Gamma-Ray Large Area Space Telescope (GLAST) Project

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

Science Data Products
Interface Control Document (ICD)

December 14, 2006

GODDARD SPACE FLIGHT
CENTER

Gamma-Ray Large Area
Space Telescope
(GLAST)
Project

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Original	4/11/06	All	Created by splitting original ICD into File Format Document and ICD
Revisions	6/28/06	All	Updates
Revisions based on GSSC issues	12/14/06	All	§4.3 reflects the LAT and GBM using different coordinate systems. Mention of possible GLAST-specific HDUCLASS keywords removed from §4.3. Limit on 31 character filenames removed from §4.4. Photon files (now LS-002) transferred from LISOC to GSSC and not extracted from event files (now LS-001; §5.2.1, §5.2.4).

TABLE OF CONTENTS

1. Introduction

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

Associated with this document is the Science Data Products File Format Document (FFD) that defines the contents of the files that are exchanged. Representatives of the GIOC, ISOC and GSSC are responsible for the maintenance of the FFD.

2. References

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

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

Science Data Products File Format Document (GLAST-GS-DOC-0001)

GSSC Ingest System Detailed Design Document (GSSC-0009)

GLAST Operations Concept Document (433-OPS-0001)

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

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

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

GLAST Spacecraft Performance Specification (433-SPEC-0003)

3. Background Information

3.1. GLAST Spacecraft

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

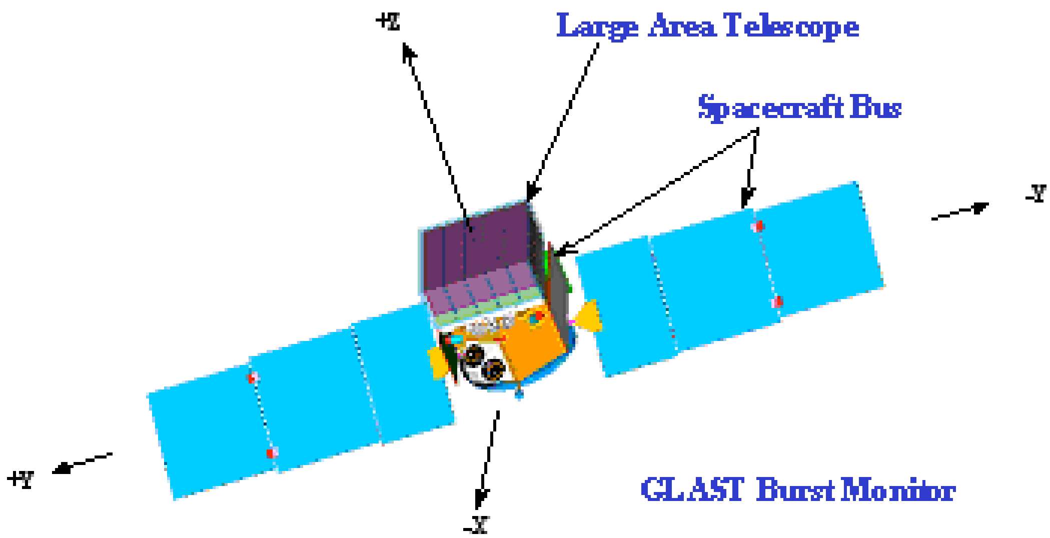

Figure 1—Simplified drawing of the GLAST observatory showing the coordinate convention.

3.2. Data Levels

3.2.1. Raw Data

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

3.2.2. Level 0 Data

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

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

3.2.3. Level 1 Data

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

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

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

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

3.2.4. Level 2 Data

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

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

3.2.5. Level 3 Data

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

3.2.6. Ancillary Data

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

4. Conventions

4.1. File Types

Unless otherwise specified, files will be formatted as OGIP-compliant FITS files.

4.2. Representation of Time

For timing analyses of celestial sources, Terrestrial Time (TT) is preferable to Coordinated Universal Time (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—Mission Elapsed Time (MET)—from a fiducial time that is presented in the header. The same fiducial time—a date given by the MJDREF keyword—will be used by all science data products for both the GBM and the LAT. The GLAST convention is that MJDREF=51910 (UTC)=51910.0007428703703703703 (TT); the fractional part of MJDREF in the TT system compensates for the use of midnight in the UTC system as the reference time. We break MJDREF into two keywords: MJDREFI, the integer part; and MJDREFF, the fractional part. In addition, the SC clock drift for data obtained during periods when the GPS time signal is not available from the SC can also be specified.

4.3. Representation of Spacecraft Position and Orientation

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

4.4. File Names

1. Files should have unique, human-readable names; newer versions of a data product should be distinguishable from earlier versions by the file name. The identity of a file may not depend on its position within the directory structure, although a file's name should allow it to be placed into such a system.
2. The allowed characters are the letters a-z, the numbers 0–9, and separators '.' and '_'; note that filenames are lower case. (These limitations are for consistency with ISO 9660 Level 2 specifications.)
3. File names should start with 'gl' and include (in order, as necessary):

i. The logical instrument: g (GBM), l (LAT), s (spacecraft);

ii. Identifier for the data type, such as 'tte' for time tagged events;

iii. GBM detectors are identified by 'n' (NaI) or 'b' (BGO) followed by a single digit—hexadecimal is used for the 12 NaI detectors, while 'all' indicates files that apply to all detectors;

iv. Identifier such as burst 'bnyymmddff', where yymmdd signifies the day and fff the fraction of day;

v. Identifier for the contact number for that day (c#), for data products that will be produced once per data downlink;

vi. Version number, such as v03, starting with 00; and

vii. Three-character format type as file extension, e.g., .fit for FITS file.

An example of a GBM burst filename is glg_tte_n1_bn080109123_v03.fit, the 3rd version of a FITS file with TTE data from the GBM's NaI detector #1 for burst bn080109123. An example of a daily GBM filename is glg_cspec_n0_070605_v01.pha, the 1st version of a FITS file with CSPEC spectra from the GBM's NaI detector #0 for June 5, 2007. An example of a LAT filename is gll_pt_090615_c3_v01.fit, the 1st version of the FITS file with pointing and time data from the 3rd pass of June 15, 2009.

4.5. FITS Headers

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

The following information should be in one of the headers:

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

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

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

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

5. The units of the quantities (TUNITx keyword) following 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 (e.g., both as a date and as MET);

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

4.6. Data Product Delivery

The data products will be transferred from the creator of the product to the relevant ground system elements using the FASTCOPY protocol. The product file(s) and a manifest file are stored in a TAR-format file. The protocol includes validation of the transferred files and notification of the sending element that the transfer has been successful. The details about the manifest file format and the FASTCopy transfer options are explained in Appendix A.

5. Summary of the Data Products and Their Delivery Schedule

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

5.1. Data Products Originating in the GIOC

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

5.1.1. Daily Data Products

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

Table 5-1: GIOC Daily Data Products Descriptions

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

Table 5-2: GIOC Daily Data Products—Filenames

ICD ID	Filename	Definition	Number of Files per Day
GS-001	glg_ctime_wz_yymmdd_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number	14
GS-002	glg_cspec_wz_yymmdd_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date xx = the version number	14
GS-005	glg_spechist_wx_yymmdd_vzz.fit	w—N or B, depending on the detector type x—hexadecimal detector number, 0-B yymmdd—date covered by file zz—version number	14
GS-006	glg_poshist_all_yymmdd_vxx.fit'	yymmdd = year, month and day xx = the version number	1

5.1.2. Burst Data Products

The burst data products are the files pertaining to a given burst trigger that are produced and sent to the GSSC within a day after the burst trigger, regardless of whether the trigger resulted from a burst. The GBM will also trigger on increases in the count rate from transients that are not bursts; on board and ground classification will determine whether the trigger was produced by a burst. The files include lists of counts, binned counts, and the response and background spectra necessary to analyze the burst data. The burst products also include catalog files with summary data resulting from pipeline processing and a file with the TRIGDAT messages sent down over TDRSS immediately after a burst. If the trigger is classified as an event other than a burst, then a simple TCAT catalog file is provided; if the trigger is a burst, a BCAT catalog file (which is a superset of a TCAT file) is provided.

Table 5-3: GIOC Burst Data Products Descriptions

ICD ID	Product	Description	Latency	Size (bytes)	Level
GS-101	CTIME (burst version)	For each detector, the counts accumulated every 0.256 s in 8 energy channels	1 day	16MB (1.15 MB /file)	1
GS-102	CSPEC (burst version)	For each detector, the counts accumulated every 8.192 s in 128 energy channels	1 day	16MB (1.15 MB /file)	1
GS-103	GBM TTE	Event data for the burst	1 day	40-60MB (3-4.5 MB /file	1
GS-104	GBM DRMs	8 and 128 energy channel DRMs for all 14 detectors	1 day	6 MB (0.4 MB /file)	1
GS-105 (non-burst trigger)	GBM Trigger Catalog Entry	Classification of GBM trigger with some characteristics	1 day, updated periodically	20 kB	1

GS-106 (burst trigger)	GBM Burst or Spectral Catalog Entry	Values of the quantities describing the burst (e.g., durations, fluences)	1	Updated periodically	100-200 kB
GS-107	GBM TRIGDAT	All the GBM's messages downlinked through TDRSS	1 day	50-100 kB	1
GS-108	GBM Background Files	Backgrounds for spectral fitting	1 day	14kB (1kB /file)	1

Table 5-4: GIOC Burst Data Products—Filenames

ICD ID	Filename	Definition	Number of Files per Burst
GS-101	glg_ctime_wz_bnyymmddfff_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number	14
GS-102	glg_cspec_wz_bnyymmddfff_vxx.pha	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number	14
GS-103	glg_tte_wz_bnyymmddfff_vxx.fit	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of the day xx = the version number	14
GS-104	glg_uu_wz_bnyymmddfff_vxx.rsp	uu='cspec' or 'ctime w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number	28
GS-105 (non-burst trigger)	glg_tcat_all_bnyymmddfff_vxx.fit	yymmdd—the date of the trigger fff = fraction of day xx—file version number	1
GS-106 (burst trigger)	glg_bcat_all_bnyymmddfff_vxx.fit	yymmdd—the date of the trigger fff = fraction of day xx—file version number	1
GS-107	glg_trigdat_all_bnyymmmddfff_vxx.fit	yymmdd = date fff = fraction of day xx = version number	1
GS-108	glg_bck_wz_bnyymmddfff_vxx.bak	w = 'n' or 'b' for detector type z = 0 to b for detector number (hex a and b used) yymmdd = the date fff = fraction of day xx = the version number	14

5.1.3. Updates

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

Table 5-5: GIOC Data Products Delivered as Updates

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

Table 5-6: GIOC Data Products Delivered as Updates—Filenames

ICD ID	Filename	Definition	Number of Files
GS-007	glg_lutww_zzz_yymmddfff_vxx.fit	ww—datatype to which look up table applies, ct for ctime and cs for cspec zzz—nai or bgo yymmdd—date of start of table validity fff—fraction of day xx—version number	4
GS-008	glg_cal_vz_zuu_azyyy_vxx.fit	v—n or b, depending on detector type z—hexadecimal detector number, 0-b uu—zenith angle, in degrees yyy—azimuth angle, in degrees xx—version number	TBD
GS-105 (non-burst trigger)	glg_tcat_all_bnyymmddfff_vxx.fit	yymmdd—the date of the trigger fff = fraction of day xx—file version number	1
GS-106 (burst trigger)	glg_bcat_all_bnyymmddfff_vxx.fit	yymmdd = date fff = fraction of day xx = version number	1

5.1.4. GSSC Processing of GBM Daily Data Products

The daily data products are copied into the appropriate Browse directory, and are cataloged by the date (the files cover a full day).

5.1.5. GSSC Processing of GBM Trigger Data Products

Note that there are two Browse catalogs resulting from GBM triggers. All GBM triggers are entered into the Trigger Catalog, while only those triggers classified as bursts are entered in to Burst Catalog. Thus a burst will be found in both the Trigger and Burst Catalogs.

The data products from a non-burst trigger are copied into the appropriate Browse Trigger Catalog directory, and the Browse entry is extracted from the TCAT catalog file that is one of the data products. The data products from a burst trigger are copied first into the appropriate Browse Burst Catalog directory and then into the appropriate Browse Trigger Catalog directory, and the Browse entry is extracted from the BCAT catalog file that is one of the data products. Note that a BCAT file is a superset of a TCAT file.

In Browse the data will be cataloged by the following quantities:

- Trigger time
- Position
- Source class
- Classification reliability

5.1.6. GSSC Processing of GBM Burst Data Products

The data products from a burst trigger are copied into the appropriate Browse Burst Catalog directory, and the Browse entry is extracted from the BCAT catalog file that is one of the data products.

In Browse the data will be cataloged by the following quantities:

- Time
- Position
- Name
- Fluence
- Peak flux
- T90
- T50
- Last update date

The 'name' will initially be GRByymmddfff as assigned by pipeline processing, but will eventually be changed to GRByymmddx where x is null or 'A' or 'B' etc. This new name requires human intervention, noting whether another burst was detected on the same day.

These catalog quantities may be updated by new BCAT files, and the date of the last update is recorded in the last column. In particular, the OBJECT keyword may be changed from GRByymmddfff to GRByymmddx (x is null or 'A' or 'B' etc.) as a result of human intervention.

5.1.7. GSSC Processing of Other GBM Data Products

GS-007 and GS-008 are calibration files that are stored in the GBM CALDB.

5.2. Data Products Originating in the LISOC

5.2.1. Daily Data Products

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

Table 5-7: LISOC Data Products Delivered After Each Pass

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

Table 5-8: LISOC Data Products Delivered After Each Pass—Filenames

ICD ID	Filename	Definition	Number of Files
LS-001	gll_evsum_yymmdd_cn_vxx.fit	yymmdd = date n = pass number xx = version number	1
LS-002	gll_phsum_yymmdd_cn_vxx.fit	yymmdd = date n = pass number xx = version number	1
LS-005	gll_pt_yymmdd_cn_vxx.fit	yymmdd = date n = pass number xx = version number	1

5.2.2. Weekly Data Products

Weekly the LISOC will send the GSSC a data product summarizing the state of the LAT, such as the number of dead Si strips per TKR tower—to provide the GSSC insight into the performance of the LAT.

Table 5-9: LISOC Data Products Delivered Weekly

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

Table 5-10: LISOC Data Products Delivered Weekly—Filenames

Filename	Definition	Number of Files
TBD	TBD	1

5.2.3. Updates

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

Table 5-11: LISOC Data Products Delivered As Updates

ICD ID	Product	Description	Delivered	Freq.	Size (bytes)	Level
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. These are the files necessary to run the backup Level 1 pipeline at the GSSC.	Weekly	1 week	TBD	1
LS-007	LAT Transient Data	Summary information for transient sources (GRBs, solar flares, and AGN flares) derived from LAT event data	Per transient	8 hours	100 kB	2
LS-008	LAT Point Source Catalog	Table of detected gamma-ray sources with derived information	On update	N/A	10 MB	3

Table 5-11: LISOC Data Products Delivered As Updates						
LS-009	LAT Burst Catalog	List and characterization of gamma-ray bursts: location, duration, intensity	On update	N/A	TBD	3
LS-010	Interstellar Emission Model	Model for diffuse gamma-ray emission from the Milky Way, input for high-level data analysis; will be refined using GLAST data	On update	N/A	40 MB	Ancillary
LS-011	LAT Energy Redistribution	Constants for parameterization of the LAT's energy redistribution	On update	N/A	12kB (12kB/ file)	1
LS-012	LAT Effective Area	Constants for parameterization of the LAT's effective area	On update	N/A	120kB (~30kB/ file)	1
LS-013	LAT PSF	Constants for parameterization of the LAT's point spread function	On update	N/A	64kB (17kB/ file)	1

Table 5-12: LISOC Data Products Delivered As Updates—Filenames

ICD ID	Filename	Definition	Number of Files
LS-003	TBD	TBD	TBD
LS-007	gll_trans_an####_vxx.fit	xx = version number	1
LS-008	gll_psc_vxx.fit	xx = version number	1
LS-009	gll_grbc_vxx.fit	xx = version number	1
LS-010	gll_iem_vxx.fit	xx = version number	1
LS-011	gll_edisp_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number	4
LS-012	gll_earea_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number	4
LS-013	gll_psf_cwz_yymmdd_vxx.fits	w—photon class identifier, e.g., a or b z—'f' for front, 'b' for back yymmdd—date the file becomes applicable xx—version number	4

5.2.4. GSSC Processing of Daily LAT Data Products

The daily LAT Data Products are the event and spacecraft files, which are received for each Ku band downlink. The LISOC will transfer two types of event files, the first with all events that might be considered photons with data necessary for processing by the SAE (LS-002), and the second with additional events and most of their merit n-tuples (LS-001). The ingest, processing and storing of these files are described in the LAT Event Summary Database Requirements (GSSC-0006) and LAT SAE Database System Detailed Design Document (GSSC-0012).

5.2.5. GSSC Processing of Weekly LAT Data Products

LS-006 is a report on the status of the LAT that is archived internally by the GSSC. These data will help GSSC scientists in supporting the user community, and are not intended to be made public.

5.2.6. GSSC Processing of Other LAT Data Products

LAT Level 1 Processing Files

LS-003 consists of the files necessary for the GSSC to run the backup LAT Level 1 processing pipeline. Thus these files must be copied into the appropriate directories.

Transient Source Catalog

The LAT Transient Source Catalog will be presented as a Browse table, and thus when the LISOC sends a LS-007 file to the GSSC, the GSSC creates the appropriate Browse data file. Transient sources will be cataloged by primary columns, that are always visible to users, and secondary columns, that users can request.

The primary columns are:
- Source name—e.g., 1GL J123456-012345
- RA
- Dec
- Average flux >100 MeV—value and its uncertainty
- Average spectral index >100 MeV, value and its uncertainty
- Detection significance—average and peak
- Counterpart—name and confidence of association

The secondary columns are:
- Confidence semi-major axis, 68% containment
- Confidence semi-minor axis, 68% containment
- Confidence ellipse position angle, 68% containment
- Confidence semi-major axis, 95% containment
- Confidence semi-minor axis, 95% containment

- Confidence ellipse position angle, 95% containment
- Variability index
- Peak flux >100 MeV—value, its uncertainty, time of occurrence, duration
- Flux history
- Flags

Point Source Catalog

The LAT Point Source Catalog will be presented as a Browse table, and thus when the LISOC sends a LS-008 file to the GSSC, the GSSC creates the appropriate Browse data file. Point sources will be cataloged by primary columns, that are always visible to users, and secondary columns, that users can request.

The primary columns are:

- Source name—e.g., 1GL J123456-012345
- RA
- Dec
- Average flux >100 MeV—value and its uncertainty
- Average spectral index >100 MeV, value and its uncertainty
- Detection significance—average and peak
- Counterpart—name and confidence of association

The secondary columns are:

- Confidence semi-major axis, 68% containment
- Confidence semi-minor axis, 68% containment
- Confidence ellipse position angle, 68% containment
- Confidence semi-major axis, 95% containment
- Confidence semi-minor axis, 95% containment
- Confidence ellipse position angle, 95% containment
- Average flux 30-100 MeV—value and its uncertainty
- Average flux 100-300 MeV—value and its uncertainty
- Average flux 300-1000 MeV—value and its uncertainty
- Average flux >3000 MeV—value and its uncertainty
- Variability index
- Peak flux >100 MeV—value, its uncertainty, time of occurrence, duration
- Flux history
- Flags

Burst Catalog

The LAT Burst Catalog will be presented as a Browse table, and thus when the LISOC sends a LS-009 to the GSSC, the GSSC creates the appropriate Browse data file. LAT bursts will be cataloged by primary columns, that are always visible to users, and secondary columns, that users can request. The LAT Burst Catalog will be linked to the GBM Burst Catalog (a burst in one catalog will be linked as appropriate to the same burst in the other).

The primary columns are:

- GCN name—the burst name of the form GRByymmddx, where x is null, 'A', 'B', etc.
- LAT trigger time
- RA
- DEC
- Radius of 90% confidence region
- Flags—indicate whether the entry is for the prompt phase or afterglow
- Burst Duration—value and its uncertainty

The secondary columns are:

- LAT GRB ID—a sequence number unique to the LAT
- GBM name—of the form BNyymmddfff
- Peak flux >30 MeV—value, its uncertainty, and time of occurrence
- Maximum photon energy—value, its uncertainty, and time of occurrence
- Beginning and end times of the duration
- Average photon energy >30 MeV—value and its uncertainty
- Fluence >30 MeV—value and its uncertainty
- Average photon energy >100 MeV—value and its uncertainty
- Fluence >100 MeV—value and its uncertainty
- Average photon spectral index—value and its uncertainty
- Rate history

Interstellar Emission Model

This model is included with the SAE, and therefore updates to the model that are received from the LISOC must be inserted into the SAE installation package. In addition, a copy is provided to the webservice that displays the model on the GSSC website.

Calibration Files

LS-011, LS-012 and LS-013 provide the data for the Instrument Response Functions, and therefore are ingested into the LAT CALDB whenever these functions are updated. Note that there might be new versions for a given time period, and versions for different time periods (e.g., if the LAT changes with time).

Appendix A. FASTCopy Usage Convention

All routine file transfers among the MOC, GSSC, LISOC, and GIOC will use the SoftLink FASTCopy file transfer product. Every file transfer consists of a single file in the Unix tape archive format (tar). The tar file contains the following items:

1. The data files being transferred
2. The message files accompanying the data files (where applicable)
3. A manifest file listing all files (data files and message files but not the manifest file itself) that are included in the transfer

The data files within the tar file may be compressed and if so, will have the appropriate extension depending on the compression algorithm used.

The **tar file** name format is:

SRCID_yyyydddhhmmss.tar

where:

SRCID identifies the origin of the file as either:
- MOC – Mission Operations Center
- GSSC – Science Support Center
- LISOC – LAT Instrument and Science Operations Center
- GIOC – GBM Instrument Operations Center

yyyydddhhmmss is the timestamp giving the date and time when the tar file was created, encoded as a four digit year, a three digit day of year, two digit hour, two digit minute, and two digit second.

tar is the file extension identifying the file as a "tar" file

The tar file is guaranteed to have a unique name. In the rare case that two tar files are created in the same second, the second instance will increment the seconds field.

The **manifest file** is a text file that contains one line per file transferred. Each line will consist of the MD5 message digest value and the base file name (no path) in that order separated by two spaces. Therefore, the manifest file can be used by the Unix md5sum utility to verify that all the files in the package were included in the tar file and that the files were not altered.

The manifest file naming convention is:

*SRCID_yyyydddhhmmss*_manifest.txt

where:

SRCID identifies the origin of the file as either MOC, GIOC, LISOC, or GSSC
yyyydddhhmmss is the timestamp when the tar file was created
_manifest.txt is a fixed field indicating that this is a manifest file

Note that the manifest file and the tar file have identical file names except for the ".tar" and "_manifest.txt" endings.

Each ground system element will have exactly one directory tree at each of the other ground system elements where they will transfer files to. This location will be set in the configuration file of the receiving site and associated with the proxy username and password provided to the sending sites. Locally, the receiving site may have separate incoming directories for the different external sites if they wish or may have a single location to receive files from all other ground system elements.

The FASTCopy daemon will be configured to listen on port 40000.

All file transfers are encrypted using SSL. The SSL parameters are TBD. The SSL phrase is specified in the Operations Agreement.

The file transfer is initiated using FASTCopy's batch capability to allow for automatic retries in the event of transmission failure. FASTCopy will transfer to the facility's prime computer using the proxy user name given in the current Operations Agreement (OA). The batch system is configured to attempt retransmission 5 times at 10 minute intervals. (TBD) If the all of the batch retransmission attempts fail, then the sending system will reconfigure to transfer to the destination facility's backup computer. If retransmission to the back system fails, the operators are informed of the serious communications error.

The FASTCopy command will include the remote_command option that initiates the facility's post-transfer command. A single post transfer command is defined to be executed for all data transfers from a particular sender to a particular receiver. The post-transfer commands for each facility pair are listed in the Table B-1.

Table A-1 Remote commands

From	**To**	**Command**	Parameters
GSSC	MOC	<TBD>	**<TBD>**
	LISOC	<TBD>	**<TBD>**
	GIOC	<TBD>	**<TBD>**
GIOC	MOC	<TBD>	**<TBD>**
	LISOC	<TBD>	**<TBD>**
	GSSC	<TBD>	**<TBD>**
LISOC	MOC	<TBD>	**<TBD>**
	GIOC	<TBD>	**<TBD>**
	GSSC	<TBD>	**<TBD>**
MOC	LISOC	<TBD>	**<TBD>**
	GIOC	<TBD>	**<TBD>**
	GSSC	**<TBD>**	**<TBD>**

The FASTCopy command will include the remote_sync option. This requires that the post-transfer script successfully completes in order for the transfer to be considered successful.

Appendix B. Acronyms

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

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