GRB high energy emission from internal shocks -

Dafne Guetta & Alessandra Galli

(Galli & Guetta 2007 submitted to A&A)

Introduction

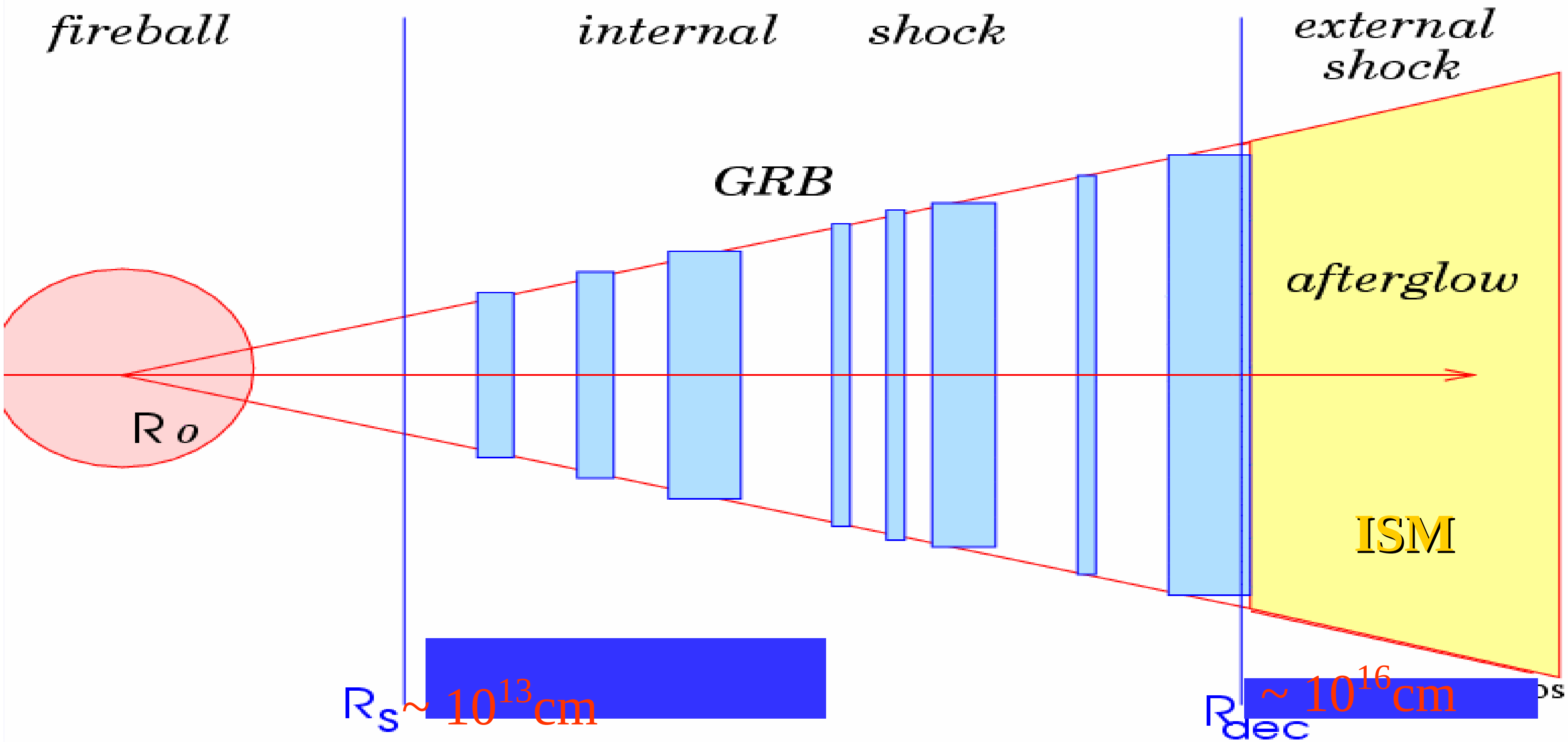
- Study the synchrotron and SSC emission from IS during the prompt and X-ray flare phases of GRBs

Aims:

1. If GRBs can be GeV sources
2. Test the IS model for the flare emission
3. Determine the IS parameters that favor the detectability by AGILE (50 MeV- 50 GeV) and GLAST (30 MeV – 300 GeV)

The internal/external shock scenario

(Rees & Meszaros 1992, '94)



$R_s \sim 10^{13}$cm

$R_{dec} \sim 10^{16}$cm

γ ray phase

X-ray, Opt.-IR, Radio

The Internal shock Model

Possible model that reproduce the γ-ray observations

Sorce produces a wind approximated as a set of discrete SHELLS

INJECTION FEATURES

Δ_j

Constant ~ R

t_j

Random

average t_v

M_j

Equals

Γ_j

γ –ray flux +spectrum observations

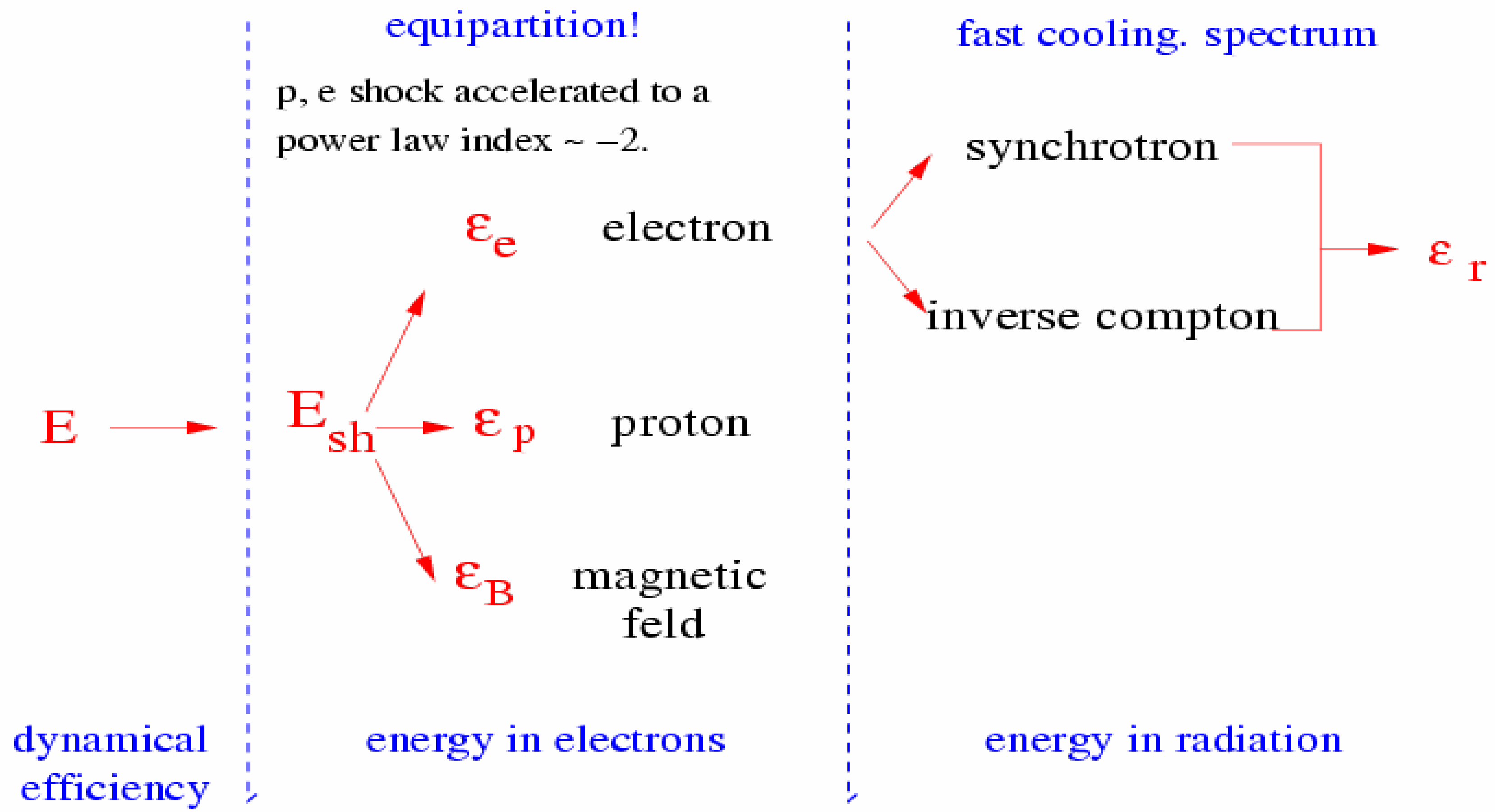
Large variance in LF (bimodal)

(Guetta, Spada & Waxman 2000 ApJ 557,399)

To get high efficiency !!

The radiation mechanisms

For each collision:



Emission properties determined by $R \sim \Gamma^2 c t_v$

High energy from the prompt

(Guetta & Granot 2003)

E_p , F, E_p^{SC} and E_{cut} strongly depend on L, t_v and Γ

$$E_p \propto L^{1/2}\,\Gamma^{-2}\,t_v^{-1}$$

$$E_p^{SC} \propto L^{1/2}\,\Gamma^{-2}\,t_v^{-1}$$

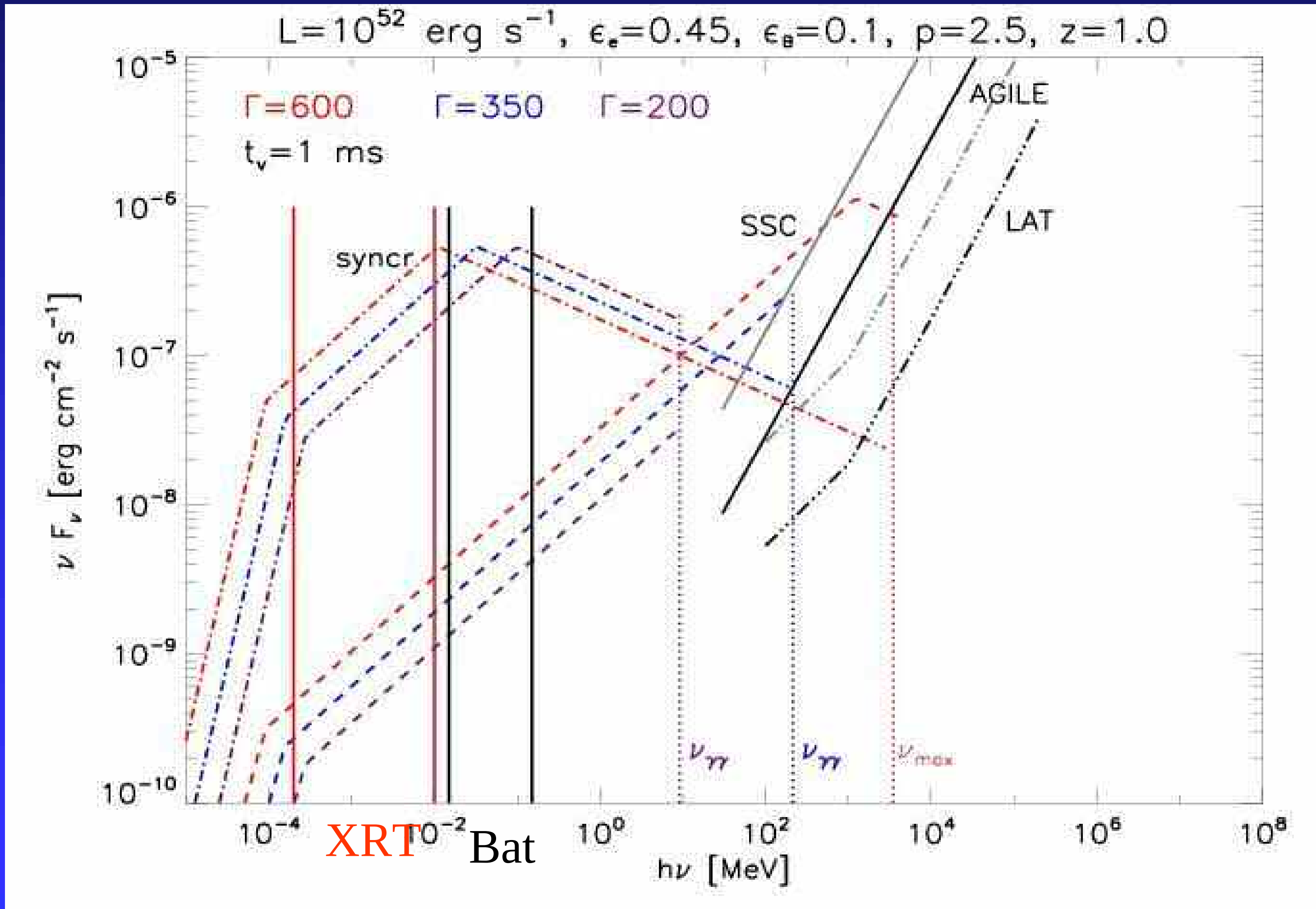
$$E_{cut} \propto L^{-1}\,\Gamma^{6}\,t_v$$

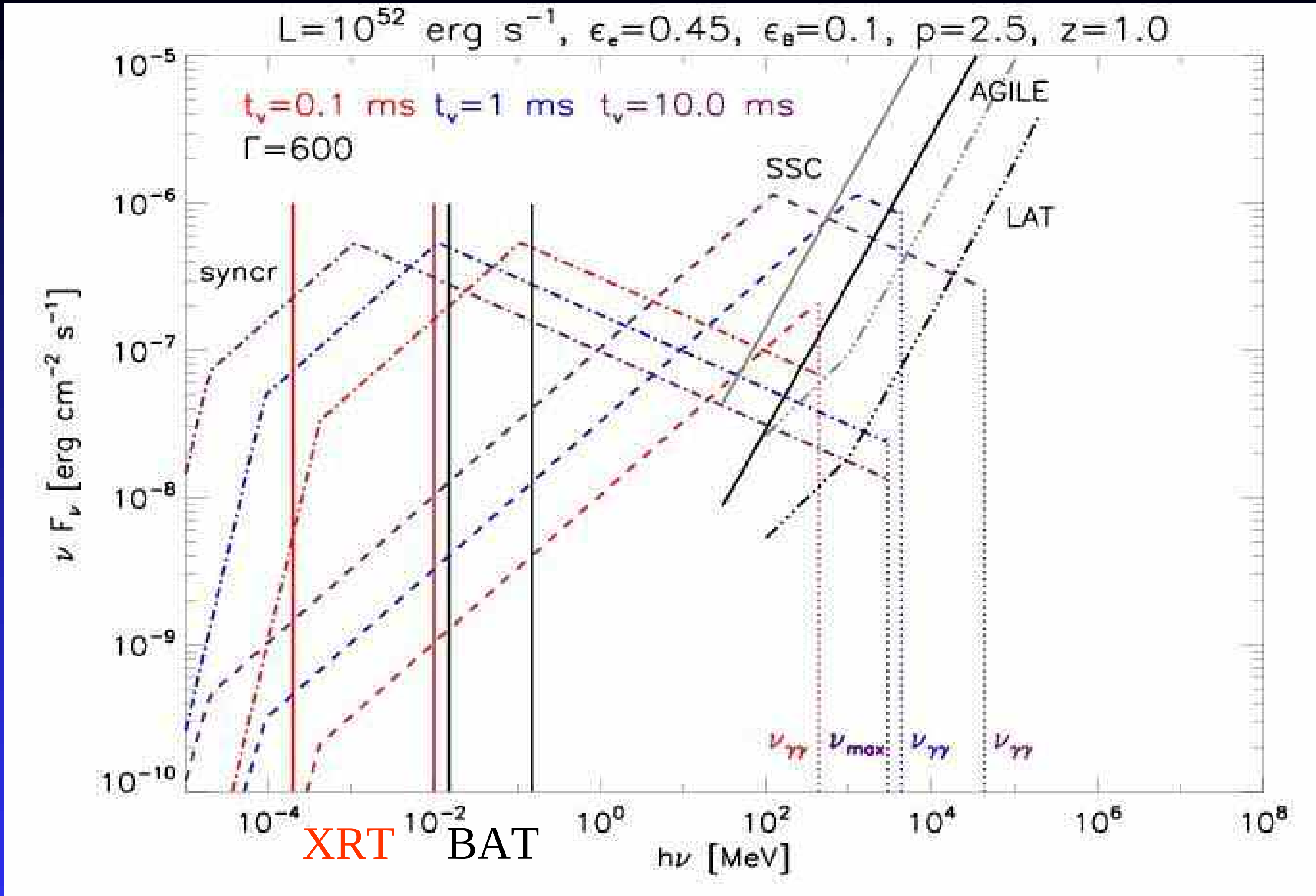
$$F_p \propto L$$

Typical prompt parameters: $L \sim 10^{52}$ erg/s $\Gamma \sim 300$ $t_v \sim 10$ ms

$R \sim 10^{13}$ cm

Detectability og HE emission improves for higher Γ





Detectability of SSC component improves for higher Γ and tv

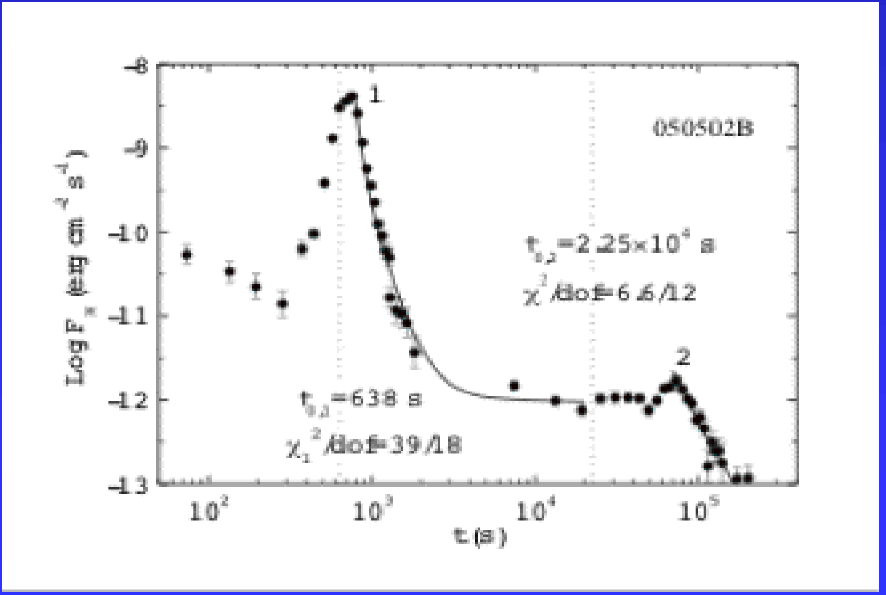
Best candidates GeV sources have low Ep

Energy band covered by Swift (15-150 kev) better than BATSE (50-300 kev)

X-ray flares have miriad characteristics

(Chincarini et al. 2007)

- Some GRBs have several flares other GRBs have only one.
- Sometimes (GRB 050502B) flux increases by a factor of 500 other GRBs show small bumps
- Sometimes late flares at days (small bumps)
- No difference between long and short GRBs, hard GRBs and X-ray flashes



Mechanisms to produce X-ray flares

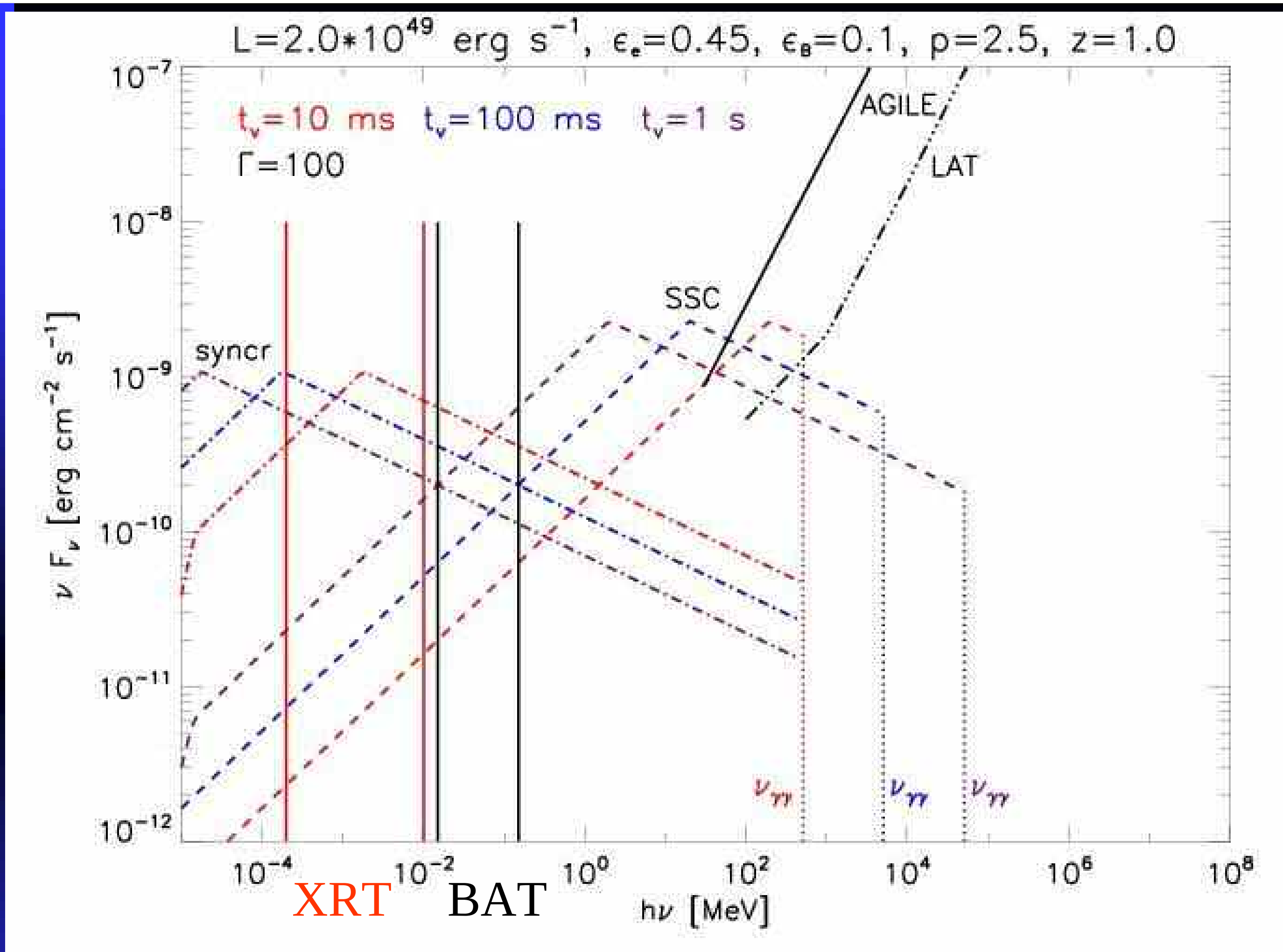
- SSC from the Reverse shock? *(Kobayashi et al. 2005)*
- Density bumps? *(Lazzati et al. 2002)*
- Two component jet, deceleration of the cocoon? *(Meszaros and Rees 2001)*
- Patchy shell, multi-jet model? *(Kumar and Piran 2000)*
- Refreshed shocks? *(Guetta et al. 2005)* *(Kumar and Piran 2000)*
- Late internal shocks? *(Zhang 2005)*

Long lasting central energy activity

X-ray and HE flares from IS

- Fundamental role of t_v in determining the R_{col} and therefore the emission properties, we take t_v~ 10ms-1s as prompt and Γ~ 100
- Sample of flares from Chincarini et al. (2007) $\langle L \rangle \sim 10^{49}$ erg/s and $\langle t_f \rangle \sim 40$ s
- Constrain: the $E_p^{\,f}$ should be in or just below the XRT band (0.2-10 kev) Falcone et al. (2007)

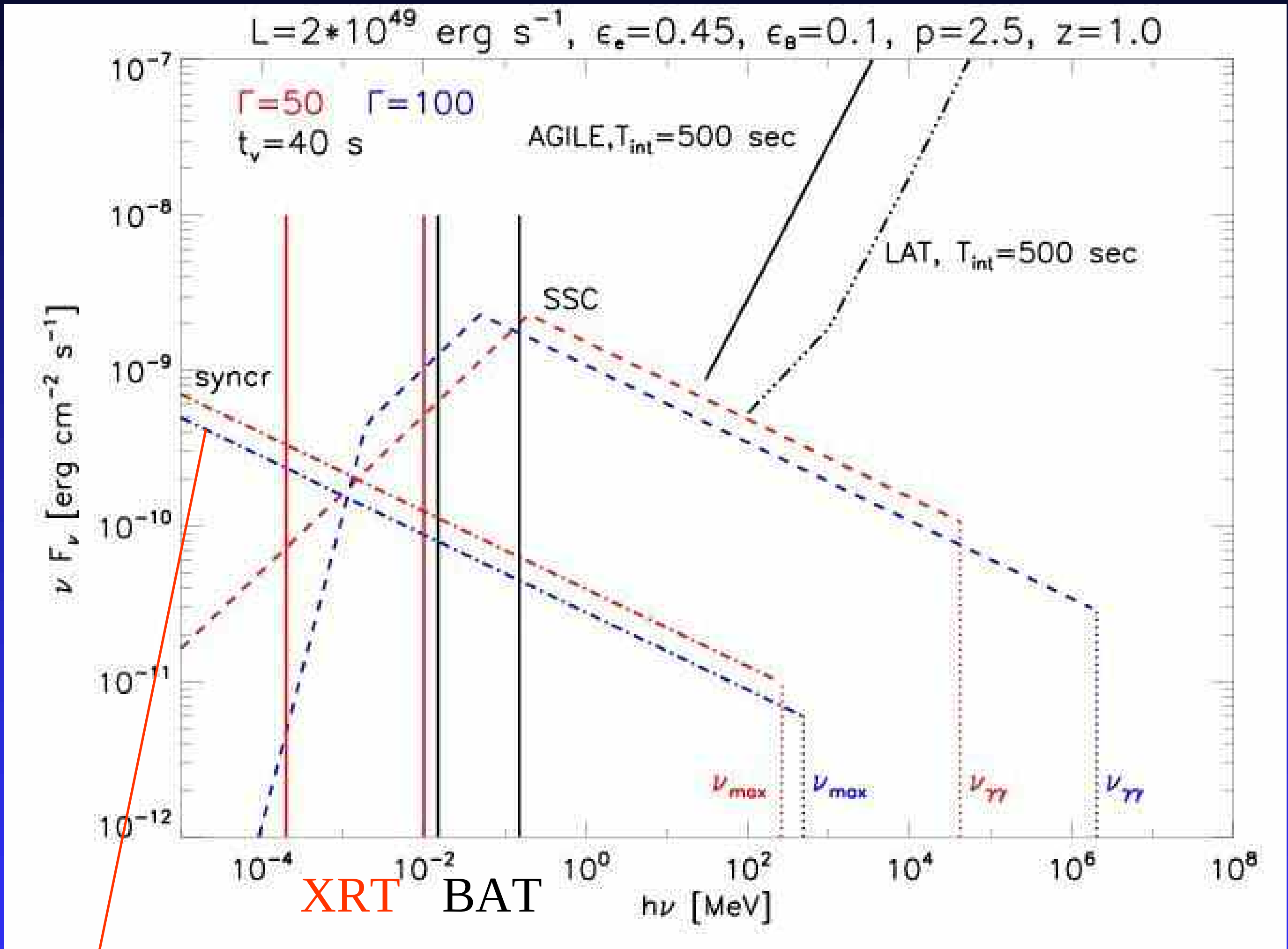
$$\mathbf{R^{flare} \sim R^{prompt}}$$



t_v~50-100 ms<<t_f to have $E_p^{\ f}$ in XRT and a detectable HE emission

If IS responsible of X-ray flare the light curve should present some substructures with t_v<<t_f

If the shells are ejected with $t_v \sim t_f \sim 40$ s



E_p very low, against observations !!! *(Falcone et al. 2007)*

$R^{flare} \sim 10^{16} >> R^{prompt}$

Conclusions

- We have studied the detectability of the sync. and SSC emission during the prompt and X-ray flare GRB phases
- Prompt: HE detectability improves for larger Γ and t_v and therefore smaller E_p, Swift band better than BATSE to identify GeV sources
- X-ray flares: If E_p in the XRT band $t_v<100$ ms, look for flux variations on this time scale mandatory to test IS

Conclusions

- AGILE and GLAST will be able to detect HE from flares
- A comparative study between the X-ray and Gev component is important to test models proposed for flares: in the ES model the SSC peak is in the GeV-TeV band *(Galli & Piro 2007)* instead of MeV-GeV for IS
- Other HE mechanism EC of X-ray photons on AG electrons, in this case the HE flare last much longer than the SSC flare *(Fan et al. 2007)*