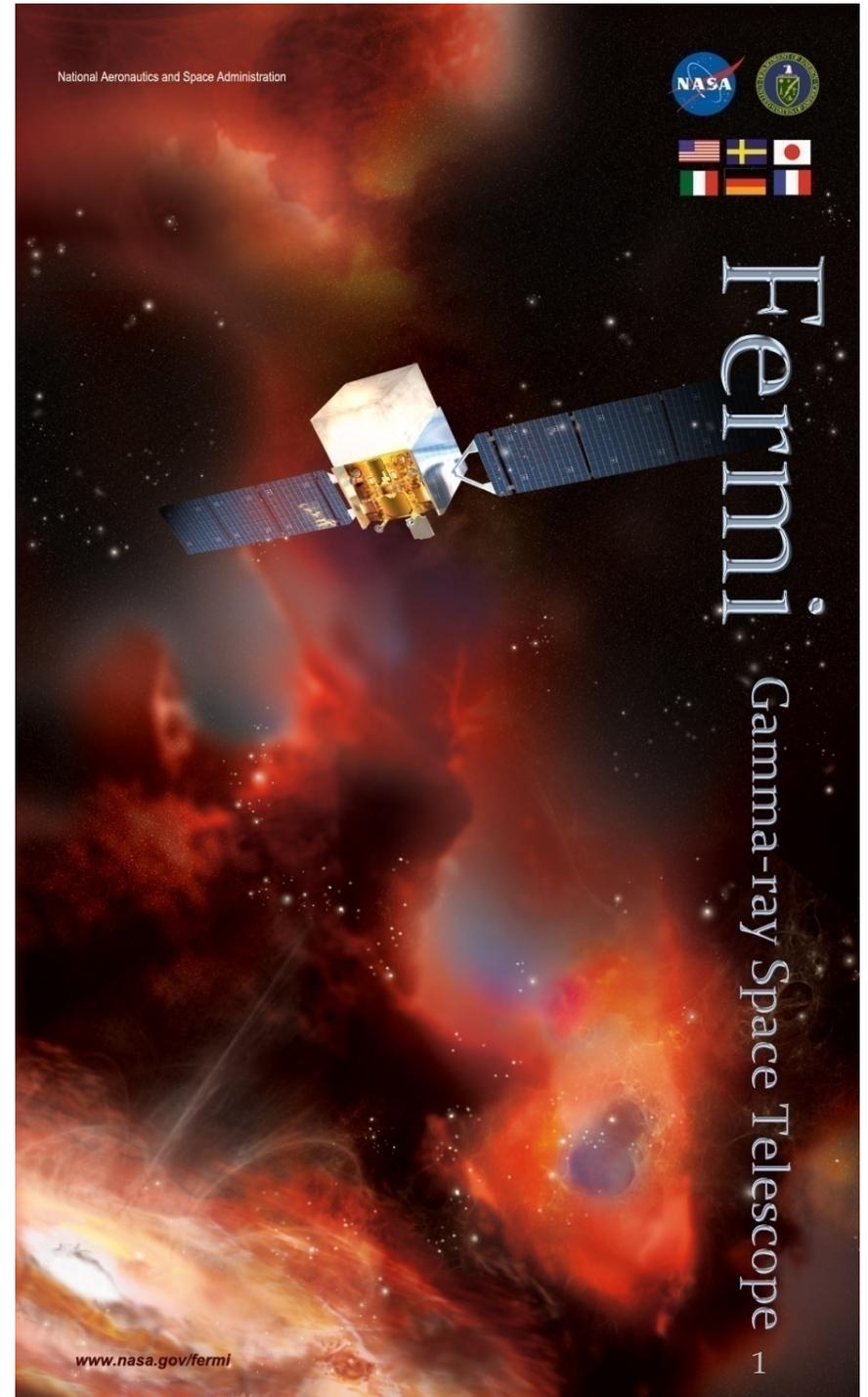


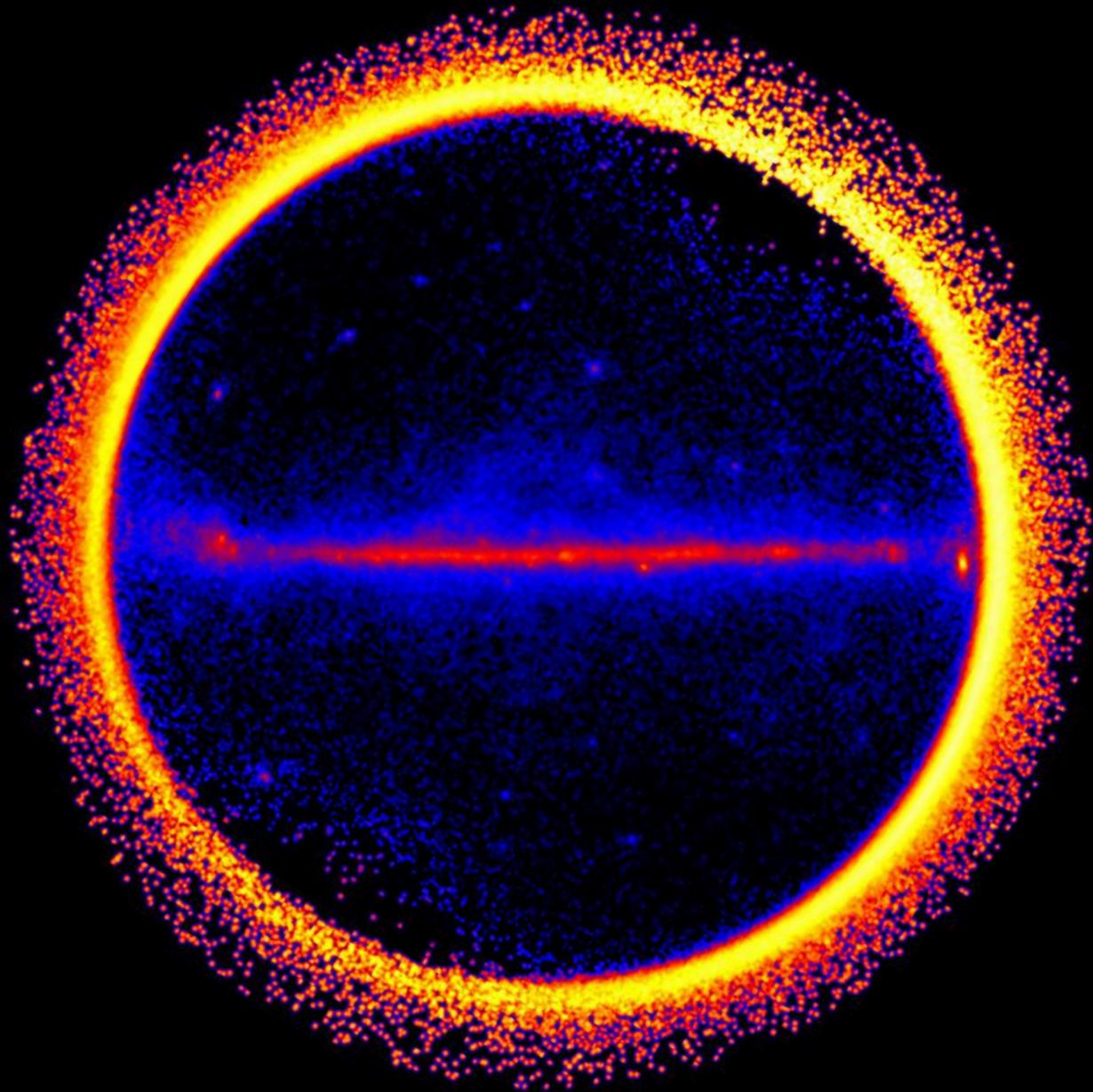
# Fermi LAT Status Report

**Peter F. Michelson  
Stanford University**

via  
**Neil Johnson  
NRL**

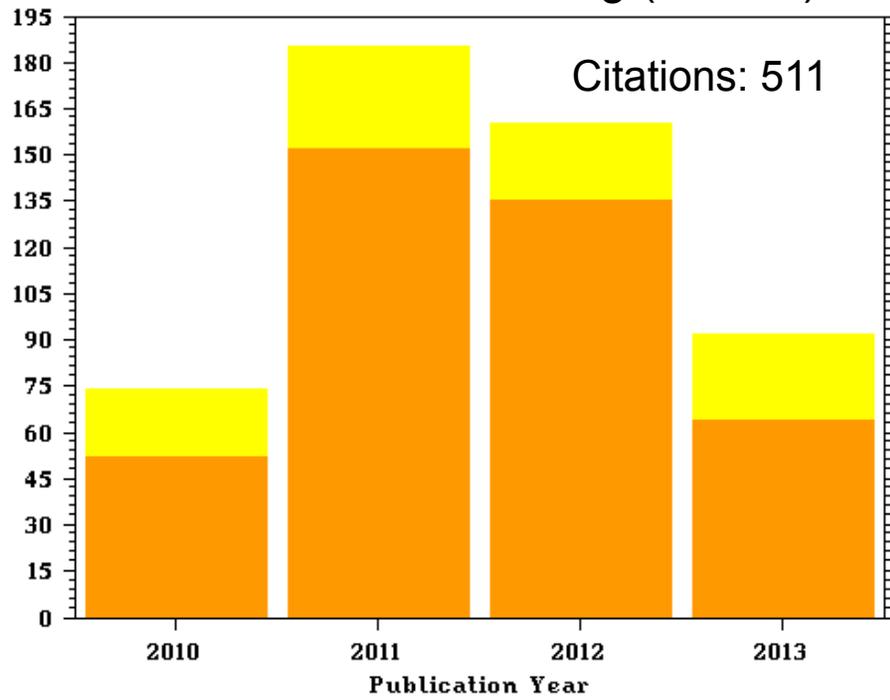
Fermi User Group meeting  
December 12, 2013



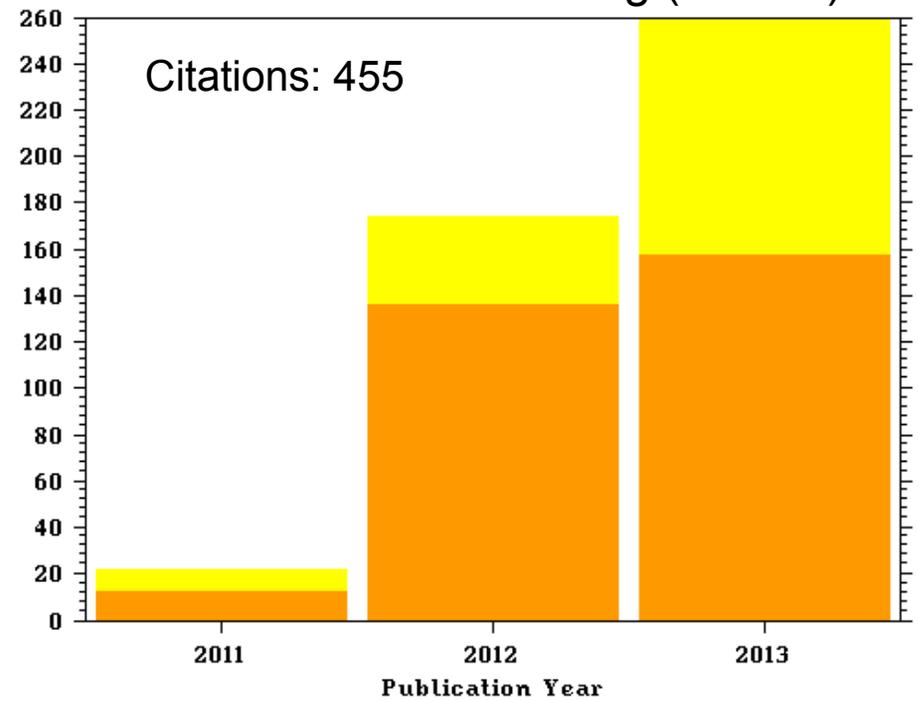


- Fermi LAT Collaboration is very busy and productive
  - maintaining coverage in all areas due to multitasking by many collaboration members;
  - several important papers published in 2013, including
    - The First Fermi-LAT Gamma-Ray Burst Catalog
      - ApJS 209, id. 11, 11/2013
    - The First Fermi-LAT Catalog of Sources above 10 GeV
      - ApJS 209, id. 34, 12/2013
    - The Second Fermi Large Area Telescope Catalog of Gamma-Ray Pulsars
      - ApJ 208, id. 17, 10/2013
    - The Fermi All-sky Variability Analysis: A List of Flaring Gamma-Ray Sources and the Search for Transients in Our Galaxy
      - ApJ 771, id. 57, 7/2013
- Instrument operation is stable
- Pass 8 reprocessing nearly complete: validation process beginning; will be major activity in 2014

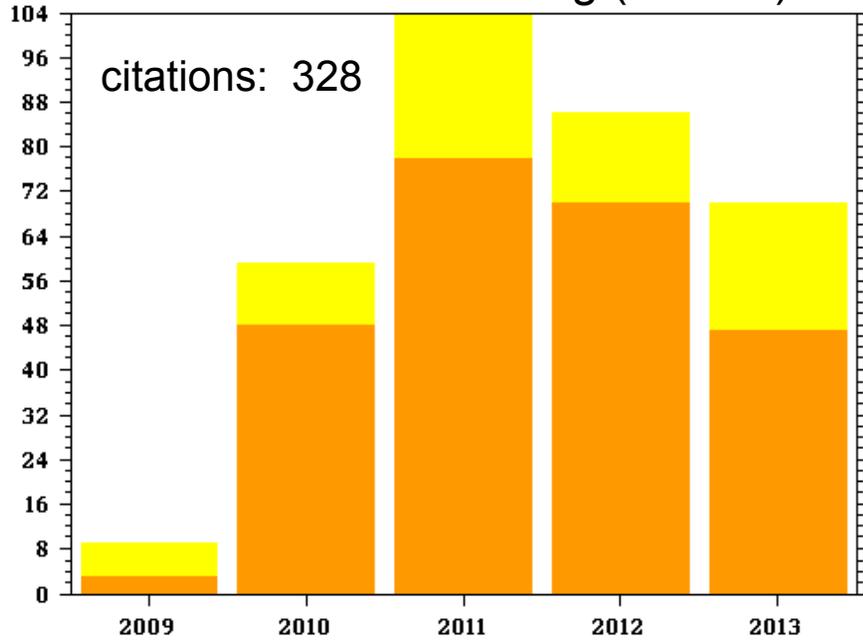
1<sup>st</sup> LAT Source Catalog (6/2010)



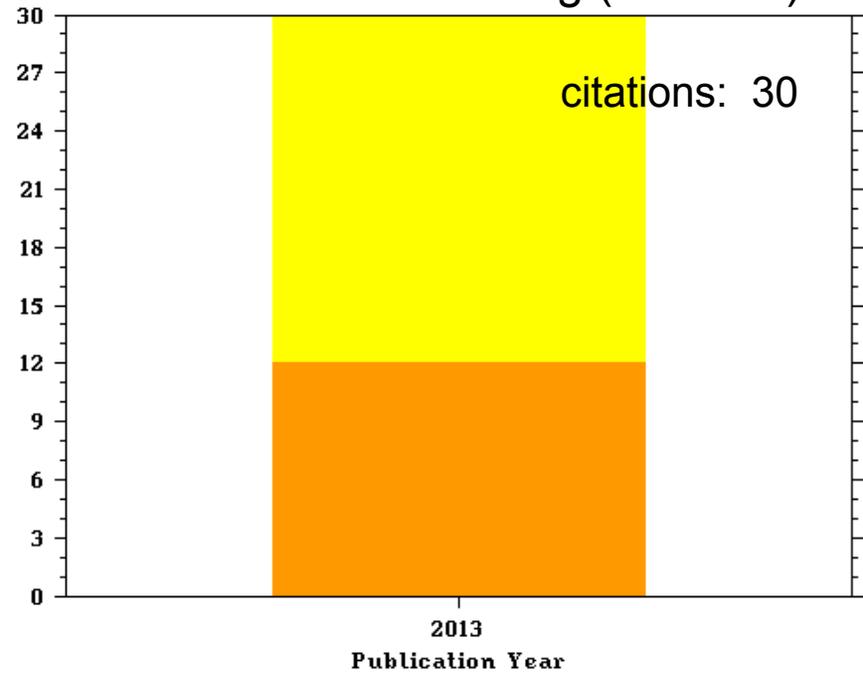
2<sup>nd</sup> LAT Source Catalog (4/2012)



1<sup>st</sup> LAT Pulsar Catalog (4/2010)



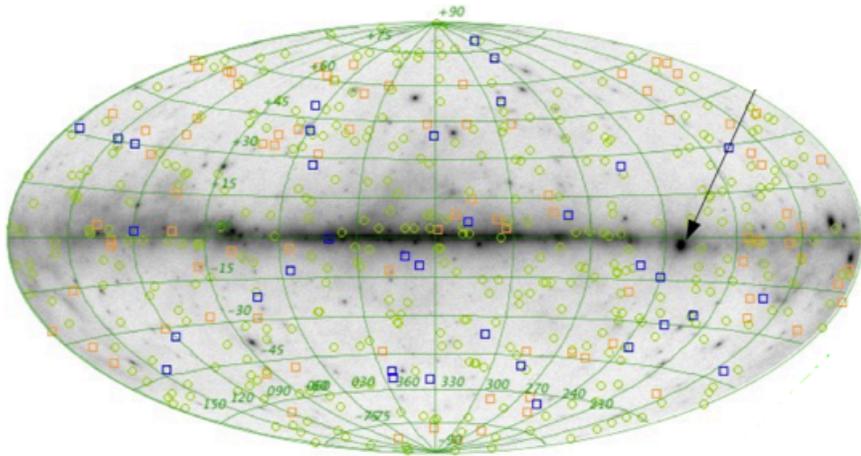
2<sup>nd</sup> LAT Pulsar Catalog (10/2013)



# new LAT catalogs

## 1<sup>st</sup> LAT-GRB Catalog

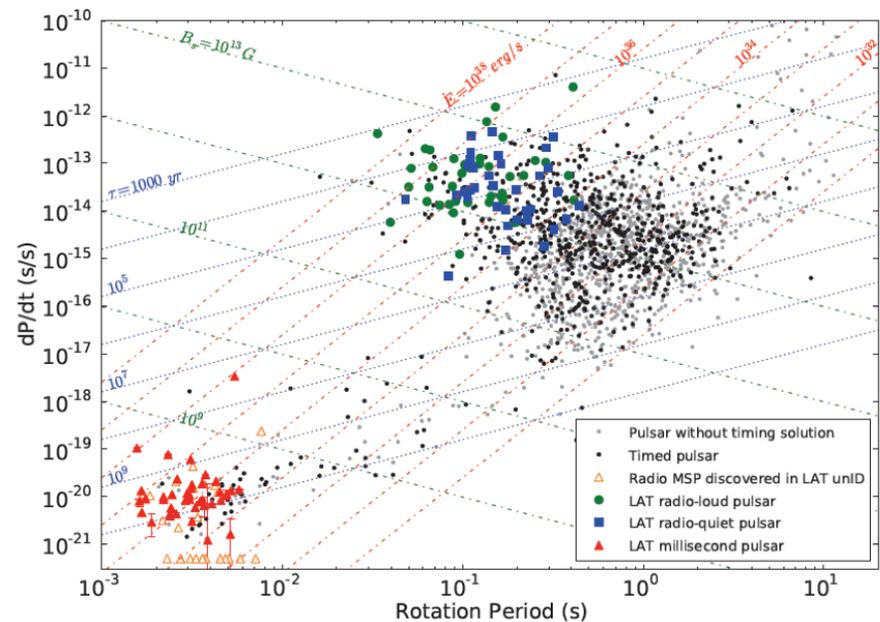
- 35 LAT GRBs / 3 years
- Delayed HE emission
- Longer HE duration
- Evidence for multi-component spectra



2013 ApJS..209...11A

## 2<sup>nd</sup> Pulsar Catalog (2PC)

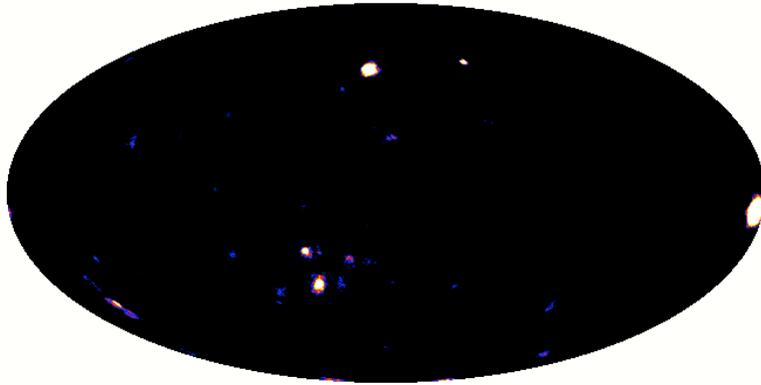
- 117 PSR
- ms PSR, radio-quiet populations
- emission away from star



2013 ApJS..208...17A

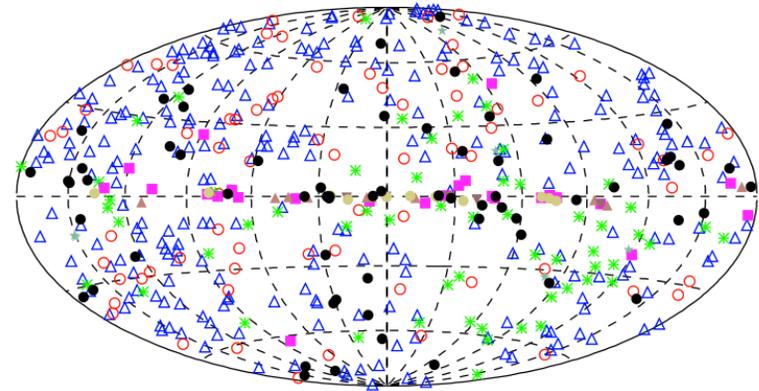
# new LAT catalogs

- Fermi All-sky Variability Analysis (FAVA)
  - Looks for relative variations
  - Correlates well with full likelihood analysis (ATels)
  - 215 flaring sources



2013 ApJ...771...57A

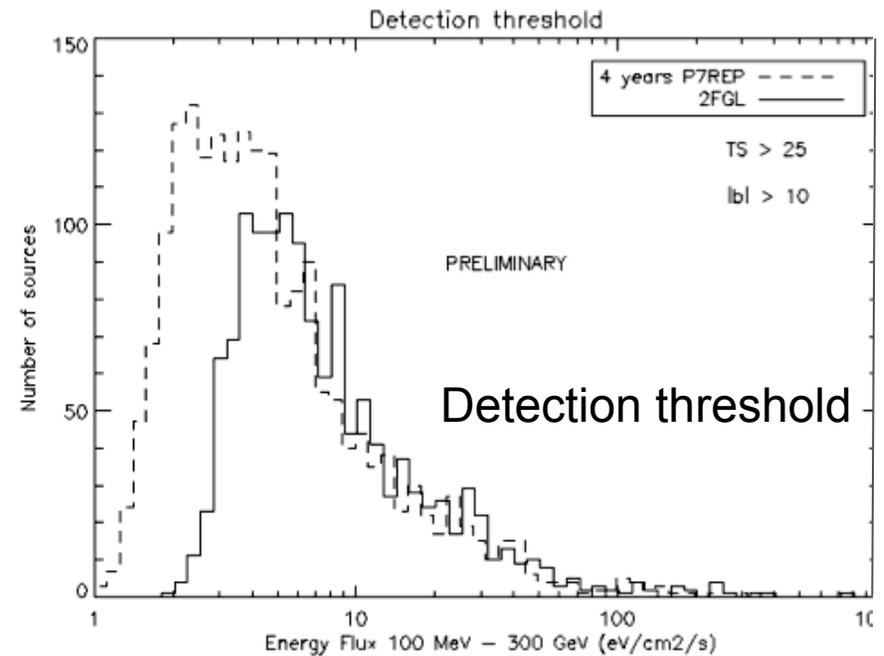
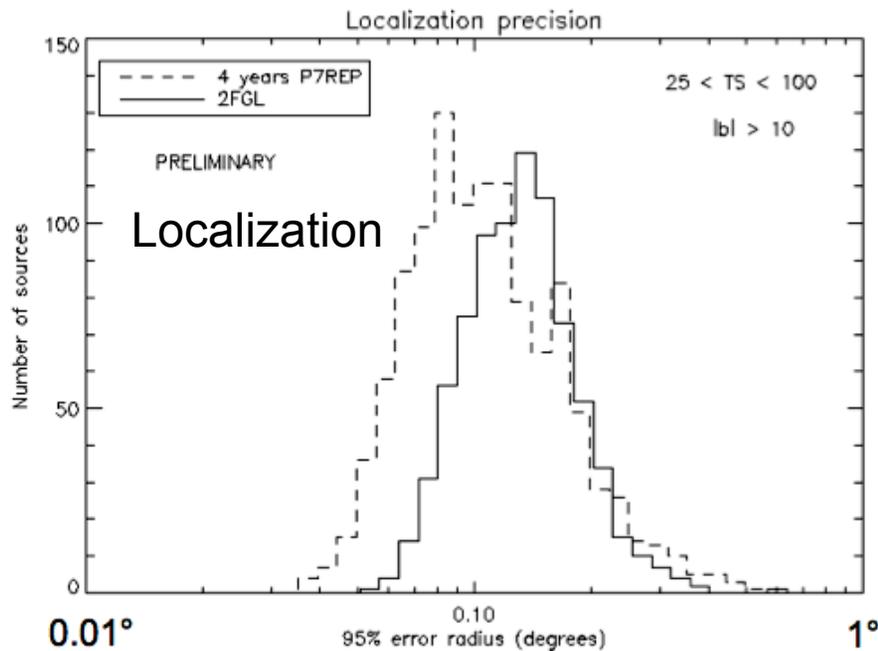
- 1<sup>st</sup> Fermi Hard source List
  - 514 source above 10 GeV
  - Not just an energy cut of the standard catalog → dedicated analysis
  - Variability and population studies



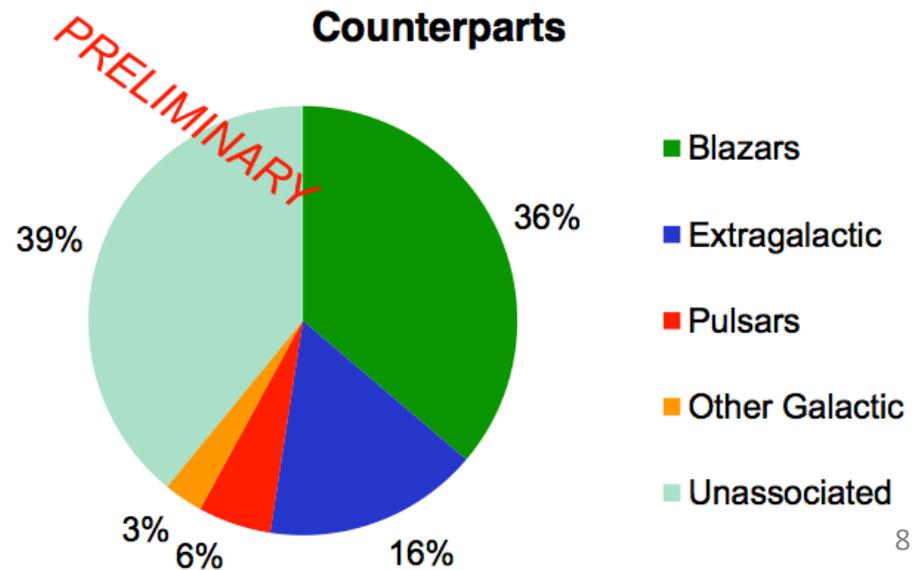
△	BL Lac	○	FSRQ	*	AGNs of unknown type
■	PSR	▲	SNR	▽	PWN
●	Other Galactic objects	*	Other (non-beamed) Extragalactic objects	●	No association

2013 ApJS 209:34

# towards 3<sup>rd</sup> Fermi LAT Catalog (3FGL)



- 4 years P7REP data, V15 IRFs and associated diffuse model
- Significantly deeper than 2FGL (threshold from 5 to 3 ergs/cm<sup>2</sup>/s)
- ≥ 2500 sources



# LAT multiwavelength synergies

- Radio, optical, X-ray, TeV
- Pulsars, GRBs, AGNs, galactic transients (e.g. novae)

LAT has generated:

257 Astronomer's Telegrams (~1 / week)

61 GCN notices = 61

 **MW follow ups**

# GRB130427A: most recent science in the press

21 November 2013 Last updated at 14:19 ET 467 Share

## Gamma-ray burst brightest ever seen

By Rebecca Morelle  
Science reporter, BBC World Service



EARTHSKY // SCIENCE WIRE, SPACE RELEASE DATE: NOV 21, 2013

### April 2013 gamma-ray burst may call for rewrite of theories

Observations of the powerful gamma-ray burst of April 2013 didn't match energy levels predicted by the standard models, say astronomers at Stanford University.

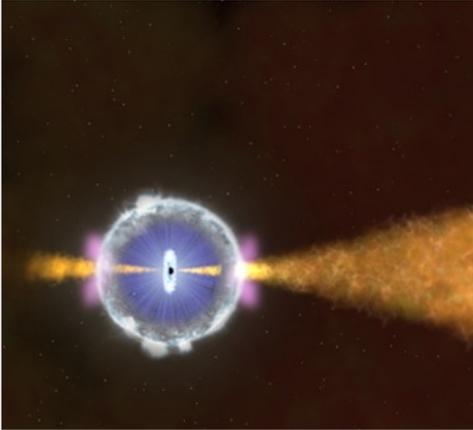
In April 2013, an incredibly bright flash of light burst from the direction of the constellation Leo. Originating billions of light-years away, this explosion of light, called a *gamma-ray burst*, has now been confirmed as the brightest gamma-ray burst ever observed. Astronomers around the world were able to view the blast in great detail and observe several aspects of the event for the first time ever, according to a [press release](#) issued today from Stanford University.

**A cosmic explosion has been analyzed.** These astronomers said the data could lead to a rewrite of standard theories of how gamma-ray bursts work.

The blast of a year by space brightest ever

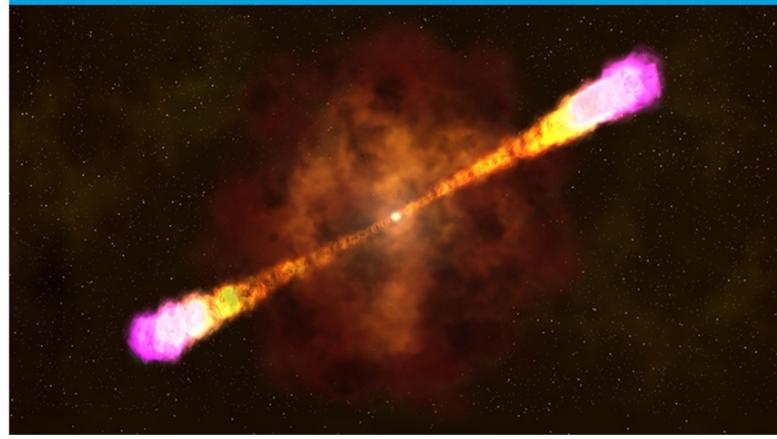
Researchers look at the Sun.

The findings are



dimensions of particle physics  
**symmetry**  
A joint Fermilab/SLAC publication

home departments science topics image bank archives



breaking  
November 21, 2013  
**Cosmic explosion calls theory into question**  
Observations of a rare cosmic explosion challenge scientists' theoretical understanding of how gamma-ray bursts work.

Courtesy of NASA's Goddard Space Flight Center

## 'Monster' cosmic blast zipped harmlessly by Earth

Posted: Nov 21, 2013 11:23 AM PST  
Updated: Nov 21, 2013 1:24 PM PST

By SETH BORENSTEIN  
AP Science Writer

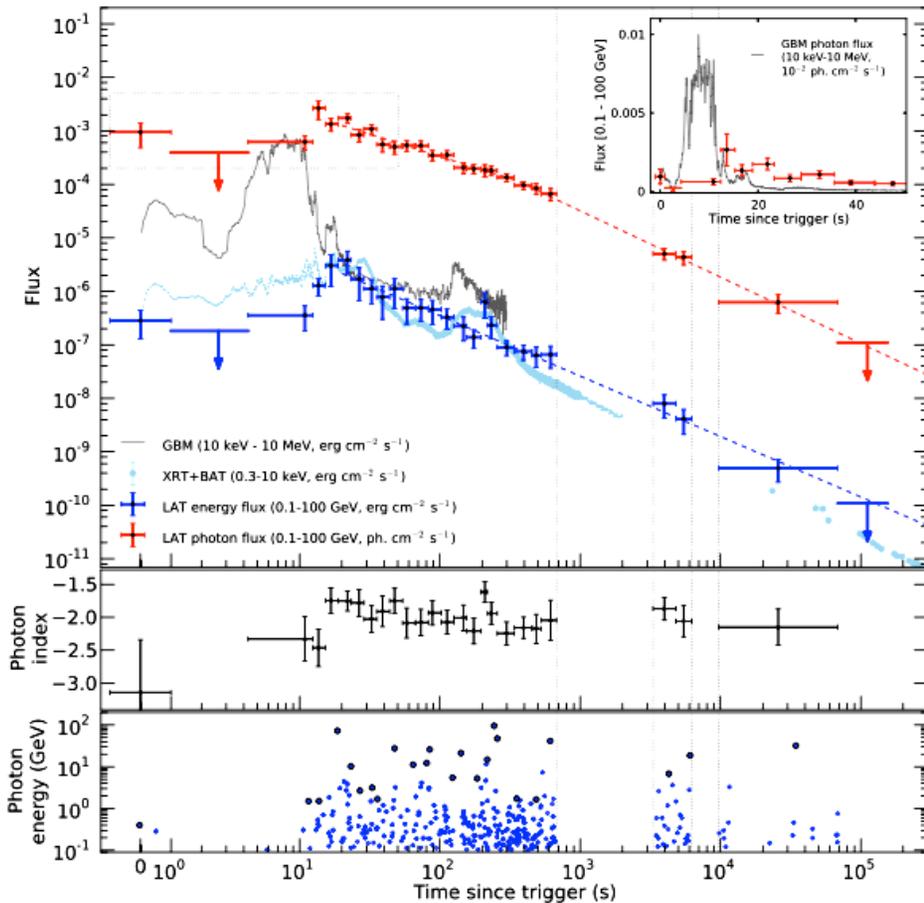
WASHINGTON (AP) - Astronomers call it the monster. It was the biggest and brightest cosmic explosion ever witnessed. Had it been closer, Earth would have been toast.

Orbiting telescopes got the fireworks show of a lifetime last spring when they spotted what is known as a gamma ray burst in a far-off galaxy.

The only bigger display astronomers know of was the Big Bang - and no one, of course, was around to witness that.

"This burst was a once-in-a-century cosmic event," NASA astrophysics chief Paul Hertz said at a news conference Thursday.

# GRB130427A



## ☐ record-breaking

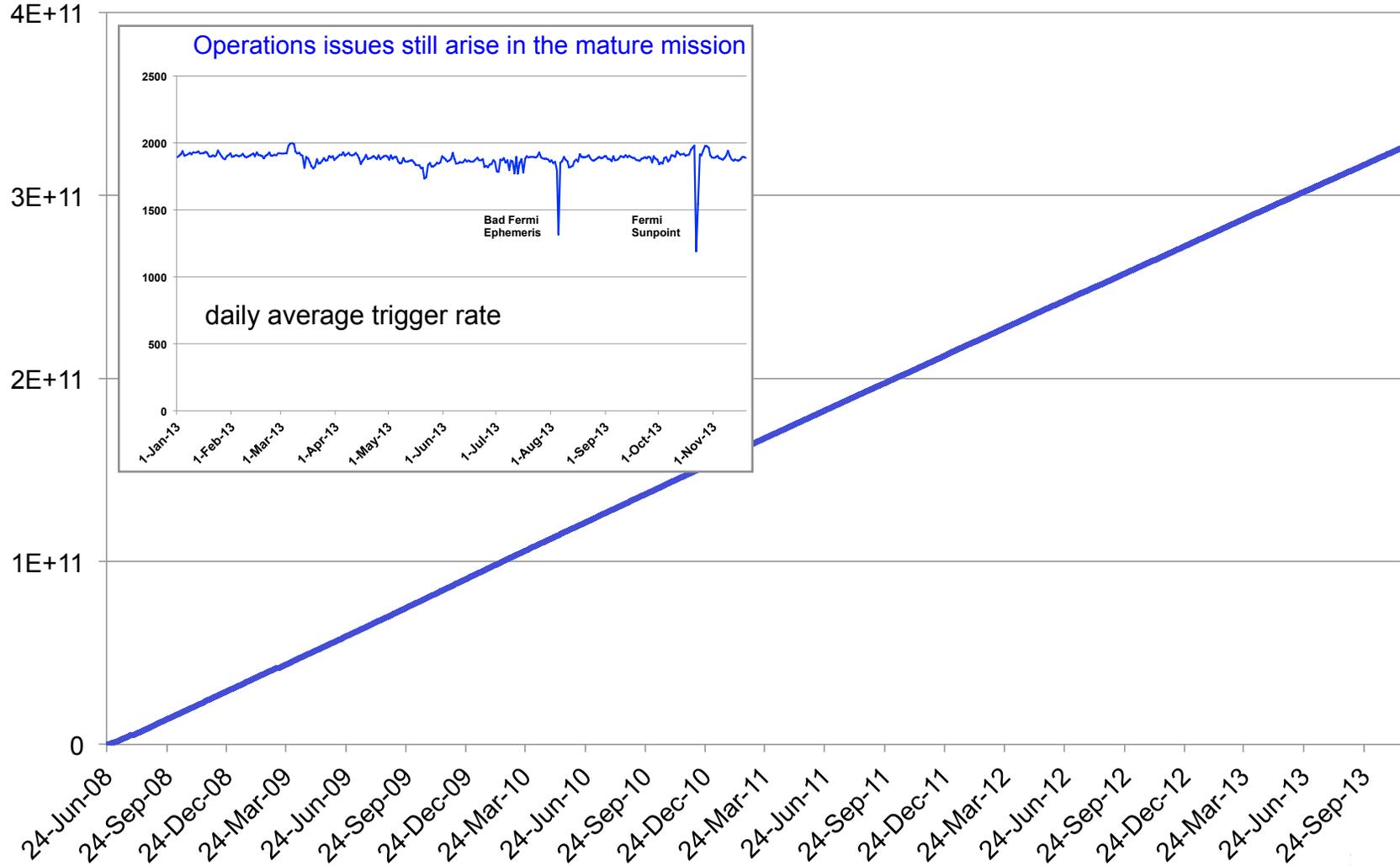
- highest  $\gamma$ -ray fluence ( $>10^{-3}$  erg cm<sup>-2</sup>)
- highest observed  $\gamma$ -ray energy (95 GeV)
- longest lived  $\gamma$ -ray emission (19 hours)
- second brightest optical flash (7th magnitude)
- within the closest 5% of GRBs ( $z = 0.34$ )

☐ 5 coordinated papers (with SWIFT, GBM, Raptor, NuStar) Science (Nov 21), and ApJL

# LAT Instrument Operations

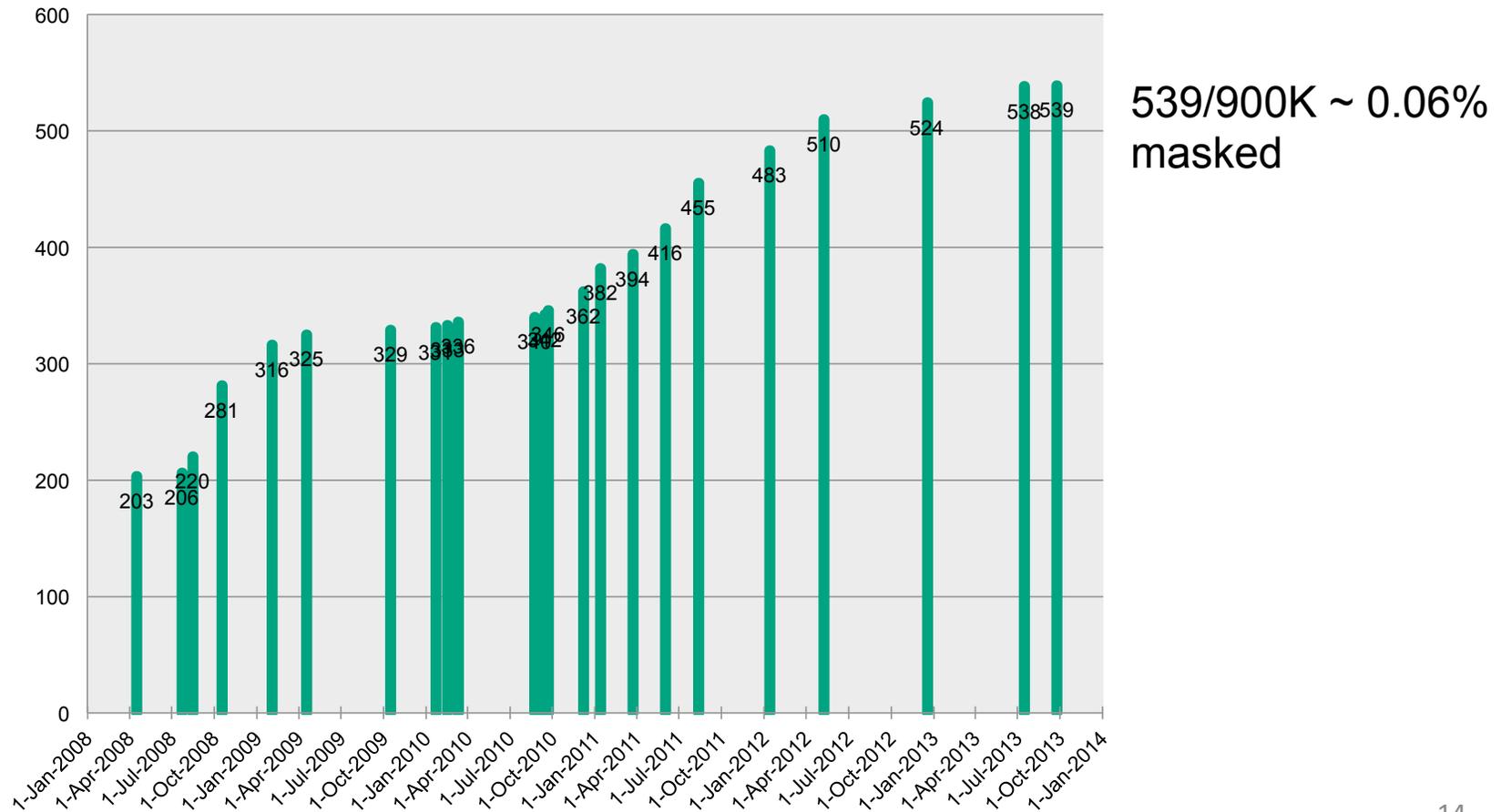
# LAT trigger count since activation

99.8% uptime for LAT data-taking



# LAT Tracker Si Strip masking

- ❑ rate of strip masking has slowed, as growth of noise on layer 35 of TKR 3 has slowed
- ❑ need for masking new strips is now assessed monthly



# Recent ISOC Operations highlights

- ❑ 2013 September 10: File transfer interface to NASA upgraded to use High Availability servers at SLAC; should provide immunity to power outages; provides ~1 month data buffer
- ❑ 2013 November 5: transitioned Level 1 processing pipeline from P7 to P7REP, to use current instrument calibrations
- ❑ Flight software updates:
  - 2013 February 14: B3-1-3, fix for infrequent event compression errors
  - near future:
    - fix ARR mode switch bug discovered in July 2013
    - speed up of code for TKR time-over-threshold calibration existing ToT calibration takes ~10 hrs; estimate new calibration ~1 hr

# Automated Science Processing - 1

## GRB Refinement Task

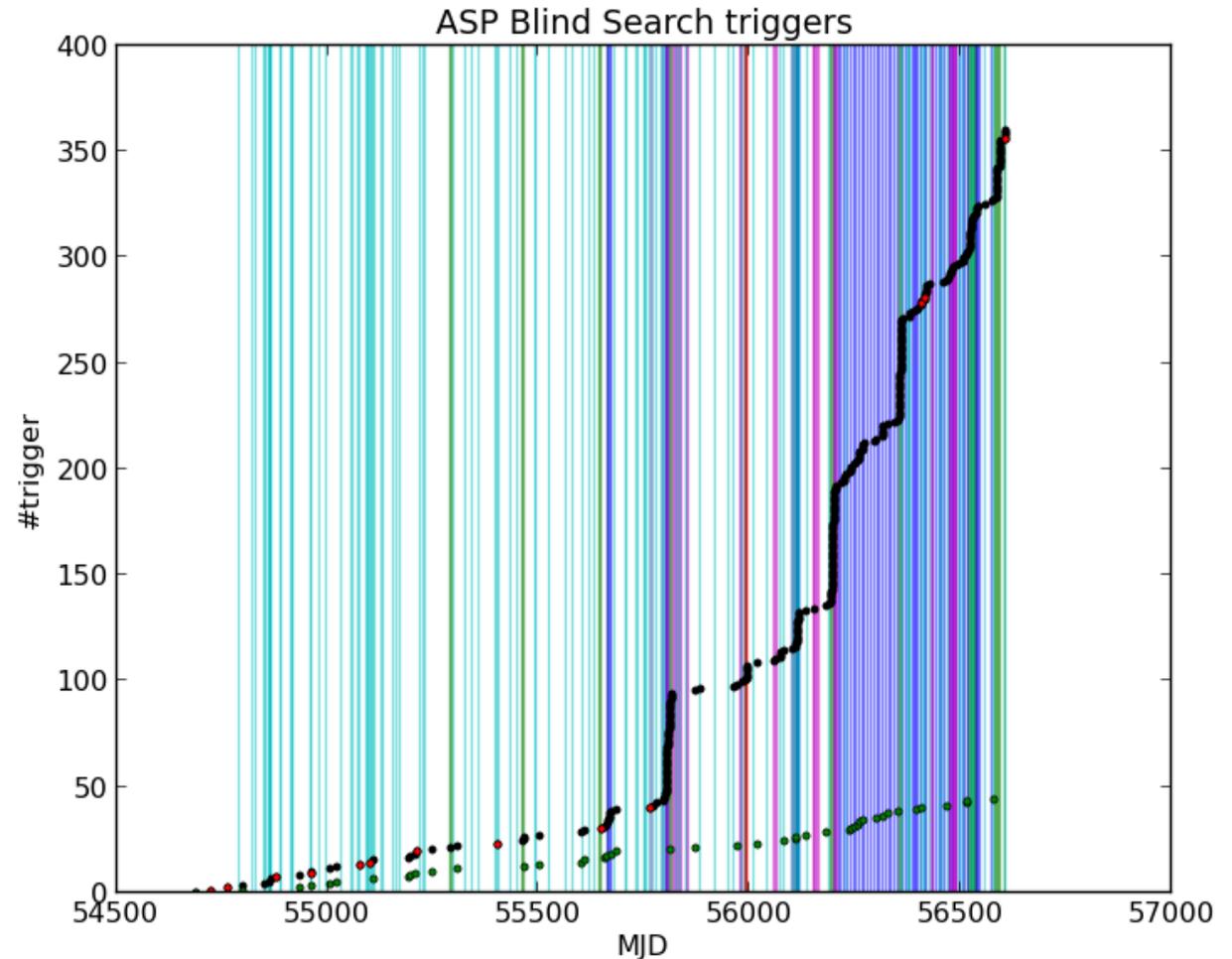
- ❑ Processed > 3429 GRB candidate notices via GCN since 4 August 2008
- ❑ Produce refined positions and spectra for 13 confirmed LAT GRBs

## GRB Blind Search Task

- ❑ 361 triggers since August 2008
- ❑ Detected 13 confirmed LAT GRBs: GRB 080916C, 081024B, 090217, 090510, 090902B, 090926A, 100116A, 100724B, 110328B, 110721A, 130427A, 130504C, 131108A (red points in Figure)

## 348 Non-GRB Blind Search Triggers

- ❑ 24 from ARR
- ❑ 10 from Nadir pointings
- ❑ 173 from TOOs, e.g., Sun pointings (MJD 55811–55815), S3 0218+35 pointings (MJD 56194–56201)
- ❑ 74 from pointed obs, e.g., Gal. Center pointing (MJD 55805), Crab Nebula pointing (MJD 56113–56116)
- ❑ 8 from Solar Flares (red): 6-7 Mar 2012 (MJD 55992-55993) and 27 May 2012 (MJD 56074)
- ❑ 45 remaining (green points) are consistent with the expected accidental rate for survey mode



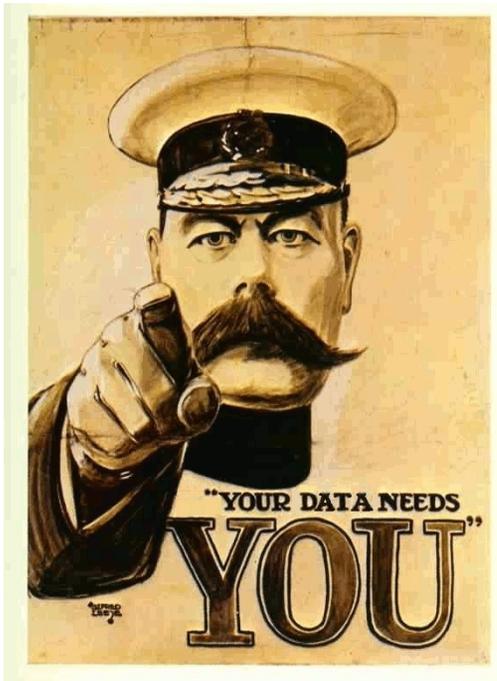
# Automated Science Processing - 2

## Flaring source detection and flux monitoring

- ❑ ASP results used by Galactic and Extragalactic Flare Advocates
- ❑ 257 Astronomers Telegrams issued for flaring sources as a result of ASP processing
  - 44 in the past year
- ❑ Daily and Weekly fluxes for the monitored source list continue to be sent to the FSSC every day
- ❑ 87 sources have been added to the original 23 source list because they have exceeded the threshold flux
  - 12 added in the past year

# LAT science operations: Data Quality Monitoring

- ❑ A procedure to send individual emails to junior members and their supervisors has proven very effective in enlisting DQM shifters
  - So far, less than 1 mailing per year is needed
- ❑ We have DQM senior shift leaders/helpers in the Collaboration
  - Considering better pre-shift training for new shifters
- ❑ DQM updates installed for P7REP, and will be needed with Pass 8



# Summary

- Fermi LAT science at the beginning of the prime phase is strong and benefits from
  - healthy instrument
  - improvements in knowledge of the instrument
- Emerging trends in scientific production
  - catalogs: more statistics and better IRFs; improved diffuse emission models
  - surprises from the  $\gamma$ -ray sky continue: react quickly to transients and analysis challenges
- Important to maintain strong LAT collaboration commitment to instrument science operations; crucial during the next year for delivering Pass8
  - Fermi IFC recently met (Nov 2013); strong support voiced by all international LAT partners