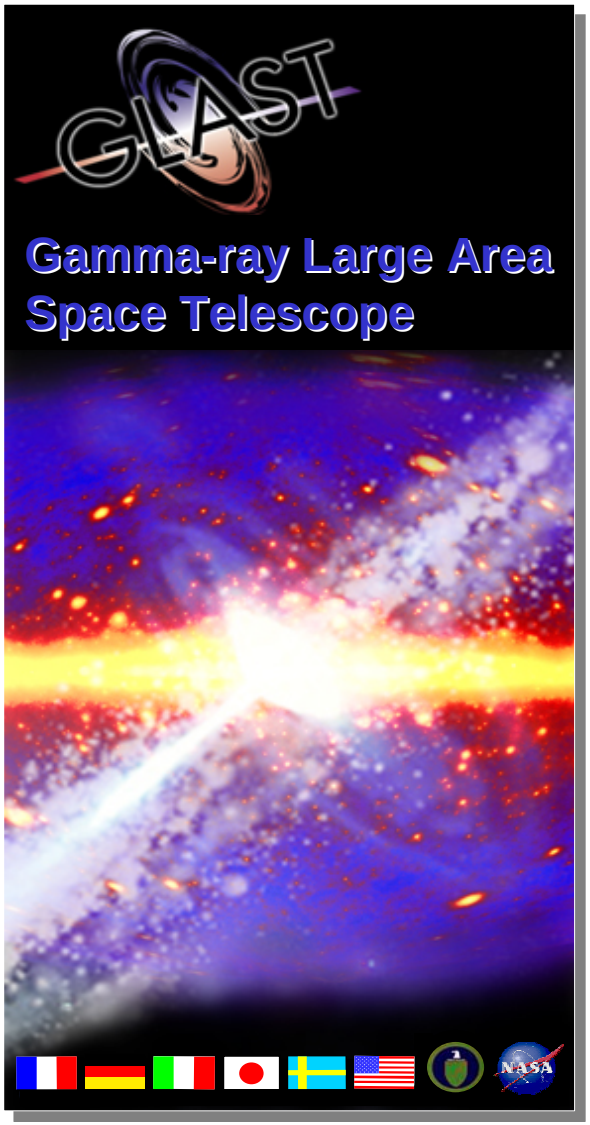

GLAST Large Area Telescope
Instrument Science Operations Center

Science Operations I

Eduardo do Couto e Silva and Seth Digel
Stanford Linear Accelerator Center

Outline

- There will be two presentations from Science Operations
  - Overview/Performance/Timeline (Eduardo do Couto e Silva)
  - Science Data Products/Resources (Seth Digel)

- Science Operations (this talk)
  - Main Responsibilities
  - Philosophy
  - Heritage
  - Interfaces within ISOC
  - Timescale of Activities

- Summary

Science Operations Responsibilities

- Part I (this talk)
- Characterize, monitor and optimize LAT Performance at all levels
  - individual LAT detectors
    - calibrations
    - performance and diagnostics
      - correlate low level characteristics with housekeeping
  - LAT as an integrated particle physics instrument
    - trigger and data flow
    - system wide calibrations
    - overall timing properties
    - performance
      - efficiencies, alignment, cross-correlation between detectors
  - LAT as a high energy gamma ray detector
    - monitor instrument performance and calibrations with
      - particle (charged and neutral) background
      - astrophysical sources
    - identify new operational settings and observing strategies to optimize scientific return
- Coordinate investigation of instrument anomalies
- Coordinate LAT operations scientist program
  - needed at early stages of operations and can be phased out as we automate processes

- Part II (Seth Digel's talk)
- Science Data Processing
- Development Milestones
- Resource requirements

Science Operations Philosophy

- Multi tasking
  - to efficiently allocate resources
- Redundancy for all priority tasks
  - to meet critical deadlines
  - to build team spirit and avoid “single point failures”
- Science Operations is an integrated process
  - Instrument is scrutinized from its lowest levels all the way up to high level science
    - We need “more eyes with a big picture”
    - People are trained in workshops (as we did for Instrument Analysis during Integration & Test) to serve as “operations scientist” for some short term duration (duties TBD)
- Participation is a must
  - all ISOC groups participate in Science Operations
    - Science Operations tasks can be taken (and sometimes encouraged) by experts who share responsibilities in more than one group
  - all Science Working Groups shall provide inputs and participate (if they wish)
    - most likely people interested in transients will be more active
  - LAT Collaborators are expected to participate
    - calibrations, monitoring of sources, etc…

Science Operations Heritage

- **Current group and corresponding skills**

Former Science Verification Analysis and Calibration group from the LAT Integration and Test and Science Tools group from SAS

  - **Astrophysicists (2 FTE) with experience on**
    - **high-energy gamma-ray astronomy**
      - **Astrophysics Data Facility**
      - **EGRET instrument specialist in the COSSC**
      - **Coordination and development of the high-level analysis software for the LAT**
    - **X ray astrophysics**
      - **Time properties of astrophysical sources**
    - **scripting for data processing**
  - **Particle Physicists (3 FTE) with experience on**
    - **design, construction, test and commissioning of particle physics detectors**
    - **data analysis of particle physics detectors**
      - **rigger and calibrations**
      - **offline event reconstruction and alignment**
    - **coordination and training of large groups**
    - **Test Planning within Systems Engineering**
- **Current Responsibilities**
  - **LAT Integration and Test**
    - **Science Verification Analysis and Calibration**
  - **LAT Collaboration effort**
    - **Coordination of LAT Diffuse and Catalog Science Working Group**
    - **Coordination and development of the high-level analysis software for the LAT**
    - **Coordination of Pre-Launch Instrument Data Analysis Effort**
    - **Co-coordination of Beam Test Effort**

How do we interface within the ISOC?

- **Science Analysis Systems (large and successful experience from I&T)**
  - tailor SAS software to operation needs
    - all software development is coordinated and managed by SAS
  - provide SAS with definitions for displays, databases, visualization and data analysis tools used for operations
  - test and provide support to improve SAS software for event reconstruction, data analysis of LAT performance and trending
  - provide inputs to SAS to guide development for science data and tools for quick-look activities
- **Flight Operations (some experience from I&T but details TBD)**
  - Work with CHS to
    - correlate science and housekeeping data
    - provide inputs for Mission planning (new observing strategies)
    - definition of visualization tools for instrument configuration and trending of housekeeping
  - Work with FSW to
    - monitor trigger, background rates and performance of on-board filter
    - provide definition of new instrument configurations
    - resolve instrument anomalies

Timescales within Science Operations

Details will be developed as we involve the LAT Collaborators

- **Daily**
  - monitor LAT performance
  - search for instrument anomalies
- **Weekly**
  - verify LAT behavior when transients occur
  - perform trending analysis
    - timescale can obviously vary for different analysis
- **Monthly**
  - provide new calibrations (if necessary)
    - some calibrations may be revisited more often and other on a yearly basis (details TBD)
- **Month(s) (details TBD)**
  - Training of Collaborators via ISOC Workshops
- **Per need basis**
  - define new LAT configurations to optimize scientific return
  - update Instrument Response Functions
  - resolve instrument anomalies

Resources (FTE)

task	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012
TOTAL (SO + LAT Collab)	8.75	14.25	15.50	12.00	9.75	9.75	9.75
TOTAL (SO)	6.50	10.25	11.50	8.00	5.75	5.75	5.75
Total (SO scientists)	4.00	6.75	7.25	4.00	3.50	3.50	3.50
Total (SO software dev)	2.50	3.50	4.25	4.00	2.25	2.25	2.25
TOTAL (LAT Collab)	2.25	4.00	4.00	4.00	4.00	4.00	4.00
Management	0.50	0.50	1.00	0.50	0.50	0.50	0.50
Scientists	0.50	0.50	1.00	0.50	0.50	0.50	0.50
Software Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LAT Collaboration	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calibrations	0.75	1.50	1.75	1.25	1.25	1.25	1.25
Scientists	0.50	1.00	1.00	0.50	0.50	0.50	0.50
Software Dev	0.25	0.50	0.75	0.75	0.75	0.75	0.75
LAT Collaboration	0.50	0.75	0.75	0.75	0.75	0.75	0.75
Performance	2.25	3.00	3.25	2.00	1.00	1.00	1.00
Scientists	1.25	1.75	1.75	0.50	0.50	0.50	0.50
Software Dev	1.00	1.25	1.50	1.50	0.50	0.50	0.50
LAT Collaboration	0.50	0.75	0.75	0.75	0.75	0.75	0.75
On-orbit Monitoring	1.00	1.50	1.50	1.00	1.00	1.00	1.00
Scientists	0.50	1.00	1.00	0.50	0.50	0.50	0.50
Software Dev	0.50	0.50	0.50	0.50	0.50	0.50	0.50
LAT Collaboration	0.75	0.50	0.50	0.50	0.50	0.50	0.50
Investigation of Anomalies	0.00	0.25	0.50	0.25	0.25	0.25	0.25
Scientists	0.00	0.25	0.25	0.25	0.25	0.25	0.25
Software Dev	0.00	0.00	0.25	0.00	0.00	0.00	0.00
LAT Collaboration	0.00	0.25	0.25	0.25	0.25	0.25	0.25
Level 1 Processing	0.50	0.75	0.75	0.50	0.50	0.50	0.50
Scientists	0.25	0.50	0.50	0.25	0.25	0.25	0.25
Software Dev	0.25	0.25	0.25	0.25	0.25	0.25	0.25
LAT Collaboration	0.00	0.25	0.25	0.25	0.25	0.25	0.25
Level 2 Processing	0.75	1.25	1.25	1.25	0.75	0.75	0.75
Scientists	0.50	1.00	1.00	1.00	0.50	0.50	0.50
Software Dev	0.25	0.25	0.25	0.25	0.25	0.25	0.25
LAT Collaboration	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Science Data Products	0.50	1.00	1.00	0.75	0.25	0.25	0.25
Scientists	0.25	0.50	0.50	0.25	0.25	0.25	0.25
Software Dev	0.25	0.50	0.50	0.50	0.00	0.00	0.00
LAT Collaboration	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Operations Scientist Program	0.25	0.50	0.50	0.50	0.25	0.25	0.25
Scientists	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Software Dev	0.00	0.25	0.25	0.25	0.00	0.00	0.00
LAT Collaboration	0.00	1.00	1.00	1.00	1.00	1.00	1.00

Seth's talk

- SO Developers needed
  - to provided by other ISOC groups
- ISOC overlaps with LAT Integration and LAT Beam Test (FY2006)
  - this is good!
    - core I&T team is in ISOC
      - lessons learned
    - core infrastructure
      - developed, debugged
    - team building
    - training infrastructure
      - 6 Instrument Data Analysis Workshops in ~ 20 months
  - the challenge
    - management and deployment of resources
    - need a carefully tuned schedule
- peak year
  - FY2008 (launch)
- operations become routine and automated as much as possible
  - FY2009 and on

FTE Justification

- The following two slides provide means to assess the number of FTEs based on
  - lessons learned and heritage from LAT Integration
  - preliminary list of developments towards on-orbit operations

Lessons Learned or Heritage from LAT Integration

- Calibration infrastructure
  - unnecessarily complex due to interdependencies between too many different groups
  - charge injection and offline work were not optimally integrated
- Data processing pipeline
  - pipeline 1
    - was not optimal for real data (worked well for Monte Carlo!)
    - after modifications has been sufficiently stable and adequate for I&T
  - pipeline 2
    - will serve as basis for ISOC development (details in Richard's talk)
- Performance and diagnostics
  - Data Quality
    - Developed automated reports to assess quality of data and display instrument configuration
      - basic idea is in place needs to be tailored for ISOC needs
    - current developing with SAS infrastructure for instrument monitoring
  - Instrument performance and debugging
    - Extensive work with L1 data at individual detectors and integrated system level
    - efficiencies, alignment, cross-correlation between detectors
      - however main focus in on sea level cosmic rays
      - working with SAS to continuously integrated software in a common framework
  - Housekeeping Data
    - Developed a simple interface to correlate L1 data with housekeeping
  - Configuration and operational settings
    - identify need for new operational settings
  - Investigation of instrument anomalies
    - studying instrumental effects down to 1% level
      - valuable for on-orbit debugging
- Interface with Collaboration
  - 20 months of experience organized 6 Instrument Data Analysis Workshops

Preliminary List of expected Science Operations Developments

- Areas in which we need to improve on the existing framework
  - transition into FSW procedures and improve validation process for calibrations
  - tailor processes for post launch calibrations
  - data processing infrastructure with Flight software
    - on the way during LAT Integration
  - work with SAS to develop a central data server and pipeline processing at all levels
  - Improve monitoring system to assess quality of data and instrument configuration
    - already working with SAS but need input from flight operations and LAT Subsystems
  - Evaluate impact on Galactic Cosmic Ray Calibrations with the calorimeter
    - there will be a presentation on Instrument Analysis Workshop 6 (Feb 27,28)
- Areas in which we need to acquire more experience and/or start the effort
  - Tailor activities to supporting the first 60 days of operations
    - from planning to implementation
  - focus on detailed studies with astrophysical sources and on-orbit background (Monte Carlo)
    - in conjunction with Science Working Groups
      - e.g. stability of alignment, impact from background rejection algorithms
  - understand expected thermal excursions on orbit
    - correlate with instrument data
  - monitoring of FSW filter, trigger rates and on-orbit background
    - work under flight operations guidance to identify and implement monitoring needs
    - there will be presentations on the Instrument Analysis Workshop 6 (Feb 27,28)
  - identify new operational settings and observing strategies to optimize scientific return
    - may affect how we load configuration on orbit
      - work under flight operations guidance
      - need to spend more time LAT Systems Engineering
  - Investigation of instrument anomalies
    - need to understand limitations on orbit for the retrieval of diagnostic data
      - may need to develop tools to inspect low level data and debug the instrument
  - LAT operations scientist program
    - need to engage collaboration in the process and science working groups

Operations Scientist Program

- Provide 24h coverage of LAT monitoring
  - benefit for LAT collaboration being distributed at different time zones
- Monitor instrument behavior
  - from the lowest level up to science data and alert (GRB/blazar flares) messages
- Training
  - use workshop series to homogenize knowledge within LAT collaborators
  - develop expertise among collaborators
  - expect at early stages of operations to have collaborators be short term residents in the ISOC
- Expect to have a coordinator of the shift crew and few people “on shift”
  - Duties are at this point TBD
    - we will develop a program that is adequate to guarantee the success of GLAST based on both particle physics and astrophysics experience within the LAT Collaboration