

Swift Observation of GRB 080604

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1 Introduction

BAT triggered on and located GRB 080604 at 07:27:01 UT (trigger=313116; La Parola et al., GCN Circ.7800). The BAT light curve showed a broad single peak structure with a duration of about 70 sec. The peak count rate was ~ 300 counts s^{-1} (15–350 keV), at ~ 10 s after the trigger. Swift slewed immediately, and the narrow field instruments were on target 119 and 128 seconds later (XRT and UVOT respectively). The best Swift position is that determined from the UVOT white filter detection of the afterglow at

RA(J2000)= $15^{\text{h}}47^{\text{m}}51.70^{\text{s}}$ (236.9654 deg),

Dec(J2000)= $+20^{\text{d}}33'28.1''$ (20.5578 deg),

with a 90% confidence interval of 0.5 arcsec (La Parola et al., GCN Circ.7800). The afterglow was detected by the following ground based observatories: Faulkes Telescope North (Rol et al., GCN Circ 7801), HET (Cucchiara et al., GCN Circ 7805), MITSuME (Yoshida et al., GCN Circ 7821), Xinglong (Meng et al., GCN Circ 7825). Gemini North provided a spectroscopic estimate of the redshift, at $z=1.416$ (Wiersema et al. GCN Circ 7818).

2 BAT Observation and Analysis

Using the data set from T-239 to T+963 sec from telemetry downlinks, we report further analysis of BAT GRB 080604 (Barthelmy et al. GCN Circ 7817). The BAT ground-calculated position is RA, Dec = 236.960, 20.557 deg, which is RA(J2000) = 15h 47m 50.3s Dec(J2000) = +20d 33' 25.4" with an uncertainty of 2.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 100%.

The mask-weighted light curve shows a single peak starting at $\sim T-25$ sec and ending at $\sim T+100$ sec. T90 (15-350 keV) is 82 ± 13 sec (estimated error including systematics).

The time-averaged spectrum from T-27.3 to T+67.2 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.78 ± 0.18 . The fluence in the 15-150 keV band is $8.0 \pm 0.9 \times 10^{-7}$ erg cm^{-2} . The 1-sec peak photon flux measured from T-3.02 sec in the 15-150 keV band is 0.4 ± 0.1 ph/cm²/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/313116/BA/

This burst satisfies Sakamoto/Ukwatta Swift-BAT possible high-z criteria (Ukwatta et al. arXiv:0802.3815):

- 1) Power Law photon index = 1.78 (PL photon index < 2)
- 2) 1-s peak photon flux = 0.4 (1-s peak photon flux < 1.0 ph $\text{cm}^{-2} \text{s}^{-1}$)
- 3) Light curve variance = 1.1e-05 (Variance < 0.0001)
- 4) T90/(Peak photon flux) = 218 (T90/(Peak photon flux) > 100)

Based on a limited sample of bursts, these criteria yield an 85% chance it has a redshift greater than 3.5. We note that the only estimate for the redshift (GCN Circ 7818) from the Gemini North spectrum yields a $z = 1.416$.

3 XRT Observations and Analysis

The Swift-XRT observed GRB 080604 for 450 ksec, starting 119.3 seconds after the BAT trigger.

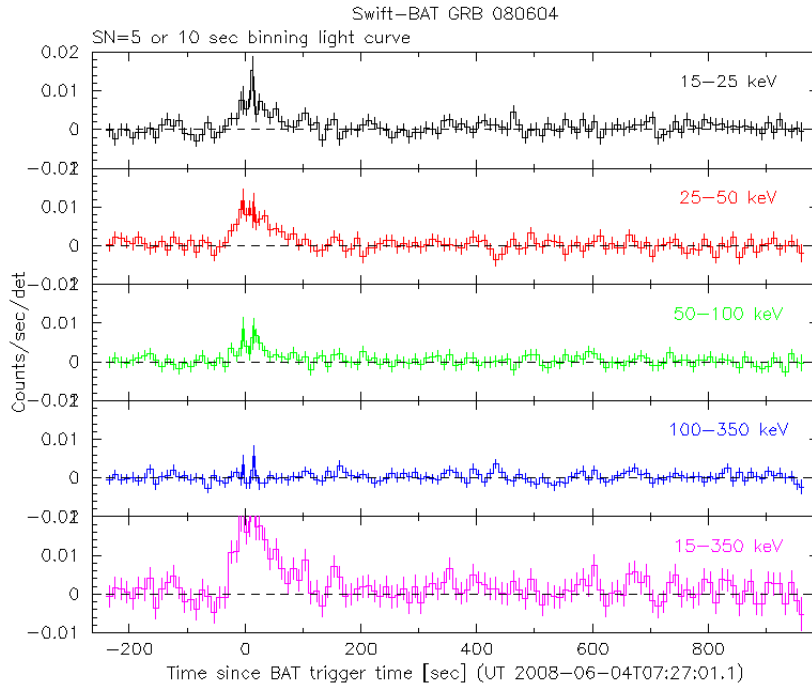


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts s^{-1} illuminated-detector $^{-1}$ (note illum-det = 0.16 cm^2) and T_0 is 2008-06-04 07:27:01 UT.

We detect an X-ray counterpart at the position (astrometrically corrected using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 236.96516, +20.55777 which is equivalent to:

RA (J2000): 15h 47m 51.64s (236.96516 deg)
 Dec (J2000): +20d 33' 28.0" (+20.55777 deg)

with an uncertainty of 1.7 arcsec (radius, 90% confidence).

The X-ray light curve shows a power law decay with slope -2.03 ± 0.03 , with a hint of a flare at $\sim T+1000$ s. It also shows a late long flare starting at $\sim T+10^4$ s, but the data do not sample the peak and decay of this flare.

The spectrum accumulated in WT mode (Exposure:285 s) over the first observation can be modelled with an absorbed ($nH=(8.0 \pm 1.8) \times 10^{20}$) power law with $\Gamma = 2.8 \pm 0.3$ plus a black body with $T = 1.3 \pm 0.3$, with a $\chi^2/dof = 69.1/72$. The spectrum accumulated in PC mode in the following 6 ksec of observation can be fitted with an absorbed ($nH=(7.0 \pm 3) \times 10^{20}$) power law with $\Gamma = 1.72 \pm 0.17$. The Galactic line of sight value of the absorbing column is $3.81 \times 10^{20} cm^{-2}$.

4 UVOT Observation and Analysis

The Swift UltraViolet/Optical Telescope (UVOT) began its first finding chart exposure of GRB080604 (La Parola et al., GCN circ. 7800) 129 seconds after the trigger in white filter. The afterglow is detected only in the white filter. Magnitudes and 3 sigma upper limits are listed in the table below.

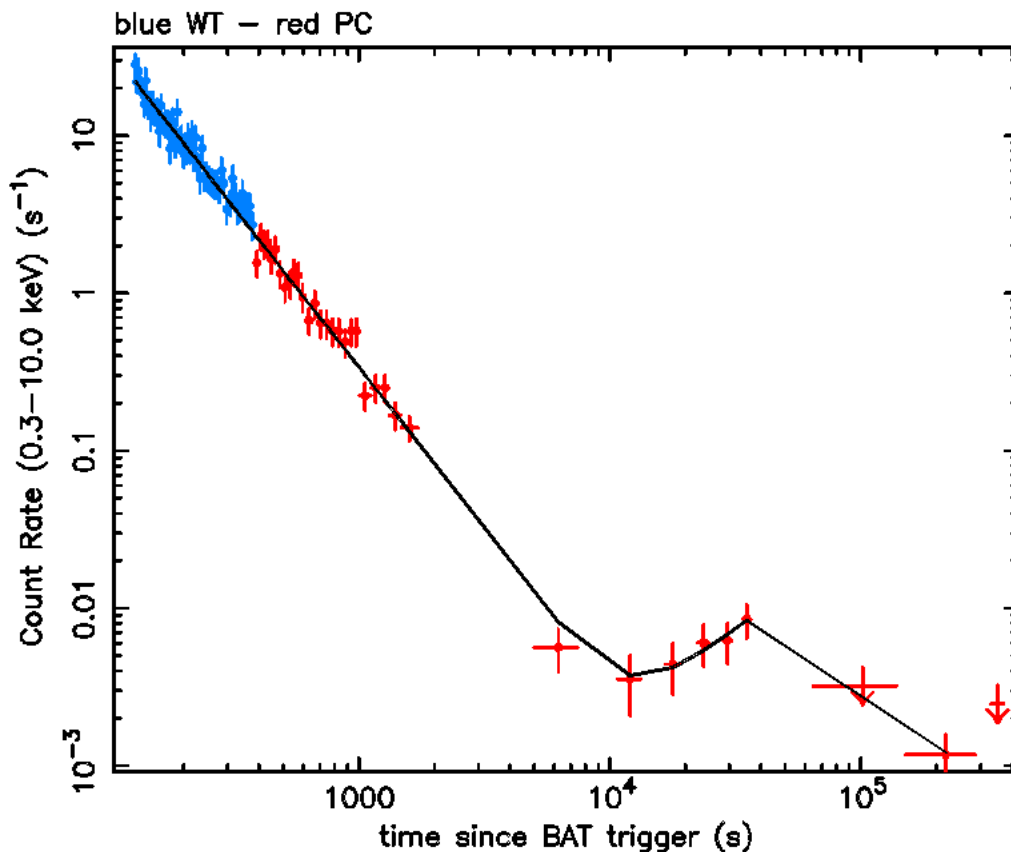


Figure 2: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is $1 \text{ count } s^{-1} \sim 5.2 \times 10^{-11} \text{ erg cm}^{-2} s^{-1}$.

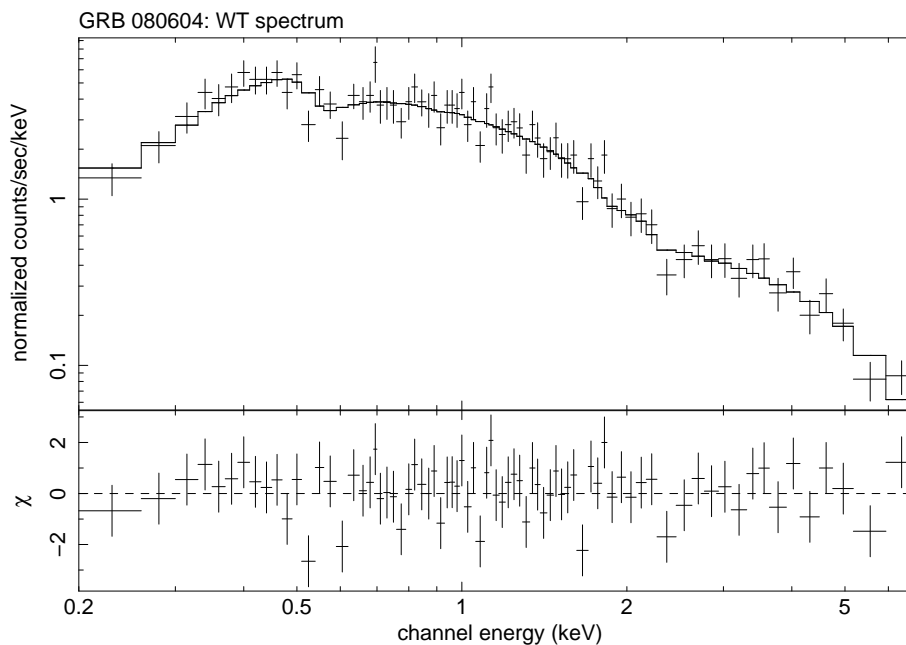


Figure 3: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is $1 \text{ count } s^{-1} \sim 5.2 \times 10^{-11} \text{ erg cm}^{-2} s^{-1}$.

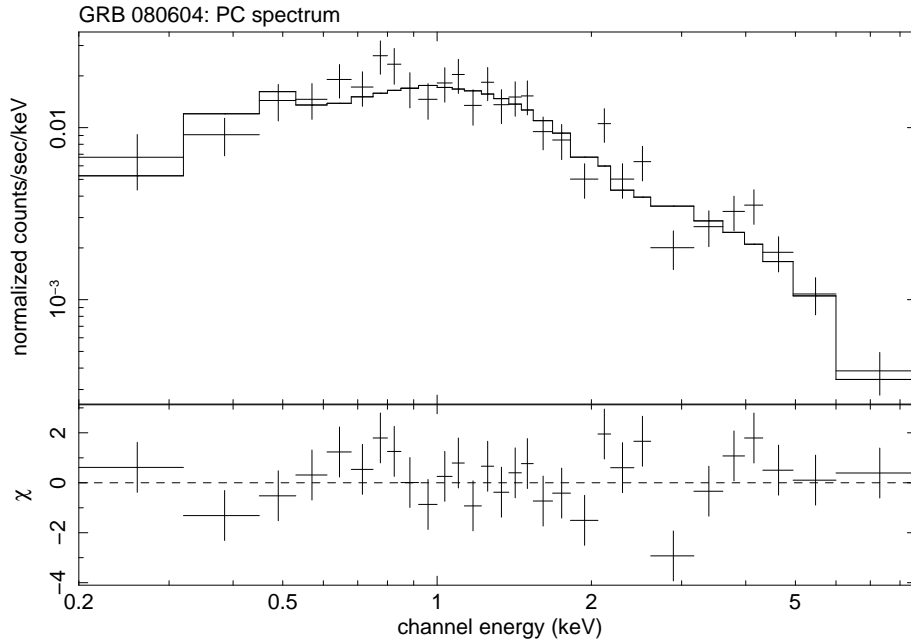


Figure 4: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is $1 \text{ count s}^{-1} \sim 5.2 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.

Filter	Tstart (s)	Exp. (s)	Magnitude mag
White	129	99	20.1 ± 0.2
White	730	10	> 19.7
White	869	99	21^{+3}_{-2}
White	1479	39	> 20.7
White	5369	393	$21.8^{+0.5}_{-0.4}$
V	235	393	> 20.1
V	769	412	> 20.0
V	1519	39	> 18.8
V	5807	393	> 19.9
V	17489	885	> 20.3
B	716	10	> 19.0
B	1454	39	> 19.8
B	5191	393	> 21.0
U	691	39	> 19.4
U	1430	39	> 19.4
U	4896	393	> 20.7
U	12600	689	> 21.0
UVW1	667	46	> 19.6
UVW1	6217	1082	> 21.2
UVM2	641	1931	> 21.6
UVW2	745	1395	> 21.4

Table 1: Magnitudes and upper limits from UVOT observations