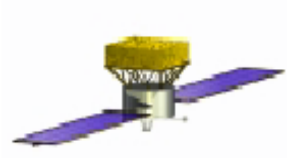
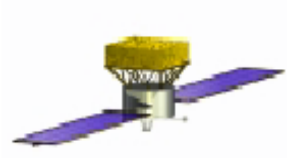


Event Generator for GRB

Status Report

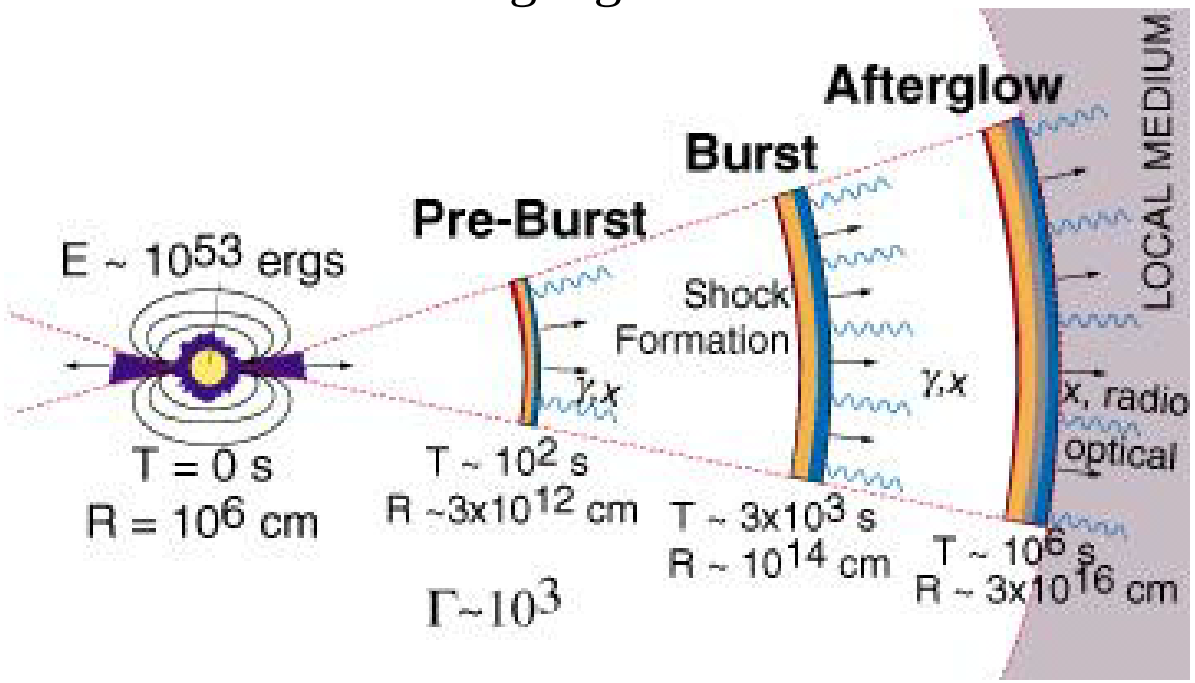
Nicola Omodei

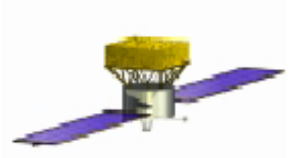
Francesco Longo



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





How does the model Work ?

Initial Conditions
Number of Shells
Random Lorentz Factors of the shells
Luminosity of the wind ejected in the ISM

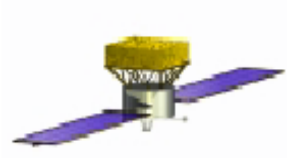
The model calculates the evolution of the shells
&
"Shock Parameters"
(E,LFfin, LFmin,Beq,Nsyn,NIC...)

Synchrotron
IC Scattering

It computes the spectrum & the light curves
for different channels

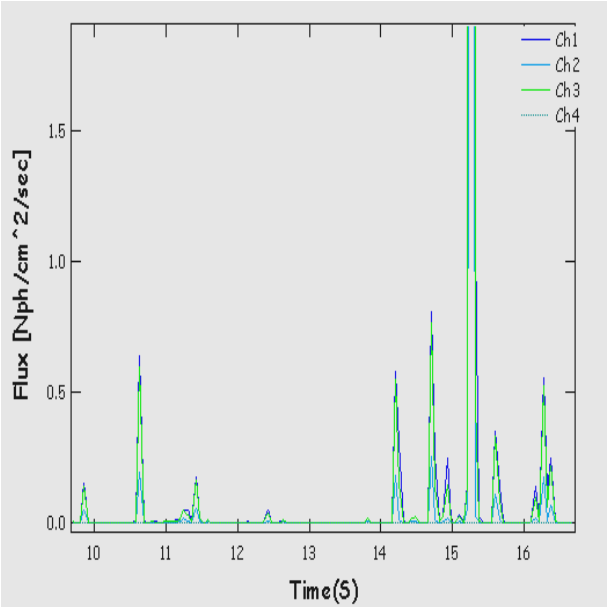
Photon List Generator
For each temporal bin (ms) it extracts photons
until the correct flux is reached

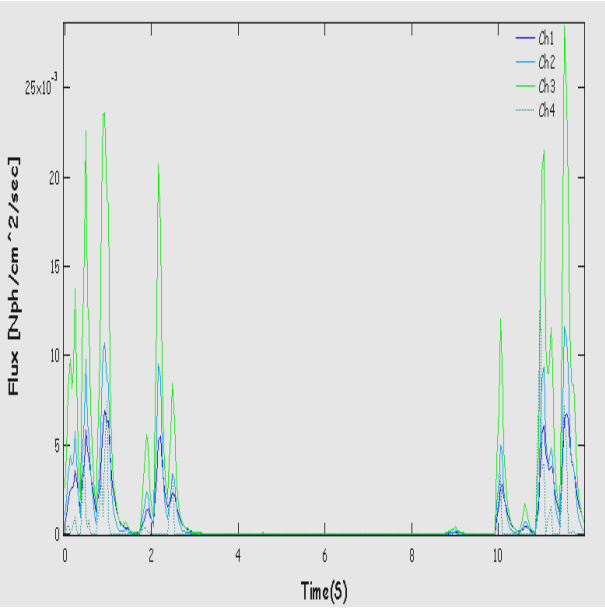
Geant-4 Simulation of the detector .

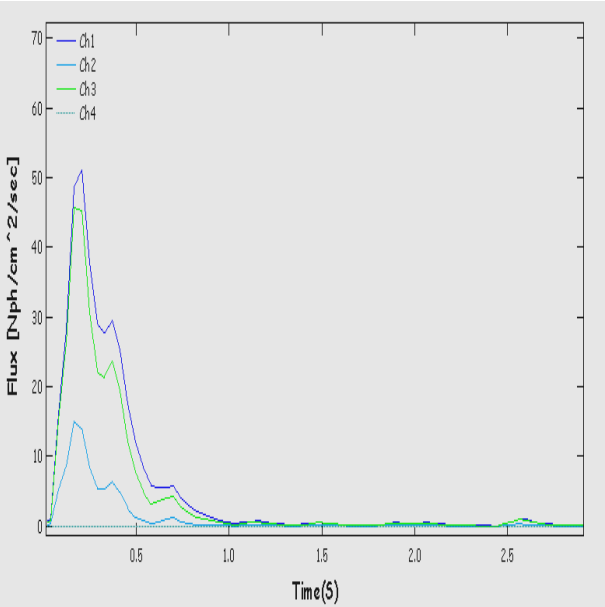


The Light Curves

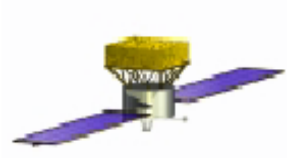
- The basic idea is to reproduce a large family of different light curves
- Extending the variability observed @ BATSE energies (< 2MeV)







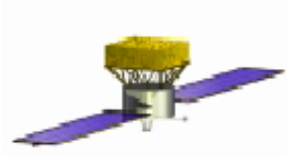
GLAST Italia



The Spectral Shape

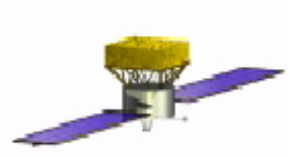
- In the fireball description the photons produced by the synchrotron emission can be up-scattered against the high energy electrons.

- The correct number of photons emitted is fixed by the Optical depth of the shell and by opacity (i.e. by Pair Production).
- Other phenomena can change the spectra (i.e π^0 annihilation)
- Three different scenarios:
  - Pure Synchrotron Model (No IC component)
  - Pure IC Model (Optical depth is 1)
  - Synchrotron + IC model, with the evaluated optical depth



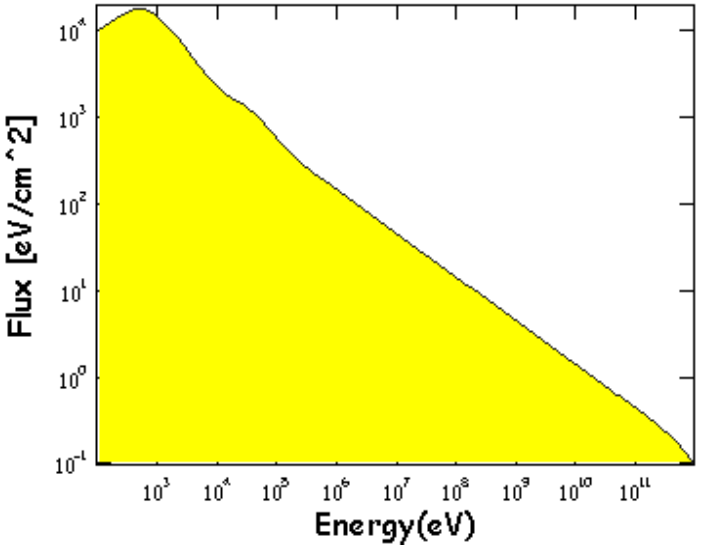
The 'Photon List'

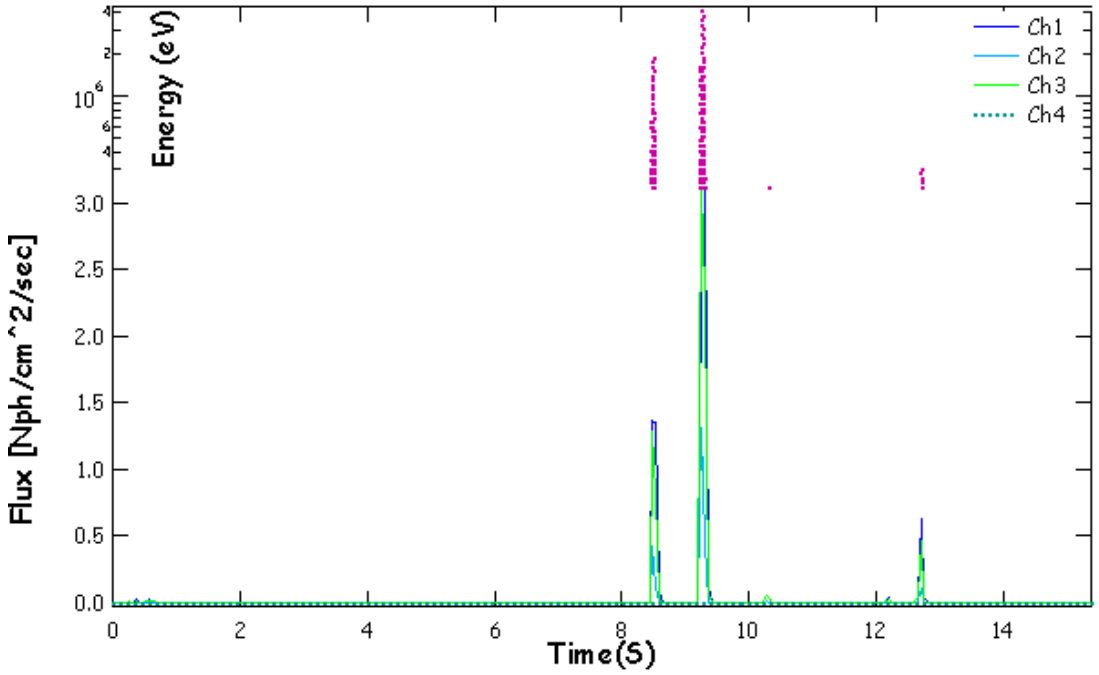
- Extracting photons of different energies until the correct flux is reached
- Extremely high photons number
  - Encountered some difficulties to process the data with GEANT4 (Memory Leakage Problem, not intrinsic in G4!)
  - Long computational time (not tested for longer then 30')
  - Big files (more than 100 Mb of ASCII data!!)
  - Solved: cutting on the energy below few MeV
- Validation of the Photon List Generator: we estimate the 'conversion efficiency' from flux into photons

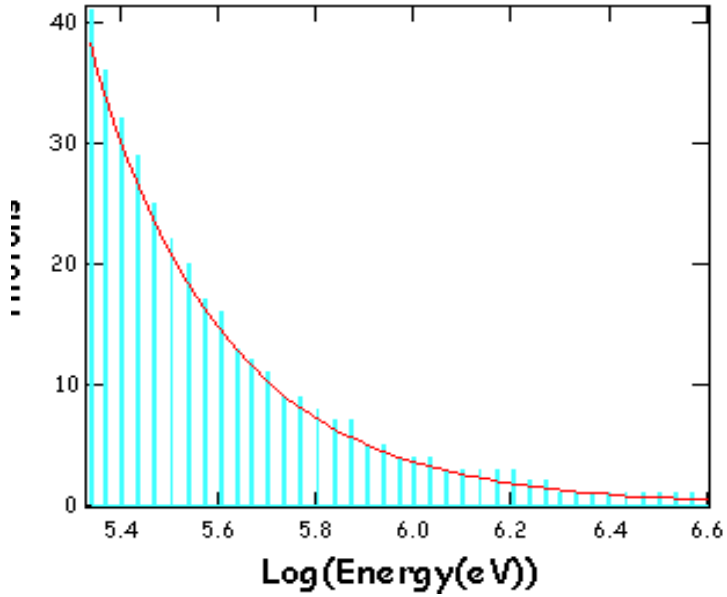


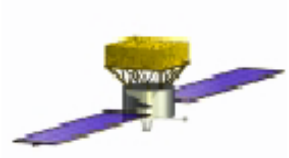
No Inverse Compton

- The spectrum has a peak in the low energy range (KeV)
- Few photons at high energy (10 MeV)
- The algorithm of photon extraction works fine.



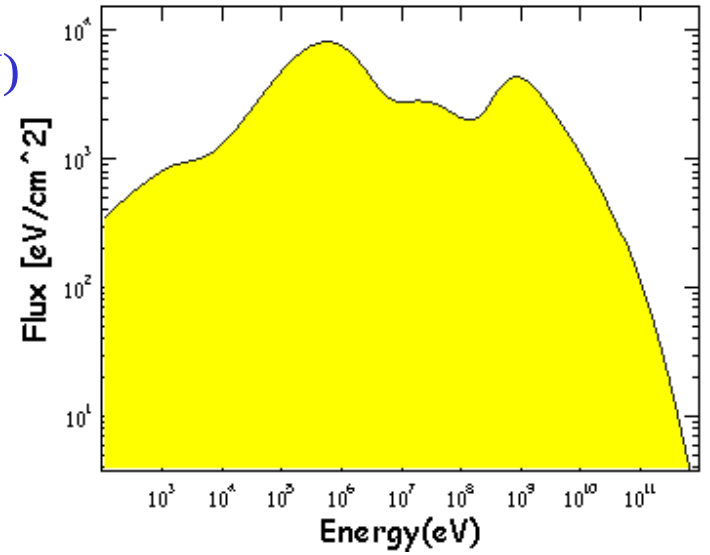


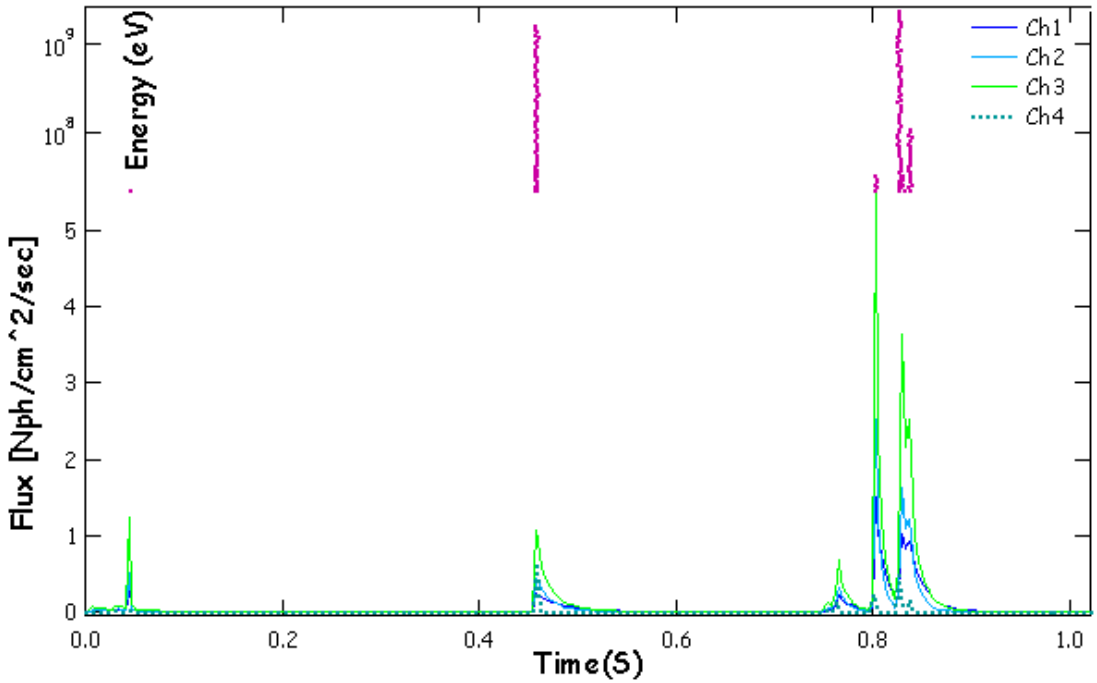




Pure Inverse Compton Model

- The spectrum has a peak @ High Energy (GeV)
- Or it shows the characteristic shape with 'two bumps'
- Photons are extracted up to 100 GeV





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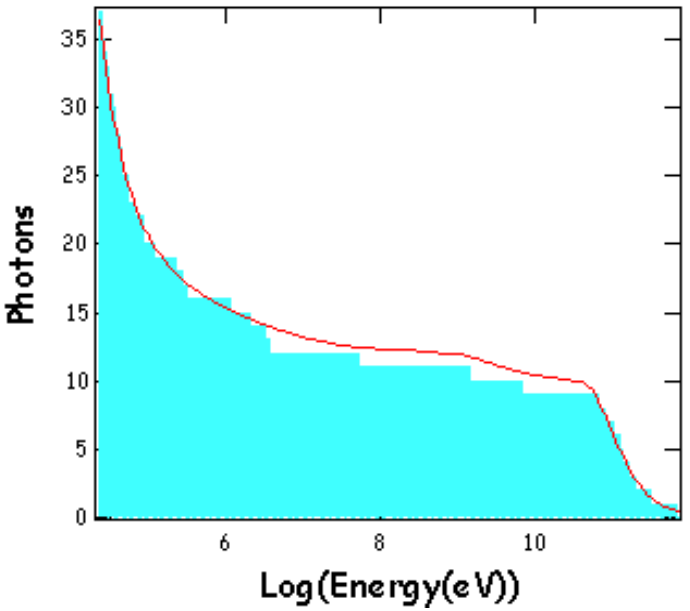
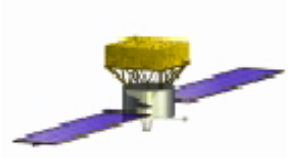
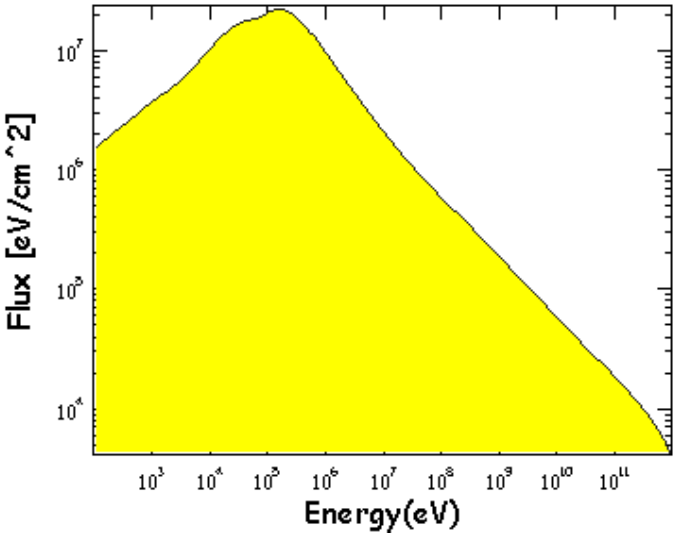
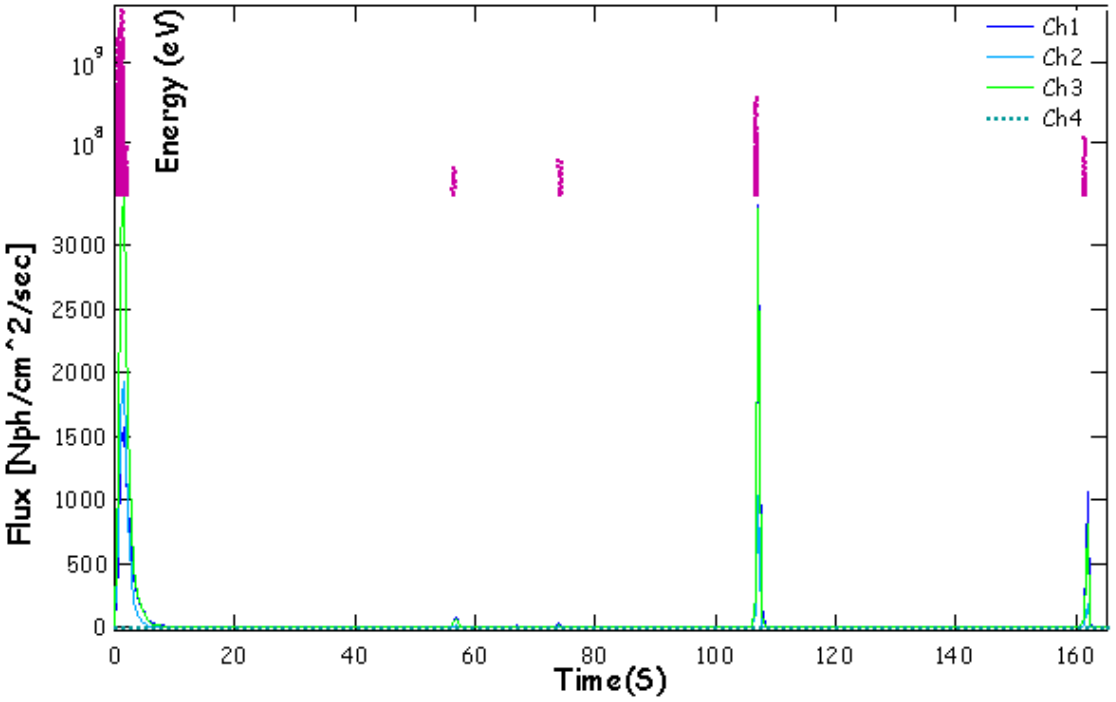


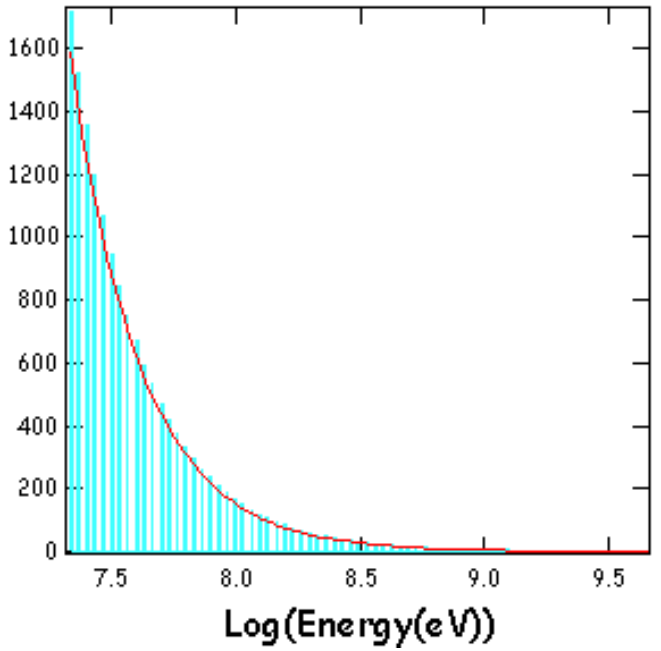


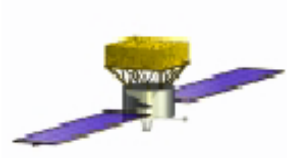
Synchrotron & Inverse Compton

- The Spectrum has a peak @ 100 KeV and doesn't present any 'IC bump'
- High Energy Photons are extracted (up 10 GeV for 10^{54} erg source located at z=1)



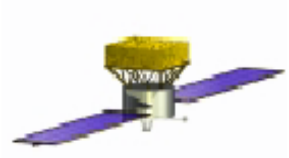






Validation Procedure

- Temporal analysis:
  - The spike duration depends on the energy band of the light curve (harder spikes are shorter)
- Spectral analysis:
  - Time integrated
    - Spectral indexes
  - Time resolved
    - Variation of the spectral indexes in the time
    - Wavelet analysis

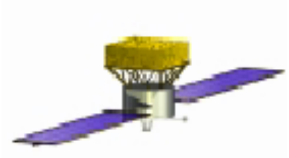


Next Step

- We need a more complete description of the fireball including non-thermal radiative processes
  - Pair Production & Pair Annihilations
  - π^0 annihilation (->high energy photons)

Arcetri !

- Illumination of the satellite in the correct way
  - Generate the correct distribution of photons as function of the galactic coordinates
  - Needed for studying the detector capabilities as function of the incident angle
- Larger Statistics -> Better Evaluation
  - Solve the Memory Leakage problem encountered processing the GEANT4 Simulator (better hits generation)



Working with other groups

- Organize a common framework with other W.G.
  - AGN simulator, Dark Matter Event Generator
  - All the models should provide the same structure of the output file! (Define Common class ? I.e. 'photon event' -> XML coded)
- We have also to consider using data collected by previous experiments (BATSE,EGRET)
  - Using real data instead of simulated data
  - Design a 'multi purpose' event generator (flux->photons)
  - Procedure to generate several input files in automatic way