Delivery test of the ALFOSC camera with E2V CCD 231-41 Ser. no. 12234-10-01

1. Gain and linearity

All linearity tests are made with setup scripts “setup_teu” (updated March 7) and “speed_100”, with a detector temperature not in lock but very slowly decreasing around -115C. Illumination is an incandescent lamp via an integrating sphere.

Output	**Gain**	**RON**	**Linearity deviation P-P**
A	0.152 e-/ADU +/- 0.003	3.49 e- +/- 0.08	2.5% 30e - 100ke
B	0.150 e-/ADU +/- 0.004	3.08 e- +/- 0.06	2.0% 30e - 100ke
C	0.149 e-/ADU +/- 0.003	3.46 e- +/- 0.82	2.2% 10ke - 100ke
D	0.151 e-/ADU +/- 0.002	3.34 e- +/- 0.05	1.5% 10ke - 100ke

All outputs display a deviation from linearity above about 30ke, but outputs C and D have a distinct discontinuity.

The jump seen in outputs C and D were checked using the internal LED light source. The resulting linearity graphs are shown in figures 5 and 6. The discontinuity is still visible for output C, although at a higher ADU level, which also might explain why is is not seen in D.

The source of the discontinuity is examined in figure 7. Here two windowed (X: full width, Y:height 300) flat fields are shown just below and above the jump level, respectively. Both suffer from about 15 rows affected by charge blooming related to windowed readout, but the top and bottom 50 rows were excluded from the linearity analysis. Just above the jump level, a vertical gradient is introduced in the image. An unconfirmed hypothesis is that this linearity issue will only occur in windowed frames with high illumination, while images with low overall background and discrete bright sources are unlikely to be affected.

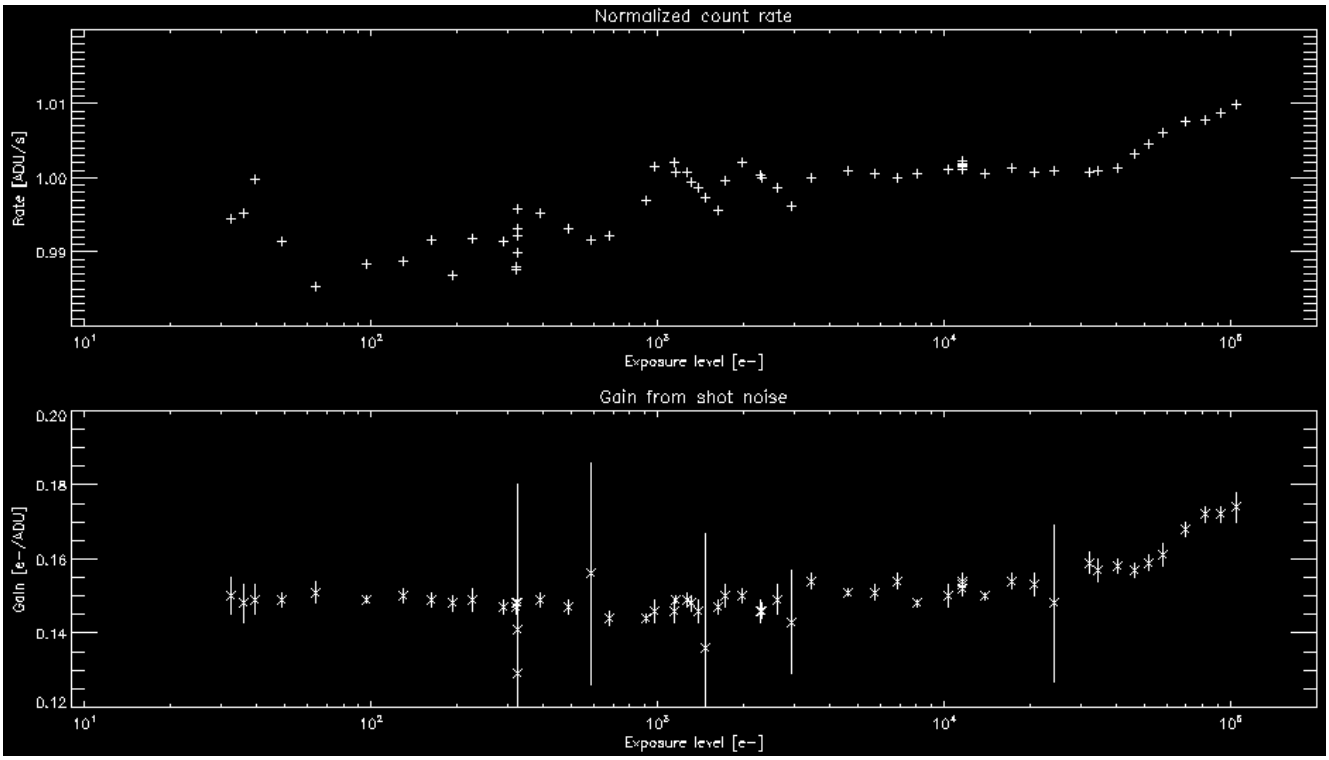

Illustration 1: Output A. Result is merged from a high- and low-level linearity exposure sequence.

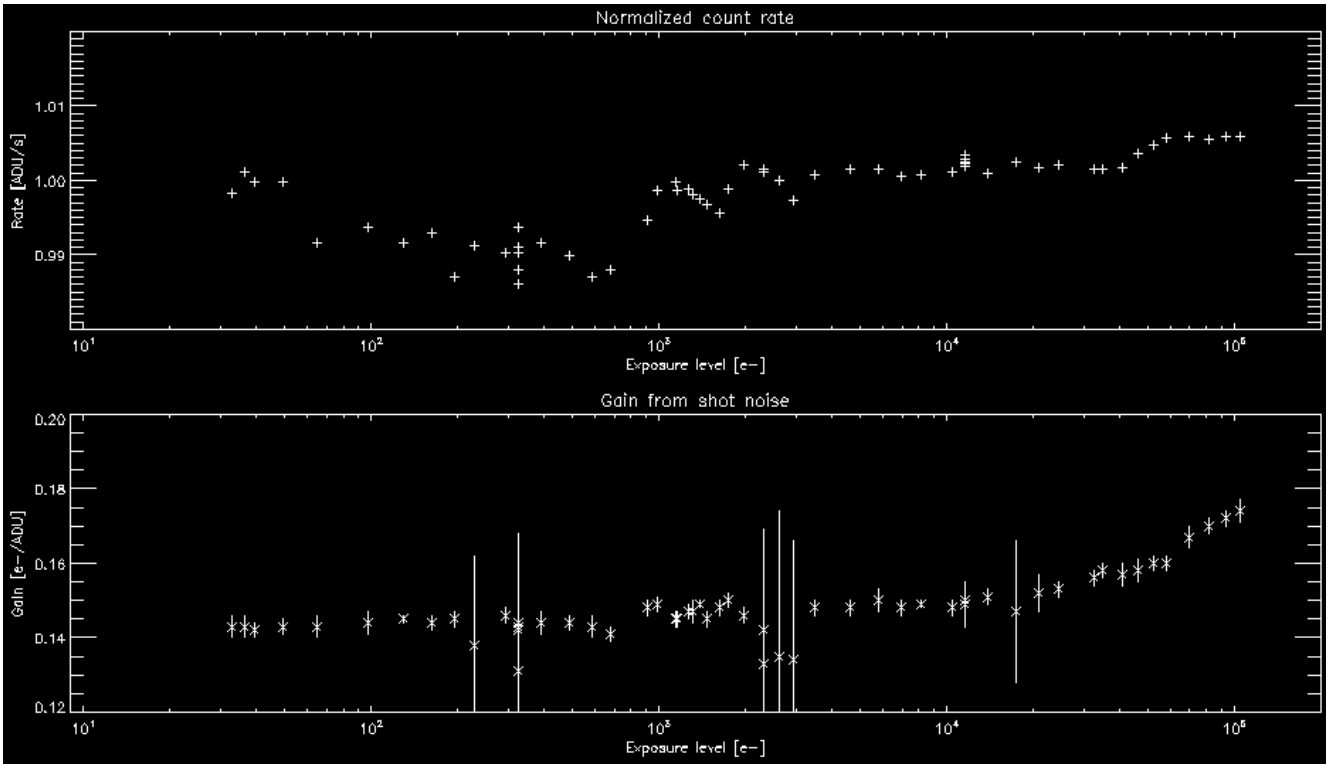

Illustration 2: Output B. Result is merged from a high- and low-level linearity exposure sequence.

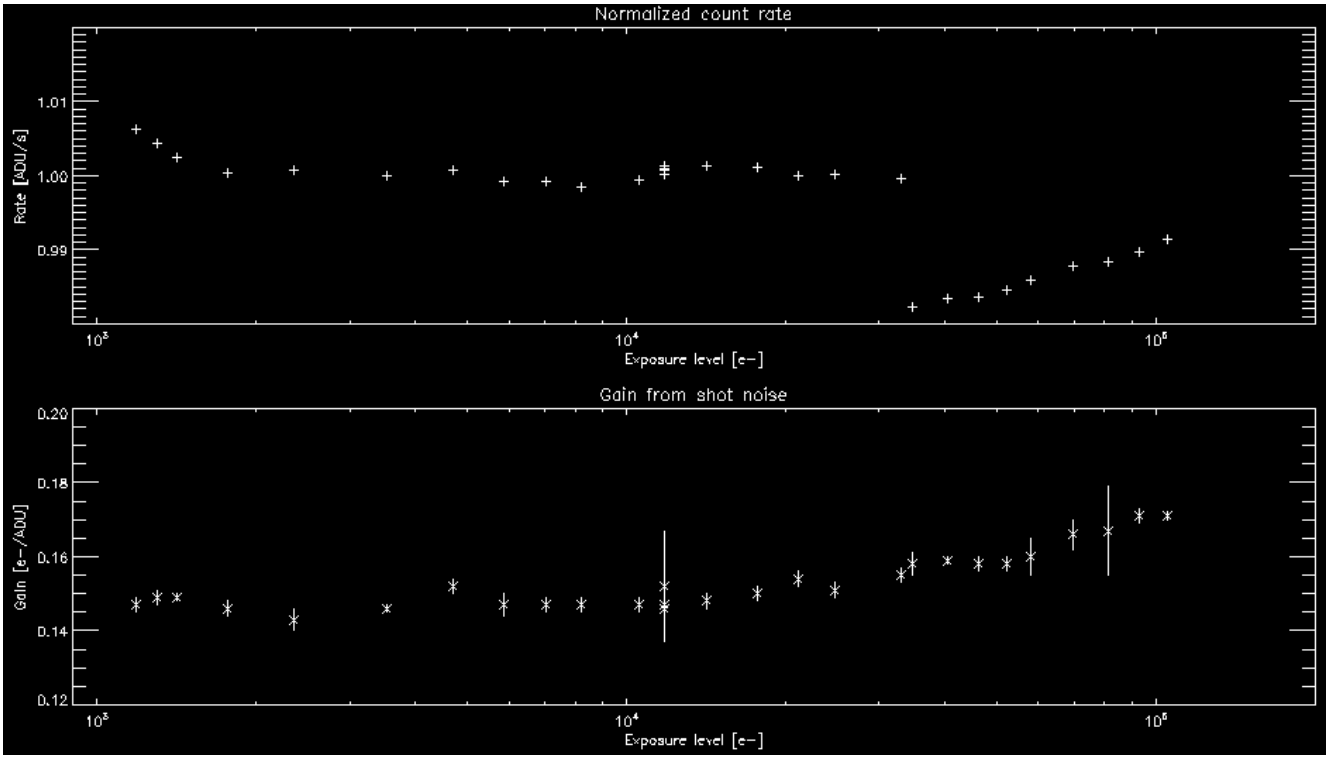

Illustration 3: Output C

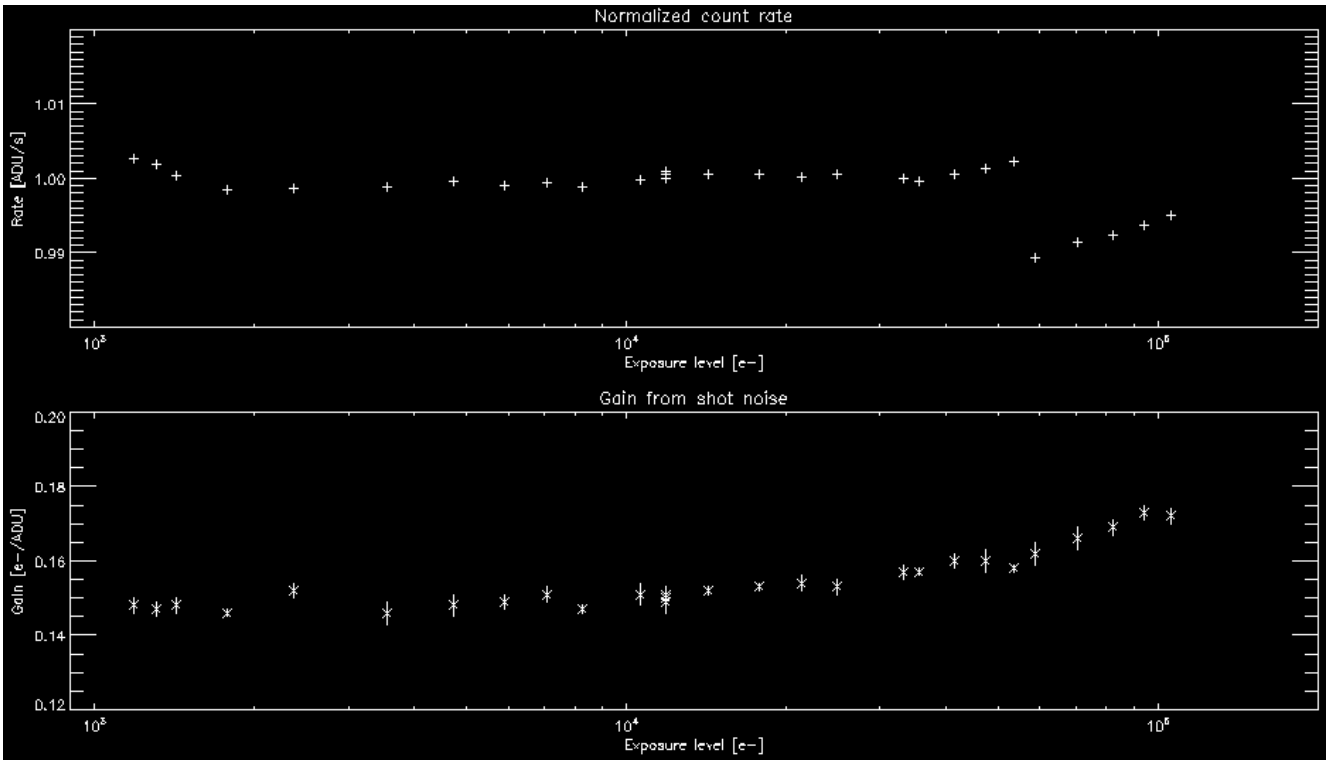

Illustration 4: Output D

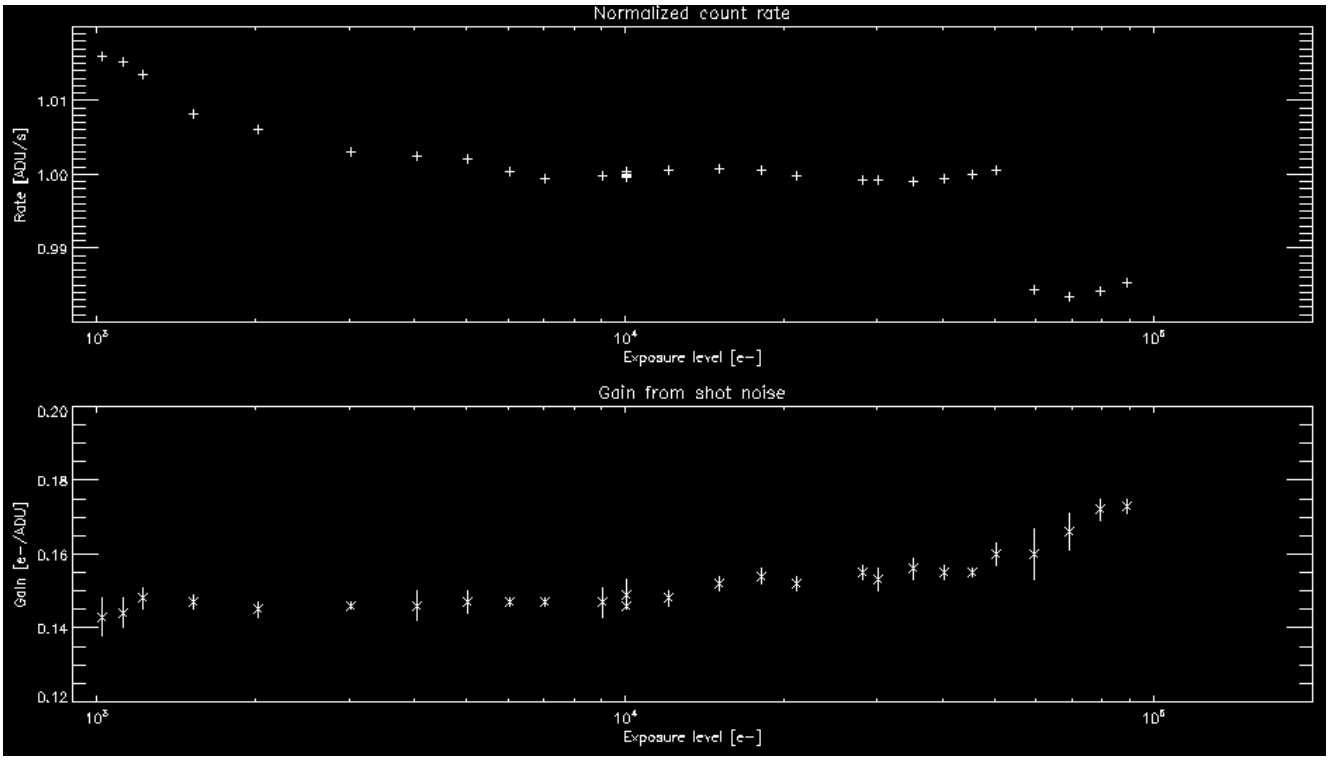

Illustration 5: Output C, LED illumination

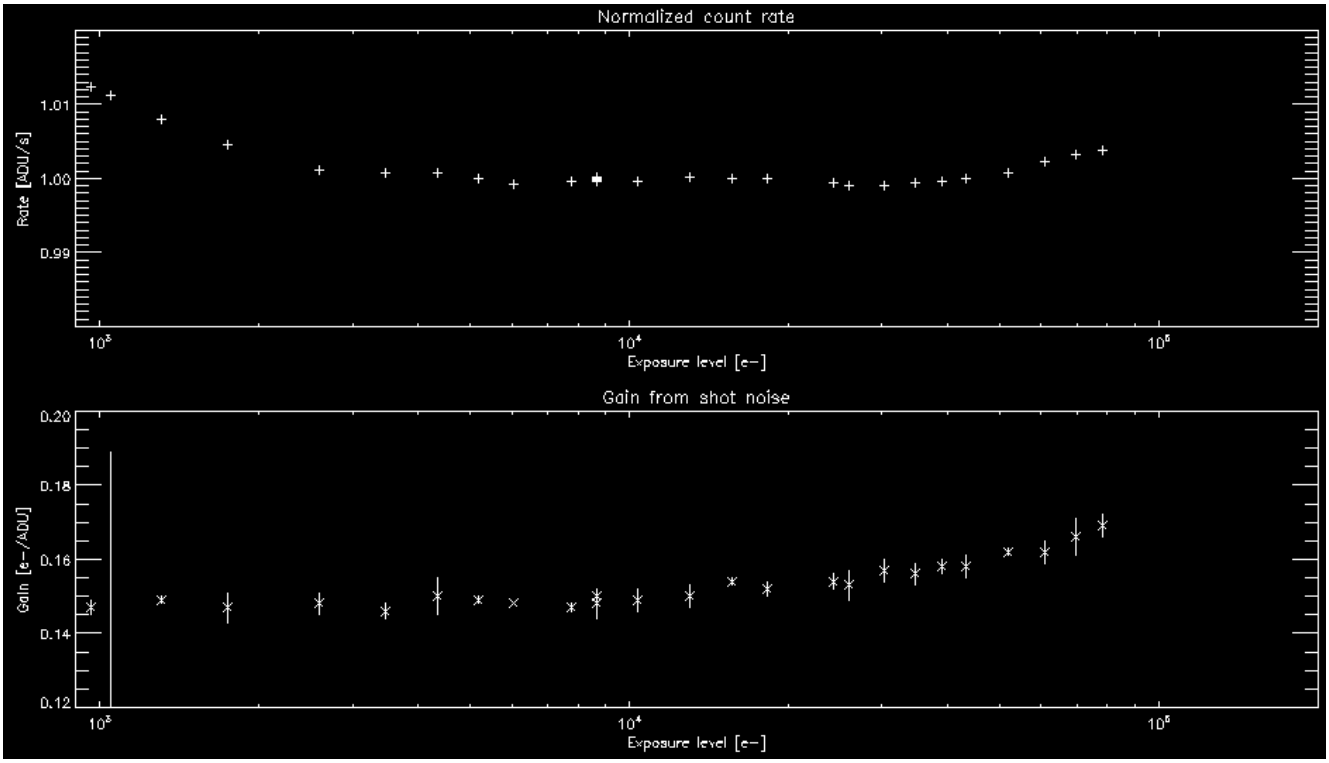

Illustration 6: Output D, LED illumination

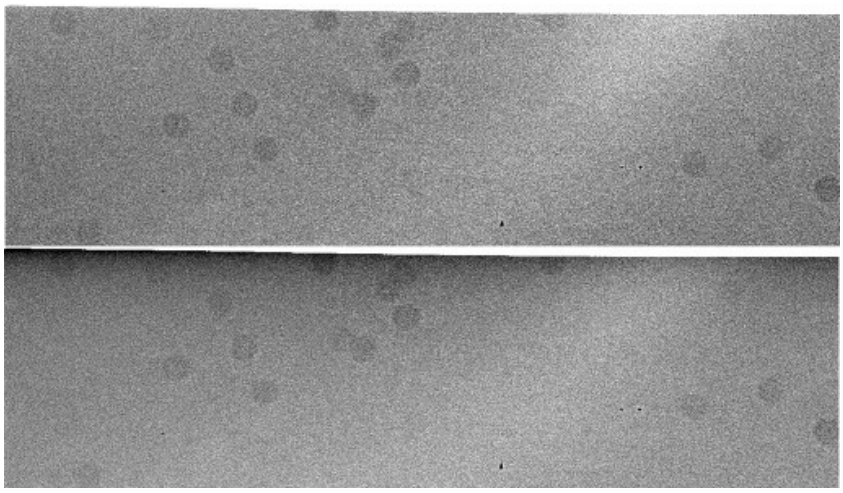

Illustration 7: Two windowed flat fields read out trough output C. Top: Just below the linearity jump level around 34ke. Bottom: Just above the level.

2. Binning

Binning of 1,2,4 was tested in X/serial direction in dual amplifier A,B readout mode, with setups: setup_teu, speed_100

Output	Binning X	Gain	RON	Linearity deviation P-P
A	**1**	0.152 e-/ADU +/- 0.003	3.56 e- +/- 0.07	1.2% 10ke - 100ke
	2	0.150 e-/ADU +/- 0.002	3.41 e- +/- 0.35	0.5% 2.5ke - 30ke
	4	0.150 e-/ADU +/- 0.002	3.37 e- +/- 0.05	0.3% 4.5ke - 60ke
B	**1**	0.150 e-/ADU +/- 0.004	3.21 e- +/- 0.09	1.0% 10ke - 100ke
	2	0.148 e-/ADU +/- 0.002	3.08 e- +/- 0.05	0.5% 2.5ke - 30ke
	4	0.149 e-/ADU +/- 0.002	3.17 e- +/- 0.04	0.3% 4.5ke - 60ke

A greater dynamic range was tested for binning 1, which may account for the greater RON and linearity deviation listed. Overall, gain, RON and linearity appears unaffected by the binning.

3. Flat fields

Flat fields made through 550 and 334nm filters are displayed below. They are compared to similar flats made 10 months earlier.
Some differences are visible:
The new window has a smaller diameter, vignetting the corners.
Dust has changed position on the windows.
Stray light from the window edge is not equally suppressed. For the older 334nm flat, a central blob is caused by the circular edge, while on the remaining flats, only an “X” is visible, as most of the edge has been masked by tape.

A non-specular appearance of the CCD surface raised concern about contamination, but the flats show no indication of this.

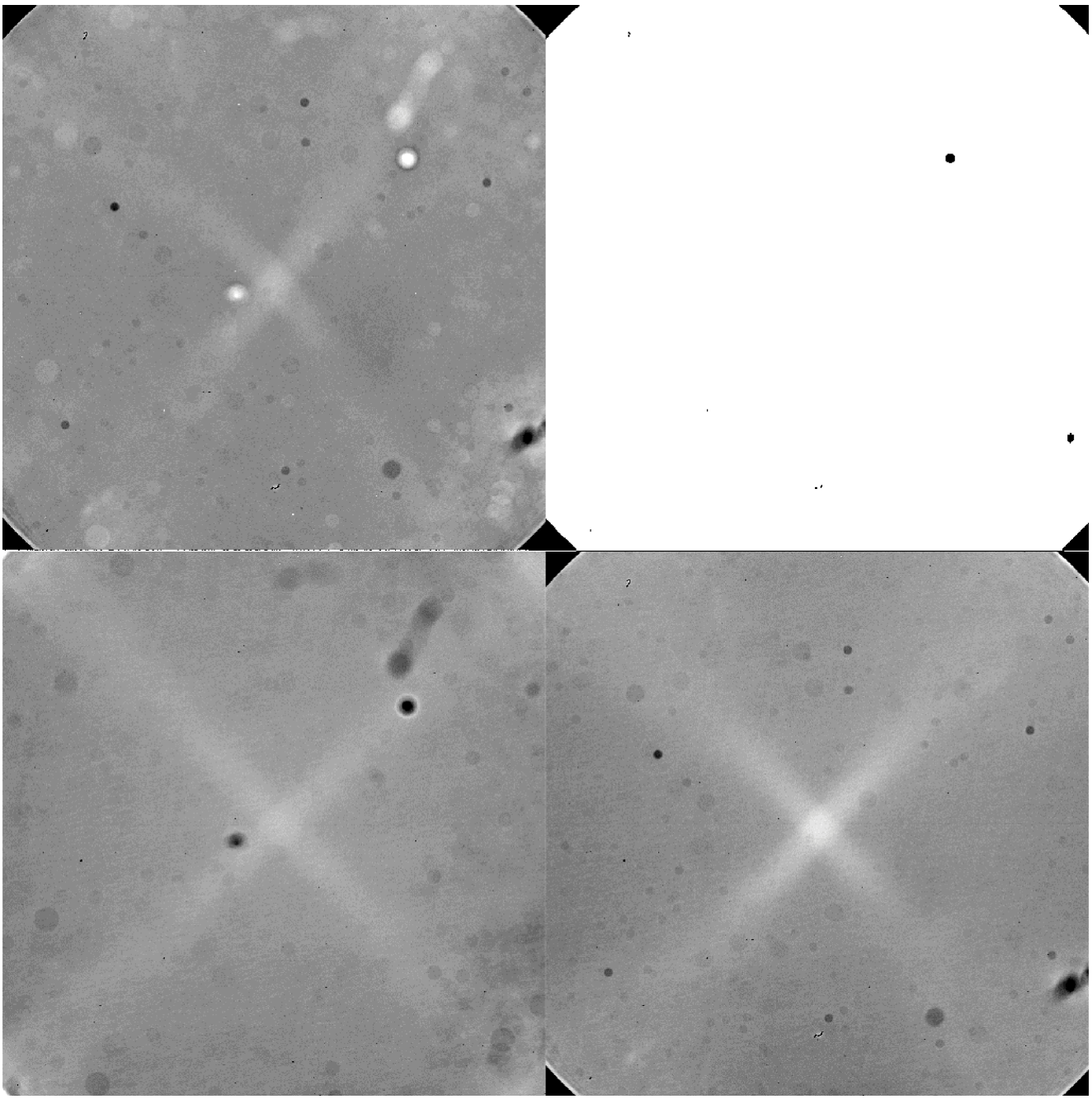

Illustration 8: 550nm flat fields. Lower left: May 2015. Lower right: March 2016. Upper left: Ratio of the two flats. All three displayed with +/- 5% grey-scale cuts.

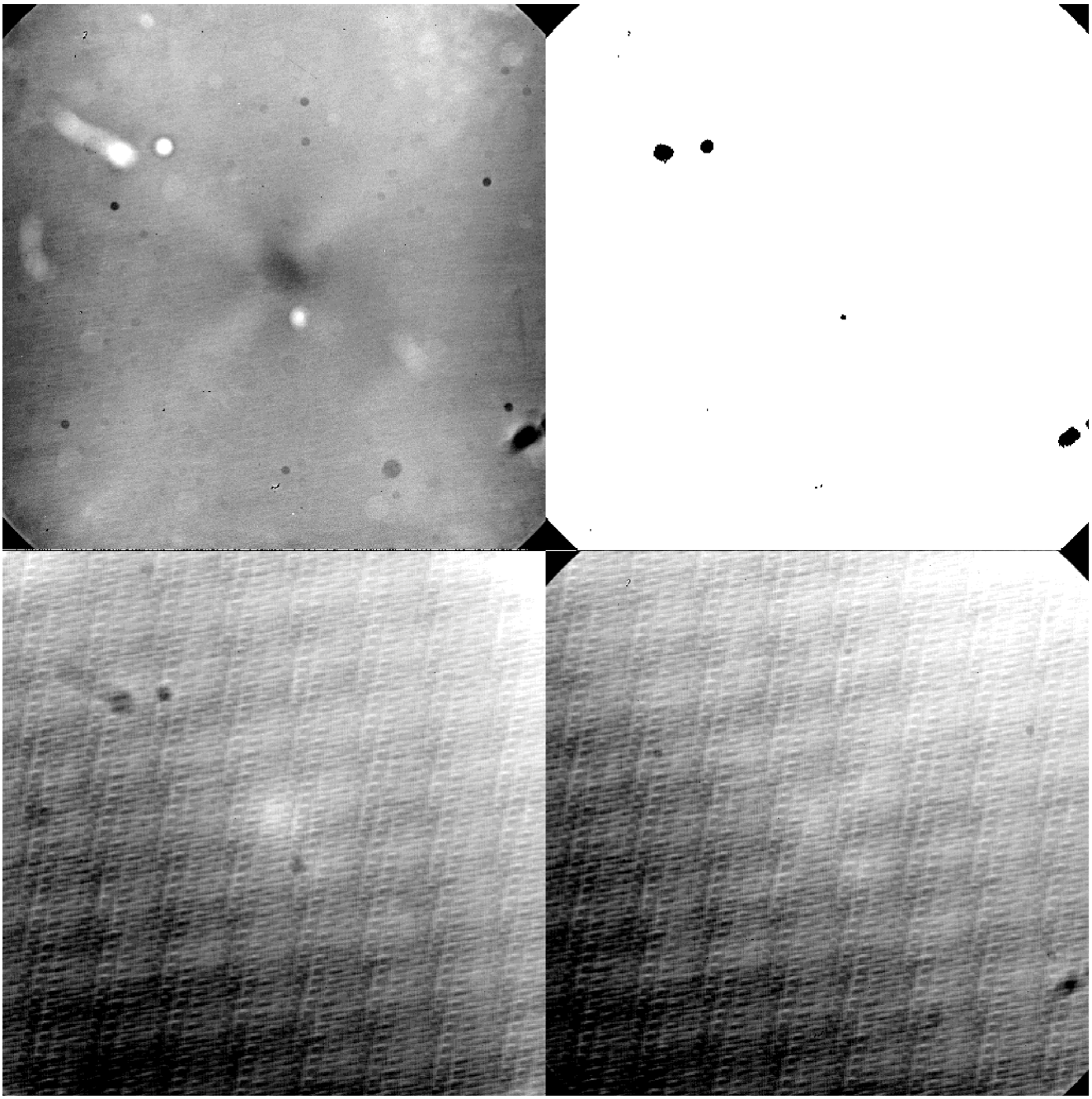

Illustration 9: 334nm flat fields. Lower left: May 2015. Lower right: March 2016. Both displayed with +/- 10% grey-scale cuts. Upper left: Ratio of the two flats, displayed with +/- 5% grey-scale cuts.

4. Remanence

A number of sources similar to star images were projected onto the detector and saturated in order to check for remanence. Immediately after the saturated exposure, 10 darks of 100 sec duration each were made. As shown in the image below, no residual is easily visible in the first dark. Examining the average level at the position of the three brightest sources does not reveal any decaying residual.

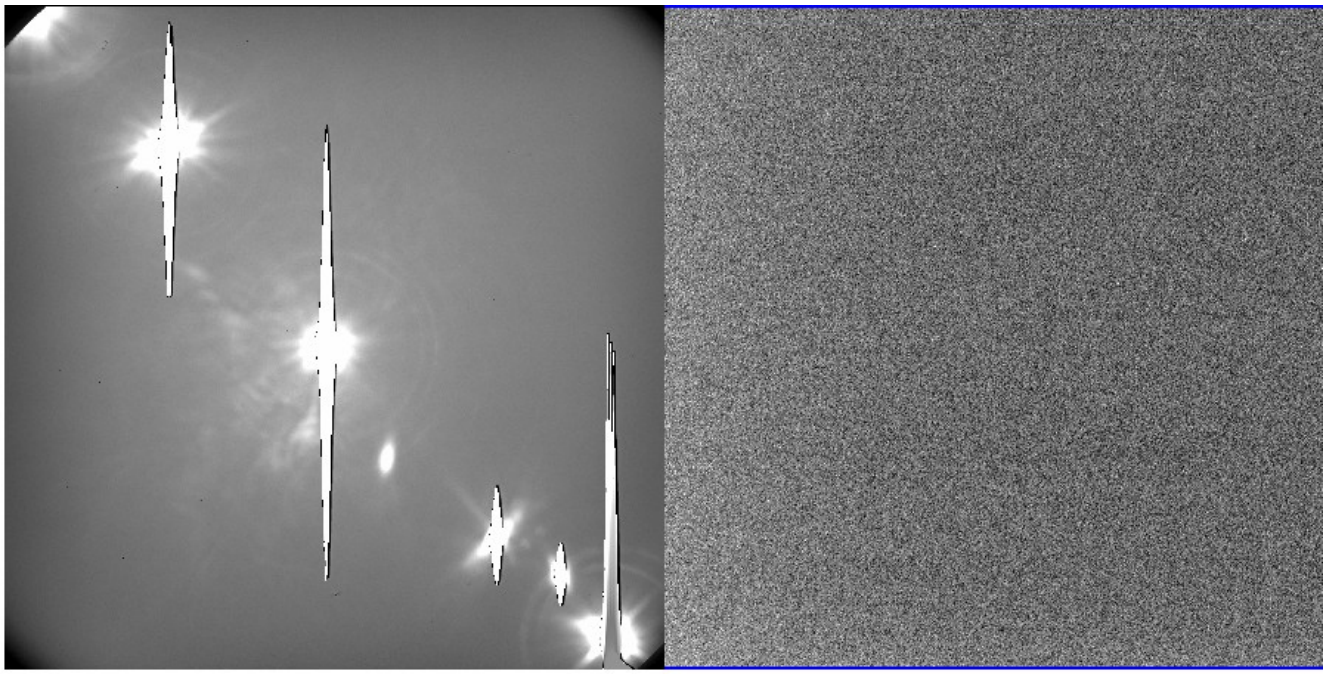

Illustration 10: Left: Saturated exposure. Right: First 100sec dark out of 10.

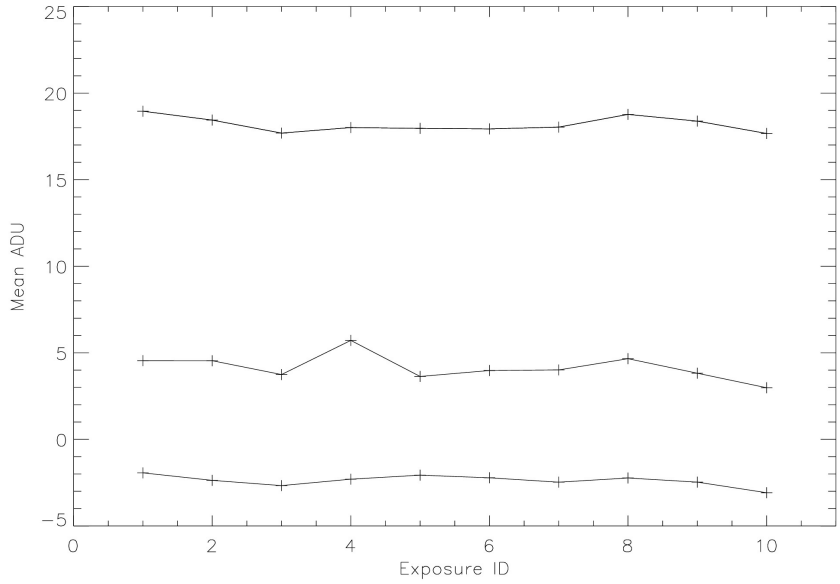

Illustration 11: Average background at the position of the three brightest saturated sources during a sequence of 10 100 sec darks.

5. Dark current

Dark current was measured in a series of 10 half-hour darks.
The average level found 1.3e-/pix/hour.
The first integration is at a level of 1.7e-/pix/hr, suggesting a slight remanence.

The dark appears featureless, without hot pixels or columns. Cosmics are well defined, indicating that CTE is good.