

Swift Observations of GRB 081228

K.L. Page (U. Leicester), H.A. Krimm (CRESS/USRA), W.B. Landsman (GSFC) & T. Ukwatta (GSFC/GWU), for the Swift Team

1 Introduction

BAT triggered on and located GRB 081228 (trigger=338338; Page et al., GCN Circ. 8742) at 01:17:40 UT on 28th December, slewing immediately. Although the XRT did not centroid onboard, a fading afterglow was detected in the promptly downlinked SPER data. The best position is that derived from using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue to correct the X-ray location astrometrically: RA, Dec (J2000.0) = $02^h 37^m 50.80^s$, $+30^\circ 51' 09.2''$ with an estimated uncertainty of 2.7 arcsec (radius, 90% confidence).

GROND detected an optical afterglow (Afonso et al., GCN Circulars 8745 and 8752) within the enhanced XRT error circle.

2 BAT Observation and Analysis

The BAT ground-calculated position is RA, Dec = 39.477, 30.833 deg which is

$$\text{RA(J2000)} = 02^h 37^m 54.4^s$$

$$\text{Dec(J2000)} = +30^\circ 49' 57.3''$$

with an uncertainty of 2.3 arcmin, (radius, sys+stat, 90% containment). The partial coding was 85% (Markwardt et al., GCN Circ. 8749).

The mask-weighted light-curve (Figure 1) begins with a possible faint soft 20 s precursor beginning at T−180 s. The main emission consists of a single peak beginning at T−0.5 s and lasting ~ 2.5 s. T₉₀ (15–350 keV) is 3.0 ± 1.4 s (estimated error including systematics). An observing constraint caused the Swift spacecraft to slew away from the burst location at $\sim T+250$ s, so no information about the burst is available after $\sim T+300$ s, when it was no longer in the field of view.

The time-averaged spectrum from T−0.1 to T+2.9 s is best fitted by a simple power-law model. The power law index of the time-averaged spectrum is $\Gamma = 2.10 \pm 0.31$. The fluence in the 15–150 keV band is $(8.9 \pm 1.8) \times 10^{-8}$ erg cm^{−2}. The 1-s peak photon flux measured from T+0.87 s in the 15–150 keV band is 0.6 ± 0.1 photon cm^{−2} s^{−1}. All the quoted errors are at the 90% confidence level.

With a duration longer than 2 s and a soft spectrum, this burst is likely to be in the "long" category.

The results of the batgrbproduct analysis are available at <http://gcn.gsfc.nasa.gov/notices.s/338338/BA/>

3 XRT Observations and Analysis

The XRT began observing the burst 78 s after the BAT trigger (Page & Evans, GCN Circ. 8746). Using 30 s of XRT Photon Counting (PC) mode data and one UVOT image for GRB 081228, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) of

$$\text{RA (J2000): } 02^h 37^m 50.80^s$$

$$\text{Dec (J2000): } +30^\circ 51' 09.2''$$

with an uncertainty of 2.7 arcsec (radius, 90% confidence).

The light-curve (Figure 2) can be modelled with an initial decay of $\alpha_1 = 1.4 \pm 0.1$, breaking around 5 ks to a decay of $\alpha_2 = 0.5 \pm 0.2$.

The spectrum of the first orbit of data can be modelled with a power-law of photon index $\Gamma = 1.5 \pm 0.4$, absorbed by the Galactic column in this direction of $8.8 \times 10^{20} \text{ cm}^{-2}$. The upper limit on the total absorbing column is $4.7 \times 10^{21} \text{ cm}^{-2}$. The observed (unabsorbed) flux over this time (86-117 s after the trigger) is 1.23×10^{-10} (1.38×10^{-10}) $\text{erg cm}^{-2} \text{ s}^{-1}$.

The counts to observed flux conversion is $1 \text{ count s}^{-1} = 5.1 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.

Detailed light-curves (in both count rate and flux units) and spectra are available from http://www.swift.ac.uk/xrt_products/00338338/

4 UVOT Observation and Analysis

The Swift Ultra-Violet/Optical Telescope (UVOT) began settled observations of the field of GRB 081228 82 s after the BAT trigger (Landsman & Page, GCN Circ. 8747). The exposure time was limited by observing constraints until about 1 hour after the trigger. We do not detect any source at the refined Swift XRT position (Page & Evans, GCN Circ. 8746). The limiting magnitudes (3-sigma in 5" apertures) in each of the UVOT filters are given in Table 1.

The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{(B-V)} = 0.16 \text{ mag}$ (Schlegel et al. 1998). All photometry is on the UVOT photometric system described in Poole et al. (2008).

Filter	Tstart (s)	Exposure (s)	Mag UL (3σ)
white	82	37	> 20.0
white	4679	137	> 20.7
v	3653	197	> 19.3
b	4473	197	> 20.3
u	4268	197	> 20.0
uvw1	4063	197	> 20.0
uvm2	3858	197	> 20.0
uvw2	9102	886	> 20.9

Table 1: UVOT magnitudes in all filters.

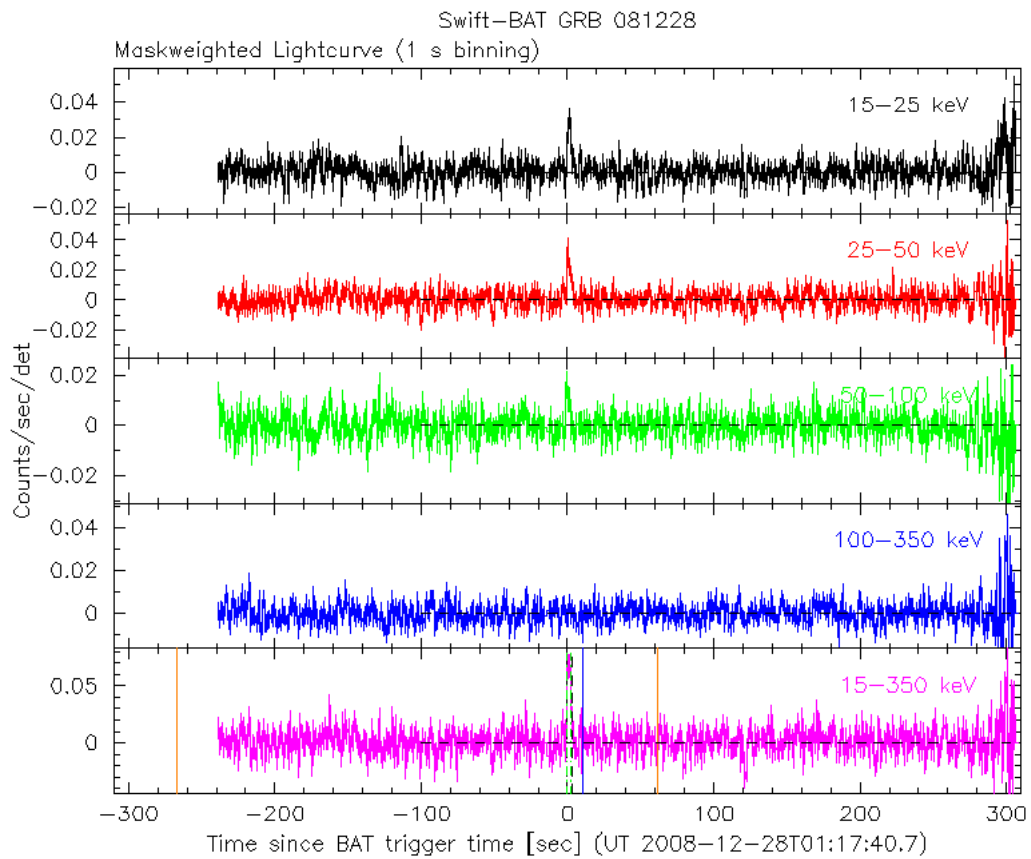


Figure 1: BAT light-curve. The mask-weighted light-curve in the 4 individual plus total energy bands. The units are counts/s/illuminated-detector (note illum-det = 0.16 cm²).

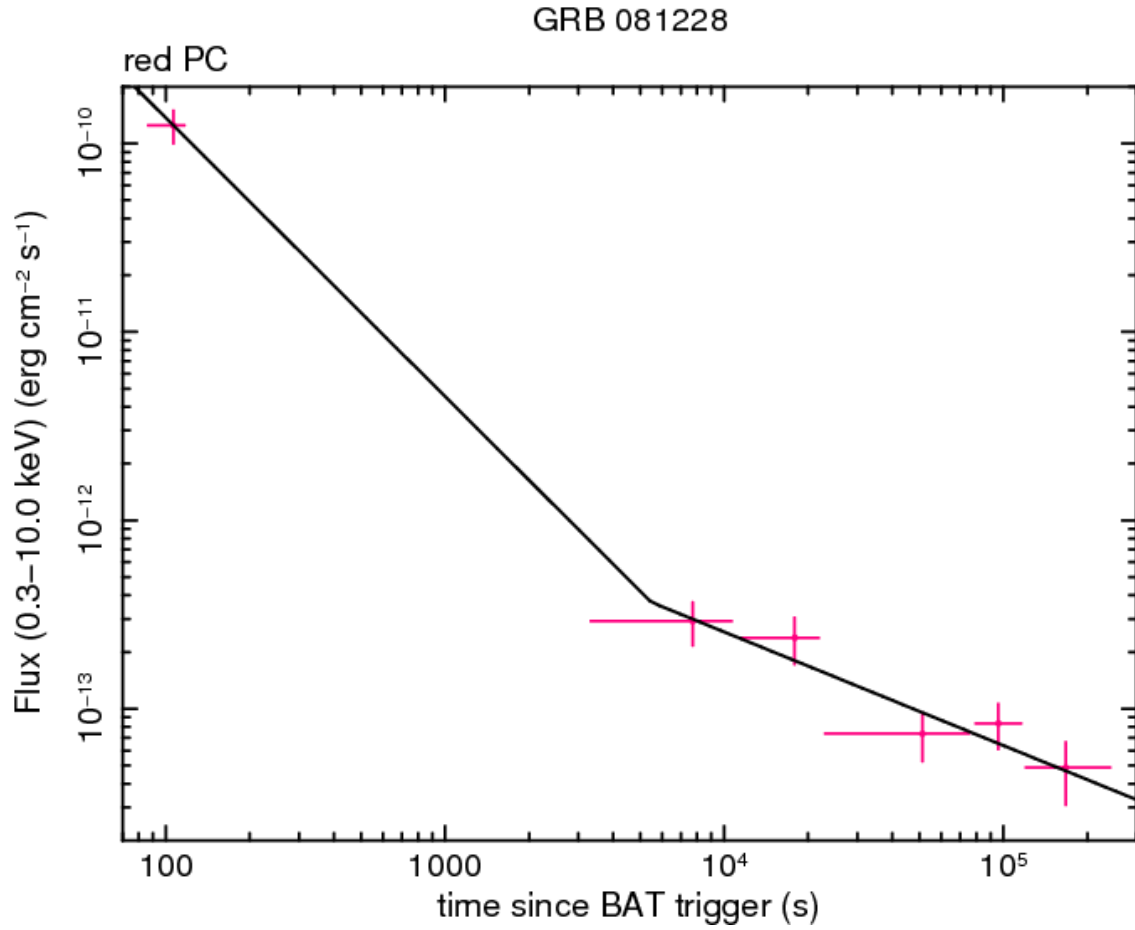


Figure 2: XRT flux light-curve; all data were collected in Photon Counting mode. The approximate counts to flux conversion is $1 \text{ count s}^{-1} = 5.1 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.