

## Swift Observations of GRB 120927A

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### 1 Introduction

BAT triggered on GRB 120927A at 22:40:46 UT (trigger 534815) (Maselli et al., *GCN Circ.* 13822). This was a rate-trigger on a long burst with  $T_{90} = 43 \pm 18$  s (Palmer et al., *GCN Circ.* 13828). *Swift* immediately slewed to this burst. XRT and UVOT follow-up observations started 138 and 158 seconds after the trigger, respectively.

The best *Swift* position is the enhanced XRT location: RA (J2000) = 136.61376 deg ( $09^h 06^m 27.30^s$ ), Dec (J2000) = +0.41620 deg ( $00^d 24' 58.3''$ ) with an uncertainty of 1.4 arcsec (90% confidence; Beardmore et al., *GCN Circ.* 13824).

The optical afterglow was not detected by UVOT (Immler & Maselli, *GCN Circ.* 13829) and by other ground-based telescopes (Rossi et al., *GCN Circ.* 13827; Andreev et al., *GCN Circ.* 13842).

### 2 BAT Observation and Analysis

Using the data set from T−239 to T+963 s, the refined analysis of BAT GRB 120927A has been performed by the *Swift* team and reported in Palmer et al. (*GCN Circ.* 13828).

The BAT ground-calculated position is RA (J2000) = 136.606 deg ( $09^h 06^m 25.3^s$ ), Dec (J2000) = 0.420 deg ( $00^d 25' 13.5''$ )  $\pm 1.0$  arcmin (radius, systematic and statistical, 90% containment). The partial coding was 64%.

The mask-weighted light curve (Fig.1) shows multiple overlapping peaks with an overall FRED profile starting about T−15 seconds and significant until about T+32 seconds.  $T_{90}$  (15–350 keV) is  $43 \pm 18$  s (estimated error including systematics).

The time-averaged spectrum from T−37.94 to T+41.04 s is best fitted by a power law model with an exponential cutoff. This fit gives a photon index of  $0.63 \pm 0.38$  and  $E_{peak}$  of  $66.1 \pm 9.6$  keV ( $\chi^2=50.98$  for 56 d.o.f.). For this model the total fluence in the 15–150 keV band is  $(2.6 \pm 0.3) \times 10^{-6}$  erg  $\text{cm}^{-2}$  and the 1-sec peak flux measured from T−3.93 s in the 15–150 keV band is  $1.6 \pm 0.2$  ph  $\text{cm}^{-2}$   $\text{s}^{-1}$ . A fit using a simple power law model gives a photon index of  $1.64 \pm 0.08$  ( $\chi^2 = 77.30$  for 57 d.o.f.). 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/534815/BA/](http://gcn.gsfc.nasa.gov/notices_s/534815/BA/)

### 3 XRT Observations and Analysis

The whole XRT dataset for GRB 120927A consists of 10.7 ks of data from 138 s to 52.8 ks after the BAT trigger. The data comprise 18 s in Windowed Timing (WT) mode (8 s taken while *Swift* was settling and 10 s in pointing mode) with the remainder in Photon Counting (PC) mode.

The enhanced XRT position for this burst was given by Beardmore et al. (*GCN Circ.* 13824). Using 4566 s of XRT PC mode data and 10 UVOT images, the astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is RA (J2000) = 136.61376 deg (09<sup>h</sup>06<sup>m</sup>27.30<sup>s</sup>), Dec (J2000) = 0.41620 deg (00<sup>d</sup>24′58.3″) ± 1.4 arcsec (90% confidence).

A preliminary refined analysis, carried out analysing 7.9 ks of XRT data from 138 s to 29.1 ks after the BAT trigger, has been reported in Stroth et al. (*GCN Circ.* 13826). The 0.3–10 keV light curve (Fig. 2) can be modelled with a broken power-law decay with the following best fit parameters:  $\alpha_1 = 0.94_{-0.06}^{+0.04}$ ,  $T_{break1} = +11.5$  ks;  $\alpha_2 = 2.6_{-0.7}^{+1.7}$ . A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of  $\Gamma = 1.75_{-0.17}^{+0.18}$ . The best-fitting absorption column is  $(2.8 \pm 0.7) \times 10^{21}$  cm<sup>-2</sup>, in excess of the Galactic value of  $3.2 \times 10^{20}$  cm<sup>-2</sup> (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from this spectrum is  $4.7 \times 10^{-11}$  ( $6.5 \times 10^{-11}$ ) erg cm<sup>-2</sup> count<sup>-1</sup>.

The results of the XRT-team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_curves/00534815](http://www.swift.ac.uk/xrt_curves/00534815)

## 4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 120927A 158 s after the BAT trigger (Immler & Maselli, *GCN Circ.* 13829).

No optical afterglow consistent with the enhanced XRT position (Beardmore et al., *GCN Circ.* 13824) is detected in the initial UVOT exposures. Preliminary 3-sigma upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the first finding chart (FC) and subsequent exposures are listed in Table 1. The quoted upper limits are not corrected for the Galactic extinction due to the reddening of  $E_{B-V} = 0.04$  in the direction of the burst (Schlegel et al. 1998, ApJS, 500, 525).

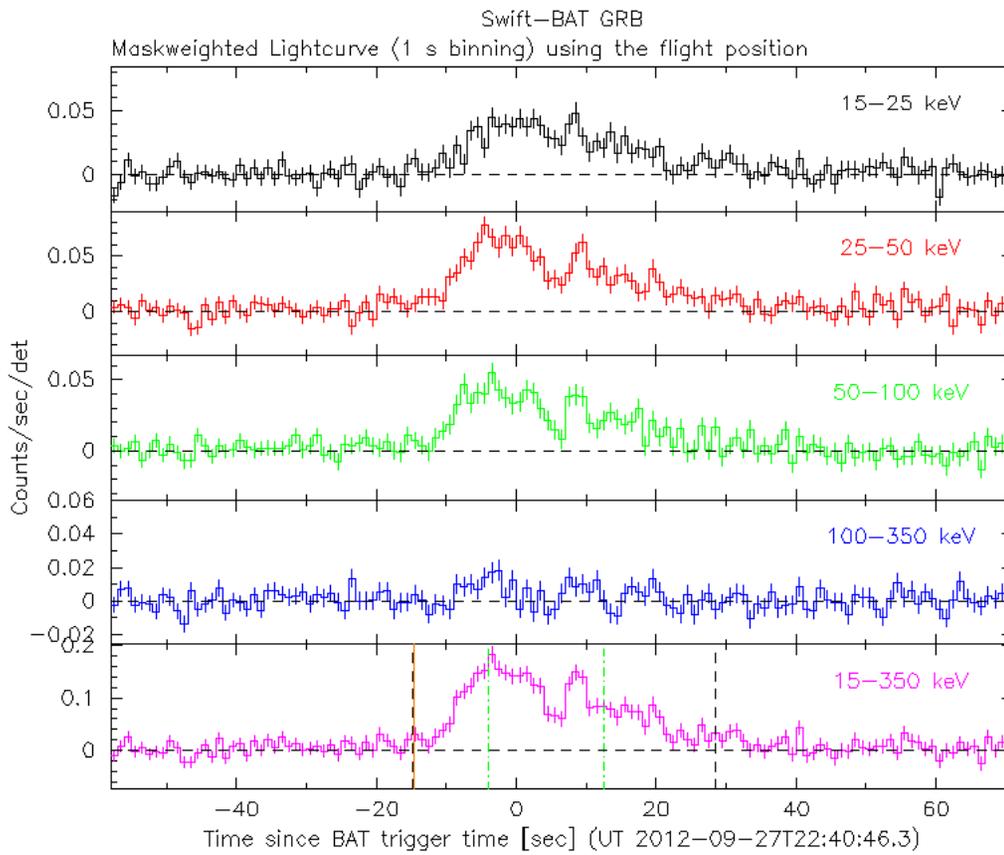


Figure 1: BAT light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts  $\text{s}^{-1}$  illuminated-detector $^{-1}$  (note illum-det = 0.16  $\text{cm}^2$ ).

Filter	Start	Stop	Exposure	3-Sigma UL
WHITE (FC)	158	308	147	> 20.3
U (FC)	317	567	246	> 19.5
V	648	6625	317	> 19.1
B	572	6127	432	> 20.1
U	317	5921	659	> 20.2
UVW1	697	5717	413	> 19.6
UVM2	672	5511	225	> 19.6
UVW2	623	6537	432	> 20.3
WHITE	158	6331	580	> 21.0

Table 1: 3-sigma upper limits from UVOT observations.

