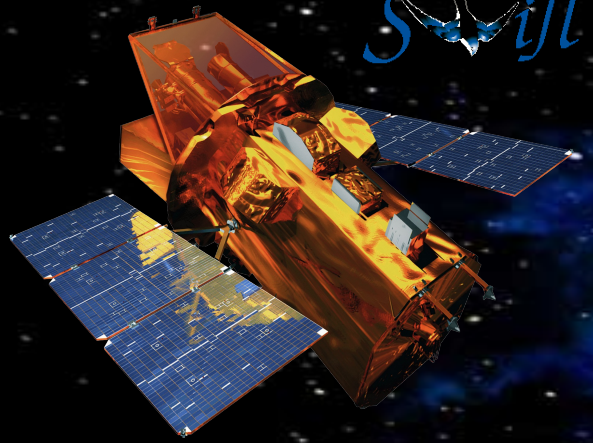
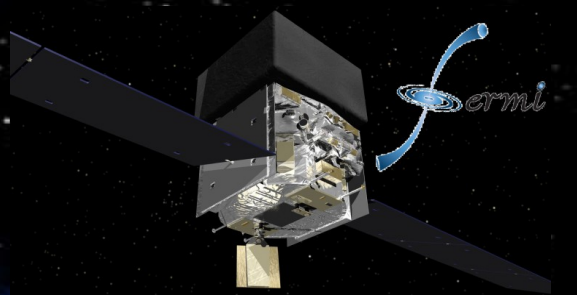
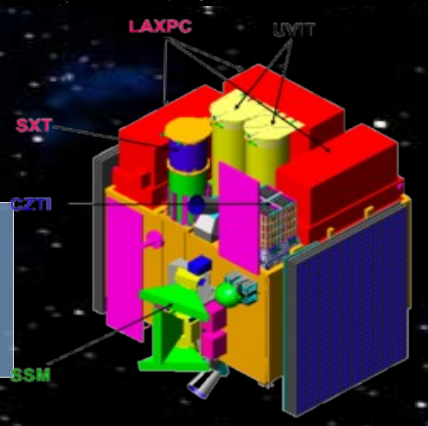
GRB 151006A:

In the context of Radiation mechanism in GRBs





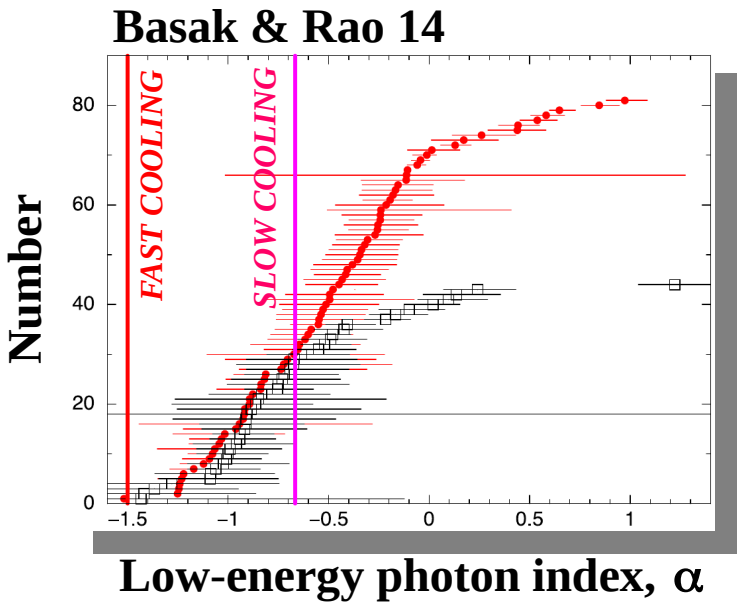


Rupal Basak

N. Copernicus Astronomical Center
of Polish Academy of Science, Warsaw

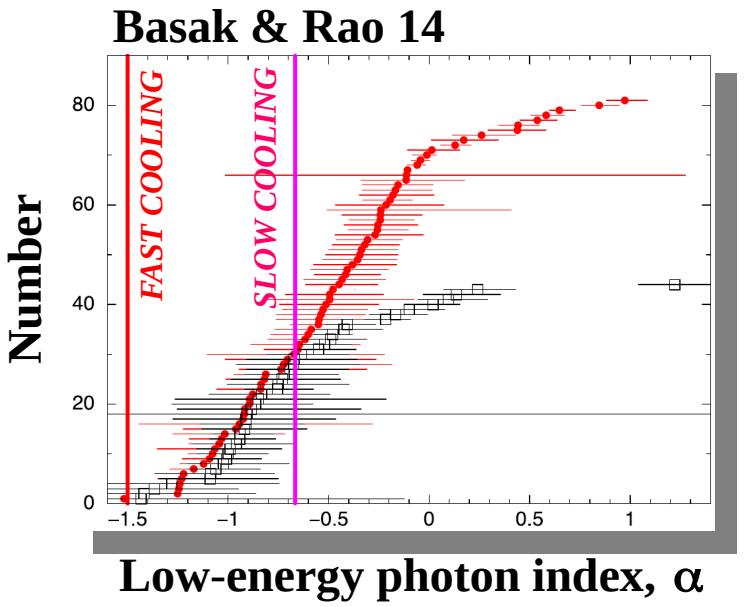
Wide Band Spectral & Timing Studies of Cosmic X-ray Sources
TIFR, January 13, 2017

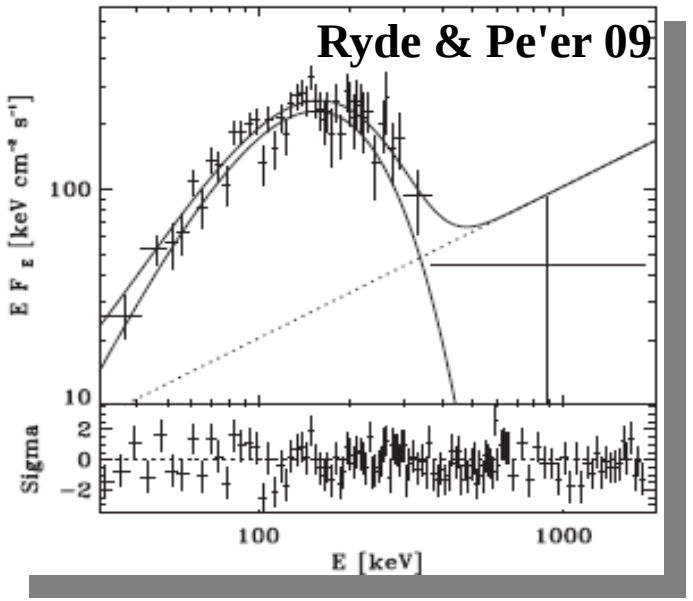
Challenges of the prompt emission study



- Standard scenario. Synchrotron (Rees & Meszaros 92, 94. Fitted with Band (+93) function.
  1. Shortcomings of synchrotron model (Preece+98).
  2. Wide field of view detectors.
  3. Rapid evolution and Overlapping pulses.

Challenges of the prompt emission study





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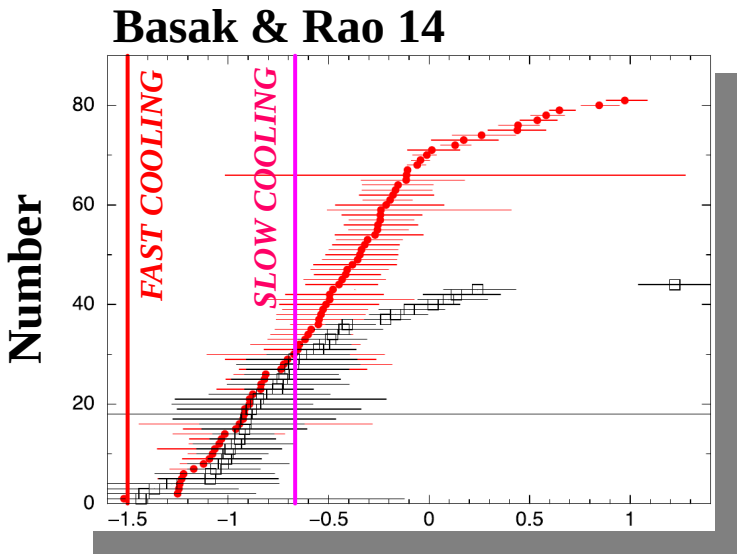
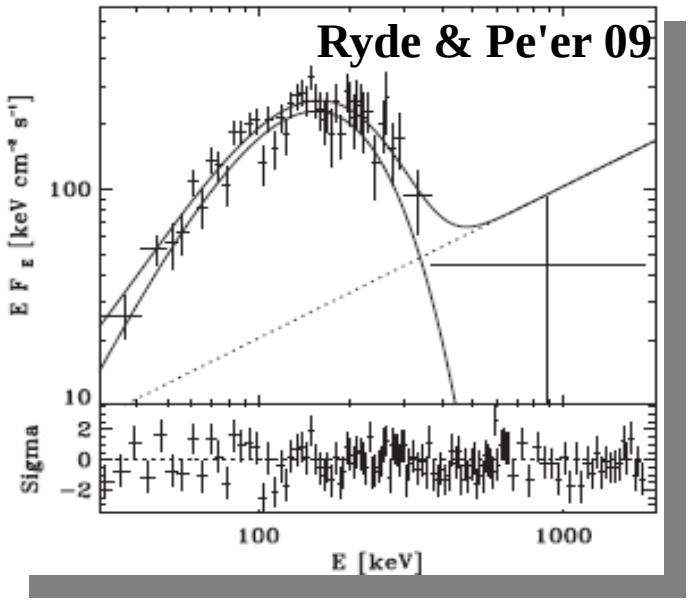
Challenges of the prompt emission study





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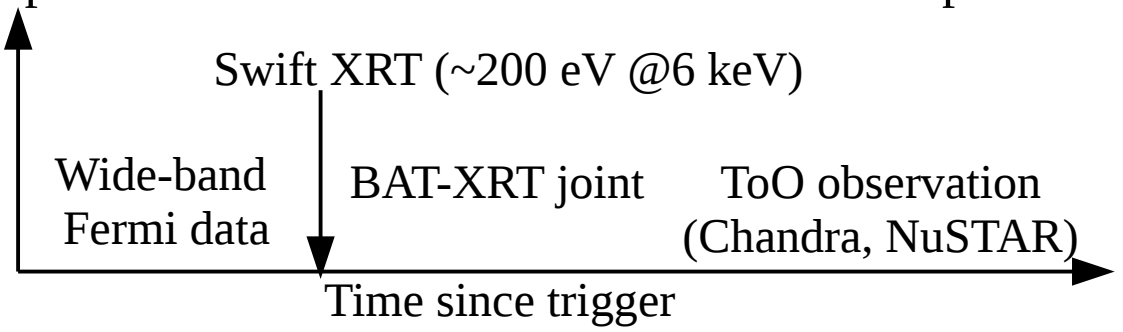
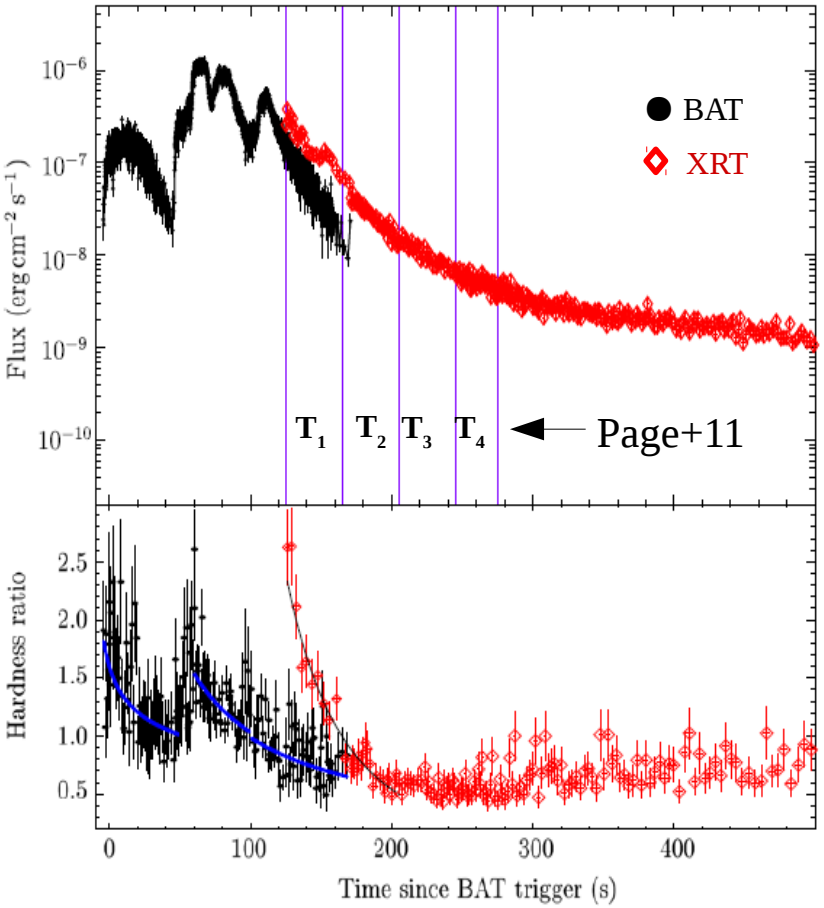
- **Single pulse:** Crider+97; Ghirlanda+03; Ryde 04, Ryde & Pe'er 09: Thermal emission.

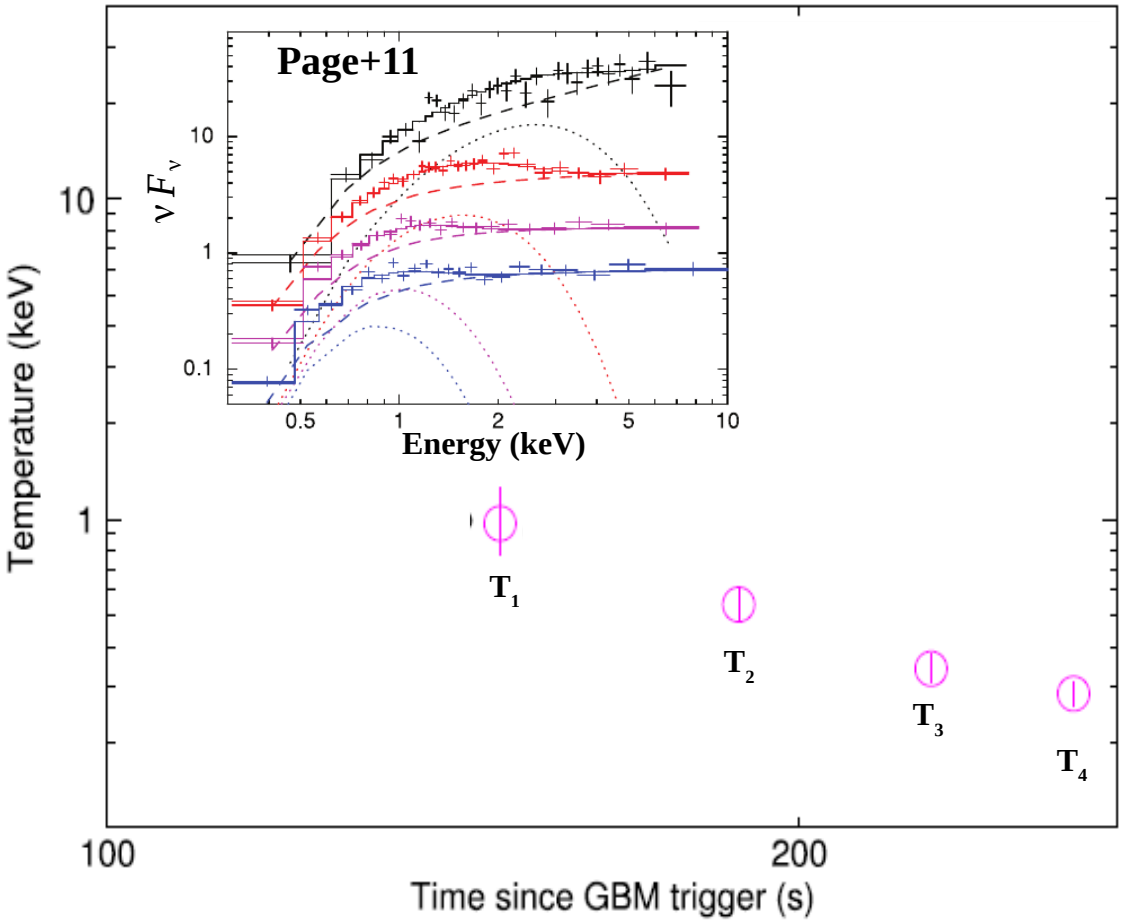
- **Fermi era:** wider band. Variety of models Ryde+10; Guiriec+11,13; Axelsson+12; Basak & Rao 13, 14; Burgess+14; Iyaani+15 (spectrum with two humps or broad top)
- Statistically difficult**, Novel strategy:** Exploit capabilities of different detectors at different phases



Example GRB I

2. GRB 090618 (Basak & Rao 2015a, ApJ)





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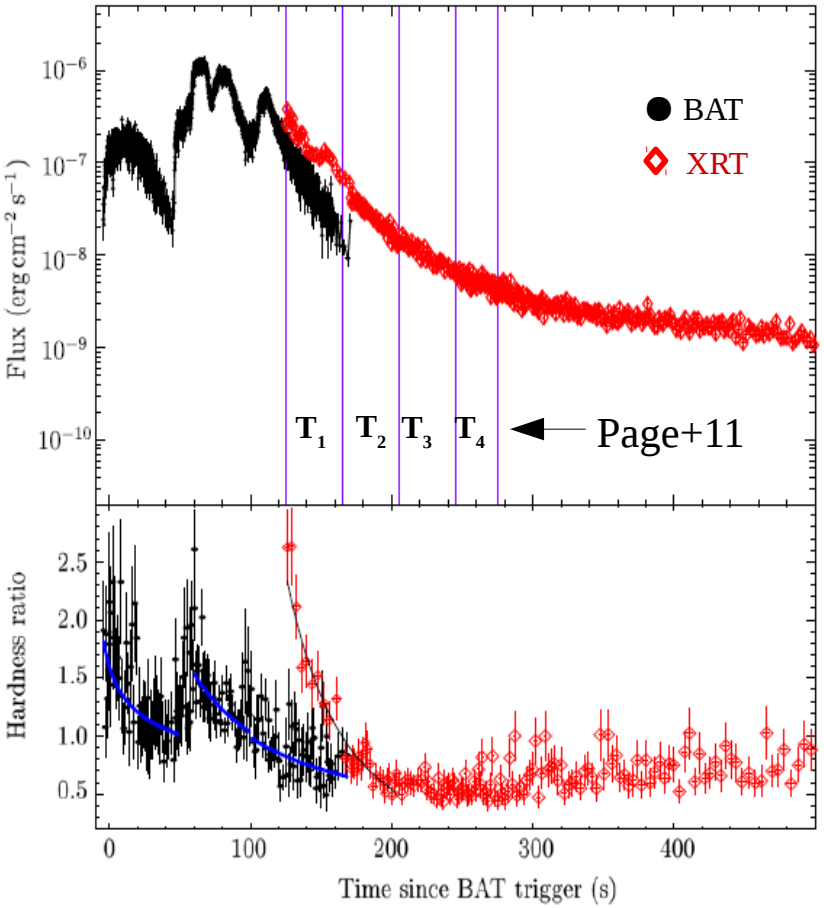

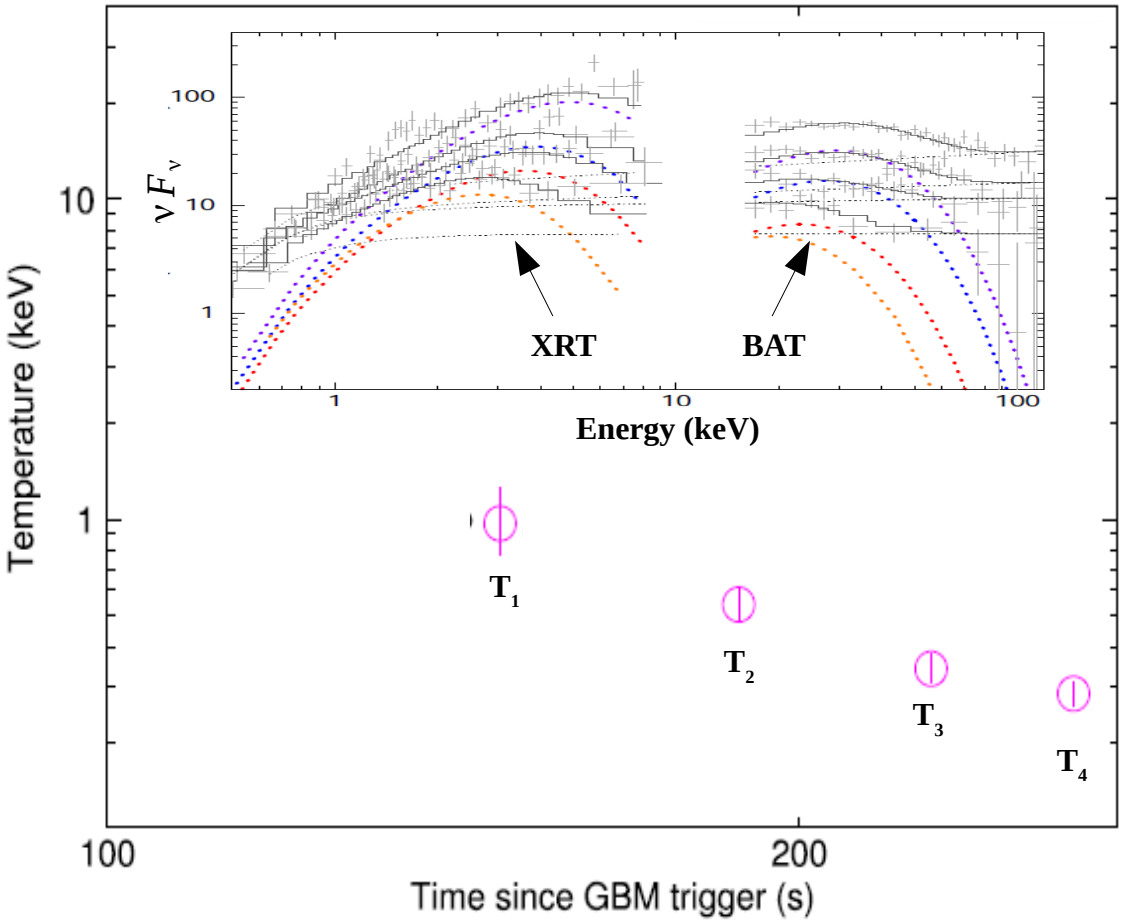

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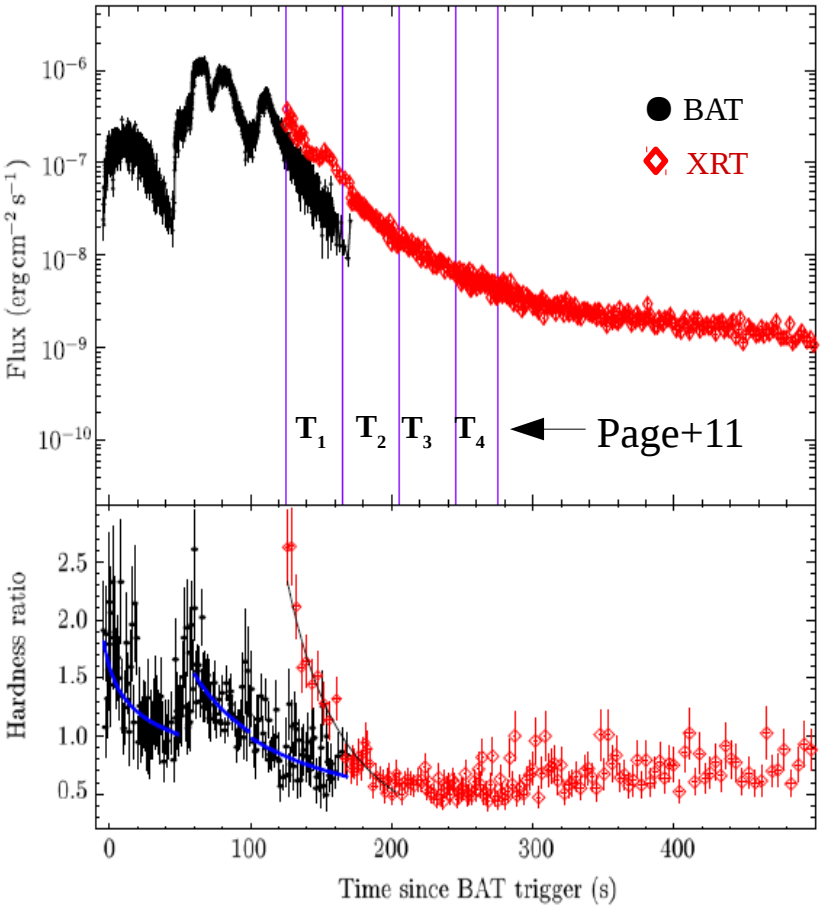
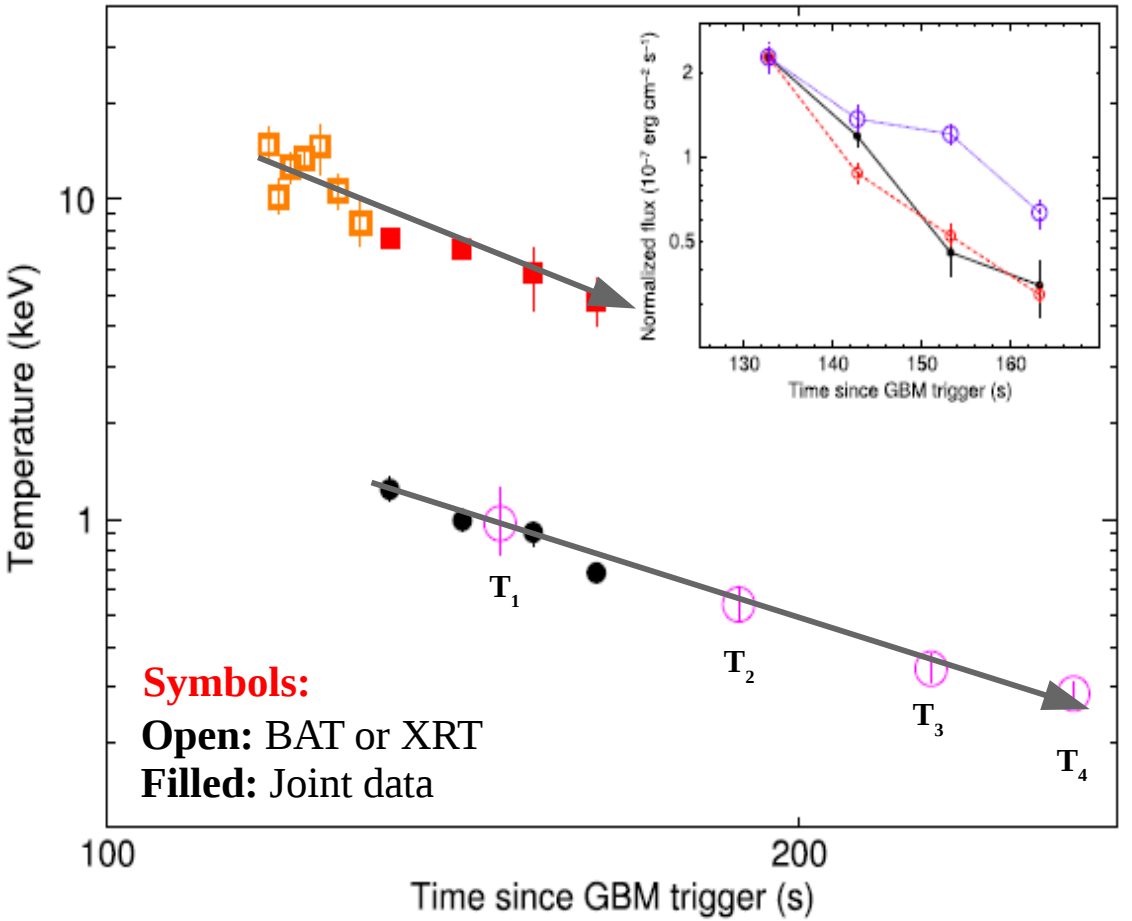


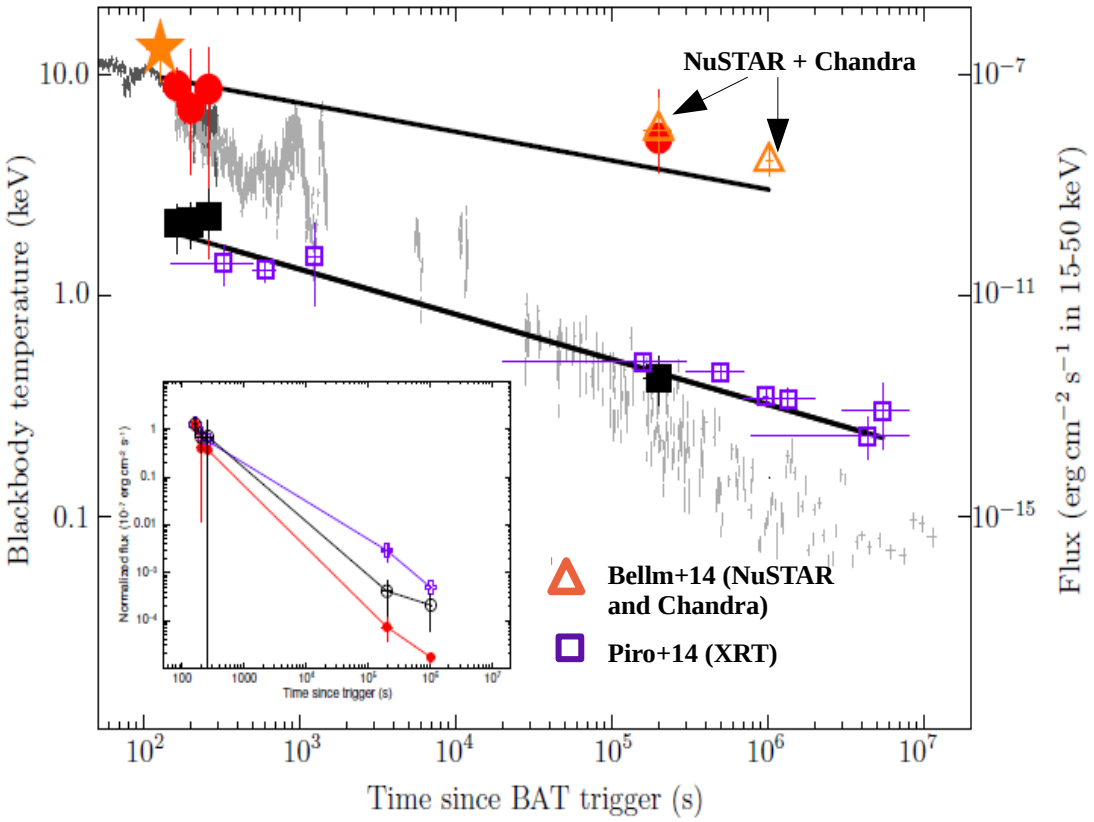


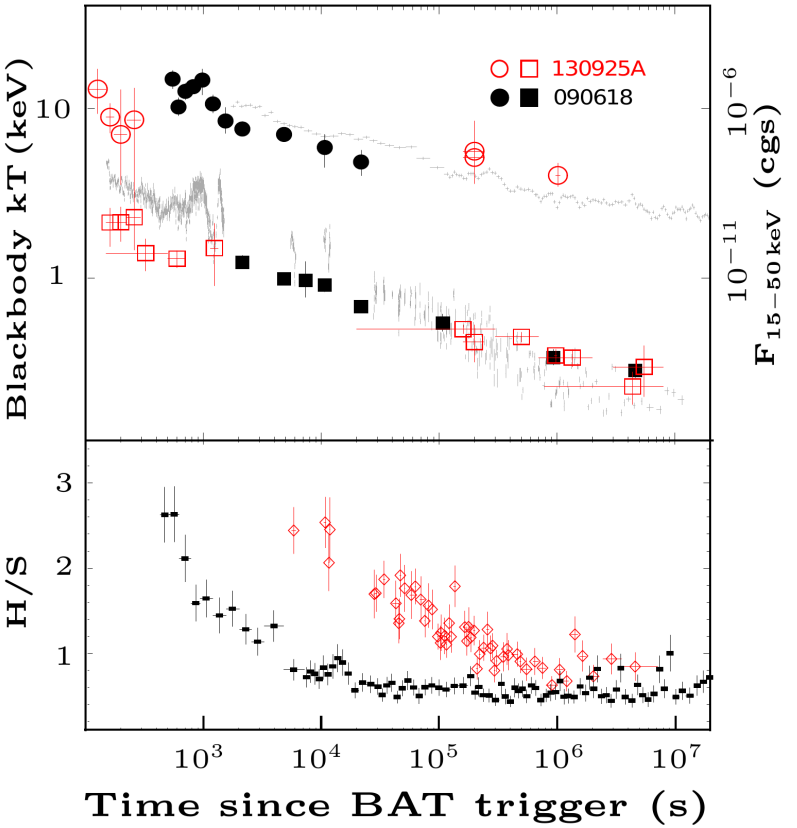
Example GRB II

3. GRB 130925A (Basak & Rao 2015b), **An ultra-long GRB**

Debate: (1) GRB or a **TDE**? HST image shows 600 pc offset from the host. But, morphology of the host indicates recent major merger. Combined study of X-ray and host galaxy

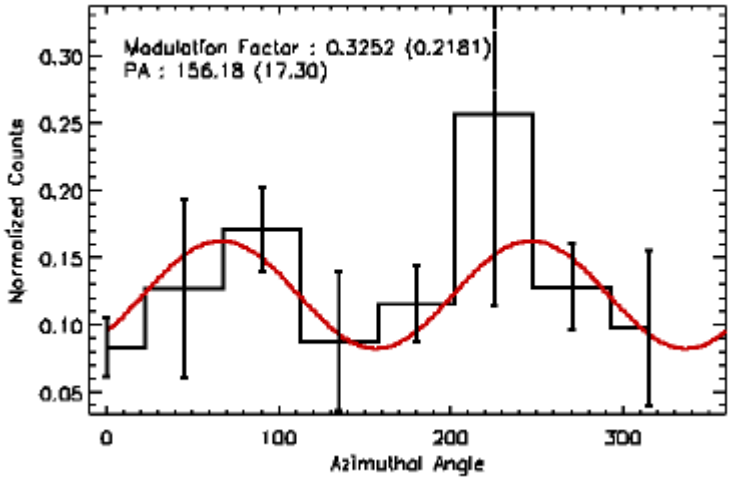
(2) Emission: **Single BB:** Bellm+14 ~5 keV, Piro+14 ~0.5 keV, **Dust scattering**: Evans+14

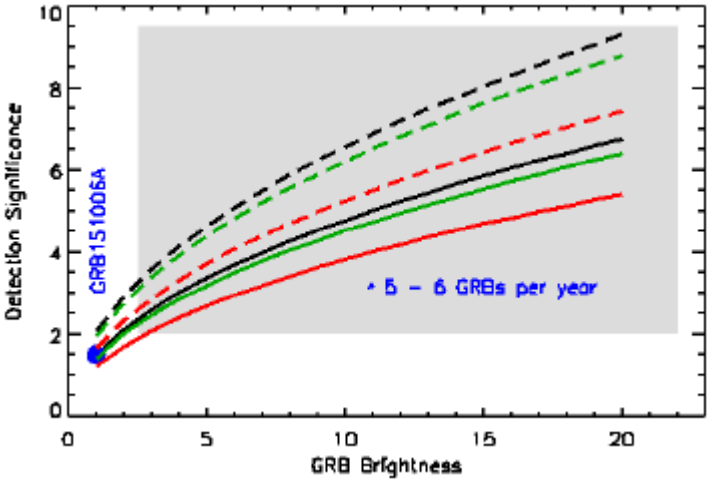




GRB 151006A: The First Astrosat detected GRB

- Astrosat: Successfully launched on 28 Sept, 2015.
- Cadmium Zinc Telluride Imager (CZTI) started operating from 6 Oct 2015
- GRB 151006A detected on **the first day.**
- Spectral, timing and image: comparable results with Swift and Fermi.
- Polarization measurement, for the first time for such a faint burst.

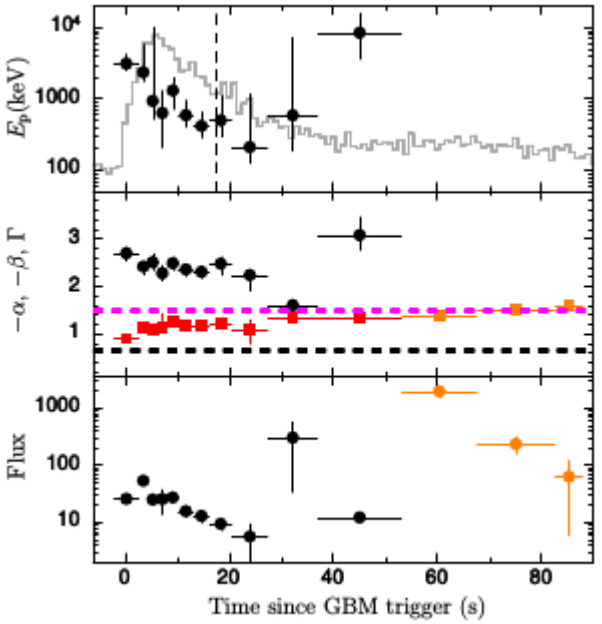


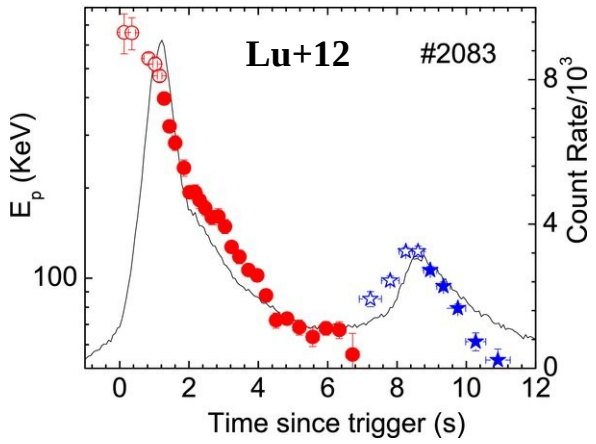


Rao et al. (2016) ApJ

Spectral Evolution of GRB 151006A

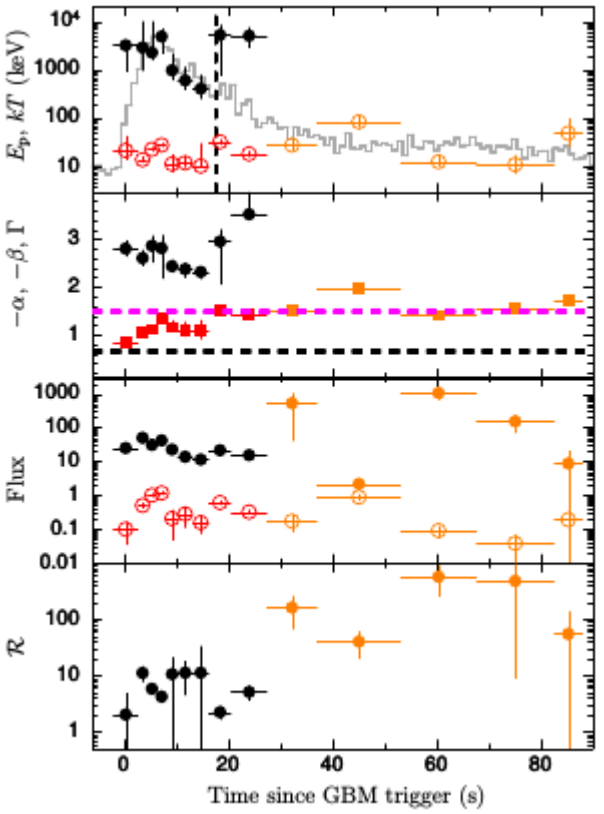
Band



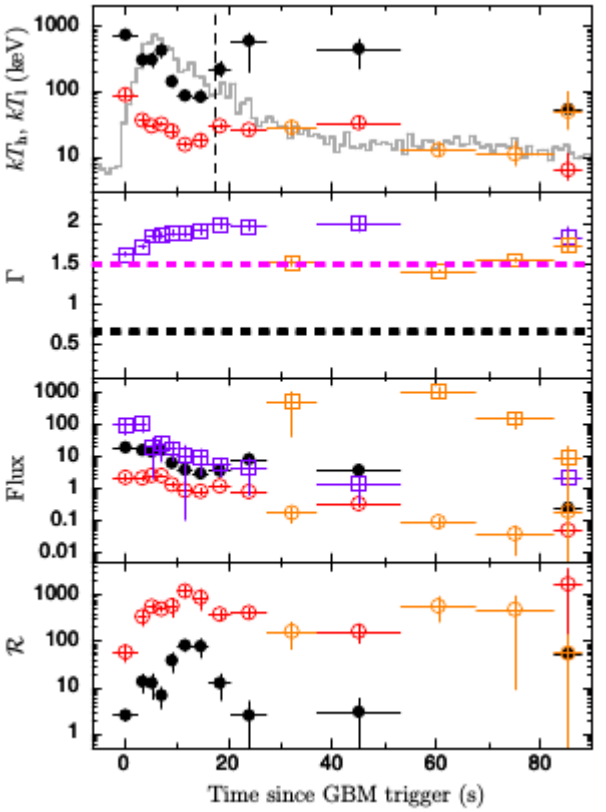


- Unusual Evolution for a single pulse GRB. Jump in peak energy
- Coincides roughly with the first LAT photon detection time

Band + BB

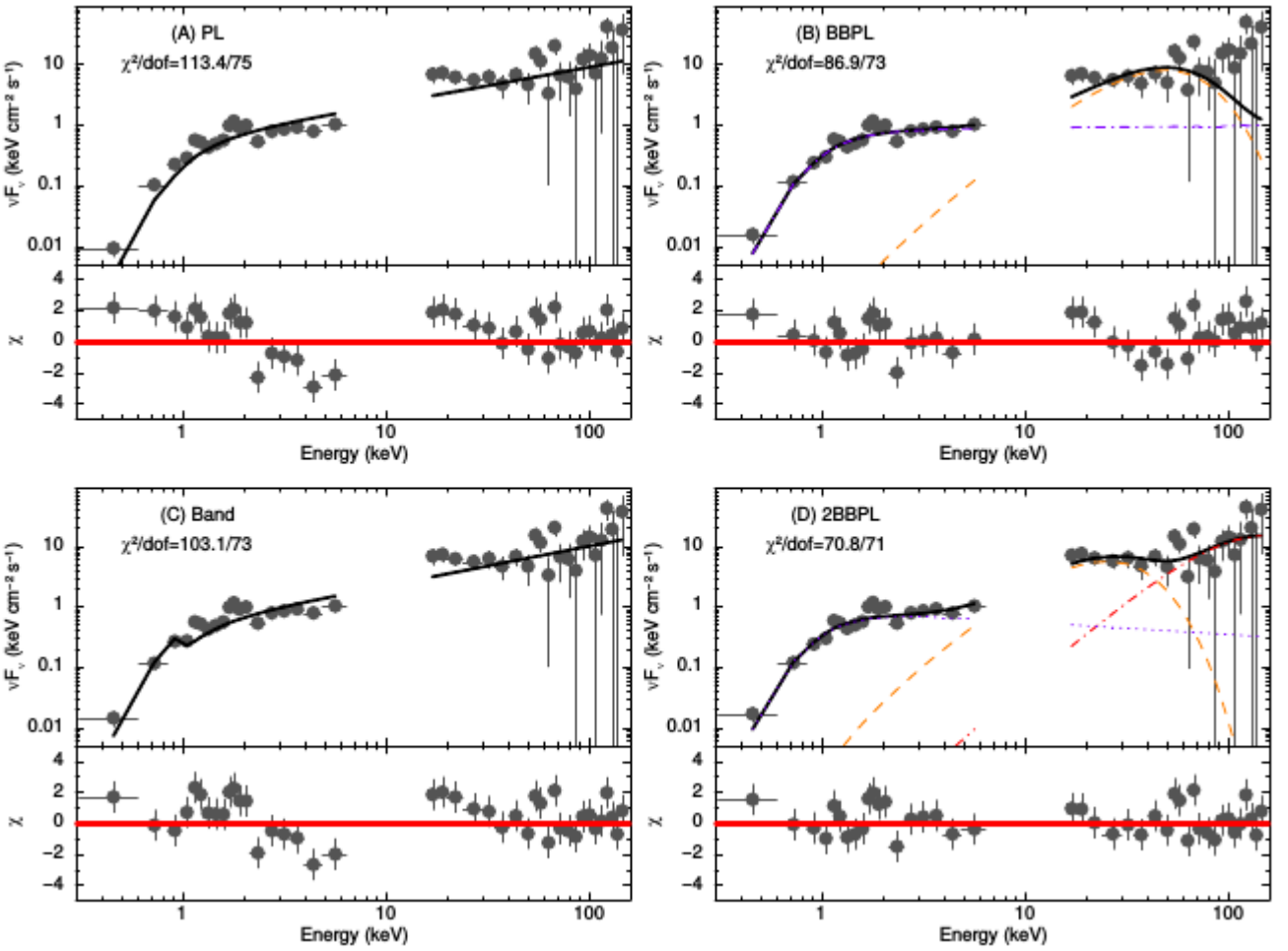


2 BB + PL



CZTI Collaboration (in prep)

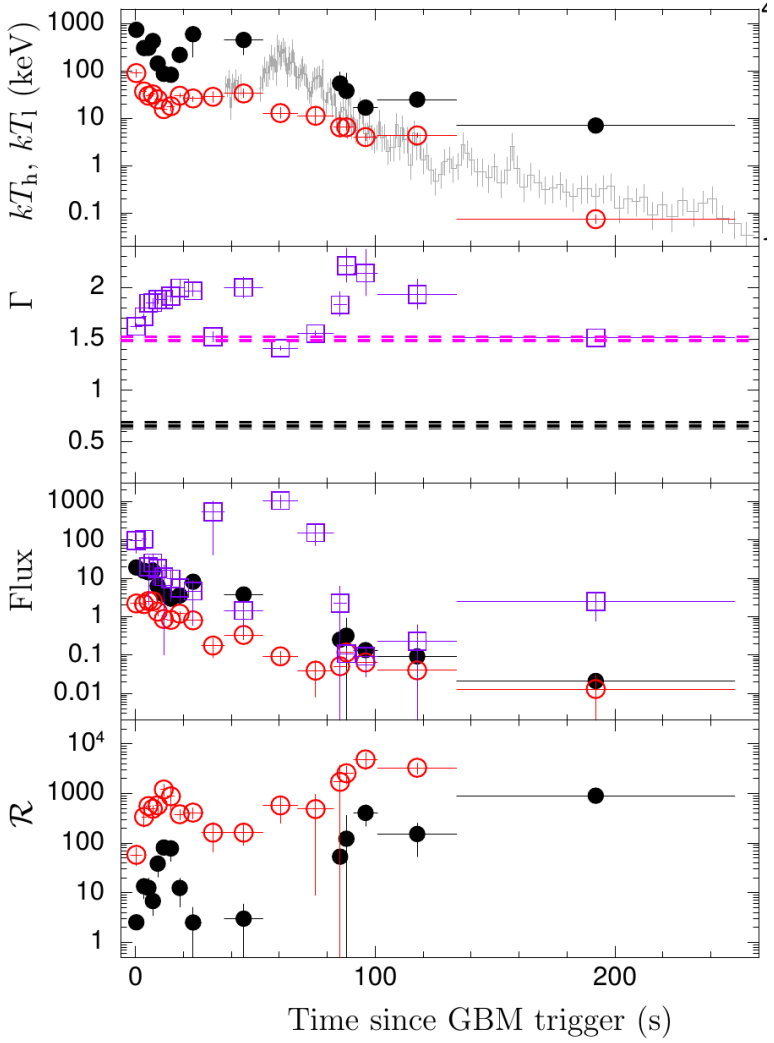
Late time spectrum with XRT and BAT



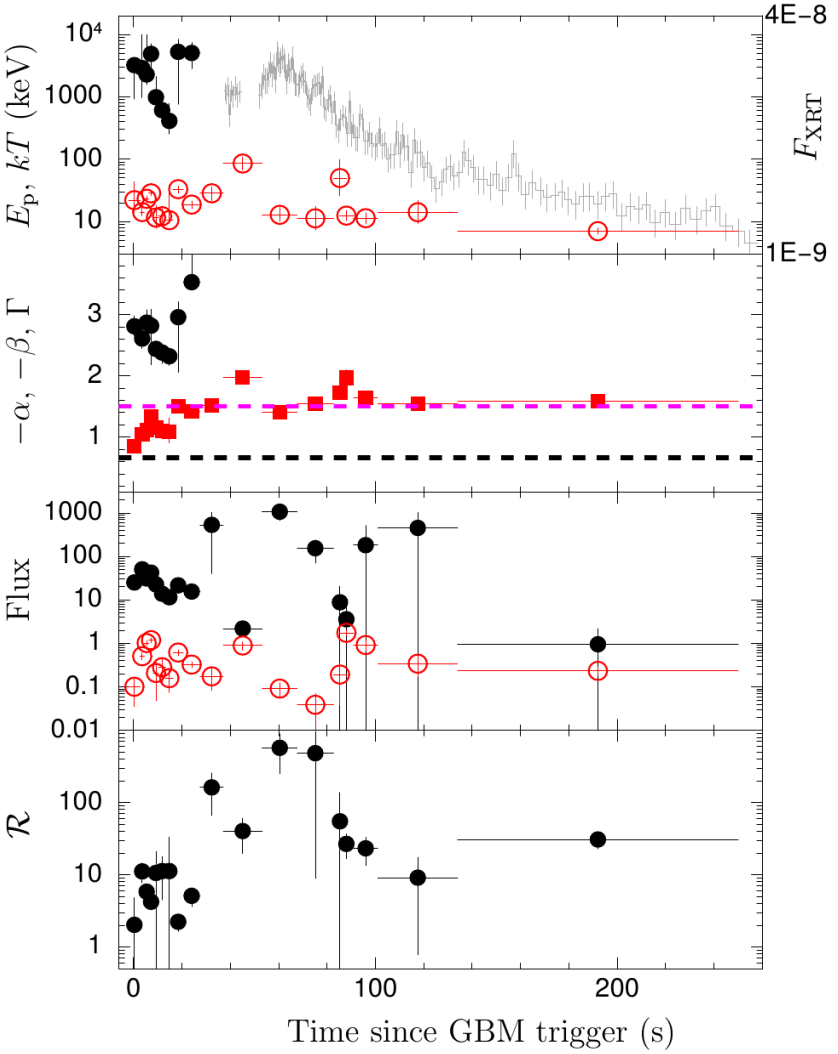
CZTI Collaboration (in prep)

Long term Evolution

2 BB + PL



Band + BB



CZTI Collaboration (in prep)

What makes the jump in the spectral evolution?

- A start of the afterglow phase?
- A second hard pulse not seen in the otherwise smooth profile?
- In any case, it is unusual

CZTI Collaboration (in prep)

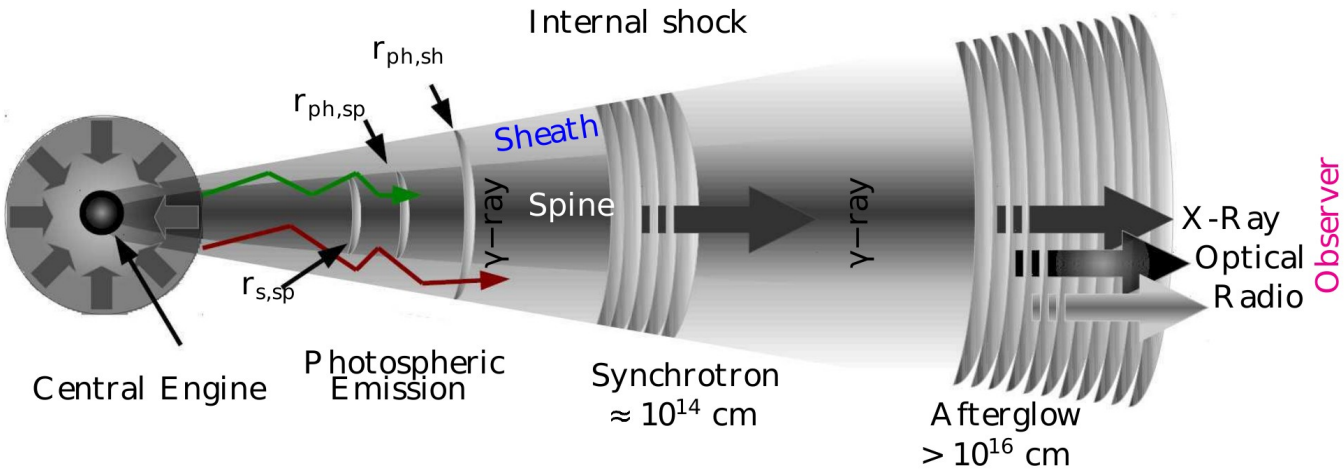
What makes 2BBPL: spine-sheath jet

Process:

Interaction with envelop
(Ramirez-ruiz+02; Zhang+04)

Radiation:

(1) Thermal emission – photosphere
(2) Non-thermal – two processes

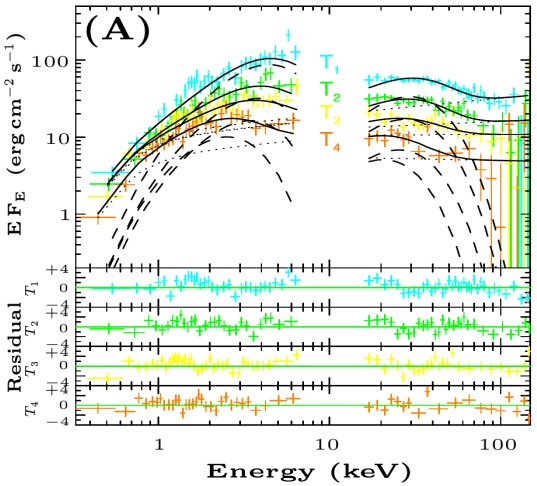


Basak & Rao 2015a, ApJ

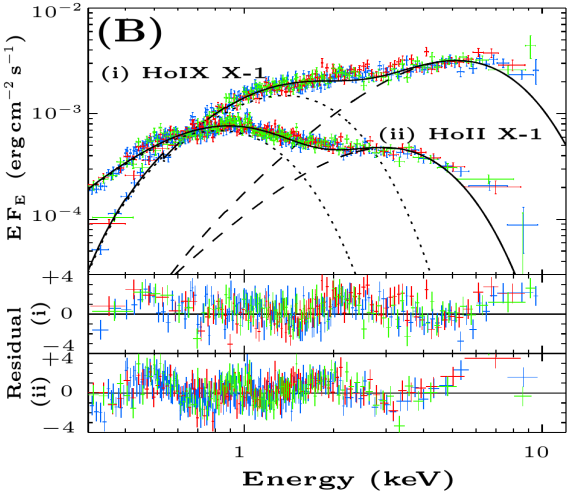
Other groups:

Ito + 13: Simulation in a stratified jet. Found the double hump and non-thermal component.
Iyyani + 15: Comptonization of thermal photons that mimics the shape.

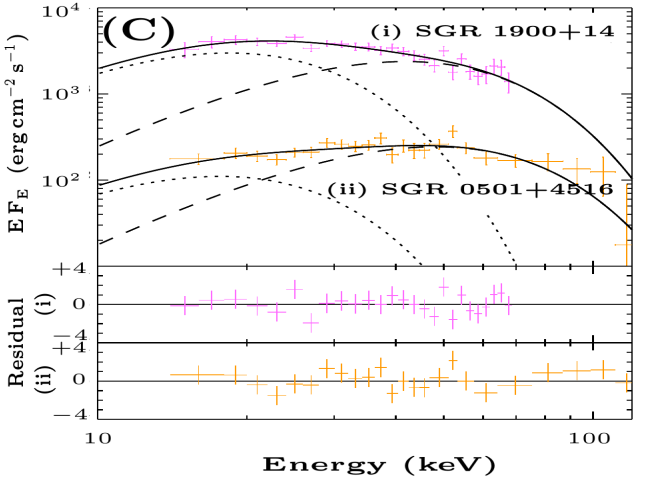
A common Feature?



GRB 090618
(Basak & Rao 2015a, ApJ)



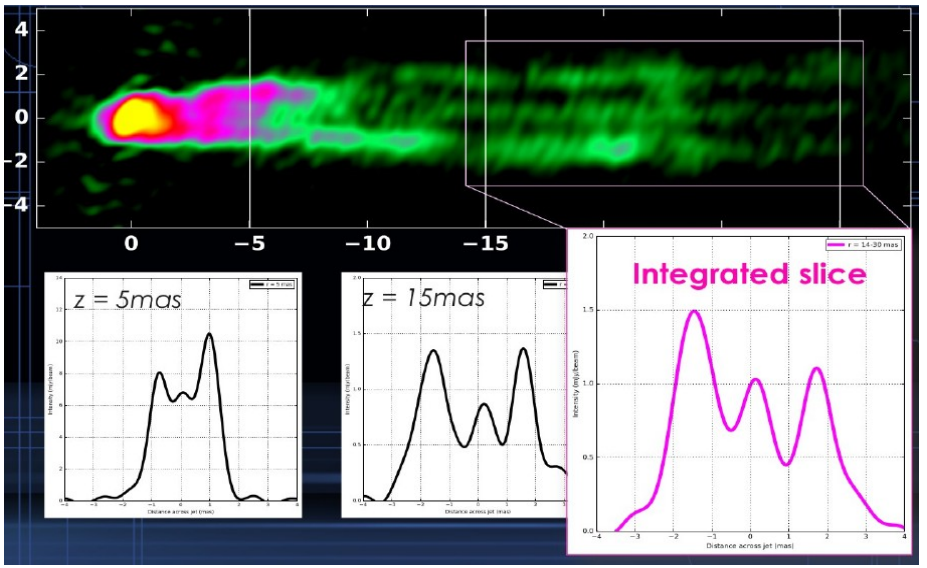
Ultraluminous X-ray sources
(Kajava & Rico-Villas 2016)



Soft Gamma Repeaters

Spine-sheath jet:
e.g., Powerful blazars (Ghisellini 2005).

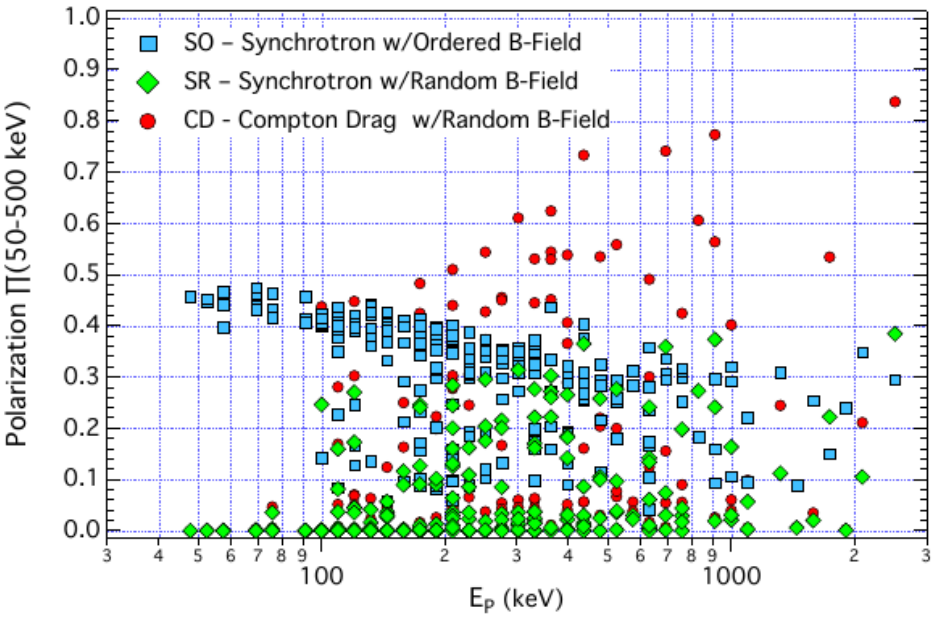
A very recent image of M87 jet.
(K. Hada, Malaga conference)
Info: 15 GHz, VLBA, pc scale.



Lessons learnt from GRB 151006A

- There could be surprises even in single pulse GRBs.
- GRB 151006 is unusua

Toma+09: Predicted polarization (50-500 keV) w.r.t E_p



- How can CZTI contribute?

  - Will require brighter GRBs. Not very rare.

  - Current sample – 40 detections.
    9 with significant polarization.

  - Interesting cases: two >3sigma detections.
    One very high, other very low.

  - Statistical sample:
    polarization degree and angle.