SWIFT-UVOT-CALDB-##
Date Original Submitted:
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Date Revised:
Revision #01
Revised by:
Pages Changed:
Comments:

SWIFT UVOT CALDB RELEASE NOTE

SWIFT-UVOT-CALDB-##: LARGE SCALE SENSITIVITY

0. Summary:

This product maps the large scale sensitivity variations for 6 filters of the UVOT.

1. Component Files:

FILE NAME	VALID DATE	RELEASE DATE	VERSION

2. Scope of Document:

This document contains a description of the Large Scale Sensitivity (LSS) calibration analysis performed to produce the LSS calibration products for the UVOT calibration database.

3. Changes:

This is the first released version of the LSS calibration document.

4. Reason For Update:

This is the first released version of the LSS calibration document.

5. Expected Updates:

Analysis of the LSS for the U, UVW1, UVW2 and UVM2 filters still needs to be done. This will happen on a timescale of ~6 months. Work is still needed to assess whether the variation in background over the image is due to scattered light effects, or due to variation in throughput of the detector. Analysis of sources at different positions off-axis should clarify this.

If it turns out that the variation in background over the image is due to sensitivity variations, the image should be normalised to 1.0 and then used to multiply any exposure.

If it turns out that the variation in background over the image is additive, then we need to scale by exposure time before subtracting. At the moment this would not be valid for an exposure time greater than 2000s because the error would be inappropriate.

However, this LSS effect is small and will not affect photometry where the background region is taken from close to the source.

6. Caveat Emptor:

Analysis of the V filter and preliminary analysis of the B filter have been done. The magnitude of the effect of large scale variations cannot be fully assessed until analysis of the other filters has been completed. It is still to be determined if this is an additive (due to stray light) or multiplicative (due to varying sensitivity across the detector) effect. Analysis of the other filters should help to determine this. Currently the final image created to correct for the LSS effects has an exposure time of <2000 secs, if an observation is taken that is longer than 2000 secs the correction image will not be valid.

We are assuming that the background received in each image is representative of the normal background and that it doesn't change much from one observation to another.

7. Data Used:

All V filter data with exposure times of 1000-2000 seconds taken from the start of the mission to June 2005. All B filter data with exposure times of 500-2000 seconds taken from the start of the mission to July 2005.

8. Description of Analysis:

This task requires that the images are full-frame, and a total ~30ks of data is needed, in as many different fields as possible. The method used performs sigma-clipping to remove the bright stars. Many images are combined to produce a median that should cancel out most of the small scale variations (i.e. stars) and should represent the large scale variations. While sigma-clipping is performed there are still residuals present hence the requirement of many images of different fields to avoid giving more weight to some stars in an image if that field is included more than once. The images are therefore scaled in such a way as to prevent any one image getting too much weight.

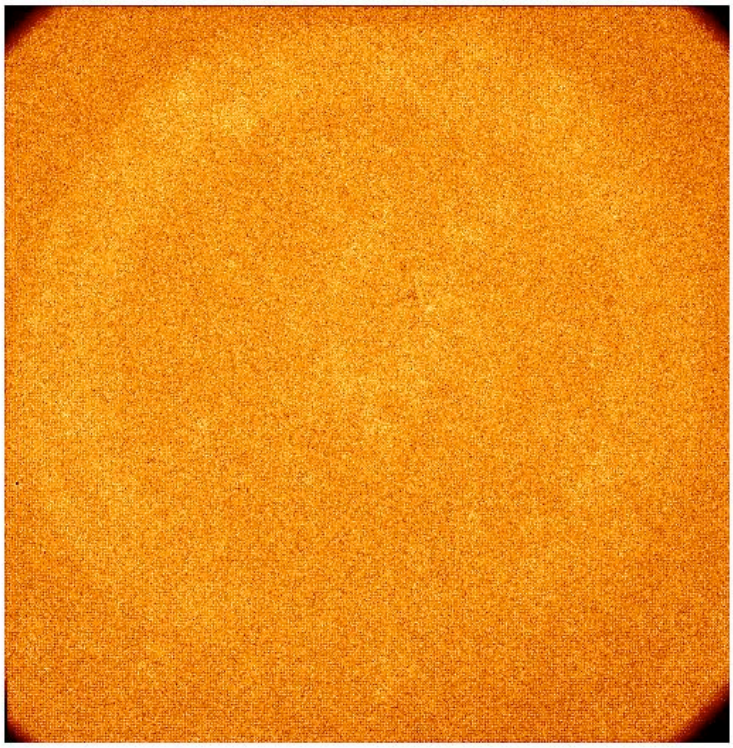
All V filter data with exposures of 1000-2000 seconds were selected. The analysis was performed using IRAF's 'imcombine' package. For fields that have multiple extensions that have adequate exposure times the extensions are combined to create an average of the field, scaling by the exposure time. The images (single and average) are divided into 3 groups by requiring that each group has a similar total exposure time. The images in each group are combined to create a median image, scaling by the median and clipping data that is greater than 2 sigma above the mean. The 3 resulting images are then combined to create an average image that is scaled by the median. This final image represents the 'background' or additional light that is received by the detector. The final image that is created has an exposure time of <2000 secs. If an observation to be corrected is >2000 secs the LSS image will not be valid. If the observation to be corrected is <2000 secs the LSS correction image should be scaled by the exposure time to remove the effect. It is yet to be determined if the LSS effect should be subtracted from the observation,

or if the observation should be divided by the LSS image. Further analysis of the other filters must be performed to determine which process should be performed.

The same method was used for the B filter data, but with images with 500-2000 second exposures and only two groups were created due to a lack of data.

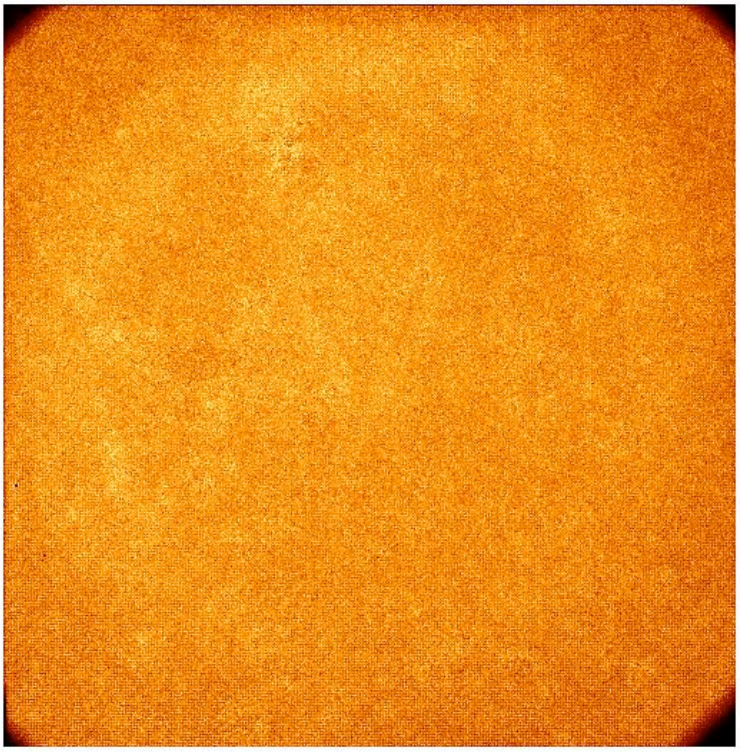
V-filter : group 1 combined median image
number of images combined = 18
exposure = 1998 s

Image	N	Exp (s)	Median	Scale
sw00020004012_V.fits[0]	3	1271	6.0	1.3
sw00020005003_V.fits[0]	3	1336	3.7	2.2
sw00020006002_V.fits[0]	3	1147	3.3	2.4
sw00020009003_V.fits[0]	3	1409	4.7	1.7
sw00020011003_V.fits[0]	2	1506	4.5	1.8
sw00030032001_V.fits[0]	3	1736	23.3	0.3
sw00054800005uvv_rw.fits[1]	1	1119	11.0	0.7



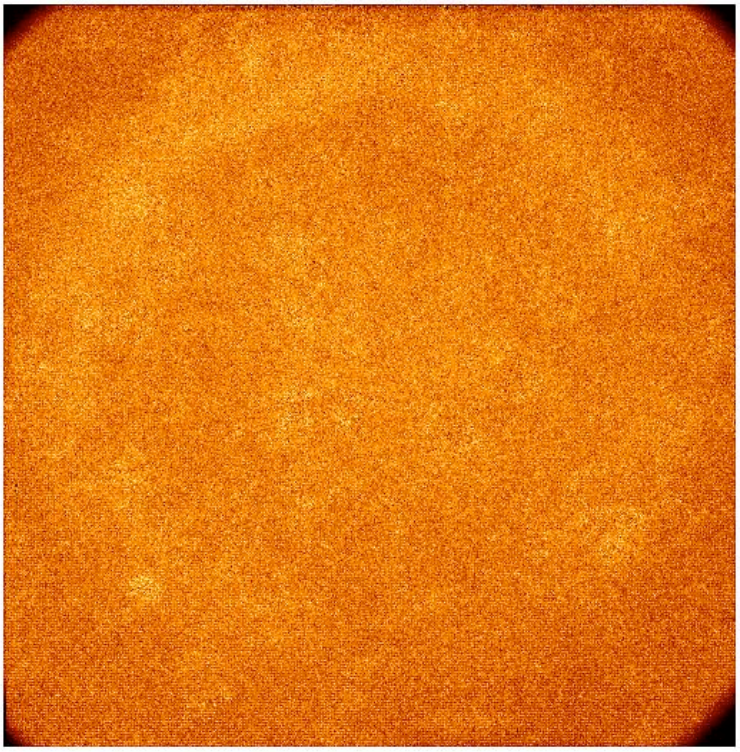
V-filter : group 2 combined median image
number of images combined = 20
exposure = 1434 s

Image	N	Exp (s)	Median	Scale
sw00067133001_V.fits[0]	2	1131	9.0	0.9
sw00113872001_V.fits[0]	3	1280	7.7	1.0
sw00114299001_V.fits[0]	3	1169	10.3	0.8
sw00114485002_V.fits[0]	3	1169	5.7	1.4
sw00114753001_V.fits[0]	3	1387	4.7	1.7
sw00114797001_V.fits[0]	3	1466	7.7	1.0
sw00115214001_V.fits[0]	3	1631	11.7	0.7



V-filter : group 3 combined median image
number of images combined = 15
exposure = 1481 s

Image	N	Exp (s)	Median	Scale
sw00116116001_V.fits[0]	3	1284	9.0	0.8
sw00117504002_V.fits[0]	3	1437	11.0	0.7
sw00118707002_V.fits[0]	3	1267	8.0	0.9
sw00130088021_V.fits[0]	3	1599	5.7	1.3
sw00055400016uvv_rw.fits[1]	1	1146	6.0	1.2
sw00055450010uvv_rw.fits[2]	1	1618	8.0	0.9
sw00055950003uvv_rw.fits[1]	1	1355	5.0	1.5



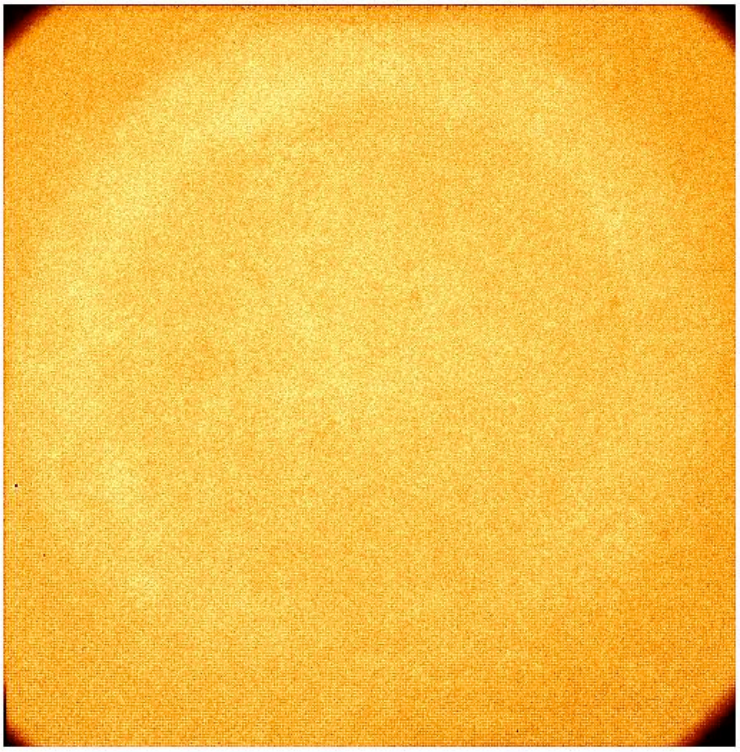
V-filter: average of the above 3 images

Group	N	Exp (s)	Median	Scale
1	18	1998	8.1	1.0
2	20	1434	8.1	1.0
3	15	1481	7.4	1.1

Number of images combined = 53
Exposure = 1636 s

Statistics of the final image:

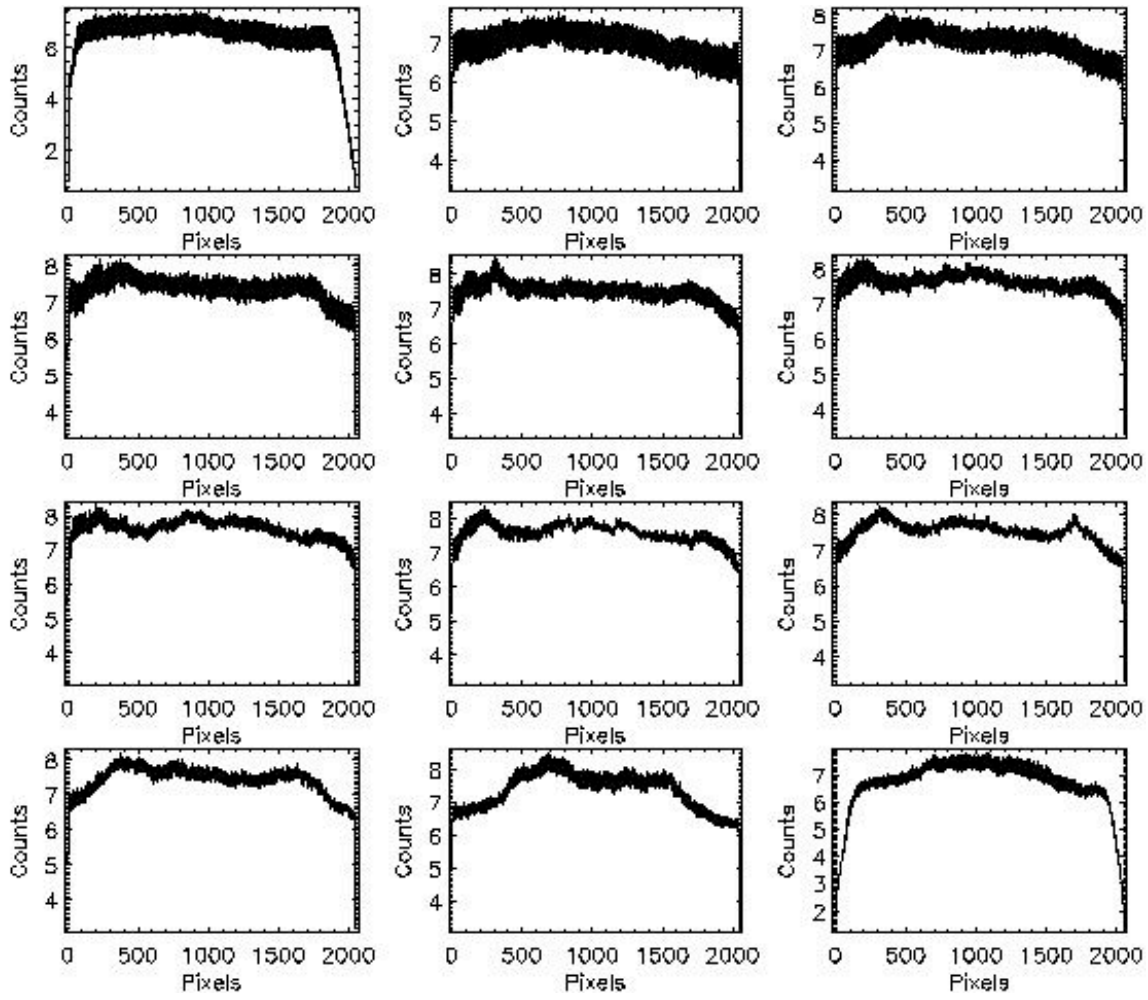
Exp (s)	Mean	Standard Deviation	Variance
1636	7.26	0.98	0.96



The following plot shows the variation of the detector in the x-direction as you move up the detector in the y-direction

The panels, starting from top left, correspond to the following y-ranges:

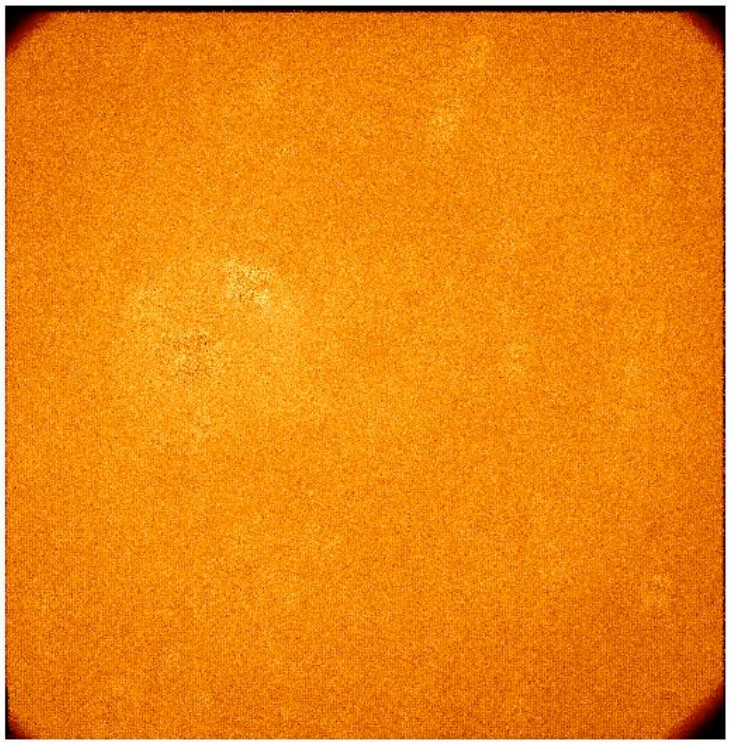
0-170, 170-340, 340-510, 510-680, 680-850, 850-1020, 1020-1190, 1190-1360, 1360-1530, 1530-1700, 1700-1870, 1870-2040



B-filter : group 1 combined median image
number of images combined = 16
exposure = 1700 s

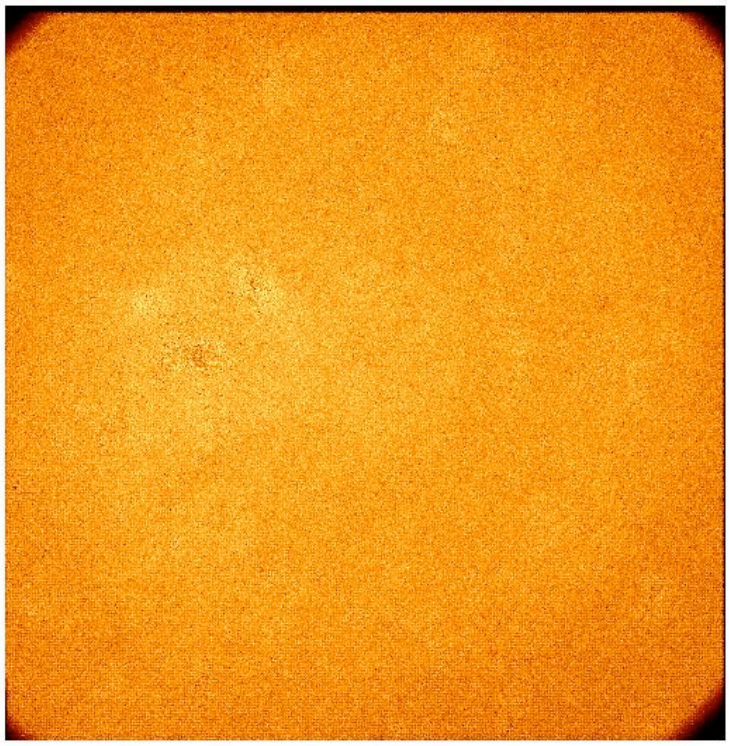
Image	N	Exp (s)	Median	Scale
sw00054500042_B.fits[0]	1	1252	12.0	1.3
sw00111622006_B_1.fits[0]	3	1264	7.3	2.1
sw00111622007_B1.fits[0]	1	1313	7.0	2.2
sw00113872002_B_1.fits[0]	3	1609	22.3	0.7

sw00113872002_B_3.fits[0]	2	1418	19.0	0.8
sw00113872002_B4.fits[0]	1	1952	25.0	0.6
sw00130088002_B1.fits[0]	1	1383	12.0	1.3
sw00055150007ubb_rw.fits[1]	1	1727	16.0	1.0
sw00113872002_B.fits[0]	3	1508	16.7	0.9



B-filter : group 2 combined median image
number of images combined = 19
exposure = 1681 s

Image	N	Exp (s)	Median	Scale
sw00054500043_B.fits[0]	1	1775	22.0	0.6
sw00111622006_B_2.fits[0]	4	1574	8.8	1.6
sw00111622007_B2.fits[0]	1	1314	7.0	2.0
sw00111622007_B3.fits[0]	1	1250	7.0	2.0
sw00113872002_B_2.fits[0]	2	1568	22.0	0.6
sw00113872002_B5.fits[0]	1	1397	23.0	0.6
sw00113872002_B9.fits[0]	1	1234	15.0	0.9
sw00130088002_B2.fits[0]	1	1244	8.0	1.7
sw00055250019ubb_rw.fits[1]	1	1046	8.0	1.7
sw00113872005_B.fits[0]	6	1520	18.0	0.8



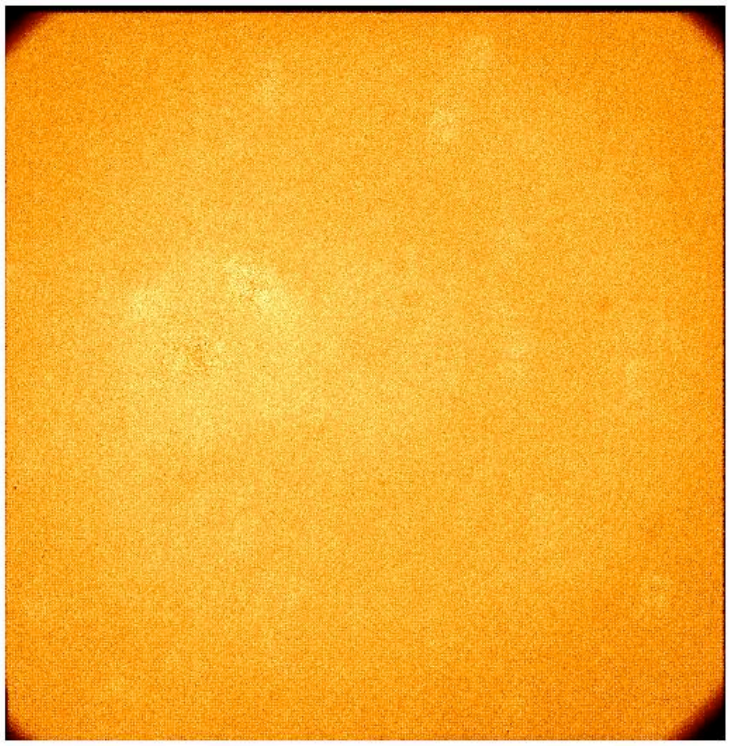
B-filter: average of the above 2 images

Group	N	Exp (s)	Mean	Scale
1	16	1700	15.2	1.0
2	19	1681	13.9	1.0

Number of images combined = 35
Exposure = 1694

Statistics of the final image:

Exp (s)	Mean	Standard Deviation	Variance
1694	12.84	2.53	6.39



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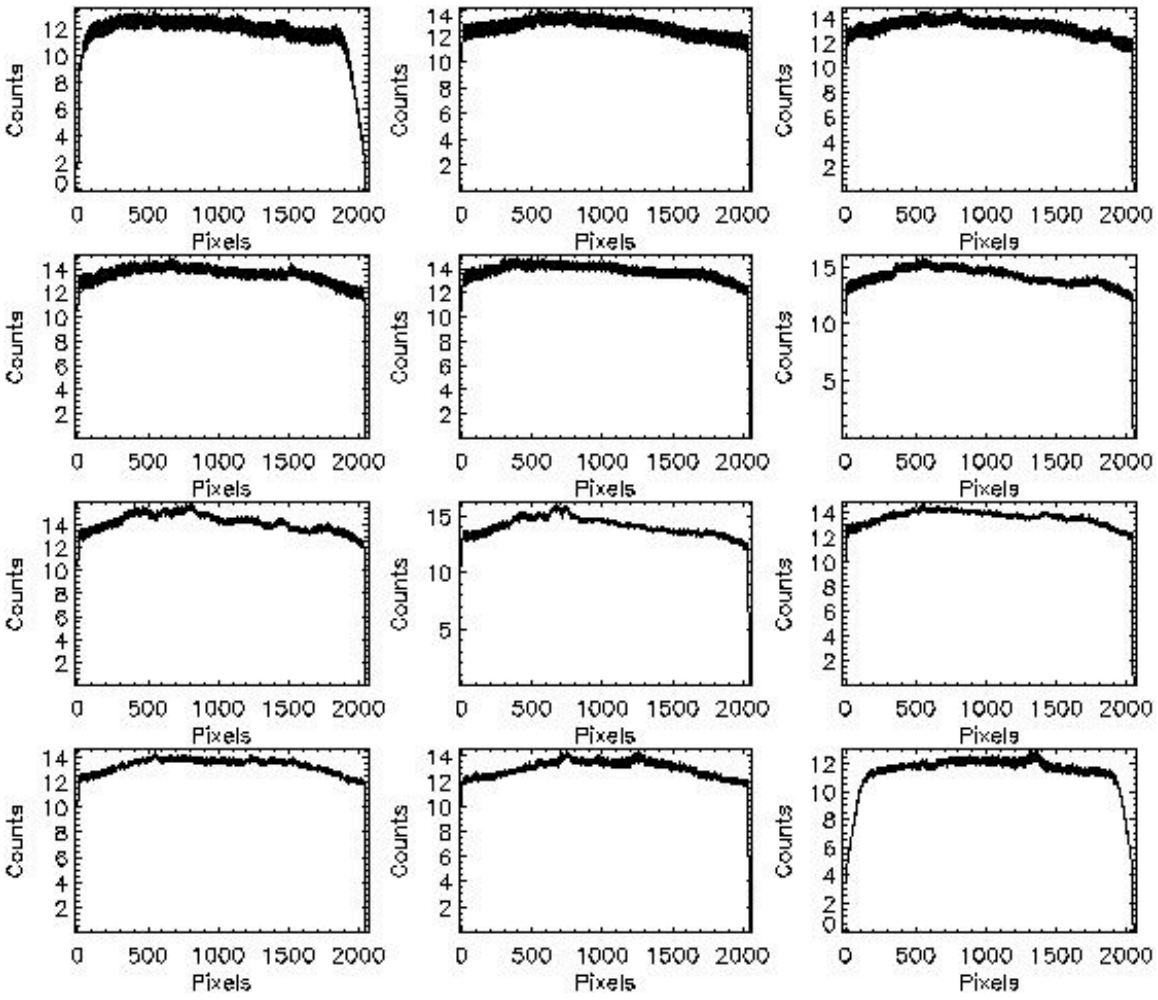
Counts
Pixels
0
500
1000
1500
2000