Title: BAT Global Bad Times and Quality Maps

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Document:	SWIFT-BAT-CALDB-BTI-V6

1. Summary

This document is meant as a summary of all the "bad times" for BAT science analysis.

In particular, it is meant to document problems with the instrument which are not readily available by scanning the telemetry. There are two tables: one which gives global bad times where the entire array may be unusable; and bad "regions" where only a part of the array (block, DM, etc) had problems.

2. Component Files

BAT Good/Bad Times

File Name	Valid Date	Release Date	Version	Description
swbbadtimes20041120v001.gti	2004-11-20	2006-10-14	1	BAT good/bad science time intervals **OBSOLETE**
swbbadtimes20041120v002.gti	2004-11-20	2007-03-22	2	BAT good/bad science time intervals **OBSOLETE**
swbbadtimes20041120v003.gti	2004-11-20	2008-02-14	3	BAT good/bad science time intervals **OBSOLETE**
swbbadtimes20041120v004.gti	2004-11-20	2008-10-26	4	BAT good/bad science time intervals **OBSOLETE**
swbbadtimes20041120v005.gti	2004-11-20	2009-01-30	5	BAT good/bad science time intervals

BAT Global Quality Maps

File Name	Valid Date	Release Date	Version	Description
swbbadpix20041120v001.fits.gz	2004-11-20	2007-10-14	1	BAT global quality map **OBSOLETE**
swbbadpix20041120v002.fits.gz	2004-11-20	2007-03-22	2	BAT global quality map **OBSOLETE**
swbbadpix20041120v003.fits.gz	2004-11-20	2008-03-06	3	BAT global quality map **OBSOLETE**
swbbadpix20041120v004.fits.gz	2004-11-20	2008-10-26	4	BAT global quality map

3. Scope of Document

This document relates to gross time and detector quality filtering for sensitive survey analysis.

4. Reason for Update

Version 4 incorporates changes after the BAT reboot of October 2008. Specifically, the times of reboot and recovery are noted, and threshold changes after the reboot are flagged.

The 'bad times' file version 5 incorporates a correction to the MJDREF keyword, to make it consistent with the Swift mission epoch.

5. Discussion

Analysis of any data involves proper quality filtering. In the case of BAT, it is especially important to remove detectors with known problems or issues because each enabled detector contributes to flux estimates of a large solid angle on the sky. Aberrant detectors can contribute noise to image and flux estimates.

These calibration files, swbbadtimes* and swbbadpix*, provide the times and positions of known problems or issues with the entire array, and with individual regions of the array.

There are two BAT ground software tasks to retrieve the data from CALDB.

- batglobalgti retrieves a good time interval file which can be used to time-filter the data
- batdetmask retrieves a detector quality map which can be used to spatially filter the data

Important Note: the user is still responsible for doing generic quality filtering of data (i.e. removing times where the spacecraft star tracker was out of lock, or removing noisy detectors

using 'bathotpix'). These files provide only high-level information about known instrumental issues.

6. swbbadtimes*: Global Good/Bad Time File

The swbbadtimes* file is a standard good time interval (GTI) file which contains global good and bad time intervals for BAT science analysis. The user should use this file conjunction with the task 'batglobalgti' to chose the desired quality level. The meanings of the QUALITY column are described below.

QUALITY	Description
0	No known issues; data OK
1	Something non-routine occurred, but it had no known impact
2	Bad data, with some possible good data; user must proceed with extreme caution
3	Bad data, with little to no good data

There is also a text comment which describes the issue, if any.

7. swbbadpix*: Global Quality Maps

The swbbadpix* file is a series of maps which are formatted according to the "BADPIX" OGIP convention (i.e. a series of BAT detector quality maps). They are crude mission-level quality maps which indicate which detectors were known to have issues or problems which affect science analysis. The file is formatted as series of FITS extensions, one for each time interval with constant quality information.

Also,

- Following the OGIP QUALITY convention, zero means "good"
- These maps provide only crude, mission-level information. The user must still screen individual detector images for problems (for example noisy detectors).

Each map has a REASON keyword which describes why a new map was created at that particular validity time. In cases where a problem was corrected, i.e. more detectors are enabled, the REASON keyword will be prefixed with "RESOLVED".

The 'batdetmask' task can extract the correct map for a given observation.

8. Reasons for Bad Times

Tables 1 and 2 in the next section provide a listing of known issues, which is meant to be

identical to the content of the FITS files. The problems and issues are described more fully in this section.

High voltage reduced - the detector bias voltage was typically reduced during critical BAT or spacecraft procedures as a precautionary measure. The gamma-ray energy scale is not correct during these intervals.

IP reboot - the BAT Instrument Processor (IP) has been rebooted several times. In some cases rebooting was an intended consequence of a flight software upgrade. In other cases a reboot was required to recover the BAT from an anomalous condition.

Gain/offset values equilibrate - after an IP reboot, the automatic calibration system typically requires several hours to reach equilibrium. During that time, the gain scale may be incorrect.

Loop heat pipe #1 shut down - the loop heat pipes are part of the instrument thermal system, used to regulate the temperatures of the detectors and instrumental electronics. For one episode in 2005, loop heat pipe #1 shut down due to a sensor anomaly. Loop heat pipe #2 still functioned, and provided adequate, although slightly reduced, thermal control until loop heat pipe #1 was restored.

Calibration task stopped - the automatic calibration task performs periodic electronics calibrations. During this interval, the calibration task was stopped, which caused the electronics (gain/offset) calibration to be frozen. Since the on-board electronics calibration appears to be quite stable, the BAT team believes this data is usable for science analysis. After an IP reboot, the calibration task was restored.

Block communications anomaly - During two episodes in 2006, the communication link between the IP and some BAT detector blocks did not function properly for unknown reasons. In the first instance (day 2006:055), the recovery process took several days. In the second case, the instrument functioned properly after a short recovery procedure, but two detector blocks remained disabled for about three weeks.

DM LLD threshold incorrect - for unknown reasons, some DM lower level discriminator threshold settings increased during SAA. Thus, the energy response for these modules was changed (low energy gamma-rays were ignored). The threshold values were reset periodically by ground command.

Spacecraft gyro anomaly (Fall 2007) - on 10 August 2007, the Swift spacecraft experienced a gyro anomaly. This anomaly, and the ensuing events, cause the BAT to be powered off. BAT operations were recovered in two stages: first, the BAT detector array was powered on; next, the flight software was updated from the launch version to the version used before the gyro anomaly (on 07 Sep 2007). For the time period 07 Sep 2007 through 18 Oct 2007, the spacecraft had limited maneuvering capability due to the gyro anomaly. During this period, observers should be watchful for periods of bad spacecraft attitude, but the BAT data should be nominal. After that 18 Oct 2007, full maneuvering capability was restored.

BAT on-board misalignment matrix is incorrect (Oct 2008) - The knowledge of the BAT instrument orientation with respect to the spacecraft boresite is kept on-board in matrix form. After a BAT reboot in Oct 2008, this matrix was incorrect for a short time. BAT positions

computed on-board were incorrect by about 8 arcminutes. Two triggers were incorrectly classified as gamma-ray bursts when they were actually known galactic sources (triggers 330074 and 330083). BAT "image status packets" have incorrect positions and fluxes during this interval. Data processed on the ground from event data or DPHs should be unaffected by the on-board misalignment matrix setting.

9. Bad Time Table

Tables 1 and 2 provide a listing of the known problems and issues.

Definition of the columns:

START

start time of the time interval in MET NNNNNNNNNN or `YYYY:DDDD:hh:mm:ss` format.

STOP

stop time of the time interval. Use "*" to indicate an unresolved problem.

B,D,S,d

The block, DM, sandwich, and/or detectors. Use "*" for "all."

Q = QUALITY

data quality

0

No known problems (may be omitted);

1

Known issue, but no known ill effects;

2

Known problem, some good and some bad data; care must be taken to analyze properly;

3

Known problem, all data bad.

COMMENT

Text comment describing the issue or problem. Use the same phrase if the same problem appears multiple times.

START	STOP	B	D	S	d	Q	COMMENT
							2004
2004:325:17:16:00	2004:346:10:00:00	*	*	*	*	2	S/C launch and BAT initial activation sequence
2004:346:10:00:00	2004:347:09:28:00	*	*	*	*	2	BAT high voltage reduced

2004:347:09:28:00	2004:350:02:03:41	*	*	*	*	2	S/C boresite quaternion adjustments
2004:354:21:33:00	2004:355:02:45:00	*	*	*	*	2	BAT high voltage reduced; S/C battery software change
2005							
2005:068:22:02:00	2005:070:18:11:00	*	*	*	*	2	BAT high voltage reduced; IP reboot
2005:070:18:11:00	2005:071:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate (estimated)
2005:091:07:30:00	2005:098:14:45:00	*	*	*	*	1	BAT loop heat pipe #1 shut down; DM temperatures less regulated
2005:158:13:38:00	2005:158:15:43:00	*	*	*	*	2	BAT high voltage reduced; IP reboot
2005:158:15:43:00	2005:159:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2005:331:14:45:00	2005:333:14:11:00	*	*	*	*	1	BAT calibration task stopped; electronic calibration frozen
2005:333:14:11:00	2005:333:17:43:32	*	*	*	*	2	BAT high voltage reduced; IP reboot
2005:333:17:43:32	2005:335:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2006							
2006:046:18:17:00	2006:046:20:46:00	*	*	*	*	2	BAT high voltage reduced; FSW upgrade; IP reboot
2006:046:20:46:00	2006:047:14:01:00	*	*	*	*	3	BAT instrument in SAA mode
2006:047:14:01:00	2006:047:18:23:00	*	*	*	*	2	BAT high voltage reduced
2006:047:18:23:00	2006:047:20:12:00	*	*	*	*	2	BAT reconfigure triggers
2006:047:20:12:00	2006:048:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2006:048:00:00:00	2006:055:21:07:00	*	*	*	*	1	BAT noisy detectors not disabled on-board; block 11 disabled
2006:055:21:07:00	2006:058:12:48:00	*	*	*	*	3	BAT block communication anomaly; recovery procedures
2006:058:12:48:00	2006:058:15:14:00	*	*	*	*	2	BAT high voltage reduced; IP reboot
2006:058:15:14:00	2006:058:18:03:00	*	*	*	*	3	BAT reconfigure instrument parameters
2006:058:18:03:00	2006:059:15:53:44	*	*	*	*	3	BAT science timestamps are not correct (derived from FSW)
2006:059:15:53:44	2006:060:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2006:166:13:00:00	2006:166:21:00:00	*	*	*	*	3	BAT block communication anomaly
2006:346:01:00:00	2006:347:18:00:00	*	*	*	*	3	BAT IP reboot and recovery
2007							

START	STOP						COMMENT
2007:072:15:16:00	2007:072:18:00:00	*	*	*	*	3	BAT high voltage reduced; FSW upgrade; IP reboot
2007:072:18:00:00	2007:073:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2007:073:15:25:00	2007:073:17:30:00	*	*	*	*	2	BAT DSP software upgrade and reboot
2007:222:20:37:00	2007:223:06:00:00	*	*	*	*	2	S/C gyro anomaly onset
2007:223:06:00:00	2007:230:22:41:24	*	*	*	*	3	BAT powered off during S/C anomaly
2007:230:22:41:24	2007:241:13:35:00	*	*	*	*	3	BAT power-on, initialization, re-enable triggers
2007:241:13:35:00	2007:242:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2007:241:13:35:00	2007:247:18:47:00	*	*	*	*	1	BAT functioning with old FSW
2007:247:18:47:00	2007:247:20:31:00	*	*	*	*	3	S/C attitude anomaly
2007:247:20:31:00	2007:250:15:21:14	*	*	*	*	1	BAT functioning with old FSW
2007:250:15:21:14	2007:250:18:46:40	*	*	*	*	3	BAT FSW update; IP reboot
2007:250:18:46:40	2007:251:00:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2007:251:00:00:00	2007:291:14:04:00	*	*	*	*	1	S/C has limited maneuvering (check for bad attitude)
2008							
2008:275:19:50:00	2008:275:23:00:00	*	*	*	*	3	BAT FSW update; IP reboot
2008:275:23:00:00	2008:276:09:00:00	*	*	*	*	2	BAT gain/offset values equilibrate
2008:276:09:00:00	2008:276:18:00:00	*	*	*	*	1	BAT on-board misalignment matrix is incorrect

Table 1. Global Bad Time Listing

START	STOP	B	D	S	d	Q	COMMENT
2004							
2004:346:10:00:00	2005:074:16:00:00	1	2	*	*	2	BAT DM LLD threshold incorrect
2005							
2005:070:16:08:52	2005:076:13:48:18	4	0	*	*	2	BAT DM LLD threshold incorrect
2005:078:13:43:52	2005:083:19:52:50	13	1	*	*	2	BAT DM LLD threshold incorrect
2005:080:08:43:52	2005:083:19:52:50	6	5	*	*	2	BAT DM LLD threshold incorrect
2005:080:08:48:52	2005:083:19:52:50	4	5	*	*	2	BAT DM LLD threshold incorrect
2005:080:10:23:52	2005:083:19:52:50	14	6	*	*	2	BAT DM LLD threshold incorrect

2005:087:06:13:52	2005:091:19:07:50	13	6	*	*	2	BAT DM LLD threshold incorrect
2005:089:04:48:54	2005:091:19:07:50	7	0	*	*	2	BAT DM LLD threshold incorrect
2005:089:17:43:52	2005:091:19:07:50	7	4	*	*	2	BAT DM LLD threshold incorrect
2005:091:06:38:52	2005:096:14:43:36	12	4	*	*	2	BAT DM LLD threshold incorrect
2005:094:09:28:52	2005:096:14:43:36	5	7	*	*	2	BAT DM LLD threshold incorrect
2005:104:01:18:52	2005:112:16:32:45	2	3	*	*	2	BAT DM LLD threshold incorrect
2005:104:16:59:30	2005:112:16:32:45	12	1	*	*	2	BAT DM LLD threshold incorrect
2005:108:22:33:52	2005:112:16:32:45	14	0	*	*	2	BAT DM LLD threshold incorrect
2005:113:18:03:52	2005:126:14:52:53	4	6	*	*	2	BAT DM LLD threshold incorrect
2005:114:18:13:52	2005:126:14:52:53	11	0	*	*	2	BAT DM LLD threshold incorrect
2005:116:11:48:52	2005:126:14:52:53	9	5	*	*	2	BAT DM LLD threshold incorrect
2005:117:18:28:52	2005:126:14:52:53	12	3	*	*	2	BAT DM LLD threshold incorrect
2005:118:11:53:52	2005:126:14:52:53	11	5	*	*	2	BAT DM LLD threshold incorrect
2005:119:15:18:55	2005:126:14:52:53	13	3	*	*	2	BAT DM LLD threshold incorrect
2005:121:15:33:55	2005:126:14:52:53	3	1	*	*	2	BAT DM LLD threshold incorrect
2005:122:15:38:55	2005:129:18:42:53	1	7	*	*	2	BAT DM LLD threshold incorrect
2005:125:09:13:55	2005:129:18:42:53	1	4	*	*	2	BAT DM LLD threshold incorrect
2005:125:10:58:55	2005:129:18:42:53	4	7	*	*	2	BAT DM LLD threshold incorrect
2005:126:09:23:55	2005:129:18:42:53	12	5	*	*	2	BAT DM LLD threshold incorrect
2005:128:07:53:55	2005:129:18:42:53	10	2	*	*	2	BAT DM LLD threshold incorrect
2005:129:09:34:40	2005:129:18:42:53	9	4	*	*	2	BAT DM LLD threshold incorrect
2005:147:12:22:00	2005:333:17:43:32	3	1	*	*	3	BAT DM leakage current too high; disabled
2006						
2006:166:13:00:00	2006:186:17:32:00	5	*	*	*	3	BAT block communication anomaly
2006:166:13:00:00	2006:186:17:32:00	15	*	*	*	3	BAT block communication anomaly
2006:345:15:00:00	2006:353:14:30:00	9	4	1	*	2	BAT DM LLD threshold incorrect
2006:348:08:00:00	2006:353:14:30:00	9	0	*	*	2	BAT DM LLD threshold incorrect
2006:348:08:00:00	2006:353:14:30:00	12	0	*	*	2	BAT DM LLD threshold incorrect
2006:349:11:30:00	2006:353:14:30:00	14	6	*	*	2	BAT DM LLD threshold incorrect
2006:350:11:30:00	2006:353:14:30:00	6	7	*	*	2	BAT DM LLD threshold incorrect
2007						

2007:072:15:16:00	2007:073:17:30:00	12	1	*	*	2	BAT DM latch-up (not reported in enable/disable map)
2007:255:16:00:00	2007:267:22:00:00	12	1	*	*	2	BAT DM LLD threshold incorrect
2007:256:11:00:00	2007:267:22:00:00	7	4	*	*	2	BAT DM LLD threshold incorrect
2007:256:14:00:00	2007:267:22:00:00	1	1	*	*	2	BAT DM LLD threshold incorrect
2007:256:14:00:00	2007:267:22:00:00	3	3	*	*	2	BAT DM LLD threshold incorrect
2007:256:19:00:00	2007:267:22:00:00	9	6	*	*	2	BAT DM LLD threshold incorrect
2007:257:12:00:00	2007:267:22:00:00	0	2	*	*	2	BAT DM LLD threshold incorrect
2007:257:12:00:00	2007:267:22:00:00	2	4	*	*	2	BAT DM LLD threshold incorrect
2007:257:13:00:00	2007:267:22:00:00	6	1	*	*	2	BAT DM LLD threshold incorrect
2007:262:11:00:00	2007:267:22:00:00	0	7	*	*	2	BAT DM LLD threshold incorrect
2007:264:12:00:00	2007:267:22:00:00	9	0	*	*	2	BAT DM LLD threshold incorrect
2007:266:14:00:00	2007:267:22:00:00	2	1	*	*	2	BAT DM LLD threshold incorrect
2008:277:07:00:00	2008:279:05:30:00	6	5	*	*	2	BAT DM LLD threshold incorrect
2008:278:08:00:00	2008:279:05:30:00	7	7	*	*	2	BAT DM LLD threshold incorrect
2008:275:05:00:00	2008:279:05:30:00	11	3	*	*	2	BAT DM LLD threshold incorrect
2008:277:07:00:00	2008:279:05:30:00	15	0	*	*	2	BAT DM LLD threshold incorrect

Table 2. Global Bad Regions Listing

10. Caveat Emptor

As noted above, the user is still responsible for performing generic quality filtering using the data at hand (i.e. searching for noisy detectors, etc).

11. Expected Updates

This file will be updated when major events occur, or when new issues are discovered. The expected update frequency is approximately 3-6 months.

12. Version History

12.1. Update 2006-11-07

Initial release.

12.2. Update 2007-03-22

- 01 Jan 2007 - add reboot of mid Dec 2006; add threshold changes of mid Dec 2006
- 22 Mar 2007 - add reboot and flight software upgrade of Mar 2007

12.3. Update 2008-02-14

- 14 Feb 2008 - add events of 2007, including spacecraft gyro anomaly and recovery.

12.4. Update 2008-03-06

- 06 Mar 2008 - add DM threshold changes after the anomaly recovery.

12.5. Update 2008-10-03

- 26 Oct 2008 - add reboot and flight software upgrade of Oct 2008, and subsequent DM threshold changes.

12.6. Update 2009-01-30

- 29 Jan 2009 - fix to MJDREF keyword in 'bad times' file