

## Swift Observations of GRB 100628A

*S. Immler (CRESST/GSFC/UMD), R. L. C. Starling (U Leicester), P.A. Evans (U Leicester), S. D. Barthelmy (GSFC), and T. Sakamoto (GSFC/UMBC) for the Swift Team*

### 1 Introduction

BAT triggered on GRB 100628A on 2010-06-28 at 08:16:40 UT (trigger 426114; GCN 10895). The BAT light curve shows a single hard spike with duration of about 0.1 sec (Fig. 1).

GRB 100628A was also detected with the SPI Anti-Coincidence System (ACS) on-board INTEGRAL. The SPI-ACS light curve shows the peak of the burst at 2010-06-28 08:16:41 with a maximum count-rate of  $\sim 600$  counts/50 msec. The duration of the GRB is about 0.05 seconds (GCN 10898).

The XRT data show an X-ray source within the BAT error circle. However, the lack of credible fading suggests that the X-ray source is unrelated to the GRB. A second X-ray source within the BAT error circle is only present in the first two orbits of data totaling 3.8 ks and might be related to the afterglow.

No optical afterglow was detected by UVOT and no fading afterglow has been found by ground-based observatories, including Magellan/Baade (GCN 10902, 10911), Gemini-North (GCN 10909), and GROND (GCN 10910).

### 2 BAT Observation and Analysis

The data set from  $T_0-240$  to  $T_0+577$  was analyzed to obtain the following information. The BAT ground-calculated position is RA, Dec = 225.943,  $-31.653$  deg, which is

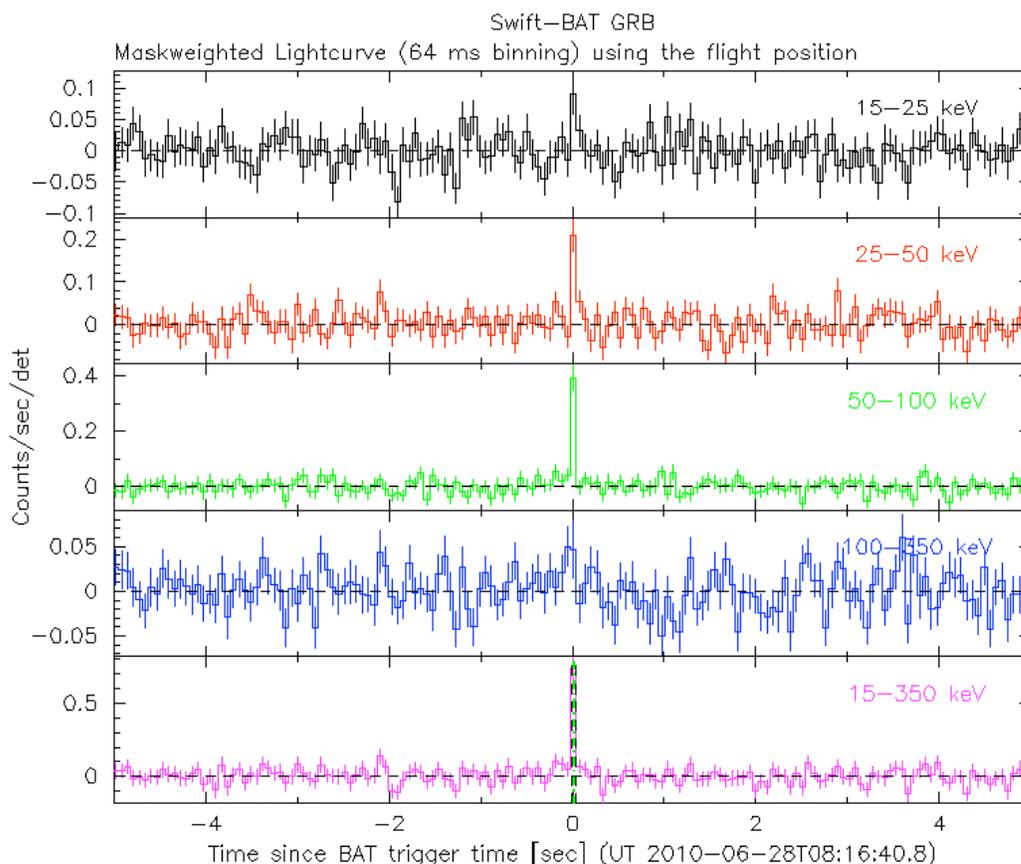
$$\text{RA(J2000)} = 15\text{h } 03\text{m } 46.2\text{s}$$

$$\text{Dec(J2000)} = -31\text{d } 39' 10.2''$$

with an uncertainty of 2.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 70%. The mask-weighted light curve shows two overlapping peaks starting at  $\sim T_0$  to  $\sim T_0+0.04$  sec.  $T_{90}$  (15–350 keV) is  $0.036 \pm 0.009$  sec (sys+stat).

The time-averaged spectrum from  $T_0-0.004$  to  $T_0+0.036$  sec is equally well fit by the exponential cutoff powerlaw and a blackbody: Exponential cutoff: photon index  $-2.67 \pm 1.8/-3.7$ , and  $E_{\text{peak}}$  of  $74.1 \pm 11.4$  keV (chi squared 60.5 for 56 d.o.f.). Blackbody:  $kT = 19.8 \pm 2.9$  (chi squared 61.0 for 57 d.o.f.).

The total fluence in the 15–150 keV band is  $2.5 \pm 0.5 \times 10^{-8}$  erg  $\text{cm}^{-2}$  and the 1-sec peak flux measured from  $T_0-0.48$  sec in the 15–150 keV band is  $0.5 \pm 0.1$  ph  $\text{cm}^{-2}$   $\text{sec}^{-1}$ . A fit to a simple power law gives a photon index of  $1.26 \pm 0.25$  (chi squared 81.3 for 57 d.o.f.). All the quoted errors are at the 90% confidence level.



**Figure 1:** BAT light curves. The mask-weighted 64 ms light curves in the four individual plus total energy bands. The units are  $\text{count s}^{-1} \text{ illuminated-detector}^{-1}$  and  $T_0$  is 2010-06-28 08:16:40.8 UT.

### 3 XRT Observation and Analysis

The XRT began observing the field 86.0 seconds after the BAT trigger for a total exposure time of 64.5 ks. No source was detected in the promptly available XRT data. A source was detected during ground processing at the  $>3$ -sigma confidence level within the BAT refined error circle at

$$\text{RA (J2000)} = 15\ 03\ 53.52$$

$$\text{Dec (J2000)} = -31\ 39\ 49.7$$

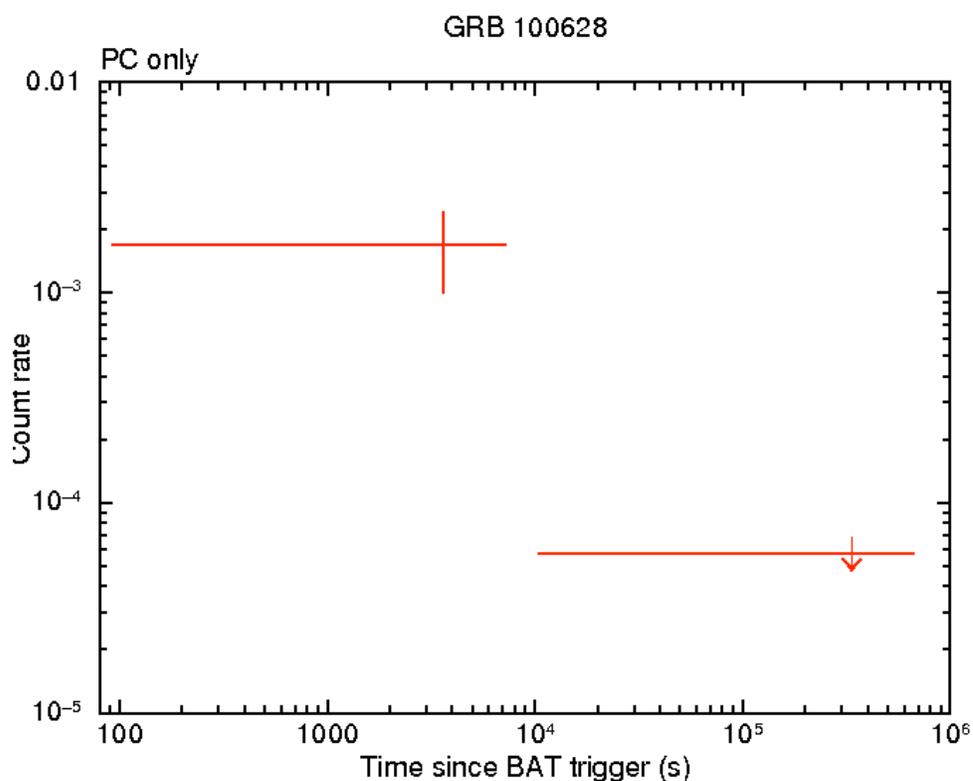
with an error of 4.7 arcsec (radius, 90% containment). There is no evidence for fading of this source, and we conclude that this is not the afterglow but may be a background AGN (GCN 10907).

Further analysis revealed a second X-ray source within the BAT error circle, located at

$$\text{RA (J2000.0)} = 15\ 03\ 52.41$$

$$\text{Dec (J2000.0)} = -31\ 39\ 30.2$$

with an uncertainty of 7 arcseconds (radius, 90% containment). This source was only present in the first two orbits of data totaling 3.8 ks from  $T_0+92$  s to  $T_0+7200$  s, with a 0.3–10 keV count rate of  $0.0017 (+0.0008, -0.0006)$  counts  $s^{-1}$  (see Fig. 2). The source comprised just 7 counts, however the predicted background level is only 0.7 counts in this time interval. Using the Bayesian method described in Kraft, Burrows & Nousek (1991) we find a detection significance  $>99.999\%$ . In the subsequent XRT data ( $>T_0+7200$  s) the source was no longer detected; a 3-sigma upper limit on the 0.3-10 keV count rate is  $5.7 \times 10^{-5}$  count  $s^{-1}$ . Therefore, if this source was real it has faded and can be considered a candidate X-ray afterglow (GCN 10941). We caution that with so few total counts a background fluctuation or other spurious detection cannot be completely ruled out.



**Figure 2:** XRT light curve of the weak and fading X-ray source inside the BAT error circle in the 0.3–10 keV band.

#### 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 100628A 90 s after the BAT trigger (GCN 10901). No optical afterglow consistent with any of the XRT positions above is detected in the UVOT exposures. Preliminary 3-sigma upper limits using the UVOT photometric system (Poole et al. 2008, MNRAS, 383, 627) for the first finding chart (FC) exposure and subsequent exposures are:

Filter	T <sub>start</sub> (s)	T <sub>stop</sub> (s)	Exp(s)	Mag/3UL
White FC	90	239	147	>20.2
u FC	302	551	246	>19.4
white	90	11409	1498	>21.4
v	631	12968	1099	>19.5
b	557	7133	471	>20.1
u	302	6928	697	>20.2
w1	680	6722	471	>19.6
m2	4882	6517	393	>19.3
w2	607	12315	1176	>20.3

The values quoted above are not corrected for the Galactic extinction due to the reddening of  $E(B-V) = 0.17$  in the direction of the burst (Schlegel et al. 1998).