CfAI
Centre for Advanced Instrumentation

Durham University

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Change Record

Issue	Date	Section(s) Affected	Description of Change/Change Request Reference/Remarks
2.1	12/05/11	Not Applicable	First draft
2.2	03/08/11	All	Second draft with input from SR,PC,DGB,LT
2.3	08/08/11	All	Minor spelling & formatting corrections

Applicable Documents

	Title	Document Number
AD 1	SALT HRS FPRD	3200
AD 2	SALT HRS Assembly, Integration and Test plan	3200 BP 0019

Reference Documents

	Title	Document Number
RD1	Keck HIRES Commissioning & Science Verification Plan	

Acronyms and Abbreviations

AD	Applicable Document
CfAI	Centre for Advanced Instrumentation of Durham University
SALT	Southern African Large Telescope
SALT HRS	SALT High-Resolution Spectrograph
FIF	SALT Fibre Instrument Feed

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1 Introduction

This document outlines the planned on-telescope commissioning and science verification plan for SALT HRS. This is a working document and will be developed as the instrument build progresses. The commissioning plan does not include tasks related to reassembly and laboratory verification of the instrument after it is shipped to the SALT observatory; these are covered in a separate document.

This document replaces 3200 AP 0031 Issue 1.3 which was written by the University of Canterbury team.

2 Commissioning Plan

2.1 Philosophy

SALT HRS contains a number of operating modes which need to be verified by on-sky commissioning. The goal of the on-sky commissioning plan is to systematically verify the performance of the instrument in each of these modes using calibration standards where appropriate. This will be followed by a science verification phase where representative science observations are taken which demonstrate the full capabilities of the instrument.

2.2 Key Performance Indicators

The key performance indicators for SALT HRS are shown in the following table. Each of these will need to be verified by one of more specific tasks in the commissioning plan.

Items	**Nominal performance**
Wavelength range	370-890nm (2 bands)
Spectral resolution	R~16500,32000,65000
Overall Efficiency	Eff >10% excl telescope & input losses
Spectral Stability	<0.1 pixel over 3 hrs
Source Acquisition	<0.2 arcsec rms
Quick-look data reduction	Extracted wavelength-calibrated spectra within <3 minutes
Exposure meter	S/N>10 for V<13 mag

3 Pre-Ship Tests

3.1 Image quality

Measurements of the delivered image quality based on Th-Ar spectra from the direct injection fibre will be compared with predictions from the optical model. [NB spec is for 80% EE in 25/35 micron box]

3.2 Solar Spectrum

Use a small telescope and fibre to feed light from the Sun down to the input of SALT HRS. Extract a spectrum of the solar spectrum and compare with solar atlas at nominal resolutions.

3.3 Spectral Resolution

Measurements will be taken with the Th-Ar lamp illuminating the main science & sky fibres. All 4 modes. FWHM vs wavelength extracted.

3.4 Spectral Format

Illumination of the science & sky fibres in all 4 modes with a tungsten continuum sources. Analysis of the order separation on the low resolution mode to confirm nod & shuffle operation.

3.5 Spectral Stability

A series of Th-Ar spectra taken with the simultaneous Th-Ar every 1hr over 12hrs (in high precision mode), and once per day over a fortnight. Measurements of line positions and widths. Analyse to see if there are correlations with temperature outside the tank [need temp sensor info in FITS header].

3.6 Calibration line profile stability

Encapsulated in Sec 3.5. Need to measure intensities of lines to satisfy RT. 17.

3.7 Scattered light

Continuum exposures with 90% full-well capacity will be obtained using a tungsten source fed at F/4.2 and the scattered continuum between the orders will be extracted.

3.8 Ghost images

Illuminate input science fibres (all four modes) with 532/633 nm laser light (single order) and measure any ghost image intensities. Optionally repeat 1 mode with continuum source and narrow band (~1 free spectral range) filter.

3.9 Simultaneous Th-Ar spectra brightness

Arc spectra will be taken with the simultaneous Th-Ar lamp in high precision mode with a range of exposure times from 300 sec to 3600 sec (TBD). Measurements will be taken

3.10 System Throughput

Illuminate the science and sky fibres (all 4 modes) with 633 and 532 nm laser light and an F/4.2 etendue; compare this with throughput measured into a 350/500 micron pinhole by a calibrated Si photodiode. Repeat with double scrambler for high precision mode. Data reduction should extract all the light from the single line and compare with flux through pinhole.

4 On-Sky Commissioning

4.1 Wavelength coverage

On-sky limitations to the wavelength coverage are restricted to the ability of the facility ADC to correct in the blue at large airmass. This can be tested using observations of the same spectrophotometric standard star at meridian crossing and the extremes of ZD. The reconstructed spectra bluewards of 400nm will be compared with each other and with standard data. Low resolution and high resolution mode only.

4.2 Spectral Resolution

Observations will be taken of a hot rapid rotating star to measure the widths of the telluric lines in the red. Interstellar H&K and other (e.g. P, Q, and R rotational lines arising from interstellar C3 at 405nm) blue lines will be measured in a similar target but with high extinction (e.g. rho Oph).

4.3 Spectral Stability

Measurements of one or more radial velocity standards interspersed with arc calibrations will be used to demonstrate hat can be achieved with either daytime calibrations or local night-time calibrations. The best candidates will be late-type giants (KIII).

4.4 Scattered light

Bright targets & sources outside of entrance apertures. Measurements of the night sky flux will be made using the low resolution mode at decreasing distances (60”, 30”, 20”, 10”, 5”) from a bright star. Measurement to be taken of mean flux as function of offset and spectral shape vs offset.

4.5 Source Acquisition using FIF

Use the expected FIF offsets to acquire bright star. Note position. Peak up using exposure meter during a dummy long exposure of same star; note new position at peak and the offsets from nominal. Check repeatability by offsetting FIF in both X&Y co-ordinates and returning to check centering at source position.

4.6 Spectrograph Efficiency

Take some spectrophotometric standards and extract S/N a function of wavelength. Compare with FPRD values. Need reliable seeing estimate to correct for entrance losses.

4.7 Quick Look Software

Test non-interlaced mode of FIEStool on spectrophotometric standards in all 4 modes. Requires suitable calibration frames to have been taken previously.

4.8 Commissioning Science

Quick science programme which would demonstrate instrument capabilities in a few key areas.

- Bright metal poor standard star for abundances (e.g. HD140283; V~7). High res mode (priority) but low & medium mode would be useful to test resolution effects. Time: 30 mins.
- Established short period extrasolar planet (HD****). High precision mode with iodine cell and with simultaneous Th-Ar. Time: 8 hrs spread over 4 days.
- BAL QSO (e.g. XXXX) in low res mode with N&S to test faint objects. 2 hrs.
- Lyman alpha forest on high redshift QSO (VISTA z>7 QSO ?). High res mode. 3 hrs.
- Magellanic Cloud target. Planetary nebulae emission lines. Med res mode. 1 hr.
- Line profile variation effects in roAp stars. High res mode with continuous readout. 3 hrs.
- Transiting planet (Rossiter–McLaughlin). High precision mode with simultaneous Th-Ar. ?? hrs.

5 Science Verification

Will be based on call to community for demonstration science programmes (e.g. abundances, ESPs, spectral variability).

- End of Document –