

## Swift Observations of GRB 130514A

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### 1 Introduction

BAT triggered and located GRB 130514A on 2013 May 14 (Trigger 555821) (Sonbas, *et al.*, 2012, *GCN Circ.* 14632). The BAT light curve showed a complex structure with a duration of  $\sim 180$  sec. The peak count rate was 3200 counts/sec (15-350 keV), at 10 sec after the trigger. The mask-weighted light curve shows two peaks beginning at  $T-20$  seconds and lasting until  $T+380$  sec.

XRT follow-up observations started  $T+88.8$  sec after the BAT trigger. A bright uncatalogued X - ray source located at a position; RA, DEC (J2000) = 19h 45m 07.33s, -07d 58' 41.1" with an uncertainty of 4.1 arcsec (radius, 90% confidence). The initial X - ray flux in the 2.5 s image was  $5.831e-09$  erg  $cm^{-2}$   $s^{-1}$  (0.2-10keV).

GRB 130514A also observed by ground based facilities promptly after the detection. P60 did not detect any source at the position coincident with the XRT position (Perley, D. *et al.*, 2013, *GCN Circ.* 14633). However, the source was detected by GROND in  $g'$ ,  $r'$ ,  $i'$ ,  $z'$ , J, H and K bands Schmidl *et al.*, (2013 *GCN Circ.* 14634). They derived a photometric redshift of  $z = 3.6 \pm 0.2$ . Upper limits were reported by RATIR, (Watson *et al.*, 2013 *GCN Circ.* 14643), PROMPT (Trotter *et al.*, 2013 *GCN Circ.* 14648).

A Konus-Wind and *Swift*/BAT joint spectral analysis was performed for the source from  $T - 5.1$  sec to  $T + 153.9$  sec in 20 - 1200 keV and 14 - 150 keV energy range. The spectrum is well fitted with a power-law with exponential cutoff model with  $E_{peak} = 110(-21,+42)$  keV.

### 2 BAT Observation and Analysis

Using the data set from  $T - 240.0$  to  $T + 723.0$  sec, analysis of BAT GRB 130514A has been performed by Swift team (Ukwatta, *et al.*, *GCN Circ.* 14636). The BAT ground-calculated position is RA( $J2000$ ) =  $296.278^\circ$  (19h45m06.8s), Dec( $J2000$ ) =  $-7.974^\circ$  (-07d58'26.1")  $\pm 1.0$  arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 60%.

The mask-weighted light curve shows two peaks (Fig.1), the first peak starting at  $\sim T - 20$  sec, peaking at  $\sim T + 12$  sec, and returning almost to a baseline at  $\sim T+80$  sec. The second peak starts at  $\sim T + 80$  sec, peaks at  $\sim T + 115$  sec, and ends at  $\sim T + 380$  sec.  $T_{90}$  is calculated as  $204 \pm 13$  sec at 15 - 350 keV.

The time-averaged spectrum from  $T - 7.09$  to  $T + 258.01$  sec is best fit by a simple power law. The power law index of the time-averaged spectrum is  $1.80 \pm 0.05$ . For this model the total fluence in the 15-150 keV band is  $9.1 \pm 0.2 \times 10^{-6}$  erg  $cm^{-2}$  and the 1-sec peak flux measured from  $T+13.42$  sec in the 15-150 keV band is  $2.8 \pm 0.3$  ph  $cm^{-2}$   $sec^{-1}$ . 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/555821/BA/](http://gcn.gsfc.nasa.gov/notices_s/555821/BA/).

### 3 XRT Observations and Analysis

1035 ks of XRT data were analysed for GRB 130514A from 95 s to 37.1 ks after the BAT trigger. The data comprise 405 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC)

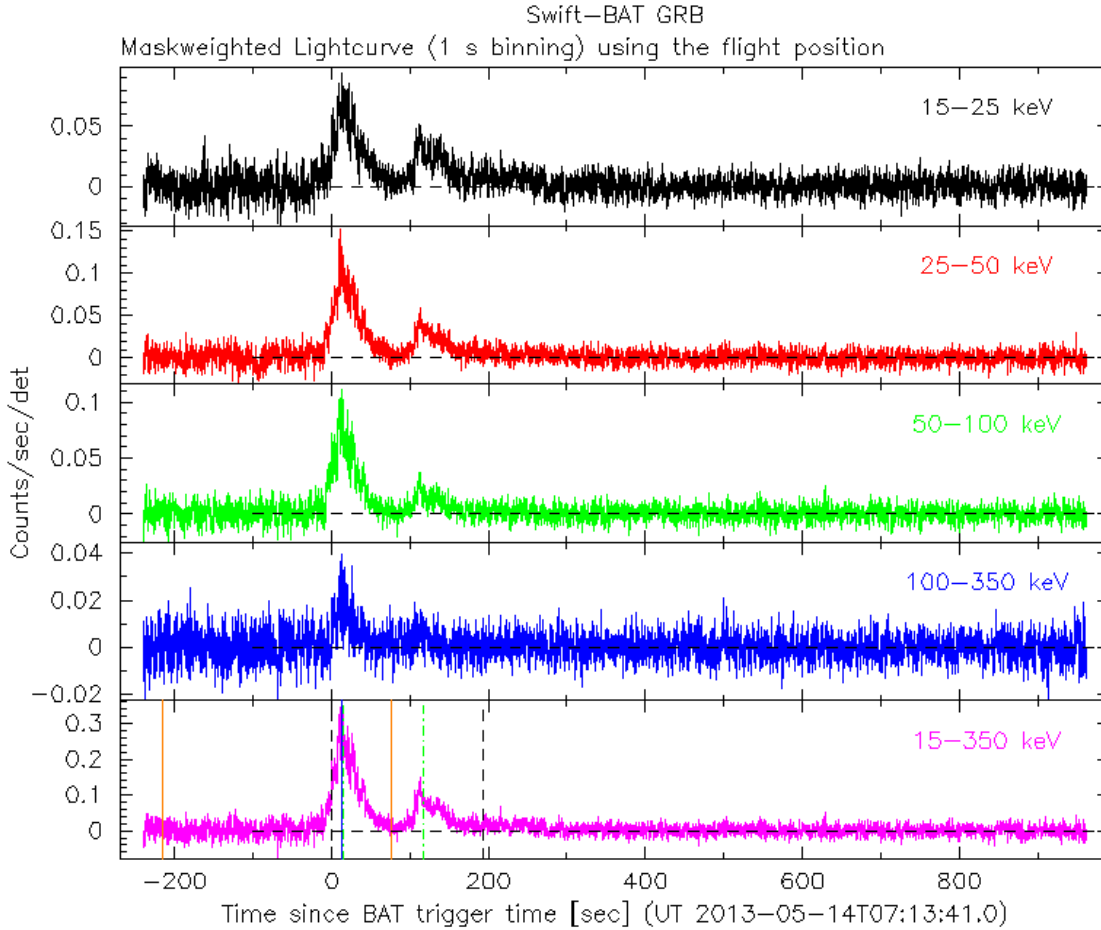


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts  $\text{sec}^{-1}\text{illuminated-detector}^{-1}$  and  $T_0$  is 07:13:41 UT.

The enhanced XRT position is  $\text{RA}(J2000) = 19\text{h } 45\text{m } 7.89\text{s}$ ,  $\text{Dec}(J2000) = -07\text{d } 58' 33.3'' \pm 1.9''$  (90% confidence) (Osborne *et al. GCN Circ.* 14637).

The late time ( $T_0+5.8$  ks) light curve (Fig.2) can be modelled with power-law with a decay index of  $\alpha = 1.15^{(+0.13)}_{(-0.12)}$ .

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of  $1.82^{(+0.03)}_{(-0.03)}$ . The best-fitting absorption column is  $3.14^{(+0.13)}_{(-0.12)} \times 10^{21} \text{cm}^{-2}$ , in excess of the Galactic value of  $7.6 \times 10^{20} \text{cm}^{-2}$  (Kalberla *et al.* 2005). The PC mode spectrum has a photon index of  $1.99^{(+0.20)}_{(-0.19)}$  and a best-fitting absorption column of  $1.4^{(+0.5)}_{(-0.5)} \times 10^{21} \text{cm}^{-2}$ . The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $3.7 \times 10^{-11} \text{erg cm}^{-2} \text{count}^{-1}$ .

The results of the XRT-team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00555821](http://www.swift.ac.uk/xrt_products/00555821).

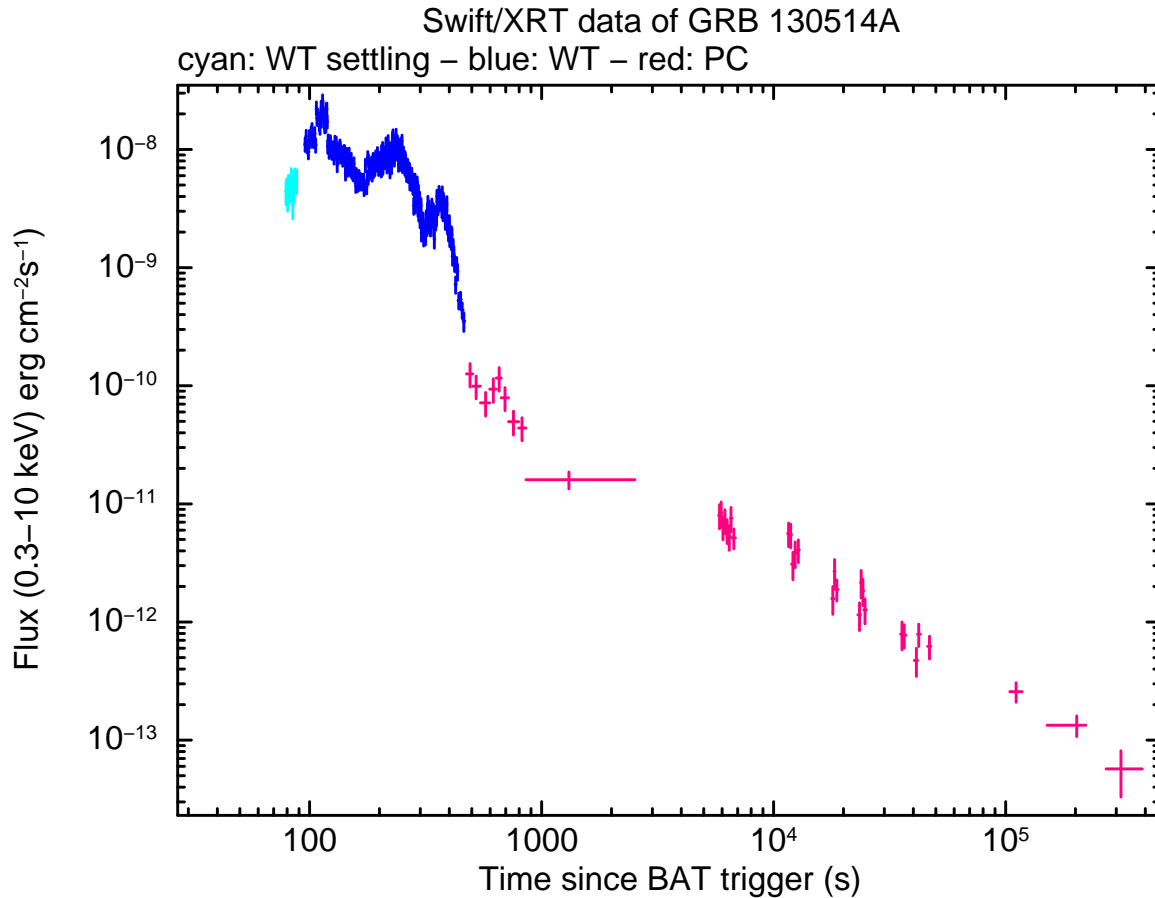


Figure 2: XRT Lightcurve in the 0.3-10 keV band: Windows Timing mode (blue) and Photon Counting mode (red). The conversion factor for this burst is  $1 \text{ count} = 3.7 \times 10^{-11} \text{ erg cm}^{-2}$ .

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 130514A, 97 s after the BAT trigger (Trigger 555821, Sonbas et al., *GCN Circ.* 14632).

No optical afterglow consistent with the optical position (Marshall et al., *GCN Circ.* 14640) is detected in the initial UVOT exposures. Preliminary 3-sigma upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the first finding chart (FC) exposure and subsequent exposures are shown in the Table 1.

## References

- [1] Breeveld, A. A. et al. 2011, AIP Conf. Proc. 1358, 373
- [2] Kalberla, P. M. et al. 2005, A&A 440, 775
- [3] Marshall, F. E. et al. 2013, GCN Circ. 14640
- [4] Osborne, J.P. et al. 2013, GCN Circ. 14637
- [5] Perley, D. et al. 2013, GCN Circ. 14633
- [6] Schlegel, D. J. et al. 1998, ApJ. v.500, p.525
- [7] Schmidl, D. et al. 2013, GCN Circ. 14634
- [8] Sonbas, E. et al. 2013, GCN Circ. 14632
- [9] Trotter, A. et al. 2013 GCN Circ. 14648
- [10] Ukwatta T. N. et al., GCN Circ. 14636
- [11] Watson, A. M. et al. 2013, GCN Circ. 14643

Filter	$T_{Start}$	$T_{Stop}$	Exposure (s)	Mag.
WHITE-FC	97	247	147	> 21.3
u-FC	310	560	246	>20.4
WHITE	97	960	281	>21.5
v	639	2529	56	>18.7
b	565	757	39	>19.1
u	310	732	265	>20.5
uvw1	688	708	19	>19.1
uvw2	2487	2507	19	>19.5

Table 1: Magnitude limits from UVOT observations .The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of  $E(B-V) = 0.23$  in the direction of the burst (Schlegel et al. 1998).