

# Guide to the *Swift* archive

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# Chapter 1

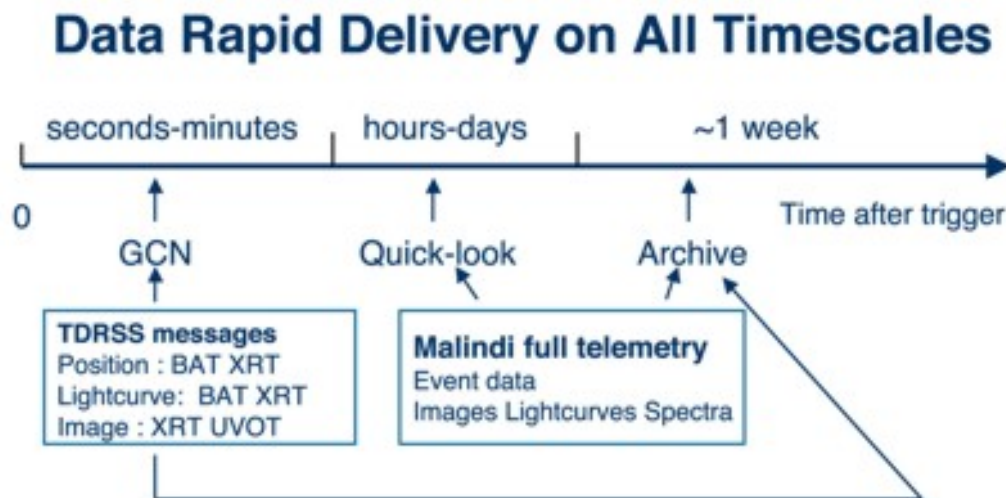
## Archive

This guide describes the contents and organization of the *Swift* archive.

### 1.1 Where and when the data are available

The Swift data will be quickly available to the community. The first-look data from the three Swift instruments for a newly discovered GRB and its afterglow are transmitted to the ground via TDRSS. The complete telemetry (including the messages transmitted via TDRSS) is subsequently sent down via the Malindi ground station. There are about 6-7 dumps to Malindi per day and these data are processed and put on-line in the quick-look area within a day. The final merged data are moved over to the main archive about a week after the end of the GRB observation. The timeline showing when the various types of data are available is shown in the following figure.

Figure 1.1: Swift data availability timeline



The three instruments on board Swift, the Figure of Merit (FoM) software, and the on-board command and data handling (C& DH) system, all generate a series of messages for each BAT trigger which are transmitted to the ground using TDRSS. For each trigger, the number of messages that are sent down depends on whether or not the trigger is confirmed by the BAT image processor, and whether or not the observatory slews to the new GRB so it can be observed by the XRT and UVOT. These messages are broadcast via the Gamma-Ray Burst Coordinates Network (GCN) as

soon as they arrive on the ground, and later included in the archive. If users want to be notified of these alerts, they should enrol in the GCN (<http://gcn.gsfc.nasa.gov>). The processing of the data telemetered to Malindi occurs at the Science Data Center (SDC), which produces both the quick-look and the final archive data. Quick-look data are produced after each Malindi dump. This typically results in the same observation (see Chapter 2) being reprocessed several times as new data arrive to fill in any gaps. After each processing, the data are made publicly available within a few hours on the SDC's Quick Look facility.

When an observation is complete, the data flow through the processing pipeline one final time to produce data for the final archive. Therefore, the data for the final archive are generated by the same pipeline and software used for the quick-look data.

When no new processing has occurred on a particular observation for one week, the data are moved from the SDC's Quick Look Facility to the Swift Archive at the HEASARC and the other European archive centers in Italy and UK, and then removed from the Quick Look Facility. Users should be aware that the quick-look data for a given observation may not be complete, especially the early dumps of an observation, and that the contents may change when and if subsequent telemetry dumps arrive.

## 1.2 Overview of the Swift archive

The Swift archive contains all the information, data and software which are needed to analyze Swift data. The Swift archival data are divided into six main areas, which are all populated on different timescales:

### 1.2.1 Observation data

The Swift data are divided into observations which are identified by a specific sequence number. For each observation, the archive will contain the data generated by the final processing pipeline. The data for an observation include the telemetry converted into FITS format with minimum processing (Level I), the calibrated and filtered data (Level II), and the results from the standard analysis carried out on the Level II data (Level III). The latter category provides a quick overview for each GRB/afterglow observation, and includes BAT light curves in several energy bands and spectra, XRT images, spectra and light curves, and UVOT integrated color images. All data are in FITS format and follow the OGIP standards for high-energy astronomy data. In addition to the FITS files, each observation includes GIF plots which preview the FITS products, and an HTML file which records the processing history. The observation data populate the archive from the start (see the section on the Swift data proprietary period), and is used to create additional catalogs and data products.

### 1.2.2 TDRSS messages

As mentioned in the previous section, the TDRSS messages also form part of the Swift archive. The messages will be converted into FITS, and the long messages will also be processed in order, for example to reproject the images from the XRT and UVOT and the UVOT finding chart into sky coordinates. The TDRSS data populate the archive immediately after processing by the SDC.

### 1.2.3 Trend and Monitoring data

This data set is created as part of the reformatting process of the Malindi data into FITS, and may include files containing monitoring information on specific instrument parameters, or some telemetered data which may not be strictly relevant to the science data. The trend data are organized in directories, each dedicated to a data type, such as background files.

### 1.2.4 Archival calibration data

The calibration data necessary for data analysis are available in the calibration database (CALDB). The Swift instrument teams have the responsibility of providing the results of their calibration efforts to the Science Support Center (SSC), accompanied by the proper documentation. The files are delivered in FITS format, and follow the recommended CALDB standards. The SSC then delivers the calibration data to the HEASARC and the other data centers in a form suitable for inclusion in the CALDB area. CALDB is populated every time new CALDB files become available or in conjunction with the software releases, if the files impact the software.

### 1.2.5 GRB Summary products

A typical GRB/afterglow will be followed up in several observations, depending on the brightness of the afterglow in the optical through X-ray regions. In order to give a standard overview of the GRB and its afterglow evolution, summary products will be systematically generated by a processing run at the HEASARC once the afterglow has faded away. These products will include all of the data from the three Swift instruments which are available in the archive. These data sets will start being populated into the Swift public area when software and products mature.

### 1.2.6 BAT, XRT, and UVOT surveys

Each of the instruments will conduct a survey in their respective energy bands. These surveys will contain information about the serendipitous sources found in the FOV of the three instruments while following GRB afterglows. While the XRT and UVOT will cover only a small fraction of the sky, the survey results for the BAT will effectively form an all-sky survey. Each instrument will produce a source catalog and derived data products, and, depending on the instrument, these will be either associated with individual sources and/or with the FOVs. Each survey will be conducted by combining the appropriate data for that instrument. The analysis of the BAT survey will be performed on a number of different timescales. Data products and catalogs from the XRT, UVOT and BAT will begin to populate the Swift archive after the first year of the mission. The XRT survey is being conducted by ISAC, the BAT survey by the BAT team at GSFC and LANL, and the UVOT survey by the UVOT team members at MSSL.

## 1.3 Database tables

Database tables recording high level information on the observation are used to browse the data. There is one general table and one specific table for each of the instruments describing the specific modes used during the observation. There is also a table dedicated to the TDRSS messages which includes most of the TDRSS messages content.

## **1.4 Proprietary Data Rights**

There are no proprietary rights for any of the data obtained by the Swift Observatory. All data will be released to the community as soon as it has been processed by the SDC. The only exception to this was during the initial activation and verification phase of the spacecraft and instruments operation. The verification phase lasted approximately 4.5 months starting from launch.

## Chapter 2

# Observation definition

### 2.1 Observation definition

The typical Swift observing strategy for a Gamma Ray Burst (GRB)/afterglow consists of a cluster of ‘snapshots’ (defined below) which are aimed to follow the GRB and its afterglow evolution. Soon after an event is triggered by the BAT, the Figure of Merit (FoM) algorithm, part of the observatory software for autonomous operations, decides if it is worth requesting a slew maneuver in order to point the narrow field instruments (NFIs) on Swift (XRT and UVOT) in the direction of the trigger. The initial follow-up is automatically set at the spacecraft level, i.e., the FoM initiates the observation using a standard configuration of modes and filters for the NFIs. These types of observation are named Automatic Targets (ATs). Observations of GRBs can be also triggered by ground commands based on observations made by other satellites. Once the trigger has occurred (based either on Swift or other satellites), a monitoring schedule is planned and uploaded from the ground. The monitoring of the GRB/afterglow will typically be initiated as soon as possible after its detection and will last until the afterglow reaches a specified minimum flux or until a specified time interval has elapsed. It is also possible that the follow-up of a particular trigger may be abandoned by Swift because other targets are deemed to be more interesting.

- The minimum unit of time spent on a target is called a **snapshot**. This is defined as the time interval spent observing the same position continuously. Because of observing constraints, the length of a snapshot will be shorter than a single orbit ( $\sim 95$  minutes). The snapshot can be interrupted either because of a new intervening trigger or because the time allocated to it expires. Instrument configurations, such as mode and/or filter, can change during a snapshot.
- An **observation** is a cluster of snapshots designed to carry out a particular set of scientific goals via a series of instrument mode configurations. Given the nature of the NFIs, this will almost always be a sequential, but not necessarily continuous, set of snapshots of the same target. During the first 10 months into the mission the roll angle within an observation was kept constant. After mid September 2005 the roll angle changed by  $\pm 2$  deg for each snapshot, therefore this is no longer constant within an observation. An observation will usually be interrupted by observation of other targets (for example an AT) or because of the observing constraints of the NFIs. The length of an observation can vary. However, to allow for quick delivery of data to the community, an observation has a duration which is limited in time to a maximum of 2 days. An observation is archived only when all the data for that observation are available.



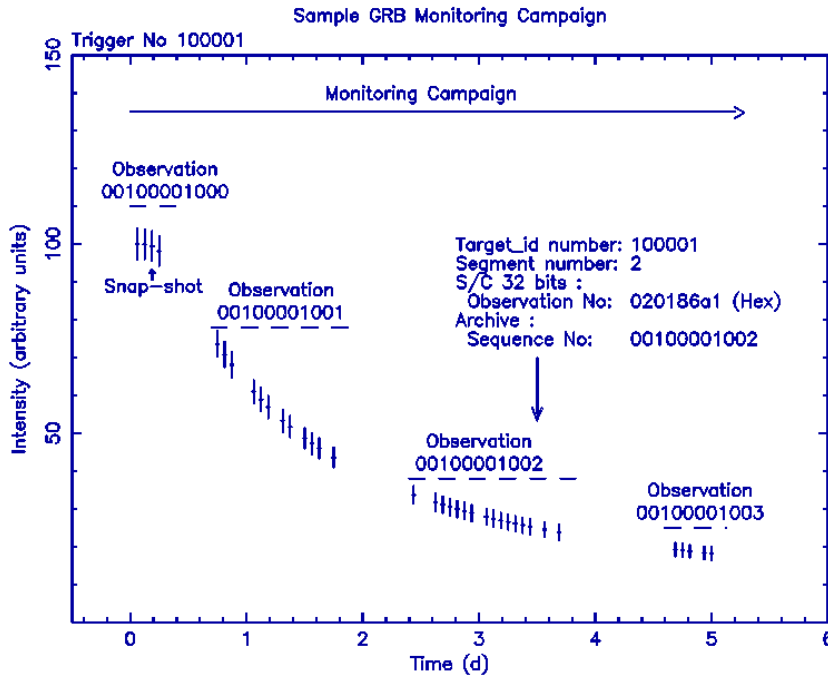


Figure 2.1: GRB Monitoring

- Depending on the evolution of the flux in the different energy ranges, the sensitivity of each instrument, and the required science, the same target may have several observations made of it over the course of a number of days or weeks. The complete collection of observations on a specific target is referred to as the **monitoring campaign**. The spacecraft roll angle can differ between the observations which form part of a monitoring campaign. There is no maximum time set for the monitoring of a target nor for the number of observations per target. However, it is expected that, in most cases, a GRB target will be monitored for about a month.

## 2.2 Target Id, Observation segment and Sequence number

The onboard software tags the data using two numbers. The first number identifies the target which is being observed, hereafter the Target ID, and this, therefore, is unique for each object. The second number identifies the observation which forms part of the monitoring campaign on a specific target, hereafter the Observation Segment. The Target ID is a 24-bit number, and the Observation Segment is an 8-bit number. The instruments will tag their science data in the telemetry with a 32-bit number where the most significant 8-bits represent the Observation Segment, and the least significant 24 bits are the Target ID. This representation is hereafter named the Observation Number, and is given as a HEX value. The Swift data are tagged sw (Swift) with an eleven digit Sequence Number, which is equivalent of the observation number expressed in decimal format. The Sequence Number is a concatenation of the Target ID (the first 8 digits, in decimal format) and the Observation Segment (the last 3 digits, in decimal format). The Sequence Number will be present as a parameter in all database tables associated with Swift data and in the as-flown timeline as well. The number allocation for the target Id follows the scheme :

0	Reserved for the spacecraft: safhold or spacecraft fails to assign a number
1-6	Used for safe pointings
1000-9999	Unassigned
10000-19999	Reserved for the BAT catalog (known sources)
20000-29999	GRBs from other missions or discovered from ground analysis of BAT data
30000-34999	Non-GRB observations, TOO and other targets uploaded from the ground
35000-39999	Fill-in targets uploaded from the ground
40000-49999	Reassigned targets for safe pointing. The reassignment occurs on ground to remove the degeneracy of the several sky positions used for safe pointing for which only 6 target id are allocated on board
50000-59999	Calibration observation performed during the mission. The calibration targets can be already included in other subgroups of target id
60000-64999	Non Science observation. Allocated to use by the SDC
65000-68999	Non Science observation. Allocated to use by the SOT In the PPT
69000-69999	Non Science observation. Allocated to use by the FOM during FOM activation.
70000-70999	Non Science observation. Allocated to use by the SOT In the PPT
71000-73999	Pre-launch calibration 'observation' (Not relevant for flight data but reported for completeness)
74000-79999	Non Science observation. Allocated to use by the SOT In the PPT
80000-89999	Unassigned
90000-99999	Target ID reserved for Guest Investigator observations
1000000-16777214	BAT trigger. Target ID is assigned to every BAT trigger even if they are judged on board not to be good GRBs. These numbers are also used for triggers of new non-GRB BAT transients, or if flux variations of a known source already in the BAT catalog generate a trigger. Subsequent PPT observations on these sources will use the same target ID.

The segment number has the following values :

- 0 Used for the first observation on a target initiated on board (AT) or a TOO initiated from the ground
- 1-255 Reserved to subsequent PPT observations of a target.
- 256-999 Reserved to the safe pointing targets which target ID is reassigned on ground. These values are therefore only valid for the target ID in the 40000-49999 range.

Using the above prescription, for a target ID of 100001 and an observation segment of 2 the sequence number associated to an observation is therefore

00100001002

Typically, at any time all three instruments will tag their data with the same observation/sequence number. However, this may not be true around the time of a trigger and will depend on whether or not the spacecraft slews to observe the newly discovered target. While the BAT will always produce data tagged with the target ID associated with the newly discovered source, the NFI will tag the data with the target ID of the newly discovered source only if the spacecraft slews to the new target. If there is no slew, the BAT will change its observation number to agree with that of

the NFI after its has run the modes used when a new target is discovered. Figures 2 and 3 show how sequence numbers are assigned to the data in the case of slew (Fig 2.2) or no-slew (Fig 2.3), respectively.

Figure 2.2: Sequence number assignment when a trigger is followed by a slew

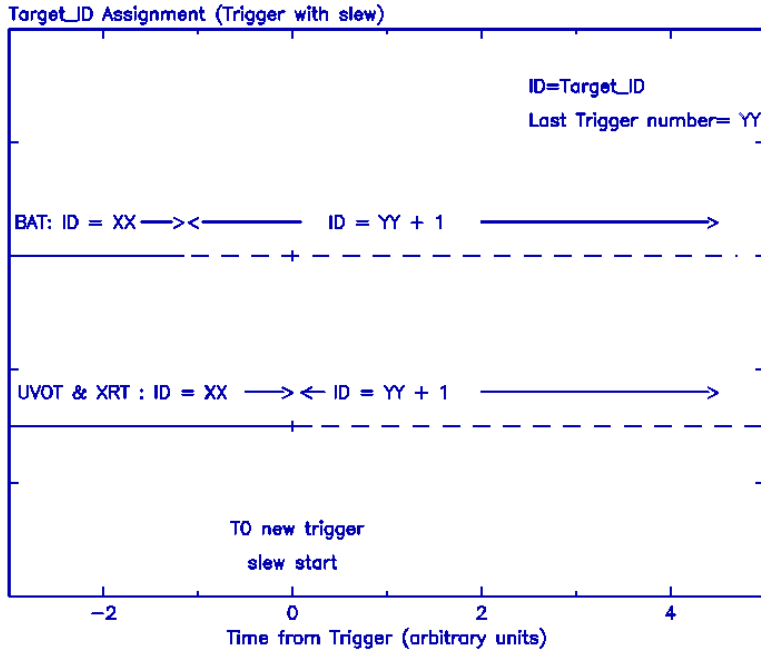
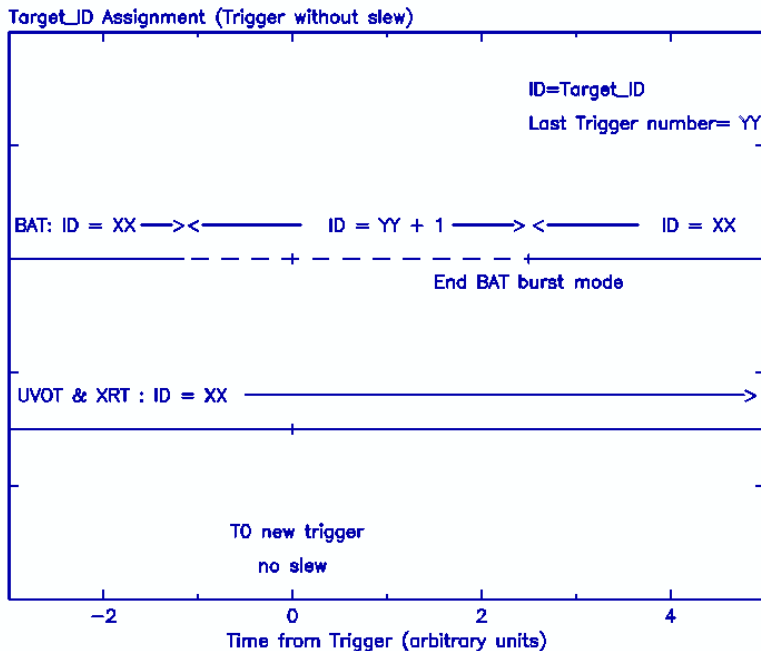


Figure 2.3: Sequence number assignment when a trigger is not followed by a slew



Therefore, in the no-slew case, the observation will only contain data from the BAT, with none from the NFI.

# Chapter 3

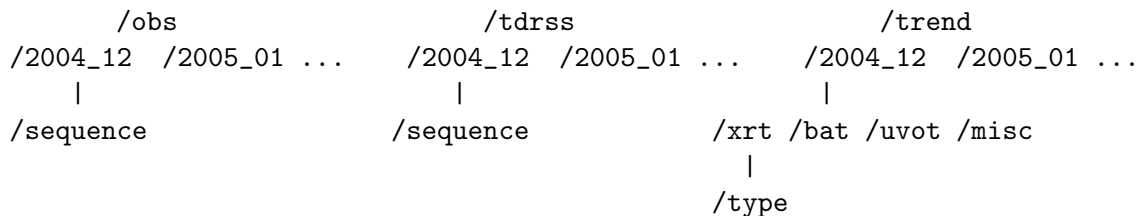
## Archive structure

### 3.1 Data organization

Each of the data sets that comprise the Swift archive are organized in distinct directories as follows:

- **obs** : contains the Swift data telemetered from the Malindi ground station and processed on the ground at the Swift Data Center. These data are organized by sequence number, each corresponding to an observation.
- **tdrss** : contains the first response to the trigger sent to the ground via TDRSS. Both false and good trigger are included. These data are organized by sequence number, however they do not necessarily correspond to an observation as for example false triggers.
- **trend** : contains instrument monitoring data telemetered from the Malindi ground station and derived trend data. These data are organized by instrument first, with subdirectories each containing a specific type of data.

To limit the number of files in each of the above directories, data are subdivided in intervals of one months and organized within these as described above. The time interval directories are named YYYY\_NN, where YYYY is the year and NN defines the month within that year.



The results of the surveys and the derived GRB products will be located in separate dedicated directories and will be documented here after these data start to arrive in the archive.

### 3.2 The 'obs' data directory structure

The science data are located under the **/obs** main directory. Each sequence is divided into the following subdirectories :

- **/auxil** : contains files common to all instruments such as attitude and orbit as well as a catalog listing all the files present in the sequence.
- **/log** : contains html files reporting logs on the data processing. item **/bat** : contains all the science and HK files related to the BAT instrument. The data within are further sub-divided into directories related to the data mode and file types.
- **/uvot** : contains all the science and HK files related to the UVOT instrument. The data within are further sub-divided into directories related to the data mode and file types.
- **/xrt** : contains all the science and HK files related to the XRT instrument. The data within are further sub-divided into directories related to the data mode and file types.
- **/tdrss** : contains the science TDRSS messages related to the data included in the sequence.

The **/auxil** and **/log** directories are always present for every sequence. The others may or may not be present, depending on the observation type and/or whether or not the instrument was generating data during a specific observation. Specifically the **/tdrss** directory is typically present only in AT observations, however it may also be present in some calibration PPT observations. Sequences related to triggers that do not generate a slew will contain only data in the **/bat** directory but not in the **/xrt** and **/uvot** directories.

Each of the instrument directory is subdivided in subdirectories. For the **/xrt** and **/uvot** directories there are :

- **/event** : contains Level 1 and Level 2 files of science data corresponding to data modes that use event FITS file as their format.
- **/image** : contains Level 1 and Level 2 files of science data corresponding to data modes that use image FITS file as their format.
- **/hk** : contains housekeeping files related to the specific instrument.
- **/products** : contains all the high-level products derived from the science files. These are lightcurves and spectra of the targetted source, and images of the entire FOV. They are provided as FITS files with their plots as a GIF.

The **/bat** directory structure instead includes the following directories:

- **/event** : contains Level 1 (and Level 2) files of science data corresponding to the data mode that use event FITS file as their format. This directory is typically present when there is an AT observation.
- **/survey** : contains Level 1 and Level 2 files of science data corresponding to the BAT survey mode. The FITS format files contain a two-dimensional array giving an 80-channel spectrum for each detector.
- **/rate** : contains the science data corresponding to the BAT rate modes, e.g. lightcurves from different parts of the detector array. They use a lightcurve FITS format to store the multi-channel counts.
- **/pulsar** : contains the science data corresponding to the BAT pulsar mode.

- **/masktag** : contains the science data corresponding to the BAT masktag mode. During an observation the BAT can 'tag' the temporal behaviour of individual sources. Typically, one of the sources is the latest GRB observed, and the others are taken from the BAT on-board catalog. These data use a FITS lightcurve format to store the multi-channel counts.
- **/hk** : contains the housekeeping files related to the specific instrument.
- **/products** : contains all of the high-level products derived from the science files. These are the lightcurves and spectra of the main source, and the images of the entire FOV. They are provided in FITS format and with their plots as GIF files.

The directory structure for a sequence that includes all of the instruments is the following :

```

                /sequence
                |
/auxil  /log  /bat  /uvot  /xrt  /tdrss

```

With the **/bat**, **/xrt**, and **/uvot** directories beeing further subdivided into :

```

                /bat
                |
/event /survey /pulsar /rate /hk /masktag /products

                /xrt
                |
/event /image /hk /products

                /uvot
                |
/event /image /hk /products

```

### 3.3 The 'tdrss' and 'trend' directory structure

The data under the sequences in the **/tdrss** or **/trend** main directories are not subdivided into directories and therefore data files are directly stored under each **/tdrss** sequence or **/trend** type. As mentioned above, the sequence directory under the **/tdrss** main directory contains all the messages sent in response to a trigger. These include messages that result in a good trigger or messages related to false triggers. For false triggers the BAT collects it also contains the tdrss for the BAT instrument.

The messages related to the good triggers are also stored within the science data, **/obs** directory tree.

# Chapter 4

## Data files

This chapter lists the file naming convention and give a brief description of the files that are included within an observation for the BAT, UVOT and XRT, as well as the files common to all instruments. The TDRSS messages and the different trend data type are also listed.

### 4.1 Filename convention

The Swift FITS science files are named according to the following convention:

```
sw[obs_id]I[submodes]_[lev].ext
```

where

- **sw** is short for Swift;
- **obs\_id** is an 11 digit sequence number that identifies the observation ;
- **I** is a single character identifying the instrument (x=XRT, u=UVOT, b=BAT, t=TAM) or subsystem (s=spacecraft, f=FoM, p=processing) ;
- **[submodes]** is a collection of two-character strings identifying either the data operating mode and other sub-parameters relevant to that mode, or the observing mode for how the data were collected;
- **lev** is a string indicating the stage of the processing. (this is omitted if the data telemetered had no further processing applied);
- **ext** identifies the type of data in the file, e.g. img for image file.

In addition, an index may be added to the filename to distinguish between files that would otherwise be identical named. This, for example, is used when splitting files that are too large in size, or when during calibration and verification the same TDRSS message type was sent multiple times. While the XRT and UVOT follow always the above syntax, for the BAT there are exceptions, mainly for the data taken in survey mode.



## 4.2 Data content within an observation

This section lists the science data files included within the sequences that are archived. Currently within a sequence all Level 1 data files are available and some of the Level 2 and Level 3 files are present. Level 2 and 3 files can be derived using the Swift software starting from the Level 1 data. The file listing is given below, broken down by directory, together with the specific filenames.

### 4.2.1 /auxil

Unless otherwise indicated all files are in FITS format.

- File containing the attitude information.  
`sw[obs-id]sat.fits`
- File containing the orbit information.  
`sw[obs-id]sao.fits`
- File containing spacecraft engineering parameters.  
`sw[obs-id]sen.fits`
- Make filter file where the attitude and the instrument housekeeping (HK) parameters are collected for use during screening.  
`sw[obs-id]s.mkf`
- File containing the UTCF timing correction for the observation.  
`sw[obs-id]sti.mkf`
- Catalog file listing all the files within the observation.  
`sw[obs-id]pob.cat`
- File containing the processing parameter file (ASCII).  
`sw[obs-id]ppr.par`
- File containing the 'job' parameter file (ASCII).  
`sw[obs-id]pjb.par`
- Two line element file used in the orbit derivation (ASCII).  
`SWIFT_TLE_ARCHIVE.txt`.

In 2007 two additional files describing attitudes are added in the auxil directory. These are :

- Processed attitude  
`sw[obs-id]pat.fits`
- UVOT attitude  
`sw[obs-id]uat.fits`

The first processed the *sat* attitude file to correct for attitude jumps, the second is derived using the UVOT data. They are not always present.

### 4.2.2 /log

The files in this directory are all in HTML format.

- File containing a summary of the available information.  
sw[obs-id]psu.html
- File containing the list of files created during processing.  
sw[obs-id]pfi.html
- File containing the instrument (BAT) exposure report.  
sw[obs-id]bir.html
- File containing the instrument (UVOT) exposure report.  
sw[obs-id]uir.html
- File containing the instrument (XRT) exposure report.  
sw[obs-id]xir.html
- File containing the log of the processing.  
sw[obs-id]pjl.html
- File containing an index of the major steps during the processing.  
sw[obs-id]pin.html
- File containing the errors that occur during the processing.  
sw[obs-id]per.html

### 4.2.3 /bat

The BAT data are divided into six subdirectories, each containing the following files:

#### **/event**

- An event file containing the data obtained in Event mode. This mode is used when a burst is detected. The file contains data taken just before the burst occurs, the interval when the satellite slews to the new position and after the slew. The time interval typically includes data for 10 minutes (Level 1).  
The file is named sw[obs\_id]bXXYYZZ.uf.evt, where XX is the mode set to 'ev' for event, YY is set to 'sh' to stand for short events, ZZ is set to 'sp' to indicate that the file contains data from both Slew and Pointing and 'uf' indicates that the data are unfiltered.

Starting in 2007 the BAT uses the event mode more regularly also during the slews. The ending of the event mode not always end at the end of the slew boundary and some event data during the pointing are taken in event mode. The slew and pointing event mode data taken during normal observation, e.g. not trigger by a burst, are kept in separate files one for the slew and one for the pointing. The filename is as above sw[obs\_id]bXXYYZZ.uf.evt where the suffix ZZ is set to 'sl' for slew and 'po' for pointing. .

- A file containing additional information derived from a ray-tracing program necessary to be generate response file. This is present when the event data are generated because a burst has been detected. The file is named `sw[obs_id]bXXYY.fits`, where XX is the mode set to 'ev' for event, and YY is set to 'tr' for ray-tracing.

### **/rate**

- A lightcurve file containing the 1 second data from the entire array in 4 energy bands. `sw[obs_id]bXXYY.lc` , where XX is the data mode set to 'rt' for rate and YY is '1s'.
- A lightcurve file containing the 64ms data from the entire array in 4 energy bands. `sw[obs_id]bXXYY.lc` , where XX is the data mode set to 'rt' for rate and YY is 'ms'.
- A lightcurve containing the 1.6 second data per quadrant (4 in total) in 4 energy bands. `sw[obs_id]bXXYY.lc` , where XX is the data mode set to 'rt' for rate and YY is 'qd'.
- A lightcurve histogram which records the maximum count rate per quadrant in 4 energy bands for various integration times (4ms, 8ms, 16ms, 32ms, 64ms). All data are stored in one file with 5 extensions, one for each of the integration times. `sw[obs_id]bXXYY.lc` , where XX is the data mode set to 'rt' for rate and YY is 'mc'

### **/masktag**

- N lightcurves from the mask-tagged rate data mode obtained for sources that were simultaneously monitored (typically 3) within the large BAT FOV. The integration time is 1.6 sec (Level 1). `sw[obs_id]bXX[target_id].lc` , where XX is the data mode set to 'mt' for mask tagged and [target\_id] is an 8 digit number identifying the target ID associated with the object that has been monitored (Level 1).
- N lightcurves from the mask-tagged rate data mode processed (Level 2). There should be one Level 2 lightcurve for any Level 1 file. `sw[obs_id]bXX[target_id].lc` , where XX is the data mode set to 'mt' for mask tagged and [target\_id] is an 8 digit number identifying the target ID associated with the object that has been monitored.

NOTE: In some sequences there are more Level 1 files than Level 2 files. These excess Level 1 lightcurves are to be considered not valid - their content is already included in different files and they will be removed in subsequent data re-processing.

### **/products**

- Light curves of the burst. `sw[obs_id]bevXX.lc`, where XX is set to '1s' for 1 sec or 'ms' for 64 ms.
- GIF plot of the light curves, es. burst. `sw[obs_id]bev1s_lc.gif`
- Spectra. `sw[obs_id]bevXX.pha`, where XX is set to 'ps' for pre-slew, 'sl' for slew, or 'as' for after-slew.

- Plot of the spectra (1 file).  
`sw[obs_id]bev_ph.gif`
- Response file.  
`sw[obs_id]bevXX.rsp`, where XX is set to 'ps' for pre-slew or 'as' for after-slew.
- Sky image.  
`sw[obs_id]bevXX_sk.img`, where XX is set to 'pb' for pre-burst, 'bu' for burst, 'ps' for pre-slew, or 'as' for after-slew.
- Detector image.  
`sw[obs_id]bevXX_dt.img`, where XX is set to the same characters as for the sky images.
- Plot image sky image, 1 file  
`sw[obs_id]bev_skim.gif`
- GTI file.  
`sw[obs_id]bevbu.gti`

### /survey

- M survey files, one for each combination of gain and offset calculated on-board during an observation. This type of file is also known as a Detector Plane Histogram (DPH, Level 1).  
`sw[obs_id]bXXYYoxxxxgzzzz.dph`, where XX is the data mode set to 'sv' for survey mode, YY indicates if the survey data are from after a burst ('ab') or pre-burst ('pb'), oxxxx and gzzzz are the offset and gain respectively.

### /pulsar

- One file per observation for a given source containing 80-channel spectra folded on-board in 32 bins.  
`sw[obs_id]bXX[target_id].fits`, where XX is the data mode set to 'pl' for pulsar mode and [target\_id] is an 8 digit number identifying the target ID associated with the object for which the folded spectra were calculated.

NOTE: Pulsar mode is not always running. From July 2006, in fact, it seems to be turned off.

### /hk

- Housekeeping data containing the header information written in the Large Data Products telemetry format.  
`sw[obs_id]bXX.hk`, where XX is set to 'hd' to indicate the telemetry header.
- Housekeeping data containing the engineering parameters.  
`sw[obs_id]bXX.hk`, where XX is set to 'en' to indicate engineering.
- Housekeeping data containing information of the detector array panel.  
`sw[obs_id]bXX.hk`, where XX is set to 'dp' to indicate the detector panel.
- Housekeeping data containing the timestamps of the event packets.  
`sw[obs_id]bXXYYZZ.hk`, where XX is set to 'ev' to indicate the mode, YY is set to 'ts' to indicate time stamps, and ZZ is set to 'sp' to indicate that the file contains data from both Slew and Pointing.

- Housekeeping data containing additional telemetry information present in the event data.  
`sw[obs_id]bXXYYZZ.hk` , where `XX` is set to 'ev' to indicate the mode, `YY` is set to 'tl' to indicate general telemetry, and `ZZ` is set to 'sp' to indicate that the file contains data from both Slew and Pointing.
- Calibration file containing the gain and offset for the observation.  
`sw[obs_id]bXXYY.hk`, where `XX` is set to 'go' for gain and offset and `YY` is set to 'cb' for calibration.
- Calibration file containing the detector enabled during an observation.  
`sw[obs_id]bXXYY.hk`, where `XX` is set to 'de' for detector enable and `YY` to 'cb' for calibration.
- Calibration file containing the detector quality flags  
`sw[obs_id]bXXYY.hk`, where `XX` is set to 'dq' for detector quality flag and `YY` to 'cb' for calibration.

#### 4.2.4 /uvot

The UVOT instrument is equipped with several filters. Data files include in their names a two-character string used as a mnemonic for the filter. These are :

Filter		Filter	
V	vv	VGRISM	gv
U	uu	UGRISM	gu
B	bb	MAGNIFIER	mg
UVW1	w1	Blocked	bl
UVW2	w2	Unknown	uk
UVM2	m2	Damaged	di
White	wh		

The UVOT data are divided into four subdirectories each containing the following files:

#### /event

The filename of the UVOT event files changed in June 2006. The description below includes both naming conventions. With the next data re-processing the new naming convention will be applied to all data.

- N event files, each containing data taken in Event mode for a specific filter and observing mode (Level 1).  
`sw[obs_id]uXXYY_uf.evt` , where `XX` is set to the filter mnemonic as listed in the table of the `/uvot` section, and `YY` indicates the observing mode. The UVOT collects data during the settling and pointing phases, for which `YY` is set to 'sd' and 'po', respectively. As for the BAT event file, 'uf' indicates that the data are unfiltered.

After June 2006 the filename has been changed as :

`sw[obs_id]uXXYYZZ_uf.evt` , where `XX` is set to the filter mnemonic as listed in the table of the `/uvot` section, `YY` is the hardware window used (see table below) and `ZZ` indicates the

observing mode. The UVOT collects data during the settling and pointing phases, for which YY is set to 'sd' and 'po', respectively. As for the BAT event file, 'uf' indicates that the data are unfiltered.

- N event files, each containing the calibrated and screened data taken in Event mode for a specific filter and observing mode (Level 2) (as for feb 2007 these have not been generated): `sw[obs_id]uXXYY_cl.evt` , where XX is set to the filter mnemonic as listed in the table of the `/uvot` section, and YY indicates the observing mode. The UVOT collects data during the settling and pointing phases, for which YY is set to 'sd' and 'po', respectively. 'cl' indicates that the data have been cleaned.

After June 2006 the filename has been changed as :

`sw[obs_id]uXXYYZZ_cl.evt` , where XX is set to the filter mnemonic as listed in the table of the `/uvot` section, YY is the hardware window used (see table below) and ZZ indicates the observing mode. The UVOT collects data during the settling and pointing phases, for which YY is set to 'sd' and 'po', respectively. 'cl' indicates that the data have been cleaned.

The uvot hardware window sizes are:

Size	YY value
0,0,128,128	w1
30,35,60,60	w2
41,46,38,38	w3
Unknown	wu

**/image**

- M files containing data taken in Image mode. There is one file per filter and each file can contain one or more extensions, one for each exposure. The coordinates in the file correspond to the raw detector coordinates (Level 1).  
`sw[obs_id]uXX_rw.img` , where XX is set to the filter mnemonic in the table of the `/uvot` section
- N files containing data taken in Image mode and Event mode transformed to sky coordinates. There is one file per filter and each file can contain one or more extensions, one for each exposure. (Level 2).  
`sw[obs_id]uXX_sk.img` , where XX is set to the filter mnemonic in the table of the `/uvot` section
- N files containing the exposure maps for the images included in the extension of the '\_sk' files. There is one file for filter, and each file can contain one or more extensions one for each exposure.  
`sw[obs_id]uXX_ex.img` , where XX is set to the filter mnemonic in the table of the `/uvot` section

NOTE : The number of raw image file corresponds to the number of filters M used in Image mode only. If the same filter is used in Image and Event mode, the raw image file contains only the exposure taken in Image mode however the sky image contains both data taken in image and in event mode. The number N of sky and exposure files include data taken with filter in image or event mode (N  $\geq$  M).

**/hk**

- Housekeeping data containing the information written in the Event mode telemetry headers.  
`sw[obs_id]uXX.hk` , where XX is set to 'hd' to indicate the telemetry header.
- Housekeeping data containing the engineering parameters.  
`sw[obs_id]uXX.hk` , where XX is set to 'en' to indicate engineering.
- Housekeeping data containing information at the start of each exposure.  
`sw[obs_id]uXX.hk` , where XX is set to 'es' to indicate exposure start.
- Housekeeping data containing a report on the exposure.  
`sw[obs_id]uXX.hk` , where XX is set to 'er' to indicate exposure report.
- Housekeeping data containing a catalog of all exposure within the observation.  
`sw[obs_id]uXX.hk` , where XX is set to 'ct' for catalog.
- Aspect correction done on ground within the observation. Not always present  
`sw[obs_id]uXX.hk` , where XX is set to 'ac' for catalog.
- Aspect correction done on board (aspect following). Not always present  
`sw[obs_id]uXX.hk` , where XX is set to 'af' for catalog.

**/products**

Level 3 files (products) are available for more recent UVOT observations. Data products will also become available for earlier data as reprocessing efforts are completed. Remember that Level 3 files can always be derived from the Level 1 files using the Swift software. Note that not all of the products files listed here will exist for every sequence.

- FITS format catalog of UVOT files in the sequence.  
`sw[obs_id]u.cat`
- Summed images for each filter.  
`sw[obs_id]uXXskim.gif`, where XX is set to the filter mnemonic in the table of the **/uvot** section.
- Finding chart plot.  
`sw[obs_id]ufc_skim.gif`
- Digital sky survey image.  
`sw[obs_id]udss_skim.gif`
- Image plot (one file).  
`sw[obs_id]u_skim.gif`
- Summed images for all filters (one file).  
`sw[obs_id]u_sk.img`
- Summed exposure maps for all filters (one file).  
`sw[obs_id]u_ex.img`
- Source light curve (all filters).  
`sw[obs_id]usr.lc`

- Source light curve plots (all filters).  
`sw[obs_id]usr_lc_xx.gif`, XX is 01 and 02 where there are 3 filter lightcurves plotted in each file.

#### 4.2.5 /xrt

Data from the XRT instrument are collected on-board via different read-out modes. Data files include in their names a two character string as the mnemonic for the modes. These are :

Modes

```
-----
Image                im
Piled-up Photodiode  pu
Low-rate Photodiode  lr
Windowed Timing      wt
Photon Counting      pc
TAM image            tm
Bias mode            bf
Raw image            rf
-----
```

In March 2007 a series of new modes were created for the XRT. These modes are mainly for supporting the slew time to get data out since they were blocked in May 2006 by a micro-meteoroid strike. These mode are:

Modes

```
-----
Sudo-pd PC mode      pp
Sudo-pd WT mode      wp
Sudo-pd refresh      rp
IM mode
Sudo-lr PC mode      pl
Sudo-lr WT mode      wl
Sudo-lr refresh      rl
IM mode
-----
```

The XRT data are divided into four subdirectories, each containing the following files:

#### /event

- N event files, each containing data taken with a specific read-out mode and observing mode combination (Level 1).  
`sw[obs_id]uXXYYZZ_uf.evt` , where XX is set to the read-out modes mnemonic as listed in the table of the /xrt section, YY indicates a submode of the read-out mode and ZZ the observing mode. In Photodiode (Low-rate and Piled-up), YY indicates whether or not the bias has been subtracted on-board, being set to 'b1' if the bias has been subtracted on-board, otherwise being set to 'b0'. In Photon Counting and Windowed Timing modes, YY instead gives the mnemonic for the fraction of the FOV exposed, according to the following table:



ww	Windowed Timing	Photon counting
w1	100 columns	490x490 pixel
w2	200 columns	500x500 pixel
w3	300 columns	600x600 pixel
w4	400 columns	480x480 pixel
wu	Window Unknown	

The XRT collects data during the slew, settling and pointing phases, for which ZZ is set to 'sl', 'sd', and 'po', respectively. As for the BAT and UVOT, 'uf' indicates that the data are unfiltered.

- K event files, each containing the reconstructed events for Windowed Timing and Photodiode modes (Level 1a)  
`sw[obs_id]uXXYYZZ_ufre.evt`, where the submode specifications XX, YY and ZZ are identical to those for the unfiltered files, but with the level specification set to 'ufre' for unfiltered reconstructed. Processing is required to obtain the Level 2 (cleaned events)
- N event files, each containing data taken with a specific read-out mode and observing mode combination (Level 2).  
`sw[obs_id]uXXYYZZ_cl.evt`, where XX, YY and ZZ has the same meaning as above, and 'cl' indicates that the data have been cleaned.

### /image

- File containing data taken in Image mode containing one or more extensions one for each exposure (Level 1).  
`sw[obs_id]xXX_rw.img`, where XX is set to 'im' to indicate image mode. In order to obtain a Level 2 data file user processing is required.

### /hk

- Housekeeping data containing the information written in the telemetry header of the event packets.  
`sw[obs_id]xXX.hk`, where XX is set to 'hd' to indicate the telemetry header of the event packets.
- Housekeeping data containing the information written in the telemetry trailers of the Large Data Products format event mode files.  
`sw[obs_id]xXX.hk`, where XX is set to 'tr' to indicate trailers.
- Housekeeping data containing the engineering parameters.  
`sw[obs_id]xXX.hk`, where XX is set to 'en' to indicate engineering.
- Bias map for the Photon Counting data.  
`sw[obs_id]xXX_rw.img`, where XX is set to 'bf' to indicate bias frame.

### /products

- Summed plot/image (one file).  
`sw[obs_id]x_skim.gif`

- Summed image.  
`sw[obs_id]xXX_im.img`, where XX is set to 'im' for Image or 'pc' for Photon Counting or 'wt' for Windowed Timing. section.
- Summed exposure image.  
`sw[obs_id]xXX_ex.img`, where XX is set to 'pc' for Photon Counting or 'wt' for Windowed Timing.
- ARF, one per mode.  
`sw[obs_id]xXXsr.arf`, where XX is set to the two-character or XXXX mnemonic for the mode. These are 'pc' for Photon Counting or 'wt' for Windowed Timing or 'lr' or 'lrb1' or 'lrb0' for Lowrate Photodiode or 'pu' or 'pub0' or 'pub1' for Photodiode pileup.
- Source light curve.  
`sw[obs_id]xXXsr.lc`, where XX is set to 'pc' for Photon Counting or 'wt' for Windowed Timing or 'lr' or 'lrb1' or 'lrb0' for Lowrate Photodiode or 'pu' or 'pub0' or 'pub1' for Photodiode pileup.
- Plot of the source light curve (1 file).  
`sw[obs_id]xsr_lc.gif` , where the plot includes data from Photon Counting and Windowed Timing.
- Plot of the source light curve.  
`sw[obs_id]xXXsr_lc.gif`, where XX is set to 'wt' for Windowed Timing or 'lr' or 'lrb1' or 'lrb0' for Low-rate Photodiode or 'pu' or 'pub0' or 'pub1' for Photodiode pileup.
- Source spectrum.  
`sw[obs_id]xXXsr.pha`, where XX is set to 'pc' for Photon Counting, 'wt' for Windowed Timing, or 'lr' or 'lrb1' or 'lrb0' for Low-rate Photodiode or 'pu' or 'pub0' or 'pub1' for Photodiode pileup.
- Plot of the source spectrum (1 file).  
`sw[obs_id]xsr_ph.gif` , where the plot includes data from Photon Counting and Windowed Timing.
- Plot of the source spectrum.  
`sw[obs_id]xXXsr_ph.gif` , where XX is set to 'wt' for Windowed Timing or 'lr' or 'lrb1' or 'lrb0' for Low-rate Photodiode or 'pu' or 'pub0' or 'pub1' for Photodiode pileup.

### 4.3 TDRSS data

The TDRSS data consist of a number of files, corresponding to messages that are sent to the ground as soon as an on-board trigger occurs. Each instrument generates specific messages, the number of which depends on whether or not a position has been obtained. The filenames convention for the TDRSS messages is the following

```
sw[obs_id]msI[submodes].ext
```

where

- `sw` is short for Swift;

- `obs_id` is an 11-digit sequence number that identifies the observation ;
- `I` is a single character identifying the instrument (`x=XRT`, `u=UVOT`, `b=BAT`) or subsystem (`s=spacecraft`, `f=FoM`, `p=processing`) ;
- `[submodes]` is a collection of two character string identifying the data.
- `ext` identifies the type of data in the file, e.g. `img` for an image file.

The TDRSS files and their names are :

- File containing the BAT alert message.  
`sw[obs_id]msbXX.fits` , where `XX` is set to `'al'` to indicate alert.
- File containing the BAT position.  
`sw[obs_id]msbXX.fits` , where `XX` is set to `'ce'` to indicate centroid.
- File containing the message that a Position was not found on-board by the BAT.  
`sw[obs_id]msbXX.fits` , where `XX` is set to `'no'` to indicate that no position was found.
- File containing the BAT lightcurve.  
`sw[obs_id]msb.lc`
- File containing the BAT attitude.  
`sw[obs_id]msbat.hk`
- File containing the BAT timestamp.  
`sw[obs_id]msbevtssp.hk`
- File containing the BAT telemetered events.  
`sw[obs_id]msbevtlsp.hk`
- File containing the BAT events.  
`sw[obs_id]msbevshsp_uf.evt`
- File containing the XRT centroid message.  
`sw[obs_id]msxXX.fits` , where `XX` is set to `'ce'` to indicate centroid.
- File containing the message that a position was not found on-board by the XRT.  
`sw[obs_id]msxXX.fits` , where `XX` is set to `'no'` to indicate that no position was found.
- File containing the raw XRT postage stamp image centered on the GRB sent on ground only if a position was successfully calculated.  
`sw[obs_id]msxXX_rw.img` , where `XX` is set to `'ps'` to indicate postage stamp.
- File containing the sky XRT postage stamp image centered on the GRB sent on ground only if a position was successfully calculated.  
`sw[obs_id]msxXX_sk.img` , where `XX` is set to `'ps'` to indicate postage stamp.
- File containing the XRT lightcurve.  
`sw[obs_id]msx.lc`
- File containing the raw XRT images full size from which the postage stamp is derived  
`sw[obs_id]msxXX_rw.img` , where `XX` is set to `'im'` to indicate the XRT data mode
- File containing the sky XRT images full size from which the postage stamp is derived  
`sw[obs_id]msxXX_sk.img` , where `XX` is set to `'im'` to indicate postage stamp.

- File containing the XRT spectrum, up to two spectra can be calculated on board.  
`sw[obs_id]msxXX_rw.pha`, where XX is set to 'lr' or 'wt' to indicate the XRT data mode.  
The spectra may need some ground processing.
- File containing the unfiltered event data recorded in PC mode taken soon after the burst. These data are a subset of the full dataset and it is used to derive the position if unsuccessful with the images  
`sw[obs_id]msxXX_uf.evt` , where XX is set to 'pc' to indicate the XRT data mode.
- File containing the cleaned event data recorded in PC mode taken soon after the burst. These data are a subset of the full dataset and it is used to derive the position if unsuccessful with the images  
`sw[obs_id]msxXX_cl.evt` , where XX is set to 'pc' to indicate the XRT data mode.
- File containing the UVOT finding chart.  
`sw[obs_id]msuXX.img`, where XX is set to 'fc' for finding chart.
- File containing the 'dark burst' UVOT image centered on the XRT position.  
`sw[obs_id]msuXX_rw.img`, where 'ni' is the identifier and 'rw' indicate that is raw coordinates.
- File containing the listing of the files included in the directory.  
`sw[obs_id]mspob.cat`

## 4.4 Trend data

For each of the instruments, the trend and monitoring data files are organized by type. The main purpose of these data is to monitor various aspects of the instrument during the mission. These data are listed in the following tables by instrument, together with their filenames and the directory names where they are located. These data arrive on a daily basis in the archive. In most cases, a file contains data for an entire observation, therefore these files are updated on a daily basis until all the data for the observation has arrived.

#### 4.4.1 BAT

<b>Trend Type description</b>	<b>Filename</b>	<b>Directory</b>
Americium detector plane histogram	sw[obs_id]bamcbgXXXXoYYYY.dph	bamdph
Americium gain	sw[obs_id]bamcbgXXXXoYYYY.fits	bamgain
Scaled map diagnostic for burst alert	sw[obs_id]bsmcb.fits	bscalemap
Detector Gain	sw[obs_id]bcbgXXXX.fits	bgain
Detector Offset	sw[obs_id]bcboYYYY.fits	boffset
Detector gain/Offset	sw[obs_id]bcbgXXXXoYYYY.fits	bgainoffs
Detector plane enable	swt[MET time]bdecb.fits	bdetflag
BAT commandables commanded table	sw[obs_id]bcdtb.fits	btbcommand
BAT on board catalog	sw[obs_id]bcttb.fits	bcatalog
On board veto	sw[obs_id]bvttb.fits	btbveto
On board long trigger	sw[obs_id]blttb.fits	btblongtr
On board short trigger	sw[obs_id]bsttb.fits	btbshorttr
On board rate trigger	sw[obs_id]brttbrp.fits	btbratetr
On board image trigger	sw[obs_id]bittb.fits	btbimgtr
Trigger flux	sw[obs_id]bfxcb.fits	btrigflx
Shell Log	sw[obs_id]bshtb.fits	bshelllg

Table 4.1: List of BAT trend data

#### 4.4.2 UVOT

<b>Trend Type description</b>	<b>Filename</b>	<b>Directory</b>
Parameters for the compression routine	sw[obs_id]ucm.fits	ucompression
Centroid	sw[obs_id]ucn.fits	ucentroid
Engennering monitor	sw[obs_id]umo.fits	umon

Table 4.2: List of UVOT trend data

#### 4.4.3 XRT

<b>Trend Type description</b>	<b>Filename</b>	<b>Directory</b>
Diagnostic mode data: Raw frame	sw[obs_id]xrf_rw.img	xrawmode
Bias for the Photon Counting	sw[obs_id]xbs_rw.img	xbiasmode
Tam images	sw[obs_id]xtm_rw.img	xtam
Calibration sources ww is the window size	sw[obs_id]xpc[ww]cb_uf.evt	xcal

Table 4.3: List of XRT trend data

#### 4.4.4 Others

In addition to the instrumental trend data, there are four other types of files with general trend data. These are :

- Clock offset table (ASCII). These files contain the measurements on-board of the clock offset compared with UTC. These files are not part of the data processing, but they are generated at the Mission Operation Center. The table is updated on a daily basis and the latest file always contains all the previous measurements. These files are located in the **/clocklog** directory.
- As Flown Timeline (ASCII). These files contain the timeline of what has observed. They are not part of the data processing but are generated at the Mission Operation Center. Each file contains a one day timeline and arrives at the archive one week later. These files are located in the **/asflown** directory.
- TDRSS diagnostic (FITS). In addition to the science TDRSS messages, there are messages that are used for diagnostics. All diagnostic messages within an observation are included in one file. As for the instrumental trend files, they are updated daily until the observation is complete. These files are located in the **/tdrssdiagnostic** directory.
- Make filter file (FITS). This file is included within each observation directory but it is also included in the trend area so as to facilitate the instrument team's global studies of some parameters included in the mkf file. Each file corresponds to an observation. As for the other instrumental trend data, these files will change daily until an observation is completed. These files are located in the **/mkfilter** directory.