Swift Observations of the Short/Hard Burst GRB 061201

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1. INTRODUCTION

At 15:58:36 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 061201 (trigger 241840; Marshall *et al.* GCN Circ. 5881). Swift slewed immediately to the burst, and the XRT began taking data ~81 seconds after the trigger. The first UVOT finding chart began ~86 seconds after the trigger.

XRT determined the best Swift position for the burst (Perri *et al.,* GCN Circ. 5885). The position is near the catalogued cluster of galaxies ACO S995 (Bloom, GCN Circ. 5880). UVOT detected a weak source inside the XRT error region (Holland & Marshall, GCN Circ. 5883), but the lack of variability suggests that the source is not the afterglow of the burst. D'Avanzo *et al.* (GCN Circ. 5884) report a candidate afterglow in the XRT error circle with I ~22.3 using VLT observations ~8.38 hours after the trigger.

2) BAT OBSERVATION AND ANALYSIS

The BAT ground-calculated position (Markwardt *et al.,* GCN Circ. 5882) is RA (J2000) = 22h 08m 19.0s (332.079°) and DEC (J2000) = -74° 34' 06.6" (-74.569°) with an uncertainty of 1.2' radius (90% containment including both statistical and systematic errors). The partial coding was 48%.

The mask-weighted light curve (Fig. 1) shows two main peaks separated by ~0.7 sec, the first starting at T+0 sec, and the second ending at T+1.1 sec. A visual scan of the light curve from T+2 to T+300 sec. places an upper limit of 0.01ph $cm^{-2}sec^{-1}$ for any extended emission. T_{90} (15-350 keV) is 0.8 ± 0.1 sec (estimated error including systematics).

The flux in the 15-25 keV band lags the flux in the 100-300 keV by 0.27 ms (+3.3 ms, -2.4 ms). Such a short lag is expected for a short/hard burst.

The time-averaged spectrum from T+0.0 to T+0.9 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 0.81 ± 0.15. The fluence in the 15-150 keV band is (3.3 ± 0.3) x 10^{-7} erg cm^{-2}. The 1-sec peak photon flux measured from T-0.05 sec in the 15-150 keV band is (3.9 ± 0.3) ph $cm^{-2}sec^{-1}$. All the quoted errors are at the 90% confidence level.

The burst shows significant hard-to-soft spectral evolution. A fit to the first peak (T+0.0 to T+0.7) gives a simple power law index of 0.57 ± 0.15, while a fit to the second peak (T+0.7 to T+0.9) has a power law index of 2.10 ± 0.35. Similarly, the light curve shows that the emission in the 15-25 keV channel extends to T+1.5 sec, while emission in the100-350 keV channel lasts only until ~T+0.6 sec.

3. XRT OBSERVATION AND ANALYSIS

We have analyzed the first 10 orbits of Swift XRT data. A 2.7 ks photon counting mode image provides a refined XRT position of RA (J2000) = 22h 08m 32.21s and Dec (J2000) = -74° 34' 47.6" with an uncertainty of 3.6" (90% containment). This position is 0.8" from the first XRT position reported in Marshall et al. (GCN Circ. 5881), 0.3"from the UVOT optical source (Holland & Marshall, GCN Circ. 5883), and 0.7"from the object reported by D'Avanzo *et al.* (GCN Circ. 5884).

The 0.3-10 keV X-ray light curve (Figure 2) between 86 s and 46.1 ks after the trigger can be fit with a broken power-law with an initial decay slope of -0.56 ± 0.12, a break at 2495 (+851, -704) s, and a post-break slope of -1.9 ± 0.2.

The X-ray spectrum covering the time period from T+99s to T+729s is well fit by an absorbed power-law model with a photon index of 1.5 ± 0.2 and column density of (1.2 ± 0.6) x 10^{21} cm^{-2}. We note the Galactic column density in the direction of the source is 5.0 x 10^{20} cm^{-2}.

4. UVOT OBSERVATION AND ANALYSIS

UVOT took an initial 100-s finding chart exposure with the White filter starting at about T+86s, which was followed immediately with a 400-s exposure using the V filter. UVOT then took a short exposure with each of 7 filters before Swift slewed away from the GRB. A weak source was seen in the White finding chart, but there is no evidence for variability in the first 10 ks after the trigger. The early photometry results are given in Table 1.

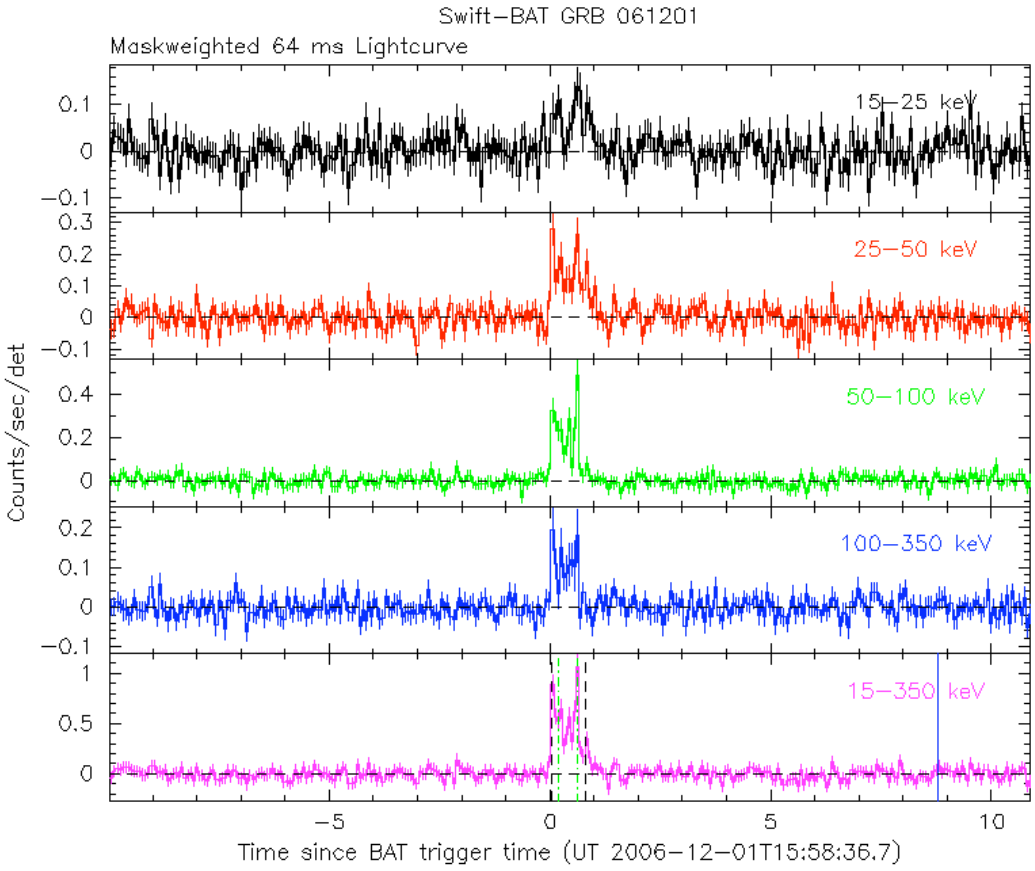

Fig.1: The BAT mask-weighted light curve in the 4 individual plus total energy bands. The units are counts s^{-1} illuminated-detector^{-1}. Each illuminated detector has an area of 0.16 cm^2.

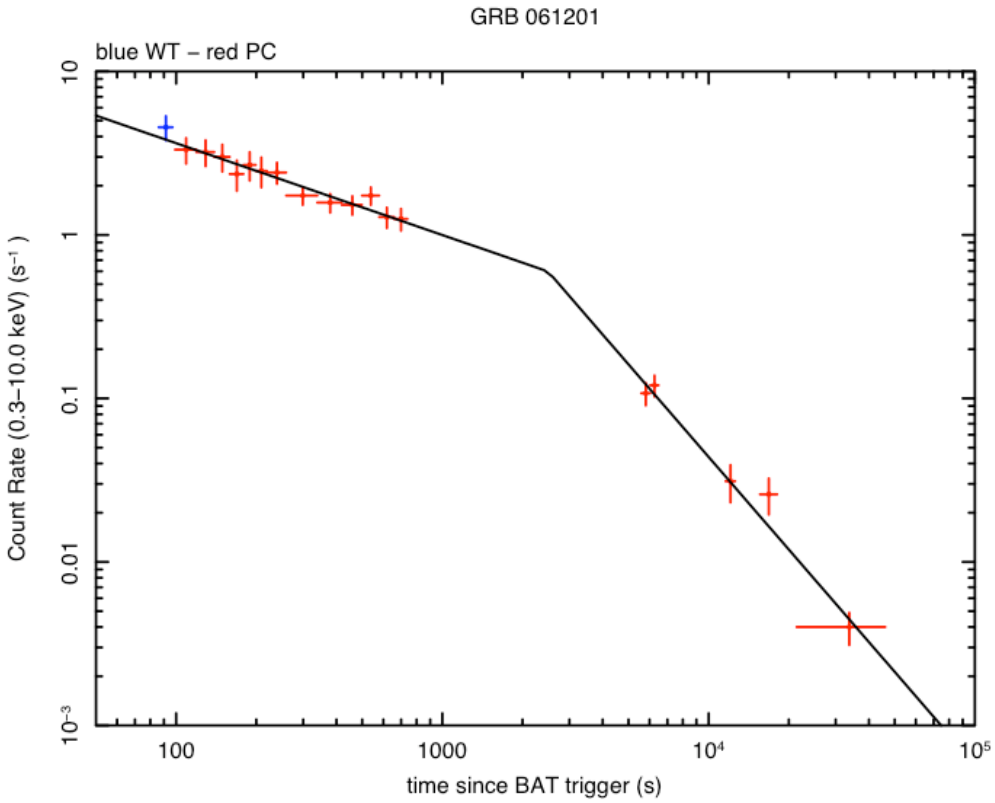

Fig. 2: XRT light curve with Windowed Timing mode data in blue and Photon Counting mode data in red. For the XRT, 1 cps is ~5.5 x 10^{-11} erg cm^{-2} s^{-1}.

Filter	Start Time	Exposure	Mag	Err
White	86	98	20.9	0.6
White	6202	197	20.9	0.4

Table 1: UVOT Observations. The start time of the exposure is given in seconds since the BAT trigger. No corrections have been made for the expected extinction in the Milky Way corresponding to E(B-V) of 0.076 (Schlegel *et al*. 1998)