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WBS No.	Name	Description	Responsibility
1.0	MISSION MANAGEMENT	This element summarizes all of the subtasks of the Mission Management task, which is to plan, organize, integrate, support, and monitor the entire formulation and implementation phases of the GLAST Mission..	Liz Citrin
1.1	SEU Program Support	Includes Program level assessments as well as shared support service contractors.	Mark Seidleck
1.2	MPS	Code 400 MPS tax. (Flight rate $35.75K/MY)	Mark Seidleck
1.3	Mission Engineering Support	This includes discipline engineering support service contractors in support of the Spacecraft and LAT & GBM Instrument development. The disciplines include, but are not limited to the following: Electrical, Mechanical, Software, Systems, and C&DH.	Mark Seidleck
1.4	Project Planning & Support	This includes tasks for Scheduling, Configuration Management, Library, LAN Administration, and Administrative support.	Mark Seidleck
1.5	Reviews	Includes external review support for typical project reviews (NAR, PDR, CDR, etc.) as well as External Independent Readiness Reviews (EIRR) called for by NASA HQ. This review support consists of the time and travel costs for the NASA HQ Independent Review Team (IRT). In addition, this element includes costs associated with support for reviews and meeting held at GSFC. Finally, this element includes travel costs associated with the GLAST Users Group meetings.	Mark Seidleck
1.6	Safety & Mission Assurance	This element includes those engineering specialty disciplines required to ensure the performance of the GLAST flight and ground hardware and software. This includes safety and reliability, hardware and software quality assurance, parts and material analyses and control, and risk management.	Patty Huber
1.6.1	Safety	This element includes the review/performance of those tasks necessary to ensure the overall safety of the GLAST mission including flight/ground hardware, software, and personnel. This includes safety plans; hazards analysis, safety non-compliance, and safety assessment reports, and ground operations plans.	Patty Huber
1.6.2	Reliability	This element includes the review/performance of those tasks necessary to ensure the overall reliability of GLAST flight/ground hardware and software. This includes failure modes and effects analyses, fault tree analyses, probabilistic risk assessments, and reliability/risk assessments/tradeoffs.	Patty Huber
1.6.3	Quality Assurance	This element includes the establishment, management, and maintenace of the overall quality of GLAST flight/ground hardware and software. This includes reviewing/preparing S&MA requirements/plans; preforming inspections and audits; monitoring quality; and maintaining oversight of the procurement, design review, manufacturing, testing/verification, and validation efforts. It includes efforts at the contractors'/developers', subcontractors', vendors', collaborators', and launch facilities.	Patty Huber
1.6.4	Risk Management	This elements includes team training/assistance/guidance in the areas of systems engineering, requirements management, risk management, and hardware/software verification and validation. It includes support/guidance in the preparation of the GLAST project plans, risk management plans/program, verification plans, and system engineering plans.	Patty Huber
1.6.5	SATC Support	This element includes support in the development of software and documentation metrics and monitoring.	Patty Huber
1.6.6	Materials Engineering	This element includes oversight into the materials control programs for GLAST hardware including materials selection and direct participation (as stated in contractual documents) in materials, lubrication, and processes control boards.. The monitored-efforts include the development of material/lubrication/processes lists, materials processes, and material usage agreements. It also includes the effort needed to evaluate/test/qualify/screen materials (including PWB coupons and fasteners) and provide/review test reports.	Patty Huber

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WBS No.	Name	Description	Responsibility
1.6.7	Parts Engineering	This element includes oversight into the parts control programs for GLAST hardware. The monitored-efforts include the establishment and maintainance of parts lists and part stress analyses as well as the review/issuance of alerts/advisories. It also includes direct participation (as stated in contractual documentation) on parts control boards and participation in, or review of, part test/qualification/screening programs, parts testing activities, and test reporting.	Patty Huber
1.7	IV&V	Includes all costs associated with support provided by the West Virginia IV&V facility.	Liz Citrin
1.8	Budget Contingency		Liz Citrin
2.0	SYSTEMS ENGINEERING	TBS	Norman Rioux
2.1	Systems Engineering Support	This element includes development of requirements traceability and verification analysis, tracking and managing of technical performance budgets, development of instrument and spacecraft ICD's, support identification and resolution of interface issues, and Project risk mitigation.	Norman Rioux
2.2	I&T	Support subsystem, instrument, spacecraft and observatory I&T including test planning and scheduling, risk mitigation.	Ed Shippey
2.3	Contamination Control	this element includes contamination control support for the GLAST instruments and spacecraft.	Norman Rioux
2.4	Radiation Support	This element includes radiation testing and environmental assessments in support of the GLAST project.	Norman Rioux
2.5			
2.6			
2.7			
3.0	SCIENCE		Jonathan Ormes
3.1	Project Science Support	Support to the Project Scientist including GLAST User's Group travel costs.	Neil Gehrels
3.2	Science Support Center (SSC)	This element comprises all implementation aspects of Science Support Center functions: conception, design, development, and testing of pipelines, archives, science algorithms, and other tools which enable and assist the community to do science with GLAST.	Jay Norris
3.2.1	Pipeline	SW elements involving implementation of modules for routine processing of data from the instrument teams, and routine creation of other data by the SSC	Jay Norris
3.2.2	Archive	SW elements involving implementation of functions for data storage, querying, and retrieval	Jay Norris
3.2.3	Science Algorithms	SW elements involving implementation of high-level analysis algorithms for performing scientific research	Jay Norris
3.2.4	Scheduling: Tool Development	SW elements involving implementation of observing tools to assist Guest Investigators in calculating instrument exposure, and source observing periods	Jay Norris
3.2.5	Mission Verification Support	Tasks involving tests of implemented pipelines, archive, and analysis SW	Jay Norris
3.2.6	H/W, COTS	"Off the Shelf" HW and SW for SW developers; archive and pipeline HW and SW	Jay Norris
3.3	Interdisciplinary Scientists (IDS)	This element includes the IDSs as selected from the GLAST AO. The NASA funded IDSs are: Charles Dermer, Naval Research Laboratory; Brenda Dingus, University of Wisconsin-Madison; and Stephen Thorsett, University of California-Santa Cruz. NRL is funded through an NDPR; the other 2 are grants. They perform science investigations; no hardware. Their investigations are as proposed to the AO. In the pre-launch phase they do science investigations to prepare for optimizing the GLAST data, as well as assist in making recommendations for mission design to optimize science return. In addition, a fourth IDS selected on a no-exchange-of-funds basis is Martin Pohl, Universitaet Bochum, Germany.	Scott Lambros

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4.0	INSTRUMENTS		
4.1	LAT	All effort, materials and services required by the Lat team during formulation and hardware phases, from selection through launch. Includes: LAT instrument hardware and software development, fabrication, integration, test, calibration, and delivery; ground systems and software development (including equipment and softeare for post-launch data handling and analysis); supporting management and administration, systems engineering, performance and safety assurance, education and public outreach; support after delivery of the LAT instrument to the observatory contractor; and a balloon flight prototype test and other prototyping activities.	Bill Althouse
4.1.1	Instrument Management	All effort by the Instrument PI, Instrument PM, Instrument Technical Manager, and Instrument Scientist, including cost and schedule control (PMCS) management and staff, administrative support for the Instrument Project Office at SLAC and on the Stanford campus, and associated supplies, equipment, consultants and travel.	Bill Althouse
4.1.2	Systems Engineering	The systems engineering tasks of design integration, analysis, validation, and verification are contained in this work element. This element also contains system management, planning, tracking and documentation of the requirements, design, testing and data activities of the project.	Tim Thurston
4.1.3	Reserved		
4.1.4	Tracker	The Tracker consists of 16 towers mounted to the main instrument support structure, the grid. Each tower has 19 trays, 12 trays with thin converters (5% radiation length), 4 trays with thick converters (18% radiation length) and 3 trays with no converters. The tray structure is made of carbon fiber because it has a very low Z. The trays are stacked up and supported by four sidewalls that act as the thermal conductor for heat transfer to the grid. The towers are mounted to the grid with flexure attachments.	Rob Johnson
4.1.5	Calorimeter	The CAL provides the energy measurement of incident photons and background particles. These measurements, along with the information in the Tracker, are used to construct the energy of the incident photons. These CAL measurements are also critical to the background particle identification and rejection. The CAL responds to TDF requests by digitizing the energy loss in the CAL and outputs the data to the dataflow system. The CAL also provides fast signals to the T&DF system that report significant energy depositions in the CAL. The CAL system consists of a 4X4 array of identical modules. Each module is a hodoscopic array of CsI scintillation crystals and associated readout electronics.	Neil Johnson
4.1.6	ACD	The ACD Subsystem element refers to all effort required to be performed by GSFC to develop and deliver an Anti-Coincidence Detector (ACD) for the GLAST LAT.	Thompson
4.1.7	Electronics	This element contains all the hardware and on-board software to operate the LAT with the exception of the front-end electronics of the CAL, Tracker, and ACD systems. Those are contained in the subsystem detector sections of the WBS. The front-end electronics have typically one analog and digital front-end ASIC which is placed on the board. The electronics interfaces for control, configuration, trigger, data readout, and environmental monitoring with components in this WBS. The main parts of the Electronics are tower-based electronics modules for each of the 16 TKR-CAl towers, plus an electronics module for the ACD, Global Trigger, plus processors to filter the event data. Interface electronics to the spacecraft as well as the entire LAT power system is included in this WBS.	G. Haller
4.1.8	Mechanical	Perform LAT system level thermal and structural analysis and manage system internal and external structural and thermal interfaces. Manage the LAT mechanical parts list and mass and dimensional bookkeeping. Develop, fabricate, assemble, and test LAT grid support structure, radiators, and the LAT thermal control system. Support LAT integration and test by maintaining and updating system thermal and structural models through LAT, Spacecraft, and Launch Vehicle I&T, and on-orbit check-out.	M. Nordby
4.1.9	I&T	Integrate and test the LAT. This includes developing I&T plans and procedures, developing, prototyping, fabricating, assembling, and testing I&T mechanical GSE, and integrating the Calibration Unit and flight LAT. Also includes thermal and structural environmental test planning, execution, and GSE, and planning and running of Calibration Unit beam tests.	E. Bloom

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4.1.A	PSA	Includes quality assurance, inspection, safety, and problem failure reporting. The predominant assurance objective is that the LAT will operate in a safe and environmentally sound manner, and will meet the science objectives and sooresponding measurement requirements specified in the GLAST Science Requirements Document. To achieve these objectives, the project will establish formal programs to address the process for achieving safety and mission success. These include Problem/Failure Resolution reporting, inspection protocols, parts selection and control plan, reliability analysis, softeare verification and validation, developing workmanship standards, and developing a safety hazard analysis.	D. Marsh
4.1.B	IOC	Design, develop and maintain a LAT Operations Facility (LOF) which will monitor LAT health and safety, perform LAT calibration, provide configuration control, validation and verification for LAT flight software updates, generate LAT command uploads, and suppport LAT operations and a rapid alert capability.	S. Williams
4.1.C	E/PO	Education and Public Outreach Program for the entire GLAST mission.	L. Cominsky
4.1.D	SAS	Includes (1) Prompt processing of instrument data through to Level 1event quantities; (2) Provide near real-time monitoring information to the IOC; (3) Monitor and update instrument calibrations; (4) Create high level science products from Level 1 for the PI team; (5) Reprocessing of instrument data; (6) Provide access to event and photon data for higher level data analysis; (7) Bulk production of Monte Carlo simulations; (8) Interface with mirror PI team site(s) - sharing data and algorithms; (9) Interface with the SSC - sharing data and algorithms.	R. Dubois
4.1.E	Balloon Flight	Design, develop, and operate a Balloon Flight Engineering Model (BFEM) of the LAT instrument on a high altitude balloon flight at the NASA Scientific Balloon Facility (NSBF). Analyze acquired data and produce preliminary assessment of BFEM performance and implications for LAT flight design and operations.	Thompson
4.2	GBM	See MSFC WBS for GBM Instrument element descriptions.	Chip Meegan
4.2.1	Science	The PI Science Team shall provide definition of the science investigation. MSFC shall also include activities to insure science requirements are integrated into all elements of the project including but not limited to: Specific output of this element include documentation of the observation requirements and development of the measurement and validation requirements. The PI Science Team shall decompose the requirements of the Science Requirements Document and develop and document the GBM Observation requirements. The PI Science Team shall plan instrument calibration to be accomplished in Phase C/D including on-orbit as part of check-out. The PI Science Team shall perform Data Analysis activities as needed to satisfy the requirements of the development tasks. Data Analysis shall also ensure that technical risk management activities support the defined Science Investigation. GBM computer simulations shall be developed and used to support the engineering development tasks. The PI shall provide support to the GLAST Facility Science team and the Guest Investigator program as requested by the GLAST Program Office.	
4.2.2	Instrument Management	The MSFC Project Organization shall provide a Project Plan developed in accordance with NPG 7120.5A, “NASA Program and Project Management Processes and Requirements”.. The Project Plan shall describe how it will operate and maintain management systems for planning, organizing, coordinating, authorizing, and controlling the project. It shall include discussions of schedules, resources, implementation approach, acquisition approach, performance assurance, risk management, safety, technology assessment, commercialization opportunities, and reviews.	
4.2.3	Systems Engineering	The Project Office shall develop a Project Systems Engineering Plan that covers all System Engineering Activities associated with the GLAST Investigation. This Plan shall cover all System Engineering Activities required for the Flight Instrument, Ground Support Equipment, and Spacecraft/Instrument integration and launch/in-flight checkout support. The Project Office shall develop and maintain a Software Development Plan that integrates information on all software development activities to be performed as part of the GBM Investigation. This Plan shall discuss the Software Development activities and development and control methodology for all software developed during this project.	
4.2.4	S&MA	Safety activities and safety requirements shall be documented in the Project Safety Plan. Project Assurance activities shall be documented in the GBM Project Assurance Plan. These plans shall include as a minimum the investigation plans for reviews, problem/failure resolution, hazard mitigation, inspections, quality assurance, reliability, parts selection and control, safety processes, and software validation activities. These Plans shall document Safety and Mission Assurance programs that are compatible with industry best practices and ISO 9001 quality standards.	

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4.2.5	Flight Instrument	This task is comprised of all work associated with design and development of the Burst Monitor Flight Instrument. MPE provides the detector assemblies including flight qualified detectors, high and low voltage power supplies, and preamplifiers. MSFC provides integration and test of the Burst Monitor, instrument harness assemblies, the Data Processing unit, and Spacecraft integration support.	
4.2.6	GSE	Define the Burst Monitor Ground Support Equipment and associated Burst Monitor test equipment.	
4.2.7	I&T	calibration.	
4.2.8	S/C I&T Support	Define and plan the effort required to support the spacecraft integration and to support launch site activity and in-fight checkout of the instrument. Evaluate Instrument specifications for compliance with the S/C to Instrument Interface Requirements. Support the Program Office in defining Instrument requirements on the Spacecraft.	
4.2.9	Data Analysis & Archiving	Planning and preliminary design of Data analysis and Archiving of Burst Monitor observations including acquiring, analyzing and managing data shall be performed. This task includes the necessary algorithm and software development, description of the data products to be produced, preparation of plans for archiving the data, and a preliminary description of the required hardware for data analysis and archiving.	
4.2.10	Instrument Operations	The PI Science Team shall establish operating requirements for the GBM.. Requirements for operation through the Mission Operations Center (MOC) shall be defined. The MOC will operate the spacecraft, send and receive command and telemetry loads to the spacecraft and instrument, and perform health and safety monitoring. These requirements shall be coordinated with the GLAST Large Area Telescope Instrument to assure no conflicts and full compliance with science requirements. The Instrument Operations Center (IOC) design and operations requirements shall be defined for supporting the operation of the instrument, performing low level data analysis, providing those data to the Science Operations Center, and performing higher level data analysis to support the science investigations performed by the IPI team.	
4.2.11	E/PO	The PI Science Team shall carry out a substantive education/outreach program that will be an integral element of the investigation. The PI shall carry out the approved plan for the education/outreach program. The GBM investigation team (together with IDS investigators) shall become actively involved in creating, designing, planning, and implementing a common GLAST Education/Public Outreach program to be carried out by the LAT IPI Team. It is anticipated that the LAT IPI will take steps after selection to establish an overall program that integrates any other IPI E/PO programs and the IDS efforts. These may include planning workshops that will focus on ways to fulfill NASA's education and outreach objectives, encourage the flow of creative ideas, inspire innovative approaches, and define and implement an integrated E/PO program.	
5.0	SPACECRAFT	TBS	Joy Bretthauer
5.1	Accomodation Studies	Includes funded studies with potential spacecraft vendors to assess mission feasibility and instrument accomodation.	Joy Bretthauer
5.2	Spacecraft	See Spectrum Astro detailed WBS.	Joy Bretthauer
5.3	Special Studies	Included special studies, analysis, and anomoly resolution.	Joy Bretthauer

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6.0	LAUNCH VEHICLE		KSC
6.1	Launch Vehicle		
6.2	Mission Analysis & Special Studies	Includes, but not limited to coupled loads analysis,	
7.0	GROUND SYSTEM DEVELOPMENT		Dennis Small
7.1	MOC Development	Assess requirements, approve designs, monitor implementation and testing and approve delivery each element below (7.1-7.5) that form a complete Mission Operations Center	Dennis Small
7.1.1	Archive System		Dennis Small
7.1.2	Analysis System		Dennis Small
7.1.3	Real-time Ops System		Dennis Small
7.1.4	Scheduling and Mission Planning		Dennis Small
7.1.5	S/C Memory Management System		Dennis Small
7.2	Operations Preparations		Dennis Small
7.2.1	Database Mangement	Review planned Database Management System (DBMS), assure Configuration Management(CM) compliance, verify database compatability with other vendors	Dennis Small
7.2.2	Command Procedure Development	Establish and enforce procedure guidelines and configuration management	Dennis Small
7.2.3	Mission Timeline	Establish timeline usage and maintainability requirements	Dennis Small
7.2.4	S/C Training	Define extent, format, and participants in the formal observatory training, schedule the necessary resources	Dennis Small
7.2.5	Ground System training	Define extent, format, and participants in the formal ground system training, schedule appropriate resources	Dennis Small
7.2.6	End-to-End Testing	Assure supporting system elements are ready to support the test, review test plans for completeness and ability to meet goals, review test scripts for timing and order of execution of command sequences.	Dennis Small
7.2.7	Mission Simulations	Assure supporting system elements are ready to support the simulation activity, review simulation plans for completeness and ability to meet goals, verify the results match the predicted responses	Dennis Small
7.2.8	Launch Rehearsals	Assure integration of launch activities into mission timeline, coordinate voice communications, esatblish clear roles and responsibilities	Dennis Small
7.2.9	Documentation		Dennis Small
7.3	Ground System I&T		Dennis Small
7.3.1	Requirements Verification		Dennis Small
7.3.2	Design reviews	Support Preliminary and Critical Design Reviews and an Acceptance Review of the Ground System	Dennis Small
7.3.3	Build Plan	Review and approve the ground system build plan	Dennis Small
7.3.4	Schedule	Maintain the ground system schedule showing external influences and provide ground system inputs to the integerated mission schedule	Dennis Small
7.3.5	Ground System Procedure	Establish and enforce procedure guidelines and configuration management	Dennis Small
7.3.6	Ground System Dataflows	Assure proper resources are in place to conduct this activity, Compare results to expected outcome	Dennis Small
7.4	Ground Stations		Dennis Small
7.4.1	Requirements Verification	Review, verify and approve all ground station requirements	Dennis Small
7.4.2	Support Plan	Identify all support expected from all ground elements	Dennis Small
7.5	Communication		Dennis Small
7.5.1	Launch Site Support Plan	Provide input to and review of the LSSP and its Comm Annex which details voice and data requirements between the MOC and the launch site	Dennis Small

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7.5.2	Voice	Review Designs, Implementation Plans and Operational Procedures for the voice communications system for Pre-launch Testing, Launch and Checkout Operations and Normal and Contingencies Mission Operations	Dennis Small
8.0	MISSION OPERATIONS & DATA ANALYSIS		
8.1	Mission Operations		
8.1.1	LAT Operations		Bill Althouse
8.1.1.1	Management		Bill Althouse
8.1.1.2	Stanford University	This summarizes WBS elements 8.1.1.1.1 through 8.1.1.1.3 below. The contractor shall manage LAT operations and data processing including personnel and facilities management, planning, budgeting and reporting. The contractor shall develop plans and schedules to meet operational and scientific requirements of the LAT operations and data processing efforts. The contractor shall provide and maintain facilities for LAt operations and data processing. The contractor shall arrange network connectivity with sufficient bandwidth and reliability for data transfer. The contractor shall monitor the health, status, and performance of the LAT for the duration of the mission. The contractor shall acquire and verify real-time and playback level 0 data. The contractor shall maintain the operations database, verify and maintain command procedures, perform science and operations planning, resolve in-flight anomalies, create contingency plans, maintain interfaces with the MOC, SSC and remote sites, support instrument calibration. The contractor shall be responsible for LAT data processing and and science data analysis software. The contractor shall maintain the instrun	Bill Althouse
8.1.1.3	NRL		Neil Johnson
8.1.1.4	GSFC		Steve Ritz
8.1.2	GBM Operations (MSFC)		Chip Meegan
8.1.3	MOC		Dennis Small
8.1.4	SSC	This element comprises all MO&DA aspects of Science Support Center functions.	Jay Norris
8.2	Data Analysis		
8.2.1	SSC	Tasks involving SW updates and maintenance; running data and calibration pipelines, and archives. Assisting the community: in use of science algorithms; observation scheduling; peer reviews; organizing GLAST symposia.	Jay Norris
8.2.2	LAT Science Analysis		
8.2.2.1	Management		Bill Althouse
8.2.2.2	Stanford University	The summarizes WBS elements 8.2.2.1.1 through 8.2.2.1.3 below. The contractor shall provide overall science planning and coordination for the LAT team including supporting the Science Working Group and advising the GLAST Project Scientist. The contractor shall provide science planning oversight, conduct science workshops, coordinate observing campaigns and coordinate data analysis with other detectors to meet LAT science objectives. The contractor shall assure the data management plan is properly implemented, support specification, development, upgrade, maintainance, test and documentation of science analysis software. The contractor shall maintain the calibration database used by the Level 1 data reduction software. The contractor shall perform science investigations using GLAST instrument data and publish results of scientific analysis in refereed scientific	Bill Althouse
8.2.2.3	NRL		Neil Johnson
8.2.2.4	GSFC		Steve Ritz
8.3	GBM Science Analysis		Chip Meegan
8.4	MOC		Dennis Small
8.5	Guest Investigator Prog.	Design and implement a Guest Investigator Program at GSFC.	Neil Gehrels
8.6	Fellowships	Implement a fellowship program at GSFC.	Neil Gehrels
8.7	IDS Investigations	This is a continuation of IDS science investigations as selected from the GLAST AO (the same 4 IDSs as funded in the pre-launch phase). This is the science investigations performed after launch, using the GLAST mission data.	Scott Lambros
8.8	E/PO		
8.8.1	SSU E/PO	Implement GLAST E/PO plan at Sonoma State University.	Althouse/Cominski
8.8.2	GSFC E/PO	Implement GLAST E/PO plan at GSFC.	Neil Gehrels
8.8.3	GSFC PR	Provide outreach and public relations pre-launch materials for the GLAST Project.	Neil Gehrels
8.9	Project Scientist Support		Neil Gehrels
9.0	GSFC E/PO		Neil Gehrels
9.1	E/PO	Implement GLAST post-launch E/PO plan.	Neil Gehrels
9.2	Public Relations	Provide outreach and public relations post-launch materials for the GLAST Project.	Neil Gehrels