CHIP CHARACTERISTICS
FOR
Loral/Lesser ml2k3ebBI L1-W_15-3

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1 General Description

Chip type	: Loral/Lesser ml2k3ebBI Grade Setup, thinned, AR coated, MPP
Chip characteristics	: AR coating: UV, 400 Å HfO_2 – PPtF, O_2 soaking required
Chip format	: 2048x2048, 0 pre-scan pixels in horizontal direction
Pixel size	: 15 x 15μm^2
Serial No.	: L1-W_15-3

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 without 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 between 160 K and 180 K, if not otherwise mentioned.

4 Voltage Setup

See table 1 on page 2 for all voltage values.

```
VLO1 :  -8.01 VHI1 :  2.51 VLO2 :  -5.00 VHI2 :  6.99
HLO1 :  -5.02 HHI1 :  7.02 HLO2 :  -5.01 HHI2 :  7.00
RLO1 :  0.00 RHI1 :  10.03 RLO2 :  0.000 RHI2 :  10.04
VDD1 :  24.50 VDR1 :  14.53 VDD2 :  24.51 VDR2 :  14.51
VGS1 :  0.69 VSS1 :  0.00 VGS2 :  1.45 VSS2 :  0.00
```

Table 1: Telemetry values

5 Noise and Gain

Amplifier 1:

The conversion factor is (at GAIN = 2)

2.213 ± 0.151 $\mathbf{e^-/ADU.}$ at subpatt 2

1.150 ± 0.010 $\mathbf{e^-/ADU.}$ at subpatt 3

1.156 ± 0.009 $\mathbf{e^-/ADU.}$ at subpatt 3 and 2x2 binning

0.573 ± 0.018 $\mathbf{e^-/ADU.}$ at subpatt 4

The readout-noise is

6.7 ± 0.4 $\mathbf{e^-}$ **RMS** at subpatt 2

6.4 ± 0.1 $\mathbf{e^-}$ **RMS** at subpatt 3

7.0 ± 0.1 $\mathbf{e^-}$ **RMS** at subpatt 3 and 2x2 binning

6.0 ± 0.2 $\mathbf{e^-}$ **RMS** at subpatt 4

Amplifier 2:

The conversion factor is (at GAIN = 2)

2.903 ± 0.002 $\mathbf{e^-/ADU.}$ at subpatt 2

1.405 ± 0.18 $\mathbf{e^-/ADU.}$ at subpatt 3

1.514 ± 0.118 **e^-/ADU.** at subpatt 3 and 2x2 binning

0.697 ± 0.013 **e^-/ADU.** at subpatt 4

The readout-noise is

8.5 ± 0.1 **e^- RMS** at subpatt 2

7.3 ± 0.1 **e^- RMS** at subpatt 3

8.6 ± 0.8 **e^- RMS** at subpatt 3 and 2x2 binning

6.5 ± 0.1 **e^- RMS** at subpatt 4

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: 18 Oct 1995 05:10:09

Detector ID	: ml2k153	Detector	: Loral/Lesser
Calibrated against	: _SDC2_NP_2	Type	: ml2k3ebBI
Detector area (cm2)	: 2.25E-06	ESO CCD No.	: 2241
e-/[ADU]	: 1.40	Used Output(s)	: 1
System gain	: 2	Subpattern	: 3
Misc.Comments	: ml2k3babL1-W_15-3		

CCD System values		Scanned CCD area	
Hor. act. Pixels	: 2060	First pixel	: 20
Tot. vert. Lines	: 2060	Last pixel	: 2030
Hor. Binning	: 1	First line	: 20
Vert. Binning	: 1	Last line	: 2030

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	158.5	635	50.56	2.79	+2.953E-07	+2.614E+06	+1.612E-12
340	300	0.0	158.5	2694	60.82	2.79	+3.761E-07	+9.219E+06	+5.369E-12
360	300	8.6	158.6	2955	70.77	3.29	+4.627E-07	+8.690E+06	+4.788E-12
380	60	8.6	158.6	2785	81.50	3.56	+5.632E-07	+3.556E+07	+1.854E-11
400	20	0.0	158.5	2138	93.43	3.93	+6.765E-07	+7.145E+07	+3.555E-11
450	10	0.0	158.6	4231	86.98	3.02	+7.090E-07	+3.037E+08	+1.342E-10
500	10	.3	158.5	4187	84.85	2.72	+7.694E-07	+3.081E+08	+1.224E-10
550	10	.6	158.5	4874	84.26	2.53	+8.413E-07	+3.612E+08	+1.303E-10
600	10	.9	158.5	3550	85.52	2.58	+9.294E-07	+2.592E+08	+8.593E-11
650	10	.9	158.5	3810	80.02	2.32	+9.339E-07	+2.973E+08	+9.176E-11
700	10	.9	158.5	4921	78.17	2.17	+9.918E-07	+3.931E+08	+1.116E-10
750	10	.9	158.5	3141	70.45	2.05	+9.571E-07	+2.784E+08	+7.381E-11
800	10	.6	158.5	6080	61.80	1.66	+8.960E-07	+6.143E+08	+1.526E-10
850	10	.7	158.5	4344	46.65	1.35	+7.201E-07	+5.814E+08	+1.357E-10
900	10	.4	158.5	5521	32.19	.93	+5.252E-07	+1.071E+09	+2.364E-10
950	10	0.0	158.5	6557	19.07	.57	+3.280E-07	+2.147E+09	+4.496E-10
1000	10	0.0	158.5	3584	7.64	.23	+1.382E-07	+2.930E+09	+5.833E-10
1040	10	0.0	158.5	3402	2.38	.11	+4.494E-08	+8.933E+09	+1.703E-09
1080	10	0.0	158.5	1663	.95	.04	+1.872E-08	+1.091E+10	+1.998E-09
1100	10	0.0	158.5	2681	1.19	.04	+2.375E-08	+1.405E+10	+2.539E-09

Calibration_error= 1.50% Conversion_factor_error= 1.31%
_ML2K153_22 stored on /users/ms/cali:HFS at 18 Oct 1995 11:50:01

Table: RQE measurement protocols for the CCD chip

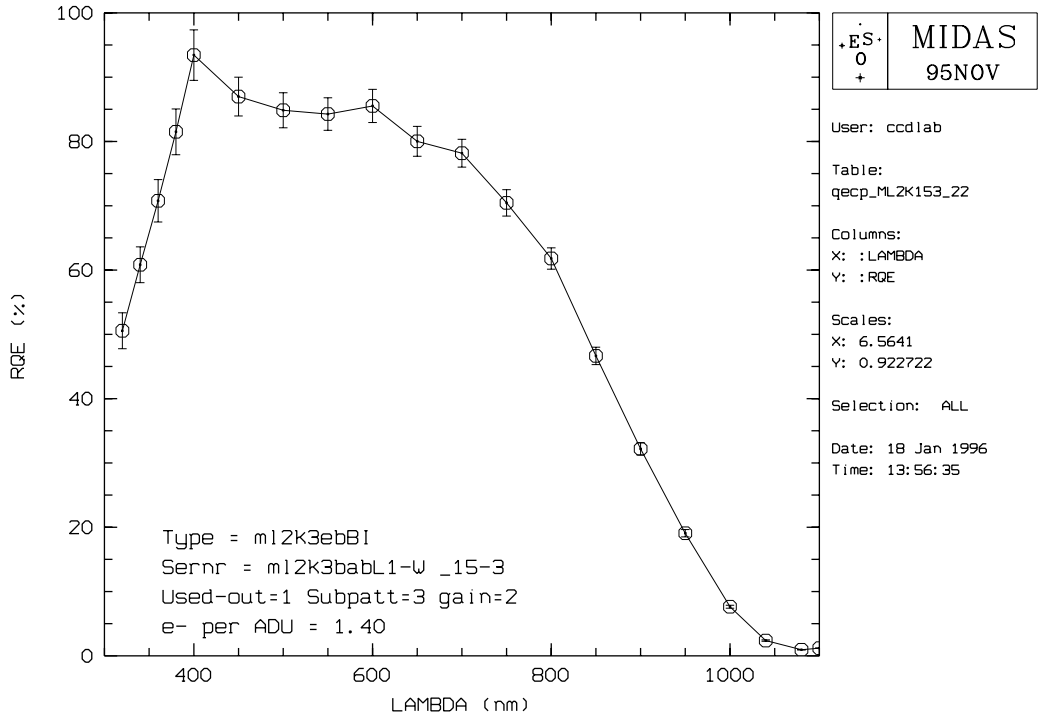


Figure 1: Plot of RQE values of the CCD (complete surface) at 158 K

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 1.3 %) 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. 93 % at 400nm.

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 2:

Serial CTE = 0.999990

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. 1.2 ± 0.3 $e^-/pixel/hour$ at 158 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 ±0.7% from the average value within 3.1 decades from 44 to 58850 e^- per pixel.

Amplifier 2: There is a maximum deviation of less than ±0.6% from the average value within 3.7 decades from 15 to 71360 e^- per pixel.

See figure 2 on page 6 for details.

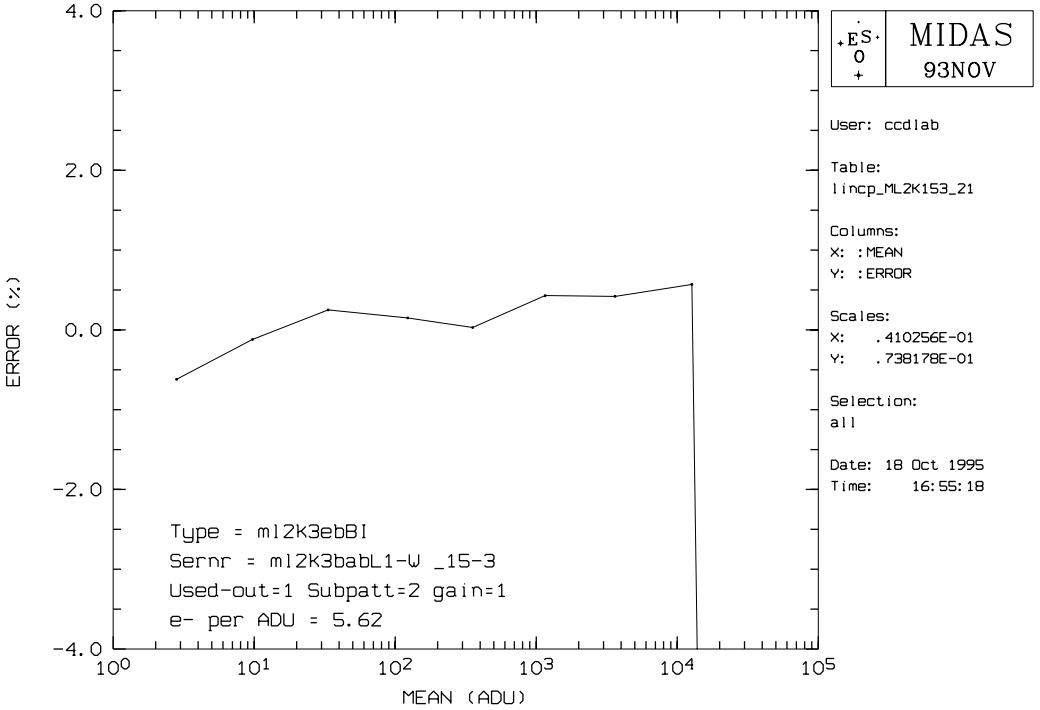


Figure 2: Linearity Measurement with amplifier 2

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. 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: 118 000 e^-/pixel
Saturation-value: 163 000 e^-/pixel

Amplifier 2:

Upper limit of linearity: 134 000 e^-/pixel
Saturation-value: 163 000 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 $1.35 + 0.8 - 0.8$ $events/min/cm^2$**.**

13 Blemishes

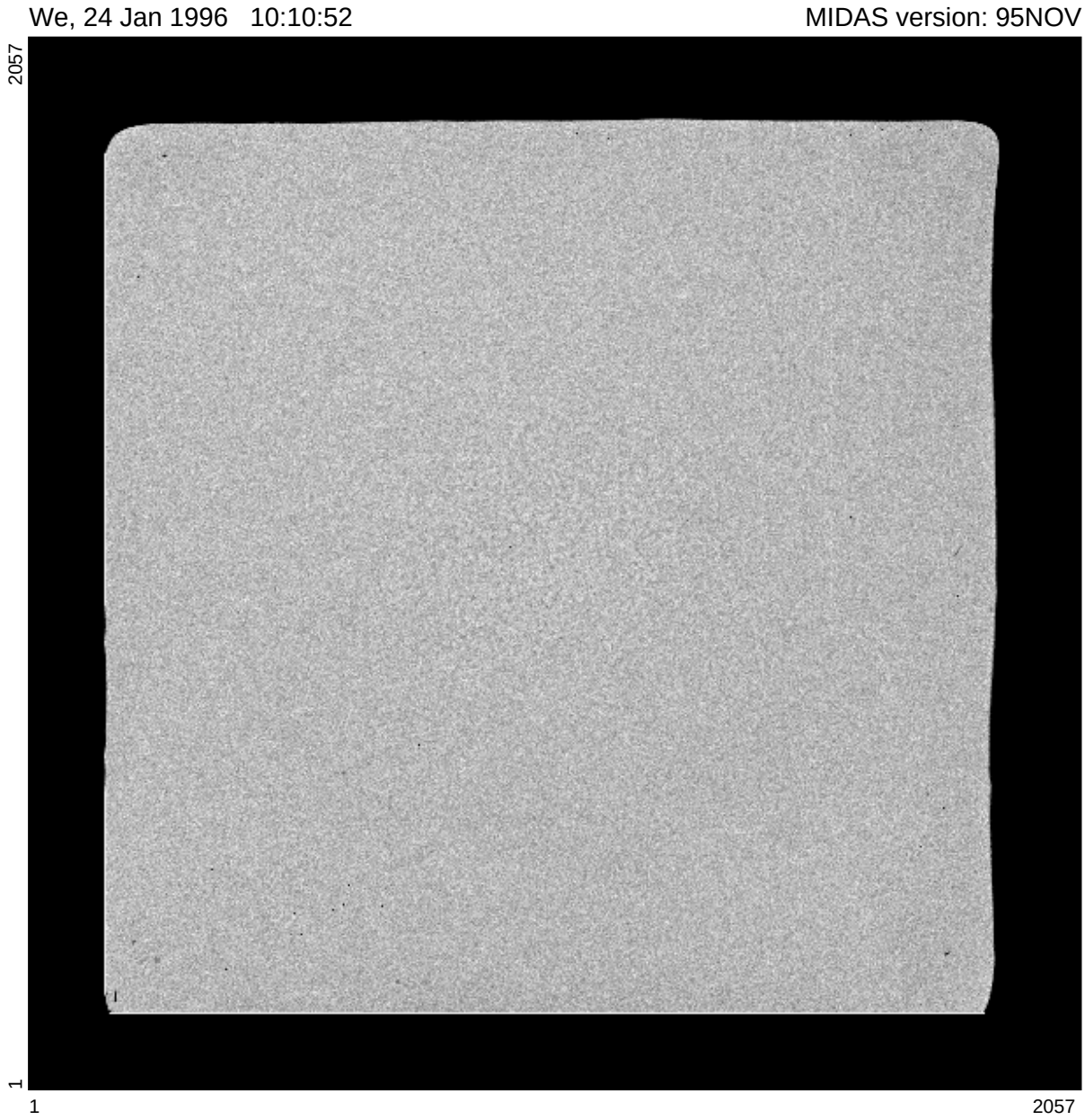
With the Amplifier 1 we found 67748 defective pixels. This was measured using three weak light images with a level of approximate 240 e^- per pixel (see page 8) and an automatic MIDAS-procedure to identify and catalogue the defects.

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: 0; Hot cluster: 0; Hot columns: 0

Number of dark defects:
Dark pixel: 18; Dark cluster: 64; Dark columns: 44; Traps: 54

Number of all defects: 180
```



Frame : weakmean
Identifier : average frame
ITT-table : ramp.itt
Coordinates : 1, 1 : 2057, 2057
Pixels : 1, 1 : 600, 600
Cut values : 340.07, 457.59
User : ccdlab

Figure 3: Weak Flat field (700nm,2.5): approx. 240 e^- per pixel with amplifier 2.

With the Amplifier 2 we found 68244 defective pixels.

```
Number of hot defects:
Hot spots: 0; Hot cluster: 0; Hot columns: 0

Number of dark defects:
Dark pixel: 18; Dark cluster: 77; Dark columns: 40; Traps: 54

Number of all defects: 189
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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	5.15
340	4.14
360	4.20
380	3.89
400	3.70
450	2.84
500	2.51
550	2.25
600	2.26
650	2.10
700	1.94
750	2.12
800	1.80
850	2.09
900	2.08
950	2.21
1000	2.34
1040	4.08
1080	4.29
1100	2.94

Table 2: Uniformity of the CCD

15 Remanence

The Remanence test was made after 10 hours in the dark and periodical wiping at at temperature of 158 K. After a high level flat field with white light which give over-

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 10.

Exposure Type	Exposure Time in [sec]	Illumination in [photons/pixel]	CCD Saturation	Remanence in [e^- per pixel]
FF white	1(Dens=1)	48000	0.24	—
DK	600	—	—	1
FF white	1	433000	2.16	—
DK	600	—	—	2
DK	600	—	—	1
DK	600	—	—	0
FF white	10	4336000	21.6	—
DK	600	—	—	7
DK	600	—	—	2
DK	600	—	—	1

Table 3: Remanence of the CCD at 158 K

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