



Section 5.3

GLAST Science Support Center

HEASARC

GCN

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GSSC Science Lead



Outline



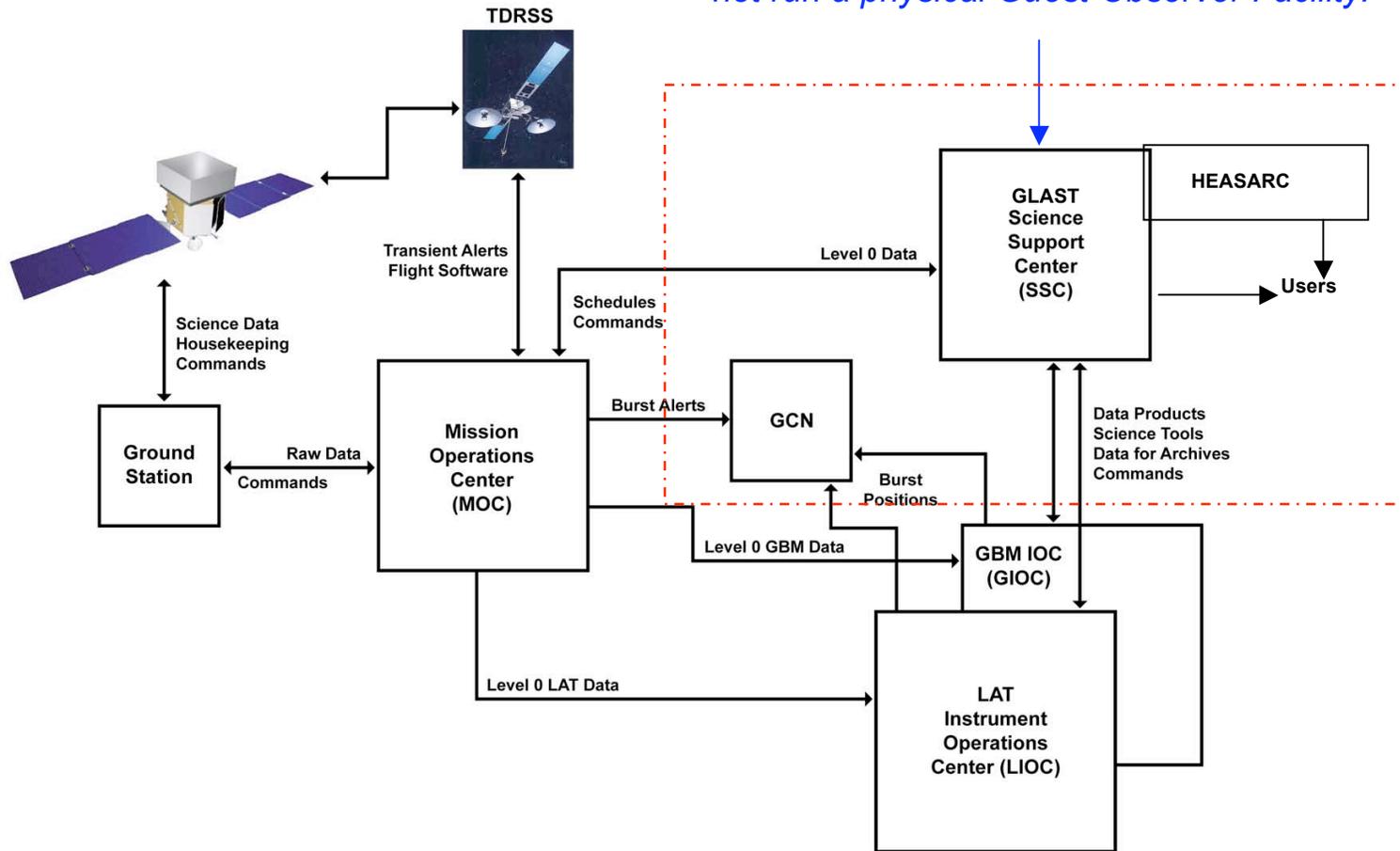
- ▶ ***Introduction***
- ▶ ***Requirements***
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- ▶ ***Software Development***
- ▶ ***HEASARC***
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The GSSC in the Ground System



The GSSC is in GSFC's Laboratory for High Energy Astrophysics (LHEA); it will not run a physical Guest Observer Facility.





The Role of the GSSC



- ▶ ***The GSSC is GLAST's interface with the scientific community. Its role is to:***
 - *Support the Guest Investigator Program*
 - *NASA HQ formally runs the GI program, but the GSSC administers it*
 - *The GSSC will follow standard GI program procedures*
 - *Disseminate data, analysis tools and documentation to the science community*
 - *The GSSC does NOT process the Level 0 data into analyzable data*
 - *Development of the analysis tools is the responsibility of the instrument teams, but the GSSC collaborates in defining and testing the suite of tools, and provides resources*
 - *Maintain the science timeline*
 - *Phase 1=1st year—sky survey while instruments are calibrated. GIs cannot affect the observing plan.*
 - *Subsequent years—GI-driven observations. Pointed observations permitted but survey mode will predominate.*



The Role of the GSSC, cont.



- *Vet IOC commands for impact on timeline*
 - *An instrument command should not disturb an observation, e.g., an instrument mode change in the middle of a pointed observation*
 - *Commands are routed from the IOCs through the GSSC to the MOC*
- *Upon Project Scientist's approval, send ToO order to MOC*
 - *ToO requests are made through the GSSC's website*
 - *The GSSC supports Project Scientist's decision-making*
- *Archive data in the High Energy Astrophysics Science Archive Research Center (HEASARC)*
 - *The GSSC's computer system is a subset of the HEASARC's*
 - *The GSSC's databases are in HEASARC-compatible format*
 - *The data deposited by the GSSC in the HEASARC are the mission's permanent archive*
- ▶ ***The GSSC's requirements were developed with this understanding of the GSSC's role.***



Requirements: Facilities



- ▶ ***Location: Part of Office of Guest Investigator Programs in LHEA at GSFC.***
- ▶ ***Computer system:***
 - *Part of HEASARC system*
 - *Comply with computer security requirements*
 - *Website will comply with Section 508 requirements*



Requirements: GI Program



Note: The GSSC supports NASA HQ in running the GI program

- ▶ ***Write NRA—released by NASA HQ***
- ▶ ***Assist proposal preparation—through software, tables and library of results***
- ▶ ***Support peer review—through selection of review panel and convening the review***
- ▶ ***Administer grants***
- ▶ ***Schedule observations***
- ▶ ***Support GI data analysis—by providing data, software and assistance***



Requirements: Mission Support



- ▶ ***Create annual observing timeline by convening and participating in Timeline Committee meeting after selection of GI observations***
- ▶ ***Create weekly science timeline***
- ▶ ***ToO***
 - *Support the decision by the Project Scientist*
 - *Implement the ToO order*
- ▶ ***Evaluate instrument commands for impact on timeline***
 - *Commands from the IOCs to the MOC go through the GSSC*
 - *High priority commands pass through without being evaluated*
- ▶ ***Support the Project Scientist, the Science Working Group and the Users' Committee—reports, logistical support***



Requirements: Analysis Tools

- ▶ ***Supply investigators with a suite of analysis tools***
 - *An analysis system will be created for both the general community and the instrument teams*
 - *The tools should:*
 - *Run on standard platforms*
 - *Not require the purchase of software*
 - *Permit multi-mission analysis*
 - *Be well documented*
 - *FITS files will conform to HEASARC standards*
- ▶ ***The definition of the tools and the representation of the response functions are a joint GSSC-instrument team responsibility***



Requirements: Data



- ▶ ***Ingest data from the MOC and IOCs.***
- ▶ ***Maintain databases for all the data products it receives from the MOC or IOCs.***
- ▶ ***Make these databases accessible to the scientific community through the GSSC website in accordance with the mission's data policies.***
- ▶ ***Provide data and software to the ASDC, the Italian mirror site.***
- ▶ ***The GSSC data and software will become GLAST's permanent archives at the HEASARC.***



Requirements: Data Processing



- ▶ ***Create maps of the observed photons and of the LAT's exposure. Post these maps on the GSSC website.***
- ▶ ***Maintain backup Level 1 processing pipelines for both instruments.***

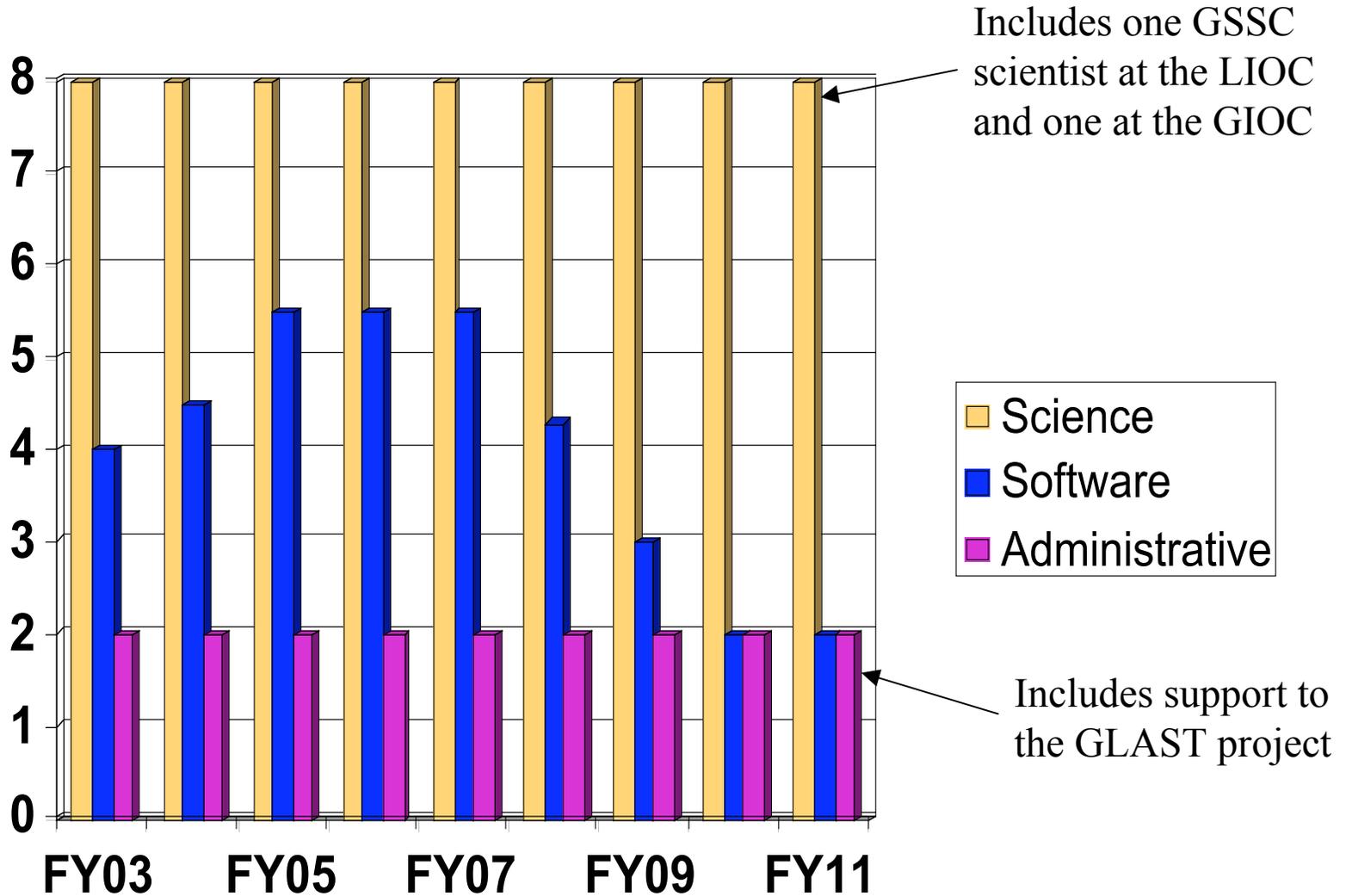


Members of the GSSC

- ▶ **Jay Norris** *Manager*
- ▶ **David Band** *Science Lead*
- ▶ **Scientists:**
 - *Dave Davis* *Databases*
 - *Masaharu Hirayama* *LAT scientist, computer security*
 - *Yasushi Ikebe* *Calibrations*
 - *Dirk Petry* *User services*
 - *Jim Chiang* *Ambassador to LIOC*
 - *Valerie Connaughton* *Ambassador to GIOC*
 - *Jerry Bonnell* *GRBs/PR*
 - *Robin Corbet (part time)* *Operations*
- ▶ **Software:**
 - *Bob Schaefer* *Databases*
 - *Sandhia Bansal* *Programmer*
 - *Chunhui Pan* *Programmer*
 - *Tom Stephens* *Programmer*
 - *James Peachey (part time)* *Programmer*
- ▶ **Support**
 - *Sandy Barnes* *Administrative assistant*
 - *Cathie Meetre (part time)* *Operations*
 - *JD Myers (part time)* *Webmaster*



Staffing Profile





GSSC Heritage



- ▶ ***The GSSC is part of the Office of Guest Investigator Programs (OGIP) in the Laboratory for High Energy Astrophysics (LHEA) at GSFC, and draws on LHEA experience***
- ▶ ***Reuse of software***
- ▶ ***SSC staff has been on:***
 - *Instrument teams:*
 - *EXOSAT—1*
 - *ASCA—1*
 - *BATSE—3*
 - *EGRET—1*
 - *Ulysses—1*
 - *WIND—2*
 - *Chandra HETG—1*
 - *Integral—1*
 - *MODIS—1*
 - *Mission operation teams:*
 - *GINGA—2*
 - *ASCA—2*
 - *RXTE—2*
 - *CGRO—5*



The Requirements: Paper Trail



▶ ***The formal hierarchy***

- *Science Requirements Document (433-SRD-0001)*
- *Mission System Specification (433-SPEC-0001)*
- *Ground System Requirements Document (433-RQMT-0006)*
- *SSC Functional Requirements Document (433-RQMT-0002)*

▶ ***Other applicable documents include***

- *GLAST Announcement of Opportunity (AO)*
- *Project Data Management Plan (PDMP)*
- *Operations Concept Document (433-OPS-0001)*
- *GSSC-HEASARC MOU*
- *Report of Data Products Working Group*



Relevant Documents



Document	Purpose	Draft	Final	CCB
Project Data Management Plan	Describes the flow of data from acquisition to final archiving and the role of the different mission components in this flow	9/02	8/03	Project
MOC-GSSC ICD	Will describe Level 0 data to GSSC and command flow. The MOC is the lead.	9/03	6/04	GS
LIOC-GSSC ICD	Will describe Level 1 data to GSSC and command flow. The GSSC is the lead.	9/03	6/04	GS
GIOC-GSSC ICD	Will describe Level 1 data to GSSC and command flow. The GSSC is the lead.	9/03	6/04	GS
GSSC-HEASARC MOU	MOU establishing mutual GSSC and HEASARC requirements.	9/02		Internal
The Standard Environment for the Analysis of LAT Data	Defines the tools and software environment for the scientific analysis of LAT data. Developed by GSSC-LAT Software Working Group.	9/02		Internal
LHEA IT Security Plan	Establishes the IT security plan for LHEA			LHEA



Internal GSSC Documents



Document	Purpose	Status
GSSC Development Plan	Plan for developing the GSSC	Draft 12/03
GSSC Design Specification	Design of the GSSC	Draft 4/04
GSSC Test Plan	Plan for testing GSSC's functions, particularly software	Draft 5/04
LAT Event Summary Database Requirements Document	Requirements for the database from which lists of LAT photons will be extracted	Draft 3/02
GSSC Database Architecture Document	Architecture of the GSSC's databases, including the computer system	Draft 5/03
GSSC Software Management Plan	Plan for the development of the GSSC-specific software	Designed, not yet drafted
GSSC Internal Software Requirements	Requirements for the GSSC-specific software	In development
Informal documents on GSSC internal website: memos, white papers, etc.		

► ***These documents will be under internal CM.***



Coordination with Ground System



- ▶ *Participation in weekly GOWGs*
- ▶ *Weekly reports to Ground System Manager*
- ▶ *Monthly Project Status Reports*
- ▶ *Regular internet teleconferences with the LAT team regarding software*
- ▶ *Meetings of tool developers*
- ▶ *Working groups (e.g., Data Products WG)*
- ▶ *Informal contact*



Reviews



- ▶ **Operations—the ground system reviews will also be the reviews of GSSC operations**
 - *GSRR (7/03)*
 - *GPDR (12/03)*
 - *GCDR (6/04)*
 - *Mission Operations Review (4/05)*
 - *Operations Readiness Review (7/06)*

- ▶ **Science—the Users' Committee will review our science plans**
 - *The Users' Committee meeting in October will be equivalent to our science PDR.*
 - *The GSSC will report to the Users' Committee at its periodic meetings.*



Release Schedule



► **Operations—Driven by GRTs**

- *Release 1 (6/30/04), tied to GRT1—ingest of Level 0 data from MOC:*
 - *a) scripts to move data from MOC to GSSC;*
 - *b) creation of GSSC database;*
 - *c) scripts to ingest data into GSSC database*
- *Release 2 (1/15/05), tied to GRT2—preliminary command and schedule tools:*
 - *a) command passing from IOCs to GSSC, and from GSSC to MOC*
 - *b) timeline creation and passing to MOC*
 - *c) ToO order creation and passing to MOC*
- *Release 3 (5/1/05), tied to GRT4—ingest of Level 1 data from IOCs:*
 - *a) scripts to move data from IOCs to GSSC*
 - *b) creation of GSSC databases*
 - *c) software to ingest data into GSSC databases*
- *Release 4 (8/1/05), tied to GRT5—completion of command and schedule tools*



Release Schedule, cont.

▶ **Computer System—Driven by GRTs**

- *Phase 1 (3/1/04)—Single processor system tied to Beowulf database system*
- *Phase 2 (1/15/05)—Preliminary multiprocessor system*
- *Phase 3 (3/1/06)—Complete multiprocessor system*

▶ **Science—Driven by data challenges**

- *Release 1 (12/15/03)—Prototypes of basic tools: data extraction from databases, likelihood tool, basic burst tools*
- *Release 2 (9/30/04)—Completion of basic tools. Prototypes of advanced tools: pulsar tools, graphic displays*
- *Release 3 (2/28/06)—Completion of all tools*



Element-Level Test Plan



- ▶ ***Rolling testing driven by the GSSC requirements matrix***
- ▶ ***Software development methodology includes automated unit tests, regression tests, stress tests***
- ▶ ***Developing system-level tests***
- ▶ ***The methodology will be described in the Test Plan***
- ▶ ***Testing of interfaces will occur informally before GRTs***
- ▶ ***Properly formatted test data will be used for developing and testing the internal software***
 - *The GSSC and the instrument teams are defining the file formats*
 - *Test data may be generated by either the instrument teams or the GSSC*
 - *For some software tests can use the EGRET data*



External Test Schedule

► **Operations—*with rest of ground system***

- *GRT1 (11/1/04): Ingest Level 0 data from MOC*
- *GRT2 (4/1/05): Preliminary test of command and activity schedule flows to and from other GS components*
- *GRT3 (6/15/05): Clean-up from GRTs 1 & 2.*
- *GRT4 (9/1/05): Ingest Level 1 data from IOCs*
- *GRT5 (11/15/05): Full command and activity schedule system*
- *GRT6, GRT7, ETEs: Clean-up, tests of full system*

► **Science—*run by LAT team***

- *Data challenge 1 (9/03-3/04): Software of release 1*
- *Data challenge 2 (9/04-3/05): Software of release 2*
- *Data challenge 3 (2/06-9/06): Software of release 3*



Software Development—Operations



- ▶ ***Operations software will be Perl scripts, C/C++ code and existing software packages (e.g., TAKO).***
- ▶ ***The interfaces with other GS components will be defined by ICDs.***
- ▶ ***The software will be maintained within a CVS repository at the GSSC. By preserving all versions, CVS enforces basic configuration control.***
- ▶ ***An GSSC configuration board will approve all operations software releases.***
- ▶ ***Operations software releases are driven by the various ground system tests, and will be evaluated during these tests.***
- ▶ ***Software-bug tracking software (e.g., Bugzilla or GNats) will be used.***



Software Development—Analysis Tools



- ▶ ***The instrument teams are responsible for managing the development of the analysis tools that will be distributed, but the GSSC participates in the development.***
- ▶ ***The software development environment for the distributed tools is based on that of the LAT team:***
 - *Code written in C++ (=object oriented software)*
 - *Top-down design identifies common classes that will be incorporated in a GLAST software library*
 - *CVS for maintaining the different versions of the code*
 - *CMT for building the code*
 - *Doxygen for documentation*
 - *Nightly build and test of all software*
 - *Periodic code reviews*
 - *Code will be delivered with test data and procedures*
 - *Releases tied to yearly “data challenges”*
 - *Support for both Windows and Linux platforms*



Analysis Tools, cont.

► **Requirements and specifications**

- *An GSSC-LAT software working group has been defining the suite of tools and the development environment*
- *A draft software requirements document (“The Standard Environment for the Analysis of LAT Data”) was reviewed by a committee chaired by Frank Marshall (head of OGIP)*
- *We have responded to the review (e.g., translating EGRET pointing/lifetime and response functions into GLAST format)*
- *The software requirements document is evolving, and will be reviewed by the Users’ Committee*

► **GSSC-specific tools will be developed within this software environment, except**

- *These tools will not be distributed but will be accessible through the GSSC website*
- *We will use the HEASARC’s build system.*
- *We will use bug tracking software (e.g., Bugzilla or GNats)*



The HEASARC and the GSSC



- ▶ ***The HEASARC and the GSSC are both constituents of OGIP in LHEA.***
- ▶ ***The mutual requirements are in an GSSC-HEASARC MOU.***
- ▶ ***Following standard HEASARC practice, the HEASARC pays for (and maintains) the GSSC's CPUs and the GSSC pays for the storage devices. The exception is the GSSC's Beowulf (needed for a crucial database), which the GSSC will buy.***
- ▶ ***The HEASARC will maintain the software environment in which many missions' software is implemented.***
 - *GLAST is extending and using HEADAS for the analysis tools*
 - *The GSSC is using HEASARC file conventions; the GSSC's data can be readily archived at the HEASARC*
- ▶ ***The HEASARC will maintain the GLAST data and software for posterity—this is the HEASARC's raison d'être!***



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GRB Coordinates Network (GCN)



- ▶ ***The GCN originates in LHEA at GSFC.***
 - *Procedures to submit or receive data are posted at gcn.gsfc.nasa.gov.*
 - *The lead is Scott Barthelmy.*
- ▶ ***GCN distributes Notices providing burst locations to observers and robotic telescopes.***
 - *The Notices are submitted to GCN by socket connection.*
 - *These Notices go out by socket, e-mail, or pages.*
- ▶ ***The GCN will distribute GLAST Notices from:***
 - *The BAP—burst alerts from the GBM or LAT (in Notices format) OR locations calculated by the BAP*
 - *The LIOC—from Level 1 data*
 - *The GIOC—from TDRSS-downlinked GBM data or from Level 1 data*
- ▶ ***The GCN also distributes Circulars submitted by observers by e-mail. The GIOC and LIOC will write circulars based on their analysis of their Level 1 data.***



Backup Slides





LAT Photon Database



- ▶ ***The LAT photon database consist of FITS files residing on a Beowulf cluster of machines. The Beowulf will perform parallel spatial searches. Why not use a standard DBMS (database management system)?***
 - *We require only simple read-only queries; many of the DBMS features are not required.*
 - *DBMS power comes with an overhead. We benchmarked the speed of searching FITS files vs. three DBMS systems; searching FITS files was the fastest! This was also found by the ASTROGRID project in the UK: <http://wiki.astrogrid.org/bin/view/Astrogrid/DbmsEvaluations>.*
 - *Storing the data in FITS files is desired by the HEASARC and easily accommodates data content modifications.*
 - *Reprocessing will replace FITS files rather than finding and deleting old photons and inserting new photons.*
 - *The downside is that we have to write our own search and interface software, but we are well on the way.*



GLAST photon beowulf database

