Tenth International Fermi Symposium

9th-15th October 2022

INTERGALACTIC MAGNETIC FIELD STUDIES BY MEANS OF γ-RAY EMISSION FROM GRB 190114C

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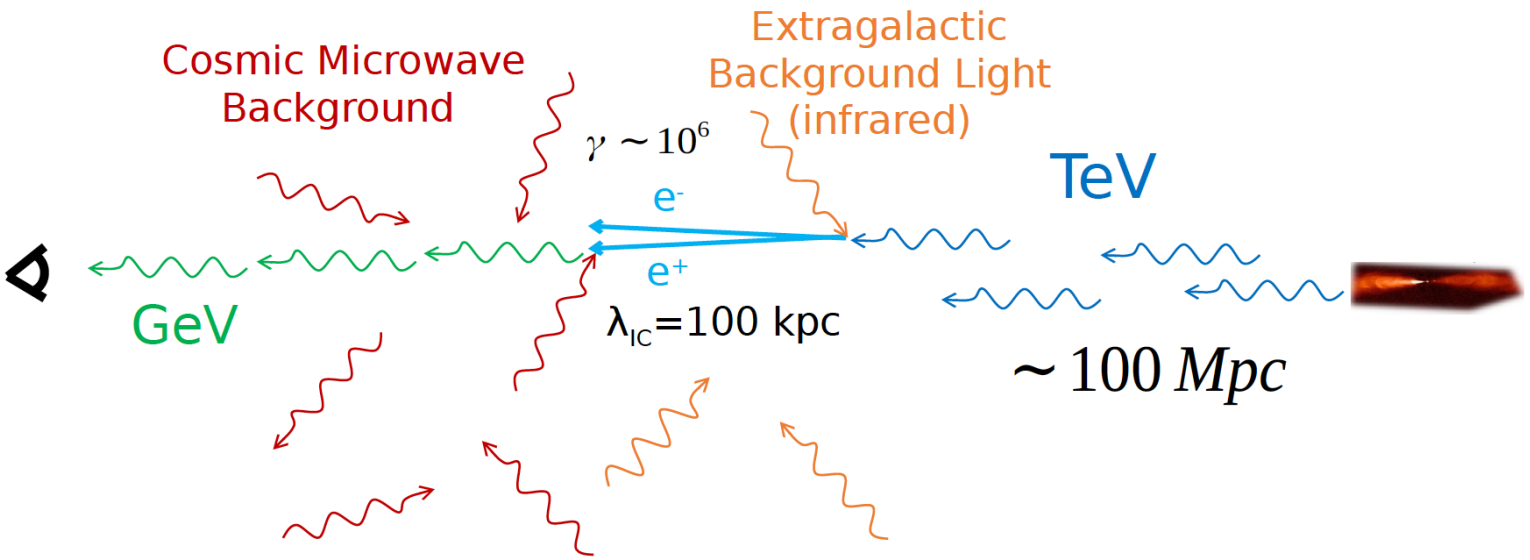
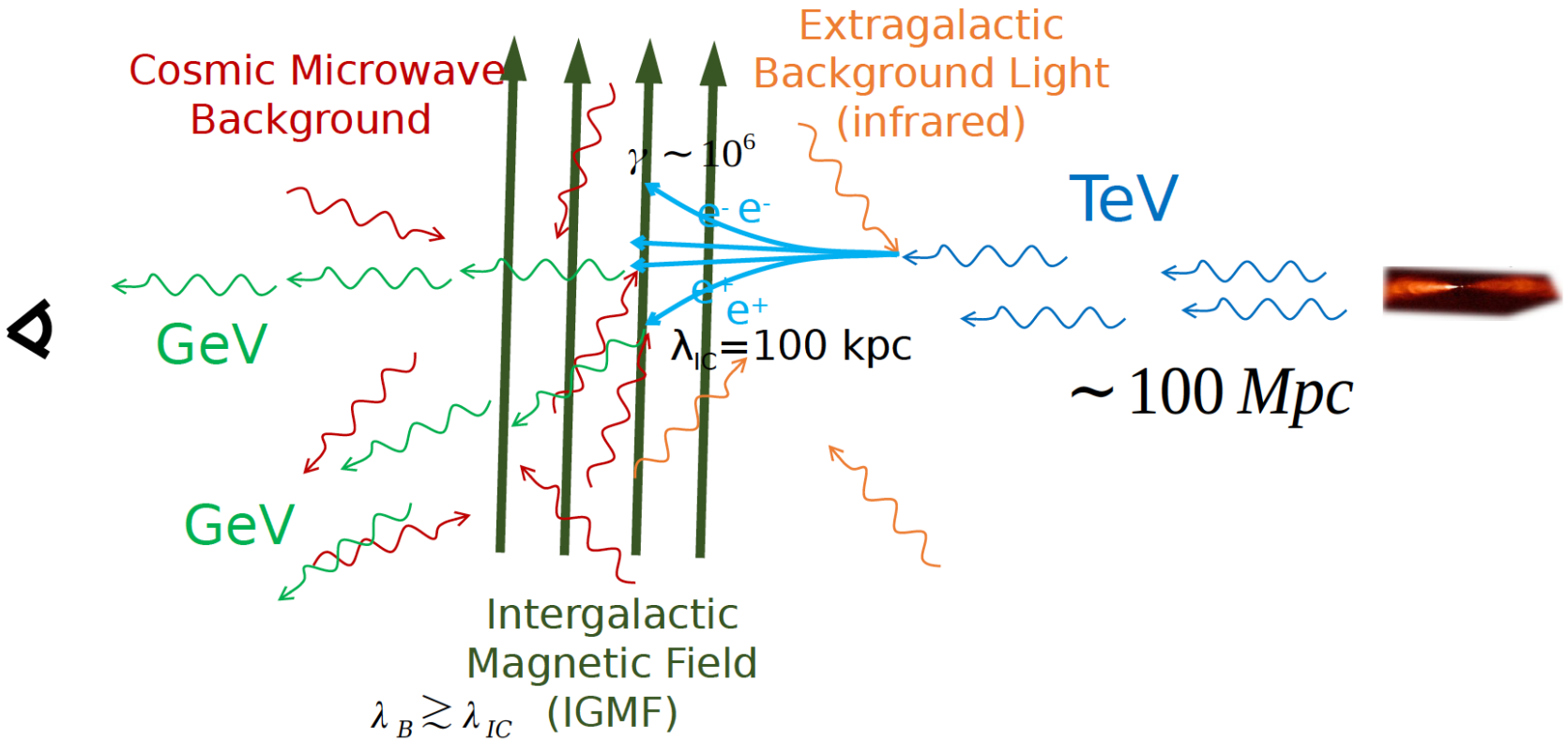
Summary

- Physical process
- Proper choice of the VHE primary spectrum
- CRPropa simulations for different IGMF settings
- Comparison between the simulated SEDs and lightcurve with Fermi/LAT

Summary of a TeV γ-ray's life absent any other process



Summary of a TeV γ-ray's life with an IGMF



Probing the “weakest” IGMF through pair echoes from GRBs

- Since the pairs are deviated, the cascade emission is also delayed (Neronov et al. 2009):

$\lambda_B >> D_e$

$$T_{delay} \simeq 7 \times 10^5 (1-\tau^{-1})(1+z)^{-5} \left[\frac{E}{0.1TeV}\right]^{-5/2} \left[\frac{B}{10^{-18}G}\right]^2 \; s$$

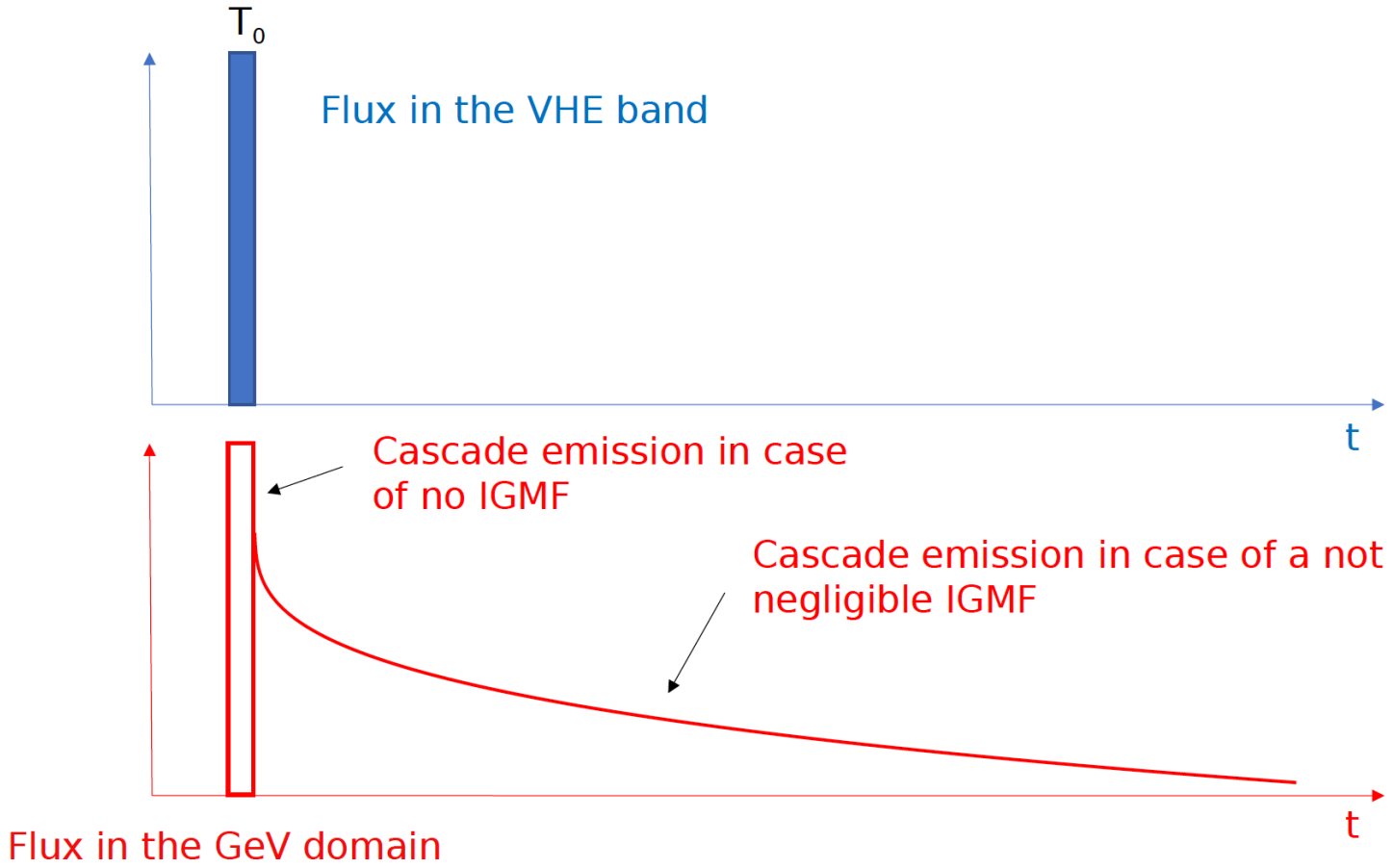
$\lambda_B << D_e$

$$T_{delay} \simeq 10^4 (1-\tau^{-1})(1+z)^{-2} \left[\frac{E}{0.1TeV}\right]^{-2} \left[\frac{B}{10^{-18}G}\right]^2 \left[\frac{\lambda_{B0}}{1kpc}\right] \; s$$

$$F_{delay} \sim \frac{T}{T_{delay}+T} F_0$$

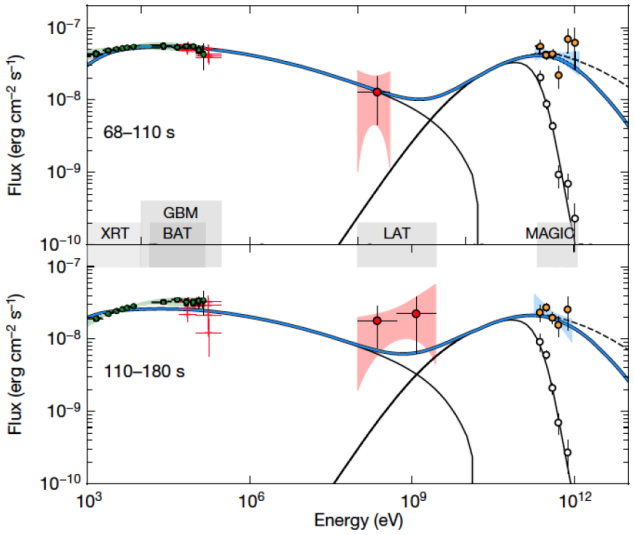
- The delayed emission is strongly diluted

“Delayed” cascade emission



Primary Spectrum

- Since the pairs are deviated, the cascade emission is also delayed (Neronov et al. 2009):



Acciari et al. 2019

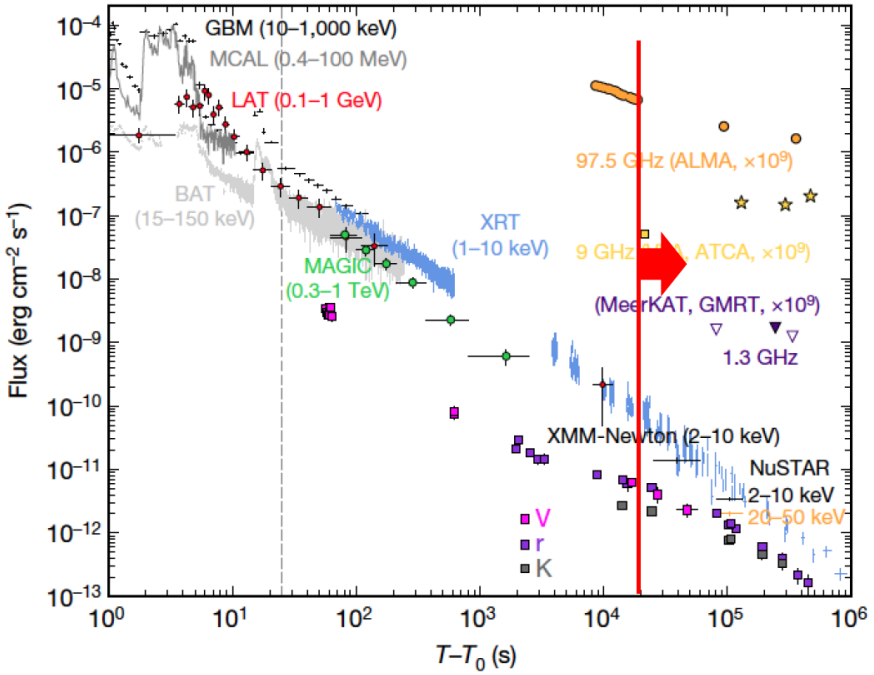
$$\frac{dN}{dE} \propto \left(\frac{E}{0.4TeV}\right)^{-2.5-0.2*\log(E/0.4TeV)}$$

- We extrapolated the flux up to the first 6s after the prompt emission

CRPropa simulations

- Source:
  - Point source
  - z=0.42
  - Logparabola spectrum between 200 GeV and 10 TeV, 1e6 primary photons
  - Minimum energy of cascade photons: 0.05 GeV
- Magnetic Field:
  - Turbulent magnetic field with a Kolmogorov spectrum and different B_{rms}
  - Correlation length: $\gtrsim$ 1 Mpc
- Observer:
  - Sphere with radius 1.6 Gpc with the source at the center

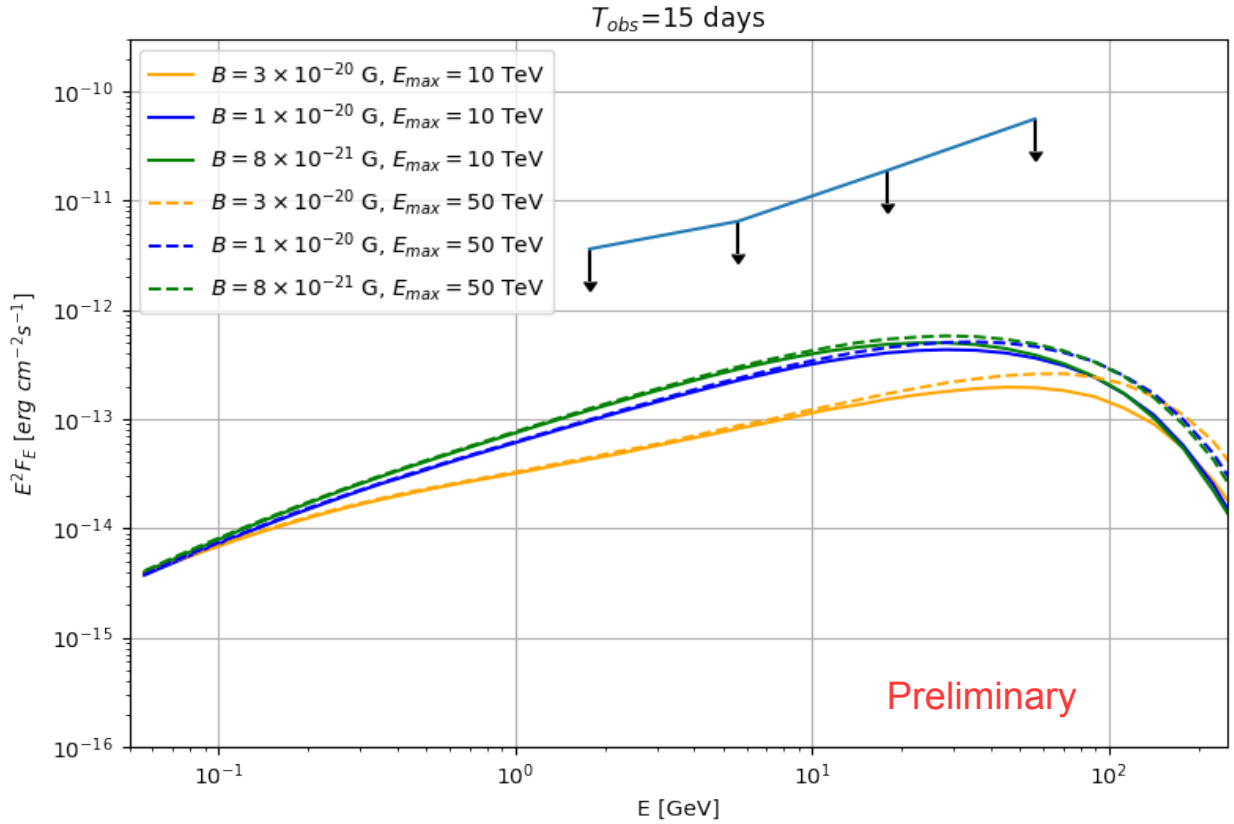
Starting time



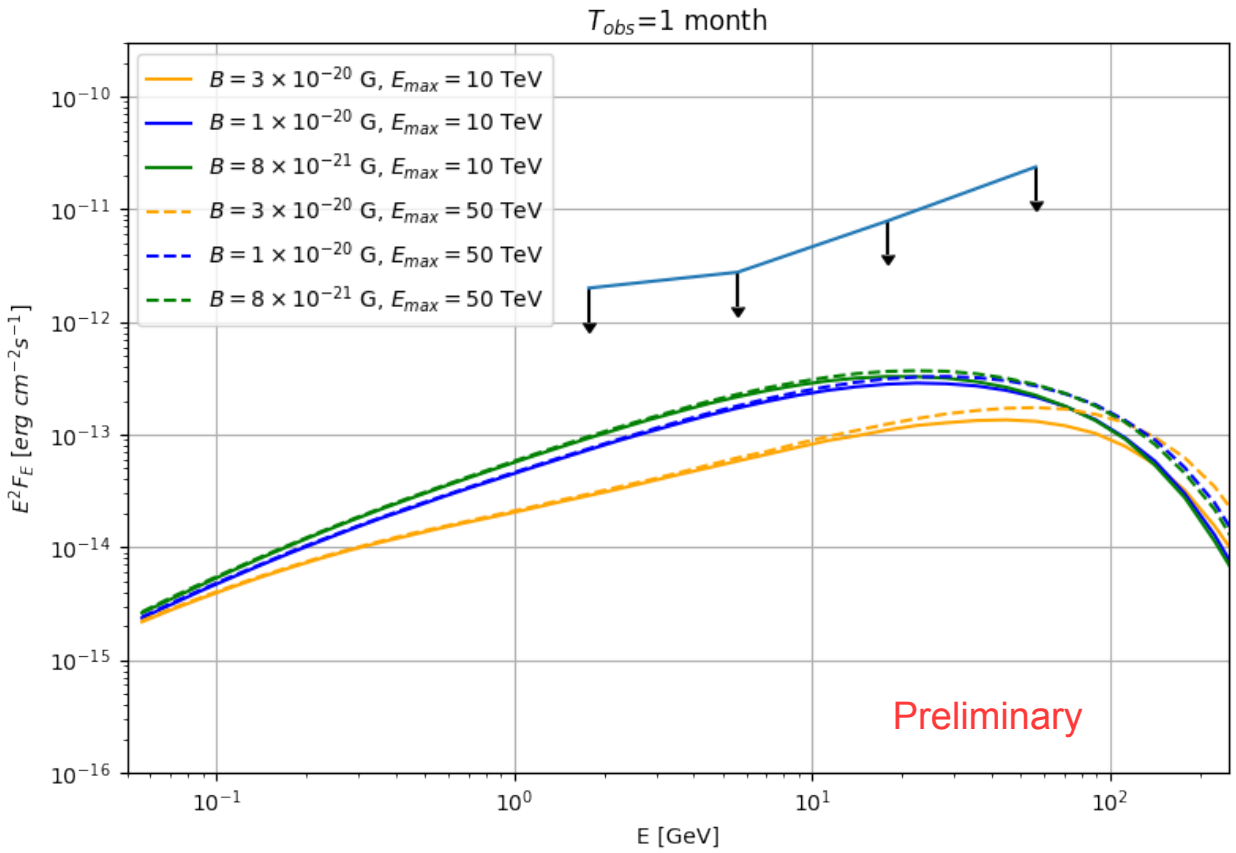
Acciari et al. 2019

- In order not to look for the echo emission in a time window where the GRB is still ongoing in the Fermi band we started counting the cascade photons from T-To=2×10^4 s

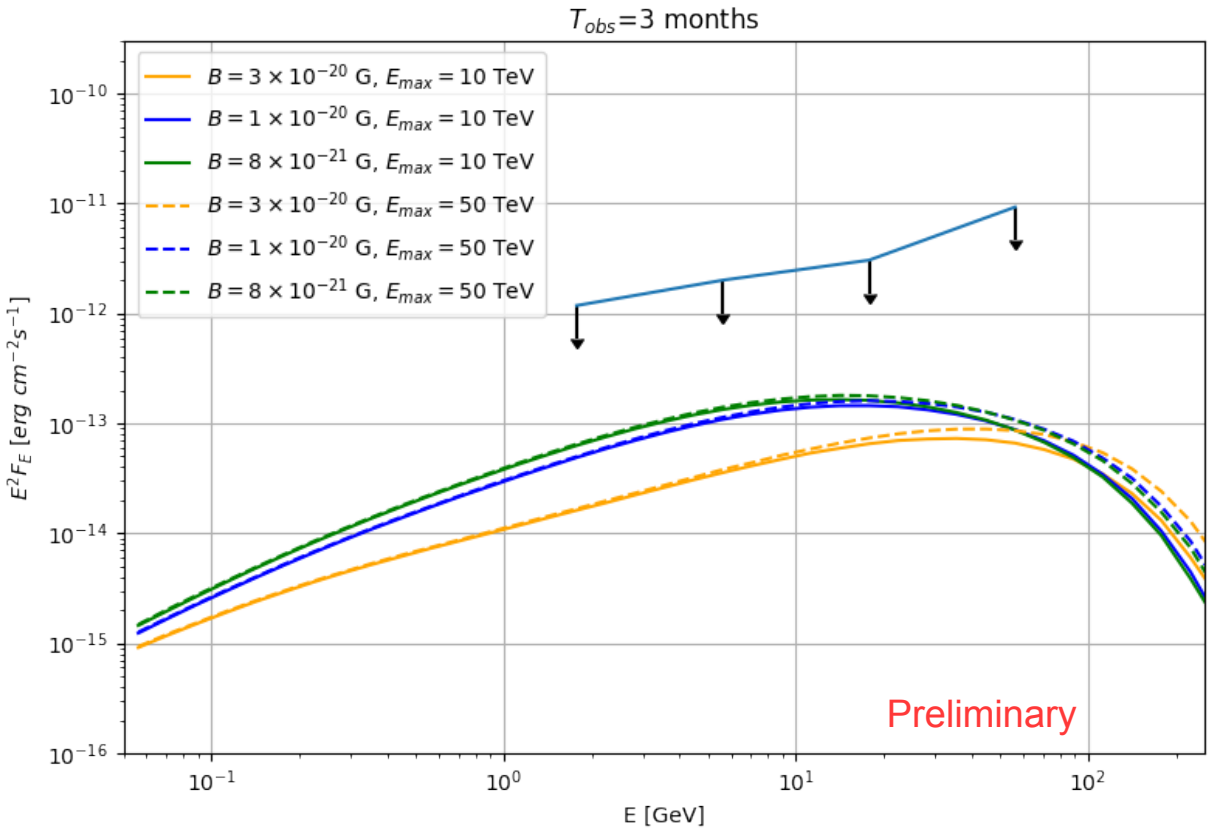
SEDs vs observation time: 15 days



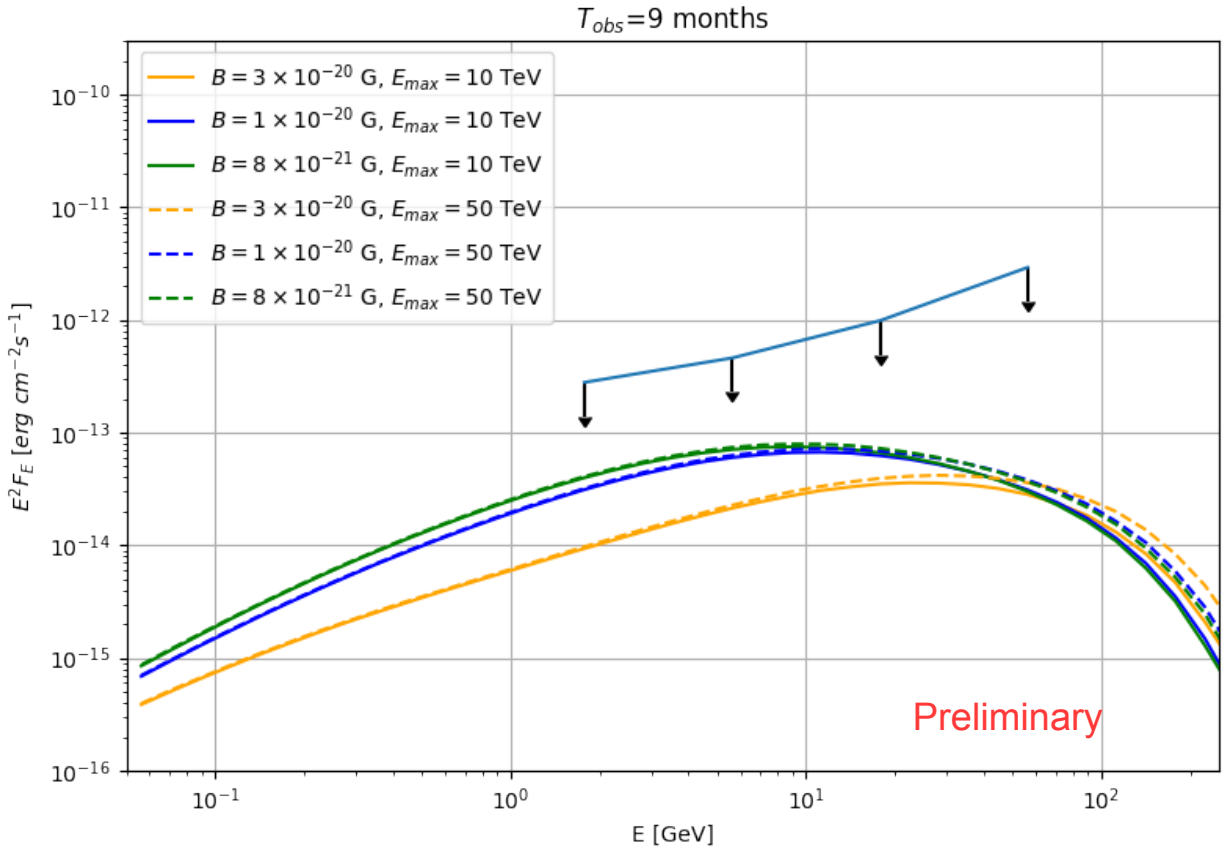
SEDs vs observation time: 1 month



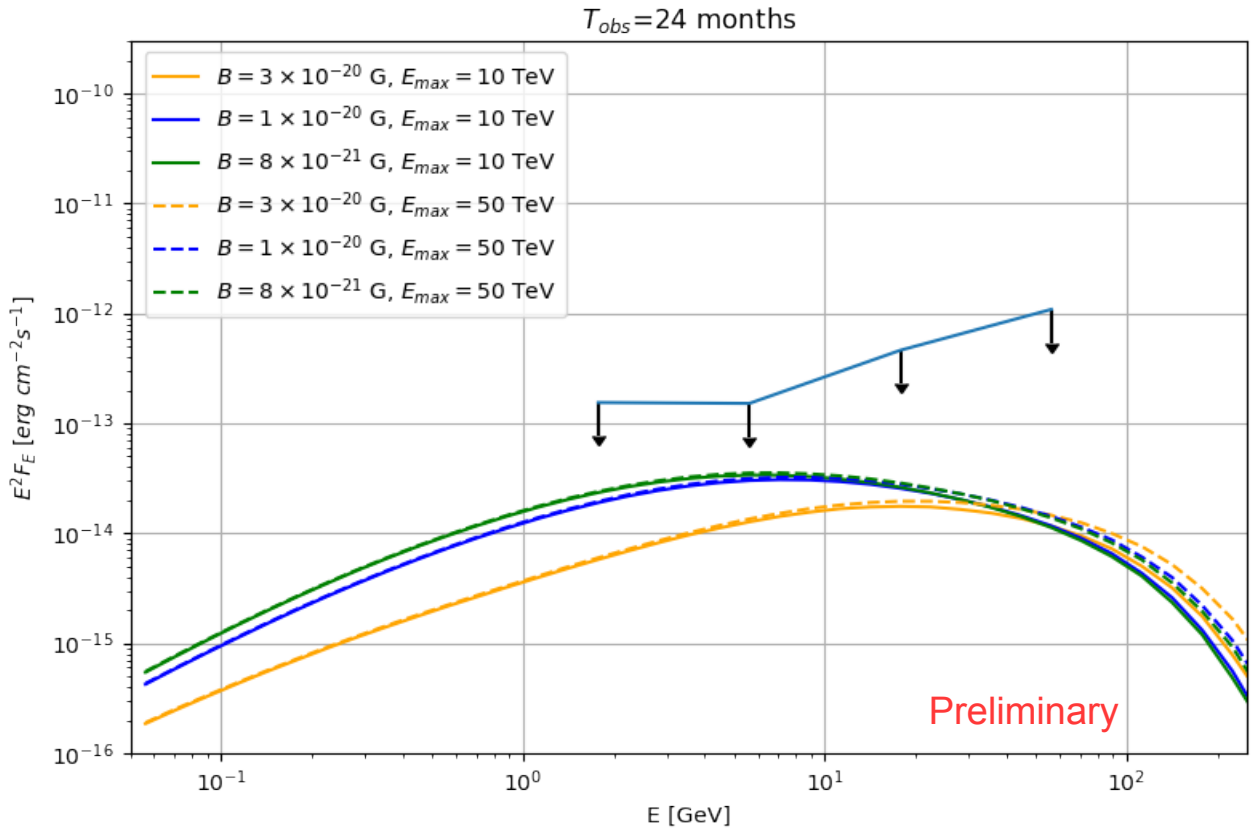
SEDs vs observation time: 3 months



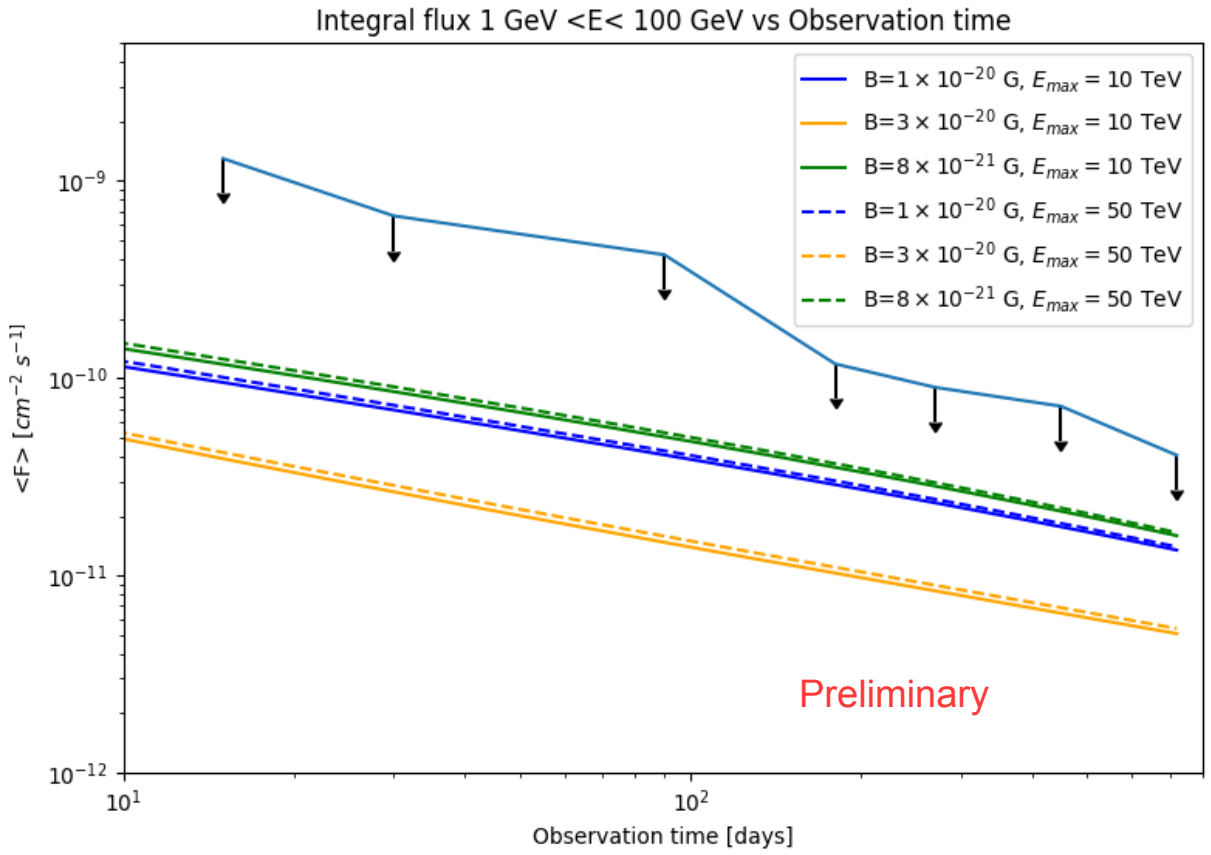
SEDs vs observation time: 9 months



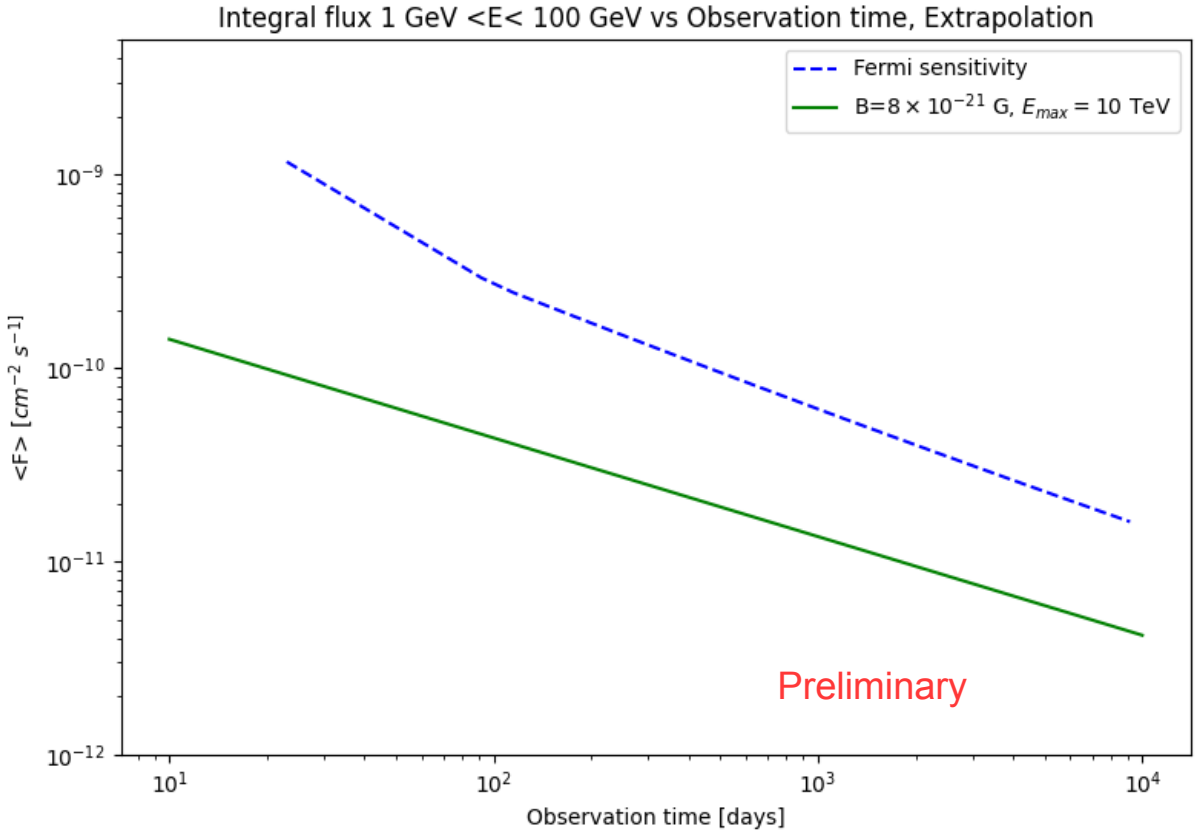
SEDs vs observation time: 24 months



Integral flux 1 GeV < E < 100 GeV



Fermi/LAT sensitivity (95% CL)



Conclusions

- We simulated the cascade delayed emission from GRB 190114C for different IGMF settings and using, as VHE primary spectrum, the GRB model published by MAGIC coll.

- We performed the Fermi/LAT analysis from the end of the GRB up to 24 months

- Comparing the simulated SEDs and lightcurve with the Fermi/LAT limits no constraints can be placed on the IGMF strength

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Thank you for your attention!

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