

# Swift Observations of GRB 140301A

K.L. Page (U. Leicester), S. D. Barthelmy (GSFC), W. H. Baumgartner (GSFC/UMBC), D. N. Burrows (PSU), N. Gehrels (NASA/GSFC), B. Porterfield (PSU) and M. H. Siegel (PSU) for the Swift team

## 1. Introduction

At 15:24:49 UT, the Swift Burst Alert Telescope (BAT) triggered on and located GRB 140301A (trigger=589590) (Page *et al.* GCN Circ. [15896](#)). Swift slewed immediately to the burst. At the time of the trigger, the initial BAT position was  $84^\circ$  from the Sun (5.8 hours East) and  $84^\circ$  from the 0%-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).

Kruehler *et al.* (GCN Circ. [15900](#)) determined a redshift of 1.416 from VLT. **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 Ukwatta *et al.* (GCN Circ. [15906](#)), the BAT ground-calculated position is RA, Dec = 69.521, -34.249 deg, which is RA(J2000) =  $04^{\text{h}}38^{\text{m}}05.0^{\text{s}}$  Dec(J2000) =  $-34^\circ14'56.8''$  with an uncertainty of 1.9 arcmin, (radius, sys+stat, 90% containment). The partial coding was 66%.

The mask-weighted light curve (**Figure 1**) shows a roughly symmetric peak starting at  $\sim T-15$  s, peaking at  $\sim T+1$  s, and ending at  $\sim T+20$  s.  $T_{90}$  (15-350 keV) is  $31.0 \pm 5.7$  s (estimated error including systematics).

The time-averaged spectrum from T-13.18 to T+22.82 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $1.96 \pm 0.28$ . The fluence in the 15-150 keV band is  $(4.4 \pm 0.8) \times 10^{-7}$  erg  $\text{cm}^{-2}$ . This fluence is larger than that of 18% of the long GRBs in the Second BAT GRB Catalog (Sakamoto *et al.* 2011). The 1-s peak photon flux measured from T+0.82 s in the 15-150 keV band is  $0.7 \pm 0.2$  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/589590/BA/](http://gcn.gsfc.nasa.gov/notices_s/589590/BA/).

## 3. XRT Observations and Analysis

Analysis of the initial XRT data was reported by Page (GCN Circ. [15905](#)). We have analysed 11 ks of XRT data for GRB 140301A, from 92 s to 97.7 ks after the BAT trigger. The data comprise 382 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Goad *et al.* (GCN Circ. [15898](#)).

The late-time light curve (**Figure 2**) (from T0+6.4 ks) can be modelled with a power-law decay with a decay index of  $\alpha=1.07$  (+0.19, -0.17).

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of  $2.01 \pm 0.09$ . The best-fitting absorption column is  $(3.3 \pm 1.0) \times 10^{21} \text{ cm}^{-2}$ , at a redshift of 1.416, in addition to the Galactic value of  $2.2 \times 10^{20} \text{ cm}^{-2}$  (Kalberla *et al.* 2005). The PC mode spectrum has a photon index of 2.43 (+0.32, -0.29) and a best-fitting absorption column of  $7.4$  (+4.1, -3.3)  $\times 10^{21} \text{ cm}^{-2}$ . The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $3.0 \times 10^{-11}$  ( $4.8 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{ count}^{-1}$ .

A summary of the PC-mode spectrum is thus:

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

Intrinsic column:  $7.4$  (+4.1, -3.3)  $\times 10^{21} \text{ cm}^{-2}$  at  $z=1.416$

Photon index: 2.43 (+0.32, -0.29)

The results of the XRT team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00589590](http://www.swift.ac.uk/xrt_products/00589590).

#### 4. UVOT Observations and Analysis

The Swift/UVOT began settled observations of the field of GRB 140301A 95 s after the BAT trigger (Porterfield and Starling, GCN Circ. [15913](#)). No optical afterglow consistent with the XRT position (Goad *et al.* GCN Circ. [15898](#)) 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 0.03 mag. in the direction of the GRB (Schlegel *et al.* 1998).

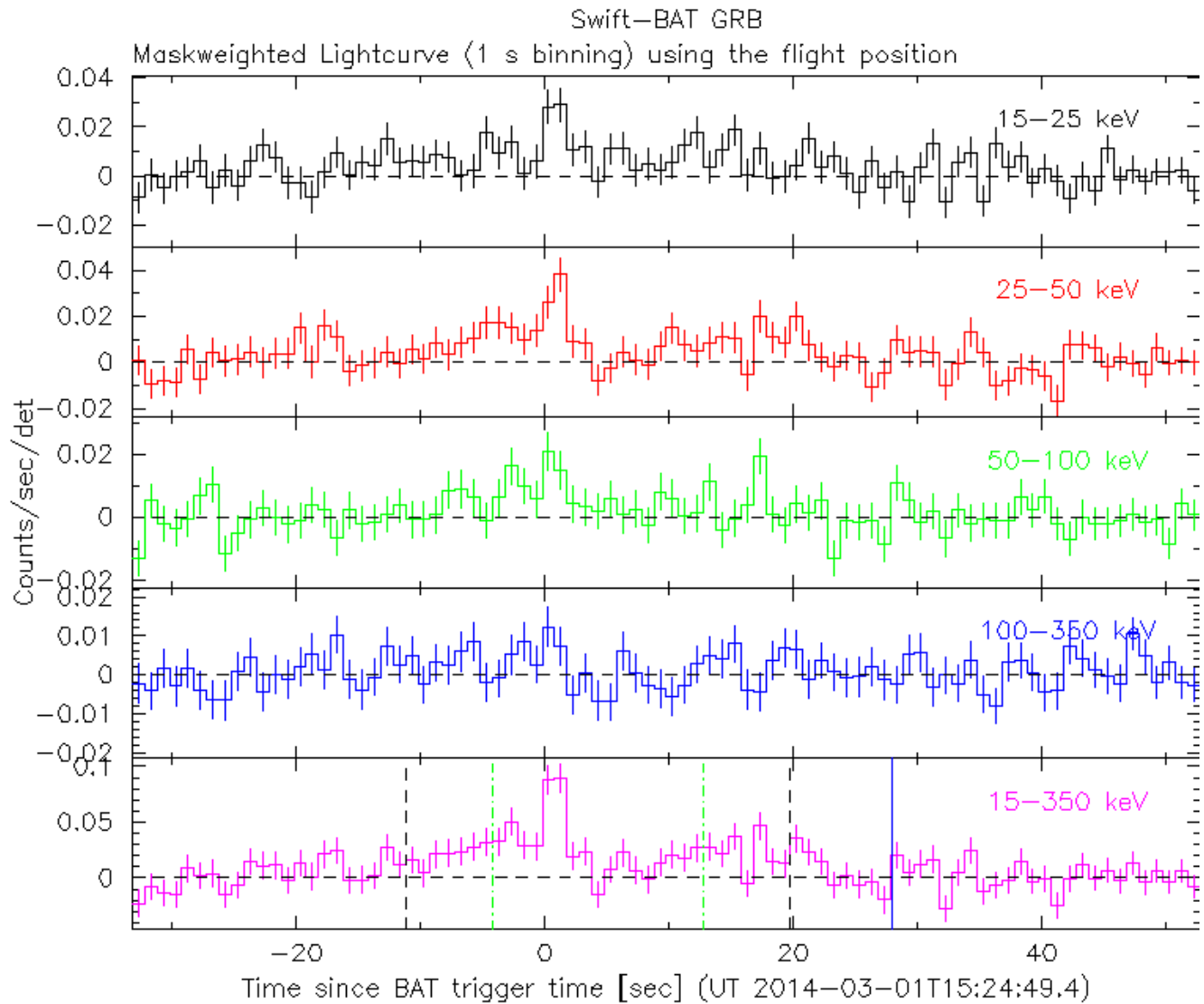


Figure 1. The BAT mask-weighted light curve in the four individual and total energy bands. The units are counts  $s^{-1}$  illuminated-detector $^{-1}$ . Green and black vertical lines in the bottom panel denote the T50 and T90 intervals, respectively. The blue vertical line shows the spacecraft slew start time.

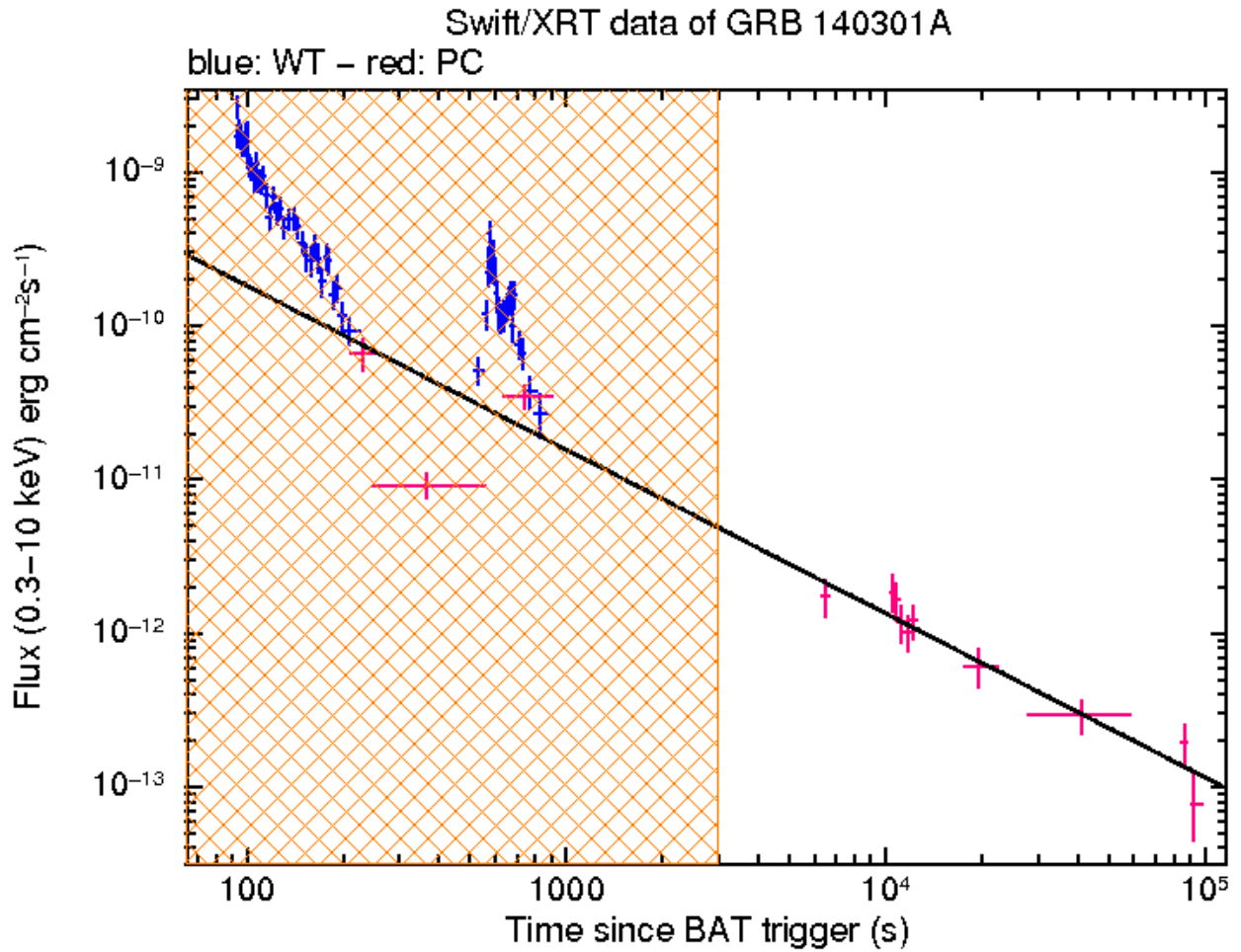


Figure 2. The XRT light curve. Any data from a cross-hatched region are not included in the fit.

RA (J2000)	Dec (J2000)	Error	Note	Reference
04 <sup>h</sup> 38 <sup>m</sup> 13.81 <sup>s</sup>	-34°15'24.3"	1.6"	XRT-final	<a href="#">UKSSDC</a>
04 <sup>h</sup> 38 <sup>m</sup> 13.78 <sup>s</sup>	-34°15'24.4"	1.9"	XRT-enhanced	Goad <i>et al.</i> GCN Circ. <a href="#">15898</a>
04 <sup>h</sup> 38 <sup>m</sup> 05.0 <sup>s</sup>	-34°14'56.8"	1.9'	BAT-refined	Ukwatta <i>et al.</i> GCN Circ. <a href="#">15906</a>

Table 1. Positions from the Swift instruments.

Band	Authors	GCN Circ.	Subject	Observatory	Notes
Optical	Trotter <i>et al.</i>	<a href="#">15897</a>	Skynet R-COP Observations	Skynet	
Optical	Kruehler <i>et al.</i>	<a href="#">15899</a>	NOT afterglow candidate	NOT	detection
Optical	Kruehler <i>et al.</i>	<a href="#">15900</a>	VLT/X-shooter redshift	VLT	redshift

Optical	Elliott <i>et al.</i>	<a href="#">15904</a>	GROND Detection of the Optical/NIR Afterglow	GROND	detection
---------	-----------------------	-----------------------	--	-------	-----------

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

Filter	T <sub>start</sub> (s)	T <sub>stop</sub> (s)	Exp(s)	Mag
white <sub>FC</sub>	108	258	292	>21.8
u <sub>FC</sub>	320	744	265	>20.7
white	108	920	231	>21.1
v	650	843	38	>18.7
v	6583	22273	392	>20.2
b	749	769	19	>19.2
b	27968	28212	240	>21.0
u	320	744	265	>20.7
w1	700	719	19	>17.9
w1	11294	45552	1408	>21.1
w2	799	818	19	>17.8
w2	6378	58531	1122	>21.4

Table 3. UVOT observations reported by Porterfield and Starling (GCN Circ. [15913](#)). The start and stop times of the exposures are given in seconds since the BAT trigger. The preliminary 3- $\sigma$  upper limits are given. No correction has been made for extinction in the Milky Way.

March 4, 2014