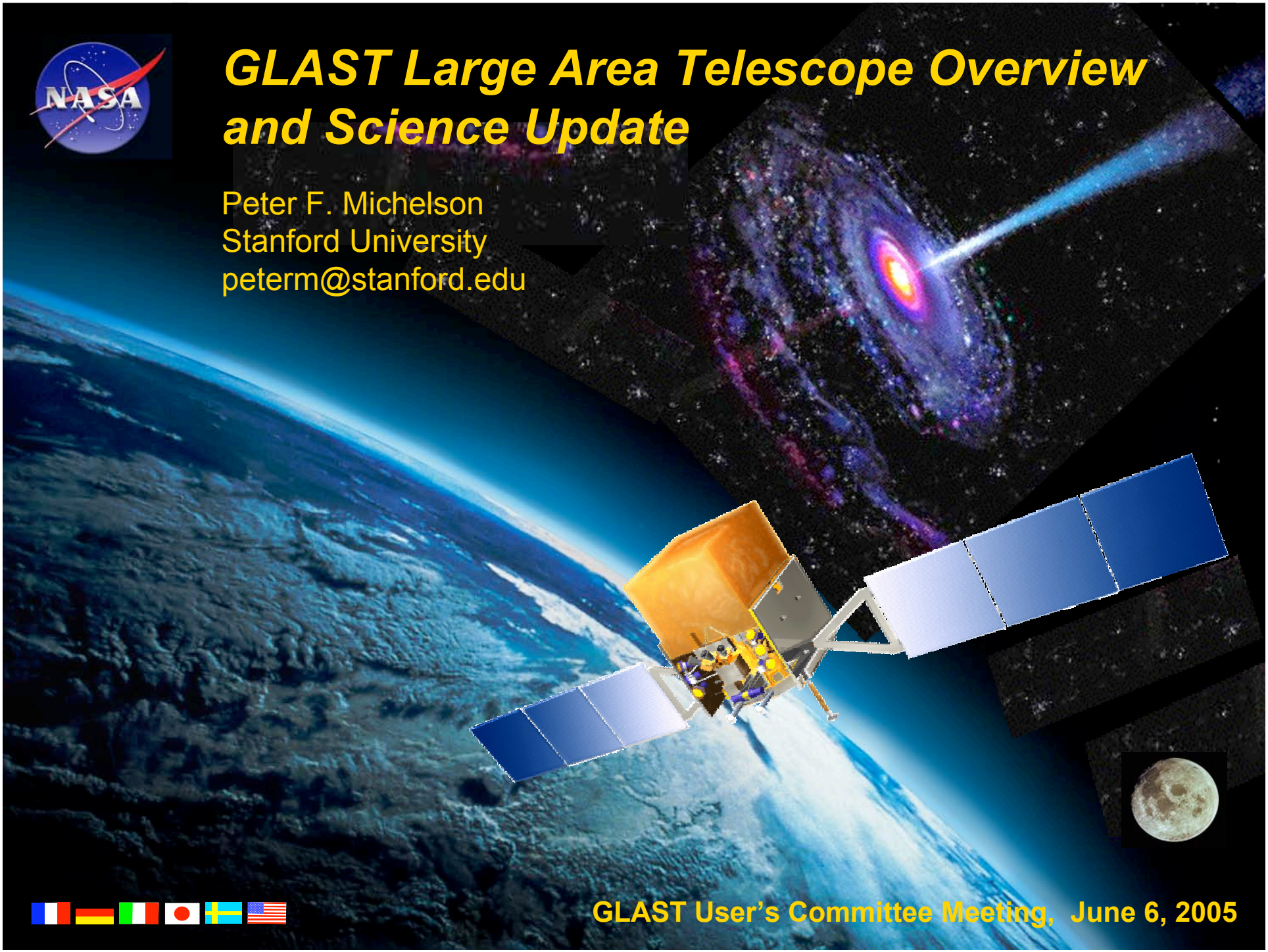
GLAST Large Area Telescope Overview and Science Update

Peter F. Michelson
Stanford University
peterm@stanford.edu



GLAST User's Committee Meeting, June 6, 2005

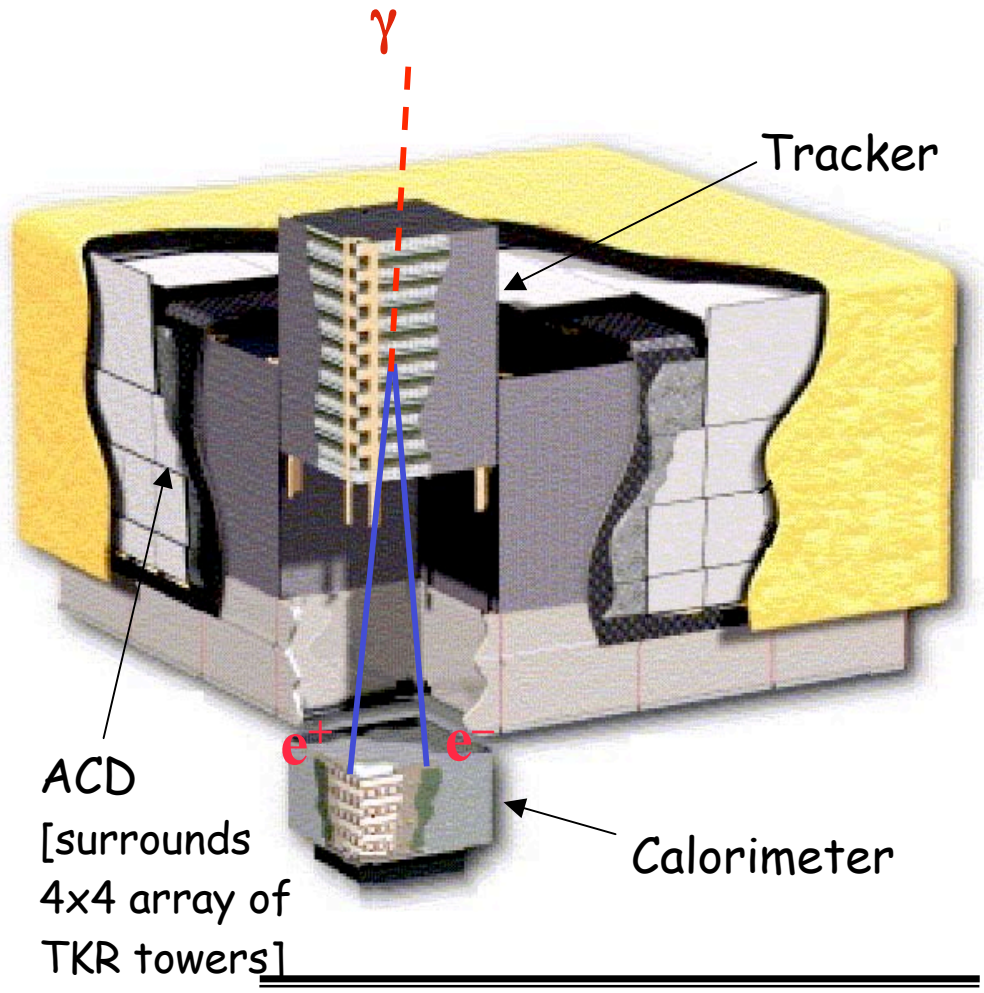
LAT Update

_ ***flight hardware production and integration well underway***

- ***4 flight towers (TKR, CAL, TEM,) installed in Grid***

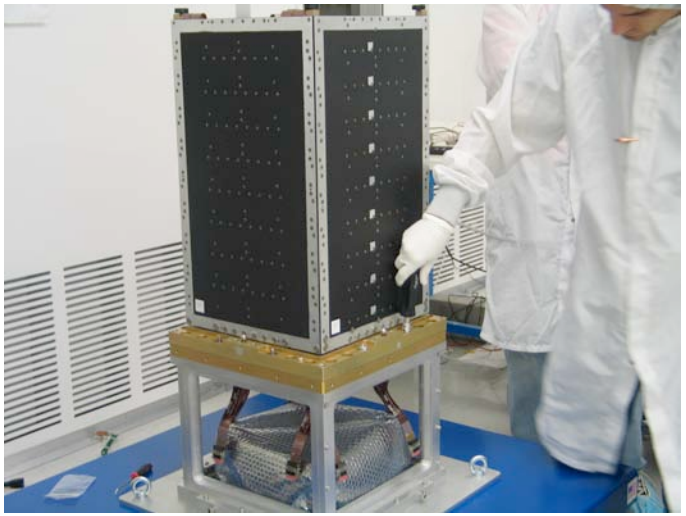
_ ***Schedule:***

- ***instrument assembly and system test complete:***
  January 2005
- ***instrument environmental tests at NRL complete:***
  April 2006
- ***LAT delivery to Spectrum-Astro (General Dynamics) for integration with spacecraft:***
  June 2006



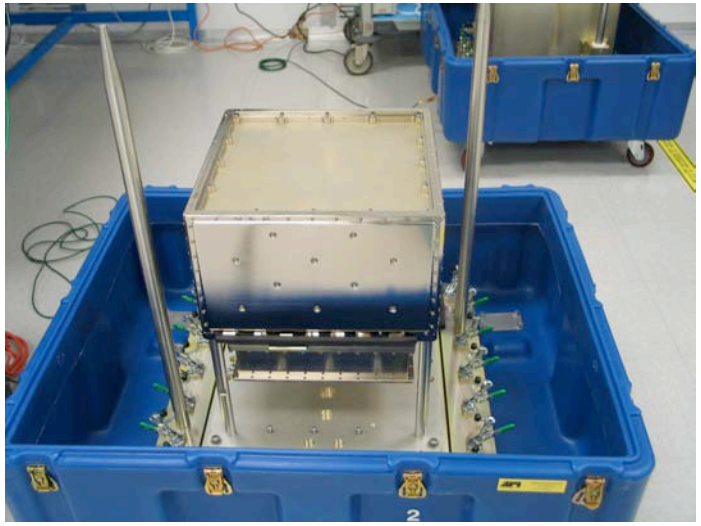
LAT Flight Hardware Integration

Preparation of flight grid for TCS integration



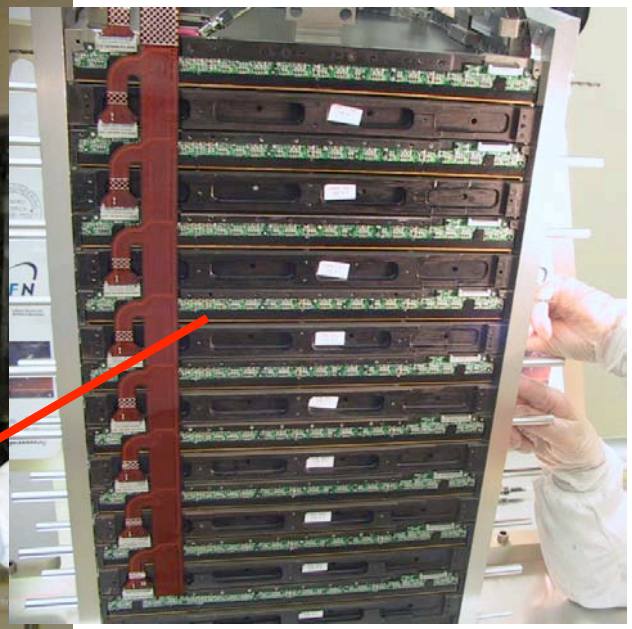
Flight Tracker in Cleanroom at SLAC

LAT Integration stand with PAP ready for proof test

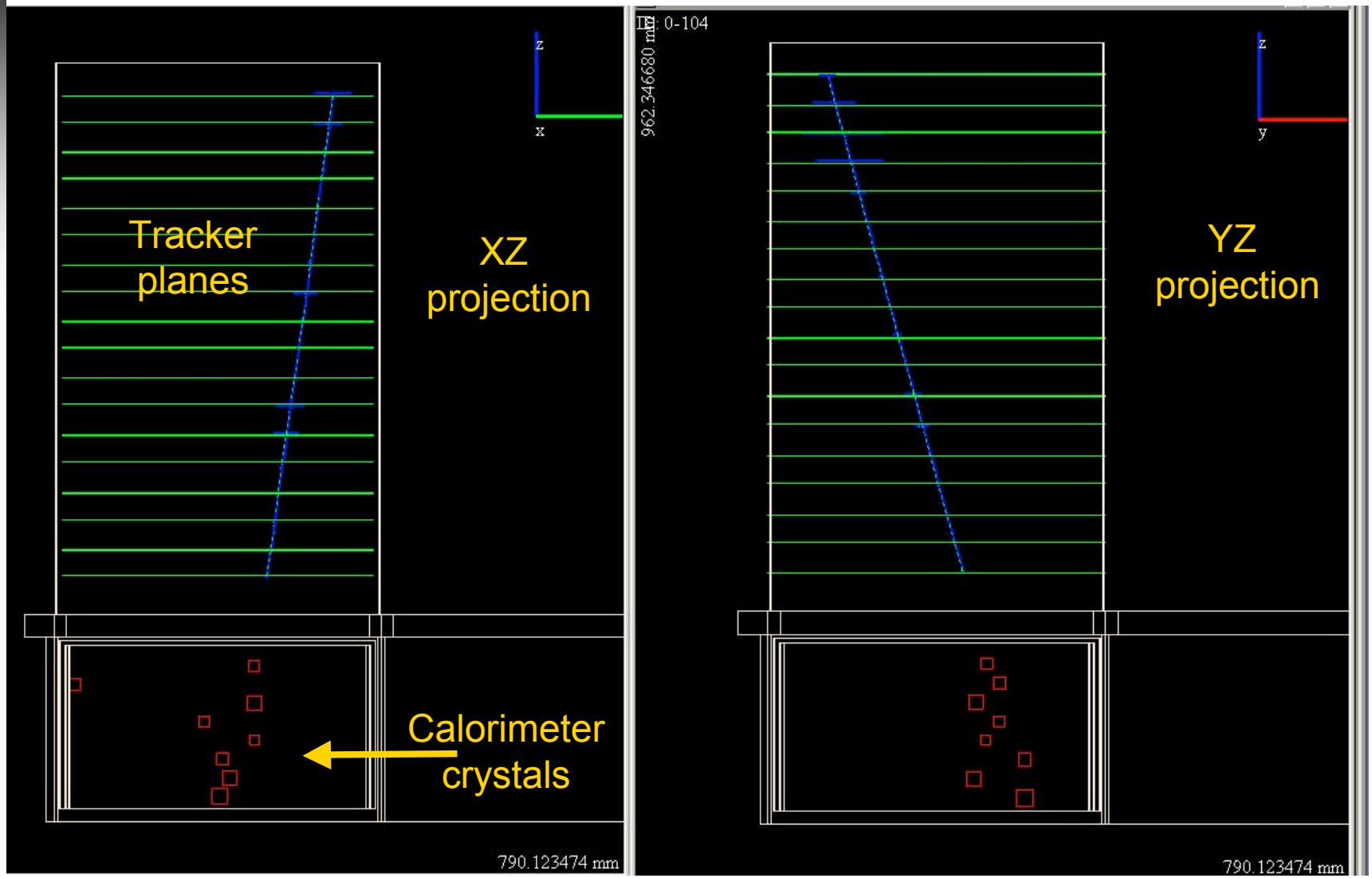


Flight Calorimeter

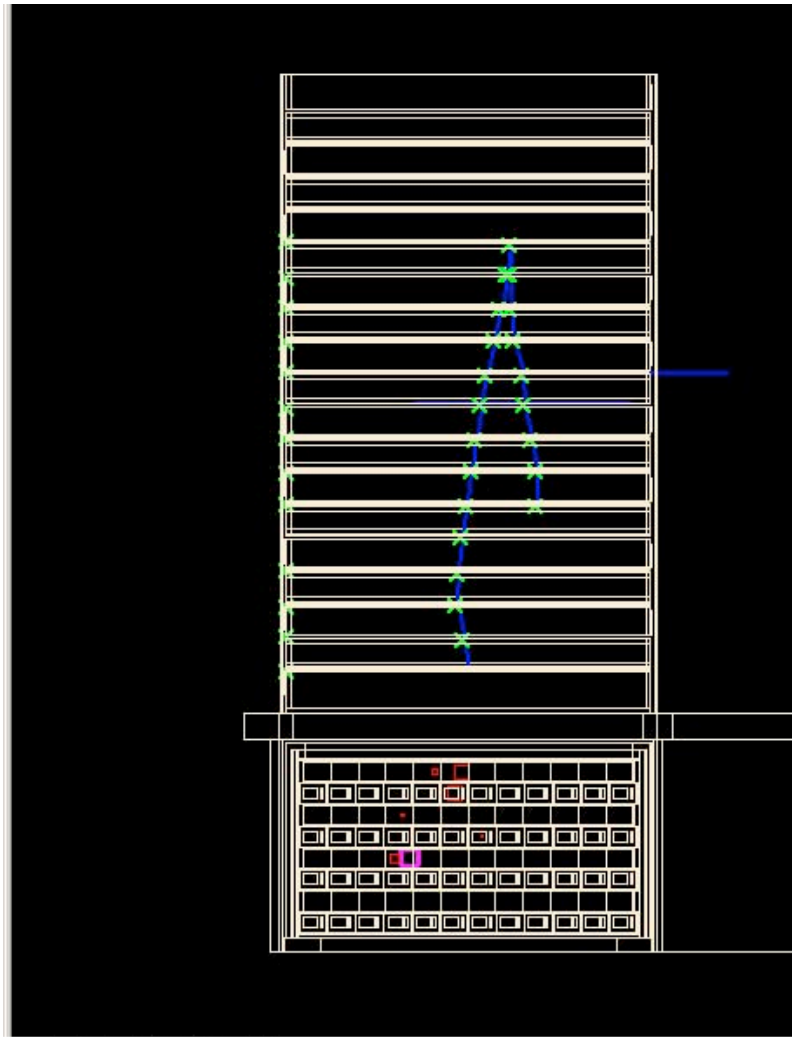
First Flight Tower in I&T

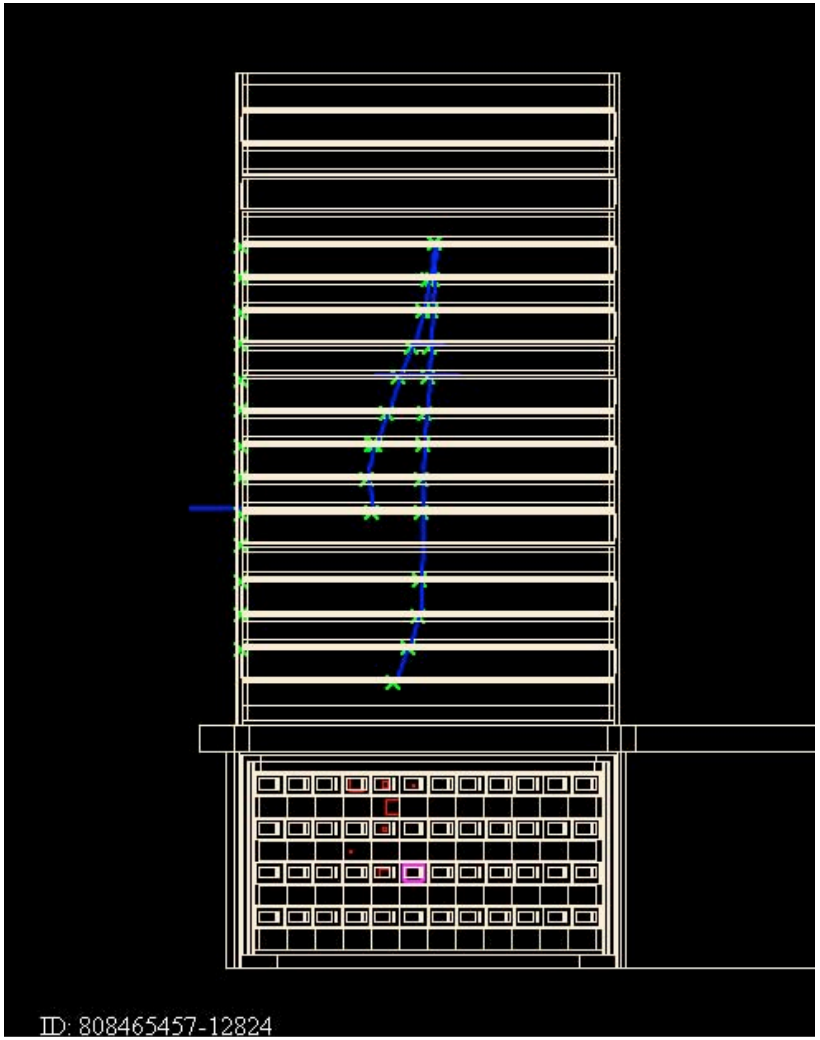


First Integrated Tower – Muon Candidate Event

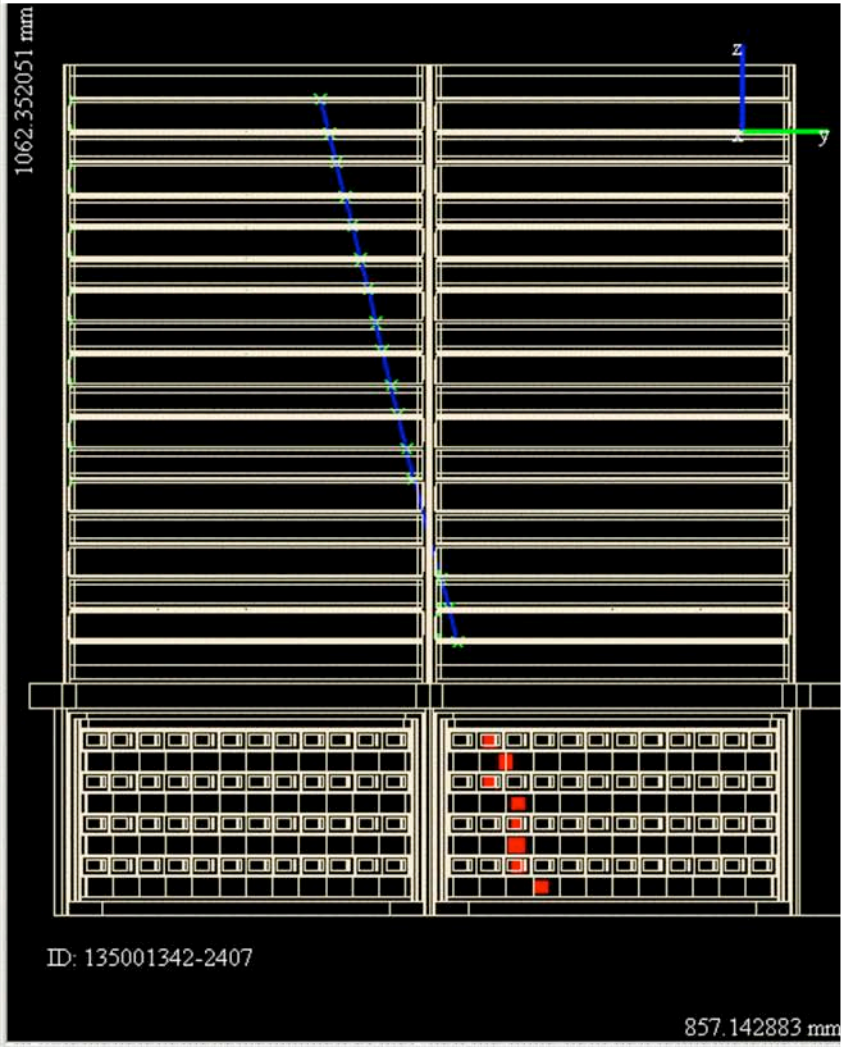


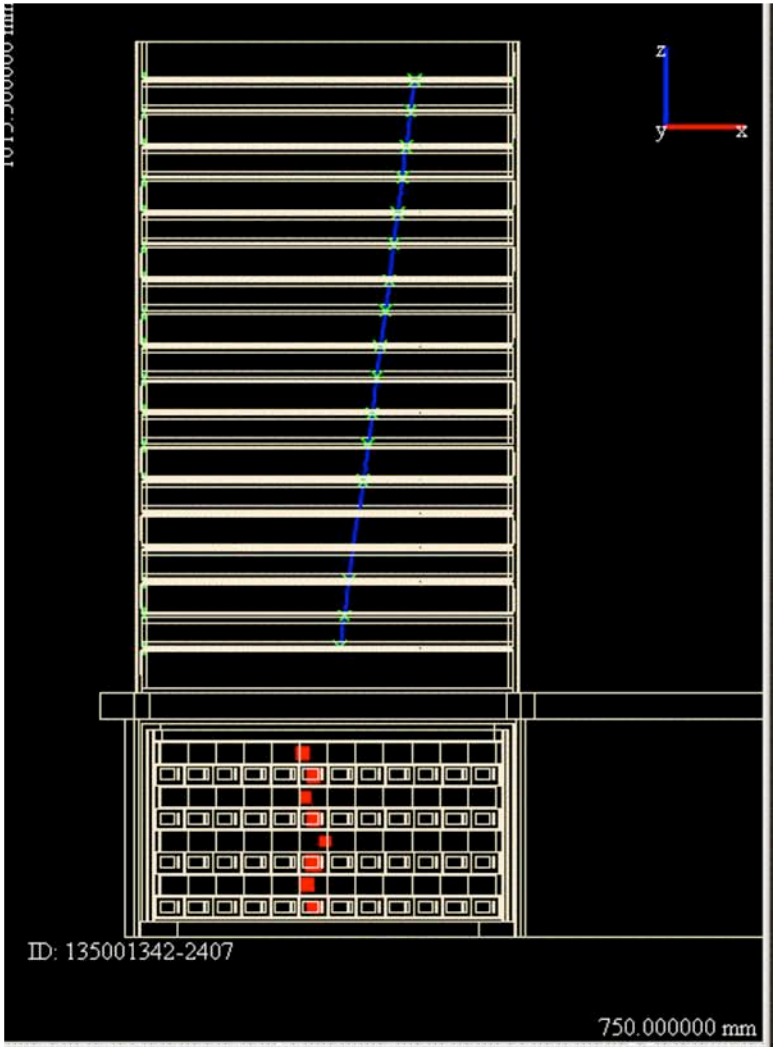
Gamma-ray Candidate Event



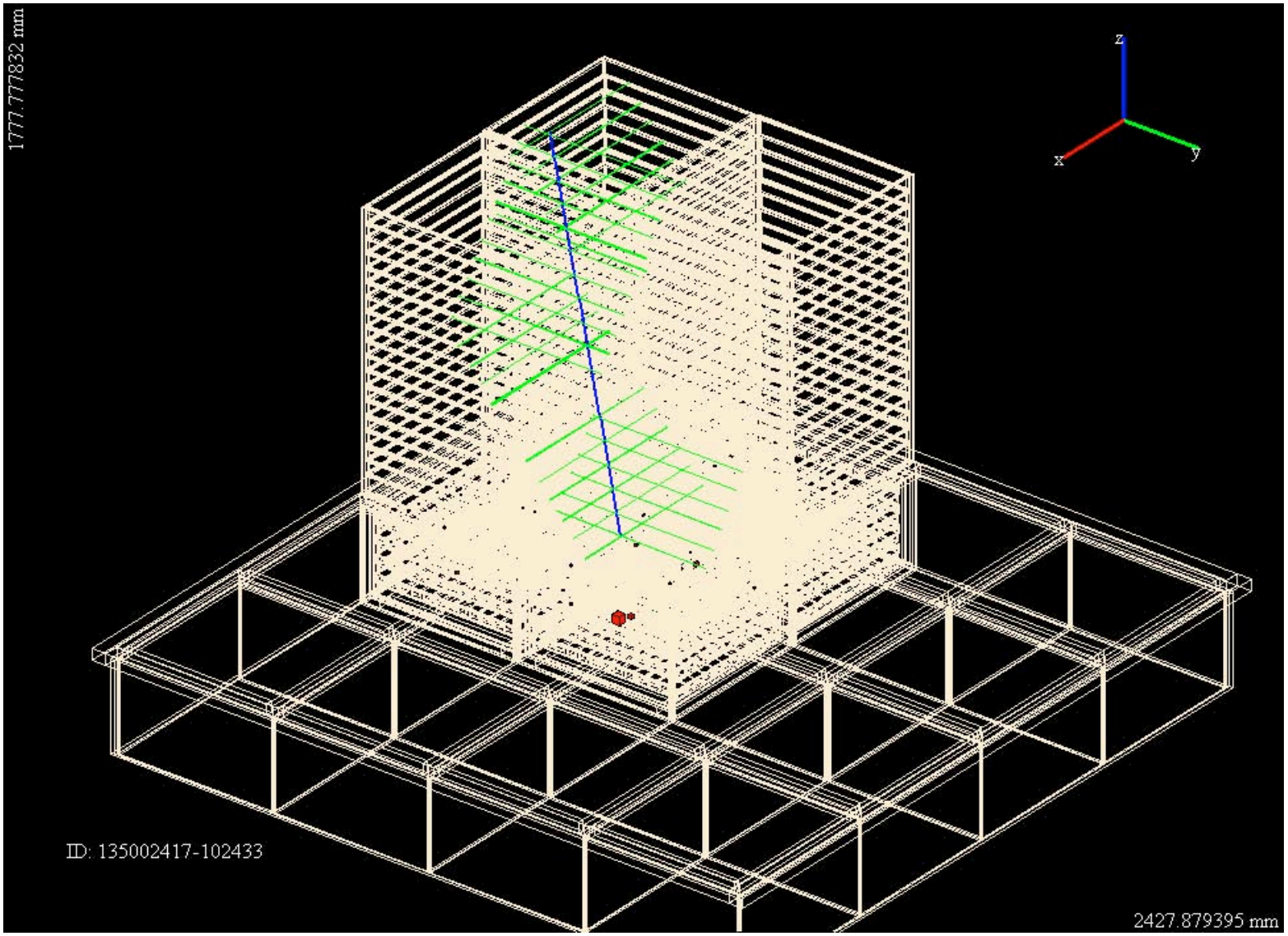


First 2-tower events





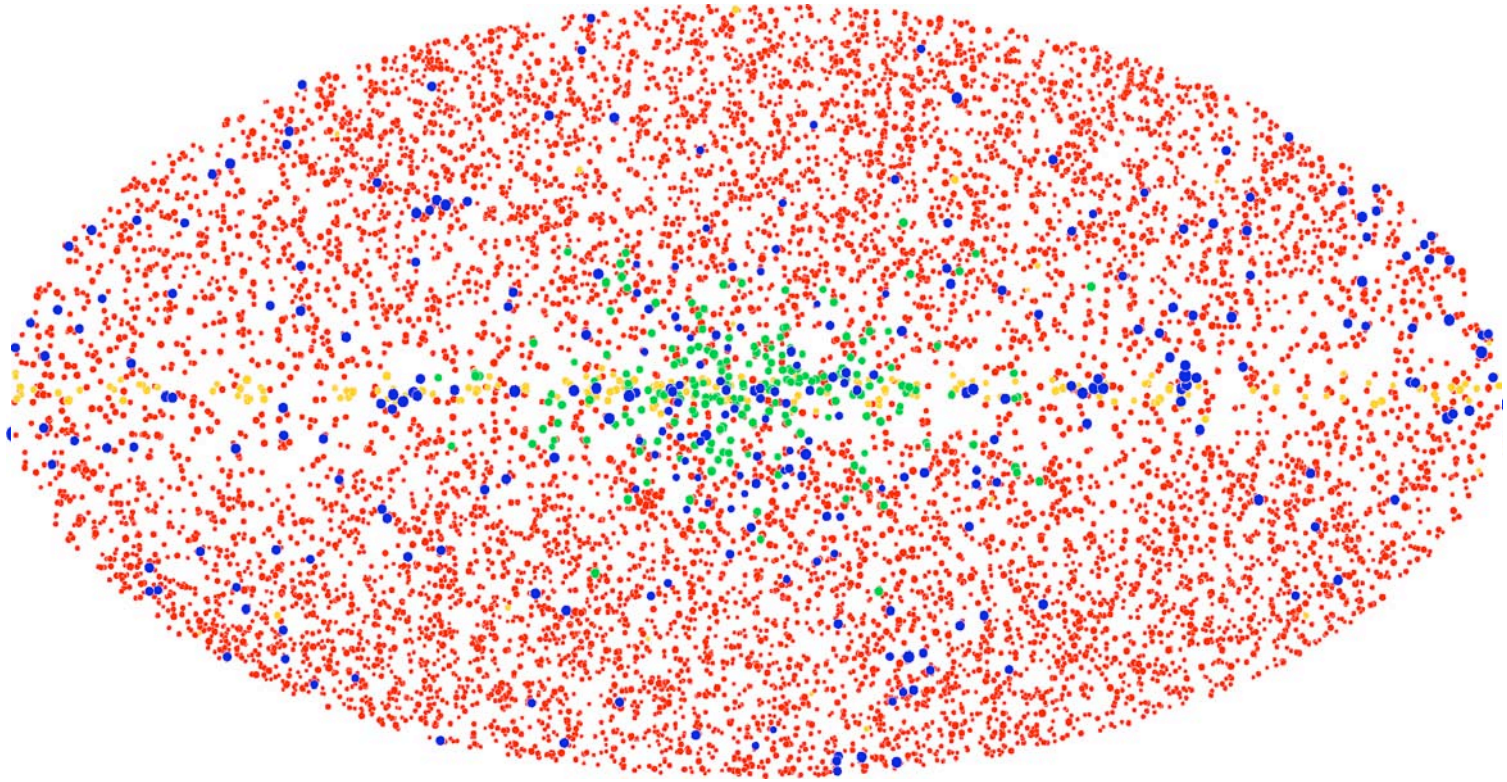
4-tower events



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 γ-ray emission from clusters of galaxies; cosmic-ray acceleration on large scales*
  - *detect γ-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*
  - *study high-energy emission from Galactic pulsars*
  - *the unknown!*

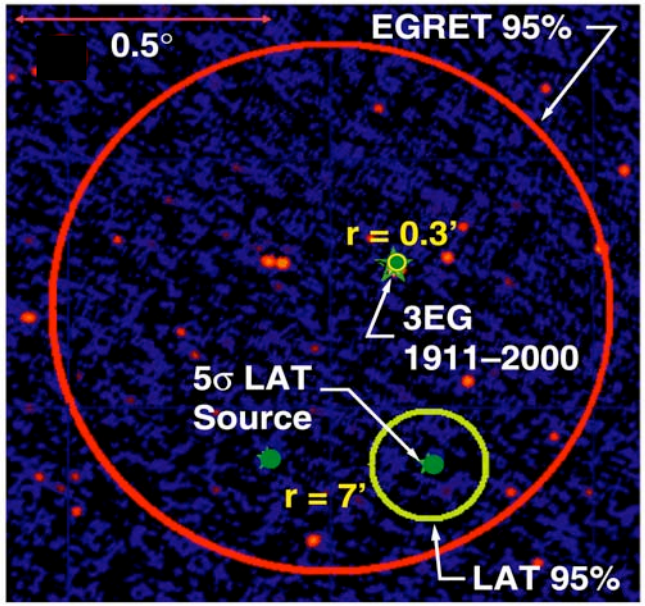
GLAST Survey: ~10,000 sources (2 years)

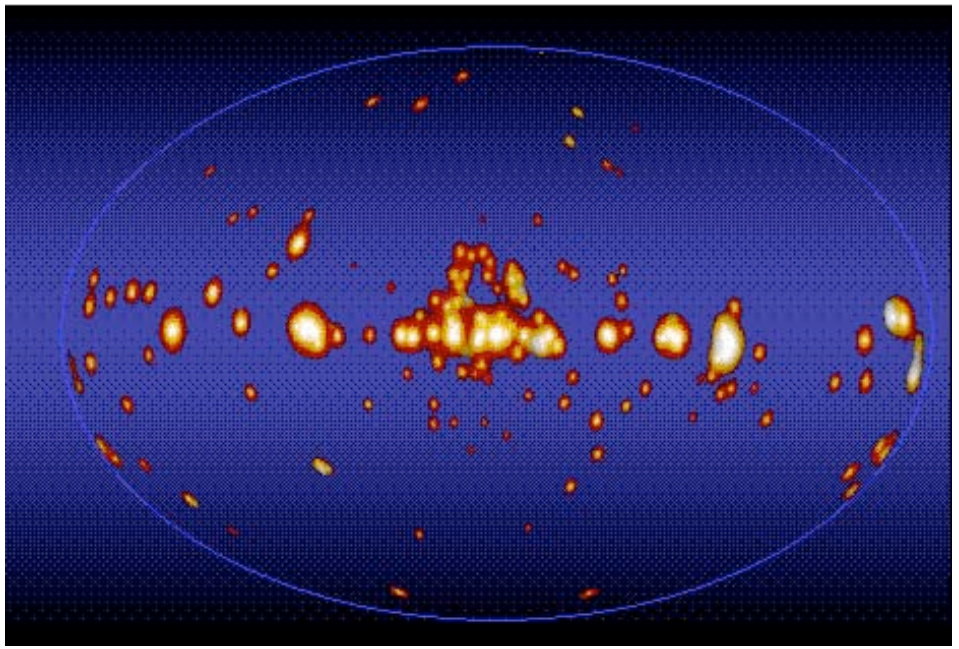


GLAST science capabilities - resolution

source identification requires a multiwavelength approach
- **localization**
- **variability**

source localization (68% radius)
- γ-ray bursts: 1 to tens arcminutes
- unid EGRET sources: 0.3' – 1'





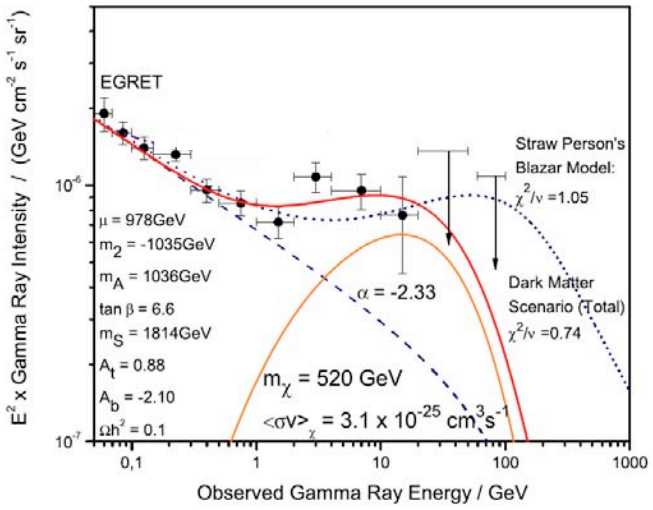
Unidentified EGRET sources

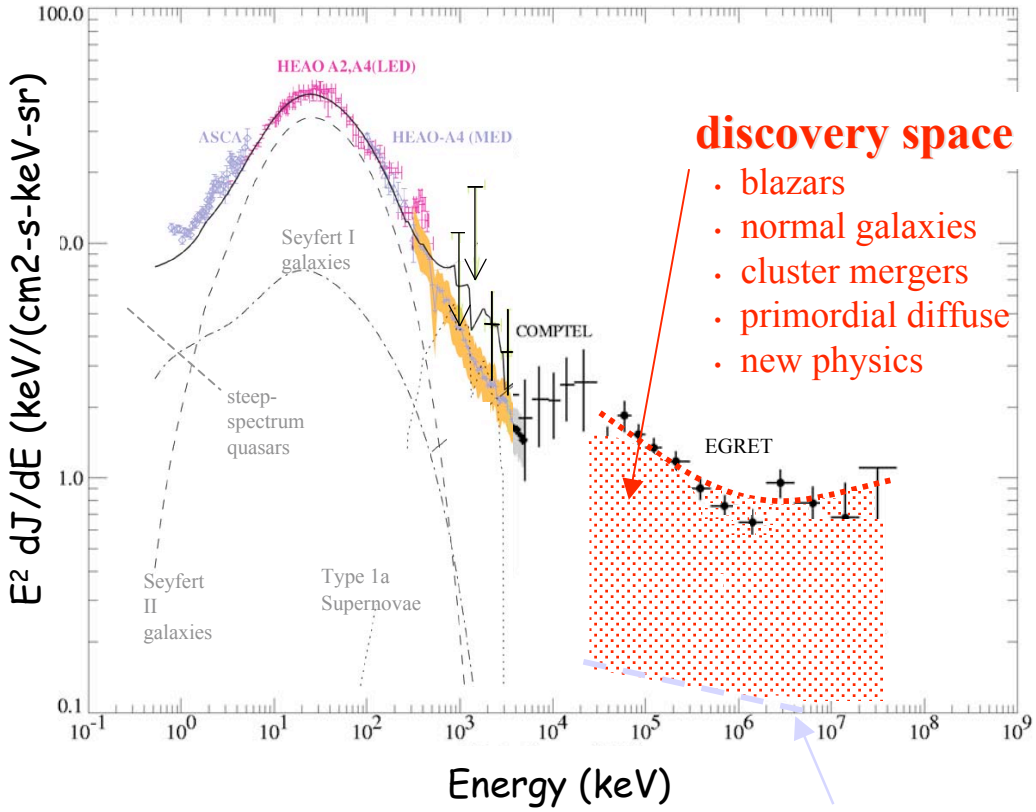
Cosmology: Origin of Extragalactic Diffuse Radiation

- ***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





discovery space

- blazars
- normal galaxies
- cluster mergers
- primordial diffuse
- new physics

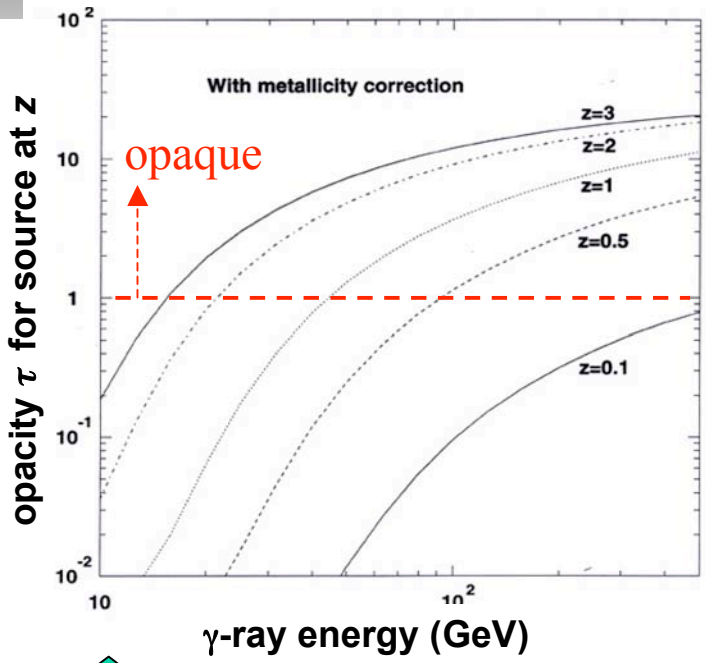
LAT baseline background limit

from Elasser & Mannheim, astro-ph/0405235

Unique science for GLAST

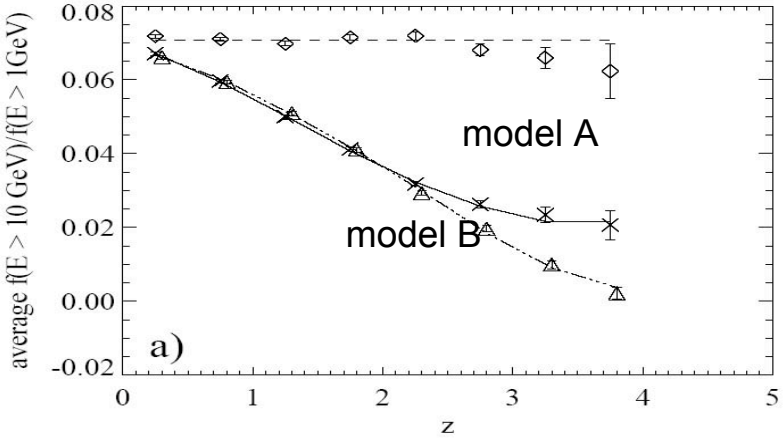
Cosmology: Probing Extragalactic Background Light

- ***High-redshift (z > 2.5) blazar detections important for visible-UV EBL studies and blazar/galaxy evolution***

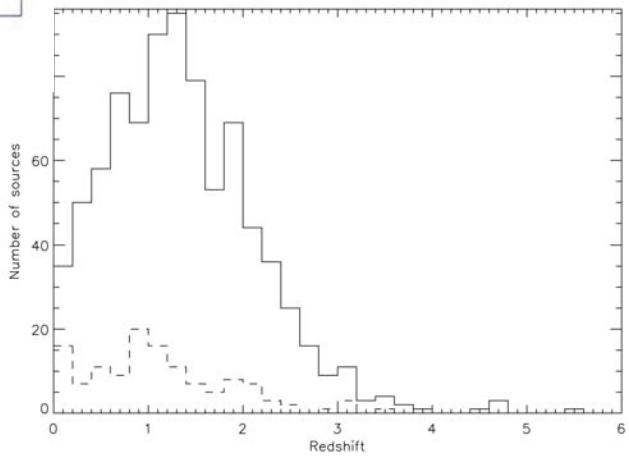


No significant attenuation below 10 GeV

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



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



70% of EGRET sources (|b|>10°) are blazars

4.8 GHz radio survey; chose bright flat-spectrum sources

95% of radio-selected sources are blazars

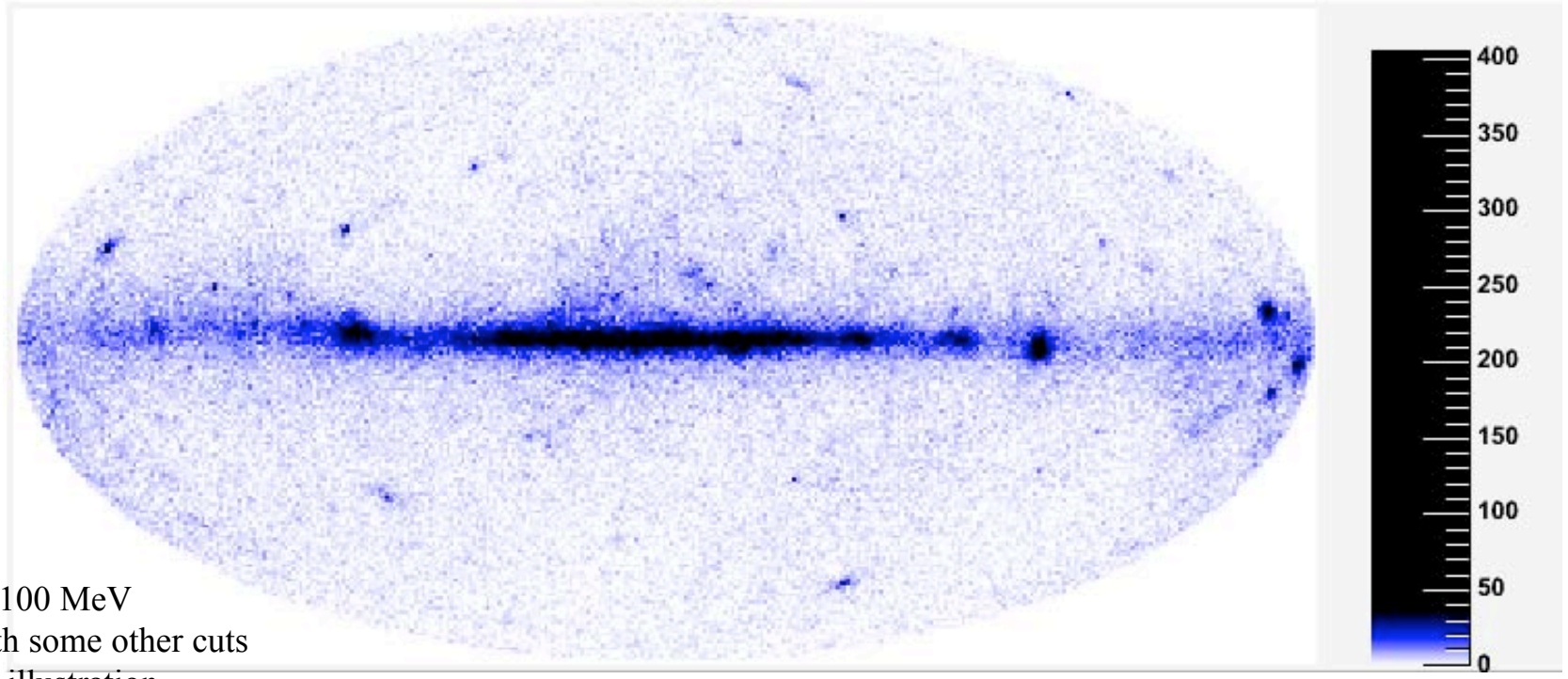
Data Challenges

- **"End-to-end" alpha testing of science analysis software.**
  - Exercises the simulation/analysis chain from low level detector simulations to top level science analysis and data servers.
- **Walk before running: design a progression of studies.**
  - **DC1. Modest goals. Contains most essential features of a data challenge.**
    - 1 simulated day all-sky survey simulation
    - find the sources, including GRBs
    - a few physics surprises
    - exercise:
      - exposure, orbit/attitude handling, data processing pipeline components, analysis tools
  - **DC2 in early 2006. More ambitious goals, incorporate lessons learned from DC1. One simulated month.**
    - toy one-month catalog.

see http://www.glast.slac.stanford.edu/software/Workshops/Feb04DC1CloseOut/overpage.htm

The DC1 Sky

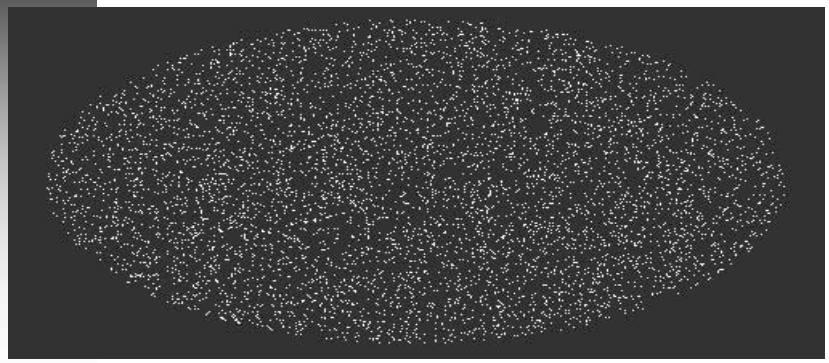
One day all-sky survey. Generated E>20 MeV.



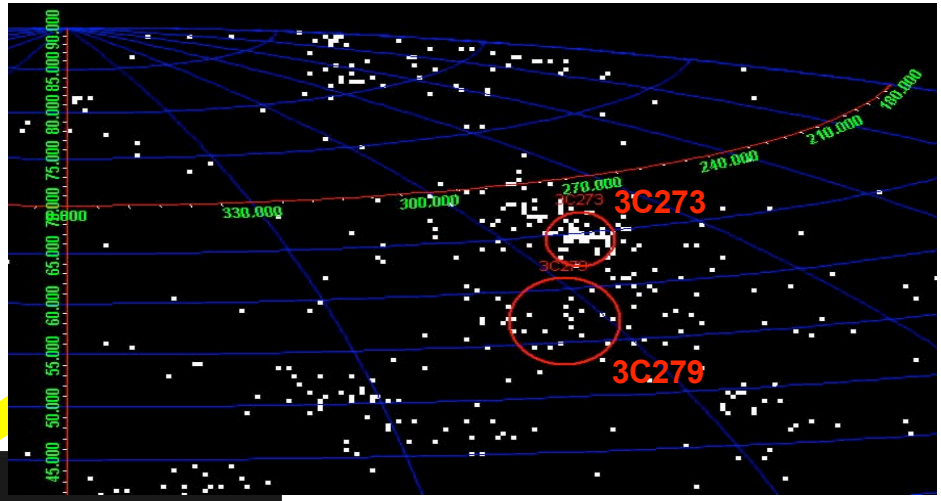
E>100 MeV
with some other cuts
for illustration

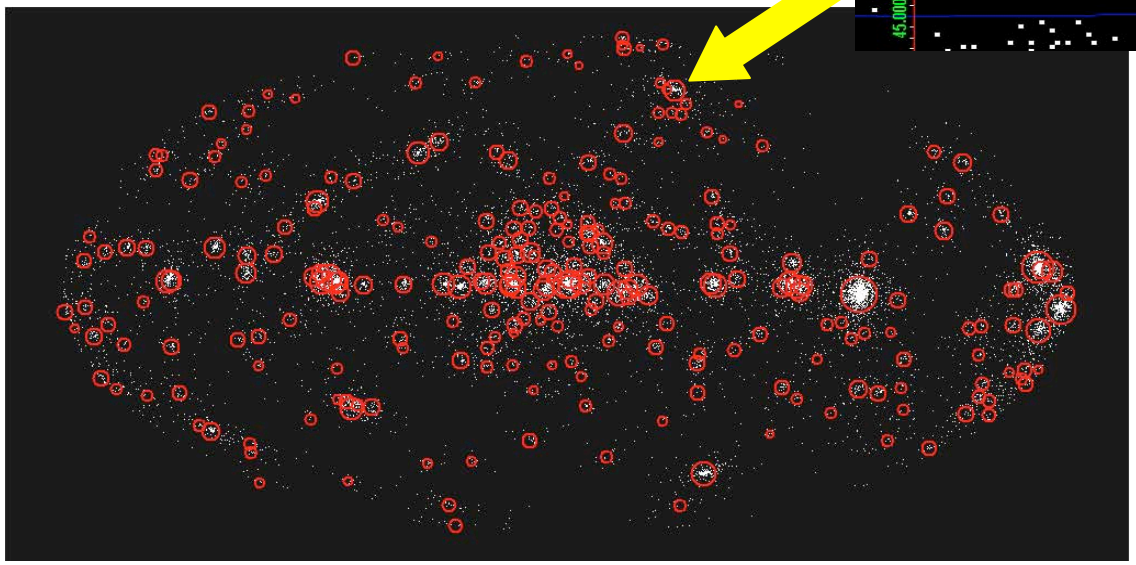
Lots to analyze!
A few surprises to find…

Data Challenge 1 Sky



isotropic diffuse





Sources – 3EG and more, with a twist

a number of physics surprises in the DC1 data, including:

- 110 GeV gamma-ray line source at the galactic center
- new source populations
- and a twist on history!

DC2 Improved Sky/Source Model

- **~ 1 month of LAT observations will produce a significantly more detailed view of the GeV gamma-ray sky than that provided by EGRET.**
  - **Sky model will be much more detailed than the model used for DC1.**
    - Greater range of source classes.
    - More detailed models of source behaviour (variable AGN, periodic pulsars…).
    - Improved luminosity distributions, source locations; include EBL effects consistently.
    - Updated diffuse Galactic emission model.
    - More detailed orbit/attitude profile and include effect of SAA.
- **Use updated event reconstruction, background rejection and Instrument response functions. Include minor/expected hardware failures and glitches (dead channels, etc.)**

DC2 Data Access and Analysis

- **More detailed sky model and simulated data allow more sophisticated analyses.**
  - Produce AGN light curves.
  - Periodicity analysis of pulsars.
  - Joint spectral analysis of GBM and LAT data for GRB.
  - Produce “toy” catalog.
  - Detailed source sensitivity and localization studies.
- **This will test and exercise many important areas including:**
  - Data servers for ease of use
  - Data formats for completeness.
  - Science analysis tools for usability
  - Documentation
  - Processing times
  - Data volumes
  - Data transfer rates

DC2 Schedule

- **Team members have been actively preparing for DC2 since January 2005.**
- **Kickoff in January 2006 with release of simulated data.**
- **Close out meeting 2-3 months later.**