Chandra Science

TEST VERSION OF THREAD

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Choosing an Energy Filter

CIAO 2.2 Science Threads
(13 June 2002)

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In many cases, the threads recommend that you filter ACIS event files on energy before beginning the analysis. For instance, see the Filtering Data and ACIS Background Subtraction threads.

There are several things to consider when choosing an energy filter for your data. Three major concerns are outlined below, with sample filters for illustrative purposes.

- ***Calibration***
  [energy=300:10000]

  The energy scale of the ACIS CCDs is only calibrated over the range 0.277–9.886 keV.

  The detectors were calibrated on the ground using various energies between 0.277 keV (the carbon K line) and 9.886 keV (the germanium K line). In flight, there are fewer energies and a narrower energy range with which to calibrate the detectors: 1.5–5.9 keV for an onboard radioactive calibration source, plus the oxygen lines from E0102 at ~0.6 keV. Therefore, it is not possible to extend the calibration beyond this range.

- ***ACIS Background***
  [energy=500:7000]

  The high energy particle background is fairly flat in the 2–7 keV range. However, it both rises sharply below the 0.3 keV mark and climbs by a factor of 8 between 7–10 keV. For more details, see this memo (PS, 17 pp) on characterizing the ACIS background, specifically Figures 1 and 2.

If you are looking at the faint extended structure of a source, the high background rate matters. Reducing the amount of background in your image will help make the structure more prominent.

- ***Pileup***
  [energy=300:]

  For unpiled sources, no source photons above 10 keV are expected. This is because the effective area of the telescope is zero beyond that point. If a source is piled, however, two 6 keV photons could be detected as a single 12 keV photon. In this case, a cut at 10 keV is fine unless you are intending to model the piled spectrum.

History

13 Jun 2002 – created topic

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TEST VERSION OF THREAD

iCXC
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DRAFT VERSION

Analysis Guide: ACIS Data Preparation

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It is possible to analyse any Chandra dataset straight out of the box. However, to get scientifically accurate results, there are a number of data processing questions that should be considered.

This guide is designed to help the user decide how an ACIS dataset should be processed and filtered before starting the data analysis stage.

The following threads are referenced:

- Use Observation–specific Bad Pixel Files
- Create a New Level=2 Events File
- Apply an ACIS Gain Map
- Remove Pixel Randomization
- Apply/Remove PHA Randomization
- A Note on Processing Versions
- Clean ACIS Background in VFAINT Mode
- Remove the acis_detect_afterglow Correction
- Destreak the ACIS–S4 Chip
- Remove the ACIS Readout Streak
- Filtering Data
- Filtering Light Curves
- Improving the Astrometry of your Data

The threads should be run in the order in which they are presented below. It is noted in the thread when steps may be combined, e.g. the processing that is done by `acis_process_events` (apply a gain map, remove pixel randomization, etc.) can be done all at once.

- ***Thread:*** Use Observation–specific Bad Pixel Files

  Although the majority of the calibration files are now contained within the Chandra Calibration Database (CALDB), the observation–specific bad pixel list must still be set by the user. This ensures that the most accurately known bad pixel list for any observation will be used in the data processing.

- The Create a New Level=2 Events File thread combines the following 6 choices into one easy–to–follow format.

  When Chandra data goes through Standard Data Processing (SDP, or the pipeline), the most recently available calibration is applied to it. Since this calibration is continuously being improved, one should check whether there are currently newer files available. Similarly, some science decisions are

made during SDP; every user has the option to reprocess the data with different parameters.

1.
Thread: Apply an ACIS Gain Map

There are two cases in which you may need to update your ACIS gain map.

1. You are analysing a −120°observation that was taken on the S3 chip. These gainfiles were updated in CALDB 2.8.
2. You are analysing any data processed with a version earlier than CALDB 2.3. All the gainfiles were updated in that release.

The information necessary to decide between these cases is recorded in the header of the level=1 event file:

```
unix% dmlist acis_evt1.fits header | grep CALDBVER
0118 CALDBVER              1.4                          String

unix% dmlist acis_evt1.fits header | grep FP_TEMP
0117 FP_TEMP                    153.4460140             Real8
unix% calc 153-273
-120

unix% dmlist acis_evt1.fits header | grep DETNAM
0035 DETNAM               ACIS-012367                   String
```

This observation, which is at −120°and uses the S3 (ccd_id=7) chip, needs to be reprocessed so that it uses *at least* CALDB 2.8.

2.
Thread: Remove Pixel Randomization

SDP randomizes the positions of events detected within a given ACIS pixel. This randomization is done to remove the instrumental "gridded" appearance of the data and to avoid possible aliasing affects associated with this spatial grid. The event coordinates are randomized over the instrument pixel size (0.5 arcsec), so technically no information is lost. However, some may wish to remove this randomization.

3.
Threads: Apply/Remove PHA Randomization
A Note on Processing Versions

For some observations, the way PHA channels are converted to PI channels will cause an aliasing problem in the final binned spectra. Since PHA is in discrete integer values, a single value of PHA corresponds to a single energy and therefore a single PI value for a given 32x32 pixel region in the gainmap file. PHA randomization became part of standard data processing in software version DS6.1.

The software version is stored in the header keyword `ASCDSVER`:

```
unix% dmlist acis_evt1.fits header | grep ASCDSVER
0008 ASCDSVER             R4CU5UPD8.2                   String
```

The software version naming convention changed after version R4CU5UPD14 to the "DS" system, starting with DS6.0.0. Since this data was processed before DS6.1, the PHA is not randomized. Similarly, one could *remove* the randomization from a file that has undergone more recent processing.

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4. ***Thread:*** Clean ACIS Background in VFAINT Mode

   In VFAINT mode, we have the benefit of working with a 5x5 pixel event island, instead of just a 3x3 event island (as in FAINT mode). Therefore, we can use the pulse heights in the outer 16 pixels of the 5x5 event island to help distinguish between good X-ray events and bad events that are most likely associated with cosmic rays.

   Check the `DATAMODE` keyword to see if the observation was done in VFAINT mode:

```
unix% dmlist acis_evt1.fits header | grep DATAMODE
0049 DATAMODE            FAINT                          String
```

   Since this data was taken in FAINT mode, the thread does not apply.

---

5. ***Thread:*** Remove the acis_detect_afterglow Correction

   Afterglow is the residual charge from cosmic ray events in CCD pixels. If they are not removed, these events can result in spurious detections of faint sources. The probable afterglow events are flagged in the level=1 event file and then filtered out of the level=2 event file by the pipeline.

   It has been determined that 3–5 % of the valid source photons may be rejected from diffracted spectra. Also, if the user is interested in modeling a piled source, e.g. with the jdpileup model in *Sherpa*, it is necessary to retain *all* the events from the level=2 file, afterglow included.

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6. ***Thread:*** Destreak the ACIS–S4 Chip

   There is a flaw in the serial readout of the chips, causing a significant amount of charge to be randomly deposited along pixel rows as they are read out. Chip S4 (ccd_id=8) is most affected by this problem. These streak events are not removed by standard grade, status, or bad–pixel filtering, and are therefore still present in the level=2 event file.

   See which chips were on for the observation:

```
unix% dmlist acis_evt1.fits header | grep DETNAM
0035 DETNAM              ACIS-012367                    String
```

The S4 chip (ccd_id=8) was not on for the observation, so this step is unnecessary.

- ***Thread:*** Remove the ACIS Readout Streak

While ACIS reads out, it is still taking data. Photons detected during the readout are clocked out in the wrong row and so have incorrect CHIPY values. For a bright source, you get a streak all along the column (on both sides of the source, since some events are from the previous exposure). We want to both remove the streak from the image (for cosmetic reasons and so that it doesn't affect source detection) and to retain the streak photons (which have more accurate timing information and are not affected by pileup).

Again, this thread is only necessary if you are analysing a bright source.

- ***Thread:*** Improving the Astrometry of your Data

  Most ACIS–I observations have an offset of up to 1.5 arcsec that needs to be corrected. See the Caveats Regarding CIAO and Archive Data page for details.

  Improved celestial location precision is possible for some observations by cross–correlating detected X–ray sources with high–precision optical, IR, or radio catalogs. This technique can be used to remove large offsets due to processing problems or to fine–tune the astrometry to well below the typical 0.6 arcsec performance.

- ***Threads:*** Filtering Data

  Filtering Light Curves

  It may be necessary to filter your data to remove periods of anomolous background levels, such as the flares seen in ACIS observations. Also, the high energy particle background can affect the detection of faint sources or features in emission. This background is fairly flat in the 2–7 keV range, but it both rises sharply below the 0.3 keV mark and climbs by a factor of 8 between 7–10 keV.

Last modified: 20 June 2002

CIAO 2.2.1 (November 2001)

Ahelp for *dmextract*

Context: tools

Synopsis

Make a histogram table file (e.g. PHA file) from a table column. Generate count histogram on supplied regions for a spatial table or image file.

Syntax

```
dmextract infile outfile [bkg] [error] [bkgerror] [bkgnorm]
[exp] [bkgexp] [sys_err] [opt] [defaults] [wmap] [clobber]
[verbose]
```

...

See Also

Threads:

Extract ACIS Spectra for Pointlike Sources and Make RMFs and ARFs Step–by–Step
Estimate Source Counts in an Image
Obtain and Fit a Radial Profile
Create a Phase–binned Spectrum

concept:

subspace

dm:

dm, dmbinning, dmcols, dmfiltering, dmimages, dmimfiltering, dmintro, dmopt, dmsyntax

tools:

dmcopy, dmfilth, dmgroup, dmimghist, dmlist, dmregrid, dmstat, fullgarf, mkarf, mkexpmap, mkgarf, mkinstmap, mkpsf, mkrmf, mkwarf, tgextract

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60 Garden Street, Cambridge, MA 02138 USA. Email: cxcweb@cfa.harvard.edu
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