

National Aeronautics and Space Administration



Fermi

Gamma-ray Space Telescope

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Fermi

Gamma-ray Space Telescope

**Users Group Meeting
28 August 2009**

Mission Status Update

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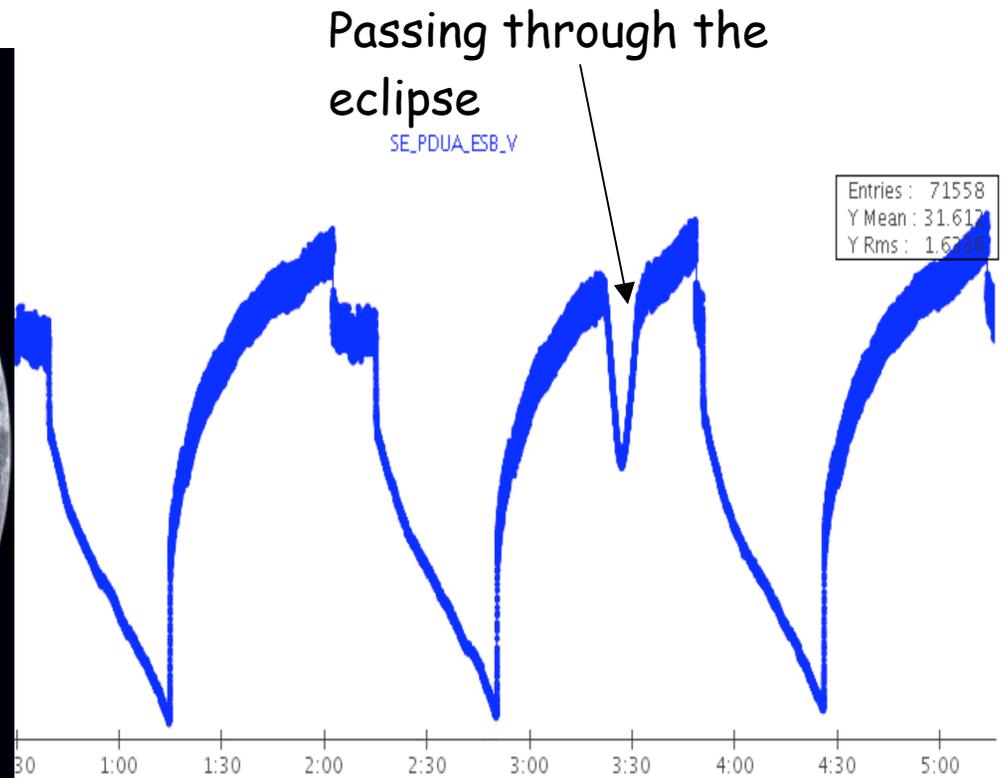
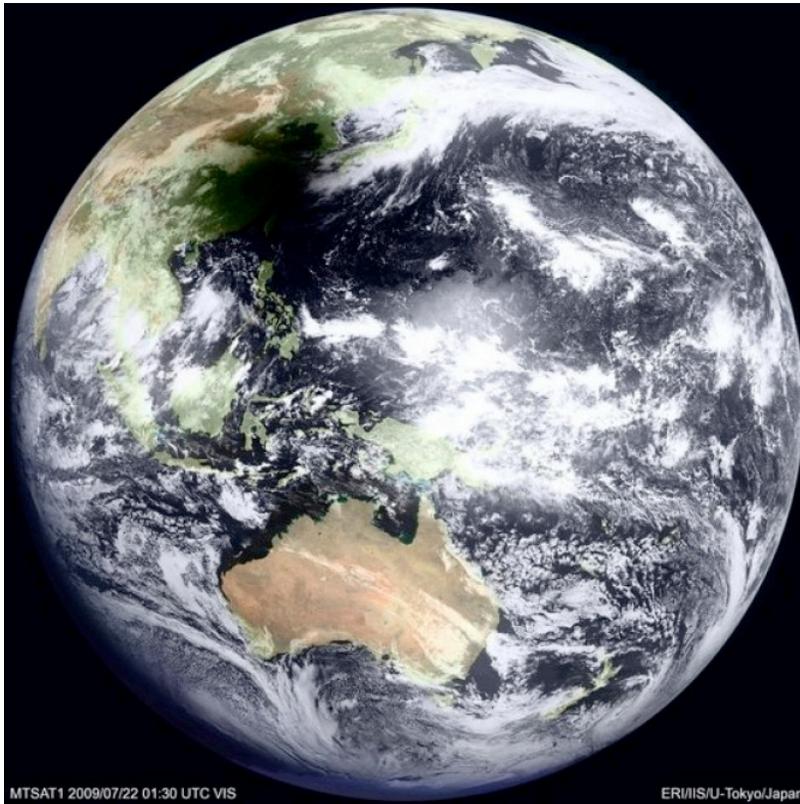
Topics

- **General status**
- **Status of LAT GCN notices/circulars**
- **Battery status and large angle rocking modes**
- **Selected instrument team activities**
- **Phasing of GI budgets/grants**

Status Highlights

- **Operations continue to be very smooth, thanks to an outstanding Flight Ops Team and great cooperation across the mission.**
 - **Weekly planning, status and issues meetings**
- **Proactively working issues to maintain smooth operations, including:**
 - **battery management (see later slides)**
 - **FSW updates (LAT, GBM, spacecraft) for minor bug fixes, operations and science processing improvements**
 - **collision avoidance**
 - **Several planning exercises to test procedures and policies**
 - **continuously looking at robustness of fault management and opportunities for improvements**
 - **carefully monitoring all subsystems (including the reaction wheels)**
- **Personnel changes...**
- **GI cycle 2 (talks this afternoon)**
- **Data release (later slides, talks this afternoon)**
- **Symposium planning (topic this afternoon)**
- **Press and outreach coordination and planning, tied to major science results releases. 11 releases (press releases and web features) to date. Many papers out, many more in the pipeline!**

Fermi sees the Solar Eclipse!



Observations summary

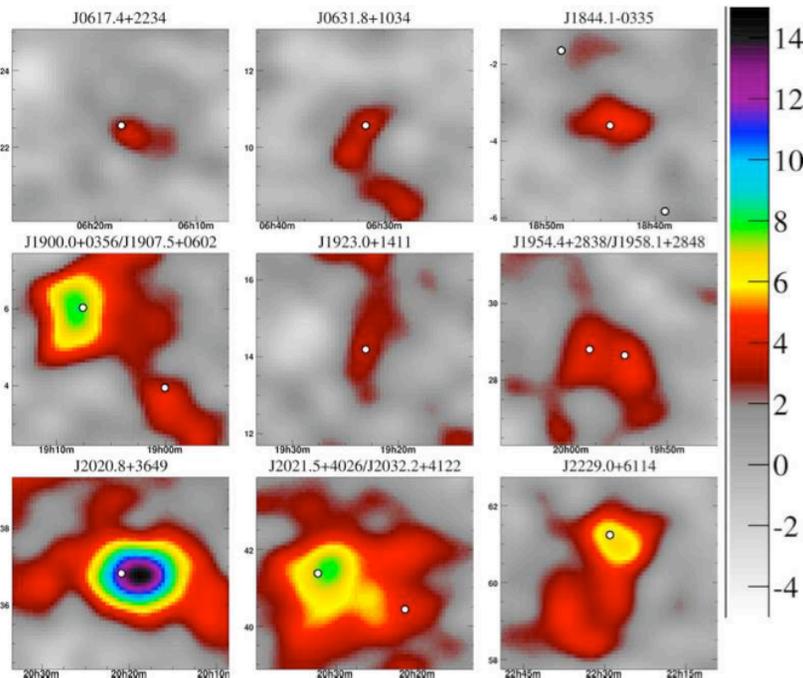
- **Almost exclusively nominal data taking in survey mode**
 - 35 deg rocking angle for first few months (some short periods at 40 and 39 deg)
 - 39 deg rocking angle from July 9, 2009
 - 50 deg rocking angle begins Sept 2, 2009
- **21 ARRAs**
 - 5 hour pointed mode observations in response to bright GBM detected bursts.
- **LAT Calibrations**
 - 13 hours (6 hr in Dec, 3.5 in March and 3.5 in Aug)
- **Reboot anomalies (now fixed)**
 - 5 days (in March and April)
- **Data recovery efficiency (do all the bytes reach the ground)**
 - <10 s of data lost since Aug 11, 2008

Science impact by citation

- **“Measurement of the Cosmic Ray e^+e^- Spectrum from 20 GeV to 1 TeV with the Fermi Large Area Telescope” (05/2009) ~110
 - Cited across a broad range - cosmic-ray, astronomy, particle physics (D0, BABAR)**
- **“Fermi/Large Area Telescope Bright Gamma-Ray Source List” (07/2009) ~60**
- **“Fermi Observations of High-Energy Gamma-Ray Emission from GRB 080916C” (03/2009) ~50**
- **“Bright Active Galactic Nuclei Source List from the First Three Months of the Fermi Large Area Telescope All-Sky Survey” (07/2009) ~40**
- **“The Fermi Gamma-Ray Space Telescope Discovers the Pulsar in the Young Galactic Supernova Remnant CTA 1” (11/2008) ~25**

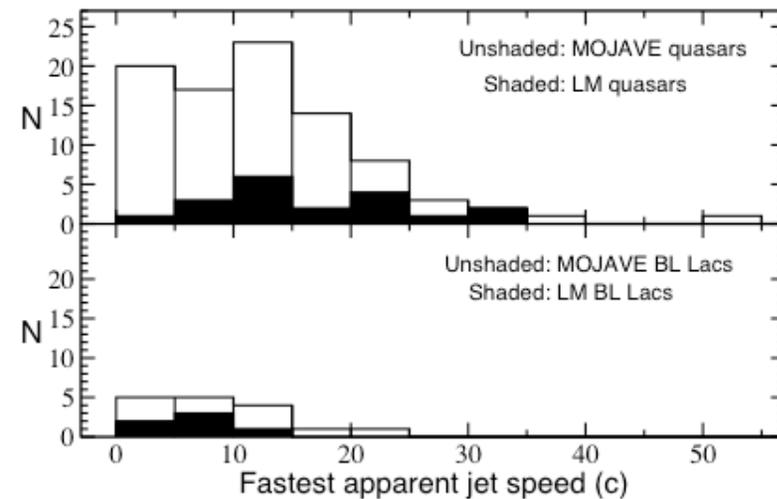
Some examples

TeV associations with LAT bright sources (mostly pulsars)



Milagro Observations of Multi-TeV Emission from Galactic Sources in the Fermi Bright Source List (Abdo et al., 2009, ApJ, 700, L127)

LAT AGN exhibit higher apparent jet speeds



A Connection Between Apparent VLBA Jet Speeds and Initial Active Galactic Nucleus Detections Made by the Fermi Gamma-Ray Observatory

(Lister, M. L., Homan, D. C., Kadler, M., Kellermann, K. I., Kovalev, Y. Y., Ros, E., Savolainen, T., Zensus, J. A. 2009, ApJ, 696, L22)

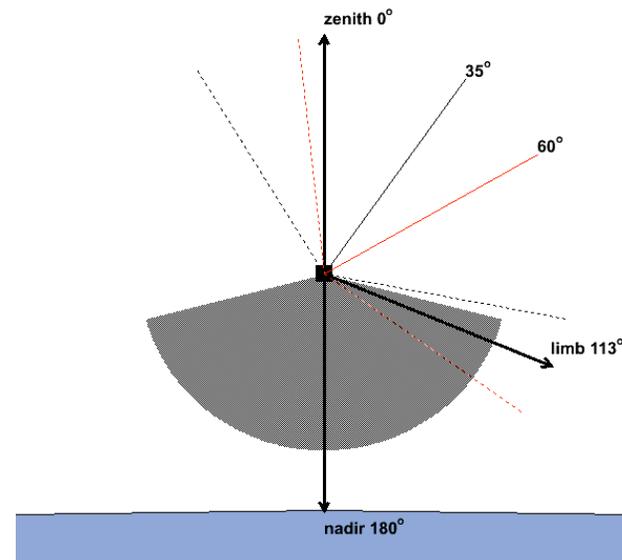
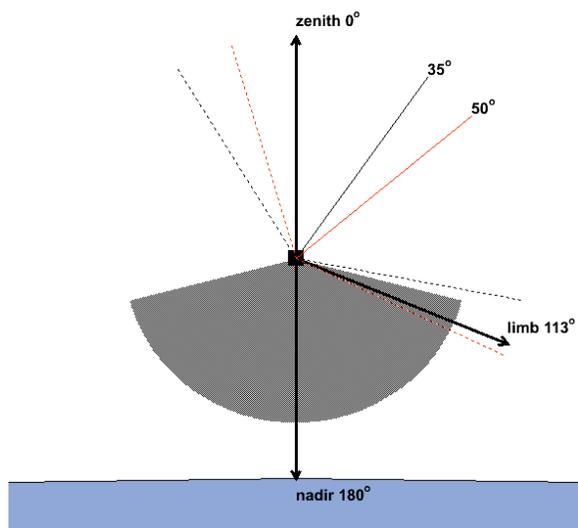


Papers based on or including Fermi data

- **Blazars**
 - **MW observations and associated interpretation**
- **GRBs**
 - **Ground follow-up of positions**
 - **Interpretation of observations**
- **Pulsars**
 - **Discoveries of Fermi pulsars in radio**
 - **Associations with TeV/multi-TeV**
- **Electron+Positron Spectrum**
 - **Related observations and interpretation**

Evaluating rocking angle survey modes

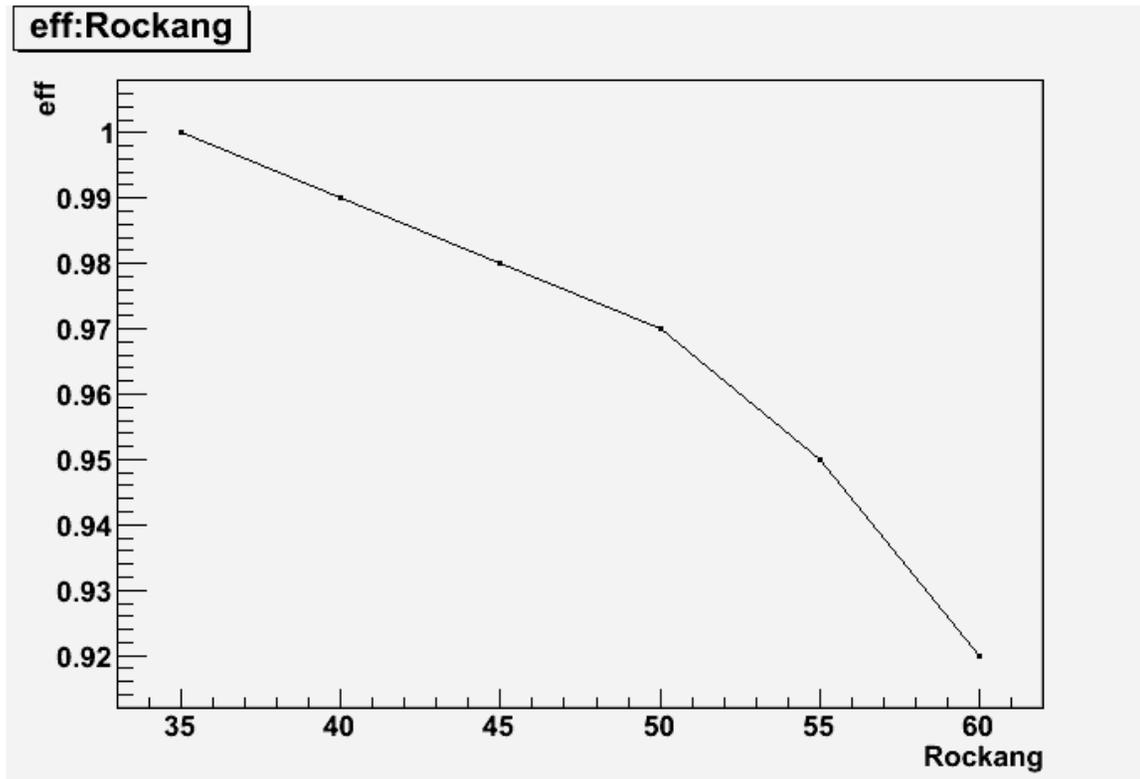
- Since the beginning of the mission there has been a trend of increasing temperature and decreasing battery pressure. Increasing the rocking angle reduces the battery cell temps, allows more flexibility in choice of charging parameters
 - The precise value will be a trade between the science impacts and the benefit to mission lifetime.
- The rocking angle is the angle between the Earth zenith and the LAT boresight.
 - RockAng=0, 180 -> zenith, nadir pointed (away,towards center of Earth)
 - RockAng=113 -> LAT boresight at Earth limb
 - RockAng=35 -> Earth limb 113-35= 78 deg from LAT boresight.
 - Zenith_cut = 105 deg (shaded grey region)



Evaluating rocking angle survey modes

- **Increasing the rocking angle**
 - **Bring Earth closer/into the LAT FoV**
 - Some loss of observing efficiency as we do not accept events collected within 8 deg of Earth limb. (<5% at 50 deg rocking)
 - Increased background rate due to increased LAT triggers from bright Earth limb (addressed by zenith selections)
 - **Decrease exposure uniformity**
 - Priority is to retain full sky coverage every 2 orbits (to allow all-sky monitoring of flaring sources). Full sky coverage is retained (over two orbits) for all allowed rocking angles (<60 deg)
 - Non-uniform sky coverage on long timescales is not necessarily detrimental (can have some advantages for population studies)
- **Generated 55 day orbit/attitude profiles for 35, 40, 45, 50, 55, 60 deg rocking angle survey profiles.**
 - **Quantified impact on observing efficiency and exposure uniformity as a function of rocking angle**

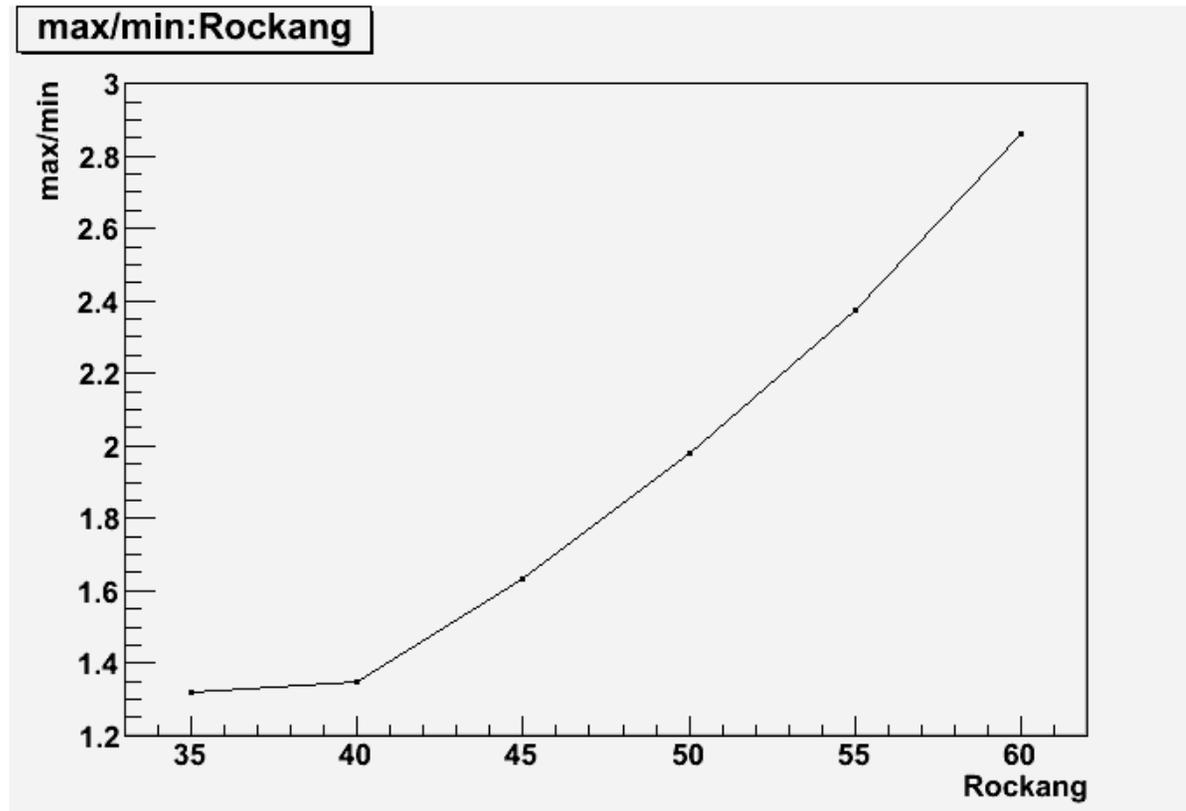
Observing efficiency



We lose around 1% of total exposure for every 5 deg increase in rocking angle. However, this loss comes from large inclination angles outside the canonical FoV, and is already excluded in the highest quality event selections.

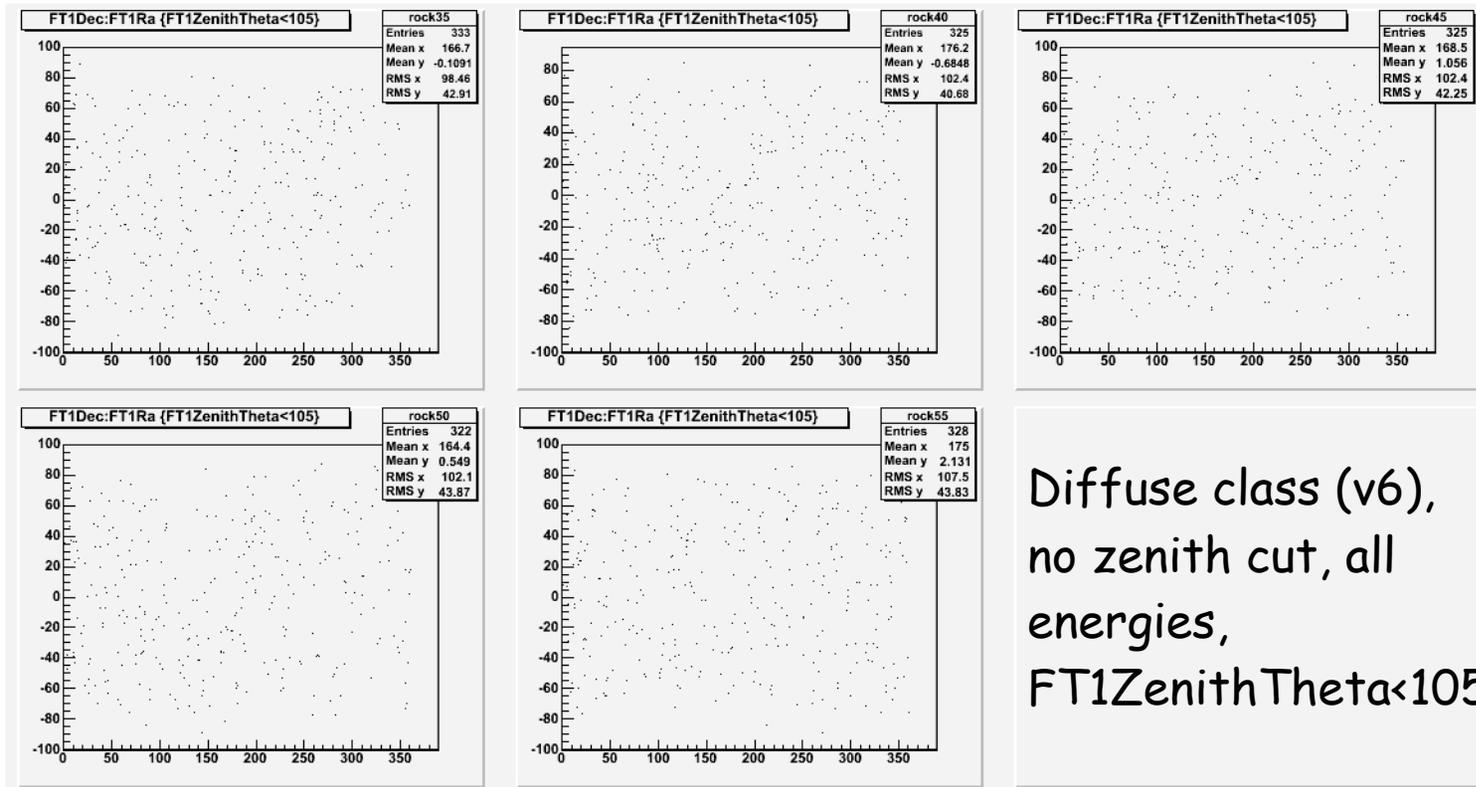
- $\text{Eff} = \text{int_exposure}_i / \text{int_exposure}_{35}$
- There will be some loss of exposure at larger rocking angles because the Earth limb will block part of the FoV
- This assumes a simple zenith cut of 105 deg (i.e. eliminate all data/events that come within 8 deg of Earth limb - the current analysis selection)

Exposure uniformity



- A measure of exposure uniformity is the ratio between the max and min pixels from the exposure maps as a function of rocking angle.

Background Contamination



- **No significant increase in residual background contamination seen in 10ks of simulated background data for each rocking angle. Note, it is ESSENTIAL to apply the standard zenith cut.**

Evaluating survey profiles

- **We retain complete sky coverage for all rocking angles up to 60 deg**
- **There is mild loss of observing efficiency (up to 5% for 50 deg rocking).**
 - **This assumes a simple zenith angle cut of 105 deg.**
- **Preliminary simulation studies suggest that there will not be a strong increase in residual backgrounds if a zenith cut/selection is applied.**
- **The science impact of moving to a larger rocking angle is mild. The potential benefit to mission lifetime may be considerable.**
 - **We are moving to a 50 deg rocking angle on Sept 2, initially to evaluate battery performance but may be an ongoing configuration.**

LAT team activities in NRA

“The LAT team’s science goals are (1) development of event reconstruction and background rejection techniques; (2) production of a full sky catalog of gamma-ray sources, and (3) a description of the diffuse gamma-ray emission. Proposed Fermi investigations should avoid duplication of the first 2 of these goals”

- **(1) Adjusted instrument response to account for “pile-up” effects.**
 - **Reduced systematic uncertainties, LAT papers now include data from 100 MeV.**
- **(1) Work on retuning event selections to account for “pile-up” effects is ongoing and will be provided when reprocessing and validations are complete**
 - **Dramatic performance improvement at lower energies (~factor of 5 at 100 MeV for standard event selection)**
 - **May include additional event classes**
- **(2) Catalog pipeline follows same method as used for bright source list**
 - **Applied to 11 months of data (Aug 2008 - July 2009), catalog will be released in October 2009**
- **(3) Diffuse Galactic Model**
 - **Updated model provided as part of LAT data release. A spectral template of the isotropic component (isotropic gamma-ray + residual instrument/cosmic-ray background) is also provided.**

GBM Team Activities in NRA

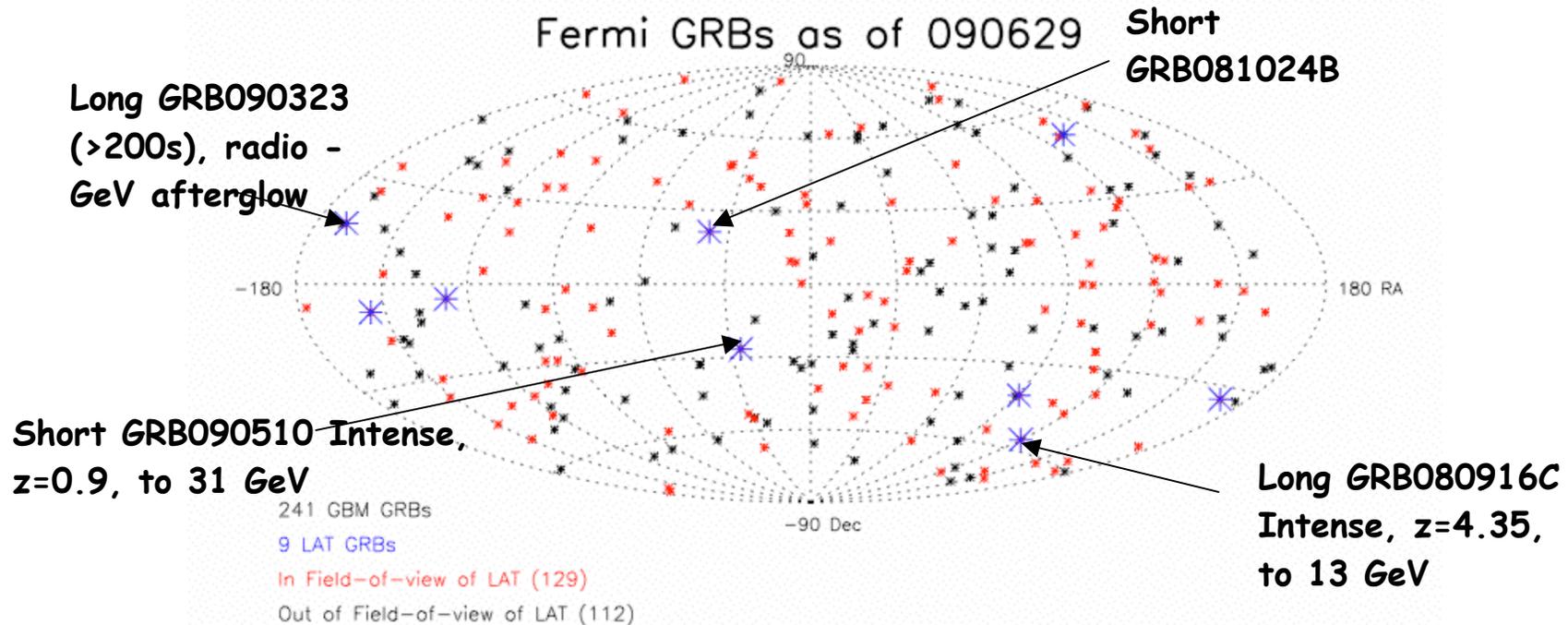
“The GBM science team is already funded to provide the community with a catalog of GRBs, including localizations and spectra. Proposals construed by peer reviewers as duplicative of this goal may, therefore, be deemed to have lower priority”

- **Currently meeting the localization requirements**
 - **Need to be good enough (<15 deg) to repoint the LAT.**
- **Work is ongoing to improve the energy calibration**
 - **Flux and spectral fits are released in GCN circulars within a few days of each burst.**
 - **A full catalog with consistently calculated fluxes and spectra will be produced in several months time.**

GI grants

- **Due to budgeting schedules, it is not possible to fully fund AO2 grants in the 2009 fiscal year (the same will be true for AO3 and AO4).**
 - **Chose to fund some grants now, and postpone others to November 2009.**
 - **Is this the right approach? It would be possible (albeit with significant bureaucratic overhead) to split some grants.**

LAT GCN status



- LAT onboard algorithm was enabled with communication to GCN in Nov 2009.
 - 3 bursts crossed the trigger threshold: 080916C, 081024b and 090510.
 - Thus only one LAT GCN notice so far.
- More sensitive search is possible with the full science data
 - Downlink and processing latencies mean that these detections are not reported until ~12 hours after the GRB trigger.

Communications

- **Making pro-active effort to encourage people to sign up for the Fermi mailing lists**
 - <http://fermi.gsfc.nasa.gov/ssc/resources/newsletter/>
- **Fermi blog is now active again**
- **Sequence of analysis workshops - opportunity to encourage people to participate in cycle 3 GI program.**
- **Continuing to update webpages**
- **Additional suggestions are welcome**