GRB observations with MAGIC

Davide Miceli

University & INFN Trieste

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Outline

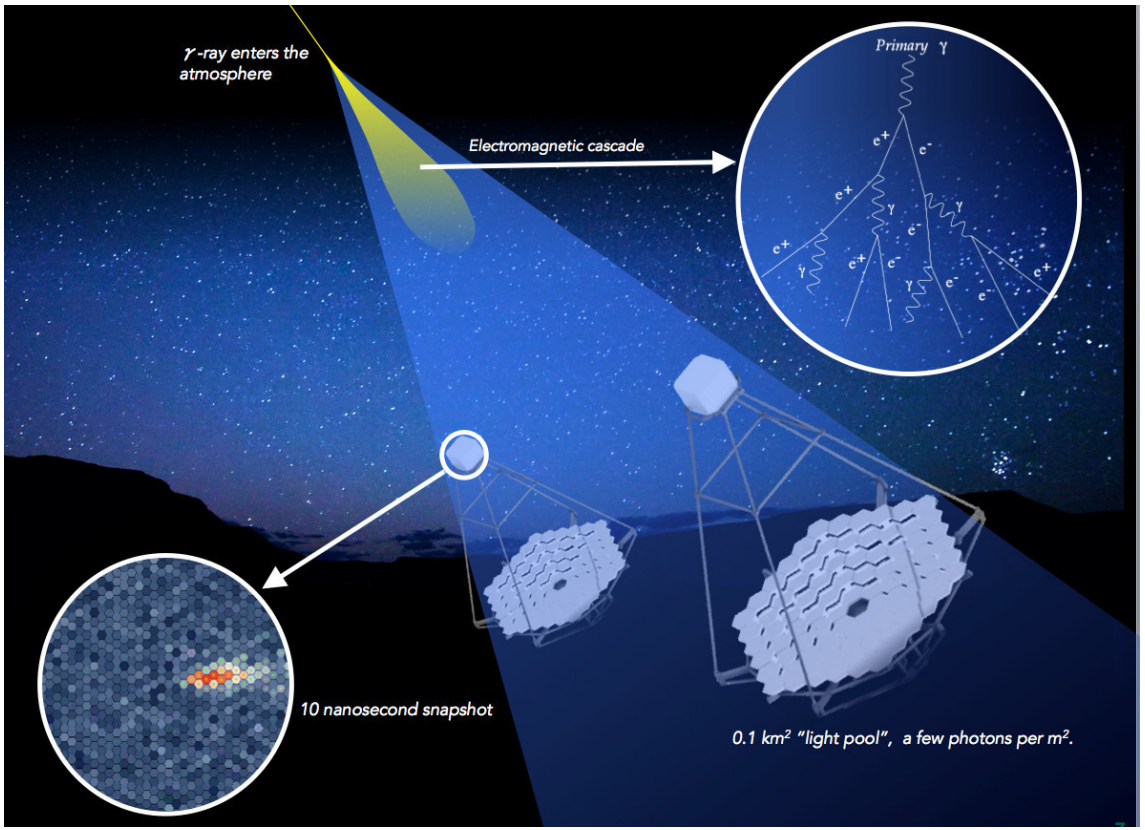
Major Atmospheric Gamma Imaging Cherenkov (MAGIC)

- Stereoscopic system of two Imaging Atmospheric Cherenkov Telescopes (IACTs) of 17 m diameter located in La Palma, Canary Island

Main Features

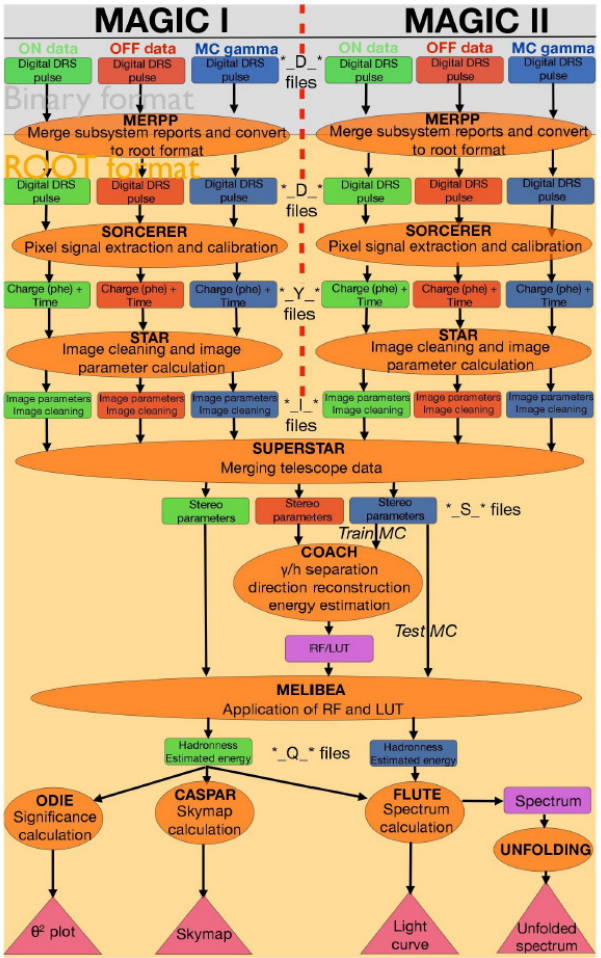
- Fast repositioning system (7°/s) for catching up GRBs
- Small Field of View (3.5°)
- Energetic Range [50 GeV - few tens of TeV]
- Energy Resolution 15% at 300 GeV
- Angular Resolution $< 0.06°$ above 300 GeV
- Integral Sensitivity $(1.45 \pm 0.02)\%$ C.U. above 100 GeV in 50 hours

The imaging technique



- γ-rays that enter in the atmosphere produce air showers
- IACTs use atmosphere as a calorimeter
- Detection of Cherenkov light flashes
- Combine spatial and temporal information to create images of the showers
- Distinguish γ-initiated showers from hadron-initiated showers

MAGIC data analysis chain



⇨ Three types of data (ON, OFF and MC)

⇨ Extraction and calibration

⇨ Image cleaning and parametrization

⇨ Stereoscopic reconstruction and parametrization

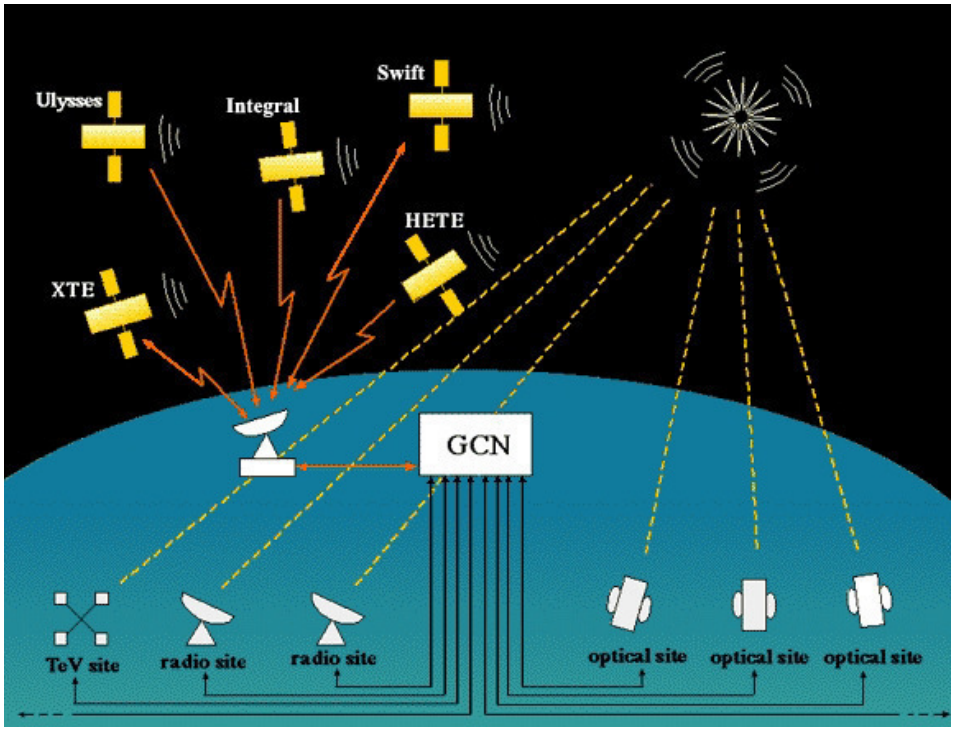
⇨ Generation of RFs and LUTs alghoritms

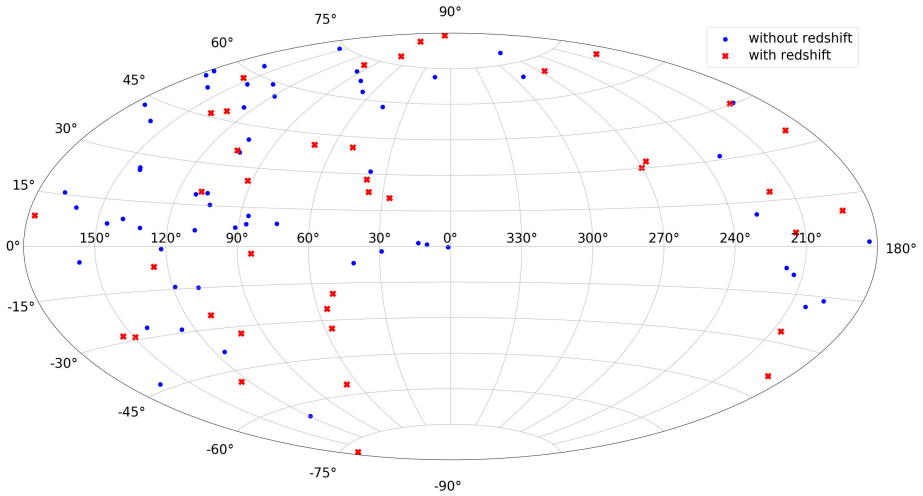
⇨ Application of RFs and LUTs to "MC test" and ON data

⇨ Significance, skymaps, SED and LC

The alert system

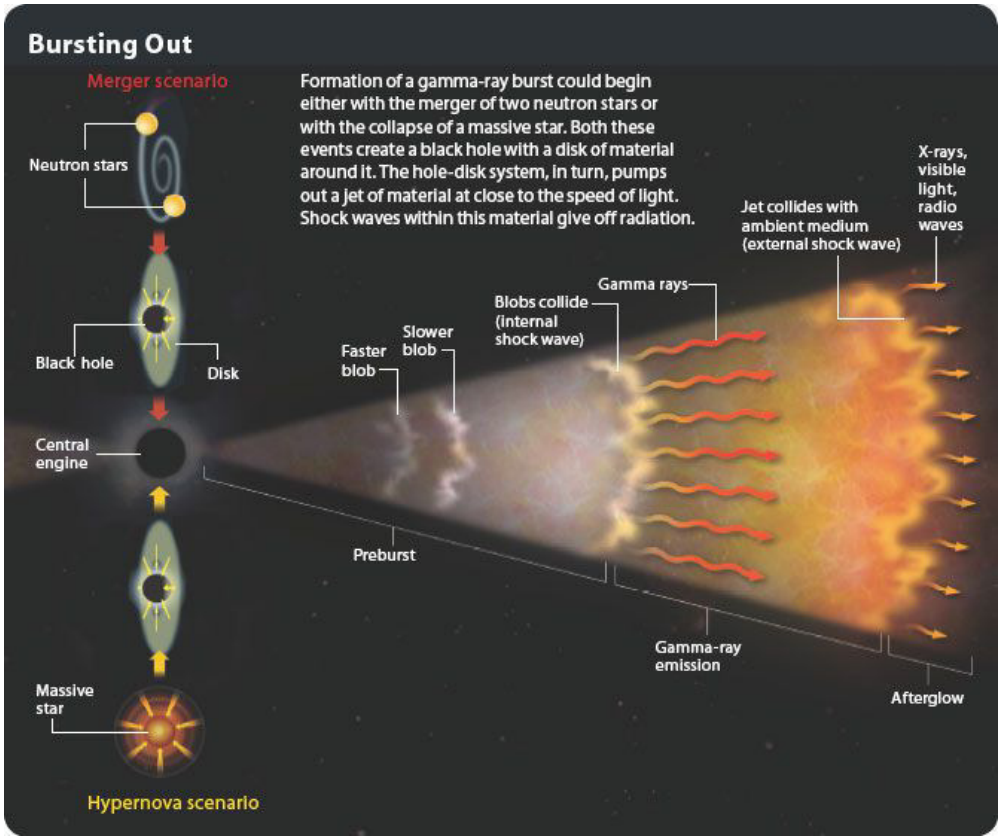
- MAGIC telescopes are able to receive real time GRB alerts via the **Gamma-ray Coordinates Network (GCN)**





- Since 2005, 97 (good) GRBs observed, 39 of them with known redshift

Problems of GRB model

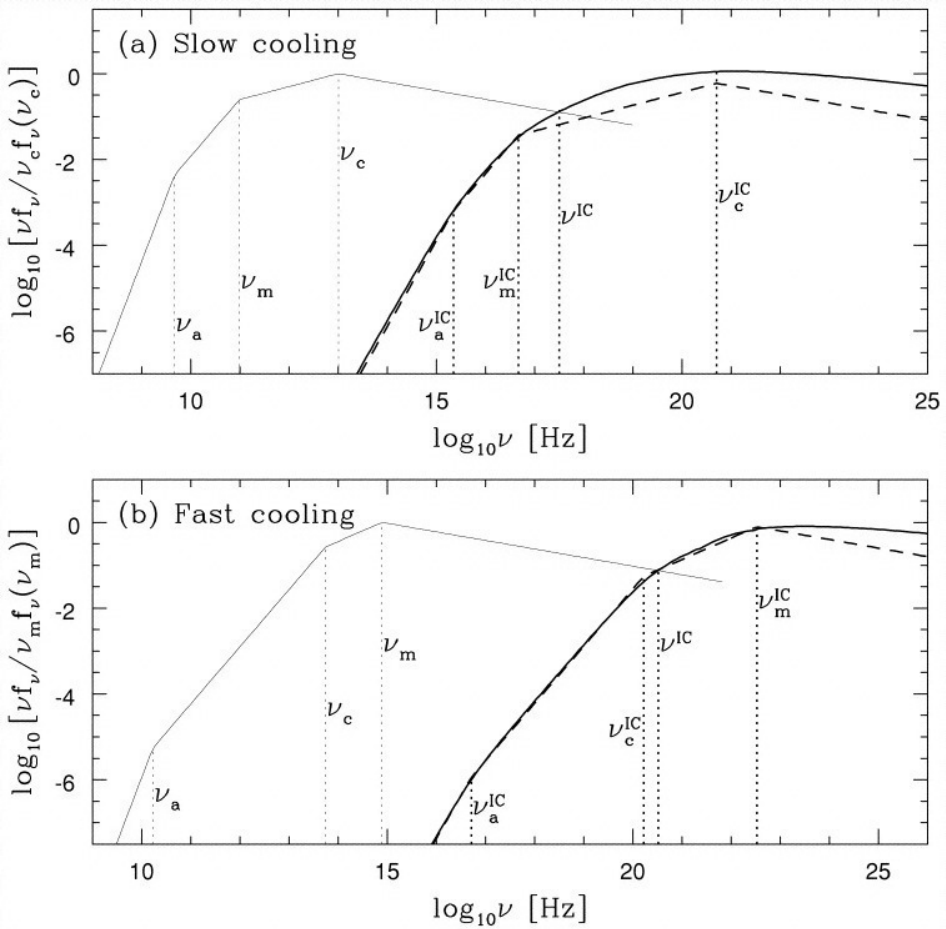


- Properties of jet (speed, structure, collimation, composition)
- Progenitors
- Prompt and early afterglow
- Emission processes
- **High Energy (HE) and Very High Energy (VHE) emission mechanism**

HE/VHE emission models

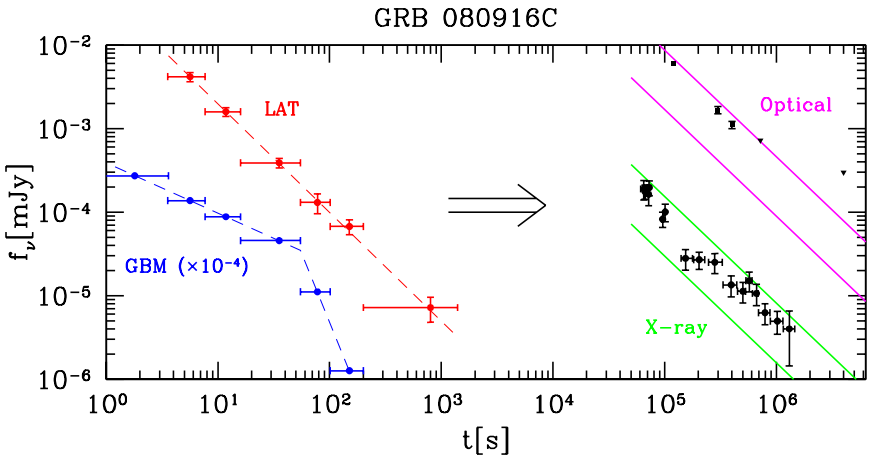
Synchrotron-Self Compton (SSC)

Sari & Esin, 2001



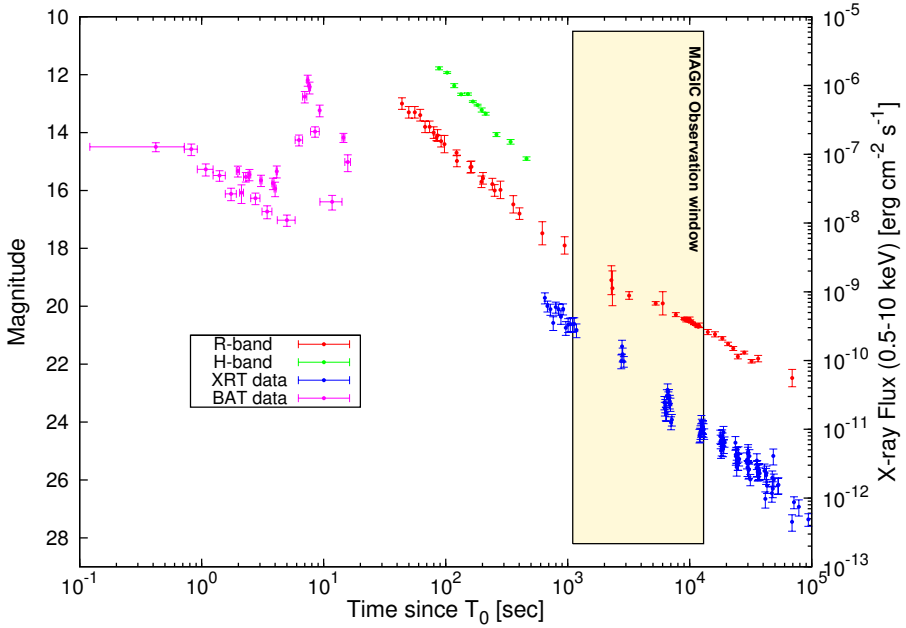
Synchrotron emission

Kumar & Duran, 2010



Search for HE/VHE emission from GRBs with MAGIC

GRB090102 (J.Aleksic et al. 2014)

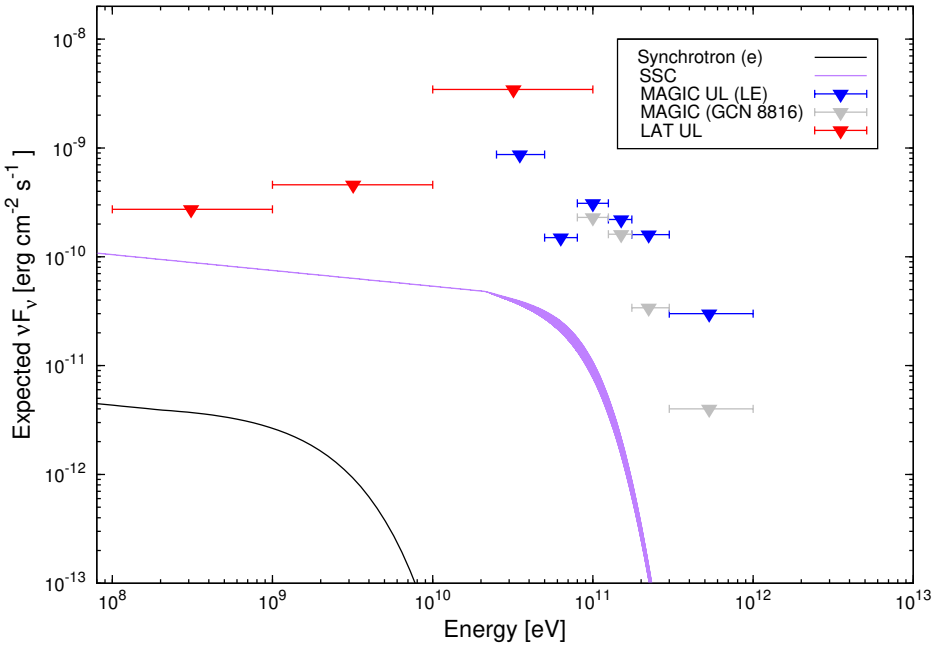


- Detected by Swift BAT
- Long GRB: $T_{90} = (27 \pm 2)$ s
- $z = 1.547$
- MAGIC observations from $T_0 + 1161$ s
- Zenital range: 5°-52°
- $T_{obs} = 13149$ s (only 5919 used)
- $E_{thr} \sim 30$ GeV
- Simultaneous observation with Fermi-LAT

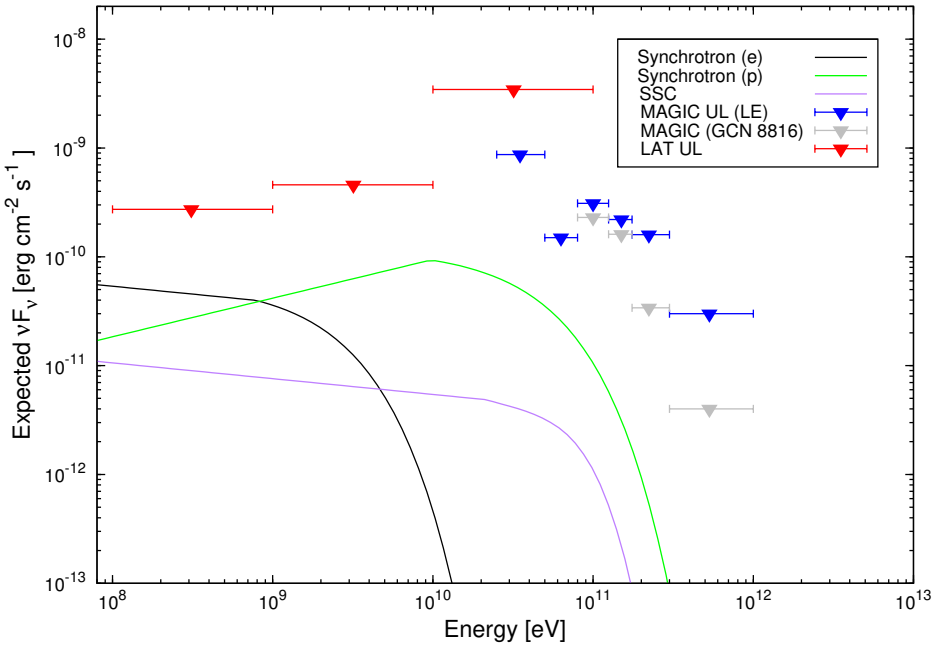
Search for HE/VHE emission from GRBs with MAGIC

GRB090102 (J.Aleksic et al. 2014)

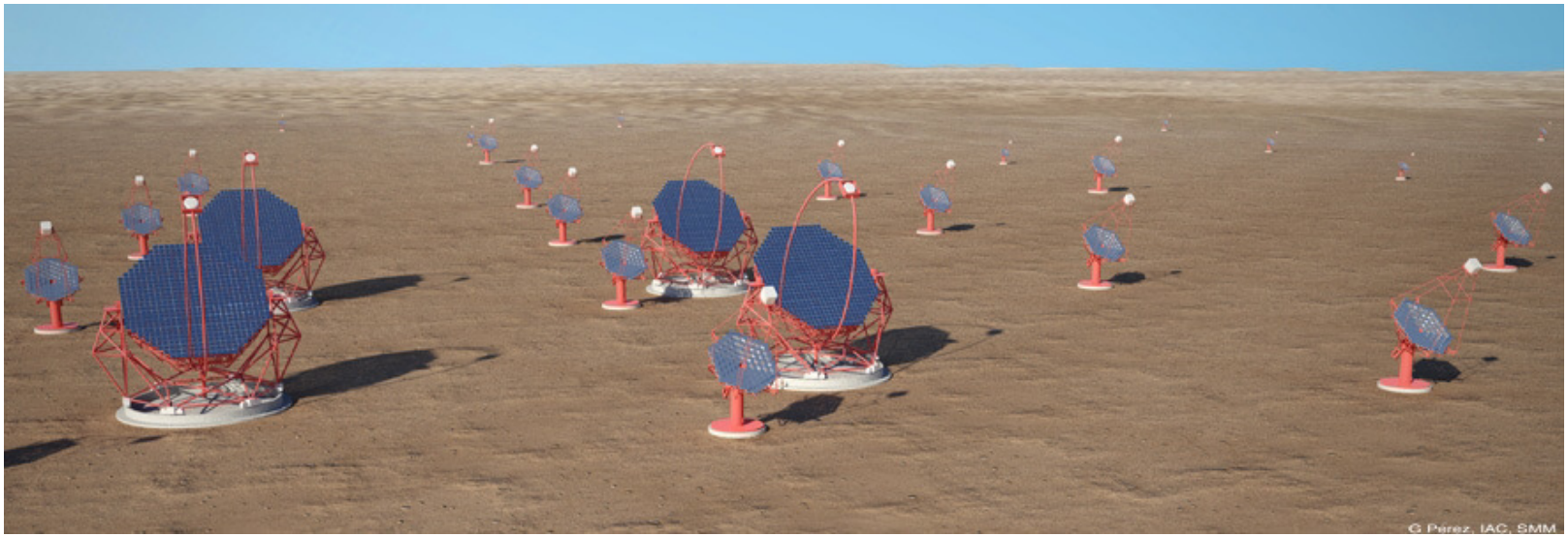
- SSC and e-Synchrotron modeled emission
- $\epsilon_e = 0.1$, $\epsilon_b = 0.01$, $E_{52} = 4.5$, $n = 1\text{cm}^3$

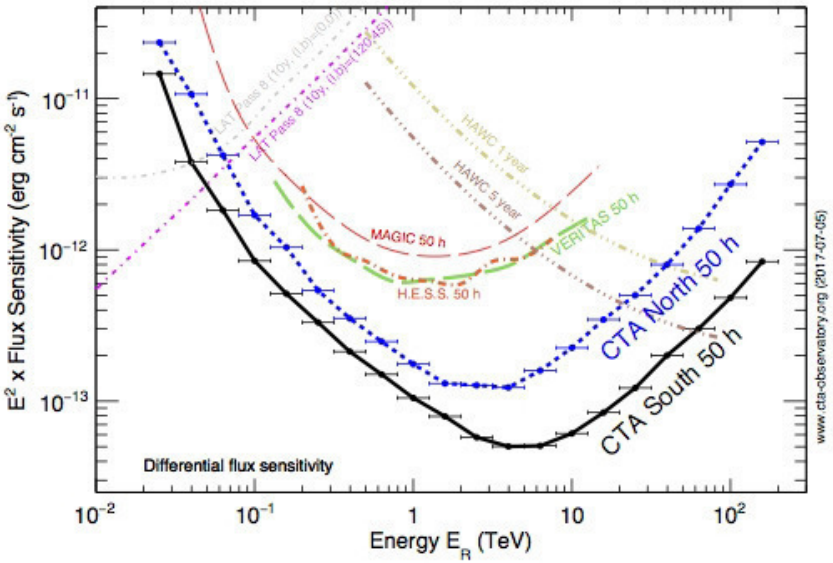


- Hadronic vs leptonic scenarios
- $\epsilon_e = 0.001$, $\epsilon_b = 0.01$, $E_{52} = 10^3$, $n = 100\text{cm}^3$



Future prospects: Cherenkov Telescope Array (CTA)





Array of two sites with:

- 4 **Large Size Telescopes (LSTs)**
- 30 Medium Size Telescopes (MSTs)
- 35-70 Small Size Telescopes (SSTs)

Summary

- MAGIC and other/future IACTs (H.E.S.S., VERITAS, **CTA**) are good instruments for observing GRBs HE/VHE emission
- For a detailed data analysis redshift information, short delay to T_0, simultaneous multiwavelength observations are essential
- ULs (!!!) are useful to put constrains on HE/VHE emission mechanisms

Research for HE/VHE emission from GRBs will help to improve the comprehension on the physical mechanisms involved and to investigate leptonic/hadronic scenarios and EBL models