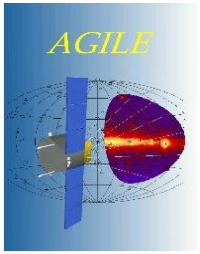


IASF-Bo

The remarkable short GRB 090510

F.Fuschino
on behalf of the AGILE team

The AGILE 7th Workshop
The Bright Gamma-Ray Sky

Outlook on the AGILE GRBs

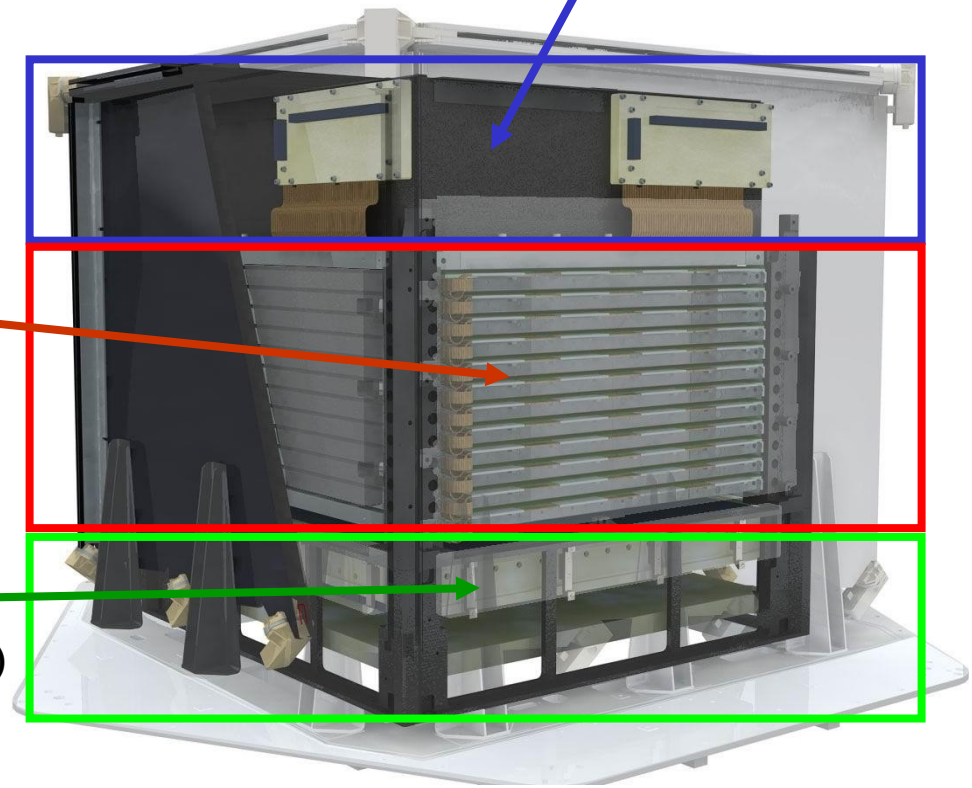
IASF-Bo

SuperAGILE

18-60 keV (Coded Aperture; ~1 sr FoV)
28 GRBs localized since July 2007 (~1GRB/month)
3 arcmin angular resolution
minimum detectable fluence 5×10^{-7} erg cm^{-2};

GRID - Gamma-Ray Imaging Detector

30 MeV – 50 GeV (Silicon tracker; ~2.5 sr FoV)
Three firm detections: **GRB080514B**, **GRB090401B** and **GRB090510**
Two less significant detections: **GRB080721** and **GRB081001**



Mini-Calorimeter (MCAL)

0.35 – 100 MeV (non imaging scintillator; all-Sky FoV)
119 GRBs detected since July 2007 (~1GRB/week)
11 Terrestrial Gamma Flashes (TGFs) detected per month (trigger on 1ms time scale)

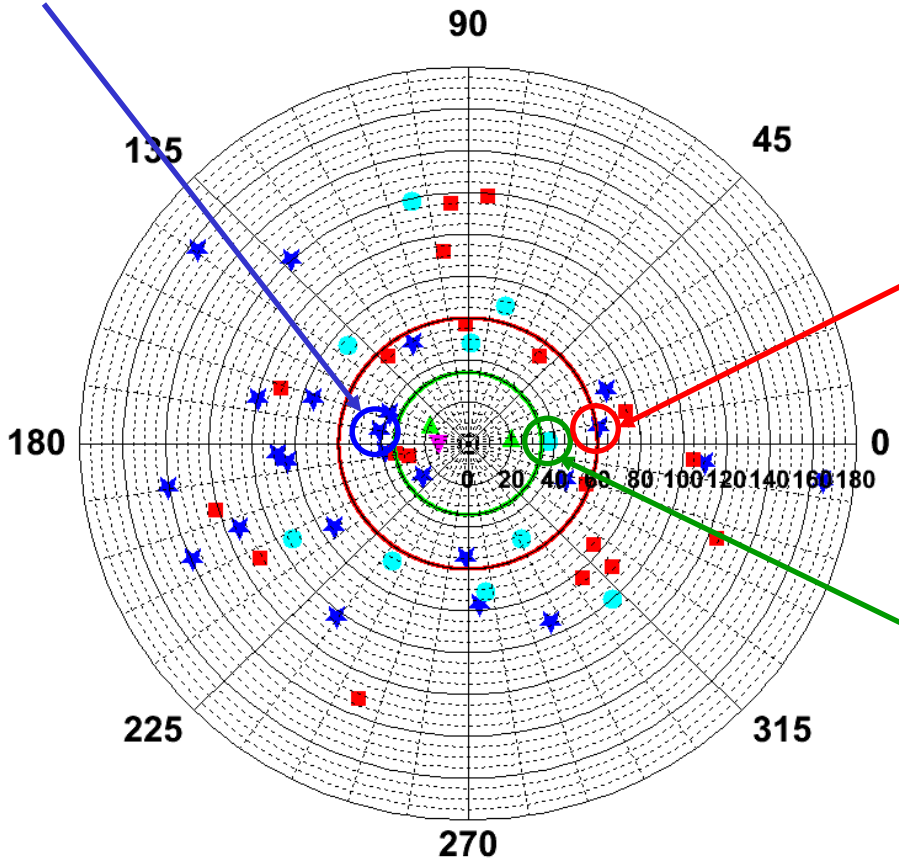
MCAL view on localized GRBs

IASF-Bo

GRB 090401B

GRB 090510

GRB 080514B

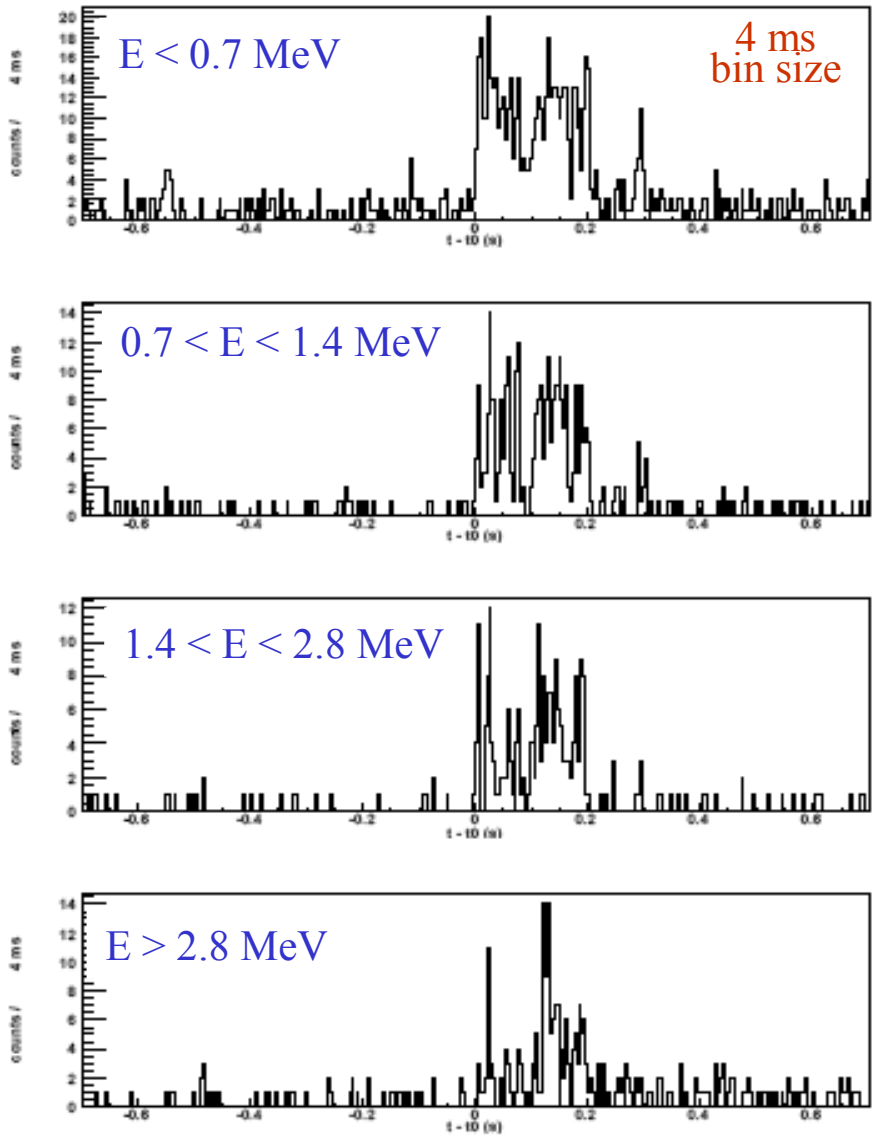


SA FOV
GRID FOV
2 Localized by Super-AGILE
10 Localized by IPN
24 Localized by SWIFT
20 Localized by Fermi-GBM
1 Localized by INTEGRAL

119 confirmed GRBs
57 localized GRBs
36 GRBs with < 90° off - axis angle
17 MCAL GRBs with spectral information

Short GRB 090510: the prompt emission in the MeV band

IASF-Bo

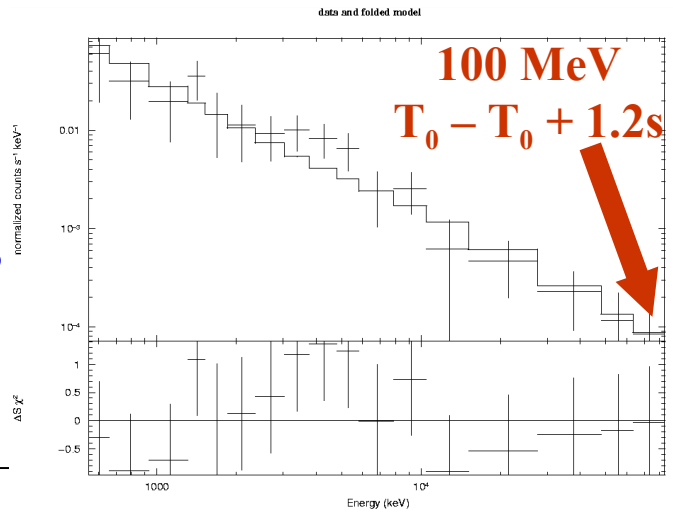


GRB 090510 has been localized by Swift (GCN 9331) and detected also by Fermi/LAT (GCN 9334), AGILE (GCN 9343), Konus-Wind (GCN 9344) and Suzaku WAM (GCN 9355). The redshift is 0.903 (GCN 9353).

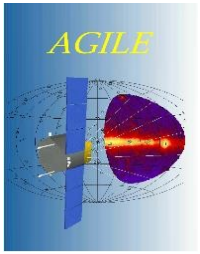
The brightest MCAL GRB in GRID FoV

The second peak is harder than the first one.

T_{90} 184±6 ms

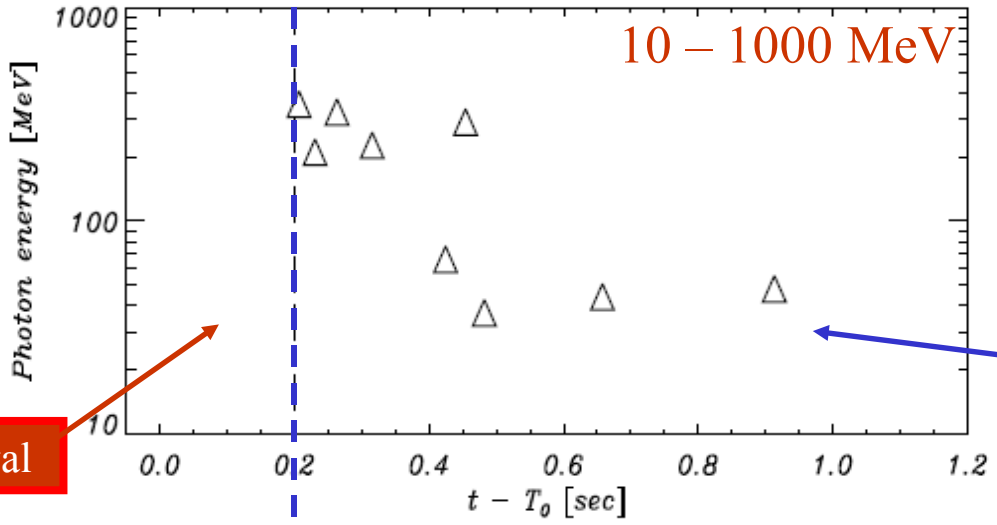


GRB 090510: the first short in GRID



> 5 σ GRID statistical significance

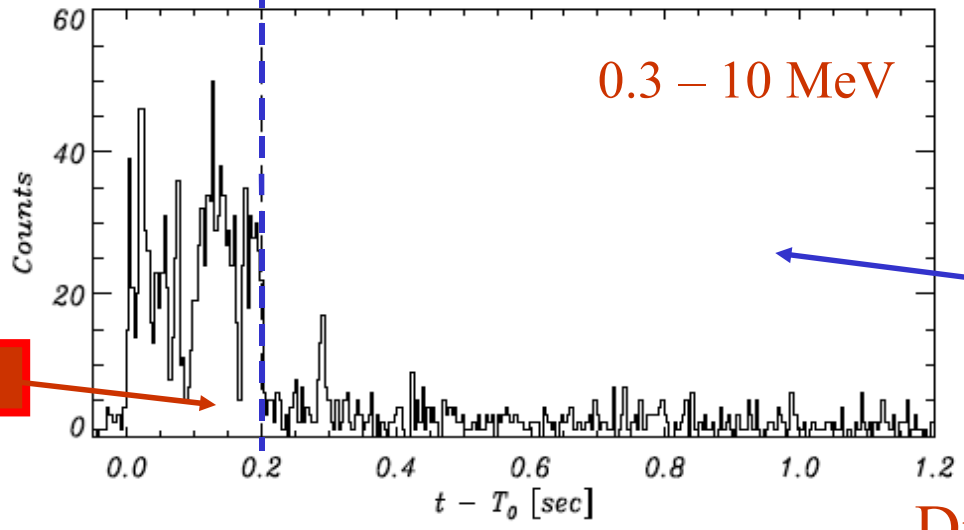
Giuliani et al. 2009, accepted by ApJ Letters



prompt emission interval

delayed emission interval

Interval 1 **Interval 2**



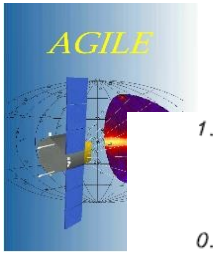
prompt emission interval

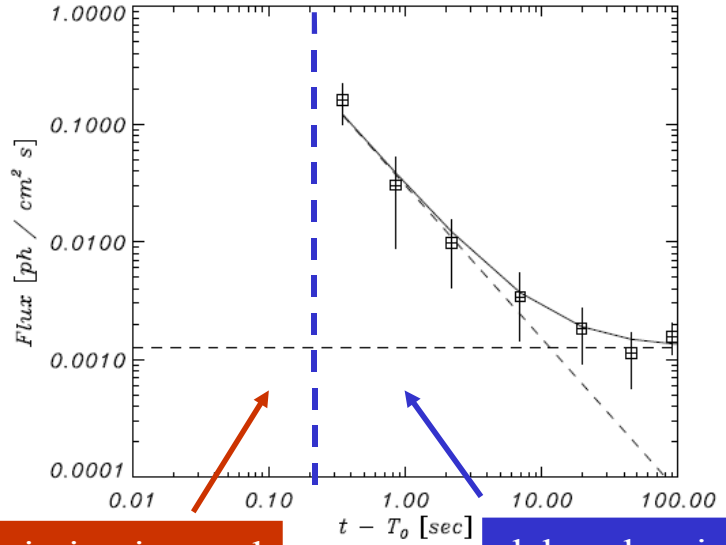
delayed emission interval

The gamma ray emission starts just at the end of the prompt emission in hard X-rays

Distinct radiation phases?

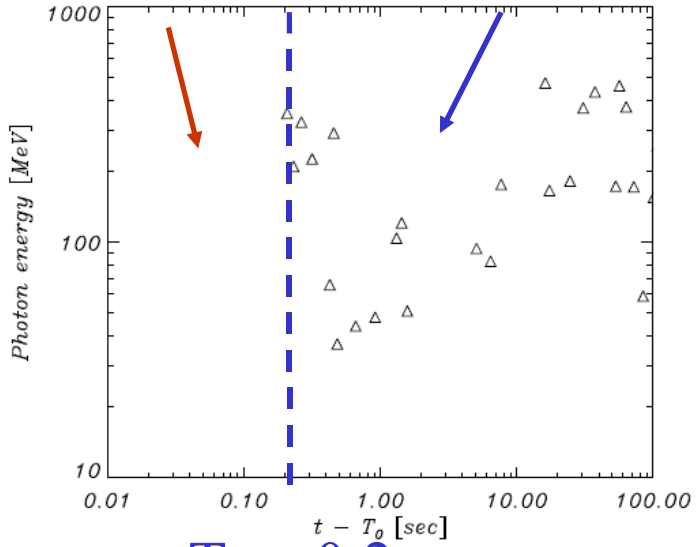
GRB 090510: the delayed emission





prompt emission interval

delayed emission interval



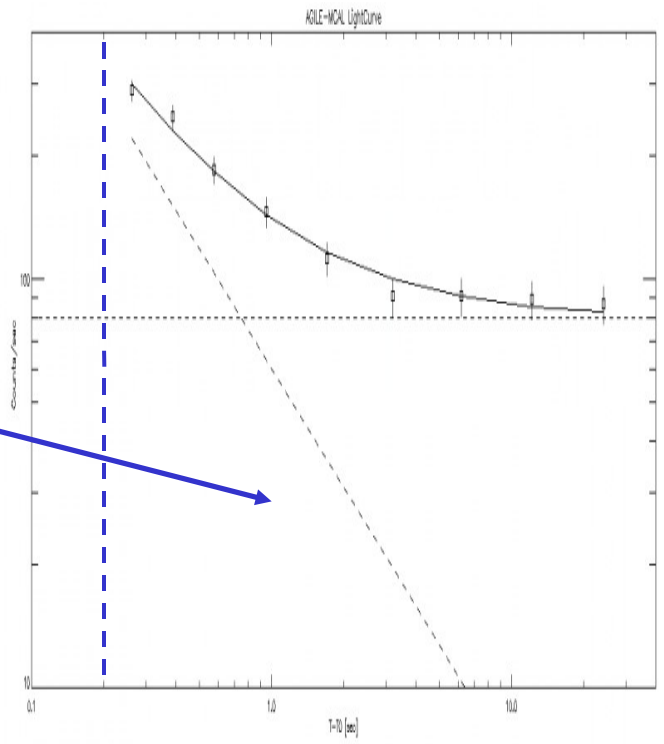
$T_0 + 0.2$ s

GRID Time decay

$F_\nu \sim t^{-\alpha}$

$\alpha \cong 1.30 \pm 0.15$

Giuliani et al. 2009, accepted by ApJ Letters



MCAL Time decay

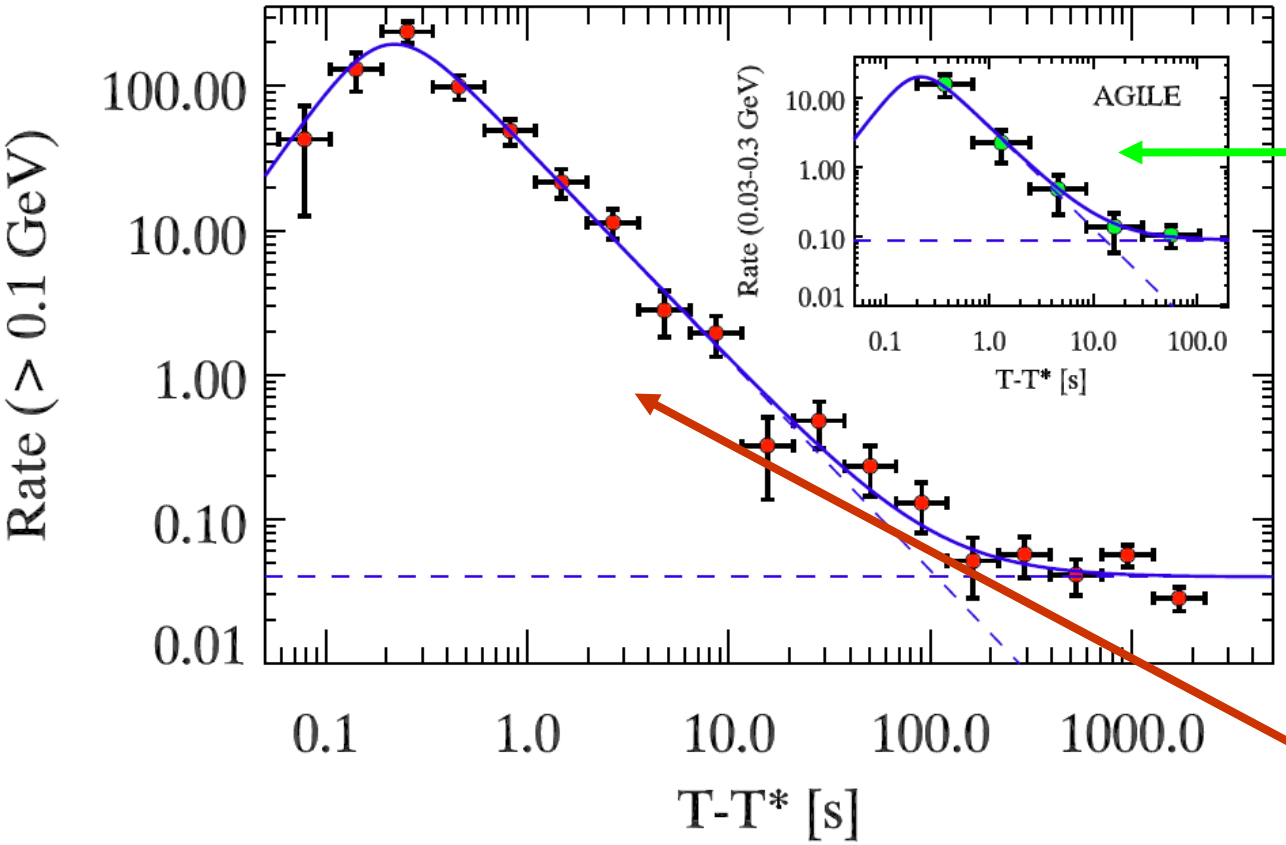
$F_\nu \sim t^{-\alpha}$

$\alpha \cong 0.97 \pm 0.14$

GRB 090510: Time decay

Fermi – AGILE Comparison

IASF-Bo



AGILE Data

from Ghirlanda et al. 2009, submitted [arXiv:0909.0016v1]

Strong consistency between AGILE & Fermi

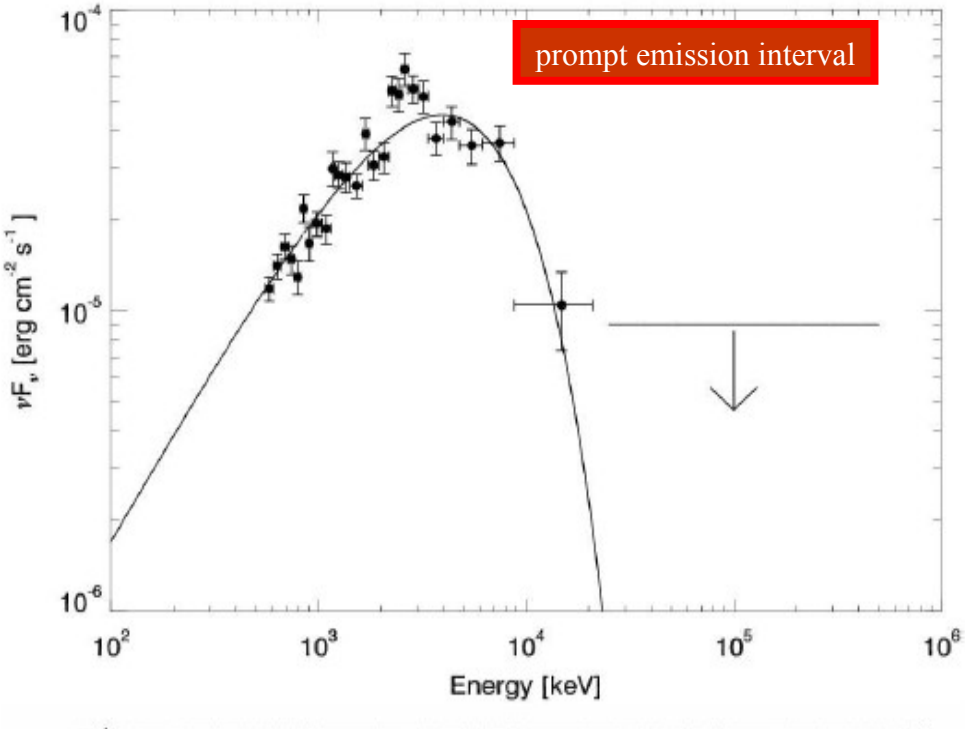
Fermi Data & Best fit

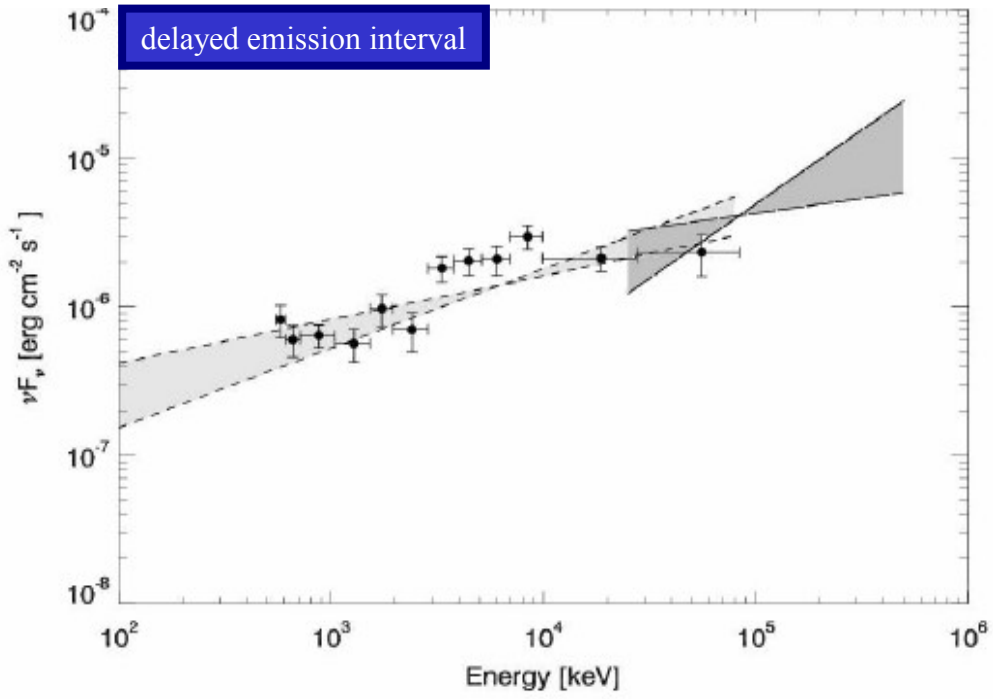
Higher Energy Fermi Photon ~ 31 GeV

see Abdo et al. 2009, submitted [arXiv:0908.1832v1] for Fermi analysis

GRB 090510: spectral evolution in a short GRB

IASF-Bo





Powerlaw with cutoff

$\alpha_1 = 0.6 \pm 0.3$
$E_C = 2.8 \pm 0.9$ MeV
1.8×10^{-5} erg/cm^2 (0.5 – 10 MeV)

$E_P \approx 3.8$ MeV
the highest
E_P ever recorded
for short GRBs

Single Powerlaw

$\alpha_2 = 1.6 \pm 0.1$
3.1×10^{-6} erg/cm^2 (0.5 – 10 MeV)

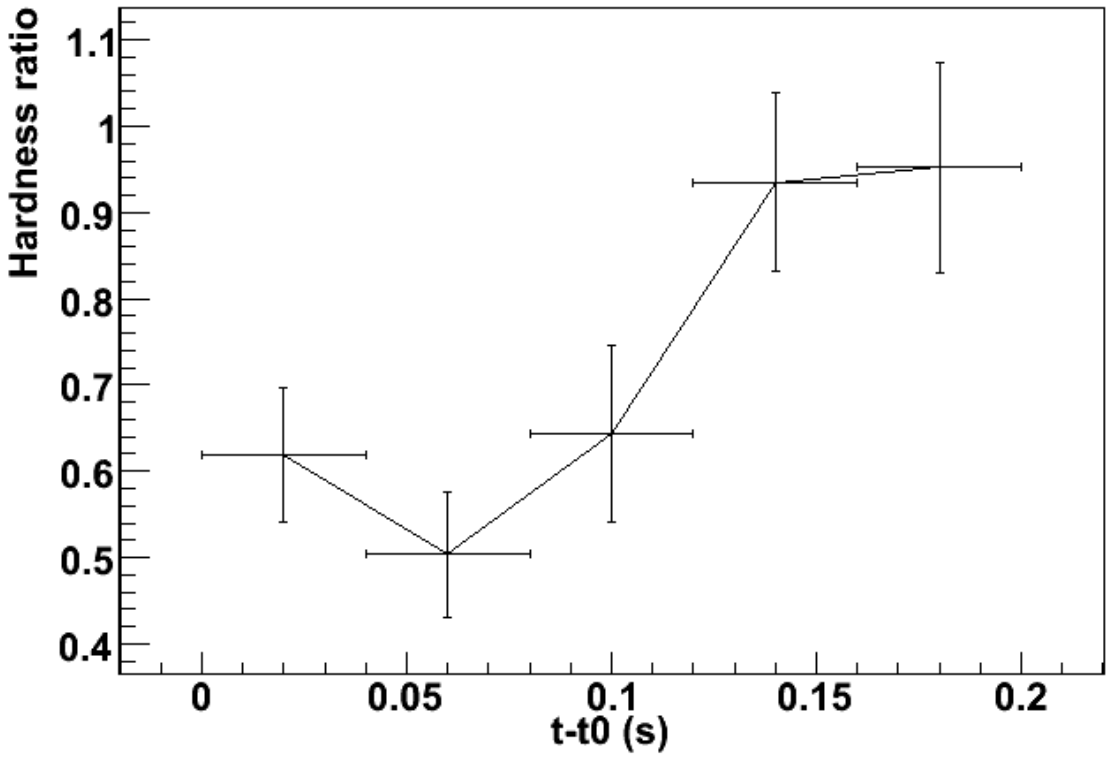
$\alpha_3 = 1.4 \pm 0.4$
2.9×10^{-5} erg/cm^2 (25 – 500 MeV)

GRB 090510: other marks of spectral evolution

IASF-Bo

CLEAR evidence of
Spectral evolution
during Prompt Phase
(Energy range > 0.35 MeV)

(Nph > 1 MeV) / (Nph < 1 MeV)



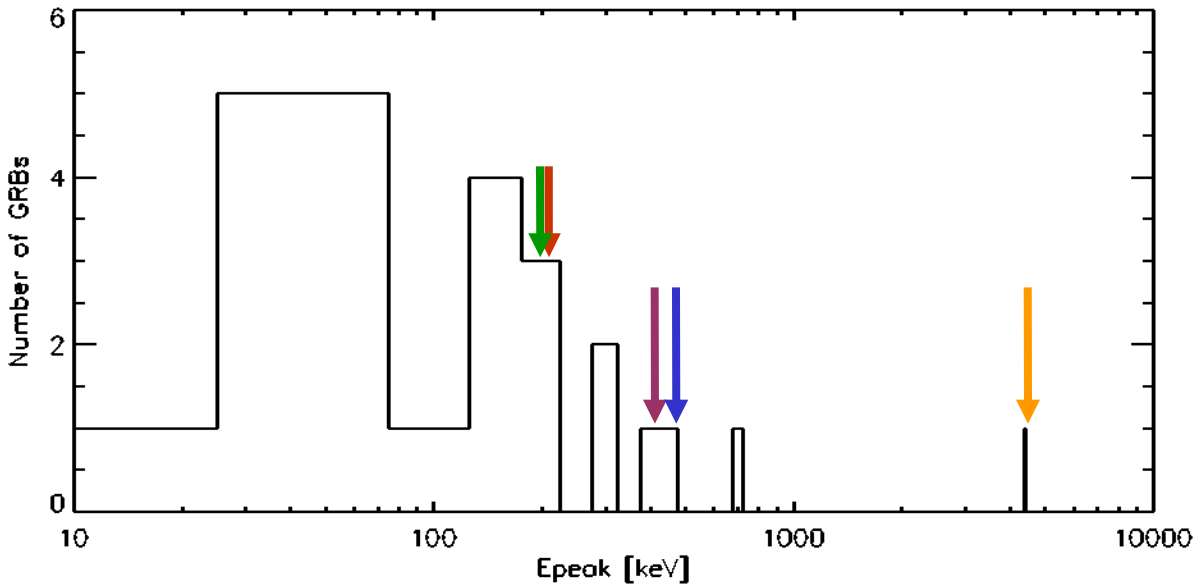
No enough MCAL statistics for single peak spectral analysis

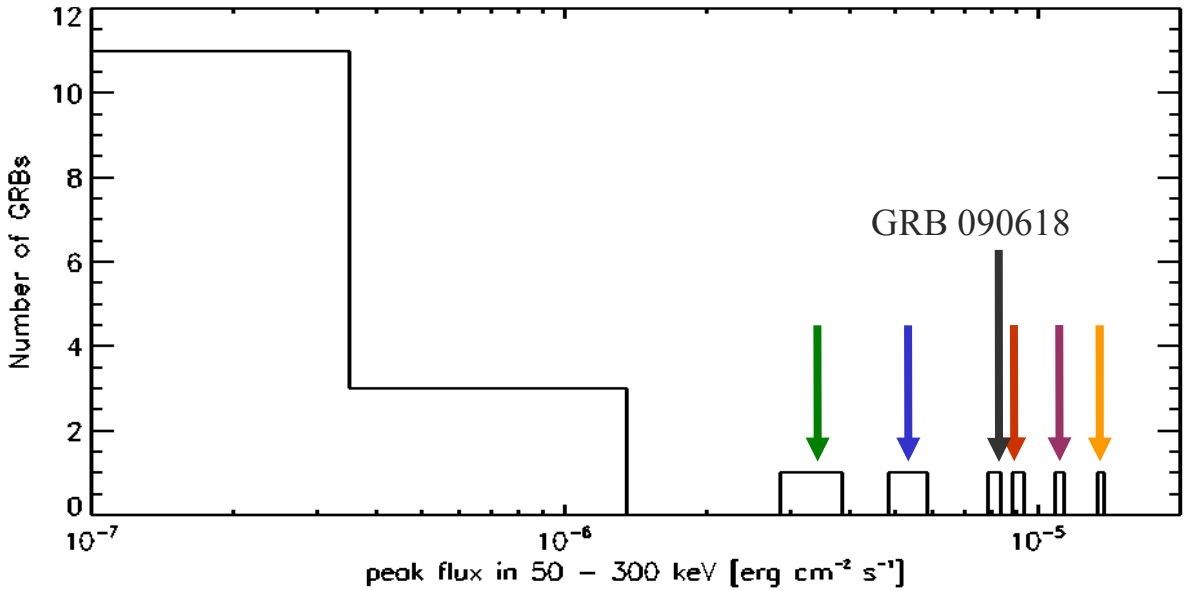
ONLY Hardness Ratio evaluation

Spectral evolution confirmed also by Fermi (see Abdo et al. 2009)

General review of GRBs in GRID FoV

IASF-Bo



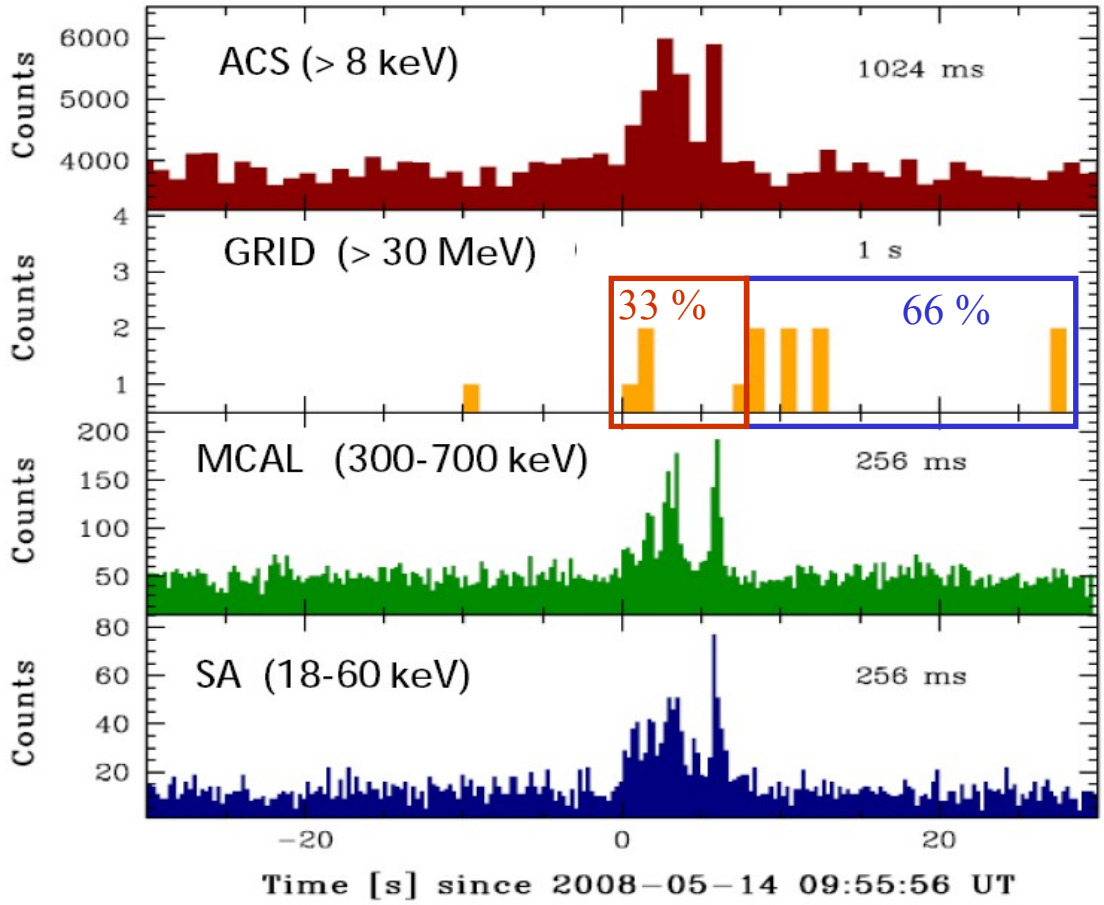


GRB080514B, GRB090401B and GRB 090510 are firmly detected by GRID;

GRB080721 and GRB081001 have smaller significance in GRID;

GRB 080514B: the first gamma-ray bright GRB associated to an afterglow

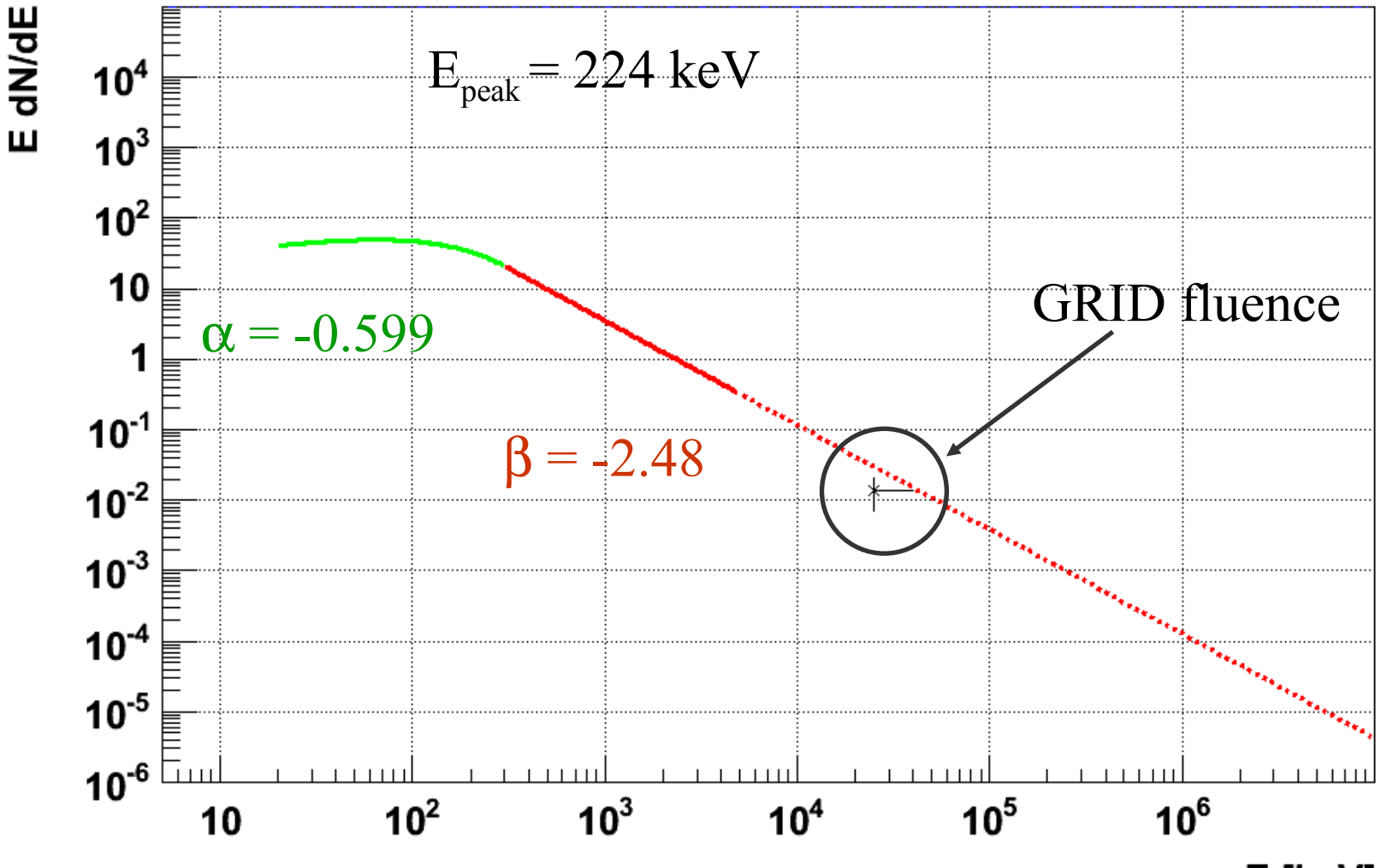
IASF-Bo



The main feature of GRB 080514B is the extended emission in gamma rays (Giuliani et al., 2008, A&A). It is the first gamma-ray bright GRB after EGRET and is also associated to an afterglow and a photometric redshift measure of 1.8 (A. Rossi et al., 2008, A&A).

A single model for the whole spectrum of GRB 080514B

-Bo

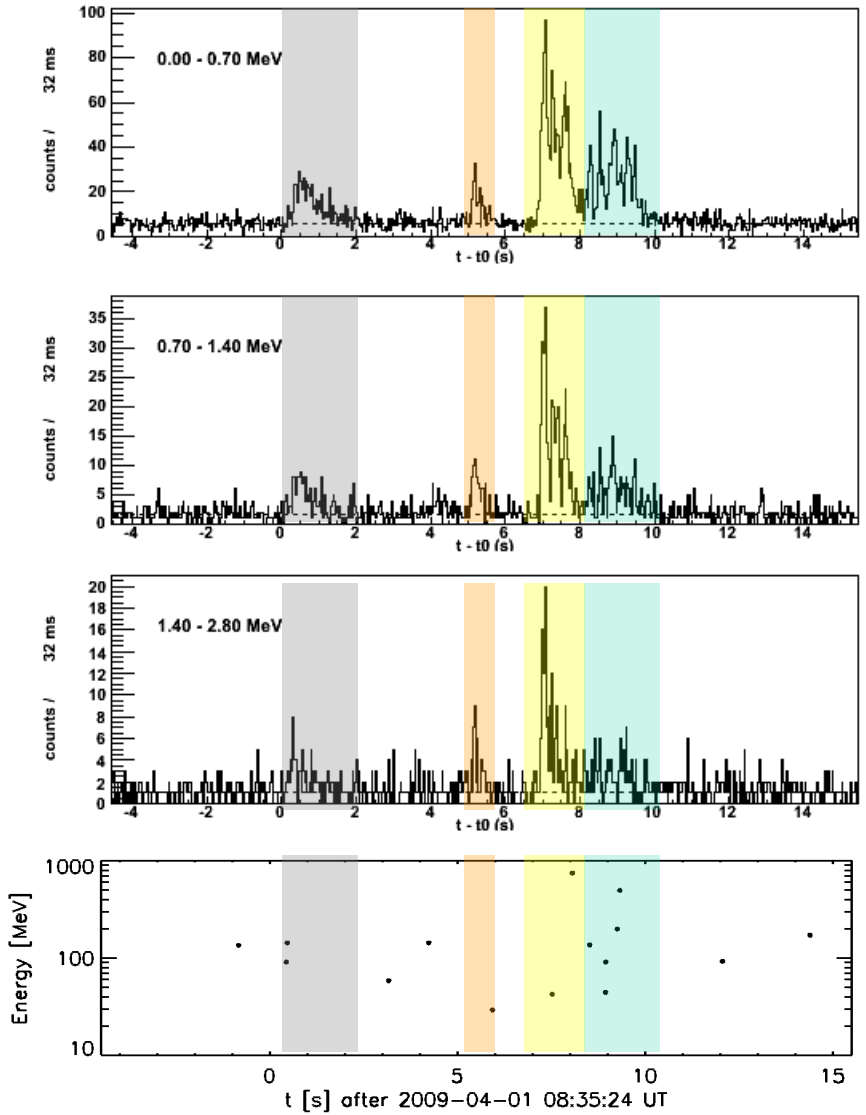


Konus-Wind spectrum in 20 keV – 5 MeV (GCN 7751).

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

GRB 090401B: prompt MeV emission

IASF-Bo

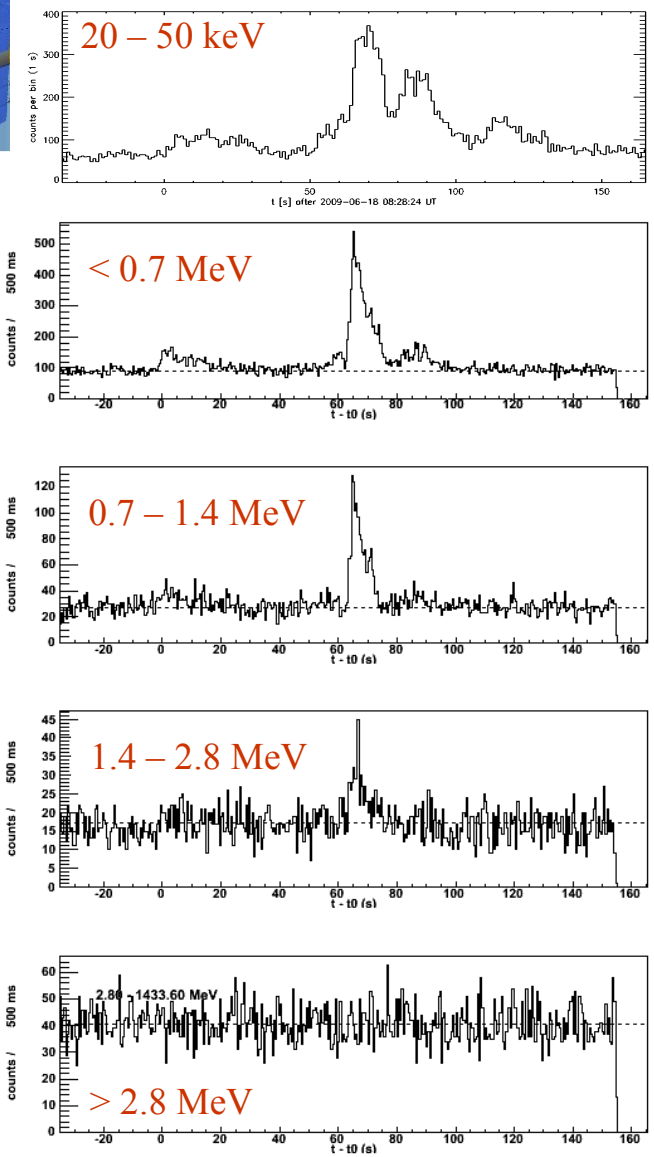


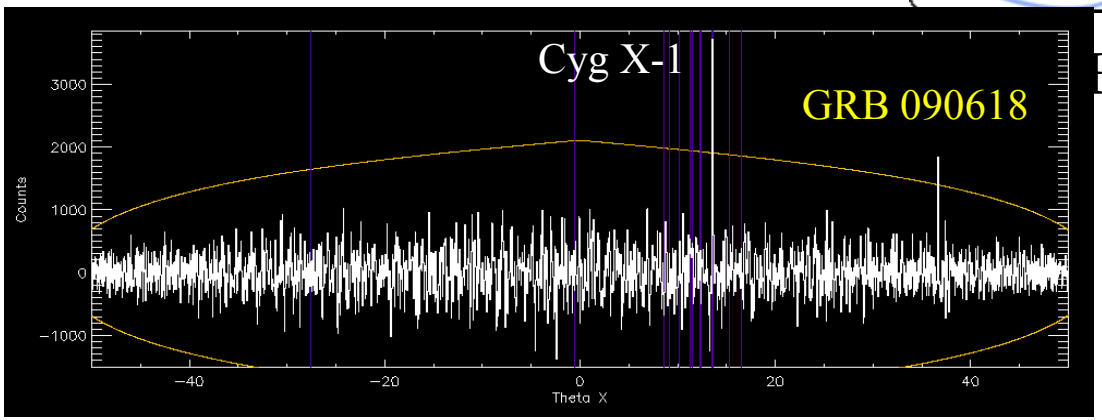
68 % of the gamma ray photons are emitted during prompt;

32 % of the gamma ray photons are in the extended emission

The AGILE MCAL detected GRB 090401B up to the MeV region. A paper is in preparation.

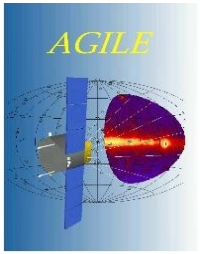
The interesting case of GRB 090618





GRB 090618 compared with Cyg X-1 in the orbital image of SuperAGILE (20 – 50 keV, 3 ks exposure).

Despite the remarkable value of E_{peak} = 186 keV (GCN 9553) and a rescaled peak flux of 8.3×10^{-6} erg/cm^2/s (in 50 – 300 keV), this GRB is not detected in the gamma ray band.



Conclusions

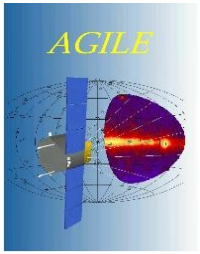
IASF-Bo

short 090510

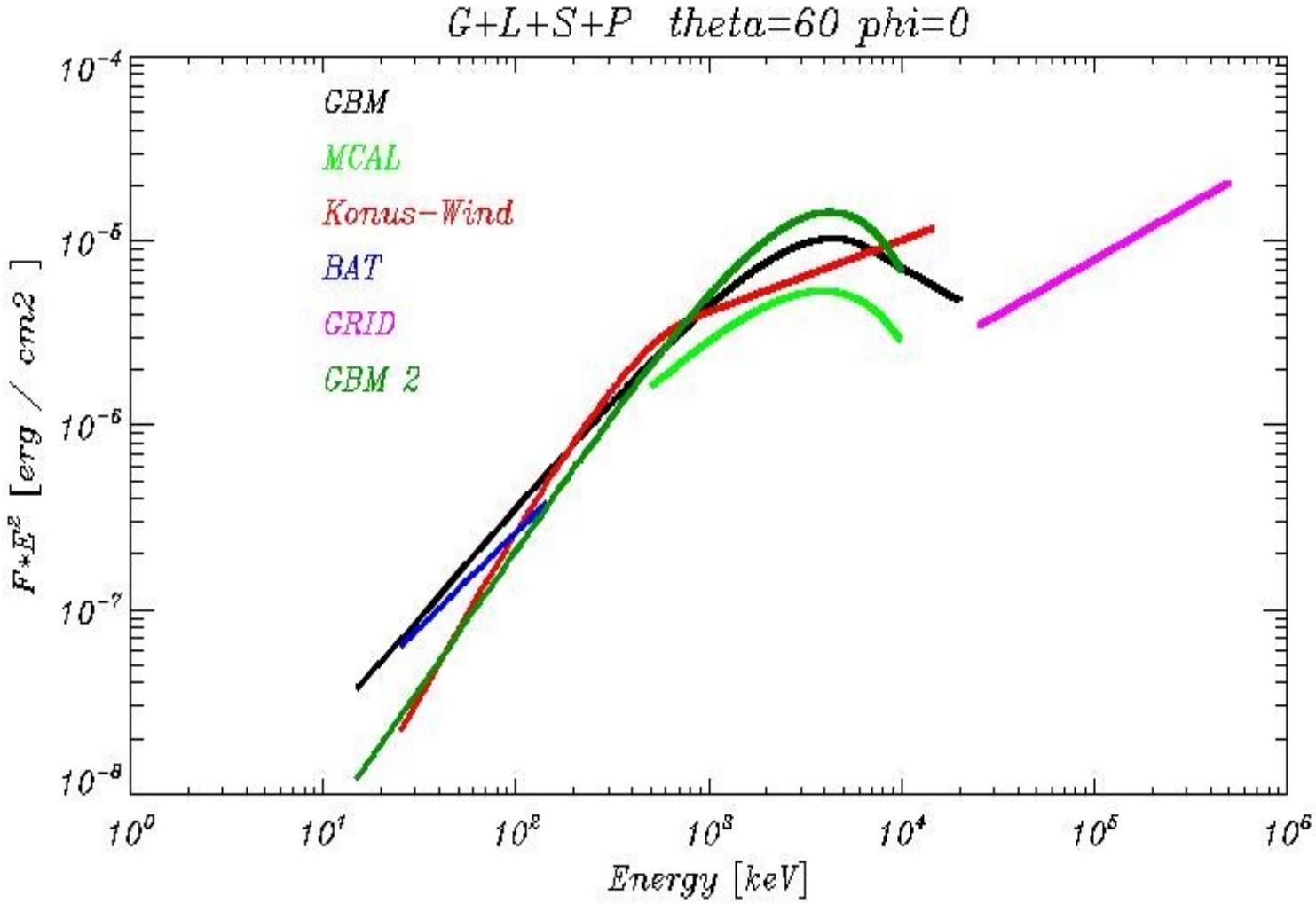
- short GRB 090510 shows, for the first time, distinct radiation phases during Interval I and II
- Clear soft to hard spectral evolution;
- Higher E_{peak} ever recorded for a short GRB
- From spectral and timing results Lorenz factor can be evaluated: $\Gamma_I \geq 150$ and $\Gamma_{II} \geq 200$ (**$\Gamma \geq 1200$** from Fermi results)
- Strong consistency with Fermi results

IN GENERAL

- The extended emission of gamma rays is a common feature of the GRBs (both long and short) detected in high energy band;
- Only a small subsample of GRBs emits in gamma rays:
  - AGILE/GRID detected 5 GRBs in two years;
  - Fermi/LAT detected 10 GRBs in one year;
- The gamma ray emission of GRB 090510 is debated: prompt or afterglow? (see e.g. Ghirlanda, Ghisellini and Nava 2009);


AGILE

IASF-Bo


G+L+S+P theta=60 phi=0
GBM
MCAL
Konus-Wind
BAT
GRID
GBM 2
F*E^2 [erg / cm2]
Energy [keV]
10^-4
10^-5
10^-6
10^-7
10^-8
10^0
10^1
10^2
10^3
10^4
10^5
10^6