

Fermi

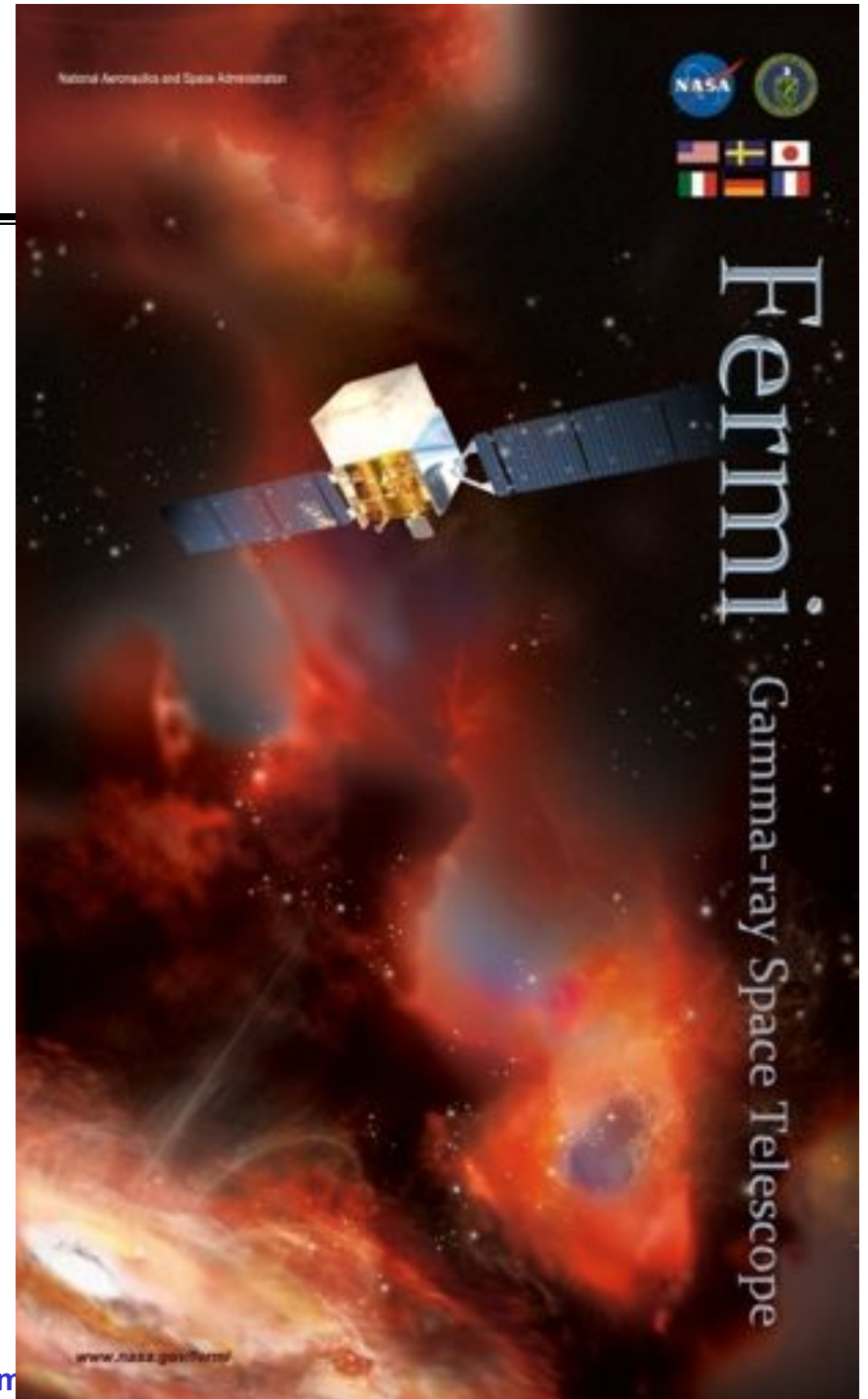
The Gamma-ray Large Area Space Telescope

Mission Status

Julie McEnery

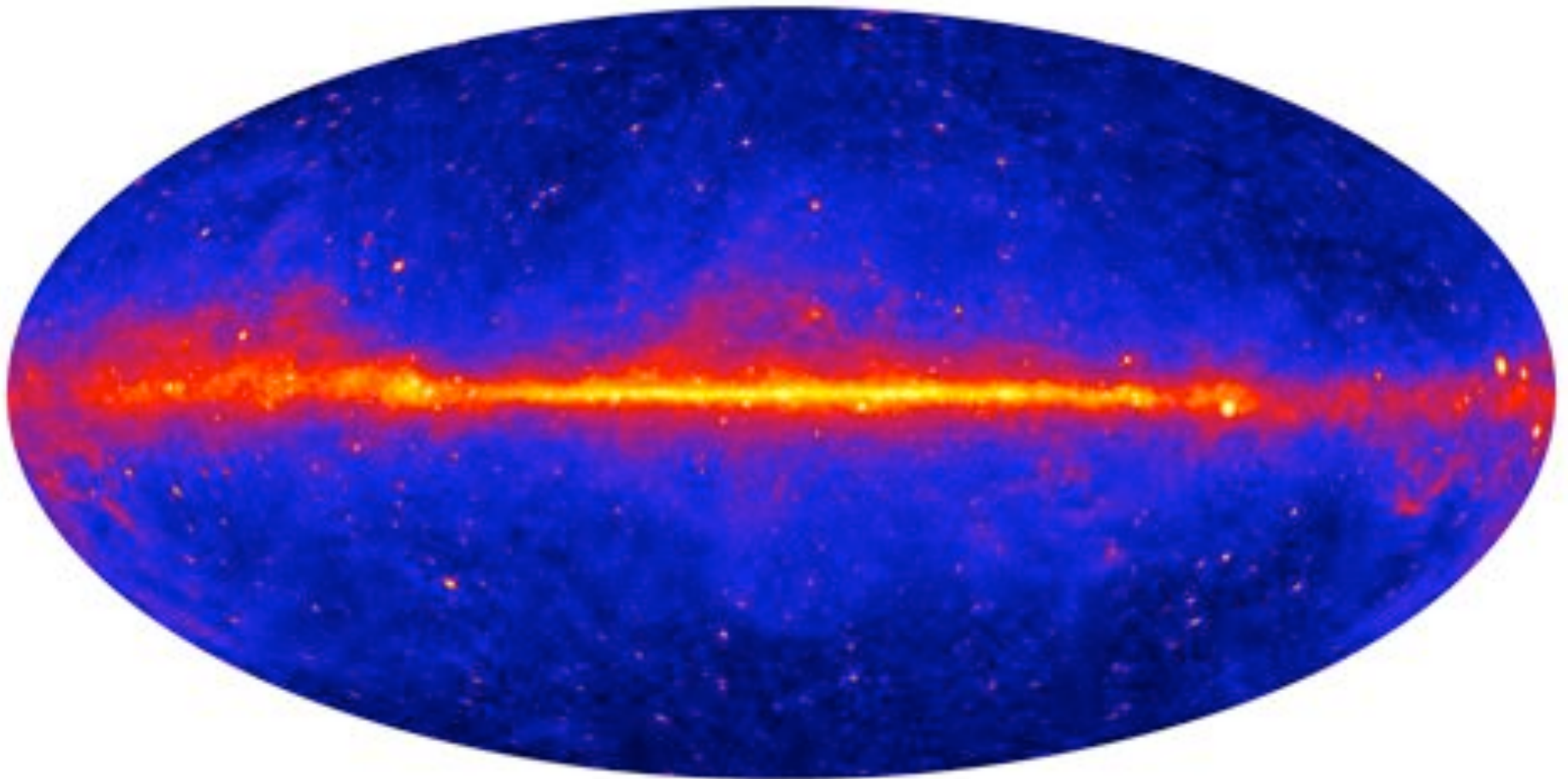
On behalf of the Fermi mission team

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

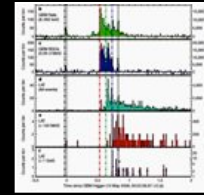
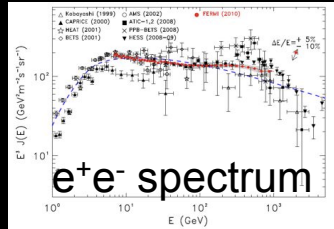


Fermi Status

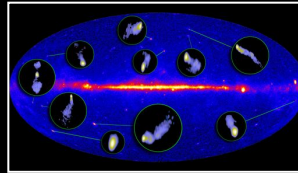
- **Observatory is operating smoothly**
 - **instruments and spacecraft operate as designed, no degradation in science performance since launch**
- **4-year sky map, >1 GeV, front converting (best psf) (4.52M events)**



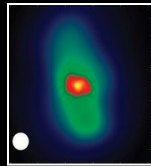
Fermi Highlights and Discoveries



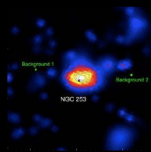
GRBs



Blazars

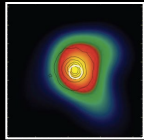
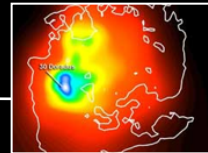


Radio Galaxies



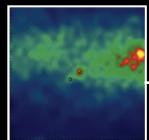
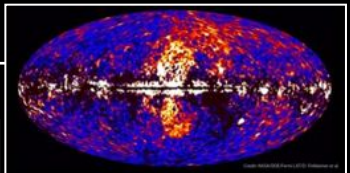
Starburst Galaxies

LMC & SMC



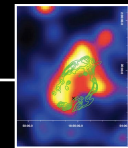
Globular Clusters

Fermi Bubbles

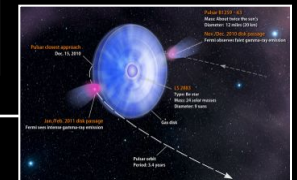


Nova

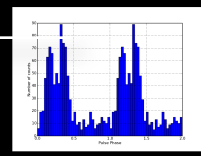
SNRs & PWN



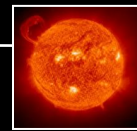
γ -ray Binaries



Pulsars: isolated, binaries, & MSPs



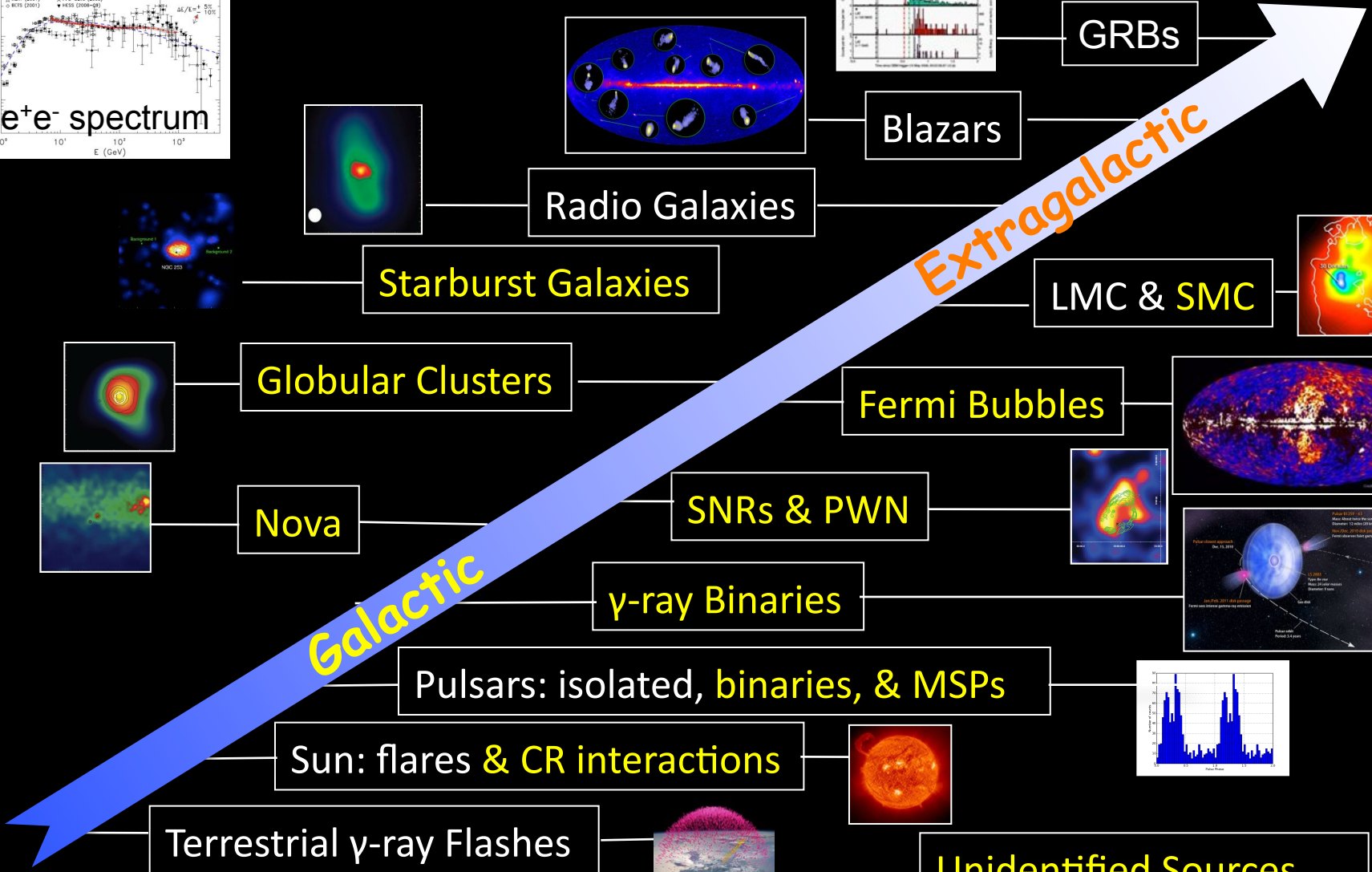
Sun: flares & CR interactions



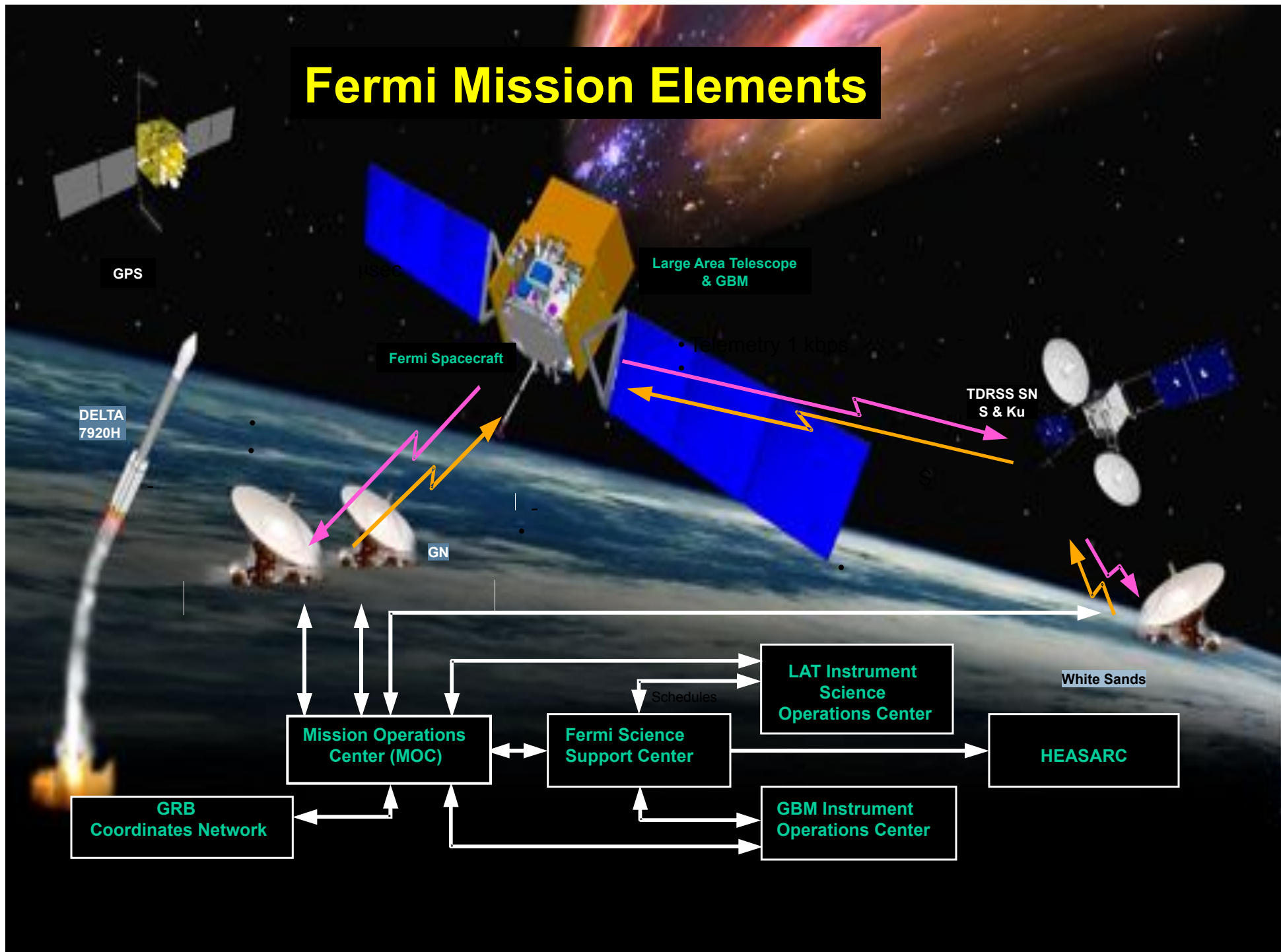
Terrestrial γ -ray Flashes



Unidentified Sources
(577/1873)



Fermi Mission Elements



All Sky Coverage



LAT exposure over
two orbits

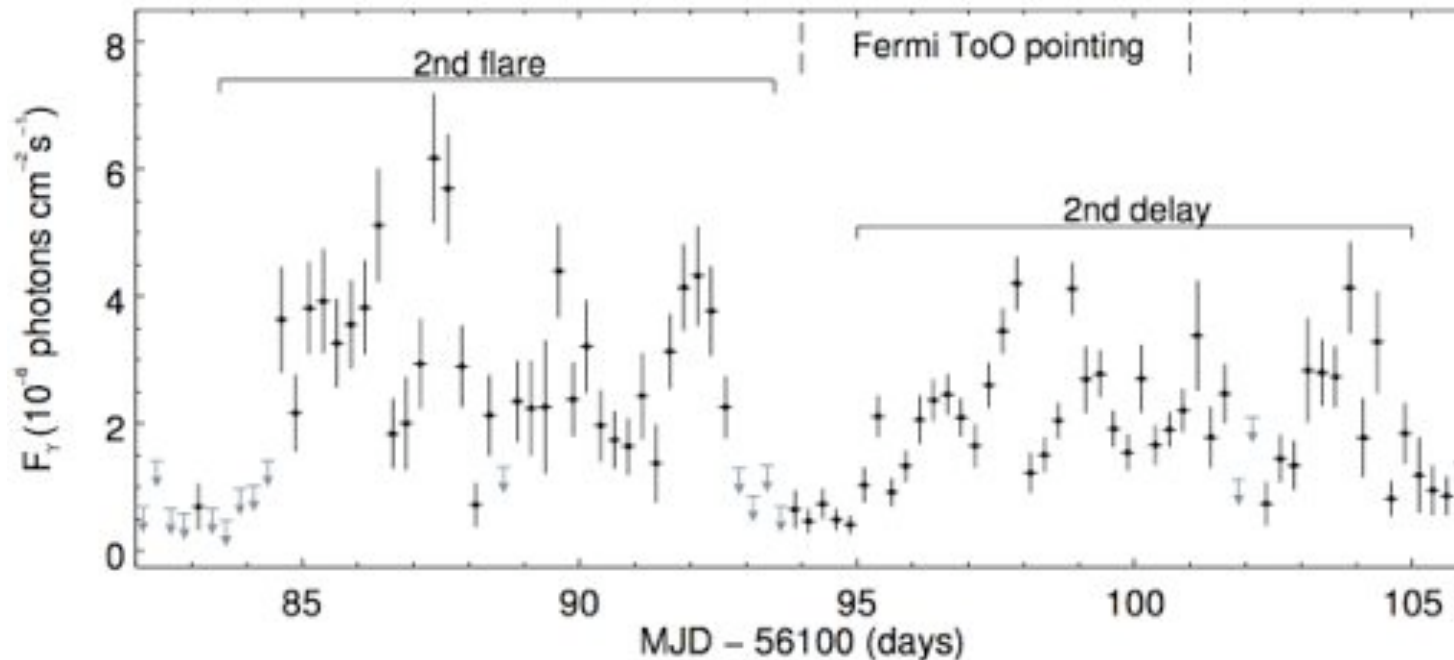
00000 seconds

- In survey mode, the LAT observes the entire sky every two orbits (~3 hours).
- Multiwavelength observations in coordination with the LAT are limited only by the ability to coordinate to other observations in other wavebands.
- Can also perform pointed observations of particularly interesting regions of the sky.
- Over 95% of observing time is all-sky survey mode

Pointed mode observations

- **Pointed mode observations can provide enhanced exposure/coverage on regions of the sky known to be interesting**
 - **Handful of pointed observations to date: Crab flares, Solar Activity, Galactic center transient searches etc**

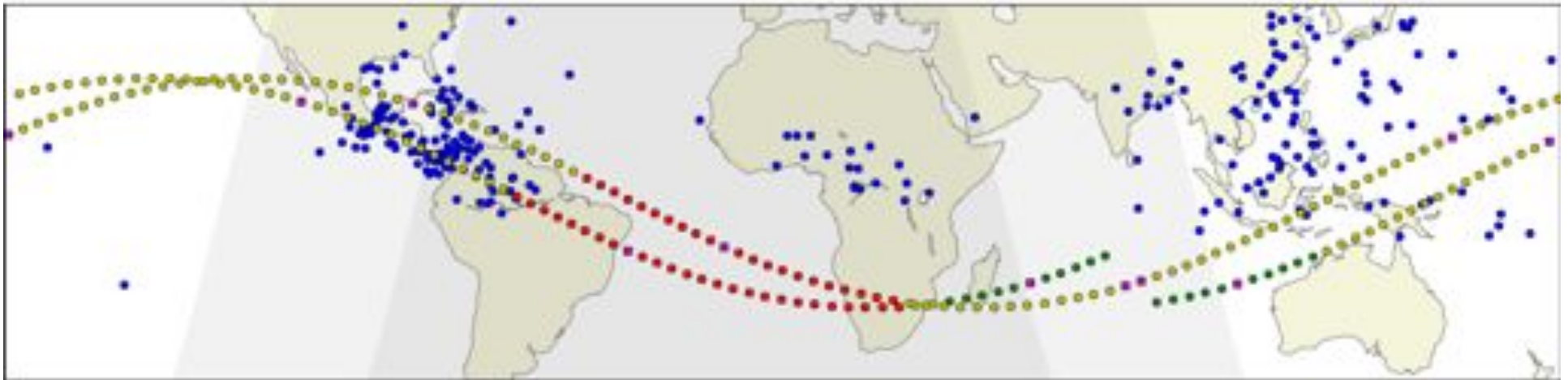
ToO on S3 0218+35 Sept 2012



From Teddy Cheung

Nadir Observations

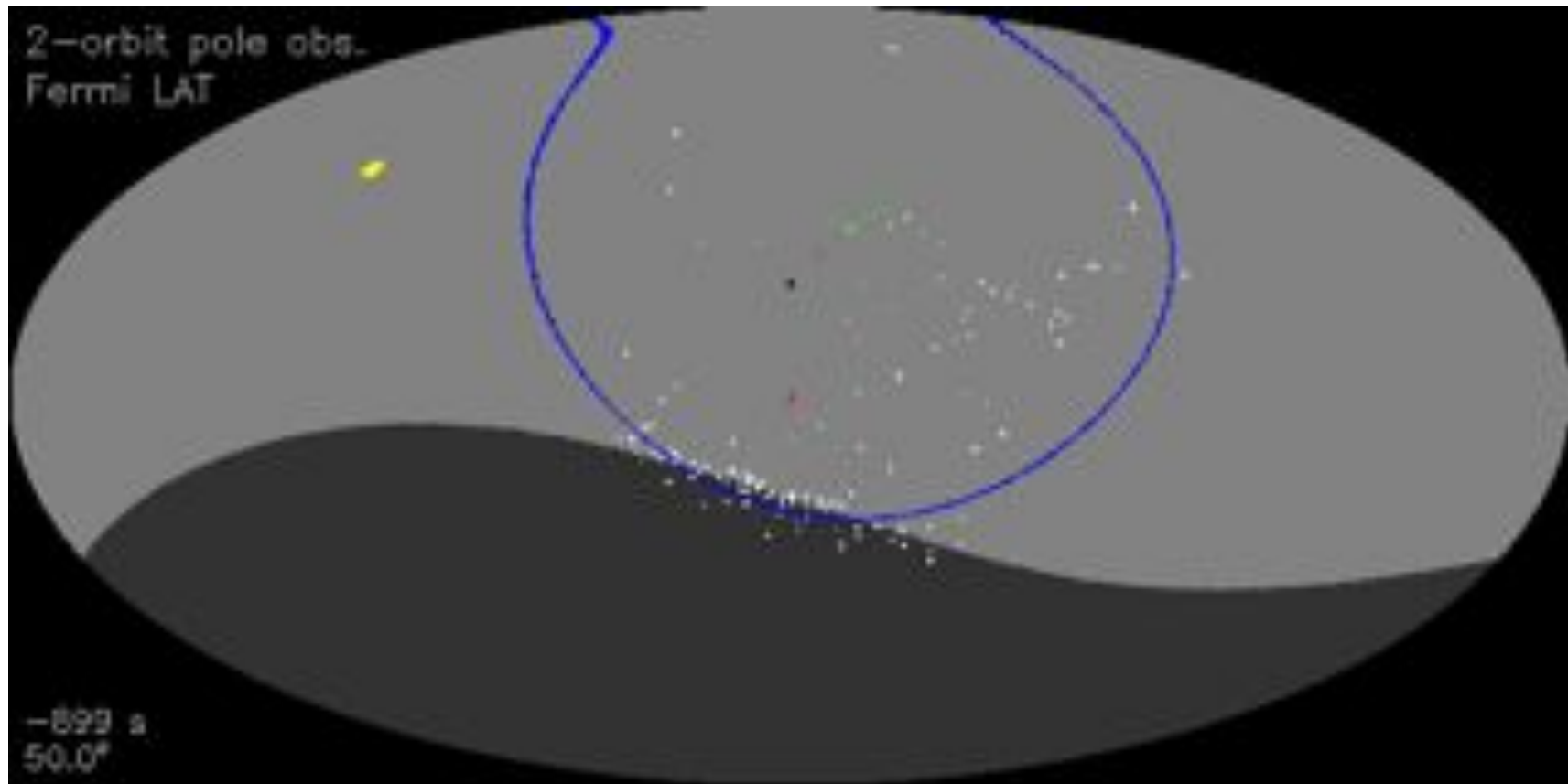
- **Point Fermi at center of Earth study high energy emission from terrestrial gamma-ray flashes (thunderstorms)**
 - Reorient to observe nadir over thunderstorm regions
 - Optimize LAT configuration for fast, bright transients



See Grove et al for more details

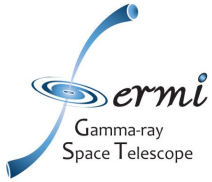
Orbit Pole

- **Weekly 3 hour observation at orbit pole**
 - **Provides regular sampling of Earth limb (bright) for calibration and monitoring**



Observations planning

- **The Science Policy Document (linked from the main Fermi users group page) describes the current policy for balance of observation modes**
 - **>70% sky survey + ARR**
 - **ARR rate is lower than originally planned, duration now shortened**
 - **<= 20% pointed mode, planned TOO, Nadir observations**
 - **None in cycles 1,2 and 3; nadir observations in cycle 4**
 - **<= 10% Mission discretionary time - MDT (unplanned TOO, time critical science observations between GI cycles, calibrations)**
 - **Crab, sun and Cyg-X3 TOOs; sun modified survey mode**
 - **Small amount of calibrations/engineering <1 day/year**
 - **Reported to FUG**
- **Unused pointed mode and MDT allocation is assigned to sky survey.**
- **It was anticipated that we may want to increase the allocation of pointed mode later in the mission – need to provide a forum for community suggestions etc**

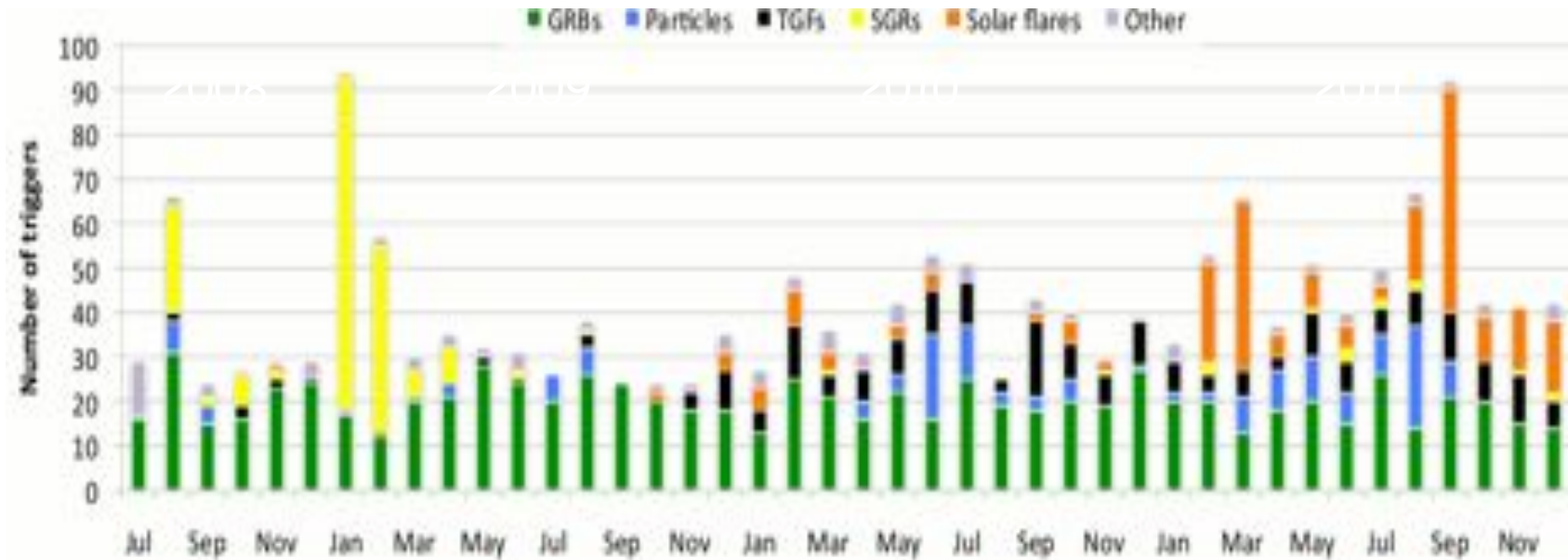


Long Duration Observations – request for input

- **Solicit white papers on new observation strategies/ideas**
 - Long pointed mode observations
 - Significantly modified survey strategies
- **FSSC and Fermi project will provide technical assistance and updated documentation on observatory capabilities and constraints**
 - We strongly encourage people to contact us and work with us to develop observations strategies
- **External panel review the white papers and provide a recommendation to the Fermi project**
- **Timeline**
 - January 2013: issue call for white papers
 - April/May 2013: submission deadline
 - May/June 2013: review

Gamma-ray Burst Monitor

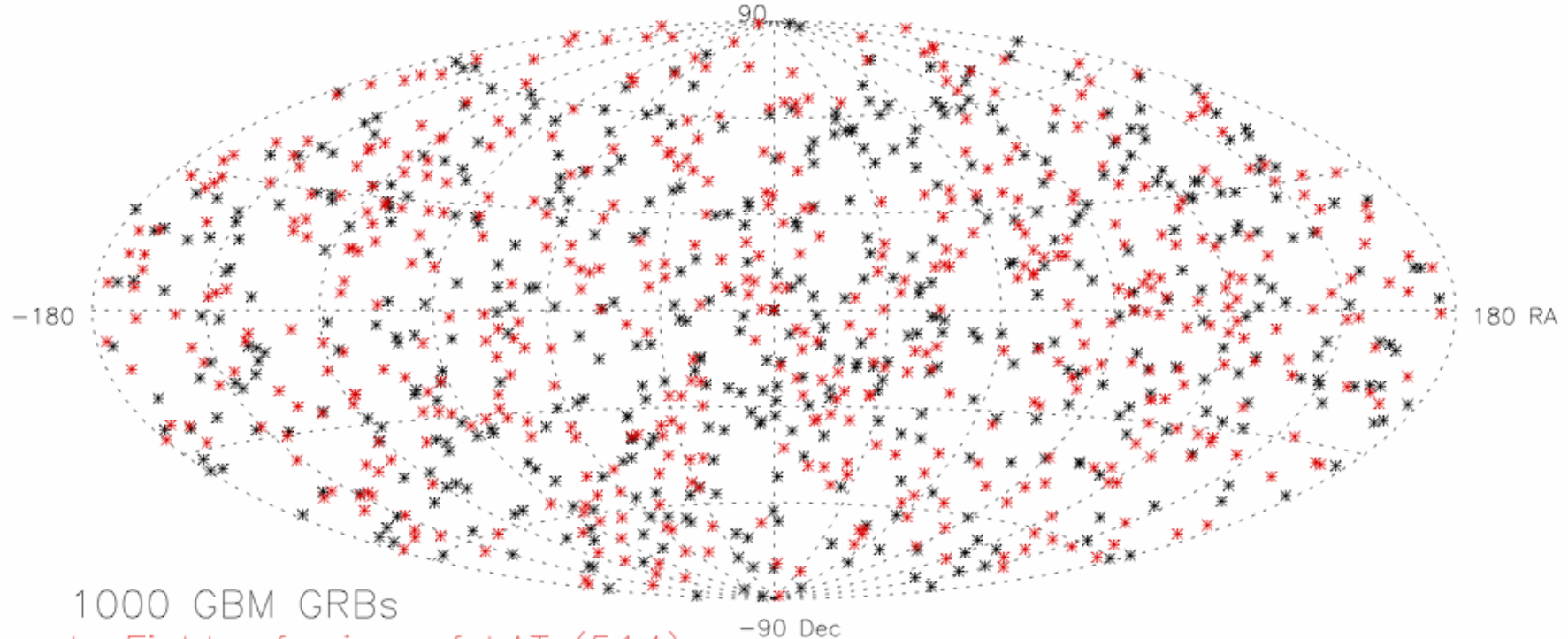
GBM is the most prolific detector of Gamma-Ray Bursts and Terrestrial Gamma-ray Flashes (thunderstorms) currently in orbit



Detecting MeV transients from Earth, Sun, Galaxy and distant Universe

1000 GBM Gamma-ray Bursts

Fermi GRBs as of 120921



1000 GBM GRBs

In Field-of-view of LAT (514)

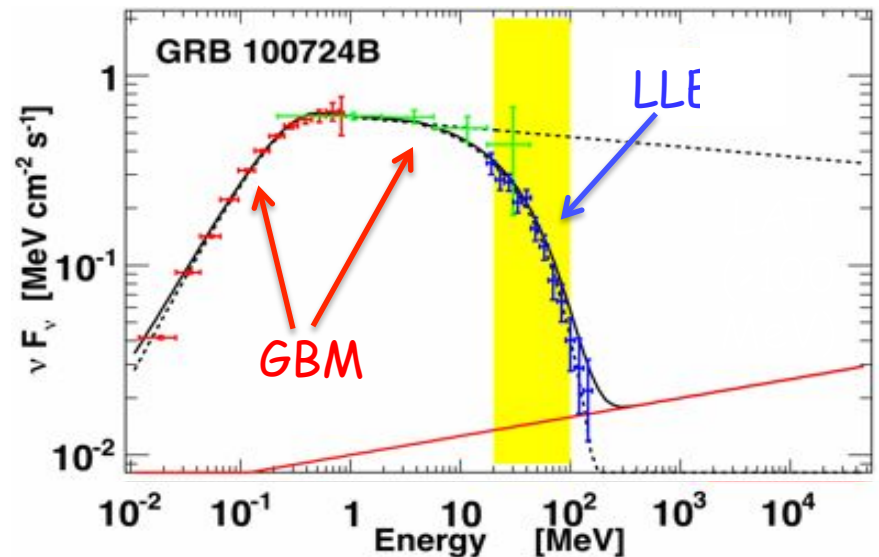
Out of Field-of-view of LAT (486)

- **On Sept 21, GBM detected it's 1000th Gamma-ray Burst!**
- **See talk by J. Greiner on Thursday for GBM GRB catalog plans**

Operations & Analysis Initiatives: LAT

Analysis and configuration improvements coupled with robust hardware means that we continue to expand LAT science capabilities

- **The LAT collects a significant amount of information for each gamma-ray event**
 - Ground processing reduces this to directions, energy, event type (gamma-ray or background) and associated errors
 - Extensive scope for analysis improvements tailored to specific science questions or scenarios
 - For details on



GRB spectral studies improves with low energy event selection

See talk by V Pelassa for details on LLE

LAT Data/software releases

- **Recent LAT releases**
 - **Reduced diffuse model (fewer MB, so easier to use)**
 - **LAT Low Energy (LLE) data**
 - **Updated spacecraft file (Sun ra/dec, data quality flag)**
 - **Science tools release with more accurate integration scheme for unbinned analysis**
 - **FT1 files with updated diffuse responses**
 - **Many thanks to all involved, especially the data processing/handling and documentation folks from LAT-ISOC and FSSC**
- **Planned upcoming releases**
 - **Reprocessed Pass 7 data (see next slide)**

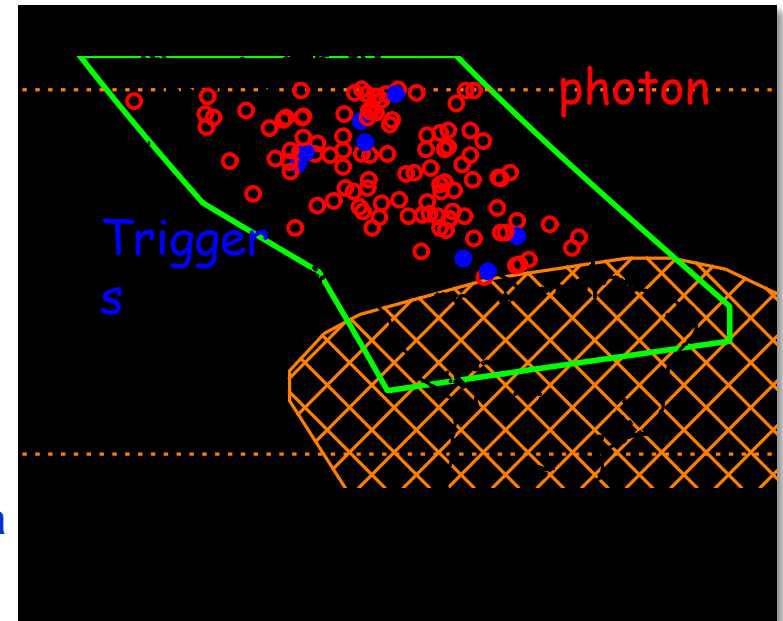
Pass7 reprocessed data

- **LAT team have reprocessed the data with updated calorimeter response calibration**
 - Updated light yield calibration in each crystal -> affects energy reconstruction
 - Light asymmetry calibration -> affects position resolution, thus improves PSF at high energies
- **Impacts and changes**
 - PSF at high energies is improved
 - Up to 5% shift in the energy scale (time and energy dependent)
 - Spectrum of background contamination has changed
- **Release plans**
 - In process of updating Models for Galactic diffuse and isotropic emission and flight IRFs
 - Data release by end of year

See poster by J Bregeon

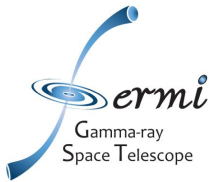
Fermi-GBM – High Time Resolution Data

- **Currently GBM provides individual photon data only for around triggers**
 - Continuous data is binned in time & energy
- **Continuous photon data will enhance science at low cost**
 - Already in place for fractions of the orbit for TGF searches
- **Science return:**
 - Increase sensitivity to short-GRB: Improved synergy with ALIGO (see posters by Pelassa and by Blackburn)
 - Searches for rapid sub-trigger astrophysics transients, such as X-ray bursts, SGRs, GRBs, etc.
 - Studies of fast pulsars, e.g., to correlate with LAT observations
- **Coming in Nov 2012, one day test in Sept**



Ground searches for TGFs using photon data have dramatically increased the detection rate

See talk by S Xiong for details on continuous photon data



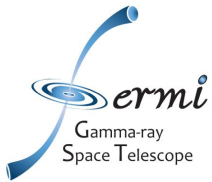
Guest Investigator Program

Primary role of the GI program is to provide financial support for Fermi studies, also provides opportunity to obtain pointed mode observations.

Deadline for cycle 6 is January 18, 2013

GI Program Details:

- **Funding for analysis of Fermi data and/or correlative observations**
- **Funding for theoretical studies related to Fermi**
- **Pointed mode or ToO observations**
- **NRAO, NOAO, Arecibo (new), VERITAS (new) or Suzaku observations related to Fermi science**
- **Funds are dispersed to GIs as soon as they are available**
- **\$8M/year disbursed through GI program (3rd largest in the astrophysics division)**
- **See <http://fermi.gsfc.nasa.gov/ssc/proposals/> for details**

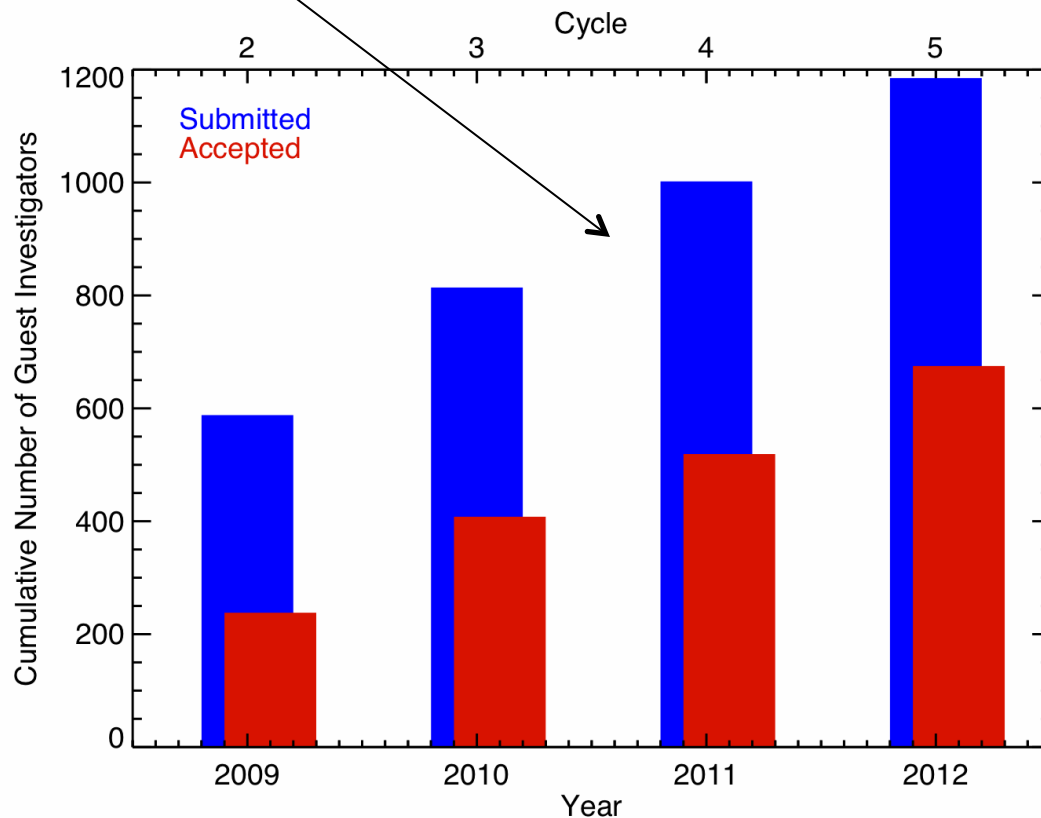


GI Program - VERITAS

- **MOU defining VERITAS/Fermi GI joint program is completed**
 - <http://fermi.gsfc.nasa.gov/ssc/proposals/veritas.html>
- **Up to 120 hours (~15% of available time), no more than 25% of any RA band**
- **Successful PI's will collaborate with the VERITAS team on the research**
- **3 Categories of VERITAS studies**
 - **A: key project of VERITAS team, not eligible for GI program (list of these sources will be posted on FSSC page)**
 - **B: Existing VERITAS team projects, successful GI will be invited to collaborate with the team (but project leadership is not guaranteed)**
 - **C: No existing VERITAS project, GI will be expected to lead a collaborative effort with VERITAS**
- **Propose through Fermi GI program, technical review by VERITAS**
- **Proposers are strongly encouraged to submit a NOI**

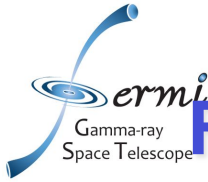
Growing Science Productivity

Total number of people participating in GI program continues to rise



- ***Fermi* is a young mission!**
 - **Community of Fermi users is growing by >20% per year**

Note: These represent U.S. Fermi users only; growth of international community likely follows similar trend

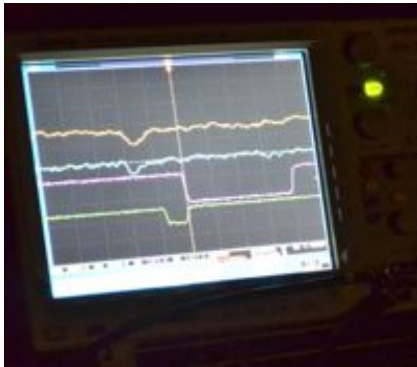


Fermi Summer School: May 29 – June 8, 2012

- **Co-organized by Fermi Project, Science Support Center, and University of Delaware**
- **10 days of lectures and workshop activities**
- **24 students**
 - **grad students and post-docs from US and non-US institutions**
- **Core instructors covering theory, modeling, instruments, and techniques**
 - **Pasquale Blasi , Markos Georganopoulos, Luca Baldini, Seth Digel, Michael Briggs, Nepomuk Otte, Andy Smith**
- **Supplemental instructors and lecturers**
 - **Alan Marscher, Martin Weisskopf, Trevor Weekes, Paul Ray, Jack Hewitt, Soeb Razzaque, Julie McEney**
- **Invaluable analysis and technical support from the FSSC**
 - **Jeremy Perkins and Davide Donato**
- **Next year's Fermi school will be in June 2013, in Delaware**

Demos

- Radioactivity in the home courtesy Ebay
- Muon Detector
- Mini-Cherenkov telescopes

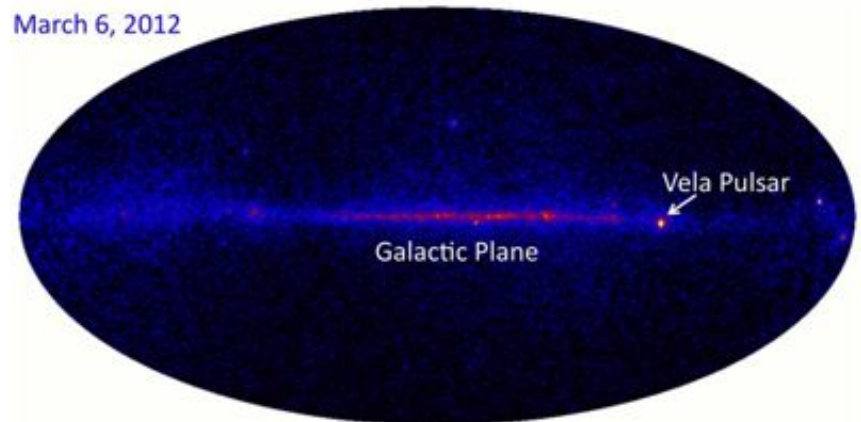


Fermi Solar Data Analysis Workshop

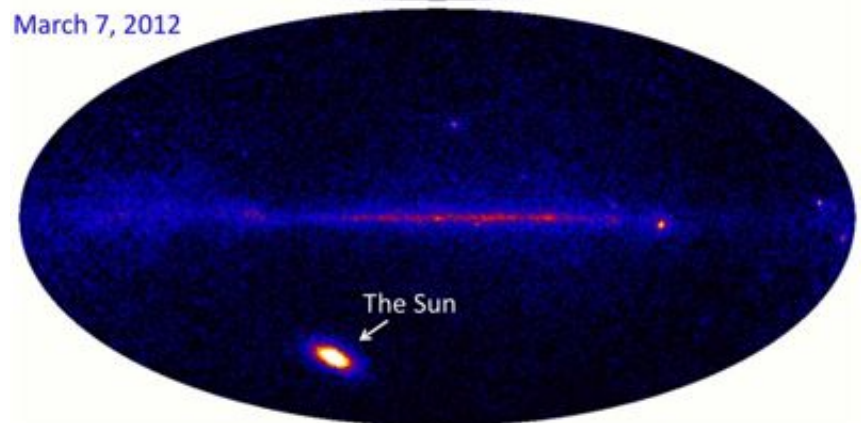
Aug 22-23 at GSFC

- **Fermi as a gamma-ray Solar Observatory?**
 - **GBM regularly detects solar flares**
 - **LAT detects both the quiescent sun and flares in survey mode**
- **Solar physics and astrophysics communities have different methods for data access and analysis**
- **Fermi data is seen as somewhat inaccessible to Solar community**
- **>50 attendees drawn from both solar and astrophysics communities**

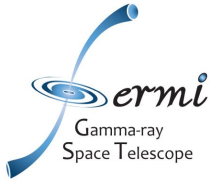
March 6, 2012



March 7, 2012



<http://apod.nasa.gov/apod/ap120315.html>



Senior Review

- **Proposal submitted Jan 18; presentation to committee on February 28.**
 - **Crucial and significant contributions from instrument teams, science support center, users group and operations staff**
 - **Many many thanks to everyone who helped!**
- **Report released April 2**
 - **Panel recommended “funding at the desired level of augmentation to provide for full operations through FY14. We recommend an extension through 2016 with a review in 2014.”**

HUNTSVILLE IN NASHVILLE: THE 7TH HUNTSVILLE GRB SYMPOSIUM



Gamma Ray Burst Symposium

14-18 April 2013 - Nashville, Tennessee

Gamma-ray bursts are the most luminous explosions in the universe, and are thought to be the birth signatures of black holes. They are exciting lies in the GRB field with new data coming from the Swift and HETE missions, dedicated GRB observing by Swift, and continued observations by NASA, STSC/STRO, and other facilities. There is also growing capability for follow-up observations by telescopes of all size classes. Scientists are actively searching for key physical conditions, and gravitational waves. There is a huge theoretical effort to understand the GRB phenomenon and keep up with the constant new papers coming from the data.

Nashville is the state capital of Tennessee with world-class education, culture, and business and food. The city is a great place to visit. There are many things to do in Nashville, including the state-of-the-art Nashville Convention Center, the Nashville Convention Center, and the Nashville Convention Center.

Swift NASA FCST

• Organizers: Michael Briggs, Valerie Connaughton, and Neil Gehrels.

• <http://huntsvilleinnashville.uah.edu>

Contact: grb2013@uah.edu

Summary

- **The Fermi mission continues to operate smoothly with no degradation in science performance**
- **Quality and capability of released data products improves as the instrument teams update calibrations and devise new data products**
 - **Pass 7 reprocessed data, LAT Low Energy etc**
 - **Pass 8 (longer term, significant revamp of low level reconstruction)**
- **Updated instrument configuration provide new science opportunities**
 - **Continuous GBM photon data**
- **New opportunities in GI program**
 - **VERITAS, Arecibo, new LAT and GBM data products**
- **Call for white papers on long term Fermi observing strategies in Jan 2013**