GeV Flares observations with GLAST LAT

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ABSTRACT: *Early X-ray afterglow observations show that X-ray flares are very common features in GRB light curves. X-ray flares may reflect long duration central engine activity. The delayed flare photons are expected to interact with relativistic electrons by Inverse Compton giving delayed high energy emission counterparts that potentially will be detected by GLAST LAT, which could observe GRB from 20 MeV to more than 300 GeV. The nature of high energy spectral components from GRB detected by EGRET is still debated. Observations with GLAST LAT will give useful information to constrain the origin of X-ray flares. In this work we simulate a set of possible GeV emitting flares in the context of External Shock model to study the capability of GLAST LAT to detect GeV flares at different intensities and durations.*

The flare phenomenon

✓ Observed the first time by BeppoSAX in XRF 011030[1], GRB 011121[1,2] and GRB 011211[2], but Swift showed that X-ray flares are a common feature in GRB light curves (~ 40% of the sample) [3]

✓Appear from hundred to thousand of seconds after the burst when the prompt-to-afterglow transition occurs: trace the central engine activity during the first phases of the burst emission.

✓ Globally softer than the prompt emission (e.g. [4]),but with a variety of spectral behaviours:

-1) **hard-to-soft spectral evoultion** resembling that of the prompt emission ⇒ **Late Internal Shock**

-2) **soft spectrum**, consistent whit that of the late afterglow emission ⇒ **External Shock by thick shell fireball**[5]

Both late internal shocks and a thick shell fireball imply a long lasting central engine activity

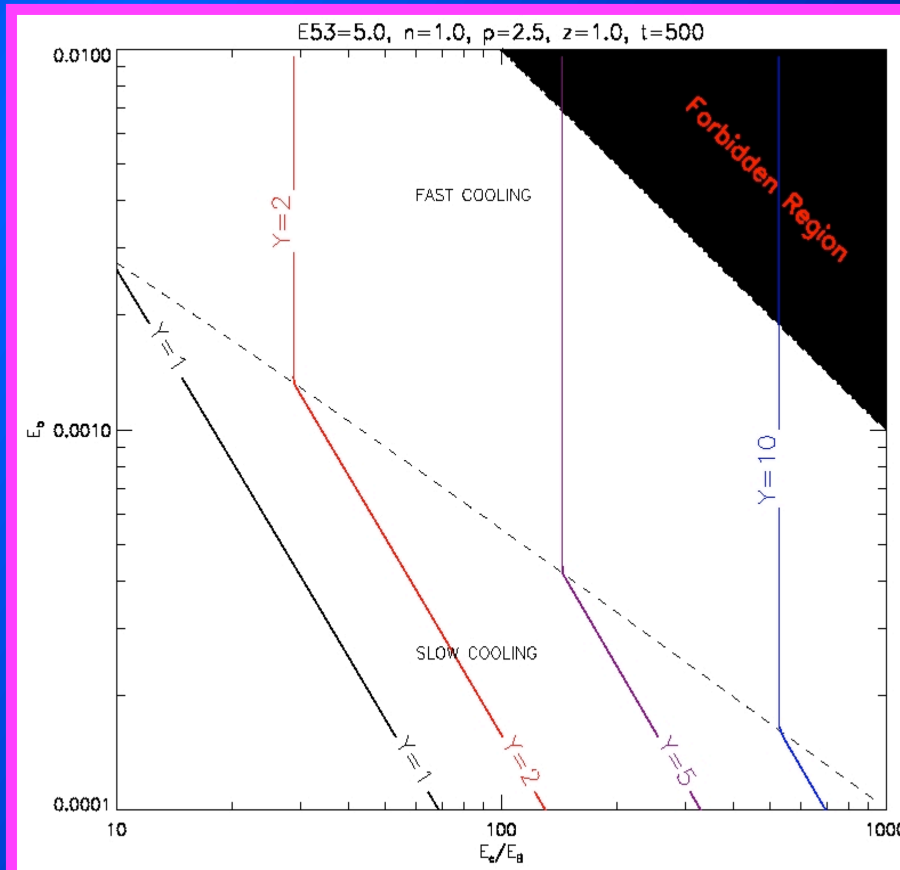
External Shock by thick shell fireball

✓Why External Shock? Some X-ray flares have a soft spectrum consistent with that of the following afterglow emission.

✓Why a thick shell fireball? The central engine release most of the energy during the last phases of its activity, i.e. around the time of flare appearance[1,2].

X-ray flares: by synchrotron emission in External Shocks (ES)

GeV flares: by Inverse Compton (IC) scattering of X-ray flare photons on afterglow electrons

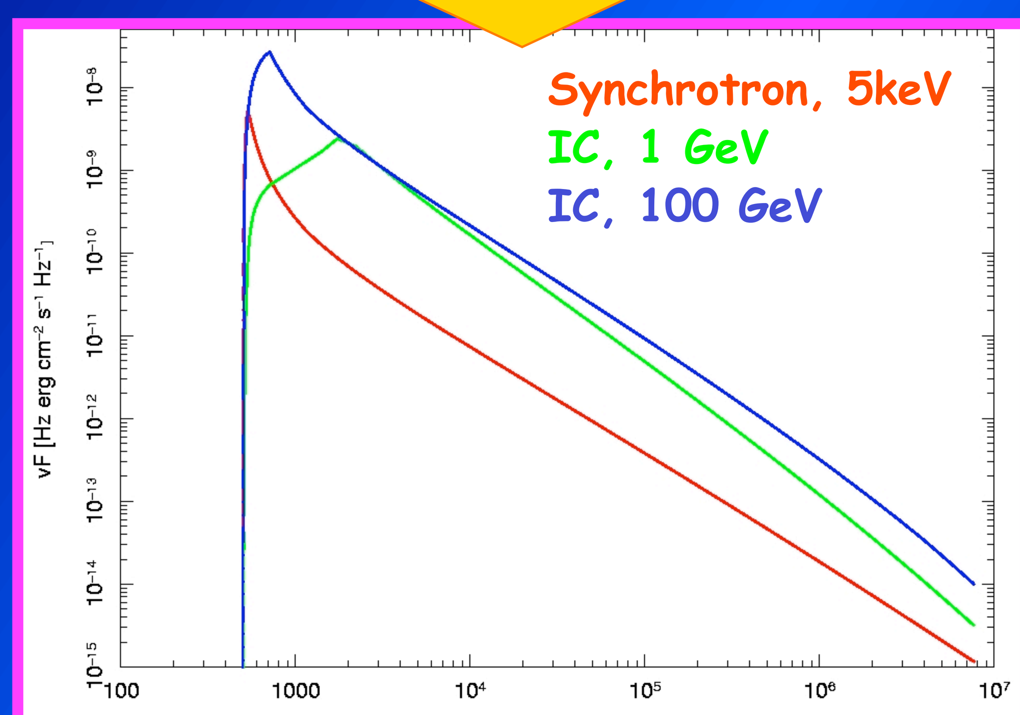


$Y \sim (\eta \epsilon_e/\epsilon_B)^{1/2}$

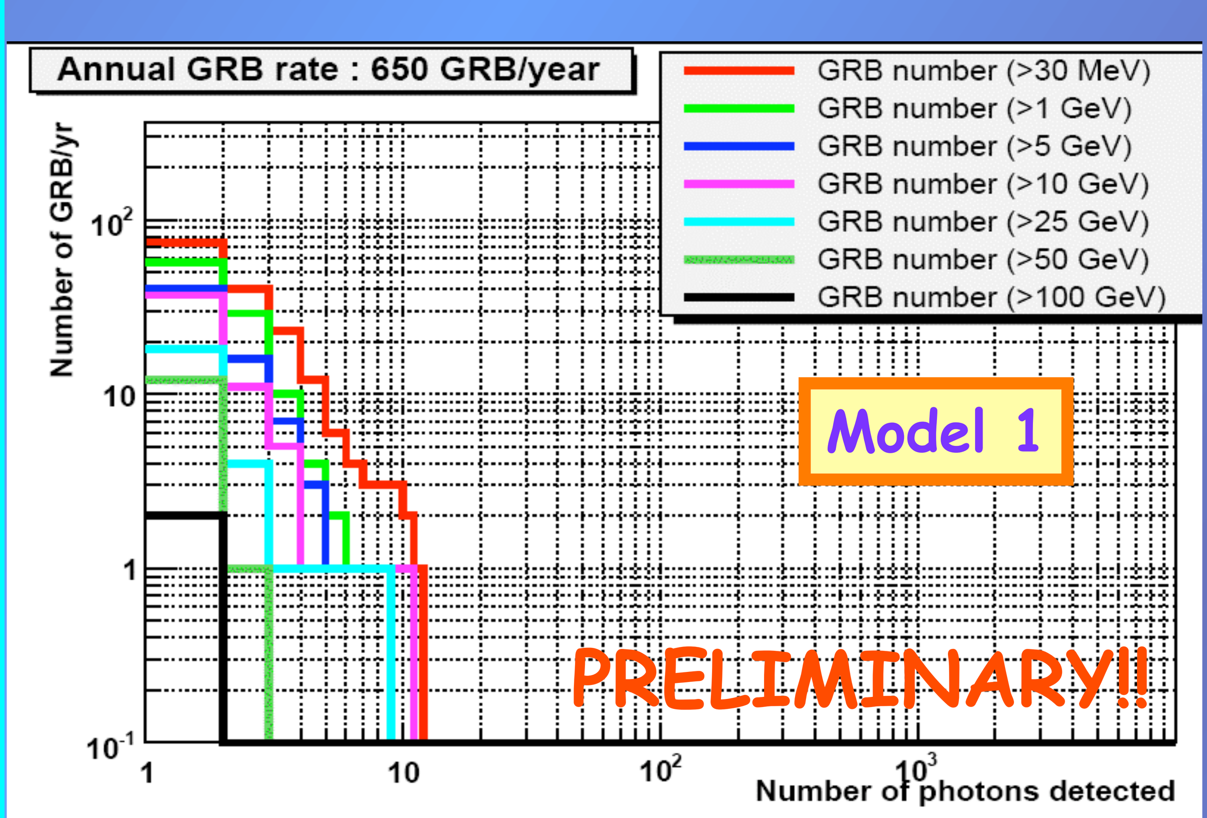
IC emission favored by greater (ϵ_e/ϵ_B) values [6]

✓ **Good temporal correlation between X-ray and GeV flares if the peak of IC emission is in the observational band [6].**

✓**Bright high energy flares**



External Shock by thick shell fireball: Flares simulation with GLAST LAT



Model 1:	E_{53}=1, $\varepsilon_{B,min}$=10^{-4}, p=2.5, z=1, t_0=200 s	Model 1: 12 flares/yr
Model 2:	E_{53}=10, $\varepsilon_{B,min}$=10^{-4}, p=2.5, z=1, t_0=200 s	Model 2: 6 flares/yr
Model 3:	E_{53}=0.1, $\varepsilon_{B,min}$=10^{-4}, p=2.5, z=1, t_0=200 s	Model 3: 1 flares/yr
Model 4:	E_{53}=1, $\varepsilon_{B,min}$=10^{-4}, p=2.5, z=2, t_0=200 s	Model 4: 9 flares/yr
Model 5:	E_{53}=1, $\varepsilon_{B,min}$=10^{-4}, p=2.5, z=1, t_0=1000 s	Model 5: 12 flares/year
Model 6:	$E_{53,min}$=0.1, n=1, ε_B=10^{-4}, z=1, t_0=200 s	Model 6: 18 flares/year
Model 7:	$E_{53,min}$=0.1, n=1, ε_B=10^{-3}, z=1, t_0=200 s	Model 7: 8 flares/year
Model 8:	$E_{53,min}$=0.1, n=1, ε_B=10^{-2}, z=1, t_0=200 s	Model 8: no flares!!

ϵ_e =0.1, n=1, p=2.5 RATE:650 flares/year

*num flares with at least 5 ph

Conclusions

✓ No temporal delay between X- ray and GeV flares if the peak of the emission is in the observational band.

✓ LAT can detect high energy flares produced in ES by thick shell fireball.

✓ Flares detection increases with E53 if the IC peak is in the LAT band

✓ Detection decreases with increasing z

✓ The detection does not depend on the flare time t_0 if LAT is source dominated

✓ The detection increases with ϵ_B

References

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