# Swift Observations of GRB 111022B

*S. T. Holland (CRESST/USRA/GSFC), T. Ukwatta (MSU), M. Stamatikos (OSU), V. D'Elia, G. Stratta (ASDC), and N. P. M. Kuin (MSSL-UCL) for the* Swift *Team*

## 1 Introduction

BAT triggered on GRB 111022B on 2011 Oct 22 at 17:13:04 UT (Trigger 506074) (Holland et al. 2011). This was a long burst with $T_{90} = 79.1$ s (Markwardt et al. 2011). *Swift* slewed immediately to this burst and follow-up observations started with the XRT at $T + 137.3$ s and UVOT at $T + 144$ s. The best *Swift* position is the UVOT-enhanced XRT location, RA, Dec (J2000.0) = 108.°96498, +49.°68362, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 07^{\rm h}15^{\rm m}51.^{\rm s}59 \\ \text{Dec (J2000.0)} &= +49^\circ 41' 01.''0 \end{aligned}$$

with an uncertainty of 1.″8 (radius, 90% containment, including systematics). No optical afterglow was detected by UVOT.

An infrared afterglow was detected by Gemini-North (Levan et al. 2011). GTC reported the afterglow in the $z'$ band (Gorosabel et al. 2011) and BTA observed the afterglow in the $I_C$ band (Moskvitin et al. 2011). MASTER measured a decay index of $\alpha \approx 1.0 \pm 0.1$ in the $R$ band (Parhomenko et al. 2011). EVLA found a radio afterglow for GRB 111022B (Zauderer & Berger 2011).

## 2 BAT Observation and Analysis

The BAT data set from $T - 239$ to $T + 963$ s was analysed to obtain the following information. The BAT ground-calculated position is RA, Dec (J2000.0) = 108.°927, +49.°663, which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 07^{\rm h}15^{\rm m}42.^{\rm s}4 \\ \text{Dec (J2000.0)} &= +49^\circ 39' 46'' \end{aligned}$$

with an uncertainty of 2.′0, (radius, systematic + statistical errors, 90% containment). The partial coding was 82% and the boresite angle was 30.°4.

The mask-weighted light curves (Figure 1) shows a multipeak structure starting at about $T - 50$ s and ending at about $T + 60$ s. $T_{90}$ (15–350 keV) is $79.1 \pm 13.5$ s (estimated error including systematics).

The time-averaged spectrum from $T - 47.84$ to $T + 53.80$ s is best fit by a simple power-law model with a photon index of $1.59 \pm 0.20$. The fluence in the 15–150 keV band is $(9.0 \pm 1.2) \times 10^{-7}$ erg cm$^{-2}$. The 1-s peak photon flux measured from $T + 49.54$ s in the 15–150 keV band is $0.4 \pm 0.3$ 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/506074/BA/.

## 3 XRT Observation and Analysis

The *Swift*/XRT began observing GRB 111022B at 17:15:21.8 UT, 137.3 s after the BAT trigger. Using 885 s of Photon Counting (PC) mode data and one UVOT image the astrometrically corrected $X$-ray position (using the XRT–UVOT alignment and matching UVOT field sources to the USNO-B1.0

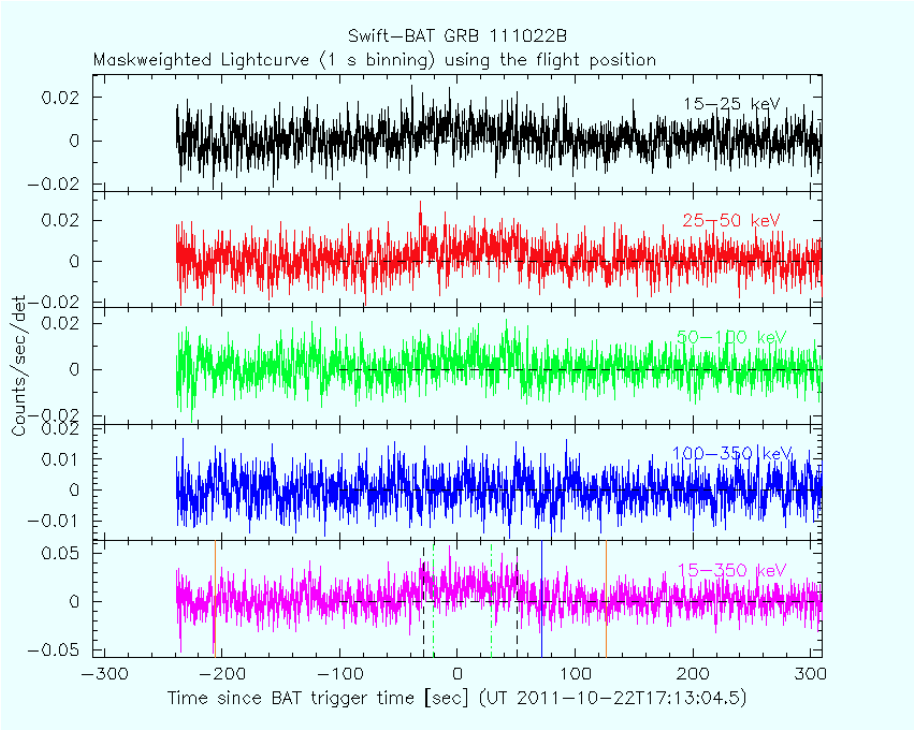


Figure 1: BAT light curves. The mask-weighted 1 s light curves in the four individual plus total energy bands. The units are count $s^{-1}$ illuminated-detector$^{-1}$ and $T_0$ is 17:13:04.5 UT.

catalogue) is RA, Dec (J2000.0) = 108.°96498, +49.°68362, (Beardmore et al. 2011) which corresponds to

$$\begin{aligned} \text{RA (J2000.0)} &= 07^{\rm h}15^{\rm m}51.^{\rm s}59 \\ \text{Dec (J2000.0)} &= +49^\circ 41' 01.''0 \end{aligned}$$

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

The $X$-ray light curve (Figure 2) can be modelled with a series of power-law decays and a flare. The initial decay index is $\alpha_1 = 1.7 \pm 0.9$. At $T+176$ s the decay steepens to $\alpha_2 = 3.64^{+0.26}_{-0.22}$ before breaking again at $T + 404$ s ¡to a final decay with $\alpha_3 = 2.05^{+0.26}_{-0.21}$. A spectrum formed from the WT mode data can be fit with an absorbed power-law with a photon spectral index of $2.41^{+0.14}_{-0.13}$. The best-fitting absorption column is $1.46^{+0.27}_{-0.26} \times 10^{21}$ cm$^{-2}$ in excess of the Galactic value of $7.3 \times 10^{20}$ cm$^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon spectral index of $1.59^{+0.15}_{-0.12}$. The results of the XRT team's automated analysis are available at http://www.swift.ac.uk/xrt_products/00506074.

## 4 UVOT Observation and Analysis

The *Swift*/UVOT began settled observations of the field of GRB 111022B at $T + 144$ s. No optical afterglow consistent with the UVOT-enhanced (Goad et al. 2008) XRT position (Beardmore et al. 2011) is detected in any of the UVOT exposures (see Figure 3). Preliminary 3-$\sigma$ upper limits using the UVOT photometric system (Poole et al. 2008) for the finding chart (FC) exposures and the coadded exposures are given in Table 1. These upper limits are not corrected for the Galactic extinction due to the reddening of $E_{B-V} = 0.07$ mag in the direction of the burst (Schlegel et al. 1998).

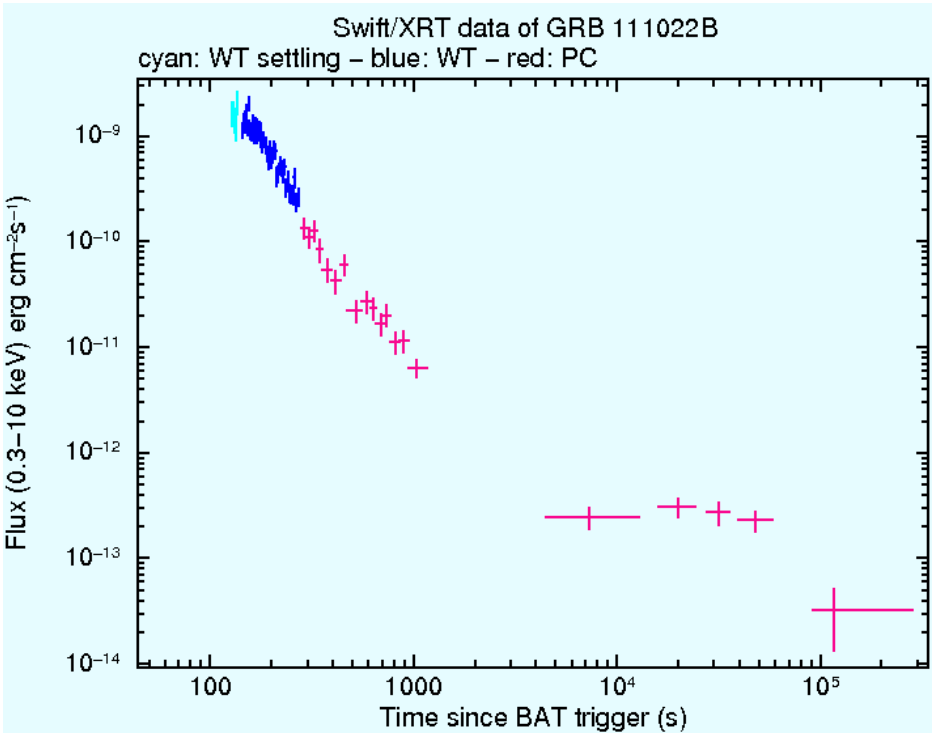


Figure 2: XRT flux light curves in erg cm$^{-2}$ s$^{-1}$ in the 0.3–10 keV band: Window Timing settling mode (cyan), Window Timing mode (blue), Photon Counting mode (red). The conversion factor to observed (unabsorbed) flux is $4.5 \times 10^{-11}$ ($5.0 \times 10^{-11}$)erg cm$^{-2}$ count$^{-1}$.

## References

Beardmore, A. P., et al., 2011, GCN Circ. 12478

Goad, M. R., et al., 2008, A&A, 492, 873

Gorosabel, J., et al., 2011, GCN Circ. 12494

Holland, S. T., et al., 2011, GCN Circ. 12472

Kalberla, P. M. W., et al., 2005, A&A, 440, 775

Levan, A. J., et al., 2011 GCN Circ. 12481

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Moskvitin, A. S., et al., 2011, GCN Circ. 12491

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Zauderer, A., & Berger, E., et al., 2011, GCN Circ. 12495

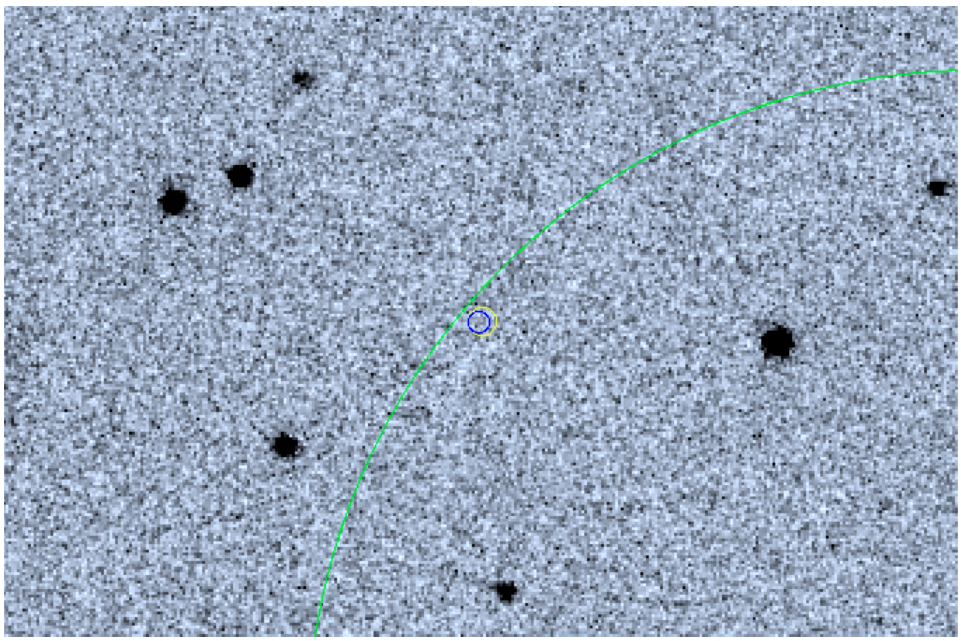

Figure 3: UVOT white finding chart for GRB 111022B. The green circle indicates the refined BAT error circle and the blue circle indicates the UVOT-enhanced XRT error circle. North is up and east is to the left.

| Filter | $T_{\rm start}$ | $T_{\rm stop}$ | Exp(s) | Mag | |
|---|---|---|---|---|---|
| white (FC) | 145 | 294 | 147 | $> 20.8$ | 3-$\sigma$ UL |
| $u$ (FC) | 303 | 552 | 246 | $> 20.0$ | 3-$\sigma$ UL |
| $v$ | 635 | 6091 | 452 | $> 19.8$ | 3-$\sigma$ UL |
| $b$ | 559 | 6912 | 452 | $> 20.3$ | 3-$\sigma$ UL |
| $u$ | 302 | 6707 | 678 | $> 20.4$ | 3-$\sigma$ UL |
| uvw1 | 685 | 6501 | 432 | $> 20.3$ | 3-$\sigma$ UL |
| uvm2 | 659 | 6296 | 452 | $> 20.3$ | 3-$\sigma$ UL |
| uvw2 | 608 | 5886 | 255 | $> 20.1$ | 3-$\sigma$ UL |
| white | 145 | 6975 | 606 | $> 21.3$ | 3-$\sigma$ UL |

Table 1: UVOT 3-$\sigma$ upper limits for GRB 111022B. $T_{\rm start}$ and $T_{\rm stop}$ are the times, in seconds since the BAT trigger, of the start and stop of the observations. Exp is the total exposure time. FC indicates a finding chart image.