Chandra X-ray Center

AHELP for CIAO 3.4   **acis_run_hotpix**   Context: tools

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Synopsis

Identify and flag "hot" pixels and cosmic–ray "afterglows."

Syntax

```
acis_run_hotpix infile outfile pbkfile badpixfile biasfile maskfile
[probthresh] [regwidth] [expnothresh] [biasthresh] [tempdir] [verbose]
[clobber]
```

Description

acis_run_hotpix is a script which executes, in sequence, the tools acis_build_badpix, acis_find_hotpix, acis_classify_hotpix and acis_build_badpix. The tool acis_build_badpix is executed twice. 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 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 and their neighbors to the output bad–pixel file (acis_build_badpix).

If a pixel in the input bad–pixel file is identified as bad because it is included in a CALDB list of known bad pixels, then the pixel is copied to the output bad–pixel file. If a pixel in the input bad–pixel file is identified as bad because it is hot, is affected by an afterglow or has a bad bias value, then the pixel is copied to the output bad–pixel file if and only if the pixel is reidentified as bad when the tool is rerun. The output bad–pixel file may also contain pixels that are not included in input bad–pixel file if they are found to be hot, to be affected by an afterglow or to have a bad bias value.

Since astrophysical sources can produce an unusually large number of events in a pixel, some care is used to try to avoid misidentifying these events as hot–pixel or afterglow events. Unlike afterglows or hot–pixel events, events from astrophysical sources are dithered. Therefore, if the number of events on the pixels surrounding a suspicious pixel is large compared to the mean number of events per pixel (see probthresh), the events are most likely associated with an astrophysical source. The events on these pixels are not flagged and the pixels are not identified as bad. Of course, this means that the tool may not find hot pixels or afterglows if they are in the dither pattern of an astrophysical source.

An "afterglow" is produced when a large amount of charge is deposited on a CCD by a cosmic ray. Most of the charge is clocked off of the CCD in a single frame. However, a small amount can be captured in charge traps, which release the charge relatively slowly. As a result, a sequence of events can appear in a single pixel

over a few to a few dozen frames as the trapped charge is released. The events need not occur in consecutive frames. There can be gaps of a few frames with no events for the pixel. The amount of charge released per frame appears to decay exponentially with time. If the median number of frames between consecutive events on a suspicious pixel is small (see expnothresh), then the events are flagged as afterglow events. The inferred start and stop times of an afterglow are copied to the columns TIME and TIME_STOP, respectively, in the output bad–pixel file. Legitimate X–ray events may be identified as afterglow events if the X–ray source is relatively faint except during some time interval which is short compared to the period of the dither.

If the events on a suspicious pixel are not associated with an astrophysical source or an afterglow, then the pixel is identified as a hot pixel.

This tool supersedes acis_detect_afterglow because it (1) misidentifies far fewer legitimate X–ray events as afterglows than acis_detect_afterglow, (2) identifies pixels that are hot or that have bad bias values, which acis_detect_afterglow does not do and (3) permits afterglows to have gaps, which acis_detect_afterglow did not do. However, there are legitimate afterglows that the tool acis_detect_afterglow identifies, but acis_run_hotpix does not. These afterglows have too few events to be considered statistically significant by acis_run_hotpix. It is possible to change the statistical threshold by using parameter probthresh, but such a change may increase the chances that real X–ray events are discarded.

This tool should only be run on data that has been taken in a TIMED exposure mode. Do not use acis_run_hotpix on continuous–clocking (CC) mode data. This is because the code is designed to look for bad pixels, not bad columns, and only the column of an event is known in CC mode.

Status Bits

acis_find_hotpix identifies 3 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 in 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.

Example

```
acis_run_hotpix acisf00732_000N002_evt1.fits new_bpix1.fits
pbkfile="acisf079650447N002_pbk0.fits"
badpixfile="acisf00732_000N002_bpix1.fits" biasfile=@bias_list.txt
maskfile="acisf00732_000N002_msk1.fits"
```

This example shows the default use of the tool acis_run_hotpix. The files acisf00732_000N002_evt1.fits, acisf079650447N002_pbk0.fits, acisf00732_000N002_bpix1.fits, bias_list.txt and acisf00732_000N002_msk1.fits are read and processed to create the file new_bpix1.fits. The input bad−pixel file should be an observation specific file (e.g. acisf00732_000N002_bpix1.fits) instead of a file from the calibration database (e.g. acisD2002−10−05badpixN0001.fits). The output file new_bpix1.fits should be used when making an imaging or grating ARF or when making an instrument (i.e. exposure) map. The file bias_list.txt contains a list of the bias maps for the observation, with one file name per line.

Parameters

name	type	ftype	def	min	max	reqd	stacks
infile	file	input				yes	yes
outfile	file	output				yes	
pbkfile	file	input				yes	
badpixfile	file	input				yes	
biasfile	file	input				yes	yes
maskfile	file	input	NONE			yes	
probthresh	real		1e−3	1e−10	0.1	no	
regwidth	integer		7	3	255	no	
expnothresh	integer		10	2	10000	no	
biasthresh	integer		6	3	100	no	
tempdir	string		${ASCDS_WORK_PATH}			no	
verbose	integer		0	0	5	no	
clobber	boolean		no			no	

Detailed Parameter Descriptions

Parameter=infile `(file required filetype=input stacks=yes)`

The name(s) of the input event data file(s) (e.g. acisf00732_000N002_evt1.fits). acis_run_hotpix can read Level 0, Level 1 and Level 2 files, but users are urged to use Level 1 files because these files contain all of the events. Some of the events are excluded from Level 2 files.

As mentioned before, this tool should only be run on data that has been taken in a TIMED exposure mode. If you are unsure of the mode of your data, check the READMODE header keyword.

Parameter=outfile `(file required filetype=output)`

The name of the output bad−pixel file. This file contains the all the identified bad pixels; note that the bad pixels in the input bad pixel file are not all necessarily included in the output bad pixel file. The output file should be used when creating an ARF with mkarf, mkgarf, mkwarf or acisspec or when making an instrument map with mkinstmap by editing the ardlib.par file.

Parameter=pbkfile `(file required filetype=input)`

The name of the input parameter−block file (e.g. acisf079650447N002_pbk0.fits). The parameter−block file is used to determine which CCDs are active, the READMODE and DATAMODE and the values of CCD_ID, FEP_ID, ROWCNT, STARTROW, TSTART, TSTOP etc.

Parameter=badpixfile `(file required filetype=input)`

The name of the observation−specific input bad−pixel file (e.g. acisf00732_000N002_bpix1.fits). Do not use the name of a file in the calibration database (CALDB).

Parameter=biasfile `(file required filetype=input stacks=yes)`

The name(s) of the optional input bias map(s) for the observation (e.g. acisf079649146N002_0_bias0.fits). Each bias map is searched for pixels whose bias values are either too low or too high (see biasthresh).

Parameter=maskfile `(file required filetype=input default=NONE)`

The name of the optional input mask file which defines the "active" region(s) of the CCD(s) used for the observation (e.g. acisf00732_000N002_msk1.fits). Typically only the outer edge of a CCD is inactive. If a pixel is inactive, it is excluded from the search for hot pixels.

Parameter=probthresh `(real not required default=1e-3 min=1e-10 max=0.1)`

This parameter specifies the minimum significance of suspicious pixels. For example, if P is the probability of obtaining S events on a pixel for an expected number of events R, then the pixel is identified as suspicious if P < (probthresh / T), where T is the total number of pixels examined. A pixel is also suspicious if P > 1 − (probthresh / T). The default value of 0.001 corresponds to 3.09 sigma for a normal distribution. The one, two and three sigma confidence values are 0.159, 0.0228 and 0.00135, respectively. The default value of this parameter should be adequate in most cases. Be cautious about using some other value.

Parameter=regwidth `(integer not required default=7 min=3 max=255)`

This parameter specifies the size of the reference region used to determine the expected number of events for a pixel. The default value of seven means that the forty−eight pixels in a 7 pixel x 7 pixel region surrounding a pixel are used. The actual number of pixels used is smaller than forty−eight if the region contains pixels known to be bad, contains inactive pixels or overlaps the edge of a node. If no events are in the reference region, then the mean number of events per pixel for the node is used as the expected number of events. The default value of regwidth should be adequate in most cases. Be cautious about using some other value.

Parameter=expnothresh `(integer not required default=10 min=2 max=10000)`

This parameter is used to distinguish between events associated with cosmic−ray afterglows and hot pixels. Events on a suspicious pixel are identified as afterglow events if the median number of frames between consecutive events is less than expnothresh. Otherwise, the suspicious pixel is identified as a hot pixel. The default value of this parameter should be adequate in most cases. Be cautious about using some other value.

Parameter=biasthresh `(integer not required default=6 min=3 max=100)`

This parameter is used to determine which pixels in a bias map have suspiciously high or low values. Before performing the test, the median bias value of a column of a CCD is subtracted from the bias values of all the pixels in the column to obtain the adjusted biases. Pixels identified as bad in the calibration, bias−err and bias−map files are excluded from the computation of the median. If the adjusted−bias value of a pixel > biasthresh adu or < −biasthresh adu, then the pixel is identified as bad and written to the output file. The

default value of this parameter should be adequate in most cases. Be cautious about using some other value.

Parameter=tempdir `(string not required default=${ASCDS_WORK_PATH})`

The name of the directory to which temporary files are written.

Parameter=verbose `(integer not required default=0 min=0 max=5)`

This parameter determines the amount of messages that is generated by acis_run_hotpix. If verbose=0, very few messages are reported. If verbose=5, the largest amount of messages is produced.

Parameter=clobber `(boolean not required default=no)`

If clobber=yes and a file exists that has the same name as the name of the output file, then the existing file is overwritten. If clobber=no, then the existing file remains unchanged.

CHANGES IN CIAO 3.3

Parameter File

The kernel parameter has been removed. The pbkfile parameter has been changed to be an automatic (not hidden) parameter, and its default was changed from "NONE" to "".

CHANGES IN CIAO 3.2.2

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.

Bugs

See the bugs page on the CIAO website for an up−to−date listing of known bugs.

See Also

tools

        acis_build_badpix, acis_classify_hotpix, acis_detect_afterglow, acis_find_hotpix, acis_process_events, acisreadcorr, destreak

Parameter=tempdir (string not required default=${ASCDS_WORK_PATH})