

Swift Observation of GRB 080605

B. Sbarufatti (INAF-IASF Pa), A. Parsons (GSFC), T. Sakamoto (GSFC/UMBC), V. Mangano (INAF-IASF Pa), V. La Parola (INAF-IASF Pa), P. Kuin (MSSL/UCL), S.D. Barthelmy (NASA/GSFC), D.N. Burrows (PSU), P. Roming (PSU), N. Gehrels (NASA/GSFC) for the Swift Team

1 Introduction

BAT triggered on GRB 080605 at 23:43:57 UT (Trigger 313299) (Sbarufatti, *et al.*, *GCN Circ.* 7828). This was a 1.024 *sec* rate-trigger on a long burst with $T_{90} = 20 \pm 1$ *sec*. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 90$ *sec*, and UVOT at $T + 82$ *sec*. Our best position is the refined UVOT location RA(*J2000*) = 262.12522*deg* (17h28m30.05s), Dec(*J2000*) = +4.01555*deg* (+04d00'55.97") with an error of 0.5 arcsec (90% confidence).

The prompt emission was also detected by Konus-Wind (Golenetskii *et al.*, *GCN Circ.* 7854) and SPI-ACS/*INTEGRAL* (Beckmann, private communication).

The optical afterglow was detected by a number of ground based telescopes, e.g.: TLS Tautenburg 1.34m Schmidt telescope (Kann *et al.*, *GCN Circ.* 7829), Liverpool Telescope (Gomboc *et al.*, *GCN Circ.* 7831), GROND (Clemens *et al.*, *GCN Circ.* 7834), BOOTES (Jelinek *et al.*, *GCN Circ.* 7837), CrAO (Rumyantsev *et al.*, *GCN Circ.* 7833), MITSuME (Yoshida *et al.*, *GCN Circ.* 7863).

A redshift estimate $z = 1.6398 \pm 0.0006$ was provided by ESO-VLT based on absorption features detected on the afterglow spectrum (Jakobsson *et al.*, *GCN Circ.* 7832).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 962$ *sec*, further analysis of BAT GRB 080605 has been performed by Swift team (Cummings, *et al.*, *GCN Circ.* 7841). The BAT ground-calculated position is RA(*J2000*) = 262.130*deg* (17h28m31.1s), Dec(*J2000*) = +4.010*deg* (+04d00'35.6") ± 1.0 *arcmin*, (radius, systematic and statistical, 90% containment). The partial coding was 41%.

The mask-weighted light curve shows a cluster of overlapping peaks starting at $T - 3$ *sec*, with the largest peak at $T + 8$ *sec*, ending at $T + 70$ *sec*. Persistent emission is detected at the 1-2- σ level in the $T + 300$ to $T + 700$ *sec* range. $T_{90}(15 - 350$ *keV*) is 20 ± 1 *sec* (estimated error including systematics).

The time-averaged spectrum from $T - 5.5$ to $T + 30.0$ *sec* is best fitted by a power law with an exponential cutoff. This fit gives a photon index of 1.11 ± 0.14 and $E_{peak} = 223 \pm 133$ *keV* ($\chi^2 = 28.10$ for 56 d.o.f.). For this model the total fluence in the 15 – 150 *keV* band is $(1.33 \pm 0.02) \times 10^{-5}$ *ergs/cm*² and the 1-sec peak flux measured from $T + 7.57$ *sec* in the 15 – 150 *keV* band is 19.9 ± 0.6 *ph/cm*²/*sec*. A fit to a simple power law gives a photon index of 1.36 ± 0.03 ($\chi^2 = 37$ for 57 d.o.f.). 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/313299/BA/.

3 XRT Observations and Analysis

The XRT began observations of GRB 080605 on 2008 May 05 at 23:49:36 UT, 90 *sec* after the BAT trigger. Using 426 *sec* of overlapping XRT Photon Counting mode and UVOT data, the astrometrically corrected X-ray position is RA(*J2000*) = 262.12533*deg* (17h28m30.08s), +4.01608*deg* (+04d00'57.9") with an uncertainty of 1.8 arcsec (radius, 90% confidence level). This position is within 3.2 *arcsec* of

the initial XRT position, and 1.9 *arcsec* from the optical afterglow candidate, reported by Holland *et al.*, *GCN Circ.* 7830.

The 0.3 – 10 *keV* light curve, totaling an exposure of 69.4 *ksec* and spanning from 96 to 9.4×10^5 *sec* (Fig.2) can be modeled by a smoothly broken powerlaw of the form: $rate = \frac{k}{(\frac{t}{t_b})^{\alpha_1 + (\frac{t}{t_b})^{\alpha_2}}}$ with best fit parameters $\alpha_1 = 0.2 \pm 0.1$, $t_b = 360_{-90}^{+150}$ *sec*, $\alpha_2 = 1.47 \pm 0.05$ (all quoted errors are at 90% confidence level).

The Windowed Timing mode data (640 *sec* of exposure) can be modeled by a powerlaw with photon index 1.78 (+/- 0.04) and an intrinsic absorbing column of $(6.6 \pm 0.9) \times 10^{21}$ *cm*⁻² at $z = 1.6398$, in excess over the Galactic value of 6.67×10^{20} *cm*⁻² (Kalberla *et al.* 2005). The observed (unabsorbed) flux for this spectrum (spanning times from $T + 96$ to $T + 736$ *sec*) is $7.5(8.1) \times 10^{-10}$ *ergs/cm*²/*sec*. The first orbit Photon Counting mode spectrum (379 *sec*) of exposure, spanning times from $T + 929$ to $T + 1355$ *sec*) can be modeled by a powerlaw with photon index 1.6 ± 0.2 and an intrinsic absorbing column of $(4.8 \pm 4) \times 10^{21}$ *cm*⁻². The observed (unabsorbed) flux is $3.0(3.3) \times 10^{-10}$ *ergs/cm*²/*sec* (Sbarufatti *et al.*, *GCN Circ.* 7838).

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 observing the field of GRB 080605 at 23:49:19 UT, 82 *sec* after the initial BAT trigger, and started the finding chart exposure in the white filter at $T + 102$ *sec*.

The refined UVOT position is RA(*J*2000) = 262.12522*deg* (17h28m30.05s), Dec(*J*2000) = +4.01555*deg* (+04d00'55.97"), with an accuracy of 0.5 *arcsec*, which is consistent with the positions reported by Holland *et al.*(*GCN Circ.* 7830) and Goad *et al.*(*GCN Circ.* 7835).

The GRB is found close (about 4 *arcsec* distant) to a star, which may cause an error in the measured flux, especially at later times. For this analysis we use a small 2 *arcsec* aperture which reduces the contamination, and apply a standard aperture correction. We note that the DSS image indicates the presence of a weak, possibly extended source near the position of the afterglow.

The magnitudes with 1-sigma errors for GRB 080605 are given below for the initial observation sequence:

Filter	Start	Stop	Exposure	3-Sigma UL
wh	102	201	98.2	18.11 +/- 0.06
v	208	607	393.5	18.53 +/- 0.11
wh	858	957	98.2	20.02 +/- 0.17
uvm2	615	788	38.9	> 18.38(3 - σ UL)
uvw1	639	813	38.9	> 18.95(3 - σ UL)
uvw2	720	739	19.5	> 18.16(3 - σ UL)
b	27679	28264	571.7	21.10 +/- 0.27
u	18432	41856	550.7	21.17 +/- 0.43

Table 1: Magnitude limits from UVOT observations

The values quoted above are on the UVOT Photometric System (Poole *et al.*, 2008). They are not corrected for the expected galactic reddening of $E(B - V) = 0.137$ in the direction of the burst (Schlegel *et al.*, 1998).

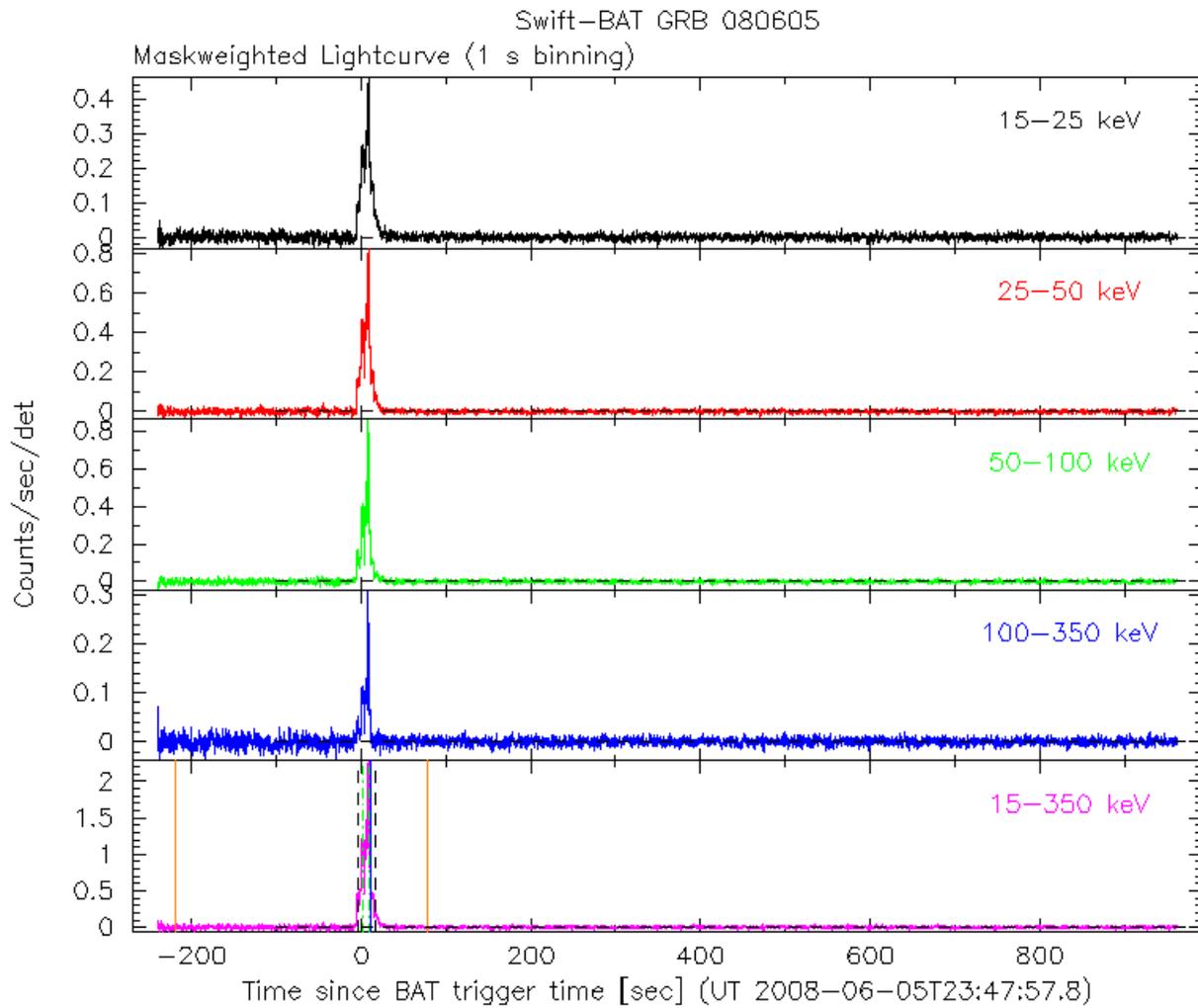


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are *counts/sec/illuminated - detector* (note *illum - det* = 0.16 cm²) and T_0 is 23:47:57 UT.

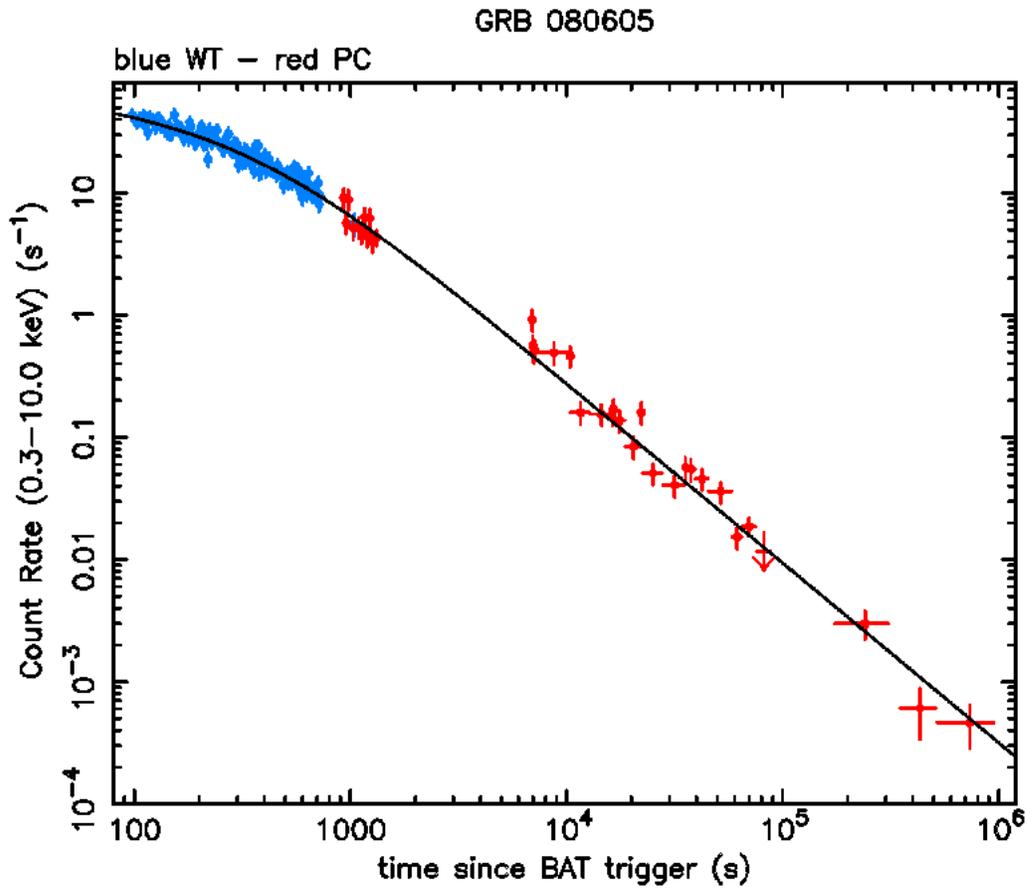


Figure 2: XRT Lightcurve. *Counts/sec* in the 0.3 – 10 keV band: Window Timing mode (blue), Photon Counting mode (red). The rate to flux conversion factor is $1 \text{ count/sec} = 4.87 \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.