

## Swift Observation of GRB 080916B

*G. Stratta (ASDC), M. Perri (ASDC), B. Preger (ASDC), M.R. Goad (U. Leicester), S.D. Barthelmy (GSFC), E.A. Hoversten (PSU), P. Roming (PSU), D.N. Burrows (PSU), N. Gehrels (GSFC) for the Swift Team*

### 1 Introduction

At 14:44:47 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 080916B (trigger=324907)(Stratta, et al., *GCN Circ.* 8240). The BAT light curve showed a multi-peaked structure with a duration of about 50 sec. The peak count rate was  $\sim 750$  counts/sec (15-350 keV), at  $\sim 0$  sec after the trigger. Due to the Earth-limb observing constraint, Swift did not slew until  $T + 18.9$  minutes and no XRT or UVOT data are available before this time. The X-ray afterglow was clearly detected while the optical counterpart was inferred by UVOT with a detection in the white filter only. No detection from ground-based facilities has been reported.

### 2 BAT Observation and Analysis

Using the data set from  $T - 239$  to  $T + 617$  sec the BAT ground-calculated position is RA, Dec = 163.632, 69.061 deg, which corresponds to RA(J2000) =  $10^h 54^m 31.6^s$  and Dec(J2000) =  $+69^d 03' 38.2''$  with an uncertainty of 2.1 arcmin (radius, sys+stat, 90% containment). The partial coding was 53%.

The mask-weighted light curve shows a weak FRED-like peak starting at  $\sim T - 4$  sec, peaking at  $\sim T + 3$  sec, and ending at  $\sim T + 50$  sec. There is a possibility of very weak emission lasting out to at least  $T + 350$  sec, at which time the spacecraft slewed away from the burst location (Figure 1).  $T_{90}$  (15-350 keV) is  $32 \pm 8$  sec (estimated error including systematics).

The time-averaged spectrum from  $T - 3.3$  to  $T + 35.7$  sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.49 \pm 0.23$ . The fluence in the 15-150 keV band is  $(6.3 \pm 0.9) \times 10^{-7}$  erg  $\text{cm}^2$ . The 1-sec peak photon flux measured from  $T + 3.30$  sec in the 15-150 keV band is  $0.6 \pm 0.2$  ph  $\text{cm}^2 \text{sec}^{-1}$ . All the quoted errors are at the 90% confidence level (Barthelmy et al., *GCN Circ.* 8250).

### 3 XRT Observations and Analysis

Using 1049 s of XRT Photon Counting mode data and 1 UVOT images for GRB 080916B, the astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is: RA, Dec = 163.66512, +69.06545 which is equivalent to RA (J2000):  $10^h 54^m 39.63^s$  and Dec (J2000):  $+69^d 03' 55.6''$  with an uncertainty of 5.1 arcsec (radius, 90% confidence) (Goad et al., *GCN Circ.* 8247).

During the first two orbits of Swift XRT data of GRB 080916B, consisting of 2.8 ks of Photon Counting data collected starting from  $T_0+1.4$  ks to  $T_0+8.5$  ks, the source shows a fading behaviour from 0.08 counts/s to 0.02 counts/s. Assuming a power law model,  $F(t) \propto t^{-\alpha}$ , the best fit decay index is  $\alpha = 1.0 \pm 0.2$  (Figure 2).

The 0.3-10 keV spectrum (2.8 ks of integration time) is consistent with an absorbed power law model. Fixing the column density to the Galactic value ( $N_H = 1.8 \times 10^{20} \text{ cm}^{-2}$  from Kalberla et al. 2007) the best fit photon index is  $2.0 \pm 0.5$ . The average 0.3-10.0 keV observed flux for this spectrum is  $(1.0 \pm 0.6) \times 10^{-12}$  erg  $\text{cm}^{-2} \text{s}^{-1}$  which corresponds to an unabsorbed flux of  $1.1 \times 10^{-12}$  erg  $\text{cm}^{-2} \text{s}^{-1}$ .

The count to observed flux conversion factor is  $6.6 \times 10^{-11}$  erg cm $^{-2}$  count $^{-1}$  (Stratta et al., *GCN Circ.* 8260).

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 080916B, 1359s after the BAT trigger (Stratta et al., *GCN Circ.* 8240). There is a possible detection of an afterglow in the UVOT white filter at RA (J2000)  $10^h 54^m 39.78^s$  and Dec (J2000)  $69^d 3' 57.9''$  with an estimated uncertainty of 0.8 arcsec (radius, 90% confidence). This position is consistent with the UVOT enhanced XRT position (Goad et al., *GCN Circ.* 8247). The afterglow candidate does not appear in the DSS images, and photometry from the second orbit of Swift observations suggests that it has faded. UVOT magnitudes and 3-sigma upper limits are reported in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of  $E(B - V) = 0.02$  mag. All photometry is on the UVOT flight system described in Poole et al. (2008, *MNRAS*, 383, 627) (Hoversten et al., *GCN Circ.* 8252).

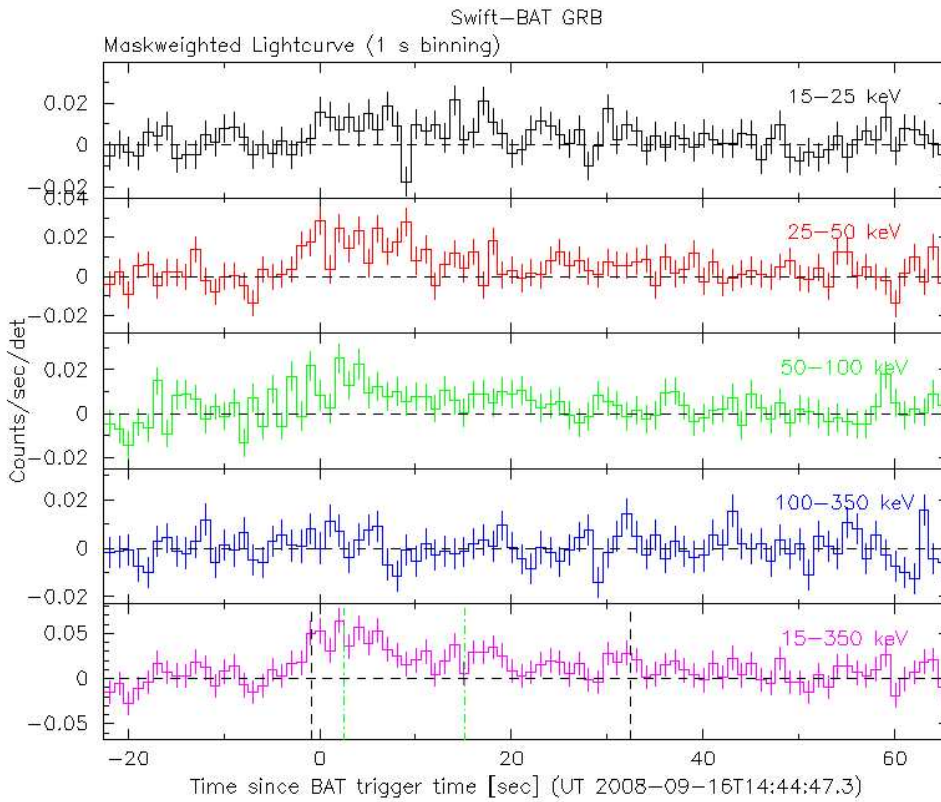


Figure 1: BAT Light curve. The mask-weighted 1-s binning light curve in the 4 individual plus total energy bands. The units are counts s $^{-1}$  illuminated-detector $^{-1}$  (note illum-det = 0.16 cm $^2$ ).

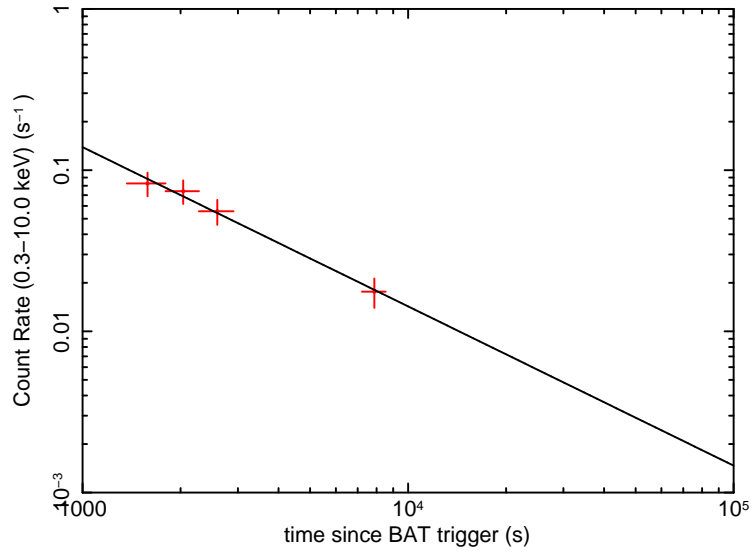


Figure 2: XRT Lightcurve. Counts  $s^{-1}$  in the 0.3-10 keV band taken in Photon Counting mode. The count rate to flux conversion factor is  $1 \text{ count s}^{-1} \sim 6.6 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ .

Filter	T_start (s)	T_stop (s)	Exp (s)	magnitudes
white	1359.0	1458.8	98.2	$20.50 \pm 0.21$
white	7826.0	8025.7	196.6	$> 21.27$
v	1340.9	2920.7	342.1	$> 19.62$
b	1516.3	2676.5	155.6	$> 20.32$
u	1491.6	2651.7	155.6	$> 19.91$
uvw1	1467.3	2627.3	155.5	$> 19.91$
uvm2	1604.9	3076.8	285.0	$> 20.06$
uvw2	1556.0	2716.0	155.5	$> 19.91$

Table 1: Apparent magnitudes and  $3\sigma$  upper limits from UVOT observations.