Gamma-Ray Large Area Space Telescope (GLAST) Project

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

Science Data Products (ICD)

Draft 1
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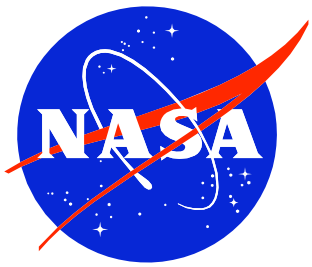

GODDARD SPACE FLIGHT CENTER

Gamma-Ray Large Area
Space Telescope
(GLAST)
Project

Science Data Products
Interface Control Document (ICD)

June 10, 2004

Gamma-Ray Large Area Space Telescope (GLAST) Project
Science Data Products Interface Control Document

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1. Introduction

The purpose of this document is to define the science data products that will be exchanged between the GLAST ground system elements; these data products are the primary science interface between these organizations. The nodes in the ground network are the Mission Operations Center (MOC), the GBM Instrument Operations Center (GIOC), the Instrument Science and Operations Center (ISOC—the LAT's Instrument Operations Center), and the GLAST Science Support Center (GSSC).

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

The specificity with which the data products need to be defined increases as launch approaches and the software that will process the dataproducts matures. With launch more than two and a half years off, only a complete list of the data products, their latencies and delivery frequencies are absolutely necessary. However, for many dataproducts the DPWG report provided a first draft of the FITS keywords and the data contents (e.g., the definition of each column). The definition of the FITS files are provided where available; however, the absence of such definitions for other dataproducts should not be regarded as a deficiency at this time.

The conventions regarding the data products are described in §2. In §3, the data products are tabulated by originating data center. In Appendix A, the data products are defined in as much detail as is practical at present.

2. Conventions

2.1 File Types

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

2.2 Representation of Time

The spacecraft will provide UTC (Coordinated Universal Time) and GPS (Global Positioning System) time to the instruments (433-IRD-0001, §3.2.5.5). Both are uniform-rate systems of time referenced to atomic clocks. UTC, however, 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 owing to changes in earth's rotation rate. GPS time is not adjusted with leap seconds. GPS time is related by a constant offset (13.184 s) to TT (Terrestrial Time), the conventional uniform time system referenced to the center of the earth.

For timing analyses of celestial sources, TT is preferable to UTC, because it does not require accounting for leap seconds. On the other hand, UTC is preferred by the MOC. Therefore, the GLAST ground system has decided that commands and other data products that the MOC will handle will use UTC, while the science data products will use TT. Consequently, TT has been adopted as the time system for the data products described in this document. Time is represented in the data as a double precision offset in seconds from a fiducial time which is presented in the header. The preferred representation of the fiducial time has two components: the day (in MJD form) and the time (in seconds) relative to the beginning of the day. The representation adopted is common to data products for both the GBM and the LAT. It includes the possible specification of information about the SC clock drift for data obtained during periods when the GPS time signal is not available from the SC.

The software developed for the analysis of GBM and LAT data should include a tool to transform TT into UTC as needed, by adding leap seconds as appropriate, for comparison with contemporaneous ground-based observations. This is not likely to be critical, however, for AGN, for which the shortest time scales that the LAT will be able to detect significant changes of flux will be minutes, but will be necessary for comparing observations of GRBs.

2.3 Representation of Spacecraft Position and Orientation

The position and orientation of the spacecraft will be represented in the same way, and with the same FITS column names and units, in the GBM and LAT data products. The position will be given in inertial coordinates (in km) with respect to the center of the earth. The x-direction will be the J2000 vernal equinox, RA, Dec (0,0), the z-direction will be (0, +90°), and the y-direction will be consistent with a right-handed coordinate system. The orientation of the spacecraft will be defined by the directions of the spacecraft z- and x-axes (in J2000 RA, Dec in deg).

2.4 File Names

1. Files should have unique, human-readable names; newer versions of a data product should be distinguishable from earlier versions by the file name. The identity of a file may not depend on its position within the directory structure, although a file's name should allow it to be placed into such a system.
2. File names should have no more than 31 characters. The allowed characters are the letters A–Z, the numbers 0–9, and separators '.' and '_'. (These limitations are for consistency with ISO 9660 Level 2 specifications.)
3. File names should start with 'GL' and include (in order):
   i. The "logical" instrument: G (GBM), L (LAT), S (spacecraft);
   ii. Two characters indicating data type, e.g., EV (Event), PH (Photon), HK (Housekeeping);
   iii. Identifier such as burst trigger number (BN####) or day (yymmdd) and time (hhmm);
   iv. Identifier for the contact number for that day (C#), for data products that will be produced once per data downlink.
   v. Version number, such as V03;
   vi. Three-character format type as file extension, e.g., .FIT (FITS);

An example file name is GLL_ EV_060705_C2_V03.FIT, the 3rd version of a FITS file with event data from the second downlink contact commencing on July 5, 2006 (UT), by GLAST's LAT instrument.

2.5 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 followed by any number of extension header-data units. The FITS standard allows duplication of metadata between primary and extension headers, but in order to make the files easier to maintain the data product descriptions here have been defined to minimize repetition. The GLAST convention is that keywords identifying the origin of the data (e.g., the

instrument name, the date of the information, the processing software) will be in the primary header, and keywords necessary for processing the data (e.g., the reference time for the data in an extension table) will be in an extension header.

The following information should be in one of the headers:

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

2. Sufficient information to identify the mission (TELESCOP keyword) and instrument (INSTRUME keyword). AUTHOR is the person running the software that produced the file.

3. HEASARC HDU keywords (HEASARC FITS Working Group Recommendation R8), to the extent practical (whether GLAST-specific HDUCLASS definitions will be useful is TBD);

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 HEASARC 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;

7. CHECKSUM and DATASUM keywords for verification of file integrity (Seaman & Pence 1995), in each header.

2.6 Data Product Delivery

The data products will be transferred between ground system elements using the FTS protocol. The protocol includes validation of the transferred files and notification of the sending element that the transfer has been successful.

3. Summary of Data Products

The tables below are organized by the sources of the relevant data. The data products are identified by 2 letters—the first indicating the node producing the data product, the second the node receiving the data—and then by a number. In the table, latency is defined to mean the interval of time between the arrival at the producing node of the last byte of information needed to produce the data product and the data product's availability for transfer to the receiving node.

Table 3-1: GIOC Data Products

ICD ID	Product	Description	Delivered	Latency	Size (bytes)	Deliver to
GS-001	CTIME (daily version)	For each detector, the counts accumulated every 0.256 s in 8 energy channels	1/day	1 day	250 M	GSSC
GS-002	CSPEC (daily version)	For each detector, the counts accumulated every 8.192 s in 128 energy channels	1/day	1 day	250 M	GSSC
GS-004	GBM Housekeeping (GHK)	Housekeeping sent through the 1553 bus	1/day	1 day	20–35 M	GSSC
GS-005	GBM gain and energy resolution history	History of the detector gains and energy resolutions; required for calculating DRMs.	1/day	1 day		GSSC
GS-006	GLAST position and attitude history	History of GLAST's position and attitude, required for calculating DRMs	1/day	1 day		GSSC
GS-007	GBM PHA Look-Up Tables	Tables of the correspondence between energy channels and the photopeak energy	On update	NA		GSSC
GS-008	GBM Calibration	Tables of fiducial detector response parameters from which the burst-specific DRMs are calculated	On update	N/A		GSSC
GS-101	CTIME (burst version)	For each detector, the counts accumulated every 0.256 s in 8 energy channels	Per burst	1 day		GSSC
GS-102	CSPEC (burst version)	For each detector, the counts accumulated every 8.192 s in 128 energy channels	Per burst	1 day		GSSC
GS-103	GBM TTE	Event data for the burst	Per burst	1 day		GSSC
GS-104	GBM DRMs	8 and 128 energy channel DRMs for all 14 detectors	Per burst	1 day		GSSC
GS-106	Preliminary GBM Burst Catalog Entry	Preliminary values of the quantities describing the burst (e.g., durations, fluences)	Per burst	1 day		GSSC
GS-107	GBM TRIGDAT	All the GBM's messages downlinked through TDRSS	Per burst	1 day		GSSC
GS-108	GBM Background Files	Backgrounds for spectral fitting	Per burst	1 day		GSSC

GS-206	GBM Burst Catalog	Characterization of triggers considered bursts	On update	N/A	50 M	GSSC
GS-207	Trigger catalog	List and characterization of triggered events	On update	N/A	TBD	GSSC
GS-306	Burst spectra catalog	Catalog of deconvolved spectra	On update	N/A	TBD	GSSC

Table 3-2: ISOC Data Products

ICD ID	Product	Description	Delivered	Latency	Size (bytes)	Deliver to
LS-002	LAT Events	Subset of merit n-tuple for subset of the events telemetered to the ground	Per Ku downlink (~6 per day)	1 day	250 M	GSSC
LS-003	LAT Low-Level Calibration	Calibration information for the subsystems, e.g., dead, off or noisy TKR strips, ACD tile status and PMT gains, CAL status and light sharing.	Weekly	1 week	TBD	GSSC
LS-004	LAT IRFs	Full IRF for all possible parameters	On update	N/A	5 M	GSSC
LS-005	LAT Pointing and Livetime History	LAT orientation and mode at 30 s intervals; used to calculate exposures	Per Ku downlink (~6 per day)	1 day	100 k	GSSC
LS-006	LAT Configuration history	Detailed LAT configuration history, all registers of each subsystem as updated	On update	12 hours	1 M	GSSC
LS-007	LAT Transient Data	Summary information for transient sources (GRBs, solar flares, and AGN flares) derived from LAT event data	Per transient	8 hours	100 k	GSSC
LS-008	LAT Point Source Catalog	Table of detected gamma-ray sources with derived information	On update	N/A	10 M	GSSC
LS-009	LAT Burst Catalog	List and characterization of gamma-ray bursts; location, duration, intensity	On update	N/A	TBD	GSSC
LS-010	Interstellar Emission Model	Model for diffuse gamma-ray emission from the Milky Way, input for high-level data analysis; will be refined using GLAST data	Initial model updated periodically	N/A	40 M	GSSC

Table 3-3: GSSC Data Products

ICD ID	Product	Description	Created	Production Latency	Size
SS-001	LAT photons	Selected parameters from the subset of events identified as gamma-ray photons	Daily	1 day	25 M
SS-002	Pulsar Ephemerides	Ephemerides of pulsars that may be detectable by the LAT	Periodically	N/A	TBD

4. References

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 Operations Concept Document (433-OPS-0001)

GLAST Spacecraft Performance Specification (433-SPEC-0003)

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

HEASARC 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

Appendix A. Detailed Descriptions of the Data Products

Descriptions of the data products are given below. For the data products whose contents are understood well enough at this time, specifications of their contents are provided using FITS keywords.

GS-001 CTIME

Interface definition	Version 0.2, Nov. 8, 2001
Interface ID	GS-001
Name of Product	CTIME (daily version)
NamingConvention	GLG_CT_N0_YYMMDD_V01.PHA or GLG_CT_B0_YYMMDD_V01.PHA
Originator of Product	GIOC
Description of Product	GBM counts from each detector (12 NaI, 2 BGO) binned in 8 energy bins and 0.256 s time bins. One file contains the counts from one detector for a full day. The format is an OGIP-standard PHA file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 day
Number of deliveries per day	1
Typical size	250 MB

Product Content Header:	Standard GLAST GBM FITS Header
Primary Table	None

Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS Rate Data Extension Header	
Extension Name	GBM_RATE_DATA	
Column Number	Column Name	Units
1	Start and stop times of spectral accumulation	Seconds
2	Count rates in the accumulation interval	Count / s
3	Livetime during accumulation interval	Seconds

GS-001 Primary Header Keywords

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
HDUCLASS	“OGIP”	Conforms to the OGIP standard indicated in the next keyword
HDUVERS	“1.0.0”	
HDUCLAS1	“RATE”	This is rate data, not photon or counts
FILETYPE	“GBM RATE DATA”	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-DD	Date of start of observation
DATE_END	YYYY-MM-DD	Date of end of observation
TIME-OBS	HH:MM:SS.ssss	Time of start of observation
TIME-END	HH:MM:SS.ssss	Time of end of observation
FILENAME	“GLG_CT_N0_YYMMDD_V01.PHA”	Name of this file
TELESCOP	“GLAST”	Name of mission / spacecraft
INSTRUME	“GBM”	Name of instrument generating data
DETECTOR	“NAI_0”	Individual detector name
DATATYPE	“CTIME”	Name of the primary datatype making up this file
OBSERVER	“Meegan”	Name of instrument PI
AUTHOR	“Preece”	Name of person responsible for file generation
TIMESYS	“UTC”	Time system used in time keywords
TIMEUNIT	s	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	0	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	86400	Time of end of observation offset from TZERO in units of TIMEUNIT
OBJECT	“GRB0600401”	Object Designation (used for trigger data)
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
PRIMTYPE	“NONE”	No primary array
END		End of Header

GS-001 Extension Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	123	Number of bytes per row
NAXIS2	####	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM-CAL-EXT"	Unique name for this extension type
TFIELDS	15	Number of fields per row
TFORM1	1D	Double precision floating point
TTYPE1	"CAL-STRT"	Start time of calibration record
TUNIT1	"MET"	Mission elapsed time
TFORM2	1D	Double precision floating point
TTYPE2	"CAL-STOP"	End time of calibration record
TUNIT2	"MET"	Mission elapsed time
TFORM3	E	
TTYPE3	'RA'	RA of zenith pointing at start of interval
TUNIT3	'deg'	
TLMIN3	0.0	Minimum value
TLMAX3	360.0	Maximum value
TFORM4	E	
TTYPE4	'DEC'	DEC of zenith pointing at start of interval
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TFORM5	E	
TTYPE5	''DEL-POS'	Change in zenith position over the observing interval
TUNIT5	'deg'	
TFORM6	E	
TTYPE6	GEOC-EL	Angle from SC equator to earth
TUNIT6	'deg'	
TLMIN6	90.0	Minimum value
TLMAX6	-90.0	Maximum value
TFORM7	E	
TTYPE7	GEOC-AZ	Angle from +x S/C axis to earth equator
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value

TFORM8	E	
TTYPE8	SC-X-POS	Earth-S/C x coordinate
TUNIT8	'KM'	
TFORM9	E	
TTYPE9	SC-Y-POS	Earth-S/C y coordinate
TUNIT9	'KM'	
TFORM10	E	
TTYPE10	SC-Z-POS	Earth-S/C z coordinate
TUNIT10	'KM'	
TFORM11	PE(4)	Variable-length array of single precision floats
TTYPE11	"LINE-NRG"	Energy of calibration line
TUNIT11	"keV"	
TFORM12	PI(4)	Variable-length integer array
TTYPE12	"LINECHAN"	Centroid channel of calibration line(s)
TUNIT12	"DIMENSIONLESS"	
TFORM13	PI(4)	Variable-length integer array
TTYPE13	"LINE-ERR"	Uncertainty in line centroid
TUNIT13	"DIMENSIONLESS"	
TFORM14	257E	Single floating-point array
TTYPE14	"THRESHOLDS"	Fiducial energy loss thresholds array
TUNIT14	"keV"	
TFORM15	16A	
TTYPE15	"DET-ID"	Name of the GBM detector; e.g. NAI0
TFORM16	16A	
TTYPE16	"CAL-NAME"	Name of channel-to-energy calibration scheme used
END		

GS-001 Extension Header 2

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 spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM_RATE_EXT"	Unique name for this extension type
TFIELDS	3	Number of fields per row
TFORM1	2D	Double precision floating point
TTYPE1	"TIMES"	Start and stop times of spectral accumulation
TUNIT1	"s"	Units of field
TFORM2	8E	Single precision floating point
TTYPE2	"RATES"	Count rates in the accumulation interval
TUNIT2	"count / s"	Units of field
TFORM3	E	
TTYPE3	"LIVETIME"	Livetime during accumulation interval
TUNIT3	"s"	
END		

GS-002 CTIME

Interface definition	Version 0.2, Nov. 8, 2001
Interface ID	GS-002
Name of Product	CSPEC (daily version)
NamingConvention	GLG_CS_N0_YYMMDD_V01.PHA or GLG_CS_B0_YYMMDD_V01.PHA
Originator of Product	GIOC
Description of Product	GBM counts from each detector (12 NaI, 2 BGO) binned in 128 energy bins and 8.192 s time bins. One file contains the counts from one detector for a full day. The format is an OGIP-standard PHA file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 day
Number of deliveries per day	1
Typical size	250 MB

Product Content Header:	Standard GLAST GBM FITS Header
Primary Table	None

Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS Rate Data Extension Header	
Extension Name	GBM_RATE_DATA	
Column Number	Column Name	Units
1	Start and stop times of spectral accumulation	Seconds
2	Count rates in the accumulation interval	Count / s
3	Livetime during accumulation interval	Seconds

GS-002 Primary Header Keywords

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
HDUCLASS	“OGIP”	Conforms to the OGIP standard indicated in the next keyword
HDUVERS	“1.0.0”	
HDUCLAS1	“RATE”	This is rate data, not photon or counts
FILETYPE	“GBM RATE DATA”	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-DD	Date of start of observation
DATE_END	YYYY-MM-DD	Date of end of observation
TIME-OBS	HH:MM:SS.ssss	Time of start of observation
TIME-END	HH:MM:SS.ssss	Time of end of observation
FILENAME	“GLG_CS_NAI0_YYMMDD_V01.PHA”	Name of this file
TELESCOP	“GLAST”	Name of mission / spacecraft
INSTRUME	“GBM”	Name of instrument generating data
DETECTOR	“NAI_0”	Individual detector name
DATATYPE	“CTIME”	Name of the primary datatype making up this file
OBSERVER	“Meegan”	Name of instrument PI
AUTHOR	“Preece”	Name of person responsible for file generation
TIMESYS	“UTC”	Time system used in time keywords
TIMEUNIT	s	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	0	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	86400	Time of end of observation offset from TZERO in units of TIMEUNIT
OBJECT	“GRB0600401”	Object Designation (used for trigger data)
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
PRIMTYPE	“NONE”	No primary array
END		End of Header

GS-002 Extension Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	123	Number of bytes per row
NAXIS2	####	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM-CAL-EXT"	Unique name for this extension type
TFIELDS	15	Number of fields per row
TFORM1	1D	Double precision floating point
TTYPE1	"CAL-STRT"	Start time of calibration record
TUNIT1	"MET"	Mission elapsed time
TFORM2	1D	Double precision floating point
TTYPE2	"CAL-STOP"	End time of calibration record
TUNIT2	"MET"	Mission elapsed time
TFORM3	E	
TTYPE3	'RA'	RA of zenith pointing at start of interval
TUNIT3	'deg'	
TLMIN3	0.0	Minimum value
TLMAX3	360.0	Maximum value
TFORM4	E	
TTYPE4	'DEC'	DEC of zenith pointing at start of interval
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TFORM5	E	
TTYPE5	''DEL-POS'	Change in zenith position over the observing interval
TUNIT5	'deg'	
TFORM6	E	
TTYPE6	GEOC-EL	Angle from SC equator to earth
TUNIT6	'deg'	
TLMIN6	90.0	Minimum value
TLMAX6	-90.0	Maximum value
TFORM7	E	
TTYPE7	GEOC-AZ	Angle from +x S/C axis to earth equator
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value

TFORM8	E	
TTYPE8	SC-X-POS	Earth-S/C x coordinate
TUNIT8	'KM'	
TFORM9	E	
TTYPE9	SC-Y-POS	Earth-S/C y coordinate
TUNIT9	'KM'	
TFORM10	E	
TTYPE10	SC-Z-POS	Earth-S/C z coordinate
TUNIT10	'KM'	
TFORM11	PE(4)	Variable-length array of single precision floats
TTYPE11	"LINE-NRG"	Energy of calibration line
TUNIT11	"keV"	
TFORM12	PI(4)	Variable-length integer array
TTYPE12	"LINECHAN"	Centroid channel of calibration line(s)
TUNIT12	"DIMENSIONLESS"	
TFORM13	PI(4)	Variable-length integer array
TTYPE13	"LINE-ERR"	Uncertainty in line centroid
TUNIT13	"DIMENSIONLESS"	
TFORM14	257E	Single floating-point array
TTYPE14	"THRESHOLDS"	Fiducial energy loss thresholds array
TUNIT14	"keV"	
TFORM15	16A	
TTYPE15	"DET-ID"	Name of the GBM detector; e.g. NAI0
TFORM16	16A	
TTYPE16	"CAL-NAME"	Name of channel-to-energy calibration scheme used
END		

GS-002 Extension Header 2

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 spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM_RATE_EXT"	Unique name for this extension type
TFIELDS	3	Number of fields per row
TFORM1	2D	Double precision floating point
TTYPE1	"TIMES"	Start and stop times of spectral accumulation
TUNIT1	"s"	Units of field
TFORM2	8E	Single precision floating point
TTYPE2	"RATES"	Count rates in the accumulation interval
TUNIT2	"count / s"	Units of field
TFORM3	E	
TTYPE3	"LIVETIME"	Livetime during accumulation interval
TUNIT3	"s"	
END		

GS-004 GBM Housekeeping (GHK)

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-004
Name of Product	GBM Housekeeping (GHK)
NamingConvention	GLG_GHK_YYMMDD_V01.FIT
Originator of Product	GIOC
Description of Product	GBM housekeeping sent through the 1553 bus
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 day
Number of deliveries per day	1
Typical size	250 MB

GS-005 GBM Gain and Energy Resolution History

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-005
Name of Product	GBM Gain and Energy Resolution History
NamingConvention	GLG_GERH_YYMMDD_V01.FIT
Originator of Product	GIOC
Description of Product	History of the detector gains and energy resolutions; required for calculating DRMs
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 day
Number of deliveries per day	1
Typical size	250 MB

GS-006 GLAST Position and Attitude History

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-006
Name of Product	GLAST Position and Attitude History
NamingConvention	GLG_PAH_YYMMDD_V01.FIT
Originator of Product	GIOC
Description of Product	GLAST Position and Attitude History, delivered daily
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 day
Number of deliveries per day	1
Typical size	250 MB

GS-007 GBM PHA Look-Up Tables

Interface definition	Version 0.1, June 3, 2004
Interface ID	GS-007
Name of Product	GBM PHA Look-Up Tables
NamingConvention	GLG_LUT_CT_N_V01.FIT, GLG_LUT_CT_B_V01.FIT, GLG_LUT_CS_N_V01.FIT, GLG_LUT_CS_B_V01.FIT,
Originator of Product	GIOC
Description of Product	GBM PHA look-up tables providing the correspondence between PHA channels and photopeak energy. There is one file per detector type (NaI or BGO) for each of the CTIME and CSPEC data types.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	NA
Product contains data for	NA
Number of deliveries per day	On update
Typical size	250 MB

GS-008 GBM Calibration

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-008
Name of Product	GBM Calibration
NamingConvention	GLG_CAL_N0_V01.FIT, GLG_CAL_B0_V01.FIT
Originator of Product	GIOC
Description of Product	Tables of fiducial detector response parameters from which the burst-specific DRMs are calculated, one per detector
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	NA
Product contains data for	NA
Number of deliveries per day	On update
Typical size	250 MB

GS-101 CTIME (burst version)

Interface definition	Version 0.2, Nov. 8, 2001
Interface ID	GS-101
Name of Product	CTIME (burst version)
NamingConvention	GLG_CT_N0_BNYYMMDDFFF_V01.PHA or GLG_CT_B0_BNYYMMDDFFF_V01.PHA
Originator of Product	GIOC
Description of Product	GBM counts from each detector (12 NaI, 2 BGO) binned in 8 energy bins and 0.256 s time bins. One file contains the counts from 4000 s before to 4000 s after a burst trigger. The format is an OGIP-standard PHA file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	250 MB

Product Content Header:	Standard GLAST GBM FITS Header
Primary Table Column Names	None
Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS Rate Data Extension Header
Extension Name	GBM_RATE_DATA

Column Number	Column Name	Units
1	Start and stop times of spectral accumulation	Seconds
2	Count rates in the accumulation interval	Count / s
3	Livetime during accumulation interval	Seconds

GS-101 Primary Header Keywords—same as GS-001 Primary Header Keywords except:

FITS Keyword	Value	Purpose
FILETYPE	“GBM RATE DATA”	Name for this type of FITS file (should be unique)
FILENAME	“GLG_CT_N0_YYMMDDFFF_V01.PHA”	Name of this file
DATATYPE	“CTIME”	Name of the primary datatype making up this file
OBJECT	“GRBYYMMDD.FFF”	Object Designation (used for trigger data)
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)

GS-001 Extension Header 1—same as GS-001 Extension Header 1

GS-101 Extension Header 2—same as GS-001 Extension Header 2

GS-102 CSPEC (burst version)

Interface definition	Version 0.2, Nov. 8, 2001
Interface ID	GS-103
Name of Product	CSPEC (burst version)
NamingConvention	GLG_CT_N0_BNYYMMDDFFF_V01.PHA or GLG_CT_B0_BNYYMMDDFFF_V01.PHA
Originator of Product	GIOC
Description of Product	GBM counts from each detector (12 NaI, 2 BGO) binned in 128 energy bins and 8.192 s time bins. One file contains the counts from one detector from 4000 s before to 4000 s after a burst trigger. The format is an OGIP-standard PHA file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	250 MB

Product Content Header:	Standard GLAST GBM FITS Header
Primary Table Column Names	None
Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS Rate Data Extension Header
Extension Name	GBM_RATE_DATA

Column Number	Column Name	Units
1	Start and stop times of spectral accumulation	Seconds
2	Count rates in the accumulation interval	Count / s
3	Livetime during accumulation interval	Seconds

GS-102 Primary Header Keywords—same as GS-002 Primary Header Keywords, except:

FITS Keyword	Value	Purpose
FILETYPE	“GBM RATE DATA”	Name for this type of FITS file (should be unique)
FILENAME	“GLG_CS_N0_BNYY MMDDFFF_V01.PHA”	Name of this file
TELESCOP	“GLAST”	Name of mission / spacecraft
INSTRUME	“GBM”	Name of instrument generating data
DETECTOR	“NAI_0”	Individual detector name
DATATYPE	“CTIME”	Name of the primary datatype making up this file
OBJECT	“GRBYYMMDD.FFF”	Object Designation (used for trigger data)

GS-102 Extension Header 1—same as GS-002 Extension Header 1

GS-102 Extension Header 2—same as GS-002 Extension Header 2

GS-103 GBM TTE

Interface definition	Version 0.2, Nov. 8, 2001
Interface ID	GS-103
Name of Product	GBM TTE
NamingConvention	GLG_TTE_ALL_BNYYMMDDFFF_V01.FIT
Originator of Product	GIOC
Description of Product	File containing individual photons at 256 fiducial energies, accumulated in each GBM detector.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	20–35 MB

Product Content Header:	Standard GLAST GBM FITS Header
Primary Table Column Names	None
Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS List Data Extension Header
Extension Name	GBM_LIST_DATA

Column Number	Column Name	Units
1	Arrival time of recorded event	Seconds, relative to trigger time
2	Detector ID of recorded event	Dimensionless
3	Channel number of recorded event	Dimensionless

GS-103 Primary Header Keywords

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
HDUCLASS	“OGIP”	Conforms to the OGIP standard indicated in the next keyword
HDUVERS	“1.0.0”	
HDUCLAS1	“PHOTON”	This is photon list data, not rates or counts
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-DD	Date file was made
ORIGIN	“GIOC”	Name of organization making file
DATE_OBS	YYYY-MM-DD	Date of start of observation
DATE_END	YYYY-MM-DD	Date of end of observation
TIME-OBS	HH:MM:SS.ssss	Time of start of observation
TIME-END	HH:MM:SS.ssss	Time of end of observation
FILENAME	“GLG_TTE_ALL_BN060401FFF_V01.FIT”	Name of this file
TELESCOP	“GLAST”	Name of mission / spacecraft
INSTRUME	“GBM”	Name of instrument generating data
DETECTOR	“NAI_0”	Individual detector name
DATATYPE	“TTE”	Name of the primary datatype making up this file
OBSERVER	“Meegan”	Name of instrument PI
AUTHOR	“Preece”	Name of person responsible for file generation
TIMESYS	“UTC”	Time system used in time keywords
TIMEUNIT	s	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	0	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	86400	Time of end of observation offset from TZERO in units of TIMEUNIT
OBJECT	“GRB06004.FFF”	Object Designation (used for trigger data)
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
PRIMTYPE	“NONE”	No primary array
END		End of Header

GS-103 Extension Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	123	Number of bytes per row
NAXIS2	####	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM-CAL-EXT"	Unique name for this extension type
TFIELDS	15	Number of fields per row
TFORM1	1D	Double precision floating point
TTYPE1	"CAL-STRT"	Start time of calibration record
TUNIT1	"MET"	Mission elapsed time
TFORM2	1D	Double precision floating point
TTYPE2	"CAL-STOP"	End time of calibration record
TUNIT2	"MET"	Mission elapsed time
TFORM3	E	
TTYPE3	'RA'	RA of zenith pointing at start of interval
TUNIT3	'deg'	
TLMIN3	0.0	Minimum value
TLMAX3	360.0	Maximum value
TFORM4	E	
TTYPE4	'DEC'	DEC of zenith pointing at start of interval
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TFORM5	E	
TTYPE5	'DEL-POS'	Change in zenith position over the observing interval
TUNIT5	'deg'	
TFORM6	E	
TTYPE6	GEOC-EL	Angle from SC equator to earth
TUNIT6	'deg'	
TLMIN6	90.0	Minimum value
TLMAX6	-90.0	Maximum value
TFORM7	E	
TTYPE7	GEOC-AZ	Angle from +x S/C axis to earth equator
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value

TFORM8	E	
TTYPE8	SC-X-POS	Earth-S/C x coordinate
TUNIT8	'KM'	
TFORM9	E	
TTYPE9	SC-Y-POS	Earth-S/C y coordinate
TUNIT9	'KM'	
TFORM10	E	
TTYPE10	SC-Z-POS	Earth-S/C z coordinate
TUNIT10	'KM'	
TFORM11	PE(4)	Variable-length array of single precision floats
TTYPE11	"LINE-NRG"	Energy of calibration line
TUNIT11	"keV"	
TFORM12	PI(4)	Variable-length integer array
TTYPE12	"LINECHAN"	Centroid channel of calibration line(s)
TUNIT12	"DIMENSIONLESS"	
TFORM13	PI(4)	Variable-length integer array
TTYPE13	"LINE-ERR"	Uncertainty in line centroid
TUNIT13	"DIMENSIONLESS"	
TFORM14	257E	Single floating-point array
TTYPE14	"THRESHOLDS"	Fiducial energy loss thresholds array
TUNIT14	"keV"	
TFORM15	16A	
TTYPE15	"DET-ID"	Name of the GBM detector; e.g. NAI0
TFORM16	16A	
TTYPE16	"CAL-NAME"	Name of channel-to-energy calibration scheme used
END		

GS-103 Extension Header 2

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 spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM_LIST_EXT"	Unique name for this extension type
TRIG_TIME	####	Trigger time in units of seconds of day (single floating point number)
TFIELDS	3	Number of fields per row
TFORM1	E	Single precision floating point
TTYPE1	"TIME"	Arrival time of recorded event
TUNIT1	"s"	Units of field
TFORM2	I	Single precision integer
TTYPE2	"DETECTOR"	Detector ID of recorded event
TUNIT2	"DIMENSIONLESS"	Units of field
TFORM3	I	Single precision integer
TTYPE3	"CHANNEL"	Channel number of recorded event
TUNIT3	"DIMENSIONLESS"	Units of field
END		

GS-104 GBM DRMs

Interface definition	Version 0.2, Nov. 20, 2001
Interface ID	GS-104
Name of Product	GBM DRMs
NamingConvention	GLG_DRM_N0_BNYYMMDDFFF_V01.RMF
Originator of Product	GIOC
Description of Product	File containing detector response functions for one GBM detector. May contain several different pointings as the spacecraft slews past the source. The format is an OGIP-standard RMF file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
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 MB

Product Content	
Header:	Standard GLAST GBM FITS Header (See ICD GBM-001)
Primary Table Column Names	None
Extension 1	Standard GLAST GBM FITS Energy Calibration Extension Header
Extension Name	GBM_ENERGY_CAL

Column Number	Column Name	Units
1	Start time of calibration record	MJD
2	End time of calibration record	MJD
3	RA of zenith pointing, J2000	Degrees
4	DEC of zenith pointing, J2000	Degrees
5	Uncertainty in zenith position	Degrees
6	Angle from zenith to earth	Degrees
7	Angle from +x S/C axis to earth equator	Degrees
8	Earth-S/C x coordinate	km
9	Earth-S/C y coordinate	km
10	Earth-S/C z coordinate	km
11	Energy of calibration line	keV
12	Centroid channel of calibration line(s)	Dimensionless
13	Uncertainty in line centroid	Dimensionless
14	Energy loss thresholds array	keV
15	Name of the GBM detector; e.g. NAI0	Dimensionless
16	Name of channel-to-energy calibration scheme used	Dimensionless

Extension 2	Standard GLAST GBM FITS List Data Extension Header

Extension Name	GBM_DRM_EXT	
Column Number	Column Name	Units
1	The times of applicability for the DRM	Seconds, relative to trigger time
2	Detector ID	Dimensionless
3	Type of matrix (0=Direct,1=Scattered, 2=Summed)	Dimensionless
4	number of rows in PHT_EDGE	Dimensionless
5	number of columns in E_EDGES	Dimensionless
6	number of elements in N_ZEROS	Dimensionless
7	number of rows in the DRM	Dimensionless
8	input bin energy edges (PHT_EDGE)	keV
9	number of of zeroes at the top of each column (N_ZEROS)	Dimensionless
10	detector response matrix	cm**2
	Note: For now, we assume BATSE DRM format. OGIP-compliant .rmf files may be substituted later. The BATSE DRMs are compressed by removing the upper ‘triangle’ of zero elements (as indicated by the N_ZEROS array). The ramaining elements are concatenated to	

GS-104 Primary Header Keywords

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
HDUCLASS	"OGIP"	Conforms to the OGIP standard indicated in the next keyword
HDUVERS	"1.0.0"	
HDUCLAS1	"RSP"	This is a detector response function
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		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-DD	Date of start of observation
DATE_END	YYYY-MM-DD	Date of end of observation
TIME-OBS	HH:MM:SS.ssss	Time of start of observation
TIME-END	HH:MM:SS.ssss	Time of end of observation
FILENAME	GLG_DRM_N0_BNYYMMDDFFF_V01.FIT	Name of this file
TELESCOP	"GLAST"	Name of mission / spacecraft
INSTRUME	"GBM"	Name of instrument generating data
DETECTOR	"NAI_0"	Individual detector name
DATATYPE	"DRM"	Name of the primary datatype making up this file
OBSERVER	"Meegan"	Name of instrument PI
AUTHOR	"Preece"	Name of person responsible for file generation
TIMESYS	"UTC"	Time system used in time keywords
TIMEUNIT	s	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	0	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	86400	Time of end of observation offset from TZERO in units of TIMEUNIT
OBJECT	"GRB06004.FFF"	Object Designation (used for trigger data)
RA_OBJ		RA of source (used for trigger data)
DEC_OBJ		DEC of source (used for trigger data)
PRIMTYPE	"NONE"	No primary array
END		End of Header

GS-104 Extension Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	
NAXIS	2	# of axes=2
NAXIS1	123	Number of bytes per row
NAXIS2	####	Number of calibration records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM-CAL-EXT"	Unique name for this extension type
TFIELDS	15	Number of fields per row
TFORM1	1D	Double precision floating point
TTYPE1	"CAL-STRT"	Start time of calibration record
TUNIT1	"MET"	Mission elapsed time
TFORM2	1D	Double precision floating point
TTYPE2	"CAL-STOP"	End time of calibration record
TUNIT2	"MET"	Mission elapsed time
TFORM3	E	
TTYPE3	'RA'	RA of zenith pointing at start of interval
TUNIT3	'deg'	
TLMIN3	0.0	Minimum value
TLMAX3	360.0	Maximum value
TFORM4	E	
TTYPE4	'DEC'	DEC of zenith pointing at start of interval
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TFORM5	E	
TTYPE5	''DEL-POS'	Change in zenith position over the observing interval
TUNIT5	'deg'	
TFORM6	E	
TTYPE6	GEOC-EL	Angle from SC equator to earth
TUNIT6	'deg'	
TLMIN6	90.0	Minimum value
TLMAX6	-90.0	Maximum value
TFORM7	E	
TTYPE7	GEOC-AZ	Angle from +x S/C axis to earth equator
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value

TFORM8	E	
TTYPE8	SC-X-POS	Earth-S/C x coordinate
TUNIT8	'KM'	
TFORM9	E	
TTYPE9	SC-Y-POS	Earth-S/C y coordinate
TUNIT9	'KM'	
TFORM10	E	
TTYPE10	SC-Z-POS	Earth-S/C z coordinate
TUNIT10	'KM'	
TFORM11	PE(4)	Variable-length array of single precision floats
TTYPE11	"LINE-NRG"	Energy of calibration line
TUNIT11	"keV"	
TFORM12	PI(4)	Variable-length integer array
TTYPE12	"LINECHAN"	Centroid channel of calibration line(s)
TUNIT12	"DIMENSIONLESS"	
TFORM13	PI(4)	Variable-length integer array
TTYPE13	"LINE-ERR"	Uncertainty in line centroid
TUNIT13	"DIMENSIONLESS"	
TFORM14	257E	Single floating-point array
TTYPE14	"THRESHOLDS"	Fiducial energy loss thresholds array
TUNIT14	"keV"	
TFORM15	16A	
TTYPE15	"DET-ID"	Name of the GBM detector; e.g. NAI0
TFORM16	16A	
TTYPE16	"CAL-NAME"	Name of channel-to-energy calibration scheme used
END		

GS-104 Extension Header 2

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 spectral accumulation records
PCOUNT	0	No extra bits in table
GCOUNT	1	No multiplier
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	"GBM_DRM_EXT"	Unique name for this extension type
TRIG_TIME	####	Trigger time in units of seconds of day (single floating point number)
TFIELDS	10	Number of fields per row
TFORM1	2E	Single precision floating point
TTYPE1	"TIMES"	The times of applicability for the DRM
TUNIT1	"s"	Seconds of day
TFORM2	16A	
TTYPE2	"DET-ID"	Name of the GBM detector; e.g. NAI0
TUNIT2	"DIMENSIONLESS"	Units of field
TFORM3	I	Single precision integer
TTYPE3	"MAT_TYPE"	0=Direct,1=Scattered, 2= Both, 3=Summed
TUNIT3	"DIMENSIONLESS"	Units of field
TFORM4	I	Single precision integer
TTYPE4	"NUMEBINS"	number of rows in PHT_EDGE
TUNIT4	"DIMENSIONLESS"	Units of field
TFORM5	I	Single precision integer
TTYPE5	"NUMCHAN"	number of columns in E_EDGES
TUNIT5	"DIMENSIONLESS"	Units of field
TFORM6	I	Single precision integer
TTYPE6	"NUMZERO"	number of elements in N_ZEROS
TUNIT6	"DIMENSIONLESS"	Units of field
TFORM7	J	Double precision integer
TTYPE7	"NUMDRM"	number of rows in the DRM
TUNIT7	"DIMENSIONLESS"	Units of field
TFORM8	####E	Array of NUMEBINS + 1 single-precision floats
TTYPE8	"PHT_EDGE"	input bin energy edges
TUNIT8	"keV"	Units of field
TFORM9	PI(####)	Array of NUMZERO single precision integer

TTYPE9	"N_ZEROS"	number of of zeroes at the top of each column
TUNIT9	"DIMENSIONLESS"	Units of field
TFORM10	PE(####)	Variable-length array of NUMDRM single-precision floats
TTYPE10	"DRM"	detector response matrix
TUNIT10	"cm**2"	Units of field

END

GS-106 Preliminary GBM Burst Catalog Entry

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-106
Name of Product	Preliminary GBM Burst Catalog Entry
NamingConvention	GLG_PCAT_BNYYMMDDFFF_V01.FIT
Originator of Product	GIOC
Description of Product	Preliminary values of the quantities characterizing a burst (e.g., duration, fluence) for use in BROWSE interface to burst data
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	250 MB

GS-107 GBM TRIGDAT

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-107
Name of Product	GBM TRIGDAT
NamingConvention	GLG_TDAT_BNYYMMDDFFF_V01.FIT
Originator of Product	GIOC
Description of Product	Compilation of all the GBM-generated TRIGDAT messages (burst messages downlinked through TDRSS) for a given burst
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	250 MB

GS-108 GBM Background Files

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-108
Name of Product	GBM Background Files
NamingConvention	GLG_BCK_N0_BNYYMMDDFFF_V01.BAK
Originator of Product	GIOC
Description of Product	Background for GBM detectors for a given burst. The format is an OGIP-standard PHA file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 burst
Number of deliveries per day	Average of 1/3-1/2
Typical size	250 MB

GS-206 GBM Burst Catalog

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-206
Name of Product	GBM Burst Catalog
NamingConvention	GLG_GRB_CAT_V01.FIT
Originator of Product	GIOC
Description of Product	List and characterization of all triggers identified as bursts
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 year (TBR)
Product contains data for	Mission since previous release until current release, with possible revisions of previous releases
Number of deliveries per day	NA—released once per year (TBR)
Typical size	250 MB

GS-207 GBM Trigger Catalog

Interface definition	Version 0.1,June 1, 2004
Interface ID	GS-207
Name of Product	GBM Trigger Catalog
NamingConvention	GLG_TRIG_CAT_V01.FIT
Originator of Product	GIOC
Description of Product	List and characterization of all GBM triggers
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 year (TBR)
Product contains data for	Mission since previous release until current release, with possible revisions of previous releases
Number of deliveries per day	NA—released once per year (TBR)
Typical size	250 MB

GS-306 GBM Burst Spectra Catalog

Interface definition	Version 0.1, June 1, 2004
Interface ID	GS-306
Name of Product	GBM Burst Spectra Catalog
NamingConvention	GLG_GRB_SPEC_CAT_V01.FIT
Originator of Product	GIOC
Description of Product	Catalog of deconvolved spectra
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 year (TBR)
Product contains data for	Mission since previous release until current release, with possible revisions of previous releases
Number of deliveries per day	NA—released once per year (TBR)
Typical size	250 MB

LS-002 Event Summary Data

Interface definition	version 0.6, 30 Oct 2001 (updated file naming, units, primary header); 0.7, 20 Nov 2001 (reformatted some text)
Interface ID	LS-002
Name of Product	Event Summary
Fulfills requirement:	TBD
Naming Convention	GLL_EVSUM_YYMMDD_C#_V##.FIT
Originator of Product	LIOC
Description of Product	Database with summary information for each LAT event telemetered to the ground
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	1 day
Product contains data for	1 Ku Band Downlink (TBR)
Number of deliveries per day	6
Typical size	250 Mbyte

Product Content

Primary HDU: Standard GLAST FITS Primary Header (primary HDU has no data)

Extension 1

Column Number	Column Name	Units
1	Energy of event	GeV
2	1-sigma uncertainty of energy	GeV
3	RA, J2000	deg
4	Dec, J2000	deg
5	Localization uncertainty, est. 1-sigma radius	deg
6	Time (Mission Elapsed Time)	s
7	Conversion layer	dimensionless
8	Number of SSD hits	dimensionless
9	Number of tracker hits NOT reconstructed	dimensionless
10	Conversion point, (x,y,z)	m
11	Reconstruction trajectory-event (dir. cosine)	dimensionless
12	Reconstruction trajectory-secondary 1 (dir. cosine)	dimensionless
13	Reconstruction trajectory secondary 2 (dir. cosine)	dimensionless
14	Secondary energies	GeV
15	ACD tiles hit (bit flags)	dimensionless
16	Quality_Parm--quality parameter for fitted trajectory	dimensionless
17	Data_Quality--Overall status of event	dimensionless
18	Deadtime accumulated since start of mission	s
19	Instrument mode (slew, diagnostic, ...)	dimensionless
20	TKR, CAL-only flag--2bit for CAL, TKR or Both	dimensionless

21	Zenith angle	deg
22	Earth azimuth angle (from north to east)	deg
23	S/C position from earth center, (x,y,z)*	km
24	Ground point--lat.	deg
25	Ground point--lon.	deg
26	Barycenter arrival time of event	s
27	Offset of Solar System Barycenter from S/C (x,y,z)	s (light travel time)
28	McIlwain B	gauss
29	McIlwain L	Earth radii
30	Geomagnetic Lat.	deg
31	Geomagnetic Long.	deg
32	Recon. version	dimensionless
33	Calib. table versions	dimensionless
34	Multiple event reconstruction	dimensionless
35	Reconstruction number within event	dimensionless
36	Original Event ID	dimensionless

The reconstructed trajectory of the photon (item 13) is in instrument coordinates, and so specifies the inclination angle and azimuth of the photon.

Instrument modes (item 19) should probably be defined in a second extension.

Perhaps multi-gamma events should just have a 'primary' gamma ray defined here, plus a flag set to indicate that special processing should be done.

* x-axis is direction RA,DEC = 0,0, z-axis is north, y-axis defined for earth-centered right-hand coordinate system, J2000

note that >1 photon can be claimed by recon (may translate into multiple Event Summary entries, with number_of_photons entry)

Quality flags above are intended to be representative of the background rejection/PSF enhancement cut parameters

Primary Header:

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	'T'	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	YYYY-MM-DD	Date file was made in YYYY-MM-DD
FILENAME	'GLL_EVSUM_YYMMDD_C#_V##.FIT'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LIOC'	Name of organization making file
DATE_OBS	'YYYY-MM-DD'	Date of start of observation (UTC)
DATE_END	'YYYY-MM-DD'	Date of end of observation (UTC)
TIME_OBS	'HH:MM:SS.ssss'	Time of start of observation (UTC)
TIME_END	'HH:MM:SS.ssss'	Time of end of observation (UTC)
GPS_OUTAGE	'Y'	Whether GPS time was unavailable at any time during this interval
GPS_CORR	'Y'	Whether a clock drift correction has been applied
AUTHOR		Name of person responsible for file generation
CREATOR	'EVENT_SUMMARY_MAKER_V##'	Software and version creating file
VERSION	#	Release version of the file
SOFTWARE	#	Version of the processing software
END		End of Header

Extension Header

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	36	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	'LAT_Event_Summary'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREF	58300	MJD date of reference epoch
TIMEUNIT	S	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	###	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from TZERO in units of TIMEUNIT
TTYPE1	'Energy'	Energy of event
TFORM1	'E'	Character string
TUNIT1	'GeV'	Units of field
TLMIN1	0	Minimum value
TLMAX1	###	Maximum value
TTYPE2	'Energy_Unc'	Est. 1-sigma uncertainty of energy
TFORM2	'E'	Floating point
TUNIT2	'GeV'	
TLMIN2	0.0	Minimum value
TLMAX2	###	Maximum value
TTYPE3	'Right_Ascension'	RA (J2000) of event
TFORM3	'E'	Floating point
TUNIT3	'deg'	
TLMIN3	0.0	Minimum value
TLMAX3	360.0	Maximum value
TTYPE4	'Declination'	Dec (J2000) of event
TFORM4	'E'	Floating point
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TTYPE5	'Direction_Unc'	Localization uncertainty, est. 1-sigma radius

TFORM5	'E'	Floating point, 3 values
TUNIT5	'deg'	
TLMIN5	0.0	Minimum value
TLMAX5	###	Maximum value
TTYPE6	'Time'	Mission Elapsed Time
TFORM6	'D'	Floating point
TUNIT6	's'	
TLMIN6	0.0	Minimum value
TLMAX6	###	Maximum value
TTYPE7	'Conversion_Layer'	Conversion layer in TKR, -1 means not in TKR
TFORM7	'I'	Integer
TUNIT7		Dimensionless
TLMIN7	-1	Minimum value
TLMAX7	18	Maximum value
TTYPE8	'TKR_Hits'	Number of hits in TKR
TFORM8	'J'	Long integer
TUNIT8		Dimensionless
TLMIN8	0	Minimum value
TLMAX8	###	Maximum value
TTYPE9	'Hits_Not_Recon'	Number of hits in TKR not used in reconstruction
TFORM9	'J'	Long integer
TUNIT9		Dimensionless
TLMIN9	0	Minimum value
TLMAX9	###	Maximum value
TTYPE10	'Conversion_Point'	Reconstructed 3-space conversion point in instr. coords.
TFORM10	'3E'	Floating point, 3 values
TUNIT10	'm'	Meters
TLMIN10	0.0	Minimum value
TLMAX10	###	Maximum value
TTYPE11	'Primary_Trajectory'	Direction cosines (instr. coords) of photon
TFORM11	'2E'	Floating point, 2 values
TUNIT11		Dimensionless
TLMIN11	-1.0	Minimum value
TLMAX11	1.0	Maximum value
TTYPE12	'Sec1_Trajectory'	Direction cosines (instr. coords) of secondary 1
TFORM12	'2E'	Floating point, 2 values
TUNIT12		Dimensionless
TLMIN12	-1.0	Minimum value
TLMAX12	1.0	Maximum value
TTYPE13	'Sec2_Trajectory'	Direction cosines (instr. coords) of secondary 2
TFORM13	'2E'	Floating point, 2 values

TUNIT13		Dimensionless
TLMIN13	-1.0	Minimum value
TLMAX13	1.0	Maximum value
TTYPE14	'Sec_Energies'	Energies of secondaries
TFORM14	'2E'	Floating point, 2 values
TUNIT14	'GeV'	
TLMIN14	0.0	Minimum value
TLMAX14	###	Maximum value
TTYPE15	'ACD_Tiles_Hit'	Bit flags for ACD tiles hit
TFORM15	'3J'	Long integer, 3 values (96 bits)
TUNIT15		Dimensionless
TLMIN15	0	Minimum value
TLMAX15	###	Maximum value
TTYPE16	'Quality_Params'	Event quality params, bit flags
TFORM16	'J'	Long integer (32 bits)
TUNIT16		Dimensionless
TLMIN16	0	Minimum value
TLMAX16	###	Maximum value
TTYPE17	'Overall_Qualtiy'	Overall quality parameter
TFORM17	'E'	Floating point
TUNIT17		Dimensionless
TLMIN17	0.0	Minimum value
TLMAX17	1.0	Maximum value
TTYPE18	'Deadtime'	Deadtime since start of mission
TFORM18	'E'	Floating point
TUNIT18	's'	Seconds
TLMIN18	0.0	Minimum value
TLMAX18	###	Maximum value
TTYPE19	'Instrument_Mode'	Operation mode of LAT
TFORM19	'J'	Long integer
TUNIT19		Dimensionless
TLMIN19	0	Minimum value
TLMAX19	###	Maximum value
TTYPE20	'Subsystem_Flag'	Indicates subsystem(s) of conversion and tracking
TFORM20	'B'	Byye
TUNIT20		Dimensionless
TLMIN20	0	Minimum value
TLMAX20	###	Maximum value
TTYPE21	'Zenith_Angle'	Zenith angle of event
TFORM21	'E'	Floating point
TUNIT21	'deg'	Degrees
TLMIN21	0.0	Minimum value
TLMAX21	180.0	Maximum value
TTYPE22	'Earth_Azimuth_Angle'	Earth azimuth (from north to east) of event

TFORM22	'E'	Floating point
TUNIT22	'deg'	Degrees
TLMIN22	0.0	Minimum value
TLMAX22	360.0	Maximum value
TTYPE23	'SC_Position'	Position of S/C wrt earth center (coord. system=?)
TFORM23	'3E'	Floating point, 3 values
TUNIT23	'm'	Meters
TLMIN23	0.0	Minimum value
TLMAX23	###	Maximum value
TTYPE24	'Gnd_Latitude'	Ground point latitude
TFORM24	'E'	Floating point
TUNIT24	'deg'	Degrees
TLMIN24	-90.0	Minimum value
TLMAX24	90.0	Maximum value
TTYPE25	'Gnd_Longitude'	Ground point longitude
TFORM25	'E'	Floating point
TUNIT25	'deg'	Degrees
TLMIN25	0.0	Minimum value
TLMAX25	360.0	Maximum value
TTYPE26	'Bary_Arr_Time'	Event arrival time at solar system barycenter
TFORM26	'D'	Double precision
TUNIT26	's'	Seconds
TLMIN26	0.0	Minimum value
TLMAX26	###	Maximum value
TTYPE27	'Bary_Offset'	Offset of solar system barycenter from S/C
TFORM27	'3E'	Floating point, 3 values
TUNIT27	'm'	Meters
TLMIN27	0.0	Minimum value
TLMAX27	###	Maximum value
TTYPE28	'B_McIlwain'	McIlwain B parameter, magnetic field
TFORM28	'E'	Floating point
TUNIT28	'Gauss'	
TLMIN28	###	Minimum value
TLMAX28	###	Maximum value
TTYPE29	'L_McIlwain'	McIlwain L parameter, distance
TFORM29	'E'	Floating point
TUNIT29	'Earth_radii'	Earth radii
TLMIN29	0.0	Minimum value
TLMAX29	###	Maximum value
TTYPE30	'Geo_Latitude'	Geomagnetic Latitude
TFORM30	'E'	Floating point
TUNIT30	'deg'	Degrees
TLMIN30	-90.0	Minimum value
TLMAX30	90.0	Maximum value

TTYPE31	'Geo_Longitude'	Geomagnetic longitude
TFORM31	'E'	Floating point
TUNIT31	'deg'	Degrees
TLMIN31	0.0	Minimum value
TLMAX31	360.0	Maximum value
TTYPE32	'Recon_Version'	Version of event reconstruction software
TFORM32	'I'	Integer
TUNIT32		Dimensionless
TLMIN32	0	Minimum value
TLMAX32	###	Maximum value
TTYPE33	'Calib_Version'	Versions of calibration tables for the ACD, CAL, TKR
TFORM33	'3I'	Integer, 3 values
TUNIT33		Dimensionless
TLMIN33	0	Minimum value
TLMAX33	###	Maximum value
TTYPE34	'Multi_Event_Flag'	Indicates whether multiple events reconstructed from same trigger
TFORM34	'B'	Byte
TUNIT34		Dimensionless
TLMIN34	0	Minimum value
TLMAX34	1	Maximum value
TTYPE35	'Recon_Number'	Indicates number of event within multi-event reconstructions
TFORM35	'I'	Integer
TUNIT35		Dimensionless
TLMIN35	1	Minimum value
TLMAX35	###	Maximum value
TTYPE36	'Event_ID'	ID number of original event
TFORM36	'J'	Long integer
TUNIT36		Dimensionless
TLMIN36	0	Minimum value
TLMAX36	###	Maximum value

END

LS-003 Low-level Calibration

Draft version 0.1, 1 Oct 2001

Naming Convention LAT_CALIB _YYMMDD_V01.FIT

Originator of Product LIOC

Description of Product

The Low-level calibration data product contains the low-level calibration information for the ACD, CAL, and TKR. This is all of the information that is needed for event reconstruction as well as generation of the high-level Instrument Response Functions (LS-004). The exact contents are TBD. The frequency with which this data product will need to be updated remains TBD; it depends on the rate at which the quantities represented change and/or the rate at which changes to these quantities significantly affect the Instrument Response Functions.

[what about TKR rate counters – the Low-Rate Physics data – and histograms described in the FWS PDR report?]

Product Format **TBD**

Product Recipient GSSC

Delivery Method FTS

Input Products Required None

Production Latency Req. 1 week

Delivery Latency Requirement 1 day (TBR)

Product Contains Data for TBD

Number of deliveries per day N/A, as updated

Typical size TBD

LS-004 LAT Instrument Response Functions

Draft version 0.2, 1 Oct 2001

Naming Convention TBD

Originator of Product LIOC

Description of Product

The Instrument Response Functions (IRFs) are the tabulations or parameterizations of the effective area, energy resolution, and point-spread function of the LAT as functions of the incident photon energy and direction (with respect to the instrument), the location within the LAT of the photon conversion, instrumental parameters, and the set of background rejection/PSF enhancement cuts applied.

The detailed representations of the IRFs for LAT data analysis cannot be defined yet. Monte Carlo studies are planned by the LAT team to determine with what detail the dependencies of the IRFs on conversion location need to be specified. In principle, different IRFs could be defined for every potential conversion location. Although the point of diminishing returns in terms of the sensitivity of high-level analyses is rapidly reached, the appropriate level of detail to include remains to be investigated.

Instrumental parameters include the states of the subsystems of the LAT. Absent major changes, such as resulting from failure of a part of one subsytem, these are expected to change little with time.

In routine analyses of LAT data, more than one set of background rejection/PSF enhancement cuts are likely to be used. Some may be optimized for large effective area and others for good angular resolution. The actual sets of cuts, or even the number of sets, have not been determined.

In the most straightforward form, the effective area would be tabulated for a multi-dimensional grid of energy, incident direction, and instrumental parameters for each set of background rejection/PSF enhancement cuts. Similarly, the energy resolution would be tabulated as redistribution matricies for a multidimensional grid of incident direction and instrumental parameters and the point-spread function would be represented as a 2-dimensional distribution for the same grid as the effective area.

In terms of managing the size of the IRFs, and the desirability of interpolation in the multidimensional parameter space, where practical, parameterizations of the IRFs will be defined. In these cases, the LS-004 LAT IRF data product would contain the parameterizations and coefficients of the parameterizing functions.

Product Format CALDB (FITS)

Product Recipient GSSC

Delivery Method FTS

Production Latency Req.	Updated as needed
Delivery Latency Requirement	1 day (TBR)
Product Contains Data for	N/A
Number of deliveries per day	N/A, as updated
Typical size	100s of Mbyte (TBR)

LS-005 Pointing and Livetime History

Interface definition	June 4, 2004; 5/28/04 FITS definition for FT2 file
Interface ID	LS-005
Name of Product	LAT Pointing and Livetime History
Fulfills requirement:	TBD
Naming Convention	GLL_PT_YYMMDD_C#_V##.FIT
Originator of Product	LIOC
Description of Product	Record of pointing, instrument mode, and livetime for regular time intervals (~30 s). Format is that of FT2 file.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	12 hours
Product contains data for	1 Ku Band Downlink (TBR)
Number of deliveries per day	6 (TBR)
Typical size	~100 kbyte (per 12 hours)

Product Content

Primary HDU:	Standard GLAST FITS Primary Header (primary HDU has no data)
Extension 1	Contains the pointing and operation history

Column Number	Contents	Units
1	starting time of interval (Mission Elapsed Time)	s
2	ending time of interval (Mission Elapsed Time)	s
3	position of S/C at start of interval (x,y,z inertial coordinates)	km
4	Latitude of ground point	dimensionless
5	Longitude of ground point	dimensionless
6	S/C altitude	dimensionless
7	RA of zenith at start	dimensionless
8	Dec of zenith at start	s
9	McIlwain B parameter (magnetic field)	deg
10	McIlwain L parameters, distance	deg
11	S/C in SAA?	km
12	RA of LAT +z axis at start	
13	DEC of LAT +z axis at start	
14	RA of LAT +x axis at start	
15	DEC of LAT +x axis at start	
16	LAT mode	
17	Livetime	
18	Deadtime since mission start	

Primary Header: LS-005

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
DATASUM	####	Checksum for data table
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.sss'	File creation date (UTC)
DATE-OBS	'YYYY-MM-DDThh:mm:ss.sss'	Observation start date and time (UTC)
DATE-END	'YYYY-MM-DDThh:mm:ss.sss'	Observation end date and time (UTC)
FILENAME	'GLL_PT_YYMMDD_C#_V##.FIT'	Name of this file
ORIGIN	'LIOC'	Name of organization making file
AUTHOR		Name of person responsible for file generation
CREATOR	'LAT_POINT_HIST_V##'	Software and version creating file
VERSION	#	Release version of the file
SOFTWARE	#	Version of the processing software
END		

Extension LS-005 Header 1

FITS Keyword	Value	Detail
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	Size of special data area
GCOUNT	1	No multiplier
TFIELDS	11	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
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 (UTC)
DATE-OBS	'YYYY-MM-DDThh:mm:ss.sss'	Observation start date and time (UTC)
DATE-END	'YYYY-MM-DDThh:mm:ss.sss'	Observation end date and time (UTC)
EXTNAME	'LAT_POINTING_HIST'	Name of the extension
TSTART	###	Mission time of start of observation
TSTOP	###	Mission time of end of observation
MJDREF	58300	MJD date of reference epoch
TIMEUNIT	S	Time unit used in TSTART, TSTOP and TZERO keywords
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_Time'	Mission Elapsed Time of start of interval
TFORM1	'D'	8-byte DOUBLE
TUNIT1	's'	Seconds
TLMIN1	0.0	Minimum value
TLMAX1	1.0D+10	Maximum value
TTYPE2	'End_Time'	Mission Elapsed Time of end of interval
TFORM2	'D'	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'	
TLMIN3	0	Minimum value
TLMAX3	###	Maximum value
TTYPE4	'LAT_GEO'	Ground point latitude
TFORM4	'E'	4-byte REAL
TUNIT4	'deg'	
TLMIN4	-90.0	Minimum value
TLMAX4	90.0	Maximum value
TTYPE5	'LON_GEO'	Ground point longitude
TFORM5	'E'	4-byte REAL
TUNIT5	'deg'	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	'RAD_GEO'	S/C altitude
TFORM6	'D'	8-byte DOUBLE
TUNIT6	'km'	
TLMIN6	0	Minimum value
TLMAX6	10000.0	Maximum value
TTYPE7	'RA_ZENITH'	RA of zenith at start
TFORM7	'D'	8-byte DOUBLE
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	'DEC_ZENITH'	DEC of zenith at start
TFORM8	'E'	4-byte REAL
TUNIT8	'deg'	
TLMIN8	-90.0	Minimum value
TLMAX8	90.0	Maximum value
TTYPE9	'B_MCILWAIN'	McIlwain B parameter, magnetic field
TFORM9	'E'	4-byte REAL
TUNIT9	'Gauss'	
TLMIN9	0.0	Minimum value
TLMAX9	100.0	Maximum value
TTYPE10	'L_MCILWAIN'	McIlwain L parameter, distance
TFORM10	'E'	4-byte REAL
TUNIT10	'Earth_Radii'	
TLMIN10	0.0	Minimum value
TLMAX10	100.0	Maximum value
TTYPE11	'IN_SAA'	Whether S/C was in SAA
TFORM11	'L'	Logical
TTYPE12	'RA_SCZ'	RA of LAT +z axis at start of observation
TFORM12	'E'	4-byte REAL
TUNIT12	'deg'	
TLMIN12	0.0	Minimum value
TLMAX12	360.0	Maximum value
TTYPE13	'DEC_SCZ'	RA of LAT +z axis at start of observation
TFORM13	'E'	4-byte REAL

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

LS-006 Configuration History

Draft version 0.1, 22 Oct 2001

Fulfills Requirement TBD

Naming Convention LAT_CONFIG_YYMMDD_V01.FIT

Originator of Product LIOC

Description of Product

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

Product Format TBD

Product Recipient GSSC

Delivery Method FTS

Production Latency Req. 12 hours

Product Contains Data for 1 Ku Band Downlink (TBR)

Number of deliveries per day N/A, as updated

Typical size TBD

LS-007 Transient Parameters

Interface definition	version 0.2, 31 Oct 2001 (updated file naming, primary header, flux units), v 0.3, 15 Nov 2001 (cleaned up formatting, became LS-010)
Interface ID	LS-007
Name of Product	Parameters of Transient Sources
Fulfills requirement:	TBD
Naming Convention	GLL_TRANS_AN####_V##.FIT
Originator of Product	LIOC
Description of Product	Summary information for transient sources detected by the LAT. This data product is meant to serve as an alert produced when a transient is detected; therefore it will contain preliminary parameters and quite likely only partial light curves.
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS
Production Latency Requirement	8 hours (TBR)
Product contains data for	time interval N/A
Number of deliveries per day	As detected
Typical size	~100 kbyte

Product Content

Primary HDU: Standard GLAST FITS Primary Header (primary HDU has no data)

Extension: Summary information (nearly identical to LS-008, the Point Source Catalog)

Column Number	Column Name	Units
1	source name (“telephone number”)	dimensionless
2	RA (best position, e.g., from when transient was brightest)	deg
3	Dec	deg
4	th68 semimajor, semiminor axis, and position angle	deg
5	th95 semimajor, semiminor axis, and position angle	deg
6	flux (>100 MeV, avg. for the time interval of the detection)	cm-2 s-1
7	flux uncertainty, 1 sigma (as above)	cm-2 s-1
8	photon spectral index or hardness ratio (avg)	dimensionless
9	variability index	dimensionless
10	significance (avg)	dimensionless

11	significance (peak)	dimensionless
12	peak flux (for time interval above?)	cm-2 s-1
13	peak flux uncertainty	cm-2 s-1
14	time of peak flux (wrt MJDREF)	s
15	interval of time	s
16	flux history	cm-2 s-1
17	flux uncertainty, 1 sigma (as above)	cm-2 s-1
18	start times of flux history entries	s
19	end times of flux history entries	s
20	candidate counterparts	dimensionless
21	degrees of confidence for the counterparts	dimensionless
22	flags (confusion, low latitude,…)	dimensionless

Note that source name (column 1) should clearly indicate that source is provisional or a transient, e.g., ‘GL TR ####+####’

Primary Header: LS-007

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	'T'	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'GLL_TRANS_AN###_V##.FIT'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LIOC'	Name of organization making file
DATE_OBS	'YYYY-MM-DD'	Date of start of observation (UTC)
DATE_END	'YYYY-MM-DD'	Date of end of observation (UTC)
TIME_OBS	'HH:MM:SS.ssss'	Time of start of observation (UTC)
TIME_END	'HH:MM:SS.ssss'	Time of end of observation (UTC)
AUTHOR		Name of person responsible for file generation
CREATOR	'TRANS_PARAM_MAKER_V##'	Software and version creating file
VERSION	#	Release version of the catalog
SOFTWARE	#	Version of the analysis software
RESPONSE	#	Version of the IRFs
END		

Extension Header LS-007

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of entries in file (1?)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	22	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	'LAT_Transient_Source'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREF	58300	MJD date of reference epoch
TIMEUNIT	S	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	###	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from TZERO in units of TIMEUNIT
TTYPE1	'Source_Name'	Source name in standard format
TFORM1	14A	Character string
TUNIT1		Units of field
TLMIN1	'GLT J0000-9000'	Minimum value
TLMAX1	'GLT J2359+9000'	Maximum value
TTYPE2	'Right_Ascension'	
TFORM2	E	Floating point
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'Declination'	DEC
TFORM3	E	Floating point
TUNIT3	'deg'	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	'Conf_68_Region'	Semimajor, semiminor axes and position angle, 68% containment confidence region
TFORM4	3E	Floating point, 3 values
TUNIT4	'deg'	
TLMIN4	0.0	Minimum value
TLMAX4	360.0	Maximum value
TTYPE5	'Conf_95_Region'	Semimajor, semiminor axes and position angle, 95% containment confidence region
TFORM5	3E	Floating point, 3 values

TUNIT5	deg’	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	‘Flux’	Average flux >100 MeV
TFORM6	E	Floating point
TUNIT6	‘cm**(-2) s**(-1)’	
TLMIN6	0.0	Minimum value
TLMAX6	###	Maximum value
TTYPE7	‘Unc_Flux’	Uncertainty (1-sigma) in average flux >100 MeV
TFORM7	E	Floating point
TUNIT7	‘cm**(-2) s**(-1)’	
TLMIN7	0.0	Minimum value
TLMAX7	###	Maximum value
TTYPE8	‘Spectral_Index’	Photon spectral index
TFORM8	E	Floating point
TUNIT8		Dimensionless
TLMIN8	-10.0	Minimum value
TLMAX8	10.0	Maximum value
TTYPE9	‘Variability_Index’	Flux variability index
TFORM9	E	Floating point
TUNIT9		Dimensionless
TLMIN9	###	Minimum value
TLMAX9	###	Maximum value
TTYPE10	‘Signif_Avg’	Detection significance (whole time interval)
TFORM10	E	Floating point
TUNIT10		Dimensionless
TLMIN10	0.0	Minimum value
TLMAX10	###	Maximum value
TTYPE11	‘Signif_Peak’	Detection significance (peak)
TFORM11	E	Floating point
TUNIT11		Dimensionless
TLMIN11	0.0	Minimum value
TLMAX11	###	Maximum value
TTYPE12	‘Flux_Peak’	Peak flux (>100 MeV) for time interval above
TFORM12	E	Floating point
TUNIT12	‘cm**(-2) s**(-1)’	
TLMIN12	0.0	Minimum value
TLMAX12	###	Maximum value
TTYPE13	‘Unc_Peak_Flux’	Uncertainty (1-sigma) in peak flux >100 MeV
TFORM13	E	Floating point
TUNIT13	‘cm**(-2) s**(-1)’	
TLMIN13	0.0	Minimum value
TLMAX13	###	Maximum value
TTYPE14	‘Time_Peak’	Center of time interval of peak significance
TFORM14	D	Double precision
TUNIT14	‘s’	
TLMIN14	0	Minimum value
TLMAX14	###	Maximum value

TTYPE15	‘Peak_Interval’	Duration of time interval of peak significance
TFORM15	D	Double precision
TUNIT15	‘s’	
TLMIN15	0	Minimum value
TLMAX15	###	Maximum value
TTYPE16	‘Flux_History’	Flux (>100 MeV) history
TFORM16	PE(100)	Floating point variable-length array
TUNIT16	‘cm**(-2) s**(-1)’	
TLMIN16	0	Minimum value
TLMAX16	###	Maximum value
TTYPE17	‘Flux_Unc_History’	Flux uncertainty (1-sigma, >100 MeV) history
TFORM17	PE(100)	Floating point variable-length array
TUNIT17	‘cm**(-2) s**(-1)’	
TLMIN17	0	Minimum value
TLMAX17	###	Maximum value
TTYPE18	‘Hist_Start’	Start of time intervals of flux history
TFORM18	PE(100)	Floating point variable-length array
TUNIT18	‘s’	
TLMIN18	0	Minimum value
TLMAX18	###	Maximum value
TTYPE19	‘Hist_End’	Ends of time intervals of flux history
TFORM19	PE(100)	Floating point variable-length array
TUNIT19	‘s’	
TLMIN19	0	Minimum value
TLMAX19	###	Maximum value
TTYPE20	‘ID_Counterpart’	Source counterparts
TFORM20	PA(20)	Character variable-length array
TUNIT20		Dimensionless
TLMIN20		Minimum value
TLMAX20		Maximum value
TTYPE21	‘Conf_Counterpart’	Confidence of association of counterpart with source
TFORM21	PE(20)	Floating point variable-length array
TUNIT21		Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value
TTYPE22	‘Flags’	Flags (TBD) for catalog entry
TFORM22	B	
TUNIT22		Dimensionless
TLMIN22		Minimum value
TLMAX22		Maximum value

END

LS-008 Source Catalog

Interface definition	version 0.5, 30 Oct 2001 (updated file naming, primary header, units)
Interface ID	LS-008
Name of Product	LAT Point Source Catalog
Naming Convention	GLL_PSC_V##.FIT
Originator of Product	LIOC
Description of Product	LAT Point Source Catalog
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS (TBR)
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: Standard GLAST FITS Primary Header
(primary HDU has no data)

Extension 1

Column Number	Column Name	Units
1	source name (“telephone number”)	dimensionless
2	RA	deg
3	Dec	deg
4	th68 semimajor, semiminor axis, and position angle	deg
5	th95 semimajor, semiminor axis, and position angle	deg
6	flux (>100 MeV, avg. for the time interval of the catalog)	cm-2 s-1
7	flux uncertainty, 1 sigma (as above)	cm-2 s-1
8	photon spectral index (avg)	dimensionless
9	variability index	dimensionless
10	significance (avg)	dimensionless
11	significance (peak)	dimensionless
12	peak flux (for time interval above?)	cm-2 s-1
13	peak flux uncertainty	cm-2 s-1
14	time of peak flux (wrt MJDREF)	s
15	interval of time	s
16	flux history	cm-2 s-1
17	flux uncertainty, 1 sigma (as above)	cm-2 s-1
18	start times of flux history entries	s

19	end times of flux history entries	s
20	candidate counterparts	dimensionless
21	degrees of confidence for the counterparts	dimensionless
22	flags (confusion, low latitude,…)	dimensionless

For source name, see http://cdsweb.u-strasbg.fr/viz-bin/DicForm

Primary Header: LS-008

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	'T'	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	GLL_PSC_V##.FIT'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LIOC'	Name of organization making file
DATE_OBS	'YYYY-MM-DD'	Date of start of interval included in this analysis (UTC)
DATE_END	'YYYY-MM-DD'	Date of end of interval included (UTC)
TIME_OBS	'HH:MM:SS.ssss'	Time of start of interval (UTC)
TIME_END	'HH:MM:SS.ssss'	Time of end of interval (UTC)
AUTHOR		Name of person responsible for file generation
CREATOR	'PSC_MAKER_V##'	Software and version creating file
VERSION	#	Release version of this catalog
SOFTWARE	#	Version of the analysis software
RESPONSE	#	Version of the IRFs
END		

Extension LS-008 Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	22	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	'LAT_Point_Source_Catalog'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREF	58300	MJD date of reference epoch
TIMEUNIT	S	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	###	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from TZERO in units of TIMEUNIT
TTYPE1	'Source_Name'	Source name in standard format
TFORM1	13A	Character string
TUNIT1		Units of field
TLMIN1	'GL J0000-9000'	Minimum value
TLMAX1	'GL J2359+9000'	Maximum value
TTYPE2	'Right_Ascension'	
TFORM2	E	Floating point
TUNIT2	'deg'	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	'Declination'	DEC
TFORM3	E	Floating point
TUNIT3	'deg'	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	'Conf_68_Region'	Semimajor, semiminor axes and position angle, 68% containment confidence region
TFORM4	3E	Floating point, 3 values
TUNIT4	'deg'	
TLMIN4	0.0	Minimum value
TLMAX4	360.0	Maximum value
TTYPE5	'Conf_95_Region'	Semimajor, semiminor axes and position angle, 95% containment confidence region
TFORM5	3E	Floating point, 3 values

TUNIT5	deg'	
TLMIN5	0.0	Minimum value
TLMAX5	360.0	Maximum value
TTYPE6	'Flux'	Average flux >100 MeV
TFORM6	E	Floating point
TUNIT6	'cm**(-2) s**(-1)'	
TLMIN6	0.0	Minimum value
TLMAX6	###	Maximum value
TTYPE7	'Unc_Flux'	Uncertainty (1-sigma) in average flux >100 MeV
TFORM7	E	Floating point
TUNIT7	'cm**(-2) s**(-1)'	
TLMIN7	0.0	Minimum value
TLMAX7	###	Maximum value
TTYPE8	'Spectral_Index'	Photon spectral index
TFORM8	E	Floating point
TUNIT8		Dimensionless
TLMIN8	-10.0	Minimum value
TLMAX8	10.0	Maximum value
TTYPE9	'Variability_Index'	Flux variability index
TFORM9	E	Floating point
TUNIT9		Dimensionless
TLMIN9	###	Minimum value
TLMAX9	###	Maximum value
TTYPE10	'Signif_Avg'	Detection significance (whole time interval)
TFORM10	E	Floating point
TUNIT10		Dimensionless
TLMIN10	0.0	Minimum value
TLMAX10	###	Maximum value
TTYPE11	'Signif_Peak'	Detection significance (peak)
TFORM11	E	Floating point
TUNIT11		Dimensionless
TLMIN11	0.0	Minimum value
TLMAX11	###	Maximum value
TTYPE12	'Flux_Peak'	Peak flux (>100 MeV) for time interval above
TFORM12	E	Floating point
TUNIT12	'cm**(-2) s**(-1)'	
TLMIN12	0.0	Minimum value
TLMAX12	###	Maximum value
TTYPE13	'Unc_Peak_Flux'	Uncertainty (1-sigma) in peak flux >100 MeV
TFORM13	E	Floating point
TUNIT13	'cm**(-2) s**(-1)'	
TLMIN13	0.0	Minimum value
TLMAX13	###	Maximum value
TTYPE14	'Time_Peak'	Center of time interval of peak significance
TFORM14	D	Double precision
TUNIT14	's'	
TLMIN14	0	Minimum value
TLMAX14	###	Maximum value

TTYPE15	'Peak_Interval'	Duration of time interval of peak significance
TFORM15	D	Double precision
TUNIT15	's'	
TLMIN15	0	Minimum value
TLMAX15	###	Maximum value
TTYPE16	'Flux_History'	Flux (>100 MeV) history
TFORM16	PE(100)	Floating point variable-length array
TUNIT16	'cm**(-2) s**(-1)'	
TLMIN16	0	Minimum value
TLMAX16	###	Maximum value
TTYPE17	'Flux_Unc_History'	Flux uncertainty (1-sigma, >100 MeV) history
TFORM17	PE(100)	Floating point variable-length array
TUNIT17	'cm**(-2) s**(-1)'	
TLMIN17	0	Minimum value
TLMAX17	###	Maximum value
TTYPE18	'Hist_Start'	Start of time intervals of flux history
TFORM18	PE(100)	Floating point variable-length array
TUNIT18	's'	
TLMIN18	0	Minimum value
TLMAX18	###	Maximum value
TTYPE19	'Hist_End'	Ends of time intervals of flux history
TFORM19	PE(100)	Floating point variable-length array
TUNIT19	's'	
TLMIN19	0	Minimum value
TLMAX19	###	Maximum value
TTYPE20	'ID_Counterpart'	Source counterparts
TFORM20	PA(20)	Character variable-length array
TUNIT20		Dimensionless
TLMIN20		Minimum value
TLMAX20		Maximum value
TTYPE21	'Conf_Counterpart'	Confidence of association of counterpart with source
TFORM21	PE(20)	Floating point variable-length array
TUNIT21		Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value
TTYPE22	'Flags'	Flags (TBD) for catalog entry
TFORM22	B	
TUNIT22		Dimensionless
TLMIN22		Minimum value
TLMAX22		Maximum value

END

LS-009 Burst Catalog

Interface definition	version 1.1, 31 Oct 2001 (updated file naming, units, primary header, column names in extension to make unique within 1st 8 chars)
Interface ID	LS-009
Name of Product	LAT GRB Catalog
Fulfills requirement:	TBD
Naming Convention	GLL_GRBC_V##.FIT
Originator of Product	LIOC
Description of Product	LAT Gamma-ray Burst Catalog
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS (TBR)
Production Latency Requirement	TBD
Product contains data for	Intervals TBR, likely years
Number of deliveries per day	< 1/day
Typical size	1 Mbyte

Product Content

Primary HDU: Standard GLAST FITS Primary Header
(primary HDU has no data)

Extension 1 Header:

Column Number	Column Name	Units
1	GRB name (date encoded name)	eg. GRByymmdd
2	alert number	running glast alert number
3	LAT alert time wrt MJDREF	s
4	GBM alert time wrt MJDREF	s
5	RA	deg
6	Dec	deg
7	th68 semimajor, semiminor axis, and position angle	deg
8	th95 semimajor, semiminor axis, and position angle	deg
9	peak flux > 30 MeV	cm-2 s-1
10	peak flux uncertainty, 1 sigma	cm-2 s-1
11	time of peak flux wrt MJDREF	s
12	energy of max energy photon	GeV
13	energy uncertainty, 1 sigma (above)	GeV
14	time of most energetic photon wrt MJDREF	s
15	duration measure	s
16	duration measure uncertainty, 1 sigma	s
17	duration measure start time wrt MJDREF	s

18	avg photon energy > 30 MeV	GeV
19	uncertainty (above)	GeV
20	fluence > 30 MeV	cm-2
21	fluence uncertainty, 1 sigma (as above)	cm-2
22	avg photon energy > 100 MeV	GeV
23	uncertainty (above)	GeV
24	fluence >100 MeV	cm-2
25	fluence uncertainty, 1 sigma (as above)	cm-2
26	rate history > 30 MeV	s-1?
27	rate history uncertainty, 1 sigma (as above)	s-1?
28	rate history bin start time	s
29	rate history bin stop time	s
30	photon spectral index (avg)	dimensionless
31	photon spectral index uncertainty, 1 sigma	dimensionless
32	flags for grb catalog entry	

Primary Header: LS-009

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	Bits per pixel
NAXIS	0	# of axes=0; header is empty
EXTEND	'T'	Data in extension table
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'GLL_GRBC_V##.FIT'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LIOC'	Name of organization making file
DATE_OBS	'YYYY-MM-DD'	Date of start of observation (UTC)
DATE_END	'YYYY-MM-DD'	Date of end of observation (UTC)
TIME_OBS	'HH:MM:SS.ssss'	Time of start of observation (UTC)
TIME_END	'HH:MM:SS.ssss'	Time of end of observation (UTC)
AUTHOR		Name of person responsible for file generation
CREATOR	'LAT_BURSTCAT_V# #'	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

Extension LS-009 Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel – assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	32	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	'LAT_GRB_Catalog'	Name of the extension
TIMESYS	'TT'	Time system used in time keywords
MJDREF	58300	MJD date of reference epoch
TIMEUNIT	S	Time unit used in TSTART, TSTOP and TZERO keywords
TSTART	###	Time of start of observation offset from TZERO in units of TIMEUNIT
TSTOP	###	Time of end of observation offset from TZERO in units of TIMEUNIT
TTYPE1	'GRB_NAME'	e.g. GRB060101 (GRByymmdd)
TFORM1	9A	Character string
TUNIT1		Units of field
TLMIN1	GRB(launch date)	Minimum value
TLMAX1	GRB(date mission ends)	Maximum value
TTYPE2	'Alert_Num'	
TFORM2	I	integer
TUNIT2		Units of field
TLMIN2	1	Minimum value
TLMAX2	10000	Maximum value
TTYPE3	'LAT_Alert_Time'	LAT alert time wrt MJDREF
TFORM3	D	Double precision
TUNIT3	's'	
TLMIN3	-1	Minimum value (no LAT alert)
TLMAX3	####	Maximum value
TTYPE4	'GBM_Alert_Time'	GBM alert time wrt MJDREF
TFORM4	D	Double precision
TUNIT4	's'	
TLMIN4	-1	Minimum value (no GBM alert)
TLMAX4	####	Maximum value
TTYPE5	'Right_Ascension'	right ascension
TFORM5	E	Floating point
TUNIT5	'deg'	
TLMIN5	0.0	Minimum value

TLMAX5	360.0	Maximum value
TTYPE6	'Declination'	DEClination
TFORM6	E	Floating point
TUNIT6	'deg'	
TLMIN6	-90.0	Minimum value
TLMAX6	90.0	Maximum value
TTYPE7	'Conf_68_Region'	Semimajor, semiminor axes and position angle, 68% containment confidence region
TFORM7	3E	Floating point, 3 values
TUNIT7	'deg'	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	'Conf_95_Region'	Semimajor, semiminor axes and position angle, 95% containment confidence region
TFORM8	3E	Floating point, 3 values
TUNIT8	'deg'	
TLMIN8	0.0	Minimum value
TLMAX8	360.0	Maximum value
TTYPE9	'Peak_30_Flux'	Peak flux >30 MeV on (TBD)binned timescale
TFORM9	E	Floating point
TUNIT9	'cm**(-2) s**(-1)'	
TLMIN9	0.0	Minimum value
TLMAX9	####	Maximum value
TTYPE10	'Unc_30_Peak_Flux'	Uncertainty (1-sigma) in peak flux >30 MeV
TFORM10	E	Floating point
TUNIT10	'cm**(-2) s**(-1)'	
TLMIN10	0.0	Minimum value
TLMAX10	####	Maximum value
TTYPE11	'Time_30_Peak_Flux'	time of peak flux >30 MeV wrt MJDREF
TFORM11	D	Double precision
TUNIT11	's'	
TLMIN11	-1	Minimum value
TLMAX11	####	Maximum value
TTYPE12	'Max_Energy'	maximum photon energy in burst
TFORM12	E	Floating point
TUNIT12	'GeV'	
TLMIN12	0.0	Minimum value
TLMAX12	10000.0	Maximum value
TTYPE13	'Unc_Max_Energy'	Uncertainty (1-sigma) in maximum energy
TFORM13	E	Floating point
TUNIT13	'GeV'	
TLMIN13	0.0	Minimum value
TLMAX13	10000.0	Maximum value
TTYPE14	'Time_Max_Energy'	time of maximum energy photon wrt MJDREF
TFORM14	D	Double precision
TUNIT14	's'	
TLMIN14	0	Minimum value
TLMAX14	####	Maximum value

TTYPE15	‘Duration’	burst duration measure
TFORM15	E	floating point
TUNIT15	‘s’	
TLMIN15	0	Minimum value
TLMAX15	####	Maximum value
TTYPE16	‘Unc_Duration’	1 sigma uncertainty for burst duration measure
TFORM16	E	floating point
TUNIT16	‘s’	
TLMIN16	0	Minimum value
TLMAX16	####	Maximum value
TTYPE17	“Start_Duration’	duration measure start time wrt MJDREF
TFORM17	D	Double precision
TUNIT17	‘s’	
TLMIN17	0	Minimum value
TLMAX17	####	Maximum value
TTYPE18	‘Avg_30_Energy’	average photon energy in burst > 30 MeV
TFORM18	E	Floating point
TUNIT18	‘GeV’	
TLMIN18	0.0	Minimum value
TLMAX18	10000.0	Maximum value
TTYPE19	‘Unc_30_Avg_Energy’	1 sigma uncertainty in avg photon energy > 30 MeV
TFORM19	E	Floating point
TUNIT19	‘GeV’	
TLMIN19	0.0	Minimum value
TLMAX19	10000.0	Maximum value
TTYPE20	‘Fluence30’	fluence > 30 MeV (number fluence?)
TFORM20	E	floating point
TUNIT20		
TLMIN20	0.0	Minimum value
TLMAX20	####	Maximum value
TTYPE21	‘Unc_Flu30’	1 sigma uncertainty in fluence > 30 MeV
TFORM21	E	Floating point
TUNIT21		
TLMIN21	0.0	Minimum value
TLMAX21	####	Maximum value
TTYPE22	‘Avg_100_Energy’	average photon energy in burst > 100 MeV
TFORM22	E	Floating point
TUNIT22	‘GeV’	
TLMIN22	0.1	Minimum value
TLMAX22	10000.0	Maximum value
TTYPE23	‘Unc_100_Avg_Energy’	1 sigma uncertainty in avg photon energy > 100MeV
TFORM23	E	Floating point
TUNIT23	‘GeV’	
TLMIN23	0.0	Minimum value
TLMAX23	10000.0	Maximum value
TTYPE24	‘Fluence100’	fluence > 100 MeV (number fluence?)

TFORM24	E	floating point
TUNIT24		
TLMIN24	0.0	Minimum value
TLMAX24	####	Maximum value
TTYPE25	‘Unc_Flu100’	1 sigma uncertainty in fluence > 100 MeV
TFORM25	E	Floating point
TUNIT25		
TLMIN25	0.0	Minimum value
TLMAX25	####	Maximum value
TTYPE26	‘Rate_Hist’	rate history for grb
TFORM26	PE(100)	Floating point variable-length array
TUNIT26	‘s**-1’	
TLMIN26	0	Minimum value
TLMAX26	####	Maximum value
TTYPE27	‘Unc_Rate_Hist’	1-sigma rate history uncertainty for grb
TFORM27	PE(100)	Floating point variable-length array
TUNIT27	‘s’	
TLMIN27	0	Minimum value
TLMAX27	####	Maximum value
TTYPE28	‘Start_Hist_Bin’	start time for each rate history bin wrt mjdref
TFORM28	PE(100)	Floating point variable-length array
TUNIT28	‘s’	
TLMIN28	0	Minimum value
TLMAX28	####	Maximum value
TTYPE29	‘Stop_Hist_Bin’	stop time for each rate history bin wrt mjdref
TFORM29	PE(100)	Floating point variable-length array
TUNIT29	‘s’	
TLMIN29	0	Minimum value
TLMAX29	####	Maximum value
TTYPE30	‘Avg_Phot_Ind’	average photon spectral index
TFORM30	E	Floating point
TUNIT30		dimensionless
TLMIN30	-999	Minimum value
TLMAX30	999	Maximum value
TTYPE31	‘Unc_Avg_Phot_Ind’	1-sigma uncertainty for average photon spec index
TFORM31	E	Floating point variable-length array
TUNIT31		dimensionless
TLMIN31	0	Minimum value
TLMAX31	999	Maximum value
TTYPE32	‘GCAT_FLAGS’	Flags (TBD) for grb catalog entry
TFORM32	B	
TUNIT32		Dimensionless
TLMIN32		Minimum value
TLMAX32		Maximum value

LS-010 Interstellar Emission Model

Interface definition	version 0.3, 31 Oct 2001 (updated naming scheme, primary header, specification of units)
Interface ID	LS-010
Name of Product	LAT Interstellar Emission Model
Naming Convention	GLL_IEM_V##.FIT
Originator of Product	LIOC
Description of Product	Model of diffuse interstellar emission from the Milky Way for use in LAT data analysis
Product Format	FITS
Product delivered to	GSSC
Delivery Method	FTS (TBR)
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: Standard GLAST FITS Primary Header
(primary HDU has no data)

The model describes the spectrum of the intensity for the entire sky. Here it is assumed that the sky is divided into pixels by some heirarchical scheme (e.g., COBE spherical cube or HEALpix), and the model is tabulated for these directions (~500,000 of

Extension 1 Contains the specification of intensity spectrum for each pixel

Column Number	Column Name	Units
1	pixel number	dimensionless
2	intensity spectrum	photon cm-2 s-1 sr-1 GeV-1
3	intensity uncertainty (1-sigma)	photon cm-2 s-1 sr-1 GeV-1

Extension 2 Contains the mapping of pixel number to ra,dec for completeness

Column Number	Column Name	Units
1	pixel number	dimensionless
2	RA	deg
3	dec	deg

Extension 3	Contains the energies for which the intensities are defined in the first extension

Column Number	Column Name	Units
1	energy	GeV

Primary Header: LS-010

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
NAXIS1		
NAXIS2		
NAXIS3		
EXTEND	'T'	Extension(s) present
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'GLL_IEM_V##.FIT'	
TELESCOP	'GLAST'	
INSTRUME	'LAT'	Name of instrument generating data
ORIGIN	'LIOC'	Name of organization making file
AUTHOR		Name of person responsible for file generation
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Extension LS-010
Header 1

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

Extension LS-010 Header 2

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

Extension LS-010
Header 3

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
THEAP	###	
GCOUNT	1	No multiplier
TFIELDS	1	Number of fields per row
CHECKSUM		Checksum for entire HDU
DATASUM		Checksum for data table
EXTNAME	'LAT_IEM_ENERGIES '	Name of the extension
TTYPE1	'Energy'	Energies for which the intensities are defined
TFORM1	'20E'	Floating point, 20 values
TUNIT1	'GeV'	Units of field
TLMIN1	20?	Minimum value
TLMAX1	3E5?	Maximum value

SS-001 LAT Photons

Interface definition	Version 1, based on Masa Hirayama's FT1 definition of 5/28/04
Interface ID	SS-001
Name of Product	LAT Photons
Naming Convention	GLL_EVSUM_YYMMDD_C#_V##.FIT
Originator of Product	GSSC
Description of Product	Selected parameters from the subset of events identified as gamma-ray photons
Product Format	FITS
Production Latency Requirement	1 day
Product contains data for	1 Ku downlink
Number of deliveries per day	6
Typical size	~15 Mbyte

Product Content

Primary HDU: Standard GLAST FITS Primary Header
(primary HDU has no data)

Extension 1 LAT event summary

Column Number	Column Name	Units
1	Energy	MeV
2	RA	deg
3	DEC	deg
4	Theta (inclination angle)	deg
5	Phi (azimuthal angle)	deg
6	Zenith angle	deg
7	Earth azimuth angle	deg
8	Time	s
9	Event ID	Dimensionless
10	RECON Version	Dimensionless
11	CALIB Version	Dimensionless
12	IMGOODCALPROB	Dimensionless
13	IMVERTEXPROB	Dimensionless
14	IMCOREPROB	Dimensionless
15	IMPSFERRPRED	Dimensionless
16	CALENERGYSUM	MeV
17	CALTOTRLN	Dimensionless
18	IMGAMMAPROB	Dimensionless
19	Conversion Point	Dimensionless
20	Conversion Layer	Dimensionless
21	Pulse Phase	Dimensionless
22	Geotime	s
23	Barytime	s

24	Bintime	s
25	GEO_Offset	m
26	BARY_Offset	m

Extension 2 Good time intervals

Column Number	Column Name	Units
1	Start	s
2	Stop	s

Primary Header: SS-001

FITS Keyword	Value	Purpose
SIMPLE	'T'	Confirms that file conforms to NOST standard
BITPIX	8	
NAXIS	0	Means no data in primary header
EXTEND	'T'	Extension(s) present
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'	Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'	End date and time of observation
FILENAME	'GLL_EVSUM_YYMMDD_C#_V##.FIT'	Name of this file
ORIGIN	'LIOC'	Name of organization making file
AUTHOR	‘NAME_OF_PERSON’	Name of person responsible for file generation
CREATOR	‘EVENT_SUMMARY_MAKER_V##’	Software and version creating files
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Extension SS-001 Header 1

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	###	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	###	
GCOUNT	1	No multiplier
TFIELDS	###	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'	Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'	End date and time of observation
EXTNAME	'EVENTS'	Name of the extension
HDUCLASS	‘OGIP’	Conforms to OGIP standard
HDUCLAS1	‘EVENTS’	Extension contains events
HDUCLAS2	‘ALL’	Extensions contains all events detected
TSTART	###	Mission time of the observation start
TSTOP	###	Mission time of the observation end
MJDREF	58300.0	MJD of spacecraft clock start
TIMEUNIT	‘s’	Units for time
TIMESYS	‘TT’	Time system
TIMEREF	‘LOCAL’	Reference frame for times
TASSIGN	‘SATELLITE’	Location where time assignment performed
CLOCKAPP	T or F	Clock drift correction applied?
GPS_OUT	T or F	Whether GPS time was unavailable at any time
OBS_ID	###	Observation ID number
OBJECT	TBD	Observed object
PSR_COLS	T or F	Pulsar columns included?
MC_TRUTH	T or F	MC truth columns included?
NDSKEYS	3	# of data subspace keywords in header
DSTYP1	‘POS(RA,DEC)’	Type of data filtering
DSUN1	‘deg’	Physical unit of filtering parameters
DSVAL1	‘circle(100.0,20.0,15.0)’	Value range of filtering parameters
DSTYP2	‘TIME’	Type of data filtering
DSUNI2	‘s’	Physical unit of filtering parameters
DSVAL2	’10.99:1000000.0’	Value range of filtering parameters
DSTYP3	‘ENERGY’	Type of data filtering
DSUNI3	‘GeV’	Physical unit of filtering parameters
DSVAL3	‘0.511:100.312’	Value range of filtering parameters

TTYPE1	‘ENERGY’	Event energy
TFORM1	‘E”	4-byte REAL
TUNIT1	‘MeV’	
TLMIN1	0.0	Minimum value
TLMAX1	1.0e+7	Maximum value
TTYPE2	‘RA’	RA (J2000)
TFORM2	‘E’	4-byte REAL
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.0	Maximum value
TTYPE3	‘DEC’	DEC (J2000)
TFORM3	‘E’	4-byte REAL
TUNIT3	‘deg’	
TLMIN3	-90.0	Minimum value
TLMAX3	90.0	Maximum value
TTYPE4	‘THETA	Inclination in instrument coordinates
TFORM4	‘E’	4-byte REAL
TUNIT4	‘deg’	
TLMIN4	0.0	Minimum value
TLMAX4	180.0	Maximum value
TTYPE5	‘PHI’	Azimuth in instrument coordinates
TFORM5	‘E’	4-byte REAL
TUNIT5	‘deg’	
TLMIN5	0.0	Minimum value
TLMAX5	180.0	Maximum value
TTYPE6	‘ZENITH_ANGLE’	Zenith angle
TFORM6	‘E’	4-byte REAL
TUNIT6	‘deg’	
TLMIN6	0.0	Minimum value
TLMAX6	180.0	Maximum value
TTYPE7	EARTH_AXIMUTH_AN GLE	Earth azimuth (from north to east)
TFORM7	‘E’	4-byte REAL
TUNIT7	‘deg’	
TLMIN7	0.0	Minimum value
TLMAX7	360.0	Maximum value
TTYPE8	‘TIME’	Mission elapsed time
TFORM8	‘D”	8-byte DOUBLE
TUNIT8	‘s’	
TLMIN8	0.0	Minimum value
TLMAX8	1.0D+10	Maximum value
TTYPE9	‘EVENT_ID’	ID of original event
TFORM9	‘J’	4-byte signed INTEGER
TLMIN9	0	Minimum value
TLMAX9	2147483647	Maximum value
TTYPE10	‘RECON_VERSION’	
TFORM10	‘I’	2-byte signed INTEGER
TLMIN10	O	Minimum value
TLMAX10	32767	Maximum value

TTYPE11	'CALIB_VERSION'	Versions of calibration tables for the ACD, CAL, TKR
TFORM11	'3I'	2-byte signed INTEGER
TTYPE12	'IMGOODCALPROB'	Classification tree probability that CAL energy is well-measured
TFORM12	'E'	4-byte REAL
TUNIT12	''	Dimensionless
TLMIN12	0.0	Minimum value
TLMAX12	1.0	Maximum value
TTYPE13	'IMVERTEXPROB'	Classification tree probability that the vertex gives a better measure of the direction than the best track alone
TFORM13	'E'	4-byte REAL
TUNIT13	''	Dimensionless
TLMIN13	0.0	Minimum value
TLMAX13	1.0	Maximum value
TTYPE14	'IMCOREPROB'	Classification tree probability that the event is in the core of the PSF
TFORM14	'E'	4-byte REAL
TUNIT14	''	Dimensionless
TLMIN14	0.0	Minimum value
TLMAX14	1.0	Maximum value
TTYPE15	'IMPSFERRPRED'	Classification tree prediction of the PSF for this event, normalized to the 68% point predicted from an analytic model
TFORM15	'E'	4-byte REAL
TUNIT15	''	Dimensionless
TLMIN15	0.0	Minimum value
TLMAX15	100.0	Maximum value
TTYPE16	'CALENERGYSUM'	Sum of the raw energies in all the crystals
TFORM16	'E'	4-byte REAL
TUNIT16	'MeV'	
TLMIN16	0.0	Minimum value
TLMAX16	1.0e+7	Maximum value
TTYPE17	'CALTOTRLN'	Total radiation lengths integrated along trajectory first track
TFORM17	'E'	4-byte REAL
TUNIT17	''	Dimensionless
TLMIN17	0.0	Minimum value
TLMAX17	100.0	Maximum value
TTYPE18	'IMGAMMAPROB'	Classification tree probability that the event is a gamma ray
TFORM18	'E'	4-byte REAL
TUNIT18	''	Dimensionless
TLMIN18	0.0	Minimum value
TLMAX18	1.0	Maximum value
TTYPE19	'CONVERSION_POINT'	Reconstructed 3-space conversion point in instrument coordinates
TFORM19	'3E'	4-byte REAL

TUNIT19	'm'	
TTYPE20	'CONVERSION_LAYER'	Conversion layer in TKR, -1 means not in TKR
TFORM20	'I'	2-byte INTEGER
TLMIN20	-1	Minimum value
TLMAX20	18	Maximum value
TTYPE21	'PULSE_PHASE'	
TFORM21	'D'	8-byte DOUBLE
TUNIT21	''	Dimensionless
TLMIN21	0.0	Minimum value
TLMAX21	1.0	Maximum value
TTYPE22	'GEOTIME'	Event arrival time at geocenter
TFORM22	'D'	8-byte DOUBLE
TUNIT22	's'	
TLMIN22	0.0	Minimum value
TLMAX22	1.0D+10	Maximum value
TTYPE23	'BARYTIME'	Event arrival time at solar system barycenter
TFORM23	'D'	8-byte DOUBLE
TUNIT23	's'	
TLMIN23	0.0	Minimum value
TLMAX23	1.0D+10	Maximum value
TTYPE24	'BINTIME'	Binary-demodulated event arrival time at solar system barycenter
TFORM24	'D'	8-byte DOUBLE
TUNIT24	's'	
TLMIN24	0.0	Minimum value
TLMAX24	1.0D+10	Maximum value
TTYPE25	'GEO_OFFSET'	Offset of Earth center from S/C
TFORM25	'3D'	8-byte DOUBLE
TUNIT25	'm'	
TTYPE26	'BARY_OFFSET'	Offset of solar system barycenter from Earth center
TFORM26	'3D'	8-byte DOUBLE
TUNIT26	'm'	
TLMIN26		Minimum value
TLMAX26		Maximum value

END

Extension SS-001 Header 2

FITS Keyword	Value	Purpose
XTENSION	'BINTABLE'	Extension type
BITPIX	8	Bits per pixel - assume single precision floating point
NAXIS	2	# of axes=2
NAXIS1	16	Number of bytes per row
NAXIS2	###	Number of point sources in file (~3e4)
PCOUNT	0	
GCOUNT	1	No multiplier
TFIELDS	2	Number of fields per row
CHECKSUM	###	Checksum for entire HDU
DATASUM	###	Checksum for data table
TELESCOP	'GLAST'	Name of telescope generating data
INSTRUME	'LAT'	Name of instrument generating data
EQUINOX	2000.0	Equinox for RA and DEC
RADECSYS	‘FK5’	World coord. system for this file (FK5 or FK4)
DATE	'yyyy-mm-ddThh:mm:ss.ssss'	File creation date
DATE-OBS	'yyyy-mm-ddThh:mm:ss.ssss'	Start date and time of observation
DATE-END	'yyyy-mm-ddThh:mm:ss.ssss'	End date and time of observation
EXTNAME	'GTT'	Name of the extension
HDUCLASS	‘OGIP’	Conforms to OGIP standard
HDUCLAS1	‘GTT’	Extension contains events
HDUCLAS2	‘ALL’	Extensions contains all events detected
TSTART	###	Mission time of the observation start
TSTOP	###	Mission time of the observation end
MJDREF	58300.0	MJD of spacecraft clock start
TIMEUNIT	‘s’	Units for time
TIMESYS	‘TT’	Time system
TIMEREF	‘LOCAL’	Reference frame for times
TASSIGN	‘SATELLITE’	Location where time assignment performed
CLOCKAPP	T or F	Clock drift correction applied?
GPS_OUT	T or F	Whether GPS time was unavailable at any time
ONTIME	###	Sum of GTI lengths
TELAPSE	###	Time between the start of the first GTI and the end of the last GTI
TTYPE1	‘START’	Start time of the first GTI
TFORM1	‘D’	8-byte DOUBLE
TUNIT1	‘s’	
TLMIN1	0.0	Minimum value
TLMAX1	1.0D+10	Maximum value
TTYPE2	‘STOP’	End time of the last GTI
TFORM2	‘D’	8-byte DOUBLE
TUNIT2	‘s’	
TLMIN2	0.0	Minimum value
TLMAX2	1.0D+10	Maximum value

END

SS-002 Pulsar Ephemerides

Interface definition	Version 1, based on D4 definitions of 5/28/04
Interface ID	SS-002
Name of Product	Pulsar Ephemerides
Naming Convention	GLL_PSREPH_YYMMDD_V##.FIT
Originator of Product	GSSC
Description of Product	Ephemerides of pulsars that may be detectable by the LAT
Product Format	FITS
Delivery frequency	On update
Typical size	~15 Mbyte

Product Content

Primary HDU: Standard GLAST FITS Primary Header
(primary HDU has no data)

Extension 1 Pulsar spin parameters

Column Number	Column Name	Units
1	Pulsar name	Dimensionless
2	RA	Deg
3	Deg	Deg
4	Valid Since	Day
5	Valid Until	Day
6	Integer part of barycentric epoch	Day
7	Fractional part of barycentric epoch	Day
8	Integer part of infinite-frequency geocentric pulse arrival time (UTC) in MJD	Day
9	Fractional part of infinite-frequency geocentric pulse arrival time (UTC) in MJD	Day
10	Pulsar rotation frequency	s-1
11	First time derivative of pulsar frequency	s-2
12	Second time derivative of pulsar frequency	s-3
13	Root-mean-square radio timing residual in milli-periods	Dimensionless
14	Source of timing information	Dimensionless
15	True for binary pulsars, false for single pulsars	Dimensionless

Extension 2 Pulsar orbital parameter

Column Number	Column Name	Units
1	Pulsar name	Dimensionless
2	Orbital period	s
3	Derivative of orbital period	Dimensionless
4	Projected semi-major axis	s
5	Derivative of projected semi-major axis	Dimensionless (TBR)

6	Orbital eccentricity	Dimensionless
7	Derivative of orbital eccentricity	s-1 (TBR)
8	Barycentric time of periastron	Day
9	Longitude of periastron	deg
10	Derivative of longitude of periastron	Deg/yr
11	Time-dilation and gravitational redshift parameter	Dimensionless
12	Shapiro delay range	TBD
13	Shape of Shapiro delay	TBD
14	Observer code	Dimensionless

Extension 3 Observer information

Column Number	Column Name	Units
1	Observer code	Dimensionless
2	Observatory	Dimensionless
3	Contact person	Dimensionless
4	Reference	Dimensionless

Extension 4 Pulsar alternative name

Column Number	Column Name	Units
1	Alternate name	Dimensionless
2	Pulsar name	Dimensionless

Primary Header: SS-002

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
EQUINOX	‘2000’	Equinox for ra and dec
RADECSYS	'FK5'	World coord. system for this file (FK5 or FK4)
DATE	'YYYY-MM-DD'	Date file was made in YYYY-MM-DD
FILENAME	'GLL_PSREPH_YYMMDD_V##.FIT'	
ORIGIN	'GSSC'	Name of organization making file
AUTHOR	‘JOHN_DOE’	Name of person responsible for file generation
CREATOR	'PULSAR_EPHEMERIDES_EXTRACTOR_V##'	Software and version creating file
VERSION	#	Release version of the model
SOFTWARE	#	Version of the generating software
END		

Extension SS-002 Header 1

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	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	‘yyy-mm-ddThh:mm:ss.sss’	File creation date
EXTNAME	'SPIN_PARAMETERS'	Name of the extension
TTYPE1	‘PSRJNAME’	Pulsar name in PSR Jxxxx+xx[xx[aa]] format (w/o 'PSR J')
TFORM1	‘11A’	Character
TTYPE2	‘RA’	RA (J2000) of pulsar
TFORM2	‘D’	8 byte DOUBLE
TUNIT2	‘deg’	
TLMIN2	0.0	Minimum value
TLMAX2	360.	Maximum value
TTYPE3	‘DEC’	Model gamma-ray intensity 1-sigma uncertainty
TFORM3	‘D’	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	‘J’	4-byte signed INTEGER
TUNIT4	‘d’	Units of field
TTYPE5	‘VALID_UNTIL’	Last date for valid timing parameters
TFORM5	‘J’	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	‘J’	4-byte signed INTEGER
TUNIT6	‘d’	
TTYPE7	‘EPOCH_FRAC’	Fractional part of barycentric epoch of RA, DEC, F0, F1, and F2 in MJD
TFORM7	‘D’’	8 byte DOUBLE

TUNIT7	‘d’	Units of field
TLMIN7	0.0	Minimum value
TLMAX7	1.0	Maximum value
TTYPE8	‘T0GEO_INT’	Integer part of infinite-frequency geocentric pulse arrival time (UTC) in MJD
TFORM8	‘J’	4-byte signed INTEGER
TUNIT8	‘d’	
TTYPE9	‘T0GEO_FRAC’	Fractional part of infinite-frequency geocentric pulse arrival time (UTC) in MJD
TFORM9	‘D’	8 byte DOUBLE
TUNIT9	‘d’	
TLMIN9	0.0	Minimum value
TLMAX9	1.1	Maximum value
TTYPE10	‘F0’	Pulsar rotation frequency
TFORM10	‘D’	8 byte DOUBLE
TUNIT10	‘s**(-1}’	Units of field
TTYPE11	‘F1’	First derivative of pulsar rotation frequency
TFORM11	‘D’	8 byte DOUBLE s
TUNIT11	‘s**(-2)’	
TTYPE13	‘F2’	Second derivative of pulsar rotation frequency
TFORM13	‘D’	8 byte DOUBLE
TUNIT13	‘s**(-3)’	
TTYPE14	‘OBSERVER_CODE	Source of timing information
TFORM14	‘1A’	Character
TTYPE15	‘BINARY_FLAG’	True for binary pulsars, false for single pulsars
TFORM15	‘L’	Logical
END		

Extension Header 2 SS-002

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	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	'yyy-mm-ddThh:mm:ss.sss'	File creation date
EXTNAME	ORBITAL_PARAMETERS'	Name of the extension
TTYPE1	'PSRJNAME'	Pulsar name in PSR Jxxxx+xx[xx[aa]] format (w/o 'PSR J')
TFORM1	'11A'	Character
TTYPE2	'PB'	Orbital period
TFORM2	'D'	8-byte DOUBLE
TUNIT2	's'	
TTYPE3	'PBDOT'	First derivative of orbital period
TFORM3	'D'	8-byte DOUBLE
TUNIT3	''	
TTYPE4	'A1'	Projected semi-major axis in light seconds (light travel time)
TFORM4	'D'	8-byte DOUBLE
TUNIT4	's'	Units of field
TTYPE5	'XDOT'	First time derivative of A1 (projected semi-major axis)
TFORM5	'D'	8-byte DOUBLE
TUNIT5	TBD	
TTYPE6	'E'	Orbital eccentricity
TFORM6	'D'	8-byte DOUBLE
TUNIT6	''	
TTYPE7	'EDOT'	First derivative of orbital eccentricity
TFORM7	'D'	8-byte DOUBLE
TUNIT7	TBD	Units of field
TTYPE8	'T0'	Barycentric time of periastron in MJD

TFORM8	'D'	8-byte DOUBLE
TUNIT8	'd'	
TTYPE9	'OM'	Longitude of periastron
TFORM9	'D'	8-byte DOUBLE
TUNIT9	'deg'	
TLMIN9	0.0	
TLMAX9	360.0	
TTYPE10	'OMDOT'	First derivative of periastron longitude (degrees per Julian year)
TFORM10	'D'	8-byte DOUBLE
TUNIT10	'deg/yr'	Units of field
TTYPE11	'GAMMA'	Time-dilation and gravitational redshift parameter
TFORM11	'D'	8-byte DOUBLE
TUNIT11	''	
TTYPE12	'R'	Range parameter of Shapiro delay in binary system
TFORM12	'D'	8-byte DOUBLE
TUNIT12	TBD	
TTYPE13	'S'	Shape parameter of Shapiro delay in binary system
TFORM13	'D'	8-byte DOUBLE
TUNIT13	TBD	Units of field
TTYPE14	'OBSERVER_CODE'	Source of orbital parameters
TFORM14	'1A'	Character

END

Extension SS-002 Header 3

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	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	‘yyy-mm-ddThh:mm:ss.sss’	File creation date
EXTNAME	‘OBSERVERS’	Name of the extension
TTYPE1	‘OBSERVER_CODE	Observer code
TFORM1	‘1A’	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		

Extension SS-002 Header 4

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	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	‘yyy-mm-ddThh:mm:ss.sss’	File creation date
EXTNAME	'ALTERNATIVE_NAMES'	Name of the extension
TTYPE1	'ALTNAME'	Alternative name for pulsar
TFORM1	'32A’	Character
TTYPE2	‘PSRJNAME’	Pulsar name in PSR Jxxxx+xx[xx[aa]] format (w/o 'PSR J')
TFORM2	‘11A’	Character
END		