**Attempt to Correct for Flat Field problems in GSECARS**

We collected data at 37 keV, and set the Pilatus threshold to 18.5 keV. However, because of a bug in camserver it was using a 60 keV flat field correction, rather than 37 keV. We should be able to fix this problem by dividing by the 60 keV flat field file, and then multiplying by the correct 37 keV flatfield file. This document describes the result of attempting to do this.

We are using these data files.

[det@ppu071 Pilatus]$ ls -ltr t\_3633\_00\*

-rw-rw-r-- 1 det det 4096828 Nov 13 07:02 t\_3633\_00000.tif

-rw-rw-r-- 1 det det 4096828 Nov 13 07:03 t\_3633\_00001.tif

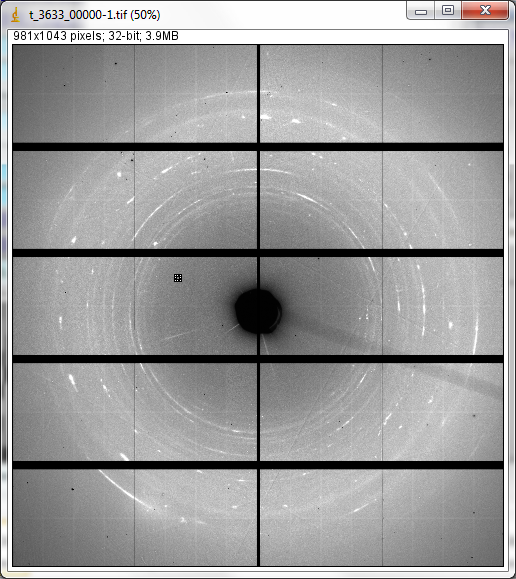
-rw-rw-r-- 1 det det 4096828 Nov 13 07:04 t\_3633\_00002.tif

-rw-rw-r-- 1 det det 4096828 Nov 13 07:05 t\_3633\_00003.tif

-rw-rw-r-- 1 det det 4096828 Nov 13 07:06 t\_3633\_00004.tif

These files were collected on the same sample, 1 minute apart. They were collected on the GSECARS 13-ID-D station. We verified that these files were collected at an energy of 37 keV.

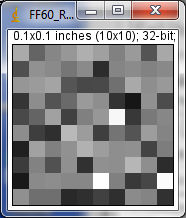
In order to see the problems clearly we focus on a small 10x10 pixel region of the detector, from pixels 325:334 in X and 460:469 in Y. This is the region with the box in the upper-left of center of the following overall image. The 10x10 region we selected is free from diffraction features and should be uniform in intensity over this small area, and also not changing except for counting statistics from one image to the next.



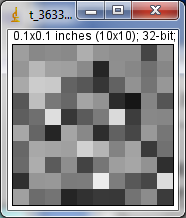
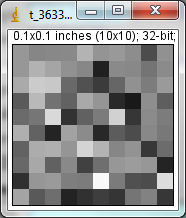
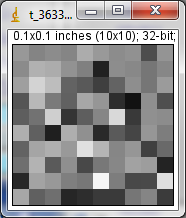
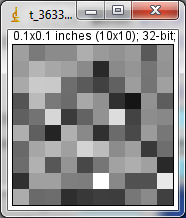
The images below are the two flat field files.

On the left is the 60 keV flatfield file (FF\_p0\_E60000\_T18500\_vrf\_m0p100.tif) produced by camserver. The greyscale is from 0.85 to 1.15, i.e. ±15%.

On the right is the 37 keV flatfield file (FF\_p0\_E37000\_T18500\_vrf\_m0p100.tif) produced by camserver. The greyscale is from 0.95 to 1.05, i.e.±5%.

The following are the images for these 5 files that we originally collected with the 60 keV flat field. These are displayed with the greyscale from 20000 to 28000 counts.



Note that there is variation between these images. However, all 5 images have bright pixels at (X,Y) = (7,5), (6,9), and (6, 10) where I am numbering pixels starting at 1, not 0. These are the same pixels that are the brightest ones in the 60 keV flatfield file shown above. They also have dark pixels at (6,2) and (8,4). These systematic differences indicate that we do indeed have a flat field calibration problem.

The following IDL program was used to read the images, including the flat fields, and do the correction, i.e. divide by the 60 keV flat field and then multiply by the 37 keV flat field. It writes out the full corrected files, as well at the 10x10 pixel ROIs that are shown here.

; This program attempts to correct the Pilatus3 CdTe data that was collected using the wrong flat field file

; It was collected with file FF\_p0\_E60000\_T18500\_vrf\_m0p100.tif, (i.e. 60 keV), but should have been collected with

; FF\_p0\_E37000\_T18500\_vrf\_m0p100.tif (e.g. 37 keV)

FF\_60 = **read\_tiff**('FF\_p0\_E60000\_T18500\_vrf\_m0p100.tif')

FF\_37 = **read\_tiff**('FF\_p0\_E37000\_T18500\_vrf\_m0p100.tif')

base\_file = 't\_3633\_0000'

data = **lonarr**(**981**, **1043**, **5**)

; Read 5 data files

**for** i=**0**, **4** **do** **begin**

**data**[**0**, **0**, i] = **read\_tiff**(base\_file + **strtrim**(i,**2**) + '.tif')

**endfor**

corrected = data

**for** i=**0**, **4** **do** **begin**

corrected[**0**, **0**, i] = **long**(data[\*, \*, i] / FF\_60 \* FF\_37 + **0.5**)

**endfor**

; Write out the entire corrected files

**for** i=**0**, **4** **do** **begin**

**write\_tiff**, base\_file + **strtrim**(i,**2**) + '\_corrected.tif', corrected[\*, \*, i], /long

**endfor**

; Now write 10x10 ROI from 325,460 for every image

xmin = **325**

xmax = **334**

ymin = **460**

ymax = **469**

roi = FF\_60[xmin:xmax, ymin:ymax]

**write\_tiff**, 'FF60\_ROI.tif', **roi**, /float

roi = FF\_37[xmin:xmax, ymin:ymax]

**write\_tiff**, 'FF37\_ROI.tif', **roi**, /float

**for** i=**0**, **4** **do** **begin**

roi = data[xmin:xmax, ymin:ymax, i]

**write\_tiff**, base\_file + **strtrim**(i,**2**) + '\_ROI.tif', **roi**, /long

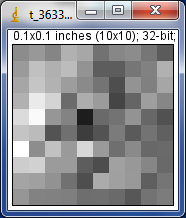
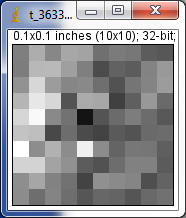
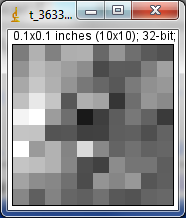
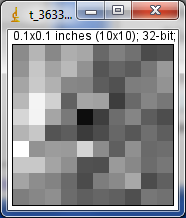
roi = corrected[xmin:xmax, ymin:ymax, i]

**write\_tiff**, base\_file + **strtrim**(i,**2**) + '\_ROI\_corrected.tif', **roi**, /long

**endfor**

**end**

The following are the images for these 5 files after correction with the IDL program above. These are displayed with the greyscale from 22000 to 26000 counts. This is smaller than the greyscale range used for the uncorrected images above because the correction has reduced the variation.

Note that there is variation between these images. However, all 5 images have a dark pixel at (5,5) and bright pixels at(2,5), (1,7), and (5,7). This is not what we expect to see if the flat field correction is done properly. Instead we should see a random distribution of intensities in this uniform region of the image, where the randomness is controlled by Poisson counting statistics.

The following table shows the mean and standard deviation for each of the 10 images before and after correction.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Before correction** | | **After correction** | |
| **Image** | **Mean** | **Standard deviation** | **Mean** | **Standard deviation** |
| 1 | 23994 | 1533 | 24158 | 664 |
| 2 | 24013 | 1527 | 24177 | 668 |
| 3 | 23875 | 1533 | 24039 | 700 |
| 4 | 23865 | 1509 | 24031 | 730 |
| 5 | 23891 | 1501 | 24057 | 708 |

From the above table it can be seen that the mean value in all of the images is about 24000 counts. The expected standard deviation due to Poisson statistics is the square root of 24000, which is 155. So before correction the actual standard deviation is 10 times the expected value. This is due to the systematic errors caused by the improper flat field correction. After correction the standard deviation has been reduced by a factor of 2.2 because the flat field correction is better. However, the average standard deviation of 694 is still 4.5 times greater than that expected from Poisson statistics, and it is clear that there are still large systematic differences between the pixel intensities. We do not understand why this is the case.