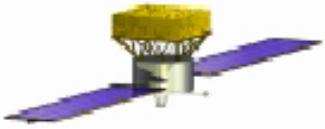


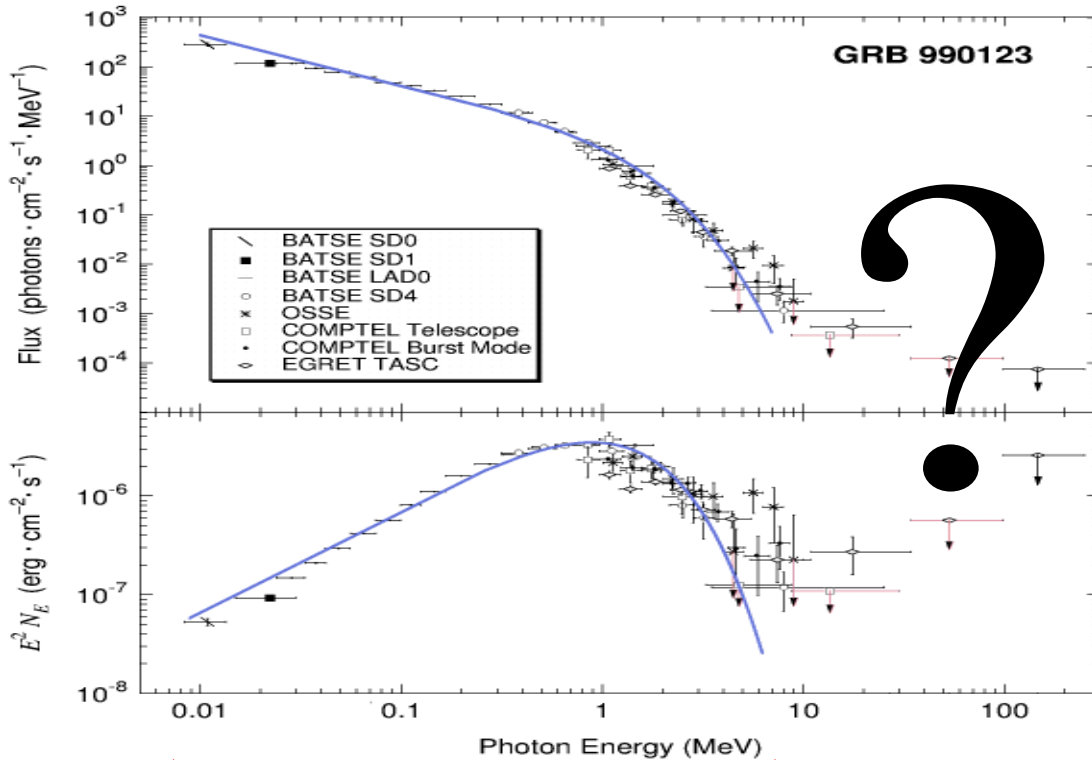
Emission Model And GRB Simulations



Nicola Omodei (University of Siena, INFN Pisa)



Spectral Properties



Data collected Range (γ)
10 KeV ÷ 10 GeV

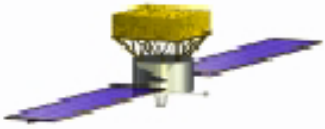
In the BATSE energy range:
 (25 KeV ÷ 10 MeV)

Double Power Low
 (D.L. Band et al. 1993)

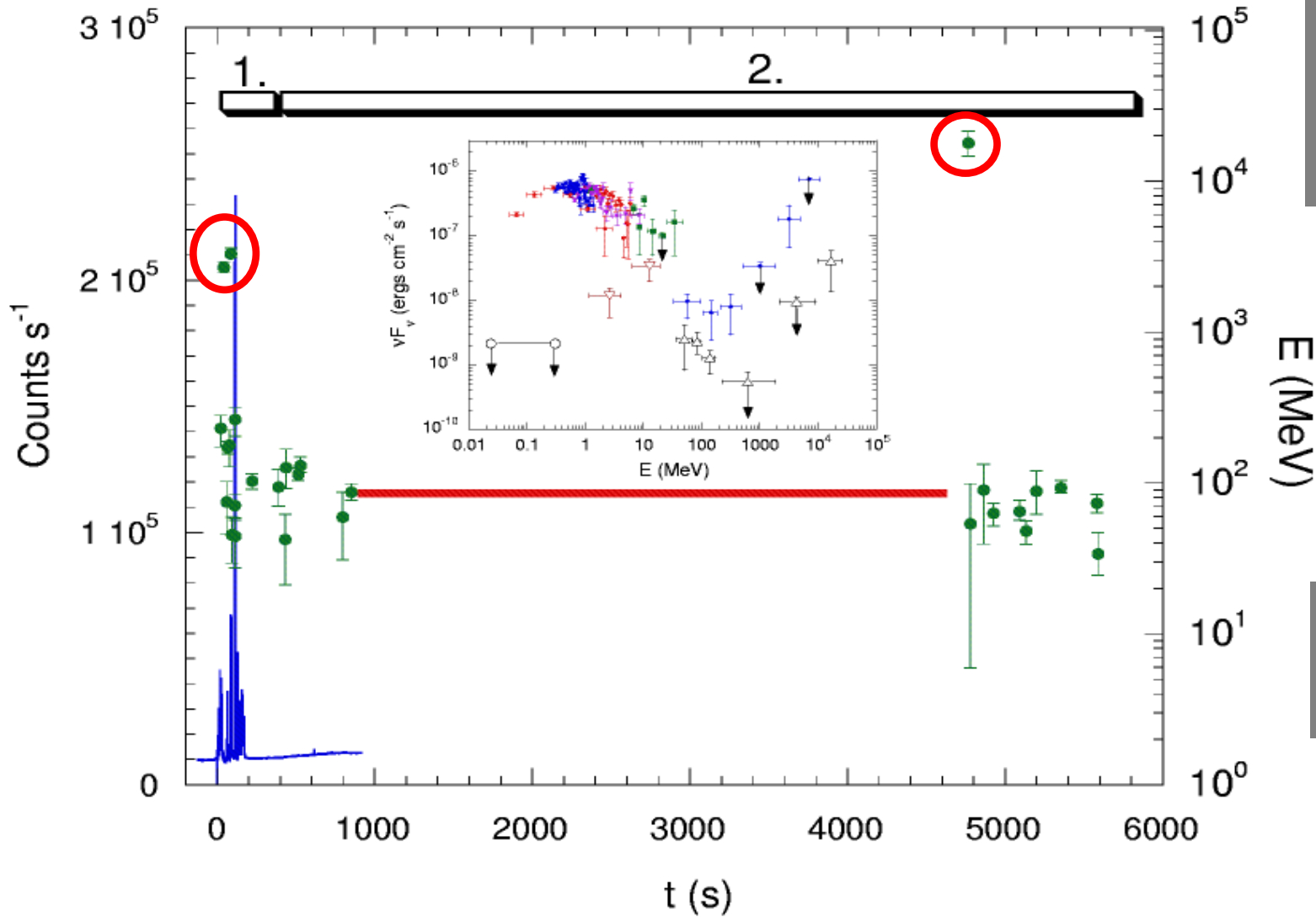
$$N(\nu) = N_0 \begin{cases} (h\nu)^\alpha \exp\left(\frac{h\nu}{E_0}\right) & h\nu < (\alpha - \beta)E_0 \\ ((\alpha - \beta)E_0)^{(\alpha - \beta)} & h\nu > (\alpha - \beta)E_0 \end{cases}$$

$$E_0 = E_p / (\alpha + 2) \quad \alpha = -0.86 \pm 0.15 \quad \beta = -2.5 \pm 0.07 \quad E_p = 457 \pm 30 \text{ KeV}$$

GLAST
 Italia

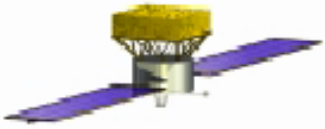


High Energy Emission

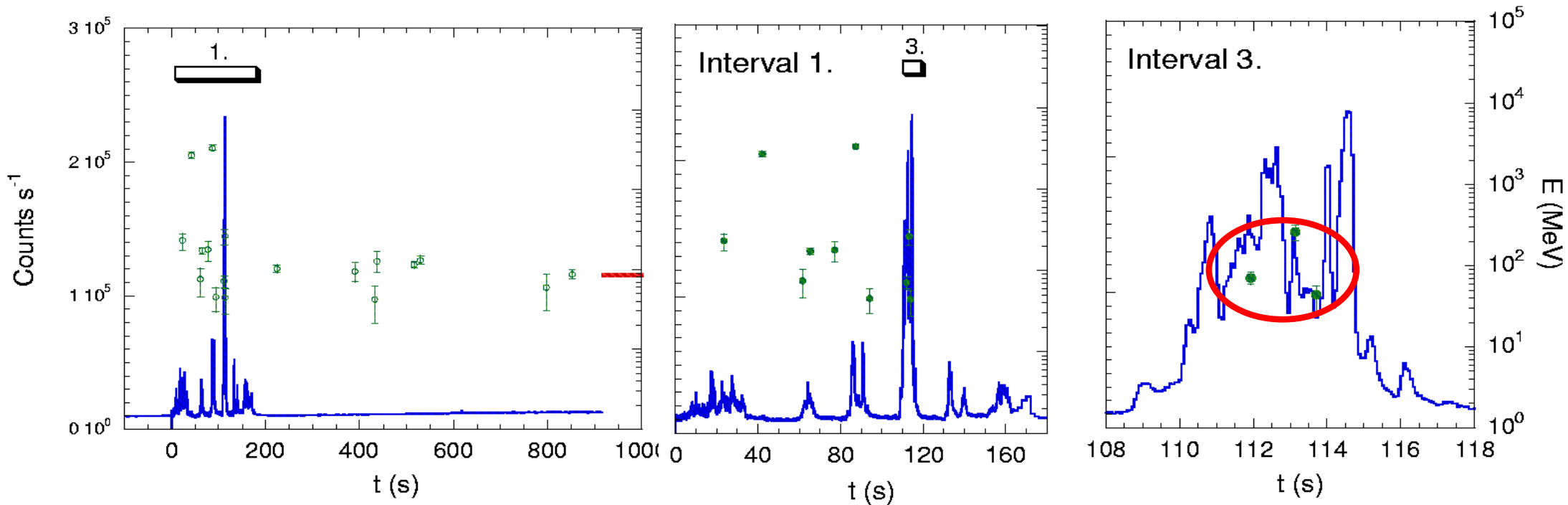


2 photons @ 3 GeV
During the
BATSE burst

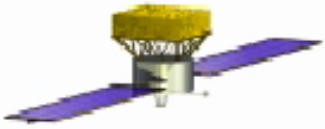
1 photon @ 18 GeV
95 minutes later



High Energy Emission

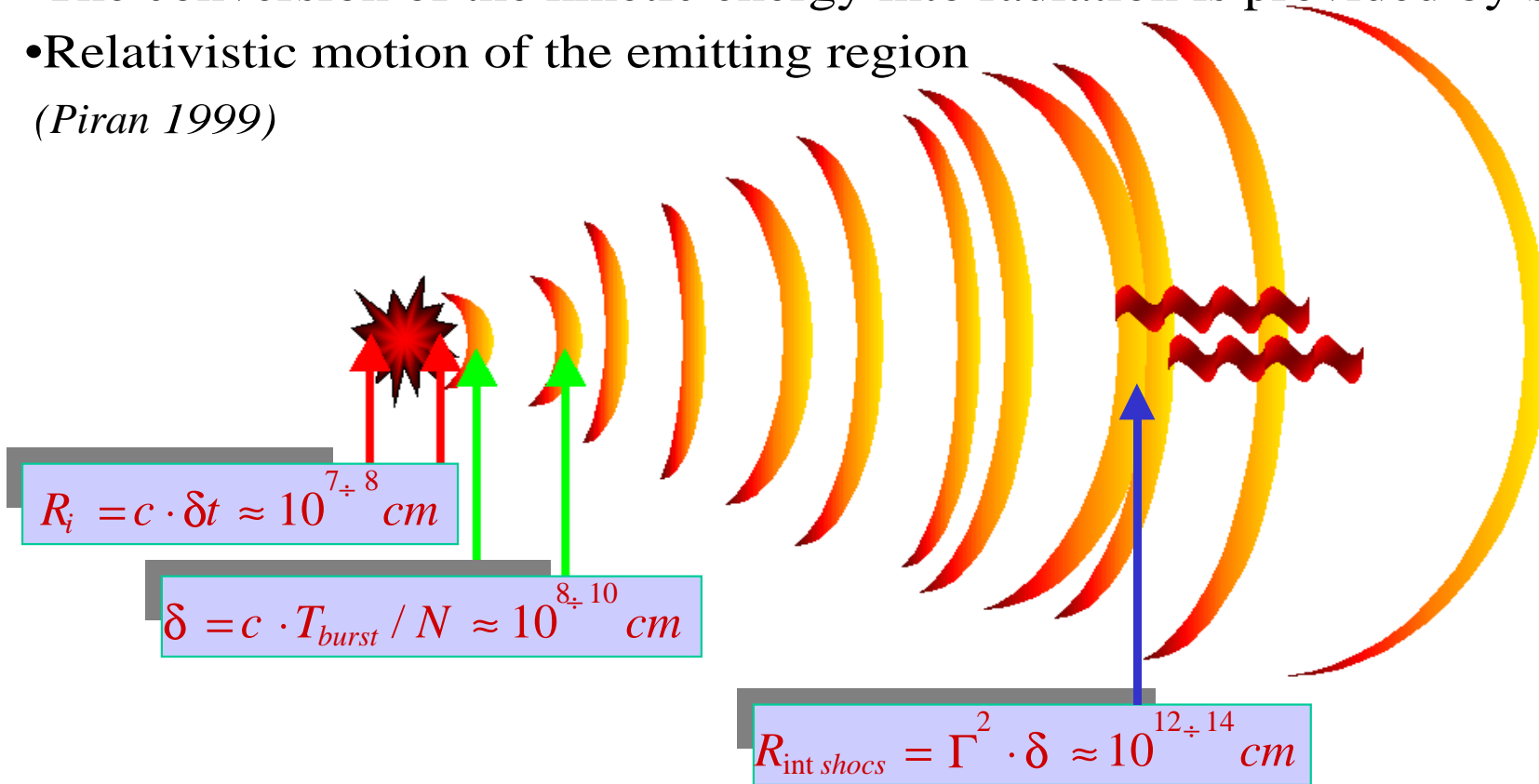


There are photons @ 10^2 MeV
During the BATSE burst



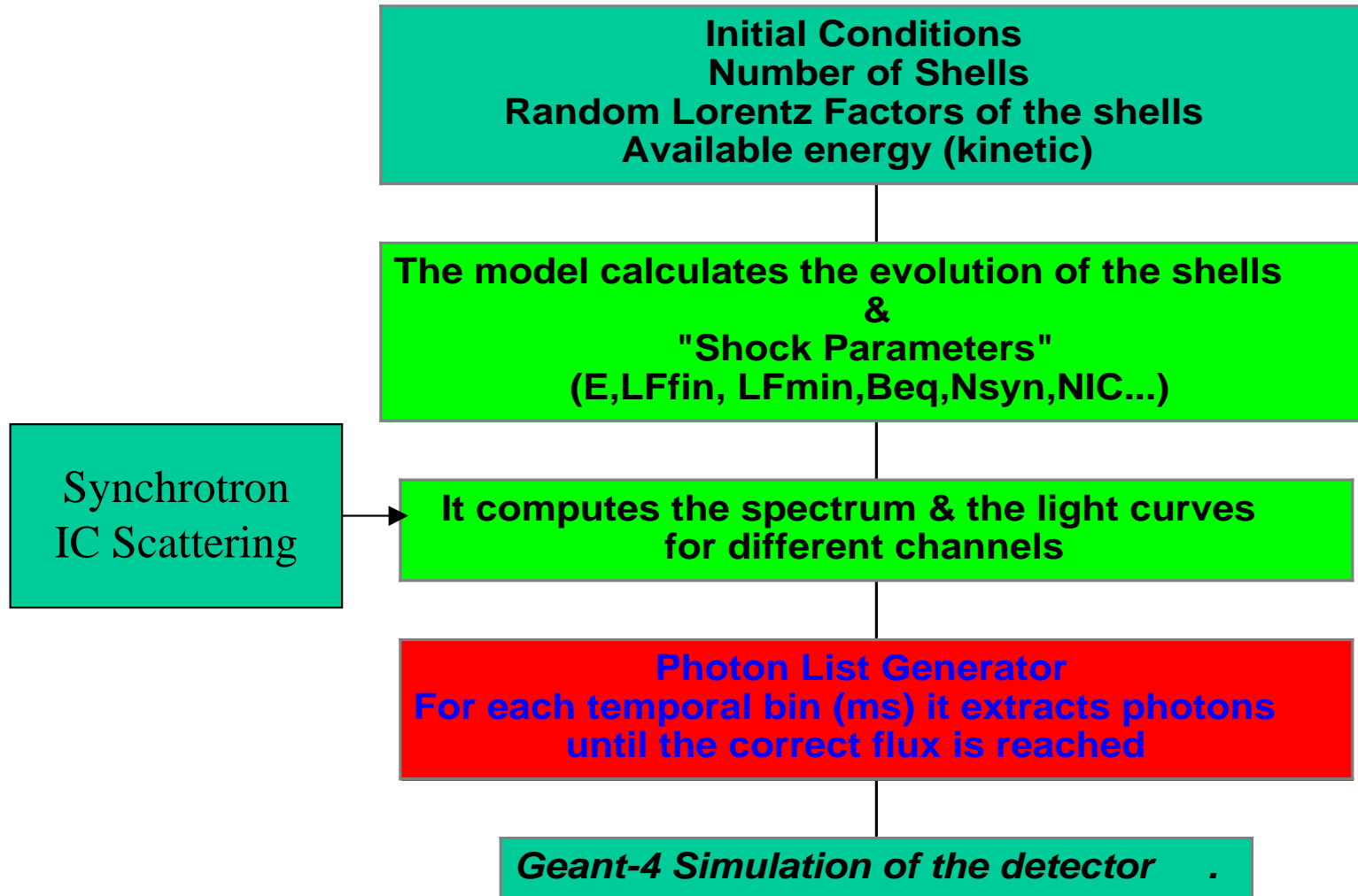
The Fireball Model (an artistic view)

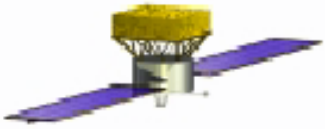
- The source has to be a compact object (from the observed time variability)
- The central engine is hidden but, the observed variability seems to be directly connected with the variability of the central engine.
- The conversion of the kinetic energy into radiation is provided by shocks
- Relativistic motion of the emitting region
(Piran 1999)



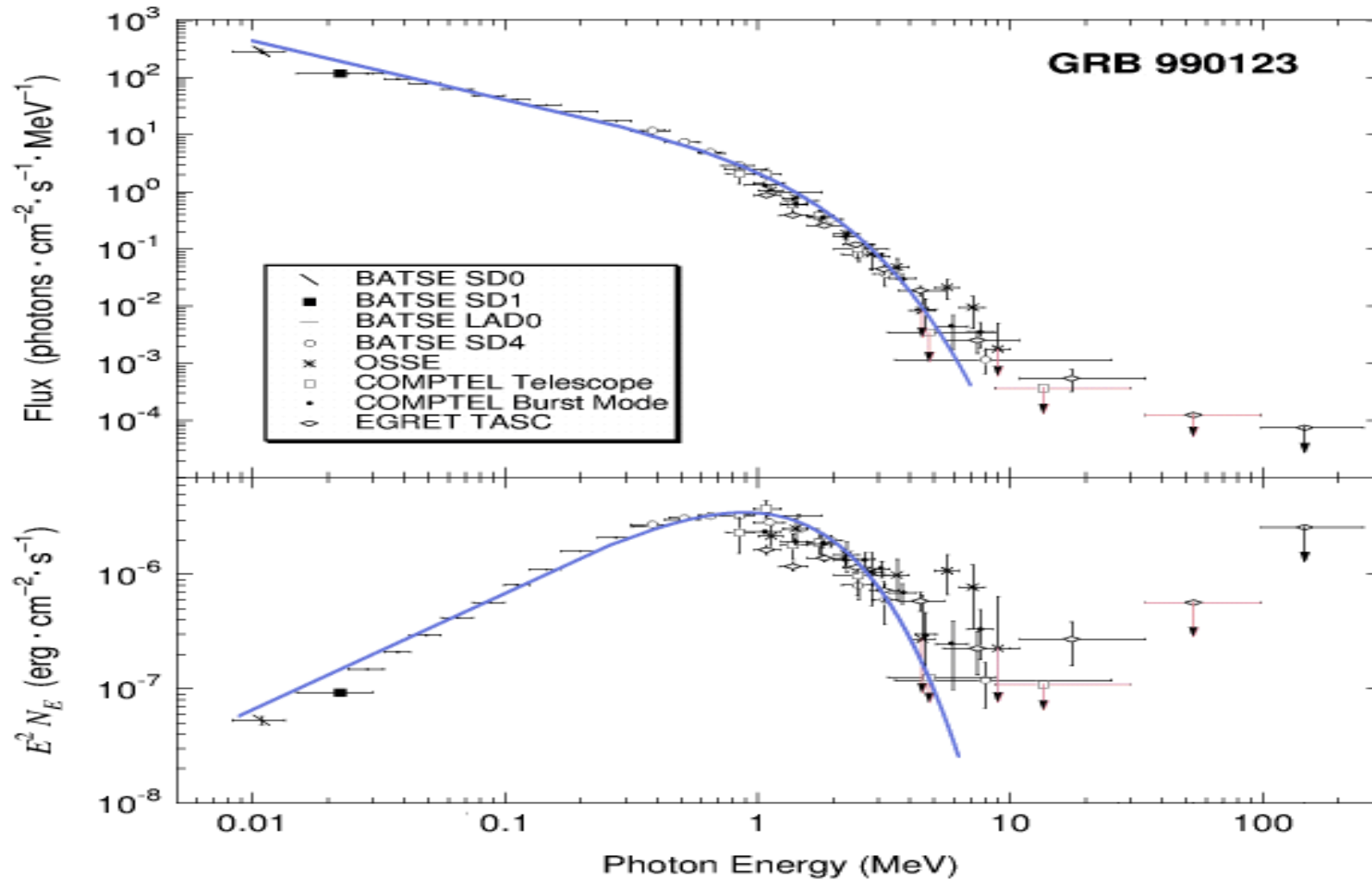


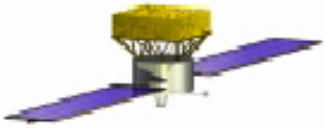
Chart





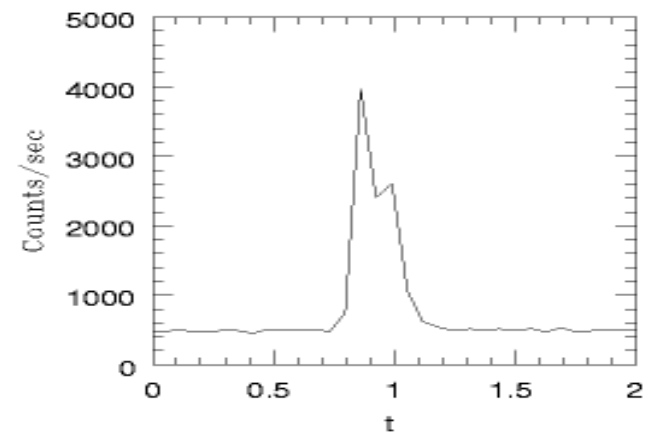
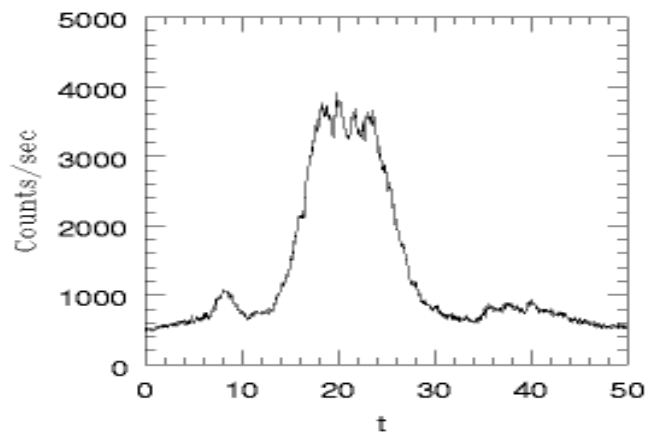
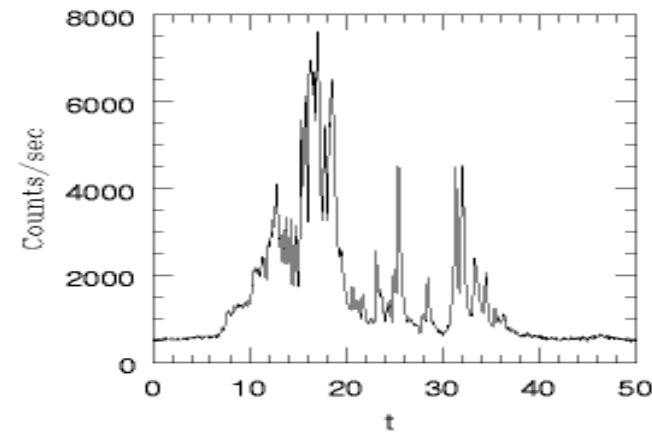
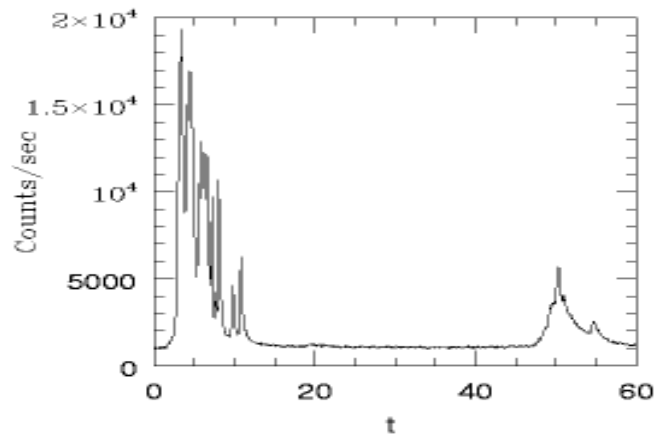
Observed Spectrum

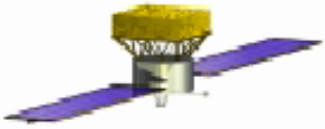




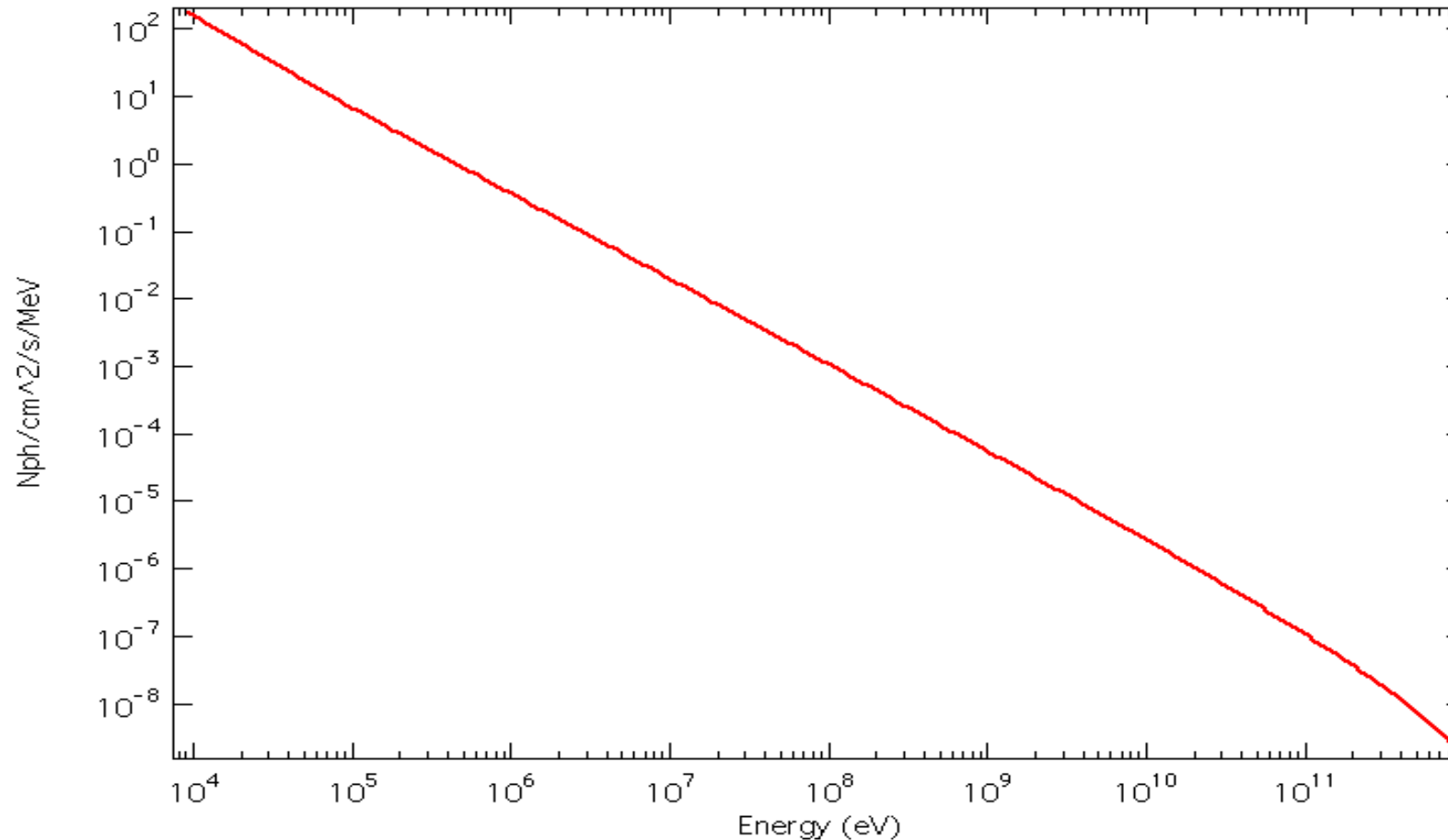
Observed Light Curve

The observed light curves present different shapes and different time durations!



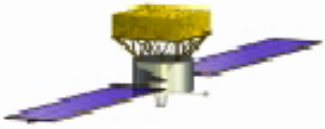


Obtained Spectrum



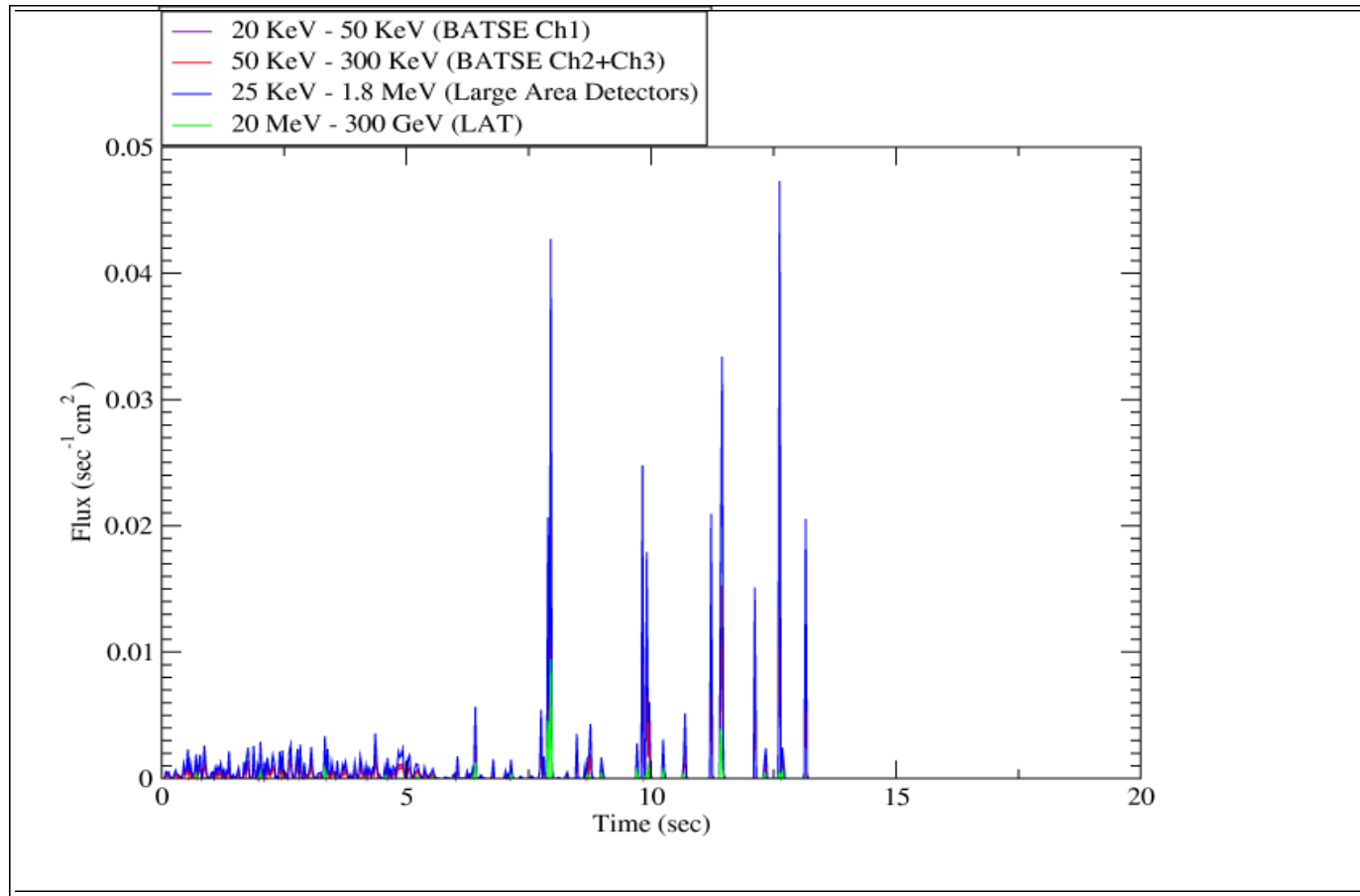
During the internal shocks phase the FBs are IC optically thick !!

GLAST
Italia



First Results

- Tuning the initial conditions one can reproduce a large family of GRB events





How can we use this model?

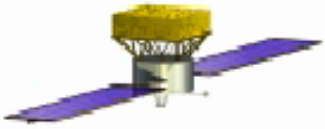
Testing the capabilities of the GLAST detector:

- Trigger
- 'Hits' reconstruction
- Data acquisition

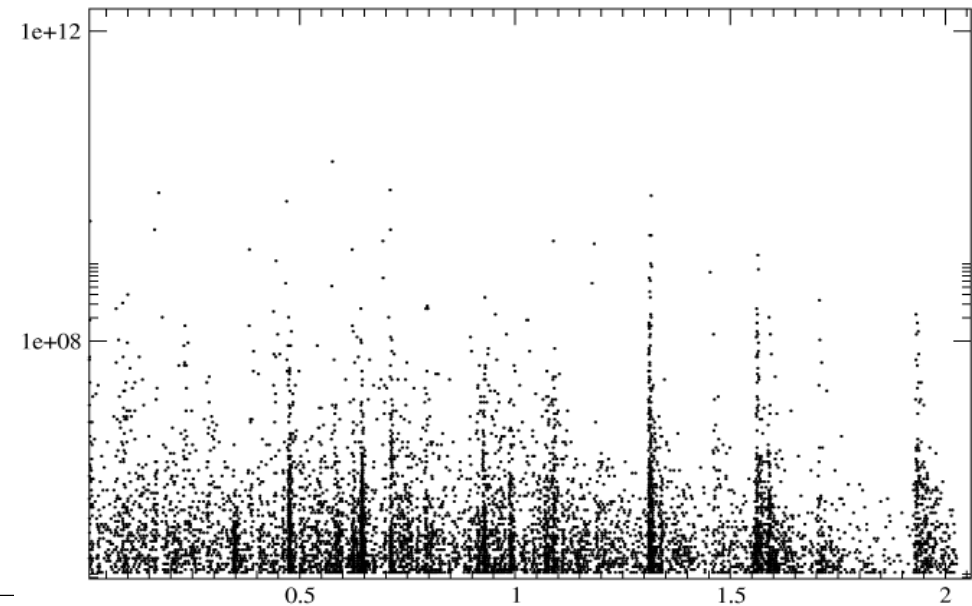
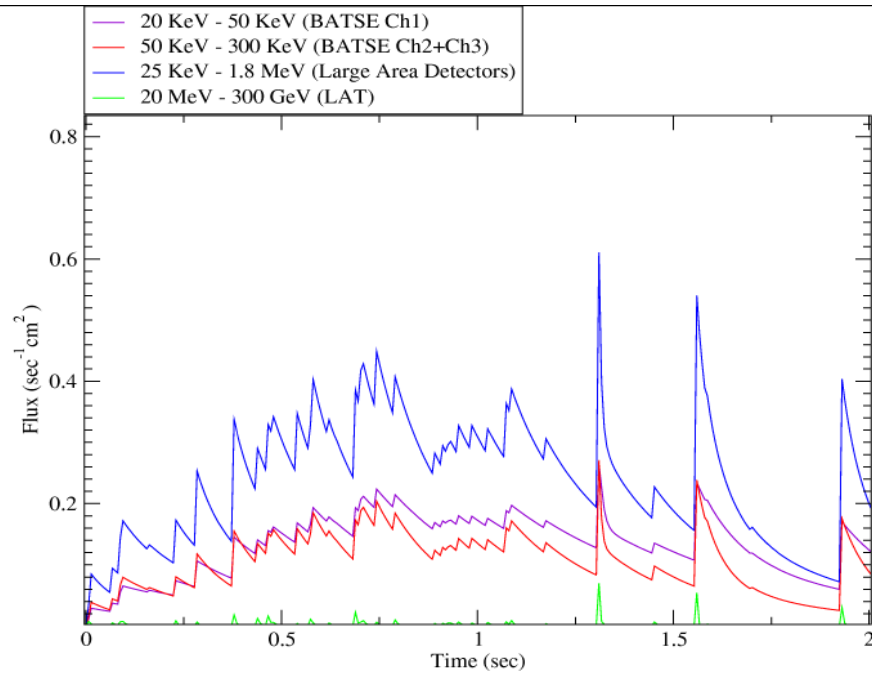
Analysis software for GLAST

- Light curve reconstruction
- Spectral Analysis

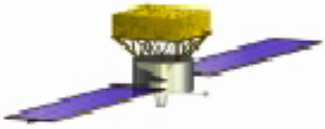
Photon list (time-energy-position)
to use as input of the
G4 simulator
“Event Generator”



“Photon List”

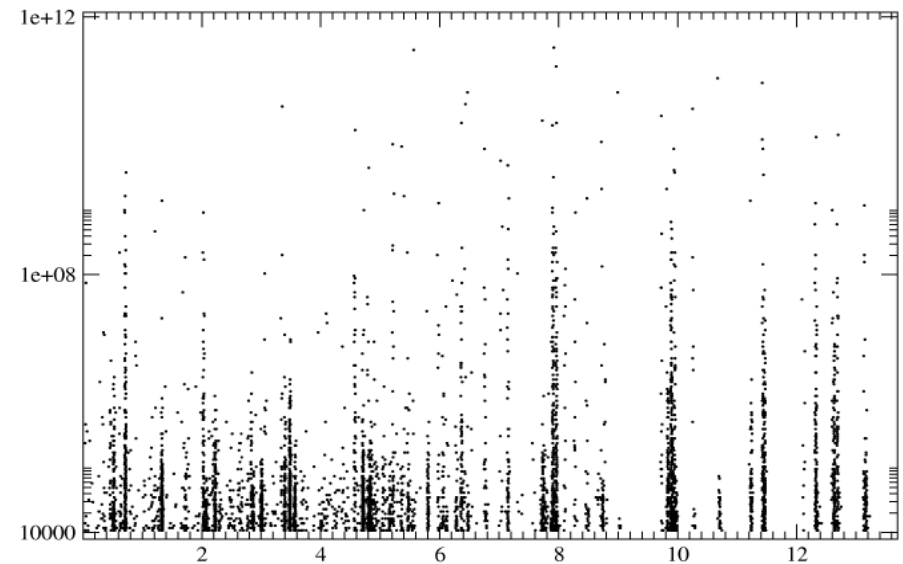
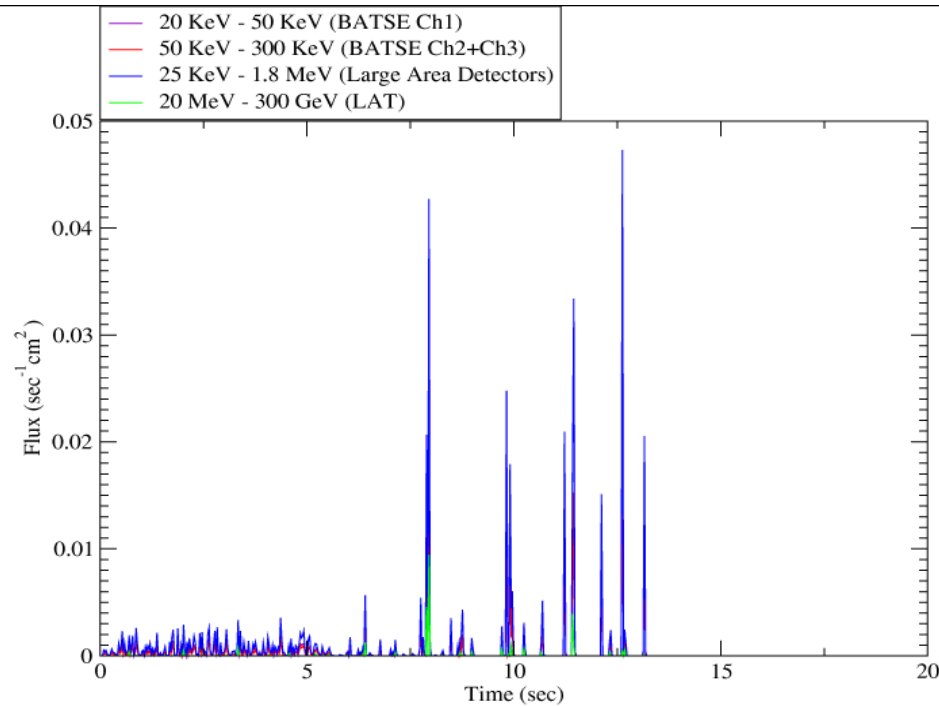


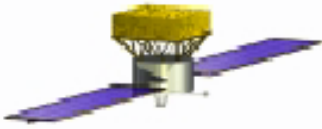
Short Burst, Bright, with spikes overlapped



“Photon List”

Long Burst, faint with separate spikes





Future Improvements

External shock model: modeling the HE spectra generated during the interaction between the shells and the ISM
(relativistic reverse shock)

Delayed HE Emission

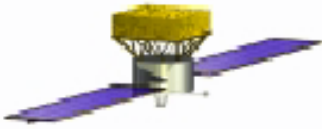
Interaction Between the high energy particles produced in the first stage with the external e.m. field (Background Radiation)

Scientific Validation of the GRB model

(how the model reproduces the observed data)

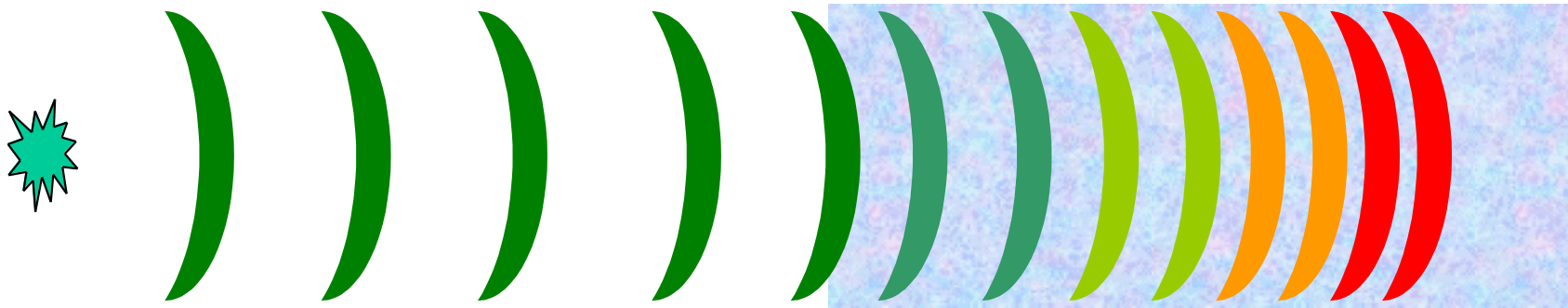
Spectral Shape

Correlations between Variability-Luminosity-Spectral Lags



External Shock Model (An Artistic View)

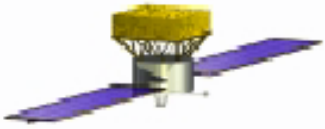
- The Blast wave interacts with the surrounding medium (SN Remnant?)
- The initial Lorentz factor of the shell is closely related to the baryon loading
- As the blast wave sweeps up and captures material from the surrounding environment, it decelerates, becomes energized and emits radiation



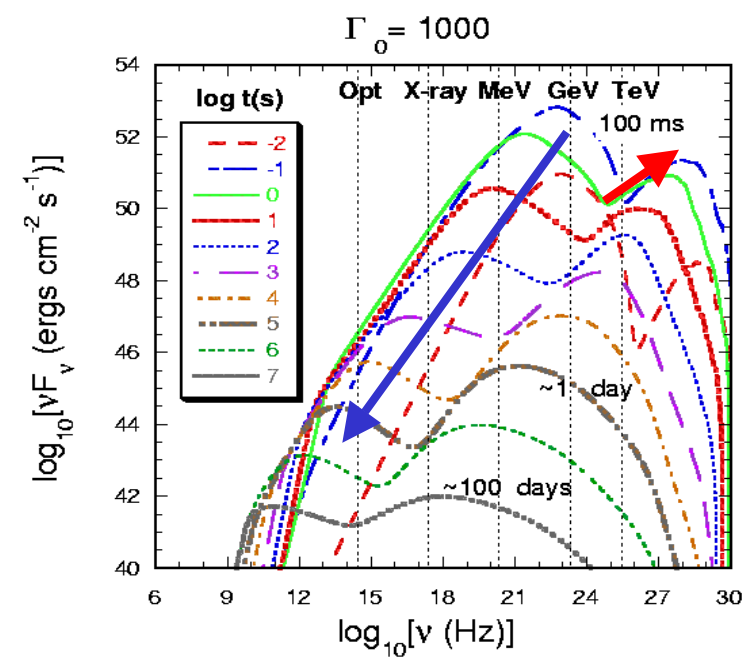
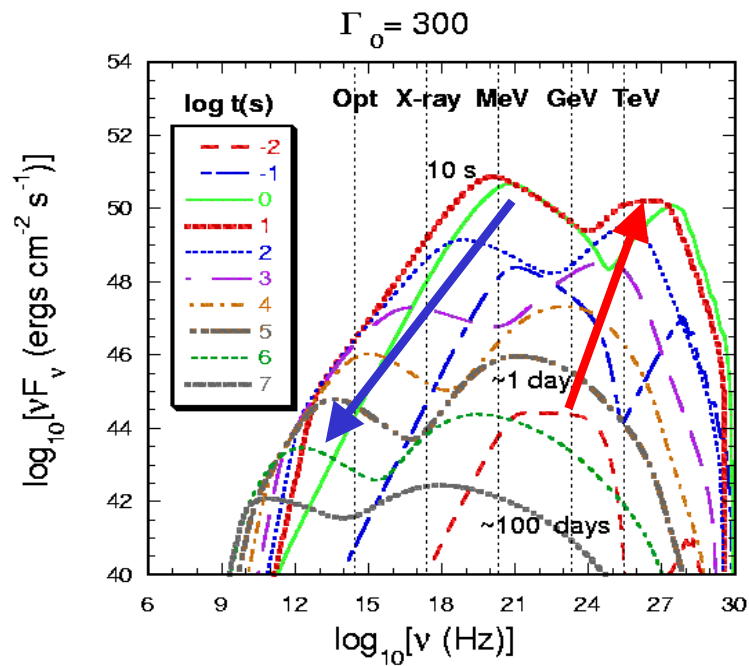
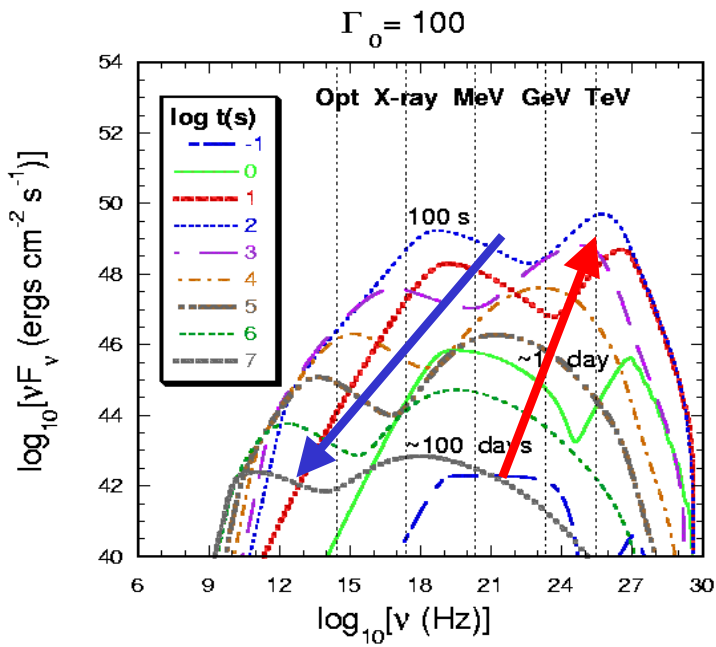
Synchrotron - Synchrotron Self Compton - Synchrotron Self Absorption

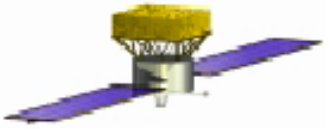
$$\gamma\gamma \rightarrow e^+e^-$$

(C.D. Dermer, J.Chang,E.Mitman, M. Böttcher, 1999)

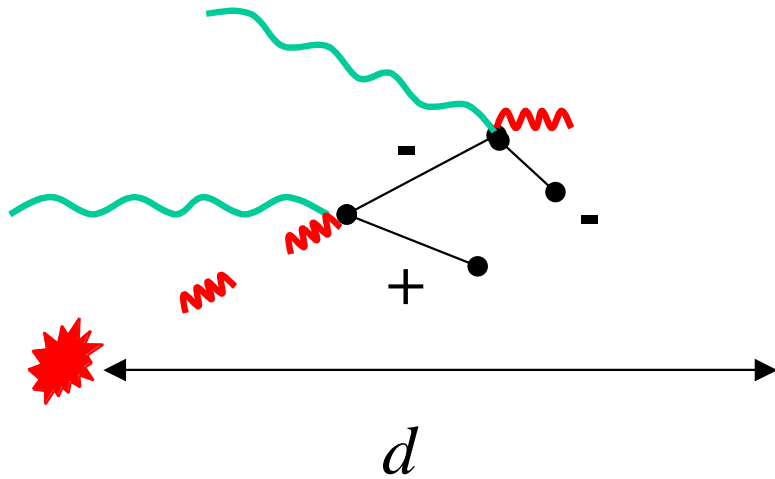


Time evolution of the Spectrum in ESM





Delayed MeV-GeV photons



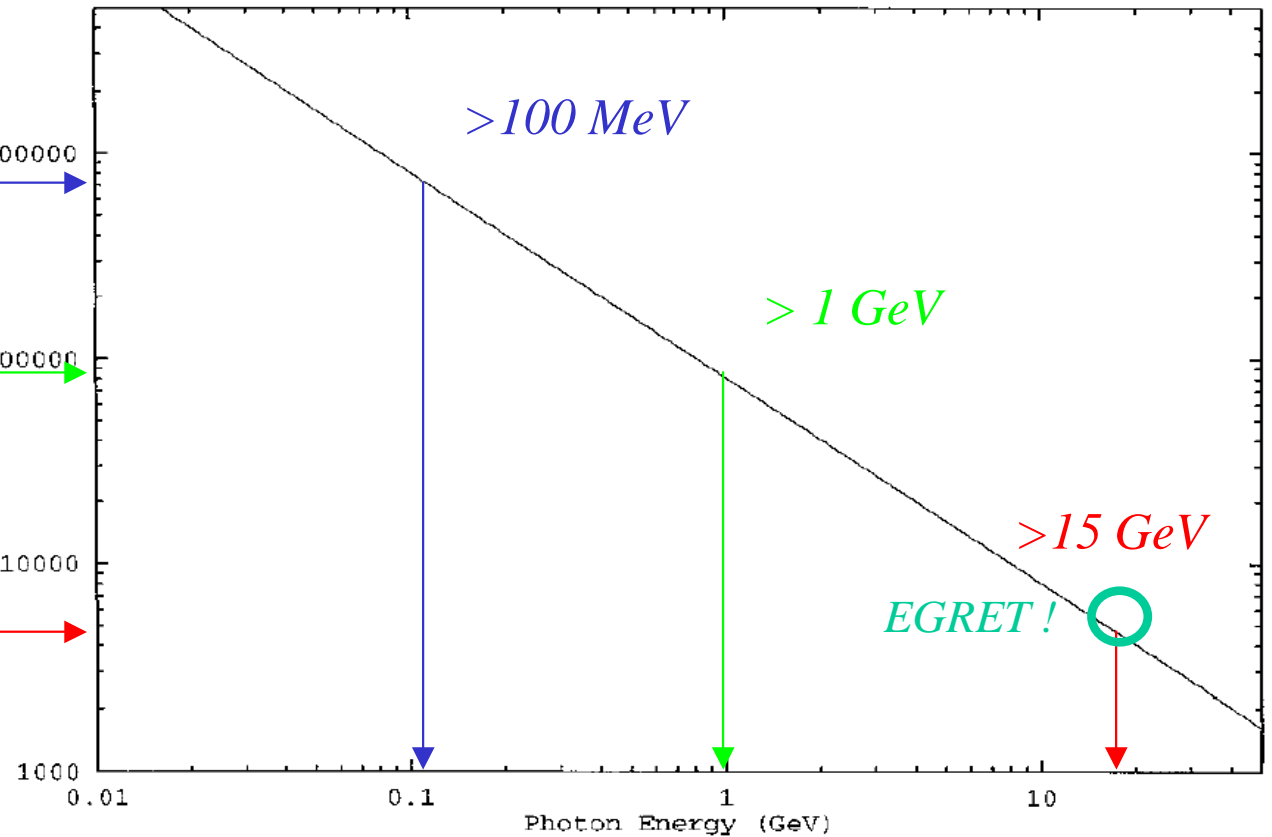
Cheng & Cheng 1996

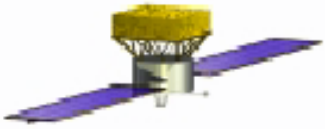
$$\delta t_{\max} = \frac{\theta^2 d}{8c} \quad \begin{cases} \theta^2 \sim \Gamma^{-2} \\ \varepsilon \sim \Gamma^2 \end{cases}$$

Without the presence of IMF !!

1 w
24 h
1 h

Maximum Time Delay (sec)

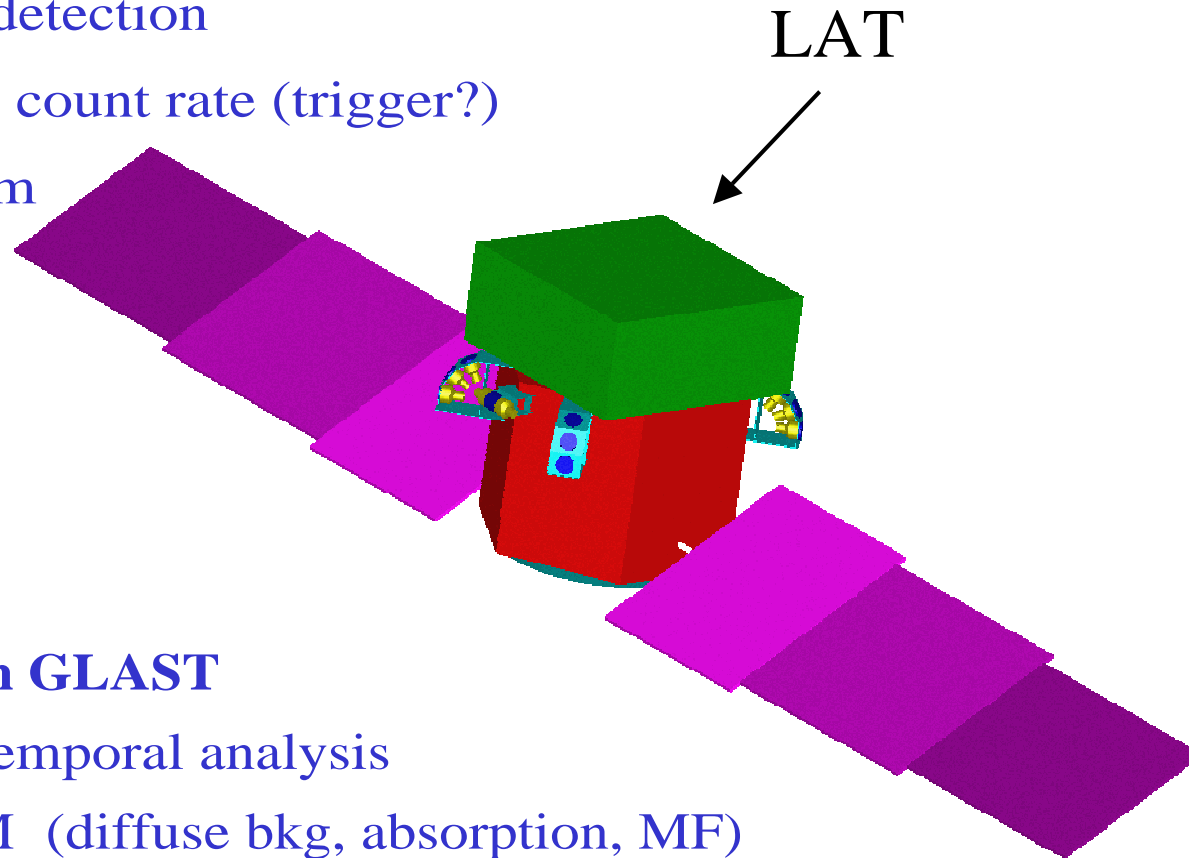




Focusing the goal...

- **LAT detection of GRB**

- ↳ HE photon detection
- ↳ Low energy count rate (trigger?)
- ↳ Alert System



- **GRB studies with GLAST**

- ↳ Spectral & temporal analysis
- ↳ ISM & IGM (diffuse bkg, absorption, MF)
- ↳ QG studies