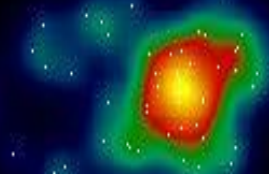


***Expected and unexpected gamma-ray emission from GRBs in light of AGILE and Fermi***

**Marco Tavani**

**(INAF & University of Rome Tor Vergata)**

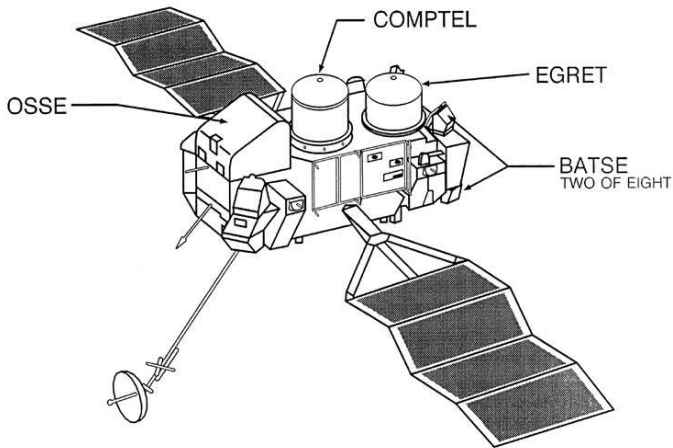


# Outline

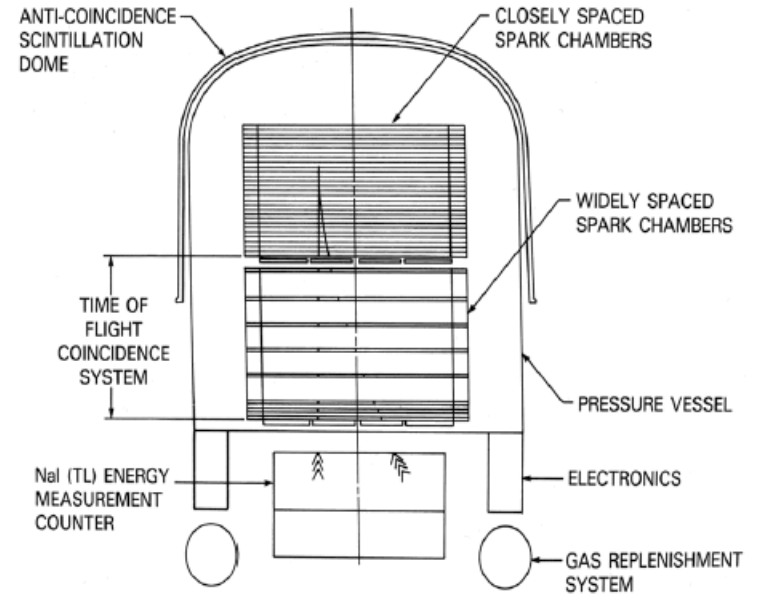
- The EGRET heritage;
- Description of the AGILE detectors for GRB;
- The AGILE HE GRBs sample:
  - GRB 080514B (extended emission, same spectrum at keV – GeV);
  - GRB 090401B (complete coverage by Swift)
  - GRB 090510 (short with delayed component and spectral evolution);
  - GRB 100724B (simultaneous emission at MeV and GeV);
  - GRB 130327B (confirmation by LAT, no Swift Detection)
  - GRB 130427A (First with detection in Likelihood analysis by AGILE/GRID)
- Upper limits in gamma-rays of the undetected GRBs;
- The AGILE MCAL GRB sample & the AGILE contribution to IPN
- Conclusions

# EGRET

## COMPTON OBSERVATORY INSTRUMENTS



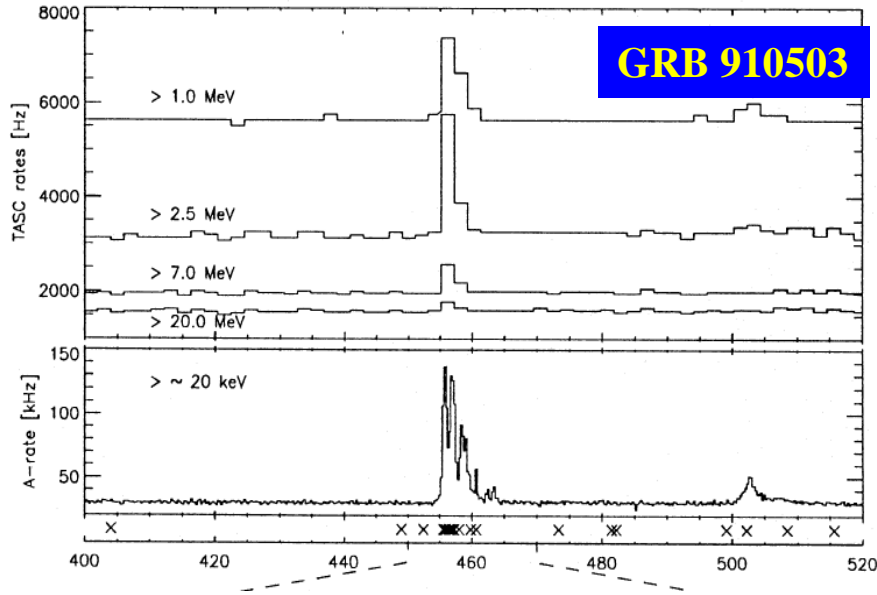
The Instruments on CGRO Cover Six Orders of Magnitude in Photon Energy



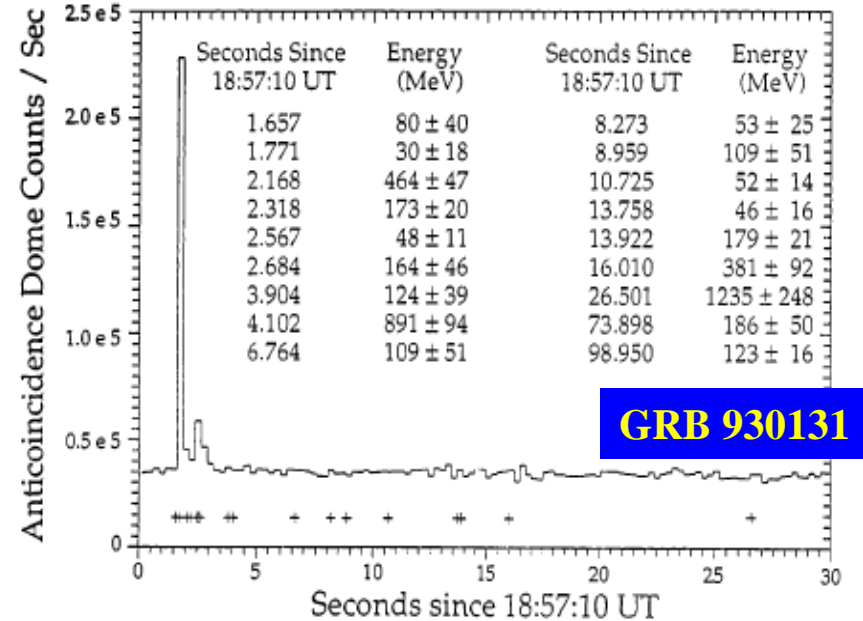
## EGRET

- 1991-2000
- 30 MeV - 30 GeV
- AGN, GRB, Unidentified Sources, Diffuse Bkg

# The EGRET heritage on GRBs



Schneid et al., 1992, A&A



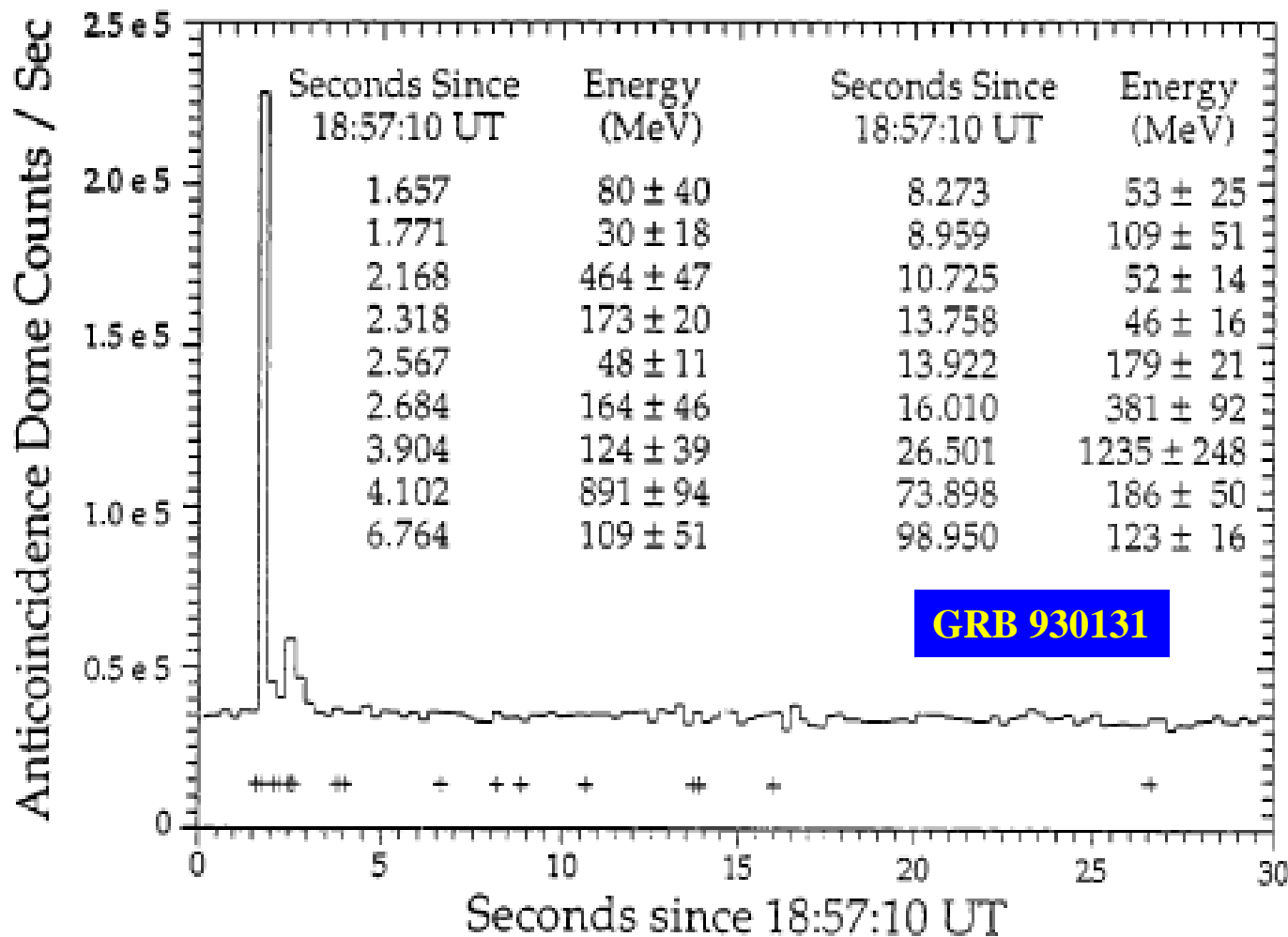
Sommer et al., 1994, ApJ

Five GRBs coincident in time with BATSE triggers were detected by EGRET above 100 MeV;

They showed both simultaneous and extended emission of gamma rays, until a few hundreds of seconds after trigger (with GRB 940217 until more than 5000 s);

In some GRBs (e. g. GRB 930131) the spectrum in 1 MeV – 1 GeV is described by the same model, others (e. g. GRB 941017) show additional components;

# The EGRET heritage on GRBs



**prompt gamma rays,  $E > 50$  MeV**

**deadtime limited**

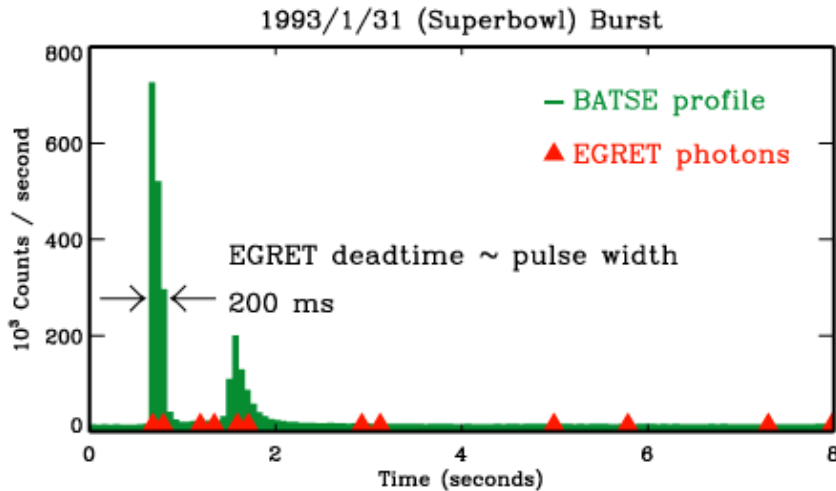
**“delayed” gamma-ray emission**

**Sommer et al., 1994, ApJ**

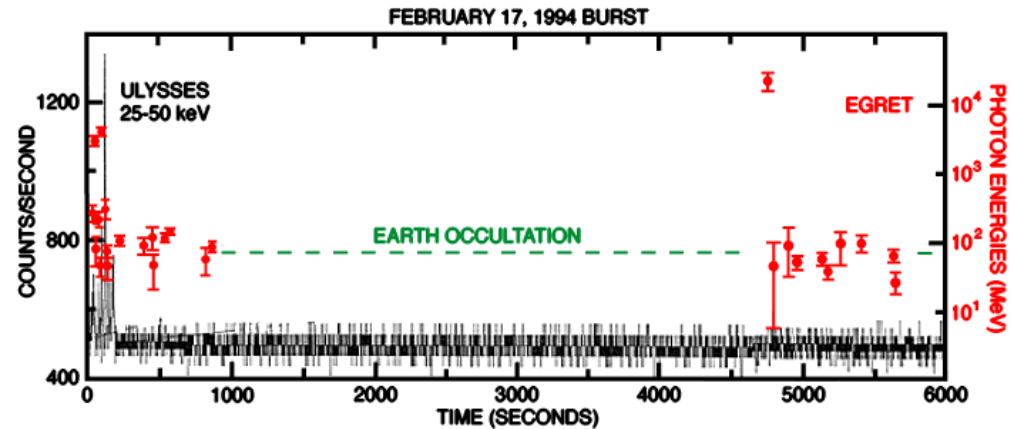
# The EGRET heritage

- Need fast timing for gamma-ray detection (improving EGRET deadtime, 100 msec → 100 microsec or less).

## Prompt Emission (GRB 930131)



## Delayed Emission (GRB 940217)



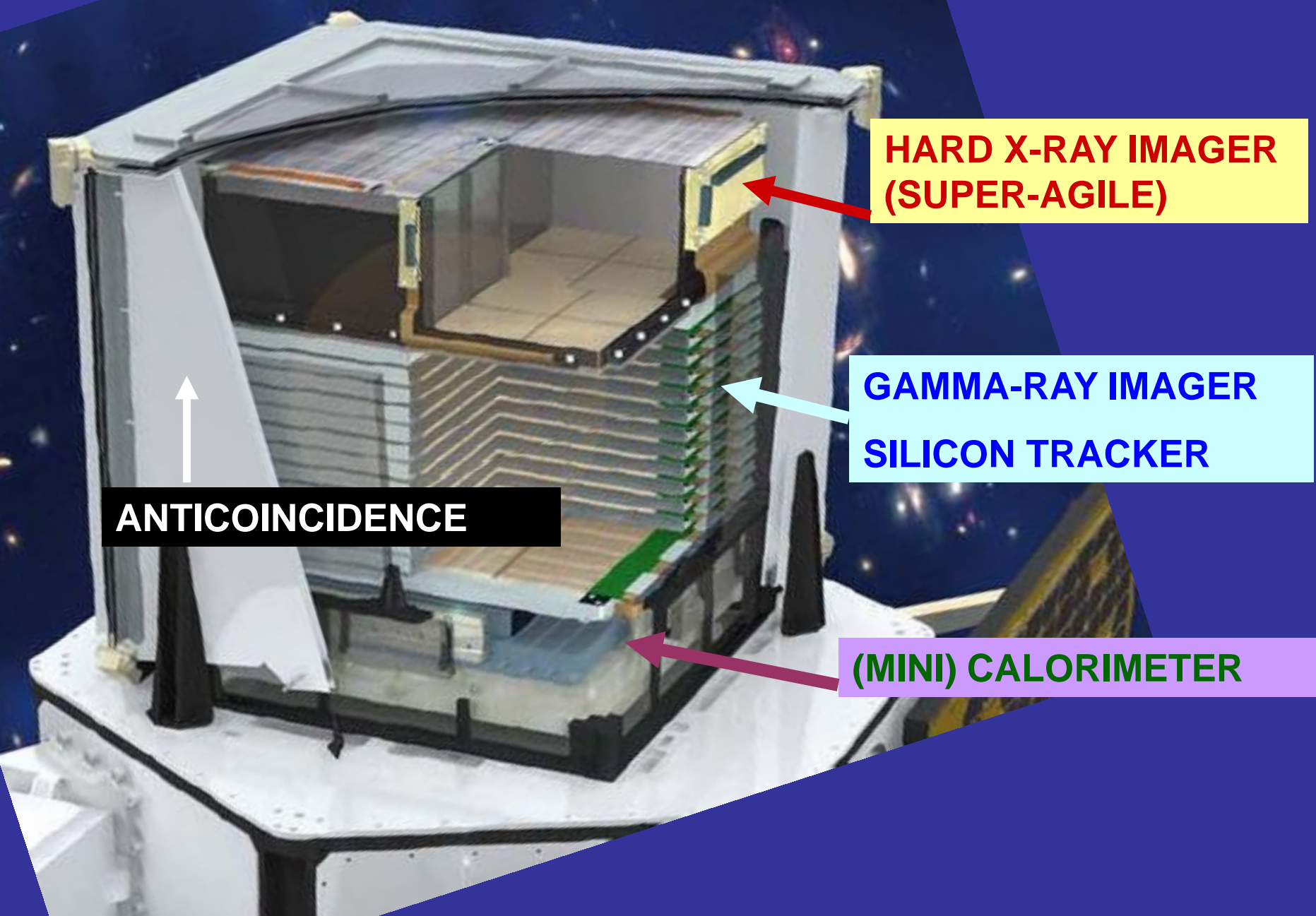




## The AGILE Payload: the most compact instrument for high- energy astrophysics

It combines for the first  
time a **gamma-ray  
imager (30 MeV- 30 GeV)**  
with a **hard X-ray  
imager (18-60 keV)** with  
large FOVs (1-2.5 sr) and  
optimal angular  
resolution

# AGILE: inside the cube...



**HARD X-RAY IMAGER  
(SUPER-AGILE)**

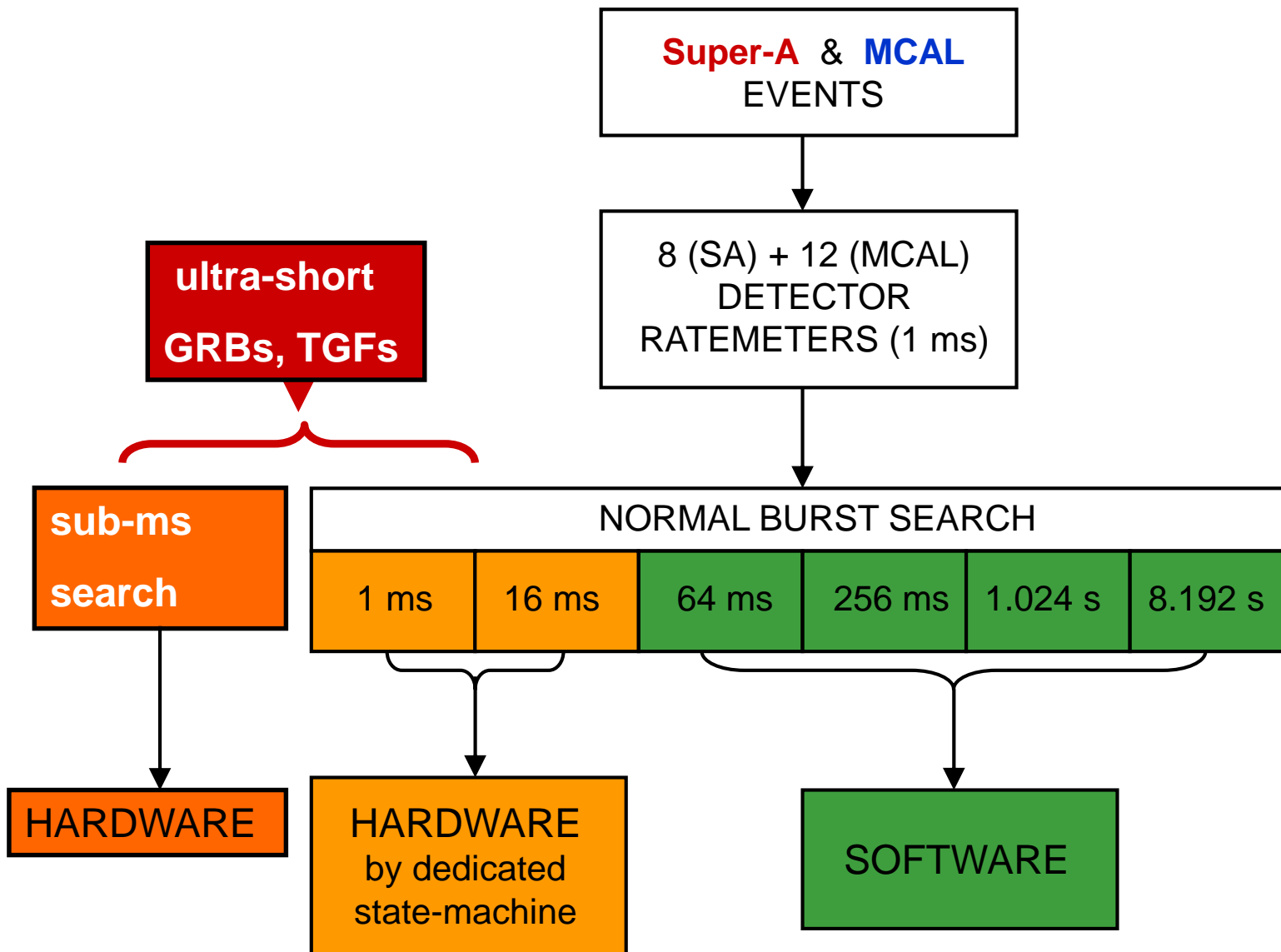
**GAMMA-RAY IMAGER  
SILICON TRACKER**

**ANTICOINCIDENCE**

**(MINI) CALORIMETER**



# AGILE GRB ON-BOARD SEARCH PROCEDURE

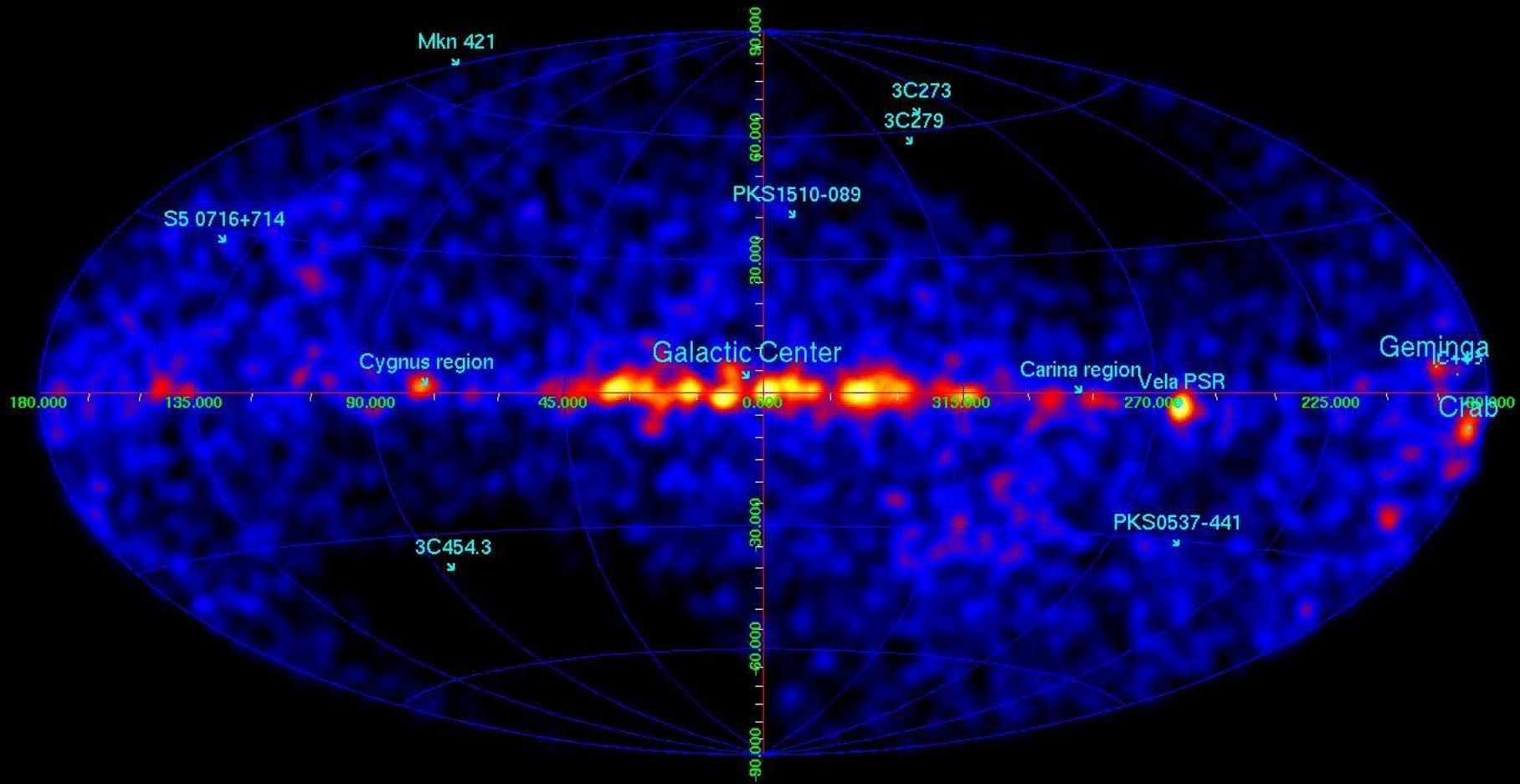




**Gamma-ray sky  
on-line with the APP  
AGILEScience  
(iPhone and Android)**

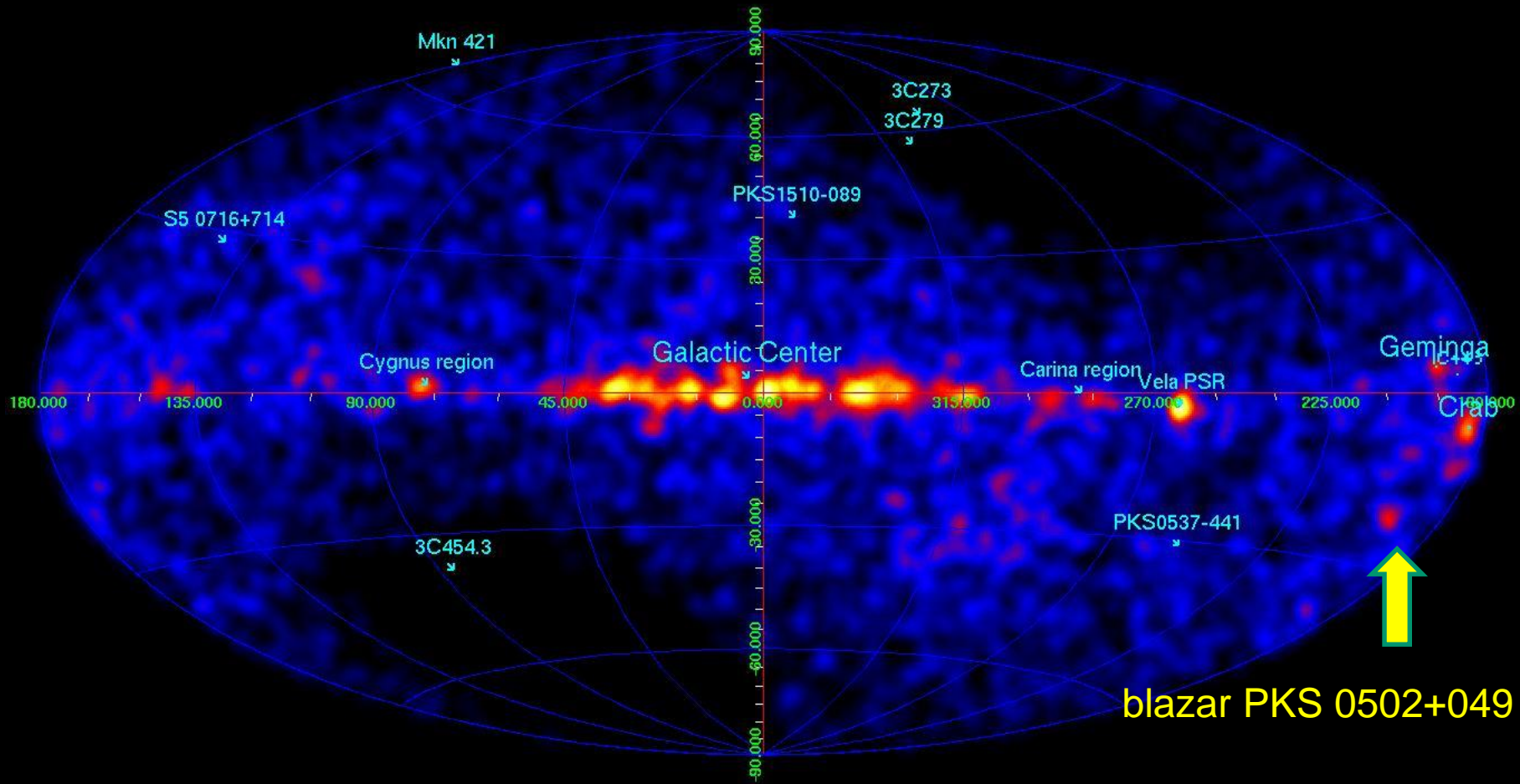
# AGILE gamma-ray sky, Sept. 20, 2014

(counts map,  $E > 100$  MeV)



# AGILE gamma-ray sky, Sept. 20, 2014

(counts map,  $E > 100$  MeV)



blazar PKS 0502+049



TIM 3G

59% 

15:45

mercoledì 10 settembre

**AGILEScience**



ATEL 6457: AGILE detects enhanced gamma-ray emission from the FSRQ PKS 0502+049

**ATEL and GCNs very fast notification with the APP AGILEScience (iPhone and Android)**



slide to unlock



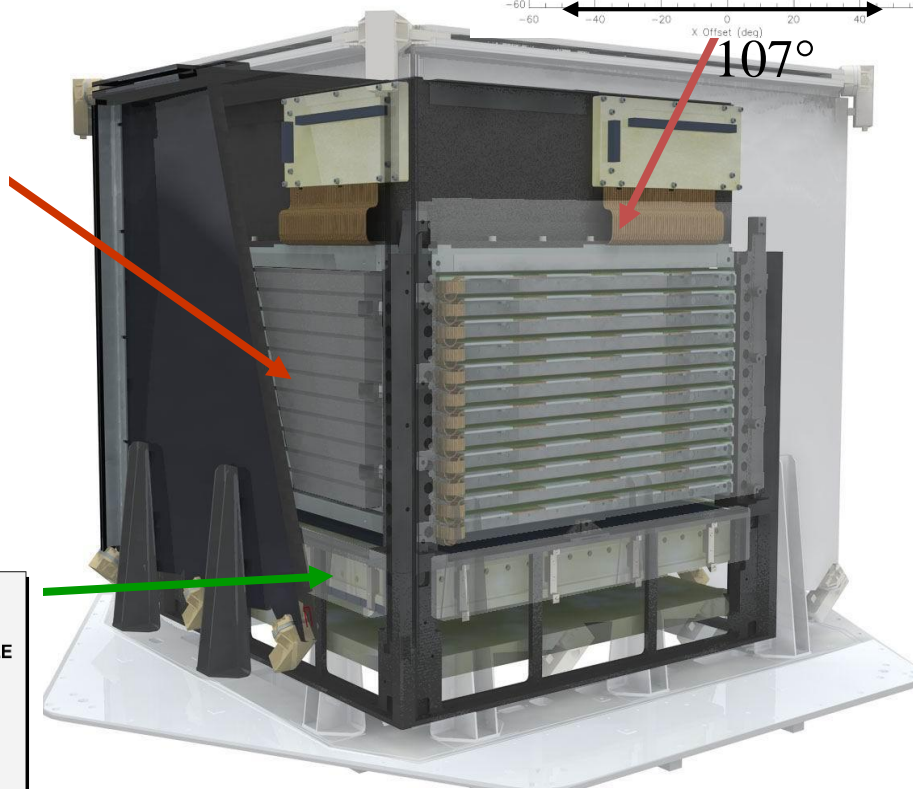
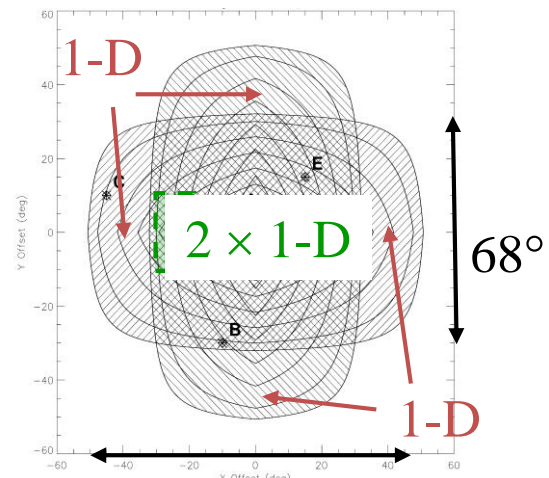
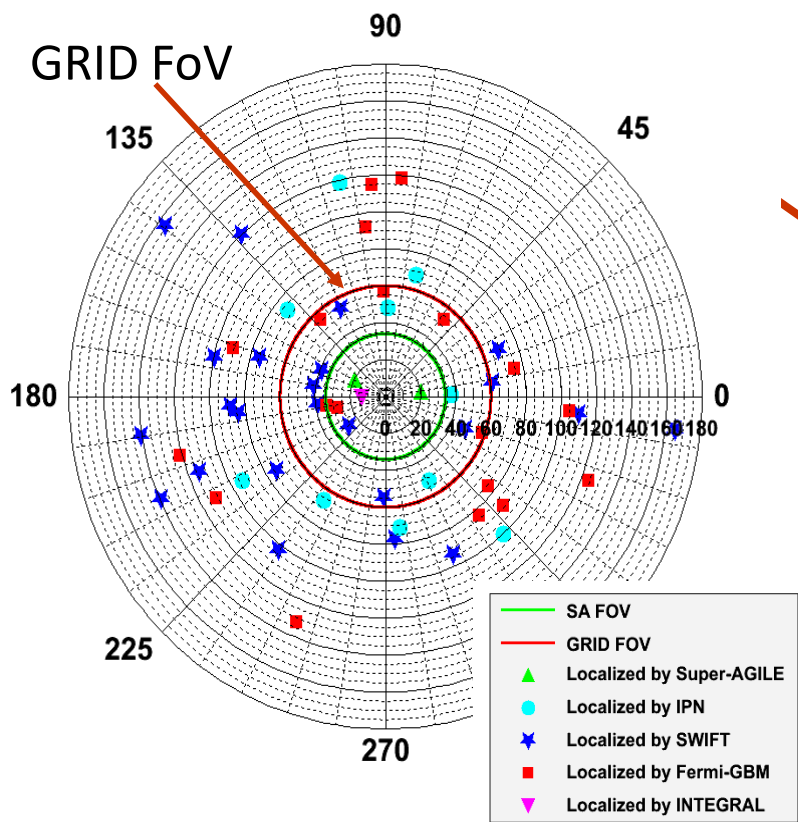


## expectations on GRBs above 100 MeV...

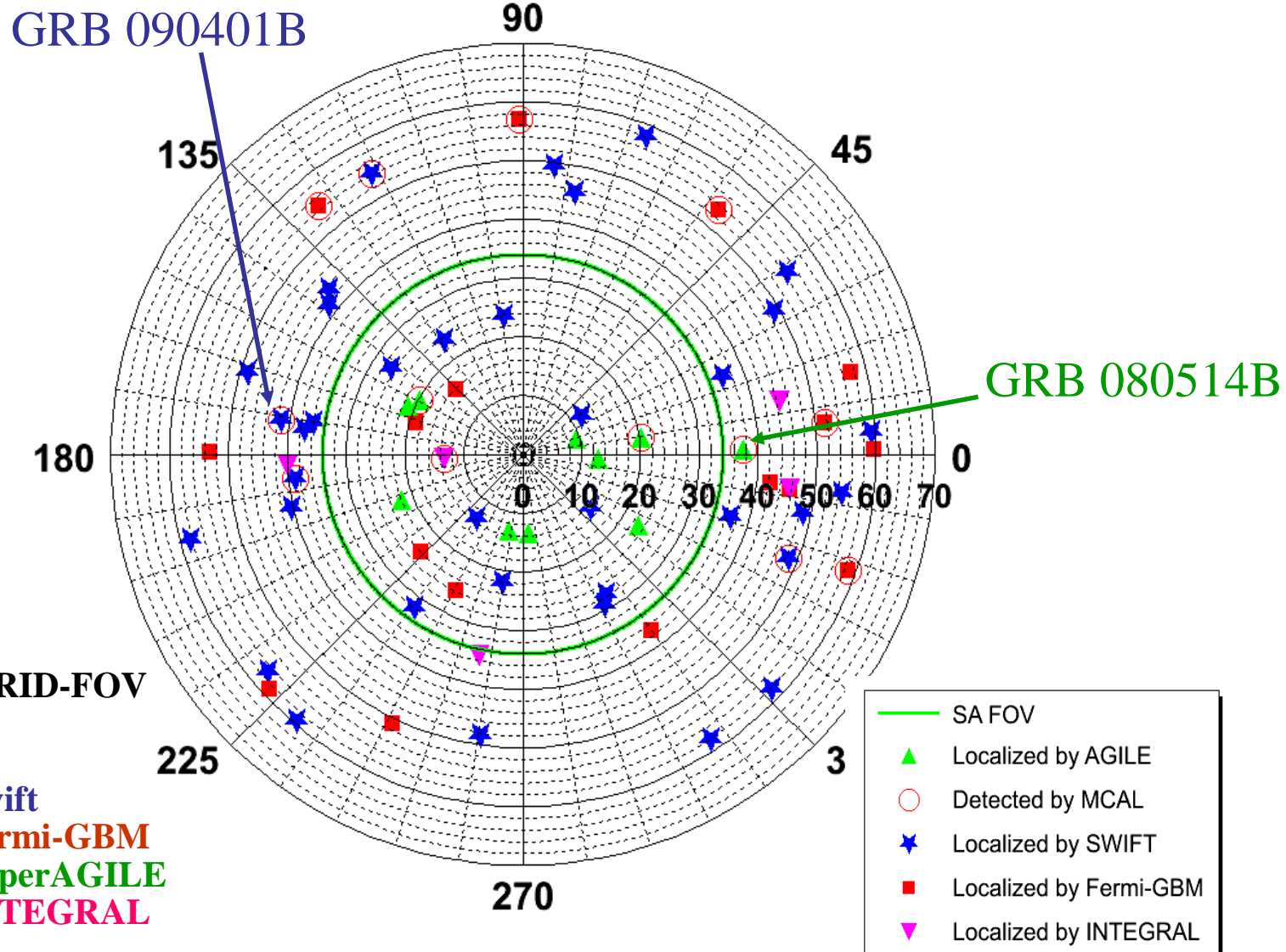
- EGRET detected **ALL bright GRBs** in its FOV (0.5 sr), 5 GRBs in 6 years.
- for a FOV  $\sim 2.5$  sr **naively** expect AGILE detection 4-5 times more than EGRET: a few / year.
- **not true.**

# AGILE and GRBs

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



# The AGILE GRB 2-year dataset (detections & upper limits)



**77 GRBs in the GRID-FOV  
until June 2009:**

**40 localized by Swift**

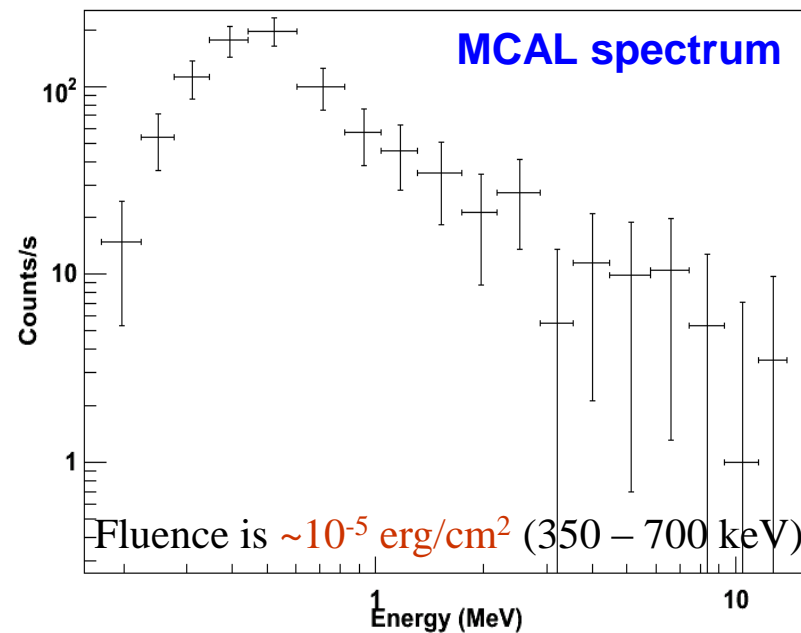
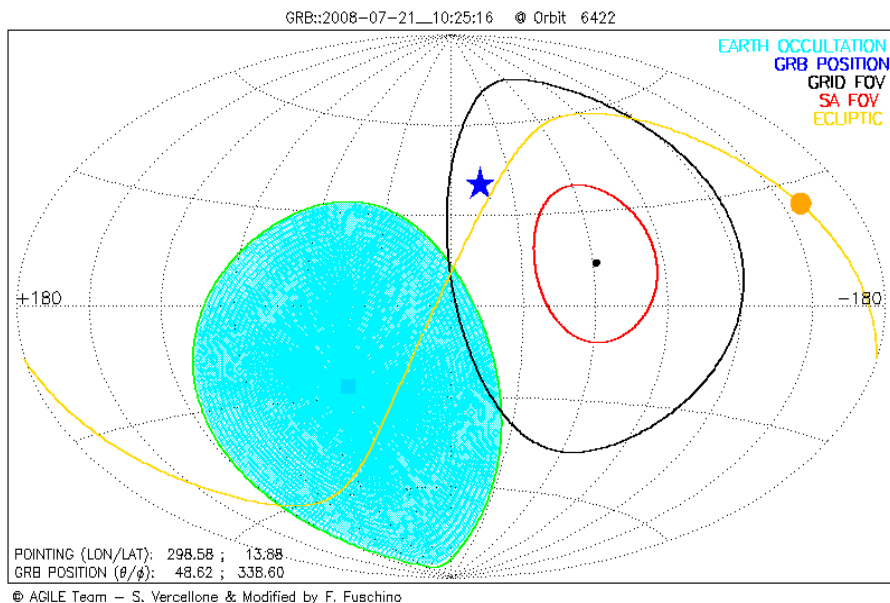
**20 localized by Fermi-GBM**

**15 localized by SuperAGILE**

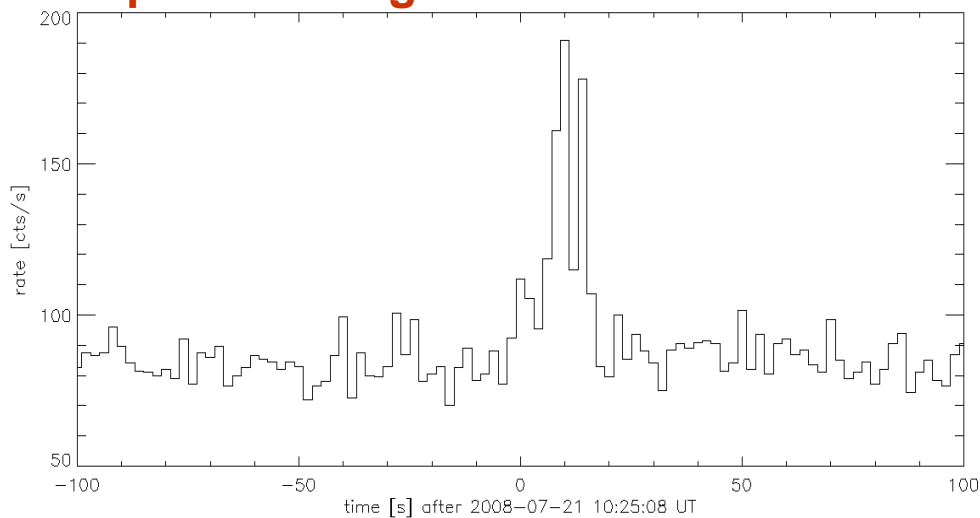
**5 localized by INTEGRAL**

**15 also detected by MCAL (strong)**

# GRB 080721



## SuperAGILE lightcurve



Off-axis  $\sim 49^\circ$

fluence  $8 \times 10^{-5}$  erg/cm<sup>2</sup>  
(20 keV – 5 MeV);

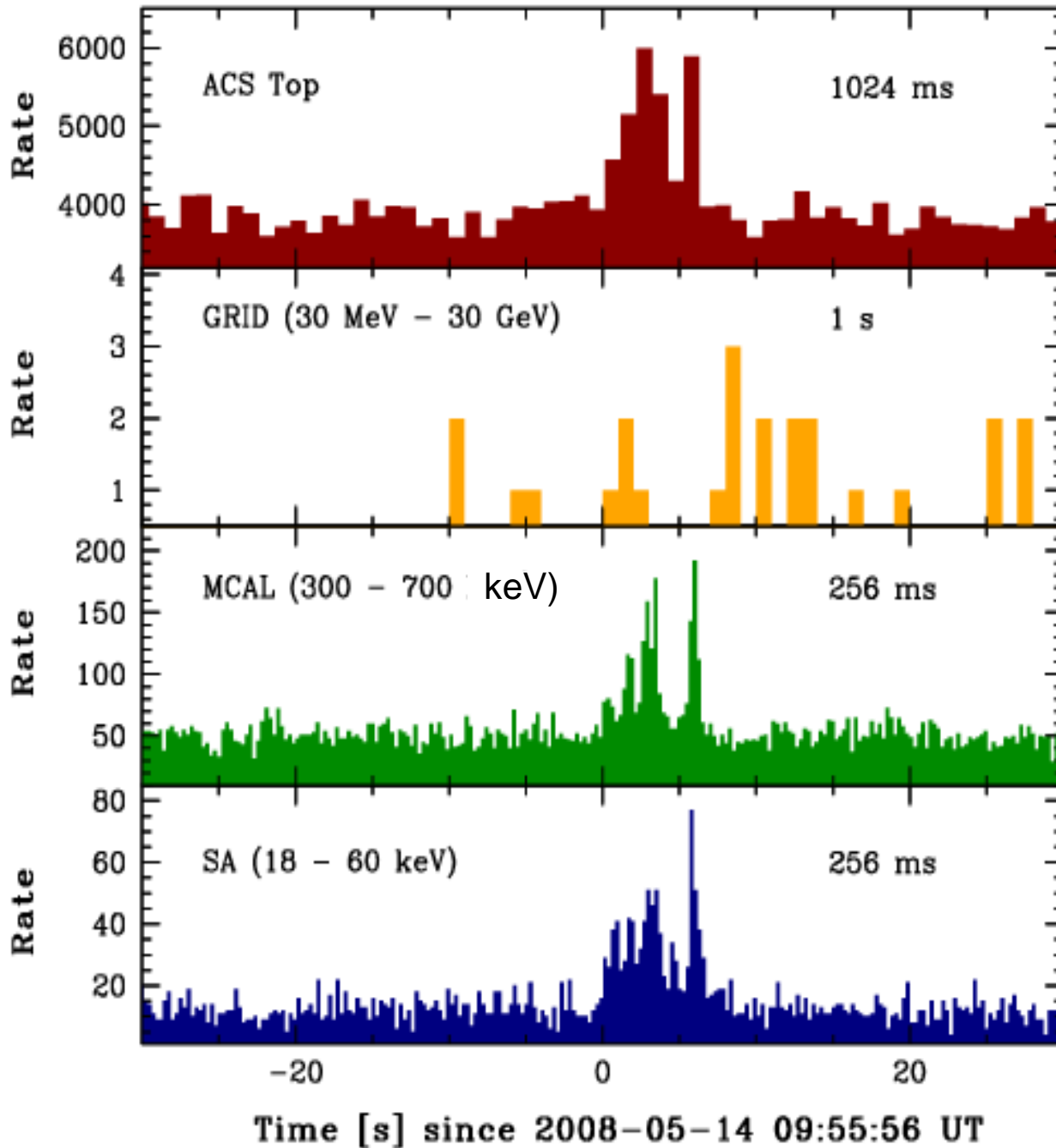
$E_{\text{peak}}$  485 keV  
(Konus-Wind, GCN 7995);

redshift 2.6 (GCN 7997);

# GRB

## 080514B

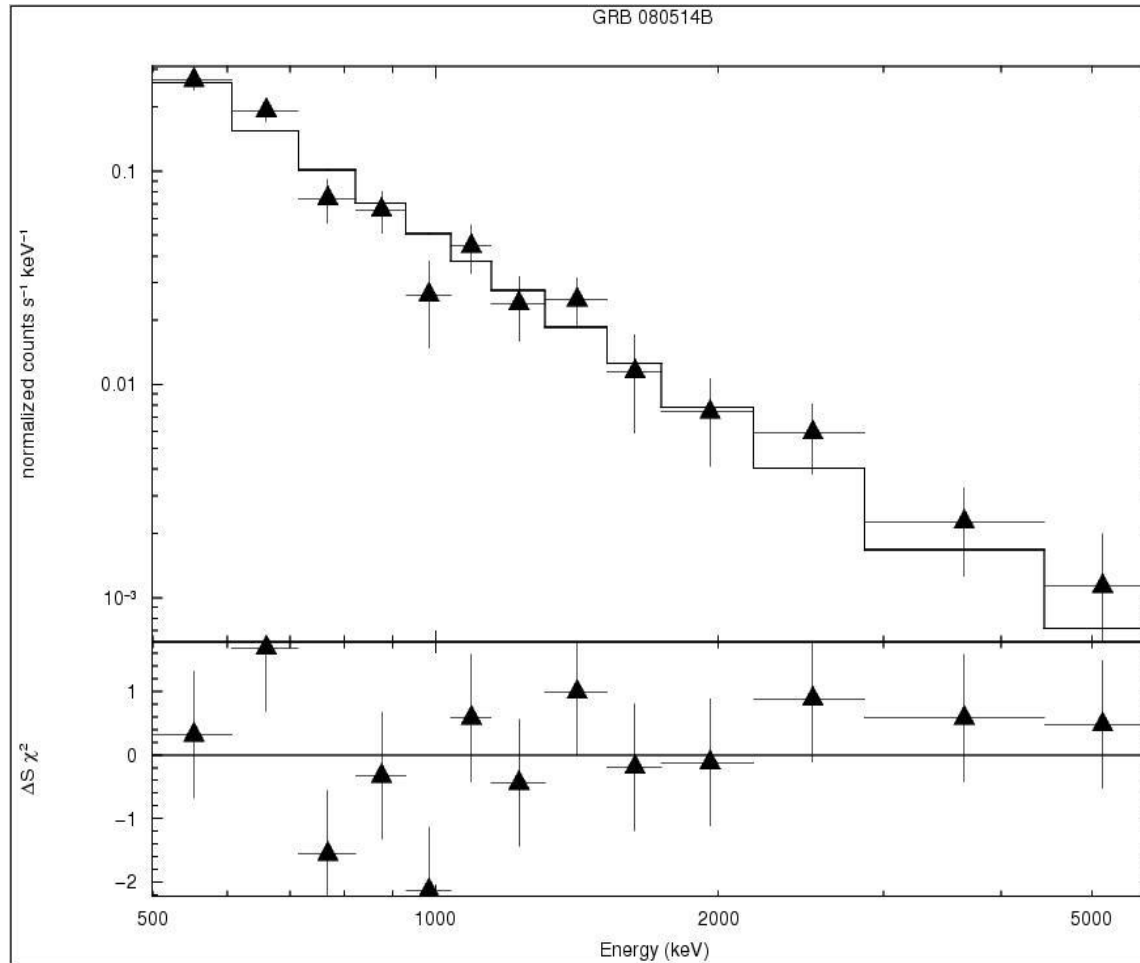
(Giuliani et al. 2009  
A&A, 491, L25;  
[arXiv:0809.1230](https://arxiv.org/abs/0809.1230))



**the first GeV-  
bright GRB after  
EGRET**, associated  
with an afterglow with  
photometric redshift  
of 1.8 (A. Rossi et al.,  
2009, A&A).

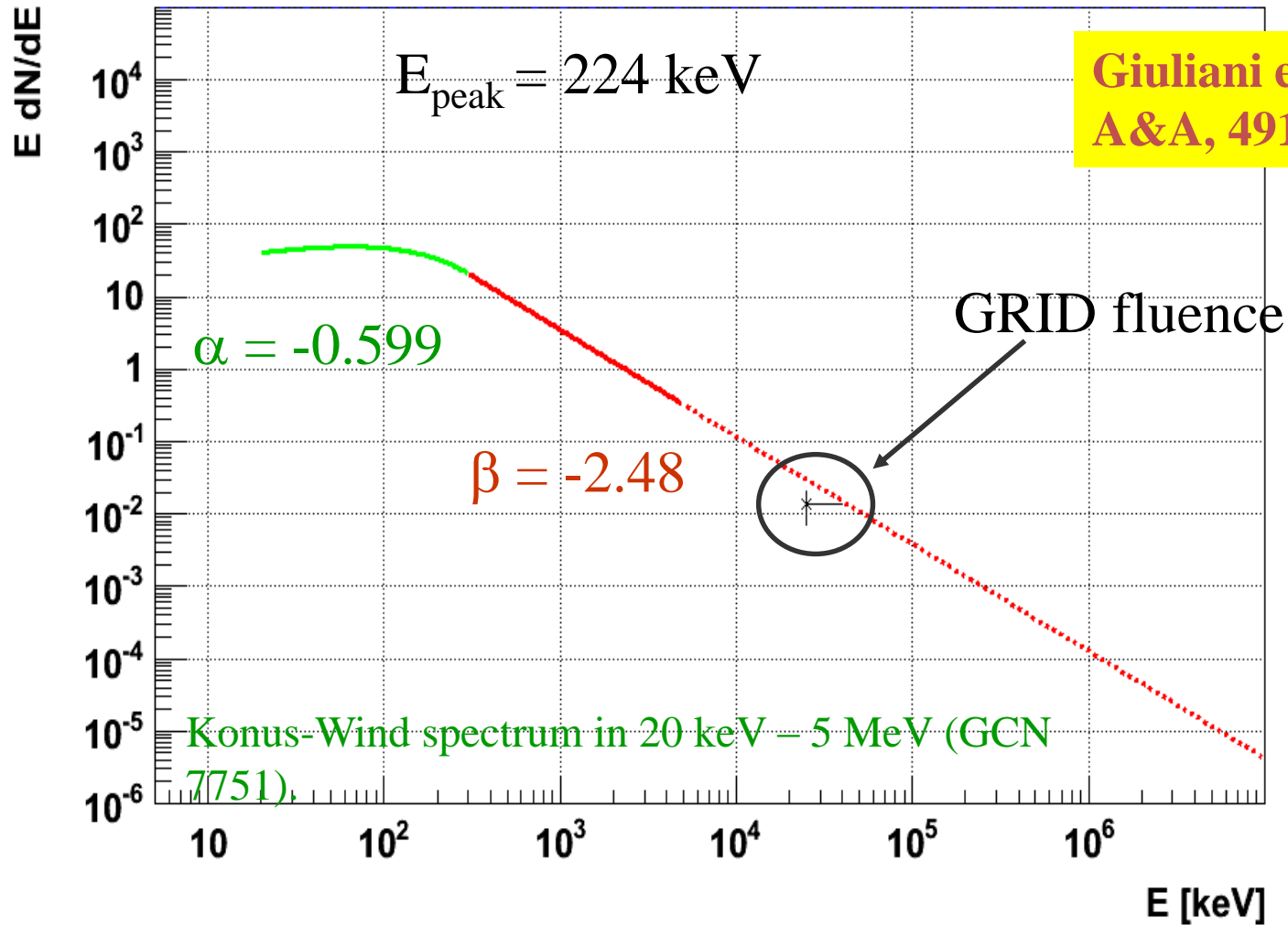


# MCAL spectrum of GRB 080514B



70% the fluence of Konus in the range 0.5-5 MeV  
beta  $\sim 2.4$ , in agreement with the Konus value

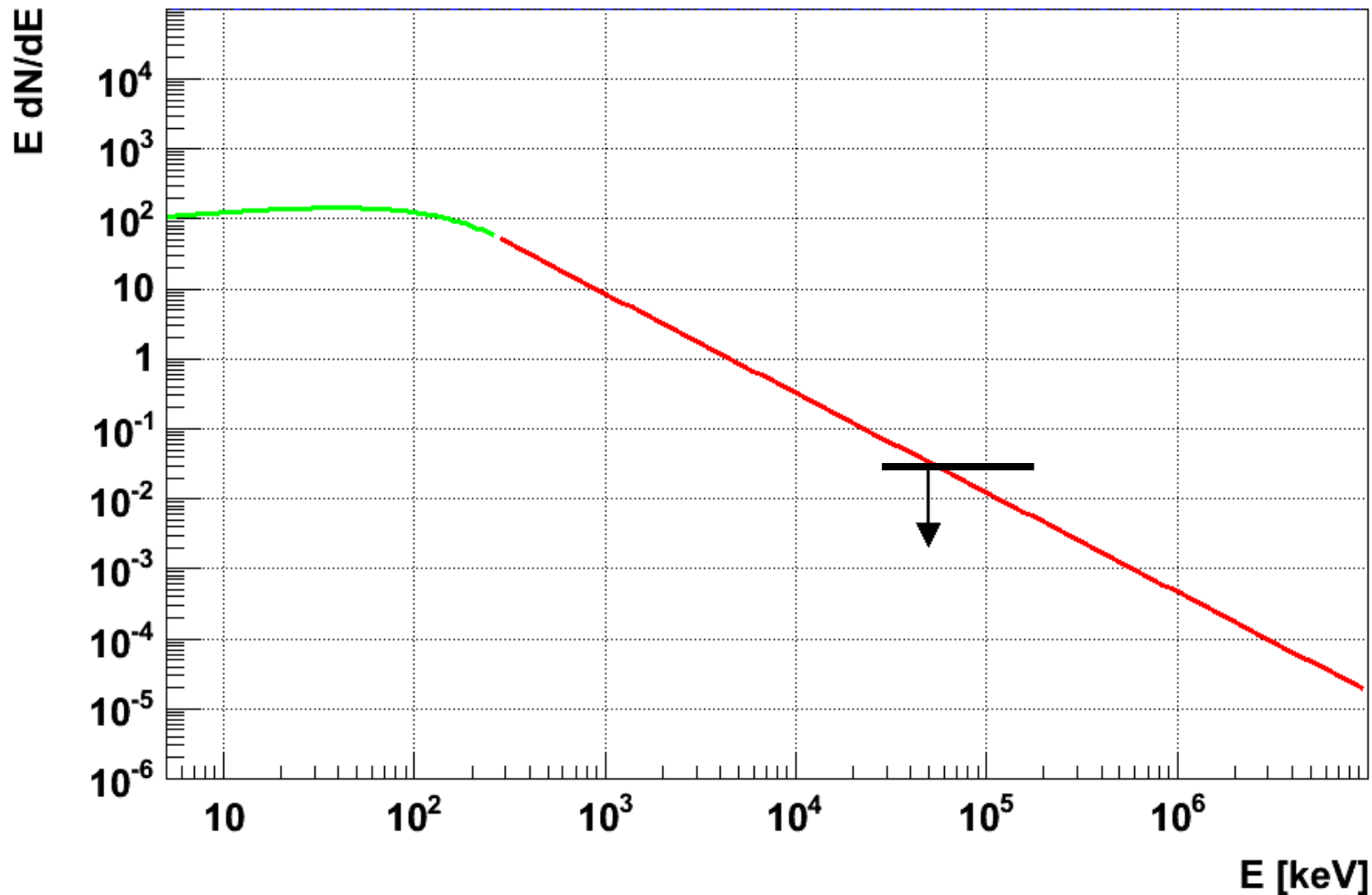
# a single Band model seems to fit the whole spectrum of GRB 080514B



The same Band model fits the spectrum from 20 keV up to 50 MeV.

# but also many non-detections above 100 MeV: AGILE-GRID upper limits

grb080723B/GCN8015: normalization  $A = 0.023 \text{ keV}^{-1}\text{cm}^{-2}\text{s}^{-1}$



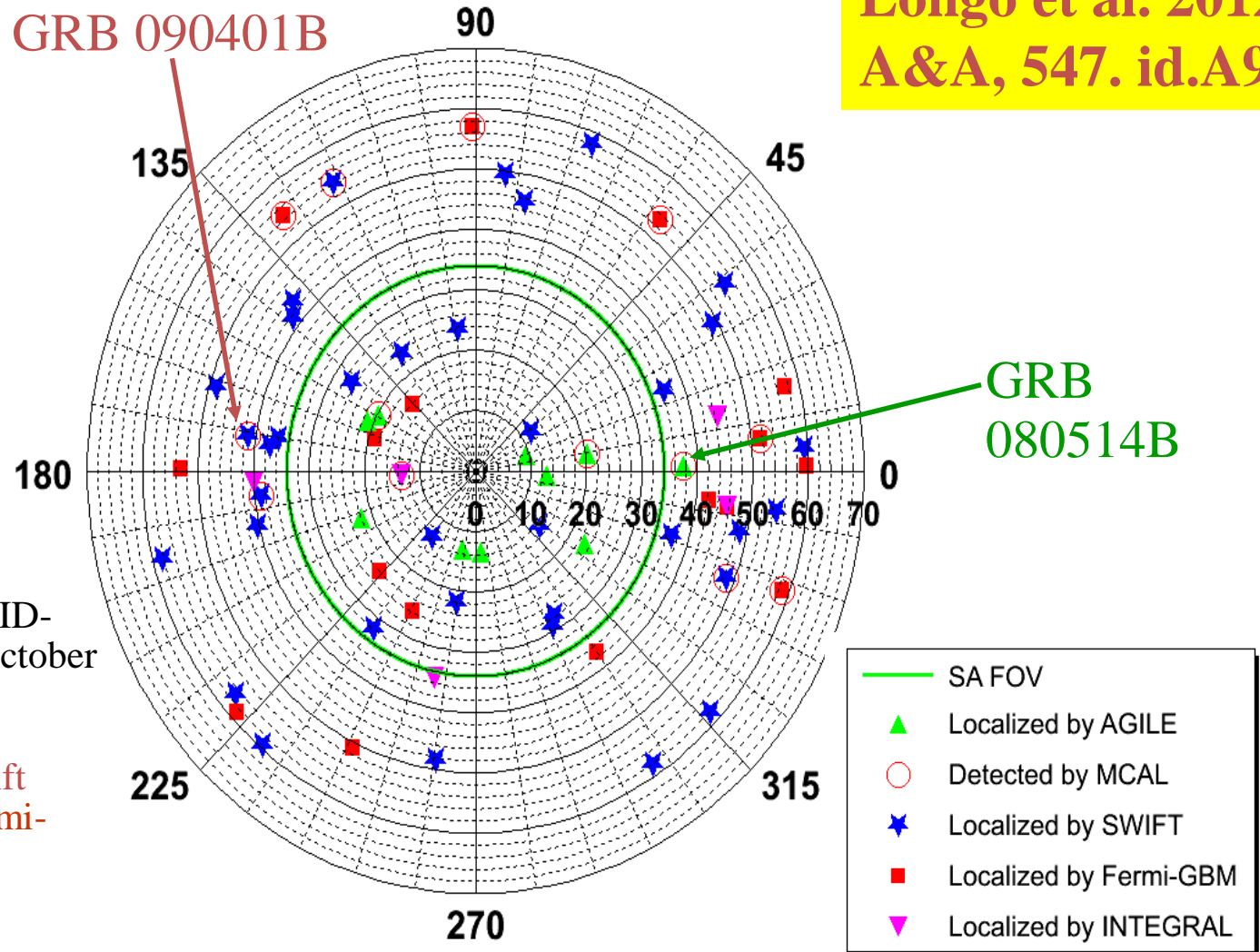
# GRB upper limits in gamma-rays: the results

Longo et al. 2012,  
A&A, 547. id.A95

- The Upper Limits are estimated with a Bayesian approach for a sample of 68 undetected GRBs from July 2007 until October 2009 with position inside the GRID FoV;
- 40 GRBs have spectral information (from Konus-Wind, Suzaku/WAM and Fermi/GBM), that is used to convert counts into flux;
- In six cases the Upper Limit is stringent with respect to the extrapolation of the GRB spectrum at lower energy;
- The corresponding 3 sigma upper limit is  $\sim 0.03 \text{ ph cm}^{-2} \text{ s}^{-1} \Rightarrow \sim 10^{-7} \text{ erg cm}^{-2} \text{ s}^{-1}$ ;
- A likelihood search of gamma-ray delayed components (up to 3600 s after trigger) for the same events does not give positive results;
- The detection rate of GRBs by AGILE/GRID is discussed and it is found that AGILE observes on average the same population as EGRET.

# Upper limits in gamma rays: the sample

Longo et al. 2012,  
A&A, 547. id.A95



68 GRBs in the GRID-FOV July 2007 – October 2009:

36 localized by Swift  
17 localized by Fermi-GBM

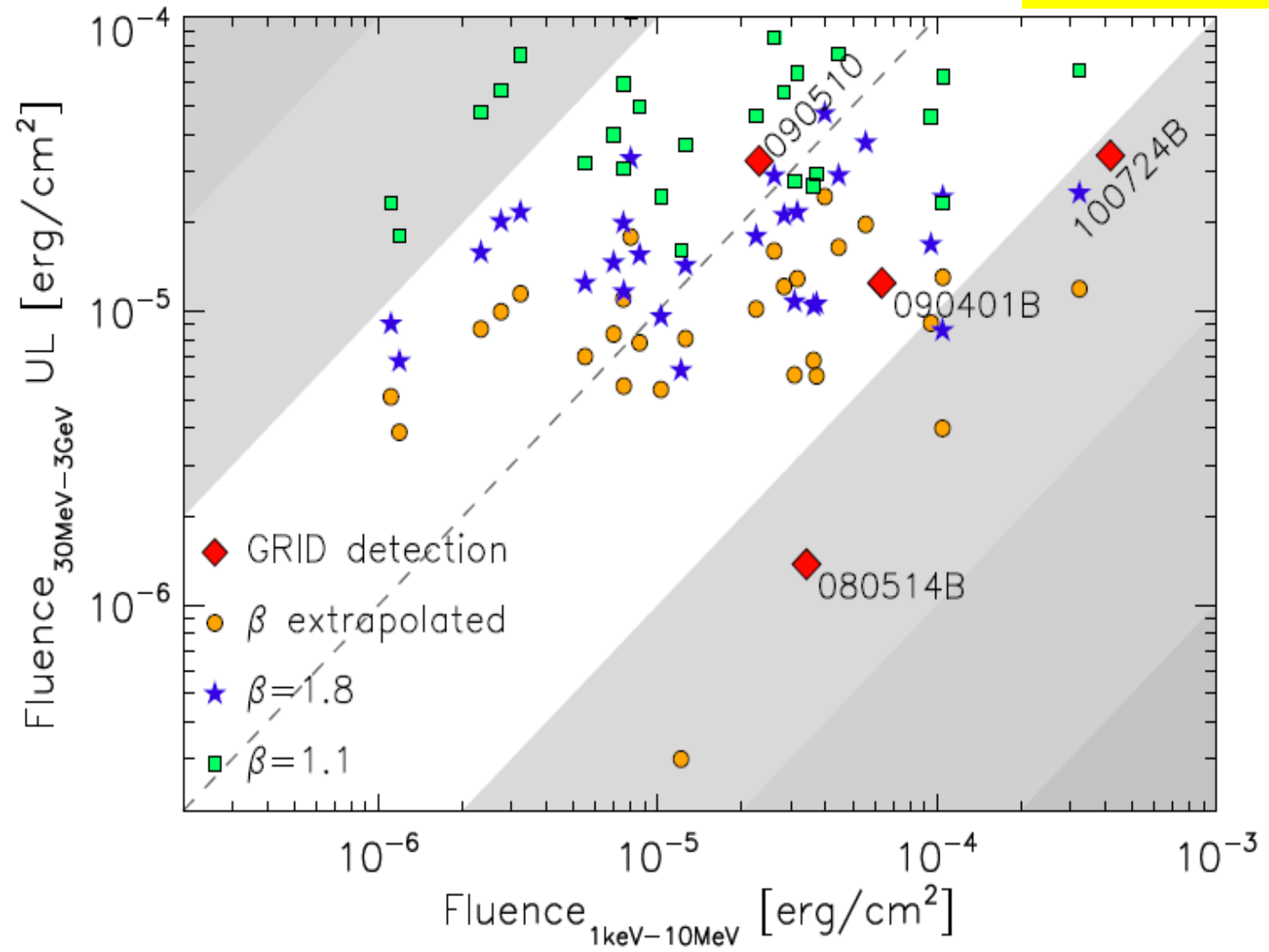
10 localized by SuperAGILE

5 localized by INTEGRAL



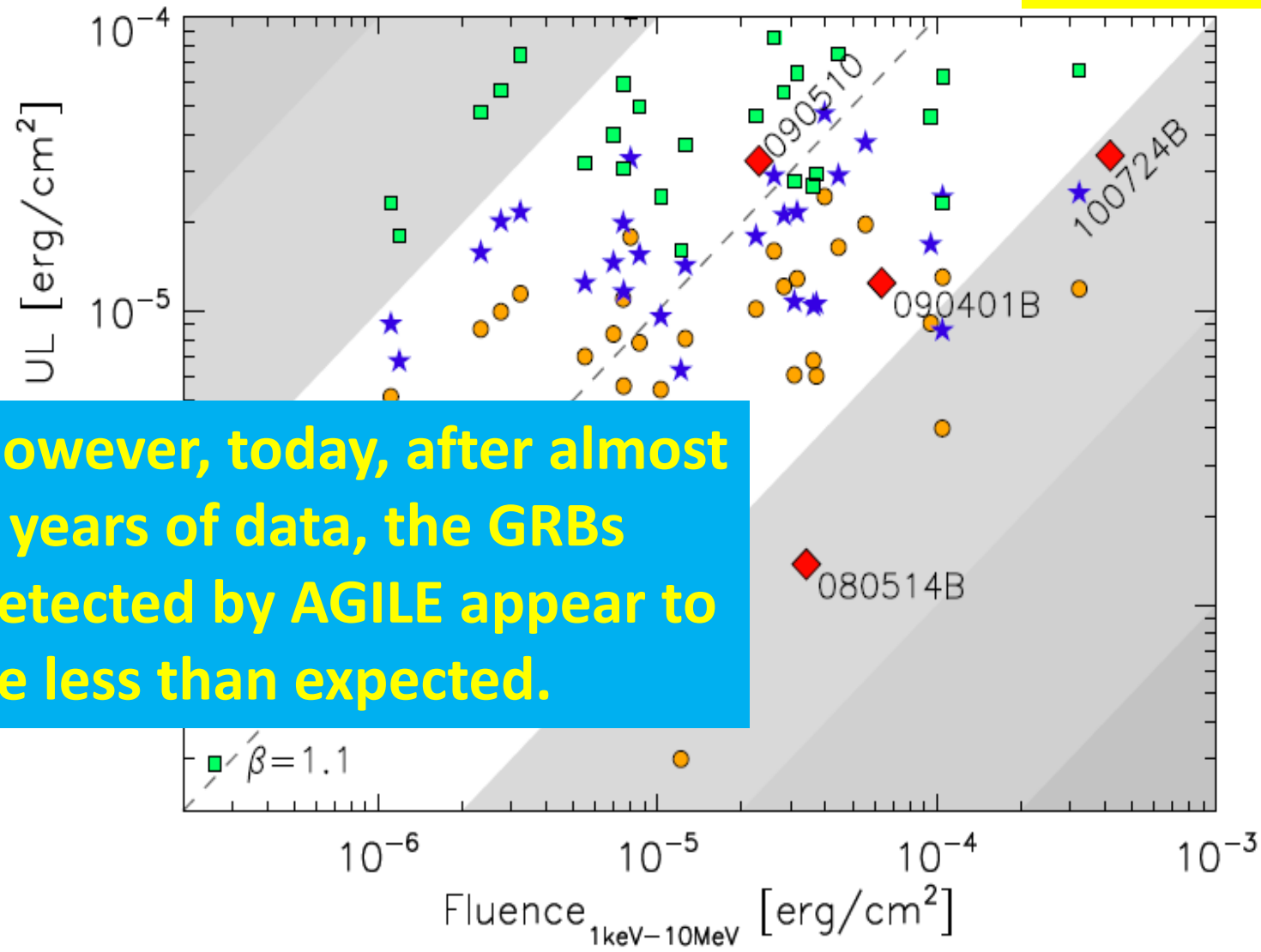
# GeV emitting GRBs tend to be high-fluence events (2-year sample)

Longo et al. 2012,  
A&A, 547. id.A95



# GeV emitting GRBs tend to be high-fluence events (2-year sample)

Longo et al. 2012,  
A&A, 547. id.A95

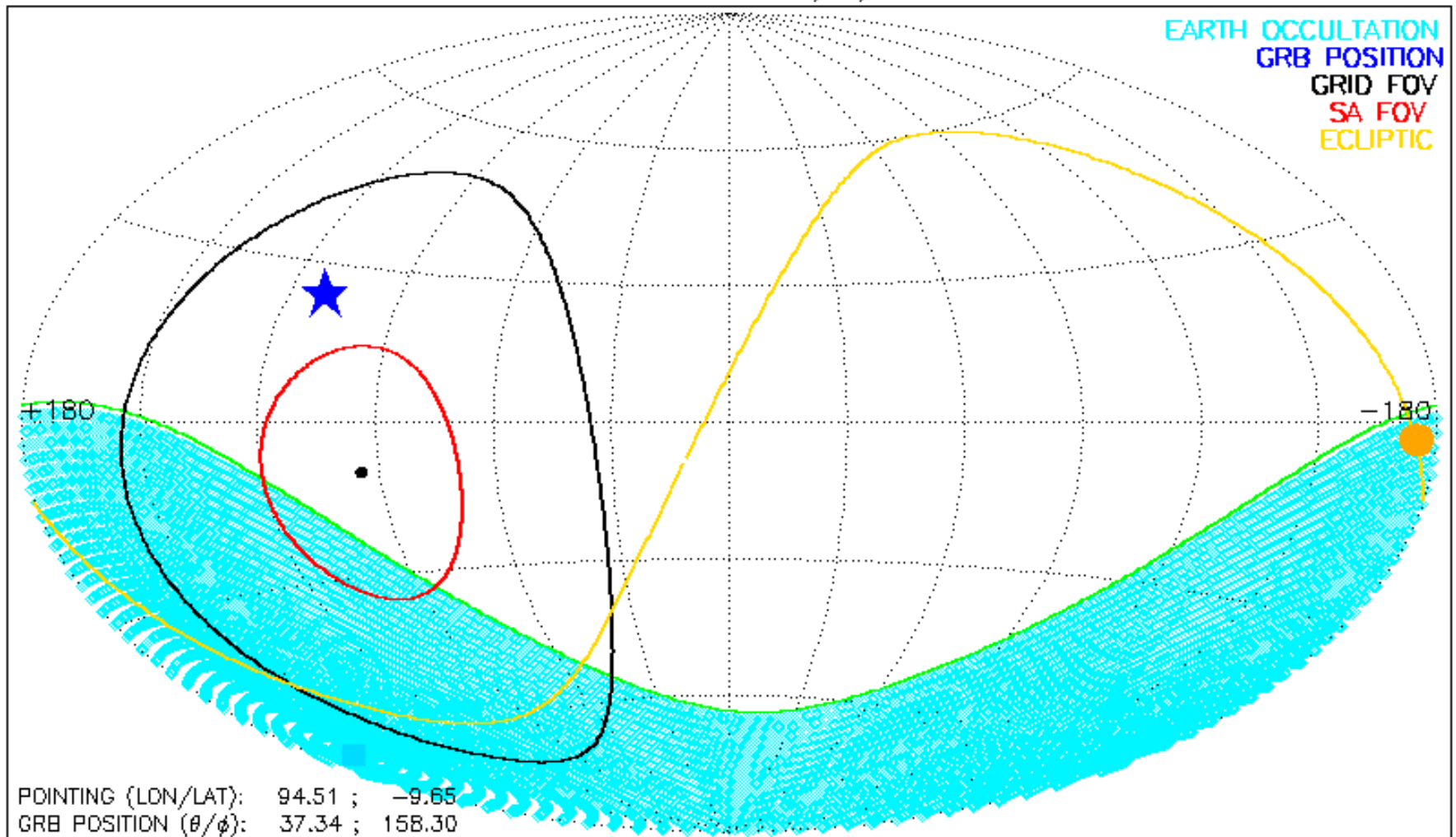


However, today, after almost 8 years of data, the GRBs detected by AGILE appear to be less than expected.

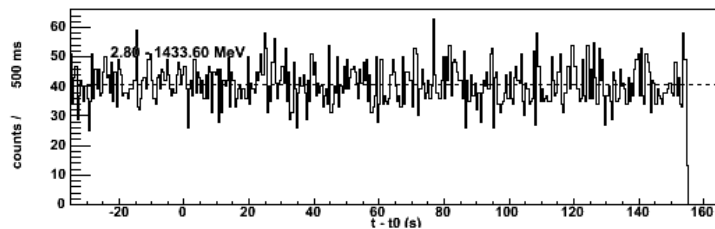
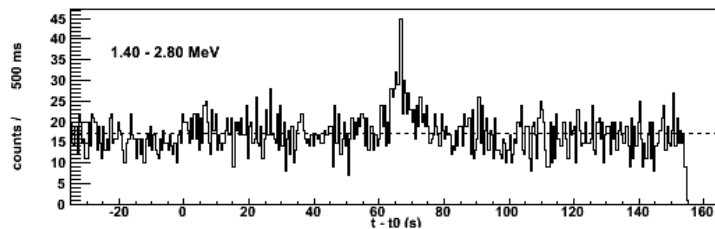
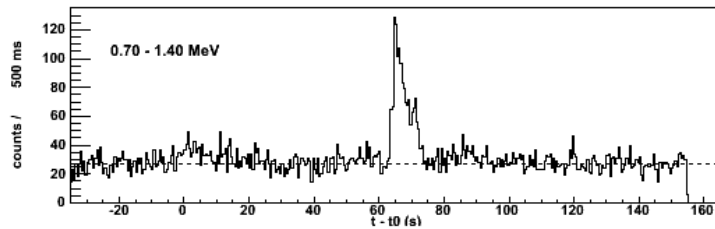
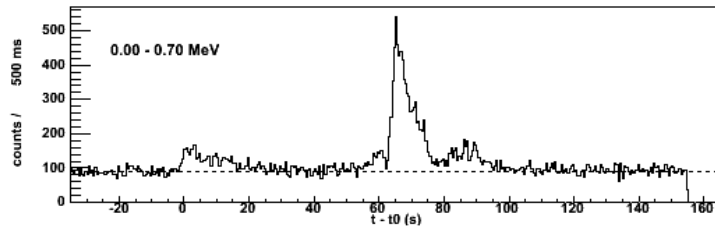
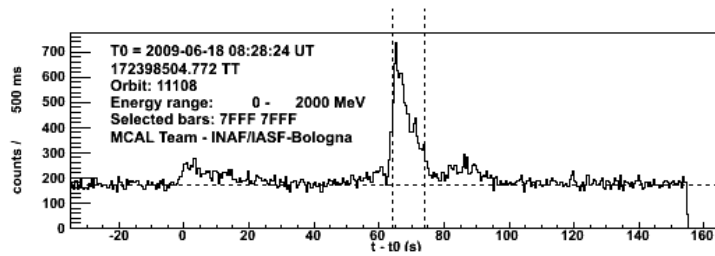
**AGILE  
and  
GRB 090818**

$z = 0.54$

\*\*\*TEMPORARY MAP\*\*\* GRB::2009/06/18 08:28:29

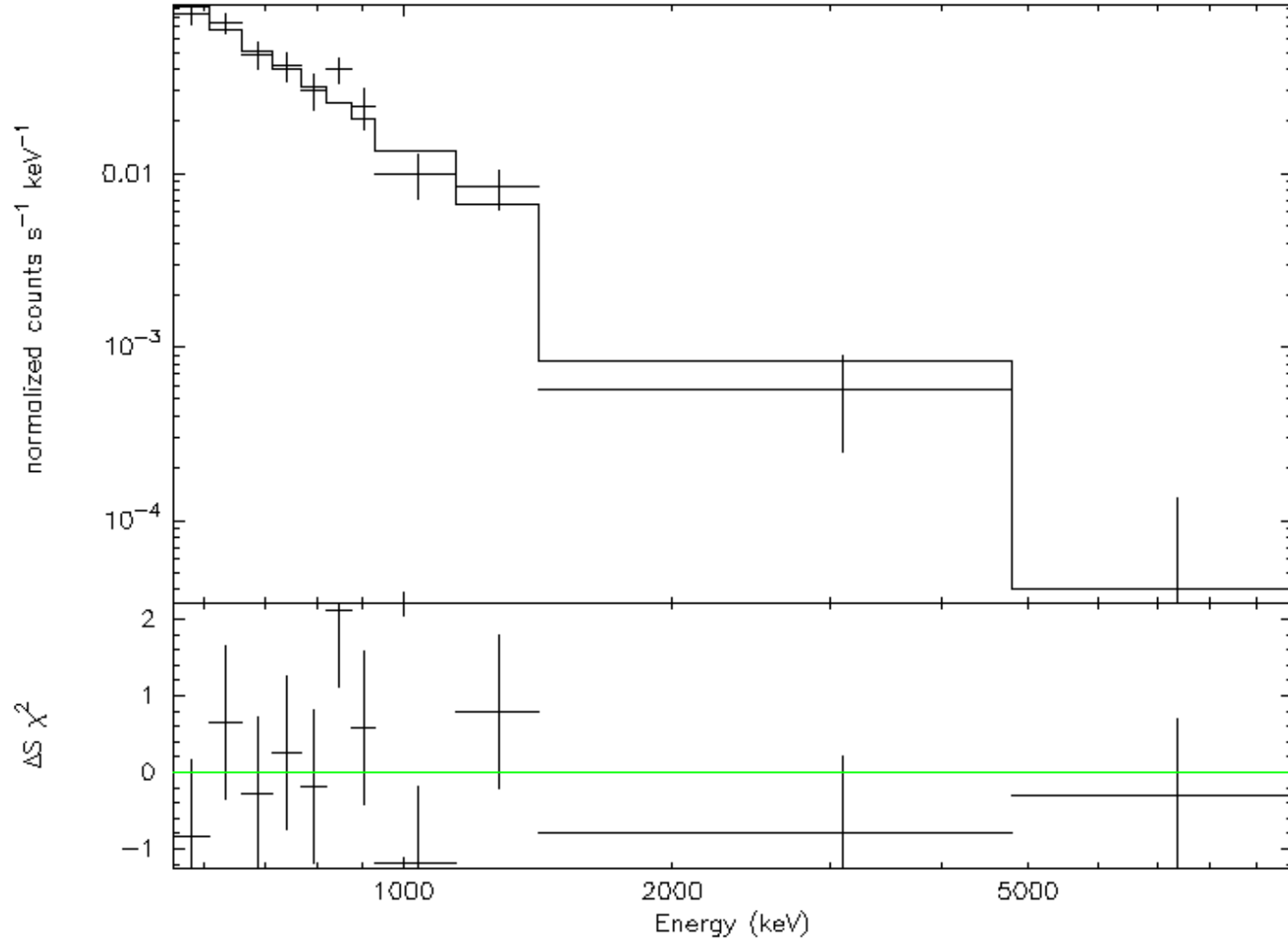


© AGILE Team - S. Vercellone & Modified by F. Fuschino



**GRB 090818: among the  
brightest GRBs detected  
at MeV energies by  
AGILE MCAL**

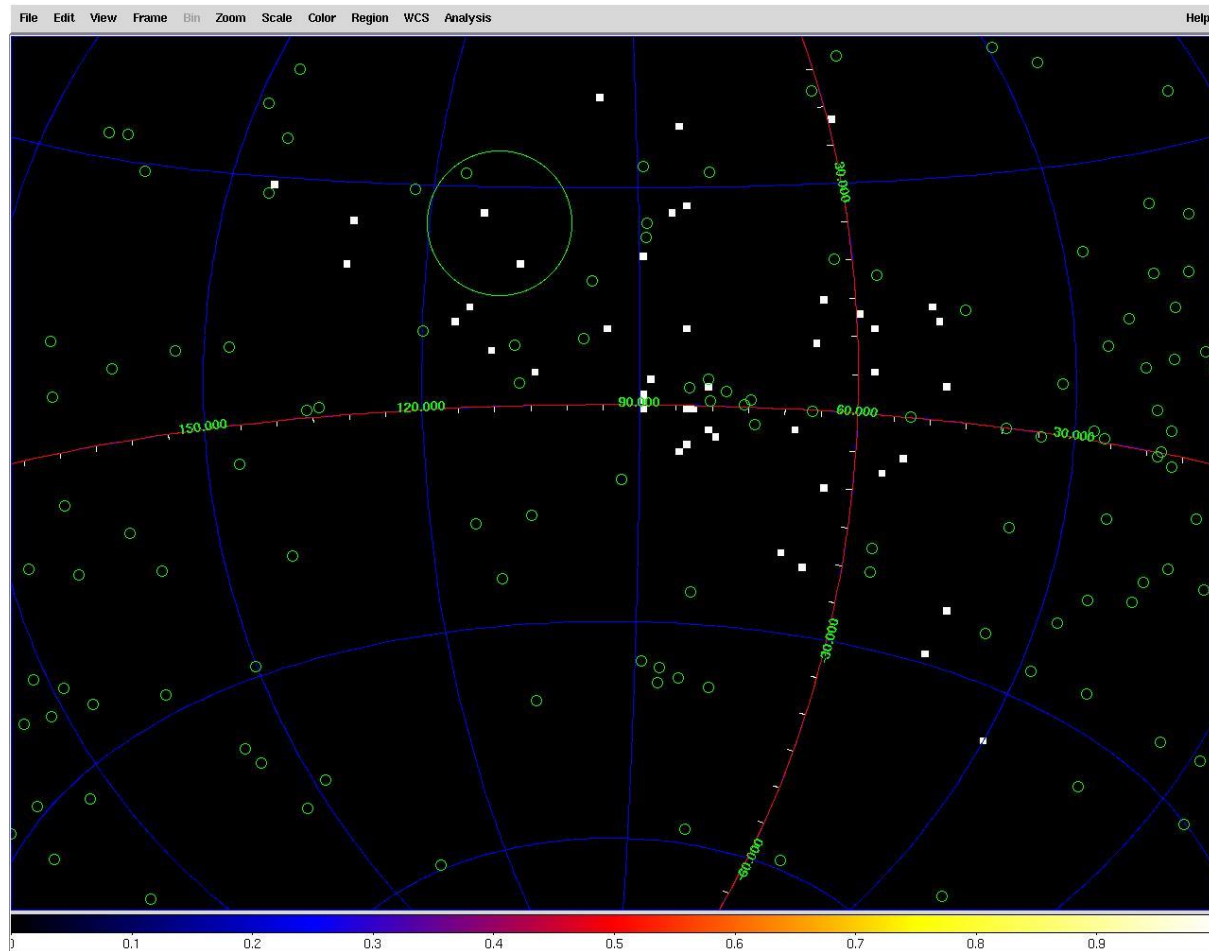
data and folded model





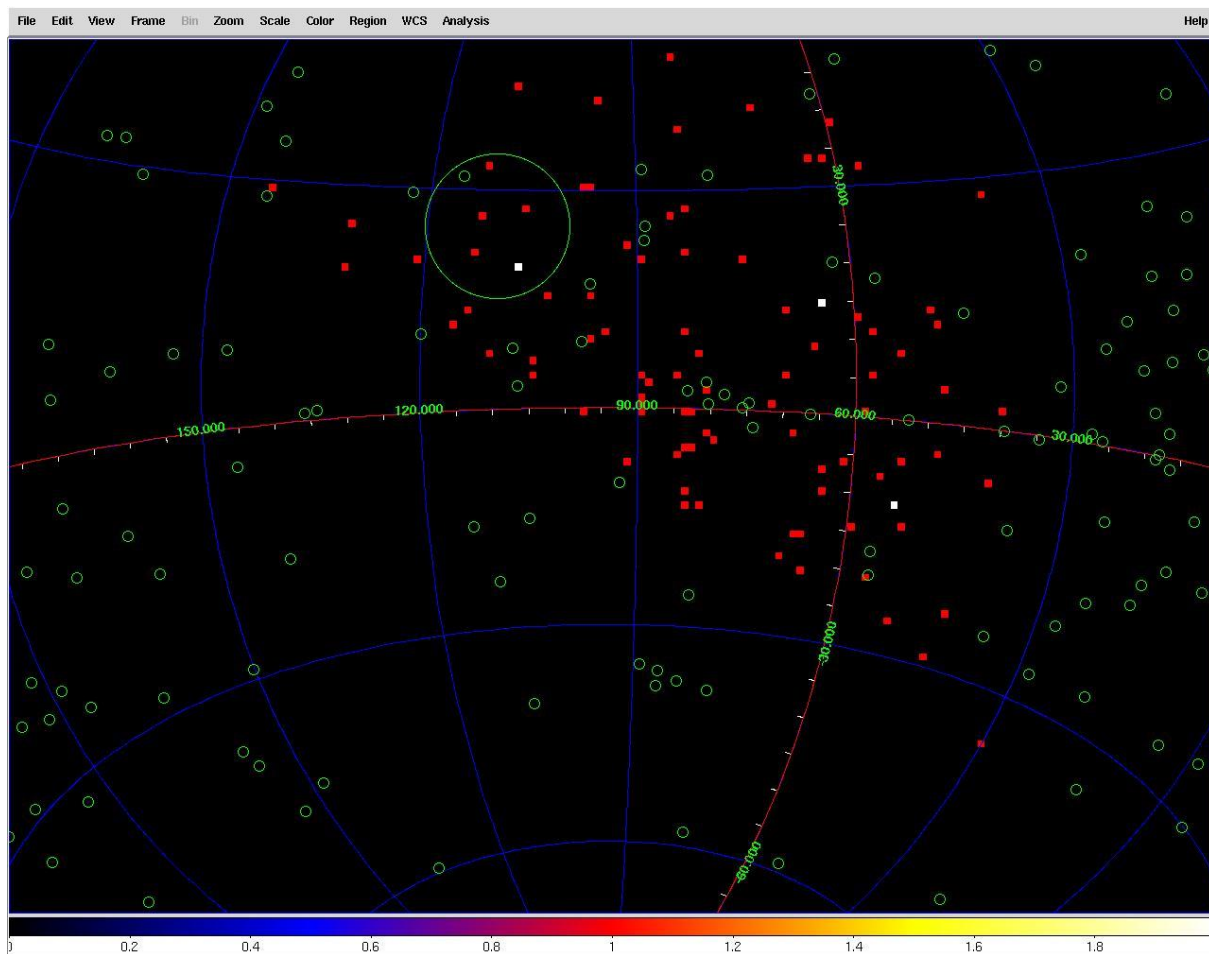
# GRID, FT, G+L+S

**T = t<sub>0</sub>** , deltaT=30 sec



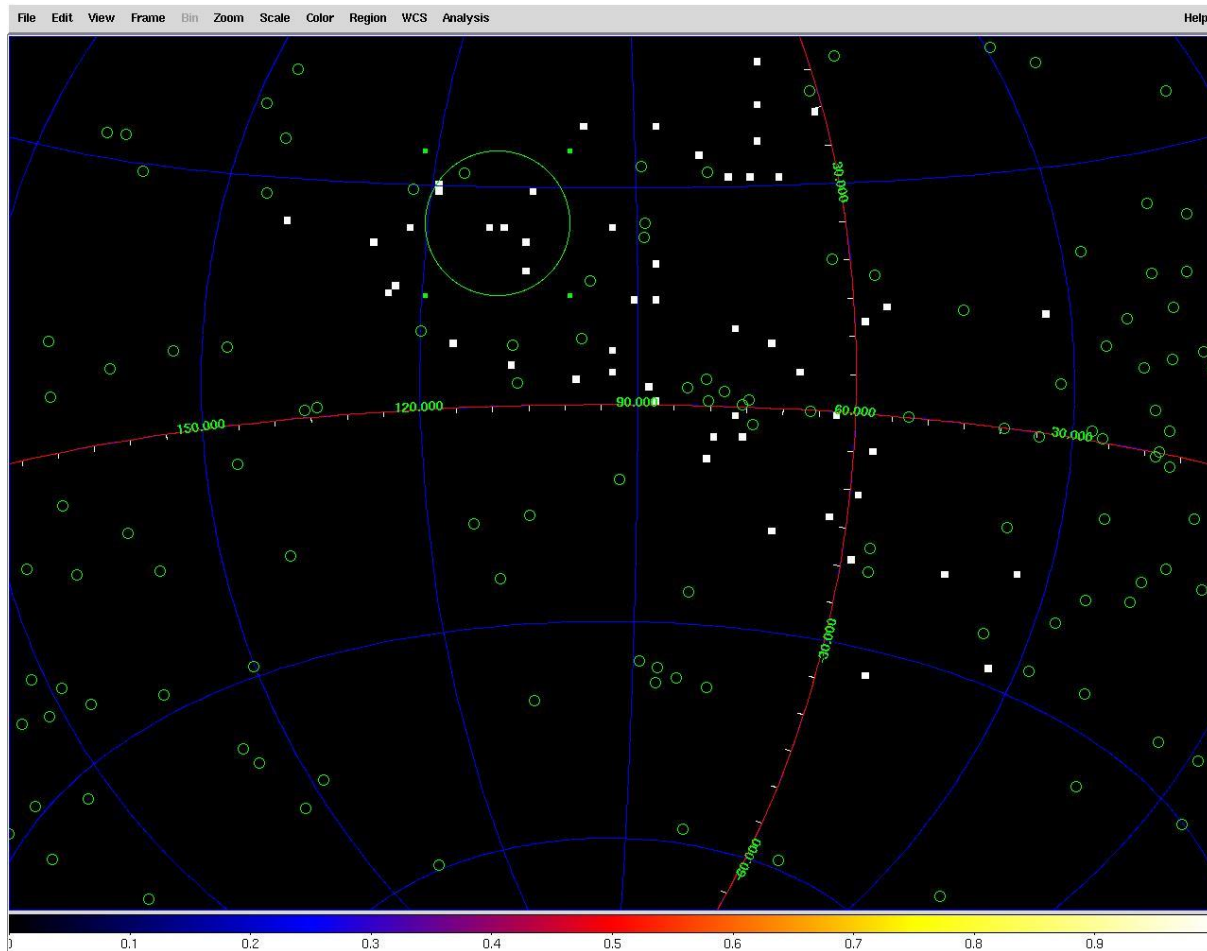
# GRID, FT, G+L+S

**T = t\_0** , **deltaT = 60 sec**



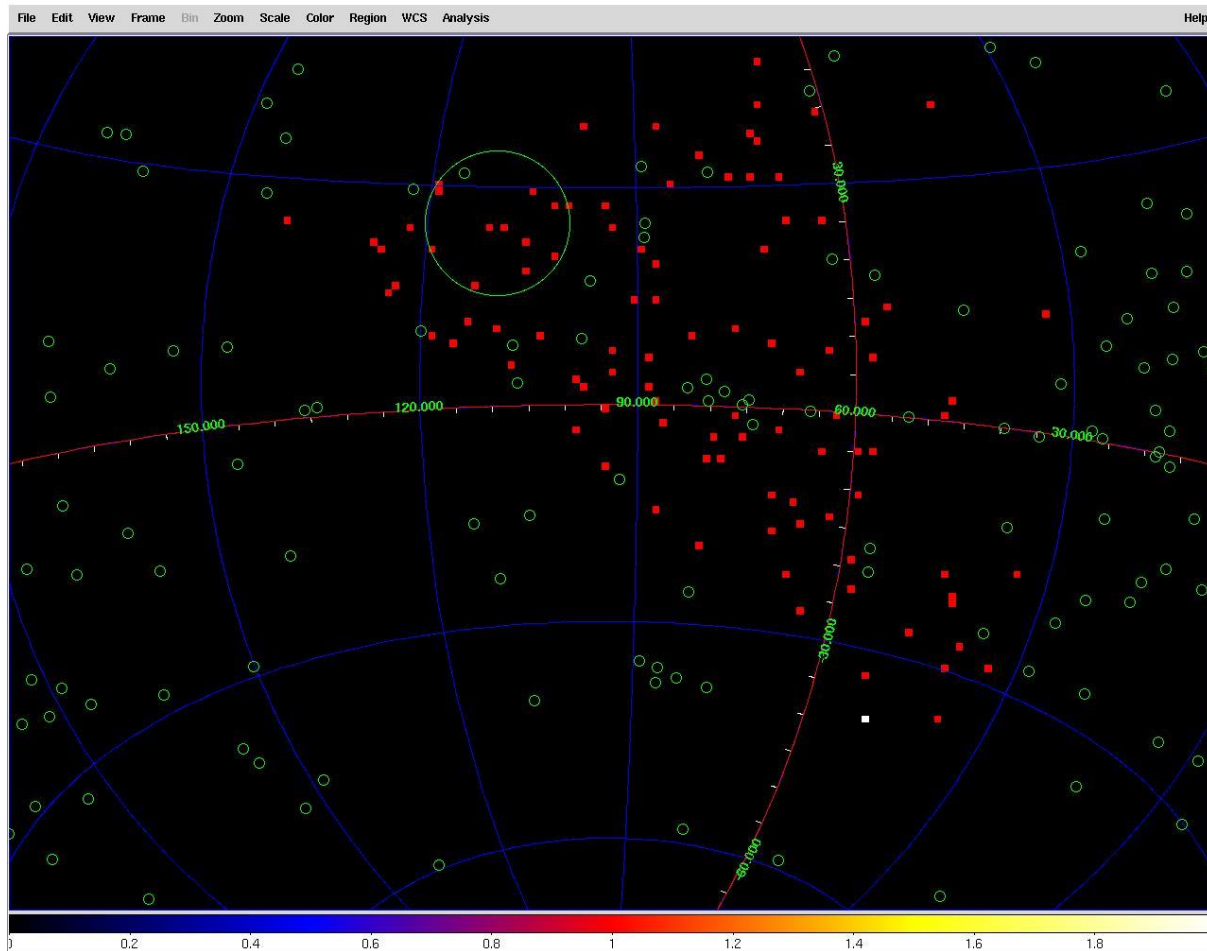
# GRID, FT, G+L+S

$T = t_0 + 60 \text{ sec}$ ,  $\Delta T = 30 \text{ sec}$



# GRID, FT, G+L+S

$T = t_0 + 60 \text{ sec}$ , **deltaT=60 sec**



## on GRB 090618...

- Among the brightest events detected by MCAL at 1-10 MeV
- About 37 degree off-axis
- clearly no gamma-ray emission above 100 MeV
  - Spectral index:  $\beta \sim -3.2$

- **AGILE GRBs detected above 100 MeV:**
  - **GRB 080514B**  
(extended emission, same spectrum at keV – GeV);
  - **GRB 090401B** (complete coverage by Swift);
  - **GRB 090510**  
(short with delayed gamma rays & spectral evolution);
  - **GRB 100724B** (simultaneous emission at MeV and GeV);
  - **GRB 130327B** (confirmation by LAT, no Swift Detection);
  - **GRB 130427A**  
(first detection by likelihood analysis by AGILE/GRID);
  - **GRB 131108A**  
(short, with delayed gamma rays & spectral evolution).

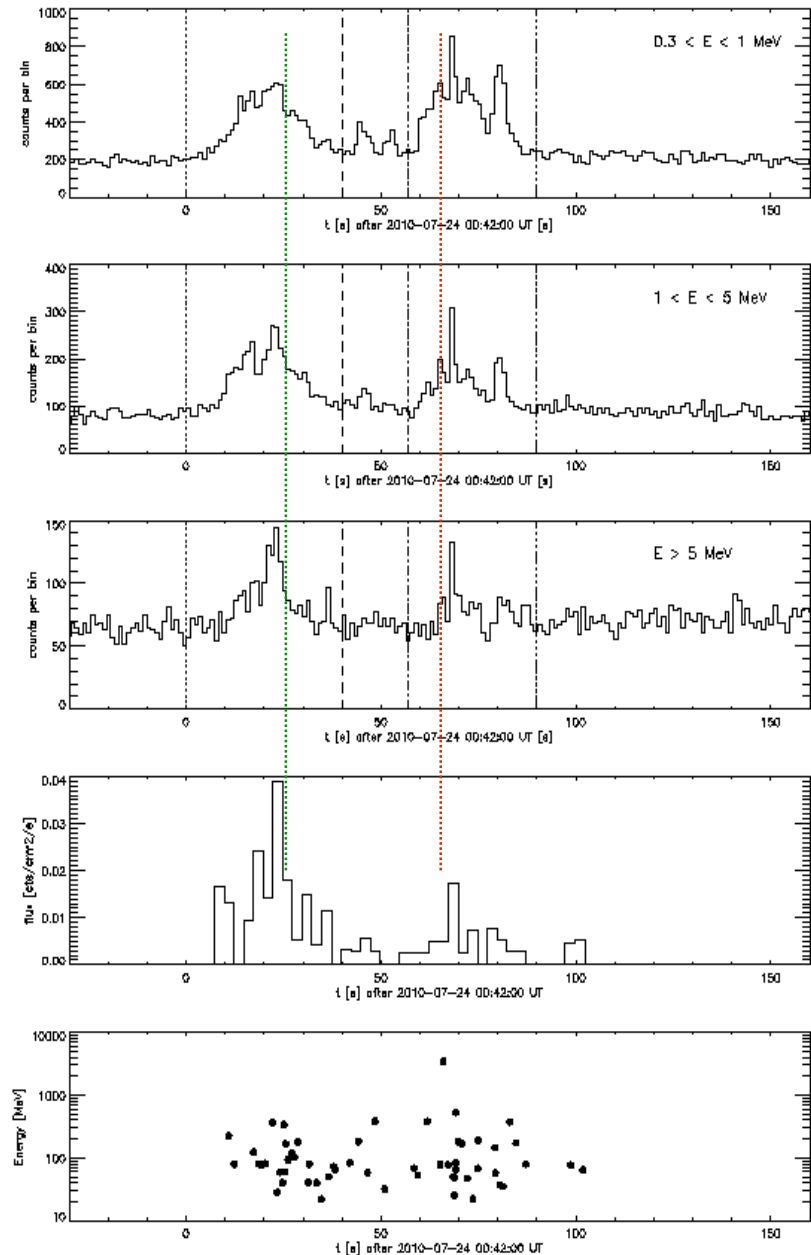


- **AGILE GRBs detected above 100 MeV:**
  - GRB 080514B  
(extended emission, same spectrum at keV – GeV);
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  - GRB 090510  
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  - GRB 130427A  
(first detection by likelihood analysis by AGILE/GRID);
  - GRB 131108A  
(short, with delayed gamma rays & spectral evolution).

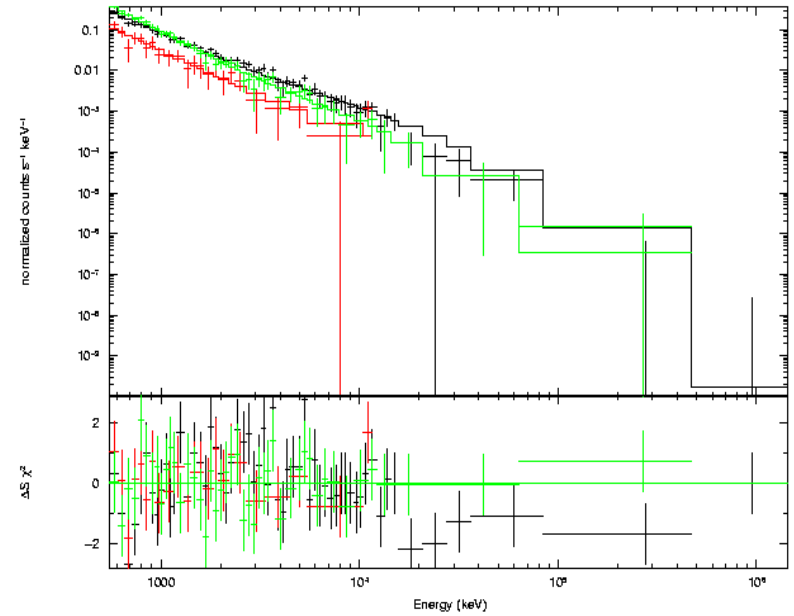
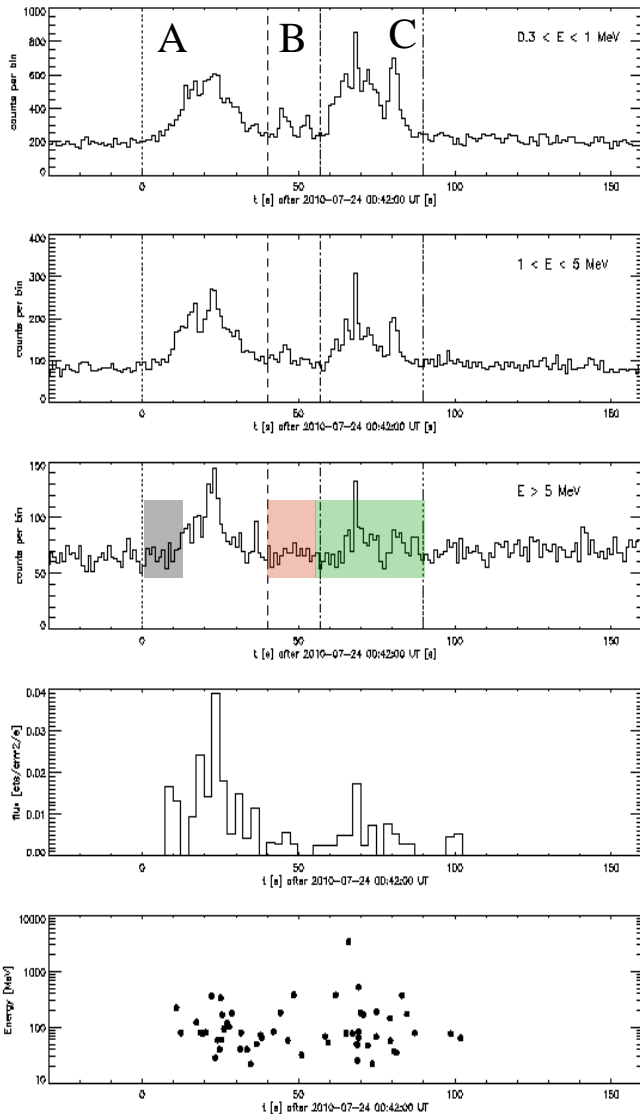
# GRB 100724B: simultaneous GeV & MeV emission

Del Monte et al., A&A, 535, 120, (2011)

- No time lag is found between the MeV and GeV emission. The two main bumps in the lightcurve show a remarkably similar shape at MeV and GeV.
- due to the spinning operative mode, GRB 100724B remained within the AGILE/GRID FoV between  $t_0+6s$  and  $t_0+125s$ .
- The GRB is not detected during the next “transit” in the FoV ( $t_0 + 410s$ ,  $t_0 + 529s$ ).



# GRB 100724B: spectral evolution



**Del Monte et al., A&A, 535, A120 (2011)**

A:  $t_0$  ,  $t_0 + 40$  s; photon index= $2.01 \pm 0.04$

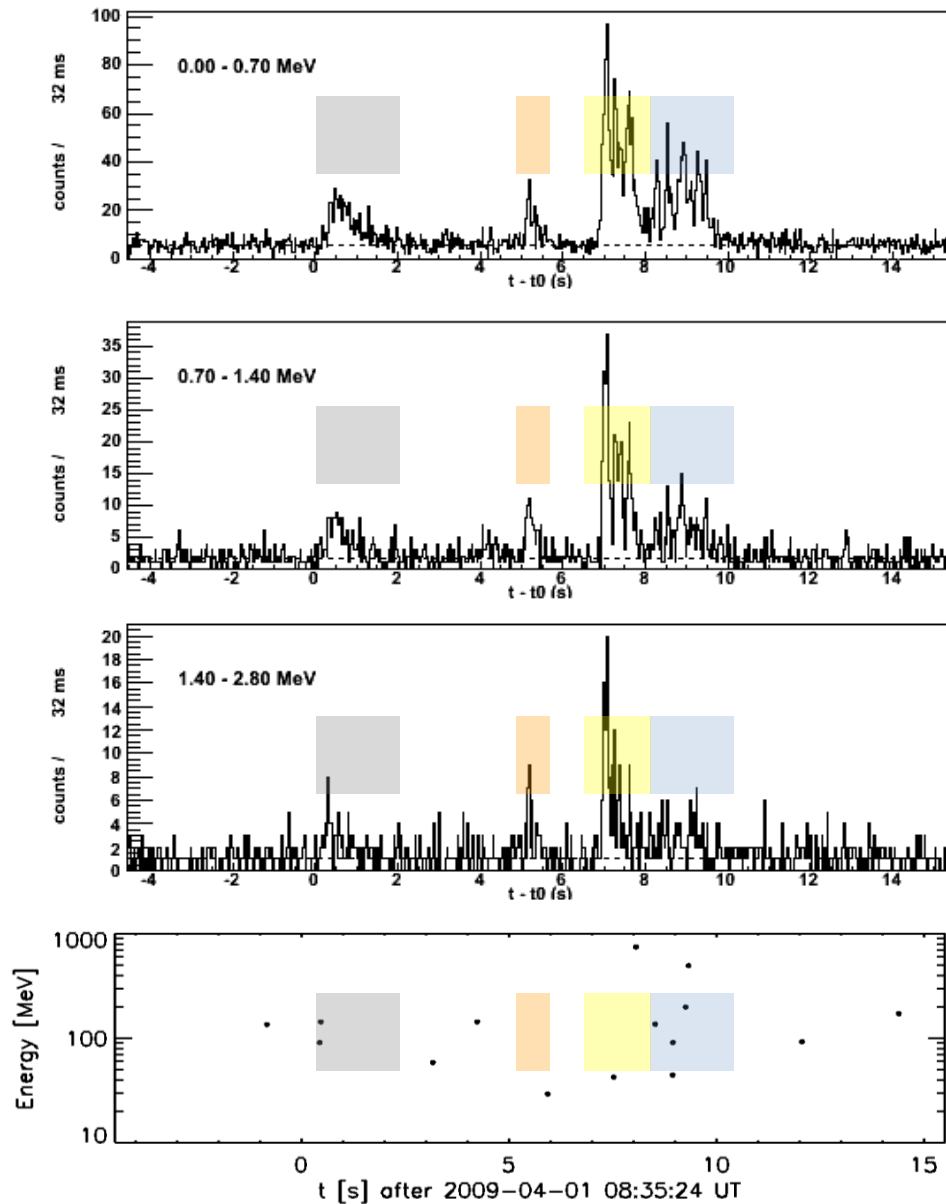
B:  $t_0 + 40$  s ,  $t_0 + 57$  s; photon index= $2.19 (+0.26,-0.19)$

C:  $t_0 + 57$  s ,  $t_0 + 90$  s; photon index= $2.35 (+0.08,-0.07)$  .

A variation at  $4.2\sigma$  is found in the spectral indices.

- **AGILE GRBs detected above 100 MeV:**
  - GRB 080514B  
(extended emission, same spectrum at keV – GeV);
  - **GRB 090401B (complete coverage by Swift);**
  - GRB 090510  
(short with delayed gamma rays & spectral evolution);
  - GRB 100724B (simultaneous emission at MeV and GeV);
  - GRB 130327B (confirmation by LAT, no Swift Detection);
  - GRB 130427A  
(first detection by likelihood analysis by AGILE/GRID);
  - GRB 131108A  
(short, with delayed gamma rays & spectral evolution).

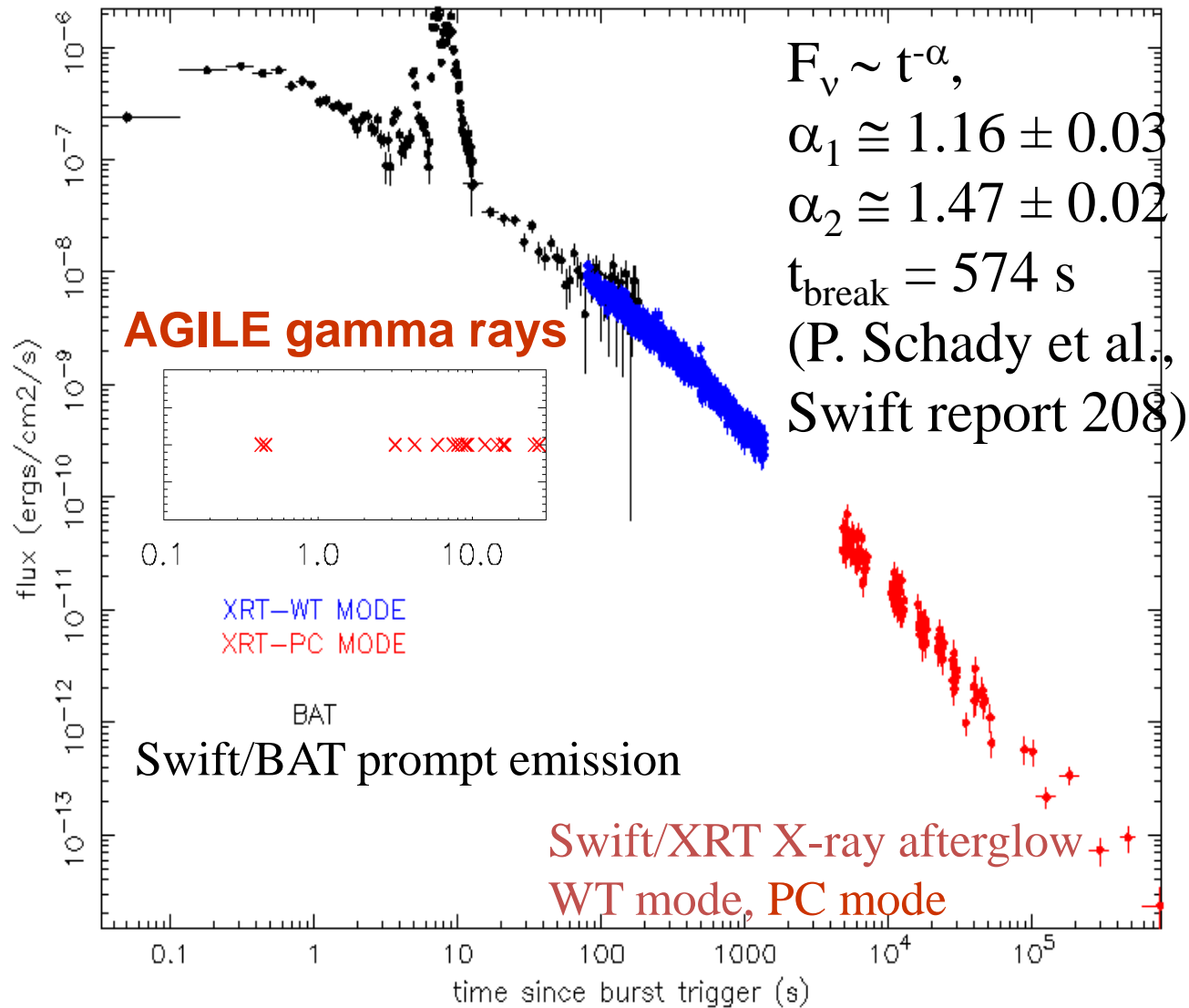
# GRB 090401B: prompt emission



68 % of the gamma-ray photons are emitted during prompt emiss.;

32 % of the gamma rays are in the “extended” emission

# GRB 090401B: a complete coverage of the afterglow

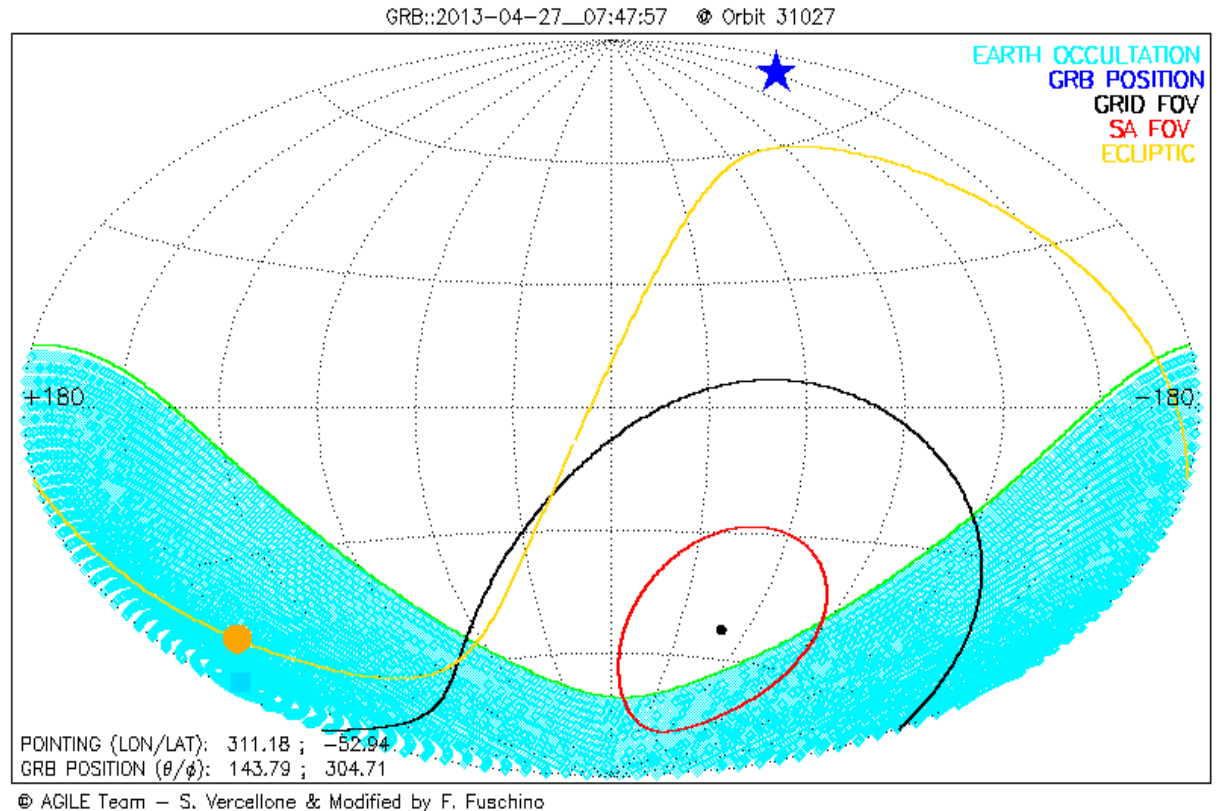




- **AGILE GRBs detected above 100 MeV:**
  - GRB 080514B  
(extended emission, same spectrum at keV – GeV);
  - GRB 090401B (complete coverage by Swift);
  - GRB 090510  
(short with delayed gamma rays & spectral evolution);
  - GRB 100724B (simultaneous emission at MeV and GeV);
  - GRB 130327B (confirmation by LAT, no Swift Detection);
  - **GRB 130427A**  
**(first detection by likelihood analysis by AGILE/GRID);**
  - GRB 131108A  
(short, with delayed gamma rays & spectral evolution).

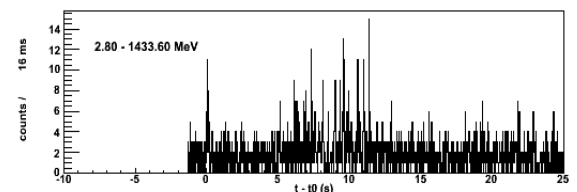
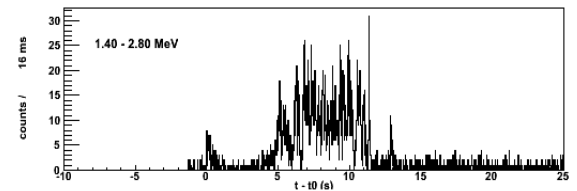
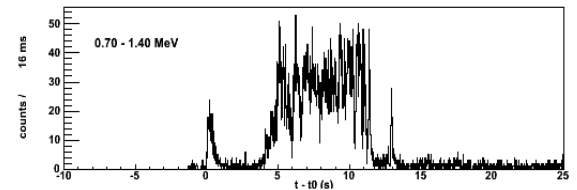
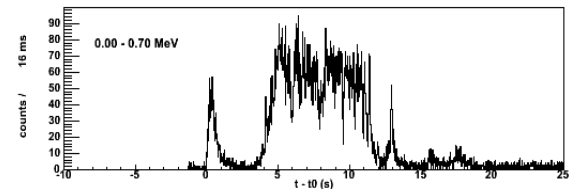
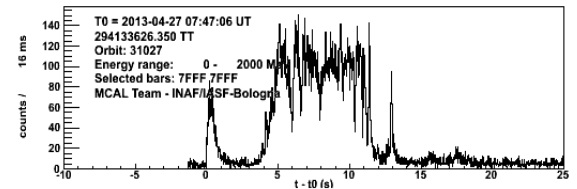
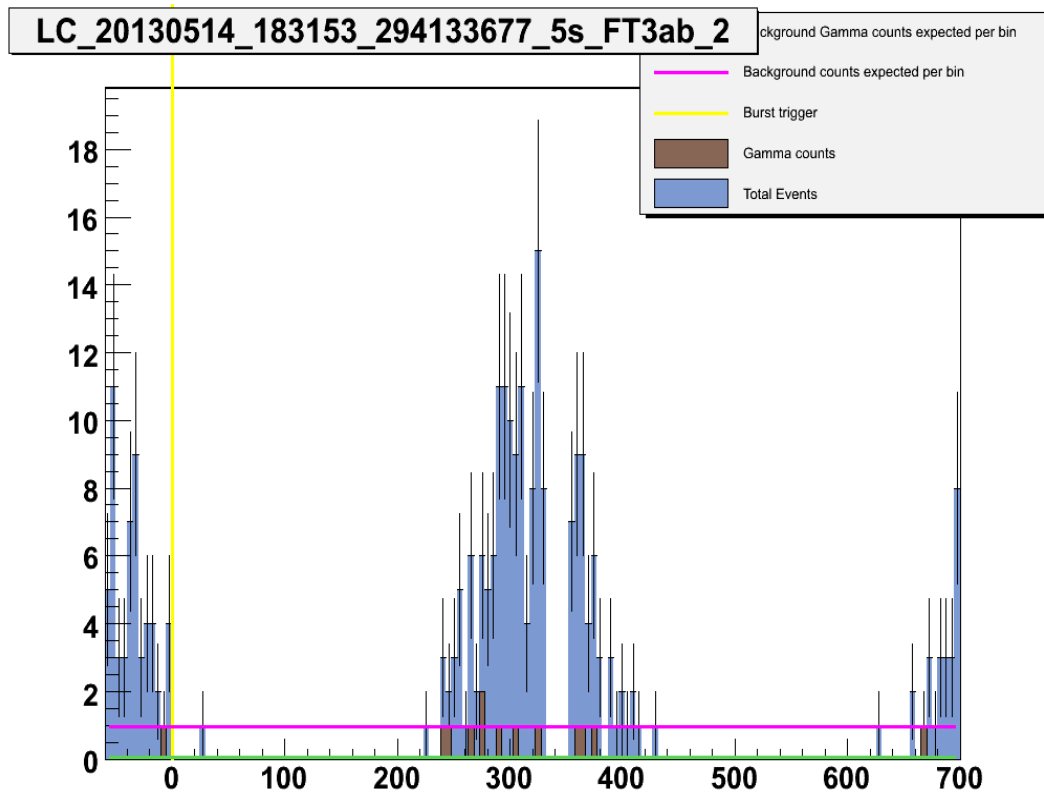
# GRB 130427A

- Outside the AGILE FoV for the first 200 s
- Detected by the automated flaring source pipeline
- First detection by likelihood of the extended emission

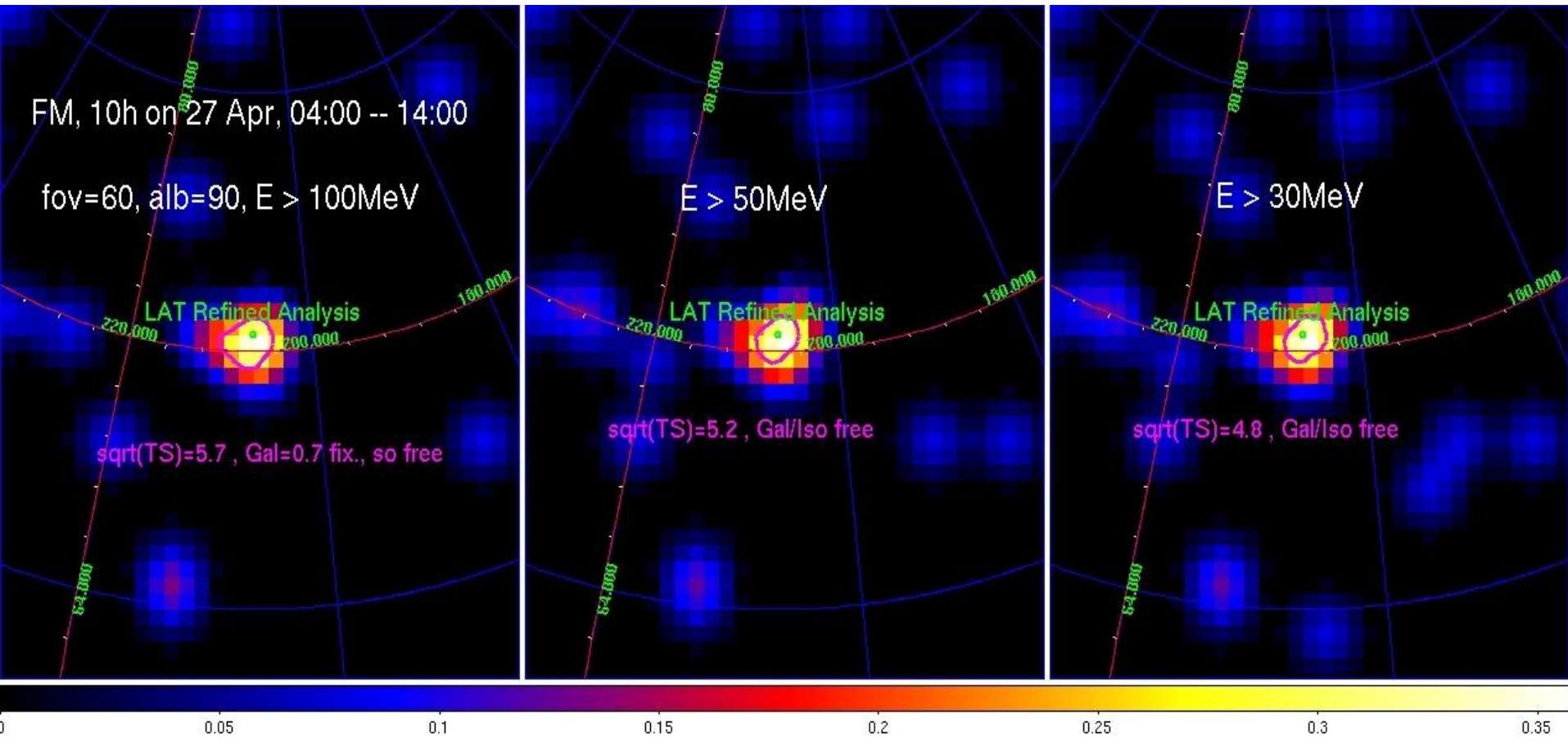


# GRB 130427A

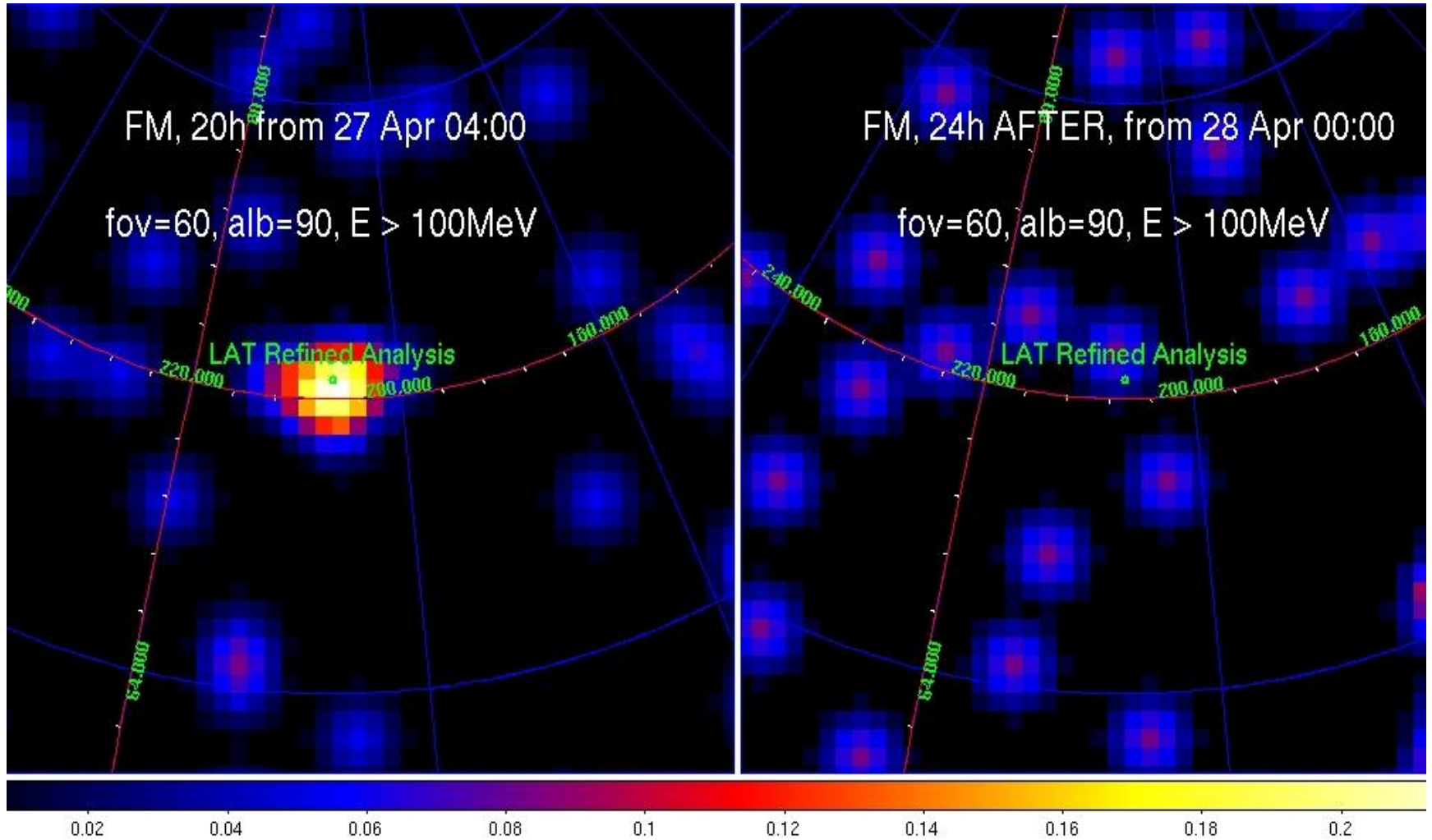
- Outside of the GRID FoV for the first ~ 200 s
- Strong prompt detection by MCAL



# GRB 130427A



# GRB 130427A

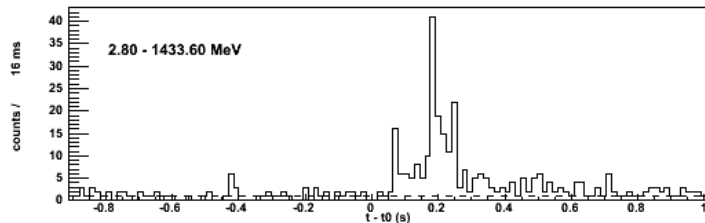
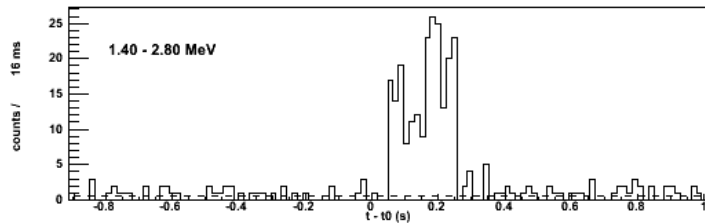
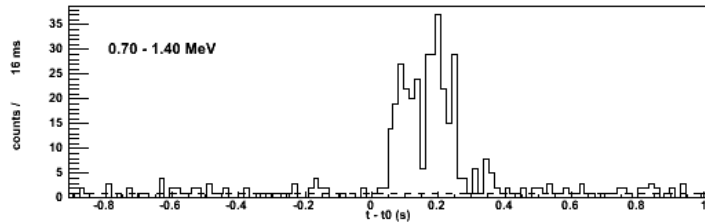
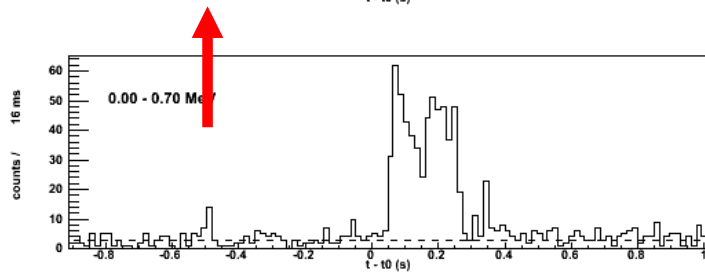
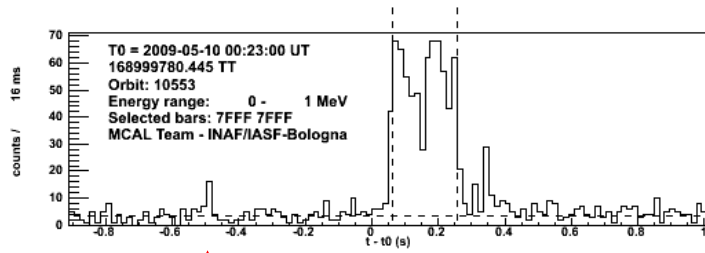


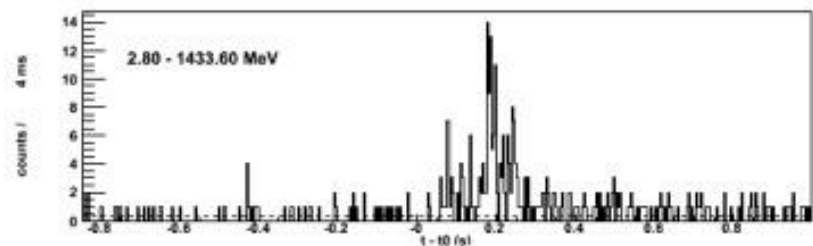
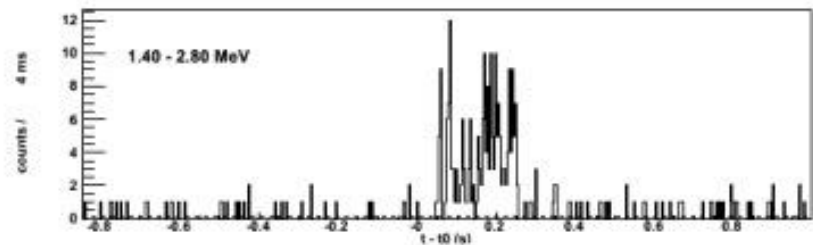
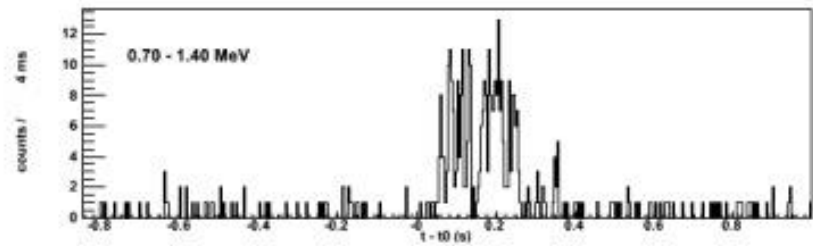
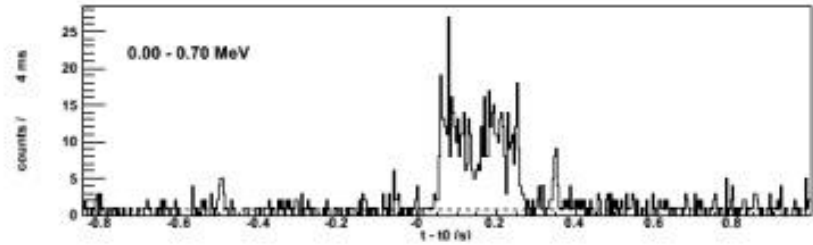
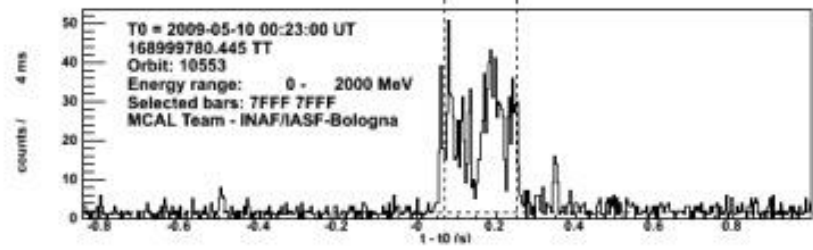
- **AGILE GRBs detected above 100 MeV:**
  - GRB 080514B  
(extended emission, same spectrum at keV – GeV);
  - GRB 090401B (complete coverage by Swift);
  - **GRB 090510**  
**(short with delayed gamma rays & spectral evolution);**
  - GRB 100724B (simultaneous emission at MeV and GeV);
  - GRB 130327B (confirmation by LAT, no Swift Detection);
  - GRB 130427A  
(first detection by likelihood analysis by AGILE/GRID);
  - **GRB 131108A**  
**(short, with delayed gamma rays & spectral evolution).**



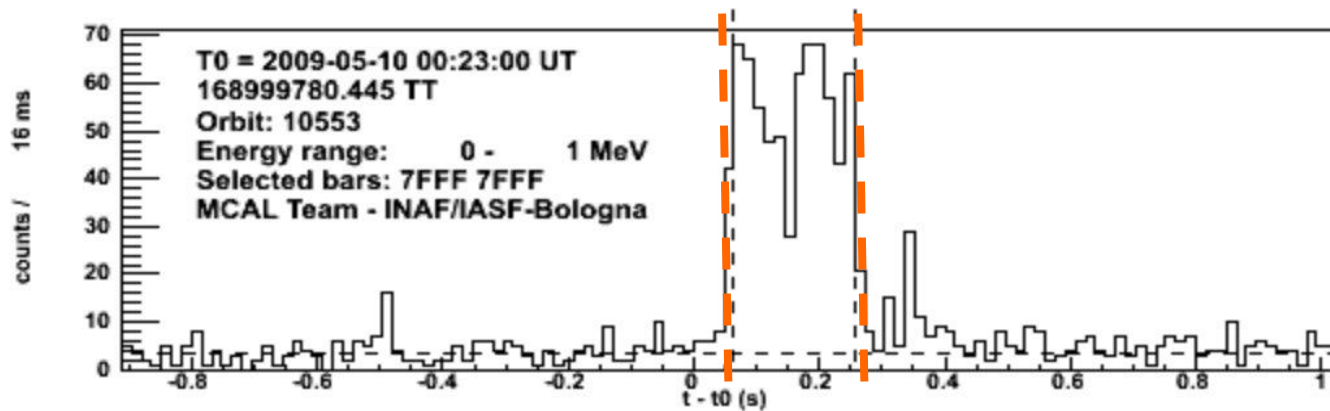
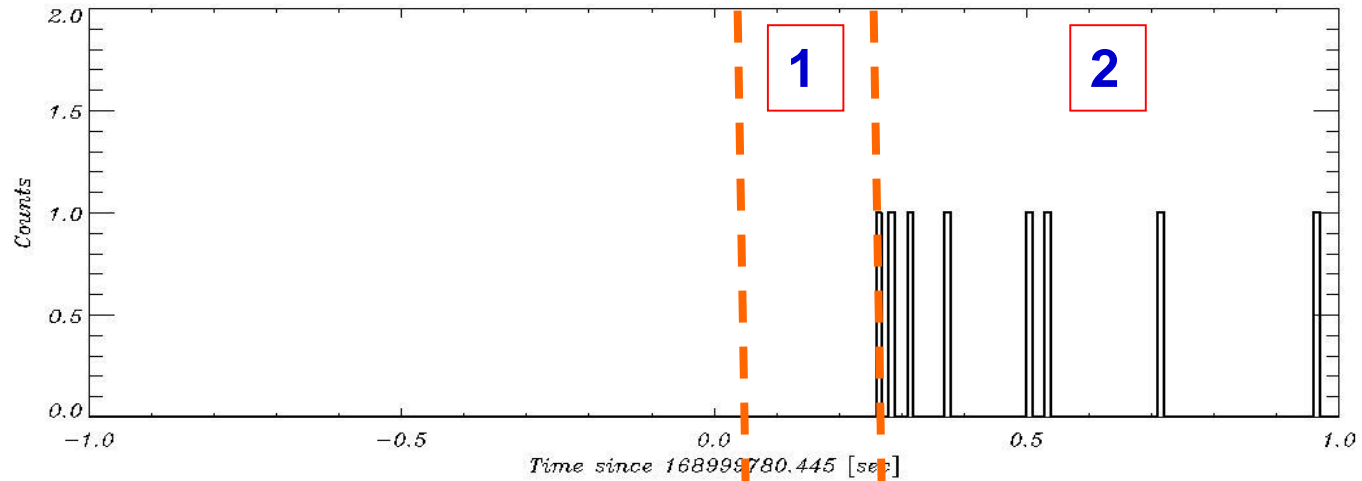
**AGILE  
and  
the “short”  
GRB 090510**

$z = 0.903$



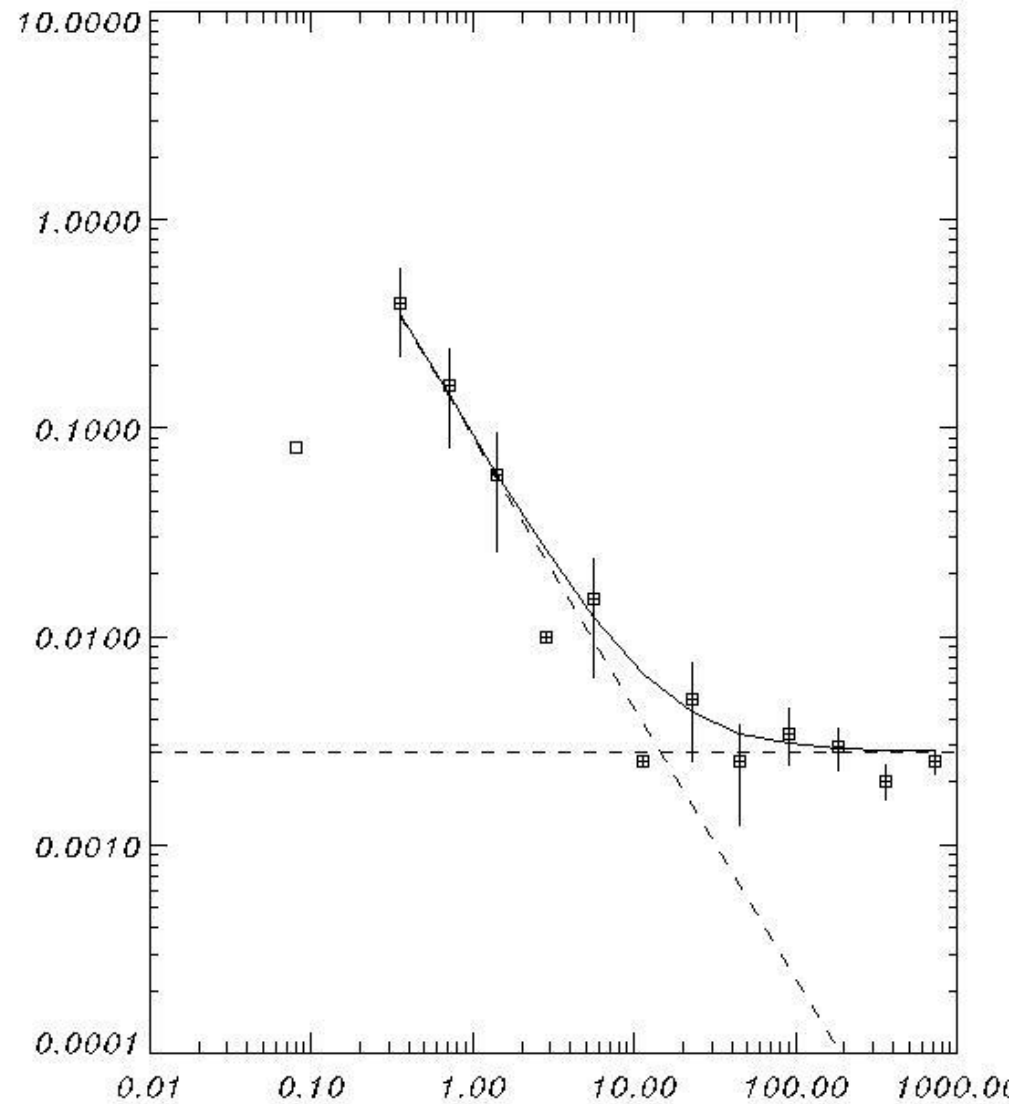


# AGILE: GRB 090510

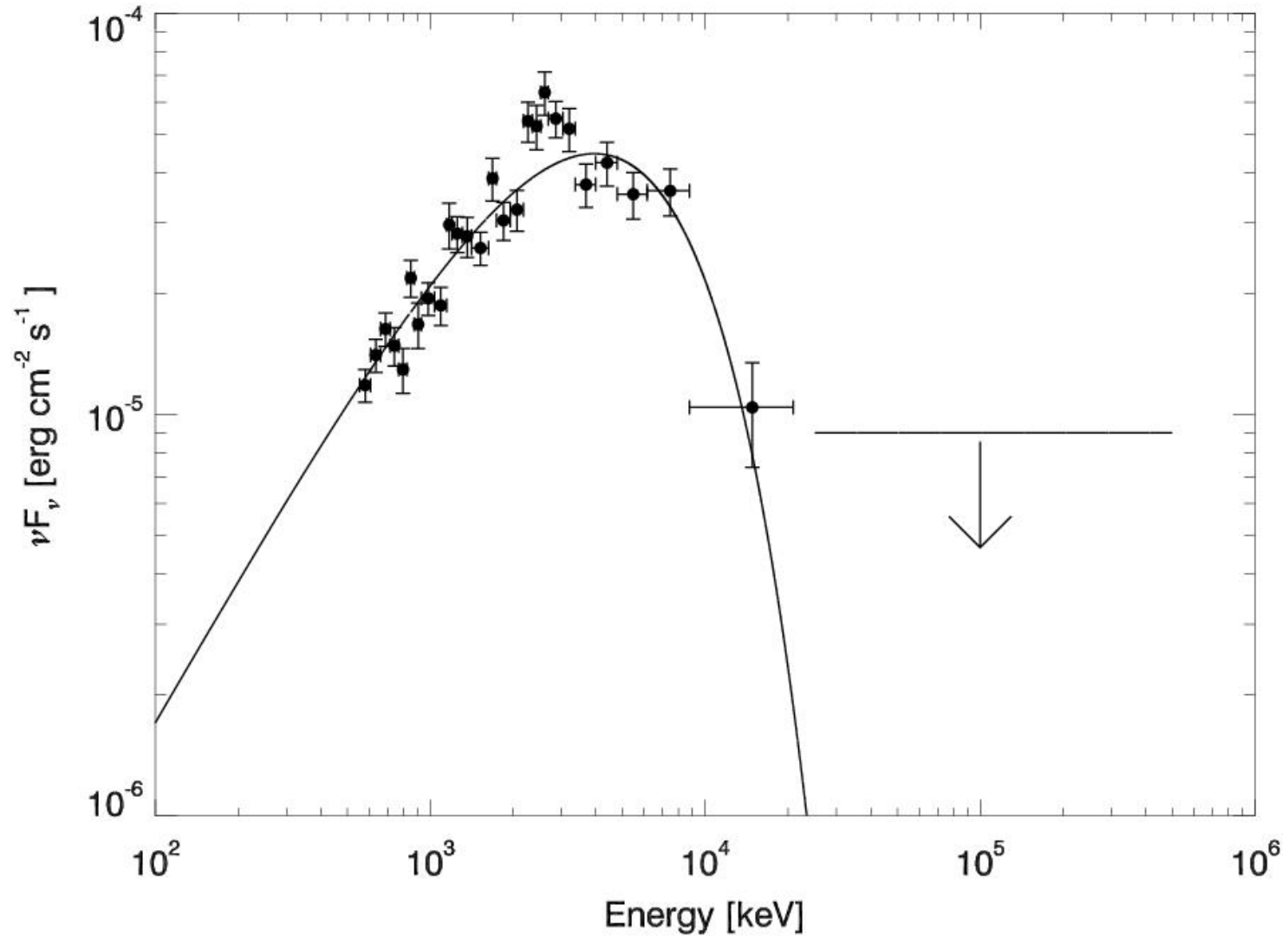


# Gamma-ray tail (delayed emission)

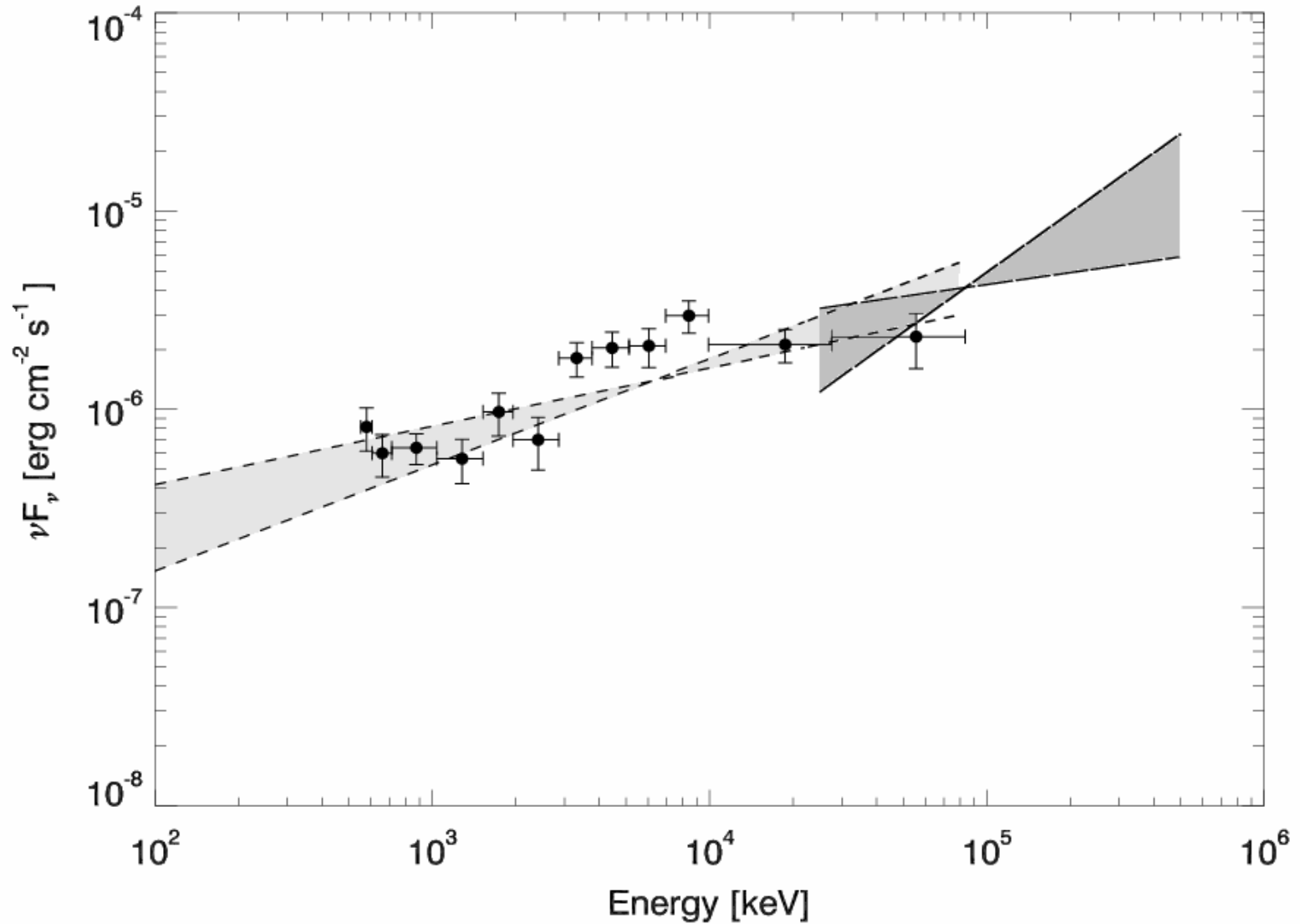
$$F = t^{-1.32}$$



# AGILE – GRB 090510: interval: 1

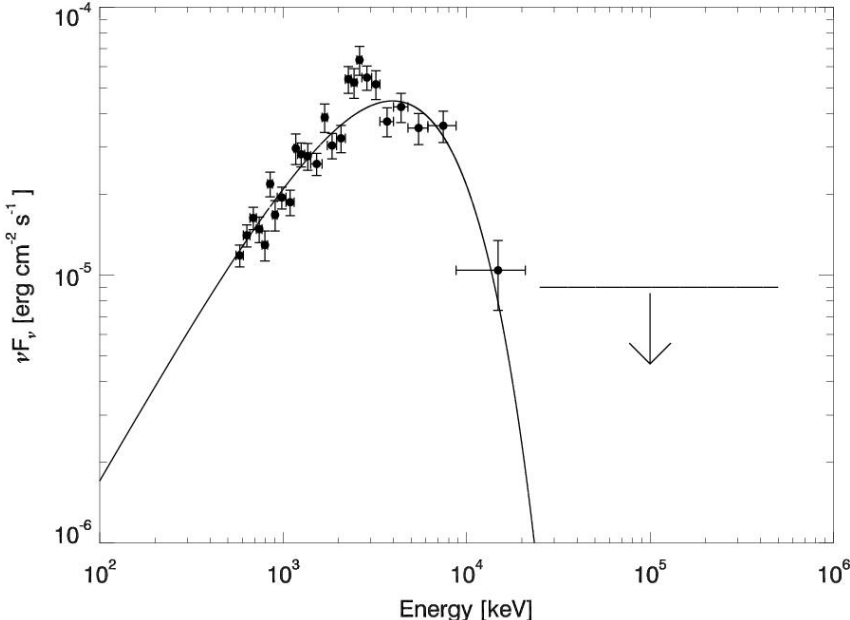


# AGILE – GRB 090510: interval: 2

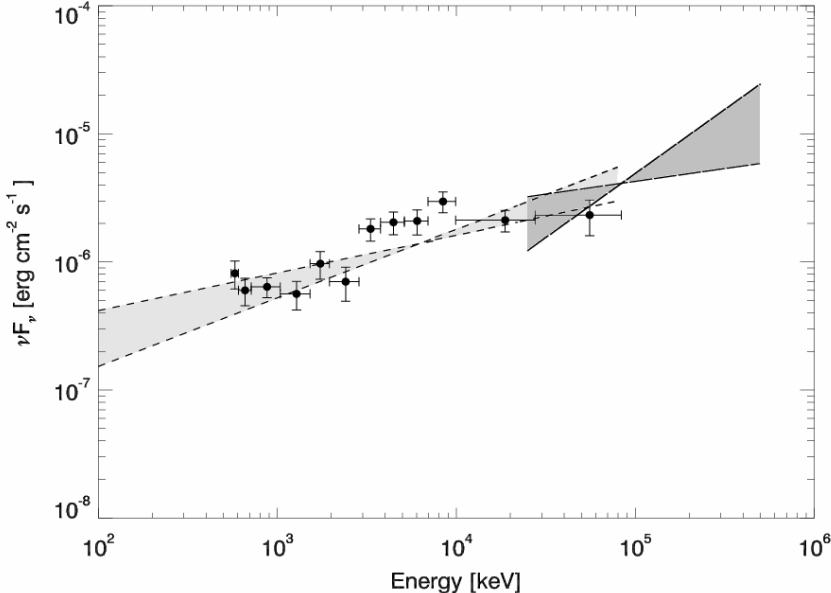




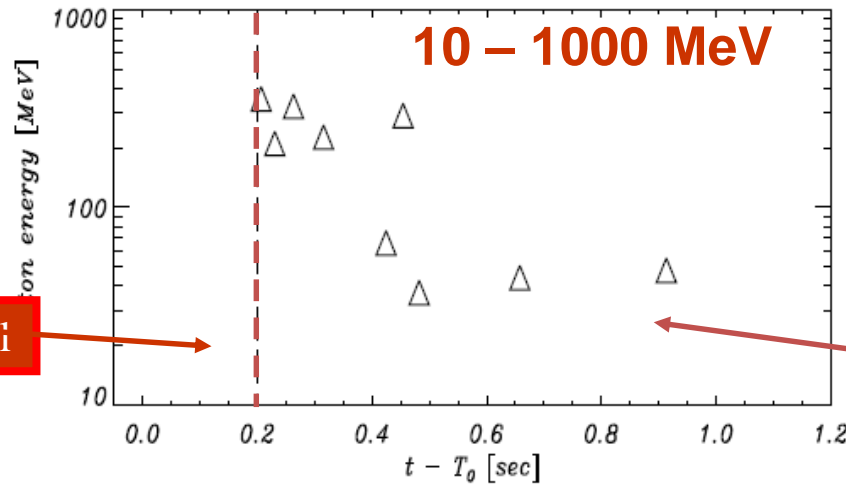
# Interval 1



# Interval 2



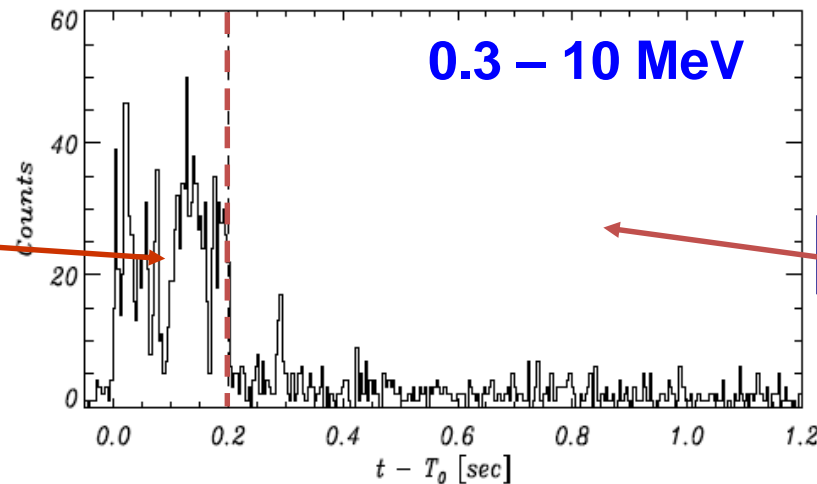
# GRB 090510: the early delayed emission



Giuliani et al. 2010,  
ApJ, 708, L84 – L88

prompt emission interval

delayed emission interval



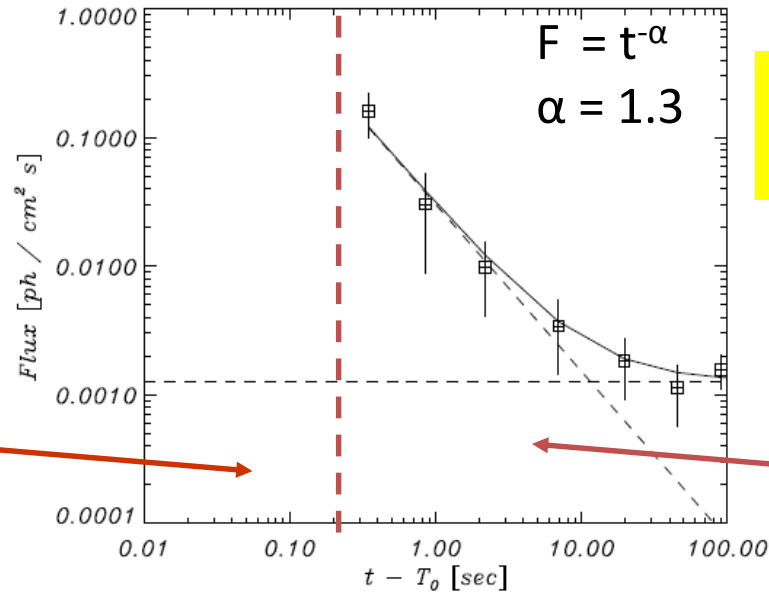
prompt emission interval

delayed emission interval

GRB 090510 has been localized by Swift and detected also by Fermi/LAT (Ackermann et al. 2010) and AGILE (Giuliani et al. 2010). The redshift is 0.903 (De Pasquale et al. 2010).

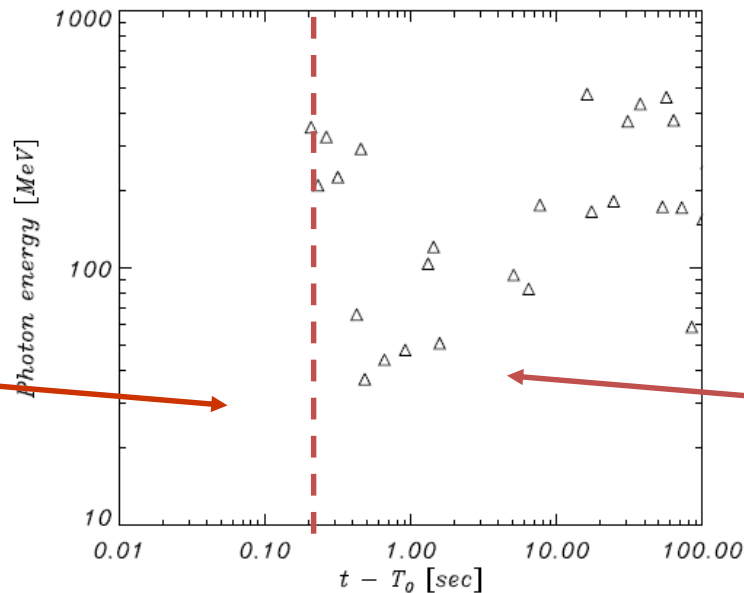
# GRB 090510: the delayed emission

Giuliani et al. 2010,  
ApJ, 708, L84 – L88



prompt emission interval

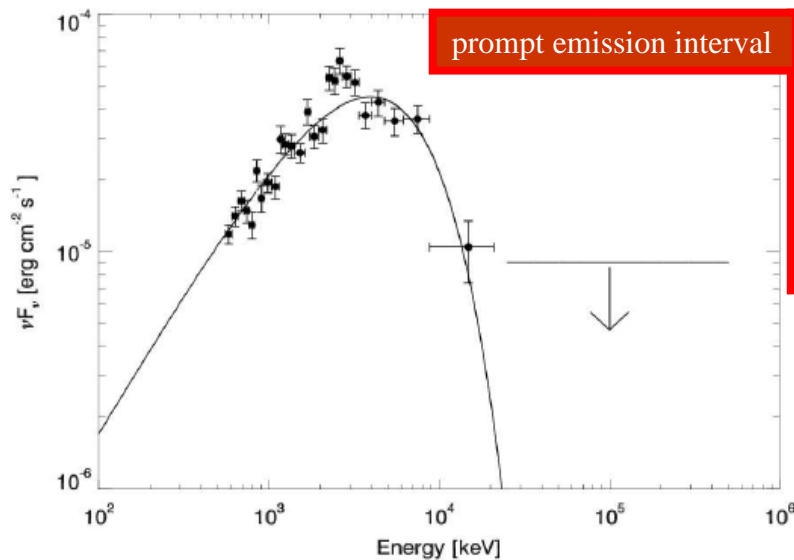
delayed emission interval



prompt emission interval

delayed emission interval

# GRB 090510: spectral evolution in a short GRB



prompt emission interval

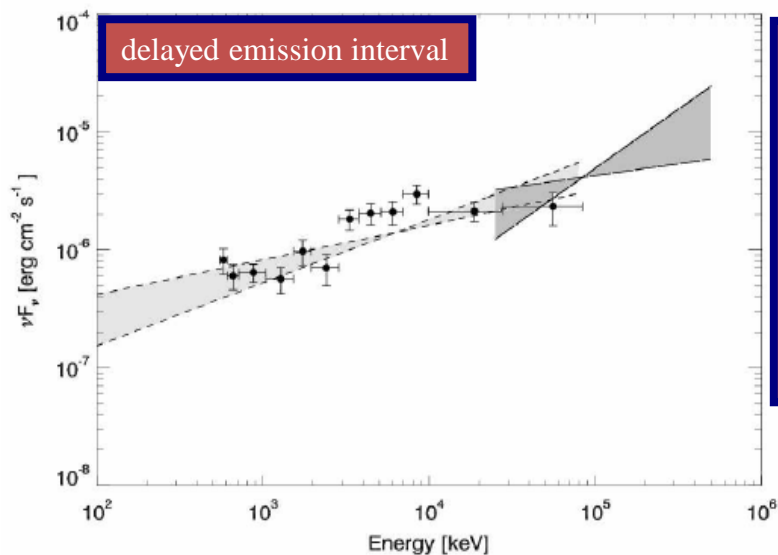
Powerlaw with cutoff

$$\alpha_1 = 0.6 \pm 0.3$$

$$E_c = 2.8 \pm 0.9 \text{ MeV}$$

$$1.8 \times 10^{-5} \text{ erg/cm}^2 \text{ (0.5 - 10 MeV)}$$

Giuliani et al. 2010,  
ApJ, 708, L84 – L88



delayed emission interval

Powerlaw without cutoff

$$\alpha_2 = 1.6 \pm 0.1$$

$$3.1 \times 10^{-6} \text{ erg/cm}^2 \text{ (0.5 - 10 MeV)}$$

$$\alpha_3 = 1.4 \pm 0.4$$

$$2.9 \times 10^{-5} \text{ erg/cm}^2 \text{ (25 - 500 MeV)}$$

## on the “short” GRB 090510...

- one of the shortest events with remarkable high-energy emission
- For a  $z \sim 0.9$ ,  $E(\text{iso}) = 10^{52}$  ergs
- MeV and gamma-ray emission above 100 MeV
  - Interval 1:  $E(\text{peak}) \sim 3$  MeV
  - Interval 2:  $E(\text{peak}) > 50$  MeV
    - »  $F = t^{-1.3}$

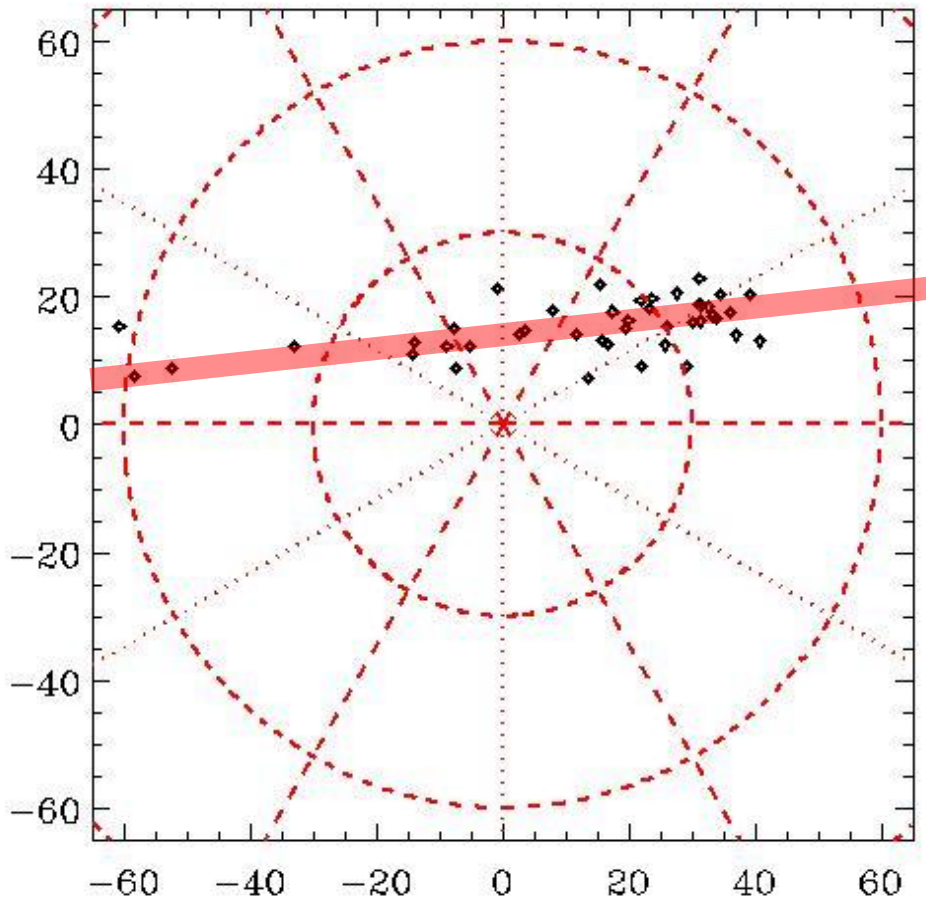
# GRB 131108A



$E > 30 \text{ MeV}$

- **Bright and distant**
- **During the first 80 seconds after T0 the GRID instrument detected 66 photons compatible with the GRB, most of which below 100 MeV**
- **Fluence of  $(2.56 \pm 0.32) 10^{-5}$  erg / cm<sup>2</sup> in the energy band 30 MeV - 1 GeV.**
- **Redshift 2.4 (GCN 15470)**

# ***GRB 131108A (Giuliani et al. 2014)***



**At  $T_0 = 20:41:55$  UTC the GRB was in the GRID FOV, at an off-axis angle of 40**

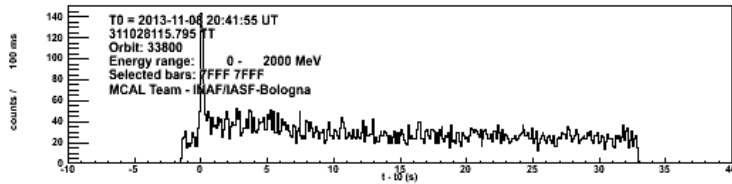
**It crossed the FOV during the following 110 s.**

**In the following rotations of the satellite, the GRB region was observed with the GRID several time**

**Detected by both GRID and MCAL**



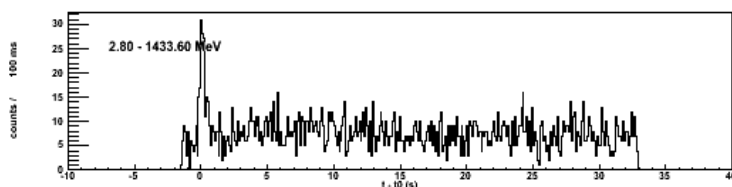
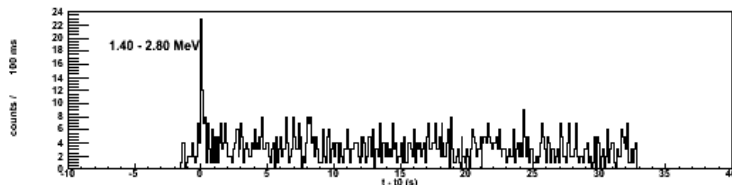
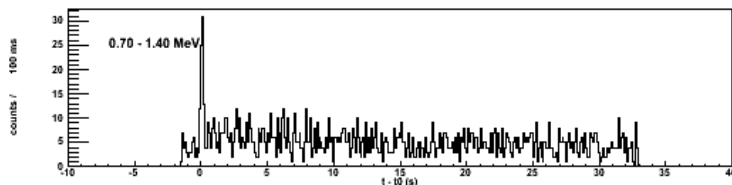
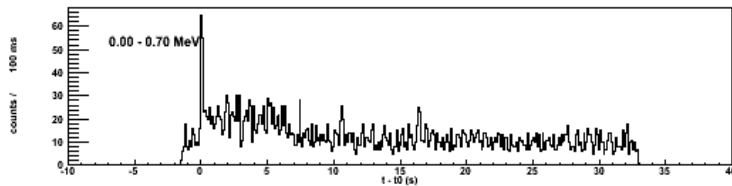
# GRB 131108A (Giuliani et al. 2014)



## MCAL Light Curve:

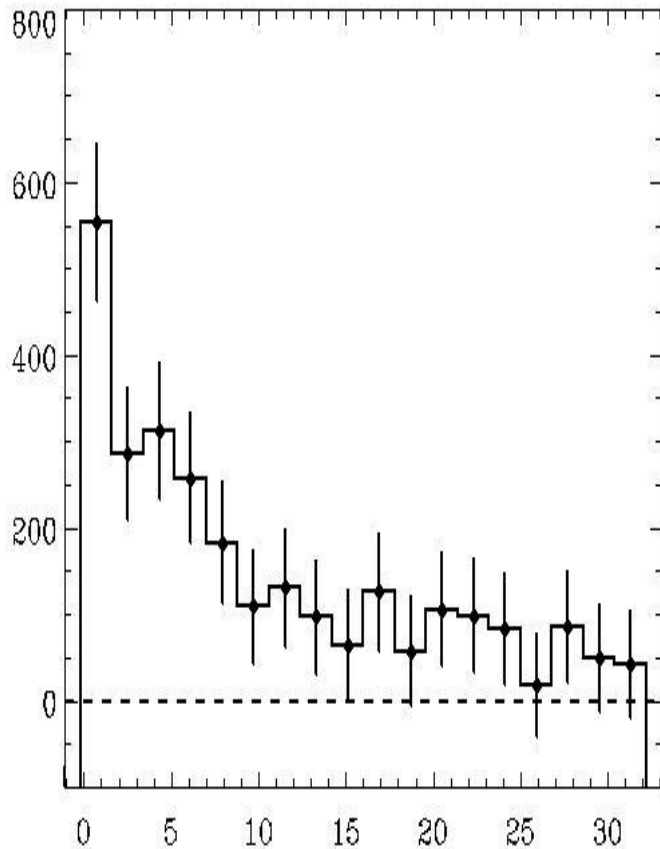
**Bright initial peak detected from 300 keV to a few MeV (width 0.1 s)**

**Above the background up to 20-25 seconds.**



# GRB 131108A

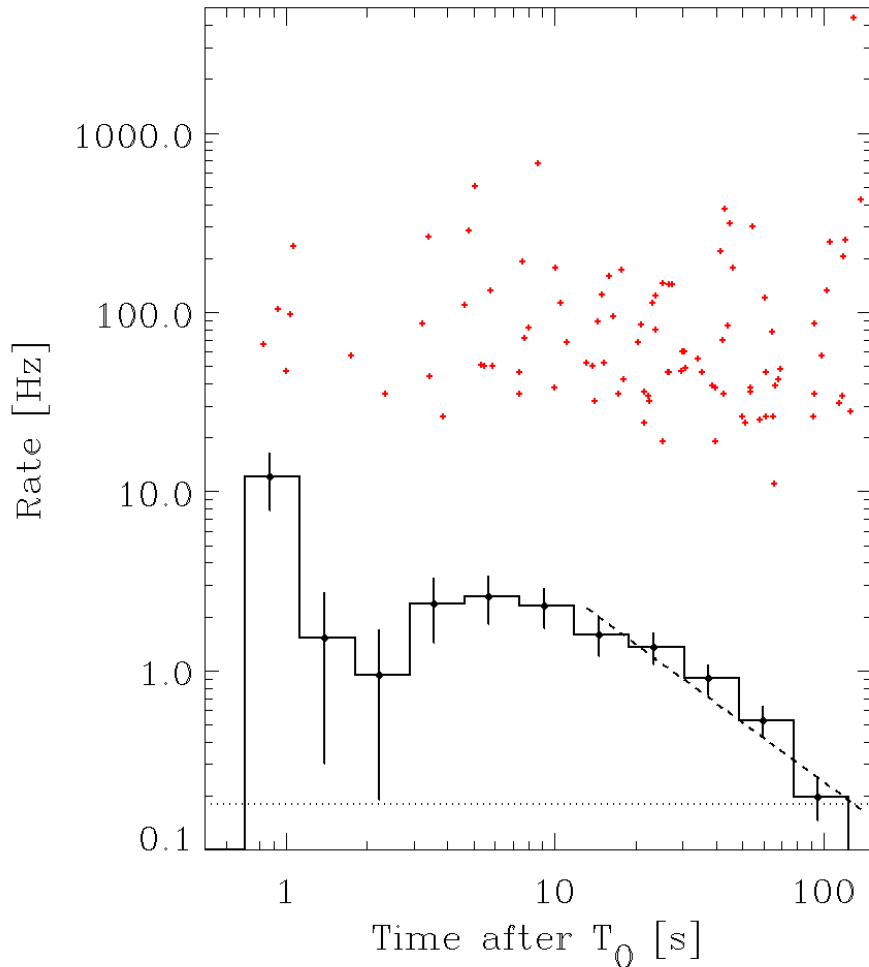
## MCAL Light Curve:



**Bright initial peak detected from 300 keV to a few MeV (width 0.1 s).**

**Above the background up to 20-25 seconds.**

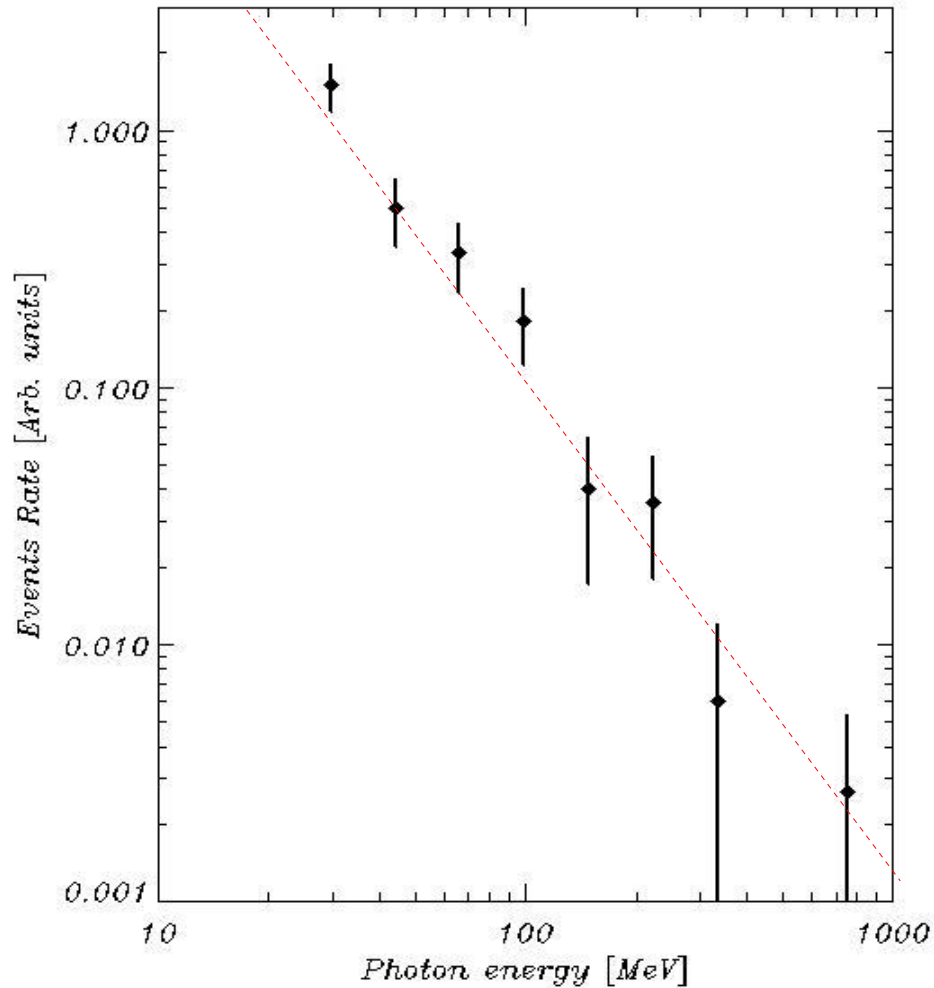
# GRB 131108A



## GRID Light Curve:

- the selected events have arrival directions within 20 from the position of GRB131108A .
- after an initial bright peak, the signal remains compatible with a constant rate for about 20-30 sec.
- The time bins after T<sub>0</sub>+20 s can be roughly fitted by a function of  $t^{-a}$  with  $a = 1.1$ .

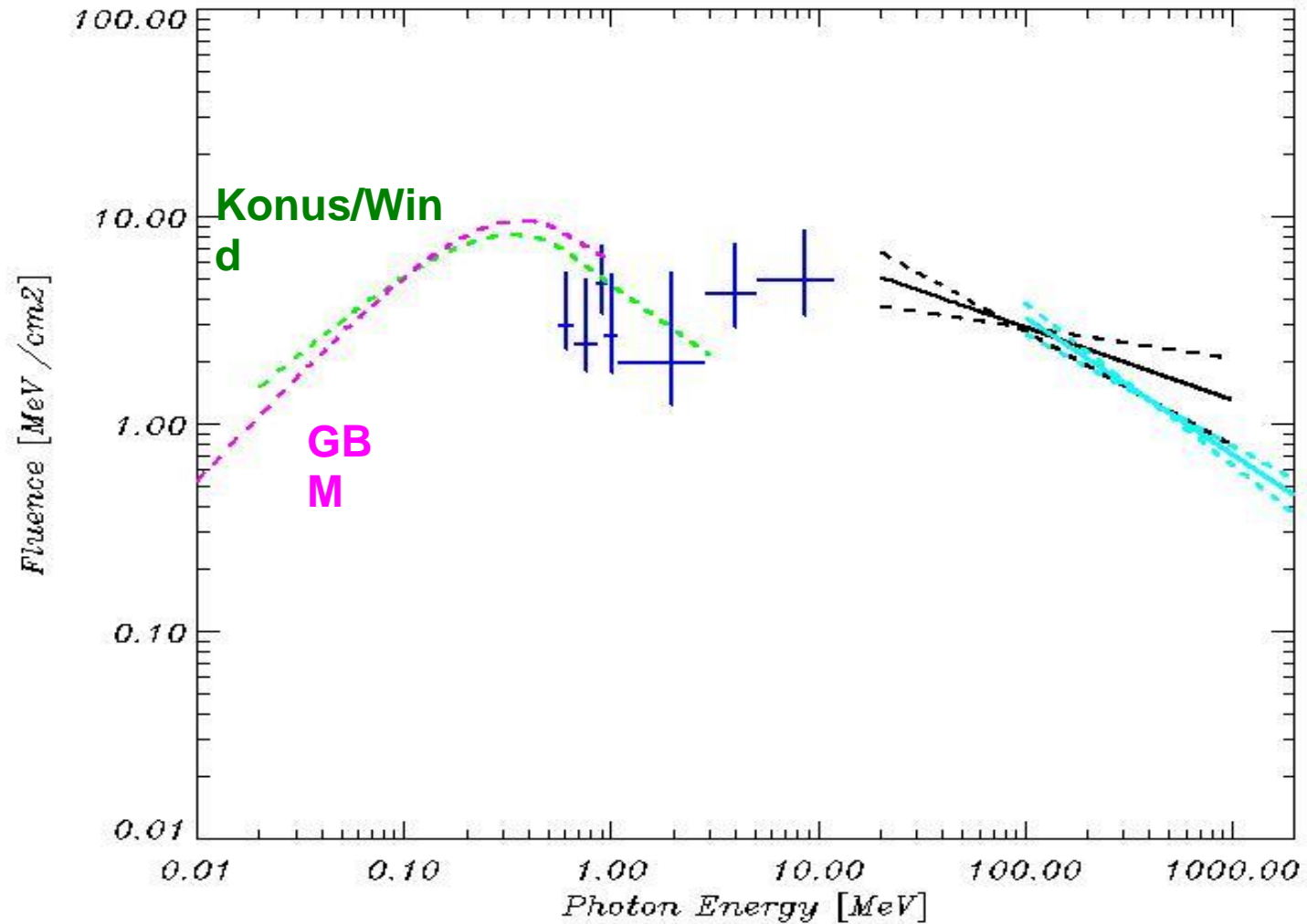
# *the gamma-ray spectrum*



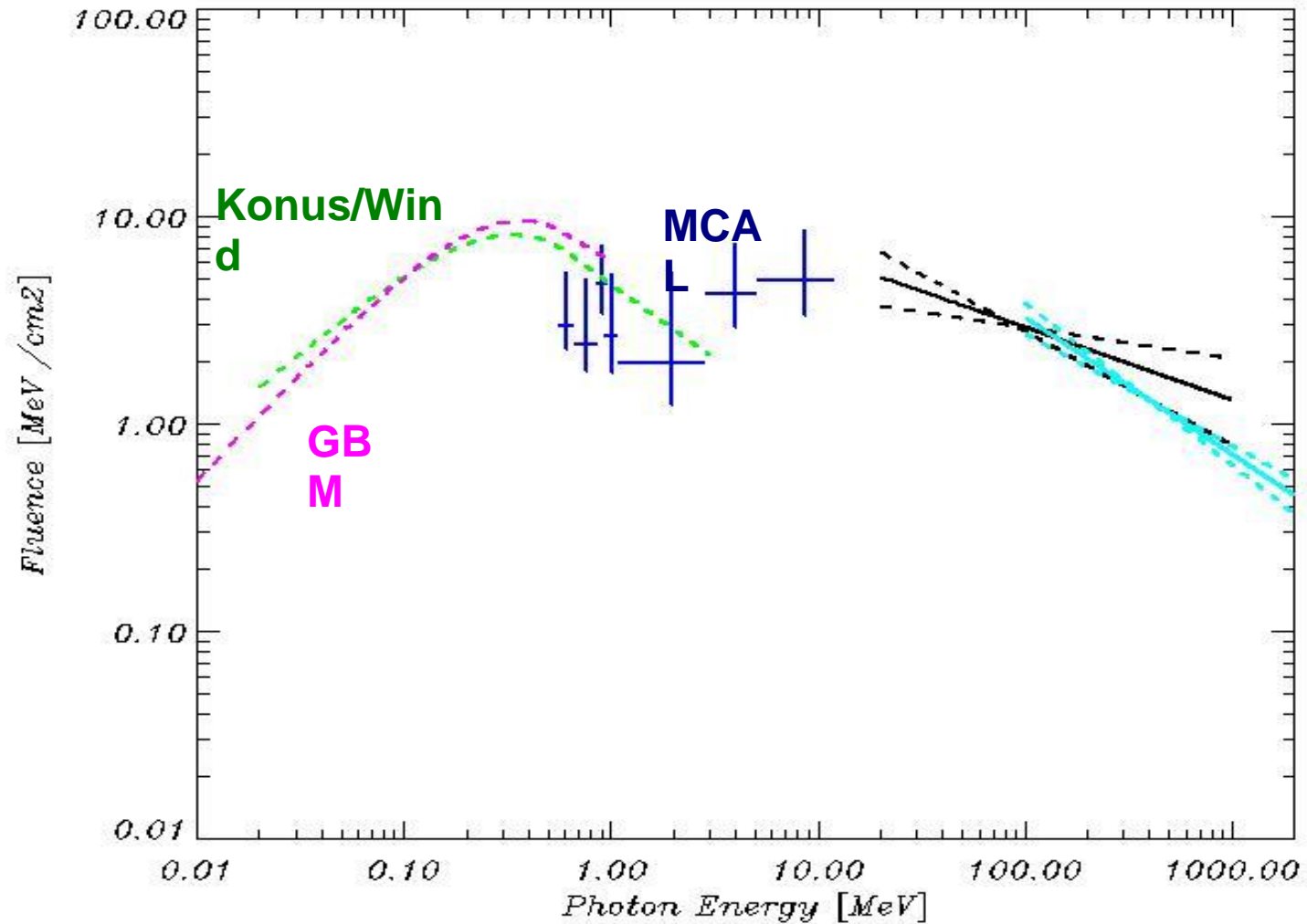
**spectral index of 2.6 +/- 0.1.**

**no evidence of change in the spectrum during the GRB.**

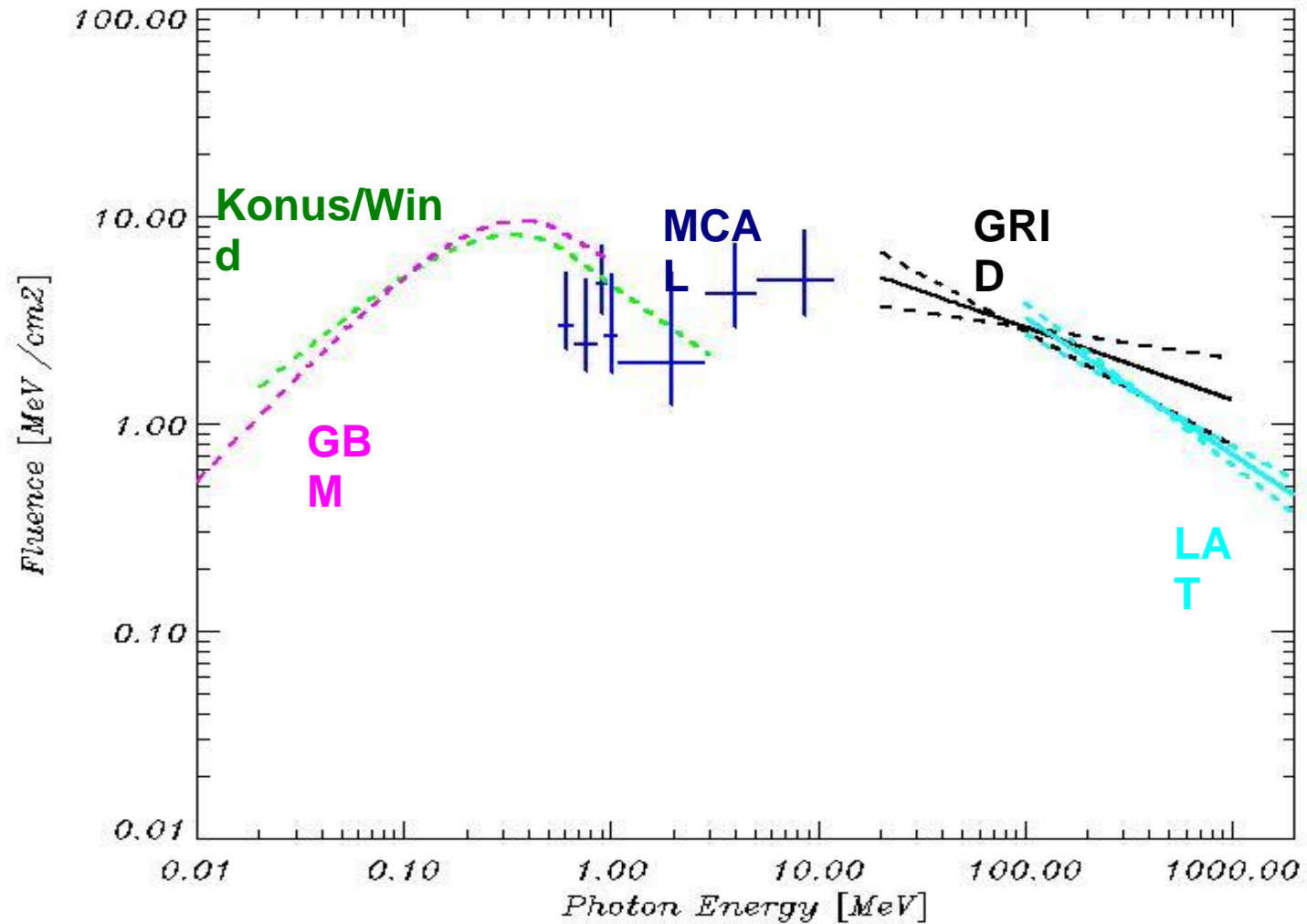
# Spectral Energy Distribution



# Spectral Energy Distribution

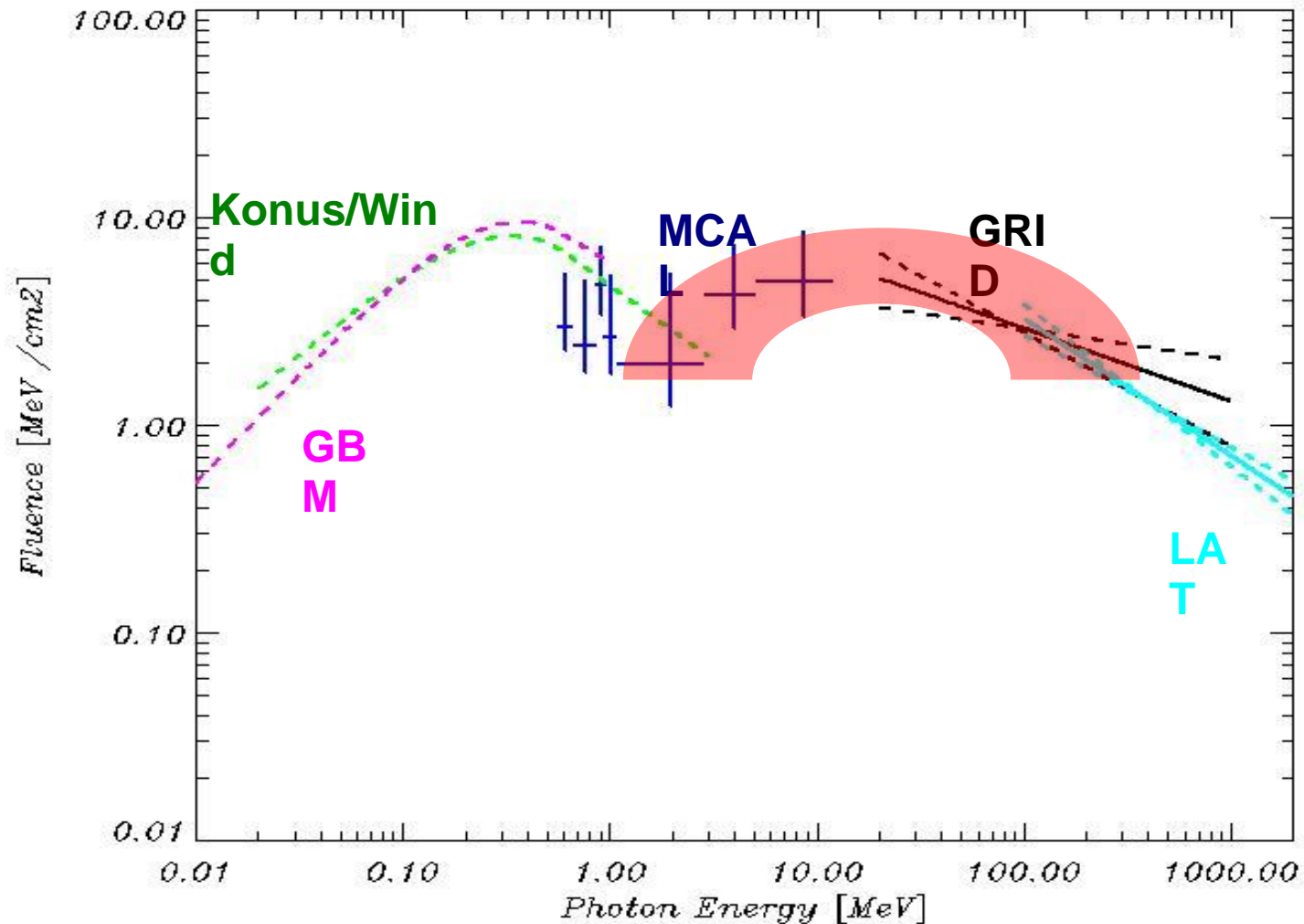


# Spectral Energy Distribution





# Spectral Energy Distribution



080514B

090401B

090510

100724B

130327B

130427A

131108A

*gamma-ray lightcurve*

- Extended (delayed) emission .....	X	X	X		X	X	X
- Delayed onset .....	X				X	X	
- $L \sim t^{-a}$ .....	X	X			X	X	
- Prompt emission .....			X	X			
- Long afterglow .....						X	

*gamma-ray spectrum*

- "extra" component .....	X					X	
---------------------------	---	--	--	--	--	---	--

# Conclusions

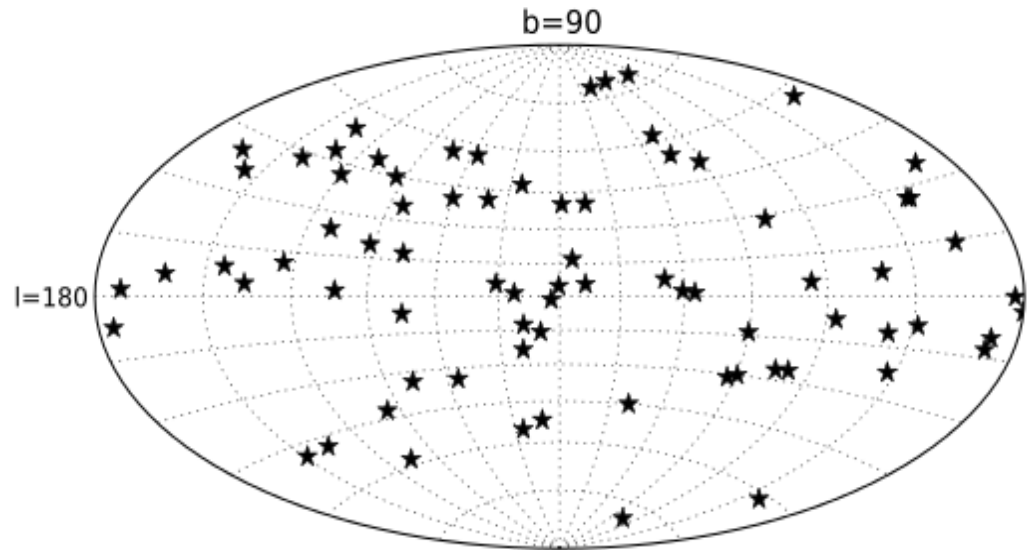
- **Gamma-ray emission above 100 MeV only from a sub-class of GRBs**
- **For several GRBs, both prompt & delayed emission**
- **In several cases, spectral indices  $\sim 3$ , and exp. cutoffs**
- **Some short GRBs, only delayed gamma rays with dramatic evolution: GRB 090510, 131108A**

## **the future above 100 MeV...**

- **gamma-ray detection from space is crucial for GRB studies.**
- **sensitivity in the range 10 MeV – 100 GeV.**
- **next-decade proposed mission/ideas:**
  - **GAMMA-400**
  - **GAMMA-LIGHT**

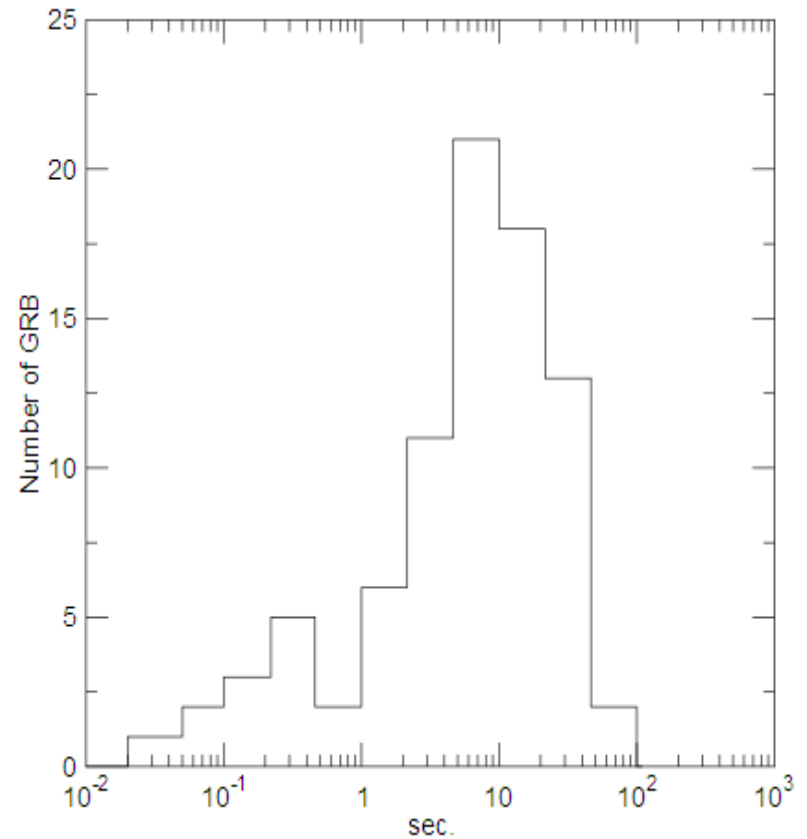
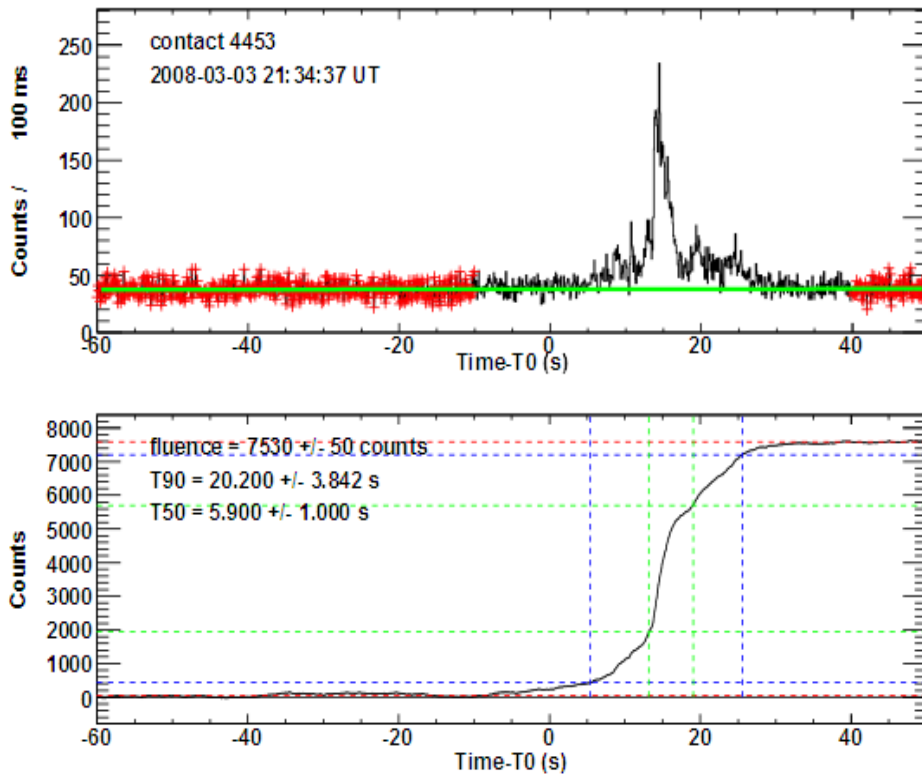
# MCAL GRB catalog

- 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



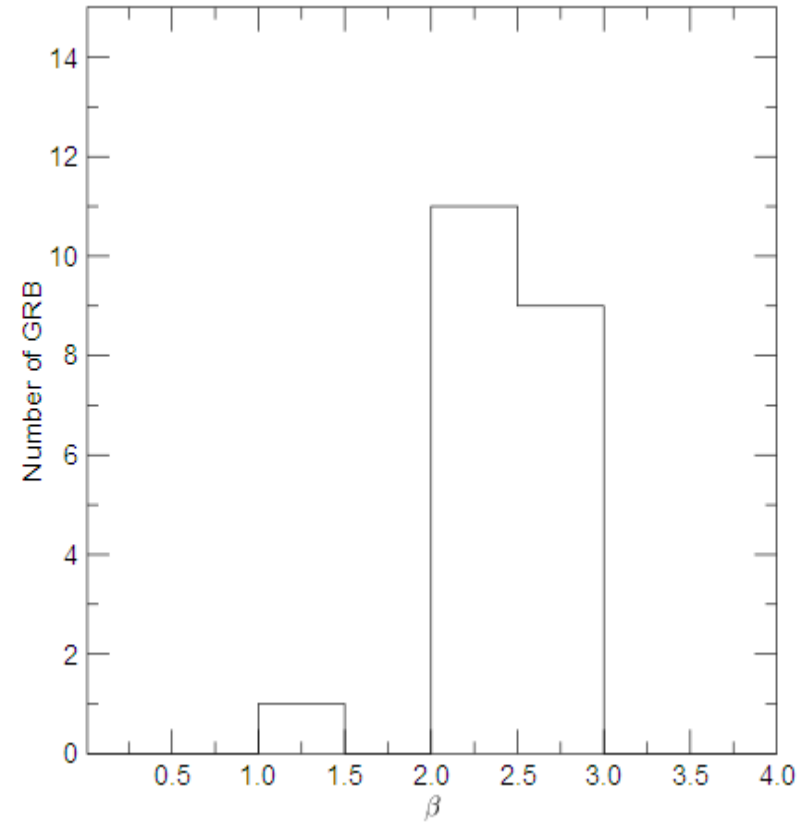
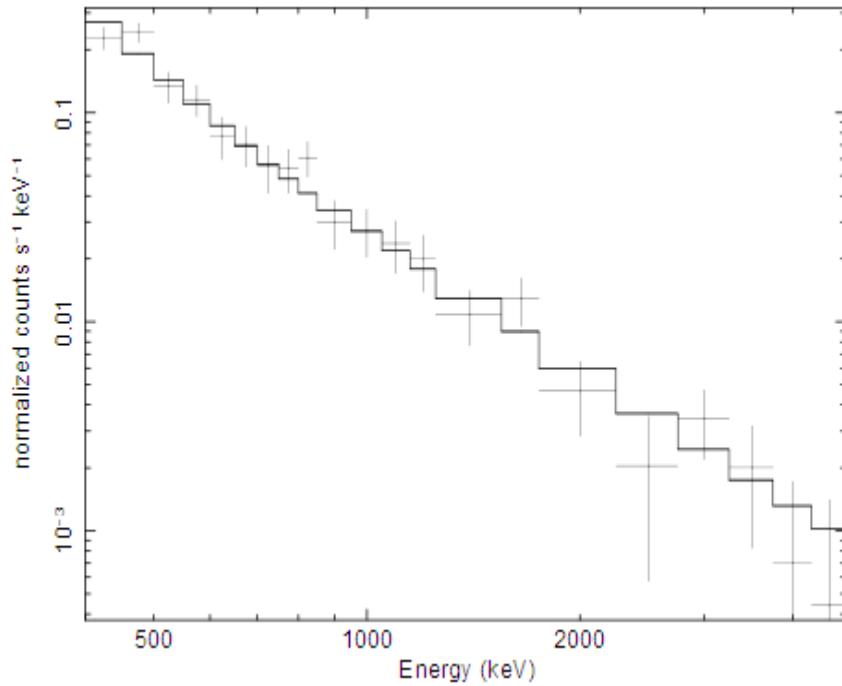
**Galli et al. 2013,  
A&A, accepted**

# MCAL GRB catalog – timing analysis



Galli et al. 2013,  
A&A, accepted

# MCAL GRB catalog – spectral analysis

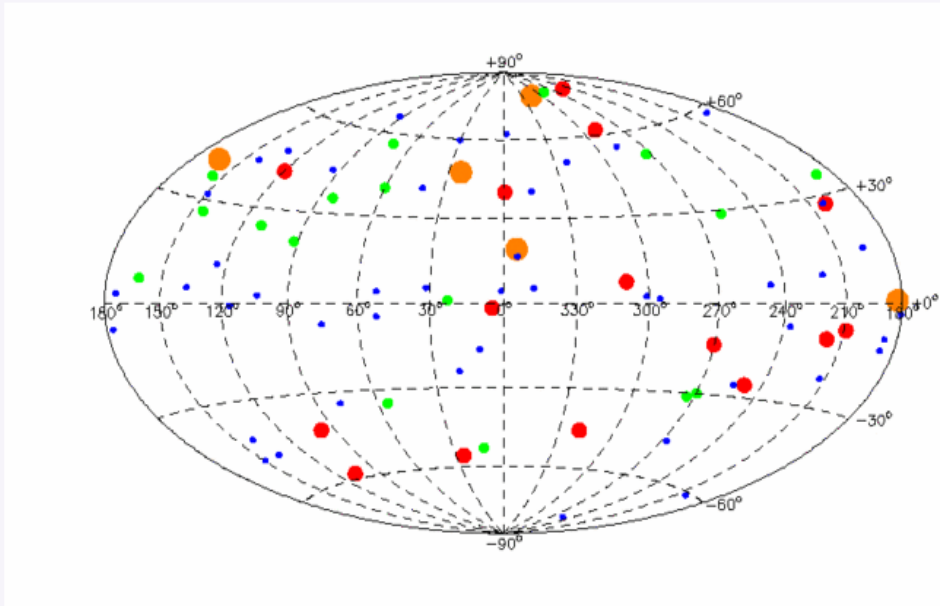


**Galli et al. 2013,  
A&A, accepted**

# MCAL GRB catalog

## The AGILE MCAL Gamma-ray Burst Catalog

GRB observed from April 2007 to October 2009  
(AGILE Pointing Mode)



**ALL** **Published** **Others**

<http://www.asdc.asi.it/mcalgrbcatalog/>

asdc  
ASI Science Data Center

VO  
Tools

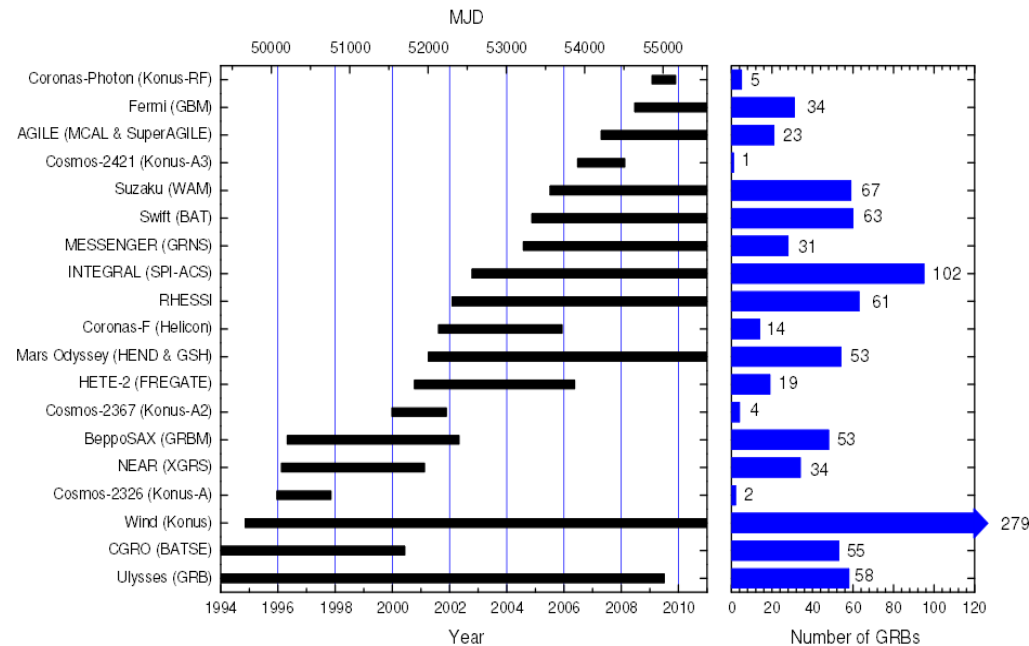
VO mode: off (turn on)  
Help

**Cone Search**  
Source Name  
Resolve name  
 RA, Dec  L, B Clean  
(e.g. 00 02 34.6, -53 01 10.2 or 0.64417, -53.0195)  
radius 60 arcmin Search  
Reset filter



# AGILE contribution to IPN

- Participation to catalog of Short Burst di Konus (arXiv:1301.3740)
  - 23 detections by AGILE
- Participation to the IPN supplement to GBM catalog – (arXiv:1301.3740)
  - 67 detections by AGILE
- 33 GCN by IPN with AGILE
- GRB data sent to IPN

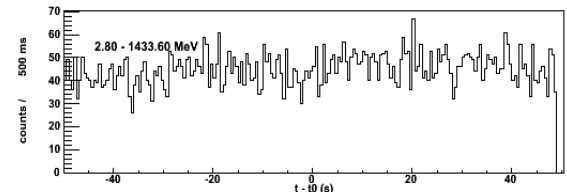
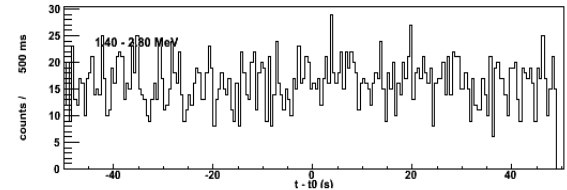
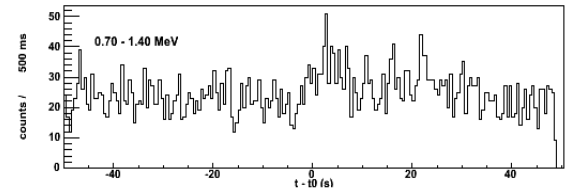
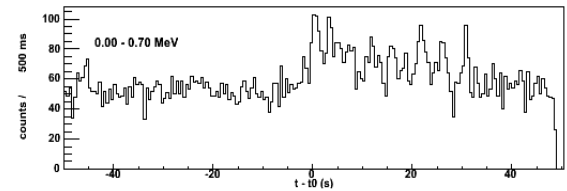
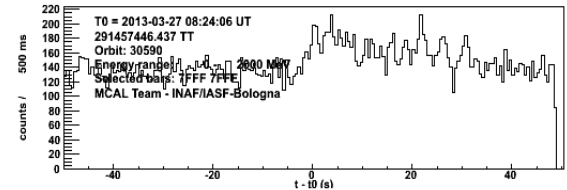
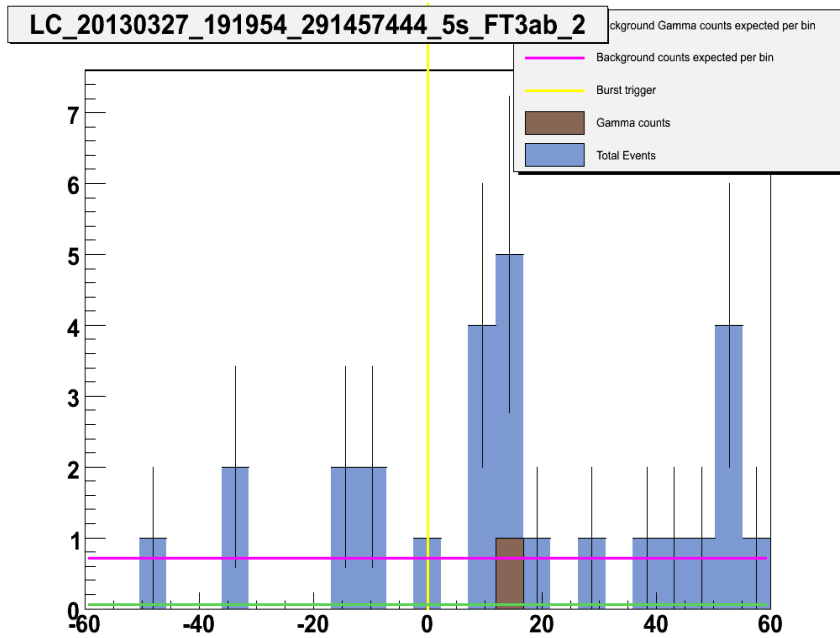


# Conclusions

- Only a small subsample of GRBs emits in gamma rays: the overall detection rate (AGILE + Fermi) is  $\approx 10$  events per year (consistent with the expectations of Band et al. 2009);
- GeV emitting are the brightest GRBs ( $\approx 10^{-5}$  erg/cm<sup>2</sup> at keV – MeV) and have high minimum Lorentz factor (600 – 1000);
- Both classes of long (e. g. GRB 080514B, GRB 090401B, GRB 100724B, GRB 130327B, 130427A) and short (e. g. GRB 090510) are detected in the gamma energy band.
- Some events have a single spectrum (e. g. GRB 080514B; GRB 100724B) other have additional spectral components (e. g. GRB 090510);
- Gamma-ray emitting GRBs seem to be characterised by high fluence and high Lorentz factor. It is still debated if gamma-rays are produced in internal (prompt) or external (afterglow) shocks.
- AGILE detected all the major characteristics of HE GRB (delayed emission, extended emission, power-law extracomponent)
- A cross calibration work with Fermi has started.

# Preliminary info on GRB 130327B

- GRB detected by AGILE GRID (GCN 14344) and Fermi/LAT (GCN 14347)



# GRB 130327B

TITLE: GCN CIRCULAR  
NUMBER: 14344  
SUBJECT: GRB 130327B: gamma-ray detection by AGILE  
DATE: 13/03/27 23:24:56 GMT  
FROM: Ettore Del Monte at IASF/INAF <sa.grb@iaps.inaf.it>

F. Longo (University of Trieste and INFN Trieste), A. Giuliani (INAF/IASF Milan), M. Marisaldi (INAF/IASF Bologna), E. Del Monte (INAF/IAPS Rome), F. Lazzarotto, I. Donnarumma, Y. Evangelista, M. Feroci, L. Pacciani, P. Soffitta, E. Costa, I. Lapshov, M. Rapisarda (INAF/IAPS Rome), G. Barbiellini, (INFN Trieste), A. Bulgarelli, F. Gianotti, M. Trifoglio, G. Di Cocco, C. Labanti, F. Fuschino, M. Galli (INAF/IASF Bologna), A. Chen, S. Mereghetti, F. Perotti, P. Caraveo (INAF/IASF Milan), M. Tavani, V. Vittorini, A. Argan, G. Piano, S. Sabatini, M. Cardillo (INAF/IASF Rome), G. Pucella (ENEA Frascati), A. Pellizzoni, A. Trois (INAF/OA Cagliari), M. Pilia (ASTRON), S. Vercellone (INAF/IASF Palermo), P. W. Cattaneo, A. Rappoldi (INFN Pavia), P. Picozza, A. Morselli, E. Striani, (INFN Roma-2), M. Prest, E. Vallazza (Universita' dell'Insubria), P. Lipari, D. Zanello (INFN Roma-1), P. Giommi, C. Pittori, F. Lucarelli, P. Santolamazza, F. Verrecchia (ASDC) and G. Valentini (ASI), on behalf of the AGILE Team, report:

The AGILE Gamma Ray Imaging Detector (GRID) detected emission from GRB 130327B, localised by Fermi/GBM (<http://gcn.gsfc.nasa.gov/other/386065447.fermi>). The GRB occurred at approximately 28 deg off-axis in the field of view of the AGILE/GRID.

A preliminary analysis of the AGILE/GRID data in temporal coincidence with the GRB shows a significant excess of gamma-ray events above 80 MeV at the location of the event. Most of the events detected by the AGILE/GRID have times between  $\sim t_0 + 9$  sec and  $t_0 + 14$  sec where  $t_0$  is 27 March 2013 at 08:24:04.05 UT.

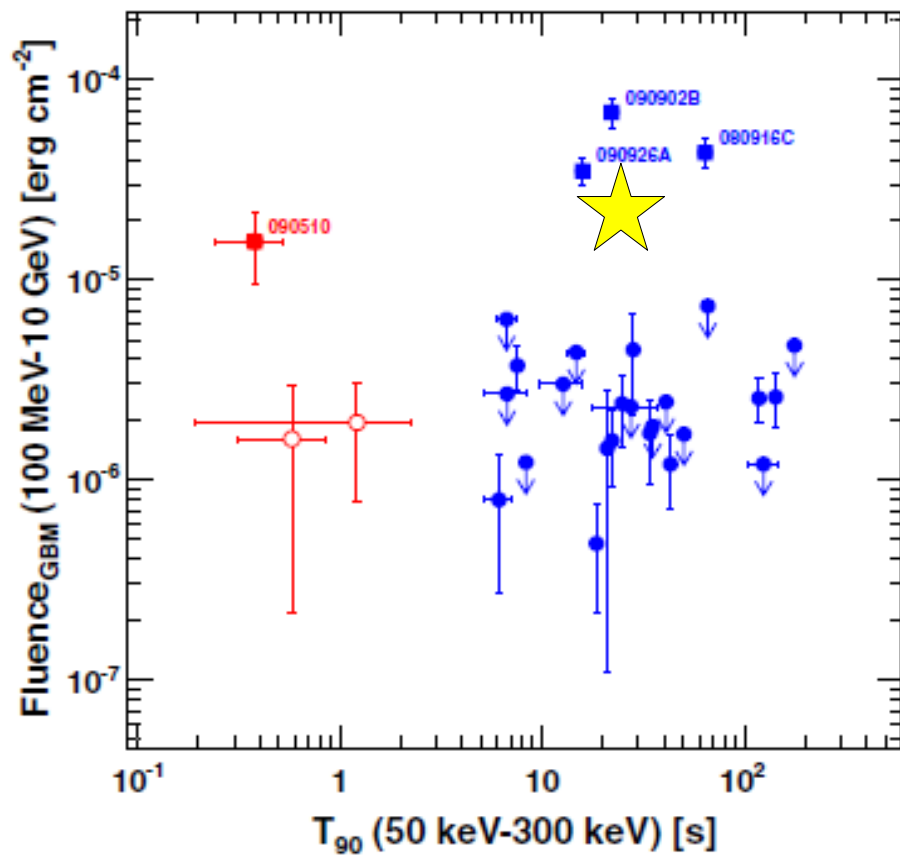
The GRB was also detected also by the AGILE/MCAL, operating in the energy range 0.5 - 100 MeV.

A more detailed analysis of the AGILE data is in progress.  
More observations of this interesting burst are strongly encouraged.

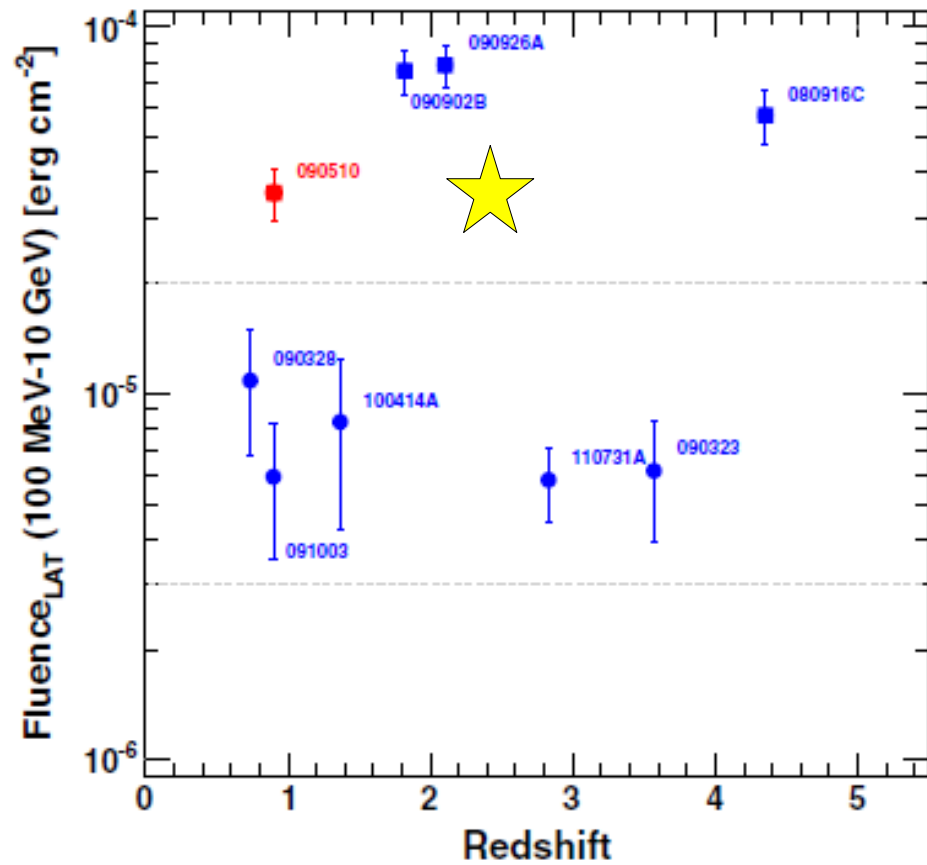
# A quick comparison

	<b>AGILE</b>	<b>FERMI/LAT</b>
<b><math>A_{\text{eff}}</math> (100 MeV) (cm<sup>2</sup>)</b>	<b>~400</b>	<b>~ 2000-2500</b>
<b><math>A_{\text{eff}}</math> (10 GeV) (cm<sup>2</sup>)</b>	<b>500</b>	<b>~ 8000-10000</b>
<b>FOV (sr)</b>	<b>2.5</b>	<b>2.5</b>
<b>sky coverage</b>	<b>1/5</b>	<b>whole sky</b>
<b>Energy resolution</b> <b>(~ 400 MeV)</b>	<b>50 %</b>	<b>10 %</b>
<b>PSF (68 % cont. radius)</b> <b>100 MeV</b> <b>1 GeV</b>	<b>3° - 4°</b> <b>&lt; 1°</b>	<b>3° - 4°</b> <b>&lt; 1°</b>

# GRB 131108A



# GRB 131108A



# GRB 131108A

