



Fermi

Gamma-ray Space Telescope



Fermi

Gamma-ray Space Telescope

Mission Overview and Data Release Plans

Tokyo Symposium

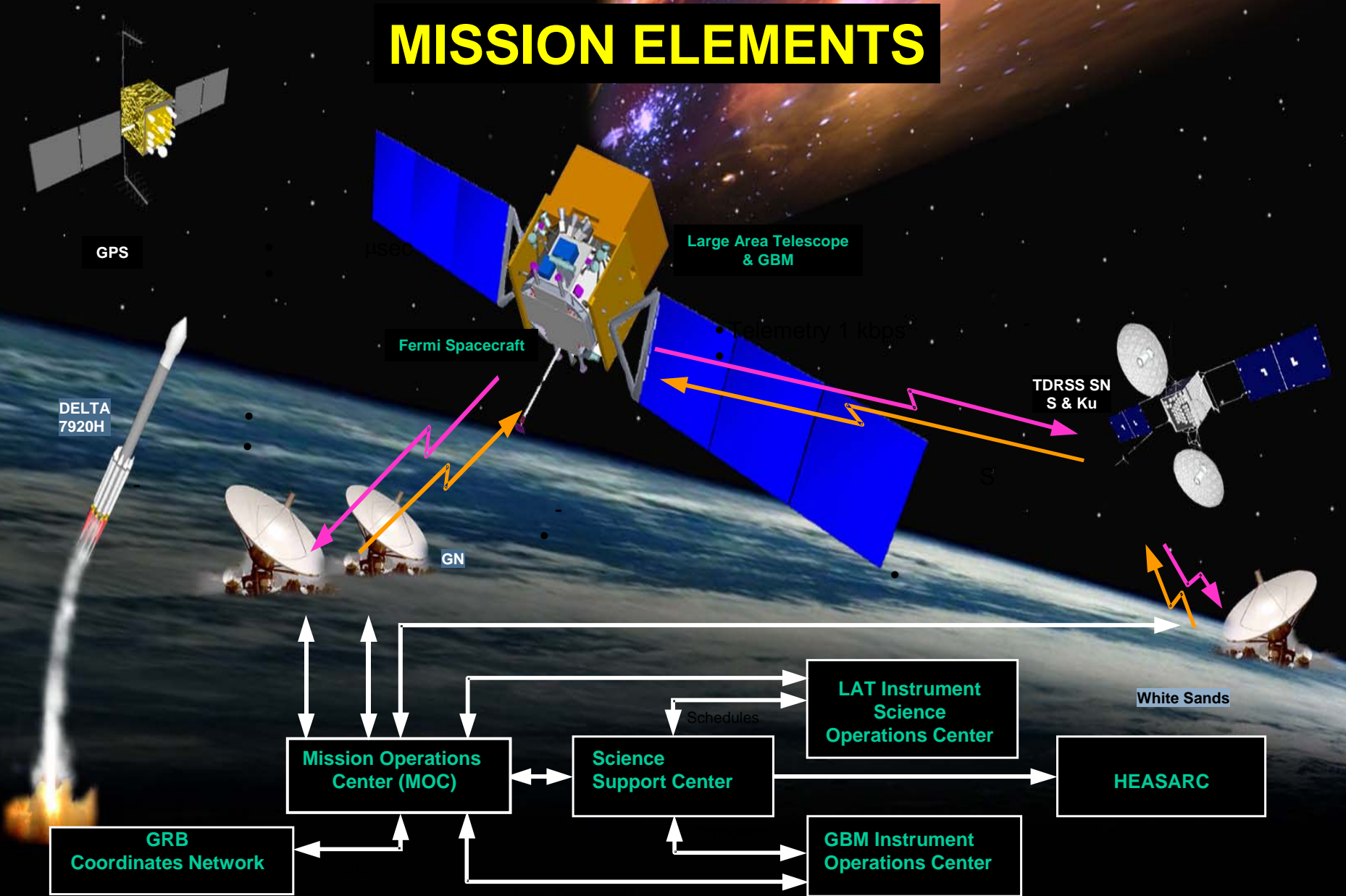
S. Ritz

NASA GSFC

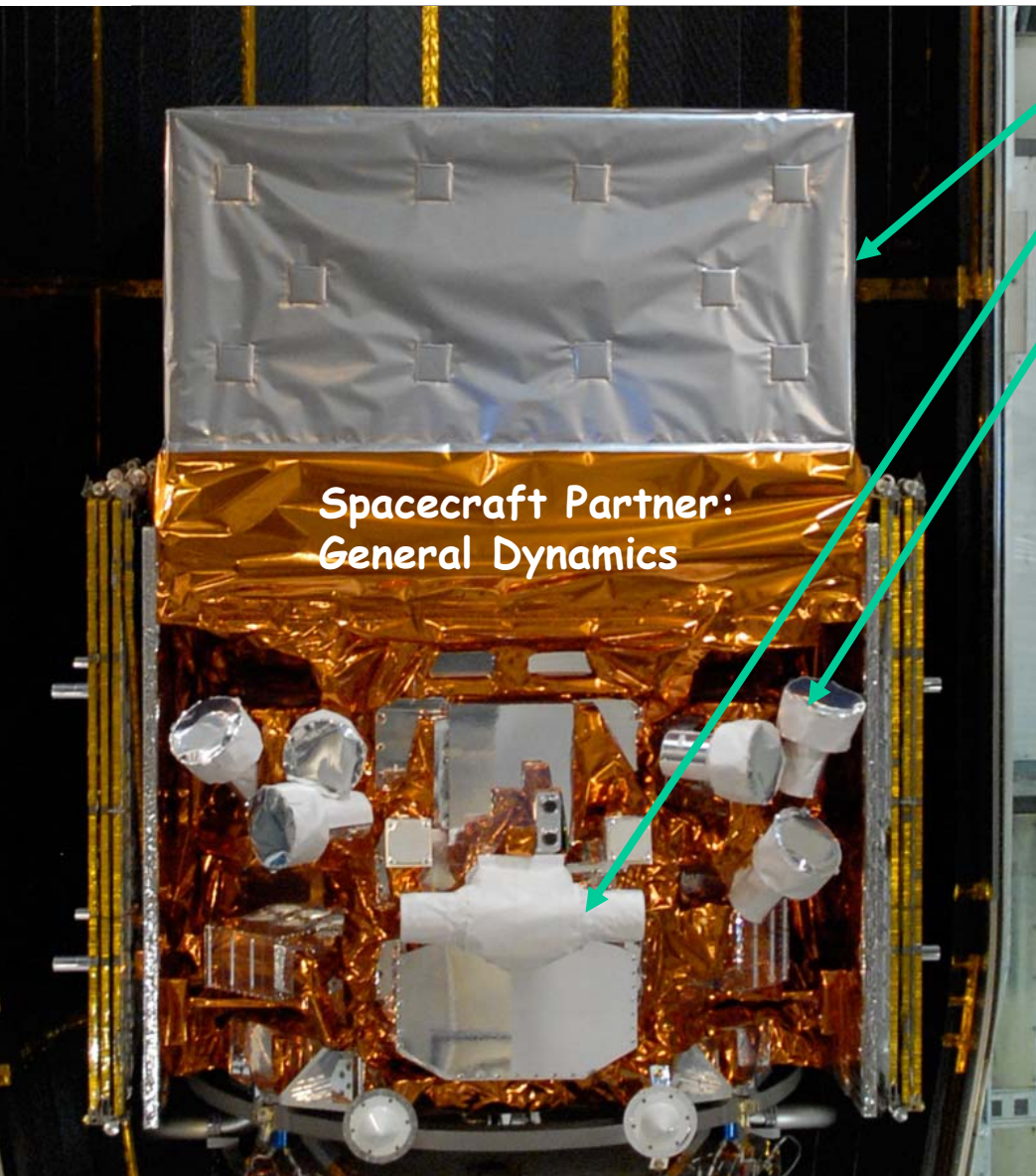
on behalf of the Fermi Mission Team

see <http://www.nasa.gov/fermi> and <http://fermi.gsfc.nasa.gov/> and links therein

MISSION ELEMENTS



The Observatory



Large Area Telescope (LAT)
20 MeV - >300 GeV

Gamma-ray Burst Monitor (GBM)
NaI and BGO Detectors
8 keV - 30 MeV

KEY FEATURES

- **Huge field of view**
 - LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours.
 - GBM: whole unocculted sky at any time.
- Huge energy range, including largely unexplored band 10 GeV - 100 GeV. **Total of >7 energy decades!**
- Large leap in all key capabilities. Great discovery potential.
- 5-year mission (10-year goal)

Prior to Fairing Installation





The Accelerator



Launch!

- **Launch from Cape Canaveral Air Station 11 June 2008 at 12:05PM EDT**
- **Circular orbit, 565 km altitude (96 min period), 25.6 deg inclination.**



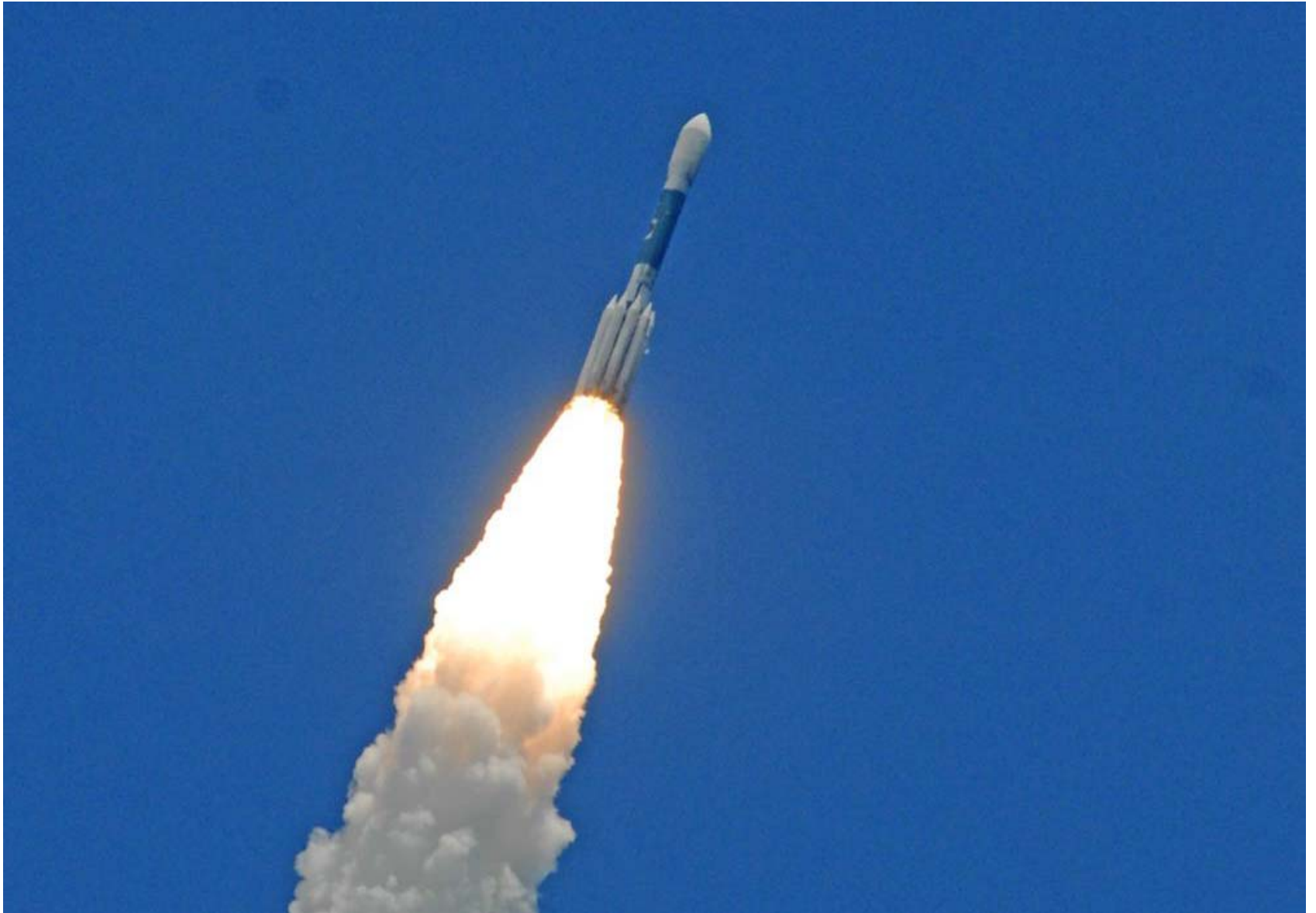
A moment later...



... and then ...

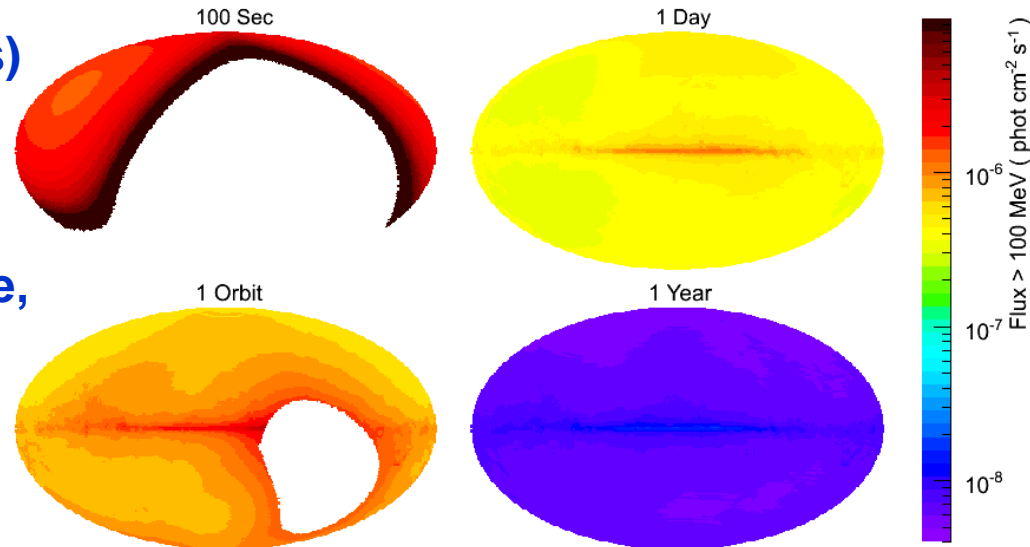


... on its way!



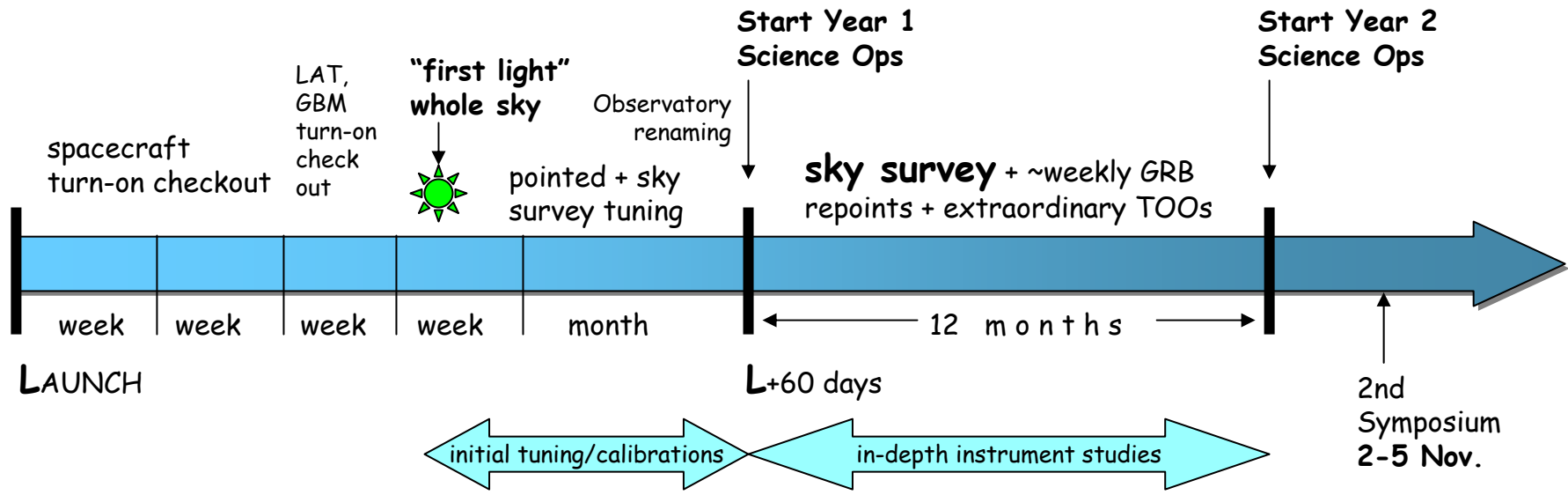
Operating modes

- **Primary observing mode is Sky Survey**
 - Full sky every 2 orbits (3 hours)
 - Uniform exposure, with each region viewed for ~30 minutes every 2 orbits
 - Best serves majority of science, facilitates multiwavelength observation planning
 - Exposure intervals commensurate with typical instrument integration times for sources
 - EGRET sensitivity reached in days

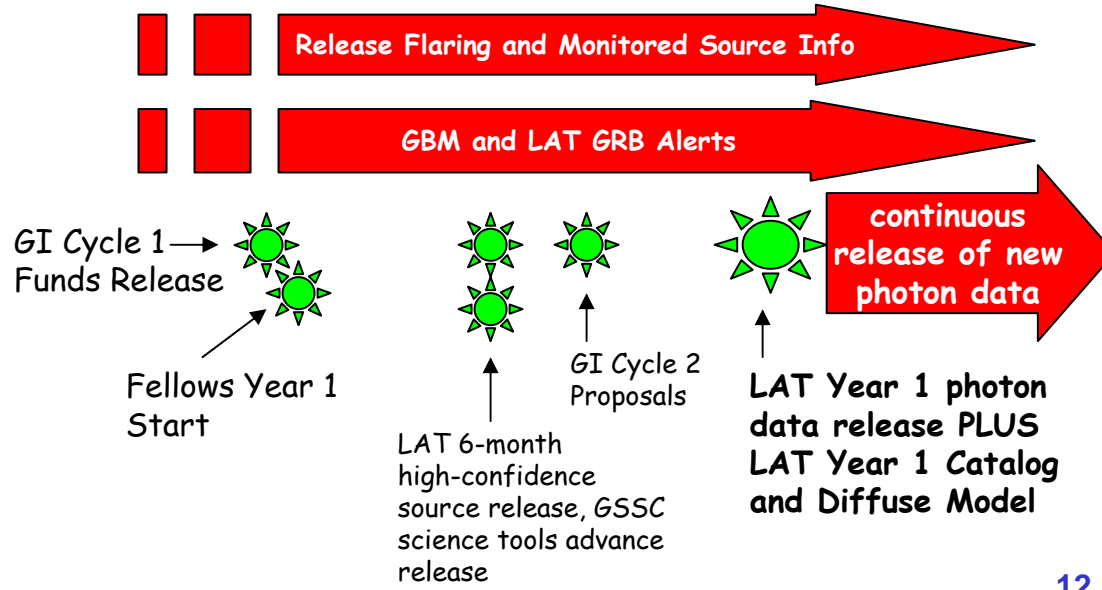


- Pointed observations when appropriate (selected by peer review in later years) with automatic earth avoidance selectable. Target of Opportunity pointing.
- Autonomous repoints for onboard GRB detections in any mode.

Year 1 Science Operations Timeline Plan



Thus far:
~20 Atels on flaring sources
>100 GRB alerts (GCN)



Fermi Science

A very broad menu that includes:

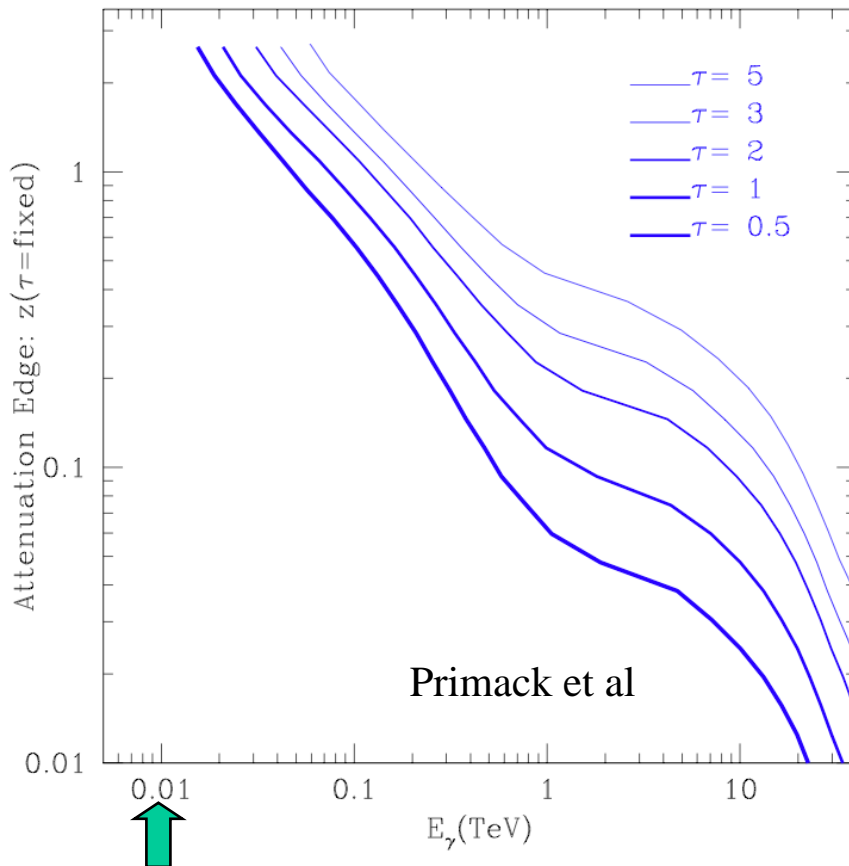
- **Systems with supermassive black holes (Active Galactic Nuclei)**
- **Gamma-ray bursts (GRBs)**
- **Pulsars**
- **Supernova remnants (SNRs), PWNe, Origin of Cosmic Rays**
- **Diffuse emissions**
- **Solar physics**
- **Probing the era of galaxy formation, optical-UV background light**
- **Solving the mystery of the high-energy unidentified sources**
- **Discovery! New source classes. Particle Dark Matter? Other relics from the Big Bang? Other fundamental physics checks.**

Huge increment in capabilities.

Draws the interest of both the High Energy Particle Physics and High Energy Astrophysics communities.

An Important Energy Band

Photons with $E > 10$ GeV are attenuated by the diffuse field of UV-Optical-IR extragalactic background light (EBL)



No significant attenuation below ~ 10 GeV.

only $e^{-\tau}$ of the original source flux reaches us

EBL over cosmological distances is probed by gammas in the 10-100 GeV range.

In contrast, the TeV-IR attenuation results in a flux that may be limited to more local (or much brighter) sources.

A dominant factor in EBL models is the star formation rate -- attenuation measurements can help distinguish models.

Science Support Center (FSSC)

- **Supports guest investigator program**
- **Provides training workshops**
- **Provides data, software, documentation, workbooks to community**
- **Archives to HEASARC**
- **Joint software development with Instrument Teams, utilizing HEA standards**
- **Located at Goddard**

see <http://fermi.gsfc.nasa.gov/ssc/>

and help desk

<http://fermi.gsfc.nasa.gov/ssc/help/>

LAT First Year Source Monitoring List

http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html

Light curves (daily and weekly integrations) in energy bands.

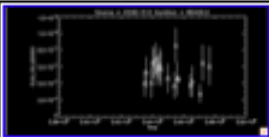
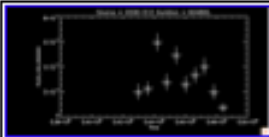
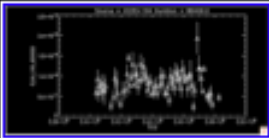
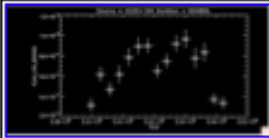
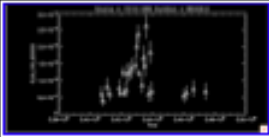
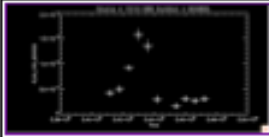
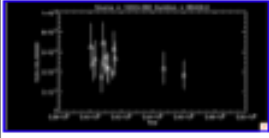
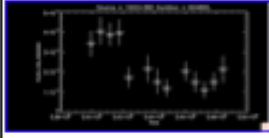
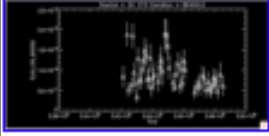
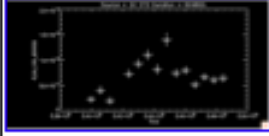
PLUS, same for any source flaring above $2e-6$ ph/cm²/s (lowering this now) until the average flux drops below $2e-7$ ph/cm²/s (two additional sources thus far: PKS 1454 and PKS 1502)

A "quicklook" analysis to get the results out as soon as possible. Tables may be updated as analysis and calibrations improve.

Updates now delivered daily!

Source Type	Source Name	EGRET Name	Average or Min. Flux (10^{-8} γ cm ⁻² s ⁻¹)	Galactic Latitude	Redshift	TeV Source
Blazar	0208-512	3EGJ0210-5055	85.5 \pm 4.5	-61.9	1.003	
	0235+164	3EGJ0237+1635	65.1 \pm 8.8	-39.1	0.94	
	PKS 0528+134	3EGJ0530+1323	93.5 \pm 3.6	-11.1	2.060	
	PKS 0716+714	3EGJ0721+7120	17.8 \pm 2.0	28	0.3	
	0827+243	3EGJ0829+2413	24.9 \pm 3.9	31.7	0.939	
	OJ 287	3EGJ0853+1941	10.6 \pm 3.0	35.8	0.306	
	Mrk 421	3EGJ1104+3809	13.9 \pm 1.8	65.0	0.031	Yes
	W Com 1219+285	3EGJ1222+2841	11.5 \pm 1.8	83.5	0.102	
	3C 273	3EGJ1229+0210	15.4 \pm 1.8	64.5	0.158	
	3C 279	3EGJ1255-0549	74.2 \pm 2.8	57.0	0.538	
	1406-076	3EGJ1409-0745	27.4 \pm 2.8	50.3	1.494	
	H 1426+428	NA		64.9	0.129	Yes
	1510-089	3EGJ1512-0849	18.0 \pm 3.8	40.1	0.36	
	PKS 1622-297	3EGJ1625-2955	47.4 \pm 3.7	13.4	0.815	
	1633+383	3EGJ1635+3813	58.4 \pm 5.2	42.3	1.814	
	Mrk 501	NA		38.9	0.033	Yes
	1730-130 NRAO 530	3EGJ1733-1313	36.1 \pm 3.4	10.6	0.902	
	1ES 1959+650	NA		17.7	0.048	Yes
	PKS 2155-304	3EG2158-3023	13.2 \pm 3.2	-52.2	0.116	Yes
	BL Lacertae (2200+420)	3EGJ2202+4217	39.9 \pm 11.6	-10.4	0.069	Yes
3C 454.3	3EGJ2254+1601	53.7 \pm 4.0	-38.3	0.859		
1ES 2344+514	NA		-9.9	0.044	Yes	
HMXB	LSI+61 303 2CG135+01	3EGJ0241+6103	69.3 \pm 6.1	1.0		Yes

Released Monitored Source Lightcurves

Source	RA	Dec	Daily	Weekly
0208-512	32.6930	-51.0170	 (lc)	 (lc)
0235+164	39.6620	16.6160	 (lc)	 (lc)
1510-089	228.170	-8.83000	 (lc)	 (lc)
1633+382	248.815	38.1350	 (lc)	 (lc)
3C 273	187.278	2.05200	 (lc)	 (lc)

Fermi Science Support Center

HOME RESOURCES PROPOSALS DATA HEASARC HELP

+ FSSC Home

Data

Data Policy

Data Access

+ LAT Data

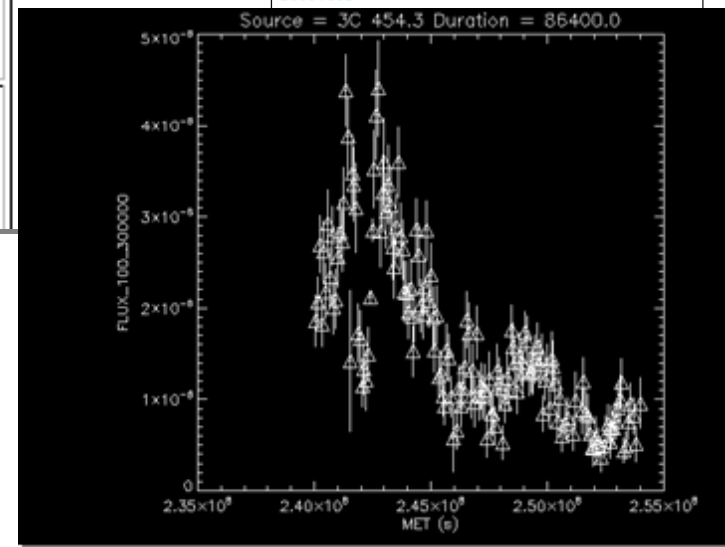
+ GBM Data

Data Analysis

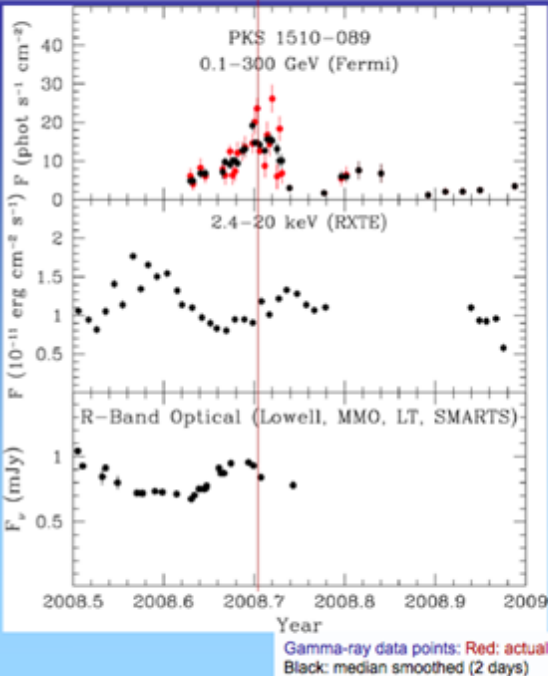
Newsletter

Monitored Source List Light Curves

Source	RA	Dec
0208-512 <ul style="list-style-type: none"> > Daily Light Curve > Daily Light Curve Fits File > Weekly Light Curve > Weekly Light Curve Fits File 	32.6930	-51.0170
0235+164 <ul style="list-style-type: none"> > Daily Light Curve > Daily Light Curve Fits File > Weekly Light Curve > Weekly Light Curve Fits File 	39.6620	16.6160
1406-076 <ul style="list-style-type: none"> > Weekly Light Curve > Weekly Light Curve Fits File 	212.235	-7.87400
1510-089 <ul style="list-style-type: none"> > Daily Light Curve > Daily Light Curve Fits File > Weekly Light Curve > Weekly Light Curve Fits File 	228.170	-8.83000
1633+382	248.815	38.1350
	187.278	2.05200



The Quasar PKS 1510-089: Results from Fermi & RXTE



Coincident X-ray & gamma-ray flare at 2008.7

- Gamma-ray flare peaks 1-2 weeks before X-ray flare

- Optical flare peaks first, then gamma-ray and then X-ray

→ Stratification in frequency/energy (of ν_s), SSC light-travel delays

Superluminal knot ejected at 2008.52

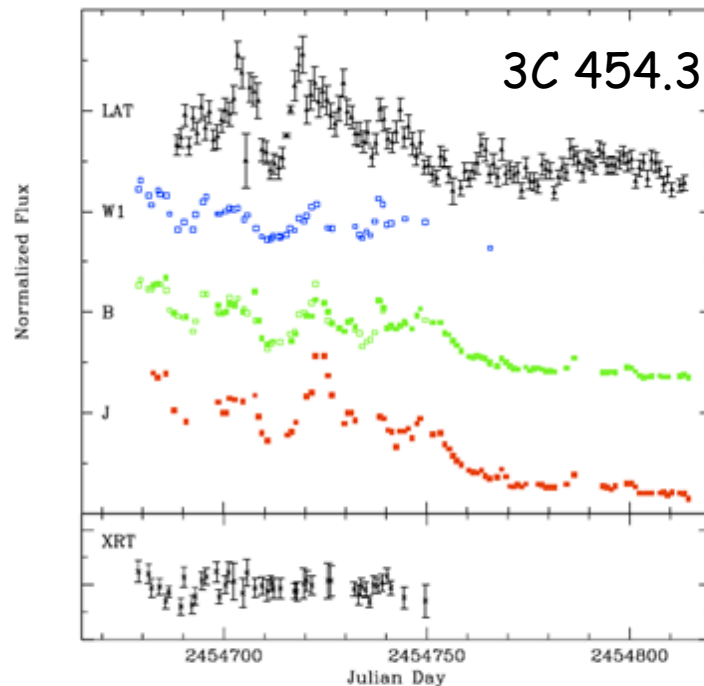
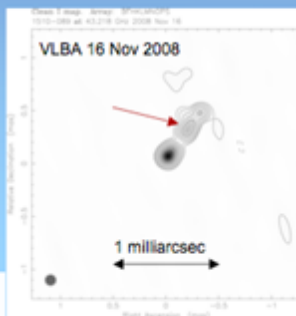


FIG. 1.— Multi-wavelength light curves of 3C 454.3 at (top panel) gamma-ray (0.1-300 GeV), UV (W1), optical (B), and IR (J) wavelengths from Fermi LAT, Swift UVOT, and SMARTS. Fluxes have been normalized to JD 2454700. Light curves are offset for clarity; minor tick spacing corresponds to 50% change. Fluxes at JD 2454700 are 2.83×10^{-6} cts s^{-1} at 0.1-300 GeV, 1.64×10^{-11} erg s^{-1} cm^{-2} in W1, 2.21×10^{-11} erg s^{-1} cm^{-2} in B, and 3.62×10^{-11} erg s^{-1} cm^{-2} in J. (Bottom panel) Swift XRT 2-10 keV light curve, normalized to flux at JD 2454700 (2.50×10^{-11} erg s^{-1} cm^{-2}). The IR/optical/UV variations are well correlated with the gamma-ray variations, with a lag of $\lesssim 1$ day, while the (minimal) X-ray variability is uncorrelated. The variability has much higher amplitude in the J-band than in B, which can be explained if there is an relatively constant blue component, as expected for an accretion disk. At $z=0.859$, Balmer continuum from an accretion disk, as well as Fe II and Mg II emission lines would be redshifted into the B and V bands; H α is shifted into the J band.

Marscher et al

Demonstrates the value of multiwavelength observations with Fermi data

Bonning et al arXiv:0812.4582v1

For campaigners' information and coordination, see <http://fermi.gsfc.nasa.gov/science/multi>

Observatory Data and GBM Data

- Predicted spacecraft position and attitude (where Fermi will be pointing)
- <http://fermi.gsfc.nasa.gov/ssc/resources/timeline/ft2/>

- **GBM Trigger table and associated data**
 - Position, trigger time and classification; Files containing count lists and binned counts.
- **GBM Burst table**
 - as above, plus further information including fluxes, fluences, T90/T50 when available.
- **GBM daily data**
 - detector count rates, monitoring of detector calibrations and spacecraft position and attitude.
- Some of the data are produced manually (e.g. response matrices and background spectra in the GBM trigger table) so may not be available as quickly as the automatically processed data types.
- **Summary of all LAT-detected GRB**
 - <http://fermi.gsfc.nasa.gov/ssc/resources/observations/grbs/>

LAT GRB Summary Info

Fermi » LAT GRB Table

http://fermi.gsfc.nasa.gov/ssc/resources/observations/grbs/grb_table/

Most Visited ▾ Getting Started Latest Headlines ↗

Fermi LAT GRB Table

Fermi SSC Home » LAT GRB Search

- 5 bursts met your search criteria.
- Database last updated: Thursday, February 19, 2009, 14:08:46 EST
- Download this table as a tab-delimited text file: [grb_table_1236331235.txt](#)

GRB	Time [UT]	Trigger Number	LAT RA (J2000)	LAT Dec (J2000)	LAT Counts	LAT Burst Advocate	GBM RA (J2000)	GBM Dec (J2000)	GBM Fluence [10^{-5} erg/cm ² /s]
090217	04:56:51	256539404	204.9 13:39:36.0	-8.4 08:24:00.0	n/a	Masanori Ohno	211.9 14:07:36.0	-2.8 02:48:00.0	3.08
081215A	18:48:36.85	251059717	TBD 00:00:00.0	TBD 00:00:00.0	TBD	Julie McEnery	135.0 09:00:00.0	53.8 53:48:00.0	5.44
081024B	21:22:41	246576161	322.9 21:31:36.0	21.204 21:12:14.4	n/a	Nicola Omodei	n/a	n/a	0.034
080916C	00:12:45	243216766	119.88 07:59:31.2	-56.59 56:35:24.0	n/a		121.8 08:07:12.0	-61.3 61:18:00.0	19
080825C	14:13:48	241366429	233.96 15:35:50.4	-4.72 04:43:12.0	n/a		232.2 15:28:48.0	-4.9 04:54:00.0	2.4

* All numbers are preliminary and may be revised as we do reprocessing (s/w improvements, thinking/experience improvements). Users are encouraged to view the actual GCN circulars for burst details.

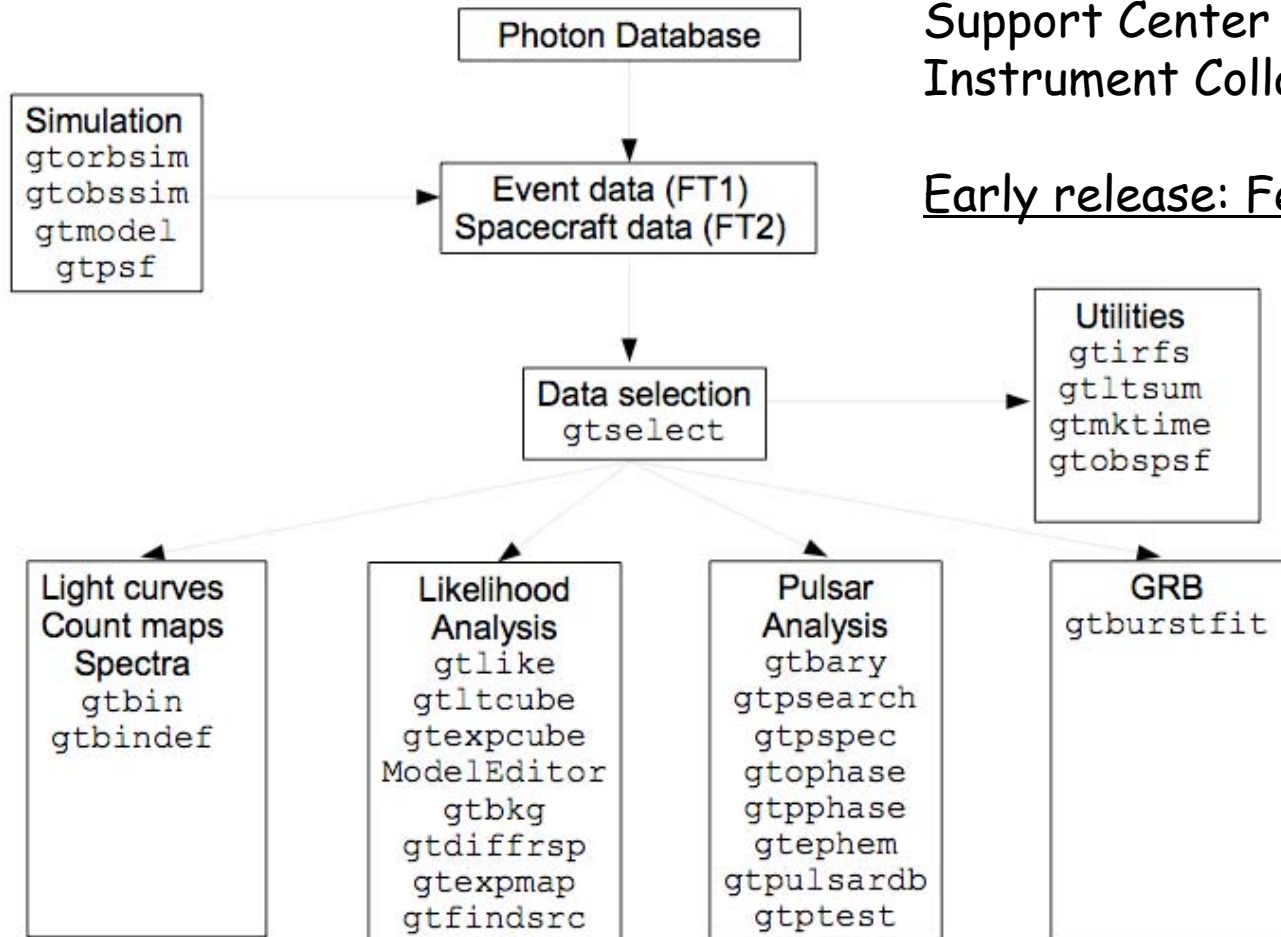
Fermi SSC Home » LAT GRB Search

Summary information - trigger time, sky position, net counts, GBM fluence - available online

Tools With the Photon Data

Developed jointly by Science Support Center and Instrument Collaborations

Early release: February '09



Guest Investigator Cycle 2

Guest Investigator **Cycle 2 proposals DUE March 6, 2009**

See <http://fermi.gsfc.nasa.gov/ssc/proposals/cycle2/>

- expect to fund ~75 regular and up to 8 large projects:
 - detailed analyses of LAT photon candidate events
 - analyses of monitored sources and summary data
 - Fermi-related MW observations
 - In addition, NRAO and NOAO MOUs provide joint observing time through the regular Fermi GI program. See FSSC site.
 - Fermi-related theory
 - Fermi-relevant data analysis methodology

Symposium

<http://fermi.gsfc.nasa.gov/science/symposium/2009/>

- **2-5 November 2009**
- **International Organizing Committee Established**
- **Local Organizing Committee completing formation.**
 - **D. Thompson and N. Johnson, co-chairs**

2009 Fermi Symposium

2-5 November 2009
Hyatt Regency Washington, Capitol Hill



International Organizing Committee

W. Atwood (UCSC)
R. Bellazzini (Pisa)
R. Blandford (Stanford/KIPAC)
E. Bloom (SLAC)
P. Caraveo (INAF-IASF, Milano)
V. Connaughton (UA Huntsville)
C. Dermer (NRL)
N. Gehrels (GSFC)
J. Greiner (MPE)
I. Grenier (Laboratoire AIM, Saclay)
D. Horan (LLR)
B. Jannuzi (NOAO)
S. Johnston (ATNF)
N. Kawai (Tokyo)
P. Michelson (Stanford)
A. Marscher (BU)
J. McEnery (GSFC)
J. Ormes (Denver)
W. Paciesas (UA Huntsville)
A. Readhead (Caltech)
S. Ritz (GSFC)
J. Ulvestad (NRAO)
S. Wagner (Heidelberg)

Summary

- **Fermi is off to a great start!**
 - instruments are beautiful. The gamma-ray sky is keeping its promise. Great cooperation across the international team.
- Already addressing many important questions from EGRET era
 - new analysis techniques and approaches are essential -- new topics!
 - the challenge of great discovery potential
- **Charter Fermi Fellows:**
 - » Nathaniel R. Butler (Berkeley)
 - » Vasiliki Pavlidou (Caltech)
 - » Uri Keshet (Harvard)
 - Now transitioning to Einstein Fellows program
- **Guest Investigator Cycle 2 proposals DUE March 6, 2009**
 - See <http://fermi.gsfc.nasa.gov/ssc/proposals/cycle2/>
- **November 2-5 2009 International Fermi Symposium in Washington, DC**
- let us hear from you (helpdesk email on the FSSC site)
- **Gamma-ray data are for you! JOIN THE FUN!!**

Sign up for newsletters:
<http://fermi.gsfc.nasa.gov/ssc/resources/newsletter/>



The Decadal Survey Process: Astro2010

The three pillars of the survey

- Science Assessment
- State of the Profession Assessment
- Prioritization

Committee on Astro2010

Roger Blandford, Chair, Stanford University

Lynne Hillenbrand, Executive Officer, California Institute of Technology

Subcommittee on Science

Martha P. Haynes, Vice Chair – Science Frontiers, Cornell University

Lars Bildsten, University of California, Santa Barbara

John E. Carlstrom, The University of Chicago

Fiona A. Harrison, California Institute of Technology

Timothy M. Heckman, Johns Hopkins University

Jonathan I. Lunine, University of Arizona

Juri Toomre, University of Colorado at Boulder

Scott D. Tremaine, Institute for Advanced Study

Subcommittee on State of the Profession

John P. Huchra, Vice Chair – State of the Profession, Harvard-University

Debra M. Elmegreen, Vassar College

Joshua Frieman, Fermi National Accelerator Laboratory

Robert C. Kennicutt, Jr., University of Cambridge

Dan McCammon, University of Wisconsin-Madison

Neil de Grasse Tyson, American Museum of Natural History

Subcommittee on Programs

Marcia J. Rieke, Vice Chair – Program Prioritization, University of Arizona

Steven J. Battel, Battel Engineering

Claire E. Max, University of California, Santa Cruz

Steven M. Ritz, NASA Goddard Space Flight Center

Michael S. Turner, The University of Chicago

Paul Adrian Vanden Bout, National Radio Astronomy Observatory

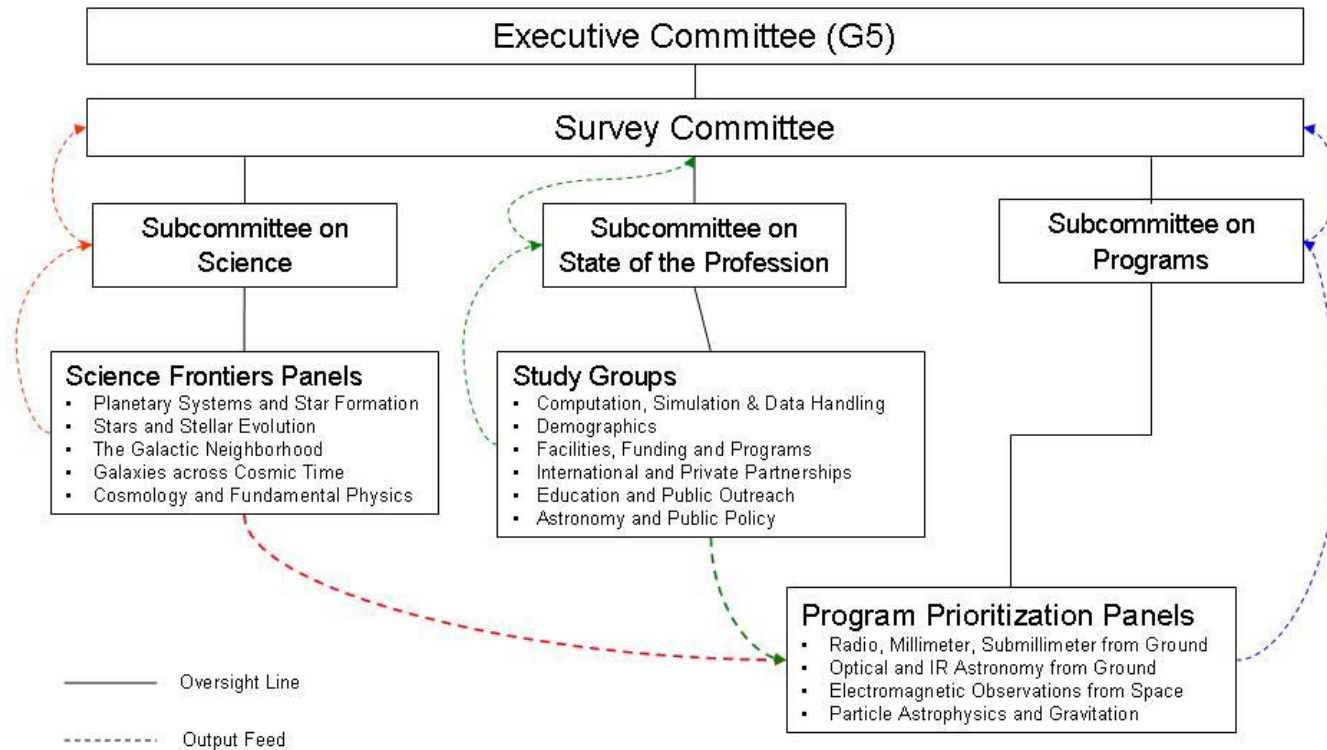
A. Thomas Young, Lockheed Martin Corporation [Retired]

Astro2010 Charge

- **The Astro2010 committee will survey the field of space- and ground-based astronomy and astrophysics, recommending priorities for the most important scientific and technical activities of the decade 2010-2020.**
- **The principal goals of the study will be to carry out an assessment of activities in astronomy and astrophysics, including both new and previously identified concepts, and to prepare a concise report that will be addressed to the agencies supporting the field, the Congressional committees with jurisdiction over those agencies, the scientific community, and the public.**

Astro2010 Structure

Astro2010 Structure



More detail available at www.nationalacademies.org/astro2010

Science Frontier Panels

- Planetary Systems and Star Formation (PSF),
Lee Hartmann
- Stars and Stellar Evolution (SSE),
Roger Chevalier
- The Galactic Neighborhood (GAN),
Mike Shull
- Galaxies across Cosmic Time (GCT),
Meg Urry
- Cosmology and Fundamental Physics (CFP),
David Spergel

Infrastructure Study Groups

- **Computation, Simulation, & Data Handling (CDH)**
- **Demographics (DEM)**
- **Facilities, Funding and Programs (FFP)**
- **International and Private Partnerships (IPP)**
- **Education & Public Outreach (EPO)**
- **Astronomy & Public Policy (APP)**

Programmatic Prioritization Panels

- Radio, Millimeter and Submillimeter from the Ground (RMS)
- Optical and Infrared Astronomy from the Ground (OIR)
- Electromagnetic Observations from Space (EOS)
- Particle Astrophysics and Gravitation (PAG)

Calls for Input

The Astro2010 Survey Committee, through its Subcommittees, has issued a series of calls for information. More detail on these calls is available on the Astro2010 web site.

www.nationalacademies.org/astro2010

Recent calls include:

- Notice of Interest from Activities (now closed – 171 inputs are posted)
- Science White Papers: (now closed – 320+ inputs to be posted soon)
- State Of The Profession Position Papers: Feb17 to Mar 15, 2009.
- Technology Development White Papers: Mar 16 to Mar29, 2009

Future calls will include a request for information from activities.

Community input is welcome at any time by emailing

astro2010@nas.edu

Astro2010 Key Dates and Milestones in 2009

- **February 17 – March 15, 2009** **Submission window for State of the Profession Position Papers**
- **February 27/28, 2009** **SFP: The Galactic Neighborhood: First Meeting (Irvine CA)**
- March 2/3, 2009 SFP: Cosmology and Fundamental Physics: First Meeting (Wash, DC)
- March 2/3, 2009 SFP: Galaxies Across Cosmic Time: First Meeting (Washington, DC)
- March 9/10, 2009 SFP: Stars and Stellar Evolution: First Meeting (Washington, DC)
- March 12/13, 2009 SFP: Planetary Systems and Star Formation: First Meeting (Wash, DC)
- March 16-29, 2009 Submission window for Technology Development White Papers
- March 28/29, 2009 SFP: The Galactic Neighborhood: Second Meeting (Washington, DC)
- March 30/31, 2009 SFP: Cosmology and Fundamental Physics: Second Meeting (Wash, DC)
- April 1, 2009 Deadline for Submission of responses to RFI (issued mid Feb)
- April 2/3, 2009 SFP: Galaxies Across Cosmic Time: Second Meeting (Washington, DC)
- April 9/10, 2009 SFP: Planetary Systems and Star Formation: Second Meeting (Irvine, CA)
- April 17/18, 2009 SFP: Stars and Stellar Evolution: Second Meeting (Irvine CA)
- May 4th/5th Astro2010 town meeting and invited sessions at APS Meeting (Denv, CO)
- May 11, 2009 Closed summit meeting of Survey Committee, SFP chairs, ISG chairs, and all PPP members (Irvine CA)
- May 12/13, 2009 First meeting of the 4 PPPs (Irvine CA)
- May/June/July, 2009 [TBC] Final meetings of SFPs
- June 8-11, 2009 Second meeting of the PPPs (Pasadena CA)
- July/Aug/Sep, 2009 [TBC] Final meeting of the PPPs
- Sept-Dec, 2009 [TBC] Fourth and Fifth Survey Committee meetings