University of Arizona
Imaging Technology Laboratory

Detector Characterization Report

Customer	University of Arizona Foundry/Magellan LDSS2 upgrade
Device	ITL SN3665 STA0500A Lot run 78093.1 Wafer 15, Die 2
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1. Introduction

The above detector is part of the University of Arizona Foundry Run. Most tests were performed at or close to -100 C, a typical operating temperature for most scientific CCDs. This device has been processed for the Magellan LDSS2 upgrade and is provided as an contribution from the University of Arizona.

2. Description of the ITL Detector Characterization System

Uniform monochromatic illumination for the Device Under Test (DUT) is provided by a system consisting of an Oriel 6255 150-watt xenon arc lamp enclosed in an Oriel 66002 lamp housing, Oriel model 68805 Universal Power Supply, Oriel 68850 Photofeedback Controller, Oriel 76995 Electronic Shutter Controller, Oriel model 76994 Shutter, Oriel 77702 Monochromator, and an 20" diameter Labsphere Integrating Sphere with a UV-enhanced interior diffuse coating.

Diode mode DUT and calibrated diode photocurrents are measured during QE testing by a Keithley Model 6512 Electrometer.

The detector was operated in a liquid-nitrogen-cooled Kadel dewar equipped with a fused quartz window of 137 millimeter aperture. The temperature was regulated at -100C for temperature-critical tests.

The device was tested with a gen1 CCD controller from Astronomical Research Cameras, Inc. The software system used was the ITL AzCam data acquisition system.

3. Diode Mode Quantum Efficiency

The quantum efficiency (QE) of the imaging device was measured by comparison with a silicon photodiode with an NIST-traceable calibrated response. The photodiode is attached to the output of the optical system (where the CCD in its dewar will be placed) and the monochromatic output of the integrating sphere is sampled at each wavelength of interest by scanning the monochromator. This procedure is then repeated with DUT by connecting the electrometer to the CCD SUBSTRATE and RESET DRAIN. QE is computed based upon the ratio of the photocurrents, UV quantum yield, relative light collecting areas and geometric factors involving the particular dewar and window material. The QE is shown in Table 1 and Figure 1.

Wavelength (nm)	QE
300	72.2%
320	75.4%
340	71.3%
350	66.2%
360	61.5%
380	66.8%
400	74.4%
450	79.0%
500	82.8%
550	90.4%
600	91.9%
650	89.4%
700	85.3%
750	78.2%
780	71.7%
820	58.5%
850	45.9%
900	30.9%
950	16.5%
1000	6.0%
1050	3.7%
1100	4.1%

Table 1. Measured QE at -100C

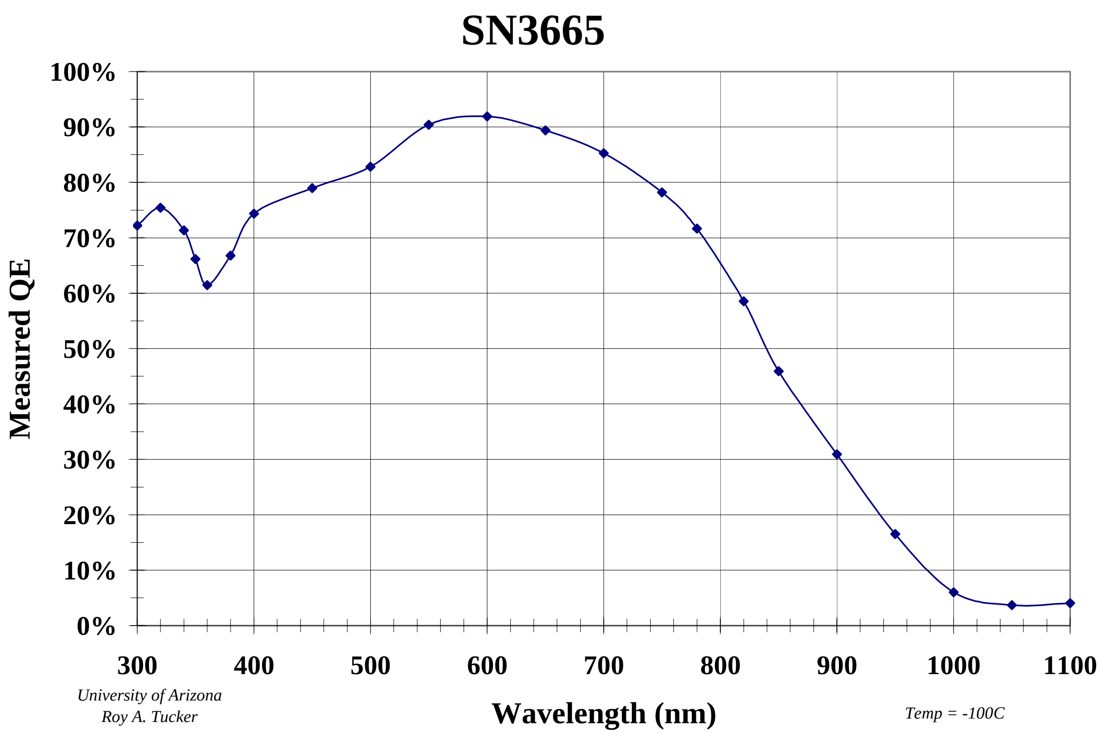

Figure 1. Measured QE at -100C

4. Detector Cosmetics

Flat field images were obtained with illumination wavelengths of 300, 400, 600, and 900 nanometers. Light of 300 and 400 nanometers wavelength is detected very close to the surface of the device and critically reveals details of the surface charging. A thin scattering of isolated spots are visible but are inconsequential to use as a scientific imager. Images at all wavelengths show a small pronounced smear near one edge but should flatfield out without problem..

600 nanometer light penetrates more deeply into the device and the detected electrons are less influenced by surface charging. At this wavelength, the appearance is generally very uniform with a very few small dark spots and the previously mentioned smear.

900 nanometer light penetrates through the imager and the resulting optical interference fringes provides information about the thinning of the device. The ‘topographic map’ pattern of fringes appears to be modulated by an off-center, vaguely concentric ring feature, probably due to variations in how the silicon crystal grew, but inconsequential in the operation of the device. Otherwise, nothing anomalous was seen.

5. Dark Current Measurement

A thirty-minute dark image was acquired at -100C. The -100C bias-subtracted dark image was featureless except for cosmic ray events and indicated a dark current of 22 electrons per pixel per hour.

6. Fe-55 Noise, Gain, and CTE measurements

Characterizations of read noise, conversion gain, and charge transfer efficiency using Fe-55 X-ray images were conducted at -100C. The readout speed was approximately 41.3 kpixel/sec. Bias and clock voltages were:

Vod = 25 volts	Vrd = 17 volts	Vog = -1.0 volt
RG = +8/-2 volts	SW = +4/-4 volts	TG = +2/-9 volts
Sx = +4/-4 volts	P1,2 = +2/-9 volts	P3 = +3.5/-7.5 volts

Performance at -100C	
Amp 0	
Parallel CTE – 0.999996	Serial CTE – 0.999986
Gain – 2.69 µV/e	Read noise – 7.05 e
Amp 1	
Parallel CTE – 0.999996	Serial CTE – 1.000002
Gain - 5.45 µV/e	Read noise – 3.26 e
Amp 2	
Parallel CTE – 0.999999	Serial CTE – 1.000008
Gain – 5.45 µV/e	Read noise – 3.46 e
Amp 3	
Parallel CTE – 0.999994	Serial CTE – 0.999994
Gain - 5.45 µV/e	Read noise – 3.37 e

6. Parallel register full well

A photon transfer series showed departure from linearity at about 41,000 ADU's or about 66 kiloelectrons. Higher positive parallel voltages would probably improve this, as would non-MPP operation.

A ramp image was obtained by opening the shutter and exposing the device to 600 nm light during the readout process. This type of images shows a linear increase in signal level until CCD full well or video processor saturation is reached. The point at which this departure from linearity occurs is one measure of maximum charge capacity. With a system gain of about 1.6 e^-/ADU, saturation was seen at about 55,000 ADUs or 88 kiloelectrons.

7. Summary

Three amps worked very well, the QE was excellent, the full well capacity was perhaps a bit shallow for the pixel size, and CTE at the typical operating temperature was very good. There are two partial bad columns and a very sparse scattering of “spots”. The read noise of about 3.5e^- or less at 173K is also excellent. The fourth amp (amp 0) has about half the gain and twice the noise of the other amps. Overall this is an A grade device.