A peek to GRB emission at VHE through 10 years of Fermi-LAT observations

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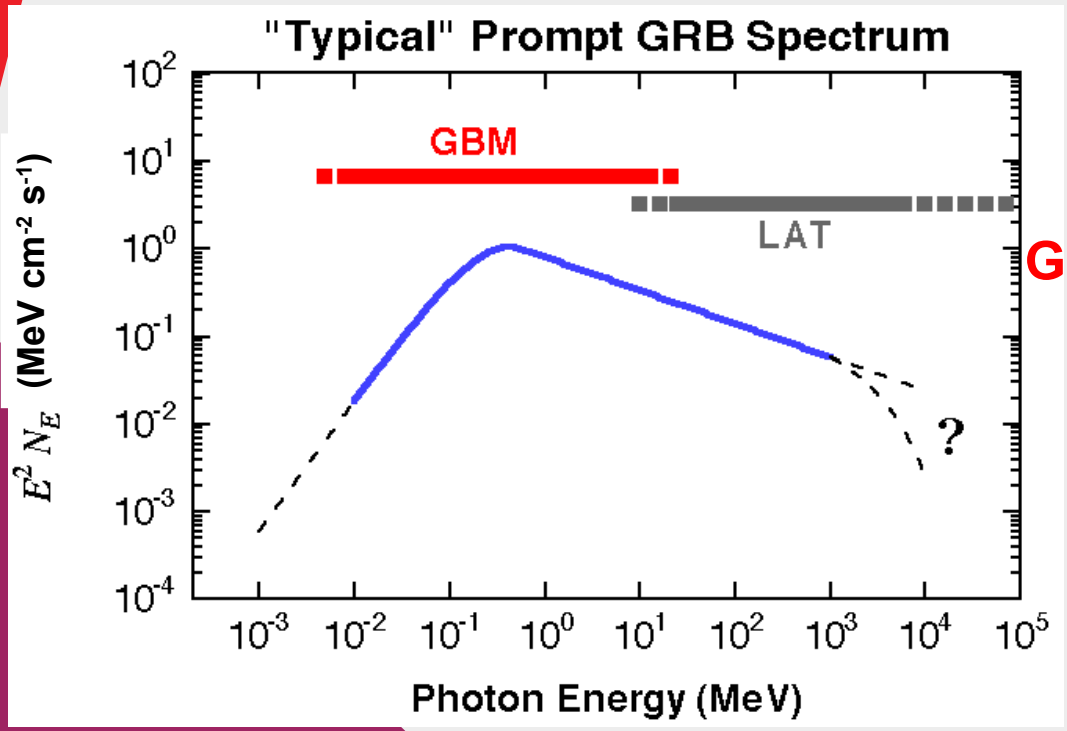
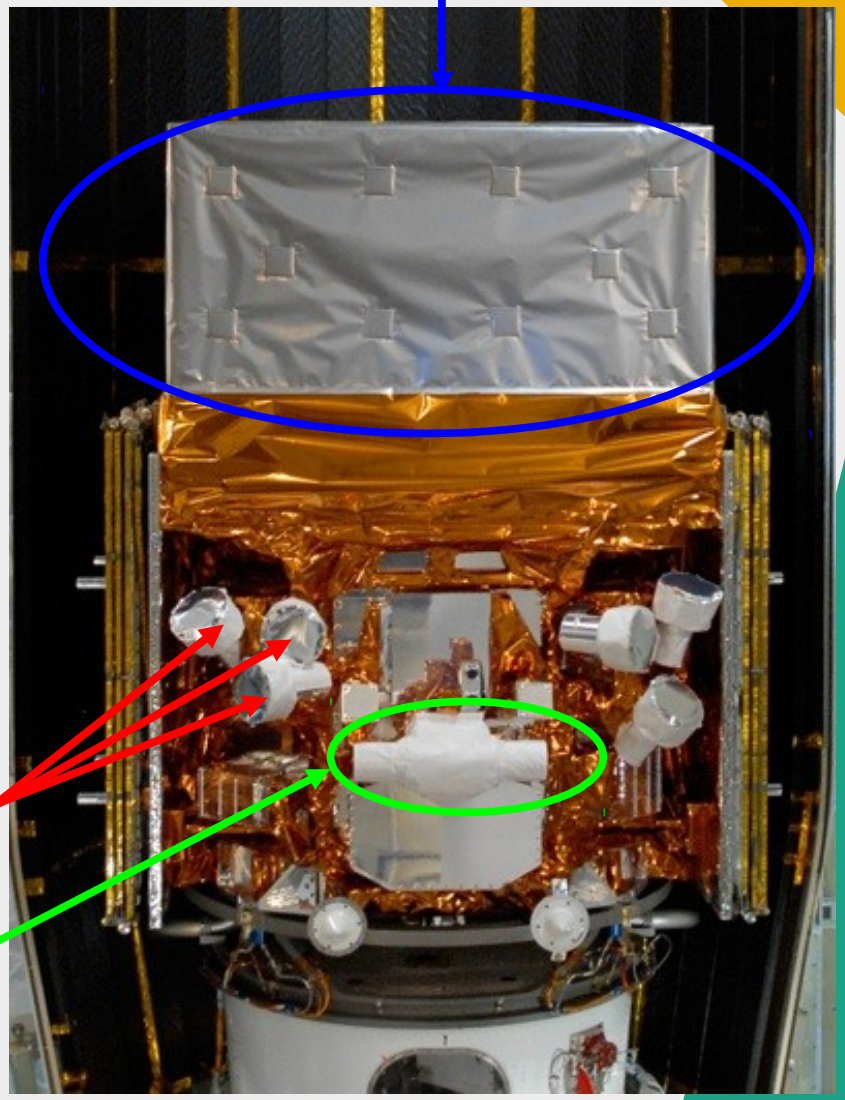
The LAT and GBM on Fermi

The GBM detects ~250 GRBs/year
~18% short
~50% in the LAT FoV
The LAT detects ~18 GRBs/year

NaI: 8 keV - 1 MeV
BGO: 200 keV - 40 MeV
LAT: 30 MeV – >300 GeV





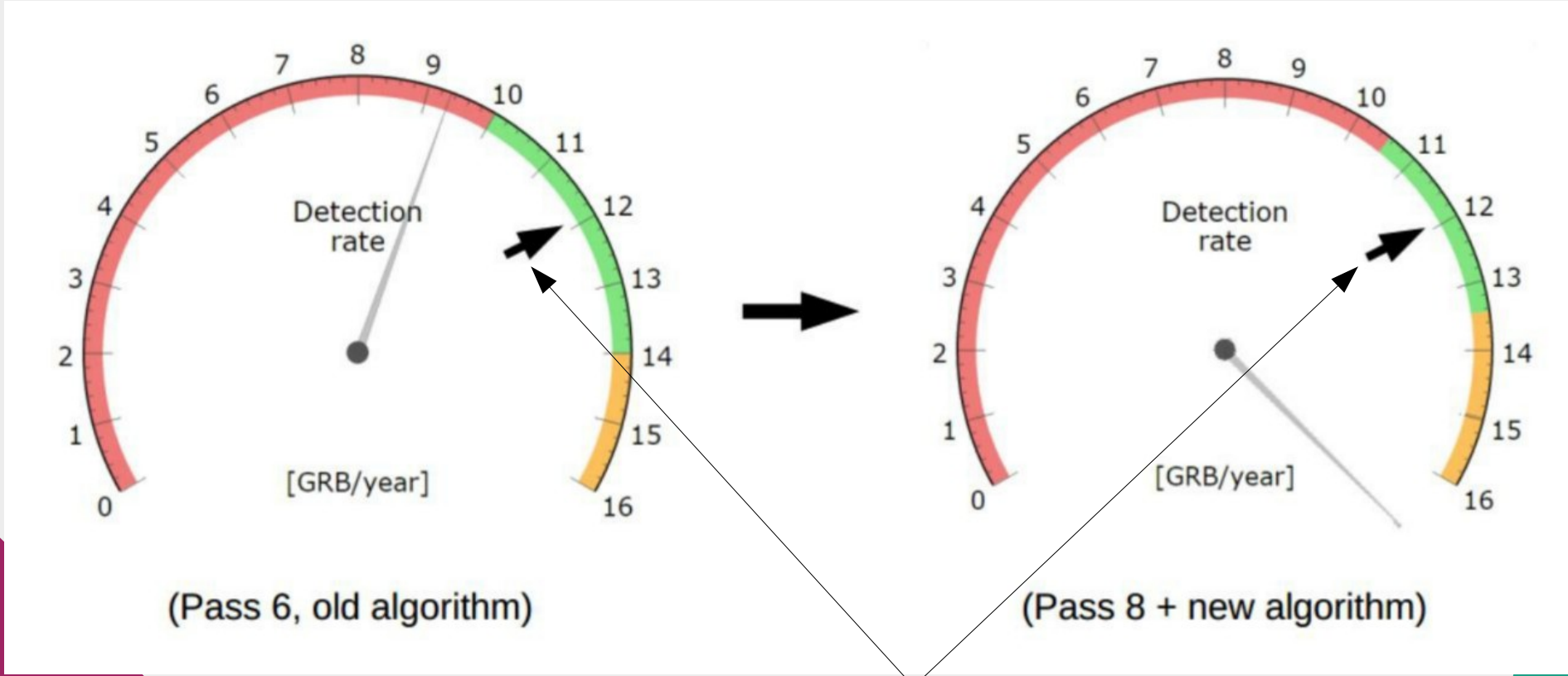
Sample

- Ajello et al. ApJ 878, 52A (2019)
- Time interval: 2008-08-04 to 2018-08-04 (10 year)
- 3044 triggers (GBM, IPN, Swift, INTEGRAL, AGILE, MAXI)
  - 186 detections
    - 168 standard >100 MeV
    - 91 LLE >30 MeV
    - 17 LLE-only
    - 34 LAT GRB with redshift measured
- Detection criteria:
  - >5 sigma after trials in one search (multiple time scales)
  - False Discovery rate over the entire list with 1% contamination
  - At least 3 photons with p>0.9 of belonging to the GRB
  - Manual checks to exclude blazars, limb (…)

Changing gear

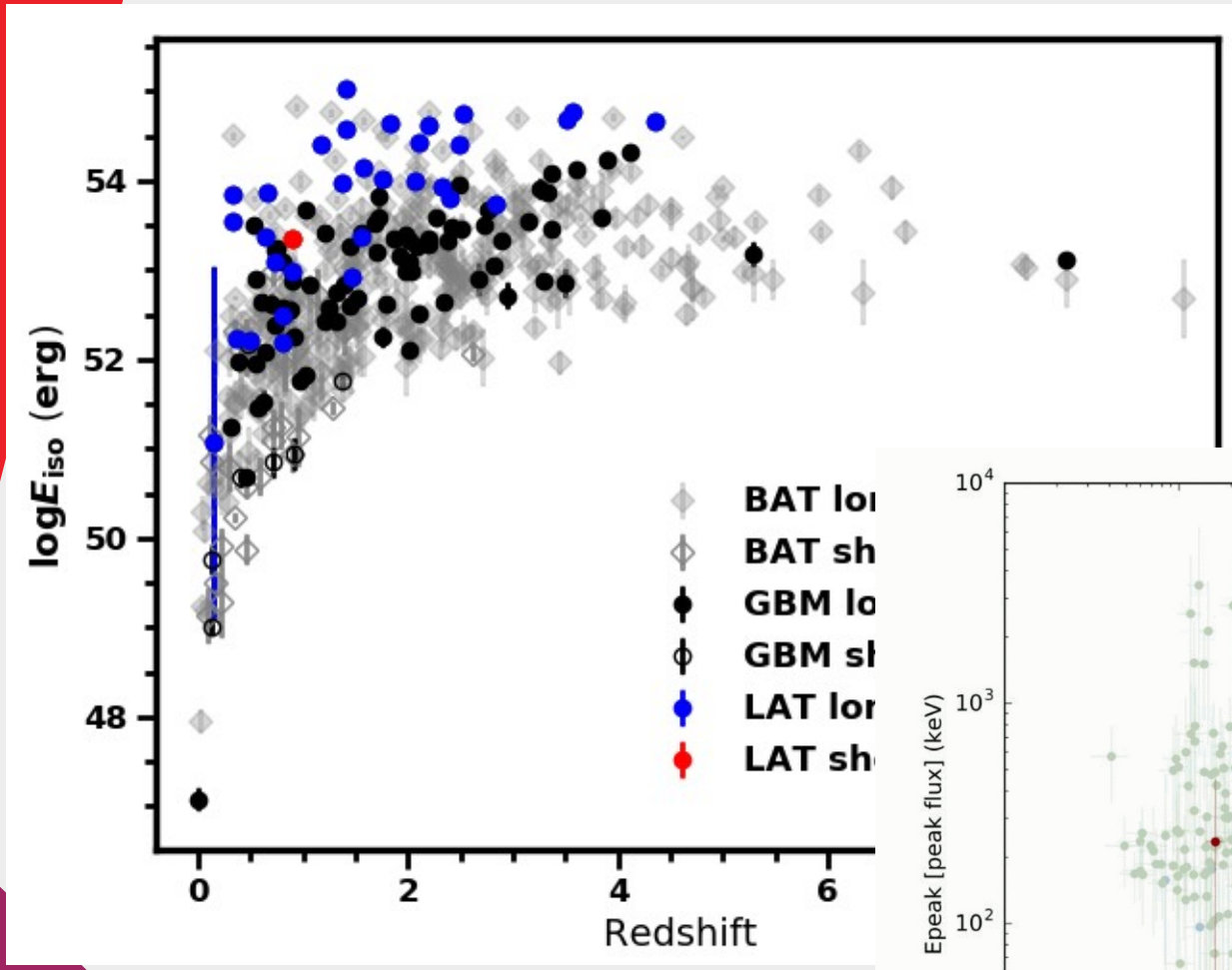
Beyond the first Fermi-GRB catalogue:

- change of event reconstruction (Pass 8);
- Change of detection algorithm (more sensitive, Vianello et al. 2015)



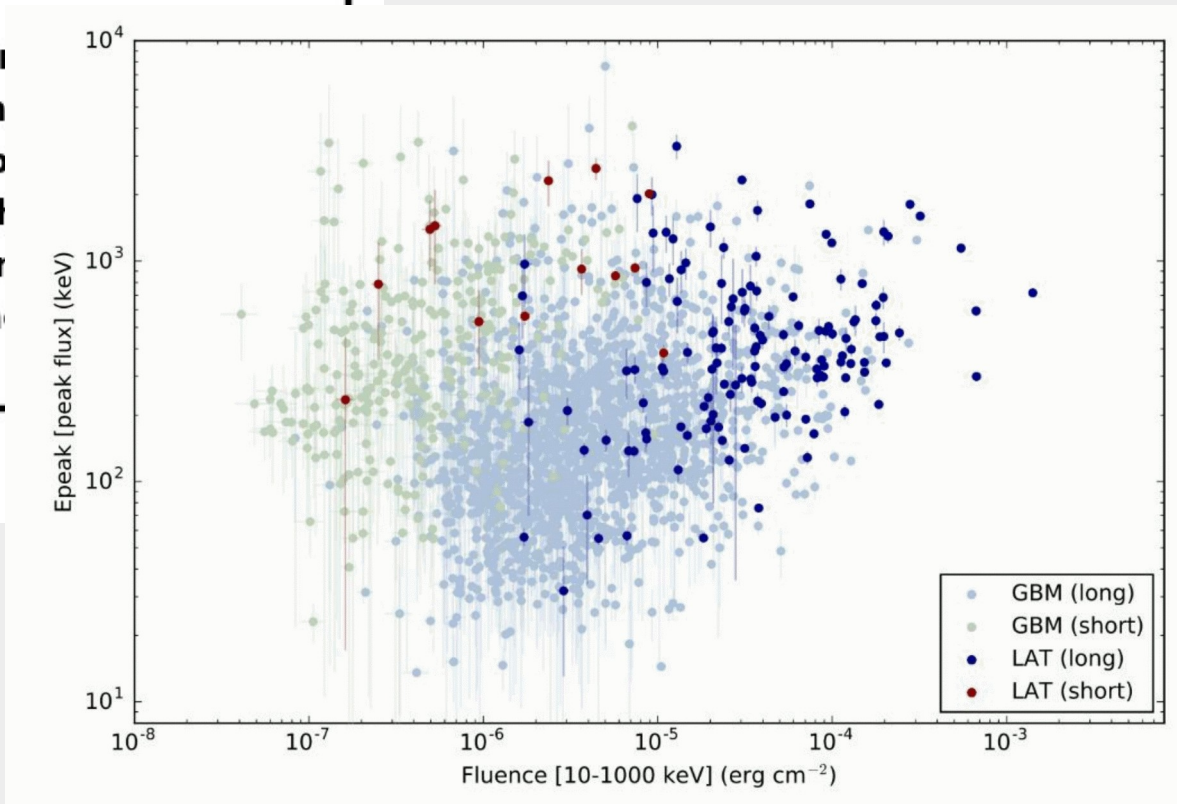
Pre-launch predictions from Band et al. 2009

Which GRBs?

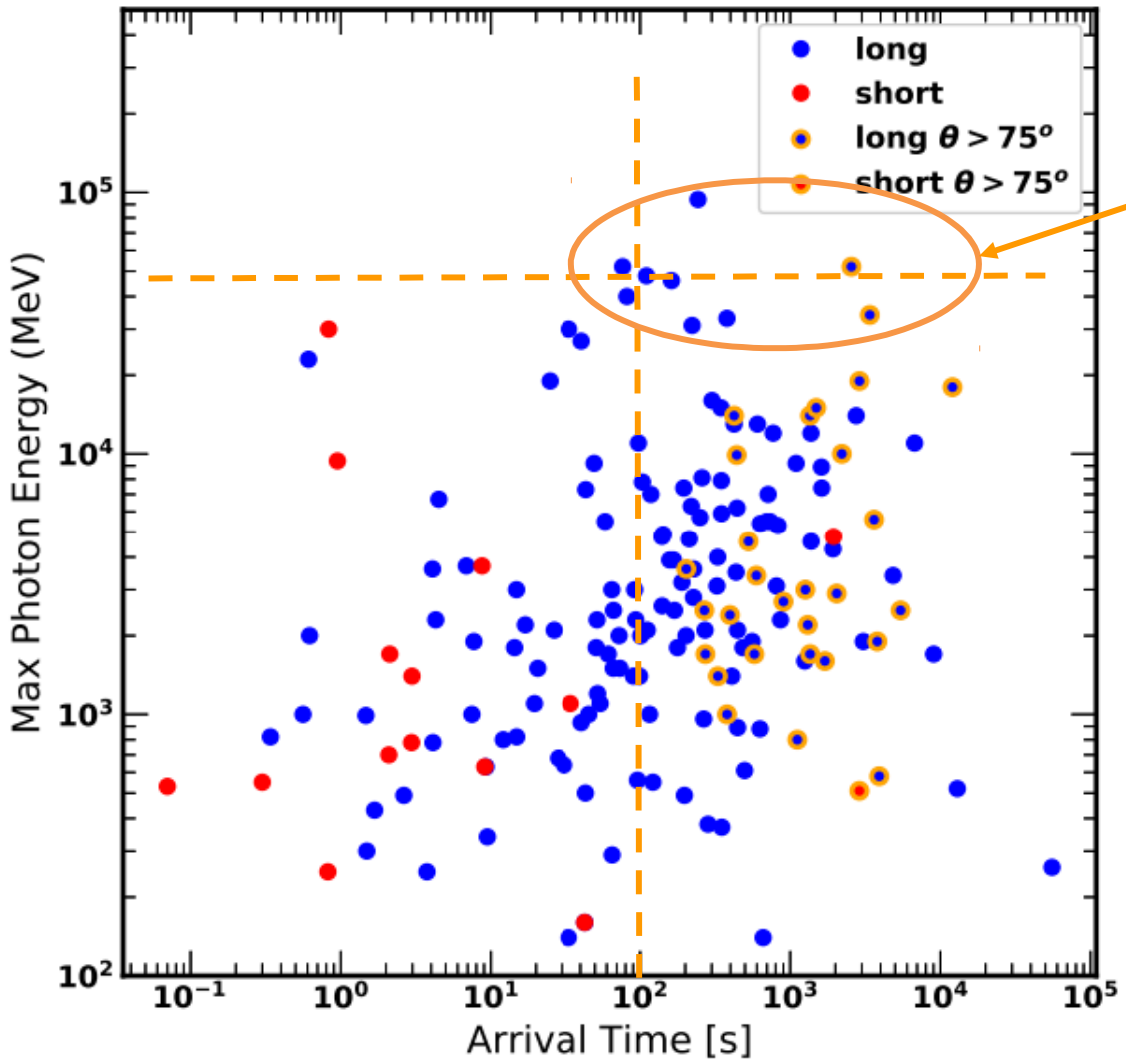


Ajello et al. ApJ 878, 52A (2019)

Fermi-LAT sees preferentially intrinsically bright GRBs with high E_p, but there are some exceptions!



Chances for IACT?

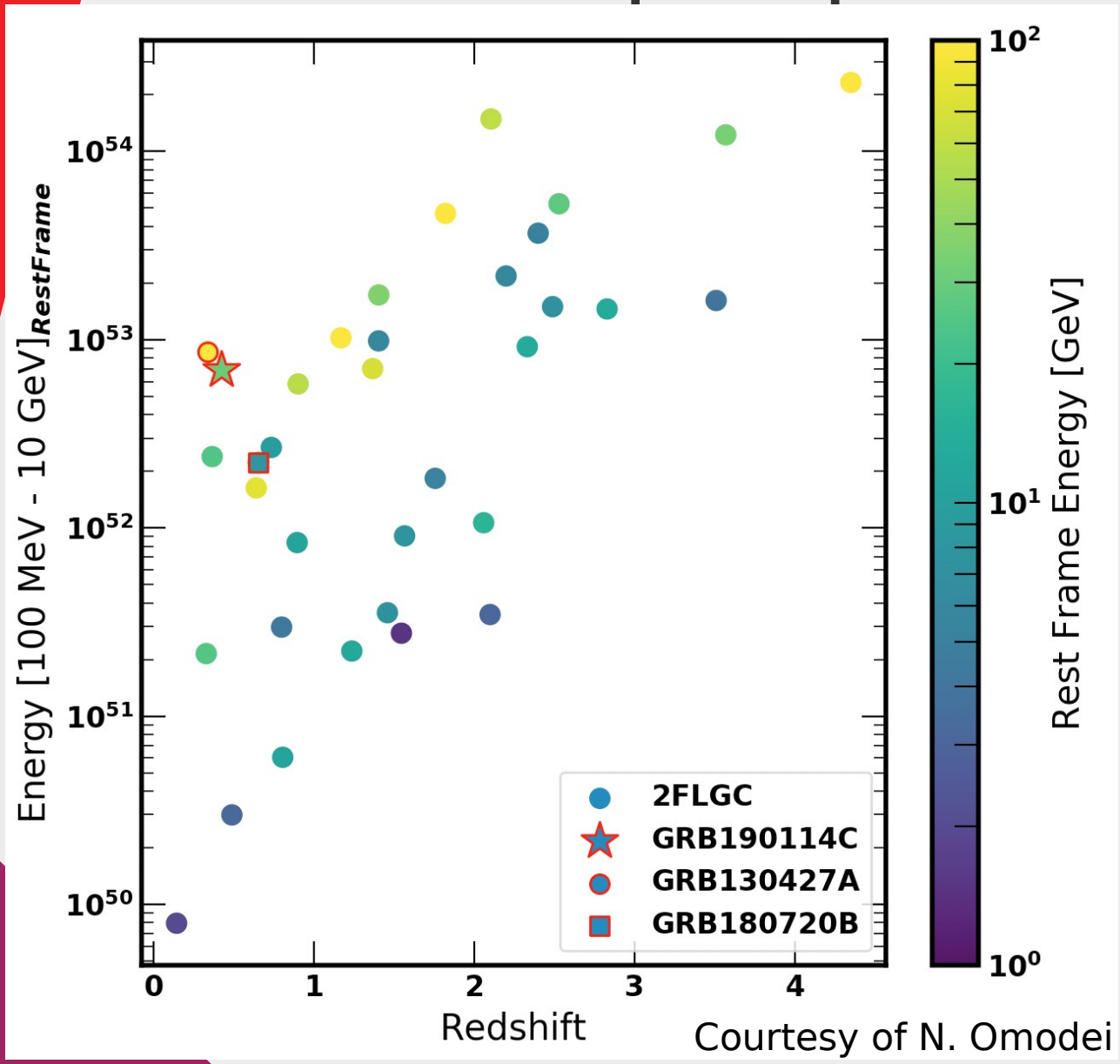


Ajello et al. ApJ 878, 52A (2019)

Possible catches for IACTs

From the findings of the Fermi-LAT 10 year catalogue the prospects of detecting a GRB at very high energy are quite low.

2019: verification of the prospects



Courtesy of N. Omodei

The first 2 detections at VHE confirm the hypothesis for which the brightest and closest GRBs can be detected by IACTs.

A more careful look

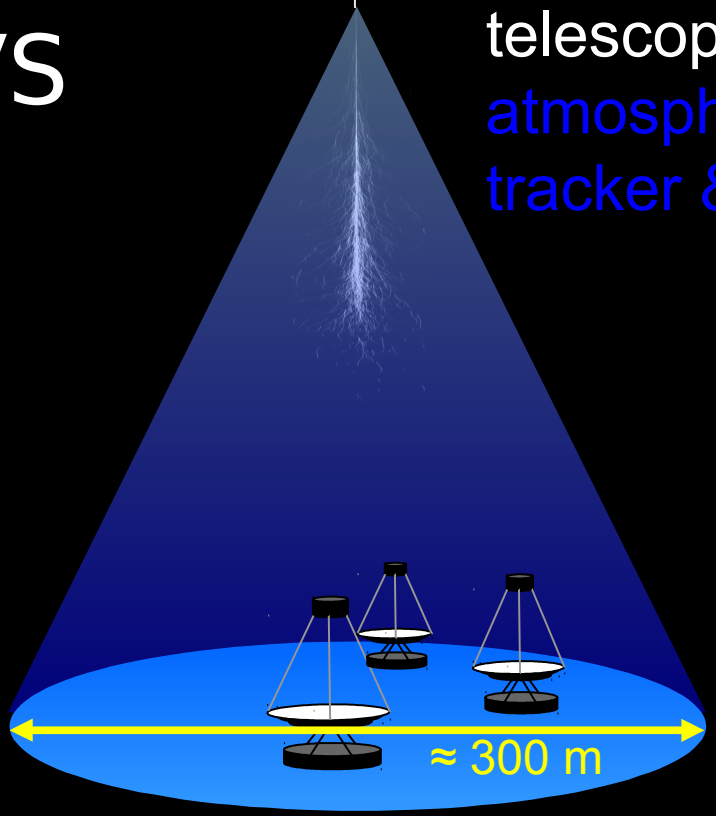
- GRB 180720B
  - detected by HESS @T0+10.1h when Fermi-LAT no longer detected any signal;
  - max photon energy in LAT: 5 GeV;
- GRB 190114C
  - max photon energy in LAT: ~20 GeV;
- GRB 190829A
  - not a bright GRB (E_{iso}~1.8x10^{50}erg);
  - close (z=0.0785, A. F. Valeev et al., GCN 25565);
  - no LAT detection at any time UL~1.8x10^{-10}erg cm^{-2} s^{-1} (F. Piron et al. GCN 25574)

Possible explanation (Part I)

- Fermi-LAT effective area ~ 7000 cm² BUT no redshift limit
- IACT effective area ~ few x100 m² BUT redshift<1

VS

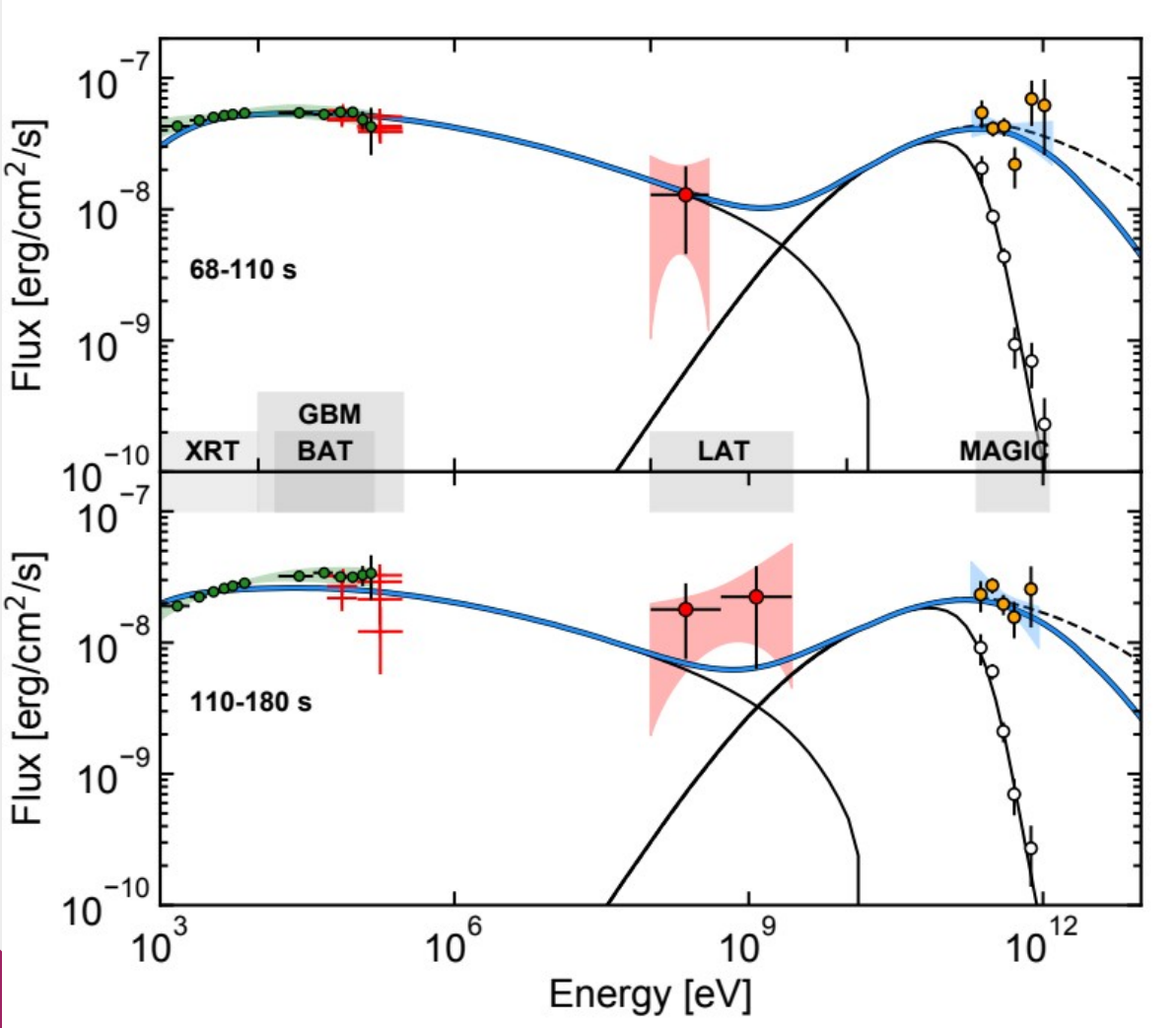
Use a “pair conversion telescope” in which the atmosphere acts as tracker & calorimeter



Huge effective area

Slide from Pr W. Hofmann

Possible explanation (Part II)



Acciari et al. Nature 575 (2019)

Fermi-LAT energy range sits on the edge of the Synchrotron and Inverse Compton components. Depending on their separation, the flux in this energy range could be low.

Conclusions

- Fermi-LAT detected 186 GRBs in its first 10 years of operations;
- Fermi-LAT sees high E_p high Fluence GRBs, but with some exceptions;
- Before 2019 the prospects for VHE detections were low and focused on high fluence GRBs;
- After the first IACT detections of GRBs the prospects from Fermi-LAT need to be updated;
- IACts are more sensitive than Fermi-LAT but have a limited visible universe;
- The energy range of Fermi-LAT sits in between the 2 spectral components.

Thank you!