Swift Observations of GRB 070318

J. Cummings (GSFC/UMBC), V. La Parola (INAF-IASFPA), T. Mineo (INAF-IASFPA), M. Page (MSSL-UCL) for the Swift Team

1. INTRODUCTION

At 07:28:56 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 070318 (trigger=271019). Swift slewed immediately to the burst. This was a rate trigger with T_{90} = 63±3 sec. Our best postion is from the UVOT.

RA(J2000) = 03:13:56.83 = 48.4868
DEC(J2000) = -42:56:46.3 = -42.9462

with a 1-sigma error radius of about 0.5 arc sec. The optical afterglow has remained bright enough to observe with the UVOT for at least several hours. The redshift has been reported as z=0.836 (Jaunsen *et al.* [1]).

2) BAT OBSERVATION AND ANALYSIS

The following analysis uses the data set from T-120 to T+302 sec. The BAT ground-calculated position is RA, Dec = 48.486, -42.950 deg, which is

RA(J2000) = 03h 13m 56.6s
Dec(J2000) = -42d 57' 1.1"

with an uncertainty of 0.8 arcmin, (radius, sys+stat, 90% containment). The partial coding was 80%.

The mask-weighted lightcurve (Figure 1) is a single FRED peak starting at ~T-10sec, peaking at ~T+2 sec, and returning to background at around T+120 sec. There is the possibility of weak peaks at ~T+140 and T+170 sec at the ~3-sigma level. There is a low-significance positive value at T+280, at the time of the XRT flare. T_{90} (15-350 keV) is 63±3 sec (estimated error including systematics).

The time-averaged spectrum from T-1.0 to T+89.4 is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.44±0.08. The fluence in the 15-150 keV band is 2.3±0.1 x 10^{-6} erg/cm2. The 1-sec peak photon flux measured from T+1.94 sec in the 15-150 keV band is 1.6±0.2 ph/cm2/sec. All the quoted errors are at the 90% confidence level.

3. XRT OBSERVATION AND ANALYSIS

We have analysed the first two orbits of Swift-XRT data on GRB 070318 with a total exposure of 427 s seconds in Window Timing (WT) mode and 33.4 ks seconds in Photon Counting (PC) mode. This provides a refined XRT position at RA,Dec=48.4870,-42.9454 which is:

RA (J2000) = 03h 13m 56.9s
Dec(J2000) = -42d 56m 43.6s

with an estimated error radius of 3.5 arcseconds (90% confidence). This position is 16.8 arcseconds from the BAT refined position (Cummings, et al., GCN 6212), 6.2 arcseconds from the initial XRT position, and 2.9 arcseconds from the UVOT optical candidate.

The 0.3-10 keV X-ray light curve (Figure 2) presents a bright flare peaking at about 280 sec from the trigger and a second fainter peak at 200 sec. The underlying light curve between 70 sec and 7.5 ksec can be fit with a simple power-law with a decay slope of 1.11±0.02. The hardness ratio (Figure 2a) shows a moderate spectral variation before and during/after the flare.

The X-ray spectrum (figure 2b) from the XRT/WT data covering up to the beginning of the bright flare is well fit by an absorbed power-law with a photon index of 1.4±0.1 and column density of 1.5±0.7 x 10^{21} cm^{-2}, higher than the Galactic column density in the direction of the source 2.5 x 10^{20} cm^{-2}. The unabsorbed 0.3-10 keV flux for this spectrum is 1.3 x 10^{-9} erg/cm^2/s. The XRT/WT spectrum of the bright flare and the XRT/PC spectrum are modelled by an absorbed power law with photon index of 1.9±0.1 and column density of 1.3±0.3 x 10^{21} cm^{-2}. The unabsorbed 0.3-10 keV flux of the bright flare is 8.2 x 10^{10} erg/cm^2/s and the one relative to the PC spectrum is 1.0 x 10^{-10} erg/cm^2/s.

Assuming the X-ray emission continues to decline at the same rate, we predict a 0.3-10 keV XRT count rate of 5 x 10^{-3} count/s at T+48hr, which corresponds to an observed 0.3-10 keV flux of 2.5 x 10^{13} erg/cm^2/s.

4. UVOT OBSERVATION AND ANALYSIS

The bright optical afterglow of GRB 070318 is following an approximately power-law decay. At 13,000 sec. after the trigger, the magnitude in the UVOT B filter is ~19.9 with a best-fit decay index of 1.16. If this rate of decay continues, the B magnitude will be 22.3 at one day after the trigger and 23.2 a day later.

The afterglow has been detected in all 7 UVOT filters indicating that the redshift is less than ~2.

The Swift/UVOT began taking data 88 sec after the BAT trigger. The afterglow is detected in all UVOT filters and is decaying with a decay index of 1.1 (see figure 3). The photometry results are given for the 7 UVOT filters below. The first White exposure was affected by attitude problems, so results from this exposure are not reported below. They will be given in an amendment to this report. The refined position is

RA (J2000) = 03h 13m 56.83s,
Dec (J2000) = -42d 56' 46.3"

with a 1-sigma error radius of about 0.5 arcseconds.

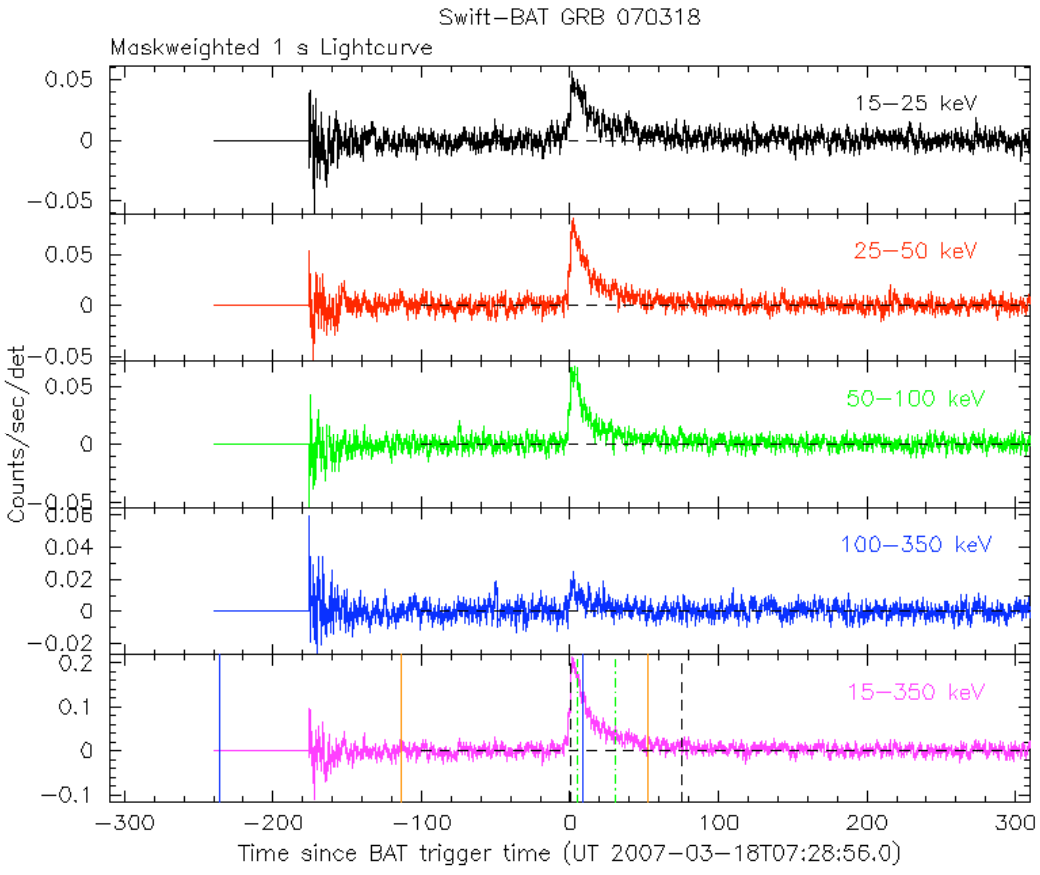

Fig.1: BAT Lightcurve. The light curve in the 4 individual plus total energy bands.

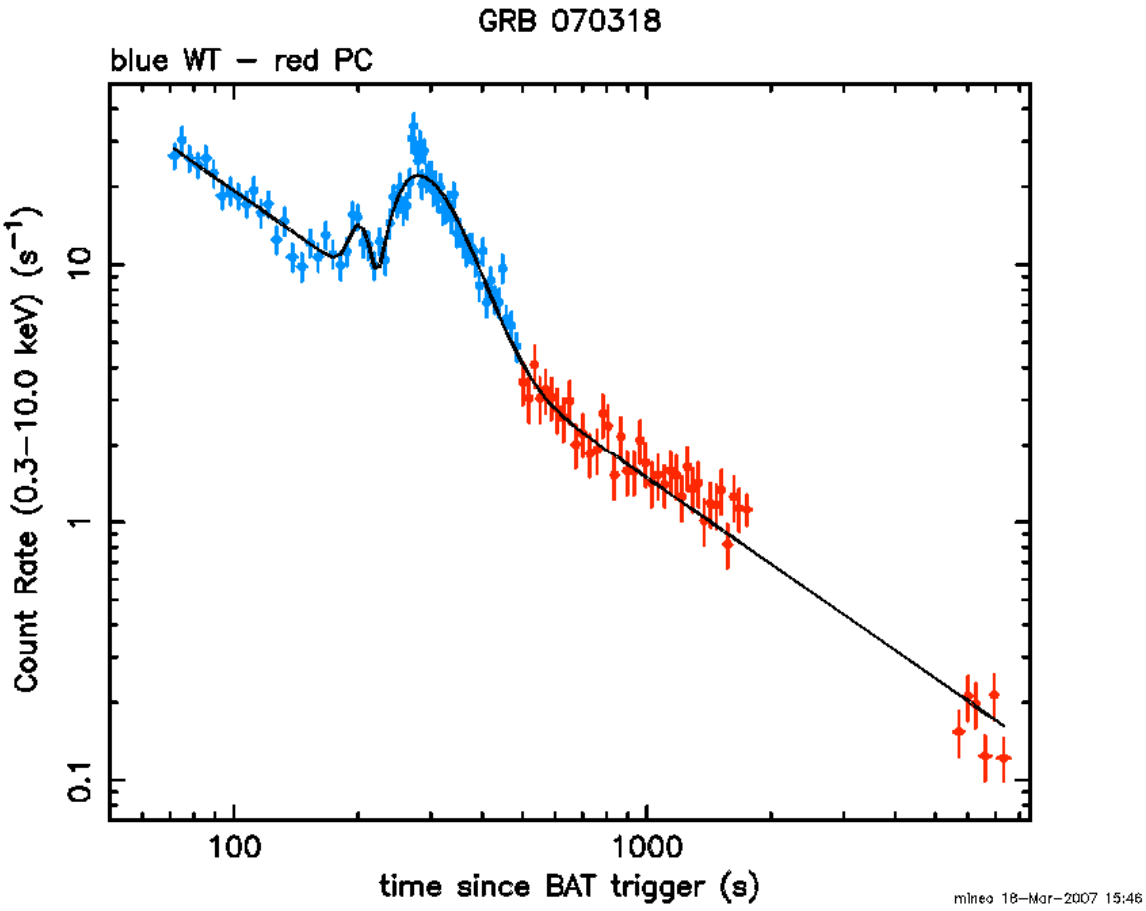

Fig. 2: XRT Lightcurve Blue is Window Timing Mode and Red is Photon Counting Mode. The conversion factor 0.3-10 keV counts -- 0.3-10 keV flux is 7.6 x 10^{-11}.

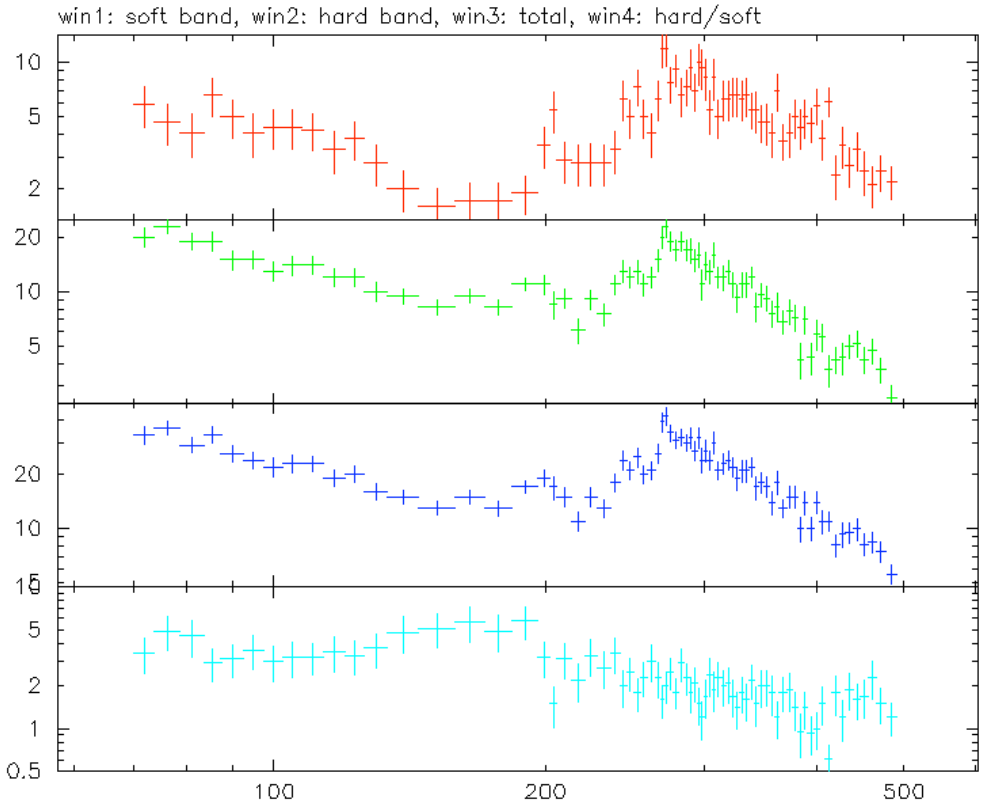

Fig 2b: XRT lightcurve in two energy bands, total, and ratio.

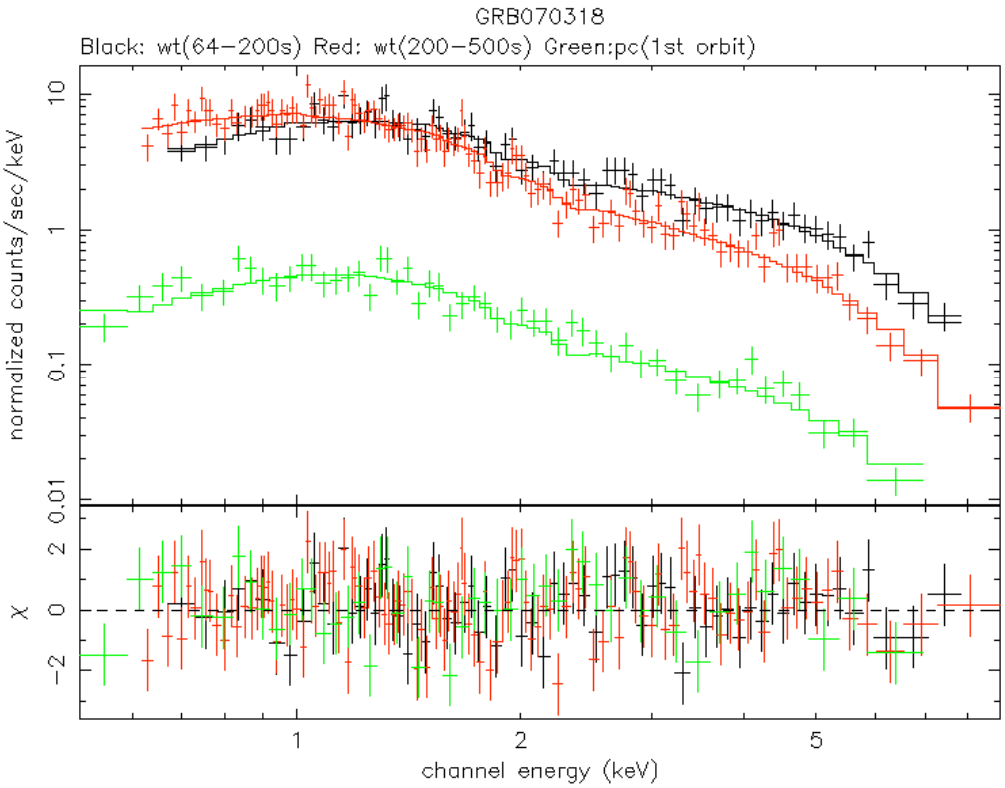

Fig 2c: XRT Spectrum

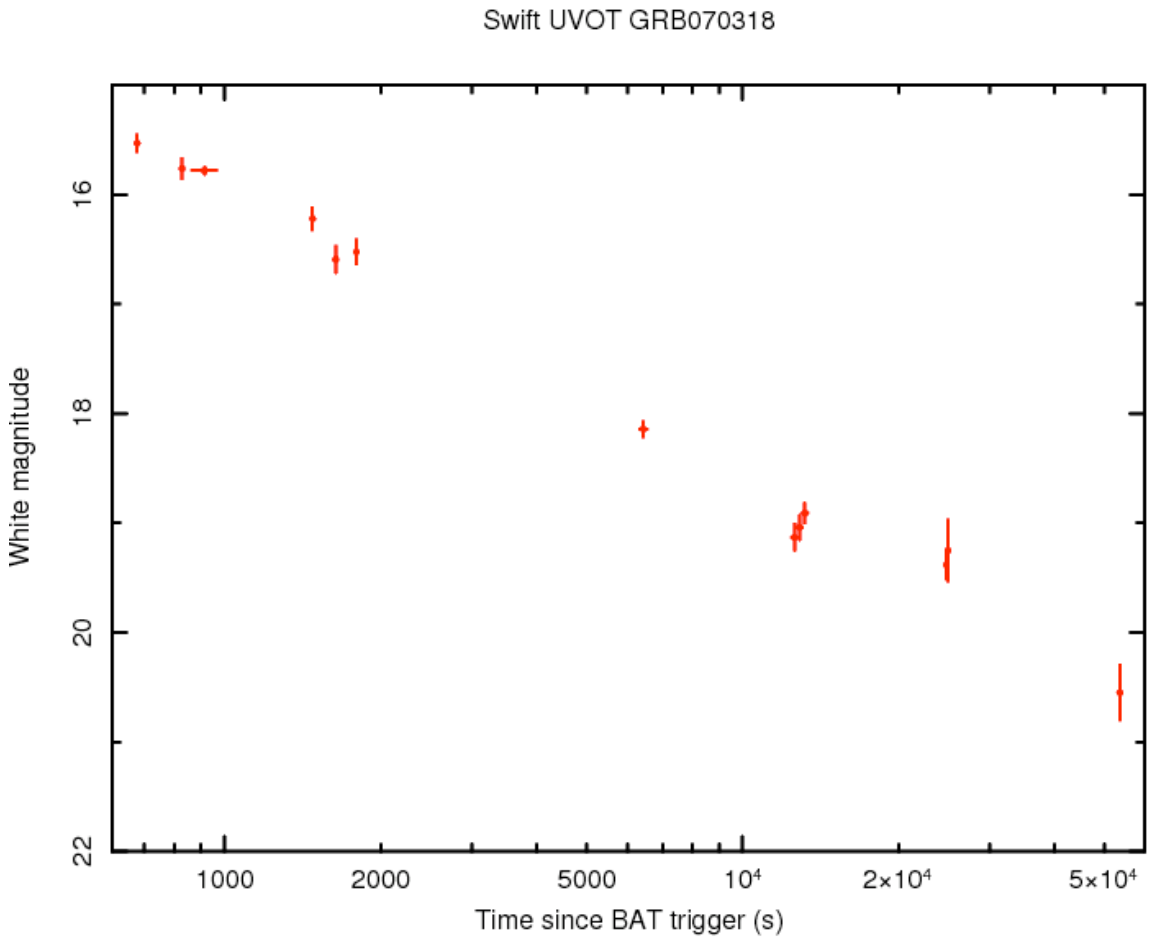

Fig. 3: UVOT Lightcurve. Excludes first image, which will be added later.

Table: UVOT Afterglow observations:

Filter	T range(s)	Exp(s)	Mag	Significance
White	672-682	10	15.53±0.08	17 sigma
V	180-580	400	15.43±0.02	54 sigma
B	658-668	10	16.25±0.12	10 sigma
U	634-644	19	15.89±0.09	13 sigma
UVW1	610-620	19	16.89±0.18	6 sigma
UVM2	586-596	19	17.97±0.37	3 sigma
UVW2	837-847	19	18.03±0.30	4 sigma

Reference

1) Jaunsen et al. GCN circular 6216. http://gcn.gsfc.nasa.gov/gcn3_archive.html