GLAST Science Working Group
Huntsville, September 13, 2002
Agenda
and
Science Requirements Document

AGENDA

8:30	Welcome and Opening Comments Introductions, Review of Agenda	J. F. Ormes
8:40	Comments from NASA and DoE Headquarters Joint Operations Working Group and Project Status	P. Hertz/K. Turner
9:00	Comments by and/or Questions from non-US participants	
9:15	Education initiatives	L. Cominsky
9:45	Public Relations	N. Gehrels
10:00	Break	
10:15	Project Overviews Data downlink rate and contact frequency, planned spacecraft trade studies, impact of special autonomous, schedule, etc.	L. Citrin
10:30	Spacecraft overview	Spectrum Astro
11:30	The Large Area Telescope (LAT) report	TBD
12:00	The Gamma-ray Burst Monitor (GBM)	C. Meegan

AGENDA, cont.

12:30	Lunch	
1:30	Preparation of GLAST Science Plan	N. Gehrels
1:45	Report of the Working Group on burst studies GBM-LAT interface, realtime on-board repointing decisions and constraints, operations planning and modes update.	C. Meegan
2:15	Break	
2:30	Report of the LAT-GRB science team	J. Norris/M. Kippen
2:45	SSC Status and Report of the SSC Software review and plans	D. Band
3:15	Review of the Actions from last meeting Definition of transient SRD revisions	J. Ormes
3:30	Other issues arising, discussion and New Actions review	J. Ormes
4:00	Adjourn	

GLAST Requirements Development Process

- **GLAST science requirements developed and sanctioned by NASA and DOE committees since 1994**
- **Foundation**
  - EGRET science 1991 - 2000
  - SR&T/ATD/DOE GLAST development programs 1994 - 1999
- **Committees / Working Groups**
  - NASA Gamma Ray Astronomy Program Working Group (GRAPWG) 1997 - 1999
  - NASA SEU Subcommittee 1997 - 2000
  - DOE Scientific Assessment Group for Experiments on Non-Accelerator Physics (SAGENAP) 1998 - 1999
  - GLAST Facility Science Team 1998 - 1999
  - NAS Decadal Review of Astronomy & Astrophysics 1999 - 2000
  - GLAST Science Working Group 2000 - present

Science Requirement Document

- **Facility Science Team (FST) formed by NASA in 1997 to develop GLAST science and generate GLAST AO SRD**
  - **Members chosen from astrophysics and particle physics communities. Technology development team members, community data experts, and theoreticians included.**
  - **Final report was SRD. Signed off at NASA in January 2000. FST disbanded in June 1999 and the AO was released.**
- **Scientific development of GLAST now led by SWG**
  - **First meeting held March 25-26, 2000**
  - **SRD signed at September 2000 meeting**
- **Now that Spacecraft vendor is selected, we are in the process of "cleaning up" the specifications**
  - **Requirements need to be verifiable**
  - **Flowdown needs to be clear**

Science Working Group (SWG)

- ***First meeting held March 25-26, 2000***
  - **Two "face-to-face meetings per year**
  - **Monthly phone calls, now bimonthly**
- **SWG:**

Project Scientist: (Chair) Jonathan F. Ormes

LAT PI: Peter Michelson

LAT US Team Reps (3): David Thompson, Neil Johnson, Elliot Bloom

LAT Foreign Team Reps (3): Isabel Grenier, Guido Barbiellini, Tsuneyoshi Kamae

GBM PI: Charles Meegan

GBM Foreign Team Rep (1): Giselher Lichti

Inter-disciplinary Scientists (4): Chuck Dermer, Brenda Dingus, Stephen Thorsett and Martin Pohl

Ex-Officio

Program Scientist: Paul Hertz (Donald Kniffen)

Project Manager: Elizabeth Citrin

Deputy Project Scientists (2): Neil Gehrels, Steve Ritz

DOE Representative: Kathleen Turner

SWG Agenda and Issues Addressed

- Science Requirements Document Reviewed and Signed
- Development Status Reviews
  - LAT and GBM
  - Project
- Integration of Interdisciplinary Scientists Proposals into Project Development Scheme
- Operations planning
  - Transients
  - Autonomous pointing
- Guest Investigator program and Data Rights
  - Review by a User's Group
- Development of the Project Data Management Plan and Observing Plans
  - Review of PDMP is first task of User's Group
- Review of Education and Outreach Activities
- Science Workshops
  - AGN (held in April 01)
  - Pulsars (Dec 01)
  - Gamma-ray Bursts (Sept 02)

WHY?

- SRD was signed in September, 2000. See
  http://glast.gsfc.nasa.gov/project/library/GLAST00010/GLAST00010.pdf

- Since then, much work has been done on mission documents. Analysis by mission system engineers has uncovered a few issues that can be addressed by minor changes to the SRD. This will help the project ensure consistency and accuracy.

- There are three suggested modifications, addressing:
  - time to respond to Targets of Opportunity (TOOs)
  - targeting
  - uniformity/coverage requirements

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  - targeting
  - uniformity/coverage requirements

Science Requirements on the GLAST Mission

	Quantity	*GLAST Requirement* [1]	*GLAST Goal* [1]	*GLAST Minimum* [1]	*Science Topic*
28	**Mission Lifetime** (<20% degradation) [2]	> 5 years	> 10 years	> 3 years	ALL
29	**Telemetry Downlink Orbit Average**	> 300 kbps	> 1 Mbps	> 300 kbps	ALL
30	**Telemetry Downlink Realtime** [3]	> 1 kbps	> 2 kbps	> 0.5 kbps	GRBs
31	**Telemetry Uplink Realtime** [3]	> 1 kbps	> 2 kbps	> 0.5 kbps	GRBs, AGN
32	**Time to Respond to TOO's on Ground** [4]	< 6 hours	< 4 hours	< 12 hours	GRBs, AGN
33	**Spacecraft Repointing Times for Autonomous Slews** [5]	< 10 min	< 5 min	NA	GRBs, AGN

Time to Respond to TOOs

- **Current requirement (32 in Table 3):**
  - < 6 hours (4 hr goal), with footnote 4 stating, "Response time for the MOC to uplink a spacecraft repointing after the decision is made to respond to a Target of Opportunity (TOO)."
- **Issues:**
  - Science Support Center is in the loop, but is not included in the footnote. There must be a requirement on SSC response time.
  - MOC does not directly uplink commands; they are scheduled by TDRSS.
- **Proposed rewording of footnote 4:**
  - "Response time for the SSC and MOC to plan and send a spacecraft repointing command after the decision is made to respond to a Target of Opportunity (TOO)."

Science Requirements on the GLAST Mission

	Quantity	*GLAST Requirement* [1]	*GLAST Goal* [1]	*GLAST Minimum* [1]	*Science Topic*
34	**GRB Notification Time to Ground by Spacecraft** [6]	< 7 sec	< 4 sec	< 10 sec	GRBs, AGN
35	**Pointing Accuracy Absolute** [7]	< 2^{o}	< 0.5^{o}	< 5^{o}	ALL
36	**Pointing Knowledge** [7]	< 10 arcsec	< 5 arcsec	< 20 arcsec	ALL
37	**Observing Modes**	- Rocking zenith pointing - Pointed mode [8]			ALL
38	**Targeting**	No restrictions on pointing of axis normal to LAT			ALL
39	**Uniformity of Sky Coverage during Scanning** [9]	< ± 20%	< ± 10%	< ± 30%	ALL

Targeting

- **Current requirement (38 in Table 3):**
  - "No restrictions on pointing axis normal to LAT"
- **Issue:**
  - The mission needs to justify and accommodate operational constraints for Earth avoidance and keeping the sun off the LAT thermal radiators.

NOTE: "Pointed mode" is already defined in SRD Table 3 footnote 8 as "Pointing of axis normal to LAT to within 30° of source (No science constraint on roll axis.)" Use this to address the issue (since sun constraint is accommodated by 30° tolerance).

- **Proposed changes:**
  - add footnote 8 also to requirement 38 (on the word "pointing").
    - "No restrictions on pointing[8] axis normal to LAT"
  - **Add a new requirement to SRD Table 3 and an associated footnote:**

    Earth Avoidance: Axis normal to LAT shall remain at >30° above Earth horizon during normal operations[14].

    Footnote 14: With the possible exception of rapid slewing to acquire a GRB."

Sky Coverage/Uniformity During Scanning

- **Current requirement (SRD #39 in Table 3):**

  Uniformity of Sky Coverage during Scanning:

  Requirement <±20%, Goal <±10%, Minimum <±30%

  With footnote #9: "Sky coverage exposure uniformity integrating for 7 days, not including SAA effects."

- **Current requirement (MSS #3.3.2.2.4):**

  Sky Coverage: "The observatory shall scan the LAT FOV (55˚ half-angle) over the full celestial sphere repetitively every 2 orbits"

- **Issue:**
  - **The MSS spec, which is important for transient searches, is not related to the SRD uniformity spec and does not flow down from any SRD spec. We also want flexibility.**
  - **Does this SRD #39 to Sky Survey only? (Change Scanning to Sky Survey"?)**
    - **"Uniformity of Sky Coverage during Sky Survey"**

- **Propose adding new requirement for SRD Table 3:**
  - **The observatory shall be capable of scanning the LAT FOV (55° half-angle) over >80% of the celestial sphere, excluding the region affected by the SAA, repetitively with selectable timescales as short as 2 orbits.**

Sky Coverage/Uniformity During Scanning

- **Propose adding new requirement for SRD Table 3:**
  - The observatory shall be capable of scanning[15] over the celestial sphere, repetitively with selectable timescales as short as 2 orbits.
  - Requirement: >80% of sky; Goal: 90% of sky; Minimum: 70% of sky
  - Footnote 15: Scan the LAT FOV (55° half-angle), excluding the region affected by the SAA.

Science Requirements on the GLAST Mission

	Quantity	*GLAST Requirement* [1]	*GLAST Goal* [1]	*GLAST Minimum* [1]	*Science Topic*
40	**Observatory Absolute Time Accuracy** [10]	< 10 μsec	< 3 μsec	< 30 μsec	Pulsars
41	**Observatory Absolute Position Accuracy**	< 3.3 km	< 1 km	< 10 km	Pulsars
42	**Observing Efficiency** [11]	> 90 %	> 95%	> 80%	ALL
43	**Data Loss** [12]	< 2 %	< 1%	< 5%	ALL
44	**Data Corruption** [13]	$< 10^{-10}$	$< 3 \times 10^{-11}$	$< 3 \times 10^{-10}$	ALL

Science Requirements: Footnotes

1 Requirement = value to design to; Goal = value to strive for to enhance science; Minimum = value that if not satisfied triggers a Project review..

2 20% degradation = no more than 20% loss of LAT science return.

3 Uplink telemetry rate for at least 80% of time outside of SAA.

4 Response time for the MOC to uplink a spacecraft repointing after the decision is made to respond to a Target of Opportunity (TOO).

5 Time for 70° slew.

6 Time from spacecraft receipt of GRB notification from GBM or LAT to delivery to the Gamma-ray Coordinates Network (GCN) computer for 80% of all GRBs detected by the GBM or LAT.

7 1 sigma radius.

8 Pointing of axis normal to LAT to within 30° of source. (No science constraint on roll axis.)

9 Sky coverage exposure uniformity integrating for 7 days, not including SAA effects.

10 Relative to Universal Time, 1 sigma r.m.s.

11 Fraction of time with data return, not including SAA effects.

12 Fraction of data taken by the instruments but not delivered to the IOC. Not including SAA data loss. Not including instrument deadtime.

13 Fraction of undetected corrupted events.

Level 1 requirements

- **Source location <0.5 arcmin**
  - **High latitude source < 10^{-7} flux, E^{-2} spectrum, 1 □ radius, 1 yr survey**
- **Point source sensitivity <6 x 10^{-9} cm^{-2} s^{-1}**
  - **High latitude source after 1 yr survey, 5 □ detection**
- **Background to be < 10% of extragalactic high latitude diffuse emission**
- **Determine burst spectra from 10 keV to >30 GeV**
  - **GBM: 10 keV to 25 MeV**
  - **LAT: 20 MeV to >30 GeV**
- **Determine burst locations <15 degrees and send to the GCN network within 7 seconds**
  - **WAS: Spacecraft capable of orienting anywhere at any time**
  - **Proposed: Spacecraft capable of observing any source on the sky at any time.**
  - **Desire autonomous repointing for bright bursts outside the LAT FoV**
- **Spacecraft pointing knowledge < 10 arcseconds (1 □)**

Transient policy

At all times, including te first twelve months of science operations, the data from transient sources discovered or detected by GLAST will immediately be made publically available.

Purpose is to facilitate follow-up observations in other wavebands.

If there are too many transients, the policy will become self-defeating.

- **Gamma-ray bursts**
- **Non-blasar, non-burst transients**
  - **5 sigma detection of a flux 3×10^{-7} cm^{-2} s^{-1} (1/2 day of sky survey)**
    - **Adjust flux limit to rate of ~one per month**
  - **Release data for 7 days before appearance and for 7 days after disappearance**
  - **One such EGRET source (Tavani et al. 1997)**
- **Blasars - are time varying sources “transients”?**

Blazars as "transients"

- Every bright blazar was found by EGRET to be variable
  - Emission at 5 GHz (S>~100mJy) should suffice to establish identification
- Purpose is to trigger follow-up in other wave bands
  - Preplanned campaigns
- Rapidly varying, extremely bright sources will be of interest
  - 5 x 10^{-6} cm^{-2} s^{-1} (E>100 MeV) with dln(flux)/dt > 1/day
  - 5 sigma should require about 10 minutes (TBR)
  - Derivative extracted from fluxes measured within +/- 1 day of the peak flux
  - Adjust to a scientifically useful rate: e.g. ~1/month (TBR)
  - Data release for 1 week prior to discovery and for 1 week after disappearance
  - Suggest posting daily average fluxes

Action Items: Gamma-ray bursts

- ACTION to establish subgroup to organize various aspects of dealing with LAT & GBM burst data
- Form SWG subgroup consisting of: Chip Meegan, Giselher Lichti, Brenda Dingus, Jay Norris, Neil Gehrels, 1 more to be appointed by Peter Michelson
  - Determine data policies wrt publications
- Define what SSC set of tools are needed to combine these data – especially joint spectra
- Plan Gamma-ray burst team for the next meeting

- ACTION Meegan

  1) Assure the GBM team works with the SSC to define software tools required and specifications for review at the next SWG meeting.

  2) Host next SWG meeting and associated workshop on gamma-ray burst studies with GLAST.

  3) Consider how to deal with pre-flight calibration data (beam tests) and determine what needs to be archived in SSC.

Action Items: Ormes

- ACTION Ormes to review specifications on impact of going to ±30° fixed antenna. To be studied by JD Myers. He will learn how to use the exposure program generated by Seth Digel and study a couple of example cases to be defined by Steve Ritz. Once we see the impacts of these cases, a determination will be made on whether or not some relief on requirements can be made. Meanwhile, the requirement for a gimbaled downlink antenna stands.

1) Figure out what we should do about redshift surveys for blazers.

2) Review impact of 5 sigma in the definition of a transient to make sure the number that pass the definition will be reasonable.

3) Schedule review of software tools for the next SWG meeting.

4) Work with Norris and White to understand the impact of having SSC scientists spend time at Stanford. Determine how it would affect the SSC hiring strategy.

Action Items: Michelson

1) Get characteristics of the LAT posted on a web site
2) Make a 1 chart explanation of how the instrument is calibrated. Include the role of beam teats, simulations and in flight tests on a source e.g. Crab
3) Assure the LAT team works with the SSC to define software tools required and specifications for review at the next SWG meeting.
4) When (how soon following launch) can a preliminary catalog be available for use by potential GIs?
5) Consider how to deal with pre-flight calibration data (beam tests) and determine what needs to be archived in SSC.

Action Items: Band

1) Send next version of the PDMP to the SWG for review to assure comments were captured properly.
2) SSC and IOCs to jointly develop lists of software tools to be developed and specifications for those tools.
3) Present at the next SWG a list of software tools to be developed for review by the SWG. Schedule review by SWG – next meeting?
4) Consider how to deal with pre-flight calibration data (beam tests) and determine what needs to be archived in SSC.
5) Pulsar timing solutions – determine who collects and maintains this data base.

Action Items: Headquarters (Kniffen)

1) check with the Users Group and solicit their opinion on the 90 day exclusive right to a scientific topic or idea as part of the GI program data policy.

2) write letters to Michelson, Meegan and the Inter Disciplinary scientists defining their data rights.

3) Provide Charter of the GLAST Users Group for review at the next SWG phone call on January 31st.

Action Items: General

- ACTION: Ormes, Gehrels, Kniffen, Michelson on Legacy program
- Obtain better definition (Gehrels)
  - What cannot be done as part of the regular GI program
  - How different from key projects
- Money before launch and before first AO to get pulsar ephemeredes (Ormes)
  - How to decide some kind of modest program

- Get additional information on NSF telescope proposal written by Carl Pennypacker at UC Berkeley from Lynn Cominski. This is necessary for understanding how we go about doing AGN followup and optical Ids, redshifts, etc.

Action Items, General cont.

- ACTIONs: Ritz:
  1) Get and post copies of Michelson's charts including the balloon flight summary charts.
  2) Work with Project to make sure we develop data rate specification as an on-board data storage capability.

- ACTION Kamae: send Ormes a memo that makes the case why having SSC scientists spend time at Stanford is needed.

- ACTIONs: Steve Thorsett -Steve to write plans for – timing data base to be maintained at SSC.
  1) **plane survey prior to launch and**
  2) **another to monitor the large statistical sample.**

Issues for the future

- SWIFT and GLAST joint observations
- Cross calibration of LAT and GBM
- Software review
- Users Group
- Blazar redshifts and observing campaigns
- Next meeting in Europe in May-June 03?
  - Diffuse gamma-ray emission (galactic, cosmic ray origin, SNR, dark matter and extra-galactic diffuse, etc.
  - Hong-Kong meeting
  - CDR
  - Integral launch

Backup slides

Action Items

- ACTION Kniffen:
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Summary of LAT Instrument Requirements

	Quantity	*EGRET*	*LAT Requirement* [1]	*LAT Goal* [1]	*LAT Minimum* [1]	*Science Topic*
1	**Energy Range Low Limit**	20 MeV	< 20 MeV	< 10 MeV	< 30 MeV	ALL
2	**Energy Range High Limit**	30 GeV	> 300 GeV	> 500 GeV	> 100 GeV	ALL
3	**Effective Area** [2]	1500 cm^2	> 8000 cm^2	> 12,000 cm^2	> 8000 cm^2	ALL
4	**Energy Resolution** [3] (on-axis, 100 MeV - 10 GeV)	10%	< 10%	< 8%	< 20%	ALL
5	**Energy Resolution** [3] (on-axis, 10-300 GeV)		<20%	<15%	<30%	ALL
6	**Energy Resolution** (>60° incidence, >10 GeV) [4]		< 6%	< 3%	NA [5]	Dark Matter

Summary of LAT Instrument Requirements

	Quantity	*EGRET*	*LAT Requirement* [1]	*LAT Goal* [1]	*LAT Minimum* [1]	*Science Topic*
7	**Single Photon Angular Resolution - 68%** [6] (on-axis, E>10 GeV)	0.5°	< 0.15°	< 0.1°	< 0.3°	ALL
8	**Single Photon Angular Resolution - 68%** [6] (on-axis, E=100 MeV)	5.8°	< 3.5°	< 3°	< 5°	ALL
9	**Single Photon Angular Resolution - 95%** [6] (on-axis)		< 3 x $\theta_{68\%}$	< 2 x $\theta_{68\%}$	< 4 x $\theta_{68\%}$	ALL
10	**Single Photon Angular Resolution** (off axis at 55°)		< 1.7 times on-axis	< 1.5 times on-axis	< 2 times on-axis	ALL
11	**Field of View** [7]	0.5 sr	> 2 sr	> 3 sr	> 1.5 sr	ALL
12	**Source Location Determination** [8,9]	5 arcmin	< 0.5 arcmin	< 0.3 arcmin	< 1 arcmin	UGOs , GRBs

Summary of LAT Instrument Requirements

	Quantity	*EGRET*	*LAT Requirement* [1]	*LAT Goal* [1]	*LAT Minimum* [1]	*Science Topic*
13	**Point Source Sensitivity** [9,10] (> 100 MeV)	~1 x 10^{-7} cm^{-2} s^{-1}	< 6 x 10^{-9} cm^{-2} s^{-1}	< 3 x 10^{-9} cm^{-2} s^{-1}	< 8 x 10^{-9} cm^{-2} s^{-1}	AGN, UGOs, Pulsars, GRBs
14	**Instrument Time Accuracy** [11]	0.1 ms	< 10 □sec	< 2 □sec	< 30 □sec	Pulsars, GRBs
15	**Background Rejection**[12] (Contamination of high latitude diffuse sample in any decade of energy for >100 MeV.)	<1%	<10%	<1%	<15%	Diffuse
16	**Dead Time**	100 ms /event	< 100 □s /event	< 20 □s /event	< 200 □s /event	GRBs
17	**GRB Location Accuracy On-Board** [13]		< 10 arcmin	< 3 arcmin	NA [5]	GRBs
18	**GRB Notification Time To Spacecraft** [14]		< 5 sec	< 2 sec	NA [5]	GRBs

LAT Instrument Requirements: Footnotes

1 Requirement = value to design to; Goal = value to strive for to enhance science; Minimum = value that if not satisfied triggers a Project review.

2 Maximum (as function of energy) effective area at normal incidence. Includes inefficiencies necessary to achieve required background rejection. Effective area peak is typically in the 1 to 10 GeV range.

3 Equivalent Gaussian 1 sigma, on-axis.

4 Effective area for side incidence is 0/1 to 0.2 that of normal incidence for high resolution measurements.

5 NA = Not Applicable. Minimum values are not applicable for parameters that were not Requirements in the AO 99-OSS-03 Announcement of Opportunity.

6 Space angle.

7 Integral of effective area over solid angle divided by peak effective area. Geometric factor is Field of View times Effective Area.

8 High latitude source of 10^{-7} cm^{-2} s^{-1} flux at >100 MeV with a photon spectral index of -2.0 above a flat background and assuming no spectral cut-off to 10 GeV. 1 sigma radius. 1-year survey.

9 Derived quantities delimited by double-lined box.

10 Sensitivity at high latitudes after a 1-year survey for a 5 sigma detection.

11 Relative to spacecraft time.

12 Assuming a high-latitude diffuse flux of 1.5×10^{-5} cm^{-2} s^{-1} sr^{-1} (>100 MeV) assuming a photon spectral index of -2.1 with no spectral cut-off.

13 For burst (>20 sec duration) with > 100 photons above 1 GeV. This corresponds to a burst of ~5 photons cm^{-2} s^{-1} peak rate in the 50 - 300 keV band assuming a spectrum of broken power law at 200 keV from photon index of -0.9 to -2.0. Such bursts are expected to occur in the LAT FOV ~10 times per year.

14 Time relative to onset of GRB.

Summary of GBM Instrument Requirements

	Quantity	*BATSE*	*GBM Requirement* [1]	*GBM Goal* [1]	*GBM Minimum* [1]	*Science Topic*
19	**Energy Range Low Limit**	25 keV	< 10 keV	< 5 keV	< 20 keV	ALL
20	**Energy Range High Limit**	10 MeV	> 25 MeV	> 30 MeV	> 20 MeV	ALL
21	**Field of View** [2]	4	> 8 sr	> 10 sr	> 6 sr	ALL
22	**Energy Resolution** [3] (0.1 - 1.0 MeV)		< 10%	< 7%	< 12%	GRBs
23	**GRB Alert Location** [5]		NA [4]	< 15 deg	NA [4]	GRBs

Summary of GBM Instrument Requirements

	Quantity	*BATSE*	*GBM Requirement* [1]	*GBM Goal* [1]	*GBM Minimum* [1]	*Science Topic*
24	**GRB Notification Time To Spacecraft** [6]		< 2 sec	< 1 sec	< 5 sec	GRBs
25	**Dead Time Average**		< 10 μsec/event	< 3 μsec/event	< 50 μsec/event	GRBs
26	**Instrument Time Accuracy** [7]	10 μsec	< 10 μsec	< 2 μsec	< 30 μsec	GRBs
27	**Burst Sensitivity** [8]	0.2 cm^{-2} s^{-1}	< 0.5 cm^{-2} s^{-1}	< 0.3 cm^{-2} s^{-1}	< 1.0 cm^{-2} s^{-1}	GRBs

GBM Instrument Requirements: Footnotes

1 Requirement = value to design to; Goal = value to strive for to enhance science; Minimum = value that if not satisfied triggers a Project review.

2 Integral of effective area over solid angle divided by peak effective area. Geometric factor is Field of View times Effective Area. Should overlap with LAT FOV.

3 Equivalent Gaussian. 1 sigma. On axis.

4 NA= Not Applicable. The addition of the GRB monitor was a "goal" in the AO 99-OSS-03. The broad-band spectroscopic capability of the GRB instrument is upgraded here to be a requirement. The location of the bursts is listed only as a goal.

5 1 sigma radius. For burst of brightness 10.0 cm^{-2} s^{-1} in 50 - 300 keV band and a duration of 1 second or longer.

6 Time relative to a GBM GRB trigger. Used for both 'rapid ground notification' or 'burst alert' through TDRSS (or equivalent real-time link) and for 'LAT notification'.

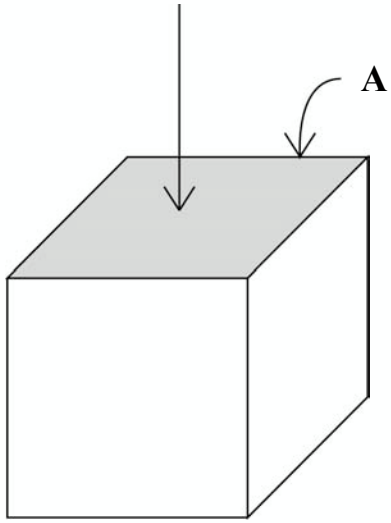
7 Relative to spacecraft time.

8 GRB peak brightness sensitivity, 50 - 300 keV range 5 sigma detection.

Definition of Terms

- **Effective Area:**

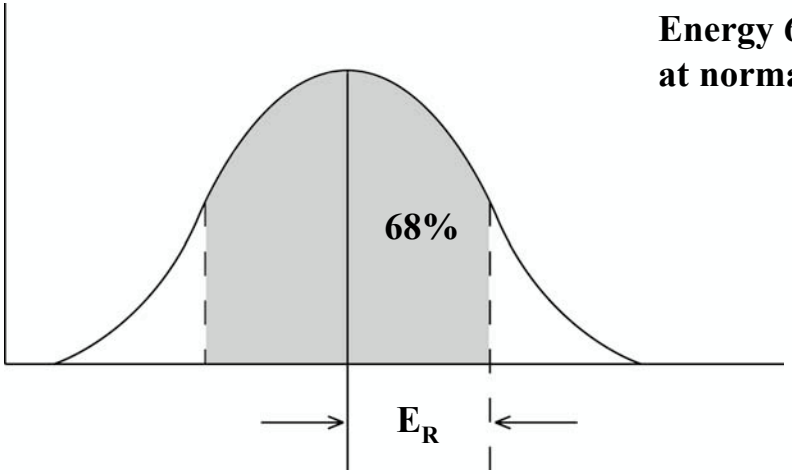
  A_{eff}



Area at normal incidence
times detection efficiency.

- **Energy Resolution:**

  E_R

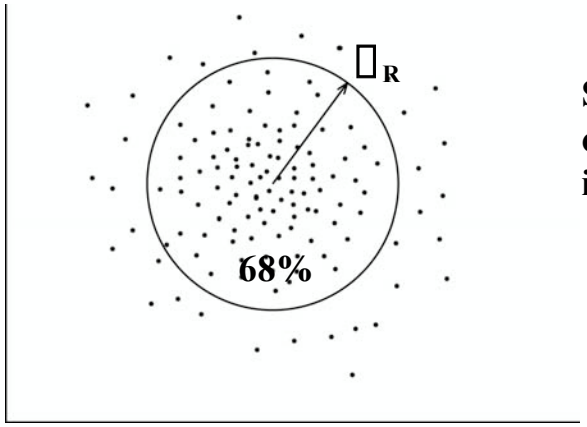


Energy 68% spread
at normal incidence.

Definition of Terms

- **Angular Resolution:**

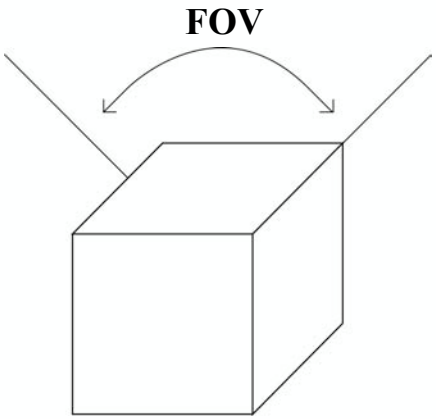
  θ_R



Space angle for 68% containment at normal incidence.

- **Field of View:**

  FOV



Integral effective area over solid angle divided by peak effective area.

- **Sensitivity:**

Flux of weakest source that can be detected at 5 sigma significance.

Project SRD

Approved by:

Jonathan F. Ormes 9/23/00
Jonathan Ormes Date
GLAST Project Scientist

9/23/00
Scott Lambros Date
GLAST Project Manager

9/23/00
Peter Michelson Date
LAT Principal Investigator

9/23/00
Charles Meegan Date
GBM Principal Investigator

Project SRD

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