LAT Status, Plans, Science Results

Fermi User Group meeting
November 5, 2010

Peter Michelson
LAT PI
peterm@stanford.edu

on behalf of the Fermi LAT collaboration

LAT Continuous Source Releases

The LAT team releases flux/ spectra as a function of time for all sources in a pre-defined list + flaring sources during flares.

- **Modified data release after ~6 months:**
  - **Lowered flux threshold to release information on flaring sources by factor of 2.**
  - **Provided information continuously (not just during flares).**
  - **started with 23 sources, now have >70, with contact people assigned.**
- **http://fermisky.blogspot.com**

FERMI GAMMA-RAY SKY

TUESDAY, NOVEMBER 2, 2010

Fermi LAT weekly report N.123

Covered period: 2010 Oct. 11 - 17

LAT Mission week: 123.57 - 124.57

- Outburst of high-redshift and gravitationally lensed FSRQ **PKS 1830-211** (z=2.507), with important gravitational magnification and Galactic absorption features. The source on October 14, 2010 showed a bright gamma-ray outburst with a daily flux of (5.2+/-1.1)E-6 more than a factor of 12 greater than reported in the Fermi-LAT 1st year catalog (ATel#2943). The flux was higher on Oct. 15 (7.8+/-0.9)E-6, about 18 times the 1-year catalog average flux).
- **PKS 2155-304** reached the threshold of daily flux (1.0+/-0.3)E-6, with photon index 2.6+/-0.3 (ATel#2944).

  This index value can be due to statistical dispersion and flux-index correlation at low test statistics values, close to the sensitivity curve, rather than to a real softer-when-brighter behavior of this high-energy peaked blazar.
- **CRATES J0531-4827** bright during the week.
- **3C 454.3** bright above daily flux 2E-6.

LAT DATA

LAT First Catalog
LAT Monitored Source List Light Curves
LAT Bright Source List
Browse interface to monitored source data
Contact Information by Individual Sources

BLOG ARCHIVE

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Fermi LAT weekly report N.123
Fermi LAT weekly report N.122
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► May (5)
► April (3)
► March (8)
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► January (6)
► 2009 (30)

CONTRIBUTORS

LAT Continuous Source Releases

The LAT team releases flux/ spectra as a function of time for all sources in a pre-defined list + flaring sources during flares.

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Contact Information for Individual Sources

Added by David J. Thompson, last edited by Filippo D'Ammando on Nov 03, 2010

Please note: This is a public page (for multifrequency purposes).

List of Contacts for Individual Sources

LAT Monitored Source List Light Curves are available for most of these sources

Fermi-LAT Weekly Sky blog and Daily Sky blog

For reference, see all Astronomer's Telegrams from the Fermi-LAT collaboration

Extragalactic sources from ATels, in order of (the First) ATel number, starting with earliest

Source Name(s)	Friend(s) of the Source	ATEL number(s)
3C 454.3	Greg Madejski (madejski at stanford.edu)	1628, 2200, 2328, 2534
PKS 1502+106	Stefano Ciprini (stefano.ciprini at pg.infn.it)	1650, 1905
PKS 1454-354	??	1701
3C273	Jim Chiang (jchiang at slac.stanford.edu), Werner Collmar (wec at mpe.mpg.de)	1707, 2168, 2200
1510-089	Andrea Tramacere (tramacer at slac.stanford.edu)	1743, 1897, 2033
AO 0235+164	Luis C. Reyes (lreyes at kicp.uchicago.edu)	1744, 1784
3C 66A	Luis C. Reyes (lreyes at kicp.uchicago.edu)	1759
PKS 0208-512	Werner Collmar (wec at mpe.mpg.de)	1759
PKS 0537-441	Gino Tosti (tosti at pg.infn.it)	1759, 2124, 2591
3C279	Greg Madejski (madejski at slac.stanford.edu), Masaaki Hayashida (mahaya at slac.stanford.edu)	1864, 2154, 2886
B0133+47	Hiromitsu Takahashi (hirotaka at hep01.hepl.hiroshima-u.ac.jp), Gino Tosti (tosti at pg.infn.it)	1877
J123939+044409	Andrea Tramacere (tramacer at slac.stanford.edu), Nanda Rea (N.Rea at uva.nl)	1888
PKS 1244-255	Andrea Tramacere (tramacer at slac.stanford.edu), Nanda Rea (N.Rea at	1894

+ FSSC Home

Data

Data Policy
Data Access
+ LAT Data
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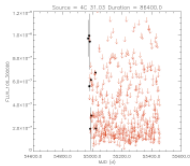
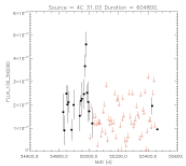
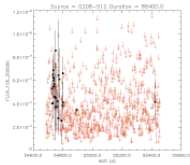
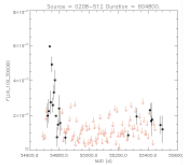
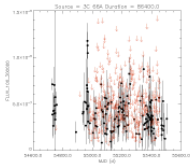
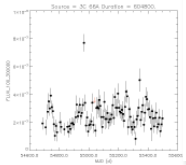
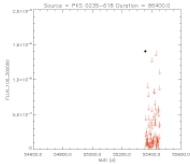
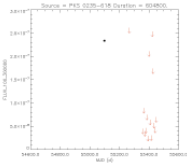
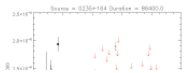
+ LAT Data Queries
+ LAT Query Results
+ LAT Weekly Files
+ GBM Data
Data Analysis
Caveats
Newsletter
FAQ

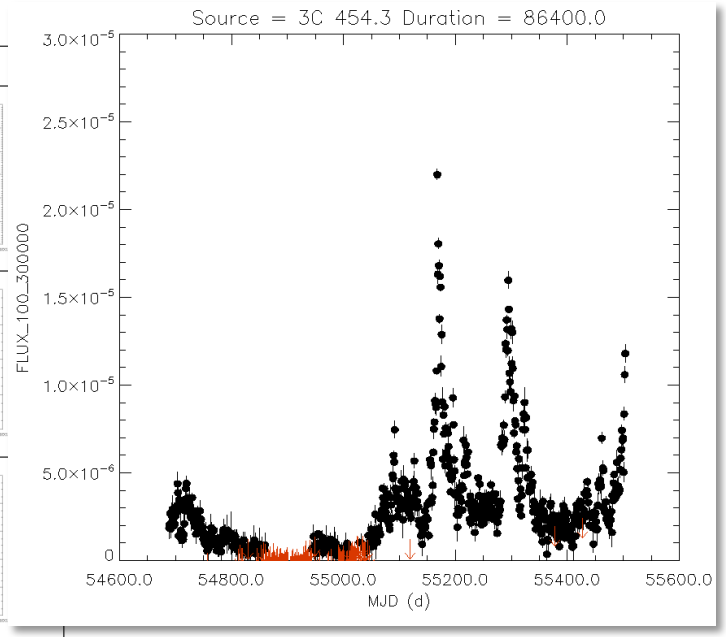
Monitored Source List Light Curves

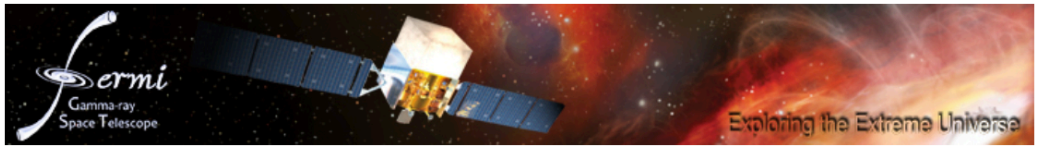
PLEASE NOTE: The tabulated fluxes are derived at the LAT Instrument Science Operations center in an automated analysis to produce results quickly to facilitate follow-up multiwavelength observations of flaring sources. The table of released fluxes will be updated as analysis and calibrations improve.

These early flux estimates **do not include systematic uncertainties and do not have an absolute flux calibration.** Use of these data as absolute flux measurements for constraining models or for comparison to other data is strongly discouraged at this time. In addition to overall normalization uncertainties, source fluxes may have variations of up to 10% due to currently-uncorrected dependencies of the gamma-ray detection efficiency on variations of the particle background in orbit. Please note that these results are produced using preliminary instrument response functions and calibrations. The quality and stability of these results will improve when updated calibrations become available over the coming months.

A detailed description of the data included in these files can be found here.

Source	Daily LC	Weekly LC
4C 31.03 (RA = 18.2100, Dec = 32.1380) » Daily Light Curve » Daily Light Curve Fits File » Weekly Light Curve » Weekly Light Curve Fits File		
0208-512 (RA = 32.6930, Dec = -51.0170) » Daily Light Curve » Daily Light Curve Fits File » Weekly Light Curve » Weekly Light Curve Fits File		
3C 66A (RA = 35.6650, Dec = 43.0350) » Daily Light Curve » Daily Light Curve Fits File » Weekly Light Curve » Weekly Light Curve Fits File		
PKS 0235-618 (RA = 39.2220, Dec = -61.6040) » Daily Light Curve » Daily Light Curve Fits File » Weekly Light Curve » Weekly Light Curve Fits File		
0235+164 (RA = 39.6620, Dec = 16.6160) » Daily Light Curve		





Rapid Publications from the Fermi LAT Collaboration: GCN and ATEL

Astronomer's Telegrams (ATEL): 114 ATELs and 29 GCNs thus far

date	number	title
2010-Nov-03	3002	Fermi LAT detection of increasing gamma-ray activity from the FSRQ PKS 1730-13
2010-Oct-30	2986	Swift follow-up confirms the high flaring state of the blazar PMN J2345-1555
2010-Oct-26	2972	Detection of a simultaneous optical and gamma-ray flare from blazar PMN J2345-1555
2010-Oct-22	2966	Fermi LAT detection of a possible new gamma-ray blazar PMN J1913-3630
2010-Oct-21	2963	Swift follow-up confirms the high activity state of CGRaBS J1848+3219
2010-Oct-19	2954	Fermi LAT detection of a GeV flare from CGRaBS J1848+3219
2010-Oct-15	2944	Fermi LAT observations of enhanced gamma-ray activity of blazar PKS 2155-304
2010-Oct-15	2943	Fermi LAT detection of an intense GeV flare from the high-redshift and gravitationally lensed blazar PKS 1830-211
2010-Oct-05	2907	Fermi-LAT detection of GeV gamma-ray emission from CRATES J0531-4827
2010-Oct-03	2901	Swift follow-up of the gamma-ray flaring blazar PKS 0727-11
2010-Sep-29	2886	Fermi LAT observations of increasing gamma-ray activity of blazar 3C279
2010-Sep-28	2879	Crab flux no longer elevated in Fermi-LAT band
2010-Sep-23	2861	Fermi LAT confirmation of enhanced gamma-ray emission from the Crab Nebula region
2010-Sep-23	2860	Fermi LAT detection of a GeV flare from the FSRQ PKS 0727-11
2010-Sep-18	2848	Flaring blazar B2 0619+33: Swift X-ray and UV/optical observations
2010-Sep-09	2837	PKS 1329-049 revived: new gamma-ray activity observed by Fermi LAT
2010-Sep-06	2829	Fermi LAT detection of a GeV flare from B2 0619+33
2010-Aug-17	2795	Fermi LAT detection of a GeV flare from blazar Ton 599 (4C 29.45)
2010-Aug-09	2783	Fermi LAT detection of increased gamma-ray activity from the FSRQs

The Astronomer's Telegram
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Present Time: 4 Nov 2010; 16:38 UT

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Fermi LAT detection of increasing gamma-ray activity from the FSRQ PKS 1730-13

ATel #3002; *F. D'Ammando (INAF-IASF Palermo), J. Vandenbroucke (Stanford/KIPAC) on behalf of the Fermi Large Area Telescope Collaboration*
on 3 Nov 2010; 15:01 UT
Distributed as an Instant Email Notice (Request for Observations)
Password Certification: Filippo D'Ammando (filippo.dammando@iasf-roma.inaf.it)

Subjects: Gamma Ray, >GeV, Request for Observations, AGN, Blazars, Quasars

The Large Area Telescope (LAT) on board the Fermi Gamma-ray Space Telescope has observed an increasing gamma-ray flux from a source positionally consistent with the Flat Spectrum Radio Quasar PKS 1730-13 (also known as NRAO 530 and 1FGL J1733.0-1308, Abdo et al. 2010, ApJS, 188, 405; R.A: 17:33:02.7057 Dec.: -13:04:49.547, J2000, Johnston et al. 1995, AJ 110, 880) at redshift z=0.902 (Junkkarinen 1984, PASP 96, 539).

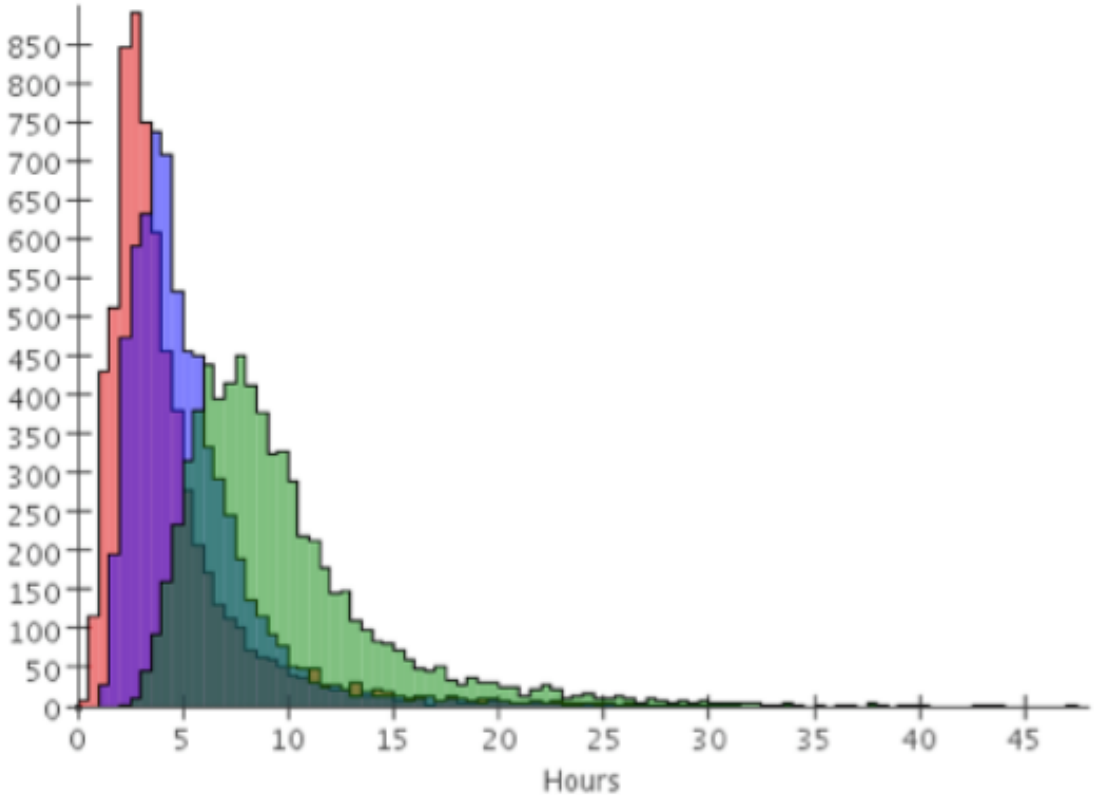
The source was detected in a high state between October 31 and November 2, 2010. Preliminary analysis indicates that on November 2, 2010 the flare reached a gamma-ray flux (E > 100MeV) of (1.7+/-0.3)x10^-6 photons/cm^2/s (errors are statistical only), which represents an increase of a factor of 20 with respect to the average source flux observed in the first eleven months of Fermi observations (Abdo et al. 2010).

Because Fermi operates in an all-sky scanning mode, regular gamma-ray monitoring of this source will continue. In consideration of the activity of this source we strongly encourage multiwavelength observations. The Fermi LAT contact people for this source are J. Vandenbroucke (justinv@stanford.edu), and F. D'Ammando (dammando@ifc.inaf.it).

The Fermi LAT is a pair conversion telescope designed to cover the energy band from 20 MeV to greater than 300 GeV. It is the product of an international collaboration between NASA and DOE in the U.S. and many scientific institutions across France, Italy, Japan and Sweden.

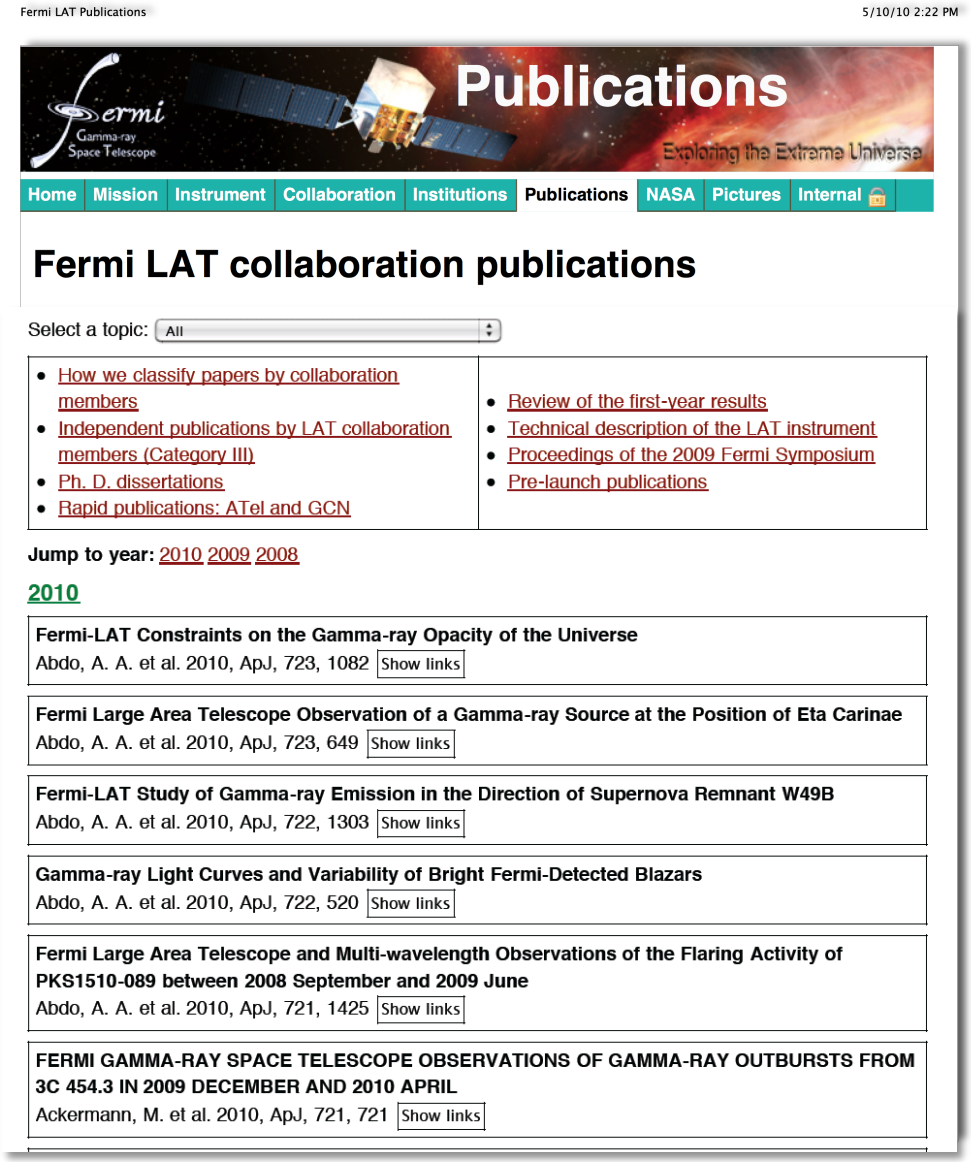
Also see http://fermisky.blogspot.com/

LAT Data Latency



- **Typical turnaround is less than 10 hours (time to get data off spacecraft, processed and back to FSSC)**

Many LAT team papers out…



LAT Collaboration papers

Journal	Published	In press	Total
Astronomy and Astrophysics	1+1=2	4	6
Astroparticle Physics	1+2=3	-	3
Astrophysical Journal	46+5=51	4	55
Astrophysical Journal Letters	16+3=19	1	20
Astrophysical Journal Supplement	3+0=3	-	3
Journal of Cosmology and Astroparticle Physics	2+2=4	-	4
Nature	2+0=2	-	2
Physical Review D	1+0=1	2	3
Physical Review Letters	4+0=4	-	4
Science	9+0=9	-	9
Total	85+13=98	11	109

published in both physics and astrophysics journals, reflecting broad interest

…with many more in the pipeline!

http://www-glast.stanford.edu/cgi-bin/pubpub

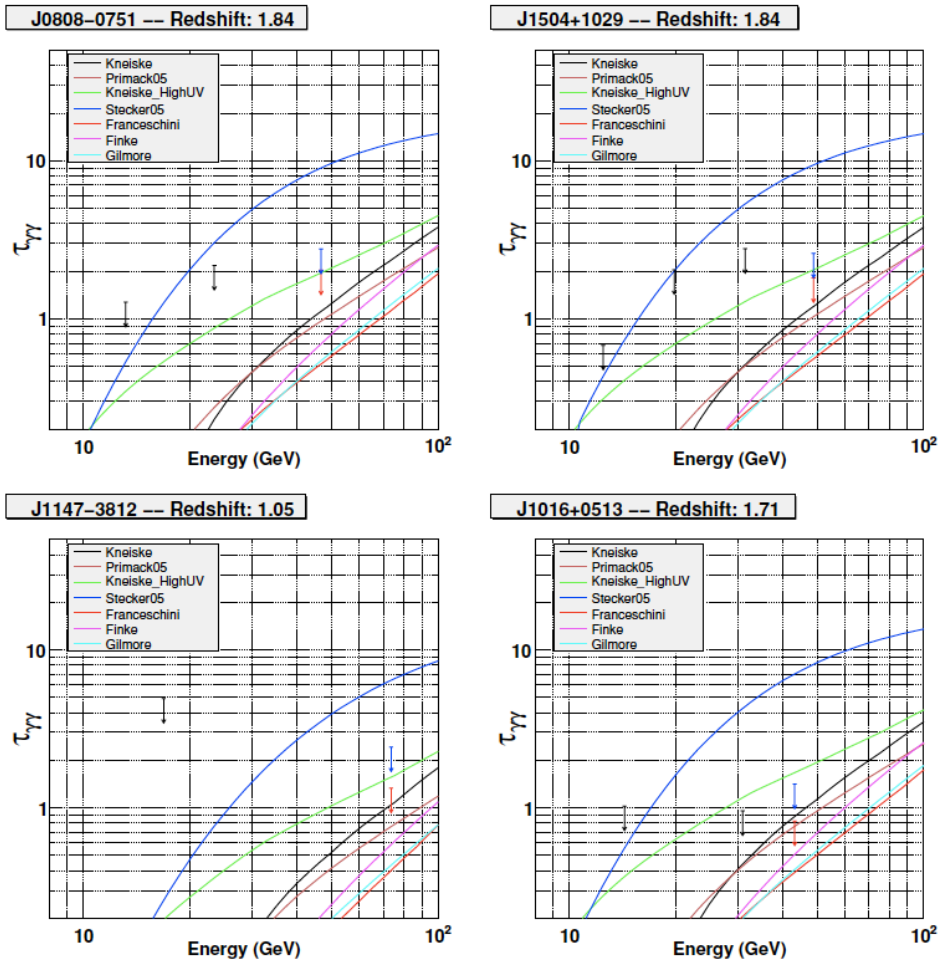
Some Highlights (May 2010)

- Discovery and study of 68 gamma-ray pulsars, 25 of which are seen to pulse only in gamma rays. 16/68 are ms pulsars.
  - 19 new ms radio pulsars discovered thanks to LAT data!
- Remarkable high-energy emission from gamma-ray bursts
  - Starting to see what was missing!
  - Also provides interesting limits on photon velocity dispersion
- Very high statistics measurement of the cosmic e+e- flux to 1 TeV
- Nailing down the diffuse galactic GeV emission
- First Fermi determination of the isotropic diffuse flux
- Early searches for Dark Matter signatures in different kinds of sources
- Many new results on supermassive black hole systems (AGN), including sources never seen in the GeV range
- More cosmic accelerators: Galactic X-ray binaries and supernova remnants. Probing the cosmic ray distributions in other galaxies; LMC and SMC.
- EBL constraints
- Year-one catalog: 1450 sources

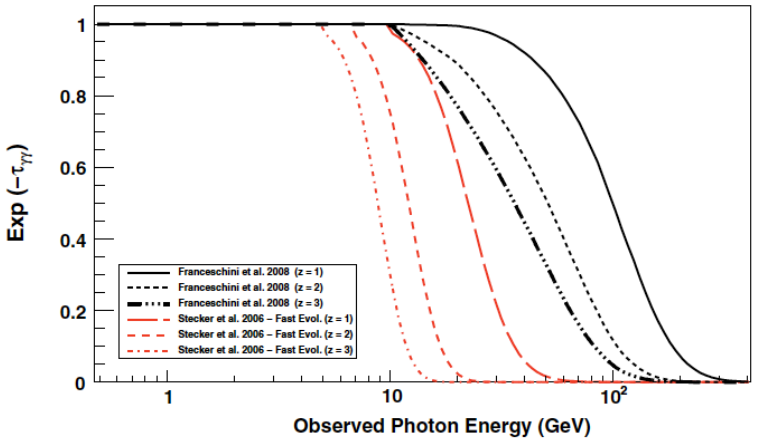
Constraints on EBL

LAT detects a sample of γ-ray blazars with redshift up to z ~ 3, and GRBs with redshift up to z ~ 4.3. Using photons above 10 GeV collected by Fermi over more than one year of observations for these sources, we place upper limits on the γ-ray opacity of the universe at various energies and redshifts and compare this with predictions from well-known EBL models.

Abdo, *et al.* (LAT Collaboration) 2010 *Ap.J.* **723**,1082



Range of models of EBL spanning minimum and maximum attenuations



Black arrow: upper limits at 95% CL in all energy bins used to determine the observed flux above 10 GeV.

Red arrow: upper limits at 95% CL for the highest energy photon.

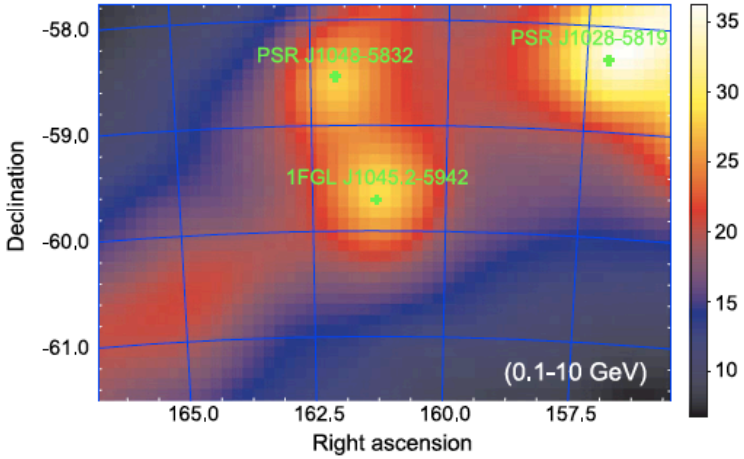
Blue arrow: upper limit at 99% CL for the highest energy photon.

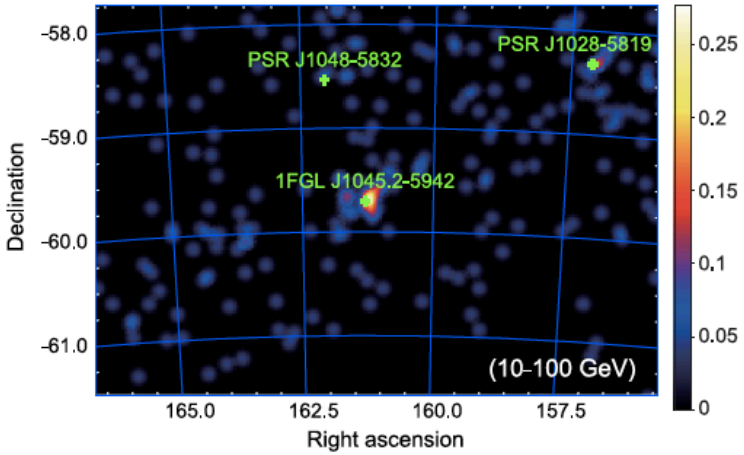
The upper limits are inconsistent with the EBL models that predict the strongest opacity.

γ-ray source at position of Eta Carinae

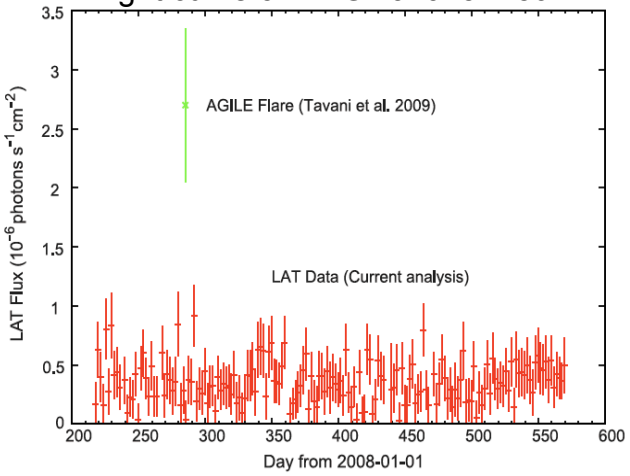
γ-ray source spatially consistent with the location of Eta Carinae. Source has been persistently bright since the beginning of the LAT survey observations. The LAT light is consistent with steady emission. No evidence of flaring activity as reported by AGILE. Also do not find any evidence for γ-ray variability correlated with large X-ray variability of Eta Carinae during 2008 Dec and 2009 Jan. Not able to establish an unambiguous identification of LAT source with Eta Carinae.

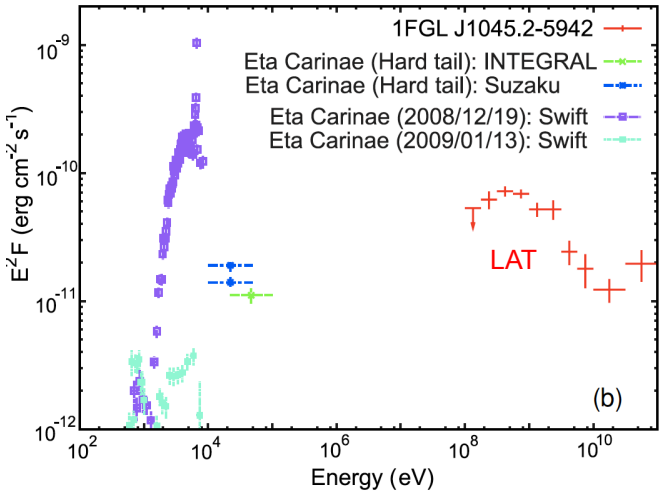
Abdo, *et al.* (LAT Collaboration) 2010 *Ap. J.* **723**.649





Light curve of 1 FGL J1045.2-5942

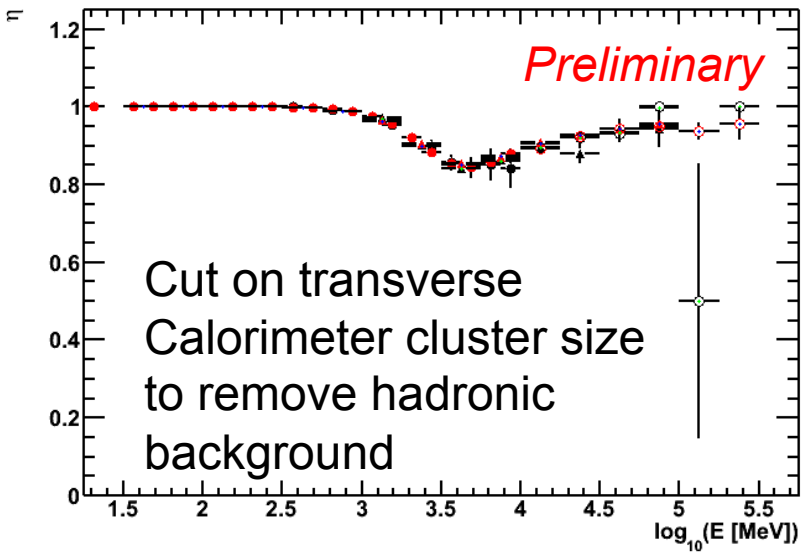




Looking Ahead

- Many further improvements in instrument performance in progress http://fermi.gsfc.nasa.gov/ssc/data/analysis/LAT_caveats.html
  - Event reconstruction and choices of event selection "knobs" all determine instrument performance. For stability, standard event class definitions established with IRFs.
  - Current data released with "Pass6".
    - Some known issues with in-flight PSF, described in Caveats on FSSC site and in LAT papers.
    - Near-term: being addressed with patch to IRFs. Longer-term: Pass7 and Pass8 to fix the remaining problems.
  - Pass7 under study
    - » Improved standard photon classes
    - » Event analysis taking into account "ghost" events
    - Working closely with FSSC on ease of use for user community.
  - There is also work on Pass8, expected to be the ultimate version.
- Work also on Diffuse Model improvements.

MC-Data Agreement

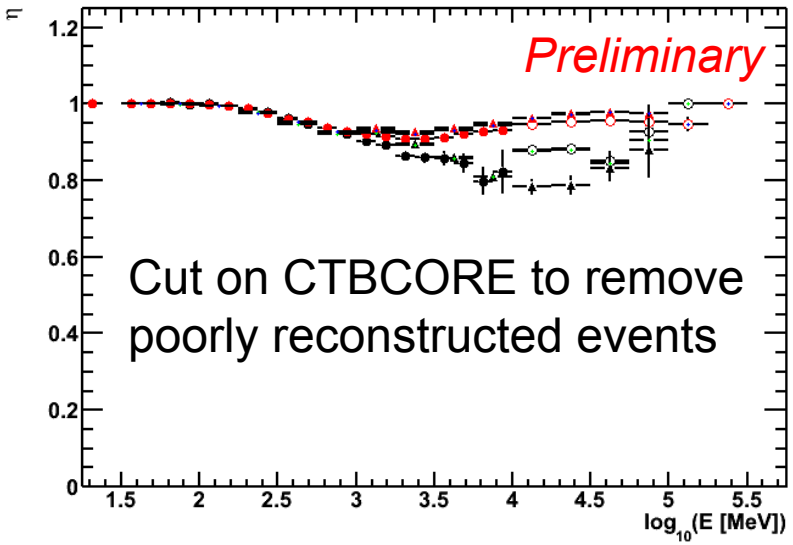


Top left distribution shows excellent agreement between flight data and simulation (the usual case)

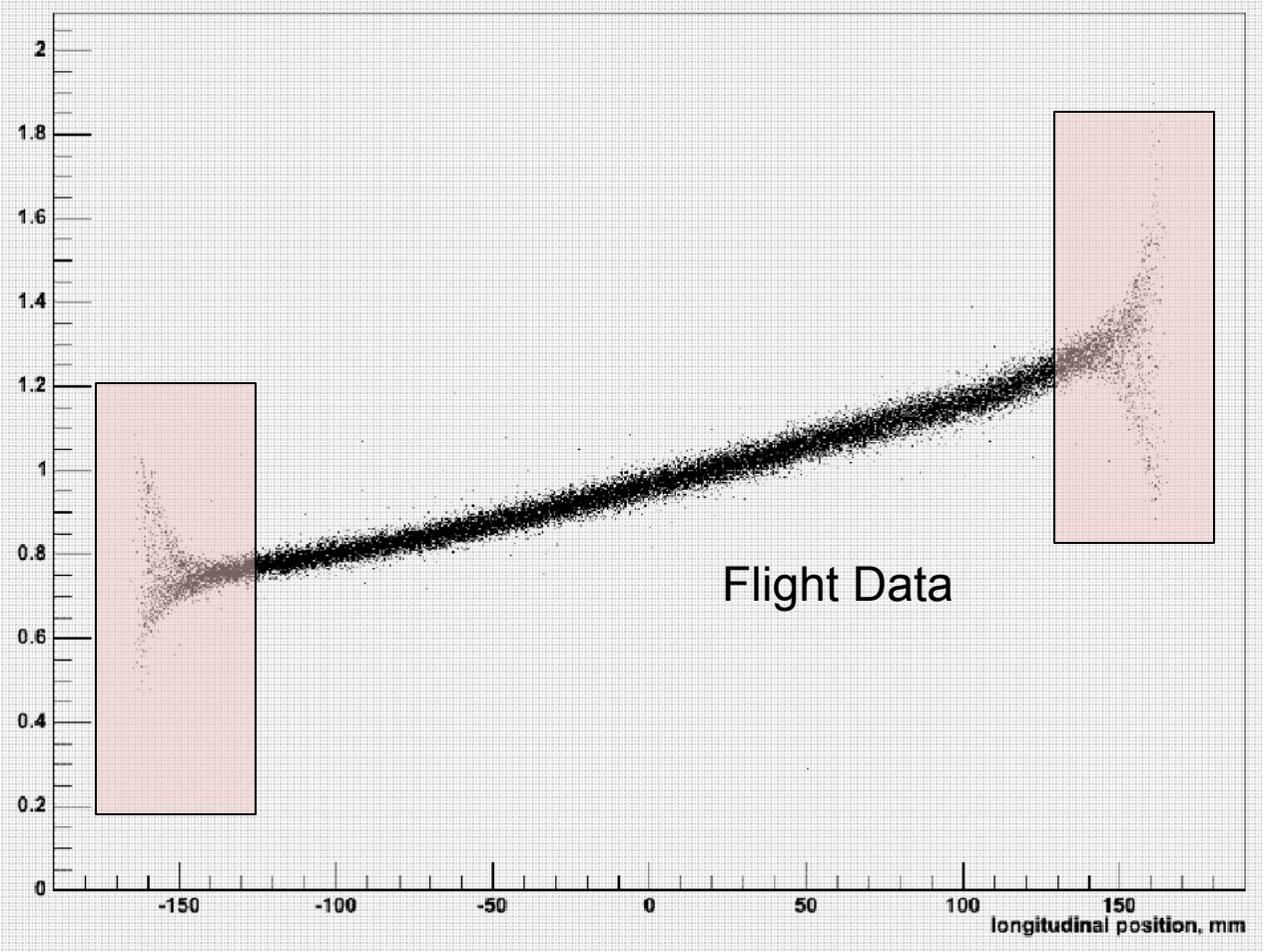
Bottom right shows the distribution with the biggest discrepancy (10-20%), which is energy dependent. Due in large part to improperly simulated CAL log edge responses: **now fixed in latest simulation** as input to Pass8.

Agreement is generally excellent

These plots show how the efficiency of two of our photon selection criteria vary with energy (red points simulated, black points data with three background subtraction methods: (pulsar phase, source direction and earth horizon selection))



Calorimeter longitudinal position



Asymmetry in the light observed at the two end of the crystal determines longitudinal position of energy deposition

Pre-flight simulation and algorithms did not deal with complex behavior and non-linearity near the end of the crystals causing few mm position errors near the ends.

Calibrations have been improved and non-linearities addressed in new algorithm.

CTBCORE probabilities are improved

At high energies (> ~1 GeV) we rely on the calorimeter position measurement to constrain the photon direction and to help select well reconstructed events are reject backgrounds

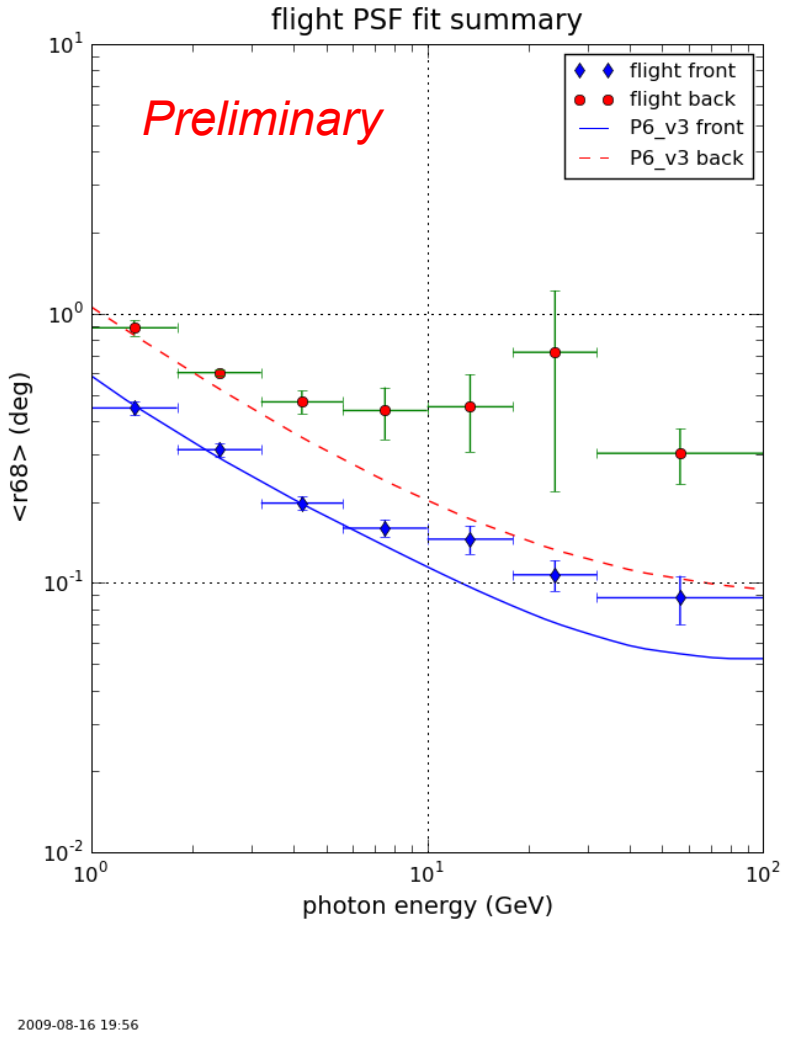
Impacts on PSF Knowledge

Stacked source analysis of AGN and pulsars

Pulsar studies allow for very clean measure of the PSF, but run out of statistics at high energy

Discrepancy in the simulation of the calorimeter longitudinal position is understood to be a major contributor to the difference between the simulated and measured PSFs

SHORT TERM FIX: modified IRFs.
LONG TERM FIX: use the more accurate simulation for Pass8, underway.



Development status of 3rd Galactic diffuse model for public release

Currently-recommended diffuse model

- v02 (gll_iem_v02.fit) has been the standard recommended model since public release in August 2009; used for 1st LAT Catalog
- Derived from a template fitting approach to the Fermi LAT data
  - N(H I), W(CO) rings, and $E(B\text{-}V)_{res}$ as gas tracers
  - GALPROP-derived template for inverse Compton scattering
  - Large-scale fits to the LAT data for the gamma-ray emissivity (CR densities)
  - Templates for local structures in the gamma-ray sky related to variations of cosmic-ray density were also fit (e.g., around Cygnus and the Aquila Rift)
  - The fitting took into account the known gamma-ray point sources

new diffuse model

v03 (gll_iem_v03.fit) derived with the same method as v02.

Summary of changes:	**v02**	**v03**
grid size	0.5^0	0.125^0
pixels	boundaries at b = 0^0	row centered on b = 0^0
size	30 Mb	500 Mb
based on	10 months	24 months
# energy bands	10 (100 MeV – 10 GeV)	14 (63 MeV – 40 GeV)
	wrong high E extrapolation	improved low and high E extrapolation
	———	improved filtering of $E(B\text{-}V)_{res}$ map to remove small-scale artifacts

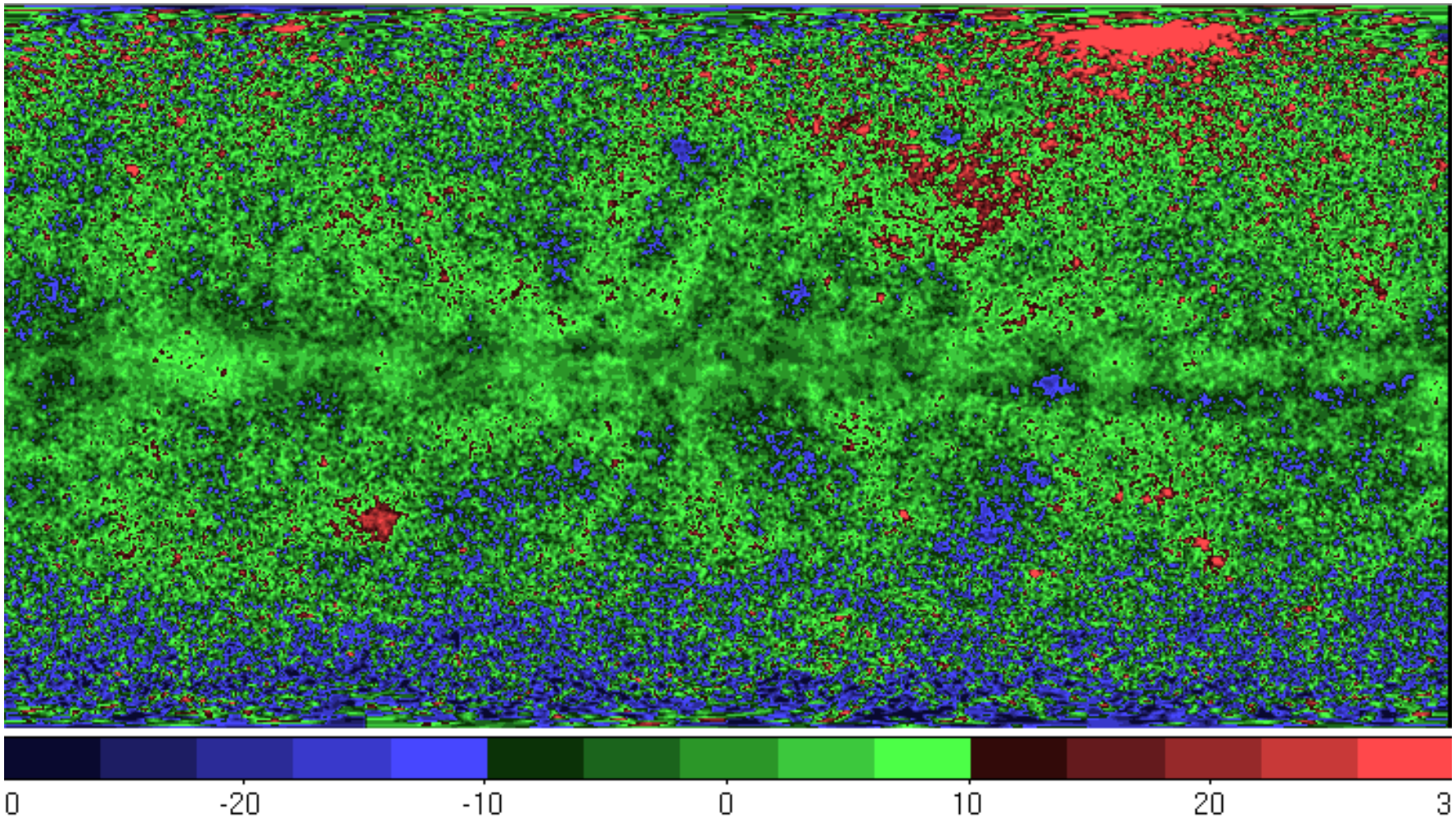
All-sky residuals in percentage for E>60 MeV.

Green is within 10%.

Note: not equal area projection

percentage, not absolute scale

(2 red flaring AGNs)



Diffuse Model

- The v03 model has been tested by the collaboration for several months. Most important, the v03 model is the input to the 2FGL catalog analysis.
- We plan to have a publication documenting the preparation and limitations of the model.
- The model should mainly be used for sources detection and identifications. Diffuse and Galactic center studies are not advised with this model**. For that, GALPROP, also developed partly within the LAT collaboration is a good alternative for those studies (WebRun, see **http://galprop.stanford.edu/webrun.php**)

** because the object of this model is to make flat residuals (spatially and spectrally) for studies of discrete sources, and contributions contributions from unresolved point sources have not been considered in developing the model. This is particularly important in the GC region.

Conclusion and questions for the FUG

- Increasing number of GI results are expected. The LAT team has tried to avoid either endorsing, criticizing or commenting technically on GI papers; restricting comments to science comments.
- Are there any problems, perceived or otherwise?

- The LAT collaboration strives to work cooperatively with the FSSC and interact well with the Fermi science community; constructive criticism and suggestions for improvement (and occasional praise) are always welcome.