Swift Observations of GRB 150201A

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1 Introduction

1.1 *Swift*/BAT

At T =13:46:59 UT, the BAT triggered and located GRB 150201A (trigger=629302; Cannizzo et al, GCN 17368). *Swift* slewed immediately to the burst. The BAT on-board calculated location is (RA, Dec) = (11.832, -37.625) deg, which is {00h 47m 26s; −37° 37' 29"} (J2000) with $\sigma = 3$ arcmin (radius, 90% containment, including systematic uncertainty). The BAT light curve showed a double-peaked structure with duration of ∼20 s. The BAT peak count rate was $\sim 21,500$ ct s^{-1} $(15 - 350$ keV), at $\sim T - 2$ s.

1.2 *Fermi*/GBM

The burst was also seen by *Fermi*/GBM (Yu et al., GCN 17370). It triggered at $T0$ =13:46:55.15 UT. The double peaked pulse seen with BAT was also visible, with $T_{90} \simeq 16$ s. The time-averaged spectrum from $T0 - 2.816$ s to $T0 + 36.097$ s is well fit by a Band function with $E_{\rm peak} = 131 \pm 2$ keV, $\alpha = -1.02 \pm 0.01$, and $\beta = -2.70 \pm 0.06$. The event fluence $(10 - 1000$ keV) in this time interval is $(6.63 \pm 0.05) \times 10^{-5}$ erg cm^{-2}. The 1.024 s peak photon flux measured starting from $T0 + 4.608$ s in the $0.01 - 1$ MeV band is 88.7 ± 0.7 ph s^{-1} cm^{-2}.

1.3 *Konus-Wind*

The burst was also seen by *Konus-Wind* (Golenetskii et al., GCN 17373) at $T0 = 49611.653$ s UT (13:46:51.653). It consisted of a double-peaked pulse with total duration ∼26 s. Emission was seen up to ∼10 MeV. No post-burst activity was observed until $\sim T0 + 450$s;

The burst fluence was $6.18(-0.22, +0.23) \times 10^{-5}$ erg cm^{-2}, and a 64-ms peak flux, measured starting at $T0 + 1.712$ s, was $2.10(-0.28, +0.30) \times 10^{-5}$ erg cm^{-2} s^{-1} (both $0.02 - 10$ MeV).

The time-averaged spectrum of the burst ($T0$ to $T0$+22.272 s) is best fit (0.02−10 MeV) by the GRB (Band) model with the following parameters: low-energy photon index $\alpha = -1.20(-0.11, +0.13)$, high energy photon index $\beta = -2.89(-0.27, +0.17)$, and peak energy $123(-6, +5)$ keV ($\chi^2 = 88/93$ dof).

The spectrum near the maximum count rate ($T0$ to $T0 + 2.048$ s) is best fit $(0.02 - 10$ MeV) by the GRB (Band) model with the following parameters: low-energy photon index $\alpha = -0.77(-0.12, +0.14)$, high energy photon index $\beta = -2.47(-0.25, +0.17)$, and peak energy $193(-20, +21)$ keV ($\chi^2 = 65/50$ dof).

1.4 *INTEGRAL*/SPI-ACS

INTEGRAL/SPI-ACS also detected GRB 150201A (v. Beckmann, priv. comm.) as a bright and double-peaked burst.

SPI-ACS 10 s light curve:

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http://www.isdc.unige.ch/integral/ibas/cgi-bin/ibas_acs_web.cgi/
                      ?trigger=2015-02-01T13-46-59.700-00000-00000-0
```

SPI-ACS 100 s light curve:

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http://www.isdc.unige.ch/integral/ibas/results/triggers/spiacs/
                       2015-02/2015-02-01T13-46-59.700-00000-00000-0.png
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1.5 GROND

Optical observations produced only upper limits. GROND observed the field of GRB 150201A (Knust et al., GCN 17372) simultaneously in g'r'i'z'JHK with GROND mounted at the 2.2 m MPG telescope at ESO La Silla. Observations began at $T + 11$ hr. They were performed at an average seeing of 1.64 arcsec and at an average airmass of 2.1. No source was detected within the *Swift*/XRT error circle (Osborne et al., GCN 17369) to $g' > 23.2$, $r' > 23.1$, $i' > 23.5$, $z' > 23.6$, $J > 21.5$, $H > 21.0$, and $K > 19.4$. The given limits are derived based on calibrating the images against GROND zeropoints and 2MASS field stars and are not corrected for the Galactic foreground extinction corresponding to a reddening of $E(B-V) = 0.012$ in the direction of the burst (Schlegel et al. 1998).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 962$ s, further analysis was performed (Palmer et al., GCN 17374). The BAT ground-calculated position is (RA, Dec) = (11.820, −37.620) deg, which is {00h 47m 16.8s; −37° 37' 10"} (J2000) with an uncertainty of 1.7 arcmin, (radius, sys+stat, 90% containment), 0.6 arcmin from the XRT enhanced position. The partial coding was 3%.

The burst was outside the BAT calibrated field of view. It came into the field during the slew to point the narrow-field instruments. The earliest calibrated event data starts at about $T + 22$ s. The non-weighted light curve shows two main peaks at about $T - 3$ s and $T + 1$ s. The emission is detectable out to approximately $T + 50$ s. T_{90} (15 − 350 keV) is 26.1 ± 5.2 s (estimated error including systematics).

The time-averaged spectrum from $T + 22.2$ to $T + 49.0$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.32 ± 0.24. The fluence in the 15 − 150 keV band is $(7.8 \pm 1.2) \times 10^{-7}$ erg cm^{-2}. This calibrated fluence is on the order of 5% of the total fluence. All the quoted errors are at the 90% confidence level.

3 XRT Observation and Analysis

XRT data starting at $T + 87.2$ s reveal a bright, uncatalogued X-ray source at (RA, Dec) = {11.8325, -37.6193}, which is {00h 47m 19.80s; −37° 37' 9.5"} (J2000) with an uncertainty of 5.0 arcsec (radius, 90% confidence). This is 20 arcsec from the initial BAT position, within the BAT error circle. The initial flux in the 2.5 s image was 3.03×10^{-9} erg cm^{-2} s^{-1} $(0.2 - 10$ keV).

308 s of PC mode data and 1 UVOT (Osborne et al., GCN 17369) yields an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): (RA, Dec) = {11.83271; -37.61883} which is {00h 47m 19.85s; −37°d 37' 07.8"} (J2000) with an uncertainty of 1.6 arcsec (radius, 90% confidence).

7.9 ks of XRT data (Beardmore et al., GCN 17371) were taken from $T + 75$ s to $T + 51.9$ ks, 823 s in WT mode (the first 7 s were taken while *Swift* was slewing) and the rest in PC mode.

The initial decay index $\alpha = 1.12(+0.15, -0.13)$. At T+161 s the decay flattens to $\alpha = 0.62(+0.03, -0.04)$ before breaking again at $T + 833$ s to a final value $\alpha = 1.256(+0.032, -0.026)$.

A spectrum from WT data can be fit with an absorbed power-law with a photon spectral index 1.86 ± 0.04. The best-fitting absorption column is $3.82(+0.21, -0.20) \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 5.8×10^{20} cm^{-2} (Willingale et al. 2013). The PC mode spectrum has a photon index $2.30(+0.17, -0.16)$ and a best-fitting absorption column $4.7(+0.8, -0.7) \times 10^{21}$ cm^{-2}. The counts to observed (unabsorbed) $0.3 - 10$ keV flux conversion factor deduced from this spectrum is $3.4 \times 10^{-11}(6.7 \times 10^{-11})$ erg cm^{-2} ct^{-1}.

4 UVOT Observation and Analysis

The *Swift*/UVOT began settled observations of the field of GRB 150201A at $T + 93$ s (Marshall et al., GCN Circ. 17375). No optical afterglow consistent with the XRT position (Osborne et al. GCN Circ. 17369) is detected in the initial UVOT exposures. Preliminary 3σ upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the first finding chart (FC) exposure and subsequent exposures are:

Filter	T_start(s)	T_stop(s)	Exp(s)	Mag
white_FC	93	243	147	>21.0
u_FC	306	556	246	>20.4
white	93	913	239	>21.5
v	635	829	39	>18.6
b	561	755	35	>19.8
u	306	729	265	>20.3
w1	685	705	19	>19.6
w2	784	804	19	>19.6

The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of $E(B - V) = 0.01$ in the direction of the burst (Schlegel et al. 1998).

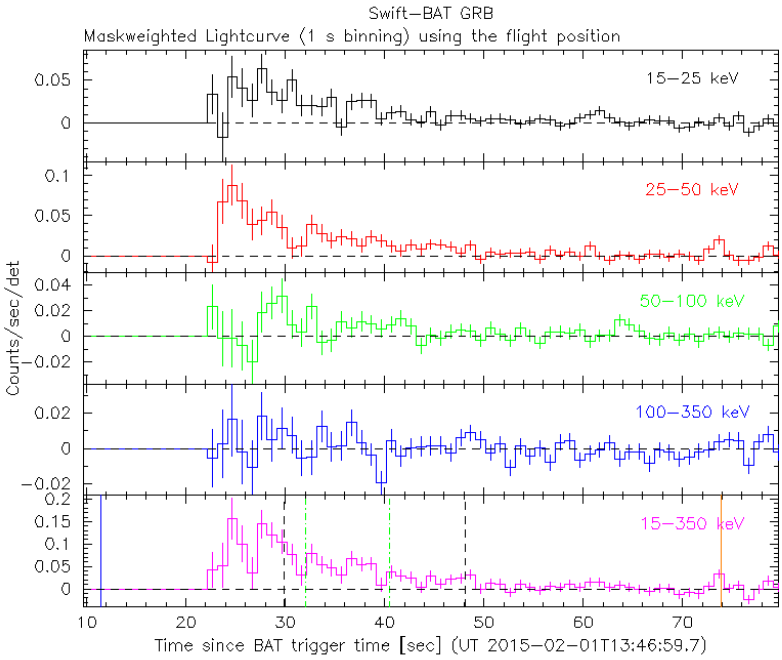

Figure 1: BAT Lightcurve. The mask weighted light curve (1s binning) in the 4 individual plus total energy bands ($15-25$ keV, $25-50$ keV, $50-100$ keV, $100-350$ keV, and $15-350$ keV).

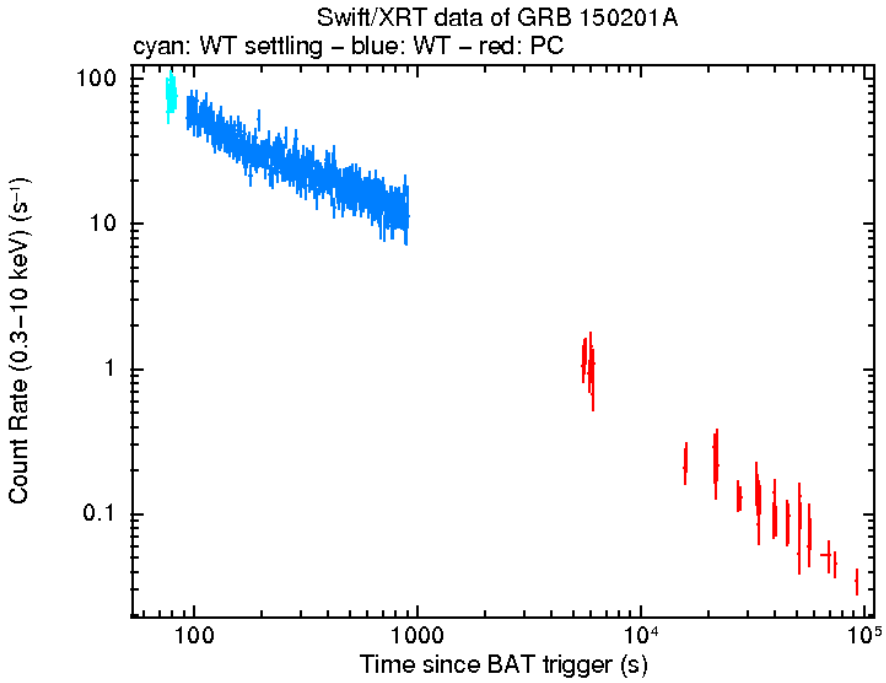

Figure 2: XRT Lightcurve. After the first orbit the decay index $\alpha = 1.19 \pm 0.07$.