SALTeNEWS

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1. Introduction

In order to improve communications with SALT partners, SALTeNEWS is being resurrected after a long hibernation. We're aiming to distribute this monthly to provide some feedback on developments at SALT. This first issue will be a bit longer than usual, given the hiatus, and incorporates some of the information included recently in a report to the SSWG and Board Executive. This (and an earlier) report can be accessed from our website under the "partners" webpage:
http://www.salt.ac.za/partners-login/partners/salt-status-report/
It is designed to give astronomers in the SALT consortium an up to date picture on the performance of SALT and its instruments.

As many will have noticed, the SALT website has been renovated and the addition of the partners webpages provides an opportunity to look at examples of SALT data, current engineering issues (e.g. image quality), calibration data, etc. Sample FITS data can be downloaded for inspection from the "data quality" pages, with the aim being both to provide a familiarity with SALT data formats and an opportunity to give *us* feedback and opinions. Such communications can be sent to myself or to the general SALT Astronomers email account, sa_internal@salt.ac.za.

Updates on the proposal process and additional information appears from time to time on the "proposals" webpages, including the latest deadlines for submission. Due to the various tasks still needing to be completed before embarking on significant science observations, the call for additional proposals for the Performance Verification phase has been indefinitely postponed. This also implies that the start of "full semester" operations, where partners will be charged for observing time, has not yet been defined. More details appear later in this newsletter.

2. Completion

While the last half of 2005 saw significant milestones achieved, including first light, first science and the inauguration of the telescope, the process of commissioning and "completing" the telescope and instruments was *not* finished, at least in terms of handing over a fully tested system complying to the various specifications. Although basic telescope and instrument functionality was achieved (e.g. being able to point & track, obtain focussed images, albeit not perfectly), a variety of issues preventing us from completing telescope and instrument commissioning and moving on to the full Performance Verification phase. These are discussed in more detail in the reports, but in summary the following items have been the major obstacles to overcome before routine science is possible:

- Telescope image quality (to specification, including size, shape and uniformity over the field and stable over time)
- Completion of crucial Payload subsystems (e.g. auto-guidance/auto-focus, calibration system, moving baffles)
- General telescope functionality and reliability (particularly the Tracker, TCS and Payload)
- Completion of SALTICAM modifications and guidance system.
- Completion of outstanding RSS tasks.

While we hesitate to put completion dates on these tasks in light of our past experiences with schedule slips and because of the dependencies between jobs, we are confident of making significant progress over the coming few months. Some of the above tasks are clearly tractable and good progress is already being achieved in some areas (e.g. Payload, TCS). The timescale for solving others are less clear at this time (e.g. image quality).

In order to ensure rapid progress in solving these remaining problems, top priority is being given to them in terms of allocating night time hours. Of course we only discover many problems when actually trying to observe "in anger", so image quality testing on sky, and commissioning or P-V observations, when appropriate, are invaluable in identifying such problems. We have decided to focus night time efforts around full Moon on engineering tasks, particularly SAMS work and software bug fixes. For the rest of the time image quality testing and other commissioning work (e.g. guidance probe mapping, calibration system characterization, instrument performance characterization) takes precedence.

A recent development has been concentrating software effort into intensive week-long activities at site when the entire software team is present, assisted where necessary by other engineering and astronomy operations staff. One such week was held in February, which also involved the Tracker contractor (RRS), during which many latent defects and minor design changes to the GUI were addressed. Progress in the maturity and reliability of the TCS software is therefore being made, and should continue to be. This software effort, coupled with engineering work in a number of subsystems, including instruments, will culminate in a series of system level tests to check functional performance of SALT against its specifications.

3. Postponing Proposal Submission

In light of the continuing completion and commissioning work on SALT and its two current instruments, SALTICAM and RSS, it has been agreed with the SALT Board Executive Committee to postpone, indefinitely, the next call for SALT Performance Verification (PV) proposals. While there has been progress in certain areas, we feel that it is premature to attempt full science observations until such time as the telescope is able to properly support this. Once commissioning programs have been completed and at least some of the existing approved PV programs attempted, we will have a much better idea on expected performance at which time it would be appropriate to call for new PV proposals.

The original March 19 deadline for new PV phase proposals has therefore fallen away and those PV proposals already submitted will be held over until the next proposal round. Existing approved or postponed PV programs will be attempted when the situation allows, and the relevant SALT Astronomers assigned to these programs will contact the PIs in due course. This will initially be done to request target updates and later to use the Phase II tools, when they become available. The TAC will also consider those programs, submitted previously, involving those RSS modes other than Long-Slit spectroscopy (i.e. MOS, Fabry-Perot, polarimetry), that were postponed.

There are currently 46 accepted SALTICAM PV programs on the books and 62 RSS programs, of which the majority (42) are for Long Slit spectroscopy. Together with the commissioning programs, we easily have enough to see us through the Performance Verification phase, although some targets will need to be updated where possible.

4. Instrument Performance

The current status of the SALT instruments are summarized in the following sections, which highlight the remaining work to be done before routine full science operations are possible. Further developments and details will appear in future issues of SALTeNEWS.

4.1 SALTICAM

SALTICAM, in its Acquisition Camera and Science Imager (ACSI) mode, has both the functionality of a sensitive acquisition camera, supporting other instruments on the telescope, and a broad-band UV-visible (320-900 nm) CCD imager. The instrument was installed in June 2005, and commissioning began at the end of August. The initial observations supported both "first light" and "first science" observations with SALT. However, early in its operation, a number of problems and deficiencies became apparent, which are itemised here:

- faulty motor encoding in dual drive focussing system
- unreliable filter change mechanism
- frame transfer mask mechanism not correctly positioning mask (fixed)
- pattern noise on CCDs (mostly fixed)
- communication errors (fixed)

In addition, the SALTICAM autoguider was not completed, necessitating open loop guiding and therefore restricting the length of exposures. Effort has gone into improving SALTICAM's operational performance, and major modification work is scheduled for mid-year when the autoguider is installed. SALTICAM will then complete its full Acceptance Testing, and the be available for full science operations.

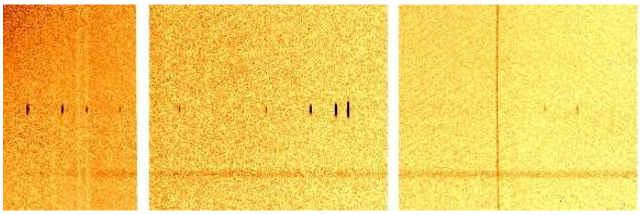
4.2 Robert Stobie Spectrograph (RSS)

The Robert Stobie Spectrograph (RSS), formerly known as PFIS, is a complex multi-purpose imaging spectrograph, with a variety of operational modes. Commissioning of the major modes of RSS was not completed, in fact hardly began, before the departure of the RSS team (Eric Burgh, Ken Nordsieck, Naseem Rangwala, Mike Smith and Ted Williams). The instrument responsibilities have been handed over to SALT Operations/SAAO, and Dr Stephen Potter (SAAO) has assumed local responsibility for the instrument. Together with SALT Operations staff, he has been continuing the process of commissioning RSS, specifically the Long Slit Spectroscopy mode. Once the telescope is in a more stable and reliable state, and following the commissioning of the crucial Prime Focus Payload subsystems and upgrading of the TCS, members of the RSS instrument team will return to assist in the commissioning of the remaining modes (i.e. Fabry-Perot spectroscopy, multi-object spectroscopy, polarimetry).

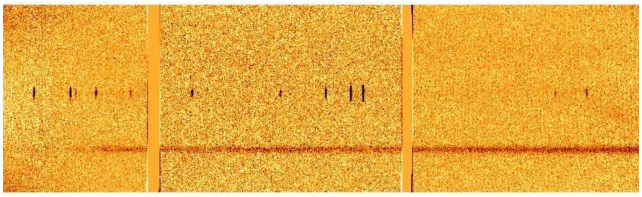
While the instrument has been "handed over" to SALT Operations in terms of responsibility to continue the commissioning work, this does not imply final acceptance of RSS. This will only occur following the completion of the acceptance testing, which follows from the completion of commissioning of all the modes originally agreed to be commissioned by the RSS team. For the purposes of accounting, RSS is considered to have completed its construction phase, but is still in the middle of commissioning.

There are a quite a number of items that need to be completed on RSS, which are being addressed by the Instrument and Operations teams. One of the more pressing items is the slitmask exchange mechanism, which has been prone to jamming. While some Long Slit spectroscopy data has been obtained of brighter objects, full commissioning of this mode is hampered by several things, which are currently being addressed:

1. inaccurate offset pointing from the guidance probes (requires completion of mapping)
2. inability to have common focus between slit viewer and acquisition images (will be addressed when SALTICAM position is moved and its focus system fixed)
3. reliability of slitmask mechanism



Example of a raw 300 sec "long-slit" RSS spectrum (360-600nm) of a B=16-17 PNe.



Same spectrum after wavelength calibration and background subtraction.

Other examples of SALT data can be seen on the "data quality" webpages, and will be updated from time to time. Many of the commissioning programs (in progress) aim at comparing SALT data with other telescopes, and we aim at posting such comparisons on these pages as and when they become available.

5. Image Quality Investigation

The single biggest factor affecting our ability to do scientifically meaningful observations is obtaining good image quality over the entire science field of view (i.e. 8 arcmin diameter), and retaining it over the timescale of a track. This whole newsletter could be devoted to this topic, so those interested in the current status should look closely at the relevant webpages, in particular:
http://www.salt.ac.za/partners-login/partners/data-quality/image-quality-investigation/

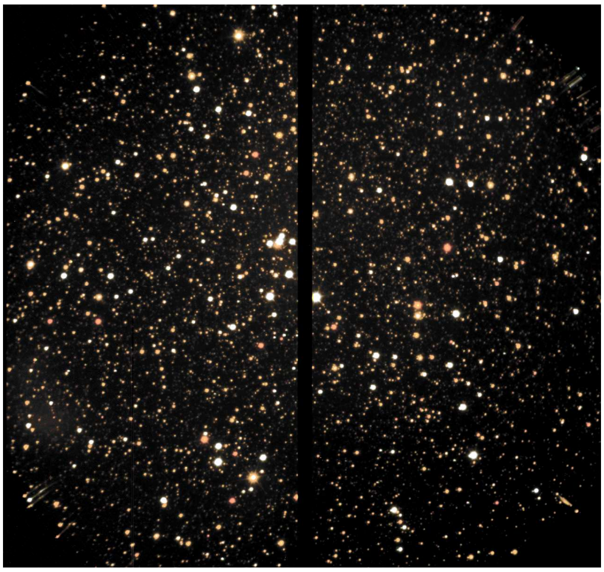
Examples of data are also present on those webpages.

The image quality (IQ) investigation is being led by Dr Darragh O'Donoghue, and supported by SALT Astronomy Operations, who have been responsible for gathering the required data. Details of the plan appear on the webpages, as well as the current conclusions which have been drawn. In a nutshell, we see the following:

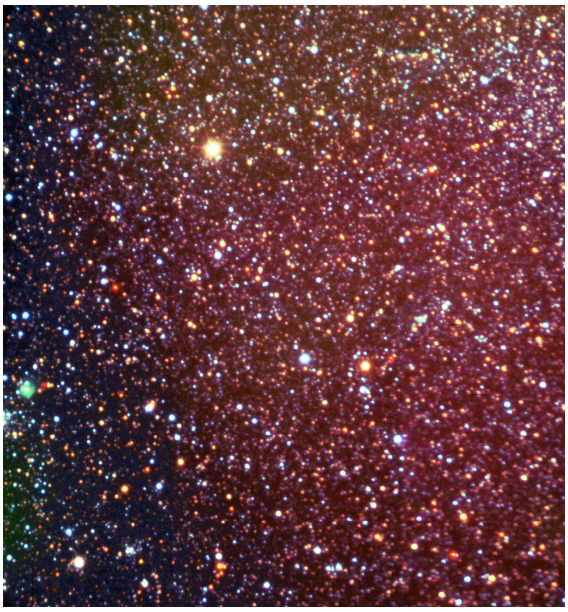
- Image quality close to specification at times, but usually only in a restricted region
- Field dependent aberrations, particularly astigmatism (elongation) and defocus
- The above appear to be fixed on the sky (i.e. they don't rotate with the instrument detectors)
- Similar behaviour is seen in both SALTICAM and RSS images
- Most of the IQ degradation seems to be caused by the non-rotating optics (i.e. the primary mirror array + SAC combination)

One of the major suspects in this is turning out to be the primary mirror array, due to the fact that it is the one inconstant item (in terms of alignment), and is possibly related to the methodology of CCAS alignment, although this is far from certain.

Despite these problems, it is encouraging that good IQ has been obtained from time to time, witness the “first light” images of the cluster NGC6152 and the SMC, and more recent IQ tests (17 Feb 2006). Images as good as ~1 arcsec FWHM have been obtained in seeing conditions of ~0.8 arcsec (measured by DIMMs), indicating performance close to specification (i.e. telescope error budget of ~0.7 arcsec FWHM). We are therefore optimistic that fundamentally the telescope IQ performance will eventually be met.



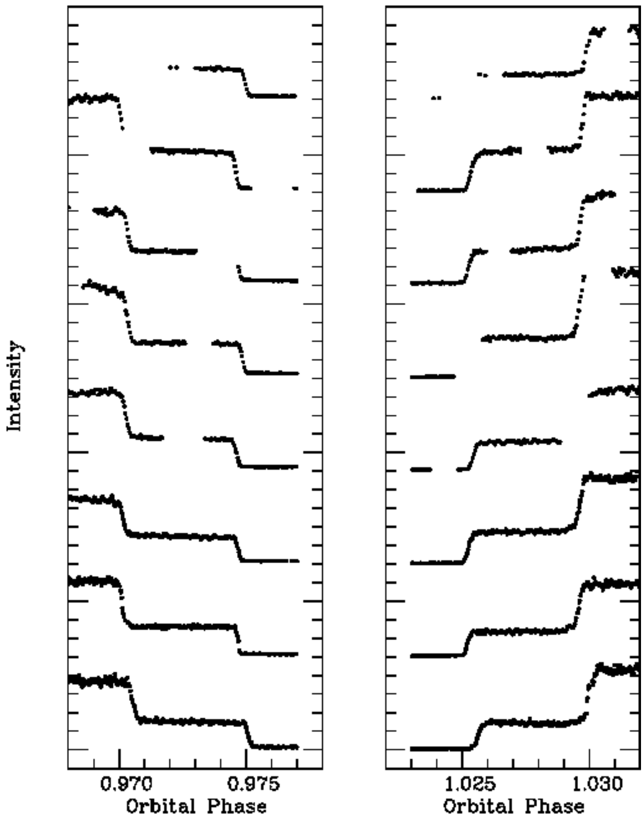
First light image of NGC6152



Composite BVI Image of part of the SMC

6. First Science

Scientific observations with SALT commenced in August 2005, with SALTICAM commissioning led by Dr Darragh O’Donoghue. One of the first programs attempted was high time resolution photometry of eclipsing magnetic cataclysmic binary stars, also known as *polars*, or *AM Herculis* stars. These objects emit the bulk of their luminosity through accretion onto a magnetic white dwarf. ‘Hot spots’ on the surface emit in the UV-visible region through reprocessing of X-ray bremsstrahlung and optical-IR cyclotron radiation in the white dwarf’s photosphere, and are located at, or near, the magnetic poles. High time resolution (ranging from 112 to 285 ms) eclipse curves of unprecedented quality were obtained for one such polar, a recently discovered deeply eclipsing (V ~ 20 at minimum) system, with a 1.45 h orbital period. In the figure below we show a montage of the eclipse ingress and egress curves, obtained in August and September 2005.



SALTICAM light curves of an eclipsing polar. The steps in the eclipse ingress/egress curves are due to the successive covering/uncovering of two hot-spots by a faint companion star.

These data clearly demonstrate that the bulk of the luminosity (~ 95%) comes from two hot-spots, located close to both magnetic poles, while the remaining light comes from the white dwarf photosphere and the accretion stream. The ingress/egress light-curves resolve the hot spots themselves, and have been used to determine their dimensions and extent. The white dwarf star is roughly the size of Earth, while the hotspots are typically the size/extent of Greenland or Japan.

A paper presenting these results and an analysis of them was submitted for publication late last year – the first to feature SALT data.

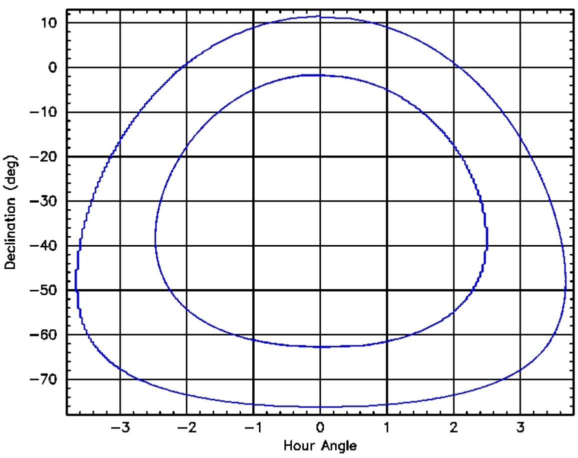
7. Miscellaneous Information

From time to time we will provide information that may assist potential SALT users in planning their observing programs. This issue features some updates on the visibility and track times for SALT.

7.1 Track Times

An important specification for the telescope is the amount of available observation time, which is dependent on Declination. This is determined by the structure tilt angle and the characteristics of the tracker motion in X (tracker bridge motion), Y (payload motion) and tip/tilt (hexapod). The tracker X,Y ranges are ± 1.6 m, and the hexapods can tip and tilt the payload by ± 6°.

The SALT visibility annulus, below, determines the maximum possible observation time of a target, which is dependent on both Declination and Hour Angle when the target is acquired.

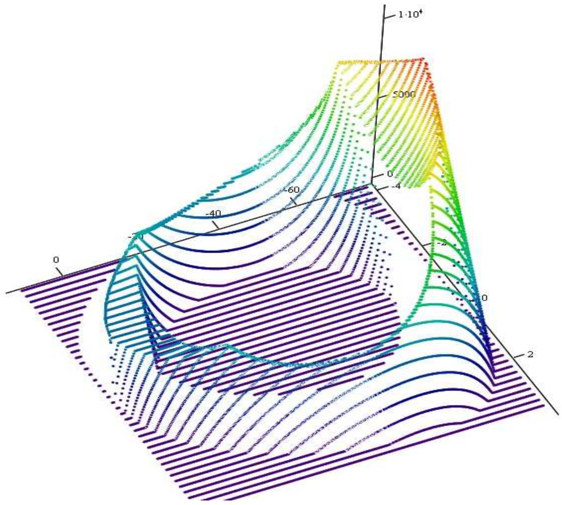


SALT Viewing Annulus

Recent simulations have been conducted to produce a track time "surface", where maximum track time is measured on the z-axis, and the x & y axes correspond to Declination and Hour Angle. The actual track time is also dependent upon the azimuth of the structure, which can be a free parameter, depending on the following:

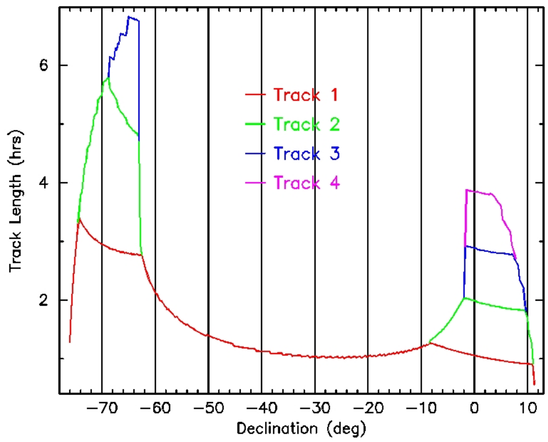
- whether the total track time is being maximized
- whether the effective pupil size is being maximized

For most declinations the maximum track time is obtained by ensuring that the chosen azimuth is that applicable to when the target enters the visibility annulus the soonest, either as it rises into the Eastern side at the lowest altitude (47°), or sets into the Western side at the highest altitude (59°). The plot below shows the SALT tracking "surface".



Tracking surface as a function of Declination and Hour Angle at which the target is first acquired.

Track times have been derived from simulations using the TCS software, which in turn takes its software limits from the Tracker Computer. These track times are dependent on the Declination and in the figure below, we show the maximum track time as a function of Declination. For objects in the range to –8º to –62º, there is only one optimal azimuth position for maximizing track length (when first acquired), and the track length for this fixed azimuth is shown as the red "Track 1" curve in the diagram below.



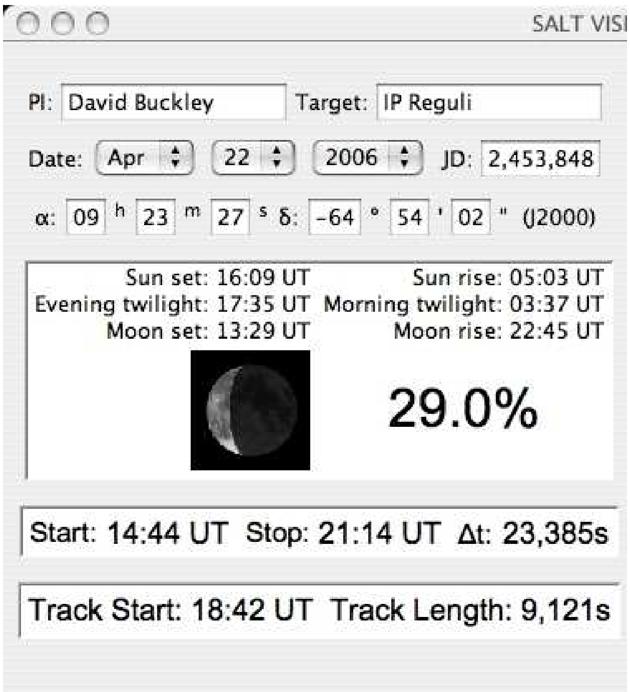
Potential total track times assuming the azimuth is chosen to ensure the earliest acquisition of a target (red), and then allowing for subsequent azimuth moves to the West, where appropriate (1 move = green, 2 moves = blue, 3 moves = purple).

The amount of observation time available on objects at the extreme south/north declination limits (–62° to –74° and –2° to +10°) can be increased by moving the structure in azimuth and re-acquiring the object. This can potentially increase the available observation time by nearly a factor of two at these extremes, as demonstrated in the previous diagram for tracks 2, 3 & 4.

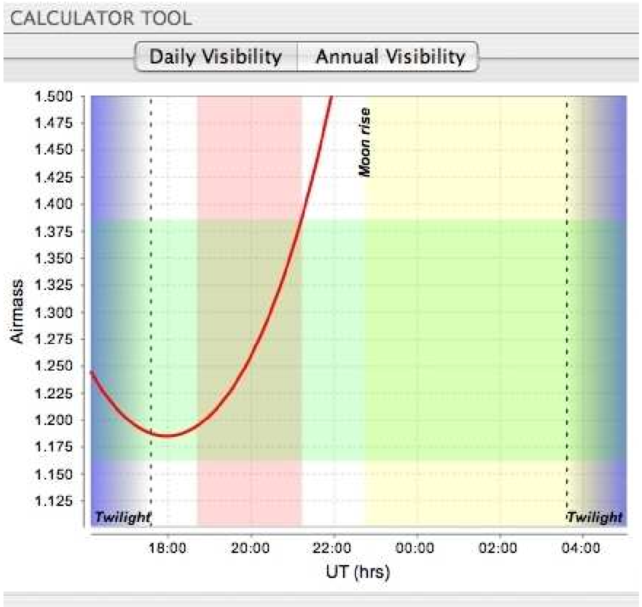
7.2 SALT Visibility Tool

The recently revamped "SALT target visibility tool" (see: http://www.salt.ac.za/proposing/observation-planning-tools/), a Java application written by Dr Martin Still, one of the SALT Astronomers, allows PIs to calculate not only when their objects are visible, but also estimate the actual track time available. This tool, which is still under development, can be used for a specific target on a specific date.

Useful information (e.g. sunrise/sunset, twilight, Moon phase, etc.) is shown on the left side of the GUI (shown below), together with the UT times when the object is visible to SALT, and the track length for a given start time.



Users can enter coordinates and dates in the GUI and are then click on an interactive Airmass – Time plot, on the right, at some specific time that an object is acquired. The total available track time is then displayed as a vertical column, shaded in red, and the maximum available "Track Length" (assuming no telescope azimuth move) is shown, together with the "Track Start" time. Moving the mouse to a different start time is possible, and the plot is refreshed with a revised "window" and start time/track length. This interactive plot is shown here:



The green horizontal shading indicates the SALT altitude limits, in terms of airmass, and the red line shows the object's trajectory. The vertical yellow shading indicates when the Moon is above the horizon, while the red shading is the maximum track time for the object, when acquired at the time defined by left limit of the red shaded area. The vertical dashed lines indicate the end/start of astronomical twilight.

8. The "Back Page"

In keeping with SALTeNEWS tradition, the final SALTeNEWS item is more informal. In this issue we show off some "formally" attired persons, present at a Technology Awards dinner (see www.tt100.co.za), held in Johannesburg in November 2005. The SALT Project won a special award from the Minister of Science and Technology entitled "the adjudicator's honorary ambassador award for technology and innovation". Present at the award were members of the SALT Project Team, SAAO and representatives from the SALT contractors BKS (Structure & Dome) and TFD (Building Management System).

SALT delegation at the TT100 Awards dinner. From left: David Buckley, Darragh O'Donoghue, Gerhard Swart, Bob Pullen (BKS), Sarel Venter (TFD), Jian Swiegers, Phil Charles and Kobus Meiring.