Southern African Large Telescope
High-Resolution Spectrograph

SALT HRS

3200AS0023 Interface Control Document

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Issue History

Number and file name	Person	Issue	Date	Status
3200AS0023 R4 ICD.doc	PLC	1.0	25 June 2004	Update of 3200AS0010
	MDA	1.1	8 July 2004	Changes for R4 design
3200AS0023 ICD	PLC	2.0	4 March 05	Changes for CDR
	PLC	2.1	13 March 05	Revised logical development of ICD
	PLC	2.2	14 March 2005	New diagram

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1 Scope

This document specifies the external interfaces between the SALT HRS and the SALT facility, as well as the internal interfaces between the components of SALT HRS. The interfaces are optical, mechanical, electrical, cryogenic, water, vacuum and communications.

Figure 1 shows a block diagram of the system. Note that SALT HRS presents a single optical and mechanical interface to the facility through the FIF (SALT-3400AS0015).

This replaces the PDR document with the same number except that it is Issue 2.

2 Optical

2.1 Fibre input at the Fibre Instrument Feed

2.1.1 Object and sky observations

The FIF will provide pairs (for both fixed object & sky and for the nod & shuffle mode) of fibres with appropriate ferrules to attach to the spectrograph via image slicers where required. The FIF ICD (SALT-3400AS0015) details how these fibres are attached and how they will be moved for their various functionalities. Three pairs of fibres (see Table 1) will be prepared for commissioning. Two of these will feed 2 image slicers and give the resolving powers shown in Table 1.

2.1.2 Calibrations

SALT facility wavelength and smooth field calibration lamps are located in the Spherical Aberration Corrector (SAC) and will enable the telescope pupil track to be duplicated for the calibrations. To ensure wavelength stability it is necessary for the ThAr lamp to remain on at all times (**TBD1**).

2.2 Light from spectrograph camera imaged on Detector subsystem

The optical output of the spectrograph is a pair of two-dimensional échelle spectra, one from the blue camera, one from the red camera, each focussed onto its respective detector. The Detector subsystem specifications are given in 3290AE0001 and how they utilise this light is given in the optical design document (3210AE0005).

Table 1: Formats for the telescope fibre feed modes.

Spectrograph feed	*D_{fibres} (μm)*	*N_{slices}*	*W_{slices} (μm)*	*H_{slices} (μm)*	*Resolving power*	*Nod & shuffle available*
High res IS	350	3	80	333	65,000	
Med res IS	500	3	160	333	37,000	
Low res	500	0			16,000	√

3 Mechanical

3.1 Fibre inputs

The fibres will emanate from the FIF with appropriate restraining fasteners to prevent the fibre from being pulled out of its optically precise fixing to the FIF. The initial three pairs of fibres will be grouped into a single bundle and then take the most direct route down the telescope structure [route to be provided by SALT personnel but of ~35m – **TBC1**] and through the hole in the roof of the Spectrograph Room. There will be further fasteners at strategic points in the single bundle route as required. There will a termination point for the single fibre bundle from the FIF and separation into unsliced and sliced fibre pairs. A single 100μm fibre will be grouped with the lowest resolving power fibre at this point to allow calibration light to be fed directly into SALT HRS from the Spectrograph Room.

3.2 Fibre selector

The lowest resolving power fibre pair will be passed directly into SALT HRS to provide maximum throughput at the lowest resolving power. There will be a rotary mechanism that will allow either of the other two pairs of sliced fibres to form the slit of the spectrograph at the higher resolving powers.

3.3 Shutters

There will be two fast shutters and two slow shutters in SALT HRS.

One fast shutter will be mounted just outside the vacuum enclosure of the spectrograph in the fibre selector arrangement - the 'slit pocket' - (see 3210AE0004 and 3230AE0030) and the other fast shutter will be inside the vacuum enclosure in front of the termination point for the direct fibre. The slow shutters are at the entrances to the two cameras (see 3210AE0004).

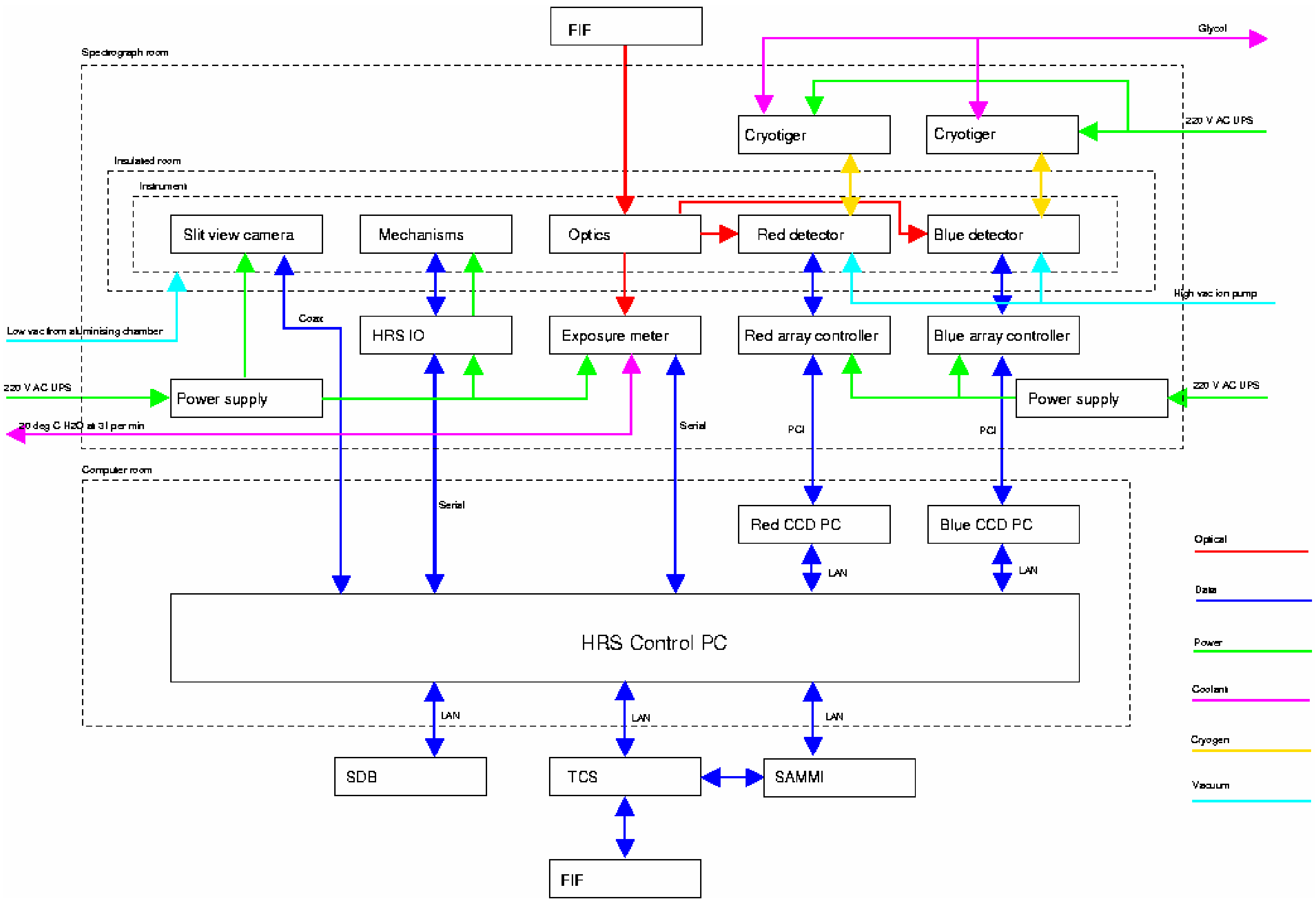

Figure 1: Block diagram of SALT HRS system and its interfaces.

3.4 Exposure meter

Light reflected off the gap between the two replications of the échelle grating will be fed using a light pipe to a water cooled photomultiplier tube, photon counting amplifier and counter mounted outside the thermally insulated enclosure.

3.5 Temperature and pressure monitors

Ten to fifteen temperature sensors, some located inside the vacuum chamber and some in the surrounding rooms, will be of thermistor type.

A barocell 0-10 mm pressure sensor (with a resolution 0.1 hPa) will be placed inside the vacuum enclosure.

3.6 Detector

3.6.1 Handling Fixtures

The cryostats shall accommodate cranes and hoists with suitably placed threaded holes to allow these components to be lifted in an attitude suitable for integration with the HRS camera structures.

3.7 Handling fixture for structure

SALT HRS is a substantial instrument. The vacuum enclosure is approximately 3.3m long, 1.2m in diameter and 1.5m high, and the total structure will weigh approximately 2000 kg. To facilitate the handling of various elements within this structure an appropriate series of internal and external handling fixtures will be designed. The vacuum enclosure will be contained within a thermally insulated enclosure.

3.7.1 External

To facilitate the lifting and manoeuvring of elements within the spectrograph there will be a portable, manually operated, floor crane.

3.7.2 Internal

The various optical elements will be manufactured with appropriate attaching points. Following installation they should not need to be moved.

3.8 Shipping containers

Considerable thought has been given as to how this instrument, and its subsystems, will be shipped.

Each of the optical elements will have their own shipping container, which will be required for all aspects of their transport after their initial figuring. There will be many steps in this process for each element and this is recognised as a serious risk to this project. Robust safety procedures will be developed and strictly adhered to **(TBD2)**. Accelerometers will be used. Shipping of the optical elements will be undertaken by air.

The large mechanical structure forming the vacuum enclosure will be shipped by sea as will the outer thermally insulated enclosure which will consist of demountable panels.

4 Electrical

4.1 Power

Electrical power will be provided by the facility. Clean UPS power is required for all SALT HRS systems and their requirements are as given in Table 2 (taken from 3250AE0029).

Table 2: System power requirements for SALT HRS

Equipment	**Power consumption (Watts)**
HRS control computer	460
Red CCD computer	460
Blue CCD computer	460
Photo multiplier cooler	270
HV power supply	20
Red CCD controller	150
Blue CCD controller	150
Red CCD cooler	500
Blue CCD cooler	500
Photon counter	5
Photon amplifier	1
Slit viewing camera	2.5
Fast shutter 1	2.5
Fast shutter 2	2.5
Flat field lamp	150
Circuit board chassis (total)	5
Stepper motors (average power)	2
ThAr lamp supply	15
Total power consumption =	**3156.5**

4.2 Electrical connections

The HRS system will use electrical connectors consistent with other SALT instruments, namely IEC type.

4.3 Signal connections

4.3.1 Fibre selector

The fibre selector will be driven by a microstepper motor that has been set to the required resolution and encoded by motor steps. Pulse and direction will be generated by the LabView card in the HRS Control PC and are described in 3250AE0029.

4.3.2 Beam-splitter and slit-viewing camera

The control of the beam-splitter for slit-viewing camera, and the slit-viewing camera itself, is described in 3250AE0029.

4.3.3 Input shutters and fold mirror

The input (fast) shutters will be opened and closed via a serial signal from the HRS control PC and are described in 3250AE0029. There will be interlocks to ensure that both input shutters cannot be opened simultaneously and to control the position of the input fold mirror.

All electrical signals between the array controller and HRS shall be optically isolated.

4.3.4 Camera shutters

The camera (slow) shutters will be controlled by the HRS Control PC and are described in 3240AE0002 and 3250AE0029.

4.3.5 Camera focus

The camera focus will use an active interface between the HRS Control PC and the controllers for the motorized actuators on each of the pupil mirror mounts (see 3220AE0004 and 3250AE0029).

4.3.6 Exposure meter

Output from the exposure meter will be sent serially to the HRS Control PC. The exposure meter can be reset, started and stopped under LabView control (see 3240AE0002 and 3250AE0029).

4.3.7 Flat field and ThAr lamps

These are lamps in the vicinity of SALT HRS and will be used for CCD sensitivity and wavelength calibration and are controlled via a serial signal from the HRS control PC and are described in 3250AE0029.

4.3.8 Temperature and pressure monitors

The design requires the monitoring of the temperature and pressure to be controlled by the HRS Control PC. The temperature and pressure sensors will be interfaced via a LabView ADC card within the HRS PC (see 3250AE0029). There will not be an active interface for temperature control, although it is a possible upgrade path should active air-conditioning be required.

5 Cryogenics and coolants

The SALT facility shall deliver glycol coolant to the HRS location for use by the Detector subsystem, which requires both cryogenic cooling for the detector housing, and refrigeration for heat disposal from the detector array controller and its power supply, the ion pump controller, and the subsystems controller. The connector will be as for other parts of the SALT facility. The glycol shall be routed within the HRS location to the Detector subsystem cooler box.

Water at a temperature of 20 degrees C and at a rate of 3 litres per minute is required for the exposure meter photomultiplier tube.

6 Communications

Communications between the HRS Control PC and other SALT computers (e.g. the TCS server, the Science Database and the SALT Astronomer MMI machines) will be on the facility Ethernet, under the control of LabView's network communications protocol.

7 Software

This interface is specified in the Software Documents: 3240AE0002 HRS Software Design which includes the Detector subsystem and in the FIF document (3400AE0024 Issue 3.0).

The SALT Astronomer will be able to choose between the following options:

Operational modes:

Night-time operations
Day-time operations
Engineering operations

Reduction mode:

Separate software for quick-look and science quality reduction.

8 Maintenance

The vacuum enclosure will ensure that the optical elements remain free from dust or damage due to mishandling. The vacuum will also provide a stable thermal and pressure environment.

The CCD cryostats will need pumping at a frequency of around six months. This will be done with each cryostat in-situ, using a vacuum pump, connecting to the cryostat by means of a flexible vacuum hose.

The spectrograph vacuum enclosure will have to be pumped at approximately six monthly intervals to maintain pressures of between 1 and 4 hPa. This can be achieved with a backing pump that could be provided as part of the SALT HRS instrument or through access to the SALT facility's vacuum system, via a pipe from the aluminising room **(TBC2)**.

A clean environment will be maintained between the vacuum enclosure containing the spectrograph and the outer thermally insulated room.

9 TBD and TBCs

TBD1 (Section 2.1.2) Wavelength calibration stability issue
TBD2 (Section 3.8) Safety procedures

TBC1 (Section 3.1) Length of fibres
TBC2 (Section 8) Vacuum line at HRS location