Swift Observation of GRB 101030A

A. Melandri (INAF-OAB), E. A. Hoversten (PSU), S. D. Barthelmy (GSFC), D. N. Burrows (PSU), M. H. Siegel (PSU), and N. Gehrels (GSFC), for the Swift Team

1 Introduction

At 15:56:29 UT the *Swift* BAT triggered on GRB 101030A (Trigger 437408) (Melandri, *et al.*, *GCN Circ.* 11386). *Swift* slewed immediately to the burst. The BAT on-board calculated location is RA, Dec = (166.390, −16.387) deg, which is

RA(J2000) = $11^h\ 05^m\ 34^s$
Dec(J2000) = $-16^\circ\ 23'\ 11$"

with an uncertainty of 3 arcmin (radius, 90% containment, including systematic uncertainty). The BAT light curve shows that the burst began with a bright peak starting at around $T-70$ s from the trigger, followed by a second episode consisting of two overlapping peaks with a duration of about 80 s. The first peak occurred during a pre-planned slew, so the BAT could not trigger on it; it is also possible that BAT missed emission from the burst before $T-100$ s. The peak count rate was ~ 2000 $counts/s$ $(15-350$ $keV)$, at ~ 0 s after T_0.

The XRT began follow-up observations at $T+65.7$ s after the BAT trigger finding a bright, fading, uncatalogued X-ray source with an enhanced position RA, Dec = (166.38198, −16.37812) deg, which is

RA (J2000) = $11^h\ 05^m\ 31.68^s$
Dec (J2000) = $-16^\circ\ 22'\ 41.2''$

with an error of $1.9''$ (90% confidence, including boresight uncertainties) (Evans, *et al.*, *GCN Circ.* 11387). The initial flux in the 2.5 s image was 2.81×10^{-9} $erg\ cm^{-2}\ s^{-1}(0.2-10$ $keV)$

UVOT took a finding chart exposure of 150 s with the White filter starting $T+73$ s after the BAT trigger. No credible afterglow candidate has been found in the initial data products. The $2.7'\times2.7'$ sub-image covers 100% of the XRT error circle. The typical 3-sigma upper limit has been about 19.6 mag. The $8'\times8'$ region for the list of sources generated on-board covers 100% of the XRT error circle. The list of sources is typically complete to about 18 mag. No correction has been made for the expected extinction corresponding to $E_{(B-V)}$ of 0.04.

2 BAT Observation and Analysis

Using the data set from $T-60$ to $T+243$ s further analysis of BAT GRB 101030A has been performed by *Swift* team (Barthelmy, *et al.*, *GCN Circ.* 11388). The BAT ground-calculated position is RA$(J2000) = 166.390$ deg $(11^h\ 05^m\ 33.6^s)$, Dec$(J2000) = -16.389$ deg $(-16^\circ\ 23'\ 22.0'')\pm1.1'$ (radius, sys+stat, 90% containment). The partial coding was 96%.

The mask-weighted light curve (Fig.1) shows the burst already in progress as it came into the BAT FoV at $T-60$ s during a pre-planned slew. The light curve decreases from that time and nearly returns to background levels at $T-18$ s. Then it begins to rise again, peaking at $T+1$ s and $T+9$ s and returning to background at $T+70$ s. There is possible emission at the 2σ level from $T+130$ s to $T+170$ s. $T_{90}(15-350keV)$ is 92.0 ± 50 s (estimated error including systematics).

The time-averaged spectrum from $T-55.2$ to $T+47.8$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.82 ± 0.10. The fluence in the $15-150$ keV band is $(2.0\pm0.1)\times10^{-6}ergs/cm^2$. The 1-sec peak photon flux measured from $T+8.78$ s in the $15-150$ keV band is 0.9 ± 0.1 $ph/cm^2/sec$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

We have analysed 7.4 ks of XRT data for GRB 101030A (Melandri, *et al.*, *GCN Circ.* 11386), from 71 s to 19.2 ks after the BAT trigger. The data comprise 118 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Evans, *et al.*, *GCN Circ.* 11387.

The light curve (Fig.2) can be modelled with a series of power-law decays. The initial decay index is $\alpha_1 = 2.32^{+0.26}_{-0.33}$. At $T + 112$ s the decay steepen to an $\alpha_2 = 3.97^{+0.24}_{-0.22}$. The light curve breaks again at $T + 478$ s to a decay with $\alpha_3 = -0.08^{+0.18}_{-1.43}$, before a final break at $T + 5105$ s after which the decay index is $\alpha_4 = 1.12^{+0.22}_{-0.21}$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of $2.87^{+0.15}_{-0.13}$. The best-fitting absorption column is $1.83^{+0.26}_{-0.24} \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 4.2×10^{20} cm^{-2} (Kalberla et al. 2005). The PC mode spectrum has a photon index of $2.11^{+0.12}_{-0.20}$ and a best-fitting absorption column of $8.1^{+2.7}_{-3.9} \times 10^{20}$ cm^{-2}. The counts to observed (unabsorbed) $0.3 - 10$ keV flux conversion factor deduced from this spectrum is $3.6 \times 10^{-11}(4.6 \times 10^{-11})$ $erg\ cm^{-2}\ count^{-1}$.

4 UVOT Observation and Analysis

The *Swift*/UVOT began settled observations of the field of GRB 101030A at $T + 73$ s (Hoversten & Melandri, *GCN Circ.* 11389) after the BAT trigger (Melandri, *et al.*, *GCN Circ.* 11386). No new source was detected at the enhanced Swift XRT position (Evans, *et al.*, *GCN Circ.* 11387). UVOT magnitude 3-sigma upper limits are summarized in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{(B-V)} = 0.04$ (Schlegel et al. 1998). All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

Filter	Start	Stop	Exposure	3-Sigma UL
WHITE(fc)	73	223	146	> 20.32
WHITE	73	1008	327	> 20.75
V	617	808	38	> 17.89
B	542	735	38	> 18.83
U	285	710	260	> 19.68
UVW1	666	857	38	> 18.39
UVM2	641	833	38	> 18.18
UVW2	592	784	38	> 18.6

Table 1: Magnitude limits from UVOT observations

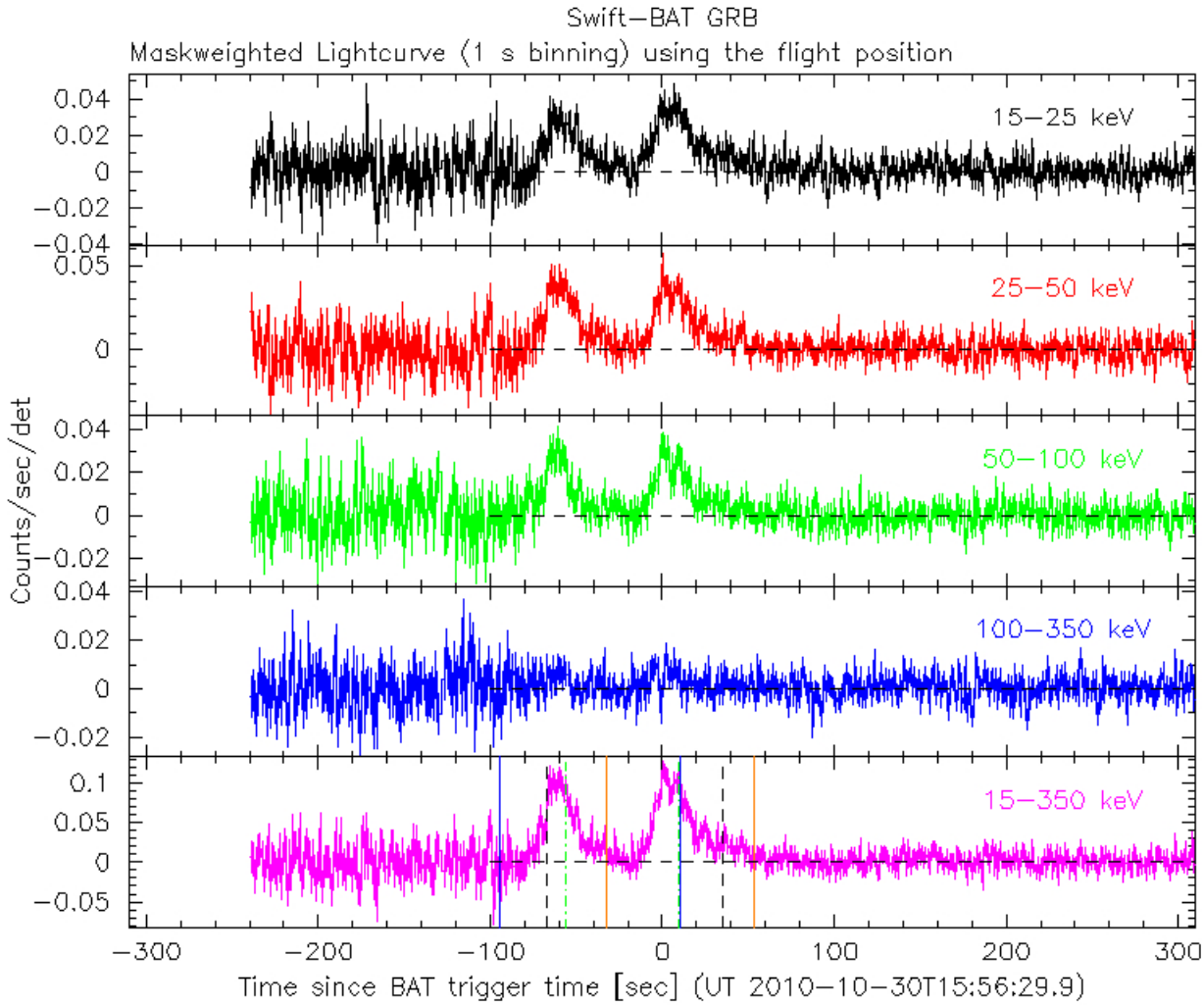

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands (15 - 25, 25 - 50, 50 - 100, 100 - 350 and 15 - 350 keV).

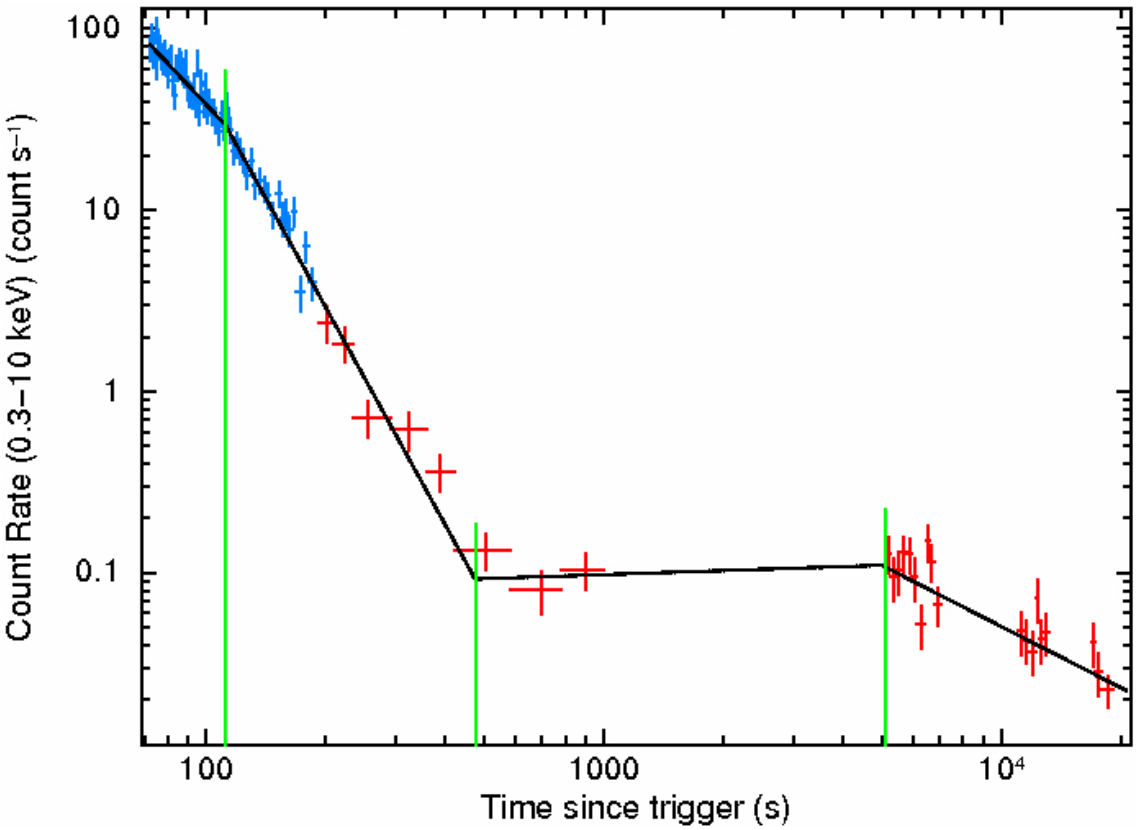

Figure 2: XRT Lightcurve. It can be modelled with a series of power-law decays, reported in the text. Data are from WT mode (blue) and PC mode (red); green vertical lines mark the times where the power-law decay changes.