

Swift Observation of GRB 061004

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1 Introduction

BAT triggered on GRB 061004 at 19:50:30.5 UT (Trigger 232339) (Ziaepour, *et al.*, *GCN Circ.* 5691). This was a 1.024 sec rate-trigger on a intermediate length burst with $T_{90} = 6.240$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 60$ sec, and UVOT at $T + 69$ sec. Our best position is the XRT location $RA(J2000) = 97.793667deg$ (06h31m10.48s), $Dec(J2000) = -45.906833deg$ ($-45d54'24.6''$) with an error of 5.5 arcsec (90% confidence, including boresight uncertainties).

2 BAT Observation and Analysis

Using the data set from $T - 239.0$ to $T + 595.8$ sec, further analysis of BAT GRB 061004 has been performed by Swift team (Krimm, *et al.*, *GCN Circ.* 5694). The BAT ground-calculated position is $RA(J2000) = 97.795deg$ (06h31m10.8s), $Dec(J2000) = -45.903deg$ ($-45d54'09.8''$) ± 0.8 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 98% (the bore sight angle was 2.06 deg).

The masked-weighted light curves (Fig.1) starts at trigger time T with a single mildly rapid rise, and returns to background at about $T + 8$ sec. $T_{90}(15 - 350keV)$ is 6.2 ± 0.3 (estimated error including systematics).

The time-averaged spectrum from $T + 0.2$ to $T + 8.1$ sec is best fitted by a simple power law model. This fit gives a photon index of 1.81 ± 0.10 , ($\chi^2 = 36.530$ for 57 d.o.f.). For this model the total fluence in the 15 – 150 keV band is $(5.7 \pm 0.3) \times 10^{-7} ergs/cm^2$ and the 1-sec peak flux measured from $T + 2.67$ sec in the 15 – 150 keV band is $2.5 \pm 0.2 ph/cm^2/sec$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using the data from the first three orbits of XRT data of GRB 061004 (3.8 ksec in Photon Counting mode), the refined XRT position is $RA(J2000) = 97.793667deg$ (06h31m10.48s), $Dec(J2000) = -45.906833 deg$ ($-45d54'24.6''$) ± 5.5 arcsec (90% confidence, including boresight uncertainties). This position is within 0.7 arcsec of the initial XRT position, and 4.75 arcsec from the optical afterglow candidate, reported by Jakobsson *et al.*, *GCN Circ.* 5698.

The 0.3 – 10 keV light curve (Fig.2) shows an initial steep decline with a slope of $1.62_{-0.14}^{+0.22}$, following by a shallow slope of 0.28 ± 0.42 , beginning at $T + 442 \pm 116$ sec. At $(2.6_{-0.9}^{+4.3}) \times 10^3$ sec the light curve breaks with a slope of 1.17 ± 0.11 .

Three segments of the X-ray spectrum can be modeled with an absorbed power-law with spectral indices of 1.43 ± 0.16 , 1.96 ± 0.13 , and 1.79 ± 0.40 , respectively. The NH column density is the same as galactic column density, $5.7 \times 10^{20} cm^{-2}$. The average observed (unabsorbed) flux over 0.3 – 10 keV for this spectrum (spanning a time of 68-86 seconds after the trigger) is 2.83×10^{-10} (3.07×10^{-10}) $ergs/cm^2/sec$.

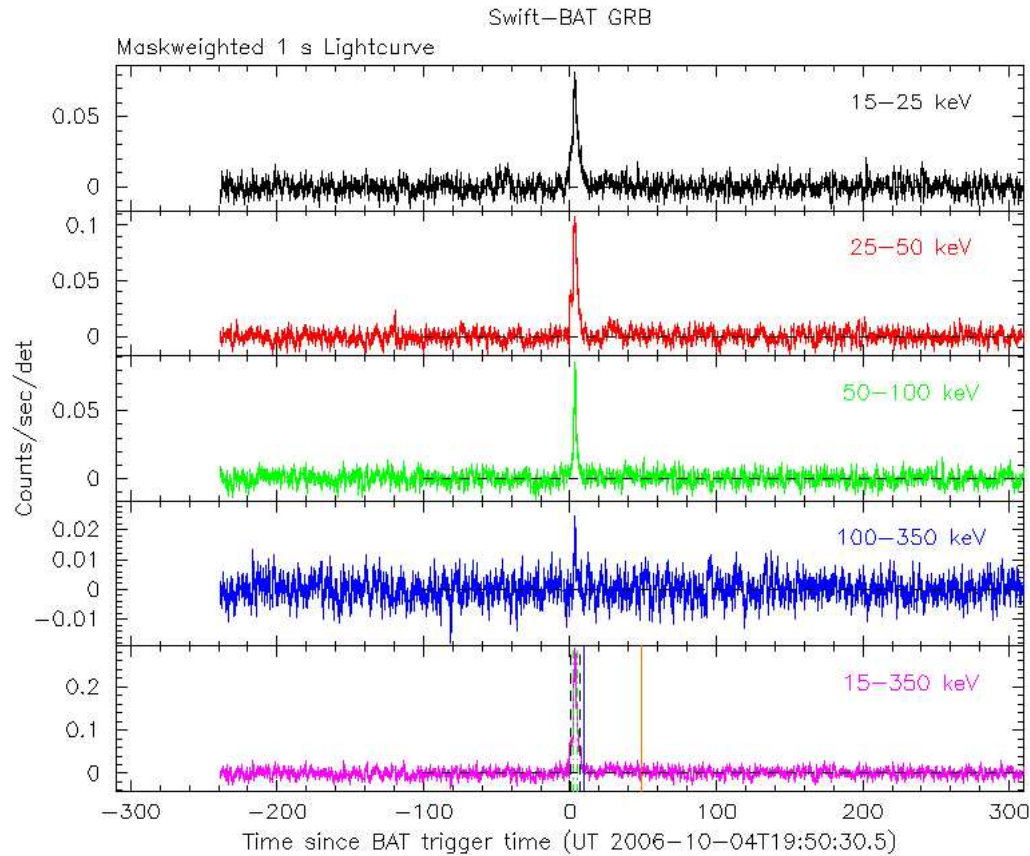


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16cm^2) and T_0 is 19:50:30.5 UT.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 061004 at 19:51:14 UT, 51 sec after the initial BAT trigger (Ziaeeepour *et al.*, *GCN Circ.* 5691). No new source was detected within the XRT error circle in the white (100 sec) and V (400 sec) finding exposures, or in the co-added images in any filter down to 3-sigma magnitude. Upper limits are summarized in Table 1. These upper limits are not corrected for Galactic extinction $E(B-V) = 0.062$.

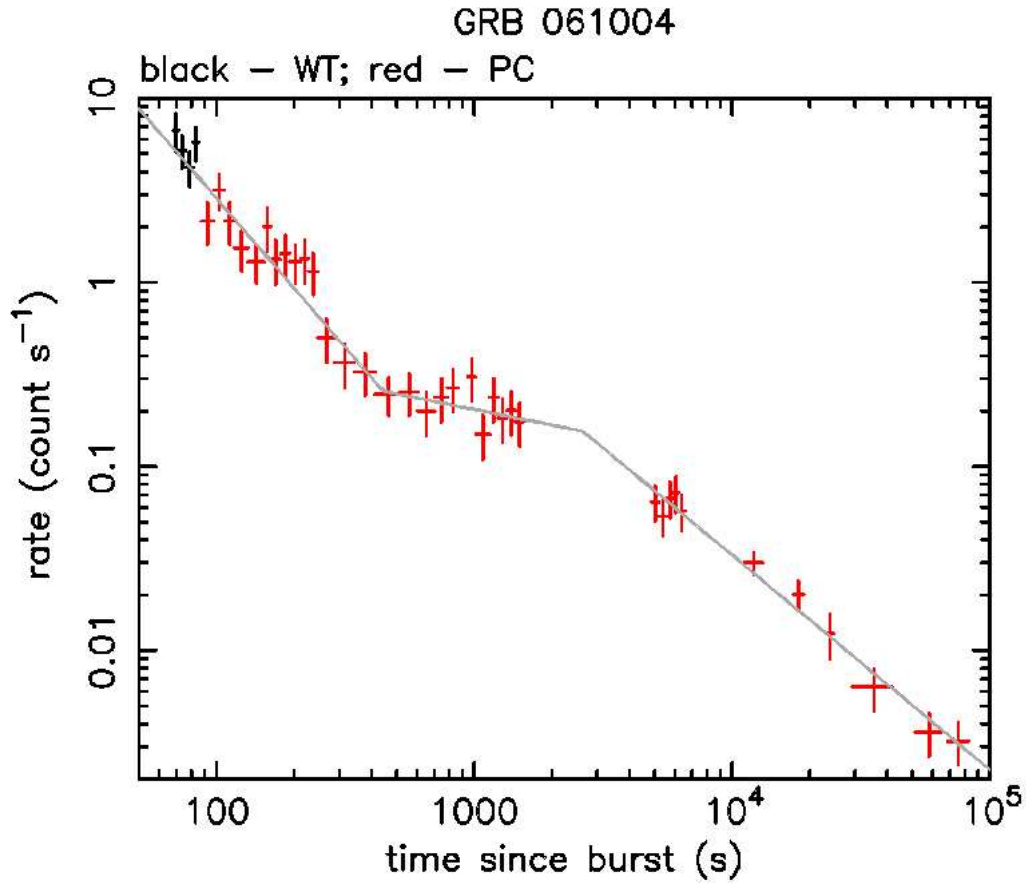


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (black), Photon Counting mode (red). The approximate conversion is $1 \text{ count/sec} = \sim 5. \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.

Filter	Start	Stop	Exposure	3-Sigma UL
WHITE (finding)	68	168	100	18.4
V (finding)	174	574	400	20.0
V	704	24752	1477	18.9
B	652	13187	928	19.9
U	625	18969	1225	20.5
UVW1	604	18895	2121	21.2
UVM2	580	17988	1357	20.4
UVW2	680	24092	1337	20.5
WHITE	665	6706	520	20.3

Table 1: Magnitude limits from UVOT observations