

## Swift Observation of INTEGRAL GRB 070707

*A. Parsons (GSFC), A. Beardmore, K. L. Page (U. Leicester), P. Schady (MSSL-UCL), and N. Gehrels (GSFC) for the Swift Team*

### 1 Introduction

GRB 070707 triggered INTEGRAL at 16:08:21 UT on July 07, 2007 (Beckmann *et al.*, *GCN Circ.* 6605, Gotz *et al.*, *GCN Circ.* 6607), resulting in a localization of R.A. DEC (J2000) = 267.7506 deg, -68.9144 deg with an uncertainty of 2.1 arcmin (90% c.l.). Refined analysis by the INTEGRAL team shows that this burst was composed of a single spike lasting about 1.1 s, with a spectrum well fit to a power law of slope of 1.4, indicating a rather hard spectrum. (Gotz *et al.*, *GCN Circ.* 6607). This burst also triggered Konus-Wind at  $T_0 = 16:08:42.823$  UT. The Konus-Wind (20 keV - 2 MeV) spectrum of the burst from  $T_0$  to  $T_0 + 0.256$  sec is well fitted by a power law with exponential cutoff model where  $\alpha = 0.57$  (-0.59, +0.43) and  $E_p = 427$  (-144, +374) keV, classifying it as a short, hard GRB (Golenetskii *et al.*, *GCN Circ.* 6615).

Since this burst was outside BAT's FOV, there was no Swift trigger for GRB 070707 and thus immediate Swift afterglow measurements were not possible. However, Swift did slew to the location of GRB 070707 as a ToO some 8.8 hours after the INTEGRAL trigger time. We report on the XRT and UVOT afterglow observations made after this time. While the XRT did detect a fading source (Beardmore *et al.*, *GCN Circ.* 6610, 6626) within the INTEGRAL error circle, no afterglow candidate was found in the UVOT data (Schady *et al.*, *GCN Circ.* 6611.)

Optical afterglow emission was detected within the XRT error circle by D'Avanzo *et al.*, (*GCN Circ.* 6609, 6613) and Piranomonte *et al.*, (*GCN Circ.* 6612) in R band images made using the FORS1 camera on the ESO-VLT telescope. A single source with  $R \approx 23.0$  was detected in the first observation at  $T_0 + \approx 11$  hours. A follow-up observation (D'Avanzo *et al.*, *GCN Circ.* 6613) was performed with the same instruments at  $T_0 + \approx 33$  hours and revealed that this object had faded by about  $0.7 \pm 0.1$  mag, indicating that it was the optical afterglow of GRB 070707.

### 2 BAT Observation and Analysis

No immediate BAT observations were made for this GRB, since the burst was outside the BAT FOV. Upon later examination of the BAT data, a short BAT rate trigger (#284062) with an excess of 461 counts in 0.384 sec was discovered at a time coincident with the burst trigger time and is thus presumably due to GRB 070707. Considering Swift's pointing direction at the trigger time, photons from GRB 070707's location must have entered BAT through the backside of the BAT array.

### 3 XRT Observations and Analysis

On 2007 Jul 08 00:57:50 UT ( $T_0 + 31.8$  ks) the Swift XRT started observing the field of the INTEGRAL burst GRB 070707 (Beckmann *et al.*, *GCN Circ.* 6605, Gotz *et al.*, *GCN Circ.* 6607). In a 3.8 ks exposure, photon counting mode image, XRT detected a source at RA, Dec = 267.7437, -68.9242, which is

$$\text{RA(J2000)} = 17\text{h } 50\text{m } 58.49\text{s}$$

$$\text{Dec(J2000)} = -68\text{d } 55\text{m } 27.0\text{s}$$

with an uncertainty of 5.4 arcsec (90% containment). This is 36.3 arcsec from the position reported by (Gotz *et al.*, *GCN Circ.* 6607), and within their error circle.

Using a circular extraction region of 10 pixels radius, XRT scientists observed 26 total counts. Together with an estimated background level of 1.0 count in the extraction region, we find the 99.73% Bayesian confidence level on the source count rate was 0.003 to 0.011 count  $s^{-1}$ .

The Swift XRT obtained further follow-up observations of GRB 070707. In an 11.1 ks exposure photon counting mode image taken from 325.1 ks to 516.6 ks after the trigger, and using the same 10 pixel radius extraction region as before, XRT found a 3 sigma upper limit to the observed count rate at 0.0011 count/s. When compared with the initial XRT detection (Beardmore *et al.*, *GCN Circ.* 6610) of  $0.0066 \pm 0.0013$  count/s (where the error bar is a 1 sigma estimate) we conclude the source has faded and that it was the X-ray counterpart to the GRB (Beardmore *et al.*, *GCN Circ.* 6610, 6626).

An absorbed power law fit to the photon energy distribution of the source observed during the first XRT observation (from 31.8 ks to 54.1 ks after the trigger), using Cash statistics and with the  $N_H$  value fixed at the (Dickey and Lockman) Galactic value of  $6 \times 10^{20} \text{cm}^{-2}$ , gave a power law index of  $2.7 \pm 0.6$ . The observed 0.3 - 10 keV flux was  $2.4 (+2.0, -1.4) \times 10^{-13}$  ergs  $\text{cm}^{-2} \text{s}^{-1}$ .

## 4 UVOT Observation and Analysis

The Swift/UVOT observed the field of the INTEGRAL burst GRB070707 starting 8.8 hrs after the INTEGRAL trigger (Beckmann *et al.*, *GCN Circ.* 6605), but did not find a new source inside the refined INTEGRAL error circle in any of the UVOT observations (Schady *et al.*, *GCN Circ.* 6611) or XRT error circle (Beardmore *et al.*, *GCN Circ.* 6610).

The 3-sigma upper limits for detecting a source inside the refined XRT error circle in the initial data products are:

Filter	$T_{mid}$ (s)	Exp(s)	Mag ( $3 \sigma$ upper limit)
V	53885	543	19.66
B	31910	324	20.55
U	47905	97	19.48
UVW1	47149	964	20.26
UVM2	39328	1190	20.47
UVW2	53182	1800	20.51

Where  $T_{mid}$  is the weighted mid time of the coadded exposure. The values quoted above are not corrected for the expected Galactic extinction corresponding to a reddening of  $E_{B-V} = 0.08$  mag in the direction of the burst (Schlegel *et al.* 1998).