Swift Observation of GRB 100915A

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1 Introduction

BAT triggered on GRB 100915A at 01:31:05.0 UT on the 15^{th} of September 2010 (Trigger 434178) (Littlejohns, *et al.*, *GCN Circ.* 11277). This was long burst with $T_{90}(15-350\ keV) = 200\ \pm 31\ s$. Swift slewed to this burst immediately and XRT began follow-up observations at T+131.9 s, and UVOT at T+140 s. The best position is that derived from using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue to correct the X-ray location astrometrically: RA($J2000$) = 315.69440 deg ($21h\ 02m\ 46.66s$), Dec($J2000$) = +65.67303 deg ($+65d\ 40'\ 22.9''$) with an error of 1.6 arcsec (90% confidence).

Observations were also performed by GRT (Sakamoto, *et al.*, *GCN Circ.* 11285), MITSuME (Kuroda, *et al.*, *GCN Circ.* 11287) and TAROT (Klotz, *et al.*, *GCN Circ.* 11292), however only upper limits were detected with these instruments.

2 BAT Observation and Analysis

Using the data set from T-239 to T+963 s, further analysis of BAT GRB 100915A has been performed by Swift team (Baumgartner, *et al.*, *GCN Circ.* 11281 & Sakamoto, *et al.*, *GCN Circ.* 11283). The BAT ground-calculated position is RA($J2000$) = 315.664 deg ($21h\ 02m\ 39.4s$), Dec($J2000$) = +65.676 deg ($+65d\ 40'\ 32.3''$) ± 2.0 $arcmin$, (radius, systematic and statistical, 90% containment). The partial coding was 54%.

The masked-weighted light curves (Fig.1) from T-56.3 to T+210.1 s shows two broad peaks, the first starting at approximately T-90 s, peaking at T+5 s and ending at T+90 s. The second, weaker peak starts at T+110 s, peaks at T+170 s and ends at T+190 s. $T_{90}(15-350\ keV)$ for this burst is $200\ \pm 31\ s$ (estimated error including systematics).

The time-averaged spectrum from T-36.3 to T+72.2 s is best fitted by a simple power law model. The power law index of the time-averaged spectrum is $1.50\ \pm 0.24$. The fluence in the 15-150 keV band is $1.5\ \pm 0.2\ \times\ 10^{-6}\ erg.cm^{-2}$. The one second peak photon flux measured from T+8.76 s in the 15-150 keV band is $0.5\ \pm 0.3\ ph.cm^{-2}.s^{-1}$. 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 100915A (5.3 ks in Photon Counting mode), the refined XRT position is RA($J2000$) = 315.69440 deg ($21h\ 02m\ 46.66s$), Dec($J2000$) = +65.67303 deg ($+65d\ 40'\ 22.9''$) ± 1.6 $arcsec$ (90% confidence).

The 0.3-10 keV light curve (Fig.2) can be modelled with a series of power law decays, with three breaks. The initial decline has a slope of $0.94^{+0.30}_{-0.34}$, followed by a steeper slope of $2.33^{+0.51}_{-0.25}$ beginning at T+$296.8^{+86.3}_{-116.5}$ s. At T+$1168^{+2700}_{-299.9}$ s there is a second break to a shallower slope of $0.61^{+9.40}_{-5.11}$, before a break at T+6124^{+2563}_{-4399} s to the final observed decay with a slope of $1.65^{+0.31}_{-0.18}$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of $1.37^{+0.21}_{-0.20}$. The best-fitting absorption column is $1.5^{+1.2}_{-1.0} \times 10^{21}\ cm^{-2}$ in excess of the Galactic value of $2.3 \times 10^{21}\ cm^{-2}$ (Kalberla, *et al.*, 2005). The PC mode spectrum has a photon

index of $1.75^{+0.16}_{0.17}$ and a best-fitting absorption column of $2.43^{+0.91}_{0.89} \times 10^{21}$ cm^{-2}. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 5.5×10^{-11}(8.3×10^{-11}) $ergs.cm^{-2}.ct^{-1}$.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 100915A 123 seconds after the initial BAT trigger (Swenson & Littlejohns, *GCN Circ.* 11282). No new source was detected at the enhanced XRT position in the white (147 s) or U filter (246 s) finding exposures, or in the co-added images in any filter down to 3σ magnitude. Upper limits are summarized in Table 1. These values update those included in the UVOT uppper limit circular (Swenson & Littlejohns, *GCN Circ.* 11282). These upper limits are not corrected for Galactic extinction E(B-V) = 0.51.

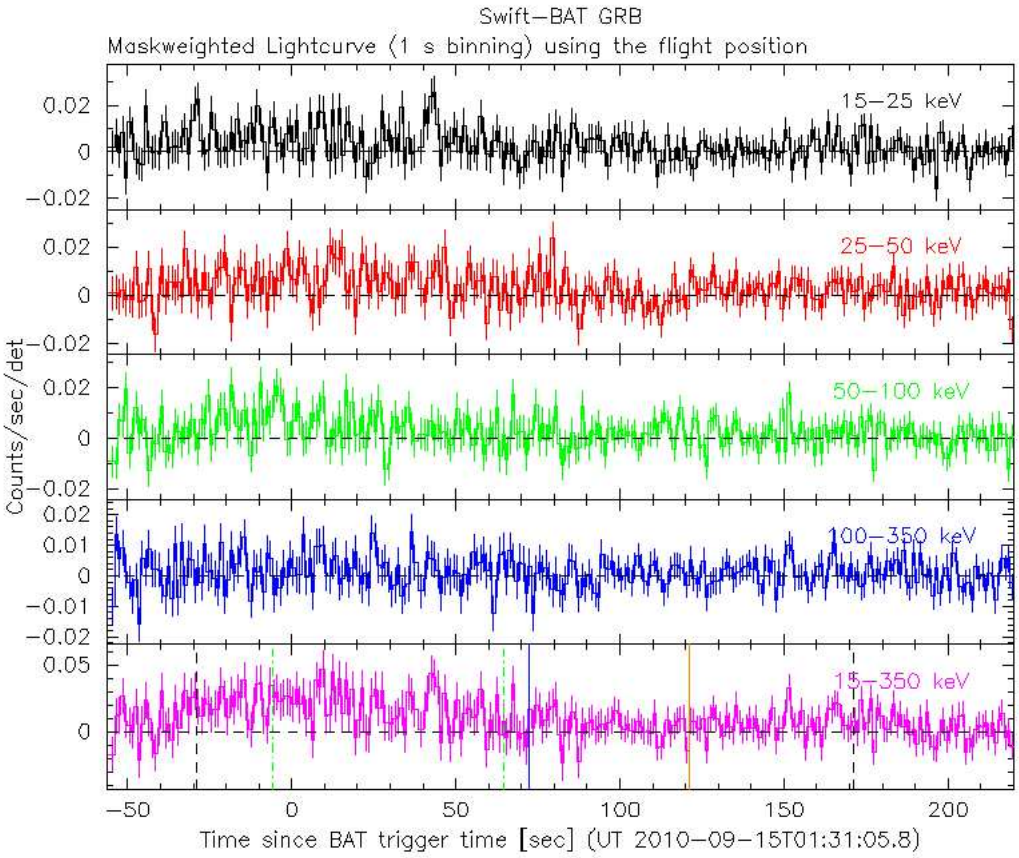

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 01:31:05.8 UT.

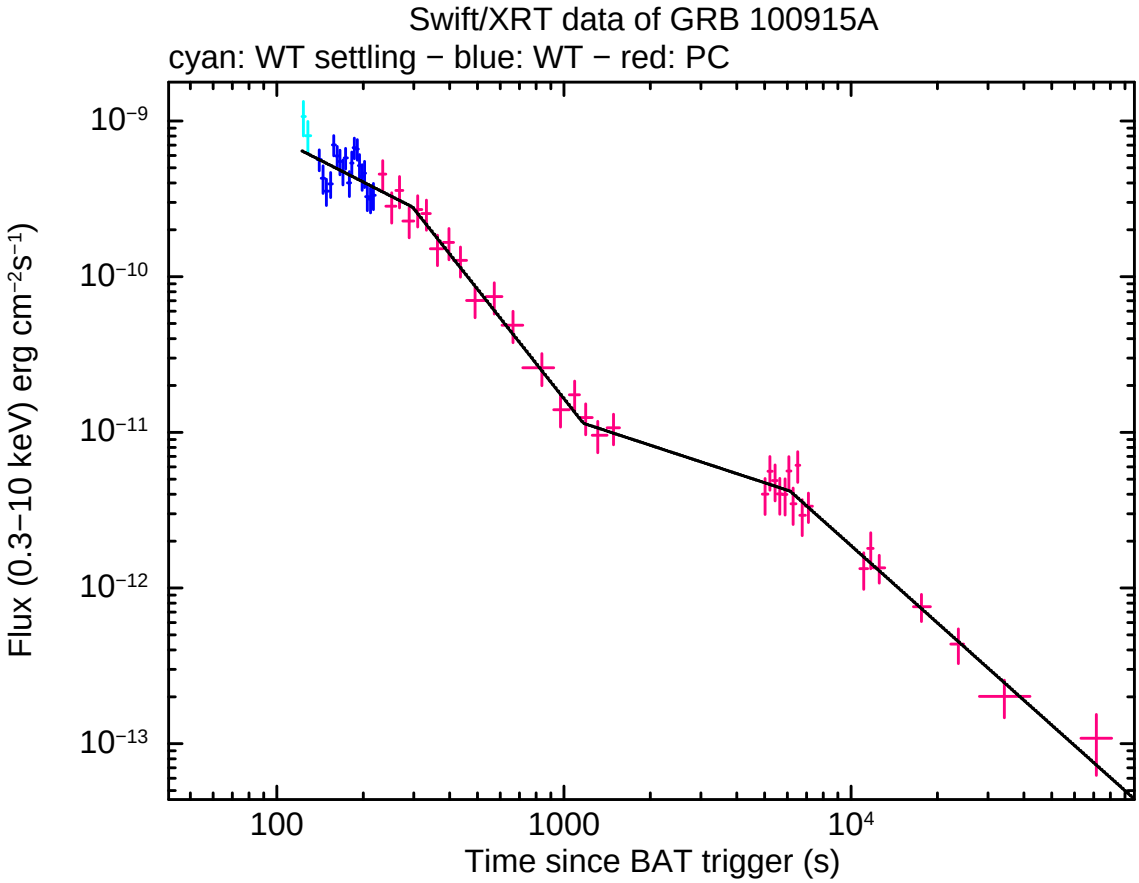

Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing Settling mode (cyan), Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count $= \sim 5.8 \times 10^{-11}$ $ergs.cm^{-2}$.

Filter	Start	Stop	Exposure	3-Sigma UL
WHITE (finding)	140	290	147	>21.46
WHITE	140	11637	1474	>22.78
V	631	13122	1049	>20.98
B	557	7343	467	>21.43
U (finding)	300	550	246	>20.68
U	300	7161	717	>21.34
UVW1	680	6956	491	>20.87
UVM2	1256	18902	2787	>21.79
UVW2	606	12544	1152	>21.50

Table 1: Magnitude limits from UVOT observations