

## Swift Observations of GRB 091003

*R.L.C. Starling, K.L. Page (U. Leicester), T.A. Pritchard (PSU), A.P. Beardmore, P.A. Evans (U. Leicester), C. Gronwall, E.A. Hoversten, D.N. Burrows, P. Roming (PSU), S. Barthelmy and N. Gehrels (GSFC) for the Swift Team*

### 1 Introduction

GRB 091003 was discovered by INTEGRAL and Fermi GBM/LAT (Rau GCN Circ. 9983; McEnery, Chiang & Hanabata GCN Circ. 9985) and was also detected by Konus-Wind (Golenetskii et al. GCN Circ. 9994) and Suzaku-WAM (Kono et al. GCN Circ. 9998). The Swift X-ray Telescope (XRT) and UV/Optical Telescope (UVOT) observed GRB 091003 on 2009 October 3 beginning at 20:07:28 UT, 15.5 hours after the Fermi trigger. This was a long, multi-peaked burst with duration of order 20 s.

The afterglow was detected with XRT (Starling et al. GCN Circ. 9986; Page et al. GCN Circ. 9991) and UVOT (Gronwall & Starling GCN Circ. 9987; Pritchard, Hoversten & Starling GCN Circ. 9990). Our best position is the UVOT position: RA(J2000) = 16h 46m 04.680s, Dec(J2000) = +36d 37' 31.08" with an error of 0.8 arcsec. The optical afterglow was then confirmed with ground-based instruments (Wiersema et al. GCN Circ. 9995; Perley et al. GCN Circ. 9997) and an emission-line redshift of  $z = 0.8969$  was determined for the potential host galaxy (Cucchiara et al. GCN Circ. 10031).

### 2 XRT Observations and Analysis

We have analysed all the Swift XRT data collected for GRB 091003, totalling 147 ks of data out to  $1.45 \times 10^6$  s after the Fermi/GBM trigger, all taken in Photon Counting mode.

Using 6853 s of XRT data and 14 UVOT images, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue; Evans et al. 2009 MNRAS 397 1177) of RA, Dec = 251.51963, 36.62473 which is equivalent to:

RA (J2000): 16h 46m 4.71s

Dec (J2000): +36d 37' 29.0"

with an uncertainty of 1.5 arcsec (radius, 90% confidence).

The light curve (Fig. 1) can be fit with a single power law, decaying with  $\alpha = 1.32 \pm 0.06$ . The final point is an upper limit containing 6 source counts in 18.8 ks.

The time-averaged spectrum is well fit with a power law of photon index  $\Gamma = 1.9_{-0.2}^{+0.1}$  absorbed by a column of  $N_{\text{H}} = (2.4_{-0.6}^{+0.7}) \times 10^{21} \text{ cm}^{-2}$  at  $z = 0.8969$ , in addition to the Galactic column of  $1.7 \times 10^{20} \text{ cm}^{-2}$  (Kalberla et al. 2005 A&A 440 775). The 0.3-10 keV observed (unabsorbed) flux is  $1.9_{-0.4}^{+0.3} (2.3) \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$ . The observed (unabsorbed) count rate to flux conversion is  $4.3 (5.2) \times 10^{-11} \text{ count s}^{-1}$ .

The results of the XRT-team automatic analysis are available at [http://www.swift.ac.uk/xrt\\_products/00020115](http://www.swift.ac.uk/xrt_products/00020115).

### 3 UVOT Observations and Analysis

The UVOT began settled observations of the field of GRB 091003 approximately 15.5 hours after the Fermi/GBM Trigger. A faint source was first identified as a candidate optical afterglow only in the uvw2 filter (Gronwall & Starling, GCN Circ. 9987) and was later detected in other UV and optical filters (Pritchard et al., GCN Circ. 9990). The source is detected at the  $3.9\sigma$  confidence level in the

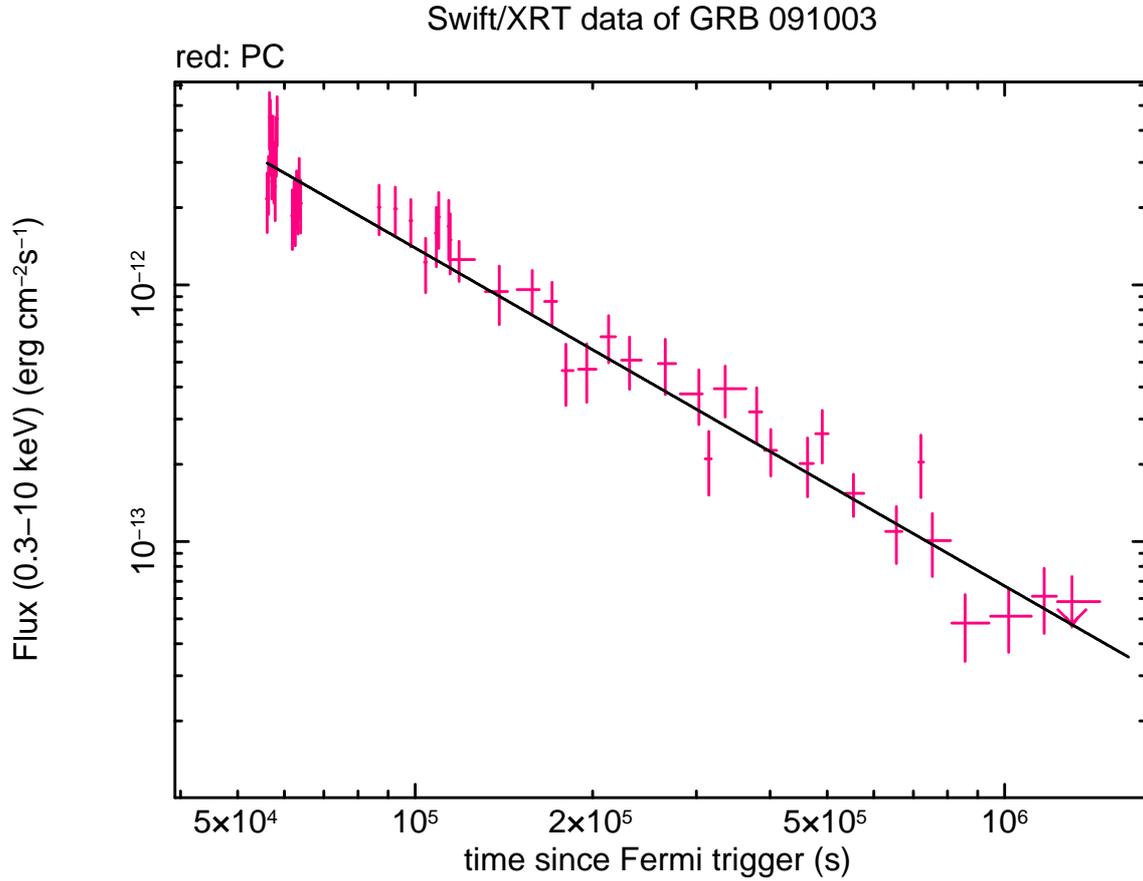


Figure 1: XRT fluxed light curve in the 0.3-10 keV band. The power law fit is described in the text. The approximate observed count rate to flux conversion is  $1 \text{ count s}^{-1} = 4.3 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ , based on the time-averaged spectrum.

summed UVOT observations at position RA, Dec = 251.5195, 36.6253 which is equivalent to:

RA (J2000): 16h 46m 4.68s  
Dec (J2000): +36d 37' 31.1''

with an uncertainty of 0.8 arcsec (radius, 90% confidence), consistent with the Swift UVOT-enhanced XRT position.

The observed magnitudes and upper limits using the UVOT photometric system (Poole et al. 2008 MNRAS 383 627) for the initial exposures are given in Table 1. The values quoted are not corrected for Galactic extinction due to the reddening of  $E(B - V) = 0.02$  in the direction of the burst (Schlegel et al. 1998 ApJ 500 525).

Filter	Start	Stop	Exposure	Mag / $3\sigma$ UL
v	86427	87191	741	$> 20.27$
b	92247	92949	685	$20.80 \pm 0.26$
u	108200	126134	620	$21.05 \pm 0.57$
uvw1	103707	104469	750	$20.70 \pm 0.32$
uvm2	98008	98710	691	$> 21.63$
uvw2	56815	64164	1150	$21.08 \pm 0.28$
white	160031	270189	10345	$21.56 \pm 0.08$

Table 1: Magnitudes and upper limits from UVOT observations. Start and stop times are given in seconds since Fermi trigger.