**Southern African Large Telescope
High-Resolution Spectrograph**

SALT HRS

3290AE0001 Detector Specifications

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1   Scope

This document provides the specification for the detectors for the SALT High Resolution Spectrograph (hereafter SALT HRS) to be supplied to the University of Canterbury (hereafter UC) by the Detector System vendor. The Detector System shall comprise two CCD Detector sub-systems for the two spectral formats – one red sensitive and the other blue sensitive – of SALT HRS.

2   Work

The Detector System vendor agrees to perform the following work to the parameters given in Sections 3 and 4.

2.1   *Detector System*
   (a) Design and build two cryogenically-cooled Detector Housings;
   (b) Provide and integrate the specified SALT HRS CCD Detectors into their respective Detector Housings with special customer supplied windows;
   (c) Integrate the Detector Housings with appropriate Array Controllers and Power Supplies;
   (d) Characterize the Detector Sub-systems' performance;
   (e) Provide CCD systems capable of charge shuffling.

2.2   *Integration and Testing*
   (a) Support integration of the Detector System into SALT HRS;
   (b) Support laboratory testing of the Detector System in SALT HRS;
   (c) Provide suitable documentation for camera hardware manual, users manual, a verifiable final test report and standard software manual and installation instructions.

3   CCD system for blue camera

   E2V Technologies 44-82, Grade 0
   Standard silicon, thinned, back illuminated CCD
   Astro BB antireflection coating
   2k x 4k x 15micron square pixels
   2 readout amplifiers

The CCD will have the following parameters:

<u>CTE:</u>   The charge transfer efficiency shall be better than 99.999 per cent.
<u>Full well:</u> The peak charge storage shall be greater than 150,000 e$^-$/pix.
<u>Sensitivities, quantum efficiency:</u> The CCD QE, as a function of wavelength, shall equal or better the values shown in the table below:

Wavelength (nm)	Minimum QE (%)
350	>40
400	>70
500	>75

Dark current: The dark current shall be less than 1 e$^-$/pix/hour at a temperature of 160 K.
Readout noise: At a readout speed of 20 kpix/sec, the readout noise must be less than 3 electrons per pixel RMS.
Cosmetics: The CCD cosmetics shall equal or better the values shown in the table below:

Defects	Grade 0
Column defects (black or white)	6 or less
White spots	500 or less
Total spots (black or white)	1250 or less
Traps	30 or less

where the definition of the defects is as in the E2V Technologies data sheet, except that the definition of a black spot is a pixel which has 50 per cent or less responsivity.

CCD controllers: The CCD controller shall be appropriate for the CCD camera supplier's hardware.
Gain: At least two gain settings, under software control, shall be supplied.
Pre-binning: Pre-binning of 1 x 1 to 9 x 9, independently adjustable in each direction, shall be available.
Readout speed: The device will be capable of operating at readout speeds of up to 1 million pixels/sec.
Readout times: The time to read out the CCD array shall be less than or equal to the values shown in the table below:

Prebin/ Readout Speed	Readout Time (sec)	Readout Noise (e$^-$/pix)
1 x 1 Slow (100kHz)	50	4
2 x 2 Slow (100kHz)	15	5
1 x 1 Fast (400kHz)	18	9
2 x 2 Fast (400kHz)	6	10

Windowing: The CCD controller and software shall enable up to 5 windows to be selectable.
Software: The CCD controller software shall be in LabVIEW and/or C.

4   CCD system for red camera

       Fairchild Imaging CCD486 (data sheet, Rev 061804), Grade 1
       Thinned, back illuminated CCD
       Broadband antireflection coating
       4k x 4k x 15micron square pixels
       4 readout amplifiers per chip

The CCD will have the following parameters:

<u>CTE:</u>   The charge transfer efficiency shall be better than 99.999 per cent.
<u>Full well:</u> The peak charge storage shall be greater than 100,000 e^-/pix.
<u>Sensitivities, quantum efficiency:</u> The CCD QE, as a function of wavelength, shall equal or better the values shown in the table below:

Wavelength (nm)	Minimum QE (%)
550	>80
650	>80
800	>80
900	>50

<u>Dark current:</u> The dark current shall be less than 1 e^-/pix/hour at a temperature of 160 K.
<u>Readout noise:</u> At a readout speed of 50 kpix/sec, the system (CCD plus controller) readout noise must be less than 4 electrons per pixel RMS.
<u>Cosmetics:</u> The CCD cosmetics shall equal or better the values shown in the table below:

Defects	Grade 1
Column defects (total)	6 or less
Point defects (dark or hot)	200 or less
Cluster defects	25 or less

where the definition of the defects is as in the Fairchild Imaging CCD486 data sheet, Rev 061804.
<u>CCD controllers:</u> The CCD controller shall be appropriate for the CCD camera supplier's hardware.
<u>Gain:</u> At least two gain settings, under software control, shall be supplied.
<u>Pre-binning:</u> Pre-binning of 1 x 1 to 9 x 9, independently adjustable in each direction, shall be available.
<u>Readout speed:</u> The device will be capable of operating at readout speeds of up to 1 million pixels/sec.
<u>Readout times:</u> The time to read out the CCD array shall be less than or equal to the values shown in the table below:

Prebin/ Readout Speed	Readout Time (sec)	Readout Noise (e$^-$/pix)
1 x 1 Slow (100kHz)	50	4
2 x 2 Slow (100kHz)	15	5
1 x 1 Fast (400kHz)	18	9
2 x 2 Fast (400kHz)	6	10

<u>Windowing:</u> The CCD controller and software shall enable up to 5 windows to be selectable.

<u>Software:</u> The CCD controller software shall be in LabVIEW and/or C.

5 Documentation

This section specifies the documentation to be supplied to UC with the Detector Systems. Text documentation shall be provided in MS Word or PDF format. Mechanical drawings shall be provided in a mutually agreed (3D) format for mechanical modeling and drawings.

5.1 *Acceptance Test Plan*
The Detector System vendor shall provide an Acceptance Test Plan suitable for demonstrating correct operation of the Detector Systems. All aspects of this Acceptance Test will be run at the vendor's facility before shipping to UC, and noise and dark tests at UC after shipping from the vendor, and again in South Africa. The plan shall be suitable for verification of correct operation as well as diagnosis of problems, in so far as they can be carried out in each location.

5.2 *Mechanical Specifications and Drawings*
The Detector System documentation (as a camera hardware manual) shall include the definition of all mechanical components and subsystems. COTS entities will be defined by supplier details and proprietary part numbers. Custom components and assemblies will be defined by a mutually agreed (3D) format for mechanical modeling and drawings. Assembly drawings will be of sufficient detail to enable a competent technician to interpret them.

5.3 *Parts Lists*
The Detector System documentation (as part of the camera hardware manual) shall include a complete description of materials, parts and components.

5.4 *Wiring Lists*
The Detector System documentation (as part of the camera hardware manual) shall include a complete description of all wiring, and lists describing every cable and connector.

5.5 *Software*
The Detector System documentation (as a compiled GUI-based package with manual and installation instructions) shall include software listings in electronic format. The

documentation shall include a software block diagram showing the relationship of software modules, and describe all inputs and outputs for each module.

5.6   Vendor Data Sheets
The Detector System documentation shall include vendor data sheets and specifications for all commercially supplied components.

5.7   Assembly, Shipping & Installation
The Detector System documentation (as part of the camera hardware manual) shall include manuals that describe the assembly (and disassembly) of the Detector System, how to pack and ship it, and how to install it into the SALT HRS.

5.8   User's Manual and Calibration Manual
The Detector System documentation (as part of the camera hardware manual) shall include a user's manual describing all operational aspects of the Detector System and its calibration.

5.9   Maintenance Manual
The Detector System documentation shall include a maintenance manual. The manual shall contain procedures for periodic maintenance and troubleshooting.

6   Deliverables For HRS CDR

The Detector System vendor agrees to perform the following work for the Critical Design Review (CDR) of SALT HRS, scheduled for April 11-14 2005 in Christchurch, New Zealand.

6.1   Schedule
The Detector System vendor shall develop the final schedule for the work and send it to the SALT HRS PI. Delivery shall occur as soon as possible but no later than 1 April 2005.

6.2   Budget
The Detector System vendor shall develop the final budget for the work and send it to the SALT HRS PI. Delivery shall occur as soon as possible but no later than 1 April 2005.

6.3   Participation in CDR
The Detector System vendor shall provide suitable documentation for CDR, and participate in CDR (on April 12 or April 13, 2005) via teleconference if required.