

## Swift Observation of GRB 110520A

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### 1 Introduction

BAT triggered on GRB yymmdd at 20:28:48 UT (Trigger 453747) (De Pasquale, *et al.*, *GCN Circ.* 12020). This was an intermediate length burst with  $T_{90} = 15.7$  sec. Swift slewed to this burst immediately and XRT began follow-up observations at  $T + 100.1$  sec, and UVOT at  $T + 104$  sec. Our best position is the XRT location  $RA(J2000) = 134.34074^\circ$  (08h57m21.78s),  $Dec(J2000) = +56.42735^\circ$  (+56d25'38.5") with an error of 1.5 arcsec (90% confidence).

### 2 BAT Observation and Analysis

Using the data set from  $T - 293$  to  $T + 963$  sec, further analysis of BAT GRB 110520A has been performed by Swift team (Ukwatta, *et al.*, *GCN Circ.* 12030). The BAT ground-calculated position is  $RA(J2000) = 134.363^\circ$  (08h57m27.1s),  $Dec(J2000) = +56.418^\circ$  (+56d25'04.9")  $\pm 1.1$  arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 70%

The masked-weighted light curves (Fig.1) starts at trigger time  $T + 2$  sec with a single FRED peak, and returns to background at about  $T + 40$  sec.  $T_{90}(15 - 350keV)$  is  $15.7 \pm 1.8$  sec (estimated error including systematics).

The time-averaged spectrum from  $T - 239$  to  $T + 963$  sec is best fitted by a simple power law model. This fit gives a photon index of  $1.13 \pm 0.10$ , ( $\chi^2 = 52.5$  for 57 d.o.f.). For this model the total fluence in the 15 – 150 keV band is  $(1.1 \pm 0.1) \times 10^{-6}$  ergs/cm<sup>2</sup> and the 1-sec peak flux measured from  $T + 4.15$  sec in the 15 – 150 keV band is  $1.1 \pm 0.2$  ph/cm<sup>2</sup>sec. All the quoted errors are at the 90% confidence level.

### 3 XRT Observations and Analysis

Using data from the 1918 of XRT data in Photon Counting mode and 2 UVOT images for GRB 110520A, the refined XRT position is  $RA(J2000) = 134.34074^\circ$  (08h57m21.78s),  $Dec(J2000) = 56.42735^\circ$  (+56d25'38.5")  $\pm 1.5$  arcsec (90% confidence).

The 0.3 – 10 keV light curve (Fig.2) shows an fast decline with decay index  $\alpha = 2$ , followed by a flare, which peaks at 254 sec. After that, there is a decline with a slope of  $1.31 \pm 0.09$ .

The spectrum formed from the PC mode data, from 156 sec to 25.2 ksec after the trigger can be modeled with an absorbed power-law with spectral indices of  $1.77 \pm 0.17$ . The NH column density is  $2.9 \times 10^{21}$  cm<sup>-2</sup>, in excess of Galactic column density,  $2.7 \times 10^{20}$  cm<sup>-2</sup> (Kalberla et al. 2005) The average observed (unabsorbed) flux for this spectrum is, in this interval and over 0.3 – 10 keV,  $5.8 \times 10^{-12}$  (8.4) ergs/cm<sup>2</sup>sec).

### 4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 110520A at hh:mm:ss UT, 104 sec after the initial BAT trigger (De Pasquale, *GCN Circ.* 12032). No new source was detected within the XRT error circle in the white (150 sec) and u (250 sec) finding exposures, or in the co-added images in any filter down

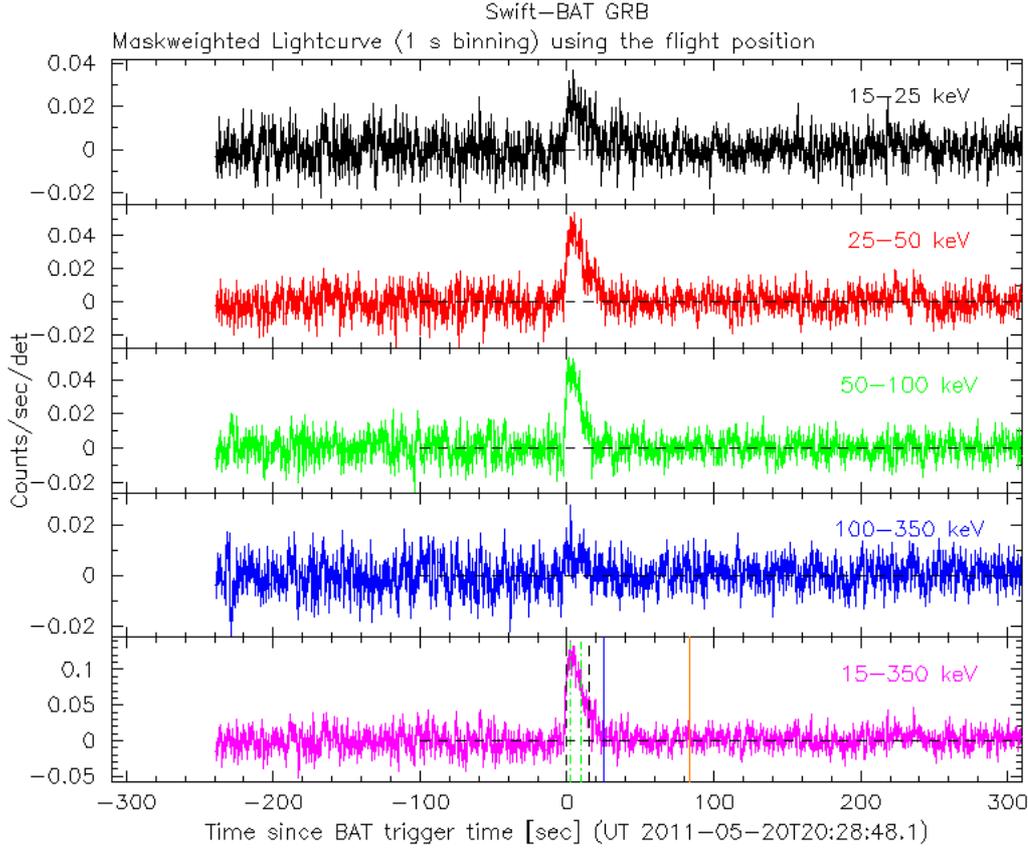


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det =  $0.16 \text{ cm}^2$ ) and  $T_0$  is 20:28:48.2 UT.

to 3-sigma magnitude. Upper limits are summarized in Table 1. These upper limits are not corrected for Galactic extinction  $E(B-V) = 0.03$  (Schlegel et al. 1998)

## 5 Other observations

No optical afterglow was detected by ground based observatories. TAROT obtained upper limits down to  $R > 19$  with observations up to 310 sec after the trigger (Klotz, *et al.*, *GCN Circ.* 12020). Liverpool Telescope obtained an upper limit of  $r' > 23.5$  1.36 hours after the trigger (Smith, *et al.*, *GCN Circ.* 12023). Skynet attained upper limits in the  $g'$ ,  $r'$ ,  $i'$ , and  $z'$  in the range of 17.8 and 19.7 within 1 hour after the trigger (LaCluyze, *et al.*, *GCN Circ.* 12024). IAC80 obtained an upper limit of  $I > 22.1$  (LaCluyze, *et al.*, *GCN Circ.* 12029). WHT observation derived upper limits of  $z > 22.1$ ,  $J > 20.8$ ,  $H > 20.1$ ,  $K > 19.5$ , 1.9 hours after the trigger for any new source inside the XRT refined error circle (Levan, *et al.*, *GCN Circ.* 12026). Subsequent observation carried out with NOT found a decaying source, from  $R = 23.9 \pm 0.1$  to  $R = 24.5 \pm 0.2$ , but it is  $4''$  far from the centre of the refined XRT error circle (Xu, *et al.*, *GCN Circ.* 12037)

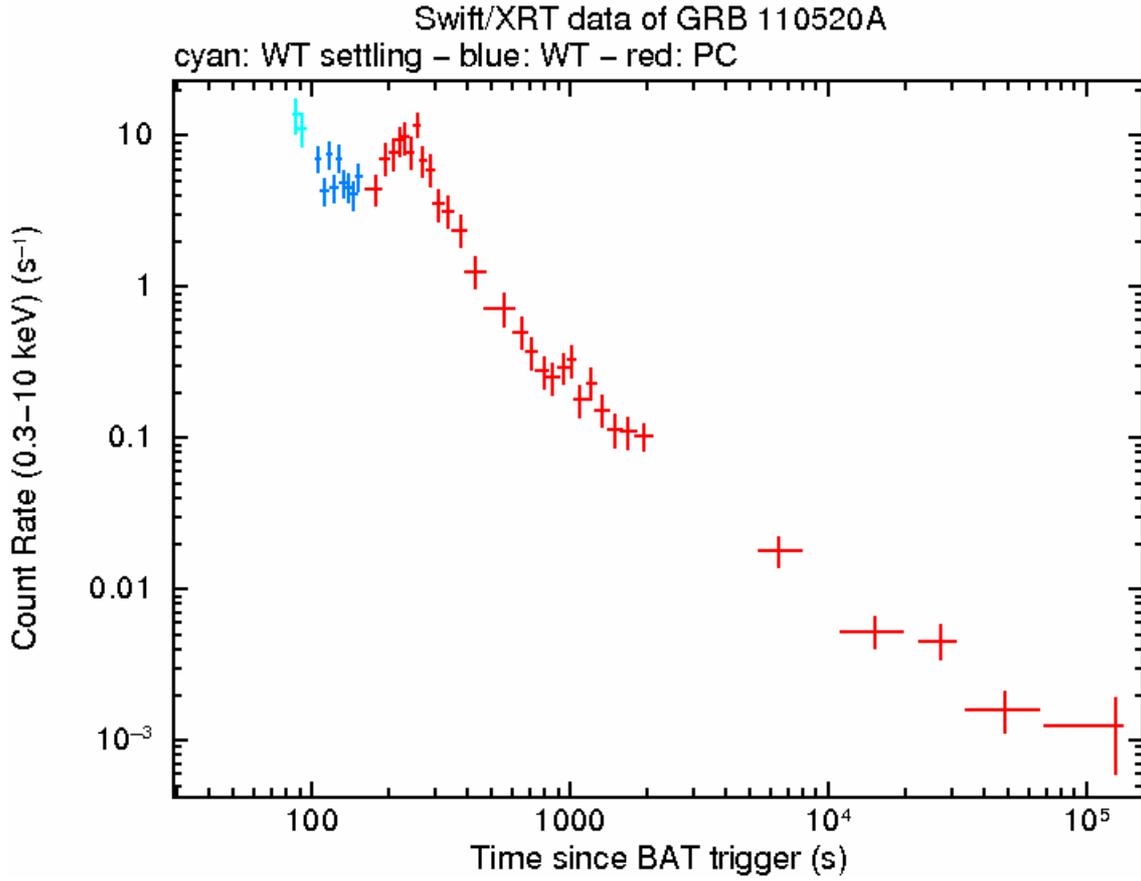


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (cyan during the settling; after that, blue), Photon Counting mode (red). The approximate conversion is 1 count/sec =  $\sim 5.1 \times 10^{-11}$  *ergs/cm<sup>2</sup>sec*.

Filter	Start	Stop	Exposure	3-Sigma UL
WHITE (finding)	104	253	147	21.1
U (finding)	316	23608	246	20.4
V	645	23608	2083	21.0
B	571	36751	2946	22.1
U	316	42529	3178	21.8
UVW1	694	41871	2965	21.8
UVM2	842	40964	2262	21.8
UVW2	621	19418	1911	21.8
WHITE	104	30973	3040	22.9

Table 1: Magnitude limits from UVOT observations