

Swift Observations of GRB 130605A

S. T. Holland (STScI), S. D. Barthelmy (GSFC), A. Melandri (INAF/OAB), and B. Porterfield (PSU) report for the Swift Team

1 Introduction

Swift/BAT triggered on GRB 130605A on 2012 June 5 at 23:41:42 UT (Trigger 557508) (Holland et al. 2013). This was a long-soft burst with a duration of $T_{90} = 12.6$ s (Barthelmy et al. 2013). *Swift* slewed immediately to this burst and follow-up observations started with the XRT 92.6 s after the BAT trigger and UVOT 96 s after the BAT trigger. The best *Swift* position is the UVOT location, RA, Dec (J2000.0) = 134°5359, $-33^{\circ}4612$, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 08^{\text{h}}58^{\text{m}}08^{\text{s}}61 \\ \text{Dec (J2000.0)} &= -33^{\circ}27'40''.2 \end{aligned}$$

with an uncertainty of $0''.50$ (radius, 90% containment, including systematics).

2 BAT Observation and Analysis

The BAT data set from $T - 61$ to $T + 242$ s was analysed to obtain the following information. The BAT ground-calculated position is RA, Dec (J2000.0) = 134°536, $-33^{\circ}477$, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 08^{\text{h}}58^{\text{m}}08^{\text{s}}7 \\ \text{Dec (J2000.0)} &= -33^{\circ}28'37'' \end{aligned}$$

with an uncertainty of $1''.7$, (radius, systematic + statistical errors, 90% containment). The partial coding was 5%.

The mask-weighted light curve (Figure 1) shows a single peak starting at about $T - 5$ s, peaking at about $T + 2$ s, and ending at about $T + 45$ s. T_{90} (15–350 keV) is 12.6 ± 3.1 s (estimated error including systematics).

The time-averaged spectrum from $T - 6.48$ to $T + 9.18$ s is best fit by a power law with a photon index of 1.58 ± 0.17 . The total fluence in the 15–150 keV band is $(2.6 \pm 0.3) \times 10^{-6}$ erg cm^{-2} . The 1-s peak photon flux measured from $T - 0.14$ s in the 15–150 keV band is 4.1 ± 0.9 ph cm^{-2} s^{-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/557508/BA/.

3 XRT Observation and Analysis

The *Swift*/XRT began observing GRB 130605A at 23:43:14.6, 92.6 s after the BAT trigger. The astrometrically corrected X-ray position (using the XRT–UVOT alignment and matching UVOT field sources to the USNO-B1.0 catalogue) is RA, Dec (J2000.0) = 134°5357, $-33^{\circ}4615$ (Melandri et al. 2013), which corresponds to

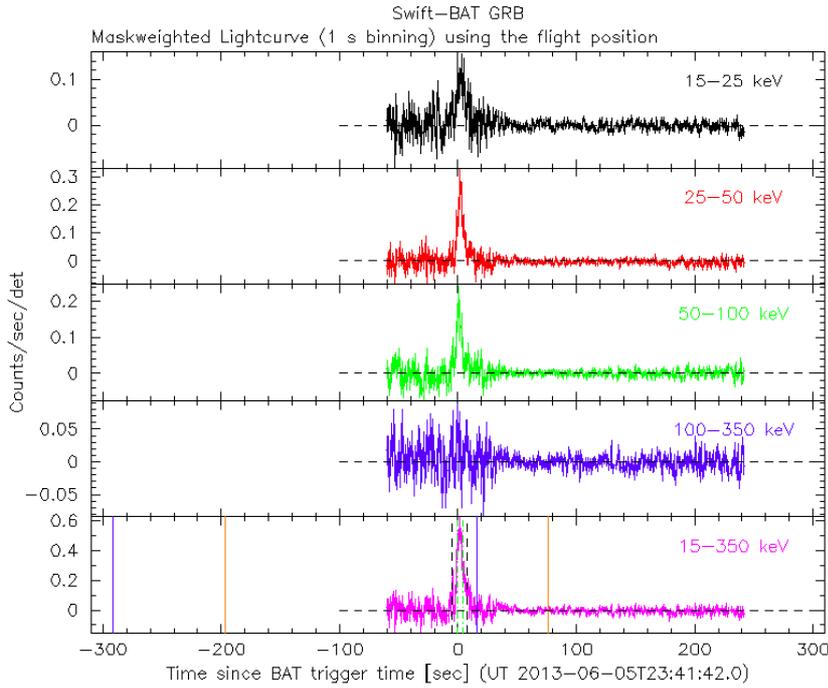


Figure 1: BAT light curves. The mask-weighted 1 s light curves in the four individual plus total energy bands. The units are count s^{-1} illuminated-detector $^{-1}$ and T_0 is 23:41:42.0 UT.

$$\begin{aligned} \text{RA (J2000.0)} &= 08^{\text{h}}58^{\text{m}}08.^{\text{s}}57 \\ \text{Dec (J2000.0)} &= -33^{\circ}27'41''.5 \end{aligned}$$

with an uncertainty of $1''.8$ (radius, 90% containment).

The X-ray light curve (Figure 2) can be modelled with a power-law decay with an index of $\alpha = 1.24 \pm 0.05$.

A spectrum formed from the Windowed Timing mode data can be fit with an absorbed power-law with a photon spectral index of $2.3^{+0.5}_{-0.3}$. The best-fitting absorption column is $2.35^{+1.96}_{-0.16} \times 10^{21}$ cm^{-2} in excess of the Galactic value of 2.2×10^{21} cm^{-2} (Kalberla et al. 2005). The counts-to-observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from this spectrum is 2.7×10^{-11} (5.0×10^{-11}) erg cm^{-2} count^{-1} . The results of the XRT team's automated analysis are available at http://www.swift.ac.uk/xrt_products/00557508.

4 UVOT Observation and Analysis

The *Swift*/UVOT observed of the field of GRB 130605A starting 78 s after the BAT trigger with settled observations starting at 96 s. There is a source consistent with the optical position (Guelbenzu et al. 2013) in the initial UVOT exposures (see Figure 3). The UVOT position RA, Dec (J2000.0) = $134^{\circ}5359$, $-33^{\circ}4612$, which corresponds to

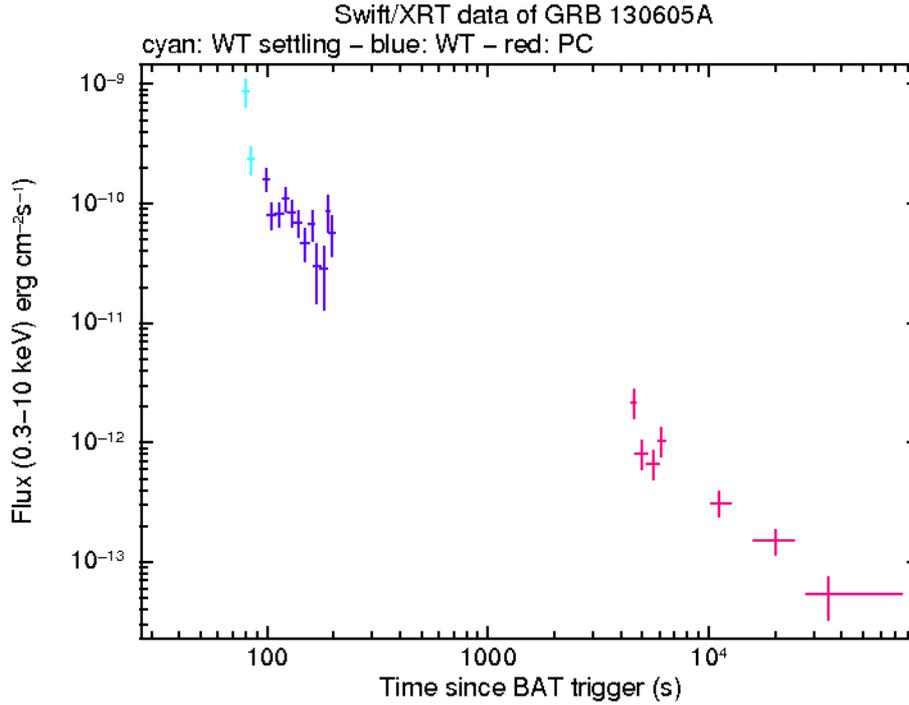


Figure 2: XRT flux light curves in $\text{erg cm}^{-2} \text{s}^{-1}$ in the 0.3–10 keV band: Settling mode (cyan), Windowed Timing mode (blue), and Photon Counting mode (red). The conversion factor to observed (unabsorbed) flux is 2.7×10^{-11} (5.0×10^{-11}) $\text{erg cm}^{-2} \text{count}^{-1}$.

$$\begin{aligned} \text{RA (J2000.0)} &= 08^{\text{h}}58^{\text{m}}08^{\text{s}}.61 \\ \text{Dec (J2000.0)} &= -33^{\circ}27'40''.2 \end{aligned}$$

Preliminary magnitudes and $3\text{-}\sigma$ upper limits using the UVOT photometric system (Breeveld et al. 2011) for the finding chart (FC) and coadded exposures are given in Table 1. These data are not corrected for the Galactic extinction due to the reddening of $E_{B-V} = 0.32$ mag in the direction of the burst (Schlafly et al. 2011).

References

- Barthelmy, S. D., et al., 2013, GCN Circ. 14787
 Breeveld et al., 2011, AIP Conf. Proc. 1358, 373
 Nicuesa Guelbenzu, A., et al., 2013, GCN Circ. 14774
 Holland, S. T., et al., 2013, GCN Circ. 14773
 Kalberla, P. M. W., et al., 2005, A&A, 440, 775
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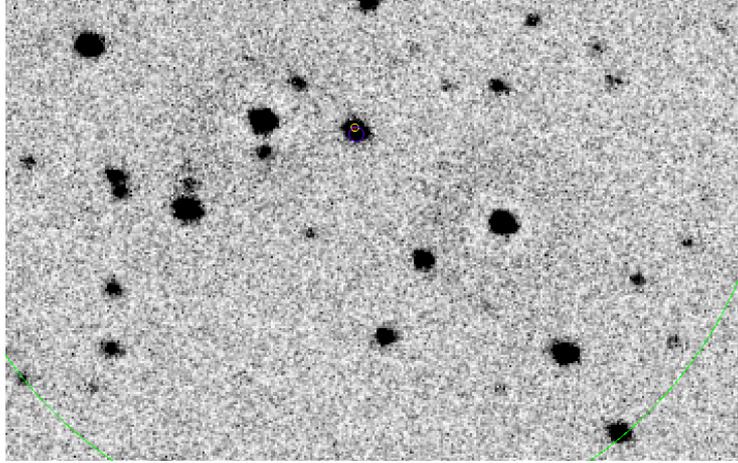


Figure 3: UVOT white finding chart for GRB 130605A. The green circle is the BAT error circle, the blue circle indicates the UVOT-enhanced XRT error circle, the yellow circle is the Guelbenzu et al. (2013) position, and the red circle is the UVOT error circle. North is up and east is to the left.

Filter	T_{start}	T_{stop}	Exp (s)	Mag	Err
white (FC)	96	202	105	16.40	0.07
<i>v</i>	4474	6109	393	19.90	0.36
<i>b</i>	5294	30 053	1355	> 21.7	
<i>u</i>	5089	35 820	3306	> 21.5	
uvw1	4884	35 150	3778	> 21.6	
uvm2	4679	34 243	2860	> 21.0	
uvw2	5705	39 258	421	> 20.3	
white	5498	5698	196	21.04	0.29

Table 1: UVOT detections and $3\text{-}\sigma$ upper limits for GRB 130605A. T_{start} and T_{stop} are the times, in seconds since the BAT trigger, of the start and stop of the observations. Exp is the total exposure time.