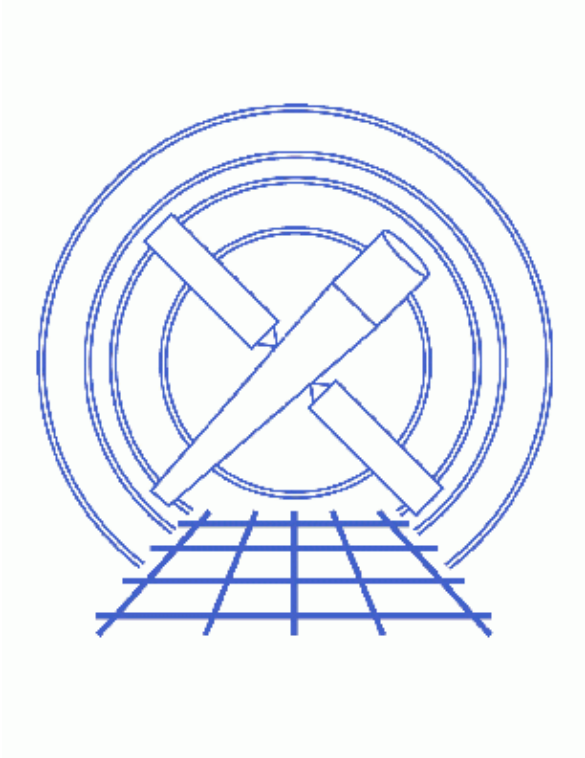
Match the Binning of an Image



CIAO 3.4 Science Threads

Table of Contents

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Overview

Last Update: 1 Dec 2006 − reviewed for CIAO 3.4: no changes

Synopsis:

There are times that you would like to create an image so that it matches an already−existing image. One example would be creating a full−resolution exposure map of a single detector chip.

Purpose:

To use the `get sky limits` script to find the binning specification of an image.

Read this thread if:

you want to create an image from a ACIS or HRC event file (or have an existing image) and to determine the binning specification for input into other CIAO tools, e.g. `dmcopy` or `mkexpmap`, to match that image.

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

Get Started

Sample ObsID used: 1838 (ACIS−S, G21.5−09)

File types needed: evt2

This thread uses the `get_sky_limits` script; for information about the script, consult the help file ("`ahelp get_sky_limits`"). The most recent version of `get_sky_limits` is v1.6 (02 November 2004):

```
unix%  grep Id `which get_sky_limits`
% $Id: get_sky_limits,v 1.6 2004/11/02 16:22:30 dburke Exp $
```

Please check that you are using the most recent version before continuing. If you do not have the script installed or need to update to a newer version, please refer to the Scripts page.

Create an image

As an example, we select a region of the observation that we are interested in:

```
unix% dmcopy \
      "acisf01838N001_evt2.fits[sky=box(4182,4392,1172,1184)][bin x=::4,y=::4]" img.fits
```

What region does the image cover?

The region represented by the image can be found in one of several ways:

A. dmlist opt=cols

The `cols` option of `dmlist` produces a report on the various coordinate systems stored for the image. In this case we find:

```
unix% dmlist img.fits cols

-------------------------------------------------------------------------------
Columns for Image Block EVENTS_IMAGE
-------------------------------------------------------------------------------

ColNo  Name                 Unit        Type             Range
   1   EVENTS_IMAGE[294,297]              Int2(294x297)  -

-------------------------------------------------------------------------------
Physical Axis Transforms for Image Block EVENTS_IMAGE
-------------------------------------------------------------------------------

Group# Axis#
   1   1,2    sky(x) = (+3595.50) +(+4.0)* ((#1)-(+0.50))
                  (y)   (+3799.50)  (+4.0)  ((#2) (+0.50))

-------------------------------------------------------------------------------
World Coordinate Axis Transforms for Image Block EVENTS_IMAGE
-------------------------------------------------------------------------------

Group# Axis#
   1   1,2    EQPOS(RA ) = (+278.3860) +TAN[(-0.000136667)* (sky(x)-(+4096.50))]
                    (DEC)   (-10.5899 )      (+0.000136667)  (   (y) (+4096.50))
```

B. dmlist opt=subspace

The `subspace` option of `dmlist` describes the filters that have been applied to the data:

```
unix% dmlist img.fits subspace | more

 --- Component 1 ---
   1 sky                  Real8              Box(4182,4392,1172,1184)
   1 sky                  Real8              Field area = 1.39709e+06 Region area = 1.38765e+06

   1 sky                  [ 1] x                  3596.0:     4768.0
   1 sky                  [ 2] y                  3800.0:     4984.0
   2 time                 Real8              TABLE GTI7

                                              84245785.9546994567: 84253741.1547068655
   3 ccd_id               Int2               7:7
```

```
   4 node_id             Int2               0:3
   5 expno               Int4               0:2147483647
   6 chipx               Int2               1:1024
   7 chipy               Int2               1:1024
   8 tdetx               Int2               1:8192
   9 tdety               Int2               1:8192
  10 detx                Real4                  0.50:     8192.50
  11 dety                Real4                  0.50:     8192.50
  12 pha                 Int4               0:36855
  13 energy              Real4                                0:  1000000.0
  14 pi                  Int4               1:1024
  15 fltgrade            Int2               0:255
  16 grade               Int2               0:0,2:2,3:3,4:4,6:6
  17 phas                Int2               −4096:4095

... (other components listed) ...
```

C. dmcoords

The dmcoords tool can be used to calculate the edges of the image in a variety of coordinate systems. Here we use it in the non−interactive mode to find the bottom−left and top−right corners:

```
unix% punlearn dmcoords

unix% dmcoords img.fits opt=logical logicalx=0.5 logicaly=0.5
unix% echo "x = `pget dmcoords x`  y = `pget dmcoords y`"
x = 3595.5  y = 3799.5

unix% punlearn dmcoords
unix% dmcoords img.fits opt=logical logicalx=294.5 logicaly=395.5
unix% echo "x = `pget dmcoords x`  y = `pget dmcoords y`"
x = 4771.5  y = 5379.5
```

The parameter files after running these two commands can be found below: bottom left and top right.

Run the script (get_sky_limits)

The `get_sky_limits` script returns the text you would use in both a DM−binning and mkexpmap xygrid specification:

```
unix% get_sky_limits img.fits verbose=1
Checking binning of image: img.fits
  Image has 294 x 297 pixels
  Lower left (0.5,0.5) corner is x,y= 3595.5, 3799.5
  Upper right (294.5,297.5) corner is x,y= 4771.5, 4987.5
  DM filter is:
    x=3595.5:4771.5:#294,y=3799.5:4987.5:#297
  mkexpmap xygrid value is:
    3595.5:4771.5:#294,3799.5:4987.5:#297
```

The binning specifications are also stored in the parameter file in the `dmfilter` and `xygrid` parameters:

```
unix% pget get_sky_limits dmfilter
x=3595.5:4771.5:#294,y=3799.5:4987.5:#297
unix% pget get_sky_limits xygrid
3595.5:4771.5:#294,3799.5:4987.5:#297
```

As discussed in the Caveats section, you may get better results if you use the `X,Y` range from the data subspace, rather than using `dmcoords`.

Caveats

As discussed in the dmbinning ahelp page, care must be taken when binning real−values columns (such as the SKY column of an event file), otherwise the edges of the files may not match up exactly. This can be seen in the above example it you use the `dmfilter` expression to create a copy of the image and subtract it from the original. In this case, 4 pixels at the bottom edge of the frame are different.

```
unix% dmcopy \
      "acisf01838N001_evt2.fits[bin x=3595.5:4771.5:#294,y=3799.5:4987.5:#297]" img2.fits
unix% dmimgcalc img.fits img2.fits diff.fits sub
unix% dmstat diff.fits centroid=no
diff.fits
    min:        −1            @:        ( 3833.5 3801.5 )
    max:        0             @:        ( 3597.5 3801.5 )
   mean:        −4.5809569619e−05
  sigma:        0.006768121682
    sum:        −4
   good:        87318
   null:        0
```

The following example shows a larger difference:

```
unix% dmcopy "acisf01838N001_evt2.fits[bin x=3570:4874:16,y=3650:4980:16]" zoom16_1.fits
unix% dmcopy "acisf01838N001_evt2.fits[x=3570:4874,y=3650:4980][bin x=::16,y=::16]" zoom16_2.fits
unix% dmimgcalc zoom16_1.fits zoom16_2.fits zoom_diff.fits sub
unix% dmstat zoom_diff.fits centroid=no
zoom_diff.fits
    min:        −27           @:        ( 4090 4266 )
    max:        40            @:        ( 4042 4234 )
   mean:        0
  sigma:        1.3381518623
    sum:        0
   good:        6888
   null:        0
```

The resulting image (zoom_diff.fits) is shown in Figure 1  , and the subspace option of dmlist reports the X,Y ranges of the files to be:

```
zoom16_1.fits: x = 3570.0:4882.0  y = 3650.0:4994.0
zoom16_2.fits: x = 3570.0:4874.0  y = 3650.0:4980.0
```

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


        infile = img.fits         Input dataset/block specification
#
# Position of photon in different coord systems
#
       chip_id = 6                Chip ID number
         chipx = 992.2008917225646 Chip X [pixel]
         chipy = −117.7120835385116 Chip Y [pixel]
         tdetx = 0                TDETX [pixel]
         tdety = 0                TDETY [pixel]
          detx = 3827.862706467882 FPC X [pixel]
          dety = 4613.263006148494 FPC Y [pixel]
             x = 3595.5           Sky X [pixel]
             y = 3799.5           Sky Y [pixel]
      logicalx = 0.5              X coordinate in binned image [pixel]
```

```
      logicaly = 0.5              Y coordinate in binned image [pixel]
            ra = 18:33:49.370     RA [deg or hh:mm:ss]
           dec = −10:37:49.78     Dec [deg or dd:mm:ss]
         theta = 4.77581941165613 Off axis angle [arcmin]
           phi = 117.4674954453872 Azimuthal angle [deg]
         order = 0                Grating order
        energy = 1                Energy [keV]
    wavelength = 0                Wavelength [A]
         ra_zo = 18:33:49.370     RA of zero order
        dec_zo = −10:37:49.78     Dec of zero order
     (asolfile = none)            Input aspect solution file
       (option = )                Conversion option
#
# Override setup for observation
# All parameters here are strings so that they can
# be set blank, in which case the data file value is used
#
       (celfmt = hms)             RA and Dec format [deg or hms] (xx.xx or xx:xx:xx.x)
     (detector = )                Detector (ACIS or HRC−I or HRC−S)
      (grating = )                Grating
        (fpsys = )                FP convention
          (sim = )                SIM position (eg 0.0 0.0 −190.6)
     (displace = )                STF displacement (X,Y,Z,AX,AY,AZ)
       (ra_nom = )                Nominal pointing RA [deg or hh:mm:ss]
      (dec_nom = )                Nominal dec [deg or dd:mm:ss]
     (roll_nom = )                Nominal roll [deg]
       (ra_asp = )                Instantaneous pointing RA [deg]
      (dec_asp = )                Instantaneous pointing Dec [deg]
     (roll_asp = )                Instantaneous Aspect roll [deg]
#
      (geompar = geom)            Parameter file for Pixlib Geometry files
      (verbose = 0)               Debug Level
         (mode = ql)
```

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


        infile = img.fits         Input dataset/block specification
#
# Position of photon in different coord systems
#
       chip_id = 8                Chip ID number
         chipx = 420.8040825766388 Chip X [pixel]
         chipy = 1145.394151296928 Chip Y [pixel]
         tdetx = 0                TDETX [pixel]
         tdety = 0                TDETY [pixel]
          detx = 5339.916579114716 FPC X [pixel]
          dety = 3351.094599709191 FPC Y [pixel]
             x = 4771.5           Sky X [pixel]
             y = 5379.5           Sky Y [pixel]
      logicalx = 294.5            X coordinate in binned image [pixel]
      logicaly = 395.5            Y coordinate in binned image [pixel]
            ra = 18:33:10.140     RA [deg or hh:mm:ss]
           dec = −10:24:52.40     Dec [deg or dd:mm:ss]
         theta = 11.88772992568938 Off axis angle [arcmin]
           phi = 329.0580869148563 Azimuthal angle [deg]
         order = 0                Grating order
        energy = 1                Energy [keV]
    wavelength = 0                Wavelength [A]
         ra_zo = 18:33:10.140     RA of zero order
        dec_zo = −10:24:52.40     Dec of zero order
     (asolfile = )                Input aspect solution file
       (option = )                Conversion option
#
```

```
# Override setup for observation
# All parameters here are strings so that they can
# be set blank, in which case the data file value is used
#
       (celfmt = hms)            RA and Dec format [deg or hms] (xx.xx or xx:xx:xx.x)
     (detector = )               Detector (ACIS or HRC−I or HRC−S)
      (grating = )               Grating
        (fpsys = )               FP convention
          (sim = )               SIM position (eg 0.0 0.0 −190.6)
     (displace = )               STF displacement (X,Y,Z,AX,AY,AZ)
       (ra_nom = )               Nominal pointing RA [deg or hh:mm:ss]
      (dec_nom = )               Nominal dec [deg or dd:mm:ss]
     (roll_nom = )               Nominal roll [deg]
       (ra_asp = )               Instantaneous pointing RA [deg]
      (dec_asp = )               Instantaneous pointing Dec [deg]
     (roll_asp = )               Instantaneous Aspect roll [deg]
#
      (geompar = geom)           Parameter file for Pixlib Geometry files
      (verbose = 0)              Debug Level
         (mode = ql)
```

History

04 Jan 2005	updated for CIAO 3.2: minor change to `dmcoords` parameter file
16 Dec 2005	reviewed for CIAO 3.3: no changes
01 Dec 2006	reviewed for CIAO 3.4: no changes

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

Image 1: Offset due to different binning filters

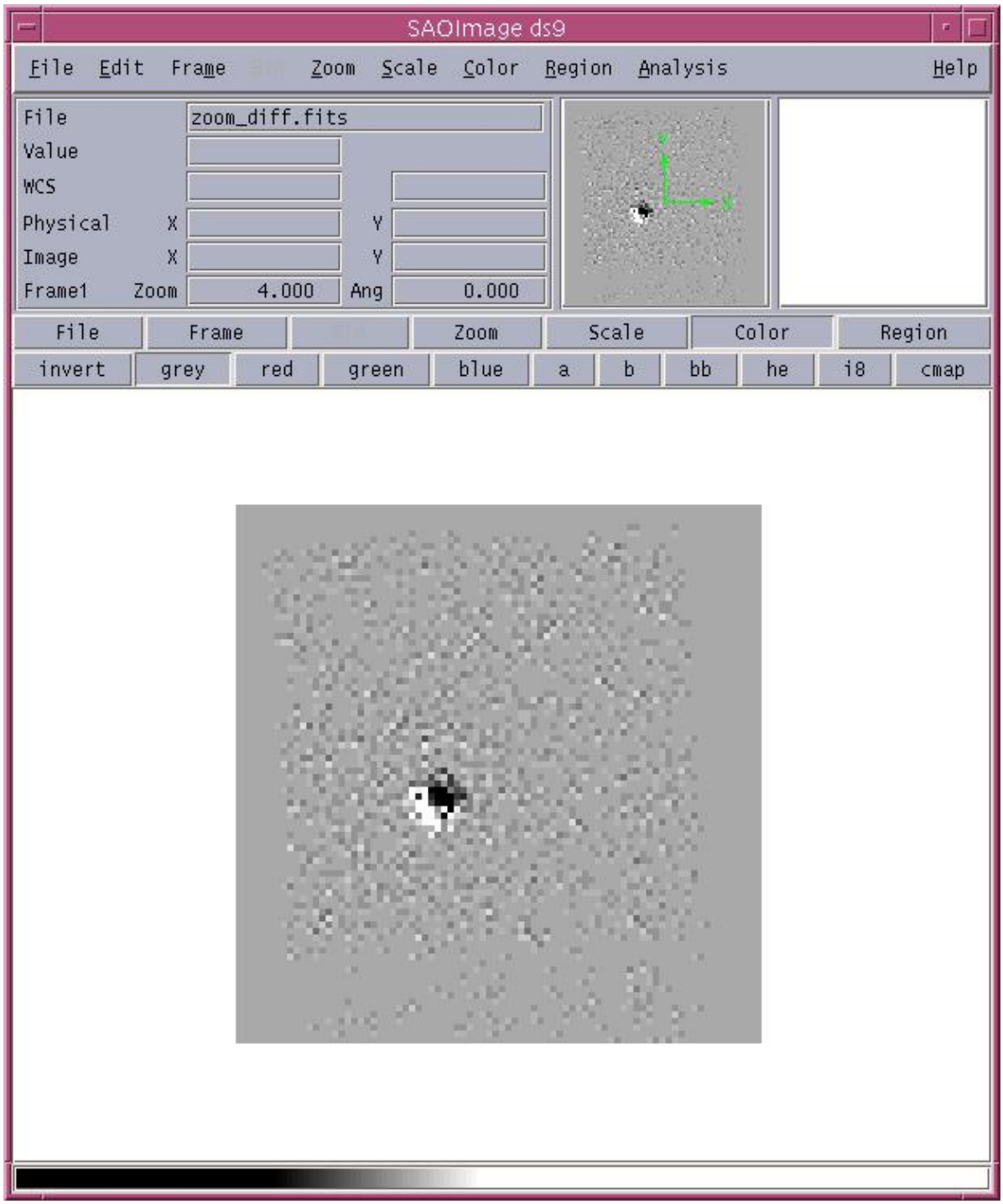

Image 1: Offset due to different binning filters