GLAST Large Area Telescope:
Status Report to SEUS

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see http://glast.gsfc.nasa.gov
and http://www-glast.slac.stanford.edu (LAT)
http://gammaray.msfc.nasa.gov/gbm (GBM)
http://glast.sonoma.edu (E/PO)
GLAST Science

GLAST will do great science, with a very broad menu that includes:

• Systems with supermassive black holes
• Gamma-ray bursts (GRBs)
• Origin of Cosmic Rays
• Probing the era of galaxy formation
• Discovery! (Particle dark matter? Other relics from the Big Bang? Testing Lorentz invariance. New source classes.)

Factor 30-100 improvement in sensitivity for $E_{\gamma} > 100$ MeV, with huge FOV (20% of the sky).

GLAST connects the High Energy Particle Physics and High Energy Astrophysics communities.
Sources

EGRET 3rd Catalog: 271 sources
5σ Sources from Simulated
One Year All-sky Survey

Results of one-year all-sky survey.
(Total: 9900 sources)

LAT 1st Catalog:
>9000 sources possible

AGN
3EG Catalog
Galactic Halo
Galactic Plane
172 of the 271 sources in the EGRET 3\textsuperscript{rd} catalog are “unidentified”

EGRET source position error circles are \(~0.5^\circ\), resulting in counterpart confusion.

GLAST will provide much more accurate positions, with \(~30\) arcsec - \(~5\) arcmin localizations, depending on brightness.
Outline

- Project
  - Science Working Group/IDS’s
  - Science Support Center
  - Spacecraft procurement

- E/PO

- LAT (20 MeV – >300 GeV)

- GBM (10 keV – 25 MeV)

- Summary
GLAST Project Master Schedule

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S. Ritz

Rev 5 – 01/31/02
Project: Science Working Group

- Chaired by Project Scientist (Jonathan Ormes). Membership includes the Interdisciplinary Scientists and delegates from the instrument teams.
- Having bimonthly telecons and ~biannual sit-down meetings.
- Sit-down meetings have included daylong topical meetings directly involving the various communities: AGN (4/01 Baltimore, adjacent to GAMMA2001); Pulsars (12/01 UCSC); Bursts (planned for 9/02 Huntsville).
- Working groups on topics as needed, including observing planning (inputs to spacecraft design) and GRB coordination.
- see http://glast.gsfc.nasa.gov/science/swg/ for meeting minutes and activities
- GLAST science sessions at major conferences. Suggestions welcome!
Project: Science Support Center Accomplishments

• Roles and responsibilities defined at the SSC-IOC interface:
  – SSC-LAT working group to define suite of science tools, establish software standards, and design key databases
  – SSC scientists will participate in developing tools with LAT team
  – SSC will have a backup Level 1 pipeline

• Staffing by mid-summer – Manager, Science Lead, 3 scientists, 2.5 scientific programmers, webmaster and administrative assistant (fraction of FTE)

• Documents
  – PMDP revised
  – SSC Functional Requirements Document revised
  – Report of GLAST Data Products Working Group (with draft ICDs)
  – Detailed WBS under development

• Event database under design
Project: SSC Near-term Plans

- **Staffing**
- **Documents**
  - Finish PDMP, SSC Functional Requirements Document
  - Develop SSC WBS
- **Databases**
  - Study and model organization of the event & photon databases
- **Level 2 Science Tools**
  - SSC-IOC software working group to define tool suite
  - Establish standards, requirements, and deadlines
  - SSC scientists part of development groups
- **Response functions**
  - Use of HEASARC CALDB in GLAST framework
- **User Committee being formed**
Project: Spacecraft Procurement

- Spacecraft will be procured through the Rapid Spacecraft Development Office (RSDO) as a fixed-price contract.
- Two previous accommodation studies with vendors surfaced many issues and helped sharpen requirements.
- IMDC run (2/02) as a check of the project’s spacecraft baseline concept; useful as a benchmark in the proposal evaluation process.
- Draft RFO released. Expect final RFO out end of April, selection by mid-summer.
Project: Personnel

- Project continues to increase staffing as needed, particularly for system engineering (including new system engineer co-located at SLAC).

- Recent senior personnel changes:
  - Project manager: Liz Citrin [previously on MAP] (12/01)
  - Deputy project manager: Al Vernacchio (4/02)
Project: Other Items

- Heavy launch vehicle (Delta 2920H) baselined for purposes of mission planning.
- Observatory c.g. being closely monitored.
- Working to minimize the chance of a premature end to the scientific mission due to presence of deorbit propulsion system.
- Impacts of X-band bandwidth limitation for space sciences missions being accommodated in Ops planning.
E/PO & PR Programs Summary

- GLAST Ambassadors program: Develop, distribute and field test GLAST material, train other teachers at local and national conferences. First five Ambassadors chosen, five more positions opening in 2004. Summer workshop @ SSU: July 02.
- GLAST exhibit booth
- Printed materials
  - Active Galaxies poster now available. Over 3500 distributed so far this year.
  - GLAST EPO flyer part of SEU folders distributed – 10,000 distributed during 2001 teacher’s conferences.
  - About 1000 GLAST Program flyers distributed
- PBS TV Show
  - Discussions with Tom Lucas are underway – negotiations ongoing w/ PBS
- Part of SEU Museum Exhibit (“Cosmic Questions”)
- GLAST Video now available on line -- 3000 CDs are being printed
- Science brochure and mission fact sheet; press releases; newsletter articles.
- Telescope network (w/ Mattox, RCT-Kitt Peak, others under discussion)
Exhibit Booth

• AAS in DC in January 2002
• Expanding Your Horizons at SSU in March 2002
• AAS Albuquerque in June 2002
LAT Status (PI: Michelson)

• High-altitude balloon flight of prototype LAT tower; achieves all objectives – August 2001
• Flight hardware engineering model development underway
• NASA-DOE agreement signed January 2002!
• Reviews:
  – February 2001: first joint NASA-DOE LAT review
  – August 2001: joint NASA-DOE interim LAT review
  • Result: LAT passes PDR “with flying colors”, except thermal subsystem which requires delta-PDR “due to a recently directed change to repackage the radiators to allow a maximum spacecraft diameter, and thus, the maximum number of potential spacecraft vendors to bid for the spacecraft contract.” Of the 11 subsystems, 4 were not baselined (ACD, I&T, Mech/Thermal, Calorimeter). [DOE Baseline review includes a rigorous grassroots cost and schedule review – unusual for NASA projects at this stage.]
  – SLAC Director’s review April 16-18.
GLAST LAT Overview: Design

**Si Tracker**
- Pitch = 228 µm
- 8.8 $10^5$ channels
- 12 layers _ 3% $X_0$
- 4 layers _ 18% $X_0$
- 2 layers

**Grid (& Thermal Radiators)**
- Flight Hardware & Spares
  - 16 Tracker Flight Modules + 2 spares
  - 16 Calorimeter Modules + 2 spares
  - 1 Flight Anticoincidence Detector
  - Data Acquisition Electronics + Flight Software
  - 3000 kg, 650 W (allocation)
  - 1.8 m _ 1.8 m _ 1.0 m
  - 20 MeV – >300 GeV

**CsI Calorimeter**
- Hodoscopic array
- 8.4 $X_0$ _ 8 _ 12 bars
- 2.0 _ 2.7 _ 33.6 cm
- cosmic-ray rejection
- shower leakage correction

**ACD**
- Segmented scintillator tiles
- 0.9997 efficiency
- minimize self-veto

**LAT managed at SLAC**
GLAST scheduled for launch in March 2006
Purpose of balloon test flight: expose prototype LAT tower module to a charged particle environment similar to space environment and accomplish the following objectives:

- Validate the basic LAT design at the single tower level.
- Show the ability to take data in the high isotropic background flux of energetic particles in the balloon environment.
- Record events for use as a background event data base.

All Objectives met by Balloon Flight on August 4, 2001
The balloon reached an altitude of 38 km, with a float time of 3 hours.

First results (real-time data): trigger rate as a function of atmospheric depth. The trigger rate never exceeded 1.5 KHz, well below the BFEM capability of 6 KHz.

All Subsystems Performed Properly
LAT Issue: Calorimeter and the CNES Situation

**Background:**
- March 5: CNES technical review recommends “pass” for French technical and management plans
  - However, R. Bonneville informs group that CNES funding severely impacted -- can likely only provide 1-2M Euros of planned (~8M Euros) CNES funding; (no previous indication that CNES funding was in jeopardy)

**Actions taken:**
- Letters and phone calls to CNES by IN2P3 and CEA/DSM directors, DOE, NASA, and prominent concerned scientists.
- Commitment obtained from CEA management to push for full restoration from CNES and to maintain efforts on GLAST CAL in the meantime.
- Meeting held on March 21 with CNES DG (Brachet) & Deputy DG (Bonnet) and IN2P3, CEA management and French LAT team leadership:
  - Urgency of situation communicated to CNES leadership, support expressed for French participation in GLAST, given French history of scientific work in the field and its importance
  - Brachet calls for emergency meeting of CNES Science Policy Committee to consider full restoration of planned CNES commitments
- **Emergency meeting of CNES Policy Committee scheduled for April 19**
GBM (PI: Meegan)

- provides spectra for bursts from 10 keV to 30 MeV, connecting frontier LAT high-energy measurements with more familiar energy domain;

Simulated GBM and LAT response to time-integrated flux from bright GRB 940217
Spectral model parameters from CGRO wide-band fit
1 NaI (14°) and 1 BGO (30°)

- provides wide sky coverage (8 sr) -- enables autonomous repoint requests for exceptionally bright bursts that occur outside LAT FOV for high-energy afterglow studies (an important question from EGRET);
- provides burst alerts to the ground.
GBM Status

- April, 2001: GBM funding included in NASA budget.
- July 27, 2001: Southwest Research Institute selected by MSFC to provide Data Processing Unit.
- Oct. 23, 2001: Jena Optronic selected by MPE to provide detectors and power supplies.
- Feb. 28, 2002: Increase in GBM mass allocation to 85 kg approved.
- March 7, 2002: Increase in GBM power allocation to 65 W approved.
- April 9-11, 2002: GBM PDR

There are no significant technical or management problems, and no changes to instrument capabilities.
GBM Collaboration

National Space Science & Technology Center

University of Alabama in Huntsville

NASA Marshall Space Flight Center

Max-Planck-Institut für extraterrestrische Physik

Michael Briggs
William Paciesas
Robert Preece

Charles Meegan (PI)
Gerald Fishman
Chryssa Kouveliotou

Giselher Lichti (Co-PI)
Andreas von Keinlin
Volker Schönfelder
Roland Diehl

On-board processing, flight software, systems engineering, analysis software, and management

Detectors, power supplies, calibration, and analysis software
GBM Instrument Design: Major Components

12 Sodium Iodide (NaI) Scintillation Detectors

- 5-inch diameter, 0.5-inch thick
- One 5-inch diameter PMT per Det.
- Placement to maximize FoV
- Thin beryllium entrance window
- Energy range: ~5 keV to 1 MeV

Major Purposes
- Provide low-energy spectral coverage in the typical GRB energy regime over a wide FoV
- Provide rough burst locations over a wide FoV

Data Processing Unit (DPU)

- Analog data acquisition electronics for detector signals
- CPU for data packaging/processing

Major Purposes
- Central system for instrument command, control, data processing
- Flexible burst trigger algorithm(s)
- Automatic detector/PMT gain control
- Compute on-board burst locations
- Issue r/t burst alert messages

2 Bismuth Germanate (BGO) Scintillation Detectors

- 5-inch diameter, 5-inch thick
- High-Z, high-density
- Two 5-inch diameter PMTs per Det.
- Energy range: ~150 keV to 30 MeV

Major Purpose
- Provide high-energy spectral coverage to overlap LAT range over a wide FoV
Summary

• Project:
  – Ramping up science preparations (SSC, SWG, Instrument teams)
  – Spacecraft procurement process in full swing
  – Mission PDR in October

• LAT:
  – Successful balloon flight
  – Successfully completed PDR, with one delta-PDR/baseline (for Thermal system) scheduled; delta-baseline review for 3 additional subsystems in June.
  – NASA-DOE agreement paves the way for remaining international agreements
  – CNES funding issue pending
  – Building engineering models of flight hardware

• GBM:
  – Main vendors selected
  – PDR this week

• E/PO:
  – vibrant and broad program; cooperation with other missions (e.g., SWIFT)