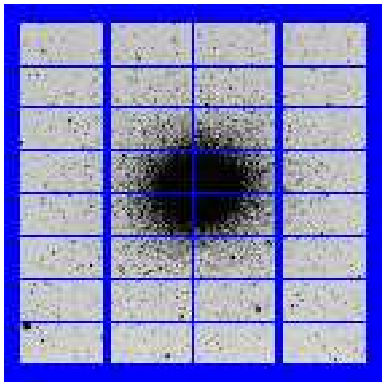
OmegaCAM Commissioning period 1A notes

Commissioning team at OmegaCEN, University of Groningen
April 24, 2011



Contents

1 Introduction

OmegaCAM Commissioning run 1A (OCAM1A) took place: March 25 - April 1, 2011

The purpose of this document is to give an overview of notions gathered from the activities in this commissioning run. During the run these notions were gathered from the activities with OmegaCAM at the VST on Paranal, Chile and from the data handling and analysis at OmegaCEN in Groningen, The Netherlands. After the run, further insight was gained from follow-up data handling and analysis at OmegaCEN.

OmegaCAM as panoramic camera had First Light in OCAM1A. At the same time OCAM1A also meant "First Light" for OmegaCAM data flow operations. This involved the transfer using EVALSO and the data handling using Astro-WISE.

OmegaCAM data were sent in compressed format from Paranal to ESO headquarters in Garching using the EVALSO-light data link. From there the data were retrieved via ftp to Groningen The Netherlands by OmegaCEN. For OCAM1A about 750 images were transferred with a total volume of ∼400 Gbytes. Data transfer has continued and up-to writing of this report about 2300 images have been transferred with a total volume of ∼1.2 Terabyte. The original commissioning plan called for some of the test data evaluated on-site, but for most of it to be recorded on disks, which were then to be carried to Europe for analysis before the next commissioning period could begin. Using EVALSO enables (i) much faster transfer time to Europe (as fast as a few hours was experienced during OCAM1A), which led to a significant compression of the commissioning schedule and increase of flexibility/contingency in the schedule, which is a significant risk reduction; and (ii) access to the commissioning data for many more people in the European team, so that off-mountain experts can be called upon to evaluate the results and flag and resolve issues with the instrument and telescope.

Astro-WISE was used for the analysis on the mountain (filebased version) and at OmegaCEN (database-based version). At OmegaCEN, the commissioning data were ingested in the project COMM2011 in Astro-WISE. Using EVALSO+Astro-WISE meant that commissioning data was quickly available for inspection, processing and analysis by OmegaCAM consortium members across Europe (inspection and processing within Astro-WISE starting as fast as 4.5 hours after observation occured in OCAM1A).

We tested the following functions of Astro-WISE in particular:

- Commissioning operations monitoring. This involved the data transfer and ingestion that could be monitored via python scripts. The progress of calibration via Calibration webservice CalTS (calts.astro-wise.org) and of science observations via DBViewer (dbview.atro-wise.org). And the processing status of data via the TargetProcessor webinterface (process.astro-wise.org). This went quite well.

- Calibration pipelines and calibration quality control and validation via CalTS and python scripts. These functioned properly. With first real data in hand we can fine-tune in particular the Astro-WISE quality-control methods.

- Image pipelines and image quality Control. The pipeline built-in QC methods were used for this, They are bundled in the Quality-WISE webservice. At OmegaCEN we created a coadded image of OCAM1A science data with first raw but complete photometric and astrometric calibration.

- Adaptability of system to ad-hoc customization. Commissioning requires many small inspection/analysis actions that need to be customized for the special case at hand. This could be dealt with by adapting the existing python recipes and tasks and writing small new scripts (”5-line scripts”). Personal repositories (via CVS) of the python code for all Astro-WISE users (as opposed only experts/developers) are very advantageous for this operation mode.

Feedback to the Paranal team from Europe for commissioning was given daily starting 2 days after First Light. Unfortunately internet access at Paranal is not fast enough to allow access to all results from Astro-WISE webservices. We made use of an emaillist that automatically created a webbased archive.

Figure 1 gives an overview of the exposure templates observed in OCAM1A. (This figure is produced by the CalTS webservice in Astro-WISE at http://calts.astro-wise.org/).

Major change in the setup of the camera that occured to which is referred throughout this document:

- 29 March 2011, 6pm local time: change in filtering setting of the FIERAs.

2 Notions

2.1 Read Noise (req 5.2.1)

As Figure 1 shows 4 Read Noise templates were observed in OCAM1A. The number of exposures in the observed templates differ from the requirement in the calibration plan. Additionally, raw bias frames from some Bias Templates were used to determine read noise levels. The read noise levels are shown in Figure 2.

Notions:

1. Readnoise levels (~ 2.25 ADU) are consistent with those measured during ILT 2005 before the change in FIERA filtering settings.
2. Readnoise levels increased to ~ 2.75 ADU after the change in FIERA filtering settings.

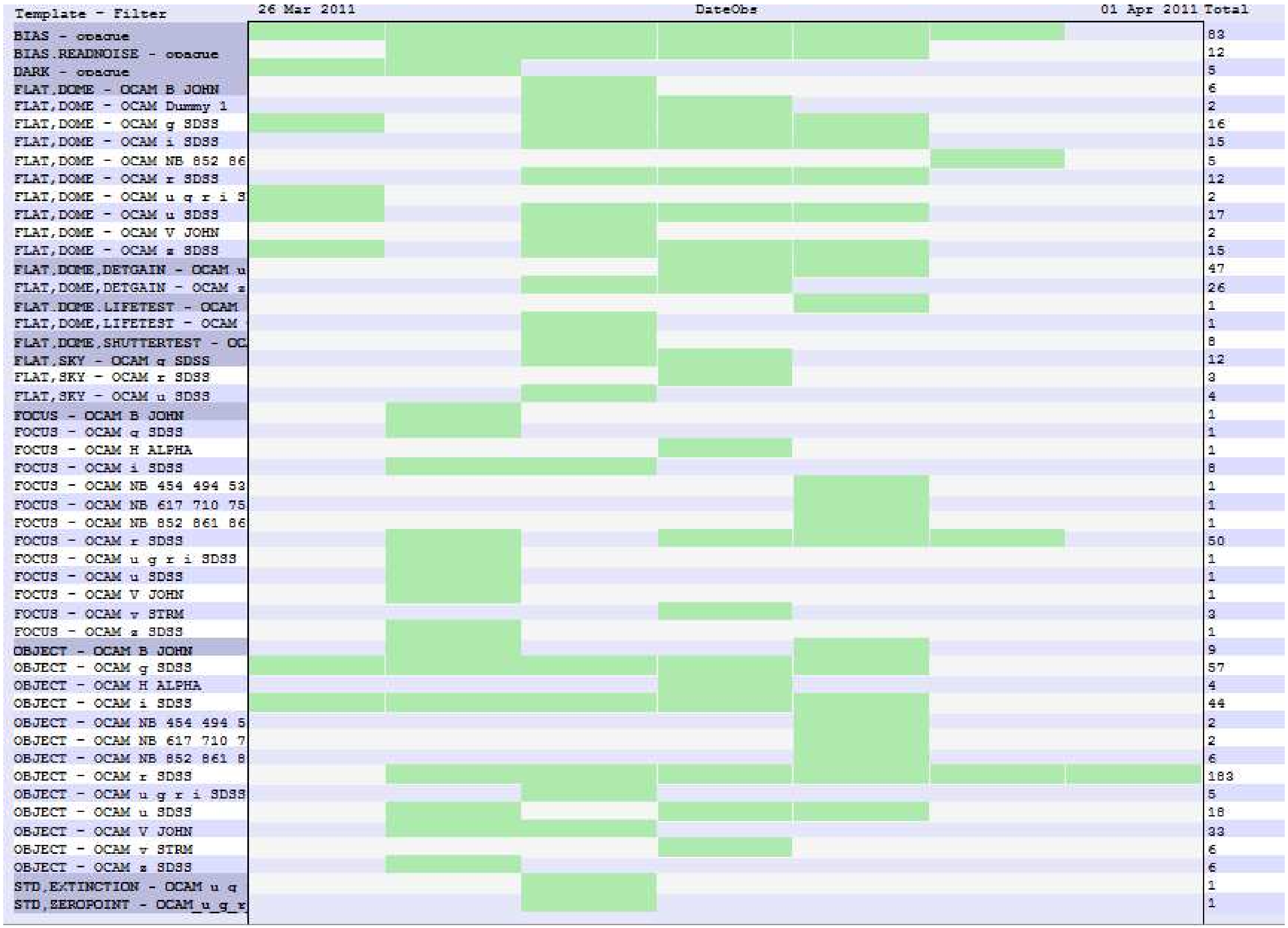
2.2 Hot Pixels (number of hot pixels) (req. 5.2.2)

Hotpixels were determined using bias templates for which the number of exposures was typically different from the requirement in the calibration plan.

Notions:

1. Hot pixel numbers are in agreement with those determined during ILT in 2005 and integration test in 2008. Numbers have dropped significantly from many 1000s to less than 1000 for detectors #67 and #68 compared to integrations test in 2008 and ILT 2005 respectively.

Details:
CCD #82 has a bad column. This detector shows changes in number of hot pixels > 100 varying in the range 3000-4200.



Template - Filter	26 Mar 2011			DateObs			01 Apr 2011	Total
BIAS - opaque	🟩	🟩	🟩	🟩	🟩	🟩		83
BIAS.READNOISE - opaque		🟩	🟩	🟩	🟩			12
DARK - opaque	🟩	🟩						5
FLAT,DOME - OCAM B JOHN			🟩					6
FLAT,DOME - OCAM Dummy 1			🟩	🟩				2
FLAT,DOME - OCAM g SDSS	🟩		🟩	🟩	🟩			16
FLAT,DOME - OCAM i SDSS			🟩	🟩	🟩			15
FLAT,DOME - OCAM NB 852 86						🟩		5
FLAT,DOME - OCAM r SDSS			🟩	🟩	🟩			12
FLAT,DOME - OCAM u g r i S	🟩							2
FLAT,DOME - OCAM u SDSS	🟩		🟩	🟩	🟩			17
FLAT,DOME - OCAM V JOHN			🟩					2
FLAT,DOME - OCAM z SDSS	🟩		🟩	🟩	🟩			15
FLAT,DOME,DETGAIN - OCAM u				🟩	🟩			47
FLAT,DOME,DETGAIN - OCAM z			🟩	🟩				26
FLAT.DOME.LIFETEST - OCAM					🟩			1
FLAT,DOME,LIFETEST - OCAM			🟩					1
FLAT.DOME,SHUTTERTEST - OC			🟩					8
FLAT,SKY - OCAM g SDSS			🟩	🟩				12
FLAT,SKY - OCAM r SDSS				🟩				3
FLAT,SKY - OCAM u SDSS			🟩					4
FOCUS - OCAM B JOHN		🟩						1
FOCUS - OCAM g SDSS		🟩						1
FOCUS - OCAM H ALPHA				🟩				1
FOCUS - OCAM i SDSS		🟩	🟩					8
FOCUS - OCAM NB 454 494 53					🟩			1
FOCUS - OCAM NB 617 710 75					🟩			1
FOCUS - OCAM NB 852 861 86					🟩			1
FOCUS - OCAM r SDSS		🟩		🟩	🟩	🟩		50
FOCUS - OCAM u g r i SDSS		🟩						1
FOCUS - OCAM u SDSS		🟩						1
FOCUS - OCAM V JOHN		🟩						1
FOCUS - OCAM v STRM				🟩				3
FOCUS - OCAM z SDSS		🟩						1
OBJECT - OCAM B JOHN		🟩			🟩			9
OBJECT - OCAM g SDSS	🟩	🟩	🟩	🟩	🟩			57
OBJECT - OCAM H ALPHA				🟩				4
OBJECT - OCAM i SDSS	🟩	🟩	🟩	🟩	🟩			44
OBJECT - OCAM NB 454 494 5					🟩			2
OBJECT - OCAM NB 617 710 7					🟩			2
OBJECT - OCAM NB 852 861 8					🟩			6
OBJECT - OCAM r SDSS		🟩	🟩	🟩	🟩	🟩	🟩	183
OBJECT - OCAM u g r i SDSS			🟩					5
OBJECT - OCAM u SDSS		🟩		🟩	🟩			18
OBJECT - OCAM V JOHN		🟩	🟩					33
OBJECT - OCAM v STRM				🟩				6
OBJECT - OCAM z SDSS		🟩						6
STD,EXTINCTION - OCAM u g			🟩					1
STD,ZEROPOINT - OCAM_u_g_r			🟩					1

Figure 1: Overview of observed templates in OCAM1A.

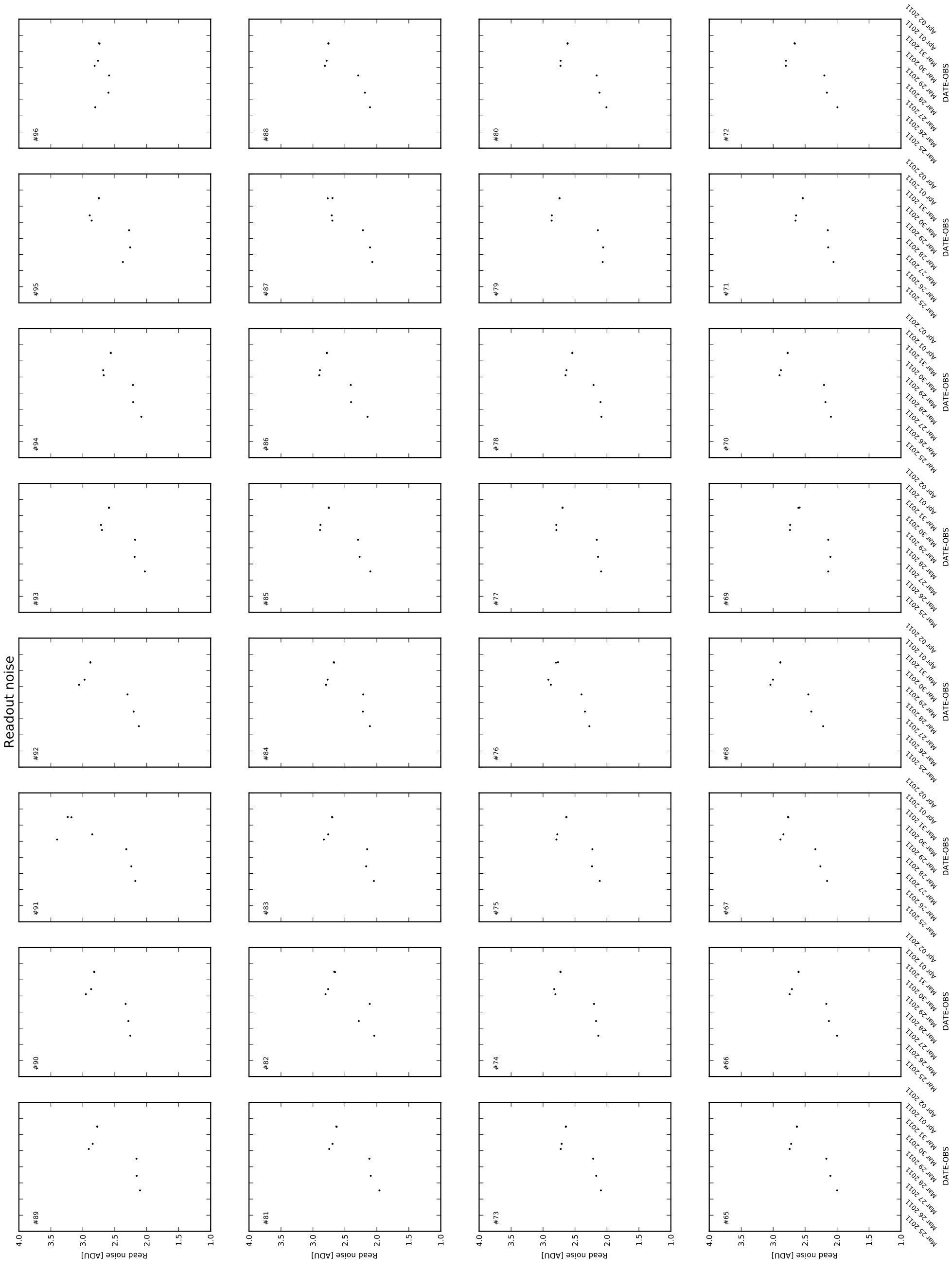


Figure 2: Read noise in ADU versus observation date.

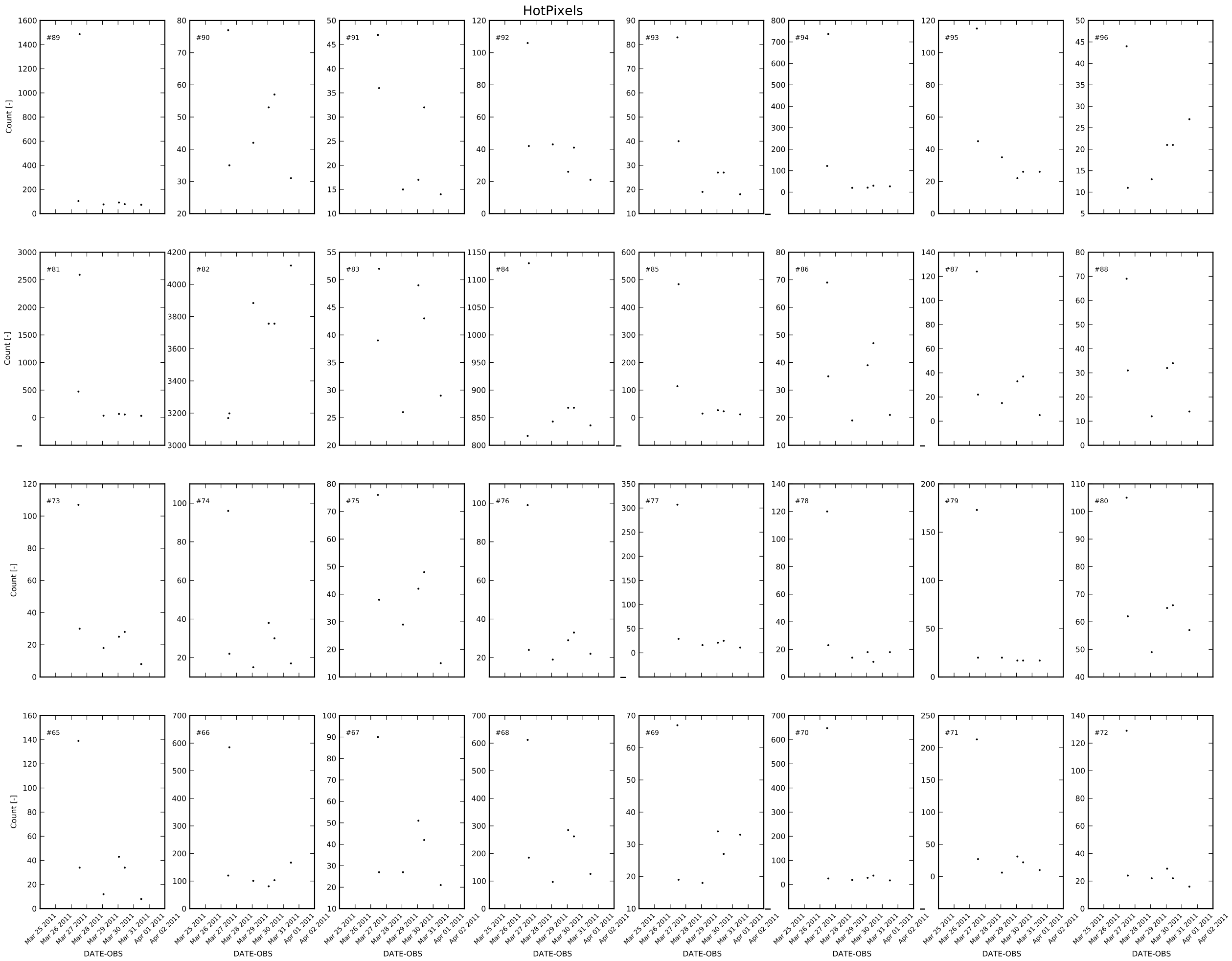


Figure 3: Hot pixels

2.3 Gain (e-/ADU) (req. 5.2.3)

On 29 March, around 18:00u local time the FIERA filtering signal was changed. To analyze the consequences we have determined the gain before and after this change. The Gain template uses the observed noise of domeflats with varying exposure time to infer the gain.

Notions:

1. The Gain determined from GAIN template before the FIERA configuration change is in agreement with ILT 2005. As shown in Figure 4, the Gain template was inferred to be ~ 2.25 e-/ADU. After the change the gain was inferred to be ~ 1.7 (e-/ADU). This ratio of ~ 1.35 holds for each detector, no strong outliers.
2. As an independent check we have determined the raw dome flat levels for fixed exposure times before and after the change in FIERA filtering settings. This was done for Sloan z domeflats with 2.0s exposure. Figure 5 shows overscan subtracted raw dome flat levels (ADU) versus Modified Julian Date of the observation (MJD-OBS). Indicated by a blue line is the moment of the change. If gain determination is correct, the ratio gain before/after equals ratio rawdomeflat levels after/before. This is indeed observed.
3. Sloan u domeflats did show a wider variations in ratio of the gain before/after $(1.1 - 1.7)$. However, interpretation is uncertain as these domeflats seem strongly affected by scattered light (see Section 2.8.
4. Analysis of gain in OCAM1B using gain template plus independent checks is important.

Other notions related to the gain change:

- Readnoise levels are typically $\sim\ 4.7e-$ assuming our gain (e-/ADU) determination is correct. This holds before and after the change in filtering settings of the FIERAs.

2.4 CCD Linearity (req. 5.3.3

The CCD linearity measurement was obtained using the GAIN template observations of 2011-03-29T11:54:36.

Notion:

1. The linearity behavior seen is similar to the ILT 2005 measurements: non-linearity of ~1-2% or smaller. See Figure 6 The linearity has to be established further during commissioning.

2.5 Cold Pixels (number of cold pixels) (req. 5.3.5)

Cold pixels are determined from domeflats. We determined cold pixels for r and z band. The domeflat templates sometimes had a number of exposures different from the requirement in the calibration plan.

Notions:

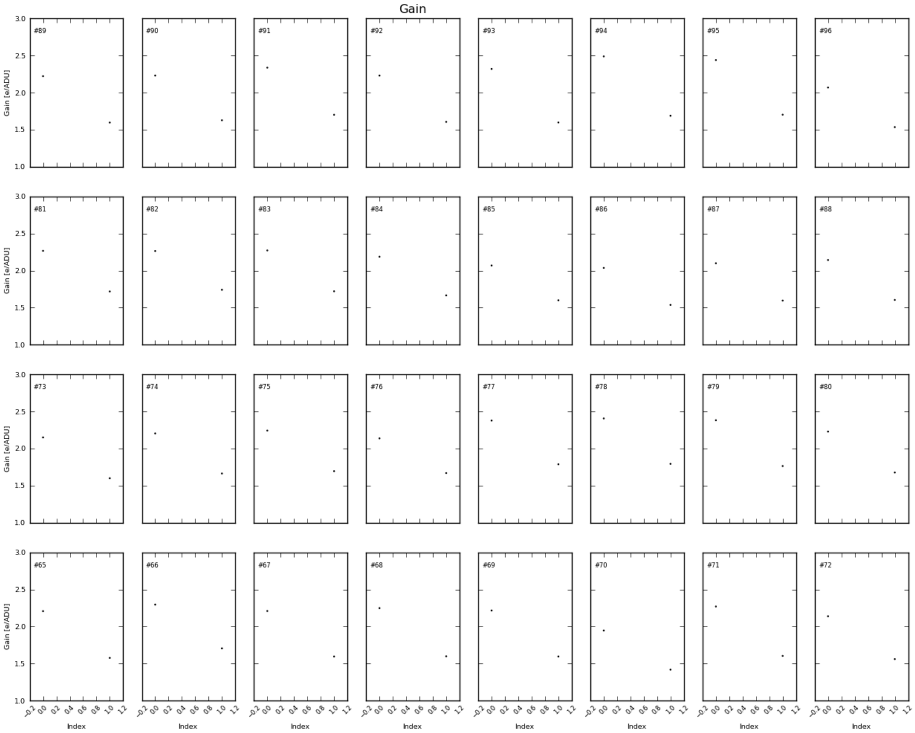


Figure 4: Gain determination versus observation date.

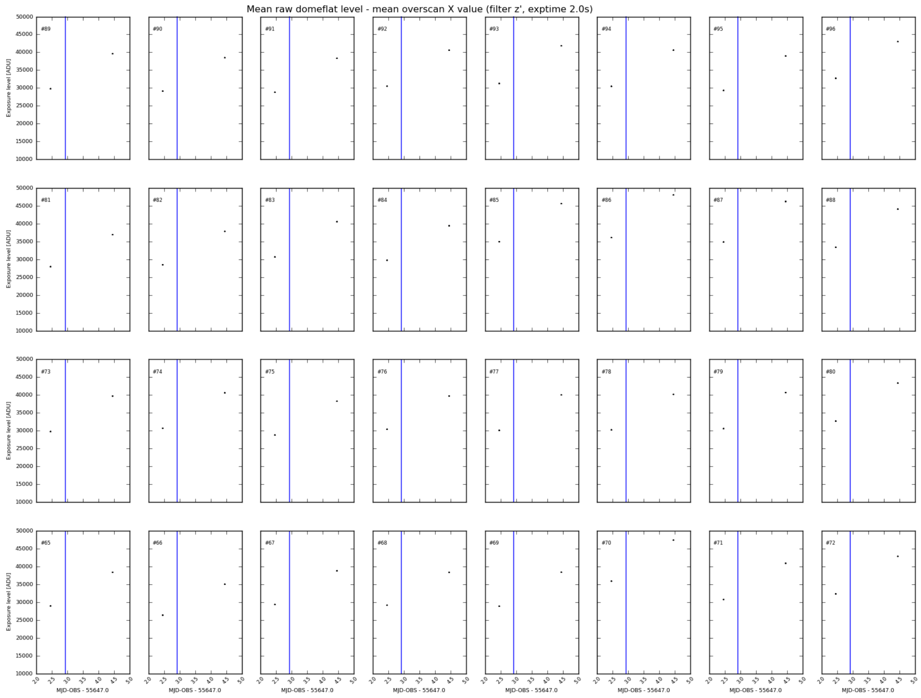


Figure 5: Counts in 2second raw domeflats in z-band with overscan subtracted versus observation date.

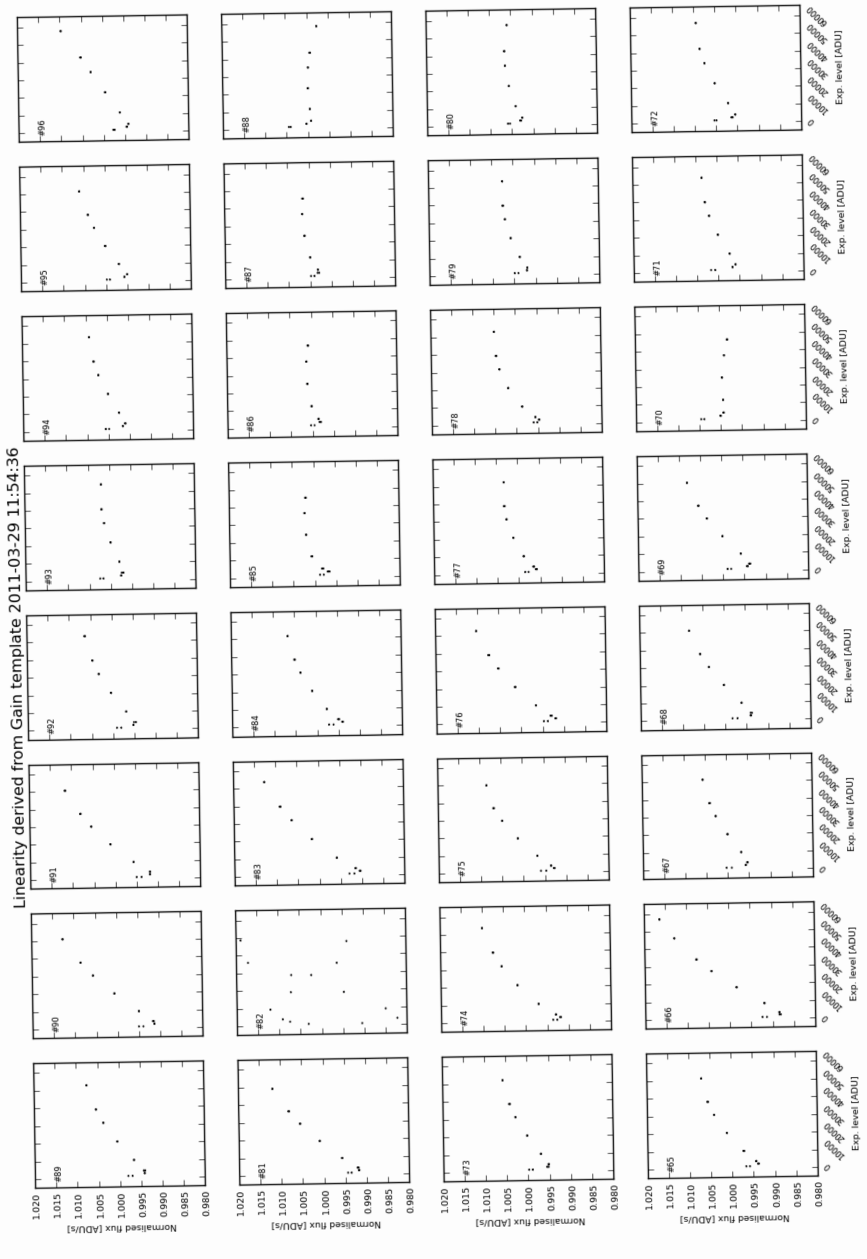


Figure 6: Linearity ADU rates (ADU/s) vs exposure level (ADU).

Table 1: Response variations in raw flats.

filter	type	response variation across single chip	response variation across mosaic
g	twilight	≤5%	∼13%
g	dome	≤6%	∼17%
u	twilight	≤8	∼30%
u	dome	∼30%	>200%

1. A few 1000 cold pixels are detected typically in r. This is much smaller than measured in ILT 2005. These much higher numbers were inferred to be caused by dust on the dewar window.
2. Many more upto 200000 cold pixels are detected in z band cold pixelmaps of some detectors. Visual inspection suggests this might be due to erroneous flatfields. Further interpretation awaits the production of twilightflats and masterflatfields for all filters which is planned for OCAM1B.

2.6 Bias (req. 5.4.1.)

Bias templates were performed daily in OCAM1A. Figure 7 shows the raw bias levels as a function of observation date.

Notions:

1. Raw bias levels before the change in the FIERA filtering setting are consistent with those of ILT 2005. They are $\sim 160 - 180$ ADU typically with a few outlier detectors.
2. After the change the raw bias levels increased for all detectors by a factor ~ 1.5 to typically $\sim 250 - 300$ ADU, again with a few outlier detectors.
3. Mean bias levels after overscan correction are typically < 1 ADU except for CCD #68 (~ 2.5 ADU) and CCD #90 (~ 1 ADU): see Figure 8

2.7 Tilt

See report attached.

2.8 Flats

In OCAM1A it was possible for the first time to observe both twilight flats and dome flats. Thus it offered the opportunity to inspect the sensitiy variation over the mosaic and the illumination variation over the domeflat screen in the dome. Twilight flats were observed for Sloan u and g. Stars are visible in the twilight flats in g, but flat is very usuable for eyeball inspection. We inspected diagonal cuts over the full mosaic for raw flat frames see Figures 9-12. Table 1 lists the variations in response measured from these cross-cuts.

Notions:

1. vignetting: Drop-off in levels in both twilights and dome flats at rectangular border between inner 2 rows of 8 detectors and outer 2 rows.

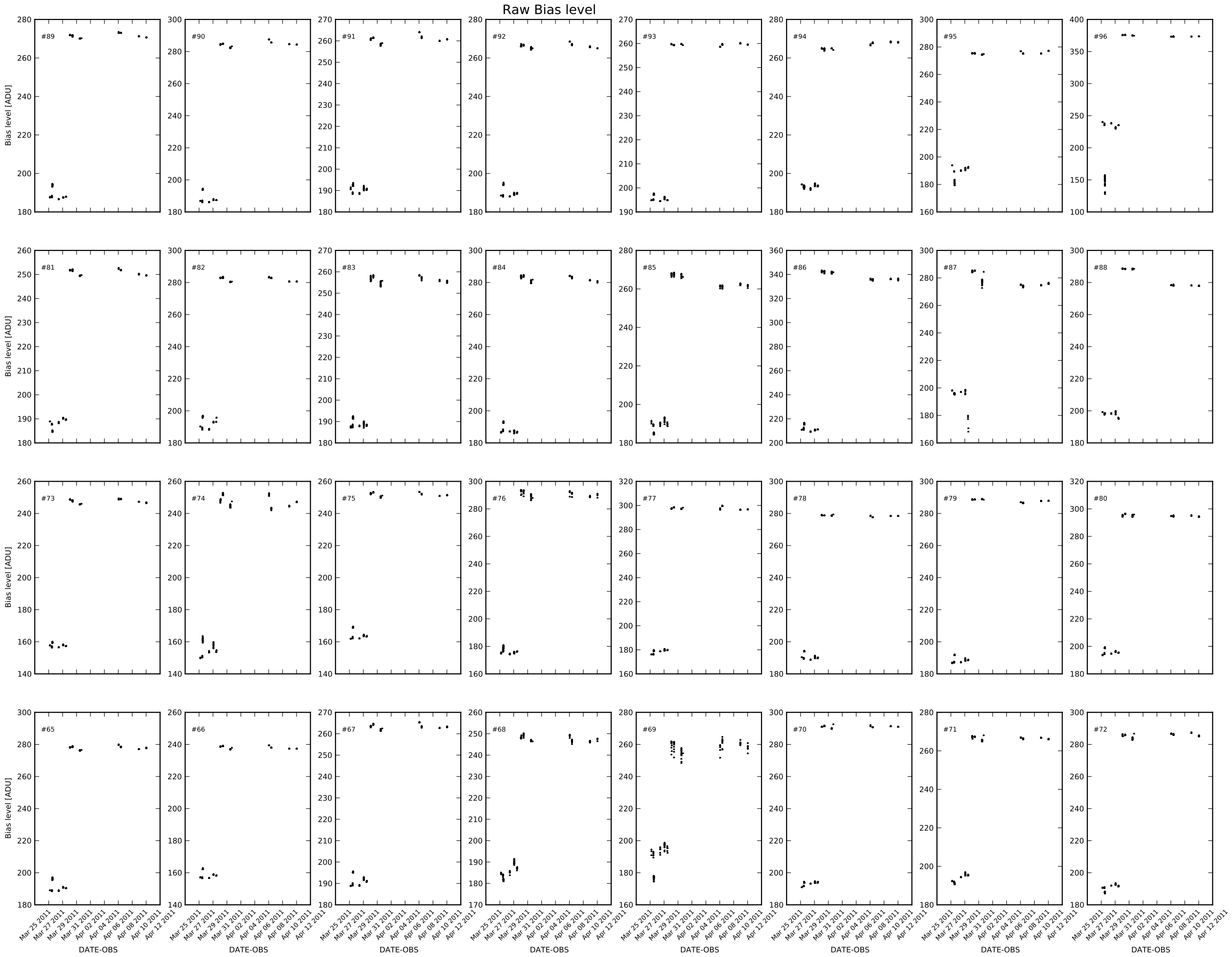


Figure 7: Raw bias levels

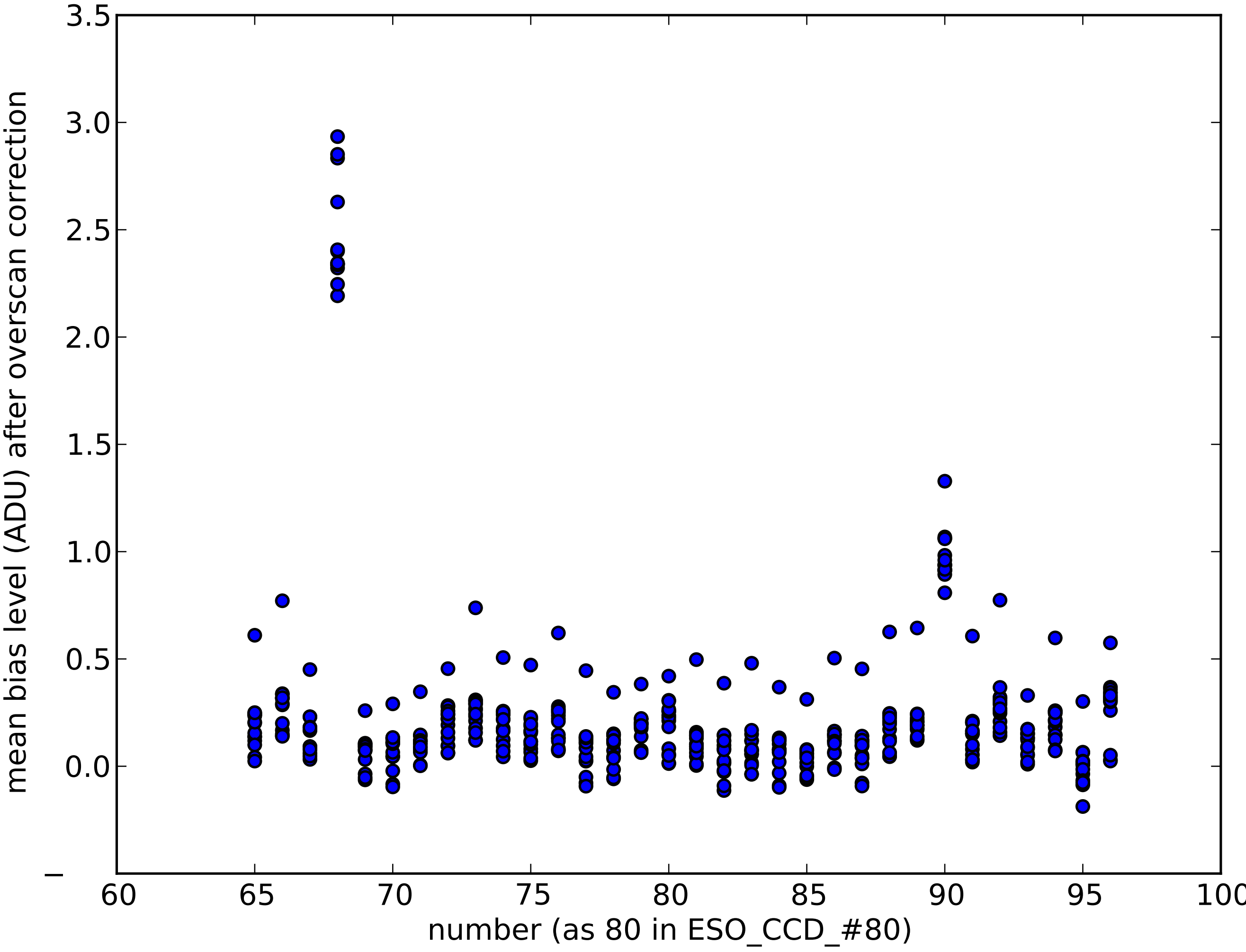


Figure 8: Mean values of MasterBias frames vs detector number.

2. Domescreen illumination variation: In Sloan g a cross-cut through the domeflat divided by the twilight shows a variation of ∼20% (see Figure 13). The mosaic center has the minimum ratio. In u-band, the ratio of dome flat over twilight shows almost a factor 2 variation ((see Figure 14). Here, the mosaic center has the maximum. In Sloan u the raw dome flat level show a steep drop in level at the mosaic edges.
3. Strong scattering in dome flat u: Fine-structure pattern is seen with min-to-max ∼ 10% amplitude in u-band twilight. It is seen and in agreement with detector analysis in thesis of F. Christen. In dome u-band however this fine-structure pattern is wahsed out: has only min-to-max ∼1% amplitude. This fact taken together with the large illumination variation, indicates a strong contribution from scattered light in the dome u-band.
4. Dither step sizes for twilight flats as given in the calibration plan should be performed to avoid star residuals in the twilight flats.
5. From OCAM1B the correct fourier filtering scales need to be determined for creating masterflats via combining dome and twilight flats.

Details:
Data used: g-band twilight/dome observations with date-obs (2011, 3, 31, 10, 38, 8) / (2011, 3, 29, 10, 16, 30). For u-band twilight/dome observations with (2011,03,31,11,30,22) / (2011,03,29,10,26,16).

2.9 Crosstalk

We have confirmed the presence of cross-talk at the start of OCAM1A in CCDs #94,95,96. Cross-talk is present in the most recent observation date that we have inspected for it: 2011-04-05T03:15:19. See Figure 15

2.10 Dark current and particle event rate

Three dark exposures of 60sec were observed. Exposure time is too short too draw conclusions. Longer darks should be observed in OCAM1B.

2.11 Segmented filters

Segmented filters show ghosts of bright stars when stars falls on borders of segments. To be investigated further in OCAM1B.

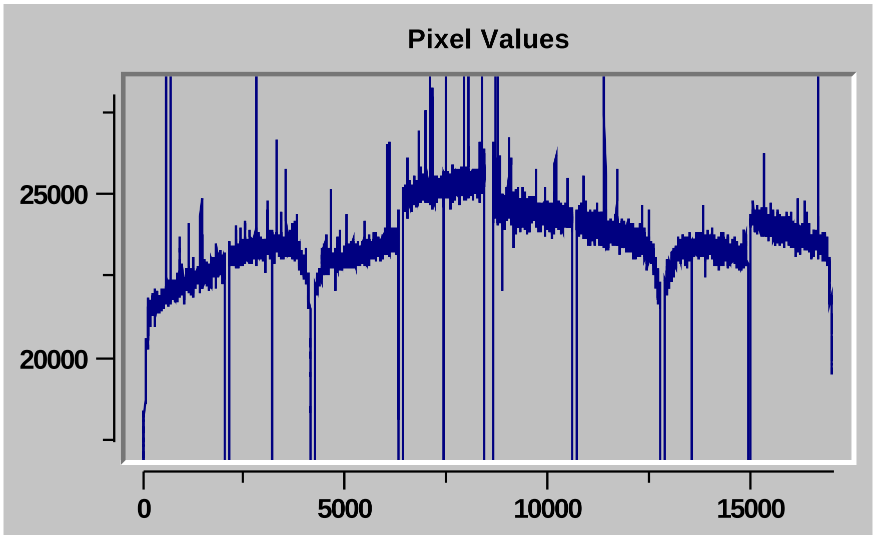


Figure 9: Counts (ADU) on a diagonal cut across a full mosaic of a raw twilight flat in g.

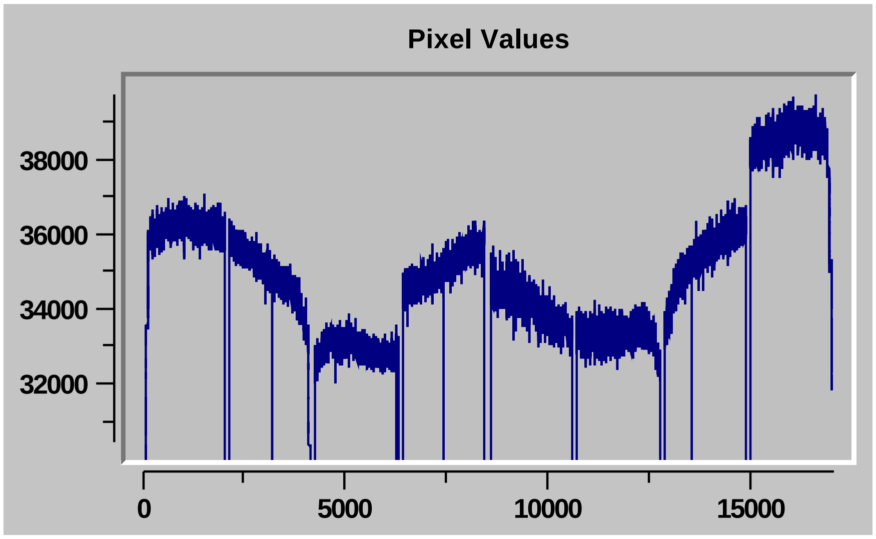


Figure 10: Counts (ADU) on a diagonal cut across a full mosaic of a raw domeflat in g.

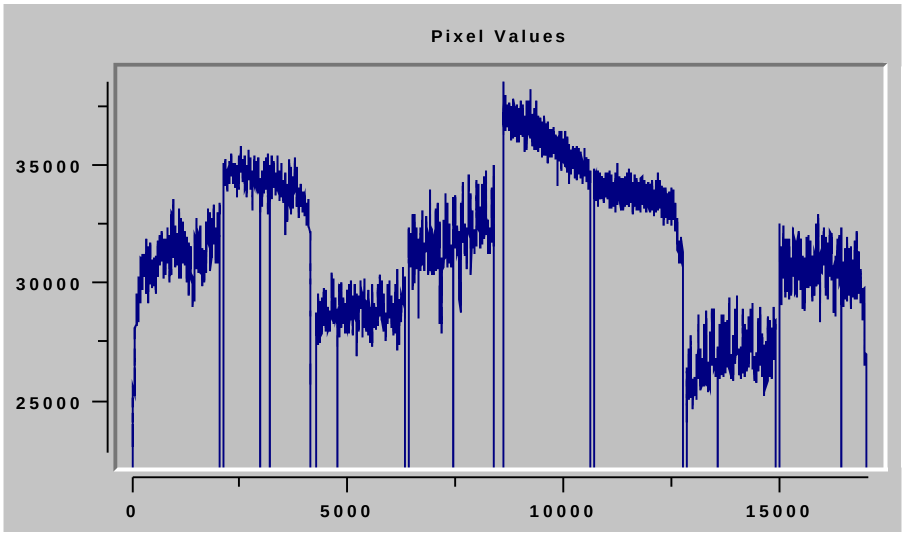


Figure 11: Counts (ADU) on a diagonal cut across a full mosaic of a raw twilight flat in u.

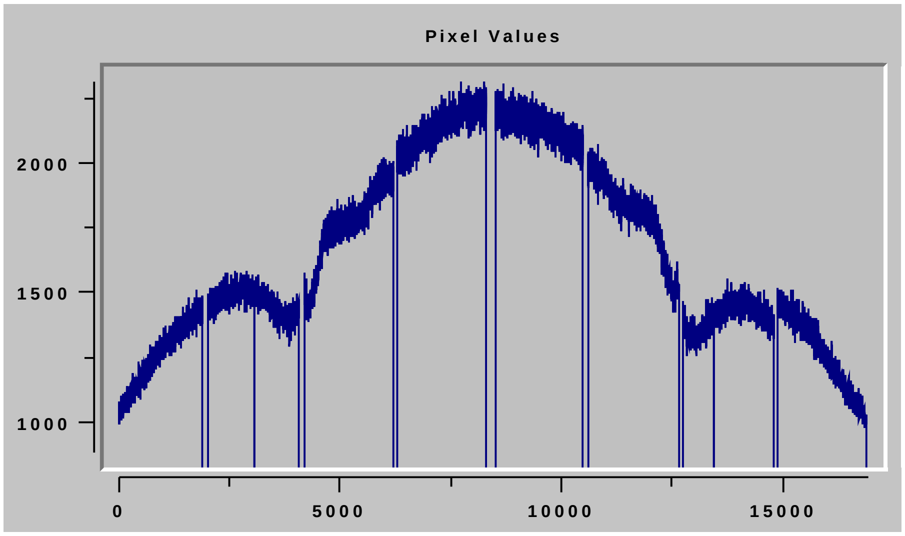


Figure 12: Counts (ADU) on a diagonal cut across a full mosaic of a raw dome flat in u.

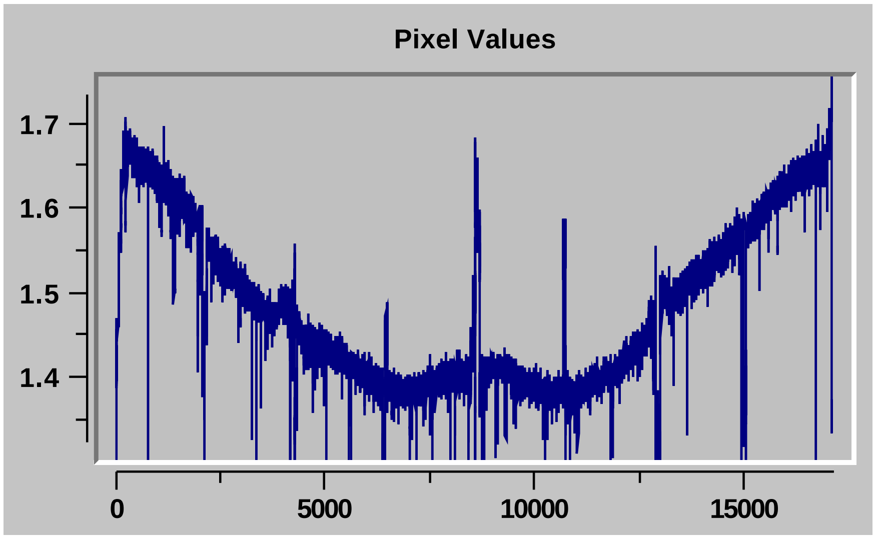


Figure 13: Diagonal cut across a full mosaic of a raw domeflat divided by a raw twilight flat in **Sloan g**.

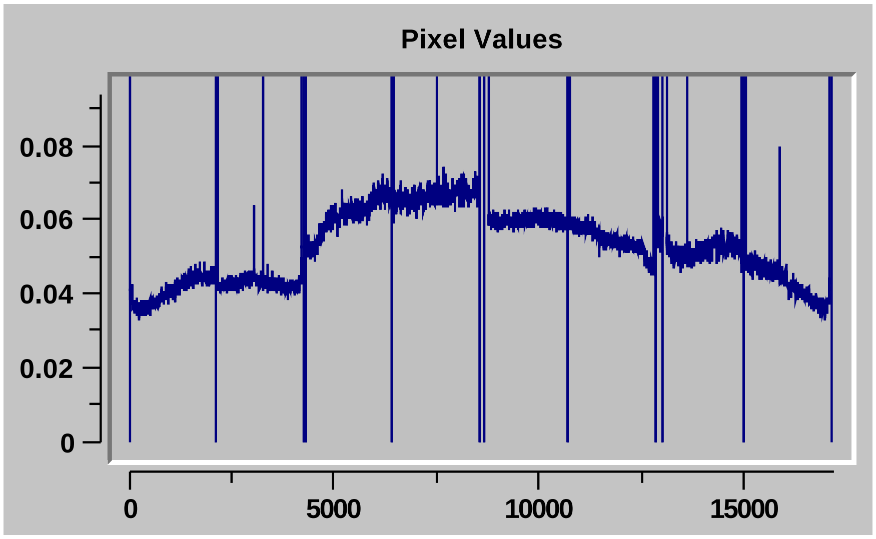


Figure 14: Diagonal cut across a full mosaic of a raw domeflat divided by a raw twilight flat in **Sloan u**.

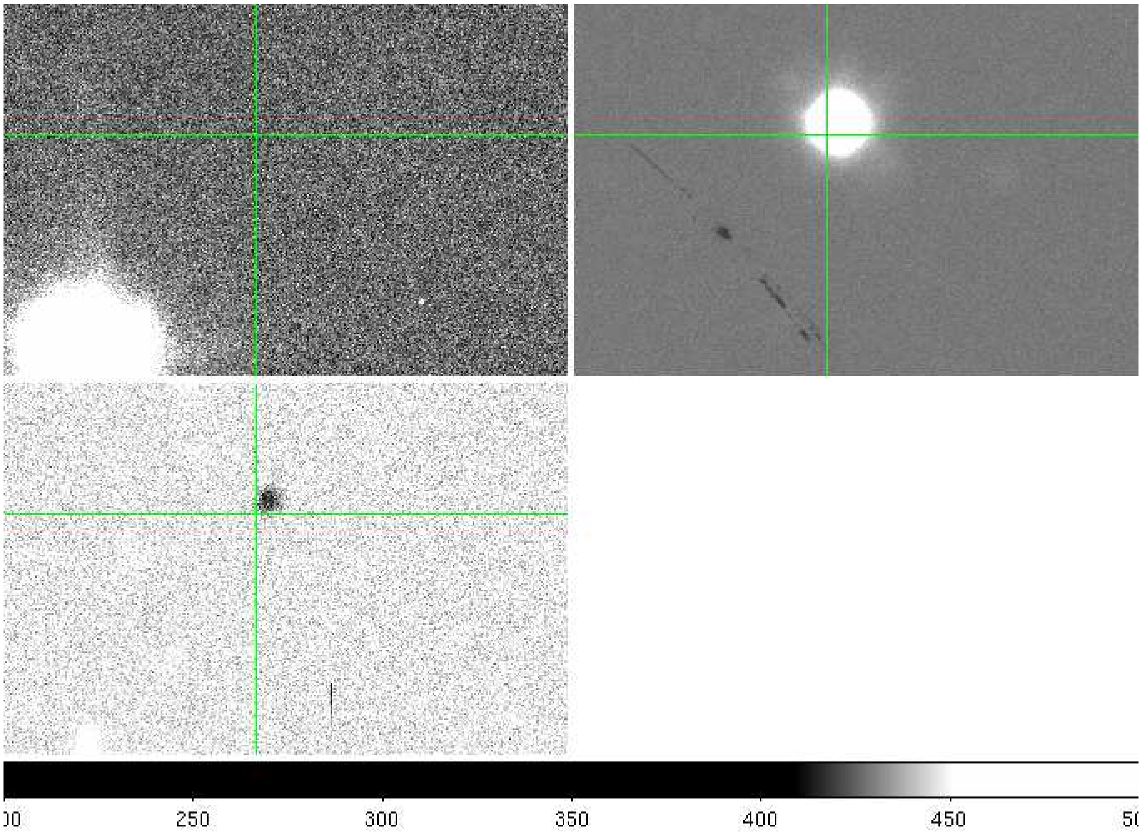


Figure 15: Crosstalk example in the science exposure with DATE-OBS 2011-04-05T03:15:19. Shown are from top-left to bottom right CCD #94,95,96. The crosshair is located at the same pixel position in each CCD.