

CHIP CHARACTERISTICS
FOR
Loral/Lesser ml2k3ebBI W_17-1,1

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May 15, 1998

1 General Description

Chip type : Loral/Lesser ml2k3ebBI Grade Setup, thinned, AR coated, MPP
Chip characteristics: 2 layer catalytic coating,
: UV flooding optional
Chip format : 2048 x 2048, 0 pre-scan pixels in horizontal direction
Pixel size : 15 x 15 μm^2
Serial No. : W_17-1,1

The cryostat electronic board has special clock shaping capacitors for this CCD (C65-67: 180nF).

2 Flatness of the chip

TBD

3 System Setup

This chip has been tested with the ESO-VME CCD camera system.

The clock-pattern ml2k3bab with two-phases non-MPP-mode have been used for the tests.

Parameters are set to SUBPATT 3 and GAIN 2, if not otherwise mentioned.

All tests were performed 163 K, if not otherwise mentioned.

4 Voltage Setup

See table 1 on page 2 for all voltage values.

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TLMCCD1: VL01 : -8.01 VHI1 : 2.49 VL02 : -5.00 VHI2 : 7.00
TLMCCD2: HL01 : -5.01 HHI1 : 6.99 HL02 : -5.00 HHI2 : 7.02
TLMCCD3: RL01 : 0.00 RHI1 : 10.02 RL02 : 0.00 RHI2 : 10.01
TLMCCD4: VDD1 : 23.40 VDR1 : 14.47 VDD2 : 23.43 VDR2 : 14.54
TLMCCD5: VGS1 : 1.01 VSS1 : 0.00 VGS2 : 1.02 VSS2 : 0.00
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Table 1: Telemetry values

5 Noise and Gain

Amplifier 1:

The conversion factor is (at GAIN = 2)

1.339 ± 0.014 e⁻/ADU. at subpatt 3

The readout-noise is

5.6 ± 0.1 e⁻ RMS at subpatt 3

Amplifier 2:

The conversion factor is (at GAIN = 2)

1.487 ± 0.012 e⁻/ADU. at subpatt 3

The readout-noise is

6.1 ± 0.1 e⁻ RMS at subpatt 3

The noise and gain was measured using the HP-desktop procedure “MEASURE CONFACT” at different illumination levels. This procedure takes two equal dark- and two equal flat-field exposures calculating noise and gain independent from the light level with the variance of the difference of the two flat-fields.

6 Pick-up Noise

At slow-mode pick-up noise could not be seen at short dark exposures.

7 Quantum Efficiency

CCD SENSITIVITY CALIBRATION:

9 Dec 1997 19:32:50

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Detector ID      : ml21711      Detector      : Loral/Lesser
Calibrated against : _SDC2_NP_2  Type         : ml2k3ebBI
Detector area (cm2) : 2.25E-06    ESO CCD No.  : 2277
e-/[ADU]        : 1.34        Used Output(s) : 0
System gain     : 2          Subpattern    : 3
Misc.Comments   : ml2k3bab2L1-_W17-1-1

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CCD System values :           Scanned CCD area
-----          :           -----
Hor. act. Pixels  : 2060      First pixel   : 20
Tot. vert. Lines : 2060      Last pixel   : 2029
Hor. Binning     : 1        First line    : 20
Vert. Binning    : 1        Last line    : 2029

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Lambda [nm]	Time [sec]	Dens [log]	Temp [K]	Counts [ADU]	RQE [%]	+/- [%]	Sensitivity [A/(W/cm2)]	Photon flux [Phot/cm2]	Irradiance [W/cm2]
320	300	0.0	164.1	752	53.41	42.79	+3.119E-07	+2.792E+06	+1.722E-12
340	300	0.0	164.1	2645	55.70	13.04	+3.445E-07	+9.421E+06	+5.487E-12
360	300	8.6	164.1	2495	55.70	13.58	+3.642E-07	+8.885E+06	+4.895E-12
380	60	8.6	164.1	2118	61.65	15.64	+4.260E-07	+3.408E+07	+1.777E-11
400	20	0.0	164.1	1791	73.35	21.38	+5.311E-07	+7.267E+07	+3.615E-11
450	10	0.0	164.1	3710	75.33	11.11	+6.140E-07	+2.931E+08	+1.295E-10
500	10	.3	164.1	3800	79.36	11.22	+7.197E-07	+2.850E+08	+1.132E-10
550	10	.3	164.1	9282	83.48	5.75	+8.335E-07	+6.617E+08	+2.387E-10
600	10	.9	164.1	3196	89.09	14.96	+9.682E-07	+2.135E+08	+7.076E-11
650	10	.9	164.1	3396	83.92	13.24	+9.795E-07	+2.408E+08	+7.432E-11
700	10	.9	164.0	4387	83.48	10.55	+1.059E-06	+3.127E+08	+8.878E-11
750	10	.9	164.1	2844	75.00	13.96	+1.019E-06	+2.257E+08	+5.984E-11
800	10	.6	164.1	4984	64.95	7.31	+9.415E-07	+4.567E+08	+1.135E-10
850	10	.3	164.1	8757	48.38	3.46	+7.468E-07	+1.077E+09	+2.514E-10
900	10	0.0	164.1	9736	33.23	2.24	+5.422E-07	+1.743E+09	+3.849E-10
950	10	0.0	164.0	5579	19.39	1.99	+3.336E-07	+1.712E+09	+3.585E-10
1000	10	0.0	164.0	2984	7.82	1.39	+1.414E-07	+2.273E+09	+4.524E-10
1040	10	0.0	164.0	3086	2.62	.45	+4.955E-08	+7.006E+09	+1.335E-09
1080	10	0.0	164.0	1504	1.04	.35	+2.052E-08	+8.583E+09	+1.571E-09
1100	10	0.0	164.0	2296	1.27	.29	+2.539E-08	+1.073E+10	+1.938E-09

Calibration_error= 1.50% Conversion_factor_error= 1.06%
 _ML21711_17 stored on /users/ms/cali:HFS at 10 Dec 1997 03:51:16

Table: RQE measurement protocols for the CCD chip

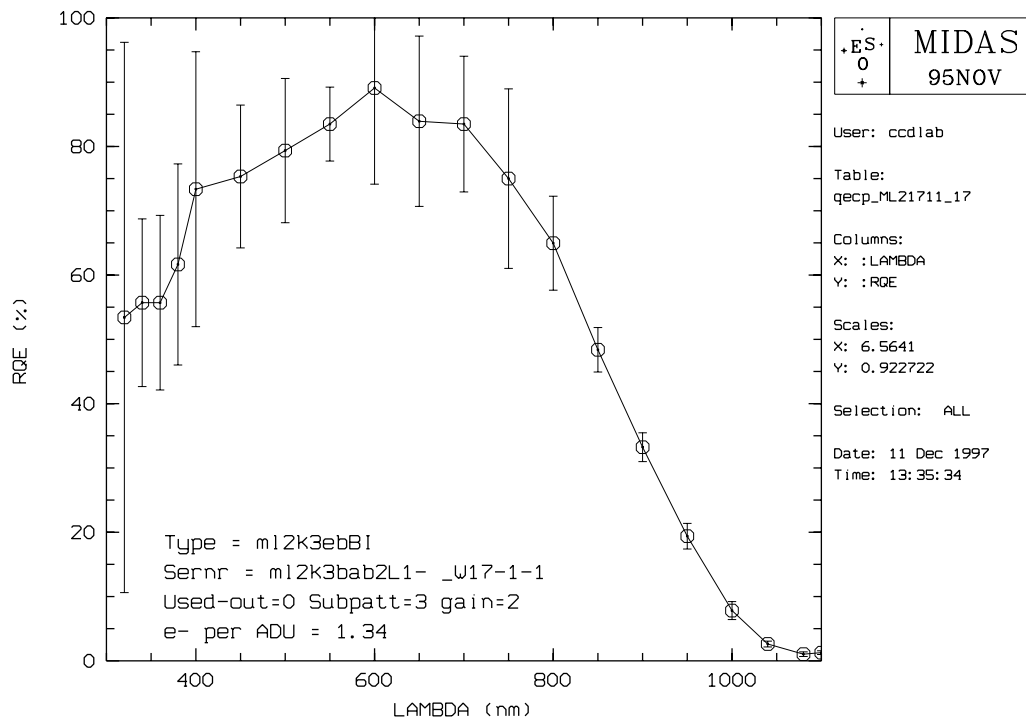


Figure 1: Plot of RQE values of the CCD (complete surface) at 168 K. Large error bars are caused by cosmetic defects.

The RQE was measured in an automatic mode using the test-bench computer. The quantum-efficiency values and their errors are listed below. The given error is the geometrical sum of the error of test-bench calibration (approximate 1.5%), the error of the CCD conversion factor measurement (approximate 1.1%) and of the variation of the quantum-efficiency over the whole chip surface (dependent from the light wavelength). The variation of quantum efficiency over the chip can be seen in detail in the homogeneity measurement in section 14 on page 9.

The peak value for RQE of CCD was approx. 89 % at 600nm.

Figure 1 on page 5 shows the plot of QE for the CCD.

8 Charge Transfer Efficiency

The CTE was measured using Flat Field exposures and its over-scan regions and gives:

Amplifier 1:

Serial CTE = 0.999997 and Parallel CTE = 0.999998

Amplifier 2:

Serial CTE = 0.999998 and Parallel CTE = 0.999995

9 Dark Current

The dark current was measured with a 20 minutes dark exposures without MPP-mode after more than 5 hours in the dark wiping the CCD every minute.

The mean dark current rate is approx. $0.5 \pm 0.3 e^-/pixel/hour$ at 168 K.

10 Linearity

Linearity was measured taking exposures of the same exposure-time at different light levels and at a wavelength of 700 nm.

Amplifier 1:

There is a maximum deviation of less than $\pm 1.0\%$ from the average value within 2.18 decades from 22 to 3320 e^- per pixel.

Amplifier 2:

There is a maximum deviation of less than $\pm 0.6\%$ from the average value within 3.99 decades from 14.7 to 145225 e^- per pixel.

See figure 2 on page 6 for details.

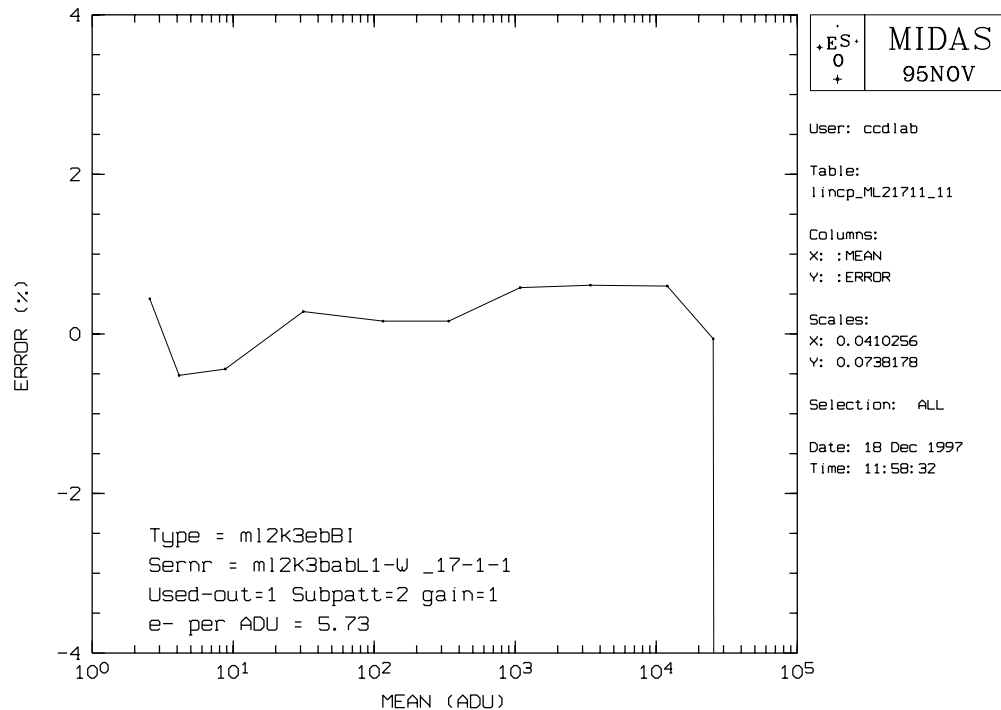


Figure 2: Linearity Measurement with amplifier 2

In view of the other problems with this CCD, the linearity was not optimized with the

voltage setup.

11 Full well capacity

The full well capacity was measured with flat-field exposures of high intensities without MPP-mode. The limit of linearity is reached, if at higher intensities the deviation from linearity starts to get larger than the given maximum deviation in the section 10 on page 6.

Amplifier 1: Upper limit of linearity: 125 000 e⁻/pixel
Saturation-value: 160 000 e⁻/pixel

Amplifier 2:

Upper limit of linearity: 130 000 e⁻/pixel
Saturation-value: 161 000 e⁻/pixel

Horizontal voltage has to be adjusted to prevent charge smearing at high illumination values.

12 Cosmic Ray Events

The Cosmic Ray Event rate was measured using our standard method (MIDAS Batch: COSMIC) to count *events* independently of their actual size.

The cosmic ray event rate is $1.44 + 0.1 - 0.1$ events/min/cm².

13 Blemishes

With the Amplifier 1 we found 26381 defective pixels. This was measured using three weak light images with a level of approximate 211 e⁻ per pixel (see page 10) and an automatic MIDAS-procedure to identify and catalogue the defects.

This test is very sensitive: A column defect is any defect which is longer than 10 pixels and a defect is any pixel which is lower than 50 % or higher than 200 % of the mean level of a weak light flat field exposure.

Number of hot defects:

Hot spots: 23; Hot cluster: 5; Hot columns: 9

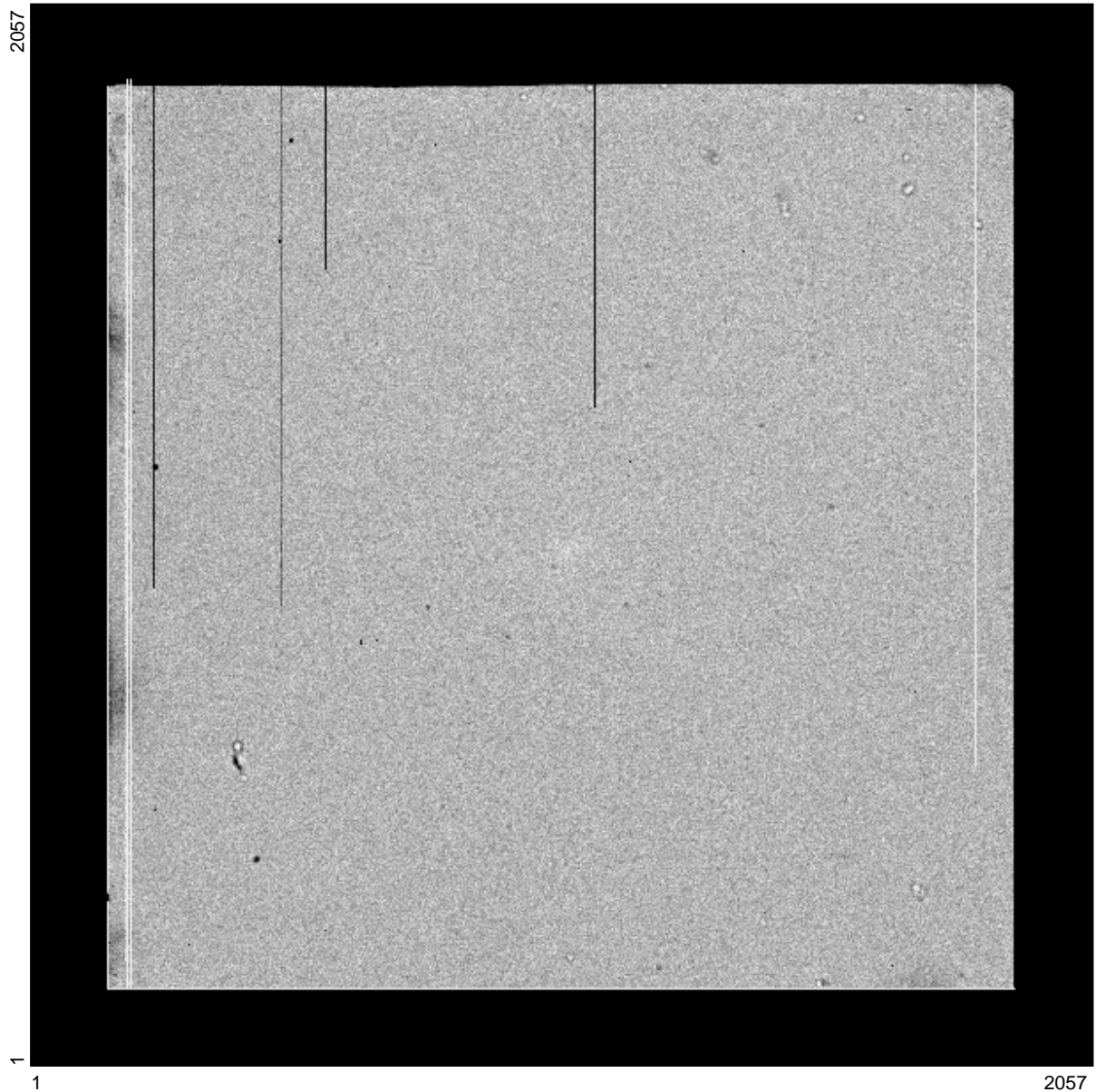
Number of dark defects:

Dark pixel: 12; Dark cluster: 154; Dark columns: 9; Traps: 21

Number of all defects: 233

Tu, 16 Dec 1997 17:24:23

MIDAS version: 95NOV



Frame : weakmean
Identifier : average frame
ITT-table : ramp.itt
Coordinates : 1, 1 : 2057, 2057
Pixels : 1, 1 : 600, 600
Cut values : 448.59, 530.23
User : ccclab

Figure 3: Weak Flat field (700nm,2.5): approx. 211 e⁻ per pixel with amplifier 2.

With the Amplifier 2 we found 26309 defective pixels.

Number of hot defects:

Hot spots: 12; Hot cluster: 0; Hot columns: 8

Number of dark defects:

Dark pixel: 13; Dark cluster: 165; Dark columns: 21; Traps: 26

Number of all defects: 245

14 Uniformity

The homogeneity was measured using a standard method of sampling the whole sensitive area and using the RMS value of it. Values of deviations from homogeneity are given in table 2 on page 9.

Flat-field exposure at a wavelength in [nm]	Maximal RMS Deviation from mean value in [%]
320	80.09
340	23.34
360	24.31
380	25.30
400	29.09
450	14.63
500	14.02
550	6.64
600	16.69
650	15.67
700	12.50
750	18.53
800	11.10
850	6.92
900	6.48
950	10.10
1000	17.73
1040	17.14
1080	33.90
1100	22.52

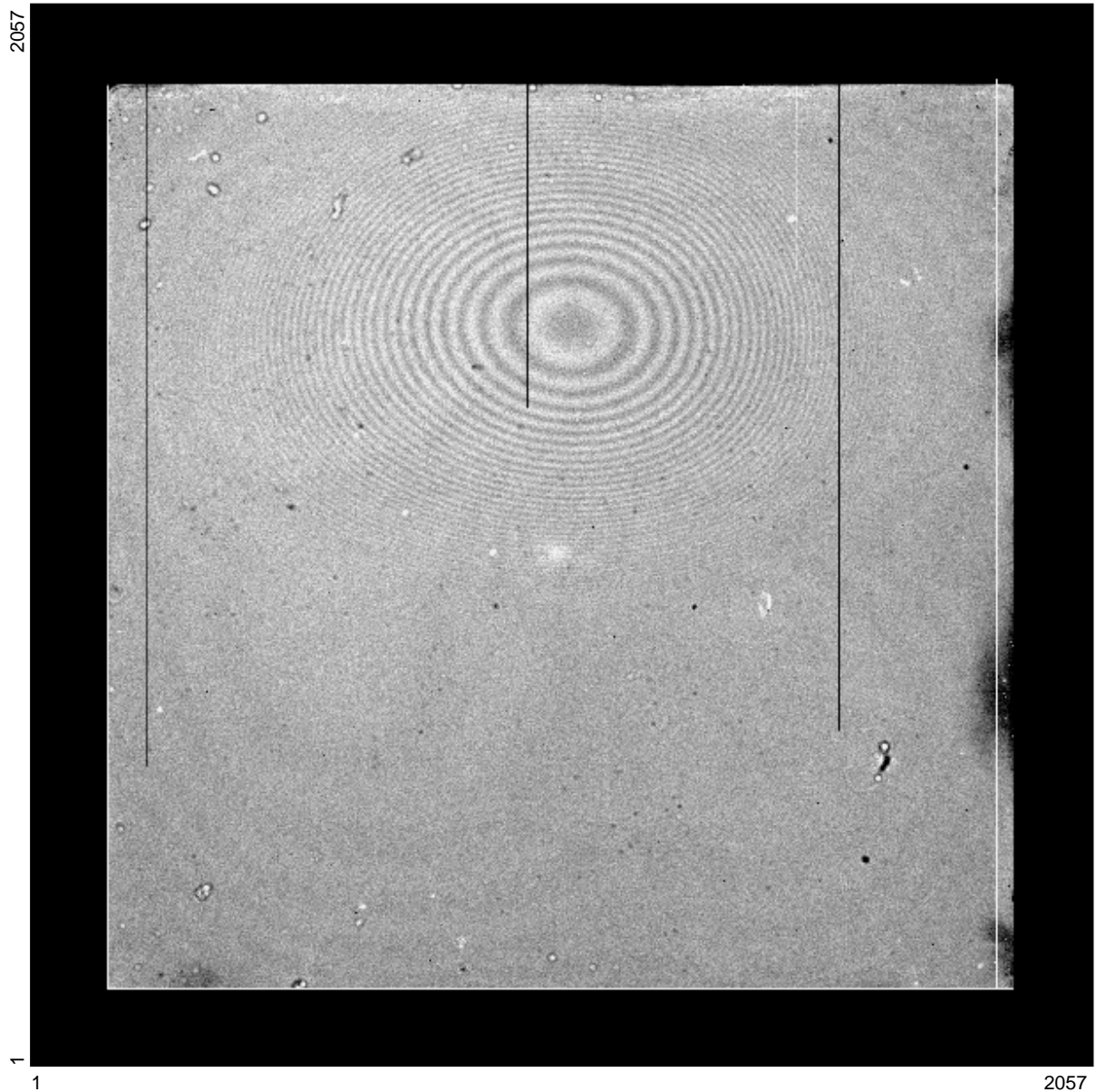
Table 2: Uniformity of the CCD (is worsened by cosmetic defects).

Fringing occurs at a wavelength of 1000 nm. The maximum value of the fringing pattern is 7 % of the mean pixel value of flat field exposure.

15 Remanence

Fr, 19 Dec 1997 09:41:18

MIDAS version: 95NOV



Frame : ccd5905
Identifier : FF/10S/900NM/.8: Loral/Lesser ml2k3ebBI L1-W17-1 163.9 K
ITT-table : ramp.itt
Coordinates : 1, 1 : 2057, 2057
Pixels : 1, 1 : 600, 600
Cut values : 1908.83, 2558.18
User : ccclab

Figure 4: Flat field (1000nm) shows fringing.

The Remanence test was made after 10 hours in the dark and periodical wiping at at temperature of 168 K. After a high level flat field with white light which give over-

Exposure Type	Exposure Time in [sec]	Illumination in [photons/pixel]	CCD Saturation	Remanence in [e ⁻ per pixel]
FF white	1(Dens=1)	49100	0.23	—
DK	600	—	—	0
FF white	1	432100	2.01	—
DK	600	—	—	0
DK	600	—	—	1
DK	600	—	—	1
FF white	10	4321700	20.13	—
DK	600	—	—	1
DK	600	—	—	4
DK	600	—	—	7

Table 3: Remanence of the CCD at 168 K

saturation on the CCD, several ten minutes dark exposures have been taken. The mean level in the centre of these dark exposures was compared with the mean level of a ten minute dark before these saturations and the remanence in e⁻ per pixel has been calculated. The results can be seen in table 3 on page 11. There is remanence with this CCD.

References

- [1] S. Deiries, M. Cullum: ESO Maintenance Manual No.5 July 89, CCD Cryostat for new VME-based Control Camera.
- [2] J. Janesick, JPL: Private communication