CHIP CHARACTERISTICS FOR Loral/Lesser ml2k3ebBI W_15-2

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1 General Description

Chip type	: Loral/Lesser ml2k3ebBI Grade Setup, thinned, AR coated, MPP
Chip characteristics:	AR coating: broadband, 500 Å HfO_2 + 900 Å MgF_2, PPtF,
	: O_2 soaking required
Chip format	: 2048x2048, 0 pre-scan pixels in horizontal direction
Pixel size	: 15 x 15μm^2
Serial No.	: W_15-2

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

The amplifier 1 was no more working after some tests (static discharge?).

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 :  2.52 VLO2 :  -5.00 VHI2 :  7.03
HLO1 :  -5.03 HHI1 :  7.02 HLO2 :  -5.02 HHI2 :  7.01
RLO1 :  0.00 RHI1 :  10.03 RLO2 :  0.00 RHI2 :  10.04
VDD1 :  23.76 VDR1 :  13.82 VDD2 :  23.45 VDR2 :  15.20
VGS1 :  0.04 VSS1 :  0.00 VGS2 :  1.83 VSS2 :  0.01
```

Table 1: Telemetry values

5 Noise and Gain

Amplifier 1:

The conversion factor is (at GAIN = 2)

1.132 ± 0.013 **e^-/ADU.** at subpatt 3

The readout-noise is

6.4 ± 0.2 **e^- RMS** at subpatt 3

Amplifier 2:

The conversion factor is (at GAIN = 2)

1.591$\pm$0.007 **e^-/ADU.** at subpatt 3

The readout-noise is

6.9$\pm$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

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CCD SENSITIVITY CALIBRATION:                        28 Oct 1995   23:11:17
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Detector ID         : ml2k152      Detector            : Loral/Lesser
Calibrated against  : _SDC2_NP_2   Type                : ml2k3ebBI
Detector area (cm2) : 2.25E-06     ESO CCD No.         :    2261
e-/[ADU]            :  1.59        Used Output(s)      :     1
System gain         :     2        Subpattern          :     3
Misc.Comments       : ml2k3babL1-W_15-2

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
```

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	855	60.70	8.24	+3.545E-07	+3.321E+06	+2.049E-12
340	300	0.0	158.5	3207	64.96	9.17	+4.018E-07	+1.164E+07	+6.777E-12
360	300	8.6	158.5	2943	63.29	9.13	+4.138E-07	+1.096E+07	+6.040E-12
380	60	8.6	158.5	2391	64.02	9.04	+4.424E-07	+4.402E+07	+2.295E-11
400	20	0.0	158.5	1794	71.44	9.78	+5.172E-07	+8.878E+07	+4.417E-11
450	10	0.0	158.5	3632	68.85	8.55	+5.612E-07	+3.731E+08	+1.649E-10
500	10	.3	158.5	3862	73.03	8.38	+6.623E-07	+3.739E+08	+1.485E-10
550	10	.6	158.5	4805	77.75	8.31	+7.763E-07	+4.371E+08	+1.577E-10
600	10	.9	158.5	3654	83.40	8.35	+9.063E-07	+3.099E+08	+1.027E-10
650	10	.9	158.5	4075	81.34	7.29	+9.493E-07	+3.543E+08	+1.093E-10
700	10	.9	158.5	5424	82.18	6.57	+1.043E-06	+4.667E+08	+1.325E-10
750	10	.9	158.5	3500	75.24	5.50	+1.022E-06	+3.290E+08	+8.724E-11
800	10	.6	158.5	6796	66.39	4.44	+9.624E-07	+7.239E+08	+1.799E-10
850	10	.7	158.5	4843	50.28	3.30	+7.761E-07	+6.811E+08	+1.590E-10
900	10	.4	158.5	5948	34.64	2.23	+5.652E-07	+1.214E+09	+2.681E-10
950	10	0.0	158.5	6985	19.83	1.29	+3.412E-07	+2.491E+09	+5.215E-10
1000	10	0.0	158.5	3657	7.55	.51	+1.367E-07	+3.424E+09	+6.816E-10
1040	10	0.0	158.5	3487	2.40	.18	+4.527E-08	+1.029E+10	+1.962E-09
1080	10	0.0	158.5	1722	.96	.07	+1.887E-08	+1.270E+10	+2.325E-09
1100	10	0.0	158.5	2711	1.21	.08	+2.419E-08	+1.580E+10	+2.855E-09

```
Calibration_error=    1.50%  Conversion_factor_error=    .42%
_ML2K152_30 stored on /users/ms/cali:HFS at 29 Oct 1995 05:46:20
```

Table: RQE measurement protocols for the CCD chip

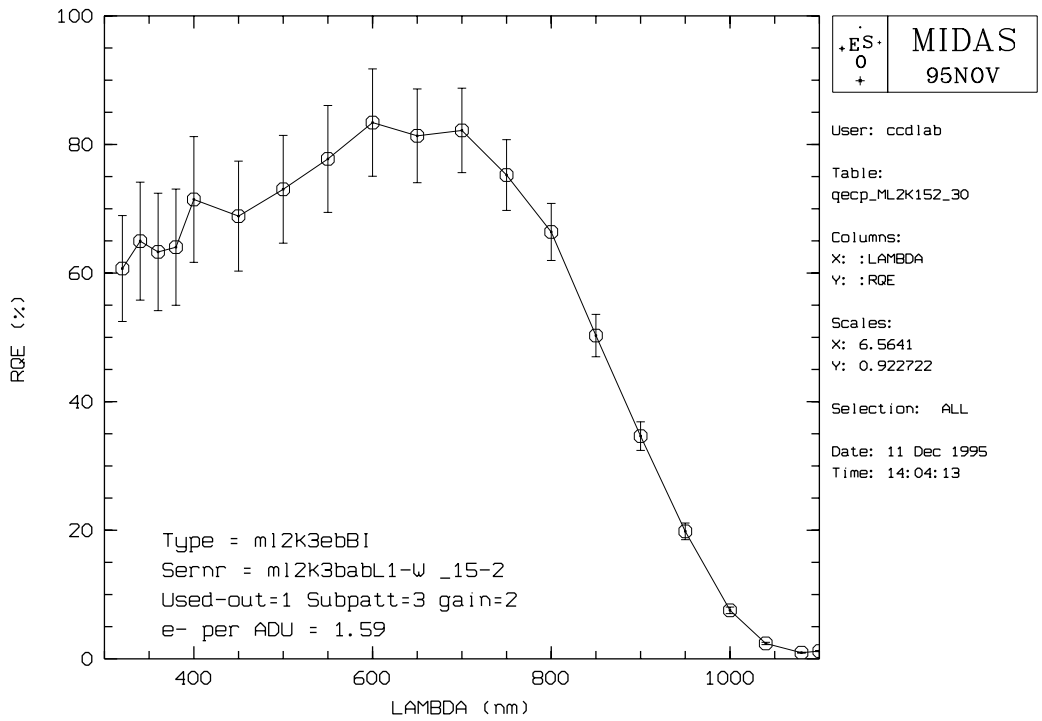

Figure 1: Plot of RQE values of the CCD (complete surface) at 158 K

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 0.4%) 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. To achieve the stated Quantum efficiency, the CCD was 1 hour soaked with synthetic air.

The peak value for RQE of CCD was approx. 83 % 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 = 0.999991 and Parallel CTE = 0.999977

Amplifier 2:

Serial CTE = 0.999992 and Parallel CTE = 0.999979

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. 3.2 ± 2.8 $e^-/pixel/hour$ 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 ±0.8% from the average value within 3.8 decades from 20 to 12200 e^- per pixel.

Amplifier 2:

There is a maximum deviation of less than ±0.9% from the average value within 2.9 decades from 28 to 22840 e^- per pixel.

See figure 2 on page 6 for details.

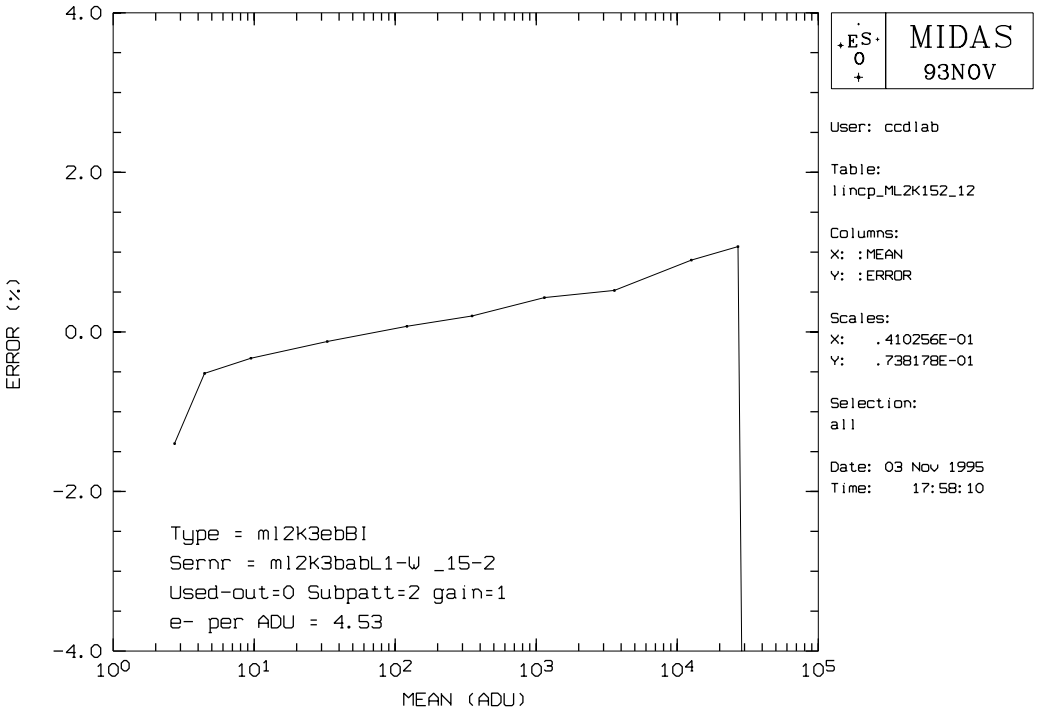

Figure 2: Linearity Measurement with amplifier 1

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: 114 000 e^-/pixel**
Saturation-value: 168 000 e^-/pixel

Amplifier 2:

Upper limit of linearity: 89 000 e^-/pixel
Saturation-value: 170 000 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 $1.59 + 0.9 - 0.9$ $events/min/cm^2$**.**

13 Blemishes

With the Amplifier 1 we found 314610 defective pixels. This was measured using three weak light images with a level of approximate 291 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: 1

Number of dark defects:
Dark pixel: 11; Dark cluster: 1671; Dark columns: 80; Traps: 56

Number of all defects: 1819
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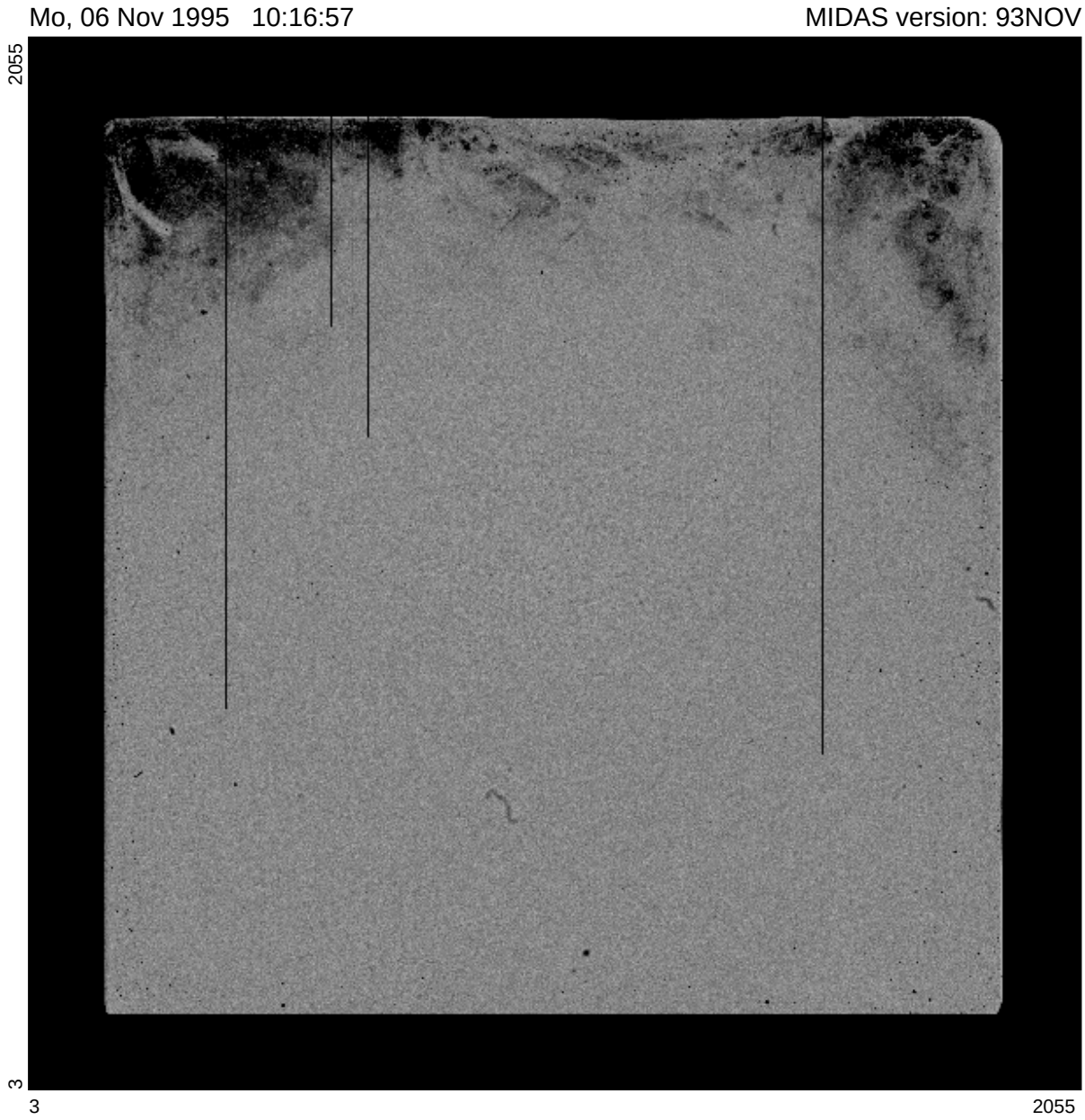

Figure 3: Weak Flat field (700nm,2.5): approx. 291 e^- per pixel with amplifier 1.

With the Amplifier 2 we found 70428 defective pixels.

```
Number of hot defects:
Hot spots: 0; Hot cluster: 2; Hot columns: 3

Number of dark defects:
Dark pixel: 11; Dark cluster: 1076; Dark columns: 126; Traps: 36

Number of all defects: 1254
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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	13.49
340	14.02
360	14.34
380	14.04
400	13.60
450	12.32
500	11.37
550	10.57
600	9.89
650	8.82
700	7.84
750	7.14
800	6.51
850	6.37
900	6.26
950	6.32
1000	6.62
1040	7.34
1080	7.54
1100	6.83

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 oversaturation on the CCD, several ten minutes dark exposures have been taken. The mean

Exposure Type	Exposure Time in [sec]	Illumination in [photons/pixel]	CCD Saturation	Remanence in [e^- per pixel]
FF white	1(Dens=1)	68000	0.32	—–
DK	600	—	—	0
FF white	1	603000	2.64	—–
DK	600	—	—	14
DK	600	—	—	2
DK	600	—	—	1
FF white	10	6030000	26.4	—–
DK	600	—	—	10
DK	600	—	—	2
DK	600	—	—	1

Table 3: Remanence of the CCD at 158 K

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.

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