

# Swift Observations of GRB 140706A

F.E. Marshall (NASA/GSFC), P. D'Avanzo (INAF-OAB), A. Amaral-Rogers (U. Leicester), and M.H. Siegel (PSU) for the Swift team

## 1. Introduction

At 19:33:33 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 140706A (trigger=603587) (Marshall *et al.* GCN Circ. [16531](#)). Swift slewed immediately to the burst. At the time of the trigger, the initial BAT position was  $81^\circ$  from the Sun (3.8 hours West) and  $127^\circ$  from the 63%-illuminated Moon. **Table 1** contains the best reported positions from Swift, and the latest XRT position can be viewed at [http://www.swift.ac.uk/xrt\\_positions](http://www.swift.ac.uk/xrt_positions).

Marshall *et al.* (GCN Circ. [16531](#)) reported the discovery with UVOT of an optical afterglow. **Table 2** is a summary of GCN Circulars about this GRB from observatories other than Swift.

Standard analysis products for this burst are available at [http://gcn.gsfc.nasa.gov/swift\\_gnd\\_ana.html](http://gcn.gsfc.nasa.gov/swift_gnd_ana.html).

## 2. BAT Observations and Analysis

As reported by Markwardt *et al.* (GCN Circ. [16539](#)), the BAT ground-calculated position is RA, Dec = 49.269, -38.058 deg which is RA (J2000) =  $03^{\text{h}}17^{\text{m}}04.6^{\text{s}}$  Dec (J2000) =  $-38^\circ03'28.6''$  with an uncertainty of 1.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 77%.

The mask-weighted light curve (**Figure 1**) shows several peaks starting at  $\sim T-20$  s, peaking at  $\sim T-15$ ,  $\sim T+1$  and  $\sim T+28$  s, and ending at  $\sim T+40$  s.  $T_{90}$  (15-350 keV) is  $48.3 \pm 4.3$  s (estimated error including systematics).

The time-averaged spectrum from  $T-21.3$  to  $T+39.6$  s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.8 \pm 0.1$ . The fluence in the 15-150 keV band is  $2.0 \pm 0.1 \times 10^{-6}$  erg  $\text{cm}^{-2}$ . This fluence is larger than that of 58% of the long GRBs in the Second BAT GRB Catalog (Sakamoto *et al.* 2011). The 1-s peak photon flux measured from  $T-0.12$  s in the 15-150 keV band is  $1.8 \pm 0.2$  ph  $\text{cm}^{-2} \text{s}^{-1}$ . 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/603587/BA/](http://gcn.gsfc.nasa.gov/notices_s/603587/BA/).

### 3. XRT Observations and Analysis

Analysis of the initial XRT data was reported by D'Avanzo *et al.* (GCN Circ. [16538](#)). We have analyzed 7.4 ks of XRT data for GRB 140706A, from 62 s to 69.4 ks after the BAT trigger. The data comprise 56 s in Windowed Timing (WT) mode (the first 9 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Beardmore *et al.* (GCN Circ. [16532](#)).

The light curve (**Figure 2**) can be modeled with an initial power-law decay with an index of  $\alpha=3.55$  (+0.25, -0.24), followed by a break at T+212 s to an  $\alpha$  of 0.69 (+0.05, -0.04).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 1.84 (+0.20, -0.19). The best-fitting absorption column is  $8.1$  (+5.2, -4.6)  $\times 10^{20}$   $\text{cm}^{-2}$ , in excess of the Galactic value of  $2.2 \times 10^{20}$   $\text{cm}^{-2}$  (Willingale *et al.* 2013). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $3.6 \times 10^{-11}$  ( $4.1 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{count}^{-1}$ .

A summary of the PC-mode spectrum is thus:

Total column:  $8.1$  (+5.2, -4.6)  $\times 10^{20}$   $\text{cm}^{-2}$

Galactic foreground:  $2.2 \times 10^{20}$   $\text{cm}^{-2}$

Excess significance:  $2.2 \sigma$

Photon index: 1.84 (+0.20, -0.19)

The results of the XRT team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00603587](http://www.swift.ac.uk/xrt_products/00603587).

### 4. UVOT Observations and Analysis

The Swift/UVOT began settled observations of the field of GRB 140706A 82 s after the BAT trigger (Siegel and Marshall GCN Circ. [16541](#)). A fading source consistent with the XRT position (Beardmore *et al.* GCN Circ. [16532](#)) is detected in the initial UVOT exposures. **Table 3** gives preliminary magnitudes using the UVOT photometric system (Breeveld *et al.* 2011, AIP Conf. Proc., 1358, 373). No correction has been made for the expected extinction in the

Milky Way corresponding to a reddening of  $E_{B-V}$  of 0.02 mag. in the direction of the GRB (Schlegel *et al.* 1998).

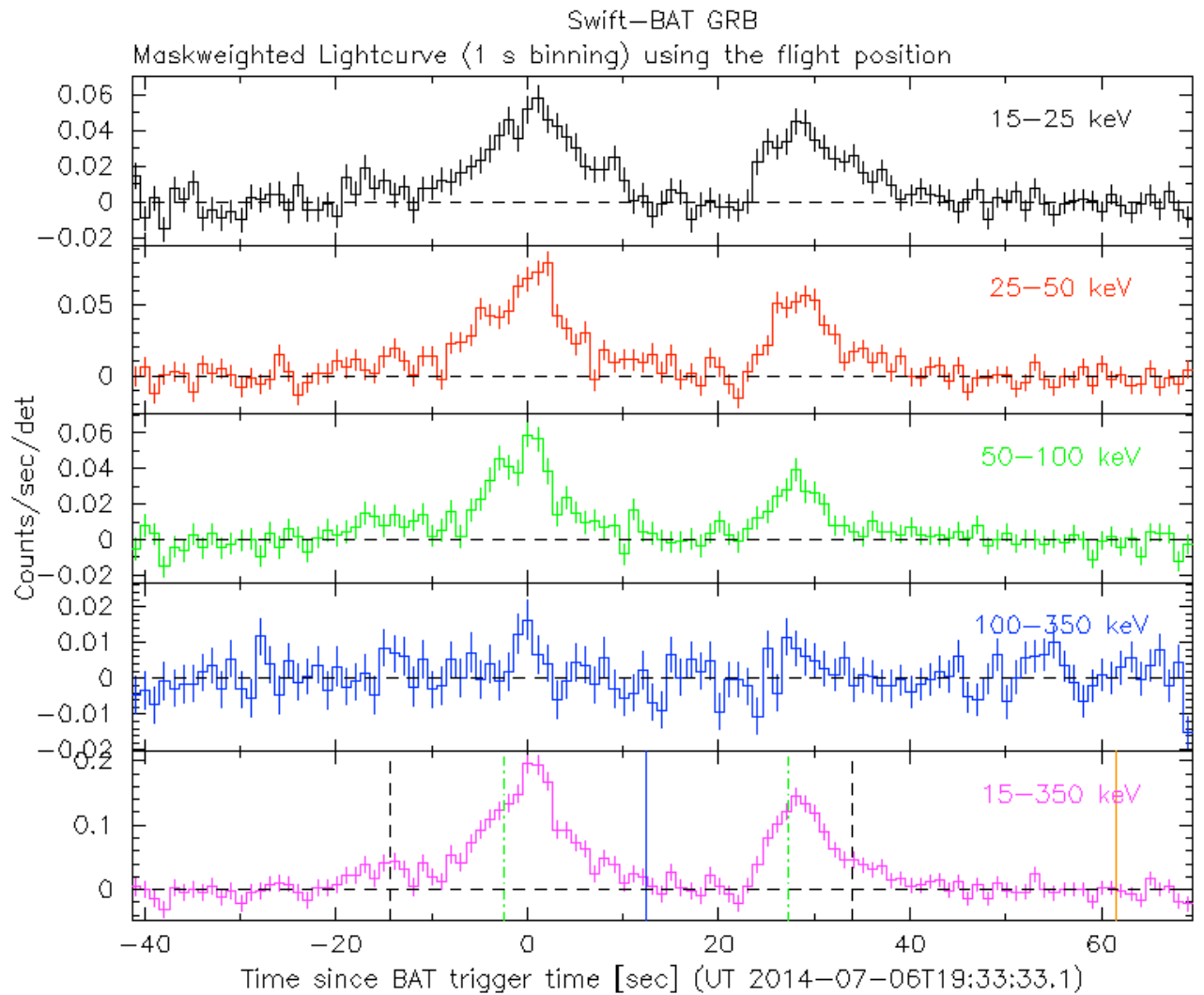


Figure 1. The BAT mask-weighted light curve in the four individual and total energy bands. The units are counts  $s^{-1}$  illuminated-detector $^{-1}$ .

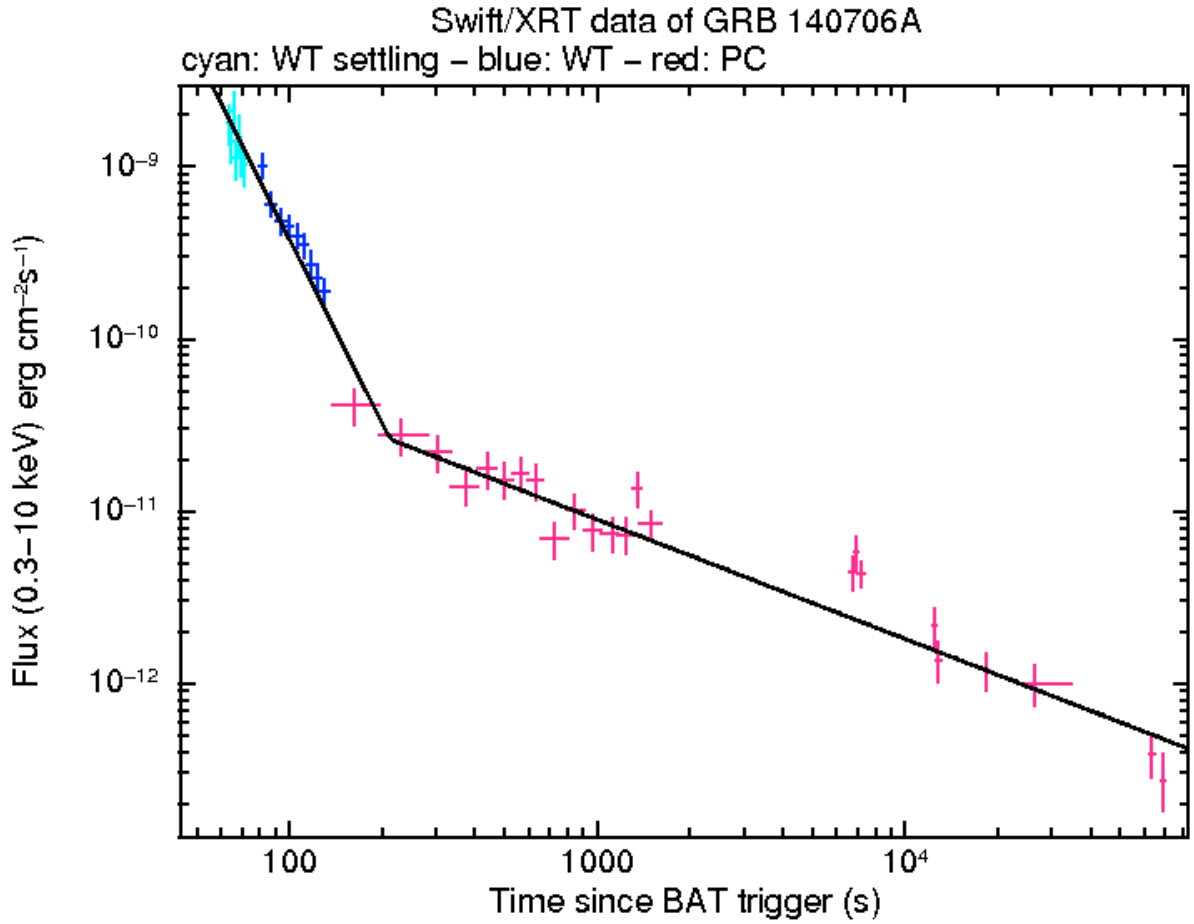


Figure 2. The XRT light curve.

RA (J2000)	Dec (J2000)	Error	Note	Reference
03 <sup>h</sup> 17 <sup>m</sup> 10.39 <sup>s</sup>	-38°03'07.8"	0.45"	UVOT-refined	Siegel and Marshall GCN Circ. <a href="#">16541</a>
03 <sup>h</sup> 17 <sup>m</sup> 10.63 <sup>s</sup>	-38°03'05.7"	1.5"	XRT-final	<a href="#">UKSSDC</a>
03 <sup>h</sup> 17 <sup>m</sup> 10.62 <sup>s</sup>	-38°03'07.0"	1.8"	XRT-enhanced	Beardmore <i>et al.</i> GCN Circ. <a href="#">16532</a>
03 <sup>h</sup> 17 <sup>m</sup> 04.6 <sup>s</sup>	-38°03'28.6"	1.1'	BAT-refined	Markwardt <i>et al.</i> GCN Circ. <a href="#">16539</a>

Table 1. Positions from the Swift instruments.

Band	Authors	GCN Circ.	Subject	Observatory	Notes
Optical	Schady <i>et al.</i>	<a href="#">16534</a>	GROND detection of the Optical/NIR afterglow	GROND	detection
Gamma-ray	Zhang	<a href="#">16537</a>	Fermi GBM detection	Fermi GBM	$E_{\text{peak}}=96\pm 19$ keV Fluence= $2.95\pm 0.28\times 10^{-6}$ erg $\text{cm}^{-2}$

Table 2. Summary of GCN Circulars from other observatories sorted by band and then circular number.

Filter	$T_{\text{start}}(\text{s})$	$T_{\text{stop}}(\text{s})$	Exp(s)	Mag
white (fc)	82	232	147	$19.04 \pm 0.06$
white	573	1541	244	$19.76 \pm 0.16$
v	624	1592	117	$>18.8$
b	550	1517	97	$>19.2$
u (fc)	294	544	246	$19.02 \pm 0.11$
u	624	1591	116	$>19.6$
w1	674	1638	94	$>19.1$
w2	775	1394	58	$>20.1$

Table 3. UVOT observations reported by Siegel and Marshall (GCN Circ. [16541](#)). The start and stop times of the exposures are given in seconds since the BAT trigger. The preliminary detections and 3- $\sigma$  upper limits are given. No correction has been made for extinction in the Milky Way.

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