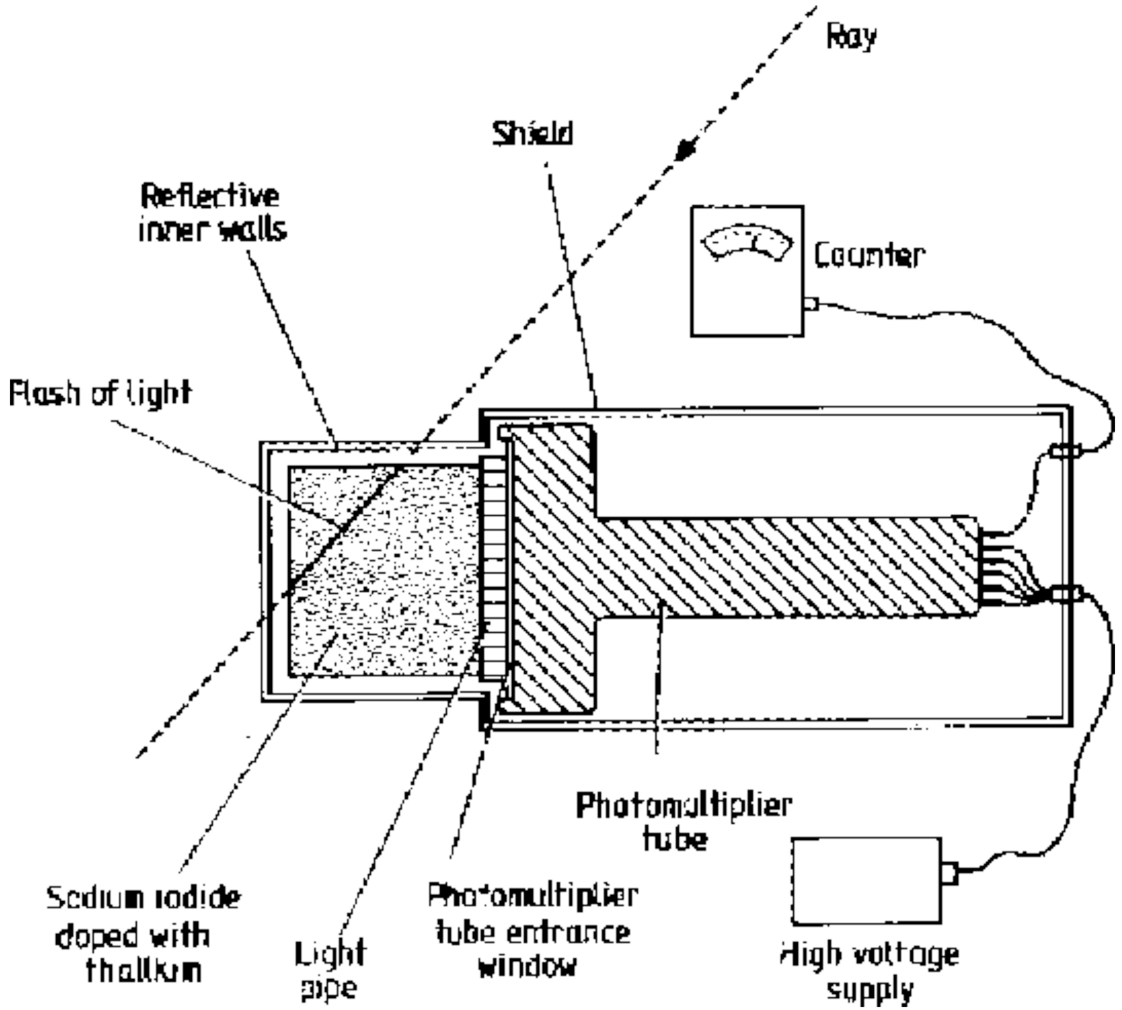
Astrofisica Nucleare e Subnucleare

“GRB” Astrophysics

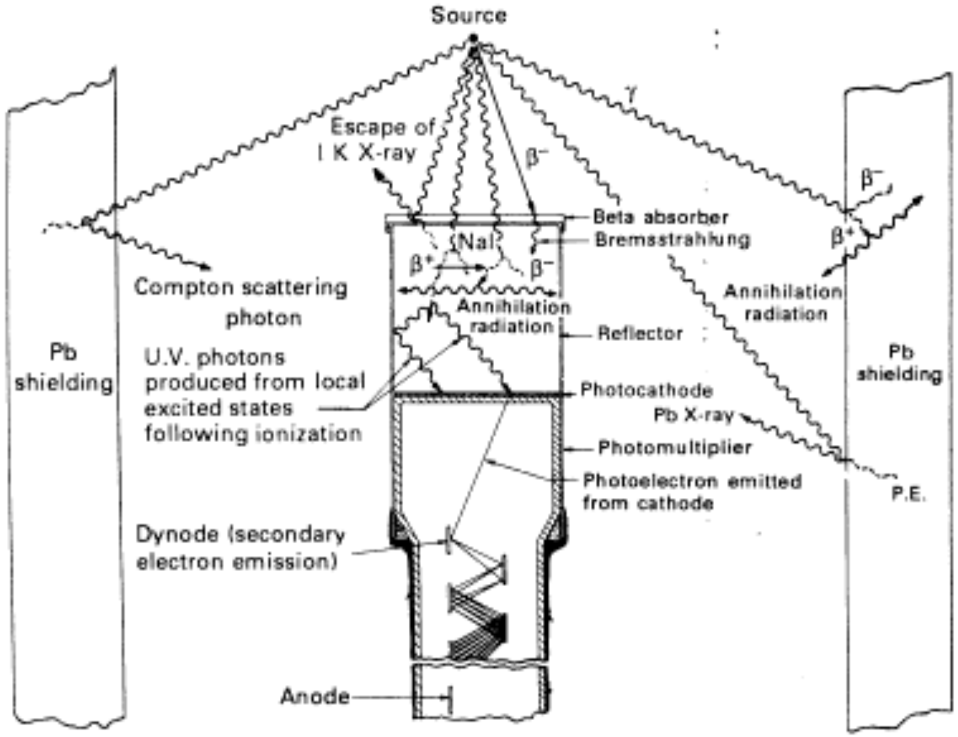
Astrofisica Nucleare e Subnucleare

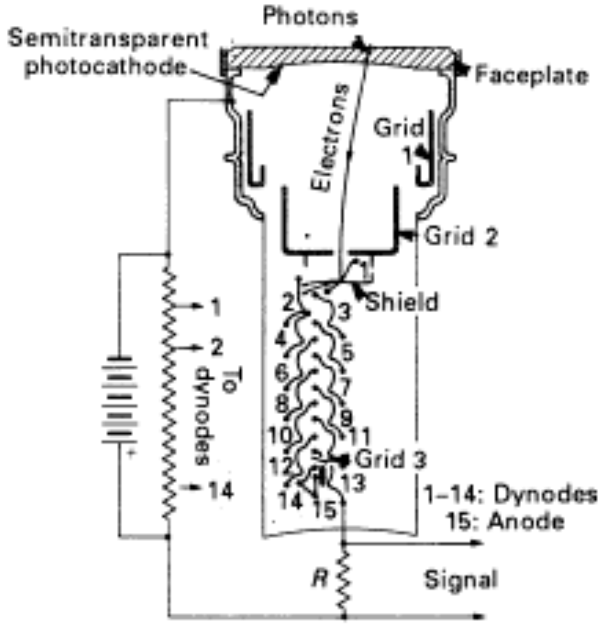
Gamma ray Bursts – I

Scintillator Detectors



Scintillation Detectors





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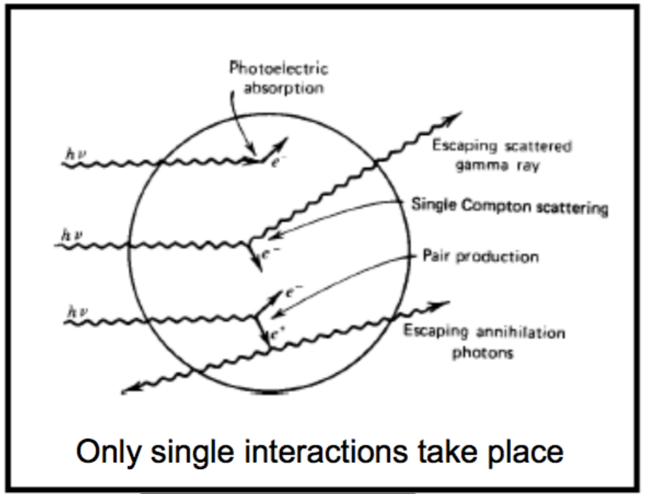


Figure 9: "Small" detector

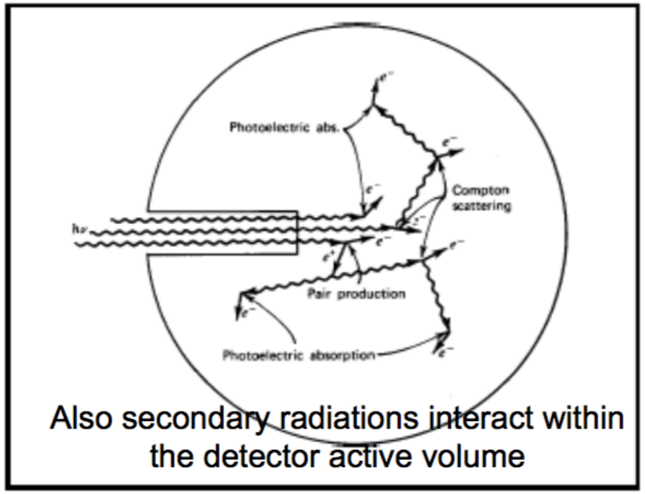


Figure 10: "Large" detector

most of the "secondary products" remain in the detector

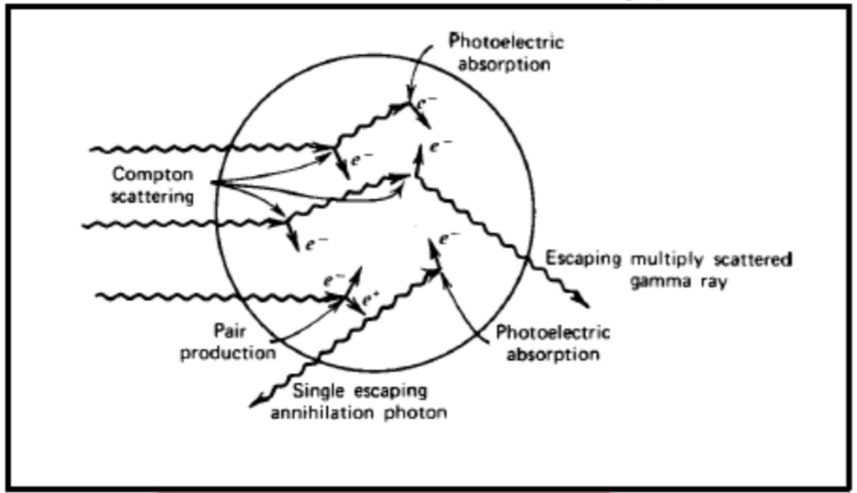
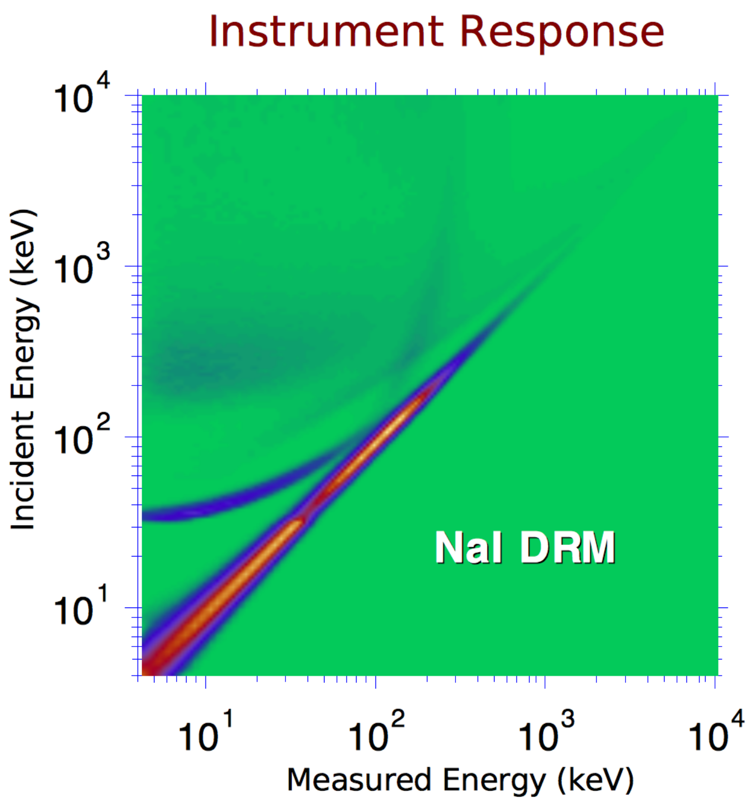


Figure 11: Intermediately sized detector

F. Knoll

Detector Response Matrix



The response of a detector, which signal depends of the energy of an incoming photon, distributes the photon of a certain energy over many pulse height channels according to the gain and energy resolution of the detector. Usually this resolution function is relative complicated and depends on the photon energy. Since the energy acceptance and resolution of a given detector is determined by its design it is convenient to table this function while the photon energy serves as a parameter. This procedure leads directly to a form of a matrix and gives the whole data set the name *detector response matrix*.

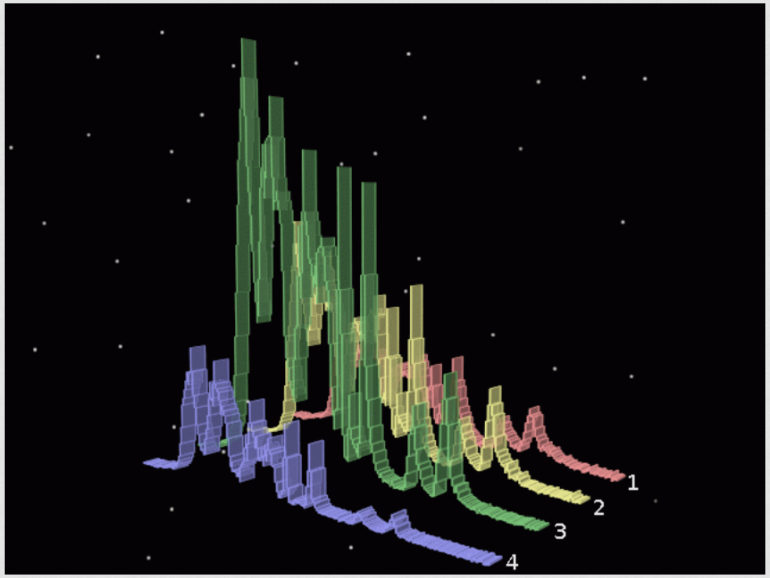
Exercise #1

- Find the web sites of BATSE (?), Fermi/GBM and Swift

Exercise #1

- Web site of BATSE
- https://gammaray.nsstc.nasa.gov/batse/

BATSE *GRB*

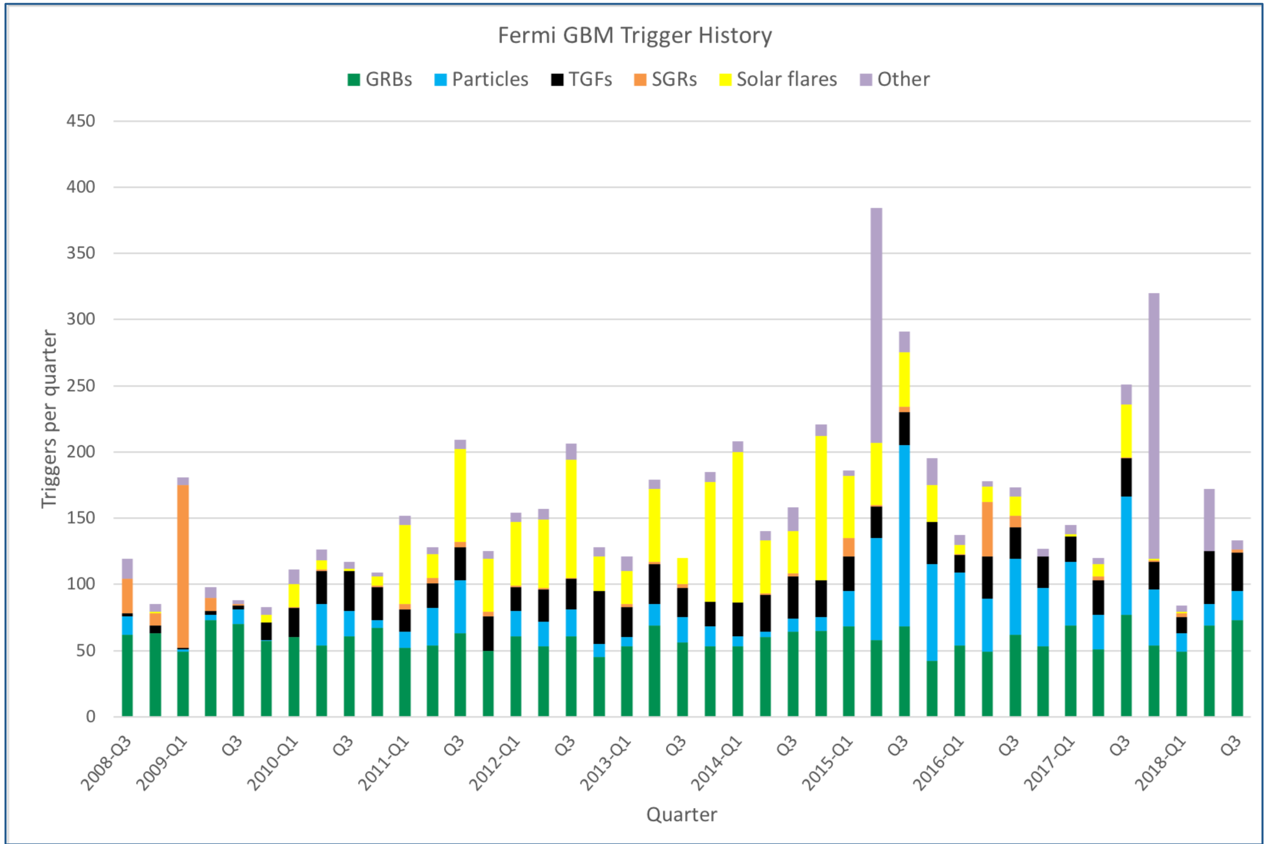


This image shows a model of a bright gamma-ray burst light curve observed with BATSE. The model was created from the four energy channel discriminator datatype known as DISCSC. The four energy channels are as follows:

1: 25 - 50 keV
2: 50 - 100 keV
3: 100 - 300 keV
4: > 300 keV

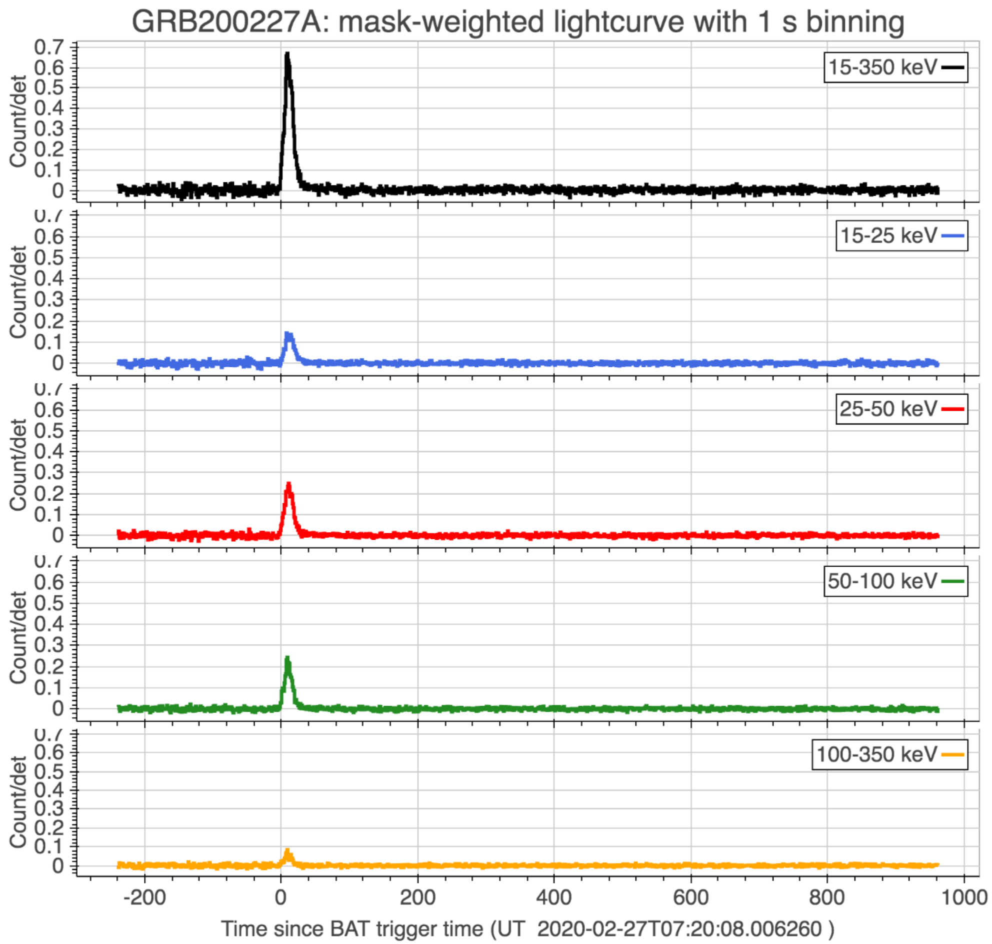
Exercise #1

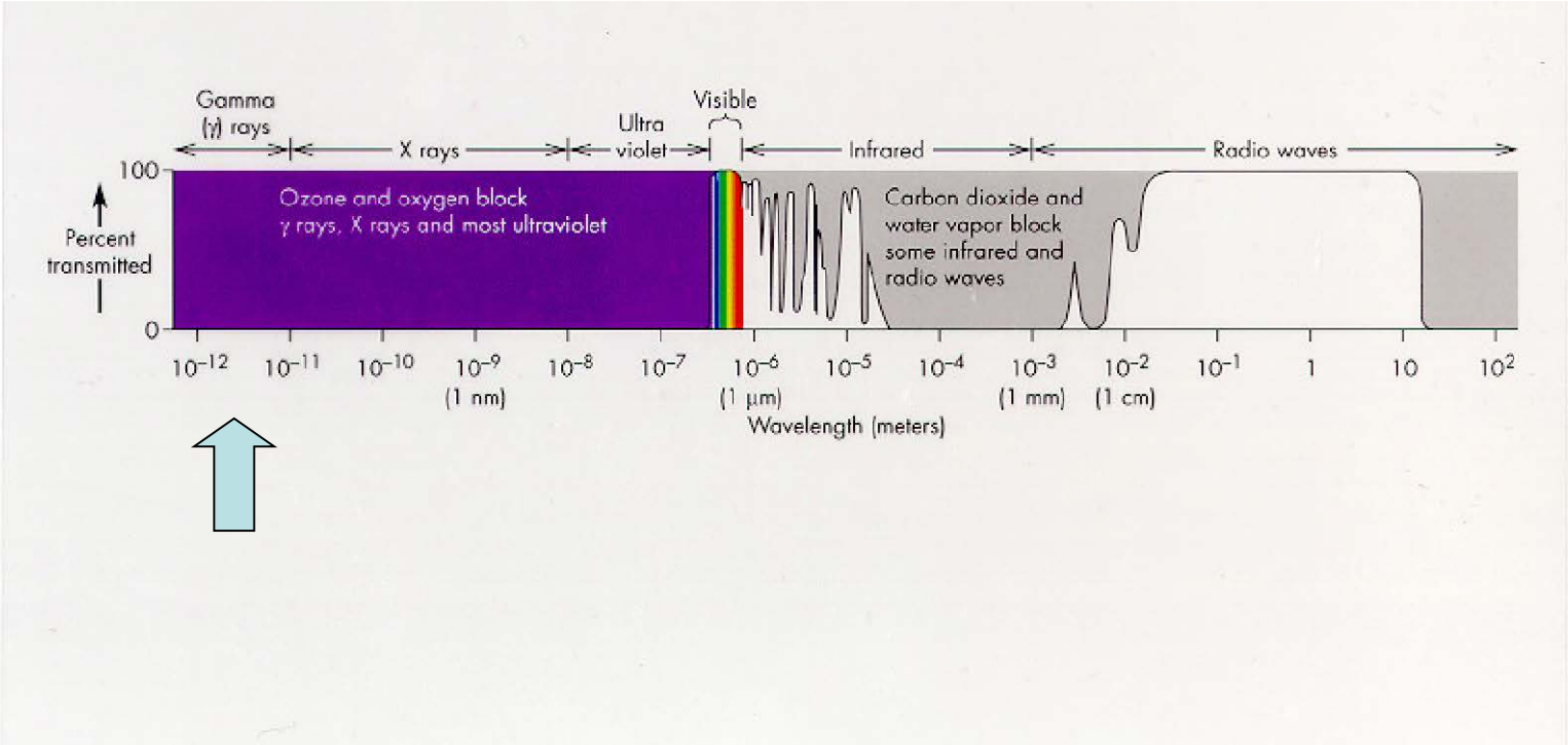
- Web site of Fermi/GBM
- https://gammaray.nsstc.nasa.gov/gbm/



Exercise #1

- Web site of Swift
- https://swift.gsfc.nasa.gov/

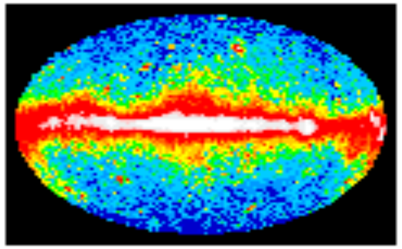


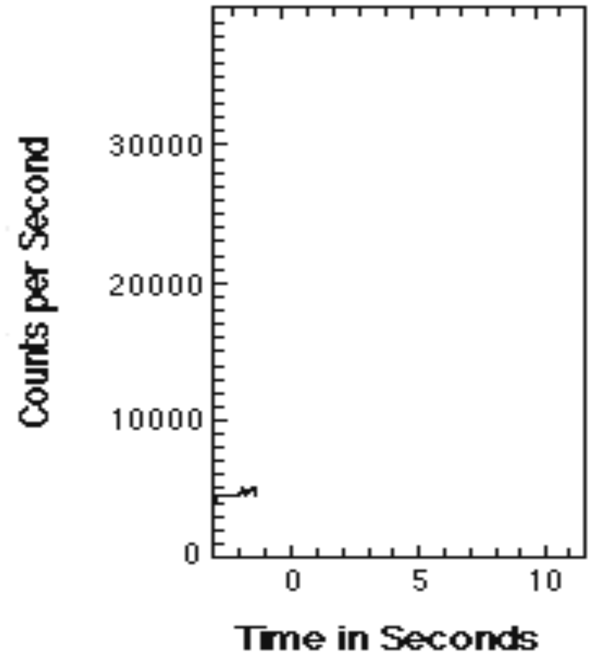


Gamma-rays are photons with energy above roughly 100keV, corresponding to temperatures above 10^9 K.

The Earth's atmosphere is optically thick to gamma-rays. Gamma-ray studies require balloons, rockets, or satellites.

The GRB phenomenon





• GRBs = sudden and unpredictable bursts of hard X / soft gamma rays with huge intensity, typical durations of tens of seconds and coming from random directions in the sky

• discovered at the end of the '60s by military satellites, first published on an astronomical journal (ApJ) in 1973

• during '70s and '80s several experiments onboard satellites, but poor improvements in understanding these phenomena

Seven eras

1) “Dark” era (1973-1991): discovery
   Klebesadel, Strong & Olson′s discovery (1973);
2) BATSE era (1992-1996): spatial distribution
   Meegan & Fishman′s discovery (1992),
   detection rate: ~1 to 3 /day, ~3000 bursts;
3) BeppoSAX era (1997-2000): afterglows
   van Paradijs, Costa, Frail′s discoveries (1997);
4) HETE-2 era (2001-2004): origin of long bursts
   Observations on GRB030329/SN2003dh
5) Swift era (2005-): very early afterglows, short-GRB afterglow, GRB subclasses? GRB cosmology?
6) Fermi era (2008-): High energy emission component, GW counterparts! – origin of short GRB
7) VHE era (2019-): VHE emission component from GRB!

The “dark” era

GRB history

THE ASTROPHYSICAL JOURNAL, **182**:L85–L88, 1973 June 1

OBSERVATIONS OF GAMMA-RAY BURSTS OF COSMIC ORIGIN

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Received 1973 March 16; revised 1973 April 2

ABSTRACT

Sixteen short bursts of photons in the energy range 0.2–1.5 MeV have been observed between 1969 July and 1972 July using widely separated spacecraft. Burst durations ranged from less than 0.1 s to ~30 s, and time-integrated flux densities from $\sim 10^{-5}$ ergs cm^{-2} to $\sim 2 \times 10^{-4}$ ergs cm^{-2} in the energy range given. Significant time structure within bursts was observed. Directional information eliminates the Earth and Sun as sources.

Subject headings: gamma rays — X-rays — variable stars

I. INTRODUCTION

On several occasions in the past we have searched the records of data from early *Vela* spacecraft for indications of gamma-ray fluxes near the times of appearance of supernovae. These searches proved uniformly fruitless. Specific predictions of gamma-ray emission during the initial stages of the development of supernovae have since been made by Colgate (1968). Also, more recent Vela spacecraft are equipped with much improved instrumentation. This encouraged a more general search, not restricted to specific time periods. The search covered data acquired with almost continuous coverage between 1969 July and 1972 July, yielding records of 16 gamma-ray bursts distributed throughout that period. Search criteria and some characteristics of the bursts are given below.

II. INSTRUMENTATION

The observations were made by detectors on the four *Vela* spacecraft, *Vela 5A, 5B, 6A,* and *6B,* which are arranged almost equally spaced in a circular orbit with a geocentric radius of $\sim 1.2 \times 10^5$ km.

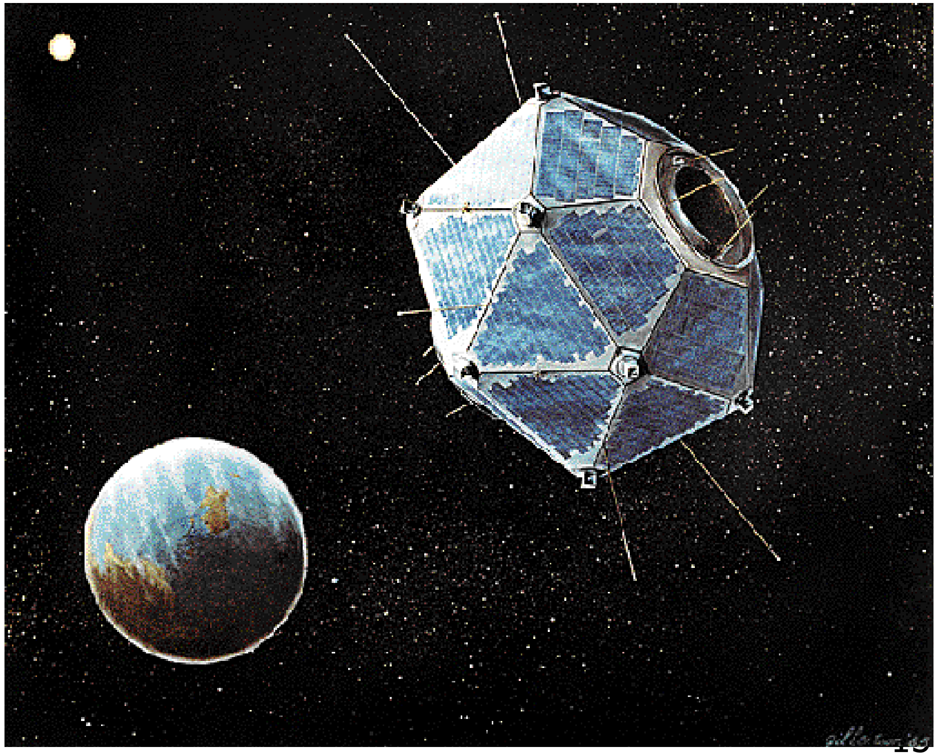
On each spacecraft six 10 cm^3 CsI scintillation counters are so distributed as to achieve a nearly isotropic sensitivity. Individual detectors respond to energy depositions of 0.2–1.0 MeV for *Vela 5* spacecraft and 0.3–1.5 MeV for *Vela 6* spacecraft, with a detection efficiency ranging between 17 and 50 percent. The scintillators are shielded against direct penetration by electrons below ~0.75 MeV and protons below ~20 MeV. A high-*Z* shield attenuates photons with energy below that of the counting threshold. No active anticoincidence shielding is provided.

Normalized output pulses from the six detectors are summed into the counting and logics circuitry. Logical sensing of a rapid, statistically significant rise in count rate initiates the recording of discrete counts in a series of quasi-logarithmically increasing time intervals. This capability provides continuous coverage in time which, coupled with isotropic response, is unique in observatonal astronomy. A time measurement is also associated with each record.

The data accumulations include a background component due to cosmic particles and their secondary effects. The observed background rate, which is a function of the energy threshold, is ~150 counts per second for the *Vela 5* spacecraft and ~20 counts per second for the *Vela 6* spacecraft.

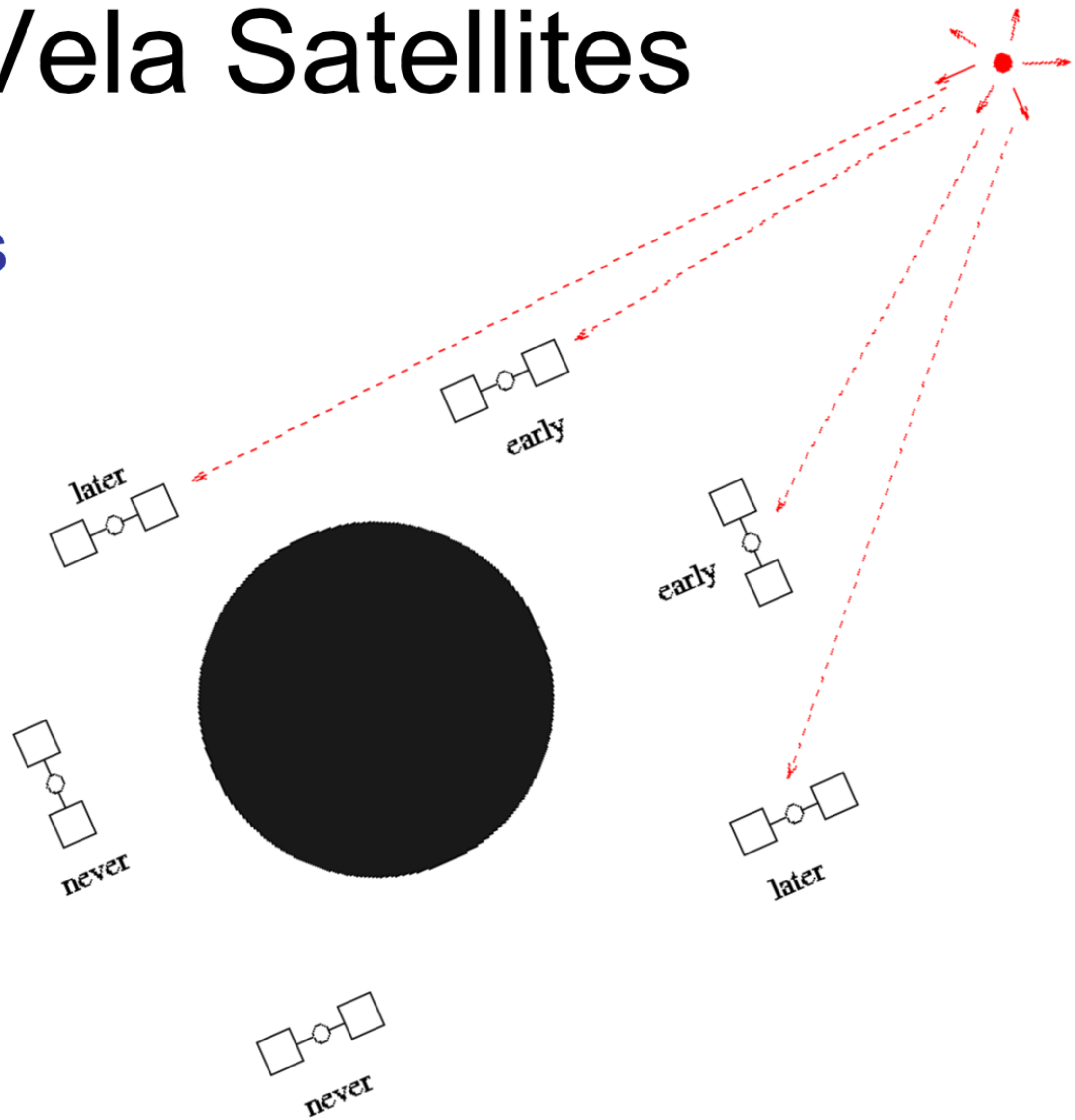
L85

- Vela satellites discovery (1967 - 1973)

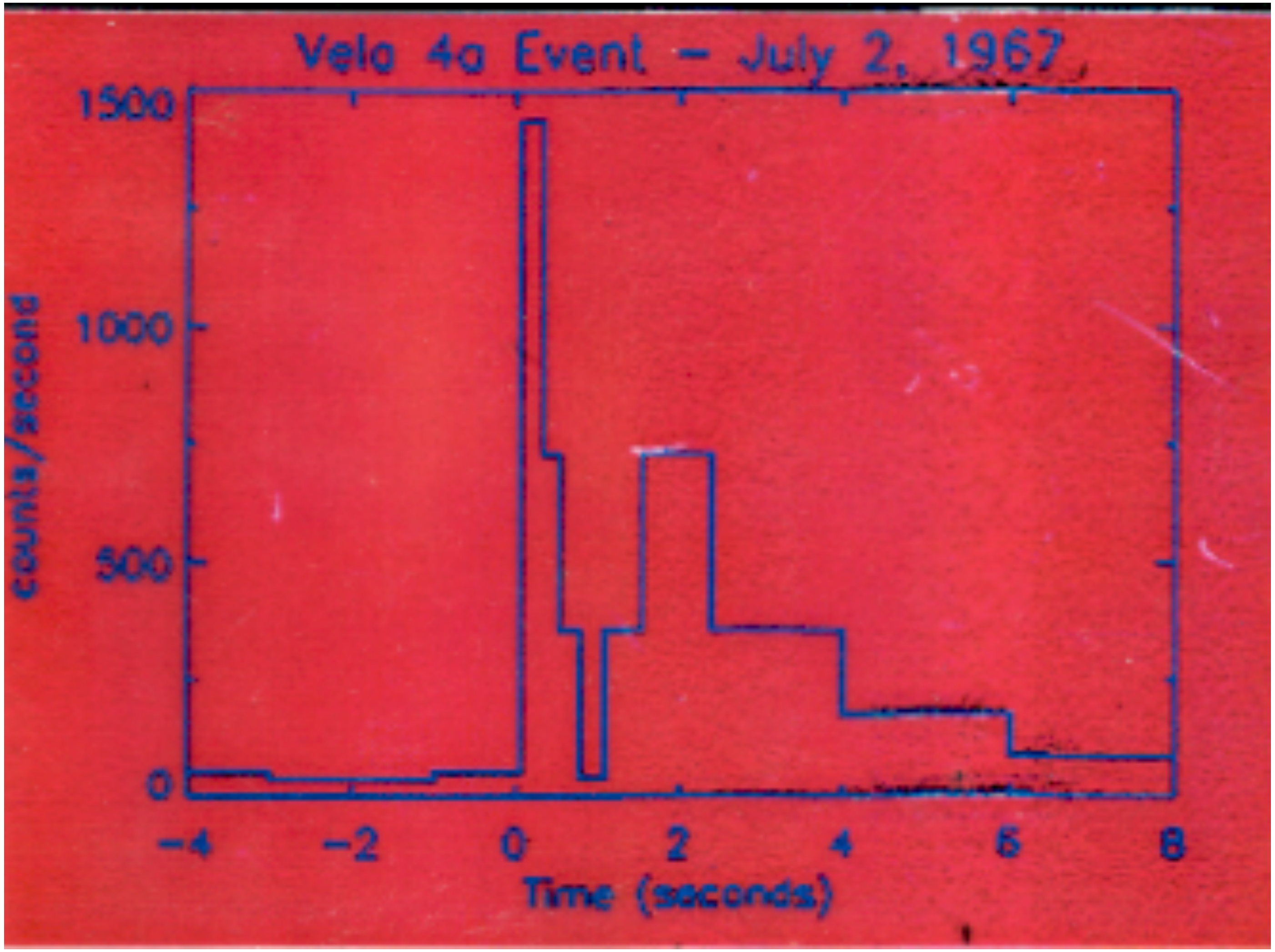


Vela Satellites

- 10^5 km Orbits
- Launched in pairs – launched 1963-1965
- Operated until 1979
- All satellites allowed for some localization.



First Detected Gamma-Ray Burst

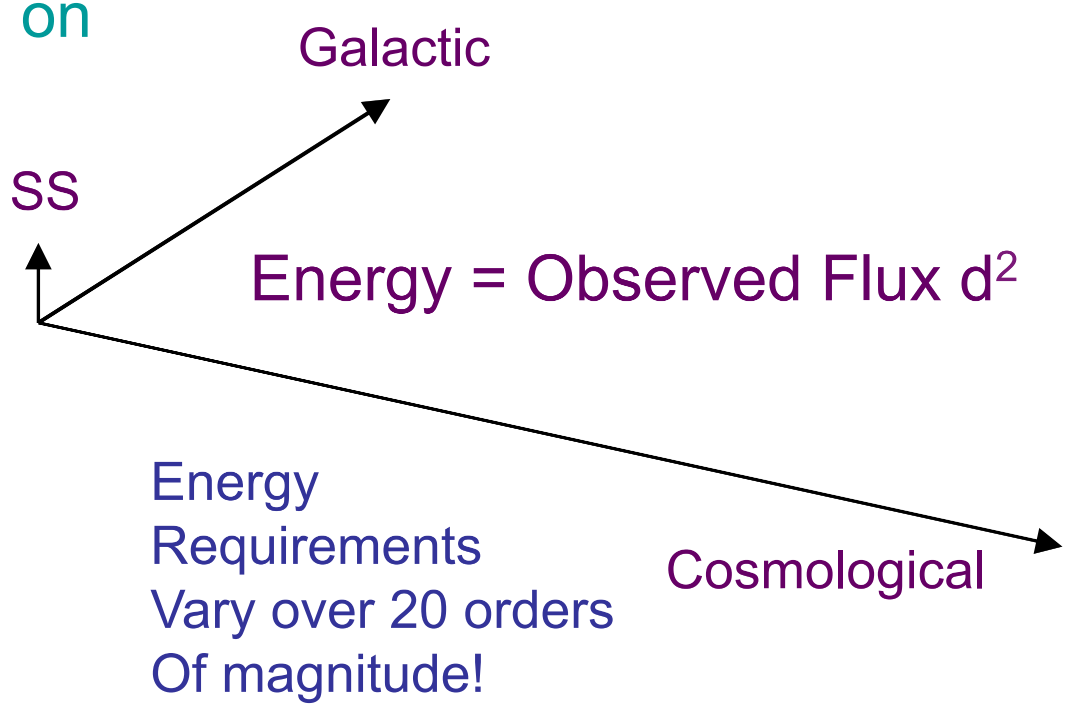


Creativity of Theorists

With so few constraints, theorists came up with all
Sorts of models relying on a range of physics.

Three Classes based on
location:

- Solar System
- Galactic
- Cosmological (outside of the Milky Way)



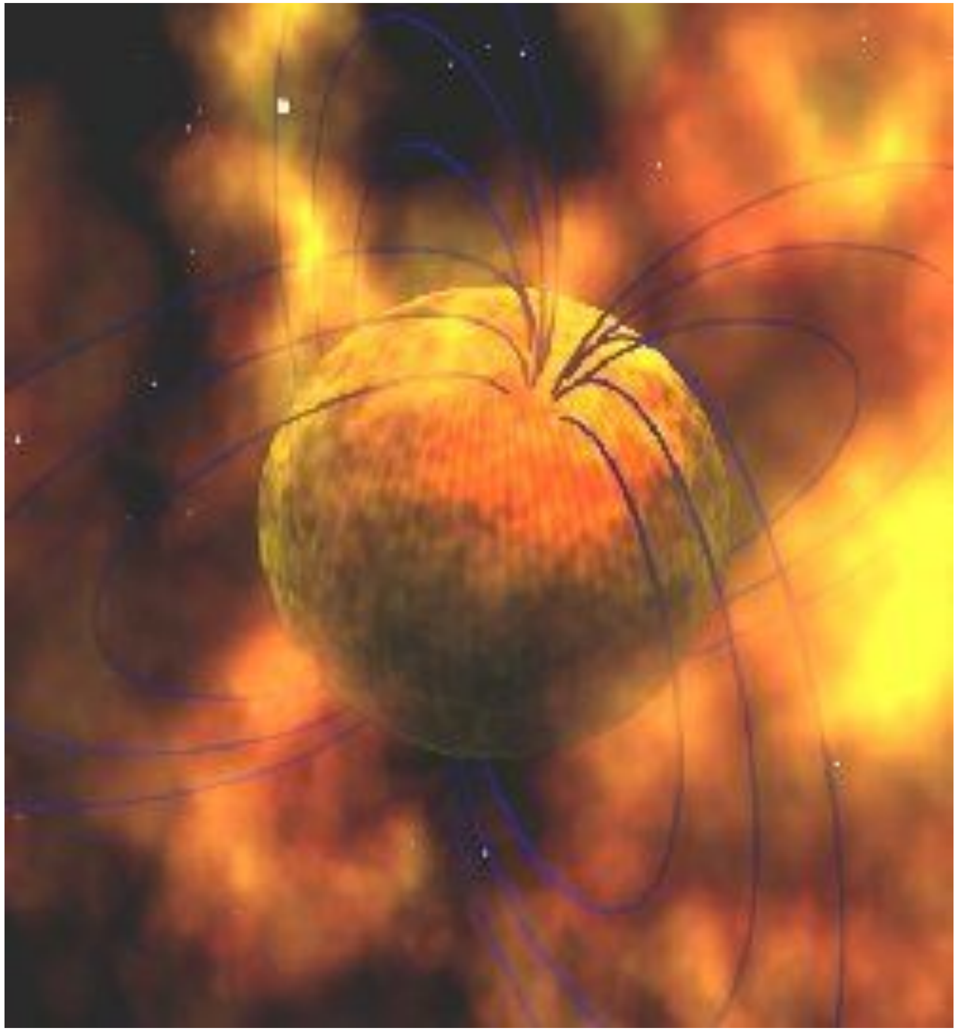
Gamma-Ray Bursts in the Solar System

- Lightning in the Earth's atmosphere (High Altitude)
- Relativistic Iron Dust Grains
- Magnetic Reconnection

Red Sprite Lightning

Models for Galactic GRBs

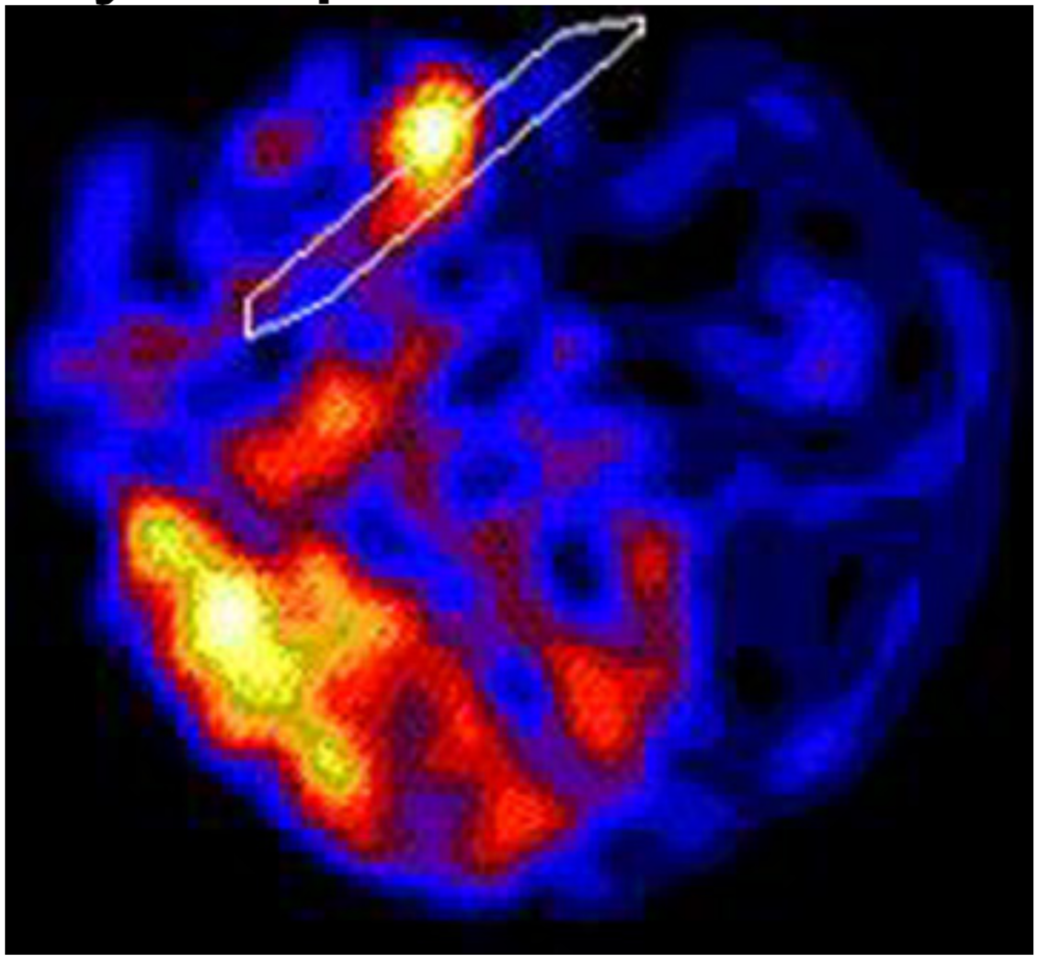
- Accretion
  I) Binary Companion
  - no companion seen
  II) SN Fallback – Too long after explosion
- Magnetic Fields
  ~10^{15} G Fields
  -“Magnetars”



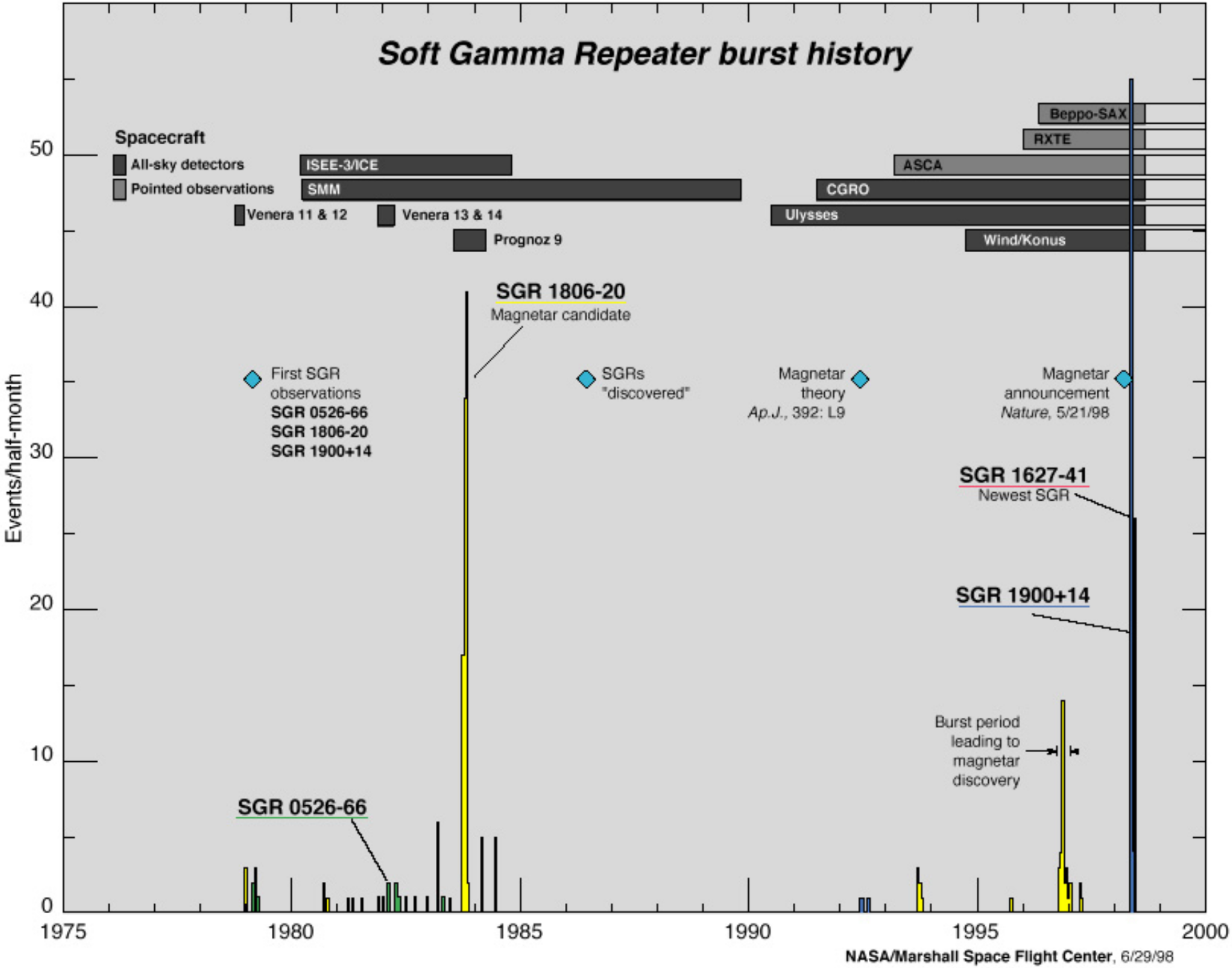
Galactic Gamma-Ray Bursts: Soft Gamma-Ray Repeaters

One Class of GRBs
Is definitely Galactic:
Soft gamma-ray
Repeaters (SGRs)

Characteristics:
1) Repeat Flashes
2) Photon Energy
Distribution lower
Energy than other
GRBs (hard x-rays)

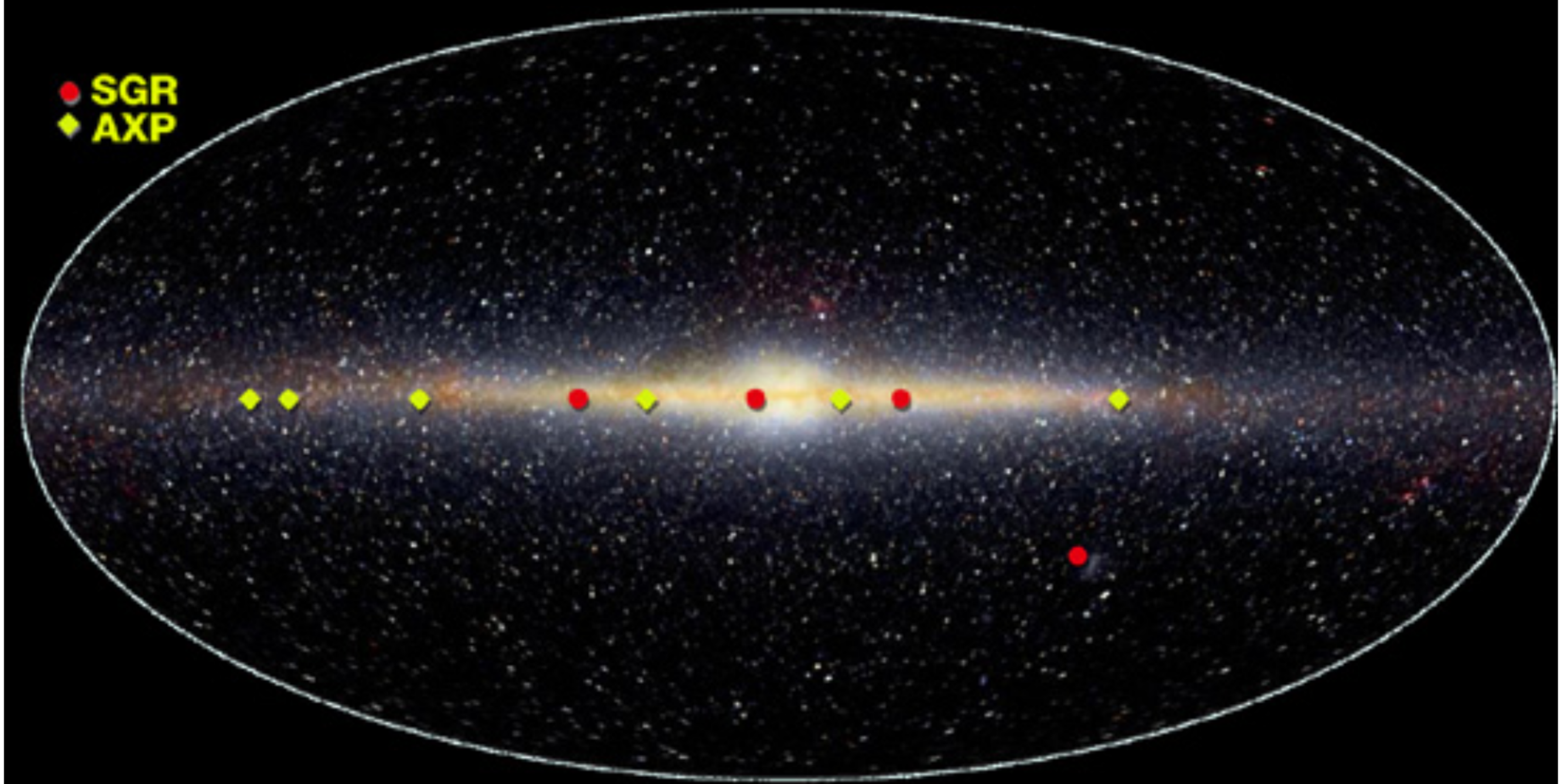


X-ray map of N49 SN remnant. The white
Box shows location of the March 5th event



Soft Gamma Repeater burst history
Spacecraft
All-sky detectors
Pointed observations
ISEE-3/ICE
SMM
Venera 11 & 12
Venera 13 & 14
Prognoz 9
Beppo-SAX
RXTE
ASCA
CGRO
Ulysses
Wind/Konus
SGR 1806-20
Magnetar candidate
First SGR observations
SGR 0526-66
SGR 1806-20
SGR 1900+14
SGRs "discovered"
Magnetar theory
Ap.J., 392: L9
Magnetar announcement
Nature, 5/21/98
SGR 1627-41
Newest SGR
SGR 1900+14
Burst period leading to magnetar discovery
SGR 0526-66
Events/half-month
0
10
20
30
40
50
1975
1980
1985
1990
1995
2000
NASA/Marshall Space Flight Center, 6/29/98

Known magnetar candidates



FORMATION OF VERY STRONGLY MAGNETIZED NEUTRON STARS: IMPLICATIONS FOR GAMMA-RAY BURSTS

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Received 1991 December 23; accepted 1992 March 2

ABSTRACT

Neutron stars with unusually strong magnetic dipole fields, $B_{\rm dipole} \sim 10^{14}$–$10^{15}$ G, can form when conditions for efficient helical dynamo action are met during the first few seconds after gravitational collapse. Such high-field neutron stars, "magnetars," initially rotate with short periods ~ 1 ms, but quickly lose most of their rotational energy via magnetic braking, giving a large energy boost to the associated supernova explosion. Several mechanisms unique to magnetars can plausibly generate large (~ 1000 km s^{-1}) recoil velocities. These include magnetically-induced anisotropic neutrino emission, core rotational instability and fragmentation, and/or anisotropic magnetic winds.

Magnetars are relatively difficult to detect because they drop below the radio death line faster than ordinary pulsars, and because they probably do not remain bound in binary systems. We conjecture that their main observational signature is gamma-ray bursts powered by their vast reservoirs of magnetic energy. If they acquire large recoils, most magnetars are unbound from the Galaxy or reside in an extended, weakly bound Galactic corona. There is evidence that the soft gamma repeaters are young magnetars.

Finally, we note that a convective dynamo can also generate a very strong dipole field after the merger of a neutron star binary, but only if the merged star survives for as long as ~ 10–100 ms.

Subject headings: gamma rays: bursts — magnetic fields — pulsars: general — stars: neutron

https://ui.adsabs.harvard.edu/abs/1992ApJ...392L...9D/abstract

Sandro Mereghetti

The strongest cosmic magnets: Soft Gamma-ray Repeaters and Anomalous X-ray Pulsars

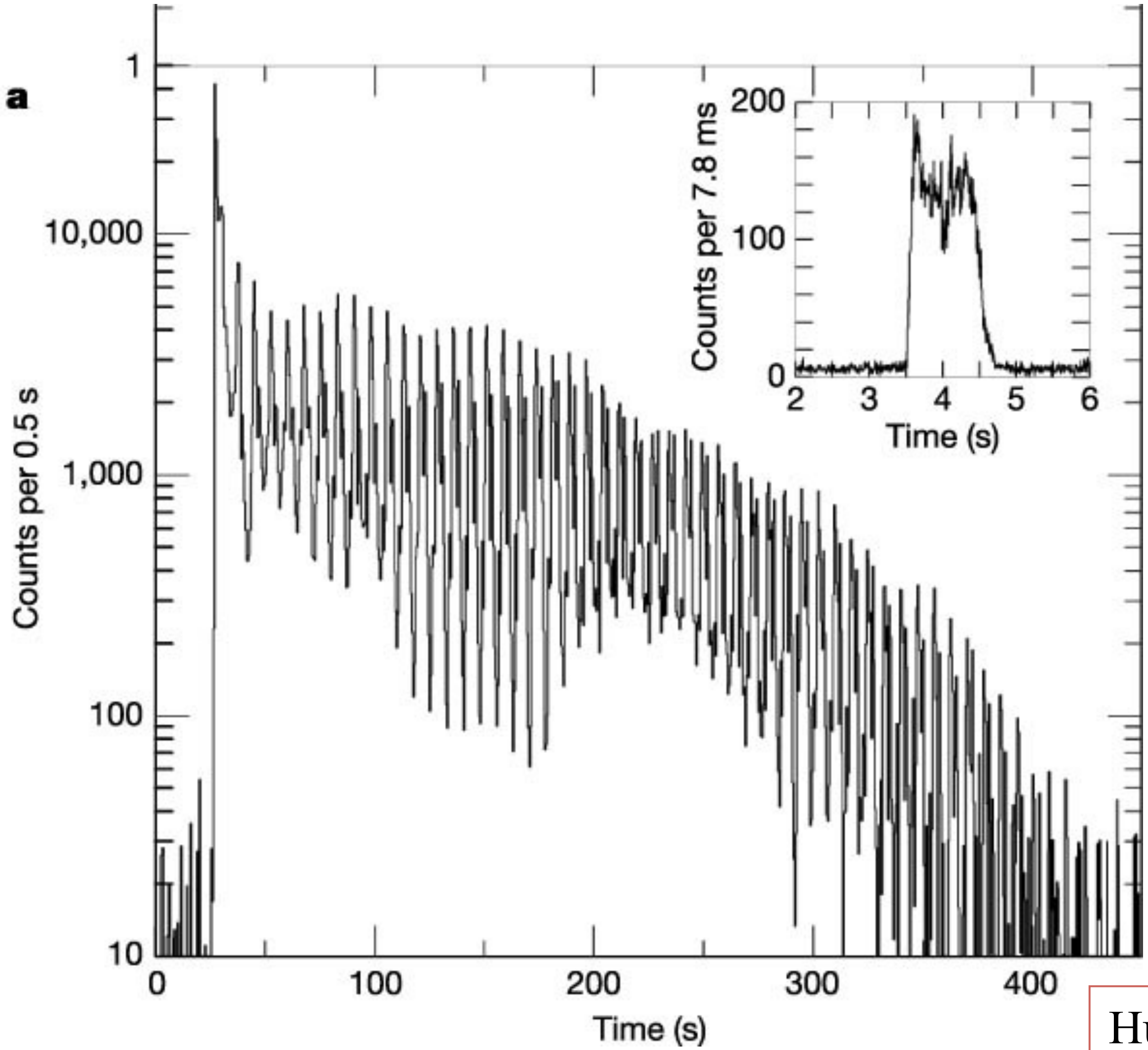
Received: date

Abstract Two classes of X-ray pulsars, the Anomalous X–ray Pulsars and the Soft Gamma–ray Repeaters, have been recognized in the last decade as the most promising candidates for being magnetars: isolated neutron stars powered by magnetic energy. I review the observational properties of these objects, focussing on the most recent results, and their interpretation in the magnetar model. Alternative explanations, in particular those based on accretion from residual disks, are also considered. The possible relations between these sources and other classes of neutron stars and astrophysical objects are also discussed.

Keywords First keyword · Second keyword · More

https://arxiv.org/pdf/0804.0250.pdf

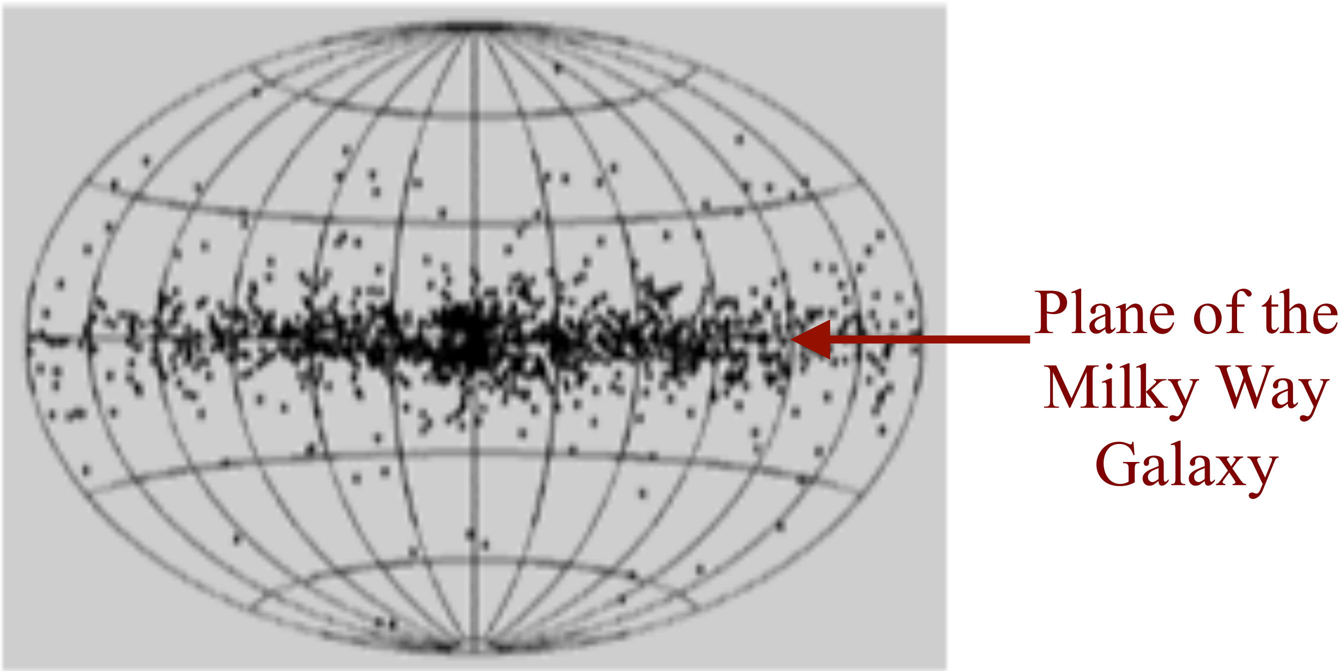
Magnetar Giant Flares



Hurley et al 2005

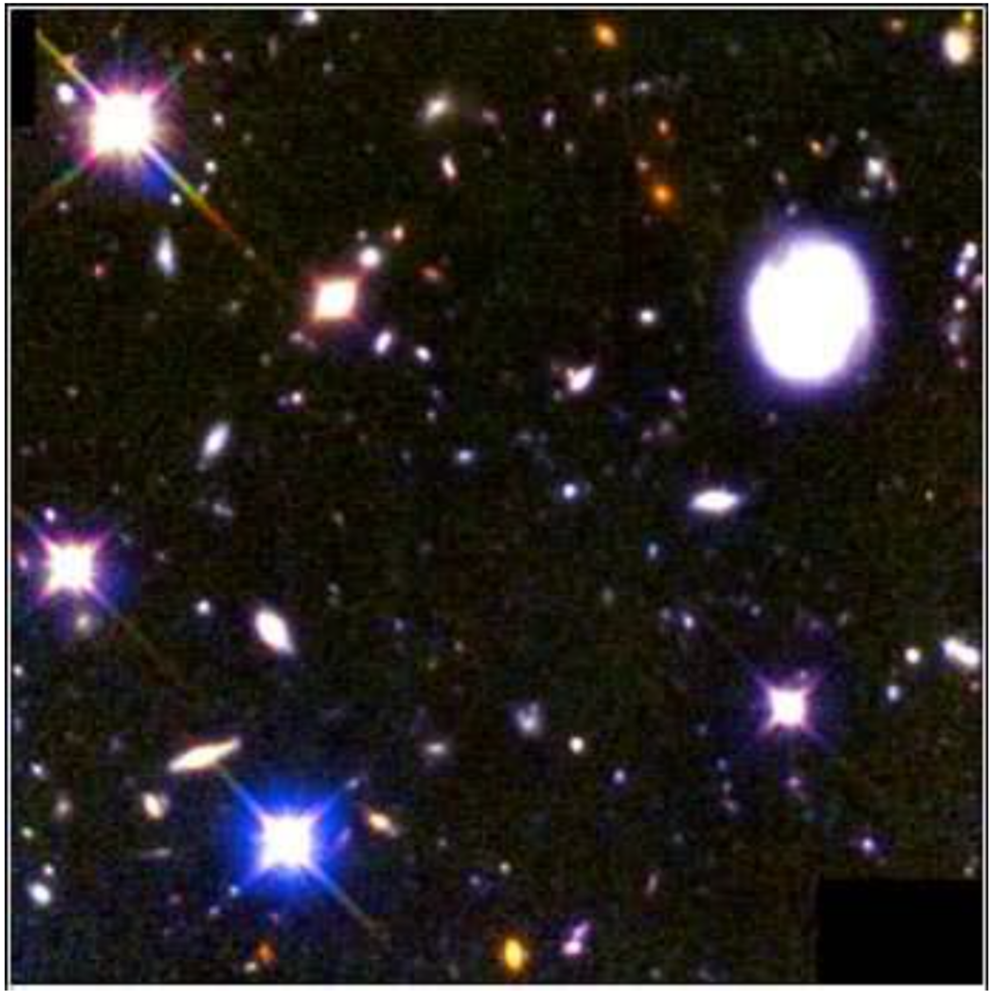
If normal GRBs are also neutron stars, GRBs should
Also center around the Galactic Equator.

This is a Prediction of the Galactic Models!



Extragalactic Models

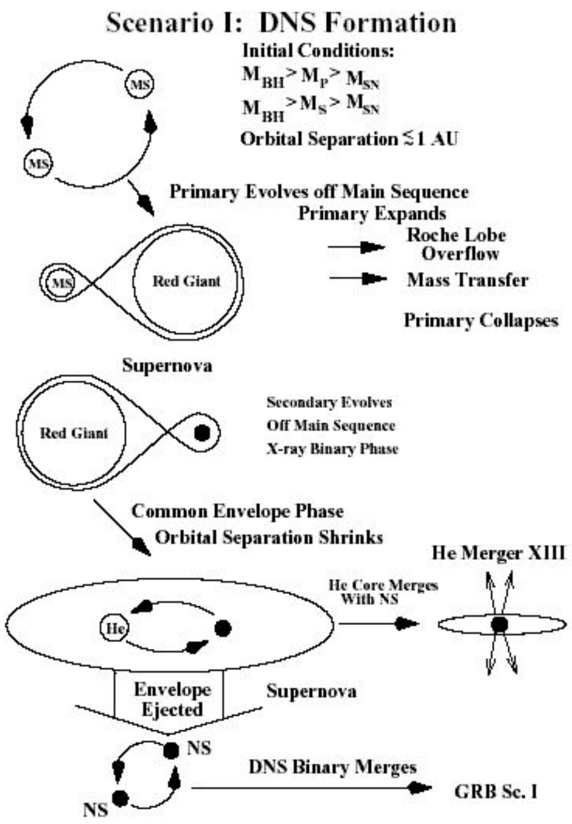
- Large distances means large energy requirement (10^{51}erg)
- Event rate rare (10^{-6}-10^{-5} per year in an L_* galaxy) – Object can be exotic

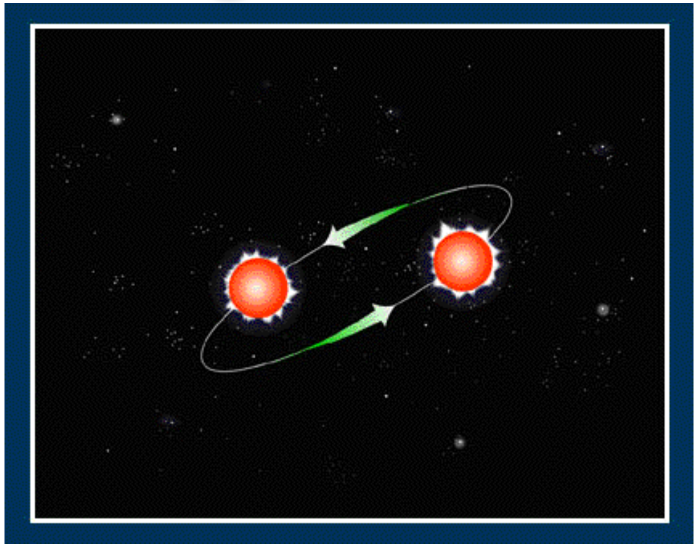


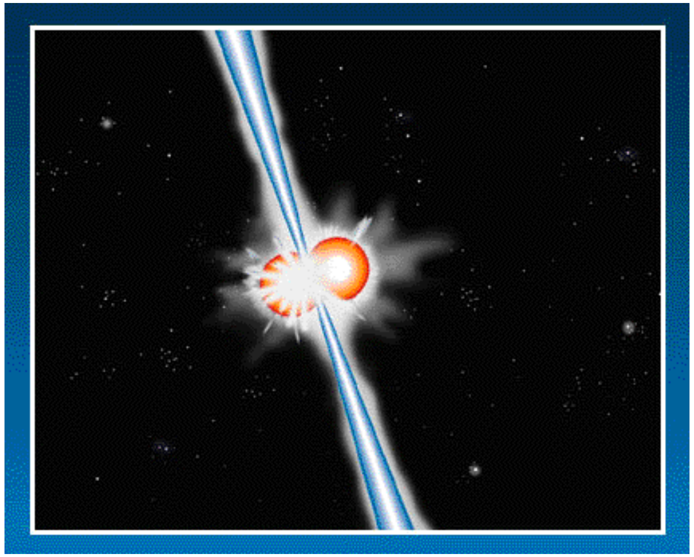
Models for Cosmological GRB

- Collapsing WDs
- Stars Accreting on AGN
- White Holes
- Cosmic Strings
- Black Hole Accretion Disks
  I) Binary Mergers
  II) Collapsing Stars

NS/BH Binary Mergers





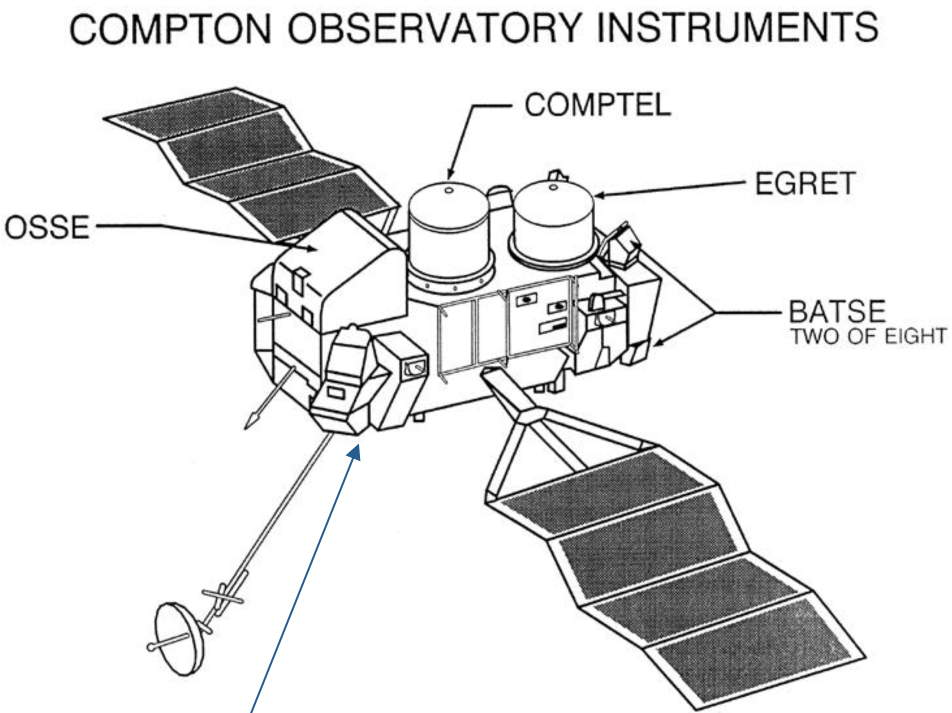


Merging of compact objects (NS-NS, NS-BH, BH-BH).
These objects are observed in our Galaxy.
The merging time is about 10^8 yr, via GW emission.

Eichler et. al. (1989)

The BATSE era

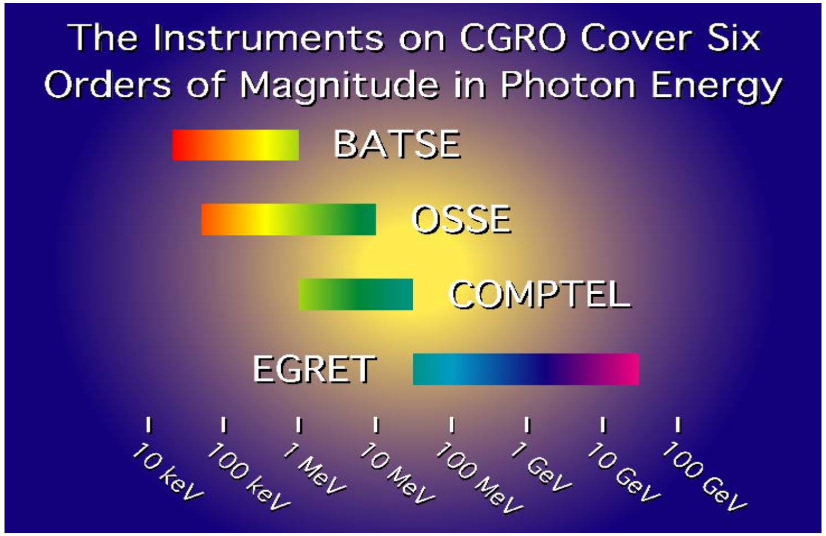
CGRO-BATSE (1991-2000)

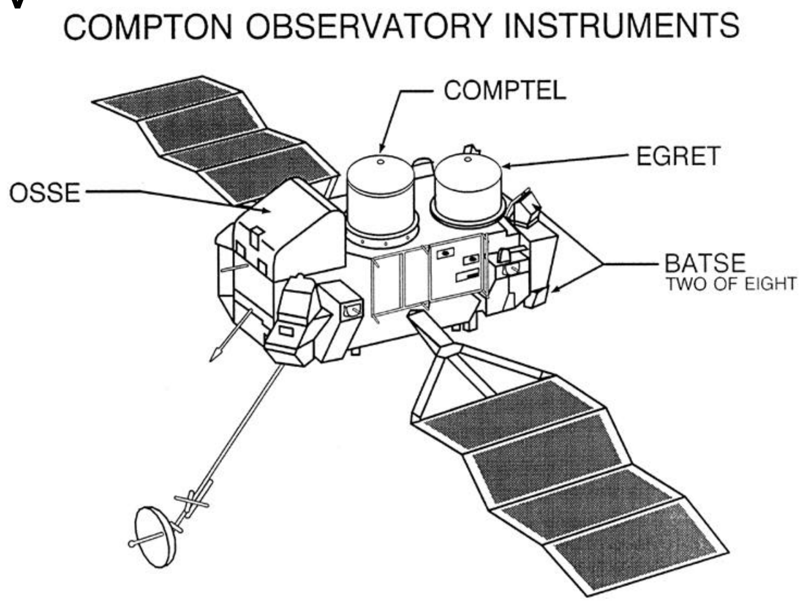


CGRO/BATSE (25 keV÷10 MeV)

The Compton Gamma Ray Observatory

http://cossc.gsfc.nasa.gov





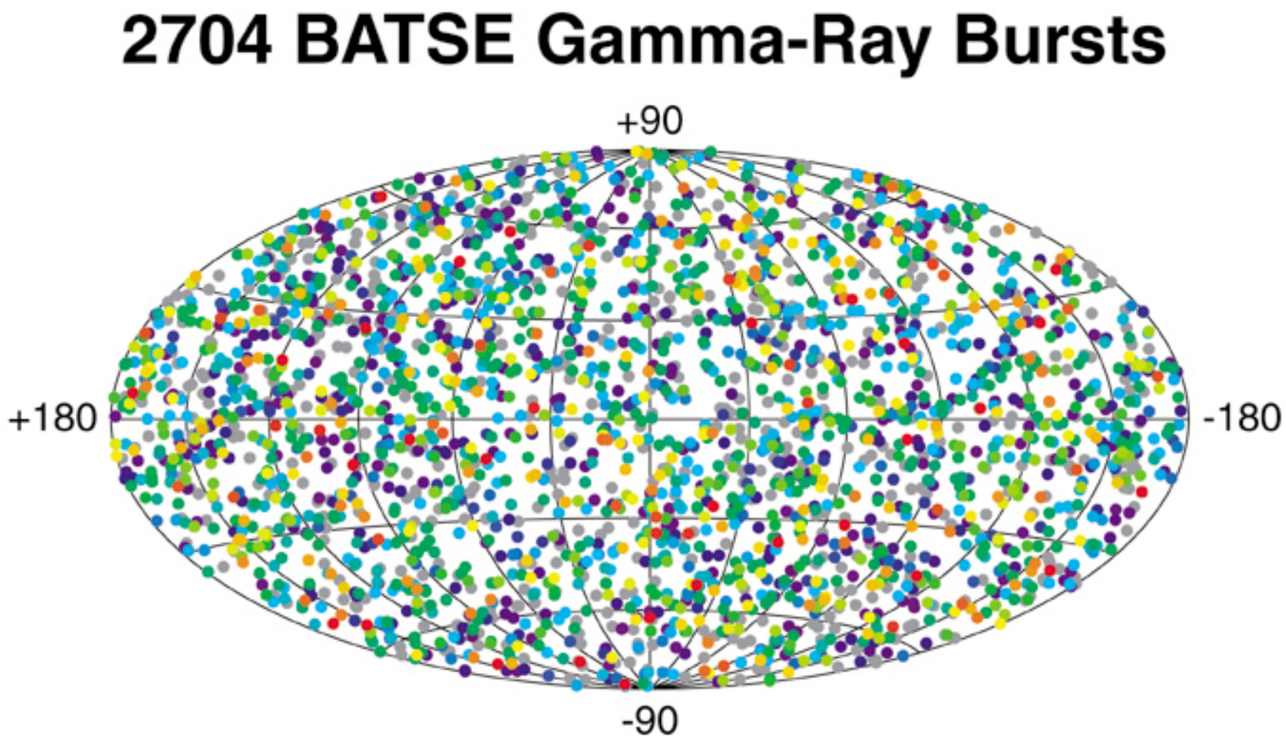
The Compton Gamma Ray Observatory (CGRO) is a sophisticated satellite observatory dedicated to observing the high-energy Universe. It is the second in NASA's program of orbiting "Great Observatories", following the Hubble Space Telescope.
While Hubble's instruments operate at visible and ultraviolet wavelengths, Compton carries a collection of four instruments which together can detect an unprecedented broad range of high-energy radiation called gamma rays. These instruments are the Burst And Transient Source Experiment (BATSE), the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL), and the Energetic Gamma Ray Experiment Telescope (EGRET).

The Compton Gamma Ray Observatory

Table 1: SUMMARY OF *COMPTON* GRO DETECTOR CHARACTERISTICS

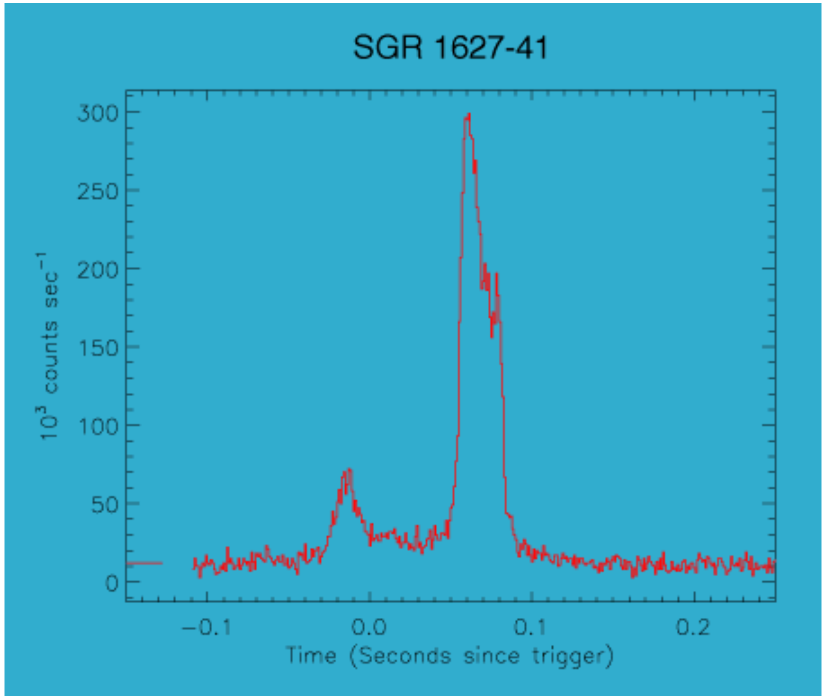
	OSSE	COMPTEL	EGRET	BATSE LARGE AREA	BATSE SPECTROSCOPY
ENERGY RANGE (MeV)	0.05 to 10.0	0.8 to 30.0	20 to 3 x 10^4	0.03 to 1.9	0.015 to 110
ENERGY RESOLUTION (FWHM)	12.5% at 0.2 MeV 6.8% at 1.0 MeV 4.0% at 5.0 MeV	8.8% at 1.27 MeV 6.5% at 2.75 MeV 6.3% at 4.43 MeV	~20% 100 to 2000 MeV	32% at 0.06 MeV 27% at 0.09 MeV 20% at 0.66 MeV	0.2% at 0.09 MeV 7.2% at 0.66 MeV 5.8% at 1.17 MeV
EFFECTIVE AREA (cm^2)	2013 at 0.2 MeV 1480 at 1.0 MeV 569 at 5.0 MeV	25.8 at 1.27 MeV 29.3 at 2.75 MeV 29.4 at 4.43 MeV	1200 at 100 MeV 1600 at 500 MeV 1400 at 3000 MeV	1000 ea. at 0.03 MeV 1800 ea. at 0.1 MeV 550 ea. at 0.66 MeV	100 ea. at 0.3 MeV 127 ea. at 0.2 MeV 52 ea. at 3 MeV
POSITION LOCALIZATION (STRONG SOURCE)	10 arc min square error box (special mode; 0.1 x Crab spectrum)	0.5 - 1.0 deg (90% confidence 0.2 x Crab spectrum)	5 to 10 arc min (1σ radius; 0.2 x Crab spectrum)	3° (strong burst)	———
FIELD OF VIEW	3.8° x 11.4°	~ 64°	~ 0.6 sr	4 π sr	4 π sr
MAXIMUM EFFECTIVE GEOMETRIC FACTOR (cm^2 sr)	13	30	1050 (~ 500 MeV)	15000	5000
ESTIMATED SOURCE SENSITIVITY — LINE	(3-8) x 10^{-5} cm^{-2} s^{-1}	1.5 x 10^{-5} to 6 x 10^{-5} cm^{-2} s^{-1}			0.4% equivalent width (5 sec integration)
(5 x10^4 sec; on source, off Galactic Plane) — CONTINUUM	3 x 10^{-7} cm^{-2} s^{-1} keV^{-1} (@1 MeV)	1.6 x 10^{-4} cm^{-2} s^{-1} (3 σ detection, 1-30 MeV)	7 x 10^{-8} cm^{-2} s^{-1} (> 100 MeV) 2 x 10^{-8} cm^{-2} s^{-1} (> 1000 MeV)	3 x 10^{-8} erg cm^{-2} (1 sec-burst)	

The Compton Gamma Ray Observatory



BATSE can determine directions to gamma-ray bursts with an accuracy of a few degrees. This diagram shows the positions of 2704 bursts detected with BATSE over 9 years of operation. The map is an Aitoff equal-area projection in Galactic coordinates. The only anisotropy detectable in the distribution is due to a small anisotropy in BATSE's sky exposure. The isotropic source distribution, combined with information from the burst intensity distribution, showed conclusively that the burst sources do not reside in the Galactic disk, as previously thought. This discovery initiated a paradigm shift to the view that the sources lie at cosmological distances. Direct redshift measurements have now confirmed this interpretation, making gamma-ray bursts the most powerful explosions in the Universe.

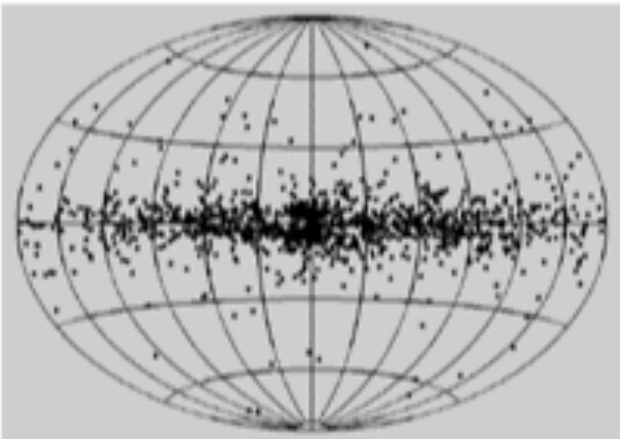
The Compton Gamma Ray Observatory



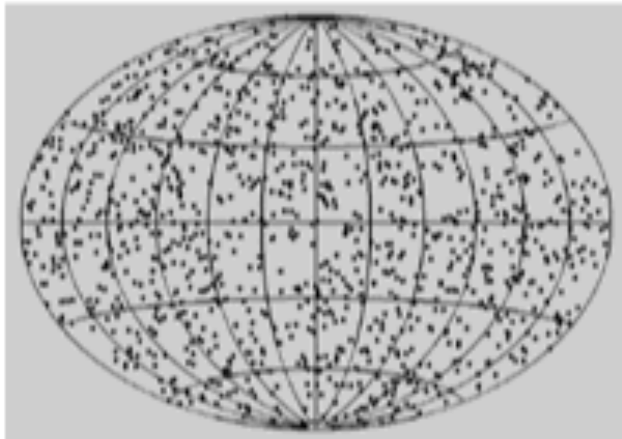
Soft Gamma Repeaters are one of the biggest success stories of BATSE on CGRO. These recurrent soft X-ray transients were discovered in the early '80s and identified as a separate population of young neutron stars that emitted frequent, but randomly spaced in time, outbursts of low-energy gamma rays, of very short duration, usually tenths of seconds. Until 1998 only three such sources were known; SGR 1627-41 is the first new SGR discovered with BATSE in June 1998. The figure displays a tremendous outburst from the source that reached a peak count rate of ~300000 counts s^{-1}, and lasted less than 150 ms. In 1998, SGRs were shown to possess extremely strong magnetic fields, of the order of 10^{14} Gauss, i.e., roughly 1000 times stronger than the average magnetic fields of radio pulsars and binary X-ray pulsars. They now form a well defined new class of objects, together with the Anomalous X-ray Pulsars (AXPs), called "magnetars".

GRB History

Distribution of Gamma-Ray Bursts on the Sky

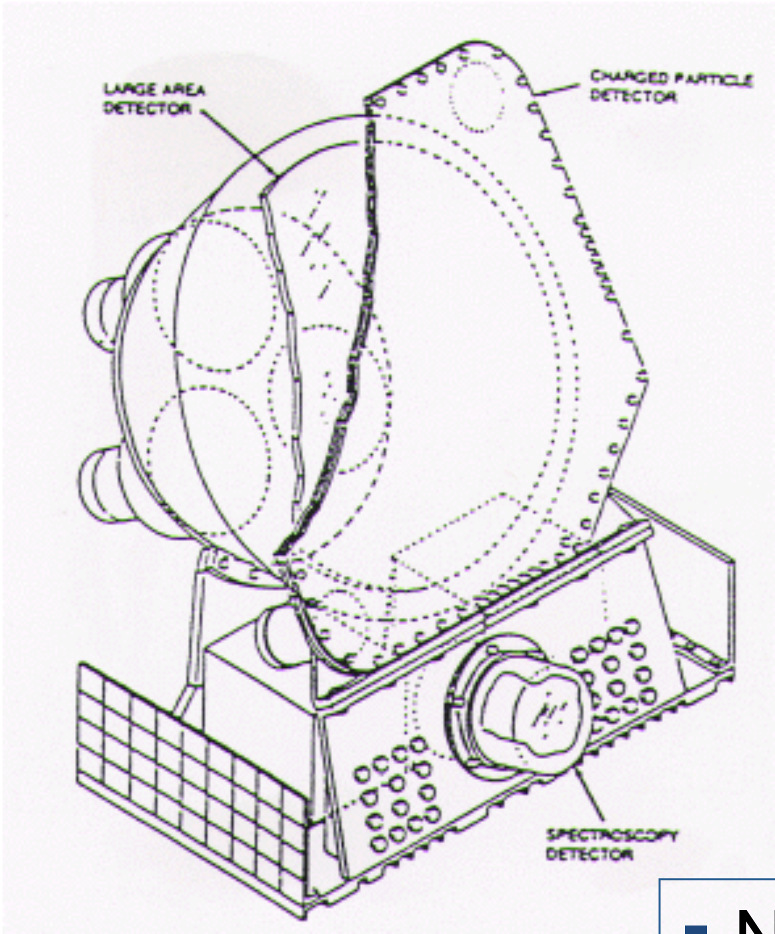


Expected



Observed

The Compton Gamma Ray Observatory



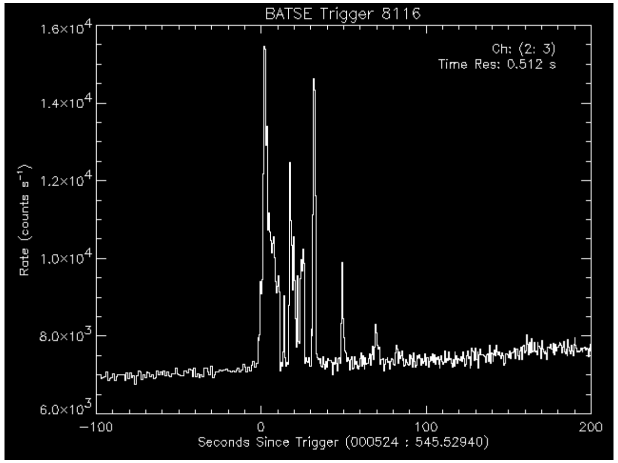
BATSE

- 20 keV -10 MeV
- GRB, SGR, X-ray sources

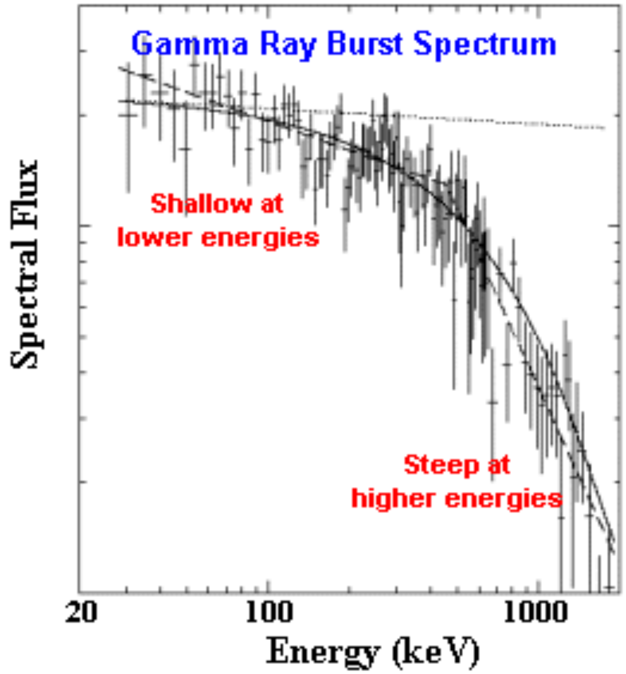
- NaI scintillators
- 20 keV – 10 MeV
- FoV 4π

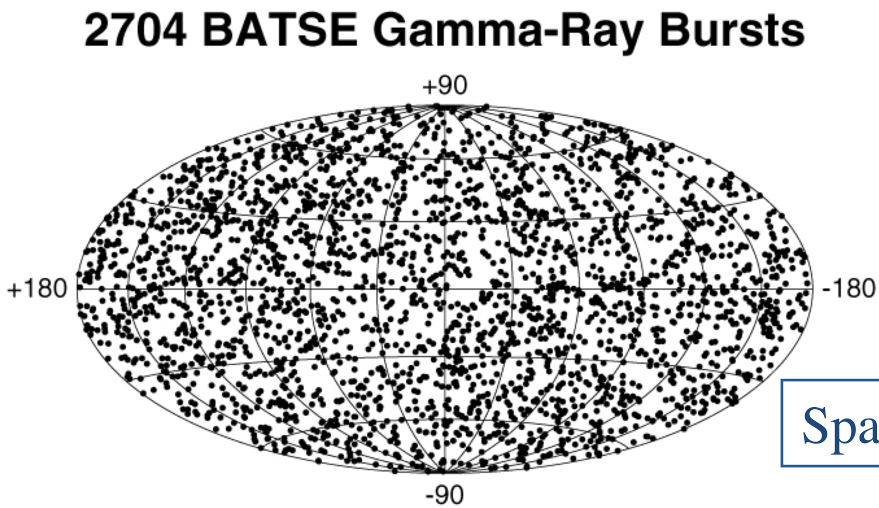
Gamma-Ray Bursts

Temporal behaviour



Spectral shape





Spatial distribution

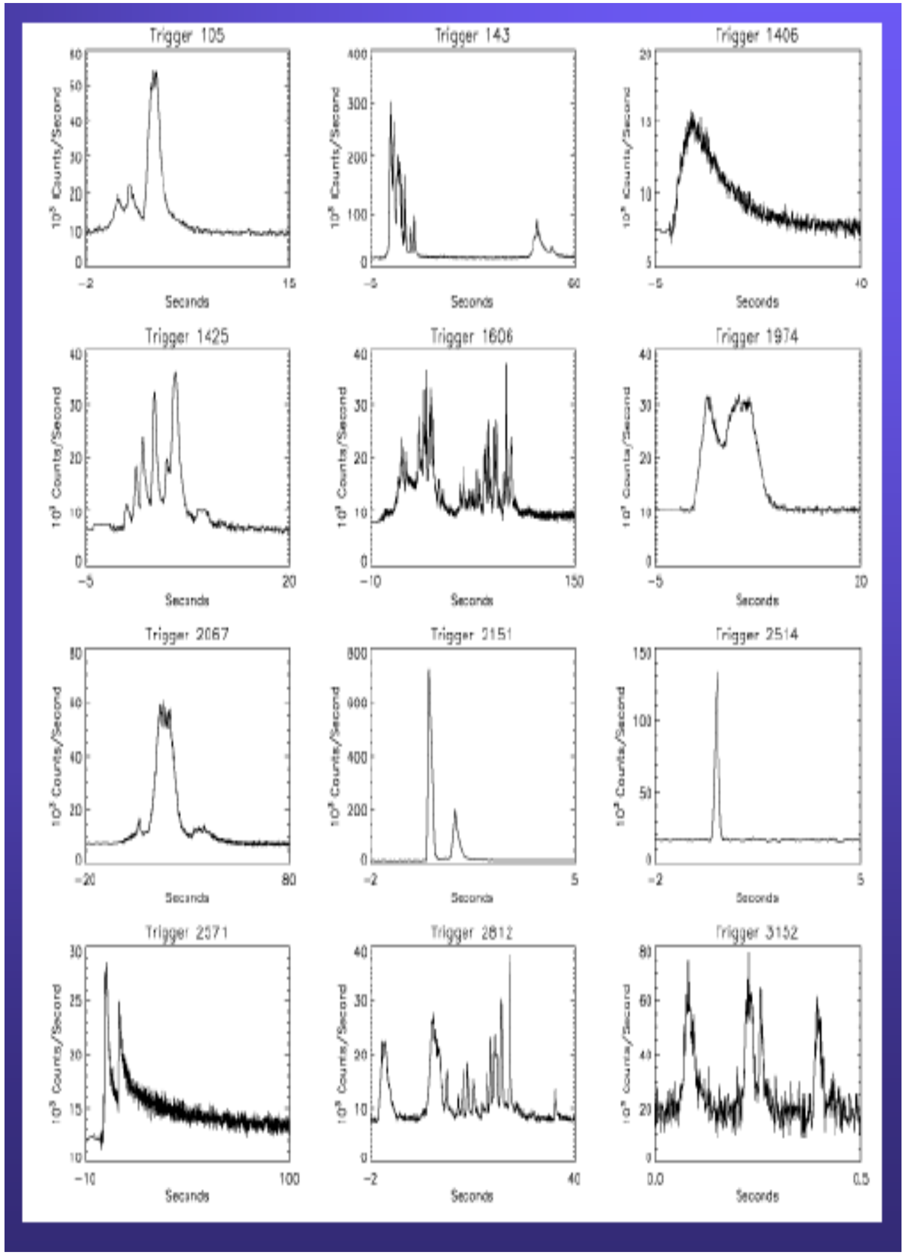
The GRB phenomenon

- most of the flux detected from 10-20 keV up to 1-2 MeV

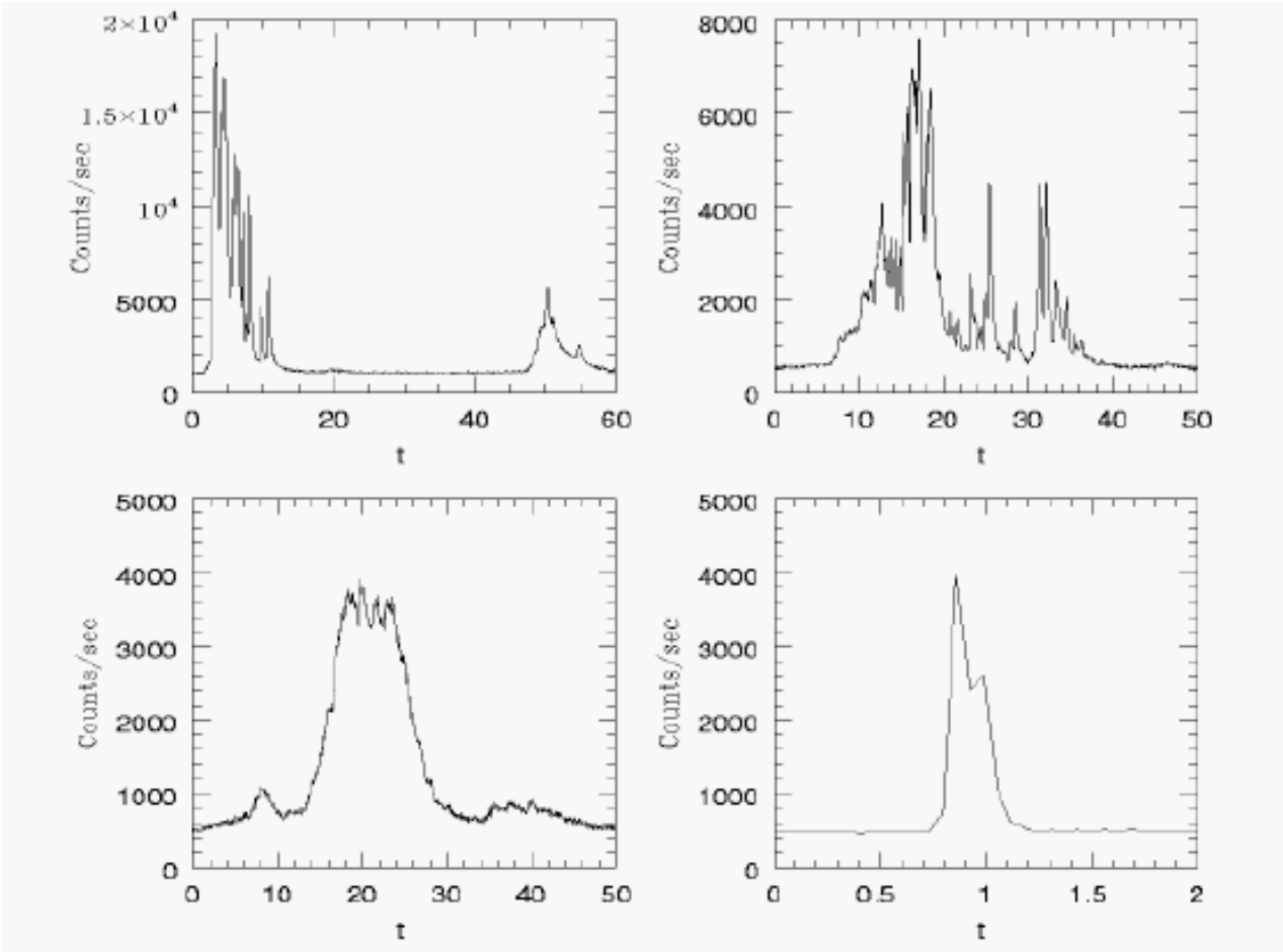
- measured rate (by an all-sky experiment on a LEO satellite): ~0.8 / day; estimated true rate ~2 / day

- fluences (= av.flux * duration) typically of ~10^{-7} – 10^{-4} erg/cm^2

- diverse and unclassifiable light curves

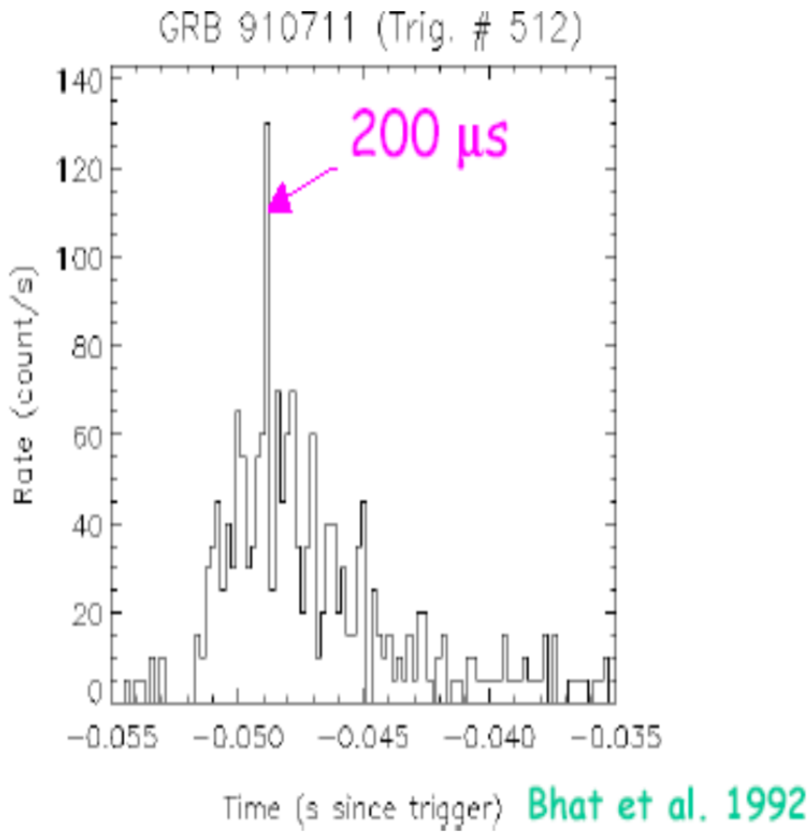


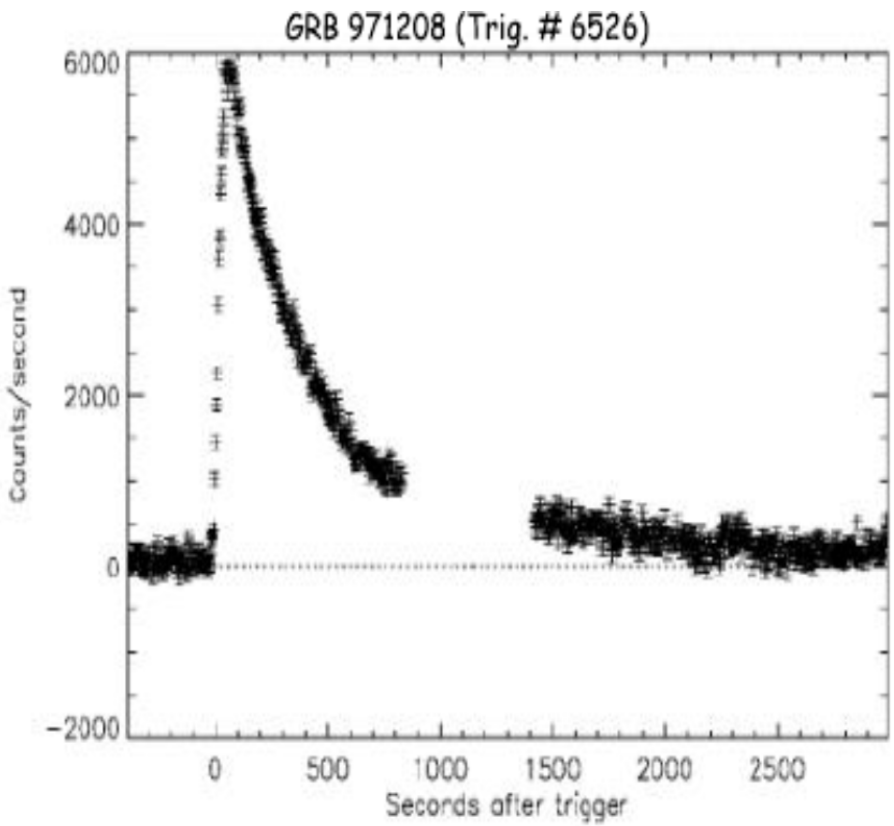
GRB light curves



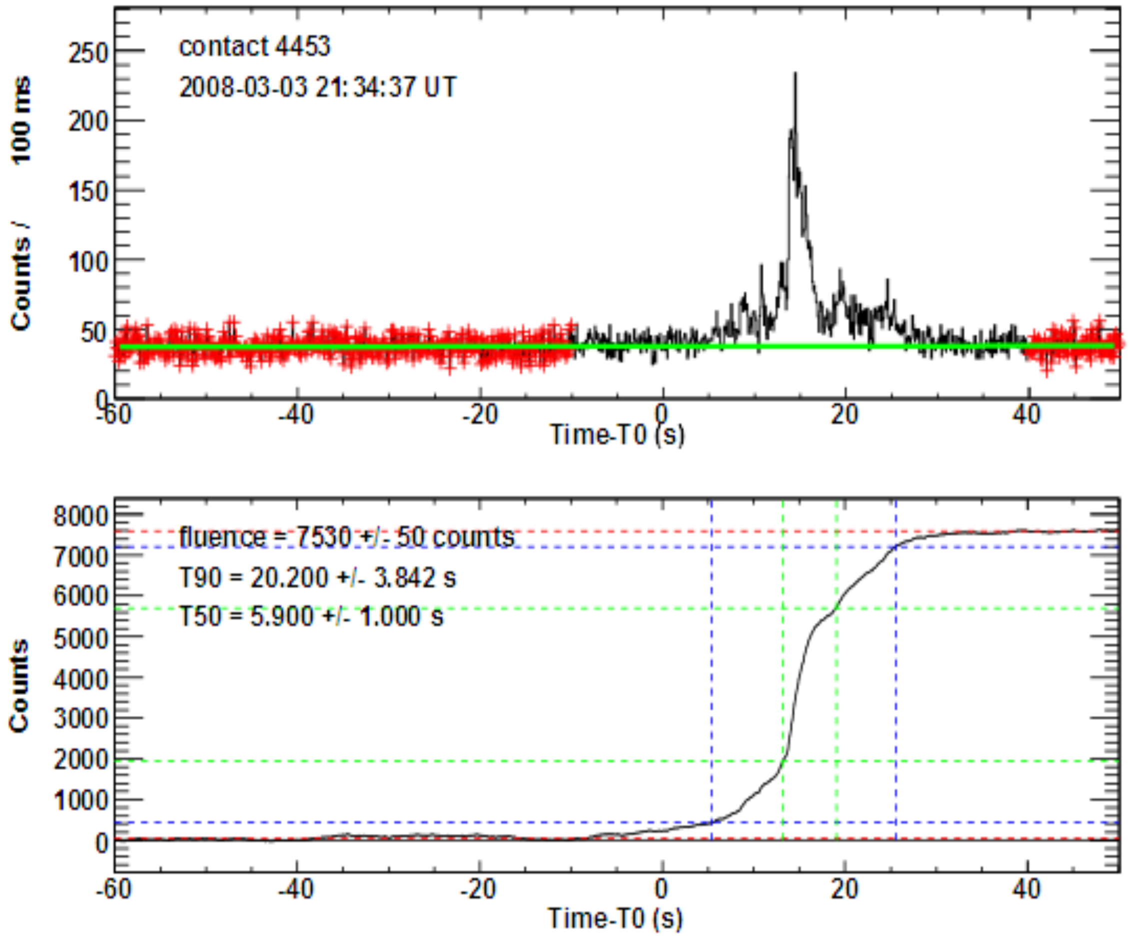
The GRB phenomenon

- shortest (~6ms) and longest (~2000s) BATSE GRBs
- typical duration is tens of s

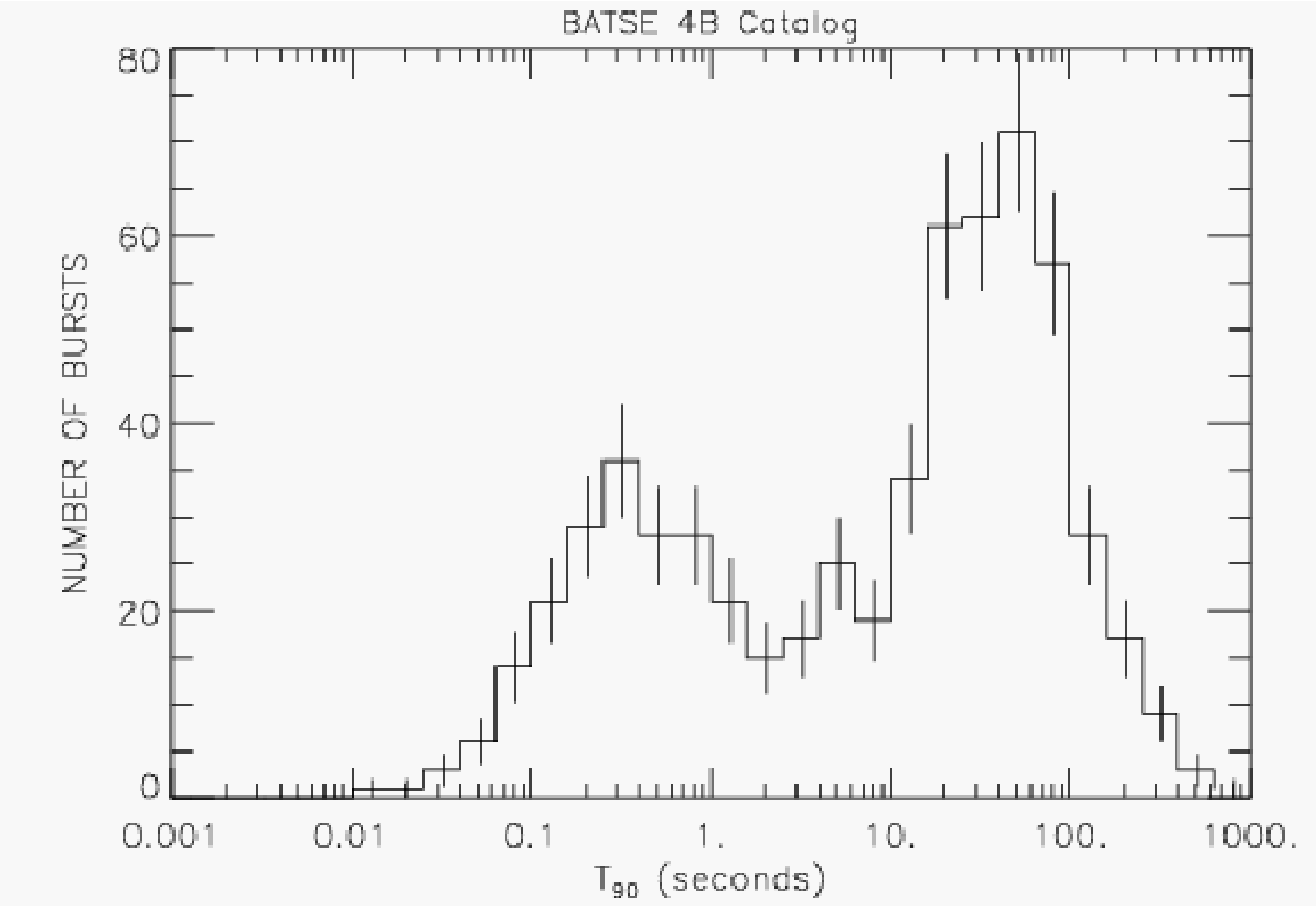




GRB duration

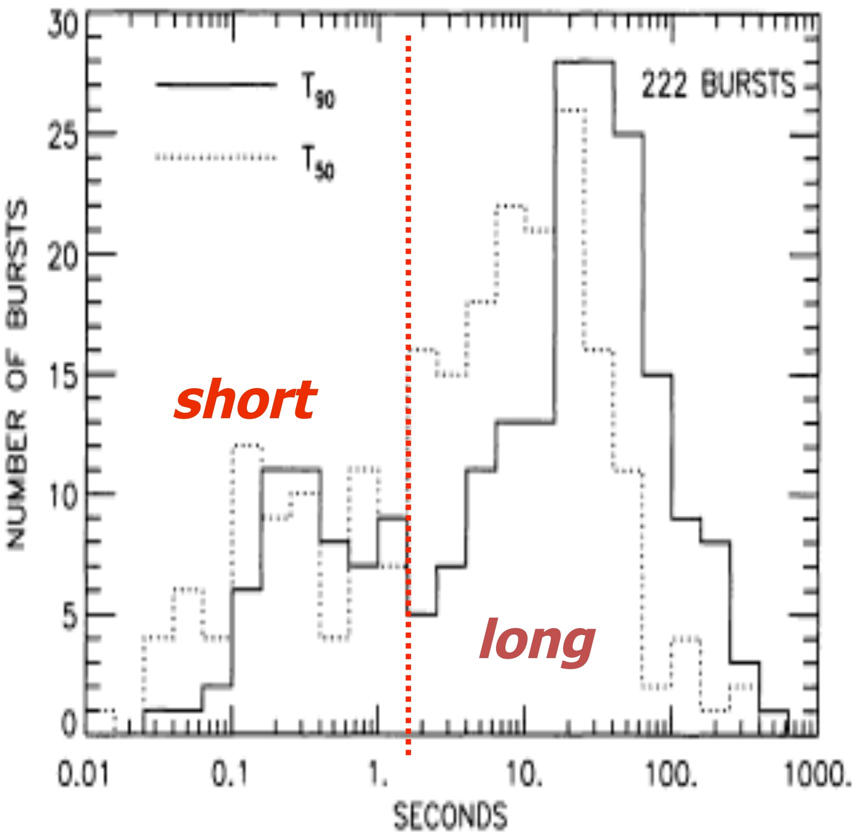


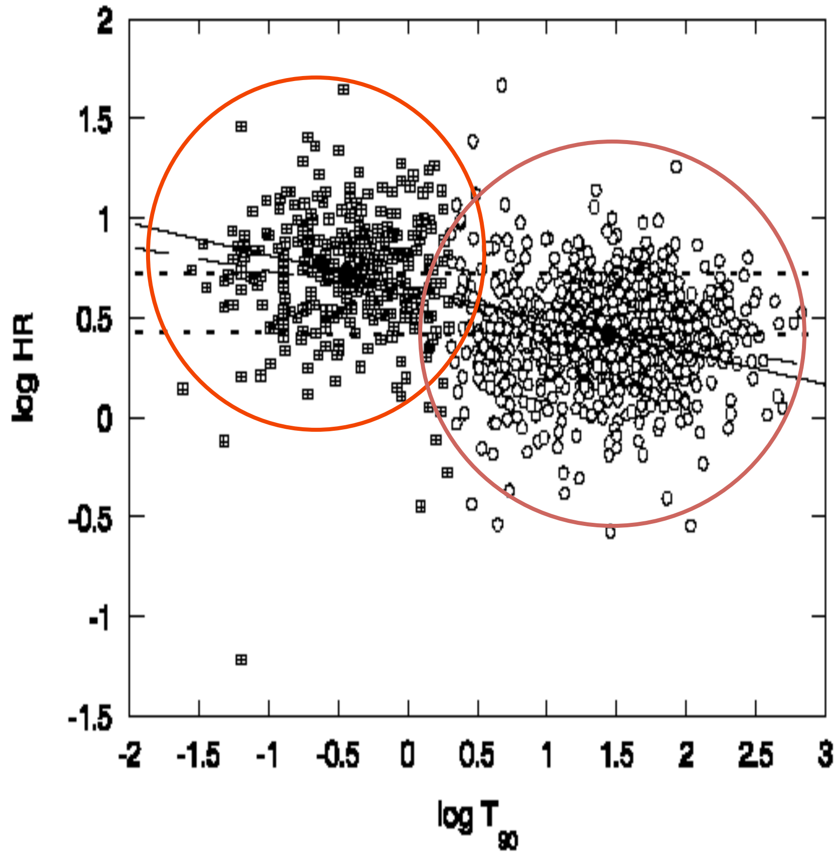
GRB duration



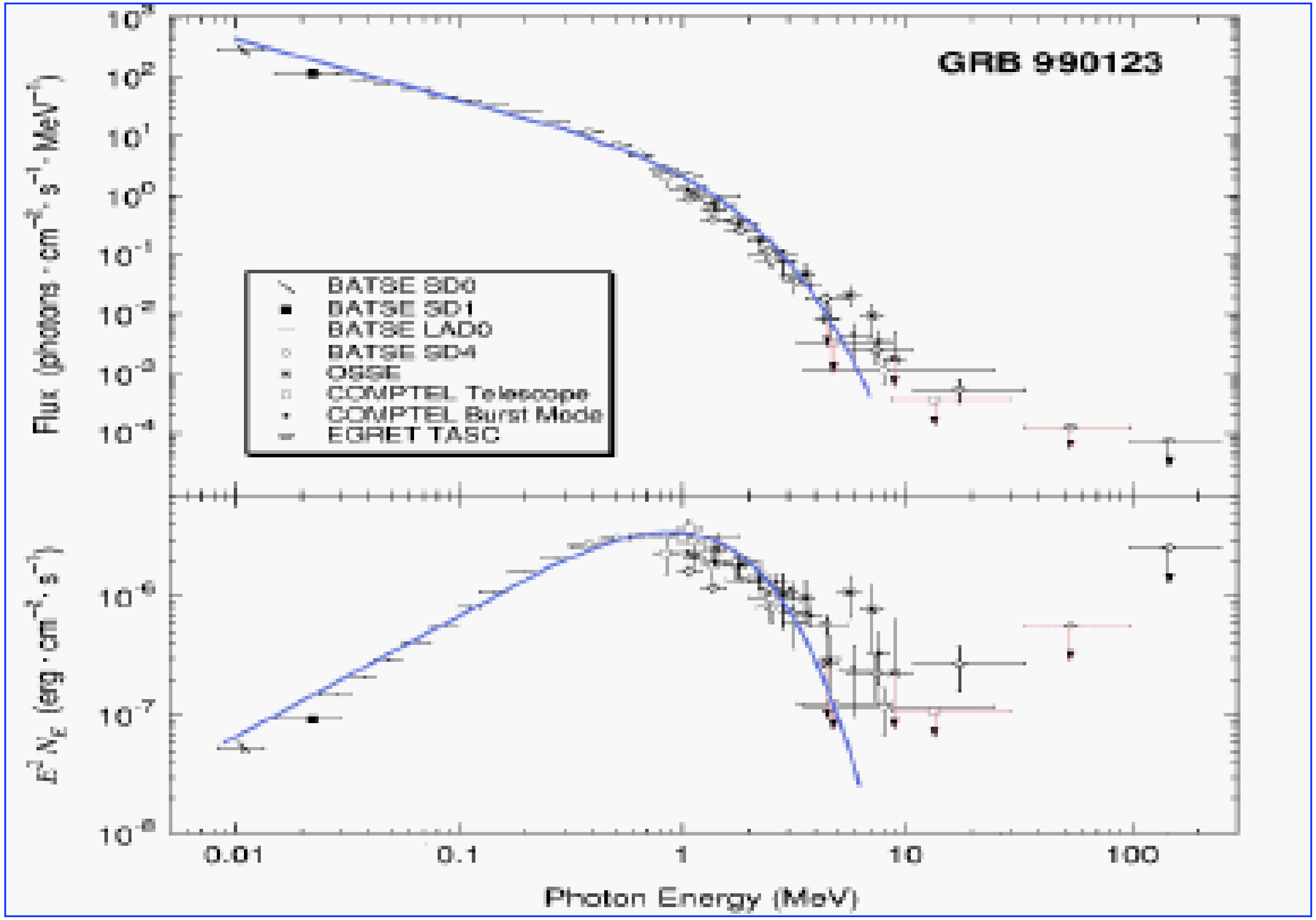
The GRB phenomenon

- bimodal distribution of durations: short and long GRBs
- short GRBs tend to be spectrally harder than long GRBs
- HR = flux (100 – 300 keV) / flux (50 – 100 keV)

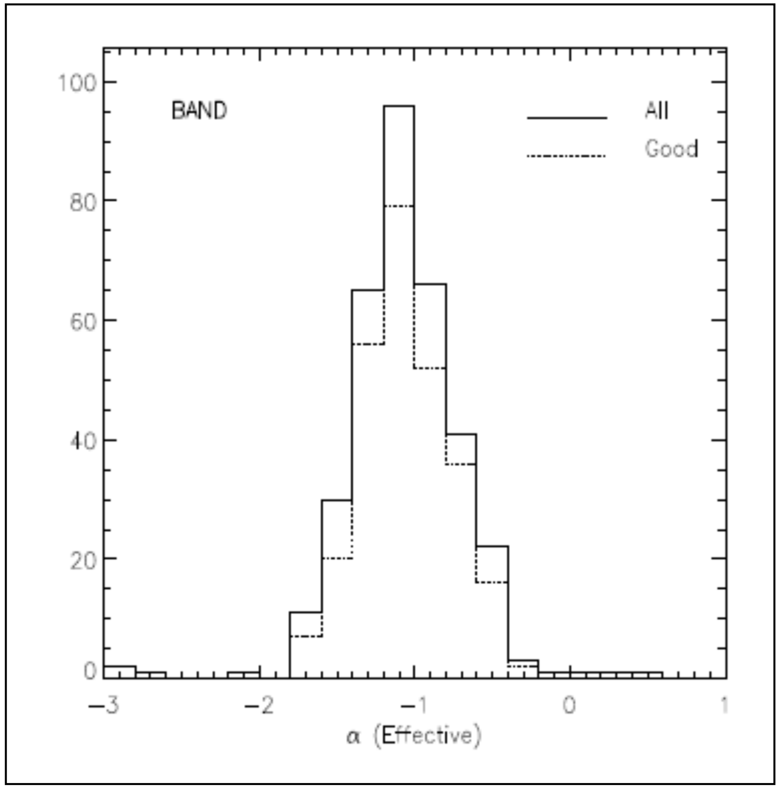




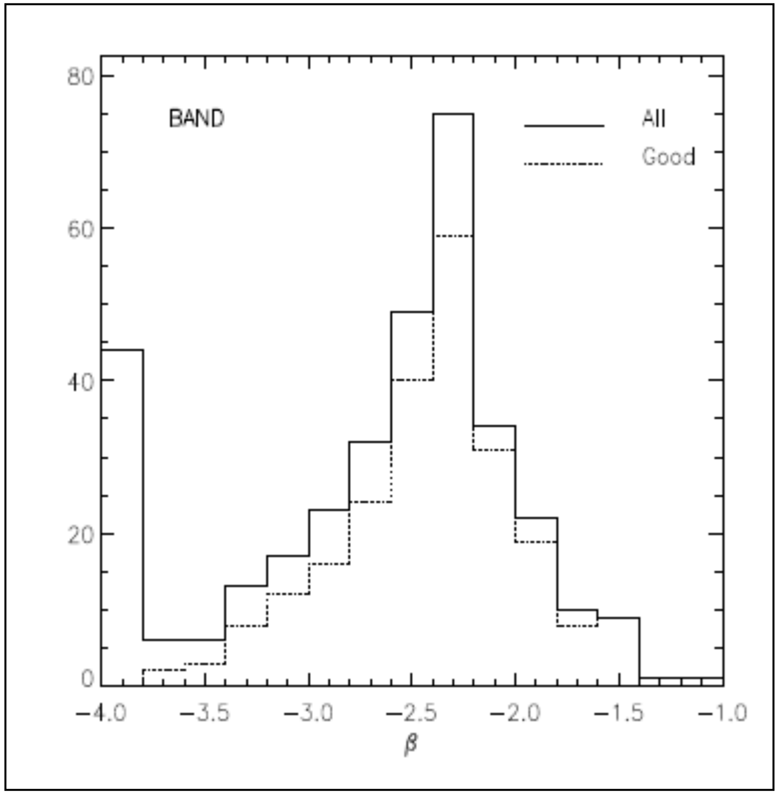
GRB spectral info



GRB spectral Info

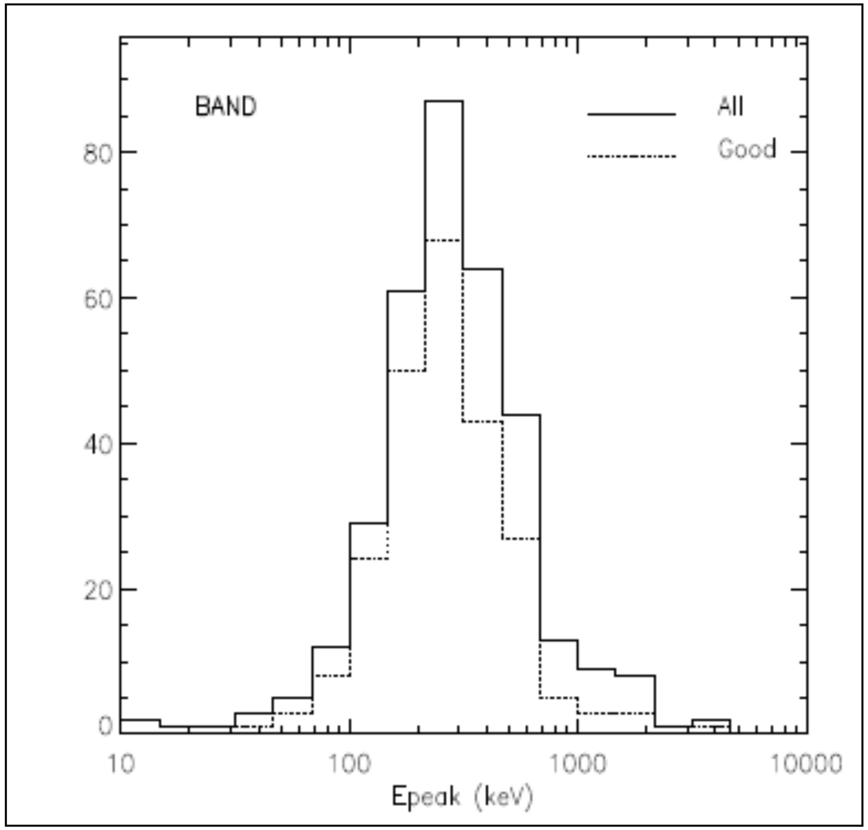


Low Energy Index



High Energy Index

GRB spectral Info



Peak Energy

Exercise #2

Find David Band' GRB parametrization in paper (1993) and in XSPEC model

$$f_{\mathrm{BAND}}(E) = A\left(\frac{E}{100}\right)^{\alpha}\exp\left(-\frac{E(2+\alpha)}{E_{\mathrm{peak}}}\right) \quad \text{if} \quad \mathrm{E} < \mathrm{E_c}$$

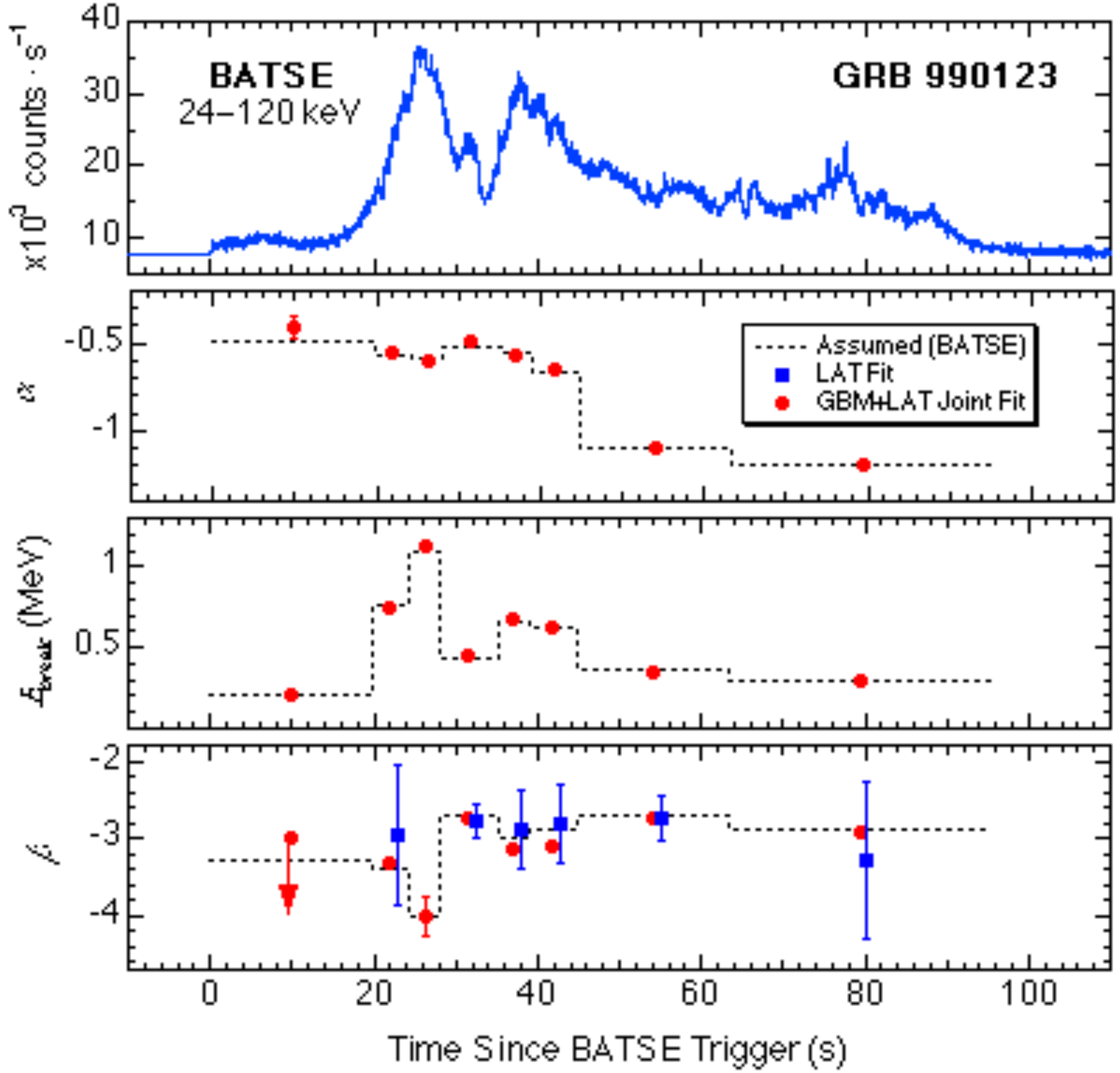
$$f_{\mathrm{BAND}}(E) = A\left[\frac{(\alpha-\beta)E_{\mathrm{peak}}}{100(2+\alpha)}\right]^{\alpha-\beta}\exp\left(\beta-\alpha\right)\left(\frac{E}{100}\right)^{\beta} \quad \text{if} \quad \mathrm{E} \geq \mathrm{E_c},$$

where

$$E_c = (\alpha-\beta)\frac{E_{\mathrm{peak}}}{2+\alpha} \equiv (\alpha-\beta)E_0.$$

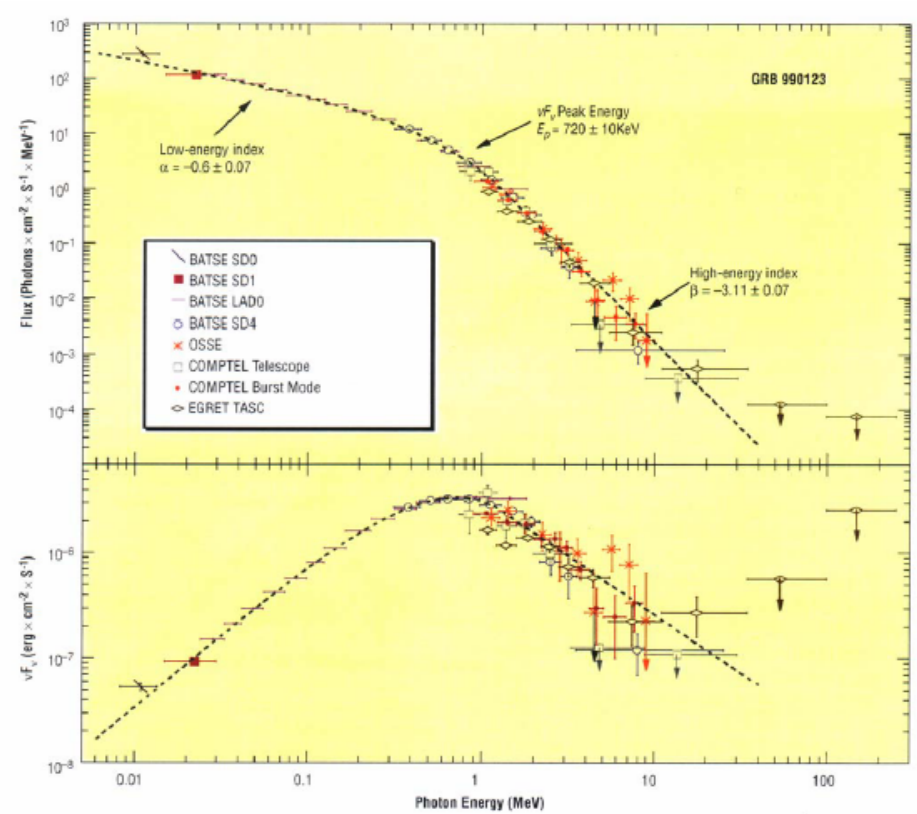
Find other papers on spectral evolution of GRBs

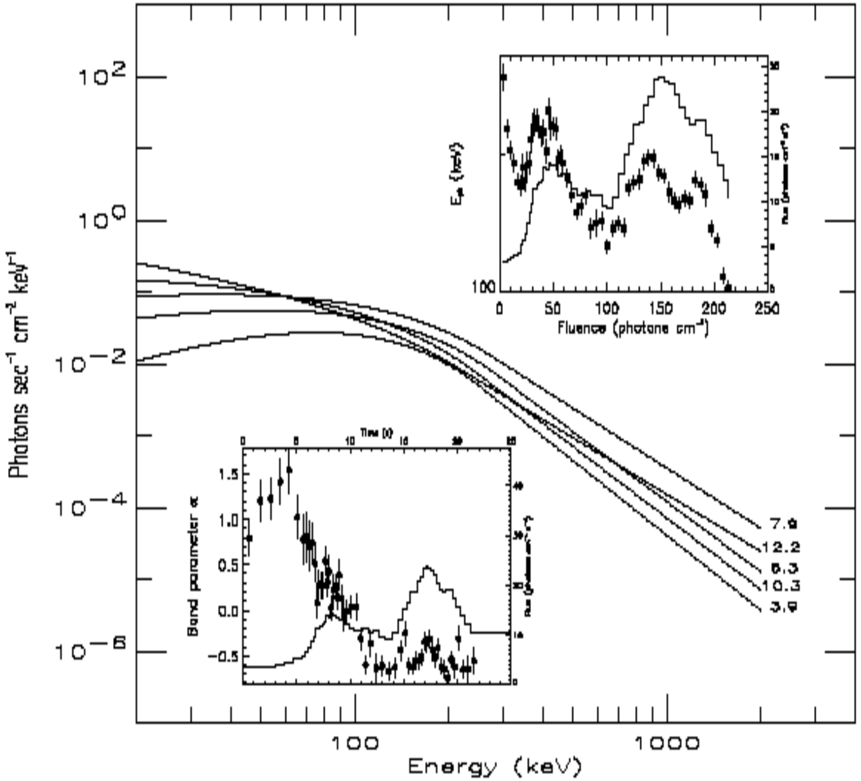
Spectral Evolution



The GRB phenomenon

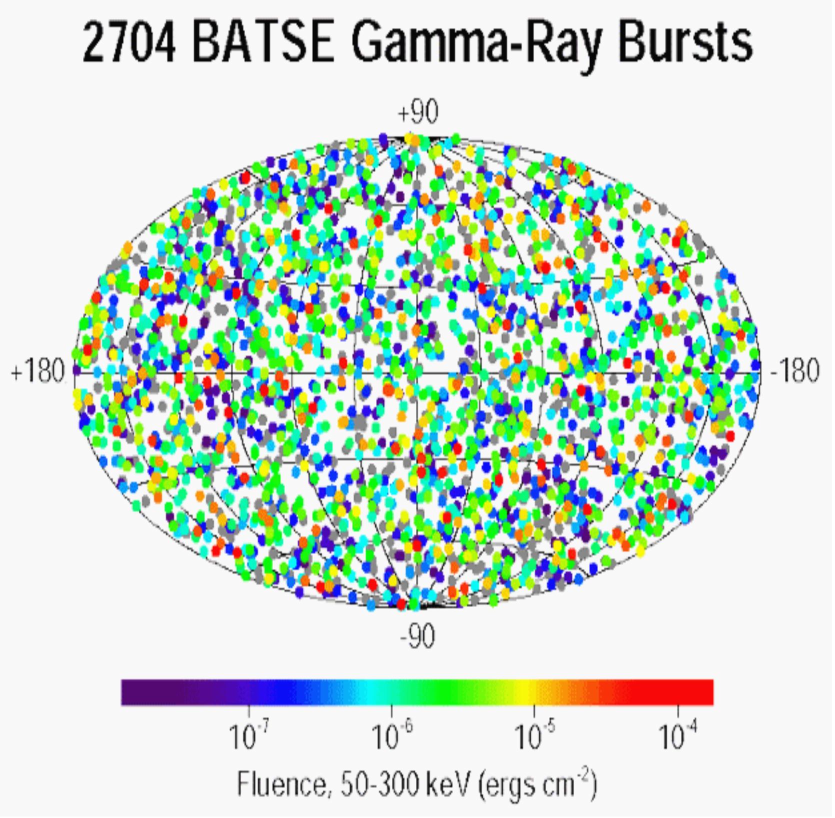
- non thermal spectra with a smooth break
- most GRBs show substantial spectral evolution
- two typical behaviours: hard to soft throughout the whole GRB or hard to soft during each pulse

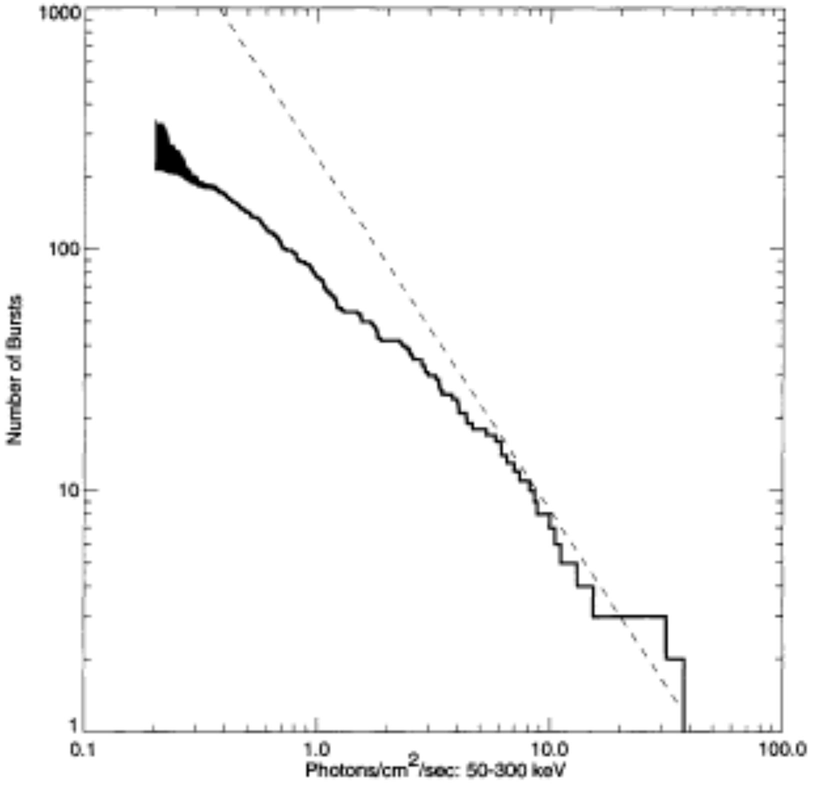




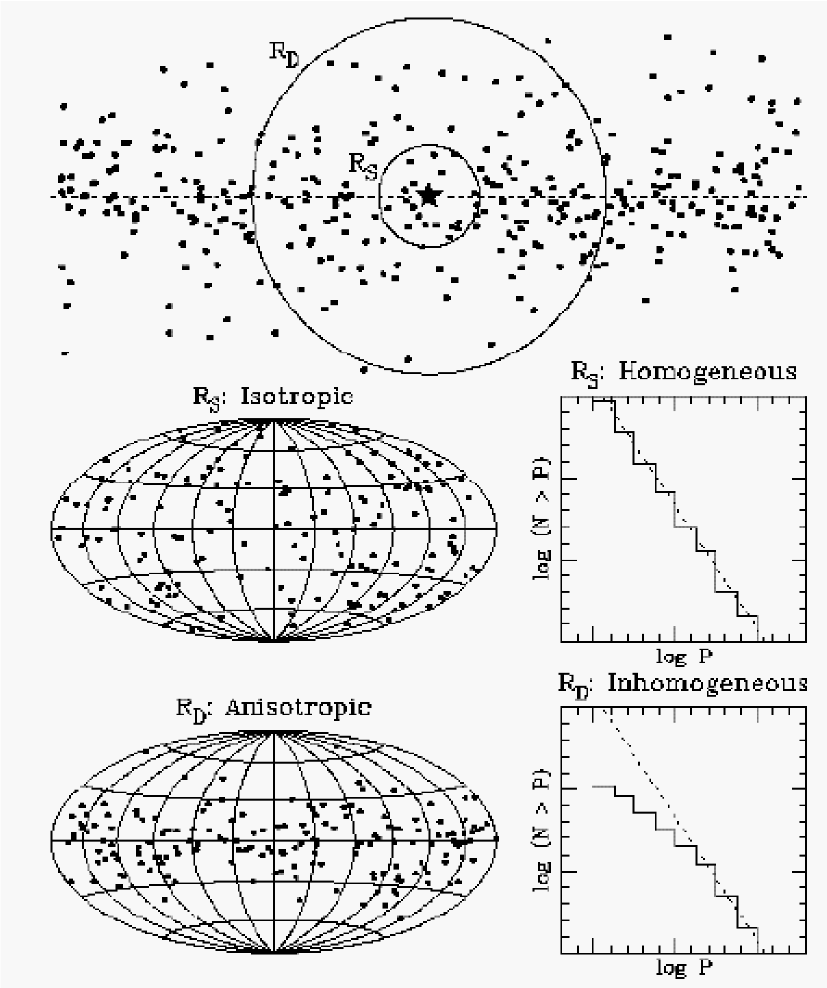
The GRB phenomenon

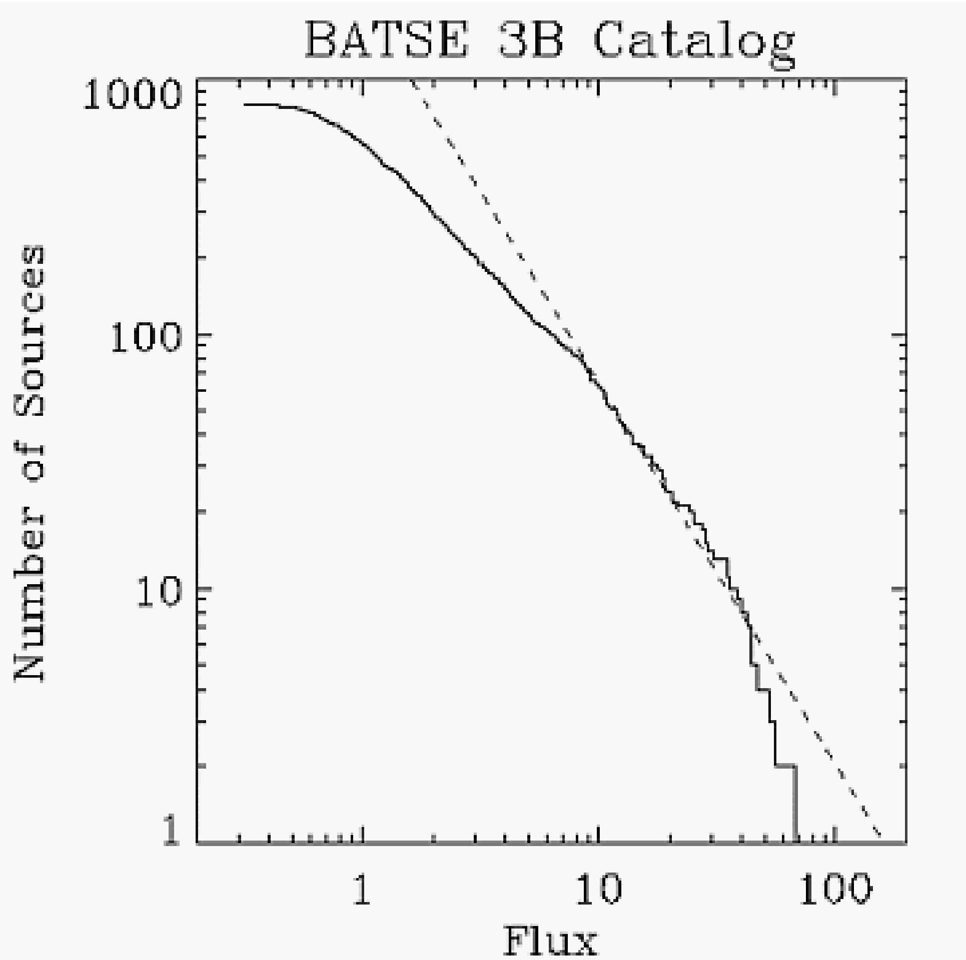
- isotropic distribution of GRBs directions
- paucity of weak events with respect to homogeneous distribution in euclidean space
- hints to cosmological origin of GRBs





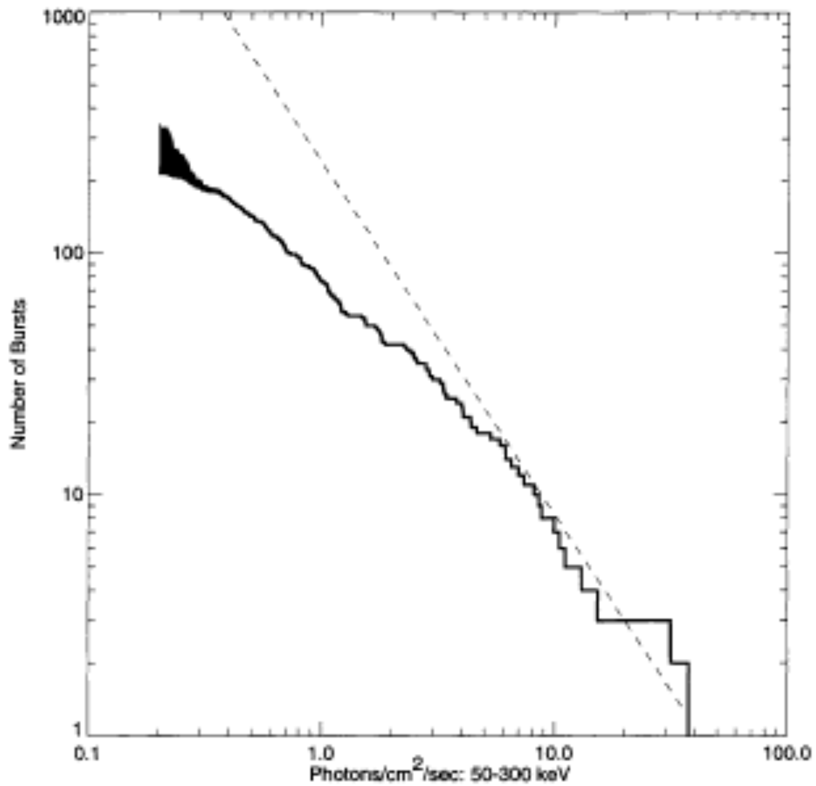
BATSE (1991 - 2000)



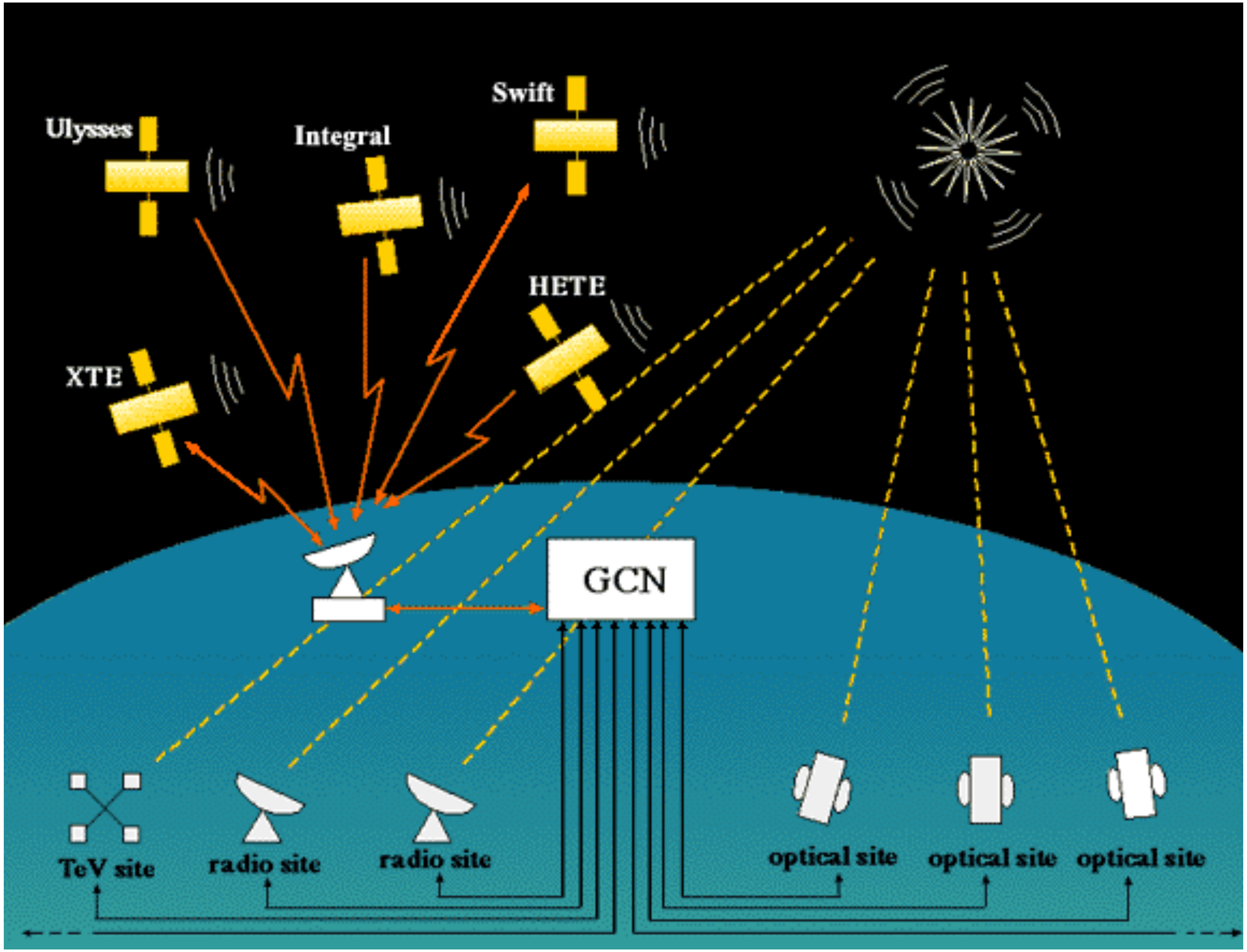


The GRB phenomenon

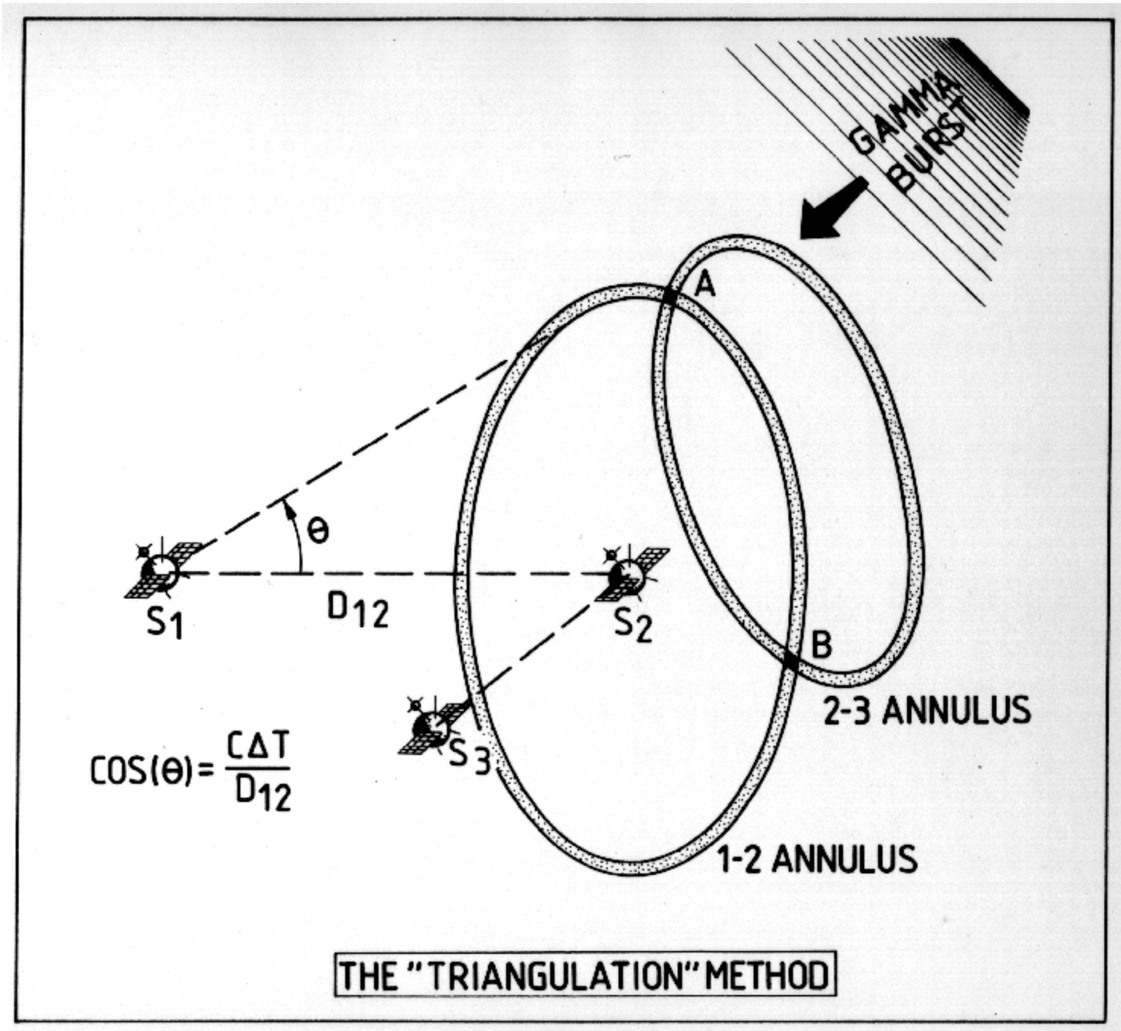
- Flux ~ d^-2
- Number ~ d^3
- d ^ N^1/3
- Flux ^ N^-2/3
- N ^ Flux ^-3/2



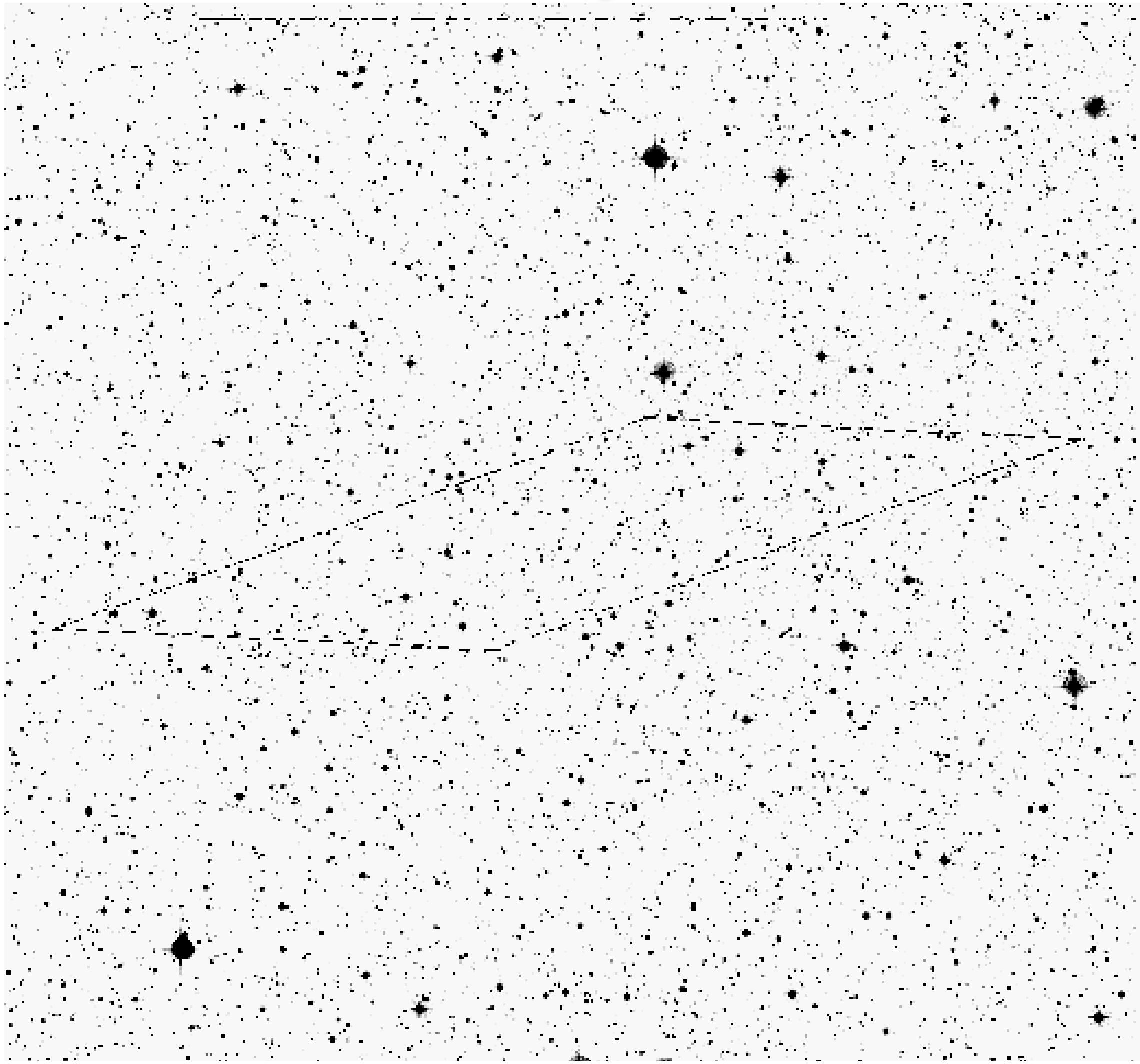
The GRB coordinates network



The Interplanetary network



No host problem



GRB: where are they?

The great debate (1995)

Cosmological - Galactic?

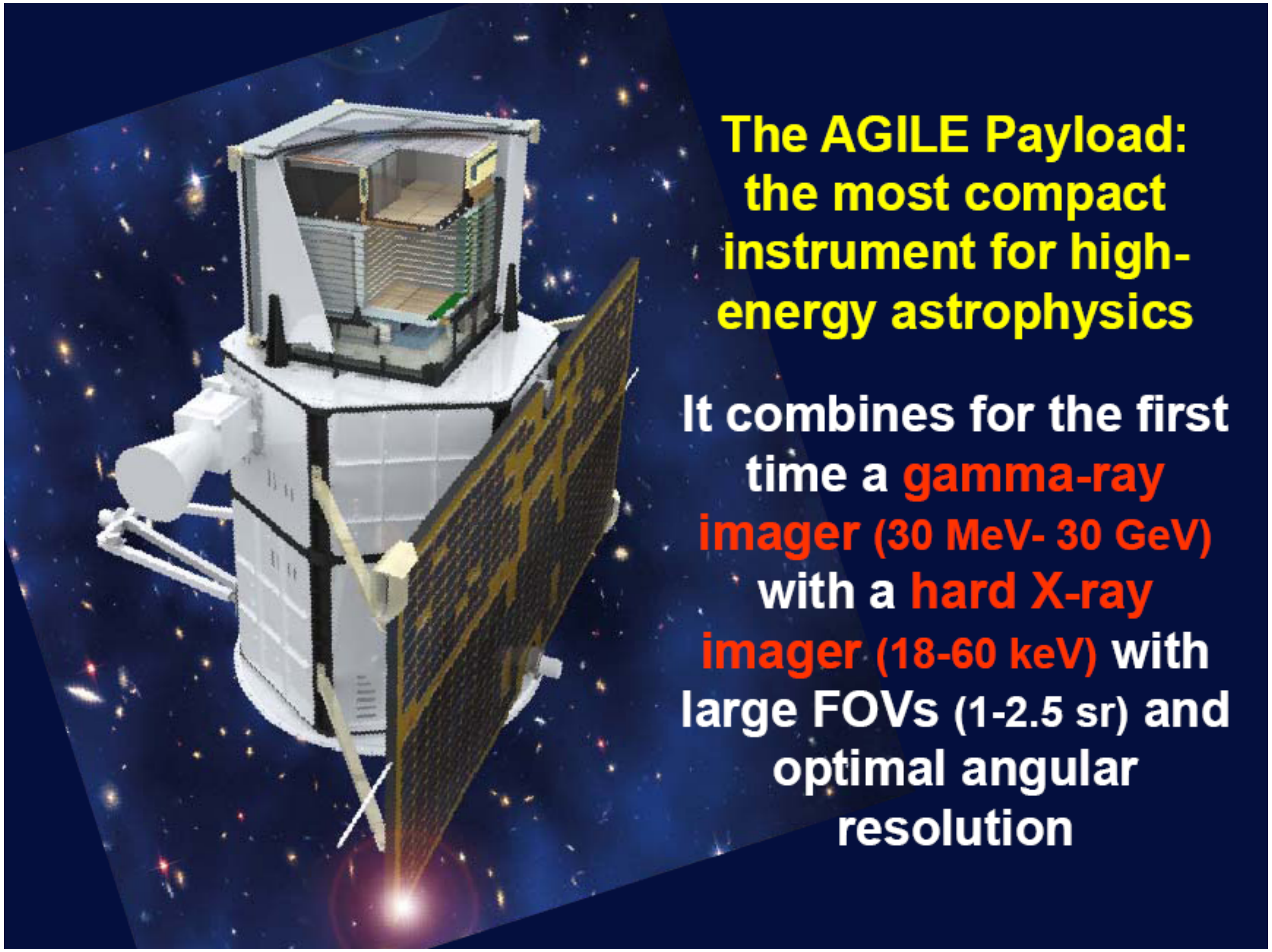
Flux: 10^{-7} erg cm^{-2} s^{-1}
Distance: 1 Gpc
Energy: 10^{51} erg

Distance: 100 kpc
Energy: 10^{43} erg

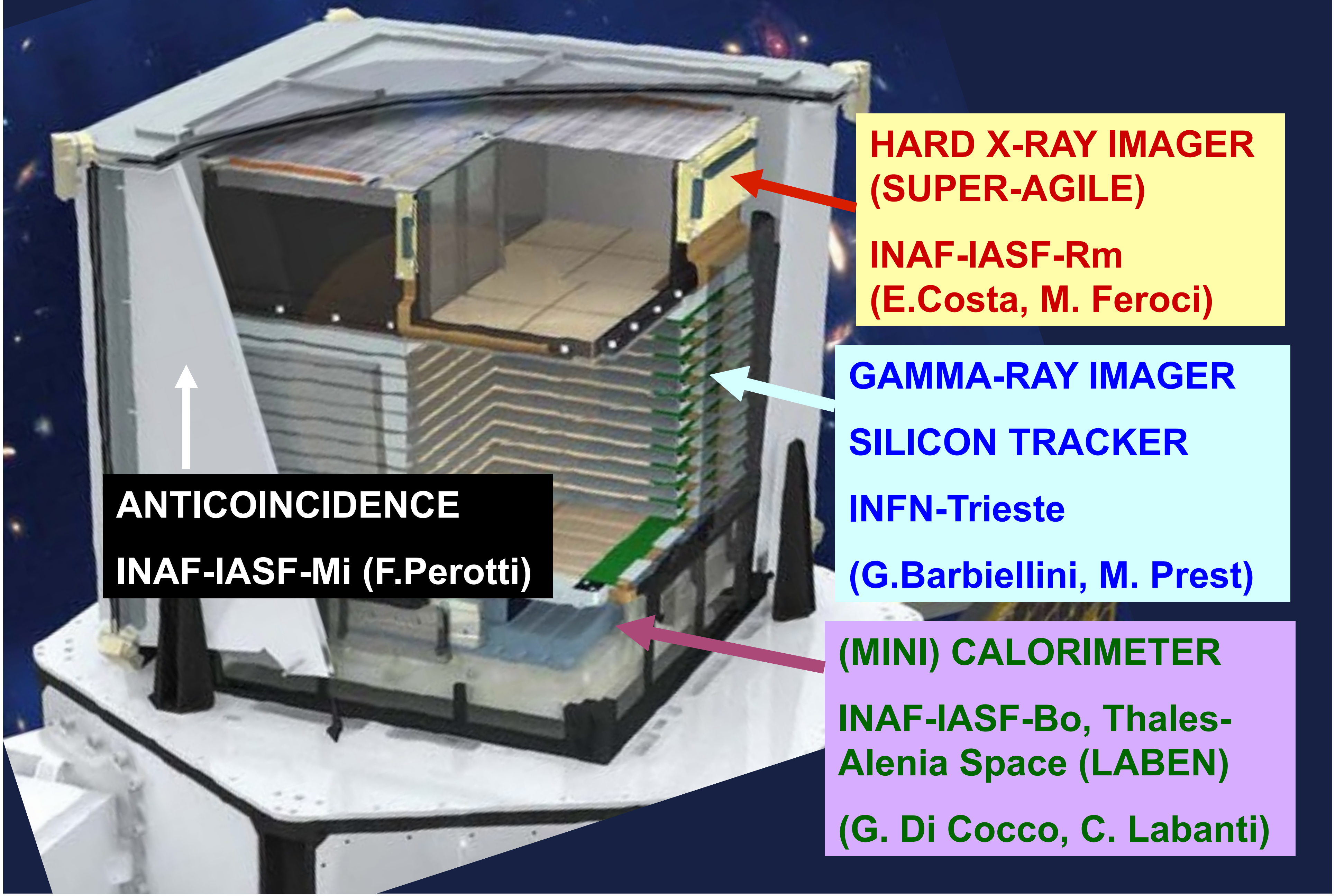
Need a new type of observation!

the “BATSE” era …?

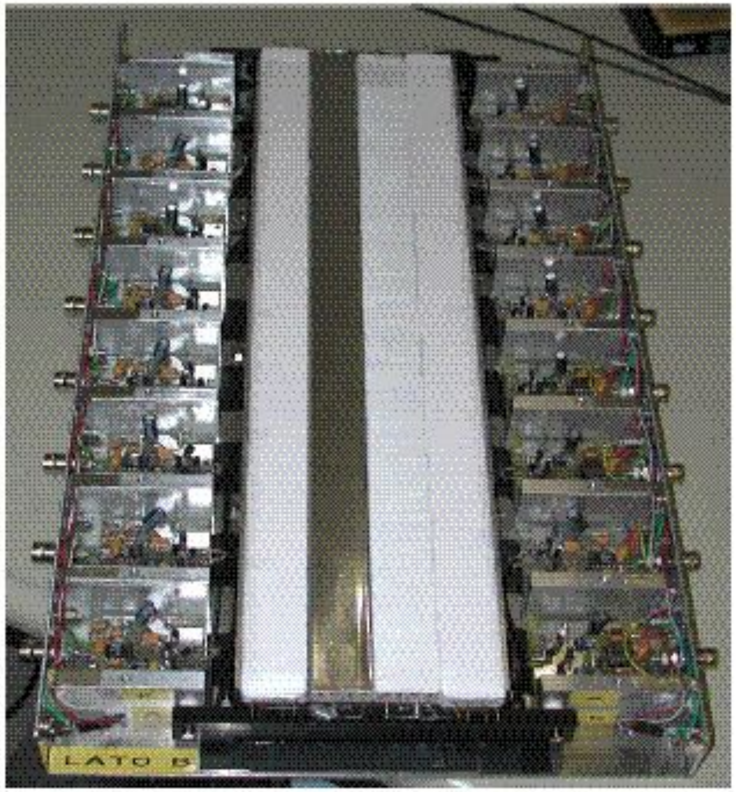
AGILE instrument



AGILE: inside the cube…



The CsI Mini-Calorimeter



MINI-CALORIMETER

DETECTOR

30 CsI bars wrapped with tight diffusion material organized in 2 orthogonal trays
- bar dimension: $40 \times 2.3 \times 1.5\ cm^3$
- total radiation length: $1.5X_0$ (in axis)

FRONTEND ELECTRONICS

- 1 photodiode on each side of the bar
- optically coupled

GOAL

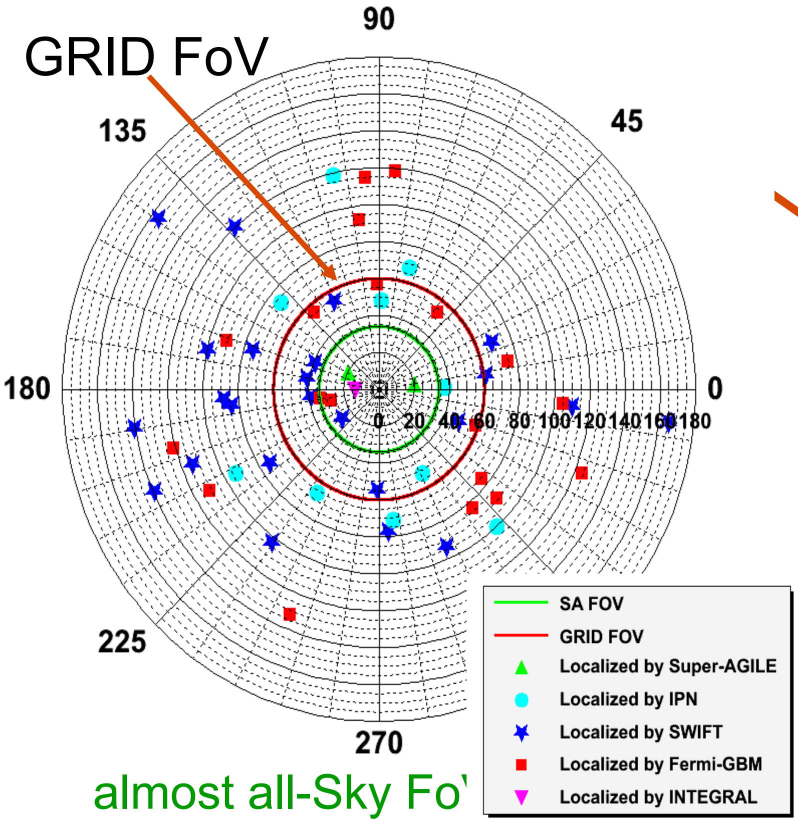
- measure energy deposit of the photon conversion pair (GRID mode)
- detect GRBs and transients in the range 0.25-250MeV (BURST mode)

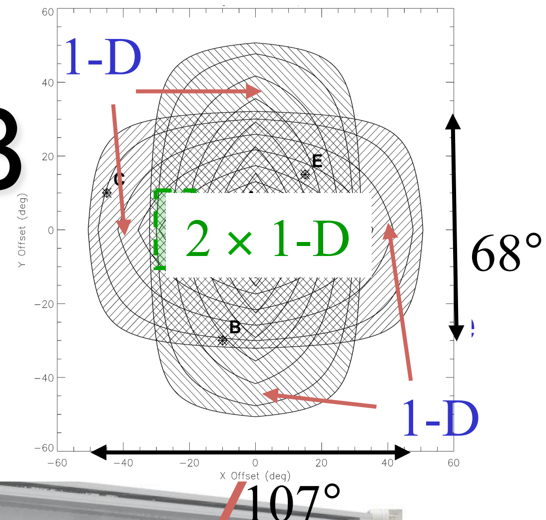
SCIENTIFIC FEATURES

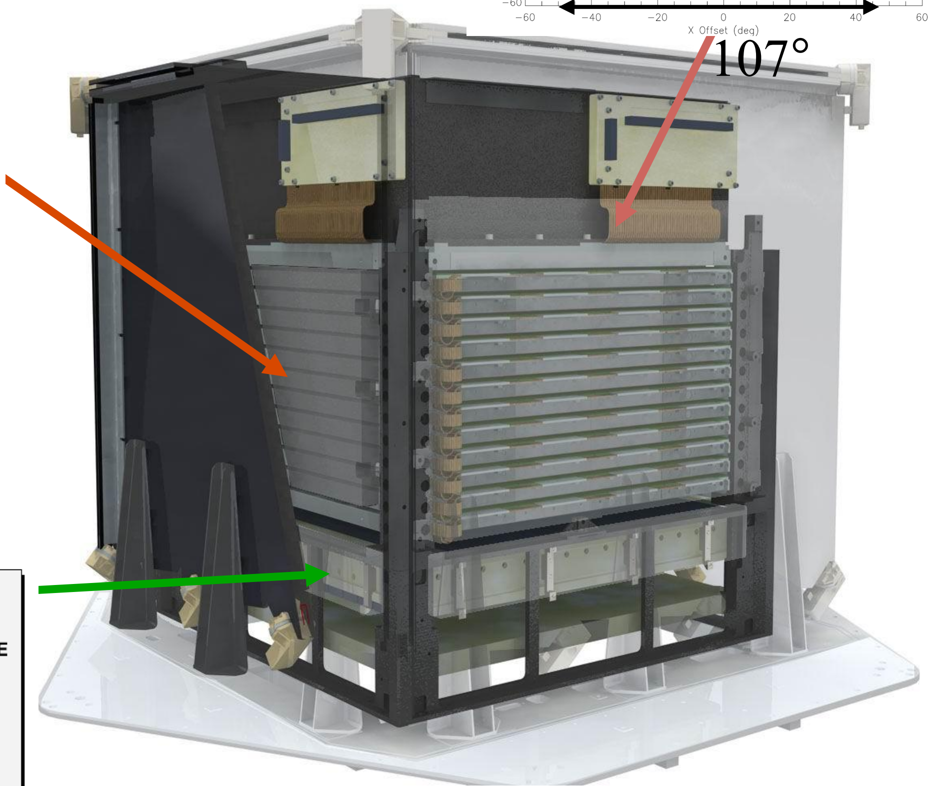
- energy resolution: 22-24%(FWHM) @ 1MeV
  0.7% @ 100MeV
- spatial resolution: 15mm @ 1MeV
  2mm @ 100MeV
- timing resolution: 2μs (BURST mode)

AGILE and GRB

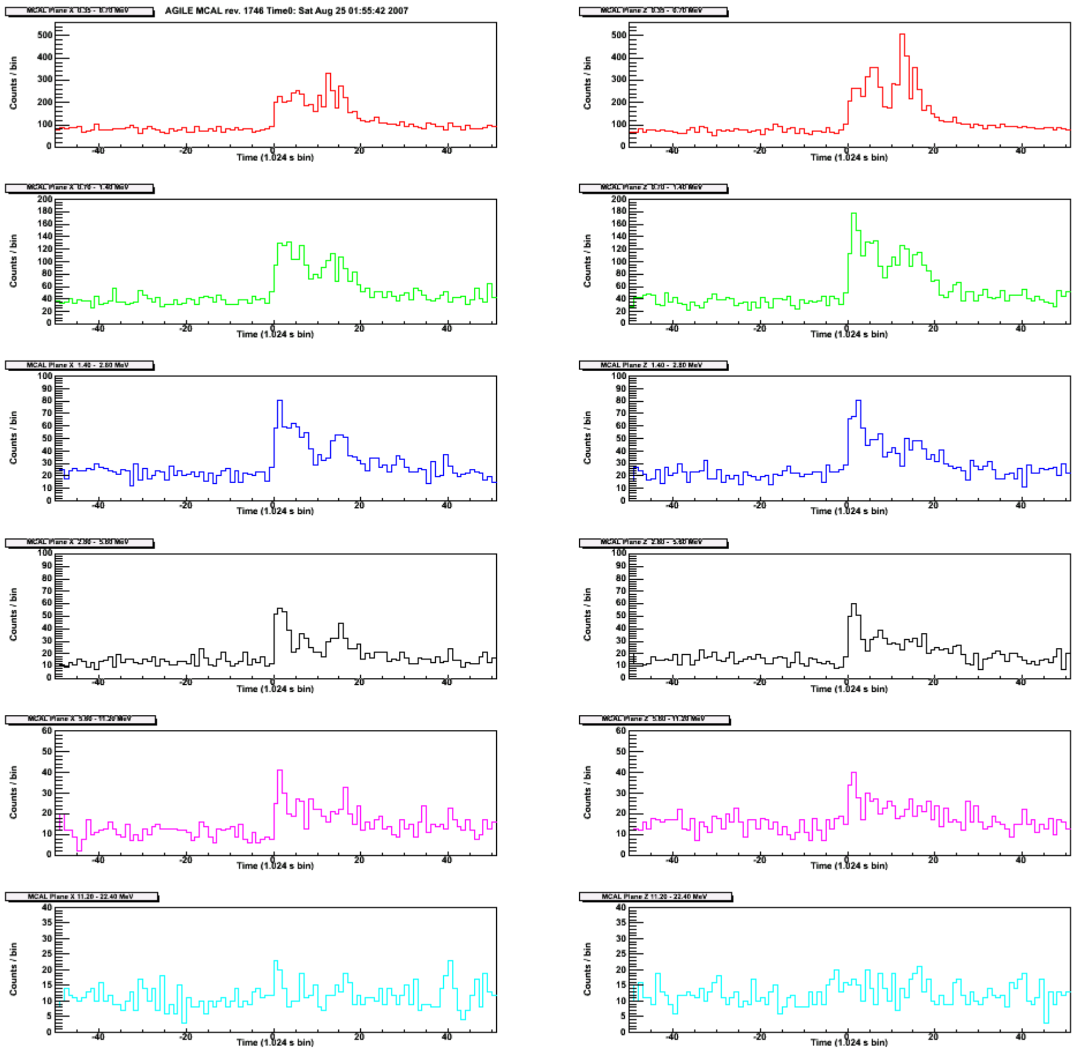
Gamma Ray Imaging Detector
Silicon tracking detector
30 MeV – 50 GeV







GRB070825: MCAL light curves



0.35-0.7 MeV

0.7 - 1.4 MeV

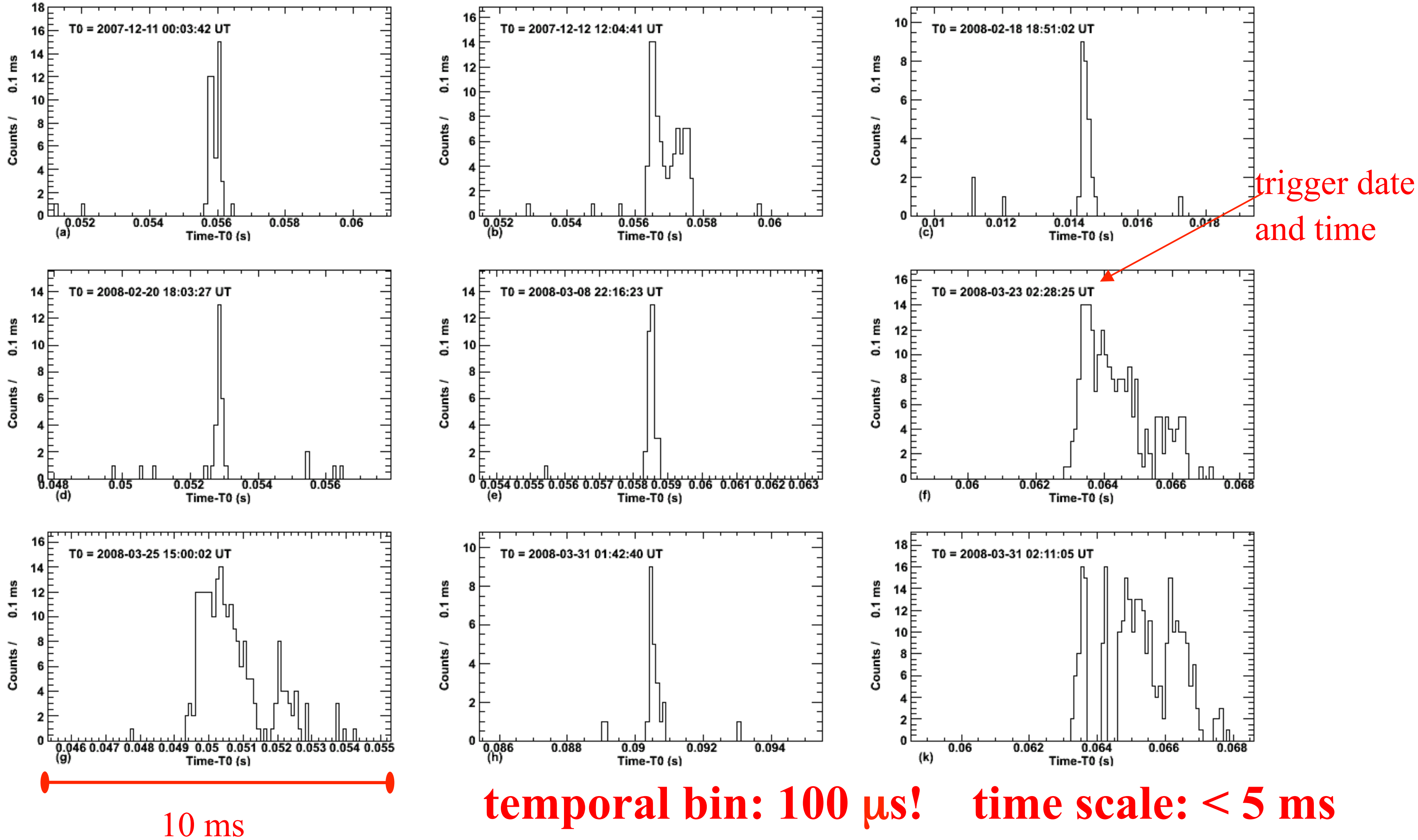
1.4 - 2.5 MeV

2.5 - 5.5 MeV

5.5 - 11 MeV

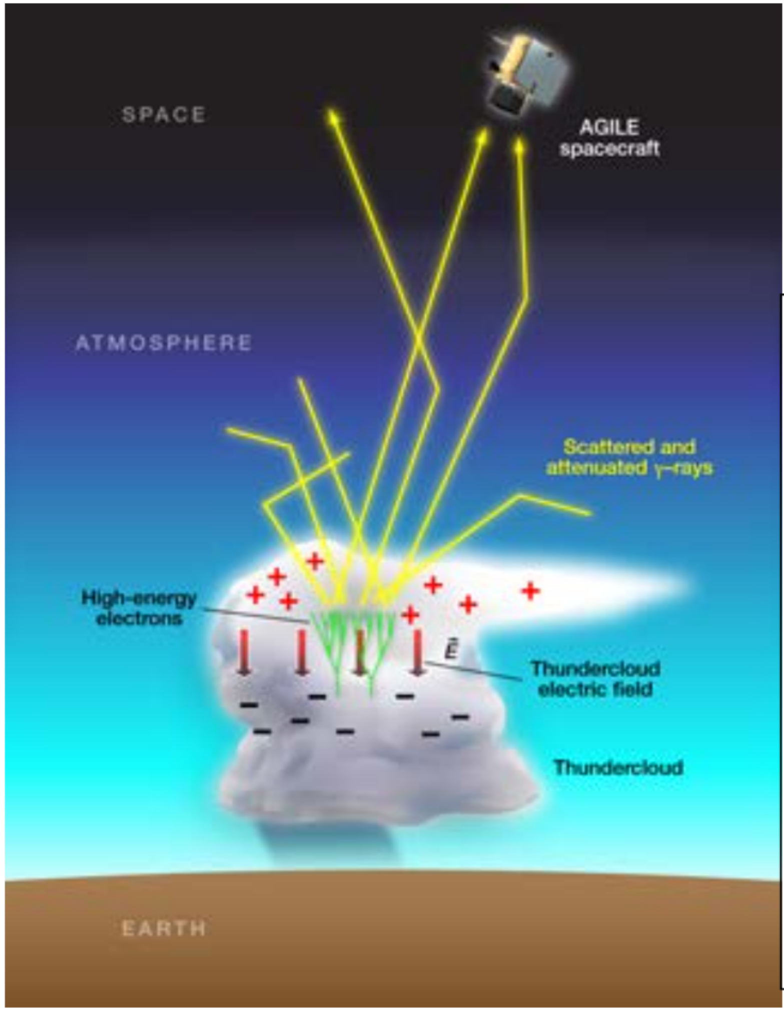
11 - 22 MeV

Terrestrial Gamma Flashes

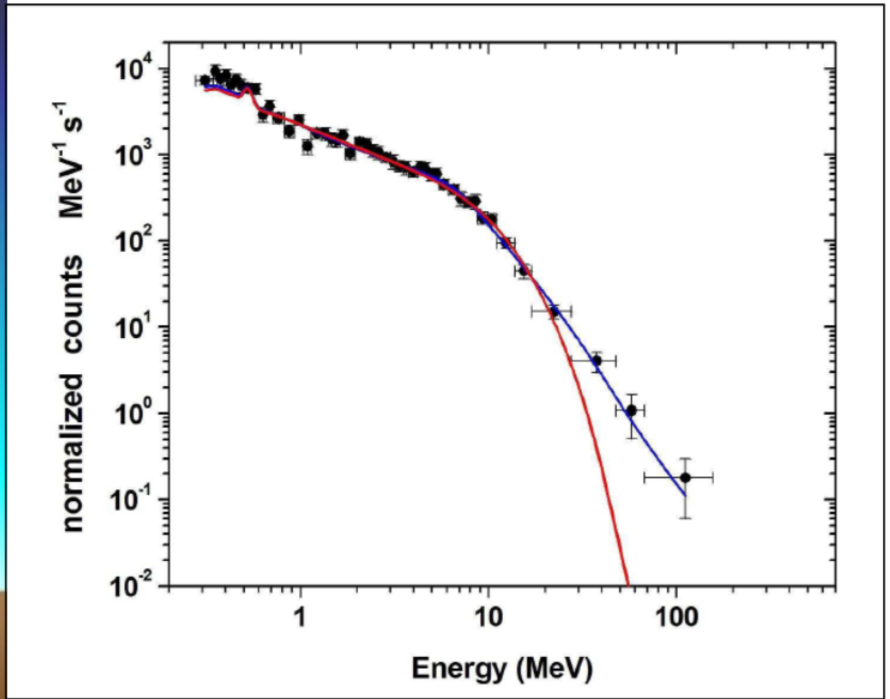


temporal bin: 100 μs! **time scale: < 5 ms**

Terrestrial Gamma-ray Flashes

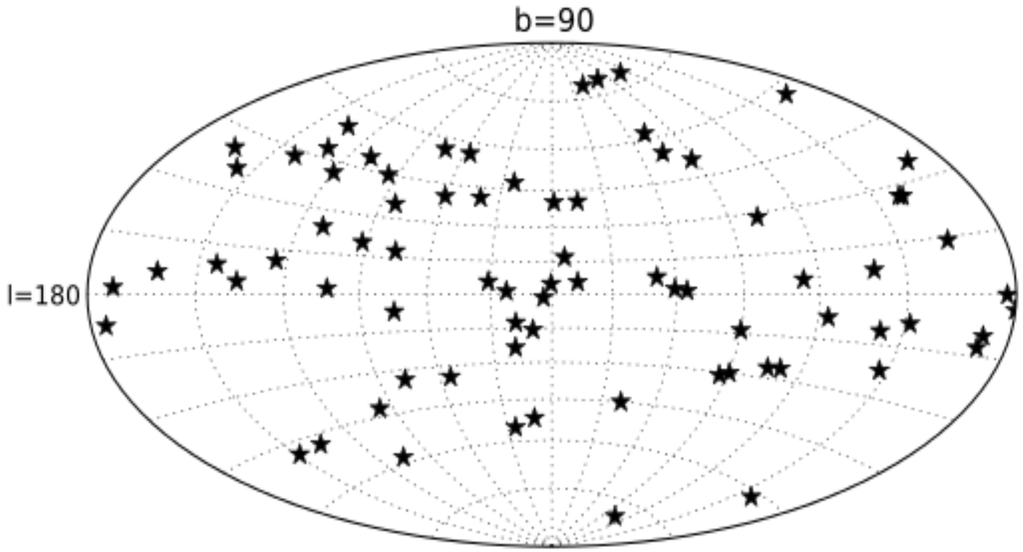


Marisaldi et al. 2010



MCAL GRB catalog

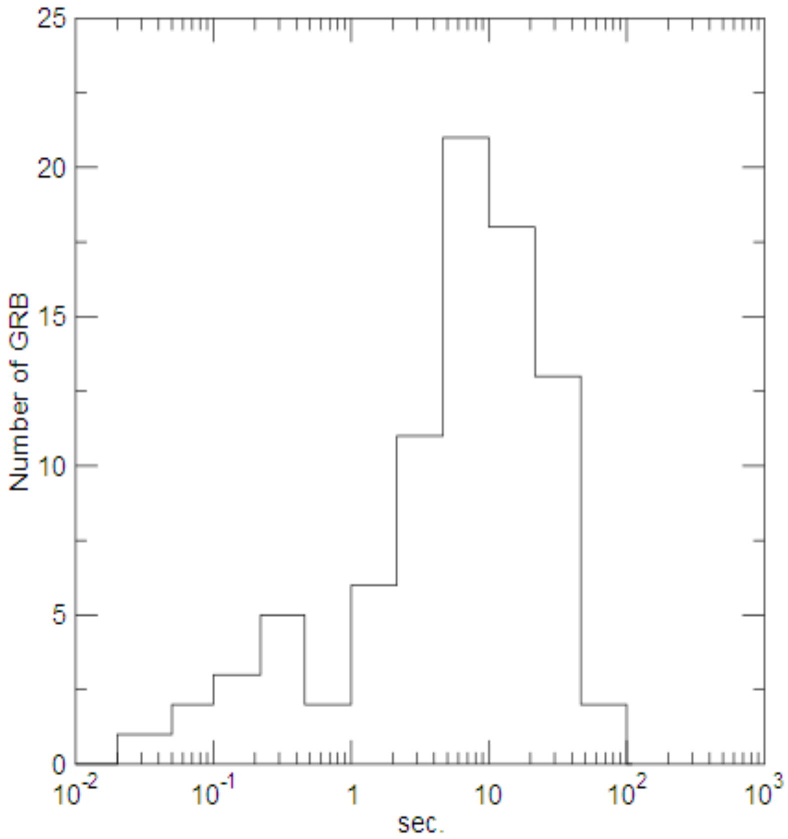
- Contains the data of the 85 hard gamma-ray bursts observed by the MCAL (April 2007 - October 2009)
- Timing data for 84 and spectral data for 21 bursts



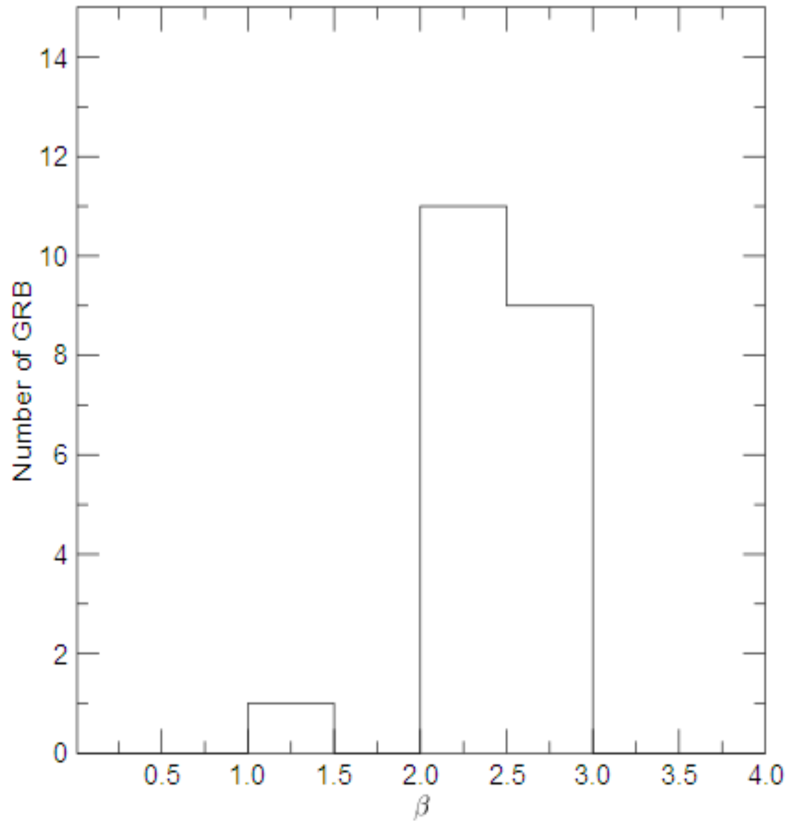
Galli et al. 2013, A&A 553, A33(2013)

MCAL GRB catalog

Galli et al. 2013, A&A 553, A33(2013)



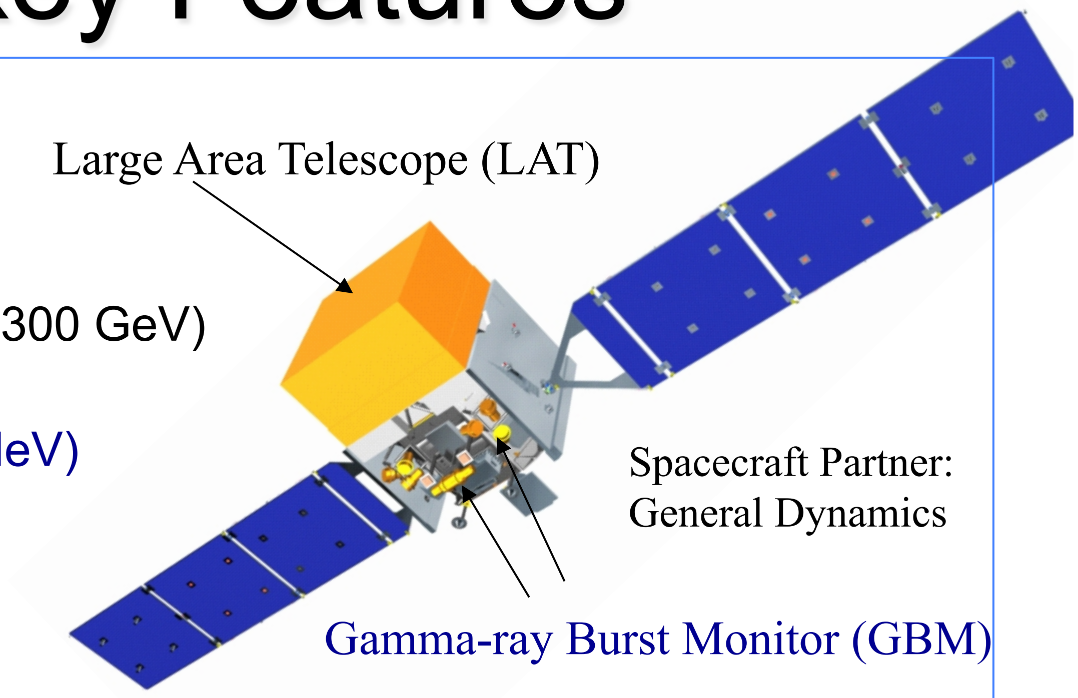
temporal analysis



spectral analysis

Fermi Key Features

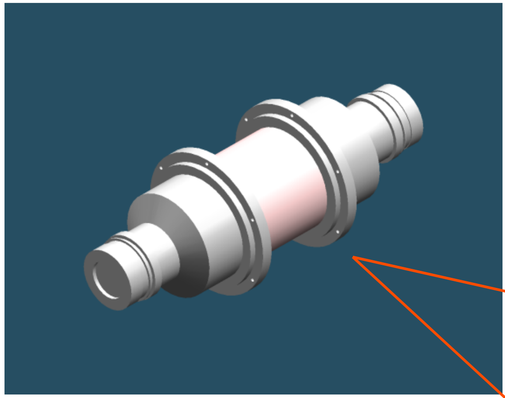
- Two instruments:
  - LAT:
    - high energy (20 MeV – >300 GeV)
  - GBM:
    - low energy (8 keV – 40 MeV)



- Huge field of view
  - LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours. GBM: whole unocculted sky at any time.

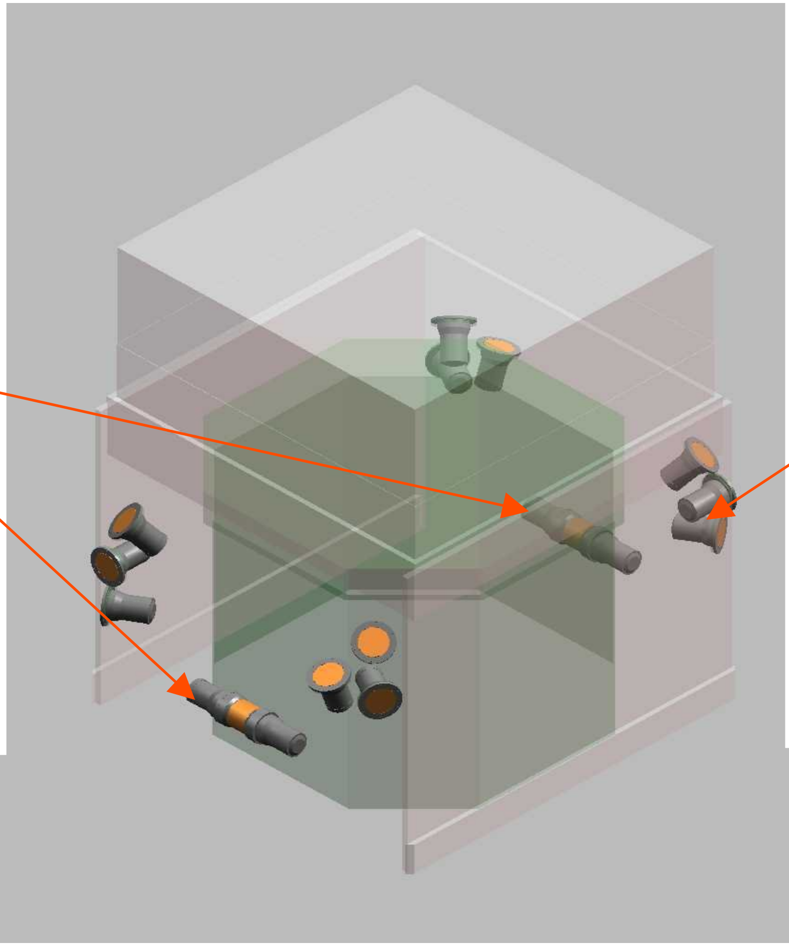
GBM Detectors

Bismuth Germanate (BGO) Scintillation Detector

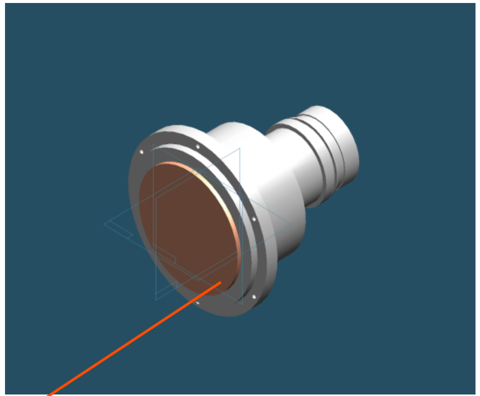


Major Purpose

- Provide high-energy spectral coverage (150 keV – 25 MeV) to overlap LAT range over a wide FoV



(12) Sodium Iodide (NaI) Scintillation Detectors



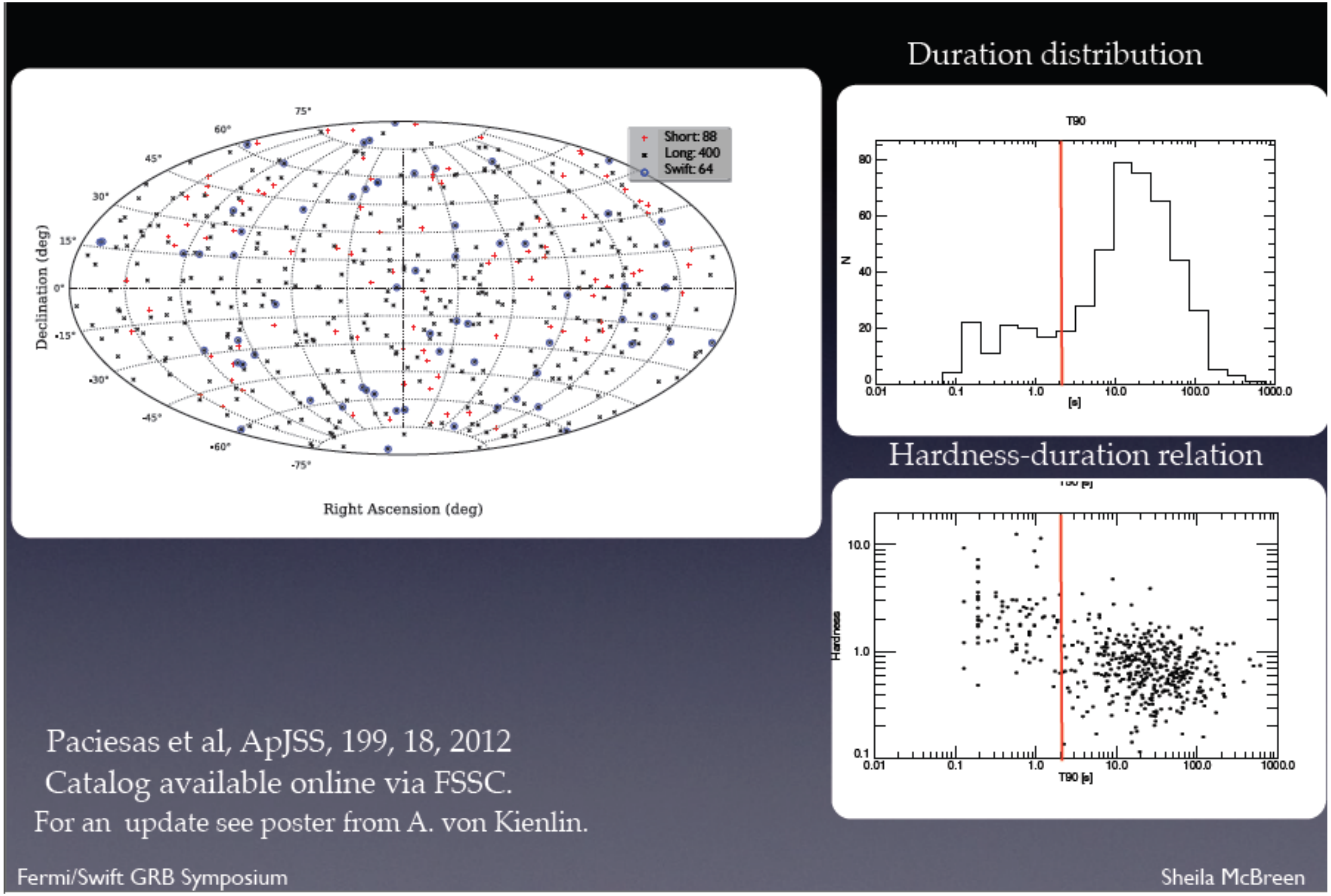
Major Purposes

- Provide low-energy spectral coverage in the typical GRB energy regime over a wide FoV (10 keV – 1 MeV)
- Provide rough burst locations over a wide FoV

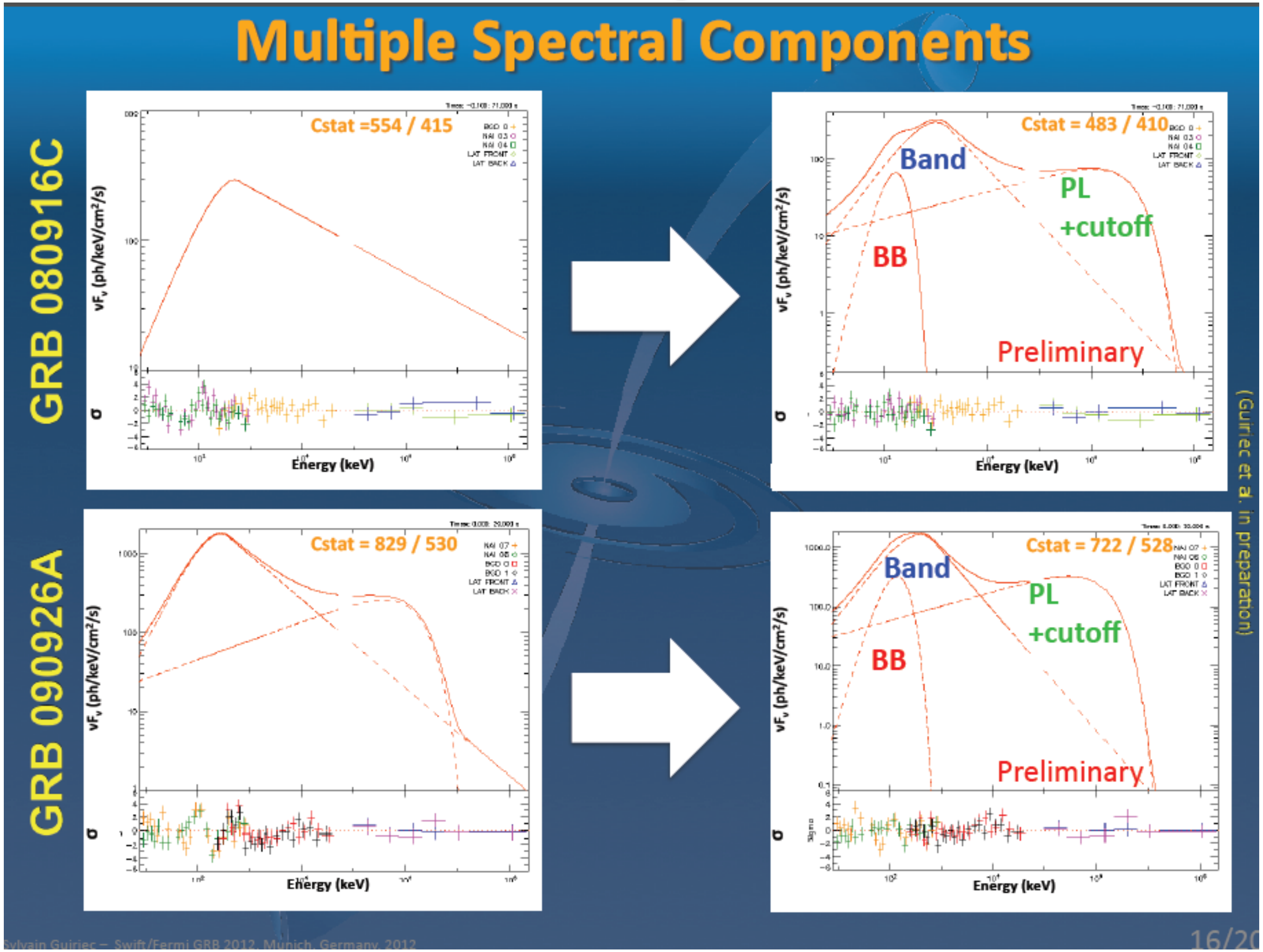
Provides spectra for GRB from 10 keV to 30 MeV.

Provides wide sky coverage (8 sr), enables autonomous repoints to allow for high energy afterglow observations with the LAT.

Fermi GBM


Duration distribution
Short: 88
Long: 400
Swift: 64
Declination (deg)
Right Ascension (deg)
T90
N
[s]
Hardness-duration relation
Hardness
T90 [s]
Paciesas et al, ApJSS, 199, 18, 2012
Catalog available online via FSSC.
For an update see poster from A. von Kienlin.
Fermi/Swift GRB Symposium
Sheila McBreen

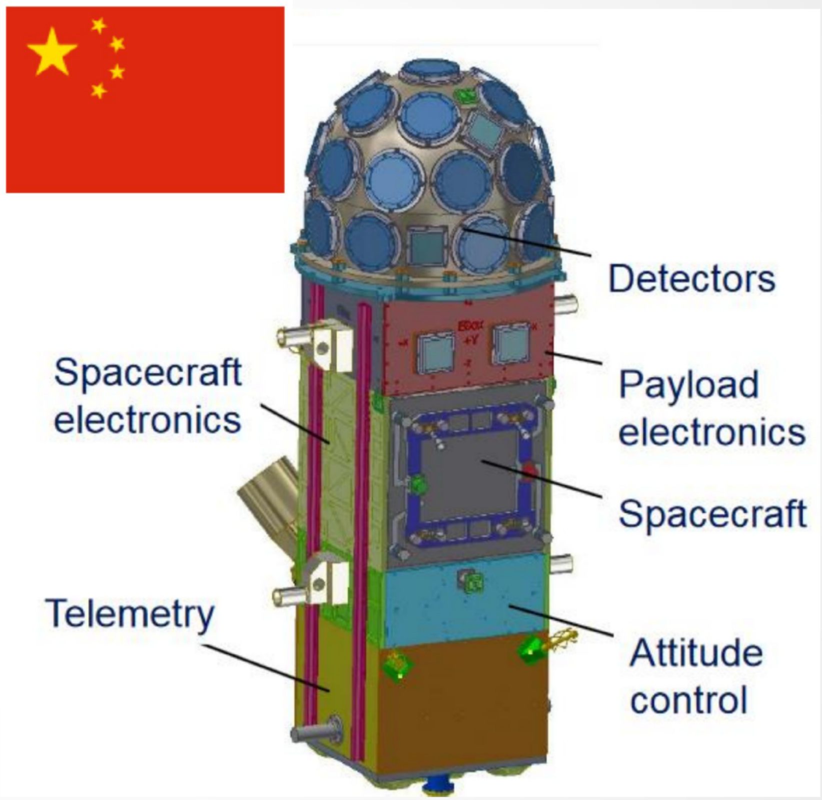
Fermi spectra



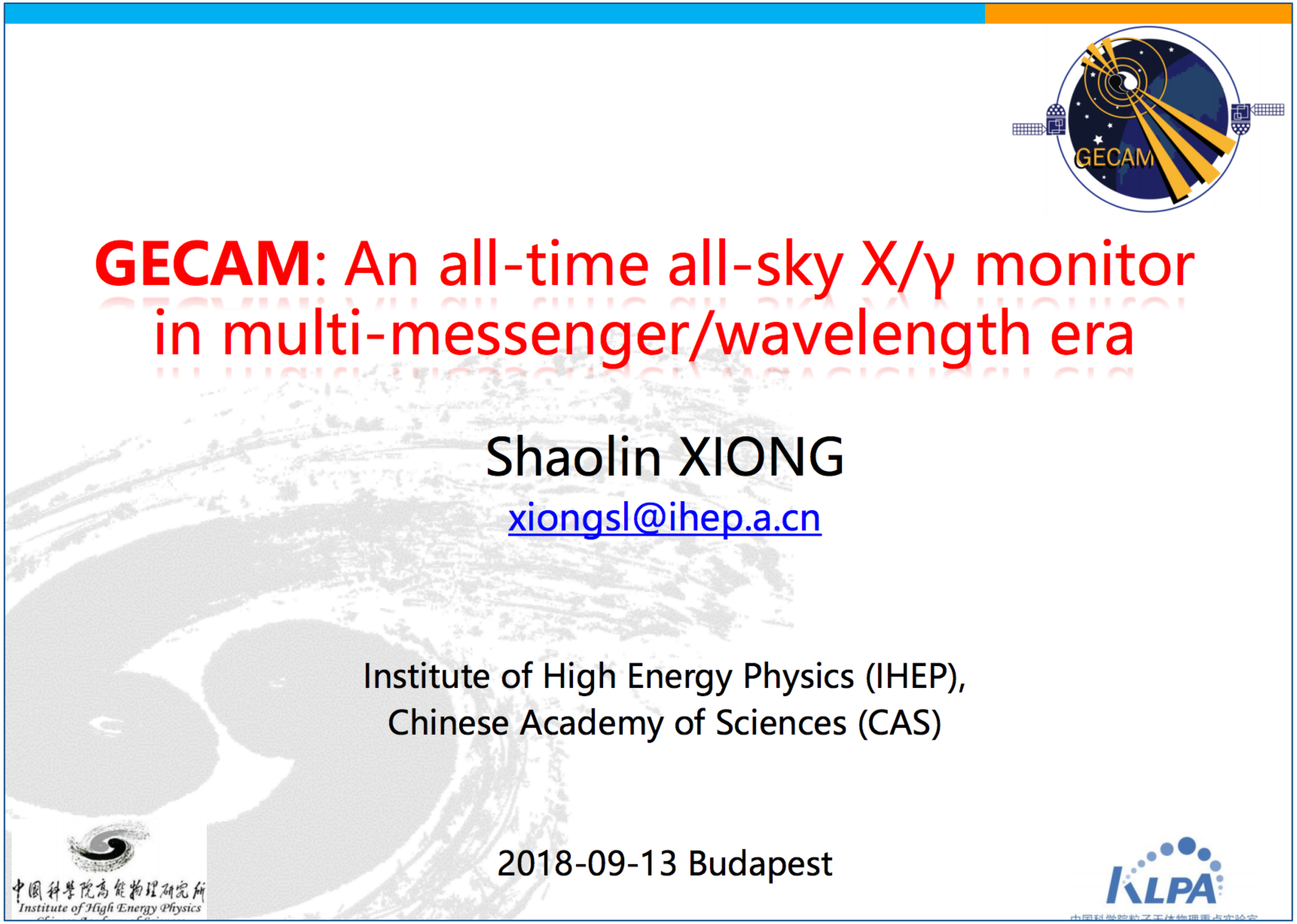
GECAM

GCAM

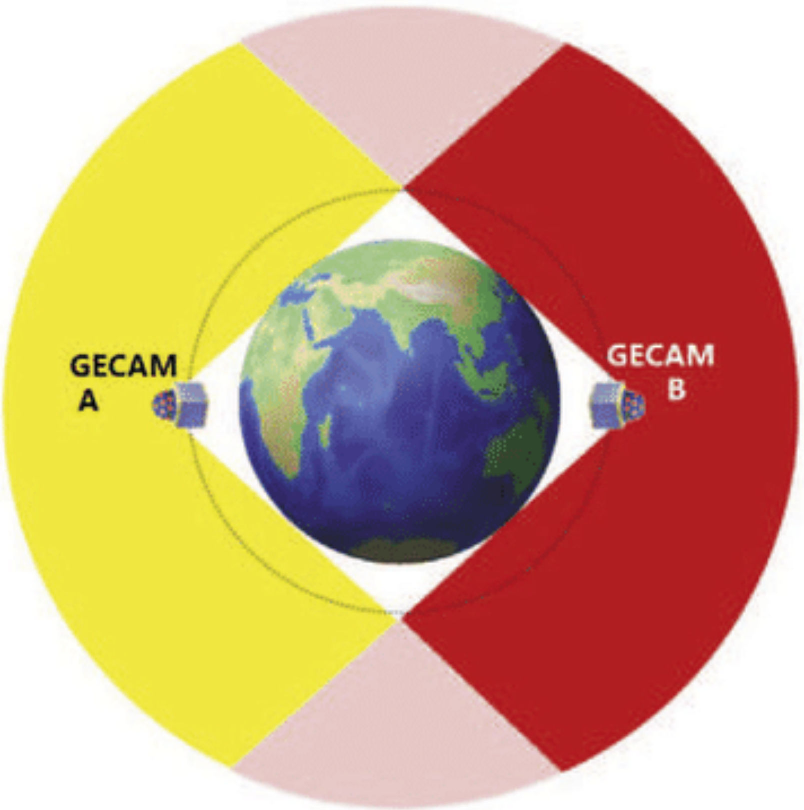
Chinese mission
Launch 2021
2 satellites
100% sky coverage.
Very similar to GBM.
Positioning by triangulation
(need 3 participants)
Some directionality.
Cannot do the work to alert CTA all
by itself.

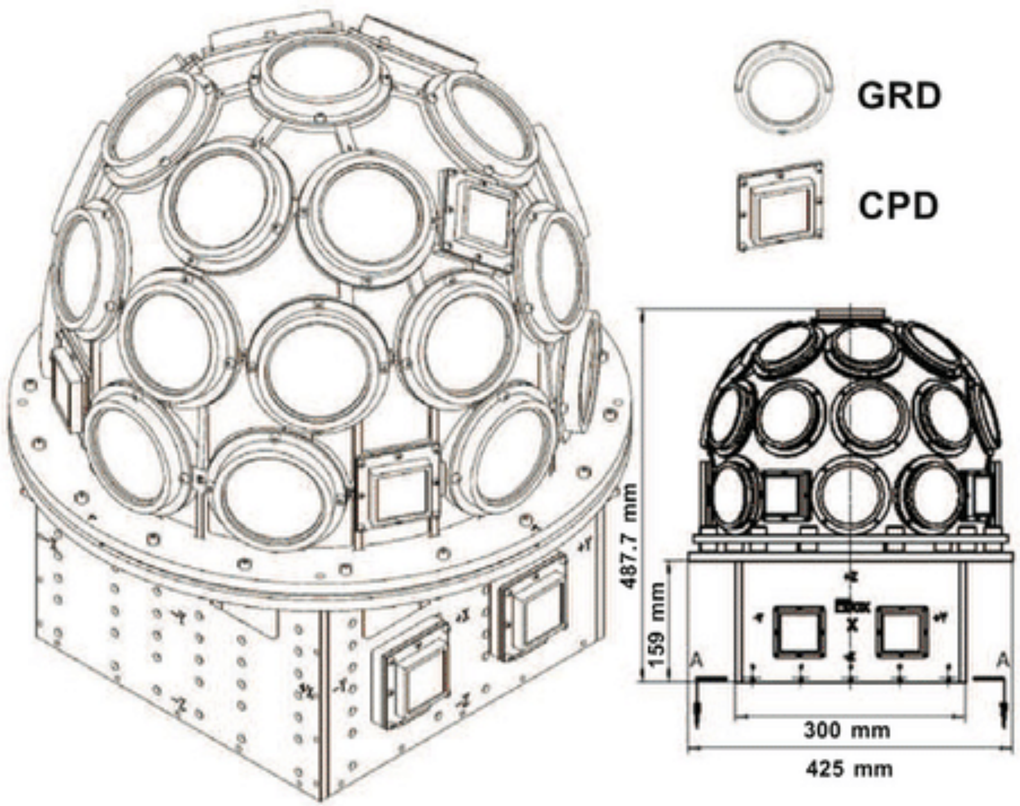


GECAM


GECAM
GECAM: An all-time all-sky X/γ monitor in multi-messenger/wavelength era
Shaolin XIONG
xiongsl@ihep.a.cn
Institute of High Energy Physics (IHEP),
Chinese Academy of Sciences (CAS)
2018-09-13 Budapest
中国科学院高能物理研究所
Institute of High Energy Physics
KLPA

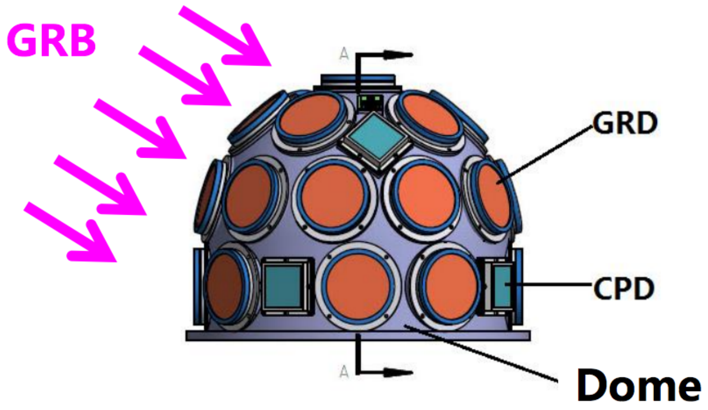
GECAM



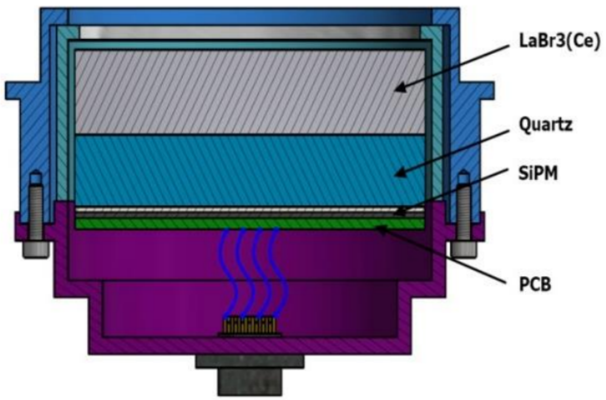


GECAM

Compact low-energy $LaBr_3$+SiPM detectors



- **Configuration for each satellite**
  - **25 Gamma-ray detectors (GRD)**
  - **8 Charged particle detectors (CPD)**
- **Novel technology**
  - **$LaBr_3$+SiPM, very compact, HV-free**
  - **Stay on during SAA passage**



Journal of Instrumentation

A low-energy sensitive compact gamma-ray detector based on $LaBr_3$ and SiPM for GECAM

P. Lv[a,b,c], S.L. Xiong[a], X.L. Sun[a,b], J.G. Lv[a,b] and Y.G. Li[a]

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