

First observations of gamma-ray burst with the Large Sized Telescope

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18th October 2021

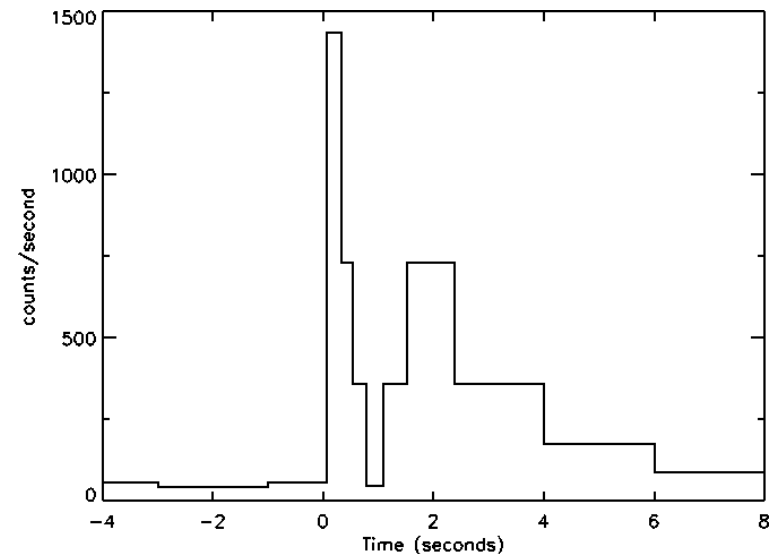
First detection by the Vela military satellite in 1967

CONFIDENTIAL



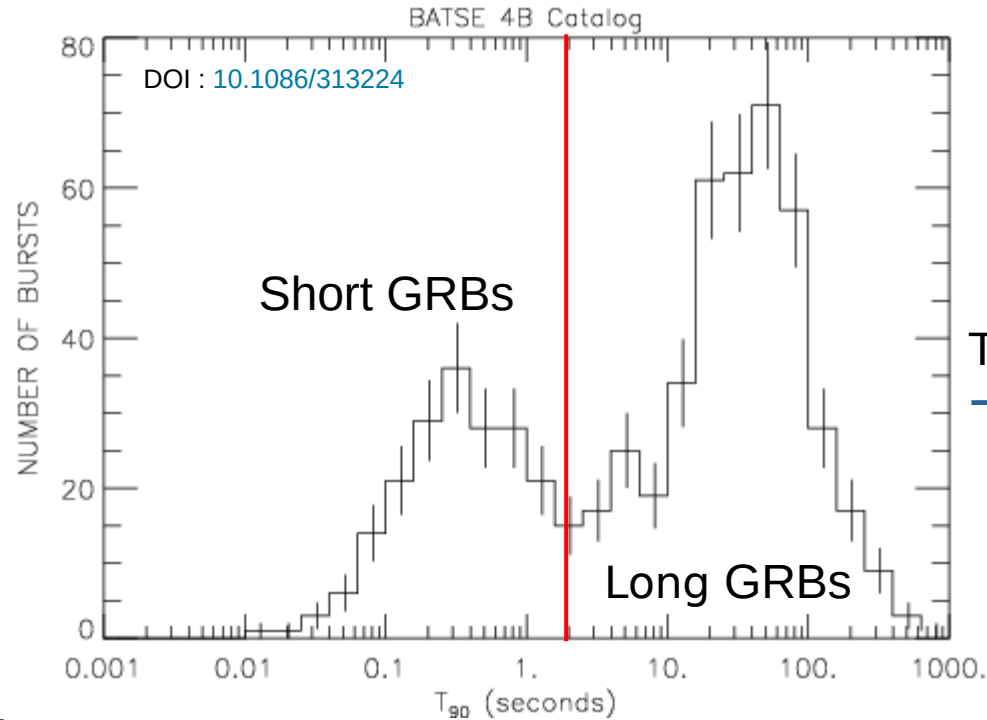
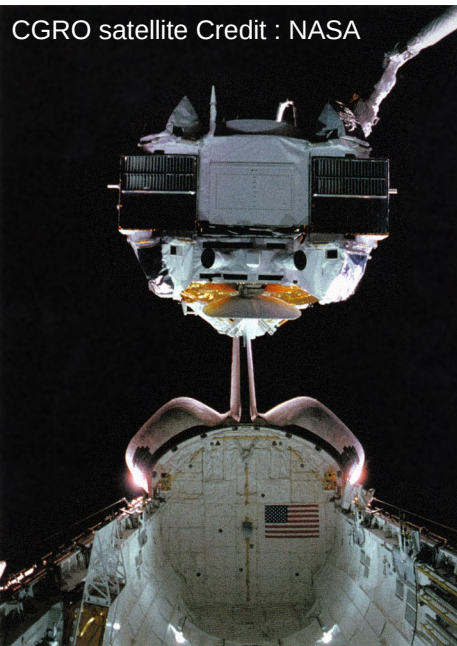
TOP SECRET

Short and bright emission of gamma-rays
The main emission is lasting from tens of milliseconds to hundreds of seconds

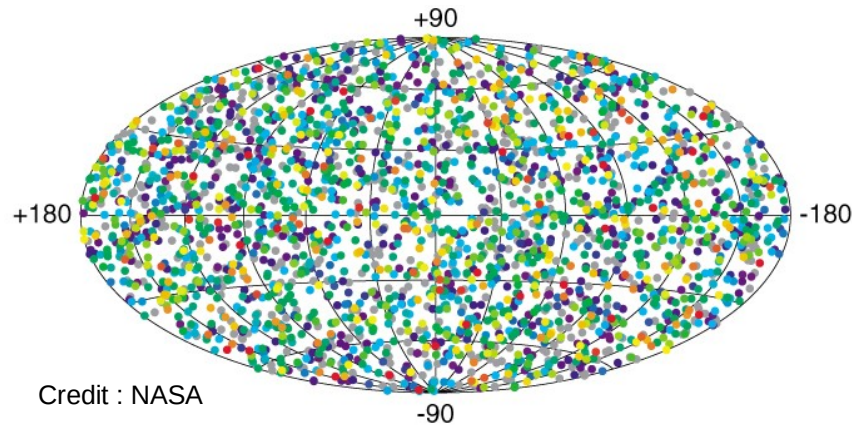


DOI : [10.1086/181225](https://doi.org/10.1086/181225)

Vela 5A&B satellite, credit : NASA

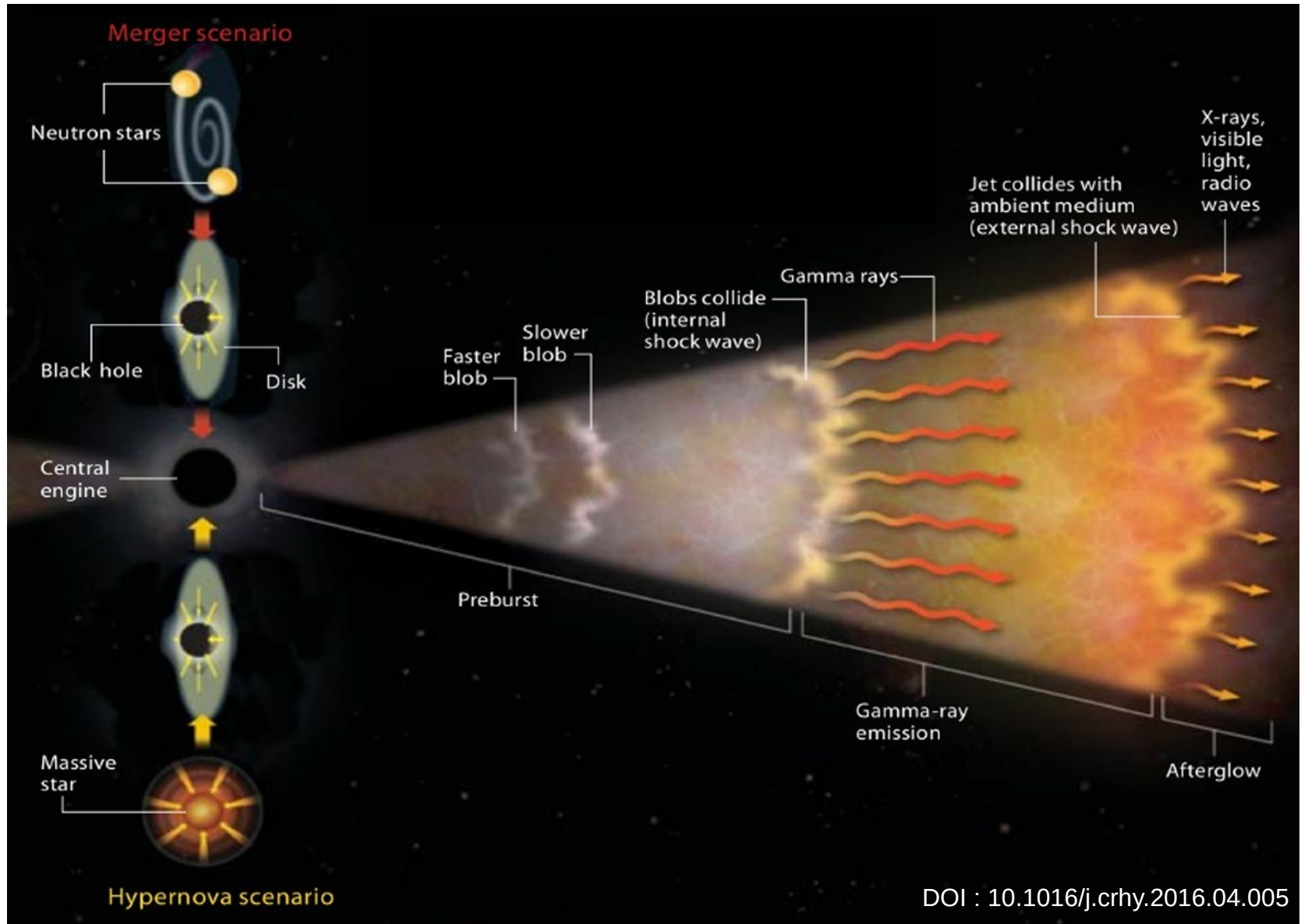


Sky distribution of the BATSE GRBs

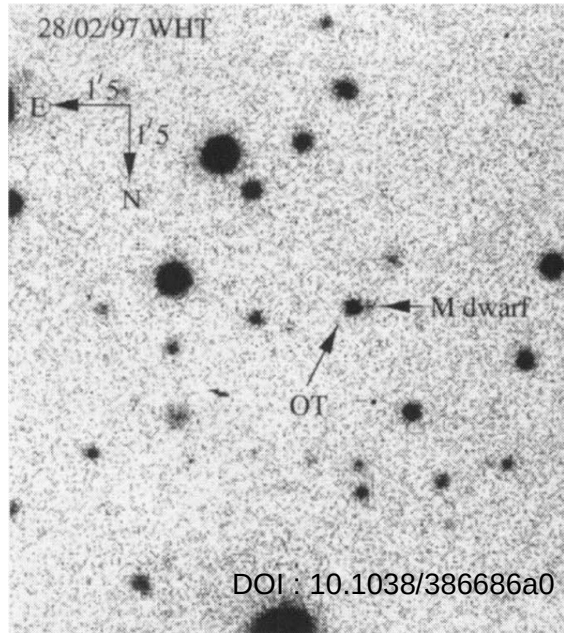


Uniform distribution accross the sky
→ **Source at cosmological distance**

Credit : NASA

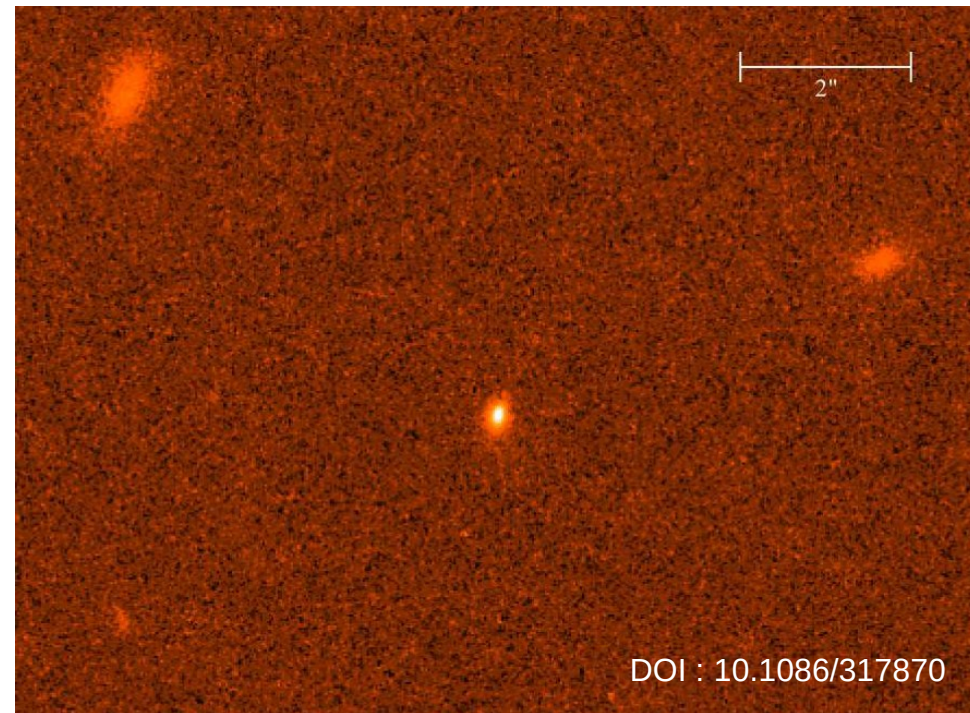


DOI : 10.1016/j.crhy.2016.04.005



GRB 970228 : First afterglow detection of a GRB
Detected in optical and X-Ray

GRB 970508 : Detection of an
afterglow from Radio up to X-Ray
**First clear association of a burst
with a galaxy**



For well localized events : ~ 96% detection of a X-Ray afterglow
~ 60% detection of an optical afterglow
~ 30% detection of a radio afterglow

GRB 930131 : **Detected up to 1 GeV** by EGRET (prompt emission)

Since the launch in 2008 of Fermi/LAT, **186 GRBs have been detected at HE**

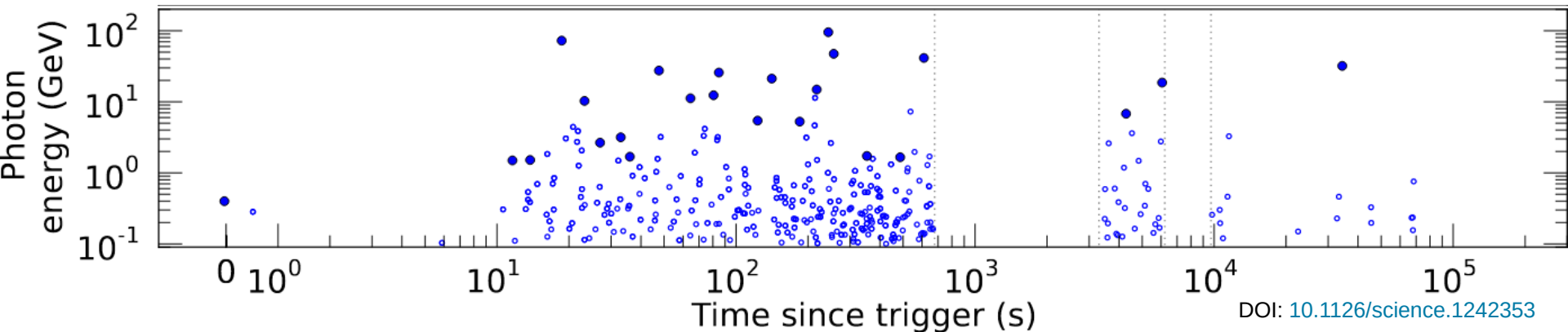


Fermi/LAT Prompt observations show hints of a second component emission
Fermi/LAT Afterglow observations show a second component emission

→ TeV detection would improve the comprehension behind this HE emission and thus comprehension of the physics of GRBs

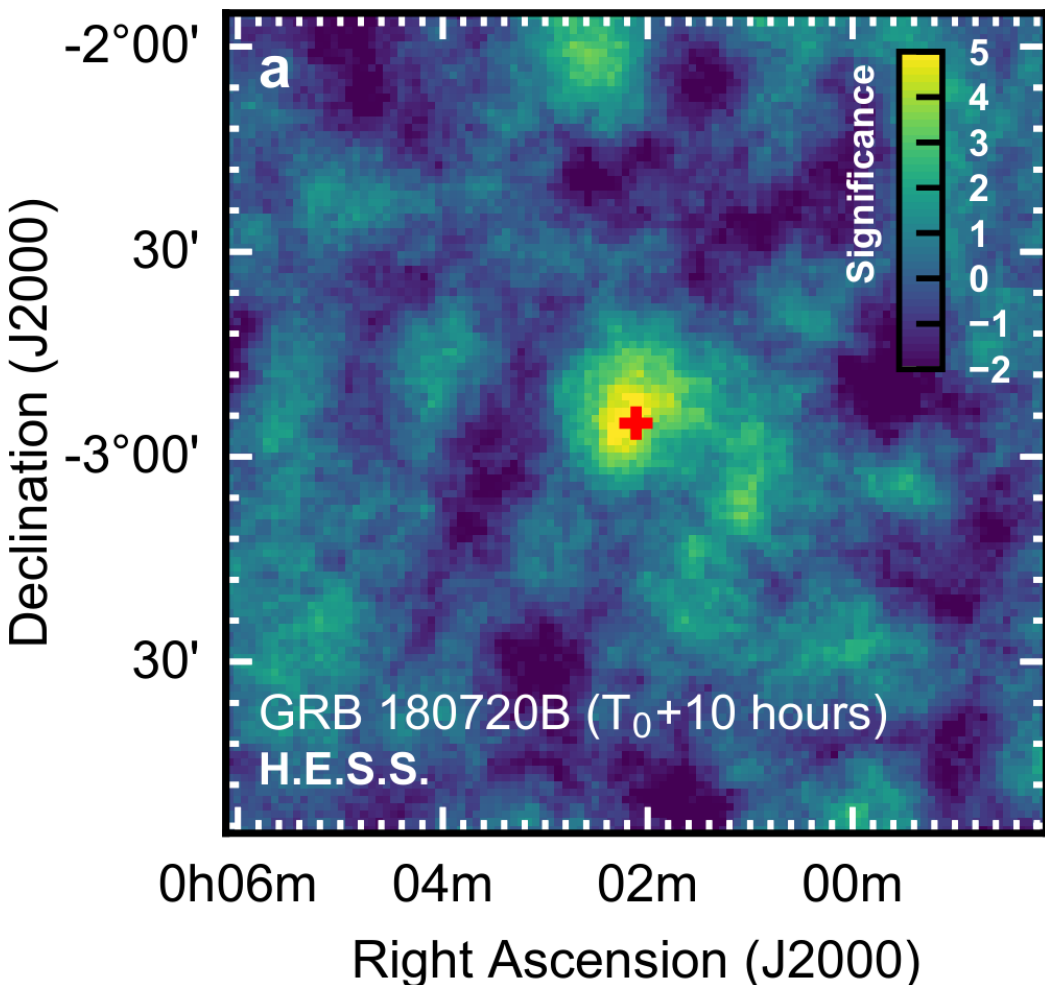
GRB 970417 : **3σ excess in Milagrito** at TeV energy range (during prompt emission)

GRB 130427A : **95 GeV**, energy of the photon with the highest energy detected by Fermi/LAT (during afterglow emission)



Cherenkov telescopes has started to searched TeV emission from GRBs from at least 15 years

First detection of GRB 180720B by H.E.S.S.



Since the first detection by H.E.S.S., **four GRBs have been detected at VHE** :

- GRB 180720B
- GRB 190114C
- GRB 190829A
- GRB 201216C

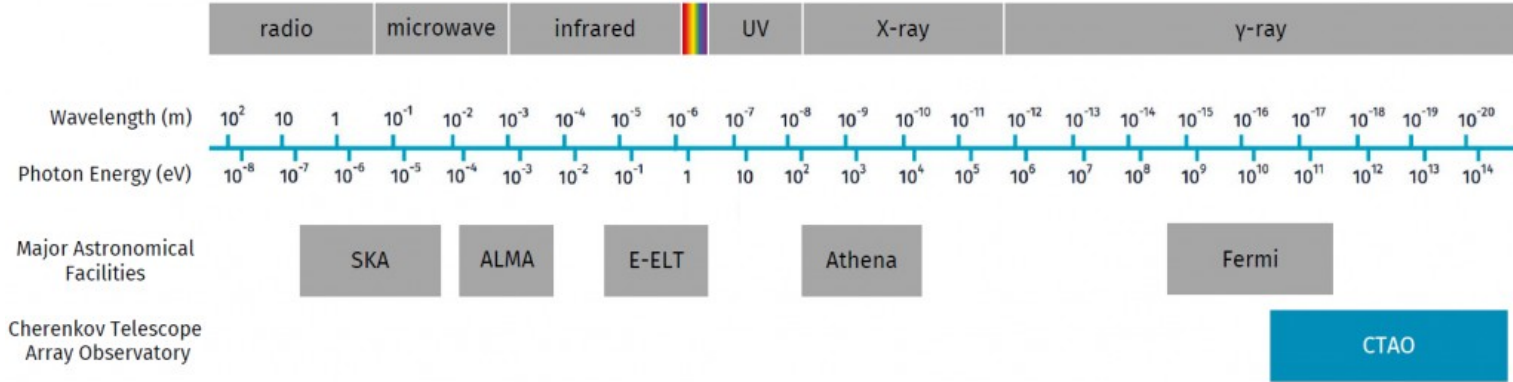
Why so much detections now and none before ?

These GRBs are at the tail of distributions but is this enough to explain it ?

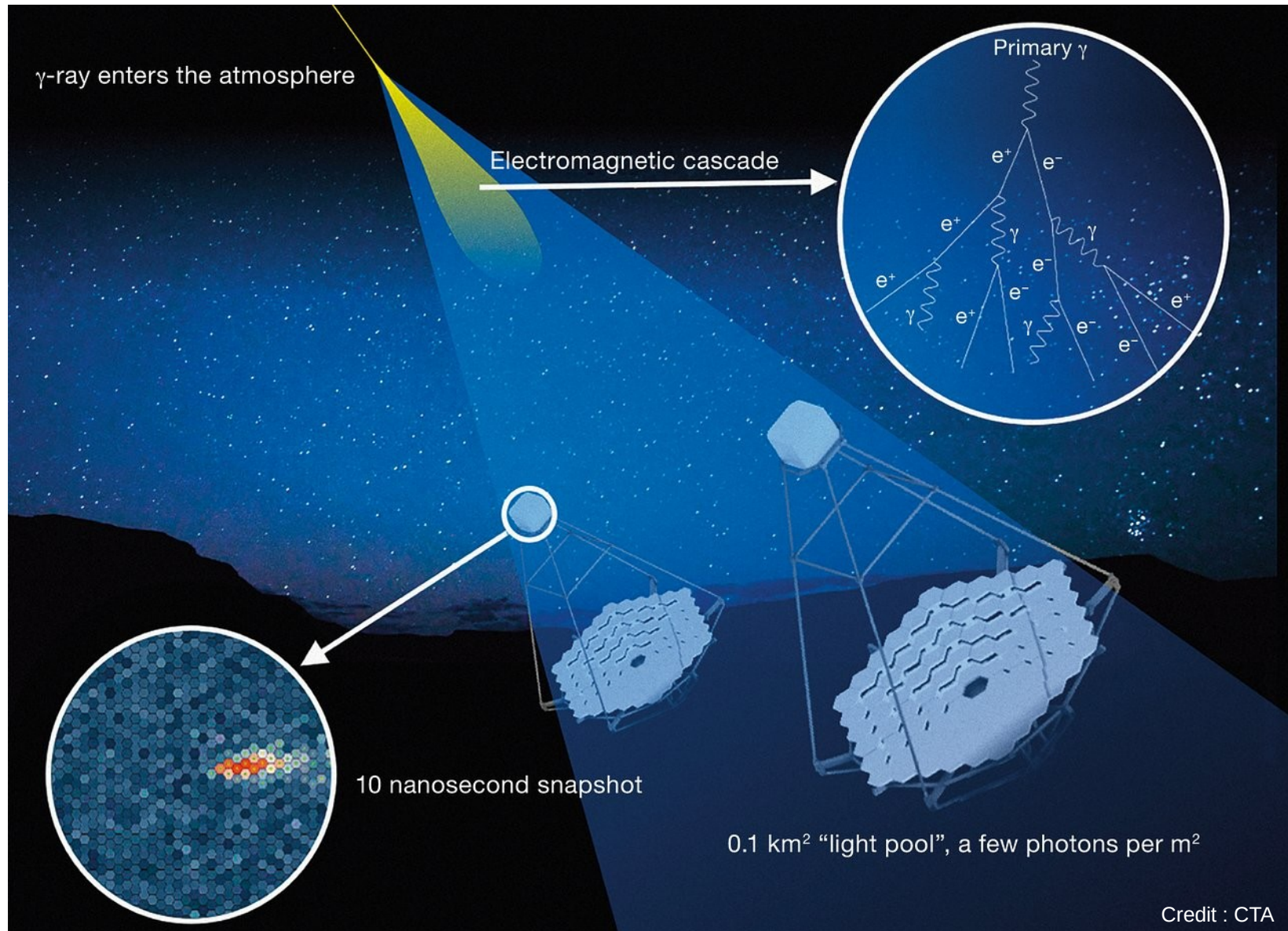
Achieving more detection could help better understand the emission process behind the VHE emission

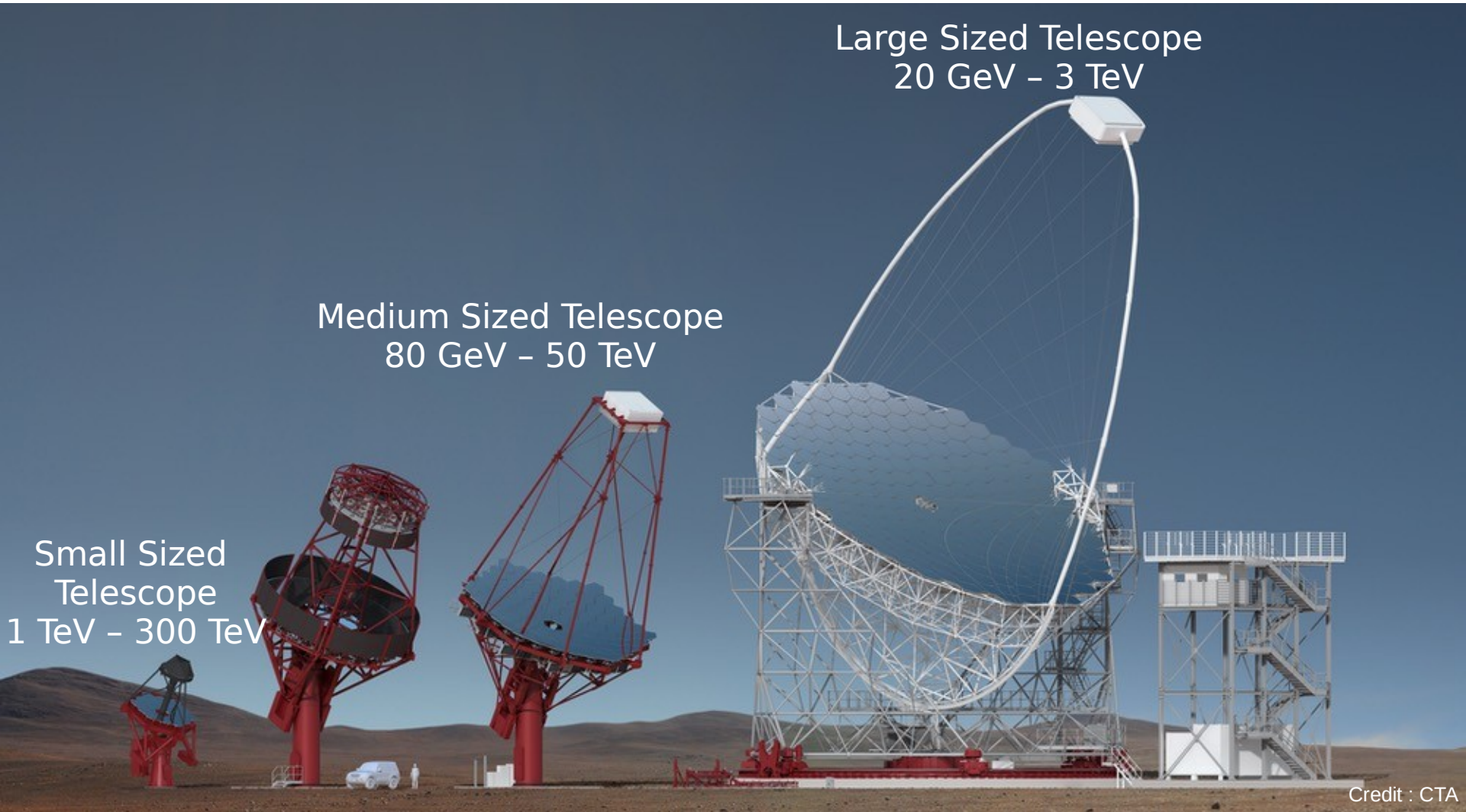
We are still looking for a prompt detection

DOI : [10.1038/s41586-019-1743-9](https://doi.org/10.1038/s41586-019-1743-9)



Future of the Cherenkov astronomy, 64 telescopes across two sites : La Palma, Spain and Paranal, Chile

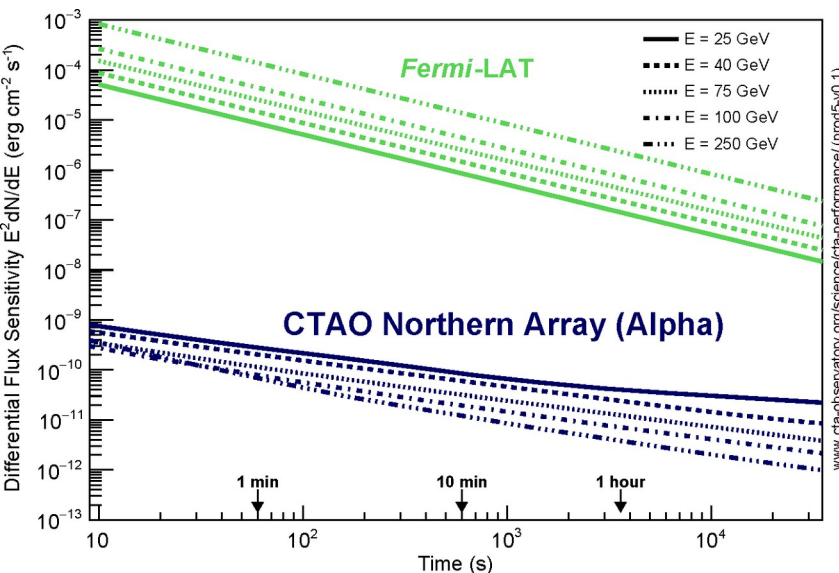




The LST 1 prototype is currently under commissioning at La Palma

The LSTs are the telescopes that will provide the low energy sensitivity of CTA

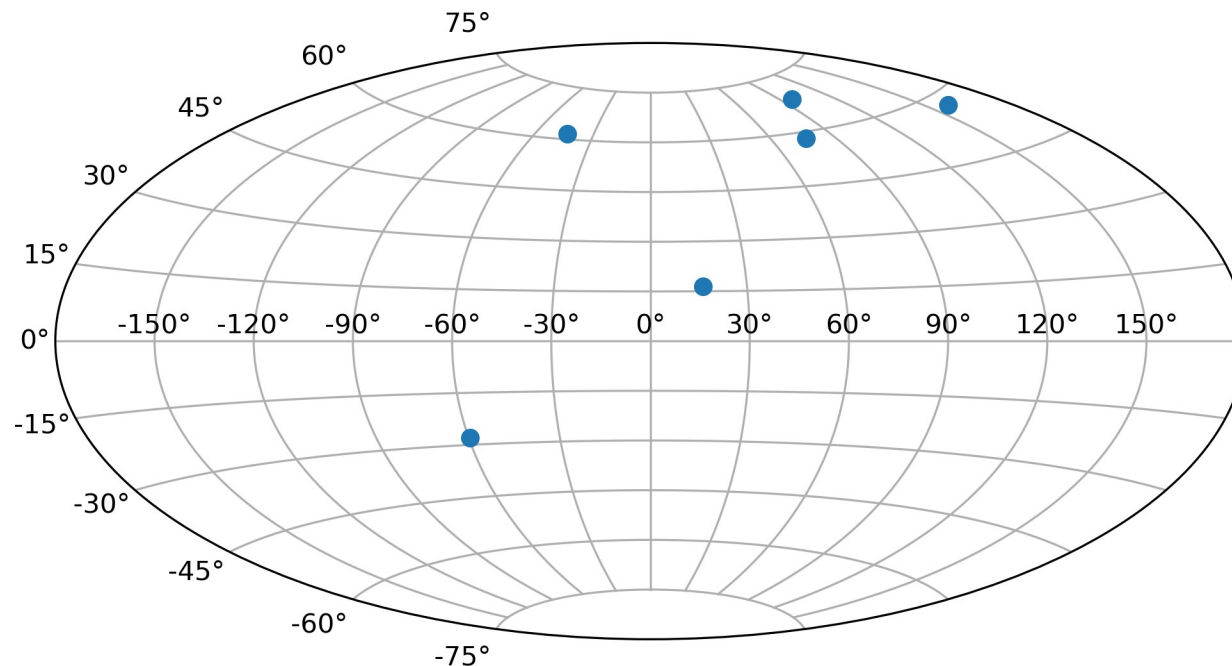
- Telescope of 23 m of diameter
- Energy threshold at few tens of GeV
- Able to repoint in 30 s



A great telescope to detect GRBs at VHE

The follow up of GRBs with LST has already started. So far, six events have been observed.

Currently no automatic follow-up but coming soon



GRBs observed by LST

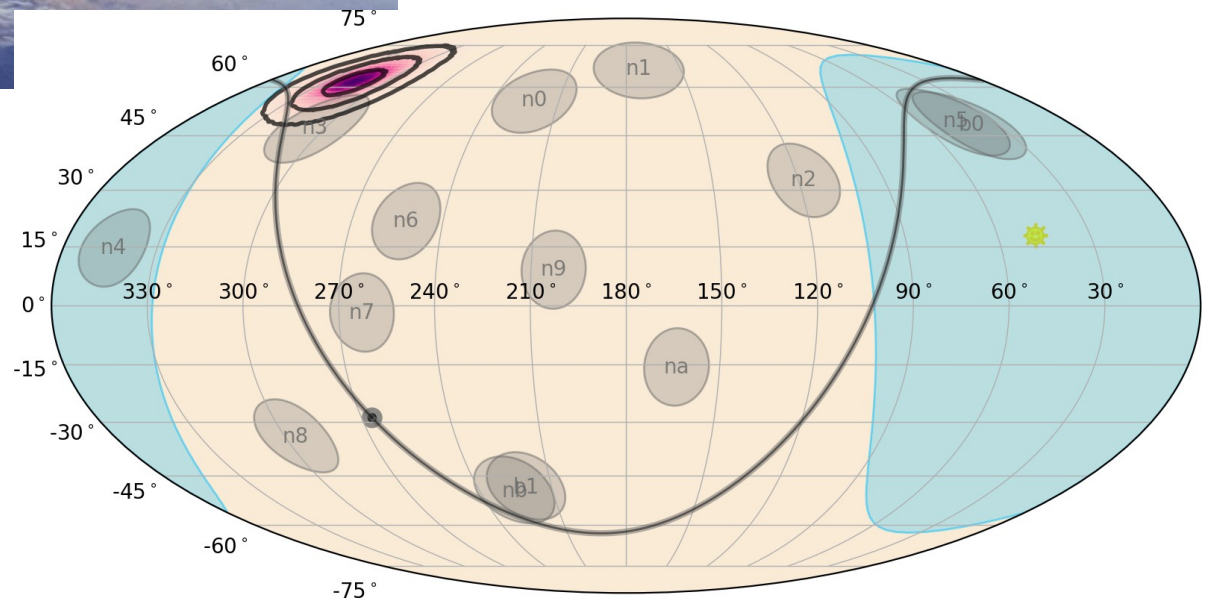
DOI : [10.22323/1.395.0838](https://doi.org/10.22323/1.395.0838)



The 11th May 2021 at 11:26:39 UTC Fermi/GBM detected a bright GRB

The GRB was also detected by GECAM, Konus-Wind, AGILE

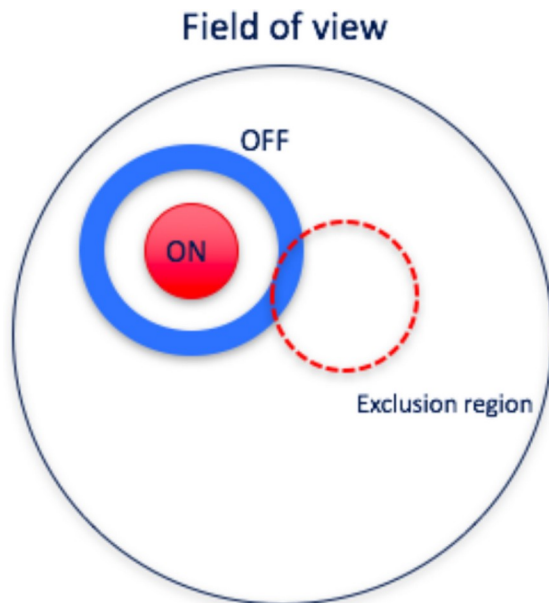
1h of observation by LST
Starting the 12th May 2021 at 03:37:54 UTC with **~ 16h of delay**



GCN 29988 & GCN 29996

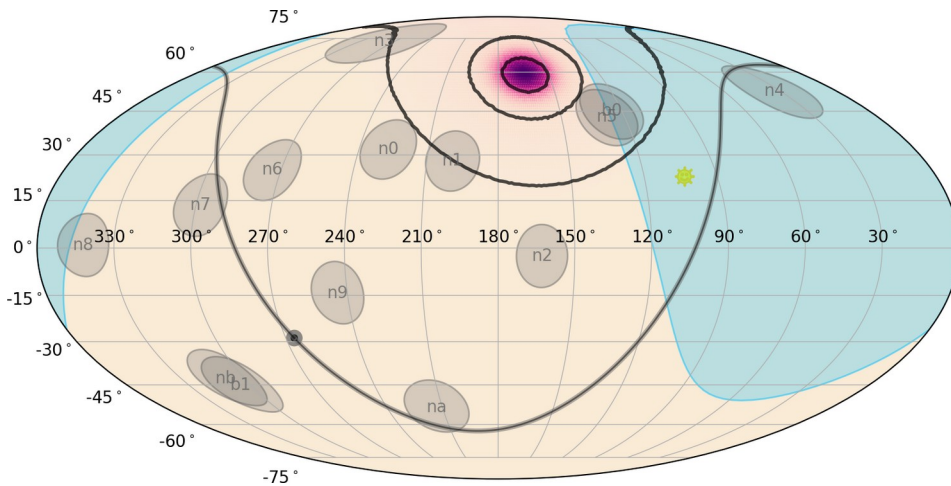
→ Issue : **large localization uncertainty**

Only **43% probability** that the GRB is **in the FOV** of the instrument



No hint of signal

Possibility of a signal close to the detection limit hidden by the poor background normalization



The 4th July 2021 at 19:33:24 UTC
Fermi/GBM detected a bright GRB

The 5th July at 11:19:51 UTC
Fermi/LAT announced the
detection of the GRB

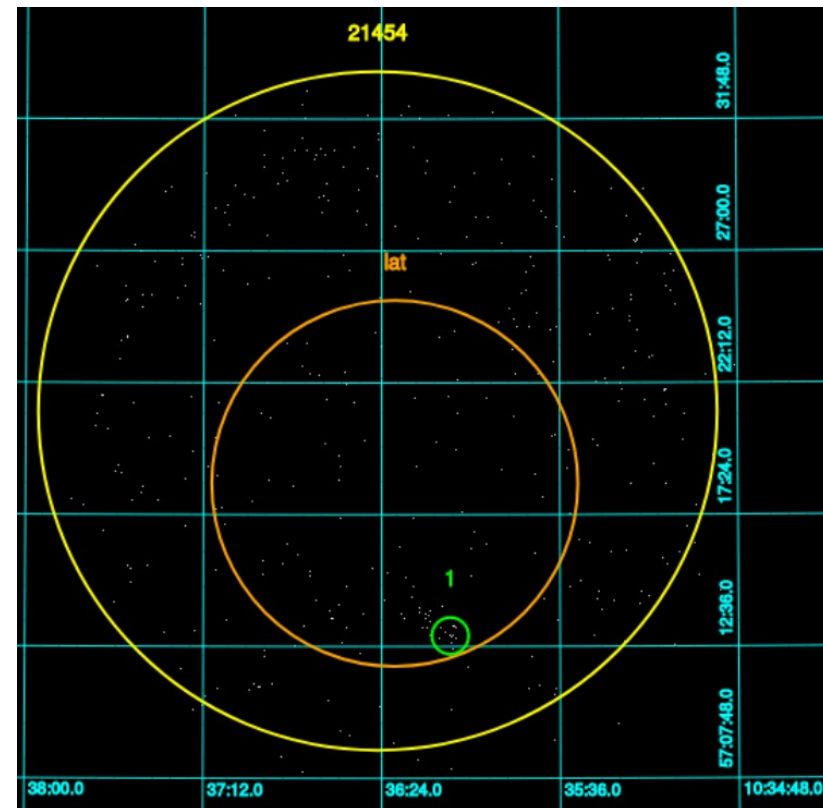
→ **Bright HE counterpart**

The 5th July at 15:34:15 UTC
Swift/XRT announced the
detection of the GRB

→ **Precise localization**

Source at the edge of the FOV (poor sensitivity)

→ **No signal from the source**



The 31th July 2021 at 22:21:08 UTC Swift/BAT detected a bright GRB
Swift/XRT and Swift/UVOT detected x-ray and optical afterglow

→ **Precise localization**

VLT/X-Shooter measured a **redshift of 1.25**

1h30 min of observations by LST

Starting the 12th May 2021 at 21:26:32 UTC with ~ **40 min of delay**

The good
localization provided
by Swift/BAT allow
for observations and
analysis typical of
classical sources

**No VHE signal
from GRB
210731A**



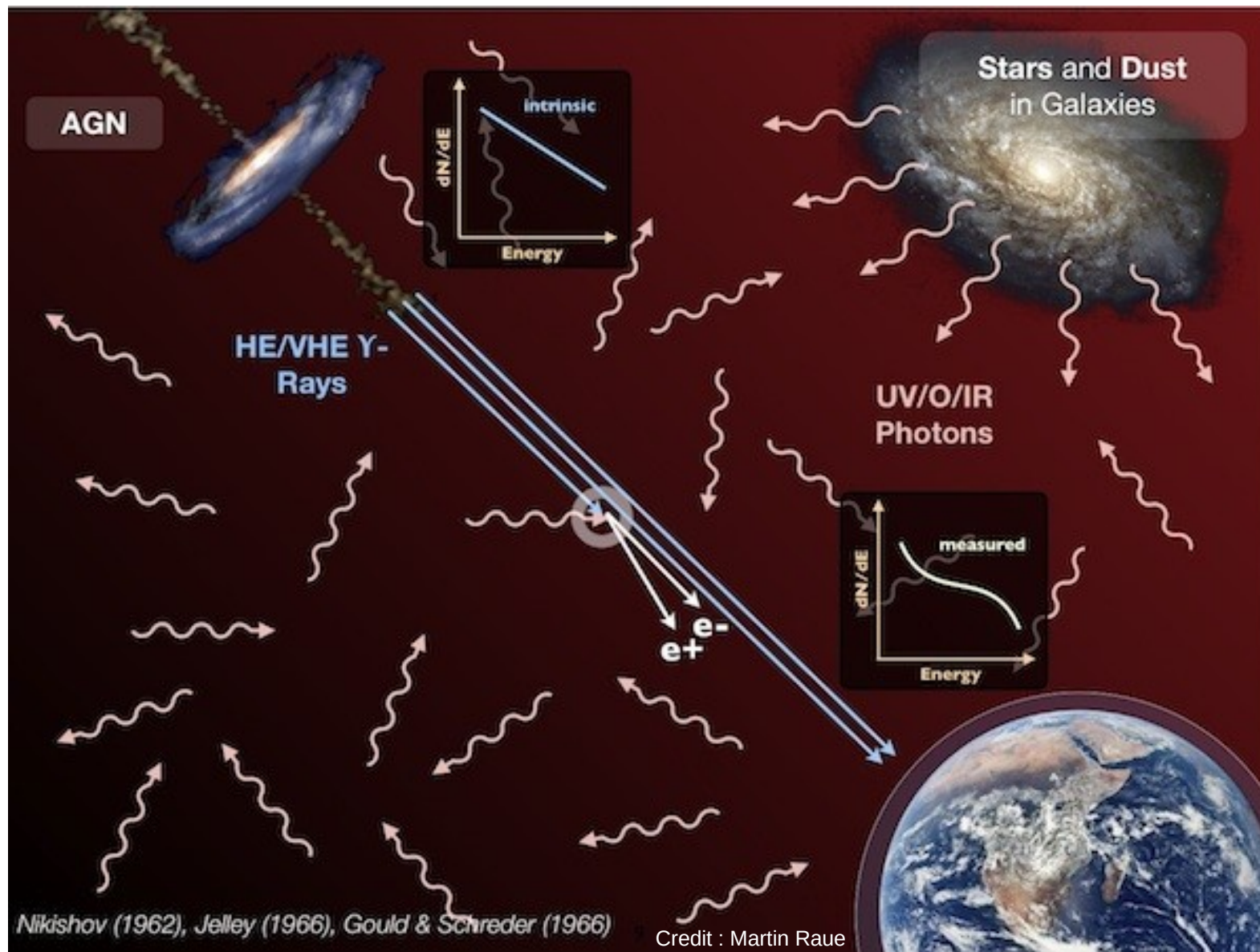
Credit : NASA

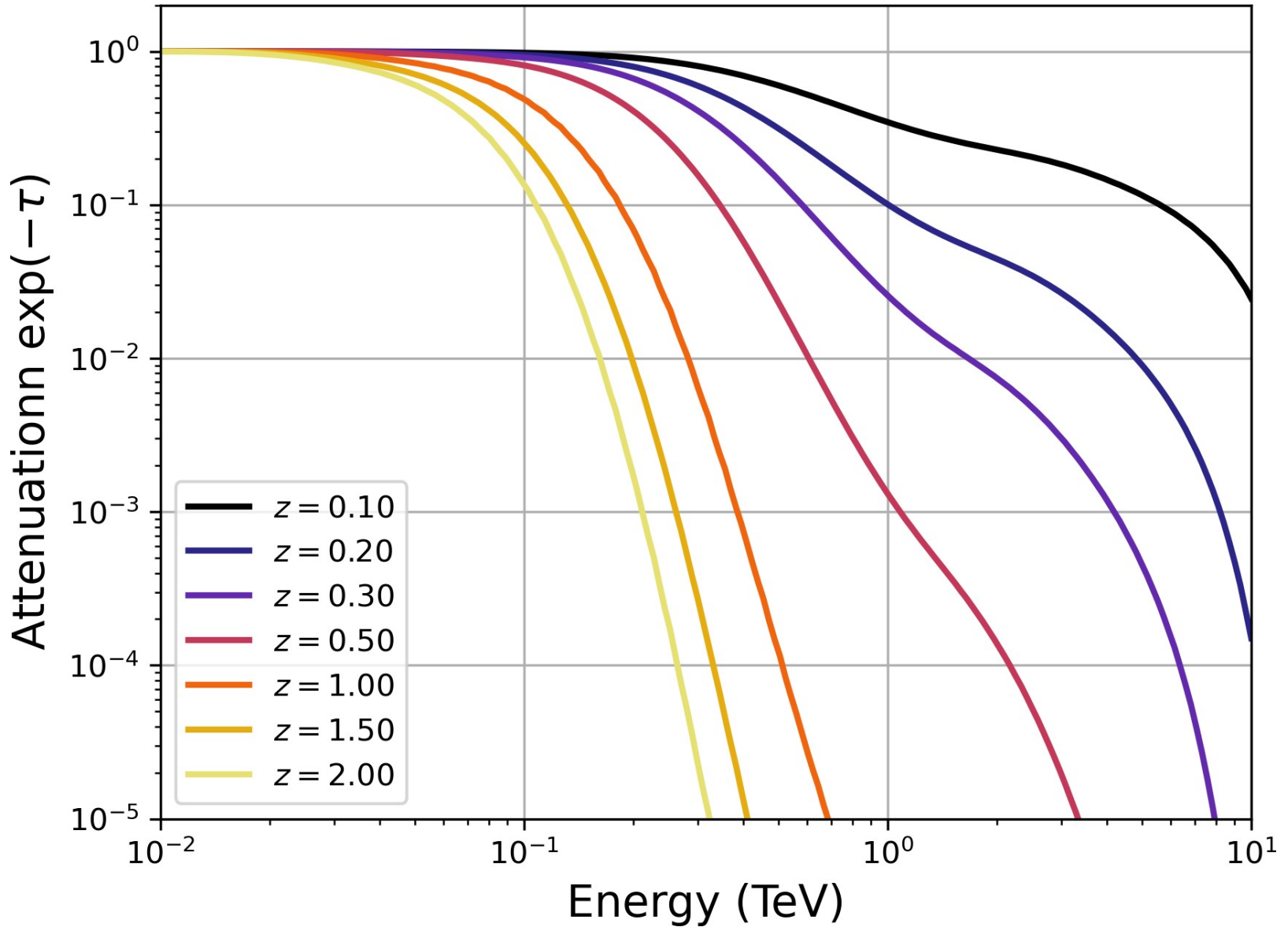
- **The Large Sized Telescope prototype has started GRB follow-up**
- So far **no detection of VHE emission by the LST**
- GRB at VHE are just starting and a lot of discoveries could be expected in the following years



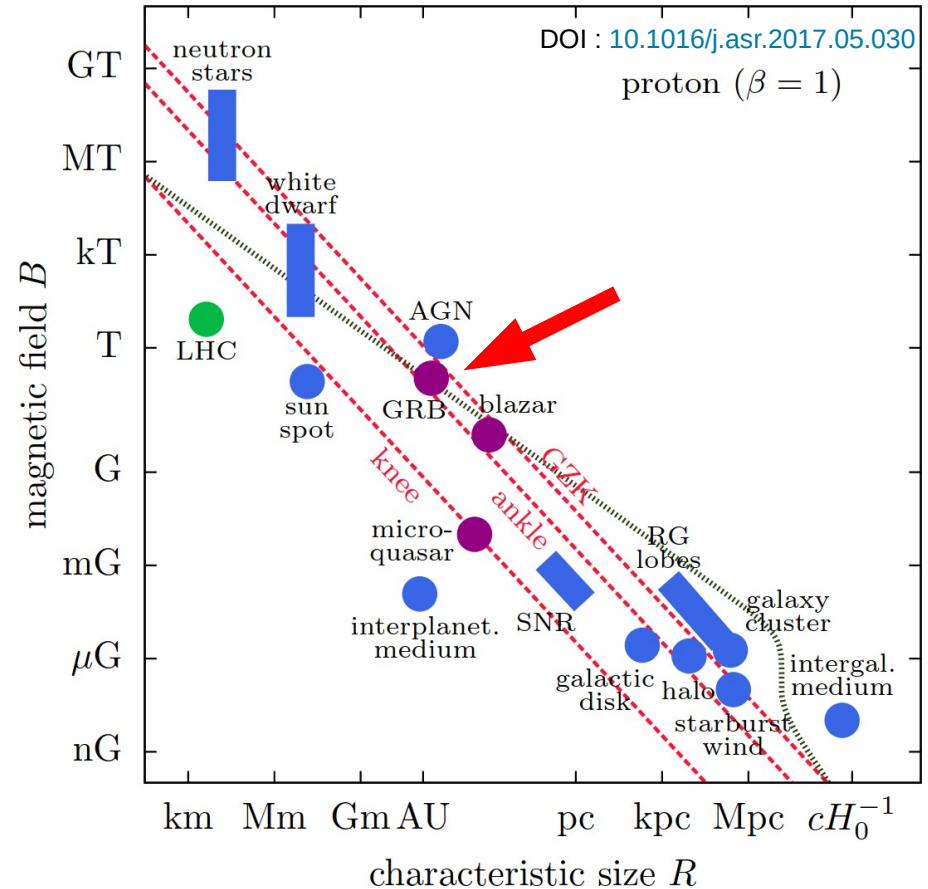
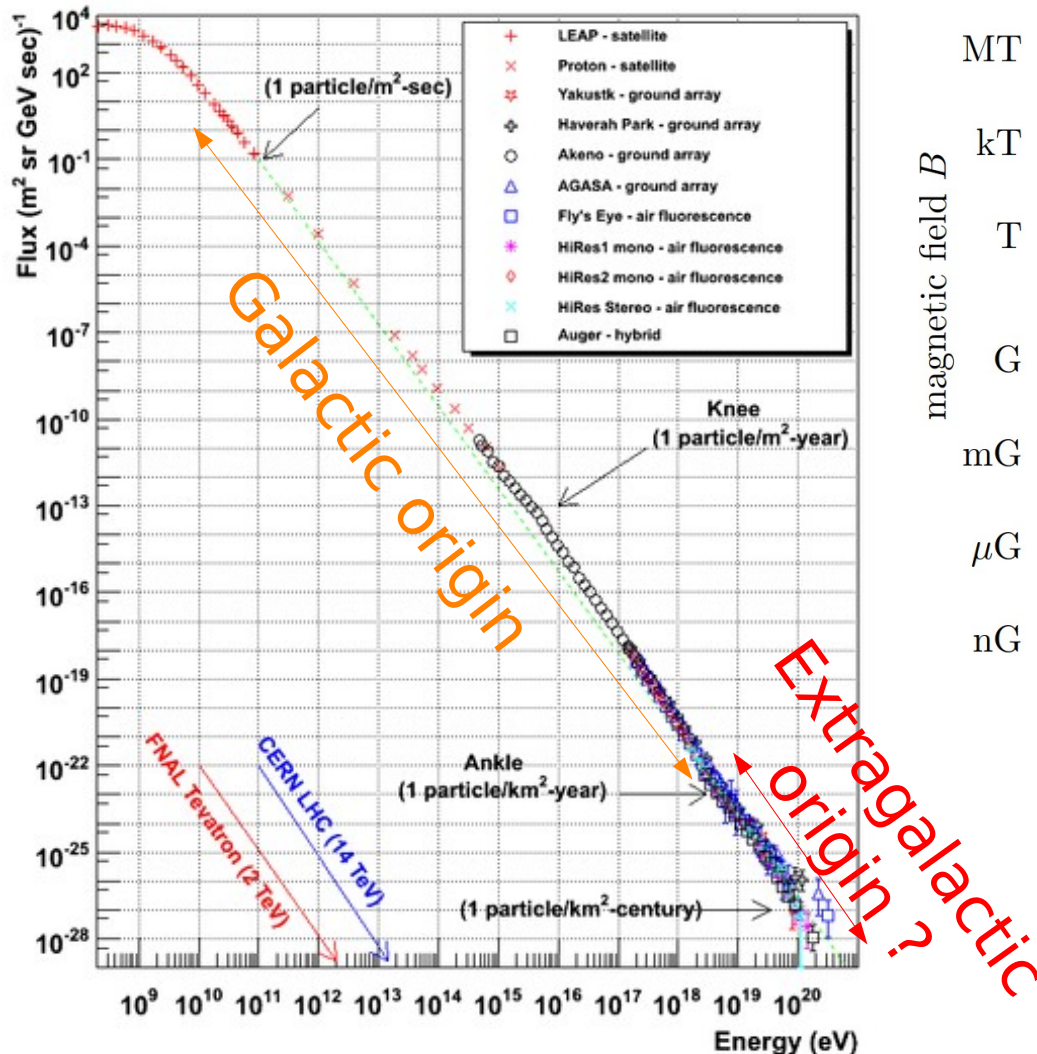
Credit : Moritz Huetten

Backup





Cosmic Ray Spectra of Various Experiments



GRBs are among the candidates to explain the origins of UHE cosmic rays