Southern African Large Telescope

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Signature:____________________ Date:______________

Abstract

This document is designed to provide information to potential SALT proposers that will assist in making their Phase 1 & 2 proposals for 2012 Semester 1 (1 May - 31 Oct 2012). It incorporates the latest experiences from SALT Astronomy Operations regarding telescope and instrument performance. The instrument simulator tools have also been updated to reflect the current situation. At the time of this call RSS has not completed full commissioning (e.g. MOS, polarimetry and some F-P modes are still outstanding), so only certain modes are offered and some are still shared risk. The document also includes proposal policies and related information. The SALT website should be consulted from time to time for further updates. **The Phase 1 proposal deadline is 24 February 2012 at 16:00 UT.**

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1. Changes from the Current Period

The current period, 2011 Semester 2 (i.e. for proposal codes starting with 2011-3), was nominally to run from 1 September 2011 to 28 February 2012. Following discussions at the last SALT Board meeting in November 2011, it was decided to extend until 30 April 2012 and for the next semester to run from 1 May to 31 October 2012. The reason for this 2 month extension was mainly the incomplete state of RSS commissioning, particularly for MOS and polarimetry. Some of the delay in completing MOS commissioning is due to telescope issues, specifically the functionality and performance of closed-loop guidance and focus, which are currently being addressed. The 2-month delay also allowed better characterization of telescope and instrument capabilities available at the time of the Call as well as the implementation of a revised Phase 1 proposal tool following on the recommendations from TACs after the last call. Ast Ops will be in contact with relevant PIs regarding the possibility of updating their targets to account for the 2 month extension in the current semester, namely 2011 Semester 2, for which all proposals have the prefix 2011-3 (commissioning proposals have the prefix 2011-2).

The revised SALT semester definitions are now:

Semester 1: 1 May to 31 October (deadline mid-February)
Semester 2: 1 November to 30 April (deadline mid-August)

The call for SALT proposals for 2012-1 opens on 20 January 2012, with updated proposal tools, including the Phase 1 submission tool. **The deadline for Phase 1 proposal submission is 24 February 2012 at 16:00 UT.**

1.1 Instrument and Mode Availabilities

Both SALTICAM and RSS will be available in the forthcoming semester, but with the following restrictions. More details can be found later in the document in relevant sections.

1. **No polarimetry** -- Due to an unforeseen fluid leak from the beamsplitter, polarimetry commissioning was regrettably halted in Nov 2011 and we are now in the process of effecting a repair. This is likely to be a protracted effort involving optical re-working of the Wollaston prisms comprising the beamsplitter mosaic, which is unlikely to be completed for many months. In light of this we are not accepting any *new* polarimetry proposals for this semester. Existing polarimetry programs may be attempted once the beamsplitter is repaired and following consultation with the relevant PIs.
2. **Compromised Fabry-Perot Performance --** Due to problems with ghosting, the dual-etalon modes have not yet been successfully commissioned. We expect to address this over the course of 2012, but PIs should be aware that dual-etalon modes may not be fully operational, or even available. This

especially impacts the high resolution (HR) mode which must be run in dual-etalon mode to avoid confusion between multiple orders. The medium (MR) and low (LR) resolution modes can be performed with single etalons, though with some trade-offs in the case of MR (see section 7.4.2).

3. **Compromised MOS alignment accuracy --** The accuracy of MOS alignment is currently at approximately the ~0.5” level and solutions to improve this are being investigated. At this stage, MOS science has not yet started and we can not guarantee the execution of the more challenging programs during the 2012-1 period, although MOS observations will begin as soon as it is feasible (see section 7.4.4).
4. **No drift scan modes --** Due to the delays in the aforementioned MOS commissioning, we will not be in a position to offer drift scanning for this proposal call.
5. **No nod and shuffle mode --** Same as 4.

2. Essential Concepts to Understand With SALT Observations

2.1 Visibility and Track Length

The altitude restrictions on SALT (47º to 59º) place observing constraints in terms of instantaneous sky access in Hour Angle and Declination, which is shown in the so-called SALT “toilet seat” diagram in Figure 1. Only objects inside the annular region are observable by SALT at any given time.

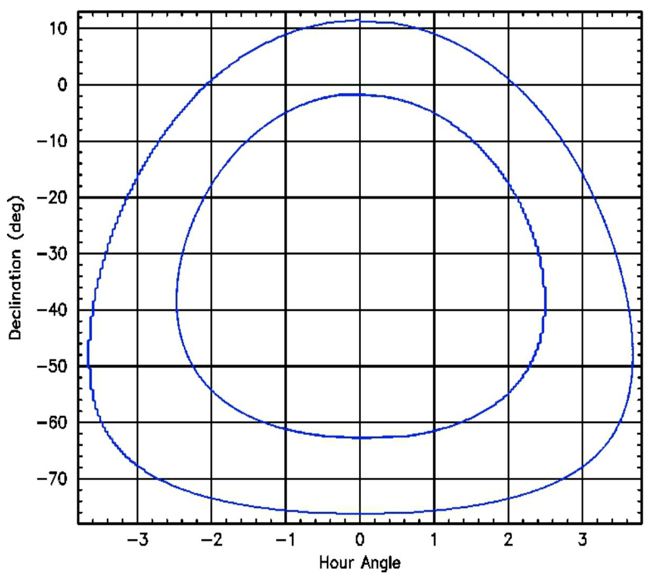

Figure 1: The *visibility* annulus of objects observable with SALT

The total maximum observing time, or visibility, for a celestial target is defined as the time it takes to transit the annulus, which is dependent on the Declination. However, the total maximum track time for an object, without having to move the telescope structure and re-acquire it, is determined by the tracker motion limits and is, therefore, equal to or shorter than the visibility time.

PIs should especially be aware that although Figure 1 and the Visibility Calculator may imply a total observing time of some hours, the tracker limits will necessarily curtail the maximum uninterrupted observing time available for a target. *It is this maximum **track time** that defines the maximum length of an observing block.*

Figure 2 shows the “actual” total maximum track time for objects as a function of Declination. For some Declinations (in the South and North), it is possible to re-acquire an object by stepping the telescope in azimuth, thereby extending the total observing time on a given night, as shown in the last graph. However, doing so incurs all of the normal overheads of repositioning the telescope and acquiring a target. Therefore, block times must be limited to available track times and observing time extended by multiple block visits.

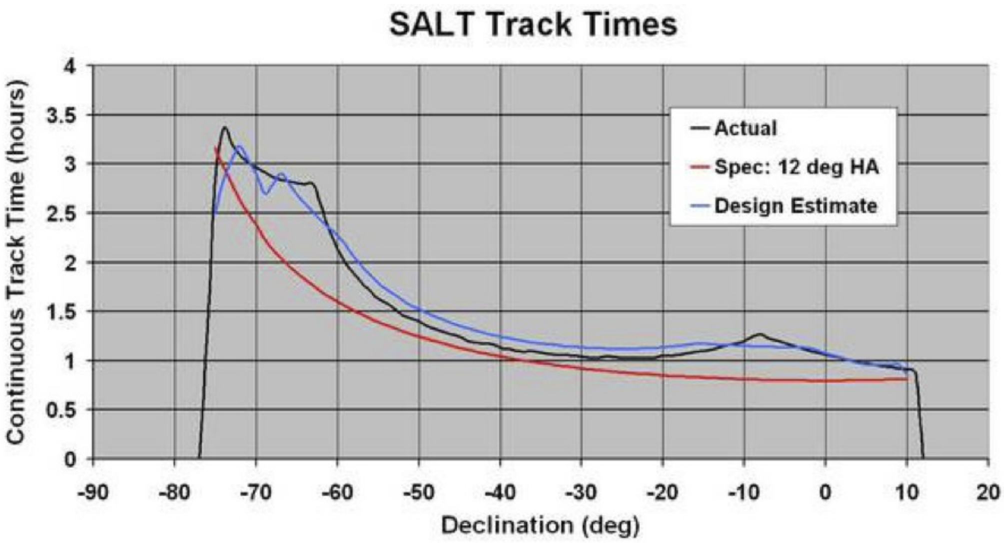

Figure 2: While objects can be visible for many hours continuously, a single *track time* may be shorter. At certain Declinations one is able to re-point the telescope in azimuth to continue for another track during the same visibility.

On the Visibility Calculator the track times can be seen by clicking at any location of the visibility curve. The Visibility Calculator is available from the SALT Observing Tool webpage at:
http://www.salt.ac.za/observing/proposing-for-salt-observations/observation-planning-tools/

2.2 Moving Pupil

As part of the SALT design, the pupil moves during the track and exposures, thereby constantly changing the effective area of the telescope. Because of this, accurate absolute photometry and spectrophotometry are not feasible. Photometric calibration of imaging must be done using external data of the same field, though internal colour information can be obtained using filter cycles in the case of short exposures. Spectrophotometric standards are routinely taken and can be used for relative spectral (shape) calibration, but not absolute flux calibration.

2.3 Observing Blocks

All SALT observations are executed using Observing Blocks. These will be defined in detail in Phase 2, but it is necessary to be aware of the basic principles when planning observations for Phase 1.

Blocks are defined as the minimum schedule-able unit. A block must be allocated to a single priority and have a single Moon brightness, seeing range, and transparency specification.

For this semester, a block will consist of only:

a. one target
b. one acquisition
c. one or more science procedures or instrument configurations.

This sequence of observations plus overheads must fit within the target's maximum available track time and it will be at least 900 seconds long, inclusive of overheads (canonical overhead has been reduced from 900 to 600 seconds this semester). Additional observing time is accrued by multiple block visits. A block will be executed under the specified weather conditions or it will be repeated. A block will also be repeated if the data quality was compromised by technical difficulties with the telescope or instrument.

2.4 PIPT, the Web Manager and Simulator Tools

All investigators (PI and Co-Is) on a SALT proposal must have an account on the SALT server before the proposal can be submitted. This can be created by means of the Web Manager by pointing a browser to https://www.salt.ac.za/wm/Register/. After a successful registration, a confirmation email is sent, which includes instructions for validating the chosen email address. This validation is necessary before a proposal can be submitted with the investigator.

Once an account has been created, the Web Manager (https://www.salt.ac.za/wm/) can be used to view one's proposals and to update one's contact details. The home page of the Web Manager also provides links for downloading the latest version of the Principal Investigator Proposal Tool (PIPT).

All proposals are created and submitted with the PIPT, both for Phase 1 and 2. This is a stand-alone application requiring Java 1.6 or higher. While the Open JDK may work, using the Java environment provided by Oracle (http://www.oracle.com/technetwork/java/) is strongly recommended. The PIPT itself can be downloaded from https://www.salt.ac.za/wm/.

New proposals can be created with the `File > New Proposal` menu item. The PIPT will ask whether the new proposal shall be a science or commissioning one. ***It is absolutely crucial to choose the science option***, as otherwise the proposal won't be forwarded to the TAC and no time will be allocated to it.

As outlined in the next section, in addition to some general information, investigators, targets and instrument configurations have to be defined for a Phase 1 proposal. These may be added by right-clicking on a node in the navigation tree. Similarly, adding and removing content from a table can be accomplished by right-clicking on the table.

Warnings should be taken very seriously, as they often indicate a serious flaw in the proposal. In most cases, submission is only possible once the problem has been fixed. A warning is displayed by clicking on the little warning sign next to the problematic input.

Before a proposal is submitted, it should be validated with the menu item `Proposal > Validate`. If the validation fails, this usually means that some required input is missing.

After the first successful submission of a proposal, a confirmation email with the proposal code is sent to all investigators. This proposal code uniquely identifies the proposal, and it should be quoted in the subject line of any email query related to the proposal. The proposal code is also added to the proposal itself, so that resubmissions do not generate new proposals in the database. It is a good idea to double-check that the correct proposal code is shown in a submitted proposal. No confirmation emails are sent for resubmissions.

When logging in to the Web Manager, a list of the user's proposals is shown. Clicking on any of the proposals leads to a page with the proposal details, which may be used to check a submitted or resubmitted proposal. However, it may take a few minutes before the content is fully visible.

In addition to the the Web Manager, the PIPT and the Visibility Calculator, Simulator Tools are supplied for Salticam and RSS, which can be used to plan the required instrument setup and the necessary exposure time. They can be downloaded from http://www.salt.ac.za/observing/proposing-for-salt-observations/observation-planning-tools/, and as the other tools they require Java 1.6.

Both Simulators allow the user to define a target spectrum and an instrument configuration, and to calculate the signal-to-noise ratio expected for these. It should be noted that ***the Simulators do not take any overheads into account***.

The Simulators have been verified for the current telescope and instrument throughput. However, the ***PIs should be aware that the wavelength ranges predicted by the RSS Simulator currently may have inaccuracies up to +/- 3 nm***. A new model is being incorporated, and should be available by Phase-2 making more accurate predictions of CCD edges and gaps possible.

3. SALT Phase 1 Proposals

- **Deadline for submissions is 24 February 2012 at 16:00:00 UT corresponding to 18:00:00 SAST.**
- SALT Phase 1 proposals can only be submitted using the latest version of the PIPT.

Proposals may be submitted, edited, and re-submitted at any time before the deadline, as many times as needed, until a final flag is set within the PIPT or in the Web Manager (WM). After the deadline edits are no longer possible.

Any questions during the submission phase should be emailed to *salthelp@salt.ac.za*. Previous submissions will have been assigned a program code - in that case, that code should be provided in the subject line.

The PIPT is deployed in various file formats, and the start page of the WM contains a brief description of how to install and launch it. The main items that need to be entered in the PIPT are:

- investigator details
- required observation conditions
- target details (if known)
- instrument(s) and mode(s) required
- basic description of program and technical justification
- scientific justification & description (optional for some partners)

All but the last two bullet points are entered in the respective boxes in the PIPT form, while the last two items must be included in the form as a PDF. This PDF is limited to three pages in length. The PDF must be generated using one of the templates provided (in Word, OpenOffice, or LaTex format). These can be downloaded from the live Phase-1 instructions page at:
http://www.salt.ac.za/observing/proposing-for-salt-observations/phase-i-proposal-instructions/

Additionally, the latest versions of the RSS and SALTICAM simulator tools must be used to plan observations. These have been considerably updated since the first Period submissions, and can be accessed from the SALT website:
http://www.salt.ac.za/observing/proposing- for-salt-observations/observation-planning-tools/

As stated in the previous section, please note that ***the Simulators do not take any overheads into account***.

3.1 The Procedure After Proposal Submission

All Phase 1 proposals will first be directed to the SALT Astronomy Operations team for a technical feasibility assessment. Comments on technical feasible will be forwarded to the individual TACs of the SALT consortium by 2 March 2012. The TACs will then allocate time to successful proposals in various priority classes and Moon brightness. The minimum time allocation for a successful proposal will be 900s per priority per Moon brightness.

The full TAC review and time allocation process is expected to end by 30 March, 2012. This will be followed by a Phase 2 submission period, during which the detailed observing Blocks will have to be submitted by the PIs to SALT operations using the PIPT. The deadline for the Phase 2 submission phase is 27 April, 2012 with the new Semester observations commencing 1 May, 2012. Please note that, after the deadline, there is essentially no time for the liaison SALT Astronomers (LSA) to review the proposals before the start of the Semester, so ***PIs should submit the Phase 2 well in advance of the deadline, particularly if observations can start at the beginning of the semester (i.e. on 1 May).*** For example, if MOS masks need to be cut or targets are getting out of season, etc., then its important for the Phase 2 proposal to be submitted sometime before the 27 April deadline.

If there are co-investigators from *multiple partners* in a single proposal, it is up to the Co-I’s to divide the proposed time between the relevant partners, or request all of it from one partner. If a program applies for time from more than one partner, all the relevant TACs will receive the application and will allocate their time individually.

In cases where only a minority of the time requested for a multi-partner partner proposal is awarded by the relevant TACs, then the SALT Astronomy Operations Manager will engage with the relevant TAC Chairs to ensure that the allocation can really result in a meaningful program.

3.2 Phase 1 Preparation FAQ

Detailed instructions on how to prepare the Phase 1 material are included within the Word/Latex templates and in the PIPT manual. Some common questions and issues are addressed below; however, a more complete, live, and frequently updated ***online FAQ*** is available at:
http://www.salt.ac.za/observing/proposing-for-salt-observations/phase-i-frequently-asked-questions/

3.2.1 Definitions of dark/gray/bright time

The definitions of sky brightness have been changed since the 2011-2 call. Previously they were apportioned in approximately equal sky magnitude steps, resulting in two "Gray" classes (17% for Bright-Gray and 9% for Dark-Grey). It was subsequently decided that there is no need for this subdivision, and the actual definition and break-down of sky conditions will be as follows:

Dark (50% of time): Lunar phase angle > 135º (illuminated Lunar fraction of < 15% or Moon below horizon).
Gray (25% of time): Lunar phase angle 45º -- 135º (illuminated Lunar fraction = 15% -- 85%)
Bright (25 % of time): Lunar phase angle 0º -- 45º (illuminated Lunar fraction > 85%)

Ideally all partners should attempt to distribute their observing time allocations accordingly. The instrument simulators should also be used to ensure that too demanding sky conditions are not requested unnecessarily.

3.2.2 Definition of Seeing

The standard measure of atmospheric turbulence is the Fried parameter, r_0. The SAAO site uses an automated Differential Image Motion Monitor (DIMM) to measure this routinely and continuously. The blurring of an image at the focal plane of a large telescope, what we refer to as "seeing", is derived from r_0 using the standard model of atmospheric turbulence. It is a function of wavelength (λ) and airmass and the ***DIMM reports seeing using the convention of λ = 500 nm (essentially V-band) and airmass = 1.0. This is the value that is used to define observing conditions and make scheduling decisions.***

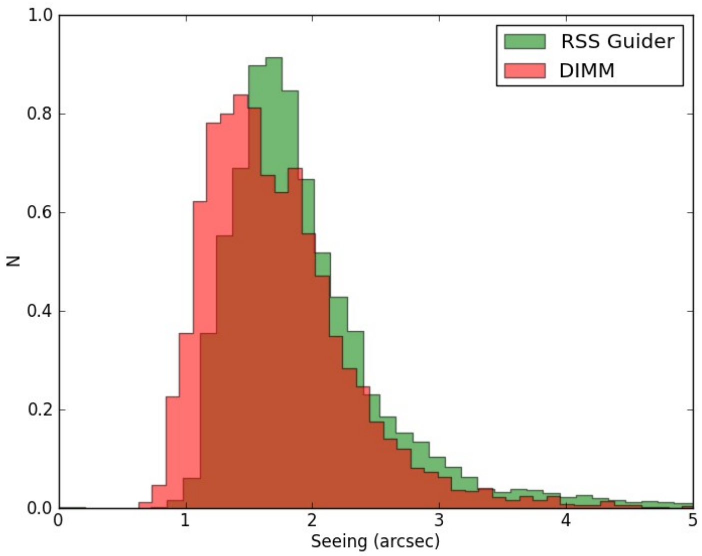

Figure 3: Seeing histograms from the SAAO DIMM and the RSS guider. The data are corrected to the middle of the visibility strip and taken from the same period of time, September through November 2011. This shows a factor of about 1.2 degradation between the intrinsic DIMM seeing and the IQ delivered to the SALT focal plane.

However, this zenithal seeing is not the same as the delivered image quality (IQ) at the SALT focal plane. The SALT visibility strip lies between 1.16 and 1.37 airmasses which leads to a factor of 1.1 to 1.2 degradation of seeing on average. There is also variable degradation in IQ due to SALT itself. Figure 3 shows histograms of seeing measured by the DIMM and the RSS guider corrected to the middle of the visibility strip. The median seeing reported by the DIMM is 1.5” versus 1.8” for the RSS guider. ***Proposers should be aware that 1” seeing equates on average to an IQ of 1.3-1.4” and that 1” seeing does not happen nearly as often as earlier site studies had found.***

The following table indicates the expected ***best*** image quality performance of SALT (in terms of the FWHM and enclosed energy diameters (50% and 80%) of the PSF for different DIMM seeing values (all V-band). The PSF is basically described by a modified Moffat function.

DIMM zenith seeing	***Seeing at average telescope airmass***	***FWHM***	***EE50***	***EE80***
1.0”	1.2”	1.4”	1.6”	2.6”
1.5”	1.7”	1.8”	2.0”	3.3”
2.0”	2.3”	2.4”	2.7”	4.2”

These values are for a perfectly aligned primary mirror, which is currently not always the situation in the absence of closed-loop active control (e.g. because of the current lack of edge sensors) and remaining second order IQ issues associated with the primary mirror alignment. For these reasons, PIs should be aware that the above numbers cannot be guaranteed.

3.2.3 Concept of "Optional Targets"

There are two types of SALT targets:

1. **Mandatory Targets:** These are all of the targets which the PI is expecting to observe if allocated the requested time.
2. **Optional Targets:** These are a list of M optional targets from which the PI is requesting that any subset consisting of N targets can be observed. This target list is thus a super-set from which actual observations can be chosen, such that the total observing time of the eventual chosen targets equates to the total requested time of the proposal. The superset of targets (M) should be less than 5 × N, the number of targets actually likely to be observed given the requested time. The actual target choice will be dependent on the queue and chosen by the duty SA or scheduling algorithm.

4. Telescope Performance and Observing Constraints

The previous section explained the basic concepts to understand when planning SALT observations, especially regarding the track times, the visibility of objects and the effect of the moving pupil for absolute (spectro)photometry. More detailed information on telescope performance and constraints on observations can be found at:
http://www.salt.ac.za/telescope/performance-characteristics/
http://www.salt.ac.za/proposing/observing-constraints/

Issues specifically affecting current Phase 1 proposal planning include:

4.1 Image Quality

The severe IQ issues that affected early SALT observations are now fixed. However, there is still about a factor of 1.2 degradation in IQ compared to intrinsic DIMM seeing as shown in Figure 3. The limiting factor in SALT's IQ is largely the quality of the primary mirror alignment. We do not have active control of the mirror segments so alignment is only done periodically. They are done routinely during evening twilight and then during the night as needed. Observations must be interrupted to perform an alignment.

4.2 Vignetting

There is strong vignetting of the field-of-view, as shown in Fig. 4. Objects observed more than 2 arcmin from the centre of the field receive up to 10%

less light, and this needs to be taken into account when planning to make use of targets over the full field of view. These numbers are greater than the specification and are currently under investigation.

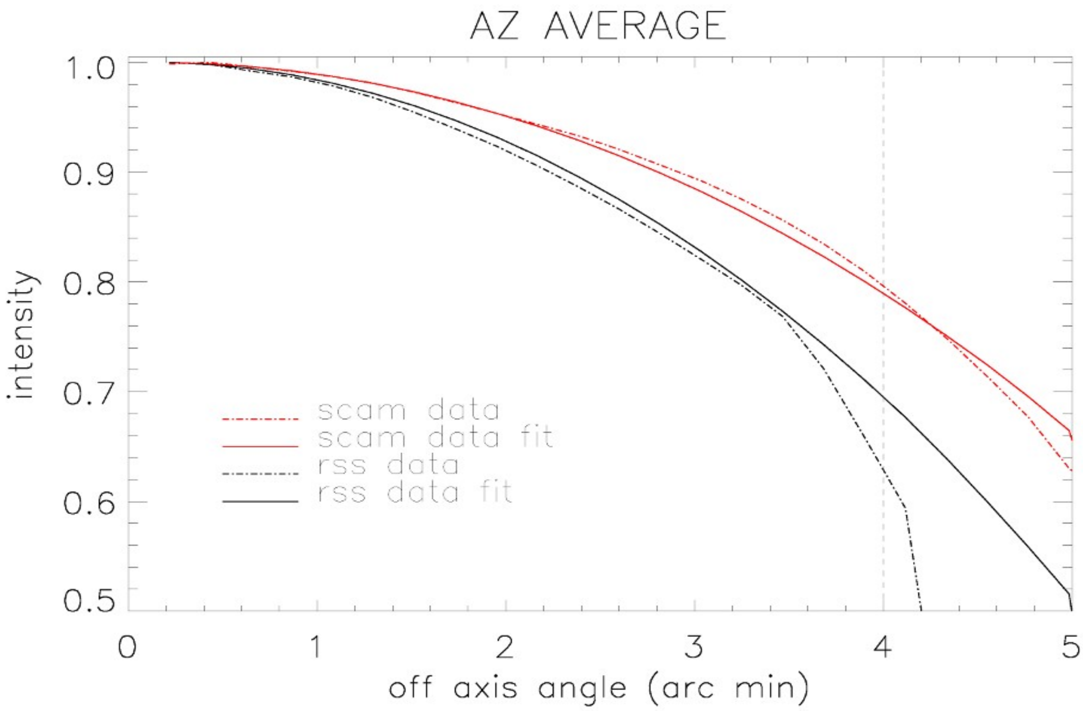

Figure 4. Vignetting of the FOV with RSS and SALTICAM.

4.3 Throughput

The primary is regularly (every week or two) cleaned with high-pressure CO_2, and individual segments are taken out for washing and re-coating in a cycle of nominally about 12 months, although many mirror segments currently have older coatings. There is also still some unavoidable dust accumulation onto the SALT primary. The dust, along with segments not recently re-coated, reduce the throughput of the telescope. This is monitored regularly, and the most recent values indicate a significant throughput shortfall in the blue wavelengths, while the throughput is better in the red. The latest values are included in the latest instrument Simulators.

Figure 5. shows the current situation. The left panel plots, as the black curve, the nominal throughput of the telescope when using SALTICAM (since there are no significant optics in this instrument so the values can be thought of as an approximation of the Telescope throughput). The nominal curve can be compared against measurements derived from standard star observations and corrected for the estimated total efficiency of the instrument (filters, CCD, and foreoptics) and the atmosphere. Since these measurements show lower values the throughput values in the Simulator have been decreased: the blue curve shows the SALTICAM throughput as included in the SALTICAM

Simulator tool during the 2011-3 proposal round, while the red curve shows what is included in the Simulator at the time of writing for proposal round 2012-1. The middle panel is the equivalent plot for RSS including the telescope throughput - one can see that in 2011 the RSS Simulator had an *ad hoc* flat factor of 3 to account for light lost, while with more recent data we have shown that the situation is better/worse in red/blue, respectively. Finally, the right panel summarises the *approximate* “fudge factors” included in the Simulators currently, which make the Simulator electron count predictions to match real data as taken at the end of 2011: the purple curve is the “Telescope shortfall” compared to a nominal case affecting all instruments, and the magenta curve is the “RSS shortfall” affecting that instrument in addition. (Note that purple curve in the right-hand panel is an approximation to the ratio of the red to the black curve in the left-hand panel, and the magenta curve in the right-hand panel is an approximation to the ratio of the red to the black curve in the middle panel, divided again by the purple curve.)

Telescope throughput values are likely to improve during 2012 with continued cleaning. We remind the users that ***the current throughput values are incorporated into the latest instrument Simulators*** and will be updated regularly. Finally, note that while the atmosphere is corrected out from Fig. 5, its effect is included in Simulator tools and can be adjusted therein.

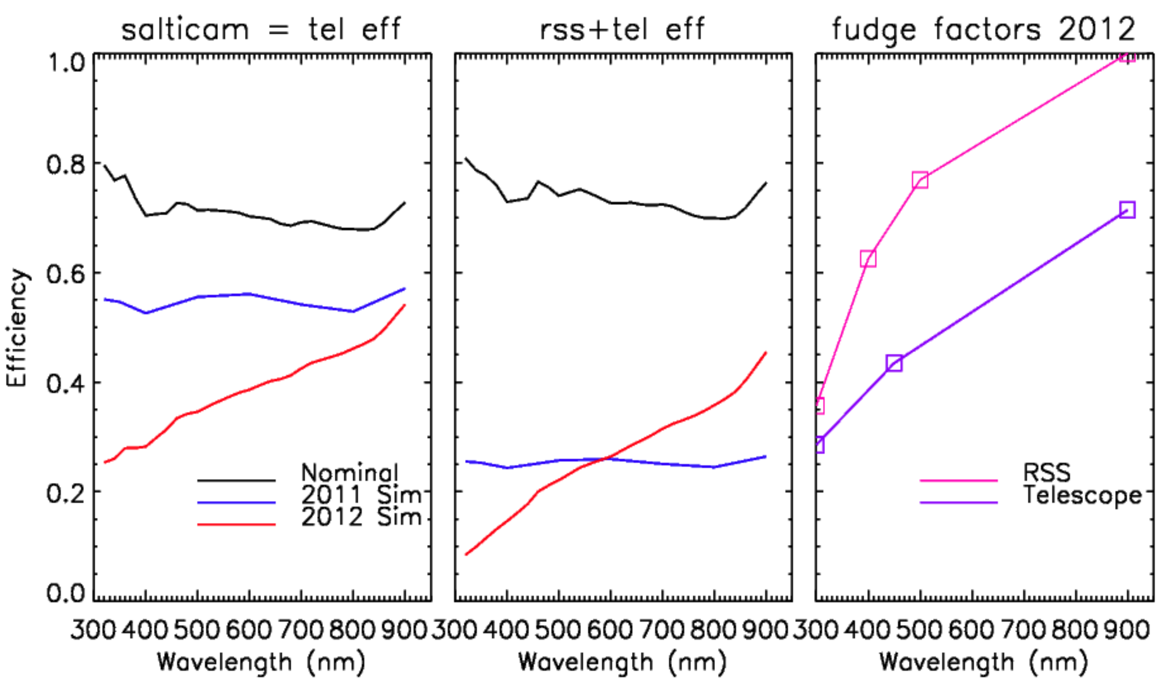

Figure 5. Telescope and instrument efficiencies shown for a nominal case, what was used in the Simulators in the first proposal round in 2011, and the currently used values. The right panel shows the approximate shortfall of efficiency for the telescope and RSS. See text for details.

4.4 Collecting Area

The nominal collecting area of the primary mirror with a central track is ~55 m^2, decreasing to ~40 m^2 for extreme off axis tracker position. This means that SALT is equivalent to between a ~7 to 8 m diameter conventional telescope.

The current default collecting area in the instrument Simulators is set to 46 m^2 (or approximately 53 fully illuminated segments) – this corresponds to experimentally derived averages of visible pupil area with tracker obscuration over a full track, and also makes allowance for the fact that the throughput calculations referred to above are normally done for a dozen or so best-quality segments. The collecting area is an adjustable parameter in the Simulators, but it should only be changed with caution.

5. SALT Calibrations

All of the latest news about the SALT calibration plan could be found at:
http://www.salt.ac.za/observing/proposing-for-salt-observations/salt-calibration-plan/

5.1 Definitions for the SALT Calibration Plan

SALT calibration data are divided into four categories:

- Default calibration (DC):
  - will be produced for every observable night
  - will be produced without PI request
  - PI will not be charged
  - will be done during day or morning time, possibly twilight and nighttime
- Library calibration (LC):
  - will be produced at some regular interval, not every observable night
  - will be produced without PI request
  - PI will not be charged
  - will be done during day-time, possibly twilight and nighttime
- User-requested charged calibrations (UCC):
  - will be produced by PI request
  - will be done during nighttime
  - PI will be charged
- User-requested non-charged calibrations (UNC):
  - will be produced by PI request
  - will be done during daytime and/or twilight
  - PI will not be charged

Please see section 6.7 for the current semester SALTICAM calibration plan and section 7.8.2 for the corresponding RSS calibrations.

6. SALTICAM Characteristics and Performance

SALTICAM is a UV-Visible (320 - 900nm) imaging and acquisition camera, capable of high time resolution imaging (at ~10 Hz). It consists of two E2V 44-82 CCDs (2048 x 4102 x 15 micron pixels), which are physically separated by a 1.5 mm gap and are read out by four amplifiers. SALTICAM is at prime focus; however, it is fed by a fold mirror and has a reduced focal ratio of f/2. The result is a nearly 10-arcmin diameter field of view, with the central 8-arcmin diameter portion being used for science and the outer annulus for guide stars. The plate scale is 0.14 arcsec/pixel.

There are four possible combinations for readout speed and gain settings, returning gain values between 1.0 and 4.5 electrons/ADU with readout noise of either 3.3 or 5 electrons per pixel (Table 1; Table 2). The dark current is typically less than 1 electron per pixel per hour. Full well depth is on the order of 170k electrons. Pixel prebinning from 1x1 to 9x9 (independent in each direction) and up to ten subframe windows can be selected. The readout times for full frame, 2x2 binning are given in Table 2. A wide range of filters are available, spanning the wavelength range 320-950 nm (Section 6.4; Table 5).

Readout Setting	Gain Setting	Actual e/ADU
Fast	Faint	1.55
Fast	Bright	4.5
Slow	Faint	1.0
Slow	Bright	2.5

Table 1: Gains for the four different readout modes selectable on SALTICAM

Detector Mode	Pre-bin	RO mode	RO Noise (e-/pix)	Total Readout Time (sec)*
Full Frame	2x2	Slow	3.3	21
Full Frame	2x2	Fast	5.0	14

Table 2: Readout (RO) times of SALTICAM for the 2x2 binning. Refer to the SALTICAM web-pages and PIPT for times of other binnings. *Inclusive of CCD readout, disk writes, and software overheads.

Standard modes of operation are normal imaging (full-frame readout), frame transfer (half-frame readout), and slot mode (144-row readout). Specific characteristics for these modes, as well as the specialised modes of non-sidereal tracking and drift scanning, are discussed below. Note that absolute photometry is not possible with SALTICAM alone because of the moving pupil.

More details on this instrument can be found at:
http://www.salt.ac.za/telescope/instrumentation/salticam/
and the links therein. A simulator that uses target characteristics and a detector configuration to return count rates, signal-to-noise ratios, pixel saturation, and readout times can be downloaded from:
http://www.salt.ac.za/observing/proposing-for-salt-observations/observation-planning-tools/

6.1 Current Status

As of this writing, SALTICAM is functioning in the standard modes. One of its four amplifiers, amplifier 4, has been flaky, now mostly being completely dead, but this is expected to be fixed before the next semester. Though guiding with SALTICAM is possible, it has several features making it not useful for many applications (see Section 6.6). Overall, we suggest limiting SALTICAM exposure times to approximately 120 seconds with open-loop tracking.

6.2 Available Instrument Modes

6.2.1 Normal Imaging

Normal imaging is the basic, full-frame SALTICAM mode, which also serves as the acquisition mode for spectroscopic observations. The sub-framing, preamplifier binning, gain, and filter options listed above are available.

6.2.2 Frame Transfer

The frame transfer mode ensures moderate time resolution (a few sec) and no dead time. It only works with the FAST readout speed. In frame transfer mode, a mask covers the lower half the detector (both chips). At the end of each exposure, the image in the top half of the chip is rapidly (0.2 sec) shifted to the lower half where it is read out while the next image in the top half accumulates during the next exposure, thereby ensuring no dead time.

A list of the minimum exposure times for frame transfer mode in each binning is provided in the third column of Table 3.

6.2.3 Slot Mode

Slot mode ensures high time resolution (to 0.05 sec) with no dead time. Just like with frame transfer, it only works with the FAST readout speed. In this mode, a mask is advanced over the entire detector except for a horizontal slot of 20 arcsec height just above the frame-transfer boundary. At the end of each exposure, 144 rows are moved down and this allows exposure times as short as 0.05 sec.

The minimum exposure time for slot mode in each binning setting is provided in the second column of Table 3. More information on slot mode is available from the SALTICAM web pages at http://www.salt.ac.za/instrumentation/salticam/slot-mode.

Pre-binning	Slot Mode (sec)	Frame Transfer (sec)
1x1	0.70	15.90
2x2	0.30	4.70
3x3	0.20	2.80
4x4	0.15	2.00
5x5	N/A	1.70
6x6	0.08	1.40
7x7	N/A	1.30
8x8	0.07	1.10
9x9	0.05	1.10

Table 3: Minimum exposure times per binning for SALTICAM Slot Mode and Frame Transfer.

6.2.4 Non-Sidereal Imaging

For imaging objects in the solar system, non-sidereal telescope tracking might be preferred. Initial tests of the implementation and accuracy of this mode at slow (a few arcsec per hour) and fast (hundreds of arcsec per hour) rates have been performed. However, at the time of this call for proposals, non-sidereal tracking is not yet fully commissioned, so any proposals would be shared risk.

6.2.5 Drift-Scan

Drift scanning is an imaging mode where the telescope is parked at a stationary position and the CCD readout is clocked at the sidereal rate. This can be used to produce long imaging “strips” on the sky, e.g. for surveys. While some preliminary SALTICAM drift scanning tests have been successfully completed, there are still some issues to iron out before this mode is offered to the community. Therefore, it will not be available for this proposal period.

6.3 Sensitivity

All SALTICAM sensitivity calculations for planning observations should be done with the newest version of the SALTICAM Simulator. For quick reference, some count rates for SALTICAM are given below in Table 4. These numbers are based on recent throughput tests with a burst mirror, as well as Sloan comparison fields, and have been extrapolated for a typical pupil during a track.

The count rates and signal-to-noise ratio numbers can be extrapolated to other exposure times and fainter/brighter targets. We have directly verified count rates up to about 5 minute exposures and these behave as expected. Longer integrations are not practical due to the difficulties with auto-guiding (see Section 6.6) and SALT’s current open-loop tracking performance. Thus, the deepest SALTICAM exposures should ideally be constructed from dithered and co-added ~2 minute exposures. Whether the ideally scaled signal-to-noise ratio is reached depends on e.g. the quality of flat-fields (see Section 6.7.2) and the stability of the PSF of sources over tens of minutes (c.f. the current lack of active segment alignment). Therefore, we urge the PIs to be conservative in estimates of deep SALTICAM imaging until proper characterisation has been obtained.

Filter	FWHM (nm)	star counts (e^-/sec)	sky counts (e^-/sec/arcsec^2)	Total Noise	S/N
U	70	125	14	15	8
B	100	870	98	40	22
V	90	1150	290	57	20
R	150	1100	555	71	16
I	150	850	920	86	10

Table 4: Count rates in electrons for a U=B=V=R=I=20 mag star with SALTICAM. Sky counts are shown for a dark sky. Noise of the combined object+sky is calculated for a 3” diameter area.

6.4 Filters

SALTICAM has an eight-position filter magazine. Available filters are listed in Table 5. Filter transmission data are provided for a collimated beam at the links under ”Filters” at http://www.salt.ac.za/telescope/instrumentation/salticam/specifications/.

The SALTICAM CCDs were optimised for visible and near UV imaging, thus no effort was made to minimise fringing at near IR wavelengths. We have not yet quantified the amplitude of fringing in all filters. We have observed fringes with an amplitude of ~10% peak-to-trough for red, narrow-band filters such as z’. Fringing is not an issue for broadband filters or those at the shorter end of the wavelength range.

Type	Name
Johnson-Cousins	*U, B, V, R, I*
Sloan	*u’, g’, r’, i’, z’*
Strömgren	*u, b, v, y, H-β wide, H-β narrow, SRE1, SRE2, SRE3, SRE4, Clear*
Other	*H-α* (zero redshift) 380-nm (FWHM 40Å) neutral density

Table 5: SALTICAM filters

6.5 Dithering

As stated above, due to the flat-fielding difficulties as a result of the moving pupil, it appears that best photometric results over the field of view will be obtained with dithered observations.

The most productive dithering schemes will depend on the science goal and size of science targets. At the moment SALT does not provide automatic dithering which makes such observations manual and time consuming. However, we will endeavour to make pre-defined dither patterns with adjustable parameters available for the Phase 2 of this period and available on the instrument by the beginning of the period. Dithering will affect overheads, since every offset will take approximately 30 seconds without guidance to fully complete and ~2 minutes if guidance is involved.

6.6 Auto-guiding

While SALTICAM is equipped with an auto-guider, it has several serious design limitations that greatly degrade its overall usefulness:

- The guide probes are large and vignette a significant portion of the SALTICAM field-of-view. Even selecting a star at the edge of the field will result in significant vignetting over at least 20% of the image. This vignetting would be different for each image in a dither pattern which would make flat-fielding even more difficult.
- The guide probes sit behind the SALTICAM shutter. Therefore guiding does not occur when the shutter is closed, such as when SALTICAM is reading out.
- The guide probes sit behind the SALTICAM filters. Therefore the auto-guider is least effective for the narrow-band filters where it is most needed.

Because of these shortcomings we do not advocate the use of the SALTICAM auto-guider during normal imaging. SALTICAM has low read-noise so the sky limit is reached quickly in most broadband filters. It's reached in under a minute for even *U*, *u'*, and H-α. Our current open-loop tracking performance allows unguided exposures of up to 2 minutes which is sufficient for all but the bluest Strömgren filters. On-going work to improve our open-loop tracking will hopefully extend this further.

We do support using the auto-guider during slot and frame-transfer mode observations, however it is not commonly used due to the extra overhead involved in configuring it for a field.

6.7 SALTICAM Calibrations

Please refer to section 5 for a general description of SALT calibrations.

6.7.1 Features of SALTICAM Calibrations

Our current SALTICAM calibrations plan (section 6.7.2) is based on the specifications of the SALT telescope and our current experience. We would like to highlight the following:

1. SALT is a telescope with a variable pupil, so that the illuminating beam changes continuously during the observations. This makes absolute flux/magnitude calibration impossible even using photometric standards. ***Therefore, the only way to get absolute photometry with SALT observations is to observe a field in which the PI has secondary photometric standards.***
2. Due to the illuminating beam changing continuously during observations, the illumination pattern also changes. For this reason, ***neither calibration screen flats nor twilight flats can help correct the illumination pattern with an accuracy better than 10–20% depending on the specific setup.***
3. Flat-fields with the calibration screen can to be used to build a pixel-to-pixel correction map, except for the red filters (starting from *z'*), where fringing is important.
4. The only way to correct the observed data for the illumination pattern is to use the data itself. For this reason, dithering patterns (described in Section 6.5) must be used. A method to build night-time flat-fields using your own data is described in the SALT Ast Ops report: http://www.salt.ac.za/science-support/salt-data-reduction/data-reduction-recipes/salticam-flat-fielding-recipe/
5. The method described in the document above works well only for compact targets. ***For extended targets (size of larger than ~1–2 arcmin) there is no known way to flat-field the data to an accuracy better than 10–20%***.
6. We cannot, as yet, reach a photometric accuracy of 0.01 mag even for stellar objects. A level of accuracy of 0.05 mag is possible and 0.1 mag can certainly be reached for observations using a dithering pattern, assuming corrections for both the illumination pattern and pixel-to-pixel variations are made during the data reduction.
7. All our tests have shown that biases cannot be used for SALTICAM data reduction. Data can be corrected using the overscan level and, in fact, the standard pipeline does so.

6.7.2 Current SALTICAM Calibrations Plan

For all the reasons stated above, the current SALTICAM calibrations plan for this semester is:

- No **DC** calibrations will be taken
- No **LC** calibrations will be taken
- User-requested night-time calibrations (**UCC**) will be taken **but we cannot guarantee that these calibration data will be useful.**
- By PI request, the following day-time (**UNC)** calibrations can be done:
    - 5 screen flats per detector and camera setup
    - 11 biases per detector setup

  Please note that a larger number of calibrations will need to be justified.

7. RSS Characteristics and Performance

The Robert Stobie Spectrograph (RSS) is the main work-horse instrument on SALT and is a complex multi-mode instrument. This means it has a wide range of capabilities -- excellent for astronomers, but a nightmare for the engineers who build it, are commissioning it, and maintain it!

RSS resides at prime focus, where it takes advantage of direct access to the focal plane, and was designed to have a range of capabilities and observing modes, each one remotely and rapidly reconfigurable. In keeping with the overall philosophy of exploiting those areas where SALT has a competitive edge, the instrument has several unique, or rare, capabilities. These capabilities include the following:

- Sensitivity from 320 to 900 nm, i.e. down to the UV atmospheric cut-off.
- A fully articulating camera/detector used with Volume Phase Holographic transmission gratings (VPHGs) allowing for a wide choice of wavelength coverage and spectral resolutions. Low to medium resolution spectroscopy (up to R ~ 5000 with 1 arcsec slits; R ~ 9000 with 0.6 arcsec slits).
- Multi-object spectroscopy (MOS) using laser-cut carbon composite focal plane slit masks, of up to ~50 objects at a time. This mode has still to be successfully commissioned at the time of writing this document. A “nod and shuffle” mode will also eventually be employed for accurate background subtraction, but is not yet available.
- All-Stokes mode spectropolarimetry and imaging polarimetry using either one or both 1/2- and 1/4-waveplate retarders and a large Wollaston beam-splitter mosaic, giving two completely off-set O- and E-images on the detector (temporarily unavailable).
- Fabry-Perot imaging spectroscopy and tunable filter imaging in the range 430−860 nm using three etalons providing three resolution regimes of R = 320−770, 1250−1650, and 9000 (the highest resolution mode is still to be commissioned).

- The use of fast frame-transfer CCDs allowing for high-speed observations (up to 0.05 s exposures) in all observing modes.

7.1 Current Status

Currently RSS is routinely being used for the following modes:

- Long-slit spectroscopy
- Narrow-band imaging
- Low resolution (LR) Fabry-Perot imaging spectroscopy and tunable filter (TF) narrow-band imaging
- Single-etalon medium resolution (MR) Fabry-Perot imaging spectroscopy for emission line studies.
- High time-resolution spectroscopy

Commissioning is continuing on MOS, polarimetry (currently stalled), and dual-etalon Fabry-Perot modes. For current *sensitivity and throughput issues* refer to Sections 4.3 and 7.5, and Figure 5.

7.2 Gratings

RSS has a complement of six transmission gratings: one standard surface-relief grating and five volume phase holographic (VPH) — see Table 6. VPH gratings have the characteristic that their efficiency varies with input angle (see Fig. 6), and thus a single grating can cover a large wavelength range with good efficiency by changing the relative angle between the collimated beam and the grating normal. This is accomplished using a rotating stage. The RSS camera is then articulated to twice the grating angle since the VPH efficiency curve for a given grating angle typically is at a maximum at the Littrow wavelength. The angle of the grating also affects spectral resolution. The higher the value of the grating tilt, the higher the spectral resolving power for a given slit width. The RSS Simulator tool found at:
http://www.salt.ac.za/observing/proposing-for-salt-observations/observation-planning-tools/
should be used to determine the optimal grating angle and slit-width for an observation. Note also that a feature of VPH gratings is that the resolution and wavelength range of an object depends on the distance of the target from the optical axis. While this is not an issue for long-slit spectroscopy, it will affect multi-object spectroscopy (see Section 7.4.4 for more details).

Grating Name	Wavelength Coverage (nm)	Usable Angles (deg)	Bandpass per tilt (nm)	Resolving Power (1.25" slit)
PG0300	370-900		390/440	250--600
PG0900	320-900	12-20	~300	600-2000
PG1300	390-900	19-32	~200	1000-3200
PG1800	450-900	28.5-50	150-100	2000-5500
PG2300	380-700	30.5-50	100-80	2200-5500
PG3000	320-540	32-50	80-60	2200-5500

Table 6: RSS grating complement

All gratings are used in first order only. Second-order contamination is removed through the use of order-blocking filters.

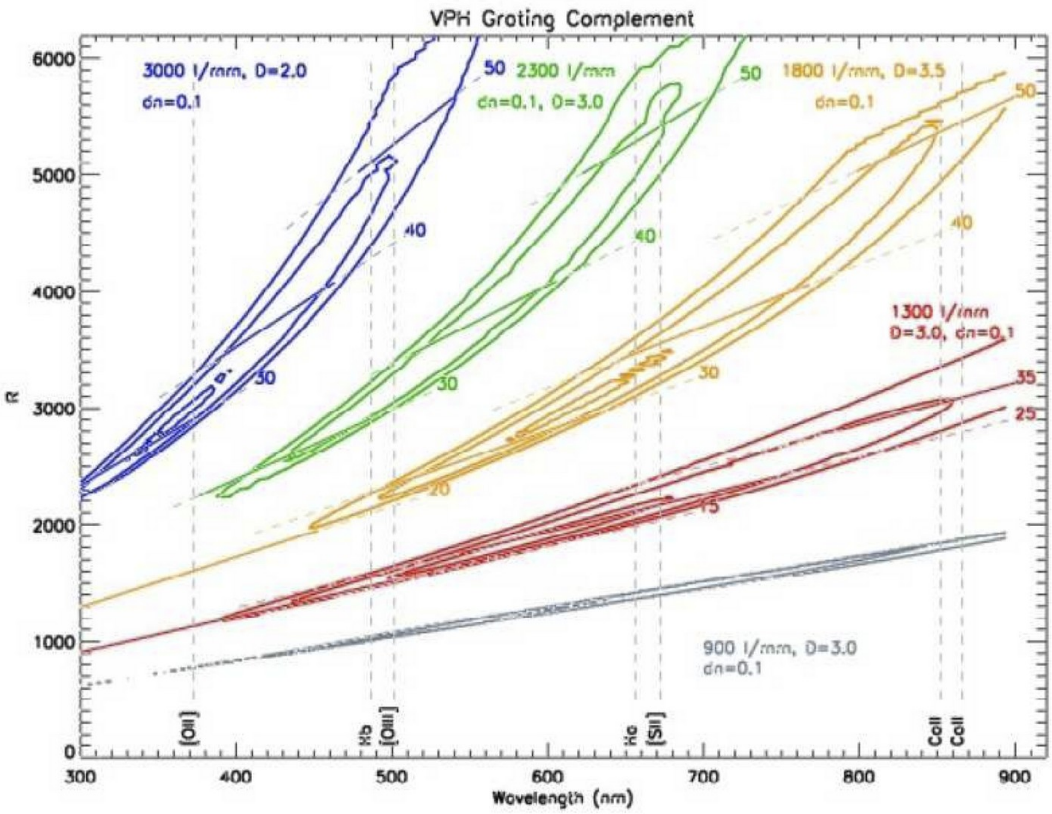

Figure 6: VPH grating efficiency as calculated using Rigorous Coupled Wave (RCW) analysis in resolving power versus wavelength for a 1.5" slit. The contours correspond to 90%, 70%, and 50%. Wavelength coverage for a few angles is shown for each grating.

7.3 Filters

Five order-blocking filters are available for RSS spectroscopy: one clear, three UV blocking, and one blue blocking. These filters are listed in Table 7. There are also 40 interference filters to be used with Fabry-Perot observations as well as narrow-band imaging (Table 8). All filter transmission curves are available online at: http://www.salt.ac.za/technical-info/instruments/rss/rss-fabry-perot/fabry-perot-filter-transmission-curves/

Type	Name
Clear	PC00000
UV	PC03200, PC03400, PC03850
Blue	PC04600

Table 7: RSS order blocking filters

7.4 Available Instrument Modes

7.4.1 Narrow-band Imaging

The RSS optical design is not optimized for broad-band imaging. Narrow-band imaging may be performed with any of the 40 Fabry-Perot interference filters listed in Table 8.

We expect that SALTICAM will be the primary instrument for SALT imaging programs. The primary use for RSS imaging will be for commissioning level astrometric and distortion characterisations. Additionally, RSS may be used for some context imaging of fields that will be used for multi-slit observations.

There is considerable fringing in the red narrow-band filters when they are illuminated at discrete wavelengths. Fringing has only been measured in the few filters mounted to date that are long-ward of 750 nm. In all filters tested, fringing is negligible for broadband illumination (sky and QTH lamps) with peak-to-trough variations of 2%. With arc lamp illumination (Ne or ThAr), the PI07500 filter shows no fringing while the PI08350, PI08535, and PI08730 filters have obvious fringing at levels of 10-20% peak-to-trough.

7.4.2 Fabry-Perot

The SALT RSS Fabry-Perot system provides spectroscopic imaging over the whole RSS science field of view (8 arcmin diameter) in the wavelength range 430-860 nm with spectral resolutions ranging from 300-10000 depending on the mode used and wavelength observed.

The system consists of three etalons with gap spacings of ~0.6 nm, ~2.8 nm, and ~13.6 nm. The etalons are referred to as the low resolution (LR), medium resolution (MR), and high resolution (HR) etalons, respectively. The LR etalon can be used in its normal LR mode or configured as an even lower resolution tunable filter (TF). The MR and HR etalons are normally used in conjunction with the LR etalon in LR mode

However, during commissioning of the dual-etalon modes, a serious reflection problem between the two inserted etalons was discovered. Multiple reflections between the etalons introduces a series of ghost images and significantly degrades throughput. Rectification of this problem is underway, but may take several months to complete. In the interim, the original MR and HR modes are NOT available, however, single-etalon MR mode is available. Table 8 shows the filters that are available for use with Fabry-Perot.

Table 8: RSS Narrow-band (Fabry-Perot) Filters

Name	Centre (Å)	FWHM (Å)
pi04340	4349.4	79.1
pi04400	4412.3	92.4
pi04465	4478.1	84.9
pi04530	4530	90
pi04600	4600	95
pi04670	4670	100
pi04740	4760.2	111.1
pi04820	4820	105
pi04895	4912.5	105
pi04975	4990.6	107.5
pi05060	5071.5	110.5
pi05145	5152.1	109.2
pi05235	5237	119.1
pi05325	5325	125
pi05420	5420	130
pi05520	5520	135
pi05620	5631.5	137
pi05725	5731.1	133.6
pi05830	5833.6	142.8
pi05945	5946.5	164.1
pi06055	6062.2	148.6
pi06170	6178.8	169
pi06290	6300.2	158.3
pi06410	6418.4	161.5
pi06530	6535.5	156
pi06645	6647.4	148.8
pi06765	6765	167.5
pi06885	6894.3	181.8
pi07005	7020.8	162.1
pi07130	7131.3	140.4
pi07260	7252.7	184.1
pi07390	7400	218
pi07535	7555.6	200.8
pi07685	7691.9	168.9
pi07840	7831.6	207.6
pi08005	7999	249.2
pi08175	8175.1	225.2
pi08350	8350	245
pi08535	8535	260
pi08730	8730	275

As of January 2012 TF, LR, and single-etalon MR modes are all calibrated for use in the H-α region (650-690 nm). LR and MR are both calibrated in the H-β/[O III] region (480-510 nm) and MR is calibrated in the 820-870 nm region. We are also accepting proposals for wavelength regions that are not currently calibrated. Wavelength calibration is an ongoing process, however, and PIs should be aware that uncalibrated wavelength regions observations will only be conducted as time and resources allow.

Flexure within RSS significantly impacts Fabry-Perot calibration so Fabry-Perot observations must be carried out as close as possible to the parallactic angle. Specific positions angles **cannot** be requested for Fabry-Perot observations. Because the position angle of the parallactic angle can vary significantly along a track or between east and west tracks it is very difficult to predict the location of the CCD gaps *a priori*. To maintain maximum flexibility in scheduling we recommend that multiple dithered scans be obtained in cases where the object(s) of interest do not fall completely on the middle CCD.

All available modes need further work on flat-fielding, throughput determination, and stability characterisation in order to be considered fully commissioned and ready for routine science observations. Therefore, all Fabry-Perot observations are considered shared-risk in this call.

Notwithstanding the previous comments, the LR and single-etalon MR modes have been used successfully for several science programs. The TF mode has not yet been used for science observations, but is considered ready for use since it shares the same hardware as LR mode. Emission line programs such as H-α mapping are generally fine to pursue with the single-etalon MR mode. Absorption line studies may be more problematic. Observers should use the tables of etalon free spectral range given in the etalon technical reports and the blocking filter curves to estimate the effects on their particular program. Because of the small free spectral range of the HR etalon, single-etalon mode HR is regrettably not usable.

Further details and links to useful documentation can be found at the SALT Fabry-Perot web page: http://www.salt.ac.za/technical-info/instruments/rss/rss-fabry-perot/

Tables containing the FWHM of the spectral resolution, the resolution and free spectral range of each etalon as a function of wavelength are included in each report. This information is helpful for proposal planning. A detailed description of the system is given in the paper by Naseem Rangwala, Ted Williams and their collaborators available at: http://iopscience.iop.org/1538-3881/135/5/1825

Additionally, Ted Williams has produced an Introduction to Fabry-Perot on SALT: http://www.salt.ac.za/fileadmin/files/Technical Info/Instruments/RSS/AnIntroductiontoFabry.pdf

7.4.3 Long-slit Spectroscopy

Long-slit spectroscopy is the most commonly-used mode for RSS. The choice of slit widths is driven by considerations of resolution and throughput. A variety of slits is available to cover the range of atmospheric seeing conditions expected at the site. The RSS slitmask magazine has room for ten, tilted longslits. These allow for the SALT Imaging Camera (SALTICAM) to be used as a slit-viewing camera. Currently available slits are specified in Table 9.

#	Slit	Size
1	0.6	0.60”x8’
2	1.0	1.00”x8’
3	1.25	1.25”x8’
4	1.5	1.50”x8’
5	2.0	2.00”x8’
6	4.0	4.00”x8’

Table 9: Available long-slits for RSS

All available gratings are described in Section 7.2. All available order-blocking filters are described in Section 7.3.

7.4.4 Multi-object Spectroscopy

RSS has multi-object spectroscopy (MOS) capability. Slits are laser-cut on carbon-fibre masks in Cape Town. The instrument can hold 30 MOS masks in a magazine at any given time, and the rest of the fabricated masks also reside at the telescope.

The masks are manufactured following user specifications through a java-based RSS Slit-Mask Tool (RSMT). This tool is downloadable from the SALT proposal tools webpages, and is fully functional. There will, nevertheless, be an updated version of the RSMT in the coming months with improved functionality to optimise mask designs from large source lists.

No SALT pre-imaging is required for the mask preparation provided FITS files of the field containing astrometric solutions accurate enough for the PIs science goal are available. Pre-imaging can naturally be obtained with SALTICAM as well; however, these require their own Blocks which have to be observed well in advance of the MOS observations. Pre-existing astrometric files are strongly preferred. Another important aspect to remember in the Phase 2 for MOS observations is the restricted Declination-dependent availability of field orientation; a document describing this can be found here:
http://www.salt.ac.za/fileadmin/files/observing/documents/SALT_PA_Visibility.pdf

One specific characteristic of VPH gratings used on RSS to keep in mind is that the wavelength dependence of the efficiency, as well as the simultaneous wavelength coverage for a given grating setup depends on the input angle to the grating. In MOS, the light entering through off-axis (in the dispersion direction) slits will hit the grating at different angles. Thus, the efficiency for the off-axis objects will be different than for the on-axis objects. This will in general not be symmetric either. Figure 7. illustrates this, and MOS users should consult the VPH grating simulator at http://www.sal.wisc.edu/PFIS/docs/rss-vis/ebb/pfis/observer/specsim.html for details.

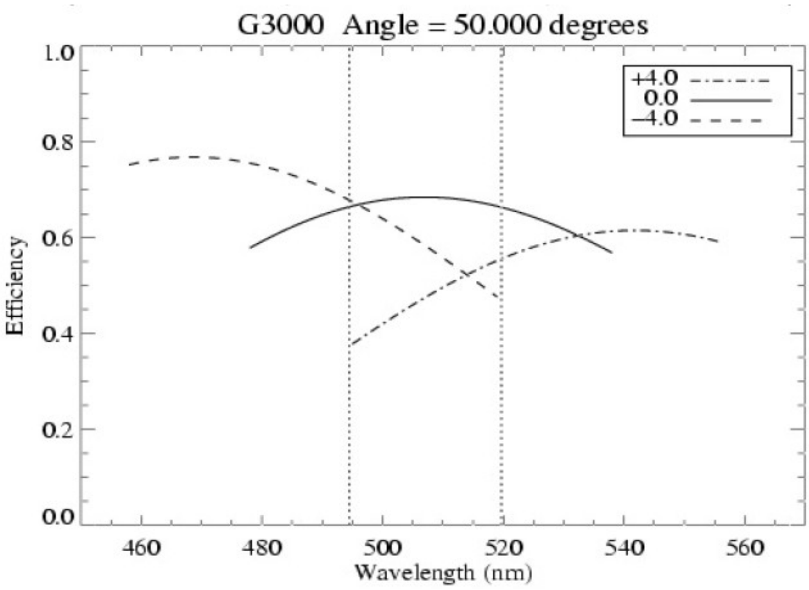

Figure 7. Example of the effect of blaze-angle on wavelength range and efficiency in MOS mode. Shown are the extreme cases of having an object at the edges of the RSS field-of-view, ±4' off-axis.

MOS commissioning is still ongoing, the process having encountered several technical difficulties. There are two remaining issues currently preventing science MOS observations:

1. It was discovered that the original design mounting the masks to their holders was too temperature sensitive. A redesign has been made, is being implemented, and will be ready for the coming Period.
2. The inherent accuracy and stability of alignment is a more serious problem. At the time of writing, there is an approximately 0.4" RMS uncertainty in the fine alignment of the mask, which is guiding related. In addition, there is typically a 0.05 degree drift in rotation during a 30 min track around the guide star (field rotation is open-loop on SALT by design). At the edge of a field this corresponds to a spatial drift of 0.4".

Solutions to these issues are being investigated, but as yet it is difficult to estimate when and to what accuracy will the situation improve. SALT Ops will inform the community when guiding accuracy improves, and whether e.g. a different approach with reference star peak-up becomes necessary. *For this Period, MOS will remain to be offered on shared-risk basis*. In particular we suggest the following:

- We ask that any MOS proposal would indicate what level of accuracy in alignment is required over the duration of a single observation. If re-alignments are necessary, note that more acquisition overhead is required.
- Programs which can accept the positional inaccuracy on-sky as given above are encouraged, e.g. those with fairly wide slits and/or bright objects. While the inaccuracy exist, these programs would be favoured operationally.
- More challenging programs may also be submitted, and it is up to the individual TACs to decide how to allocate their time. However, we cannot guarantee that these programs will be attempted during the Period.

7.4.5 Polarimetry Imaging/Spectropolarimetry

All polarimetric modes are currently unavailable due to problems with the Wollaston beamsplitter mosaic. No polarimetry proposals will be accepted in the current proposal call.

7.4.6 High-speed Spectroscopy/Frame Transfer

This mode of operation ensures moderate time resolution (a few sec) and no dead time. It only works with the FAST readout speed.

In Frame Transfer mode a mask covers the lower half the detector (all three chips). At the end of each exposure, the image in the top half of the chip is rapidly (0.2 sec) shifted to the lower half where it is readout while the next image in the top half accumulates during the next exposure, thereby ensuring no dead-time.

A list of the minimum exposure times for frame transfer in each binning can be seen in the third column of Table 10.

Frame Transfer spectroscopy is only currently available with the 1.5” slit, but please contact the SALT team should you require a different width.

Pre-binning	Slot Mode (sec)	Frame Transfer (sec)
1x1	0.70	20.0
2x2	0.30	8.4
3x3	0.20	4.7
4x4	0.15	2.0
5x5	N/A	2.6
6x6	0.08	2.2
7x7	N/A	1.9
8x8	0.07	1.7
9x9	0.05	1.6

Table 10: Minimum exposure times for Frame Transfer and Slot Mode for RSS.

7.5 Sensitivity

All RSS sensitivity calculations for planning observations should be done with the newest version of the RSS Simulator. PIs are warned that the RSS throughput below 400 nm is currently not as good as expected, the reason is not known. See Section 4.3 and Figure 5. for more information. **All current information on both the telescope and instrument throughput based on recent measurements is incorporated into the RSS Simulator.**

As a guideline, approximate magnitude limits at a mid-range wavelength for each grating are tabulated in Table 11. The limits have been calculated for 30-min exposures using the 1.5” slit, with 1.3” seeing at Zenith, in dark conditions, for an A0V type star (point-source). The numbers are applicable to long-slit and MOS observations. The magnitude limit here corresponds to signal-to-noise ratio of 5 per pixel in 2x2 binning over a 2 x FWHM aperture spectral extraction at the tabulated wavelength. As a crude rule of thumb for limiting magnitudes in good conditions, verified by actual observations, V=23 magnitude point sources can produce measurable flux in ~30 minute exposures with the PG900 grating and V=21 magnitude point sources with the PG3000 grating in blue settings.

Grating	Central λ (nm)	Resolution (λ/δλ)	Mag Limit (*V*)
PG0300	620	350	21.9
PG0900	605	1065	21.5
PG1300	665	1800	21.1
PG1800	677	2890	20.6
PG2300	566	3220	20.7
PG3000	434	3215	20.7

Table 11: Guideline RSS sensitivities in the middle of the ranges of the gratings. See Figure 6 for available ranges. The RSS Simulator tool should be used for more detailed calculations.

We also draw to the attention of RSS users that the current RSS Simulator may have inaccuracies up to 3–4 nm in its wavelength range predictions. The Simulator model is being updated, and it is hoped that a more accurate model will be available by Phase 2. However, at this stage, PIs are urged not to trust e.g. the CCD gap and edge locations to better than ±3 nm accuracy.

7.6 Guiding

The RSS auto-guider is routinely used for almost all RSS observations. Unfortunately, its sensitivity is limited to rather bright guide stars. The practical limit is *V* ~ 16 mag with 16.5 mag possible in good seeing. This is usually not a problem for long-slit work, but can be an issue for MOS and Fabry-Perot where the available field for selecting a guide star is much more restricted.

The nominal closed-loop tracking performance with a bright guide star is about 0.2” RMS. With fainter guide stars and longer integrations this can degrade to 0.4” RMS. Work is ongoing to improve this and to improve the sensitivity of the guide camera.

In addition to guiding in position, the RSS autoguider provides the ability to guide focus as well. This requires a bright guide star ($V < 15$) and good conditions to work reliably.

It is also possible to use SALTICAM as a guide camera in conjunction with the pellicle. The pellicle degrades throughput to RSS by ~5-7%, but this mode provides the ability to correct for drifts in field rotation. This may be especially critical for MOS observations and may be worth the loss of throughput. This mode is being explored and developed as part of MOS commissioning.

7.7 Blind Offsets/Nodding/Dithering

Our positional repeatability is currently 0.5” RMS as measured by performing offsets of sizes varying from 0.5” to 30” and returning to the original position. This accuracy is not sufficient for reliable blind offsetting, so for faint objects we recommend providing a brighter alignment object and a PA that will ensure placement of the fainter object in the slit.

This lack of repeatability greatly curtails our ability to do accurate nodding. Couple this with the lack of software to support it, it means we will not be offering nod-and-shuffle as an observing mode.

All of the comments and caveats about SALTICAM dithering that are discussed in Section 6.5 apply to RSS as well. The accuracy of the dithering is, again, limited currently to 0.5” RMS. For some purposes (e.g. Fabry-Perot), this is perfectly fine. For others (e.g. dithering between different slit positions), it may not be.

7.8 Calibrations

7.8.1 Features of RSS Calibrations

The RSS calibration plan (see section 7.8.2) is based on the SALT telescope specifications and on current experience. We would like to point out the following items:

- SALT is a telescope with a variable pupil so that the illuminating beam changes continuously during the observations. This makes it impossible to perform absolute flux calibration even using spectrophotometric or photometric standards.
- Our current experience shows that biases cannot be used for RSS data reduction. The overscan regions can be used, and they are in fact being used by the standard SALT pipeline.
- **Imaging Mode:** Everything described in Section 6.7.2 about SALTICAM flat-fielding also applies to RSS imaging.
- **Long-slit Mode:**
    - Unless reference spectra (arcs) are obtained immediately before, after, or between science observations, wavelength calibration solutions may shift up to 10-14 unbinned pixels: 0.5-0.7 nm for grating PG0900 and 0.1-0.2 nm for PG3000.
    - For reference spectra we guarantee that the RMS uncertainty of 2D wavelength solutions will be **at most** ½ of an unbinned pixel for most of the spectral setups: 0.025 nm for PG0900 and 0.008 nm for PG3000.
    - Due to flexures of the spectrograph, spectra can have trends in their wavelength solutions of up to 1 unbinned pixel over the course of a track.

  - Each slit has some variations in throughput along the slit due to roughness in the slit edges. These variations are up to 10% row-to-row and can shift significantly due to spectrograph flexure and lack of mechanical repeatibility. To correct for this effect, spectral flats must be obtained immediately before or (preferably) after science frames.
  - Spectral pixel-to-pixel variations are also corrected using spectral flats. These corrections can decrease the background RMS for data up to 5%. At the same time "lazy pixels" can be corrected for up to 95% of their difference in sensitivity.
  - The map of spectral pixel-to-pixel variations is roughly constant with maximum of 10-20% variation over a week's time.
- **MOS mode:** MOS calibrations are equivalent to long-slit calibrations. Arcs and flats will be taken through the PI-specified mask. However, the spectrophotometric standard will be taken with a 4" long-slit using otherwise the same RSS configuration.
- **Fabry-Perot mode:** Ring calibration images using appropriate arc lamps are taken both before and after science data to define the wavelength calibration. The first ring calibration is used to calibrate the control software so that the etalon is accurately configured to the correct wavelengths. The second image is used later to measure the drift in wavelength calibration over time.

7.8.2 Current RSS Calibration Plan

The calibration plan (see Section 5.1 for definitions) for RSS for the upcoming semester is:

- No **DC** calibrations will be done
- No **LC** calibrations will be done
- **UCC** calibrations will be done by PI request and the PI will be charged accordingly. These include:
  - **Long-slit mode:**
    1. Observations of any reference arc spectra **before / in between / after** science observations. For each reference arc spectrum the PI will be charged approximately 120 sec because of the time it takes to configure the calibration system and the integration time required to obtain a good arc spectrum (often 60 sec). For increased efficiency, we recommend the arc observation to occur **after** the science. Arcs are normally taken for every program.
    2. Observations of 5 spectral flats **before / in between / after** science observations. For each set of 5 spectral flats the PI will be charged approximately 120 sec, which includes the setup, integrations and readouts. We recommend spectral flats be taken **after** science for efficiency. For clarity, we ask that the PI

clearly mentions in both phase-1 and phase-2 **whether or not** flats are needed.

- **UNC** calibrations can be done by PI request:
- **Long-slit mode:**
  1. Observations of one spectrophotometric standard star (3 exposures) per detector and spectrograph setup. These observations will be taken with the widest available long-slit (normally 4”). The star will be placed in the middle of the slit. This data will be acquired during the *next available* twilight. Note that arcs and flats are not normally taken for spectrophotometric standards (the sets coming with the science exposures should be sufficient). For clarity, we ask that the PI clearly mentions in both phase-1 and phase-2 **whether or not** spectrophotometric standards are needed for the science. Finally, note that if a specific standard star needs to be observed, or the PI wants arcs/flats with the star, these are charged.
  2. Observations of one Lick standard star (3 exposures) per detector and spectrograph setup. The star will be placed in the middle of the slit. These data will be acquired during the *next available* twilight. See comments above.
  3. 5 spectral flats per detector and spectrograph setup taken during the day or twilight. These can be requested **instead** of, or **in addition** to, the charged UCC flats taken during the night time after the science frames.
- **Imaging mode:**
  1. 5 calibration screen flats per detector and camera setup taken during twilight or day.
  2. 11 biases per detector setup.

- Any additional calibrations can be done upon PI request and PIs will be charged accordingly.

8. HRS

The SALT HRS is a dual-beam (370-550 nm & 550-890 nm) fibre-fed, white-pupil, èchelle spectrograph, employing VPH gratings as cross dispersers. The cameras are all-refractive. The concept is for SALT HRS to be an efficient single-object spectrograph using pairs of large (350 µm to 500 µm; 1.6-2.2 arcsec) diameter optical fibers, one for source (star) and one for background (sky). Some of these will feed image slicers before injection into the spectrograph, which will deliver resolving powers of R ~16,000 (unsliced 500 µm fibres), ~37,000 (sliced 500 µm fibres), and ~67,000 (sliced 350 µm fibres). A single 2k x 4k CCD will be sufficient to capture all the blue orders, while a 4k x 4k detector, using a fringe-suppressing deep-depletion

CCD, will be used for the red camera. Complete free spectral ranges are covered by both the blue and red arms.

HRS construction began at Durham University's Centre for Advanced Instrumentation in late-2007 and it is scheduled to begin science commissioning on the telescope by late 2012. An Expression of Interest call will be released in May 2012 inviting submission of HRS commissioning proposals with observations anticipated to start later in 2012.

9. BVIT

The Berkeley Visible Image Tube camera (BVIT) is a visitor instrument built at the Space Science Laboratory of the University of California-Berkeley. It is a photon-counting camera with a 2 arcmin field of view, capable of very high time resolution (millisec or microsec) photometry. Some commissioning observations have been successfully carried out already, but BVIT is not yet available as a facility instrument; therefore, no proposals for this instrument are being solicited in the current call.

10. Overheads

All SALT Phase-1 proposals *must* include the overhead times associated with the science observations in the proposed time. The most accurate way to estimate overheads is to use the PIPT tool to build actual Blocks to see how long their execution times are. While Block preparation is not required at Phase 1, the exercise is strongly encouraged to check how feasible the science observations are regarding track times and Block limitations (see Section 2.3) when overheads are included. The main sources of overheads are summarised in Table 12 as well for PIs to get an idea of the involved times. PIs must be especially aware that in addition to pointing and acquisition related overheads, there may be calibration related overheads. The latter may or may not be charged for (see Sections on Calibration Plans, 6.7.2 and 7.8.2), and may or may not affect the available time for science during a track time (e.g. arcs taken after an observation vs. arcs in-between observations).

Please note especially that the basic acquisition time including pointing, focusing, object acquisition, and guidance configuration ***has been decreased from 900 sec to 600 sec*** in all instrument modes ***except MOS***.

Item	**Time (sec)**	**Comments**
SALTICAM		
Acquisition w/ guiding	600	point, acquire, guide
Acquisition w/o guiding	300	point, acquire
Dither move	30	with ~0.5” accuracy
Filter change	11	
Readout, Full Frame, Slow	9.0, 21, 53	6x6, 2x2, 1x1
Readout, Full Frame, Fast	8, 14, 26	6x6, 2x2, 1x1
Readout: Frame Transfer	0	minimum exp.times apply
Readout: Slot Mode	0	minimum exp.times apply
RSS		
Imaging acquisition	600	point, acquire, guide, RSS config
Long-slit acquisition	600	point, acquire, guide, RSS config
FP acquisition	600	point, acquire, guide, RSS config
MOS acquisition	900	point, acquire, guide, RSS config
Full RSS config change	240	
Grating angle change	15	
Filter change	45	
Slitmask change	60	
Articulation movement	71, 38, 142	100 → 0 , 50 → 0 , 100 0
Nod along slit, blind offset	60	with ~0.5” accuracy
Arc	120	Cal.sys insert + 1 x 60s frame
Spectral flat	120	5 frames, Cal.sys already inserted
Readout Full Frame, Slow	7.3, 17.7, 27, 51	4x4, 2x2, 1x2, 1x1
Readout Full Frame, Fast	6.0, 11, 14, 25	4x4, 2x2, 1x2, 1x1
Readout: Frame Transfer	0	minimum exp.times apply
Readout: Slot Mode	0	minimum exp.times apply

Table 12: SALTICAM and RSS overhead estimates.

11. Policies

11.1 Proposal Types

An individual observing program will consist of a number of observations of different targets and will be assigned a set of priorities and Moon brightness by the relevant TAC(s). Each partner TAC will have the same breakdown in terms of the percentages of different priorities, and all observations are charged in the same manner. The priorities just influence the likelihood of a given target being observed on a particular night or over several nights.

Priority 0

Highest rated Targets of Opportunity (ToO) programs or time critical observations. Once scheduled, and weather permitting, Priority 0 observations will have the highest chance of being observed at the time requested. Examples of such observations might include supernovae, GRBs, and rare periodic phenomena.

Any proposal can consist of time critical observations, but only ones allocated a P0 priority will in general be observed in preference to other priority classes.

Priority 1

Highest rated proposals, which, if scheduled, will have a high chance of being observed in a given night. Such targets will be the most scientifically compelling of all standard priority targets and completion of all P1 programs in a given semester is expected. P1 proposals represent 13.33% of those submitted and 20% of those eventually observed.

Priority 2

P2 programs are not as highly rated as P1 by the TACs, but are still considered to be compelling and will have a good chance (>90%) of being completed in a given semester. P2 proposals represent 20% of those submitted and 30% of those eventually observed.

Priority 3

P3 programs are lowest priority science as assigned by the TACs, but still worthy of consideration. P3 proposals are deliberately over-subscribed by a factor of 2 in order to always have a full queue, and so will have a 50% chance of being observed in a given semester. Because of the nature of such dynamic scheduling the easiest P3 proposals are the ones that are likely to be observed in a given night. P3 proposals represent 66.66% of those submitted and 50% of those eventually observed.

Priority 4

This is a newly created priority class designed to consist of “filler” targets, to be done in marginal observing conditions (i.e. poor transparency or bad seeing), not strictly 10-m class science, but deemed to be useful in such degraded conditions. P4 programs *will not be charged*.

PIs should justify in the application (technical section) why their proposed programs should be considered P4 time (e.g. brightness, observing mode, allowable conditions). TACs will accept or reject the P4 proposals as they see fit. Accepted P4 programs are not guaranteed to be completed in a given semester and observations of P4 programs will only ever be attempted if, at the duty SA’s discretion, there are no other viable P0 - P3 programs that can be attempted instead.

11.2 Time Allocation

SALT proposals can only be submitted by astronomers who are members of a SALT consortium institution, or are collaborating with such astronomers. Time can be requested from different SALT partner TACs according to the nature of the collaboration and it is entirely up to the PI and Co-Is to decide what fractions are requested from each TAC. It should be noted, however, that some TACs may look with disfavour on proposals from other partner institutions which request the majority of time from them if the respective Co-Is are minor players in the collaboration.

11.3 Long-term Programs

Programs that are foreseen to extend over multiple semesters will need to be re-applied for and details on the progress of such programs must be provided in the proposal.

11.4 Time Charging

At the present time observing time is charged on the basis of completion of *requested* observing blocks as they appear in the PIPT and SALT Web Manager. It is anticipated that a more realistic time-keeping of *actual* observing time used will be implemented in the near future, but this is currently awaiting the implementation of the required software.

11.5 Phase 1 Policies

Details of the requirements for Phase 1 proposals are outlined in a separate document. Once TACs have approved proposals and allocated time according to priority class and Moon brightness, the Phase 2 proposals have to be completed adhering to these allocations. In addition, targets (mandatory or optional) cannot be changed between Phase 1 and Phase 2 unless agreed to by the relevant TACs.

11.6 Phase 2 Policies

For a Phase 2 proposal, the PIPT will ensure that:

- It does not require more observing time than allocated by the TAC
- It does not contain any observation blocks with sky conditions *tighter* than those requested during Phase 1 and approved by the TACs. Conditions may be relaxed, however.

When an imported proposal exists on the user's computer already, the version on the computer will be replaced with the imported one. Naturally, the user shall be warned beforehand.

Submission of Phase 2 proposals should be done at the earliest opportunity following confirmation of proposal acceptance by the TAC, and ideally by the stipulated deadline, although later submissions are permissible for programs whose targets are not immediately available to observe at the start of the semester.

All accepted SALT proposals will be assigned a Liaison SALT Astronomer (LSA) who will be the main point of contact between the PI and SALT Ast Ops. Communications regarding the completion of the Phase 2 proposal, the status of the proposal and and issues regarding the observations and data should be communicated with the LSA in the first instance (please refer to Section 11.7).

11.7 Communications with SALT Astronomy Operations

All communications with SALT Ast Ops should be via email (or telephonically in urgent cases, like ToO alerts) primarily to the SALT Help email address (*sa@salt.ac.za*). In all cases relating to existing proposals it is imperative that the assigned proposal code is included in the subject of the email. This will ensure that Ast Ops staff are aware of a request or query even if the particular Liaison SA is unavailable.

11.8 ToO Alerts

For activation of ToO programs, PIs should communicate their request to *salthelp@salt.ac.za*. For short notice or urgent real-time alerts, the SALT control room telephone number (+27 23 5711356) can be used to contact the duty SA directly.

11.9 Data Distribution

The PI has two options for data distributions: Normal and Fast. All data will be made available at *ftp://saltdata.salt.ac.za/* and is accessible by the contact-PI logging onto that site with their Web Manager username and password.

For "Normal" data distribution, the PI will receive an email when the data has passed through the pipeline in Cape Town. This will typically be within 24 hours of the observations, but may be up to one week later. The PI will receive the raw data, processed data, and documentation including the night log. Information about the current status of the process data can be found at:
https://wiki.salt.ac.za/index.php/SALT Data Quality

The data will only be guaranteed to be on the ftp site for two weeks. All data should have been downloaded by that time, but if necessary, the user should contact *salthelp@salt.ac.za* for further access to their data.

For "Fast" data distribution, the raw data will be made immediately available along with any quicklook product. Once the first observation has been taken for the proposal during a night, the contact-PI will be notified that observations are being made for their proposal. Due to limits on bandwidth and data processing, we ask that only proposals that would truly benefit from this high response time select this option.

Data Proprietary Period

The proprietary period of the data will be decided by each individual partner. At this time, none of the partners have yet specified a proprietary period. The PI may specify any proprietary period for their data - we suggest an 18 month proprietary period.

11.10 Publication Policy

Publications

Please notify *sa@salt.ac.za* of any publication made using SALT data including reviewed papers and conference proceedings.

Science Paper Acknowledgements

All science papers that include SALT data which are submitted for publication in refereed science journals must include the following words of acknowledgment:

> *"All/some [choose which is appropriate] of the observations reported in this paper were obtained with the Southern African Large Telescope (SALT)."*

In addition, a footnote symbol should appear after the paper title*, and the following text should be written as a footnote:

> **based on observations made with the Southern African Large Telescope (SALT)*

If possible, please include the Proposal Code and Principle Investigator for the observations in the paper.

If you use data reduced by the SALT science pipeline or use the PySALT software, please provide a link to http://pysalt.salt.ac.za/ and cite the following paper:

Crawford, S.M., Still, M., Schellart, P., Balona, L., Buckley, D.A.H., Gulbis, A.A.S., Kniazev, A., Kotze, M., Loaring, N., Nordsieck, K.H., Pickering, T.E., Potter, S., Romero Colmenero, E., Vaisanen, P., Wiliams, T., Zietsman, E., 2010. PySALT: the SALT Science Pipeline. SPIE Astronomical Instrumentation, 7737-82