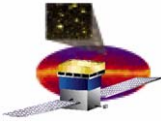


GLAST Large Area Telescope

Instrument Science Operations Center

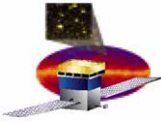
Monthly Status Review 29 June 2006

Rob Cameron
rac@slac.stanford.edu
650-926-2989

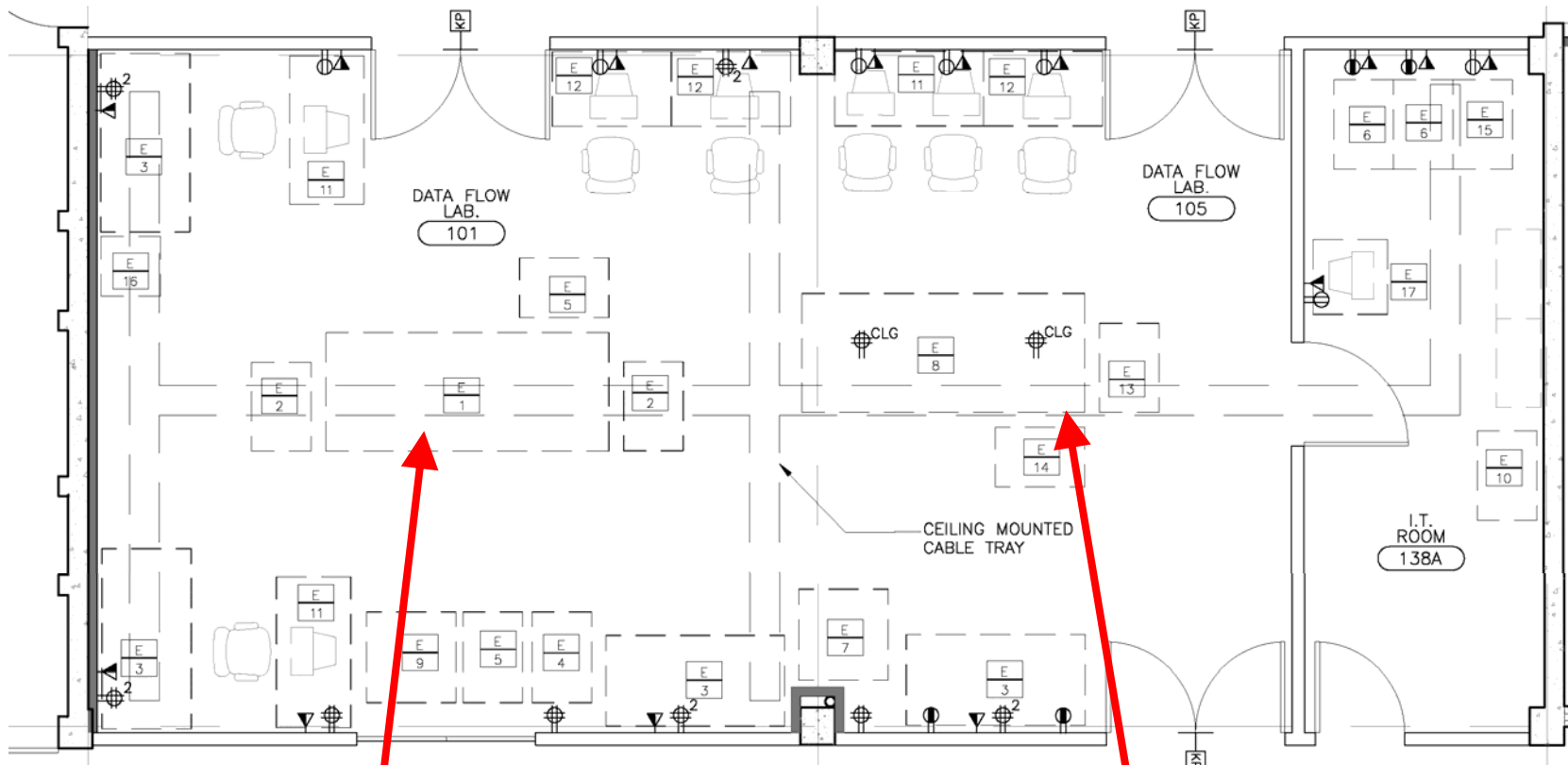


ISOC Management

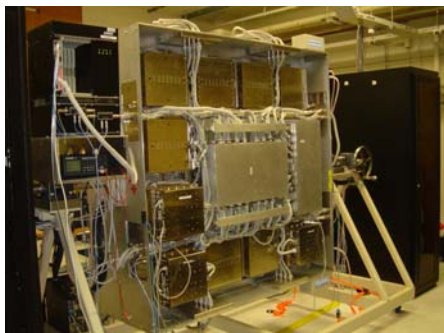
- ❑ **ISOC Operations Facility**
 - Floor plan of operations control room area finalized
 - Schematics through final review
 - Schedule
 - Aug 2006: construction starts
 - Nov 2006: Control room construction completed
 - Jan 2007: Dataflow lab extension complete
- ❑ **ISOC office consolidation in Bdg 84/Central Lab Annex**
 - Office moves well underway – majority of moves completed
- ❑ **Events**
 - Successful closeout meeting for Data Challenge 2
 - ISOC Technical review rescheduled to August 17
 - Prelim agenda prepared



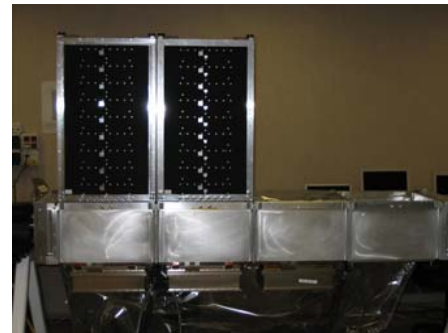
Dataflow Lab Expansion

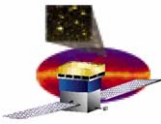


DAQ Testbed



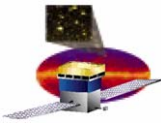
Future:
LAT
Calibration
Unit





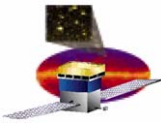
CHS Status

- ❑ **Software release 2.0 planned for 12 July**
 - Logging enhancements
 - Level 0 data input into science processing pipeline
 - “MOCTicker” – real-time data and alert server
 - Process all HK telemetry at 6x acquired rate
 - Trending enhancements
- ❑ **Acceptance testing in progress**
 - Full regression test
 - 10 new tests and 25 previously run tests
 - Acceptance testing automation (S. Condamoor)
 - 15 tests currently being automated
- ❑ **Successfully tested BAP forwarding of burst alert info to ISOC**
- ❑ **GRT 5 re-scheduled for late August (date TBD)**
- ❑ **Possible GRT 6 move to early Dec 2006**
- ❑ **NP and PROC development continuing**
 - Jon Pineau brought on to help with NP and PROC development
 - L&EO timeline being detailed



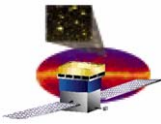
Requirements Tracking

Requirement Category	GRT					total
	2	3	5	6	7	
Misc (Facility, Redundancy, Security, Doc, etc.)	5	1	8	31	17	62
Mission Planning	2	2	1		59	64
Telemetry Processing	5	3	14	14	8	44
Science Data Processing			3	4	29	36
Telemetry Monitoring		1	5	29	3	38
Logging			4	5	1	10
Trending			20	2		22
Anomaly Tracking & Notification				16	1	17
total	12	7	55	101	118	293



CHS Software Development Activity

- ❑ **Software Releases**
 - Finalizing Release 2.0 for GRT5 support
 - Includes automated processing of L0 data to L1 “event summary” product.
- ❑ **Data Handling**
 - Monitoring & troubleshooting of automated data delivery to SVAC pipeline, including NRL network link.
 - Learning Fastcopy-related (single stream) transfer speed limits
 - Regular network monitoring implemented after network outage
 - Setup of automated data delivery for BeamTest.
- ❑ **Software Development**
 - Data model / database tables for LAT calibration trending
 - Tables match content of offline calib files for TKR, CAL, ACD
 - Inter-downlink science datagram reassembly
 - Data relay application for MOC, BAP real-time data feeds
 - Downlink-based L0 data dispatch and initial L1 pipeline processing.

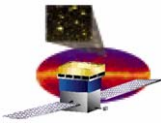


LAT Procedure Development

- ❑ Narrative procedures in development
 - 66 procedures identified for on-orbit operations
 - 17 procedures identified for LAT activation and checkout
 - Pineau currently developing LAT turn-on proc for L&EO
- ❑ Procedure need-date driven by ETE schedule

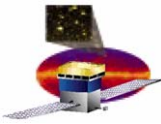
	Date	Number of Procedures	Comments
ETE 1b	Jan-07	3	All are in review stage
ETE 2	Mar-07	20	13 are in draft form, including LAT turn-on
ETE 3	Apr-07	33	
ETE 4	Jun-07	27	

- ❑ Begin validation in August (with E. Ferrara)



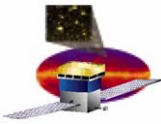
LAT Config Tools

- ❑ **FMX now deployed on MCR, being used with LICOS (Waite, Panetta)**
 - **Manages FSW logical and physical filesystems**
 - **MySQL database replicated between MCR and SLAC**
- ❑ **Several development releases of MOOT code**
 - **Python-based interface being tested with LICOS**
 - **Adapted DB queries for LICOS, and other fixes/improvements**
 - **DB replication has been demonstrated, akin to FMX**
- ❑ **Next**
 - **DB replication with ssh tunneling**
 - **Insert realistic configuration build (E. Charles)**
 - **Adapt LICOS config loading scripts such as IntSeApp.py**
 - **Support for LTC config files**



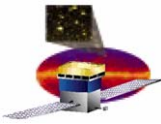
Science Operations

- ❑ **Automated Science Processing (aka Quick Look)**
 - Detailed specification of processing steps underway
 - Inputs, dependencies, algorithms, outputs (Chiang, Carson). Working with LAT Science Groups.
 - Pathfinder task (GRB localization refinement?) to be implemented in Pipeline 2
 - Needed infrastructure:
 - Pipeline2
 - Definition of processing tracking metadata
 - Command line interface to Astro data server
- ❑ **Science data product definitions being finalized for GRT 5**
 - L1 event summary data similar to DC2 products
- ❑ **Prep for ISOC technical review**
 - Defining areas of concentration in Science Operations
 - Identifying tasks and resources
 - Defining interfaces with SAS and LAT Collaboration
 - Defining minimum set of histograms to be implemented as an example to test the SAS infrastructure



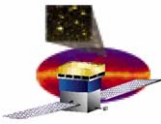
SAS: Beamtest Support

- ❑ **Reminder: starts end July at CERN**
- ❑ **Providing offline support:**
 - **Sweeping data to SLAC for processing**
 - demonstrated from Pisa – cloned svac pipeline tasks
 - **Using standard sim/recon tools**
 - Performed bulk simulations to make a matrix of particle type, energy; CU angle, position to help define experimental layout
 - **Additions to Recon for beam data**
 - Digitizations, recon, time-dependent calibrations
 - In progress
 - **Providing prompt reconstruction at the experiment**
 - Setting up a socket connection to LATTE to feed recon
 - In progress
 - **Apply Data Handling web infrastructure to BT data**
 - DataServer, Data Monitoring
 - In progress



SAS: Preparing for LAT Handoff

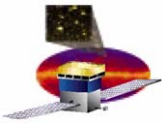
- ❑ Updated DC2 code version for account for modern thickness of blanket
- ❑ Regenerated 1 day of backgrounds + 2 M gammas to redo PSF and background analysis
 - 50k CPU-hrs done as farm-filler
- ❑ Updating recon code for new PSF Classification Trees
- ❑ Starting the redo of the background analysis
- ❑ Targeted for August



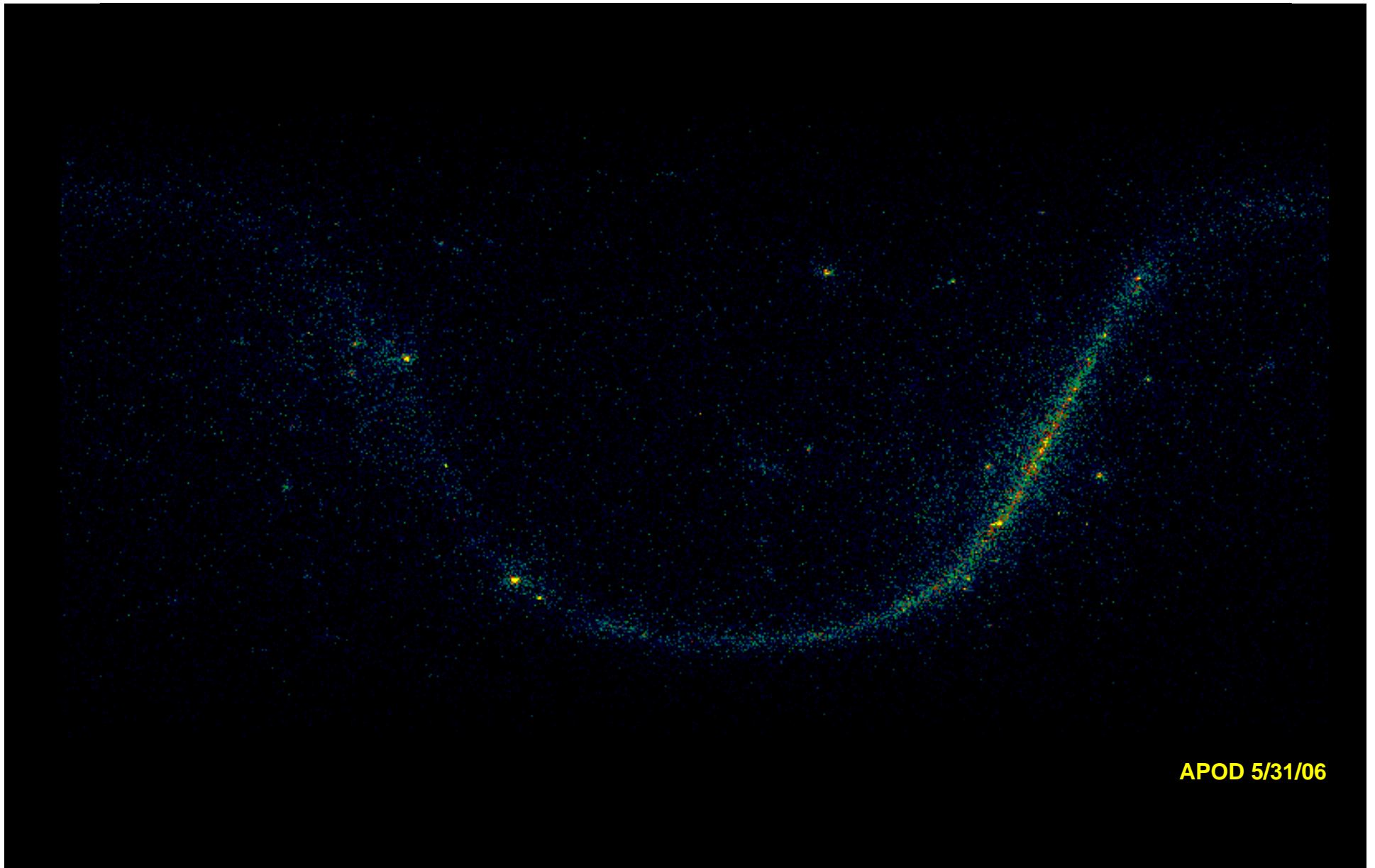
Possible SC Components

- **Target**
 - L0 'downlink' ->L1->L2 processing and product generation
 - daily operations exercises
 - calibrations; reprocessing
 - handling of anomalies
- **Possible Elements**
 - target 2 months (probably regenerated) of orbit data with DC2-like sky
 - have different calibrations for MC and Recon
 - misalign the LAT relative to the satellite
 - misalign towers relative to each other
 - we would be reconstructing data with old calibrations; and then have to reprocess
 - any actual faults? Break a something or two towards the end of the period?
 - Generate LDF/CCSDS etc for input to the reconstruction pipeline
 - break up the task into simulation/reconstruction pieces
 - Dribble the data through recon etc as per 3 hr downlinks
 - can we make runs span downlinks?
 - do 1 week of 'shifts', with run coordinator and shiftees, including overnight unattended operations?
 - Exercise "eLog" for tracking runs and shift output
 - Extract livetime and pointing histories
 - transfer of L1 products to SSC
 - approval process?
 - automated transfer and receipt
 - audit data trail
 - Exercise Data Diagnostics
 - Exercise trending of Science Data
 - Exercise ASP
 - need flaring sources
 - need list of standard sources to monitor
 - standard products to report on; web interface for export
 - (what about GRBs?)
 - transfer of L2 products to SSC(?)

**Under Discussion in the Collaboration
To be fully fleshed out for the ISOC Review**



A Glimpse of the Future

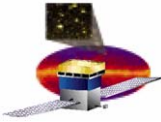


APOD 5/31/06

Data Challenge 2

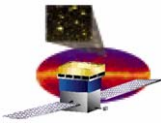


- ❑ 112 registered attendees at March kickoff meeting at SLAC
- ❑ Closeout meeting at GSFC, May 31-June 2
- ❑ Results at
 - <http://www-glast.slac.stanford.edu/software/DataChallenges/DC2/JuneCloseout/default.html>
 - Results slides borrowed from Julie McEnery summary



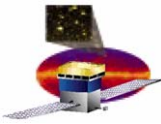
Preparations for DC2

- **Full background analysis!**
 - Tremendous collaboration effort to reduce the backgrounds to Science Requirements levels
 - Revision of background model – x4 higher than DC1 estimate
 - Detailed skymodel
 - Flaring objects; pulsars; joint GBM data(!); etc etc
 - Mechanically a huge change from DC1
 - Have to simulate backgrounds 10^3 x signal
 - 100,000 CPU-hrs to simulate 1 day of background: 5 billion events
 - Machinery to randomly interleave that day 55 times, while simulating full rate deadtime effects
 - High-stress test of processing pipeline
 - ~400 CPUs running simultaneously for a week for the backgrounds runs
 - ~200,000 batch jobs total for DC2
 - Many scaling problems fixed



DC2 Goals, requirements and purpose

- **55 days of LAT data provide a deeper view of the high energy gamma-ray sky than has previously been achieved.**
 - **Results from previous gamma-ray missions provide, at best, an incomplete guide to the DC2 sky.**
 - **Part of the challenge of DC2 will be to figure out what was included in the sky model.**
 - **DC2 data has a fairly realistic level of detail which will support a wide variety of both science and instrument performance studies.**
 - **Exercise the science tools – but don't feel restricted to them**
 - **Improve the documentation and analysis software from user feedback.**



Gamma-ray sources in the DC2 Milky Way

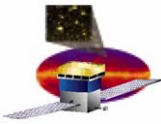
- With the exception of Pulsars, which were based on a population model and a lot of research and fiddling, we included only likely examples each source class
 - Typically associated with an already-known source (sorry Olaf & Patrizia) without attempting a pop. synthesis
- ‘Other 3EG’ means that we included all non-spurious sources from the 3rd EGRET catalog (Hartman et al. 1999) even if we did not have a specific counterpart in mind

γ -rays*

Milky Way itself (1)	1,704,807
Pulsars (414)	140,596
Plerions (7)	9780
SNR (11)	22,592
XRB (5)	1491
OB associations (4)	295
Small molecular clouds (40)	1741
Dark matter (~2)	5158
‘Other 3EG’ (120)	112,386
Sun (1 flare)	4669
Moon (1)	10,523

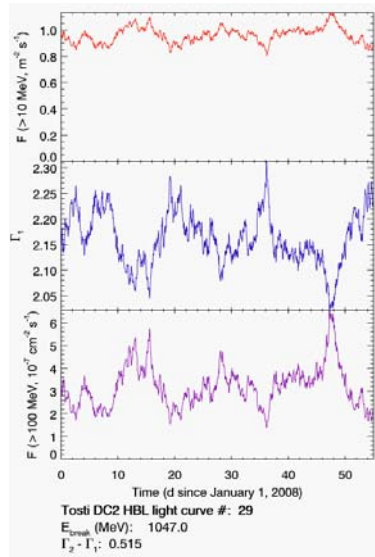
S.Digel

*Out of 3,340,146

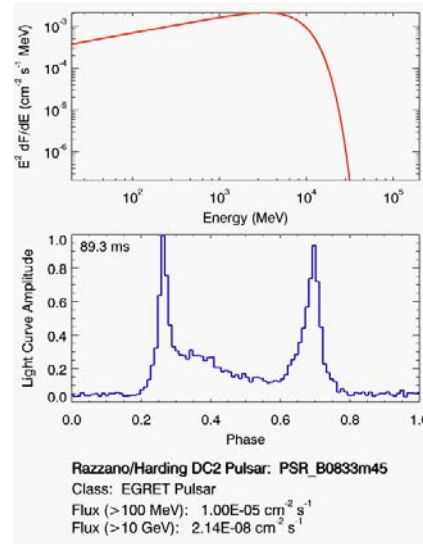


Examples of Variable Sky

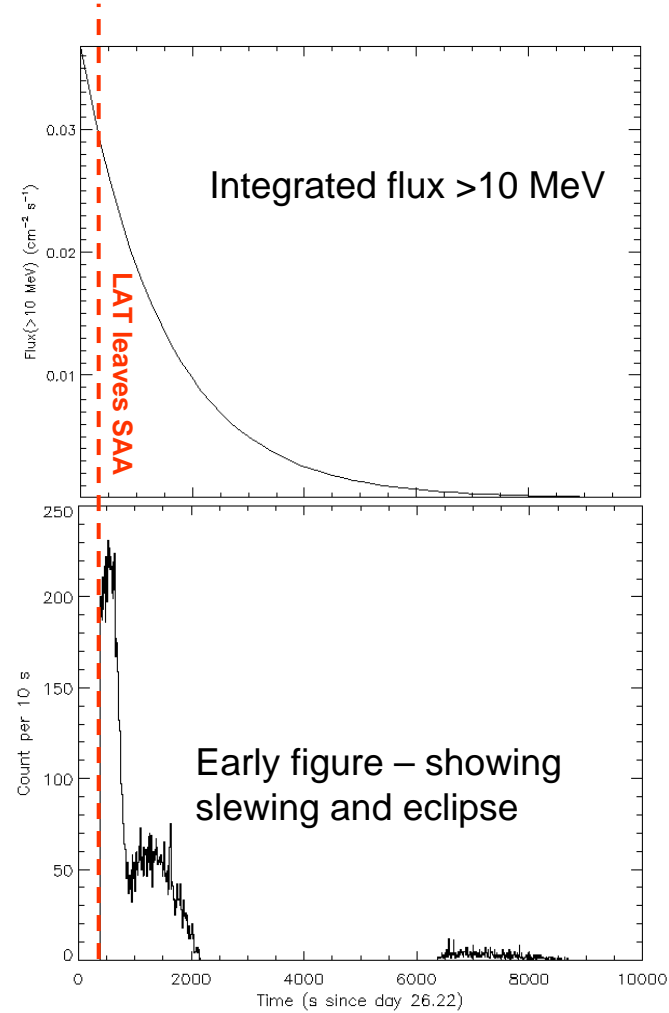
AGN: Mk 421

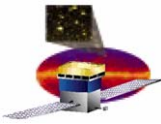


Pulsar



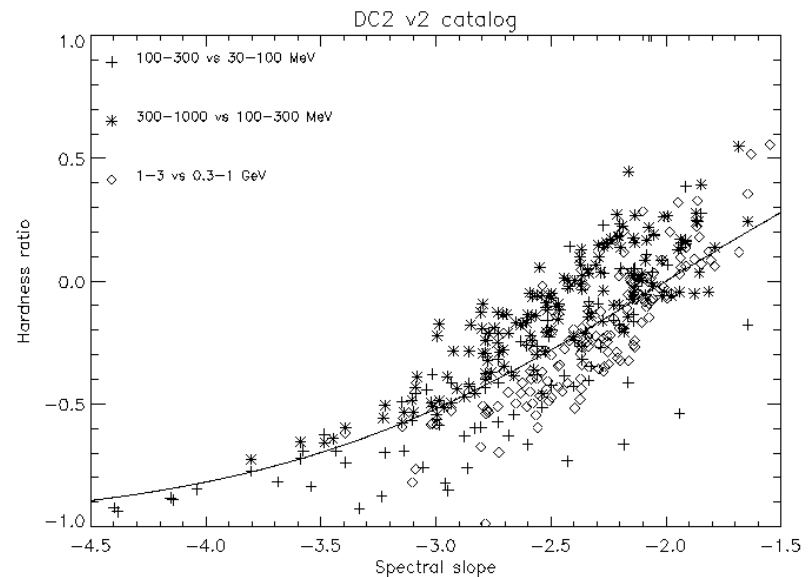
Sun





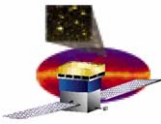
Produced LAT point source catalog

- **Requirement: Spectral index and flux (with associated uncertainties), location with 68% and 95% confidence ranges, flux in discrete energy bands.**
- **Goal: Variability index, flux history, peak flux, measure of whether a source is extended.**



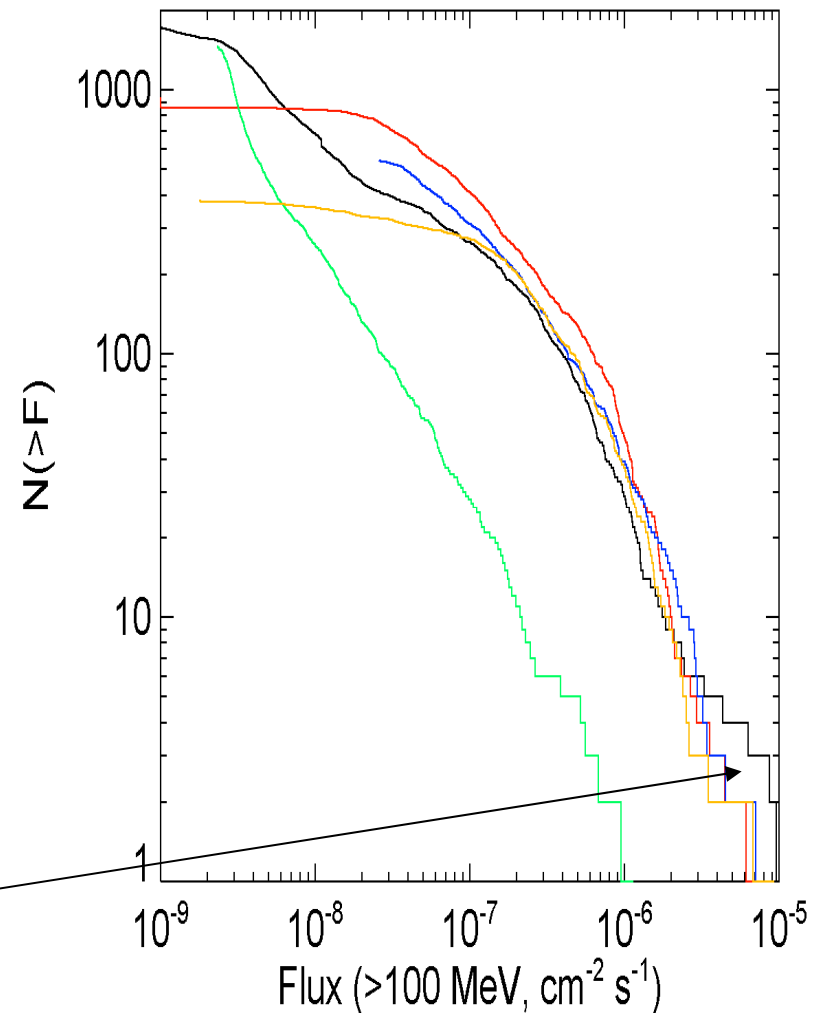
The catalog analysis and results proved to be an extremely important part of DC2. It provided a starting point for a large fraction of the more detailed source analysis and was a reference for people doing population/source detection type studies.

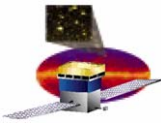
There was a somewhat higher rate of false detections than would have been expected (~10%), this needs to be understood.



Develop and test source detection algorithms

- **Requirement:** That these algorithms are tested and compared with one another in a systematic way using the DC2 data.
 - Many source detection methods developed – Stephens, Tosti, Burnett, Casandjian, Ballet, Romeo/Cillis
 - Compared with one another by Seth Digel

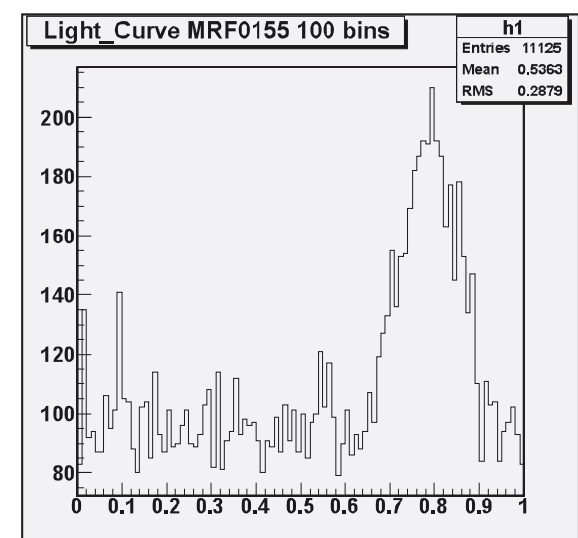
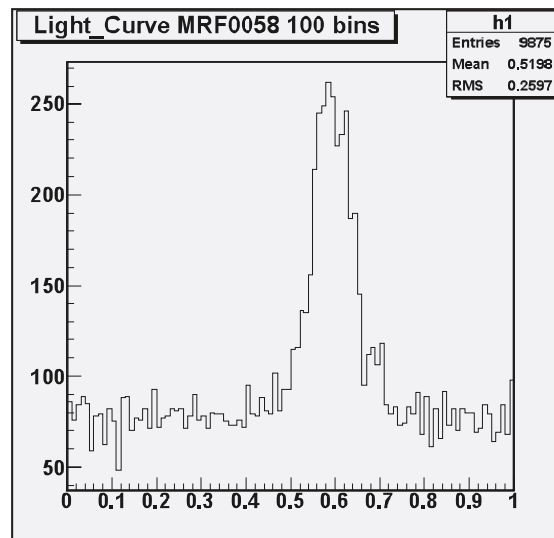
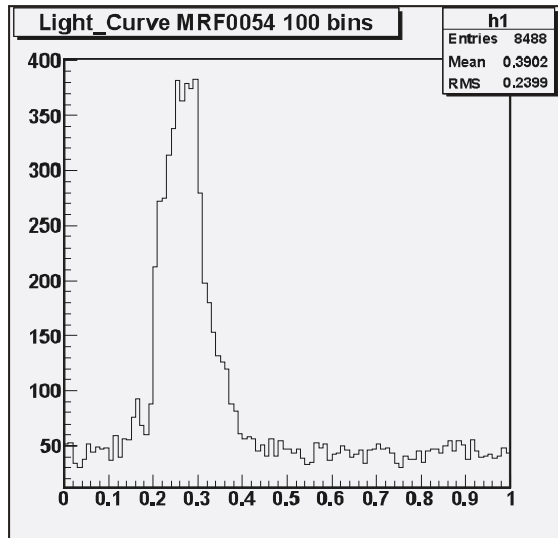




Pulsars

- Goal: blind periodicity searches on candidate DC2 pulsars
 - Use time differences to measure power
 - Look for frequency at peak power

Marcus Ziegler – lightcurves of pulsars without radio data.

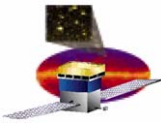


Epoch_MET = 220838550
 F0= 5.885928323969
 F1= -1.306230 e-012
 F2= 1.0 e-021

Epoch_MET = 220838550
 F0 = 3.91691474178
 F1 = -1.936137 e-013
 F2 = 6.0 e-022

Epoch_MET = 220838550
 F0 = 3.766282209980
 F1 = -3.677283 e-013
 F2 = -3.3 e-021

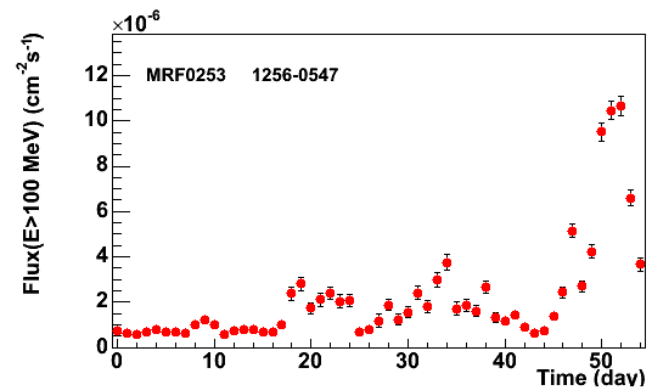
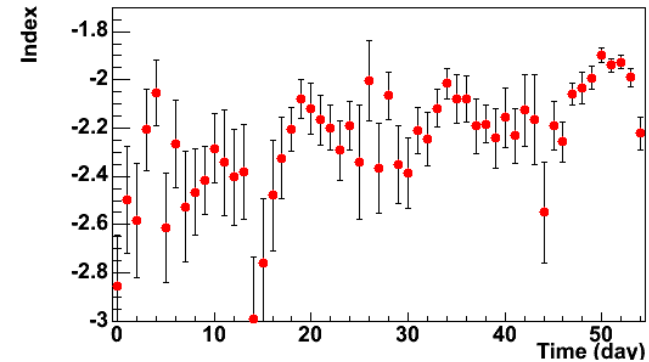
Phased light curves for radio quiet pulsars



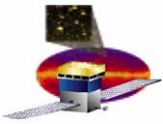
Variable sources

- Requirement: Produce lightcurves for at least 20 bright sources (from the data release plan, these are the sources we will release high level data from in year 1)
- Goal: look at lightcurves for many more sources

Source name	other name	v1 Catalog name	DRMNGB	MINUIT	simple estimate
0208-512	3EGJ0210-5055	MRF0294	light curve , file	light curve , file	light curve
PKS 0528+134	3EGJ0530+1323	MRF0194	light curve , file	light curve , file	light curve
0827+243	3EGJ0829+2413	MRF0264	light curve , file	light curve , file	light curve
Mrk421	3EGJ1104+3809	MRF0404	light curve , file	light curve , file	light curve
3C 273	3EGJ1229+0210	MRF0409	light curve , file	light curve , file	light curve
3C 279	3EGJ1255-0549	MRF0253	light curve , file	light curve , file	light curve
1406-076	3EGJ1409-0745	MRF0224	light curve , file	light curve , file	light curve
PKS1622-297	3EGJ1625-2955	MRF0362	light curve , file	light curve , file	light curve
1633+383	3EGJ1635+3813	MRF0258	light curve , file	light curve , file	light curve
1730-130	3EGJ1733-1313	MRF0020	light curve , file		light curve
3C 454.3	3EGJ2254+1601	MRF0293	light curve , file	light curve , file	light curve
LSI +61 303	3EGJ0241+6103	MRF0044	light curve , file	light curve , file	light curve
Mrk501		MRF0257	light curve , file	light curve , file	light curve
W Com	3EG1222+2841	MRF0234	light curve , file	light curve , file	light curve
1ES 1959+650		MRF0012	light curve , file	light curve , file	light curve
1ES 2344+514		MRF0351	light curve , file	light curve , file	light curve
H 1426+428		MRF0240	light curve , file	light curve , file	light curve
PKS2155-304		MRF0330	light curve , file	light curve , file	light curve



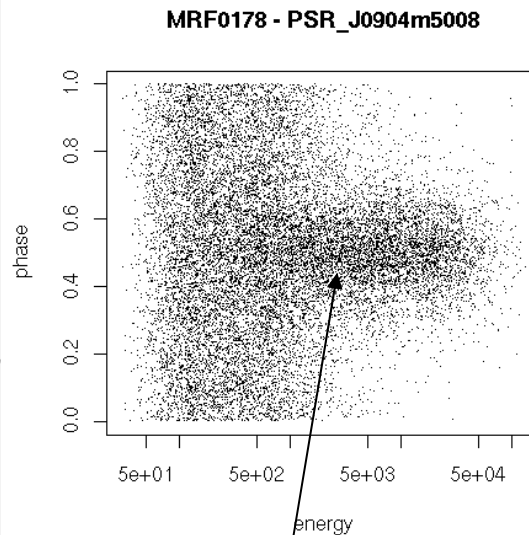
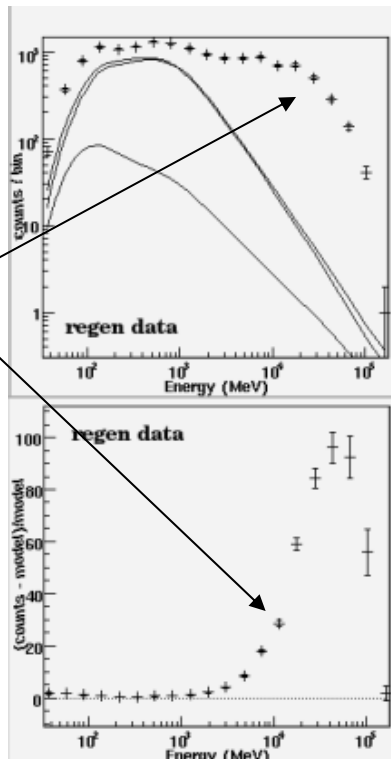
By Benoit Lott



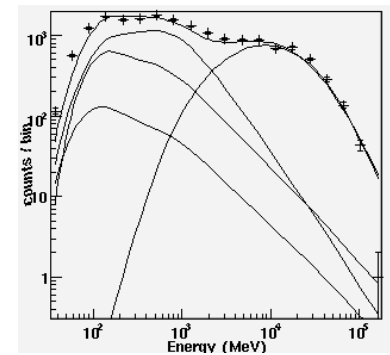
Spectral Studies

- ❑ Riccardo Rando found a source that appeared to consist of two components, a pulsed hard component and a soft, steady component.

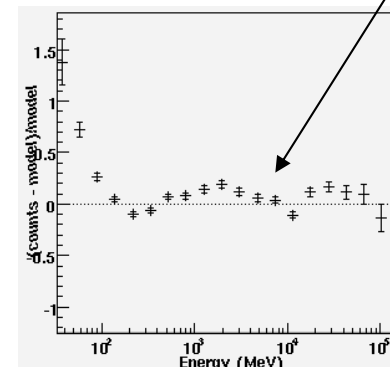
Power-law point source + background model is a very poor fit to the data

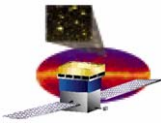


Phase vs energy plot shows that the pulsed emission dominates above 1 GeV

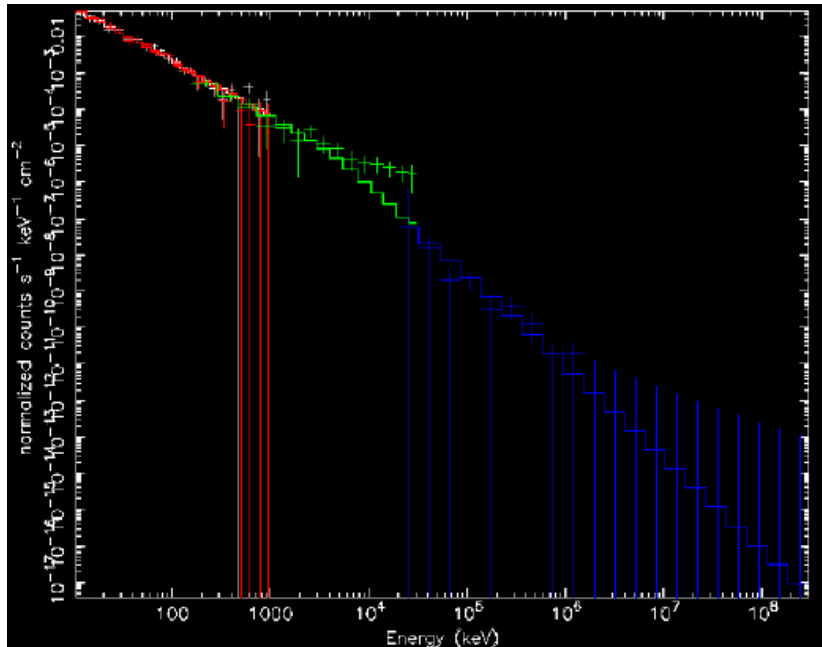


Refit with a composite source consisting of a power-law and a log normal component





Gamma-ray bursts



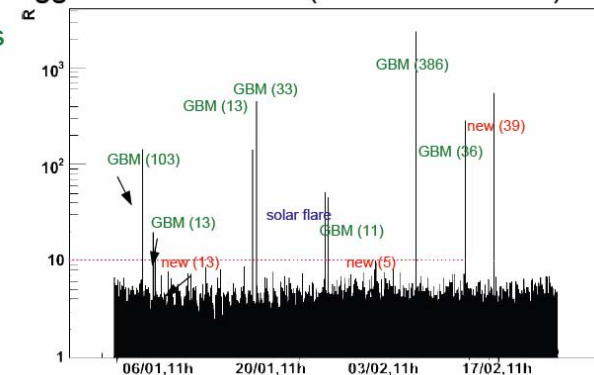
This was one of the “rejected” fits due to the strange spectrum. The cause is likely to be because this GRB was simulated with an additional “hard” extended component lasting for 400s.

GRB08015885 – Nukri Komin

132 generated in 4π
 64 bursts seen in GBM
 25 in LAT; 16 with $> 4 \gamma$

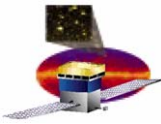
Blind GRB Search

- spikes in LAT trigger rate $R = 10/\Delta t$ (rate for 10 events)
- 7 GBM bursts
- 3 new bursts
- 1 solar flare



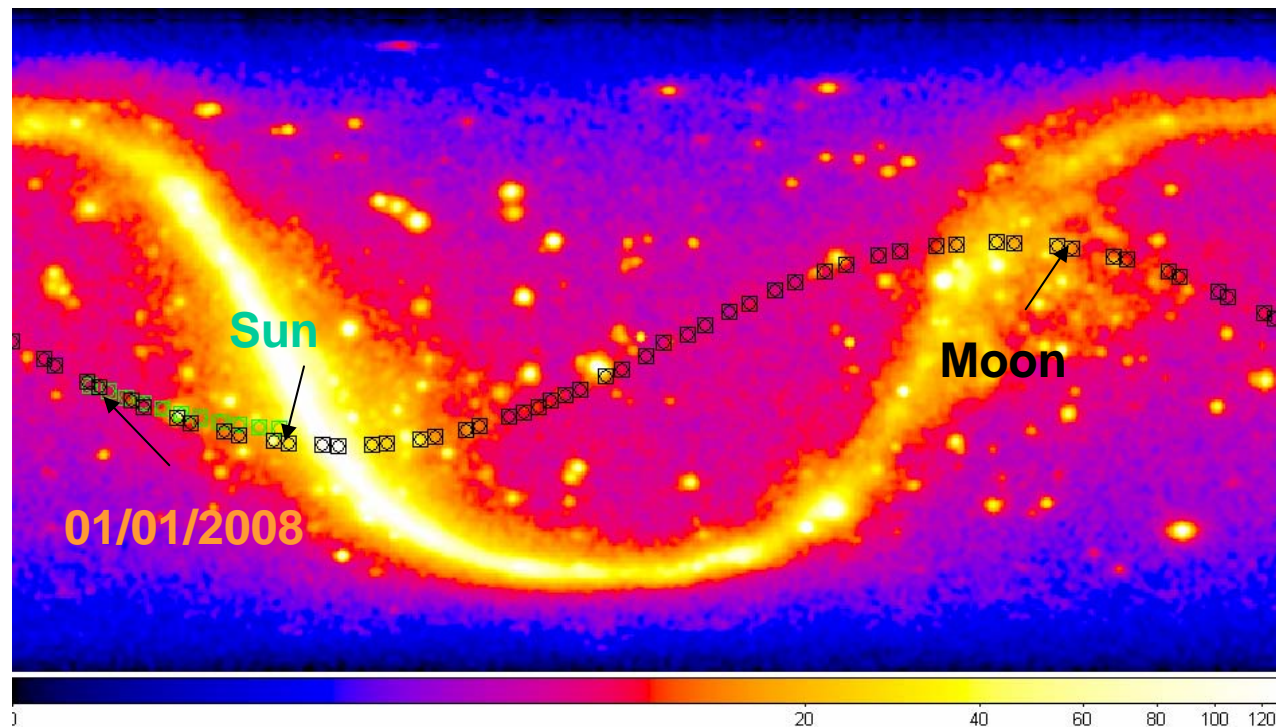
```
root [0] .L GRBsearch.C+
root [1] GRBsearchMulti(
end with ';', '@':abort > "LAT_allsky*.fits.root"
end with ';', '@':abort > 10,10)
```

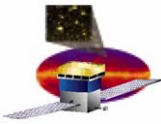
DC2 close out, GSFC, 31/05/06



Other sources

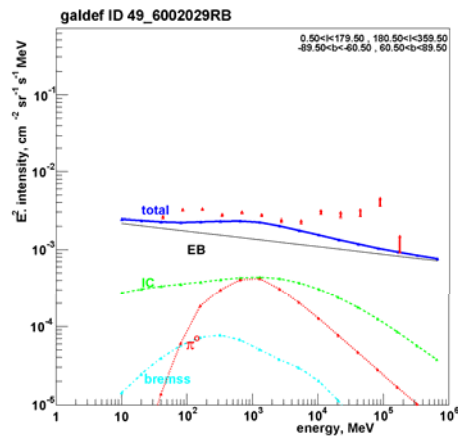
- ❑ Requirement: Identify at least one source that is not a pulsar, AGN or GRB (there are some that can be identified from the gamma-ray data)
- ❑ Moon (Tosti, Rando)
- ❑ Sun (Tosti, Chiang)



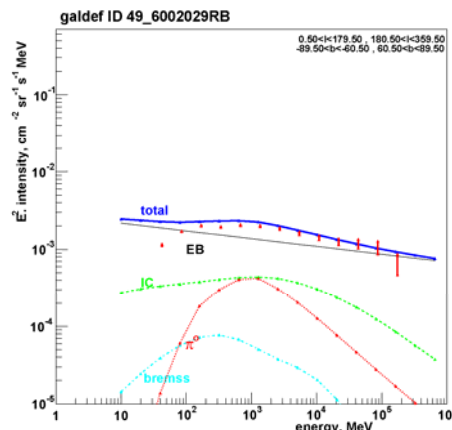


Diffuse Emission

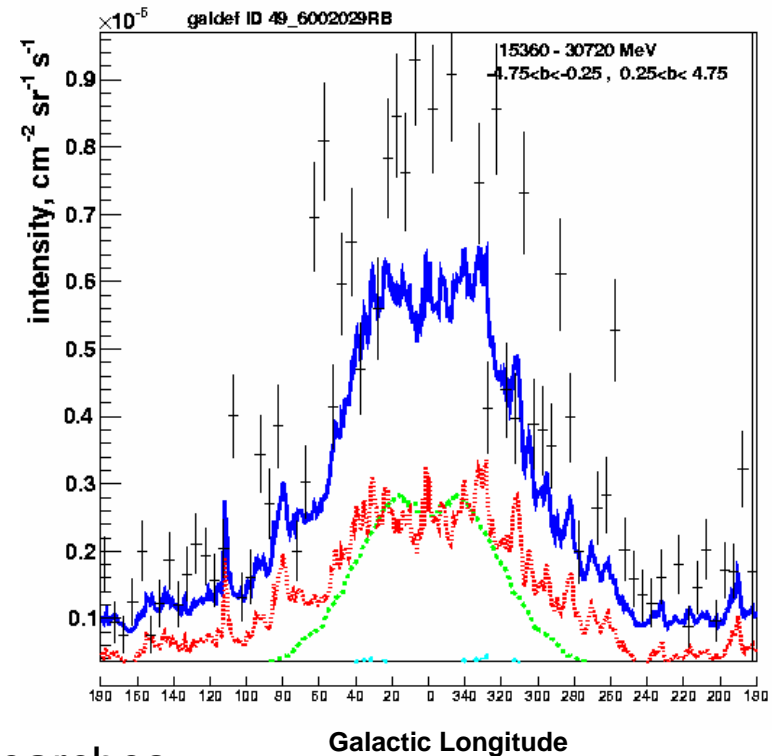
- Goal: Study flux, spectra and spatial distribution of the galactic diffuse and compare with the diffuse model provided for source analysis.
- Studied by Jean Marc Casanjan, Andy Strong and Larry Wai



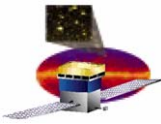
Full sim



Fast sim
No resid bkg

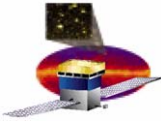


Diffuse is background to non-linear dark matter searches



Beyond DC2

- ❑ **The DC2 sky is probably the best rendition to date of the gamma ray sky**
 - a great dataset for future development
 - 55 days of simulated downlink to practice with
 - Testing of Data Monitoring
 - Develop ASP
- ❑ **Planning for third Data Challenge is starting:**
 - Further coordinated science group studies – multiple simulation datasets; no “secret sky”
 - ISOC service challenges and operations rehearsals – prepare for Science Operations
 - Joint activity between ISOC and LAT science groups – prepare for early operations analyses, first light observations, analysis tuning, background measurement ops, survey & pointed ops, ...



ISOC “Service Challenge”

- **Target**
 - L0 'downlink' ->L1->L2 processing and product generation
 - daily operations exercises
 - calibrations; reprocessing
 - handling of anomalies
- **Possible Elements**
 - target 2 months (probably regenerated) of orbit data with DC2-like sky
 - have different calibrations for MC and Recon
 - misalign the LAT relative to the satellite
 - misalign towers relative to each other
 - we would be reconstructing data with old calibrations; and then have to reprocess
 - any actual faults? Break a something or two towards the end of the period?
 - Generate LDF/CCSDS etc for input to the reconstruction pipeline
 - break up the task into simulation/reconstruction pieces
 - Dribble the data through recon etc as per 3 hr downlinks
 - can we make runs span downlinks?
 - do 1 week of 'shifts', with run coordinator and shiftees, including overnight unattended operations?
 - Exercise "eLog" for tracking runs and shift output
 - Extract livetime and pointing histories
 - transfer of L1 products to SSC
 - approval process?
 - automated transfer and receipt
 - audit data trail
 - Exercise Data Diagnostics
 - Exercise trending of Science Data
 - Exercise ASP
 - need flaring sources
 - need list of standard sources to monitor
 - standard products to report on; web interface for export
 - (what about GRBs?)
 - transfer of L2 products to SSC(?)

**Under Discussion in the Collaboration
To be fully fleshed out for the ISOC Review**