Southern African Large Telescope
SALTICAM
Preliminary Design Review

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Control

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Table of Contents

1 SCOPE 3

2 INSTRUMENT CONTROL 3

2.1 MECHANISM REQUIREMENTS 4
2.2. ADDITIONAL SUBSYSTEMS 5
2.2.1 Closed Cycle Cryotiger Cooler 5
2.2.2 Ion Pump 5
2.2.3 Vacuum Gauge 5

3 THE SDSU II CONTROLLER 5

4 AUXILIARY SUB-SYSTEMS CONTROL 6

4.1 FILTER MECHANISM 6
4.1.1 Verification Instrument (VI) mode 6
4.1.2 Acquisition Camera/Science Imager (ACSI) Mode 6
4.2 SHUTTER UNIT 6
4.3 FRAME TRANSFER MASK 6
4.4 FOCUS MECHANISM 7

5 POWER REQUIREMENTS 7

6 ENVIRONMENTAL/TEMPERATURE ASPECTS 7

7 LIST OF TBC/TBD ISSUES 8

1 Scope

This is the Control Systems Definition Document for the preliminary design review of SALTICAM, the verification instrument, acquisition camera, and scientific imager of the Southern African Large Telescope (SALT). It describes the major functions and capabilities of the instrument controller hardware, including the detector controller and auxiliary sub-systems such as filter change, shutter control, frame transfer mask and focus.

2 Instrument Control

SALTICAM is controlled from a standard type PC running Real Time (RT) Linux. Communication with the instrument on the Payload is via a fiber-optic PCI interface to the San Diego State University CCD controller which. All necessary CCD control functions are inherently part of the SDSU controller's architecture, in addition the controller functions as the communications link between the control PC and the auxiliary subsystems control unit. Figure 1 shows a basic block diagram.

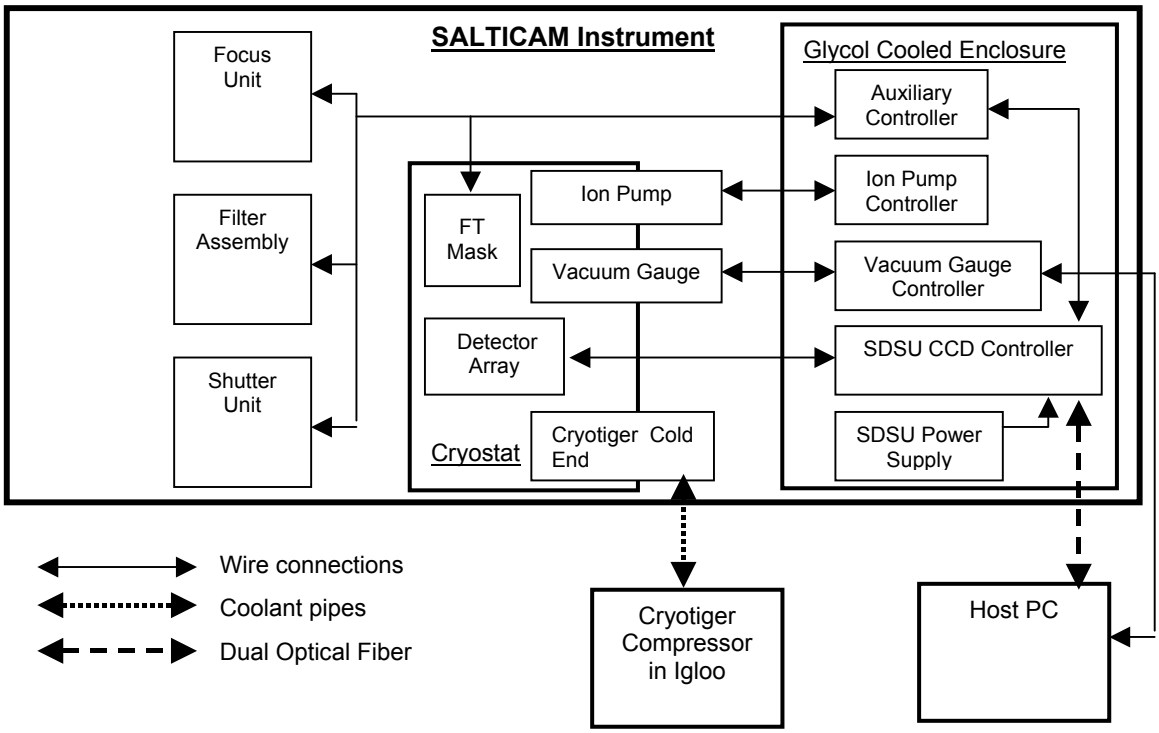


Figure 1: SALTICAM Block Diagram

The three SALTICAM operational modes (verification and acquisition/science modes) have very little impact on the control system. In science imager and acquisition mode the instrument architecture remains the same. In verification instrument mode the focus mechanism is not required and the filter cassette mechanism is replaced with two 4-position filter wheels

2.1 Mechanism Requirements

This section lists the control requirements for each mechanism of SALTICAM. In the preliminary design, we treat only the basic motion control functions and indicators. The issues of health and safety interlocks, soft and hard limits, and assignment of responsibility between software and hardware systems will be detailed in the critical design. The one design philosophy that we can stress here is that it will be impossible for the software to harm the hardware. The safety analysis and hardware implementation will ensure that the worst result of control errors will be limited to loss of observing time.

The mechanisms do not interact with each other, thus there is no requirement for safety interlocks between mechanisms.

The following table outlines the control requirements of each mechanism. In the "Encoder" columns the following terms are used:

- Reference: A reference position used to initialize a position counter, after which an open loop step counter defines position.
- Position: indication of actual position by either absolute or incremental encoder.
- Limits: Binary indications of safe limits of travel

Note that the **#Ops** column represents absolute worst case numbers.

Mechanism	Operation	Actuator	Encoder	Travel	Power(W)	Time	#Ops
Filter Wheel	Rotation	Stepper	Reference Position	60º/Filter position	7	**TBD1**	180/Hr
Filter Cassette	In/Out	Stepper (2)	Reference Position Limits	**TBD2**	7+4.8	**TBD1**	180/Hr
Shutter	open/close	Solenoids	Open/Close	50mm (Ø100)	**TBD3**	<100mS	180/Hr
FT Mask	In/Slot/Out	Stepper	Reference Position Limits	~65mm	1.5	60S	15/Hr
Focus	Linear	Stepper	Reference limits	4mm, 10µ/stp	**TBD4**	**TBD5**	15/Hr

2.2. Additional Subsystems

In addition to the above direct instrument features, the following "standalone" units are required. These are all COTS units:

2.2.1 Closed Cycle Cryotiger Cooler

An APD Cryogenics closed cycle cooler is used to remove heat from the CCD cryostat. The compressor unit will be housed in the "igloo" under the main mirror. The compressor is a stand-alone unit, it has no remote connection capability for control or status monitoring.

2.2.2 Ion Pump

A Varian Ion Pump unit is used to maintain the cryostat vacuum integrity. Control of the pump will be via the sub-system controller to start/stop pumping. The Ion pump may also function satisfactorily as a vacuum gauge. **TBD6**

2.2.3 Vacuum Gauge

A Granville Phillips series 355 vacuum gauge provides means for long-term monitoring of the state of the cryostat vacuum to facilitate maintenance planning. The gauge output data is monitored by RS232 link to the SALTICAM computer. Note that as mentioned above it may be possible to use the Ion pump as a vacuum gauge in place of this unit. **TBD6**

3 The SDSU II Controller

The SDSU CCD controller to be used for CCD control/readout functions consists of a DC power supply unit and standard 6-slot controller cardframe. It will have a timing board, utility board, clock driver board and two dual video boards. CCD Readout performance is covered in the document 3360AE0001_detector.pdf, a synopsis of functionality includes:

> Full frame readout, frame transfer readout, strip scan readout, binning up to 9x9, windowed readout (up to 10 windows), selectable gain and readout speed, idle mode clocking.

The detector array temperature will be controlled to <0.5ºC. The controller will monitor at least one other temperature.

Connection to the auxiliary Sub-systems controller is optically isolated.

4 Auxiliary Sub-Systems Control

This unit is an intelligent multi-axis controller developed by staff at Canada/France/Hawaii Telescope/Univ. of Hawaii. Alternatively SAAO will develop a controller using mainly COTS units. **TBD7.** Communication/control from the SALTICAM computer is via the SDSU controller utility board 16-bit I/O port. All connections to the SDSU controller are optically isolated. It controls the following SALTICAM sub-systems:

4.1 Filter Mechanism

4.1.1 Verification Instrument (VI) mode

The filter mechanism consists of two four-position filter wheels.

4.1.2 Acquisition Camera/Science Imager (ACSI) Mode

The filter mechanism consists of a cassette containing twelve filter holders on a linear slide and a pick-off mechanism to select and position filters in the optical path.

4.2 Shutter Unit

The shutter unit is a commercial (Prontor) unit. It will be modified to have latching dual solenoid operation such that the solenoids are only active while opening or closing the shutter to give average power dissipation close to 0W.

4.3 Frame Transfer mask

The frame transfer mask will be mounted inside the cryostat as close to the focal plane as reasonably possible. It will have three positions:

Out of optical beam	for full frame imaging
Frame Transfer	for standard frame transfer mode of CCD readout
Slot Mode	A slot is positioned over the image area of the detector close to the store area. This allows for ultra high speed data acquisition.

4.4 Focus Mechanism

The focus mechanism will move the lens system contained in the second barrel to enable SALTICAM to be brought to a common focus position with other instruments on the Payload.

5 Power Requirements

Igloo enclosure:

Cryotiger compressor:	UPS 220v @ **TBD8** kW

Instrument Payload electronics package:

SDSU controller	*UPS 220v @ 0.15 kW
Other:	UPS 220v @ 0.3 kW **TBC1**

* UPS specifically for detector systems, must be separate from other general use UPS supplies.

6 Environmental/Temperature Aspects

To conform to SALT surface temperature/heat dissipation specifications the following units shall be housed in a glycol-cooled enclosure (supplied by SALT).

- SDSU controller power supply
- Auxiliary subsystems controller and power supply
- Ion pump controller
- Vacuum gauge electronics
- The SDSU controller: Note that due to the restriction on cable length for connections between the controller and the cryostat, the controller may be mounted outside the cooled enclosure. In this case one of the controller side panels will be substituted with a glycol cooled heat exchanger panel. **TBD9**.

The cryotiger compressor will be housed in the cooled “igloo” underneath the main mirror.

All mechanisms – especially the shutter - are designed such that power is only dissipated when the mechanism is moving, and most mechanisms have a very low duty cycle – active times are short compared to exposure/data acquisition times.

The Cryostat window is to be kept frost-free using a dry-air flush or window heater. **TBD10**

7 List of TBC/TBD Issues

TBC1	SALTICAM auxiliary units mains power requirements
TBD1	Filter mechanism time to change
TBD2	Filter mechanism travel
TBD3	Shutter unit power dissipation
TBD4	Focus mechanism power dissipation
TBD5	Focus mechanism time to move
TBD6	Use of Ion Pump as a vacuum Gauge
TBD7	Decision on auxiliary sub-system controller
TBD8	Cryotiger mains power requirements
TBD9	Controller mounted in cooler or outside with heat exchanger
TBD10	Window defrosting, heater/dry air.