

Exploring the low-energy domain of LAT-detected GRBs



Elisabetta Bissaldi*, Nicola Omodei,
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on behalf of the Fermi-LAT Collaboration

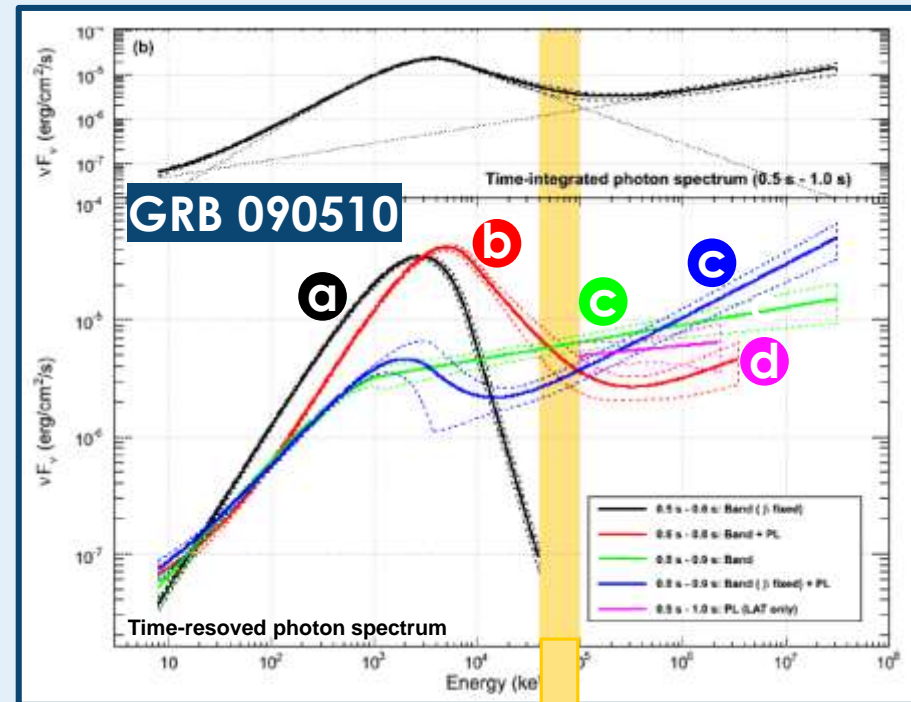
GRB observation in the Fermi Era

- Understanding the **temporal** and **spectral** properties of GRBs at high energies in the **Fermi era**

Ackermann+2013

- Study of the **prompt GRB emission** in the range **10–100 MeV: a previously poorly explored territory**

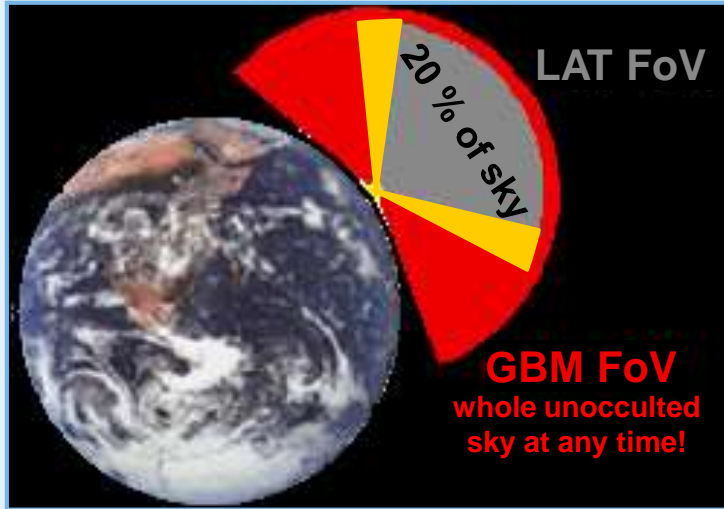
- Possible break and/or continuation?
- Different component?



Pelassa+10

40–100 MeV energy band

GRB observation in the Fermi Era



Gamma-Ray Burst Monitor

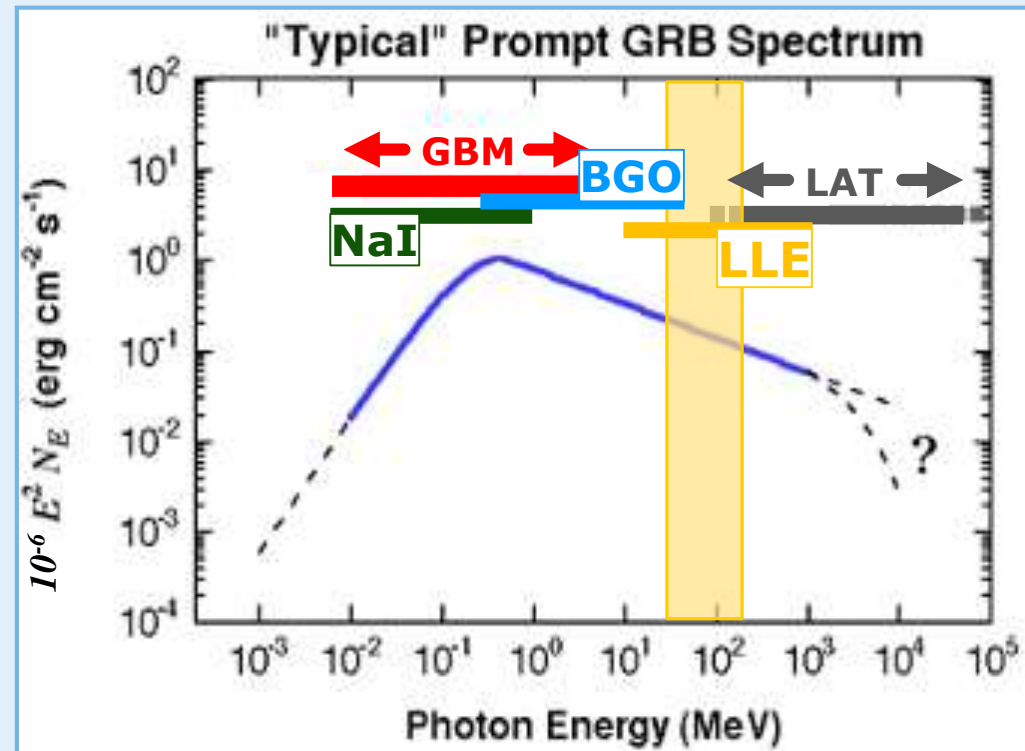
➔ **NaI:** 8 – 900 keV
➔ **BGO:** 250 keV – 40 MeV

Large Area Telescope

➔ **LAT:** 100 MeV – 300 GeV

➔ **LLE*:** 10 MeV – 1 GeV

*LAT Low-energy Technique



The LAT Low-energy technique



- The **LLE class**
 - looser selection criteria, higher acceptance
 - larger effective area at lower energies (<100 MeV) and at larger off-axis angles ($>60^\circ$)
 - Wide PSF \rightarrow higher background contamination, limited spatial resolution

Fermi Science Data Product Interface Control Document
http://fermi.gsfc.nasa.gov/ssc/library/support/Science_DP_ICD_RevA.pdf

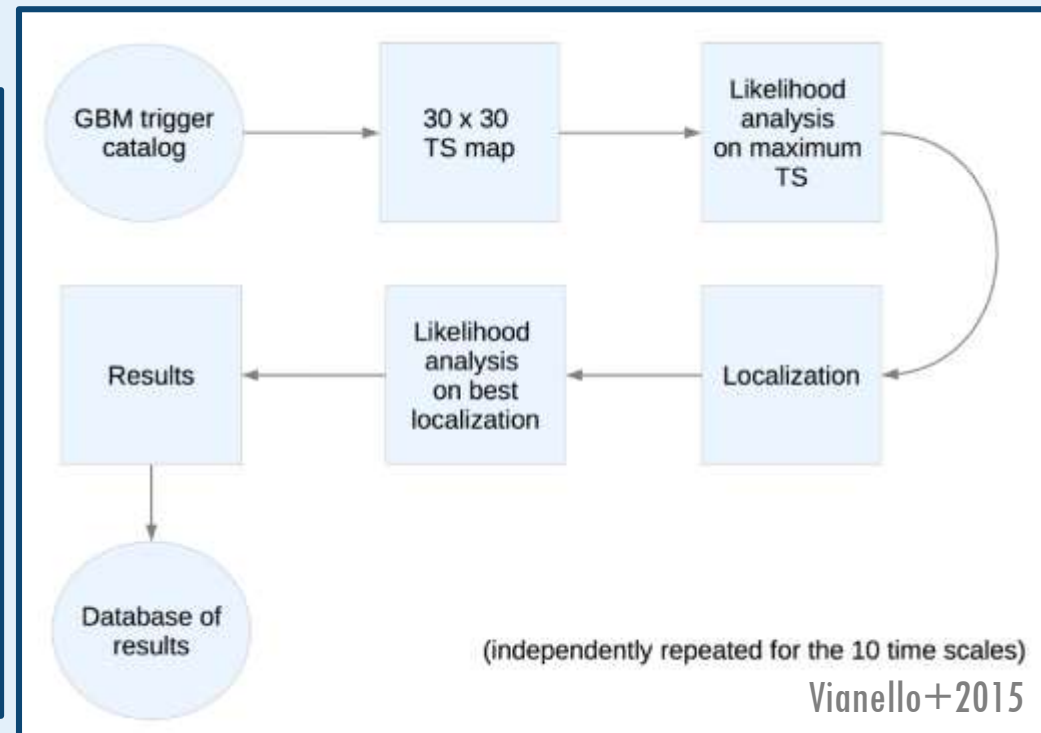
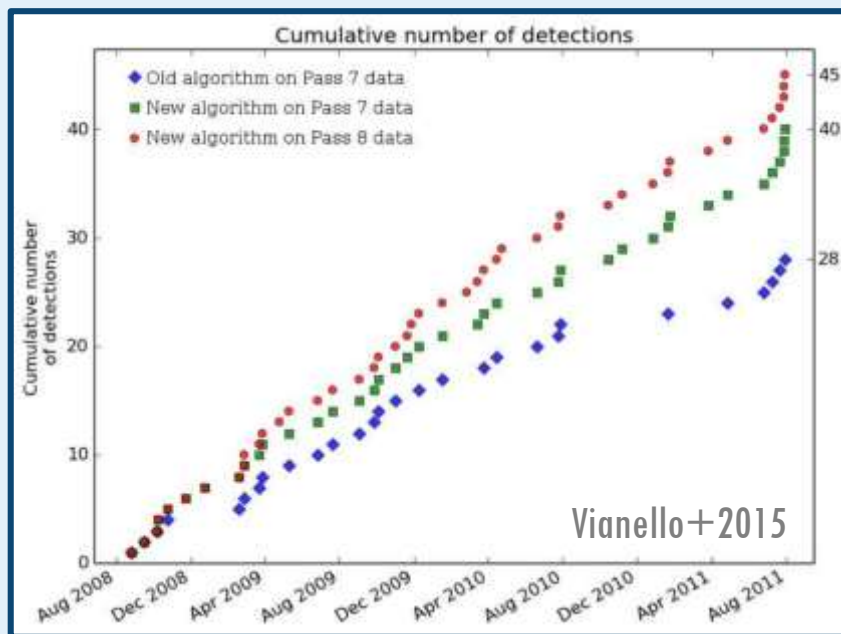
| LS-015 | LLE CSPEC | LAT Low Energy Events CSPEC files for GRB and Solar Flares | Selected GRB and Solar Flares | On update | < 1Mbyte | Ancillary |
|--------|--------------|--|-------------------------------|-----------|----------|-----------|
| LS-016 | LLE RSP | LAT Low Energy Events response file for GRB and Solar Flares | Selected GRB and Solar Flares | On update | < 1Mbyte | Ancillary |
| LS-017 | LLE PHA1 | LAT Low Energy Events count spectrum (PHA1) files | Selected GRB and Solar Flares | On update | < 1Mbyte | Ancillary |
| LS-018 | LLE Selected | LAT Low Energy Events event file containing only selected events | Selected GRB and Solar Flares | On update | < 1Mbyte | Ancillary |
| LS-019 | LLE PT | LAT Low Energy Events pointing and livetime history file | Selected GRB and Solar Flares | On update | < 1Mbyte | Ancillary |

- Designed for:
 - Analysis of transients (GRBs, solar flares) with **soft spectra** or occurring at **high off-axis angles**
 - Detailed studies of the **temporal structure** of GRB emission
 - Studies of **short transients**
- In the framework of the **LAT GRB catalog**:
 - LLE data is used only for **source detection** and **duration measurement**



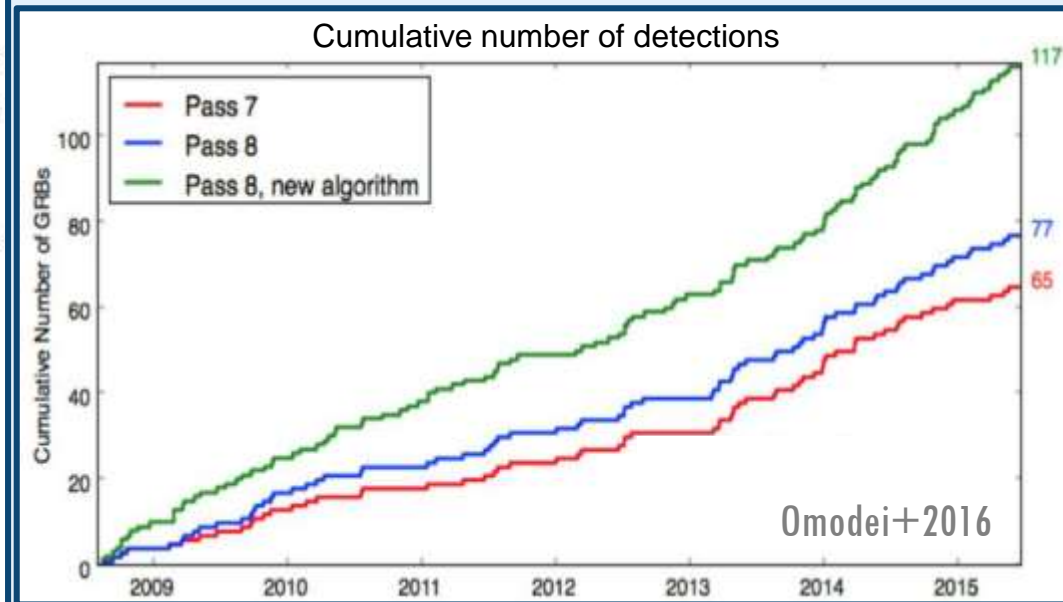
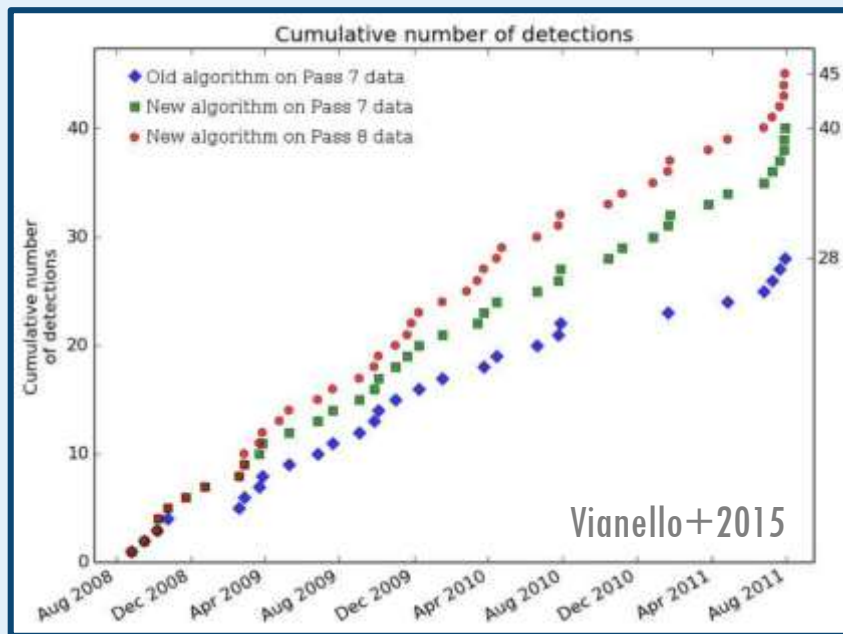
Towards the 2° LAT GRB Catalog

- The LAT collaboration implemented a new scheme to detect GRBs, the **LAT Transient Factory (LTF)** Vianello+2015
 - **Overcome** large GBM systematic error on the **localization**
 - Search on **different time scales**
 - ➔ **Increase** by >50% of the rate of **LAT-detected bursts**
 - ➔ Also evident in published **GCNs**!



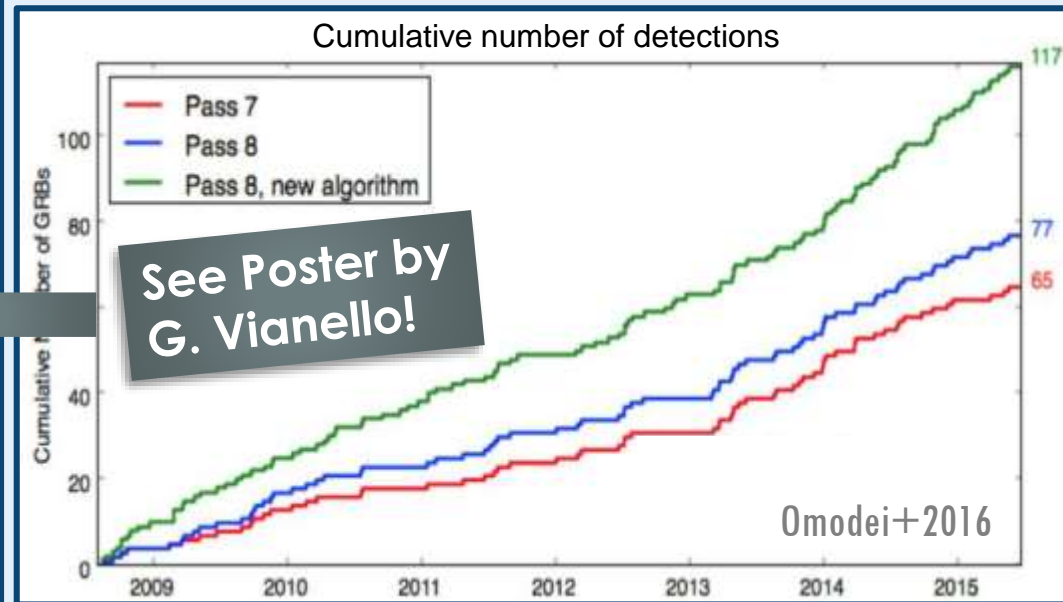
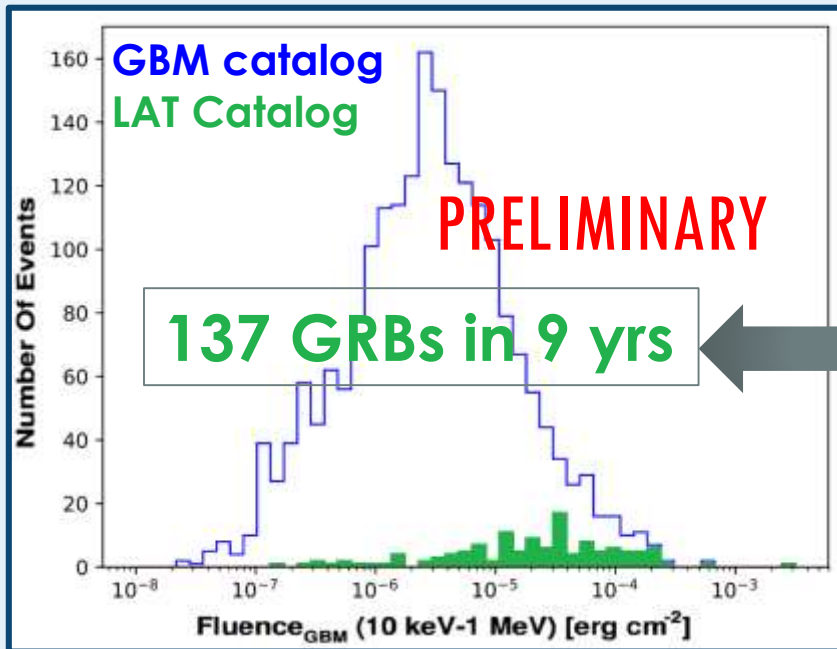
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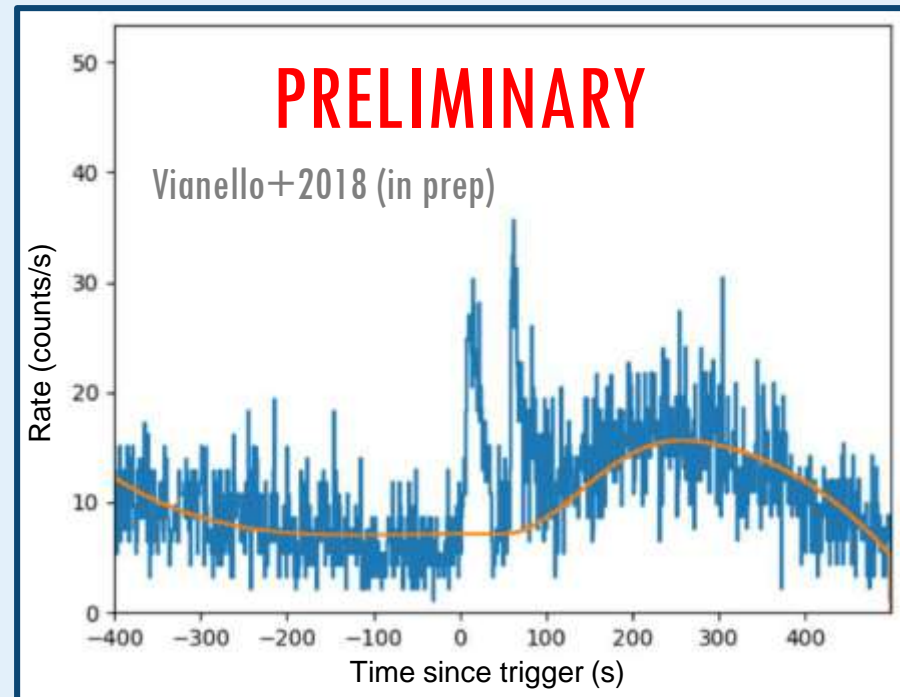
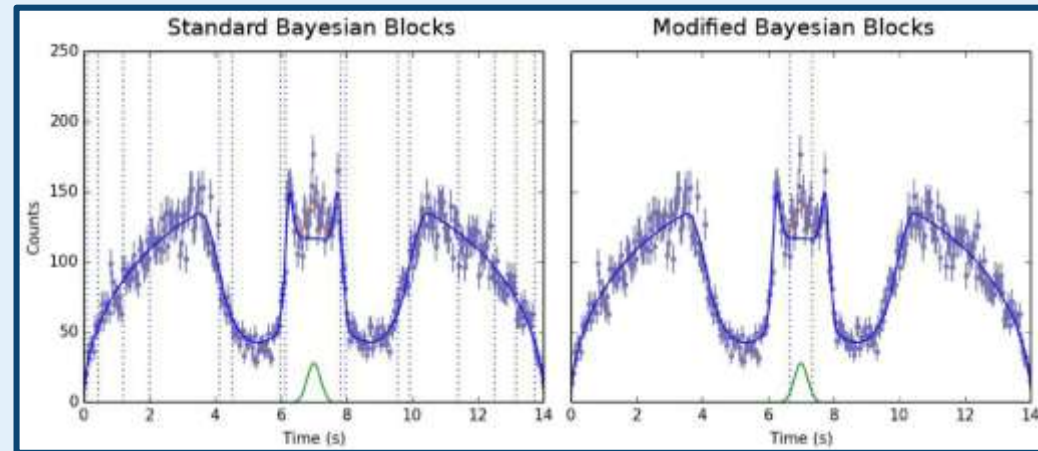
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Exploring the LAT lower energies

- The analysis:
Bayesian blocks analysis
in presence of
time-varying background
- The method:
 - Definition of **on-pulse** and **off-pulse windows**
 - Background: polynomial multiplied by $\cos(\theta)$
 - Application of mod-BB in the pulse window
 - Detected intervals:
Measurement of net flux and significance
 - **Very fast** computation



The new LLE sample



- In the first LAT catalog:
21 out of 35 GRBs (**66 %**) detected <100 MeV
 - **7 LLE-only GRBs (20 %)**

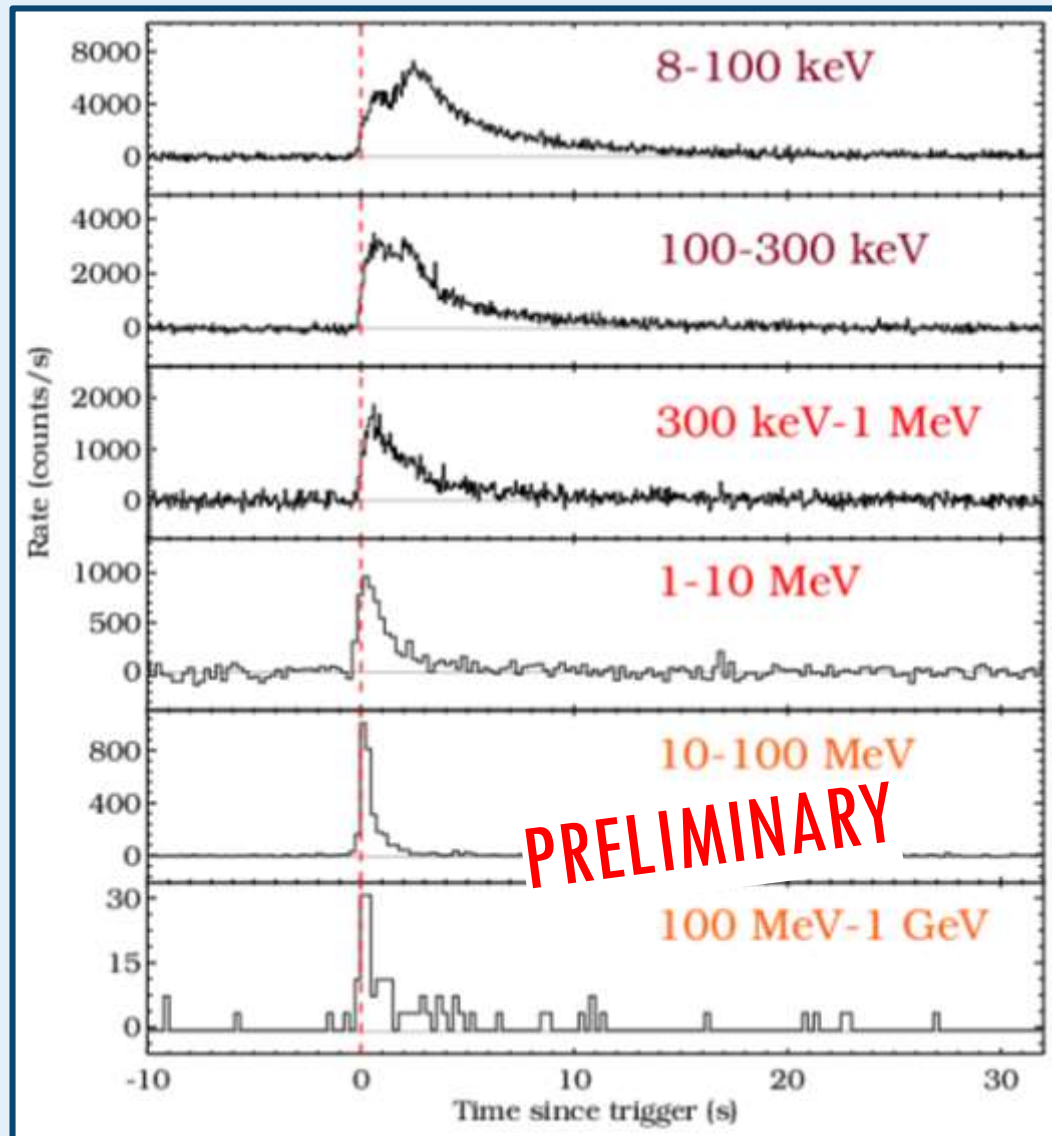
- With the new analysis:
~ 80 out of ~137 GRBs (**60 %**) detected <100 MeV
 - **~20 LLE-only bursts (15 %)**
 - Some old LLE-only GRBs are **now detected** also at higher energies (>100 MeV!) with the LTF analysis/Pass 8

→ Final numbers are still being cross-checked!



The new LLE sample – some examples

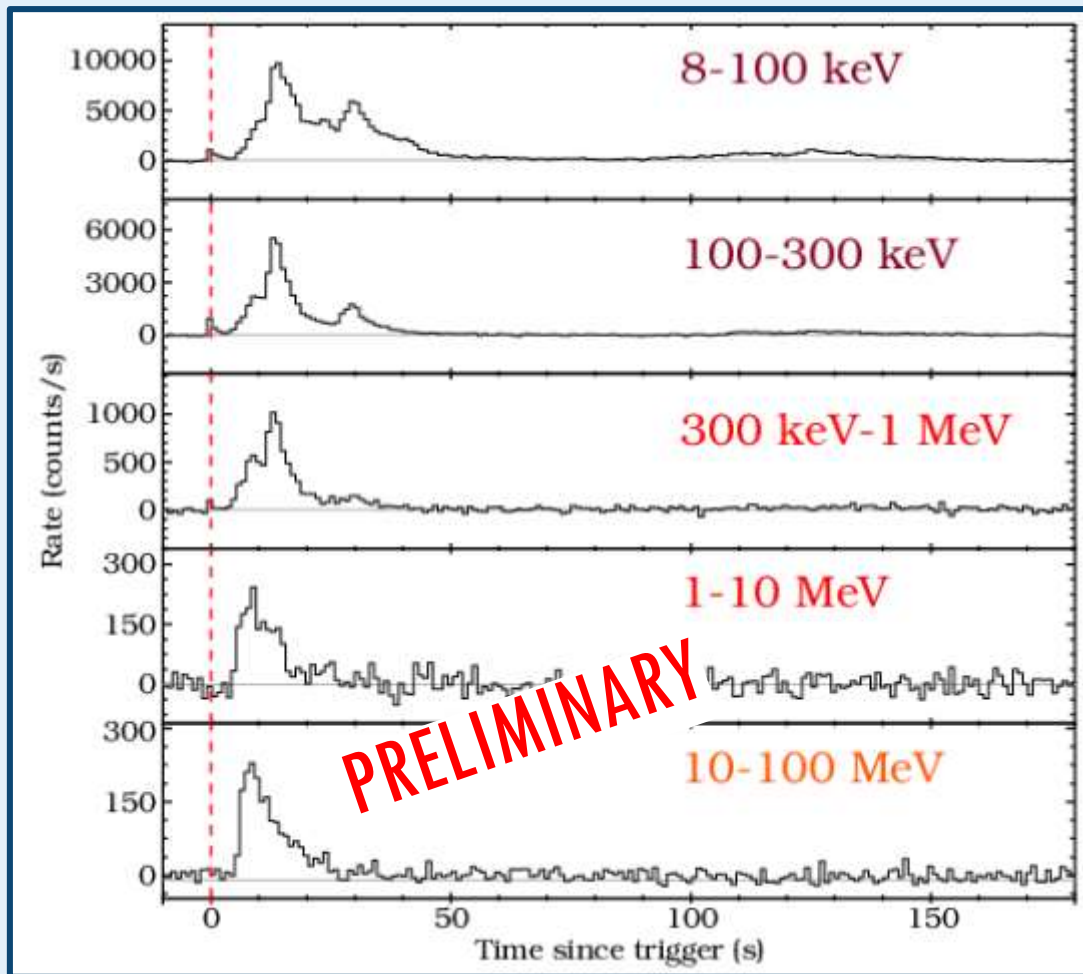
- GRB 110721.200
(old & new catalog)
- Prompt emission:
 - Bright in GBM
 - NaI (8–300 keV)
 - BGO (0.3–1 MeV)
 - Bright LLE
(10–100 MeV)
 - Bright LAT
(>100 MeV)



The new LLE sample – some examples

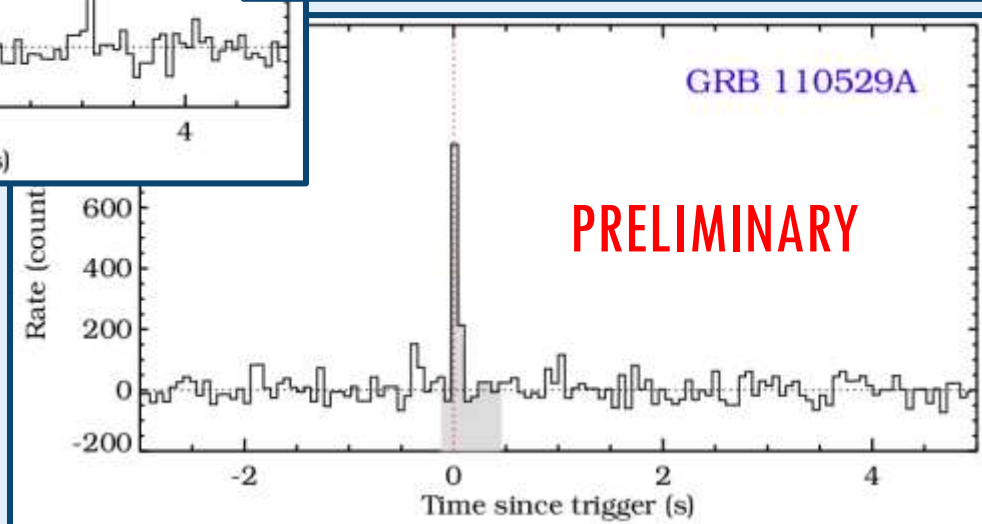
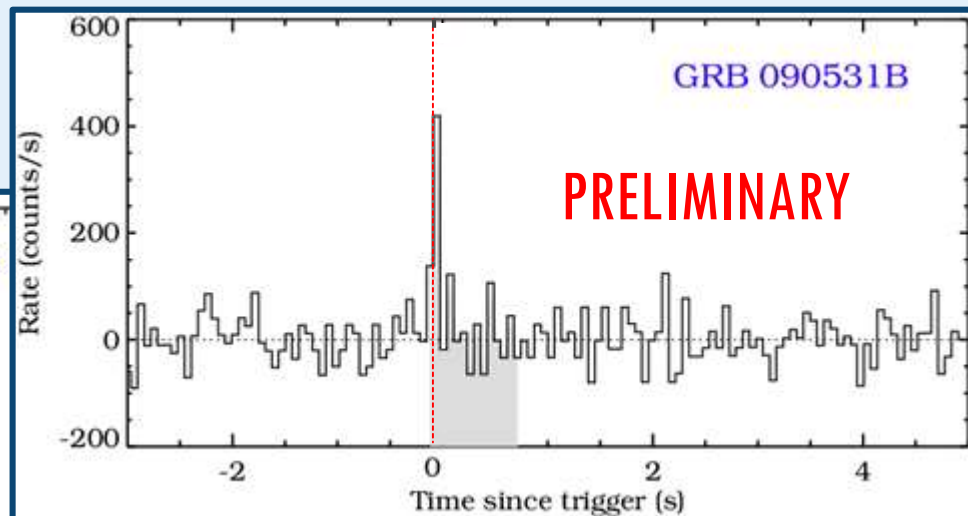
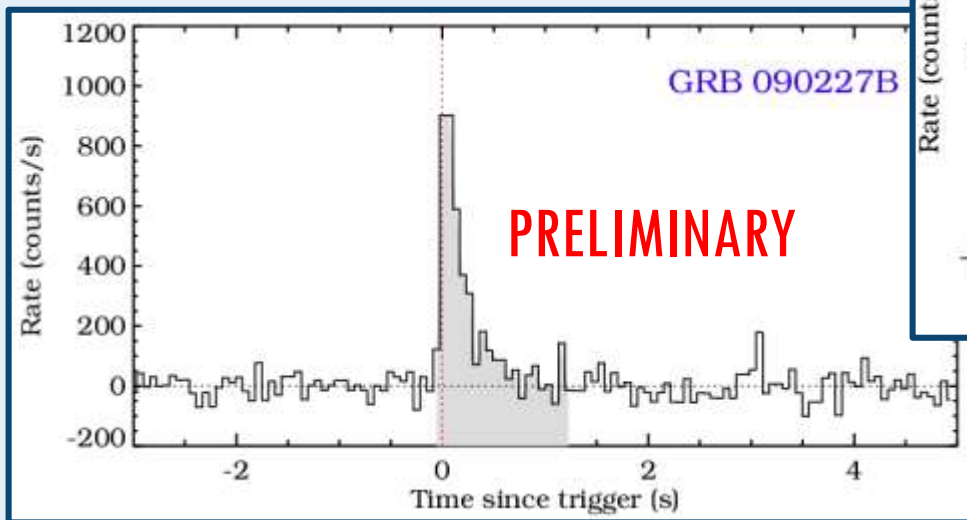
- GRB 140206.275
([new catalog](#))
- Prompt emission:
 - Bright in GBM
 - Bright LLE
 - **No LAT emission above 100 MeV!**

See next talk
by G. Vianello!



The new LLE sample – some examples

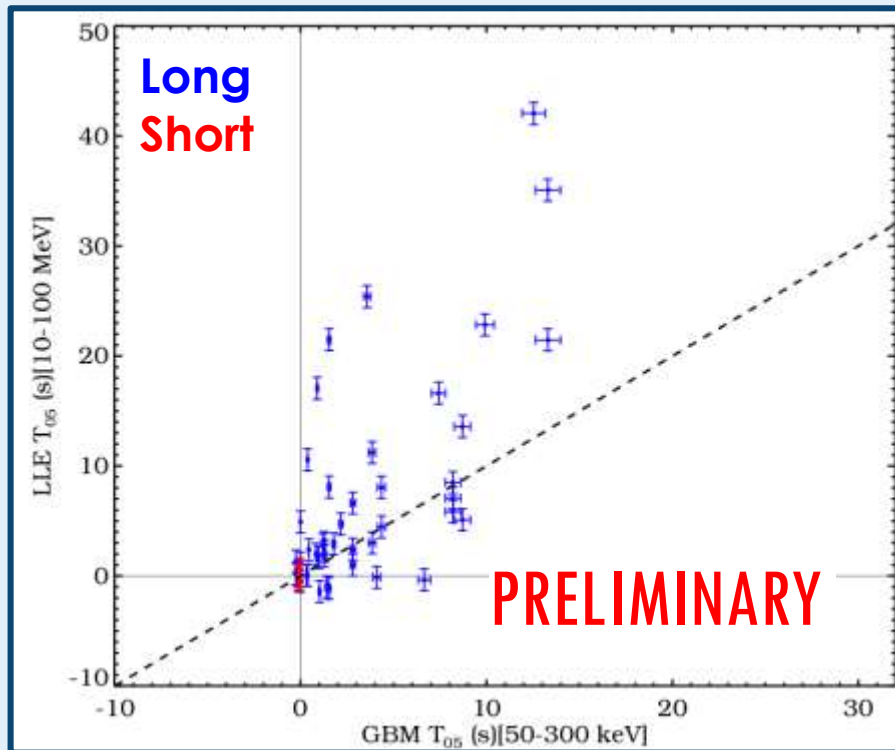
- 3 nice short GRBs!



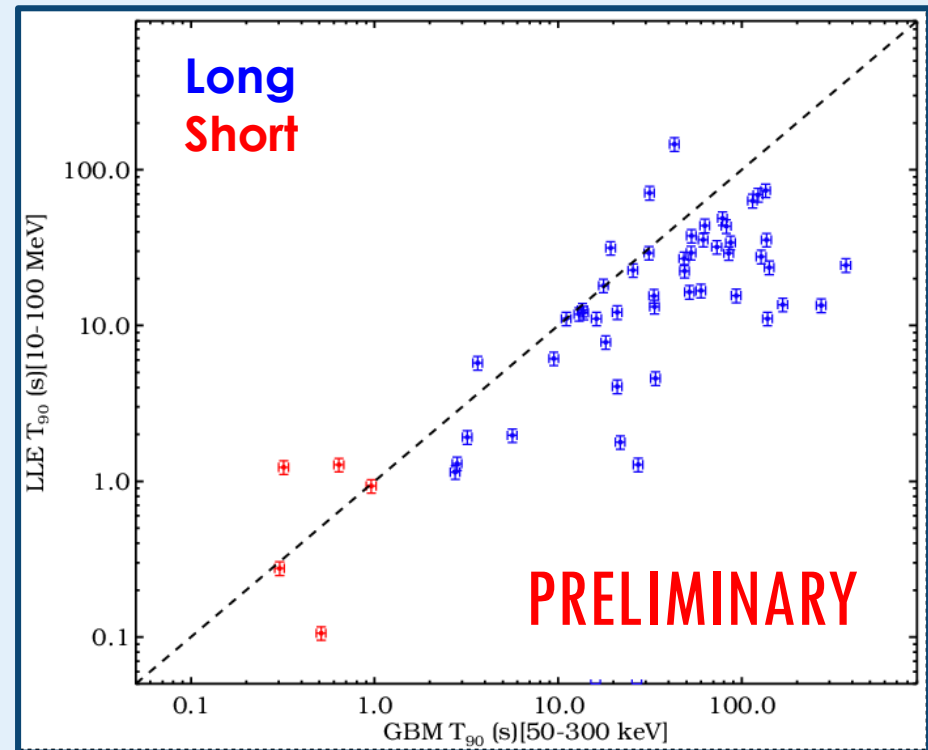
The new LLE sample

- LLE temporal analysis: **GBM** vs **LLE** results

Onset time: T₀₅



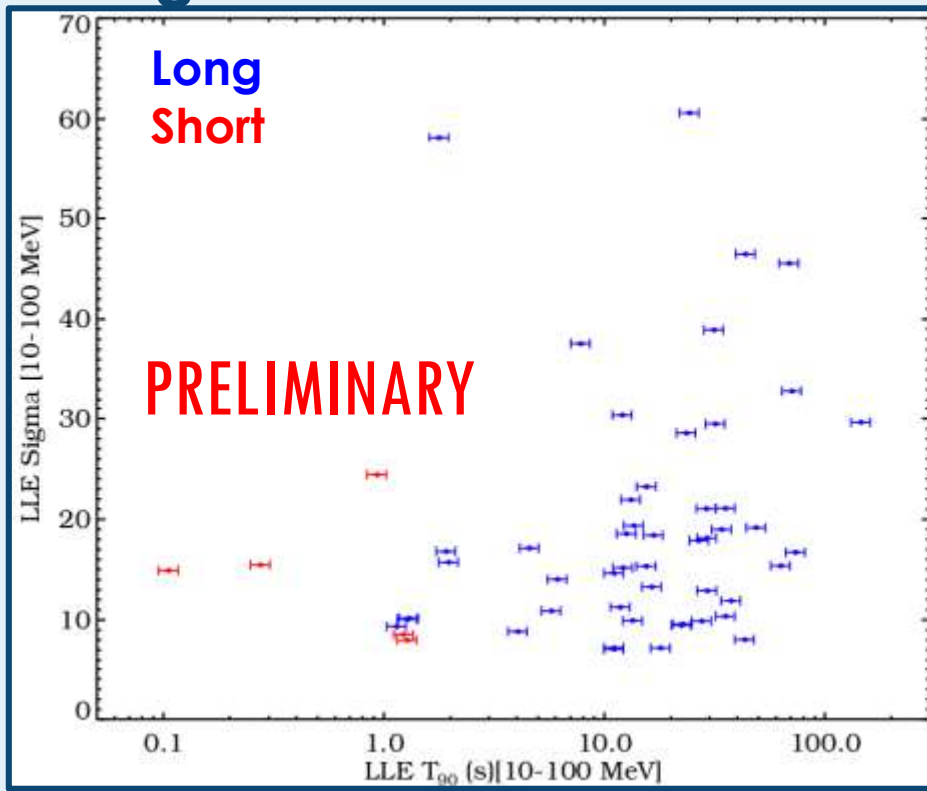
Duration: T₉₀



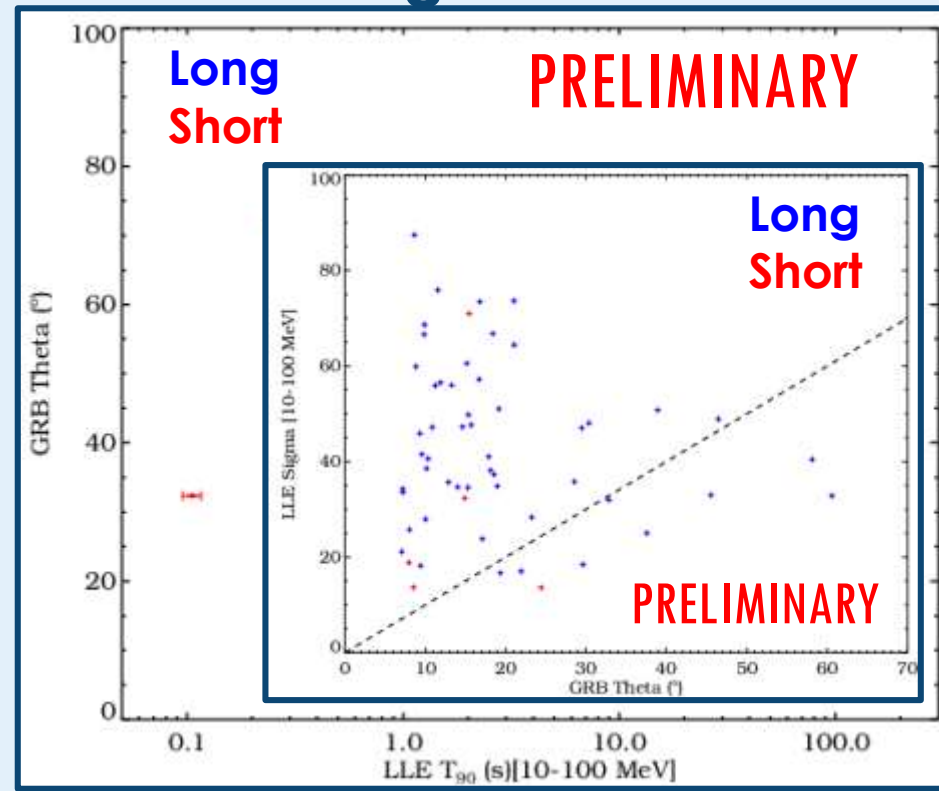
The new LLE sample

- LLE temporal analysis: **LLE** results

Significance of detection



GRB angle wrt Fermi



- Adding **more bursts** to the 2^o Fermi-LAT GRB catalog
 - +20 LEE only (**+10%**)
 - Interesting **features at MeV** energies!
- Still a lot to be done
 - **More spectral analysis** will follow!
 - Study of **duration vs energy** relations
- **MeV is the key!**
 - Good science case for future missions like **eAstrogam** & **Amego**

Thank
You!