

Swift Observation of GRB 070704

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1 Introduction

BAT triggered on GRB 070704 at 20:05:57 UT (Trigger 283791) (Sakamoto, *et al.*, *GCN Circ.* 6594). This was a 64 sec image-trigger with $T_{90} = 380$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T+153$ sec, and UVOT at $T+265$ sec. Our best position is the XRT location $\text{RA}(J2000) = 354.69915$ deg ($23^{\text{h}}38^{\text{m}}47.80^{\text{s}}$), $\text{Dec}(J2000) = +66.25328$ deg ($+66^{\circ}55'11.8''$) with an error of 2.7 arcsec (90% confidence, including boresight uncertainties).

2 BAT Observation and Analysis

Using the data set from $T-239$ to $T+523$ sec, further BAT analysis of GRB 070704 has been performed. The BAT ground-calculated position is $\text{RA}(J2000) = 354.707$ deg ($23^{\text{h}}38^{\text{m}}49.6^{\text{s}}$), $\text{Dec}(J2000) = +66.257$ deg ($+66^{\circ}15'25''$) ± 1.6 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 42% (the bore sight angle was 42.5 deg).

The mask-weighted light curve (Fig.1) shows the burst started at $T-65$ sec when Swift was executing a preplanned slew. There are multiple peaks with decreasing amplitude with time. There are also a strong hard-to-soft spectral evolution during this prompt phase. The burst almost returns to background during $T+110$ to $T+230$ sec, but then has emission from $T+250$ to $T+410$ sec. T_{90} (15-350 keV) is 380 ± 10 sec (estimated error including systematics).

The time-averaged spectrum from $T-57.3$ to $T+400.8$ sec is best fitted by a simple power law model. This fit gives a photon index of 1.79 ± 0.08 . For this model the total fluence in the 15 – 150 keV band is $(5.9 \pm 0.3) \times 10^{-6}$ ergs/cm² and the 1-sec peak flux measured from $T-53.1$ sec in the 15 – 150 keV band is 2.1 ± 0.2 ph/cm²/sec. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

Using the data from the first three orbits of XRT data of GRB 070704 (8.5 ksec in Window Timing (WT) and Photon Counting (PC) mode), the astrometrically corrected refined XRT position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is $\text{RA}(J2000) = 354.69915$ deg ($23^{\text{h}}38^{\text{m}}47.80^{\text{s}}$), $\text{Dec}(J2000) = +66.25328$ deg ($+66^{\circ}15'11.8''$) ± 2.7 arcsec (90% confidence, including boresight uncertainties). This position is within 3.7 arcsec of the initial XRT position.

The XRT 0.3 – 10 keV light curve (Fig.2) exhibits an initial decay on which is superposed a large flare peaking around $T+300$ sec. We note that between $T+250$ and $T+410$ sec an emission was also detected in the BAT (Markwardt *et al.*, *GCN Circ.* 6596). The light-curve from $T+600$ to $T+3 \times 10^4$ sec is fit well by a power-law with a decay index of $0.87^{+0.11}_{-0.12}$.

The spectrum of the WT data from $T+153$ to $T+527$ sec is fit well by an absorbed power-law with a photon index of 1.85 ± 0.06 and column density of $N_H = (1.08 \pm 0.06) \times 10^{22}$ cm⁻² in excess of the Galactic value (8.6×10^{21} cm⁻²; Dickey & Lockman, 1990). The absorbed (unabsorbed) 0.3-10.0 keV flux for that spectrum is $(1.57 \pm 0.05) \times 10^{-9}$ (2.85×10^{-9}) ergs cm⁻² s⁻¹. The spectrum of the PC data from $T+530$ to $T + 3 \times 10^4$ sec is fit well by an absorbed power-law with a photon index of

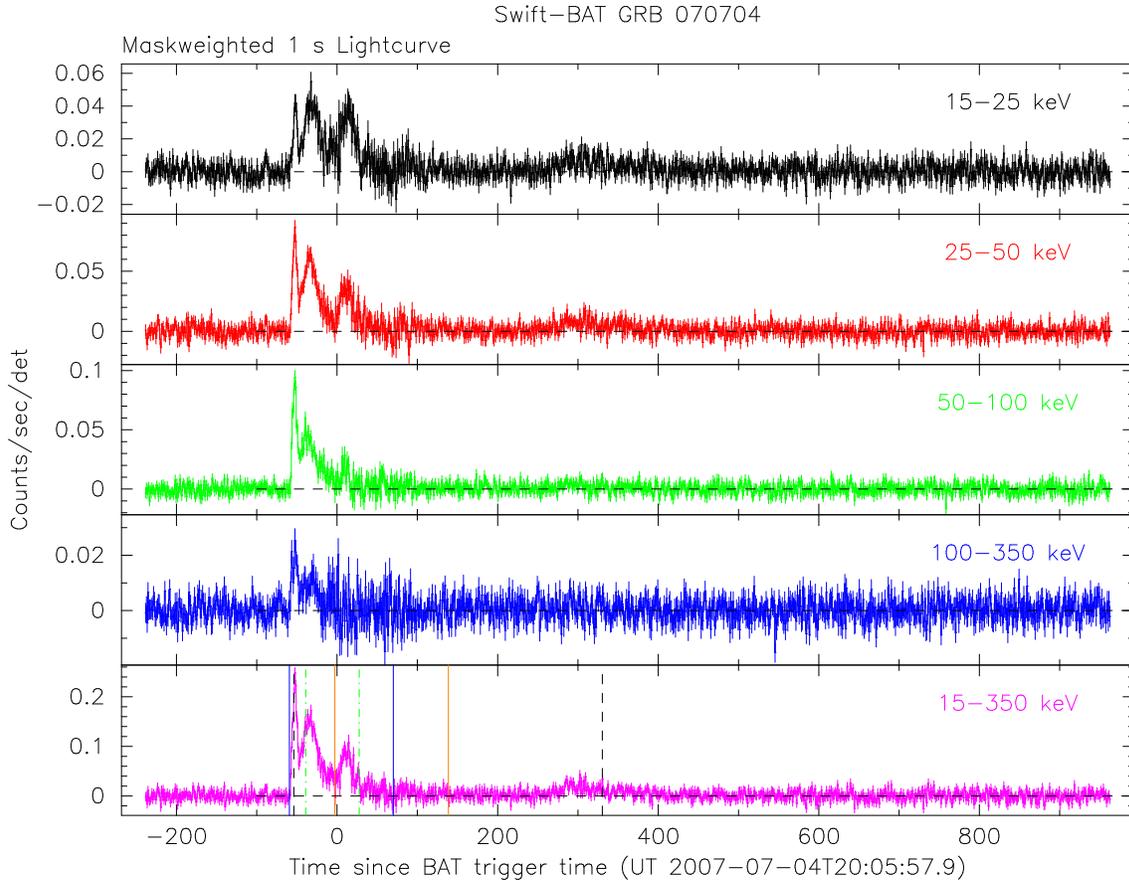


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 20:05:57.9 UT. The blue vertical lines are the start time of the spacecraft slew and the orange vertical lines are the stop time of the spacecraft slew. The black and green dotted lines show the T_{90} and T_{50} intervals.

1.97 ± 0.27 with N_H fixed at $1.08 \times 10^{22} \text{ cm}^{-2}$. The absorbed (unabsorbed) 0.3-10.0 keV flux for that spectrum is $3.3_{-0.8}^{+0.6} \times 10^{-12}$ (6.54×10^{-12}) $\text{ergs cm}^{-2} \text{ s}^{-1}$.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 070704 starting 265 sec after the initial BAT trigger (Sakamoto *et al.*, *GCN Circ.* 6594). We do not find any source, in any of the UVOT observations, inside the XRT error circle (Sakamoto *et al.* 2007, *GCN Circ.* 6594).

The 3-sigma upper limits are summarized in Table 1. These upper limits are not corrected for Galactic extinction $E(B-V) = 1.81$ in the direction of the burst (Schlegel *et al.* 1998).

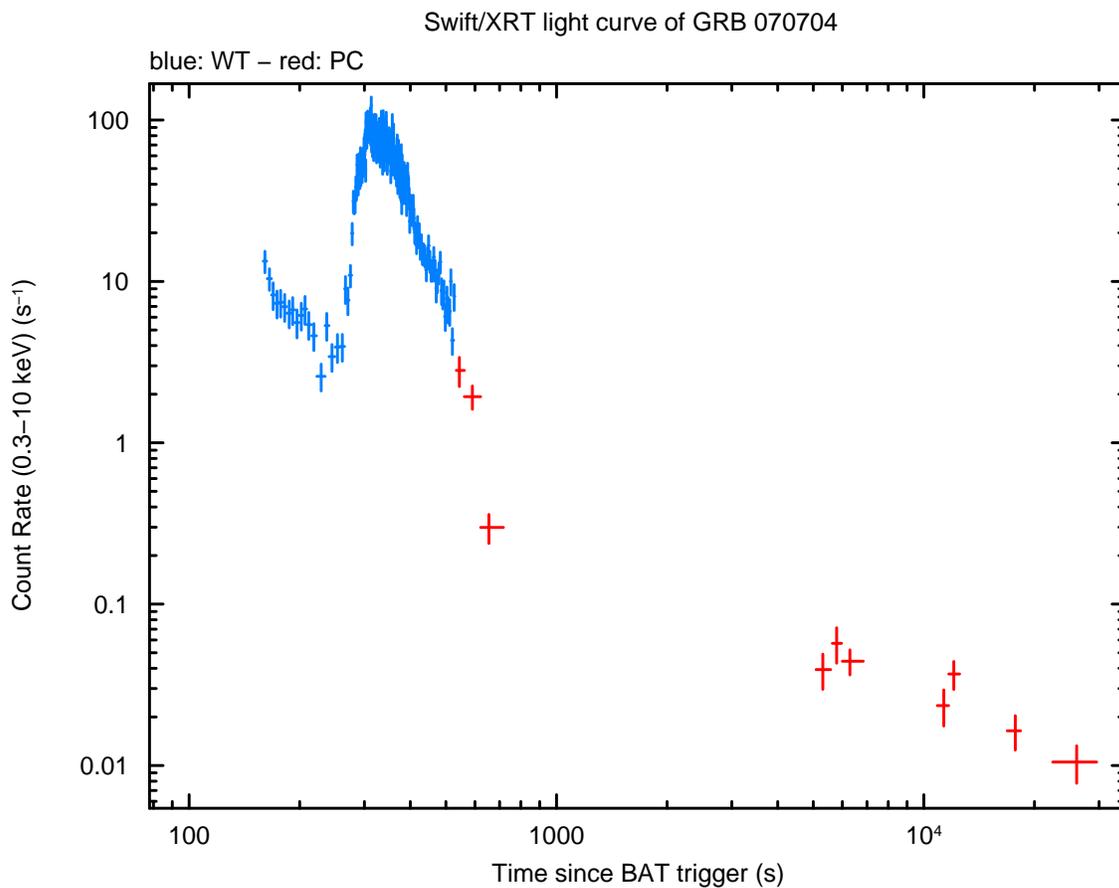


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (black), Photon Counting mode (red). The approximate conversion is $1 \text{ count/sec} \sim 2.8 \times 10^{-10} \text{ ergs/cm}^2/\text{sec}$.

| Filter | T_{mid} (s) | Exposure (s) | 3-Sigma UL (mag) |
|--------|------------------|-----------------|---------------------|
| V | 654 | 597 | 19.16 |
| B | 749 | 10 | 17.56 |
| U | 729 | 20 | 17.64 |
| UVW1 | 5603 | 439 | 18.91 |
| UVM2 | 4431 | 239 | 19.36 |
| UVW2 | 5697 | 220 | 19.27 |
| WHITE | 574 | 209 | 19.65 |

Table 1: Magnitude limits from UVOT observations. T_{mid} is the weighted mid time of the coadded exposure.