

Swift GRB Products Guide

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1 Introduction

This document describes the on-line data products for the Swift Gamma Ray Burst Catalog.

2 Archive Structure and Filenames

2.1 Directory Layout

A complete GRB products set contains at most five sub-directories:

- `html` - All required files for on-line GRB web pages
- `images` - GIF images from each available instrument
- `info` - FITS information table (see §2.2.4)
- `lightcurves` - FITS light curves and plots for all available instruments
- `spectra` - BAT and XRT spectra and plots

If there are no archive data for a given GRB (e.g. TDRSS messages only), then there will only be an `html` directory.

2.2 File Naming Conventions

2.2.1 Light Curves and Plots

Light curves in FITS format are generated for each Swift instrument, and various modes of each instrument. Plots of some of these light curves are also produced, as well as plots of combinations of them. The FITS and gif light curve products archived for each GRB have the following general form:

```
GRBNAME_[I] [MM] [BB] [OO] [T] [b?] .1c
```

which has the following parts:

- `GRBNAME` is the name of the GRB in lower case (e.g. `grb051221a`).
- `I` is the instrument as shown in the left half of Table 1.
- `MM` is the mode as shown in the right half of Table 1.
- `BB` is the spectral band represented as shown in Table 2.
- `OO` indicates what the light curve represents: `'sr'` for source or `'bg'` for background.

Table 1: *Left two columns:* Instrument character codes and their meaning. *Right two columns:* Instrument mode character codes and their meaning

Character Code	Meaning	Character Code	Meaning
x	XRT Only	pc	XRT PC mode
b	BAT Only	wt	XRT WT mode
u	UVOT Only	pw	XRT WT/PC mode
m	Mixed Instruments	xb	XRT and BAT
		pp	BAT Pre-Pre-slew Epoch
		ps	BAT Pre-slew Epoch
		is	BAT In-slew Epoch
		as	BAT After-slew Epoch
		ba	BAT All Available Epochs
		uv	UVOT (all filters)

Table 2: Energy band character codes

Character Code	Meaning			
	BAT	XRT	UVOT	BAT/XRT
et	15-350 keV	0.3-10 keV	All filters	0.3-10 keV
e1	15-25,25-50,50-100,100-350 keV	0.3-2 keV	-	-
e2	15-150 keV	2-10 keV	-	2-10 keV

- T is the type of light curve as shown in Table 3.
- If the last character before '.lc' is 'b', this indicates that the file contains binned data only, where the bins are something other than fixed time bins. If the 'b' is not present, the light curve contains both time binned and another form of binned data, e.g. counts, bayesian blocks or UVOT snapshot binning.

The gifs of various light curves are named in an identical manner, except that '.lc' is replaced with '_lc.gif'. Note that not all light curves have a corresponding plot (in fact, most will not), and some gifs are combinations of different light curves.

2.2.2 Spectra and Spectral Plots

In addition to light curves, there are spectra and related plots produced for the BAT and XRT. These are named in a similar manner:

GRBNAME_*[I]* *[MM]* *[BB]* *[OO]* *[EE?]* .pha

GRBNAME, I , MM , BB and OO are identical to §2.2.1. GIF plots will have '_ph.gif' in place of '.pha'.

Table 3: Data type character codes

Character Code	Meaning
c	Corrected Net Rate
n	Net Rate
f	Flux
a	Combination of n,c,f*
r	Hardness Ratio
m	Magnitude or Fitted light curve**

* The 'a' character code corresponds to single light curve files with a 'RATE' extension containing several light curves. The TIME, XAX_E (if extant), TIMEDEL, and FRACEXP columns are valid for all curves in the file.

** Magnitude only applies to UVOT light curves and plots and Fitted light curve only applies to XRT light curve plots.

Table 4: Image Plot Character Codes

Character Code	Meaning
i1	Image Mosaic (XRT/BAT) or Single Image (UVOT)
i2	Finding Chart Image (UVOT only)
i3	Image Plot (two zooms)

For the XRT, the *EE* field, if present, indicates which light curve interval the spectrum represents - *tt* stands for total spectrum, *t1* stands for the first interval, *t2* the second, etc.. The presence of the *EE* field also indicates that any GRB flares have been excluded from the spectrum. There is also a corresponding ancilliary response file (ARF) for each spectrum. These files are named similarly to the spectra they are used with, except that the '.pha' is replaced with '.arf'.

For the BAT GIF spectral plots, the *EE* field can be either 'c' or 'p'. A 'c' indicates that the plotted model is an exponential cutoff power-law. A 'p' indicates that the plotted model is a pure power-law. Also for the BAT, there will be a response matrix file for each spectrum (indicated with the '.rsp' extension).

2.2.3 Image Plots

Lastly, there are plots of image and event data for all instruments. They are named in a similar manner to light curves and spectra:

GRBNAME_*[I]* *[MM]* *[BB]* *[OO]* *[TT]* *[a-z?]*.gif

where GRBNAME, *I*, *MM*, *BB* and *OO* are identical to §2.2.1. *TT* is the type of image as shown in Table 4. A trailing character from a through z indicates that a mosaic image was split into multiple images.

Table 5: GRB HTML pages

	Filename	Description
	grb051221a.html	Main interface html page
	grb051221a_spectra.html	BAT and XRT spectra html page
	grb051221a_curves.html	Light curves html page
	grb051221a_images.html	Images html page

2.2.4 Information FITS File

In addition to the data products above, there will also be an information table for each GRB. This table will have at most four extensions - 'XRTINFO', 'XRTFLDREG', 'XRTFITINFO' and 'BATINFO'. This table will be named:

`GRBNAME_info.fits`

The 'XRTINFO' extension contains information for each interval considered in the extraction of light curve and spectral products from the XRT event data. This includes interval start and stop times, spectral fit statistics, region shapes used, raw counts among other information.

The 'XRTFLDREG' extension contains a list of detected sources in the combined event file for this GRB. These are detected using XImage, and the format is nearly identical to the output from XImage's `detect` command. The only difference being that the region used to exclude the field source from the GRB analysis is also included.

The 'XRTFITINFO' extension contains fit parameters from the light curve fitting process and subsequent interval spectral analysis. This extension is produced by the task `xrtgrblspec`.

Lastly, the 'BATINFO' extension contains spectral fit statistics for each observation epoch of the GRB (e.g. Pre-slew, Slew, etc.), as well as total fluxes in several energy bands.

2.3 GRB HTML Pages

For each GRB there is also a set of HTML web pages, and all of files required to reproduce the on-line WWW pages. The main html elements are shown in Table 5.

3 GRB Product Set

Tables 6 through 10 show an example GRB product file set. Not included in these tables is the informational FITS table (see previous section). It should be noted that this represents the maximum possible set of products for a given burst, and that most bursts will have a smaller subset of these products.

Table 6: XRT Only FITS Products

Filename	Description
grb051221a_xpcetsra.lc	XRT PC 0.3-10 keV source light curves
grb051221a_xwtetsra.lc	XRT WT 0.3-10 keV source light curves
grb051221a_xpce1sra.lc	XRT PC 0.3-2 keV source light curves
grb051221a_xwte1sra.lc	XRT WT 0.3-2 keV source light curves
grb051221a_xpce2sra.lc	XRT PC 2-10 keV source light curves
grb051221a_xwte2sra.lc	XRT WT 2-10 keV source light curves
grb051221a_xpcetsrrb.lc	XRT PC 0.3-10 keV source binned hardness ratio*
grb051221a_xwtetsrrb.lc	XRT WT 0.3-10 keV source binned hardness ratio*
grb051221a_xpcetsr.pha	XRT PC total source spectrum (including flares)
grb051221a_xpcetbg.pha	XRT PC total background spectrum
grb051221a_xpcet.arf	XRT PC total ancillary response file
grb051221a_xpcetsrtt.pha	XRT PC total source spectrum (excluding flares)
grb051221a_xpcetbgtt.pha	XRT PC total background spectrum
grb051221a_xpcetsrtt.arf	XRT PC total ancillary response file
grb051221a_xpcetsrt1.pha	XRT PC time interval 1 source spectrum
grb051221a_xpcetbgt1.pha	XRT PC time interval 1 background spectrum
grb051221a_xpcetsrt1.arf	XRT PC time interval 1 ancillary response file
grb051221a_xpcetsrt2.pha	XRT PC time interval 2 source spectrum
grb051221a_xpcetbgt2.pha	XRT PC time interval 2 background spectrum
grb051221a_xpcetsrt2.arf	XRT PC time interval 2 ancillary response file
grb051221a_xpcetsrt3.pha	XRT PC time interval 3 source spectrum (including flares)
grb051221a_xpcetbgt3.pha	XRT PC time interval 3 background spectrum
grb051221a_xpcetsrt3.arf	XRT PC time interval 3 ancillary response file
grb051221a_xwtetsr.pha	XRT WT source spectrum (including flares)
grb051221a_xwtetbg.pha	XRT WT background spectrum
grb051221a_xwtetsr.arf	XRT WT ancillary response file
grb051221a_xwtetsrtt.pha	XRT WT total source spectrum (excluding flares)
grb051221a_xwtetbgtt.pha	XRT WT total background spectrum
grb051221a_xwtetsrtt.arf	XRT WT total ancillary response file
grb051221a_xwtetsrt1.pha	XRT WT time interval 1 source spectrum
grb051221a_xwtetbgt1.pha	XRT WT time interval 1 background spectrum
grb051221a_xwtetsrt1.arf	XRT WT time interval 1 ancillary response file
grb051221a_xwtetsrt2.pha	XRT WT time interval 2 source spectrum
grb051221a_xwtetbgt2.pha	XRT WT time interval 2 background spectrum
grb051221a_xwtetsrt2.arf	XRT WT time interval 2 ancillary response file
grb051221a_xwtetsrt3.pha	XRT WT time interval 3 source spectrum (including flares)
grb051221a_xwtetbgt3.pha	XRT WT time interval 3 background spectrum
grb051221a_xwtetsrt3.arf	XRT WT time interval 3 ancillary response file

* These light curves have both the 0.3-2.0 keV and 2.0-10.0 keV binned light curves in them, as well as the hardness ratio.

Table 7: XRT Only GIF Products

	Filename	Description
grb051221a_xpwetsrcb_lc.gif		XRT PC/WT 0.3-10 keV source cal. binned light curve
grb051221a_xpwetsrfb_lc.gif		XRT PC/WT 0.3-10 keV source flux binned light curve
grb051221a_xpwetsrrb_lc.gif		XRT PC/WT 0.3-10 keV source hardness ratio binned
grb051221a_xpwetsrmb_lc.gif		XRT PC/WT 0.3-10 keV source best fit light curve
grb051221a_xpcetsri1.gif		XRT PC 0.3-10 keV image mosaic
grb051221a_xpcetsri3.gif		XRT PC 0.3-10 keV double diagonal image
grb051221a_xwtetsri1.gif		XRT WT 0.3-10 keV image mosaic
grb051221a_xwtetsri3.gif		XRT WT 0.3-10 keV double diagonal image
grb051221a_xpwetsrtt_ph.gif		XRT PC/WT total source spectrum (excluding flares)
grb051221a_xpwetsrt1_ph.gif		XRT PC/WT time interval 1 source spectrum
grb051221a_xpwetsrt2_ph.gif		XRT PC/WT time interval 2 source spectrum
grb051221a_xpwetsrt3_ph.gif		XRT PC/WT time interval 3 source spectrum

Table 8: BAT Only Products

		FITS Products
	Filename	Description
grb051221a_bbaetsrn_lc		BAT 15-350 keV source net light curve
grb051221a_bbae1srn_lc		BAT 4-channel source net light curve
grb051221a_bbae2srfb_lc		BAT 0.3-150 keV Multi-band flux BAT-block light curves
grb051221a_bppetsr_ph		BAT 15-350 keV 80-channel Pre-Pre-slew source spectrum
grb051221a_bppetsr_rsp		Response matrix for Pre-Pre-slew
grb051221a_bpsetsr_ph		BAT 15-350 keV 80-channel Pre-slew source spectrum
grb051221a_bpsetsr_rsp		Response matrix for Pre-slew
grb051221a_bisetsr_ph		BAT 15-350 keV 80-channel In-slew source spectrum
grb051221a_bisetsr_rsp		Response matrix for In-slew
grb051221a_basetsr_ph		BAT 15-350 keV 80-channel After-slew source spectrum
grb051221a_basetsr_rsp		Response matrix for After-slew
grb051221a_bbaetsr_ph		BAT 15-350 keV 80-channel Total source spectrum
grb051221a_bbaetsr_rsp		Response matrix for Total
		GIF Products
	Filename	Description
grb051221a_bbaetsrn_lc.gif		BAT 15-350 keV source net light curve gif
grb051221a_bbae1srn_lc.gif		BAT 4-channel source net light curve gif
grb051221a_bppe2srp_ph.gif		BAT 15-150 keV Pre-Pre-slew source spectrum (power-law)
grb051221a_bppe2src_ph.gif		BAT 15-150 keV Pre-Pre-slew source spectrum (cutoff power-law)
grb051221a_bpse2srp_ph.gif		BAT 15-150 keV Pre-slew source spectrum (power-law)
grb051221a_bpse2src_ph.gif		BAT 15-150 keV Pre-slew source spectrum (cutoff power-law)
grb051221a_bise2srp_ph.gif		BAT 15-150 keV In-slew source spectrum (power-law)
grb051221a_bise2src_ph.gif		BAT 15-150 keV In-slew source spectrum (cutoff power-law)
grb051221a_base2srp_ph.gif		BAT 15-150 keV After-slew source spectrum (power-law)
grb051221a_base2src_ph.gif		BAT 15-150 keV After-slew source spectrum (cutoff power-law)
grb051221a_bbae2srp_ph.gif		BAT 15-150 keV Total source spectrum (power-law)
grb051221a_bbae2src_ph.gif		BAT 15-150 keV Total source spectrum (cutoff power-law)
grb051221a_bbaetsri1.gif		BAT 15-350 keV Pre- and Post-slew source image gif

Table 9: UVOT Only Products

		FITS Products
	Filename	Description
	grb051221a_uuvetsrab_lc	UVOT All filter source binned light curves
		GIF Products
	Filename	Description
	grb051221a_uuvetsri1.gif	UVOT optical source image
	grb051221a_uuvetsri2.gif	UVOT optical source finding chart image
	grb051221a_uuvetsrfb_lc.gif	UVOT optical source flux light curves
	grb051221a_uuvetsrmb_lc.gif	UVOT optical source magnitude light curves

Table 10: XRT and BAT Combined Products

		GIF Products
	Filename	Description
	grb051221a_mxbetsrfb_lc.gif	XRT + BAT 0.3-10 keV source flux binned light curve
	grb051221a_mxbe3srfb_lc.gif	XRT + BAT 2.0-10 keV source flux binned light curve

4 Example Plots

4.1 XRT Plots

Figure 1 shows the plotted XRT PC and WT mode corrected count rate, flux and hardness ratio light curves for GRB 090618. This figure also contains the fitted XRT light curve, which is used to extract and fit spectra from up to three epochs. Figure 2 shows the extracted and fitted spectra from each fitted epoch, and the total fitted spectra. Figure 3 shows the plotted XRT PC and WT images and image mosaics for GRB 090618.

4.2 BAT Plots

Figures 4 through 7 show typical BAT only plots. Figure 4 shows the BAT light curve plots. Figure 5 shows the BAT spectral plots with a power-law model fit. Figure 6 shows the same, but with an exponential cutoff model fit. And Figure 7 shows the pre- and post-slew BAT burst images.

4.3 UVOT Plots

Figure 8 shows the flux converted light curves for GRB 090618, and the magnitude light curves for the same source. Figure 9 shows the highest signal to noise image from the UVOT, and the UVOT finding chart image for GRB 090618.

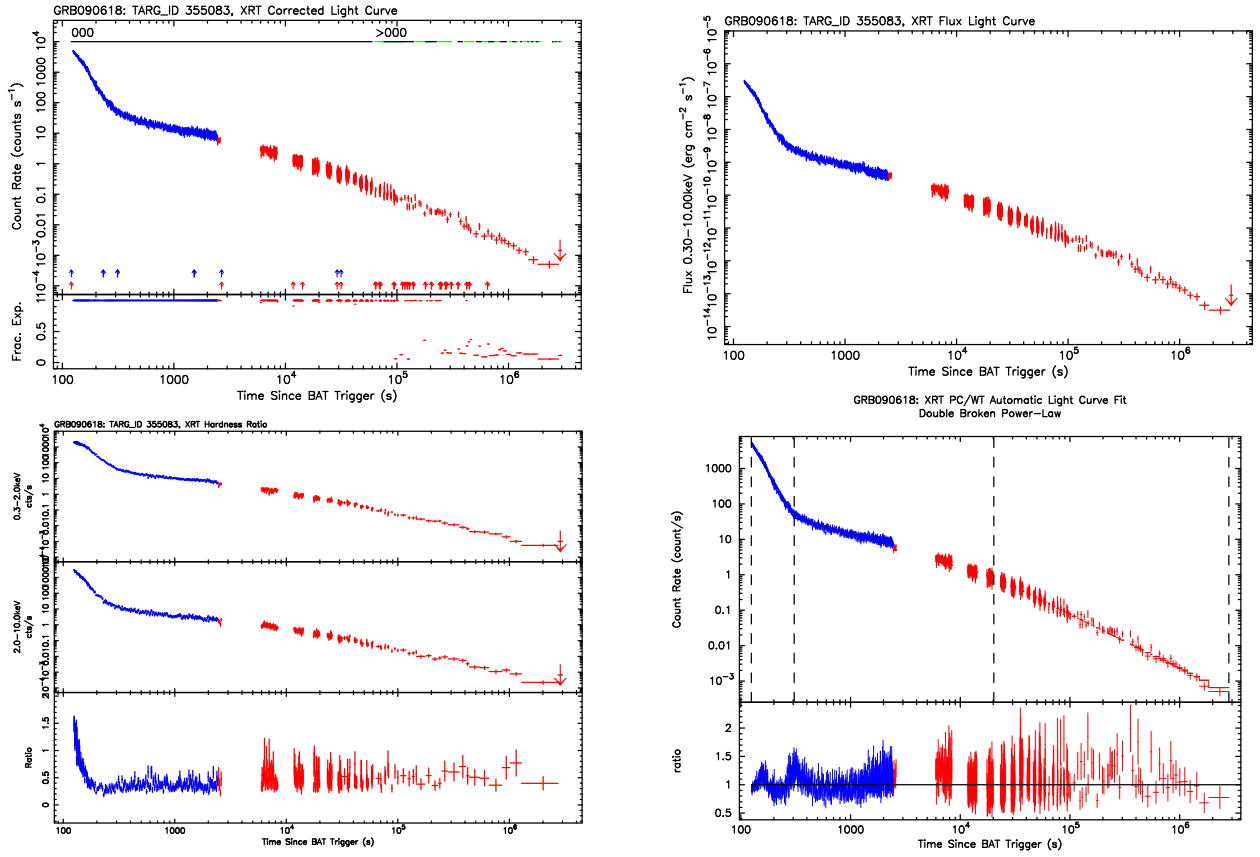


Figure 1: *Clockwise from top left:* GRB 090618 XRT PC and WT mode corrected rate light curves; Flux light curves; Modelled light curve – dashed lines show fitted time breaks; 0.3-2.0 keV light curves, 2-10 keV light curves, and hardness ratios.

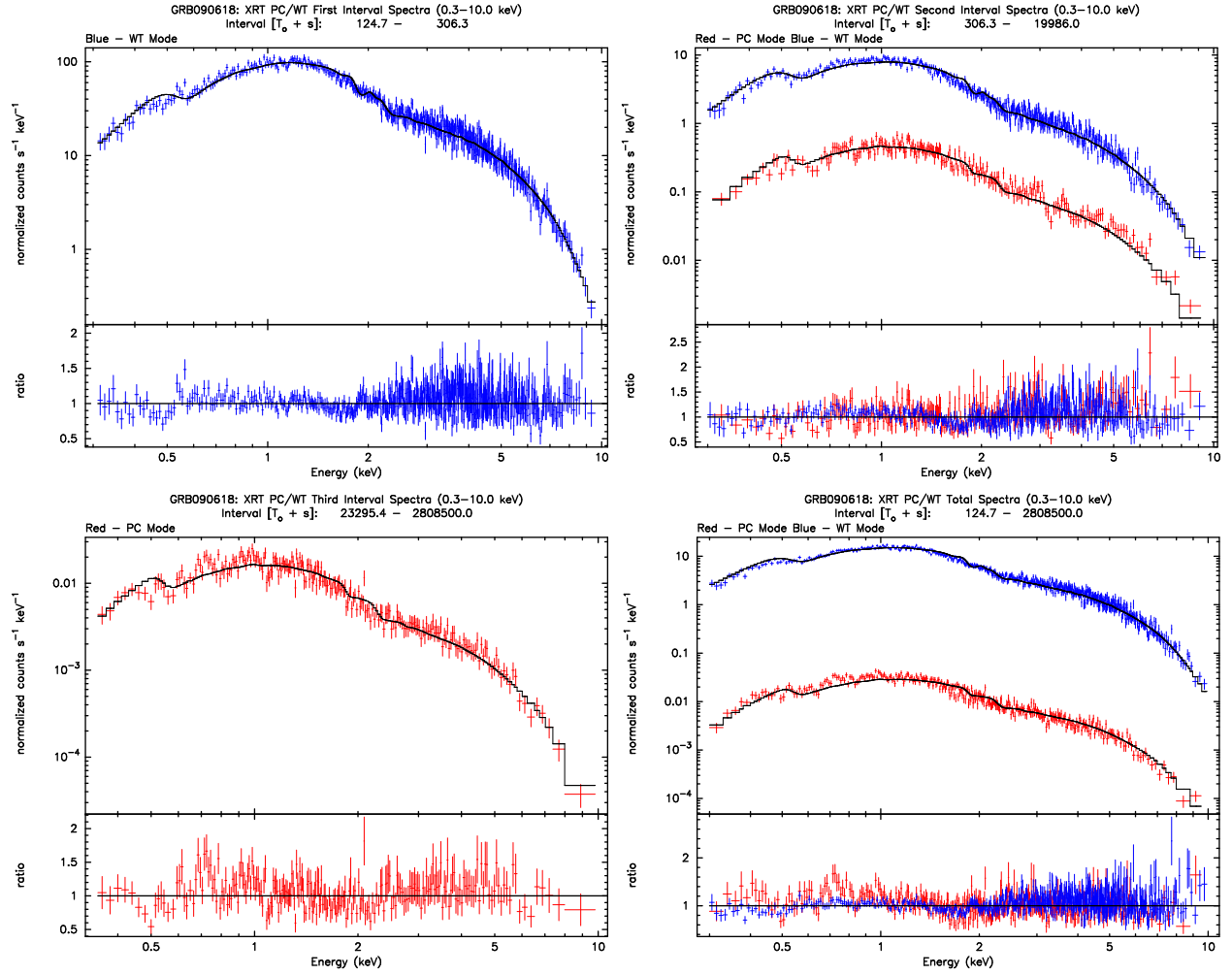


Figure 2: *Clockwise from top left:* GRB 090618 XRT PC and WT mode spectrum from the first time interval (see bottom right panel of Figure 1); Second time interval spectra; Third time interval spectra; Total spectrum

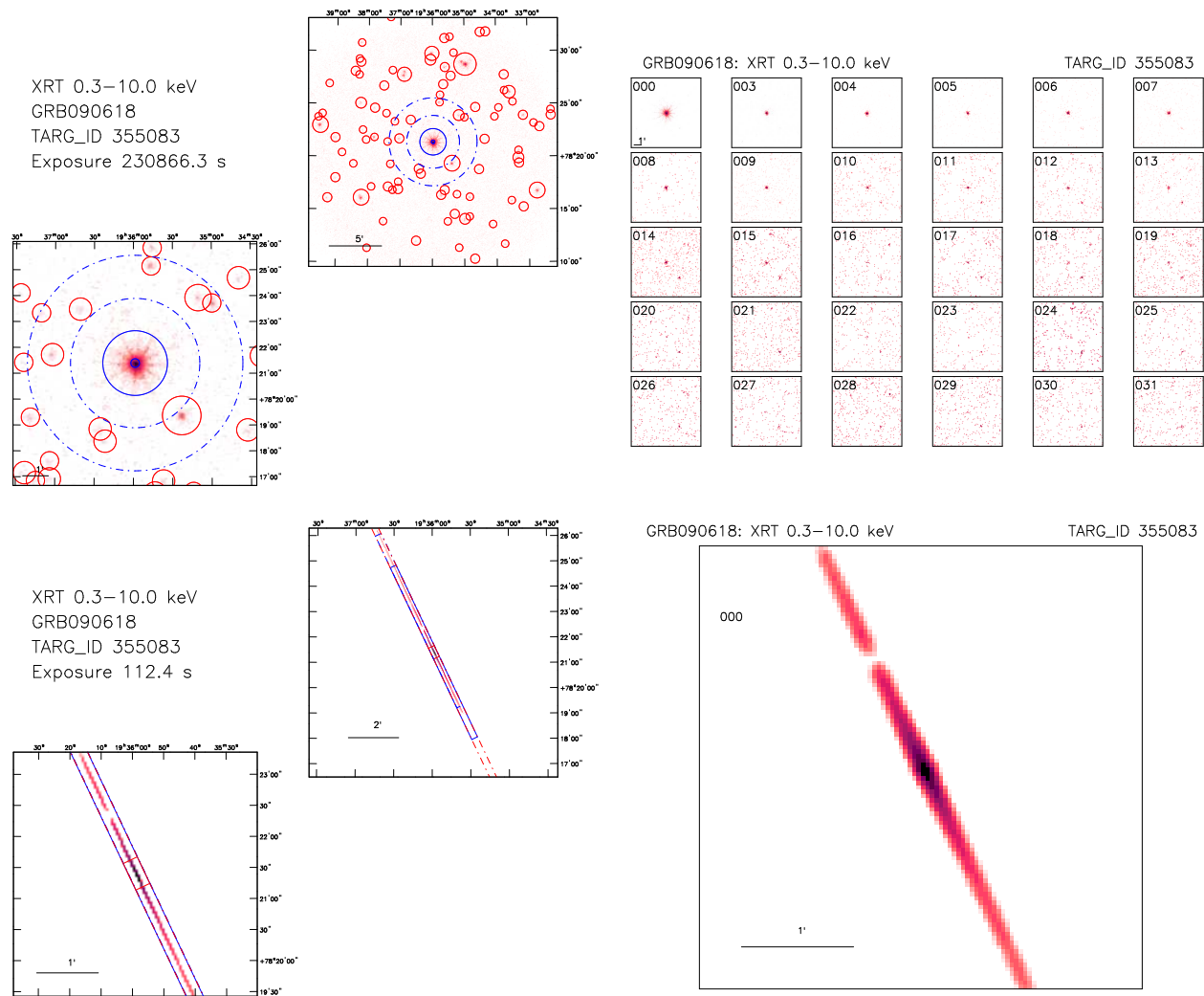


Figure 3: *Clockwise from top left:* GRB 090618 XRT PC double image; Per-segment XRT PC image mosaic; Per-segment XRT WT image mosaic; XRT WT double image

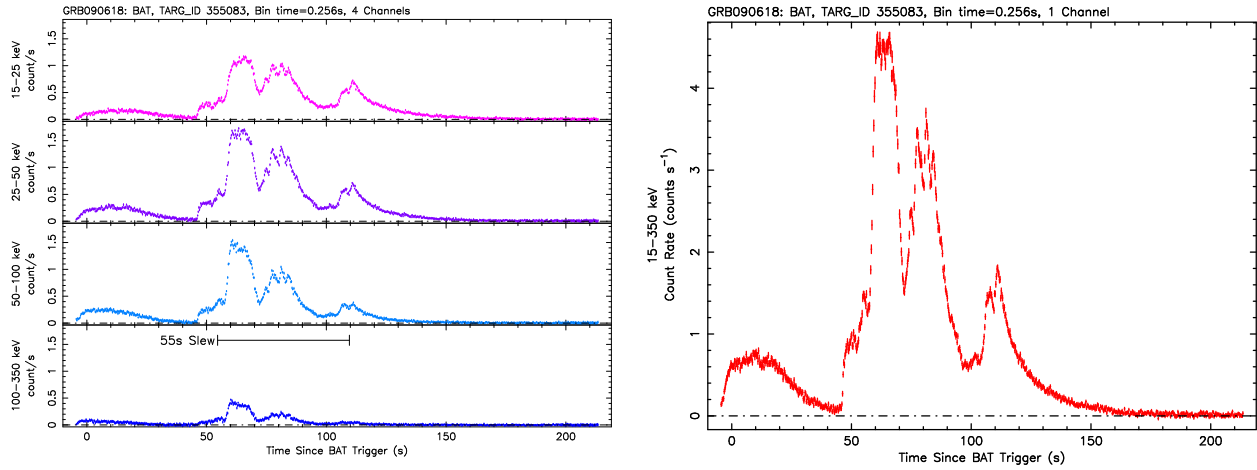


Figure 4: *Left*: GRB 090618 4-channel BAT constant time bin light curves. The energy band of each light curve is in shown in the upper right corner of each panel. *Right*: GRB 090618 1-channel (15-350 keV) BAT constant time bin light curve.

4.4 Combined BAT/XRT Plots

Figure 10 shows the combined BAT and XRT flux converted light curve plots for GRB 090618.

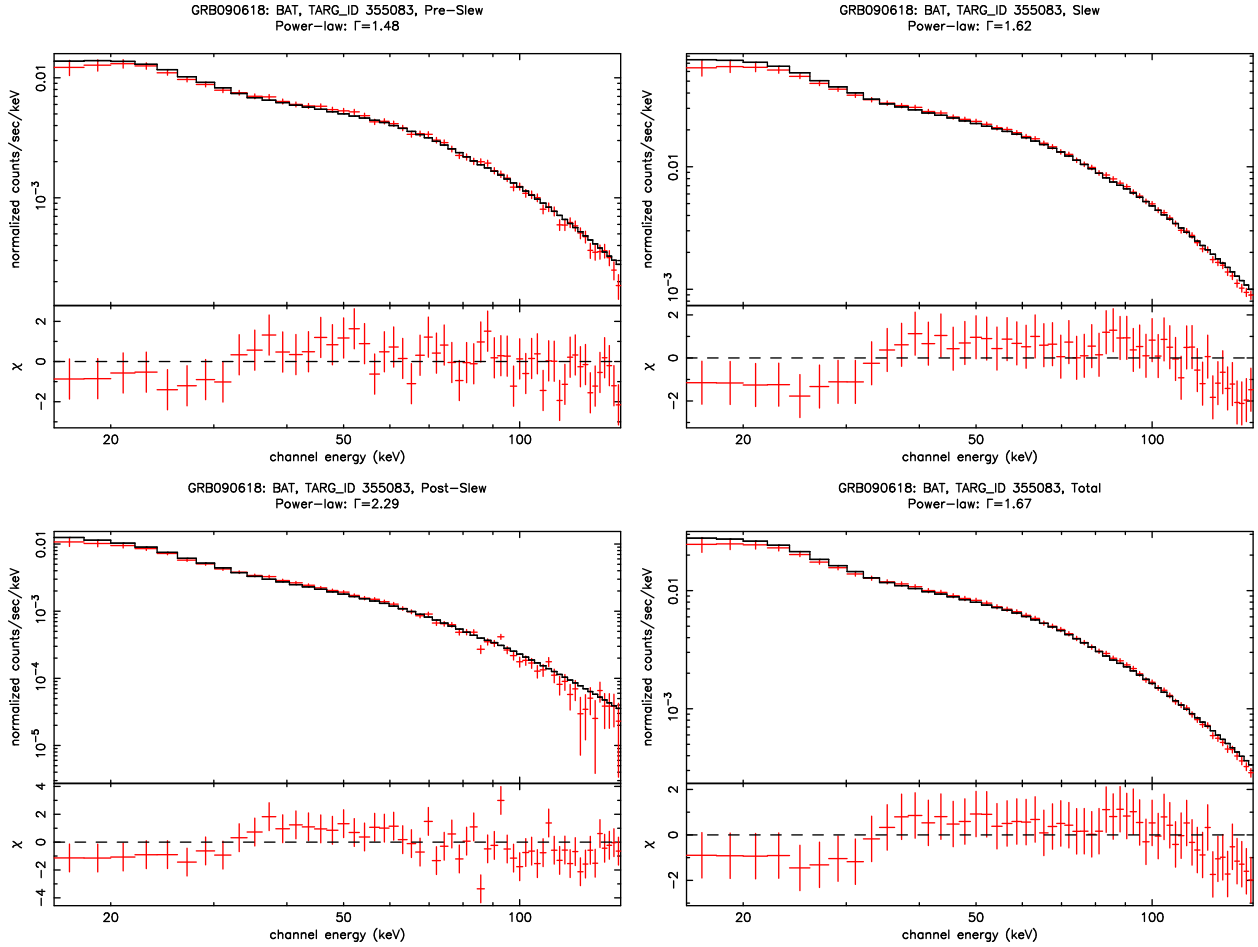


Figure 5: *Clockwise from top left:* GRB 090618 BAT pre-slew spectrum fitted with a simple power-law model normalized at 50 keV. GRB 090618 BAT slew spectrum fitted with the same model. GRB 090618 BAT post-slew spectrum fitted with the same model. GRB 090618 total BAT spectrum fitted with the same model.

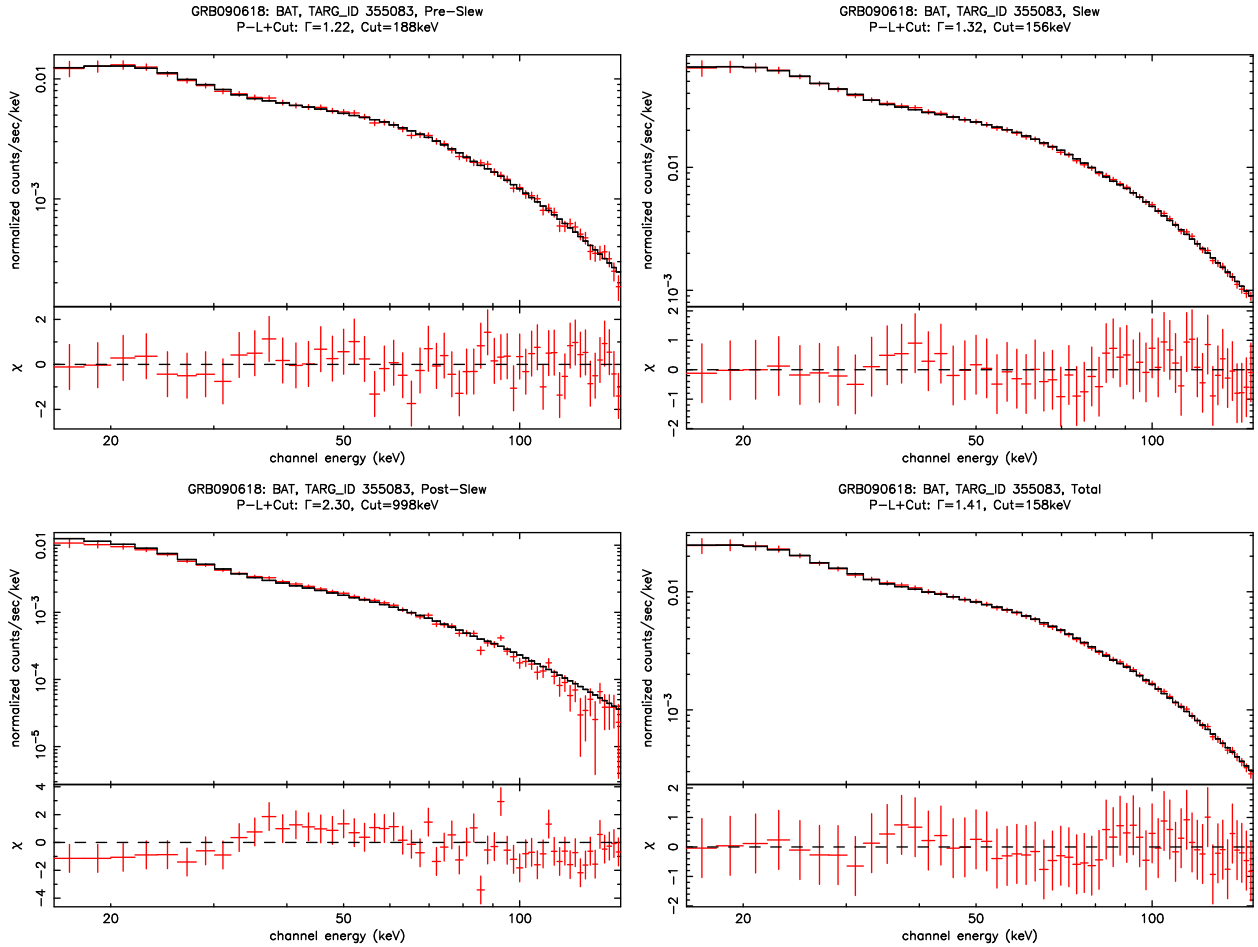


Figure 6: *Clockwise from top left*: GRB 090618 BAT pre-slew spectrum fitted with an exponential cut-off power-law model normalized at 50 keV. GRB 090618 BAT slew spectrum fitted with the same model. GRB 090618 BAT post-slew spectrum fitted with the same model. GRB 090618 total BAT spectrum fitted with the same model.

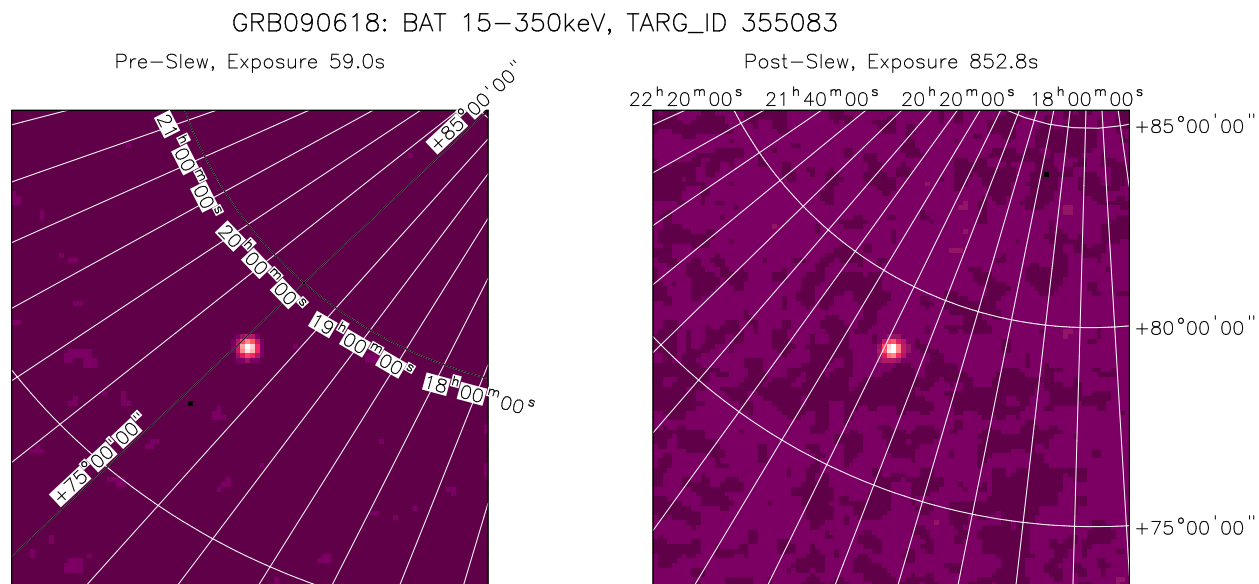


Figure 7: *Left:* GRB 090618 BAT pre-slew image of the GRB field-of view. *Right:* GRB 090618 BAT post-slew image.

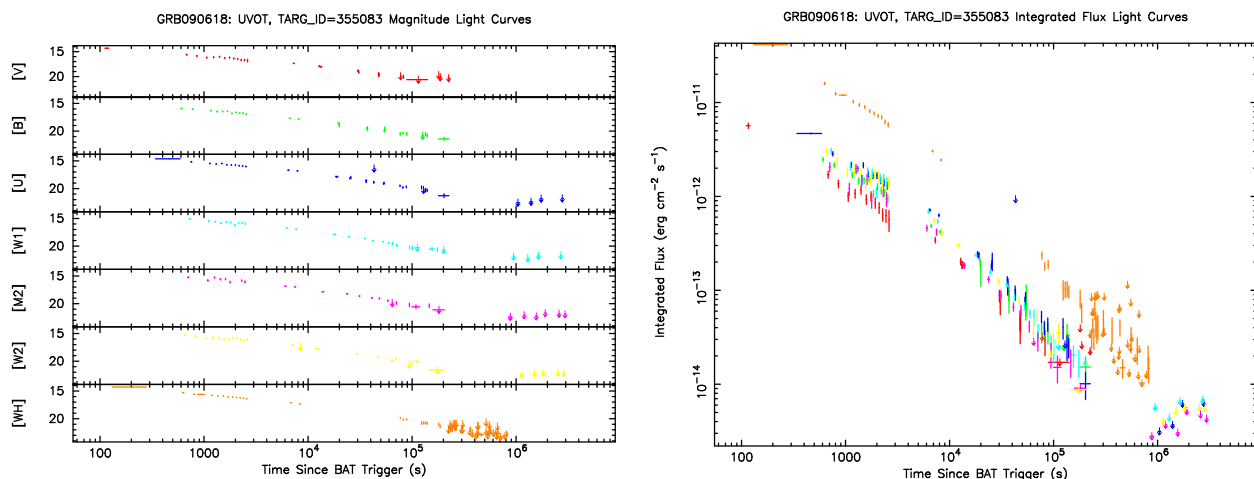
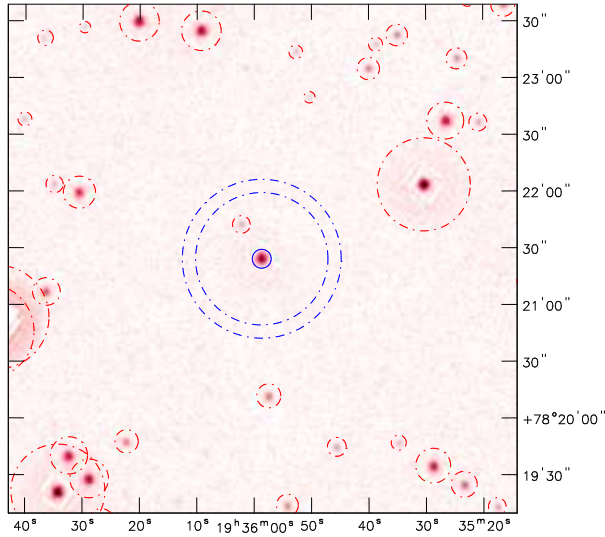


Figure 8: *Left:* GRB 090618 UVOT integrated flux light curves. *Right:* GRB 090618 UVOT magnitude light curves.

GRB090618: UVOT, TARG_ID=355083, Highest S/N Image
 OBS_ID=00355083000, FILTER=WHITE



GRB090618: UVOT, TARG_ID=355083, Finding Chart Image
 OBS_ID=00355083000, FILTER=V, EXPID=267006625

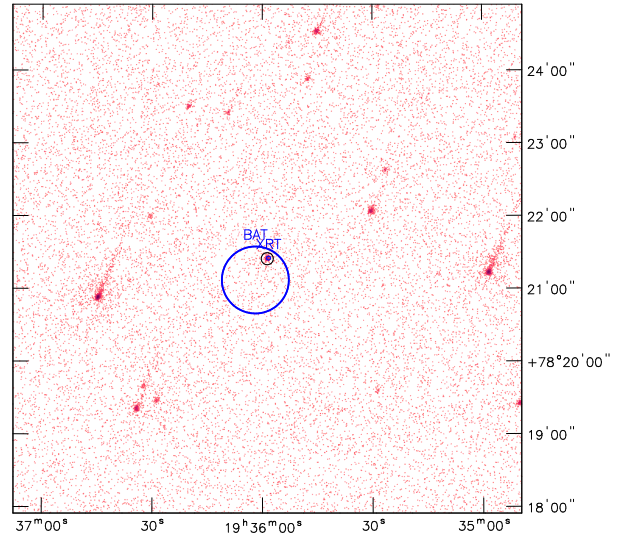


Figure 9: *Left*: GRB 090618 UVOT highest signal to noise image. *Right*: GRB 090618 UVOT finding chart image.

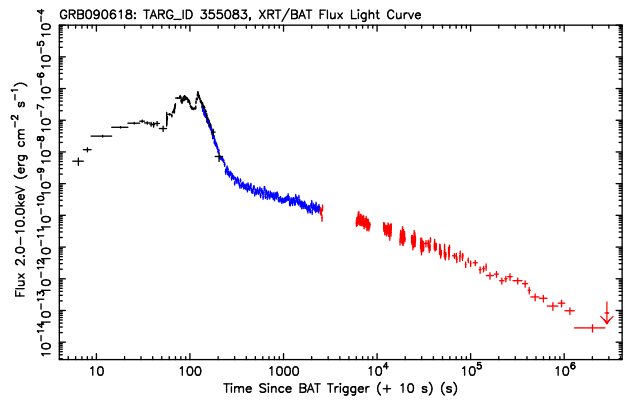
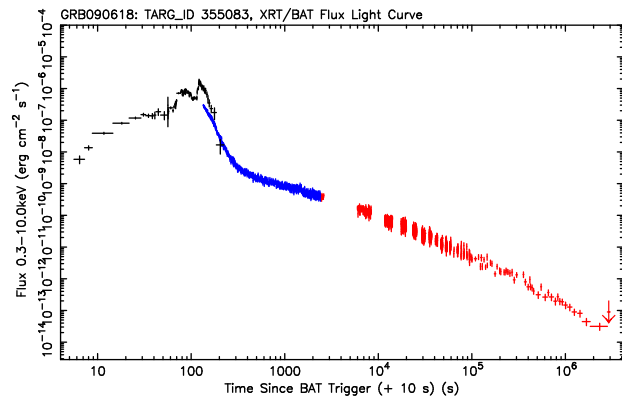


Figure 10: *Left*: GRB 090618 BAT and XRT flux converted light curves in 0.3-10 keV. *Right*: GRB 090618 BAT and XRT flux converted light curves in 2-10 keV.