

Swift Observation of GRB 100614A

G. Stratta (ASDC), V. D'Elia (ASDC), S. T. Holland (CRESST/USRA/GSFC), T. N. Ukwatta (GSFC/GWU), S.D. Barthelmy (GSFC), D.N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC) for the Swift Team

1 Introduction

At 21:38:26 UT, the Swift Burst Alert Telescope (BAT) triggered and located the long GRB 100614A (trigger=424716, Stratta et al., GCN Circ. 10837).

The BAT light curve shows a smooth peak with a duration of about 300 sec.

Swift slewed immediately, and the narrow field instruments were on target 133 seconds later. The X-ray telescope XRT detected a bright X-ray afterglow.

UVOT took a finding chart exposure of nominal 250 seconds with the U filter starting 873 seconds after the BAT trigger. No white observations were taken because there is a $V = 7.4$ star in the UVOT field of view. No credible afterglow candidate has been found in the initial data products to an estimated magnitude limit of $u > 19.2$.

No detection from ground-based facilities has been reported.

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ sec from prompt telemetry downlinks, the BAT ground-calculated position is RA, Dec = 263.534, 49.232 deg which is RA(J2000) = $17^h 34^m 08.2^s$ and Dec(J2000) = $+49^d 13' 56.4''$ with an uncertainty of 1.6 arcmin, (radius, sys+stat, 90% containment). The partial coding was 56%.

The mask-weighted light curve shows a relatively smooth peak starting at $\sim T - 10$ sec, peaking around $T + 50$ sec, and ending at $\sim T + 275$ sec. $T_{90}(15 - 350 \text{ keV})$ is 225 ± 55 sec (estimated error including systematics).

The time-averaged spectrum from $T - 9.0$ to $T + 282.0$ sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.88 ± 0.15 . The fluence in the 15 – 150 keV band is $2.7 \pm 0.2 \times 10^{-6}$ erg cm^{-2} . The 1-sec peak photon flux measured from $T + 31.00$ sec in the 15 – 150 keV band is 0.7 ± 0.2 ph $\text{cm}^{-2} \text{sec}^{-1}$. All the quoted errors are at the 90% confidence level.

The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/424716/BA/

3 XRT Observations and Analysis

The enhanced Swift/XRT position RA (J2000)= $17^h 33^m 59.82^s$ and Dec (J2000)= $+49^d 14' 03.6''$ with an uncertainty of 1.7 arcsec (radius, 90% confidence) was given by Osborne *et al.* (GCN Circ. 10849).

The XRT data comprise 451 sec in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode. The light curve can be modelled with a double broken power-law model with an initial decay index of $\alpha_1 = (2.2 \pm 0.1)$, a temporal break around $T + (3975 \pm 10)$ sec, a second decay index of $\alpha_2 = 0.434 \pm 0.001$, a second temporal break at $T + (150^{+10}_{-30})$ ks and a final decay index $\alpha_3 = 2.0 \pm 0.4$. Modest X-ray flaring activity is detected in the first 1000 sec of observation.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 1.85 ± 0.05 . The best-fitting absorption column is $1.60 \pm 0.15 \times 10^{21} \text{cm}^{-2}$, in excess

of the Galactic value of $2.2 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon index of $2.05_{-0.17}^{+0.16}$ and a best-fitting absorption column of $(1.0 \pm 0.3) \times 10^{21} \text{ cm}^{-2}$. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 3.8×10^{-11} (5.2×10^{-11}) $\text{erg cm}^{-2} \text{ count}^{-1}$.

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at http://www.swift.ac.uk/xrt_curves/00424716.

4 UVOT Observation and Analysis

The Swift/UVOT observed the field of GRB 100614A starting 123 s after the BAT trigger (Stratta, et al., 2010, GCN Circ. 10837). Settled observations started at 139 s. No white observations were taken due to the presence of the bright A0 star HD 159607 ($V = 7.4$) located 11.5 arcmin from the XRT source. We do not find any new source, relative to the DSS, USNO-B1.0, or 2MASS at the position of the XRT afterglow (Osborne, et al. 2010, GCN Circ. 10849). Preliminary 3-sigma upper limits for detecting a source in the u-band finding chart, and in the co-added images, using a 2.5 arcsecond radius circular aperture, are reported in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight corresponding to a reddening of $E_{B-V} = 0.03$ mag (Schlegel, et al., 1998, ApJS, 500, 525). All photometry is on the UVOT photometry system described in Poole et al. (2008, MNRAS, 383, 627).

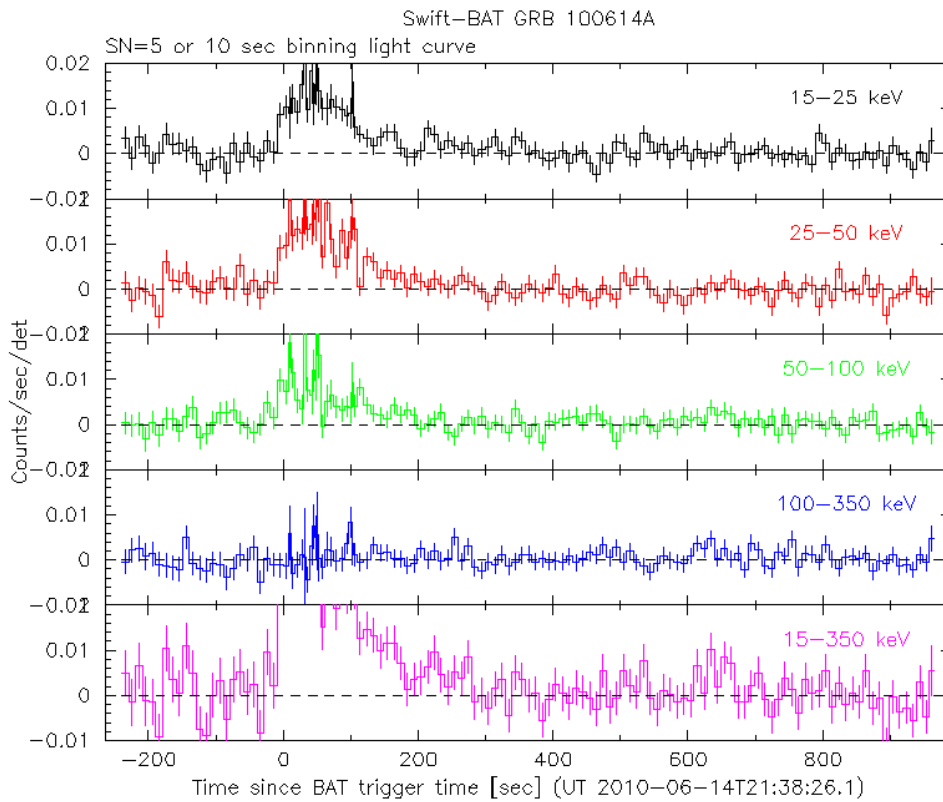


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts s^{-1} illuminated-detector $^{-1}$ (note illum-det = 0.16 cm^2).

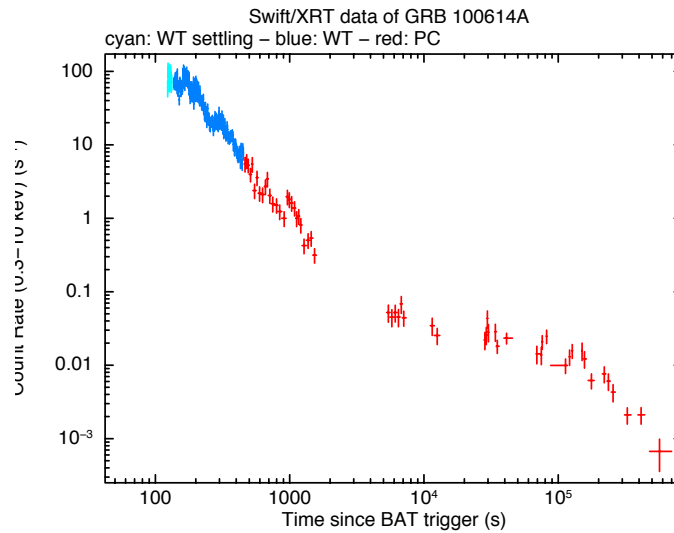


Figure 2: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion to observed (unabsorbed) flux is $1 \text{ count s}^{-1} \sim 3.8(5.2) \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.

| Filter | T_start (s) | T_stop (s) | Exp (s) | 3-sigma UL mag |
|--------|----------------|---------------|------------|-------------------|
| u(fc) | 139 | 339 | 246 | > 21.0 |
| v | 445 | 12065 | 1218 | > 21.4 |
| b | 395 | 7165 | 549 | > 21.8 |
| u | 139 | 6960 | 897 | > 21.7 |
| uvw1 | 494 | 13145 | 675 | > 21.2 |
| uvm2 | 770 | 12970 | 1102 | > 21.4 |
| uvw2 | 421 | 7365 | 484 | > 21.1 |

Table 1: Magnitude limits from UVOT observations.