

## Swift Observation of GRB 130122A

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### 1 Introduction

BAT triggered on GRB 130122A at 23:44:09 UT (Trigger 546731) (Lien *et al.*, *GCN Circ.* 14140). This was a 12.16 sec rate-trigger on a long burst with  $T_{90} = 64 \pm 36$  sec. Swift slewed to this burst immediately and XRT began follow-up observations at  $T + 116.9$  sec, and UVOT at  $T + 121$  sec. Our best position is the UVOT location RA(J2000) = 194.28459 deg, Dec(J2000) = -59.01487 deg, which is equivalent to

RA (J2000) = 12h 57m 08.30s

Dec (J2000) = +59d 00' 53.5"

with an estimated uncertainty of 0.53 arc sec. (radius, 90% confidence).

The optical/NIR afterglow is also detected by the 1.0 meter T100 telescope and the Russian-Turkish 1.5-m telescope at the TUBITAK National Observatory (Sonbas *et al.*, *GCN Circ.* 14141; Galeev *et al.*, *GCN Circ.* 14152), the MASTER II robotic telescope (Gorbovskoy *et al.*, *GCN Circ.* 14142), RATIR (Butler *et al.*, *GCN Circ.* 14147), and the ISON-Kislovodsk observatory (Volnova *et al.*, *GCN Circ.* 14148)

### 2 BAT Observation and Analysis

Using the data set from T-61 to T+242 sec from recent telemetry downlinks, the BAT team reported further analysis of GRB 130122A (Barthelmy *et al.*, *GCN Circ.* 14146). The BAT ground-calculated position is RA, Dec = 194.307, 59.003 deg, which is

RA(J2000) = 12h 57m 13.8s

Dec(J2000) = +59d 00' 09.2"

with an uncertainty of 3.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 89%.

The mask-weighted light curve (Fig 1) shows a single roughly FRED-like peak starting at T+0 sec, peaking at T+10 sec, and ending at T+100 sec.  $T_{90}$  (15-350 keV) is  $64 \pm 36$  sec (estimated error including systematics).

The time-averaged spectrum from T-12.6 to T+67.4 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.34 \pm 0.24$ . The fluence in the 15-150 keV band is  $7.4 \pm 1.1 \times 10^{-7}$  erg  $\text{cm}^{-2}$ . The 1-sec peak photon flux measured from T+10.92 sec in the 15-150 keV band is  $0.4 \pm 0.1$  ph  $\text{cm}^{-2} \text{sec}^{-1}$ . 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/546731/BA/](http://gcn.gsfc.nasa.gov/notices_s/546731/BA/)

### 3 XRT Observations and Analysis

Using 488 s of XRT Photon Counting mode data and 1 UVOT images for GRB 130122A, an astrometrically corrected X-ray position is found (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue; Beardmore *et al.*, *GCN Circ.* 14143): RA, Dec = 194.28517 deg, +59.01455 deg, which is equivalent to:

RA (J2000): 12h 57m 8.44s

Dec (J2000): +59d 00' 52.4"  
with an uncertainty of 1.8 arcsec (radius, 90% confidence).

Furthermore, the XRT team analyzed 9.6 ks of XRT data for GRB 130122A, from 102 s to 29.4 ks after the BAT trigger (D'Elia *et al.*, *GCN Circ.* 14145). The data comprise 76 s in Windowed Timing (WT) mode (the first 8 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode.

The light curve (Fig. 2) can be modelled with a power-law decay with a decay index of  $\alpha=1.27$  ( $\pm 0.04$ ).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 1.67 (+0.21, -0.20). The best-fitting absorption column is  $6.3 (+5.3, -4.6) \times 10^{20} \text{ cm}^{-2}$ , in excess of the Galactic value of  $9.3 \times 10^{19} \text{ cm}^{-2}$  (Kalberla *et al.* 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $4.3 \times 10^{-11}$  ( $4.8 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{ count}^{-1}$ .

A summary of the PC-mode spectrum is thus:

Total column:  $6.3 (+5.3, -4.6) \times 10^{20} \text{ cm}^{-2}$

Galactic foreground:  $9.3 \times 10^{19} \text{ cm}^{-2}$

Excess significance: 1.9 sigma

Photon index: 1.67 (+0.21, -0.20)

The results of the XRT-team automatic analysis are available at  
[http://www.swift.ac.uk/xrt\\_products/00546731](http://www.swift.ac.uk/xrt_products/00546731).

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 130122A 121 s after the BAT trigger (Breeveld *et al.*, *GCN Circ.* 14149). A source consistent with the XRT position reported in (Beardmore *et al.*, *GCN Circ.* 14143) is seen in the initial exposures.

Filter	T_start(s)	T_stop(s)	Exp(s)	Mag
white_FC	121	271	148	$18.75 \pm 0.09$
white	559	579	19	$18.57 \pm 0.23$
v	609	629	19	$>17.9$
b	535	555	19	$18.35 \pm 0.32$
u	279	529	246	$18.49 \pm 0.14$
uvw1	3974	5610	393	$>20.9$
uvm2	5205	5404	197	$>20.0$
uvw2	4795	4995	197	$>20.4$

Table 1: Magnitudes and limits from UVOT observations

The preliminary UVOT position is:

RA (J2000) = 12:57:08.30 = 194.28459 (deg)

Dec (J2000) = +59:00:53.5 = 59.01487 (deg)

with an estimated uncertainty of 0.53 arc sec. (radius, 90% confidence).

Preliminary detections and 3-sigma upper limits using the UVOT photometric system (Breeveld *et al.* 2011, AIP Conf. Proc. 1358, 373) for the finding chart (FC) and earliest exposures are shown in Table 1.

The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of

$E(B-V) = 0.01$  in the direction of the burst (Schlegel et al. 1998).

The UVOT light curves are shown in Fig. 3.

## References

- [1] Barthelmy et al. 2013, GCN Circ. 14146
- [2] Beardmore et al. 2013, GCN Circ. 14143
- [3] Breeveld et al. 2011, AIP Conf. Proc. 1358, 373
- [4] Breeveld et al. 2013, GCN Circ. 14149
- [5] Butler et al. 2013, GCN Circ. 14147
- [6] DELia et al. 2013, GCN Circ. 14145
- [7] Galeev et al. 2013, GCN Circ. 14152
- [8] Gorbovskoy et al. 2013, GCN Circ. 14142
- [9] Kalberla, P. M. W., Burton, W. B., Hartmann, D., et al. 2005, A&A, 440, 775
- [10] Lien et al. 2013, GCN Circ. 14140
- [11] Schlegel, D. J. 2013, Finkbeiner, D. P., & Davis, M. 1998, ApJ., 500, 525
- [12] Sonbas et al. 2013, GCN Circ. 14141
- [13] Volnova et al. 2013, GCN Circ. 14148

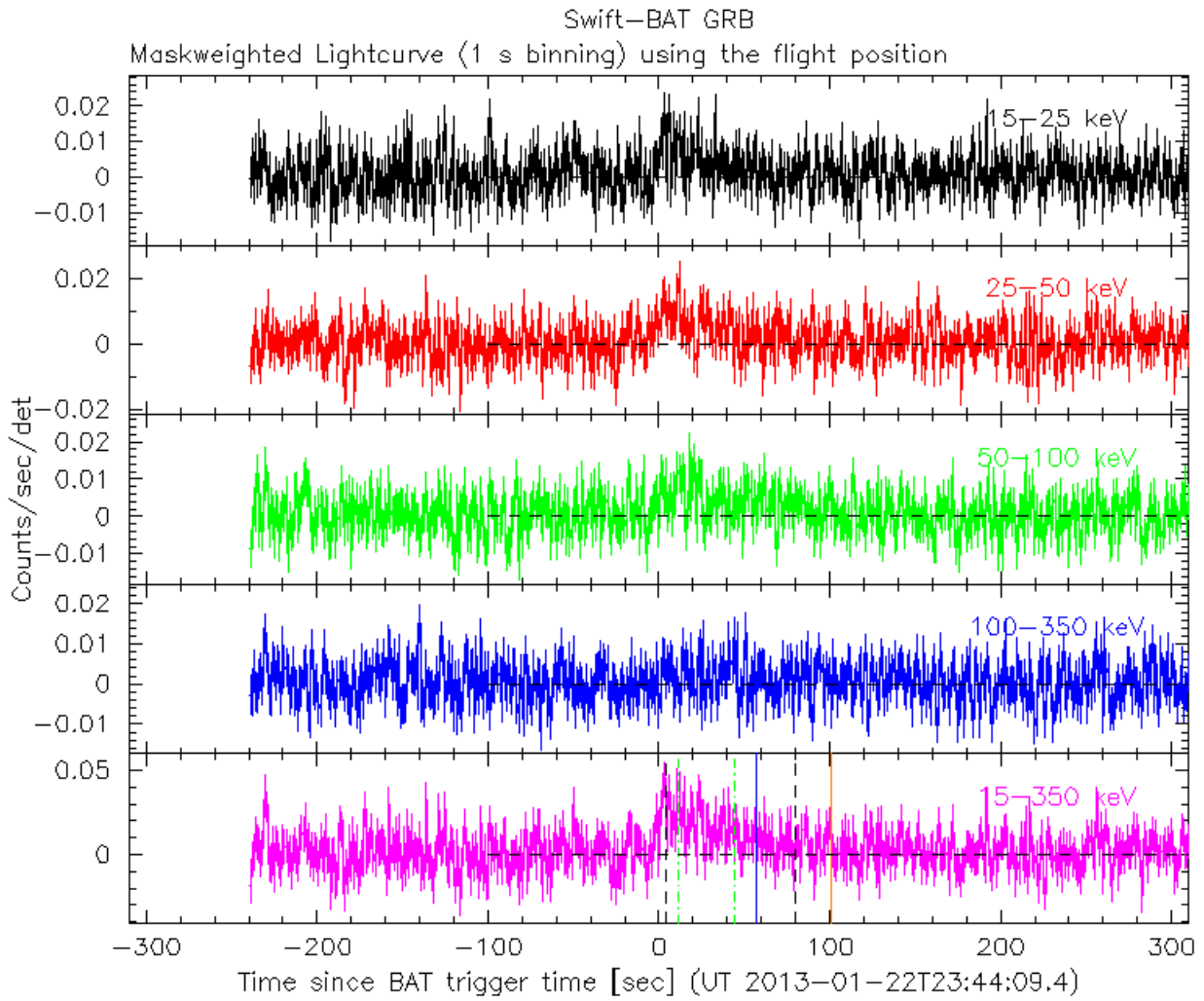


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det =  $0.16\text{cm}^2$ ) and  $T_0$  is 23:44:09 UT.

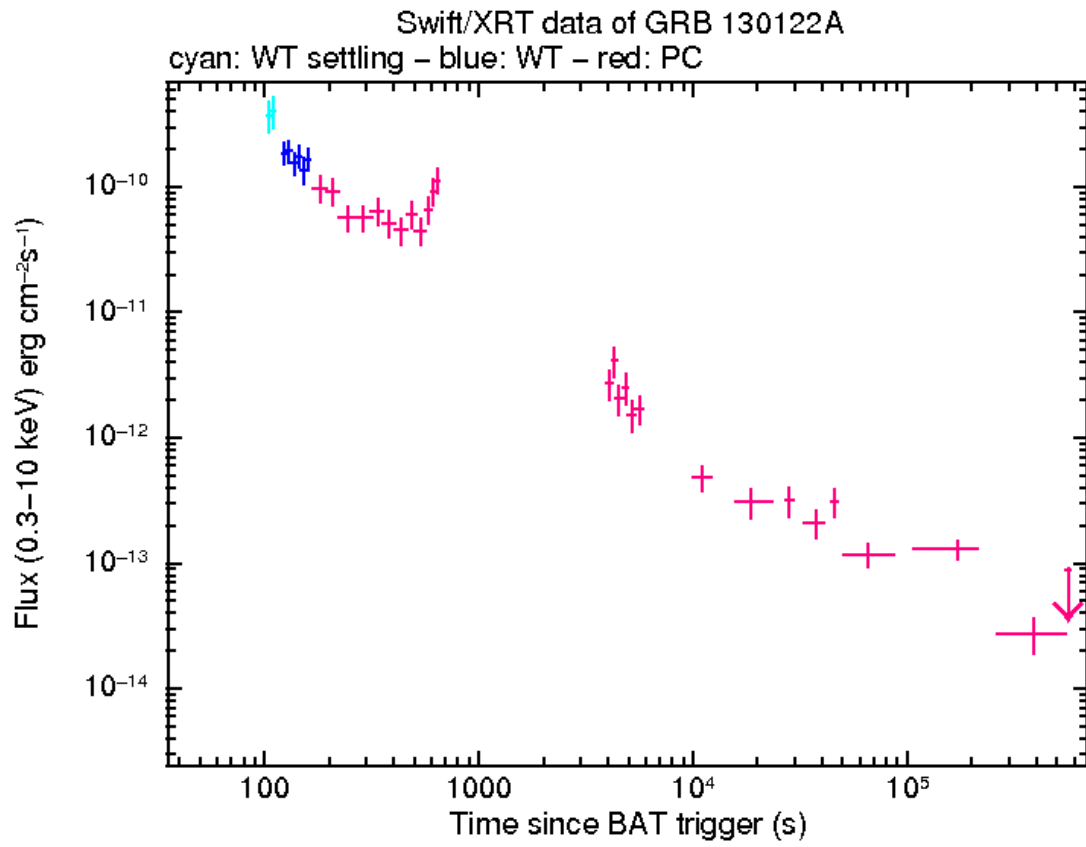


Figure 2: XRT Lightcurve in the 0.3-10 keV band: Window Timing Setting mode (cyan), Window Timing mode (black), Photon Counting mode (red).

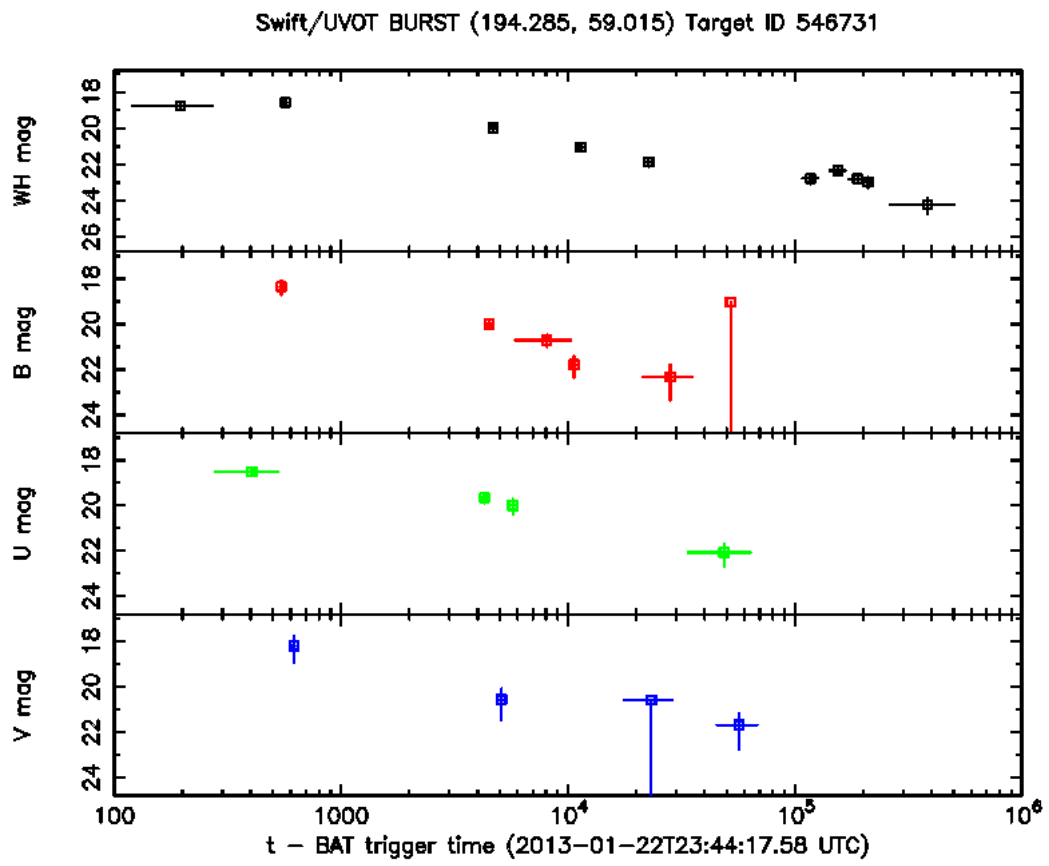


Figure 3: UVOT Lightcurve.