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Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Conceptual Design of the GLAST LAT Tracker Construction Database

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
v0.1	March 13, 2001	Original version
v0.2	March 15, 2001	Revised for the Eduardo's comments
v0.3	March 28, 2001	Revised for the Luca' comments
v0.4	March 30, 2001	Improved in wording
v1.0	April 4, 2001	Minor corrections and modifications
v1.1	October 17, 2001	Rewritten for the GLAST document archive

Contents

1 Purpose

This report serves to document the conceptual design of the GLAST LAT Tracker construction database. The database keeps track of the sub-components of the LAT tracker and includes assembly-related information generated during the prototype assemblies and the flight model production, such as assembly status and test results.

2 Scope

The GLAST LAT tracker includes enormous number of the sub-components, such as about 10000 silicon strip detectors (SSD), 650 TMCM's (Tracker Multi-Chip Module), and 300 detector trays. Since all the components should be kept track of during the LAT tracker construction, we use a relational database that includes assembly status, test results, and relationship between components. This document illustrates a conceptual model of the LAT tracker construction database. For use in the database system, the LAT coordinate system is described in [5] the naming convention of the sub-components in [6].

3 Definitions

3.1 Acronyms

ASIC	—	Application Specific Integrated Circuit
GLAST	—	Gamma-ray Large Area Space Telescope
LAT	—	Large Area Telescope
TMCM	—	Tracker Multi-Chip Module
SSD	—	Silicon Strip Detector

4 References

[1] LAT-TD-00156 LAT Tracker Preliminary Design Report
[2] LAT-SS-00017 LAT TKR Subsystem Specification — Level III Specification
[3] LAT-SS-00134 LAT TKR Subsystem Specification — Level IV Specification
[4] LAT-SS-00152 LAT TKR Subsystem Specification — Level IV Readout Electronics Requirements
[5] LAT-TD-00035 LAT Coordinate System
[6] LAT-TD-00376 Naming Convention For Glast Tracker Construction And Tray Orientation In Tracker Tower

5 Tracker assembly and construction database

This section summarizes background information for a conceptual design of the GLAST LAT tracker construction database. Described below are a list of institutes directly contributing to the construction, a projected production flow, and flow of the tracker components, and usage of the construction database during and after the tracker production.

5.1 Construction institutes

There are four institutes conducting the GLAST tracker construction, hereafter construction institutes, the Hiroshima University (Hiroshima), University of California at Santa Cruz (UCSC), Istituto Nazionale di Fisica Nucleare at Pisa (Pisa), and Stanford Linear Accelerator Center (SLAC). Each institute is responsible in items in the table below.

Tracker components are assembled at the construction institutes, at manufacturers, and at assembling companies under their contract with the institutes. Then, the components are sent to Pisa to assemble into tracker towers and shipped to SLAC. The construction institutes are responsible to update the database; they should collect information from their manufacturers, their assembling companies, and other construction institutes, in order to update the database.

Table 1: Institute relating to the GLAST tracker construction

Construction site	Responsible to
Hiroshima	Measurements and tests of silicon strip detectors
UCSC	Production and tests of TMCM's
Pisa	Production and tests of tracker towers
SLAC	Assembly of the qual towers; calibration; I&T

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                  detectors
Hiroshima -------------+            towers
                       +--> Pisa ----------> SLAC
UCSC ------------------+
                  TMCM
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Figure 1: Flow of the tracker components between the construction institutes. Note that some components, such as a tray close-out, are manufactured or assembled by companies that are not shown here.

5.2 Requirements for the database

For effective use of the information collected before, during, and after the construction, the construction database should be designed, built, and operated in a way to meet the following requirements.

1. During the production, new kinds of information should be able to add to the database in a timely manner to accommodate unexpected, newly identified failure modes.
2. Limited access to the database contents by non-constructors should be allowed for monitoring purpose; all the construction institutes should prepare user-interface for the purpose at their sites.
3. After the tracker construction, all the information about the tracker construction should be available in a database at SLAC. The database will then provide fundamental information for the tracker part of the instrument calibration database, which is eventually needed to science analyses after the launch.

6 Conceptual design of the database

This section describes a conceptual design of the construction database. First, our basic strategy to approach the problem will be shown; described below is how we should share the information among the contributing institutes scattered all over the world. Then, configuration of the entire database system will be explained. Data transfer strategy will also be explained and data categorization to match the strategy will be considered.

6.1 Distributed database

Maintainability and flexibility of the construction database are key to efficient, timely production of the tracker. The centralized database system, however, tends to be not flexible enough to modify it for unexpected failure modes in timely manner, for instance. Also, it will be very large, which make it difficult to implement it and to maintain it. Furthermore, such a database system requires large amount of data to be transfered all over the world, which may not be in immediate need. On the other hand, a distributed system generally requires interfaces between different databases and synchronization mechanism. Simple interfaces and smooth data flow has to be maintained between distributed databases throughout the construction.

To build a flexible, workable database system, we chose that each construction institute should develop its own database system locally, separate from the main database. A local database records all information relating to production processes at an institute and the information will be used locally at the institute to control their production. To minimize data transfer, only a part of information should be exchanged between the construction institutes during the tracker production, and the rest should stay in a local database at each institute. All of the information in local databases will be transfered to the main database after the tracker construction.

This approach should be validated in the future prototyping phase in practice. Before the mass production starts, we will refine our design based on achievements and performance in the prototype run.

6.2 Database configuration

The construction database consists of one main database and four local databases. Each construction institute has one local database for its own production processes. A local database stores all the information produced or collected at the institute during the tracker construction. The main database resides at SLAC and collects all the information from the local databases after completion of the tracker production and before the launch.

Exchange of information is required between the main database and local databases as a result of distributed-database approach. For example, when tracker components are shipped from one construction institute to another, a part of a local database at the shipping institute needs to be transfered to a local database at the shipped institute. At the end of the production, all the information will be sent to the main database.

For flexibility of database management and feasibility of its implementation and maintenance, each construction institute implements the local database at their institute. Also, each institute is allowed to choose a database software to use at their institute. For production monitoring during the production, each database is required to have an interface to browse its contents or their summary.

6.3 Data transfer between institutes

Various types of data transfers are needed between the construction institutes during the tracker construction. They can be categorized in three different modes by update frequency: immediate transfer, transfer at component shipping, and transfer after the construction to complete the main database at the end of the construction. All the modes are explained below.

Immediate transfer

Data flow	assembly site → local database at the construction institute
Transfer method	TBD at each construction institute
Data type	measurement recording, assembly logging, etc.

At component shipping

Data flow	shipping institute → local database at shipped institute
Transfer method	Electronic copy (FTP etc.)
Data type	information about components being shipped

After construction

Data flow	construction institute → the main database
Transfer method	TBD
Data type	all the information in all the local databases

6.4 Data classification

All the data that are produced in the construction are categorized into two groups based on its information type, its needs in the construction flow, and update frequency required for the needs. Here are the two data types:

Exchange data — Information to be exchanged between the construction institute

Update frequency:	Once per component shipment
Who wants to see:	Four construction institutes
What kinds of data:	Sub-component data needed to assemble a tracker
Data shipped from:	Local database at a construction site
Data shipped to:	Local database at the next construction institute
Data entry method:	Electronic copy (FTP etc.)
Examples:	Strip detector measurements (Hiroshima to Pisa)
	TMCM test results (UCSC to Pisa)
	Tower test results (Pisa to SLAC)
	Component assignment (Pisa to SLAC)

In-house data — Information needed only at a construction institute

Update frequency:	Immediate at operation
Who wants to see:	Operators within a construction institute ONLY
What kinds of data:	Assembly-specific information not important to the production flow
Data shipped from:	Assembly/test station
Data shipped to:	Local database at a construction institute
Data entry method:	To be developed at each construction institute
Example:	Date and time of assembly/test/measurement
	Operator's name
	Assembly jig number, test station number

7 Definition of data contents

7.1 Exchange data — data exchanged between institutes —

The exchange data include all the information relevant to assembly processes at Pisa and at SLAC, in order to assemble subcomponents into higher-level components, such as detectors onto trays, and towers into LAT. They will be transfered when a set of subcomponents are shipped to Pisa or SLAC. Only the exchange data of the subcomponents being shipped are transfered with the components. They should separately be stored at a shipped institute, but as a copy of the data. If there is any discrepancy in the exchange data between the shipping institute and the shipped institute, the one at the shipping institute should be taken. Here is a list of the exchange data. Note that these lists may change due to identifications of unexpected failure modes during the assembly processes.

Detector information (Hiroshima to Pisa)

1. Detector ID number
2. Bad strip list (by the manufacturer and by Hiroshima)
3. Leakage current, normalized at 25 degrees
4. Notes (special batch, lower break down voltage, etc.)

TMCM information (UCSC to Pisa)

1. TMCM ID number
2. Bad channel list
3. Currents on power lines
4. Notes (bad chip list, minor problems in tests)

Tray/Tower information (Pisa to SLAC)

1. Tray/Tower ID number
2. Configuration (list of subcomponents and their locations)
3. Mechanical measurement/test results (tray)
4. Subcomponents alignment (ladder/tray)
5. Detector currents per tray, cable, and tower
6. Post-assembly bad channel list
7. Currents on electronics power lines per tray, cable, and tower
8. Notes (special instructions for testing, etc.)

To minimize the data transfer, a shipping institute should send only the latest results of measurements and tests performed at the institute. Note that the exchange data sent to Pisa is not forwarded to SLAC. Such data are re-measured, re-tested, merged, or added together at the tray/tower assembly process at Pisa, and only the latest results are to be shipped to SLAC.

7.2 In-house data — local information at an institute —

The in-house data will be defined locally at each construction institute. All the data will be transfered to the main database at the end of the tracker construction. It is beyond the scope of this document, however, to itemize the in-house data and to define its data format. In fact, it may grow during the construction due to identifications of new information critical for the production, such as unexpected failure modes during the assembly processes.

8 Guidelines for data transfer

8.1 Immediate transfer within an institute

Each construction institute is responsible for implementing the data transfer within the institute and from assembling companies to the institute. Therefore, protocol(s) for such data transfer should be defined at each institute. Also, a construction institute may change the protocol to flexibly cope with newly identified problems or to improve assembly efficiency and production quality.

8.2 Data transfer at component shipping

Before the first set of subcomponents are shipped from one institute to another, the shipping institute and the shipped institute should establish data transfer between them. Therefore, their data format and transfer method should be defined and agreed between the the institutes. They can be different, however, from one combination of the shipping and the chipped institutes to another, since such data transfer is local to each type of subcomponent shipments. There are a couple of ways to transfer the exchange data between the institutes.

For simplicity and ease of data handling, data format should be one of well-known, widely-available formats, such as 1) tab-separated ASCII files, 2) MS Excel files, or 3) database-specific format. For the same reasons, their transfer method should be based on well-established, widely-spread technologies such as 1) E-mail, 2) specially-designed web page, or 3) electronic copy (e.g., ftp or scp). Also, to avoid possible problems in transferring data, there must be a database administrator at each construction institute, only who uploads the exchange data that is sent to them.

8.3 Data transfer after construction

The protocol for the data transfer after the tracker construction can be very different from those described above, because it will happen only once in the project. It is beyond the scope of this document, however, to define the transfer protocol in detail, because the entire data to be transfered at the end are not known at the moment; note that the database is kept flexible so as to include more information than what is anticipated when it is designed. It will be less time-critical than any other data transfer in the production, which allows us to do it in a slow process, such as sending CD-ROM's including the entire local database, or copying them electronically over the network.