15:07:20,2011-251-15:07:20,337187242,2011-09-10 23:27:11,2011-253-
23:27:11,337390033,0-5,159,23,4,30,TOO
2011-09-22 20:15:50,2011-265-20:15:50,338415352,2011-09-23 11:20:56,2011-266-
11:20:56,338469658,0-5,101,15,3,18,Nadir
2011-09-27 18:35:38,2011-270-18:35:38,338841340,2011-09-28 11:39:03,2011-271-
11:39:03,338902745,0-5,101,15,3,18,Nadir
2011-10-01 19:22:05,2011-274-19:22:05,339189727,2011-10-02 00:12:10,2011-275-
00:12:10,339207132,0-5,101,15,3,18,Nadir
2011-10-05 17:11:26,2011-278-17:11:26,339527488,2011-10-05 23:32:17,2011-278-
23:32:17,339550339,0-5,101,15,3,18,Nadir
```

6.9. GS-013 Hourly TTE Data

Version: 1.0
Revision date: 7/19/17

6.9.1. Product Description

These files provide the event list for the counts in one detector. This data product is similar to GS-003 (Ground initiated TTE). The counts are characterized by arrival time and one of 128 energy channels. The file will begin with up to the last 120 seconds of TTE data from the previous hour.

Naming Convention	glg_tte_wz_yymmdd_HHz_vxx.fit glg_tte_wz_yymmdd_HHz_vxx.fit.gz	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date HH = hour of day in UTC (00 - 23) xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	Produced by GIOC within 24 hours of arrival of last input data.	
Product contains data for	Time tagged events which occurred during the hour including up to the last 120 seconds of events from the previous hour.	
Number of deliveries per day	24	
Typical size	40-60 MB (3-4.5 MB per file)	

Product Content	
Header	
Extension 1 Name	EBOUNDS
Extension 2 Name	EVENTS
Extension 3 Name	GTI

6.9.2. 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	'MakeHourlyTte vX.X.X (rev: XXXXXX)'	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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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_wz_yymmdd_HHz_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
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	MakeHourlyTte v1.5.3-RC (rev: 74d34be6)		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	'2017-07-04T20:19:33'		Date file was made
ORIGIN	'GIOC'		Name of organization making file
DATE-OBS	'2017-07-04T17:58:00'		[UTC] date of start of observation
DATE-END	'2017-07-04T18:59:59'		[UTC] 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	520883885.002746		Observation's start time relative to MJDREF, double precision
TSTOP	520887604.999466		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_nb_170704_18z_v00.fit'		Name of this file
INFILE01	'glg_lutcs_nai_121126640_v00.fit'		File(s) used to create this FITS file
INFILE02	'GLAST_2017185_194100_VC09_GBTTE.0.00'		File(s) used to create this FITS file
TELESCOP	'GLAST'		Name of mission / spacecraft
INSTRUME	'GBM'		Name of instrument generating data
DETNAM	'NAI_0B'		Individual detector name
DATATYPE	'TTE'		Name of the primary datatype making up this file
OBSERVER	'Meegan'		Name of instrument PI
END			End of Header

6.9.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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	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	127	More than the number of channels

TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for channel
TUNIT2	'keV'	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	'1E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for channel
TUNIT3	'keV'	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
GBMCKSUM	(GBM ICRC Checksum)	GBM FSW icrc shecksum value (hex)
CH2E_VER	(Conversion scheme)	Channel to energy conversion scheme used
GAIN_COR	(Gain Correction Scale)	Gain correction factor applied to energy edges
END		End of Header

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	'2017-07-04T17:58:00'	[UTC] date of start of observation
DATE-END	'2017-07-04T18:59:59'	[UTC] 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	'2017-07-04T20:19:33'	Date file was created
FILTER	'none'	Not applicable to GBM
DETNAM	'NAI_0B'	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		127	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		0.	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		0.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
GBMCKSUM	'ea20 '		GBM FSW icrc shecksum value (hex)
CH2E_VER	'SPLINE 2.0'		Channel to energy conversion scheme used
GAIN_COR	1.0		Gain correction factor applied to energy edges
END			

6.9.4. Extension Header 2: EVENTS

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
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
EVT_DEAD		Deadtime per event (s)
EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event

TUNIT2	' '	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	####	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_0B'	Detector ID of recorded events
OBSERVER	'MEEGAN'	In this case, the PI
ORIGIN	'GIOC"	Origin of file
DATE	'2017-07-04T20:19:33'	Date file was created
DATE-OBS	'2017-07-04T17:58:00'	[UTC] date of start of observation
DATE-END	'2017-07-04T18:59:59'	[UTC] 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
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EVT_DEAD	2.5e-6	Deadtime per event (s)
EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event
TUNIT2	' '	Units of field
	G	
END		

6.9.5. Extension Header 3: GTI

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'	[UTC] Date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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	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	'2017-07-04T20:19:33'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'2017-07-04T17:58:00'	[UTC] date of start of observation
DATE-END	'2017-07-04T18:59:59'	[UTC] 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
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

6.10. GS-101 CTIME (Burst Version)

Version: 2.7
Revision date: 5/13/08

6.10.1. Product Description

The CTIME data type provides the counts accumulated by each detector over 0.256 s binned into 8 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	FSSC	
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

6.10.2. 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'	[UTC] date of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date 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
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
zFILENAME	'glg_ctime_wz_bnyymmdd fff_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

ERR_RAD		Localization uncertainty
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 entire HDU
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
TRIGTIME	3.455761920D7	Trigger time (s) 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	23.	RA of burst
DEC_OBJ	45.2	DEC of burst
ERR_RAD	1.9	Localization uncertainty
END		End of Header

6.10.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
ERR_RAD		Localization uncertainty
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	7	More than the number of channels
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for channel
TUNIT2	'keV'	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	'1E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for channel
TUNIT3	'keV'	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
ERR_RAD			Localization uncertainty
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		7	More than the number of channels
TFORM2	'1E '		Single precision floating point
TTYPE2	'E_MIN'		Low energy bound for row
TUNIT2	'keV'		
TLMIN2		0.	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		0.	Lowest channel energy
TLMAX3		2000.	Highest channel energy
END			

6.10.4. Extension Header 2: Spectrum

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date 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
ERR_RAD			Localization uncertainty
HDUCLASS	'OGIP'		
HDUCLAS1	'SPECTRUM'		
HDUCLAS2	'TOTAL'		Indicates source + background
HDUCLAS3	'COUNT'		Indicates PHA data stored as counts
HDUCLAS4	'TYPEII'		Extension contains multiple spectra
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; must increase monotonically
TUNIT4	's'		Seconds
TZERO4			Offset (s) relative to MJDREF, equal to TRIGTIME
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time
TUNIT5	's'		Seconds
TZERO5			Offset (s) relative to MJDREF, equal to TRIGTIME
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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)
ERR_RAD		Localization uncertainty
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUCLAS4	'TYPEII'	Extension contains multiple spectra

```
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

TFORM5      '1D'                    Double precision
TTYPE5      'ENDTIME'               Stop time
TUNIT5      's'                     Seconds
TZERO5              3.455751920D7   Offset (s) relative to MJDREF, equal to TRIGTIME

END
```

6.10.5. Extension Header 3: GTI

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
ERR_RAD		Localization uncertainty

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
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TRIGTIME
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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
ERR_RAD		Localization uncertainty
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
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
END		

6.11. GS-102 CSPEC (Burst Version)

Version: 2.9
Revision date: 5/13/08

6.11.1. Product Description

The CSPEC data type provides the counts accumulated by each detector over 4.096 s or less 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	FSSC	
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

6.11.2. 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'	[UTC] date of start of observation, same format as DATE
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date 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
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
FILENAME	'glg_cspec_wz_bnyymmdd dfff_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
ERR_RAD		Localization uncertainty
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'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:45:12.00'	[UTC] 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
TRIGTIME	3.455761920D7	Trigger time (s) 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)
ERR_RAD	5.3	Localization uncertainty
END		End of Header

6.11.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
ERR_RAD		Localization uncertainty
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	127	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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
ERR_RAD		Localization uncertainty
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	127	More than the number of channels
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for row
TUNIT2	‘keV’	
TLMIN2	0.	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	0.	Lowest channel energy
TLMAX3	2000.	Highest channel energy

END

6.11.4. Extension Header 2: Spectrum

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
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
ERR_RAD			Localization uncertainty
HDUCLASS	'OGIP'		
HDUCLAS1	'SPECTRUM'		
HDUCLAS2	'TOTAL'		Indicates source + background
HDUCLAS3	'COUNT'		Indicates PHA data stored as counts
HDUCLAS4	'TYPEII'		Extension contains multiple spectra
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; must increase monotonically
TUNIT4	's'		Seconds
TZERO4			Offset (s) relative to MJDREF, equal to TRIGTIME
TFORM5	'1D'		Double precision
TTYPE5	'ENDTIME'		Stop time relative to MJDREF
TUNIT5	's'		Seconds
TZERO5			Offset (s) relative to MJDREF, equal to TRIGTIME
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	'2007-06-05T12:32:45'	Date file was created
DATE-OBS	'2007-06-04T23:58:46.12'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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)
ERR_RAD	5.8	Localization uncertainty
HDUCLASS	'OGIP'	
HDUCLAS1	'SPECTRUM'	
HDUCLAS2	'TOTAL'	Indicates source + background
HDUCLAS3	'COUNT'	Indicates PHA data stored as counts
HDUCLAS4	'TYPEII'	Extension contains multiple spectra

```
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

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

END
```

6.11.5. Extension Header 3: GTI

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’	[UTC] date of start of observation
DATE-END	‘yyyy-mm-ddThh:nn:ss.ss’	[UTC] 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
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
ERR_RAD		Localization uncertainty

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
TFORM2	‘1D’	Double precision
TTYPE2	‘STOP’	Stop time of GTI interval
TUNIT2	‘s’	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TRIGTIME
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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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
ERR_RAD		Localization uncertainty
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
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
END		

6.12. GS-103 GBM TTE

Version: 2.9
Revision date: 5/13/08

6.12.1. 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 trigger.

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	FSSC	
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
Extension 3 Name	GTI

6.12.2. 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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
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)
ERR_RAD		Localization uncertainty
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_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	'2007-06-06T02:24:15'	Date file was made
ORIGIN	'GIOC'	Name of organization making file
DATE-OBS	'2007-06-05T22:28:24.00'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:45:12.00'	[UTC] 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
TRIGTIME	3.455761920D7	Trigger time (s) 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)
ERR_RAD		Localization uncertainty
END		End of Header

6.12.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
ERR_RAD		Localization uncertainty
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	127	More than the number of channels
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for channel
TUNIT2	'keV'	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	'1E '	Single precision floating point
TTYPE3	'E_MAX'	High energy bound for channel
TUNIT3	'keV'	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
ERR_RAD		Localization uncertainty
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	127	More than the number of channels
TFORM2	'1E '	Single precision floating point
TTYPE2	'E_MIN'	Low energy bound for row
TUNIT2	'keV'	
TLMIN2	0.	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	0.	Lowest channel energy
TLMAX3	2000.	Highest channel energy
END		

6.12.4. Extension Header 2: EVENTS

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		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
ERR_RAD		Localization uncertainty
DATE-OBS	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
TRIGTIME		Trigger time (s) since MJDREF
TIMESYS	'TT'	Time system used in time keywords
TIMEUNIT	's'	Time unit used in TSTART, TSTOP
EVT_DEAD		Deadtime per event (s)

EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
FIFO_END	MET value	Time of last event in the FIFO
PRMT_BEG	MET value	Time of first event in the prompt data
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event
TUNIT2	' '	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	####	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_bn0706 05401_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)
ERR_RAD	5.8	Localization uncertainty
DATE-OBS	'2007-06-04T23:58:46.12'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
EVT_DEAD	2.5e-6	Deadtime per event (s)
EVTDEDHI	1.04170E-05	Deadtime per overflow channel event
DETCHANS	128	Total number of channels
EXTNAME	'EVENTS'	Unique name for this extension type
HDUCLASS	'OGIP'	Conforms to OGIP/GSFC conventions
HDUCLAS1	'EVENTS'	Extension contains events
EXTVER	1	Version of this extension format
FIFO_END	3.455761920D7	Time of last event in the FIFO
PRMT_BEG	3.455761920D7	Time of first event in the prompt data
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
TFORM2	'1I '	Single precision integer
TTYPE2	'PHA'	Channel number of recorded event
TUNIT2	' '	Units of field

END

6.12.5. Extension Header 3: GTI

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
ERR_RAD		Localization uncertainty

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
TFORM2	'1D'	Double precision
TTYPE2	'STOP'	Stop time of GTI interval
TUNIT2	's'	Seconds
TZERO2		Offset (s) relative to MJDREF, equal to TRIGTIME
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	'2007-06-08T03:31:54'	Date file was created
HDUCLASS	'OGIP'	OGIP standard
HDUCLAS1	'GTI'	Contains Good Time Intervals
HDUVERS	'1.2.0'	File format version
DATE-OBS	'2007-06-05T22:28:24.00'	[UTC] date of start of observation
DATE-END	'2007-06-06T00:45:12.00'	[UTC] 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 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
ERR_RAD		Localization uncertainty
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
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
END		

6.13. GS-104 GBM DRMs

Version: 2.11
Revision date: 8/14/09

6.13.1. 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 or glg_uu_wz_bnyymmddfff_vxx.rsp2 for RSPII format files.	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	FSSC	
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

6.13.2. 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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
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
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'	[UTC] date of start of observation
DATE-END	'2007-06-05T23:45:24.00'	[UTC] 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
TRIGTIME	3.455761920D7	Trigger time (s) 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

6.13.3. Extension Header 1: EBOUNDS

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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
TLMIN1	0	Channel numbers are non-negative
TLMAX1	127	More than the number of channels
TUNIT1	‘ ‘	
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for channel
TUNIT2	‘keV’	
TLMIN2		Lowest channel energy, 0 keV for both detector types
TLMAX2		Highest channel energy, 2000 keV for NaI detectors, 50000 keV for BGO detectors
TFORM3	‘1E ‘	Single precision floating point
TTYPE3	‘E_MAX’	High energy bound for channel
TUNIT3	‘keV’	
TLMIN3		Lowest channel energy, 0 keV for both detector types
TLMAX3		Highest channel energy, 2000 keV for NaI detectors, 50000 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’	[UTC] date of start of observation
DATE-END	‘2007-06-07T00:02:17.06’	[UTC] 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	‘ ‘	
TFORM2	‘1E ‘	Single precision floating point
TTYPE2	‘E_MIN’	Low energy bound for row
TUNIT2	‘keV’	
TLMIN2	0.	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	0.	Lowest channel energy
TLMAX3	2000.	Highest channel energy
END		

6.13.4. Extension Header 2:n+1: SPECRESP MATRIX

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. The matrix number is indicated by the EXTVER keyword.

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		Number of rows in matrix
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		Version of this extension, thus the number of the matrix
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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] 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
RSP_NUM		Response matrix number
SRC_AZ	Float	Azimuth of source in detector coordinates (degrees)
SRC_EL	Float	Elevation of source in detector coordinates (degrees)
GEO_AZ	Float	Azimuth of geocenter in detector coordinates (degrees)

GEO_EL	Float	Elevation of geocenter in detector coordinates (degrees)
DET_ANG	Float	Angle between source and detector normal (0 -180 degrees)
GEO_ANG	Float	Angle between geocenter and detector normal (0 -180 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		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
TFIELDS	6	Number of fields per row
TFORM1	'1E '	Single precision floating point
TTYPE1	'ENERG_LO'	Upper energy bound of the energy bin
TUNIT1	'keV	
TFORM2	'1E '	Single precision floating point
TTYPE2	'ENERG_HI'	Upper energy bound of the energy bin
TUNIT2	'keV	
TFORM3	'I '	INTEGER scalar
TTYPE3	'N_GRP'	The number of 'channel subsets' in the response array for energy channel
TFORM4	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE4	'F_CHAN'	The channel number of the start of each 'channel subset' in the response array
TFORM5	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE5	'N_CHAN'	The number of channels within each 'channel subset' in the response array
TFORM6	'PE(####)'	Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE6	'MATRIX'	The compressed detector response matrix
TUNIT6	'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	128	Number of rows

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'	[UTC] date of start of observation
DATE-END	'2007-06-07T00:02:17.06'	[UTC] 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
RSP_NUM	1	Response matrix number
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
TFIELDS	6	Number of fields per row
TFORM1	'1E '	Single precision floating point
TTYPE1	'ENERG_LO'	Upper energy bound of the energy bin
TUNIT1	'keV	
TFORM2	'1E '	Single precision floating point
TTYPE2	'ENERG_HI'	Upper energy bound of the energy bin
TUNIT2	'keV	

TFORM3	'I '	INTEGER scalar
TTYPE3	'N_GRP'	The number of 'channel subsets' in the response array for energy channel
TFORM4	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE4	'F_CHAN'	The channel number of the start of each 'channel subset' in the response array
TFORM5	'PI(####)'	Variable length INTEGER array, each length is equal to Sum(N_GRP)
TTYPE5	'N_CHAN'	The number of channels within each 'channel subset' in the response array
TFORM6	'PE(####)'	Variable-length array of 4-byte REAL. The length is equal to Sum(N_CHAN)
TTYPE6	'MATRIX'	The compressed detector response matrix
TUNIT6	'cm**2'	Units of field

END

6.14. GS-105 GBM Trigger Catalog Entry

Version: 2.8
Revision date: 01/20/10

6.14.1. 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 FSSC.

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	FSSC	
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

Possible classes (see CLASS keyword) are:

Class	Description
DISTPAR	Distance particle event
GALBIN	Galactic binary
GRB	Gamma-ray burst
LOCLPAR	Local particles
SFLARE	Solar flare
SGR	Soft gamma repeater
TGF	Terrestrial Gamma-Ray Flash
TRANSNT	Generic transient
UNCERT	Uncertain classification

6.14.2. Primary Header

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	String	Software and version creating file
FILETYPE	TRIGGER ENTRY	Unique FITS file type name
CHECKSUM	Computed value	For entire HDU
DATASUM	Computed value	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	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] 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
TRIGSCAL	Integer	[ms] Triggered timescale
TRIG_ALG	Integer	Triggered algorithm number
CHAN_LO	Integer	Trigger channel: low
CHAN_HI	Integer	Trigger channel: high
ADC_LO	Integer	Trigger channel: low (ADC: 0 - 4095)
ADC_HI	Integer	Trigger channel: high (ADC: 0 - 4095)
DET_MASK	String of 14 0's and 1's	Triggered detectors: (0-13)
TSTART	MET time	Observation start time, rel to MJDREF
TSTOP	MET time	Observation end time, rel to MJDREF,
TRIGTIME	MET time	Trigger time (s) relative to MJDREF
TIMESYS	TT	Time system
TIMEUNIT	s	Time unit
TRIG_SIG	Float	Burst significance at trigger time
OBJECT	String	Name of source (e.g., burst name)
RADECSYS	FK5	Stellar reference frame
EQUINOX	2000.	Equinox for RA and Dec
RA_OBJ	Float	RA of burst, J2000
DEC_OBJ	Float	DEC of burst, J2000
LOC_SRC	String	Mission or telescope providing RA_OBJ and DEC_OBJ
ERR_RAD	Float	Localization uncertainty
GEO_LONG	Float	[deg] Spacecraft geographical east longitude
GEO_LAT	Float	[deg] Spacecraft geographical north latitude
RA_SCX	Float	[deg] Pointing of spacecraft x-axis: RA
DEC_SCX	Float	[deg] Pointing of spacecraft x-axis: Dec
RA_SCZ	Float	[deg] Pointing of spacecraft z-axis: RA
DEC_SCZ	Float	[deg] Pointing of spacecraft z-axis: Dec
THETA	Float	[deg] Angle from spacecraft zenith
PHI	Float	[deg] Angle from spacecraft +X axis toward +Y
LOC_VER	String	Version string of localizing software
LOC_ENRG	(float, float)	Energy range used for localization
GCN_FLAG	Yes or No	Was this file used for GCN Notice generation?
CLASS	String	Classification of trigger. See table above.

OBJ_CLAS	String	GIOC internal classification of trigger
RELIABLT	Float	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 / 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
CREATOR = 'rmfit v2.5rc1'      / Software and version creating file
FILETYPE= 'TRIGGER ENTRY'      / Name for this type of FITS file
TELESCOP= 'GLAST   '           / Name of mission/satellite
INSTRUME= 'GBM     '           / Specific instrument used for
observation
OBSERVER= 'Meegan  '           / GLAST Burst Monitor P.I.
ORIGIN  = 'GIOC    '           / Name of organization making file
DATE    = '2009-05-08T14:11:39' / file creation date (YYYY-MM-
DDThh:mm:ss UT)
DATE-OBS= '2009-05-02T18:37:18' / [UTC] date of start of observation
DATE-END= '2009-05-02T18:47:32' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time since MJDREF, used in TSTART and
TSTOP
MJDREFI =                51910 / MJD of GLAST reference epoch, integer
part
MJDREFF = 7.428703703703703D-4 / MJD of GLAST reference epoch,
fractional part
TSTART  =     262982238.021874 / [GLAST MET] Observation start time
TSTOP   =     262982852.430104 / [GLAST MET] Observation stop time
FILENAME= 'glg_tcat_all_bn090502777_v02.fit' / Name of this file
TRIGTIME=     262982376.647612 / Trigger time relative to MJDREF,
double precisi
OBJECT  = 'GRB090502777'       / Burst name in standard format,
yymmddfff
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =              267.820 / Calculated RA of burst
DEC_OBJ =             -20.3100 / Calculated Dec of burst
ERR_RAD =              7.36000 / Calculated Location Error Radius
LOC_SRC = 'Fermi, GBM'         /Mission/Instrument providing the
localization
CLASS   = 'GRB     '           / Classification of trigger
```

```
OBJ_CLAS= 'GRB     '           / Classification of trigger
TRIGSCAL=                  256 / [ms] Triggered timescale
TRIG_ALG=                    9 / Triggered algorithm number
CHAN_LO =                    3 / Trigger channel: low
CHAN_HI =                    4 / Trigger channel: high
ADC_LO  =                  259 / Trigger channel: low (ADC: 0 - 4095)
ADC_HI  =                 1352 / Trigger channel: high (ADC: 0 - 4095)
TRIG_SIG=                  4.8 / Trigger significance (sigma)
DET_MASK= '00000001100000'       / Triggered detectors: (0-13)
GEO_LONG=             184.6479 / [deg] Spacecraft geographical east
longitude
GEO_LAT =              14.3777 / [deg] Spacecraft geographical north
latitude
RA_SCX  =              46.9161 / [deg] Pointing of spacecraft x-axis:
RA
DEC_SCX =               8.5867 / [deg] Pointing of spacecraft x-axis:
Dec
RA_SCZ  =             307.8723 / [deg] Pointing of spacecraft z-axis:
RA
DEC_SCZ =              46.1505 / [deg] Pointing of spacecraft z-axis:
Dec
THETA   =                 00.0 / [deg] Angle from spacecraft zenith
PHI     =                 00.0 / [deg] Angle from spacecraft +X axis
toward +Y
LOC_VER =          'dol v1.19' / Version string of localizing software
LOC_ENRG=      '(50.0, 300.0)' / Energy range used for localization
GCN_FLAG=                 'No' / Was this file used for GCN Notice
generation?
INFILE01= 'GLAST_2009122_185400_VC03_GTRIG.0.00' / Level 0 input data
file
CHECKSUM= '98HVG6EV96EVG6EV'   / HDU checksum updated 2009-05-
11T15:56:03
DATASUM = '         0'         / data unit checksum updated 2009-05-
02T19:43:54
RELIABLT=              1.00000 / Reliability of classification
END
```

6.15. GS-106 GBM Burst Catalog Entry

Version: 3.0
Revision date: 06/30/11

6.15.1. Product Description

This file provides basic burst parameters such as duration, peak flux and fluence. Updates will be sent (with new version numbers) as these parameters are refined. This ‘bcat’ file is sent out for all triggers that are considered bursts, and supplements the initial data in the ‘tcat’ file that is sent out for all triggers. The file includes two extensions describing the spectrum that was used to calculate the fluence. The spectrum and its associated background are created with a standard procedure to produce a consistent fluence calculation. The ‘scat’ files of GS-109 will provide additional spectra.

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	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	3 days, 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 PARAMETERS

6.15.2. Primary Header

Definition

FITS Keyword	Value	Purpose
SIMPLE	T	
BITPIX	8	
NAXIS	0	
EXTEND	T	File contains extensions
CREATOR	String	Software/version creating file
FILETYPE	SPECTRAL FITS	Unique FITS file type name
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	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	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] 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	MET Time	Observation start time, rel to MJDREF
TSTOP	MET Time	Observation end time, rel to MJDREF,
TRIGTIME	MET Time	Trigger time (s) relative to MJDREF
TIMESYS	TT	Time system
TIMEUNIT	s	Time until
FLU	Float	[erg/cm^2] 10-1000 keV fluence
FLU_ERR	Float	Uncertainty on fluence
PFLX	Float	[ph/cm^2/s] 10-1000 keV peak flux (1024ms timescale)
PFLX_ERR	Float	Uncertainty on peak flux (1024ms timescale)
PFLX_INT	Float	[s] Time interval for peak flux (1024ms timescale)
PFLX_BEG	Float	[s] Start time for peak flux interval (1024ms timescale) relative to TRIGTIME
FLU_LOW	Float	[keV] Lower limit of flux/fluence integration
FLU_HIGH	Float	[keV] Upper limit of flux/fluence integration
FLUB	Float	[erg/cm^2] 50-300 keV fluence (BATSE standard)
FLUB_ERR	Float	Uncertainty on fluence (BATSE standard energies)
PFLXB	Float	[ph/cm^2/s] 50-300 keV peak flux (1024ms timescale)
PFLXBERR	Float	Uncertainty on 50-300 keV peak flux (1024ms timescale)
PFLXBBEG	Float	[s] Start time for peak flux interval (1024ms timescale) relative to TRIGTIME
PF64	Float	[ph/cm^2/s] 10-1000 keV peak flux (64ms timescale)
PF64_ERR	Float	Uncertainty on peak flux (64ms timescale)
PF64_INT	Float	[s] Time interval for peak flux (64ms timescale)
PF64_BEG	Float	[s] Start time for peak flux interval (64ms timescale) relative to TRIGTIME
PF64B	Float	[ph/cm^2/s] 50-300 keV peak flux (64ms timescale)
PF64BERR	Float	Uncertainty on 50-300 keV peak flux (64ms timescale)

PF64BBEG	Float	[s] Time interval for peak flux (64ms timescale) relative to TRIGTIME
PF256	Float	[ph/cm^2/s] 10-1000 keV peak flux (256ms timescale)
PF256ERR	Float	Uncertainty on peak flux (256ms timescale)
PF256INT	Float	[s] Time interval for peak flux (256ms timescale)
PF256BEG	Float	[s] Start time for peak flux interval (256ms timescale) relative to TRIGTIME
PF256B	Float	[ph/cm^2/s] 50-300 keV peak flux (256ms timescale)
PF256BER	Float	Uncertainty on 50-300 keV peak flux (256ms timescale)
PF256BBG	Float	[s] Start time for peak flux interval (256ms timescale) relative to TRIGTIME
DUR_LOW	Float	[keV] Lower limit of duration integration
DUR_HIGH	Float	[keV] Upper limit of duration integration
T90	Float	[s] T90 Using deconvolution method
T90_ERR	Float	[s] Uncertainty on T90
T50	Float	[s] T50 Using deconvolution method
T50_ERR	Float	[s] Uncertainty on T50
T90START	Float	[s] Start of T90 interval relative to TRIGTIME
T50START	Float	[s] Start of T50 interval relative to TRIGTIME
LOBCKINT	(float, float)	[s] Lower background selection interval for duration
HIBCKINT	(float, float)	[s] Upper background selection interval
FILENAME	Name of the file	Name of FITS file: glg_bcat_all_bnyymmddfff_vxx.fit 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
BCATALOG	Integer	Catalog version of the file. Zero for preliminary files. Integer value (1, 2, 3, etc.) for official catalog releases.
IDXFIX	Integer	Optional keyword. A value of 1 indicates that a change has been made to the t50/t90 value fixing a known bug in the duration code. This fix is necessary only if CREATOR is rmfit with version < 4.1.
END		

Example

```
SIMPLE  =                    T /Written by IDL:  Sat Jan 29 13:59:34
2011
BITPIX  =                    8 /
NAXIS   =                    0 /
EXTEND  =                    T /File contains extensions
DATE    = '2011-08-30T19:41:04' / file creation date (YYYY-MM-
DDThh:mm:ss UT)
FILETYPE= 'SPECTRAL FITS'      /Unique FITS file type name
CREATOR = 'rmfit 3.3rc11'      /Software/version creating file
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04/MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
```

```
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2010-04-24T17:28:17' /Date of start of observation
DATE-END= '2010-04-24T17:34:03' /Date of start of observation
TSTART  =    293822897.4383867 /Observation start time, relative to
MJDREF
TSTOP   =    293823243.4283388 /Observation end time, relative to
MJDREF
TRIGTIME=    293823012.1284120 /Trigger time, relative to MJDREF
FLU     =          7.40525E-06 /[erg/cm^2]  10- 1000 keV fluence
FLU_ERR =          5.66328E-08 /[erg/cm^2] Uncertainty on fluence
FLUB    =          3.96533E-06 /[erg/cm^2] 50-300 keV fluence
FLUB_ERR=          3.06407E-08 /[erg/cm^2] Uncertainty on fluence
FLU_LOW =              10.0000 /[keV] Lower limit of flux/fluence
integration
FLU_HIGH=              1000.00 /[keV] Upper limit of flux/fluence
integration
DUR_LOW =              50.0000 /[keV] Lower limit of duration
integration
DUR_HIGH=              300.000 /[keV] Upper limit of duration
integration
PFLX_INT=              1.02402 /[s] Time interval for peak flux
PFLX    =              2.74581 /[ph/(s cm^2)]  10- 1000 keV peak flux
PFLX_ERR=             0.286320 /[ph/(s cm^2)] Uncertainty on peak flux
PFLX_BEG=              99.1377 /[s] Start time for peak flux interval
PFLXB   =             0.754161 /[ph/(s cm^2)] 50-300 keV peak flux
PFLXBERR=            0.0812362 /[ph/(s cm^2)] Uncertainty on peak flux
PFLXBBEG=              99.1377 /[s] Start time for peak flux interval
(BATSE)
PF64_INT=            0.0640030 /[s] Time interval for peak flux
PF64    =              5.16393 /[ph/(s cm^2)]  10- 1000 keV peak flux
PF64_ERR=              1.99577 /[ph/(s cm^2)] Uncertainty on peak flux
PF64_BEG=              82.9454 /[s] Start time for peak flux interval
PF64B   =              2.09180 /[ph/(s cm^2)] 50-300 keV peak flux
PF64BERR=             0.521340 /[ph/(s cm^2)] Uncertainty on peak flux
PF64BBEG=              96.3856 /[s] Start time for peak flux interval
(BATSE)
PF256INT=             0.256020 /[s] Time interval for peak flux
PF256   =              3.92750 /[ph/(s cm^2)]  10- 1000 keV peak flux
PF256ERR=             0.617901 /[ph/(s cm^2)] Uncertainty on peak flux
PF256BEG=              85.6974 /[s] Start time for peak flux interval
PF256B  =              1.24685 /[ph/(s cm^2)] 50-300 keV peak flux
PF256BER=             0.195063 /[ph/(s cm^2)] Uncertainty on peak flux
PF256BBG=              85.7614 /[s] Start time for peak flux interval
(BATSE)
T90     =              175.107 /[s] T90 duration
T90_ERR =              1.49276 /[s] Uncertainty on T90
T90START=             -25.3445 /[s] Start of t90 interval
T50     =              83.2014 /[s] T50 duration
T50_ERR =              1.71734 /[s] Uncertainty on T50
T50START=              15.8722 /[s] Start of t50 interval
LOBCKINT= '(-114.58, -39.58)'  /[s] Lower background selection
HIBCKINT= '(159.38, 231.25)'   /[s] Upper background selection
FILENAME= 'glg_bcat_all_bn100424729_v00.fit' /Name of FITS file
COMMENT This file consists of time-sequenced spectral fit parameters
DATASUM = '         0'         / data unit checksum created 2011-01-
29T19:59:55
```

```
CHECKSUM= 'f25Ah124f129f129'   / HDU checksum updated 2011-08-
30T19:41:04
BCATALOG=              1 / Catalog version
IDXFIX= 1 / Change to the t50/t90 value to fix a duration code bug.
END
```

6.15.3. Extension Header 1: DETECTOR DATA

This extension provides deconvolved spectra over the burst.

Definition

FITS Keyword	Value	Purpose
XTENSION	BINTABLE	
BITPIX	8	
NAXIS	2	Binary table
NAXIS1	Integer	Number of bytes per row
NAXIS2	Integer	Number of rows
PCOUNT	Integer	Random parameter count
GCOUNT	1	Group count
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	For data table
TFIELDS	13	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
ORIGIN	GIOC	Originating ground element
DATE	yyyy-mm-ddThh:mm:ss.ss	Date file was created
DATE-OBS	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of end of observation
MJDREFI	51910.	Reference epoch MJD date, integer part
MJDREFF	7.428703703703703D-4	Reference epoch MJD, fractional part
NUMFITS	Integer	Number of spectral fits
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	INSTRUME	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	RSPFILE	Response function file for this dataset
TFORM7	60A	Character string
TTYPE7	FIT_INT	Fit intervals
TFORM8	1J	Integer*4 (long integer)

TTYPE8	CHANNUM	# of energy channels for this detector
TFORM9	2J	Integer*4 (long integer)
TTYPE9	FITCHAN	Channels selected in fitting detector
TFORM10	1PE(x)	Real*4 (floating point), variable length, x CHANNUM+1
TUNIT10	keV	
TTYPE10	E_EDGES	Energy edges for each selected detector
TFORM11	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), NUMFITS
TUNIT11	photon/cm**2/s/keV	
TTYPE11	PHTCNTS	Array of photon counts data
TFORM12	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), y NUMFITS
TUNIT12	photon/cm**2/s/keV	
TTYPE12	PHTMODL	Array of photon model data
TFORM13	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), y NUMFITS
TUNIT13	photon/cm**2/s/keV	
TTYPE13	PHTERRS	Array of errors in photon counts data
END		

Example

```
XTENSION= 'BINTABLE'           /Written by IDL:  Sat Jan 29 13:59:54
2011
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  304 / Number of bytes per row
NAXIS2  =                    3 /Number of rows
PCOUNT  =              1169964 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   13 / Number of columns
TFORM1  = '20A     '           /Character string
TTYPE1  = 'INSTRUME'           / Instrument name for this detector
TFORM2  = '20A     '           /Character string
TTYPE2  = 'DETNAM  '           / Detector number; 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
TFORM7  = '60A     '           /Character string
TTYPE7  = 'FIT_INT '           /Fit intervals
TFORM8  = '1J      '           /Integer*4 (long integer)
TTYPE8  = 'CHANNUM '           /Total number of energy channels for
this detecto
TFORM9  = '2J      '           /Integer*4 (long integer)
TTYPE9  = 'FITCHAN '           /Channels selected in fitting this
detector
```

```
TFORM10 = '1PE(9)  '           /Real*4 (floating point), variable
length
TUNIT10 = 'keV     '
TTYPE10 = 'E_EDGES '           /Energy edges for each selected detector
TFORM11 = '1PE(36558)'         /Real*4 (floating point), variable
length
TUNIT11 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE11 = 'PHTCNTS '           /Array of photon counts data
TFORM12 = '1PE(36558)'         /Real*4 (floating point), variable
length
TUNIT12 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE12 = 'PHTMODL '           /Array of photon model data
TFORM13 = '1PE(36558)'         /Real*4 (floating point), variable
length
TUNIT13 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE13 = 'PHTERRS '           /Array of errors in photon counts data
DATE    = '2011-08-30T19:41:04' / file creation date (YYYY-MM-
DDThh:mm:ss UT)
EXTNAME = 'DETECTOR DATA'      /Name of this binary table extension
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04/MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2010-04-24T17:28:17' /Date of start of observation
DATE-END= '2010-04-24T17:34:03' /Date of start of observation
TSTART  =    293822897.4383867 /Observation start time, relative to
MJDREF
TSTOP   =    293823243.4283388 /Observation end time, relative to
MJDREF
TRIGTIME=    293823012.1284120 /Trigger time (s) relative to MJDREF
DATASUM = '3846027618'         / data unit checksum updated 2011-01-
29T20:00:46
CHECKSUM= 'iJbelHZdiHbdiHZd'   / HDU checksum updated 2011-08-
30T19:41:04
TTYPE6  = 'RSPFILE '           / Response file name for this dataset
TFORM6  = '60A     '           / format of field
NUMFITS =                 4062 / Number of spectral fits
END.
```

6.15.4. Extension Header 2: FIT PARAMETERS

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

Definition

FITS Keyword	Value	Purpose
XTENSION	BINTABLE	
BITPIX	8	
NAXIS	2	Binary table
NAXIS1	Integer	Number of bytes per row
NAXIS2	Integer	Number of rows
PCOUNT	Integer	Random parameter count
GCOUNT	Integer	Group count
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	For data table
TFIELDS	15	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
ORIGIN	GIOC	Originating ground element
DATE	yyyy-mm-ddThh:mm:ss.ss	Date file was created
DATE-OBS	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of end of observation
MJDREFI	51910.	Reference epoch MJD date, integer part
MJDREFF	7.428703703703703D-4	Reference epoch MJD, fractional part
TSTART	MET Time	Start time relative to MJDREF
TSTOP	MET Time	Stop time relative to MJDREF
TRIGTIME	MET Time	Trigger time (s) relative to MJDREF, double precision
TIMESYS	TT	Time system for time keywords
TIMEUNIT	s	Time unit used
FLU_LOW	Float	E_lo of flux/fluence integ. (keV)
FLU_HIGH	Float	E_hi of flux/fluence integ. (keV)
TFORM1	2D	Real*4 (floating point)
TTYPE1	TIMEBIN	Start/stop times rel. to trigger
TFORM2	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE2	PARAM0	Comptonized, Epeak: Amplitude
TFORM3	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE3	PARAM1	Comptonized, Epeak: Epeak
TFORM4	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE4	PARAM2	Comptonized, Epeak: Index
TFORM5	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE5	PARAM3	Comptonized, Epeak: Pivot E =fix
TFORM6	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE6	PHTFLUX	Photon Flux (ph/s-cm^2)

TFORM7	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE7	PHTFLNC	Photon Fluence (ph/cm^2)
TFORM8	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE8	NRGFLUX	Energy Flux (erg/s-cm^2)
TFORM9	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE9	NRGFLNC	Energy Fluence (erg/cm^2)
TFORM10	1E	Real*4 (floating point) array containing (value, ±error)
TTYPE10	REDCHSQ	Reduced Chi-squares
TFORM11	1I	Integer*2 (short integer)
TTYPE11	CHSQDOF	Degrees of Freedom
TFORM12	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE12	PHTFLUXB	Photon Flux (ph/s-cm^2) in BATSE standard energies
TFORM13	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE13	DURFLNC	Photon Fluence (ph-cm^2) for durations (user)
TFORM14	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE14	NRGFLNCB	Energy Fluence (erg-cm^2) BATSE energy (50-300)
TFORM15	16E	Real*4 (floating point)
TTYPE15	COVARMAT	Covariance matrix for the fit (units as for PARAMn)
STATISTC	String	Indicates the statistical merit function used. Possible values: CHISQ, -2 LOG (LIKELIHOOD), Castor C-STAT
N_PARAM	Integer	Number of parameters used in the model fit
NUMFITS		Number of spectral fits
END		

Example

```
XTENSION= 'BINTABLE'           /Written by IDL:  Sat Jan 29 14:00:31
2011
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  118 / Number of bytes per row
NAXIS2  =                 4062 /Number of rows
PCOUNT  =               148776 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   15 / Number of columns
TFORM6  = '2E      '           /Real*4 (floating point)
TTYPE6  = 'PHTFLUX '           /Photon Flux (ph/s-cm^2) std energy (8-
1000)
TFORM7  = '2E      '           /Real*4 (floating point)
TTYPE7  = 'PHTFLNC '           /Photon Fluence (ph/cm^2) std energy (8-
1000)
TFORM8  = '2E      '           /Real*4 (floating point)
TTYPE8  = 'NRGFLUX '           /Energy Flux (erg/s-cm^2) std energy (8-
1000)
TFORM9  = '2E      '           /Real*4 (floating point)
TTYPE9  = 'NRGFLNC '           /Energy Fluence (erg/cm^2) std energy
(8-1000)
TFORM10 = '1E      '           /Real*4 (floating point)
TTYPE10 = 'REDCHSQ '           /Reduced Chi-squares
TFORM11 = '1I      '           /Integer*2 (short integer)
TTYPE11 = 'CHSQDOF '           /Degrees of Freedom
TFORM12 = '2E      '           /Real*4 (floating point)
```

```
TTYPE12 = 'PHTFLUXB'           /Photon Flux (ph/s-cm^2) BATSE energy
(50-300)
TFORM13 = '2E      '           /Real*4 (floating point)
TTYPE13 = 'DURFLNC '           /Photon Fluence (ph-cm^2) for durations
(user)
TFORM14 = '2E      '           /Real*4 (floating point)
TTYPE14 = 'NRGFLNCB'           /Energy Fluence (erg-cm^2) BATSE energy
(50-300)
TFORM15 = '1PE(16) '           /Real*4 (floating point), variable
length
TTYPE15 = 'COVARMAT'           /Covariance matrix for the fit (#free
params ^2)
DATE    = '2011-08-30T19:41:04' / file creation date (YYYY-MM-
DDThh:mm:ss UT)
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04/MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2010-04-24T17:28:17' /Date of start of observation
DATE-END= '2010-04-24T17:34:03' /Date of start of observation
TSTART  =    293822897.4383867 /Observation start time, relative to
MJDREF
TSTOP   =    293823243.4283388 /Observation end time, relative to
MJDREF
TRIGTIME=    293823012.1284120 /Trigger time (s) relative to MJDREF
FLU_LOW =              10.0000 /Lower limit of flux/fluence integration
(keV)
FLU_HIGH=              1000.00 /Upper limit of flux/fluence integration
(keV)
STATISTC= 'Castor C-STAT'      /Indicates merit function used for
fitting
EXTNAME = 'FIT PARAMS'         /Name of this binary table extension
DATASUM = '321451622'          / data unit checksum updated 2011-08-
30T19:41:04
CHECKSUM= 'TPhOTOfLTOfLTOfL'   / HDU checksum updated 2011-08-
30T19:41:04
N_PARAM =                    4 / Number of parameters used in the model
fit
TTYPE2  = 'PARAM0  '           / Comptonized, Epeak: Amplitude
TFORM2  = '2E      '           / format of field
TTYPE3  = 'PARAM1  '           / Comptonized, Epeak: Epeak
TFORM3  = '2E      '           / format of field
TTYPE4  = 'PARAM2  '           / Comptonized, Epeak: Index
TFORM4  = '2E      '           / format of field
TTYPE5  = 'PARAM3  '           / Comptonized, Epeak: Pivot E =fix
TFORM5  = '2E      '           / format of field
TTYPE1  = 'TIMEBIN '           / Start and stop times relative to
trigger
TFORM1  = '2D      '           / Real*8 (double precision)
NUMFITS =                 4062 / Number of spectral fits
END
```

6.16. GS-107 GBM TRIGDAT

Version: 2.9
Revision date: 9/22/08

6.16.1. 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	FSSC	
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

6.16.2. 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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty
GEO_LONG=                      / [deg] Spacecraft geographical
                                    east longitude
GEO_LAT =                      / [deg] Spacecraft geographical
                                    north latitude
RA_SCX  =                      / [deg] Pointing of spacecraft x-axis:
                                    RA
DEC_SCX =                      / [deg] Pointing of spacecraft x-axis:
                                    Dec
RA_SCZ  =                      / [deg] Pointing of spacecraft z-axis:
                                    RA
DEC_SCZ =                      / [deg] Pointing of spacecraft z-axis:
                                    Dec
TRIGSCAL=                  256 / [ms] Triggered timescale
TRIG_ALG=                    3 / Triggered algorithm number
TRIG_SIG=                      / Burst significance at the time of the
                                    trigger (single float)
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= '00100000001000'   / Triggered detectors: (0-13)
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' / [UTC] Date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / [UTC] Date of 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
ERR_RAD =                  5.8 / Localization uncertainty
GEO_LONG=                  10. / Spacecraft geographical east longitude
GEO_LAT =                 45.2 / Spacecraft geographical north latitude
RA_SCX  =                      / Pointing of spacecraft x-axis: RA
DEC_SCX =                      / Pointing of spacecraft x-axis: Dec
RA_SCZ  =                 123. / Pointing of spacecraft z-axis: RA
DEC_SCZ =                 -23. / Pointing of spacecraft z-axis: Dec
TRIGSCAL=                  256 / [ms] Triggered timescale
TRIG_ALG=                    3 / Triggered algorithm number
```

```
TRIG_SIG=                    / Burst significance at trigger time
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' / L0 input data file
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
```

6.16.3. Extension Header 1: TRIGRATE

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
TFIELDS =                    5 /Number of columns
EXTNAME = 'TRIGRATE'           /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.ss' / Date file was created
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
TFIELDS =                    5 /Number of columns
EXTNAME = 'TRIGRATE'           /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' / [UTC] date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / [UTC] 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
ERR_RAD =                  5.8 / Localization uncertainty

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
```

6.16.4. Extension Header 2: BCKRATES

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
CHECKSUM=                        / For entire HDU
DATASUM =                        / For data table
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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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' / [UTC] date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
```

6.16.5. Extension Header 3: OB_CALC

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.

The column TR_SCAZ ("Trigger_SC_Zen") is the angle from the Z-axis to the direction of the trigger and thus is the source zenith angle. However, in the FSW this variable is sometimes called "S/C Elevation," which is the name used in the ICD (page 7 and Fig. 4-3 of the GLAST GBM to SC ICD—1196 EI-Y46312-000 Rev A of 2003 April 21).

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
TFIELDS =                   15 /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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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

TFORM13 = '1E      '           /
TTYPE13 = 'TRIG_TS '           / DataTimescale_ms / Location data
                                  timescale
TUNIT13 = 's'

TFORM14 = '1E      '          /
TTYPE14 = 'TR_SCAZ '          / Trigger_SC_Az / Source azimuth with
                                 respect to Spacecraft
TUNIT14 = 'degree'

TFORM15 = '1E     '           /
TTYPE15 = 'TR_SCZEN '         / Trigger_SC_Zen / Source Zenith with
                                 respect to Spacecraft
TUNIT15 = 'degree'

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
TFIELDS =                   15 /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’ / [UTC] date of start of observation
DATE-END= ‘2007-06-04T13:56:46.12’ / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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

TFORM13 = '1E      '           /
TTYPE13 = 'TRIG_TS '           / Location data timescale
TUNIT13 = 's'

TFORM14 = '1E      '          /
TTYPE14 = 'TR_SCAZ '          / Source azimuth wrt Spacecraft
TUNIT14 = 'degree'

TFORM15 = '1E     '           /
TTYPE15 = 'TR_SCZEN '         / Source Zenith wrt Spacecraft
TUNIT15 = 'degree'

END
```

6.16.6. Extension Header 4: MAXRATES

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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' / [UTC] date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
```

6.16.7. Extension Header 5: EVNTRATE

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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' / [UTC] date of start of observation
DATE-END= '2007-06-04T13:56:46.12' / [UTC] 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
ERR_RAD =                      / Localization uncertainty

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
```

6.17. GS-108 GBM Background Files

Version: 2.8
Revision date: 5/13/08

6.17.1. 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_uu_wz_bnyymmddfff_vxx.bak	uu = 'ctime' or 'cspec' 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	FSSC	
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	28 kB (1kB x 28 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

6.17.2. 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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddThh:nn:ss.ss'	[UTC] date of end of observation
FILENAME	glg_uu_wz_bnyymmddfff_vxx.bak	Name of this file: uu = 'ctime' or 'cspec' 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
DATATYPE		Name of the primary datatype upon which file is based, either 'CTIME' or 'CSPEC'
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
ERR_RAD		Localization uncertainty
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'	[UTC] date of start of observation
DATE-END	'YYYY-MM-DDTHH:MM:SS.ss'	[UTC] 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)
DATATYPE	'CSPEC'	Name of the primary datatype upon which file is based
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)
ERR_RAD		Localization uncertainty
END		End of Header

6.17.3. Extension Header 1: EBOUNDS

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  =                      / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
TFIELDS =                    3 / number of fields in each row
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ORIGIN  = ‘GIOC’               / Originating ground element
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
ERR_RAD =                      / Localization uncertainty
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=                      / Number of detector channels available
HDUCLASS= ‘OGIP’               /
HDUCLAS1= ‘RESPONSE’           /
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  =                         / 7 for CTIME version, 127 for CSPEC
                                    version

TTYPE2  = 'E_MIN   '              / label for field
TFORM2  = '1E      '              / format of field
TUNIT2  = 'keV     '              / Unit of this field
TLMIN2  =                      5. / Lowest channel energy, 0 keV for both
                                    detector types
TLMAX2  =                   2000. / Highest channel energy, 2000 keV for
                                    NaI detectors, 50000 keV for
                                    BGO detectors

TTYPE3  = 'E_MAX   '              / label for field
TFORM3  = '1E      '              / format of field
TUNIT3  = 'keV     '              / Unit of this field
TLMIN3  =                         / Lowest channel energy, 0 keV for both
                                    detector types
TLMAX3  =                         / Highest channel energy, 2000 keV for
                                    NaI detectors, 50000 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)
CHECKSUM=                         / For entire HDU
DATASUM =                         / For data table
TFIELDS =                       3 / number of fields in each row
DATE-OBS= '2007-06-04T23:58:46.12' / [UTC] date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / [UTC] 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
ORIGIN  = 'GIOC'                  / Originating ground element
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
ERR_RAD =                         / Localization uncertainty
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= ‘RESPONSE’            /
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   =                  129 / Number of channels

TTYPE2   = 'E_MIN   '           / label for field
TFORM2   = '1E      '           / format of field
TUNIT2   = 'keV     '           / Unit of this field
TLMIN2   =                   0. / 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   =                   0. / Lowest channel energy
TLMAX2   =                2000. / Highest channel energy
```

6.17.4. Extension Header 2: Spectrum

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  =                      / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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
ORIGIN  = 'GIOC'               / Originating ground element
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=                      / Number of available detector channels
DATE-OBS= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                       / Localization uncertainty
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  =                       / 7 for CTIME version, 127 for CSPEC
                                  version

TTYPE2  = 'RATE    '            / label for field
TFORM2  = '1E      '            / format of field
TUNIT2  = '/s'                  / Rates have units of s^-1

TTYPE3  = 'STAT_ERR'            / Statistical error
TFORM3  = '1E      '            / format of field
TUNIT3  = '/s'                  / Rates have units of s^-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)
CHECKSUM=                       / For entire HDU
DATASUM =                       / For data table
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
ORIGIN  = 'GIOC'                / Originating ground element
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' / [UTC] date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / [UTC] 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
ERR_RAD =                      / Localization uncertainty
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  =                  129 /

TTYPE2  = 'RATE    '           / label for field
TFORM2  = '1E      '           / format of field
TUNIT2  = '/s'                 / Rates have units of s^-1

TTYPE3  = 'STAT_ERR'           / Statistical error
TFORM3  = '1E      '           / format of field
TUNIT3  = '/s'                 / Rates have units of s^-1

END
```

6.17.5. Extension Header 3: GTI

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)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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
ORIGIN  = 'GIOC'               / Originating ground element
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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty
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)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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
ORIGIN  = 'GIOC'               / Originating ground element
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' / [UTC] date of start of observation
DATE-END= '2007-06-07T13:56:46.12' / [UTC] 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
ERR_RAD =                      / Localization uncertainty
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
```

6.17.6. Extension Header 4: BACKMOD

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)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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
ORIGIN  = 'GIOC'               / Originating ground element
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' / [UTC] date of start of observation
DATE-END= 'yyyy-mm-ddThh:mm:ss.ss' / [UTC] 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
ERR_RAD =                      / Localization uncertainty
```

```
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  =                      / 7 for CTIME version, 127 for CSPEC
                                 version

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)
CHECKSUM=                      / For entire HDU
DATASUM =                      / For data table
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
ORIGIN  = ‘GIOC’               / Originating ground element
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’ / [UTC] date of start of observation
DATE-END= ‘2007-06-07T13:56:46.12’ / [UTC] 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
ERR_RAD =                        / Localization uncertainty
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  =                    129 /

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

END
```

6.18. GS-109 GBM Spectral Catalog Entry

Version: 3.1
Revision Date: 06/30/11

6.18.1. Product Description

This data product provides different types of spectral fits to be included in a spectral catalog of GBM bursts. The type is coded into the filename. There are currently three spectrum categories:

- Peak flux (‘pflx’)—a single spectrum over the time range of the burst’s peak flux
- Fluence (‘flnc’)—a single spectrum over the entire burst
- Time (‘time’)—a series of spectra over the burst

The time ranges for the spectra are included with the spectra. The spectra are fit with a number of models, whose complexity often depends on the signal-to-noise ratio of the spectrum. The current set is:

- Power law (‘plaw’),
- Comptonized (exponentially attenuated power law; ‘comp’)
- Band (‘band’)
- Smoothly broken Power Law (‘sbpl’)

The set of detectors used for the fit is not coded into the filename, and may not be the same as the set of detectors that triggered. Choosing the appropriate detectors will be the responsibility of the person creating the file.

Naming Convention	glg_scat_all_bnyymmddfff_type_modl _vxx.fit	yymmdd = date fff = fraction of day xx = version number type=”pflx”, “flnc” or “time” modl=”plaw”,”comp”,”band”,”sbpl”
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	3 days, 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 PARAMETERS

6.18.2. Primary Header

Definition

FITS Keyword	Value	Purpose
SIMPLE	T	
BITPIX	8	
NAXIS	0	
EXTEND	T	File contains extensions
CREATOR	String	Software/version creating file
FILETYPE	SPECTRAL FITS	Unique FITS file type name
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	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	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] 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	MET Time	Observation start time, rel to MJDREF
TSTOP	MET Time	Observation end time, rel to MJDREF,
TRIGTIME	MET Time	Trigger time (s) relative to MJDREF
TIMESYS	TT	Time system
TIMEUNIT	s	Time until
FILENAME	Name of the file	Name of FITS file
TELESCOP	GLAST	Name of mission
INSTRUME	GBM	Name of instrument
OBSERVER	Meegan	Name of instrument PI
SCATALOG	Integer	Catalog version of the file. Zero for preliminary files. Integer value (1, 2, 3, etc.) for official catalog releases.
END		

Example

```
SIMPLE  =                    T /Written by IDL:  Wed Mar  9 14:55:42
2011
BITPIX  =                   16 /
NAXIS   =                    0 /
EXTEND  =                    T /File contains extensions
DATE    = '2011-03-09T20:55:43' /
FILETYPE= 'SPECTRAL FITS'      /Unique FITS file type name
CREATOR = 'rmfit 3.4rc1'       /Software/version creating file
ORIGIN  = 'GIOC    '           /Name of organization
```

```
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04 /MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2008-07-14T02:04:12' /Date of start of observation
DATE-END= '2008-07-14T02:04:16' /Date of start of observation
TSTART  =    237693852.0293660 /Observation start time, relative to
MJDREF
TSTOP   =    237693856.1253661 /Observation end time, relative to
MJDREF
TRIGTIME=    237693853.0533660 /Trigger time, relative to MJDREF
FILENAME= 'glg_scat_all_bn080714086_flnc_band_v00.fit' /Name of FITS
file
COMMENT This file consists of time-sequenced spectral fit parameters
CHECKSUM= 'Di6DDg49Dg4CDg49'   / HDU checksum updated 2011-07-
25T15:56:36
DATASUM = '0       '            / data unit checksum updated 2011-06-
14T14:31:53
SCATALOG=                    1 / Catalog version
END
```

6.18.3. Extension Header 1: DETECTOR DATA

This extension provides deconvolved spectra over the burst.

Definition

FITS Keyword	Value	Purpose
XTENSION	BINTABLE	
BITPIX	8	
NAXIS	2	Binary table
NAXIS1	Integer	Number of bytes per row
NAXIS2	Integer	Number of rows
PCOUNT	Integer	Random parameter count
GCOUNT	1	Group count
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	For data table
TFIELDS	13	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
ORIGIN	GIOC	Originating ground element
DATE	yyyy-mm-ddThh:mm:ss.ss	Date file was created
DATE-OBS	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of end of observation
MJDREFI	51910.	Reference epoch MJD date, integer part
MJDREFF	7.428703703703703D-4	Reference epoch MJD, fractional part
NUMFITS	Integer	Number of spectral fits
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
STATISTC	String	Indicates the statistical merit function used. Possible values: CHISQ, -2 LOG (LIKELIHOOD), Castor C-STAT
TFORM1	20A	Character string
TTYPE1	INSTRUME	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	RSPFILE	Response function file for this dataset

TFORM7	60A	Character string
TTYPE7	FIT_INT	Fit intervals
TFORM8	1J	Integer*4 (long integer)
TTYPE8	CHANNUM	# of energy channels for this detector
TFORM9	2J	Integer*4 (long integer)
TTYPE9	FITCHAN	Channels selected in fitting detector
TFORM10	1PE(x)	Real*4 (floating point), variable length, x CHANNUM+1
TUNIT10	keV	
TTYPE10	E_EDGES	Energy edges for each selected detector
TFORM11	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), y NUMFITS
TUNIT11	photon/cm**2/s/keV	
TTYPE11	PHTCNTS	Array of photon counts data
TFORM12	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), y NUMFITS
TUNIT12	photon/cm**2/s/keV	
TTYPE12	PHTMODL	Array of photon model data
TFORM13	1PE(xy)	Real*4 (floating point), variable length x dim(CHANNUM), y NUMFITS
TUNIT13	photon/cm**2/s/keV	
TTYPE13	PHTERRS	Array of errors in photon counts data
END		

Example

```
XTENSION= 'BINTABLE'           /Written by IDL:  Wed Mar  9 14:55:43
2011
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                 2324 /Number of bytes per row
NAXIS2  =                    4 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   13 /Number of columns
TFORM1  = '20A     '           /Character string
TTYPE1  = 'INSTRUME'            /Instrument name for this detector
TFORM2  = '20A     '           /Character string
TTYPE2  = 'DETNAM  '            /Detector number; 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  = 'RSPFILE '           /Response file name for this dataset
TFORM7  = '60A     '           /Character string
TTYPE7  = 'FIT_INT '           /Fit intervals
TFORM8  = 'J       '           /Integer*4 (long integer)
TTYPE8  = 'CHANNUM '           /Total number of energy channels for
this detecto
TFORM9  = '2J      '           /Integer*4 (long integer)
```

```
TTYPE9  = 'FITCHAN '           /Channels selected in fitting this
detector
TFORM10 = '129E    '           / Real*4 (floating point), variable
length
TUNIT10 = 'keV     '           /
TTYPE10 = 'E_EDGES '           /Energy edges for each selected detector
TFORM11 = '128E    '           / Real*4 (floating point), variable
length
TUNIT11 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE11 = 'PHTCNTS '           /Array of photon counts data
TFORM12 = '128E    '           / Real*4 (floating point), variable
length
TUNIT12 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE12 = 'PHTMODL '           /Array of photon model data
TFORM13 = '128E    '           / Real*4 (floating point), variable
length
TUNIT13 = 'Photon cm^-2 s^-1 keV^-1' /
TTYPE13 = 'PHTERRS '           /Array of errors in photon counts data
DATE    = '2011-03-09T20:55:43' /
EXTNAME = 'DETECTOR DATA'      /Name of this binary table extension
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04 /MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2008-07-14T02:04:12' /Date of start of observation
DATE-END= '2008-07-14T02:04:16' /Date of start of observation
TSTART  =    237693852.0293660 /Observation start time, relative to
MJDREF
TSTOP   =    237693856.1253661 /Observation end time, relative to
MJDREF
TRIGTIME=    237693853.0533660 /Trigger time (s) relative to MJDREF
NUMFITS =                    1 /Number of spectral fits in the data
CHECKSUM= 'YG5AaF38TF3AYF35'    / HDU checksum updated 2011-08-
03T15:35:26
DATASUM = '2142889215'          / data unit checksum updated 2011-08-
03T15:35:26
END
```

6.18.4. Extension Header 2: FIT PARAMETERS

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

Definition

FITS Keyword	Value	Purpose
XTENSION	BINTABLE	
BITPIX	8	
NAXIS	2	Binary table
NAXIS1	Integer	Number of bytes per row
NAXIS2	Integer	Number of rows
PCOUNT	Integer	Random parameter count
GCOUNT	Integer	Group count
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	For data table
TFIELDS	Integer	Number of columns (which will vary based on the model)
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
ORIGIN	GIOC	Originating ground element
DATE	yyyy-mm-ddThh:mm:ss.ss	Date file was created
DATE-OBS	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] date of end of observation
MJDREFI	51910.	Reference epoch MJD date, integer part
MJDREFF	7.428703703703703D-4	Reference epoch MJD, fractional part
TSTART	MET Time	Start time relative to MJDREF
TSTOP	MET Time	Stop time relative to MJDREF
TRIGTIME	MET Time	Trigger time (s) relative to MJDREF, double precision
TIMESYS	TT	Time system for time keywords
TIMEUNIT	s	Time unit used
FLU_LOW	Float	E_lo of flux/fluence integ. (keV)
FLU_HIGH	Float	E_hi of flux/fluence integ. (keV)
TFORM1	2D	Real*4 (floating point)
TTYPE1	TIMEBIN	Start/stop times rel. to trigger
TFORM2	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE2	PARAM0	Band's GRB, Epeak: Amplitude (for band model) Comptonized, Epeak: Amplitude (for comp model)
TFORM3	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE3	PARAM1	Band's GRB, Epeak: Epeak (for band model) Comptonized, Epeak: Epeak (for comp model)
TFORM4	3E	Real*4 (floating point) array containing (value, +error, -error)

TTYPE4	PARAM2	Band's GRB, Epeak: alpha (for band model) Comptonized, Epeak: Index (for comp model)
TFORM5	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE5	PARAM3	Band's GRB, Epeak: beta (for band model) Comptonized, Epeak: Pivot E =fix (for comp model)
TFORM6	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE6	PHTFLUX	Photon Flux (ph/s-cm^2)
TFORM7	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE7	PHTFLNC	Photon Fluence (ph/cm^2)
TFORM8	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE8	NRGFLUX	Energy Flux (erg/s-cm^2)
TFORM9	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE9	NRGFLNC	Energy Fluence (erg/cm^2)
TFORM10	2E	Real*4 (floating point)
TTYPE10	REDCHSQ	Reduced Chi-squares (1) and reduced fitting statistic (2)
TFORM11	1I	Integer*2 (short integer)
TTYPE11	CHSQDOF	Degrees of Freedom
TFORM12	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE12	PHTFLUXB	Photon Flux (ph/s-cm^2) in BATSE standard energies
TFORM13	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE13	DURFLNC	Photon Fluence (ph-cm^2) for durations (user)
TFORM14	2E	Real*4 (floating point) array containing (value, ±error)
TTYPE14	NRGFLNCB	Energy Fluence (erg-cm^2) BATSE energy (50-300)
TFORM15	16E	Real*4 (floating point)
TTYPE15	COVARMAT	Covariance matrix for the fit (units as for PARAMn).
TDIM15	(4,4)	Array dimensions of covariance matrix
STATISTC	String	Indicates the statistical merit function used. Possible values: CHISQ, -2 LOG (LIKELIHOOD), Castor C-STAT
N_PARAM	Integer	Number of parameters used in the model fit
ASYMERnn	0 or 1	=1 if asymmetric errors were allowed in fit for PARAMnn, =0 if not
NUMFITS		Number of spectral fits
END		

For power law and smoothly broken power law models the number of parameters in the model changes to three or six, respectively. The columns are then:

TFORM2	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE2	PARAM0	Power Law: Amplitude
TFORM3	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE3	PARAM1	Power Law: Pivot E =fix
TFORM4	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE4	PARAM2	Power Law: Index
TTYPE14	COVARMAT	Covariance matrix for the fit (units as for PARAMn).
TFORM14	9E	Real*4 (floating point)
TDIM14	(3,3)	Array dimensions of covariance matrix

TFORM2	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE2	PARAM0	Smoothly Broken PL: Amplitude

TFORM3	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE3	PARAM1	Smoothly Broken PL: Pivot E fix
TFORM4	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE4	PARAM2	Smoothly Broken PL: Index1 < BE
TFORM5	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE5	PARAM3	Smoothly Broken PL: Break E
TFORM6	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE6	PARAM4	Smoothly Broken Power Law: Break scale
TFORM7	3E	Real*4 (floating point) array containing (value, +error, -error)
TTYPE7	PARAM5	Smoothly Broken Power Law: Index2 > BE
TTYPE17	COVARMAT	Covariance matrix for the fit (units as for PARAMn).
TFORM17	36E	Real*4 (floating point)
TDIM17	(6,6)	Array dimensions of covariance matrix

The rest of the column numbers are shifted appropriately.

Example

```
XTENSION= 'BINTABLE'           /Written by IDL:  Wed Mar  9 14:55:43
2011
BITPIX  =                    8 /
NAXIS   =                    2 /Binary table
NAXIS1  =                  194 /Number of bytes per row
NAXIS2  =                    1 /Number of rows
PCOUNT  =                    0 /Random parameter count
GCOUNT  =                    1 /Group count
TFIELDS =                   15 /Number of columns
TFORM1  = '2D      '           /Real*4 (floating point)
TTYPE1  = 'TIMEBIN '           /Start and stop times relative to
trigger
TFORM2  = '3E      '           / Real*4 (floating point), variable
length
TTYPE2  = 'PARAM0  '           /Band's GRB, Epeak: Amplitude
ASYMER0 =                    0 /Corresponding PARAM contains (value,
+/- error)
TFORM3  = '3E      '           / Real*4 (floating point), variable
length
TTYPE3  = 'PARAM1  '           /Band's GRB, Epeak: Epeak
ASYMER1 =                    0 /Corresponding PARAM contains (value,
+/- error)
TFORM4  = '3E      '           / Real*4 (floating point), variable
length
TTYPE4  = 'PARAM2  '           /Band's GRB, Epeak: alpha
ASYMER2 =                    0 /Corresponding PARAM contains (value,
+/- error)
TFORM5  = '3E      '           / Real*4 (floating point), variable
length
TTYPE5  = 'PARAM3  '           /Band's GRB, Epeak: beta
ASYMER3 =                    0 /Corresponding PARAM contains (value,
+/- error)
TFORM6  = '2E      '           /Real*4 (floating point)
TTYPE6  = 'PHTFLUX '           /Photon Flux (ph/s-cm^2) std energy (8-
1000)
TFORM7  = '2E      '           /Real*4 (floating point)
```

```
TTYPE7  = 'PHTFLNC '           /Photon Fluence (ph/cm^2) std energy (8-
1000)
TFORM8  = '2E      '           /Real*4 (floating point)
TTYPE8  = 'NRGFLUX '           /Energy Flux (erg/s-cm^2) std energy (8-
1000)
TFORM9  = '2E      '           /Real*4 (floating point)
TTYPE9  = 'NRGFLNC '           /Energy Fluence (erg/cm^2) std energy
(8-1000)
TFORM10 = '2E       '           /Real*4 (floating point)
TTYPE10 = 'REDCHSQ '            /Reduced Chi^2 (1) and fitting
statistic (2)
TFORM11 = 'I       '           /Integer*2 (short integer)
TTYPE11 = 'CHSQDOF '           /Degrees of Freedom
TFORM12 = '2E      '           /Real*4 (floating point)
TTYPE12 = 'PHTFLUXB '          /Photon Flux (ph/s-cm^2) BATSE energy
(50-300)
TFORM13 = '2E      '           /Real*4 (floating point)
TTYPE13 = 'DURFLNC '           /Photon Fluence (ph-cm^2) for durations
(user)
TFORM14 = '2E      '           /Real*4 (floating point)
TTYPE14 = 'NRGFLNCB '          /Energy Fluence (erg-cm^2) BATSE energy
(50-300)
TFORM15 = '16E     '            /Real*4 (floating point)
TTYPE15 = 'COVARMAT '          /Covariance matrix for the fit (N_PARAM
^2)
TDIM15  = '( 4, 4) '            /COVARMAT array dimensions
DATE    = '2011-03-09T20:55:43' /
ORIGIN  = 'GIOC    '           /Name of organization
TELESCOP= 'GLAST   '           /Name of mission
INSTRUME= 'GBM     '           /Name of instrument
OBSERVER= 'Meegan  '           /Name of instrument PI
MJDREFI =              51910.0 /MJD date of reference epoch, int part
MJDREFF = 7.428703703703703E-04 /MJD date of reference epoch, frac part
TIMESYS = 'TT      '           /Time system
TIMEUNIT= 's       '           /Time unit used in TSTART, TSTOP and
TRIGTIME
DATE-OBS= '2008-07-14T02:04:12' /Date of start of observation
DATE-END= '2008-07-14T02:04:16' /Date of start of observation
TSTART  =    237693852.0293660 /Observation start time, relative to
MJDREF
TSTOP   =    237693856.1253661 /Observation end time, relative to
MJDREF
TRIGTIME=    237693853.0533660 /Trigger time (s) relative to MJDREF
NUMFITS =                    1 /Number of spectral fits in the data
N_PARAM =                    4 /Total number of fit parameters (PARAMn)
FLU_LOW =              10.0000 /Lower limit of flux/fluence integration
(keV)
FLU_HIGH=              1000.00 /Upper limit of flux/fluence integration
(keV)
STATISTC= 'Castor C-STAT'      /Indicates merit function used for
fitting
EXTNAME = 'FIT PARAMS'         /Name of this binary table extension
CHECKSUM= 'YpBAbn98ZnAAan75'   / HDU checksum updated 2011-07-
25T15:56:36
DATASUM = '3879521712'         / data unit checksum updated 2011-07-
25T15:56:36
END
```

6.19. GS-110 GBM Localization Contour File

Version: 1.0
Revision date: 10/23/13

6.19.1. Product Description

This product supports follow-up observations of GRB locations. When the Burst Advocate uploads the human-in-loop trigger catalog file (GS-105), they also upload a chi-squared grid file that generates this product, a FITS file, and a PNG plot describing the localization contours.

Naming Convention	glg_loclist_all_bnyymmddfff_vnn.txt	yymmdd—the date of the trigger fff = fraction of day xx—file version number
Originator of Product	GIOC	
Product Format	ASCII	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Input Products Required	NA	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	On update	
Typical size	10 kB	

6.19.2. Definition

The file has a number n followed by n lines of right ascension and declination values corresponding to the chi-squared minima, 1-sigma, 2-sigma, and 3-sigma contours.

6.19.3. Example

```
1
124.500 -54.500
  91
122.645 -59.418
122.112 -59.339
[89 more lines]
 151
121.202 -62.260
120.875 -62.224
[149 more lines]
```

```
 295
121.202 -69.102
120.807 -69.078
[293 more lines]
```

6.20. GS-111 GBM Localization Contour FITS File

Version: 1.0
Revision date: 06/19/14

6.20.1. Product Description

This product supports follow-up observations of GRB locations. When the Burst Advocate uploads the human-in-loop trigger catalog file (GS-105), they also upload a chi-squared grid file that generates a text file (GS-110), this FITS file, and a PNG plot describing the localization contours.

Naming Convention	glg_locprob_all_bnyymmddfff_vnn.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	FSSC	
Delivery Method	FASTCOPY	
Input Products Required	NA	
Production Latency Requirement	NA	
Product contains data for	NA	
Number of deliveries per day	On update	
Typical size	2 MB	

6.20.2. Primary Header

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	String	Software and version creating file
FILETYPE	IMAGE	Unique FITS file type name
CHECKSUM	Computed value	For entire HDU
DATASUM	Computed value	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	[UTC] date of start of observation
DATE-END	yyyy-mm-ddThh:mm:ss.ss	[UTC] 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	MET time	Observation start time, rel to MJDREF
TSTOP	MET time	Observation end time, rel to MJDREF,
TRIGTIME	MET time	Trigger time (s) relative to MJDREF
TIMESYS	TT	Time system
TIMEUNIT	s	Time unit
OBJECT	String	Name of source (e.g., burst name)
RADECSYS	FK5	Stellar reference frame
EQUINOX	2000.	Equinox for RA and Dec
RA_OBJ	Float	RA of burst, J2000
DEC_OBJ	Float	DEC of burst, J2000
LOC_SRC	String	Mission or telescope providing RA_OBJ and DEC_OBJ
ERR_RAD	Float	Localization uncertainty
GEO_LONG	Float	[deg] Spacecraft geographical east longitude
GEO_LAT	Float	[deg] Spacecraft geographical north latitude
RA_SCX	Float	[deg] Pointing of spacecraft x-axis: RA
DEC_SCX	Float	[deg] Pointing of spacecraft x-axis: Dec
RA_SCZ	Float	[deg] Pointing of spacecraft z-axis: RA
DEC_SCZ	Float	[deg] Pointing of spacecraft z-axis: Dec
THETA	Float	[deg] Angle from spacecraft zenith
PHI	Float	[deg] Angle from spacecraft +X axis toward +Y
LOC_VER	String	Version string of localizing software
LOC_ENRG	(float, float)	Energy range used for localization
CLASS	String	Classification of trigger. See table for GS-105.
OBJ_CLAS	String	GIOC internal classification of trigger
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
LMETHOD	Interactive or Pipeline	Method of Localization
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
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
CREATOR = 'locationContours.py 1.0' / Software and version creating file
FILETYPE= 'IMAGE   '           / Name for this type of FITS file
TELESCOP= 'GLAST   '           / Name of mission/satellite
INSTRUME= 'GBM     '           / Specific instrument used for observation
OBSERVER= 'Meegan  '           / GLAST Burst Monitor P.I.
ORIGIN  = 'GIOC    '           / Name of organization making file
DATE    = '2014-07-05T14:39:05' / file creation date (YYYY-MM-DDThh:mm:ss UT)
DATE-OBS= '2014-07-05T12:53:14' / Date of start of observation
DATE-END= '2014-07-05T13:03:28' / Date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time since MJDREF, used in TSTART and TSTOP
```

```
MJDREFI =              51910 / MJD of GLAST reference epoch, integer part
MJDREFF = 7.428703703703703D-4 / MJD of GLAST reference epoch, fractional part
TSTART  =    426257594.522296 / [GLAST MET] Observation start time
TSTOP   =    426258208.931562 / [GLAST MET] Observation stop time
FILENAME= 'glg_locprob_all_bn140705539_v00.fit'
TRIGTIME=    426257731.740308 / Trigger time relative to MJDREF, double precisi
OBJECT  = 'GRB140705539'       / Burst name in standard format, yymmddfff
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =             2000.0 / Equinox for RA and Dec
RA_OBJ  =            163.860  / Calculated RA of burst
DEC_OBJ =            56.9700  / Calculated Dec of burst
ERR_RAD =            5.83000  / Calculated Location Error Radius
THETA   =            74.9440  / [deg] Angle from spacecraft zenith
PHI     =            48.9721  / [deg] Angle from spacecraft +X axis toward +Y
LOC_SRC = 'Fermi, GBM'         / Mission/Instrument providing the localization
CLASS   = 'GRB     '           / Classification of trigger
OBJ_CLAS= 'GRB     '           / Classification of trigger
GEO_LONG=           182.1667 / [deg] Spacecraft geographical east longitude
GEO_LAT =             4.1333 / [deg] Spacecraft geographical north latitude
RA_SCX  =            99.4794 / [deg] Pointing of spacecraft x-axis: RA
DEC_SCX =            31.0066 / [deg] Pointing of spacecraft x-axis: Dec
RA_SCZ  =           328.7821 / [deg] Pointing of spacecraft z-axis: RA
DEC_SCZ =            47.3328 / [deg] Pointing of spacecraft z-axis: Dec
LOC_VER = 'dol v4.15adb3'      / Version string of localizing software
LOC_ENRG= '(50, 300)'          / Energy range used for localization
LMETHOD = 'Interactive'        / Method of localization
CHECKSUM= 'nEASo94RnCARn93R'   / HDU checksum updated 2014-07-08T13:01:21
DATASUM = '0       '           / data unit checksum updated 2014-07-08T13:01:21
END
```

6.20.3. Extension Header 1: PMAP

Definition

FITS Keyword	Value	Purpose
XTENSION	IMAGE	
BITPIX	-64	
NAXIS	2	Binary table
NAXIS1	512	Number of pixels
NAXIS2	512	Number of pixels
PCOUNT	Integer	Random parameter count
GCOUNT	Integer	Group count
CHECKSUM	Computed Value	For entire HDU
DATASUM	Computed Value	For data table
EXTNAME	PMAP	Extension Name
WCSAXES	2	Number of coordinate axes
CRPIX1	256.5	Pixel coordinate of reference point
CRPIX2	256.5	Pixel coordinate of reference point
CDELT1	Float	[deg] Coordinate increment at reference point
CDELT2	Float	[deg] Coordinate increment at reference point
CUNIT1	deg	Units of coordinate increment and value
CUNIT2	deg	Units of coordinate increment and value

CTYPE1	RA---TAN	Right ascension, gnomonic projection
CTYPE2	DEC--TAN	Declination, gnomonic projection
CRVAL1	Float	[deg] Coordinate value at reference point
CRVAL2	Float	[deg] Coordinate value at reference point
LONPOLE	Float	[deg] Native longitude of celestial pole
LATPOLE	Float	[deg] Native latitude of celestial pole
RADESYS	ICRS	Equatorial coordinate system
BUNIT	significance	The significance level, 1-P
END		

Example

```
XTENSION= 'IMAGE   '           / Image extension
BITPIX  =                  -64 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                  512
NAXIS2  =                  512
PCOUNT  =                    0 / number of parameters
GCOUNT  =                    1 / number of groups
WCSAXES =                    2 / Number of coordinate axes
CRPIX1  =                256.5 / Pixel coordinate of reference point
CRPIX2  =                256.5 / Pixel coordinate of reference point
CDELT1  =      -0.100302216566 / [deg] Coordinate increment at reference point
CDELT2  =      -0.100302216566 / [deg] Coordinate increment at reference point
CUNIT1  = 'deg'                / Units of coordinate increment and value
CUNIT2  = 'deg'                / Units of coordinate increment and value
CTYPE1  = 'RA---TAN'           / Right ascension, gnomonic projection
CTYPE2  = 'DEC--TAN'           / Declination, gnomonic projection
CRVAL1  =                164.2 / [deg] Coordinate value at reference point
CRVAL2  =                   58 / [deg] Coordinate value at reference point
LONPOLE =                  180 / [deg] Native longitude of celestial pole
LATPOLE =                   58 / [deg] Native latitude of celestial pole
RADESYS = 'ICRS'               / Equatorial coordinate system
BUNIT   = 'significance'       / The significance level, 1-P
EXTNAME = 'PMAP    '           / extension name
CHECKSUM= 'TdRDWdPCTdPCTdPC'   / HDU checksum updated 2014-07-08T19:27:18
DATASUM = '2521410651'         / data unit checksum updated 2014-07-08T13:01:21
COMMENT The values of this skymap are in units of significance, the complement
COMMENT of the confidence (e.g. 95% confidence level is at a value of 0.05)
HISTORY File modified by user 'dhorner' with fv  on 2014-07-08T15:27:18
END
```

6.21. GS-112 GBM HEALPix File

Version: 1.0
Revision date: 11/14/16

6.21.1. Product Description

These files provide the full-sky localization posterior and significance distributions of GBM-localized GRBs stored as HEALPix arrays. These files additionally contain the equatorial location of the Geocenter, sun, and the equatorial pointings of each GBM detector at the time of the GRB.

Naming Convention	glg_healpix_all_bnyymmddfff_vxx.fit	yymmdd = the date fff= fraction of the day xx = the version number
Originator of Product	GIOC	
Product Format	FITS	
Product delivered to	FSSC	
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	1.6 MB	

Product Content	
Header	
Extension 1 Name	HEALPIX

6.21.2. Primary Header Keywords

Definition

FITS Keyword	Value	Description
SIMPLE	T	Conforms to FITS standard
BITPIX	8	Bits used per pixel
NAXIS	0	Number of axes in PRIMARY table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_healpix.py 1.0'	Software and version creating file
FILETYPE	'IMAGE '	Name for this type of FITS file
FILE-VERS	'1.0.0'	Version of the format of this file type.
TELESCOP	'GLAST '	Name of mission / spacecraft
INSTRUME	GBM '	Specific instrument used for observation
OBSERVER	'Meegan '	GLAST Burst Monitor P.I.
ORIGIN	'GIOC '	Name of organization making file
DATE	'YYYY-MM-DDThh:mm:ss'	file creation date (YYYY-MM-DDThh:mm:ss UT)
DATE-OBS	'YYYY-MM-DDThh:mm:ss'	Date of start of observation
DATE-END	'YYYY-MM-DDThh:mm:ss'	Date of end of observation
TIMESYS	'TT '	Time system used in time keywords
TIMEUNIT	's '	Time since MJDREF, used in TSTART and TSTOP
MJDREFI	51910	MJD of GLAST reference epoch, integer part
MJDREFF	7.428703703703703E-4	MJD of GLAST reference epoch, fractional part
TSTART	MET time	[GLAST MET] Observation start time
TSTOP	MET time	[GLAST MET] Observation stop time
TRIGTIME	MET time	Trigger time relative to MJDREF, double precisi
FILENAME	'glg_healpix_all_bnyymmddfff_vxx.fit'	Name of this file
OBJECT	'CLASSyymmddfff'	Burst name in standard format, yymmddfff
RADECSYS	'FK5 '	Stellar reference frame
EQUINOX	2000	Equinox for RA and Dec
RA_OBJ	Float	RA of burst
DEC_OBJ	Float	DEC of burst
ERR_RAD	Float	Localization uncertainty
THETA	Float	[deg] Angle from spacecraft zenith
PHI	Float	[deg] Angle from spacecraft +X axis toward +Y
LOC_SRC	'Fermi, GBM'	Mission / Instrument providing the localization
CLASS	'GRB '	Classification of trigger
OBJ_CLAS	'GRB '	Classification of trigger
GEO_LONG	Float	[deg] Spacecraft geographical east longitude
GEO_LAT	Float	[deg] Spacecraft geographical north latitude
RA_SCX	Float	[deg] Pointing of spacecraft x-axis: RA

DEC_SCX	Float	[deg] Pointing of spacecraft x-axis: Dec
RA_SCZ	Float	[deg] Pointing of spacecraft z-axis: RA
DEC_SCZ	Float	[deg] Pointing of spacecraft z-axis: Dec
LOC_VER	'dol v4.14fdb3'	Version string of localizing software
LOC_ENRG	'(50, 300)'	Energy range used for localization
LMETHOD	'Interactive'	Method of localization
CHECKSUM	Calculated Value	HDU checksum
DATASUM	Calculated Value	Data unit checksum
END		

Example

FITS Keyword	Value	Description
SIMPLE	T	Conforms to FITS standard
BITPIX	8	Bits used per pixel
NAXIS	0	Number of axes in PRIMARY table
EXTEND	T	Extensions are permitted
CREATOR	'GBM_healpix.py 1.0'	Software and version creating file
FILETYPE	'IMAGE '	Name for this type of FITS file
FILE-VERS	'1.0.0'	Version of the format of this file type.
TELESCOP	'GLAST '	Name of mission / spacecraft
INSTRUME	GBM '	Specific instrument used for observation
OBSERVER	'Meegan '	GLAST Burst Monitor P.I.
ORIGIN	'GIOC '	Name of organization making file
DATE	'2016-11-10T23:02:30'	file creation date (YYYY-MM-DDThh:mm:ss UT)
DATE-OBS	'2013-05-17T18:42:02'	Date of start of observation
DATE-END	'2013-05-17T18:52:16'	Date of end of observation
TIMESYS	'TT '	Time system used in time keywords
TIMEUNIT	's '	Time since MJDREF, used in TSTART and TSTOP
MJDREFI	51910	MJD of GLAST reference epoch, integer part
MJDREFF	7.428703703703703E-4	MJD of GLAST reference epoch, fractional part
TSTART	390508922.1	[GLAST MET] Observation start time
TSTOP	390509536.5	[GLAST MET] Observation stop time
TRIGTIME	390509056	Trigger time relative to MJDREF, double precisi
FILENAME	'glg_healpix_all_bn130517781_v00.fit'	Name of this file
OBJECT	'GRB130517781'	Burst name in standard format, yymmddfff
RADECSYS	'FK5 '	Stellar reference frame
EQUINOX	2000	Equinox for RA and Dec
RA_OBJ	41.86	RA of burst
DEC_OBJ	42.66	DEC of burst
ERR_RAD	1.5	Localization uncertainty

THETA	15.8916	[deg] Angle from spacecraft zenith
PHI	331.065	[deg] Angle from spacecraft +X axis toward +Y
LOC_SRC	'Fermi, GBM'	Mission / Instrument providing the localization
CLASS	'GRB '	Classification of trigger
OBJ_CLAS	'GRB '	Classification of trigger
GEO_LONG	284.4833	[deg] Spacecraft geographical east longitude
GEO_LAT	13.8833	[deg] Spacecraft geographical north latitude
RA_SCX	59.1537	[deg] Pointing of spacecraft x-axis: RA
DEC_SCX	-31.8072	[deg] Pointing of spacecraft x-axis: Dec
RA_SCZ	49.4043	[deg] Pointing of spacecraft z-axis: RA
DEC_SCZ	57.8183	[deg] Pointing of spacecraft z-axis: Dec
LOC_VER	'dol v4.14fdb3'	Version string of localizing software
LOC_ENRG	'(50, 300)'	Energy range used for localization
LMETHOD	'Interactive'	Method of localization
CHECKSUM	'dJLigIJidIJidIJi'	HDU checksum
DATASUM	'0 '	Data unit checksum
END		

6.21.3. Extension Header 1: HEALPIX

The full-sky localization posterior and significance distributions of GBM-localized GRBs.

Definition

FITS Keyword	Value	Description
XTENSION	'BINTABLE'	Binary table extension
BITPIX	8	Bits per Pixel
NAXIS	2	Number of axis
NAXIS1	Computed Value	Number of bytes per row
NAXIS2	Computed Value	Number of rows
PCOUNT	0	Number of group parameters
GCOUNT	1	Number of groups
TFIELDS	2	Number of table fields
TTYPE1	'PROBABILITY'	Differential probability per pixel
TFORM1	'1024E '	
TTYPE2	'SIGNIFICANCE'	Integrated probability
TFORM2	'1024E '	
PIXTYPE	'HEALPIX '	HEALPIX pixelisation
ORDERING	'NESTED ' or 'RING '	Pixel ordering scheme, either RING or NESTED
COORDSYS	'C' or 'G' or 'E'	Ecliptic, Galactic or Celestial (equatorial)
EXTNAME	'HEALPIX '	Name of this binary table extension
NSIDE	128	Resolution parameter of HEALPIX
FIRSTPIX	0	First pixel # (0 based)
LASTPIX	Computed Value	Last pixel # (0 based)
INDXSCHM	'IMPLICIT'	Indexing: IMPLICIT or EXPLICIT
OBJECT	'CLASSyymmddfff'	Burst name in standard format, yymmddfff
SUN_RA	Float	RA of Sun
SUN_DEC	Float	Dec of Sun
GEO_RA	Float	RA of Geocenter relative to Fermi
GEO_DEC	Float	Dec of Geocenter relative to Fermi
GEO_RAD	Float	[deg] Radius of the Earth observed by Fermi
N0_RA	Float	RA pointing for detector n0
N0_DEC	Float	Dec pointing for detector n0
N1_RA	Float	RA pointing for detector n1
N1_DEC	Float	Dec pointing for detector n1
N2_RA	Float	RA pointing for detector n2
N2_DEC	Float	Dec pointing for detector n2
N3_RA	Float	RA pointing for detector n3

N3_DEC	Float	Dec pointing for detector n3
N4_RA	Float	RA pointing for detector n4
N4_DEC	Float	Dec pointing for detector n4
N5_RA	Float	RA pointing for detector n5
N5_DEC	Float	Dec pointing for detector n5
N6_RA	Float	RA pointing for detector n6
N6_DEC	Float	Dec pointing for detector n6
N7_RA	Float	RA pointing for detector n7
N7_DEC	Float	Dec pointing for detector n7
N8_RA	Float	RA pointing for detector n8
N8_DEC	Float	Dec pointing for detector n8
N9_RA	Float	RA pointing for detector n9
N9_DEC	Float	Dec pointing for detector n9
NA_RA	Float	RA pointing for detector na
NA_DEC	Float	Dec pointing for detector na
NB_RA	Float	RA pointing for detector nb
NB_DEC	Float	Dec pointing for detector nb
B0_RA	Float	RA pointing for detector b0
B0_DEC	Float	Dec pointing for detector b0
B1_RA	Float	RA pointing for detector b1
B1_DEC	Float	Dec pointing for detector b1
CHECKSUM	Computed Value	HDU checksum
DATASUM	Computed Value	Data unit checksum
END		

Example

FITS Keyword	Value	Description
XTENSION	'BINTABLE'	Binary table extension
BITPIX	8	Bits per Pixel
NAXIS	2	Number of axis
NAXIS1	8192	Number of bytes per row
NAXIS2	192	Number of rows
PCOUNT	0	Number of group parameters
GCOUNT	1	Number of groups
TFIELDS	2	Number of table fields
TTYPE1	'PROBABILITY'	Differential probability per pixel
TFORM1	'1024E '	
TTYPE2	'SIGNIFICANCE'	Integrated probability
TFORM2	'1024E '	
PIXTYPE	'HEALPIX '	HEALPIX pixelisation
ORDERING	'NESTED '	Pixel ordering scheme, either RING or NESTED

COORDSYS	'C '	Ecliptic, Galactic or Celestial (equatorial)
EXTNAME	'HEALPIX '	Name of this binary table extension
NSIDE	128	Resolution parameter of HEALPIX
FIRSTPIX	0	First pixel # (0 based)
LASTPIX	196607	Last pixel # (0 based)
INDXSCHM	'IMPLICIT'	Indexing: IMPLICIT or EXPLICIT
OBJECT	'GRB130517781'	Burst name in standard format, yymmddfff
SUN_RA	54.52820183	RA of Sun
SUN_DEC	19.44569942	Dec of Sun
GEO_RA	261.413271	RA of Geocenter relative to Fermi
GEO_DEC	-13.97656286	Dec of Geocenter relative to Fermi
GEO_RAD	67.52493819498842	[deg] Radius of the Earth as observed by Fermi
N0_RA	178.465862	RA pointing for detector n0
N0_DEC	78.3746198	Dec pointing for detector n0
N1_RA	338.2715272	RA pointing for detector n1
N1_DEC	76.49869201	Dec pointing for detector n1
N2_RA	2.410312067	RA pointing for detector n2
N2_DEC	31.45786149	Dec pointing for detector n2
N3_RA	231.1110612	RA pointing for detector n3
N3_DEC	34.43865179	Dec pointing for detector n3
N4_RA	248.1237119	RA pointing for detector n4
N4_DEC	-8.876486387	Dec pointing for detector n4
N5_RA	300.9770167	RA pointing for detector n5
N5_DEC	21.75388135	Dec pointing for detector n5
N6_RA	169.9663927	RA pointing for detector n6
N6_DEC	37.51981554	Dec pointing for detector n6
N7_RA	168.3558277	RA pointing for detector n7
N7_DEC	11.80983164	Dec pointing for detector n7
N8_RA	180.2873126	RA pointing for detector n8
N8_DEC	-31.79493205	Dec pointing for detector n8
N9_RA	106.6039986	RA pointing for detector n9
N9_DEC	38.48599578	Dec pointing for detector n9
NA_RA	68.26609092	RA pointing for detector na
NA_DEC	7.986172647	Dec pointing for detector na
NB_RA	121.3110869	RA pointing for detector nb
NB_DEC	-22.01483937	Dec pointing for detector nb
B0_RA	297.8198719	RA pointing for detector b0
B0_DEC	20.14933602	Dec pointing for detector b0
B1_RA	117.8198719	RA pointing for detector b1
B1_DEC	-20.14933602	Dec pointing for detector b1
CHECKSUM	'Sp6dUo3aSo3aSo3a'	HDU checksum
DATASUM	'1952149975'	Data unit checksum
END		

LS-001 Event Summary Data

Version: 3.6
Revision date: 8/19/10

6.21.4. Product Description

File contains the event list for a single LAT processing run, usually covering one orbit. 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).

The definition is very similar to that of an FT1/LS-002 file, except that it has many more columns in the EVENTS extension.

Naming Convention	gll_ev_pyyy_rnnnnnnnnnn_vxxx.fit	yyy = processing version number nnnnnnnnnn = MET of beginning of run xxx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 day	
Product contains data for	Processing run	
Number of deliveries per day	15	
Typical size	250 Mbyte	

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

6.21.5. 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
GPS_OUT =                            / whether GPS time was unavailable at
                                          any time during this interval
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_ev_pyyy_rnnnnnnnnnn_vxxx.fit' / name of this file:
                                      yyy = processing version matching PROC_VER
                                           nnnnnnnnnn = MET of beginning of run
                                           xxx = version number
ORIGIN  = 'LISOC'                    / name of organization making file
CREATOR =                            / software and version creating file
VERSION = 1                          / release version of the file
PROC_VER = XXX                       / Integer indicating the processing version
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
GPS_OUT = F                          / whether GPS time was unavailable
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__p123_ev_r0253166000_v000.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
PROC_VER = 123                      / processing version of the file
END
```

6.21.6. Extension Header 1: EVENTS

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 =                           / 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
PASS_VER = 'XXXX'                 / Analysis pass for event classification

The large number of columns are defined is a separate document.

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
PASS_VER = 'P7V3'                / Analysis pass for event classification
```

The large number of columns are defined is a separate document.

END

6.21.7. Extension Header 2: GTI

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
```

6.22. LS-002 LAT Photons

Version: 2.7
Revision date: 01/30/15

6.22.1. 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 FSSC will aggregate the photons into progressively longer lists.

The FT1 files used in the SAE will include DSS keywords to indicate cuts that have been made, and additional columns added by different tools (e.g., phases for a particular pulsar).

Naming Convention	gll_ph_pyyy_rnnnnnnnnnn_vxxx.fit	yyy = processing version number nnnnnnnnnn = MET of beginning of run xxx = version number
Originator of Product	LISOC	
Product Format	FITS	
Production Latency Requirement	1 day	
Product contains data for	Processing run	
Number of deliveries per day	15	
Typical size	~15 Mbyte	

Product Content

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

6.22.2. 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
GPS_OUT =                           / whether GPS time was unavailable at
                                        any time during this interval
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_ph_pyyy_rnnnnnnnnnn_vxxx.fit' / name of this file:
                                     yyy = processing version matching PROC_VER
                                          nnnnnnnnnn = MET of beginning of run
                                          xxx = 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
GPS_OUT = F                         / whether GPS time was unavailable
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_ph_p123_r0253166000_v000.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
PROC_VER = 123                     / processing version of the file
END
```

6.22.3. Extension Header 1: EVENTS

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 =                        18 / 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 = 1                         / # of data subspace keywords in
                                        header
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
DSTYP2  = string
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, 1, 2,...
TFORM15 = '32X'                    / data format of field: 32-bit
array
TLMIN15 =  0                     / minimum value
TLMAX15 =  32767                 / maximum value
TTYPE16 = 'EVENT_TYPE'          / event types encoded as bit array
TFORM16 = '32X'                    / data format of field: 32-bit
array
TLMIN16 =  0                     / minimum value
TLMAX16 =  32767
TTYPE17 = 'CONVERSION_TYPE'      / type of conversion: 0=Front
converting, 1=Back
TFORM17 = 'I'                    / data format of field: 2-byte
signed INTEGER
TLMIN17 =  0                     / minimum value
TLMAX17 =  32767                 / maximum value
TTYPE18 = 'LIVETIME'             / Accumulated livetime since mission
start
TFORM18 = 'D'                    / data format of field: 8-byte
DOUBLE
TUNIT18 = 's'                    / physical unit of field
TLMIN18 = 0.0                    / minimum value
TLMAX18 = 1.0D+10                / maximum value
TTYPE19 = 'DIFRSP0' / Diffuse response label for component 0
TFORM19 = 'E       '
TTYPE20 = 'DIFRSP1' / Diffuse response label for component 1
TFORM20 = 'E       '
TTYPE21 = 'DIFRSP2' / Diffuse response label for component 2
TFORM21 = 'E       '
TTYPE22 = 'DIFRSP3' / Diffuse response label for component 3
TFORM22 = 'E       '
TTYPE23 = 'DIFRSP4' / Diffuse response label for component 4
TFORM23 = 'E       '
DIFRSP0 = 'p6_v3_diffuse__eg_v02'         / Diffuse response label
for component 0
DIFRSP1 = 'p6_v3_diffuse__gal_v02'         / Diffuse response label
for component 1
DIFRSP2 = 'p6_v11_diffuse__eg_v02'         / Diffuse response label
for component 2
DIFRSP3 = 'p6_v11_diffuse__gal_v02'         / Diffuse response label
for component 3
DIFRSP4 = 'NONE'           / Diffuse response label for component 4
NDIFRSP =                    5 / Number of diffuse response labels
```

```
PASS_VER = 'XXXX'                / Analysis pass for event classification


END
```

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   98 / width of table in bytes
NAXIS2  =                35261 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   23 / number of fields in each row
TTYPE1  = 'ENERGY  '           / energy of event
TFORM1  = 'E       '           / data format of field: 4-byte REAL
TTYPE2  = 'RA      '           / right ascension (J2000) of event
TFORM2  = 'E       '           / data format of field: 4-byte REAL
TTYPE3  = 'DEC     '           / declination (J2000) of event
TFORM3  = 'E       '           / data format of field: 4-byte REAL
TTYPE4  = 'L       '           / Galactic longitude of event
TFORM4  = 'E       '           / data format of field: 4-byte REAL
TTYPE5  = 'B       '           / Galactic latitude of event
TFORM5  = 'E       '           / data format of field: 4-byte REAL
TTYPE6  = 'THETA   '           / inclination angle of event in
instrument coordi
TFORM6  = 'E       '           / data format of field: 4-byte REAL
TTYPE7  = 'PHI     '           / azimuthal angle of event in instrument
coordina
TFORM7  = 'E       '           / data format of field: 4-byte REAL
TTYPE8  = 'ZENITH_ANGLE'       / zenith angle of event
TFORM8  = 'E       '           / data format of field: 4-byte REAL
TTYPE9  = 'EARTH_AZIMUTH_ANGLE' / Earth azimuth (from north to east) of
event
TFORM9  = 'E       '           / data format of field: 4-byte REAL
TTYPE10 = 'TIME    '           / Mission Elapsed Time
TFORM10 = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE11 = 'EVENT_ID'           / ID number of original event
TFORM11 = 'J       '           / data format of field: 4-byte signed
INTEGER
TTYPE12 = 'RUN_ID  '           / Run number of original event
TFORM12 = 'J       '           / data format of field: 4-byte signed
INTEGER
TTYPE13 = 'RECON_VERSION'      / version of event reconstruction
software
TFORM13 = 'I       '           / data format of field: 2-byte signed
INTEGER
TTYPE14 = 'CALIB_VERSION'      / versions of calibration tables for the
ACD, CAL
TFORM14 = '3I      '           / data format of field: 2-byte signed
INTEGER
TTYPE15 = 'EVENT_CLASS'        / event class: 0, 1, 2,...
TFORM15 = '32X     '           / data format of field: 32 bit array
TTYPE16 = 'EVENT_TYPE'         / event types encoded as bit array
TFORM16 = '32X     '           / data format of field: 32 bit array
```

```
TTYPE17 = 'CONVERSION_TYPE'    / type of conversion: 0=Front
converting, 1=Back
TFORM17 = 'I       '           / data format of field: 2-byte signed
INTEGER
TTYPE18 = 'LIVETIME'           / Accumulated livetime since mission
start
TFORM18 = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE19 = 'DIFRSP0 '           / Diffuse response component
TFORM19 = 'E       '           / data format
TTYPE20 = 'DIFRSP1 '           / Diffuse response component
TFORM20 = 'E       '           / data format
TTYPE21 = 'DIFRSP2 '           / Diffuse response component
TFORM21 = 'E       '           / data format
TTYPE22 = 'DIFRSP3 '           / Diffuse response component
TFORM22 = 'E       '           / data format
TTYPE23 = 'DIFRSP4 '           / Diffuse response component
TFORM23 = 'E       '           / data format
CHECKSUM= '2ahH3VgF2agF2UgF'   / HDU checksum updated 2015-01-
27T15:52:53
DATASUM = '727464961'          / data unit checksum updated 2015-01-
27T15:52:48
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5
or FK4)
DATE    = '2015-01-27T15:52:30.0000' / file creation date (YYYY-MM-
DDThh:mm:ss U
DATE-OBS= '2014-09-30T21:14:08.0000' / start date and time of the
observation (U
DATE-END= '2014-09-30T22:52:48.0000' / end date and time of the
observation (UTC
OBSERVER= 'Peter Michelson'    / GLAST/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  '           / extension contains events
HDUCLAS2= 'ALL     '           / extension contains all events detected
TSTART  =           433804451. / mission time of the start of the
observation
TSTOP   =           433810371. / mission time of the end of the
observation
MJDREFI =               51910. / Integer part of MJD corresponding to
SC clock s
MJDREFF =  0.00074287037037037 / Fractional part of MJD corresponding
to SC cloc
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at
any time du
PASS_VER= 'P8R2    '           / IRF pass version corresponding to a
specific se
NDIFRSP =                    5 / Number of diffuse response labels
```

```
DIFRSP0 = 'NONE    '           / Diffuse response label for component 0
DIFRSP1 = 'NONE    '           / Diffuse response label for component 1
DIFRSP2 = 'NONE    '           / Diffuse response label for component 2
DIFRSP3 = 'NONE    '           / Diffuse response label for component 3
DIFRSP4 = 'NONE    '           / Diffuse response label for component 4
TUNIT1  = 'MeV     '           / physical unit of field
TLMIN1  =                   0. / minimum value
TLMAX1  =            10000000. / maximum value
TUNIT2  = 'deg     '           / physical unit of field
TLMIN2  =                   0. / minimum value
TLMAX2  =                 360. / maximum value
TUNIT3  = 'deg     '           / physical unit of field
TLMIN3  =                 -90. / minimum value
TLMAX3  =                  90. / maximum value
TUNIT4  = 'deg     '           / physical unit of field
TLMIN4  =                   0. / minimum value
TLMAX4  =                 360. / maximum value
TUNIT5  = 'deg     '           / physical unit of field
TLMIN5  =                 -90. / minimum value
TLMAX5  =                  90. / maximum value
TUNIT6  = 'deg     '           / physical unit of field
TLMIN6  =                   0. / minimum value
TLMAX6  =                 180. / maximum value
TUNIT7  = 'deg     '           / physical unit of field
TLMIN7  =                   0. / minimum value
TLMAX7  =                 360. / maximum value
TUNIT8  = 'deg     '           / physical unit of field
TLMIN8  =                   0. / minimum value
TLMAX8  =                 180. / maximum value
TUNIT9  = 'deg     '           / physical unit of field
TLMIN9  =                   0. / minimum value
TLMAX9  =                 360. / maximum value
TUNIT10 = 's       '           / physical unit of field
TLMIN10 =                   0. / minimum value
TLMAX10 =         10000000000. / maximum value
TLMIN11 =                    0 / minimum value
TLMAX11 =           2147483647 / maximum value
TLMIN12 =                    0 / minimum value
TLMAX12 =           2147483647 / maximum value
TLMIN13 =                    0 / minimum value
TLMAX13 =                32767 / maximum value
TLMIN15 =                    0 / minimum value
TLMAX15 =                32767 / maximum value
TLMIN16 =                    0 / minimum value
TLMAX16 =                32767 / maximum value
TLMIN17 =                    0 / minimum value
TLMAX17 =                32767 / maximum value
TUNIT18 = 's       '           / physical unit of field
TLMIN18 =                   0. / minimum value
TLMAX18 =         10000000000. / maximum value
TLMIN19 =                   0. / minimum value
TLMAX19 =              1.0E+38 / maximum value
TLMIN20 =                   0. / minimum value
TLMAX20 =              1.0E+38 / maximum value
TLMIN21 =                   0. / minimum value
TLMAX21 =              1.0E+38 / maximum value
TLMIN22 =                   0. / minimum value
```

```
TLMAX22 =              1.0E+38 / maximum value
TLMIN23 =                   0. / minimum value
TLMAX23 =              1.0E+38 / maximum value
EXTVER  =                    1 / auto assigned by template parser
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
DSTYP2  = 'BIT_MASK(EVENT_CLASS,128,P8R2)'
DSUNI2  = 'DIMENSIONLESS'
DSVAL2  = '1:1     '
NDSKEYS =                    2
END
```

6.22.4. Extension Header 2: GTI

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
```

6.23. LS-003 LAT Livetime Cubes

Version: 1.4
Revision date: 8/01/09

6.23.1. Product Description

The livetime cube provides the LAT livetime at different positions on the sky in different inclination bins. An additional extension provides the livetime weighted livetime fraction (a measure of the trigger rate of the LAT) with the same binning. The additional extension is planned to be used for making exposure corrections for rate-induced ineffiencies. These files contain the livetimes and livetime-weighted livetime fractions accumulated over a processing run (covering one orbit).

Naming Convention	gll_lt_pyyy_rnnnnnnnnnn_vxxx.fit	yyy = processing version number nnnnnnnnnn = MET of beginning of run xxx = version number
Originator of Product	LISOC	
Product Format	FITS	
Production Latency Requirement	1 day	
Product contains data for	Processing run	
Number of deliveries per day	8	
Typical size	15 Mbyte	

Product Content
Primary HDU:

Extension 1	LAT exposure
Extension 2	Weighted exposure
Extension 3	Inclination angle grid
Extension 4	Good time intervals

6.23.2. 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
GPS_OUT =                          / whether GPS time was unavailable at
                                        any time during this interval
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_lt_pyyy_rnnnnnnnnnn_vxxx.fit' / name of this file:
                                    yyy = processing version matching PROC_VER
                                         nnnnnnnnnn = MET of beginning of run
                                         xxx = version number
ORIGIN  = 'LISOC'                  / name of organization making file
CREATOR =                          / software and version creating file
VERSION = 1                        / release version of the file
PROC_VER = XXX                     / Integer indicating the processing version
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
GPS_OUT = F                        / whether GPS time was unavailable
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_lt_r0253166000_v000.fit' / name of this file:
```

```
ORIGIN  = 'LISOC'                      / name of organization making file
CREATOR = 'gtltcube'                   / software and version creating file
VERSION = 1                            / release version of the file
PROC_VER = 123                         / processing version of the file
END
```

6.23.3. Extension Header 1: EXPOSURE

This extension provides the livetime accumulations on a healpix grid.

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 =                            3 / 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 = 'EXPOSURE'                   / name of this binary table extension
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?
PIXTYPE = 'HEALPIX '                   /
ORDERING= 'NESTED  '                   /
HIER_CRD= 'EQU     '                   /
NSIDE   =                              /
FIRSTPIX=                              /
LASTPIX =                              /
THETABIN= 'SQRT(1-COSTHETA)'           /
NBRBINS =                              /
COSMIN  =                           0. /
PHIBINS =                              / Number of phi bins
NDSKEYS =                            1 / # of data subspace keywords in
                                           header
DSTYP1  = 'TIME    '                   /
DSUNI1  = 's       '                   /
DSVAL1  = 'TABLE   '                   /
DSREF1  = ':GTI    '                   /
```

```
TTYPE1  = 'COSBINS'                    /
TFORM1  = '39E'                        / data format of field: 4-byte REAL
TUNIT1  = 's'                          / physical unit of field
TTYPE2  = 'RA'                         / RA of HEALPixel center
TFORM2  = 'E'
TUNIT2  = 'deg'
TLMIN2  = 0.0                          / minimum value
TLMAX2  = 360.0                        / maximum value
TTYPE3  = 'DEC'                        / DEC of HEALPixel center
TFORM3  = 'E'
TUNIT3  = 'deg'
TLMIN3  = -90.0                        / minimum value
TLMAX3  = 90.0                         / 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 =                            3 / 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?
PIXTYPE = 'HEALPIX '                   /
ORDERING= 'NESTED  '                   /
HIER_CRD= 'EQU     '                   /
NSIDE   =                           64 /
FIRSTPIX=                            0 /
LASTPIX =                        49151 /
THETABIN= 'SQRT(1-COSTHETA)'           /
NBRBINS =                           39 /
COSMIN  =                           0. /
NDSKEYS =                            1 /
DSTYP1  = 'TIME    '                   /
```

```
DSUNI1  = 's       '               /
DSVAL1  = 'TABLE   '               /
DSREF1  = ':GTI    '               /
TTYPE1  = 'COSBINS'                /
TFORM1  = '39E'                    / data format of field: 4-byte REAL
TUNIT1  = 's'                      / physical unit of field
TTYPE2  = 'RA'                     / RA of HEALPixel center
TFORM2  = 'E'
TUNIT2  = 'deg'
TLMIN2  = 0.0                      / minimum value
TLMAX2  = 360.0                    / maximum value
TTYPE3  = 'DEC'                    / DEC of HEALPixel center
TFORM3  = 'E'
TUNIT3  = 'deg'
TLMIN3  = -90.0                    / minimum value
TLMAX3  = 90.0                     / maximum value
END
```

6.23.4. Extension Header 2: WEIGHTED_EXPOSURE

This extension provides the livetime accumulations on a healpix grid.

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 =                    3 / number of fields in each row
TTYPE1  = 'COSBINS '           / label for field
TFORM1  = '39E     '           / data format of field: 4-byte REAL
TTYPE2  = 'RA      '           / RA of HEALPixel center
TFORM2  = 'E       '           / format of field
TTYPE3  = 'DEC     '           / DEC of HEALPixel center
TFORM3  = 'E       '           / format of field
CHECKSUM=                      / HDU checksum updated 2009-07-23T23:12:16
DATASUM =                      / data unit checksum updated 2009-07-23T23:12:16
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instr. generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5 or FK4)
DATE    =                      / file creation date (UTC)
DATE-OBS=                      / start date/time of the obs. (UTC)
DATE-END=                      / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'    / LAT PI
ORIGIN  = 'LISOC   '           / name of organization making file
EXTNAME = 'WEIGHTED_EXPOSURE'  / name of this binary table extension
TSTART  =                      / mission time of the obs. start
TSTOP   =                      / mission time of the obs. end
MJDREFI =               51910. / 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. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / clock drift correction applied?
GPS_OUT =                    F / GPS time unavailable at any time during
interva
PIXTYPE = 'HEALPIX '           / Indicates this is a HEALPix representation
ORDERING= 'NESTED  '           / Can be NESTED or RING
COORDSYS= 'EQU     '
NSIDE   =                      / Number of pixels per side per dodecahedron
face
FIRSTPIX=                      / First pixel index
LASTPIX =                      / Last pixel index
THETABIN= 'SQRT(1-COSTHETA)'   / Costheta binning scheme
NBRBINS =                      / Number of costheta bins
COSMIN  =                   0. / Minimum costheta value
PHIBINS =                      / Number of phi bins
TUNIT1  = 's       '           / physical unit of field
TUNIT2  = 'deg     '
TLMIN2  =                   0. / minimum value
TLMAX2  =                 360. / maximum value
TUNIT3  = 'deg     '
TLMIN3  =                 -90. / minimum value
```

```
TLMAX3  =                  90. / maximum value
EXTVER  =                    1 / auto assigned by template parser
NDSKEYS =                    1
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
END
```

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  164 / width of table in bytes
NAXIS2  =                49152 / 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
TTYPE1  = 'COSBINS '           / label for field
TFORM1  = '39E     '           / data format of field: 4-byte REAL
TTYPE2  = 'RA      '           / RA of HEALPixel center
TFORM2  = 'E       '           / format of field
TTYPE3  = 'DEC     '           / DEC of HEALPixel center
TFORM3  = 'E       '           / format of field
CHECKSUM= 'Z6lVi4kSZ4kSf4kS'   / HDU checksum updated 2009-07-23T23:12:16
DATASUM = '2330558218'         / data unit checksum updated 2009-07-23T23:12:16
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instr. generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5 or FK4)
DATE    = '2009-07-23T23:12:16.0000' / file creation date (UTC)
DATE-OBS= '2008-08-06T03:45:25.9819' / start date/time of the obs. (UTC)
DATE-END= '2008-08-06T05:19:58.0904' / end date/time of the obs. (UTC)
OBSERVER= 'Peter Michelson'    / LAT PI
ORIGIN  = 'LISOC   '           / name of organization making file
EXTNAME = 'WEIGHTED_EXPOSURE'  / name of this binary table extension
TSTART  =     239687126.981927 / mission time of the obs. start
TSTOP   =     239692799.090442 / mission time of the obs. end
MJDREFI =               51910. / 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. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / clock drift correction applied?
GPS_OUT =                    F / GPS time unavailable at any time during
interva
PIXTYPE = 'HEALPIX '           / Indicates this is a HEALPix representation
ORDERING= 'NESTED  '           / Can be NESTED or RING
COORDSYS= 'EQU     '
NSIDE   =                   64 / Number of pixels per side per dodecahedron
face
FIRSTPIX=                    0 / First pixel index
LASTPIX =                49151 / Last pixel index
THETABIN= 'SQRT(1-COSTHETA)'   / Costheta binning scheme
NBRBINS =                   39 / Number of costheta bins
COSMIN  =                   0. / Minimum costheta value
PHIBINS =                    0 / Number of phi bins
TUNIT1  = 's       '           / physical unit of field
TUNIT2  = 'deg     '
```

```
TLMIN2  =                   0. / minimum value
TLMAX2  =                 360. / maximum value
TUNIT3  = 'deg     '
TLMIN3  =                 -90. / minimum value
TLMAX3  =                  90. / maximum value
EXTVER  =                    1 / auto assigned by template parser
NDSKEYS =                    1
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
END
```

6.23.5. Extension Header 3: *CTHETABOUNDS*

This extension provides the instrument inclination grid.

Definition

```
XTENSION = 'BINTABLE'           / Binary table extension
BITPIX   =                    8 / Bits per pixel
NAXIS    =                    2 / Required value
NAXIS1   =                    0 / Number of bytes per row
NAXIS2   =                    0 / Number of rows
PCOUNT   =                    0 / Normally 0 (no varying arrays)
GCOUNT   =                    1 / Required value
TFIELDS  =                    2 / Number of columns in table
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 = 'CTHETABOUNDS'        / Extension name
HDUCLASS= 'OGIP'                / Format confirms to OGIP standard
#HDUCLAS1=                      / Extension contains ??
#HDUCLAS2=                      / Extension contains ??
HDUVERS =                 0.0.0 / Version number of the format
TTYPE1  = 'CTHETA_MIN'          / Lower boundary of the COSTHETA bin
TFORM1  = 'E'                   / Data format of this field
TLMIN1  = -1.0                  / minimum value
TLMAX1  = 1.0                   / maximum value
TTYPE2  = 'CTHETA_MAX'          / Upper boundary of the COSTHETA bin
TFORM2  = 'E'                   / Data format of this field
TLMIN2  = -1.0                  / minimum value
TLMAX2  = 1.0                   / maximum value
END
```

Example

```
XTENSION = 'BINTABLE'           / Binary table extension
BITPIX   =                    8 / Bits per pixel
NAXIS    =                    2 / Required value
NAXIS1   =                    0 / Number of bytes per row
NAXIS2   =                    0 / Number of rows
PCOUNT   =                    0 / Normally 0 (no varying arrays)
GCOUNT   =                    1 / Required value
TFIELDS  =                    2 / Number of columns in table
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 (
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 = 'CTHETABOUNDS'        / Extension name
HDUCLASS= 'OGIP'                / Format confirms to OGIP standard
#HDUCLAS1=                      / Extension contains ??
#HDUCLAS2=                      / Extension contains ??
HDUVERS =                 0.0.0 / Version number of the format
TTYPE1  = 'CTHETA_MIN'          / Lower boundary of the COSTHETA bin
TFORM1  = 'E'                   / Data format of this field
TLMIN1  = -1.0                  / minimum value
TLMAX1  = 1.0                   / maximum value
TTYPE2  = 'CTHETA_MAX'          / Upper boundary of the COSTHETA bin
TFORM2  = 'E'                   / Data format of this field
TLMIN2  = -1.0                  / minimum value
TLMAX2  = 1.0                   / maximum value
END
```

6.23.6. Extension Header 4: GTI

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
```

6.24. LS-005 Pointing and Livetime History

Version: 3.10
Revision date: 10/16/12

6.24.1. 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 in a LAT processing run covering one orbit.

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_pyyy_rnnnnnnnnnn_vxxx.fit	yyy = processing version number nnnnnnnnnn = MET of beginning of run xxx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	12 hours	
Product contains data for	Processing run	
Number of deliveries per day	15	
Typical size	~100 kbyte (per 12 hours)	

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

6.24.2. 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
TIMESYS	'TT'	Time system used
TIMEUNIT	's'	Units for TSTART and TSTOP keywords
GPS_OUT		Whether GPS time was unavailable during this time interval
MJDREFI	51910.	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
FILENAME	'gll_pt_pyyy_rnnnnnnnnnn_vxxx.fit'	Name of this file yyy = processing version matching PROC_VER value nnnnnnnnnn = MET of beginning of run xxx = 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
PROC_VER	###	Integer indicating the processing version
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
TIMESYS	'TT'	Time system used
TIMEUNIT	's'	Units for TSTART and TSTOP keywords
GPS_OUT	F	Whether GPS time was unavailable
MJDREFI	51910.	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
FILENAME	'gll_pt_r0253166000_v000.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
PROC_VER	123	processing version of the file

END

6.24.3. Extension Header 1: SC_DATA

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	30	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	'SC_DATA'	Name of the extension
EXTVER	1	Version of extension
TSTART	###	Mission [UTC] date of start of observation
TSTOP	###	Mission [UTC] 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
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	'GEOMAG_LAT'	Invariant geomagnetic latitude
TFORM11	'1E '	4-byte REAL
TUNIT11	'deg'	
TLMIN11	0.0	Minimum value
TLMAX11	90.	Maximum value
TTYPE12	'LAMBDA'	Effective geomagnetic latitude
TFORM12	'1E '	4-byte REAL
TUNIT12	'deg'	
TLMIN12	-90.	Minimum value
TLMAX12	90.	Maximum value
TTYPE13	'IN_SAA'	Whether S/C was in SAA
TFORM13	'1L '	Logical
TTYPE14	'RA_SCZ'	viewing direction at START (RA of S/C +z axis)
TFORM14	'1E '	4-byte REAL
TUNIT14	'deg'	
TLMIN14	0.0	Minimum value
TLMAX14	360.0	Maximum value
TTYPE15	'DEC_SCZ'	viewing direction at START (Dec of S/C +z axis)
TFORM15	'1E '	4-byte REAL
TUNIT15	'deg'	
TLMIN15	-90.0	Minimum value
TLMAX15	90.0	Maximum value
TTYPE16	'RA_SCX'	viewing direction at START (RA of S/C +x axis)
TFORM16	'1E '	4-byte REAL
TUNIT16	'deg'	
TLMIN16	0.0	Minimum value
TLMAX16	360.0	Maximum value
TTYPE17	'DEC_SCX'	viewing direction at START (Dec of S/C +x axis)
TFORM17	'1E '	4-byte REAL
TUNIT17	'deg'	
TLMIN17	-90.0	Minimum value
TLMAX17	90.0	Maximum value
TTYPE18	'RA_NPOLE'	RA of north orbital pole at START
TFORM18	'E'	data format of field: 4-byte REAL
TUNIT18	'deg'	physical unit of field: dimensionless
TLMIN18	0.0	Minimum value
TLMAX18	360.0	Maximum value
TTYPE19	'DEC_NPOLE'	Dec of north orbital pole at START
TFORM19	'E'	data format of field: 4-byte REAL
TUNIT19	'deg'	physical unit of field: dimensionless
TLMIN19	-90.0	Minimum value
TLMAX19	90.0	Maximum value
TTYPE20	'ROCK_ANGLE'	angle z axis from zenith (+=north)
TFORM20	'E'	data format of field: 4-byte REAL
TUNIT20	'deg'	physical unit of field: dimensionless
TLMIN20	-180.0	Minimum value
TLMAX20	180.0	Maximum value

TTYPE21	'LAT_MODE'	spacecraft GNC mode. The 3 nominal modes are 3(inertial point), 4 (Maneuver) and 5 (zenithpoint/survey). Other modes include 1 and 2 (capture and sunpoint – probably means that we are in safe hold) and 6 and 7 (reentry modes...)
TFORM21	'1J '	4-byte signed INTEGER
TTYPE22	'LAT_CONFIG'	flag for config. of LAT (1=nominal sci. config)
TFORM22	'B'	data format of field: byte
TTYPE23	'DATA_QUAL'	1 = ok, 2 = waiting review, 3 = good with bad parts, 0 = bad; -1 to -n for solar flares & particle events; +2 to +n for bright GRBs excluded from the catalog analysis
TFORM23	'I'	data format of field: 2-byte signed INTEGER
TTYPE24	'LIVETIME'	Livetime
TFORM24	'1D '	8-byte DOUBLE
TUNIT24	's'	
TTYPE25	'QSJ_1'	First component of SC attitude quaternion
TFORM25	'1D '	8-byte DOUBLE
TTYPE26	'QSJ_2'	Second component of SC attitude quaternion
TFORM26	'1D '	8-byte DOUBLE
TTYPE27	'QSJ_3'	Third component of SC attitude quaternion
TFORM27	'1D '	8-byte DOUBLE
TTYPE28	'QSJ_4'	Fourth component of SC attitude quaternion
TFORM28	'1D '	8-byte DOUBLE
TTYPE29	'RA_SUN'	RA of Sun
TFORM29	'E'	4-byte REAL
TUNIT29	'deg'	physical unit of field: degrees
TLMIN29	0.0	minimum value
TLMAX29	360.0	maximum value
TTYPE30	'DEC_SUN'	Dec of Sun
TFORM30	'E'	4-byte REAL
TUNIT30	'deg'	physical unit of field: degrees
TLMIN30	-90.0	minimum value
TLMAX30	90.0	maximum value
TTYPE31	'SC_VELOCITY'	S/C velocity at START of interval
TFORM31	'3E'	4-byte REAL
TUNIT31	'm/s'	physical unit of field

Example

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

```
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                  139 / width of table in bytes
NAXIS2  =                   18 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   30 / number of fields in each row
TTYPE1  = 'START   '           / STARTing time of interval (Mission
Elapsed Time
TFORM1  = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE2  = 'STOP    '           / ending time of interval (Mission
Elapsed Time)
TFORM2  = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE3  = 'SC_POSITION'        / S/C position at START of interval
(x,y,z inerti
TFORM3  = '3E      '           / data format of field: 4-byte REAL
TTYPE4  = 'LAT_GEO '           / ground point latitude
TFORM4  = 'E       '           / data format of field: 4-byte REAL
TTYPE5  = 'LON_GEO '           / ground point longitude
TFORM5  = 'E       '           / data format of field: 4-byte REAL
TTYPE6  = 'RAD_GEO '           / S/C altitude
TFORM6  = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE7  = 'RA_ZENITH'          / RA of zenith direction at START
TFORM7  = 'E       '           / data format of field: 8-byte DOUBLE
TTYPE8  = 'DEC_ZENITH'         / Dec of zenith direction at START
TFORM8  = 'E       '           / data format of field: 4-byte REAL
TTYPE9  = 'B_MCILWAIN'         / McIlwain B parameter, magnetic field
TFORM9  = 'E       '           / data format of field: 4-byte REAL
TTYPE10 = 'L_MCILWAIN'         / McIlwain L parameter, distance
TFORM10 = 'E       '           / data format of field: 4-byte REAL
TTYPE11 = 'GEOMAG_LAT'         / invariant geomagnetic latitude
TFORM11 = 'E       '           / 4-byte real
TTYPE12 = 'GEOMAG_LAT'         / effective geomagnetic latitude (signed
to indicate N/S hemisphere)
TFORM12 = 'E       '           / 4-byte real
TTYPE13 = 'IN_SAA  '           / whether spacecraft was in SAA
TFORM13 = 'L       '           / data format of field: logical
TTYPE14 = 'RA_SCZ  '           / viewing direction at START (RA of S/C
+z axis)
TFORM14 = 'E       '           / data format of field: 4-byte REAL
TTYPE15 = 'DEC_SCZ '           / viewing direction at START (Dec of S/C
+z axis)
TFORM15 = 'E       '           / data format of field: 4-byte REAL
TTYPE16 = 'RA_SCX  '           / viewing direction at START (RA of S/C
+x axis)
TFORM16 = 'E       '           / data format of field: 4-byte REAL
TTYPE17 = 'DEC_SCX '           / viewing direction at START (Dec of S/C
+x axis)
TFORM17 = 'E       '           / data format of field: 4-byte REAL
TTYPE18 = 'RA_NPOLE'           / RA of north orbital pole at START
TFORM18 = 'E       '           / data format of field: 4-byte REAL
TTYPE19 = 'DEC_NPOLE'          / Dec of north orbital pole at START
TFORM19 = 'E       '           / data format of field: 4-byte REAL
TTYPE20 = 'ROCK_ANGLE'         / angle z axis from zenith (+=north) at
START
TFORM20 = 'E       '           / data format of field: 4-byte REAL
TTYPE21 = 'LAT_MODE'           / attitude mode of LAT
TFORM21 = 'J       '           / data format of field: 4-byte signed
INTEGER
```

```
TTYPE22 = 'LAT_CONFIG'          / flag for config. of LAT (1=nominal
sci. config)
TFORM22 = 'B       '            / data format of field: byte
TTYPE23 = 'DATA_QUAL'           / flag for quality of data (1=nominal)
TFORM23 = 'I       '            / data format of field: 2-byte signed
INTEGER
TTYPE24 = 'LIVETIME'            / livetime
TFORM24 = 'D       '            / data format of field: 8-byte DOUBLE
TTYPE25 = 'QSJ_1   '            / First component of SC attitude
quaternion
TFORM25 = 'D       '            / 8-byte DOUBLE
TTYPE26 = 'QSJ_2   '            / Second component of SC attitude
quaternion
TFORM26 = 'D       '            / 8-byte DOUBLE
TTYPE27 = 'QSJ_3   '            / Third component of SC attitude
quaternion
TFORM27 = 'D       '            / 8-byte DOUBLE
TTYPE28 = 'QSJ_4   '            / Fourth component of SC attitude
quaternion
TFORM28 = 'D       '            / 8-byte DOUBLE
TTYPE29 = 'RA_SUN'              / RA of Sun
TFORM29 = 'E'                   / 4-byte REAL
TTYPE30 = 'DEC_SUN'             / DEC of Sun
TFORM30 = 'E'                   / 4-byte REAL
CHECKSUM= 'ZhmSafkPUfkPZfkP'    / HDU checksum updated 2009-04-
15T23:03:41
DATASUM = '3609553176'          / data unit checksum updated 2009-04-
15T23:03:41
TELESCOP= 'GLAST   '            / name of telescope generating data
INSTRUME= 'LAT     '            / name of instrument generating data
EQUINOX =                 2000. / equinox for ra and dec
RADECSYS= 'FK5     '            / world coord. system for this file (FK5
or FK4)
DATE    = '2009-04-15T23:03:38.9999' / file creation date (YYYY-MM-
DDThh:mm:ss U
DATE-OBS= '2009-01-27T13:14:32.9233' / START date and time of the
observation (U
DATE-END= '2009-01-27T13:23:23.3474' / end date and time of the
observation (UTC
OBSERVER= 'Peter Michelson'     / GLAST/LAT PI
ORIGIN  = 'LISOC   '            / name of organization making file
EXTNAME = 'SC_DATA '            / name of this binary table extension
TSTART  =     254754874.923318 / mission time of the START of the
observation
TSTOP   =     254755405.347419 / mission time of the end of the
observation
MJDREFI =                51910. / Integer part of MJD corresponding to
SC clock S
MJDREFF = '7.428703703703703D-4' / Fractional part of MJD corresponding
to SC cl
TIMEUNIT= 's       '            / units for the time related keywords
TIMEZERO=                    0. / clock correction
TIMESYS = 'TT      '            / type of time system that is used
TIMEREF = 'LOCAL   '            / reference frame used for times
TASSIGN = 'SATELLITE'           / location where time assignment
performed
CLOCKAPP=                     F / whether a clock drift correction has
been appli
```

```
GPS_OUT =                    F / whether GPS time was unavailable at
any time du
TUNIT1  = 's       '           / physical unit of field
TLMIN1  =                   0. / minimum value
TLMAX1  = '1.0D+10 '           / maximum value
TUNIT2  = 's       '           / physical unit of field
TLMIN2  =                   0. / minimum value
TLMAX2  = '1.0D+10 '           / maximum value
TUNIT3  = 'm       '           / physical unit of field
TUNIT4  = 'deg     '           / physical unit of field
TLMIN4  =                 -90. / minimum value
TLMAX4  =                  90. / maximum value
TUNIT5  = 'deg     '           / physical unit of field
TLMIN5  =                   0. / minimum value
TLMAX5  =                 360. / maximum value
TUNIT6  = 'm       '           / physical unit of field
TLMIN6  =                   0. / minimum value
TLMAX6  =               10000. / maximum value
TUNIT7  = 'deg     '           / physical unit of field: dimensionless
TLMIN7  =                   0. / minimum value
TLMAX7  =                 360. / maximum value
TUNIT8  = 'deg     '           / physical unit of field: dimensionless
TLMIN8  =                 -90. / minimum value
TLMAX8  =                  90. / maximum value
TUNIT9  = 'Gauss   '           / physical unit of field
TLMIN9  =                   0. / minimum value
TLMAX9  =                 100. / maximum value
TUNIT10 = 'Earth_Radii'        / physical unit of field
TLMIN10 =                   0. / minimum value
TLMAX10 =                 100. / maximum value
TLMIN11 =                   0. / minimum value
TLMAX11 =                  90. / maximum value
TUNIT11 = 'deg     '           / physical unit
TLMIN12 =                 -90. / minimum value
TLMAX12 =                  90. / maximum value
TUNIT12 = 'deg     '           / physical unit
TUNIT14 = 'deg     '           / physical unit of field: dimensionless
TLMIN14 =                   0. / minimum value
TLMAX14 =                 360. / maximum value
TUNIT15 = 'deg     '           / physical unit of field: dimensionless
TLMIN15 =                 -90. / minimum value
TLMAX15 =                  90. / maximum value
TUNIT16 = 'deg     '           / physical unit of field: dimensionless
TLMIN16 =                   0. / minimum value
TLMAX16 =                 360. / maximum value
TUNIT17 = 'deg     '           / physical unit of field: dimensionless
TLMIN17 =                 -90. / minimum value
TLMAX17 =                  90. / maximum value
TUNIT18 = 'deg     '           / physical unit of field: dimensionless
TLMIN18 =                   0. / minimum value
TLMAX18 =                 360. / maximum value
TUNIT19 = 'deg     '           / physical unit of field: dimensionless
TLMIN19 =                 -90. / minimum value
TLMAX19 =                  90. / maximum value
TUNIT20 = 'deg     '           / physical unit of field: dimensionless
TLMIN20 =                -180. / minimum value
TLMAX20 =                 180. / maximum value
TUNIT24 = 's       '           / physical unit of field
```

```
TUNIT29 = 'deg'                   / physical unit of field: degrees TLMIN29
= 0.0                  / minimum value
TLMAX29 = 360.0                   / maximum value
TUNIT30 = 'deg'                   / physical unit of field: degrees TLMIN30
= -90.0                / minimum value
TLMAX30 = 90.0                    / maximum value
EXTVER  =                       1 / auto assigned by template parser
TTYPE31 = 'SC_VELOCITY'           / S/C velocity at START of interval
TFORM31 = '3E      '              / data format of field: 4-byte REAL
TUNIT31 = 'm/s     '              / physical unit of field
END
```

6.25. LS-006 ASP Source Fluxes

Version: 1.0
Revision date: 8/21/08

6.25.1. Product Description

This file contains the ASP-calculated fluxes for transients and sources which the LAT team is monitoring for the community.

Naming Convention	gll_asp_mmmmmmmmmm_vxx.fit	mmmmmmmmmm = MET of last update xx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	TBD	
Product contains data for	I	
Number of deliveries per day	N/A	
Typical size	~10 Mbyte	

Product Content	
Primary HDU:	
Extension 1	Lightcurves

6.25.2. 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
DATASUM =                           /
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    = 'YYYY-MM-DDThh:mm:ss'     / file creation date (UTC)
TIMEUNIT= 's'                       / units for the time related keywords
TIMESYS = 'TT'                      / type of time system that is used
GPS_OUT = F                         / whether GPS time was unavailable
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_asp_mmmmmmmmmm_vxx.fit' / name of this file:
                                        mmmmmmmmmm = MET of last update
                                        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= 'ndgdnadbnadbnadb'   / HDU checksum updated 2008-05-23T20:06:18
DATASUM = '         0'         / data unit checksum updated 2008-05-23T20:06:18
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    = '2008-05-23T20:06:13' / file creation date (UTC)
TIMEUNIT= 's       '           / units for the time related keywords
TIMESYS = 'TT      '           / type of time system that is used
GPS_OUT =                    F / whether GPS time was unavailable
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_asp_0212121212_v00.fit' / name of this file:
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = 'ASP/drpMonitoring v1r3p1' / software and version creating file
VERSION =                    1 / release version of the file
END
```

6.25.3. Extension 1: Lightcurves

Definition

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
CHECKSUM= '                '   / HDU checksum
DATASUM = '          '         / data unit checksum
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                      / length of dimension 1
NAXIS2  =                      / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                   16 / number of table fields
EXTNAME = 'LIGHTCURVES'        / Extension name
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    = 'YYYY-MM-DDThh:mm:ss' / file creation date (UTC)
TIMEUNIT= 's       '           / units for the time related keywords
TIMESYS = 'TT      '           / type of time system that is used
GPS_OUT =                    F / whether GPS time was unavailable
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 name
FILENAME= 'gll_asp_mmmmmmmmmm_vxx.fit' / name of this file:
                                          mmmmmmmmmm = MET of last
update
                                          xx = version number
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = '                  ' / software and version creating file
VERSION =                      / release version of the file

TTYPE1  = 'START   '           / start time of interval in MET
TFORM1  = 'D       '
TUNIT1  = 's       '           / Unit of time

TTYPE2  = 'STOP    '           / stop time of interval in MET
TFORM2  = 'D       '
TUNIT2  = 's       '           / Unit of time

TTYPE3  = 'NAME    '           / LAT source name
TFORM3  = '30A     '
TTYPE4  = 'RA      '           / RA of LAT source
TFORM4  = 'E       '
TUNIT4  = 'deg     '           / Unit of RIGHT ASCENSION

TTYPE5  = 'DEC     '           / Dec of LAT source
TFORM5  = 'E       '
TUNIT5  = 'deg     '           / Unit of DECLINATION

TTYPE6  = 'FLUX_1000_300000'   / Flux, 1-300 Gev
TFORM6  = 'E       '
```

```
TUNIT6  = 'photon/cm**2/s'

TTYPE7  = 'ERROR_1000_300000'  / 1-sigma error on flux
TFORM7  = 'E       '
TUNIT7  = 'photon/cm**2/s'

TTYPE8  = 'UL_1000_300000'     / Flag to indicate flux value is a 90%
CL UL
TFORM8  = 'L       '

TTYPE9  = 'FLUX_300_1000'      / Flux, 300-1000 MeV
TFORM9  = 'E       '
TUNIT9  = 'photon/cm**2/s'

TTYPE10 = 'ERROR_300_1000'     / 1-sigma error on flux
TFORM10 = 'E       '
TUNIT10 = 'photon/cm**2/s'

TTYPE11 = 'UL_300_1000'        / Flag to indicate flux value is a 90%
CL UL
TFORM11 = 'L       '

TTYPE12 = 'FLUX_100_300000'    / Flux, 100-300000 MeV
TFORM12 = 'E       '
TUNIT12 = 'photon/cm**2/s'

TTYPE13 = 'ERROR_100_300000'   / 1-sigma error on flux
TFORM13 = 'E       '
TUNIT13 = 'photon/cm**2/s'

TTYPE14 = 'UL_100_300000'      / Flag to indicate flux value is a 90%
CL UL
TFORM14 = 'L       '

TTYPE15 = 'DURATION'           / time interval duration: stop - start
TFORM15 = 'E       '
TUNIT15 = 's       '           / Unit of duration

TTYPE16 = 'TEST_STATISTIC'     / Test statistic for 100-300000 MeV
measurement
TFORM16 = 'E       '
END
```

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
CHECKSUM= 'MS0ZNR0WMR0WMR0W'   / HDU checksum
DATASUM = '3575959325'         / data unit checksum
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                   79 / length of dimension 1
NAXIS2  =                   37 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                   16 / number of table fields
EXTNAME = ‘LIGHTCURVES’        / Extension name
```

```
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    = '2008-05-23T20:06:18' / file creation date (UTC)
TIMEUNIT= 's       '           / units for the time related keywords
TIMESYS = 'TT      '           / type of time system that is used
GPS_OUT =                    F / whether GPS time was unavailable
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 name
FILENAME= 'gll_asp_0212121212_v00.fit' / name of this file:
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = 'ASP/drpMonitoring v1r4p4' / software and version creating
file
VERSION =                    1 / release version of the file
TTYPE1  = 'START   '           / start time of interval in MET
TFORM1  = 'D       '
TUNIT1  = 's       '           / Unit of time
TTYPE2  = 'STOP    '           / stop time of interval in MET
TFORM2  = 'D       '
TUNIT2  = 's       '           / Unit of time
TTYPE3  = 'NAME    '           / LAT source name
TFORM3  = '30A     '
TTYPE4  = 'RA      '           / RA of LAT source
TFORM4  = 'E       '
TUNIT4  = 'deg     '           / Unit of RIGHT ASCENSION
TTYPE5  = 'DEC     '           / Dec of LAT source
TFORM5  = 'E       '
TUNIT5  = 'deg     '           / Unit of DECLINATION
TTYPE6  = 'FLUX_1000_300000'   / Flux, 1-300 Gev
TFORM6  = 'E       '
TUNIT6  = 'photon/cm**2/s'
TTYPE7  = 'ERROR_1000_300000'  / 1-sigma error on flux
TFORM7  = 'E       '
TUNIT7  = 'photon/cm**2/s'
TTYPE8  = 'UL_1000_300000'     / Flag to indicate flux value is a 90%
CL UL
TFORM8  = 'L       '
TTYPE9  = 'FLUX_300_1000'      / Flux, 300-1000 MeV
TFORM9  = 'E       '
TUNIT9  = 'photon/cm**2/s'
TTYPE10 = 'ERROR_300_1000'     / 1-sigma error on flux
TFORM10 = 'E       '
TUNIT10 = 'photon/cm**2/s'
TTYPE11 = 'UL_300_1000'        / Flag to indicate flux value is a 90%
CL UL
TFORM11 = 'L       '
TTYPE12 = 'FLUX_100_300000'    / Flux, 100-300000 MeV
TFORM12 = 'E       '
TUNIT12 = 'photon/cm**2/s'
TTYPE13 = 'ERROR_100_300000'   / 1-sigma error on flux
TFORM13 = 'E       '
TUNIT13 = 'photon/cm**2/s'
TTYPE14 = 'UL_100_300000'      / Flag to indicate flux value is a 90%
CL UL
TFORM14 = 'L       '
```

```
TTYPE15 = 'DURATION'            / time interval duration: stop - start
TFORM15 = 'E       '
TUNIT15 = 's       '            / Unit of duration
TTYPE16 = 'TEST_STATISTIC'      / Test statistic for 100-300000 MeV
measurement
TFORM16 = 'E       '
END
```

6.26. LS-008 Source Catalog

Revision date: 02/01/10

6.26.1. 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	FSSC	
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	LAT_Point_Source_Catalog
Extension 2	Hist_Start
Extension 3	GTI

6.26.2. 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
TELESCOP	Fermi or GLAST	Name of mission / spacecraft
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	MET value	Mission time of the observation start
TSTOP	MET value	Mission time of the observation end
TIMEUNIT	s	Units for TSTART and TSTOP keywords
TIMESYS	TT	Time system used
MJDREFI	51910.0	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
OBSERVER	Peter Michelson	Instrument PI
FILENAME	gll_psc_vxx.fit	Name of this file
ORIGIN	LISOC	Name of organization making file
CREATOR	string	Software and version creating file
VERSION	string	Release version of the file
CHECKSUM	Computed value	Checksum for entire HDU
DATASUM	0	Checksum for data table
END		

Example

```
SIMPLE  =                    T / Written by IDL:  Thu Jan 14 15:32:40 2010
BITPIX  =                    8 / array data type
NAXIS   =                    0 / number of array dimensions
EXTEND  =                    T
TELESCOP= 'Fermi   '           / 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    = '2009-11-24T12:49:12' / file creation date (UTC)
DATE-OBS= '2008-08-04T15:43:36.4939' / start date/time of the obs. (UTC)
DATE-END= '2009-07-04T16:01:17.0999' / end date/time of the obs. (UTC)
TSTART  =        239557417.494 / mission time of the obs. start
TSTOP   =          268416079.1 / 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_psc_v01.fit'    / name of this file
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = 'PointSourceCat'     / software and version creating file
VERSION = 'v01     '           / release version of the file
CHECKSUM= '7pGXAnEU0nEU7nEU'   / HDU checksum updated 2010-01-14T14:32:41
DATASUM = '         0'         / data unit checksum updated 2009-11-24T11:49:
END
```

6.26.3. Extension 1: LAT_Point_Source_Catalog

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	Extension type
BITPIX	8	Bits used per pixel – depends on production operating systemdata type
NAXIS	2	Number of axes
NAXIS1	integer	Number of bytes per row
NAXIS2	integer	Number of rows in the table
PCOUNT	0	Number of group parameters
GCOUNT	1	Number of groups
HDUCLAS1	SRCLIST	OGIP standard class
TELESCOP	Fermi or GLAST	Name of mission / spacecraft
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	MET value	Mission time of the observation start
TSTOP	MET value	Mission time of the observation end
TIMEUNIT	s	Units for TSTART and TSTOP keywords
TIMESYS	TT	Time system used
MJDREFI	51910.0	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
OBSERVER	Peter Michelson	Instrument PI
ORIGIN	LISOC	Name of organization making file
CREATOR	String	Software and version creating file
VERSION	String	Release version of the file
EXTNAME	LAT_Point_Source_Catalog	Name of this binary table extension
HDUDOC	GLAST Project Science Data products format document	Document describeing the format/classification used
HDUCLASS	OGIP	Format conforms to OGIP standard
HDUVERS	X.X.X	Version of the format
CDS-NAME	#FGL	Catalog Name
STVERS	String	ScienceTools version
PIPVERS	String	Pipeline code version
RUNNAME	String	Name of Run
TSMIN	Integer	Test Statistic Treshold
EMIN	Number	Low limit for the energy band (MeV)
EMAX	Number	High limit for the energy band (MeV)
SYSABS	Number	Absolute systematic error for flux
ERRUPLIM	Number	Relative error above which the errors are computed
TSUPLIM	10.0	Test statistic below which the errors are computed

		from upper limits.
ERPOSABS	0.000000	Systematic position error radius
ERPOSFAC	1.10000	Security factor on position error
CHECKSUM	Computed value	Checksum for entire HDU
DATASUM	Computed value	Checksum for data table
ERFLUVAR	Number	Relative systematic error for flux variability
TFIELDS	59	Number of fields per row
TTYPE1	Source_Name	Source Designation
TFORM1	18A	
TBUCD1	meta.id;meta.main	UCD for Source_Name
TTYPE2	RA	Right Ascension
TFORM2	E	
TUNIT2	deg	
TDISP2	F8.4	
TBUCD2	pos.eq.ra;meta.main	UCD for RA
TLMIN2	0.000000	Minimum value for RA
TLMAX2	360.000	Maximum value for RA
TTYPE3	DEC	Declination
TFORM3	E	
TUNIT3	deg	
TDISP3	F8.4	
TBUCD3	pos.eq.dec;meta.main	UCD for DEC
TLMIN3	-90.0000	Minimum value for DEC
TLMAX3	90.0000	Maximum value for DEC
TTYPE4	GLON	Galactic Longitude
TFORM4	E	
TUNIT4	deg	
TDISP4	F8.4	
TBUCD4	pos.galactic.lon	UCD for GLON
TLMIN4	0.000000	Minimum value for GLON
TLMAX4	360.000	Maximum value for GLON
TTYPE5	GLAT	Galactic Latitude
TFORM5	E	
TUNIT5	deg	
TDISP5	F8.4	
TBUCD5	pos.galactic.lat	UCD for GLAT
TLMIN5	-90.0000	Minimum value for GLAT
TLMAX5	90.0000	Maximum value for GLAT
TTYPE6	Conf_68_SemiMajor	Semi-Major Axis of Error Ellipse at 68% Confidence (degrees)
TFORM6	E	
TUNIT6	deg	
TDISP6	F8.4	
TBUCD6	pos;stat.error	
TLMIN6	0.000000	
TTYPE7	Conf_68_SemiMinor	Semi-Minor Axis of Error Ellipse at 68% Confidence (degrees)
TFORM7	E	
TUNIT7	deg	
TDISP7	F8.4	
TBUCD7	pos;stat.error	
TLMIN7	0.000000	
TTYPE8	Conf_68_PosAng	Position Angle of the 68% Semi-Major Axis, East of North (degrees)

TFORM8	E	
TUNIT8	deg	
TDISP8	F8.3	
TTYPE9	Conf_95_SemiMajor	Semi-Major Axis of Error Ellipse at 95% Confidence (degrees)
TFORM9	E	
TUNIT9	deg	
TDISP9	F8.4	
TBUCD9	pos;stat.error	UCD for Conf_95_SemiMajor
TLMIN9	0.000000	Minimum value for Conf_95_SemiMajor
TTYPE10	Conf_95_SemiMinor	Semi-Minor Axis of Error Ellipse at 95% Confidence (degrees)
TFORM10	E	
TUNIT10	deg	
TDISP10	F8.4	
TBUCD10	pos;stat.error	UCD for Conf_95_SemiMinor
TLMIN10	0.000000	Minimum value for Conf_95_SemiMinor
TTYPE11	Conf_95_PosAng	Position Angle of the 95% Semi-Major Axis, East of North (degrees)
TFORM11	E	
TUNIT11	deg	
TDISP11	F8.3	
TTYPE12	Signif_Avg	Source Detection Significance in Gaussian Sigma Units
TFORM12	E	
TDISP12	F8.3	
TLMIN12	0.000000	Minimum value for Signif_Avg
TTYPE13	Pivot_Energy	Source Detection Significance in Gaussian Sigma Units
TFORM13	E	
TUNIT13	MeV	
TDISP13	F10.2	
TBUCD13	em.energy	UCD for Pivot_Energy
TLMIN13	0.000000	Minimum value for Pivot_Energy
TTYPE14	Flux_Density	Differential Flux at Pivot Energy
TFORM14	E	
TUNIT14	photon/cm**2/MeV/s	
TDISP14	E10.4	
TBUCD14	phot.flux.density	UCD for Flux_Density
TLMIN14	0.000000	Minimum value for Flux_Density
TTYPE15	Unc_Flux_Density	1-Sigma Uncertainty on Differential Flux at Pivot Energy
TFORM15	E	
TUNIT15	photon/cm**2/MeV/s	
TDISP15	E10.4	
TBUCD15	phot.flux.density;stat.error	UCD for Unc_Flux_Density
TLMIN15	0.000000	Minimum value for Unc_Flux_Density
TTYPE16	Spectral_Index	Best Fit for the Photon Number Power-Law Index
TFORM16	E	
TDISP16	F8.4	
TBUCD16	spect.index	UCD for Spectral_Index
TLMIN16	0.000000	Minimum value for Spectral_Index
TLMAX16	5.00000	Maximum value for Spectral_Index
TTYPE17	Unc_Spectral_Index	1-Sigma Uncertainty in Photon Spectral Index

TFORM17	E	
TDISP17	F8.4	
TBUCD17	spect.index;stat.error	UCD for Unc_Spectral_Index
TLMIN17	0.000000	Minimum value for Unc_Spectral_Index
TTYPE18	Flux1000	Flux 1 to 100 GeV
TFORM18	E	
TUNIT18	photon/cm**2/s	
TDISP18	E10.4	
TBUCD18	phot.count;em.gamma	
TLMIN18	0.000000	
TTYPE19	Unc_Flux1000	1-Sigma Uncertainty in Flux 1 to 100 GeV
TFORM19	E	
TUNIT19	photon/cm**2/s	
TBUCD19	phot.count;em.gamma;stat.error	
TLMIN19	0.000000	
TTYPE20	Energy_Flux	Energy Flux from 100 MeV to 100 GeV
TFORM20	E	
TUNIT20	erg/cm**2/s	
TDISP20	E10.4	
TBUCD20	phot.flux	UCD for Energy_Flux
TLMIN20	0.000000	Minimum value for Energy_Flux
TTYPE21	Unc_Energy_Flux	1-Sigma Error in Energy Flux from 100 MeV to 100 GeV
TFORM21	E	
TUNIT21	erg/cm**2/s	
TDISP21	E10.4	
TBUCD21	phot.flux;stat.error	UCD for Unc_Energy_Flux
TLMIN21	0.000000	Minimum value for Unc_Energy_Flux
TTYPE22	Curvature_Index	Measure of Compatibility with Power Law
TFORM22	E	
TTYPE23	Flux30_100	Flux 30 to 100 MeV
TFORM23	E	
TUNIT23	photon/cm**2/s	
TBUCD23	phot.count;em.gamma	
TTYPE24	Unc_Flux30_100	Flux 30 to 100 MeV Uncertainty
TFORM24	E	
TUNIT24	photon/cm**2/s	
TBUCD24	phot.count;em.gamma;stat.error	
TTYPE25	Sqrt_TS30_100	Square Root of Likelihood Test Statistic for the 30-100MeV Flux
TFORM25	E	
TDISP25	F8.3	
TLMIN25	0.000000	
TTYPE26	Flux100_300	Flux 100 to 300 MeV
TFORM26	E	
TUNIT26	photon/cm**2/s	
TBUCD26	phot.count;em.gamma	UCD for Flux100_300
TTYPE27	Unc_Flux100_300	Flux 100 to 300 MeV Uncertainty
TFORM27	E	
TUNIT27	photon/cm**2/s	
TBUCD27	phot.count;em.gamma;stat.error	UCD for Unc_Flux100_300
TTYPE28	Sqrt_TS100_300	Square Root of Likelihood Test Statistic for Flux 100 to 300 MeV
TFORM28	E	

TDISP28	F8.3	
TLMIN28	0.000000	
TTYPE29	Flux300_1000	Flux 0.3 to 1 GeV
TFORM29	E	
TUNIT29	photon/cm**2/s	
TBUCD29	phot.count;em.gamma	UCD for Flux300_1000
TTYPE30	Unc_Flux300_1000	Flux 0.3 to 1 GeV Uncertainty
TFORM30	E	
TUNIT30	photon/cm**2/s	
TBUCD30	phot.count;em.gamma;stat.error	UCD for Unc_Flux300_1000
TTYPE31	Sqrt_TS300_1000	Square Root of Likelihood Test Statistic for Flux 0.3 to 1 GeV
TFORM31	E	
TDISP31	F8.3	
TLMIN31	0.000000	
TTYPE32	Flux1000_3000	Flux 1 to 3 GeV
TFORM32	E	
TUNIT32	photon/cm**2/s	
TBUCD32	phot.count;em.gamma	UCD for Flux1000_3000
TTYPE33	Unc_Flux1000_3000	Flux 1 to 3 GeV Uncertainty
TFORM33	E	
TUNIT33	photon/cm**2/s	
TBUCD33	phot.count;em.gamma;stat.error	UCD for Unc_Flux1000_3000
TTYPE34	Sqrt_TS1000_3000	Square Root of Likelihood Test Statistic for Flux 1 to 3 GeV
TFORM34	E	
TDISP34	F8.3	
TLMIN34	0.000000	
TTYPE35	Flux3000_10000	Flux 3 to 10 GeV
TFORM35	E	
TUNIT35	photon/cm**2/s	
TBUCD35	phot.count;em.gamma	UCD for Flux3000_10000
TTYPE36	Unc_Flux3000_10000	Flux 3 to 10 GeV Uncertainty
TFORM36	E	
TUNIT36	photon/cm**2/s	
TBUCD36	phot.count;em.gamma;stat.error	UCD for Unc_Flux3000_10000
TTYPE37	Sqrt_TS3000_10000	Square Root of Likelihood Test Statistic for Flux 3 to 10 GeV
TFORM37	E	
TDISP37	F8.3	
TLMIN37	0.000000	
TTYPE38	Flux10000_100000	Flux 10 to 100 GeV
TFORM38	E	
TUNIT38	photon/cm**2/s	
TBUCD38	phot.count;em.gamma	UCD for Flux10000_100000
TTYPE39	Unc_Flux10000_100000	Flux 10 to 100 GeV Uncertainty
TFORM39	E	
TUNIT39	photon/cm**2/s	
TBUCD39	phot.count;em.gamma;stat.error	UCD for Unc_Flux10000_100000
TTYPE40	Sqrt_TS10000_100000	Square Root of Likelihood Test Statistic for Flux 10 to 100 GeV
TFORM40	E	
TDISP40	F8.3	
TLMIN40	0.000000	

TTYPE41	Variability_Index	Measure of the Source Variability
TFORM41	E	
TTYPE42	Signif_Peak	Source Significance in Peak Interval
TFORM42	E	
TTYPE43	Flux_Peak	Peak Integrated Flux from 100 MeV to 100 GeV
TFORM43	E	
TUNIT43	photon/cm**2/s	
TTYPE44	Unc_Flux_Peak	1-Sigma Uncertainty in Peak Flux
TFORM44	E	
TUNIT44	photon/cm**2/s	
TTYPE45	Time_Peak	Time of Center of Interval in Which Peak Flux Was Measured
TFORM45	D	
TUNIT45	s	
TTYPE46	Peak_Interval	Length of Interval in Which Peak Flux Was Measured
TFORM46	E	
TUNIT46	s	
TTYPE47	Flux_History	Array containing flux histories
TFORM47	11E	
TUNIT47	photon/cm**2/s	
TTYPE48	Unc_Flux_History	Array containing errors on flux history
TFORM48	11E	
TUNIT48	photon/cm**2/s	
TTYPE49	Unc_Flag_History	1 if it is half of the difference between the 2 sigma upper limit and the maximum-likelihood value given in Flux_History, 0 if it is the 1 sigma uncertainty derived from a significant detection in the interval
TFORM49	11B	
TTYPE50	0FGL_Name	Corresponding Source in Fermi Bright Source List (If Any)
TFORM50	18A	
TTYPE51	ASSOC_GAM1	Designation of the Likely Corresponding Source from 1AGL Catalog (If Any)
TFORM51	18A	
TTYPE52	ASSOC_GAM2	Designation of the Likely Corresponding Source from 3EG Catalog (If Any)
TFORM52	18A	
TTYPE53	ASSOC_GAM3	Designation of the Likely Corresponding Source from EGR Catalog (If Any)
TFORM53	18A	
TTYPE54	TEVCAT_FLAG	'P' if positional association with <40' source in TeVCat, 'E' if associated with a more extended source in TeVCat, N if no TeV association
TFORM54	A	
TTYPE55	CLASS1	Primary Classification of Source
TFORM55	3A	
TTYPE56	CLASS2	Secondary Classification of Source
TFORM56	3A	
TTYPE57	ASSOC1	Identification or Positional Associations with Potential Counterparts
TFORM57	24A	
TTYPE58	ASSOC2	Identification or Positional Associations with

		Potential Counterparts
TFORM58	24A	
TTYPE59	Flags	Flags Indicate Possible Issues in Detection or Characterization of Source
TFORM59	I	
END		

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                  418 / length of dimension 1
NAXIS2  =                 1451 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                   57 / number of table fields
COMMENT
COMMENT  *** End of mandatory fields ***
COMMENT
COMMENT
COMMENT  *** Column names ***
COMMENT
TTYPE1  = 'Source_Name '       /
TTYPE50 = 'ASSOC_GAM1 '        /
TTYPE51 = 'ASSOC_GAM2 '        /
TTYPE52 = 'ASSOC_GAM3 '        /
TTYPE53 = 'CLASS1  '           /
TTYPE54 = 'CLASS2  '           /
TTYPE55 = 'ASSOC1  '           /
TTYPE56 = 'ASSOC2  '           /
COMMENT
COMMENT  *** Column formats ***
COMMENT
TFORM1  = '18A     '           /
TBUCD1  = 'meta.id;meta.main'  / UCD for Source_Name
TTYPE2  = 'RA      '           /
TFORM2  = 'E       '           /
TUNIT2  = 'deg     '           /
TDISP2  = 'F8.4    '           /
TBUCD2  = 'pos.eq.ra;meta.main' / UCD for RA
TLMIN2  =             0.000000 / Minimum value for RA
TLMAX2  =              360.000 / Maximum value for RA
TTYPE3  = 'DEC     '           /
TFORM3  = 'E       '           /
TUNIT3  = 'deg     '           /
TDISP3  = 'F8.4    '           /
TBUCD3  = 'pos.eq.dec;meta.main' / UCD for DEC
TLMIN3  =             -90.0000 / Minimum value for DEC
TLMAX3  =              90.0000 / Maximum value for DEC
TTYPE4  = 'GLON    '           /
TFORM4  = 'E       '           /
TUNIT4  = 'deg     '           /
TDISP4  = 'F8.4    '           /
TBUCD4  = 'pos.galactic.lon'   / UCD for GLON
```

```
TLMIN4  =             0.000000 / Minimum value for GLON
TLMAX4  =              360.000 / Maximum value for GLON
TTYPE5  = 'GLAT    '           /
TFORM5  = 'E       '           /
TUNIT5  = 'deg     '           /
TDISP5  = 'F8.4    '           /
TBUCD5  = 'pos.galactic.lat'   / UCD for GLAT
TLMIN5  =             -90.0000 / Minimum value for GLAT
TLMAX5  =              90.0000 / Maximum value for GLAT
TTYPE6  = 'Conf_68_SemiMajor ' /
TFORM6  = 'E       '           /
TUNIT6  = 'deg     '           /
TDISP6  = 'F8.4    '           /
TBUCD6  = 'pos;stat.error'     /
TLMIN6  =             0.000000 /
TTYPE7  = 'Conf_68_SemiMinor ' /
TFORM7  = 'E       '           /
TUNIT7  = 'deg     '           /
TDISP7  = 'F8.4    '           /
TBUCD7  = 'pos;stat.error'     /
TLMIN7  =             0.000000 /
TTYPE8  = 'Conf_68_PosAng '    /
TFORM8  = 'E       '           /
TUNIT8  = 'deg     '           /
TDISP8  = 'F8.3    '           /
TTYPE9  = 'Conf_95_SemiMajor ' /
TFORM9  = 'E       '           /
TUNIT9  = 'deg     '           /
TDISP9  = 'F8.4    '           /
TBUCD9  = 'pos;stat.error'     / UCD for Conf_95_SemiMajor
TLMIN9  =             0.000000 / Minimum value for Conf_95_SemiMajor
TTYPE10 = 'Conf_95_SemiMinor ' /
TFORM10 = 'E       '           /
TUNIT10 = 'deg     '           /
TDISP10 = 'F8.4    '           /
TBUCD10 = 'pos;stat.error'     / UCD for Conf_95_SemiMinor
TLMIN10 =             0.000000 / Minimum value for Conf_95_SemiMinor
TTYPE11 = 'Conf_95_PosAng '    /
TFORM11 = 'E       '           /
TUNIT11 = 'deg     '           /
TDISP11 = 'F8.3    '           /
TTYPE12 = 'Signif_Avg '        /
TFORM12 = 'E       '           /
TDISP12 = 'F8.3    '           /
TLMIN12 =             0.000000 / Minimum value for Signif_Avg
TTYPE13 = 'Pivot_Energy '      /
TFORM13 = 'E       '           /
TUNIT13 = 'MeV     '           /
TDISP13 = 'F10.2   '           /
TBUCD13 = 'em.energy'          / UCD for Pivot_Energy
TLMIN13 =             0.000000 / Minimum value for Pivot_Energy
TTYPE14 = 'Flux_Density '      /
TFORM14 = 'E       '           /
TUNIT14 = 'photon/cm**2/MeV/s' /
TDISP14 = 'E10.4   '           /
TBUCD14 = 'phot.flux.density'  / UCD for Flux_Density
TLMIN14 =             0.000000 / Minimum value for Flux_Density
```

```
TTYPE15 = 'Unc_Flux_Density '  /
TFORM15 = 'E       '           /
TUNIT15 = 'photon/cm**2/MeV/s' /
TDISP15 = 'E10.4   '           /
TBUCD15 = 'phot.flux.density;stat.error' / UCD for Unc_Flux_Density
TLMIN15 =              0.000000 / Minimum value for Unc_Flux_Density
TTYPE16 = 'Spectral_Index '    /
TFORM16 = 'E       '           /
TDISP16 = 'F8.4    '           /
TBUCD16 = 'spect.index'        / UCD for Spectral_Index
TLMIN16 =              0.000000 / Minimum value for Spectral_Index
TLMAX16 =               5.00000 / Maximum value for Spectral_Index
TTYPE17 = 'Unc_Spectral_Index ' /
TFORM17 = 'E       '           /
TDISP17 = 'F8.4    '           /
TBUCD17 = 'spect.index;stat.error' / UCD for Unc_Spectral_Index
TLMIN17 =              0.000000 / Minimum value for Unc_Spectral_Index
TTYPE18 = 'Flux1000 '          /
TFORM18 = 'E       '           /
TUNIT18 = 'photon/cm**2/s'     /
TDISP18 = 'E10.4   '           /
TBUCD18 = 'phot.count;em.gamma' /
TLMIN18 =              0.000000 /
TTYPE19 = 'Unc_Flux1000 '      /
TFORM19 = 'E       '           /
TUNIT19 = 'photon/cm**2/s'     /
TBUCD19 = 'phot.count;em.gamma;stat.error' /
TLMIN19 =              0.000000 /
TTYPE20 = 'Energy_Flux '       /
TFORM20 = 'E       '           /
TUNIT20 = 'erg/cm**2/s'        /s'        /
TDISP20 = 'E10.4   '           /
TBUCD20 = 'phot.flux'          / UCD for Energy_Flux
TLMIN20 =              0.000000 / Minimum value for Energy_Flux
TTYPE21 = 'Unc_Energy_Flux '   /
TFORM21 = 'E       '           /
TUNIT21 = 'erg/cm**2/s'        /s'        /
TDISP21 = 'E10.4   '           /
TBUCD21 = 'phot.flux;stat.error' / UCD for Unc_Energy_Flux
TLMIN21 =              0.000000 / Minimum value for Unc_Energy_Flux
TTYPE22 = 'Curvature_Index '   /
TFORM22 = 'E       '           /
TTYPE23 = 'Flux30_100 '        /
TFORM23 = 'E       '           /
TUNIT23 = 'photon/cm**2/s'     /
TBUCD23 = 'phot.count;em.gamma' /
TTYPE24 = 'Unc_Flux30_100 '    /
TFORM24 = 'E       '           /
TUNIT24 = 'photon/cm**2/s'     /
TBUCD24 = 'phot.count;em.gamma;stat.error' /
TTYPE25 = 'Sqrt_TS30_100 '     /
TFORM25 = 'E       '           /
TDISP25 = 'F8.3    '           /
TLMIN25 =              0.000000 /
TTYPE26 = 'Flux100_300 '       /
TFORM26 = 'E       '           /
TUNIT26 = 'photon/cm**2/s'     /
```

```
TBUCD26 = 'phot.count;em.gamma' / UCD for Flux100_300
TTYPE27 = 'Unc_Flux100_300 '   /
TFORM27 = 'E       '           /
TUNIT27 = 'photon/cm**2/s'     /
TBUCD27 = 'phot.count;em.gamma;stat.error' / UCD for Unc_Flux100_300
TTYPE28 = 'Sqrt_TS100_300 '    /
TFORM28 = 'E       '           /
TDISP28 = 'F8.3    '           /
TLMIN28 =             0.000000 /
TTYPE29 = 'Flux300_1000 '      /
TFORM29 = 'E       '           /
TUNIT29 = 'photon/cm**2/s'     /
TBUCD29 = 'phot.count;em.gamma' / UCD for Flux300_1000
TTYPE30 = 'Unc_Flux300_1000 '  /
TFORM30 = 'E       '           /
TUNIT30 = 'photon/cm**2/s'     /
TBUCD30 = 'phot.count;em.gamma;stat.error' / UCD for Unc_Flux300_1000
TTYPE31 = 'Sqrt_TS300_1000 '   /
TFORM31 = 'E       '           /
TDISP31 = 'F8.3    '           /
TLMIN31 =             0.000000 /
TTYPE32 = 'Flux1000_3000 '     /
TFORM32 = 'E       '           /
TUNIT32 = 'photon/cm**2/s'     /
TBUCD32 = 'phot.count;em.gamma' / UCD for Flux1000_3000
TTYPE33 = 'Unc_Flux1000_3000 ' /
TFORM33 = 'E       '           /
TUNIT33 = 'photon/cm**2/s'     /
TBUCD33 = 'phot.count;em.gamma;stat.error' / UCD for Unc_Flux1000_3000
TTYPE34 = 'Sqrt_TS1000_3000 '  /
TFORM34 = 'E       '           /
TDISP34 = 'F8.3    '           /
TLMIN34 =             0.000000 /
TTYPE35 = 'Flux3000_10000 '    /
TFORM35 = 'E       '           /
TUNIT35 = 'photon/cm**2/s'     /
TBUCD35 = 'phot.count;em.gamma' / UCD for Flux3000_10000
TTYPE36 = 'Unc_Flux3000_10000 ' /
TFORM36 = 'E       '           /
TUNIT36 = 'photon/cm**2/s'     /
TBUCD36 = 'phot.count;em.gamma;stat.error' / UCD for Unc_Flux3000_10000
TTYPE37 = 'Sqrt_TS3000_10000 ' /
TFORM37 = 'E       '           /
TDISP37 = 'F8.3    '           /
TLMIN37 =             0.000000 /
TTYPE38 = 'Flux10000_100000 '  /
TFORM38 = 'E       '           /
TUNIT38 = 'photon/cm**2/s'     /
TBUCD38 = 'phot.count;em.gamma' / UCD for Flux10000_100000
TTYPE39 = 'Unc_Flux10000_100000 ' /
TFORM39 = 'E       '           /
TUNIT39 = 'photon/cm**2/s'     /
TBUCD39 = 'phot.count;em.gamma;stat.error' / UCD for
Unc_Flux10000_100000
TTYPE40 = 'Sqrt_TS10000_100000 ' /
TFORM40 = 'E       '           /
TDISP40 = 'F8.3    '           /
```

```
TLMIN40 =             0.000000 /
TTYPE41 = 'Variability_Index ' /
TFORM41 = 'E       '           /
TTYPE42 = 'Signif_Peak '       /
TFORM42 = 'E       '           /
TTYPE43 = 'Flux_Peak '         /
TFORM43 = 'E       '           /
TUNIT43 = 'photon/cm**2/s'     /
TTYPE44 = 'Unc_Flux_Peak '     /
TFORM44 = 'E       '           /
TUNIT44 = 'photon/cm**2/s'     /
TTYPE45 = 'Time_Peak '         /
TFORM45 = 'D       '           /
TUNIT45 = 's       '           /
TTYPE46 = 'Peak_Interval '     /
TFORM46 = 'E       '           /
TUNIT46 = 's       '           /
TTYPE47 = 'Flux_History '      /
TFORM47 = '11E     '           /
TUNIT47 = 'photon/cm**2/s'     /
TTYPE48 = 'Unc_Flux_History '  /
TFORM48 = '11E     '           /
TUNIT48 = 'photon/cm**2/s'     /
TTYPE49 = '0FGL_Name '         /
TFORM49 = '18A     '           /
TTYPE57 = 'Flags   '           /
TFORM57 = 'I       '           /
HDUCLAS1= 'SRCLIST '           / an OGIP standard class
TELESCOP= 'Fermi   '           / 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    = '2009-11-28T17:45:00' / file creation date (UTC)
DATE-OBS= '2008-08-04T15:43:36.4939' / start date/time of the obs.
(UTC)
DATE-END= '2009-07-04T16:01:17.0999' / end date/time of the obs. (UTC)
TSTART  =        239557417.494 / mission time of the obs. start
TSTOP   =          268416079.1 / 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
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = 'PointSourceCat'     / software and version creating file
VERSION = 'v01     '           / release version of the file
EXTNAME = 'LAT_Point_Source_Catalog' / name of this binary table
extension
HDUDOC  = 'GLAST Project Science Data products format document' /
Document descr
HDUCLASS= 'OGIP    '           / format conforms to OGIP standard
HDUVERS = '1.0.0   '           / version of the format
CDS-NAME= '1FGL    '           / Catalog Name
STVERS  = 'ScienceTools-v9r15p5opt' / ScienceTools version
PIPVERS = 'Gpipeline-v2r11p9T5' / Pipeline code version
RUNNAME = '11months_v4'        / Name of Run
```

```
TSMIN   =                   25 / Test Statistic Treshold
EMIN    =                  100 / low limit for the energy band (MeV)
EMAX    =             100000.0 / high limit for the energy band (MeV)
SYSABS  =                  0.0 / Absolute systematic error for flux
ERRUPLIM=                  0.5 / Relative error above which the errors
are compu
TSUPLIM =                 10.0 / Ts below which the errors are computed
from Upp
ERPOSABS=             0.000000 / Systematic position error radius
ERPOSFAC=              1.10000 / Security factor on position error
CHECKSUM= 'h1AHk11Hh18Hh18H'   / HDU checksum updated 2010-01-
14T14:34:12
DATASUM = '541967547'          / data unit checksum updated 2010-01-
14T14:34:12
ERFLUVAR=                 0.03 / Relative systematic error for flux
variability
TFORM50 = '18A     '           /
TFORM51 = '18A     '           /
TFORM52 = '18A     '           /
TFORM53 = '3A      '           /
TFORM54 = '3A      '           /
TFORM55 = '24A     '           /
TFORM56 = '24A     '           /
HISTORY File modified by user 'Jbb' with fv  on 2009-12-06T08:38:36
COMMENT
END
```

6.26.4. Extension 2: Hist_Start

This extension provides the time intervals of the flux histories given in extension 1. It contains a single column called Hist_Start of type (n+1)D in s containing the starting point of all (consecutive) intervals. The last entry is the end of the last interval. The reference time (at which t=0) is given (in modified Julian days) by the MJDREFI and MJDREFF keywords.

Definition

FITS Keyword	Value—Required or Standard	Definition
XTENSION	BINTABLE	Extension type
BITPIX	8	Bits used per pixel – depends on production operating systemdata type
NAXIS	2	Number of axes
NAXIS1	integer	Number of bytes per row
NAXIS2	integer	Number of rows in the table
PCOUNT	0	Number of group parameters
GCOUNT	1	Number of groups
TFIELDS	1	Number of fields per row
TELESCOP	Fermi or GLAST	Name of mission / spacecraft
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	MET value	Mission time of the observation start
TSTOP	MET value	Mission time of the observation end
TIMEUNIT	s	Units for TSTART and TSTOP keywords
TIMESYS	TT	Time system used
MJDREFI	51910.0	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
OBSERVER	Peter Michelson	Instrument PI
ORIGIN	LISOC	Name of organization making file
CREATOR	String	Software and version creating file
VERSION	String	Release version of the file
EXTNAME	Hist_Start	Name of this binary table extension
CHECKSUM	Computed value	Checksum for entire HDU
DATASUM	Computed value	Checksum for data table
TTYPE1	Hist_Start	
TFORM1	D	
TUNIT1	s	
END		

Example

6.26.5. Extension 3: GTI

Definition

FITS Keyword	Value—Required or Standard	Definition
XTENSION	BINTABLE	Extension type
BITPIX	8	Bits used per pixel – depends on production operating systemdata type
NAXIS	2	Number of axes
NAXIS1	integer	Number of bytes per row
NAXIS2	integer	Number of rows in the table
PCOUNT	0	Number of group parameters
GCOUNT	1	Number of groups
TFIELDS	2	Number of fields per row
TELESCOP	Fermi or GLAST	Name of mission / spacecraft
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	MET value	Mission time of the observation start
TSTOP	MET value	Mission time of the observation end
TIMEUNIT	s	Units for TSTART and TSTOP keywords
TIMESYS	TT	Time system used
TIMEZERO	0.	Clock correction
CLOCKAPP	F	Whether a clock drift correction has been applied
GPS_OUT	F	Whether GPS time was unavailable at any time during this interval
MJDREFI	51910.0	Integer part of the MJD of the SC clock
MJDREFF	7.428703703703703D-4	Fractional part of the MJD of the SC clock
OBSERVER	Peter Michelson	Instrument PI
ORIGIN	LISOC	Name of organization making file
CREATOR	String	Software and version creating file
VERSION	String	Release version of the file
EXTNAME	GTI	Name of this binary table extension
CHECKSUM	Computed value	Checksum for entire HDU
DATASUM	Computed value	Checksum for data table
HDUCLASS	OGIP	Format conforms to OGIP
HDUCLAS1	GTI	Extension contains Good Time Intervals
HDUCLAS2	ALL	Extension contains all science time
EXTVER	Number	Auto assigned by template parser
ONTIME	Computed value	Sum of GTIs
TTYPE1	START	Start of GTI interval
TFORM1	D	Double Precision
TUNIT1	s	Seconds
TLMIN1	0	Minimum Allowed GTI Value
TLMAX1	1.0D+10	Maximum Allowed GTI Value
TTYPE2	STOP	Stop of GTI interval
TFORM2	D	Double Precision
TUNIT2	s	Seconds

TLMIN2	0	Minimum Allowed GTI Value
TLMAX2	1.0D+10	Maximum Allowed GTI Value

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   16 / width of table in bytes
NAXIS2  =                 5493 / 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
TFORM1  = 'D       '           / data format of field: 8-byte DOUBLE
TUNIT1  = 's       '           / physical unit of field
TTYPE2  = 'STOP    '           / label for field   2
TFORM2  = 'D       '           / data format of field: 8-byte DOUBLE
TUNIT2  = 's       '           / physical unit of field
EXTNAME = 'GTI     '           / name of this binary table extension
TIMEZERO=                   0. / clock correction
HDUCLASS= 'OGIP    '           / format conforms to OGIP/GSFC standards
HDUCLAS1= 'GTI     '           / Extension contains Good Time Intervals
HDUCLAS2= 'ALL     '
CHECKSUM= 'k9IPn9GPk9GPk9GP'   / HDU checksum updated 2010-01-
14T14:34:12
DATASUM = '4190726823'         / data unit checksum updated 2009-11-
29T12:10:45
TSTART  =        239557417.494
TSTOP   =          268416079.1
DATE-OBS= '2008-08-04T15:43:36.4939'
DATE-END= '2009-07-04T16:01:17.0999'
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5
or FK4)
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
ORIGIN  = 'LISOC   '           / name of organization making file
MJDREFI =               51910. / Integer part of MJD corresponding to
SC clock s
MJDREFF = '7.428703703703703D-4' / Fractional part of MJD corresponding
to SC cl
TIMEUNIT= 's       '           / units for the time related keywords
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at
any time du
TLMIN1  =                   0. / minimum value
TLMAX1  = '1.0D+10 '           / maximum value
TLMIN2  =                   0. / minimum value
TLMAX2  = '1.0D+10 '           / maximum value
EXTVER  =                    1 / auto assigned by template parser
ONTIME  =          23300655.64 / Sum of GTIs
END
```

6.27. LS-009 Burst Catalog

Version: 3.1
Revision date: 4/29/08

6.27.1. 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	FSSC	
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

6.27.2. 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'	[UTC] date of start of observation
DATE-END	'yyyy-mm-ddT hh:mm:ss.ssss'	[UTC] 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_v00.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'	[UTC] date of start of observation
DATE-END	'2008-01-04T14:22:53'	[UTC] date of end of observation
CREATOR	'catalogGRB.py'	Software and version creating file
VERSION	'v1'	Release version of this catalog
SOFTWARE	'ScienceTools v9r5'	Version of the analysis software
RESPONSE	'P5_v0_transient'	Version of the IRFs
END		End of Header

6.27.3. Extension Header 1: LAT_GRB_Catalog

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

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                      / length of dimension 1
NAXIS2  =                      / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                   24 / number of table fields
CHECKSUM=
DATASUM =
DATE    = 'yyyy-mm-dd'         / Date file was made in YYYY-MM-DD
EXTNAME = 'LAT_GRB_CATALOG'    / Extension name
TELESCOP= 'GLAST   '           / Name of the mission
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'MICHELSON'          / Instrument PI
DATE-OBS= ' yyyy-mm-dd hh:mm:ss.sss ' / [UTC] date of start of
observation
DATE-END= 'yyyy-mm-dd hh:mm:ss.sss' / [UTC] date of end of observation
CREATOR = ' '                  / Software creating file
VERSION = ' '                  / Software version
SOFTWARE= ' '                  / Version of the analysis software
RESPONSE= ' '                  / Version of the IRFs
TIMESYS = 'TT      '           / Time system used in time keywords
MJDREFI =                51910 / MJD date of ref. epoch, integer part
MJDREFF = 0.0007428703703703703 / MJD date of ref. epoch, fract. part
TIMEUNIT= 's       '           / Time unit in TSTART and TSTOP keywords
TSTART  =                      /  [UTC] date of start of observation
offset
TSTOP   =                      /  [UTC] date of end of observation
offset

TTYPE1  = 'GCN_NAME'           / GCN Universal name; YYMMDD.L with L
                                 a letter ( A,B,C...) This is fixed
                                 by the GCN naming convention.  Empty
                                 if no GCN
TFORM1  = '10A     '

TTYPE2  = 'GBM_GRB_ID'         / LAT GRB identifier; YYMMDD.FFF
                                 Universal GLAST naming (here the
                                 LAT alert time)
TFORM2  = '10A     '

TTYPE3  = 'LAT_GRB_ID'         / GBM Identifier; YYMMDD.FFF the GBM
                                 catalog entry number
TFORM3  = '10A     '
```

```
TTYPE4  = 'LAT_Alert_Time'     / LAT alert time, or time of 1st LAT
                                 photon associated to this burst; in
                                 UTC or MET
TFORM4  = 'D       '

TTYPE5  = 'Right_Ascension'    / (J2000)
TFORM5  = 'E       '
TUNIT5  = 'deg     '

TTYPE6  = 'Declination'      / (J2000)
TFORM6  = 'E       '
TUNIT6  = 'deg     '

TTYPE7  = 'Conf_90_Region'   / Radius of error circle (90% confidence)
TFORM7  = 'E       '
TUNIT7  = 'deg     '

TTYPE8  = 'First_Time'
TFORM8  = 'D       '
TUNIT8  = 's       '

TTYPE9  = 'Last_Time'
TFORM9  = 'D       '
TUNIT9  = 's       '

TTYPE10 = 'Hardness_Ratio'  / Hardness Ratio, count ratio
                              C(>1GeV)/C(<1 GeV)
TFORM10 = 'D       '

TTYPE11 = 'Times   '
TFORM11 = 'PJ()    '        / Variable length array
TUNIT11 = 's       '

TTYPE12 = 'Energies'
TFORM12 = 'PJ()    '        / Variable length array
TUNIT12 = 'MeV     '

TTYPE13 = 'GCAT_Flag'       / GCAT_Flags Prompt-Afterglow emission
TFORM13 = 'B       '

TTYPE14 = 'Peak_Flux_30MeV'   / Peak flux >30 MeV
TFORM14 = 'D       '
TUNIT14 = '1/cm**2/s'

TTYPE15 = 'UncPeak_Flux_30MeV'/ Peak flux >30 MeV uncertainty
TFORM15 = 'D       '
TUNIT15 = '1/cm**2/s'

TTYPE16 = 'TimePeak_Flux_30MeV'   / Peak flux >30 MeV Time (sec after
                                    MJDREF)
TFORM16 = 'D       '
TUNIT16 = 's       '

TTYPE17 = 'Fluence_30MeV'
TFORM17 = 'D       '
TUNIT17 = 'erg/cm**2'
```

```
TTYPE18 = 'ErrorFluence_30MeV'
TFORM18 = 'D       '
TUNIT18 = 'erg/cm**2'

TTYPE19 = 'Fluence_100MeV'
TFORM19 = 'D       '
TUNIT19 = 'erg/cm**2'

TTYPE20 = 'ErrorFluence_100MeV'
TFORM20 = 'D       '
TUNIT20 = 'erg/cm**2'

TTYPE21 = 'Fluence_1GeV'
TFORM21 = 'D       '
TUNIT21 = 'erg/cm**2'

TTYPE22 = 'ErrorFluence_1GeV'
TFORM22 = 'D       '
TUNIT22 = 'erg/cm**2'

TTYPE23 = 'Fluence_10GeV'
TFORM23 = 'D       '
TUNIT23 = 'erg/cm**2'

TTYPE24 = 'ErrorFluence_10GeV'
TFORM24 = 'D       '
TUNIT24 = 'erg/cm**2'

END
```

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                 1763 / length of dimension 1
NAXIS2  =                    3 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                   24 / number of table fields
CHECKSUM=
DATASUM =
DATE    = '2008-04-23'         / Date file was made in YYYY-MM-DD
EXTNAME = 'LAT_GRB_CATALOG'   / Extension name
TELESCOP= 'GLAST   '           / Name of the mission
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'MICHELSON'          / Instrument PI
DATE-OBS= '2009-01-01 00:00:00.000' / [UTC] date of start of
observation
DATE-END= '2009-12-31 23:59:59.999' / [UTC] date of end of observation
CREATOR = 'catalogGRB.py'      / Software creating file
VERSION = 'v1      '           / Software version
SOFTWARE= 'ScienceTools v9r5'  / Version of the analysis software
```

```
RESPONSE= 'P5_v0_transient'    / Version of the IRFs
TIMESYS = 'TT      '           / Time system used in time keywords
MJDREFI =                51910 / MJD date of ref. epoch, integer part
MJDREFF = 0.0007428703703703703 / MJD date of ref. epoch, fract. part
TIMEUNIT= 's       '           / Time unit in TSTART and TSTOP keywords
TSTART  =          252460800.0 /  [UTC] date of start of observation
offset
TSTOP   =          283996799.0 /  [UTC] date of end of observation
offset

TTYPE1  = 'GCN_NAME'           / GCN Universal name

TFORM1  = '10A     '

TTYPE2  = 'GBM_GRB_ID'         / LAT GRB identifier

TFORM2  = '10A     '

TTYPE3  = 'LAT_GRB_ID'         / GBM catalog entry number
TFORM3  = '10A     '

TTYPE4  = 'LAT_Alert_Time'     / LAT alert time, or 1st photon time
TFORM4  = 'D       '

TTYPE5  = 'Right_Ascension'    / (J2000)
TFORM5  = 'E       '
TUNIT5  = 'deg     '

TTYPE6  = 'Declination'      / (J2000)
TFORM6  = 'E       '
TUNIT6  = 'deg     '

TTYPE7  = 'Conf_90_Region'   / Radius of error circle (90% confidence)
TFORM7  = 'E       '
TUNIT7  = 'deg     '

TTYPE8  = 'First_Time'
TFORM8  = 'D       '
TUNIT8  = 's       '

TTYPE9  = 'Last_Time'
TFORM9  = 'D       '
TUNIT9  = 's       '

TTYPE10 = 'Hardness_Ratio'  / Hardness Ratio, C(>1GeV)/C(<1 GeV)
TFORM10 = 'D       '

TTYPE11 = 'Times   '
TFORM11 = 'PJ(30)  '
TUNIT11 = 's       '

TTYPE12 = 'Energies'
TFORM12 = 'PJ(30)  '
TUNIT12 = 'MeV     '

TTYPE13 = 'GCAT_Flag'       / GCAT_Flags Prompt-Afterglow emission
TFORM13 = 'B       '
```

```
TTYPE14 = 'Peak_Flux_30MeV'   / Peak flux >30 MeV
TFORM14 = 'D       '
TUNIT14 = '1/cm**2/s'

TTYPE15 = 'UncPeak_Flux_30MeV'/ Peak flux >30 MeV uncertainty
TFORM15 = 'D       '
TUNIT15 = '1/cm**2/s'

TTYPE16 = 'TimePeak_Flux_30MeV'   / Peak flux >30 MeV Time
TFORM16 = 'D       '
TUNIT16 = 's       '

TTYPE17 = 'Fluence_30MeV'
TFORM17 = 'D       '
TUNIT17 = 'erg/cm**2'

TTYPE18 = 'ErrorFluence_30MeV'
TFORM18 = 'D       '
TUNIT18 = 'erg/cm**2'

TTYPE19 = 'Fluence_100MeV'
TFORM19 = 'D       '
TUNIT19 = 'erg/cm**2'

TTYPE20 = 'ErrorFluence_100MeV'
TFORM20 = 'D       '
TUNIT20 = 'erg/cm**2'

TTYPE21 = 'Fluence_1GeV'
TFORM21 = 'D       '
TUNIT21 = 'erg/cm**2'

TTYPE22 = 'ErrorFluence_1GeV'
TFORM22 = 'D       '
TUNIT22 = 'erg/cm**2'

TTYPE23 = 'Fluence_10GeV'
TFORM23 = 'D       '
TUNIT23 = 'erg/cm**2'

TTYPE24 = 'ErrorFluence_10GeV'
TFORM24 = 'D       '
TUNIT24 = 'erg/cm**2'

END
```

6.28. LS-010 Interstellar Emission Model

Version: 3.0
Revision date: 1/16/08

6.28.1. Product Description

This file contains the LAT team's best model of the diffuse emission underlying the point and extended sources. As a MapCube file it has a data cube in the primary HDU and then an extension with a table listing the energy of each plane of the cube. 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	FSSC	
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:	Includes datacube with skymaps in different energy bands
Extension 1	Energies of the different map planes

6.28.2. Primary Header

Definition

FITS Keyword Value—Required or Standard Definition

```
SIMPLE  =                    T /
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    3 /
NAXIS1  =                      / length of data axis 1
NAXIS2  =                      / length of data axis 2
NAXIS3  =                      /
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=              / Checksum for entire HDU
DATASUM =              /
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
CRVAL1  =                      /
CRPIX1  =                      /
CTYPE1  = 'GLON-CAR'           /
CUNIT1  = 'deg     '           /
CDELT1  =                      /
CRVAL2  =                      /
CRPIX2  =                      /
CTYPE2  = 'GLAT-CAR'           /
CUNIT2  = 'deg     '           /
CDELT2  =                  0.5 / Increment of axis 2
CRVAL3  =                      /
CRPIX3  =                      /
CTYPE3  = 'photon energy'      /
CUNIT3  = 'log_MeV '           /
CDELT3  =                      / Increment of axis 3
END
```

Example

FITS Keyword Value Purpose

```
SIMPLE  =                    T /
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    3 /
NAXIS1  =                  720 / length of data axis 1
NAXIS2  =                  361 / length of data axis 2
NAXIS3  =                   17 /
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=              / Checksum for entire HDU
DATASUM =              /
DATE    = '2008-12-25' / Date file was made in YYYY-MM-DD
FILENAME= 'gll_iem_v04.fit' /File name
TELESCOP='GLAST'
INSTRUME= 'LAT'       /Name of instrument generating data
ORIGIN  = 'LISOC'     /Name of organization making file
OBSERVER= ‘MICHELSON’ / Instrument PI
CRVAL1  =              0.00000 /
CRPIX1  =              360.000 /
CTYPE1  = 'GLON-CAR'           /
CUNIT1  = 'deg     '           /
CDELT1  =            -0.500000 /
CRVAL2  =              0.00000 /
CRPIX2  =              181.000 /
CTYPE2  = 'GLAT-CAR'           /
CUNIT2  = 'deg     '           /
CDELT2  =                  0.5 / Increment of axis 2
CRVAL3  =        10.2400000000 /
CRPIX3  =              1.00000 /
CTYPE3  = 'photon energy'      /
CUNIT3  = 'log_MeV '           /
CDELT3  =    0.301029995663981 / Increment of axis 3
HISTORY From GALPROP 53_6002029RG run; l = 359.5 interpolated across
HISTORY Integrated flux (m-2 s-1) over all sky and energies:   17.61
HISTORY Written by combine_maps_new2.pro
END
```

6.28.3. Extension Header 1: ENERGIES

This extension provides the energies of the different skymap planes.

Definition

```
XTENSION= 'BINTABLE'           /
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)
DATASUM =                      /
CHECKSUM=                      /
DATE    = 'yyyy-mm-dd'         / Date file was made in YYYY-MM-DD
TELESCOP='GLAST'
INSTRUME= 'LAT'       /Name of instrument generating data
ORIGIN  = 'LISOC'     /Name of organization making file
OBSERVER= 'MICHELSON' / Instrument PI
TFIELDS =                    1 /number of fields in each row
EXTNAME = 'ENERGIES'           /name of this binary table extension
TTYPE1  = 'Energy  '           /label for field
TFORM1  = '1D      '           /format of field
END
```

Example

```
XTENSION= 'BINTABLE'           /
BITPIX  =                    8 /8-bit bytes
NAXIS   =                    2 /2-dimensional binary table
NAXIS1  =                    8 /width of table in bytes
NAXIS2  =                   17 /number of rows in table
PCOUNT  =                    0 /size of special data area
GCOUNT  =                    1 /one data group (required keyword)
DATASUM =                      /
CHECKSUM=                      /
DATE    = '2008-12-25'         / Date file was made in YYYY-MM-DD
TELESCOP='GLAST'
INSTRUME= 'LAT'       /Name of instrument generating data
ORIGIN  = 'LISOC'     /Name of organization making file
OBSERVER= 'MICHELSON' / Instrument PI
TFIELDS =                    1 /number of fields in each row
EXTNAME = 'ENERGIES'           /name of this binary table extension
TTYPE1  = 'Energy  '           /label for field
TFORM1  = '1D      '           /format of field
END
```

6.29. LS-011 LAT Energy Redistribution

Version: 2.3
Revision date: 4/29/08

6.29.1. Product Description

This FITS file contains the constants for the parameterization of the energy distribution function.

Naming Convention	gll_edisp_cwy_yymmdd_vxx.fit	w is the source class y is f or b (front or back) yymmdd is the date the file becomes relevant xx is the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
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 DISPERSION—Contains the constants for the parameterization of the energy redistribution function

6.29.2. 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_psf_cwy_yymmdd_vxx.fit’ / w is the source class
                                         y is f or b (front or back)
                                         yymmdd is the date the file
                                            becomes relevant
                                         xx is the version number
ORIGIN  = ‘LISOC’              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= ‘Michelson’          / Instrument PI
DETNAM  =

END
```

6.29.3. Extension Header 1: ENERGY DISPERSION

This extension contains the constants for the parameterization of the energy distribution function. The parameterization, and therefore the columns, may change with time.

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 DISPERSION'  / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
DETNAM  =

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

HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
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 '           /
CCLS0001= 'BCF     '           /
CDTP0001= 'DATA    '           /
CCNM0001= 'EDISP   '           /
CBD10001= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    '
CVSD0001= 'yyyy-mm-dd'         / Dataset validity start date (UTC)
CVST0001= 'hh:mm:ss'           /
```

```
CDES0001= 'GLAST LAT ENERGY DISPERSION'

End of CALDB keywords

EXTVER  =                      1 / auto assigned by template parser
TFIELDS =                     10 / number of fields in each row

TTYPE1  = 'ENERG_LO'           /
TFORM1  = '18E     '
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           /
TFORM2  = '18E     '
TUNIT2  = 'MeV     '           /

TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '8E      '
TUNIT3  = '        '

TTYPE4  = 'CTHETA_HI'          /
TFORM4  = '8E      '
TUNIT4  = '        '

TTYPE5  = 'DNORM   '           /
TFORM5  = '144E    '
TUNIT5  = '        '           /
TDIM5   = '(18, 8) '
1CTYP5  = 'ENERGY  '           / Always use log(ENERGY) for
interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /

TTYPE6  = 'LTAIL   '           /
TFORM6  = '144E    '
TUNIT6  = '        '           /
TDIM6   = '(18, 8) '

TTYPE7  = 'RWIDTH  '           /
TFORM7  = '144E    '
TUNIT7  = '        '           /
TDIM7   = '(18, 8) '

TTYPE8  = 'NR2     '           /
TFORM8  = '144E    '
TUNIT8  = '        '           /
TDIM8   = '(18, 8) '

TTYPE9  = 'LT2     '           /
TFORM9  = '144E    '
TUNIT9  = '        '           /
TDIM9   = '(18, 8) '

TTYPE10 = 'RT2     '           /
TFORM10 = '144E    '
TUNIT10 = '        '           /
TDIM10  = '(18, 8) '
```

```
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 DISPERSION'  / name of this binary table extension
ORIGIN  = ‘LISOC’              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= ‘Michelson’          / Instrument PI
DETNAM  = 'FRONT   '
HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'EDISP   '           /
HDUVERS = '1.0.0   '           /
EARVERSN= '1992a   '           / Identifies CALDB file standard
CSYSNAME= 'XMA_POL '           /
CCLS0001= 'BCF     '           /
CDTP0001= 'DATA    '           /
CCNM0001= 'EDISP   '           /
CBD10001= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    '
CVSD0001= '2007-01-17'         / Dataset validity start date (UTC)
CVST0001= '00:00:00'           /
CDES0001= 'GLAST LAT ENERGY DISPERSION'
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                   10 / number of fields in each row
TTYPE1  = 'ENERG_LO'           /
TFORM1  = '18E     '
TUNIT1  = 'MeV     '           /
TTYPE2  = 'ENERG_HI'           /
TFORM2  = '18E     '
TUNIT2  = 'MeV     '           /
TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '8E      '
TUNIT3  = '        '
TTYPE4  = 'CTHETA_HI'          /
```

```
TFORM4  = '8E      '
TUNIT4  = '        '
TTYPE5  = 'DNORM   '           /
TFORM5  = '144E    '
TUNIT5  = '        '           /
TDIM5   = '(18, 8) '
1CTYP5  = 'ENERGY  '           / Always use log(ENERGY) for
interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /
TTYPE6  = 'LTAIL   '           /
TFORM6  = '144E    '
TUNIT6  = '        '           /
TDIM6   = '(18, 8) '
TTYPE7  = 'RWIDTH  '           /
TFORM7  = '144E    '
TUNIT7  = '        '           /
TDIM7   = '(18, 8) '
TTYPE8  = 'NR2     '           /
TFORM8  = '144E    '
TUNIT8  = '        '           /
TDIM8   = '(18, 8) '
TTYPE9  = 'LT2     '           /
TFORM9  = '144E    '
TUNIT9  = '        '           /
TDIM9   = '(18, 8) '
TTYPE10 = 'RT2     '           /
TFORM10 = '144E    '
TUNIT10 = '        '           /
TDIM10  = '(18, 8) '

END
```

6.30. LS-012 LAT Effective Area

Version: 2.2
Revision date: 4/29/08

6.30.1. Product Description

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

Naming Convention	gll_earea_cwy_yymmdd_vxx.fit	w is the source class y is f or b (front or back) yymmdd is the date the file becomes relevant xx is the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
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

6.30.2. *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_cwy_yymmdd_vxx.fit’ / w is the source class
                                           y is f or b (front or back)
                                           yymmdd is the date the file
                                              becomes relevant
                                           xx is the version number

ORIGIN  = ‘LISOC’              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= ‘Michelson’          / Instrument PI
DETNAM  = '       '

END
```

6.30.3. Extension Header 1: EFFECTIVE AREA

This extension provides the effective area as a function of energy and inclination angle. Note that the columns will differ given the current parameterization.

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
DETNAM  = '       '

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= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    '
```

```
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
TFIELDS =                    5 / number of fields in each row

TTYPE1  = 'ENERG_LO'           /
TFORM1  = '60E     '
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           /
TFORM2  = '60E     '
TUNIT2  = 'MeV     '           /

TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '32E     '           /
TUNIT3  = '        '

TTYPE4  = 'CTHETA_HI'          /
TFORM4  = '32E     '           /
TUNIT4  = '        '

TTYPE5  = 'EFFAREA '           /
TFORM5  = '1920E   '
TUNIT5  = 'm**2    '           /
TDIM5   = '(60, 32)'
1CTYP5  = 'ENERGY  '           / Always use log(ENERGY) for
interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /

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
DETNAM  = 'FRONT   '
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= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    'CVSD0001= '2006-03-01'         / Start date of
validity (UTC)
CVST0001= '00:00:00'           / Start time (within date) of validity
CDES0001= 'GLAST LAT effective area' /
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    5 / number of fields in each row
TTYPE1  = 'ENERG_LO'           /
TFORM1  = '60E     '
TUNIT1  = 'MeV     '           /
TTYPE2  = 'ENERG_HI'           /
TFORM2  = '60E     '
TUNIT2  = 'MeV     '           /
TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '32E     '           /
TUNIT3  = '        '
TTYPE4  = 'CTHETA_HI'          /
TFORM4  = '32E     '           /
TUNIT4  = '        '
TTYPE5  = 'EFFAREA '           /
TFORM5  = '1920E   '
TUNIT5  = 'm2      '           /
TDIM5   = '(60, 32)'
1CTYP5  = 'ENERGY  '        / Always use log(ENERGY) for interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /

END
```

6.31. LS-013 LAT PSF

Version: 2.2
Revision date: 4/29/08

6.31.1. Product Description

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

Naming Convention	gll_psf_cwy_yymmdd_vxx.fit	w is the source class y is f or b (front or back) yymmdd is the date the file becomes relevant xx is the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
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

6.31.2. 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_cwy_yymmdd_vxx.fit’ / w is the source class
                                         y is f or b (front or back)
                                         yymmdd is the date the file
                                            becomes relevant
                                         xx is the version number
ORIGIN  = ‘LISOC’              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= ‘Michelson’          / Instrument PI
DETNAM  = 'FRONT   '
END
```

6.31.3. Extension Header 1: RPSF

Contains the constants for the parameterization of the point spread function (PSF) after energy scaling. The columns may change as the parameterization changes.

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 = 'RPSF    '           / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
DETNAM  =
The following HDU keywords identify the extension as following a
standard type

HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'RPSF    '           /
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= 'RPSF     '          / OGIP codename
CBD10001= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    '
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
TFIELDS =                    8 / number of fields in each row

TTYPE1  = 'ENERG_LO'           /
TFORM1  = '18E     '
TUNIT1  = 'MeV     '           /

TTYPE2  = 'ENERG_HI'           /
TFORM2  = '18E     '
TUNIT2  = 'MeV     '           /

TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '8E      '
TUNIT3  = '        '

TTYPE4  = 'CTHETA_HI'          /
TFORM4  = '8E      '
TUNIT4  = '        '

TTYPE5  = 'NCORE   '           /
TFORM5  = '144E    '
TUNIT5  = '        '           /
TDIM5   = '(18, 8) '
1CTYP5  = 'ENERGY  '        / Always use log(ENERGY) for interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /

TTYPE6  = 'SIGMA   '           /
TFORM6  = '144E    '
TUNIT6  = '        '           /
TDIM6   = '(18, 8) '

TTYPE7  = 'GCORE   '           /
TFORM7  = '144E    '
TUNIT7  = '        '           /
TDIM7   = '(18, 8) '

TTYPE8  = 'GTAIL   '           /
TFORM8  = '144E    '
TUNIT8  = '        '           /
TDIM8   = '(18, 8) '
END
```

Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                 2512 / 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 = 'RPSF    '      / name of this binary table extension
ORIGIN  = 'LISOC'              / Organization creating file
TELESCOP= 'GLAST   '           /
INSTRUME= 'LAT     '           /
OBSERVER= 'Michelson'          / Instrument PI
DETNAM  = 'FRONT   '
HDUCLASS= 'OGIP    '           /
HDUDOC  = 'CAL/GEN/92-019'     /
HDUCLAS1= 'RESPONSE'           /
HDUCLAS2= 'RPSF    '           /
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= 'RPSF     '          / OGIP codename
CBD10001= 'VERSION(PASS5_v0)'
CBD20001= 'CLASS(P5_Source_front)'
CBD30001= 'ENERG(18-560000)MeV'
CBD40001= 'CTHETA(0.2-1)'
CBD50001= 'PHI(0-360)deg'
CBD60001= 'NONE    '
CBD70001= 'NONE    '
CBD80001= 'NONE    '
CBD90001= 'NONE    '
CVSD0001= '2007-01-17'         / Dataset validity start date (UTC)
CVST0001= '00:00:00'           /
CDES0001= 'GLAST LAT point spread function' /
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    8 / number of fields in each row
TTYPE1  = 'ENERG_LO'           /
TFORM1  = '18E     '
TUNIT1  = 'MeV     '           /
TTYPE2  = 'ENERG_HI'           /
TFORM2  = '18E     '
TUNIT2  = 'MeV     '           /
TTYPE3  = 'CTHETA_LO'          /
TFORM3  = '8E      '
TUNIT3  = '        '
TTYPE4  = 'CTHETA_HI'          /
TFORM4  = '8E      '
TUNIT4  = '        '
TTYPE5  = 'NCORE   '           /
TFORM5  = '144E    '
TUNIT5  = '        '           /
TDIM5   = '(18, 8) '
1CTYP5  = 'ENERGY  '         / Always use log(ENERGY) for interpolation
2CTYP5  = 'COSTHETA'           / Off-axis angle cosine
CREF5   = '(ENERG_LO:ENERG_HI,CTHETA_LO:CTHETA_HI)' /
TTYPE6  = 'SIGMA   '           /
TFORM6  = '144E    '
TUNIT6  = '        '           /
```

```
TDIM6    = '(18, 8) '
TTYPE7   = 'GCORE   '           /
TFORM7   = '144E    '
TUNIT7   = '        '           /
TDIM7    = '(18, 8) '
TTYPE8   = 'GTAIL   '           /
TFORM8   = '144E    '
TUNIT8   = '        '           /
TDIM8    = '(18, 8) '
END
```

6.31.4. Extension Header 2: PSF_SCALING_PARAMS

Provides the parameters for the energy scaling. The parameterization may change from version to version.

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
DETNAM  =

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
EXTVER  =                    1 / auto assigned by template parser
TFIELDS =                    1 / number of fields in each row

TTYPE1  = 'PSFSCALE'           / PSF energy scaling parameters
TFORM1  = '5E      '           / format of field
TDIM1   = '        '
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
DETNAM  = 'FRONT   '
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
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  = '5E    '           / format of field
TDIM1   = '        '

END
```

6.32. LS-014 LLE Events

Version: 1.2
Revision date: 02/22/12

6.32.1. Product Description

LAT Low Energy events (LLE) are automatically produced for each GBM GRB in the TCAT file (GS-105) with a position within the 90 degrees off axis from the LAT boresight. LLE data are generated for a given position in the sky (RA, DEC) and for a given interval of time (T0, T1). The standard LLE selection applied to Merit data is the following:

```
(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || GltEngine==7) &&
EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0) && (FT1Theta<=90.0) &&
(((cos(FT1Dec*0.0174533)*(FT1Ra - (RA)))^2+ (FT1Dec- (DEC))^2)<
PSF(EvtEnergyCorr, Theta)
```

where PSF(EvtEnergyCorr, Theta) is a function of the reconstructed energy (EvtEnergyCorr) and reconstructed source direction (Theta) and represents the functional form of the containment radius of the Point Spread Function (PSF) of the LAT. The exact cut used to select the events is saved in the keyword **LLECUT**, in the primary header of the file. If a refined localization (from LAT or Swift or from a refined on ground analysis) is delivered to the TCAT file, the LLE data are automatically updated and a new version of LLE files is produced. In some cases, LLE data could be manually generated (using a better localization not in the TCAT file). For each updated position the **VERSION** keyword increases by one.

LLE TTE file format is similar to the FT1 file format with some exceptions. Because the LLE data are tightly connected to a particular OBJECT (position and time), the keyword **OBJECT** has been added. Generally this will correspond to the entry of the TCAT file used to generate LLE data. For similar reason also the position of the object **(RA_OBJ, DEC_OBJ)** used to select LLE file is written in the header of each extension of each LLE files. **PROC_VER** corresponds to the iteration of the analysis of LLE data. **PASS_VER** corresponds to the iteration for the reconstruction and the general event classification (Pass6, Pass7, etc.). **VERSION** corresponds to the version of the LLE product for this particular event. The update of a location of a GRB will increase the number of VERSION in the file, but will leave the PASS_VER and PROC_VER unchanged.

Naming Convention	glg_lle_bnyymmddfff_vxx.fit	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	

Production Latency Requirement	1 week	
Product contains data for	Time period around bright GRBs and solar flares	
Number of deliveries per day	N/A (~1 Month)	
Typical size	1.2 Mbyte	

Product Content

Primary HDU:	Standard GLAST FITS Primary Header	Additional keywords: OBJECT, LLECUT
Extension 1	Event list	
Extension 2	GTI	

6.32.2. Primary Header

This is the primary header of the LAT TTE file.

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
COMMENT TRIGTIME=243216766.614
CHECKSUM= 'iT7MiQ6MiQ6MiQ6M'   / HDU checksum updated 2012-06-
21T08:33:38
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5
or FK4)
DATE    = '2012-06-21T08:33:37.0000' / file creation date (YYYY-MM-
DDThh:mm:ss U
DATE-OBS= '2008-09-15T23:56:05.6140' / start date and time of the
observation (U
DATE-END= '2008-09-16T00:29:25.6139' / end date and time of the
observation (UTC
TSTART  =        243215766.614 / mission time of the start of the
observation
TSTOP   =        243217766.614 / mission time of the end of the
observation
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at any
time du
MJDREFI =               51910. / Integer part of MJD corresponding to SC
clock s
MJDREFF =  0.00074287037037037 / Fractional part of MJD corresponding to
SC cloc
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
FILENAME= 'gll_lle_bn080916009_v03.fit' / name of this file
ORIGIN  = 'LISOC   '           / name of organization making file
CREATOR = 'makeLLE ScienceTools-09-28-00' / software and version
creating file
VERSION = '3       '           / Version of the file
PROC_VER=                    1 / Version of LLE Data Analysis
DATASUM = '         0'         / data unit checksum updated 2012-06-
21T08:31:41
PASS_VER= 'P7V6    '           / Version of Event Analysis
```

```
DATATYPE= 'LLE     '           / LAT datatype used for this file
FILETYPE= 'LAT PHOTON LIST'    / Name for this type of FITS file
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
TRIGTIME=        243216766.614 / Trigger time (s) relative to MJDREF,
double pre
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
END
```

6.32.3. Extension Header 1: EVENTS

This extension provides the event list.

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   60 / width of table in bytes
NAXIS2  =                19935 / number of rows in table
PCOUNT  =                    0 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   14 / number of fields in each row
TTYPE1  = 'ENERGY  '           / energy of event
TFORM1  = 'E       '           / data format of field: 4-byte REAL
TTYPE2  = 'RA      '           / right ascension (J2000) of event
TFORM2  = 'E       '           / data format of field: 4-byte REAL
TTYPE3  = 'DEC     '           / declination (J2000) of event
TFORM3  = 'E       '           / data format of field: 4-byte REAL
TTYPE4  = 'L       '           / Galactic longitude of event
TFORM4  = 'E       '           / data format of field: 4-byte REAL
TTYPE5  = 'B       '           / Galactic latitude of event
TFORM5  = 'E       '           / data format of field: 4-byte REAL
TTYPE6  = 'THETA   '           / inclination angle of event in
instrument coordi
TFORM6  = 'E       '           / data format of field: 4-byte REAL
TTYPE7  = 'PHI     '           / azimuthal angle of event in instrument
coordina
TFORM7  = 'E       '           / data format of field: 4-byte REAL
TTYPE8  = 'ZENITH_ANGLE'       / zenith angle of event
TFORM8  = 'E       '           / data format of field: 4-byte REAL
TTYPE9  = 'EARTH_AZIMUTH_ANGLE' / Earth azimuth (from north to east) of
event
```

```
TFORM9  = 'E       '           / data format of field: 4-byte REAL
TTYPE10 = 'TIME    '           / Mission Elapsed Time
TFORM10 = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE11 = 'EVENT_ID'           / ID number of original event
TFORM11 = 'J       '           / data format of field: 4-byte signed
INTEGER
TTYPE12 = 'RUN_ID  '           / Run number of original event
TFORM12 = 'J       '           / data format of field: 4-byte signed
INTEGER
CHECKSUM= 'DT9MDQ8MDQ8MDQ8M'   / HDU checksum updated 2012-06-
21T08:33:38
DATASUM = '3262480030'         / data unit checksum updated 2012-06-
21T08:33:37
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5
or FK4)
DATE    = '2012-06-21T08:33:37.0000' / file creation date (YYYY-MM-
DDThh:mm:ss U
DATE-OBS= '2008-09-15T23:56:05.6140' / start date and time of the
observation (U
DATE-END= '2008-09-16T00:29:25.6139' / end date and time of the
observation (UTC
OBSERVER= 'Peter Michelson'    / GLAST/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  '           / extension contains events
HDUCLAS2= 'ALL     '           / extension contains all events detected
TSTART  =        243215766.614 / mission time of the start of the
observation
TSTOP   =        243217766.614 / mission time of the end of the
observation
MJDREFI =               51910. / Integer part of MJD corresponding to
SC clock s
MJDREFF =  0.00074287037037037 / Fractional part of MJD corresponding
to SC cloc
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at
any time du
PASS_VER= 'P7V6    '           / Version of Event Analysis
TUNIT1  = 'MeV     '           / physical unit of field
TLMIN1  =                   0. / minimum value
TLMAX1  =            10000000. / maximum value
TUNIT2  = 'deg     '           / physical unit of field
TLMIN2  =                   0. / minimum value
TLMAX2  =                 360. / maximum value
TUNIT3  = 'deg     '           / physical unit of field
TLMIN3  =                 -90. / minimum value
TLMAX3  =                  90. / maximum value
TUNIT4  = 'deg     '           / physical unit of field
```

```
TLMIN4  =                   0. / minimum value
TLMAX4  =                 360. / maximum value
TUNIT5  = 'deg     '           / physical unit of field
TLMIN5  =                 -90. / minimum value
TLMAX5  =                  90. / maximum value
TUNIT6  = 'deg     '           / physical unit of field
TLMIN6  =                   0. / minimum value
TLMAX6  =                 180. / maximum value
TUNIT7  = 'deg     '           / physical unit of field
TLMIN7  =                   0. / minimum value
TLMAX7  =                 360. / maximum value
TUNIT8  = 'deg     '           / physical unit of field
TLMIN8  =                   0. / minimum value
TLMAX8  =                 180. / maximum value
TUNIT9  = 'deg     '           / physical unit of field
TLMIN9  =                   0. / minimum value
TLMAX9  =                 360. / maximum value
TUNIT10 = 's       '           / physical unit of field
TLMIN10 =                   0. / minimum value
TLMAX10 =         10000000000. / maximum value
TLMIN11 =                    0 / minimum value
TLMAX11 =           2147483647 / maximum value
TLMIN12 =                    0 / minimum value
TLMAX12 =           2147483647 / maximum value
EXTVER  =                    1 / auto assigned by template parser
TTYPE13 = 'CTBCLASSLEVEL'      / label for field
TFORM13 = 'J       '           / format of field
TTYPE14 = 'LIVETIME'           / label for field
TFORM14 = 'E       '           / format of field
HISTORY Input file: @/scratch/generateDRM_GRB080916009/meritList.txt
HISTORY Filter string: (FswGamState==0 && TkrNumTracks>0 &&
(GltEngine==6 || Glt
HISTORY Engine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0) &&
(FT1Theta<=
HISTORY 90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - (119.8)))^2+(FT1Dec-
(-56.6))
HISTORY ^2)< (-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55),
pow(EvtEnergyCorr/59
HISTORY .,  -0.87))))^2 ) && (FT1ZenithTheta<180) && (EvtElapsedTime >=
24321576
HISTORY 6.614)  && (EvtElapsedTime <= 243217766.614)
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
NDSKEYS =                    1
PROC_VER=                    1 / Version of LLE Data Analysis
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
TRIGTIME=        243216766.614 / Trigger time (s) relative to MJDREF,
double pre
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
```

```
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
COMMENT TRIGTIME=243216766.614
END
```

6.32.4. Extension Header 2: GTI

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

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   16 / 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
TTYPE1  = 'START   '           / start time of good time intervals
TFORM1  = 'D       '           / data format of field: 8-byte DOUBLE
TTYPE2  = 'STOP    '           / stop time of good time intervals
TFORM2  = 'D       '           / data format of field: 8-byte DOUBLE
CHECKSUM= 'GZrEJXoDGXoDGXoD'   / HDU checksum updated 2012-06-
21T08:33:38
DATASUM = '2110699824'         / data unit checksum updated 2012-06-
21T08:33:37
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
EQUINOX =                2000. / equinox for ra and dec
RADECSYS= 'FK5     '           / world coord. system for this file (FK5
or FK4)
DATE    = '2012-06-21T08:33:37.0000' / file creation date (YYYY-MM-
DDThh:mm:ss U
DATE-OBS= '2008-09-15T23:56:05.6140' / start date and time of the
observation (U
DATE-END= '2008-09-16T00:29:25.6139' / end date and time of the
observation (UTC
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
ORIGIN  = 'LISOC   '           / name of organization making file
EXTNAME = 'GTI     '           / name of this binary table extension
HDUCLASS= 'OGIP    '           / format conforms to OGIP standard
HDUCLAS1= 'GTI     '           / extension contains good time intervals
HDUCLAS2= 'ALL     '           / extension contains all science time
TSTART  =        243215766.614 / mission time of the start of the
observation
TSTOP   =        243217766.614 / mission time of the end of the
observation
MJDREFI =               51910. / Integer part of MJD corresponding to SC
clock s
MJDREFF =  0.00074287037037037 / Fractional part of MJD corresponding to
SC cloc
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
```

```
GPS_OUT =                    F / whether GPS time was unavailable at any
time du
ONTIME  =                2000. / sum of GTI lengths
TELAPSE =                2000. / TSTOP - TSTART
TUNIT1  = 's       '           / physical unit of field
TLMIN1  =                   0. / minimum value
TLMAX1  =         10000000000. / maximum value
TUNIT2  = 's       '           / physical unit of field
TLMIN2  =                   0. / minimum value
TLMAX2  =         10000000000. / maximum value
EXTVER  =                    1 / auto assigned by template parser
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
TRIGTIME=        243216766.614 / Trigger time (s) relative to MJDREF,
double pre
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
COMMENT TRIGTIME=243216766.614
END
```

6.33. LS-015 LLE CSPEC File

Version: 1.2
Revision date: 02/22/12

6.33.1. Product Description

CSPEC file is obtained directly binning the merit files. It provides a series of spectra, accumulated each every second, from -1000 to 1000 s around the burst. Each spectrum is binned in 50 energy channels, ranging typically from 10 MeV to 100 GeV.
The format of the CSPEC file is tailored to satisfy *rmfit* standards, and it is not directly usable in XSPEC. Technically, XPSPEC can load CSPEC files, and they appear to be very similar to PHA2 files, but it will be difficult to combine them into a single meaningful spectrum and to extract a background file. The use of CSPEC file is recommended only in *rmfit*. On the other hand, XSPEC can load and work with PHA1 files obtained by binning selected LLE TTE file (LS-014) with *gtselect* and *gtbin*, available in *ScienceTools*. The CSPEC files are therefore only usable by the *rmfit* program.

In addition to the standard keywords, LLE CSPEC files include information about the selection used to create the spectral file. This information is saved in the keyword **LLECUT** and represents the selection applied to the original ROOT MeritFiles in order to select LLE events. If a refined localization (from LAT or Swift or from a refined on ground analysis) is delivered to the TCAT file, the LLE data are automatically updated and a new version of LLE files is produced. In some cases, LLE data could be manually generated (using a better localization not in the TCAT file). For each updated position the **VERSION** keyword increases by one.

LLE CSPEC file format is similar to the GBM CSPEC file format. Because the LLE data are tightly connected to a particular OBJECT (position and time), the keyword **OBJECT** has been added. Generally this will correspond to the entry of the TCAT file used to generate LLE data. For similar reason also the position of the object **(RA_OBJ, DEC_OBJ)** used to select LLE file is written in the header of each extension of each LLE files. **PROC_VER** corresponds to the iteration of the analysis of LLE data. **PASS_VER** corresponds to the iteration for the reconstruction and the general event classification (Pass6, Pass7, etc.). **VERSION** corresponds to the version of the LLE product for this particular event. The update of a location of a GRB will increase the number of VERSION in the file, but will leave the PASS_VER and PROC_VER unchanged.

Naming Convention	glg_cspec_bnyymmddfff_vxx.pha	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	

Delivery Method	FASTCOPY	
Production Latency Requirement	1 week	
Product contains data for	Time period around bright GRBs and solar flares	
Number of deliveries per day	N/A (~1 Month)	
Typical size	<1 Mbyte	
Product Content		
Primary HDU:	Standard GLAST FITS Primary Header	Additional keywords: OBJECT, LLECUT
Extension 1	EBOUNDS	
Extension 2	SPECTRUM	
Extension 3	GTI	

6.33.2. Primary Header

Definition/Example

```
SIMPLE  =                    T / conforms to FITS standard
BITPIX  =                    8 / array data type
NAXIS   =                    0 / number of array dimensions
EXTEND  =                    T
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
VERSION = '2       '           / Version of the file
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
DATE    = '2012-02-22T21:44:51' / Date file was made
DATE-OBS= '2008-09-15T23:56:05' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:29:25' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =       243215766.6135 / Observation's start time relative to
MJDREF, do
TSTOP   =       243217766.6135 / Observation's stop time relative to
MJDREF, dou
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
FILETYPE= 'PHAII   '           / The file format is OGIP PHAII which
contains mu
DATATYPE= 'CSPEC   '           / Name of the primary datatype making up
this fil
CREATOR = 'mkdrm_ez'           / Software and version creating file
FILENAME= 'gll_cspec_bn080916009_v02.pha' / Name of this file
CHECKSUM= 'h5Tki4Sih4Sih4Si'   / HDU checksum updated 2012-02-
23T05:44:51
```

```
DATASUM = '         0'         / data unit checksum updated 2012-02-
23T05:44:51
END
```

6.33.3. Extension Header 1: EBOUNDS

Provides a list of the energy channel that have been used to binning the data. Usually this channels are 50 energy bins from 1.0E+04 keV (10 MeV) to 1.0E+08 keV (100 GeV).

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                   10 / length of dimension 1
NAXIS2  =                   50 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                    3 / number of table fields
TTYPE1  = 'CHANNEL '
TFORM1  = 'I       '
TTYPE2  = 'E_MIN   '
TFORM2  = 'E       '
TUNIT2  = 'keV     '           / physical unit of field
TTYPE3  = 'E_MAX   '
TFORM3  = 'E       '
TUNIT3  = 'keV     '           / physical unit of field
EXTNAME = 'EBOUNDS '           / extension name
TLMIN1  =                    1 / Channel numbers are positive
TLMAX1  =                   50 / Greater than the number of channels
TLMIN2  =              10000.0 / Lowest channel energy
TLMAX2  =           10000000.0 / Highest channel energy
TLMIN3  =              10000.0 / Lowest channel energy
TLMAX3  =           10000000.0 / Highest channel energy
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
CHANTYPE= 'PI     '           / No corrections have been applied
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
DETCHANS=                   50 / Total number of Energy channels
HDUCLASS= 'OGIP    '           / Conforms to OGIP standard indicated in
HDUCLAS
HDUCLAS1= 'RESPONSE'           / These are typically found in RMF files
HDUCLAS2= 'EBOUNDS '           / Energy Channels
HDUVERS = '1.0.0   '           / Version of HDUCLAS1 format in use
EXTVER  =                    1 / Version of this extension format
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
```

```
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
DATE    = '2012-02-22T21:44:51' / Date file was made
DATE-OBS= '2008-09-15T23:56:05' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:29:25' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.000742870370370370 / MJD date of reference epoch,
fractional part
TSTART  =       243215766.6135 / Observation's start time relative to
MJDREF, do
TSTOP   =       243217766.6135 / Observation's stop time relative to
MJDREF, dou
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
CHECKSUM= 'U2hGW1eDU1eDU1eD'   / HDU checksum updated 2012-02-
23T05:44:51
DATASUM = '3866778640'         / data unit checksum updated 2012-02-
23T05:44:51
END
```

6.33.4. Extension Header 2: SPECTRUM

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                  222 / length of dimension 1
NAXIS2  =                 2000 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                    5 / number of table fields
TTYPE1  = 'COUNTS  '
TFORM1  = '50J     '
TZERO4  =       243216766.6135 / Offset, equal to TRIGTIME
TUNIT1  = 'Counts  '
TTYPE2  = 'EXPOSURE'
TFORM2  = 'E       '
```

```
TZERO5  =       243216766.6135 / Offset, equal to TRIGTIME
TUNIT2  = 's       '
TTYPE3  = 'QUALITY '
TFORM3  = 'I       '
TTYPE4  = 'TIME    '
TFORM4  = 'D       '
TUNIT4  = 's       '
TTYPE5  = 'ENDTIME '
TFORM5  = 'D       '
TUNIT5  = 's       '
EXTNAME = 'SPECTRUM'           / extension name
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
HDUCLASS= 'OGIP    '           / Format conforms to OGIP standard
HDUCLAS1= 'SPECTRUM'           / PHA dataset (OGIP memo OGIP-92-007)
HDUCLAS2= 'TOTAL   '           / Indicates gross data (source +
background)
HDUCLAS3= 'COUNT   '           / Indicates data stored as counts
HDUCLAS4= 'TYPEII  '           / Indicates PHA Type II file format
HDUVERS = '1.0.0   '           / Version of HDUCLAS1 format in use
DETCHANS=                   50 / Total number of channels in each rate
POISSERR=                    T / Assume Poisson Errors
BACKFILE= 'none    '           / ame of corresponding background file
(if any)
CORRFILE= 'none    '           / Name of corresponding correction file
(if any)
CORRSCAL=                    1 / orrection scaling file
RESPFILE= 'none    '           / ame of corresponding RMF file (if any)
ANCRFILE= 'none    '           / Name of corresponding ARF file (if
any)
SYS_ERR =                  0.0 / No systematic errors
GROUPING=                    0 / No special grouping has been applied
AREASCAL=                  1.0 / No special scaling of effective area
by channel
BACKSCAL=                  1.0 / No scaling of background
CHANTYPE= 'PI     '           / No corrections have been applied
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
DATE    = '2012-02-22T21:44:51' / Date file was made
DATE-OBS= '2008-09-15T23:56:05' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:29:25' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =       243215766.6135 / Observation's start time relative to
MJDREF, do
```

```
TSTOP   =       243217766.6135 / Observation's stop time relative to
MJDREF, dou
NDSKEYS =                    4
EXTVER  =                    1 / Version of this extension format
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
CHECKSUM= 'TaJHTT9GTYGGTY9G'   / HDU checksum updated 2012-02-
23T05:44:51
DATASUM = '1352583199'         / data unit checksum updated 2012-02-
23T05:44:51
END
```

6.33.5. *Extension Header 3: GTI*

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

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                   16 / length of dimension 1
NAXIS2  =                    1 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                    2 / number of table fields
TTYPE1  = 'START   '
TFORM1  = 'D       '
TUNIT1  = 's       '
TTYPE2  = 'STOP    '
TFORM2  = 'D       '
TUNIT2  = 's       '
EXTNAME = 'GTI     '           / extension name
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
DATE    = '2012-02-22T21:44:51' / Date file was made
DATE-OBS= '2008-09-15T23:56:05' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:29:25' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
```

```
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =       243215766.6135 / Observation's start time relative to
MJDREF, do
TSTOP   =       243217766.6135 / Observation's stop time relative to
MJDREF, dou
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
HDUCLASS= 'OGIP    '           / Conforms to OGIP standard indicated in
HDUCLAS
HDUCLAS1= 'GTI     '           / Indicates good time intervals
HDUVERS = '1.0.0   '           / Version of HDUCLAS1 format in use
CREATOR = 'mkdrm_ez'           / Software and version creating file
EXTVER  =                    1 / Version of this extension format
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
CHECKSUM= '5Ea8AEX85Ea8AEU8'   / HDU checksum updated 2012-02-
23T05:44:51
DATASUM = '2110666270'         / data unit checksum updated 2012-02-
23T05:44:51
END
```

6.34. LS-016 LLE CSPEC RSP File

Version: 1.2
Revision date: 02/22/12

6.34.1. Product Description

The detector response matrix D_{ji} is calculated from Monte Carlo simulations, and it corresponds to a single matrix for each GRB or SFLARE. The LLE 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, such as:

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

The integration time varies depending on the transient duration. The energy binning must be the same as the energy binning of the spectrum file. After the MC generation, the LLE selection of events must be applied to the simulated dataset, and the cut applied to generate the response must be the same as the cut used to produce LLE spectral data files (LS-014 and LS_015). This information is saved in the keyword **LLECUT** and represents the selection applied to the original ROOT MeritFiles in order to select LLE events. If a refined localization (from LAT or Swift or from a refined on ground analysis) is delivered to the TCAT file, the LLE data are automatically updated and a new version of LLE files is produced. In some cases, LLE data could be manually generated (using a better localization not in the TCAT file). For each updated position the **VERSION** keyword increases by one.

Because the LLE responses are tightly connected to a particular OBJECT (position and time), the keyword **OBJECT** has been added. Generally this will correspond to the entry of the TCAT file used to generate LLE data. For similar reason also the position of the object **(RA_OBJ, DEC_OBJ)** used to select LLE file is written in the header of each extension of each LLE files. **PROC_VER** corresponds to the iteration of the analysis of LLE data. **PASS_VER** corresponds to the iteration for the reconstruction and the general event classification (Pass6, Pass7, etc.). **VERSION** corresponds to the version of the LLE product for this particular event. The update of a location of a GRB will increase the number of VERSION in the file, but will leave the PASS_VER and PROC_VER unchanged.

The format of the RSP file is such that both *RMFIT* and *XSPEC* can work with it.

Naming Convention	glg_cspec_bnyymmddfff_vxx.rsp	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 week	

Product contains data for	Time period around bright GRBs and solar flares
Number of deliveries per day	N/A (~1 Month)
Typical size	<1 Mbyte

Product Content

Primary HDU:	Standard GLAST FITS Primary Header	Additional keywords: OBJECT, LLECUT
Extension 1	EBOUNDS	
Extension 2	SPECRESP MATRIX	

6.34.2. Primary Header

Definition/Example

```
SIMPLE  =                    T / conforms to FITS standard
BITPIX  =                    8 / array data type
NAXIS   =                    0 / number of array dimensions
EXTEND  =                    T
CREATOR = 'mkdrm_ez'           / Software and version creating file
FILENAME= 'gll_cspec_bn080916009_v02.rsp' / This file name
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
VERSION = '2       '           / Version of the file
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
DATE    = '2012-02-22T21:44:13' / Date file was made
DATE-OBS= '2008-09-16T00:12:41' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:13:41' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =    243216762.2093255 / Observation's start time relative to
MJDREF, do
TSTOP   =    243216822.5093255 / Observation's stop time relative to
MJDREF, dou
```

```
OBJECT   = 'GRB080916009'       / Object name in standard format,
yymmddfff
DRM_NUM =                     1 / Number of DRMs stored in this file
DRM_TYPE= 'CSPEC   '            / Data type for which DRM is intended
FILETYPE= 'LAT LLE DRM'         / Name for this type of FITS file
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
RADECSYS= 'FK5     '
EQUINOX =                2000.0
RA_OBJ  =                 119.8
DEC_OBJ =                 -56.6
CHECKSUM= 'kW75mT44kT44kT44'   / HDU checksum updated 2012-02-
23T05:44:13
DATASUM = '         0'         / data unit checksum updated 2012-02-
23T05:44:13
END
```

6.34.3. Extension Header 1: EBOUNDS

Provides a list of the energy channel that have been used to binning the data. Usually this channels are 50 energy bins from 1.0E+04 keV (10 MeV) to 1.0E+08 keV (100 GeV).

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                   10 / length of dimension 1
NAXIS2  =                   50 / length of dimension 2
PCOUNT  =                    0 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                    3 / number of table fields
TTYPE1  = 'CHANNEL '
TFORM1  = 'I       '
TTYPE2  = 'E_MIN   '
TFORM2  = 'E       '
TUNIT2  = 'keV     '           / physical unit of field
TTYPE3  = 'E_MAX   '
TFORM3  = 'E       '
TUNIT3  = 'keV     '           / physical unit of field
EXTNAME = 'EBOUNDS '           / extension name
TLMIN1  =                    1 / Channel numbers are positive
TLMAX1  =                   50 / Greater than the number of channels
TLMIN2  =              10000.0 / Lowest channel energy
TLMAX2  =           10000000.0 / Highest channel energy
TLMIN3  =              10000.0 / Lowest channel energy
TLMAX3  =           10000000.0 / Highest channel energy
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
CHANTYPE= 'PI     '           / No corrections have been applied
```

```
DETCHANS=                   50 / Total number of channels in each rate
HDUCLASS= 'OGIP    '           / Conforms to OGIP standard indicated in
HDUCLAS
HDUCLAS1= 'RESPONSE'           / These are typically found in RMF files
HDUCLAS2= 'EBOUNDS '           / Energy bins
HDUVERS = '1.0.0   '           / Version of HDUCLAS1 format in use
EXTVER  =                    1 / Version of this extension format
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
DATE    = '2012-02-22T21:44:13' / Date file was made
DATE-OBS= '2008-09-16T00:12:41' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:13:41' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
TIMEUNIT= 's       '           / Time unit used in TSTART, TSTOP
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.000742870370370370 / MJD date of reference epoch,
fractional part
TSTART  =    243216762.2093255 / Observation's start time relative to
MJDREF, do
TSTOP   =    243216822.5093255 / Observation's stop time relative to
MJDREF, dou
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
CHECKSUM= '9hgEJegD9egDGegD'   / HDU checksum updated 2012-02-
23T05:44:13
DATASUM = '3866778640'         / data unit checksum updated 2012-02-
23T05:44:13
END
```

6.34.4. Extension Header 2: SPECRESP MATRIX

Provides the response of the instrument computed in the interval of time ranging from DATE-OBS to DATE-END (or from TSTART to TSTOP).

Definition/Example

```
XTENSION= 'BINTABLE'           / binary table extension
BITPIX  =                    8 / array data type
NAXIS   =                    2 / number of array dimensions
NAXIS1  =                   34 / length of dimension 1
NAXIS2  =                   50 / length of dimension 2
PCOUNT  =                10200 / number of group parameters
GCOUNT  =                    1 / number of groups
TFIELDS =                    6 / number of table fields
TTYPE1  = 'ENERG_LO'
TFORM1  = 'E       '
TUNIT1  = 'keV     '
TTYPE2  = 'ENERG_HI'
TFORM2  = 'E       '
TUNIT2  = 'keV     '
TTYPE3  = 'N_GRP   '
TFORM3  = 'I       '
TTYPE4  = 'F_CHAN  '
TFORM4  = 'PI(1)   '
TTYPE5  = 'N_CHAN  '
TFORM5  = 'PI(1)   '
TTYPE6  = 'MATRIX  '
TFORM6  = 'PE(50)  '
TUNIT6  = 'cm**2   '
EXTNAME = 'SPECRESP MATRIX'    / extension name
TELESCOP= 'GLAST   '           / Name of mission / spacecraft
INSTRUME= 'LAT     '           / Name of instrument generating data
ORIGIN  = 'LISOC   '           / Name of organization making file
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
CHANTYPE= 'PI     '           / No corrections have been applied
DETCHANS=                   50 / Total number of Energy channels
HDUCLASS= 'OGIP    '           / Conforms to OGIP standard indicated in
HDUCLAS
HDUCLAS1= 'RESPONSE'           / These are typically found in RMF files
HDUCLAS2= 'RSP_MATRIX'         / Response Matrix
HDUVERS = '1.0.0   '           / Version of HDUCLAS1 format in use
EXTVER  =                    1 / Version of this extension format
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
DATE    = '2012-02-22T21:44:13' / Date file was made
DATE-OBS= '2008-09-16T00:12:41' / [UTC] date of start of observation
DATE-END= '2008-09-16T00:13:41' / [UTC] date of end of observation
TIMESYS = 'TT      '           / Time system used in time keywords
```

```
TIMEUNIT= 's       '            / Time unit used in TSTART, TSTOP
MJDREFI =               51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =    243216762.2093255 / Start time for generating the response
matrix
TSTOP   =    243216822.5093255 / End  time for generating the response
matrix
TRIGTIME=       243216766.6135 / Trigger time (s) relative to MJDREF,
double pre
RADECSYS= 'FK5     '            / Stellar reference frame
EQUINOX =                2000.0 / Equinox for RA and Dec
RA_OBJ  =                 119.8 / RA of the source
DEC_OBJ =                 -56.6 / DEC of the source
TLMIN4  =                     1 / Channel numbers are positive
TLMAX4  =                    50 / Maximum number of energy channel
CHECKSUM= 'EIXWFFWTEFWTEFWT'   / HDU checksum updated 2012-02-
23T05:44:13
DATASUM = '4210267479'         / data unit checksum updated 2012-02-
23T05:44:13
END
```

6.35. LS-017 LLE PHA-I File

Version: 1.0
Revision date: 06/26/12

6.35.1. Product Description

The PHAI file contains the count spectrum binned in energy, using energy channels defined in the EBOUNDS extension. It is created from the LLE events (LS-014) by using the standard Fermi LAT ScienceTools *gtselect* and *gtbin.* The selected time interval is chosen in order to match the response file available for the same event (LS-016). The file is optimal for time integrated spectral analysis, but, by construction, cannot be used for time resolved spectral analysis. The keywords TSTART and TSTOP in the extensions are the start and send of the selected time interval, the exposure is provided by the keyword EXPOSURE. The keyword LLECUT contains the exact selection of events applied to obtain this file and it is the same cut applied to obtain the response of the instrument (LLE RSP file).

The format of the PHA file is such that both *RMFIT* and *XSPEC* can work with it.

Naming Convention	gll_pha_bnyymmddfff_vxx.rsp	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	

Production Latency Requirement	1 week
Product contains data for	Time period around bright GRBs and solar flares
Number of deliveries per day	N/A (~1 Month)
Typical size	<1 Mbyte

Product Content

Primary HDU:	Standard PHAI FITS Primary Header
Extension 1	SPECTRUM
Extension 2	EBOUNDS

6.35.2. *Primary Header*

Definition/Example

```
SIMPLE  =                    T / File conforms to NOST standard
BITPIX  =                    8 / Bits per pixel
NAXIS   =                    0 / No data is associated with this header
EXTEND  =                    T / Extensions may 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
COMMENT TRIGTIME=243216766.614
DATE    = '2012-06-25T08:29:59' / file creation date (YYYY-MM-
DDThh:mm:ss U
FILENAME= 'gll_pha_bn080916009_v04.fit' /
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
DATE-OBS= '2008-09-16T00:12:41' / [UTC] start date of the selected time
interval
DATE-END= '2008-09-16T00:13:41' / [UTC] end date of the selected time
interval
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at any
time du
OBSERVER= 'Peter Michelson'    / GLAST/LAT PI
CREATOR = 'mkdrm_ez'           / Software and version creating file
HISTORY                   LatSingleBinnedTemplate,v 1.6 2005/04/05
21:06:39 peac
HISTORY hey Exp
CHECKSUM= 'KjhYMggWKggWKggW'   / HDU checksum updated 2012-06-
25T15:30:00
DATASUM = '         0'         / data unit checksum updated 2012-06-
25T15:29:59
DATATYPE= 'LLE     '           / LAT datatype used for this file
```

```
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
TRIGTIME=        243216766.614 / Trigger time (s) relative to MJDREF,
double pre
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
VERSION = '4       '           / Version of the file
ORIGIN  = 'LISOC   '           / Name of organization making file
FILETYPE= 'SPECTRUM'           / Name for this type of FITS file
RADECSYS= 'FK5     '           / Stellar reference frame
EQUINOX =               2000.0 / Equinox for RA and Dec
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =    243216762.2093675 / Start Time of the selected interval
relative to
TSTOP   =    243216822.5093675 / End Time of the selected interval
relative to M
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
END
```

6.35.3. *Extension Header 1: SPECTRUM*

Contains the spectrum binned in energy, integrated over a time interval from TSTART to TSTOP, for a total exposure of EXPOSURE. This interval is the same of the response file provided with the LLE data product for this event.

Definition/Example

```
XTENSION= 'BINTABLE'           / Binary table extension
BITPIX  =                    8 / Bits per pixel
NAXIS   =                    2 / Required value
NAXIS1  =                   10 / Number of bytes per row
NAXIS2  =                   50 / Number of rows
PCOUNT  =                    0 / Normally 0 (no varying arrays)
GCOUNT  =                    1 / Required value
TFIELDS =                    3 / Number of columns in table
TTYPE1  = 'CHANNEL '           / Label for this field
TFORM1  = 'I       '           / Data format of this field
TTYPE2  = 'COUNTS  '           / Count rate in each bin
TFORM2  = 'J       '           / Data format of this field
TTYPE3  = 'STAT_ERR'           / Statistical error
```

```
TFORM3  = 'E       '           / Data format of this field
EXTNAME = 'SPECTRUM'           / Extension name
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
More?[Yes]
HDUCLAS1= 'SPECTRUM'           / PHA dataset (OGIP memo OGIP-92-007)
HDUCLAS2= 'TOTAL   '           / Type of data stored
HDUCLAS3= 'COUNT   '           / Further details of type of data stored
HDUCLAS4= 'PHA:I   '           / Single PHA dataset
HDUVERS = '1.2.0   '           / Version number of the format (this
document des
DETCHANS=                   50 / Total number of detector channels
available.
POISSERR=                    F / Whether Poissonian errors are
appropriate to th
TSTART  =    243216762.2093675 / Start Time of the selected interval
relative to
TSTOP   =    243216822.5093675 / End Time of the selected interval
relative to M
EXPOSURE=     55.7505703227305 / Integration time (in seconds) for the
PHA data
BACKFILE= 'NONE    '           / Name of background file (if any)
CORRFILE= 'NONE    '           / Name of correction file (if any)
CORRSCAL=                   1. / Correction scaling factor.
RESPFILE= 'NONE    '           / Name of redistribution matrix file (if
any)
ANCRFILE= 'NONE    '           / Name of ancillary response file (if
any)
STAT_ERR=                   0. / Statistical error
SYS_ERR =                   0. / Fractional systematic error
QUALITY =                    0 / Data quality flag
GROUPING=                    0 / Data grouping flag
AREASCAL=                   1. / Area scaling factor
BACKSCAL=                   1. / Scaling factor to be applied to
Bkgdfile
CHANTYPE= 'PI      '           / Whether channels used in the file have
been cor
FILTER  = 'NONE    '           / Instrument filter in use (if any)
More?[Yes]
OBJECT  = 'GRB080916009'       / Object name in standard format,
yymmddfff
EQUINOX =               2000.0 / Equinox for RA and Dec
RADECSYS= 'FK5     '           / Stellar reference frame
DATE-OBS= '2008-09-16T00:12:41' / [UTC] start date of the selected time
interval
DATE-END= '2008-09-16T00:13:41' / [UTC] end date of the selected time
interval
TIMEUNIT= 's       '           / units for the time related keywords
TIMEZERO=                   0. / clock correction
TIMESYS = 'TT      '           / type of time system that is used
TIMEREF = 'LOCAL   '           / reference frame used for times
CLOCKAPP=                    F / whether a clock drift correction has
been appli
GPS_OUT =                    F / whether GPS time was unavailable at
any time du
NDSKEYS =                    2
```

```
CREATOR = 'mkdrm_ez'           / Software and version creating file
HISTORY                   LatSingleBinnedTemplate,v 1.6 2005/04/05
21:06:39 peac
HISTORY hey Exp
TUNIT2  = 'Counts  '           / Unit of this field
EXTVER  =                    1 / auto assigned by template parser
CHECKSUM= '7IQ6A9Q48GQ4A9Q4'   / HDU checksum updated 2012-06-
25T15:30:00
DATASUM = '3686054060'         / data unit checksum updated 2012-06-
25T15:30:00
DSTYP1  = 'TIME    '
DSUNI1  = 's       '
DSVAL1  = 'TABLE   '
DSREF1  = ':GTI    '
DSTYP2  = 'ENERGY  '
DSUNI2  = 'MeV     '
DSVAL2  = '0:1000000000'
PASS_VER= 'P7V6    '           / Version of Event Analysis
PROC_VER=                    1 / Version of LLE Data Analysis
ORIGIN  = 'LISOC   '           / Name of organization making file
RA_OBJ  =                119.8 / RA of the source
DEC_OBJ =                -56.6 / DEC of the source
TRIGTIME=        243216766.614 / Trigger time (s) relative to MJDREF,
double pre
MJDREFI =              51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
LONGSTRN= 'OGIP 1.0'           / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
HISTORY The following history was copied from input files by gtbin
HISTORY ----------------------------------------------------------------
---------
HISTORY BEGIN history copied from
/scratch/generateDRM_GRB080916009/gll_selected
HISTORY _bn080916009_v04.fit[EVENTS]
HISTORY ----------------------------------------------------------------
---------
HISTORY Input file: @/scratch/generateDRM_GRB080916009/meritList.txt
HISTORY Filter string: (FswGamState==0 && TkrNumTracks>0 &&
(GltEngine==6 || Glt
HISTORY Engine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0) &&
(FT1Theta<=
HISTORY 90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - (119.8)))^2+(FT1Dec-
(-56.6))
HISTORY ^2)< (-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55),
pow(EvtEnergyCorr/59
HISTORY .,  -0.87))))^2 ) && (FT1ZenithTheta<180) && (EvtElapsedTime >=
24321576
```

```
HISTORY 6.614)  && (EvtElapsedTime <= 243217766.614)
HISTORY CFITSIO used the following filtering expression to create this
table:
HISTORY
/scratch/generateDRM_GRB080916009/gll_lle_bn080916009_v04.fit[EVENTS][0
HISTORY <= ENERGY && ENERGY <= 1000000000 && 243216762.20899999142 <=
TIME && TI
HISTORY ME <= 243216822.50900000334 && gtifilter()]
HISTORY Filter string: 0 <= ENERGY && ENERGY <= 1000000000 &&
243216762.20899999
HISTORY 142 <= TIME && TIME <= 243216822.50900000334 && gtifilter()
HISTORY -------------------------------------------------------------
---------
HISTORY END copied history
HISTORY -------------------------------------------------------------
---------
COMMENT TRIGTIME=243216766.614
END
```

6.35.4. *Extension Header 2: EBOUNDS*

Provides the energy bounds used in this spectral file.

Definition/Example

```
XTENSION= 'BINTABLE'           / Binary table extension
BITPIX  =                    8 / Bits per pixel
NAXIS   =                    2 / Required value
NAXIS1  =                   10 / Number of bytes per row
NAXIS2  =                   50 / Number of rows
PCOUNT  =                    0 / Normally 0 (no varying arrays)
GCOUNT  =                    1 / Required value
TFIELDS =                    3 / Number of columns in table
TTYPE1  = 'CHANNEL '           / Raw channel number
TFORM1  = 'I       '           / Data format of this field
TTYPE2  = 'E_MIN   '           / Lower boundary of detector channel
TFORM2  = 'E       '           / Data format of this field
TTYPE3  = 'E_MAX   '           / Upper boundary of detector channel
TFORM3  = 'E       '           / Data format of this field
EXTNAME = 'EBOUNDS '           / Extension name
TELESCOP= 'GLAST   '           / name of telescope generating data
INSTRUME= 'LAT     '           / name of instrument generating data
FILTER  = 'NONE    '           / Instrument filter in use (if any)
CHANTYPE= 'PI      '           / Energy channel type
DETCHANS=                   50 / Total number of detector channels
available.
HDUCLASS= 'OGIP    '           / Format confirms to OGIP standard
HDUCLAS1= 'RESPONSE'           / Extension contains response data
HDUCLAS2= 'EBOUNDS '           / Extension contains response matrix
HDUVERS = '1.2.0   '           / Version number of the format
DATE-OBS= '2008-09-16T00:12:41' / [UTC] start date of the selected time
interval
DATE-END= '2008-09-16T00:13:41' / [UTC] end date of the selected time
interval
TIMEUNIT= 's       '           / units for the time related keywords
```

```
TIMEZERO=                       0. / clock correction
TIMESYS = 'TT      '              / type of time system that is used
TIMEREF = 'LOCAL   '              / reference frame used for times
CLOCKAPP=                        F / whether a clock drift correction has
been appli
GPS_OUT =                        F / whether GPS time was unavailable at
any time du
CREATOR = 'mkdrm_ez'              / Software and version creating file
HISTORY                   LatSingleBinnedTemplate,v 1.6 2005/04/05
21:06:39 peac
HISTORY hey Exp
TUNIT2  = 'keV     '              / physical unit of field
TUNIT3  = 'keV     '              / physical unit of field
EXTVER  =                        1 / auto assigned by template parser
CHECKSUM= 'eKEShJDReJDReJDR'   / HDU checksum updated 2012-07-
03T01:34:56
DATASUM = '3866778640'         / data unit checksum updated 2012-07-
03T01:34:56
TLMIN1  =                        1 / Channel numbers are positive
TLMAX1  =                       50 / Greater than the number of channels
TLMIN2  =                  10000.0 / Lowest channel energy
TLMAX2  =               10000000.0 / Highest channel energy
TLMIN3  =                  10000.0 / Lowest channel energy
TLMAX3  =               10000000.0 / Highest channel energy
PASS_VER= 'P7V6    '              / Version of Event Analysis
PROC_VER=                        1 / Version of LLE Data Analysis
ORIGIN  = 'LISOC   '              / Name of organization making file
RA_OBJ  =                    119.8 / RA of the source
DEC_OBJ =                    -56.6 / DEC of the source
RADECSYS= 'FK5     '              / Stellar reference frame
EQUINOX =                   2000.0 / Equinox for RA and Dec
OBJECT  = 'GRB080916009'          / Object name in standard format,
yymmddfff
TRIGTIME=            243216766.613 / Trigger time (s) relative to MJDREF,
double pre
MJDREFI =                  51910.0 / MJD date of reference epoch, integer
part
MJDREFF = 0.0007428703703703703 / MJD date of reference epoch,
fractional part
TSTART  =       243216762.2093675 / Start Time of the selected interval
relative to
TSTOP   =       243216822.5093675 / End Time of the selected interval
relative to M
LONGSTRN= 'OGIP 1.0'              / The OGIP Long String Convention may be
used.
LLECUT  = '(FswGamState==0 && TkrNumTracks>0 && (GltEngine==6 || &'
CONTINUE  'GltEngine==7) && EvtEnergyCorr > 0) && (FT1ZenithTheta<90.0)
&& &'
CONTINUE  '(FT1Theta<=90.0) && (((cos(FT1Dec*0.0174533)*(FT1Ra - &'
CONTINUE  '(119.8)))^2+(FT1Dec- (-56.6))^2)< &'
CONTINUE  '(-1.0*(11.5*min(pow(EvtEnergyCorr/59., -0.55), &'
CONTINUE  'pow(EvtEnergyCorr/59.,  -0.87))))^2 )&'
CONTINUE  '&' / String used to select LLE events
COMMENT TRIGTIME=243216766.613
END
```

6.36. LS-018 LLE Selected Events

Version: 1.0
Revision date: 06/26/12

6.36.1. Product Description

The LLE selected events are identical to the LLE Events (LS-014) but with an additional selection applied between TMIN and TMAX (the same TMIN and TMAX used for the response (LS-016) and PHA-I (LS-017) files). The following keywords are added to the EVENTS extension:

```
DSTYP2  = 'ENERGY  '
DSUNI2  = 'MeV     '
DSVAL2  = '0:1000000000'
```

Naming Convention	glg_selected_bnyymmddfff_vxx.fit	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 week	
Product contains data for	Time period around bright GRBs and solar flares	
Number of deliveries per day	N/A (~1 Month)	
Typical size	1.2 Mbyte	

Product Content

Primary HDU:	Standard GLAST FITS Primary Header	Additional keywords: OBJECT, LLECUT
Extension 1	Event list	
Extension 2	GTI	

6.37. LS-019 LLE Pointing and Livetime History

Version: 1.0
Revision date: 06/26/12

6.37.1. *Product Description*

The LLE pointing and livetime history file is identical in format to the LAT pointing and livetime history file (LS-005) but with entries every second (instead of every 30 seconds). It spans 4600 seconds before and 4600 after the trigger time.

Naming Convention	glg_pt_bnyymmddfff_vxx.fit	yymmdd = the date fff = fraction of the day xx = the version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	1 week	
Product contains data for	Time period around bright GRBs and solar flares	
Number of deliveries per day	N/A (~1 Month)	
Typical size	1 Mbyte	

Product Content

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

6.38. LS-020 High Resolution Pointing and Livetime History

Version: 1.0
Revision date: 08/02/13

6.38.1. Product Description

The LLE pointing and livetime history file is identical in format to the LAT pointing and livetime history file (LS-005) but with entries every second (instead of every 30 seconds).

Naming Convention	gll_pt1s_pyyy_rnnnnnnnnnn_vxxx.fit	yyy = processing version number nnnnnnnnnn = MET of beginning of run xxx = version number
Originator of Product	LISOC	
Product Format	FITS	
Product delivered to	FSSC	
Delivery Method	FASTCOPY	
Production Latency Requirement	12 hours	
Product contains data for	Processing run	
Number of deliveries per day	15	
Typical size	~3000 kbyte (per 12 hours)	

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

6.39. SS-002 Pulsar Ephemerides

Version: 2.0
Revision date: 2/15/06

6.39.1. 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	FSSC	
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

6.39.2. 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	'FSSC'	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	'FSSC'	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	'FSSC'	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	'FSSC'	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		

6.39.3. Extension Header 1: SPIN_PARAMETERS

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	'FSSC'	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	'FSSC'	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		

6.39.4. Extension Header 2: ORBITAL_PARAMETERS

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	'FSSC'	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	'FSSC'		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		

6.39.5. Extension Header 3: OBSERVERS

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	'FSSC'	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	'FSSC'	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		

6.39.6. Extension Header 4: ALTERNATIVE_NAMES

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	'FSSC'	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	'FSSC'	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
FSSC	Fermi Science Support Center, formerly the GSSC
GBM	Gamma-ray Burst Monitor, formerly the GLAST Burst Monitor
GIOC	GBM Instrument Operations Center
GLAST	Gamma-ray Large Area Space Telescope, pre-launch name of Fermi
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