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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

GLAST BURST MONITOR INSTRUMENT OPERATIONS CENTER (IOC) REQUIREMENTS

DRAFT

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Developed by:

William S. Paciesas/UAH
GBM Ground System Manager

Approved by:

Charles A. Meegan/SD50
GBM Principal Investigator

Steve Elrod/SD21
GBM Project Manager

Giselher Lichti/MPE
GBM Co-Principal Investigator

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Table of Acronyms

CCSDS	Consultative Committee for Space Data Systems
DPU	Data Processing Unit
GBM	GLAST Burst Monitor
GCN	Gamma-Ray Burst Coordinates Network
GLAST	Gamma Ray Large Area Space Telescope
GRB	Gamma-Ray Burst
GSFC	Goddard Space Flight Center
IOC	Instrument Operations Center
MOC	Mission Operations Center
MPE	Max Planck Institute for Extraterrestrial Physics
MSFC	Marshall Space Flight Center
NSSTC	National Space Science and Technology Center
PDMP	Project Data Management Plan
SSC	Science Support Center
TBD	To be defined
TBR	To be resolved
TT	Terrestrial Time

1 Purpose

This document defines level II system requirements for the GLAST Burst Monitor (GBM) Instrument Operations Center (IOC).

2 Applicable Documents

GSFC 433-SRD-0001, "GLAST Science Requirements Document (SRD)"

GSFC 433-SPEC-0001, "GLAST Mission System Specification"

GSFC 433-IRD-0002, "GLAST GBM Science Instrument – Spacecraft Interface Requirements Document"

GSFC 433-OPS-0001, "GLAST Operations Concept Document"

GSFC TBD, "GLAST Project Data Management Plan"

MSFC GBM-REQ-1007, "GBM System Requirements, Verification and Compliance"

MSFC GBM-ICD-1009, "GBM Internal Interface-Control Document"

MSFC, "A Proposal to NASA for a Burst Monitor (GBM) for the GLAST Mission"

MSFC GBM-REQ-TBD, "GBM Mission Operations & Data Analysis Software Requirements"

3 Requirements

3.1 System Description

The GBM IOC is the ground-based analysis and operations center for the GBM instrument. It will be located at the NSSTC in Huntsville, AL. Its primary functions are to perform nominal instrument operations and to process the instrument data into a useful form for delivery to the GLAST Science Support Center (SSC) and the GBM science team. Additional IOC functions include instrument commanding, state-of-health monitoring, calibration, verification of flight data, quick-look science data analysis, and generation of rapid science alerts. The IOC is also responsible for production and maintenance of GBM flight and ground software. The following sections describe the functional requirements in more detail. These are in addition to, or flow from, requirements in *GBM System Requirements, Verification and Compliance* (MSFC GBM-REQ-1007). Detailed IOC software requirements will be included in *GBM Mission Operations & Data Analysis Software Requirements* (MSFC GBM-REQ-TBD).

3.2 Instrument Health and Safety Monitoring

The IOC shall ensure proper operation of the GBM detector system by comparing in-orbit instrument parameters and detector counting rates with expected values.

3.2.1 Housekeeping data conversion

The GBM IOC shall convert housekeeping data to engineering units that are monitored against limits and configuration states.

3.2.2 Instrument operational status alerts

Alarms and automated operator alerts shall be generated when selected differences between the expected and the telemetered status are registered.

3.2.2.1 Logging of instrument operational status alerts

These records shall be logged for subsequent operator analysis and anomaly reporting.

3.2.3 Summary reports

Operations personnel shall generate daily summary reports, charts, and graphs of instrument status and performance for visual inspection.

3.2.4 Operations log

The IOC shall produce and maintain an operations log that includes a record of the instrument configuration and any anomalous conditions that are relevant for science data analysis.

3.3 Instrument Commanding

The GBM IOC shall generate data and command loads required to configure and calibrate the GBM instrument in normal operations mode.

3.3.1 Command loads

The IOC shall transmit command loads to the MOC for uplink to the spacecraft.

3.3.2 Command scheduling

Except under emergency conditions, the IOC shall schedule the uplink of command loads via the SSC. These commands will be coordinated with observing plans developed by the SSC.

3.3.3 Contingency procedures

The GBM IOC shall coordinate development of contingency procedures with the MOC for rapid and safe handling of instrument anomalies.

3.4 Science Data Production Processing

The GBM science data will be buffered onboard the spacecraft and at the ground station. The system data latency, including processing by the IOC, is specified in the

GLAST MSS to be less than 72 hours 95% of the time. The maximum system data latency is 120 hours.

3.4.1 Level 1 Data Processing

The IOC shall receive GBM level 0 science data from the MOC and perform the processing necessary to generate level 1 data products as described in the GLAST PDMP.

3.4.2 Level 1 Processing Efficiency

The IOC shall be able to generate level 1 data products at a rate that is twice the orbit average rate at which data are produced by GBM.

3.4.3 Level 1 Data Products

Production of standard data products shall occur within the latency times specified in the PDMP and the MSS.

3.4.4 Data Reprocessing

The IOC shall be able to reprocess existing data at a rate of at least two times the real time data collection rate.

3.4.5 Data Storage

The IOC shall produce and maintain an archive of all level 0 and level 1 GBM data at least through the end of the GLAST mission.

3.4.6 High-Level Science Products

The IOC shall support the GBM instrument team in the development of high-level science products, including the production of gamma-ray burst catalogs and detailed analysis of individual gamma-ray bursts and other transient events.

3.5 Response to GBM Trigger Alerts

The IOC shall receive GBM trigger alert data from the MOC and perform a standard set of analysis procedures, including determination of sky locations and selected other burst parameters using algorithms and/or data selections that may improve upon those calculated on-board by GBM or at the MOC.

3.5.1 GCN alerts

The IOC shall transmit alert messages to the GRB Coordinates Network (GCN) as needed to distribute refined burst trigger information to the science community.

3.6 Instrument Calibration

The GBM IOC shall analyze instrument calibration data to maintain instrument adjustments and operating parameters and to produce and update calibration parameters that are used in production data processing.

3.6.1 Test and Calibration Data Processing

The IOC shall receive and process GBM test and calibration data during both ground and flight operations.

3.6.2 Detector gain and resolution

The IOC shall monitor the gain and resolution of all GBM detectors and produce a history of these parameters for calibration purposes.

3.6.3 Detector response

The IOC shall produce and maintain a database of parameters necessary to generate detector response matrices. These parameters will be derived as appropriate from pre-launch calibrations, computer simulations, and in-flight observations.

3.6.4 Delivery of calibration data

Calibration data shall be delivered to the SSC for archiving as described in the GLAST PDMP.

3.7 Science Data Analysis

The GBM IOC shall provide analysis tools and access to data to the instrument team.

3.7.1 Data analysis software

The IOC shall produce and maintain software for analysis of GBM data as needed for IOC functions and for GBM team science investigations as described in the GBM proposal.

3.7.2 Delivery to MPE

A functionally identical set of GBM science data analysis software tools shall be transported to the GBM team site at MPE.

3.7.3 Delivery to SSC

A set of GBM science data analysis software tools shall be transported to the SSC as described in the PDMP.

3.8 Flight Software

The GBM IOC shall produce and maintain the instrument flight software for the duration of on-orbit mission operations.

3.8.1 Validation of flight software

The GBM IOC shall be responsible for on-orbit validation of the operation and performance of flight software. This will include investigation of all software-generated error messages and anomaly conditions, inspection of regular downloads of the program memory and parameter tables, and ground analyses as appropriate.

3.8.2 Changes to flight software

Changes to flight software shall be routed through the MOC for uplink to the spacecraft.

3.8.3 Flight software simulator

The IOC shall maintain a flight software simulator, including a GBM-type DPU and at least one of each GBM-type detector, so that changes to the flight software may be implemented and tested prior to uplink to the instrument.

3.9 IOC Staffing

3.9.1 Routine operations

At least one member of the IOC staff shall be present during a single prime shift on non-holiday weekdays.

3.9.2 On-call operations

A member of the IOC staff shall remain on-call and reachable by pager or similar means at all times during non-prime hours, weekends and holidays.

3.9.3 Special operations during on-orbit checkout

On-orbit checkout of GLAST is expected to take up to 60 days. The GBM IOC shall be staffed around the clock as needed during this phase for GBM instrument checkout activities.

3.10 GBM Mirror Site

The IOC shall provide data to and acquire high-level science data from the MPE mirror site provided as part of the GBM team effort.

3.11 Communications

3.11.1 Data retransmissions

The IOC shall be able to accept retransmission of GBM science and housekeeping data from the MOC.

3.11.2 Autonomous operation

The IOC shall be available to accept GBM science and housekeeping data from the MOC autonomously using internet protocols (TBD).

3.11.3 Command transmissions

The IOC shall transmit instrument commands and software uploads to the MOC using internet protocols (TBD).

3.11.4 Data product transmissions

The IOC shall transmit data products to the SSC using internet protocols (TBD).

3.12 Data Standards

3.12.1 Coordinate system

The IOC shall use the J2000 inertial coordinate system for identifying and reporting celestial sources.

3.12.2 Time base

The IOC shall use Terrestrial Time (TT) (TBR) as the primary time base for all data products.

3.13 Data Formats

3.13.1 Communications format and protocol

The IOC shall employ the standard communications format and protocol as recommended by CCSDS for telemetry and telecommands.

3.13.2 Software upload formats

The IOC shall format software uploads in blocks as specified by the MOC.

3.14 Data Quality

The IOC shall evaluate and maintain the quality of science data in the transmission and processing of the data.

3.15 Availability

The IOC availability for receipt of autonomous data transfers from the MOC shall be at least TBD percent.

3.16 Security

The IOC shall be connected to the other operations and support centers by an intranet of wide area networks that is closed to, or protected from, public users of the external internet.

3.17 Data Verification

Data verification and validation shall be accomplished through generation of daily orbit plots and trigger event data for visual inspection for anomalies. Data are also verified as part of the ongoing science investigations.

4 Requirements Verification Strategy

The verification strategy will test, analyze, inspect, or demonstrate all requirements of section 3 to ensure that the IOC meets its specified requirements. Table 4-1 is a Verification Requirements Matrix indicating how each specification requirement of section 3.0 is verified by phase, method and level, as defined by the symbols listed below.

Verification Method

1.0	Test	
	1.1	Functional
	1.2	Environmental
2.0	Analysis	
3.0	Demonstration	
4.0	Inspection	
5.0	Validation of Records	
6.0	Similarity	
7.0	Review of Design Documentation	

Verification Level

a.	Component
b.	DPU Subsystem
c.	GBM Instrument System
d.	GLAST Observatory

Verification Phase

D	Development
Q	Qualification
A	Acceptance
I	Integration
F	Flight
N/A	Not Applicable

Table 4-1 GBM IOC Requirements Verification Matrix

Section 3 Paragraph Number	VERIFICATION BY LEVEL AND METHOD						Notes
	Verification Phase						
	D	Q	A	I	F	N/A	
3						X	
3.1						X	
3.2			3b				
3.2.1			3b				
3.2.2			3b				
3.2.2.1			3b				
3.2.3			3b				
3.2.4			3b				
3.3			3b				
3.3.1			3b				
3.3.2			3b				
3.3.3			5b				
3.4						X	
3.4.1			1.1c				
3.4.2				3b			
3.4.3			1.1b				
3.4.4			1.1b				
3.4.5					7c		
3.4.6			3b				
3.5					1.1d		
3.5.1				3d			
3.6				3d			
3.6.1				3d			
3.6.2				1.1d			
3.6.3				3d			
3.6.4				3d			
3.7						X	
3.7.1				3c			
3.7.2				3c			
3.7.3				3d			
3.8						X	
3.8.1					1.1d		
3.8.2				3d			
3.8.3				3c			

Table 4-1(cont) GBM IOC Requirements Verification Matrix

Section 3 Paragraph Number	VERIFICATION BY LEVEL AND METHOD						Notes
	Verification Phase						
	D	Q	A	I	F	N/A	
3.9						X	
3.9.1					3d		
3.9.2					3d		
3.9.3					3d		
3.10				3d			
3.11						X	
3.11.1				1.1d			
3.11.2				1.1d			
3.11.3				1.1d			
3.11.4				1.1d			
3.12						X	
3.12.1				5d			
3.12.2				5d			
3.13						X	
3.13.1				3d			
3.13.2				3d			
3.14					3d	X	
3.15					3d	X	
3.16				5d			
3.17					3d		