



# Gamma-Ray Bursts prompt emission



*Lara Nava*  
*Marie Skłodowska-Curie Fellow*

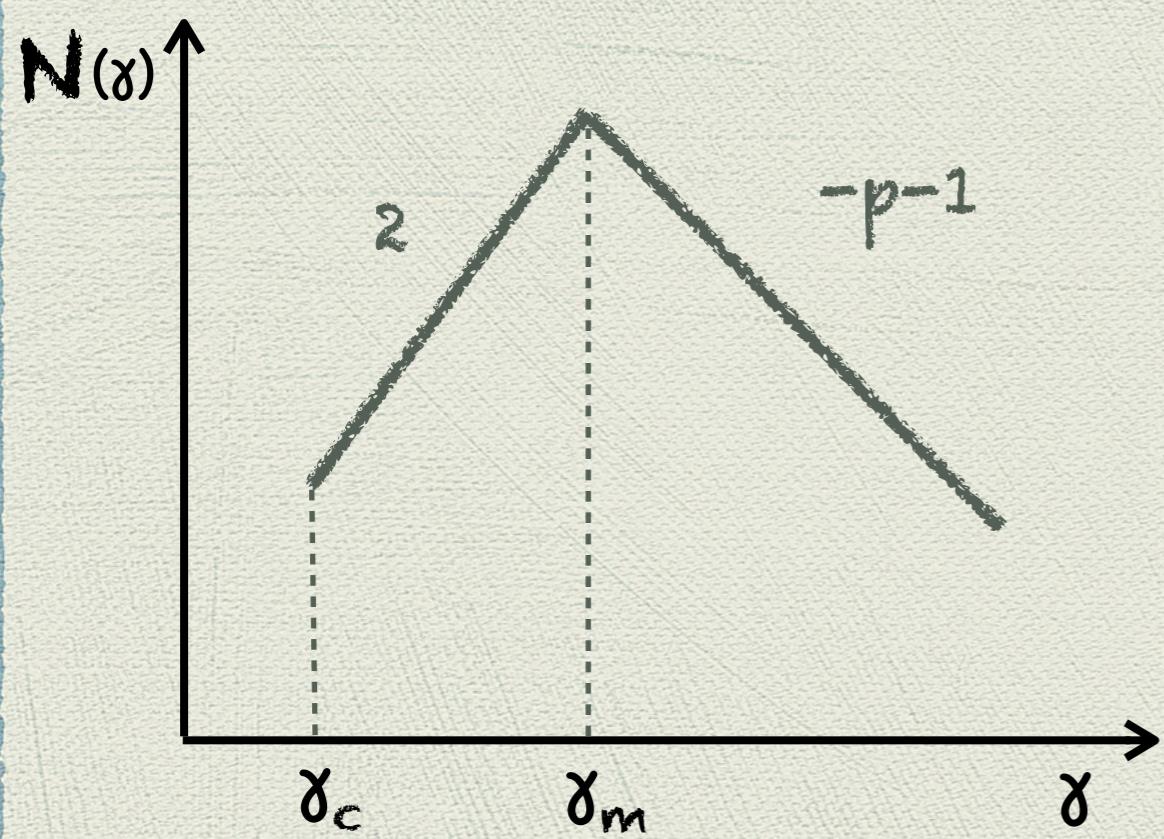
*INAF - OAB*  
*INAF - OATs*



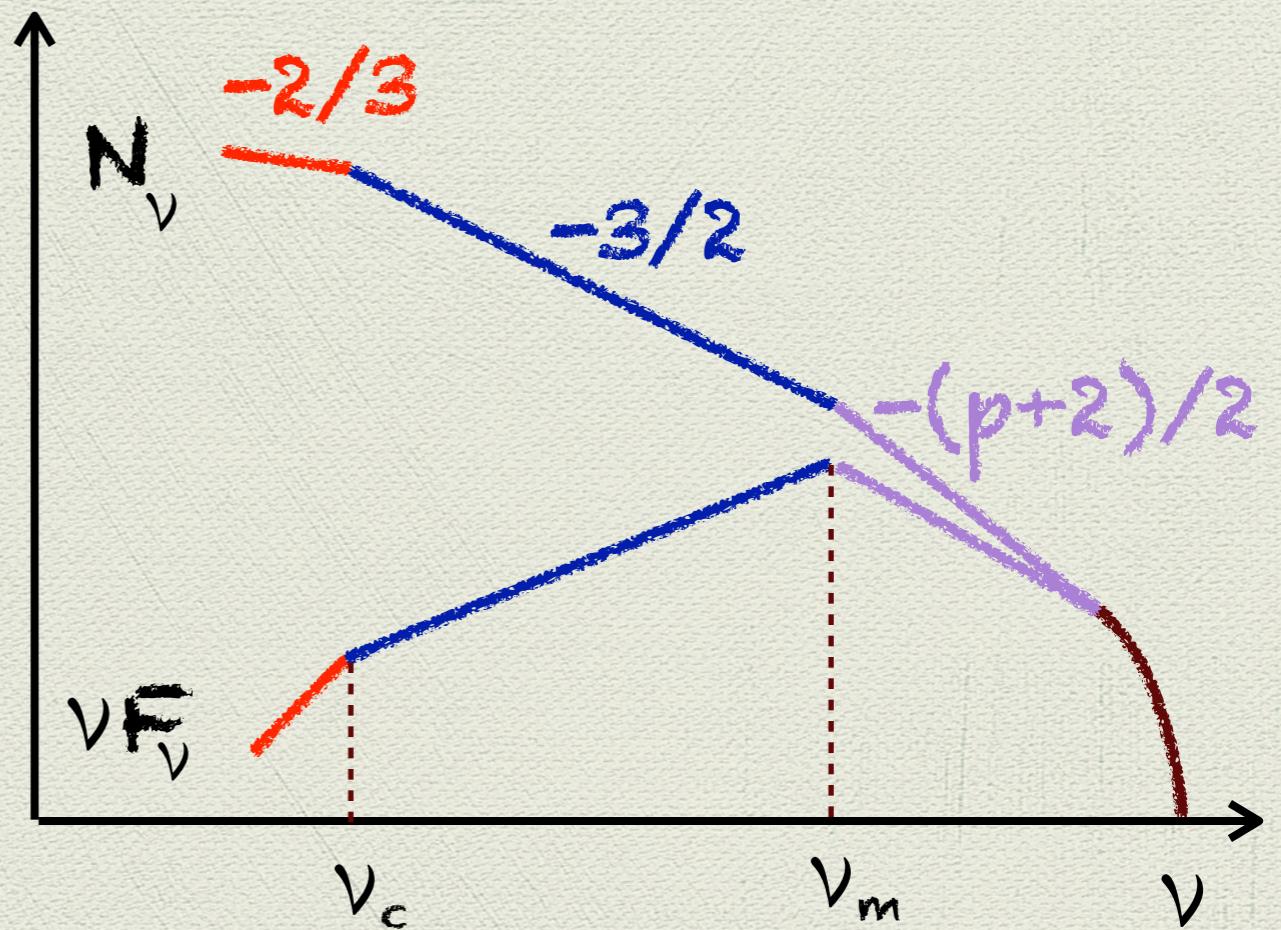
In collaboration with: Gor Oganesyan (SISSA),  
Giancarlo Ghirlanda (INAF-OAB), Annalisa Celotti (SISSA)

# Synchrotron model

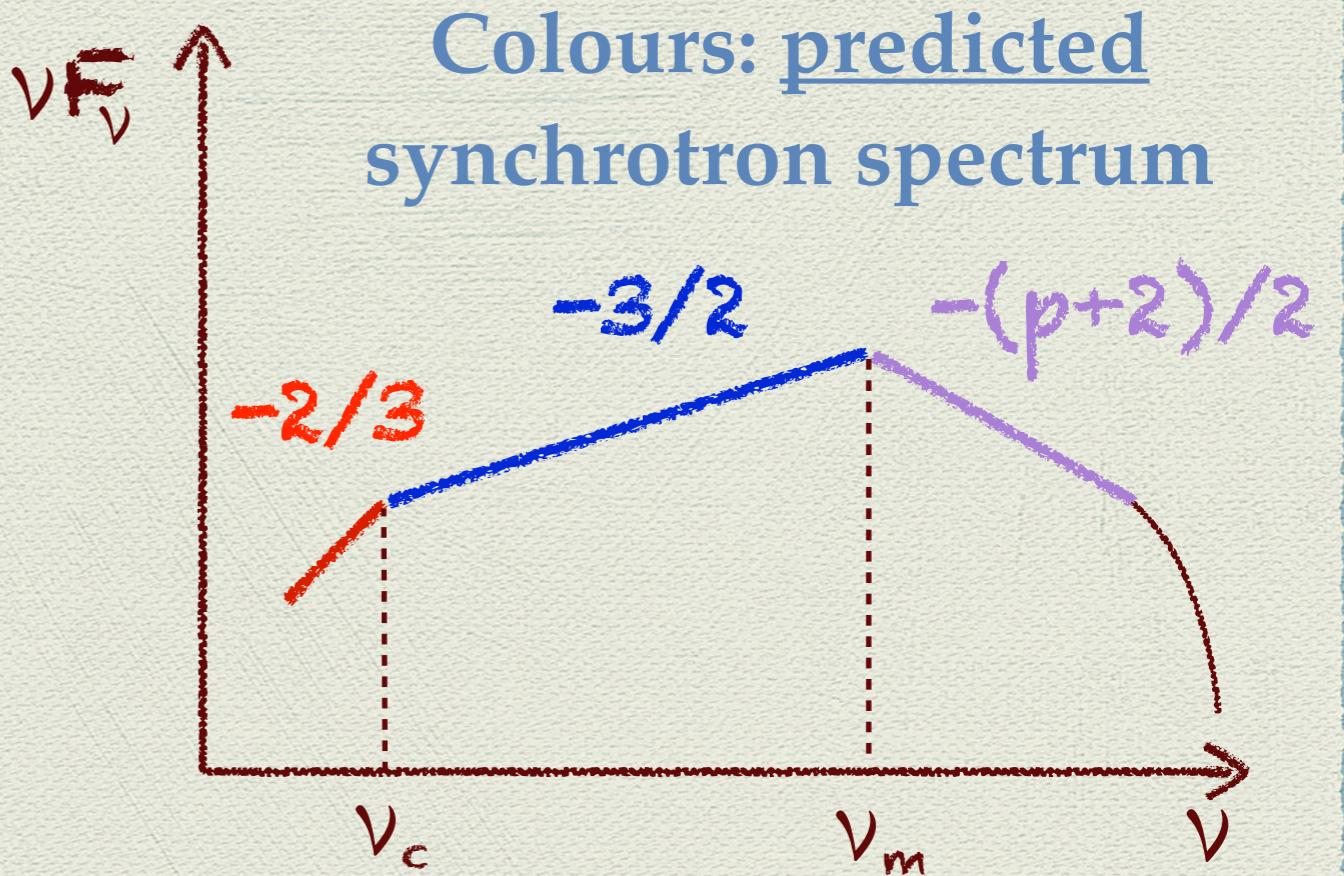
Energy distribution of the electron population



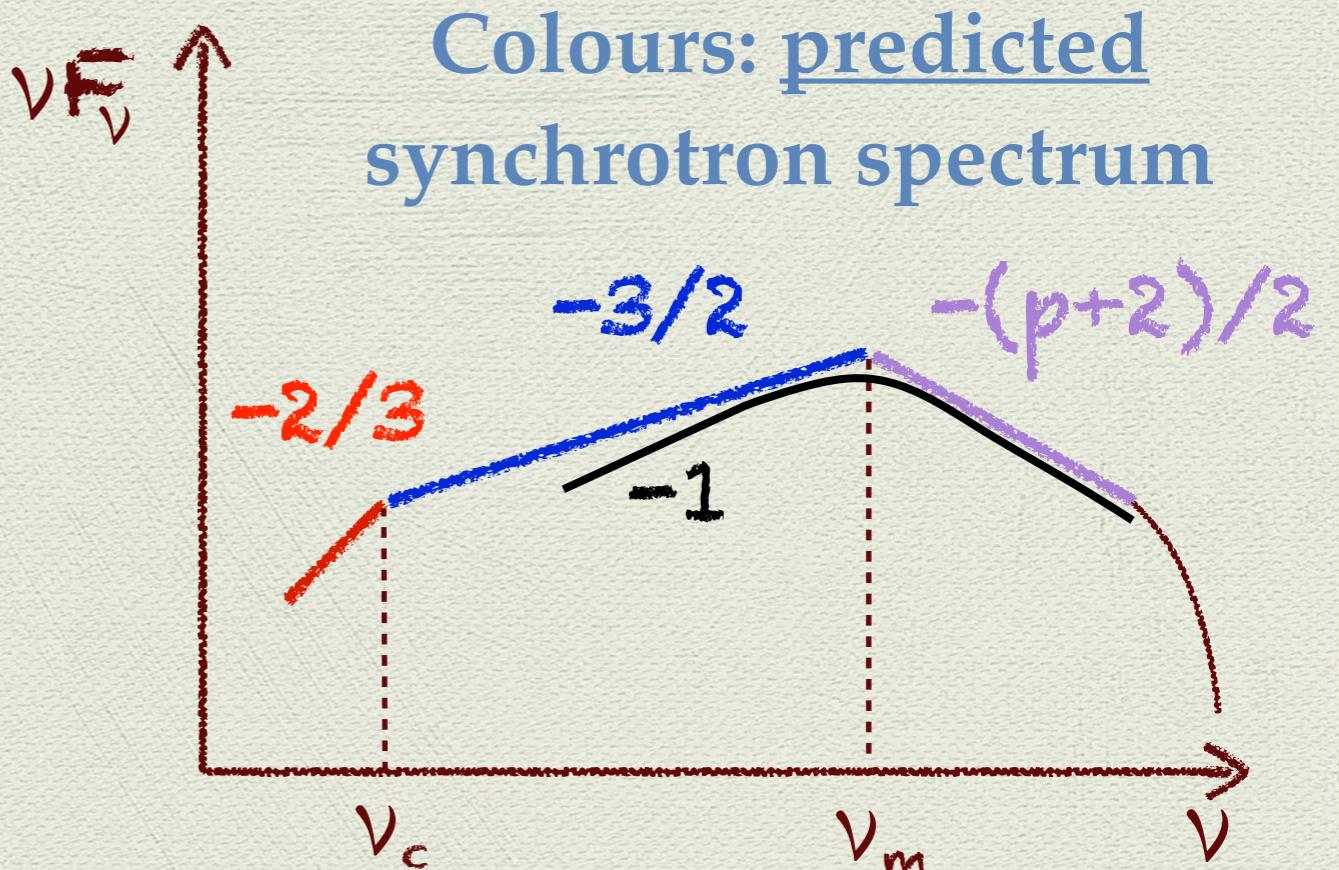
Photon spectrum from a population of non-thermal electrons



# Inconsistency with synchrotron interpretation

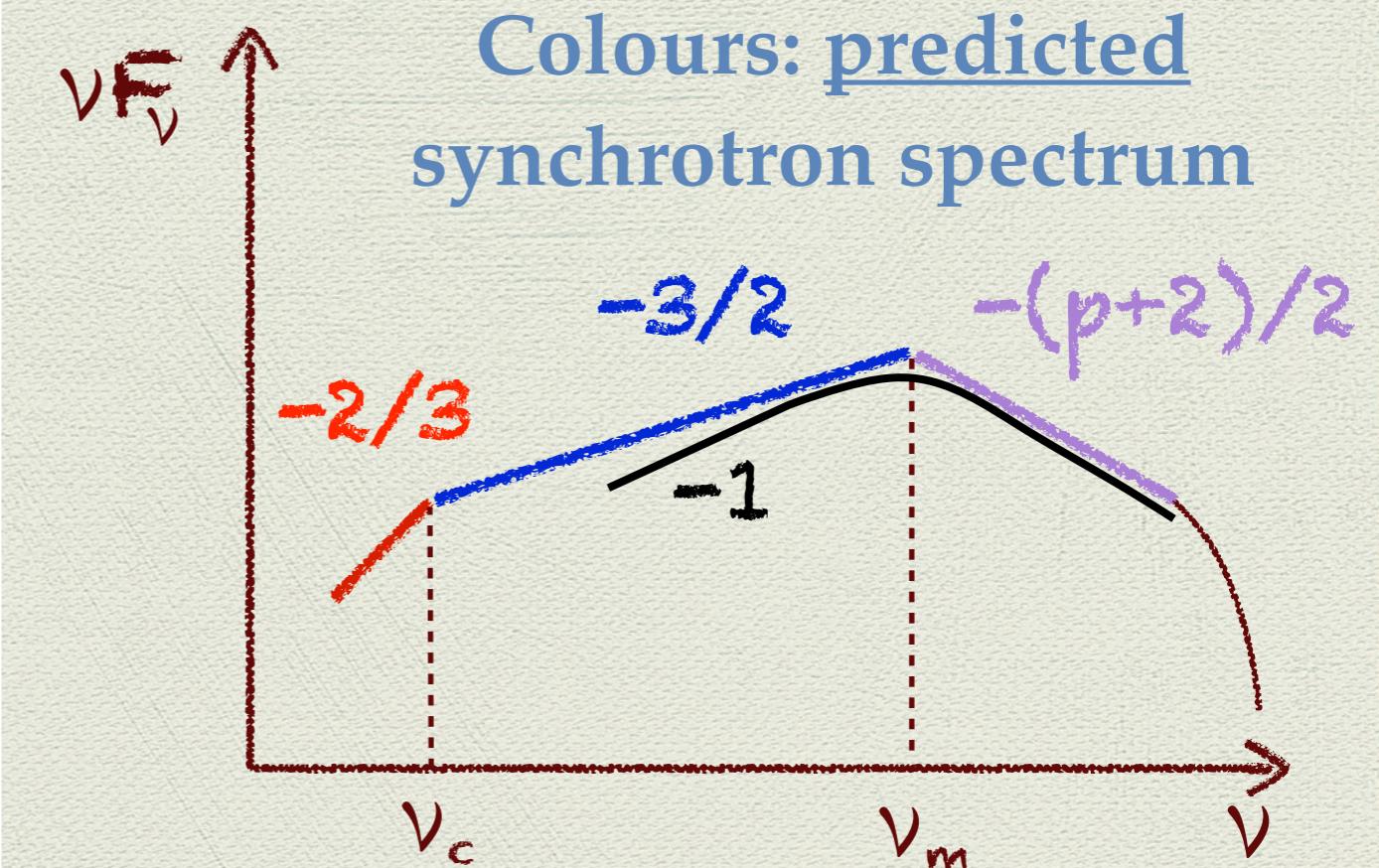
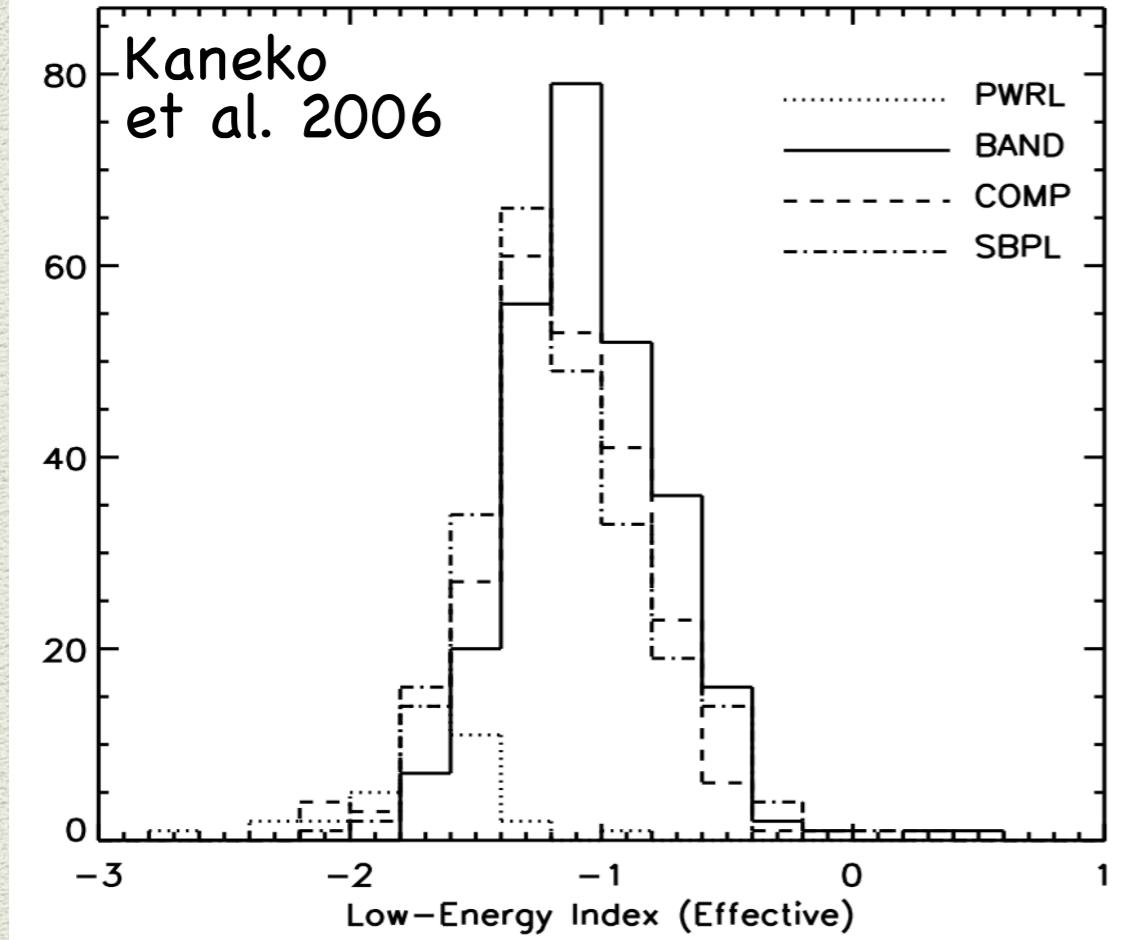


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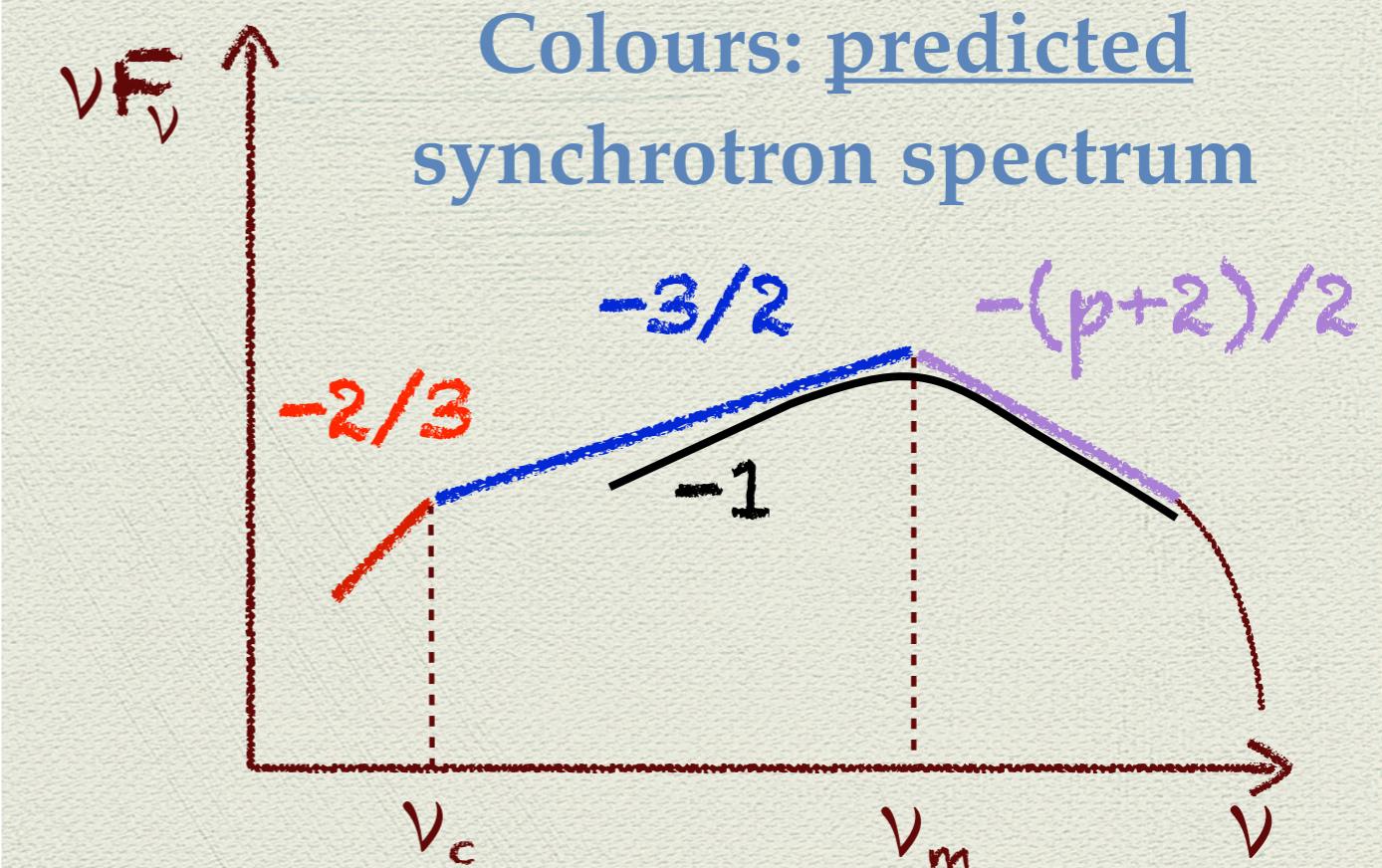
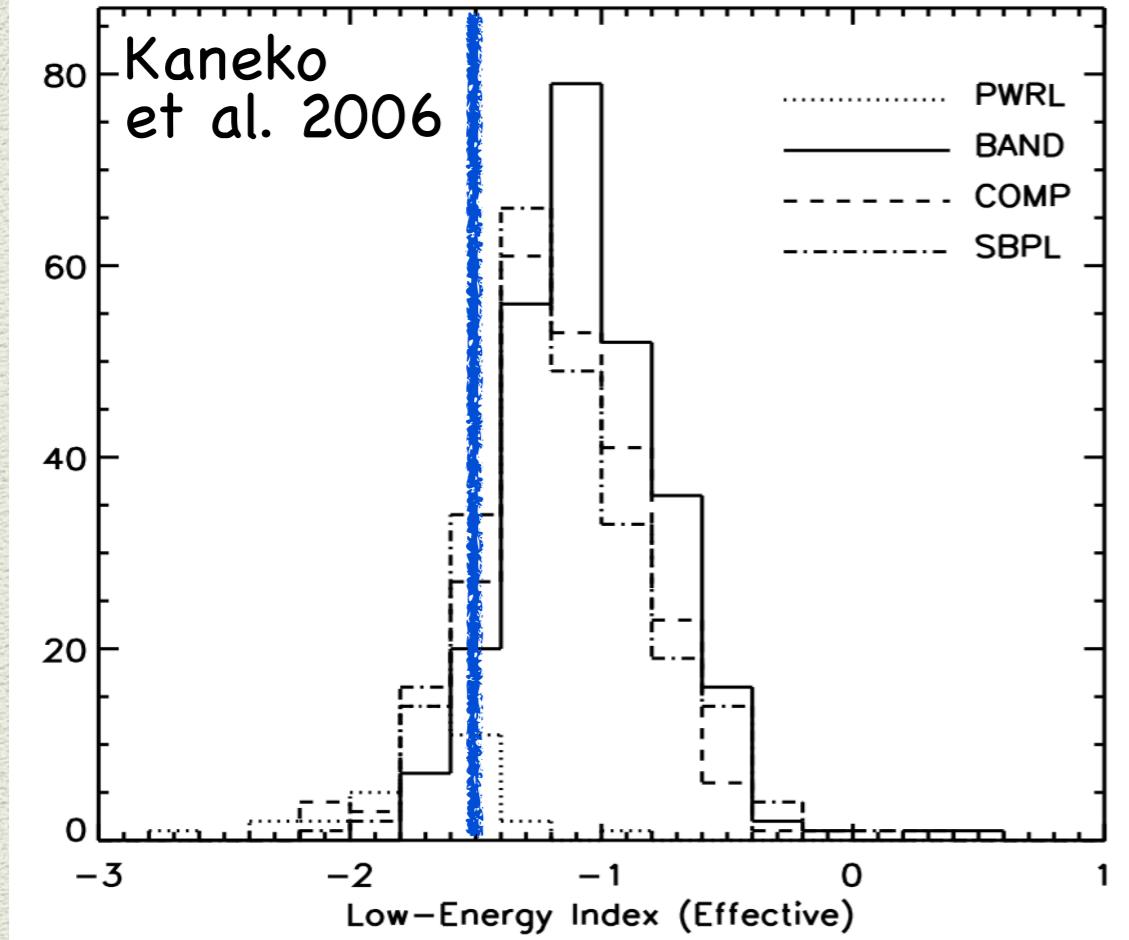
Black: typical observed prompt spectrum

# Inconsistency with synchrotron interpretation



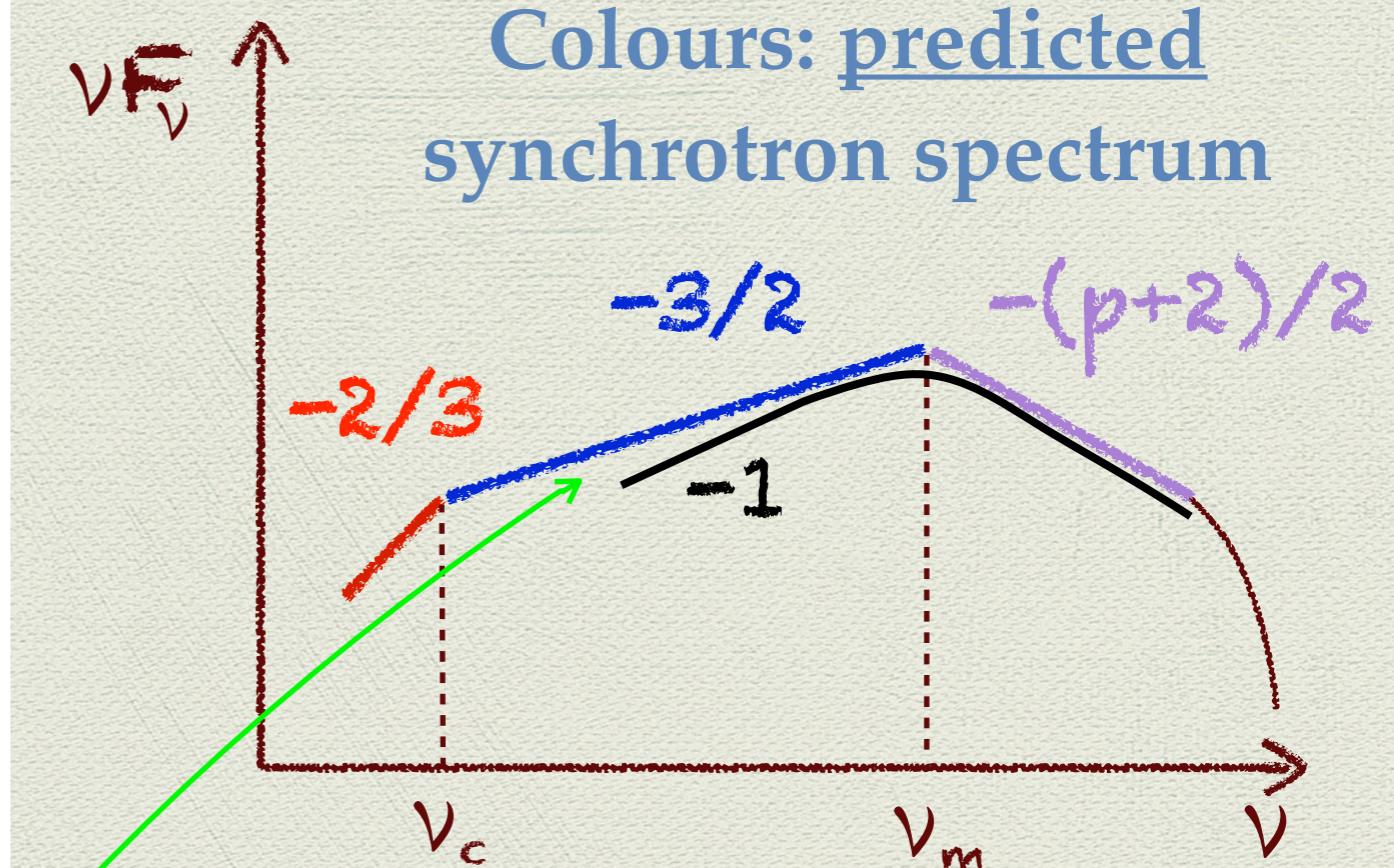
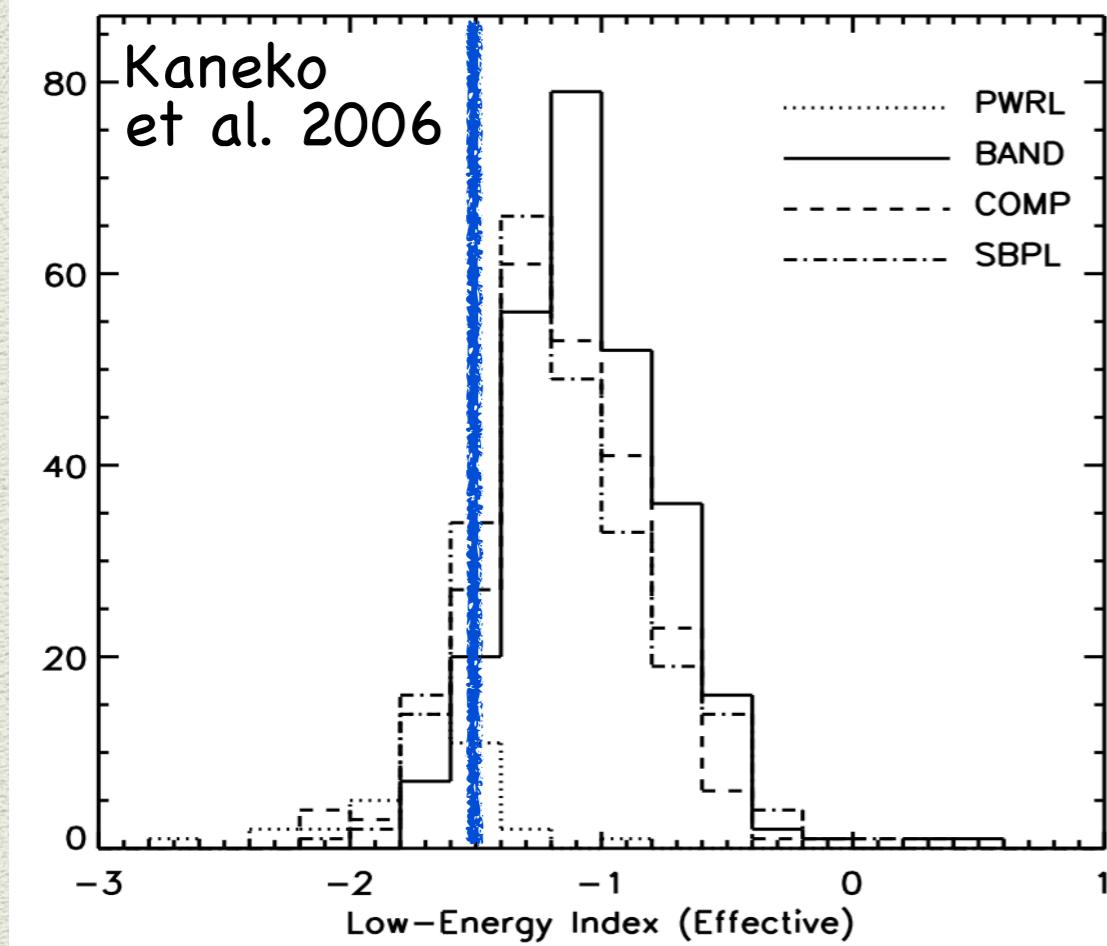
Black: typical observed prompt spectrum

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Problem is at low energies:  
let's look at XRT prompt data

# Samples of GRBs with BAT+XRT simultaneous observations of the prompt (or part of it)

1. BAT S/N > 30 in at least four bins

14 events (time-resolved analysis)

Oganesyan, Nava, Ghirlanda, Celotti, 2017, ApJ

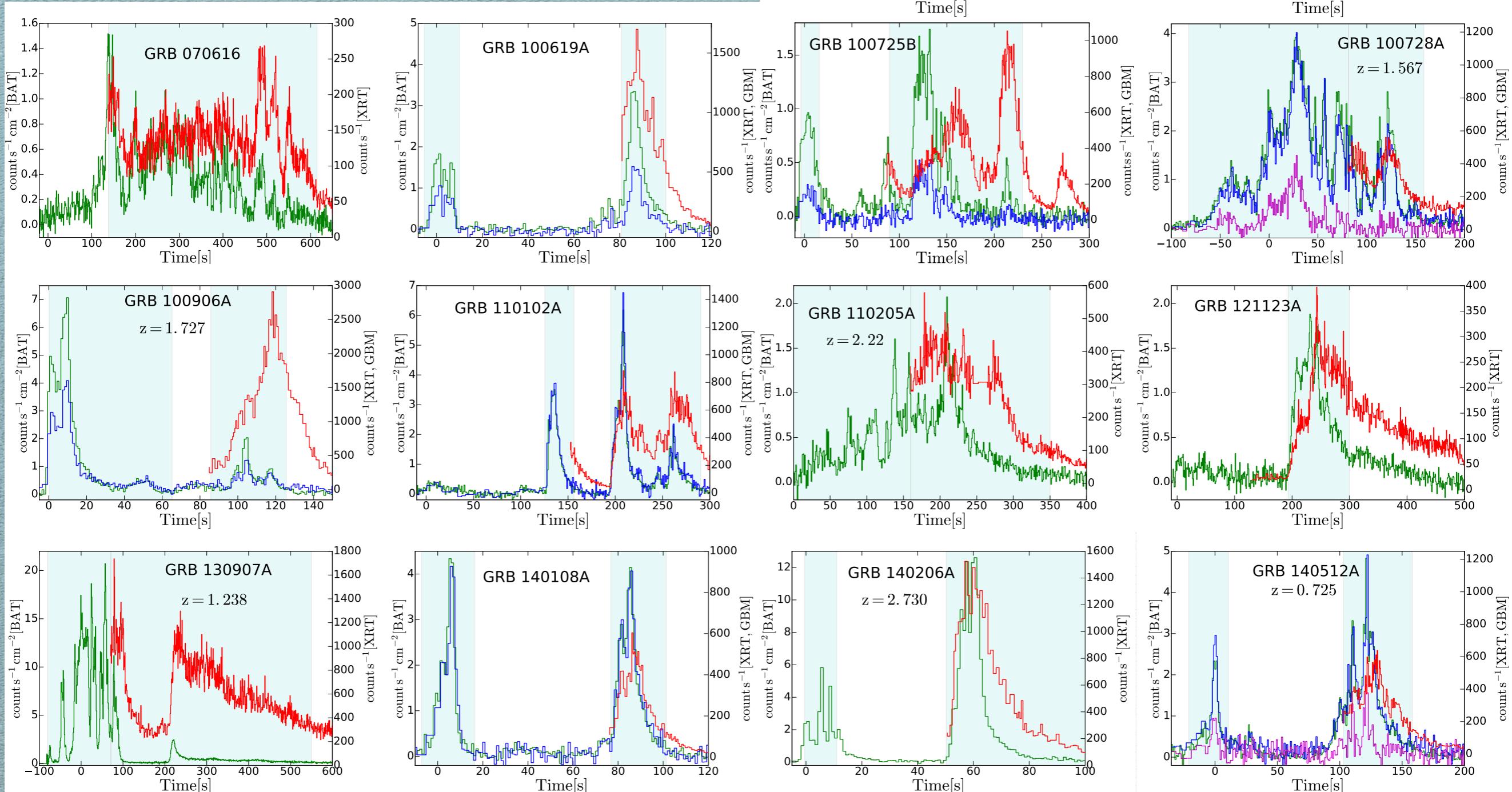
2. BAT S/N > 30

34 GRBs (time-integrated analysis)

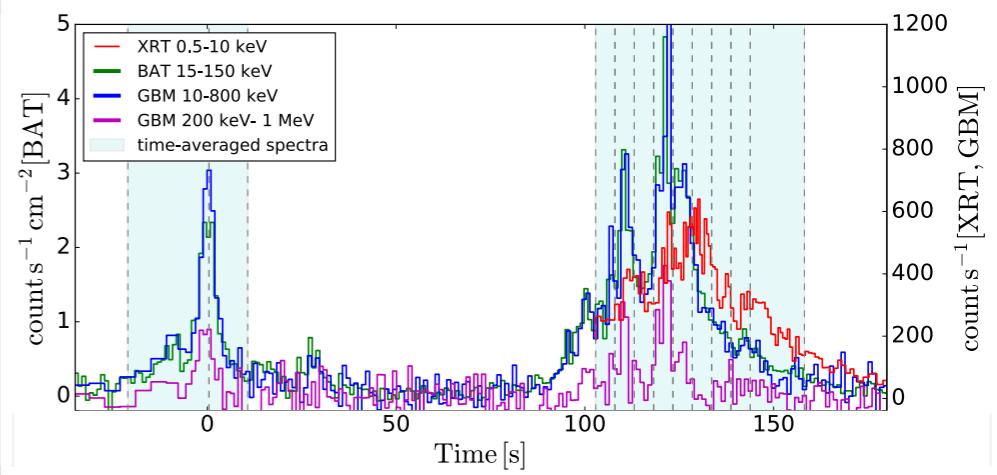
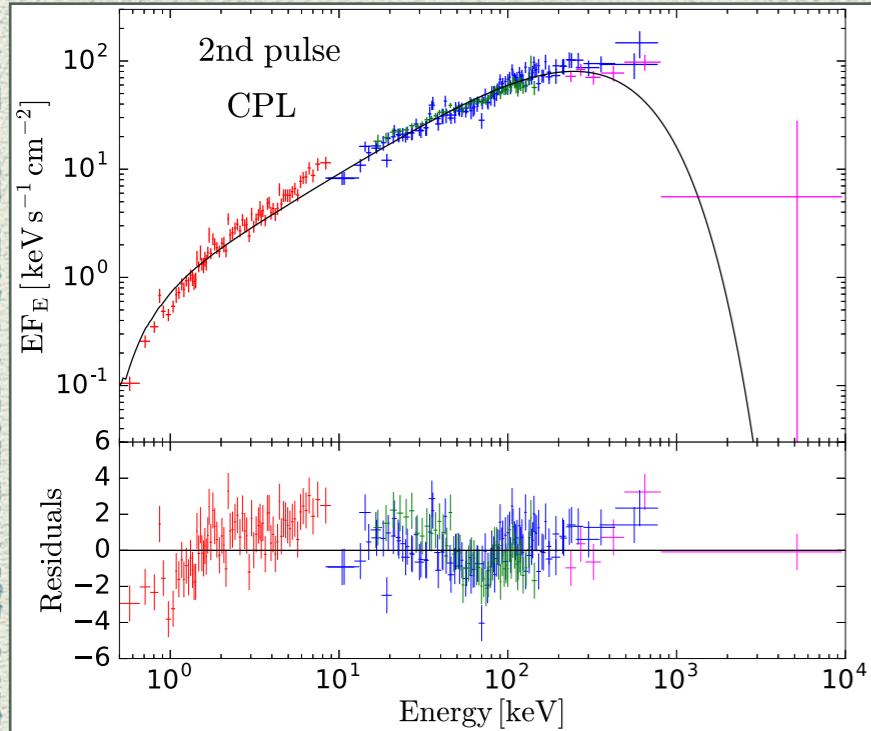
Oganesyan, Nava, Ghirlanda, Celotti, in preparation

# Light curves

**red = XRT**      **blue = GBM/NaI**  
**green = BAT**      **purple = GBM/BGO**



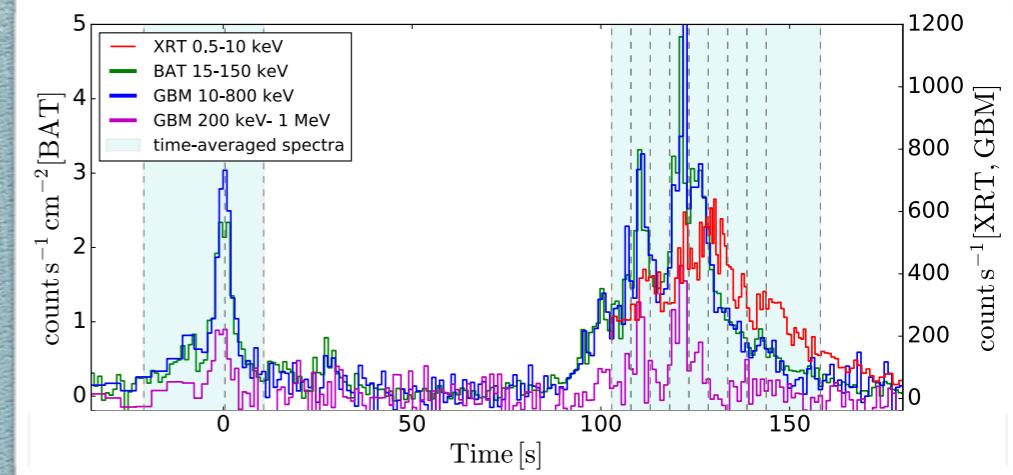
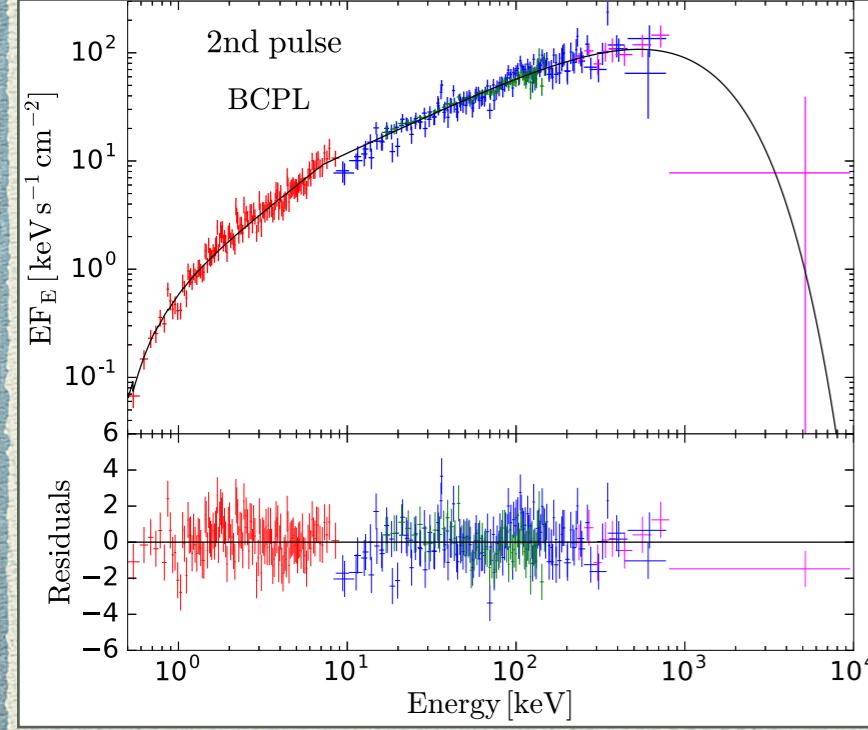
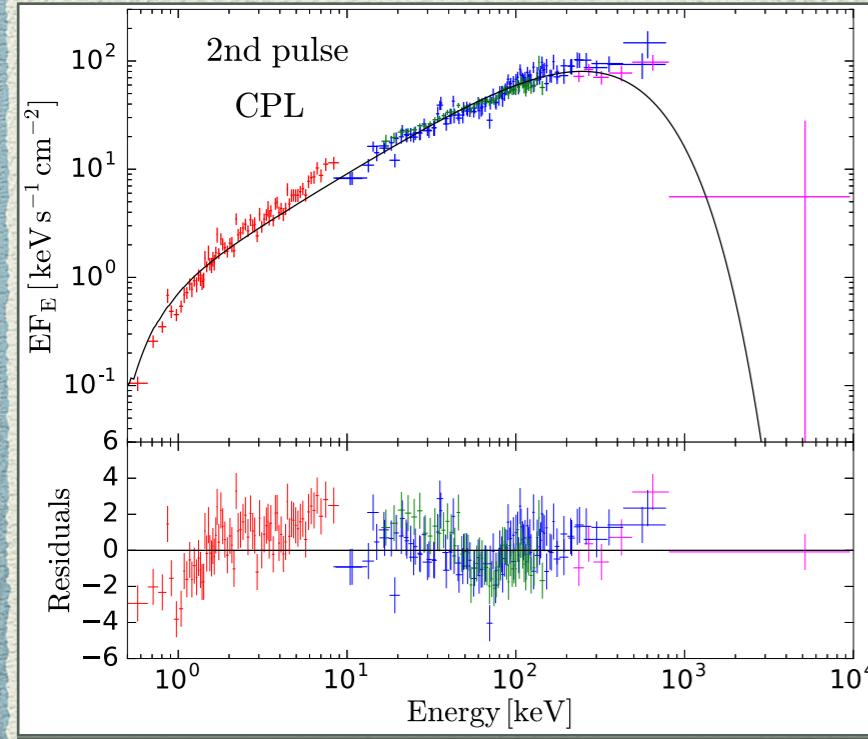
# Example of spectral fit including XRT data



**CPL (Cutoff PL) model:**

$$\chi^2 = 613.6 \text{ (d.o.f. = 480)}$$

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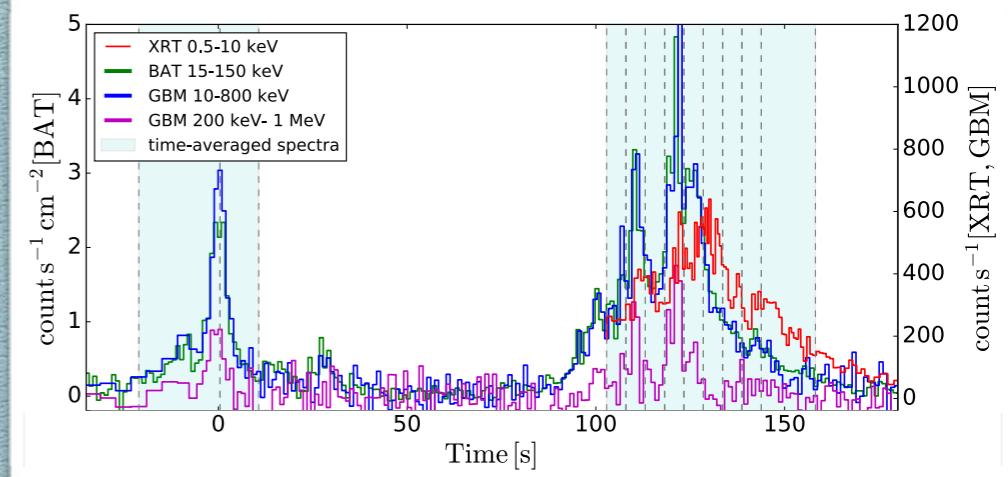
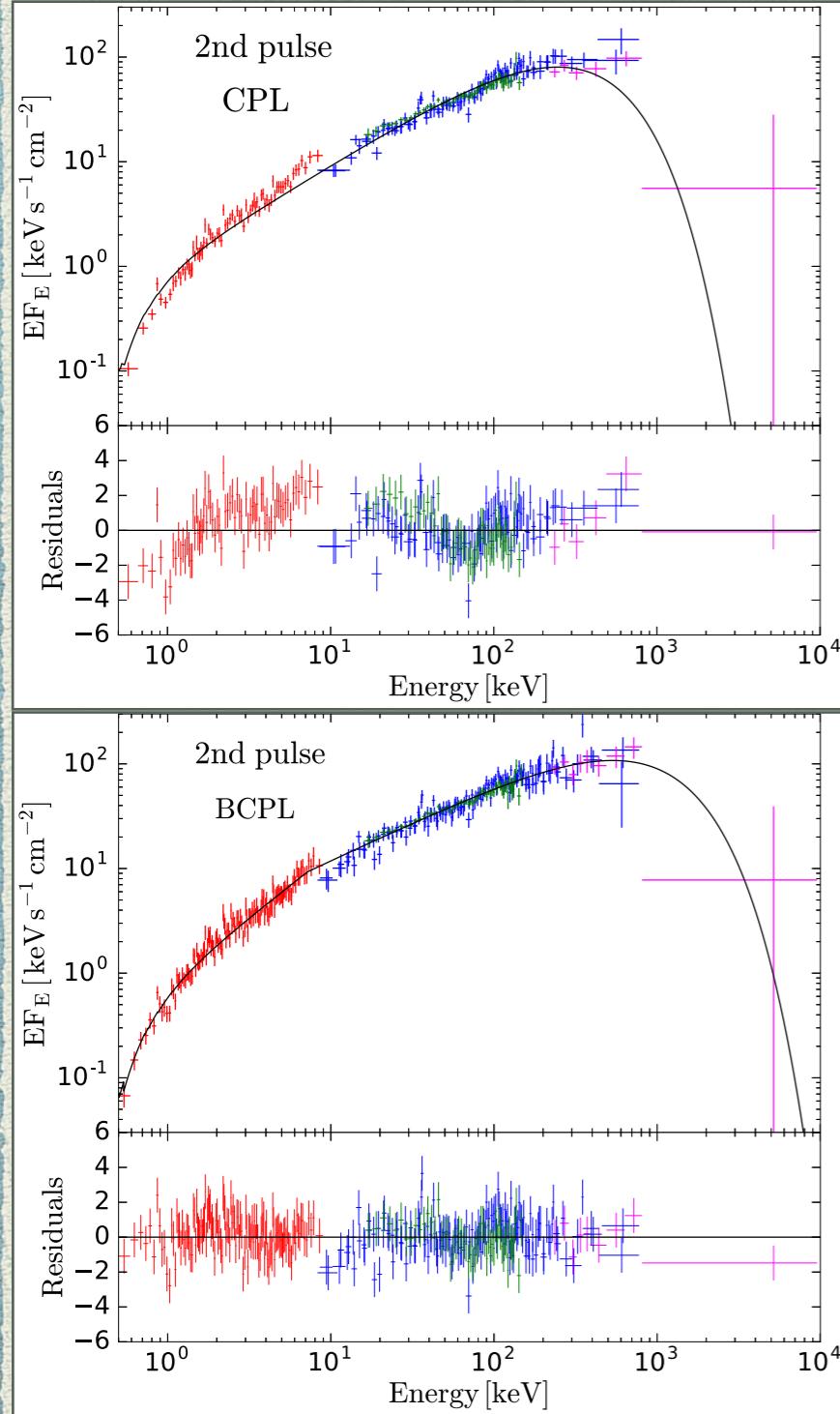
**CPL + break at low energy:**

$$\chi^2 = 442.8 \text{ (d.o.f. = 478)}$$

$$E_{\text{break}} = (7.2 \pm 1) \text{ keV}$$

$$E_{\text{peak}} = (532 \pm 150) \text{ keV}$$

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**CPL (Cutoff PL) model:**

$$\chi^2 = 613.6 \text{ (d.o.f. = 480)}$$

8.4  $\sigma$  improvement

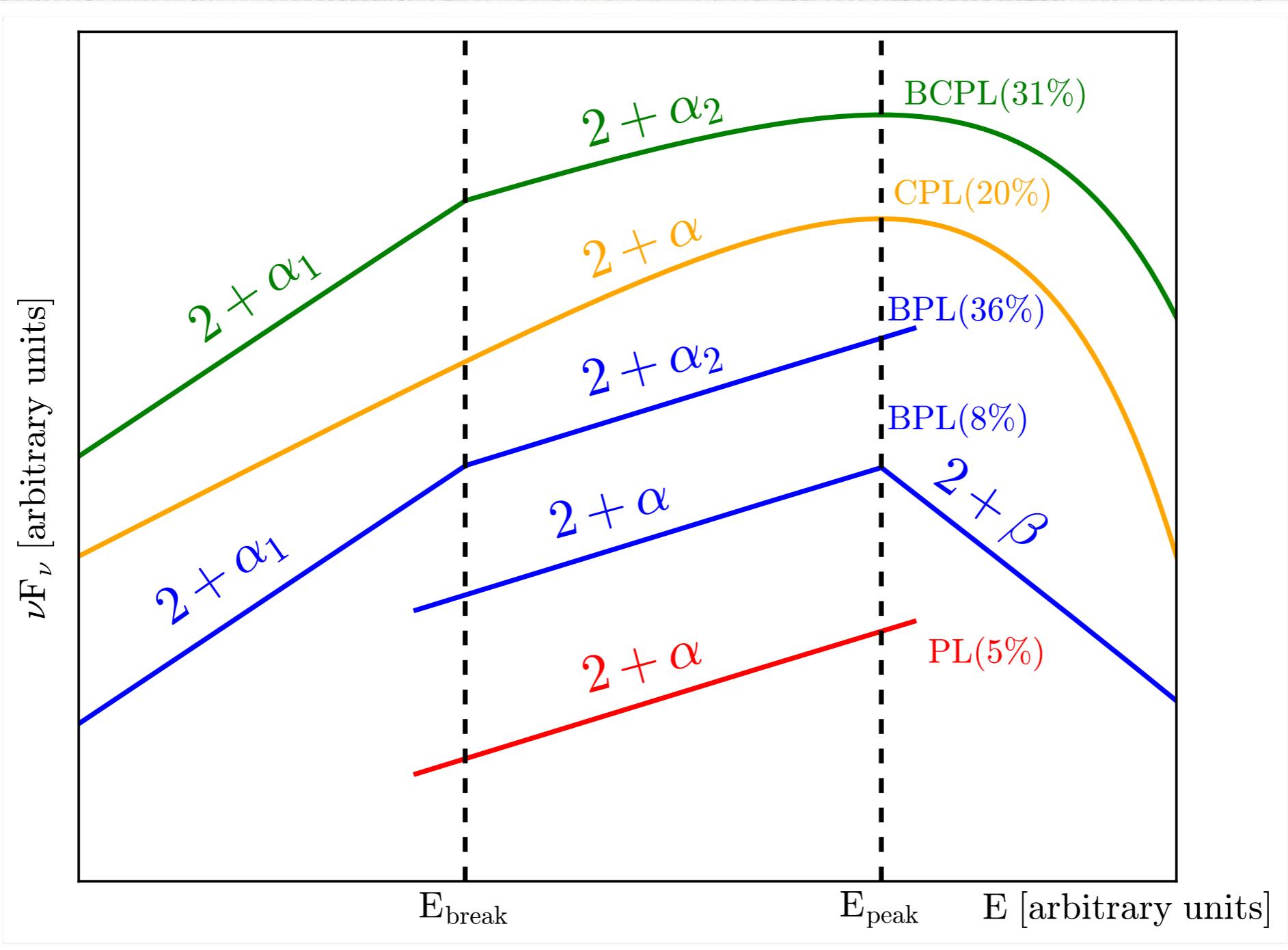
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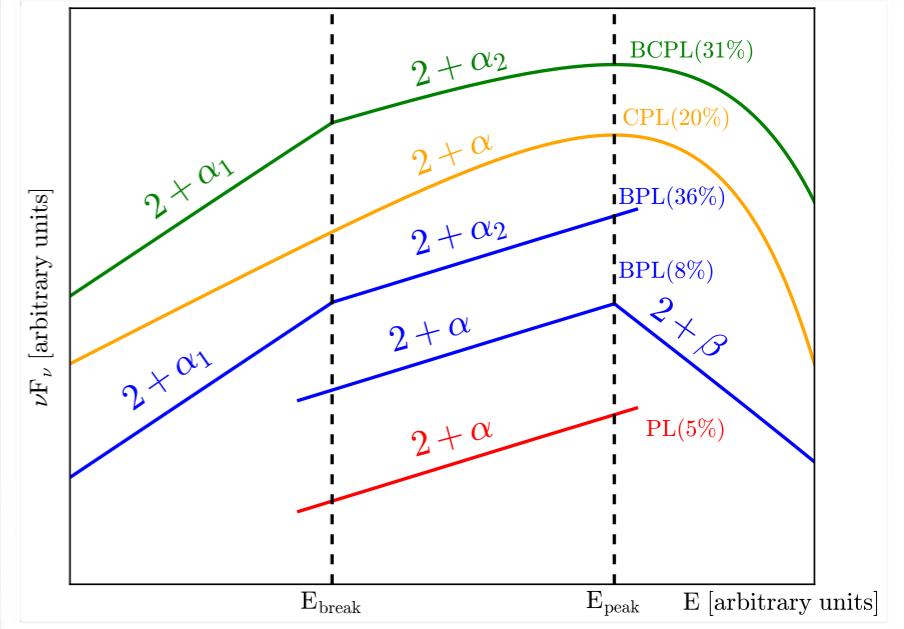
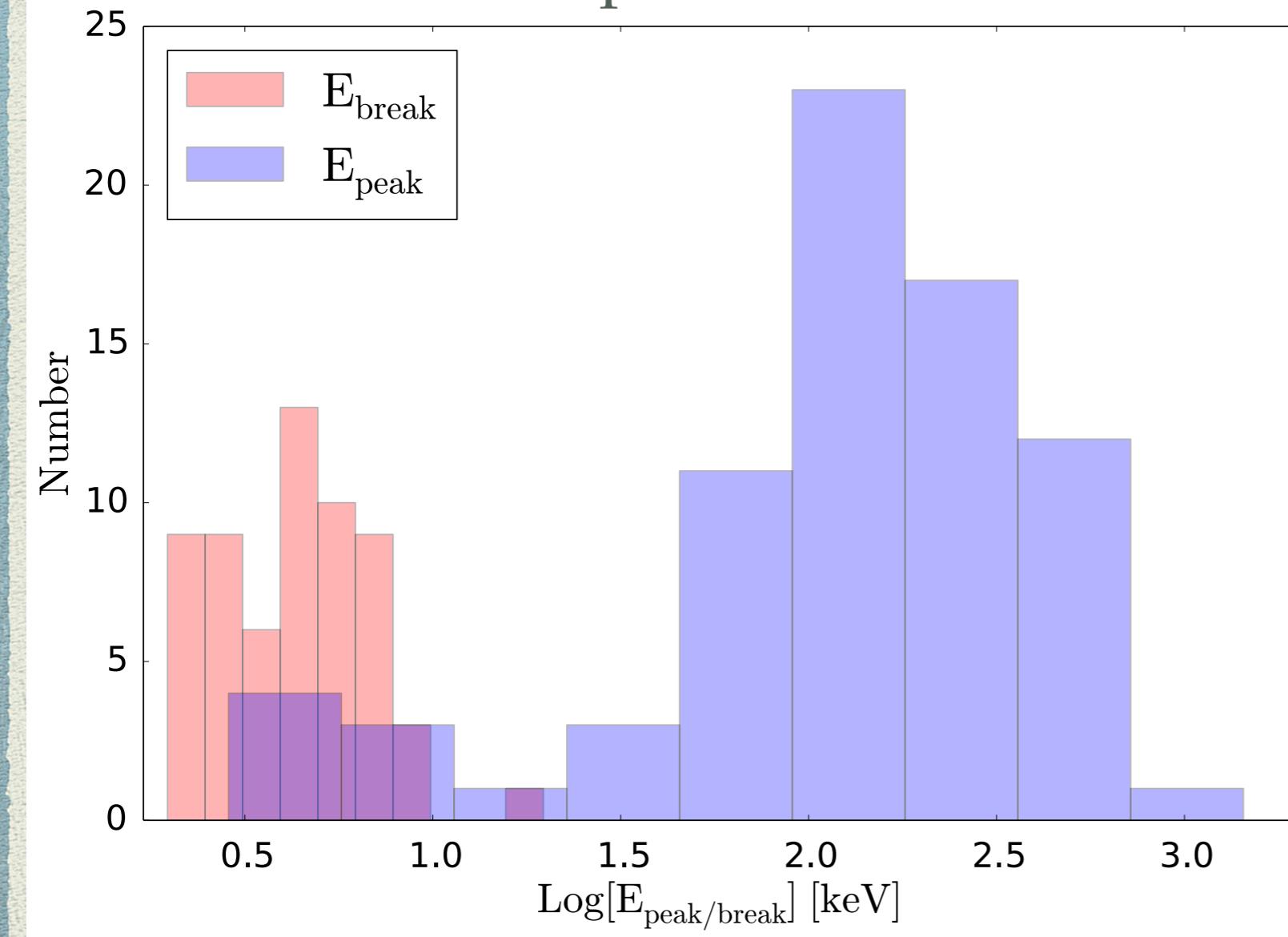
$$E_{\text{peak}} = (532 \pm 150) \text{ keV}$$

# Spectral models



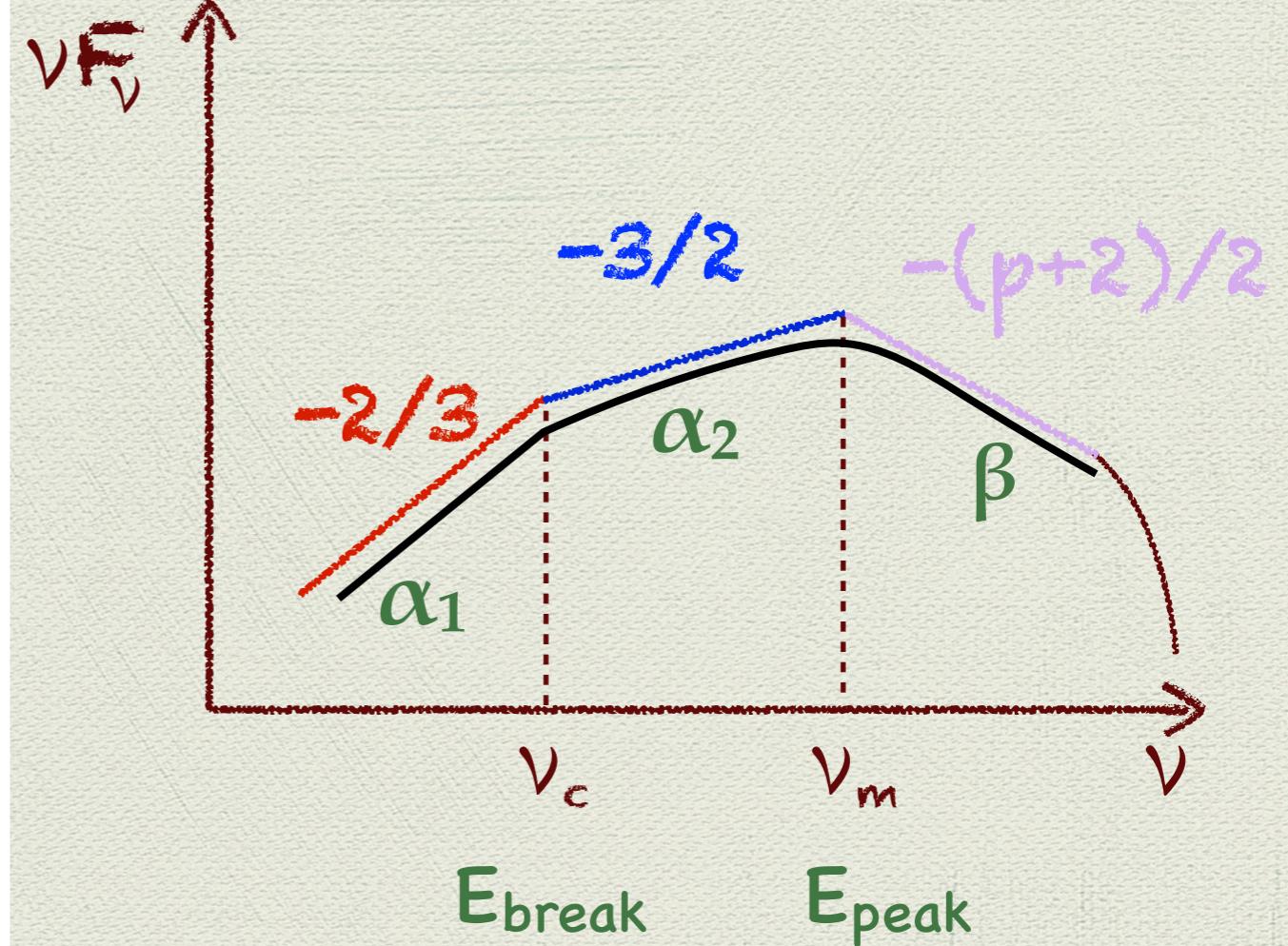
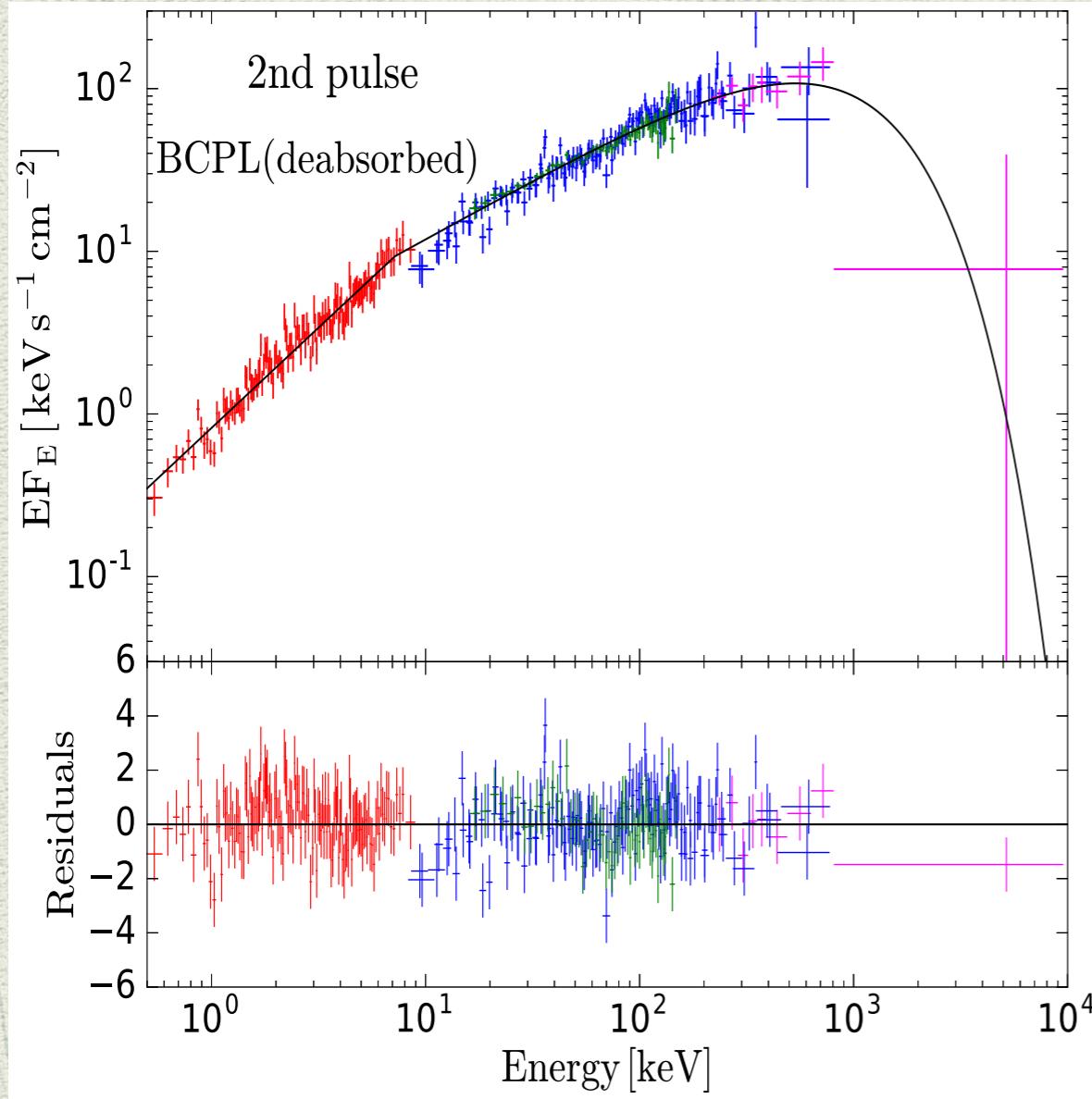
# Spectral fit: full sample time resolved analysis

## Distribution Epeak and Ebreak



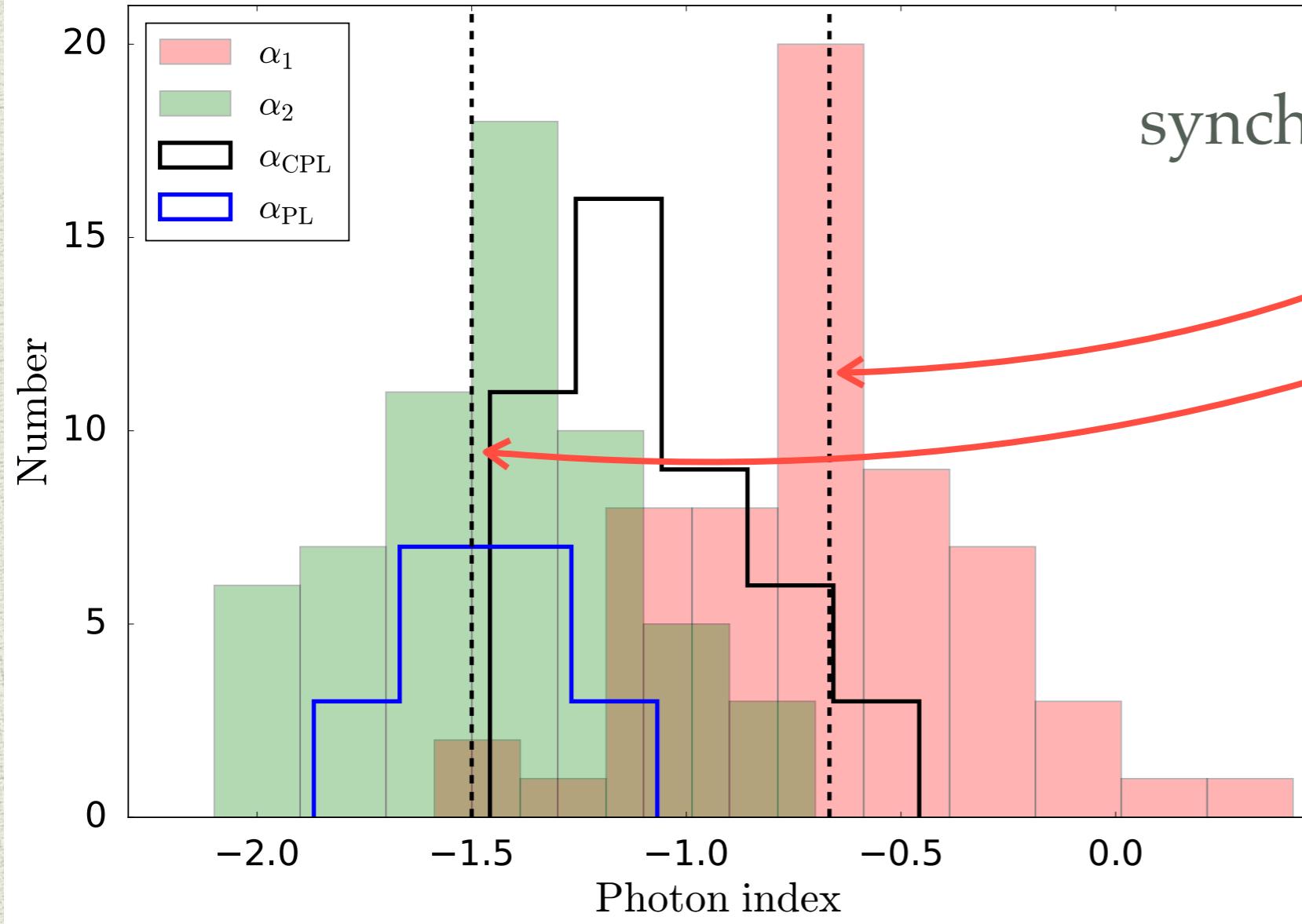
# Example of spectral fit including XRT data

Oganesyan, Nava, Ghirlanda, Celotti, 2017, ApJ

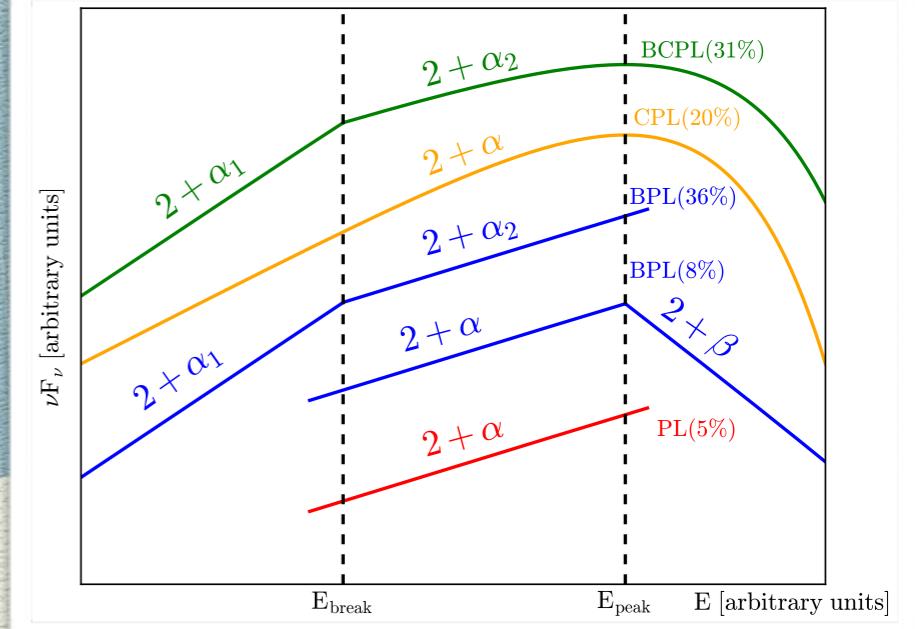


# Spectral fit: full sample time resolved analysis

## Distribution photon indices

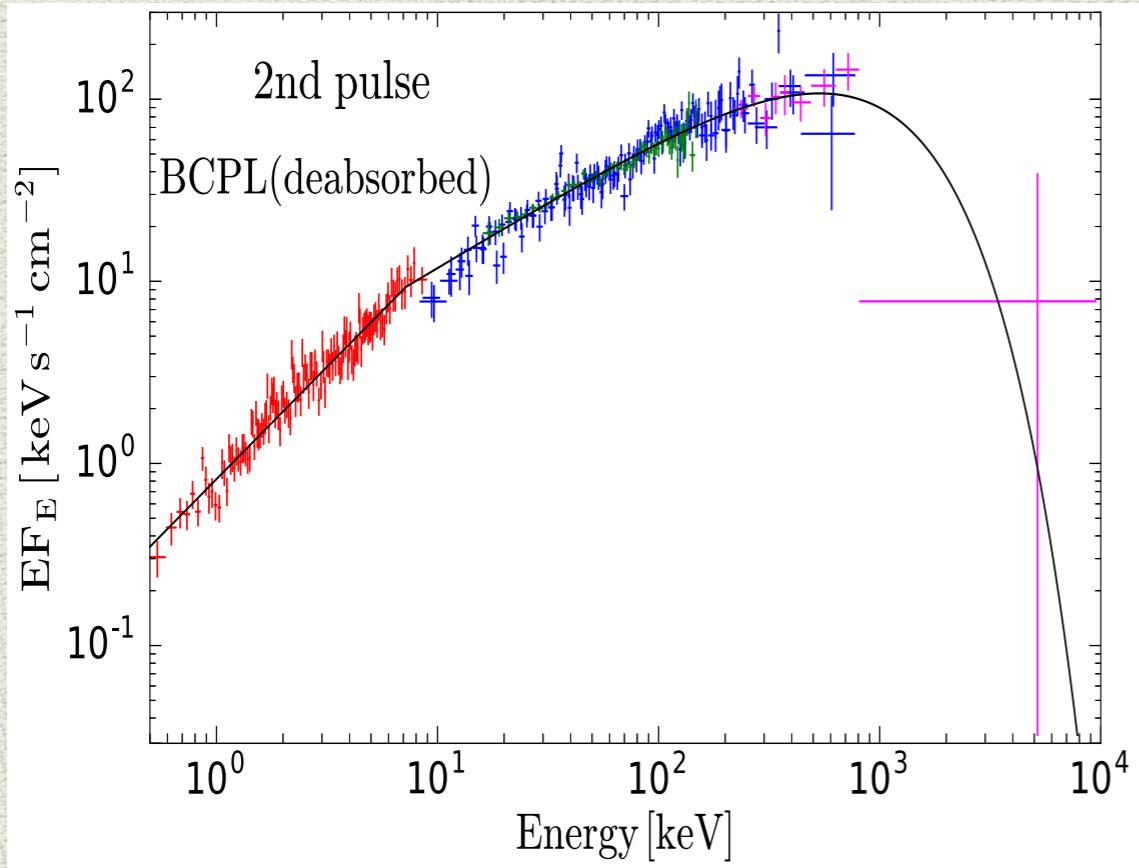


synchrotron predictions  
for  $\alpha_1$  and  $\alpha_2$



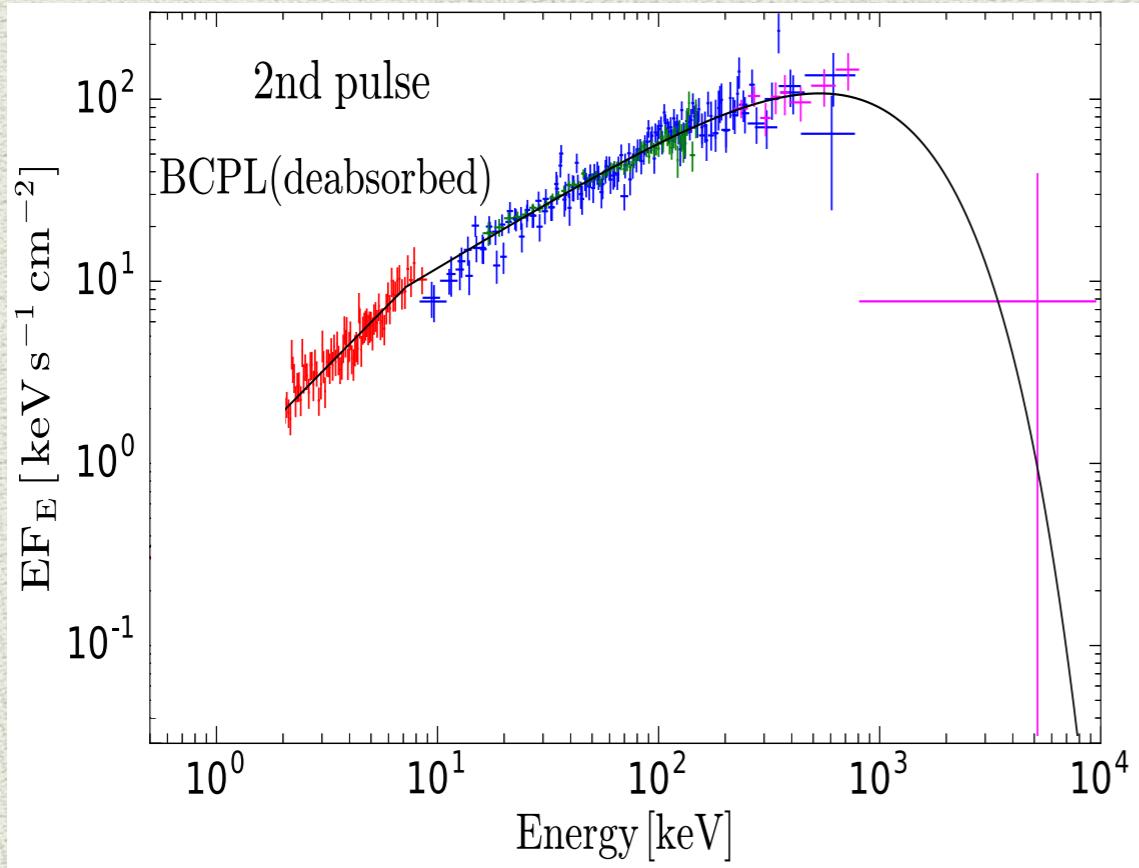
# THESEUS

XRT + BAT + GBM  
(0.5 keV - 20 MeV)



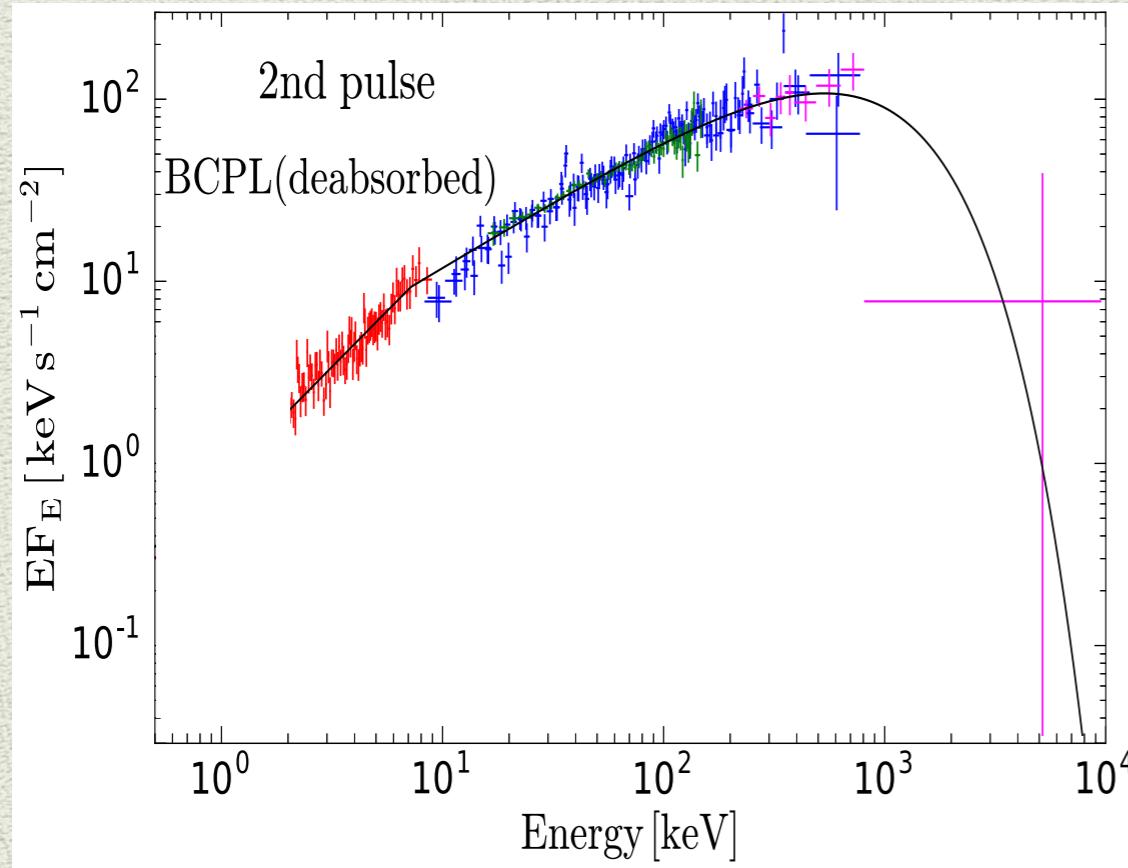
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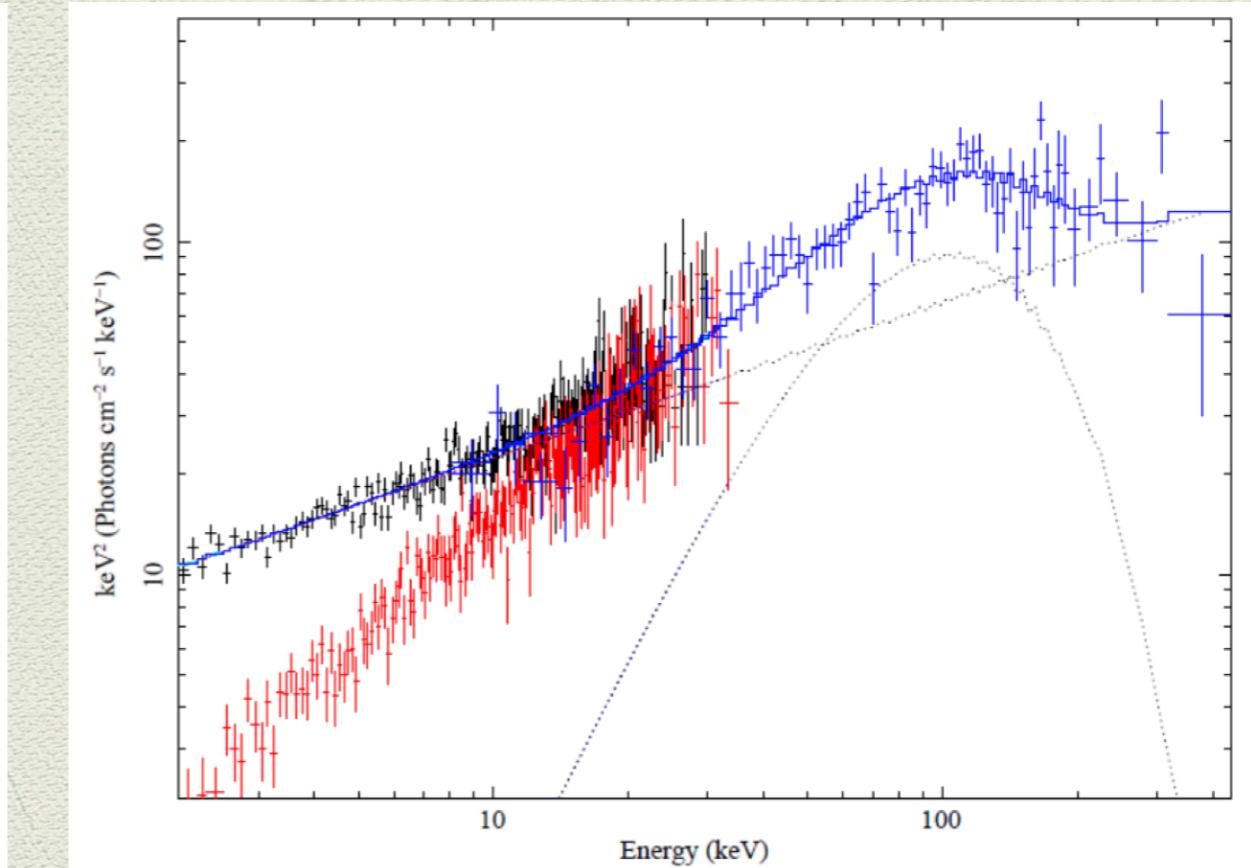


# THESEUS

XRT + BAT + GBM  
(0.5 keV - 20 MeV)



XGIS  
(2 keV - 20 MeV)



# Conclusions

- ◆ 14 GRBs with XRT observations during the prompt
- ◆ Band and CPL models not adequate
- ◆ 67% of spectra have break in the soft-Xray
- ◆ Photon indices below and above the break consistent with synchrotron spectrum
- ◆  $E_{\text{break}} = \text{cooling frequency?}$