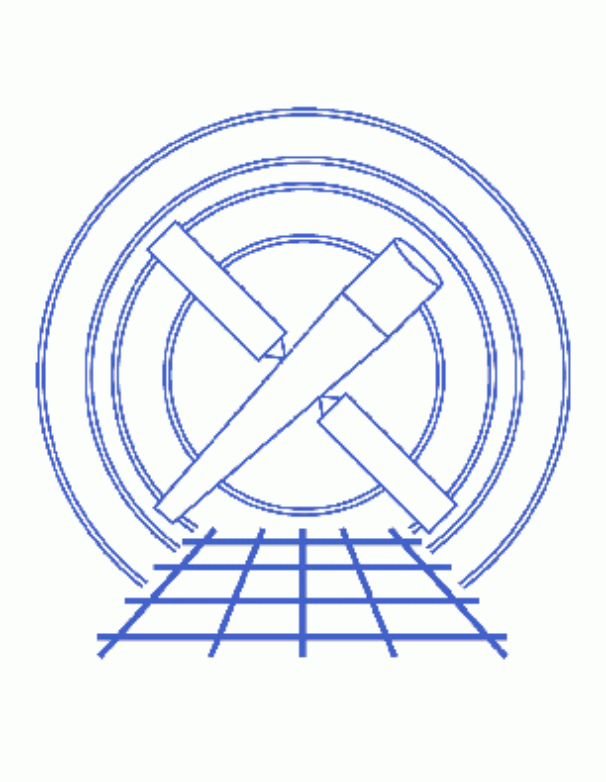
Filtering Data



CIAO 3.4 Science Threads

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URL: http://cxc.harvard.edu/ciao/threads/filter/ Last modified: 1 Dec 2006

Filtering Data

CIAO 3.4 Science Threads

Overview

Last Update: 1 Dec 2006 − updated for CIAO 3.4: `kernel` parameter removed from `dmgti`

Synopsis:

The CIAO Data Model allows powerful filtering of datafiles. A file may be filtered on any of its columns, e.g. energy, time, position. Any (or none) of the filtering actions described in this thread may need to be performed on your dataset.

Related Links:

- Analysis Guide: ACIS Data Preparation
- Complete syntax descriptions and further examples of filtering data are available from "ahelp dmfiltering" and "ahelp dmimfiltering".

Proceed to the HTML or hardcopy (PDF: A4 | letter) version of the thread.

Get Started

Sample ObsID used: 1843 (ACIS−I, G21.5−0.9)

File types needed: evt2

Filtering is not restricted to the level=2 event file; in fact, filters are usually applied to the `evt1.fits` file when working with grating data.

Restrict The Energy Range

For most ACIS analyses, you will want to include at most the 0.3 kev to 10.0 kev energy range, as explained in the Choosing an Energy Filter why topic.

```
unix% punlearn dmcopy
unix% dmcopy "acisf01843N001_evt2.fits[energy=300:10000]" acis_1843_evt2_0.3-10.fits
```

This command creates a new event file that only includes the data within the specified energy range.

Using Exclude Filters

It is also possible to create a filter based on what you *do not* want in the final file by using the `exclude` syntax:

```
unix% dmcopy "acisf01843N001_evt2.fits[exclude ccd_id=0:4,6,8:9]" acis_1843_evt2_bi.fits
```

This filter only keeps the back−illuminated chips (`ccd_id=5,7`).

Care must be taken when combining filters; this syntax ***WILL NOT WORK***:

```
unix% dmcopy "acisf01843N001_evt2.fits[exclude sky=region(reg.fits)][energy=300:10000]" \
      acis_1843_evt2_out.fits
Failed to open virtual file acisf01843N001_evt2.fits[exclude sky=region(reg.fits)][energy=300:10000]
DM Parse error: cannot mix EXCLUDE and FILTER
```

The second filter (on energy) must be rewritten in terms of an exclude for `dmcopy` to produce the desired output:

```
unix% dmcopy "acisf01843N001_evt2.fits[exclude sky=region(reg.fits),energy=:299,10000:]" \
      acis_1843_evt2_out.fits
```

Applying Time Filters

For simple time filters, e.g. selecting a particular interval, the basic DM syntax may be used:

```
unix% dmcopy "acisf01843N001_evt2.fits[time=60413209:60414209]" acis_1843_evt2_1000s.fits
```

For more involved filters, use the CIAO tool `dmgti`. This tool allows the user to set constraints on the other (i.e. non−TIME) columns in the file and extract the set of times for which those constraints are true. A general outline of this process is given first, followed by a common filtering scenario in detail (Eliminate High Background Times).

Time Filtering in General

Applying time filters to an event file involves four primary steps:

1. ***Define the filter***

   Determine a filtering criterion that can be expressed as a valid `dmgti userlimit` parameter.
2. ***Create a Good Time Interval***

   A good time interval (GTI) indicates which data are "good", based on the chosen filter definition. The tool `dmgti` is used to create a GTI table:

   ```
   unix% punlearn dmgti
   unix% pset dmgti infile=filename_mtl2.fits
   unix% pset dmgti outfile=myfilter_gti.fits
   unix% pset dmgti userlimit="<filtering criterion>"
   ```

```
unix% dmgti
```

3. ***Apply the GTI table***

   Apply the GTI table to the event fits file with dmcopy:

```
unix% punlearn dmcopy
unix% dmcopy "filename_evt2.fits[@myfilter_gti.fits]" filename_evt2_flt.fits
```

4. ***Verify filtering***

   Looking at the EXPO keyword is one way to see the results of filtering; this will show the amount of time that was eliminated in creating the filtered event file:

```
unix% dmlist event_filename.fits header | grep EXPO
unix% dmlist event_filename_flt.fits header | grep EXPO
```

   The tool dmkeypar may also be used to examine specific header keywords:

```
unix% dmkeypar event_filename.fits EXPOSUR7 echo+
```

Eliminate High Background Times

The Chandra Calibration team notes the following in its study of the ACIS background available from the Calibration page: "A phenomenon not anticipated prior to launch that can seriously affect the scientific value of an observation is background flares, when the count rate can increase by a factor of up to 100. Such flares have been observed anywhere in the orbit, including near the apogee." Therefore, eliminating high−background periods is another type of filtering that might be required for your data:

Here is one example of how to eliminate periods of high background. The ACIS background and Filtering lightcurves threads also discuss ways of filtering out flares.

1. ***View the image***

   An event file may be viewed directly by ds9:

```
unix% ds9 acis_1843_evt2_0.3-10.fits &
```

   A log scale (Scale −> log) and some adjustment to the color table show the object and the background. It may also be necessary to adjust the blocking factor to view the whole image at once; try "Bin −> block 8" for a reasonable view.

2. ***Select the background area***

   From this image, regions may be created to define the background area. Select "Region −> Ellipse" from the ds9 toolbar, then hold down the left mouse button at the center of the field, and drag until the ellipse covers the desired area. Clicking on the resulting shape will select the region, allowing you to reposition or resize it; this FAQ shows how to rotate regions in ds9. This region is used for the example.

   The defined region is saved using the following steps:

   - Region −> File Format−> CIAO
   - Region −> File Coordinate System −> Physical
   - Region −> Save Regions... −> Save As "obj.reg"

The imaging (ds9) window may be closed by choosing "File −> Exit".

The resulting obj.reg file will look something like this:

```
unix% more obj.reg
# Region file format: CIAO version 1.0
ellipse(1628,4116,100,140,0) # blue
```

3. ***Extract a background−only lightcurve***

Now it is possible to create a background lightcurve by using the "virtual file" syntax. We do this by specifying the whole field, minus the source object(s). In this case, the ellipse that is defined in `obj.reg` is omitted; note that we could have also used the `exclude` syntax to ignore the source (i.e. "`exclude sky=region(obj.reg)`" in the `infile` parameter:

```
unix% punlearn dmextract
unix% pset dmextract \
      infile="acis_1843_evt2_0.3−10.fits[sky=field()−ellipse(1628,4116,100,140,0)][bin time=::3.2410
unix% pset dmextract outfile=background_lc.fits
unix% pset dmextract opt=ltc1
unix% dmextract
Input event file  (acis_1843_evt2_0.3−10.fits[sky=field()−ellipse(1628,4116,100,140,0)][bin time=::3
Enter output file name (background_lc.fits):
```

You can check the resulting parameter file with plist dmextract. Here the shorthand "`sky`" was used to specify x,y coordinates. Since "`sky`" is an alias of "`(x,y)`", both work in this context.

4. ***Examine the lightcurve and define a filter***

The lightcurve that was just created can be plotted and examined in *ChIPS*:

```
unix% chips

Welcome to ChIPS, version CIAO 3.4
Copyright (C) 1999−2003, Smithsonian Astrophysical Observatory

chips> curve "background_lc.fits[cols time,count_rate]"
chips> xlabel Time
chips> ylabel "Background Count Rate"
```

Which produces Figure 2 . We can see that there is a spike in the lightcurve. The coordinates can be found with the *ChIPS* `pickpoints` command:

```
chips> pickpoints

Click LMB or tap spacebar to pick point.
Click RMB or type 'q' to quit picking points.

Point picked: (84274280.000000, 84.512329)
Point picked: (84274280.000000, 126.068245)

chips> quit
```

Here we have marked the "top" and "bottom" of the spike.

To remove this feature from the dataset, we need to define a filter that excludes rates greater than ~85.0 counts/sec.

5. ***Create a Good Time Interval table***

As mentioned before, the Good Time Interval (GTI) table contains the times during which the data are good, based on the filter definition. For this example, it will be the times when the count rate is below 85.0 counts/sec, as determined in the previous step:

```
unix% punlearn dmgti
unix% pset dmgti infile=background_lc.fits
unix% pset dmgti outfile=bkg_gti.fits
unix% pset dmgti userlimit="count_rate <=85.0"
unix% dmgti
Input MTL file (background_lc.fits):
Output GTI file (bkg_gti.fits):
User defined limit string (count_rate <=85.0):
```

A more complex filter could be applied instead, such as `"count_rate >= 5.5 && count_rate <=85.0"`; see ahelp dmfiltering for other examples of filtering syntax.

You can check the resulting parameter file with plist dmgti.

6. ***Apply the GTI table***

   To apply the GTI table to the dataset, `dmcopy` is run:

```
unix% dmcopy "acis_1843_evt2_0.3−10.fits[@bkg_gti.fits]" acis_1843_evt2_0.3−10_bkgflt.fits
```

7. ***Verify filtering***

   Examination of the EXPO keywords shows the amount of filtering that was done in the creation of the new event file:

```
unix% dmlist acis_1843_evt2_0.3−10.fits header | grep EXPO
0082 EXPOSUR0                  7857.6259545448 [s]       Real8        [s] Total exposure time
0085 EXPOSUR1                  7857.6259545448 [s]       Real8        [s] Total exposure time
0088 EXPOSUR2                  7857.6259545448 [s]       Real8        [s] Total exposure time
0091 EXPOSUR3                  7854.4664748687 [s]       Real8        [s] Total exposure time
0094 EXPOSUR6                  7857.6259545448 [s]       Real8        [s] Total exposure time
0097 EXPOSUR7                  7857.6259545448 [s]       Real8        [s] Total exposure time
0100 EXPOSURE                  7857.6259545448 [s]       Real8        [s] Total exposure time

unix% dmlist acis_1843_evt2_0.3−10_bkgflt.fits header | grep EXPO
0081 EXPOSUR0                  7825.6259545417 [s]       Real8        [s] Total exposure time
0084 EXPOSUR1                  7825.6259545417 [s]       Real8        [s] Total exposure time
0087 EXPOSUR2                  7825.6259545417 [s]       Real8        [s] Total exposure time
0090 EXPOSUR3                  7822.4664748655 [s]       Real8        [s] Total exposure time
0093 EXPOSUR6                  7825.6259545417 [s]       Real8        [s] Total exposure time
0096 EXPOSUR7                  7825.6259545417 [s]       Real8        [s] Total exposure time
0099 EXPOSURE                  7825.6259545417 [s]       Real8        [s] Total exposure time
```

Summary

The result of this thread is the level=2 event file `acis_1843_evt2_0.3−10_bkgflt.fits`, which is filtered for high background and restricted to a specific energy range.

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


#−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−
#
# DMEXTRACT −− extract columns or counts from an event list
#
#−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−
        infile = acis_1843_evt2_0.3−10.fits[sky=field()−ellipse(1628,4116,100,140,0)][bin time=::3.24104] I
       outfile = background_lc.fits Enter output file name
          (bkg = )                  Background region file or fixed background (counts/pixel/s) subtraction
        (error = gaussian)          Method for error determination(poisson|gaussian|<variance file>)
     (bkgerror = gaussian)          Method for background error determination(poisson|gaussian|<variance file
      (bkgnorm = 1.0)               Background normalization
          (exp = )                  Exposure map image file
       (bkgexp = )                  Background exposure map image file
      (sys_err = 0)                 Fixed systematic error value for SYS_ERR keyword
          (opt = ltc1)              Output file type: pha1
     (defaults = ${ASCDS_CALIB}/cxo.mdb −> /soft/ciao/data/cxo.mdb) Instrument defaults file
          (wmap = )                 WMAP filter/binning (e.g. det=8 or default)
      (clobber = no)                OK to overwrite existing output file(s)?
      (verbose = 0)                 Verbosity level
          (mode = ql)
```

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


        infile = background_lc.fits Input MTL file
       outfile = bkg_gti.fits     Output GTI file
     userlimit = count_rate <=85.0 User defined limit string
      (mtlfile = none)            Optional output smoothed/filtered MTL file
     (lkupfile = none)            Lookup table defining which MTL columns to check against (NONE|none|<file
       (smooth = yes)             Smooth the input MTL data?
      (clobber = no)              Clobber output file if it exists?
      (verbose = 0)               Debug level
          (mode = ql)
```

History

14 Dec 2004	reviewed for CIAO 3.2: no changes
01 Dec 2005	updated for CIAO 3.3: default value of `dmextract` `error` and `bkgerror` parameters is "gaussian", update to screen output in "Verify filtering" step of the Eliminate High Background Times section
01 Dec 2006	updated for CIAO 3.4: `kernel` parameter removed from `dmgti`

URL: http://cxc.harvard.edu/ciao/threads/filter/ Last modified: 1 Dec 2006

Image 1: Selecting a region of interest

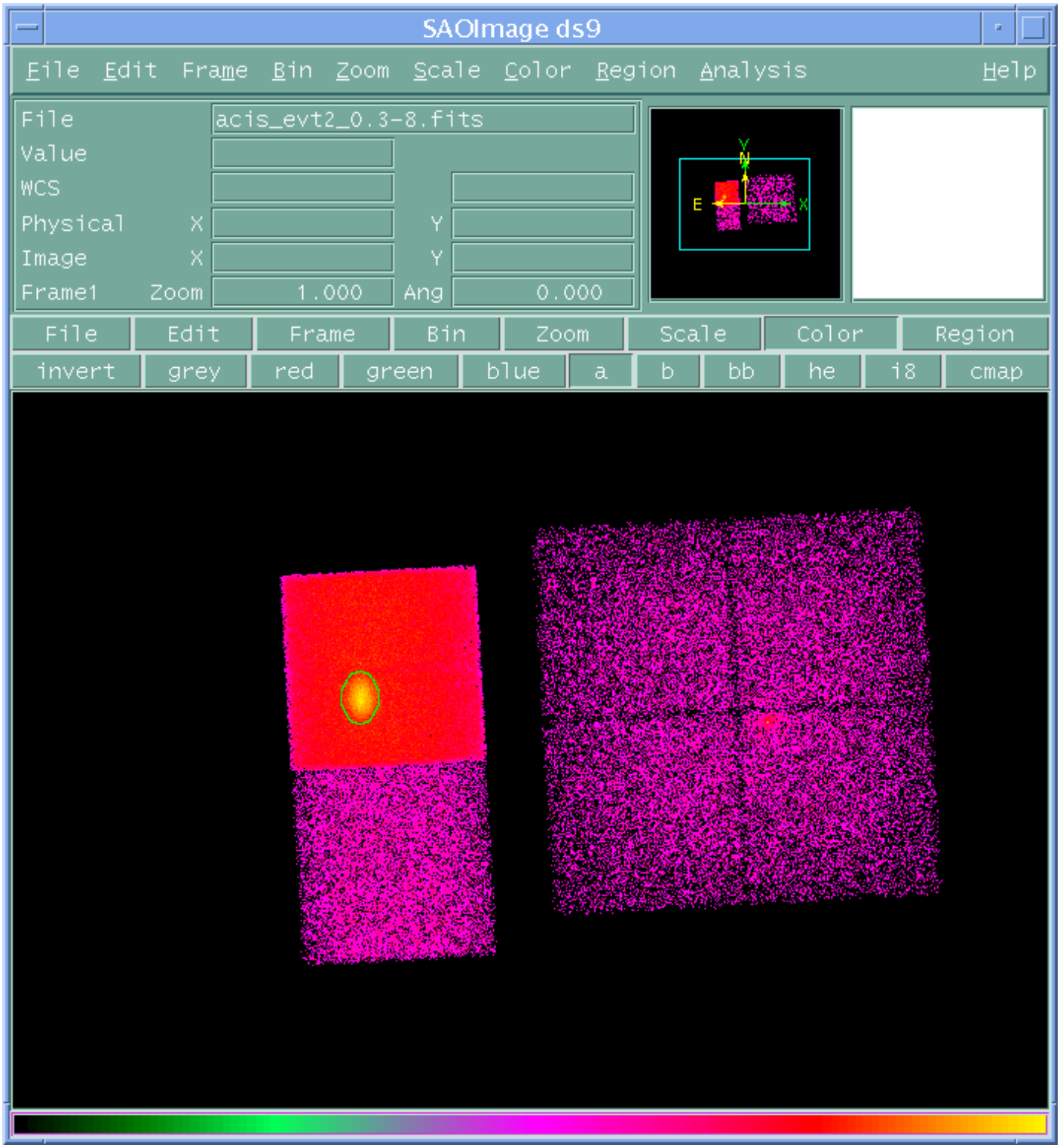
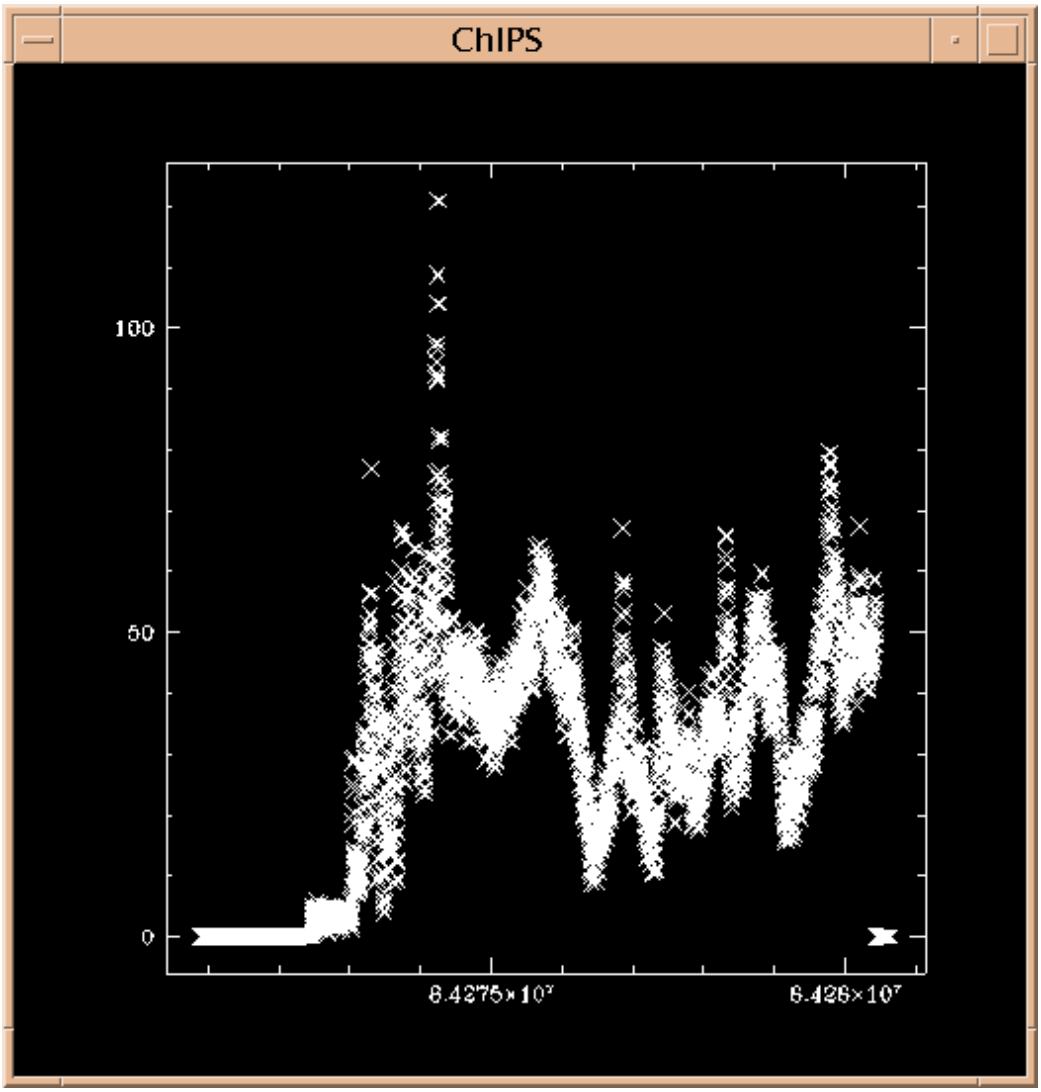
Image 2: Lightcurve of the background