Swift Observation of GRB 130603B

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1 Introduction

At 15:49:14 UT, the *Swift* Burst Alert Telescope (BAT) triggered and located GRB 130603B (trigger=557310; Melandri, *et al.*, *GCN Circ.* 14735). *Swift* slewed immediately to the burst. The best *Swift* position is the enhanced, astrometrically corrected X-ray position reported in Evans *et al.*, *GCN Circ.* 14739.

2 BAT Observation and Analysis

Using the data set from $T-61$ to $T+242$ s further analysis of BAT GRB 130603B has been performed by *Swift* team (Barthelmy, *et al.*, *GCN Circ.* 14741). The BAT ground-calculated position is RA(J2000) = 172.222 deg ($11^h\ 28^m\ 53.2^s$), Dec(J2000) = +17.063 deg ($+17^\circ\ 03'\ 48.2''$) $\pm$ 1.0′ (radius, sys+stat, 90% containment). The partial coding was 100%.

The mask-weighted light curve shows a single FRED-like spike starting at $\sim T - 0.00$ s, peaking at $\sim T + 0.012$ s, and returning to baseline at $\sim T + 0.2$ s. There is a smaller pulse ridding on the tail of the initial pulse. T_{90} (15-350 keV) is 0.18 ± 0.02 s (estimated error including systematics).

The time-averaged spectrum from $T + 0.01$ to $T + 0.26$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 0.82 ± 0.07. The fluence in the 15-150 keV band is $6.3 \pm 0.3 \times 10^{-7}$ $ergs/cm^2$. The 1-sec peak photon flux measured from $T - 0.36$ s in the 15-150 keV band is 6.4 ± 0.3 $ph/cm^2/sec$. All the quoted errors are at the 90% confidence level.

2.1 Spectral lag analysis and redshift determination

Using 2-ms binned light curves, the spectral lag for the 15-25 keV to 50-100 keV bands is 0.6 $\pm$ 0.7 ms, and -2.5 $\pm$ 0.7 ms for the 25-50 keV to 100-350 keV bands for both peaks combined. These lag values and the hard spectrum (Barthelmy, *et al.*, *GCN Circ.* 14741) place this burst in the short burst category. There is no evidence for extended emission at the 0.005 counts det^{-1} s^{-1} level (Norris, *et al.*, *GCN Circ.* 14746).

The redshift of GRB 130603B afterglow has been determined to be $z = 0.356$ and confirmed by various group (Thone, *et al.*, *GCN Circ.* 14744; Foley, *et al.*, *GCN Circ.* 14745; Sanchez-Ramirez, *et al.*, *GCN Circ.* 14747; Cucchiara, *et al.*, *GCN Circ.* 14748; Xu, *et al.*, *GCN Circ.* 14757).

3 XRT Observation and Analysis

We have analysed 12.7 ks of XRT data for GRB 130603B (Melandri *et al.*, *GCN Circ.* 14735), from 62 s to 51.6 ks after the BAT trigger. The data comprise 378 s in Windowed Timing (WT) mode (the first 9 s were taken while *Swift* was slewing) with the remainder in Photon Counting (PC) mode. The enhanced, astrometrically corrected X-ray position (Evans *et al.*, *GCN Circ.* 14739) for this burst is RA, Dec (J2000) = 172.200, +17.071 which is equivalent to:

RA (J2000) = $11^h\ 28^m\ 48.17^s$
Dec(J2000) = $+17^\circ\ 04'\ 16.0''$

with an uncertainty of 2.0 arcsec (radius, 90% confidence).

The light curve can be modelled with a broken power-law decay (Fig.2) with a initial decay index of $\alpha_1 = 0.35 \pm 0.08$, followed by a break at $t_b = (2.7 \pm 0.4) \times 10^3$ s and a final decay index $\alpha_2 = 1.61 \pm 0.08$.

The late time spectrum formed from 12.4 ks of PC mode data can be fitted with an absorbed power-law with a photon spectral index of 2.18 ± 0.18. The best-fitting absorption column is $(2.2 \pm 0.5) \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 1.9×10^{20} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 4.0×10^{-11} (6.0×10^{-11}) erg cm^{-2} count^{-1} (Kennea, *GCN Circ.* 14749).

4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 130603B 62 s after the BAT trigger (Melandri, *et al.*, *GCN Circ.* 14735). A source 2 arcseconds from the centre of the XRT error circle and coincident with the optical afterglow detected by WHT (Levan *et al.*, *GCN Circ.* 14742) and NOT (de Ugarte Postigo *et al.*, *GCN Circ.* 14743) is detected in UVOT exposures. The source, in UVOT images, shows no clear fading behaviour between the first and the latest exposures.

Preliminary detections and 3σ upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the early exposures are:

Filter	T_{start} (s)	T_{stop} (s)	Exp (s)	Mag
white	62	4981	383	20.81 ± 0.17
v	605	5393	225	> 19.8
b	530	6212	432	21.14 ± 0.45 (2.5σ)
u	275	6007	659	20.87 ± 0.39 (2.8σ)
w1	654	5802	413	> 20.6
m2	3960	5597	393	> 20.4
w2	580	6555	365	20.69 ± 0.39 (2.8σ)

Table 1: 3σ upper limits from UVOT observations (De Pasquale & Melandri, *GCN Circ.* 14759). The values quoted above are not corrected for the Galactic extinction due to the reddening of $E_{(B-V)} = 0.02$ in the direction of the burst (Schlegel et al. 1998).

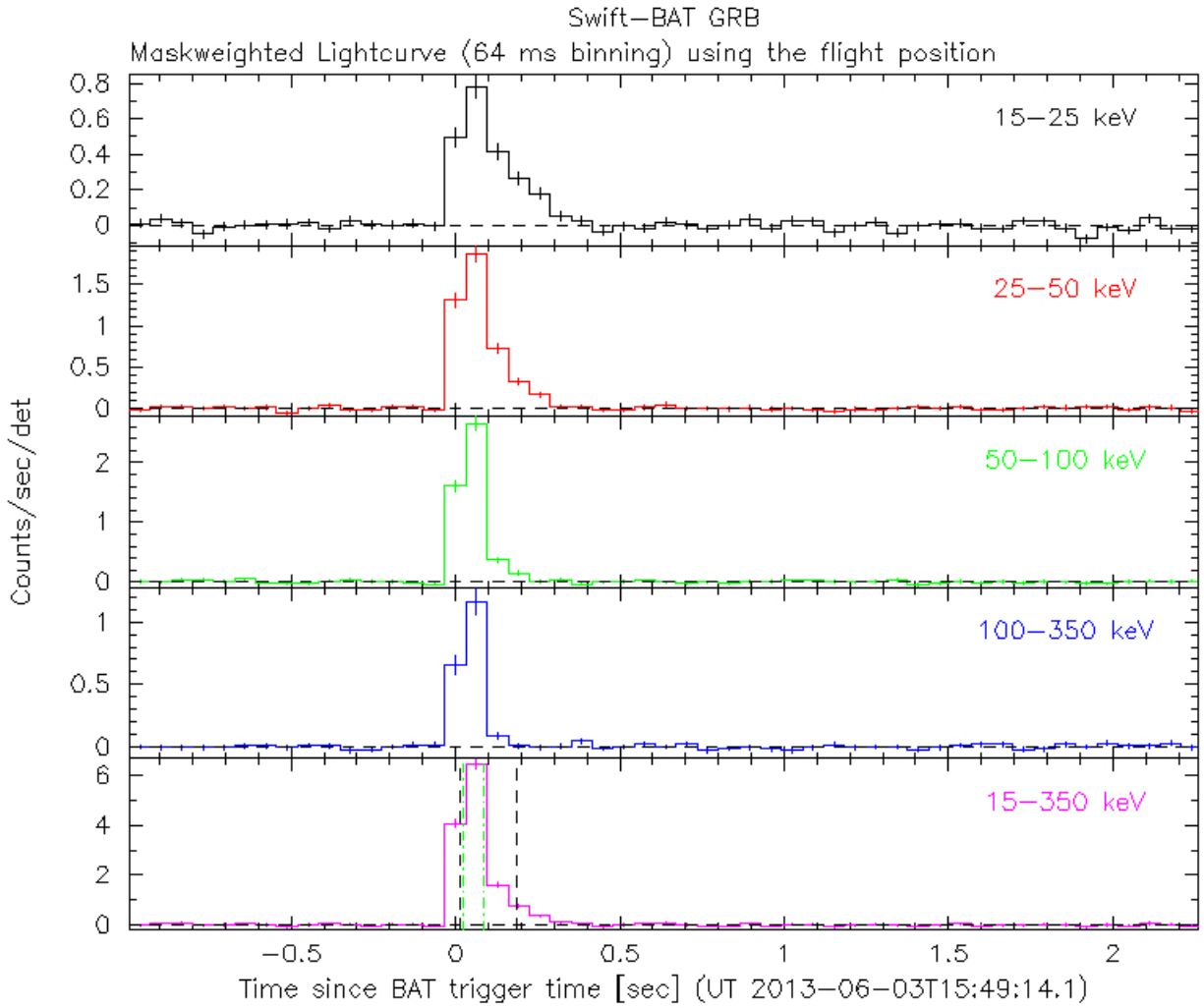

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands (15 - 25, 25 - 50, 50 - 100, 100 - 350 and 15 - 350 keV).

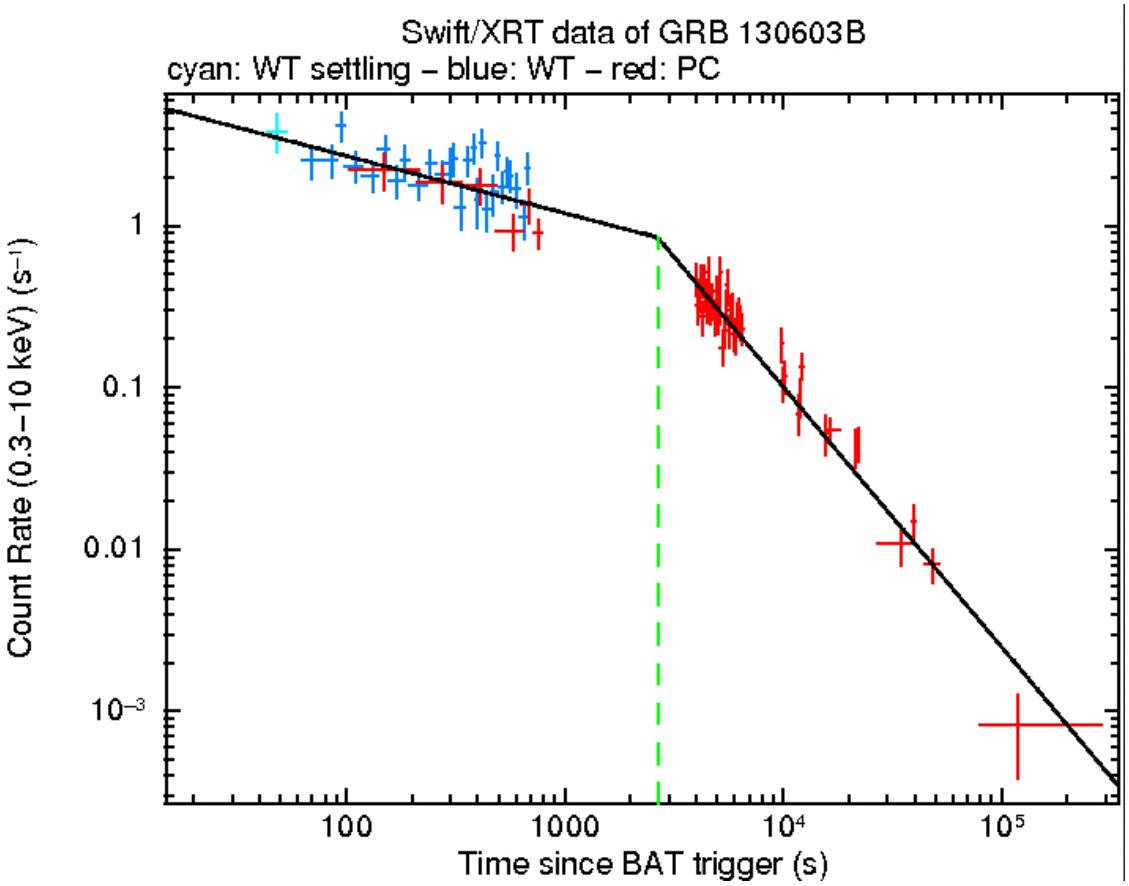

Figure 2: XRT Lightcurve. It can be modelled by a broken power-law.