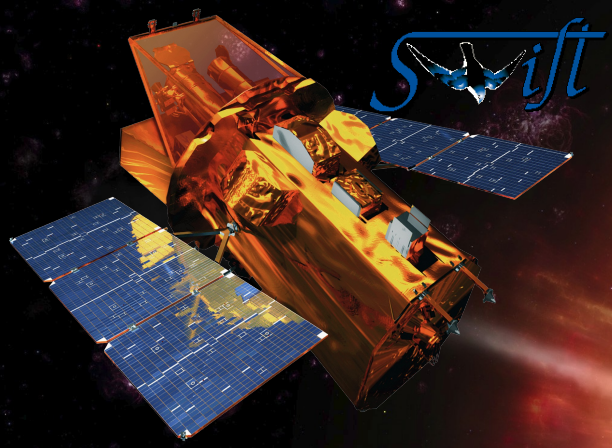
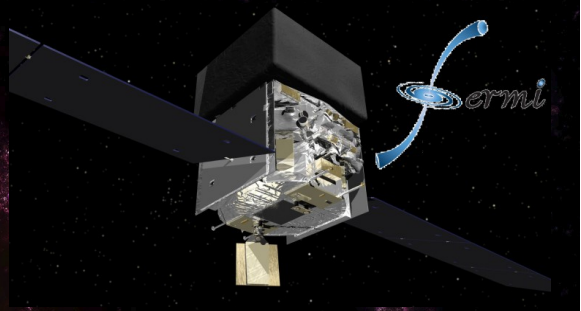
Spectral, timing and polarization study of GRB prompt emission: a multi-instrument perspective





Rupal Basak

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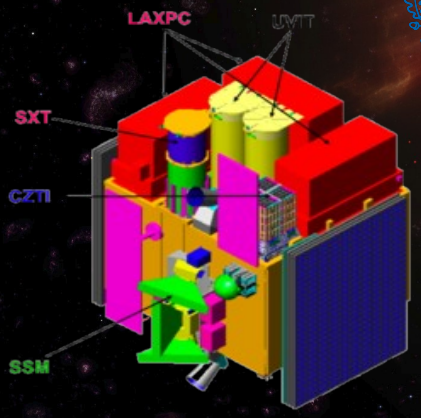
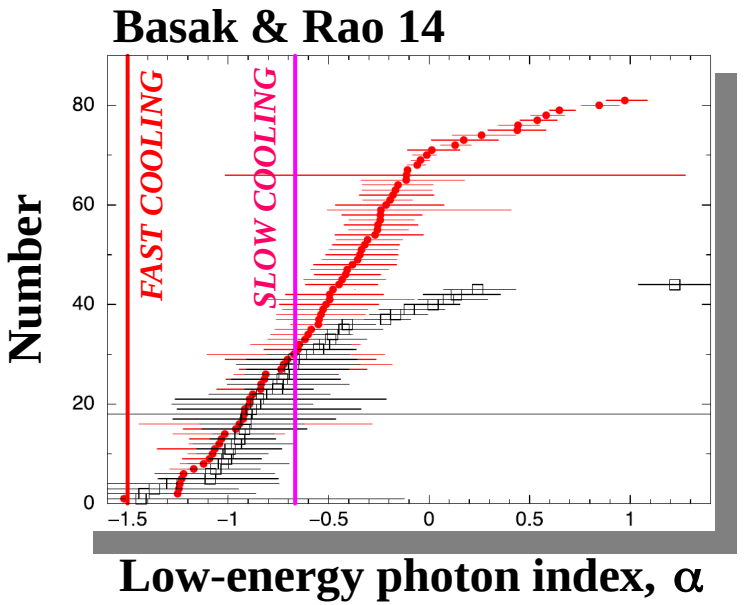
Stockholm, Sweden



Astrosat

Theseus Workshop, Napoli, Italy, 5 – 6 Oct, 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.

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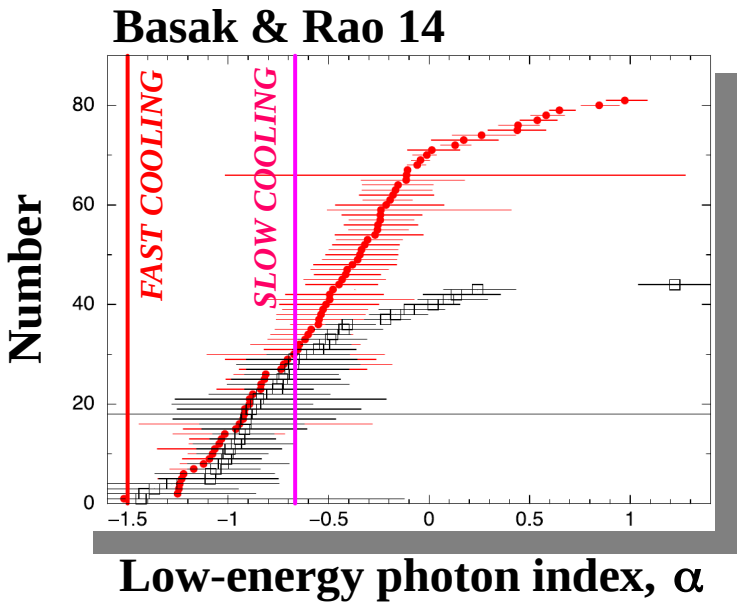

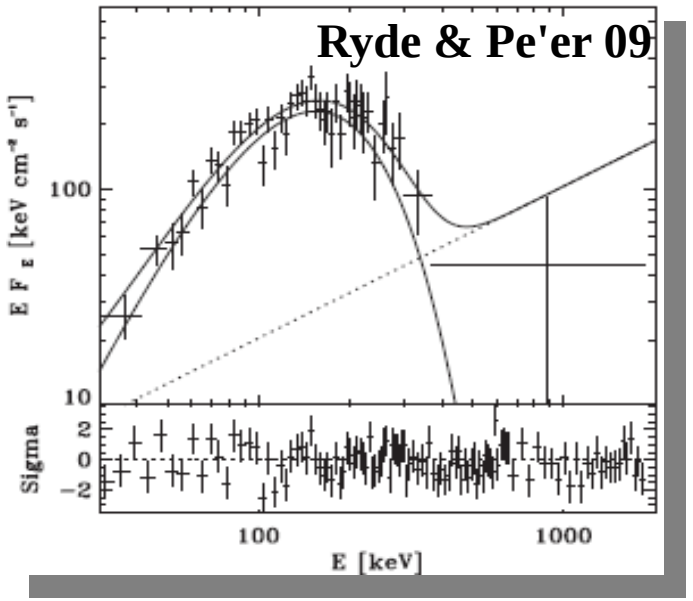

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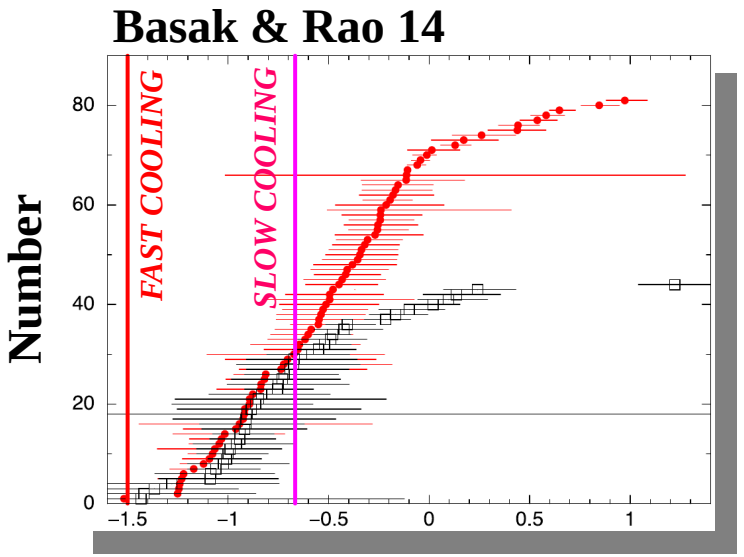

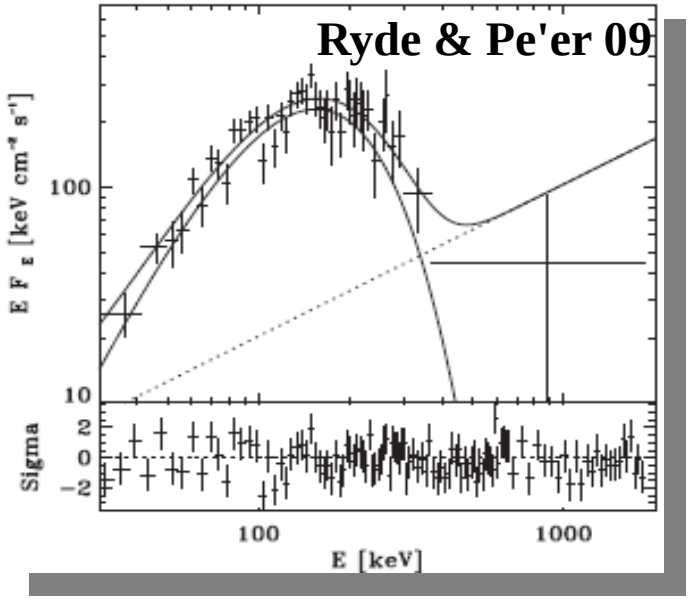

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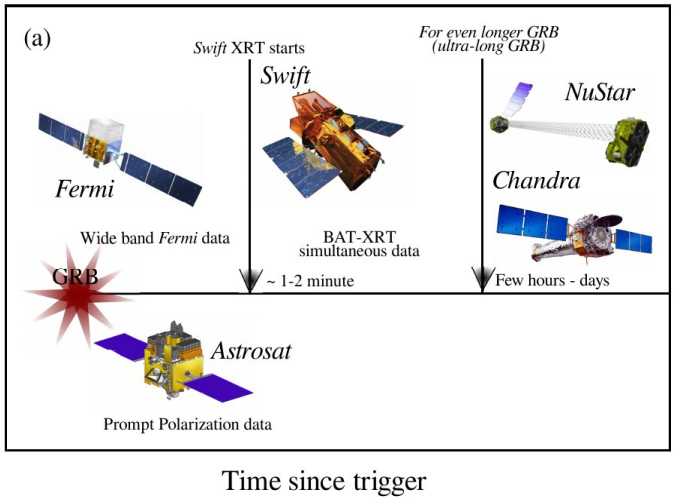
- **Single pulse:** Crider+97; Ghirlanda+03; Ryde 04, Ryde & Pe'er 09: Thermal emission.

- **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)

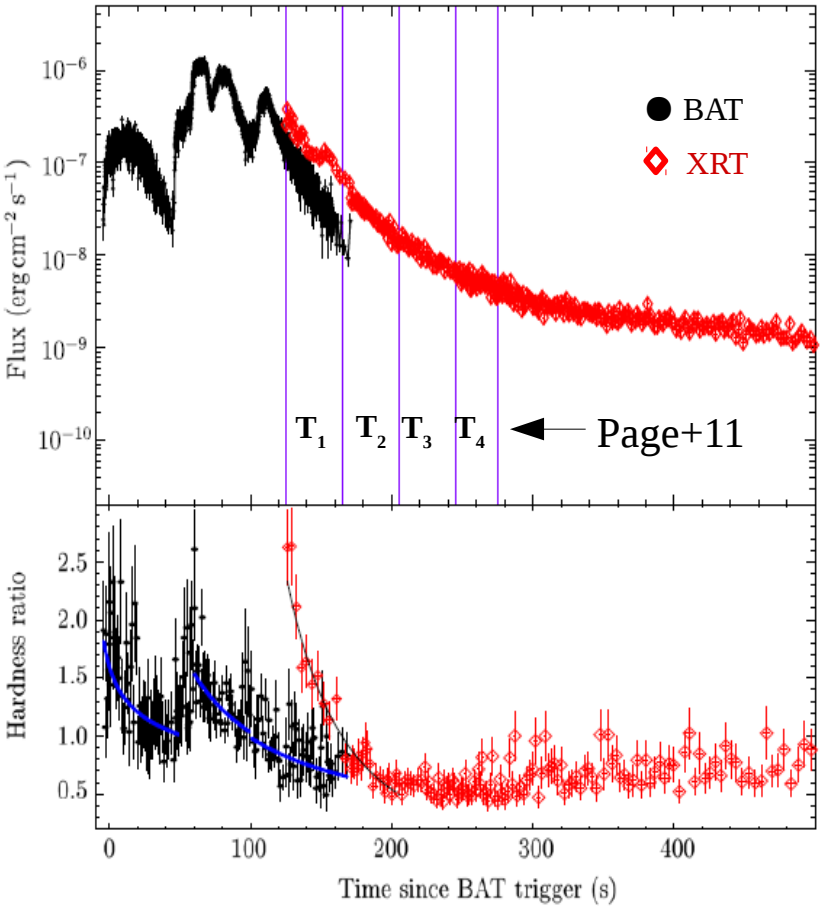
- Statistically difficult,

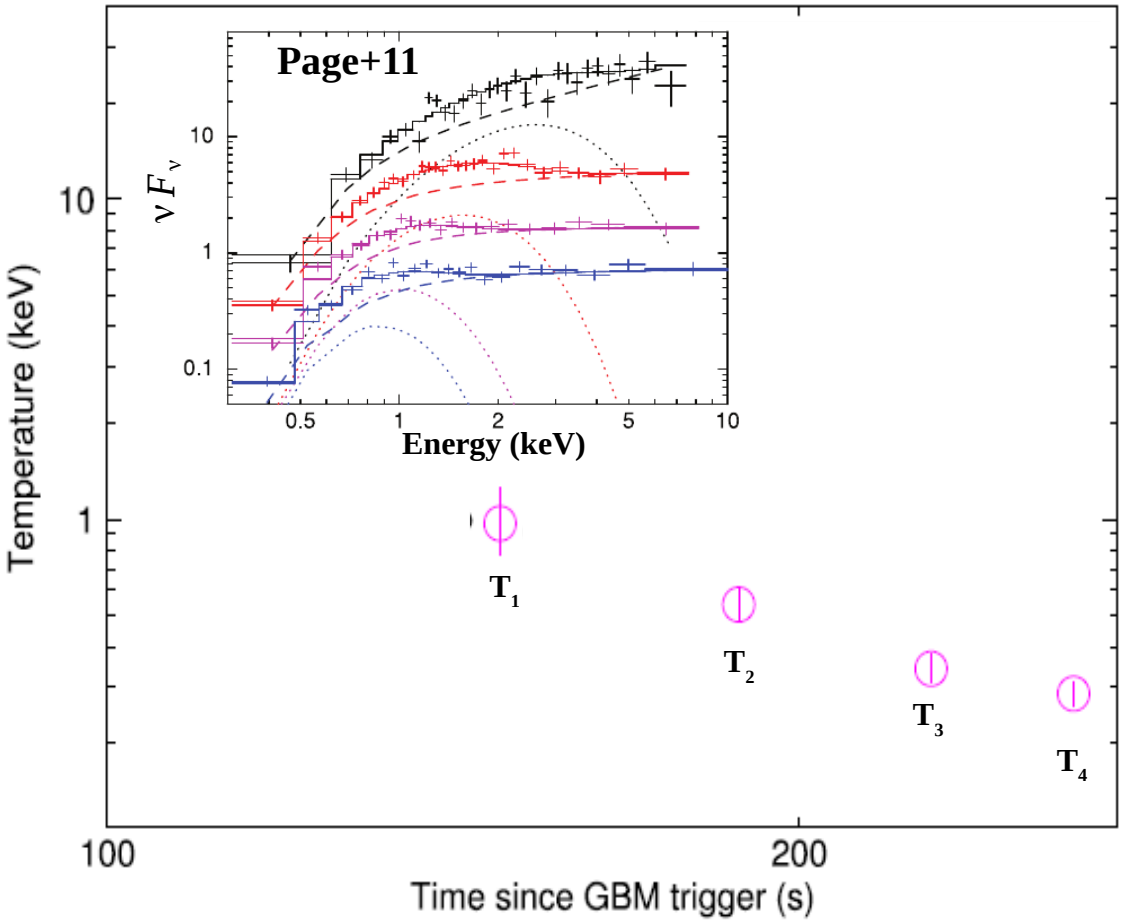
Multi-instrument strategy



Example GRB I

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





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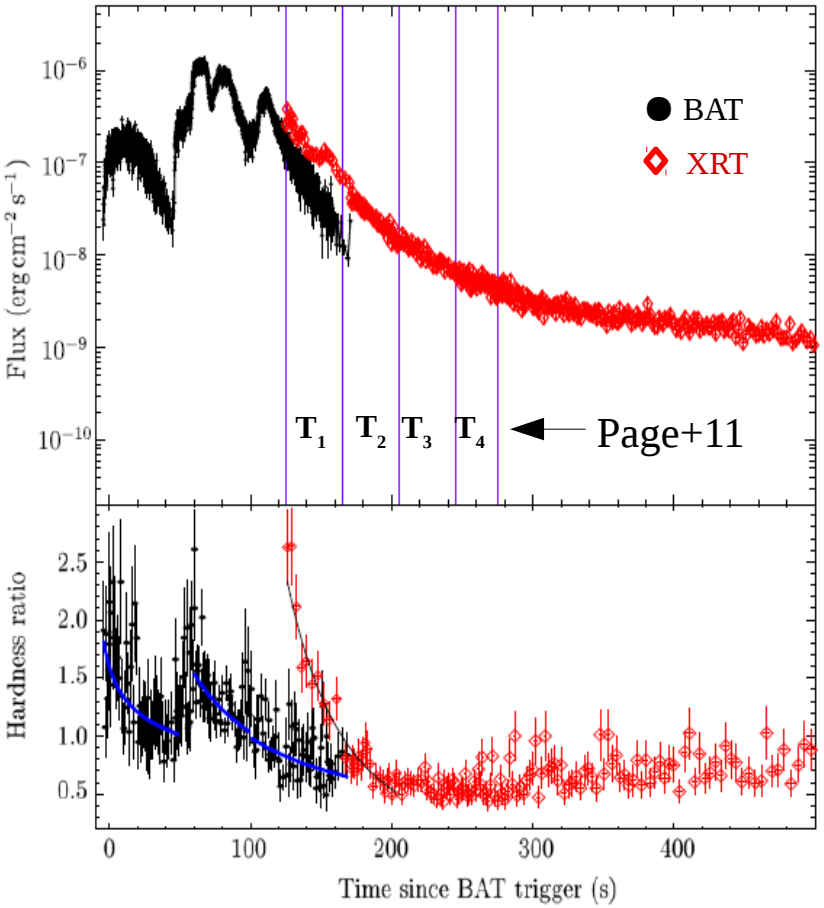

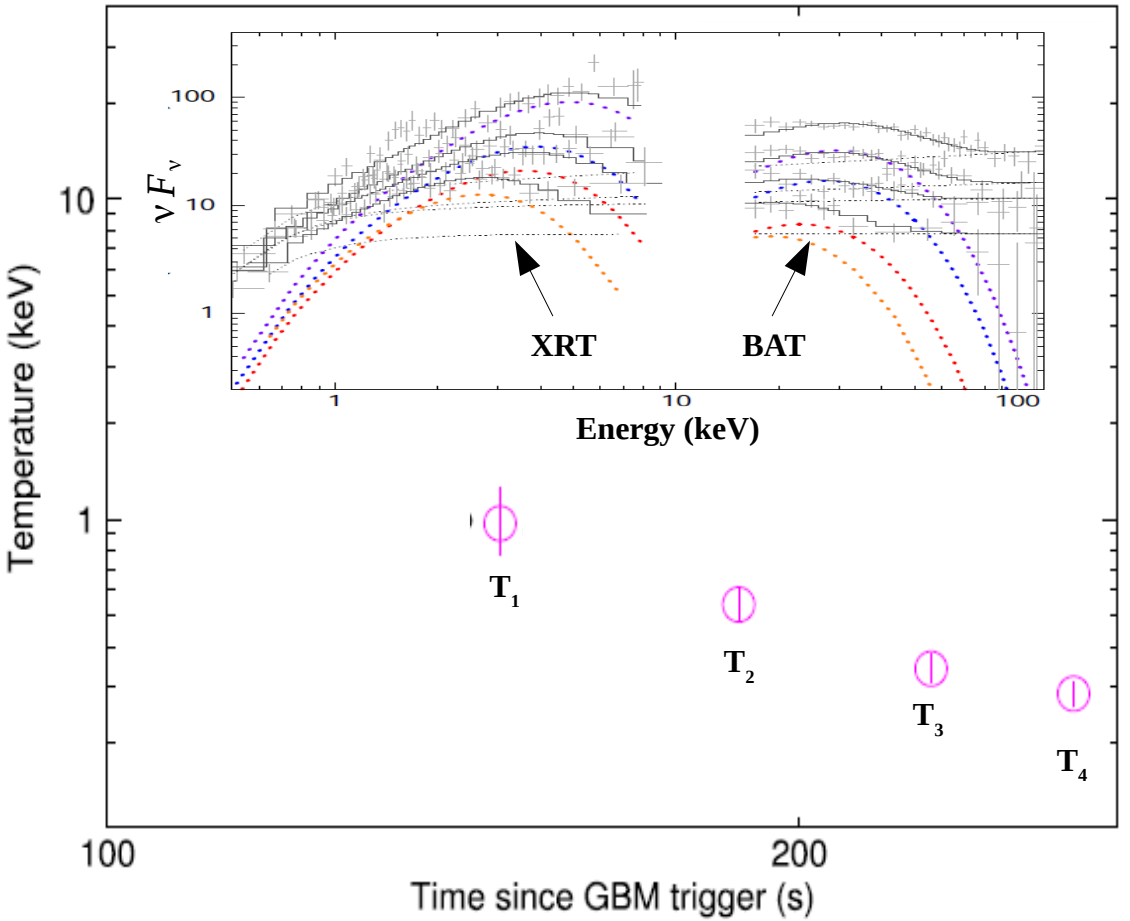

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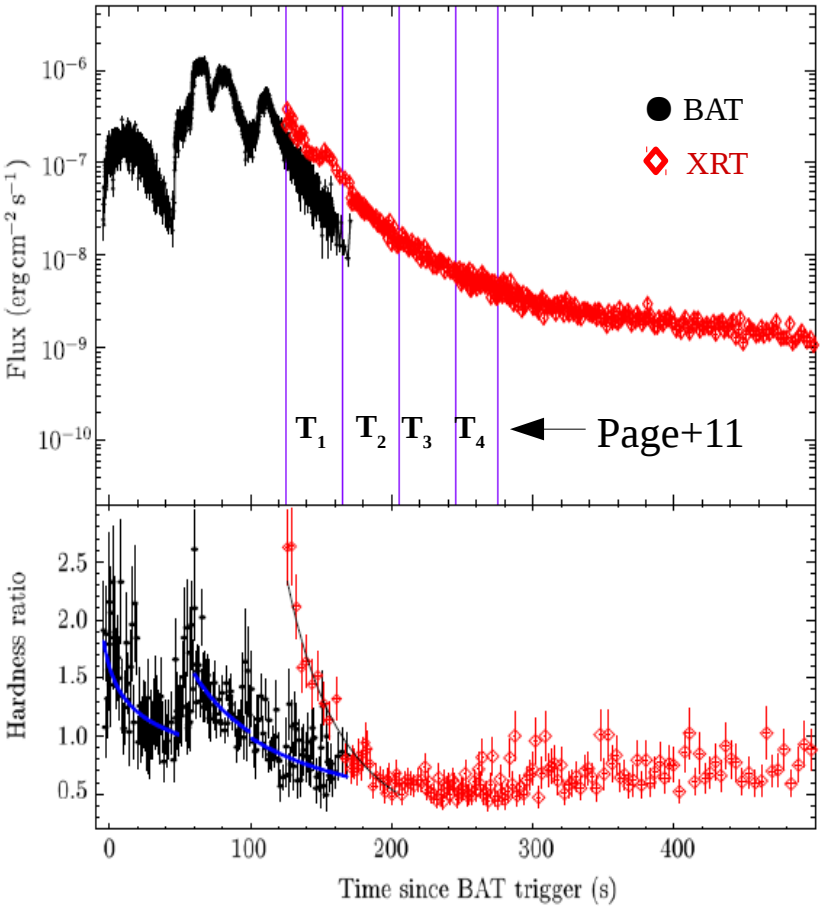
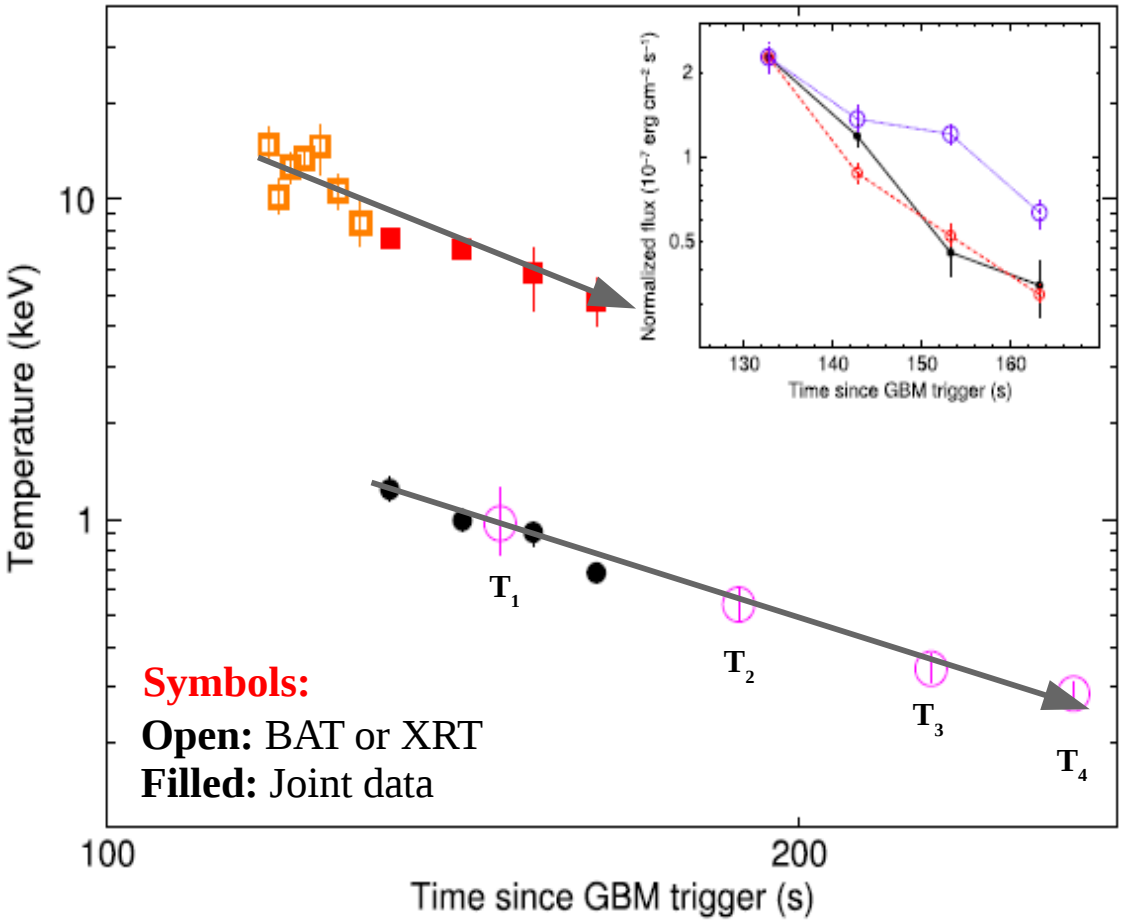




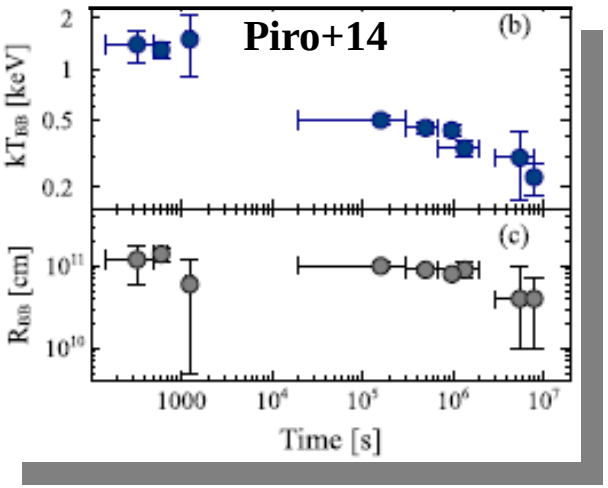
Example GRB II

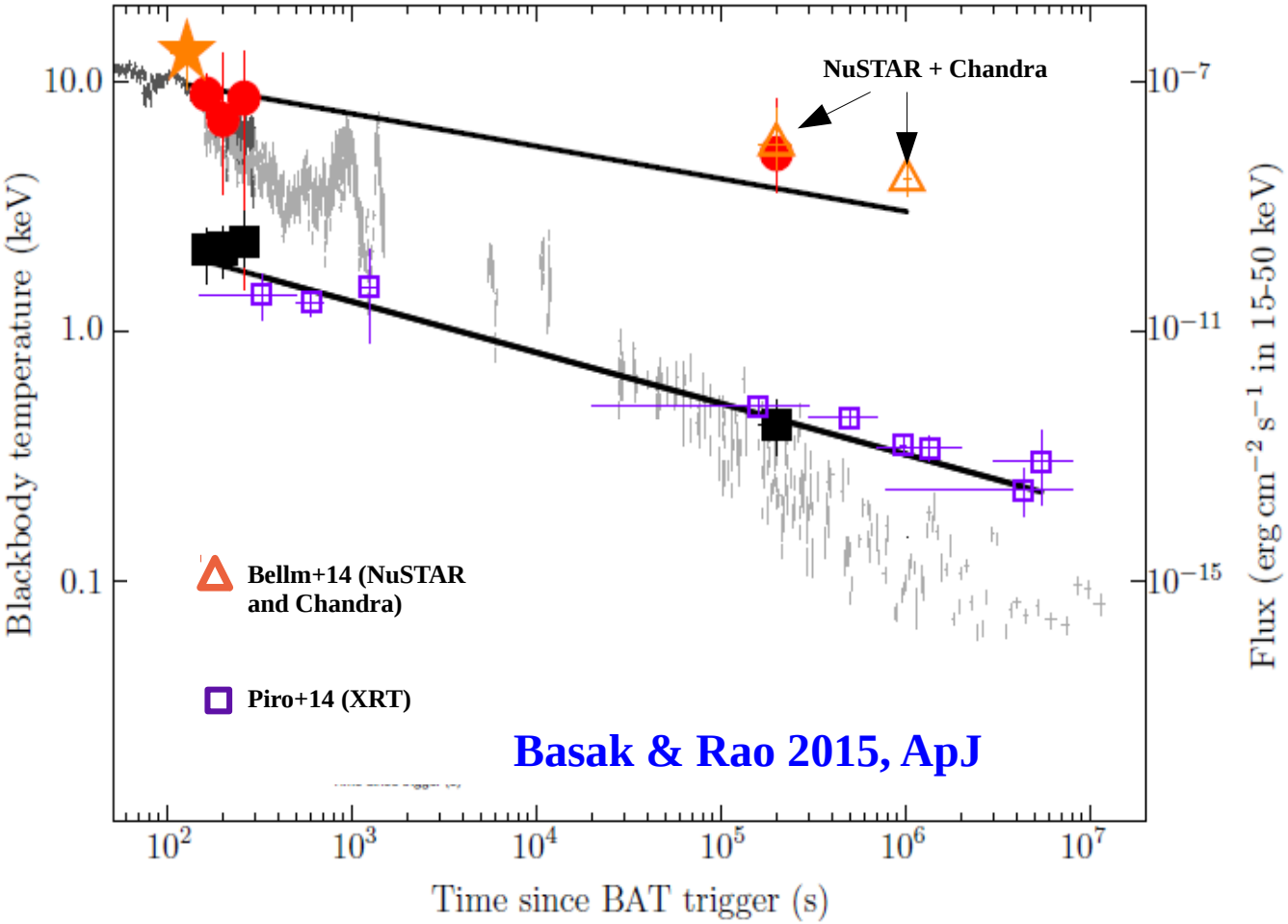
2. GRB 130925A (Basak & Rao 2015b), **Ultra-long GRB**

Debate: (1) GRB or a **TDE**? HST image shows 600 pc offset from the host. But, morphology of the host indicates recent major merger. Combine the knowledge from host study and emission process.

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

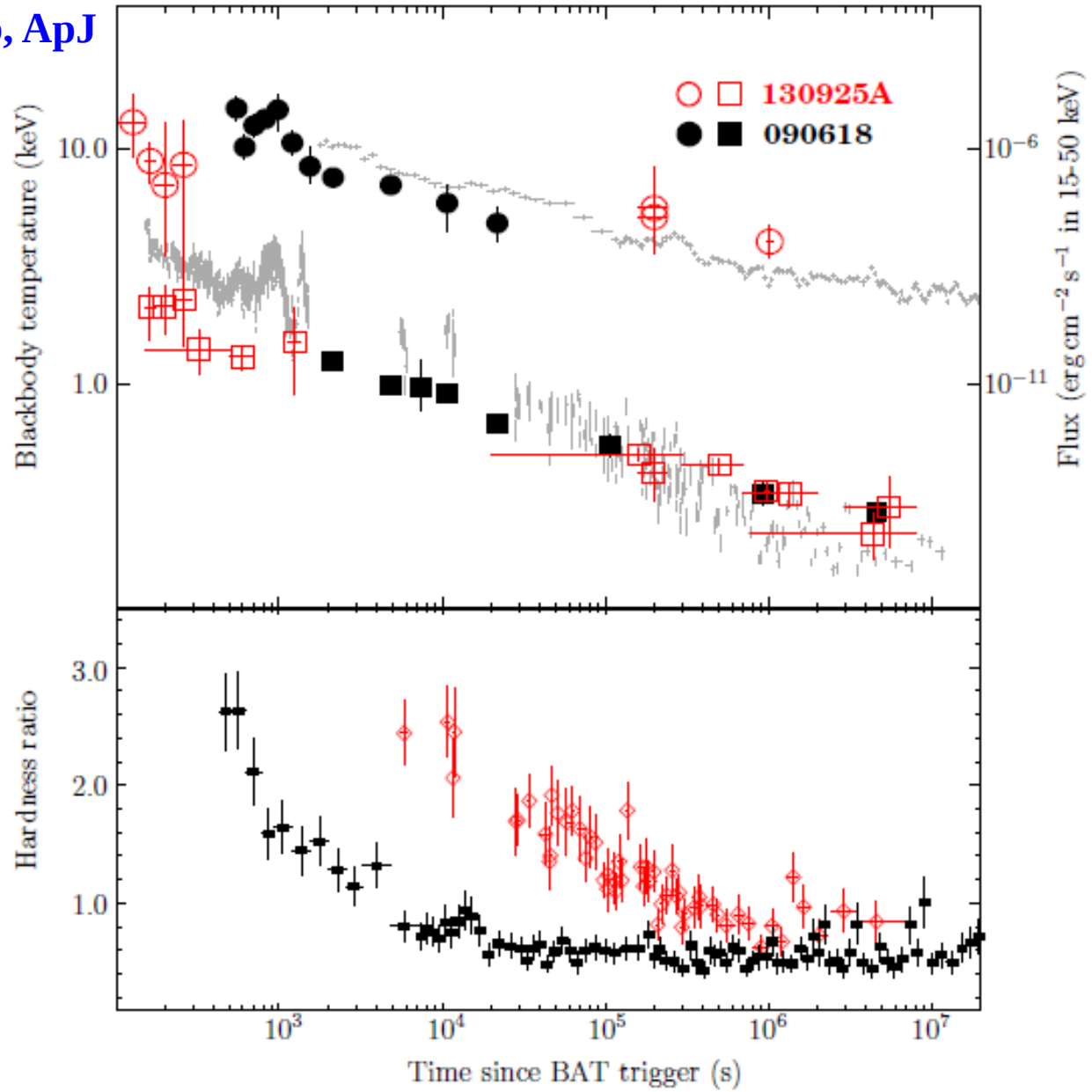
Dust scattering: Evans+14





130925A (ultra-long) vs 090618 (long)

Basak & Rao 2015b, ApJ



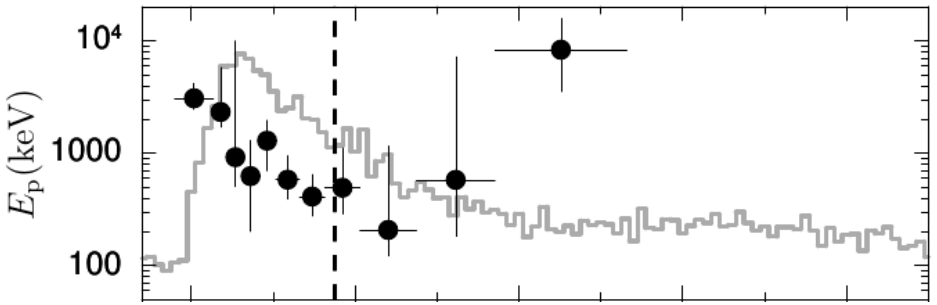
GRB 151006A: First Astrosat GRB

Surprising Spectral evolution in Single Pulse GRB 151006A.

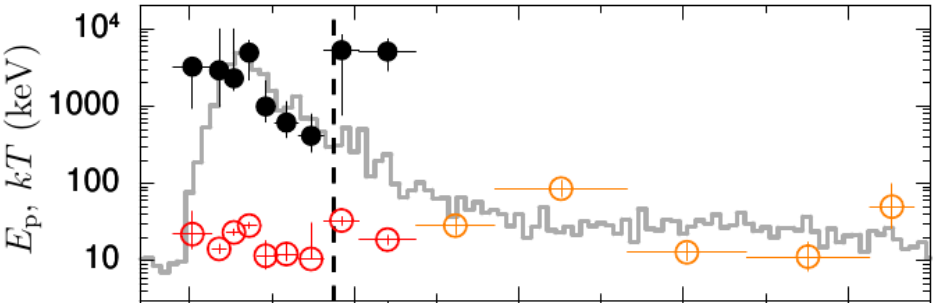
The first GRB detected by Astrosat (Bhalerao+16, Rao+16).
Unusual spectral evolution seen (Basak+17, MNRAS).

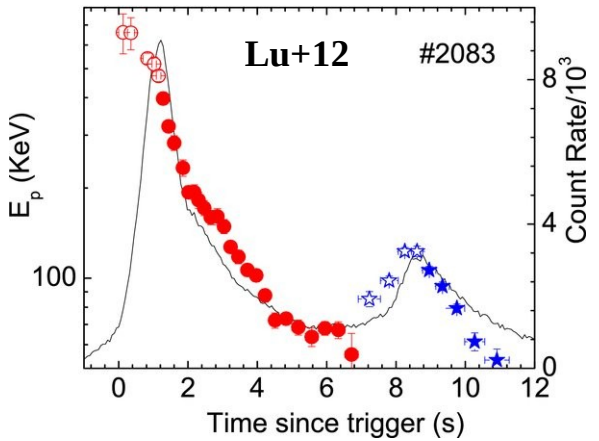
Basak+17, MNRAS

Band

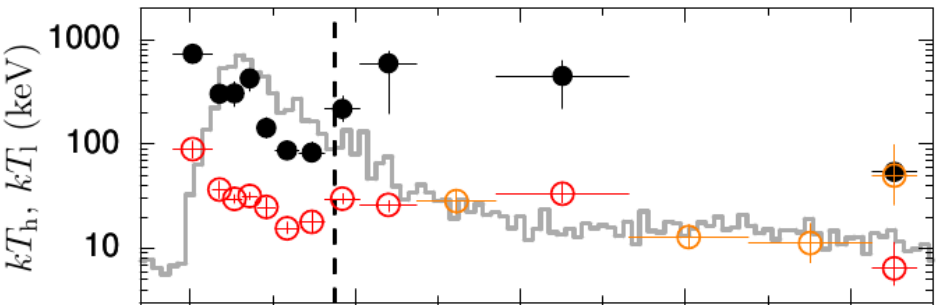


2 BB + PL





Band + BB



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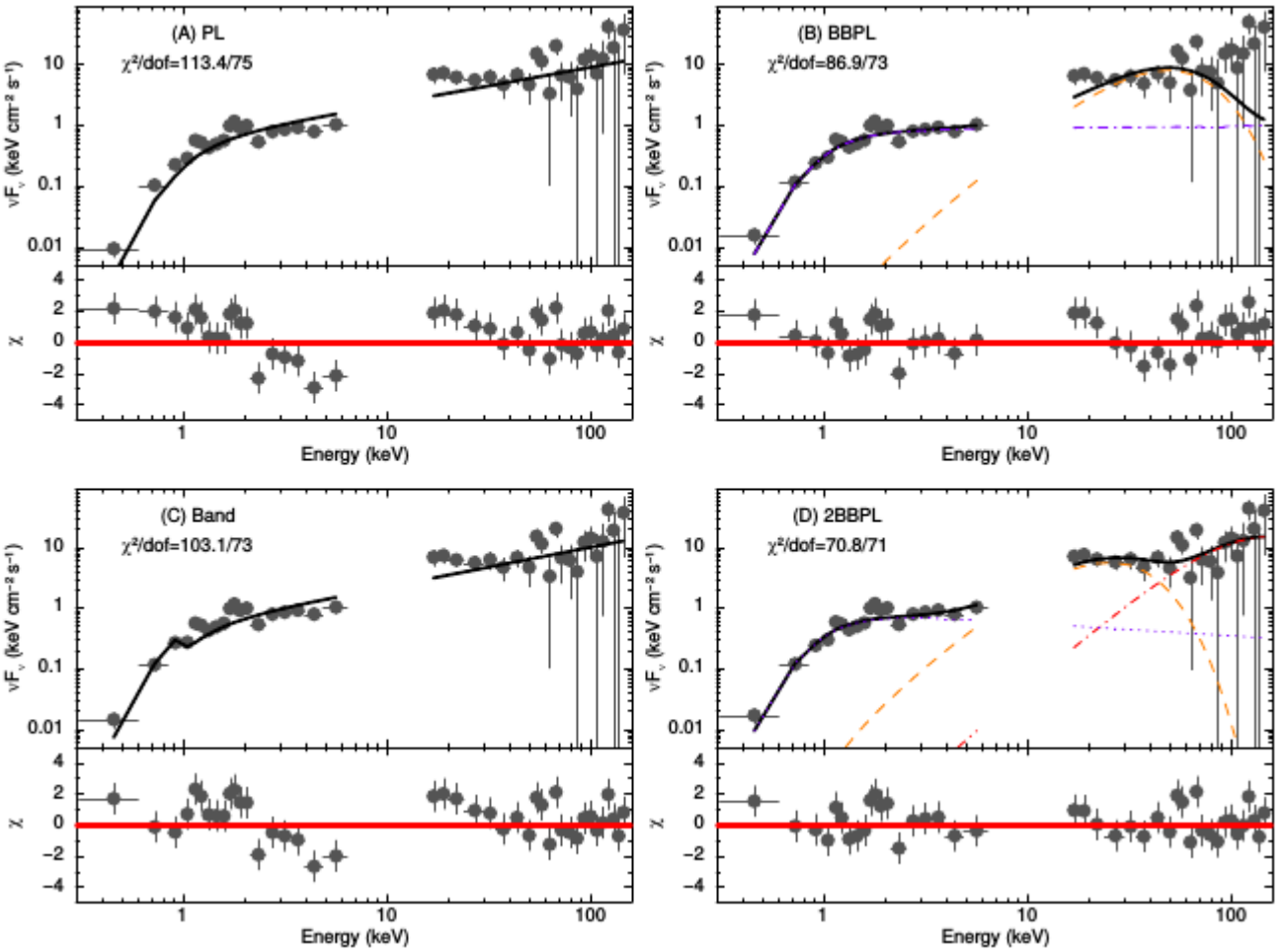
I. Spectral curvature at late time



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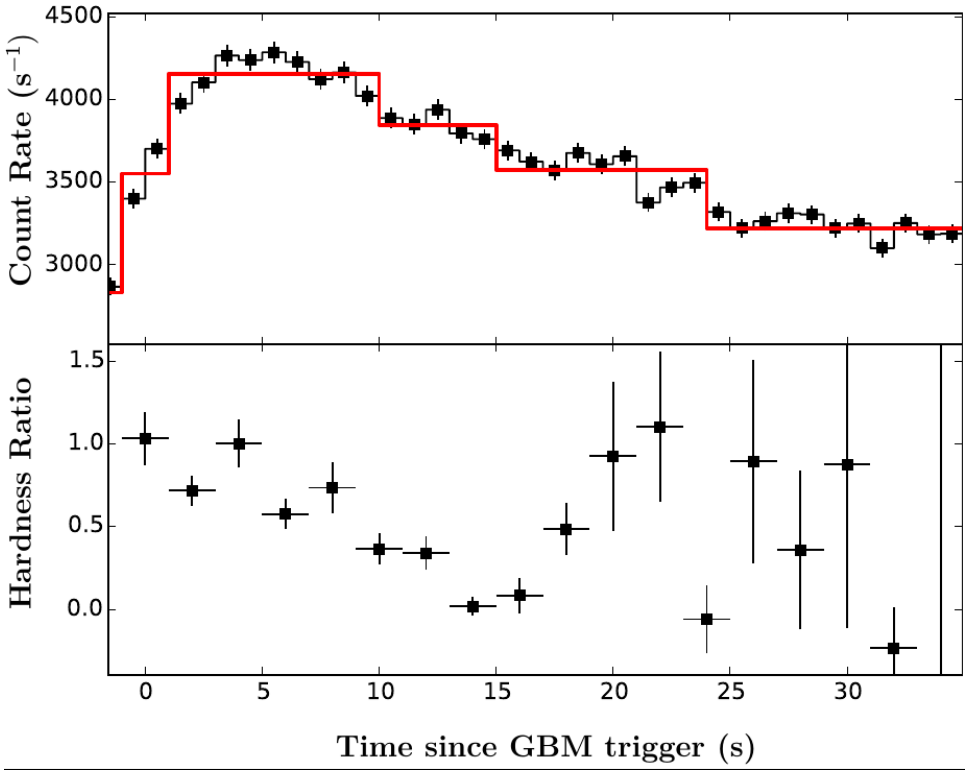
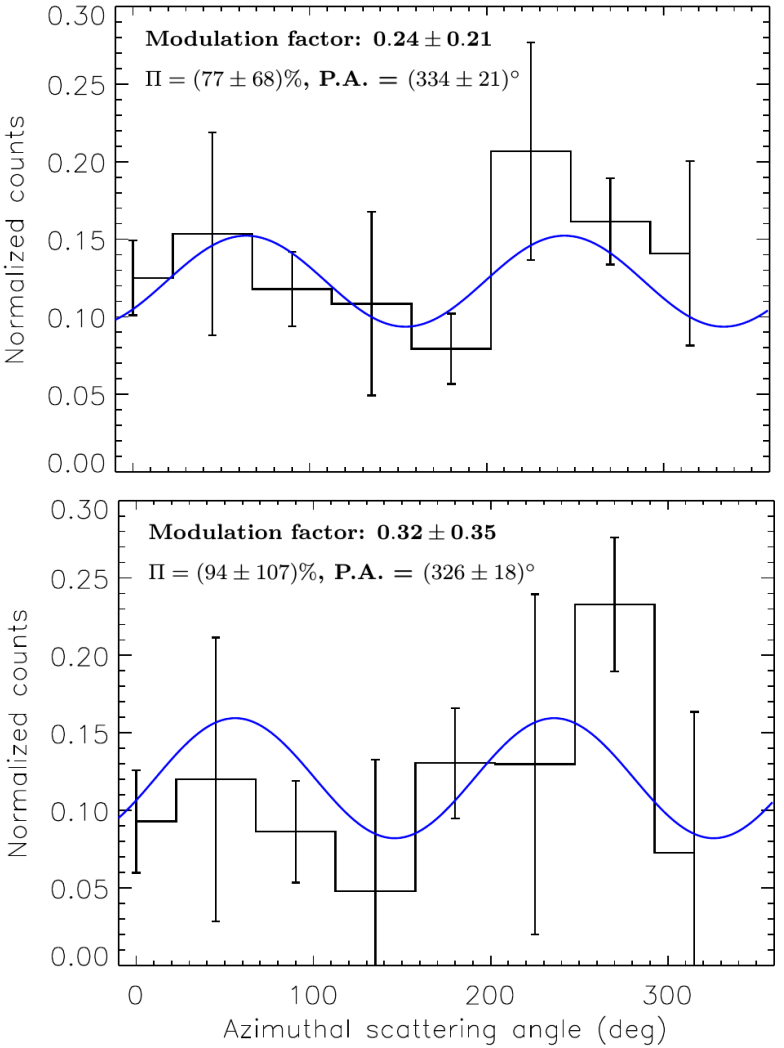
II. Bayesian block and Hardness evolution



III. Evolution of Polarization



Rupal Basak, KTH, Stockholm

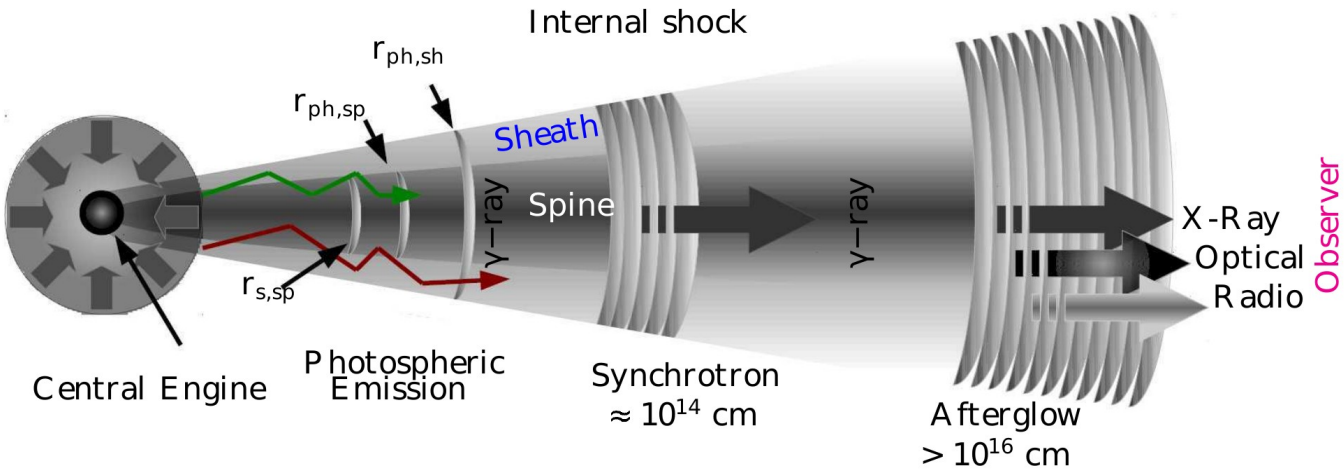
Origin of 2BBPL: spine-sheath jet?

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.

Summary and Conclusion

- Prompt Emission spectral shape still debated. Degeneracies.
- Multi-wavelength and Multi-instrument required.
  Long term spectral evolution. Better sensitivity and resolution.
- Spectrum has double hump.
  Phenomenological model: Two blackbodies and a power law (with cutoff)
- A spine-sheath jet fits in the observations.

Outlook

- Theseus for GRB prompt spectroscopy:

  - XGIS: 2 keV – 20 MeV. Wide band, high sensitivity and resolution for time resolved spectroscopy

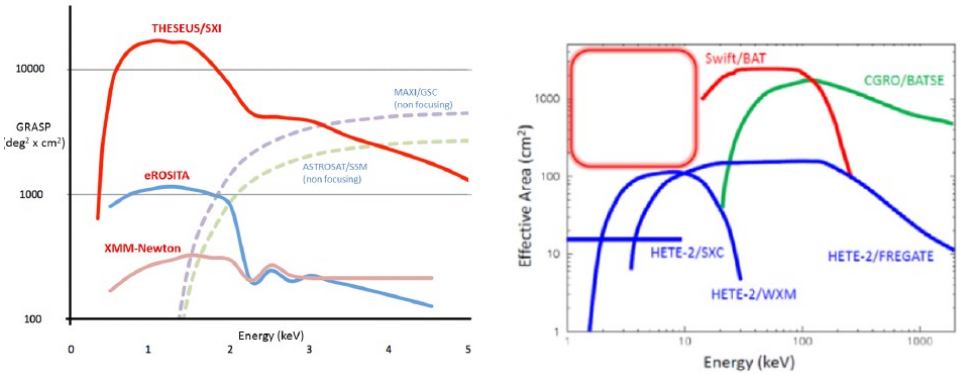
  - SXI: early spectral data in low energies with good resolution and sensitivity.

- How can CZTI contribute?

  - Current sample – >50 detections. 11 with significant polarization (Chattopadhyay + 17)

  - Individual cases and Statistical sample: polarization degree and angle.

Theseus consortium paper (Amati+17)



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