

## Swift Observation of long GRB 090912

*T. N. Ukwatta (GSFC/GWU), B. Sbarufatti (INAF-IASFPA), P.A. Curran (MSSL-UCL), S. D. Barthelmy (GSFC), D. N. Burrows (PSU), P. Roming (PSU), N. Gehrels (GSFC), for the Swift Team*

### 1 Introduction

BAT triggered on GRB 090912 at 15:50:29 UT (Trigger 362633) (Ukwatta, *et al.*, *GCN Circ.* 9905). This was a 10 sigma rate-trigger on a long burst with  $T_{90} = 144 \pm 23$  sec. Swift executed a delayed slewed to the burst. Narrow field instruments started observations at  $\sim T + 792.6$  sec, and our best position is the UVOT-enhanced XRT location  $RA(J2000) = 188.04297$  deg (12h 32m 10.31s),  $Dec(J2000) = +61.48454$  deg (+61d 29' 04.4") with an uncertainty of 1.8 arcsec (90% confidence, including boresight uncertainties), reported by Beardmore *et al.*, *GCN Circ.* 9906.

### 2 BAT Observation and Analysis

Using the data set from  $T - 240$  to  $T + 962$  sec, further analysis of BAT GRB 090912 has been performed by BAT team (Ukwatta, *et al.*, *GCN Circ.* 9909). The BAT ground-calculated position is  $RA(J2000) = 188.046$  deg (12h 32m 11.1s),  $Dec(J2000) = 61.475$  deg (+61d 28' 29.4")  $\pm 1.2$  arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 30% (the bore sight angle was 33.9 deg).

The mask-weighted light curve (Fig. 1) shows two peaks. The first starts around  $\sim T - 4$  sec, shows three sub peaks at  $\sim T + 0$  sec,  $\sim T + 4$  sec, and  $\sim T + 7$  sec, and ends around  $\sim T + 25$  sec. The second peak starts at  $\sim T + 70$  sec, peaks at  $\sim T + 88$ , and ends around  $\sim T + 145$  sec.  $T_{90}$  (15 – 350 keV) is  $144.0 \pm 22.6$  sec (estimated error including systematics).

The time-averaged spectrum from  $T - 15.9$  to  $T + 160.1$  sec is best fit by a power law with an exponential cutoff. This fit gives a photon index of  $0.91 \pm 0.44$ , and  $E_{\text{peak}}$  of  $69.3 \pm 19.5$  keV (chi squared 42.50 for 56 d.o.f.). For this model the total fluence in the 15 – 150 keV band is  $(4.5 \pm 0.3) \times 10^{-6}$  erg/cm<sup>2</sup>. The 1-sec peak photon flux measured from  $T + 87.56$  sec in the 15 – 150 keV band is  $1.0 \pm 0.1$  ph/cm<sup>2</sup>/sec. A fit to a simple power law gives a photon index of  $1.66 \pm 0.09$  (chi squared 52.84 for 57 d.o.f.). 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/362633/BA/](http://gcn.gsfc.nasa.gov/notices_s/362633/BA/)

### 3 XRT Observations and Analysis

XRT data were collected from  $\sim T + 806$  s to  $\sim T + 66$  ks after the BAT trigger. The data are entirely in Photon Counting (PC) mode. The best position of the X-ray afterglow is the UVOT-enhanced XRT position (Beardmore, *et al.*, *GCN Circ.* 9906)

$RA(J2000) = 12\text{h } 32\text{m } 10.31\text{s}$   
 $Dec(J2000) = +61\text{d } 29' 04.4''$

with an uncertainty of 1.8 arcsec (radius, 90% confidence).

The 0.3 – 10 keV X-ray light curve (Fig. 2) is best fitted by a power-law with a decay index of  $-0.75 \pm 0.03$ . Faint flaring activity is detected along the decay.

The average XRT spectrum (Fig. 3) is best fit by a power-law with a index of  $2.1 \pm 0.1$ . The absorbing

column is  $NH = (5.2 \pm 0.7) \times 10^{20} \text{ cm}^{-2}$ , in excess with respect to the Galactic value of  $1.3 \times 10^{20} \text{ cm}^{-2}$  (Kalberla et al. 2005). The average observed (unabsorbed) fluxes are  $3.0(5.7) \times 10^{-12} \text{ ergs cm}^{-2} \text{ s}^{-1}$ .

The results of the XRT-team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00362633](http://www.swift.ac.uk/xrt_products/00362633).

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 090912, 796 seconds after the BAT trigger. No optical afterglow consistent with the enhanced XRT position (Beardmore *et al.*, *GCN Circ.* 9906) is detected in the UVOT exposures. Preliminary magnitudes and 3-sigma upper limits using the UVOT photometric system (Poole *et al.*, 2008, MNRAS, 383, 627) for the first finding charts (fc) and subsequent exposures are:

Filter	Tstart (s)	Tstop (s)	Exposure (s)	Magnitude
white(fc)	796	946	147	>20.50
white	796	7707	608	>21.09
v	1129	8118	294	>19.04
b	1228	7502	254	>19.91
u	1204	7297	313	>19.58
uvw1	1179	7092	313	>19.82
uvm2	6688	8273	344	>19.78
uvw2	7713	7913	197	>19.78

Table 1: Magnitudes and limits from UVOT observations

The values quoted above are not corrected for the Galactic extinction due to the reddening of  $E_{B-V} = 0.01$  in the direction of the burst (Schlegel, *et al.*1998, ApJS, 500, 525).

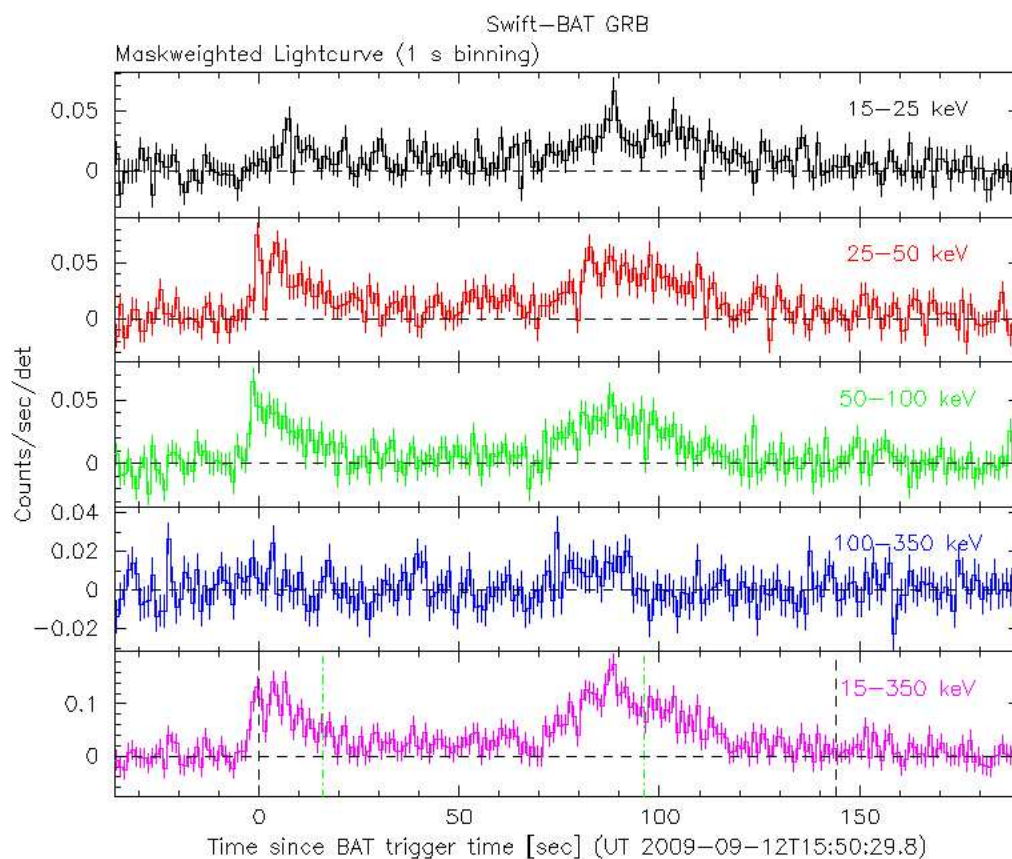


Figure 1: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and  $T_0$  is 15:50:29 UT.

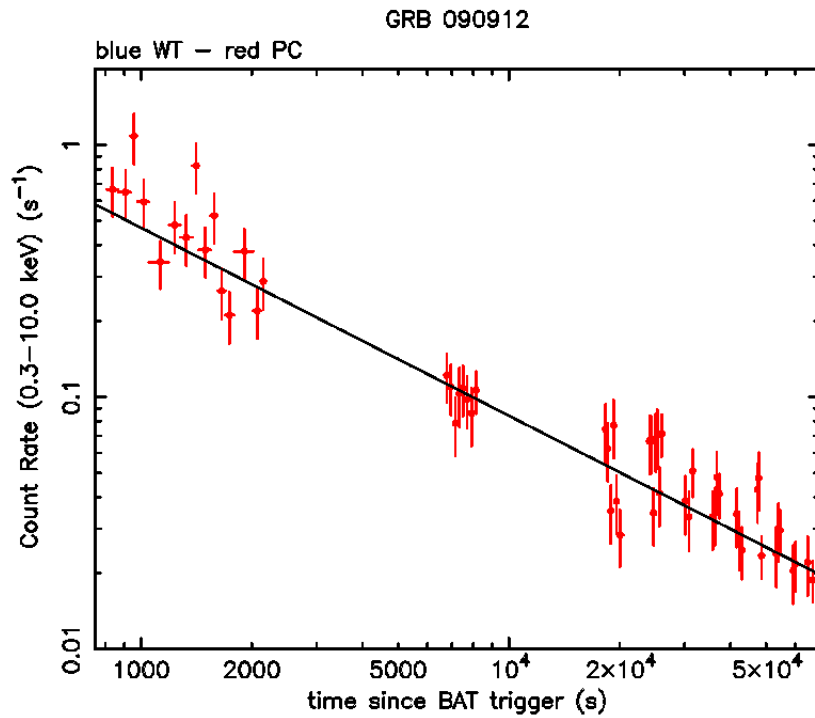


Figure 2: XRT Lightcurve. Flux in the 0.3 – 10 keV band. The approximate conversion is 1 count/sec =  $\sim 4.9 \times 10^{-11}$  ergs/cm<sup>2</sup>/sec.

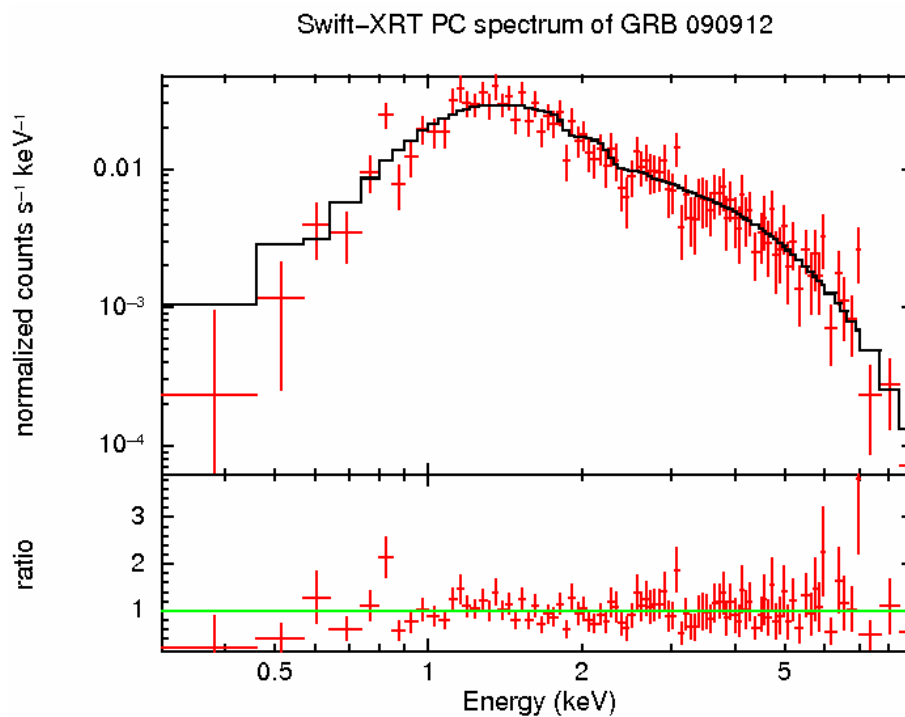


Figure 3: XRT Spectrum. Counts/sec in the 0.3 – 10 keV band.