

Final Swift Observations of the GRB 080205

C. B. Markwardt (CRESST/U.Md/NASA/GSFC), R. Starling (U. Leicester), S. Oates (MSSL),
S.D. Barthelmy (GSFC), D.N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC)
for the Swift Team:

1. INTRODUCTION

At 07:55:51 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 080205 (trigger=302506, Markwardt et al. GCN 7250). Swift slewed immediately to the burst. Our best Swift position is from the Swift UVOT, which is:

RA (J2000) = 06h 33m 00.62s

Dec (J2000) = +62d 47' 31.98"

with an error of about 0.5". The BAT light curve shows three roughly equal-height peaks spanning approximately 120 seconds. Counterparts were detected by both Swift XRT and UVOT in the White and V bands. In addition, the afterglow was detected from the ground in the optical/IR (Li et al. GCNs 7251, 7254; Burenin et al. GCN 7275), IR (Rol et al. GCN 7258) and 8.46 GHz radio (Chandra & Frail, GCN 7259). No observations, taken ~12 hours after the GRB or later, were reported. Although a spectroscopic redshift was not reported, the lack of detections shortward of V band suggests a redshift of ~4, or a highly extinguished afterglow.

2) BAT OBSERVATION AND ANALYSIS

The following uses data from T-239 to T+963 sec (Cummings et al. GCN 7257). The BAT ground-calculated position is RA, Dec = 98.261, 62.782 deg which is

RA(J2000) = 6h 33m 2.6s

Dec(J2000) = 62d 46' 56"

with an uncertainty of 1.5 arcmin, (radius, sys+stat, 90% containment). The partial coding was 52%, and was 38.5 deg off axis.

The mask-weighted light curve, shown in Figure 1, has at least 3 peaks at about T+2, T+65, and T+93 sec. T₉₀ (15-350 keV) is 106.5 ± 5.0 sec (estimated error including systematics).

The time-averaged spectrum from T-10.1 to T+105.3 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.08 ± 0.12 . The fluence in the 15-150 keV band is $2.1 \pm 0.1 \times 10^{-6}$ erg/cm². The 1-sec peak photon flux measured from T+0.22 sec in the 15-150 keV band is 1.4 ± 0.2 ph/cm²/sec. All the quoted errors are at the 90% confidence level.

3. XRT OBSERVATION AND ANALYSIS

Swift XRT observations began 101 seconds after the BAT trigger (Starling et al. GCN 7255) in Windowed Timing mode and continued in Photon Counting (PC) mode 208 s after the trigger.

Using 794 s of overlapping XRT Photon Counting mode and UVOT V-band data for GRB 080205, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 98.25223, +62.79186 which is equivalent to:

RA (J2000): 06h 33m 0.54s

Dec (J2000): +62d 47' 30.7"

with an uncertainty of 2.0 arcsec (radius, 90% confidence). (reference for XRT refined position: Osborne et al. GCN 7252).

The XRT light curve, shown in Figure 2, can be fit with a power law with two breaks. The initial steep decay has a slope of $\alpha_1 = 4.5 \pm 0.3$, breaking at $T_{bk1} = 203 \pm 22/-8$ s to a plateau with slope $\alpha_2 = 0.5 \pm 0.3/-0.8$. The plateau phase ends at $T_{bk2} = 543 \pm 155/-126$ s and the decay continues with slope

1.76 ± 0.08 . However, the final decay is somewhat irregular and cannot be fit by a single power law. Data beyond $T+10000$ s can be fit with a power law slope of $1.2 +0.1/-0.2$.

We fit the first orbit PC mode spectrum, totalling 1.5ks of data and covering T_0+208 s to T_0+1728 s, with an absorbed power law. We measure a photon index of $\Gamma = 1.8 \pm 0.2$ and intrinsic absorption of $N_H = (1.0 \pm 0.7) \times 10^{21} \text{ cm}^{-2}$ (at $z=0$), whilst fixing the Galactic absorption at $7.1 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The 0.5-10 keV observed (unabsorbed) flux is 6×10^{-11} (7.2×10^{-11}) $\text{erg/cm}^2/\text{s}$. The count rate to flux conversion is approximately $1 \text{ count/s} = 4.7 \times 10^{-11} \text{ erg/cm}^2/\text{s}$.

4. UVOT OBSERVATION AND ANALYSIS

The Swift/UVOT observed starting 111 seconds after the BAT trigger (Oates et al. GCN 7253). We detect the optical afterglow at the position:

RA (J2000) = 06h 33m 00.62s

Dec (J2000) = +62d 47' 31.98"

with an error of about 0.5".

The optical afterglow initially brightens in the first few hundred seconds after the trigger and then begins to decay at around $\sim T+1000$ s. The afterglow is detected in the white and v filters only. The lack of detection in the b, u and uv filters suggests that this GRB is at a $z \sim 4.0$, or has a highly extinguished afterglow.

The magnitudes and 3-sigma upper limits are displayed in Table 1. The values quoted in the Table are not corrected for the expected Galactic extinction corresponding to a reddening of $E_{B,V} = 0.091 \text{ mag}$ in the direction of the burst (Schlegel et al. 1998).

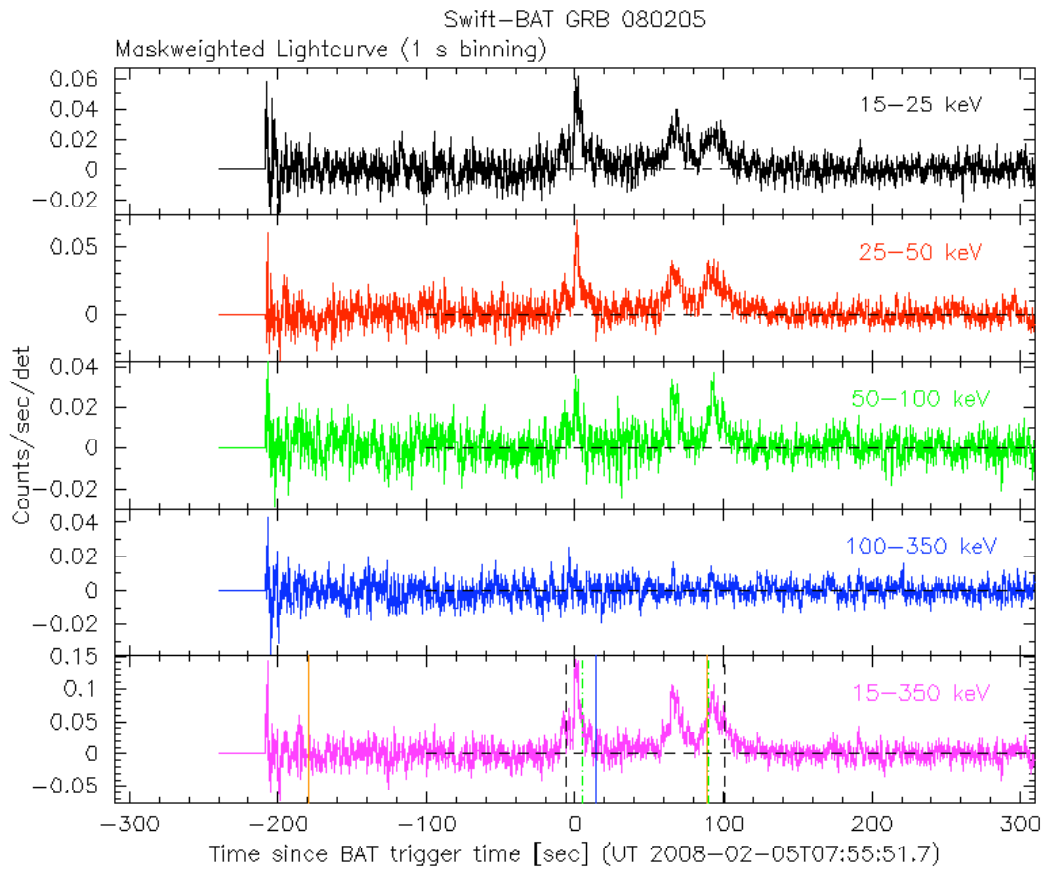


Fig.1: BAT lightcurve with 1 sec time bins. The lightcurve has 4 individual energy bands (15-25 keV, 25-50, 50-100, 100-150, starting from top), plus the total band (bottom). The vertical dashed lines indicate the T50 (green) and T90 (black) intervals. The beginning and end of the slew are marked by blue and red vertical lines).

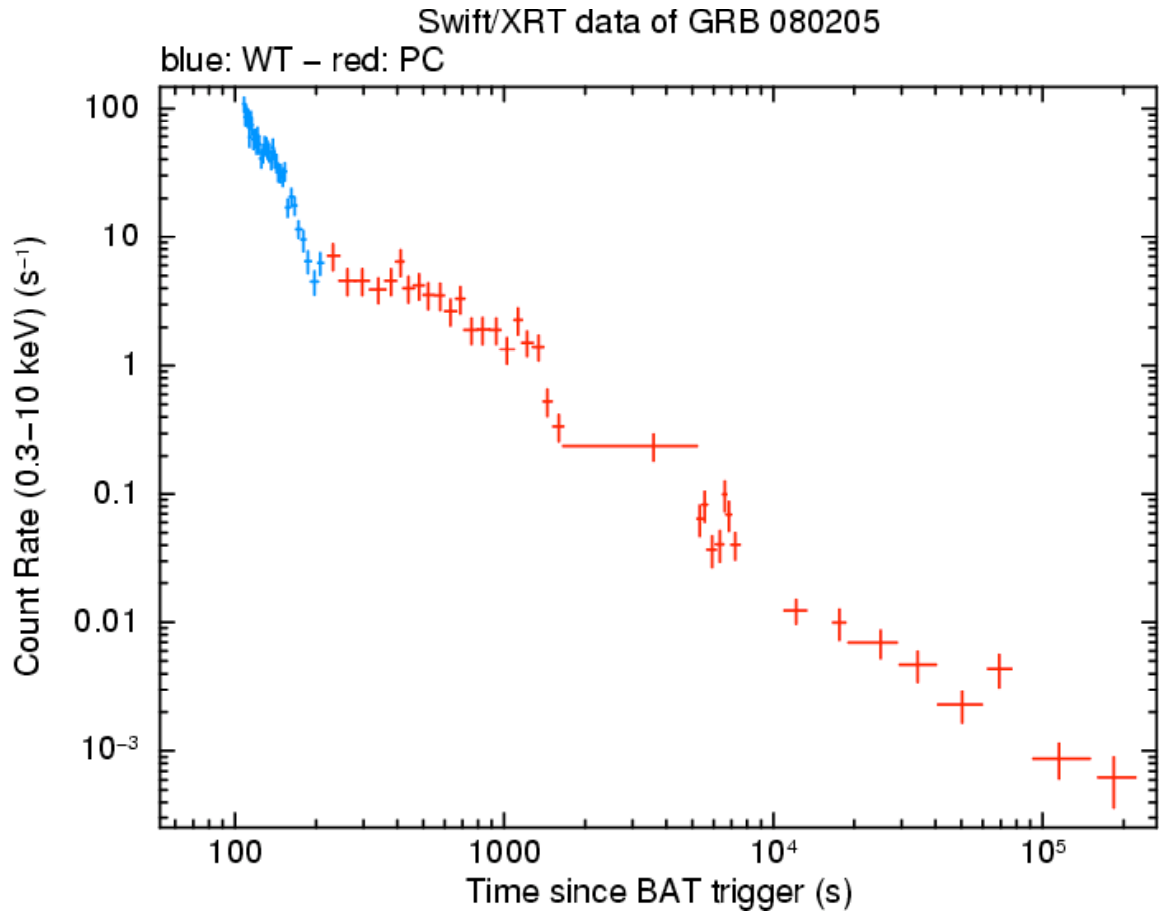


Fig. 2: Swift XRT lightcurve of the afterglow in count units. The initial data were taken in WT mode (blue) and the remainder were taken in PC mode (red). The count rate to flux conversion is approximately $1 \text{ count/s} = 4.7 \times 10^{-11} \text{ erg/cm}^2/\text{s}$.

Table 1: UVOT Measurements and Upper Limits. The values marked by “UL” are 3-sigma upper limits.

Filter	T_start(s)	T_stop(s)	Expo(s)	Mag
White	111	222	98	20.37 ± 0.28
White	864	964	98	19.76 ± 0.17
White	5436	5636	196	20.59 ± 0.25
v	217	617	393	18.07 ± 0.09
v	970	1370	393	19.02 ± 0.20
b	697	686	451	20.83 UL
u	672	6664	471	20.45 UL
uvw1	647	6458	286	20.13 UL
uvm2	622	7525	329	20.03 UL
uvw2	727	7279	452	20.39 UL