

Swift Observation of GRB 080804

*J. L. Racusin (PSU), N. P. M. Kuin (MSSL/UCL), C. Markwardt (GSFC/UMD), C. Pagani (PSU)
for the Swift Team*

1 Introduction

BAT triggered on GRB 080804 at 23:20:14 UT (Trigger 319016) (Racusin, *et al.*, *GCN Circ.* 8057). This was a rate-trigger with $T_{90} = 34$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 99$ sec, and UVOT at $T + 91$ sec. The redshift of GRB 080804 ($z=2.2045$) was measured by Thoene *et al.* (*GCN Circ.* 8058). Our best position is the UVOT location $RA(J2000) = 328.6675deg$ ($21h54m40.2s$), $Dec(J2000) = -53.18461deg$ ($-53d11'04.6''$) with an uncertainty of 0.4 arcsec (radius, 90% confidence, including boresight uncertainties).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 962$ sec, further analysis of BAT GRB 080804 has been performed by Swift team (Markwardt, *et al.*, *GCN Circ.* 8067). The BAT ground-calculated position is $RA(J2000) = 328.675deg$ ($21h54m41.9s$), $Dec(J2000) = -53.189deg$ ($-53d11'20.2''$) with an uncertainty of 1.2 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 19%.

The masked-weighted light curves (Fig.1) shows the main peak starting at $\sim T - 10$ sec, peaking at $T + 2$ sec, and ending at $T + 100$ sec. $T_{90}(15 - 350keV)$ is 34 ± 16 (estimated error including systematics).

The time-averaged spectrum from $T - 0.4$ to $T + 62.8$ sec is best fit by a simple power law model. This fit gives a photon index of 1.19 ± 0.09 . For this model the total fluence in the 15 – 150 keV band is $(3.6 \pm 0.2) \times 10^{-6} ergs/cm^2$ and the 1-sec peak flux measured from $T + 1.57$ sec in the 15 – 150 keV band is $3.1 \pm 0.4 ph/cm^2/sec$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using 6979 s of XRT Photon Counting mode data and 8 UVOT images for GRB 080804, the astrometrically corrected X-ray position (Beardmore *et al.*, *GCN Circ.* 8066, using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is: $RA(J2000) = 328.66755$ ($21h54m40.21s$), $Dec(J2000) = -53.18483deg$ ($-53d11'05.4''$) with an uncertainty of 1.5 arcsec (radius, 90% confidence). This position is 4.1 arcsec of the initial XRT position, and 0.8 arcsec from the UVOT optical afterglow candidate, reported by Kuin *et al.* (*GCN Circ.* 8069).

The 0.3 – 10 keV light curve (Fig.2) can be fit with a single power-law with decay index of 1.10 ± 0.02 .

The X-ray spectrum can be modeled with an absorbed power-law with spectral index of 1.6 ± 0.2 . The intrinsic NH column density is at a level of $1.7 \times 10^{21} cm^{-2}$, in addition to the galactic column density of $1.6 \times 10^{20} cm^{-2}$. The average observed (unabsorbed) flux over 0.3 – 10 keV for this spectrum (spanning a time of 100-25000 seconds after the trigger) is 2.5×10^{-10} (2.6×10^{-10}) $ergs/cm^2/sec$.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 080804 at 23:21:45 UT, 91 sec after the initial BAT trigger (Racusin *et al.*, *GCN Circ.* 8057), and started the finding chart exposure in the white filter

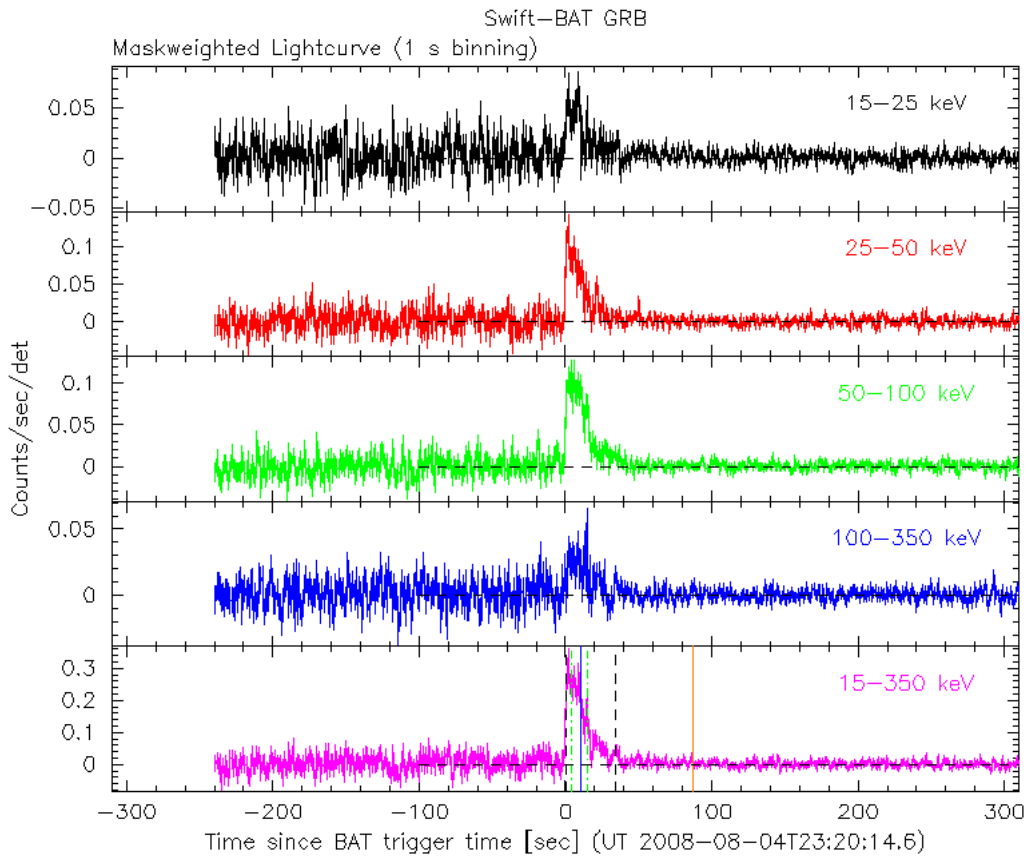


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 23:20:14 UT.

at 111 seconds after the trigger (Kuin *et al.*, *GCN Circ.* 8069). The magnitudes with 1-sigma errors are summarized in Table 1, and the u-band light curve is given in Fig. 3. These values are on the UVOT Photometric System (Poole *et al.*, 2008, *MNRAS* 383,627). They are not corrected for the expected galactic reddening of $E(B-V) = 0.016$ in the direction of the burst (Schlegel *et al.* 1998). The upper limits in uvw2, uvm2, and weak detection in uvw1 are consistent with the reported redshift of $z=2.2045$ by Thoene *et al.* (*GCN Circ.* 8058).

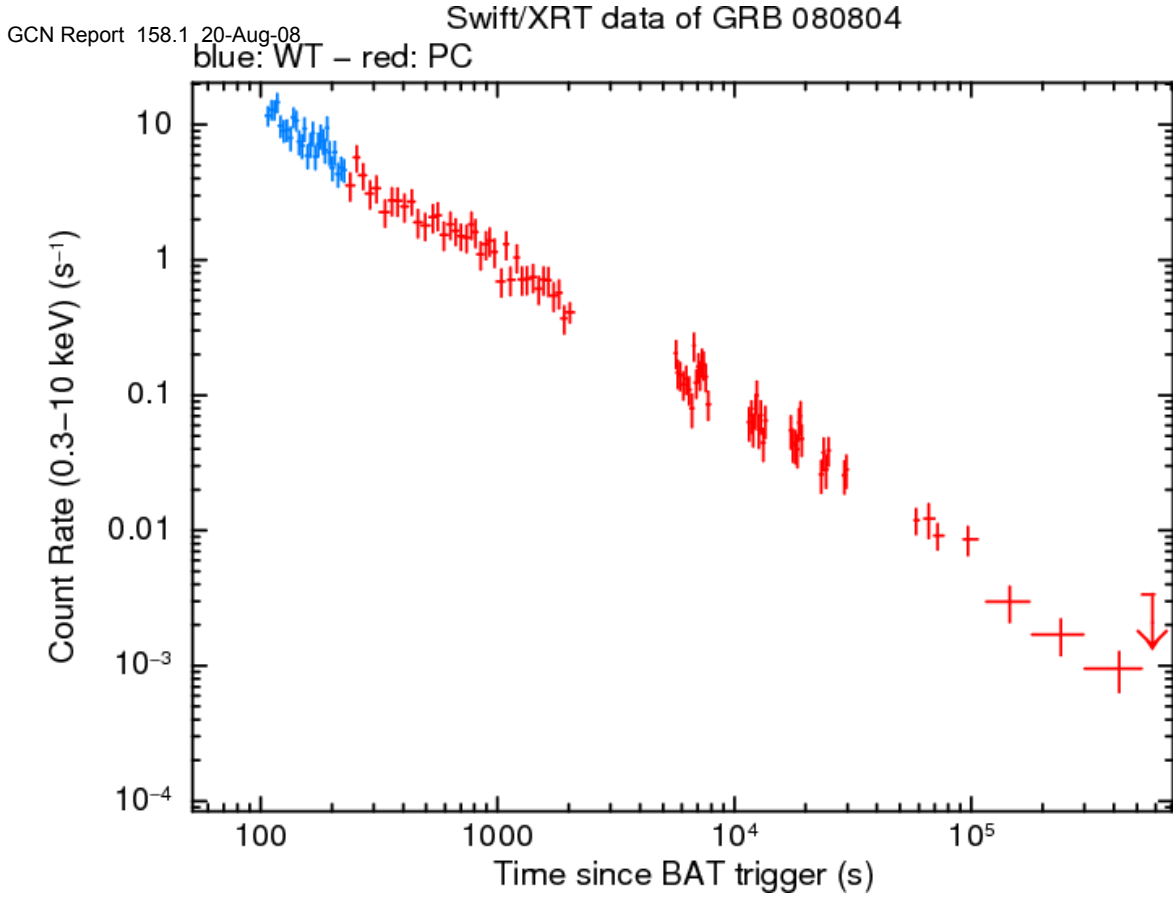


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count/sec = $\sim 4.2 \times 10^{-11}$ $ergs/cm^2/sec$.

Filter	Start(s)	Stop(s)	Exposure(s)	Magnitude
white	111	210	98.2	16.83 ± 0.03
v	217	616	393.5	17.17 ± 0.05
uvm2	623	642	19.5	> 17.6
uvw1	648	667	19.4	> 18.2
b	697	706	9.6	18.1 ± 0.27
u	672	691	19.4	17.4 ± 0.17
white	711	720	9.6	18.3 ± 0.16
uvw2	727	746	19.5	> 18.2
v	752	771	19.4	17.85 ± 0.30
uvw1	648	7442	529.3	20.9 ± 0.4
uvm2	623	7237	529.4	> 20.8
uvw2	727	6827	1179.5	> 21.8
white	93626	116288	995	> 22.5
u	92908	115961	994	21.62 ± 0.47
b	93267	116125	994	22.83 ± 1.06
v	93986	116384	815	> 20.80
u	261744	434385	13583	23.20 ± 0.51
u	435635	592126	15184	23.60 ± 0.70

Table 1: UVOT magnitudes in all filters. 3σ upper limits are given where the afterglow was not detected.

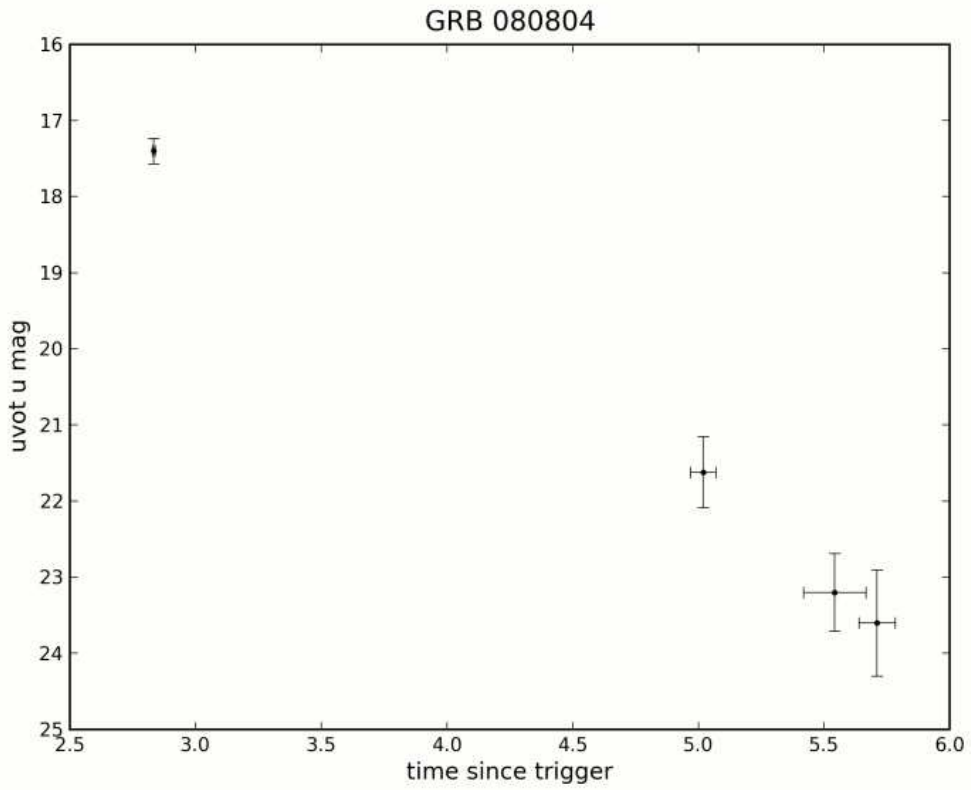


Figure 3: UVOT u-band Lightcurve. Time axis is logarithmic. Errors are 1σ .