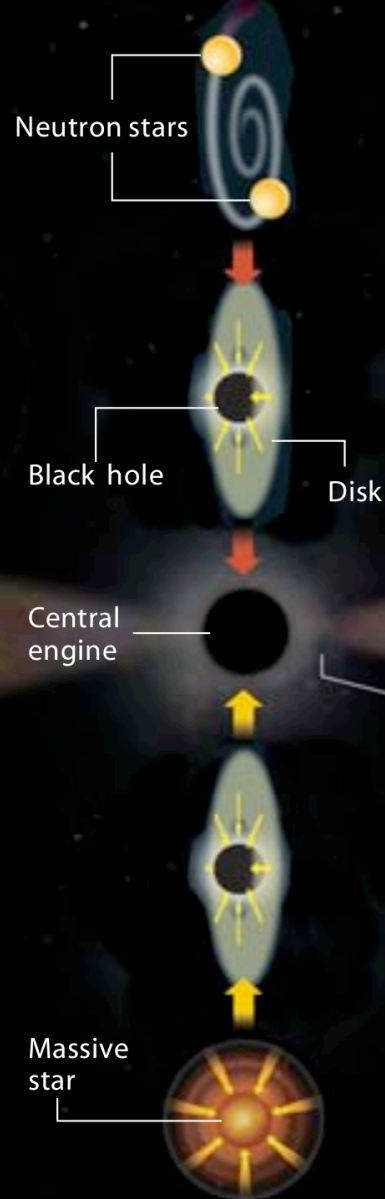


Looking for photospheric thermal emission in HETE-2 GRBs

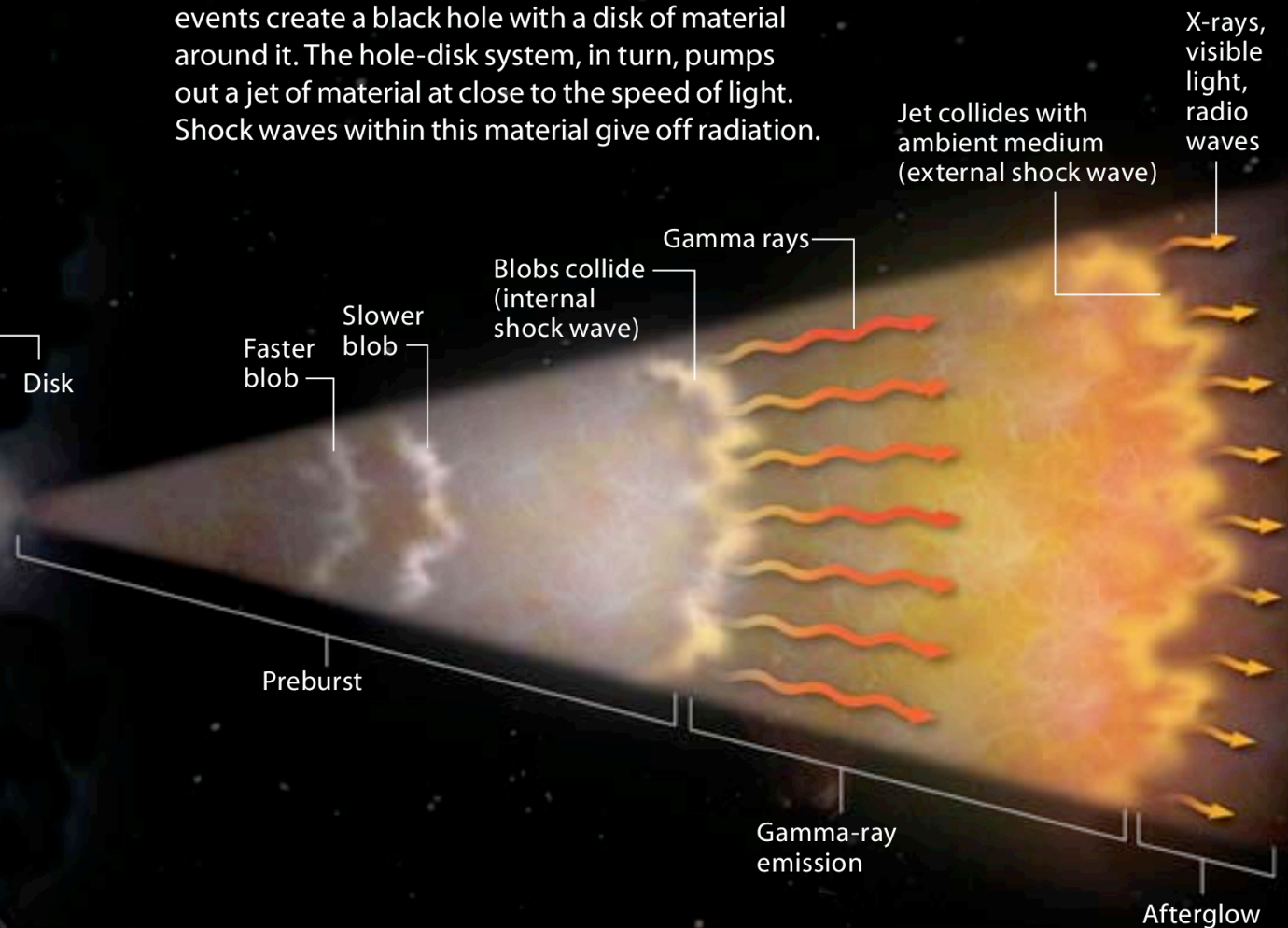
J-L. Atteia for the HETE collaboration

Bursting Out

Merger scenario

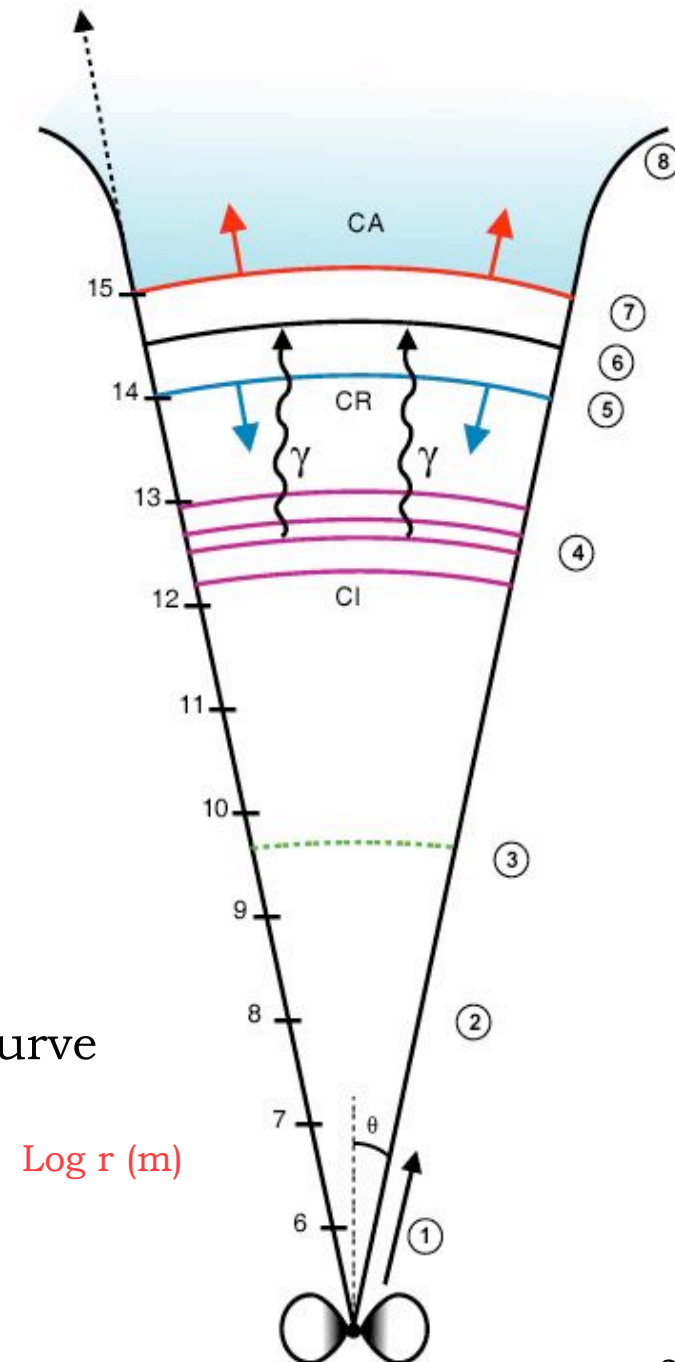


Formation of a gamma-ray burst could begin either with the merger of two neutron stars or with the collapse of a massive star. Both these events create a black hole with a disk of material around it. The hole-disk system, in turn, pumps out a jet of material at close to the speed of light. Shock waves within this material give off radiation.



The « standard model » (in one figure)

- 1) Acceleration
- 2) Coasting phase: $\Gamma > 100$
- 3) Transparency $\rightarrow$ thermal precursor ?
- 4) Internal shocks (CI) $\rightarrow \gamma$ -ray emission
- 5) Reverse shock (CR) $\rightarrow$ early afterglow ?
- 6) Contact discontinuity
- 7) Forward shock (CA) $\rightarrow$ afterglow
- 8) $1/\Gamma > \theta \rightarrow$ break in the afterglow light-curve



Aims

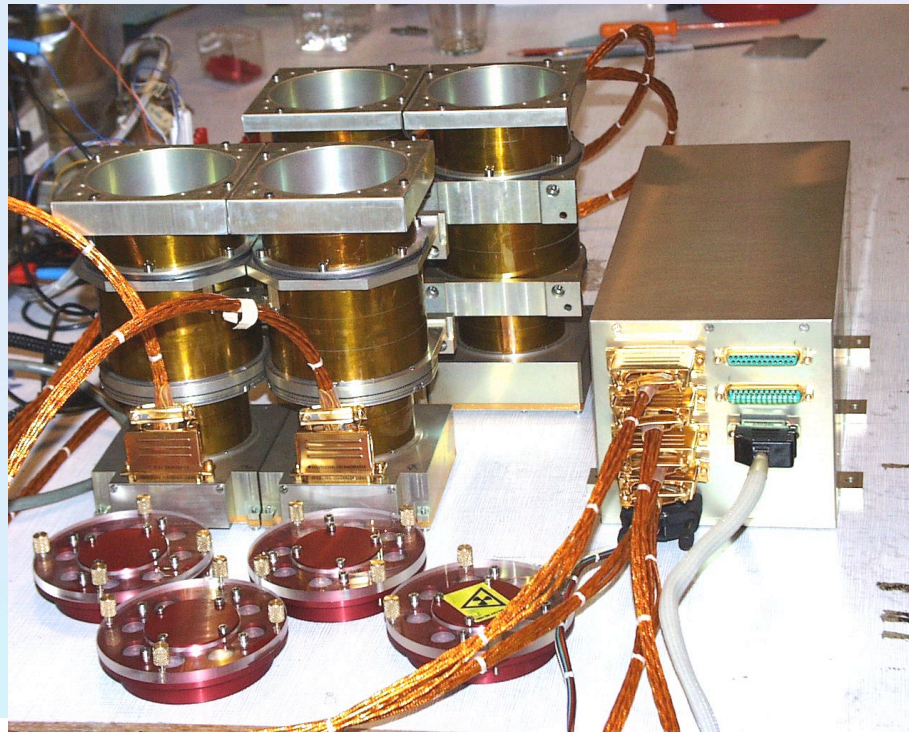
- The jet is radiatively efficient: the prompt GRB represents a significant fraction of the total energy output
- When the jet becomes transparent, its thermal energy is radiated quickly → photospheric emission
 - The thermal energy content of the jet is not known, it can be small if most of the energy is stored into the baryons
- The photosphere could/should play a role in the observed emission. Its spectrum is thermal or quasi-thermal.
- On-going discussions about the importance of thermal emission in Fermi and BATSE GRBs
- Which constraints can we put on the presence of thermal emission in bright HETE GRBs?

Methods

- Study 11 bright GRBs detected with HETE-2/Fregate
- Look for blackbody emission in the integrated spectrum of the prompt GRB:
 - Compare Band and Band+blackbody spectral fits
 - Measure the parameters of the blackbody components (temp. – flux), when it is required/possible
 - Compute the maximum allowed flux in the blackbody component
- Use light-curves in different energy bands to confirm/reject the need for two distinct spectral components

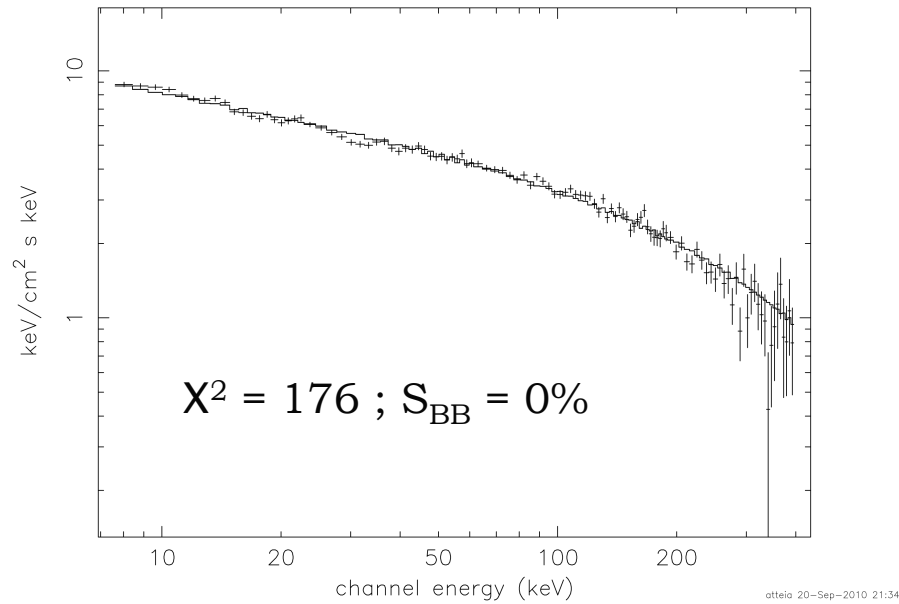
FREGATE

- Small detectors : 160 cm^2
 - The search for an extra spectral component requires bright GRBs
- Broad energy range : 7 – 400 keV, well suited for this analysis
- ~100 GRB localized by the WXM from 2001 to 2006

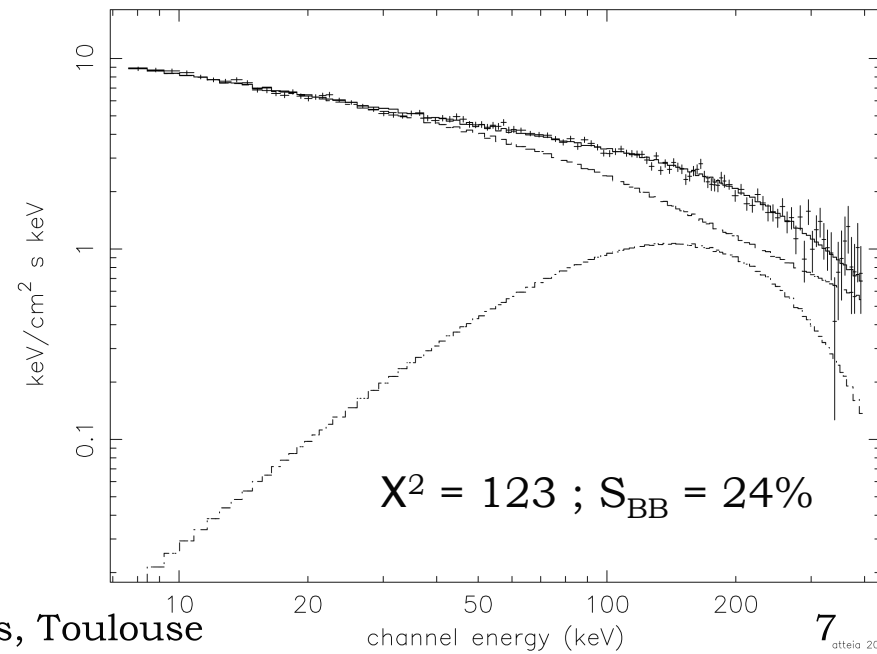
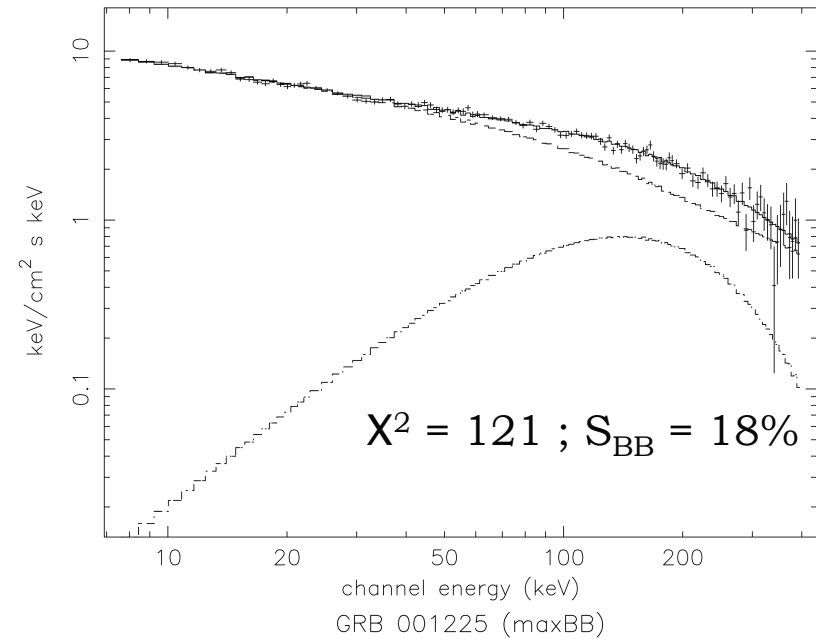


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GRB 001225 (Band)



GRB 001225

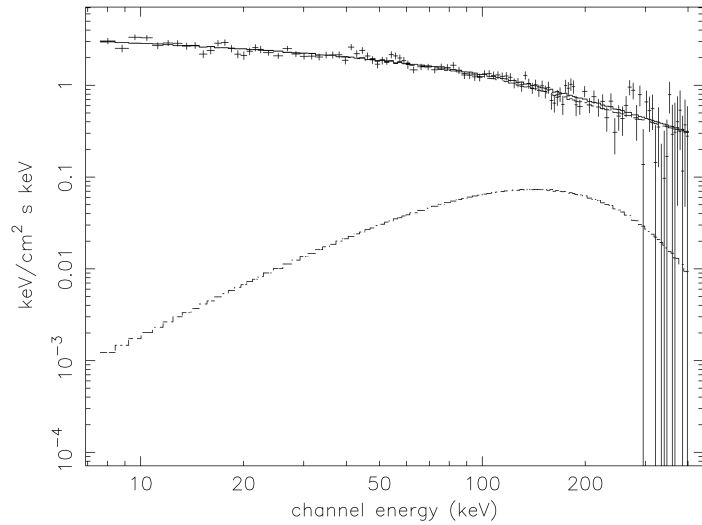


Results

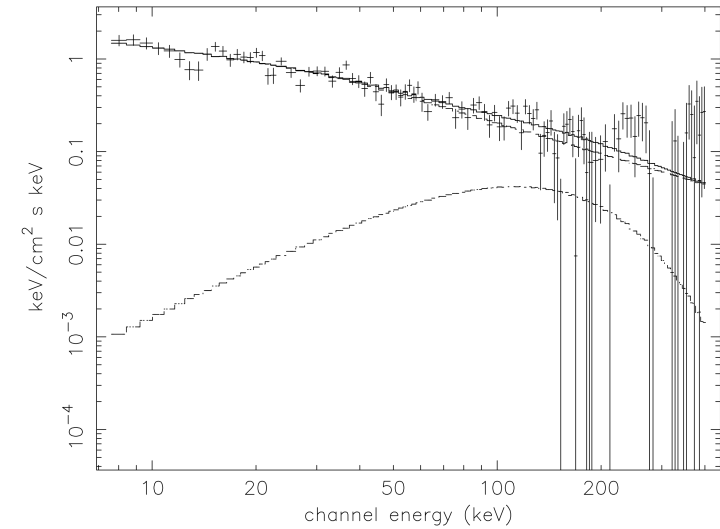
GRB Name	z	S_{7-400}^*	Band				PL+BB	Band+BBmax						
			α	β	E_{peak} keV	χ^2_{112}	χ^2_{112}	χ^2_{112}	$[\Delta\chi^2]$	α	β	E_{peak} keV	BB-kT keV	BB-fluence %
GRB 001225		16.4	-1.28	-2.1*	239	176	212	115	[-61]	-1.29	-2.1*	116	50	24
GRB 010613		3.8	-1.51	-2.1*	79	165	168	166	[+1]	-1.3	-2.1*	38	40	16
GRB 020813	1.25		-1.16	-2.1*	160	103	153	??	[]		-2.1*			
GRB 030328	1.52	3.9	-0.97	-2.0	95	95	132	93	[-2]	-0.79	-4	61	60	40
GRB 030329	0.17	16.1	-1.26	-2.3	83	168	619	145	[-23]	-1.14	-3.6	48	50	25
GRB 030519		6.9	-0.80	-1.7	143	79	131	81	[+2]	-0.67	-3.4	93	90	44
GRB 030528	0.78	1.34	-0.3	-2.24	17	91	94	93	[+2]	-1. [†]	-2.2	47	3.7	21
GRB 030725		2.3	-1.27	-2.1*	114	142	154	138	[-4]	-1.2	-2.1*	53	30	21
GRB 031109a		4.9	-1.12	-2.1	157	148	168	151	[+3]	-1.1	-2.1*	98	50	19
GRB 040709		1.8	-1.22	-2.6	72	134	148	136	[+2]	-1.3	-2.1*	36	20	23
GRB 041006	0.72	1.1	-1.29	-3.0*	45	94	145	84	[-10]	-0.9	-3.0*	22	20	34
GRB 051022	0.8		-1.24	-1.7	344	178	184							

Case 1: the BB never dominates the spectrum

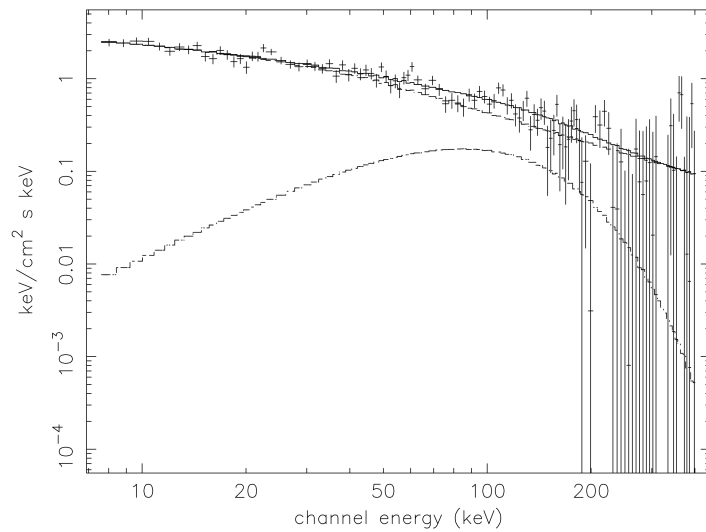
GRB 031109A (Band+BB)



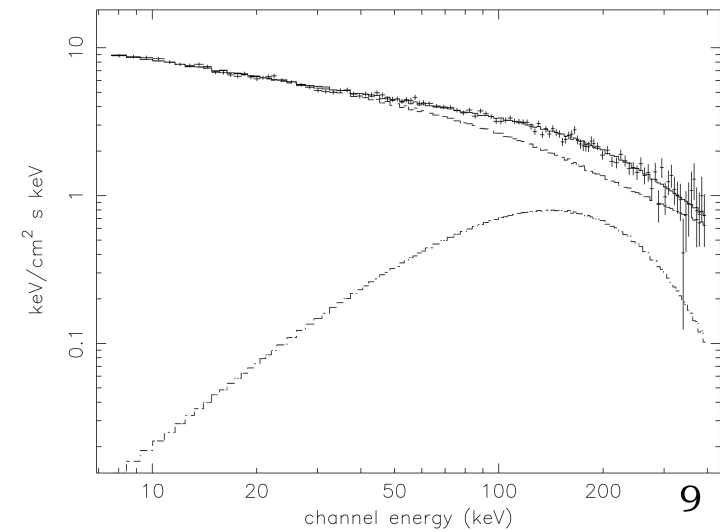
GRB 010613



GRB 030725 (Band+BB)

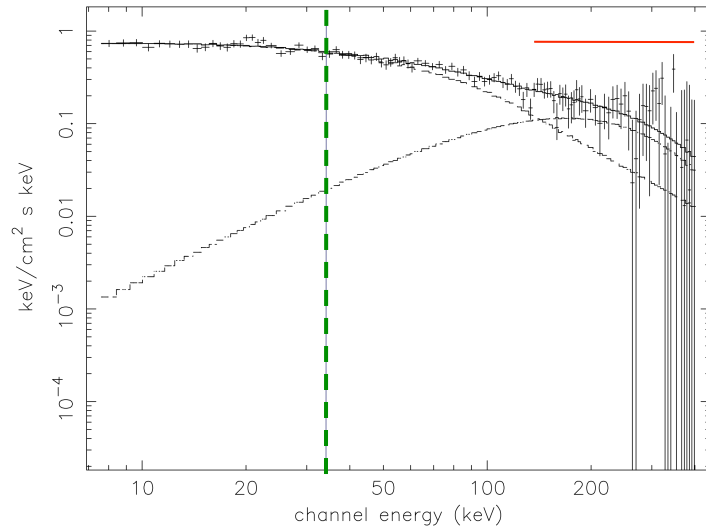


GRB 001225

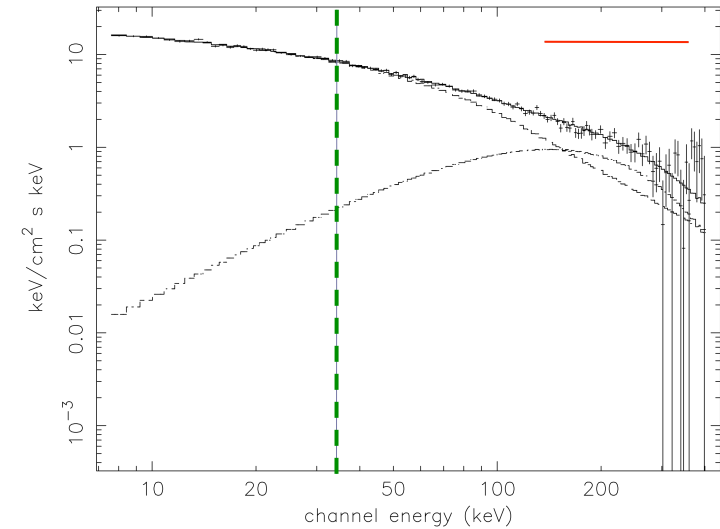


Case 2: the BB dominates at some energies

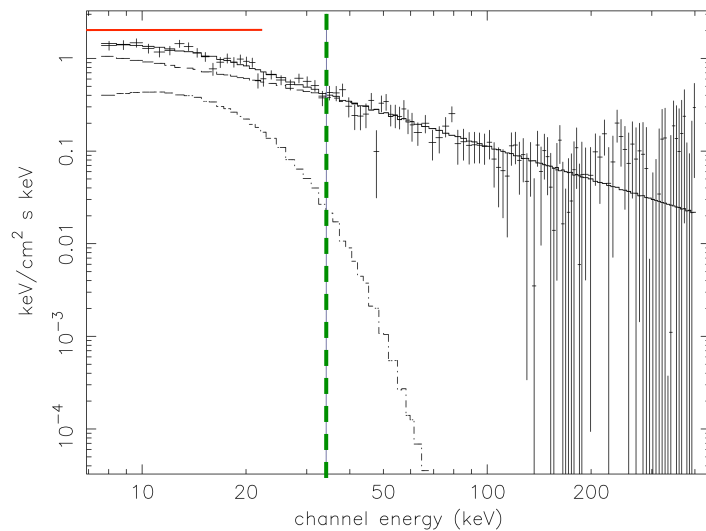
GRB 030328



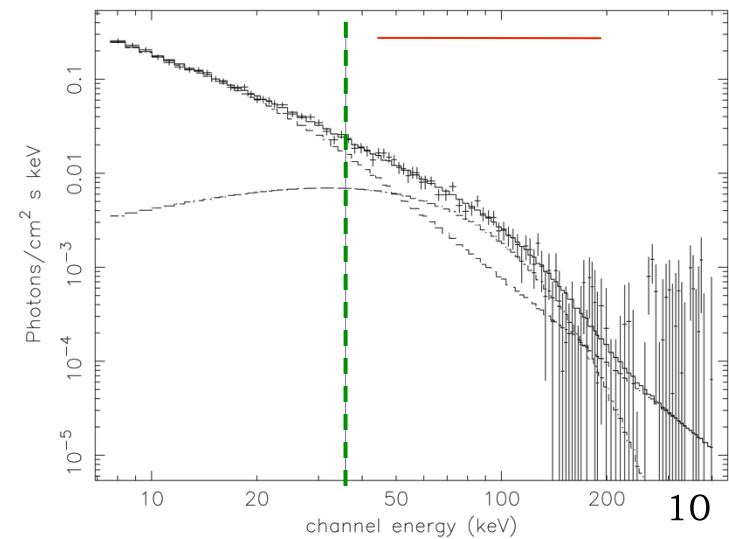
GRB 030329



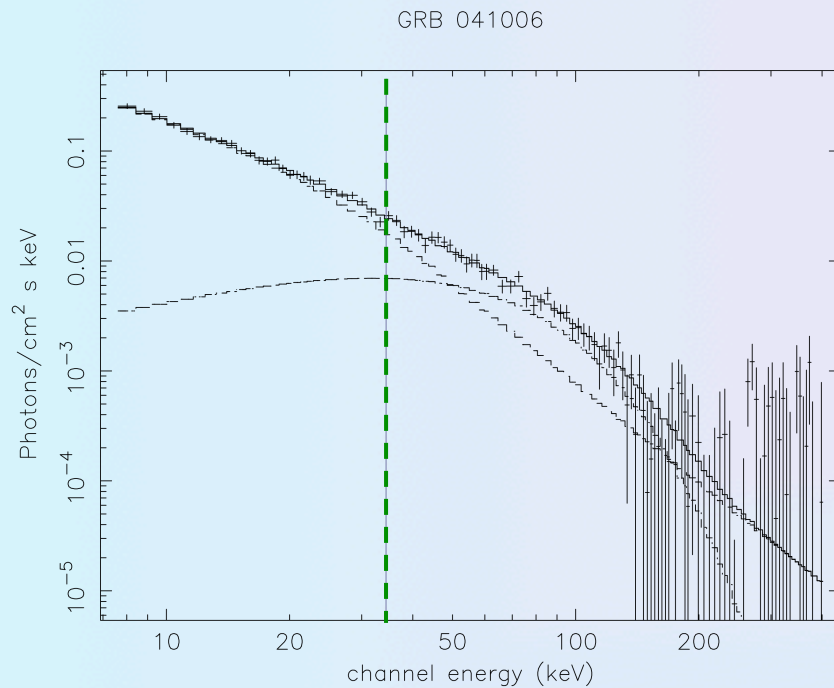
GRB 030528 (Band+BB)



GRB 041006



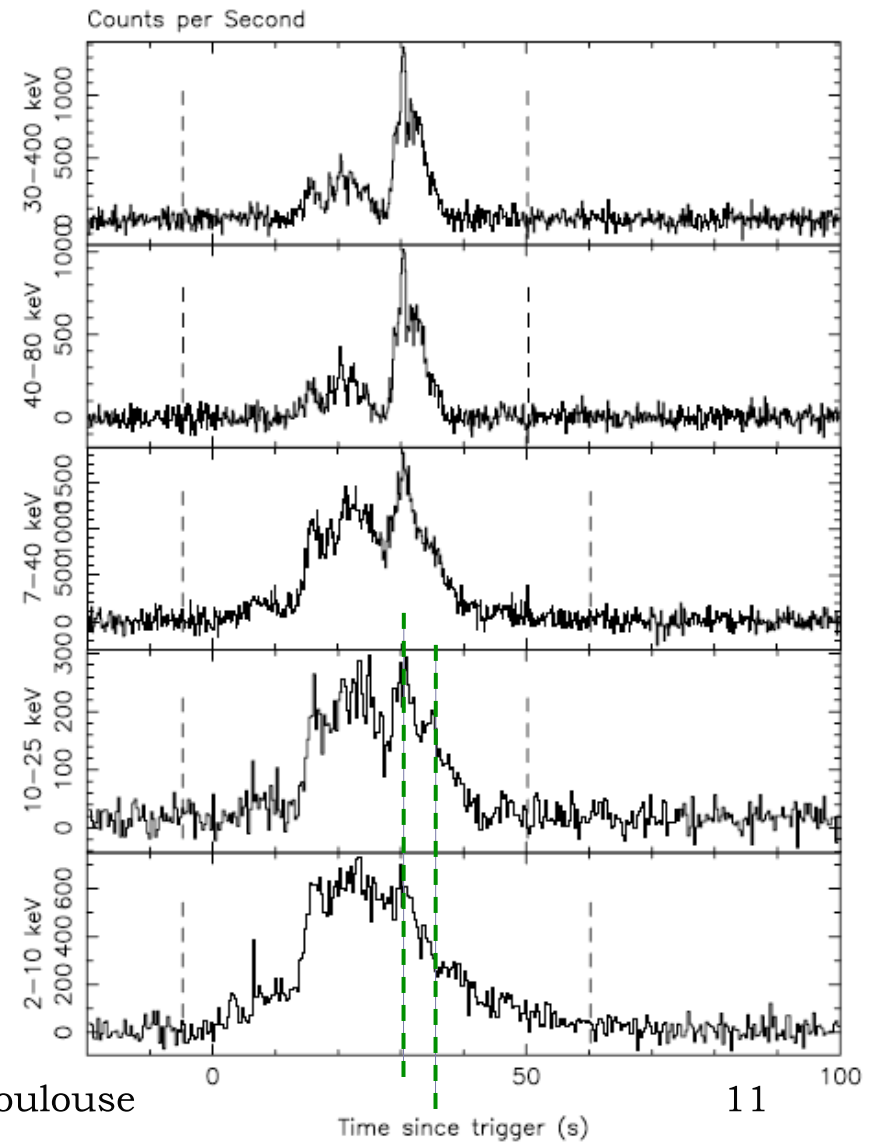
GRB 041006



GRB041006=H3570

$T_0=12:18:08$ UT

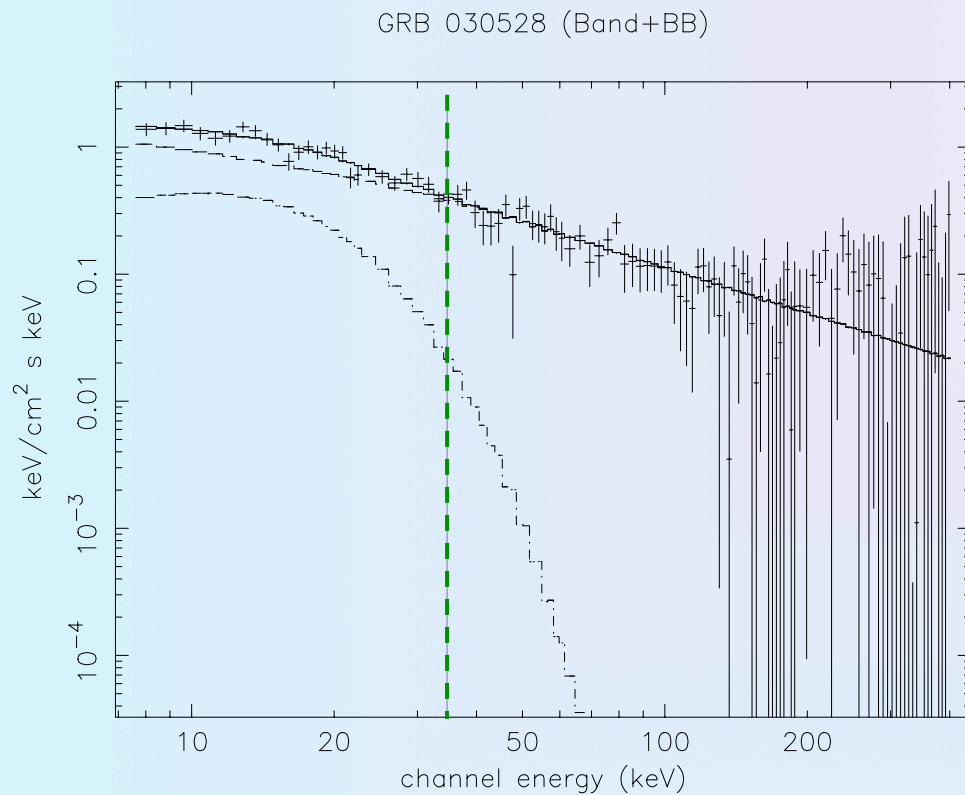
WXM localization, $\theta=5^\circ$



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Atelier GRBs, Toulouse

GRB 030528



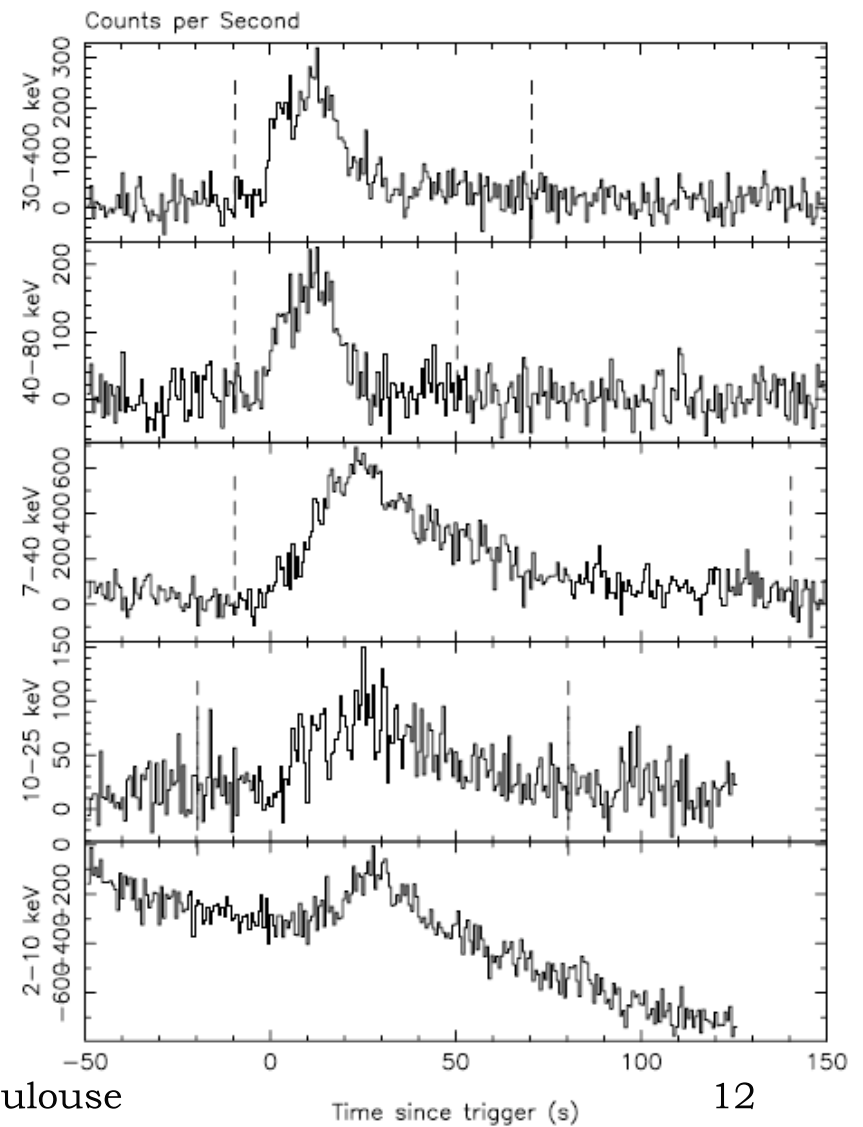
Sept. 23, 2010

Atelier GRBs, Toulouse

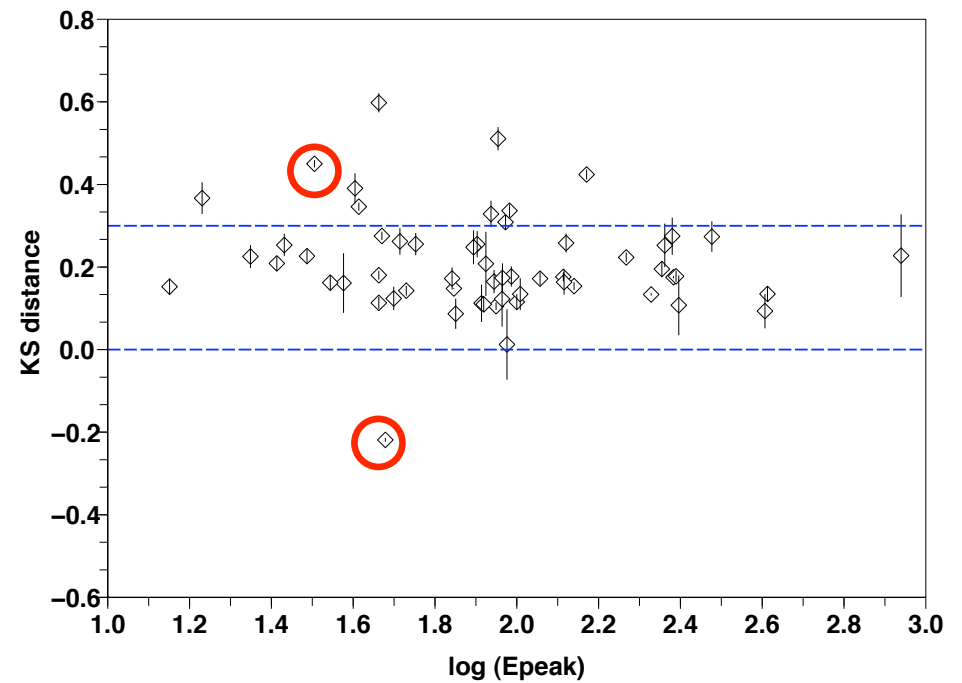
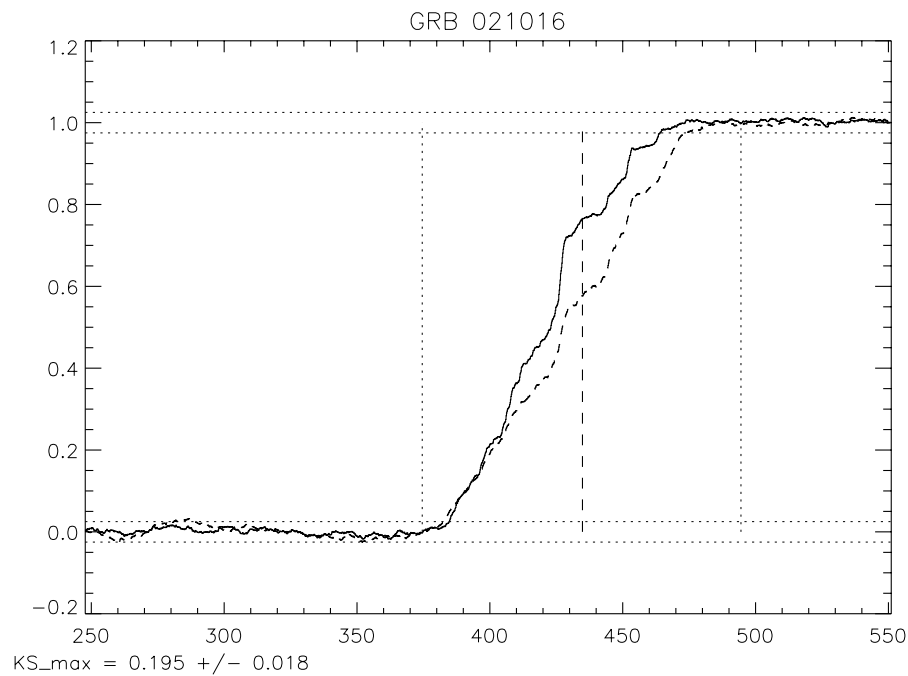
GRB030528=H2724

$T_0=13:03:02$ UT

WXM localization, $\theta=21^\circ$



How significant are the observed differences?



Conclusions (preliminary)

- A thermal component, representing 15-45% of the flux, can be included in the spectral fits of bright GRBs, under some conditions :
 - The thermal emission is added to a Band function
 - The temperature of the blackbody and the Band Epeak are very close (except GRB 030528)
- These observations do not prove the need, nor the reality, of the thermal emission. This reality can be assessed with the comparison of light curves in the energy ranges respectively dominated by the assumed blackbody and the Band spectral components... The analysis is on-going.

More to come, soon...

