

## Swift Observation of GRB 081230

*V. La Parola, B. Sbarufatti, V. Mangano (INAF-IASFPa), D. Palmer (LANL), S. Oates (UCL-MSSL), T.S., Holland (CRESST/GSFC/USRA), S.D. Barthelmy (GSFC), D.N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC) for the Swift Team*

### 1 Introduction

At 20:36:12 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 081230 (trigger=338633; La Parola, et al., GCN Circ. 8753). Swift slewed immediately to the burst, and the narrow field instruments started their observations 124 and 132 seconds (XRT and UVOT respectively) after the trigger .

The best Swift position is that determined from the UVOT white filter detection of the afterglow at RA(J2000)= 02<sup>h</sup>29<sup>m</sup>19.467<sup>s</sup> (37.331113 deg), Dec(J2000)= -25<sup>d</sup> 08' 51.0" (-25.1475 deg), with a 90% confidence interval of 0.9 arcsec (Oates et al., GCN Circ.8757).

The afterglow was detected on ground by the ROTSE-IIIc telescope (Yuan, et al., GCN Circ. 8754) 700.8 s after the burst, at magnitude 19.1 and by the GROND observatory (Afonso et al. GCN Circ. 8760) 4.2 hours and 33.99 hours after the burst at magnitudes  $\sim 21$  and  $\sim 23$  respectively.

### 2 BAT Observation and Analysis

Using the data set from T-300 to T+1197 sec, the BAT ground-calculated position (Palmer, et al., GCN Circ. 8753) is RA, Dec = 37.330, -25.145 deg corresponding to

RA(J2000) = 02h 29m 19.2s

Dec(J2000) = -25d 08' 42.6"

with an uncertainty of 1.4 arcmin, (radius, sys+stat, 90% containment). The partial coding was 100%.

The mask-weighted light curve (Figure 1) consists of a series of overlapping peaks ranging from T+5 sec to T+70 sec, with the strongest emission at  $\sim T+50$  seconds. T90 (15-350 keV) is  $60.7 \pm 13.8$  sec (estimated error including systematics).

The time-averaged spectrum from T-14.4 to T+62.4 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.97 \pm 0.16$ . The fluence in the 15-150 keV band is  $8.2 \pm 0.8 \times 10^{-7}$  erg/cm<sup>2</sup>. The 1-sec peak photon flux measured from T+46.63 sec in the 15-150 keV band is  $0.7 \pm 0.1$  ph/cm<sup>2</sup>/sec. 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/338633/BA/](http://gcn.gsfc.nasa.gov/notices_s/338633/BA/)

### 3 XRT Observations and Analysis

We report on the analysis of the XRT observations for GRB 081230 (La Parola et al. GCN Circ 8753), with an exposure time of 104 s in WT mode and 11.4 ks in PC mode. The astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is RA, Dec = 37.3314 -25.1477, corresponding to:

RA (J2000): 02h 29m 19.53s

Dec (J2000): -25d 08' 51.8

with an uncertainty of 1.8 arcsec (radius, 90% confidence, Osborne et al. GCN Circ 8756).

The lightcurve (Figure 2) can be fitted with a power-law with two breaks, with the following parameters:

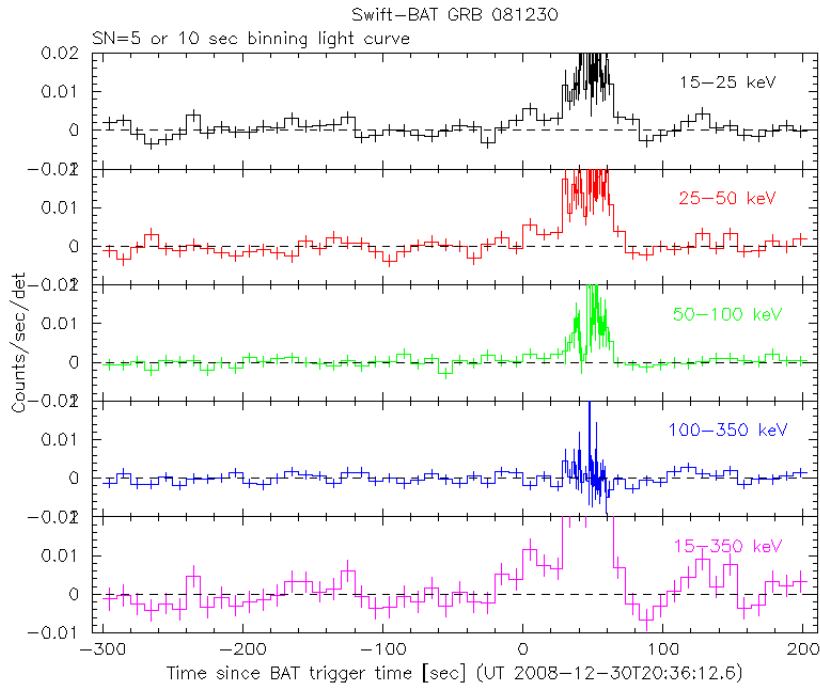


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts  $s^{-1}$  illuminated-detector $^{-1}$  and  $T_0$  is 2008-12-30 20:36:12 UT.

$$\alpha_1 = -6.910 \pm 0.007$$

$$T_{\text{break}1} = 288 \pm 7$$

$$\alpha_2 = -0.73 \pm 0.3$$

$$T_{\text{break}2} = 1 \times 10^5 \text{ (fixed)}$$

$$\alpha_3 = -1.6 \pm 0.4$$

There is evidence for a late flare peaking at 5000s.

The spectrum (Figure 3) of the data collected in WT mode (with exposure time 104 s) can be fitted with a powerlaw with photon index  $\Gamma = 1.96 \pm 0.11$ , absorbed by the Galactic column in this direction of  $1.7 \times 10^{20} \text{ cm}^{-2}$ , plus an intrinsic column of  $(6.4 \pm 2.2) \times 10^{20} \text{ cm}^{-2}$ . The observed (unabsorbed) flux over this time is  $1.03 \times 10^{-9}$  ( $1.3 \times 10^{-9}$ )  $\text{erg cm}^{-2} \text{ s}^{-1}$ , corresponding to a counts to observed flux conversion of  $4.1 \times 10^{11} \text{ erg cm}^{-2} \text{ count}^{-1}$ . The spectrum of the data collected in PC mode (with exposure time 111.4 ks) can be fitted with a powerlaw with photon index  $\Gamma = 2.14_{-0.20}^{+0.10}$ , with an intrinsic column of  $(5.3_{-3.7}^{+2.2}) \times 10^{20} \text{ cm}^{-2}$ . The observed (unabsorbed) flux over this time is  $2.1 \times 10^{-12}$  ( $2.7 \times 10^{-12}$ )  $\text{erg cm}^{-2} \text{ s}^{-1}$ .

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations the field of GRB 081230 132 s after the BAT trigger (La Parola et al., GCN Circ. 8753). The optical afterglow was detected in the white, v, b and u filters at the position:

$$\text{RA(J2000.0)} = 02:29:19.467$$

$$\text{DEC(J2000.0)} = -25:08:51.0$$

with an estimated uncertainty of 0.9 arcsec (radius, 90% confidence). This position is consistent with the UVOT-enhanced XRT position (Osborne et al., GCN 8756) and the optical afterglow position

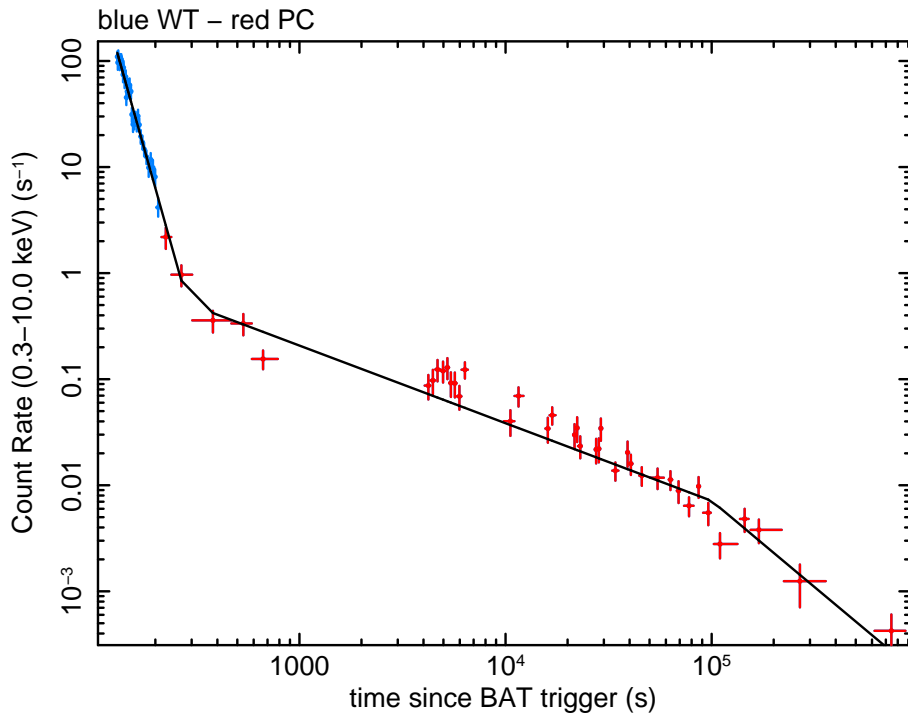


Figure 2: XRT Lightcurve. Counts  $\text{s}^{-1}$  in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is  $1 \text{ count s}^{-1} \sim 3.5 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ .

reported by ROTSE-III (Yuan et al., GCN 8754).

The magnitudes and 3 sigma upper limits are reported in Table 1. These magnitudes have not been corrected for the Galactic extinction, which corresponds to a reddening of  $E_{B-V} = 0.01$  mag (Schlegel et al., 1998, ApJS, 500, 525). The photometry is on the UVOT flight system described in Poole et al. (2008, MNRAS, 383,627). The u filter lightcurve can be seen in Figure 4. The arrows represent data points with a signal to noise of less than 2 and are 3 sigma upper limits.

Filter	T_start (s)	T_stop	Exposure	Mag/ $3\sigma$ UL
white	4060	4210	147	$20.45 \pm 0.35$
v	587	607	19	$18.30 \pm 0.48$
b	388	408	19	$18.92 \pm 0.36$
u	132	382	246	$20.28 \pm 0.38$
u	511	531	19	$19.0 \pm 40.52$
uvw1	487	5854	435	$> 21.23$
uvm2	462	5649	255	$> 20.95$
uvw2	414	6575	353	$> 21.44$

Table 1: Magnitudes and upper limits from UVOT observations

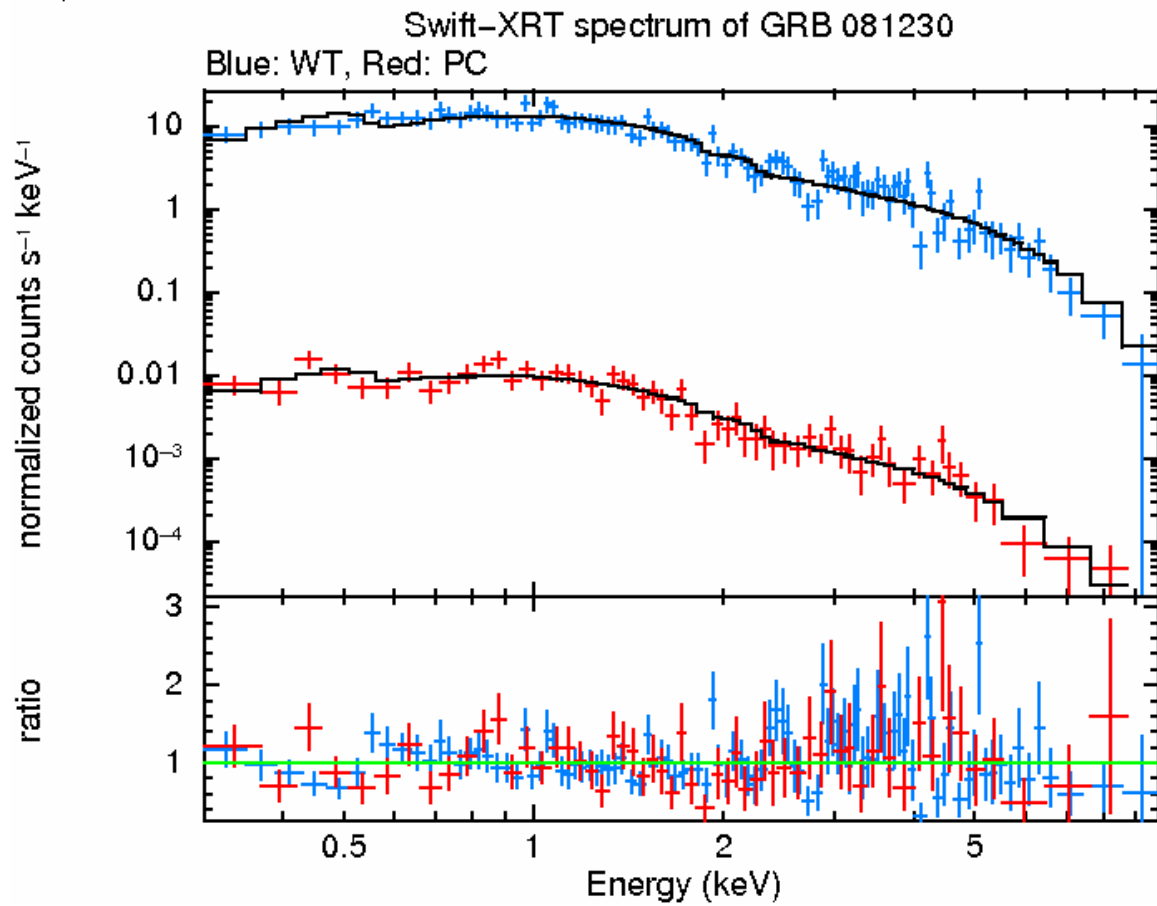


Figure 3: XRT Spectrum with best fit model and data to model ratio. Blue is Window Timing mode, red is Photon Counting mode.

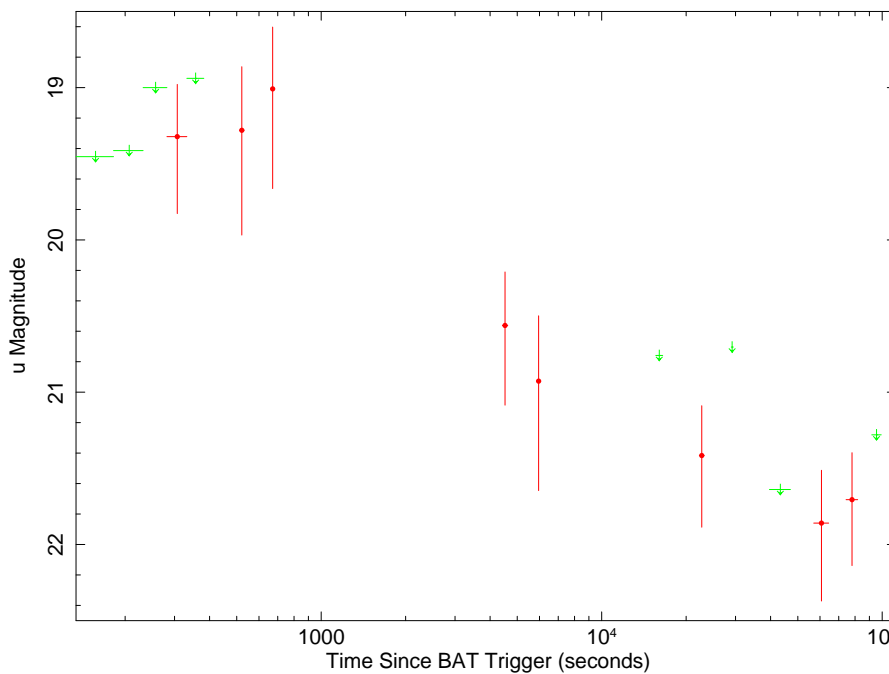


Figure 4: u filter light curve of GRB 081230