

# V&V Reference Report

## L2 ASCDS Version : 8.4.5

Observation 1794 - L2 Version 10  
Chandra X-Ray Center

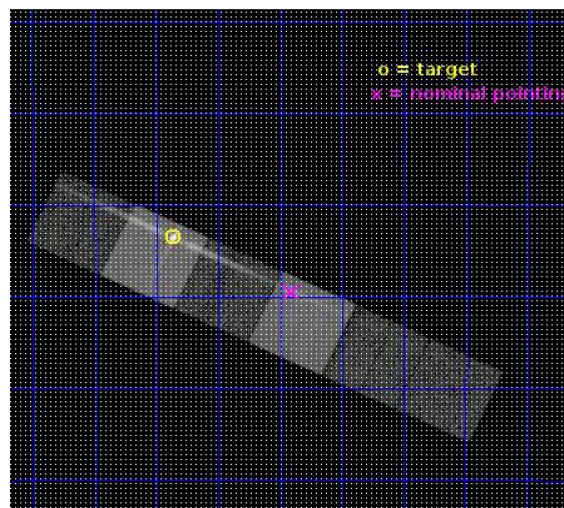
L2 Processing Date : Apr 5 2019

## Contents

|          |                               |           |
|----------|-------------------------------|-----------|
| <b>1</b> | <b>Front</b>                  | <b>2</b>  |
| <b>2</b> | <b>OBI</b>                    | <b>3</b>  |
| 2.1      | OBI . . . . .                 | 3         |
| 2.1.1    | Images . . . . .              | 3         |
| 2.1.2    | Bias . . . . .                | 3         |
| 2.1.3    | Parameters . . . . .          | 4         |
| 2.1.4    | Events . . . . .              | 4         |
| 2.2      | Compared Parameters . . . . . | 5         |
| 2.3      | Aspect . . . . .              | 6         |
| 2.4      | Star Slots . . . . .          | 9         |
| 2.4.1    | Slot 3 . . . . .              | 9         |
| 2.4.2    | Slot 4 . . . . .              | 10        |
| 2.4.3    | Slot 5 . . . . .              | 11        |
| 2.4.4    | Slot 6 . . . . .              | 12        |
| 2.4.5    | Slot 7 . . . . .              | 13        |
| 2.5      | FID Slots . . . . .           | 14        |
| 2.5.1    | Slot 0 . . . . .              | 14        |
| 2.5.2    | Slot 1 . . . . .              | 15        |
| 2.5.3    | Slot 2 . . . . .              | 16        |
| <b>3</b> | <b>Gratings</b>               | <b>17</b> |
| 3.1      | LETG Arm . . . . .            | 17        |
| <b>A</b> | <b>Summary</b>                | <b>19</b> |
| A.1      | Status . . . . .              | 19        |
| A.2      | Comments . . . . .            | 19        |

# 1 Front

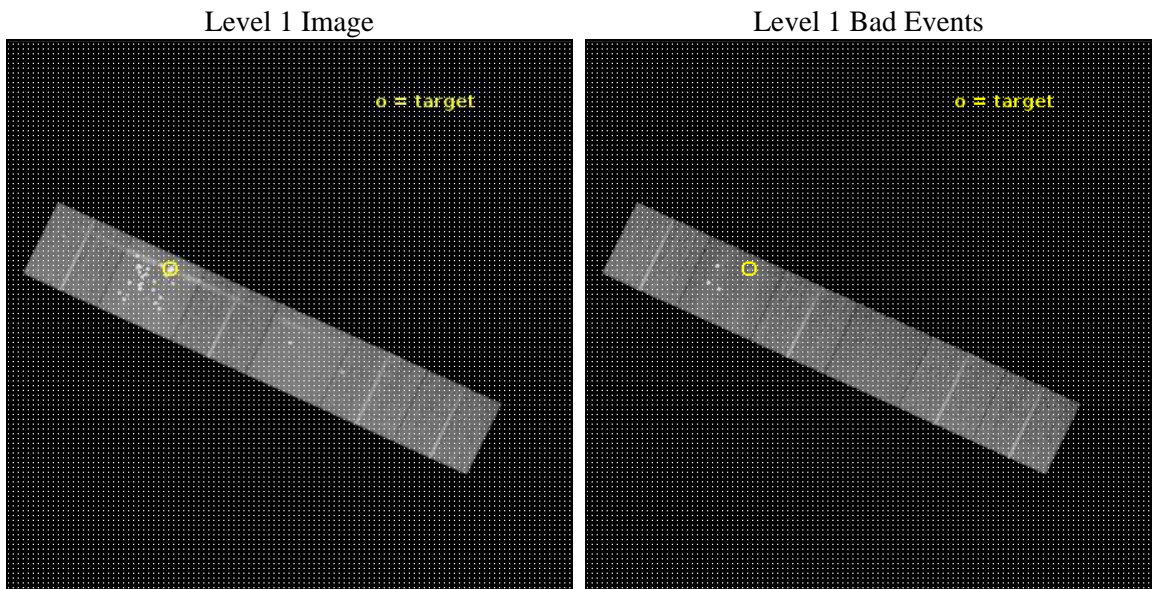
|          |   |   |
|----------|---|---|
| seq_num  | 390012  | Sequence number                             |
| obs_id   | 1794  | Observation id                              |
| title    | GRATINGS CALIBRATION OBSERVATIONS OF<br>PKS2155-304 | Proposal title                              |
| observer | Dr. CXC Calibration                                 | Principal investigator                      |
| object   | PKS2155-304   | Source name                                 |
| dtcycle  | 0   | &#160                                       |
| cycle    | P   | events from which exps?<br>Prim/Second/Both |
| ra_targ  | 329.716667  | Observer's specified<br>target RA [deg]     |
| dec_targ | -30.225556  | Observer's specified<br>target Dec [deg]    |
| ra_nom   | 329.4774750894                                      | Nominal RA [deg]                            |
| dec_nom  | -30.32457315319                                     | Nominal Dec [deg]                           |
| roll_nom | 25.261647347543                                     | Nominal Roll [deg]                          |
| revision | 10  | Processing version of<br>data               |
| ontime   | 21158.40001969                                      | Sum of GTIs [s]                             |
| livetime | 20890.479618582                                     | Livetime [s]                                |
| ontime4  | 21158.40001969                                      | Sum of GTIs [s]                             |
| ontime5  | 21158.40001969                                      | Sum of GTIs [s]                             |
| ontime6  | 21158.40001969                                      | Sum of GTIs [s]                             |
| ontime7  | 21158.40001969                                      | Sum of GTIs [s]                             |
| ontime8  | 21155.159029543                                     | Sum of GTIs [s]                             |
| ontime9  | 21155.159029543                                     | Sum of GTIs [s]                             |
| l2events | 258550  | Number of level 2 events                    |



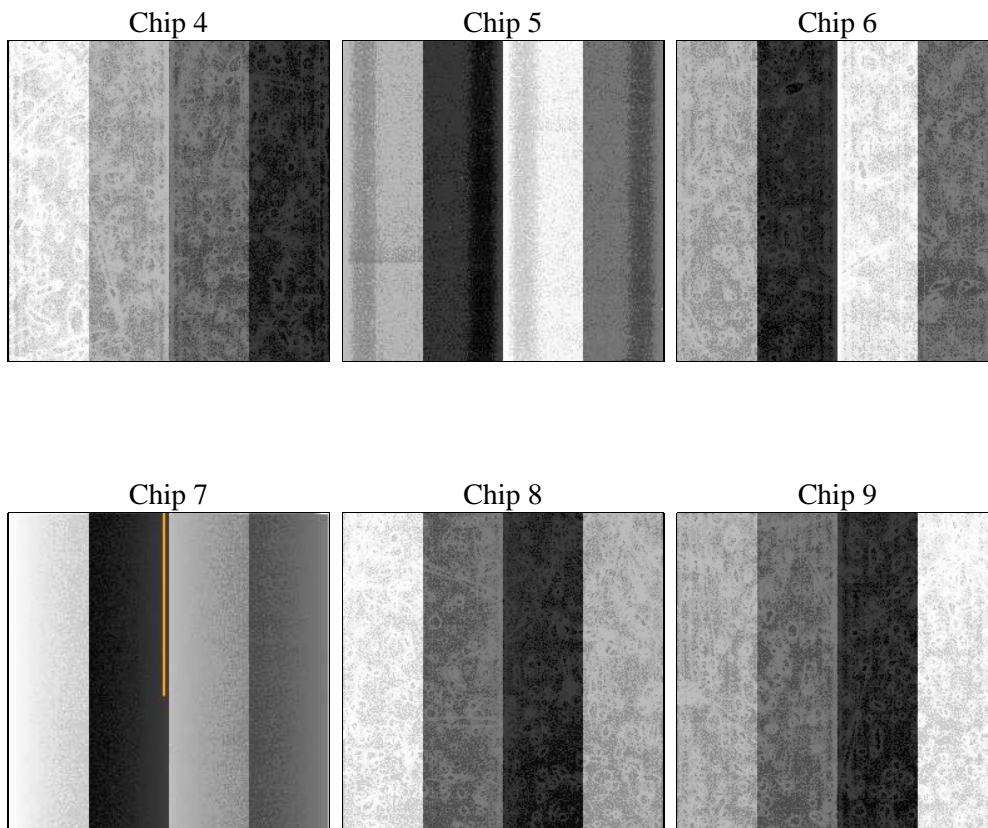
## 2 OBI

### 2.1 OBI

#### 2.1.1 Images



#### 2.1.2 Bias



### 2.1.3 Parameters

|          |                     |                                |                |                   |   |
|----------|---------------------|--------------------------------|----------------|-------------------|---|
| obi_num  | 0                   | Obi number                     | sched_exp_time | 21400.000000      | [s] Scheduled observation exposure time |
| ascdsver | 10.7.1              | Processing system revision     | ontime         | 21158.40001969    | Sum of GTIs [s]                         |
| caldsver | 4.8.2               | &#160                          | ontime4        | 21158.40001969    | Sum of GTIs [s]                         |
| date     | 2019-04-05T16:34:58 | Date and time of file creation | ontime5        | 21158.40001969    | Sum of GTIs [s]                         |
| revision | 6                   | Processing version of data     | ontime6        | 21158.40001969    | Sum of GTIs [s]                         |
|          |                     |                                | ontime7        | 21158.40001969    | Sum of GTIs [s]                         |
|          |                     |                                | ontime8        | 21155.159029543   | Sum of GTIs [s]                         |
|          |                     |                                | ontime9        | 21155.159029543   | Sum of GTIs [s]                         |
|          |                     |                                | l1events       | 1051742           | Number of level 1 events                |
|          |                     |                                | tgmethod       | FINDZO            | Method used to create src1a file        |
|          |                     |                                | z0_pos         | (0580 22 4820 22) | src1a sky pixel position                |

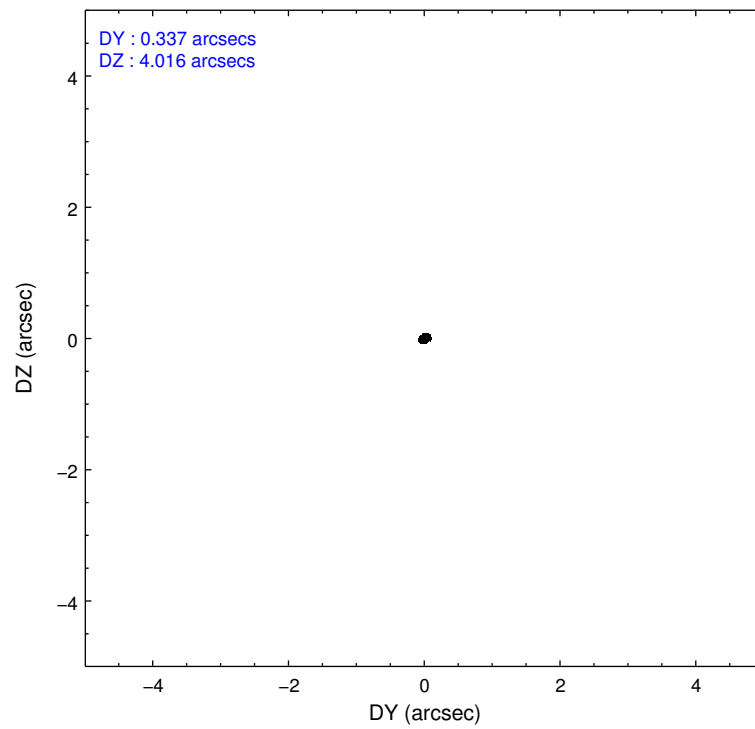
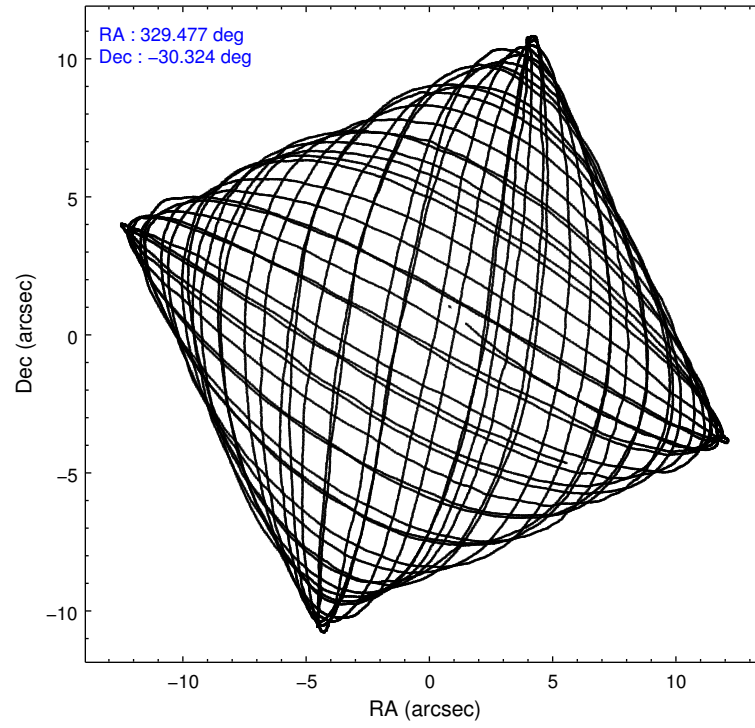
### 2.1.4 Events

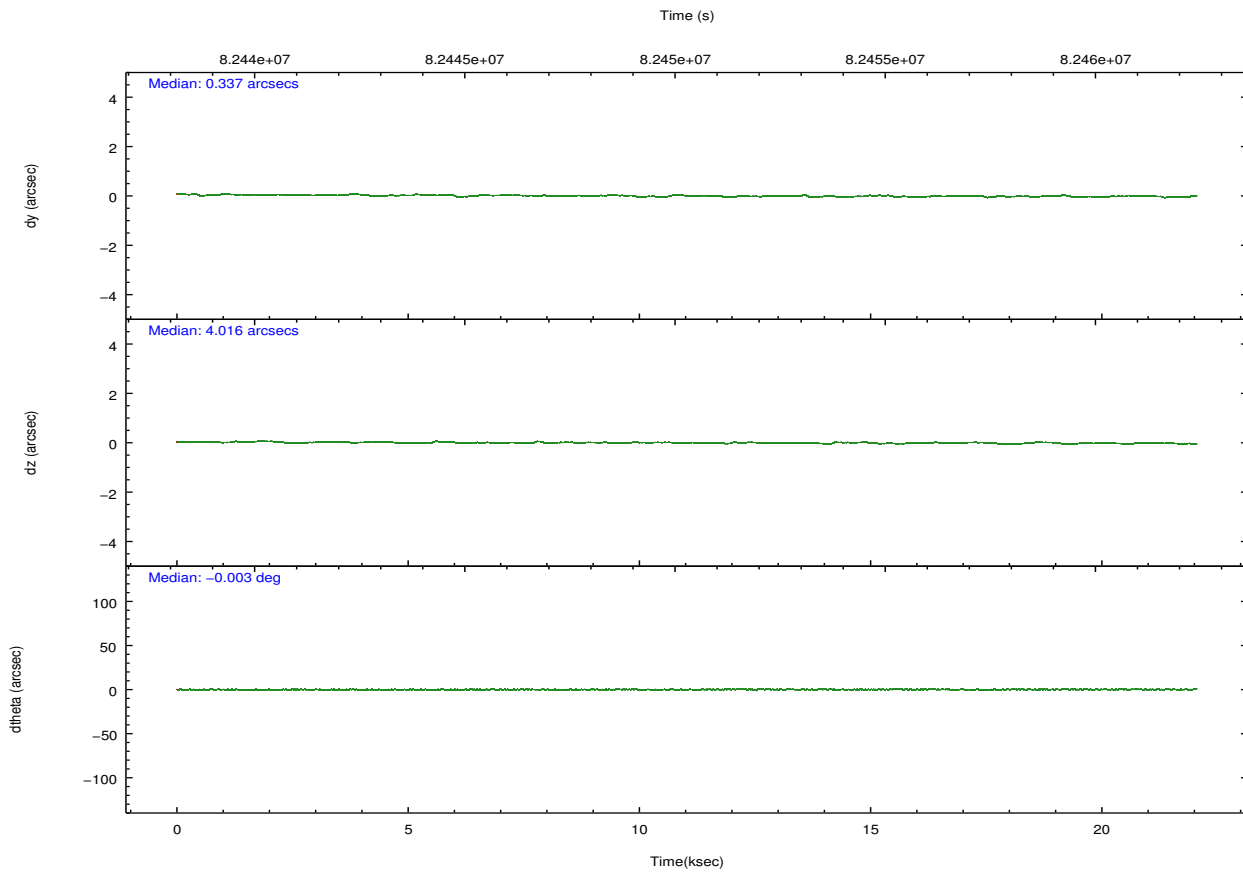
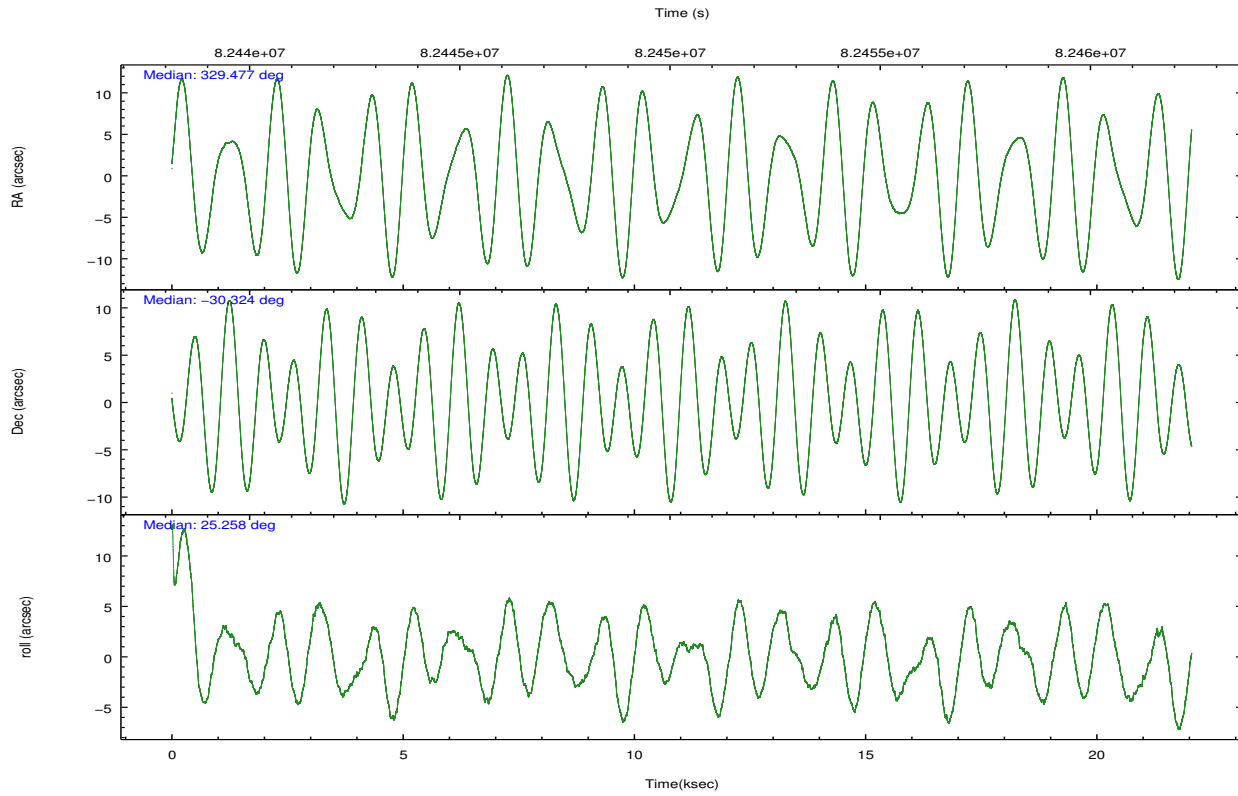
|                 | ccd 4  | ccd 5  | ccd 6  | ccd 7  | ccd 8  | ccd 9  |                | ccd 4  | ccd 5  | ccd 6  | ccd 7 | ccd 8  | ccd 9  |
|-----------------|--------|--------|--------|--------|--------|--------|----------------|--------|--------|--------|-------|--------|--------|
| level 1 events  | 140152 | 356106 | 125873 | 163084 | 148257 | 118270 | grade 0 events | 5662   | 127077 | 8376   | 11440 | 8866   | 3348   |
| rejected events | 122540 | 111309 | 105722 | 88418  | 118445 | 103646 |                | 4%     | 35%    | 6%     | 7%    | 5%     | 2%     |
| rejected %      | 87%    | 31%    | 83%    | 54%    | 79%    | 87%    | grade 1 events | 36     | 245    | 31     | 72    | 57     | 16     |
|                 |        |        |        |        |        |        |                | 0%     | 0%     | 0%     | 0%    | 0%     | 0%     |
|                 |        |        |        |        |        |        | grade 2 events | 7062   | 41779  | 6372   | 14925 | 9293   | 6044   |
|                 |        |        |        |        |        |        |                | 5%     | 11%    | 5%     | 9%    | 6%     | 5%     |
|                 |        |        |        |        |        |        | grade 3 events | 757    | 9779   | 934    | 4109  | 2230   | 819    |
|                 |        |        |        |        |        |        |                | 0%     | 2%     | 0%     | 2%    | 1%     | 0%     |
|                 |        |        |        |        |        |        | grade 4 events | 726    | 7807   | 869    | 3912  | 1968   | 832    |
|                 |        |        |        |        |        |        |                | 0%     | 2%     | 0%     | 2%    | 1%     | 0%     |
|                 |        |        |        |        |        |        | grade 5 events | 2493   | 14719  | 3096   | 8795  | 4157   | 3126   |
|                 |        |        |        |        |        |        |                | 1%     | 4%     | 2%     | 5%    | 2%     | 2%     |
|                 |        |        |        |        |        |        | grade 6 events | 3406   | 58375  | 3602   | 40291 | 7457   | 3582   |
|                 |        |        |        |        |        |        |                | 2%     | 16%    | 2%     | 24%   | 5%     | 3%     |
|                 |        |        |        |        |        |        | grade 7 events | 120010 | 96325  | 102593 | 79540 | 114229 | 100503 |
|                 |        |        |        |        |        |        |                | 85%    | 27%    | 81%    | 48%   | 77%    | 84%    |

## 2.2 Compared Parameters

| Parameter                         | Planned             | Actual               | Parameter                             | Planned   | Actual  |
|-----------------------------------|---------------------|----------------------|---------------------------------------|-----------|---------|
| Instrument                        | ACIS                | ACIS                 | Obspar format version number          | 7         | 7       |
| Detector                          | ACIS-456789         | ACIS-456789          | Obspar file type                      | PREDICTED | ACTUAL  |
| Grating                           | LETG                | LETG                 | Obspar update status                  | NONE      | UPDATED |
| Data mode                         | FAINT               | FAINT                | Number of optional ACIS chips dropped | 0         | 0       |
| Observation mode                  | POINTING            | POINTING             | On-chip summing requested             | N         | N       |
| [deg] Pointing RA                 | 329.459541          | 329.4774750894015    | Subarray requested                    | NONE      | NONE    |
| [deg] Pointing Dec                | -30.347163          | -30.3245731531896    | Alternating exposures requested       | N         | N       |
| [deg] Pointing Roll               | 25.095959           | 25.26164734754287    | [s] Primary exposure time             | 0.000000  | 3.2     |
| [mm] SIM focus pos                | -0.684267           | -0.6828225247311905  |                                       |           |         |
| [mm] SIM defocus                  | 0                   | 0.001444936568705701 |                                       |           |         |
| [mm] SIM translation stage pos    | -182.131972         | -182.1344861297048   |                                       |           |         |
| [mm] SIM translation stage offset | -8.000551           | -7.998036453302973   |                                       |           |         |
| [s] Observation start time (MET)  | 82439456.184000     | 82439076.93731301    |                                       |           |         |
| Observation start date            | 2000-08-12T03:49:52 | 2000-08-12T03:44:36  |                                       |           |         |
| [s] Observation end time (MET)    | 82460856.184000     | 82461619.25065599    |                                       |           |         |
| Observation end date              | 2000-08-12T09:46:32 | 2000-08-12T10:00:19  |                                       |           |         |
| Read mode                         | TIMED               | TIMED                |                                       |           |         |

## 2.3 Aspect





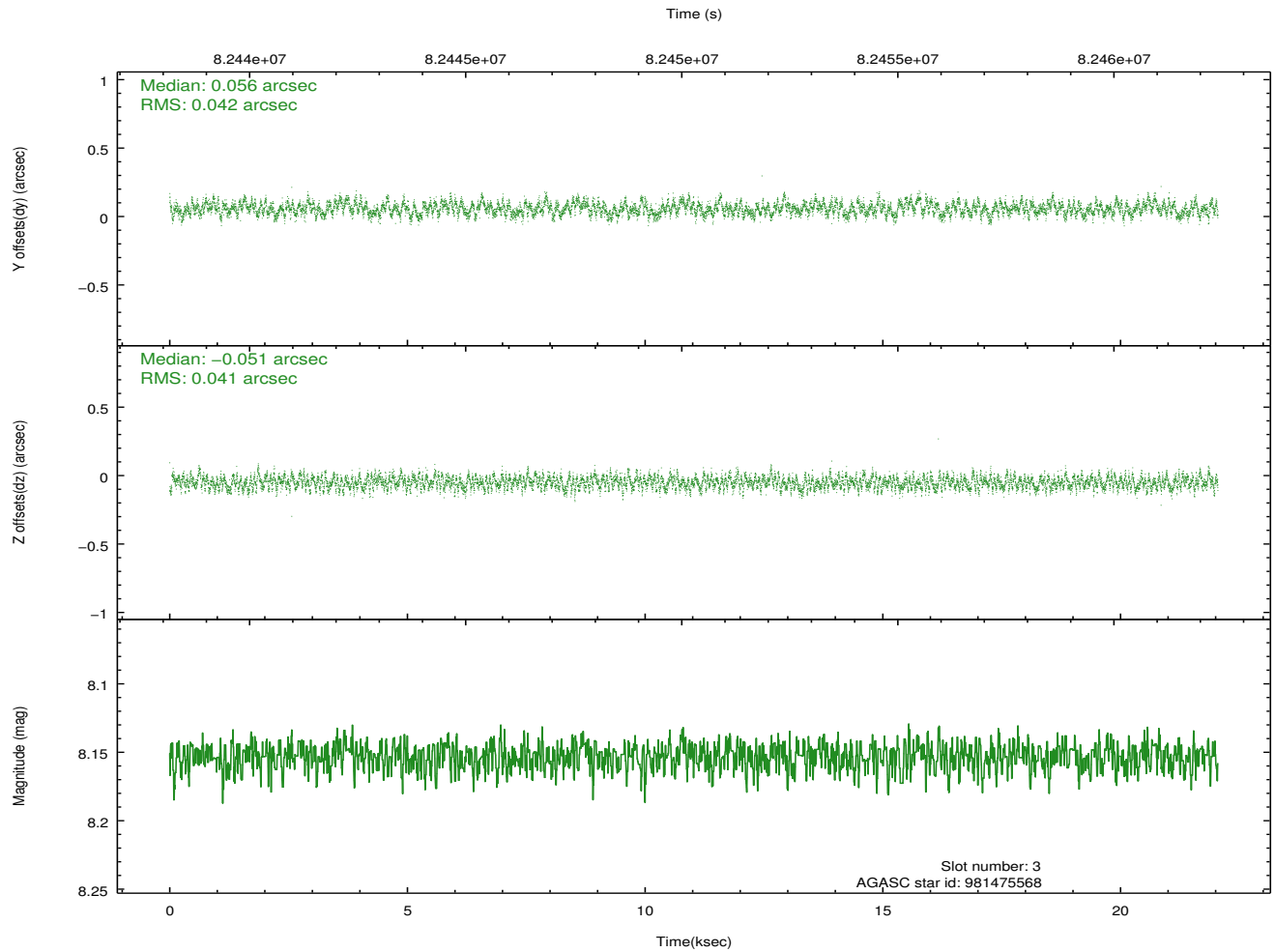
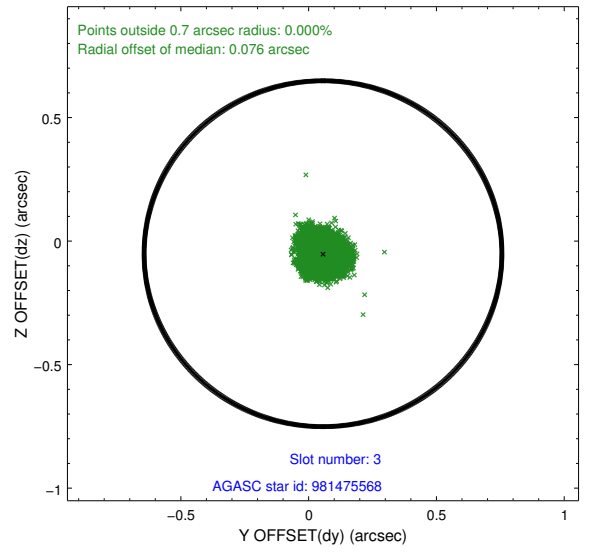
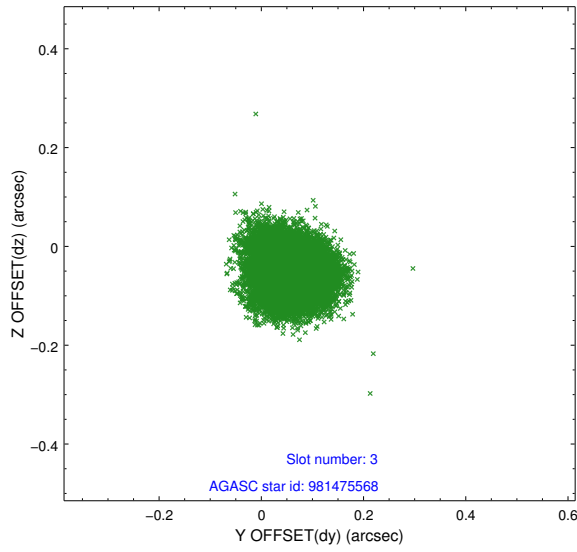
### Slot Statistics

| slot | status | used | id        | mag  | n_pts | frac_pts | med_dy | med_dz | dr1   | dr2   | ra         | dec        | mean_y   | mean_x |
|------|--------|------|-----------|------|-------|----------|--------|--------|-------|-------|------------|------------|----------|--------|
| 0    | FID    |      | ACIS-S-2  | 7.10 | 5376  | 1.000    | -0.060 | -0.110 | 0.007 | 0.012 | 0.000000   | 0.000000   | -752.42  | -1889  |
| 1    | FID    |      | ACIS-S-4  | 7.18 | 5378  | 1.000    | 0.087  | 0.059  | 0.005 | 0.011 | 0.000000   | 0.000000   | 2160.96  | 18     |
| 2    | FID    |      | ACIS-S-5  | 7.23 | 5379  | 1.000    | -0.058 | 0.059  | 0.007 | 0.012 | 0.000000   | 0.000000   | -1805.03 | 12     |
| 3    | GUIDE  | used | 981475568 | 8.15 | 10754 | 1.000    | 0.056  | -0.051 | 0.064 | 0.098 | 328.999408 | -30.923402 | -2167.40 | -1279  |
| 4    | GUIDE  | used | 912275088 | 9.05 | 10754 | 1.000    | -0.041 | 0.008  | 0.069 | 0.112 | 329.619228 | -29.738698 | 1381.09  | 1770   |
| 5    | GUIDE  | used | 981478504 | 9.39 | 10749 | 1.000    | -0.109 | -0.006 | 0.084 | 0.136 | 329.103554 | -31.216754 | -2320.54 | -2372  |
| 6    | GUIDE  | used | 981478152 | 9.39 | 10726 | 1.000    | 0.004  | 0.074  | 0.088 | 0.143 | 329.415589 | -30.057192 | 318.89   | 1002   |
| 7    | GUIDE  | used | 981468128 | 9.36 | 10752 | 1.000    | 0.093  | -0.024 | 0.070 | 0.115 | 329.756350 | -30.158334 | 1125.05  | 221    |

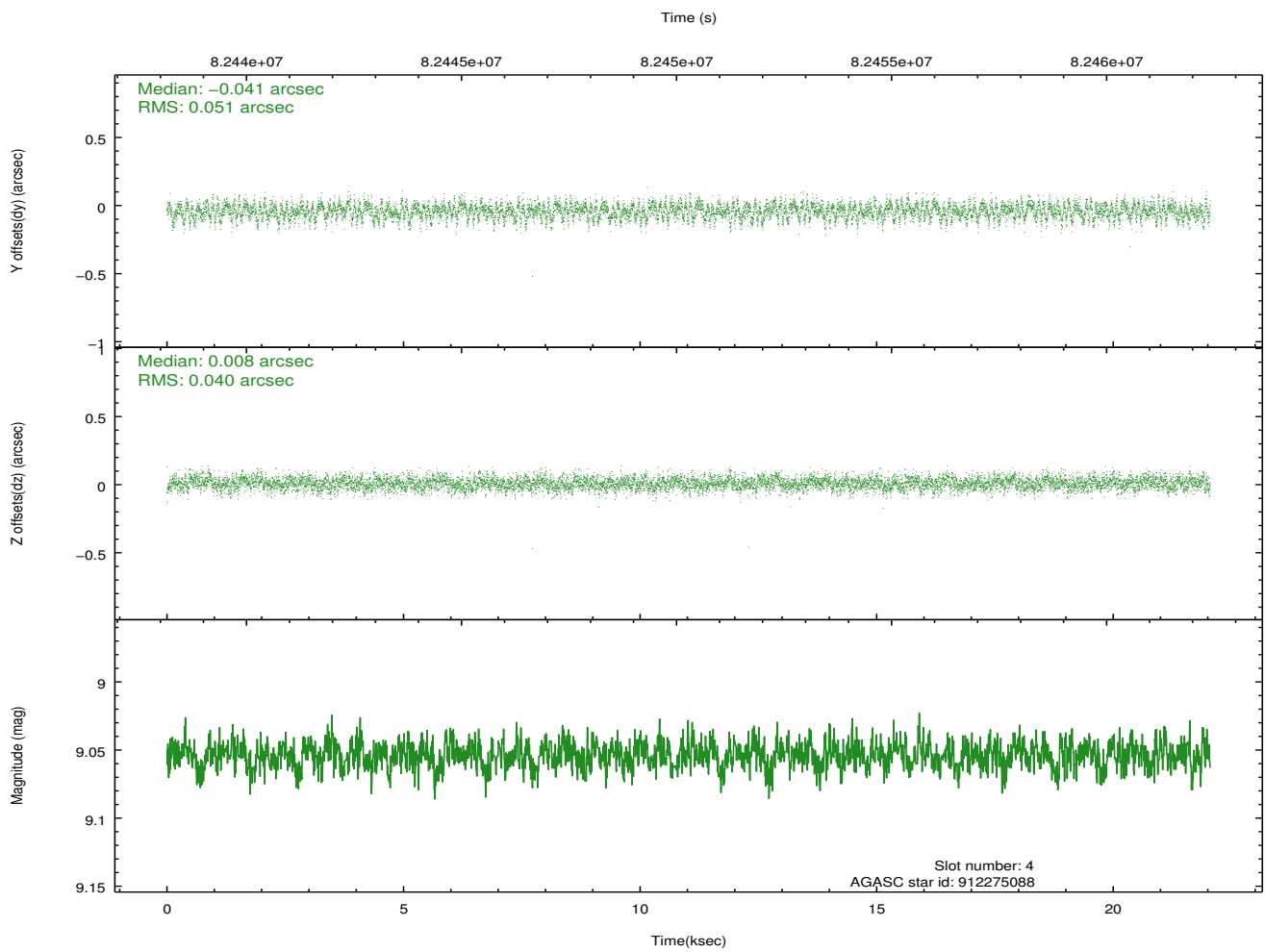
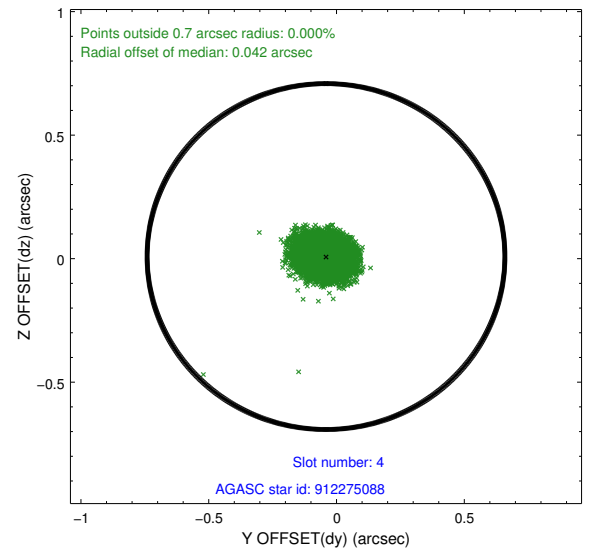
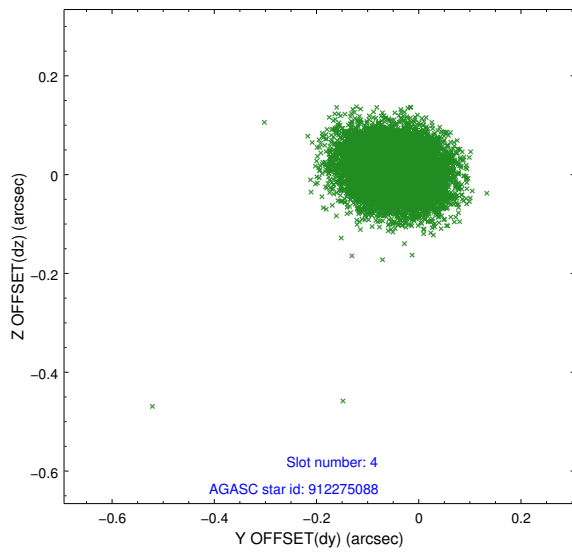
∞

## 2.4 Star Slots

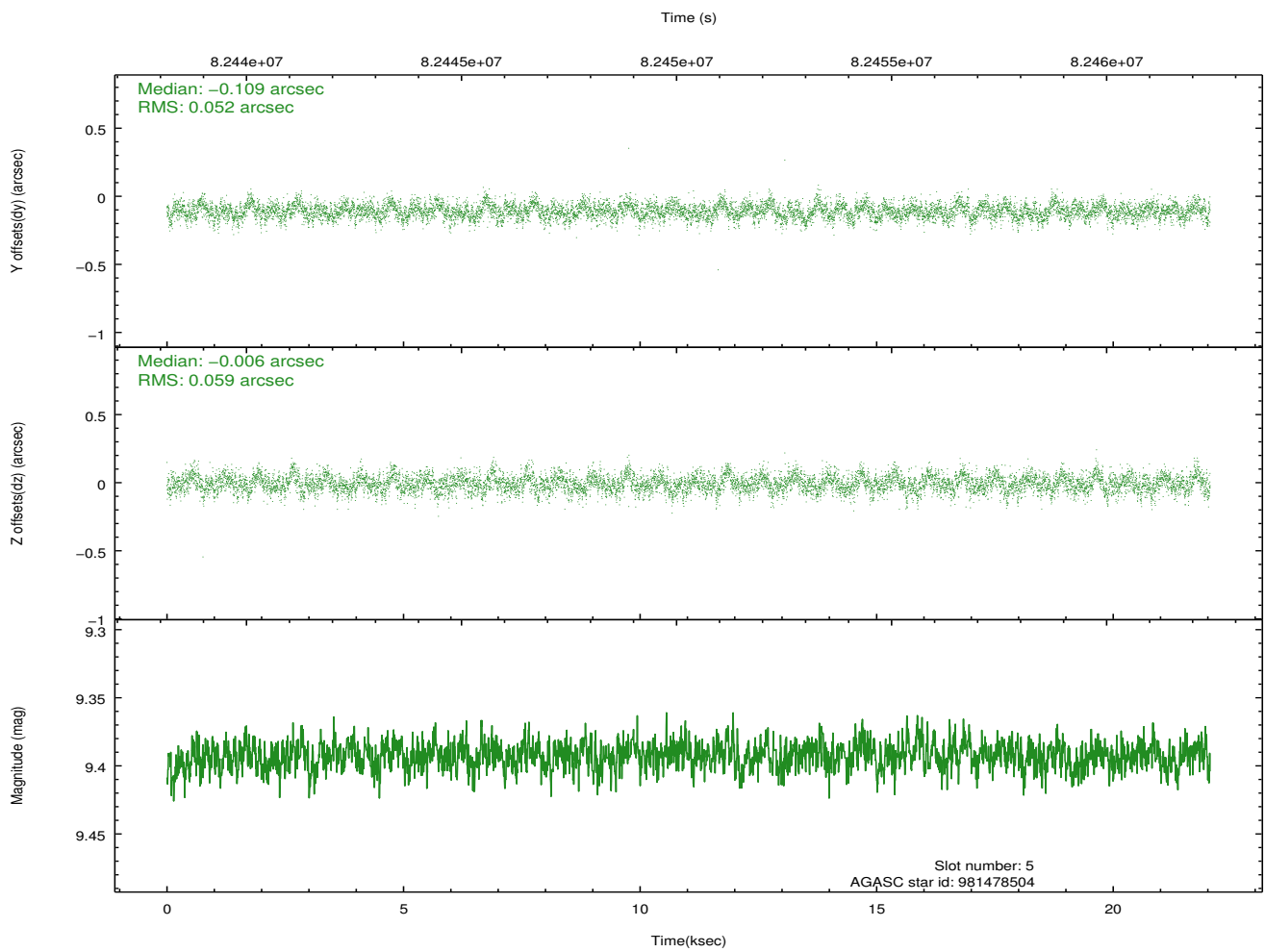
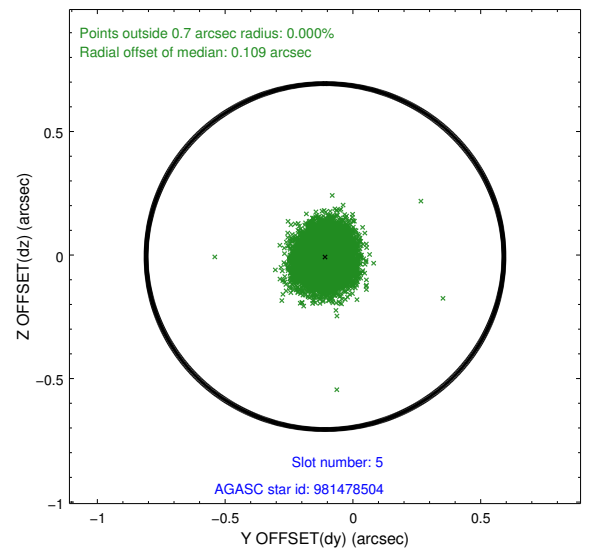
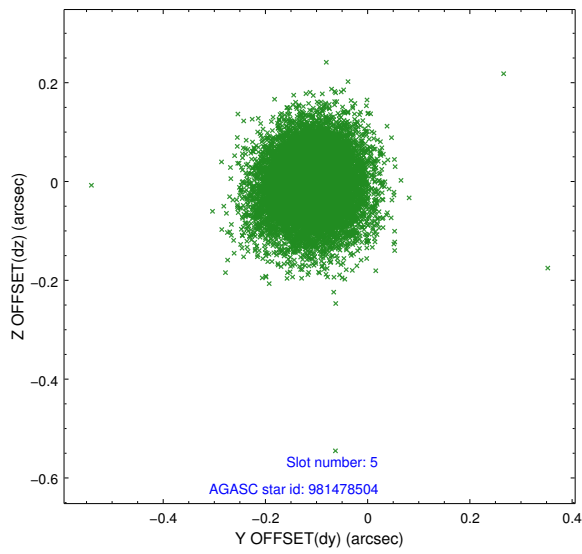
### 2.4.1 Slot 3



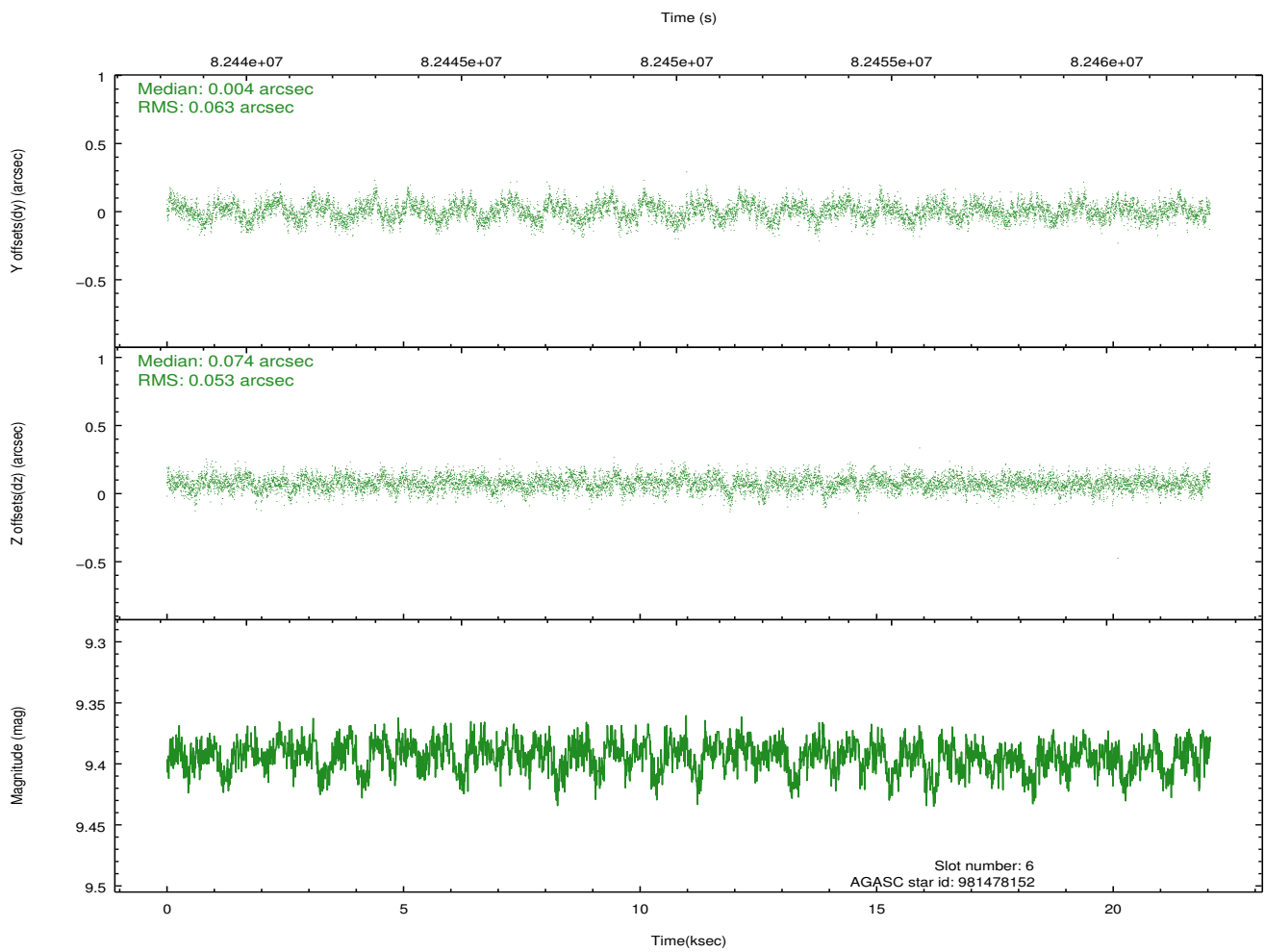
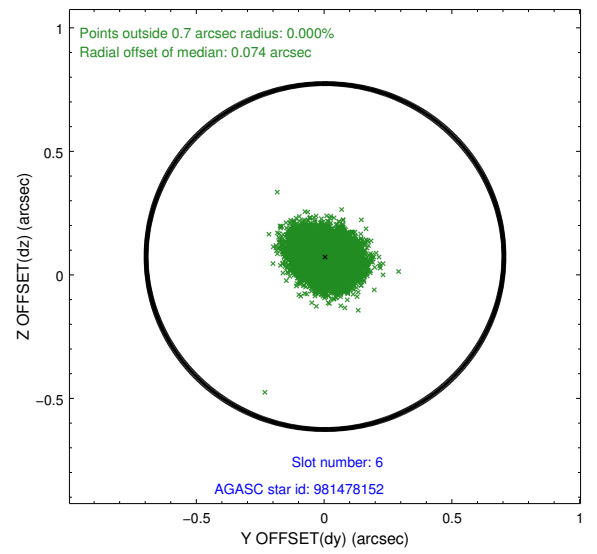
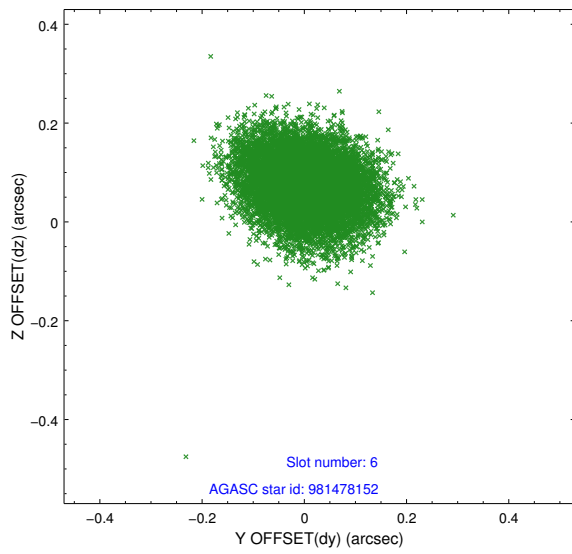
## 2.4.2 Slot 4



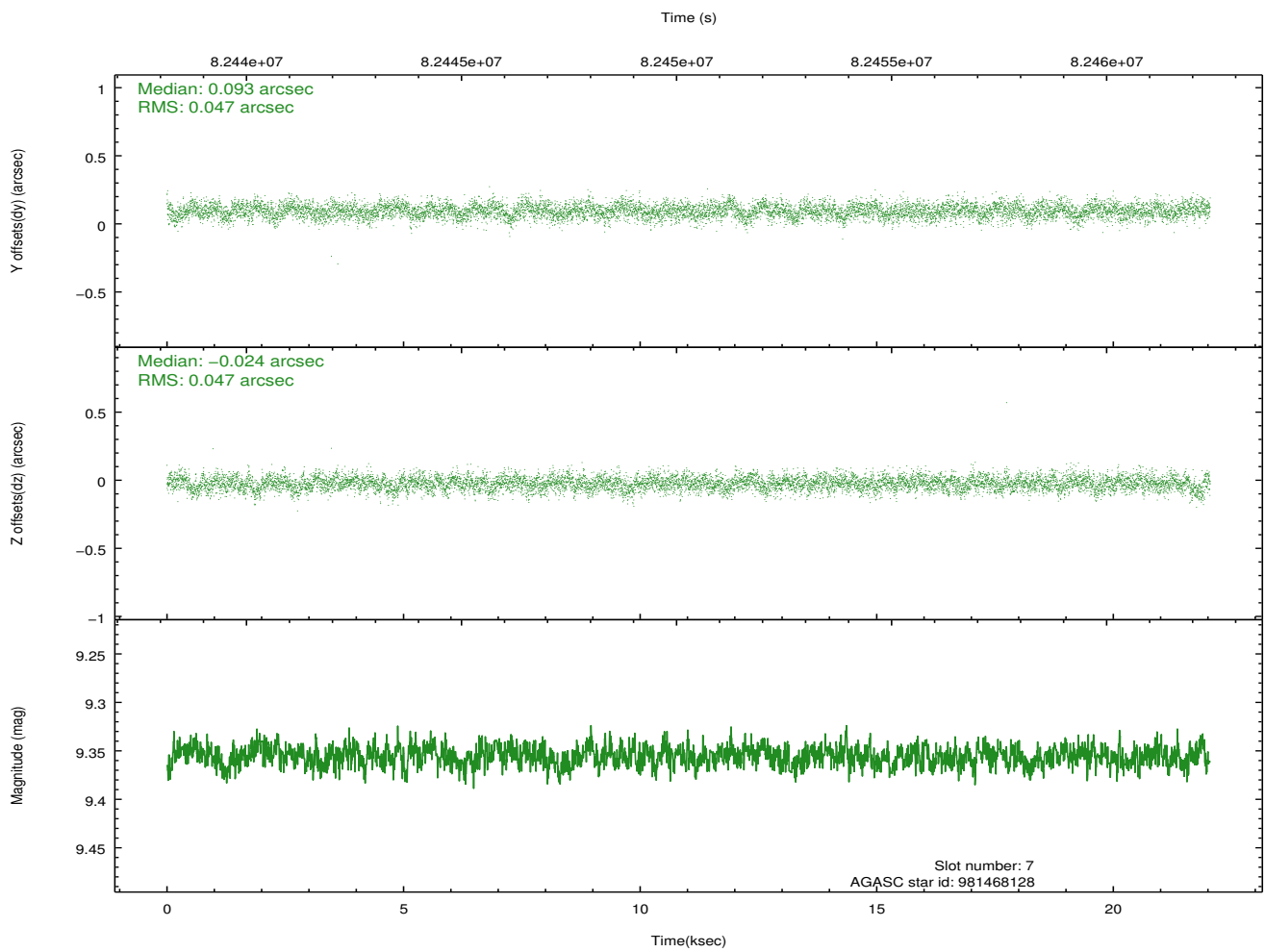
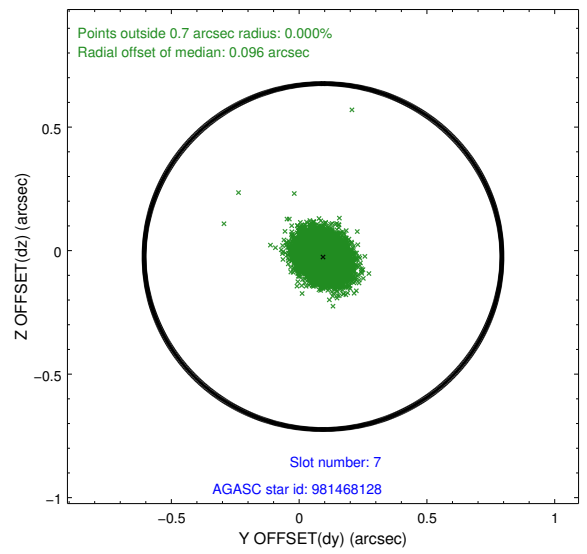
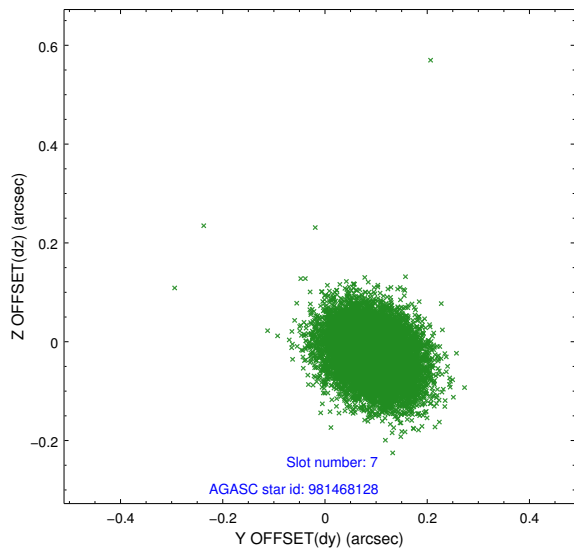
### 2.4.3 Slot 5



## 2.4.4 Slot 6

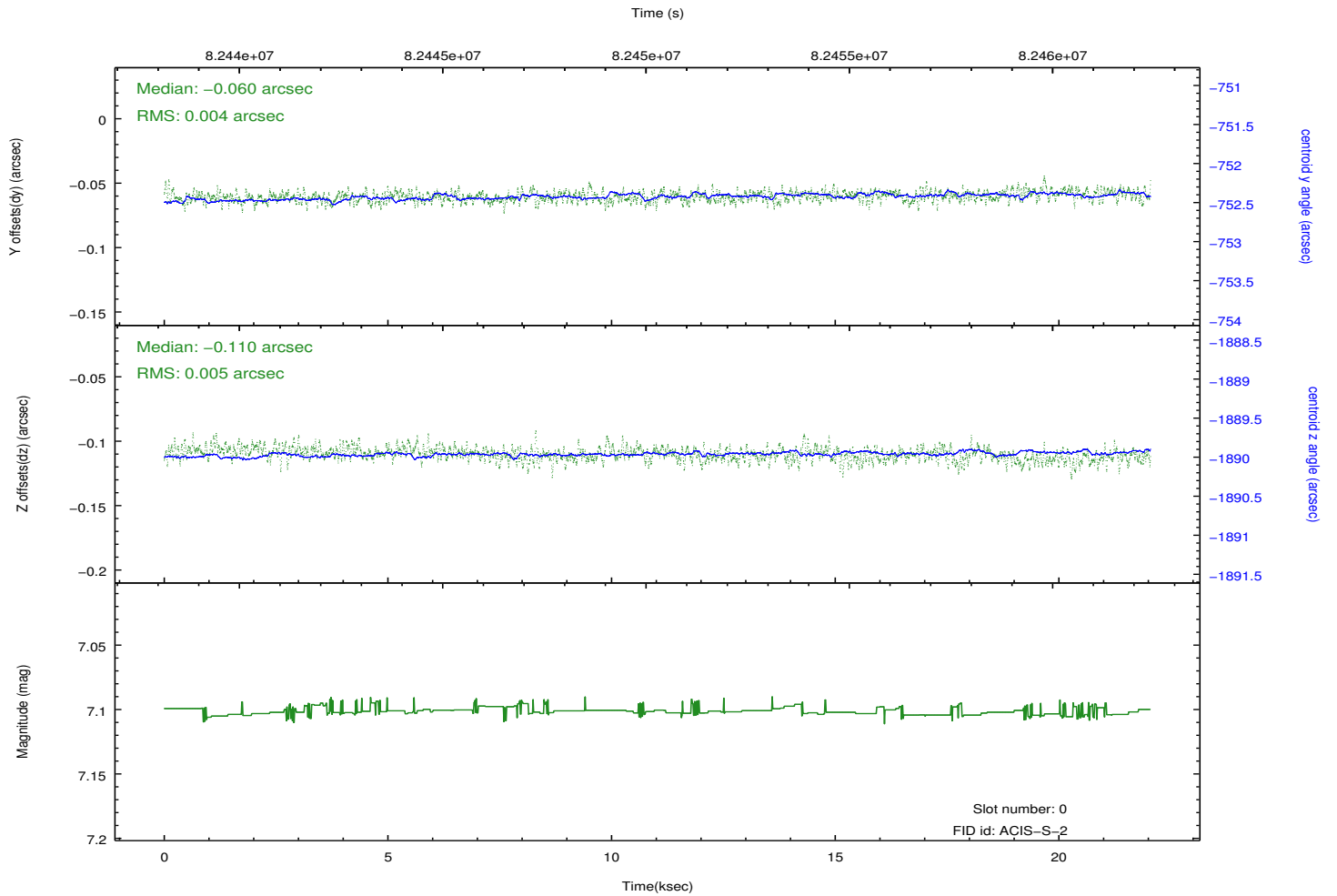
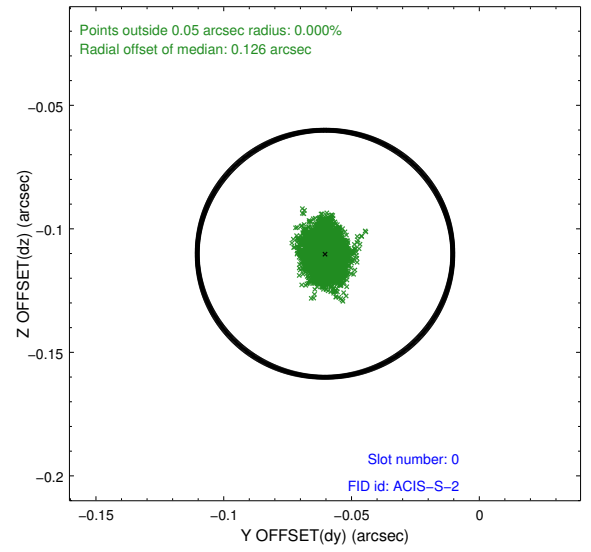
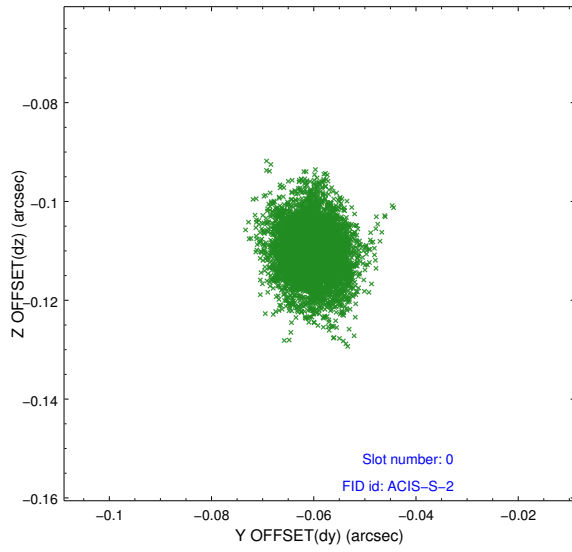


## 2.4.5 Slot 7

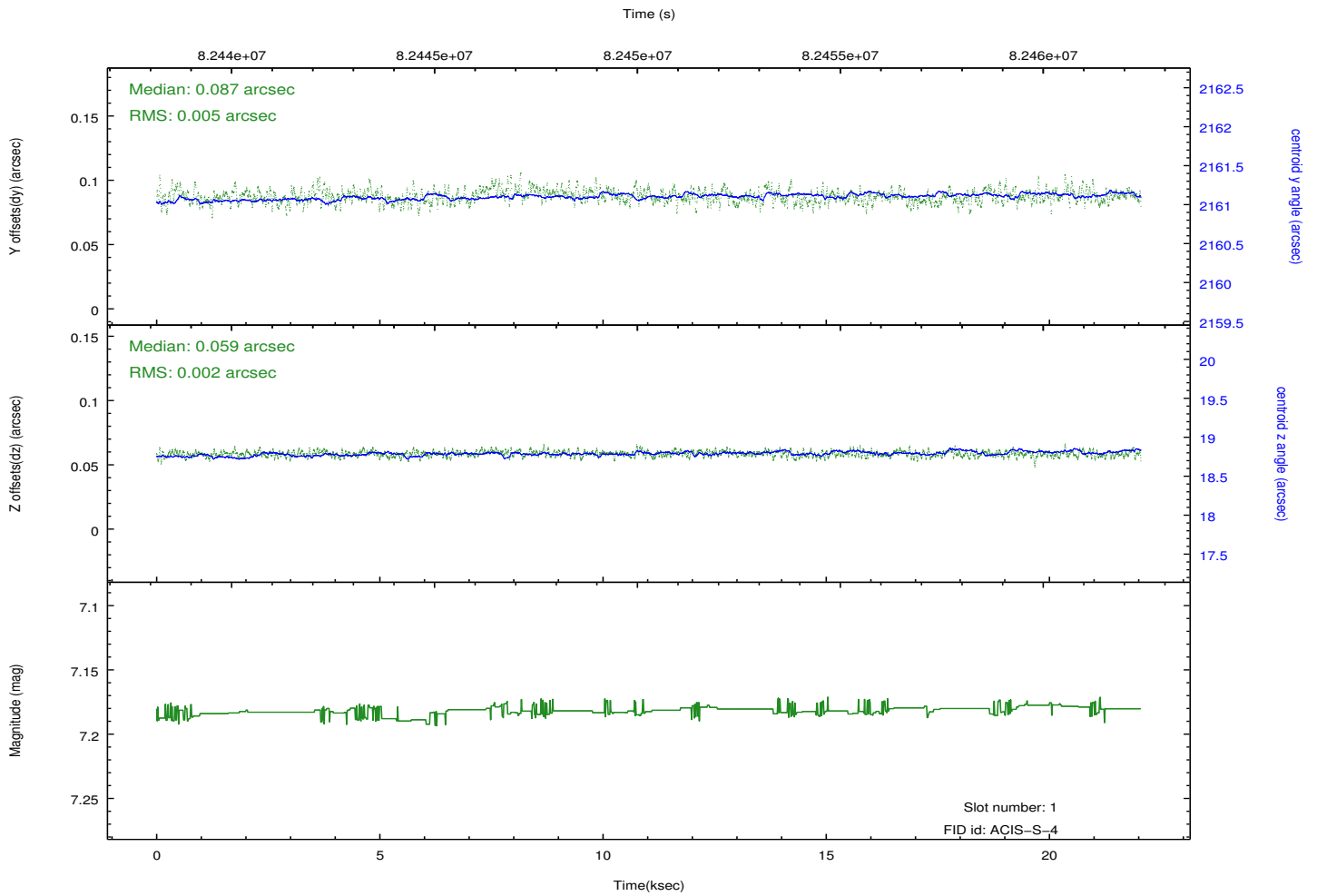
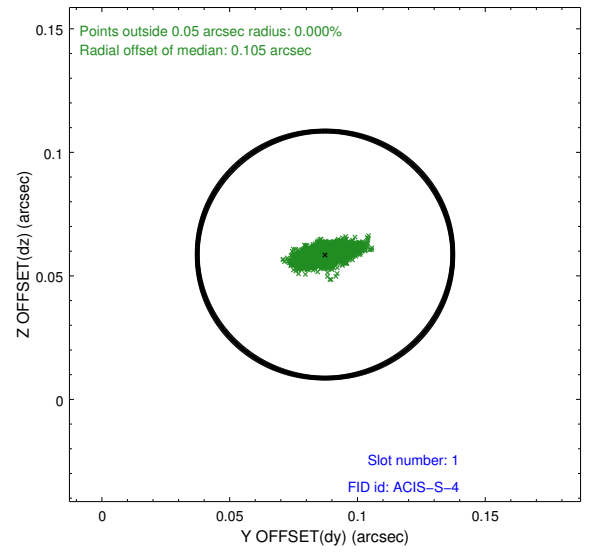
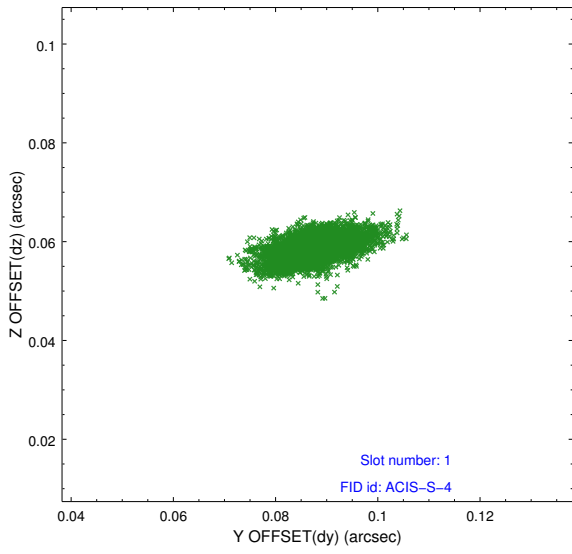


## 2.5 FID Slots

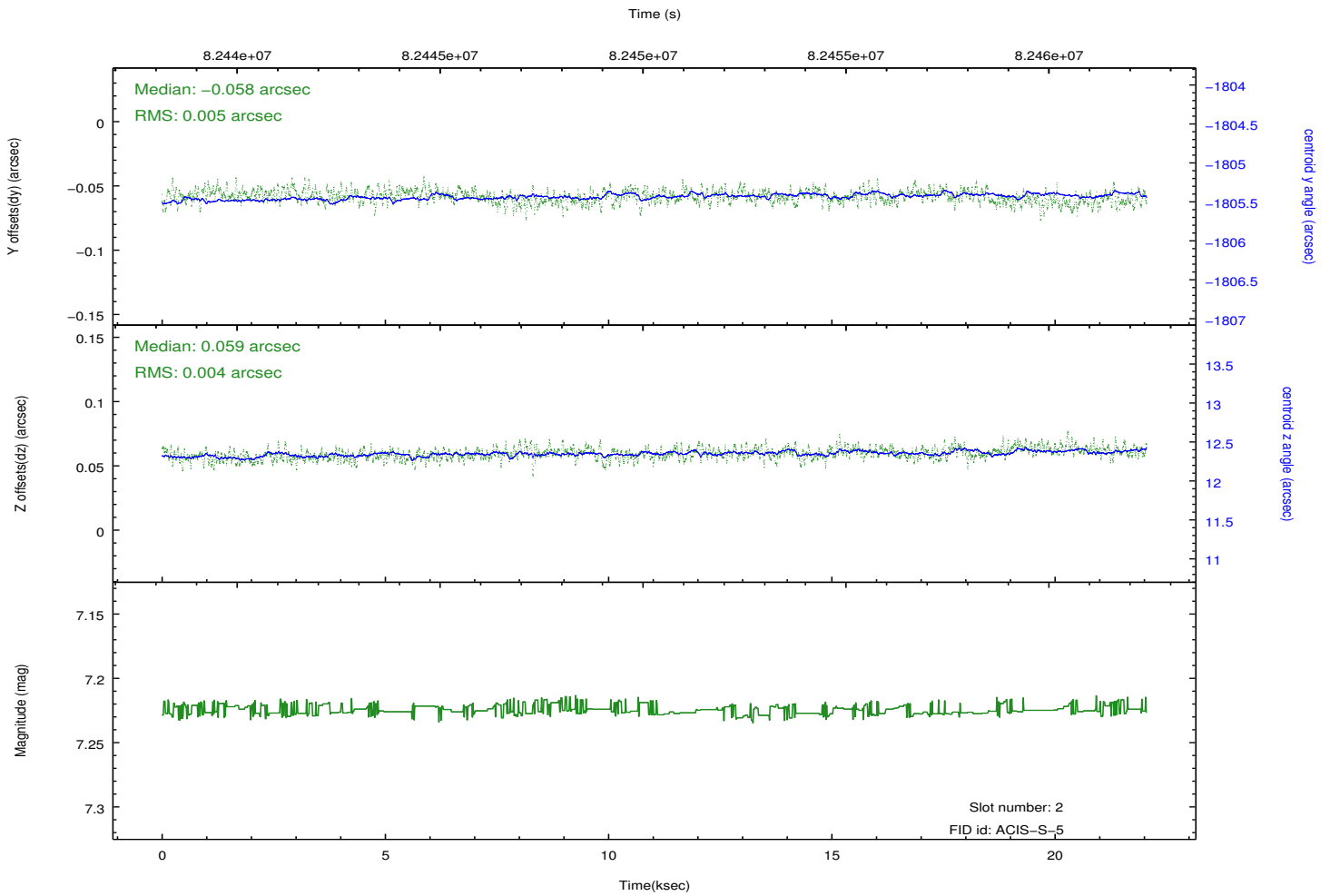
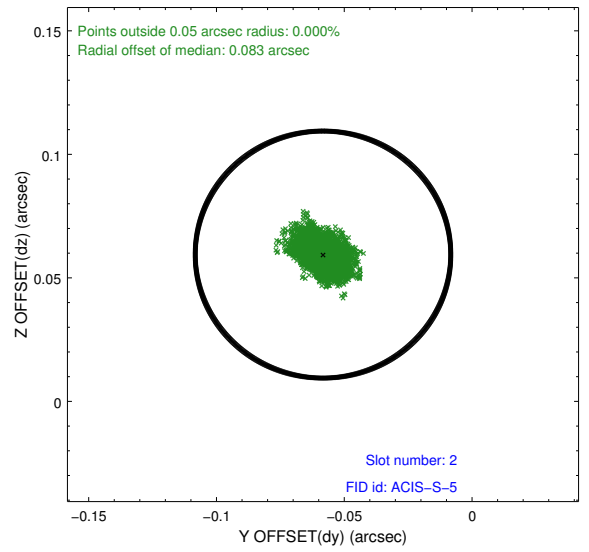
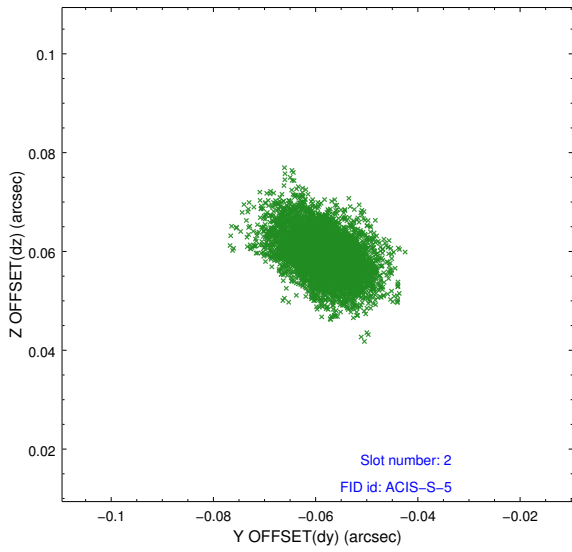
### 2.5.1 Slot 0



## 2.5.2 Slot 1

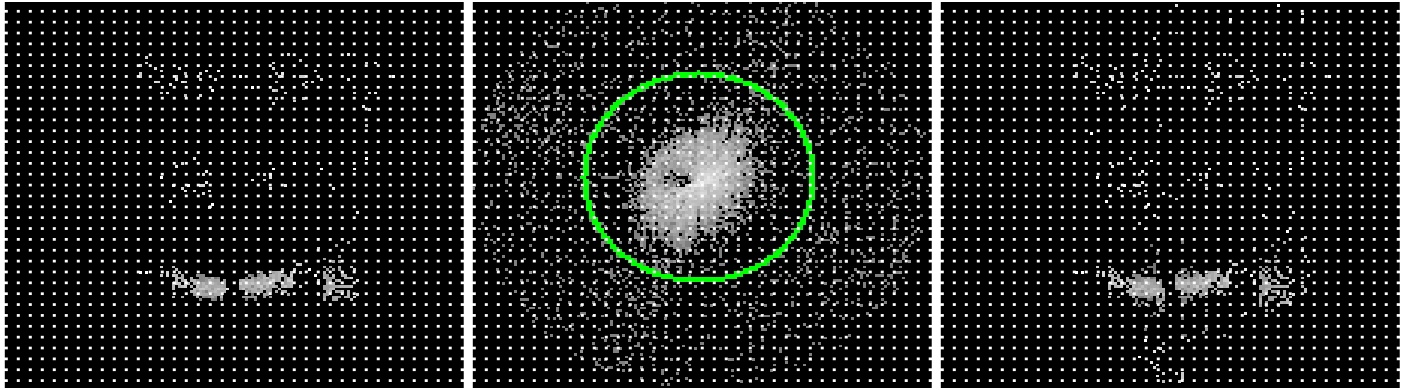


### 2.5.3 Slot 2



# 3 Gratings

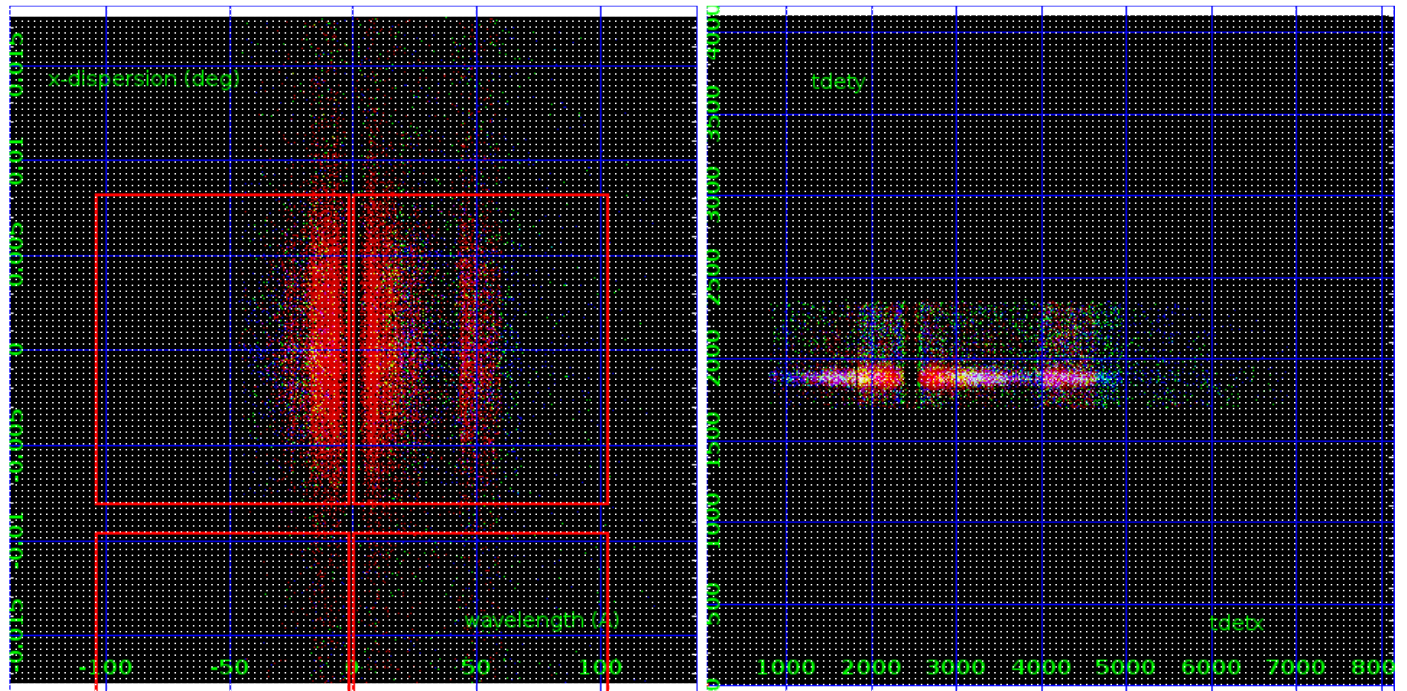
## 3.1 LETG Arm



LETG Order Sort 123

LETG Zero Order

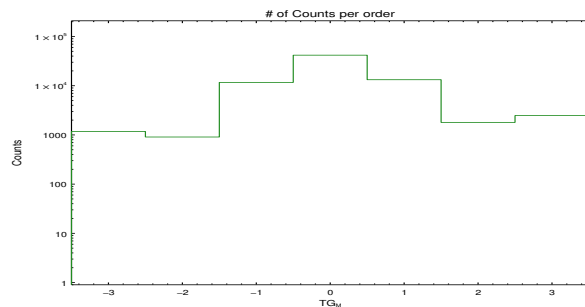
LETG Order Sort ALL

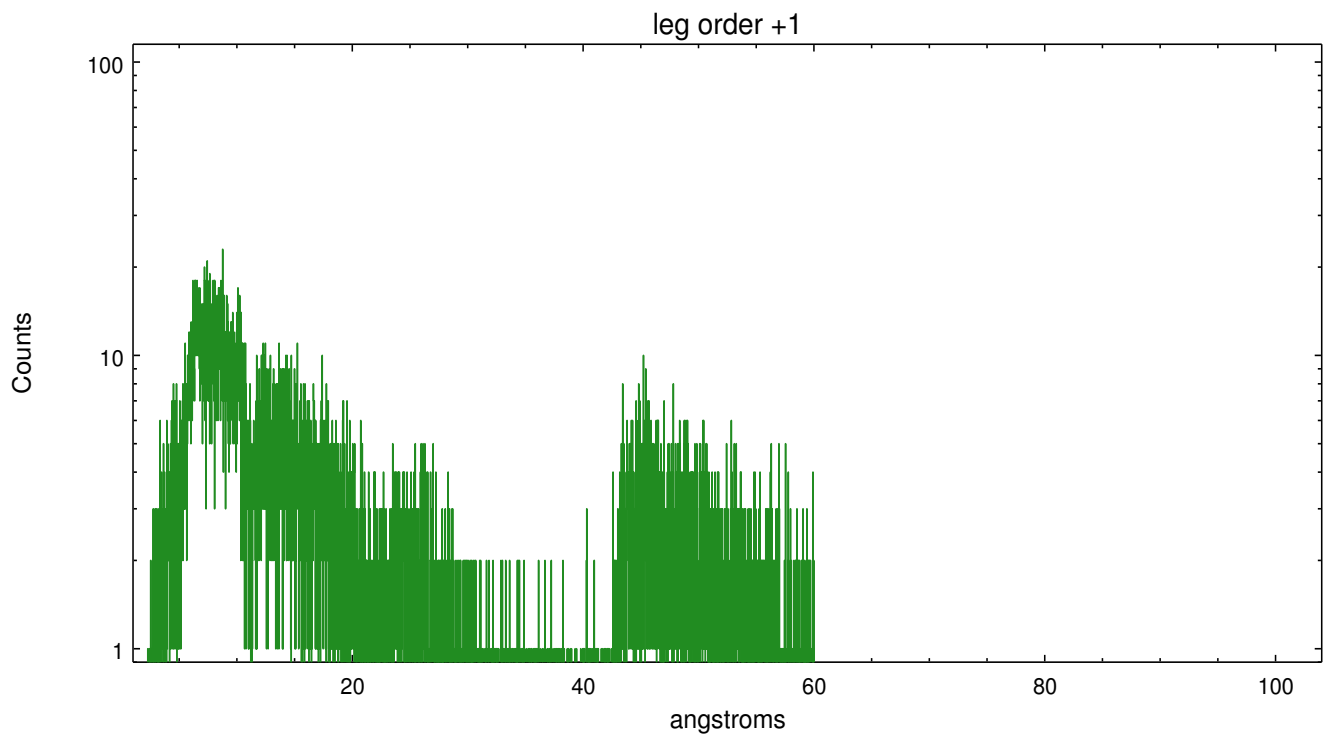
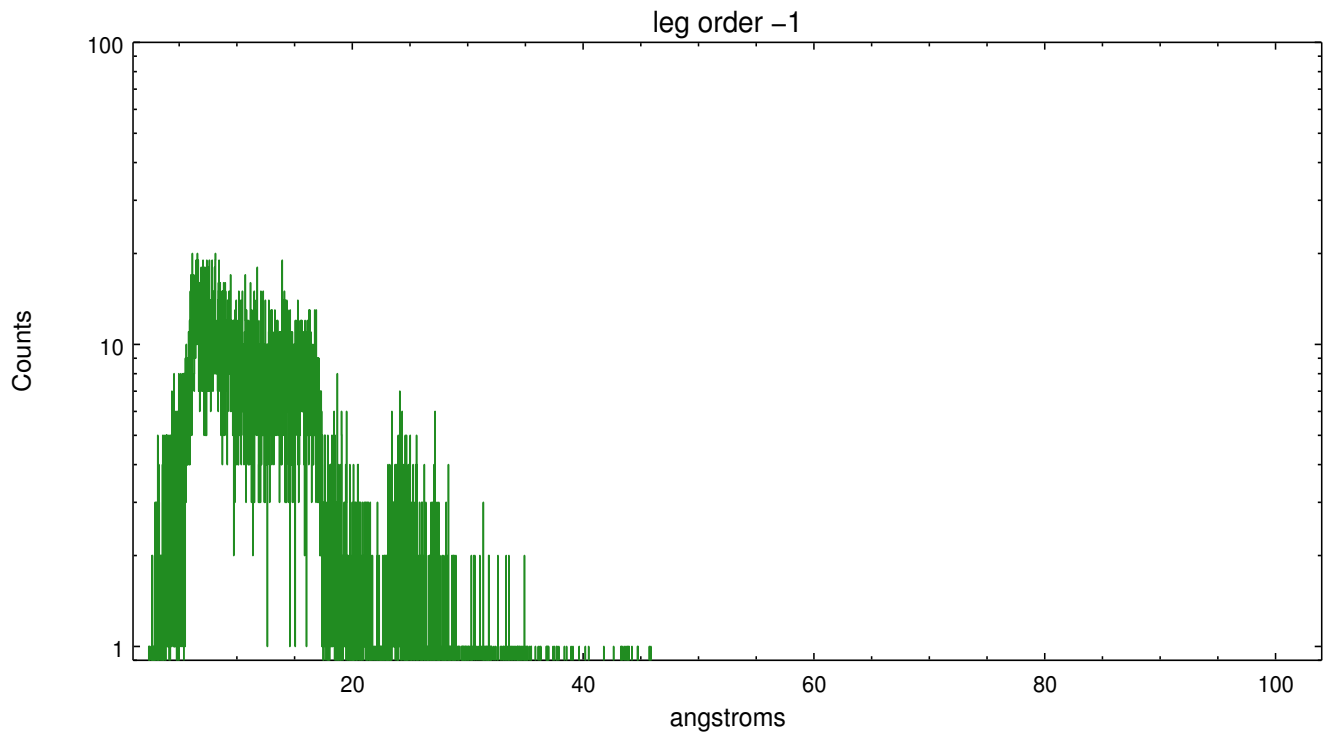


Spot Image LETG

Full Detector LETG

|        | order<br>-3 | order<br>-2 | order<br>-1 | order<br>0 | order<br>1 | order<br>2 | order<br>3 |
|--------|-------------|-------------|-------------|------------|------------|------------|------------|
| Events | 1175        | 907         | 11678       | 41742      | 13249      | 1797       | 2472       |





# A Summary

## A.1 Status

|                            |             |
|----------------------------|-------------|
| V&V Scientist              | Joy Nichols |
| V&V Date (YYYY-MM-DD)      | 2019.04.15  |
| V&V Edition                | 1           |
| V&V Disposition and Status | OK          |
| V&V Charge Time            | 21.161      |

## A.2 Comments

Note: off-axis (13.7 arcmin) and psf-broadened. In tgextract, the off-axis source extent requires the tg\_d range to be increased. Used custom extraction regions.

Reprocessed using the following method: Grating region information for custom extractions. Columns x, y, r, w give parameters for tg\_create\_mask Columns s1, s2, d1, d2, u1, u2 give paramters for tgextract. Customized parts of the usage are as follows: tg\_create\_mask use\_user\_pars = yes sA\_zero\_x = \$x sA\_zero\_y = \$y sA\_zero\_rad = \$r sA\_width\_heg = \$w sA\_width\_meg = \$w sA\_width\_leg = \$w tgextract min\_tg\_d = \$s1 max\_tg\_d = \$s2 min\_downbkg\_tg\_d = \$d1 max\_downbkg\_tg\_d = \$d2 min\_upbkg\_tg\_d = \$u1 max\_upbkg\_tg\_d = \$u2 PKS 2155 series (LETG/ACIS): # obsid x y r w s1 s2 d1 d2 u1 u2 1794 2586.22 4820.53 86.59 919.04 -8.099e-03 8.099e-03 -3.045e-02 -9.718e-03 2.430e-02 7.192e-02.

====

Zeroth order is extended. The zeroth order sky position was determined using a software tool developed by CXC called findzero, which is available in CIAO as part of the tgdetect2 tool. The tool calculates the point of intersection of the readout streak on the ACIS CCD and the meg dispersed spectral arm, rather than using a centroid position of the source. The findzero results are more accurate than source centroid in this case.

====

To compensate for a few bad pixels not marked as bad that were not removed in the Level 2 processing, a custom bad pixel file with additional bad pixels at (chipx, chipy) = (232:234,322:339) in S1 was added in this processing. As a result, the user will NOT find a relatively bright square of pixels on the S1 chip for level 2 data caused by the application of the dither algorithm to the bad pixels in question, as opposed to previous processing(s).

====

The ACIS focal plane temperature is warmer than -114.0 C degrees during the interval 82439689.74 - 82455532.94 (MET s) of this observation. This temperature is the upper limit of the verified ACIS calibration for the front-illuminated chips. The focal plane temperature is warmer than -112.0 C during the interval 82439689.74 - 82453513.74 (MET s) of this observation. This temperature is the upper limit of the verified ACIS

calibration for the back-illuminated chips. The focal plane temperature during part of this observation was warmer than the upper limit for optimum calibration of the ACIS gain and spectral resolution (i.e., -114.0 C for ACIS-I and -112.0 C for ACIS-S).

The Chandra calibration team calibrates the ACIS gain and spectral resolution using data from the external calibration source (ECS). ECS data show that the frontside-illuminated (FI) CCDs are more temperature sensitive than the backside-illuminated (BI) CCDs.

A summary of the current calibration status of the ACIS gain and spectral resolution can be found at:

[http://asc.harvard.edu/cal/Acis/Cal\\_prods/Gain\\_and\\_Spectral\\_Resolution/ACIS\\_response\\_summary.html](http://asc.harvard.edu/cal/Acis/Cal_prods/Gain_and_Spectral_Resolution/ACIS_response_summary.html)

The main points are:

- 1) The gain on BI chips remains within 0.3% (i.e., the systematic uncertainty in the ACIS gain quoted on the Chandra Calibration Status Summary web page) at all measured temperatures.
- 2) The gain on FI chips remains within 0.3% below row 600 at all measured temperatures.
- 3) The gain on FI chips above row 600 can be underestimated by as much as 1% for focal plane temperatures exceeding -116 C.
- 4) The spectral resolution (i.e., FWHM) on BI chips is insensitive to the focal plane temperature.
- 5) Warmer focal plane temperatures increase the FWHM on FI chips by up to 30 eV near row 512 and by up to 70 eV near the top of the chips.

In summary, the user should be cautious in the spectral analysis of high S/N emission lines detected on the top half of FI chips in this observation. Default processing with the current version of the CALDB will underestimate photon energies by up to 1% and broaden emission lines by up to 70 eV.