

HETE-2

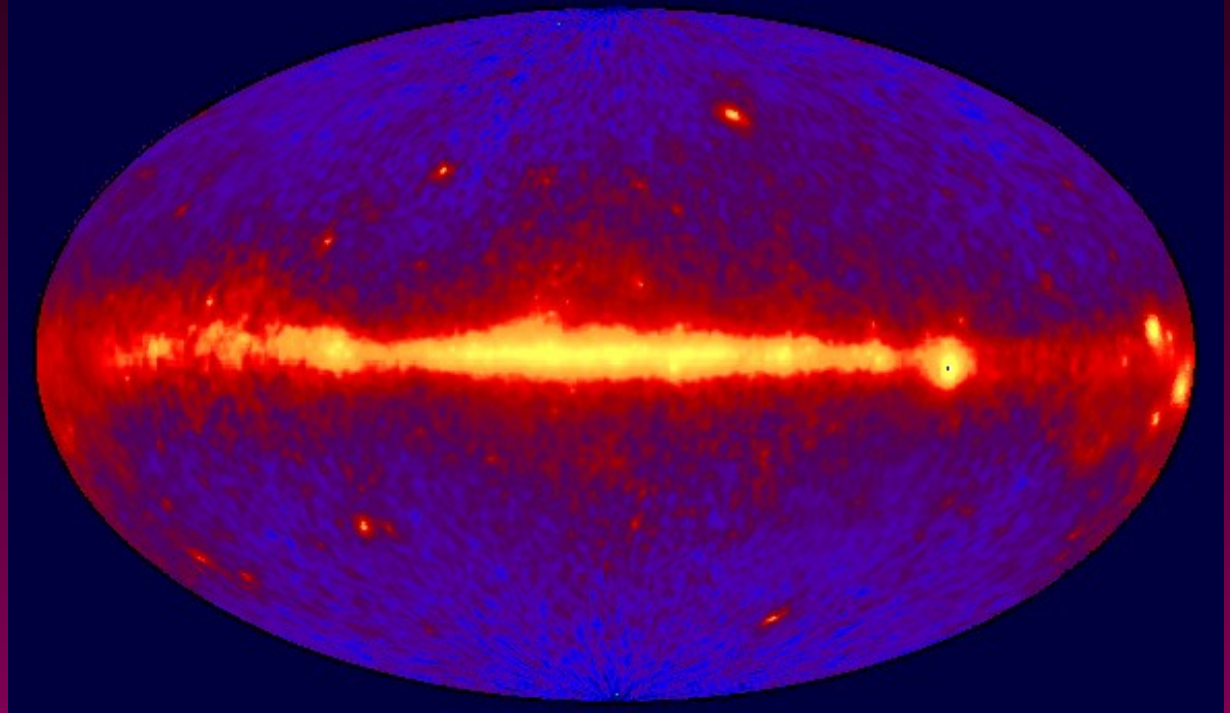
High Energy Transient Explorer



Gamma-ray Astronomy
Missions, and their Use of a
Global Telescope Network

The Big Picture

- Whole sky glows
- Extreme environments
- Probes of the Universe



CGRO/EGRET All Sky Map

Early Gamma-ray Astronomy

- **Gamma-ray Bursts**
 - Vela Program : A Bomb or Not a Bomb?
 - A few hundred events, a few hundred theories
- **Gamma-ray Sources**
 - SAS-2 – discovered 2 pulsars (1972)
 - COS-B – about 25 sources (1975-82)
 - Most unidentified, but 1 quasar
 - Diffuse extra-galactic background

Sources of γ -ray Emission

- **Black holes**
- **Active Galaxies**
- **Pulsars**
- **Gamma-ray bursts**
- **Diffuse emission**
- **Supernovae**
- **Unidentified**

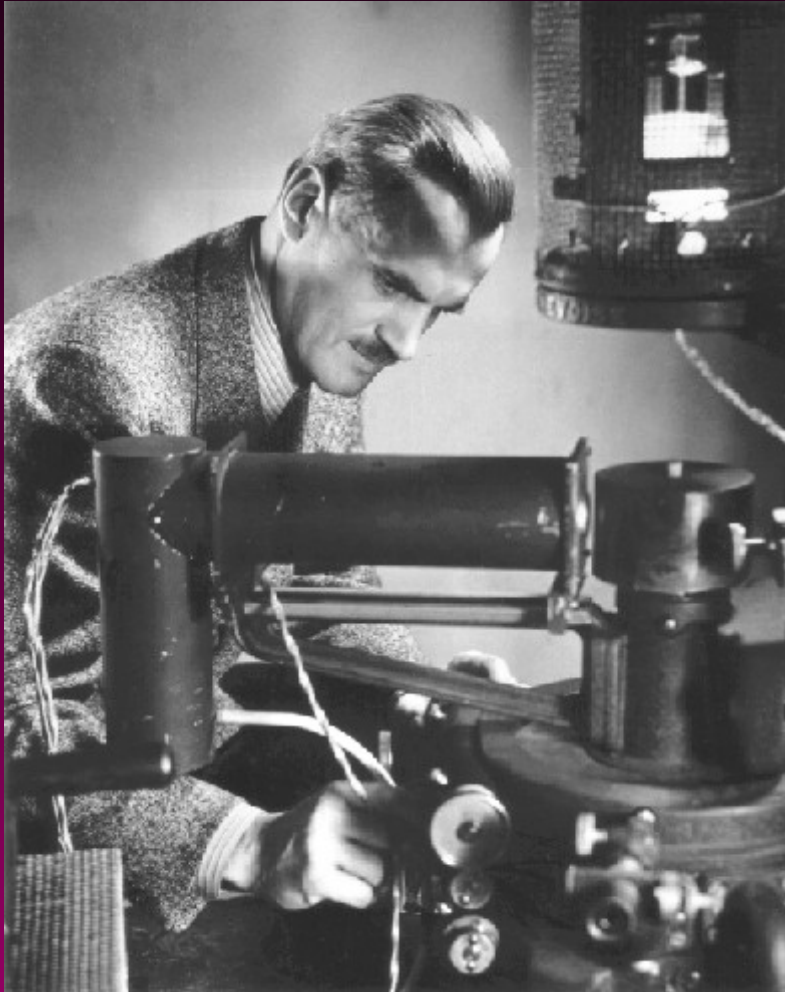
movie



CGRO (1991-2000)



Dr. Arthur Holly Compton

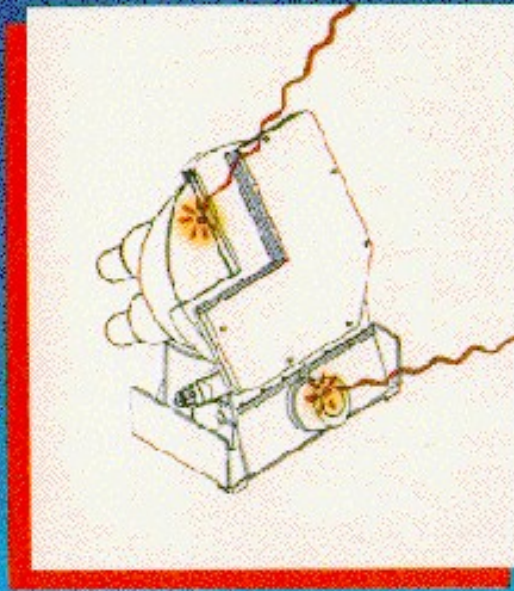
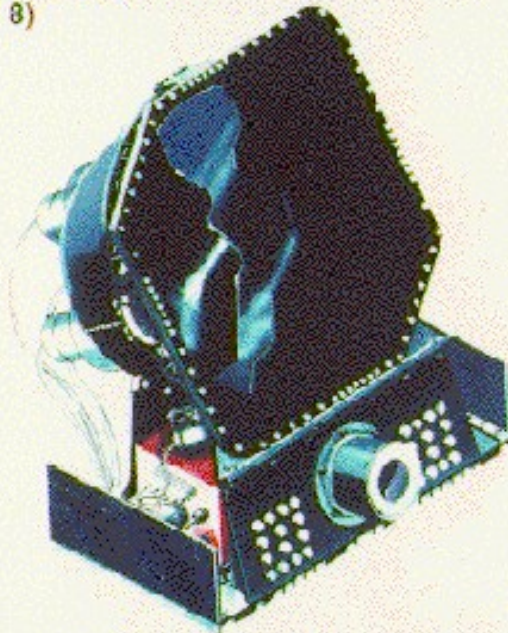


- 1927 Nobel Prize for Compton Effect
- First experimental proof of dual wave and particle nature of light

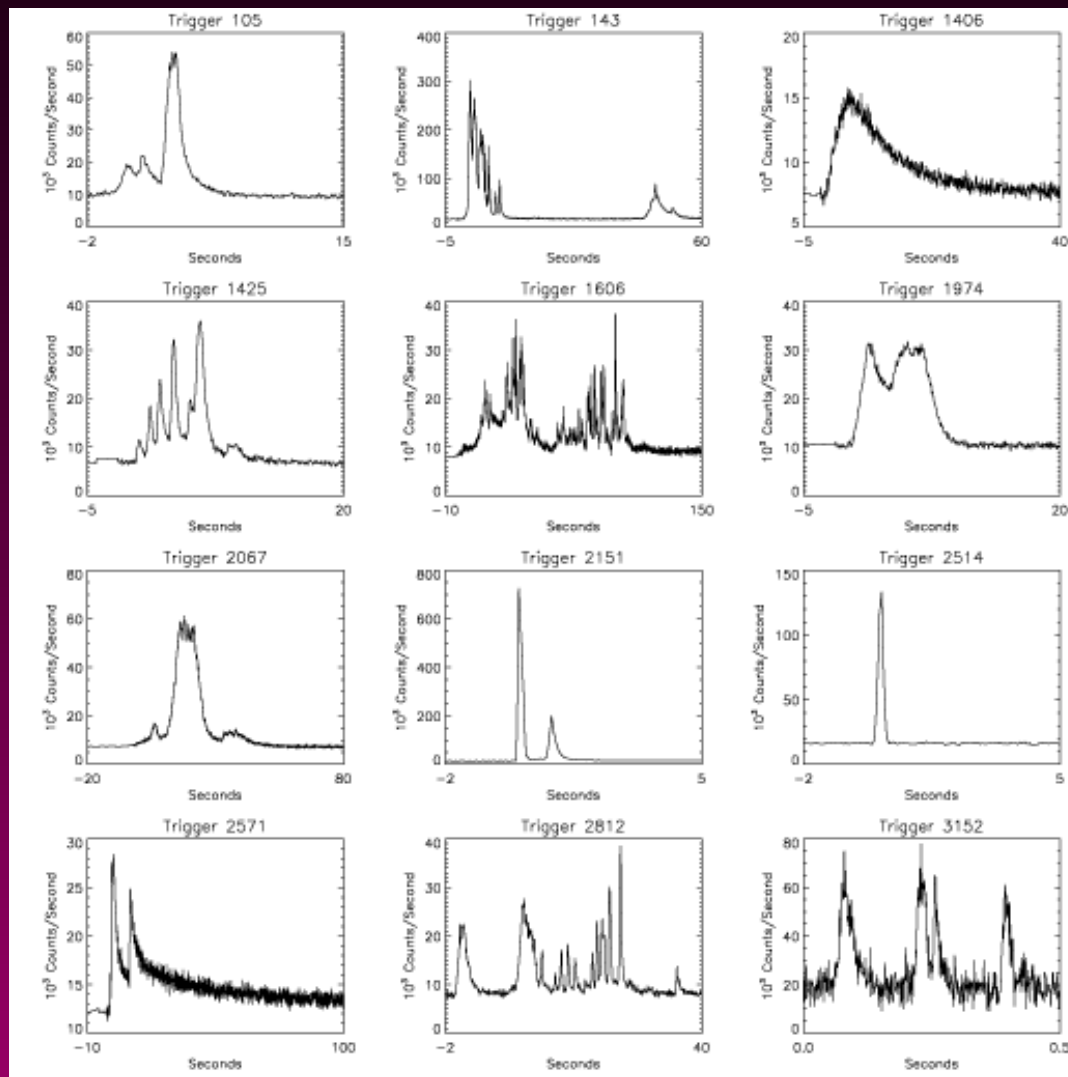
BATSE

Burst and Transient Source Experiment (BATSE)

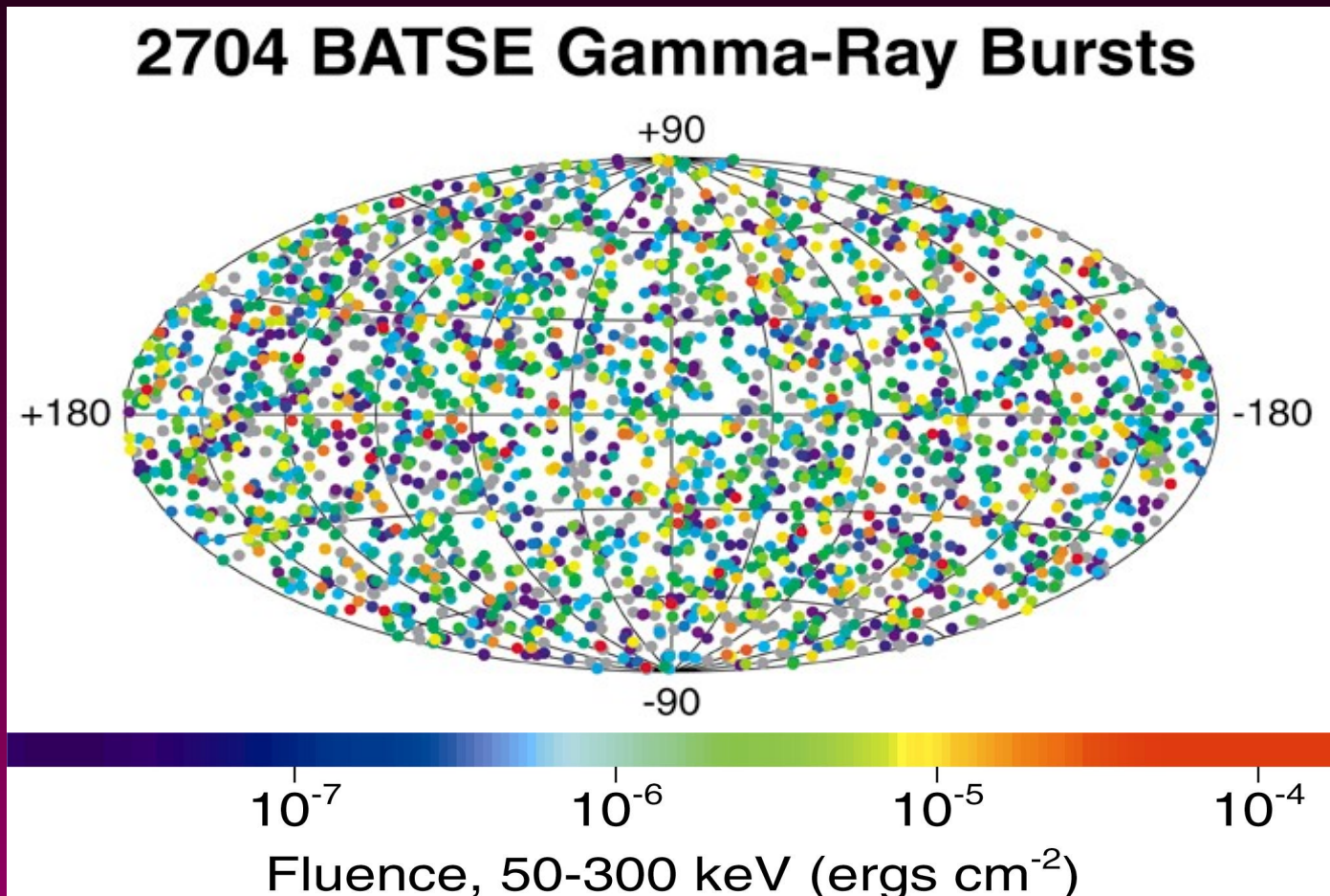
BATSE
DETECTOR MODULE
(1 OF 8)



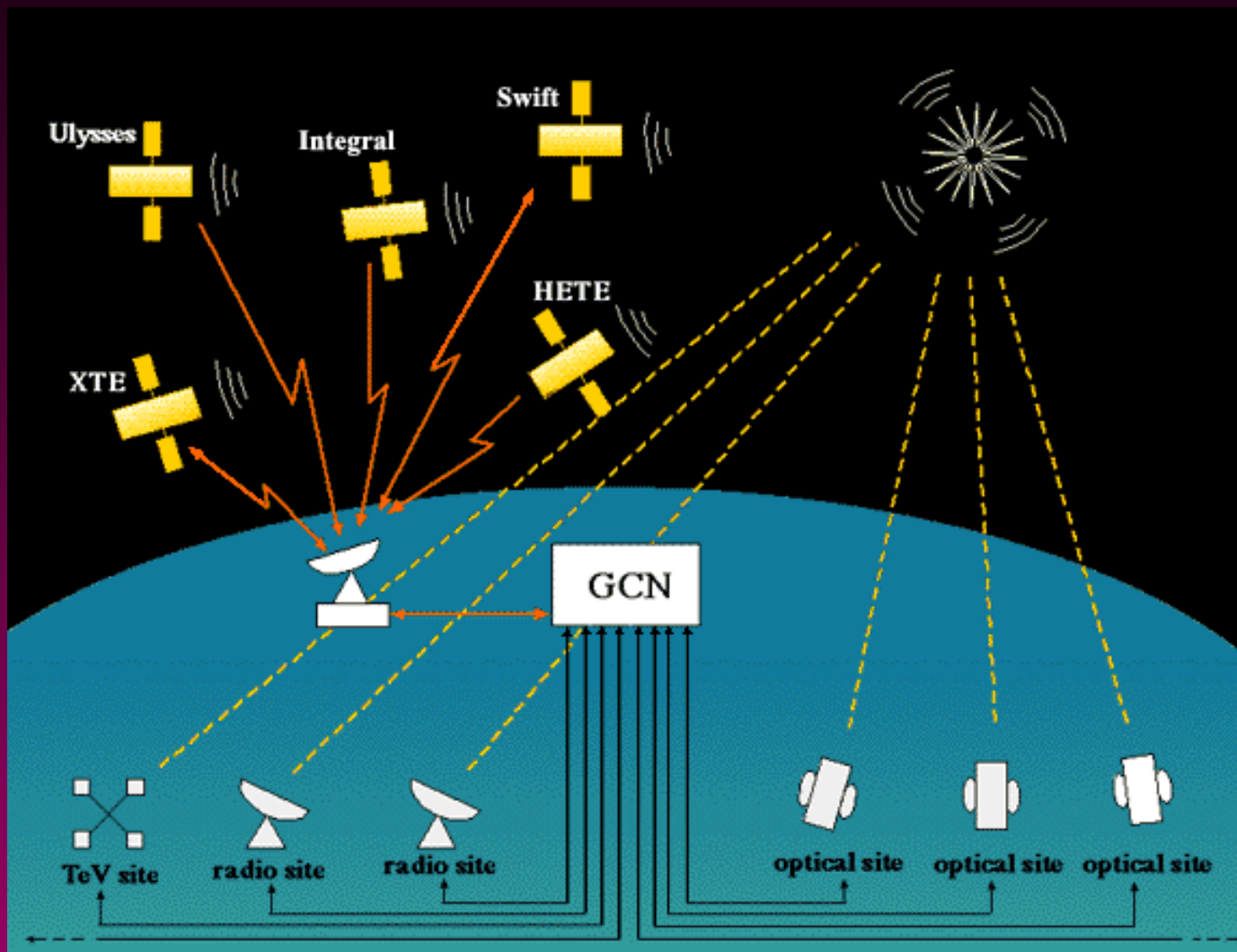
Gamma-Ray Bursts



Distribution of GRBs in the Sky



Gamma-ray Coordinates Network (GCN)



Gamma-ray Coordinates Network (GCN)

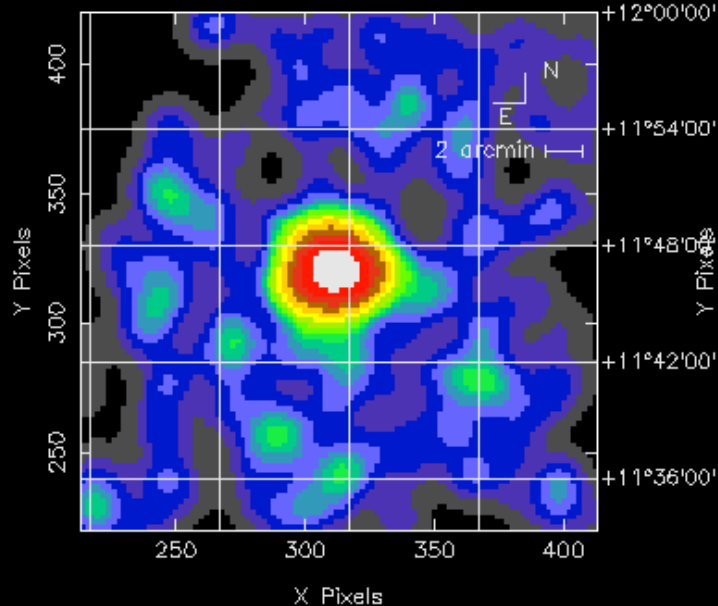
- Originally developed at NASA/MSFC as BACODINE under Scott Barthelmy to support BATSE positions/identifications –
- Now at NASA/GSFC – it distributes near real time GRB positions from active satellites as well as reports of follow-up observations by ground-based observers
- To join: <http://gcn.gsfc.nasa.gov/invitation.html>

Gamma-ray Burst Progress

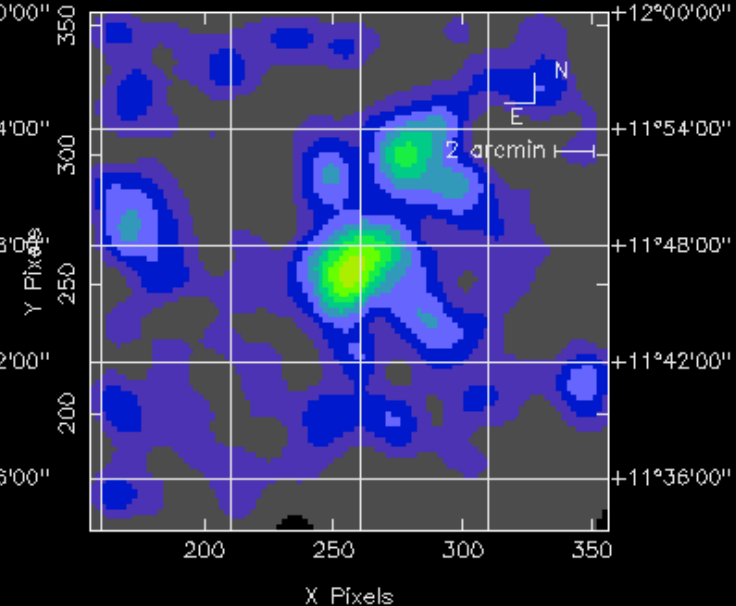
- Beppo/SAX finds evidence for X-ray afterglow from several GRBs (2/28/97)
- Jan van Paradijs finds optical afterglow
- Redshifts indicate cosmological distances (Keck, HST)
- ROTSE catches GRB in the act at visible wavelengths (1/23/99)
- Evidence mounts for two types of GRBs

What BeppoSAX Saw

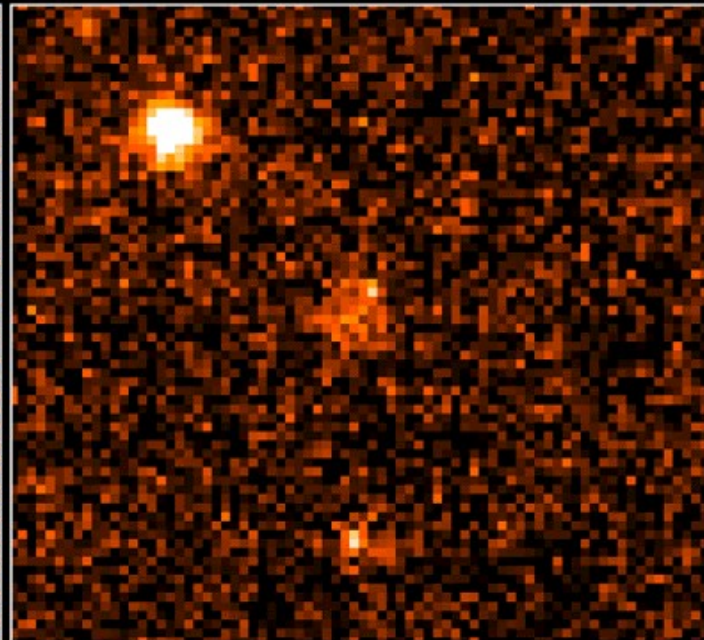
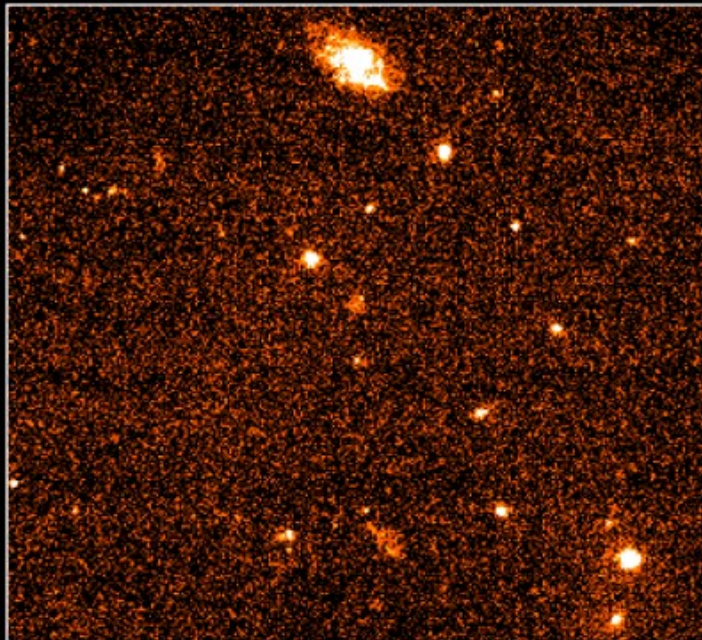
BeppoSAX observation of GRB970228 field
SAX MECS 1997 Feb 28 Exposure: 14334 s
5^h02^m36^s 5^h02^m09^s 5^h01^m42^s 5^h01^m15^s



BeppoSAX observation of GRB970228 field
SAX MECS 1997 Mar 3 Exposure: 16272 s
5^h02^m36^s 5^h02^m09^s 5^h01^m42^s 5^h01^m15^s

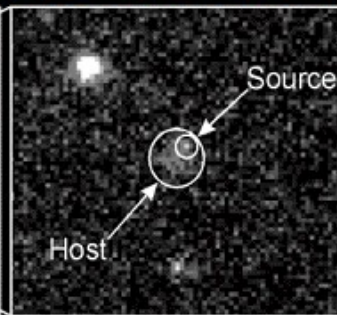
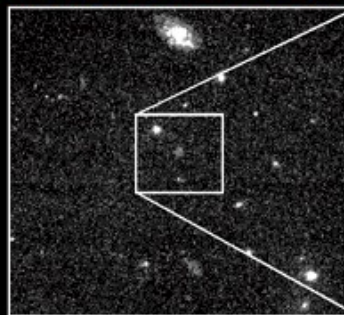


What HST Saw (Much Later)

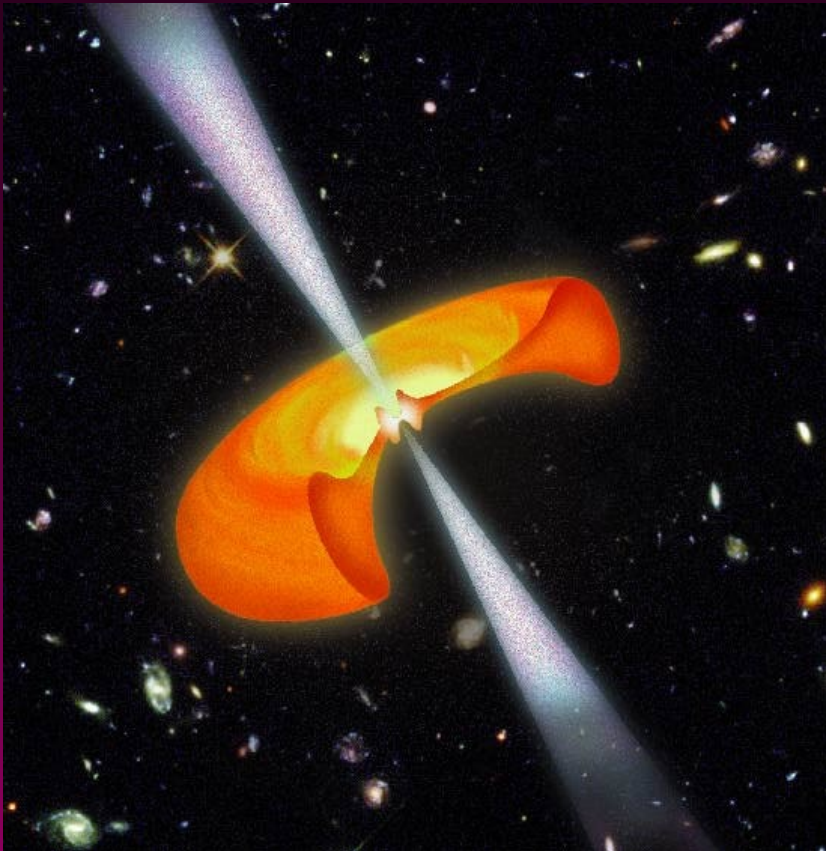


HST • STIS

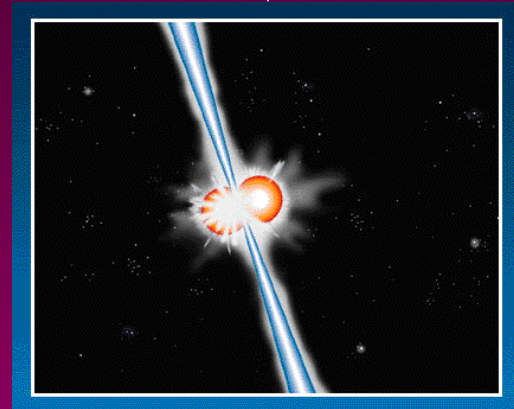
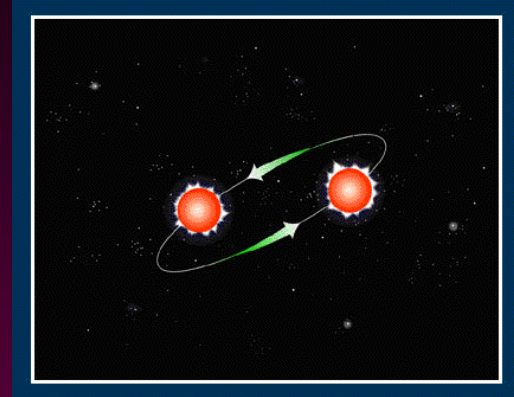
**Gamma Ray
Burst
GRB 970228**



Models for GRBs



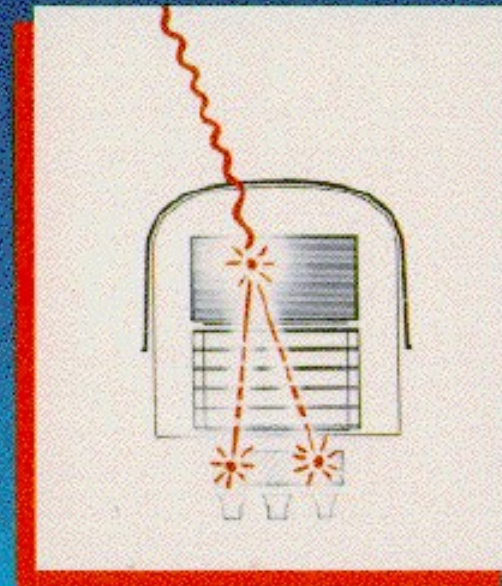
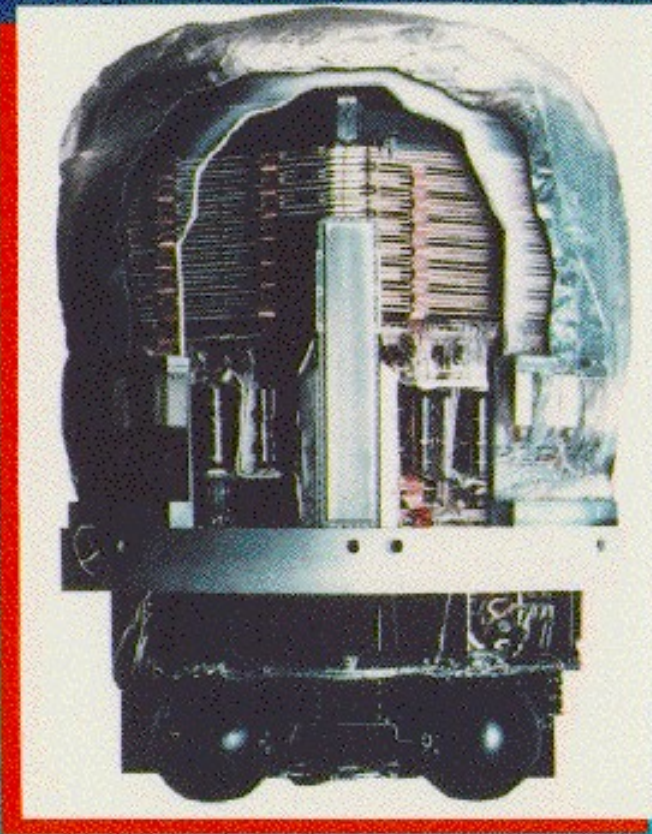
Hypernova



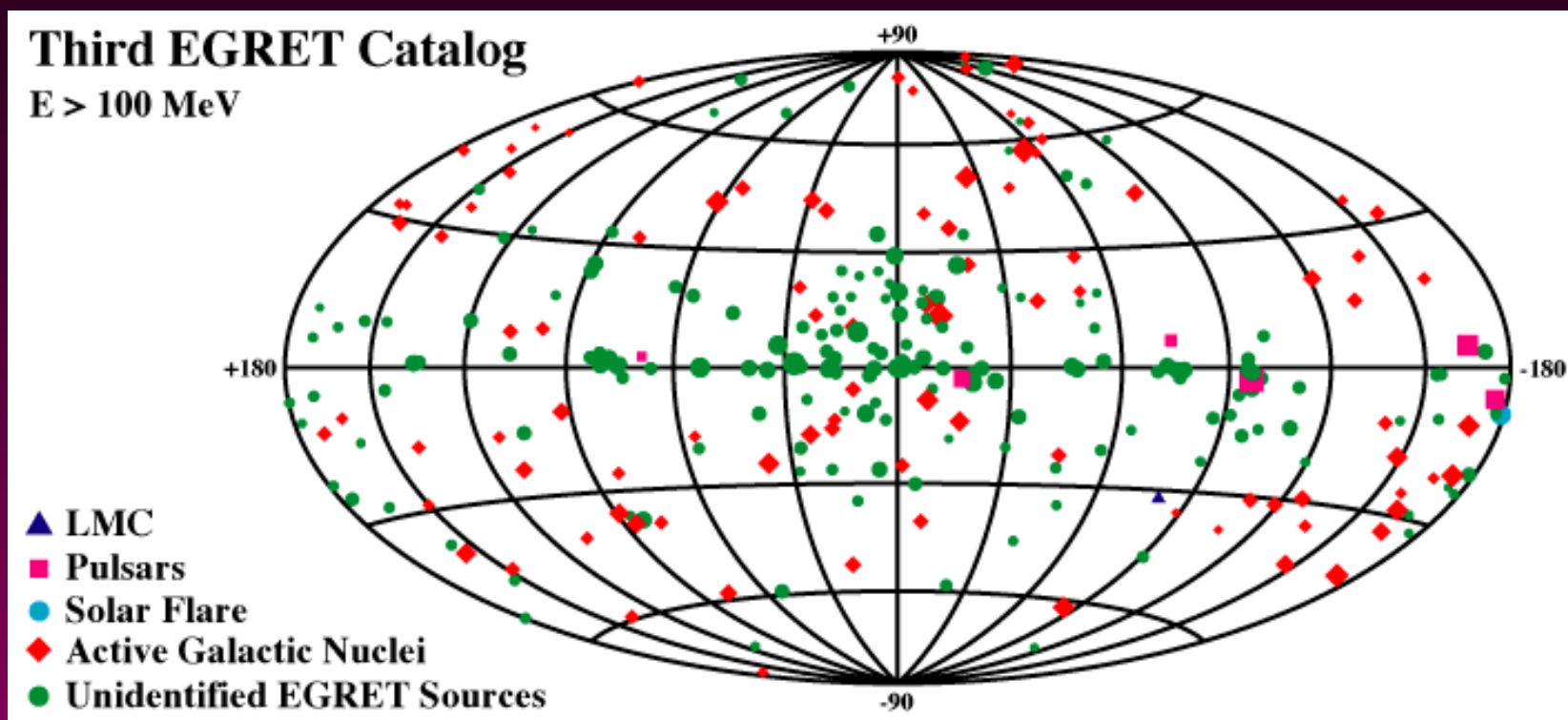
Merging Neutron Stars

EGRET

Energetic Gamma Ray Experiment
Telescope (EGRET)

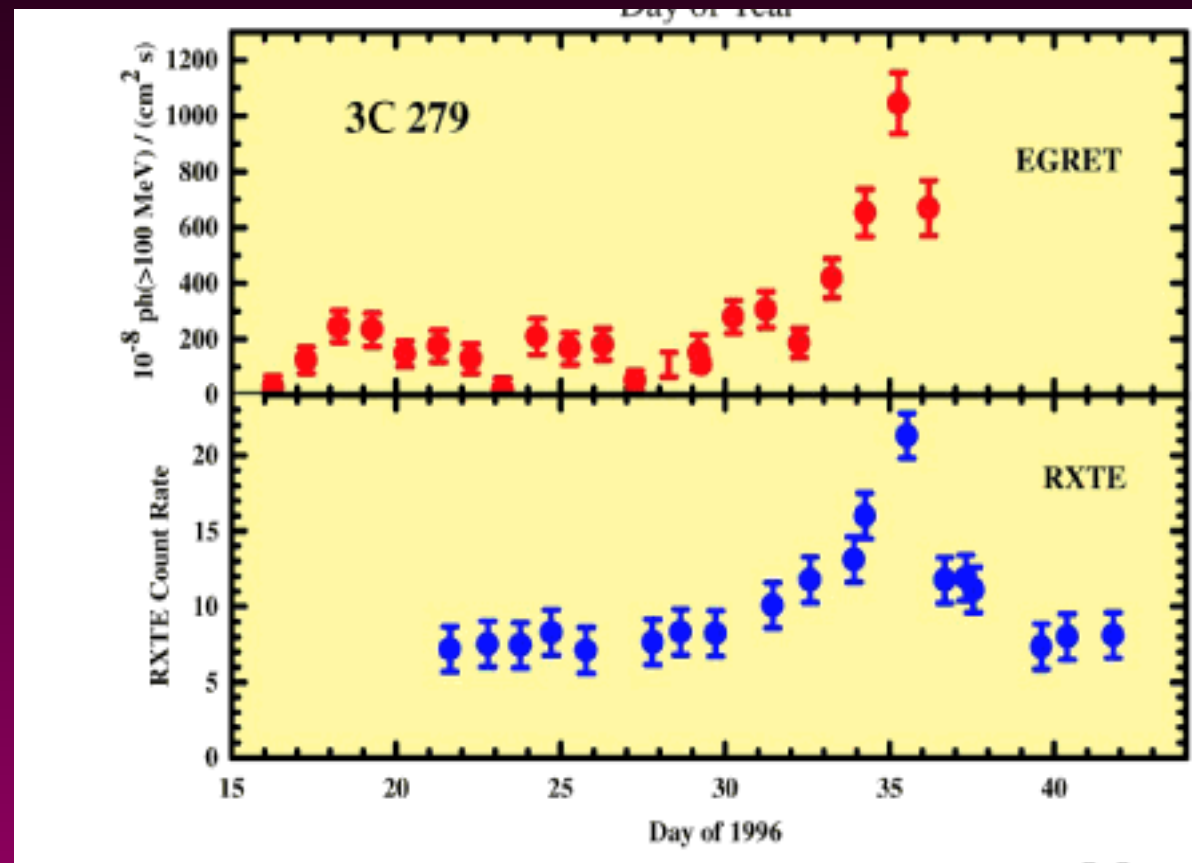


Third EGRET Catalog Sky Map



EGRET Blazars

- 3C279 is brightest AGN at high energies
- Multi-wavelength coverage essential to understand flare mechanism

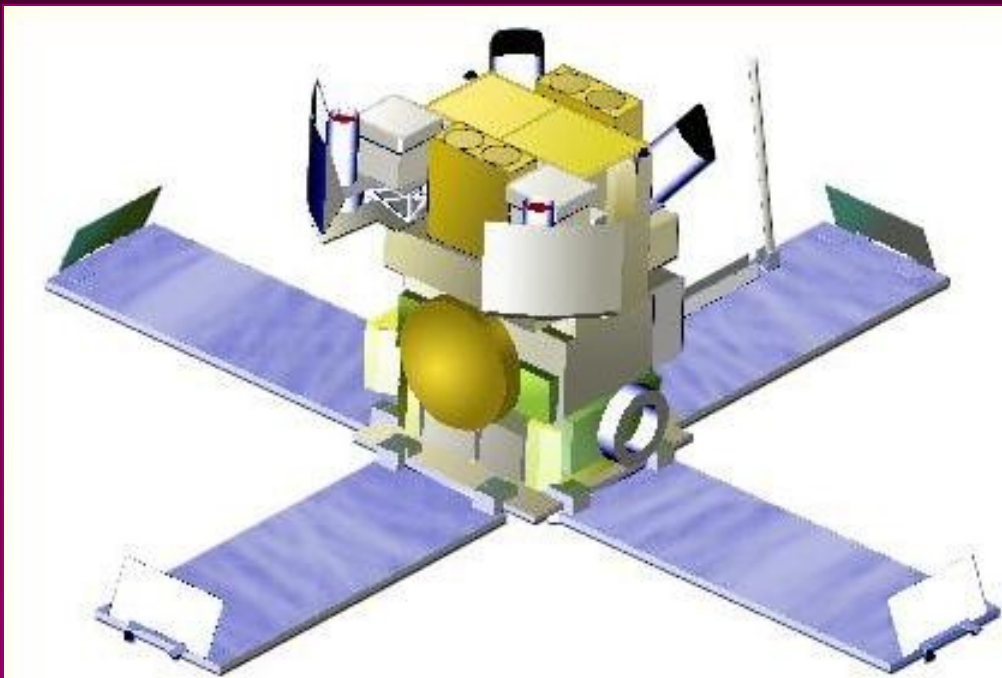


Blazar questions

- Where are the acceleration and emission sites in blazar jets? **Multi-wavelength campaigns from radio to TeV**
 - How do galaxies “cool their jets”? **Study X/ γ**
 - Are jets leptonic or hadronic? **Study H- α / γ to distinguish between leptonic models. Study X/ γ to distinguish leptonic/hadronic models**
- All require energy and time-resolved spectra of blazars during flares and quiescence*

HETE II

- Launched 10/9/00
- Operational 2/01
- Good data starts ~8/15/01



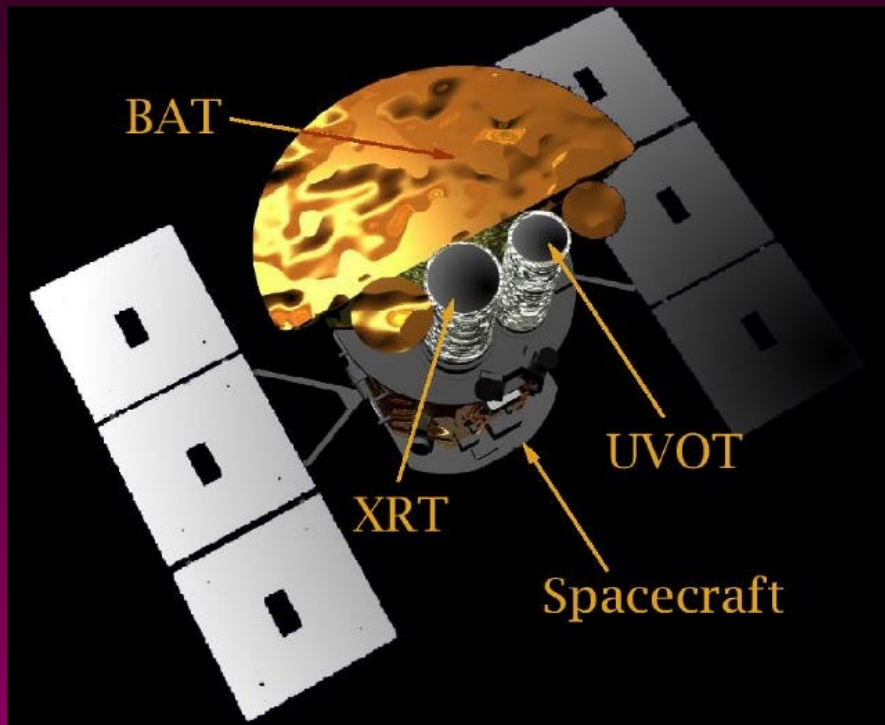
- GRB positions from 10" to 10' to GCN within a few seconds
- Will detect about 30 GRBs per year
- Anti-solar pointing optimized for ground observers

Coordinating with HETE

- ▣ HETE has ~12 ground stations near the equator to transmit positions in near real time
- ▣ Sockets are available through GCN (<http://gcn.gsfc.nasa.gov/>) to get burst alerts as they occur
- ▣ To see where HETE is pointing: [#hetepointing](http://space.mit.edu/HETE/mission_status.htm)
- ▣ It will soon be leaving the galactic center and better data should be forthcoming!

Swift

To be launched in 2003



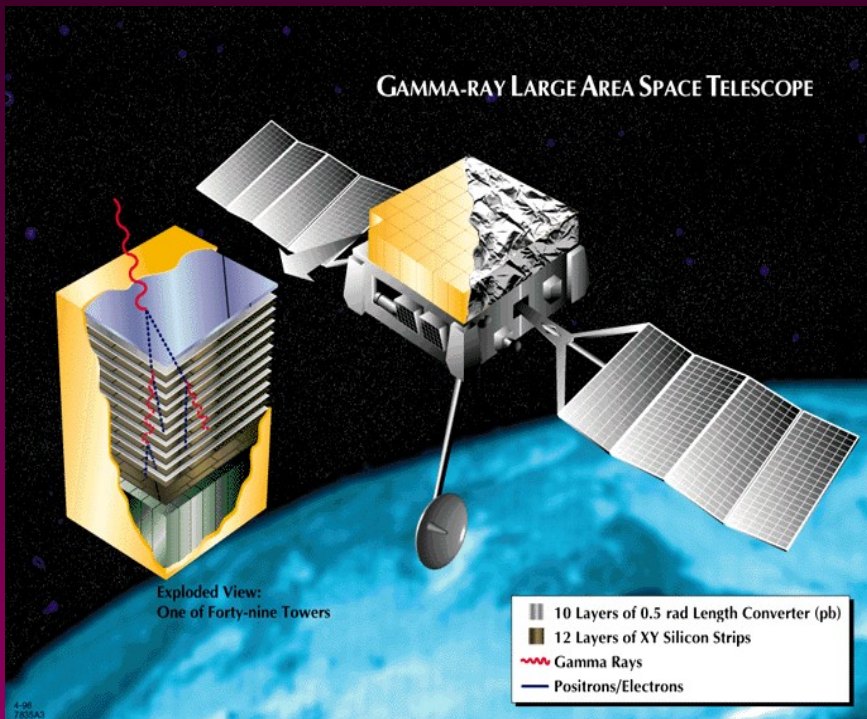
- Repoints within 50 s for X-ray and optical data
- Sends initial coordinates to ground within 15 s
- Sends high resolution coordinates to ground within 50 s
- Detects about 300 GRBs per year

Swift Telescope Network

- ▣ Swift has many Associate Investigators who will be observing GRB targets
- ▣ Kevin Hurley (UCB) is coordinating these professional astronomers
- ▣ Swift positions will be available through GCN
- ▣ GLAST Telescope network members will be invited to test their systems using Swift and HETE alerts – scientific coordination will be probably also be possible

GLAST

To be launched in
2006



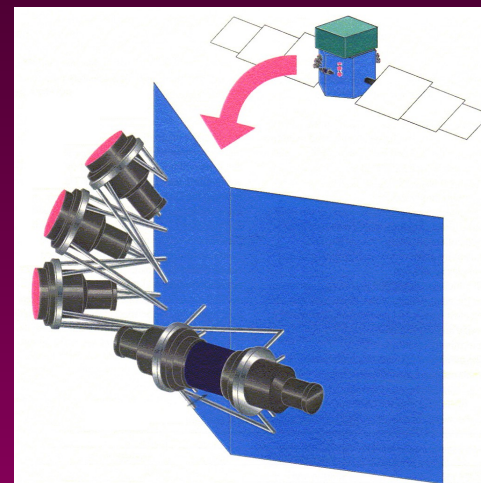
- GLAST Burst Monitor and Large Area Telescope will study GRBs over energies 10 MeV – 300 GeV
- High-energy GRs from AGN flares

Mission

- ▣ First space-based collaboration between astrophysics and particle physics communities
- ▣ Launch expected in 2006
- ▣ First year All-sky Survey followed by...
- ▣ Competitive Guest Observer Program
- ▣ Expected duration 5-10 years

GLAST Burst Monitor

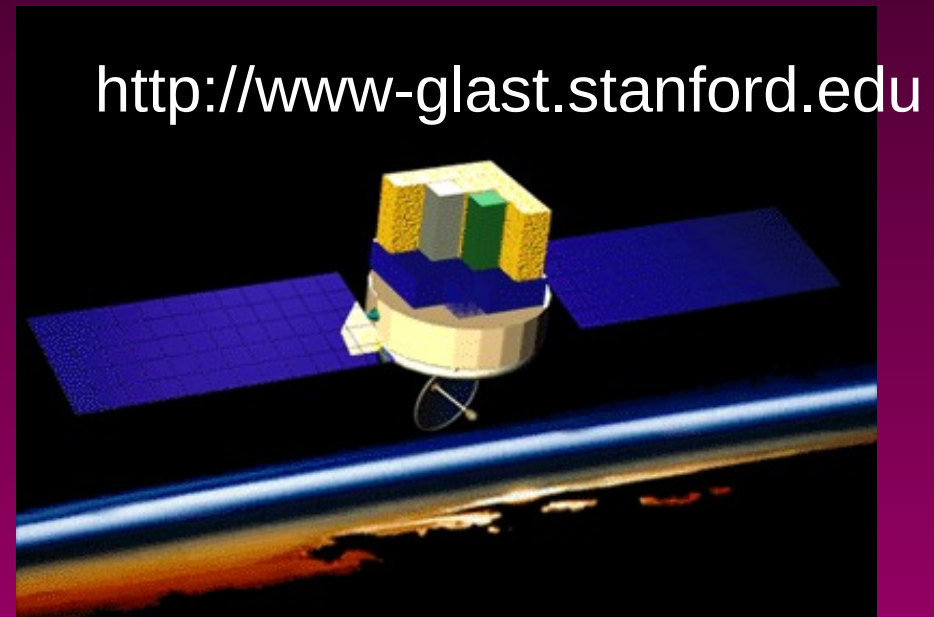
- PI Charles Meegan (NASA/MSFC)
- US-German secondary instrument
- 12 Sodium Iodide scintillators
 - » Few keV to 1 MeV
 - » Burst triggers and locations
- 2 bismuth germanate detectors
 - » 150 keV to 30 MeV
 - » Overlap with LAT
- <http://gammaray.msfc.nasa.gov/gbm/>



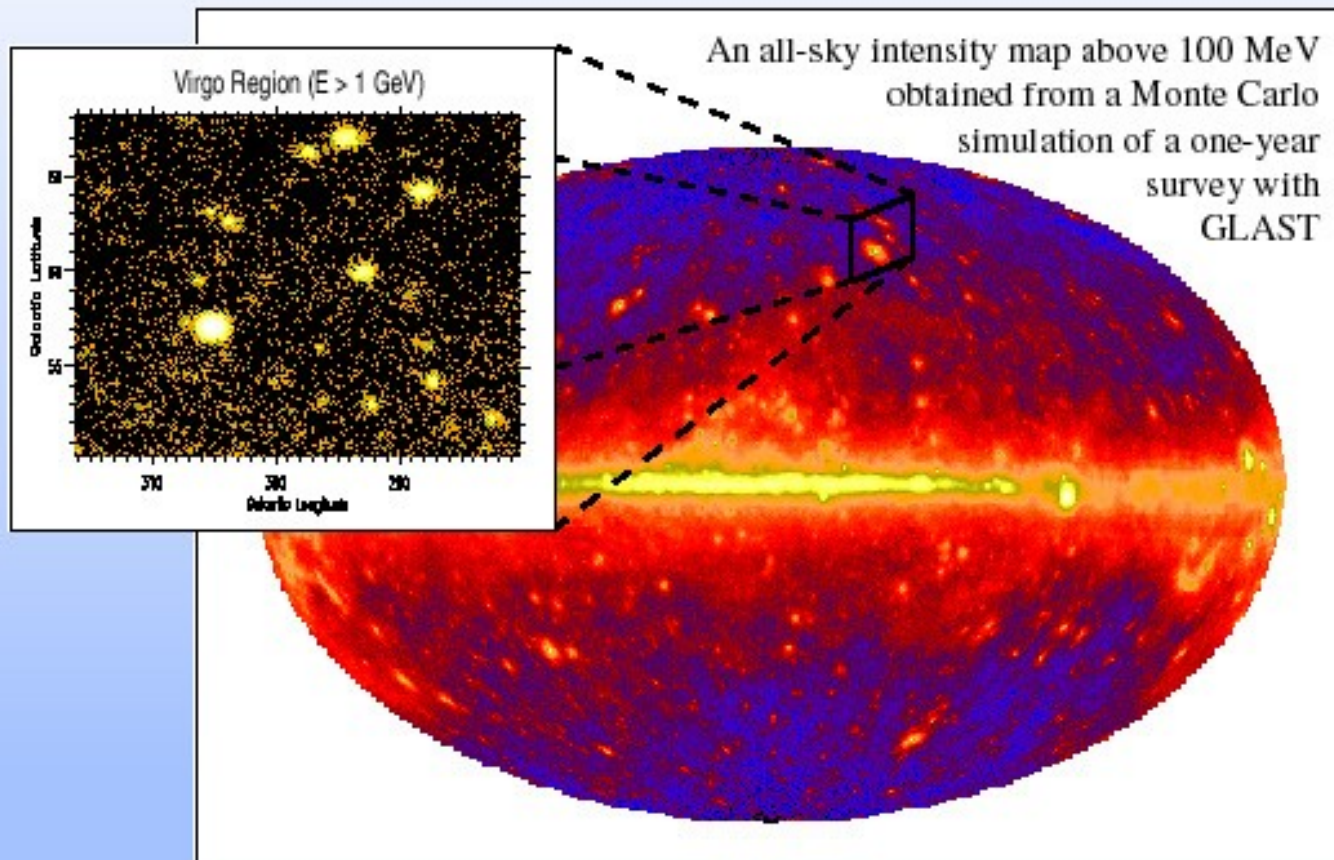
Large Area Telescope

- ▣ PI Peter Michelson (Stanford)
- ▣ International Collaboration: USA NASA and DoE, France, Italy, Japan, Sweden

- ▣ LAT is a 4 x 4 array of towers
 - Each tower is a pair conversion telescope with calorimeter



GLAST All Sky Map



GLAST Telescope Network

- ▣ As part of the GLAST EPO program, we are assembling a global telescope network of amateurs, students and professionals
- ▣ RCT will be participating through John Mattox – SLAC will archive all data for RCT
- ▣ Targets for GLAST will be both GRBs and AGN flares
- ▣ SSU Observatory will also be participating
- ▣ Gordon Spear is directing this effort
- ▣ All are welcome to join!

For More Information

- ▣ HETE Mission- <http://space.mit.edu/HETE>
- ▣ Swift Mission - <http://swift.sonoma.edu/>
- ▣ GLAST Mission - <http://www-glast.sonoma.edu/>
- ▣ CGRO Mission - <http://cossc.gsfc.nasa.gov>