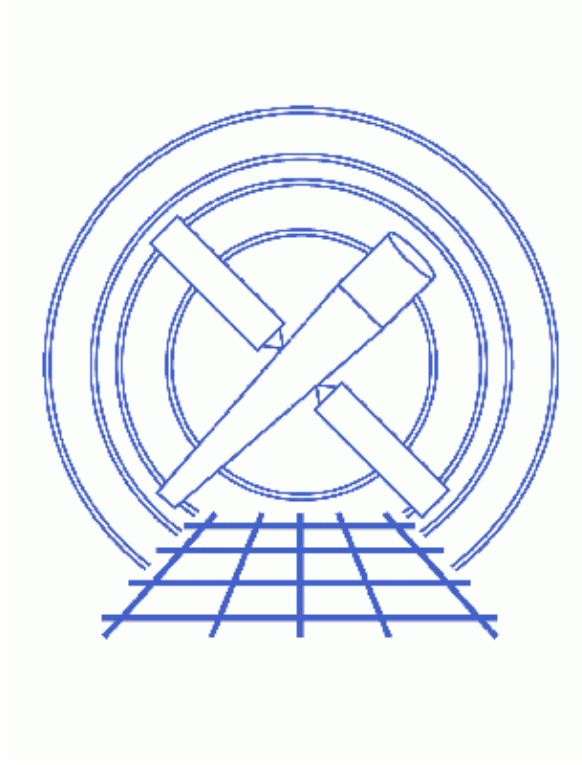


Create a New ACIS Bad Pixel File: Identify ACIS Hot Pixels and Cosmic Ray Afterglows



CIAO 3.4 Science Threads

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Create a New ACIS Bad Pixel File: Identify ACIS Hot Pixels and Cosmic Ray Afterglows

CIAO 3.4 Science Threads

Overview

Last Update: 1 Dec 2006 – updated for CIAO 3.4: added "Create a New ACIS Bad Pixel File" to thread title; CIAO version in warning

Synopsis:

An afterglow is the residual change from the interaction of a cosmic ray in a CCD. Some of the excess charge is captured by charge traps and released in a few to a few dozen subsequent frames. If afterglow events are not removed from the data, they can result in the spurious "detection" of faint sources.

New tools were introduced in CIAO 3.2 to identify and flag hot pixel and afterglow events in ACIS observations. [acis_run_hotpix](#) is a script that runs the ACIS hot pixel tools in order; see the [About the ACIS Hot Pixel Tools section](#) for details.

These tools supersede `acis_detect_afterglow` and replaced that tool in [standard data processing](#) (SDP, aka "the pipeline") in DS 7.4.0. `acis_run_hotpix` is better because it finds some afterglows that `acis_detect_afterglow` does not, it also finds pixels that are hot or have bad bias values and it misidentifies far fewer legitimate X-ray events as bad.

Users should remove any afterglow correction that was applied via `acis_detect_afterglow` (e.g. during SDP) before running this thread; see the [Remove the acis_detect_afterglow Correction thread](#) for instructions.

Purpose:

To flag hot pixel and afterglow events in the event file, and to create a new bad pixel file with those pixels identified as bad.

Read this thread if:

- you are working with any FAINT or GRADED TIMED exposure mode ACIS observation (imaging or grating) processed with an SDP version *lower than* DS 7.4.0. Data processed with DS 7.4.0 or higher have had this correction applied in the pipeline.
- you are working with any VFaint TIMED exposure mode ACIS observation (imaging or grating) processed with an SDP version *lower than* DS 7.6. The [VFaint mode data section](#) has details.
- **Do not use `acis_run_hotpix` on continuous-clocking (CC) mode data.** The tools are designed to look for bad pixels, not bad columns, and only the column of an event is known in CC mode.

The [Get Started section](#) shows how to check the software processing version and mode used for the observation.

Related Links:

- Analysis Guide: [ACIS Data Preparation](#)

Proceed to the [HTML](#) or [hardcopy \(PDF: \[A4\]\(#\) / \[letter\]\(#\)\)](#) version of the thread.

About the ACIS Hot Pixel Tools

`acis_run_hotpix` is a script which executes, in this order, `acis_build_badpix`, `acis_find_hotpix`, `acis_classify_hotpix`, and `acis_build_badpix` a second time.

Collectively, these tools

1. search for pixels where the bias value is too low or too high (`acis_build_badpix`),
2. search for suspicious pixels where there is an unusually large or unusually small number of events (`acis_find_hotpix`),
3. classify the events on suspicious pixels as being associated with cosmic ray afterglows, hot pixels or astrophysical sources (`acis_classify_hotpix`), and
4. write the bad pixels (`acis_classify_hotpix`) and their neighbors (`acis_build_badpix`) to the output bad pixel file.

Note that the bad pixels in the input bad pixel file are not all necessarily included in the output bad pixel file. All the bad pixels are recalculated and flagged as appropriate in the output file.

Which status bits are used?

`acis_find_hotpix` identifies three different kinds of anomalies: hot pixels, afterglow events, and pixels with bright bias. These are represented by the following status bits in the *bad pixel* file:

Cause	Bad Pixel Status Bit
hot pixel	14
afterglow event	15
bright bias	16

When the bad pixel and event files are input to `acis_process_events`, different bits are set in the *event file* to record these same anomalies:

Cause	Event Status Bit
hot pixel	4
afterglow event	16
bright bias	4

For more information on the status bits in the bad pixel file, see "[ahelp acis_build_badpix](#)". Technical information on status bits in bad pixel and event files is available from the memos on the [MIT CXC Documents page](#).

Doing pileup analysis

With the `acis_detect_afterglow` correction, users were advised to filter the data to retain all events tagged as afterglows if the source is piled and you intend use the `jdpileup` model in *Sherpa* or *XSPEC*. The new hot pixel tools are more judicious with respect to throwing away piled source events, *so users should be able to analyze the data without having to unfilter events first*. The [Using A Pileup Model thread](#) has more information on pileup modeling.

VFAINT mode data

The `acis_build_badpix` tool – which is called by `acis_run_hotpix` – no longer identifies pixels belonging to the outer 5x5 pixel island in VFAINT mode as bad. It will also clear those bits from an input file.

Originally, all of the outer 24 pixels of a 5x5 island in VFAINT mode were checked to make sure that the "adjacent" pixels to the center were not bad. However, only the center 3x3 is used to compute the pulse height and grade; the outer 16 pixels of the 5x5 are only used to search for potential cosmic-ray events if `check_vf_pha=yes`. To avoid discarding more events unnecessarily, the code was changed to only consider the central pixel and the eight pixels adjacent to the central pixel when searching for events where one of the pixels is bad.

This change was released on 23 June 2005 in the CIAO 3.2.2 software patch, and became part of SDP at version DS 7.6.

Users working with VFAINT mode data should:

1. run `acis_build_badpix` in CIAO 3.2.2 *or higher* (assuming that the data was processed with an SDP version lower than DS 7.6)
2. reprocess the event file with `acis_process_events` using the new bad pixel file in the `badpixfile` parameter
3. recreate any images or spectra from that event file

It is not necessary to remake ARFs, instrument maps, or exposure maps, as the outer 16 pixels of a 5x5 island are not accounted for during those processes. You may wish to do so regardless, for the sake of consistency.

Get Started

Sample ObsID used: 459 (HETG/ACIS-S, 3C 273)

File types needed: `evt1; bpix1; msk1; bias0; pbk0`

The event file (`acis_459_reset_evt1.fits`) was created by running the [Remove the acis_detect_afterglow Correction](#); it is not the `evt1` file from standard processing. Also, it is now possible to obtain the correct bias and parameter block files from *ChaSeR* or *WebChaSeR*; they are included in the secondary data products.

In this thread, we assume that all relevant files are in the same working directory.

Check the mode of the observation:

```
unix% dmkeypar acis_459_reset_evt1.fits READMODE echo+
TIMED
```

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```
unix% dmkeypar acis_459_reset_evt1.fits DATAMODE echo+
FAINT
```

This is a TIMED FAINT mode observation, so `acis_run_hotpix` may be used.

We also need to check the processing version:

```
unix% dmkeypar acis_459_reset_evt1.fits ASCDSVER echo+
CIAO 3.4
```

Since this data has already had [acis_detect_afterglow](#) correction removed, the ASCDSVER keyword value is the CIAO software version that was used. If you have not removed the correction yet, you should see something like this:

```
unix% dmkeypar acisf00459_000N002_evt1.fits ASCDSVER echo+
R4CU5UPD11.1
```

The observation was processed before the tool was included pipeline, i.e. the ASCDSVER is lower than DS 7.4.0. Note that the [version naming convention](#) changed after version R4CU5UPD14 to the "DS" system, starting with DS 6.0.0. *Before continuing, remove any afterglow correction that was applied via `acis_detect_afterglow`* (e.g. during SDP); see the [Remove the acis_detect_afterglow Correction](#) for instructions.

Create a New Bad Pixel File

The `acis_run_hotpix` tool is run to create the new bad pixel file:

```
unix% punlearn acis_run_hotpix
unix% pset acis_run_hotpix infile=acis_459_reset_evt1.fits
unix% pset acis_run_hotpix outfile=acis_459_new_bpix1.fits
unix% pset acis_run_hotpix badpixfile=acisf00459_000N002_bpix1.fits
unix% pset acis_run_hotpix biasfile=@bias_files.lis
unix% pset acis_run_hotpix maskfile=acisf00459_000N002_msk1.fits
unix% pset acis_run_hotpix pbkfile=acisf063875928N002_pbk0.fits
unix% acis_run_hotpix
Input event list (acis_459_reset_evt1.fits):
Output bad pixel file (acis_459_new_bpix1.fits):
Input mask file ( <filename> | default | none | NONE ) (acisf00459_000N002_msk1.fits):
Input bad pixel file (acisf00459_000N002_bpix1.fits):
Input bias images (@bias_files.lis):
```

The `badpixfile` parameter is set to the observation-specific bad pixel file from the Archive, *not* a bad pixel file from the CALDB. The latter should not be used when running this tool.

Note that for most observations there will be more than one bias file. *All* the files must be input to the `biasfile` parameter, either as a list or as a stack (see [ahelp_stack](#) for more information). Here we used:

```
unix% more bias_files.lis
acisf063874723N002_1_bias0.fits
acisf063874723N002_2_bias0.fits
acisf063874723N002_3_bias0.fits
acisf063874723N002_4_bias0.fits
acisf063874723N002_5_bias0.fits
```

The contents of the parameter file may be checked using `plist acis_run_hotpix`.

Applying the File

Now that we have a new bad pixel file, it needs to be applied to the event file. To do so, run `acis_process_events` as shown in the [Create a New Level=2 Event File thread](#). The bad pixel file is used in the `badpixfile` parameter:

```
unix% pset acis_process_events badpixfile=acis_459_new_bpix1.fits
```

Also, set this as the observation-specific bad pixel file for any subsequent analysis tasks; see the [Use Observation-specific Bad Pixel Files thread](#) for instructions.

Warning message: "File /tmp/hotpixel_list.fits does not have any rows"

Some datasets will return this warning when `acis_run_hotpix` is run:

```
# acis_classify_hotpix (CIAO 3.4): WARNING: File /tmp/hotpixel_list.fits does not have any rows.
```

It just means that no hot pixels were identified in the observation, which is a normal occurrence.

Caveats

There are a few caveats associated with `acis_run_hotpix`.

- `acis_run_hotpix` will not find afterglows and hot pixels if they are embedded in a bright source.
- The tool can misidentify some legitimate X-ray events as bad. The worst case scenario is a very faint source that has a flare whose duration is much less than the period of the dither (nominally 707 s in the Z direction). The [dither why topic](#) has more information.

Parameters for `/home/username/cxcds_param/acis_run_hotpix.par`

```

infile = acis_459_reset_evt1.fits Input event list
outfile = acis_459_new_bpix1.fits Output bad pixel file
badpixfile = acisf00459_000N002_bpix1.fits Input bad pixel file
biasfile = @bias_files.lis Input bias images
maskfile = acisf00459_000N002_msk1.fits Input mask file ( <filename> | none | NONE )
pbkfile = acisf063875928N002_pbk0.fits Input parameter block file
(probthresh = 1.0e-3) Minimum significance of potentially bad pixels after trials (e.g. 0.001)
(regwidth = 7) Size of reference region for comparison (e.g. 7 pixels x 7 pixels)
(expnthresh = 10) Minimum difference in frame numbers between hot pixels
(biasthresh = 6) Minimum bias offset for invalid pixels in adu
(tempdir = ${ASCDS_WORK_PATH} -> /tmp) Temporary work directory
(verbose = 0) Debug level
(clobber = no) Clobber output files?
(mode = ql)

```

History

- 10 Feb 2005 updated for CIAO 3.2.1: new acis_run_hotpix parameter (pbkfile); new interface for retrieving bias files
- 16 Feb 2005 clarified statement in *Overview* that acis_run_hotpix should not be used on CC-mode data
- 23 Jun 2005 CIAO 3.2.2 patch: added VFAINT mode data section
- 21 Jul 2005 explained "File /tmp/hotpixel_list.fits does not have any rows" **Warning**
- 12 Dec 2005 updated for CIAO 3.3: users should be able to obtain correct bias and parameter block files from *ChaSeR* or *WebChaSeR*; minor changes to acis_run_hotpix parameter file
- 22 Mar 2006 added Which status bits are used? subsection
- 29 Mar 2006 expanded information in Which status bits are used? subsection
- 05 Apr 2006 updated ASCDSVER check in Get Started to show that it may return a CIAO version
- 01 Dec 2006 updated for CIAO 3.4: added "Create a New ACIS Bad Pixel File" to thread title; CIAO version in warning

URL: <http://cxc.harvard.edu/ciao/threads/acishotpixels/>

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