Swift Observations of GRB 080503

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1 Introduction

BAT triggered on GRB 080503 at 12:26:13 UT (Trigger 310785) (Mao *et al.*, *GCN Circ.* 7665). This was a short burst with extended emission (Ukwatta *et al.*, *GCN Circ.* 7673, *GCN Circ.* 7677). XRT observations began at $T + 81$ s and discovered a bright X-ray source. UVOT began observing at $T + 84$ s and no optical afterglow was detected (Brown *et al.*, *GCN Circ.* 7675).

The ground-based telescope Gemini North promptly detected the possible host galaxy and the re-brightening counterpart (Perley *et al.*, *GCN Circ.* 7678, *GCN Circ.* 7680). After approximately 5.2 days, Hubble Space Telescope detected the associated source (Bloom *et al.*, *GCN Circ.* 7703, Perley *et al.*, *GCN Circ.* 7749). Chandra observed this GRB 4.3 days after the trigger and the results were roughly consistent with those of XRT (Butler *et al.*, *GCN Circ.* 7704).

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ s, the BAT ground-calculated position is RA(J2000) = 286.686 deg ($19^{\rm h}06^{\rm m}44.7^{\rm s}$), Dec(J2000)= +68.803 deg ($+68^{\rm d}48'09.2''$) with an uncertainty of 3.5 arcmin (radius, sys+stat, 90% containment). The partial coding was 75%.

The mask-weighted light curve (Fig. 1) shows an initial spike starting at $\sim T + 0.1$ s with a fast rise to a peak at $\sim T + 0.2$ s, then, a roughly exponential decay down to background at $\sim T + 0.7$ s. The soft emission starts at about $T + 10$ s, rising with two peaks at about $T + 26$ s and +37 s, and then falling to background levels at $T + 220 \pm 20$ s. T_{90} (15–350 keV) is 170 ± 40 s (estimated error including systematics).

The time-averaged spectrum from $T + 0.2$ to $T + 220.6$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.00 ± 0.13. The fluence in the 15–150 keV band is $(2.0 \pm 0.1) \times 10^{-6}$ erg cm^{-2}. The 1–s peak photon flux measured from $T + 26.58$ s in the 15–150 keV band is 0.9 ± 0.1 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/310785/BA/`.

The spectral lag analysis of the data from T-1 s to T+1 s (the initial spike), yields a lag of -13 ± 9 ms for the 15-25 to 50-100 keV bands using lightcurve binnings of 4, 8 and 16 ms. For the on-going emission ($T + 10$ to $T + 220$ s), the signal is too weak and lacking sufficient structure to yield a significant lag measurement.

The burst has been divided into an initial phase ($T + 0.0$ to $T + 0.7$ s) and the extended phase ($T + 10$ to $T + 170$ s). The simple power law fits are: For the initial phase, PLI is 1.59 ± 0.28, normlization at 50 keV is $(8.15 \pm 1.5) \times 10^{-3}$ ph cm^{-2} s^{-1} keV^{-1}, χ^2/dof is 69/59 ; For the extended phase, PLI is 1.91 ± 0.12, normalization at 50 keV is $(1.19 \pm 0.08) \times 10^{-3}$ ph cm^{-2} s^{-1} keV^{-1} and χ^2/dof is 52/59.

This lag value plus the spectral results puts this burst in the short hard burst category.

3 XRT Observations and Analysis

The Swift-XRT began observing GRB 080503 in Window Timing mode, 81 s after the BAT trigger. The enhanced XRT position was given in Goad *et al.*, (*GCN Circ.* 7669).

The light curve from 81 s to 13.2 ks can be modelled with the combination of an exponential with a power law taking over at late time, with the following best-fitting parameters: e-folding time= (72 ± 4) s, power-law index alpha= 2.2 (-1.1, +0.6). The χ^2/dof = 202/151 is due to short-term variability superposed to the model.

The WT mode spectrum spanning from 81 to 282 s can be fit by a power-law model, with a photon index of 1.27 ± 0.03 and column density consistent with the average Galactic one in this direction of 5.6×10^{20} cm^{-2}. The PC mode spectrum, starting from 282 s and totalling 6.3 ks of exposure, is fit with a power law with a photon index of 2.45 ± 0.25 and no evidence for any additional column density with respect to the Galactic one. The corresponding observed (unabsorbed) 0.3-10 keV flux is 2.9×10^{-12} (3.9×10^{-12}) erg cm^{-2} s^{-1}.

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at `http://www.swift.ac.uk/xrt_curves/`.

4 UVOT Observation and Analysis

The UVOT began settled observations of GRB 080503 84 s after the BAT trigger. No afterglow is detected at the enhanced XRT position (Goad *et al.*, *GCN Circ.* 7665) in the initial white finding chart or subsequent summed images. The limiting magnitudes (3-sigma in 5" radius apertures) in each of the UVOT filters are as follows:

Filter	$T_{start}(s)$	$T_{stop}(s)$	Exp(s)	Mag UL (3sig)
white	85	184	98	> 20.0
white	85	12500	1314	> 22.3
v	191	6749	1219	> 20.5
b	671	11588	1203	> 21.4
u	646	7365	471	> 20.3
uvw1	622	7160	471	> 20.4
uvm2	597	6954	471	> 20.3
uvw2	701	13219	1133	> 21.0

Table 1: Magnitudes from UVOT observations. Upper limits are 3 σ.

The values quoted above are in the UVOT photometric system (Poole *et al.*, 2008, MNRAS, 383, 627). They are not corrected for the expected Galactic extinction corresponding to a reddening of E(B-V)=0.06 mag in the direction of the burst (Schlegel *et al.*, 1998).

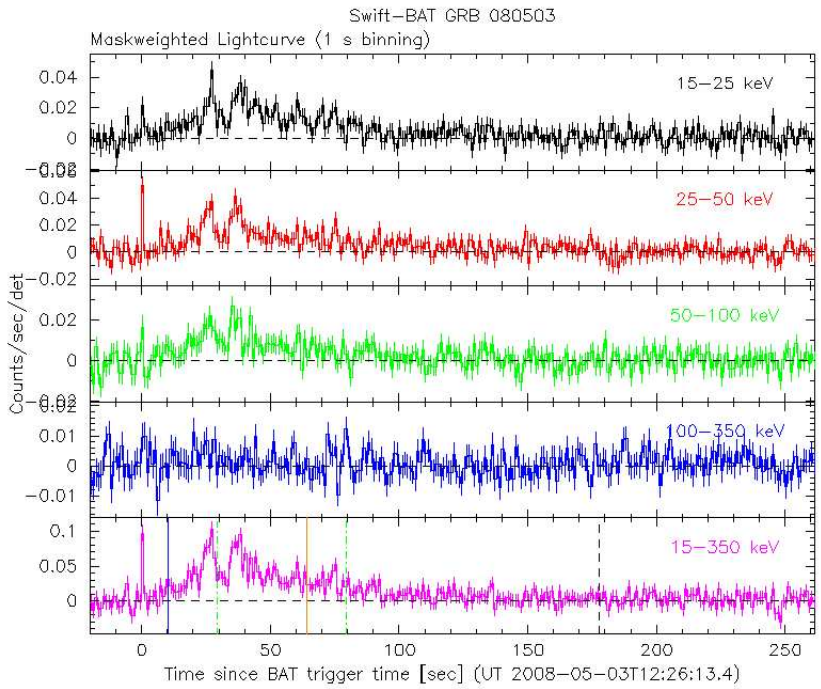

Figure 1: BAT Lightcurve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/s/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 12:26:13 UT.

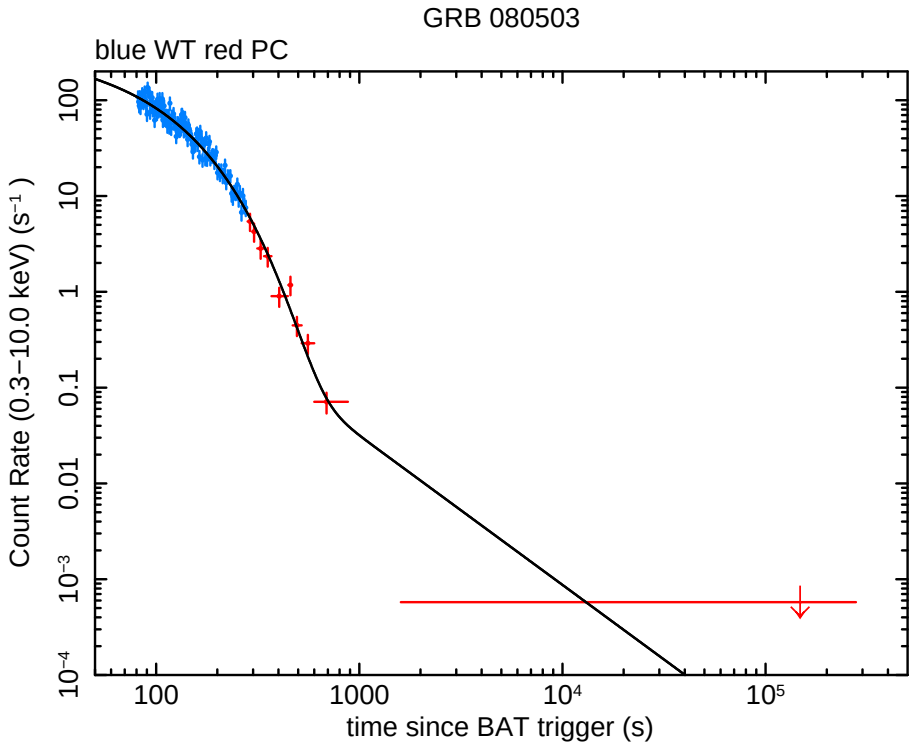

Figure 2: XRT Lightcurve. Flux is in the 0.3-10 keV band. The lower limit is 6.5×10^{-4} count/s at 1.2×10^5 s. The approximate conversion is 1 count/s $\sim 6.0 \times 10^{-11}$ erg cm^{-2} s^{-1}.