

# Swift Observations of GRB 141017A

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## 1. Introduction

At 18:25:28 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 141017A (trigger=615672) (Marshall *et al.* GCN Circ. [16919](#)). Swift slewed immediately to the burst. At the time of the trigger, the initial BAT position was  $92^\circ$  from the Sun (7.3 hours West) and  $78^\circ$  from the 32%-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).

Oates and Marshall (GCN Circ. [16924](#)) reported the detection with UVOT of an optical afterglow. Kann *et al.* (GCN Circ. [16926](#)) confirmed the optical afterglow and reported the position from GROND. The GRB was also detected with INTEGRAL/SPI-ACS (V. Beckman, private communication). **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. [16927](#)), the BAT ground-calculated position is RA, Dec = 93.601, -58.596 deg which is RA(J2000) =  $06^{\text{h}}14^{\text{m}}24.2^{\text{s}}$  Dec(J2000) =  $-58^\circ35'45.9''$  with an uncertainty of 2.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 64%.

The mask-weighted light curve (**Figure 1**) shows a double-peaked structure. The first peak starts at  $\sim T-1$  s, peaks at  $\sim T+1$  s, and ends at  $\sim T+3$ s. The second peak starts at  $\sim T+40$ s, peaks at  $\sim T+46$ s, and ends at  $\sim T+60$ s.  $T_{90}$  (15-350 keV) is  $55.7 \pm 2.8$  s (estimated error including systematics).

The time-averaged spectrum from T-1.2 to T+65.1 s is best fit by a power law with an exponential cutoff. This fit gives a photon index  $1.05 \pm 0.28$ , and  $E_{\text{peak}}$  of  $80.4 \pm 17.2$  keV ( $\chi^2$  39.44 for 56 d.o.f.). For this model the total fluence in

the 15-150 keV band is  $3.1 \pm 0.1 \times 10^{-6}$  erg cm<sup>-2</sup> and the 1-s peak flux measured from T+46.60 s in the 15-150 keV band is  $6.7 \pm 0.3$  ph cm<sup>-2</sup> s<sup>-1</sup>. This fluence is larger than that of 72% of the long GRBs in the Second BAT GRB Catalog (Sakamoto *et al.* 2011). A fit to a simple power law gives a photon index of  $1.66 \pm 0.06$  ( $\chi^2$  55.80 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/615672/BA/](http://gcn.gsfc.nasa.gov/notices_s/615672/BA/).

### 3. XRT Observations and Analysis

Analysis of the initial XRT data was reported by Page *et al.* (GCN Circ. [16922](#)). We have analysed 29 ks of XRT data for GRB 141017A, from 90 s to 442.7 ks after the BAT trigger. The data comprise 102 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. [16921](#)).

The light curve (**Figure 2**) can be modelled with a series of power-law decays. The initial decay index is  $\alpha=4.75$  (+0.26, -0.25). At T+216 s the decay flattens to an  $\alpha$  of -0.13 (+0.21, -0.22). The light curve breaks again at T+870 s to a decay with  $\alpha=0.76 \pm 0.05$ , before a final break at T+14.9 ks s after which the decay index is 1.30 (+0.14, -0.11).

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 2.45 (+0.15, -0.14). The best-fitting absorption column is  $2.1 \pm 0.4 \times 10^{21}$  cm<sup>-2</sup>, in excess of the Galactic value of  $3.8 \times 10^{20}$  cm<sup>-2</sup> (Willingale *et al.* 2013). The PC mode spectrum has a photon index of  $2.02 \pm 0.11$  and a best-fitting absorption column of  $1.9$  (+0.4, -0.3)  $\times 10^{21}$  cm<sup>-2</sup>. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $3.5 \times 10^{-11}$  ( $4.7 \times 10^{-11}$ ) erg cm<sup>-2</sup> count<sup>-1</sup>.

A summary of the PC-mode spectrum is thus:

Total column:  $1.9$  (+0.4, -0.3)  $\times 10^{21}$  cm<sup>-2</sup>

Galactic foreground:  $3.8 \times 10^{20}$  cm<sup>-2</sup>

Excess significance: 7.2  $\sigma$

Photon index:  $2.02 \pm 0.11$

The results of the XRT team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00615672](http://www.swift.ac.uk/xrt_products/00615672).

#### 4. UVOT Observations and Analysis

The Swift/UVOT began settled observations of the field of GRB 141017A 92 s after the BAT trigger (Oates and Marshall GCN Circ. [16924](#)). A source consistent with the XRT position (Goad *et al.* GCN Circ. [16921](#)) is detected in the initial UVOT white filter 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 0.04 mag. in the direction of the GRB (Schlegel *et al.* 1998).

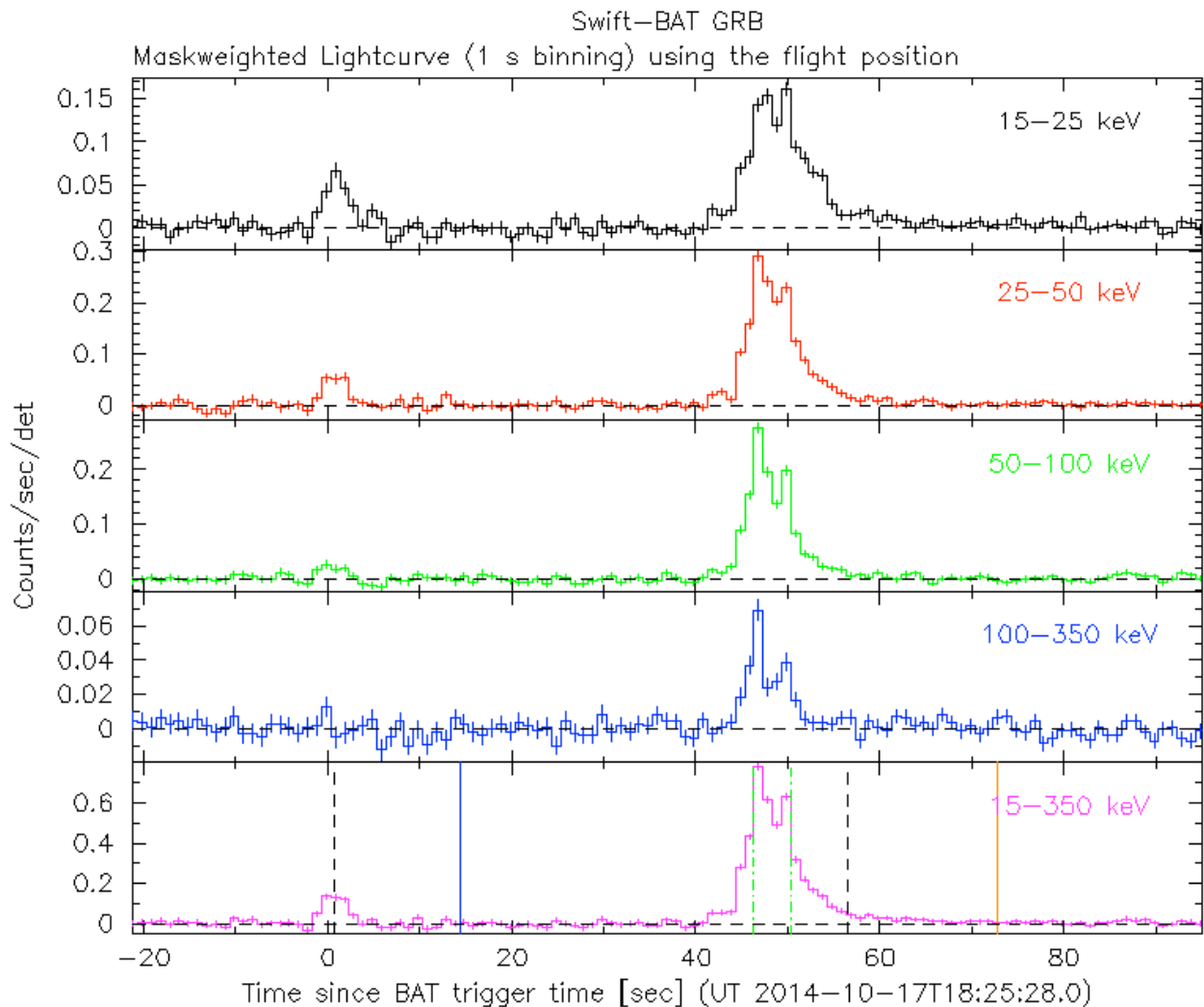


Figure 1. The BAT mask-weighted light curve in the four individual and total energy bands. The units are counts  $s^{-1}$  illuminated-detector $^{-1}$ .

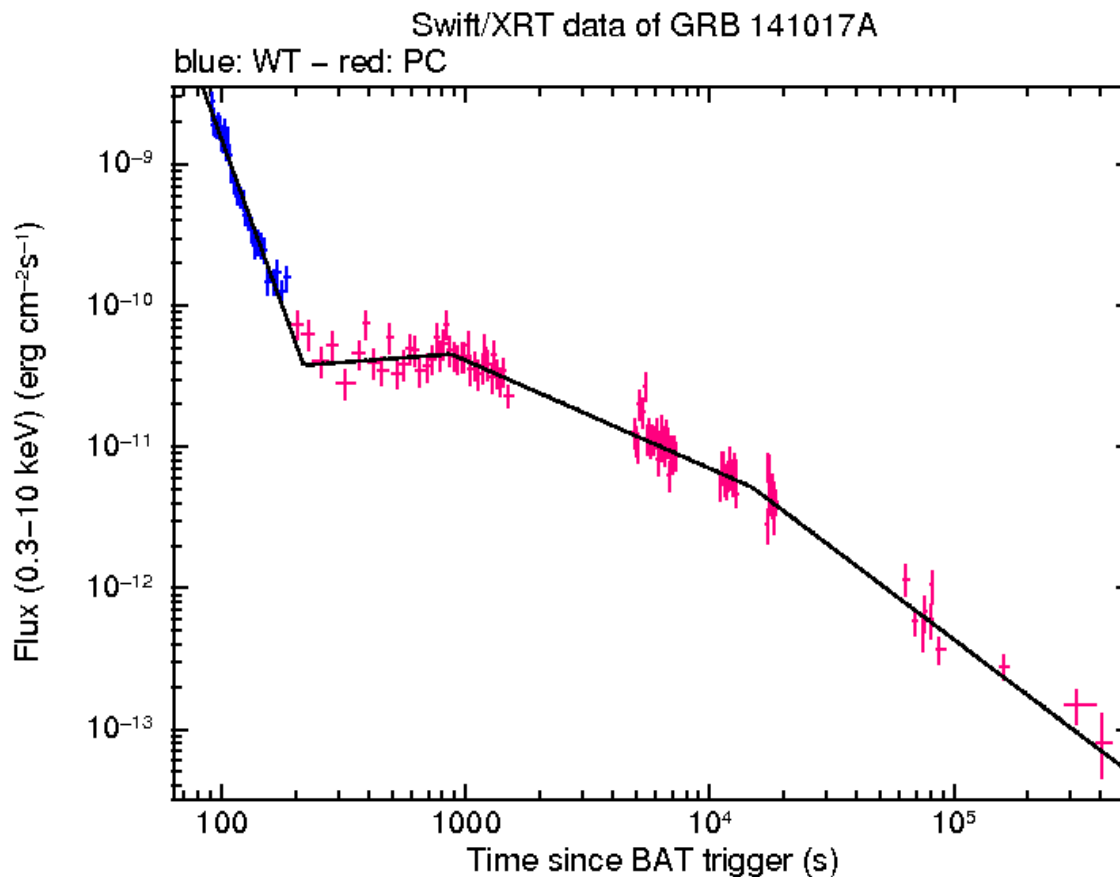


Figure 2. The XRT light curve.

| RA (J2000)   | Dec (J2000) | Error | Note         | Reference   |
|--|-------------|-------|--------------|---|
| 06 <sup>h</sup> 14 <sup>m</sup> 31.18 <sup>s</sup> | 58°34'56.5" | 1.4"  | XRT-final    | <a href="#">UKSSDC</a>                                  |
| 06 <sup>h</sup> 14 <sup>m</sup> 31.19 <sup>s</sup> | 58°34'56.2" | 1.5"  | XRT-enhanced | Goad <i>et al.</i> GCN Circ. <a href="#">16921</a>      |
| 06 <sup>h</sup> 14 <sup>m</sup> 24.2 <sup>s</sup>  | 58°35'45.9" | 2.1'  | BAT-refined  | Markwardt <i>et al.</i> GCN Circ. <a href="#">16927</a> |

Table 1. Positions from the Swift instruments.

| Band      | Authors                      | GCN Circ.             | Subject   | Observatory | Notes  |
|-----------|------------------------------|-----------------------|---|-------------|--|
| Optical   | Klotz <i>et al.</i>          | <a href="#">16920</a> | Zadko observatory<br>- Gingin optical<br>observations | Zadko       |  |
| Optical   | Kann <i>et al.</i>           | <a href="#">16926</a> | GROND<br>Afterglow<br>Confirmation                    | GROND       | detection  |
| Gamma-ray | Golenetskii<br><i>et al.</i> | <a href="#">16929</a> | Konus-Wind<br>observation                             | Konus-Wind  | $E_{\text{peak}}=97$<br>(-10,+12)<br>keV<br>Fluence=4.0<br>(-0.5,+0.5) $\times$<br>$10^{-6}\text{erg cm}^{-2}$ |

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 <sub>FC</sub> | 92                           | 242                         | 150    | $20.54 \pm 0.25$ |
| white               | 859                          | 1009                        | 159    | $>20.91$         |
| v                   | 633                          | 13060                       | 691    | $>20.0$          |
| b                   | 559                          | 17991                       | 1306   | $>21.4$          |
| u                   | 304                          | 7171                        | 717    | $>20.7$          |
| w1                  | 683                          | 6966                        | 471    | $>20.3$          |
| m2                  | 5133                         | 6761                        | 388    | $>20.1$          |
| w2                  | 6152                         | 12850                       | 1082   | $>21.1$          |

Table 3. UVOT observations reported by Oates and Marshall (GCN Circ. [16924](#)). 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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