

## Swift Observation of GRB 080703

*H. Ziaeeppour (UCL/MSSL), D. Palmer (LANL), T. Sakamoto (GSFC/UMBC), O. Godet (U Leicester), P. Schady (UCL/MSSL), P. Ward (UCL/MSSL) for the Swift Team*

### 1 Introduction

BAT triggered on GRB 080703 at 19:00:13.6 UT (Trigger 315819) (Ziaeeppour, et al., *GCN Circ.* 7936). This was a 1.024 sec rate-trigger with significance of 11.78 on an apparently short burst with  $T_{90} = 3.4$  sec in 15 – 350 keV band. Swift slewed to this burst immediately. The XRT began its observations at  $T + 100$  sec, and UVOT started its finding chart exposure at  $T + 102$  sec. They both found a varying afterglow (Godet & Ziaeeppour *GCN Circ.* 7942, Ward & Ziaeeppour *GCN Circ.* 7941). The optical counterpart was relatively bright and fast decaying. The position of this source is: RA ( $J2000$ ) = 101.8027 deg (06h47m12.64s), Dec( $J2000$ ) =  $-63.2192$  deg ( $-63d13'08.96''$ ). The optical afterglow was also detected by the ROTSE-III (E.S. Rykoff, et al. *GCN Circ.* 7935) and by the VLT (D. Malesani, et al. *GCN Circ.* 7940).

### 2 BAT Observation and Analysis

Using the data from  $T - 120$  to  $T + 183$  sec, further analysis of BAT GRB 080703 has been performed by Swift team (Sakamoto, et al., *GCN Circ.* 7938). The BAT ground-calculated position is RA( $J2000$ ) = 101.822 deg (06h47m17.2s), Dec( $J2000$ ) =  $-63.211$  deg ( $-63d12'40.7''$ )  $\pm 1.1$  arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 53% (the offset angle was 21.42 deg).

The mask-weighted 64-msec binned light curves (Fig.1) show a single peak started at about  $\sim T - 5$  sec, peaking at  $\sim T + 0$ . sec, and ending at  $\sim T + 4$  sec.  $T_{90}$  in (15 – 350 keV) is  $3.4 \pm 0.8$  sec (estimated error including systematics).

A power-law fit of the time-averaged spectrum from  $T - 1.7$  to  $T + 2.1$  sec gives a photon index of  $1.53 \pm 0.22$  ( $\chi^2 = 70.28$  for 56 d.o.f.). For this model the total fluence in the 15 – 150 keV band is  $(2. \pm 0.3) \times 10^{-7}$  ergs  $\text{cm}^{-2}$  and the 1-sec peak flux measured from  $T + 0.04$  sec in the 15 – 150 keV band is  $1. \pm 0.2$  ph  $\text{cm}^{-2} \text{sec}^{-1}$ . A fit to a Band model gives  $\alpha = 0.47$ ,  $\beta = -2.$ ,  $E_{peak} = 47.11$  keV ( $\chi^2 = 68.1$  for 55 d.o.f.), and total fluence in the 15 – 150 keV band  $(1.88 \pm 0.3) \times 10^{-7}$  ergs  $\text{cm}^{-2}$ . All the quoted errors are at the 90% confidence level.

### 3 XRT Observations and Analysis

Using 3392 sec of overlapping XRT Photon Counting (PC) mode and UVOT data for GRB 080703, the enhanced Swift-XRT position is RA ( $J2000$ ) = 101.8018 deg (06h47m12.43s), Dec( $J2000$ ) =  $-63.2189$  deg ( $-63d13'08.2''$ )  $\pm 1.4$  arcsec (90% confidence) (Osborne, et al., *GCN Circ.* 7939). This position is within 1.6 arcsec of the UVOT position (Ward & Ziaeeppour *GCN Circ.* 7941).

The 0.3 – 10 keV light curve (Fig.2) shows an initial rise of the X-ray emission before  $T + 106$  sec to a maximum at  $\sim T + 200$  sec. Then it decays with a slope of  $\sim 1.2$ . From  $T + 700$  sec to  $T + 2000$  sec, the XRT light curve shows some flaring activities. A shallow slope regime or flaring continues until  $\sim T + 10^4$  sec where the light curve breaks to a steeper slope of  $1.57 \pm 0.21$ . This continues until the end of the XRT observations at  $\sim T + 10^5$  sec.

The hardness ratio does not show any significant spectral variation from  $\sim T + 106$  sec to  $T + 10^5$  sec.

The PC spectrum from  $T + 106$  sec to  $T + 3.1 \times 10^4$  sec is well fitted by an absorbed power-law with a photon index of  $1.7 \pm 0.1$  and an absorption column of  $8.9_{-3.3}^{+3.9} \times 10^{20} \text{ cm}^{-2}$ , in excess with respect to the Galactic  $N_H$  of  $5.2 \times 10^{20} \text{ cm}^{-2}$  (Kalberla et al.2005). The observed 0.3 – 10 keV flux over this time interval is  $8.2_{-1.2}^{+0.8} \times 10^{-12} \text{ ergs cm}^{-2} \text{ sec}^{-1}$ .

## 4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 080703 about 102 sec after the initial BAT trigger (Ward & Ziaeeepour, *GCN Circ.* 7941). A quickly fading candidate afterglow was found in the XRT error circle in White and V filters. The UVOT position of the optical afterglow is: RA ( $J2000$ ) = 101.8027 deg (06h47m12.64s), Dec( $J2000$ ) =  $-63.2192$  deg ( $-63d13'08.96''$ ) with a 1-sigma error radius of about 0.5 arcsec. Between  $\sim T + 100$  and  $\sim T + 1000$  sec the light curve decays with an index of  $1.30 \pm -0.08$  obtained from White and V bands combined light curve. The source was not observed in  $B$  and shorter wavelengths. This puts a lower limit on its redshift  $z \gtrsim 2.5$ . The observed magnitude and 3-sigma upper limits are given in Table 1. They are not corrected for the Galactic extinction in the line of sight, corresponding to a reddening of  $E(B-V) = 0.798$  mag (Schlegel et al., *ApJS*. **500** (1998) 525). The photometry is based on the UVOT photometric system (Poole, et al., *MNRAS* **383** (2008) 627).

Filter	$T_{start}$ (sec)	$T_{stop}$ (sec)	Exposure (sec)	Mag/UL
White	101	200	99.8	$17.40 \pm 0.03$
White	857	956	99.8	$20.27 \pm 0.35$
White	5905	6102	196.6	$21.29 \pm 0.49$
White	5905	19222	869.5	$> 21.77$ (1.9-sigma)
V	207	606	399.8	$18.02 \pm 0.10$
V	963	1362	399.8	$19.06 \pm 0.27$
V	6315	6512	196.6	$> 19.65$ (0.2-sigma)
V	6315	12021	1081.7	$> 20.83$ (0.9-sigma)
B	687	1788	78.9	$> 19.48$ (1.8-sigma)
B	663	1764	99.0	$> 19.33$ (1.5-sigma)
UVW1	638	1885	99.9	$> 19.55$ (0.1-sigma)
UVM2	613	1878	118.7	$> 19.67$ (1.7-sigma)
UVW2	718	1829	79.1	$> 19.55$ (0.9-sigma)

Table 1: Magnitude and upper limits from the UVOT observations.

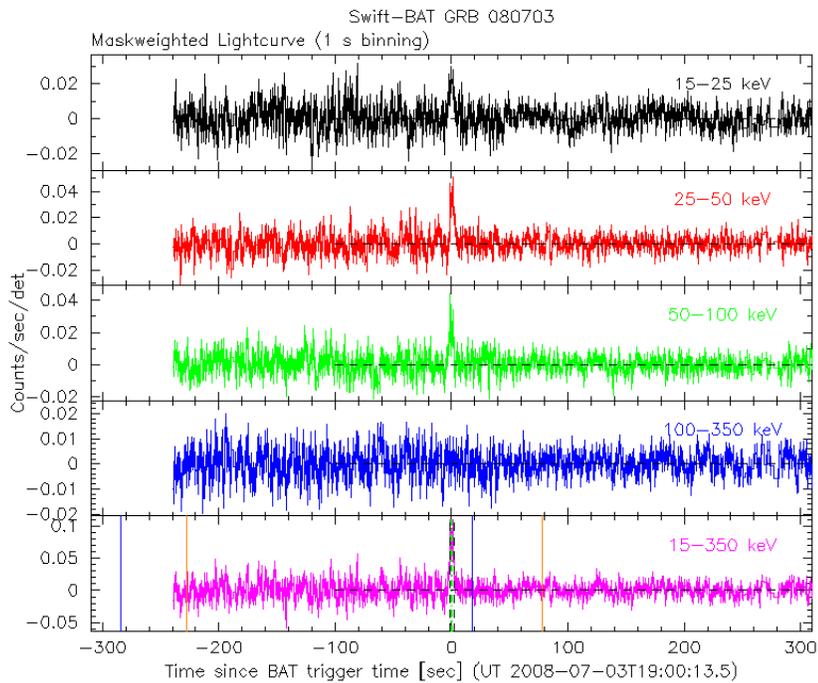


Figure 1: BAT light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and  $T_0$  is 19 : 00 : 13.6 UT.

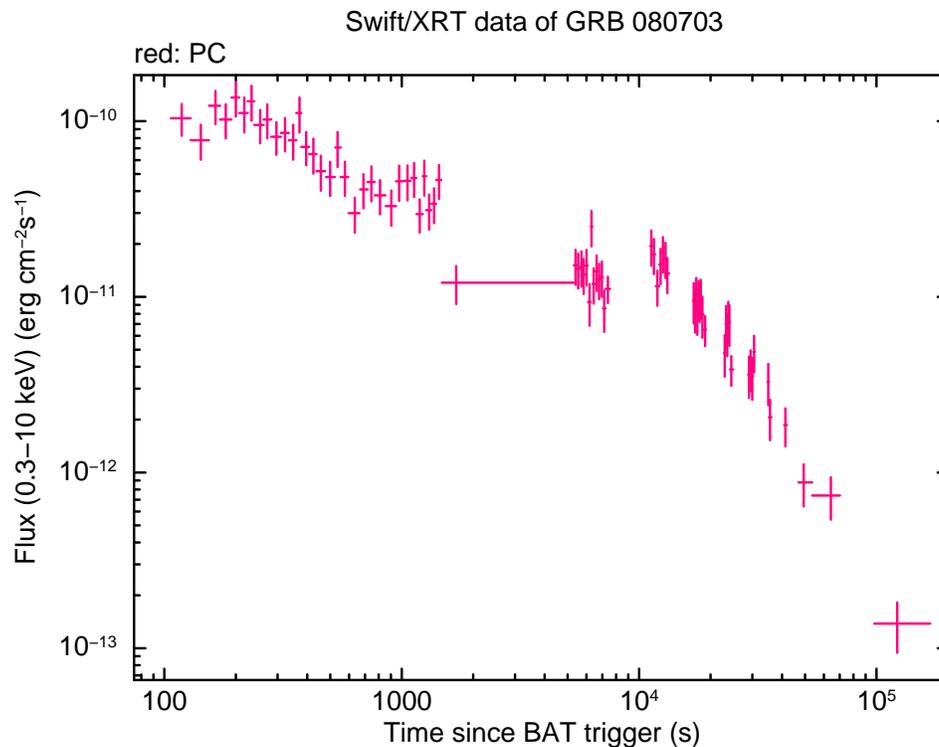


Figure 2: XRT light curve in the 0.3 – 10 keV band: Photon Counting (PC) mode (red). The conversion factor from count rate to absorbed flux is 1 count/sec  $\sim 5.1 \times 10^{-11}$  ergs cm $^{-2}$  sec $^{-1}$ .