Swift Observations of GRB 100504A

J. Mao (INAF-OAB), D. M. Palmer (LANL), M. H. Siegel (PSU), D.N. Burrows (PSU), P. Roming (PSU), N. Gehrels (NASA/GSFC) for the Swift Team

1 Introduction

At 19:20:59 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100504A (trigger=421124). Swift slewed immediately to the burst (Mao *et al.* GCN circ 10712). The enhanced Swift-XRT position RA (J2000)=17h 02m 17.13s, Dec(J2000)=-35d 35' 14.7" was given by Osborne *et al.* (GCN Cric. 10718).

The BAT light curve shows a double-peaked structure with a duration of about 30 sec. The peak count rate is 2500 counts/sec (15-350 keV), at 0 and 10 sec after the trigger. The XRT began observing the field 62.6 seconds after the BAT trigger. UVOT took a finding chart exposure of 150 seconds with the White filter starting 71 seconds after the BAT trigger. No credible afterglow candidate has been found in the initial data products.

Fermi-GBM triggered on GRB 100504A at 19:20:55.53 UT on 04 May 2010. The GBM light curve shows a single pulse with a duration (T90) of about 16 s (50-300 keV). The time-averaged spectrum from T0-6.1 to T0+23.6 s is best fit by a power-law with an exponential high-energy cutoff. The power-law index is $-0.82^{+0.17}_{-0.16}$, and the cutoff energy, parameterized as Epeak, is $85.7^{+8.0}_{-6.6}$ keV (Chaplin GCN circ 10723). Some optical limits have been obtained (Updike *et al.* GCN circ 10715, Schady *et al.* GCN circ 10717, Kuroda *et al.* GCN circ 10740).

2 BAT Observation and Analysis

Using the data set from T-239 to T+363 sec from the recent telemetry downlink, we report further analysis of BAT GRB 100504A (trigger 421124). The BAT ground-calculated position is RA, Dec = 255.575, -35.590 deg, which is RA(J2000) = 17h 02m 18.1s, Dec(J2000) = -35d 35' 23.0" with an uncertainty of 1.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 92%.

The mask-weighted light curve (Fig. 1) shows two overlapping peaks followed by a weak third peak, starting at T-10 sec, peaking at T+0, T+8, and T+90 sec, and ending at T+100 sec. T90 (15-350 keV) is 97.3 ± 7.3 sec (estimated error including systematics).

The time-averaged spectrum from T-9.7 to T+102.2 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.76 ± 0.10. The fluence in the 15-150 keV band is $(2.4 \pm 0.1) \times 10^{-6}$ erg cm^{-2}. The 1-sec peak photon flux measured from T+7.60 sec in the 15-150 keV band is (1.7 ± 0.2) ph cm^{-2} 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/421124/BA/`

3 XRT Observations and Analysis

The Swift-XRT began observing the field 62.6 seconds after the BAT trigger.

The light curve shows evidence of flaring in WT mode, peaking at about 83 s, after that, the light curve can be modelled with a double broken power-law in PC mode, with an initial decay index of $\alpha_1 = 2.86 \pm 0.54$ and the first break time is $470 \pm 73s$. The shallow decay index is $\alpha_2 = 0.57 \pm 0.05$

and the second break time is about $3.5 \times 10^4 s$. After that, the light curve has the third decay index of $\alpha_3 = 1.16 \pm 0.13$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 1.95 ± 0.09. The best-fitting absorption column is $(9.07 \pm 0.71) \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 3.77×10^{21} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $5.96 \times 10^{-11}(9.31 \times 10^{-11})$ erg cm^{-2} count^{-1}.

The spectrum formed from the expousure time 8.7 ks PC mode data can be fitted with an absorbed power-law with a photon spectral index of 2.40 ± 0.37 and the absorption column density is consistent with the Galactic one in the GRB direction. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $5.56 \times 10^{-11}(6.72 \times 10^{-11})$erg cm^{-2} count^{-1}.

The results of the XRT-team automatic analysis are available at

`http://www.swift.ac.uk/xrt_products/00421124`.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 100504A 72s after the BAT trigger. Data summed from the first and second orbits do not reveal a source at the enhanced position of the X-ray afterglow.

The 3-sigma upper limits for the finding chart (fc) and summed exposures are reported in Table 1:

FILTER	T_{start}(s)	T_{stop}(s)	Exposure (s)	Mag/3UL
white fc	72	222	147	> 20.39
white	73	1705	391	> 20.91
v	614	1755	136	> 18.54
b	713	1680	97	> 19.35
u	1463	1816	45	> 18.43
uvw1	836	1804	97	> 18.92
uvw2	762	1037	38	> 18.43

Table 1: Magnitudes from UVOT observations.

The above magnitudes are not corrected for the Galactic extinction corresponding to a reddening of $E_{B-V} = 0.87$ (Schlegel et al., 1998, ApJS, 500, 525). The photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

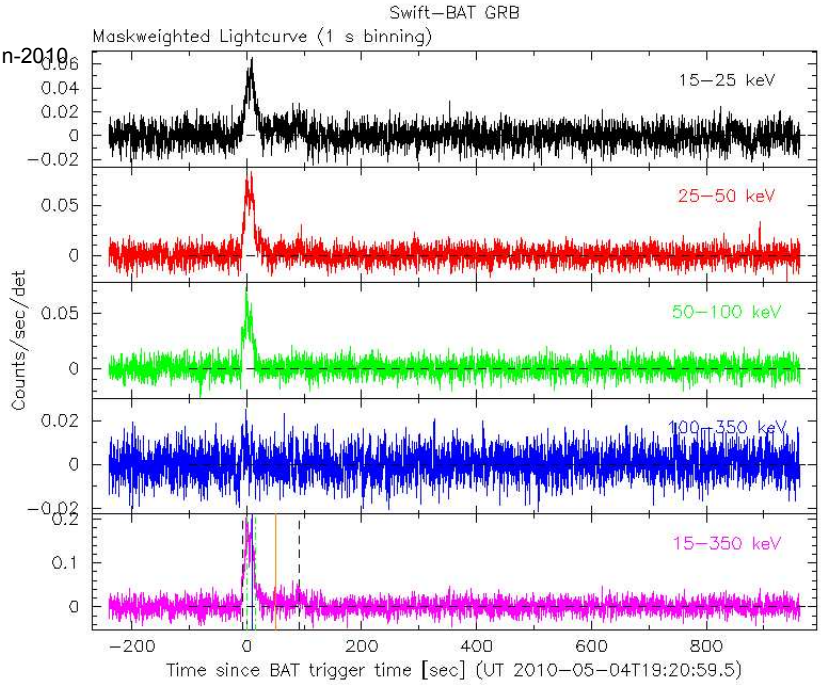

Figure 1: BAT Lightcurve. The mask-weighted light curve in the 4 individual plus total energy bands: 15-25 keV (black), 25-50 keV (red), 50-100 keV (green), 100-350 keV (blue), 15-350 keV (magenta).

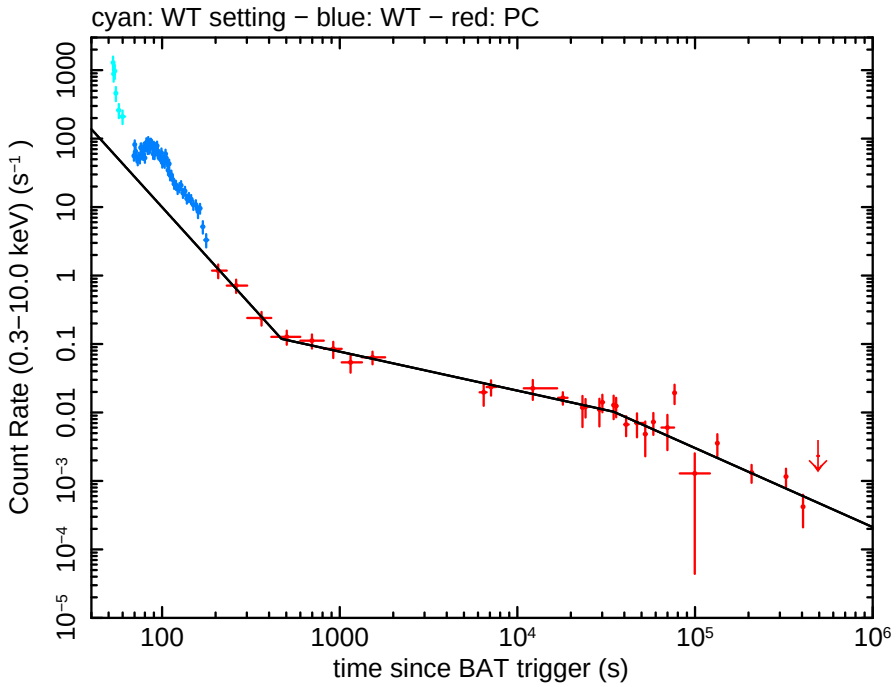

Figure 2: XRT Lightcurve in the 0.3-10 keV band. The approximate conversion is 1 count $s^{-1} \sim 5.6 \times 10^{-11}$ erg cm^{-2} s^{-1}.