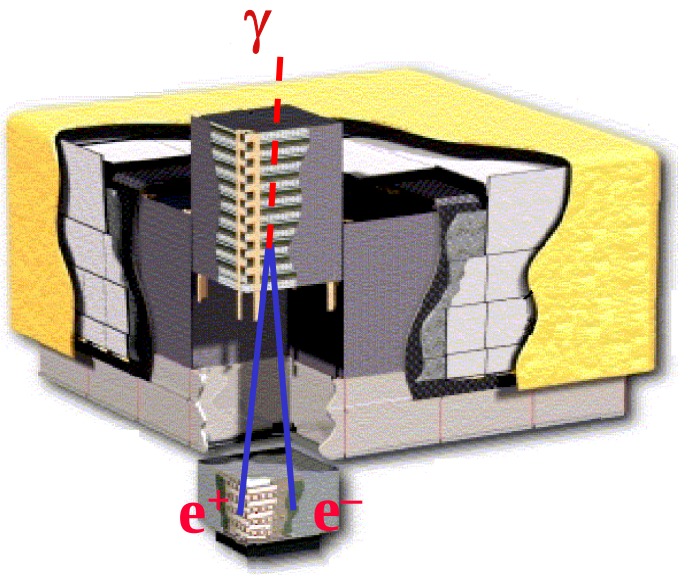
# Project Overview and Collaboration Status

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*Stanford University*
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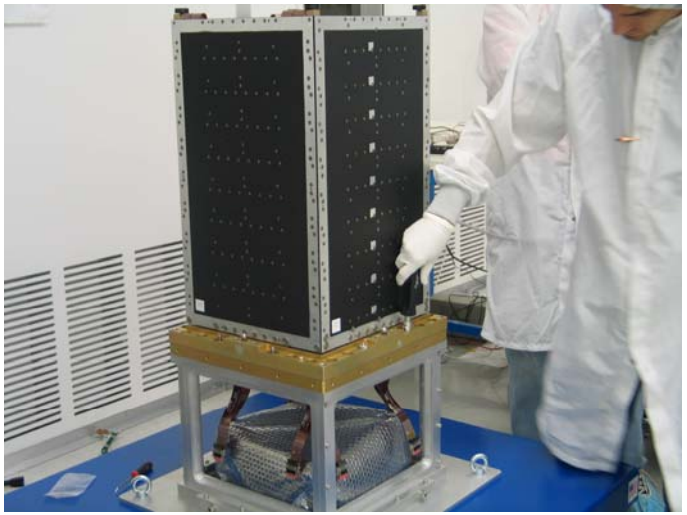
# Recent Events

- ***flight hardware now arriving at SLAC for instrument integration***
  - ***2 tracker modules, 7 calorimeter modules, 2 tower electronics modules, instrument Grid***
- ***GLAST rebaseline: necessary to address schedule and cost growth***
  - ***Feb 24 discussion with NASA Headquarters about possible LAT descope; no actions directed***
- ***Collaboration meeting, scheduled for March 8-10, cancelled due to priority placed on flight hardware manufacture and delivery schedule – next meeting scheduled for early September***
- ***I&T Data Analysis Workshop held at SLAC, March 10, 2005***
- ***Instrument Science Operations Center planning well underway – ISOC Manager, Rob Cameron***
- ***Science Analysis Planning underway***
  - ***science analysis plan formulated and science group coordinators identified***
  - ***preparations for DC-2***
  - ***proposal for 1st year data release to community prepared***

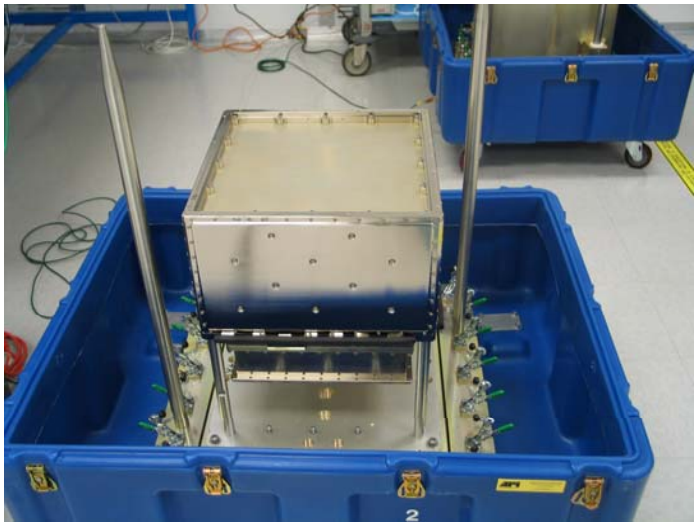
# Flight Hardware Integration

**Preparation of flight grid for TCS integration**



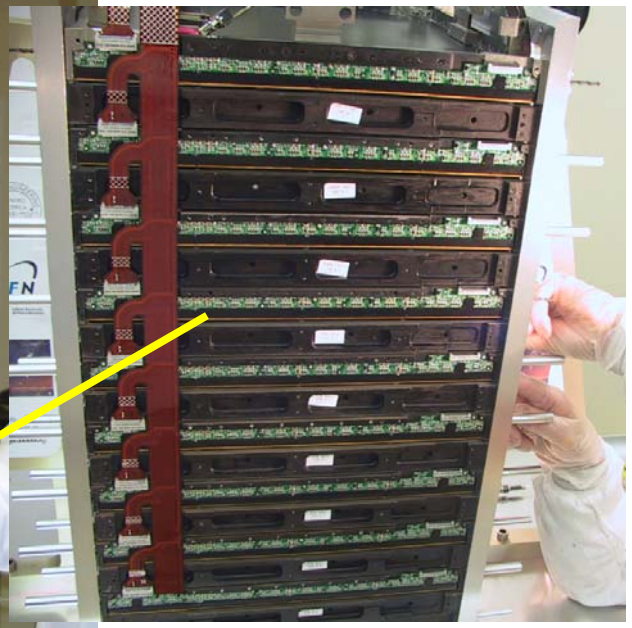
**Flight Tracker in Cleanroom at SLAC**

**LAT Integration stand with PAP ready for proof test**



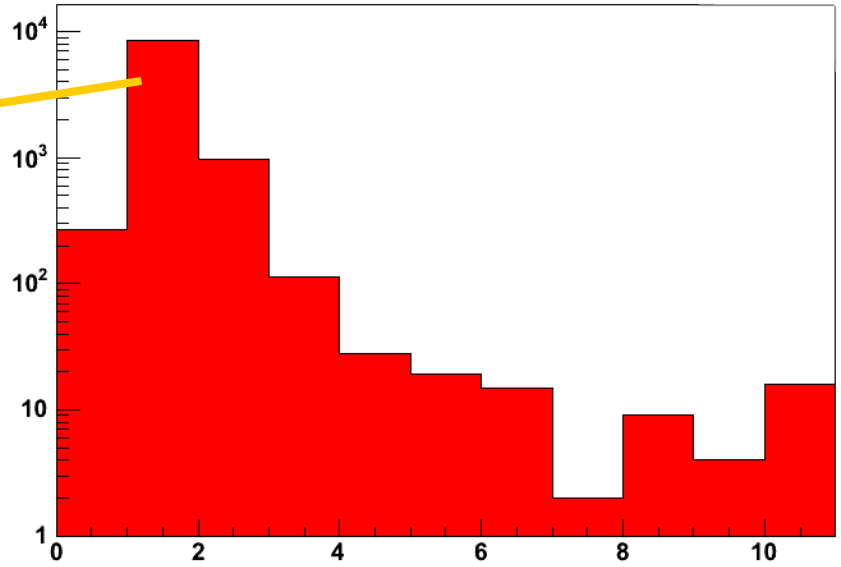
**Flight Calorimeter**

# First Flight Tower in I&T

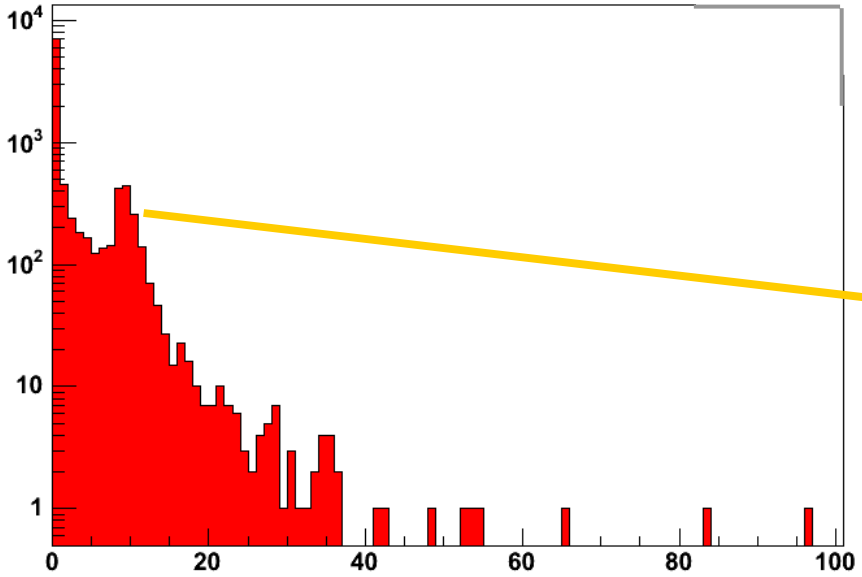



# First Integrated Tower – Cosmic Ray Data

***Most of the cosmic ray (muon) events are expected to have single tracks***



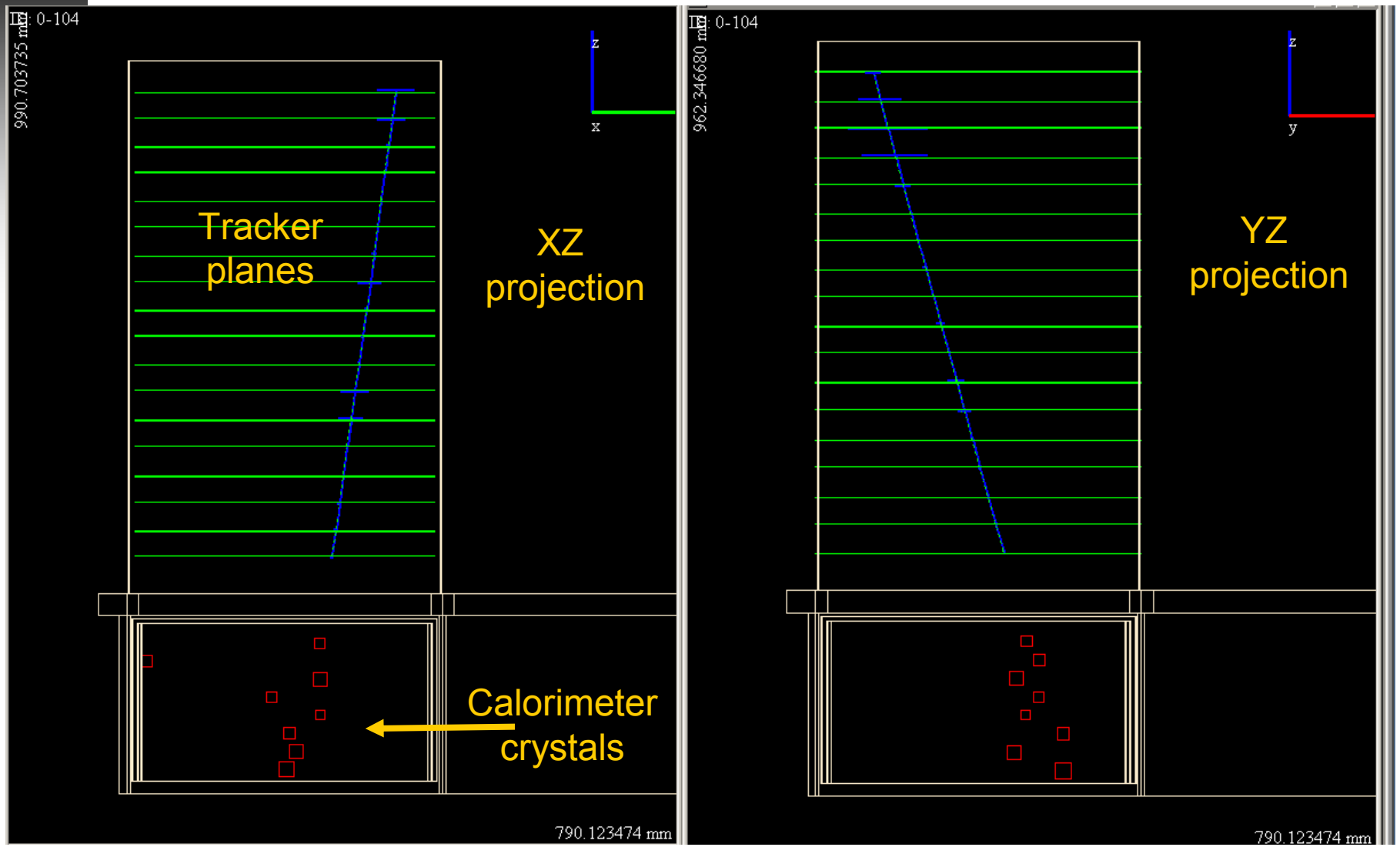

**Number of reconstructed tracks per event**



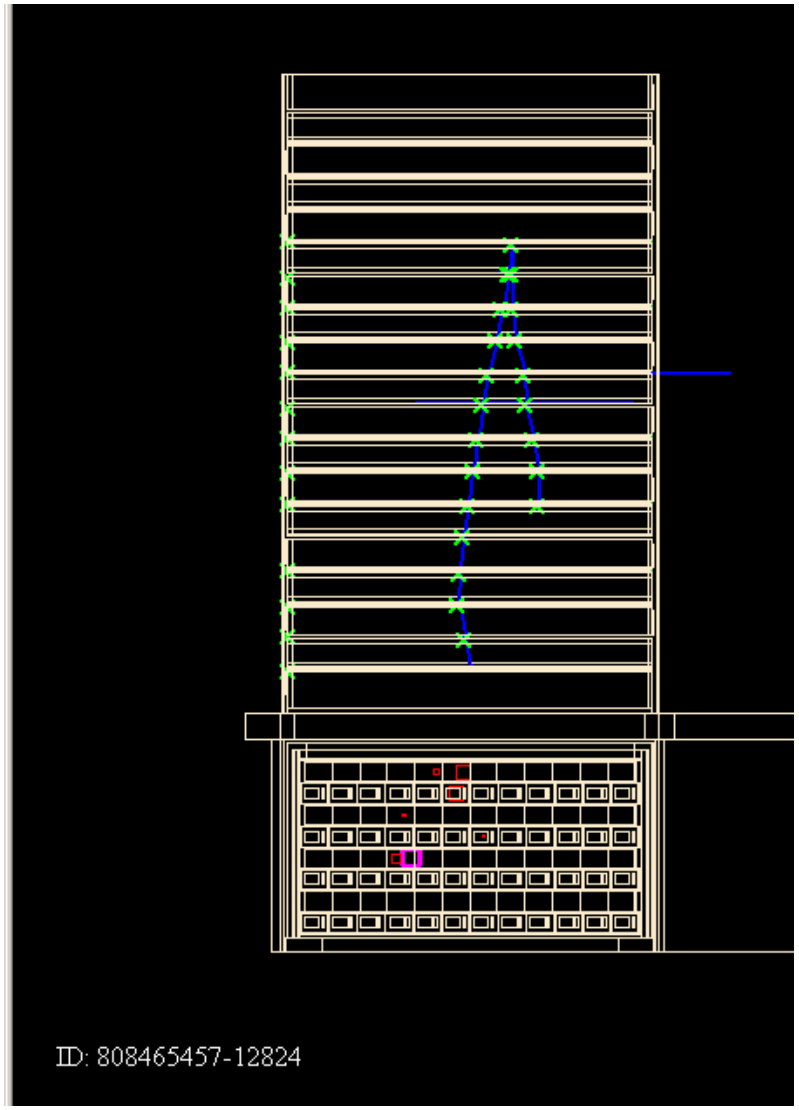

**Number of calorimeter crystals hit per event**

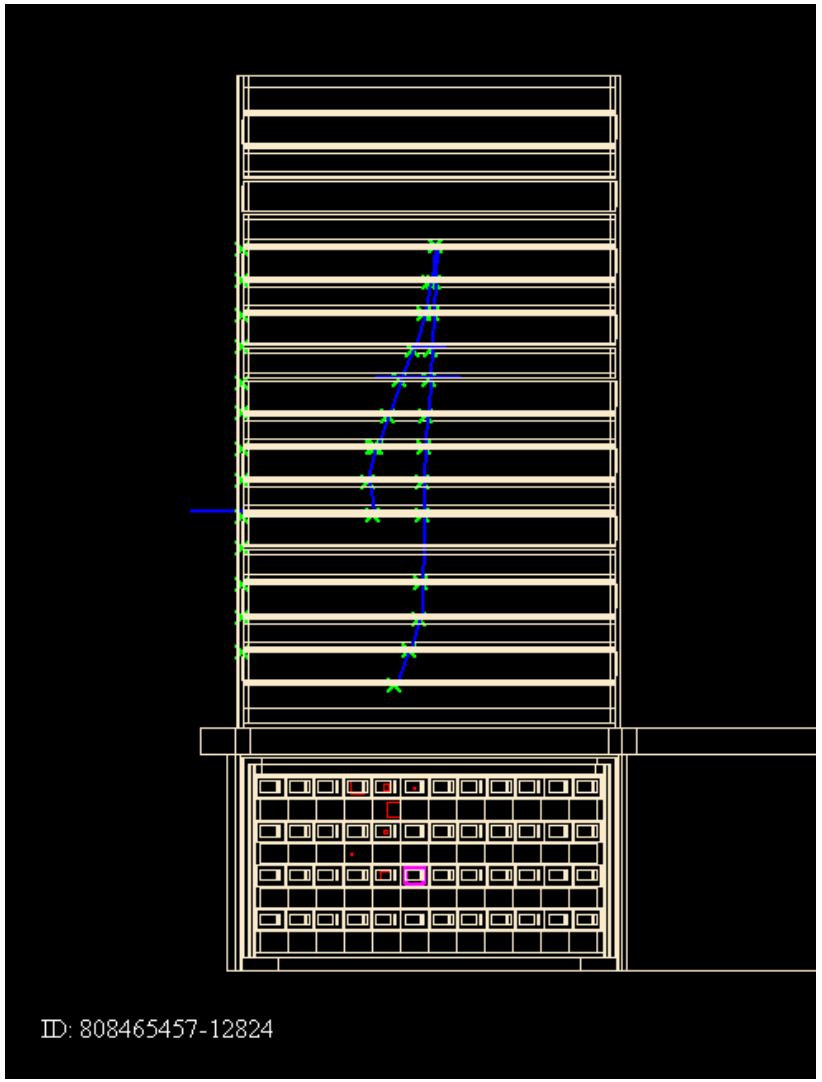
***Most of the cosmic ray (muon) events with on-axis incidence are expected to hit about 8 CAL crystals***

# First Integrated Tower – Muon Candidate Event



# Gamma-ray Candidate Event




# GLAST Discovery Reach

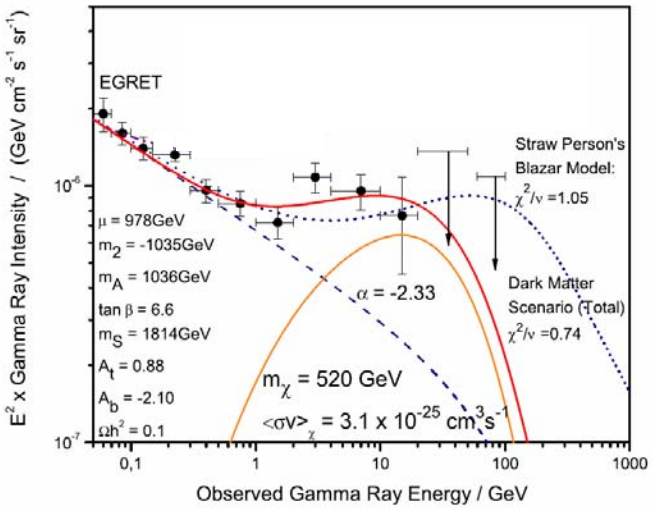
- ***Many opportunities for exciting discoveries:***
  - *determine the origin(s) of the high-energy extragalactic diffuse background*
  - *measure extragalactic background light to z > 3*
  - *detect $\gamma$-ray emission from clusters of galaxies; cosmic-ray acceleration on large scales*
  - *detect $\gamma$-rays from Ultra-Luminous Infrared Galaxies; cosmic ray acceleration efficiency and star formation rate*
  - *detect high-latitude Galactic Inverse-Compton emission and thereby measure TeV-scale CR electrons in the Galaxy*
  - *the unknown!*

# Cosmology: Origin of Extragalactic Diffuse Radiation

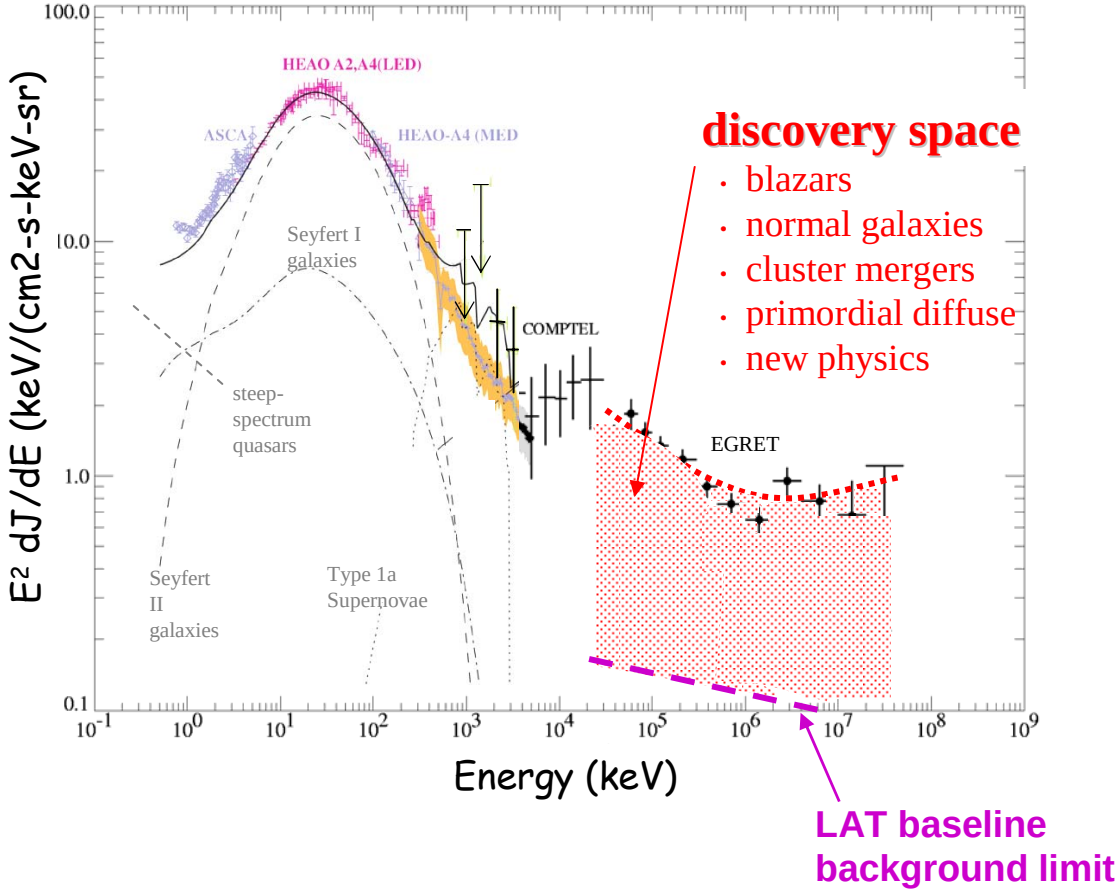
- ***origin is a mystery; either sources there for GLAST to resolve (and study!) OR there is a truly diffuse flux from the early Universe***

*EGRET constrains blazars to be > 25% of diffuse;*

*annihilation of cosmological neutralinos has, in principle, a distinctive spectral signature*



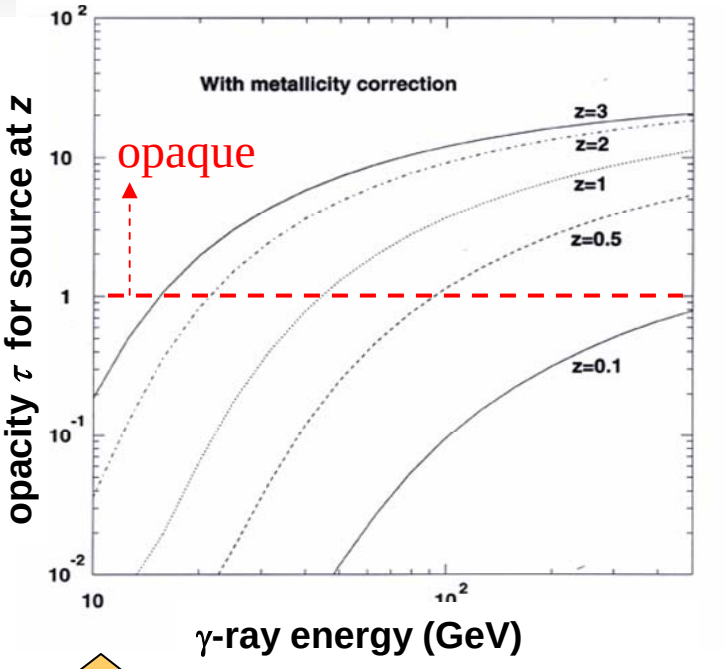

from Elasser & Mannheim, astro-ph/0405235




***Unique science for GLAST***

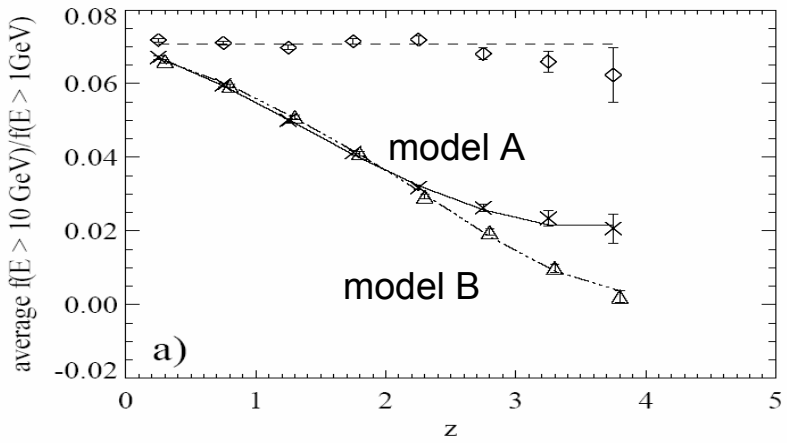
# Cosmology: Probing Extragalactic Background Light

- ***High-redshift (z >3) blazar detections important for visible-UV EBL studies and blazar/galaxy evolution***
  - ***Number of blazar detections with spectral measurements above 10 GeV important***




No significant attenuation below 10 GeV

measure flux E>10 GeV/flux E>1 GeV




number of sources in bins of z luminosity-function dependent (important science for GLAST!)

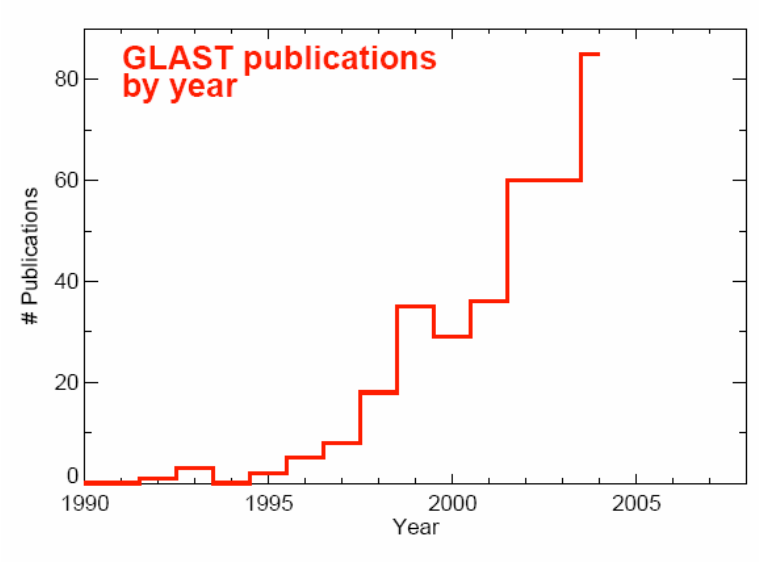
| | *# blazars with spectra z >3* |
|---|---|
| *E>1 GeV* | *62* |
| *E>10 GeV* | *12* |

# Broad Science Community Involvement

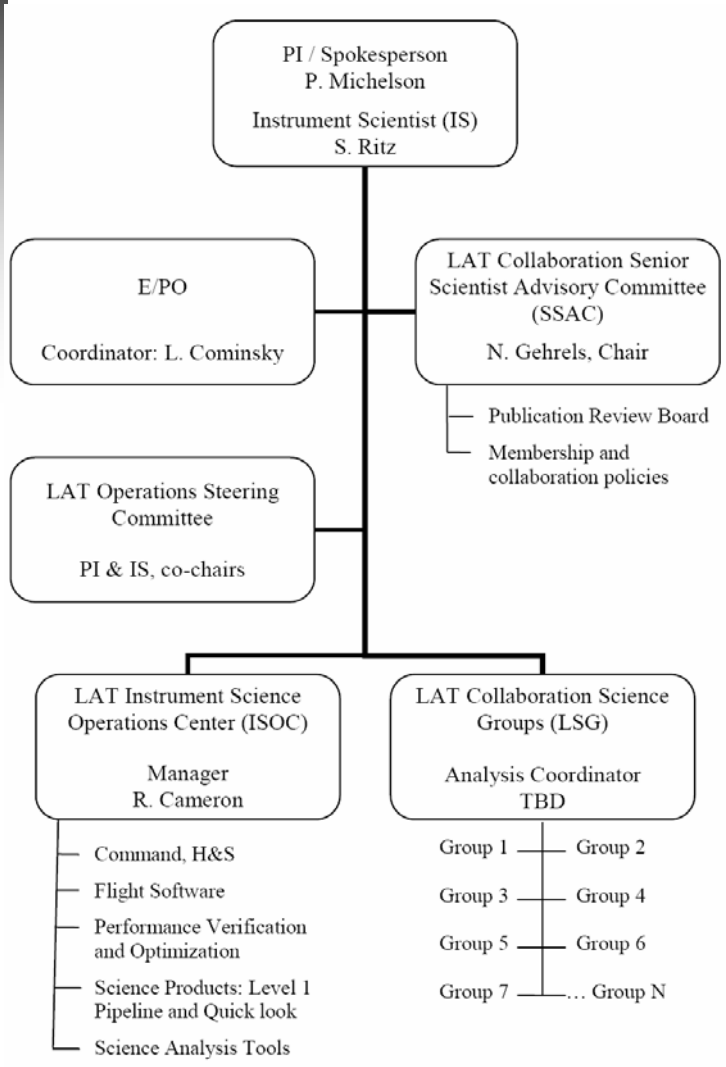
- ***At all mission levels, including Conferences, Workshops.***
- ***Multiwavelength survey initiatives underway***
  - *VLA monitoring for a large sample of flat-spectrum, compact sources (Ulvestad, et al.)*
  - *VLBA Imaging and Polarimetry Survey proposed to obtain a set of reference images for 1000 potential LAT sources in advance of GLAST launch (Taylor, et al.).*
  - *Northern and Southern hemisphere radio pulsar timing campaigns in support of GLAST mission (Thorsett, et al. ; Manchester, et al.)*
  - *optical monitoring of LAT AGN*
- ***Broad and growing interest***

**Publications & Conference Proceedings**

| | | pre-launch | total |
|---|---|---|---|
| ***COS-B*** | ***1975-1982*** | ***11*** | ***481*** |
| ***EGRET*** | ***1991-2000*** | ***53*** | ***1212*** |
| ***GLAST*** | ***2007-*** | ***342*** | ***???*** |



# Operations Phase LAT Organization Chart




- ***Instrument Science Ops Center (ISOC)***
  - *responsible for instrument operation (monitoring, configuration management, flight software, calibration, science analysis software, etc) and operation of Level 1 Data Pipeline*
  - *performance analysis and tools development are coordinated across the Collaboration by the ISOC*
- ***LAT Collaboration Science Groups***
  - *responsible for collaboration's analysis and extraction of science results from LAT data; including galactic diffuse model and source catalogs*
  - *Science Groups plus Multi-$\lambda$ Coordination Working Group*
  - *each science group to have 2 coordinators; with one resident at Stanford (in particular during 1st year)*
  - *day-to-day efforts coordinated by Analysis Coordinator, also resident at Stanford-SLAC*


# GLAST LAT Science Groups

| Group | Principal Responsibilities |
|---|---|
| 1. Catalogs | Prepare comprehensive LAT catalog for publication, after 1, 2, and 5 years (nominal), including cross-identifications when known. |
| 2. Galactic Diffuse and Molecular Clouds | Generate Galactic diffuse model for delivery to community (GSSC) and provide periodic updates; study mass tracers and CR density in individual clouds |
| 3. Extragalactic Diffuse | Analysis of the residual isotropic gamma-ray emission (after accounting for LAT sources and Galactic diffuse) including its spectra and angular fluctuations; assess contributions from various source classes |
| 4. Blazars & Other AGNs | Analysis of spectra and time variability of LAT-detected blazars and other types of AGNs; modeling of spectra (e.g. SSC model) including effects of EBL; study evolution with redshift |
| 5. Other Galaxies | Search for emission from other galaxies, particularly nearby galaxies such as M31, ULRGs, and from clusters of galaxies; determine source spectra and/or set upper limits |
| 6. Pulsars, SNRs & Plerions | Construct phase-resolved "light curves" and spectra for LAT-detected radio pulsars; search for periodic emission in other sources, including unidentified sources; identify SNRs and plerions and model spectra of these sources |
| 7. Unidentified Sources & Population Studies | Coordinate deep multiwavelength studies of the error boxes of the unidentified GLAST sources and correlate with potential counterpart populations; determine the heterogeneity of the population and correlate with source characteristics \(e.g. time variability; spectral index, etc.) |
| 8. Dark Matter and Exotic Physics | Search for signatures of dark matter, extra dimensions (e.g. KK graviton decay), quantum gravity dispersion effects, etc. |
| 9. Gamma-Ray Bursts | Construct LAT GRB catalogs; determine burst spectra, including time evolution; coordinate joint analysis of bursts with GBM |
| 10. Sources in the Solar System | Solar flares; lunar emission; … |
| 11. Calibration and Analysis Methods | Pre-flight performance of the LAT and on-orbit calibration and performance<br>(1) Monte Carlo model of LAT; event reconstruction and background rejection methods; (2) astrophysical data analysis methods (e.g. likelihood analysis; time series analysis; source spectral analysis, cross-correlation methods, etc.) |


# Proposed LAT Year-1 Data Release Plan

- ***consistent with NASA AO 99-OSS-03:***
  - *"At all times, including during the first twelve months of science operations, the data from transient sources discovered or detected by GLAST will immediately be made publicly available."*
    - *operational definition of transient source: any source for which a significant change in source flux is detected on a timescale sufficiently short that rapid follow-up multi-wavelength observations are warranted (e.g. GRBs, a significant flare from a blazar, a solar flare, etc.)*
  - *"During the first twelve months of science operations, data from specific sources of interest to qualified individual researchers will be made available…"*
    - *Data products on specific sources of interest will be released, by the LAT team, periodically via a publicly assessable web site.*


# Proposed LAT Year-1 Data Release Plan

- ***during Phase 1 (sky survey & verification phase), event reconstruction & background rejection cuts will be refined in several stages***
  - *each modification of algorithms will likely require reprocessing of level-0 to level-1 data;*
  - *expect frequency of reprocessing to be relatively high and effects on level-1 data base to be more significant in Phase 1 than during subsequent phases;*

- ***during Phase 1: release high-level data on transients and monitored sources consisting of flux (fluence) on various timescales, spectra, source position, and errors (including estimate of systematic errors) for all of these quantities;***
  - *no release in phase 1 of individual reconstructed photon events.*


# Some specifics

- ***GRBs:***
  - *on-board detections released "immediately"*
  - *refinement of parameters (e.g. source position, fluence in several energy bands )with subsequent processing on the ground; release information as soon as available.*
  - *for GRBs detected by GBM but not by LAT, a LAT upper limit will be released.*

- ***Sources of Interest:***
  - *monitor and regularly release data, via the web, on list of sources of interest*
  - *update data weekly and include fluxes (daily to weekly averages), estimates of the spectra (weekly averages), position, and errors*
  - *expected latency between receipt of level-0 data at ISOC and availability of processed high-level data will improve with time. Nominal schedule is*
    - *first month of Phase 1; 2 weeks*
    - *month 2-6; within 3 days*
    - *months 6-12; within 1 day*
    - *months 13-N; within 1 day (goal of 6 hours)*


# Conclusion

- ***GLAST flight hardware in production; BEAUTIFUL data from first integrated flight tower***
- ***Collaboration is actively engaged in the production, integration, and testing of flight hardware;***
- ***also continuing effort to develop science analysis tools; DC-2 preparations underway***
- ***working with broader community to support / initiate multiwavelength observations and surveys needed for GLAST science***
- ***science planning will be major focus of September Collaboration meeting***