The Chandra Data Products

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http://cxc.harvard.edu/ciao

Outline

I. Context

II. Understanding the Observational Method

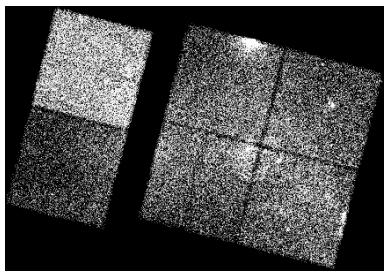
III. The Data Products

I. Context

You write a proposal.

It is accepted.

A year or so later, data! $\longrightarrow$



```
cxcguest1: ls
oif.fits        primary/         secondary/

cxcguest1: ls primary/
acisf01842N001_cntr_img2.fits  acisf01842_000N001_evt1.fits
acisf01842N001_evt2.fits       acisf01842_000N001_flt1.fits
acisf01842N001_full_img2.fits  acisf01842_000N001_mtl1.fits

cxcguest1: ls secondary/
acisf01842N001_src2.fits       acisf01842_000N001_soff1.fits
acisf01842_000N001_aoff1.fits  acisf01842_000N001_stat1.fits
acisf01842_000N001_bpix1.fits  aspect/
acisf01842_000N001_msk1.fits   ephem/
```

Typically. . .

- $\sim$ 80 files associated with your observation
- $\sim$ 15 you will see
- $\sim$ 5 you may use more than once

II. Understanding the Observational Method – (a little observational theory)

The requirements of an observation will determine the form of the output.

Example 1: An Interferometric Radio Observation

Measuring waves.

Data and associated products: electric field (phase and amplitude) for each dish, pointing, dish properties, atmospheric properties. . .

Example 2: An Infrared (CCD) Observation

Collecting energy flux.

Data and associated products: data image, flat and bias images, 'off-source' image, pointing, CCD/mirror properties. . .

Your *Chandra* Observation

Counting photons.

Data and associated products: event files, pha file, aspect offsets, mtl, bad pixels. . .

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Specifically, I will discuss the following:

```
Event (evt1, evt1a, evt2)        Image (cntr_img2, full_img2)
Filter (flt1)                    Mission Timeline (mtl1)
Source (src2, src1a)             Bad Pixel (bpix1)
Offsets (aoff1, soff1)           Aspect Solution (asol1)
Mask (msk1)                      Exposure Stats (stat1)
Grating PHAs (pha2)              Deadtime Fraction, HRC (dtf1)
```
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III. The Data Products – General Stuff

a) Processing levels (type 'ahelp level')

Range from 0-3

L0 – telemetry files packaged in the FITS format
L1 – calibrated data from a single OBSID
L1.5 – grating events assigned to orders or sso ("super-L1")
L2 – merged and filtered data from all OBIs of an OBSID
start here
L3 – aggregate analysis of multiple OBSIDs (DNE, yet)

b) Naming convention

L2: <inst><p method><OBSID>N<p version>_<data type>.fits

```
acisf01842N001_src2.fits
hrcm01464N001_pha2.fits
```

pre-L2: <inst><meth><OBSID>_<OBInum>N<ver>_<d type>.fits

```
hrcf00144_000N001_dtf1.fits
acisf01198_000N002_evt1.fits
```

c) CALDB (type 'ahelp caldb')

- A directory and indexing structure for all calibration files.
- Modeled after the HEASARC style CALDB.

Note: SDP probably used an older version of the CALDB. Know how your data was processed! (See threads.)

Events – evt2, evt1a, evt1

Description: The Event file is a *table* containing information on each event detected by the instrument. Each row represents an event, the columns describe the values attributed to that event.

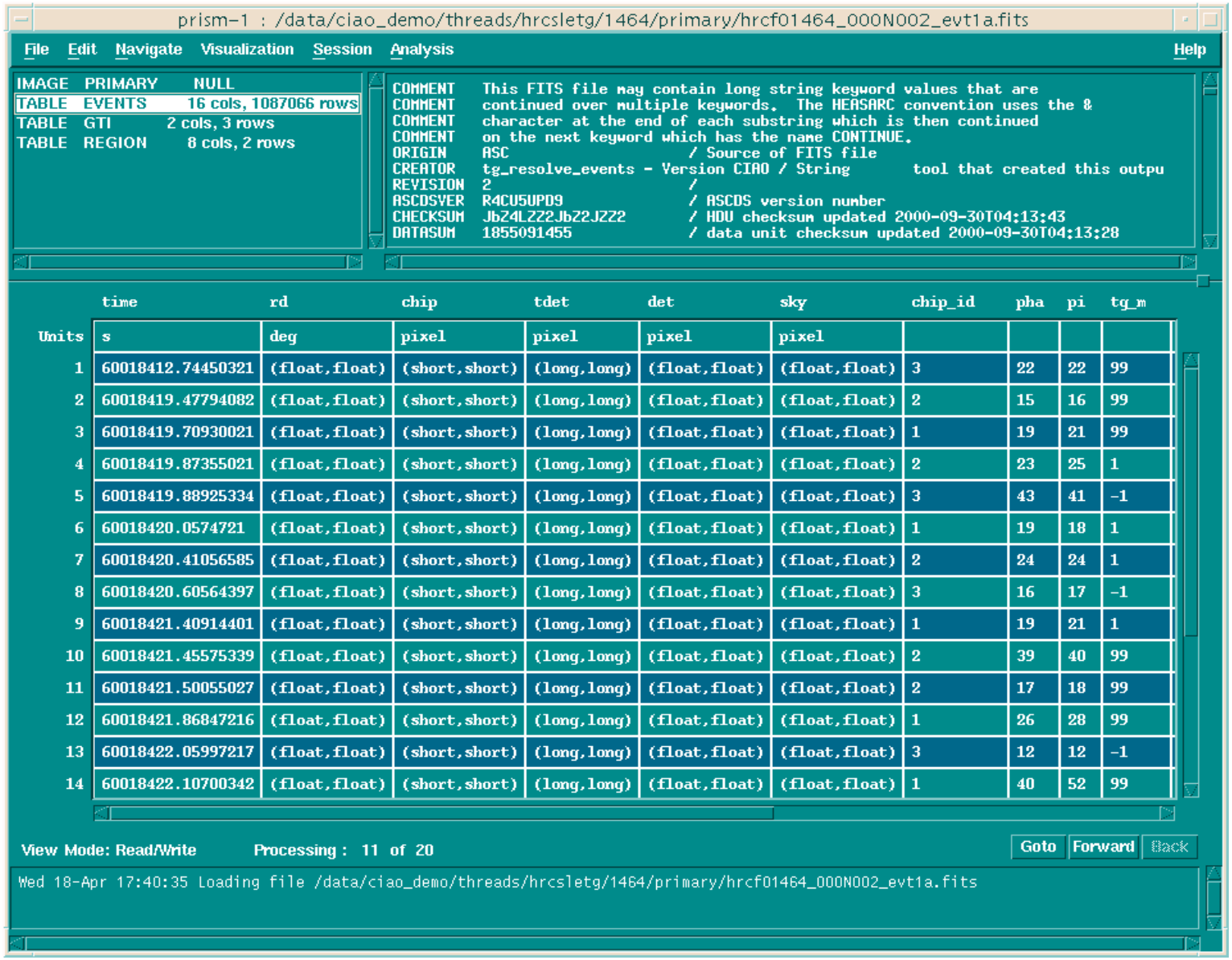
Columns, ACIS evt2:

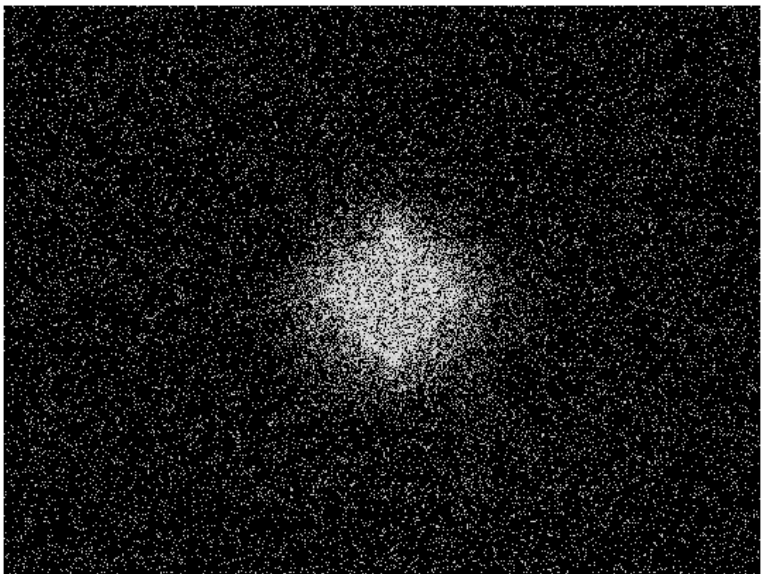
```
cxcguest1: dmlist acisf01842N001_evt2.fits cols

-------------------------------------------------------------------
Columns for Table Block EVENTS
-------------------------------------------------------------------

ColNo  Name                Unit      Type          Range
   1   time                s         Real8    84280645:84289427
   2   ccd_id                        Int2            0:9
   3   node_id                       Int2            0:3
   4   expno                         Int4            0:2147483647
   5   chip(chipx,chipy)   pixel     Int2            1:1024
   6   tdet(tdetx,tdety)   pixel     Int2            1:8192
   7   det(detx,dety)      pixel     Real4       0.50:8192.50
   8   sky(x,y)            pixel     Real4       0.50:8192.50
   9   pha                 adu       Int4            0:36855
  10   energy              eV        Real4           0:1000000.0
  11   pi                  chan      Int4            1:1024
  12   fltgrade                      Int2            0:255
  13   grade                         Int2            0:7
  14   status[4]                     Bit(4)
```

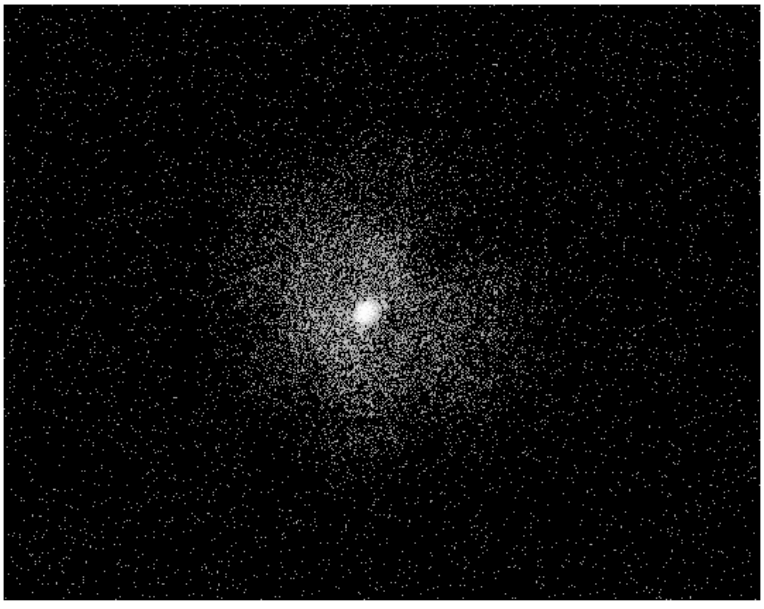
Created by: dmcopy (L2)
tgdetect, tg_resolve_events (L1.5)
acis_process_events or hrc_process_events (L1)

Used by: nearly all tools... (not image tools)

Important: Header info, Processing info, other?

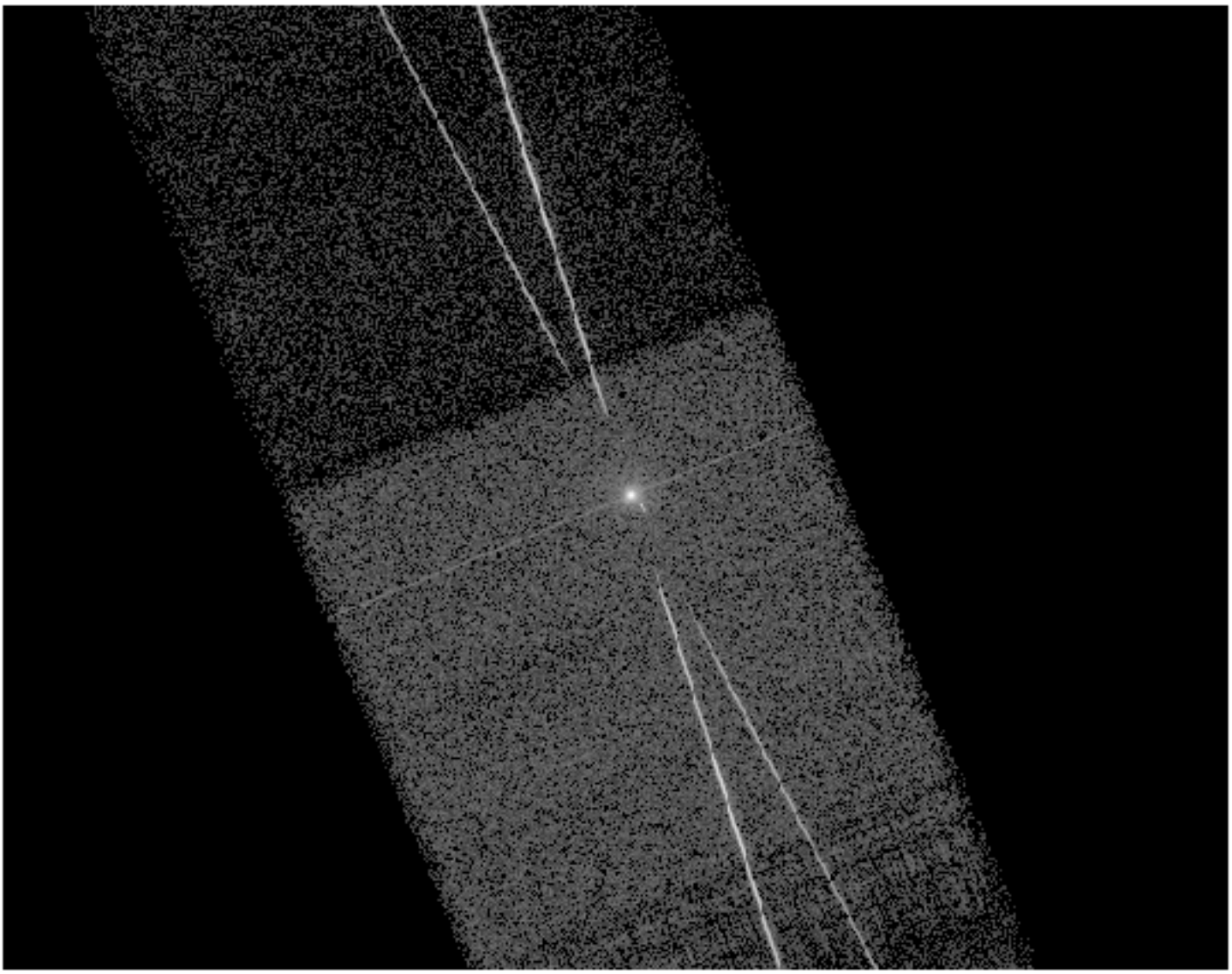

prism-1 : /data/ciao_demo/threads/hrcsletg/1464/primary/hrcf01464_000N002_evt1a.fits
File Edit Navigate Visualization Session Analysis Help
IMAGE PRIMARY NULL
TABLE EVENTS 16 cols, 1087066 rows
TABLE GTI 2 cols, 3 rows
TABLE REGION 8 cols, 2 rows
COMMENT This FITS file may contain long string keyword values that are
COMMENT continued over multiple keywords. The HEASARC convention uses the &
COMMENT character at the end of each substring which is then continued
COMMENT on the next keyword which has the name CONTINUE.
ORIGIN ASC / Source of FITS file
CREATOR tg_resolve_events - Version CIAO / String tool that created this outpu
REVISION 2 /
ASCDSVER R4CU5UPD9 / ASCDS version number
CHECKSUM JbZ4LZZ2JbZ2JZZ2 / HDU checksum updated 2000-09-30T04:13:43
DATASUM 1855091455 / data unit checksum updated 2000-09-30T04:13:28
time rd chip tdet det sky chip_id pha pi tg_m
Units s deg pixel pixel pixel pixel
1 60018412.74450321 (float,float) (short,short) (long,long) (float,float) (float,float) 3 22 22 99
2 60018419.47794082 (float,float) (short,short) (long,long) (float,float) (float,float) 2 15 16 99
3 60018419.70930021 (float,float) (short,short) (long,long) (float,float) (float,float) 1 19 21 99
4 60018419.87355021 (float,float) (short,short) (long,long) (float,float) (float,float) 2 23 25 1
5 60018419.88925334 (float,float) (short,short) (long,long) (float,float) (float,float) 3 43 41 -1
6 60018420.0574721 (float,float) (short,short) (long,long) (float,float) (float,float) 1 19 18 1
7 60018420.41056585 (float,float) (short,short) (long,long) (float,float) (float,float) 2 24 24 1
8 60018420.60564397 (float,float) (short,short) (long,long) (float,float) (float,float) 3 16 17 -1
9 60018421.40914401 (float,float) (short,short) (long,long) (float,float) (float,float) 1 19 21 1
10 60018421.45575339 (float,float) (short,short) (long,long) (float,float) (float,float) 2 39 40 99
11 60018421.50055027 (float,float) (short,short) (long,long) (float,float) (float,float) 2 17 18 99
12 60018421.86847216 (float,float) (short,short) (long,long) (float,float) (float,float) 1 26 28 99
13 60018422.05997217 (float,float) (short,short) (long,long) (float,float) (float,float) 3 12 12 -1
14 60018422.10700342 (float,float) (short,short) (long,long) (float,float) (float,float) 1 40 52 99
View Mode: Read/Write
Processing : 11 of 20
Goto Forward Back
Wed 18-Apr 17:40:35 Loading file /data/ciao_demo/threads/hrcsletg/1464/primary/hrcf01464_000N002_evt1a.fits





Columns, HRC-LETG evt1a:

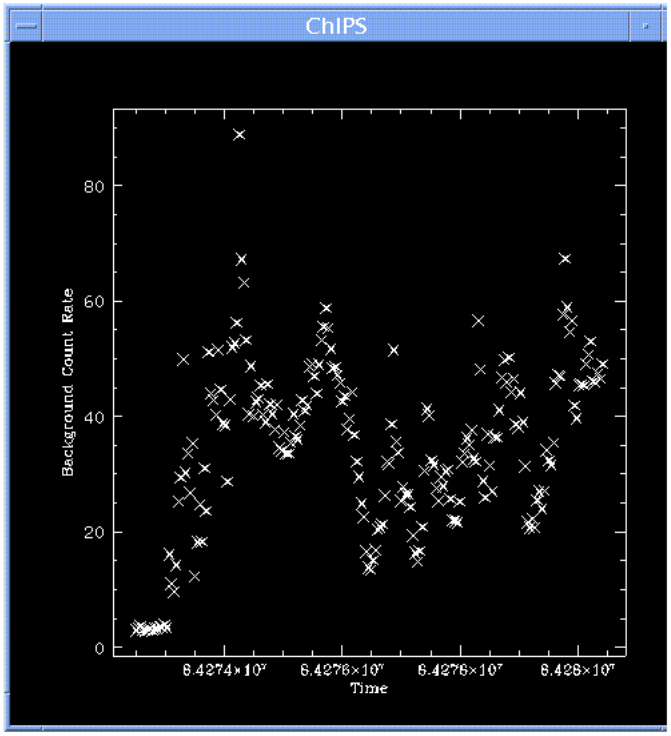
```
cxcguest1: dmlist hrcf01464_000N002_evt1a.fits cols

------------------------------------------------------------------------
Columns for Table Block EVENTS
------------------------------------------------------------------------

ColNo  Name                Unit       Type          Range
   1   time                s          Real8   60013497:60033417
   2   rd(tg_r,tg_d)       deg        Real4       -2.0:2.0
   3   chip(chipx,chipy)   pixel      Int2           1:4096
   4   tdet(tdetx,tdety)   pixel      Int4           1:49368
   5   det(detx,dety)      pixel      Real4          0.50:65536.50
   6   sky(x,y)            pixel      Real4          0.50:65536.50
   7   chip_id                        Int2           1:3
   8   pha                            Int2           0:255
   9   pi                             Int2           0:255
  10   tg_m                           Int2         -62:62
  11   tg_lam              angstrom   Real4          0:400.0
  12   tg_mlam             angstrom   Real4     -400.0:400.0
  13   tg_srcid                       Int2           0:32767
  14   tg_part                        Int2           0:99
  15   tg_smap                        Int2           0:32767
  16   status[4]                      Bit(4)
```



Filter – flt1

Description: The filter file describes the Good Time Intervals (GTIs) for a given observation. The columns of a GTI consist of START and STOP times, during which observing conditions were good.

It is used when creating the L2 event file.

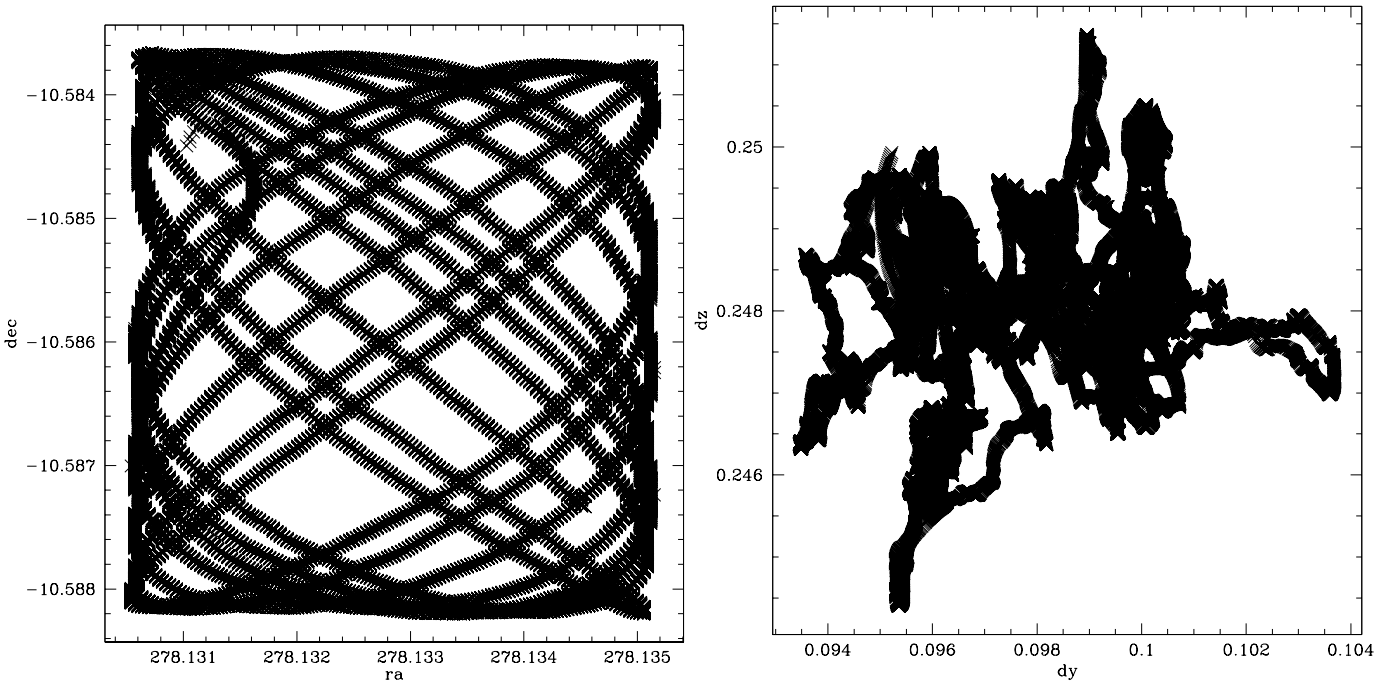


Created by: dmgti

Important: Further filtering may be necessary. See threads. . .

Aspect Solution – asol1

Description: The Aspect Solution file describes the motion of the instrument reltive to the aimpoint. This file takes into account the telescope dither, location of the instrument, flexture of the telescope, etc. This will be discussed in more detail in another talk.



Important: aoff & soff are created from the asol file, but are being phased out. Currently, the aoff file is used when making an exposure map.

Mission Timeline – mtl1

Description: The Mission Timeline (MTL) file describes the "mission critical" parameters, parameters that define the safety of the telescope and good observing times. The GTIs are created from the MTL file.

Columns, mtl1:

```
avitar-756: dmlist acisf01842_000N001_mtl1.fits cols

------------------------------------------------------------------------
Columns for Table Block MTL
------------------------------------------------------------------------

ColNo  Name                Unit      Type          Range
   1   time                 s        Real8   84280645:84289427
   2   Point_SunLimbAng    deg       Real8       -Inf:+Inf
   3   Point_MoonLimbAng   deg       Real8       -Inf:+Inf
   4   Point_EarthLimbAng  deg       Real8       -Inf:+Inf
   5   Point_RamVectorAng  deg       Real8       -Inf:+Inf
   6   Dist_SatEarth       m         Real8       -Inf:+Inf
   7   SCP4           Hz/cm**2/sr    Real8       -Inf:+Inf
  24   asp_sol_status                Int2           0:0
  30   HRMA_TEMP            K        Real8       -Inf:+Inf
  33   THR_PIX                       Real8       -Inf:+Inf
  34   EVTSENT                       Real8       -Inf:+Inf
  35   DETNAM                        String[11]
  36   DATAMODE                      String[24]
  37   READMODE                      String[14]
  38   FP_TEMP                       Real8       -Inf:+Inf
  39   GRATING                       String[7]
  40   MOVING                        Logical
  41   AOFF_GAP                      Int2           0:0
  42   ASPTYPE                       String[6]
  43   COUNT_RATE                    Real8       -Inf:+Inf
```

Source – src2

The Source file is a table of source parameters, as determined by the tool celldetect. This will be discussed in more detail in the DETECT talk.

Mask – msk1

The Mask file describes the regions on the detector which were active during the observation.

PHA – pha1

The PHA file contains the spectral information for grating observations. This will be discussed further in the Grating Analysis talk.

Image – img2

The Image files contain the spatial (but not spectral) information of the event file.

Bad Pixel – bpix1

The Bad Pixel file describes an ACIS observation's "bad" pixels. Users may wish to create a new, expanded bpix file.

Exposure Statistics – stat1

The Exposure Statistic file gives statistics for the observation, as a whole. Examples: number of events filtered on-board, number of events sent to ground, overclocking, etc.

Deadtime Factor – dtf1

The Dead Time Factor file gives the DTF for each event detected by the HRC. The DTF essentially describes the likelihood that *another* event can be detected.