Swift Observations of GRB 100424A

E. A. Hoversten (PSU), P. A. Curran (MSSL-UCL), M. C. Stroh (PSU), D. Grupe(PSU), H. A. Krimm (GSFC/USRA), S. D. Barthelmy (GSFC), D. N. Burrows (PSU), P. W. A. Roming (PSU), & N. Gehrels (GSFC) for the Swift Team

1 Introduction

At 16:32:42 UT on 24 April 2010 BAT triggered on and located GRB 100424A (Hoversten, *et al.*, *GCN Circ.* 10667, Trigger #420367). Swift slewed to this burst immediately. XRT began follow up observations at $T + 126$ s, and UVOT observations began at $T + 128$ s. Our best position is the UVOT-enhanced XRT position at RA($J2000$) = 209.44775 deg ($13h57m47.46s$), Dec($J2000$) = $+1.53897$ deg ($+01d32'20.3''$) with an uncertainty of 1.7 arcsec (radius, 90% confidence). The afterglow was not detected by UVOT.

Ground-based observations of GRB 100424A were reported by numerous observatories. Gemini/NIRI detected the afterglow in the J and K bands at $T + 14$ hrs (Cenko, *et al.*, *GCN Circ.* 10682) and confirmed that it was fading at $T + 17$ hrs (Cenko, *et al.*, *GCN Circ.* 10690). The spectral shape indicated that the red colors were due to large reddening rather than a large redshift. The CrAO observatory report the detection of a source in the R band 2.8" from the XRT position, but do not see a source at the Gemini position (Rumyantsev, *et al.*, *GCN Circ.* 10693). Optical non detections were reported by NOT (Malesani, *et al.*, *GCN Circ.* 10671), WHT (Levan, *et al.*, *GCN Circ.* 10672), PAIRITEL (Morgan, *et al.*, *GCN Circ.* 10675), GROND (Olivares, *et al.*, *GCN Circ.* 10676), Lulin (Huang, *et al.*, *GCN Circ.* 10677), MITSuME (Kuroda, *et al.*, *GCN Circ.* 10679), D50 (Strobl, *et al.*, *GCN Circ.* 10681), and Liverpool Telescope (Cano, *et al.*, *GCN Circ.* 10687). The afterglow was not detected at 8.46 GHz (Frail & Chandra, *GCN Circ.* 10701).

2 BAT Observation and Analysis

Using the data set from $T - 60$ to $T + 243$ s further analysis of GRB 100424A (trigger #420367) was performed by the Swift team (Krimm, *et al.*, *GCN Circ.* 10667). The BAT ground-calculated position is RA($J2000$) = 209.453 deg ($13h57m48.6s$), Dec($J2000$) = $+1.512$ deg ($+01d30'44.2$") with an uncertainty of 1.5 arcmin, (radius, sys+stat, 90% containment). The partial coding was 88%.

The mask-weighted light curve shows a single broad peak from about $T + 20$ to $T + 150$ s. T_{90} ($15 - 350keV$) is 104 ± 15.5 s (estimated error including systematics).

The time-averaged spectrum from $T + 22.3$ to $T + 148.5s$ is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.83 ± 0.13. The fluence in the 15-150 keV band is $1.5 \pm 0.1 \times 10^{-6} erg\ cm^{-2}$. The 1-second peak photon flux measured from $T + 58.28$ s in the 15-150 keV band is 0.4 ± 0.1 $photon\ cm^{-2}\ s^{-1}$. All the quoted errors are at the 90% confidence level.

The BAT light curve is shown in Figure 1.

3 XRT Observations and Analysis

The UVOT-enhanced XRT position of GRB 100424A is RA($J2000$) = 209.44775 deg ($13h57m47.46s$), Dec($J2000$) = $+1.53897$ deg ($+01d32'20.3''$) with an uncertainty of 1.7 arcsec (radius, 90% confidence, Evans, *et al.*, *GCN Circ.* 10669). This position is within 1.5 arcsec of the near infrared position reported by Cenko, *et al.*, *GCN Circ.* 10682.

XRT observations began 126 seconds after the BAT trigger. Analysis of 641 s of XRT data from 126

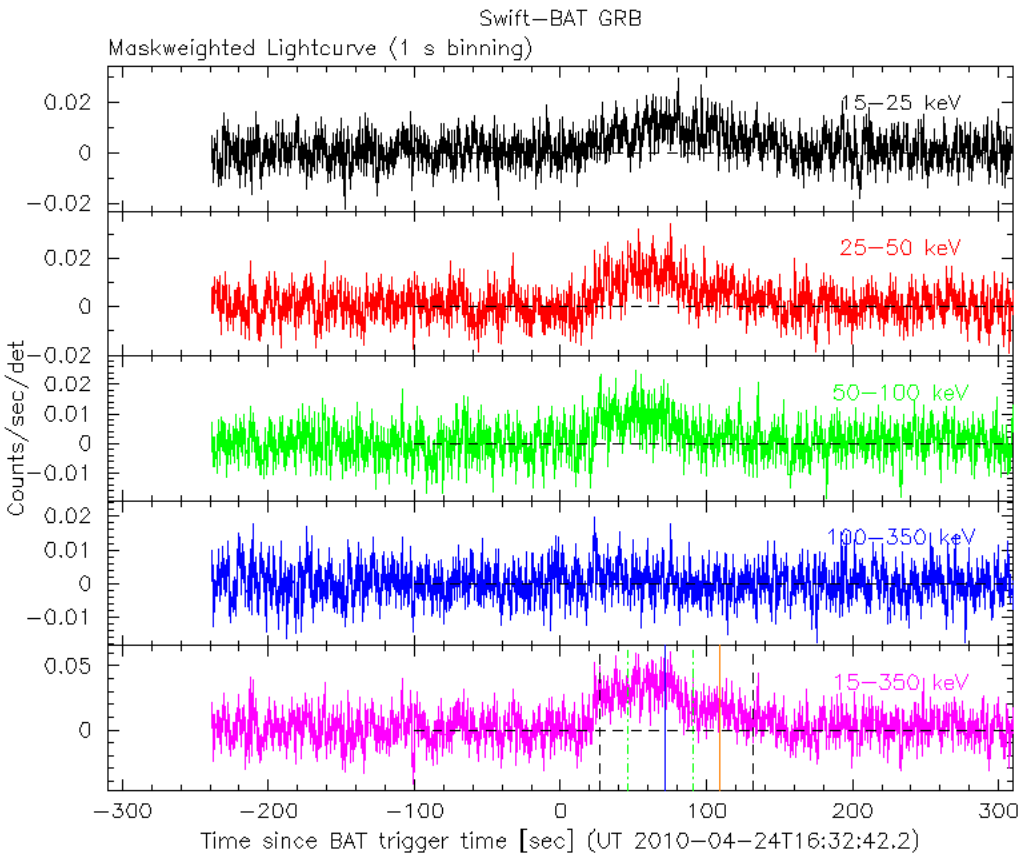

Figure 1: BAT Light curve. The mask-weighted light curve over all energy bands. The units are counts/s/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 16:32:42.2 UT.

to 769 s after the BAT trigger was performed (Stroh, *et al.*, *GCN Circ.* 10674). The data comprise of 509 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode. The light curve can be modeled with a series of power-law decays. The initial decay index is $\alpha = 0.63 \pm 0.14$. At $T + 288$ s the decay steepens to $\alpha = 1.41^{+0.27}_{-0.19}$ before breaking again at $T + 526$ s to a final decay with index $\alpha = 2.8^{+0.9}_{-0.6}$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 1.26 ± 0.06. The best-fitting absorption column is $1.62^{+0.22}_{-0.21} \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 2.3×10^{20} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 5.8×10^{-11} (6.5×10^{-11}) $erg\ cm^{-2}\ count^{-1}$.

The XRT light curve is shown in Figure 2.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 100424A 128 s after the BAT trigger (Curran & Hoversten, *GCN Circ.* 10688). No optical afterglow consistent with the UVOT-enhanced XRT position or at the position of the NIR counterpart (Cenko, *et al.*. *GCN Circ.* 10682) is detected in the UVOT exposures. Upper limits are summarized in Table 1. The magnitudes reported in the table are on the UVOT Photometric System (Poole et al., 2008, MNRAS 383,627). They are

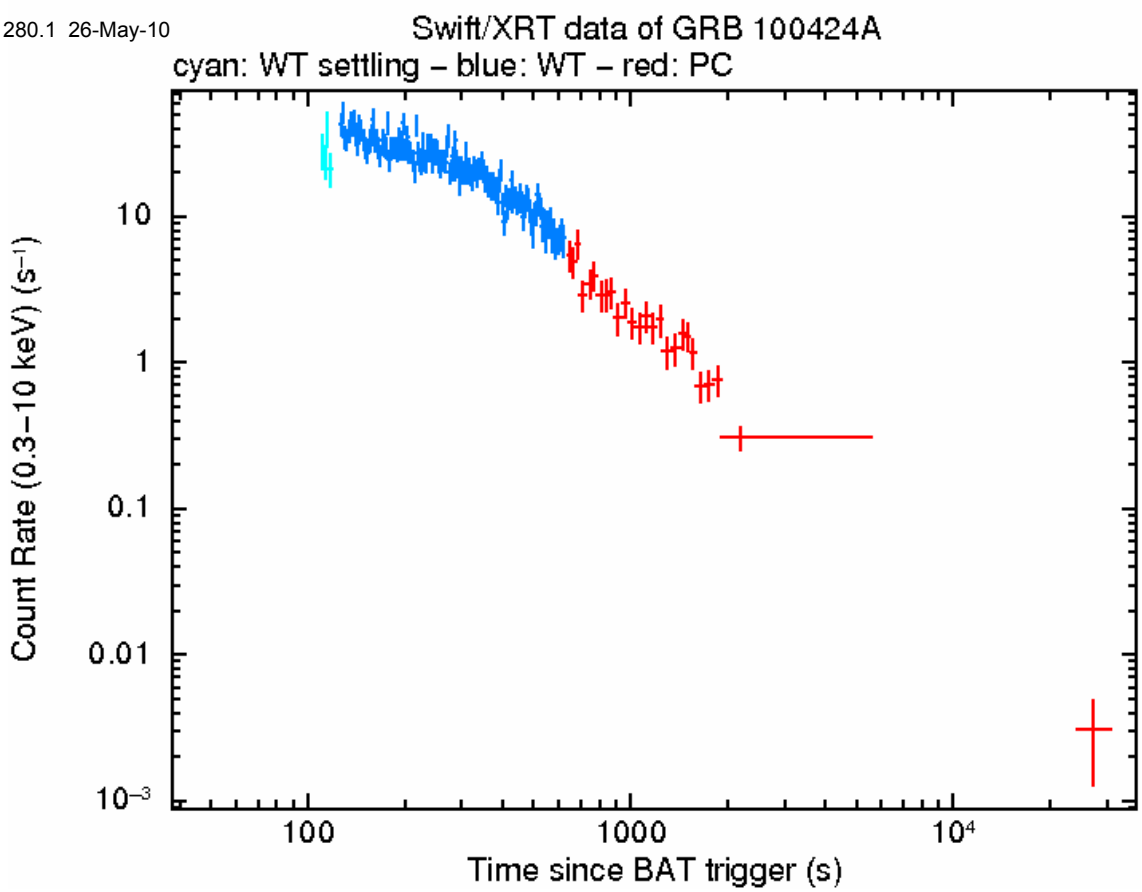

Figure 2: XRT Light curve. Flux in the 0.3-10 keV band: settling exposure (cyan), Window Timing Mode (blue), and Photon Counting mode (red). The approximate conversion is 1 count $s^{-1} \simeq 5.8 \times 10^{-11}$ ergs cm^{-2} s^{-1}.

not corrected for Galactic extinction which is $E(B-V) = 0.08$ along the line of sight to the burst (Schlegel, Finkbeiner, & Davis, 1998).

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Filter	Start	Stop	Exposure	Magnitude
white	128	278	147	> 20.8 (FC)
u	288	537	246	> 20.0 (FC)
white	128	2046	444	> 21.2
v	618	1930	156	> 19.2
b	543	2028	156	> 20.1
u	288	2003	382	> 20.1
uvw1	668	1979	156	> 19.7
uvm2	642	1955	97	> 19.1
uvw2	594	5584	193	> 20.0

Table 1: UVOT observations